GAS PROCESS SURVEY

ROANOKE NO. 5

KILN SYSTEM

1979

Source category: Portland Cement
Plant name : Lone Star Cement, Inc.
Test date : 7/22 - 10/12/79
Process : dry (1,3,4) & wet (5)

Date: 01/15/93
Location: Roanoke, VA
Ref. No.: 14
Basis for process rate : feed/production
Ratio: 1.50 dry
1.59 wet

Source	Type of control	Pollutant	Run No.	Emission rate, lb/hr	Process rate, ton/hr	Emission factor kg/Mg	Emission factor lb/ton	Total PM emission rate, lb/hr	Total catch, mg	Filt/probe catch, mg	Impinger catch, mg
Rotary kiln No. 1	Cooling tower + multiclone + ESP	BASED ON FEED RATE									
		filt. PM	45	8.14	21.0	0.194	0.388	12.9	0.1764	0.1113	0.0651
		filt. PM	46	9.85	21.9	0.225	0.450	14.5	0.1860	0.1263	0.0597
		filt. PM	47	11.08	20.7	0.268	0.535	16.4	0.2056	0.1389	0.0667
		filt. PM	48	14.51	20.7	0.350	0.701	18.4	0.2118	0.1670	0.0448
		filt. PM	49	45.52	21.0	1.08	2.17	48.0	0.4343	0.4119	0.0224
		filt. PM	50	56.43	21.0	1.34	2.69	60.2	0.5880	0.5512	0.0368
					average	0.577	1.155	Rating: B			
		cond. inor. PM	45	4.76	21.0	0.113	0.227	12.9	0.1764	0.1113	0.0651
		cond. inor. PM	46	4.65	21.9	0.106	0.213	14.5	0.1860	0.1263	0.0597
		cond. inor. PM	47	5.32	20.7	0.129	0.257	16.4	0.2056	0.1389	0.0667
		cond. inor. PM	48	3.89	20.7	0.0940	0.188	18.4	0.2118	0.1670	0.0448
		cond. inor. PM	49	2.48	21.0	0.0589	0.118	48.0	0.4343	0.4119	0.0224
		cond. inor. PM	50	3.77	21.0	0.0897	0.179	60.2	0.5880	0.5512	0.0368
					average	0.0985	0.197	Rating: B			
Rotary kiln No. 3	Cooling tower + multiclone + ESP	BASED ON FEED RATE									
		filt. PM	51	18.48	22.1	0.418	0.836	21.4	0.2114	0.1826	0.0288
		filt. PM	52	23.30	22.1	0.527	1.05	28.0	0.2975	0.2476	0.0499
		filt. PM	53	20.19	21.9	0.461	0.922	25.7	0.2837	0.2229	0.0608
		filt. PM	54	18.50	21.9	0.422	0.845	23.0	0.2477	0.1992	0.0485
		filt. PM	55	17.43	20.7	0.421	0.842	22.5	0.2498	0.1935	0.0563
		filt. PM	56	15.24	20.7	0.368	0.736	20.8	0.2440	0.1788	0.0652
					average	0.436	0.873	Rating: B			
		cond. inor. PM	51	2.92	22.1	0.0660	0.132	21.4	0.2114	0.1826	0.0288
		cond. inor. PM	52	4.70	22.1	0.106	0.213	28.0	0.2975	0.2476	0.0499
		cond. inor. PM	53	5.51	21.9	0.126	0.251	25.7	0.2837	0.2229	0.0608
		cond. inor. PM	54	4.50	21.9	0.103	0.206	23.0	0.2477	0.1992	0.0485
		cond. inor. PM	55	5.07	20.7	0.122	0.245	22.5	0.2498	0.1935	0.0563
		cond. inor. PM	56	5.56	20.7	0.134	0.269	20.8	0.2440	0.1788	0.0652
					average	0.110	0.219	Rating: B			
Rotary kiln No. 4	Cooling tower + multiclone + ESP	BASED ON FEED RATE									
		filt. PM	39	22.46	26.0	0.432	0.864	26.9	0.2569	0.2145	0.0424
		filt. PM	40	27.00	26.0	0.519	1.04	30.5	0.2965	0.2625	0.0340
		filt. PM	41	28.91	25.6	0.565	1.13	29.0	0.2456	0.2448	0.0008
		filt. PM	42	24.52	25.6	0.479	0.958	29.6	0.3167	0.2623	0.0544
		filt. PM	43	24.53	32.1	0.382	0.764	26.5	0.2397	0.2219	0.0178
		filt. PM	44	22.20	32.1	0.346	0.692	31.0	0.3794	0.2717	0.1077
					average	0.454	0.908	Rating: B			
		cond. inor. PM	39	4.44	26.0	0.0854	0.171	26.9	0.2569	0.2145	0.0424
		cond. inor. PM	40	3.50	26.0	0.0673	0.135	30.5	0.2965	0.2625	0.0340
		cond. inor. PM	41	0.09	25.6	0.00184	0.00369	29.0	0.2456	0.2448	0.0008
		cond. inor. PM	42	5.08	25.6	0.0993	0.199	29.6	0.3167	0.2623	0.0544
		cond. inor. PM	43	1.97	32.1	0.0307	0.0613	26.5	0.2397	0.2219	0.0178
		cond. inor. PM	44	8.80	32.1	0.137	0.274	31.0	0.3794	0.2717	0.1077
					average	0.0703	0.141	Rating: B			
Rotary kiln No. 5	ESP	BASED ON FEED RATE									
		filt. PM	7	21.38	102.0	0.105	0.210	45.3	0.3025	0.1428	0.1597
		filt. PM	8	4.27	102.0	0.0209	0.0418	17.1	0.2345	0.0585	0.1760
					average	0.0629	0.126	Rating: B			
		cond. inor. PM	7	23.92	102.0	0.117	0.234	45.3	0.3025	0.1428	0.1597
		cond. inor. PM	8	12.83	102.0	0.0629	0.126	17.1	0.2345	0.0585	0.1760
					average	0.0901	0.180	Rating: B			

GAS PROCESS SURVEY

ROANOKE NO. 5

KILN SYSTEM

1979

Interoffice Memo

LONE STAR CEMENT INC.

P. O. Box 27, Cloverdale, Virginia 24077

Originating Office: Roanoke Plant

Date: October 15, 1979

PERSONAL & BUSINESS CONFIDENTIAL

TO: W. J. Cavanaugh

FROM: W. W. Hurst

SUBJECT: Process Gas Survey on Roanoke No. 5 Kiln System

CC: W. L. Greer
C. W. Moore

Gas volumes, particulate emissions and compositions were tested at various process locations in the No. 5 Kiln System on September 16 & 17. Survey included hourly collection of data over periods of 6 & 8 hours covering two consecutive days. Testing was conducted in accordance with EPA Methods for stationary sources.

Objectives were:

1. Measure gas parameters at 5 different locations simultaneously.
2. Determine electrostatic precipitator efficiency based on both the "wet" and "dry" catch.
3. Determine the sulfur content of gases in the "Recoup Duct".

Results showed:

1. Average gas conditions at various locations

Location	ACFM	% H_2O	% CO_2	% O_2	Temp. ^oF
Stack	275,000	10.8	11.1	14.5	291
Pptr. Input	269,000	11.9	14.1	13.0	312
Preheater	174,000	13.0	24.2	7.8	338
By-Pass	181,000	4.0	5.6	17.4	660
Recoup	85,000	0.86	0.17	20.9	392

2. Precipitator efficiency on a "wet catch basis" was 98.8%; whereas, the efficiency on a "dry catch basis" was 99.3%.

3. Sulfur content of gases flowing in the recoup gas duct contained essentially no sulfur at less than 1 ppm.

Respectfully submitted

W. W. Hurst, P.E.

WWH/lbc

Supplement

Objective 4 was to rerun Objective 1. This was done on October 15.

Results Showed:

Location	ACFM	$\%H_2O$	$\% CO_2$	$\% O_2$	Temp. ^oF
Stack	186,000	11.4	10.9	14.7	310
Pptr. Input	259,000	12.0	13.6	12.3	284
Preheater	196,000	15.2	23.9	8.4	350
By-Pass	199,000	4.9	6.2	16.7	658
Recoup	81,000	0.7	0.1	20.85	384

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I. INTRODUCTION

During the course of stack particulate emission testing at Roanoke, Mr. Cavanaugh requested that we divert from planned program and conduct some special tests. These special tests were conceived to produce process data that would assist Bill in his continued effort to optomize the new No. 5 Kiln System.

We were requested to conduct tests in three catagories: 1. Gas volumes and associated parameters that existed in 5 locations throughout the kiln system at the present level and conditions of operation. 2. Perform efficient tests at a time when the Kopper Representative was available for optomizing the precipitator operation. 3. Determine sulfur concentration of the recoup duct gases for design consideration during a proposed modification of the duct.

The purpose of this report is to present test data and evaluate the accuracy of the results. It is not our purpose to evaluate the results as they might effect the kiln system level of uniformity of operation.

The gas volumes and associated parameters determined at the 5 testing locations were observed simultaneously on an hourly basis over a period of two days covering 14 cycles of data. Precipitator efficiency data consisted of 6 runs, in sets of 2 runs conducted simultaneously at the precipitator input and output. Each set of runs on the precipitator was conducted on different days. Sulfur determinations were made on measured volumes of gas drawn from the recoup duct over four test periods of approximately 4 hours each.

The report is divided into four major sections: 1. Test equipment and procedures are described, 2. Test results are discussed including possible process implication in the future, 3. Conclusions are stated, 4. Recomendations are offered.

Supplement

Preliminary review of test results in Category 1, mentioned above, indicated gas measurements at the various locations might not reflect the equipment operation sought. Accordingly, equipment adjustments were made to the pelletizing system by the equipment manufacturer's representative and tests were repeated.

II. TEST EQUIPMENT AND TESTING PROCEDURE

"S" type pitot tubes meeting EPA specifications for certification were used to measure velocity of duct gases along with conventional inclined manometers. All measurements were made in accordance with EPA Methods 1 & 2, Standards of Performance for New Stationary Sources.

Moisture levels of the various gas streams were determined by drawing a gas sample at about ½ CFM continuously at the various testing stations over a period of 4-5 hrs. centered near the middle of the overall test period each day. Moisture in the gases was condensed in impingers mounted in an ice bath. All techniques were in accordance with good practice as outlined by EPA Method 4.

Integrated samples of gas at the various locations were sampled for gas composition analysis near the beginning and ending of each daily test. These gas samples were analyzed with the conventional "Orsat Equipment" for gas composition. Results were averaged to represent a daily average. Composition analysis of the various gas streams was performed as prescribed in EPA Method 3.

Temperature levels of the gases were measured with thermocouples working into digital indicators which were sensitive to ± 1% of readings. Indicators were calibrated with a potentiometer accurate to ± ½%. All temperature data met or exceeded EPA standards for this type of work.

IV. CONCLUSIONS

1. Simultaneous testing at various points in a kiln system has no substitute insofar as reflecting the true process inter-related conditions at any given period in time.

2. Conditions of gas volume, temperature, composition and moisture at the various testing locations were consistent with one another and with respect to a mass and energy balance.

3. Precipitator efficiency was significantly lowered due to the influence of the "ammonium compound" syndrome which according to EPA and/or VACB constitutes a particulate.

4. Precipitator efficiency was short of stated 99.8% level stipulated in the performance guarantee.

5. Corrosion cannot logically deteriorate the recoup duct as a result of airborne sulfuric acid and/or sulfur compounds.

Supplement

1. Rerun results developed while simultaneously measuring gas parameters at 5 test locations seemed compatible with previous work in this testing category.

2. Though equipment adjustment might have altered and/or improved the No. 5 Kiln System operation, it did not materially change gas volumes, temperatures, moisture or composition.

TABLE I

ROANOKE PROCESS GAS SURVEY

NO. 5 KILN STACK GAS EMISSION

1979

AREA OF STACK = 78.5 SQ. FT.

