AP-42 Section 11.6
Reference 8
Report Sect. 4
Reference 1

EMISSION TESTING REPORT

ETB TEST NUMBER 71-MM-01

FINAL

FINAL

Emissions From
Wet Process Cement Kiln
And Clinker Cooler

at

FINAL

MAULE INDUSTRIES, INC.
HIALEAH, FLORIDA

FINAL

FINAL

Project Officer
Clyde E. Riley

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

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71-MN-01
71

PREFACE

The work reported herein was conducted by The Environmental Protection Agency (EPA), Office of Air Programs, Emission Testing Branch (ETB), Metallurgical and Mechanical Section. Mr. Clyde Riley served as the Project Officer and directed the ETB field team consisting of: Messrs. Robert Martin, Ray Mobley, Allan Riley, Dana Ludwig, and Howard Crist. Mr. Philip York and Mr. Tom Jacobs served as Project Engineers. Mr. Howard Crist and Mr. Allan Riley performed the pollutant analyses at the EPA laboratories.

Approved:

Environmental Protection Agency

Gene W. Smith

Gene W. Smith
Chief, Metallurgical & Mechanical Section

March 27, 1972

FINAL

Need Appendix B, C, & F

TABLE OF CONTENTS

FINAL

I. LIST OF TABLES AND FIGURES

II. 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.

The development of realistic performance standards requires accurate data on pollutant emissions within the various source categories. In the cement industry, the Maule Industries plant located in Hialeah, Florida, was designated by EPA as representative of a well controlled operation, and was thereby selected for the emission testing program. This report presents the results of the tests conducted at the Maule plant.

The recently constructed Maule cement plant has been in operation for over two years. as 1/1972 The plant has two parallel wet process units, each consisting of a kiln, electrostatic precipitator and stack; and a clinker cooler, electrostatic precipitator and stack.

The gases from each of the separate rotating kilns are directed through one of two parallel electrostatic precipitators, then emitted into the atmosphere through a connecting stack.

As the clinker falls from the rotating kiln onto a cooler-bed, air is drawn through the red-hot clinker. The resulting dust-laden gases are then directed through one of two electrostatic precipitators prior to discharge through a connecting stack. Three particulate samples were collected at this stack.

Sampling at the kiln stack consisted of continuous monitoring for CO_2, O_2, and CO, plus the collection of three particulate and four nitrogen oxides samples.

The following sections of this report treat (1) the summary of results, (2) the description of the process, (3) the location of sampling points, (4) process operating conditions, and (5) sampling and analytical procedures.

III. SUMMARY OF RESULTS

Tables I, II, and III present a summary of results from the particulate and gas emission testing.

The clinker cooler particulate emissions contained in the front-half catch (probe, cyclone, & filter) ranged from 0.0798 pounds per ton of feed to 0.106 pounds per ton of feed. The total catch (includes impinger portion) ranged from 0.0885 pounds per ton of feed to 0.112 pounds per ton feed.

The kiln stack particulate emissions contained in the front-half catch ranged from 0.634 pounds per ton feed to 1.799 pounds per ton feed. Results from the kiln stack testing are not as consistent as the clinker cooler results. This is possibly due to several upset conditions encountered in the kiln operation during the testing.

Nitrogen oxide levels ranged between 85 ppm and 265 ppm during the course of the particulate testing.

The average concentrations of CO_2, O_2, and CO at the kiln stack are presented in Table III.

* Standard Conditions - 70°F, 29.92 in.Hg

TABLE I

RESULTS FOR CLINKER COOLER STACK NO. 1

Run Number	1	2	3
Date	2-25-71	2-25-71	2-25-71
Percent Excess Air	NA	NA	NA
Percent Isokinetic	106.2	110.0	103.7
Stack Flow Rate - SCFM* dry	19,473	17,369	18,996
Stack Flow Rate - ACFM wet	23,898	21,360	23,216
Volume of Dry Gas Sampled - SCF*	74.90	69.25	71.41
Feed Rate - tons/hr	41.2	41.2	41.2
Particulates			
Probe, Cyclone, & Filter Catch			
mg	128	127	94
gr/SCF* dry	0.0263	0.0282	0.0203
gr/CF @ Stack Conditions	0.0214	0.0229	0.0166
lbs/hr	4.381	4.203	3.286
lbs/ton feed	0.106	0.102	0.0798
Total Catch			
mg	134	138	104
gr/SCF* dry	0.0276	0.0307	0.0224
gr/CF @ Stack Conditions	0.0224	0.0249	0.0183
lbs/hr	4.596	4.551	3.647
lbs/ton feed	0.112	0.110	0.0885
% Impinger Catch	4.5	8.0	9.6

*70°F, 29.92" Hg
NA - Not Applicable

TABLE II

RESULTS FOR KILN STACK NO. 1

Run Number	1	2	3
Date	2-26-71	2-26-71	2-26-71
Percent Excess Air	181	181	181
Percent Isokinetic	96.1	94.5	96.2
Stack Flow Rate - SCFM* dry	55,031	54,413	52,018
Stack Flow Rate - ACFM wet	126,208	122,704	118,324
Volume of Dry Gas Sampled - SCF*	48.84	47.49	46.17
Feed Rate - tons/hr	40.3	40.3	40.3
Particulates			
Probe, Cyclone, & Filter Catch			
mg	172	272	488
gr/SCF* dry	0.0542	0.0882	0.163
gr/CF @ Stack Conditions	0.0236	0.0391	0.0715
lbs/hr	25.53	41.08	72.51
lbs/ton feed	0.634	1.019	1.799
Total Catch			
mg	189	321	518
gr/SCF* dry	0.0596	0.104	0.173
gr/CF @ Stack Conditions	0.0260	0.0461	0.0759
lbs/hr	28.07	48.54	76.99
lbs/ton feed	0.696	1.204	1.910
% Impinger Catch	9.0	15.3	5.8

* 70°F, 29.92" Hg

TABLE III

GASEOUS RESULTS FOR KILN STACK NO. 1

Run No.	Gas Composition (Vol. % Dry(1)) CO_2	O_2	CO	N_2
1	10.5	13.0	<1	76.5

Sample No.	Gas Composition (ppm dry)* NO_x
1	265
2	85
3	147
4	215

(1) Represents average values of results from continuous monitoring.

* Standard Conditions - 70°F, 29.92 in. Hg

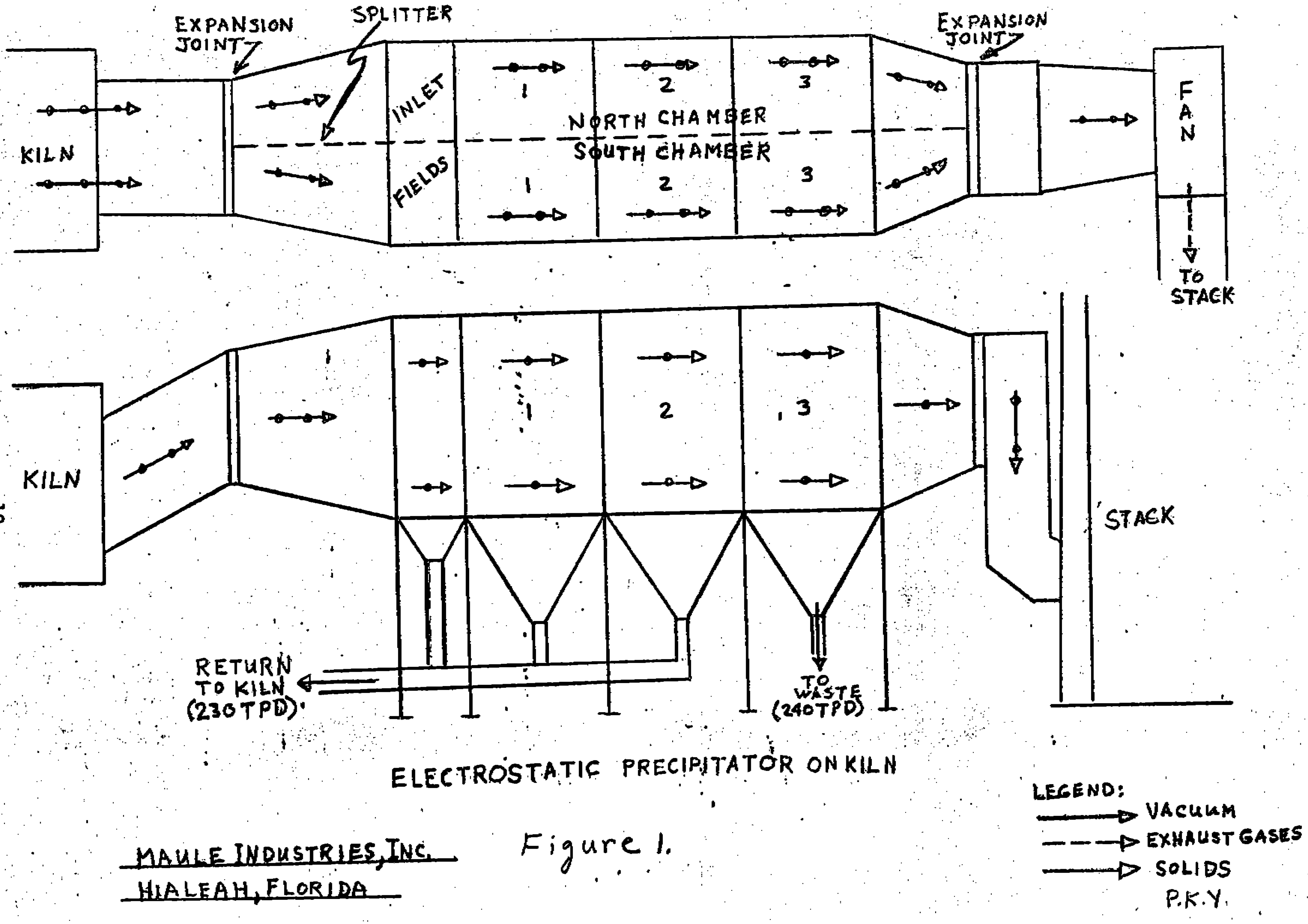
IV. PROCESS DESCRIPTION

Clay and crushed limestone are conveyed to the plant from an open pit quarry adjacent to the plant. These materials are ground and blended with shale and pyrite in a rotating ball mill to form a slurry.

