STATE OF FLORIDA

DEPARTMENT OF ENVIRONMENTAL REGULATION

TWIN TOWERS OFFICE BUILDING
2600 BLAIR STONE ROAD
TALLAHASSEE, FLORIDA 32301-8241

BOB GRAHAM
GOVERNOR

VICTORIA J. TSCHINKEL
SECRETARY

August 9, 1985

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

Mr. A. L. Chiles, Jr.
Lonestar Florida Pennsuco, Inc.
P. O. Box 122035 - PVS
Hialeah, Florida 33012

Dear Mr. Chiles:

We have reviewed your July 23, 1985 request for higher emission stardards for Lonestar's No. 3 kiln. This office was involved in establishing the emission standards for the No. 3 kiln. The standards were based on the data supplied by Lonestar in both their July, 1980 application for the permit to construct and the November, 1982 request to increase the allowable sulfur dioxide emissions for all three kilns. We believe the kiln, as it was being operated at that time, would meet the emission limits established by the Best Available Control Technology determination and listed in the revised construction permit AC 13-054054.

The attachments to your July 23 letter described modifications that have been made to the kiln since the construction permit was issued. The major modification was a change in the method of operation to manufacture a different product which required a different mix of raw material, more fuel per ton of product, and higher kiln temperatures. It was also noted that the sulfur content in the raw material has increased. Each of these changes increased the potential of the kiln to emit air pollutants. Lonestar should have applied for a permit to modify the kiln prior to manufacturing a new product. We understand that the kiln, as it is presently operated, cannot comply with both the sulfur dioxide and nitrogen oxide emission standards simultaneously.

The construction permit for this kiln that authorized the use of coal has expired. A construction permit does not authorize commercial operation of an air pollution source prior to confirming compliance with the emission standards and submitting a complete application for permit to operate. If Lonestar is unable to comply with the conditions in the construction permit, then the continued operation of the kiln is in violation of state permit No. 13-054054 and the air pollution control regulations. If Lonestar believes the kiln must be operated out of compliance with the regulation, then the Company should try to negotiate a Consent Order with the Department.

Also, as the method of operation of the No. 3 kiln has changed, it is not appropriate to amend the expired state construction permit. If Lonestar plans to operate the kiln under different circumstances than the data in the 1980 application for permit to construct was based on, as was stated in attachment to your July 23 letter, then the Company needs to submit a complete, new, application for permit to construct to the Department. The application would have to address all criteria pollutants and, if any pollutant has a significant net emissions increase, would be subject to the PSD regulations. This requires a BACT determination for each criteria pollutant that has a significant net emissions increase.

By copy of this letter, we are notifying EPA of the status of the No. 3 kiln so that they may take whatever action is appropriate for violations of federal permit No. PSD-FL-050.

If you have any questions on how to proceed in resolving this matter, please call Willard Hanks or write me at the Department's Tallahassee address.

Sincerely,

C. H. Fancy P.E.
Deputy Chief
Bureau of Air Quality
Management

CF/WH/p

cc: James T. Wilburn
Roy Duke
Dade County

P 085 152 633

RECEIPT FOR CERTIFIED MAIL

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Restricted Delivery Fee	
Return Receipt Showing to whom and Date Delivered	
Return receipt showing to whom, Date, and Address of Delivery	
TOTAL Postage and Fees	$
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PS Form 3800, Feb. 1982

PS Form 3811, July 1983

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2. ☐ Restricted Delivery.

3. Article Addressed to:

Mr. A. L. Chiles, Jr.
Lonestar Florida Pennsuco, Inc.
P. O. Box 122035 - PVS
Hialeah, Florida 33012

4. Type of Service:

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Article Number: P 085 152 633

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X

6. Signature – Agent
X [signature]

7. Date of Delivery

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8. Addressee's Address (ONLY if requested and ...)

PM
7-23-85
Miami, FL

LONESTAR FLORIDA PENNSUCO, INC.

Cement & Aggregate Plant
11000 N. W. 121 Way
Medley, Florida 33178
P. O. Box 122035 - PVS
Hialeah, Florida 33012
(305) 823-8800

DER
JUL 25 1985
BAQM

July 23, 1985

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Mr. James T. Wilburn, Chief
Air Management Branch
Enviromental Protection Agency
Region IV
345 Courtland Street
Atlanta, Georgia 30365

Re: EPA Permit No. PSD-FL-050
DER Permit No. AC13-054054
(Lonestar's Cement Plant - Miami Florida)

Dear Mr. Wilburn:

In reference to the above mentioned EPA and DER permits; and, also based on a comprehensive study by our consultant, Enviromental Science and Engineering, Inc., we are enclosing a request to revise the SO_2/NO_x emission limits for our Kiln #3, but maintaining the same limits for the Pennsuco Cement Plant.

Supporting computer model printouts are to be sent you under separate cover.

Lonestar respectively requests that these revised SO_2/NO_x limits be approved in order for us to operate an efficient kiln and produce good quality cements.....in our continuing efforts to "fight" foreign clinker and cement imports.

Sincerely,

A. L. Chiles, Jr.

A. L. Chiles, Jr.
Manager Engineering

ALC:gkf
Enclosures

cc: Messrs: C. H. Fancy
Tom Tittle
Art Bolivar/Patrick Wong

REQUEST TO REVISE SO_2/NO_x EMISSION LIMITS FOR KILN NO. 3
LONESTAR FLORIDA HOLDING, INC.
PENNSUCO CEMENT PLANT

Submitted to:

U.S. ENVIRONMENTAL PROTECTION AGENCY
Region IV
and
FLORIDA DEPARTMENT OF ENVIRONMENTAL REGULATION
and
METRO-DADE COUNTY DEPARTMENT OF
ENVIRONMENTAL RESOURCES MANAGEMENT

7/26
Patty -
This will be
a revision to
permit. Willard
did it last time

Prepared by:

ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
Gainesville, Florida

ESE No. 85-153-0100-2110

July 22, 1985

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 BACKGROUND INFORMATION

Lonestar Florida Pennsuco, Inc. was originally issued a Prevention of Significant Deterioration (PSD) permit for its Hialeah, Florida, portland cement plant by the U.S. Environmental Protection Agency (EPA) on July 8, 1980. The PSD permit (PSD-FL-050) was for the conversion of Kilns 1, 2, and 3 to coal. The permit specified certain emission limits for sulfur dioxide (SO_2) and nitrogen oxides (NO_x).

Subsequent to issuance of the PSD permit, Lonestar converted Kiln 3 to coal and also implemented energy-efficiency improvements in the kiln. The first compliance test was conducted in July 1981. This test showed compliance with the allowable NO_x emission limits, but the measured levels of SO_2 [506 pounds per hour (lb/hr)] far exceeded the allowable level (27.51 lb/hr) (see letter of January 5, 1982, in Appendix A). An additional compliance test and an in-house test were conducted by Lonestar in April and May of 1982. These tests displayed results similar to the first compliance test, with SO_2 emissions far exceeding the allowable limits (see letter of June 18, 1982, in Appendix A).

On the basis of these test results, Lonestar requested from EPA on November 19, 1982, a revision of its PSD SO_2 emission limits (see Appendix A). No revision of the NO_x limits were requested at that time. The requested SO_2 levels were 100 lb/hr for Kilns 1 and 2 each, and 400 lb/hr for Kiln 3. Based upon Lonestar's submittal, EPA revised Lonestar's PSD permit on December 28, 1984. The revised SO_2 limits were 125 lb/hr SO_2 from Kilns 1 and 2 each, and 400 lb/hr from Kiln 3. The revised permit required Lonestar to conduct a series of SO_2 compliance tests to demonstrate compliance with the revised standard. On March 22, 1985, the Florida Department of Environmental Regulation (DER) issued a construction permit (AC13-054054) which was consistent with the EPA PSD permit.

Compliance tests to demonstrate compliance with the revised PSD permit were conducted in May 1985. Although the tests showed compliance with the SO_2 emission limits, the margin of compliance was small. In addition, the tests showed that both the SO_2 and NO_x emission limits could not be attained simultaneously on a continuous basis. As a result of the recent source test results and the necessity of Lonestar to maintain clinker product quality, which restricts certain operating parameters within the kiln, Lonestar is now requesting a revision to the current SO_2 and NO_x emission limits contained in the EPA PSD and DER construction permits. Subsequent sections of this report discuss current permit conditions and their basis, production practices, historic test data, alternative control technologies, and the proposed emission limit revisions.

2.0 CURRENT PERMIT LIMITS AND REQUIREMENTS RELATING TO SO_2/NO_x

2.1 DER PERMIT NO. AC 13-054054
(ISSUED MARCH 22, 1985; EXPIRED MAY 28, 1985)

This DER air construction permit, issued for the conversion of Kilns 1, 2, and 3 to coal, specifies the following SO_2 emission limits:

Source	Max Emission Limit	Emission Limit
Kiln 1	125 lb/hr SO_2	5.0 lb SO_2/ton of clinker produced
Kiln 2	125 lb/hr SO_2	5.0 lb SO_2/ton of clinker produced
Kiln 3	400 lb/hr SO_2	4.6 lb SO_2/ton of clinker produced

In order to comply with the Dade County Ambient Air Quality Standards (AAQS) for SO_2, only the following fuel mixes are allowed and were defined as Best Available Control Technology (BACT):

	Fuel Mix			
Source	1	2	3	4
Kiln 1	Gas	Coal or Oil	Coal or Oil	Oil
Kiln 2	Coal or Oil	Gas	Coal or Oil	Oil
Kiln 3	Coal or Oil	Coal or Oil	Shutdown	Oil

Source emission tests were required to demonstrate compliance with the SO_2 limits and also to demonstrate no actual emission increase in NO_x emissions. An NO_x emission limit was not specified in the permit.

2.2 EPA PERMIT NO. PSD-FL-050
(ISSUED JULY 8, 1980; REVISED DECEMBER 28, 1984)

The EPA PSD permit limits SO_2 emissions to the same levels as specified in the DER air construction permit for each kiln. Only two kilns are allowed to operate on coal at the same time. In addition, the coal sulfur content was limited to the following, whichever is more restrictive:

1. 1.75 percent as a monthly average;
2. 2.0 percent as a maximum; and
3. A sulfur content coal that consistently meets the SO_2 emission limits.

The maximum coal sulfur content was to be determined by a stack test program.

NO_x emissions were limited in the EPA permit to the following:

Kiln	Emission Limit
1	118 lb/hr or 4.73 pounds per ton (lb/ton) clinker, whichever is less
2	118 lb/hr or 4.73 lb/ton clinker, whichever is less
3	592 lb/hr or 6.77 lb/ton clinker, whichever is less

Compliance tests were to be performed using EPA Method 6 for SO_2 and Method 7 for NO_x. The Method 7 tests were to consist of at least four grab samples per run, taken at approximately 15-minute intervals.

3.0 BASIS FOR ESTABLISHMENT OF CURRENT SO_2/NO_x EMISSION LIMITS

3.1 SO_2 EMISSION LIMITS

The original air construction permit applications for the Lonestar Kilns 1, 2, and 3 coal conversion proposed SO_2 emission limits of 56.7 lb/hr for Kilns 1 and 2 each and 26.3 lb/hr for Kiln 3. The SO_2 emission rates for all kilns were based upon a maximum of 2.0 percent sulfur in coal and 0.08 percent sulfur in the raw feed (as SO_3). Kilns 1 and 2 emissions were further based upon a stack test on Kiln 1 conducted in June 1979, while firing 2.4 percent sulfur fuel oil. The calculated SO_2 absorption efficiency of Kiln 1 was 91.3 percent. Similarly, Kiln 3 was also tested at the same time, and the SO_2 absorption efficiency was calculated to be 98.7 percent. These inherent SO_2 control efficiencies formed the basis of the original emission limits. There was no information available at that time that coal firing would result in significantly different SO_2 removal efficiencies within the kiln. Subsequently, on July 8, 1980, EPA issued the federal PSD permit (PSD-FL-050), and on May 28, 1980, DER issued the state permit (AC 13-27742) approving the originally proposed emission limits.

Lonestar converted only Kiln 3 to coal, due to economic conditions, and conducted initial compliance tests in July 1981. These initial tests showed SO_2 emissions to be as high as 500 lb/hr. In correspondence to EPA dated January 5, 1982 (Appendix A), Lonestar attributed the high emissions to the hotter operation of the kiln (due to energy efficiency improvements). It was stated that high excess oxygen (O_2) levels in the kiln were required to obtain high sulfur absorption into the clinker, but too high of an excess O_2 level will cause too high of a back-end kiln temperature, affecting product quality. In addition, it was noted that there was a high probability of not meeting the NO_x limits at the higher excess O_2 levels.

Additional SO_2/NO_x testing was conducted on Kiln 3 in April and May of 1982. The first tests in April exceeded the 400 lb/hr limit on Kiln 3, but the May tests showed that SO_2 levels could be controlled to under the 400 lb/hr level.

On the basis of these results, in November 1982, Lonestar requested from EPA a revision to the SO_2 emission limits for Kilns 1, 2, and 3. The requested levels were 125 lb/hr for Kilns 1 and 2 each and 400 lb/hr for Kiln 3. Lonestar submitted along with this request, and in a subsequent submittal (letter to DER dated June 13, 1983), information related to the air quality impact of the requested emission limits and a BACT evaluation. The BACT evaluation discussed add-on control equipment (i.e., baghouses, flue gas desulfurization, etc.), use of low-sulfur coal, and process variables which affect SO_2 emissions.

On August 6, 1984, DER issued the Preliminary Determination and proposed federal PSD permit for the SO_2 revision. This included an engineering evaluation and BACT determination which concurred with Lonestar's assessment of the SO_2 removal capabilities of Kilns 1, 2, and 3 and its assessment of alternative SO_2 emission control technologies. Due to the uncertainties surrounding the SO_2 removal capabilities of the kilns, which were estimated to achieve a maximum 75 percent removal, Lonestar might need to burn coal with a sulfur content as low as 1 percent in order to meet the revised SO_2 emission limits. The PSD Final Determination was issued by DER on November 9, 1984, and EPA revised the federal PSD permit (PSD-FL-050) on December 28, 1984. The Final Determination and final permit did not deviate from the Preliminary Determination and draft permit.

3.2 NO_x EMISSION LIMITS

The original air construction permit applications for the Lonestar Kilns 1, 2, and 3 coal conversion proposed an NO_x emission limit of 1.69 lb/ton clinker produced when burning coal. The basis for this emission rate was a series of NO_x emission tests conducted in 1979 on Kiln 3 when burning both oil and gas (see Appendix A). Maximum emissions were on gas and were determined to be 6.77 lb/ton clinker produced. Hilousky (1977) indicated that conversion of a cement kiln from gas to coal firing should result in a 75-percent reduction in NO_x emissions (see Appendix A). On this basis, the estimated coal-fired NO_x emission rate was proposed as 1.69 lb/ton of clinker produced.

Subsequently in 1980, Lonestar conducted additional NO_x emissions testing while firing gas and oil in Kilns 1 and 2. Based upon these test results and because of the uncertainty in meeting the originally proposed NO_x emission rates, Lonestar proposed that the NO_x emission limits be revised to equal those measured when firing gas (i.e., no increase in NO_x emissions over those from gas firing) (see Appendix A for April 25, 1980 correspondence). The revised emission limit proposed at that time was 830 lb/hr from the entire Pennsuco facility. Based upon further discussions between EPA and Lonestar, the NO_x emission limits specified in the original EPA PSD permit was 592 lb/hr or 6.77 lb/ton of clinker produced for Kiln 3 and 118 lb/hr or 4.7 lb/ton clinker produced for Kilns 1 and 2.

These original NO_x limits were based entirely upon emission measurements while burning gas and oil in the Lonestar kilns. Emission test data for coal firing was not available for Lonestar or from other cement kilns in the United States, except for the kiln discussed in the article in Appendix A. The clinker product being produced at that time was also significantly different than that produced at Lonestar today (see discussion in Section 4.0).

4.0 PAST AND CURRENT PRODUCTION PRACTICES

Primarily due to the foreign imports of clinker and cement, the Lonestar plant has changed its manufacturing process in order to compete and survive in the cement industry within the state of Florida. Prior to 1983, this plant was basically a Type I cement manufacturing operation with other types of cement being manufactured on a smaller scale. With foreign products entering U.S. ports, this plant was forced to change its manufacturing process to produce a Type I/II cement plus other specialty cements. This change occurred at Lonestar in 1983.

In order to maintain compressive strengths and manufacture a good quality Type I/II product, more calcium carbonate was added to the chemical formulation of the raw kiln feed. By doing this, the tricalcium silicate (C_3S) content of the product remained the same to maintain Type I strengths in the new Type I/II product. The increased calcium carbonate content requires more fuel to calcine and combine with the silica, aluminum, and iron components of the mix to produce the C_3S as well as the other required mineral structures. The higher fuel requirements lead to greater SO_2 emissions. The increased SO_2 emisisons are offset somewhat by a higher volumetric flow rate through the kiln to support the combustion process. The additional oxygen acts to absorb a portion of the additional SO_2 generated from the fuel. However, the higher kiln heat requirements, and therefore kiln temperatures, act to increase NO_x emissions (see discussion in subsequent sections). Thus, the change in clinker product since 1983 at Lonestar has contributed to the higher SO_2 and NO_x levels indicated by the recent source test results.

Another factor which can significantly affect SO_2 emissions from cement kilns is the sulfur content of the raw feed material. Since 1981, Lonestar has utilized bottom ash from various coal-fired power plants as a source of alumina, silica, and iron. These substances are required in the raw feed to produce acceptable clinker. The sources of the bottom ash have varied over the years as Lonestar seeks the cheapest supply available. Because the supply of bottom ash has varied, the sulfur content of the bottom ash and ultimately of the raw feed has also varied. The effects of this variability on potential SO_2 emissions from Kiln 3 are discussed further in Section 5.0.

Another effect of the current domestic cement economy and foreign cement imports is that Kilns 1 and 2 at Lonestar have not operated since June 1982. At this time, it is not anticipated that these kilns will operate at any time within the near future. Also, due to these same economic conditions related to foreign clinker and cement imports, the General Portland cement plant in Miami, Florida was shut down last year. This year, General Portland's cement plant in Tampa, Florida shut down their kiln operations; however, they continued to operate their grinding mill facilities--grinding foreign clinker into cement.

5.0 EVALUATION OF SO_2 AND NO_x EMISSIONS TEST DATA

Since Lonestar converted Kiln 3 to coal in 1981, several emissions tests have been conducted for SO_2 and NO_x emissions. Presented in Table 5-1 are the results of those tests for which SO_2 or NO_x emissions and the oxygen content of the kiln gases were measured. These tests constitute 18 individual SO_2 runs, during which several NO_x grab samples were also obtained. Additional in-house SO_2 tests were conducted in March 1983 and March 1984; however, concurrent NO_x samples and oxygen levels in the kiln were not measured.

The source emission tests were conducted at or near the maximum capacity of Kiln 3 [87.5 tons per hour (TPH) clinker], ranging from 79.0 to 87.6 TPH. Coal feed rate and sulfur content were relatively constant for all the tests, ranging from 13.5 to 16.5 TPH and from 1.28 to 1.96 percent sulfur (% S), respectively. The percent SO_3 in the raw feed was also fairly uniform, ranging from 0.09 to 0.22, except for the May 16, 1985 tests, which ranged from 0.44 to 0.60 percent.

All source tests were conducted using EPA Method 6 for SO_2 and EPA Method 7 for NO_x. The O_2 content of the flue gases exiting the kiln were also measured during the tests. The oxygen measurement is taken at the feed end of the kiln, which is opposite the end from the combustion zone.

Review of the test data shows that compliance with the SO_2 emission limit for Kiln 3 of 400 lb/hr is achievable. The May 24, 1985 and May 31, 1985 tests averaged 375 lb/hr and 388 lb/hr SO_2, respectively. The test of May 12, 1982, averaged 280 lb/hr SO_2. All of these tests were run under kiln O_2 levels which averaged between 2 and 3 percent. The May 16, 1985 and April 30, 1982 tests exceeded the emission limit, and kiln O_2 levels averaged between 1.9 and 2.0 percent. Thus, it appears, under current operating conditions in the kiln, a kiln O_2 content of greater than 2.0 percent would be required to comply with the SO_2 standard. However, compliance may only be marginal, as the best test results were only 6 percent below the emission limit.

Table 5-1. Summary of SO_2/NO_x Testing, Lonestar Kiln 3 Burning Coal

Test Date	Raw Feed Rate (TPH) (dry)	Raw Feed % SO_3 (dry)	Coal Rate (TPH)	Coal % S (as fired)	Clinker Rate (TPH)	Clinker % SO_3 (dry)	Kiln % O_2	Flue Gas SO_2 (lb/hr)	Flue Gas NO_x (lb/hr)	Flow Rate (ACFM)	Flow Rate (DSCFM)	% H_2O	Temp. (°F)	Individual NO_x (lb/hr) 1	2	3	4	SO_2 Removal Efficiency (%)
04/30/82																		
1	138.28	0.17	16.5	1.40	85.6	0.19	1.4	864	405	330,025	153,911	27.79	357	364	408	451	395	
2	138.28	0.17	16.5	1.44	85.6	0.19	1.3	709	511	319,869	147,463	27.94	365	459	472	581	533	
3	138.28	0.22	16.5	1.56	85.6	0.19	2.9	332	695	316,722	145,883	28.16	363	662	656	706	756	
Average	138.28	0.19	16.5	1.47	85.6	0.19	1.9	635	537	322,205	149,086	27.96	362					54.3
05/12/82 In-house test submitted to EPA																		
1	127.59	0.11	13.9	1.68	79.0	0.82	3.4	319	793		155,886		343	838	747	--	--	
2	127.59	0.11	13.5	1.52	79.0	1.27	2.9	295	523	319,286*	149,023	27.73*	344	529	516	--	--	
3	127.59	0.11	14.4	1.48	79.0	0.84	2.8	265	464		149,124		346	463	465	--	--	
4	127.59	0.12	14.4	1.28	79.0	0.86	3.1	197	438		153,814		343	458	417	--	--	
5	127.59	0.10	14.4	1.36	79.0	1.03	2.9	265	218	320,478†	151,523	27.62†	344	229	207	--	--	
6	127.59	0.10	15.5	1.36	79.0	0.72	1.6	579	347		148,903		352	329	364	--	--	
Average	127.59	0.11	14.4	1.45	79.0	0.92	2.8	320	464	319,882	151,379	27.68	345					77.1
05/16/85																		
1	133.5	0.44	14.90	1.56	87.5	0.11	1.75	535	643	318,126	141,902	29.2	379	518	734	520	799	
2	132.8	0.56	14.55	1.86	87.5	0.08	2.2	439	855	310,068	143,367	26.7	378	572	953	836	1,057	
3	132.7	0.60	14.65	1.64	87.4	0.22	2.0	514	750	319,034	147,152	26.5	382	788	846	639	727	
Average	133.0	0.53	14.70	1.69	87.5	0.14	2.0	496	749	315,743	144,140	27.5	380					87.0
05/24/85																		
1	132.8	0.09	14.75	1.96	87.2	0.16	2.3	380	732	332,881	152,149	26.4	392	894	293	744	998	
2	132.5	0.14	14.50	1.93	87.3	0.14	2.3	357	809	322,952	146,703	26.6	395	757	833	760	885	
3	132.3	0.11	14.50	1.88	87.7	0.06	2.2	388	768	331,212	148,867	27.4	395	731	850	793	698	
Average	132.5	0.11	14.58	1.92	87.4	0.12	2.3	375	770	329,015	149,240	26.8	394					78.0
05/31/85																		
1	132.8	0.18	14.60	1.96	87.6	0.18	3.0	384	647	336,040	154,249	25.9	394	575	658	585	769	
2	132.8	0.14	14.60	1.93	87.6	0.14	2.6	409	618	333,299	149,830	26.9	401	667	607	626	573	
3	132.8	0.16	14.55	1.86	87.6	0.16	2.7	372	779	341,786	153,083	27.3	400	680	605	1,019	812	
Average	132.8	0.16	14.58	1.92	87.6	0.16	2.8	388	681	337,042	152,387	26.7	398					80.0

*Average of runs 1 through 3.
†Average of runs 4 through 6.

Source: Lonestar Florida Holding, Inc., 1985.

An additional factor to be considered in review of the recent SO_2 test results is that Kiln 3 was shut down for annual maintenance in April 1985. The SO_2 tests were conducted just after the annual maintenance, when the kiln was operating at optimum fuel efficiency. Over time, the kiln will experience a slow degradation in fuel efficiency, requiring more fuel to be burned to produce the same amount of clinker. Increased SO_2 emissions will result from the additional fuel burned. Although the two most recent SO_2 tests on Kiln 3 complied with the 400 lb/hr limit, the margin of compliance was small, and future tests may result in levels above the limit.

A total of five compliance or in-house tests are shown in Table 5-1. Of these five, only one test showed simultaneous compliance with both SO_2 and NO_x allowable levels (May 12, 1982 test). During this test, the kiln O_2 level was relatively high, averaging 2.8 percent.

The test of May 31, 1985, was conducted under similar kiln O_2 levels (average of 2.8 percent), and the average SO_2 emissions were 388 lb/hr (below the allowable level of 400 lb/hr). During this test, however, NO_x emissions averaged 681 lb/hr, in excess of the 592 lb/hr allowable level. These tests, as well as the other test data, emphasize the highly variable nature of NO_x emissions from the kiln and the problem of meeting both the SO_2 and NO_x emission limits simultaneously while firing coal in Kiln 3.

A statistical analysis of the source test data was performed to determine if any correlation exists between SO_2 emissions, NO_x emisions, and kiln O_2 level. Shown in Figure 5-1 are measured SO_2 emissions plotted against NO_x emissions. As shown from this figure, there is no direct correlation between SO_2 and NO_x emisisons. It is concluded that the relationship is a complex function of several parameters, as discussed in Sections 3.0 and 6.0.

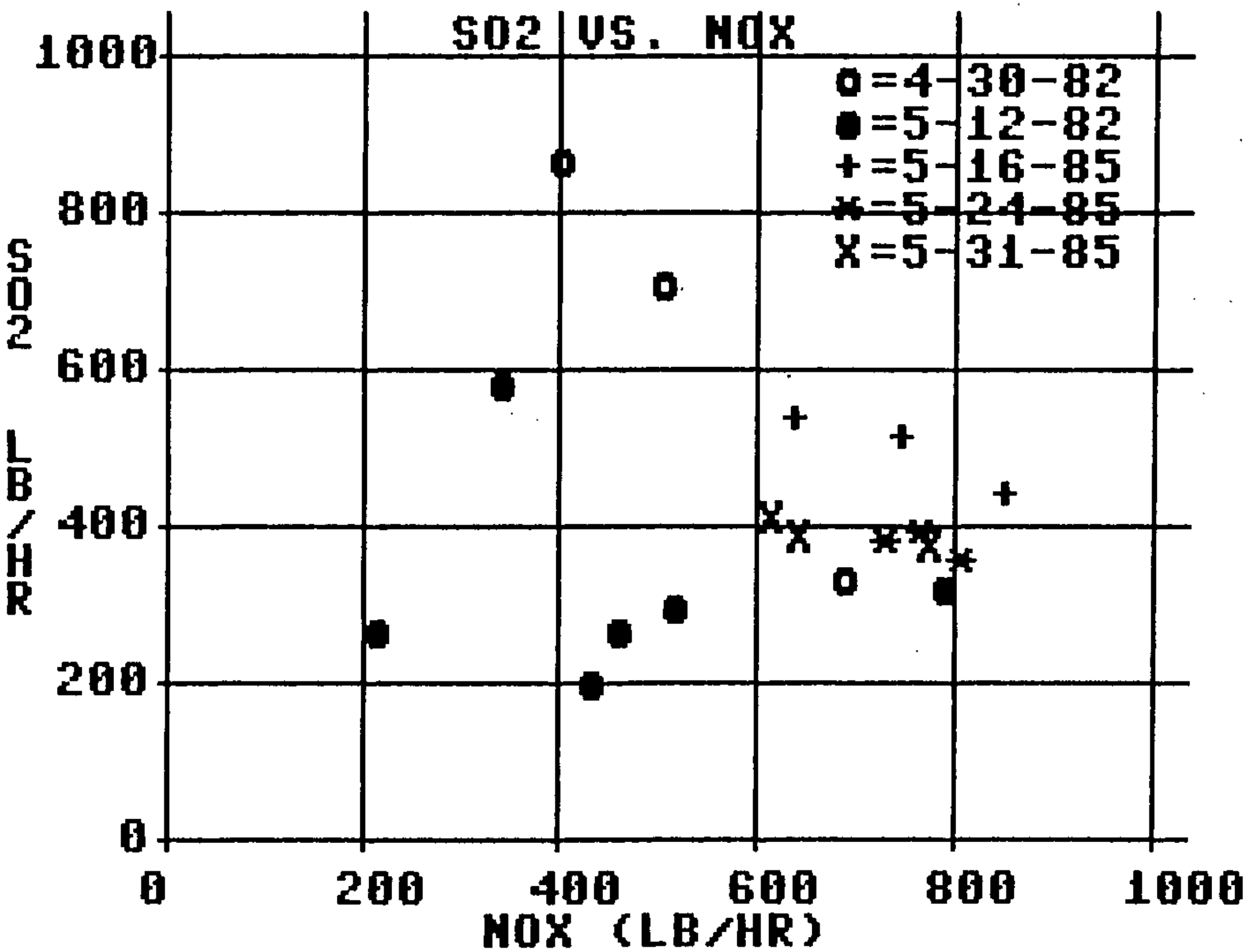

Figure 5-1
SO_2 VERSUS NO_X EMISSIONS,
KILN 3 BURNING COAL

SOURCE: ESE, 1985.

LONESTAR FLORIDA
HOLDING, INC.

Presented in Figure 5-2 is the relationship between SO_2 emissions and kiln O_2 content. This figure shows a very strong correlation between SO_2 and kiln O_2 (an expected result, as discussed in Sections 3.0 and 6.0) and suggests a linear relationship. To test this relationship, a linear regression analysis was performed on the data. The following equation was found to describe the line of best fit:

$$SO_2 \text{ (lb/hr)} = 996 - 238 \; (\%O_2)$$

This line is shown in Figure 5-2. The correlation coefficient (R) for this line of best fit is -0.88, indicating a fairly good correlation.

Although many of the tests were conducted at kiln O_2 levels ranging from 2 to 3 percent, clinker product quality considerations dictate that a more desirable O_2 level in the kiln is about 1 percent. As the O_2 level in the kiln increases (indicating increased volumetric flow rate through the kiln), heat is lost from the kiln, and the energy efficiency decreases. If this condition persists, the quality of the clinker becomes degraded.

As discussed in Section 4.0, the Type I/II product presently produced at Lonestar has a high C_3S content and requires more heat to process than the previous Type I product. If heat in the kiln decreases to unacceptable levels, either more fuel must be added to compensate, which in turn lowers the O_2 content in the kiln (the additional combustion consumes the O_2), or the air flow rate through the kiln must be lowered, which also lowers the O_2 in the kiln.

Presented in Figure 5-3 are measured NO_x emissions as a function of kiln O_2. As shown, no correlation is evident between these two variables. This supports the conclusion that NO_x emissions are primarily a function of the temperature in the kiln. The Lonestar plant uses their NO_x stack monitor as one of their burning controls in operating the kiln--as the

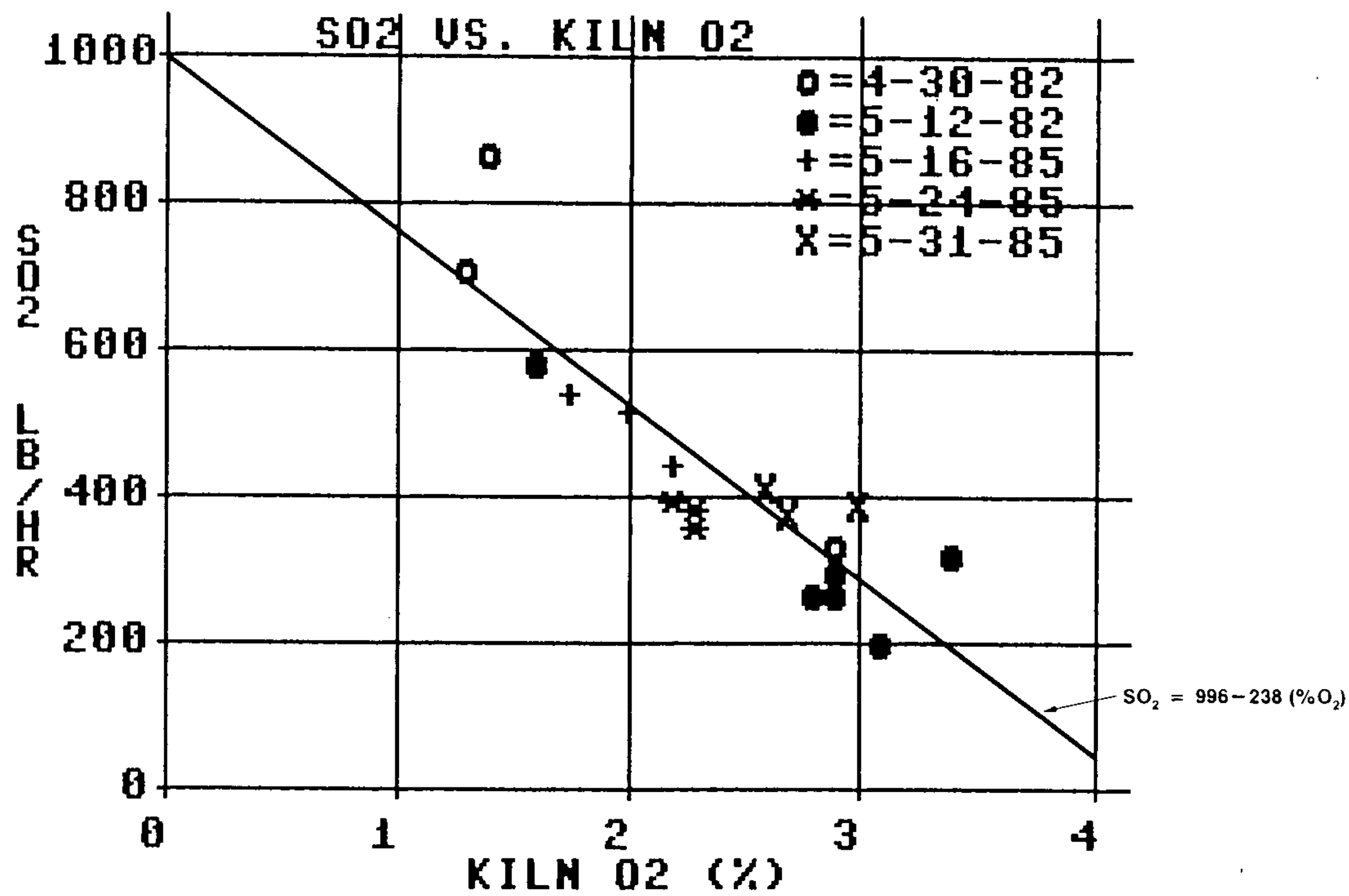

Figure 5-2
SO_2 EMISSIONS VERSUS KILN O_2,
KILN 3 BURNING COAL

SOURCE: ESE, 1985.