PITOT TUBE COEF. = 0.83

Sept. 16

Moisture = 11.3%
Gas Mol. Wt. = 28.94
Baro. Press. = 29.01" Hg.
Duct Static Press. = -0.71" H_2O
Duct Press. ABS. = 28.96" Hg.
CO_2 = 10.9%
O_2 = 14.7%
N_2 = 74.4%

Sept. 17

Moisture = 10.3%
Gas Mol. Wt. = 29.11
Baro. Press. = 29.04" Hg.
Duct Static Press. = -0.52" H_2O
Duct Press. ABS. = 29.00" Hg.
CO_2 = 11.3%
O_2 = 14.4%
N_2 = 74.3%

Time Day	Trav. $\sqrt{\Delta p}$. " H_2O	Duct Temp ^oR	Gas Vel. Ft/Sec	ACFM$_5$ x 10^5	Time Day	Trav. p. " H_2O	Duct Temp ^oR	Gas Vel. Ft/Sec	ACFM$_5$ x 10^5
8.45	0.88	750	59.1	2.78	8:00	0.95	770	64.4	3.03
9:45	0.86	757	58.0	2.73	9:00	0.88	762	59.3	2.79
10:45	0.87	744	58.2	2.74	10:00	0.86	759	57.9	2.72
11:45	0.86	739	57.3	2.70	11:00	0.89	759	59.9	2.82
12:45	0.86	737	57.2	2.70	12:00	0.86	752	57.6	2.71
13:45	0.87	742	58.1	2.74	13:00	0.87	750	58.2	2.74
					14:00	0.86	752	57.6	2.71
					15:00	0.83	743	55.2	2.60
Ave/Day	0.87	745	58.0	2.73	Ave/Day	0.88	756	68.7	2.77

TABLE I - CONT.

ROANOKE PROCESS GAS SURVEY

NO. 5 KILN STACK GAS EMISSION

1979

AREA OF STACK = 78.5 SQ. FT.

PITOT TUBE COEF. = 0.83

10/15/79

Moisture = 11.4%
Gas Mol. Wt. = 28.93
Baro. Press. = 28.89" Hg
Duct. Static Press. = -0.44" H_2O
Duct. Press. Abs. = 28.86
CO_2 = 10.9%
O_2 = 14.7%
N_2 = 74.4%

	Time Day	Traverse $\sqrt{\Delta P}$ ("H_2O)	Duct Temp (^oR)	Gas Vel. (ft/sec)	ACFM ($X10^5$)
	7:40	0.58	769	39.50	1.86
	8:40	0.59	771	40.22	1.89
	9:35	0.58	772	39.57	1.86
	10:35	0.58	766	39.42	1.86
	11:35	0.57	769	38.82	1.83
	12:35	0.59	763	40.02	1.88
	12:35	0.57	769	38.82	1.83
	14.35	0.58	778	39.73	1.87
Ave/Day		0.58	770	39.51	1.86

TABLE II

ROANOKE PROCESS GAS SURVEY

NO. 5 KILN PRECIPITATOR INPUT GASES

1979

AREA OF DUCT = 55.0 SQ. FT.

PITOT TUBE COEF. = 0.83

Sept. 16

Moisture = 11.9%
Gas Mol. Wt. = 29.19
Baro. Press. = 29.01" Hg.
Duct Static Press. = -6.1" H_2O
Duct Press. ABS. = 28.56" Hg.
CO_2 = 13.6%
O_2 = 13.1%
N_2 = 73.3%

Sept. 17

Moisture = 11.9%
Gas Mol. Wt. = 29.30
Baro. Press. = 29.04" Hg.
Duct Static Press. = -5.7" H_2O
Duct Press. ABS. = 28.62" Hg.
CO_2 = 14.5%
O_2 = 12.8%
N_2 = 72.7%

Time Day	Trav. $\sqrt{\Delta p}$. " H_2O	Duct Temp ^oR	Gas Vel. Ft/Sec	ACFM$_5$ x 10^5	Time Day	Trav. $\sqrt{\Delta p}$. " H_2O	Duct Temp ^oR	Gas Vel. Ft/Sec	ACFM$_5$ x 10^5
8:45	1.11	759	75.1	2.48	8:00	1.33	769	90.4	2.98
9:45	1.14	771	77.8	2.57	9:00	1.24	786	85.2	2.81
10:45	1.10	757	74.4	2.45	10:00	1.22	788	83.9	2.77
11:45	1.13	761	76.6	2.53	11:00	1.20	787	82.5	2.72
12:45	1.22	744	81.8	2.70	12:00	1.25	790	86.1	2.84
13:45	1.15	760	77.9	2.57	13:00	1.23	802	86.7	2.86
					14:00	1.24	785	85.1	2.81
					15:00	1.23	766	83.4	2.75
Ave/Day	1.14	759	77.3	2.55	Ave/Day	1.24	784	85.4	2.82

TABLE II CONT.

ROANOKE PROCESS GAS SURVEY

NO. 5 KILN PRECIPITATOR INPUT GASES

1979

AREA OF DUCT = 55.0 SQ. FT.

PITOT TUBE COEF. = 0.83

10/15/79

Moisture = 12.0%
Gas Mol. Wt. = 29.15
Baro. Press. = 28.89" Hg
Duct Static Press = -7.53" H_2O
Duct Press. Abs = 28.34" Hg
CO_2 = 13.6%
O_2 = 12.3%
N_2 = 74.1%

	Time Day	Traverse $\sqrt{\Delta P}$ ("H_2O)	Duct Temp (^oR)	Gas Vel. (ft/sec)	ACFM ($X10^5$)
	8:15	1.154	763	78.69	2.60
	9:00	1.194	769	81.74	2.70
	9:43	1.163	749	78.58	2.59
	10:34	1.194	739	80.13	2.64
	11:34	1.183	737	79.28	2.62
	12:38	1.160	726	77.16	2.55
	13:34	1.124	736	75.28	2.48
	14:37	1.151	736	77.09	2.54
Ave/Day		1.165	744	78.49	2.59

TABLE III

ROANOKE PROCESS GAS SURVEY

NO. 5 KILN PREHEATER EXIT GASES

1979

AREA OF DUCT = 33.06 SQ. FT.

PITOT TUBE COEF. = 0.83

Sept. 16

Moisture = 14.1%
Gas Mol. Wt. = 30.19
Baro. Press. = 29.01" Hg.
Duct Static Press. = -7.6" H_2O
Duct Press. ABS. = 28.45" Hg.
CO_2 = 24.3%
O_2 = 7.7%
N_2 = 68.0%

Sept. 17

Moisture = 11.9%
Gas Mol. Wt. = 30.49
Baro. Press. = 29.04" Hg.
Duct Static Press. = -5.8" H_2O
Duct Press. ABS. = 28.61" Hg.
CO_2 = 24.1%
O_2 = 7.9%
N_2 = 68.0%

Time Day	Trav. $\sqrt{\Delta p}$ " H_2O	Duct Temp ^oR	Gas Vel. Ft/Sec	ACFM$_5$ x 10^5	Time Day	Trav. $\sqrt{\Delta p}$ " H_2O	Duct Temp ^oR	Gas Vel. Ft/Sec	ACFM$_5$ x 10^5
8:45	1.35	789	91.8	1.82	8:00	1.17	825	80.7	1.60
9:45	1.34	790	91.2	1.81	9:00	1.33	819	91.4	1.81
10:45	1.21	790	82.3	1.63	10:00	1.32	817	90.6	1.80
11:45	1.13	780	76.4	1.52	11:00	1.34	816	91.9	1.82
12:45	1.32	794	90.0	1.79	12:00	1.43	788	96.4	1.91
13:45	1.27	799	86.9	1.72	13:00	1.30	793	87.9	1.74
					14:00	1.29	798	87.5	1.74
					15:00	1.27	783	85.4	1.69
Ave/Day	1.27	790	88.4	1.72	Ave/Day	1.31	805	89.0	1.76

TABLE III - CONT.

ROANOKE PROCESS GAS SURVEY

NO. 5 KILN PREHEATER EXIT GASES

1979

AREA OF DUCT = 33.06 SQ. FT.

PITOT TUBE COEF. = 0.83

10/15/79

Moisture = 15.2%
Gas Mol. Wt. = 33.01
Baro. Press. = 28.89" Hg
Duct Static Press. = -7.57" H_2O
Duct Press. Abs = 28.33" Hg
CO_2 = 23.9%
O_2 = 8.4%
N_2 = 67.7%

Time Day	Traverse $\sqrt{\Delta P}$ ("H_2O)	Duct Temp (^oR)	Gas Vel. (ft/sec)	ACFM ($X10^5$)
7:50	1.434	830	100.52	1.99
8:30	1.262	817	87.77	1.74
9:31	1.464	823	102.19	2.03
10:29	1.400	801	96.41	1.91
11:27	1.481	806	102.31	2.03
12:30	1.451	790	99.23	1.97
13:27	1.483	801	102.13	2.03
14:29	1.455	815	101.07	2.00
Ave/Day	1.429	810	98.95	1.96

TABLE IV

ROANOKE PROCESS GAS SURVEY

NO. 5 KILN BYPASS GASES

1979

AREA OF DUCT = 40.11 SQ. FT.

PITOT TUBE COEF. = 0.83

Sept. 16

Moisture = 4.5%
Gas Mol. Wt. = 29.29
Baro. Press. = 29.01" Hg.
Duct Static Press. = -4.67" H_2O
Duct Press. ABS. = 28.67" Hg.
CO_2 = 6.0%
O_2 = 17.1%
N_2 = 76.9%

Sept. 17

Moisture = 3.5%
Gas Mol. Wt. = 29.19
Baro. Press. = 29.04" Hg.
Duct Static Press. = -4.66" H_2O
Duct Press. ABS. = 28.70" Hg.
CO_2 = 5.2%
O_2 = 17.7%
N_2 = 77.1%

Time Day	Trav. $\sqrt{\Delta}$ p. " H_2O	Duct Temp ^oR	Gas Vel. Ft/Sec	ACFM x 10^5	Time Day	Trav. p. " H_2O	Duct Temp ^oR	Gas Vel. Ft/Sec	ACFM x 10^5
8:45	0.86	1110	69.9	1.69	8:00	0.94	1125	76.9	1.85
9:45	0.96	1110	77.9	1.87	9:00	0.95	1102	77.3	1.86
10:45	0.93	1100	75.8	1.82	10:00	0.95	1118	78.0	1.88
11:45	0.88	1150	73.4	1.77	11:00	0.93	1128	76.7	1.85
12:45	0.87	1110	70.6	1.70	12:00	0.91	1134	75.3	1.81
13:45	0.93	1105	75.9	1.83	13:00	0.91	1128	74.6	1.79
					14:00	0.91	1141	75.6	1.82
					15:00	0.94	1115	76.8	1.85
Ave/Day	0.91	1116	73.9	1.78	Ave/Day	0.93	1124	76.5	1.84

TABLE IV - CONT.

ROANOKE PROCESS GAS SURVEY

NO. 5 KILN BYPASS GASES

1979

AREA OF DUCT = 40.11 SQ. FT.

PITOT TUBE COEF. = 0.83

10/15/79

Moisture = 4.9%
Gas Mol. Wt. = 29.09
Baro. Press. = 28.89" Hg
Duct Static Press. = -4.98" H_2O
Duct Press. Abs = 28.52" Hg
CO_2 = 6.2%
O_2 =16.7%
N_2 =77.1%

	Time Day	Traverse $\sqrt{\Delta P}$ ("H_2O)	Duct Temp (^oR)	Gas Vel. (ft/sec)	ACFM ($X10^5$)
	7:30	1.018	1103	83.27	2.00
	8:30	1.005	1116	82.69	1.99
	9:30	1.005	1107	82.36	1.98
	10:30	1.011	1100	82.59	1.99
	11:30	0.995	1142	82.81	1.99
	12:30	0.999	1088	81.16	1.95
	13:30	1.001	1144	83.39	2.01
	14:30	1.001	1145	83.43	2.01
Ave/Day		1.004	1118	82.71	1.99

TABLE V

ROANOKE PROCESS GAS SURVEY

NO. 5 KILN CLINKER COOLER RECOUP GASES

1979

AREA OF DUCT = 25.22 SQ. FT.

