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New Orleans LS

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AP-42 Section	<u>11.6</u>
Reference	<u>43</u>
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Reference	<u>43</u>

ENTROPY
ENVIRONMENTALISTS, INC.

SPECIALISTS IN AIR POLLUTION MEASUREMENT & MANAGEMENT

STATIONARY SOURCE SAMPLING REPORT

LONE STAR INDUSTRIES, INC.

NEW ORLEANS, LOUISIANA

POLLUTANT EMISSIONS EXPERIMENTAL TESTING

KILN #1 & #2 STACKS

MAY 20, 21, 25 & 26, 1982

P.O. Box 12291, Research Triangle Park, North Carolina 27709
Phone 919-781-3550

REPORT CERTIFICATION

The sampling and analysis performed for this report was carried out under my direction and supervision.

Date July 21, 1982

Signature



Michael L. Kirkman

I have received all testing details and results in this test report and hereby certify that the test report is authentic and accurate.

Date July 21, 1982

Signature



Walter S. Smith, P.E.

TABLE OF CONTENTS

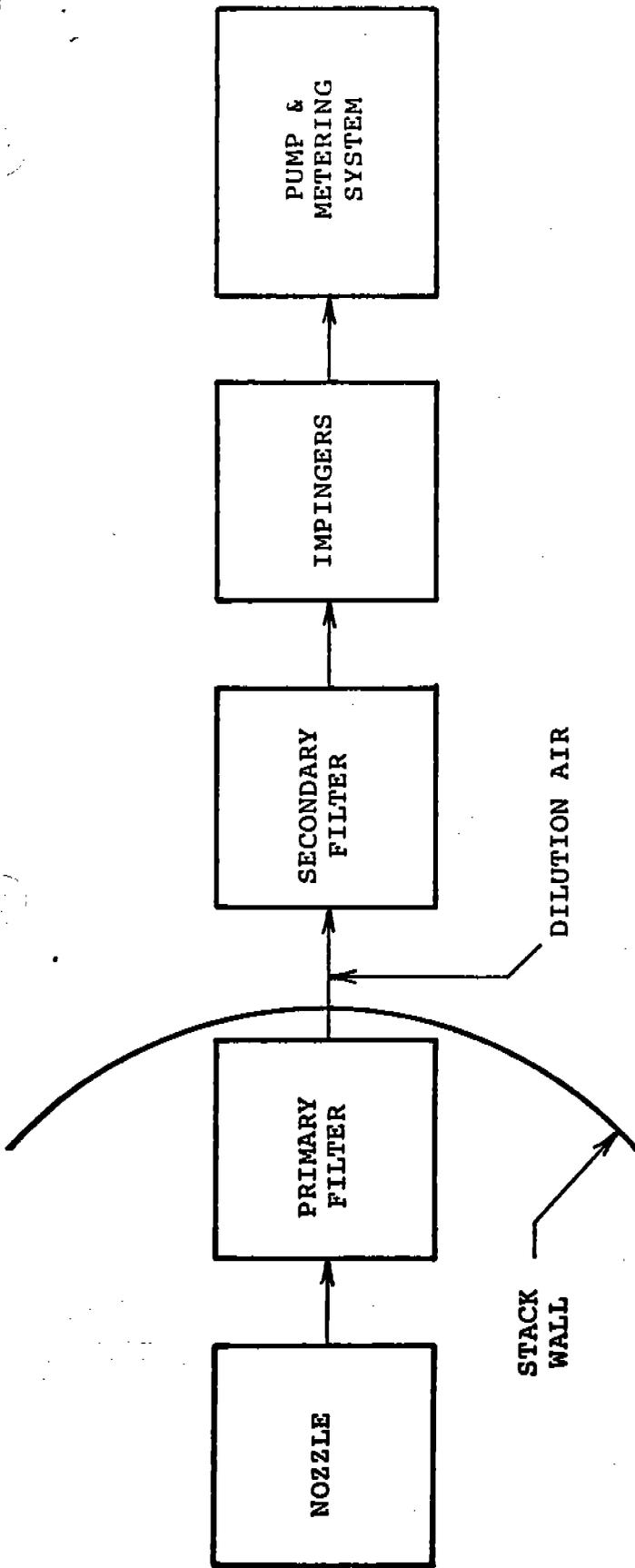
<u>SECTION</u>	<u>PAGE</u>
INTRODUCTION	1
SUMMARY OF RESULTS	4
PROCESS DESCRIPTION AND OPERATION	13
SAMPLING AND ANALYTICAL PROCEDURES	17
APPENDICES	19
A - Pollutant Results and Example Calculations	
1 - Kiln #2 Experimental Runs 22-24	
2 - Gaseous & Particulate Component Concentrations	
3 - Nitrogen Oxides Results	
a - Kiln #1 Samples 1-12	
b - Kiln #2 Samples 13-24	
B - Field and Analytical Data	
1 - Kiln #2 Experimental Runs 22-24	
2 - Gaseous & Particulate Component Analytical Results	
3 - Nitrogen Oxides	
a - Kiln #1 Samples 1-12	
b - Kiln #2 Samples 13-24	
C - Control Equipment and Process Data	
D - Test Participants	
E - Sampling and Analytical Procedures	
F - Calibration Data	