The blended slurry is fed into the upper end of one of the two sloping, slowly revolving kilns. These gas-fired kilns are 421 ft. long, 12 ft. in diameter at the feed end and tapering to 10.5 ft. at the discharge end with refractory lining encased in a steel cyclinder. Fuel consumption is approximately 1,420,000 BTU per ~. 376 356 lb. barrel of clinker produced. During passage through the kiln, the raw materials are heated to a temperature of about 2800°F to produce the element hydraulic calcium silicates, known in the trade as "clinker". This marble-sized clinker material is discharged from the lower end at the kiln at temperatures exceeding 2000°F and fed immediately into air-quenching cooler units which reduce the clinker temperature to about 150°F. From these coolers, the newly-formed clinker material is conveyed to a storage silo.

A small amount of gypsum (4.45% by weight) is added to the clinker material and this mixture is fed into the finish grinding mill. The mixture leaving the grinding mill is fed to an air-separator or classifier where the coarse material is returned to the mill and the finished cement (90% through 325 mesh screen) is pneumatically pumped to storage silos. Present plant production is approximately 2,340,000 barrels of cement per year.

The control equipment of interest in this report consists of two Koppers electrostatic precipitators, one on the No. 1 kiln and the other unit on the No. 1 clinker cooler (Refer Sketch).



ELECTROSTATIC PRECIPITATOR ON KILN

Figure 1.

MAULE INDUSTRIES, INC.
HIALEAH, FLORIDA

The electrostatic precipitator is designed for a performance of 98.8 percent efficiency with an inlet loading of 8.0 gr/ACF at 525°F and an outlet loading of 0.016 gr/ACF to treat a gas volume of 120,000 ACFM containing 30 to 40 percent water. The collection surface area is 46,200 ft.^{2} which gives a gas-to-surface ratio of 2.59:1. The linear gas velocity is 4.05 ft. per sec. and the residence time is 8.6 sec. There are 22 gas passages in the precipitator and each passage is 9 in. wide and contains 42 emitting electrodes. The operating voltage of the inlet field is 35,000 with a current of 500 milliamperes, and the operating voltage of the other three (3) fields is 53,000 with a current of 750 milliampeares.

The electrostatic precipitator on the clinker cooler is designed for a performance of 99.2 percent efficiency with an inlet loading of 1.0 gr/ACF at 300°F and an outlet loading of 0.008 gr/ACF to treat an air volume of 48,000 ACFM containing less than 1 percent water. The collection surface area is 22,400 ft.^{2} which gives an air-to-surface ratio of 2.14:1. The linear air velocity is 2.38 ft. per sec., and the residence time is 10.5 sec. There are 16 air passages in the precipitator and each passage is 9 in. wide and contains 30 emitting electrodes. The operating voltage of the inlet field is 35,000 with a current of 500 milliampeares, and the operating voltage of the other two (2) fields is 45,000 with a current of 500 milliampeares. The approximate total cost of all four precipitators in 1968 was $1,250,000.00 and the annual operating costs for these units was not available.

V. LOCATION OF SAMPLING POINTS

The two sampling ports for the clinker cooler stack were positioned approximately 16 feet (2.6 stack diameters) above the breeching inlet and 20 feet (3.3 stack diameters) below the stack outlet. The identification and distribution of sampling point locations used for the three particulate runs was selected from the Federal Register, "Standards of Performance for New Stationary Sources" (23 December, 1971).

The four sampling ports located on the kiln stack were approximately 80 feet (10 stack diameters) above the breeching inlet and 100 feet (12.5 stack diameters) below the stack outlet. The identification and distribution of sampling point locations was also selected from the Federal Register.

For the gaseous sampling the probe was positioned consecutively at one of the four ports located on the kiln stack and extended approximately four feet into the stack.

VI. PROCESS OPERATION

Process operation was frequently interrupted by kiln upsets and ring formations within the kiln. This was attributed to the recent innovation of insufflating the captured dust from the kiln electrostatic precipitator back into the kiln process. It was estimated by the Project Engineer that the kiln stack opacity ranged from 20 to 30 percent during the testing period.

No major upsets or interruptions occurred while testing the clinker cooler. The Project Engineer estimated the clinker cooler stack opacity to range between 5 and 10 percent during the testing period.

VII. SAMPLING AND ANALYTICAL PROCEDURES

For particulate sampling the train specified in Method 5 of the Federal Register, "Standards of Performance For New Stationary Sources" (23 December, 1971) with impingers as described was used.

The equipment and procedures used for collecting and analyzing the nitrogen oxide samples at the kiln stack are described in Method 7 of the Federal Register.

Carbon dioxide, oxygen, and carbon monoxide were analyzed continuously in the field with an infrared analyzer.

The procedures for analyzing the particulates conform to Method 5 specified in the Federal Register. In addition, the impinger catch was analyzed for particulate residue including organic matter.

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

APPENDIX B

GASEOUS RESULTS

The results of the testing for carrier gas composition are shown in Table B-I. Gas concentrations were determined directly from an infrared analyzer continuously monitoring the kiln stack gases. An average value is shown for each day. Nitrogen oxide emission data with the mathematical equation is shown in Table B-II.

GASEOUS RESULTS

TABLE B-I
Carrier Gas Data

Date	Kiln Stack	Gas Composition (Vol. % dry) CO_2	O_2	CO	N_2
2-23-71	No. 2	10.5	13	<1	76.5
2-24-71	No. 1	12.5	10.5	<1	77.5

TABLE B-II
NO_x EMISSION DATA

Run No.	1	2	3	4
Date	2-26-71	2-26-71	2-26-71	2-26-71
mg NO_2	0.82	0.26	0.45	0.67
T_f - Flask Temperature, °F	81	89	89	82
V_f - Flask Volume, liters	2.061	2.057	2.059	2.081
P_i - Initial Flask Vacuum, "Hg.	24	24	24	24
P_f - Final Flask Vacuum, "Hg.	0	0	0	0
ppm NO_2 std. cond.*	265	85	147	215
ppm NO_2 stack cond.	189	61	104	153

* 70°F, 29.92 in. Hg.

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

APPENDIX C

FIELD DATA

This section presents the actual field data from the testing of (1) the No. 1 clinker cooler stack (C-1), and (2) the No. 1 Kiln stack (C-2).

PRESURVEY - PROCESS INDUSTRY & POWER PLANTS FTS 305-350-5011

NAME OF COMPANY Maule Industries Cement DATE OF PRESURVEY 2-11-71

ADDRESS Hyw 27 Northwest CITY Miami STATE Florida

NAME OF CONTACT H. Burk TITLE Plant Mgr. PHONE 305 ~~885 6431~~ 823 6570

M. Coe V. Presid-

PROVIDE FLOW DIAGRAM OF EACH PROCESS TO BE SAMPLED, INCLUDING FEED COMPOSITIONS AND RATES, OPERATING TEMPERATURES AND PRESSURES, PRODUCT RATES, AND PROPOSED SAMPLING SITES:

See snapshots

No. 1 + No. 2 - Stacks carry kiln exhaust ~~ga~~ gases from ESP units.

Stack size - see exhaust stack data by A.R. Trendolm.
Flow data - see data sheet.

No. 3 + No. 4 - Stacks carry clinker cooler exhaust gases from ESP units.

Stack size - See data ~~cold~~ cooler exhaust!
Flow data - See data sheet.

COMMENTS:

75
40
675

PROVIDE DIAGRAM OF EACH SAMPLING SITE. INCLUDE THE FOLLOWING INFORMATION:

DIMENSIONS TO NEAREST OBSTRUCTION IN ALL DIRECTIONS FROM SAMPLING PORT.

COMPLETE DESCRIPTION OF ALL PORTS INCLUDING ALL DIMENSIONS. DESCRIPTION OF ANY UNUSUAL FEATURES ABOUT ENVIRONMENT; HEIGHT, ODORS, TOXIC CONDITIONS, TEMPERATURE, DUST, ETC.

<u>Kiln stacks sampling point</u> @ 80 ft off ground.
Downstream dia. from fan inlet is @ 7-8
Upstream dia is @ 17.
Ports are covered with a plate; opening is @ 4" I.D.
Cage type platform surrounds stack sampling area, and extends out from stack @ 2½'
Ladder desends from cage platform to ground.
Enviroment is fine; no dust, odors <u>just outside</u>!
Ports are 90° to each other and @ 4-5 ft above base of cage platform. <u>No electric on cage area</u>.

<u>Clinker cooler stacks</u> @ 65 ft off ground level
Downstream dia from fan inlet is @ 2
Upstream dia is @ 3-4
Ports are pipe nipples 3" I.D.; 2 ports 90° to each other
Cage type platform surrounds only 180° of the stack dia.
Ports are @ 4ft above cage platform! Ladder descends from platform to grate platform @ 25' long; steps ~~and~~ ~~width~~ then lead to ground.
Environment is fine; ~~no~~ very little dust; just outside.
No electric in area; plant will furnish electric to area site.

Plant operates 2 kilns ; 2 kiln stacks ; 2 clinker cooler units ; ESP units (Kopper)

Process – wet

Fuel – Natural gas

Clinker cooler gases pass through multi cyclone and then through ESP units.

Plant uses slurry for raw feed and does not have dust problems in raw feed area.

Clinker grinders – 2 / each kiln ; baghouse on each see snapshot No. 5 ; Exhaust from 1 of the grinder baghouses.
Baghouse also handles dust from several feed away points along with grinder dust.
Duct extends @ 4 ft above roof line ; has no ports at this time.
Duct size @ 27" Dia.