PITOT TUBE COEF. = 0.83

Sept. 16

Moisture = 0.72%
Gas Mol. Wt. = 28.80
Baro. Press. = 29.01" Hg.
Duct Static Press. = 0.18" H_2O
Duct Press. ABS. = 29.02" Hg.
CO_2 = 0.25%
O_2 = 20.95%
N_2 = 78.8%

Sept. 17

Moisture = 1.0%
Gas Mol. Wt. = 28.74
Baro. Press. = 29.04" Hg.
Duct Static Press. = 0.16" H_2O
Duct Press. ABS. = 29.05" Hg.
CO_2 = 0.1%
O_2 = 20.9%
N_2 = 79.0%

Time Day	Trav. $\sqrt{\Delta p}$. " H_2O	Duct Temp ^oR	Gas Vel. Ft/Sec	ACFM$_5$ x 10^5	Time Day	Trav. p. " H_2O	Duct Temp ^oR	Gas Vel. Ft/Sec	ACFM$_5$ x 10^5
8:45	0.79	834	56.0	0.85	8:00	0.78	823	54.9	0.83
9:45	0.77	870	55.7	0.84	9:00	0.77	767	52.4	0.79
10:45	0.76	877	55.2	0.84	10:00	0.78	827	55.1	0.83
11:45	0.74	976	56.7	0.86	11:00	0.78	814	54.6	0.83
12:45	0.79	826	55.7	0.84	12:00	0.78	862	56.2	0.85
13.45	0.79	860	56.9	0.86	13:00	0.80	805	55.7	0.84
					14:00	0.76	887	55.6	0.84
					15:00	0.78	848	55.8	0.84
Ave/Day	0.77	874	56.0	0.85	Ave/Day	0.78	829	55.0	0.84

TABLE V - CONT.

ROANOKE PROCESS GAS SURVEY

NO. 5 KILN CLINKER COOLER RECOUP GASES

1979

AREA OF DUCT = 25.22 SQ. FT.

PITOT TUBE COEF. = 0.83

10/15/79

Moisture = 0.76%
Gas Mol. Wt. = 28.73
Baro. Press. = 28.89" Hg
Duct Static Press. = 0.41" H_2O
Duct Press. Abs = 28.92" Hg
CO_2 = 0.1%
O_2 = 20.85%
N_2 = 79.05%

Time Day	Traverse $\sqrt{\Delta P}$ ("H2O)	Duct Temp (^oR)	Gas Vel. (ft/sec)	ACFM ($X10^5$)
8:00	0.78	833	55.41	0.84
8:30	0.74	866	54.33	0.82
9:30	0.75	840	53.50	0.81
10:25	0.75	818	52.80	0.80
11:25	0.73	868	52.94	0.80
12:25	0.77	803	53.71	0.81
13:25	0.74	855	53.26	0.81
14:25	0.74	872	53.79	0.81
Ave/Day	0.75	844	53.72	0.81

TABLE VI

ROANOKE PROCESS GAS SURVEY

NO. 5 KILN SYSTEM - GAS FLOW RATE, DAILY AVERAGES

1979

Testing Date - Sept. 16
6 Hr. Average

Location	Temp. °F.	ACFM	% Moisture	% CO_2
Stack Gases	285	273,000	11.3	10.9
Precipitator Input Gases	299	255,000	11.9	13.6
Pre-Heater Exit Gases	330	172,000	14.1	24.3
Kiln By-Pass Gases	656	179,000	4.5 * (Est.)	6.0
Clinker Cooler Recoup Gases	414	85,000	0.7	0.3

Testing Date - Sept. 17
8 Hr. Average

Location	Temp. °F.	ACFM	% Moisture	% CO_2
Stack Gases	296	287,000	10.3	11.3
Precipitator Input Gases	324	282,000	11.9	14.5
Pre-Heater Exit Gases	345	176,000	11.9	24.1
Kiln By-Pass Gases	664	184,000	3.6 * (Est.)	5.2
Clinker Cooler Recoup Gases	369	83,000	1.0	0.1

* Value based on CO_2 balance and moisture level indicated for recoup and preheater gases.

Testing Date - Oct. 15
8 Hr. Average

Location	Temp. °F.	ACFM	% Moisture	% CO_2
Stack	310	186,000	11.4	10.9
Precipitator Input Gases	284	259,000	12.0	13.6
Pre-Heater Exit Gases	350	196,000	15.2	23.9
Kiln By-Pass Gases	658	199,000	4.9 * (Est.)	6.2
Clinker Cooler Recoup Gases	384	81,000	0.7	0.1

TABLE VII

ROANOKE EMISSION SURVEY

PARTICULATE AND PRECIPITATOR EFFICIENCY

1979

Runs	Date	Location	Particulate Emissions		% Efficiency	
			Wet*	Dry*	Wet	Dry
9	8/4	Pptr. Input	4910	4830	98.7	99.2
10		Stack	65.0	37.6		
11	8/5	Pptr. Input	6630	6340	98.6	99.2
12		Stack	89.7	53.5		
13	8/6	Pptr. Input	7670	7530	99.0	99.5
14		Stack	76.9	38.5		
Average			77.2	43.2	98.8	99.3

* Emission "Wet" weight includes impinger catch
  Emission "Dry" weight excludes impinger catch

TABLE VIII

ROANOKE EMISSION SURVEY

NO. 5 KILN SYSTEM - 1979

A. EXHAUST GAS CHARACTERISTICS

Run No.	Pitot Tube Factor	Temp. ^{o}R	% H_2O In Gas	Gas Density	Stack Gas Press. "Hg.	Static Gas Press. "H_2O
9	0.83	846	13.2	28.84	28.38	-6.0
10	"	789	12.1	28.75	28.87	+0.72
11	"	847	9.8	29.12	28.41	-6.0
12	"	777	12.2	28.82	28.91	+0.74
13	"	849	11.9	29.05	28.38	-6.0
14	"	799	12.7	28.76	28.87	+0.65

B. EXHAUST GAS FLOW

Run No.	Temp. ^{o}F	Duct Area Sq. Ft.	$\sqrt{\Delta P}$ "H_2O	Velocity Ft./Sec	Volume ACFM	CFH St. Cond, Dry x 10^6
9	386	55.0	1.29	93.05	307,000	9.49
10	329	78.5	0.88	61.40	289,000	9.71
11	387	55.0	1.28	91.89	303,000	9.74
12	317	78.5	0.89	60.98	287,000	9.96
13	389	55.0	1.28	92.16	304,000	9.51
14	339	78.5	0.91	62.67	295,000	10.10

C. GAS SAMPLING AND TESTING PARAMETERS

Run No.	% Iso-Kinetic	Nozzle Size Sq. Ft.	Test Duration Min.	Meter Temp. ^{o}R	Meter Volume .Ft.	Meter Volume Std.Cond. Cu.Ft.	Meter Press. "Hg.	Meter Press. "ΔH" "H_2O
9	101.3	0.000085	140	541	36.67	34.62	28.84	0.23
10	96.7	0.000289	144	541	87.30	82.62	28.91	1.22
11	98.1	0.000085	140	541	36.43	34.44	28.88	0.23
12	94.3	0.000287	144	541	88.00	82.62	28.95	1.26
13	100.5	0.000085	140	543	36.27	34.09	28.83	0.19
14	87.7	0.000287	144	543	83.92	79.16	28.92	1.31

TABLE VIII - CONT'D

ROANOKE EMISSION SURVEY

NO. 5 KILN SYSTEM - 1979

D. GAS ANALYSIS AND METIOROLOGICAL CONDITIONS

Run No.	Date	Gas Analysis $\%CO_2$	$\%O_2$	$\%N_2$	Rel. Humidity %	Ambient Temp. ^oF	Baro. Press. "Hg
9	8/4	12.2	13.6	74.2	76	68	28.82
10	8/4	10.2	15.0	74.8	76	68	28.82
11	8/5	11.0	14.2	74.6	81	70	28.86
12	8/5	10.8	15.0	74.2	81	70	28.86
13	8/6	12.5	13.5	74.0	60	77	28.82
14	8/6	10.8	15.0	74.2	60	77	28.82

TABLE IX

HOUSTON EMISSION STUDY

SULFURIC ACID & SULFUR TRIOXIDE EMISSION - EPA METHOD 8

1979

(A) Normality of Std. H_2SO_4 - 0.010
(B) Mls. Std. H_2SO_4 used - 20.00
(C) Mls. Barium Perchlorate Soln. Req'd. - 20.30
(D) Normality of Ba (CLO_4) $3H_2O$ Soln. - 0.0095

(D) = (A) (B)/(C)

Sample No.	Location of Test	(E) Tot. Vol. Alcohol / SO_2 Mls.	(F) Aliquot titrated Mls.	(G) Quantity Factor (E)/(F)	(H) Vol. Gas Sampled @ Std.Cond. Dry - Cu.Ft.	(I) Vol. Ba(CLO_2) Soln. titrant Mls.
27	Recoup	223	50	4.46	60.90	0.1
28	Gas	215	50	4.30	77.84	0.1
29	Duct	216	50	4.32	58.64	0.1
30	-	219	50	4.38	86.1	0.15

Sample No.	(J) Blank Corr. -Mls.	(K) Net Titrant Mls. (I-J)	(L) Run Const, $(1.08X10^{-4})$ (D)=(L) X 10^{-6}	(M) Conc.H_2SO_4 Lbs/Std.C.F. Dry $\frac{(L)\ (K)\ (G)}{(H)} \times 10^{-6}$	(N) Conc. as Sulfur Lbs/Std. C.F.Dry $(.327)(M) \times 10^{-6}$	H_2SO_4 Lbs/Hr. Std.Cond. Dry (M)(CFH)
27	0.1	0	1.03	-	-	-
28	0.1	0	1.03	-	-	-
29	0.1	0	1.03	-	-	-
30	0.1	0	1.03	-	-	-