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HOLDING, INC.

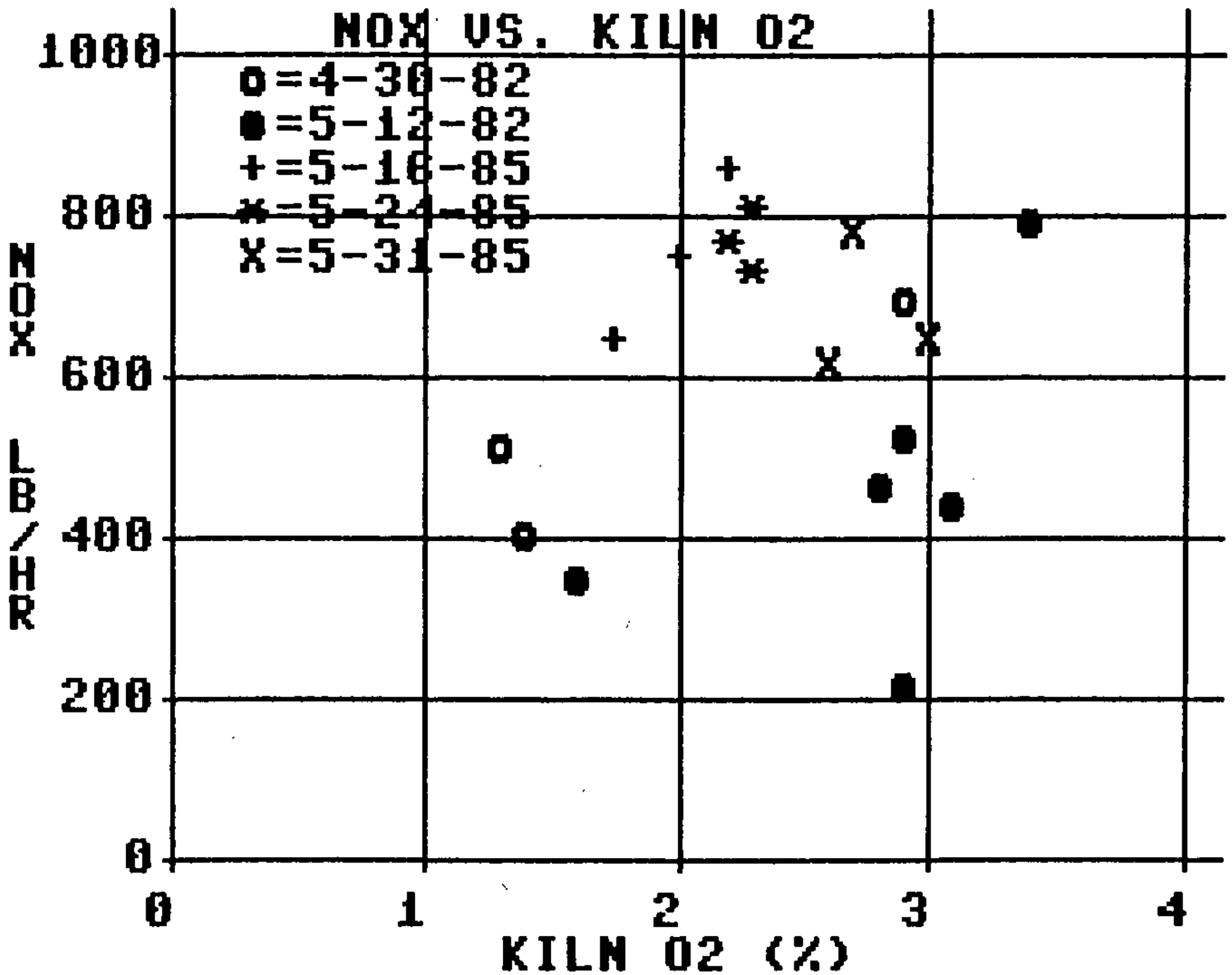

Figure 5-3
NO_X EMISSIONS VERSUS KILN O_2,
KILN 3 BURNING COAL

SOURCE: ESE, 1985.

LONESTAR FLORIDA HOLDING, INC.

NO_x increases, the kiln temperature also increases--and vice versa. It also indicates that achieving compliance with the SO_2 emission limits by increasing the kiln O_2 will not ensure compliance with the NO_x emissions limit for Kiln 3.

Correlations were also attempted between SO_2 emissions and clinker sulfate (SO_3) content and between kiln O_2 and clinker SO_3 contents. No correlation between these variables was found. However, these are the results of short testing periods. Actually, as O_2 goes up in kiln exit gases, SO_3 absorption in the clinker goes up and SO_2 stack emissions go down. It takes approximately 5 hours for the raw feed to travel the length of the kiln to the discharge end. As a result, emission tests performed on the kiln exhaust gases are not representative of clinker product sampled during the same time period as the emission tests.

As discussed in Section 4.0, another factor which can significantly affect SO_2 emissions from cement kilns is the sulfur content of the raw feed material. In Lonestar's original permit application for the coal conversion, the maximum sulfur in the raw feed was stated to be 0.08 percent (as SO_3, on a dry basis). At the maximum raw feed input rate of 141.75 TPH, the maximum potential SO_2 emissions from the raw feed was calculated as follows:

141.75 tons/hr x 2,000 lb/ton x 64 lb SO_2/80 lb SO_3
x 0.0008 = 181.4 lb/hr potential

Thus, the sulfur in the raw feed would have contributed only about 10 percent to the total potential SO_2 due to the raw feed and coal feed (SO_2 due to coal feed was calculated as 1,840 lb/hr). ← depends on S content
(181.4 + 1840)(1 - .75) = 500+ #/hr

Review of Table 5-1 shows a high degree of variability in the SO_3 contents of the raw feed, which range from 0.11 to 0.53 percent (dry basis, average of test series). Based upon the raw feed rates shown, potential SO_2 emissions due to the raw feed would vary between 224 and

1,128 lb/hr. These potential emissions are significantly higher than were envisioned in the original permit application and contribute to the problem of consistently meeting the current SO_2 emission limits for Kiln 3.

SO_2 removal efficiencies for Kiln 3 based upon the theoretical sulfur input to the process are also shown in Table 5-1. The average efficiency based upon the averages of the test runs for each date was calculated. These results indicate a very high inherent SO_2 removal efficiency for the kiln, ranging from 54 percent to 87 percent. Four of the five averages are above 77 percent. This level of SO_2 removal exceeds the 75 percent removal considered by DER to be the maximum obtainable on the kilns at Lonestar (reference DER Preliminary Determination, 1984, in Appendix).

6.0 CONTROL TECHNOLOGIES

Lonestar has addressed various alternative SO_2 and NO_x control technologies in the course of receiving the original state and federal air construction permits for the coal conversion and in receiving revised permits with new SO_2 emission limitations. The following discussion summarizes the previous evaluations and findings, and addresses any new technologies or studies conducted recently.

6.1 NO_x CONTROL TECHNOLOGIES

The original federal PSD permit and Final Determination, issued on July 8, 1980, addressed BACT for NO_x emissions from the three coal-fired kilns at Lonestar's Pennsuco plant. Published test data and references were presented that indicated a substantial reduction in NO_x emissions when cement kilns are converted from natural gas to coal. The reduction was attributed to the characteristics of the flame, with coal flames being longer and lazier with lower temperatures in the center of the flame. However, a high potential for fuel derived NO_x was cited. Also, AP-42 factors and New Source Performance Standards for utility boilers indicated the potential for increased NO_x emissions when firing coal instead of gas. EPA concurred with Lonestar that operating conditions could be found which would result in no net increase in NO_x emissions above those due to gas firing.

Recently, additional studies have become available addressing control technologies for NO_x emissions from cement kilns. An article entitled "Evaluation of Combustion Variable Effects on NO_x Emissions from Mineral Kilns" (excerpts attached) evaluated NO_x emissions from a wet process cement kiln. The pertinent conclusions of the study were as follows:

1. NO_x emissions were found to decrease as O_2 content within the kiln decreased. Only a weak correlation was found. Normal variations in coal nitrogen content, burnability of the feed material, and temperatures within the kiln all could significantly affect emissions.

2. A stronger correlation between SO_2 emissions and O_2 content was found, with SO_2 decreasing as O_2 increases. Normal variations in coal and feed sulfur contents could have a significant effect on kiln SO_2 emissions.
3. Normal variations in process operation (e.g., burning zone temperature, feed composition, and fuel properties) can affect both NO_x and SO_2 emissions.
4. For the particular kiln tested, 55 percent of the coal sulfur was emitted as SO_2.
5. The thermal efficiency of the kiln decreased as the O_2 content in the kiln increased (indicates that as O_2 is increased to reduce SO_2, more fuel is required to compensate for the lower thermal efficiency, thereby increasing potential SO_2 emissions).

These conclusions agree well with the results and conclusions reached for Lonestar's Kiln 3 (in Section 5.0).

The subscale laboratory program conducted in the study identified several variables which may affect NO_x emissions from cement kilns. These variables are: fuel injection velocity, combustion air preheat, furnace wall temperature, carrier gas composition, and excess O_2. Approaches suggested to reduce NO_x were:

- Reduce fuel injection velocity. This variable has a strong effect on NO_x emissions, but it can reduce flame geometry often essential for product quality.
- Reduce oxygen content of carrier gas. This approach would substantially lower NO_x emissions while preserving the flame geometry. increased SO_2 emissions
- Reduce furnace wall temperature. This can be achieved by enclosing the primary combustion zone of the flame in a water/air cooled shroud to prevent the radiation of the flame to the hot refractory or by the re-injection of cement dust in a

shroud surrounding the flame to provide a heat sink for radiation from the flame and hence reduce the flame temperature.

- Distribute cold combustion air to near burner flame zone. The approach involves injecting a layer of cold air in the mixing region between the fuel/carrier jet and the preheated combustion air to act as a shield and minimize NO_x produced with high levels of preheat. Optimizing the amount of cold air would minimize the potential adverse impact on efficiency.

These studies were performed at the subscale (laboratory) level, but their feasibility and effectiveness have not been demonstrated at the pilot scale level, let alone at an actual operating kiln installation.

A report entitled "Application of Advanced Combustion Modifications to Industrial Process Equipment: Subscale Test Results" (excerpts attached) also described results of subscale testing on cement kilns. The study evaluated the following combustion modification techniques and found the stated maximum NO_x reduction achievable with each:

Sulfur injection:	12-20 percent reduction
Water injection:	14 percent reduction
Kiln dust injection:	14 percent reduction
Fly ash injection:	28 percent reduction

Kiln dust injection is used on Lonestar's Kiln 3. This process, called "insulfation," takes the dust collected in the precipitator and recycles it back into the kiln. As a result, Lonestar is already practicing one of the control techniques evaluated in this study.

Based on the above review, there are no new proven technologies for reducing NO_x emissions from coal-fired cement kilns. The only feasible, proven, cost-effective technology is control of process variables. However, process variables are restricted within certain limits by product quality considerations. Because of the many factors involved in

NO_x formation in the kiln, emissions can vary substantially from hour to hour. In addition, measures which act to reduce SO_2 emissions (i.e., increase excess O_2) may increase NO_x emissions.

6.2 SO_2 CONTROL TECHNOLOGIES

Subsequent to conversion of Kiln 3 at Lonestar to coal, it became apparent that the original SO_2 limits in the air construction permits could not be met. In a letter dated January 5, 1982 to EPA, Lonestar discussed possible reasons for not being able to achieve the anticipated SO_2 absorption in the kiln. Among these reasons were (1) that coal flames were shorter and more intense than oil flames (which formed the basis for the SO_2 absorption efficiencies), (2) coal firing results in a coating on the kiln bricks and thus better heat retention, and (3) because of other energy improvements to Kiln 3, it was now operating hotter than it did when burning oil. High excess oxygen levels in the kiln were needed to give high sulfur absorption, but excess oxygen also effects kiln operating temperature and heat transfer to the back end of the kiln and must be closely monitored to prevent melting. It was also noted that as SO_2 absorption increases (i.e., SO_2 emissions decrease), NO_x emissions increase.

On November 19, 1982, Lonestar submitted a control technology analysis to EPA in support of its SO_2 emission limit revision request (attached in Appendix). In this analysis, kiln operating variables that affect SO_2 emissions and alternative control technologies were evaluated. Alternative controls included baghouses versus electrostatic precipitators (ESP). Lonestar stated that it already had ESPs installed, and that baghouses might achieve about 12 percent greater overall SO_2 absorption than ESP, but this conclusion was based upon limited test data. Retrofitting baghouses on Kiln 3 at Lonestar was estimated to cost about $3.3 million (1981 dollars, capital and installation costs). It was concluded that control of excess oxygen in the kiln is the most cost-effective means of controlling SO_2 emissions.

Lonestar presented additional control technology evaluations in a letter to DER dated June 13, 1983 (see Appendix). This letter evaluated flue gas desulfurization equipment and rejected such add-on equipment based upon its high cost and stated that Lonestar was already achieving 75 to 80 percent removal of potential SO_2 emissions. The cost of firing lower sulfur coals was evaluated (1.75, 1.0, and 0.75 percent S), and it was shown that the cost of firing lower sulfur coal (i.e., 1.0 or 0.75 percent S) would cost between $0.88 million and $1.76 million, annually. This was considered to be a significant economic burden and a competitive disadvantage to Lonestar.

The EPA PSD permit for the revised SO_2 emissions limits for Kilns 1, 2, and 3 included BACT determination by DER. The preliminary determination concluded that, based on test data submitted by Lonestar, the average SO_2 removal efficiency of Kiln 3 was 75 percent when the flue gas oxygen was above 2.8 percent. The data did not show that an SO_2 removal efficiency of greater than 75 percent could be consistently achieved on the existing system. Flue gas desulfurization systems were considered not feasible for the Lonestar plant at that time. It was indicated that 1 percent S coal might need to be burned in order to meet the revised emission limits, depending upon raw feed sulfur and absorption efficiency in the kiln. These conclusions were also adopted in the PSD Final Determination, issued by DER on November 9, 1984.

As the preceding discussion indicates, Lonestar has previously evaluated all feasible options for controlling SO_2 emissions (i.e., FGD systems, low sulfur coal, and controlling process variables). The conclusions reached previously for FGD and low sulfur coal are considered applicable today. These alternatives are too costly and would place a severe economic burden on Lonestar at a time when they are already under severe economic hardships. The only feasible alternative for Lonestar is the control of process variables to increase sulfur absorption in the system. However, as discussed in Section 4.0, the type clinker product Lonestar now produces restricts these variables. In addition, as shown in Table 5-1, Lonestar is achieving between 50 percent and 90 percent SO_2 absorption in Kiln 3, and the last three emission tests indicate SO_2 removal efficiencies between 78 and 87 percent.

The following theoretical calculation shows the SO_2 removal efficiency required of Kiln 3 to achieve an SO_2 emission rate of 650 lb/hr, assuming design process input rates (as specified in the original permit application).

Design Parameters

0.08 percent SO_3 in raw feed

2.0 percent S in coal ← High

Sulfur Input:

Raw feed: 283,500 lb/hr x 0.0008 x 32/80 = 90.72 lb/hr

Coal: 46,000 lb/hr x 0.02 = 920 lb/hr (460 lb/hr @ 1% S in Coal)

Total = 1,010.72 lb/hr — 550.72 lb/hr with 1% S coal

1 lb S = 2 lb SO_2

1,010.72 x 2 = 2,021.44 lb/hr SO_2 — 1101.44 lb SO_2/hr with 1% S coal

Maximum emitted 650 lb/hr SO_2

Efficiency = [(2,021.44 - 650)/2,021.44] x 100 = 67.8 percent — lower than they meet

(1101 − 400)/(1101) = 64% allow to meet std

The following presents the theoretical SO_2 removal efficiency based upon SO_2 emissions of 650 lb/hr and process input rates reflective of the three May 1985 emission tests. High!

Maximum SO_2 emissions = 650 lb/hr

Feed rates based upon data in Table 5-1 (May 1985 tests)

Raw feed rate (dry) = 132.8 tons/hr

Percent SO_3 in raw feed (dry) 0.11 - 0.53 percent — initially said 0.08%

Coal firing rate: 14.62 tons/hr 29,240 lb/hr

Percent S in coal: 2.0 percent maximum High

Sulfur Input

Raw feed: 132.8 tons/hr x 0.11 / 100 x 32/80 = 0.0584 tons/hr

132.8 tons/hr x 0.53 / 100 x 32/80 = 0.2815 tons/hr

Coal: 14.62 tons/hr x 2.0 / 100 = 0.2924 tons/hr

Total sulfur input = 0.3508 to 0.5739 tons/hr

1 lb S = 2 lb SO_2

Potential SO_2 emissions = 0.7016 to 1.1478 tons/hr

SO_2 Removal Efficiency

SO_2 emissions = 650 lb/hr = 0.325 tons/hr

Efficiency = [(In - Out)/In] x 100

= [(0.7016 - 0.325) / 0.7016] x 100 = 53.4 percent

= [(1.1478 - 0.325) / 1.1478] x 100 = 71.7 percent

Efficiency Range = 53.4 to 71.7 percent low

would meet requested limit

7.0 PROPOSAL TO REVISE CURRENT SO_2 EMISSION LIMITS

The Lonestar facility is currently allowed to emit a total of 650 lb/hr of SO_2, with 125 lb/hr from Kilns 1 and 2 each, and 400 lb/hr from Kiln 3. Considering (1) the difficulty in simultaneously meeting the current SO_2 and NO_x emission limits for Kiln 3, (2) the need to maintain clinker product quality, and (3) the remote probability of restarting Kilns 1 and 2, Lonestar proposes the following:

1. Limit total SO_2 emissions from Kiln 3 to 650 lb/hr, and
2. Leave Kilns 1 and 2 on shut down status. (These kilns have not operated since June 1982.)

This proposal will not increase total permitted SO_2 emissions from the Lonestar facility of 650 lb/hr. In addition, the Dade County AAQS will not be threatened by this proposal. The Kiln 3 stack has a greater volumetric flow rate and therefore has a greater plume rise compared to Kilns 1 and 2. Therefore, shifting the entire 250 lb/hr SO_2 from Kilns 1 and 2 to Kiln 3 will actually result in an improvement (reduction) in maximum predicted ground-level SO_2 concentrations.

To demonstrate compliance with the national, State of Florida, and Dade County SO_2 AAQS in the vicinity of the Lonestar plant, an atmospheric dispersion modeling evaluation was conducted. The EPA- and DER-approved Industrial Source Complex Short-Term (ISCST) model was used to estimate annual, 24-hour, and 3-hour SO_2 impacts due to Lonestar and nearby significant sources for comparison to State of Florida AAQS. Highest, second-highest concentrations were used for short-term averaging times (24 hours or less), since these standards can be exceeded once per year at each receptor. To evaluate compliance with Dade County AAQS, annual, 24-hour, 4-hour and 1-hour concentrations were examined. Maximum predicted short-term (24 hours or less) concentrations were used, since Dade County AAQS are never to be exceeded. A 5-year meteorological data base (1970 to 1974) from Miami International Airport was used in conjunction with the ISCST.

For Class I PSD impacts, 33 discrete receptors were placed on the boundary of the Class I area (Everglades National Park). For short-term averaging times, highest, second-highest predicted concentrations at each receptor were utilized.

Class II PSD increment consumption and maximum impact concentrations were determined by executing the ISCST with a radial receptor grid placed around the Lonestar plant. Receptors ranged from 0.4 kilometer (km) to 2.8 km with a 0.3 km radial grid spacing. Lonestar and Resource Recovery were determined to be the only significant increment consuming sources in the area. Highest, second-highest concentrations were utilized for short-term averaging times.

Lonestar's interaction with other sources was also examined in two additional 5-year ISCST model executions; i.e., receptors were placed downwind of Resource Recovery and South Florida Materials (formerly Houdaille) in the directions aligning Lonestar with these sources. Since the modeling for receptors around Lonestar showed that Lonestar by itself will comply with all ambient air quality standards, the purpose of this modeling was to determine if Lonestar would cause or contribute to exceedances of the AAQS in the vicinity of these other sources. A 0.2 km receptor spacing was utilized in these model runs.

Predicted short-term concentrations were refined with the ISCST for cases where standards were predicted to be approached or exceeded. Based on the modeling results, refinements were performed for only the 4-hour averaging time since the Dade County 4-hour AAQS was being approached. A 0.1 km receptor spacing was utilized to refine the concentrations.

Stack parameters used in the modeling are shown in Table 7-1. The parameters for Kiln 3 are those measured during the May 16, 1985 source test and represent the lowest volumetric flow rate and stack temperature from the most recent tests. These values will result in lower plume rise in the model and will provide a conservative estimate of maximum air quality impacts. A conversation with Mr. Art Bolivar of Metro-Dade County Environmental Resources Management revealed that Alton Box, which was evaluated in previous Lonestar So_2 modeling studies, is now burning natural gas in its boiler. Therefore, this source was not considered in the present modeling study. Mr. Bolivar also provided updated stack parameters for South Florida Materials based on a particulate stack test of April 17, 1985. These parameters were used in the present study and are shown in Table 7-1.

Table 7-2 presents the maximum air quality impacts on PSD Class I and Class II increments and Florida and Dade County AAQS. The dispersion modeling analysis predicted that Class I and Class II area impacts will not exceed the allowable PSD increments, and no Florida or Dade County AAQS will be exceeded with Kilns 1 and 2 offline and Kiln 3 burning coal with 650 lb/hr SO_2 emissions. The increment consumption values shown in Table 7-2 are conservative since they reflect the entire emissions from Kiln 3 as being increment consuming. Only emissions above those due to natural gas firing in Kiln 3 are increment consuming, and the shut down of Kilns 1 and 2 would provide increment expansion.

Comparison of the revised SO_2 impacts shown in Table 7-2 with previous Lonestar SO_2 impacts (i.e., Kilns 1 and 2 limited to 125 lb/hr each and Kiln 3 to 400 lb/hr SO_2) shows that the revised SO_2 impacts are all less than the previous impacts, except for the 1-hour averaging time. The 1-hour maximum impacts are still well below the Dade County AAQS. This analysis shows that the current proposal to operate Kiln 3 only and not increase total SO_2 emissions will result in a net air quality improvement.

Table 7-1. Stack Parameters Used in Lonestar Modeling Evaluation

Source	SO_2 Emission Rate (lb/hr)	SO_2 Emission Rate (g/sec)	Stack Height (m)	Stack Diameter (m)	Stack Gas Velocity (m/sec)	Stack Temp. (°K)
Kiln #3	650.0	81.9	61.0	4.33	10.11	466
South Florida Materials	18.9	2.38	11.6	1.20	22.1	405
Resource Recovery	111.1	14.00	45.7	2.70	14.00	489

Sources: Lonestar Florida Holding, Inc., 1985.
ESE, 1985.

Table 7-2. Summary of Lonestar Modeling Results, Kiln 3 Burning Coal

Scenario	Maximum Concentrations ($\mu g/m^3$)*				
	Annual	24-Hour	4-Hour	3-Hour	1-Hour
Class I Increment Consumption†					
Lonestar Only	0.3	2.7	NA	10.0	NA
Lonestar and Resource Recovery	0.3	2.9	NA	10.0	NA
Allowable Class I Increments**	2.0	5.0	NA	25.0	NA
Class II Increment Consumption†					
Lonestar Only	1.5	12.1	NA	50.2	NA
Lonestar and Resource Recovery	1.6	12.2	NA	50.2	NA
Allowable Class II Increments**	20	91	NA	512	NA
Total Air Quality Impacts					
Receptors in Vicinity of Lonestar	2.1	13.4	49.7	50.2	143.9
Receptors in Vicinity of South Florida Materials (Houdaille)††	1.4	17.2	47.0	48.0	73.4
Receptors in Vicinity of Resource Recovery††	0.7	10.2	29.6	29.2	66.5
Dade County AAQS***	NA	28.6	57.2	NA	286.0
Florida AAQS**	60	260	NA	1,300	NA

Note: NA = Not applicable.

*Total air quality impacts for 24-hour, 4-hour, and 1-hour averaging times are based upon maximum predicted impacts. All other 24-hour, 4-hour, and 1-hour impacts, as well as all 3-hour impacts, are based upon highest, second-highest predicted concentrations.

†Values shown assume that all Lonestar emissions consume increments; therefore, numbers are conservative.

**Short-term standards (i.e., averaging time 24 hours or less) can be exceeded once per year.

††Receptors were placed downwind of indicated source in direction which aligned Lonestar with the respective source.

***Standards never to be exceeded.

Source: ESE, 1985.

8.0 PROPOSAL TO REVISE CURRENT NO_x EMISSION LIMITS

The Lonestar facility is currently allowed to emit a total of 828 lb/hr of NO_x. Kilns 1 and 2 are allowed to emit 118 lb/hr each, while Kiln 3 is allowed 592 lb/hr. Considering (1) the difficulty in simultaneously meeting both the current SO_2 and NO_x emission limits for Kiln 3, (2) the necessity to produce a specialty cement product which restricts kiln operating parameters, and (3) the remote possibility of restarting Kilns 1 and 2, Lonestar proposes the following:

1. Limit total NO_x emissions from Kiln 3 to 828 lb/hr, and
2. Leave Kilns 1 and 2 on shut down status (these kilns have not operated since June 1982).

This proposal will not increase total NO_x emissions from the Lonestar facility of 828 lb/hr. Based upon the atmospheric dispersion modeling evaluation presented in Section 7.0 and by ratioing the SO_2 emissions to the NO_x emissions from Kiln 3, the maximum annual average NO_x impact from Kiln 3 emitting at the proposed limit of 828 lb/hr is 1.9 $\mu g/m^3$. This maximum impact is well below the national, DER, and Dade County NO_x AAQS of 100 $\mu g/m^3$ annual average concentration.

9.0 CONCLUSIONS

The significant conclusions of this study are summarized as follows:

- The original emission limits for SO_2/NO_x when firing coal in Lonestar's cement kilns were based on source tests conducted on gas and oil firing and available literature.
- Lonestar has changed its clinker product from Type I cement to Type I/II cement and specialty cements since original permit limits were established. In addition, the source of certain constituents in the raw feed has varied. This has, in turn, changed the raw feed composition and burning conditions in the kiln.
- Source testing has demonstrated that, under current kiln burning conditions, the current SO_2/NO_x emission limits cannot be simultaneously met.
- Alternative control technologies for SO_2/NO_x, such as add-on control equipment and low sulfur, are not considered warranted or economically feasible.
- The propsed SO_2/NO_x emission limits for Kiln 3, in conjunction with the shut down of Kilns 1 and 2, will not increase total emission to the atmosphere and compliance with all air quality standards is predicted.

An additional consideration on Lonestar's behalf is its plan to utilize Refuse Derived Fuel (RDF) in Kiln 3. RDF is expected to be used in Kiln 3 (hopefully late this year) in order to help reduce fuel costs and at the same time help with the local "waste disposal" problem. By burning RDF, Lonestar will eventually reduce fuel (coal) usage by as much as 25 percent. Consequently, a considerable improvement is expected in SO_2 stack emissions. In addition Lonestar used 40,000 tons of the ash from the Dade County municipal waste disposal plant in 1984 for iron and alumina raw materials.

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APPENDIX A

LONESTAR FLORIDA/PENNSUCO, INC.
Cement and Aggregate Division
Post Office Box 122035
Palm Village Station
Hialeah, Florida 33012
(305) 823-8800

January 5, 1982

Mr. Tommie A. Gibbs
Air Facilities Branch
U. S. Environmental Protection Agency
Region IV
345 Courtland Street
Atlanta, Georgia 30365

Reference: Lonestar's P.S.D. Permit #FL-050

Dear Mr. Gibbs:

As you are aware, the referenced permit issued by E.P.A. was for the conversion of our three portland cement kilns to coal. This authorization established an emission limiting standard on particulates, sulfur dioxide, and oxides of nitrogen. Lonestar elected to convert Kiln #3 first with Kilns #1 and #2 to follow. When the kiln was converted, stack tests were made to determine compliance with the emission standards. The particulate emissions were well below the allowable emissions; 17.09 lbs./hr. versus an allowable of 53.06 lbs./hr. The oxides of nitrogen emissions were 582.45 lbs./hr. with an allowable of 620.80 lbs./hr. or "tests shall be run to optimize the operating conditions towards a minimum emissions of nitrogen oxides." Emissions of sulfur dioxide were 505.59 lbs./hr. with an allowable emission rate of 27.51 lbs./hr. These emission rates were calculated using the allowable lbs./ton times the process weight.

As you can see, the sulfur dioxide emissions were far in excess of the permitted value. I believe at this time, it is appropriate to explain how the sulfur dioxide emissions standards were established for Kiln #3.

When Lonestar acquired Maule Industries physical assets, it also assumed the air pollution operational permits. The permit on Kiln #3 allowed firing of the kiln either by natural gas or No. 6 fuel oil and permit provisos only required compliance testing for particulates. During 1976 and for this permit (coal conversion) in 1979, No. 6 oil was burned and tests performed showing a sulfur absorption rate of 98%+ (copy of 1979 test report was included in the coal conversion application). With this documentation, Lonestar in "good faith" negotiated a permit using this absorption efficiency and gave up the old permit which did not limit sulfur dioxide emissions. The permit was issued allowing firing of 23 tons/hr. and a sulfur content of 2%. original permit

During the compliance testing of July 15, 1981, the kiln burned 1.3% sulfur coal at a rate of 17.5 tons/hr. In other words, the usage and sulfur content of the coal is substantially lower than the permitted rate. Absorption of the lower amount of sulfur input (into the process) was approximately 55%.

Calculations in the application shows an input of 1010.72 lbs./hr. of sulfur while actual testing was performed at 558.1 lbs./hr. of sulfur input and approximately 4% higher production of clinker or a substantially lower ratio of sulfur input to clinker during testing that what was shown in the application.

Your letter of November 16, 1981, requested an analysis of why our sulfur absorption was lower than what we had anticipated using test data. As you are aware, a wet process rotary kiln consists of a relatively long steel tube receiving slurry at a given water content at the feed end, then drying, calcining, and burning the raw material to form clinker. To perform this function, heat is necessary. When the absorption tests were performed high sulfur oil was burned which has a flame characteristic that is longer, less intense, and burns the clinker further up into the kiln. Coal flames, on the other hand, are much shorter, more intense, and burns the clinker closer to the nose of the kiln. Coal also has the added advantage of forming a better coating on the bricks in the kiln giving better brick life and most important better heat retention. Along with this coal conversion, Lonestar upgraded the kiln in various ways to promote greater energy efficiency by installing better chain systems (heat recovery and transfer), reduce air inleakage around the firing hood and various other less apparent upgrades which all contribute to better usage of the energy input and helped account for the lower than permitted tons of coal per ton of clinker usage. With this better energy usage in mind, it is easy to see that the kiln is operating hotter than it did when burning oil.

less coal per clinker ?

To get high sulfur absorption, a kiln must operate at a high level of excess oxygen. While our kiln is operating in a oxidation atmosphere (to prevent combustibles getting into the precipitators), we must closely monitor the amount of excess oxygen because as it increases the heat transfer to the back-end will increase and the temperatures will climb in excess of the chains maximum design temperature and melting will occur. Therefore, we are now running at the maximum back-end temperature without melting.

chain melt if temp gets too high

Another matter to consider is that when the oxygen is increased sulfur is absorbed into the product, but nitrogen oxides increase substantially with the high probability of us not meeting the emission standards set for this kiln and contributing to the non-attainment problem which Dade County has for photochemical-oxidants.

lower SO_2 E) raise NOx E) hurt Dade C.

We are embarking on certain further improvements to the system which we feel will drop our sulfur emissions without overly increasing our nitrogen oxides emissions.

We have made some of these improvements, but we are now suffering from the economic crunch and this kiln is operating at only 80% of capacity and is scheduled for shut down by the end of January. When we are able to start-up and run at 100% capacity, we will schedule a stack test to determine the success of our improvements.

Enclosed is a computer model using the tested sulfur oxide emission rate on Kiln #3 and showing Kilns #1 and #2 burning natural gas which is the case. As you can see at the present, we are in compliance with all federal, state, and county ambient air quality standards for sulfur dioxide.

Even though we are in compliance with the applicable ambient air quality standards with which the Clean Air Act and NSPS standards are based on, we are still not able to meet our BACT permit at this time. can't meet BACT

One more point to make is that we are confident that we can continue to secure coal contracts which will provide us with 2% sulfur coal. continue to get 2% S coal

When the economic situation turns favorable for our operation, we will then re-test our Kiln #3 to quantify our emissions and make the appropriate requests to rectify the discrepancy between our permit and the actual emissions. At this time, we are skeptical of the smaller Kilns #1 and #2 being able to meet their BACT emission limitations, but feel that negotiations on these would be frivolous until we have resolved Kiln #3. Don't think 1+2 Kilns can meet BACT

Lonestar wishes to continue it's good working relationship with E.P.A. and opens it's doors to any assistance or questions you may have.

Sincerely,

Albert W. Townsend

Albert W. Townsend
Coordinator of Ecological Planning

AWT/dc

enclosure

CC: C. Metzgar
D. Coppinger/T. Mendez
M. Reid
F.D.E.R./enclosure
D.C.E.R.M./enclosure
D. Buff, E.S.E.