Clinker conveying belts and elevator to silos – 2 baghouses ; one on each kiln.
@ same set-up as the grinder baghouses (somewhat) smaller.

Cement silos – 2 baghouses ; one on each kiln
@ same as conveyor belt baghouses.

OPERATING HOURS OF PLANT PERSONNEL 24 hrs. 7 days

OPERATING SCHEDULE FOR EACH PROCESS TO BE SAMPLED same

ARE PROCESSES BATCH OR CONTINUOUS? continuous

LIST FEED RATES AND COMPOSITION FOR EACH PROCESS

LIST ANY CONTROL EQUIPMENT, INCLUDING SIZE ESP units

LIST EXPECTED CONSTITUENTS OF STACK GAS FOR EACH SAMPLING SITE

see eng. data

STACK DATA: HEIGHT see data sheet WIDTH DIAMETER I.D.

O.D. AMOUNT OF INSULATION WALL THICKNESS

MATERIAL OF CONSTRUCTION GAS TEMPERATURE

PRESSURE WET BULB TEMPERATURE

AVERAGE PITOT TUBE READING

DISTANCE TO NEAREST UPSTREAM RESTRICTION TYPE OF RESTRICTION

DISTANCE TO NEAREST DOWNSTREAM RESTRICTION TYPE OF RESTRICTION

ARE PORTS EXISTING? ☑ YES, SIZE

☐ NO, WHO WILL PROVIDE THEM?

SCAFFOLDING OR OTHER MEANS OF SUPPORT PRESENT?

☑ YES

☐ NO, WHO WILL PROVIDE IT? ____________

SOURCE OF ELECTRICITY AVAILABLE? ☐ YES, MAXIMUM AMPERAGE PER CIRCUIT 20

☑ NO

DISTANCE 100-150' WHO WILL PROVIDE EXTENSION CORDS? plant to test areas

LOCATION OF FUSE BOX inside control room, bldg.

PARKING FACILITIES AVAILABLE FOR TRAILER OR VAN? yes

SIGNATURE REQUIRED ON PASSES? no WAIVERS? ____________

NEARBY RESTAURANTS AND MOTELS

Chesapeake Motel (305-885-7343)

For lunch a caterer is usually around the plant area.

LIST ANY SPECIAL SAFETY EQUIPMENT OR RULES Hard hats; no jumping off stacks!

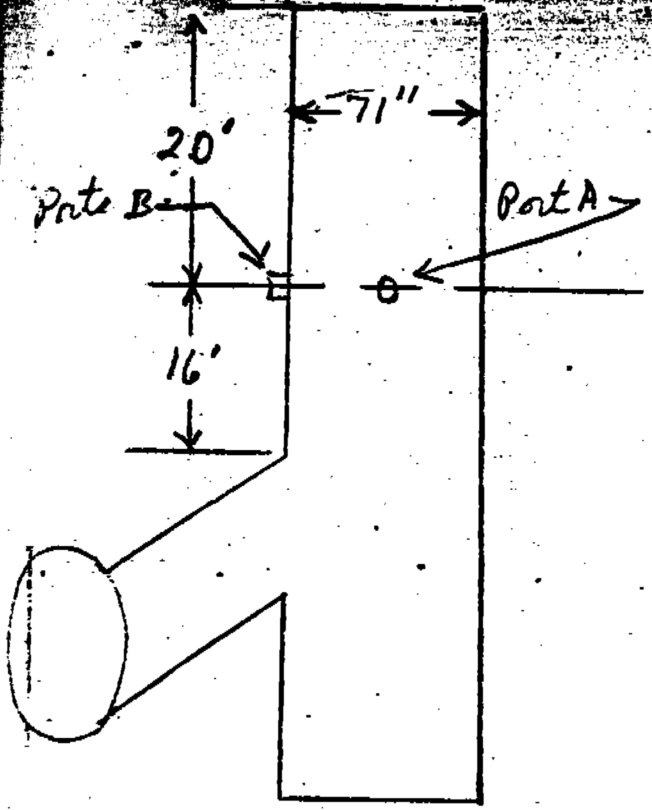
SURVEY BY C. E. Riley

COMMENTS:

Plant will furnish a clean-up area in a warehouse space. No ice is around plant area! It is requested that plant personnel be allowed to work with the testing crew for educational purposes.

C - 1

NO. 1 CLINKER COOLER STACK FIELD DATA



Sketch of stack cross-section showing sampling holes

PRELIMINARY FIELD DATA

Stack Geometry

Test No. Maule Industries

Location No. 1 Clinker Cooler Stack

Date 2-24-71

A. Dist. from inside of far wall to outside of near wall, in., = 74"

B. Wall thickness, in., = $3\frac{1}{4}$"

Inside diameter of stack = A-B $70\frac{3}{4}$"

Stack Area = 3929

Comments: 2-ports
22 traverse points/axis.
44-Total sampling points

Calculations:

Dia. downstream – 2.6
Dia. upstream – 3.0

Point	% Dia. for circular stack	Dist. from outside of sample port, in.
(see	following	sheet!)

Calculator C. C. Riley

NCAP-28 (12/67)

Clinker Cooler Stack No. 1

Point	% Dia of stack	Dist. from inside stack		Dist. from outside of pipe
1	1.1	.80 + 3¼"	=	4"
2	3.5	2.50	=	5¾"
3	6.0	4.25	=	7½"
4	8.7	6.15	=	9⅜"
5	11.6	8.20	=	11½"
6	14.6	10.3	=	13½"
7	18.0	12.7	=	16"
8	21.8	15.4	=	18¾"
9	26.2	18.5	=	21¾"
10	31.5	22.2	=	25½"
11	39.3	27.8	=	31⅛"
12	60.7	43.0	=	46¼"
13	68.5	48.5	=	51¾"
14	73.8	52.2	=	55½"
15	78.2	55.3	=	58⅝"
16	82.0	58.0	=	61¼"
17	85.4	60.3	=	63⅝"
18	88.4	62.5	=	65¾"
19	91.3	64.5	=	67¾"
20	94.0	66.5	=	69¾"
21	96.5	68.3	=	71⅝"
22	98.9	70.	=	73¼"

C. E. Riley 2-23-71

VELOCITY TRAVERSE FIELD DATA

Static press - .2 in. H_2O

Plant Mauli Industries

Test Preliminary

Location No. 1 Clinton Cooler Stack

Date 2-24-71

Operator Bob Martin

Meter ΔH 1.92

Clock Time	A Point	(1) ΔP, in. H_2O	(1) $\sqrt{\Delta P}$, in. H_2O	~~(2)~~ ΔP, in. H_2O Point		(2) $\sqrt{\Delta P}$, in. H_2O	Stack Tempt. °F (1)	Stack Tempt. °F (2)
11:45	1A	.03		14	.02		175	175
	2	.03		15	-.01			
	3	.03		16	-.01			
	4	.05		17	0			
	5	.07		18	-.02			
	6	.10		19	-.02			
	7	.09		20	-.02			
	8	.12		21	-.03			
	9	.10		22	-.02			
	10	.08						
	11	.04						
	12	.03						
	13	.04						

(1) ΔP, in. H_2O Average .05

(2) ΔP, in. H_2O Average

175

Comments:

CAP-29 (12/67)

Plant Maule Ind. Date 2-24-71

Sampling location No. 1 Clinker Cooler Stack

STACK DATA FOR NOMOGRAPH:

1. Meter ΔH 1.92 in H_2O

2. Avg. meter tempt (ambient + 20° 90 110 °F

3. Moisture (volume) 3 %

4. Avg. static press. ⊕ .22 in. H_2OX.073 = + .016 in. Hg.

5. Bar. press sampling point 30.00 in.Hg ⊕ .01 (static press in.Hg) = 30.01 in. Hg.

6. Bar press of meter 30.00 in. Hg.

7. P_s/P_m = $\frac{5. \text{ in. Hg}}{6. \text{ in. Hg}}$ = 1.0

8. Avg. stack temperature 175 °F.

9. Avg. stack velocity (ΔP) 0.07 in H_2O. Max. velocity 0.18 inH

C factor (1) 1.2 (2)

Readings every 3 MIN

PARTICULATE FIELD DATA

Plant Maule
Run No. 1
Location Clinker Cooler stack No. 1
Date 2-25-71
Operator Bomtrt
Sample Box No. 4
Meter Box No. NC 8
Meter ΔH 1.92
C Factor 1.2

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point.

PATHOLOGICAL INCINERATORS- read and record every 5 minutes.