INTRODUCTION

Lone Star Industries' New Orleans, Louisiana plant uses two coal-fired rotary kilns in the production of Portland Cement. A problem exists in that the plumes of less than 5% opacity from the stacks become detached plumes of 100% opacity within 20 feet of the stacks and do not dissipate until at least a half-mile from the stacks; plumes caused by water vapor alone, i.e., steam plumes, typically dissipate much sooner.

An experimental test program of stationary source sampling was performed on the precipitator stack at Kiln #2 on May 26, 1982 to try to determine the pollutants causing this slow-dissipating detached plume. Compliance type particulate and nitrogen oxides emissions testing was performed at Kiln #1 on May 20 and 21, 1982 and at Kiln #2 on May 25, 1982.

Three modified Method 17 particulate tests were performed on the stack on Kiln #2 to collect filterable particulate at a lower-than-stack temperature, and gaseous pollutants that could be collected in the impingers' water. Figure 1 gives a schematic of the sampling train and filter locations; during the experimental runs, the sampling train simulated the effect of the gases cooling and mixing with ambient air. Also shown are the filtration temperatures for each filter location for each run performed. The particulate and water were analyzed for ammonia, chlorides, sulfates, fluorides, and nitrates; additionally, the impingers' water were also analyzed for sodium



Run Numbers	Compliance Kiln 1	Experimental Kiln 2	Compliance Kiln 2
1-3	1-3	22-24	19-21
Primary filter temperature (same as stack)	332°F	390°F	352°F
Secondary filter temperature	250-265°F	155-188°F	250-265°F
Impinger temperature	< 70°F	< 70°F	< 70°F
Dilution air	no	yes	no

FIGURE 1. SAMPLING TRAIN SCHEMATIC SHOWING FILTER LOCATIONS & FILTRATION TEMPERATURES

and potassium. Particulate from previous compliance tests were also analyzed for the same compounds; the impingers' water analytical results from those tests are also presented in this report.

Immediately following is the "Summary of Results" section which presents the test results; for detailed results of each run, refer to Appendix A. A description of the source and an air flow schematic appear in the "Process Description and Operation" section. Process data as supplied Lone Star personnel is included in Appendix C. The "Sampling and Analytical Procedures" section briefly describes the sampling strategy used. For a detailed description of the equipment and procedures, refer to Appendix E. Pertinent calibration data is presented in Appendix F.

SUMMARY OF RESULTS

The experimental test program performed for Lone Star Industries at the New Orleans Portland cement facility was designed to show if aerosol particulates are forming in the plumes from the kilns as the gases cool, a potential cause of the prolonged visible plume. Since the opacity of the gases at the stack are less than 5%, any filterable particulate at stack temperatures is not causing the opacity problem and, therefore, was filtered out so that the secondary filter caught only particulate formed due to the cooling of the gases.

Basically, the test program determined the filterable particulate emissions at two lower-than-stack temperatures; the results are shown in Table 1 which also includes the major particulate component emissions. Note that the lower temperature of filtration data gives the highest emissions, indicating that as the gases cool, gaseous pollutants liquify/solidify into various hygroscopic aerosol particulates which are probably the cause of the lingering plume.

Table 2 gives the individual run emissions and concentrations of the filterable particulate for the compliance tests on Kiln #1 and Kiln #2 and also for the single point experimental runs on Kiln #2. A summary of the emissions based on the analyses of the primary and secondary filter particulate and of the impingers' water is presented in Table 3. The data in Table 1 and Table 2 shows that while the primary filter

particulate emissions remained constant, the secondary filter particulate emissions greatly increased on the experimental runs on Kiln #2; Table 3 shows that a corresponding decrease in the gaseous concentration as measured in the impingers' water also occurred.