LONESTAR FLORIDA PENNSUCO, INC.
6451 N. Federal Highway
Fort Lauderdale, Florida 33308
Post Office Box 6097
Fort Lauderdale, Florida 33310
(305) 491-0900

June 18, 1982

Mr. Thomas W. Devine, Director
Air & Waste Management Division
U.S. Environmental Protection Agency
345 Courtland Street
Atlanta, GA 30365

Reference PSD-FL-050; KILN # 3

In accordance to your letter of March 4, 1982 and pursuant to Section 114(a) of the Clean Air Act, enclosed please find a source test for particulate, sulfur dioxide and nitrogen oxides on our Kiln #3 conducted April 30, 1982. results listed in table

In conjunction with the source test a pre-test meeting was held with Mr. Jim Littell of EPA in which it was decided that due to an obstruction of one sampling ports, three ports would be utilized with an expanded number of sampling points per port. This decision was predicated upon two conditions. One, that the source test could be used to satisfy the Section 114 requirements and by Lonestar to generate data necessary to renegotiate our emission limiting standard for Kiln #3. Two, once a revised emission limiting standard has been established, if necessary, we would retest Kiln #3 for full compliance purposes using required test methods. USED 3 ports

As you can see from the results of the source test, our sulfur dioxide emissions during the test were 635 pounds per hour. These tested emissions surprised us in the light of the on-going improvements to the kiln system to reduce the sulfur dioxide emissions from the level reported during the initial July 15, 1981 test. An expanded source test consisting of six one hour sampling periods was conducted in-house on May 11, 1982, and showed a marked increase in sulfur absorption in the kiln system with a resultant reduction of sulfur dioxide emissions. The results of this expanded test showed sulfur dioxide emissions to be in a more realistic range of 300 pounds per hour.

This test data along with revised modeling analysis addressing all significant changes, and other necessary information needed for consideration of a revised emission limitation, is being put together for proper submittal. Unfortunately, the current economic situation has caused a shutdown of the entire cement production facilities which may cause a delay in acquiring some of the necessary information.

Additionally, please note the corrections on Page 1, and 2 and Page 2 of the Appendix C to the submitted test report. Should you need anything further regarding the source test, please feel free to contact me.

Sincerely,

Scott Quaas
Environmental Specialist

Attachments
SQ/jh
cc: D. Coppinger
A. Townsend
T. Mendez

LONESTAR FLORIDA/PENNSUCO, INC.
Cement and Aggregate Division
Post Office Box 122035
Palm Village Station
Hialeah, Florida 33012
(305) 823-8800

November 19, 1982

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

Mr. Thomas W. Devine, Director
Air & Waste Management Division
Environmental Protection Agency - Region IV
345 Courtland Street
Atlanta, GA 30365

RE: PSD-FL-050; Lonestar Florida/Pennsuco, Inc.; Kilns 1, 2 and 3; Request for Revision of Sulfur Dioxide Emission Limitations

Dear Mr. Devine:

In accordance with my letter to you dated November 2, 1982, the following items are enclosed to assist your office in revising the above referenced permit:

1) A revised air quality modeling analysis addressing significant changes which would influence the model predictions and which shows compliance with applicable ambient air quality standards.

2) A revised BACT analysis showing that alternate controls for SO_2 emissions are unwarranted. Retrofitting the three existing kilns with additional or alternative control devices would have only minimal effect on emissions, would have an insignificant effect on reducing ambient air impacts, and would prohibit the company from implementing the complete conversion of its kilns to coal. The analysis also contains an explanation of operating variables in a Portland cement kiln and the resulting effect on SO_2 emissions.

3) A summary of recent stack tests including SO_2 absorption calculations with resulting emission estimates for kiln 3.

Mr. Thomas W. Devine, Director
November 19, 1982
Page 2

Based upon these materials Lonestar respectfully requests a revision to the SO_2 emission limiting standards in the above PSD permit as follows:

Kiln 1	100 lbs/hr.
Kiln 2	100 lbs/hr.
Kiln 3	400 lbs/hr.

We look forward to answering any questions you may have and meeting with you at an early date to discuss this request.

Sincerely,

Scott Quaas

SCOTT QUAAS
Environmental/Specialist

cc: S. Smallwood-DER

PS Form 3811, Jan. 1979 — RETURN RECEIPT, REGISTERED, INSURED AND CERTIFIED MAIL

● SENDER: Complete items 1, 2, and 3.
Add your address in the "RETURN TO" space on reverse.

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2. ARTICLE ADDRESSED TO:
Mr. S. Smallwood
Florida Dept. Environmental Reg.
Twin Towers Office Bldg.
2600 Blair Stone Rd.
Tallahassee, FL
32301

3. ARTICLE DESCRIPTION:

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	060531	

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I have received the article described above.
SIGNATURE ☐ Addressee ☐ Authorized agent

Judy Fisher

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NOV 22 1982

TALLAHASSEE FL NOV 22 1982

5. ADDRESS (Complete only if requested)

6. UNABLE TO DELIVER BECAUSE: — CLERK'S INITIALS

☆GPO : 1979-288-848

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- [ ] RESTRICTED DELIVERY. Show to whom, date, and address of delivery. $

(CONSULT POSTMASTER FOR FEES)

2. ARTICLE ADDRESSED TO:
T.W. Devine, Director
Air & Waste Mangement Div.
Environmental Protection Agency
345 Courtland St.
Atlanta, G

3. ARTICLE DESCRIPTION:

REGISTERED NO.	CERTIFIED NO.	INSURED NO.
	060693	

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LONESTAR FLORIDA PENNSUCO, INC.
BEST AVAILABLE CONTROL TECHNOLOGY

Operating Variables that Affect SO_2 Emissions

During the operation of a wet process cement kiln there are several process variables that will affect the emission of SO_2 from the kiln's stack.

The major variable is the oxygen content of the kiln and its possible reduction/oxidation zones. The sulfur that has the potential to form SO_2 comes from the kiln feed, fuel and insulflated dust. Depending on the oxygen content in the kiln, the sulfur from the kiln feed will either stay as an oxidized sulfur compound or will be reduced to SO_2. Oxygen contents below about 0.5 percent will tend to generate SO_2 while higher oxygen contents will retain the sulfur with the feed and eventually in the clinker. This is basically a surface reaction of sulfur oxides on MgO and CaO particles and proceeds until $MgSO_4$ or $CaSO_4$ have encapsulated the particle and it has diffused to its interior.

higher O_2 lowers SO_2 emission

As the fuel burns, sulfur oxides are formed in the oxidizing area of the flame. With sufficient oxygen and contact in the kiln with the feed material, compounds such as calcium sulfate are formed and retained in this material.

As the feed material is calcinated and reaches the point of insipient fusion (clinker formation), potassium and sodium oxides are volatized and combined with available sulfur oxides to form alkaline salts in a gas reaction. These salts are very fine particles that are caught in the pollution control equipment downstream of the kiln. The return of all the dust to the kiln (insulflation) is performed as Lonestar's kiln #3. The insulflated sulfates are eventually retained with the clinker as were the sulfates in the feed material and sulfur oxides from the fuel.

The overall effect of excess oxygen in the kiln is that less than 0.5 percent will enhance SO_2 emissions and excess oxygen in the range of 0.5-1.5 percent will significantly reduce emissions. The use of excess oxygen greater than 1.5 percent can cause operational problems (too hot of a backend kiln temperature, improper clinker burning zone, kiln dusting) as well as wasting fuel by heating the excess air. The use of too little excess oxygen causes incomplete combustion and very unstable operating conditions. When an electrostatic precipitator (ESP) is used, the carbon monoxide generated can cause explosive conditions in the ESP.

Other variables for the emission of SO_2 are sulfur content of fuel, chemistry of kiln feed and kiln dust, NO_x formation and unstable kiln conditions. These factors can be significant as to

SO_2 generation, but for the specific long term operating conditions at Lonestar's kilns they are not considered as important for this analysis as is excess oxygen content.

Control Technology Available

The two types of particulate control equipment typically used to meet New Source Performance Standards (NSPS) and Best Available Control Technology (BACT) review criteria are electrostatic precipitators (ESP) and baghouses. Historically, there has been very little success in using baghouses on wet process kilns due to condensation, temperature and maintenance problems. Baghouses are usually multicompartmental with thousands of fiberglass bags for filtering the dust from the kiln gases. The collection is done on the dust cake which forms on the dirty side of the bags. When a kiln is started or stopped, there is potential for the filter cake temperature to fall below the dew point unless heated by a separate heat source. If condensation does occur (the usual moisture content of the exhaust gases is 30 percent) this cake will harden and permanently blind the bag. Another major problem with baghouses has been the inability to sustain the high operational temperatures without gas conditioning equipment (dilution air). During unstable kiln conditions this can become a problem to adequately cool or heat the bags to prevent excursions of their temperature limits or cooling below the dew point.

Another operational problem with baghouses has been maintaining the thousands of bags. The fiberglass fibers will fatigue with time or fail due to condensation or temperature and can develop pin hole leaks that will necessitate patching or bag replacement. Therefore, a routine maintenance program is a necessity to monitor the conditions of the bags and maintain the reliability of the system.

ESP's, such as those presently installed at Lonestar's kilns, do not have condensation, temperature, or maintenance problems. They do not require any auxiliary heating and can take relatively large fluctuations in gas temperatures without problem. An ESP is designed to have extensive internal maintenance during annual kiln shutdowns and not on a daily basis. It has multi-stages that the gases must travel through (not just a thin filter cake) for collection of the kiln dust. These stages are individually controlled as to voltage, amperage and cleaning cycle. Operational problems in one stage can be compensated for by externally adjusting the other stages. ESP's do not have the daily maintenance problems associated with baghouses.

With regard to SO_2 emissions, approximately 75 percent of the SO_2 is absorbed by the proper burning of the kiln and is incorporated in the clinker. EPA has stated that due to the gases having to pass through the filter cake an additional 50 percent removal of the remaining 25 percent (that is,

75% SO_2 removal

approximately 12 percent) of the SO_2 may be achieved. This was developed through review of limited testing data on several kilns in the early 1970's; however, no actual tests comparing both control devices under the same operating kiln conditions have been performed.

Furthermore, the reasonableness of that 50 percent additional removal is questionable. In a baghouse system, the gases quickly move from the inlet manifold to a compartment and through a filter cake (approximately 1/4 inch thick) and back to the clean air plenum. The residence time in the collector is much less than in a precipitator. The additional residence time in an electrostatic precipitator (ESP) allows for longer reaction time with the dust particles for good absorption.

Environmental Impacts

The ambient air quality impacts due to conversion of Lonestar's kilns are addressed in the accompanying dispersion modeling evaluation. The predicated impacts reflect SO_2 emissions using ESP's. Lonestar's maximum annual and highest, second-highest short-term predicted SO_2 impacts with ESP control are shown below in terms of percentages of the AAQS and PSD increments consumed:

Percentage of Air Quality Standards

Consumed by Lonestar Kilns 1, 2 and 3

Averaging Time	Class I Increments	Class II Increments	Florida AAQS	Dade County AAQS
Annual	15%	11%	5%	N/A
24-Hour	58%	18%	6%	59%
4-Hour	N/A	N/A	N/A	97%
3-Hour	56%	12%	5%	N/A
1-Hour	N/A	N/A	N/A	37%

N/A - Not applicable

Retrofitting all three kilns with baghouses, and adopting the undocumented assumption of 50% additional removal of the SO_2, would reduce the percentages by one half. With existing ESP control, however, Lonestar's impacts are predicted to be less than 20 percent of Class II increments and Florida AAQS. Therefore, reducing these impacts by 50 percent would not produce significant air quality benefits. In the case of Class I PSD increments and Dade County AAQS (the most stringent standards), Lonestar's impacts do not exceed 60 percent of those standards, except for the 4-hour Dade County AAQS. Therefore, even if a 50% reduction is assumed to be achievable, the ultimate benefit to the environment of such a reduction is not significant.

The impacts presented in this analysis represent the combination of maximum Lonestar production capacity and worst case meteorological conditions. For the majority of time, actual impacts due to Lonestar are expected to be far below these predicted levels.

ECONOMIC ANALYSIS

An economic analysis was performed for retrofitting baghouses on kilns 1, 2 and 3. The analysis was performed using procedures described in the August 1978 through November 1978 issues of the Journal of the Air Pollution Control Association (Volume 28, Nos. 8-11) in a series of articles entitled "Capital and Operating Costs of Selected Air Pollution Control System."

Purchased Equipment Costs:

	K 1	K 2	K 3
Flow rate, ACFM	82,000*	82,000*	311,400
Air/Cloth Ratio	2:1	2:1	2:1
Total Net Cloth Area (ft^2)	41,000	41,000	156,000
Total Gross Cloth Area (ft^2)	46,000	46,000	164,000
Insulated, suction baghouse	243,000	243,000	815,500
Bag Filters $	96,000	96,000	342,000
Fans & Motors $	13,000	13,000	41,000
1977 $	352,000	352,000	1,198,500
X 1.6 = 1981 $	563,200	563,200	1,917,500
Gas Conditioner	25,000	25,000	50,000
Total 1981 $	588,200	588,200	1,967,500

* Average of Kilns 1 and 2

Installation Costs:

Item	Cost Factor
Foundations & Supports	0.04
Erection & Handling 0.50 x 2	1.0 (retrofit)
Electrical	0.08
Piping	0.01
Insulation	0.07
Painting	0.02
Engineering/Supervision	0.10
Construction & Field Expense	0.20
Construction Fee	0.10
Start-up	0.01
Performance Test	0.01
Contingencies	0.03
Total	1.67

Total Installation Costs:

K1-	588,200
K2-	588,200
K3-	1,967,500

$ 3,143,900 x 1.67 = $5,250,313

Total Costs:

Total equipment and installation costs are estimated at:

$3,143,900 + $5,250,313 = $8,394,213

This does not include operating or maintenance costs.

Cost Benefit Analysis

Although no test data is presented to support the claim of an additional 50 percent SO_2 removal through the baghouse, for purposes of this analysis the 50 percent removal was assumed. Kilns 1, 2 and 3 are proposed to emit a total of 600 lb/hr of SO_2. Based upon maximum capacity and year-round operation, a reduction of 50 percent in emissions would equal 1,314 tons per year of SO_2. The total cost of installing baghouses on kilns 1, 2 and 3 is estimated above at $8,400,000. This cost is extremely high and does not include the substantially higher maintenance/operation costs of a baghouse. Considering that the existing ESP system is already removing up to 80 percent of the potential SO_2 emissions from the kiln system, the additional costs a baghouse system would impose upon Lonestar are not warranted.

Summary

The question of SO_2 emission control in a wet process cement kiln is not one of control equipment (which one has better control) but concerns the maintaining of sufficient excess oxygen to drive the SO_2 into the clinker material. At Lonestar's facilities the oxygen is maintained in this range (above 0.5 percent) not only for SO_2 control but to provide for complete combustion of the coal and economic benefits. Additionally, SO_2 emissions will be controlled by utilizing coal having a sulfur content of 2 percent or less.

Alternative controls for SO_2 emissions were rejected since retrofitting the three existing kilns with additional or alternative control devices would have only a minimal effect on emissions and would have an insignificant effect on reducing ambient air impacts. The costs of retrofitting would prohibit the company from implementing the complete conversion of its kilns to coal.

	[illegible]	[illegible]	2	2.1	331	306
	150.1	Oil	3	2.1	279	258
	150.1	Oil	4	2.1	478	442
	150.1	Oil	5	2.1	469	434
AVERAGE					374	346

*Based on the same gas flow rate as oil firing.

NO_x REDUCTIONS IN THE PORTLAND CEMENT INDUSTRY WITH CONVERSION TO COAL-FIRING

Presented at the 1977
Environmental Protection Agency
Emission Inventory/Factor Workshop
Raleigh, North Carolina - September 13-15, 1977

By

ROBERT J. HILOVSKY, P.E.
Supervisor, Source Test Section
Engineering Division, Eastern Zone
South Coast Air Quality Management District
Colton, California

Introduction

The cement industry is one of the nation's most energy-intensive industries - where more energy is consumed producing a dollar's worth of product than for any other major product. A report issued by the Cost of Living Council in 1973 shows that the energy cost for cement was 43 percent of the product. This figure has continued to rise with the increasing cost of fuel. The cement plants of Southern California have used natural gas as fuel, with oil as a standby energy source. The high availability of natural gas, ease of handling and its cheap cost compared to other fuels were the major factors for continuing its use. However, with the growing shortage of natural gas, estimates by the California Public Utilities Commission that no gas supplies will be available to major industries by 1980 and large price increases (38 percent in 1975) for gas, the cement industry began conversion to fuel oil and coal.

The South Coast Air Quality Management District (SCAQMD) has four cement companies (operating six different facilities) under its jurisdiction. All of these facilities are located in the Eastern Zone of the District, with five plants in San Bernardino County and one plant in Riverside County. The SCAQMD was formed on February 1, 1977, as a successor agency of the Southern California APCD. That APCD, in turn, had been formed on

July 1, 1975, from the Los Angeles, Orange, Riverside and San Bernardino County APCD's. All data referenced in this report was collected by the same group of personnel - although the organization changed names.

Background

The San Bernardino County APCD began source testing for NO_x emissions in 1969-70 for all industries in the county for both compliance and emission inventory information. The larger industries in the county were also tested on an annual basis, beginning in 1972. Variations in NO_x emissions from one facility were observed, but investigation as to the cause was not pursued at that time. The emission inventories showed that the cement industry comparatively was a very large NO_x emitter (Table I) in San Bernardino County.

TABLE I

NO_x Emissions from
San Bernardino County Cement Plants

Facility	NO_x Emissions (Tons/Day)*
California Portland Cement Co., Colton	19.10
Riverside Cement Co., Oro Grande	25.66
Kaiser Cement & Gypsum Corp., Lucerne Valley	20.42
Southwestern Portland Cement Co., Victorville	7.0
Southwestern Portland Cement Co., Black Mountain	13.44
TOTAL	85.62

*Based on an average rate of 80% production, natural gas for fuel. NO_x is reported as NO_2.

Fuel Changes and Effects Upon Pollutants

Riverside Cement Company and California Portland Cement Company filed applications in 1974 with the District to convert their rotary kilns to coal-firing. Review of these applications, in considering the possible changes in emissions, led to the analysis of the data collected from source tests on cement kilns. Analysis of these data revealed:

(1) The sulfur in the fuel oil was absorbed in the clinker manufacturing process (as sulfates or sulfides) and only very small amounts of sulfur dioxide would be emitted to the atmosphere. It was expected, therefore, that the sulfur in the coal also would be absorbed and would not cause any violation (500 ppm limit) of the District's SO_2 rules.

(2) Existing air pollution control equipment could adequately control any increase in particulate matter expected from coal use.

(3) The use of fuel oil showed a reduction in NO_x emissions, compared to NO_x from natural gas.

It is believed that when burning fuel oil in the cement kiln that it can more readily be burned with a flame that is less oxidizing than the flame resulting from natural gas combustion. (It would appear to be a "lazy" flame pattern when viewed through flame ports.) With these differences in the kinetics of combustion in the kiln, the result is lower NO_x generation when burning fuel oil in the cement kiln - compared to natural gas. The use of coal for fuel should result in an even further reduction of NO_x emissions since it typically produces a longer, "lazier" flame (with lower temperature in the center of the flame) than does fuel oil combustion in the cement kiln. In reviewing applications from the cement plants, the "Permits to Construct" were approved since it was calculated that an overall reduction in emissions into our air basin would occur.

Oil produces less NOx than gas

Coal should produce less NOx

The conversion to coal was completed by November 1974 for the Riverside Cement Company and by May 1975 for the California Portland Cement Company. Southwestern Portland Cement Company and Kaiser Cement & Gypsum Corporation switched over from natural gas to fuel oil combustion in 1976. Source testing of these units has indicated that a substantial reduction occurred in NO_x emissions into the atmosphere.

TABLE II

NO_x Reductions in Cement Kilns
Due to Fuel Changes

FACILITY	NO_x EMISSIONS[1] (TONS/DAY)			PERCENT REDUCTION
	Gas	Oil	Coal	
California Portland Cement	19.10	4.58[2]	3.50	76[2]/81.7
Riverside Cement	25.66	----	7.75	69.7
Kaiser Cement & Gypsum	20.42	15.46	----	24.2
Southwestern Portland Cement (Victorville)	7.0	4.30	----	38.2
Southwestern Portland Cement (Black Mountain)	13.44	12.06	----	10.2
TOTAL	85.62	43.07		49.7

(1) Based on 80% production rate. NO_x is measured as NO_2.

(2) Not used at this facility since conversion to coal.

Table II shows that larger reductions in NO_2 emissions are accomplished with conversion to coal-firing versus oil-firing. With the growing scarcity of petroleum products, there would be more advantages in the long run for cement plants to convert to coal-firing (directly from natural gas) rather than to oil-firing; even though a conversion to oil-firing would somewhat reduce NO_x emissions into the atmosphere. Kaiser Cement & Gypsum Corporation has filed an application for coal conversion with the District, and Southwestern Portland Cement Company has approved funds for coal conversion.

Test Methods and Procedures

Two test methods were used in obtaining the data (Appendix A) presented in this report. The Phenoldisulfonic Acid (PDS) method, which is the approved California Air Resources Board and U. S. Environmental Protection Agency reference method, was used along with a continuous electrochemical cell analyzer (Envirometrics) and recorder. Both methods well complimented each other although the analyzer was not obtained until 1972. Some early PDS data was considered invalidated when it was indicated that NO_x concentrations were over 1,000 ppm. For NO_x values near or over 1,000 ppm, the chemist performing the PDS analysis must be aware of the potentially high concentration so proper steps in the preparation of aliquot portions can be taken to assure accuracy in the analysis.

The continuous analyzer revealed variations in emissions throughout the process operations (Figure 1). For example, the concentration range for one test was 950 to 1,650 ppm NO_x, with an average of 1,490 ppm. For this example, the PDS values could vary greatly depending upon when the "grab sample" was taken, with respect to hitting "peaks" or "valleys" in the NO_x versus time curve.

Emission Factors

The five plants tested have different configurations of exhaust gas ducting and different types of control systems. This resulted in different excess-air concentrations for each test site. To obtain a correlation of NO_x emissions into the atmosphere, emission factors were generated. These are listed in Tables III, IV and V and divided into categories dependent upon (1) fuel use, (2) type of process and (3) production rate.

Conclusions and Recommendations

Table VI is a summary of the emission factors generated, and Figures 2, 3 and 4 are plots of the emission factors versus kiln capacity. The following conclusions are indicated from this data:

(1) Emission factors vary greatly depending upon fuel, type of process and kiln size.

(2) There is a significant reduction in NO_2 emissions when either oil or coal is used for fuel, versus natural gas. It appears that greater reductions in emissions are available for coal-firing versus oil-firing (Table II).

(3) The emission factors for wet-process operations tend to be lower than for those with dry-process operations (Table VI).

(4) As the capacity of the kiln increases, the emission factor decreases for dry-process operations (Figures 2 and 3) while the reverse is indicated for wet-process operations (Figures 2 and 4). There can, however, be a larger NO_x variation between kilns of the same size - especially the smaller units (Figures 2 and 3).

(5) The emission factor and NO_x reduction from natural gas-firing versus oil-firing, for dry-process kilns of 100,000 lbs/hr of clinker, were much greater than for a 175,000 lbs/hr kiln (respectively 4.53 lbs/ton and 76% reduction versus 12.05 lbs/ton and 10.2% reduction).

(6) The NO_x emission factors depend upon a number of variables, and the use of only one factor should be discouraged in estimating NO_x emissions from cement kilns.

Some of the more important variables have been covered in this paper although other factors, such as diameter of kiln, length of fire zone and dwell-time before emitting into the atmosphere, should be investigated before developing a family of curves for cement kiln NO_x emission factors.

TABLE III

Emission Factors for Cement Kilns
Using Natural Gas

Kiln	Raw Material Feed (1,000 lbs/hr)	Emission Factor (lbs. NOx/ton) Raw Material Feed	Clinker
Dry Process Units*			
RC1	64	14.3	22.4
RC2	64	13.9	21.8
RC3	64	12.6	19.7
RC4	64	13.7	21.4
RC5	64	12.5	19.6
RC6	65.7	15.8	24.7
CP1	161	13.6	20.5
CP2	161	11.9	18.7
BM	264	10.9	16.9
BM	240	11.7	18.1
Wet Process Units			
SW5	29	18.7	28.9
SW6	39	3.9	6.1
	49	9.5	14.6
SW7	40	3.3	5.1
	50	5.2	8.1
SW8	38	5.6	8.6
	46	6.5	10.0
SW9	40	8.3	12.7
	41	15.3	23.6
KC1	92.4	3.2	5.0
KC2	92.4	4.1	6.4
KC3	184	6.6	10.3
	184	6.0	9.4

*RC = Riverside Cement, Oro Grande; CP = California Portland Cement, Colton; BM = Southwestern Portland Cement, Black Mountain; SW = Southwestern Portland Cement, Victorville; KC = Kaiser Cement & Gypsum, Lucerne Valley

TABLE IV

Emission Factors for Cement Kilns
Using Fuel Oil

Kiln	Raw Material Feed (1,000 lbs/hr)	Emission Factor (lbs. NO_x/ton) Raw Material Feed	Clinker
Dry Process Units			
CP1	168	1.6	2.6
	168	4.1	6.9
CP2	168	2.9	4.9
	168	2.8	4.6
BM	240	10.5	16.1
Wet Process Units			
SW7	49	3.7	5.7
SW8	49	7.9	12.2
SW9	41	2.3	3.5
KC1	92	2.8	4.4
	92	2.9	4.5
KC2	92	3.0	4.7
	92	3.1	4.8
KC3	184	5.1	7.9

Coal NOx Emission Factors

TABLE V

Emission Factors for Cement Kilns Using Coal

Kiln	Raw Material Feed (1,000 lbs/hr)	Emission Factor ($lbs.\ NO_x/ton$) Raw Material Feed	Emission Factor ($lbs.\ NO_x/ton$) Clinker
Dry Process Units			
RC2	64	1.4	2.2
	64	3.6	5.7
RC3	64	4.4	6.9
	64	4.9	7.6
RC4	64	5.4	8.5
	64	5.6	8.6
RC5	64	6.2	9.7
	64	6.2	9.6
RC6	65.7	4.1	6.4
CP1	161	2.0	3.3
	171	2.9	4.7
CP2	159	2.4	3.7
	157	1.9	3.1

9.7 # NOx / Ton Clinker Max

TABLE VI

Summary of NO_2 Emission Factors for Cement Kilns (lbs. NO_x/ton of Clinker)

Fuel	Type of Cement-Manufacturing Process	Range	Average
Gas	Dry	16.9 to 24.7	20.4
Gas	Wet	5.0 to 28.9	11.5
Oil	Dry	2.6 to 16.1	7.0
Oil	Wet	3.5 to 12.2	5.9
Coal	Dry	2.2 to 9.7	6.2
Coal	Wet	0.72	

APPENDIX A

TEST DATA USED FOR REPORT

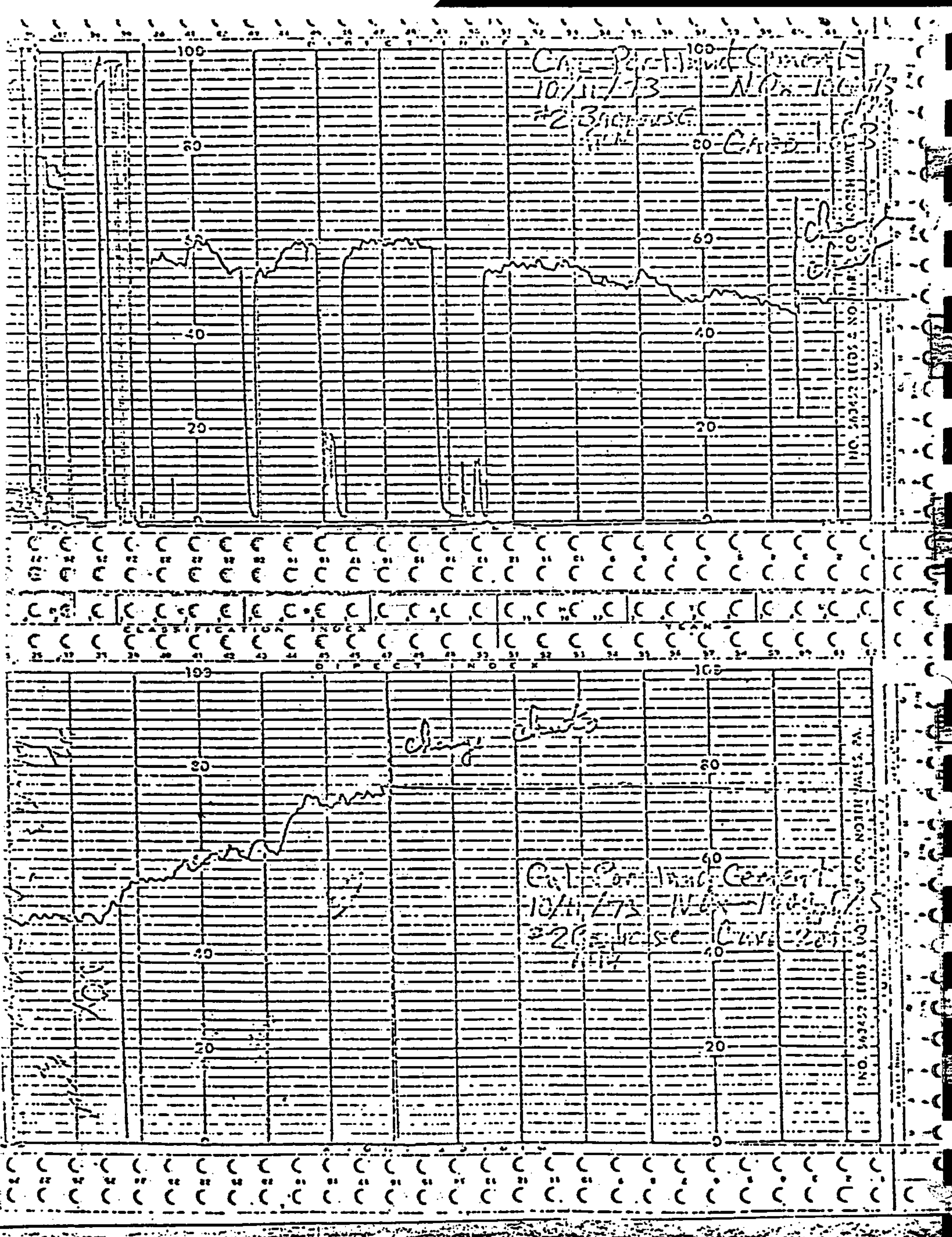
Unit	Capacity Bbl/day	Test Date	Raw Material lbs/hr	Clinker Production Tons/hr	Fuel	Flowrate DSCFM	NO_2 Emissions PPM	NO_2 Emissions lbs/hr	Emission Factor Raw Material (lbs/ton)	Cl
Dry Process										
CP1	6,500	12/28/76	151,000 (+ 20,400 coal)	50	Coal	138,555	220	221.9	2.94 (2.6)	4 (4
		6/15/76	161,000	50	Coal	150,000	150	165.1	2.0	3
		10/12/73			Gas	140,500	1,000	1,023.2	13.5	20
		1/28/70	168,000		Oil	127,900	142	132.3	1.6	2
		4/28/70			Oil	127,900	372	346.5	4.1	6
CP2	6,500	12/28/76	159,000	50	Petroleum Coke & Oil	139,597	183	186.0	2.4	3
		6/15/76	157,780	49	Coal	135,000	157	154.7	1.96	3
		10/12/73			Gas	146,600	880	939.4	11.9	13
		4/28/70	168,000		Oil	188,041	178	243.7	2.9	4
		1/28/70			Oil	188,000	169	231.4	2.8	4

Unit	Capacity Bbl/day	Test Date	Raw Material lbs/hr		Fuel	Flowrate DSCFM	NO_2 Emissions PPM	NO_2 Emissions lbs/hr	Emission Factor(s): Raw Material (lbs/ton)	C…
Wet Process										
KC1	4,000	3/5/76	136,400	Solids (92,300)	Oil	77,939	493	279.8	4.1 (2.8)*	
					Oil	78,630	503	288.0	4.3	
		5/2/72	142,588		Gas	60,933	770	341.7	4.8	
KC2	4,000	12/14/76	136,137	Solids (92,300)	Oil	57,100	710	294.9	4.4 (3.0)*	
						57,012	780	324.0	4.8	
		5/2/72	142,588		Gas	55,185	1,082	434.3	6.1	
KC3	8,000	12/16/76	273,100	Solids (184,615)	Oil	119,072	1,180	1,023.0	7.5 (5.1)*	1…
						108,443				
		10/15/73	292,786		Gas	99,600	2,000	1,450.6	9.9 (6.6)*	1…
		5/2/72	276,255		Gas	90,973	1,880	1,245.5	9.0 (6.0)*	1…

*Raw material feed of dry product excluding water

Unit	Capacity Bbl/day	Test Date	Raw Material lbs/hr	Clinker Production Tons/hr	Fuel	Flowrate DSCFM	NO2 Emissions PPM	NO2 Emissions lbs/hr	Emission Factor Raw Material (lbs/ton)	Cl
Dry Process										
RC1	2,600	3/19/74			Gas	48,917	1,288	458.6	14.3	2
RC2	2,600	5/25/76	64,000	20.51	Coal	45,990	135	45.2	1.4	
					Coal	44,478	360	116.6	3.6	
		3/19/74			Gas	44,478	1,382 (1,050-1,640)	447.6	13.9	2
RC3	2,600	5/25/76	64,000	20.51	Coal	46,520	417	141.2	4.4	(
					Coal	40,295	535	156.9	4.9	
		3/19/74			Gas	40,295	1,380 (990-1,520)	404.9	12.6	1
RC4	2,600	5/25/76	64,000	20.51	Coal	59,940	398	173.7	5.4	8
					Coal	~ 59,000	170	73.0	5.6	8
		3/19/74			Gas	~ 44,000	1,375 (1,160-1,400)	440.0	13.7	2
RC5	2,600	5/25/76	64,000	20.51	Coal	58,794	465	199.1	6.2	9
					Coal	58,800	460	196.9	6.2	9
		3/19/74			Gas	~ 48,900	1,128 (920-1,200)	401.6	12.5	19
RC6	3,000	11/12/75	63,000	20.19	Coal	44,462	400	129.5	4.1	6
	3,000	7/28/74	65,700	21.05	Gas	36,710	1,158	520.4	15.8	24
						17,997	1,609			

