Note: This is a reference cited in *AP 42, Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources.* AP42 is located on the EPA web site at www.epa.gov/ttn/chief/ap42/

The file name refers to the reference number, the AP42 chapter and section. The file name "ref02_c01s02.pdf" would mean the reference is from AP42 chapter 1 section 2. The reference may be from a previous version of the section and no longer cited. The primary source should always be checked.

AP-42 Section 11.6
Reference 13
Report Sect. 4
Reference 6

EMISSION TESTING REPORT

ETB TEST NUMBER 71-MM-07

FINAL

FINAL

Emissions From Wet Process Cement Kiln at

GIANT PORTLAND CEMENT
HARLEYVILLE, SOUTH CAROLINA

FINAL

FINAL

Project Officer
Clyde E. Riley

ENVIRONMENTAL PROTECTION AGENCY
Office of Air Programs
Research Triangle Park, North Carolina 27711

Source category: Portland Cement
Plant name : Giant Portland Cement
Test date : 6/9 - 6/11/71
Process : wet

Date: 01/15/93
Location: Harleyville, SC
Ref. No.: 6
Basis for process rate :

Source	Type of control	Pollutant	Run No.	Emission rate, lb/hr	Process rate, ton/hr	Emission factor		Volumetric flow rate, DSCFM	Concen. ppm
						kg/Mg	lb/ton		
rotary kiln (gas-fired)	fabric filter	filt. PM	1	21.6	40.3	0.268	0.536	Rating:	C
		con. inorg. P	1	27.0	40.3	0.335	0.670	Rating:	C
rotary kiln (No. 6 oil-fired) (gas-fired)	fabric filter	filt. PM	1	20.5	40.0	0.256	0.513	Rating:	C
		con. inorg. P	1	25.3	40.0	0.286	0.573	Rating:	C
	fabric filter	SO2	1	232	40.8	2.85	5.69	48,132	484
		SO2	2	307	40.8	3.77	7.54	48,132	641
					average	3.31	6.62	Rating:	C
rotary kiln (No. 6 oil-fired)	none	SO2	1	753	40.0	9.42	18.8	56,282	1,344
								Rating:	UNRATED
	fabric filter	SO2	1	502	40.0	6.27	12.5	56,282	895
		SO2	2	338	40.0	4.23	8.45	56,282	603
					average	5.25	10.5	Rating:	B
rotary kiln (gas-fired)	fabric filter	NOx	1	202	40.3	2.51	5.01	48,132	588
		NOx	2	78.0	40.3	0.97	1.93	48,132	227
					average	1.74	3.47	Rating:	B
rotary kiln (oil-fired)	fabric filter	NOx	1	109	40.3	1.36	2.71	56,282	272
								Rating:	UNRATED
rotary kiln (gas-fired)	fabric filter	Hg	1	0.00124	40.2	1.54E-05	3.08E-05	52,207	0.000758
		Hg	2	0.000605	40.2	7.54E-06	1.51E-05	52,207	0.000371
					average	1.15E-05	2.29E-05	Rating:	C

Notes:

1. Total of 12 stacks from common exhaust duct.
2. PM test conducted on pairs of stacks (total of 6 measurements, 1 run)
3. Hg factors based on average flow and process rates; downrate to C.

EMISSION TESTING REPORT
ETB TEST NUMBER 71-MM-07

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Emissions From
Wet Process Cement Kiln
at

GIANT PORTLAND CEMENT
HARLEYVILLE, SOUTH CAROLINA

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Office of Air Programs
Research Triangle Park, North Carolina 27711

71-MM-07

EMISSION TESTING REPORT
ETB TEST NUMBER 71-MM-07

Emissions From
Wet Process Cement Kiln
at

BEST COPY AVAILABLE

GIANT PORTLAND CEMENT
HARLEYVILLE, SOUTH CAROLINA

Project Officer
Clyde E. Riley

ENVIRONMENTAL PROTECTION AGENCY
Office of Air Programs
Research Triangle Park, North Carolina 27711

PREFACE

(TRW is Parent Corp.)

The work reported herein was conducted by Resources Research, Inc. (RRI), pursuant to a Task Order issued by the Environmental Protection Agency (EPA), under the terms of EPA Contract No. CPA-70-81. Mr. Robert N. Allen served as the Project Chief and Mr. Carlos Gonzalez, who directed the RRI field team and also the pollutant analyses performed at the RRI laboratories, served as chemist crew leader.

Mr. Clyde Riley, Office of Air Programs (OAP), Emission Testing Branch, served as Project Officer and was responsible for coordinating the performance evaluation.

Mr. Tom Jacobs, Mr. Lew Felleisen, and Mr. Philip York served as Project Engineers from the Office of Air Programs, Performance Standards Branch, and were responsible for monitoring process operations.

RRI submitted a draft document to EPA from which EPA personnel prepared the final report (Test No. 71-MM-07).

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II. LIST OF TABLES

III. LIST OF FIGURES

IV. INTRODUCTION

Under the Clean Air Act, as amended, the Environmental Protection Agency is charged with the establishment of performance standards for new installations or modifications of existing installations in stationary source categories which may contribute significantly to air pollution. A performance standard is a standard for emissions of air pollutants which reflects the best emission reduction systems that have been adequately demonstrated (taking into account economic considerations).

The development of realistic performance standards requires accurate data on pollutant emissions within the various source categories. In the cement industry, the No. 4 cement kiln operation of the Giant Portland Cement Plant in Harleyville, South Carolina, was designated by OAP as representative of a well controlled source and was thereby selected for the emission testing program. This report presents the test results which were obtained at the Giant Portland No. 4 kiln baghouse.

The exhaust gases from the wet process kiln are directed to an induced draft fan and through a connecting manifold prior to being cleaned in the baghouse collector. After having passed through one of the twelve collector compartments the gases move outward to the atmosphere through one of twelve steel stacks (See Figure 1).

Press.
BH

Testing at the baghouse location included the determination of filterable and total particulate matter, sulfur dioxide, nitrogen oxide, gaseous mercury, and carrier gas measurements[1]. Samples were obtained from each of the twelve exhaust stacks and also from the inlet duct connecting the draft fan and collector manifold.

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[1] CO_2, O_2, and CO

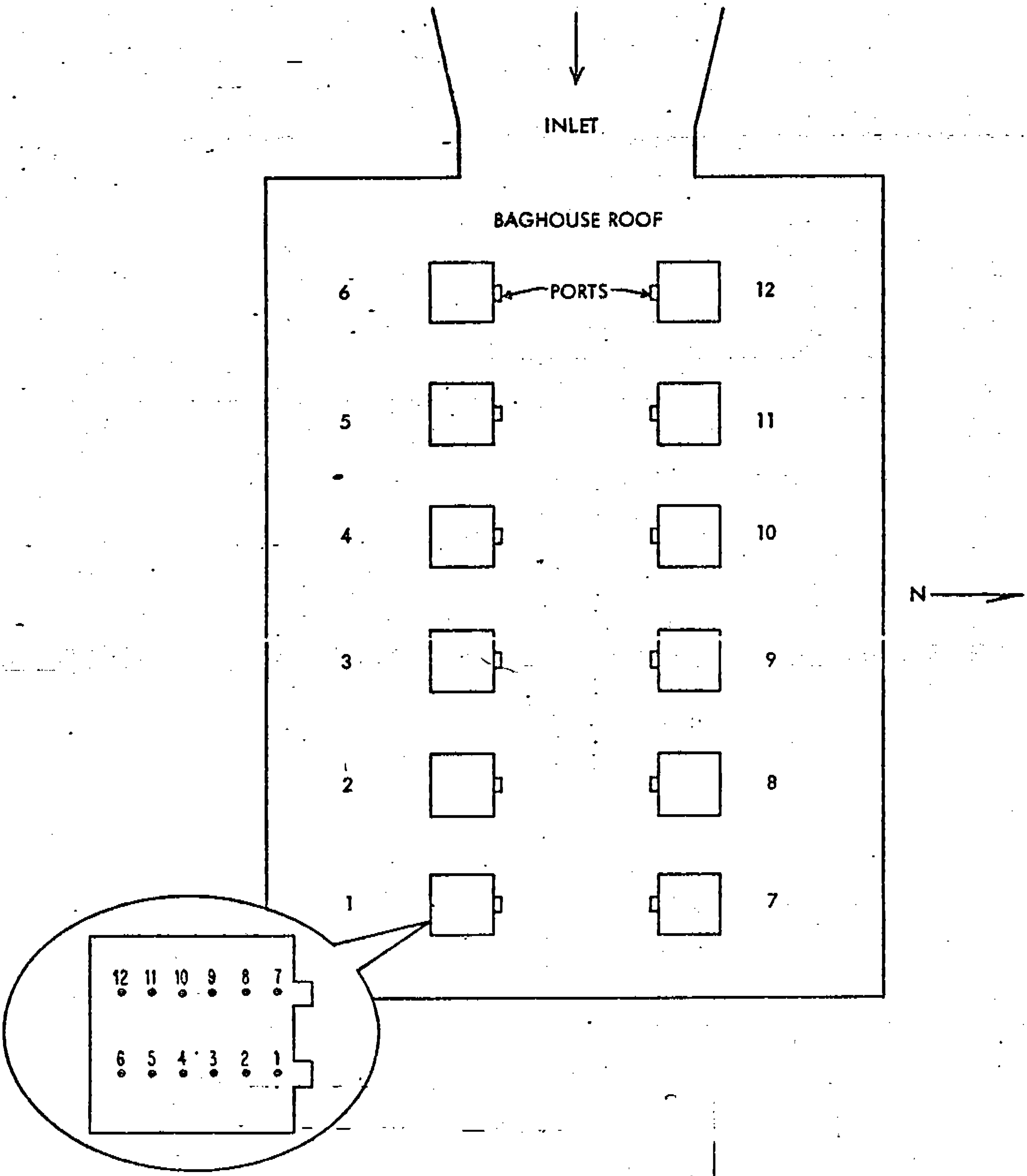

FIGURE 1. STACK DIAGRAM

Emission programs were evaluated under two separate kiln process conditions. One program was performed while the kiln used natural gas as fuel, and the second program was performed while the kiln was fired with No. 6 fuel oil.

This report is comprised of the following sections: (1) summary of results, (2) description of the process, (3) location of sampling points, (4) process operating conditions, and (5) sampling and analytical procedures.

V. SUMMARY OF RESULTS

RRI collected two overall exhaust particulate samples, each composed of six individual runs with two stacks sampled in each run. Four SO_2 and twenty-eight NO_x emission tests were conducted at the exhaust location. ✓ Two SO_2 tests were conducted at the inlet location. Twelve special samples were collected at the exhaust location for metals emission levels with analysis conducted by EPA laboratories. In addition, EPA/OAP personnel conducted tests for mercury, NO_x, and SO_2 gaseous emissions.

Gas temperatures and velocities appeared relatively uniform during the entire survey. There were mild fluctuations but no particular trends during either kiln operating condition.

Particulate emissions indicated negligible differences between gas and oil fired operation, especially when noting the wide variations between individual results. ★ The combined probe and filter catch collected during the gas fired operation was found to be 0.536 pounds per ton of kiln feed. The total catch (includes impinger portion) was 1.21 pounds per ton of kiln feed. For the oil fired operation the combined probe and filter catch was 0.513 pounds per ton of kiln feed, with the total catch (includes impinger portion) being 1.14 pounds per ton of kiln feed.

Table I presents a summary of the combined particulate results. Represented in Tables II and III are individual summaries for each pair of stacks sampled during the use of two separate fuels for firing the kiln.