TABLE 1
KILN #2 AVERAGE EMISSIONS PER FILTRATION TEMPERATURE

	Emissions, lb/hr	
	@ 250-265°F	@ 155-188°F**
Particulate*	0.3	12.8
<u>Components</u>		
Ammonia as N	0.0	2.3
Chlorides as Cl	0.05	8.3
Sulfates as SO ₄	0.0	1.7

* includes the component emissions

** adjusted for dilution air

With that apparent transfer of some of the pollutants from a gaseous emission to a filterable particulate emission, as noted above, an explanation for the length of the plumes is possible. Although not enough fluorides, nitrates, potassium, and sodium were found in the gaseous state to be important, there were enough ammonia, chloride, and sulfate ions present to cause the plume, as described below.

By comparing the total available material (ammonia, chlorides, and sulfates), it can be seen that the chlorides are

TABLE 2
 FILTERABLE PARTICULATE EMISSIONS AND CONCENTRATIONS

<u>Kiln/ Condition</u>	<u>Run Number</u>	<u>Emissions, lb/hr*</u>		<u>Concentration, gr/DSCF**</u>	
		<u>Primary</u>	<u>Secondary</u>	<u>Primary</u>	<u>Secondary</u>
Kiln #2*** Experimental	22	9.71	11.46	0.0168	0.0198
	23	13.61	14.40	0.0236	0.0249
	24	9.13	12.45	0.0163	0.0223
	Average	10.82	12.77	0.0189	0.0223
Kiln #2 Compliance	19	3.73	0.07	0.0066	0.0001
	20	15.21	0.40	0.0278	0.0007
	21	12.11	0.48	0.0211	0.0008
	Average	10.35	0.32	0.0185	0.0005
Kiln #1 Compliance	1	31.93	1.27	0.0491	0.0019
	2	11.48	0.11	0.0174	0.0002
	3	8.83	0.23	0.0132	0.0003
	Average	17.41	0.54	0.0266	0.0008

* For a summary of the component emissions, see Table 3.

** For a summary of the component concentrations (in ppm), see Appendix A-2.

*** The experimental test results have been adjusted to account for the dilution with ambient air.

TABLE 3

AVERAGE GASEOUS AND PARTICULATE COMPONENT POLLUTANT EMISSIONS

<u>Pollutants, pounds/hour</u>	<u>Compliance Tests</u>		<u>Exp. Test</u>
	<u>Kiln #1</u>	<u>Kiln #2</u>	<u>Kiln #2*</u>
Ammonia as N			
Primary Filter	0.553	0.0172	0.0133
Secondary Filter	0.061	< 0.05	2.30
Impingers	3.30	10.6	6.44
Total	3.91	10.6	8.75
Chlorides as Cl			
Primary Filter	1.75	0.339	0.382
Secondary Filter	0.248	0.042	8.34
Impingers	27.9	51.4	44.6
Total	29.9	51.7	53.2
Sulfate as SO ₄			
Primary Filter	< 0.08	< 0.05	< 0.4
Secondary Filter	< 0.08	< 0.05	1.65
Impingers	17.3	12.2	9.95
Total	17.3	12.2	11.6
Fluorides as F			
Primary Filter	0.00668	0.00606	0.0149
Secondary Filter	0.00672	0.00242	0.0151
Impingers	0.072	0.0517	0.0131
Total	0.0854	0.0578	0.0431
Nitrates as N			
Primary Filter	0.00078	< 0.002	< 0.02
Secondary Filter	< 0.006	< 0.004	< 0.02
Impingers	0.188	0.363	0.219
Total	0.189	0.363	0.219
Potassium as K			
Impingers (Total)	0.0614	0.047	0.057
Sodium as Na			
Impingers (Total)	0.402	0.165	0.0962

* These averages are adjusted to take into account dilution

the most available compounds and can account for much more weight than the total solid in-stack emissions; when the flue gases enter the atmosphere and begin to cool, these gaseous pollutants tend to liquify/solidify into various hygroscopic aerosols. The exhaust gases contain enough moisture for each hygroscopic aerosol molecule to attach as many as 20 water molecules and, in effect, lower the vapor pressure of the water vapor. The aerosol molecules with attached waters would have sufficient mass to result in a detached plume with 100 percent opacity; the detached plume would eventually dissipate (reevaporate) with further mixing and cooling in the atmosphere. The results show that this phenomenon occurs at plume temperatures below 188 degrees F.