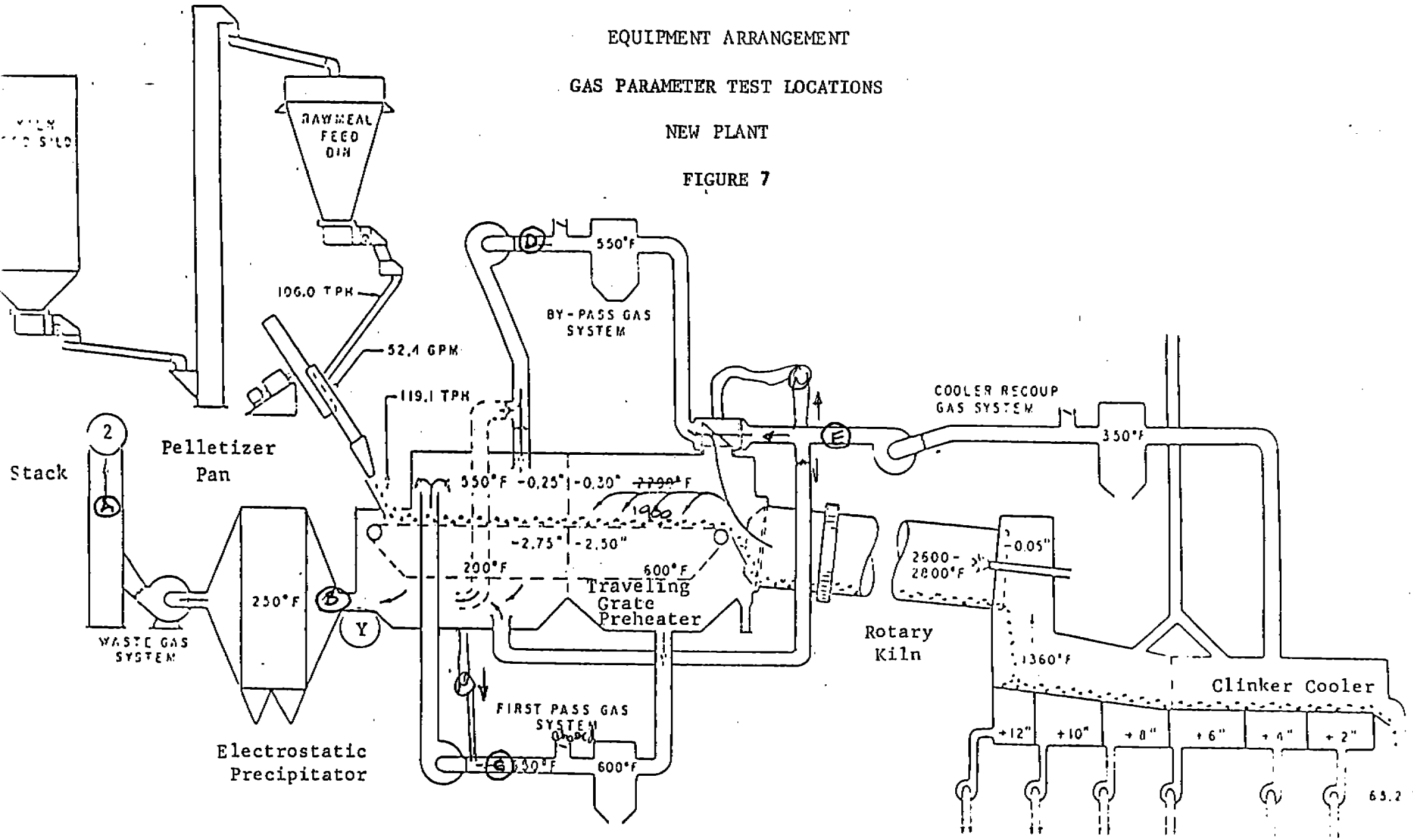
ROANOKE PLANT

EQUIPMENT ARRANGEMENT

GAS PARAMETER TEST LOCATIONS

NEW PLANT

FIGURE 7



KEY

A - Stack
B - Precipitator Input
C - Preheater
D - By-Pass
E - Recoup

TABLE IX

HOUSTON EMISSION STUDY

SULFUR DIOXIDE EMISSION - EPA METHOD 8

1979

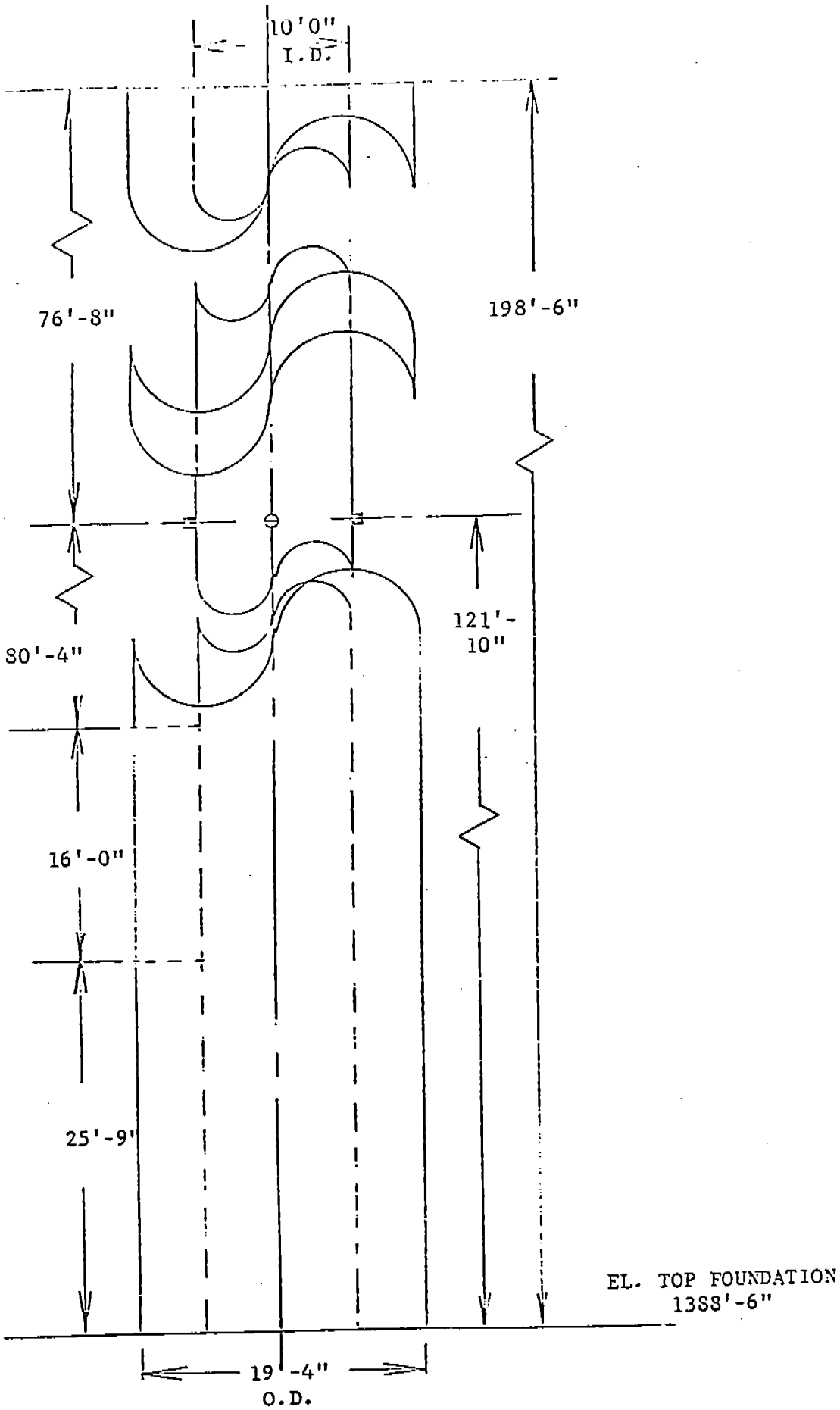
(A) Normality of Std. H_2SO_4 - 0.010
(B) Mls. Std. H_2SO_4 used - 20.00
(C) Mls. Barium Perchlorate Soln. Req'd. - 20.30
(D) Normality of $Ba(CLO_4)$ $3H_2O$ Soln. - 0.0095

$$(D) = (A)\ (B)/(C)$$

Sample No.	Location of Test	(E) Tot. Vol. Peroxide/ SO_2 Mls.	(F) Aliquot titrated Mls.	(G) Quantity Factor (E)/(F)	(H) Vol. Gas Sampled @ Std. Cond. Dry - Cu.Ft.	(I) Vol. $Ba(CLO_2)$ Soln. titrant Mls.
27	Recoup	700	5.0	140	60.90	0.3
28	Gas	670	5.0	134	77.84	0.2
29	Duct	650	5.0	130	58.64	0.2
30		670	5.0	134	86.1	0.15

Sample No.	(J) Blank Corr. -Mls.	(K) Net Titrant Mls. (I-J)	(L) Run Constant $(7.05X10^{-5})$ (D) $X10^{-7}$	(M) Conc.SO2 Lbs/Std. C.F. Dry $\frac{(L)(K)(G)}{(H)} X\ 10^{-7}$	(N) Conc. as Sulfur Lbs/Std. C.F. Dry $(0.5)(M) X\ 10^{-7}$	SO_2 Lbs/Hr. Std.Cond. Dry (M)(CFH)
27	0.1	0.2	6.7	3.08	1.54	0.77
28	0.1	0.1	6.7	1.54	0.77	0.46
29	0.1	0.1	6.7	1.54	0.77	0.40
30	0.1	0.05	6.7	0.77	0.39	0.24