The high sulfur dioxide emissions during natural gas firing indicated that the source of SO_2 was other than the fuel itself. There was, of course, a greater concentration of sulfur dioxide produced while using oil. Comparison between sulfur dioxide concentrations from the inlet and outlet samples with each fuel condition indicates that the alkaline nature of the dust cake on the bag filters was responsible for reducing SO_2 emissions. Nitrogen oxide emission averages during gas firing appeared somewhat lower than those during oil fired conditions.

Table IV presents the individual gaseous emissions summaries for the carrier gases, SO_2, NO_x, and mercury.

TABLE I

Summary of Combined Particulate Emissions

Kiln fuel	Natural Gas	No. 6 Fuel Oil
Volume of Gas Sampled - DSCF[a]	488.76	464.54
Percent Moisture by Volume	41.43	36.98
Average Stack Temperature - °F	429.	420.
Stack Volumetric Flow Rate - DSCFM[b]	48,132	56,282
Stack Volumetric Flow Rate - ACFM[c]	137,500	146,754
Percent Isokinetic	96.8	90.2
Percent Excess Air	24.90	26.48
Percent Opacity	5-25	5-25
Feed Rate - ton/hr	40.33	40.00
Particulates - probe, cyclone, and filter catch		
mg	1818.3	1375.9
gr/DSCF	0.0524	0.0395
gr/ACF	0.0195	0.0152
lb/hr	21.6	20.5
lb/ton feed	0.536	0.513
Particulates - total catch		
mg	3808.4	2866.5
gr/DSCF	0.117	0.0914
gr/ACF	0.0408	0.350
lb/hr	48.6	45.8
lb/ton feed	1.21	1.14
Percent impinger catch	52.3	52.0

---

[a] Dry standard cubic feet at 70°F, 29.92 in. Hg.

[b] Dry standard cubic feet per minute at 70°F, 29.92 in.

[c] Actual cubic feet per minute

TABLE II

Summary of Results For Nat. Gas Fired Process

Stack Number	1 and 7[1]	2 and 8	3 and 9
Date	6-9-71	6-9-71	6-9-71
Volume of Gas Sampled - DSCF[a]	82.65	87.93	99.31
Percent Moisture by Volume	40.06	41.94	40.84
Average Stack Temperature - °F	424	434	405
Stack Volumetric Flow Rate - DSCFM[b]	7,220	7,678	8,530
Stack Volumetric Flow Rate - ACFM[c]	20,064	22,242	23,468
Percent Isokinetic	93.9	93.9	95.5
Percent Excess Air	24.90	24.90	24.90
Percent Opacity	5-10	5-20	5-25
Feed Rate - ton/hr	39.9	39.9	39.9
Particulates - probe, cyclone, and filter catch			
mg	66.8	411.1	499.9
gr/DSCF	0.0124	0.0720	0.0775
gr/ACF	0.00447	0.0248	0.0282
lb/hr	0.765	4.74	5.66
lb/ton feed	0.0192	0.119	0.142
Particulates - total catch			
mg	268.8	763.5	935.2
gr/DSCF	0.0501	0.134	0.145
gr/ACF	0.0180	0.0461	0.0527
lb/hr	3.10	8.79	10.6
lb/ton feed	0.0776	0.220	0.266
Percent impinger catch	75.1	46.2	46.5

[1] See Appendix E, Particulate testing.

---

[a] Dry standard cubic feet at 70°F, 29.92 in. Hg.

[b] Dry standard cubic feet per minute at 70°F, 29.92 in. Hg.

[c] Actual cubic feet per minute

TABLE II (Concluded)

Summary of Results For Nat. Gas Fired Process

Stack Number	4 and 10[1]	5 and 11	6 and 12
Date	6-10-71	6-10-71	6-10-71
Volume of Gas Sampled - DSCF[a]	61.85	63.37	93.65
Percent Moisture by Volume	38.82	45.08	41.89
Average Stack Temperature - °F	421	448	444
Stack Volumetric Flow Rate - DSCFM[b]	8,508	8,388	7,808
Stack Volumetric Flow Rate - ACFM[c]	22,956	25,998	22,768
Percent Isokinetic	97.5	101.3	98.4
Percent Excess Air	24.90	24.90	24.90
Percent Opacity	5-10	5-20	5-25
Feed Rate - ton/hr	40.75	40.75	40.75
Particulates - probe, cyclone, and filter catch			
mg	11.8	172.1	656.6
gr/DSCF	0.00294	0.0418	0.108
gr/ACF	0.00109	0.0135	0.0370
lb/hr	0.213	3.00	7.22
lb/ton feed	0.00522	0.0737	0.177
Particulates - total catch			
mg	300.8	475.0	975.1
gr/DSCF	0.0973	0.115	0.160
gr/ACF	0.0360	0.0372	0.0549
lb/hr	7.09	8.30	10.7
lb/ton feed	0.174	0.204	0.263
Percent impinger catch	97.0	63.8	32.7

[1] See Appendix E, Particulate testing.

---

[a] Dry standard cubic feet at 70°F, 29.92 in. Hg.

[b] Dry standard cubic feet per minute at 70°F, 29.92 in. Hg.

[c] Actual cubic feet per minute

TABLE III

Summary of Results For Oil Fired Process

Stack Number	1 and 7	2 and 8	3 and 9
Date	6-11-71	6-11-71	6-11-71
Volume of Gas Sampled - DSCF[a]	62.02	115.55	65.16
Percent Moisture by Volume	37.47	35.14	35.39
Average Stack Temperature - °F	402	436	406
Stack Volumetric Flow Rate - DSCFM[b]	6,396	11,082	10,640
Stack Volumetric Flow Rate - ACFM[c]	16,498	28,580	26,644
Percent Isokinetic	90.8	85.5	89.3
Percent Excess Air	24.48	24.48	24.48
Percent Opacity	5-10	5-15	5-25
Feed Rate - ton/hr	40.0	40.0	40.0
Particulates - probe, cyclone, and filter catch			
mg	19.2	300.7	234.3
gr/DSCF	0.00477	0.0401	0.0554
gr/ACF	0.00185	0.0155	0.0221
lb/hr	0.256	3.80	5.04
lb/ton feed	0.00640	0.0950	0.126
Particulates - total catch			
mg	109.7	494.3	440.7
gr/DSCF	0.0272	0.0659	0.106
gr/ACF	0.0106	0.0255	0.0421
lb/hr	1.49	6.25	9.62
lb/ton feed	0.0373	0.156	0.240
Percent impinger catch	82.5	39.2	47.5

---

[a] Dry standard cubic feet at 70°F, 29.92 in. Hg.

[b] Dry standard cubic feet per minute at 70°F, 29.92 in. Hg.

[c] Actual cubic feet per minute

TABLE III (Concluded)

Summary of Results For Oil Fired Process

Stack Number	4 and 10	5 and 11	6 and 12
Date	6-11-71	6-11-71	6-11-71
Volume of Gas Sampled - DSCF[a]	60.96	58.17	102.68
Percent Moisture by Volume	38.13	40.55	35.22
Average Stack Temperature - °F	416	417	441
Stack Volumetric Flow Rate - DSCFM[b]	9,254	8,952	9,958
Stack Volumetric Flow Rate - ACFM[c]	24,464	24,706	25,862
Percent Isokinetic	96.0	94.7	84.6
Percent Excess Air	24.48	24.48	24.48
Percent Opacity	5-15	5-20	10-35
Feed Rate - ton/hr	40.0	40.0	40.0
Particulates - probe, cyclone, and filter catch			
mg	40.7	80.8	700.2
gr/DSCF	0.0103	0.0214	0.105
gr/ACF	0.00388	0.00775	0.0404
lb/hr	0.814	1.64	8.95
lb/ton feed	0.0204	0.0410	0.224
Particulates - total catch			
mg	339.9	368.4	1107.5
gr/DSCF	0.0859	0.0975	0.166
gr/ACF	0.0325	0.0353	0.0639
lb/hr	6.802	7.47	14.2
lb/ton feed	0.170	0.187	0.354
Percent impinger catch	88.0	78.1	36.8

---

[a] Dry standard cubic feet at 70°F, 29.92 in. Hg.

[b] Dry standard cubic feet per minute at 70°F, 29.92 in. Hg.

[c] Actual cubic feet per minute

TABLE IV

Summary of Gaseous Testing

A. Carrier Gases

	Gas Composition (Vol. % Dry)			
Fuel	CO_2	O_2	CO	N_2
Gas	18.1	4.1	<1	77.8
Oil	19.8	4.2	<1	76.0

B. Sulfur Dioxide

✓Thorin - Barium Perchlorate Method

Fuel	Baghouse Inlet Average ppm SO_2	Baghouse Exit Average ppm SO_2
Gas	719	563
Oil	1344	749

Thorin - Barium Chloride Method

Fuel	Baghouse Inlet Average ppm SO_2	Baghouse Exit Average ppm SO_2
Gas	802	582
Oil	1411	772

Dynascience Continuous Monitor[1]

Fuel		Baghouse Exit Average ppm SO_2
Gas		255
Oil		295

---

[1] See Table B-111

TABLE IV (Concluded)

C. Oxides of Nitrogen
(Phenoldisulfonic Acid Method)

Fuel	Date	Average ppm NO_2
Gas	6/9/71	588
	6/10/71	227
Oil	6/11/71	272

D. Oxides of Nitrogen
(Dynascience Continuous Monitor)

Fuel	Date	Average ppm NO_2
Gas	6/10/71	226
Oil	6/11/71	165
	6/12/71	115

E. Mercury

Fuel	Date	Average ppm Hg
Gas	6/8/71	0.000565

VI. PROCESS DESCRIPTION

The Giant Portland Cement process is typical of most wet-mix cement plants. Raw materials are mined nearby, pulverized, and mixed with water to produce a slurry. The slurry is pumped from storage tanks into a rotary kiln and the fired clinker product emerges from the hot end of the kiln. This product is then cooled, ground, and stored for shipment. Process and schematic diagrams are shown in Figures 2 and 3.

Reaction gases and exhaust gases from the kiln burner carry finely divided particulate and fuel ash through the cold end of the kiln. These dust laden gases pass through a mechanical collector and then a baghouse where the particulates are collected and the hot gases discharged into the atmosphere. The bags are periodically cleaned by reversing the air flow and by sonic vibration which is produced by an internal horn. The solid matter then drops to the bottom of the baghouse for removal.

The Dracco baghouse collector is designed to handle an air volume of 140,000 ACFM @ 550°F. The baghouse contains twelve individual compartments, each containing seventy-eight bags for a total bag count of 936. The effective collecting surface area of the baghouse is 75,816 square feet, which gives an air-to-cloth ratio of 1.85 to 1 feet per minute, overall, or 2.01 to 1 feet per minute while one compartment is being cleaned. The pressure drop across one compartment ranges from 4 to 4.5 inches of water. The expected life of the bags is about two (2) years, and each bag costs approximately $14.00. During the period of May 25 to June 2, 1971, 884 new bags were installed.