The nitrogen oxides emissions test results are summarized in Table 4 for Kiln #1 and Table 5 for Kiln #2. Nitrogen oxides emissions averaged (193) pounds per hour for Kiln #1 and (183) pounds per hour for Kiln #2.

TABLE 4
 NITROGEN OXIDES TESTS SUMMARY
 Kiln #1 Precipitator Outlet Stack

SAMPLE NUMBER -----	1 --	2 --	3 --
DATE	5/20/82	5/20/82	5/20/82
VOLUME OF GAS SAMPLED MLS*, DRY	1863.0	1867.7	1798.7

NITROGEN DIOXIDE (NO2) RESULTS:

MICROGRAMS ABSORBED	1708.3	1553.0	1118.2
PPM BY VOLUME, DRY	479.5	434.8	325.1
POUNDS PER HOUR	260.69	236.39	176.73

SAMPLE NUMBER -----	4 --	5 --	6 --
DATE	5/20/82	5/20/82	5/20/82
VOLUME OF GAS SAMPLED MLS*, DRY	1785.2	1808.4	1734.4

NITROGEN DIOXIDE (NO2) RESULTS:

MICROGRAMS ABSORBED	1242.4	1118.2	1180.3
PPM BY VOLUME, DRY	363.9	323.3	355.8
POUNDS PER HOUR	197.86	177.79	195.66

*68 DEG F, 29.92 IN. HG

347 ppm

190 #/hr

1-4

217.9

TABLE 4 (continued)
 NITROGEN OXIDES TESTS SUMMARY
 Kiln #1 Precipitator Outlet Stack

SAMPLE NUMBER -----	7 --	8 --	9 --
DATE	5/20/82	5/20/82	5/21/82
VOLUME OF GAS SAMPLED MLS*, DRY	1924.1	1757.3	1691.5
NITROGEN DIOXIDE (NO2) RESULTS: -----			
MICROGRAMS ABSORBED	1149.2	1242.4	1211.3
PPM BY VOLUME, DRY	312.3	369.7	374.5
POUNDS PER HOUR	171.73	203.28	211.01
SAMPLE NUMBER -----	10 --	11 --	12 --
DATE	5/21/82	5/21/82	5/21/82
VOLUME OF GAS SAMPLED MLS*, DRY	1675.7	1707.5	1677.8
NITROGEN DIOXIDE (NO2) RESULTS: -----			
MICROGRAMS ABSORBED	931.8	900.7	931.8
PPM BY VOLUME, DRY	290.8	275.8	290.4
POUNDS PER HOUR	163.84	155.43	163.64
*68 DEG F, 29.92 IN. HG	285 ppm	161.	

TABLE 5
 NITROGEN OXIDES TESTS SUMMARY
 Kiln #2 Precipitator Outlet Stack

SAMPLE NUMBER	13	14	15
DATE	5/25/82	5/25/82	5/25/82
VOLUME OF GAS SAMPLED MLS*, DRY	1793.3	1670.5	1721.1

NITROGEN DIOXIDE (NO2) RESULTS:

MICROGRAMS ABSORBED	1894.7	1708.3	1335.6
PPM BY VOLUME, DRY	552.5	534.7	405.8
POUNDS PER HOUR	259.59	251.27	190.67

SAMPLE NUMBER	16	17	18
DATE	5/25/82	5/25/82	5/25/82
VOLUME OF GAS SAMPLED MLS*, DRY	1758.2	1850.8	1823.0

NITROGEN DIOXIDE (NO2) RESULTS:

MICROGRAMS ABSORBED	1335.6	1242.4	1304.5
PPM BY VOLUME, DRY	397.2	351.0	374.2
POUNDS PER HOUR	186.65	160.89	171.51
*68 DEG F, 29.92 IN. HG	374 ppm	173	

TABLE 5 (continued)
 NITROGEN OXIDES TESTS SUMMARY
 Kiln #2 Precipitator Outlet Stack

<u>SAMPLE NUMBER</u>	19	20	21
DATE	5/25/82	5/25/82	5/25/82
VOLUME OF GAS SAMPLED MLS*, DRY	1794.1	1820.4	1683.6

NITROGEN DIOXIDE (NO2) RESULTS:

MICROGRAMS ABSORBED	1242.4	1366.6	1335.6
PPM BY VOLUME, DRY	362.1	392.5	414.8
POUNDS PER HOUR	165.97	179.93	199.13

<u>SAMPLE NUMBER</u>	22	23	24
DATE	5/25/82	5/25/82	5/25/82
VOLUME OF GAS SAMPLED MLS*, DRY	1839.7	1752.3	1741.1

NITROGEN DIOXIDE (NO2) RESULTS:

MICROGRAMS ABSORBED	1025.0	993.9	1025.0
PPM BY VOLUME, DRY	291.3	296.6	307.8
POUNDS PER HOUR	139.86	142.37	147.78

*68 DEG F, 29.92 IN. HG

298 ppm

143

PROCESS DESCRIPTION AND OPERATION

The New Orleans, Louisiana plant of Lone Star Industries uses two coal-fired Rotary Kilns in the production of Portland Cement. This report covers the testing of Kilns #1 and #2 outlet stacks.

The basic raw materials used are argonite and clay. These materials are fed to a ball mill in proportion of 80 percent argonite, 18 percent clay, and 2 percent iron ore and are ground so that 70 percent passes 200 mesh screen. Water is added to this mixture in the ball mill forming a slurry containing 36 to 40 percent water.

The slurry, when properly blended and conforming to the desired chemical composition, is fed or pumped to the rotary kiln. The kiln temperatures range from 600 degrees F at the feed end to 2800 degrees F in the clinkering zone. Within the kiln, the slurry or raw feed goes through four main processes which are as follows:

1. Drying
2. Calcination or decarbonation of argonite or limestone.
3. Clinkering - liquid formation to form cement compounds.
4. The cooling of clinker.

The liquid, upon cooling, forms hard masses 1/8 inch to 1-1/2 inches in diameter in size. These masses are called clinkers. Clinkers, when cooled, are conveyed to a storage area and are eventually transferred to a ball mill where they are

ground to a fine powder. This is the final product. A general material flow diagram and the process data are included in Appendix C.

During the past several years, considerable production and process data has been compiled and summarized which enables a prediction and verification of production capacities of the various process units.

Presently, kiln production is obtained by weighing clinker as it departs the clinker cooler area to storage. Daily clinker production may be further substantiated by flow meter rate, slurry tank measurements, or an inventory of raw mix slurries.

Plant operations were normal during emission testing of Kiln #1 although there were kiln feed problems during the testing of Kiln #2. Tabulated below is a summation of production data accumulated during inlet testing of Kilns #1 and #2, as provided by Lone Star personnel.

PRODUCTION DATA DURING TESTING

	OUTLET NO. 1 & NO. 2		
	<i>Raw Feed</i> Clinker Production tons/hr	Coal Feed tons/hr	Total Feed tons/hr
Kiln #1	81.8	9.7	91.5
Kiln #2	84.8	9.6	94.4
Kiln #2 Special Test	81.8	9.5	91.3

Emissions from the process are fine particulates and combustion gases. Coal is used as a source of fuel which

contains some sulfur; consequently, the combustion gases are a mixture of water vapor, oxygen, carbon dioxide, and sulfur dioxide. The particulates are composed of calcined or semi-calcined argonite and clay.

From the kilns, the air enters a dust collector and splits into two electrostatic precipitators where the majority of the particulate is removed. The air is then exhausted through a fan out the stack to the atmosphere, as shown in Figure 2.