22 points/axis
44 points total
3 min/point
total time 132 MIN

Ambient Temp °F 98
Bar. Press. "Hg 30.02
Assumed Moisture % 3
Heater Box Setting, °F 250
Probe Tip Dia., In. .370
Probe Length 6 ft
Probe Heater Setting 80
Avg. ΔP .07 Avg. ΔH 1.37

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O ΔP	Orifice ΔH in. H_2O Desired	Orifice ΔH in. H_2O Actual	Dry Gas Temp. °F Inlet	Dry Gas Temp. °F Outlet	Pump Vacuum In. Hg Gauge	Box Temp. °F	Impinger Temp °F	Stack Press in. Hg	Stack Temp °F
A 1	935 0	300.28	.035	.67	.67	84	85	5		65		180
2	3		.05	.85	.95	84	85	6				180
3	6	303.26	.06	1.15	1.15	88	84	6				180
4	9	304.93	.07	1.38	1.38	90	85	7	ADJUST K FOR TEMP.			180
5	12	306.75	.08	1.85	1.85	94	84	8				[illegible]
6	15	308.78	.04	.88	.88	94	84	5				183
7	18	310.48	.07	1.50	1.50	97	85	7		65		183
8	21	312.29	.09	1.95	1.95	99	86	9				183
9	24	314.35	.08	1.85	1.85	100	88	8	ADJUST K FOR TEMP (170)			185
10	27	316.46	.09	1.45	1.45	102	88	7				170
11	30	318.37	.09	1.45	1.45	102	89	7				180
12	33	320.24	.07	1.35	1.35	102	89	7				180
13	36	322.07	.09	1.75	1.75	102	90	8				180
14	39	324.06	.09	1.75	1.75	102	90	8				180
15	42	326.17	.04	.80	.80	104	91	5				180
16	45	327.68	.06	1.15	1.15	104	91	7				180

Comments:

Note — (-) values use @ .2 in. H_2O on ΔH_1 =

NCAP-37 (12/67)

Comments	No. 1 Clock Time	Dry Gas Meter, CF	Pitot in. H_2O ΔP	Orifice ΔH in H_2O Desired	Orifice ΔH in H_2O Actual	Dry Gas Temp. °F Inlet	Dry Gas Temp. °F Outlet	Pump Vacuum In. Hg Gauge	Box Temp. °F	Impinger Temp °F	Stack Press in. Hg	Stack Temp °F
	17 48	329.34	.04	.78	.78	101	87	5	250	65		180
	11 51	330.80	.04	.78	.78	101	88	5				180
	19 54	332.21	.02	.40	.40	101	88	4				180
No. 1	20 57	333.31	.05	.95	.95	101	88	6				180
*	21 60	334.76	.01-NEG	.2	.2	98	90	3				180
CHANGE *	22 63	335.65	NEG	.2	.2	98	90	3				180
10:44 B	23 66	336.40	.02	1.4	1.4	90	90	7				180
	24 69	338.22	.12	2.3	2.3	95	97	11				180
	25 72	340.55	.16	3.0	3.0	101	90	13				180
*	26 75	343.22	.25	4.7	3.8 MAX	104	90	18				180
*	27 78	346.21	.25	4.7	3.8 MAX	107	92	18				180
*	28 81	349.23	.23	4.4	3.8 MAX	108	92	18				180
*	29 84	352.27	.25	4.7	3.8 MAX	109	92	18				180
	30 87	356.28	.20	3.7	3.7	110	92	18				180
	31 90	358.30	.20	3.7	3.7	110	92	18				180
	32 93	361.32	.20	3.7	3.7	111	93	18				180
	33 96	364.33	.17	3.2	3.2	111	93	18				180
	34 99	367.20	.10	1.9	1.9	112	94	10				180
	35 102	369.47	.03	.59	.59	112	94	5				180
	36 105	370.88	.015	.30	.30	106	94	4				180
*	37 108	371.86	0	.20	.20	105	94	3				180
*	38 111	372.62	0	.20	.20	104	95	3				180
*	39 114	373.41	NEG	.20	.20	98	92	3				180
*	40 117	374.19	NEG	.20	.20	98	92	3				180
*	41 120	374.98	NEG	.20	.20	96	92	3				180
	42 123	375.77	.015	.30	.30	96	92	4				180
*	43 126	376.67	NEG	.20	.20	96	92	3				180
*	44 129	377.46	NEG	.20	.20	96	92	3				180
1150	END	378.23	35									
	132	77.95			1.49	100.5	89.9					180
						95						
*	POINTS	NOT ISOKINETIC										

39

PARTICULATE FIELD DATA

Plant MAULE

Run No. 2

Location CLINKER COOLER STACK 1

Date 2-25-71

Operator BOMRAT

Sample Box No.

Meter Box No. NC8

Meter Δ H 1.92

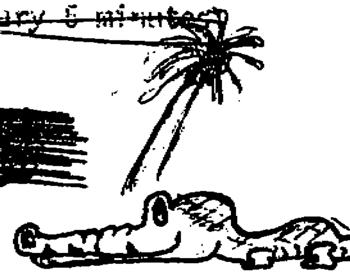
C Factor 1.2

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point.

~~PATHOLOGICAL INCINERATORS~~
~~read and record every 5 minutes~~

[redacted]



Ambient Temp °F 90

Bar. Press. "Hg 30.0C

Assumed Moisture % 3

Heater Box Setting, °F 250

Probe Tip Dia., In. .370

Probe Length 6'

Probe Heater Setting 80

Avg. Δ P .07 Avg. ΔH 1.38

Point	Clock Time	GET 1ST READING OFF EASTSMAN / Dry Gas Meter, CF	Pitot in. H_2O ΔP	Orifice ΔH in H_2O Desired	Orifice ΔH in H_2O Actual	Dry Gas Temp. °F Inlet	Dry Gas Temp. °F Outlet	Pump Vacuum In. Hg Gauge	Box Temp. °F	Impinger Temp °F	Stack Press in. Hg	Stack Temp. °F
B 1 23	1:15	378.23	.15	2.9	2.9	100	97	12	250	70		180
2 24	18	380.61	.10	2.0	2.0	100	97	9	250	70		180
3 25	21	382.87	.10	2.0	2.0	104	98	9	250	70		180
4 26	24		.13	2.5	2.5	104	98	10	250	70		180
5 27	27		.15	2.9	2.9	112	98	12	250	70		180
6 28	30		.13	2.5	2.5	115	99	11	250	70		180
7 29	33	392.74	.12	2.3	2.3	116	99	12	250	70		180
8 30	36	395.36	.12	2.3	2.3	116	99	10	250	70		180
9 31	39	397.29	.18	3.2	3.2	118	100	13	250	70		180
10 32	42	400.51	.13	2.5	2.5	118	100	10	250	70		180
11 33	45	403.03	.10	2.0	2.0	118	100	9	250	70		180
12 34	48		.06	1.15	1.15	118	100	6	250	70		180
13 35	51	407.15	.03	.60	.60	116	100	4	250	70		180
14 36	54		.01	.2	.2	116	100	3	250	70		180
15 37	57	409.30	.01	.2	.2	116	100	3				180
16 38	2:00	410.18	.0	.2	.2	109	101	3				180

Comments: Note — (-) values use @ .2 in H_2O on ΔH

NCAP-37 (12/67)

Run # 2 Comments	Clock Time	No 2 Dry Gas Meter, CF	Pitot in. H_2O ΔP	Orifice ΔH in H_2O Desired	Orifice ΔH in H_2O Actual	Dry Gas Temp. °F Inlet	Dry Gas Temp. °F Outlet	Pump Vacuum In. Hg Gauge	Box Temp. °F	Impinger Temp °F	Stack Press in. Hg	Stack Temp °F
	17 39	410.85	0	.2	.2	109	100	3				180
	18 40	411.51	0	.2	.2	108	100	3				180
	19 41	412.14	NEG	.2	.2	108	100	3				180
73	20 42	413.15	NEG	.2	.2	108	100	3				180
69	21 43	413.93	0	.2	.2	108	100	3				180
66	22 44		.01	.2	.2	109	100	3				180
CHG 69	23 9 1	415.49	.04	.78	.78	104	101	5				180
A 72	24 12 2		.04	.78	.78	104	101	5				180
75	25 3	419.69	.05	.96	.96	104	101	6				180
78	26 4	421.27	.06	1.20	1.20	107	101	6				180
81	27 5	422.96	.07	1.35	1.35	107	98	6				180
84	28 6	424.75	.06	1.35	1.35	107	99	7				180
87	29 7	426.59	.08	1.50	1.50	110	98	7				180
90	30 8	428.50	.08	1.50	1.50	110	98	7				180
93	31 9	430.43	.07	1.35	1.35	110	98	7				180
96	32 10	432.24	.08	1.50	1.50	112	96	7				180
99	33 11	434.14	.11	2.2	2.2	112	96					180
102	34 12	436.40	.08	1.50	←1.50	112	96					180
105	35 13	438.4	.07	1.35	1.35	112	96	6.5				185
108	36 14	440.25	.05	.96	.96	112	96	5				185
111	37 15	441.86	.07	1.35	1.35	112	96	6.5				185
114	38 16	443.66	.08	1.50	1.50	112	96	7				185
117	39 17	445.57	.05	.96	.96	112	96	5				185
120	40 18	447.19	.09	.60	.60	112	96	4				185
123	41 19	448.52	.0	.2	.2	112	96	2				185
126	42 20	449.31	.0	.2	.2	112	96	2				185
129	43 21	450.17	.0	.2	.2	112	94	2				185
14?	44 22	450.85	.0	.2	.2	112	94	2				185
3:50		451.505	~~.0~~	~~.2~~	~~.2~~	~~112~~	~~96~~	~~2~~				~~185~~
			34									
	132	23.28	~~.084~~		1.23	110.5	98.4					183
						104.						

PARTICULATE FIELD DATA

Plant MAULE

Run No. 3

Location Clinker Cooler

Date 2-23-71

Operator MARTIN

Sample Box No.

Meter Box No. NC 8

Meter ΔH@ 1.92

C Factor

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point.

PATHOLOGICAL INCINERATORS-
read and record every 5 minutes

Ambient Temp °F 85

Bar. Press. "Hg 30.02

Assumed Moisture % 3

Heater Box Setting, °F 250

Probe Tip Dia., In. .370

Probe Length 6'

Probe Heater Setting

Avg. ΔP .07 Avg. ΔH 1.38

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O ΔP	Orifice ΔH in H_2O Desired	Orifice ΔH in H_2O Actual	Dry Gas Temp. °F Inlet	Dry Gas Temp. °F Outlet	Pump Vacuum In. Hg Gauge	Box Temp. °F	Impinger Temp. °F	Stack Press in. Hg	Stack Temp. °F
A 1	1:15 0	451.51	.025	.5	.5	101	97	4	200	70		180
2	3	452.64	.05	.95	.95	102	96	6	250			180
3	6	454.16	.05	.95	.95	103	96	6				
4	9	455.74	.065	1.26	1.25	103	96	7				
5	12	457.47	.06	1.15	1.15	104	96	7				
6	15	459.23	.09	1.75	1.75	105	96	8				
7	18	461.25	.07	1.35	1.35	106	96	8				
8	21	463.18	.12	2.3	2.3	107	96	10				
9	24	464.45	.09	1.75	1.75	107	96	9				
10	27	467.52	.07	1.35	1.35	107	97	7				
11	30	469.47	.09	1.76	1.75	108	94	9				
12	3	471.55	.05	.95	.95	108	94	6				
13	6		.05	.95	.95	104	93	6				
14	9	474.74	.03	.6	1.6	101	93	4				
15	12	476.04	.04	.78	.78	100	93	4				
16	15	n	.04	.78	.78	97	92	6				

Comments: Note - (-) value use @ .20 in H_2O on ΔH!