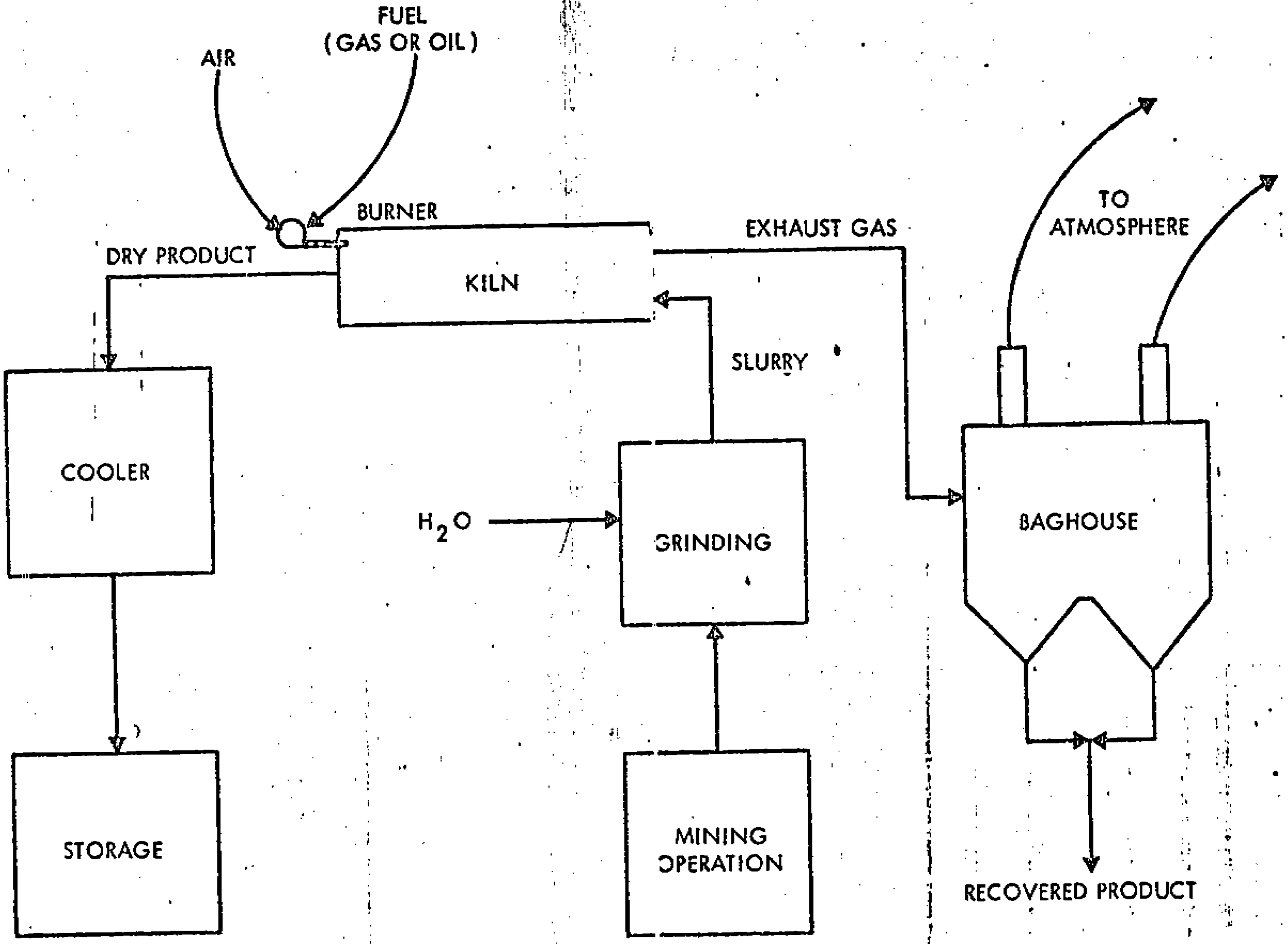

FIGURE 2. PROCESS FLOW DIAGRAM

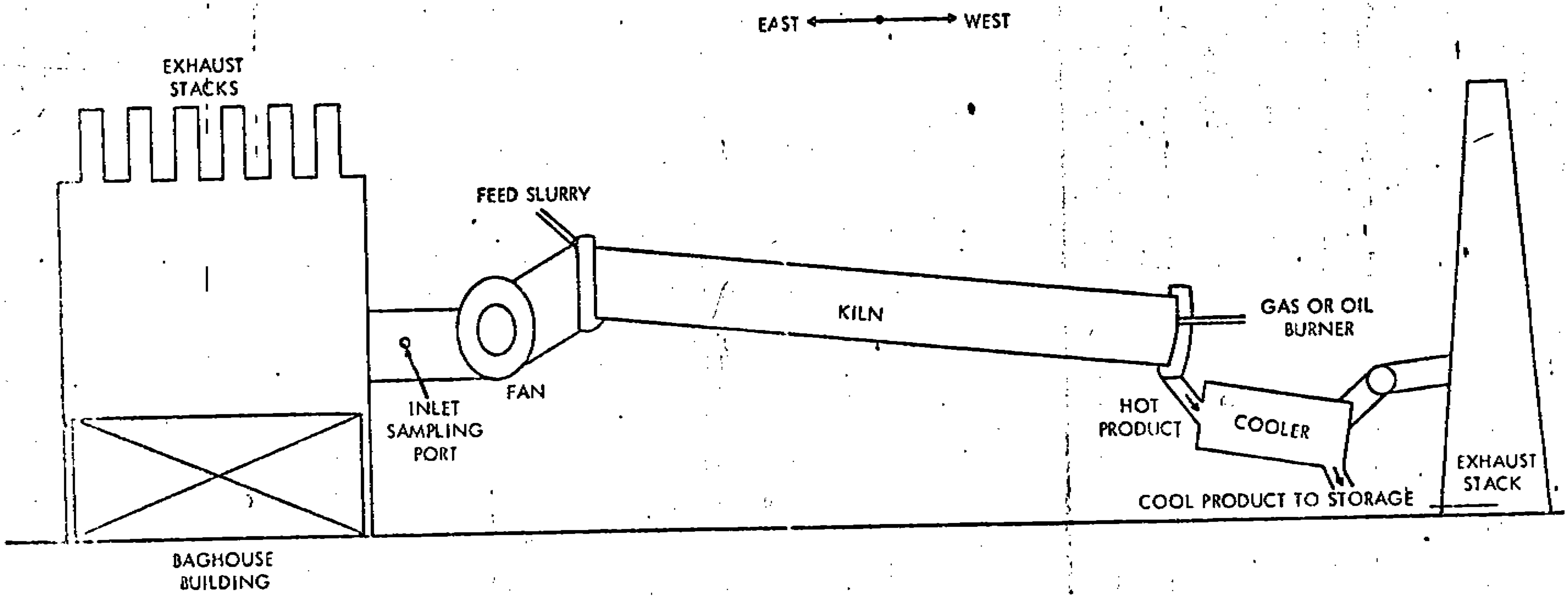

FIGURE 3. SCHEMATIC DIAGRAM OF #4 KILN

The annual operating cost of the baghouse is about $15,000.00, of which $6,500.00 is for bag replacement, $2,200.00 for dust handling equipment, $1,200.00 for air system and dampers, and $5,100.00 for miscellaneous costs.

VII. LOCATION OF SAMPLING POINTS

The particulate sampling ports located on the twelve effluent stacks were positioned approximately 10 feet (3.1 stack diameters) above the nearest upstream disturbance and 4 feet (1.5 stack diameters) below the nearest downstream disturbance. The number and locations of the sampling points within the stack cross-section were determined by the project officer.

The cross-section of each stack was divided into twelve equal areas, and sampling was carried out for five minutes at the centroid of each area. A view of a baghouse exhaust stack is shown in Figure 4 on the following page.

For the metal tests six samples were performed by traversing the cross-section, and six samples were performed at the average point in the stack cross-section. The stacks chosen for the metal tests were considered to be the most representative by the project officer.

For the gaseous sampling the probes were positioned at the most convenient sampling ports and extended approximately 12 inches into the cross-section.

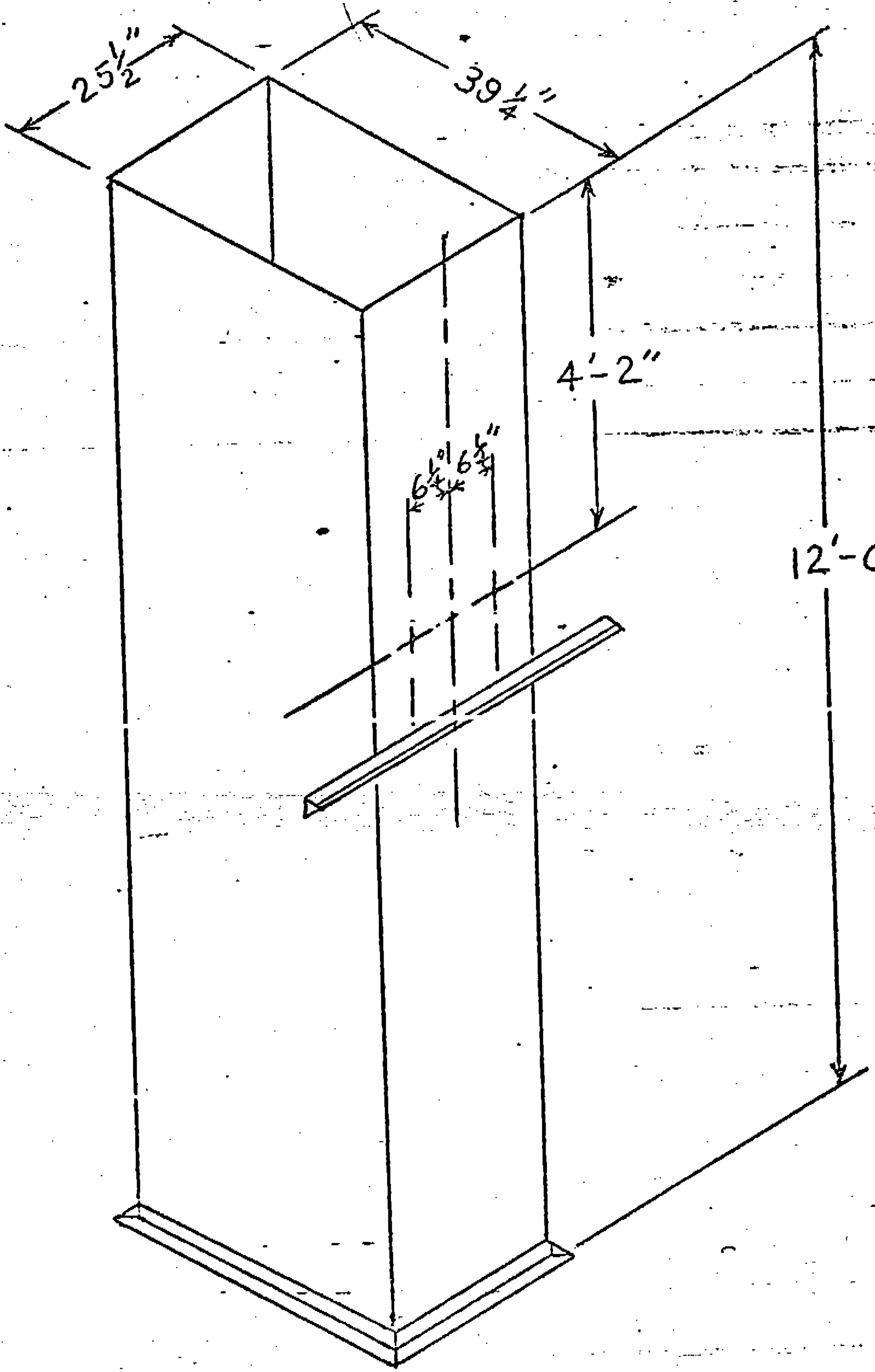

Figure 4. Baghouse Exhaust Stack

VIII. PROCESS OPERATION

Just prior to the testing program the No. 4 kiln baghouse, connecting duct work, and screw conveyor packings had undergone a major overhaul to correct excess air leakage points. This included the baghouse being recovered with new asbestos siding, installation of twelve new effluent stacks, and replacement of 884 filter bags, the remaining 52 bags being examined for wear and visible leakage.

The kiln had been in operation for about two weeks after this major overhaul when a mechanical breakdown resulting from feed blockage forced another shut-down. During this time the baghouse compartments were again inspected and checked for any visible bag leakage.

Due to the nature of the firing operation and the incipient fusion of materials within the kiln, operational variations of temperature, draft, and process were common during the testing program. There were some fluctuations in the kiln operation during testing, but these were all considered to be within normal limits.

A team member was placed in the control room to collect data and communicate any upsets or abnormalities during the testing periods. Appendix C tabulates these readings which were taken at thirty minute intervals.