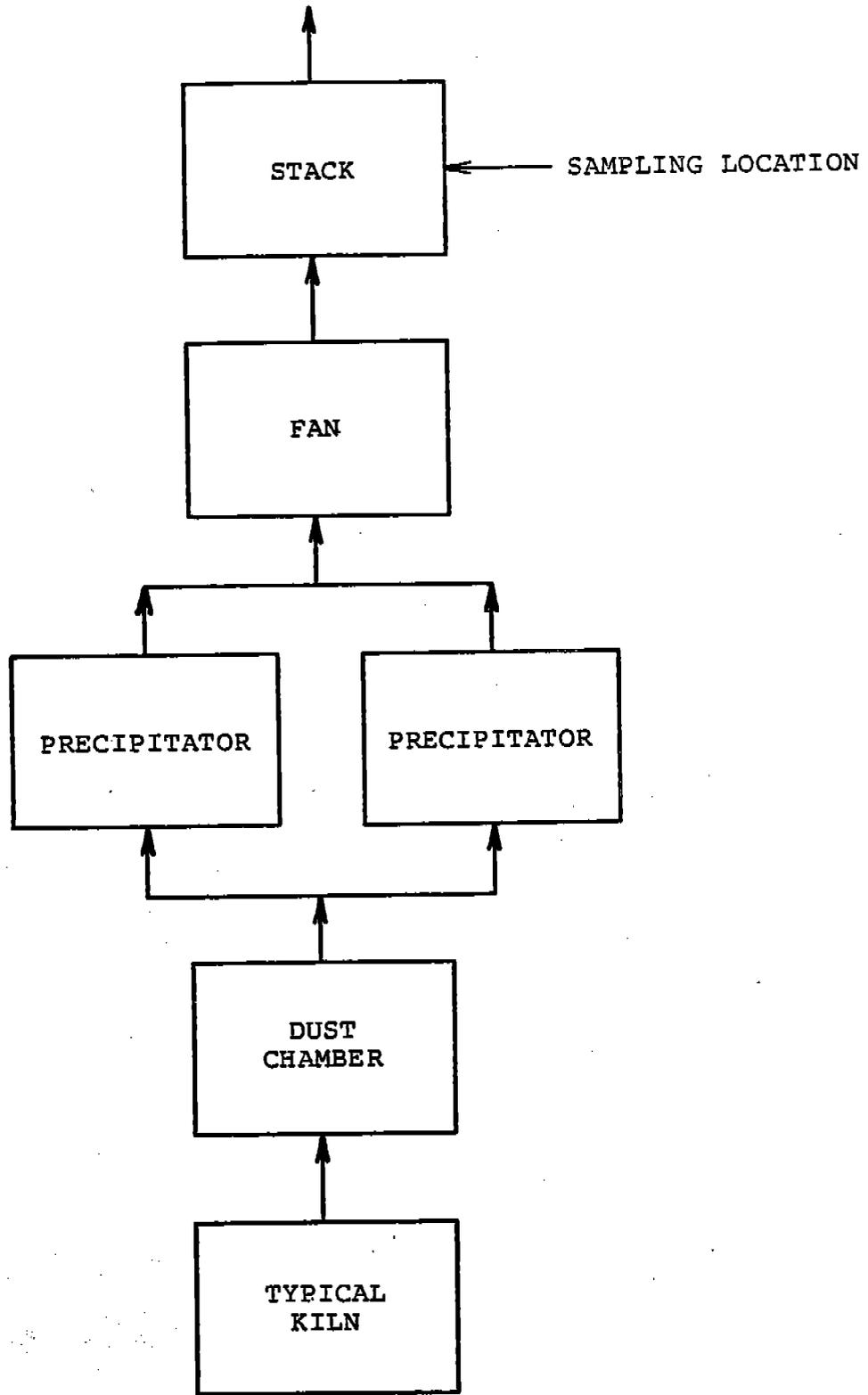


FIGURE 2. KILN AIR FLOW SCHEMATIC SHOWING SAMPLING LOCATION

SAMPLING AND ANALYTICAL PROCEDURES

All sampling and analytical procedures used were those generally recommended by the United States Environmental Protection Agency and the Louisiana Health and Human Resources Administration. Complete details of the equipment and procedures used are described in Appendix E, which is extracted from the Federal Register, August 18, 1977.

During the experimental testing of the exhaust stack on Kiln #2, a single point with an average velocity was used. Method 1 was used to determine the sampling point locations for the compliance tests; see the separate report covering only the compliance tests. The net run time for run 22 was 45 minutes, while for runs 23 and 24, the net run time was 60 minutes.

Velocity measurements were made according to Method 2. Method 3 was followed in determining the flue gas composition and molecular weight.

To study the formation of aerosol particulate, a special probe with an adjustable diluent air intake located between the primary and secondary filters was constructed to permit cooling of the exhaust gases and mixing with ambient air between the primary and secondary filters. The secondary filter was not heated during the experimental runs. An integrated sample of the gases exiting the sampling train and an integrated gas sample from the stack were collected and analyzed as per Method 3. By ratioing the CO_2 of the stack gas to the CO_2 of the gas exiting

the sampling train, and multiplying the catch weights by the ratio, the catches from the experimental runs were adjusted to account for the ambient air dilution used to simulate post-stack conditions.

In addition to the gravimetric analyses of the filter catches, ammonia, chloride, fluoride, nitrate, and sulfate analyzes were performed on the primary filter, secondary filter, and impingers' water catches. The impingers' water was also analyzed for sodium and potassium. Nitrogen oxides emissions were determined using Method 7.

All sampling equipment used was manufactured by Nutech Corporation or Entropy Environmentalists, Inc.