NCAP-37 (12/67) [redacted]

Run 3 Comments	Point	Clock Time	No. 3 Dry Gas Meter, CF	Pitot in. H_2O ΔP	Orifice ΔH in H_2O Desired	Orifice ΔH in H_2O Actual	Dry Gas Temp. °F Inlet	Dry Gas Temp. °F Outlet	Pump Vacuum In. Hg Gauge	Box Temp. °F	Impinger Temp °F	Stack Press in. Hg	Stack Temp °F
	17	18	478.75	.02	.40	.40	97	91	4	250	70		180
	18	21	479.84	.05	.95	.95	97	91	5	250	70		180
	19	24	481.35	.02	.40	.40	97	91	3	250	70		180
	20	27	482.43	.02	.40	.40	97	91	3	250	70		180
	21	30	483.45	.02	.40	.40	97	91	3	250	70		180
B-	22	3	484.58	.02	.20	.20	97	91	3	250	70		180
	23	0	485.50	.08	.16	.16	92	89	8	250	70		180
	24	7	487.34	.12	.23	.23	92	89	10	250	70		180
	25	6	489.76	.25	[illegible]	.37 max	97	88	13	250	70		180
	26	9	492.51	.18	35	3.5	100	88	18	250	70		180
*	27	12	495.50	.17	3.3	3.3	101	88	17	251	70		175
	28	15	498.47	.19	3.7	3.6 max	103	88	18	250	70		175
	29	18	500.40	.24	4.5	3.6 max	104	88	18	250	70		175
	30	21	504.38	.25	4.5	3.6 max	104	88	18	250	70		175
	31	24	507.34	.20	3.8	3.6 max	105	89	18	250	70		175
	32	27	510.34	.19	3.7	3.6 max	106	88	18	250	70		175
	33	30	512.23	.11	2.1	2.4	108	89	11	250	70		175
	34	3	515.89	.03	0.6	0.61	107	88	5	250	70		175
	35	6	517.36	.015	.29	.29	102	90	3	250	70		175
	36	9	518.34	.010	.2	.2	100	90	3	250	70		175
	37	12	519.16	.005	.23	.21	98	90	3	250	70		175
	38	15	519.84	.008	.15	.20	94	88	3	250	70		175
	39	18	520.67	-.0001	.0	.20	92	89	3	250	70		175
	40	21	521.32	-.005	.0	.20	91	88	3	250	70		175
	41	24	522.02	-.005	.0	.20	90	88	3	250	70		175
	42	27	522.76	0	.2	.20	90	88	3	250	70		175
	43	30	523.50	0	.2	.20	90	88	3	250	70		175
	44	3	524.25	0	.2	.20	90	88	3	250	70		175
	END		525.99										
1855				38									
	132		74.48	~~.083~~		1.35	100	91.3					178
								95.6					

PARTICULATE CLEANUP SHEET

Date: 2-25-71
Run number: 1
Operator: Ray Molby
Sample box number: 4

Plant: Marble Industries
Location of sample port: Clinker Cooler No. 1
Barometric pressure: 30.02
Ambient temperature: 85°

Impinger H_2O

Volume after sampling 224 ml
Impinger prefilled with 208 ml
Volume collected 16 ml

Container No. 1A
Extra No. ____

Ether-chloroform extraction of impinger water ~~6.0~~ mg
Impinger water residue 6.0 mg

Impingers and back half of filter, acetone wash: Container No. 1B; Extra No. ____; Weight results added to water catch mg

Dry probe and cyclone catch: Container No. ____; Extra No. ____; Weight results ____ mg

Probe, ~~cyclone~~, ~~flask~~, and front half of filter, acetone wash: Container No. 1C; Extra No. ____; Weight results 71.0 mg

Filter Papers and Dry Filter Particulate

Filter number	Container no.	Filter number	Container no.
012323	1D		

Filter particulate weight 57.0 mg

Total particulate weight 134 mg

Silica Gel

Weight after test:	216.7			
Weight before test:	200.0			
Moisture weight collected:	16.7			
Container number:	1.	2.	3.	4.

Moisture total 32.7 gm

Sample number: 1
Analyze for: Mass
Method determination:
Comments:

PARTICULATE CLEANUP SHEET

Date: 2-25-71
Plant: Maule
Run number: 2
Location of sample port: Center Cooler No. 1
Operator: Ray Mobley
Barometric pressure: 30.02
Sample box number: ~~#~~ 11
Ambient temperature: 85°

Impinger H_2O

Volume after sampling 221 ml
Impinger prefilled with 208 ml
Volume collected 13 ml
Container No. 2A
Extra No.
Ether-chloroform extraction of impinger water ____ mg
Impinger water residue 11.0 mg

Impingers and back half of filter, acetone wash:
Container No. 2B
Extra No.
Weight results 0 mg

Dry probe and cyclone catch:
Container No. ~~2B~~
Extra No.
Weight results ____ mg

Probe, ~~cyclone~~, ~~flask~~, and front half of filter, acetone wash:
Container No. 2C
Extra No.
Weight results 75.0 mg

Filter Papers and Dry Filter Particulate

Filter number	Container no.	Filter number	Container no.
012425	2D		

Filter particulate weight 52.0 mg

Total particulate weight 138 mg

Silica Gel

Weight after test:	215.4			
Weight before test:	200.0			
Moisture weight collected:	15.4			
Container number:	1.	2.	3.	4.

Moisture total 28.4 gm

Sample number: 2
Analyze for: Mar

Method determination:

Comments:

PARTICULATE CLEANUP SHEET

Date: 7-25-71
Run number: 3
Operator: Ray Mobley
Sample box number: 4

Plant: Maule Ind.
Location of sample port: Clinker Cooler No.1
Barometric pressure: 30.02
Ambient temperature: 85°

Impinger H_2O

Volume after sampling 220 ml
Impinger prefilled with 208 ml
Volume collected 12 ml

Container No. 3A
Extra No. ____

Ether-chloroform extraction of impinger water ____ mg
Impinger water residue 18.0 mg

Impingers and back half of filter, acetone wash:
Container No. 3B
Extra No. ____
Weight results 0 mg

Dry probe and cyclone catch:
Container No. ____
Extra No. ____
Weight results ____ mg

Probe, ~~cyclone, flask~~, and front half of filter, acetone wash:
Container No. 3C
Extra No. ____
Weight results 56 mg

Filter Papers and Dry Filter Particulate

Filter number	Container no.	Filter number	Container no.
012317	3D		

Filter particulate weight 38 mg

Total particulate weight 104 mg

Silica Gel

Weight after test:	215.5			
Weight before test:	200			
Moisture weight collected:	15.5			
Container number:	1.	2.	3.	4.

Moisture total 28.5 gm

Sample number: 3
Analyze for: Mass
Method determination:
Comments:

SAMPLING SUMMARY SHEETS

ANT Maule Ind LOCATION No. 1 Clinker Cooler Stack

MPLED SOURCE at Hialeah, Florida

ain Data

un o.	Date	Nozzle dia. in.	Net time min.	Bar. pres. "Hg.	Orifice diff. Δ H "H_2O	Volume sampled meter cond. cu. ft.	Meter temp. ^oF	Volume sampled standard cond. cu. ft.
1	2-25-71	.370	132	30.02	1.49	77.95	95	74.90
2	2-25-71	.370	132	30.02	1.23	73.28	104	69.25
3	2-25-71	.370	132	30.02	1.35	74.48	96	71.41

isture and Gas Data

un o.	Total moisture ml.	Moisture std. cond. cu. ft.	% Moisture by volume	Mole fraction dry gas	Molecular wt. of dry stack gas	Molecular wt. of moist. stack gas
1	32.7	1.55	2.63	.980	29.00	28.78
2	28.4	1.35	1.91	.981	29.00	28.79
3	28.5	1.35	1.86	.981	29.00	29.80
					(air)	

ck Data

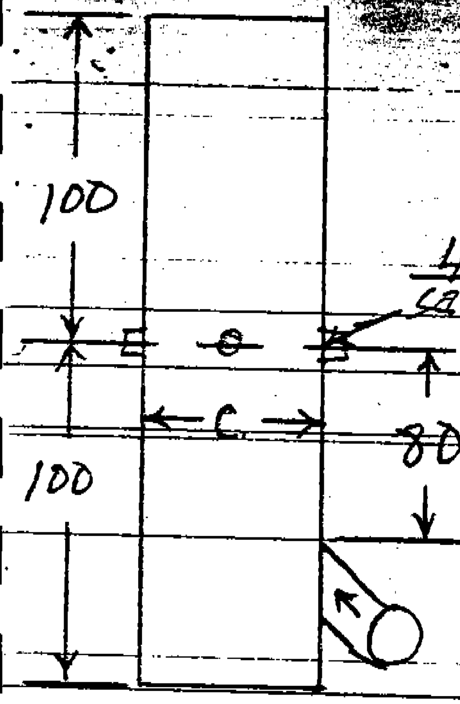
n .	Stack area in^2	Velocity head "H_2O	Static press. "Hg.	Stack press. "Hg. Abs.	Stack temp. ^oF
	3929	.05	.02	30.04	180
	3929	.04	.02	30.04	182
	3929	.05	.02	30.04	178
	(785 x d^2)				

ocity and Calculation Data

n .	Average √ Velocity x temperature ^oR	Stack velocity fpm stack cond.	Stack gas volume scfm	Percent isokinetic
	5.91	876	19,423	106.2
	5.28	783	17,369	110.0
	5.74	851	18,994	103.7