After the completion of testing with natural gas as the kiln fuel (June 10, 1971), the plant switched from natural gas to No. 6 fuel oil. Testing the next morning was delayed to allow the process to reach normal operating levels. Oil firing was continued until completion of the testing (June 12, 1971).

The routine cleaning device for the baghouse was a combination of sonic vibration from an internal horn and a reversed gas flow within the compartments. It was planned to cease sampling whenever that particular section was being cleaned; however, some of the horns were inoperable and the sound was not a satisfactory indication of which particular compartment was being cleaned. The gas flow was rather low and this, too, was not always a good indication of the cleaning cycles. It is believed that all tests were carried out during operational periods; however, it is possible that a sample included a short segment of a cleaning cycle.

IX. SAMPLING PROCEDURES

Inlet Duct

Only sulfur dioxide sampling was conducted at the inlet duct. Samples were simultaneously collected along with the effluent SO_2 samples for each fuel condition. The inlet duct location presented problems because of the high pressure immediately following the induced draft fan, thus causing a high velocity stream of hot gases and dust every time the port was opened. The high concentration of dust also created problems in sampling for sulfur dioxide gas. A special parallel, multi-filter arrangement was employed to filter the high dust loading prior to obtaining the SO_2 samples in the midget impinger train. A heated probe, with no glass wool, was positioned approximately 12 inches inside the duct work and was connected to one of three-parallel glass filter holders inside a heated box. Each filter holder contained a 2 5/8 inch glass fiber filter. The filter holders were interconnected to a common manifold that passed the gas stream to the midget impinger train described in Method 6 of the December 23, 1971, Federal Register, "Standards of Performance for New Stationary Sources." Due to the reaction expected between the alkaline dust and the SO_2, sample flow rates were kept at a minimum (0.1 C.F.M.) and each filter was changed after ten minutes of service. The impinger solutions were also changed due to the high moisture content of the gas stream (40%). Total sampling time for each test was thirty minutes. Sample recovery followed the same procedures as outlined in Method 6.

Outlet Duct

Particulate samples were collected at the outlet with the train specified in Method 5 of the December 23, 1971, Federal Register. Due to the number of effluent stacks (twelve) it was not possible to sample all twelve simultaneously. Instead No. 1, No. 2, and No. 3 stacks (see figure 1) were sampled simultaneously for sixty minutes at which time the probe and impingers were turned around, and No. 7, No. 8, and No. 9 stacks were sampled together. The combination sample for each pair of stacks was recovered and analyzed as one. The trains were then moved to the west side of the baghouse where the same sampling procedure was used for stacks 4 & 10, 5 & 11, and 6 & 12. This sampling procedure was used for both the natural gas and oil testing programs.

The procedures for clean-up of the sampling train after each run included brushing and rinsing the probe tip, probe, and filter-inlet glassware with acetone. The impingers and accessory glassware were rinsed with distilled water and acetone. Otherwise the procedures for sampling and recovery of particulates conform to Method 5.

The metals sampling train was the same as the particulate train, but instead of the glass fiber filter a membrane filter was used. Cleanup consisted only of recovery of the membrane filter.

The equipment and procedure used for the collection of the cumulative carrier gas samples are essentially the same as specified in Method 3 of the December 23, 1971, Federal Register. The sampling rate was set at a constant value for any testing period so that a total gas volume of between 2 and 3 cubic feet would be collected.

The procedures for gaseous sampling of NO_2 and SO_2 conform to Method 7 and Method 8, respectively, as specified in the December 23, 1971, Federal Register.

Two gaseous mercury samples were collected using a midget impinger train. The effluent gas was bubbled through an acidic solution of iodine monochloride, collecting mercury and mercury containing compounds. Additional information pertaining to gaseous mercury sampling may be found in Method 1, December 7, 1971, Federal Register (Vol. 36, No. 235). The results of the two mercury tests are presented in Table B-VII.

Continuous monitoring of sulfur dioxide and oxides of nitrogen was conducted at the effluent stacks using electrochemical reaction sensing analyzers. SO_2 and NO_2 emissions data are presented in Tables B-III and B-VI.

X. ANALYTICAL PROCEDURES

The procedures for analyzing the particulate, sulfur dioxide, and nitrogen oxide emissions are described in Methods 5, 6, and 7 contained in the December 23, 1971, Federal Register. In addition to the particulate analysis specified, the impinger

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X. ANALYTICAL PROCEDURES

The procedures for analyzing the particulate, sulfur dioxide, and nitrogen oxide emissions are described in Methods 5, 6, and 7 contained in the December 23, 1971, Federal Register. In addition to the particulate analysis specified, the impinger catch was analyzed for particulate residue and organic matter with the organic extraction being performed only on the oil fired segment of the particulate samples.

Quantitative analyses of material collected on the glass fiber filter and in the residue samples are reported in Appendix F.

Two methods were employed for analysis of all SO_2 samples. This report is based upon the modified Shell Development Method, using barium perchlorate with thorin indicator. A second cross-check method was the colorimetric barium chloranilate procedure which was found to duplicate the former method very well. The analytical data for both procedures is included in the Appendix B.

In accordance with instructions by the EPA project officer, the NO_x grab samples were treated after aging overnight. These samples were neutralized with a mild solution of sodium hydroxide in order to stabilize their chemical properties during transportation to the laboratory for analysis.

Analyses for carbon dioxide, oxygen, and carbon monoxide were performed in the field within a few hours after the sampling was completed, using an Orsat apparatus.

The procedure for analyzing the two mercury samples may be found in Method 1, December 7. 1971, Federal Register (Vol. 36, No. 235).

APPENDIX B

Gaseous Results

The results of the testing for SO_2, NO_2, and mercury are shown in the following tables.

TABLE B-I

SO_2 EMISSION DATA

(Barium Perchlorate Method)

Fuel - Natural Gas	Inlet Duct	Outlet Stack No.6	Outlet Stack No.8
Date	6/10	6/10	6/10
Time	15:35 16:40	15:45 17:02	15:45 16:45
mg SO_2	204.2	190.8	197.1
T_m - Average Gas Meter Temperature, ^oF	93	120	94
P_b - Barometric Pressure, "Hg abs.	30.2	30.2	30.2
V_m - Volume of dry gas sampled @ meter conditions, ft.^{3}	3.90	5.68	4.23
ppm SO_2	719	484	641

(Barium Chloride Method)

Fuel - Natural Gas	Inlet Duct	Outlet Stack No.6	Outlet Stack No.8
Date	6/10	6/10	6/10
Time	15:35 16:40	15:45 17:02	15:45 16:45
mg SO_2	228	209	195
T_m - Average Gas Meter Temperature, ^oF	93	120	94
P_b - Barometric Pressure, "Hg abs.	30.2	30.2	30.2
V_m - Volume of dry gas sampled @ meter conditions, ft.^{3}	3.90	5.68	4.23
ppm SO_2	802	530	634

Note--All samples were diluted to volume in 100 ml volumetric flasks with H_2O and then poured through a column of Dow 50W x 8. Results were obtained by analyzing two different aliquots of the same sample.

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TABLE B-II

SO_2 EMISSION DATA

(Barium Perchlorate Method)

Fuel - No. 6 Fuel Oil	Inlet Duct	Outlet Stack No.6	Outlet Stack No.8
Date	6/12	6/12	6/12
Time	09:44 10:33	09:40 11:05	09:45 11:00
mg SO_2	384.9	369.2	242.5
T_m - Average Gas Meter Temperature, °F	91	128	127
P_b - Barometric Pressure, "Hg abs.	30.25	30.25	30.25
V_m - Volume of dry gas sampled @ meter conditions, $ft.^3$	3.91	6.01	5.85
ppm SO_2	1344	895	603

(Barium Chloride Method)

Fuel - No. 6 Fuel Oil	Inlet Duct	Outlet Stack No.6	Outlet Stack No.8
Date	6/12	6/12	6/12
Time	09:44 10:33	09:40 11:05	09:45 11:00
mg SO_2	404	390	240
T_m - Average Gas Meter Temperature, °F	91	128	127
P_b - Barometric Pressure, "Hg abs.	30.25	30.25	30.25
V_m - Volume of dry gas sampled @ meter conditions, $ft.^3$	3.91	6.01	5.85
ppm SO_2	1411	946	597

Note-All samples were diluted to volume in 100 ml volumetric flasks with H_2O and then poured through a column of Dow 50W x 8. Results were obtained by analyzing two different aliquots of the same sample.

Equation used for calculating ppm SO_2:

$$\text{ppm } SO_2 = \frac{0.7496 \text{ X mg } SO_2 \text{ X } (T_m + 460)}{P_b \text{ X } V_m}$$

TABLE B-III

Sulfur Dioxide Data Comparing The Modified Shell Method[1] VS The Dynascience Instrument

(All values are in ppm SO_2)

Date	Time	Fuel	Shell Method Average	Dynascience
6-10-71	16:30	Gas	562	200
6-10-71	16:55	Gas	562	310
6-10-71	17:05	Gas	562	230
6-12-71	17:15	Oil	603	360
6-12-71	17:25	Oil	603	360

Sampling location - effluent stacks

Comments - It should be noted that during testing the Dynascience monitor was not operating properly and recorded emission levels may have been altered significantly.

[1] Method using barium perchlorate

TABLE B-IV

NO_x EMISSION DATA

(Natural Gas)

Stack No.	6			12			1		
Flask No.	1	2	3	4	5	6	7	8	9
Date	6/9	6/9	6/9	6/9	6/9	6/9	6/10	6/10	6/10
Time	1050	1106	--	1135	1150	1210	0935	0945	0955
mg NO_2	2.32	1.71	--	2.17	1.73	1.51	0.27	0.27	0.33
T_f - Flask Temperature, °F	99	105	Void	102	101	104	88	88	84
V_f - Flask Volume, liters	2.080	2.050	--	2.064	2.073	2.078	2.098	2.088	2.045
P_i - Initial Flask Vacuum, "Hg.	26.1	26.1	--	26.1	26.1	26.1	26.3	26.3	26.3
P_f - Final Flask Vacuum, "Hg.	0.2	0	--	0.5	0.5	0.5	0.6	0.4	0.5
ppm NO_2	711	533	--	682	540	473	81	81	101

Stack No.	7			2			8
Flask No.	10	11	12	13	14	15	16
Date	6/10	6/10	6/10	6/10	6/10	6/10	6/10
Time	1015	1020	1030	1145	1150	1155	1215
mg NO_2	0.45	0.57	0.80	1.27	1.27	1.20	1.05
T_f - Flask Temperature, °F	86	86	83	92	91	92	100
V_f - Flask Volume, liters	2.085	2.038	2.095	2.064	2.064	2.080	2.078
P_i - Initial Flask Vacuum, "Hg.	26.5	26.5	26.5	26.3	26.3	26.3	26.3
P_f - Final Flask Vacuum, "Hg.	0.4	0.5	0.5	0.5	0.5	0.4	0.3
ppm NO_2	133	174	236	389	388	363	321

$$\text{ppm } NO_2 = \frac{29.54 \times \text{mg } NO_2 \times (T_f + 460)}{V_f \times (P_i - P_f)}$$

TABLE B-V

NO_x EMISSION DATA

(Fuel Oil)

Stack No.	2			8		
Flask No.	1	2	3	4	5	6
Date	6/11	6/11	6/11	6/11	6/11	6/11
Time	0955	1005	1012	1028	1035	1040
mg NO_2	0.30	0.45	0.47	0.48	0.17	0.12
T_f - Flask Temperature, ^oF	84	87	89	95	97	97
V_f - Flask Volume, liters	2.098	2.038	2.103	2.088	2.085	2.045
P_i - Initial Flask Vacuum, "Hg.	26.5	26.5	26.6	26.9	27.0	26.9
P_f - Final Flask Vacuum, "Hg.	0.4	0.1	0.4	0.3	0.2	0.1
ppm NO_2	88	140	138	142	50	36