FIGURE 1
KILN STACK EMISSION SAMPLING



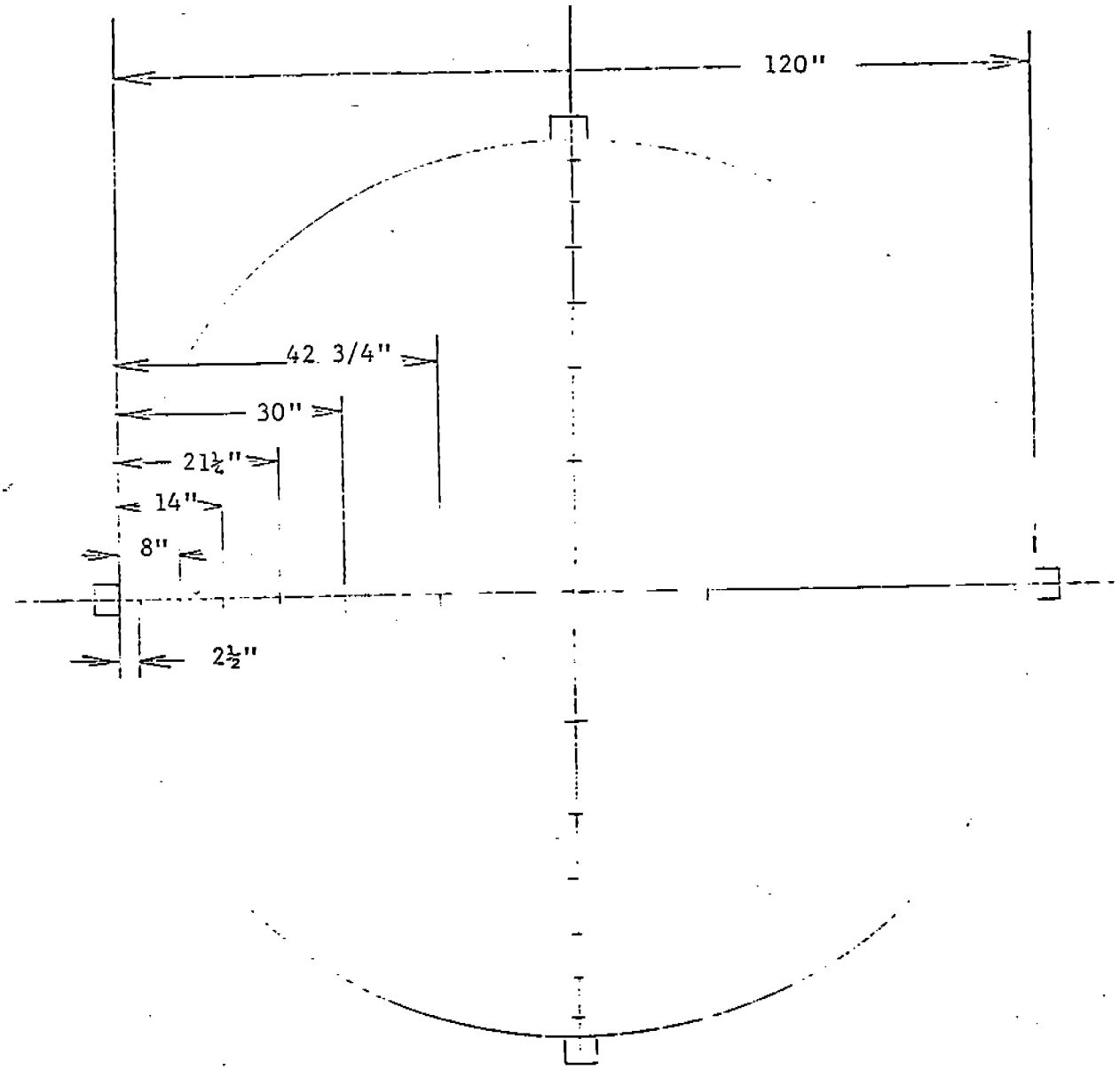
ROANOKE DUST SURVEY

KILN STACK

VELOCITY & PARTICULATE

SAMPLING TRAVERSE

FIGURE 2

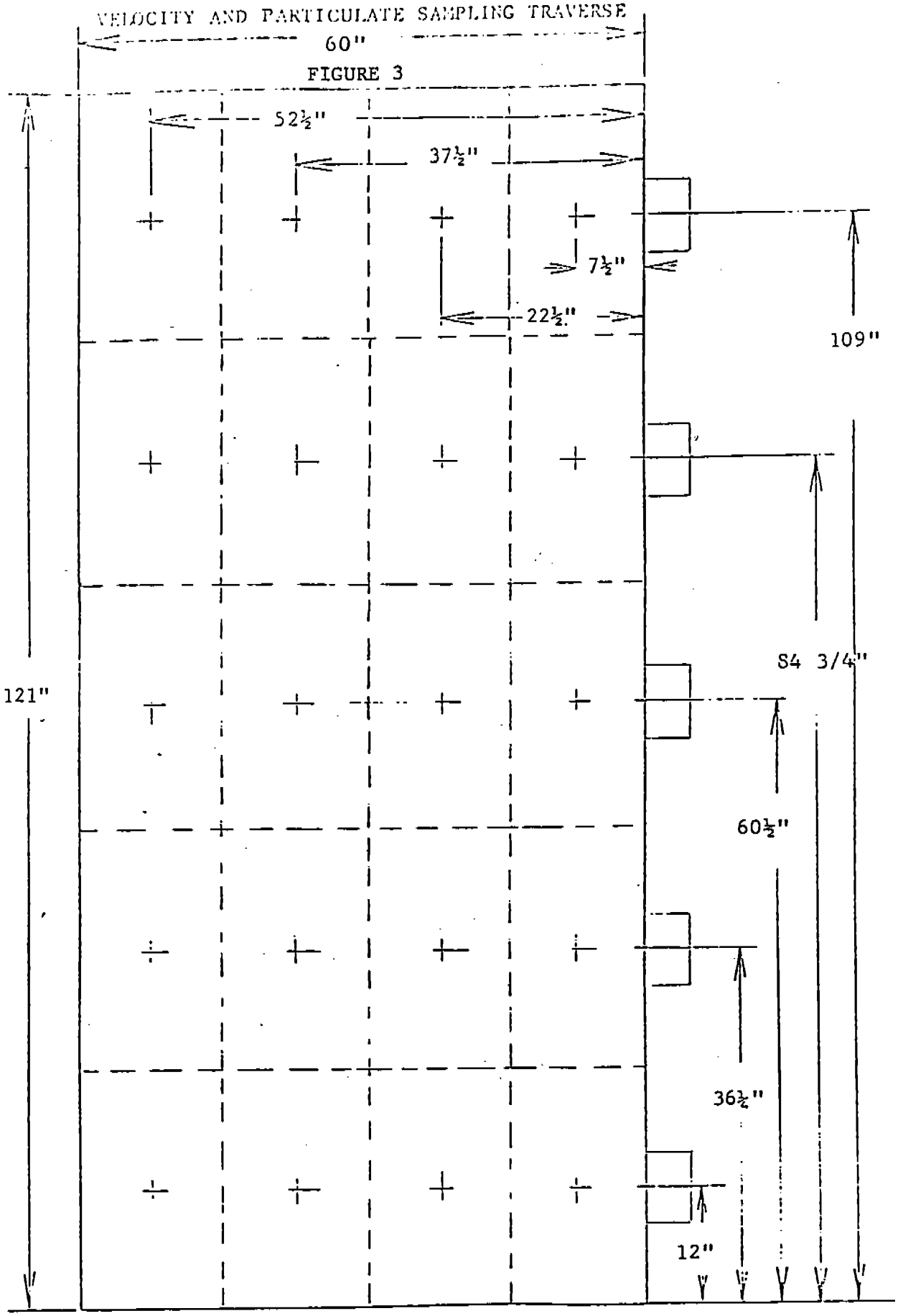


PLAN VIEW

CROSS SECTIONAL AREA = 78.5 SQ. FT.

NO. 5 PRECIPITATOR INPUT DUCT
VELOCITY AND PARTICULATE SAMPLING TRAVERSE

FIGURE 3



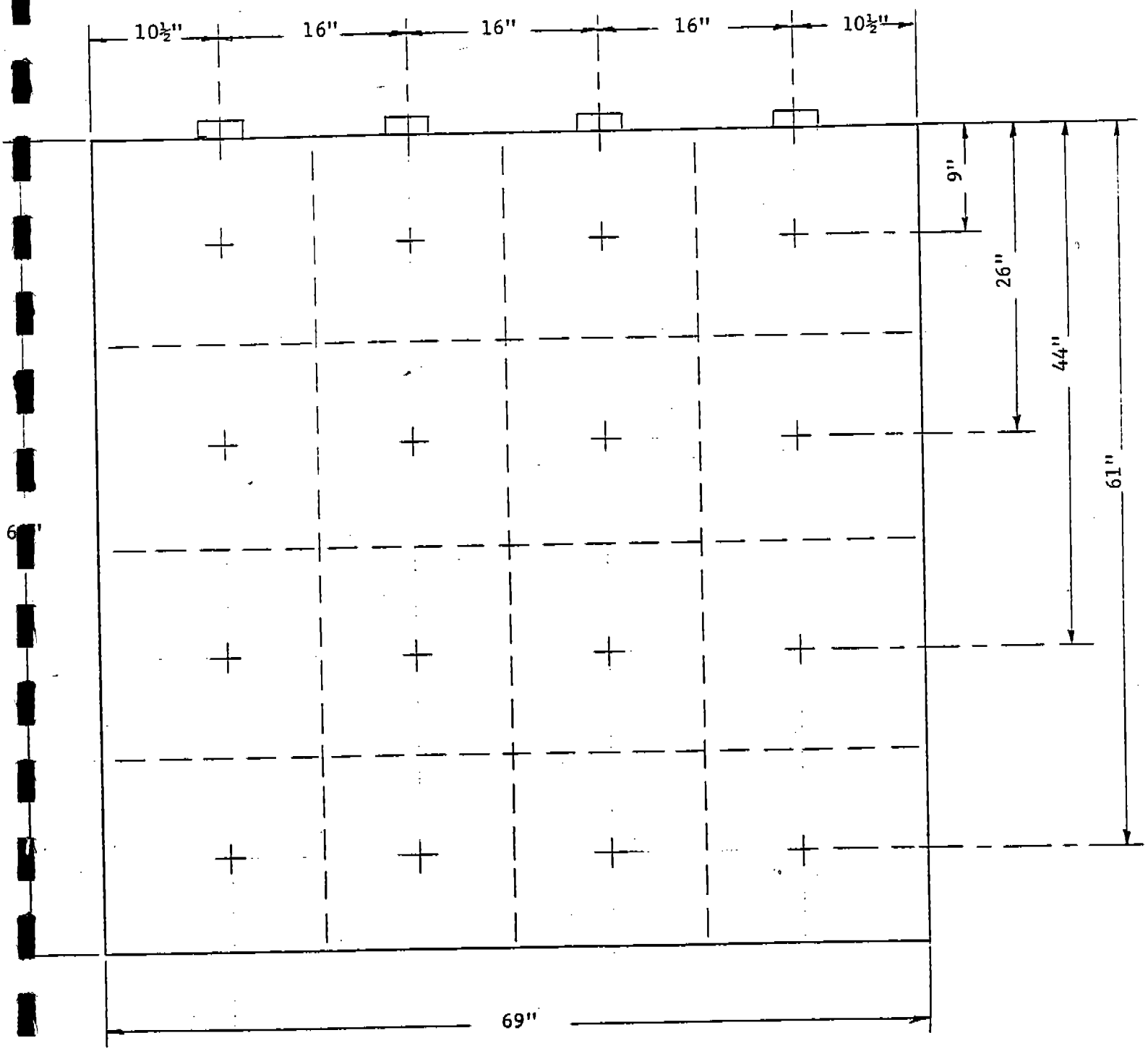
CROSS SECTIONAL AREA = 55.0 SQ. FT.