C - 2

NO. 1 KILN STACK FIELD DATA



PRELIMINARY FIELD DATA

Stack Geometry

Plant Maule

Test No. 1

Location Kiln Stack No. 1

Date 2-24-71

A. Dist. from inside of far wall to outside of near wall, in., = 126½

B. Wall thickness, in., = 32"

C. Inside diameter of stack = A-B 94½

Stack Area = 7010

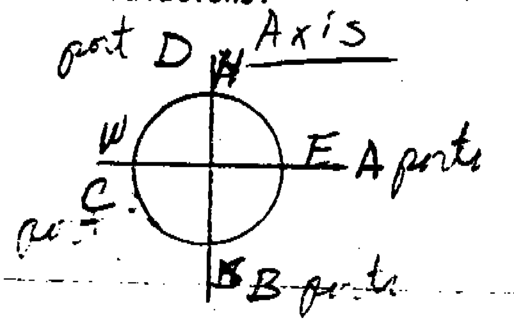
Comments: Downstream Dia To port — 10

~~From~~ ~~rotations~~ suitable Upstream dia. From port – 12

3 points/radius 12 sampling points

Sketch of stack cross-section showing sampling holes

Calculations:



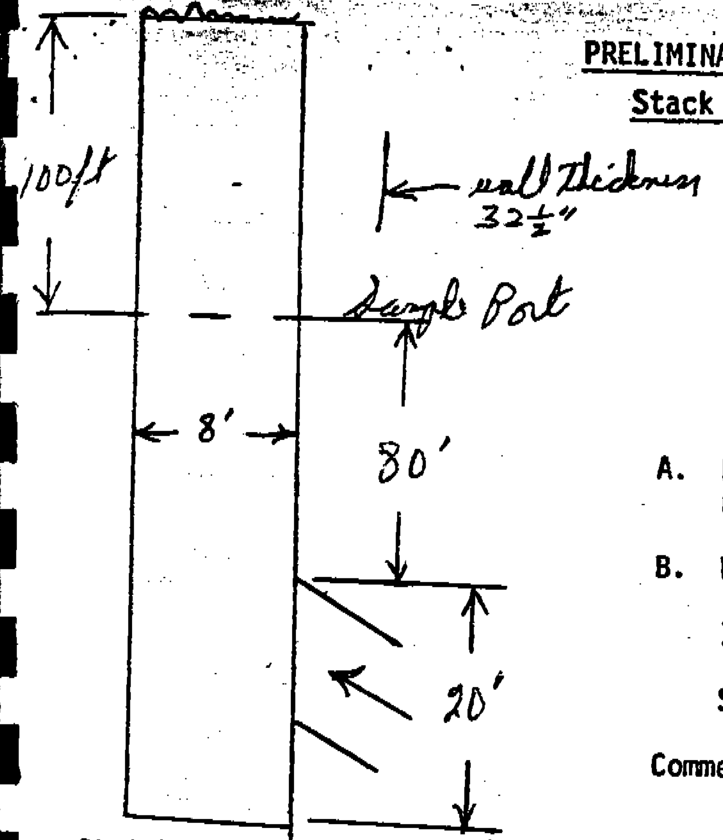
Point	% Dia. for circular stack	Dist. from outside of sample port, in.
1	4.4	4.2 + 32 = 36
2	14.7	13.5 = 46
3	29.7	26.9 = 59

Calculator C. E. Riley

NCAP-28 (12/67)

PRELIMINARY FIELD DATA

Stack Geometry



Sketch of stack cross-section showing sampling holes

Plant Maule

Test No. 1

Location Kiln No. 2

Date 2-23-71

A. Dist. from inside of far wall to outside of near wall, in., = 128½

B. Wall thickness, in., = 32½

Inside diameter of stack = A-B 96"

Stack Area = ~~2279~~ 7235 in²

Comments: .785 x (d²)
.785 x (96)²

~~Calculations~~ Port:

Dia. downstream — 10

Dia upstream — 12

Point	% Dia. for circular stack	Dist. from outside of sample port, in.
1	4.4	4.3 + 32½ = 37"
2	14.7	14.2 + = 46½"
3	29.7	27.0 + = 60"

Calculator C E Riley

NCAP-28 (12/67)

VELOCITY TRAVERSE FIELD DATA

Plant Marb

Test 1

Location Kiln stack No. 2

Date 2-23-71 1530

Operator Mobley

Meter ΔH 1.88 2nd time

Clock Time	Point	(1) ΔP, in. H_2O	(1) $\sqrt{\Delta P}$, in. H_2O	(2) ΔP, in. H_2O	(2) $\sqrt{\Delta P}$, in. H_2O	Stack Tempt. °F (1)	Stack Tempt. °F (2)
10:15 A	A 1	.25	~~11:05 A~~	.25		415	415
	2	.32		.33			
	3	.36		.35			
	B 4	.28	B	.28			
	5	.37		.35			
	6	.26		.23			
	C 7	.34	C	.33			
	8	.29		.27			
	9	.34		.34			
	D 10	.25	D	.28			
	11	.38		.36			
	12	.36		.37			

(1) ΔP, in. H_2O Average .33

(2) ΔP, in. H_2O Average .33

Comments: C factor .52

Static press + .47" H_2O

.41 Avg = .46

.50

NCAP-29 (12/67)

VELOCITY TRAVERSE FIELD DATA

Plant Maule

Test Preliminary

Location Kiln Stack No. 1

Date 2-25-71

Operator C E Riley

Meter ΔH 1.88

Clock Time	Point	(1) ΔP, in. H_2O	(1) $\sqrt{\Delta P}$, in. H_2O	(2) ΔP, in. H_2O	(2) $\sqrt{\Delta P}$, in. H_2O	Stack Tempt. °F (1)	Stack Tempt. °F (2)
1300	A1	.24				400	
	2	.38					
	3	.34					
	B1	.28					
	2	.30					
	3	.36					
	C1	.26	.32				
	2	.34					
	3	.35					
	D1	.27					
	2	.36					
	3	.36				410	

(1) ΔP, in. H_2O Average .32 405

(2) ΔP, in. H_2O Average

Comments:

CAP-29 (12/67)

Plant Maule Industries Date 2-26-71

Sampling location No. 1 Kiln Stack

STACK DATA FOR NOMOGRAPH:

1. Meter ΔH 1.88 in H_2O

2. Avg. meter tempt (ambient 80 + 20° 100 °F

3. Moisture (volume) 30 %

4. Avg. static press. ⊕ .45 in. H_2O X.073 = ⊕ .03 in. Hg.

5. Bar. press sampling point 30.02 in.Hg ⊕ .03 (static press in.Hg) = 30.05 in. Hg.

6. Bar press of meter 30.03 in. Hg.

7. P_s/P_m = $\frac{5. \_\_\_\_ \text{in. Hg}}{6. \_\_\_\_ \text{in. Hg}}$ = 1.0

8. Avg. stack temperature 405 °F.

9. Avg. stack velocity (ΔP) 0.32 in H_2O. Max. velocity .39 in H_2O

C factor (1) .66 (2)

Plant Maule Industries Date 7-23-71

Sampling location Kiln Stack No. 2

STACK DATA FOR NOMOGRAPH:

1. Meter ΔH 1.88 in H_2O

2. Avg. meter tempt (~~ambient~~ 80 + 20° 100 °F

3. Moisture (volume) 30 %

4. Avg. static press. + .46 in. H_2OX.073 = + .03 in. Hg.

5. Bar. press sampling point 30.00 in.Hg + .03 (static press in.Hg) = 30.03 in. Hg.

6. Bar press of meter 30.00 in. Hg.

7. $P_s/P_m = \dfrac{5.\_\_\_\ \text{in. Hg}}{6.\_\_\_\ \text{in. Hg}} =$ 1.0

8. Avg. stack temperature 415 °F.

9. Avg. stack velocity (ΔP) .33 in H_2O. Max. velocity .38 inH_2O

C factor (1) .64 (2) ______

PARTICULATE FIELD DATA

Plant	Maule
Run No.	1
Location	Kiln Stack No.1
Date	2-26-71
Operator	Ray
Sample Box No.	4
Meter Box No.	10
Meter Δ H	1.88
C Factor	

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point.

PATHOLOGICAL INCINERATORS-
read and record every 5 minutes.

6 points/axis
12 points total
5 MIN/point
total time 60 MIN

Ambient Temp °F	80°
Bar. Press. "Hg	30.02
Assumed Moisture %	30
Heater Box Setting, °F	250
Probe Tip Dia., In.	.370
Probe Length	6 ft
Probe Heater Setting	70
Avg. Δ P	.33
Avg. Δ H	2.7

Point	Clock Time	Dry Gas Meter, CF	Pitot In. H_2O ΔP	Orifice ΔH in H_2O Desired	Orifice ΔH in H_2O Actual	Dry Gas Temp. °F Inlet	Dry Gas Temp. °F Outlet	Pump Vacuum In. Hg Gauge	Box Temp. °F	Impinger Temp °F	Stack Press In. Hg	Stack Temp °F
A-1	0	470.09	.26	2.1	2.1	83	82	6	250	80		385
2	5	472.8	.35	2.8	2.8	90	82	7.5		63		390
3	10	47[illegible].09	.39	3.1	3.1	94	82	9		78		
B-1 1240	15	48[illegible].59	.28	2.3	2.3	92	84	7		75		
2	20	486.52	.36	2.9	2.9	98	86	8		64		
3	25	490.87	.39	3.1	3.1	102	87	9		68		
C-1 1225	30	495.41	.25	2.0	2.0	91	84	6		74		
2	35	499.06	.32	2.6	2.6	98	84	8		44		
3	40	503.2	.36	2.9	2.9	101	87	10		68		
D-1 1255	45	507.63	.27	2.2	2.2	106	88	7		64		
2	50	511.5	.36	2.9	2.9	98	88	10		68		
3	55	515.87	.42	3.4	3.4	106	90	11		68		390
	60	520.40										
	60	50.31	.33		2.69	96.6	85.8					389

91.2

390

Comments: Start time — 11:35
Completion time — 1110

515.87
11.5
4.37
15.87
20.24

PARTICULATE FIELD DATA

Plant: Maule
Run No.: 2
Location: Kiln Stack No. 1
Date: 2-26-71
Operator: Ray
Sample Box No.: 1
Meter Box No.: 10
Meter Δ H: 1.88
C Factor:

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point.