Stack No.	9					
Flask No.	7	8	9	10	11	12
Date	6/11	6/11	6/11	6/11	6/11	6/11
Time	1135	1142	1150	1159	1207	1215
mg NO_2	0.92	1.42	1.65	1.38	1.19	2.38
T_f - Flask Temperature, ^oF	101	104	104	103	106	91
V_f - Flask Volume, liters	2.073	2.080	2.075	2.064	2.078	2.125
P_i - Initial Flask Vacuum, "Hg.	26.5	26.9	26.9	26.9	26.9	26.8
P_f - Final Flask Vacuum, "Hg.	0.2	0.2	0.2	0.2	0.2	0.4
ppm NO_2	280	426	496	416	359	691

$$\text{ppm } NO_2 = \frac{29.54 \times \text{mg } NO_2 \text{ X } (T_f + 460)}{V_f \text{ X } (P_i - P_f)}$$

TABLE B-VI

Nitrogen Oxide Data Comparing the PDS[1] Method VS the Dynascience Instrument

(All values are NO_2 ppm by volume)

Date	Time	Fuel	PDS Method	Dynascience
6-9-71	10:50	Gas	711	---
6-9-71	11:06	Gas	533	---
6-9-71	11:35	Gas	682	---
6-9-71	11:50	Gas	540	---
6-9-71	12:10	Gas	473	---
6-10-71	09:35	Gas	81	180
6-10-71	09:45	Gas	81	140
6-10-71	09:55	Gas	101	190
6-10-71	10:15	Gas	133	190
6-10-71	10:20	Gas	174	---
6-10-71	10:30	Gas	236	---
6-10-71	11:30	Gas	---	430
6-10-71	11:45	Gas	389	---
6-10-71	11:50	Gas	388	---
6-10-71	11:55	Gas	363	---
6-10-71	12:15	Gas	321	---
6-10-71	16:40	Gas	---	260
6-10-71	16:55	Gas	---	240
6-10-71	17:25	Gas	---	180
6-10-71	17:30	Gas	---	220
6-11-71	09:55	Oil	88	---
6-11-71	10:05	Oil	140	---
6-11-71	10:12	Oil	138	---
6-11-71	10:28	Oil	142	---
6-11-71	10:35	Oil	50	---
6-11-71	10:40	Oil	36	---
6-11-71	11:35	Oil	280	---
6-11-71	11:42	Oil	426	---
6-11-71	11:50	Oil	496	---
6-11-71	11:59	Oil	416	---
6-11-71	12:07	Oil	359	100
6-11-71	12:15	Oil	691	115
6-11-71	17:35	Oil	---	210
6-11-71	17:40	Oil	---	200
6-11-71	18:00	Oil	---	200
6-12-71	09:45	Oil	---	100
6-12-71	09:55	Oil	---	115
6-12-71	10:10	Oil	---	110
6-12-71	10:20	Oil	---	120
6-12-71	10:50	Oil	---	120
6-12-71	11:20	Oil	---	120
6-12-71	11:[illegible]	Oil	---	120

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(1) PDS: Phenoldisulfonic

Sampling location - effluent stacks

TABLE B-VII

MERCURY EMISSION DATA

(Natural Gas)

Run No.	1	2
Date	6/8	6/8
Time	9:20 10:20	10:37 11:32
mg Hg	0.000450	0.000191
T_m - Average Gas Meter Temperature, °F	105	120
P_b - Barometric Pressure, "Hg abs.	30.05	30.05
V_m - Volume of dry gas sampled @ meter conditions, $ft.^3$	2.677	2.389
ppm Hg	0.000758	0.000371

$$\text{ppm Hg} = \frac{0.2399 \times \text{mg Hg} \times (T_m + 460)}{V_m \times P_b}$$

Note: Values are within limits of detectability of the analysis method (2×10^{-5}).

APPENDIX C

Complete Operation Results

Flue Gas Conditions

The stack flue gas flow rates were measured continuously, with the pitobe arrangement, for each stack during each series of tests. The flue gas volumes varied appreciably between different exhaust stacks. Variation was also noted at the same exhaust stack, when sampling was repeated under oil fired operating conditions. Orsat analyses were not conducted for each separate exhaust stack, therefore no variation is noted, however, the percent water vapor from different exhaust stacks showed some variations. It would not be unlikely that the moisture content would vary with time, but it would have been expected that the water vapor during any one set of test samples should have been relatively constant between exhaust stacks. The process involved a single cement kiln and a single inlet duct to the baghouse collection device. Unless there were unusual problems of flow patterns and buildup within the baghouse it would not seem logical to have such widely varying emission conditions, especially of the gaseous constituents, which should have been completely uniform as they entered the inlet duct to the collector. At first impression, the variation in gas temperature does not appear to be as extreme, however, the differences are considerably greater than could ordinarily be expected from a single well insulated unit with a single supply of gas flow. Any correlation between varying temperatures, moistures and gas flows is rather confusing, but it would seem that there are major problems in either leakage and/or inter-connections and/or blockages within the various sections of this particular baghouse unit.

There were some fluctuations in the kiln operating variables during testing, but these were all considered to be within normal operating limitations.

Process Operations

a. On Wednesday morning (6/9/71), No. 4 kiln was gas fired. Kiln speed rate and feed rate were reduced from 8:30 to 9:00 due to a drop in burning zone temperature, but was back to normal by 9:30. Feed to kiln averaged 39.99 tons per hour (dry basis).

b. On Thursday morning, No. 4 kiln was gas fired. Kiln operating smoothly with average feed rate of 40.75 tons per hour.

c. On Friday morning and afternoon, No. 4 kiln was oil fired (2.5 percent sulfur) and operating smoothly with an average feed rate of 40.00 tons per hour.

The following tables present a detailed log of control room readings taken at thirty minute intervals during the testing programs.

TABLE G-I

No. 4 Kiln 6-8-71

	3:30	4:00	4:30	5:00	5:30	6:00	6:30
Feed Hood Temp. °F	450	480	620	550	520	500	510
Feed Hood Pressure, in. H_2O	4.00	3.00	4.40	4.40	4.60	4.60	4.70
Baghouse Inlet Temp. °F	420	450	530	480	450	440	450
Baghouse Inlet Pressure, in. H_2O	.90	.90	.90	.80	.80	.80	.80
Chain Discharge Temp. °F	1260	1300	1480	1500	1330	1270	1280
Kiln Feeder Speed RPH (Red)	36	48	56	75	76	76	76
Kiln Speed RPH (Green)	32	46	53	71	71	71	71
Burning Zone Temp. °F	1400	2200	2200	2480	2550	2460	2450
Gas (Foxboro) x 100 ft^3	37298	38283	39412	40459	41336	42369	43518
Clinker Cooler							
ID Fan, in. H_2O	+.1	-.3	-.3	-.15	-.15	-.25	-.05

TABLE C-I (Continued)

No. 4 Kiln

Time	6-8-71 7:00 PM		6-9-71 8:00 AM	8:30 AM	9:00 AM	9:30 AM	10:00 AM	10:30 AM	11:00 AM
Feed Hood Temp. °F	520		560	600	600	600	580	590	570
Feed Hood Pressure	4.60		4.20	2.80	3.00	3.70	4.00	4.20	4.50
Baghouse Inlet Temp. °F	460		500	530	520	510	500	510	500
Baghouse Inlet Pressure	.80		.90	1.00	.90	1.00	1.10	1.00	.80
Chain Discharge Temp. °F	1320		1320	1490	1480	1520	1420	1420	1360
Kiln Feeder Speed (RPH)(Red)	76		46	60	52	74	76	76	76
Kiln Speed (RPH) (Green)	71		41	59	47	70	71	71	71
Burning Zone Temp.	2500		1500	2120	1600	2320	2500	2560	2470
Gas (x 100 Cu.Ft.)	44591		72453	73460	74628	75798	76820	77815	78768
Clinker Cooler (H_2O)	-.15		+.03	-.10	-.05	-.25	0	-.20	- 0.30

Time	6-9-71 11:30 AM	Noon 12:00		6-10-71 8:00 AM	8:30 AM	9:00 AM	9:30 AM	10:00 AM	10:30 AM
Feed Hood Temp. °F	560	560		570	580	590	595	580	580
Feed Hood Pressure	4.50	4.60		4.80	4.50	4.30	4.20	4.30	4.60
Baghouse Inlet Temp. °F	490	500		510	520	530	535	520	520
Baghouse Inlet Pressure	.80	.85		.85	.90	.80	.80	.80	.60
Chain Discharge Temp. °F	1340	1325		1340	1380	1400	1420	1420	1390
Kiln Feeder Speed (RPH)	76	76		78	78	78	77	78	78
Kiln Speed (RPH)	71	71		71	71	71	71	71	71
Burning Zone Temp.	2580	2440		1900	2000	2000	2050	2090	2040
Clinker Cooler (in.H_2O)	-.30	-.30		-.30	-.30	-.30	-.22	-.28	-.30
Gas (x 100 Cu. Ft.)	79712	80682		74219590	20617	21650	23159	23894	24917

TABLE C-1 (Concluded)

No. 4 Kiln

Time	6-10-71 11:00 AM	11:30 AM	12:00	12:30PM	1:00 PM	1:30	6-10-71 3:00 PM	3:30	4:00
Feed Hood Temp. °F	570	565	565	570	565	570	560	560	560
Feed Hood Pressure	4.60	4.60	4.70	4.80	4.70	5.10	5.00	4.80	4.70
Baghouse Inlet Temp. °F	510	500	500	500	495	500	490	490	495
Baghouse Inlet Pressure	.80	.80	1.00	.85	.80	.70	0.0	.40	1.10
Chain Discharge Temp. °F	1360	1330	1320	1310	1300	1300	1300	1310	1330
Kiln Feeder Speed (RPH)	78	78	78	78	78	78	78	78	78
Kiln Speed (RPH)	71	71	71	71	71	71	71	71	71
Burning Zone Temp.	2300	2380	2390	2350	2350	2360	2240	2280	2300
Gas (x 100. Cu. Ft.)	26010	26887	27847	28792	29664	30649	33637	34648	35608
Clinker Cooler (H_2O)	-.30	-.30	-.30	-.30	-.30	-.30	-.30	-.30	-.30
Oil in Gal.							15253656		

Time	6-10-71 4:30 PM	5:00 PM
Feed Hood Temp. °F	560	560
Feed Hood Pressure	4.60	4.50
Baghouse Inlet Temp. °F	495	500
Baghouse Inlet Pressure	1.10	.90
Chain Discharge Temp. °F	1330	1320
Kiln Feeder Speed (RPH)	78	78
Kiln Spped (RPH)	71	71
Burning Zone Temp.	2280	2300
Gas (x 100 Cu. Ft.)	36626	37597
Clinker Cooler (H_2O)	-.30	-.30
Oil in Gal.		