Unit	Capacity Bbl/day	Test Date	Raw Material lbs/hr	Clinker Production Tons/hr	Fuel	Flowrate DSCFM	NO2 Emissions PPM	NO2 Emissions lbs/hr	Emission Factor Raw Material (lbs/ton)	Emission Factor Clinker
Solids - Wet Process										
SW5	1,300	4/26/74	29,150	9.5	Gas	25,319	1,490 (950-1,650)	274.7	18.7	28.9
SW6	2,200	3/21/74	49,300	16.0	Gas	38,373	836 (700-900)	233.6	9.5	14.6
		5/12/70	39,720	12.9	Gas	29,601	362	78.2	3.9	6.1
SW7	2,200	5/12/70	40,610	13.1	Gas	30,948	297	66.9	3.3	5.1
		5/1/70	50,240	16.2	Gas	42,821	420	130.9	5.2	8.1
		4/29/76	49,318	16.0	Oil	38,240	330	91.9	3.7	5.7
SW8	2,200	5/12/70	38,610	12.5	Gas	27,747	535	108.1	5.6	8.6
		3/21/74	46,200	15.0	Gas	32,500	636	150.4	6.5	10.0
		4/29/76	49,641	16.1	Oil	40,900	659	196.3	7.9	12.2
SW9	2,200	3/21/74	40,400	13.1	Gas	36,333	631	166.9	8.3	12.7
		4/29/76	41,603	13.5	Oil	37,459	179	48.0	2.3	3.5
		6/11/75	41,600	13.5	Gas	36,200	1,212	319.4	15.3	23.6
Dry Process										
Blk Mtn	9,500	7/12/74	264,000	85.3	Gas	86,340	2,300	1,445.6	10.95	16.9
		6/11/75	240,000	77.5	Gas	86,340	2,230	1,401.6	11.68	18.1
		4/30/76	240,000	77.9	Oil	86,340	2,000	1,257.1	10.47	16.1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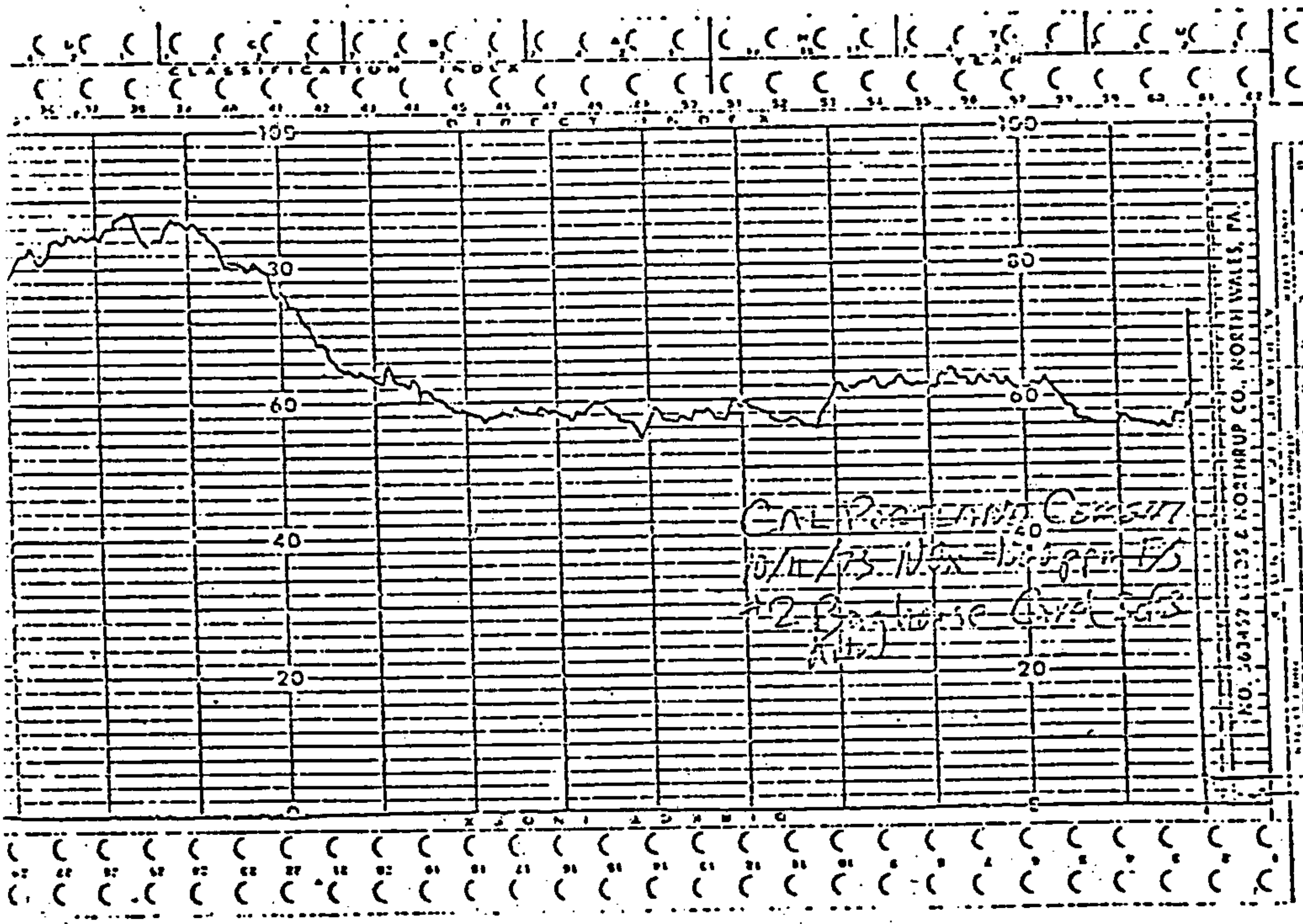
CLASSIFICATION INDEX
DIRECT INDEX


CLASSIFICATION INDEX
YEAR
100
80
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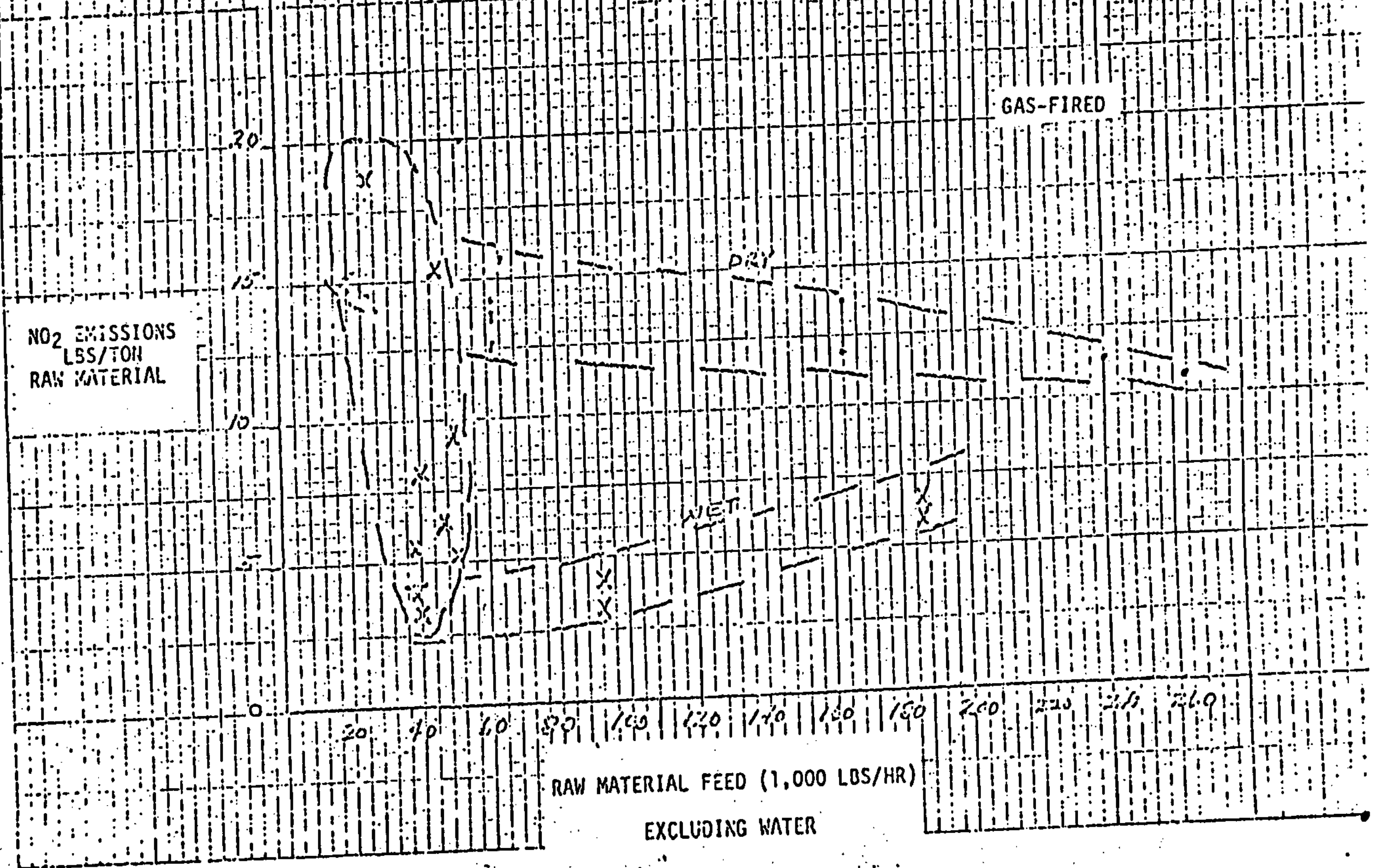
LEEDS & NORTHRUP CO., NORTH WALES, PA.
CAL PORTLAND CEMENT
10/6/83 NOx
#2 Baghouse Outlet

Figure 2

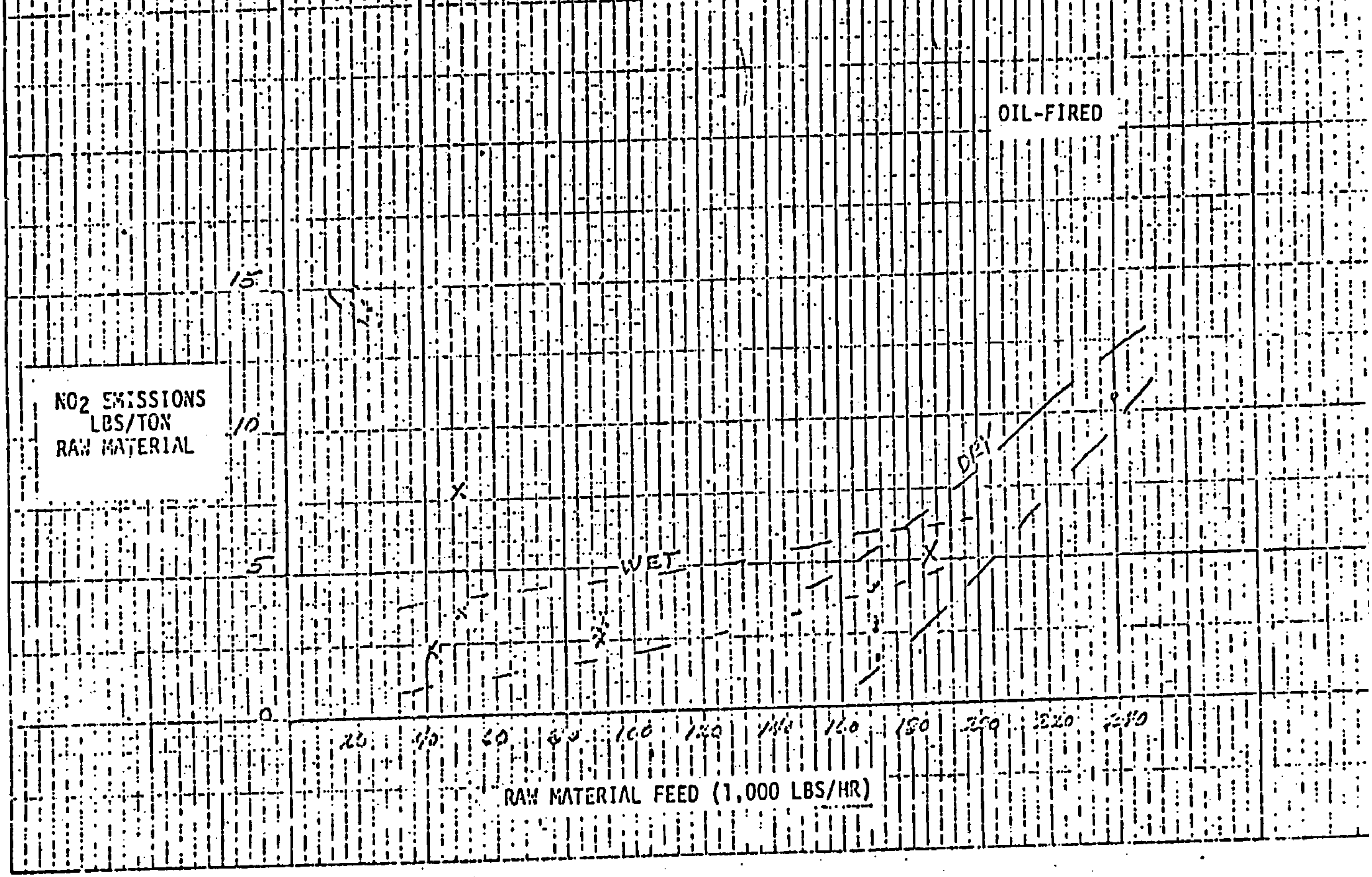


GAS-FIRED
NO2 EMISSIONS LBS/TON RAW MATERIAL
DRY
WET
RAW MATERIAL FEED (1,000 LBS/HR) EXCLUDING WATER


COAL-FIRED
NO2 EMISSIONS
LBS/TON
RAW MATERIAL
10
0
60
100
RAW MATERIAL FEED (1,000 LBS/HR)

Figure 3

Figure 4



OIL-FIRED
NO_2 EMISSIONS
LBS/TON
RAW MATERIAL
15
10
5
0
WET
DRY
20
40
60
80
100
120
140
160
180
200
220
240
RAW MATERIAL FEED (1,000 LBS/HR)

LONESTAR FLORIDA/PENNSUCO, INC.

Cement and Aggregate Division
Post Office Box 122035
Palm Village Station
Hialeah, Florida 33012
(305) 823-8800

April 25, 1980

Mr. Jack Preece
T.R.W. Environmental Engineering Division
Progress Center
3200 E. Chapel Hill Road/Nelson Highway
P. O. Box 13000
R.T.P., N. C. 27709

RE: Lonestar Florida Pennsuco, Inc.: Coal Conversion

Dear Mr. Preece:

This letter is to supplement the above captioned application, pursuant to our conversations of April 17th and 18th, and our meeting of March 11, 1980. As we discussed, Lonestar has conducted several nitrogen oxide (NOx) emissions tests on our small Portland cement kilns.

The object of these tests was to arrive at a realistically attainable emission level of NOx, which we could adhere to and at the same time produce high quality clinker. This, we found, was a most difficult determination since our test results reveal that NOx emissions vary significantly from hour to hour. These kinds of variances can be expected with any fuel fired in a cement kiln. The test data, attached, is somewhat inconclusive. The proposed fuel conversion to coal from natural gas, however, should not increase NOx emissions, and such emissions should substantially decrease.

As you know , it is well-documented in several E.P.A. publications that little is known about NOx control technologies for Portland cement kilns. Lonestar nevertheless will make every reasonable effort to minimize these emissions and at the same time produce high quality cement clinker. With these objectives in mind, we have investigated low NOx burners, in the past, but studies have shown that the state-of-the-art has not been achieved to reduce NOx in this manner without jeopardizing product quality. (Please see attached list of references.)

We therefore propose a NOx emission level of 830 pounds per hour, from the entire Pennsuco facility. This is a reduction from existing gas-fired NOx emissions from the Pennsuco plant, which, although it can vary, has been measured as high as 903 pounds per hour as shown in our application. With respect to oil, Lonestar has used oil on only four occasions in the past three years, and each instance was for environmental testing purposes only.

We believe that this level is realistic, provided it is recognized that NOx emissions tend to vary significantly as discussed above. Lonestar will adhere to this proposed level except in the event that the quality of the cement clinker becomes unacceptable.

Co won't meet NOx STD if Quality Kiln Removed

Finally, our permit application states that the nitrogen content of our coal will be typically about 3%. I am now advised that this figure is approximately 1.7%, and the application should be adjusted accordingly.

1.7% N in coal

Please do not hesitate to contact me should you have any further questions.

Sincerely,

Albert W. Townsend

Albert W. Townsend
Coordinator of Ecological Planning

AWT/dc

CC: T. Gibbs, U.S.E.P.A.
J. Bauch, D.E.R.
E. Anderson, D.C.E.R.M.

DATE	FUEL	# NOx/HR.	TONS OF CLINKER/HR.	# NOx/TONS OF CLINKER
3/20	gas	211.5	21.25	9.95
3/20	gas	109.1	21.25	5.13
3/20	gas	107.4	21.25	5.05
3/20	gas	101.8	21.25	4.79
3/20	gas	96.7	21.25	4.55
3/20	gas	95.4	21.25	4.49
3/20	gas	91.2	21.25	4.29
3.20	gas	57.1	21.25	2.69
3/20	gas	86.5	21.25	4.07
3/20	gas	89.1	21.25	4.19
3/20	gas	124.5	21.25	5.86
3/20	gas	35.6	21.25	1.68
Average		100.49		4.73
3/21	oil	148.0	25	5.92
3/21	oil	125.8	25	5.03
3/21	oil	147.7	25	5.91
3/21	oil	140.8	25	5.63
3/21	oil	143.7	25	5.75
3/21	oil	267.6	25	10.70
3/21	oil	252.6	25	10.10
3/21	oil	114.1	25	4.56
3/21	oil	81.4	25	3.26
3/21	oil	141.3	25	5.65
3/21	oil	217.8	25	8.71
3/21	oil	233.5	25	9.34
Average		167.86		6.71
3/29	gas	156	25	6.24
3/29	gas	53	25	2.12
3/29	gas	77	25	3.08
3/29	gas	63	25	3.08
3/29	gas	95	25	2.52
3/29	gas	121	25	3.8

3/29	gas	126	25	4.84
3/29	gas	94	25	5.04
3/29	gas	59	25	3.76
3/29	gas	80	25	3.2
3/29	gas	40	25	1.6
3/29	gas	67	25	2.68
Average		85.92		3.44

4/8	oil	113.3	25	4.53
4/8	oil	128.13	25	5.13
4/8	oil	125.23	25	5.01
4/8	oil	107.53	25	4.30
4/8	oil	80.34	25	3.21
4/8	oil	105.06	25	4.20
4/8	oil	111.24	25	4.45
4/8	oil	131.43	25	5.26
4/8	oil	94.35	25	3.77
4/8	oil	114.95	25	4.6
4/8	oil	88.58	25	3.54
4/8	oil	128.54	25	5.14
Average		110.7		4.43

This nitrogen oxides cap is derived as follows:

Kiln #1	25 tons clinker/hr. x 4.7 #/ton = 117.5 #/hr.	
Kiln #2	25 tons clinker/hr. x 4.7 #/ton = 117.5 #/hr.	original NOx stoc.
*Kiln #3	87.5 tons clinker/hr. x 6.8 #/ton = 595 #/hr.	

Total # of Nitrogen Oxides = 830 #/hr.

*Kiln #3 was tested in April, 1979 and test results are in the initial coal conversion submittal.

REFERENCES

1) United States Environmental Protection Agency publication, "Multimedia Assessment and Environmental Research Needs of the Cement Industry", May 1979.

2) United States Environmental Protection Agency publication, "Control Techniques for Nitrogen Oxides Emissions from Stationary Sources, Second Edition, January 1978.

3) United States Environmental Protection Agency publication, "Review of Standards of Performance for New Stationary Sources - Portland Cement Industry, March 1979.

EPA-600/7-83-045
August 1983

EVALUATION OF COMBUSTION VARIABLE EFFECTS ON NO_x EMISSIONS FROM MINERAL KILNS

by

R. J. Tidona, W. A. Carter, H. J. Buening,
S. S. Cherry, M. N. Mansour

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18006 Skypark Boulevard
Irvine, California 92714

Contract No. 68-02-2645

EPA Project Officer: Robert E. Hall

Industrial Environmental Research Laboratory
Office of Environmental Engineering and Technology
Research Triangle Park, NC 27711

Prepared for:

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT
WASHINGTON, D.C. 20460

ABSTRACT

Results of tests performed on a lime kiln, precalciner cement kiln and conventional wet process cement kiln are presented and discussed. Where applicable, the effectiveness of excess air variations on pollutant emissions are quantified and compared to previous results. Mass balances were also calculated for the two cement kilns.

Lower excess air (oxygen reduced from 4.4 percent to 2.8 percent) was found to produce a 23 percent reduction in NO_x for the lime kiln. A linear regression of the data obtained for a conventional coal-fired wet process cement kiln predicted a 38 percent NO_x reduction when the oxygen was reduced from 2 percent to 1.5 percent. However, a regression of the data predicted a 47 percent increase in SO_2 emissions when the O_2 was lowered over the same range. Combustion modifications were not implemented on the precalciner cement kiln.

A combustion tunnel was designed, fabricated and operated to determine the effect of burner operating variables on cement kiln near-flame NO_x production. The effects of combustion air preheat, carrier air dilution and fuel injection velocity were the primary variables assessed for both natural gas and coal.

At the subscale level, reducing the carrier air oxygen content from 20.9 percent to 11 percent had a significant effect on NO_x, reducing the emissions by 19 percent. Lowering the fuel injection velocity from 61.0 m/s (200 ft/sec) to 30.5 m/s (100 ft/sec) reduced NO_x by 37 percent. Reducing the combustion air temperature also has a significant impact on NO_x emissions. However, this may not be a viable control on economic grounds.

SECTION 5.0

ROTARY WET CEMENT KILN - LOCATION 9

This coal-fired wet process kiln is 127 m (415 ft.) long and 3.7 m (12 ft.) in diameter. Figure 5-1 is a sketch of a conventional process kiln. All testing was performed with the sample line located between the kiln exit and the electrostatic precipitator (ESP).

Testing was conducted at each of three conditions:

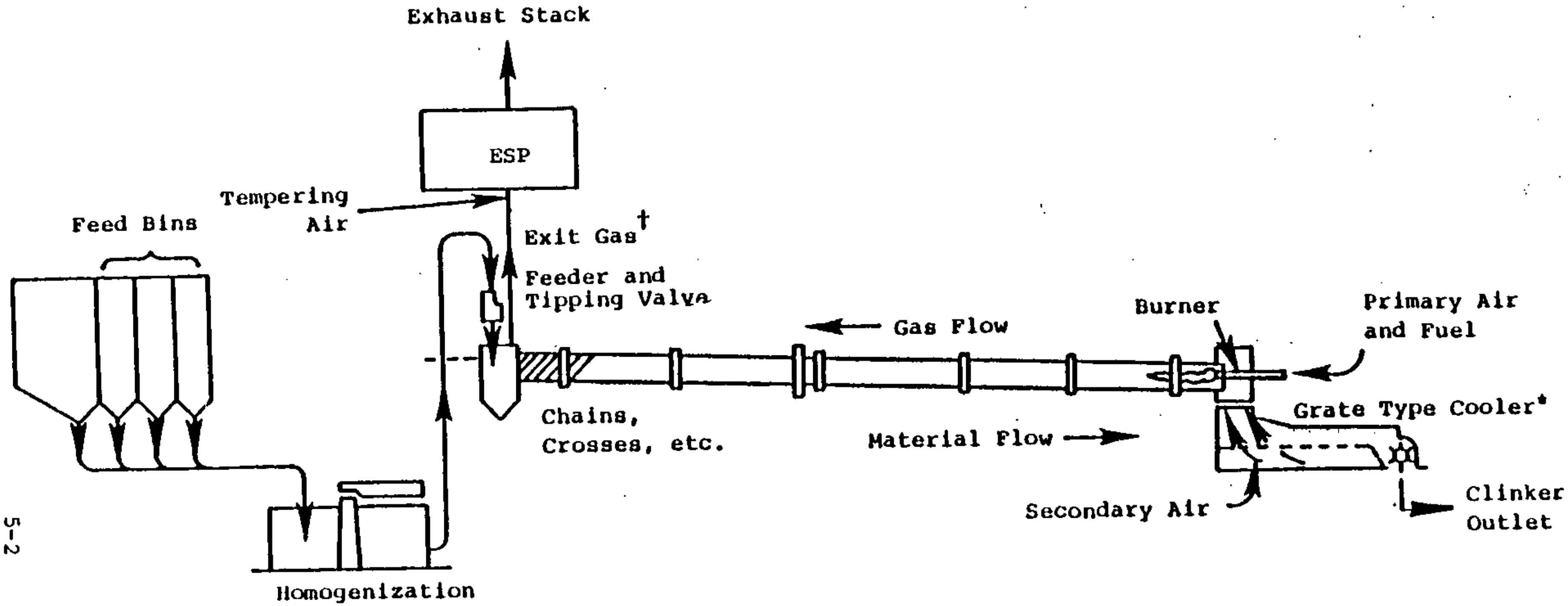
1. As found -- kiln operating under normal conditions with no attempt to control oxygen.
2. Baseline -- oxygen level maintained at nominal value.
3. Oxygen variation -- intentional variations in oxygen level.

Table 5-1 presents the kiln operating conditions (clinker rate and fuel input) and measured gaseous emissions.* Figure 5-2 is a plot of NO_x versus oxygen for all the data except those measured under kiln start-up conditions (tests 9-26 through 9-28). Also shown in this figure are the results of a linear regression between NO_x and O_2, i.e.:

$$NO_x \text{ (ppm)} = a + b\ (\%O_2)$$

This relationship was able to explain 39.9 percent of the data scatter (a rather weak, but still positive correlation) with the balance (60.1 percent) being due to other than the oxygen variation. Normal variations in the coal nitrogen content could also have a significant effect on NO_x emissions. Quantification of this effect would require, at least, an extensive coal sampling and analysis effort. In addition, the "burnability" of the feed (a measure of the clinker forming reactions), as determined from a detailed feed analysis, influences the temperature within the kiln and, therefore, the NO_x

*The column headed "Input MW" represents the fuel thermal energy input to the kiln. The appropriate conversion is: MW = 0.293 x 10^6 Btu/hr.



*Cooling air not used for secondary air is exhausted through pollution control device to atmosphere.

†Exhaust gases pass through pollution control device to atmosphere.

Figure 5-1. Schematic of a conventional process cement kiln.

TABLE 5-1. SUMMARY OF GASEOUS EMISSIONS FROM A WET PROCESS ROTARY KILN - LOCATION 9

Test No.	Time	Date 1980	Clinker Rate kg/s	Input MW	O_2 (%)	CO_2 (%)	NO_x (ppm)	NO (ppm)	CO (ppm)	SO_2 (ppm)	Comments
9-1	11:30	8-19	7.66	--	2.8	>20	199	195	129	528	As Found
9-2	12:30	8-19	7.66	--	2.5		185	182	126	924	As Found
9-3	15:30	8-19	7.66	--	1.5		179	175	108	1,624	As Found
9-4	16:00	8-19	7.66	--	2.0		155	149	161	1,934	As Found
9-5	16:30	8-19	7.66	--	1.5		183	171	120	1,691	As Found
9-6	10:00	8-20	7.76	60.5	2.8		186	183	168	2,033	As Found
9-7	11:00	8-20	7.76	60.5	2.8		--	173	188	--	As Found
9-8	12:00	8-20	7.76	60.5	3.0		166	165	175	1,207	As Found
9-9	13:00	8-20	7.76	60.5	2.8		190	188	188	1,542	As Found
9-10	14:00	8-20	7.76	60.5	2.6		158	154	166	1,773	As Found
9-11	15:00	8-20	7.76	60.5	3.1		156	151	191	1,652	As Found
9-12	16:00	8-20	7.76	60.5	2.8		157	143	184	1,368	As Found
9-13	17:00	8-20	7.76	60.5	2.9		154	152	143	1,727	As Found
9-14	18:00	8-20	7.76	60.5	3.1		143	140	191	1,288	As Found
9-15	10:30	8-21	7.99	54.4	2.9		192	185	189	1,577	Baseline
9-16	11:00	8-21	7.99	54.4	2.9		180	175	179	1,083	Baseline
9-17	11:30	8-21	7.99	54.4	2.7		179	179	167	1,738	Baseline
9-18	12:00	8-21	7.99	54.4	2.9		198	191	159	1,865	Baseline
9-19	13:30	8-21	7.99	54.4	3.6		200	193	151	754	O_2 Variation
9-20	14:00	8-21	7.99	54.4	4.1		208	199	155	815	O_2 Variation
9-21	14:30	8-21	7.99	54.4	4.0		207	196	169	712	O_2 Variation
9-22	15:00	8-21	7.99	54.4	3.9		223	218	154	467	O_2 Variation
9-23	15:30	8-21	7.99	54.4	3.9		206	195	168	881	O_2 Variation
9-24	16:00	8-21	7.99	54.4	4.6		279	269	159	244	O_2 Variation
9-25	16:30	8-21	7.99	54.4	2.5		136	126	296	788	O_2 Variation
9-26	7:30	8-23	--	--	1.2		224	214	116	1,213	Kiln under start-up
9-27	7:45	8-23	--	--	0.9	>20	201	197	1,791	>2,000	Kiln under start-up
9-28	8:00	8-23	--	--	1.2	19.8	325	318	145	982	Kiln under start-up

NO_x, NO, CO and SO_2 corrected to 3% O_2, dry.

NO_x (ng/J) = NO_x (ppm) · 0.654, includes CO_2 generation in kiln.

NO (ng/J) = NO (ppm) · 0.654.

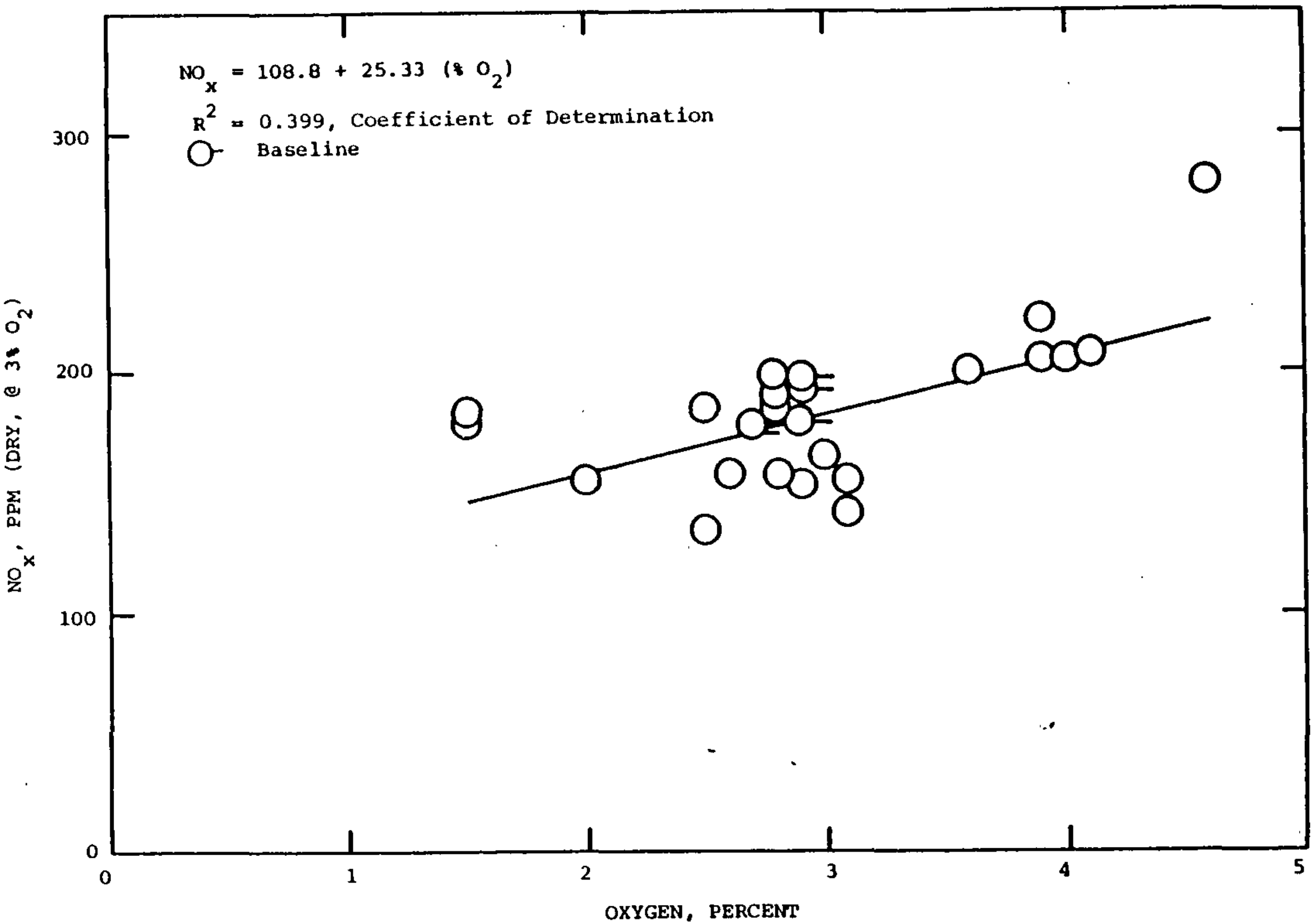


Figure 5-2. Variation of NO_x with Kiln Exit Oxygen, Location 9 Wet Process Cement Kiln

emissions. Based on the linear regression a NO_x reduction of 38 percent is predicted when the oxygen level is lowered from 2.9 percent (baseline average) to 1.5 percent.

Similarly, Figure 5-3 depicts the effect of oxygen on SO_2 emissions. The linear regression between SO_2 and O_2 is also noted and shows a decrease in SO_2 with an increase in O_2. Also, the linear regression shows that the variation in O_2 explains 43.6 percent of the variation in SO_2. This relationship predicts a 46.6 percent increase in SO_2 concentration if the operating O_2 is reduced from 2.85 percent (baseline average) to 1.5 percent.

Normal variations in coal and feed sulfur contents could have a significant effect on kiln SO_2 emissions. As was discussed for NO_x vs. O_2, quantification of this effect would require an extensive program involving the analysis of many fuel and feed samples and their relationship to the measured SO_2 concentration.

Normal variations in process operation (e.g., burning zone temperature, feed composition and fuel properties) can also affect both the NO_x and SO_2 emissions. Indeed, a linear regression performed on the NO_x and O_2 data measured during a three-hour time period on the same day (Tests 9-19 through 9-25) was able to explain 88.4 percent of the NO_x data scatter. This regression conducted with data obtained over a short period of time, when compared with the regression of all the data, illustrates that normal variations in feed and fuel properties and kiln conditions can affect the long-term relationships between NO_x, SO_2, and oxygen.