PATHOLOGICAL INCINERATORS- read and record every 5 minutes.

Ambient Temp °F: 80
Bar. Press. "Hg: 30.02
Assumed Moisture %: 30
Heater Box Setting, °F: 250
Probe Tip Dia., In.: .370
Probe Length: 6 ft
Probe Heater Setting: 70
Avg. Δ P:
Avg. ΔH:

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O ΔP	Orifice ΔH in H_2O Desired	Orifice ΔH in H_2O Actual	Dry Gas Temp. °F Inlet	Dry Gas Temp. °F Outlet	Pump Vacuum In. Hg Gauge	Box Temp. °F	Impinger Temp °F	Stack Press. in. Hg	Stack Temp °F
D-1	0	520.75	.25	2.0	2.0	92	49	2	250	80		390
2	5	524.5	.34	2.8	2.8	91	86	5		60		380
3	10	528.69	.4	3.2	3.2	98	86	6		62		380
C-1 1420	15	533.29	.23	1.8	1.8	101	87	2		64		380
2	20	536.76	.39	3.1	3.1	96	86	5		65		390
3	25	541.1	.44	3.6	3.6	101	87	6		65		395
B-1 1437	30	545.95	.27	2.2	2.2	92	86	4		80		410
2	35	549.85	.35	2.8	2.8	96	87	3		64		420
3	40	554.14	.39	3.0	3.0	102	88	5		64		420
A-1 1500	45	558.62	.18	1.5	1.5	99	88	3		68		400
2	50	561.85	.29	2.3	2.3	98	88	5		64		400
3	55	565.75	.30	2.4	2.4	102	89	-5		64		400
	60	569.78										
	60	49.03	.32		2.56	97.3	87.3					~~378~~ 395

92.3

Comments: Start time – 1:45
Completion time – 3:15

NCAP-37 (12/67)

PARTICULATE FIELD DATA

Plant	Maul	Ambient Temp °F	80°
Run No.	3	Bar. Press. "Hg	30.02
Location	Kiln Stack No. 1	Assumed Moisture %	30
Date	2-26-71	Heater Box Setting, °F	250
Operator	Ray	Probe Tip Dia., In.	.370
Sample Box No.	4	Probe Length	6 ft
Meter Box No.	10	Probe Heater Setting	70
	1.88	Avg. ΔP .33	Avg. ΔH 2.7
C Factor	6.7		

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point.

EPA... Read and record every 5 minutes.

Point	Clock Time	Dry Gas Meter, ft^3	Pitot in. H_2O ΔP	Orifice ΔH in. H_2O Desired	Orifice ΔH Actual	Dry Gas Temp. °F Inlet	Dry Gas Temp. °F Outlet	Pump Vacuum in. Hg Gauge	Box Temp. °F	Impinger Temp °F	Stack Press in. Hg	Stack Temp °F
A-1	0	570.0	~~.20~~	1.6	1.6	94	88	2	250	90		400
2	5	573.36	.25	2.0	2.0	94	88	4		60		400
3	10	576.99	.3	2.4	2.4	100	88	5		60		400
B-1 1555	15	581.08	.21	1.7	1.7	94	88	4		66		405
2	20	584.48	.27	2.2	2.2	96	88	5		64		400
3	25	588.36	.35	2.8	2.6	100	88	6		64		400
C-1 1620	30	592.73	.25	2.0	2.0	93	87	4		64		390
2	35	596.44	.35	2.8	2.8	97	88	6		64		390
3	40	600.76	.38	3.1	3.1	101	88	7		64		400
D-1 1145	45	605.32	.25	2.0	2.0	94	88	5		68		400
2	50	609.0	.33	2.6	2.6	98	88	6		64		405
3	55	613.13	.38	3.0	3.0	102	88	8		64		405
	60	617.69										
	60	47.67	.29		2.35	96.9 ~~97.4~~	88.					400

92.4

Comments: Start time — 3:30

Completion time — 5:00

RCAP-37 (12/69)

3:10

PARTICULATE CLEANUP SHEET

Date: 2-26-71 Plant: Marb clnd.
Run number: 1 Location of sample port: Kiln stack No. 1
Operator: C.E. Riley Barometric pressure: 30.02
Sample box number: 4 Ambient temperature: 85°

Impinger H_2O

Volume after sampling 635 ml Container No. 4A Ether-chloroform extraction of impinger water ______ mg
Impinger prefilled with 208 ml Extra No. 4A-1
Volume collected 427 ml Impinger water residue 17 mg

Impingers and back half of filter, acetone wash: Container No. 4B
Extra No. ___ Weight results ______ mg

Dry probe and cyclone catch: Container No. ~~4B~~
Extra No. ___ Weight results ______ mg

Probe, ~~cyclone~~ 1/2, ~~flask~~ 1/2, and front half of filter, acetone wash: Container No. 4C
Extra No. 4C-1 Weight results 104 mg

Filter Papers and Dry Filter Particulate

Filter number	Container no.	Filter number	Container no.
012345	4D		
012344			

Filter particulate weight 68 mg

Total particulate weight 189 mg

Silica Gel

Weight after test:	222.3			
Weight before test:	200			
Moisture weight collected:	22.3			
Container number:	1.	2.	3.	4.

22.3
427.
449.3

Moisture total 449 gm

Sample number: 4 Analyze for: Mass
Method determination:
Comments: 2 filter papers were placed in filter holder by mistake

PARTICULATE CLEANUP SHEET

Date: 2-26-71 Plant: Maul [illegible]
Run number: 2 Location of sample port: Kiln Stack No. [illegible]
Operator: C. E. Riley Barometric pressure: 30.02
Sample box number: 1 Ambient temperature: 85°

Impinger H_2O

Volume after sampling 595 ml Container No. 5A Ether-chloroform extraction of impinger water ______ mg
Impinger prefilled with 208 ml Extra No. 5A-1
Volume collected 387 ml Impinger water residue 49 mg

Impingers and back half of filter, acetone wash: Container No. 5B
Extra No. ______ Weight results ______ mg

Dry probe and cyclone catch: Container No. ______
Extra No. ______ Weight results ______ mg

Probe, ~~cyclone~~ Port, ~~flask~~ Seal, and front half of filter, acetone wash: Container No. 5C
Extra No. ______ Weight results 138 mg

Filter Papers and Dry Filter Particulate

Filter number	Container no.	Filter number	Container no.
012343	5D		

Filter particulate weight 134 mg

Total particulate weight 321 mg

Silica Gel

Weight after test:	219.3			
Weight before test:	200			
Moisture weight collected:	19.3			
Container number:	1.	2.	3.	4.

387
19.3
406.3

Moisture total 406 gm

Sample number: 5 Analyze for: Mass
Method determination: ______
Comments: ______

PARTICULATE CLEANUP SHEET

Date: 2-21-71 Plant: Maule

Run number: 3 Location of sample port: Kiln Stack No.1

Operator: C.E. Riley Barometric pressure: 30.02

Sample box number: ______ Ambient temperature: 85°

Impinger H_2O

Volume after sampling 588 ml Container No. 6A Ether-chloroform extraction of impinger water ______ mg

Impinger prefilled with 208 ml Extra No. ______

Volume collected 380 ml Impinger water residue 30 mg

~~Impingers and back half of filter, acetone wash:~~ Container No. 6B Extra No. ______ Weight results ______ mg

---

Dry probe and ~~[illegible]~~: Container No. ______ Extra No. ______ Weight results ______ mg

---

Probe, ~~cyclone~~, ~~flask~~, and front half of filter, acetone wash: Container No. 6C Extra No. ______ Weight results 206 mg

---

Filter Papers and Dry Filter Particulate

Filter number	Container no.	Filter number	Container no.
~~12343~~	~~6D~~		
12342			

Filter particulate weight 282 mg

Total particulate weight 518 mg

Silica Gel

	1	2	3	4
Weight after test:	217.9			
Weight before test:	200			
Moisture weight collected:	17.9			
Container number:				

380
17.9
397.9

Moisture total 397.9 gm

Sample number: 6 Analyze for: Mass

Method determination: ______

Comments: ______

Infrared

~~ORSAT~~ FIELD DATA

Location Maule Ind

Date 2-25-71

Time ~~8~~ 11:15 – 1430

Operator Ray Miller + Dana Ludwig

Comments: Kiln Stack No. 1

Test average	(CO_2) Reading 1	(O_2) Reading 2	(CO) Reading 3
1	12.5	20.5	28 ppm

30.42

NCAP-31 (12/67)

Infrared

~~ORSAT~~ FIELD DATA

Location Maule Ind

Date 2-23-71

Time ~~15~~ 0830 - 1530 Average

Operator Ray Moller

Comments:
Kiln Stack No. 2

Test	(CO_2) Reading 1	(O_2) Reading 2	(CO) Reading 3
Average			
1	10.5	13.0	30 ppm

30.0

NCAP-31 (12/67)

SAMPLING SUMMARY SHEETS

PLANT Maule Industries LOCATION Florida

SAMPLED SOURCE No. 1 Kiln Stack

Train Data

Run No.	Date	Nozzle dia. in.	Net time min.	Bar. pres. "Hg.	Orifice diff. ΔH "H_2O	Volume sampled meter cond. cu. ft.	Meter temp. °F	Volume sampled standard cond. cu. ft.
1	2-26-71	.370	60	30.02	2.69	50.31	91	48.82
2	2-26-71	.370	60	30.02	2.56	49.03	92	47.46
3	2-26-71	.370	60	30.02	2.35	47.69	92	46.14