TABLE C-II

No. 4 Kiln

Oil

6-11-71 Time	8:00 AM	8:30	9:00	9:30	10:00	10:30	11:00	11:30	Noon 12:00
Feed Hood Temp. °F	490	510	600	590	590	595	585	580	575
Feed Hood Pressure	0.50	3.10	4.60	4.20	4.50	4.50	4.30	4.40	4.40
Baghouse Inlet Temp. °F	430	470	520	510	510	520	510	500	500
Baghouse Inlet Pressure	0.90	0.80	0.80	1.00	1.10	0.70	0.60	0.95	0.90
Chain Discharge Temp. °F	1000-	1000-	1360	1390	1390	1410	1390	1360	1350
Kiln Feeder Speed (RPH)	0	49	77	77	77	77	77	77	77
Kiln Speed (RPH)	0	45	71	71	71	71	71	71	71
Burning Zone Temp.	1400-	1400-	1400-	1400-	2200	2260	2390	2390	2400
Gas (x 100 = Cu. Ft.)				-	-	-	-	-	-
Oil in Gal.	15263956	15264531	15265191	15265723	15266390	15266991	15267614	15268254	15268837
Cooler Vent Stack (in. H_2O)	+.04	-.12	-.06	-.02	-.10	-.04	-.03	-.06	-.08

Time	6-11-71 12:30 PM	6-11-71 3:30 PM	4:00 PM	4:30 PM	5:10 PM	5:30 PM	6:00 PM	6:30
Feed Hood Temp. °F	570	560	560	550	550	550	555	555
Feed Hood Pressure	4.40	4.70	4.70	4.90	5.00	5.10	5.00	4.90
Baghouse Inlet Temp. °F	495	490	485	485	490	485	485	490
~~Baghouse Inlet Pressure~~	0.80	1.00	0.90	0.75	0.90	0.70	0.80	0.75
Chain Discharge Temp. °F	1320	1330	1310	1300	1300	1290	1290	1300
Kiln Feeder Speed (RPH)	77	77	77	77	77	77	77	77
Kiln Speed (RPH)	71	71	71	71	71	71	71	71
Burning Zone Temp.	2410	2380	2360	2300	2100	2000	1960	1620
Oil	15269436	15272919	15273505	15274025	15274839	15275164	15275758	15276244
Cooler Vent Stack (in. H_2O)	-.09	-.20	-.24	-.25	-.28	-.24	-.22	-.26

TABLE C-II (Concluded)

No. 6 Kiln

6-12-71 Time	9:30 AM	10:00	10:35	11:00	11:30	12:00	12:30	1:00
Feed Hood Temp. °F	585	580	580	580	575			
Feed Hood Pressure	5.10	5.00	5.10	5.10	5.10			
Baghouse Inlet Temp. °F	510	505	500	505	500			
Baghouse Inlet Pressure	0.95	0.80	0.80	0.90	0.70			
Chain Discharge Temp.	1380	1370	1365	1370	1365			
Kiln Feeder Speed (RPH)	78	78	78	78	78			
Kiln Speed (RPH)	70	70	70	70	70			
Burning Zone Temp. *	1400-	1400-	1400-	1400-	1400-			
Oil	15293456	15294029	15294743	15293210	15295827			
Cooler Vent Stack (in. H_2O)	-.04	-.04	-.02	-.02	-.02			

*These temperatures are questionable due to dirty scale lenses.

APPENDIX F

Laboratory Report

Table F-I presents the particulate analysis results which were reported by the Resources Research laboratory.

TABLE F-I

Particulate Mass Determination

Stack No.	Fuel	Fraction		Particulate, mg
1 and 7	Gas	Impg. water residue		159.3
		Back half rinse		42.7
		Front half rinse		59.6
		Filter.		7.2
			Total	268.8
2 and 8	Gas	Impg. water residue		254.3
		Back half rinse		98.1
		Front half rinse		126.1
		Filter		285.0
			Total	763.5
3 and 9	Gas	Impg. water residue		346.9
		Back half rinse		88.4
		Front half rinse		334.3
		Filter		165.6
			Total	935.2
4 and 10	Gas	Impg. water residue		363.8
		Back half rinse		15.2
		Front half rinse		7.1
		Filter		4.7
			Total	390.8
5 and 11	Gas	Impg. water residue		278.8
		Back half rinse		24.1
		Front half rinse		153.3
		Filter		18.8
			Total	475.0
6 and 12	Gas	Impg. water residue		296.1
		Back half rinse		22.4
		Front half rinse		326.4
		Filter		330.2
			Total	975.1

TABLE F-I (Concluded)

Stack No.	Fuel	Fraction		Particulate, mg
1 and 7	Oil	Ether-chloroform extraction		11.9
		Impg. water residue		72.1
		Back half rinse		6.5
		Front half rinse		18.6
		Filter		0.6
			Total	109.7
2 and 8	Oil	Ether-chloroform extraction		9.4
		Impg. water residue		174.6
		Back half rinse		9.6
		Front half rinse		168.0
		Filter		132.7
			Total	494.3
3 and 9	Oil	Ether-chloroform extraction		16.7
		Impg. water residue		189.1
		Back half rinse		6.6
		Front half rinse		170.4
		Filter		63.9
			Total	446.7
4 and 10	Oil	Ether-chloroform extraction		39.1
		Impg. water residue		250.8
		Back half rinse		9.3
		Front half rinse		37.9
		Filter		2.8
			Total	339.9
5 and 11	Oil	Ether-chloroform extraction		8.9
		Impg. water residue		266.9
		Back half rinse		11.8
		Front half rinse		64.8
		Filter		16.0
			Total	368.4
6 and 12	Oil	Ether-chloroform extraction		11.3
		Impg. water residue		289.6
		Back half rinse		106.4
		Front half rinse		420.3
		Filter		279.7
			Total	1107.5

The above results reflect subtraction of the blanks. For detail laboratory analysis procedures see following pages.

LABORATORY ANALYSIS PROCEDURE FOR DETERMINATION OF PARTICULATE EMISSIONS FROM STATIONARY SOURCES

The following is a detailed outline of the laboratory procedure used in determining the weights of particulate and water collected in the various containers resulting from sample recovery from field collection trains.

All glassware used for evaporation and residue determinations in the following steps was first soaked in 40% nitric acid for several hours. The beakers were then washed and rinsed with distilled water followed by oven-drying. After drying the beakers were descicated to constant weight and kept in a descicator until used. Beakers were weighed to ±0.1 mg.

A. Container No. 1 (Filter)

1.) Preparation

The filters are oven-dried @ 105°C for a minimum of four hours, and then descicated to constant weight. Filters are weighed to +.0001 grams. After weighing the filters are placed in plastic petri dishes until used.

2.) Particulate weight determination

Filter and any loose particulate matter are transferred to a tared glass weighing dish, and descicated to constant weight. The weight gain is then recorded.

B. Container No. 2 (Acetone washings prior to filter)

1.) These acetone washings are received in glass bottles, are measured and transferred to the tared beakers prepared as described above.

2.) The acetone washings are then allowed to evaporate to dryness at ambient temperature and pressure. The beakers are covered with ribbed cover glasses to facilitate evaporation without allowing dust or other foreign matter into the beakers. When dry, the beakers are descicated to constant weight. Beakers are weighed to nearest 0.1 mg.

3.) A blank of the acetone (measured amount) is evaporated also as described above. Any residue resulting from this blank is used to correct for the amount of acetone used in the washings. The net weight is the required particulate residue.

C. Container No. 3 (Impinger water plus water rinsings)

1.) The volume of impinger water has been measured at the recovery station and recorded. Our laboratory measures the final volumes in these containers which allows us to determine the volume of washings used and to correct for this water using a blank.

2.) After measuring the volume of water, the solution is transferred to a separatory funnel. The organic particulate is then extracted using three 25 ml portions of chloroform, followed by three 25 ml portions of ethyl ether. The organic solvents are then combined and washed once with 100 ml of distilled water. The combined solvents are transferred to a tared beaker (prepared as above) and evaporated at 70°F until dry. The samples are then descicated to constant weight.

A blank of the distilled water used in the impingers and washings is also extracted with the chloroform and ether. The organic extract is then used as a blank for the organic particulate and the water phase as a blank for the impinger water and washings. The water phase is evaporated at 212°F until dry. The residue is descicated to constant weight and corrected for any blank found.

D. Container No. 4 (Acetone washings-back)

1.) Acetone washings are first measured and then transferred to tared beakers (prepared as above) and allowed to evaporate to dryness at ambient temperature and pressure. Upon drying, the beakers are descicated to constant weight. A blank of the acetone used is also evaporated and any corrections due to the acetone are made if necessary. Beakers are weighed to nearest 0.1 mg.

E. Container No. 5 (Silica gel)

1.) Preparation

The silica is placed in a wide mouth plastic bottle and capped. The silica gel is then weighed to ±0.1 gm.

2.) After sampling, the used silica gel is weighed to nearest 0.1 gm and weight of water collected is determined.

Special Note

All samples are dried in 250 ml beakers to a constant weight.

ENVIRONMENTAL PROTECTION AGENCY
Office of Air Programs
411 W. Chapel Hill Street, Durham, N.C. 27701

Reply to Attn of:

Date: June 22, 1971

Subject: Mercury Samples

To: Dr. Robert E. Lee, Acting Chief
Source Sample and Fuels Analytical Branch,
Division of Atmospheric Surveillance

1. Origin: Giant Cement Plant, Harleyville, S.C.

2. Date Collected: June 7-11, 1971

3. Samples Collected: Four samples were collected at this plant. One sample was void.

4. Analysis: Please analyze the enclosed samples for mercury. A 5 ml aliquot of each sample was removed and sent to Mr. D. Von Lehmden for analysis by neutron activation.

5. Sample Data:

Run No.	Original Vol.,ml	Dry Gas Vol.,ft^3	% moisture
1	168	2.677	45
2	135	2.389	45
4	170	2.525	45

6. Results: Results are to be submitted to William J. Basbagill, Room 860, North Carolina Mutual Building, 411 W. Chapel Hill Street, Durham, N.C. 27701.

William J. Basbagill

William J. Basbagill
Emission Testing Branch
Division of Applied Technology

Enclosures:

cc:
Mr. M.R. Neligan
Dr. A. Altshuller
Mr. G. Morgan
Dr. R . Lee
Mr. D. Von Lehmden
Mr. G. Smith
Mr. B. Riley
Dr. H. Crist
Mr. R. Atherton
Mr. P. York
Mr. D. Slaughter
Mr. J. McGinnity

Date: July 1, 1971

Mercury Data from Giant Cement Plant, Harleyville, S.C.

Chief, Source Sample & Fuels Analytical Branch
Through: Chief, Metals & Advanced Analysis Branch

1. Below is a table containing the amounts of mercury found in the samples taken at the Giant Cement Plant, Harleyville, S.C. Determinations were made using the flameless atomic absorption technique.

TABLE F-II

Sample Number	Sampling Date	Total Mercury found (μg)
1 - (flue gas)	6/8/71	0.450
2 - (flue gas)	6/8/71	0.191
4 - (oil feed)	6/11/71	0.0
blank		0.052/45ml

Mary Ann Feige

Mary Ann Feige, Chemist
Bioanalytical Section
Air Quality Analytical Laboratory Branch
Division of Atmospheric Surveillance

Office of Air Programs
Research Triangle Park, North Carolina 27711

Reply to Attn of:

Date: 7/30/71

Subject: Special Membrane Filter Samples for Metals

To: Roy L. Bennett, Source
Emission Measurement Branch,
DCP

As per your request membrane filter samples were collected at the Giant Cement Company, Harleyville, South Carolina. Samples were collected when the plant was using oil and gas as fuel. The attached samples are tabulated below.

Stack	Filter Wt. gm.	Sampling Time, min.	Meter, Sample Volume, f^3	Fuel
1 A-B	0.226919	60	28.85	oil
1 A-B	0.179321	10	5.30	oil
1 A-B	0.235688	10	5.33	gas
2 B-B	0.227924	60	55.88	oil
2 B-B	0.178067	10	10.66	oil
3 C-B	0.176626	60	42.70	oil
3 C-B	0.225628	10	7.00	oil
4 D-B	0.171570	60	35.75	gas
4 D-B	0.169000	10	6.01	gas
5 E-B	0.236525	60	34.28	Gas
5 E-B	0.221225	10	6.49	gas

William J Basbagill

William J. Basbagill
Emission Testing Branch
Division of Applied Technology

Attachment

cc:
R. Neligan
G. Morgan
J. McGinnity
H. Crist
R. Atherton
D. Von Lehmden
G. Smith
G. Riley
A. Altshuller
K. [illegible]
J. [illegible]

QUANTITATIVE ANALYSIS TABLES

Contained herein are: (1) a summary of weight data on samples, (2) the results of the residue samples analysis, and (3) an analysis of the material collected on the glass fiber filter. The data contained in the tables should be considered only as a general guide.