The purpose of developing the linear regressions for NO_x and SO_2 was to determine the extent to which they were related to a single independent variable, namely O_2. It was recognized that this procedure would not consider the effects of other potentially significant variables. In combustion devices where there is direct contact between the combustion products and the feed, there is some degree of interaction between the streams such that a regression in terms of multiple independent variables would be necessary to more completely describe the measured pollutant concentrations in terms of operational conditions.

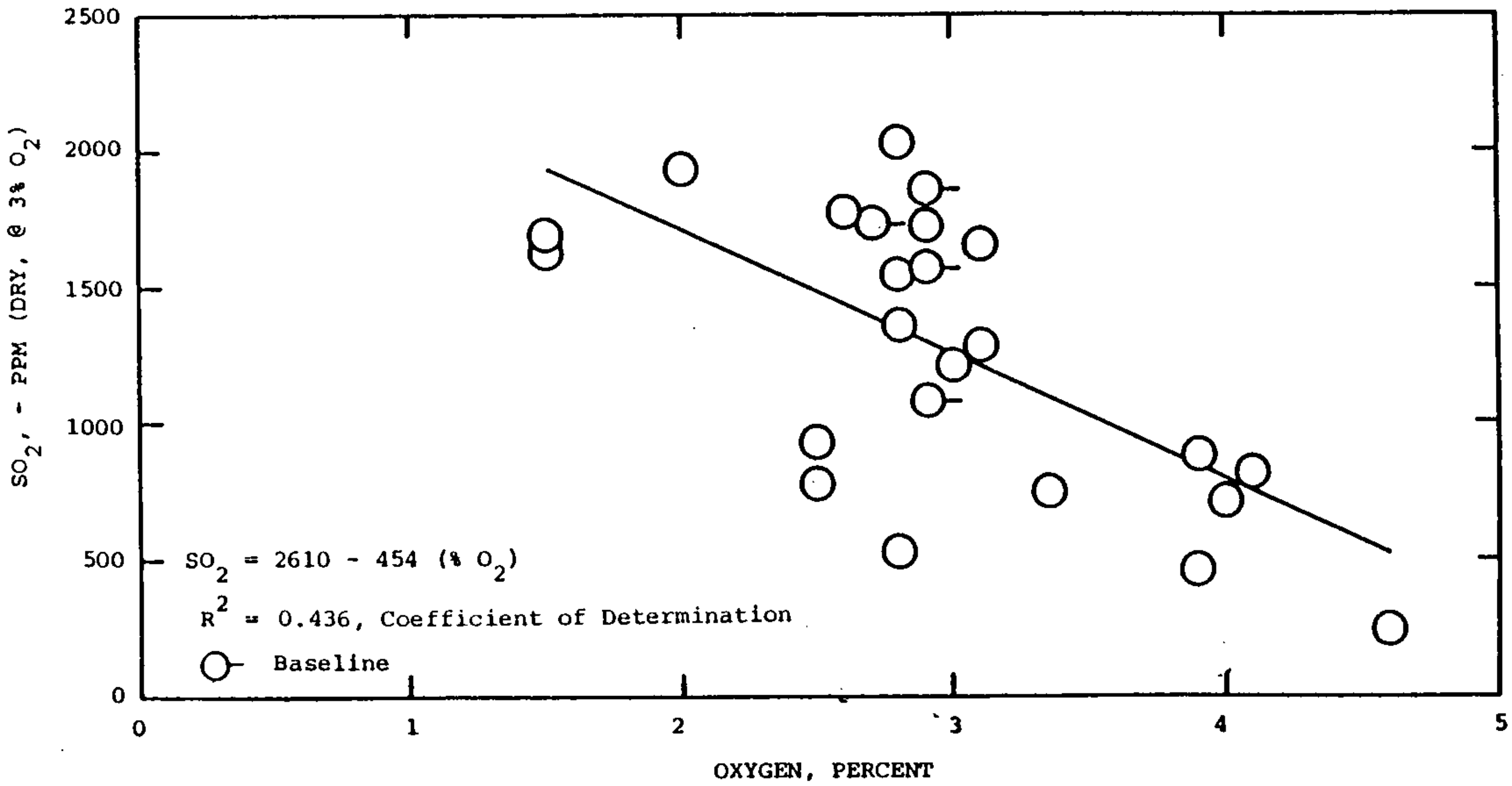


Figure 5-3. Variation of SO_2 with Kiln Exit Oxygen, Location 9 Wet Process Cement Kiln

The SO_2 dependence suggests a reaction between SO_2 and feed alkali components in the presence of oxygen. Laboratory and full-scale tests (Reference 5) have also shown that water vapor speeds up the reaction between SO_2 and alkali. In this respect the feed is performing as a flue gas desulfurization agent (Reference 6), i.e.:

$$SO_2(g) + 0.5\ O_2(g) + CaCO_3(s) + 2\ H_2O(g) \rightarrow CaSO_4 \cdot 2\ H_2O(s) + CO_2(g)$$

where

g = gas

s = solid

The above global reaction indicates that both oxygen and water vapor are required for the reaction between SO_2 and limestone (or lime).

Triplicate particulate runs were performed upstream of the ESP during tests 9-1, 9-4 and 9-18. The solid particulate results were 10,062, 11,318 and 12,023 ng/J (23.40, 26.32 and 27.96 $lb/10^6$ Btu). No particulate measurements were made dowhstream of the ESP.

On August 20, 1980, hourly samples were obtained of coal, kiln feed, clinker and precipitator catch for the express purpose of performing constituent mass balances. The sample analysis results are shown in Tables 5-2 and 5-3. (An oxide analysis of the coal ash was not performed.) X-ray fluorescence (XRF) was used by the plant for the elemental analyses. The procedures contained in ASTM C-114 were followed including equipment certification with NBS standards. In addition, a single coal sample was analyzed on both a proximate and ultimate basis (Table 5-4). As noted from Table 5-2 the coal fuel was the only source of sulfur since none was measured in the dry feed.

In addition to the coal consumption rate and clinker production rate, the precipitator catch was also measured. Not measured, however, was the kiln feed rate. This quantity was estimated on the basis that 1.67 kg of dry feed is required to produce 1 kg of clinker. This value was taken from previous tests on a natural gas-fired wet kiln (Reference 1) and includes the evolution of CO_2 gas and entrainment of a portion of the feed by the combustion

TABLE 5-2. KILN MATERIAL ANALYSIS FOR WET PROCESS CEMENT KILN - LOCATION 9

	Weight Percent (Standard Deviation)		
	Dry Feed	Clinker	Precipitator Dust
SiO_2	13.46 (0.12)	20.44 (0.20)	15.27 (0.70)
Al_2O_3	3.45 (0.13)	5.90 (0.14)	4.63 (0.27)
Fe_2O_3	1.89 (0.14)	4.10 (0.17)	1.78 (0.11)
CaO	41.82 (0.28)	64.19 (0.23)	36.06 (1.73)
MgO	2.26 (0.14)	3.65 (0.19)	2.59 (0.19)
SO_3	0	0.23 (0.09)	8.08 (0.31)
K_2O	0.53 (0.01)	0.57 (0.12)	2.81 (0.47)
TiO_2	0	0.27 (0.02)	0
Mn_3O_4	0	0.02 (0.01)	0
P_2O_5	0	0.01 (0.01)	0
Ignition Loss*	36.43 (0.10)	0	21.93 (1.05)
Total	99.84	99.38	93.15

*Weight loss due to carbonate decomposition.

TABLE 5-3. COAL PROXIMATE ANALYSES FOR WET PROCESS CEMENT KILN - LOCATION 9

Average (Standard Deviation)

Volatiles*	37.7 (0.59)
Ash*	16.3 (3.60)
Fixed Carbon*	42.8 (3.74)
Sulfur*	3.27 (0.21)
Btu/lb	11,917 (107)
kJ/kg	27,719 (249)

*Weight percent, dry basis

TABLE 5-4. COAL FUEL ANALYSIS FOR LOCATION 9 WET PROCESS CEMENT KILN

TEST 9-3

Proximate Analysis	As Rec'd.	Dry Basis	Ultimate Analysis	As Rec'd.	Dry Basis
%Moisture	2.38	xxxxx	%Moisture	2.38	xxxxx
%Ash	13.39	13.72	%Carbon	65.88	67.49
%Volatile	36.08	36.96	%Hydrogen	4.61	4.72
%Fixed Carbon	48.15	49.32	%Nitrogen	1.17	1.20
	100.00	100.00	%Chlorine	0.10	0.10
			%Sulfur	3.43	3.51
Btu/lb.	12,004	12,297	%Ash	13.39	13.72
kJ/kg	27,921	28,603	%Oxygen (diff.)	9.04	9.26
%Sulfur	3.43	3.51		100.00	100.00

products. The oxide analysis of a coal with a similar ash content was used as an input stream in the mass balances.

Mass balances were performed for aluminum, silicon, iron, calcium, magnesium, potassium and sulfur using the measured oxide concentrations in the kiln feed, clinker and precipitator catch. As previously mentioned a coal ash analysis was assumed since none was made on the coal actually used. In addition, the average flue gas SO_2 volume concentration measured during the same time period was converted to an equivalent sulfur outlet stream on a weight basis. The overall approach does not account for particulates passing through the ESP and assumes that the gaseous SO_2 is not converted to other sulfur compounds within the ESP. (With respect to ESP collection efficiency, a previous KVB test on a wet kiln (Reference 1) demonstrated an ESP collection efficiency of 99.59 percent.)

The mass balance results are shown in Table 5-5 for each individual constituent and for all the constituents. As noted, the largest difference was for iron oxide where the outlet streams exceeded the inlet streams by 29.5 percent. Part of this difference could be due to kiln metal material loss which would increase the iron content of the outlet streams (clinker and precipitator catch). Based on the sulfur mass balance it is estimated that the coal sulfur is distributed as follows:

	S in Coal
Clinker	10.3%
Precipitator Catch	23.8%
Flue Gas	54.5% — emitted
Unaccounted	11.4%
	100.0%

Thus, for this particular kiln only 54.5 percent of the coal sulfur is emitted as SO_2.

Also noted in Table 5-5 is that the overall mass balance for the seven constituents is within 4 percent.

TABLE 5-5. MASS BALANCES FOR WET PROCESS CEMENT KILN - LOCATION 9

Constituent	In Mg/d	In (tons/day)	Out Mg/d	Out (tons/day)	% Difference*
Al_2O_3	40.1	(44.2)	41.4	(45.6)	3.2
SiO_2	152.1	(167.7)	143.0	(157.6)	-6.0
Fe_2O_3	21.7	(23.9)	28.1	(31.0)	29.5
CaO	468.2	(516.1)	443.9	(489.3)	-5.2
MgO	25.4	(28.0)	25.5	(28.1)	0.4
K_2O	5.96	(6.57)	5.03	(5.55)	-15.6
S	5.98	(6.59)	5.30	(5.84)	-11.4
Total	719.4	(793.1)	692.2	(763.0)	-3.8

$*\frac{(\text{Out-In})}{\text{In}} \times 100$

The kiln heat rate varied from 7897 kJ/kg (6.8×10^6 Btu/ton clinker) to 6812 kJ/kg (5.9×10^6 Btu/ton clinker) during the test program. These values are at or below the average of 7897 kJ/kg (6.8×10^6 Btu/ton clinker) reported for a 1973 survey of wet process kilns (Reference 4).

The stack losses were computed for several of the tests and the results presented below:

Test	O_2, %, dry	Stack Loss, % of Fuel Input
9-18	2.9	11.9
9-19	3.6	12.2
9-20	4.1	12.4
9-24	4.6	12.6
9-25	2.5	11.7

As noted, the stack loss decreases (thermal efficiency increases) as the operating O_2 is reduced.

SECTION 6.0

SUBSCALE CEMENT KILN STUDIES

The objectives of the laboratory program are to identify the mechanisms of NO_x formation in the "near burner" zone within a cement kiln and to determine possible methods for the control of NO_x emissions. The results would provide guidance for the field modification of a pilot-scale unit to demonstrate advanced NO_x control approaches.

6.1 LABORATORY FACILITY

A lab-scale model of a typical cement kiln burner and furnace, capable of firing natural gas or pulverized coal, was constructed in KVB's Combustion Laboratory. The key variables investigated were fuel injection velocity, furnace temperature, preheat temperature, fuel carrier oxygen concentration, and excess air. No product was made by the furnace.

The test furnace is shown in Figure 6-1. By using a different size refractory, the furnace inside diameter can be made either 5 or 8 inches (0.127 or 0.203 m). In addition, refractories of two different thermal conductivities were used to vary the furnace temperature. These insulations were Kaiser Purotab Coarse* (high density, high thermal conductivity, 97 percent alumina) and Kaiser Purolite 30* (low density, low thermal conductivity, 54 percent alumina). At 1500°F (1089 K) the ratio of the thermal conductivities is 2.8. In subsequent discussions these insulations are referred to as "HD" and "LD", respectively. The secondary combustion air is admitted through two concentric annuli. The flow can be biased to one or the other annulus, and it is also possible to preheat one stream and not the other. The fuel carrier can be air or nitrogen, or a combination of the two. Pulverized coal, when fired, is fed to the injection pipe by a Vibra-screw feeder. Figure 6-2 shows the furnace and its ancillary equipment. Flue

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*Mention of trade names or products does not constitute endorsement by EPA.

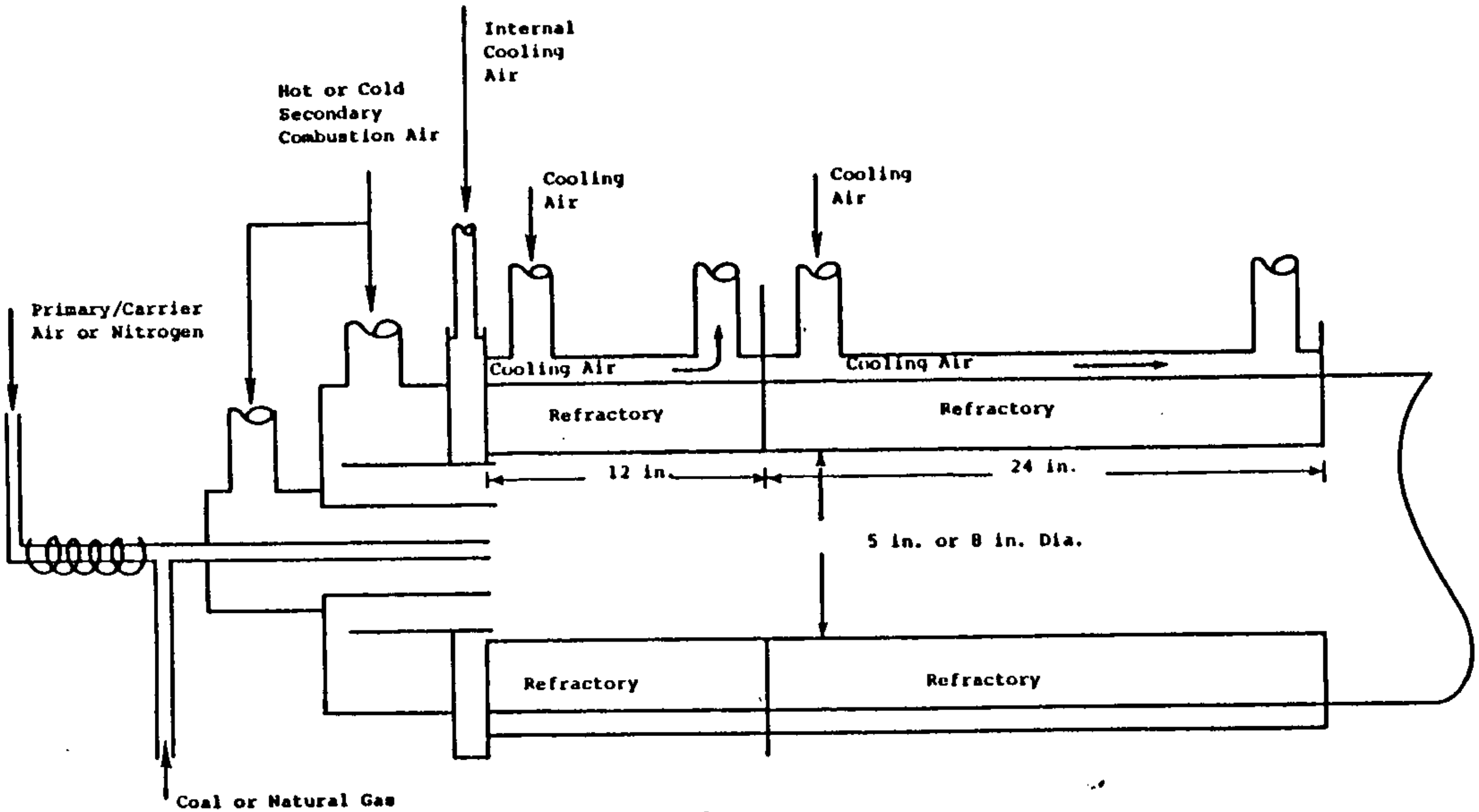


Figure 6-1. Schematic of Subscale Test Furnace

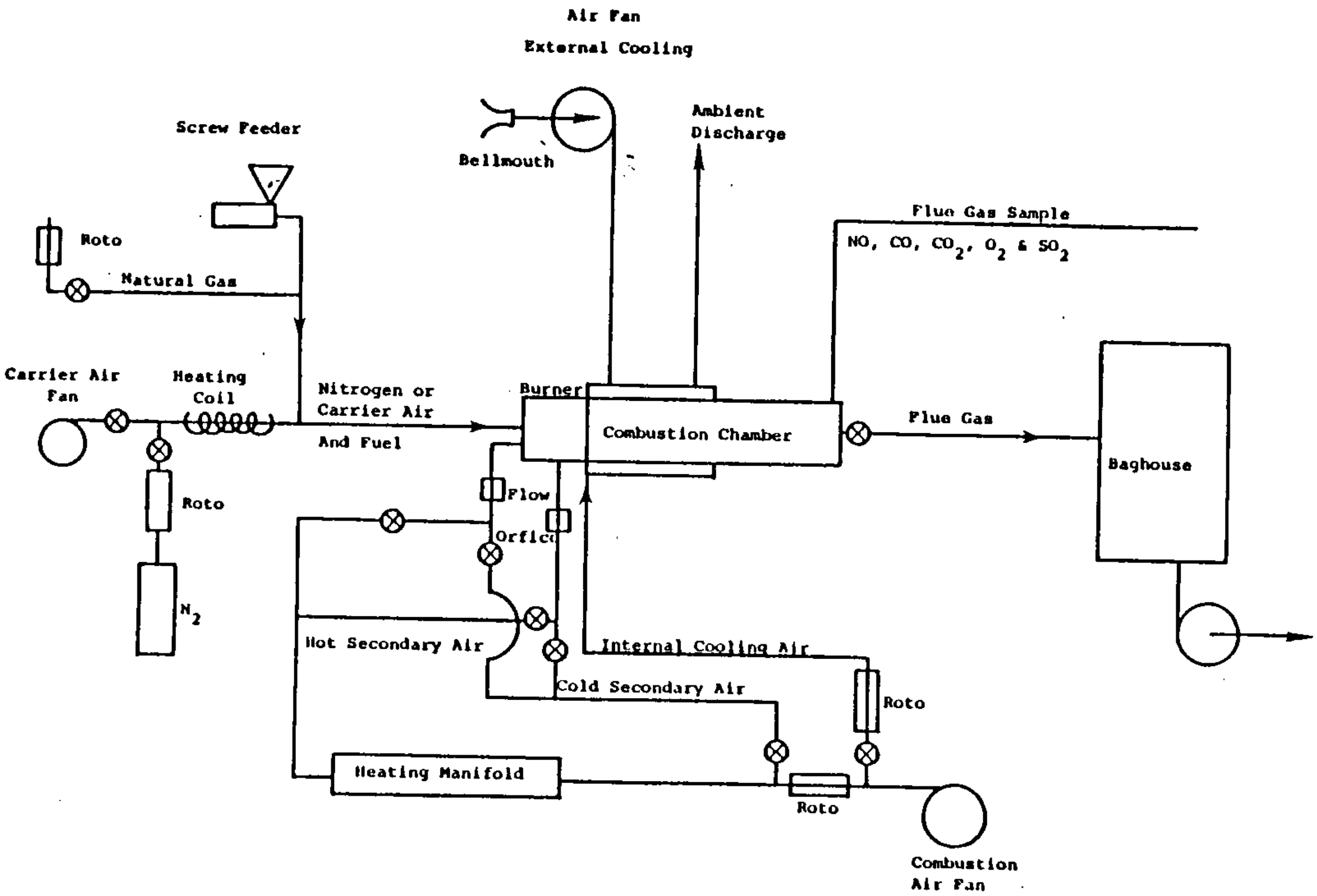


Figure 6-2. Schematic of test facility

gas is drawn from the stack and fed to continuous NO/NO_x, CO, CO_2, and SO_2 analyzers. Table 6-1 is a listing of the measurement equipment. All mass flows supplied to the furnace were monitored.

The burners used in this program for both fuels were straight sections of pipe of differing diameter. The diameters ranged from 3/16" (4.8 mm) to 1" (25.4 mm) and were used to vary the fuel injection velocity at constant heat input rate.

A combustion preheater was added to the existing test facility. This natural gas-fired preheater is supplied with air at about 900°F (756 K) from the electric heating manifold (shown in Figure 6-2) and increases the combustion air temperature to 1600°F (1144 K). Pure oxygen is added at the discharge to bring the oxygen concentration to 21 percent. The testing capabilities of the cement kiln simulation facility are primarily as follows:

- Fuel - pulverized coal, natural gas
- Combustion air preheat - 80-900°F (300-756 K) (electric preheat) - 1600°F (1144 K) (combustion preheat)
- Fuel injection velocity - 10-900 ft/sec. (3.1-274 m/s)
- Heat input - up to 230,000 Btu/hr (0.07 MW_t)
- Burner surface heat release rate - 660,000 - 1,760,000 Btu/ft^2-hr (0.018-0.048 MW_t/m^2)

The natural gas injection velocity and coal carrier gas injection velocity were calculated on the basis of their measured mass flow rate, injector area and the assumption of standard temperature and pressure at the injection plane.

Table 6-2 contains two ultimate analyses of the coal used in the program. This coal is classified as a high volatile "A" bituminous. No analysis was made of the natural gas fuel.

6.2 TEST RESULTS

This section will describe the scope of tests completed, the most significant data, and provide a summary of the key variables identified in the laboratory to affect NO_x formation in cement kilns.

TABLE 6-1. ANALYTICAL INSTRUMENTATION EMPLOYED - LABORATORY TEST FURNACE

Emission Species	Measurement Method	Manufacturer	Model No.
Oxygen	Fuel Cell	Teledyne	720P4
Carbon Dioxide	NDIR	Horiba	PIR2000
Carbon Monoxide	NDIR	Horiba	PIR2000
Nitrogen Oxides	Chemiluminescent	Thermo Electron	10A
Sulfur Dioxide	UV Spectrometer	Du Pont	411

TABLE 6-2. COAL ULTIMATE ANALYSES - LABORATORY TEST FURNACE

As Received

	Sample 1	Sample 2
Moisture	3.85	3.51
Carbon	71.31	73.54
Hydrogen	4.79	4.88
Nitrogen	1.29	1.18
Chlorine	0.04	0.05
Sulfur	1.01	1.05
Ash	8.97	7.63
Oxygen (diff)	8.74	8.16
Btu/lb	12,698	13,019
kJ/kg	29,536	30,282

Test variables examined during this program included:

- Combustion air preheat
- Oxygen concentration in carrier air
- Furnace wall temperature
- Furnace heat release rate
- Fuel injection velocity
- Furnace O_2

A review of the important results obtained during the program is presented below.

Figure 6-3 presents NO_x as a function of injection velocity for natural gas fuel with air carrier and with N_2 carrier. The data show that NO_x emissions are higher with air carrier than with N_2 carrier. The slope of the NO_x vs. fuel injection velocity curve is also greater with air carrier. This apparently results from the improved fuel/oxidant mixing when oxidant is present in both the fuel jet and the secondary air stream. The flame thus burns oxidant rich, and more O_2 is available to form NO. Another possible factor is the quenching effect of the nitrogen resulting in a reduced combustion temperature.

This effect is also noted for coal fuel as shown in Figure 6-4 which demonstrates the NO_x reduction measured when the carrier (primary) stream oxygen content is reduced by the addition of N_2. On a full-scale kiln this effect could be implemented by replacing a portion of the carrier air stream with recirculated flue gas products or other inert gas.

Figure 6-5 illustrates the effect of furnace temperature upon NO_x emissions with a pure gas fuel jet, i.e., without primary air. With high-density (high thermal conductivity) refractory and no preheat, NO_x emissions are low and the NO_x vs. injection velocity slope is very small. Preheated combustion air (800-900°F--700-756 K) in the same furnace increases NO_x emissions and the slope. When low density (low thermal conductivity) refractory was used with air preheat, the NO_x and the slope increased further reflecting a more intense and hot combustion.

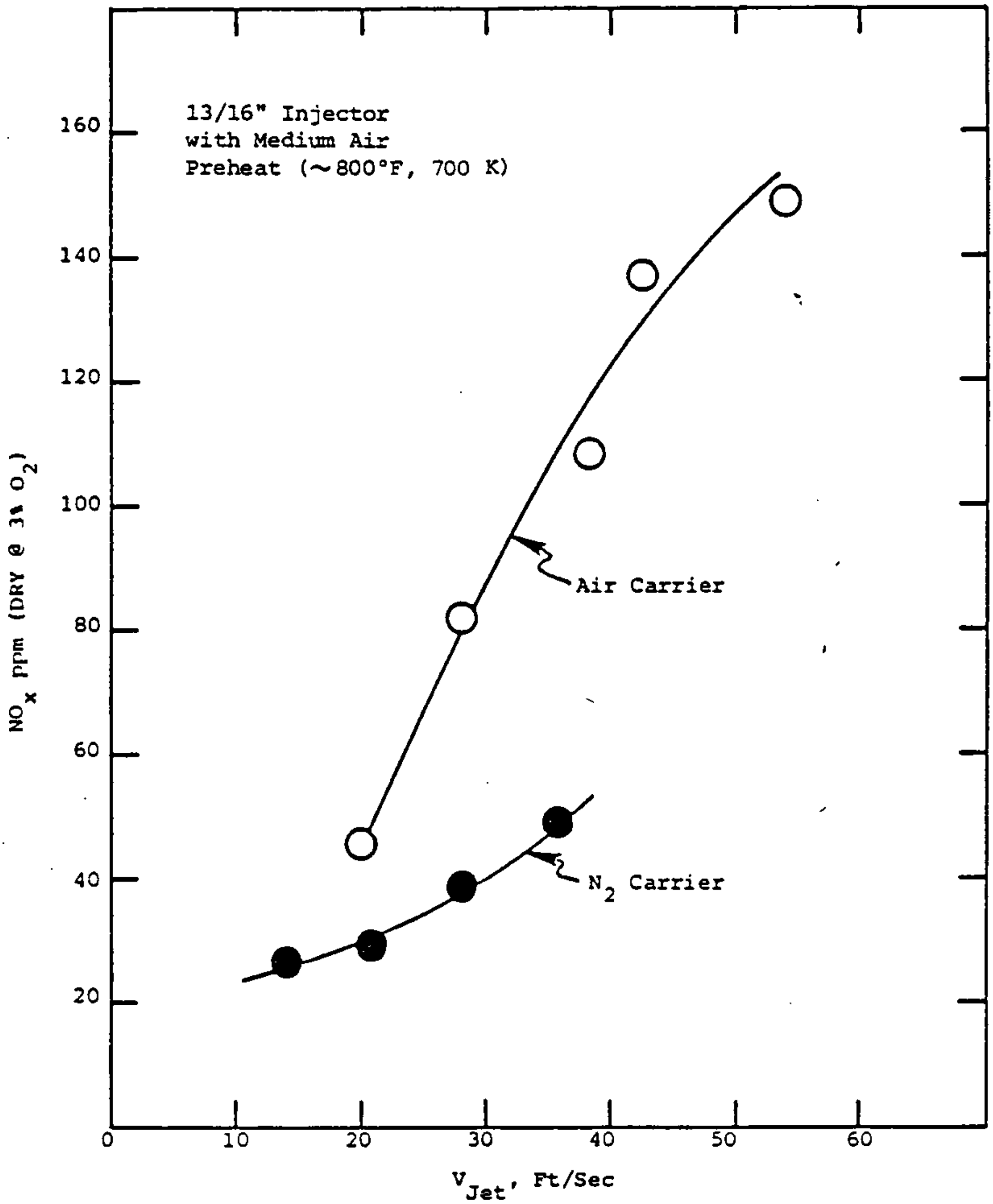


Figure 6-3. NO_x vs. Injection Velocity for Air and N_2 Carriers
Gas Fuel - 8" Furnace - HD Insulation.

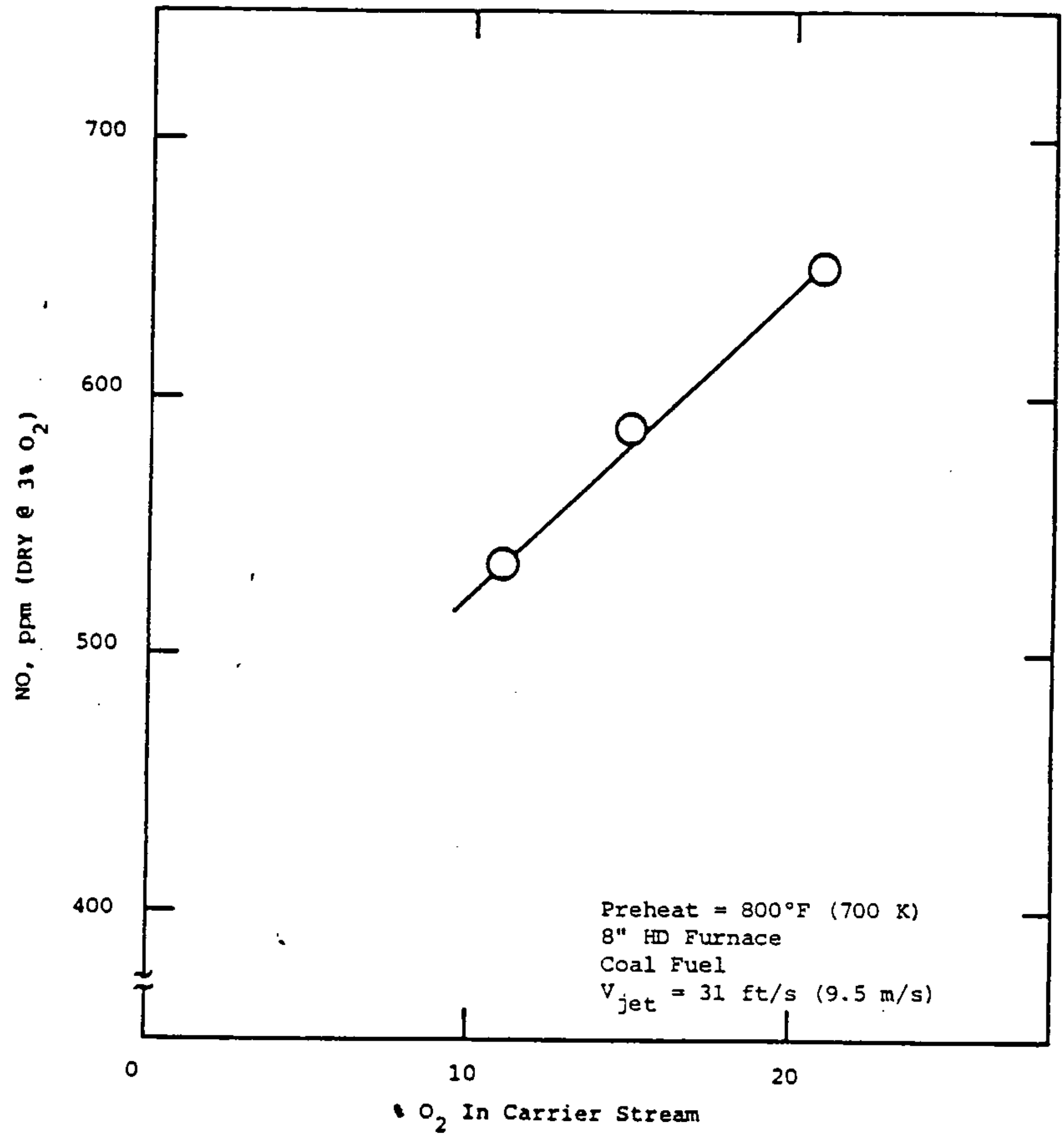


Figure 6-4. Effect of Carrier O_2 on NO_x

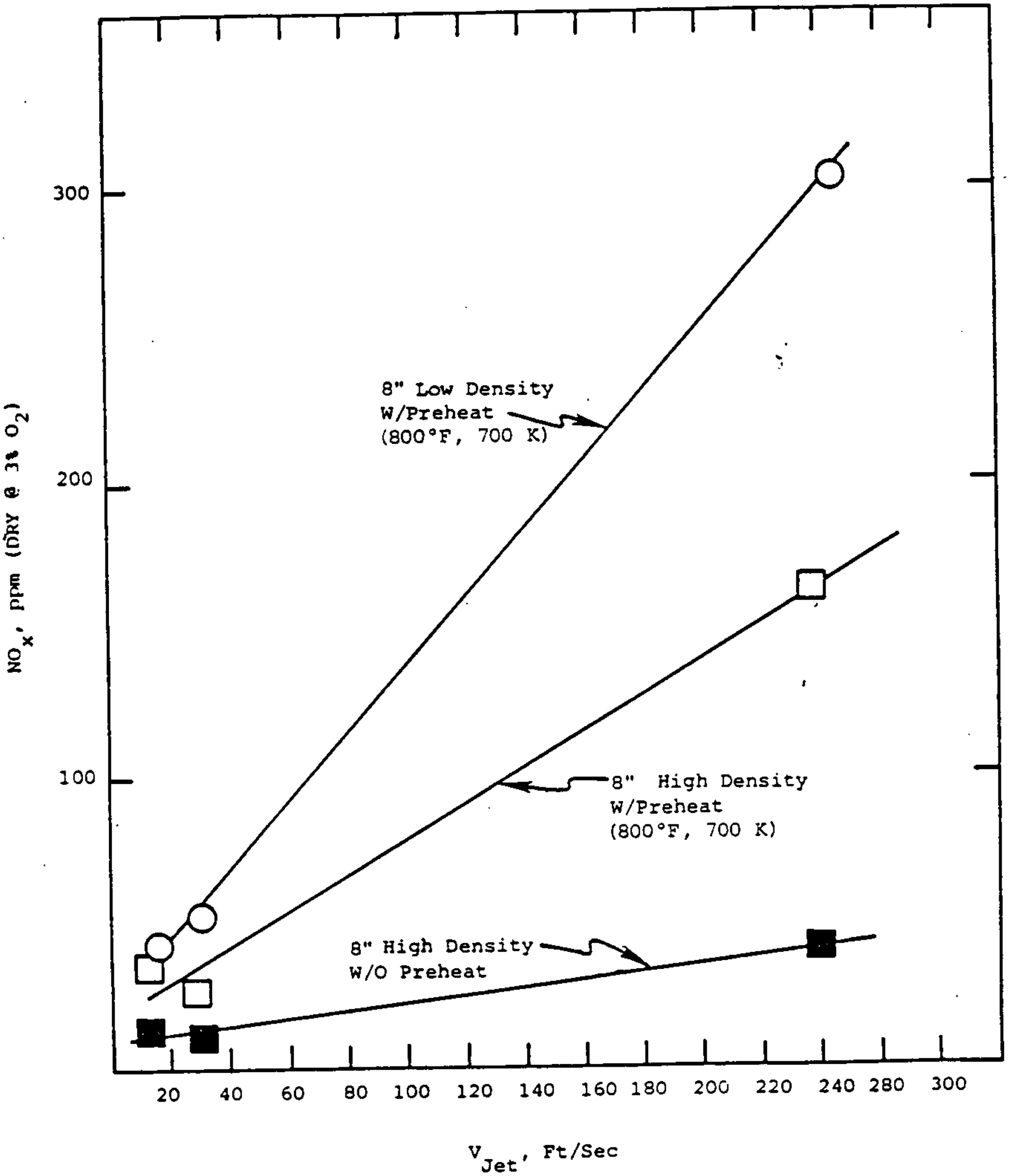


Figure 6-5. NO_x vs. Injection Velocity - Natural Gas Only.