ROANOKE EMISSIONS SURVEY

NO. 5 PREHEATER GAS DUCT

VELOCITY SAMPLING TRAVERSE

FIGURE 4



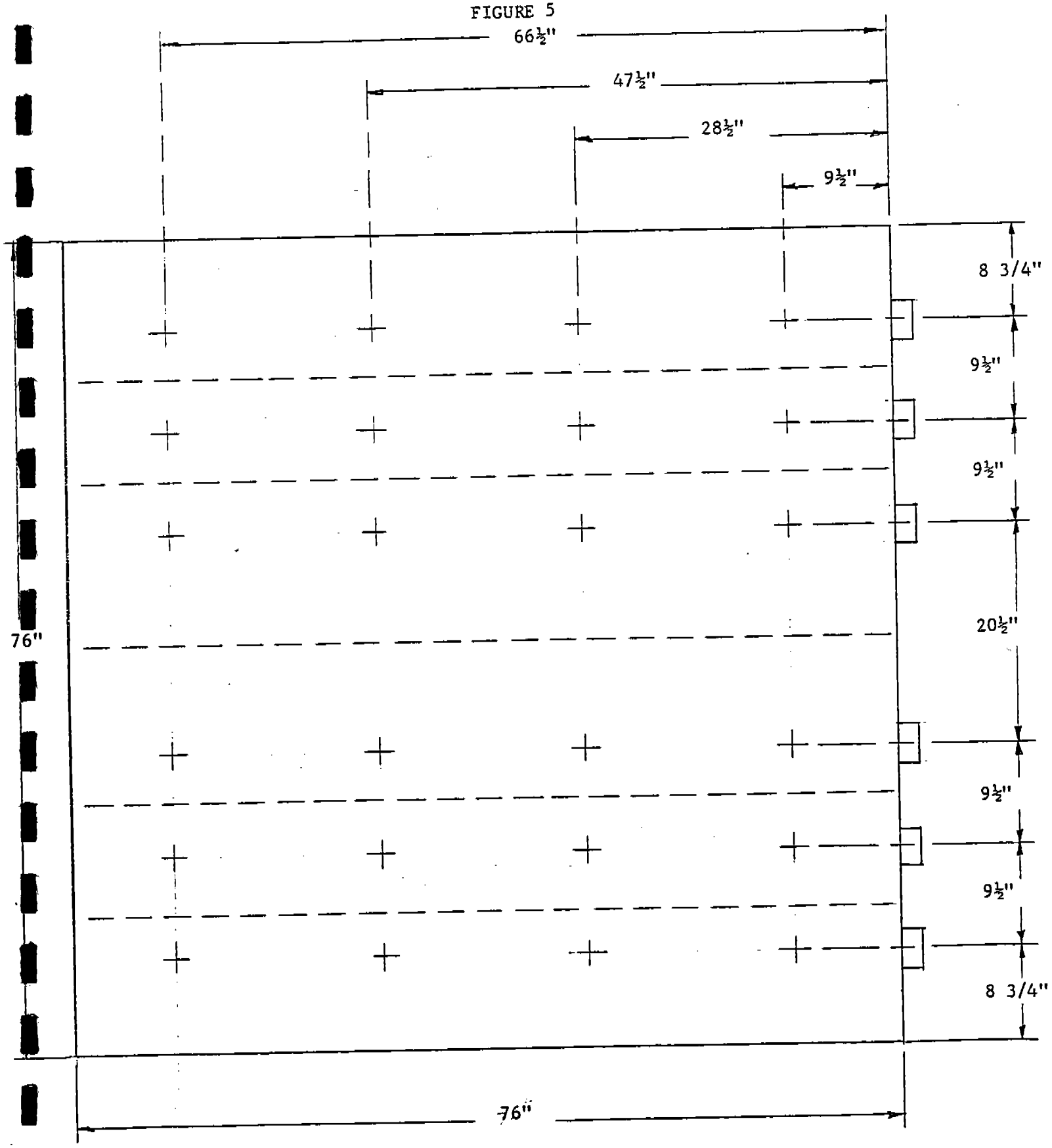
CROSS SECTIONAL AREA = 33.06

ROANOKE EMISSIONS SURVEY

NO. 5 BY-PASS GAS DUCT

VELOCITY SAMPLING TRAVERSE

FIGURE 5



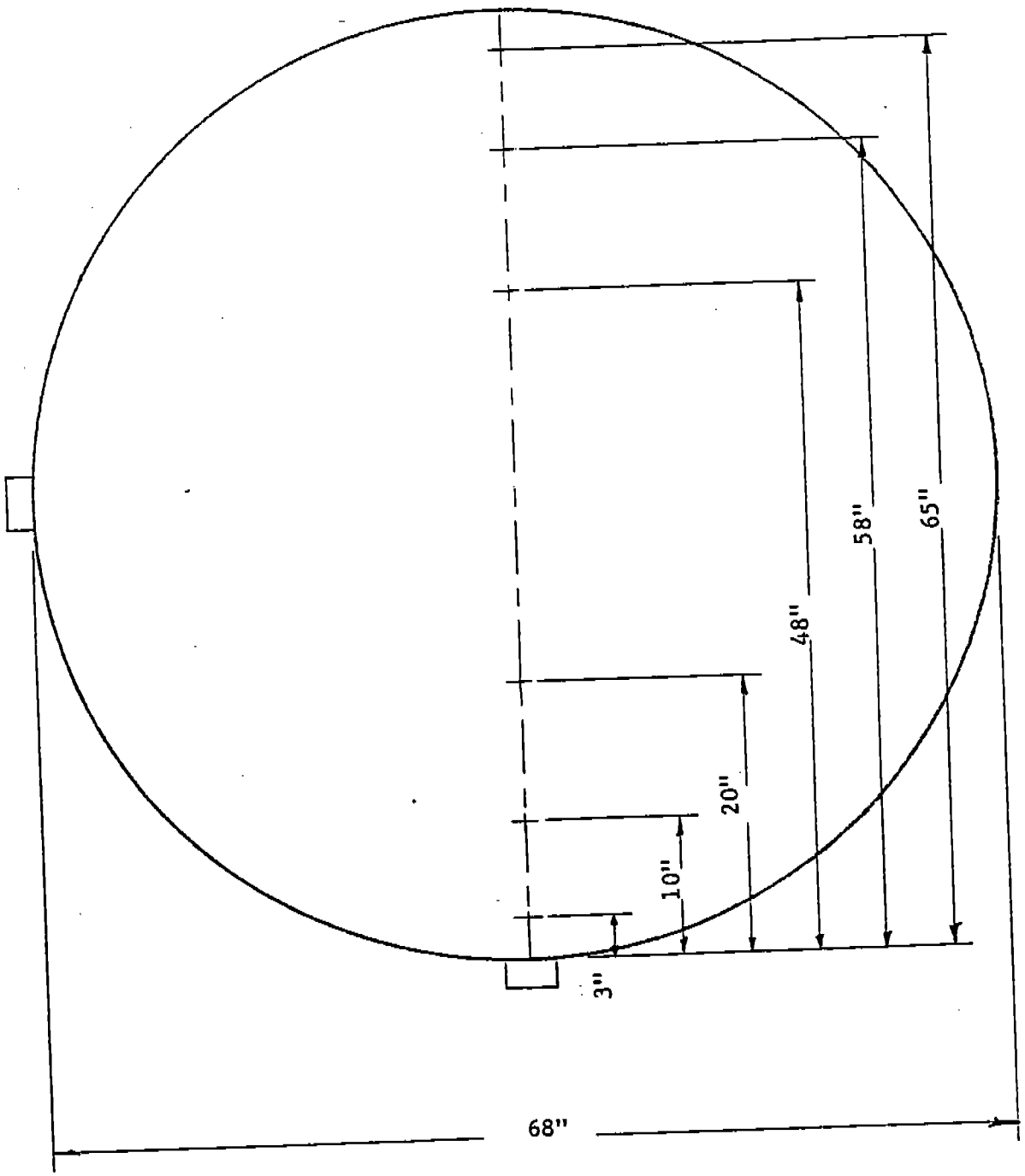
CROSS SECTIONAL AREA = 40.11 SQ. FT.

ROANOKE EMISSIONS SURVEY

NO. 5 CLINKER COOLER RECOUP GAS DUCT

VELOCITY SAMPLING TRAVERSE

FIGURE 6



CROSS SECTIONAL AREA = 25.22 SQ. FT.

TABLE X

ROANOKE EMISSION SURVEY

NO. 5 KILN SYSTEM

PROCESS RATE, CONSUMPTION & PRODUCTION

1979

DATE: 9-16-79

OPERATOR 1st Hartsell

2nd Brant

3rd Landy

TIME	0700	0900	1100	1300	1500	1700	1900	2100	2300	0100	0300	0500
KILN SPEED	115	115	115	115	115	115	115	115	115	115	115	115
FEED RATE	110	110	110	110	110	110	110	110	110	110	110	110
WATER RATE	57.8	58.0	58.0	59.7	59.4	59.1	58.9	58.7	59.1	58.7	59.0	59.
COAL RATE	9.8	90.0	9.8	9.9	10.1	9.9	9.9	9.9	9.9	9.9	10.0	10.4
KILN OXYGEN	0.48	0.20	0.39	0.18	0	.24	1.75	1.33	0.87	0.80	0.50	0.87
I.D. FAN SPEED	671	671	671	671	669	669	669	669	669	669	669	669
PREHEAT FAN DAMPER	47	47	47	47	46	46	46	46	46	46	46	46
BYPASS FAN DAMPER	57	57	57	57	57	57	57	57	57	57	57	57
RECIP. EXIT TEMP.	308	318	306	303	309	308	306	299	298	302	334	327
KILN EXIT TEMP.	1943	1965	1954	1938	1938	1953	1950	1942	1938	1936	1950	1968
SECONDARY AIR TEMP.	2069	2081	2056	2242	2176	2231	2225	2189	2192	2164	2122	2122
COOLER EXHAUST TEMP.	378	470	530	392	400	472	400	329	342	372	326	291
RECOUP FAN SPEED	489	491	491	491	492	492	492	492	496	494	495	495
RECOUP FAN DAMPER	40	40	40	40	40	40	40	40	40	40	40	40
INCLINE COOLER SPEED	6.8	6.8	8.0	6.7	5.6	6.4	5.5	5.8	5.9	4.5	4.5	7.1
#1 UNDERGRATE PRESS.	15.8	15.9	16.3	15.9	15.9	15.9	15.9	16.1	15.8	15.0	14.9	16.0
HORIZONTAL COOLER SPEED	9.1	9.2	9.8	8.9	9.2	9.1	9.2	9.1	9.2	9.1	9.3	9.3
#4 UNDERGRATE PRESS.	5.7	5.6	6.6	6.1	5.7	5.1	5.6	5.9	6.2	6.5	6.2	6.1
#1 FAN DAMPER	46	46	46	46	46	46	46	46	46	46	46	46
#2 FAN DAMPER	48	48	48	48	48	48	48	48	48	48	48	48
#3 FAN DAMPER	48	48	48	48	48	48	48	48	48	48	48	48
STACK OPACITY	14	14	14	14	13	13	16	14	13	13	14	14

TABLE X - CONT.

ROANOKE EMISSION SURVEY

NO. 5 KILN SYSTEM

PROCESS RATE, CONSUMPTION & REDUCTION

1979

DATE: 9-17-79

OPERATOR 1st Austin

2nd Brant

3rd Hanby

TIME	0700	0900	1100	1300	1500	1700	1900	2100	2300	0100	0300	0500
KILN SPEED	115	115	115	115	115	115						
FEED RATE	110	110	110	110	110	110						
WATER RATE	59.3	59.4	57.4	59.4	58.9	57.4	D					
COAL RATE	10.0	9.8	9.5	9.5	9.5	9.5		D				
KILN OXYGEN	.20	.10	1.58	1.19	.83	.96	D					
ID. FAN SPEED	677	676	677	677	677	674		D				
PREHEAT FAN DAMPER	45	45	45	45	46	46	W					
BYPASS FAN DAMPER	58	58	58	58	56	56		W				
CIP. EXIT TEMP.	319	320	327	321	321	314	N					
KILN EXIT TEMP.	1957	1944	1926	1924	1912	1910		N				
SECONDARY AIR TEMP.	2241	2242	2241	2242	2242	2142						
COOLER EXHAUST TEMP.	390	369	421	473	526	530						
RECOUP FAN SPEED	496	481	478	478	478	480						
RECOUP FAN DAMPER	40	40	40	40	40	40						
INCLINE COOLER SPEED	7.1	7.3	8.1	4.7	4.1	6.0						
#3 UNDERGRATE PRESS.	16.1	15.9	16.0	15.3	15.0	15.7						
HORIZONTAL COOLER SPEED	8.8	8.9	8.9	9.0	9.0	8.9						
#4 UNDERGRATE PRESS.	4.3	4.6	5.3	5.2	6.6	6.0						
#4 FAN DAMPER	48	48	48	48	48	49						
#3 FAN DAMPER	48	48	48	48	48	50						
#3 FAN DAMPER	48	48	48	48	48	50						
STACK OPACITY	14	14	14	13	14	13						

TABLE X - CONT.

ROANOKE EMISSION SURVEY OPERATOR 1st Randy

DATE: 10-15-79 NO. 5 KILN SYSTEM 2nd

PROCESS RATE, CONSUMPTION & PRODUCTION 3rd

1979

TIME	0700	0900	1100	1300	1500	1700	1900	2100	2300	0100	0300	0500
KILN SPEED	115	115	115	115								
FEED RATE	110	110	110	110								
WATER RATE	54.4	55.2	54.9	55.9								
COAL RATE	10.3	10.1	10.0	10.0								
KILN OXYGEN	—	—	—	—								
I.D. FAN SPEED	689	690	689	689								
PREHEAT FAN DAMPER	48	48	48	48								
BYPASS FAN DAMPER	58	56	56	56								
PH. EXIT TEMP.	317	323	315	311								
KILN EXIT TEMP.	1907	1879	1857	1893								
SECONDARY AIR TEMP.	2150	2065	2167	2197								
COOLER EXHAUST TEMP.	320	447	450	360								
ECOUP FAN SPEED	487	487	486	486								
ECOUP FAN DAMPER	40	40	40	40								
INCLINE COOLER SPEED	5.9	5.2	5.4	4.5								
UNDERGRATE PRESS.	15.9	15.6	15.4	15.6								
HORIZONTAL COOLER SPEED	7.5	7.4	7.4	7.5								
UNDERGRATE PRESS.	5.1	5.8	5.2	4.7								
FAN DAMPER	46	46	46	46								
FAN DAMPER	48	47	47	47								
FAN DAMPER	48	47	47	47								
OPACITY	13	12	12	12								

III. DISCUSSION OF RESULTS

(A) Gas Parameters At Different Locations

Results showed range of variation of parameters during testing at various stages in process remained rather constant. For details note raw data in Appendix I, as well as, summary data included in Tables I-V.

Table V showed stack gases to have a volume of around 280,000 ACFM with 10-11% moisture derived from both combustion and pelletizing processes. CO_2 at around 11% with oxygen at 14.5% was consistent with cement processes that theoretically exit gases from the kiln at 35-37% CO_2. (No excess air and assuming all CO_2 liberation from raw mix occurs in the kiln.) The stack gas temperature was around 300°F.

Precipitator input gas volume was somewhat less than stack gases at slightly higher moisture (1%), slightly richer in CO_2 and at a little higher temperature (20°-25°F). Accordingly, all precipitator input gas characteristics were exactly what might be anticipated and were at the proper magnitude to indicate a slight infiltration of outside air between the two testing locations - probably around the induction fan.