The type of analysis performed was not anticipated at the beginning of the program and decisions regarding sample preparation and methods of analysis demanded an immediate response. The resulting analysis scheme was devised, on short notice, to fit the general laboratory practice, making it possible to respond to the program needs as quickly as possible.

Following is a discussion of the methods used in the analysis scheme. No claim is made however that the analysis scheme used is the best nor the best approach to the problems involved. It is believed to be technically sound, to provide reliable data, and to be within the limitations noted in the discussion.

Discussion of Methods

The methods used for the chemical analysis of residues were chosen because they represent reliable procedures used almost routinely in our laboratory. Because of this no preliminary testing nor experimentation were required before the analytical work was begun and results could be obtained in the short time allowed. No claim is made that these methods represent the best analytical scheme for this work.

The methods used for determining chloride and ammonium ion are quite sensitive. Reasonable readings above blanks assure reliable results down to about 0.03 mg in the residue sample. The methods have the added advantage of being able to handle samples which unpredictably contain large amounts of these ions.

The gravimetric method for sulfate lacks the sensitivity one might desire for this type of work if measurement of less than 1 milligram is necessary. However, it is capable of determining the occasional high sulfate found in some samples without repeating the determination as would be necessary when using some methods.

The nitrate determination is adequate when the NH_4^+ content of the samples is low or is present in amounts approaching the concentration of NO_3^-. Being a "difference" method it is least effective in determining small amounts of NO_3^- in the presence of large amounts of NH_4^+. However, even in the most unfavorable combinations it will indicate the presence of about 1 mg of NO_3^-.

TABLE F-III

- Back Half Sample Identification

Sample No.	Stack	Fuel	Fraction	Weight, mg
No. 9	1 and 7	Gas	Impg. water	139.1(1)
No. 33	5 and 11	Gas	Back half acetone rinse	24.1
No. 42	5 and 11	Gas	Impg. water	102.1(2)
No. 53	5 and 11	Gas	Impg. water	44.9(2)
No. 54	5 and 11	Gas	Impg. water	131.8(2)

(1) Represents only part of total impinger catch of 159.3 mg.

(2) Three individual beakers were used to analyze the impinger water, combined weight 278.8 mg.

Infrared Analysis

Three of the original residue samples contained noticeable amounts of water-insoluble organic matter. It was possible to obtain a quantitative measurement of the organic phase present in sample Giant Cement No. 9 by filtering a water suspension of the residue. Organic matter made up a major portion of sample No. 33. The water-insoluble portion of this sample was examined by infrared for qualitative identification. Results are summarized in Table F-IV.

The results of our analyses strongly indicate that ammonium sulfate is the major inorganic component of the samples listed in the following Tables F-V and F-VI.

TABLE F-IV

Identification of Organic Components

Sample	Organic Components Present
Giant Cement No. 33	methyl silicone aliphatic ester aromatic hydrocarbon

Perhaps the presence of aromatic hydrocarbons and aliphatic esters in the residues obtained from impinger collections can be traced to the fuel used in the kilns. However, the presence of methyl silicone compounds suggests the possibility that some contamination from stop-cock grease has occurred.

TABLE F-V

Results of Emission Spectrographic Analysis

Sample Identification	Metals Found - Weight Percent																
	Na	K	Ca	Al	Fe	Mg	B	Si	Cu	Ba	Mn	Pb	Sn	Cr	Ni	Ti	Co
Giant Cement No. 9	0.1	0.1	0.4	0.02	0.07	0.02	<0.01	0.1	<0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Giant Cement No. 42	<0.1	0.1	0.4	0.02	0.02	0.02	<0.01	0.03	0.005	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01
Giant Cement No. 33	0.1	0.2	3.	0.1	0.1	0.1	0.02	2.	0.03	<0.01	<0.01	<0.01	0.02	0.01	<0.01	<0.01	0.01
Giant Cement No. 54	<0.1	0.1	0.3	0.05	0.04	0.02	<0.01	0.03	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Giant Cement No. 53	<0.1	0.1	1.	0.03	0.04	0.03	<0.01	0.2	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

TABLE F-VI

Results of Chemical Analysis

Sample	Weight Percent					Remarks
	NH_4^+	SO_4	Acid as H_2SO_4	Cl	Water Insoluble	
Cement No. 9	22.3	59.2	<0.2	-	9.3	Water insoluble is organic material
Cement No. 42	27.0	65.5	<0.2	0.3	0.8	-
Cement No. 33	6.1	15.0	0.7	-	-	Major phase is organic material
Cement No. 54	26.1	63.7	0.3	<0.1	0.5	-
Cement No. 53	24.5	64.0	0.2	0.7	0.2	-

Listed below are the individual code numbers and descriptions for the samples used for the metals analysis.

Analyses Code No.	Industry	Sample Description
B-28	Cement Mfg. Giant Cement Harleyville	Source Test, Run 1 (gas)
B-29	"	Slurry (gas fired)
B-30	"	Clinker (gas fired)
B-31	"	Baghouse return dust (gas fired)
B-32	"	Source Test, Run 1 (oil)
B-33	"	Clinker (oil fired)
B-34	"	Fuel oil
B-35	"	Slurry (oil fired)
B-36	"	Baghouse return dust oil fired)

The results of optical emission spectrographic analyses on Samples B-28 through B-36 are reported in Tables F-VII and F-VIII. As requested details on the methodology used are given below.

The samples were grouped according to similar type and in most cases were analyzed using three optical emission spectrographic techniques.

<u>Technique (a)</u> - For very low impurity concentrations samples were mixed 1-1 with graphite and run versus 1-1 graphite standards.

<u>Technique (b)</u> - For impurities generally in the range of >1000 ppm samples were mixed in the ratio of 1 part samples - 9 parts pure germanium metal - 10 parts graphite and run versus germanium standards.

<u>Technique (c)</u> - For mercury determination samples were put in boiler-cap electrodes and run versus standards containing known amounts of mercury.

The estimates of precision for the above techniques as used on these samples are as follows: technique (a) ±50 percent; technique (b) ±25 percent; and technique (c) ±100 percent.

In the tabular data major (M) indicates that the element is present in concentratio over 25 percent. Similarly high (H) indicates the element is present in concentrati greater than 10 percent.

Source Samples B-28, B-32,

Source samples were provided which consisted of several different types of air particulates including a filter-containing particulate in each case. Although our initial instructions were to combine the various types of collections and to report data in terms of total micrograms, the filter portion of each sample was run separately. This was discussed by telephone with Dr. von Lehmden wherein it was pointed out that the high level of impurities in the glass filter could "swamp out" collected particulate impurity data. Thus, all portions of each sample, viz A, B, C, etc., except the filters were combined and analyzed and the filter portion of each sample was analyzed and the two analyses are reported separately in the attached tables.

The acid leach technique of analysis was not used since it was deemed desirable to attempt to obtain some data on impurities such as F, Se which could be lost on acid leaching. Sample quantities of the filters were judged too little to attempt both total analysis less blanks and acid leach. Further there was little or no real blank filter material provided in most cases and a "make do" blank had to be achieved by taking small segments from the edges of the filters.

Other comments regarding the analyses of these samples are given in the following tables.

TABLE F-VII Analysis of Source Test Sample B-28[a]

Contract No. 68-02-0447

Determinations Requested - Priority 1 and 2 elements

Types of Analyses - Spark Source Mass Spectrograph (SSMS)
Optical Emission Spectrography (OES)

Type of Fuel - Gas

ment	SSMS B-28 (B+C+D+E)	OES B-28 (B+C+D+E)	SSMS B-28 (A)*	OES B-28 (A)*	Element	SSMS B-28 (B+C+D+E)	OES B-28 (B+C+D+E)	SSMS B-28 (A)*	
Hg	20.	15.	<0.4	0.4	B	30.	15.	(c)	
e	<0.1	<1.	0.02	<3.	F	1,500.	(b)	500.	
i	30.	<50.	<0.2	<100.	Li	5.	<5.	10.	
As	30.	<100.	≤1.	<50.	Ag	10.	3.	<0.4	
	20.	25.	<10.	10.	Sn	50.	50.	2.	
n	20.	20.	<3.	3.	Fe	2,000.	2,500.	<500.	
Ni	200.	100.	3.	4.	Sr	50.	50.	30.	
Sb	3.	<50.	≤0.06	<25.	Na	High	1,500.	High	
r	50.	200.	<10.	10.	K	High	15,000.	High	40,
	300.	100.	<4.	<50.	Ca	High	150,000.	High	
Cu	60.	30.	1.	<5.	Si	High	10,000.	(c)	
b	150.	100.	30.	50.	Mg	High	1,000.	High	4
e	300.	(b)	15.	(b)					

All results given in total micrograms per sample.

Not detectable by OES.

Useful determination is precluded by high contribution from blank.

Glass filters - values given are impurity levels above glass background.

omments: -- (1) Estimates of precision are ±25% and ±100% for SSMS.

(2) Where discrepancies in results occur between OES and SSMS, take the average as being most correct. If greater accuracy is demanded, the concentrations can be determined by AA, other classical chemical techniques and/or better standardization of the OES and SSMS.

(3) High in the SSMS column is given where concentrations are found generally greater than 500 ppm. The latitude of the photographic emulsion prevents obtaining detections to 0.1 ppm and up to 500 ppm. This would not be a problem with electrical detection.

TABLE F-VIII Analysis of Source Test Sample B-32[a]

Contract No. 68-02-0447

Determinations Requested - Priority 1 and 2 elements

Types of Analyses - Spark Source Mass Spectrograph (SSMS) -
Optical Emission Spectrography (OES)

Type of Fuel - Oil

Element	SSMS B-32 (B+C+D+E+F+G+H+I)	OES B-32 (B+C+D+E+F+G+H+I)	SSMS B-32 (A)*	OES B-32 (A)*	Element	SSMS B-32 (B+C+D+E+F+G+H+I)	OES B-32 (B+C+D+E+F+G+H+I)	SSMS B-32 (A)*	OES B-32 (A)*
Hg	0.2	0.3	<0.4	1.	B	10.	15.	(c)	2,000.
Be	<0.1	<0.6	0.1	<2.	F	300.	(b)	100.	(b)
Cd	15.	<30.	<2.	<80.	Li	0.1	<3.	≤10.	30.
As	10.	<60.	≤1.	<40.	Ag	2.	0.6	<0.4	<2.
V	20.	30.	10.	10.	Sn	60.	60.	≤1.	<20.
Mn	30.	15.	≤2.	2.	Fe	2,000.	1,500.	500.	600.
Ni	100.	60.	≤2.	2.	Sr	15.	30.	60.	20.
Sb	2.	<30.	<0.1	<20.	Na	High	900.	(c)	1,000.
Cr	60.	100.	10.	10.	K	High	9,000.	High	6,000.
Zn	40.	<60.	3.	<40.	Ca	High	80,000.	High	10,000.
Cu	50.	20.	0.5	<4.	Si	High	6,000.	(c)	(c)
Pb	30.	30.	≤10.	30.	Mg	High	600.	(c)	2,000.
Se	150.	(b)	≤0.5	(b)					

(a) All results given in total micrograms per sample.

(b) Not detectable by OES.

(c) Useful determination is precluded by high contribution from blank.

* Glass filters - values given are impurity levels above glass background.

Comments - (1) Estimates of precision are ±25% and ±100% for SSMS.

(2) Where discrepancies in results occur between OES and SSMS, take the average as being most correct. If greater accuracy is demanded, the concentrations can be determined by AA, other classical chemical techniques and/or better standardization of the OES and SSMS.