Figure 6-6 shows the effect of preheat on NO_x emissions from coal. At the same heat input (~200,000 Btu/hr--0.06 MW_t) and injection velocity (52-55 ft/sec--15.9-16.7 m/s), a moderate level of preheat increases the NO_x emissions 40 to 60 percent, depending on excess O_2. As with the gas tests, the preheated air temperature was 800-900°F (700-756 K).

Figure 6-7 shows NO_x emissions as a function of injection velocity for gas fuel. The injection velocities were changed by varying the injector diameters. The data are presented for three levels of combustion air preheat - none, ~800°F (700 K), and ~1600°F (1144 K). The figure clearly shows the effect of high preheat upon NO_x formation. The data at high preheat suggests that the NO_x decreases at very high fuel injection velocities. This effect may be due to the decreased gas residence time within the combustor which would inhibit NO_x production. Another possible explanation would be that at very high fuel injection velocities, the mixing is so rapid that the combustion would correspond to a premixed flame for which the maximum NO_x would occur at 0 percent excess air.

The curve shown at high preheat is a quadratic regression of NO_x as a function of fuel injection velocity, i.e.:

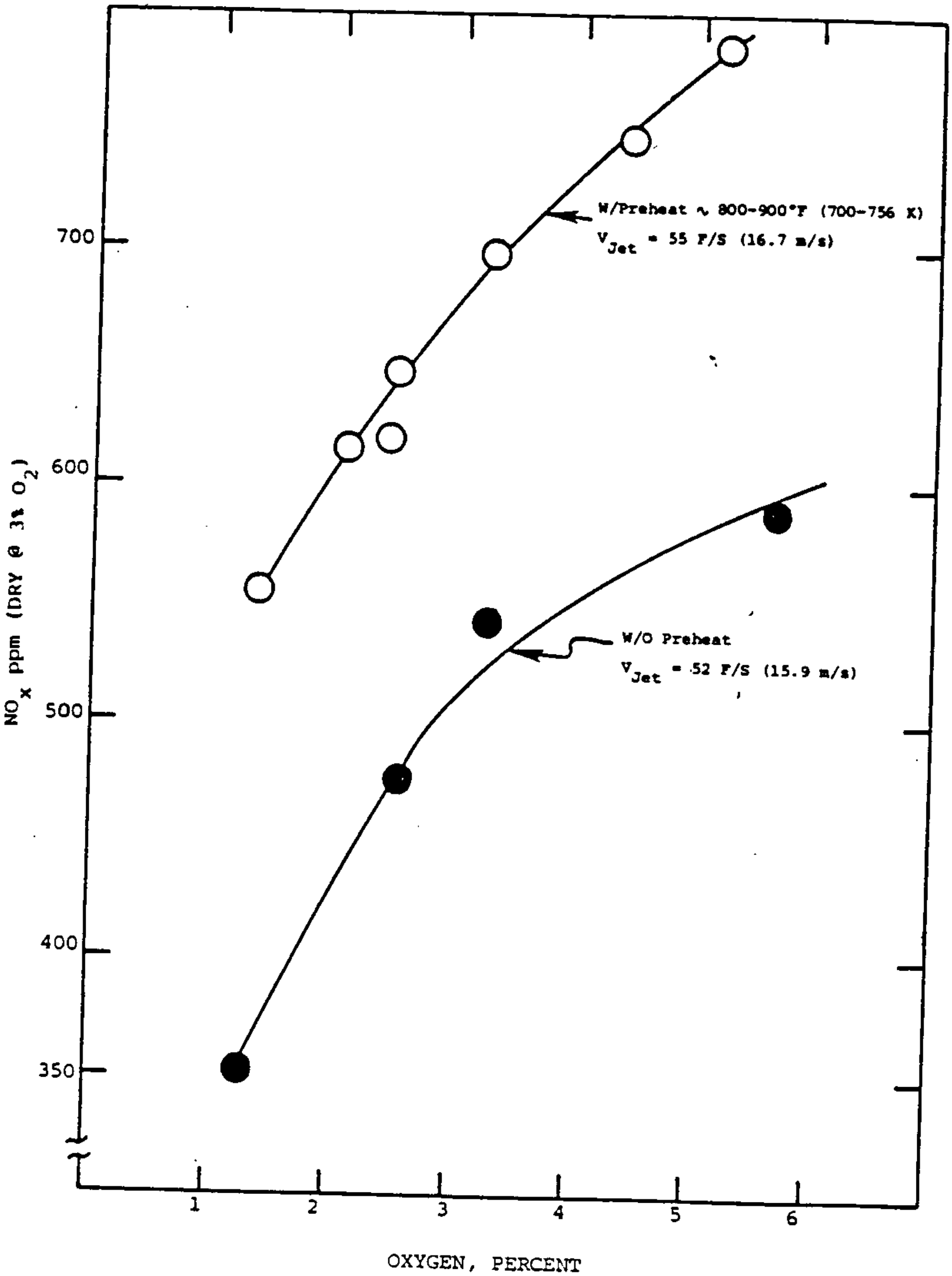
$$NO_x = a + b\,V_{jet} + c\,V_{jet}^2$$

This function is able to account for 87 percent of the data scatter. The effect of high fuel injection velocity on NO_x is less pronounced at the lower combustion air temperatures.

Several significant variables affecting NO_x formation in cement kilns have been identified. These variables are:

- Fuel injection velocity
- Combustion air preheat
- Furnace wall temperature
- Carrier gas composition
- Excess O_2

influence NOx emission



6-6. NO_x vs. O_2 - Coal-Constant V_{Jet} - 8" LD Furnace

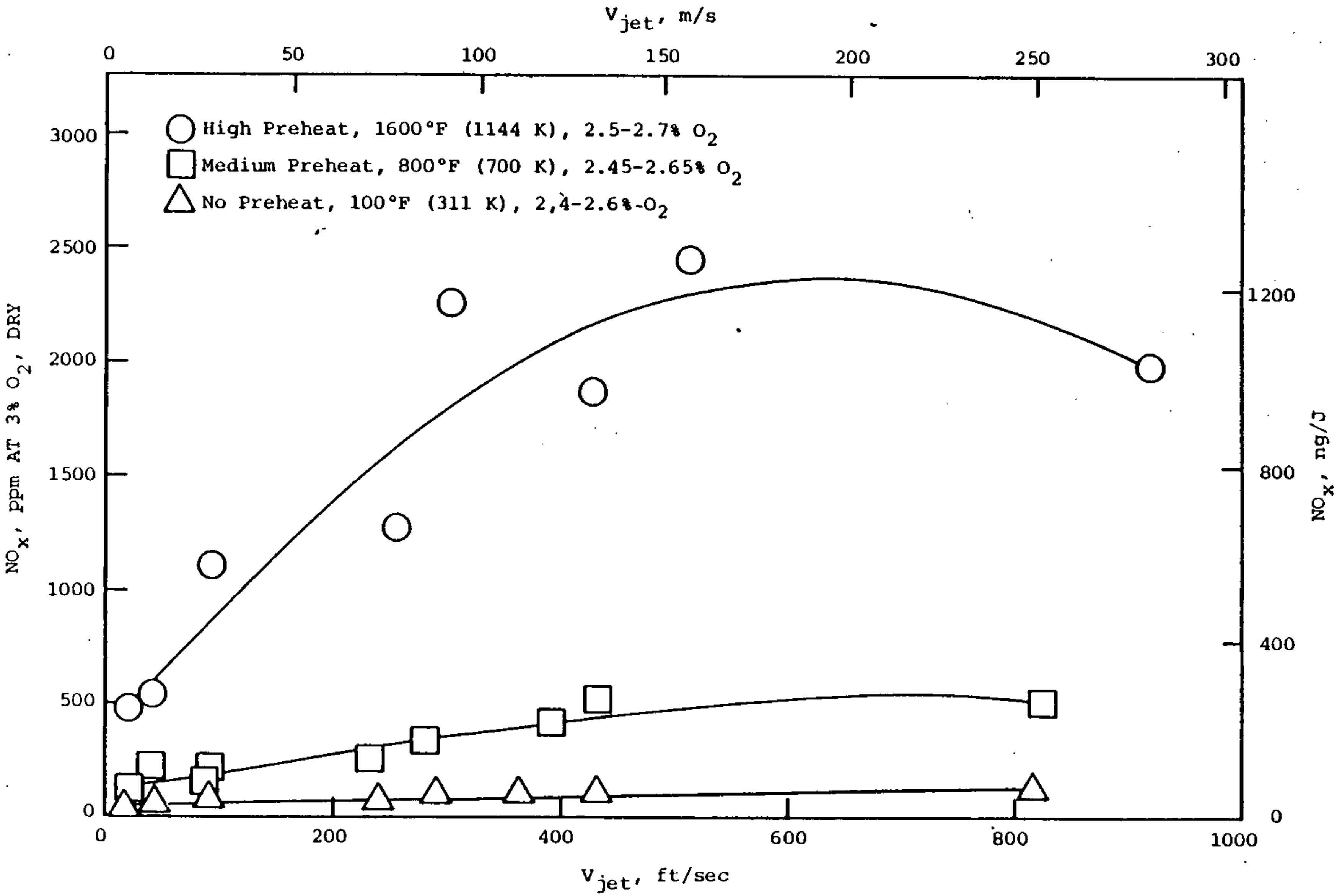


Figure 6-7. NO_x Emissions vs. Injection Velocity - Natural Gas Fuel

These results suggest a number of approaches to NO_x reduction:

- Reduce fuel injection velocity. This variable has a strong effect on NO_x emissions, but it can reduce flame geometry often essential for product quality.
- Reduce oxygen content of carrier gas. This approach would substantially lower NO_x emissions while preserving the flame geometry.
- Reduce furnace wall temperature. This can be achieved by enclosing the primary combustion zone of the flame in a water/air cooled shroud to prevent the radiation of the flame to the hot refractory or by the re-injection of cement dust in a shroud surrounding the flame to provide a heat sink for radiation from the flame and hence reduce the flame temperature.
- Distribute cold combustion air to near burner flame zone. The approach involves injecting a layer of cold air in the mixing region between the fuel/carrier jet and the preheated combustion air to act as a shield and minimize NO_x produced with high levels of preheat. Optimizing the amount of cold air would minimize the potential adverse impact on efficiency.

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Application of Advanced Combustion Modifications to Industrial Process Equipment: Subscale Test Results

by

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ABSTRACT

Results of subscale tests to evaluate combustion modifications for emission control on petroleum process heaters, cement kilns, and steel furnaces are reported. The objective was to assess applicability, NO_x emissions reductions, and cost effectiveness of several modifications and to select the most promising for pilot scale tests. Subscale process heater baseline NO_x emissions were about 55 ng/J firing natural gas at 2.9 MW heat input. NO_x was reduced by 67 percent with staged combustion and by 63 percent with flue gas recirculation. Firing No. 6 oil, baseline NO_x of 160 ng/J was reduced by 51 percent with staged combustion and by 39 percent with flue gas recirculation. Staged combustion was selected for pilot scale tests. Subscale cement kiln baseline NO_x emissions were 30 to 60 ng/J firing natural gas at about 80 kW heat input. Fly ash, kiln dust, water, and sulfur were injected separately to evaluate the NO_x reduction potential. Fly ash injection reduced NO_x emissions by 28 percent, while the other injectants reduced NO_x by 12 to 20 percent. Further work at a larger scale is planned prior to selecting modifications for pilot scale tests. For the subscale steel furnace, baseline NO_x emissions of 115 ng/J firing natural gas at 0.6 MW heat input were reduced by 88 percent with flue gas recirculation and by 47 percent with water injection. Firing No. 2 oil, baseline NO_x emissions of 160 ng/J were reduced by 77 percent with flue gas recirculation and by 89 percent with steam injection.

SECTION 5.0

SUBSCALE TEST - ROTARY CEMENT KILN

5.1 INTRODUCTION

KVB completed a series of tests on a small pilot cement kiln. The cement kiln, located at a major cement industry association facility, has a 13 cm (5 in.) ID, 30 cm (12 in.) OD, and is 4.6 m (15 ft) in length. The maximum kiln feed rate is 0.0015 kg/s (12 lb/hr), and the unit has no air preheat capability.

All tests were conducted with natural gas fuel. The objectives of the tests were the following: to determine the effects of (1) sulfur addition either with the fuel or with the feed, (2) water injection at the burner, (3) kiln dust injection at the burner, and (4) fly ash injection at the burner on gaseous emissions, kiln operating conditions (temperature), and clinker quality.

Table 5-1 summarizes the effects of sulfur addition, water injection, and fly ash injection on gaseous emissions and kiln operating temperatures. The analysis of the clinker material from the kiln for each set of conditions was carried out by the cement association, and that information was supplied to KVB in a report which has been reproduced in Appendix B. Essentially, the injection of these materials had little effect on clinker quality according to that report. Excess air changes had more significant effects on the clinker.

5.2 EMISSIONS SAMPLING

All emissions measurements were taken from the center of the dustbox (at the back end of the kiln upstream of the cyclone as illustrated in Fig. 5-1). Flame zone temperature readings were taken with an optical pyrometer, and the cyclone inlet temperature was measured with a thermocouple. Dustbox excess oxygen measurements were verified using a portable oxygen analyzer.

TABLE 5-1. SUMMARY OF GASEOUS EMISSION DATA - LOCATION 2, RESEARCH ROTARY CEMENT KILN[1]

Test No.	Date, 1978	Kiln Feed Rate g/s (lb/h)	Heat Input Rate kW(10^6Btu/h)	O_2 %[2]	CO_2 %[2]	NO_x ppm*	NO_x ng/J	NO ppm*	NO ng/J	CO ppm*	SO_2 ppm*	HC ppm*	S Inj. %[2]	H_2O Inj. %[2]	Kiln Dust Inj. %[2]	Fly Ash Inj. %[2]	Flame Zone Temp. K (°F)	Cyclone Inlet Temp. K (°F)	Comments[3]
2/3-1	8-17	1.06 (8.4)	78.5 (0.268)	0.20	13.4	64	33	64	33	407	36	31	0	0	0	0	1839(2850)	849(1068)	Baseline - LSF
2/3-2				0.15	12.4	1.0	0.5	1.0	0.5	>1727	35	22	7.3	0	0	0	1805(2790)	849(1068)	Sulfur Injection-LSF
2/3-3		↓	↓	0.10	12.4	~1.0	~0.5	~1.0	~0.5	>1722	~860	--	25	0	0	0	1789(2760)	849(1068)	
2/3-4		0.78 (6.2)	79.7 (0.272)	0.20	11.9	0	0	0	0	>1731	685	52	14	0	0	0	1797(2775)	839(1050)	↓
2/3-5	↓	↓	78.5 (0.268)	0.40	11.9	3.1	1.6	2.6	1.3	830	350	--	0	0	0	0	1800(2780)	844(1060)	Sulfur burn-out - LSF
2/3-6	8-18	0.93 (7.4)	75.7 (0.258)	1.8	12.0	66	34	65	33	28	23	77	0	0	0	0	1761(2710)	850(1070)	Baseline - LSF
2/3-7	↓	↓	↓	2.0	11.5	58	30	57	29	19	11	85	8.1	0	0	0	1761(2710)	843(1058)	Sulfur Injection-LSF
2/4-1	8-18	0.45 (3.6)	75.7 (0.258)	2.1	9.9	63	32	44	23	19	0	40	0	0	0	0	1755(2700)	833(1040)	Baseline - HSF
2/4-2		↓		3.75	9.4	--	--	35	18	21	~125	~104	19	0	0	0	1755(2700)	836(1045)	Sulfur Injection-HSF
2/4-3		0.76 (6.0)		3.1	10.2	55	28	47	24	21	17	--	0	0	0	0	1722(2640)	833(1040)	Baseline - HSF
2/4-4	↓	↓	↓	2.4	10.4	52	27	46	24	48	485	134	18	0	0	0	1739(2670)	836(1045)	Sulfur Injection-HSF
2/5-1	8-18	0.76 (6.0)	79.7 (0.272)	2.55	10.2	58	30	45	23	24	66	153	0	0	0	0	1733(2660)	830(1035)	Baseline - HSF
2/5-2			↓	2.05	10.6	51	26	44	23	24	22	104	0	13	0	0	1755(2700)	832(1038)	Water Injection - HSF
2/5-3			79.3 (0.271)	2.2	10.6	58	30	53	27	24	25	88	0	24	0	0	1758(2705)	838(1048)	
2/5-4				2.05	10.6	54	28	45	23	52	27	88	0	59	0	0	1744(2680)	839(1050)	↓
2/5-5	↓	↓	↓	1.7	12.0	63	32	55	28	23	12	99	0	0	0	0	1766(2720)	836(1045)	Baseline - HSF
2/6-1	8-21	0.44 (3.5)	71.7 (0.245)	1.3	11.4	77	40	73	38	32	0	23	0	0	0	0	1755(2700)	805 (990)	Baseline - LSF
2/6-2		0.61 (4.8)	70.9 (0.242)	1.6	11.2	66	34	65	33	28	0	13	0	0	3.1	0	1733(2660)	803 (985)	Kiln Dust Injection - LSF
2/6-3				1.5	11.6	67	34	66	34	23	0	11	0	0	8.6	0	1694(2590)	805 (990)	
2/6-4		↓	↓	1.55	11.2	78	40	73	38	28	0	9	0	0	9.8	0	1678(2560)	803 (985)	↓
2/6-5		0.76 (6.0)	73.3 (0.250)	0.25	12.0	36	19	35	18	226	19	8	0	0	0	0	1761(2710)	816(1010)	Baseline - LSF
2/6-6				0.10	12.2	17	8.8	16	8.2	1068	20	26	0	0	3.4	0	1766(2720)	811(1000)	Kiln Dust Injection - LSF
2/6-7				0.15	12.4	44	23	40	21	1470	24	18	0	0	9.3	0	1772(2730)	808 (995)	↓
2/6-8	↓	↓	↓	0.30	12.8	76	39	72	37	296	0	37	0	0	0	0	1800(2780)	808 (995)	Baseline - LSF
2/7-1	8-21	0.76 (6.0)	73.7 (0.252)	0.4	13.2	103	53	100	51	227	22	21	0	0	0	2.2	1766(2720)	794 (970)	Fly Ash Injection - LSF
2/7-2			74.9 (0.256)	0.3	13.2	91	47	89	46	1077	0	14	0	0	0	6.6	1783(2750)	791 (965)	↓
2/7-3			73.3 (0.250)	0.3	12.8	119	61	116	60	198	11	12	0	0	0	0	1789(2760)	794 (970)	Baseline - LSF
2/7-4			↓	1.5	11.8	82	42	82	42	28	0	21	0	0	0	0	1789(2760)	794 (970)	Baseline - LSF
2/7-5			73.7 (0.252)	1.5	11.7	73	38	73	38	148	0	13	0	0	0	2.4	1791(2765)	800 (980)	Fly Ash Injection - LSF
2/7-6			↓	1.8	11.7	71	37	71	37	38	0	10	0	0	0	7.3	1755(2700)	794 (970)	↓
2/7-7	↓	↓	73.3 (0.250)	1.6	11.6	99	51	96	49	202	0	13	0	0	0	0	1778(2740)	794 (970)	Baseline - LSF

[1]Natural gas fuel used for all tests.
[2]Percent by mass of kiln feed rate
[3]LSF = Low-Sulfur Feed; HSF = High-Sulfur Feed
*dry, corrected to 3% O_2

KV3 6015-798

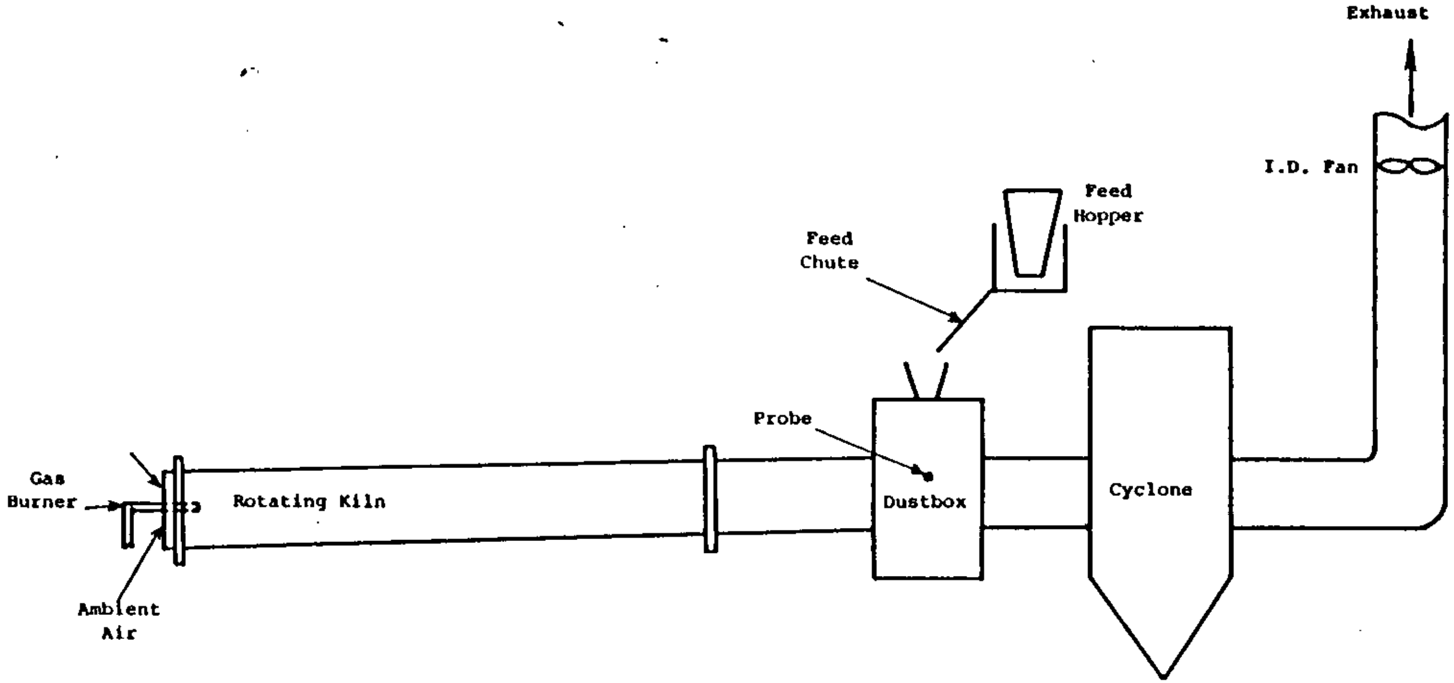

Figure 5-1. Schematic of subscale dry process rotary cement kiln (not equipped with air preheat).

The kiln feed used in the tests was pelletized from a difficult-to-burn mix. This mix was high in limestome content and contained a relatively large amount of binder material to lower the dust loading. The hard-burning mix was selected so that flame zone temperatures would be abnormally high, thus providing a worst-case situation from the standpoint of NO_x emissions.

The fuel analysis for all tests is given in Table 5-2 below.

TABLE 5-2. NATURAL GAS FUEL ANALYSIS (TYPICAL)

Component	Volume %
Nitrogen	1.7
Hydrogen	0.1
Carbon Dioxide	0.5
Methane	95.0
Ethane	2.0
Propane	0.5
Butane	0.2
High Heating value, dry, J/m^3 (Btu/CF)	37.89×10^6 (1017)
Specific gravity	0.5816

The following sections discuss each of the combustion modifications and the results obtained.

5.3 COMBUSTION MODIFICATION

5.3.1 Sulfur Addition

Sulfur was injected with the fuel at different rates for two different feed sulfur contents. The sulfur was injected through a screw feeder and blown in with air. The sulfur injection rate was determined after each test by measuring the total mass of sulfur injected and the time taken to inject it.

Under ordinary operating conditions, the dustbox oxygen is maintained at 1.0% to 2.0%. At approximately this oxygen level the maximum NO_x reductions were ~20% below a baseline value of 63 ppm (dry, corrected to 3% O_2) with the higher sulfur feed (0.99% SO_3 by weight) and 12% below a baseline of 66 ppm (dry, corrected to 3% O_2) with the lower sulfur feed (0.53% SO_3). The NO_x levels at this O_2 level did not appear to be affected by the change in feed sulfur content although a greater proportion of the total NOx occurred as NO_2 (~12%) with the high-sulfur feed. The injection of sulfur produced significant increases in SO_2 emissions when the sulfur injection rate was greater than 10% of the kiln feed rate.

At lower dustbox oxygen ($\leq$ 0.4%) the NO_x dropped sharply on the low-sulfur feed. A full 100% reduction in NO_x concentration was observed at 0.2% O_2 on the low-sulfur feed. At the same time, SO_2 emissions increased from a baseline level of 36 ppm (dry, corrected to 3% O_2) to 685 ppm (dry, corrected to 3% O_2). The large decrease in NO_x emissions may be partially a result of oxygen consumption by sulfur (to form SO_2). However, the decrease in NO_x may also have been caused by a drop in oxygen which occurred during the test. The O_2 values reported in Table 5-1 for Tests 2/3-1 to 2/3-5 are nominal values; the lag time ~ 60 sec in measuring the oxygen concentration may have resulted in readings which did not match kiln conditions precisely. [In tests subsequent to the sulfur injection tests it was determined that small changes in oxygen concentration at low (< 0.5%) produced significant changes in NO_x emissions. Special effort was made in those latter tests to hold oxygen levels constant.]

At the low oxygen conditions with the low-sulfur feed, CO concentrations went off scale (> 2000 ppm) during sulfur injection, up from an initial baseline at 0.20% O_2 of 407 ppm (dry, corrected to 3% O_2). At higher oxygen conditions, CO concentrations were generally < 30 ppm.

Figures 5-2 and 5-3 graph the relationship of NO_x emissions to (1) dustbox oxygen, and (2) sulfur injection rate for the two different kiln feed contents. (Low-O_2 conditions were not tested with the high-sulfur feed because of a shortage of feed.) Figure 5-4 shows NO_x emissions versus SO_2 emissions. However, no direct relationship between the two is implied by this graph.

5.3.2 Water Injection

Water was sprayed into the flame zone at three different flow rates for one feed sulfur content and at approximately 2% oxygen. Water was metered through a pipette and entered the kiln through a pipe next to the burner pipe.

NO dropped with O2 SO2 increased

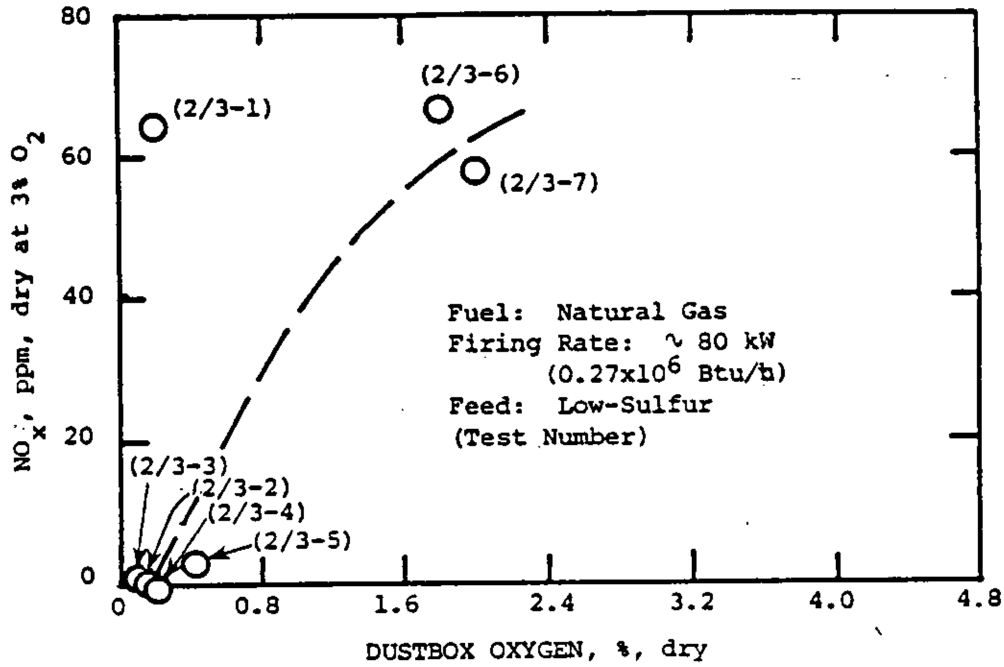

Figure 5-2a. NO_x emissions as a function of dustbox oxygen for a research cement kiln with low-sulfur kiln feed.

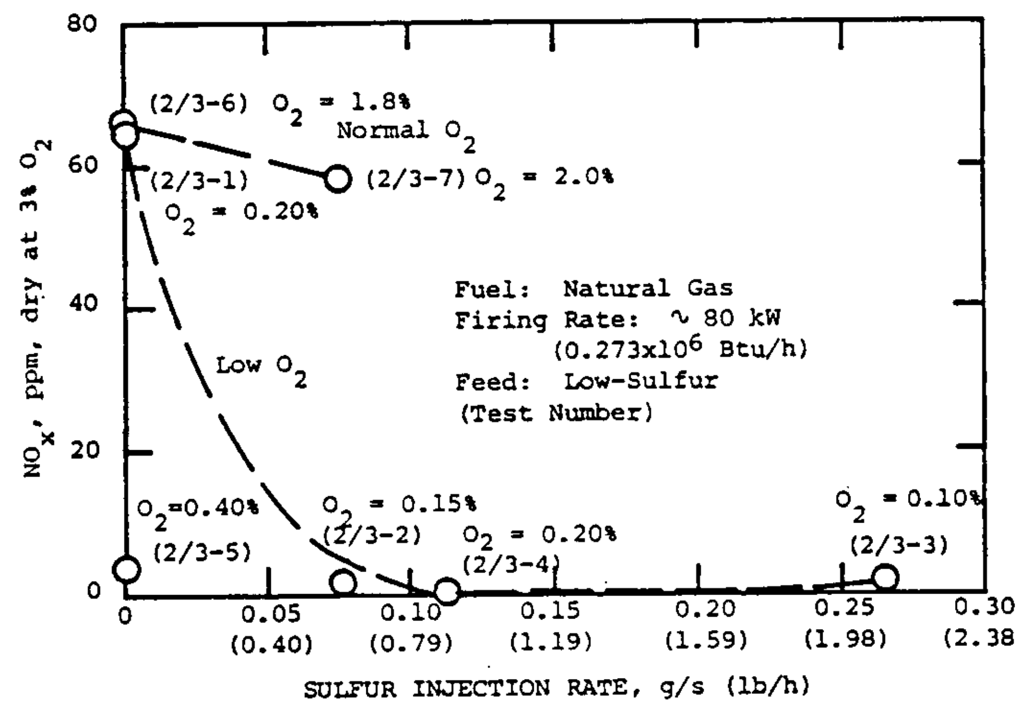

Figure 5-2b. NO_x emissions as a function of sulfur injection rate for a research cement kiln with low-sulfur kiln feed.

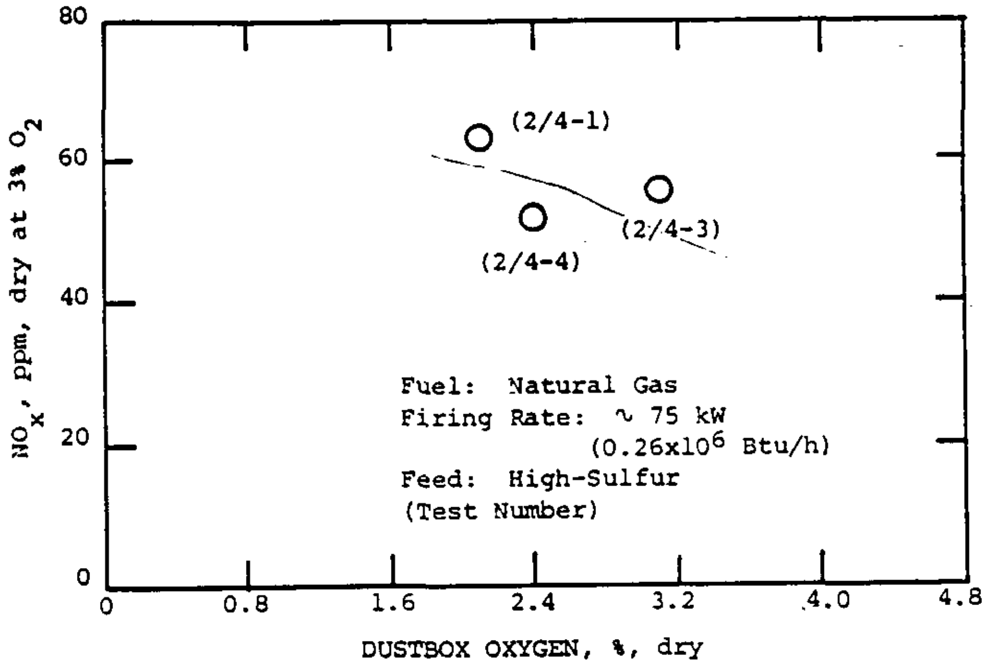

Figure 5-3a. NO_x emissions as a function of dustbox oxygen for a research cement kiln with high-sulfur kiln feed.