Preheater gases of considerable volume @ 175,000 ACFM showed a rather high CO_2 level indicating limited adulteration by outside air. Preheater temperatures were quite low @ 330-345°F. When one considered exit gases from the kiln were 1900°-2000°F, the obvious conclusion was that excellent heat transfer from kiln exit gases to kiln feed pellets existed since this was the only way to lower kiln exit gas temperatures drastically and still maintain a high level of CO_2. Also, note the moisture was around 13% which was consistent with the CO_2 level and the combustion process. Off hand, one might conclude that 13% moisture @ 24% CO_2 was not consistent with 12% moisture @ 14% CO_2 as shown for gas composition later in process at the precipitator input. However, all comes into balance when one considers the air dilution of gases from 24% CO_2 to 14% CO_2 (water dilution from 13% to around 7.5%) was associated with the moisture addition from pellets. Pellet water raised the gas moisture level to around 12%, as shown, for precipitator input gases.

Bypass gas at 650°F and 6% CO_2 was about what one would expect if ⅓ of the bypass volume consisted of kiln gases @ 24% CO_2 and 1950°F were mixed with 3¼ ambient and recoup air. This being the case, about 45,000 ACFM kiln exit gases were bypassed rather than preheated the raw mix.

Recoup gases showed a relatively low temperature since they were produced by heat transfer from hot clinker at the low potential section of the clinker cooler. Since "recoup" gases consisted only of heated ambient air, one would expect the CO_2 and moisture level of recoup gases to be very low, essentially zero, which was the case.

(B) Precipitator Effiency

Runs 9-14 reported 3 sets of runs made on the stack and precipitator input simultaneously. The stack and precipitator "output" were considered to be one and the same insofar as the end result was concerned. Note, results were reported at both ends of the precipitator (input & stack) on a "Lbs/Hr" basis making the recorded weight rates independent of volume rate. This precluded any

error that might seem to occur due to infiltrated air. That is to say, infiltrated air would decrease the concentration of particulates but yield a larger volume so that the product of concentration times volume remains the same.

Simultaneous collection of data before and after a unit under test eliminated any error due to variance that might occur if the unit input and output were measured singularly at different periods in time.

Note, the precipitator efficiency (Table VII) has been reported by two methods - "Wet Efficiency" and "Dry Efficiency". The output component of "Wet Efficiency" consisted of particulates that were collected on a filter plus material that passed the filter - probably for the most part as a vapor - and was absorbed in the water of the impingers. The impinger water, following testing, was evaporated leaving the absorbed material as solid crystals. The output component of "Dry Efficiency" consisted of particulate solids that one would normally consider as dust which was collected on the filter.

Also, consider that the "wet emission" was roughly twice the magnitude of the "dry emissions" which made a significant difference in the calculated precipitator efficiency as shown in the Table VII under results on a wet and dry basis.

The No. 5 Roanoke kiln system associated possibly with the nature of Roanoke raw materials gives rise to an "ammonium compound" phenomenon that has not been noted at other Lone Star plants. This is not to say that the phenomenon is non-existant at other Lone Star plants, but we have not detected same. Of concern was the order of magnitude of this phenomenon which was notably greater at Roanoke No. 5 kiln system.

The No. 5 kiln system produced the usual dust which was granular in nature and remained as a well established particulate at kiln temperatures (except the Burning Zone). These are the type of particulates which do not easily undergo a change of state (solid, liquid or vapor) and that the precipitator was designed to remove since they possess electrostatic characteristics and can be attracted to electrodes for concentration and removal from the gases.

Also, the kiln system produces an "ammonium compound" that has been associated with sulfur, sodium and potassium with possible trace elements. The nature of the ammonium compounds, which may or may not be a solid at kiln system exit temperatures, but rather a vapor, does not seem to be effectively removed by electrostatic precipitation. There was some evidence that the ammonium compound existed largely as a vapor at stack temperatures of 300°F and remains as a vapor to below 250°F (filter oven temperature). This was the reason why most of the ammonium compound ended up in the inpinger with little to no evidence of salting out in the pores of the filter. If only a portion of the ammonium compound that was collected in the impinger condensed in the pores of the filter there should be a notable pressure drop across the filter, as well as, some indication of the ammonium compound white crystals on the filter.

The ammonium compound (NH_4 SO_3 · NAO · K_2O, etc.) has been cited in the literature as a kiln product from other cement clinker kilns in this country and abroad so that it was not unique to the Roanoke No. 5 Kiln System.

The practical significance of the existing "ammonium compound" was that it loads the stack gases with particulate emissions, though ironically, as it leaves the processing equipment (pptr. & stack), it was mainly a vapor. Unfortunately, the definition of particulate emissions included the recovered solids from inpingers in the Commonwealth of Virginia so that the vaporous ammonium might just as well be conventional particulates, such as, clinker or raw mix dust, with respect to the regulations.

Recalling again, data in Table VII, showed that the difference between "wet" & "dry" particulates was the "ammonium compound" which was about half of the total. That is to say, inclusion of the "ammonium compound" almost doubles the particulate emission burden so that the conventional dust designed for removal by the electrostatic precipitator can be only about half the allowable limit if the total load remained in compliance.

It should clearly be pointed out for future consideration - like the proposed Georgetown Plant - that at locations where:

(a) the process equipment configuration and/or raw materials significantly produce the "ammonium compound" phenomenon and,

(b) local emission regulations include the impinger catch, particulate abatement processing should be considered as a double function.

(1) Electrostatic precipitation or bag house filtering to remove conventional particulates.

(2) Spray System, etc. for the absorption and removal of "ammonium compounds" from the process gases.

At Roanoke Bill Cavanaugh has conveniently solved the "ammonium compound" problem of excessive particulate emissions (conventional and ammonium compounds) by minimizing the volume of stack gas. This has been accomplished by using stack gases for drying the raw mix. However, when the total kiln gases were emitted from the kiln stack - though the precipitator was operated at peak conditions - the wet particulate emissions consistently exceeded the allowable limit. (See Virginia, 1979, Emission Survey Report, Table I, No Gas Bypassed)

Though splitting the stack gas load was conceived in the interest of fuel economy, its side benefit of reducing stack emissions from the kiln stack has developed as a major plus for the Gas Bypass System.

People being what they are, it is conceivable that the time might come when the Regulatory Group might view the Kiln Bypass System, not only as an economic move to recover energy, but speculate that it was conceived primarily as a means to circumvent the intent of the regulations by restricting particulate emissions. If this happens, undoubtedly we would be obliged to test the raw mill stack which potentially could open a new can of worms. At this time we have no idea as to the particulate nature of the raw mill stack but suffice it to say, raw mill emission allowables are less than kiln stack emission allowables. (See Virginia Regulations)

(C) Sulfur Determinations

Sulfur analysis tabulated in Table IX indicate concentrations in recoup gases at less than 1 ppm. Though the lower limit of defection was probably beyond the actual sulfur content of the gas, the fundamental objective was accomplished. Similar testing of clinker cooling gases has shown essentially no sulfur content though hot clinker invariably freezes some sulfur on cooling that might conceivably be liberated to the cooling gases.

Supplement

It would seem the rerun on gas parameters measured simultaneously was performed with tabulated results added to Tables 1-5 on October 15. These results were summarized in Table VI so that they could be readily compared with work done in September without having to turn a page.

In a word, the work done on October 15 was just about a carbon copy of work done on September 16, as well as, in close agreement with work on September 17.

There are two noticable differences in the rerun data vs. initial work.

1. The ACFM up the stack on September 16 & 17 included all the kiln process gas; whereas, the ACFM up the stack on October 15 included only a portion of the kiln process gas. The difference between 186,000 ACFM shown on October 15 and approximately 300,000 ACFM shown in September represents bypass gas that was used to dry raw mix for a one raw mill operation.

2. Note the stack temperature recorded for October 15 was 310°F; whereas, the precipitator input temperature was 284°F. Of course this cannot be the case - especially over an 8 hour period with approximately 200 individual temperature entries making up the average at each location. The indicated temperature at each location showed the normal and usual variation. Accordingly, we were led to believe the discrepancy was due to one or both of the thermocouple indicators being out of calibration - a fact which was confirmed later.

V. RECOMMENDATIONS

1. For best system testing results, simultaneous testing of the various component parts should be undertaken whenever practical.

2. New particulate abatement systems should include adequate facilities for removal of conventional particulates as well as pseudomorphic "ammonium compounds" if their presence can be anticipated.

Supplement

If equipment modification or adjustments are calculated to influence gas flow in the kiln system, it is recommended testing should be done just before the adjustment and repeated immediately thereafter in order to yield the best data on system gas behavior.

Volume Measurements

and SOX and NOX

Monitoring

Roanoke Plant
11/29,30 - 12/1
1977

Interoffice Memo

LONE STAR INDUSTRIES, INC.

P. O. Box 2148, Houston, Texas 77001

Originating Office: Central Research Laboratory

Date: December 7, 1977

PERSONAL & BUSINESS CONFIDENTIAL

TO: Mr. W. J. Cavanaugh
Roanoke Plant

FROM: D. V. Vu

SUBJECT: Volume Measurements and SOX and NOX Monitoring

CC: Messrs: G. F. Messinger
C. D. Fehnel
C. W. Moore
W. W. Hurst
J. D. Davenport

Dear Mr. Cavanaugh:

At your request, two tests were made at the plant on three days: November 29, 30 and December 1st, 1977.

The first test was to measure the Volume Flow rate and Temperature of the kiln exit gas at two locations: Cooling tower inlet for kiln #1, and cooling tower outlet for kiln #4. The test was conducted in accordance with EPA - Method 2 given in Federal Register, Vol. 42, No. 160, dated August 18, 1977. The results showed:

Date (1977)	Location	Volume (ACFM)	Temperature (F°)
11-29	Cooling Tower Inlet (Kiln #1)	80,000	1074
11-29	Cooling Tower Outlet (Kiln #4)	93,600	773

The second test was to monitor continuously and simultaneously the SOX and NOX levels by Envirometrics Analyzer, Model NS-300, at three different locations of kiln #5. The results showed:

Date (1977)	Location	Temperature (°F)	SOX, ppm (Dry Basis)	NOX, ppm (Dry basis)
11-30	Precipitator Outlet	~400	80-100	450-500
12-1	Preheater Inlet (Under Grate)	~700	<10	900-1000
12-1	Kiln Exit (Over Grate)	~1800	<10	>1000

Also, enclosed please find all the data and calculations of the results.

Respectfully submitted,

D. V. Vu
Environmental Control Engineer

DVV/po

Encl.

Discussion:

The objective of the first test was originally planned to measure the volume flow rate of exit gas of kiln #1 and #4 at the Cooling Tower Inlet of each kiln, (See Fig. 1 for plant equipment arrangement). There are 4 ports at Cooling Tower Inlet Duct of Kiln #1, but only one port at Cooling Tower Inlet Duct of Kiln #4, and this only port was insufficient to measure the volume flow rate of Kiln #4's exit gas, according to EPA - Method 2. Therefore, the volume measurement for Kiln #4 was instead made at its Cooling Tower Outlet Duct which has enough ports (4), and the volume was greater than the one measured at Kiln #1 Exit (even though the kilns are about the same size), due to the added cooling water.

Three different locations of Kiln #5 (see Fig. 4): Precipitator Outlet, Preheater Inlet (under grate) and Kiln Exit (over grate) were chosen to measure the SOX and NOX concentrations. Each location has only one port which, however, is sufficient for the sample probe to collect gas sample for Envirometrics Analyzer. The sample probe consists of a stainless steel filter which was connected to a 5/8" (O.D.) stainless steel rod by a galvanized coupling. At the kiln exit location (over grate), due to a high temperature ($\sim$ 1800°F), this coupling had melted and dropped the filter in the feed bed, after nearly 10 minutes of sampling and monitoring by the Analyzer. This accident, however, was expected and discussed before the sample probe was put in the kiln exit port, but it was worth this to know how long the gas sample could be collected and analyzed so that the SOX and NOX levels would be recorded at this location. It was noted that the NOX concentration at this location was much higher than the analyzer's maximum range which is 1000 ppm.

The SOX level at the precipitator outlet of kiln #5 was about 100 ppm which should be nearly the same as the SOX concentration in the stack. This result will be confirmed again by conducting EPA - Method 8 at the stack in a future date.