(3) High in the SSMS column is given where concentrations are found generally greater than 500 ppm. The latitude of the photographic emulsion prevents obtaining detections to 0.1 ppm and up to 500 ppm. This would not be a problem with electrical detection.

Samples Accompanying Source Test Samples B-29,
B-30, B-31, B-33, B-34, B-35. and B-36)

The above samples were analyzed by optical emission and spark source mass spectrographic methods and the results are given in the attached tables. Notations concerning the data are given with the tabular presentation of the results.

TABLE F-IX Analysis of Slurry (Gas Fired) B-29[a]

Contract No. 68-02-0447

Determinations Requested - Priority 1 and 2 elements

Types of Analyses - Spark Source Mass Spectrograph (SSMS)
Optical Emission Spectrography (OES)

Element	SSMS B-27	OES B-27	Element	SSMS B-27	OES B-27
Hg	<0.4	<1.	B	15.	20.
Be	0.2	<2.	F	300.	(b)
Cd	<2.	<100.	Li	7.	<10.
As	<3.	<200.	Ag	≤4.	<2.
V	30.	20.	Sn	2.	<100.
Mn	100.	40.	Fe	~2.%	1.%
Ni	10.	20.	Sr	300.	200.
Sb	1.	<100.	Na	600.	800.
Cr	200.	200.	K	~2,000.	~2,000.
Zn	20.	<200.	Ca	High	40.%
Cu	2.	<10.T	Si	High	4.%
Pb	10.	<100.	Mg	7,000.	5,000.
Se	<5.	(b)			

(a) All results given in parts per million, weight basis except Si, Ca, and Fe.

(b) Not detectable by OES.

T = Trace.

TABLE F-X Analysis of Slurry (Oil Fired) B-35(a)

Contract No. 68-02-0447

Determinations Requested - Priority 1 and 2 elements

Types of Analyses - Spark Source Mass Spectrograph (SSMS)
Optical Emission Spectrography (OES)

Element	SSMS B-35	OES B-35	Element	SSMS B-35	OES B-35
Hg	<1.	<1.	B	30.	20.
Be	1.	<2.	F	300.	(b)
Cd	<2.	<100.	Li	3.	<10.
As	3.	<200.	Ag	<1.	<2.
V	40.	30.	Sn	<3.	<100.
Mn	50.	40.	Fe	~1.%	1.%
Ni	≤30.	20.	Sr	300.	200.
Sb	<1.	<100.	Na	1,000.	1,000.
Cr	200.	200.	K	~2,000.	3,000.
Zn	<10.	<200.	Ca	High	40.%
Cu	7.	<10.T	Si	High	4.%
Pb	2.	<100.	Mg	4,000.	5,000.
Se	<10.	(b)			

(a) All results given in parts per million, weight basis except Mg, Si, Ca, and Fe.

(b) Not detectable by OES.

T = Trace.

TABLE F-XI Analysis of Clinker (Gas Fired) B-30(a)

Contract No. 68-02-0447

Determinations Requested - Priority 1 and 2 elements

Types of Analyses - Spark Source Mass Spectrograph (SSMS)
Optical Emission Spectrography (OES)

Element	SSMS B-30	OES B-30	Element	SSMS B-30	OES B-30
Hg	<0.5	<1.	B	20.	40.
Be	<0.5	<2.	F	150.	(b)
Cd	<2.	<100.	Li	10.	10.
As	4.	<200.	Ag	<1.	<2.
V	30.	60.	Sn	<2.	<100.
Mn	100.	100.	Fe	~1.%	2.%
Ni	30.	60.	Sr	300.	200.
Sb	<1.	<100.	Na	2,000.	2,000.
Cr	200.	400.	K	~1,500.	2,000.
Zn	<10.	<200.	Ca	High	40.%
Cu	≤5.	<10.T	Si	High	6.%
Pb	0.3	<100.	Mg	~1.%	1.%
Se	<2.	(b)			

(a) All results given in parts per million, weight basis except Mg, Si, Ca, and Fe.

(b) Not detectable by OES.

T = Trace.

TABLE F-XII Analysis of Clinker (Oil Fired) B-33[(a)]

Contract No. 68-02-0447

Determinations Requested - Priority 1 and 2 elements

Types of Analyses - Spark Source Mass Spectrograph (SSMS)
Optical Emission Spectrography (OES)

Element	SSMS B-31	OES B-31	Element	SSMS B-31	OES B-31
Hg	<1.	<1.	B	30.	40.
Be	0.4	<2.	F	300.	(b)
Cd	<0.6	<100.	Li	10.	<10.T
As	1.	<200.	Ag	<1.	<2.
V	40.	80.	Sn	1.	<100.
Mn	300.	200.	Fe	~1.%	2.%
Ni	≤30.	60.	Sr	300.	200.
Sb	≤1.	<100.	Na	1,000.	2,000.
Cr	2,000.	2,000.	K	~2,000.	2,000.
Zn	30.	<200.	Ca	High	40.%
Cu	2.	<10.T	Si	High	6.%
Pb	0.7	<100.	Mg	~2.%	2.%
Se	<6.	(b)			

(a) All results given in parts per million, weight basis except Mg, Si, Ca, and Fe.

(b) Not detectable by OES.

T = Trace

TABLE F-XIII Analysis of Baghouse Return Dust (Gas Fired) B-31(a)

Contract No. 68-02-0447

Determinations Requested - Priority 1 and 2 elements

Types of Analyses - Spark Source Mass Spectrograph (SSMS)
Optical Emission Spectrography (OES)

Element	SSMS B-31	OES B-31	Element	SSMS B-31	OES B-31
Hg	<0.4	<1.	B	30.	40.
Be	<0.5	<2.	F	2,000.	(b)
Cd	≤2.	<100.	Li	20.	40.
As	10.	<200.	Ag	<3.	2.
V	30.	20.	Sn	<2.	<100.
Mn	50.	40.	Fe	~1.%	1.%
Ni	30.	40.	Sr	200.	200.
Sb	<1.	<100.	Na	4,000.	6,000.
Cr	200.	200.	K	High	10.%
Zn	100.	<200.	Ca	High	40.%
Cu	5.	<10.T	Si	High	4.%
Pb	150.	250.	Mg	~1.%	5,000.
Se	≤10.	(b)			

(a) All results given in parts per million, weight basis except Mg, Si, Ca, and Fe.

(b) Not detectable by OES.

T = Trace.

TABLE F-XIV Analysis of Baghouse Return Dust (Oil Fired) B-36(a)

Contract No. 68-02-0447

Determinations Requested - Priority 1 and 2 elements

Types of Analyses - Spark Source Mass Spectrograph (SSMS)
Optical Emission Spectrography (OES)

Element	SSMS B-36	OES B-36	Element	SSMS B-36	OES B-36
Hg	<0.4	<1.	B	40.	40.
Be	<0.5	<2.	F	3,000.	(b)
Cd	<6.	<100.	Li	30.	50.
As	10.	<200.	Ag	<4.	<2.T
V	100.	200.	Sn	<2.	<100.
Mn	30.	40.	Fe	~1.%	1.%
Ni	≤50.	40.	Sr	200.	200.
Sb	<1.	<100.	Na	3,000.	6,000.
Cr	150.	400.	K	High	10.%
Zn	60.	<200.	Ca	High	40.%
Cu	<10.	<10.T	Si	High	4.%
Pb	150.	200.	Mg	~1.%	5,000.
Se	<30.	(b)			

(a) All results given in parts per million, weight basis except Mg, Si, Ca, and Fe.

(b) Not detectable by OES.

T = Trace.

TABLE F-XV Analysis of Fuel Oil B-34[a]

Contract No. 68-02-0447

Determinations Requested - Priority 1 and 2 elements

Types of Analyses - Spark Source Mass Spectrograph (SSMS)
Optical Emission Spectrography (OES)

Element	SSMS B-34	OES B-34	Element	SSMS B-34	OES B-34
Hg	<0.01	<0.01	B	0.001	<0.02
Be	<0.001	<0.02	F	<0.01	(b)
Cd	<0.006	<1.	Li	0.1	<0.2
As	<0.01	<2.	Ag	<0.01	<0.02
V	High	300.	Sn	0.03	<1.
Mn	0.02	<0.2	Fe	3.	6.
Ni	15.	20.	Sr	0.004	<0.6
Sb	<0.1	1.	Na	20.	10.
Cr	0.03	<0.2	K	3.	<6.
Zn	0.3	<2.	Ca	2.	4.
Cu	0.2	<0.2T	Si	0.5	1.
Pb	0.04	<1.	Mg	7.	4.
Se	<0.03	(b)			

(a) All results given in parts per million, weight basis except Mg, Si, Ca, and Fe.

(b) Not detectable by OES.

T = Trace.

TABLE F-XVI

Subject: Giant Harleyville Oil Sample Analysis

September 16, 1971

Environmental Protection Agency
Research Triangle Park,
North Carolina 27711

Attention: Mr. D. J. vonLehmden
Subject: Report No. Y-7654-B

Dear Darryl:

The following are the results on your oil sample EPA-5-FA.*

Heat Value	110,510 BTU/gal.
Sulfur	2.04%
Ash	0.078%
Water	.07%
Sediment	0.002%

Very truly yours,

Abraham J. Kurtz
Vice President
Environmental Sciences

AJK/wm

* EPA-5-FA- Giant Cement Company, Harleyville South Carolina. Oil Sample [illegible]

APPENDIX G

Test Log

Below is a log of the test performed by Resources Research, Inc. during the period June 8, 1971 - June 12, 1971.

Fuel	Date	Stack Tested	Type Test
Gas	6/9/71	#2B-B and #8B-A #3C-B and #9C-A #1A-A and #7A-B	Particulate (120 min. per test total)
Gas	6/10/71	#6F-B and #12F-A #4D-B and #10D-A #5E-B and #11E-A	Particulate (120 min. per test total)
Gas	6/8/71	#5E-B #4D-B #1A-B	Metal (60 and 10 min. tests at each stack)
Oil	6/11/71	#2B-B and #8B-A #3C-B and #9C-A #1A-B and #7A-A #6F-B and #12F-A #4D-B and #10D-A #5E-D and #11E-A	Particulate (120 min. per test total)
Oil	6/12/71	#2B-B #3C-B #1A-B	Metal (60 and 10 min. tests at each stack)

SO_2 samples were collected "in" and "out" of the baghouse simultaneously after each particulate test; that is, one set of two "out" and one "in" per fuel condition. Exhaust NO_x and CO_2 samples were obtained during particulate tests for each fuel condition. The 60-minute metal tests at each stack were conducted in the same manner as the particulate testing.

The baghouse inlet duct was sampled for SO_2 only.

Process Samples collected

Plant was operated with gas and oil as fuels. Two sets of process samples were collected under both operating conditions. Samples collected are as follows:

1. Slurry - 1 sample
2. No. 6 Fuel Oil
3. Baghouse return dust - 1 sample
4. Clinker - 1 sample
5. Product (type 1 cement) - 1 sample

APPENDIX H

Project Participants and Titles

[illegible] Resources Research)

R. N. Allen, P.E.,	Pre-Survey Inspection
C. C. Gonzalez,	Chemist Crew Leader
N. A. Blessing,	Chemist
W. E. Schroeder,	Chemist
L. W. Baxley,	Technician
E. Cook,	Technician
J. McReynolds,	Technician
R. H. Kilburne,	Technician
B. M. Brown,	Technician
C. E. Tessner,	Technician

(EPA, OAP)

Howard Crist,	Analytical Chemist, ETB
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Tom Jacobs,	Chemical Engineer, SDID
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Clyde Riley,	Technician, ETB
Gene Smith,	Chemical Engineer, ETB
Philip York,	Chemical Engineer, SDID