Moisture and Gas Data

Run No.	Total moisture ml.	Moisture std. cond. cu. ft.	% Moisture by volume	Mole fraction dry gas	Molecular wt. of dry stack gas	Molecular wt. of moist. stack gas
1	449	21.28	30.36	.700	30.20	26.54
2	406	19.24	28.85	.710	30.20	~~26.66~~ 26.66
3	398	18.87	29.03	.710	30.20	26.66

Stack Data

Run No.	Stack area in^2	Velocity head "H_2O	Static press. "Hg.	Stack press. "Hg. Abs.	Stack temp. °F
1	7010	.29	.04	30.06	390
2	7010	.32	.04	30.06	395
3	7010	.32	.04	30.06	400

Velocity and Calculation Data

Run No.	Average $\sqrt{\text{Velocity} \times \text{temperature } ^\circ R}$	Stack velocity fpm stack cond.	Stack gas volume scfm	Percent isokinetic
1	16.79	2586	55,200	95.8
2	16.38	2517	54,175	94.9
3	15.79	2426	51,900	96.3

OXIDES OF NITROGEN FIELD DATA

Date 2-26-71

Plant Maule

Sample Collected By Crist

Run No. 4 Kiln #1

Power Stat Setting 60

Field Data

Clock time	12:07				
Flask number	5				
Volume of flask less correction (~~liter~~) ml	2086 − 25 = 2061				
Vacuum ~~Pressure~~ before sampling in Hg.	24				
Vacuum ~~Pressure~~ after sampling in Hg.	0				
Flask temperature, °F	80 82				

Remarks:

25 ml reagent added

length of probe 67"

length of probe sticking out from edge of sampling nipple 9"

no neg

NCAP-35 (12/67)

$mg\ NO_2 = 0.82$

3

OXIDES OF NITROGEN FIELD DATA

Date 2-26-71

Plant Maule

Sample Collected By Crist

Run No. 25 Kiln #1

Power Stat Setting 60

Field Data

Clock time	2:00				
Flask number	1				
Volume of flask less correction ~~(liter)~~ ml	2084 -25 2059				
~~Pressure~~ Vacuum before sampling in Hg.	24				
~~Pressure~~ Vacuum after sampling in Hg.	0				
Flask temperature, °F	85 87				

Remarks:

54
-25

25 ml reagent added
probe - 67"
length sticking from nipple

NCAP-35 (12/67)

mg NO_2 = .045

OXIDES OF NITROGEN FIELD DATA

Date 12-26-71

Plant maulo

Sample Collected By Crist

Run No. 4 Kiln #1

Power Stat Setting 60

Field Data

Clock time	12:45				
Flask number	20				
Volume of flask less correction (~~liter~~) ml	2082 - 25 2057				
Vacuum ~~Pressure~~ before sampling in Hg.	24				
Vacuum ~~Pressure~~ after sampling in Hg.	0				
Flask temperature, °F	~~90~~ 88				

Remarks:

25ml reagent added

probe - 67"

length sticking from nipple - 9'

NCAP-35 (12/67)

mg NO_2 = 0.26

6

OXIDES OF NITROGEN FIELD DATA

Date 2-26-71

Plant Maule

Sample Collected By Crist

Run No. #6 Kiln #1

Power Stat Setting 60

Field Data

Clock time	4:30				
Flask number	11				
Volume of flask less correction (~~liter~~) ml	2106 - 25 2081				
Vacuum ~~Pressure~~ before sampling in Hg.	24				
Vacuum ~~Pressure~~ after sampling in Hg.	0				
Flask temperature, °F	80 83				

Remarks:

25 ml reagent added

probe 67"

length sticking from nipple 9"

NCAP-35 (12/67)

mg NO_2 = 0.67

TABLE E - I
STACK SAMPLE ANALYSIS
Maule Industries Cement Plant
Hialeah, Florida
March, 1971

Sample No.	Partic. mg	Nitrogen Dioxide mg	Run No.	Location
1A	6		1	Clinker-Cooler Stack No. 1 (Outlet)
1C	71			
1D	57			
Total	134			
2A	11		2	Clinker-Cooler Stack No. 1 (Outlet)
2C	75			
2D	52			
Total	138			
3A	10		3	Clinker-Cooler Stack No. 1 (Outlet)
3C	56			
3D	38			
Total	104			
4A	17	0.82	4	Kiln Stack No. 1 (Outlet)
4C	104	0.26		
4D	68			
Total	189			
5A	49	0.45	5	Kiln Stack No. 1 (Outlet)
5C	138			
5D	134			
Total	321			
6A	30	0.67	6	Kiln Stack No. 1 (Outlet)
6C				

TABLE E - 1 (Continued)

STACK SAMPLE ANALYSIS

Maule Industries Cement Plant

Hialeah, Florida

March, 1971

Legend: A - impinger water
C - acetone rinse of probe cyclone, flask, and front half of filter
D - glass fiber filter particulate

Note: Samples 1, 2, 3, and 6 were obtained without a cyclone and flask in the sampling train. One NO_2 sample was void for run 6
and one f

TABLE E - I (Continued)

STACK SAMPLE ANALYSIS

Maule Industries Cement Plant

Hialeah, Florida

March, 1971

Legend: A - impinger water
C - acetone rinse of probe cyclone, flask, and front half of filter
D - glass fiber filter particulate

Note: Samples 1, 2, 3, and 6 were obtained without a cyclone and flask in the sampling train. One NO_2 sample was void for run 5 and one for run 6.

The following additional samples were obtained for future reference and analysis:

(1) finished product (cement)

(2) clinker

(3) slurry (kiln feed)

(4) material removed by electrostatic precipitator of kiln No. 1

(5) material removed by electrostatic precipitator of clinker-cooler No. 1

(6) raw feed to grinding mill

TABLE E - II

ANALYSIS OF IMPINGER PARTICULATE*

Sampling Location	Sample Wt. mg	Sulfate mg	Calcium mg	Potassium mg	Iron ug	Magnesium ug
Clinker Cooler Stack No. 1	10(1)	0.4	0.30	0	30	12
Kiln Stack No. 1	49(2)	17	0.4	0.11	30	34

(1) Clinker cooler stack Run No. 3 impinger catch.

(2) Kiln stack Run No. 2 impinger catch.

* Analyses performed by EPA

TABLE E - III

METALS EMISSION DATA*

Element	Sample Conc. (ug/gm Sample) Clinker Stack #1(1)	Sample Conc. (ug/gm Sample) KILN Stack #1(2)
Be	7.2	BDL
Cd	BDL	BDL
As	BDL	BDL
V	200	139
Mn	300	130
Ni	1304	2204
Sb	0	0
Cr	1376	3273
Fe	23,880	10,430
Cu	231	256
Sr	3854	2853
Pb	BDL	815
Weight of sample-mg	134	189

$$\text{Metal wt.\%} = \frac{\text{wt. metal}}{\text{wt sample}} \times 100$$

(1) Clinker stack Run No. 1 total catch.

(2) Kiln stack Run No. 1 total catch.

* Analyses conducted by EPA

TABLE E - IV

Results of Emission Spectrographic Analysis

Performed on the Impinger Particulate*

Results given in weight percent

Metals	Clinker Cooler Run No. 2	Kiln Stack Run No. 3
Na	1.0	0.2
K	0.2	0.2
Ca	1.0	0.5
Al	0.02	0.1
Fe	0.4	0.04
Mg	0.4	0.1
B	0.1	< 0.01
Si	2.0	0.1
Cu	0.02	0.03
Ba	0.01	<0.01
Mn	<0.01	0.01
Pb	<0.01	<0.01
Sn	0.02	0.04
Cr	0.02	<0.01
Ni	0.04	0.04
Ti	0.01	<0.01
Co	<0.01	0.02

* Analysis conducted by Battelle Laboratories for EPA.

TABLE E - V

Analysis Results of Impinger Particulate*

Type of Analyses: Category Visual Absorption Spectrography

Results in weight percent

Analysis For	Clinker Cooler Stack Run No. 2	Kiln Stack Run No. 3
$SO_4^{=}$	1.0	50.0
NH_4^{+}	<0.1	13.0
Acid as H_2SO_4	-	18.0
Cl^{-}	-	-
Water soluble	-	(1)(2)

(1) Estimate 20 percent of sample is organic material.

(2) Organic Components Present - a. methyl silicone

b. aliphatic esters

c. aromatic hydrocarbons

* Analyses conducted by Battelle Laboratories for EPA.

APPENDIX F

TEST LOG

Table F - I presents the actual time during which sampling was conducted.

TABLE F - I

Sampling Log

(Clinker Cooler)

Run	Date	Sampling Port	Began	Ended	Elapsed Time(Min)
1	2-25-71	A	09:15	10:21	66
		B	10:44	11:50	66
2	2-25-71	B	13:15	14:21	66
		A	14:44	15:50	66
3	2-25-71	A	16:15	17:21	66
		B	17:39	18:55	66

(Kiln)

Run	Date	Sampling Port	Began	Ended	Elapsed Time(Min)
1	2-26-71	A	11:35	11:50	15
		B	12:01	12:16	15
		C	12:25	12:40	15
		D	12:55	13:10	15
2	2-26-71	D	13:45	14:00	15
		C	14:10	14:25	15
		B	14:37	14:52	15
		A	15:00	15:15	15
3	2-26-71	A	15:30	15:45	15
		B	15:55	16:10	15
		C	16:20	16:35	15
		D	16:45	17:00	15

APPENDIX C

PROJECT PARTICIPANTS AND TITLES

Name	Title
Howard Crist	Analytical Chemist, ETB
Robert Jacobs	Chemical Engineer, SCB
Dana Ludwig	Technician, ETB
Robert Martin	Technician, ETB
Raymond Mobley	Technician, ETB
Allan Riley	Technician, ETB
Clyde Riley	Technician, ETB
Gene Smith	Chemical Engineer, ETB
Philip York	Chemical Engineer, SCB