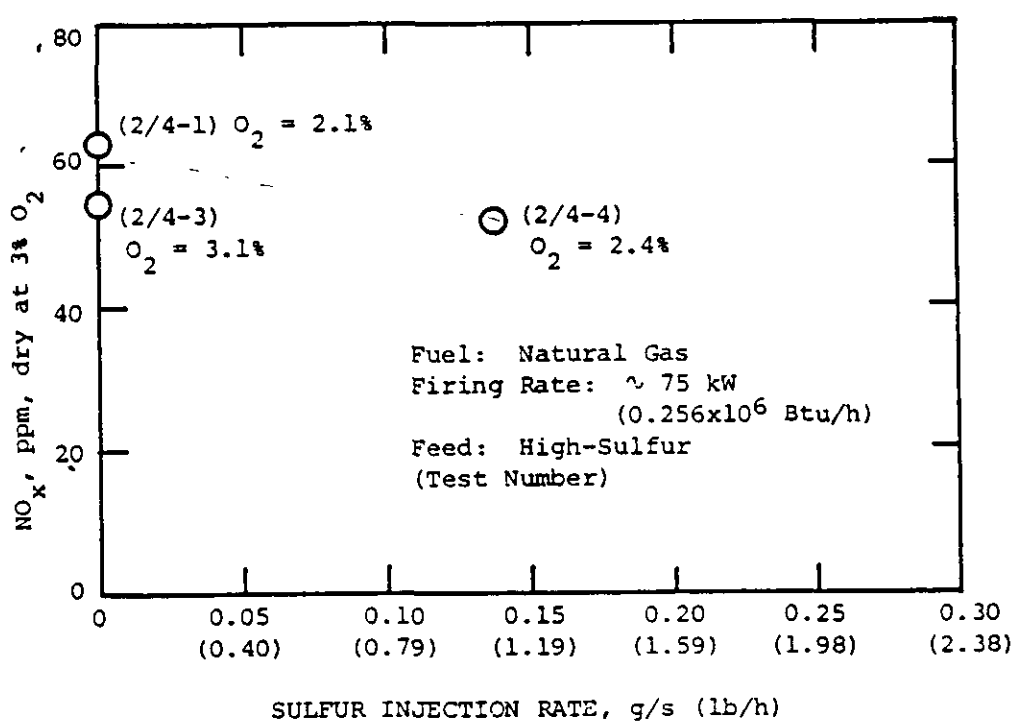

Figure 5-3b. NO_x emissions as a function of sulfur injection rate for a research cement kiln with high-sulfur kiln feed.

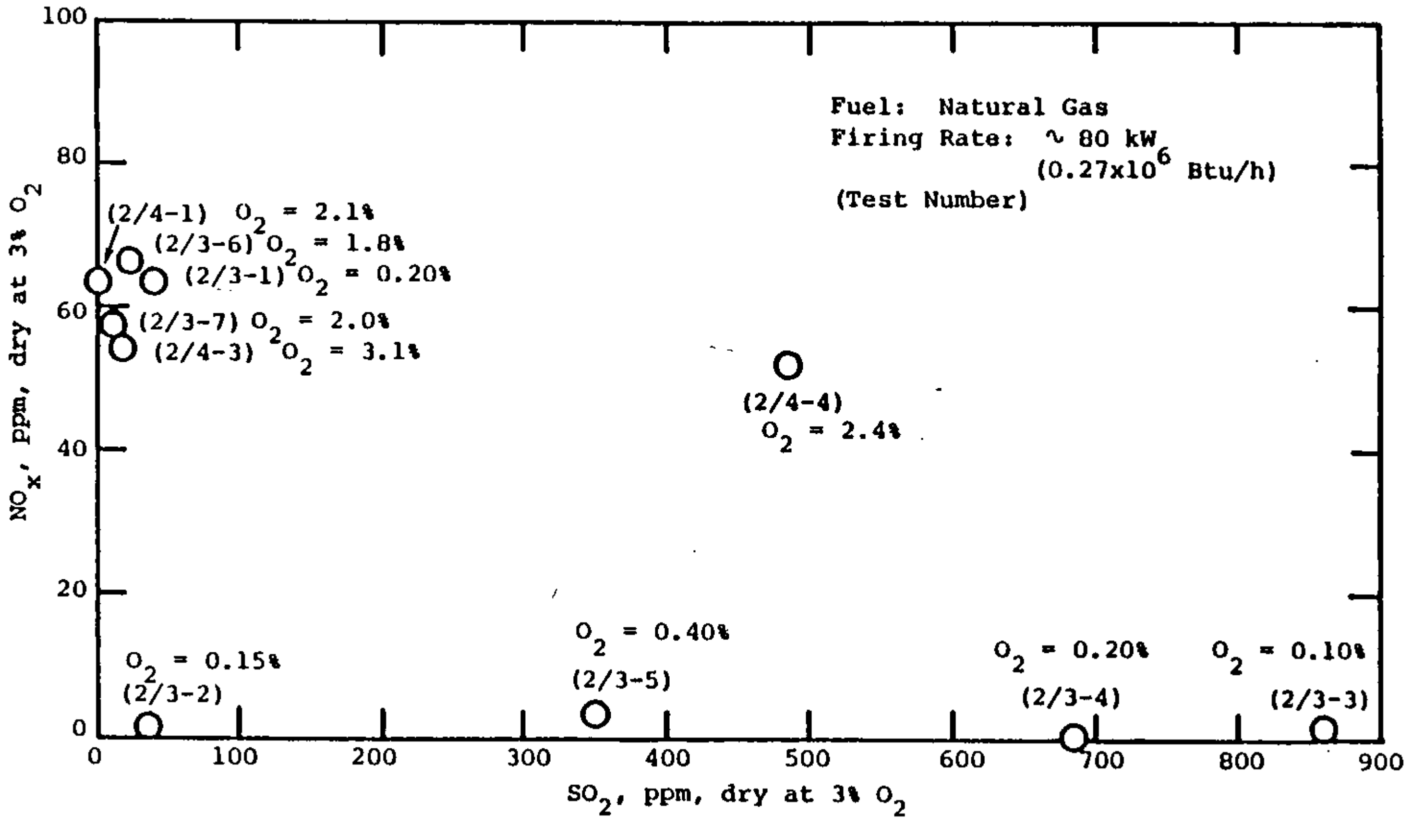

Figure 5-4. NO_x emissions as a function of SO_2 emissions for several sulfur addition rates and dustbox oxygen conditions.

Small reductions in NO_x of 12-14% below baseline levels of 58-63 ppm (dry, corrected to 3% O_2) occurred during the water injection tests. The NO_x concentration did not appear to vary significantly with the water injection rate. At the highest injection rate, however, the CO concentration was twice the baseline value (52 ppm, dry, corrected to 3% O_2 up from 24 ppm, dry, corrected to 3% O_2).

Figure 5-5 shows the relationship between NO_x emissions and water injection rate at a nominal O_2 level of 2% for the high-sulfur kiln feed.

5.3.3 Kiln Dust Injection

Kiln dust containing 6.76% sulfur (by weight) was injected at various rates and at two different oxygen conditions while burning the low-sulfur kiln feed. The injection technique was the same as that used for sulfur addition.

At a baseline oxygen level of approximately 1.5%, the maximum NO_x reduction of 14% below the baseline of 77 ppm (dry, corrected to 3% O_2) occurred with the lowest rate of the kiln dust injection (approximately 3% of kiln feed rate). Increases in dust injection rate caused the NO_x to increase rather than decrease. CO, SO_2, and hydrocarbon emissions were all very low at this O_2 level.

At the low oxygen conditions, the maximum reduction of NO_x again occurred at the smallest kiln dust injection rate (again approximately 3% of kiln feed rate). This reduction, however, was accompanied by a slight drop in oxygen similar to the drop which occurred during the sulfur injection tests. Thus, changes in O_2 may have been responsible, at least in part, for the reduction in NO_x concentration observed at less than 0.3% oxygen.

During the dust addition at the low O_2 levels the CO concentration rose to greater than 1000 ppm. SO_2 and hydrocarbon concentrations were low, however, although they were slightly higher than they had been at the higher O_2 condition.

Figure 5-6 graphs NO_x emissions versus dustbox oxygen and kiln dust injection rate.

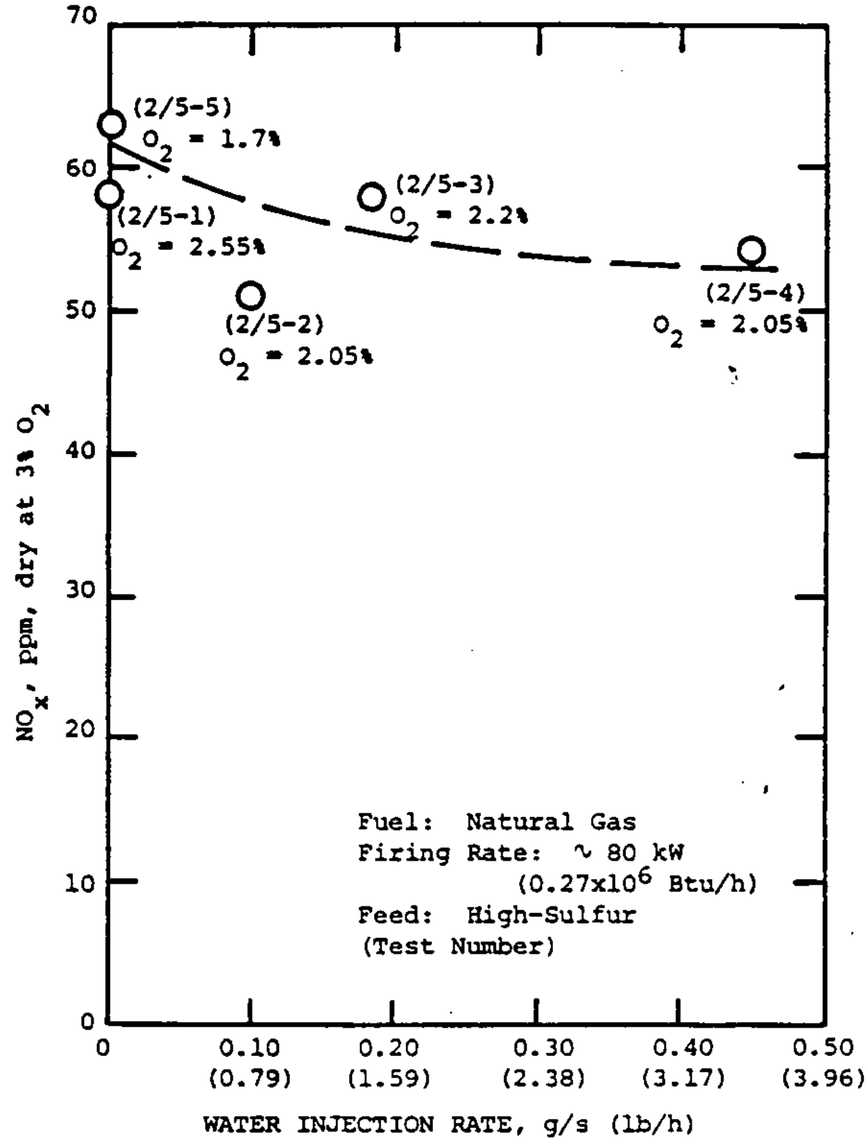

Figure 5-5. NO_x emissions as a function of water injection rate for a research cement kiln.

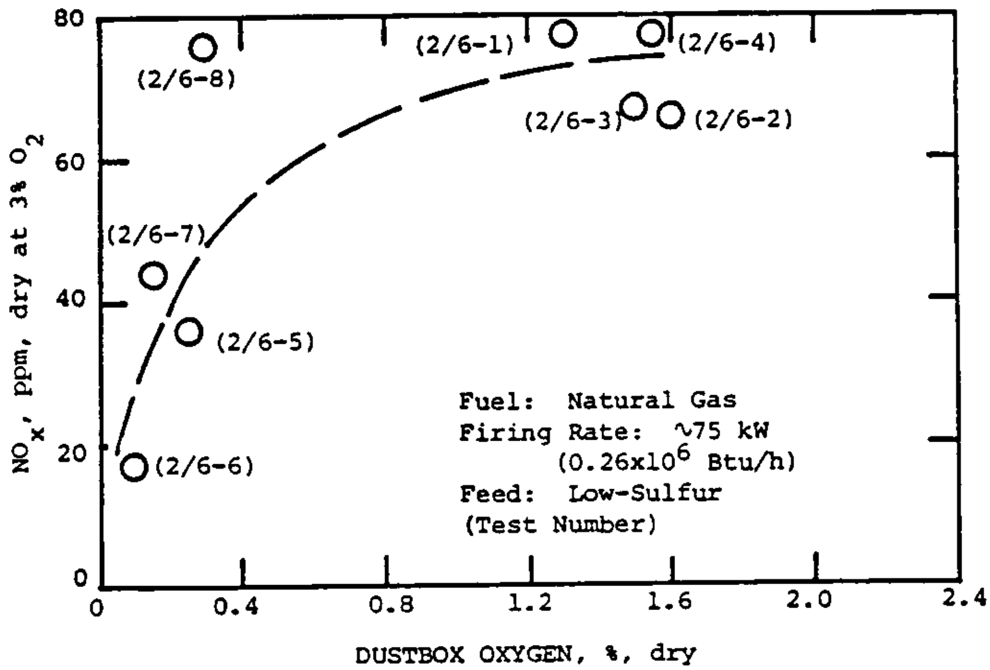

Figure 5-6a. NO_x emissions as a function of dustbox oxygen for a research cement kiln.

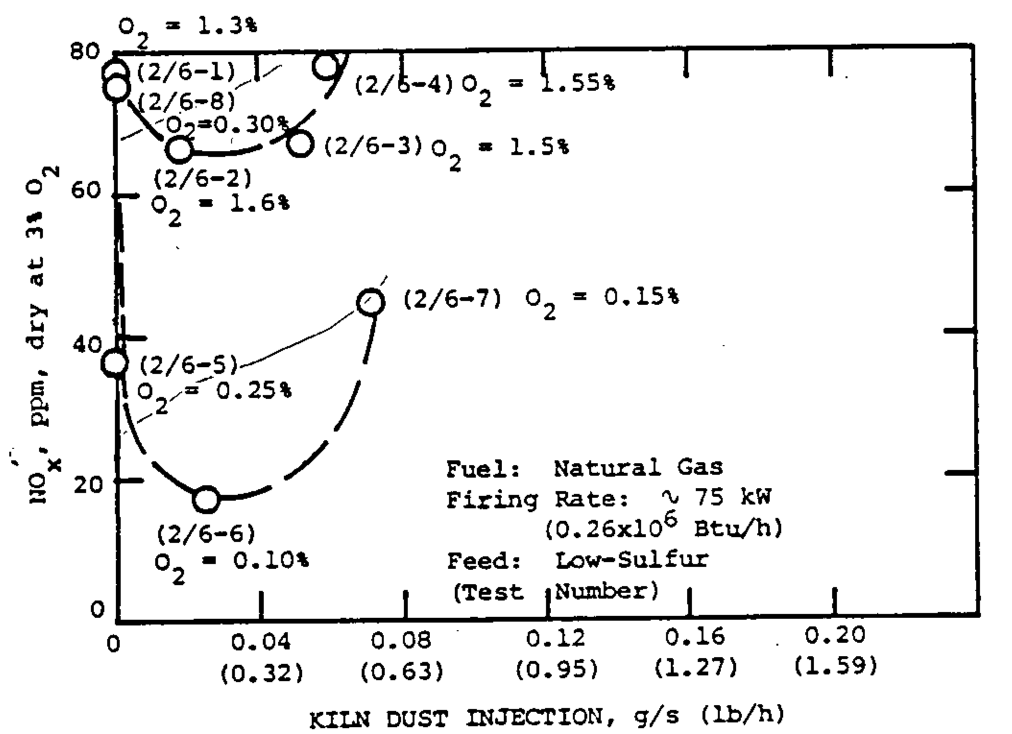

Figure 5-6b. NO_x emissions as a function of kiln dust injection for a research cement kiln.

5.3.4 Fly Ash Injection

Fly ash containing 0.16% sulfur by weight was injected at various rates and at two different oxygen levels while firing the low-sulfur feed. The injection method was that used for sulfur and kiln dust addition. Figure 5-7 shows the effects on NO_x emissions of fly ash injection rate and dustbox oxygen.

At the baseline oxygen level of approximately 1.5%, the maximum NO_x reduction of 28% below a baseline of 99 ppm (dry, corrected to 3% O_2) occurred at the maximum fly ash injection rate (approximately 7% of kiln feed rate). CO concentrations rose somewhat during fly ash injection to 100-200 ppm from a baseline level of 28 ppm (dry, corrected to 3% O_2) . Other emissions were low.

At low oxygen conditions (approximately 0.3%) NO_x values dropped a maximum of only 24% from a baseline level of 119 ppm (dry, corrected to 3% O_2). This reduction occurred at the greatest fly ash injection rate (again, approximately 7% of kiln feed rate). The CO concentration rose to 1077 ppm (dry, corrected to 3% O_2) from a baseline value of 198 ppm (dry, corrected to 3% O_2). SO_2 and hydrocarbon emissions were low.

Special effort was made during the fly ash injection tests to maintain constant oxygen levels throughout and, especially, to prevent the oxygen concentration from dropping below 0.3% at the low O_2 condition. The results showed that NO_x reduction potential may not be any greater at very low O_2 than it is at the baseline O_2 level.

5.4 CONCLUSIONS

Operation of the cement kiln at very low oxygen levels (below 0.5%) does not seem to be practical. Very low NO_x levels may be attained, but the accompanying CO concentrations are high. In addition, when special care was taken to hold the oxygen level constant, the results indicated that a modification applied at baseline O_2 (approximately 1.5%) has nearly the same effect on NO_x emissions when applied at low O_2 conditions.

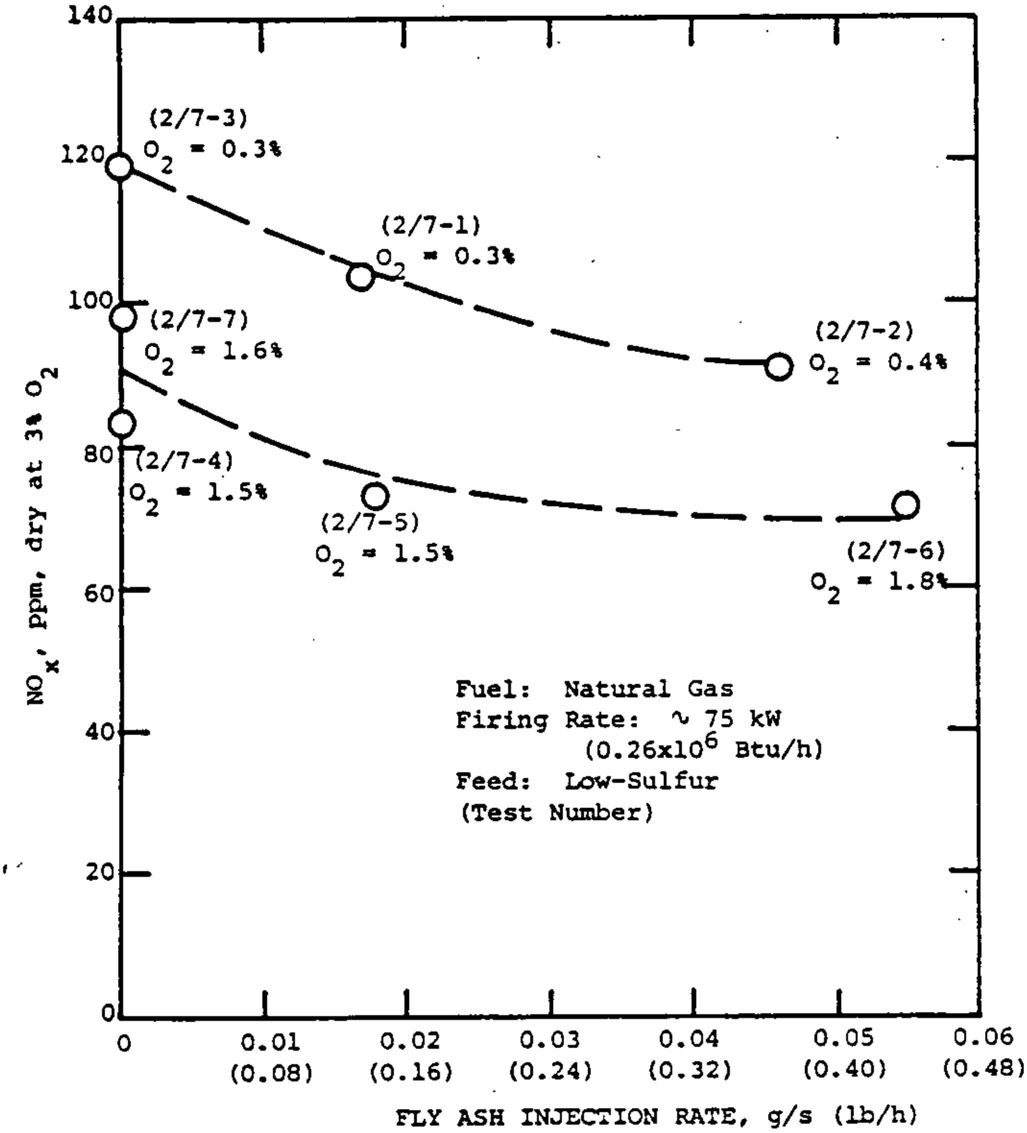

Figure 5-7. NO_x emissions as a function of fly ash injection rate at baseline and low oxygen conditions.

The maximum practical NO_x reductions attained in the research kiln are shown in Table 5-3. These reductions all occurred at baseline oxygen conditions. Sulfur, water, and kiln dust injection seem to produce similar results. Fly ash injection produced the largest practical NO_x reduction.

TABLE 5-3. MAXIMUM PRACTICAL NO_x REDUCTIONS FOR FOUR COMBUSTION MODIFICATIONS TO A RESEARCH CEMENT KILN

Combustion Modification	Maximum NO_x Reduction (%)
Sulfur Injection	12 - 20
Water Injection	14
Kiln Dust Injection	14
Fly Ash Injection	28

It is important to note that the baseline NO_x levels observed for the pilot kiln were far lower than any observed by KVB on full-scale kilns. The most likely explanation for this occurrence is the fact that ambient air was used in all of the subscale tests. In an actual kiln, air preheat temperatures of 1144 K (1600°F) are not uncommon. The report in Appendix B suggests in addition that the high surface-to-volume ratio may have resulted in greater heat losses from the flame zone, thus lowering NO_x production and also that the high gas-to-solids ratio in the subscale kiln limited the effect of kiln feed nitrogen on the NO_x emissions.

File copy

LONESTAR FLORIDA PENNSUCO, INC.

Cement & Aggregate Plant
11000 N. W. 121 Way
Medley, Florida 33178
P. O. Box 122035 - PVS
Hialeah, Florida 33012
(305) 823-8800

June 13, 1983

Mr. Clair Fancy
Bureau of Air Quality Management
Florida Department of Environmental Regulation
2600 Blair Stone Road
Tallahassee, Florida 32301-8241

Re: PSD-FL-050, Request for Emission Limitation Revision

Dear Mr. Fancy,

This is a response to your April 7, 1983 letter where in you requested additional information and clarification regarding our request for revisions to the SO_2 emission limitations in the referenced federal permit. We request that the contents of this letter be kept confidential in accordance with Section 403.111, Florida Statutes because of the proprietary nature of the information provided. For clarification I will answer each item as it was asked in your letter.

- Lonestar Florida (LSF) presently has on file with the Department's West Palm Beach office an application for the extension of construction permit for coal conversion of Kiln Nos. 1,2 & 3 (File No. AC-13-54054). It is being held in abeyance until the SO_2 emission limitation in the PSD permit is resolved.

- Flue gas desulfurization was not considered because to the best of our knowledge there has been no installation of desulfurization equipment in a commercially active wet process cement plant. Control processes and their economics would therefore be highly speculative. Enclosed is an excerpt from a report which discusses the cost and impact of controlling SO_2 emissions in the cement industry (Attachment 1). The report shows that the cost of installing and operating gas desulfurization equipment on three hypothethical cement plants would range from 30-34 cent per pound of SO_2 removed from each kiln. Considering that we are already removing 75 to 80 percent of the potential SO_2, the additional costs projected in the report to remove a purported 90 percent of the remaining SO_2 are not warranted.

PDS-FL-050, Request for Emission Limitation Revision

o Four grades of coal with 0.75 to 2.0 percent sulfur were analyzed from an economic and process standpoint. The coals analyzed were from our two current major suppliers and were of the same specifications with the exception of sulfur. The prices quoted are F.O.B. mine and are as follows:

% Sulfur	Company A	Company B
<2.0 % (Current Contract)	$ 32	$ 28
1.75 %	32	28
1.0 %	36	31
0.75 %	39	35

Annual costs using the above prices averaged together (LSF utilizes both companies equally to assure a non-interrupted supply) show the economic disadvantage of the lower sulfur coal. The costs are F.O.B. mine based on Kilns 1-3 operating at permitted capacities.

% Sulfur	Annual Cost	% Increase above<2% S
<2 % (Current Contract)	$7,560,000	NA
1.75 %	7,560,000	0
1.0 %	8,440,000	12%
0.75 %	9,320,000	23%

It must be noted that our current contract specifies coal with a sulfur content of <2%. During the past six months our weekly as-fired coal averaged 1.67% sulfur. This accounts for the lack of a price difference between <2% and 1.75% sulfur coal in that they are basically the same coal.

As you are probably aware the cement industry is highly competitive. The additional cost of the low sulfur coal would place Lonestar Florida at an un-fair economic position with our local competitors who are not restricted to the use of low sulfur coal. As the above costs clearly show, Lonestar Florida would be required to expend an additional 0.88 to 1.76 million dollars annually if required to burn lower sulfur coal. This is a genuine economic disadvantage especially in view of the fact that Lonestar Florida will be in compliance with Federal, State and County ambient air quality standards and PSD increments using ≤2% coal.

PSD-FL-050, Request for Emission Limitation Revision

- Kiln 3 is operated with an excess oxygen level of between 0.5 and 3.0 percent. The overall effect of excess oxygen, as pointed out in the BACT originally submitted, is that lower excess oxygen level will enhance SO_2 formation and resultant emissions where higher excess oxygen levels will enhance the retention of sulfur compounds with the feed material and eventually in the clinker. However, a balance exists between higher excess oxygen levels and such variables as kiln feed rates, dust insulflation rates, slurry moisture content, chemistry of slurry and NO_x formation. Higher excess oxygen levels can also cause unstable kiln conditions, such as too hot of a backened kiln temperature, which must be corrected by adjusting one of the variables listed above; all of which will impact the overall production rate of the kiln.

- Attachment 2. provides the calculations of Kiln 3 at permit capacity utilizing 2% coal. The sulfur content of the feed material is the average of analyses of slurry from 15 test runs dating from April 1982 to March 1983. The SO_2 absorption into the clinker is 77.7 percent. The SO_2 emissions of 386.9 #/hr. would meet the emission limit of 400 #/hr. selected as BACT. We believe absorption in Kilns 1 and 2 would fall in the range of 75-85 percent and would meet the emission limits of 100 #/hr. selected as BACT for each source.

- The sulfur content of the raw feed material is relatively constant. [now claim up to 0.5%] Analysis of slurry from 15 test runs mentioned above range from a minimum of 0.040 percent sulfur to a maximum of 0.088 percent sulfur with an average of 0.064 percent.

- Attachment 3. is an evaluation of predicted violations of the Dade County ambient air quality standards for SO_2 downwind of Alton Box. The summary will show that Lonestar Florida does not contribute significantly (<5.0 ug/m^3) to any predicted violation near Alton Box. Supportive computer model printouts will be forwarded under seperate cover.

I sincerely hope this additional information will answer all concerns regarding our request, and again remind you of its proprietary nature. Should you have any further questions or question regarding the information provided herein, please don't hesitate to call.

Sincerely,

Scott Quaas
Environmental Specialist

SQ/ep

CC: R. DuBose - EPA, Region IV
T. Tittle - DER, West Palm Beach
E. Cahill - DERM

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An Assessment of the Impact of Reducing Emissions in Five Critical Industries for the Purpose of Acid Deposition Mitigation

Prepared for the U.S. Office of Technology Assessment

by

Energy and Resource Consultants, Inc.
P.O. Drawer O
Boulder, CO 80306

ATTACHMENT 1.

TWIN TOWERS OFFICE BUILDING
2600 BLAIR STONE ROAD
TALLAHASSEE, FLORIDA 32301-8241

BOB GRAHAM
GOVERNOR

VICTORIA J. TSCHINKEL
SECRETARY

August 6, 1984

AUG 15 Rec'd

CERTIFIED MAIL-RETURN RECEIPT REQUESTED

Mr. Scott Quaas
Environmental Specialist
Lonestar Florida Pennsuco, Inc.
Post Office Box 122035 - PVS
Hialeah, Florida 33012

Dear Mr. Quaas:

RE: Preliminary Determination - Lonestar Florida Pennsuco, Inc.
PSD-FL-050, Request for Revision

The Florida Department of Environmental Regulation, under the authority delegated by the U.S. Environmental Protection Agency, Region IV, has reviewed your application to modify the referenced source under the provisions of the Prevention of Significant Deterioration Regulations (40 CFR 52.21) and has made a preliminary determination of approval with conditions. Please find enclosed one copy of the Preliminary Determination and proposed federal permit.

You are requested to publish (at your own expense) the attached Public Notice. The notice must appear, one time only, in the legal advertising section of a newspaper of general circulation in Dade County. A copy of the Preliminary Determination and your application will be open to public review and comment for a period of 30 days. The public can also request a public hearing to review and discuss specific issues. At the end of this period, the Department will evaluate the comments received and make a final determination and recommendation to EPA regarding the proposed modification.

I. Applicant

Lonestar Florida Pennsuco, Inc.
Cement and Aggregate Division
Post Office Box 122035
Palm Village Station
Hialeah, Florida 33012

II. Location

The sources affected by the proposed revision are located at the applicant's existing Portland cement plant at 11000 Northwest 121 Street, Hialeah, Dade County, Florida. The UTM coordinates are Zone 17, 562.75 km E and 2861.65 km N.

III. Background

The applicant received federal permit No. PSD-FL-050 in 1980 which authorized the fuel conversion of existing kilns Nos. 1, 2, and 3 from gas or oil to coal containing up to two percent sulfur. Burning coal instead of oil or gas in the kilns will increase the sulfur dioxide emissions from the kilns. The Best Available Control Technology (BACT) determination on which the emission standards were based limited the sulfur dioxide (SO_2) emissions from the existing electrostatic precipitators serving the three kilns to the quantities listed below.

Kiln No.	Maximum Sulfur Dioxide Emission Standards
1	1.42 lb/ton dry feed or 56.7 lbs/hr, 248.4 TPY
2	1.42 lb/ton dry feed or 56.7 lbs/hr, 248.4 TPY
3	0.19 lb/ton dry feed or 26.3 lbs/hr, 115.1 TPY

These standards were the emission limits requested by the applicant. The applicant had estimated a SO_2 removal efficiency of over 90 percent for the system. This removal efficiency was based on test data collected on the systems by a limited number of flue gas tests while the kilns were burning high sulfur fuel oil.

Kiln No. 3 has been converted to coal and actual stack test data shows that SO_2 removal is less than 90 percent. The applicant has studied the latest test data and now believes the systems will obtain only 75 to 85 percent SO_2 removal.

The Company is now requesting a revised BACT determination which would set SO_2 emission limits for the three kilns, while they are burning coal containing two percent sulfur, at the values shown below.

Kilns	Sulfur Dioxide Emission Limit
1	125 lb/hr
2	125 lb/hr
3	400 lb/hr

The company also agrees to operate only 2 kilns at any one time with coal as fuel. The third kiln will be fired with natural gas if it is operated while the other two are operating. Thus, the maximum SO_2 emissions from the three kilns will be 525 lb/hr or 2,300 tons per year.

Model results of the proposed SO_2 emissions from the three kilns shows no violation of the SO_2 increments or ambient air quality standards.

Although other criteria pollutants were regulated by the construction permit, SO_2 is the only pollutant that the Company has addressed in its request for a revision to the BACT determination and the permit.

IV. Rule Applicability

The original application for a permit to burn coal in the three kilns was subject to Prevention of Significant Deterioration (PSD) review for sulfur dioxide in accordance with the provisions of Title 40, Code of Federal Regulations, Part 52.21 (40 CFR 52.21) promulgated on June 19, 1978, because the original application proposed an increase in sulfur dioxide emissions of greater than 100 tons per year (562 tons per year). This PSD review required a BACT determination and an air quality review and growth analysis. However, the applicant demonstrated that the predicted air quality impacts upon the annual, 24-hour, and 3-hour National Ambient Air Quality Standards (NAAQS) and the PSD Class II increments were below the significance levels as published in 43 FR 26398, June 19, 1978; therefore, a detailed air quality review and growth analysis was not required for the original application.

The applicant is now requesting a revised BACT determination which would increase the sulfur dioxide emission limits for the three kilns. This change in limits results in predicted air quality impacts upon the NAAQS and PSD Class II increments which are greater than the significance levels mentioned above; thus, a detailed air quality review and growth analysis under the June 19, 1978 PSD regulations is required for this change.

V. Engineering Evaluation

The 77.7 percent SO_2 removal efficiency for this system that the applicant's requested revision of the BACT SO_2 emission limits is based on, is greater than EPA implies can be achieved in the AP-42 Manual, Compilation of Air Pollutant Emission Factors. A cement kiln with a baghouse control device is estimated to remove 75 percent of the SO_2. The baghouse is believed to be more efficient in facilitating SO_2 removal than the electrostatic precipitators used by Lonestar. The Company has submitted a limited number of test results on kiln No. 3 that shows the average SO_2 removal efficiency, when the percent oxygen in the flue gas was above 2.8 percent, is 75 percent. No data has been provided that gives assurance that the existing system can consistently achieve a removal efficiency above this. Based on the data available, the department believes the system should achieve 75 percent SO_2 removal.

Flue gas desulfurization equipment (FGD) may be able to meet the standards set in the original BACT determination. However, the applicant stated that FGD on this type of source is unproven and, if used, would cause a financial hardship. The Department is in agreement that FGD is not feasible for this plant at this time.

Using fuels with a lower sulfur content is the only feasible way of reducing sulfur dioxide emissions from this plant. However, the original SO_2 standards initially selected as BACT cannot be met with low sulfur coal alone. Also, if the removal efficiency of the system is only 75 percent, the proposed SO_2 BACT standards will be exceeded at maximum permitted production when using coal containing two percent sulfur (Company's plan) and raw material containing 0.088 percent sulfur (highest estimated sulfur content of the raw material). Coal with a lower sulfur content is available which will allow the Company to meet their proposed SO_2 standards.

Calculations using the maximum raw material and coal inputs to the kilns listed in the original application for a permit to construct, the maximum sulfur content in the feed from Lonestar's June 13, 1983 letter, and a sulfur removal of 75 percent by the system show the kilns would have to burn coal with one percent sulfur to meet the sulfur dioxide emission standards now being requested (See Table I and Figure 1). This is low sulfur fuel. As these emissions cause no ambient air violations, the Department finds these standards acceptable.

VI. Air Quality Impact Analysis

As noted in Section IV., the revision in SO_2 emission limits will result in air quality impacts greater than significance levels, thus requiring a detailed air quality impact analysis for SO_2.

The air quality impact analyses required for SO_2 includes:

- An analysis of existing air quality;
- A PSD increment analysis;
- An Ambient Air Quality Standards (AAQS) analysis;
- An analysis of impacts on soils, vegetation, and visibility, and growth-related air quality impacts.

The analysis of existing air quality generally relies on preconstruction monitoring data collected in accordance with EPA-approved methods. The PSD increment and AAQS analyses depend on air quality modeling carried out in accordance with EPA guidelines.

Based on these required analyses, the department has reasonable assurance that the proposed revision, as described in this permit and subject to the conditions of approval proposed herein, will not cause or contribute to a violation of any PSD increment or ambient air quality standard. A discussion of the modeling methodology and required analyses follows:

1. Modeling Methodology

The EPA-approved Industrial Source Complex (ISC) dispersion model was used in the air quality impact analysis. This model was used to predict annual, 24-hour, 4-hour, 3-hour, and 1-hour average concentrations resulting from the Lonestar sources and all other existing sources in the vicinity of Lonestar.

The maximum short-term impacts were refined with a 0.1 kilometer spacing between receptors for only the days on which worst-case meteorological conditions occurred. Emissions from interacting sources were included in these runs.

The surface meteorological data used in the model were National Weather Service data collected at Miami, Florida during the period 1970-1974. Upper air meteorological data used in the model were collected during the same time period at Miami, Florida. Final stack parameters and emission rates used in modeling and analyzing the proposed revision are contained in Tables 2 and 3.

2. Analysis of Existing Air Quality

In order to evaluate existing air quality in the area of a proposed project, the department may require a period of continuous preconstruction monitoring for any pollutant subject to federal PSD review. Since the original PSD permit application for the Lonestar coal conversion project was complete before June 8, 1981, and this application is for a revision to the original permit, the department is not requiring any preconstruction SO_2 monitoring. This is in accordance with the 1978 ambient monitoring guidelines in effect at the time of the original permit application.

Since the Lonestar plant is located in a remote area with respect to SO_2 emissions from non-specified sources, a background of 0 ug/m^3 for SO_2 is assumed. The department also assumed this background since all sources of SO_2 which would interact with emissions from Lonestar are accounted for in the modeling. The department assumed no contribution to the background value from natural and distant non-specified sources because of the prevailing subtropical easterly winds and the lack of space heating requirements in the area. This background was used for all averaging times and is consistent with EPA monitoring guidelines applicable to projects submitting complete applications prior to June 8, 1981.

3. PSD Increment Analysis

The Lonestar plant is located in an area where the Class II PSD increments apply. However, the Everglades National Park is located about 30 kilometers from the plant so an analysis of Class I impacts was also performed.

Lonestar and Dade County Resource Recovery were determined to be the only significant increment consuming sources in the area. Modeling results shown in Table 4 predict that the proposed revision, in combination with Dade County Resource Recovery, will not cause a violation of any Class I or Class II PSD increment. The highest, second highest short-term predicted concentrations are given in the table since five years of meteorological data were used in the modeling.

4. Ambient Air Quality Standards Analysis

As shown in Table 5, modeling results predict that maximum ground-level concentrations of SO_2 as a result of the proposed revision will be below all national (NAAQS), state (FAAQS) and local (Dade County AAQS) ambient air quality standards. The highest, second highest predicted value is given in the table for the three-hour averaging time since five years of meteorological data were used in the modeling and since this value is exclusively compared to NAAQS and FAAQS. However, the highest predicted values are given for the one-hour, four-hour and 24-hour averaging times since these values are compared with the Dade County AAQS, which require the use of the highest predicted value for comparison.

5. Analysis of Impact on Soils, Vegetation and Visibility and Growth-Related Air Quality Impacts

The maximum impact of the proposed increase in SO_2 emissions, as demonstrated through the air quality analysis, will be below the national secondary air quality standards established to protect public welfare related values. Therefore, no adverse effects on soils, vegetation and visibility are expected.

There will be no increase in the number of employees at the site due to the revision. No secondary residential, commercial or industrial growth which will adversely affect air quality in the area is expected.

VII. Conclusion

Based on the data available, the Department has concluded that the original BACT determination for SO_2 was too restrictive. The SO_2 emission standards of 400 lb/hr for kiln 3 and 125 lb/hr each for kilns 1 and 2 are reasonable. These emissions will not cause an ambient air quality violation or exceed any allowable increase of SO_2 in the ambient air if only two kilns are fired with coal at any one time. Higher SO_2 emissions from the existing plant could increase the SO_2 concentration in the ambient air near the plant above that allowed by Dade County regulations.

The proposed SO_2 emission standards can be achieved by controlling the percent sulfur in the coal. The maximum percent sulfur that can be allowed in the coal is a function of the sulfur dioxide removal efficiency of the system. Low sulfur coal, one percent sulfur, may have to be burned to meet these standards. A controlled test series on all three kilns is needed to resolve what is the maximum percent sulfur in the coal that can be used in the kilns without exceeding the emission standards.

new Cond 4 - SO_2 emis 1 + 2 125 #/hr, ~~K#3~~
5 - K#3 400 #/hr max 187.5 #/hr clinker
6 - Coal used K 1 2 3 Sulfur content less than 1.75 monthly average and 2% limit.

VIII. Revised BACT:

Best Available Control Technology (BACT) Determination

Lonestar Florida Pennsuco, Inc.

Dade County

The applicant has requested a revision of a previous BACT determination for sulfur dioxide emission limits for the three cement kilns located at their facility in Hialeah, Florida. Federal permit PSD-FL-050, issued in 1980, specified that SO_2 emissions from kiln No.1 and No.2 shall not exceed 56.7 pounds per hour per kiln and 26.3 pounds per hour from kiln No.3. The SO_2 emission limits were based on tests using 2.38% sulfur content fuel oil.

Kiln No. 3 was converted from oil/gas fired to coal fired and the emissions measured. The No. 3 kiln test results indicate a lower absorption of SO_2 by the products in the kiln, and consequently more SO_2 is being emitted to the atmosphere than originally proposed based on the tests using oil as fuel. Based upon the new data, the applicant has requested a revision of the SO_2 emission limits for the No. 3 kiln and No. 1 and No. 2 kiln, both of which will also be converted to coal-fired units as originally proposed.

The requested change would result in an increase of 68 lb/hr from kilns 1 and 2 and 374 lb/hr from kiln 3 above the original limits determined as BACT.

BACT Determination Requested by the applicant:

The following fuel operating mix for the three kilns would be:

A.	Kiln 1-coal (125)	Kiln 2-gas(9)	Kiln 3-coal(400)
B.	Kiln 1-gas(9)	Kiln 2-coal(125)	Kiln 3-coal(400)
C.	Kiln 1-coal(125)	Kiln 2-coal(125)	Kiln 3-DOWN

* figure in parenthesis is pounds SO_2 emissions per hour.

Kiln operations per any of the three scenarios will not cause violation of the Federal, State, or Dade County ambient air quality standards.

Date of receipt of a BACT application:

June 4, 1984

Date of Publication in the Florida Administrative Weekly:

June 22, 1984

Review Group Members:

The determination was based upon comments received from the New Source Review Section, Air Modeling Section, the Dade County Department of Environmental Resources Management, and the Southeast District Office.

BACT Determined by DER:

Pollutant	Emission Limit
Kiln No.1	125 lb SO_2/hr
Kiln No.2	125 lb SO_2/hr
Kiln No.3	400 lb SO_2/hr

The SO_2 emission limits determined as BACT do not result in a violation of Federal or State ambient air quality standards, but, do violate the Dade County standards. The department, therefore, has incorporated the proposed three operating scenarios as BACT to prevent violation of the Dade County standards.

Matrix	Matrix	Matrix
Kiln 1 fire coal	Kiln 1 fire gas	Kiln 1 fire coal
Kiln 2 fire gas	Kiln 2 fire coal	Kiln 2 fire coal
Kiln 3 fire coal	Kiln 3 fire coal	Kiln 3 down

Compliance with the SO_2 emission limit will be in accordance with 40 CFR 60, Appendix A; Methods 1, 2, 3, 4 and 6.

Proof of compliance with the operating matrix provision will be the kiln operating log. The day, time and type of fuel fired will be recorded for each kiln. The time period Number 3 kiln is down will also be recorded in the operating log. Each log will be kept a minimum of two years.

BACT Determination Rationale:

The cement kilns were originally fired with natural gas and residual oil. The applicant had submitted test data while firing residual oil containing 2.38 percent sulfur to determine kiln product absorption of SO_2. The data indicated that 91.3% of the potential SO_2 was absorbed by the aggregate processed in kilns 1 and 2 and 98.7% in kiln 3. A BACT determination was made based upon the applicant's data.

A construction permit was issued that authorized the use of coal in all three kilns. Kiln No. 3 was converted to fire coal and the exhaust gases were tested for SO_2 content. The data indicated the absorption of SO_2 in the kiln product was 75 to 80 percent, not the reduction originally anticipated. The coal fired in the kiln during the test contained two percent sulfur.

AP-42, Section 8.6-1 indicates the overall control inherent in the process is approximately 75 percent or greater of the available sulfur in ore and fuel if a baghouse that allows SO_2 to come in contact with the cement dust used. The existing sources use electrostatic precipitators for the control of particulate emissions; therefore, the department believes the maximum absorption would be 75 percent. The amount of SO_2 emissions will vary according to the alkali and sulfur content of the raw materials and fuel.

The SO_2 emission limits determined as BACT are obtainable by firing low sulfur coal. The economics of firing two percent sulfur coal is evident. The applicant has the option of burning a lower sulfur coal or installing additional SO_2 controls to meet the SO_2 limits determined as BACT.

The three operating scenarios proposed by the applicant to protect the Dade County AAQS are acceptable. The application of production process techniques is a recognized method to achieve the required level of emission control.

<u>Details of the Analysis May be Obtained by Contacting:</u>

Edward Palagyi, BACT Coordinator
Department of Environmental Regulation
Bureau of Air Quality Management
2600 Blair Stone Road
Tallahassee, Florida 32301

STATE OF FLORIDA

DEPARTMENT OF ENVIRONMENTAL REGULATION

TWIN TOWERS OFFICE BUILDING
2600 BLAIR STONE ROAD
TALLAHASSEE, FLORIDA 32301-8241

BOB GRAHAM
GOVERNOR

VICTORIA J. TSCHINKEL
SECRETARY

November 9, 1984

Mr. James T. Wilburn, Chief
Air Management Branch
Environmental Protection Agency-Region IV
345 Courtland Street
Atlanta, Georgia 30365

RE: Request for Revision of PSD-FL-050

Dear Mr. Wilburn:

Enclosed is the department's recommendations on revision of the sulfur dioxide emission standards in federal permit PSD-FL-050 for Lonestar Florida Pennsuco, Inc.'s three Portland cement kilns.

Public notice of the proposed revisions was published in the Miami Herald on August 28, 1984. Comments on the proposal were received from the department's Southeast District office and the National Park Service. These comments and the department's response, which resulted in several changes to the proposed permit specific conditons, are discussed in the final determination.

The department recommends that federal permit PSD-FL-050 be revised as shown in the final determination. If the Environmental Protection Agency approves the department's recommendations, then the state construction permits issued for the three kilns will be revised by the department's Southeast District office to be consistent with the federal permit.

Sincerely,

for Clair Fancy, P.E.
Deputy Chief
Bureau of Air Quality
Management

CHF/WH/agh
cc: Roy Duke, Southeast District

Final Determination

Revision of Best Available Control Technology Determination
and
Permit to Construct

Lonestar Pennsuco, Inc.
Dade County

Federal Permit Number
PSD-FL-050

Florida Department of Environmental Regulation
Bureau of Air Quality Management
Central Air Permitting

November 9, 1984

Final Determination

The Florida Department of Environmental Regulation has completed its review of the Lonestar Florida Pennsuco, Inc.'s February 23, 1983, request for revisions to the sulfur dioxide emission standards listed in federal permit number PSD-FL-050 for the three Portland cement kilns at its plant in Hialeah, Dade County, Florida. Public notice of the department's intent to revise the Best Available Control Technology (BACT) determination and the permit to construct was published in the Miami Herald on August 28, 1984.

Comments on the department's intent were received from the Southeast District office and the National Park Service. The district requested the sulfur dioxide emission limits for kiln No. 3 be reduced from 4.6 to 4.57 lb SO_2/ton clinker produced, that the stack test program to be used to determine the maximum sulfur content that can be in the coal be described, and that the Company be required to maintain an operating log on the three kilns. The National Park Service asked for an explanation of the discrepancy in the test data that showed sulfur dioxide removals of 75 and 98.7 percent, commented on the background sulfur dioxide levels in the park, and asked that the impact analysis be included in the application.

In response to the district's comments, the difference between emission factors for kiln No. 3 of 4.6 and 4.57 lb. SO_2 per ton clinker is less than one percent. The actual factor (400 lb. SO_2 per hour emission/87.5 tons per hour clinker production) rounded off to one decimal place is adequate for this permit. The procedures used to measure the sulfur dioxide emissions are not accurate enough to justify a more precise emission factor. Proposed specific condition No. 5 was not changed in the final determination.

The test program to establish the highest sulfur content of the coal that can be burned in the kilns is as follows. The program will consist of at least three separate EPA Method 6 compliance tests on each kiln. Each test will be no less than 168 hours apart to account for unknown variations in the feed and operation of the kilns. Should any test fail, the subsequent tests will be run with the kilns fired on coal containing a sulfur content 0.25 percent less than the preceeding test. This program is for the initial compliance test only. Any operating permits issued for the kilns will require only one test, as described in 40 CFR 60, Appendix A, per year. Specific condition No. 6 is revised to include this requirement.

The National Park Service requested an explanation for the discrepancy in the sulfur dioxide removal reported by the Company. The initial applications for permits to burn coal in the kilns were based on a sulfur dioxide absorption rate measured while burning No. 6 fuel oil in the kilns. The Company assumed a similar sulfur dioxide removal efficiency when the kilns were fired with coal. Tests on the one kiln converted to coal showed much lower sulfur dioxide absorption rates. The conclusion is that coal-fired cement kilns do not retain as much of the potential sulfur dioxide emissions as oil-fired ones.

In answer to the National Park Service's comments on the background SO_2 level in the Everglades National Park, we acknowledge that the SO_2 level in the park is greater than zero ug/m^3. According to 1983 SO_2 monitoring data from the park, an annual average concentration of 7 ug/m^3 was measured. If Lonestar's predicted impact of 0.4 ug/m^3, which is much less than the Class I increment, is added to this concentration, the resulting impact is predicted to be 7.4 ug/m^3. As stated in the preliminary determination, this impact is not expected to have an adverse impact on park resources.

In response to the Park Service's comment on the impact analysis, there were no additional increment consuming sources besides Dade County Resource Recovery which would have an impact on the receptors used in the modeling to evaluate the impact of Lonestar's modification on the Class I area. All other increment consuming sources were located at least 50 kilometers away from those receptors. Therefore, no impact area was defined.

The revised specific conditions, with the changes discussed above, are as follows:

Revised Specific Conditions:

4. Emissions of sulfur dioxide from Nos. 1 and 2 kilns shall not exceed 125.0 pounds per hour from each kiln at the maximum operating rate of 25 tons per hour of clinker produced per kiln. At lesser operating rates the emissions of sulfur dioxide shall not exceed 5.0 pounds per ton of clinker produced.

5. Emissions of sulfur dioxide from No. 3 kiln shall not exceed 400 pounds per hour at the maximum operating rate of 87.5 tons per hour of clinker produced. At lesser operating rates the emissions of sulfur dioxide shall not exceed 4.6 pounds per ton of clinker produced.

6. The coal used to fuel kilns Nos. 1, 2, and 3 shall have a sulfur content of less than 1.75 percent (monthly average) and 2.0 percent maximum; or the sulfur content, determined once by the stack test program described below, that consistently meets the revised sulfur dioxide emission standards, whichever sulfur content is most restrictive.

TEST PROGRAM

In establishing the maximum sulfur content of the coal that can be used in each kiln, the Company shall conduct a test series on the kilns while they are operating near maximum production.

The test series shall consist of a minimum of three separate compliance tests, each test at least 168 hours after the preceeding test, and using fuel with a constant ($\pm$ 0.25 percent) sulfur content. All test results for coal of this sulfur content must be below the BACT standards.

If test results show the SO_2 emissions from a kiln do not meet the BACT standard, then the Company shall reduce the sulfur content of the coal burned in this kiln by at least 0.25 percent (average) and repeat the test series until the emissions consistently comply with the revised BACT standards. For each test the Company shall provide a test report giving, as a minimum, the data listed in Chapter 17-2.700(7), FAC.

In addition, for each test sample the Company shall measure or estimate and report:

- feed rate (TPH)
- sulfur content of feed
- coal rate (TPH)
- sulfur content of coal
- oxygen content of flue gas

New Condition:

13. Only two kilns will be operated with coal as fuel at the same time. The Company shall maintain a log or logs that shows, as a minimum: the operational status of all three kilns at any time; when each kiln is placed in service; the clinker, feed, and fuel feed rates to each kiln; and when the kiln is taken out of service.

LONESTAR FLORIDA PENNSUCO, INC.
Cement & Aggregate Plant
11000 N. W. 121 Way
Medley, Florida 33178
P. O. Box 122035 - PVS
Hialeah, Florida 33012
(305) 823-8800

October 24, 1984

Mr. C. H. Fancy
Deputy Bureau Chief
Bureau of Air Quality Management
2600 Blair Stone Rd.
Tallahassee, Florida 32301

Re: PSD-FL-050, Request for Revision.

Dear Mr. Fancy:

This letter is in response to telephone conversations with Mr. Willard Hanks of your office regarding public comment received concerning the above referenced permit. Four (4) items needing further clarification were raised from the comments received.

1. STACK TEST PROGRAM - The preliminary determination references a stack test program without further clarification. It is my understanding that this program is detailed in DER internal files and it amounts to a series of three (3) SO_2 emission tests. Each consecutive test would be no less than 168 hours apart. Additionally, should any test fail, the subsequent test would be run with the kiln fired on coal with a sulfur content 0.25% less than the preceeding test. This stack test program is acceptable provided that it is for initial compliance purposes only. All subsequent annual compliance tests will consist of one (1) stack test in accordance with 40 CFR 60, Appendix A.

2. VERIFICATION OF BACT OPERATING RATES - Operating logs are kept for each kiln of the day, time, type and amount of fuel fired.

3. CHANGES IN PROJECTED SO_2 ABSORPTION - This has been the basis of the entire SO_2 emission limitation revision request and was documented in many previous correspondence. To briefly summarize, the initial 1979 coal conversion permit SO_2 emission limits were based on sulfur absorption rates derived from stack tests performed on the kilns while burning No. 6 fuel oil.

Those tests showed sulfur absorption at ± 98%. Little information was available at that time of similar kiln systems converting to coal so the assumption that absorption rates would be similar was accepted. When the coal conversion was completed on the Kiln No. 3 system a compliance test was conducted which demonstrated that much lower absorption rates could be expected utilizing coal. A series of stack test after that initial test were utilized to arrive at the absorption rate of 77.7% in our permit revision request.

4. STACK TESTS ON COAL REPRESENTATIVE OF OPERATION - All stack tests were conducted during normal kiln operations while burning coal averaging 1.7% S.

I hope this answers the questions raised, but should you need anything further please call.

Sincerely,

Scott Quaas
Environmental Specialist

cc: C. D. Coppinger
A. Townsend

United States Department of the Interior

NATIONAL PARK SERVICE
SCIENCE PUBLICATIONS OFFICE
75 Spring Street, S.W.
Atlanta, Georgia 30303

IN REPLY REFER TO:
N3615(475)

SEP 25 1984

Mr. C. H. Fancy, P.E.
Deputy Bureau Chief
Bureau of Air Quality Management
2600 Blair Stone Road
Tallahassee, Florida 32301

Dear Mr. Fancy:

Thank you for sending us information regarding your preliminary approval of Lonestar Florida Pennsuco's (Lonestar) permit modification request. As we understand it, Lonestar was granted a permit in 1980 for the fuel conversion of three existing kilns from gas/oil firing to coal firing, but is now requesting an increase in the allowable sulfur dioxide (SO_2) limit. The Lonestar facilities, which are located in Hialeah, Florida, are 30 kilometers northeast of Everglades National Park, a mandatory class I area.

You indicate that original stack tests performed, while the kilns were firing oil, show that 91.3 percent of the potential SO_2 was absorbed by the aggregate processed in kilns 1 and 2, and 98.7 percent in kiln 3. The emission limitations for the fuel conversion permit were based on these data. Actual stack test data for coal firing indicate that the observed SO_2 removal is only approximately 75 percent. Consequently, Lonestar is requesting the SO_2 allowable limit in their permit be increased by 1,688 tons per year.

In the information you provided, there was little discussion regarding the large discrepancy in the test data (75 percent versus 98.7 percent). We would like to know if the difference is attributable entirely to the fuel change, if the coal-fired tests were properly conducted and were representative of normal operation, and if the kilns were being operated in the same manner as when the oil-fired tests were performed.

We note that the predicted SO_2 concentrations in Everglades National Park were made assuming a zero micrograms per cubic meter (ug/m^3) background concentration. Using this assumption, Lonestar predicts an annual SO_2 concentration of 0.4 ug/m^3 in the park. Although we do not expect this concentration to have an adverse impact on park resources, please note for future permits that SO_2 monitoring has been done in the park, and these data indicate that background levels, although low, are not zero ug/m^3. Future permits should include the background concentrations in any impact discussion.

The applicant asserts that "Lonestar and Dade County Resource Recovery were determined to be the only significant increment consuming sources in the area." This implies that an analysis was performed to define some impact area. This analysis should be included in the application.

If you have any questions regarding this matter, please contact Mark Scruggs of our Air and Water Quality Division at (303) 234-6620.

Sincerely,

Acting Regional Director
Southeast Region

Best Available Control Technology (BACT) Determination

Lonestar Florida Pennsuco, Inc.

Dade County

The applicant has requested a revision of a previous BACT determination for sulfur dioxide emission limits for the three cement kilns located at their facility in Hialeah, Florida. Federal permit PSD-FL-050, issued in 1980, specified that SO_2 emissions from kiln No.1 and No.2 shall not exceed 56.7 pounds per hour per kiln and 26.3 pounds per hour from kiln No.3. The SO_2 emission limits were based on tests using 2.38% sulfur content fuel oil.

Kiln No. 3 was converted from oil/gas fired to coal fired and the emissions measured. The No. 3 kiln test results indicate a lower absorption of SO_2 by the products in the kiln, and consequently more SO_2 is being emitted to the atmosphere than originally proposed based on the tests using oil as fuel. Based upon the new data, the applicant has requested a revision of the SO_2 emission limits for the No. 3 kiln and No. 1 and No. 2 kiln both of which will also be converted to coal-fired units as originally proposed.

The requested change would result in an increase of 68 lb/hr from kilns 1 and 2 and 374 lb/hr from klin 3 above the original limits determined as BACT.

BACT Determination Requested by the applicant:

The following fuel operating mix for the three kilns would be:

A.	Kiln 1-coal(125)#	Kiln 2-gas(9)	Kiln 3-coal(400)
B.	Kiln 1-gas(9)	Kiln 2-coal(125)	Kiln 3-coal(400)
C.	Kiln 1-coal(125)	Kiln 2-coal(125)	Kiln 3-DOWN

* figure in parenthesis is pounds SO_2 emissions per hour.

Kiln operations per any of the three scenarios will not cause violation of the Federal, State or Dade County ambient air quality standards.

Date of receipt of a BACT application:

June 4, 1984

Date of Publication in the Florida Administrative Weekly:

June 22, 1984

Review Group Members:

The determination was based upon comments received from the New Source Review Section, Air Modeling Section, the Dade County

Department of Environmental Resources Management and the Southeast District Office.

BACT Determined by DER:

Pollutant	Emission Limit
Kiln No.1	125 lb SO_2/hr
Kiln No.2	125 lb SO_2/hr
Kiln No.3	400 lb SO_2/hr

The SO_2 emission limits determined as BACT do not result in a violation of Federal or State ambient air quality standards, but, do violate the Dade County standards. The department, therefore, has incorporated the proposed three operating scenarios as BACT to prevent violation of the Dade County standards.

Matrix	Matrix	Matrix
Kiln 1 fire coal	Kiln 1 fire gas	Kiln 1 fire coal
Kiln 2 fire gas	Kiln 2 fire coal	Kiln 2 fire coal
Kiln 3 fire coal	Kiln 3 fire coal	Kiln 3 down

Compliance with the SO_2 emission limit will be in accordance with 40 CFR 60, Appendix A; Methods 1, 2, 3, 4 and 6.

Compliance with the operating matrix provision will be the kiln operating log. The day, time and type of fuel fired will be recored for each kiln. The time period Number 3 kiln is down will also be recorded in the operating log. Each log will be kept a minimum of two years.

BACT Determination Rationale:

The cement kilns were originally fired with natural gas and residual oil. The fuel was switched to coal in 1980 as per the conditions of permit number PSD-FL-050. The applicant submitted test data while firing residual oil containing 2.38 percent sulfur to determine kiln product absorption of SO_2. The data indicated that 91.3% of the potential SO_2 was absorbed by the aggregate processed in kilns 1 and 2 and 98.7% in kiln 3. A BACT determination was made based upon the applicants data.

After one of the the kilns had been converted to fire coal, the exhaust gases were tested for SO_2 content. The data indicated the absorption of SO_2 in the kiln product was 75 to 80 percent, not the reduction originally anticipated. The coal fired in the kiln during the test contained two percent sulfur.

AP-42, Section 8.6-1 indicates the overall control inherent in the process is approximately 75 percent or greater of the available sulfur in ore and fuel if a baghouse that allows SO_2 to come in contact with the cement dust is used. These existing sources use electrostatic precipitators for the control of particulate emissions, therefore, the department believes the maximum absorption would be 75 percent.

The amount of SO_2 emissions, of course, will vary according to the alkali and sulfur content of the raw materials and fuel.

The SO_2 emission limits determined as BACT are obtainable by firing low sulfur coal. The economics of firing two percent sulfur coal is evident. The applicant has the option of burning a lower sulfur coal or installing additional SO_2 controls to meet the SO_2 limits determined as BACT.

The three operating scenarios proposed by the applicant, to protect the Dade County AAQS, are acceptable. The application of production process techniques are a recognized method to achieve the required level of emission control.

Details of the Analysis May be Obtained by Contacting:

Edward Palagyi, BACT Coordinator
Department of Environmental Regulation
Bureau of Air Quality Management
2600 Blair Stone Road
Tallahassee, Florida 32301

Recommended by:

____

C.H. Fancy Deputy Bureau Chief

Date: ______________________________

Approved: ______________________________

Victoria J. Tschinkel, Secretary

Date: ______________________________

ED/agh

State of Florida
DEPARTMENT OF ENVIRONMENTAL REGULATION

INTEROFFICE MEMORANDUM

For Routing To District Offices And/Or To Other Than The Addressee	
To:	Loctn.:
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Reply Optional [ ] Reply Required [ ] Info. Only [ ]	
Date Due:	Date Due:

TO: Tom Tittle, Southeast District

work for

FROM: Bill Thomas, BAQM

DATE: May 15, 1985

SUBJ: Lonestar RDF Fuel

We have examined the proposal and concluded that the request will not be likely to result in any increased emissions or emissions of any new pollutants. The kiln is capable of accommodating RDF and, therefore, the use of RDF would not be a modification requiring any change to the federal or state construction permits.

Lower sulfur content and lower BTU value with higher moisture content results in a decrease, or at least no increase, in SO_2 and NO_x. High temperatures necessary for production of clinkers with relatively long residence times should effectively remove any toxic concerns, and any metals not removed during delivery processing should be controlled by the ESP.

Lonestar has addressed the equipment for handling the RDF. If you and DERM are satisfied that a construction permit is not required, we feel that the appropriate vehicle for documenting this would be an operating permit amendment with a Method 5 and 6 at maximum RDF consumption for verification of no increased emissions.

BT/ks

cc: Art Bolivar, DERM

STATE OF FLORIDA

DEPARTMENT OF ENVIRONMENTAL REGULATION

TWIN TOWERS OFFICE BUILDING
2600 BLAIR STONE ROAD
TALLAHASSEE, FLORIDA 32301-8241

BOB GRAHAM
GOVERNOR

VICTORIA J. TSCHINKEL
SECRETARY

February 12, 1985

Mr. A. L. Chiles, Jr.
Manager - Engineering & Projects
Lonestar Florida Pennsuco, Inc.
P. O. Box 122035-PVS
Hialeah, Florida 33012

Dear Mr. Chiles:

Re: Kiln No. 3 Fuel Modification

Before the Department can process your January 8, 1985, request to burn refuse derived fuel (RDF) in kiln No. 3, we will need the following information:

1. Analysis of the RDF produced in the South Dade Facility, including its Btu content.

2. The calculated emissions of regulated pollutants from burning this RDF, and emission test data on this or a similar RDF.

3. The estimated changed in emissions of all air pollutants that will occur when the maximum proposed quantity of RDF is burned in kiln No. 3.

4. A description of the RDF storage and feed system that includes the precaution to prevent fugitive dust and objectionable odors emissions.

5. What is the minimum residence time and temperature the RDF will be subject to in kiln No. 3?

6. What safeguards and monitoring procedures are proposed to reasonably assure the destruction of all hazardous compounds while burning RDF?

After the Department reviews your reply to this letter, we will be able to advise you on how to proceed with your request. If the emissions of any pollutant increases above the de minimus levels, Lonestar will need ~~be~~ to submit an application for permit to construct. If there are no increases or new pollutants emitted, the Department and the Environmental Protection Agency may be able to modify your existing permits to construct kiln No. 3 and allow the use of RDF.

If you have any questions on this matter, please contact Willard Hanks at (904)488-1344 or write me at the above address.

Sincerely,

C. H. Fancy, P.E.
Deputy Chief
Bureau of Air Quality
Management

CHF/WH/s

cc: James Wilburn
Isidore Goldman
Raymond Moreau

1-25-85
Jan 21, 1985

Best Available Control Technology (BACT) Determination Lonestar (Amendment)
Lonestar Florida Pennsuco, Inc.
Dade County

The applicant has requested a revision of a previous BACT determination for sulfur dioxide emission limits for the three cement kilns located at their facility in Hialeah, Florida. Federal permit PSD-FL-050, issued in 1980, specified that SO_2 emissions from kiln No. 1 and No. 2 shall not exceed 56.7 pounds per hour per kiln and 26.3 pounds per hour from kiln No.3. The SO_2 emission limits were based on tests using 2.38% sulfur content fuel oil.

Kiln No. 3 was converted from oil/gas fired to coal fired and the emissions measured. The No. 3 kiln test results indicate a lower absorption of SO_2 by the products in the kiln, and consequently more SO_2 is being emitted to the atmosphere than originally proposed based on the tests using oil as fuel. Based upon the new data, the applicant has requested a revision of the SO_2 emission limits for the No. 3 kiln and No. 1 and No. 2 kiln both of which will also be converted to coal-fired units as originally proposed. higher SO_2 generation

The requested change would result in an increase of 68 lb/hr from kilns 1 and 2 and 374 lb/hr from kiln 3 above the original limits determined as BACT.

<u>BACT Determination Requested by the applicant:</u>

The following fuel operating mix for the three kilns would be:

A.	Kiln 1-coal (125)	Kiln 2-gas(9)	Kiln 3-coal(400)
B.	Kiln 1-gas(9)	Kiln 2-coal(125)	Kiln 3-coal(400)
C.	Kiln 1-coal(125)	Kiln 2-coal(125)	Kiln 3-DOWN

* figure in parenthesis is pounds SO_2 emissions per hour.

Kiln operations per any of the three scenarios will not cause violation of the Federal, State, or Dade County ambient air quality standards.

<u>Date of receipt of a BACT application:</u>

June 4, 1984

<u>Date of Publication in the Florida Administrative Weekly:</u>

June 22, 1984

AP-42, Section 8.6-1 indicates the overall control inherent in the process is approximately 75 percent or greater of the available sulfur in ore and fuel if a baghouse that allows SO_2 to come in contact with the cement dust used. The existing sources use electrostatic precipitators for the control of particulate emissions; therefore, the department believes the maximum absorption would be 75 percent. The amount of SO_2 emissions will vary according to the alkali and sulfur content of the raw materials and fuel.

The SO_2 emission limits determined as BACT are obtainable by firing low sulfur coal. The economics of firing two percent sulfur coal is evident. The applicant has the option of burning a lower sulfur coal or installing additional SO_2 controls to meet the SO_2 limits determined as BACT.

The three operating scenarios proposed by the applicant to protect the Dade County AAQS are acceptable. The application of production process techniques is a recognized method to achieve the required level of emission control.

Details of the Analysis May be Obtained by Contacting:

Edward Palagyi, BACT Coordinator
Department of Environmental Regulation
Bureau of Air Quality Management
2600 Blair Stone Road
Tallahassee, Florida 32301

Recommended By: C. H. Fancy (signature)

C. H. Fancy, Deputy Chief

Date: 1/21/85

Approved By: (signature) for Victoria J. Tschinkel, Secretary

Date: 21 JAN 1985