Gas Flow Rate Calculations:

1. Kiln #1 Exit Gas (Before Cooling Tower)

(a) Velocity

The formula for calculating gas velocity, given by EPA - Method 2, is:

$$V = 85.49 \times C_p \times (\sqrt{\Delta P})_{avg.} \times \sqrt{\frac{T_{s\ (avg.)}}{P_s \times M_s}}$$

where:

*C_p = Avg. Pitot Tube Coefficient
= 0.79, from Table 1

*$(\sqrt{\Delta P})_{avg.}$ = Square Root of Velocity head, avg.
= 0.63, from Table 1

* $T_{s\ (avg.)}$ = Average Duct Temperature (°R)
= 1534 °R, from Table 1

*P_s = Absolute Duct gas Pressure, mm Hg
= $P_{bar} + P_{static}$

$$= 28.96 - \frac{(0.40)}{(13.6)}$$

= 28.93 mm Hg

* M_s = Molecular Weight of Duct Gas, Wet Basis, Lb/Lb. mole
= $M_d\ (1 - \%\ H_2O) + 18(\%\ H_2O)$

* M_d = Molecular weight of Duct Gas, Dry Basis, Lb/Lb. mole
= $44\ (\%\ CO_2) + 32(\%\ O_2) + 28(\%\ N_2)$

The moisture of Kiln Exit Gas was approximately 6% and Orsat Analysis of one gas sample gave: CO_2 = 22.5% ,

O_2 = 8% and N_2 = 69.5%. Therefore,

$$M_d = 44(0.225) + 32(0.08) + 28(0.695)$$

$$= 31.92 \text{ Lb/Lb-mole}$$

and $$M_s = M_d(1 - \% H_2O) + 18(\% H_2O)$$

$$= 31.92(1 - 0.06) + 18(0.06)$$

$$= 31.08 \text{ Lb/Lb-mole}$$

Hence:

$$V = 85.49 \times 0.79 \times 0.63 \times \sqrt{\frac{1534}{(28.93)(31.08)}}$$

$$= \underline{55.57} \text{ ft/sec}$$

(b) Gas Flow Rate

= V x 60 x Cross Sectional Area
= 55.57 x 60 x 24
= 80,000 ACFM

2. Kiln #4 Exit Gas (After Cooling Tower)

(a) Velocity

$$V = 85.49 \times C_p \times (\sqrt{\Delta P})_{avg.} \times \sqrt{\frac{T_{s(avg.)}}{(P_s)(M_s)}}$$

Here,

* C_p = 0.79, from Table 2

* $(\sqrt{\Delta P})_{avg.}$ = 0.80, from Table 2

* $T_{s(avg.)}$ = 773°F or 1233°R, from Table 2

* $P_s = 28.96 - \frac{1.20}{13.6}$, from Table 2

= 28.87 mm Hg

* With Moisture = 12% and CO_2 = 16.5%,

O_2 = 10.5% and N_2 = 73.0%

$M_d = 44(0.165) + 32(0.105) + 28(0.730)$

$= 31.06$ Lb/Lb-mole

$M_s = 31.06(1 - 0.12) + 18(0.12)$

$= 29.49$ Lb/Lb-mole

Hence,

$$V = 85.49 \times 0.79 \times 0.80 \times \sqrt{\frac{1233}{(28.87)(29.49)}}$$

$= \underline{65.02}$ ft/sec

(b) Gas Flow Rate

= V x 60 x Cross Sectional Area

= 65.02 x 60 x 24

= 93,600 ACFM

List of Tables

Table 1

Velocity Traverse Data

Plant	:	Roanoke
Location	:	Kiln #1 @ Cooling Tower Inlet
Date	:	11-29-1977
Duct Dimensions, ft.	:	4 x 6
Barometric Pressure, mm Hg	:	28.96
Cross Sectional Area, ft^2	:	24
Pitot Tube		
Avg. Coefficient, C_p	:	0.79
Last Date Calibrated	:	April 1977

Traverse Point No.		Velocity Head ΔP, in. H_2O	Temperature ^oF	Static Press. in. H_2O	$\sqrt{\Delta P}$
1	Port # 1	0.31	985	---	0.56
2		0.38	1080	---	0.62
3		0.53	1083	-0.40	0.73
4		0.49	1089	---	0.70
5		0.44	1088	---	0.66
6		0.38	1085	---	0.62
7	Port # 2	0.28	995	---	0.53
8		0.32	1086	---	0.56
9		0.39	1094	-0.40	0.62
10		0.46	1096	---	0.68
11		0.45	1094	---	0.67
12		0.41	1089	---	0.64
13	Port # 3	0.32	998	---	0.56
14		0.37	1089	---	0.61
15		0.42	1098	-0.45	0.65
16		0.44	1099	---	0.66
17		0.49	1097	---	0.70
18		0.44	1088	---	0.66
19	Port # 4	0.24	995	---	0.49
20		0.28	1082	---	0.53
21		0.38	1083	-0.36	0.62
22		0.49	1098	---	0.70
23		0.45	1093	---	0.67
24		0.47	1090	---	0.68

Table 2

Velocity Traverse Data

Plant	:	Roanoke
Location	:	Kiln #4 @ Cooling Tower Outlet
Date	:	11-29-1977
Duct Dimensions, ft.	:	4 x 6
Barometric Pressure, mm Hg	:	28.96
Cross Sectional Area, ft^2	:	24
Pitot Tube		
Avg. Coefficient, C_p	:	0.79
Last Date Calibrated	:	April 1977

Traverse Point No.		Velocity Head ΔP, in. H_2O	Temperature ^oF	Static Press. in. H_2O	$\sqrt{\Delta P}$
1	Port # 1	0.41	760	---	0.64
2		0.62	765	---	0.79
3		0.74	769	-1.20	0.86
4		0.66	775	---	0.81
5		0.73	779	---	0.85
6		0.67	772	---	0.82
7	Port # 2	0.51	761	---	0.71
8		0.53	778	---	0.73
9		0.77	782	-1.20	0.88
10		0.78	781	---	0.88
11		0.70	780	---	0.84
12		0.60	772	---	0.77
13	Port # 3	0.42	759	---	0.65
14		0.47	768	---	0.68
15		0.78	779	-1.20	0.88
16		0.76	788	---	0.87
17		0.72	787	---	0.85
18		0.60	781	---	0.77
19	Port # 4	0.47	755	---	0.68
20		0.56	761	---	0.75
21		0.78	768	-1.20	0.88
22		0.79	779	---	0.89
23		0.75	776	---	0.87
24		0.65	768	---	0.81

List of Figures

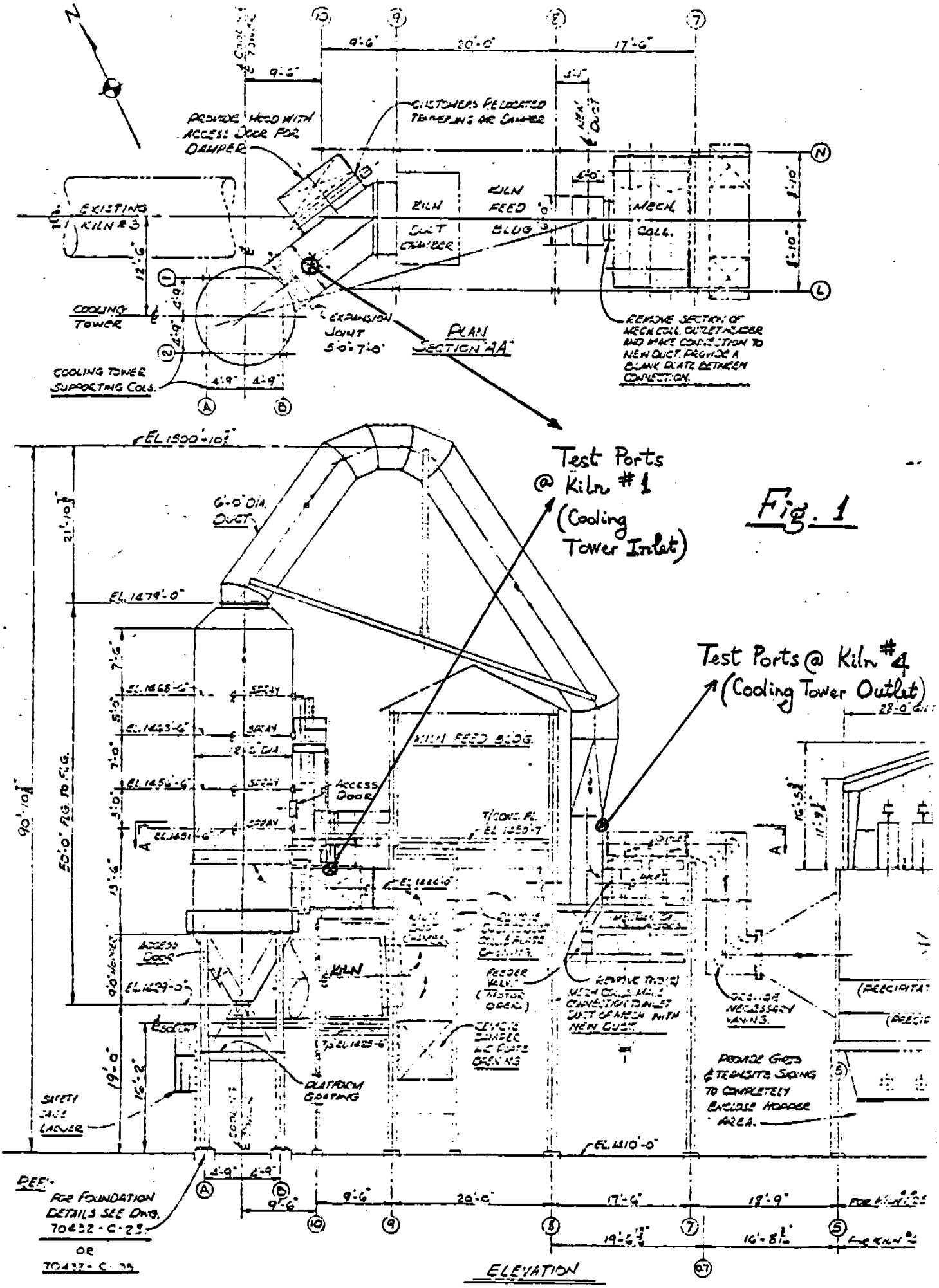

PROVIDE HOOD WITH ACCESS DOOR FOR DAMPER
CIL. TOWERS RELOCATED TEMPERING AIR DAMPER
NEW DUCT
EXISTING KILN #3
KILN DUST CHAMBER
KILN FEED BLDG
MECH. COLL.
COOLING TOWER
EXPANSION JOINT 5'-0"-7'-0"
PLAN SECTION AA
REMOVE SECTION OF MECH COL. OUTLET HOOD AND MAKE CONNECTION TO NEW DUCT. PROVIDE A BLANK PLATE BETWEEN CONNECTION.
COOLING TOWER SUPPORTING COLS.
EL 1500'-10"
6'-0" DIA. DUCT
Test Ports @ Kiln #1 (Cooling Tower Inlet)
EL 1479'-0"
Test Ports @ Kiln #4 (Cooling Tower Outlet)
KILN FEED BLDG.
ACCESS DOOR
KILN
FEEDER VALVE (MOTOR OPER.)
REMOVE THIS MECH COLL. MFG. CONNECTION DAMPER DUCT OF HOOD WITH NEW DUCT
PROVIDE GRATE & TRANSITE SIDING TO COMPLETELY ENCLOSE HOPPER AREA.
PLATFORM GRATING
SAFETY CAGE LADDER
REF: FOR FOUNDATION DETAILS SEE DWG. 70432-C-29 OR 70432-C-39
ELEVATION

Fig. 1

$D = \frac{2LW}{L+W}$

$= \frac{(2)(84-12)(60-12)}{(84-12)+(60-12)} =$

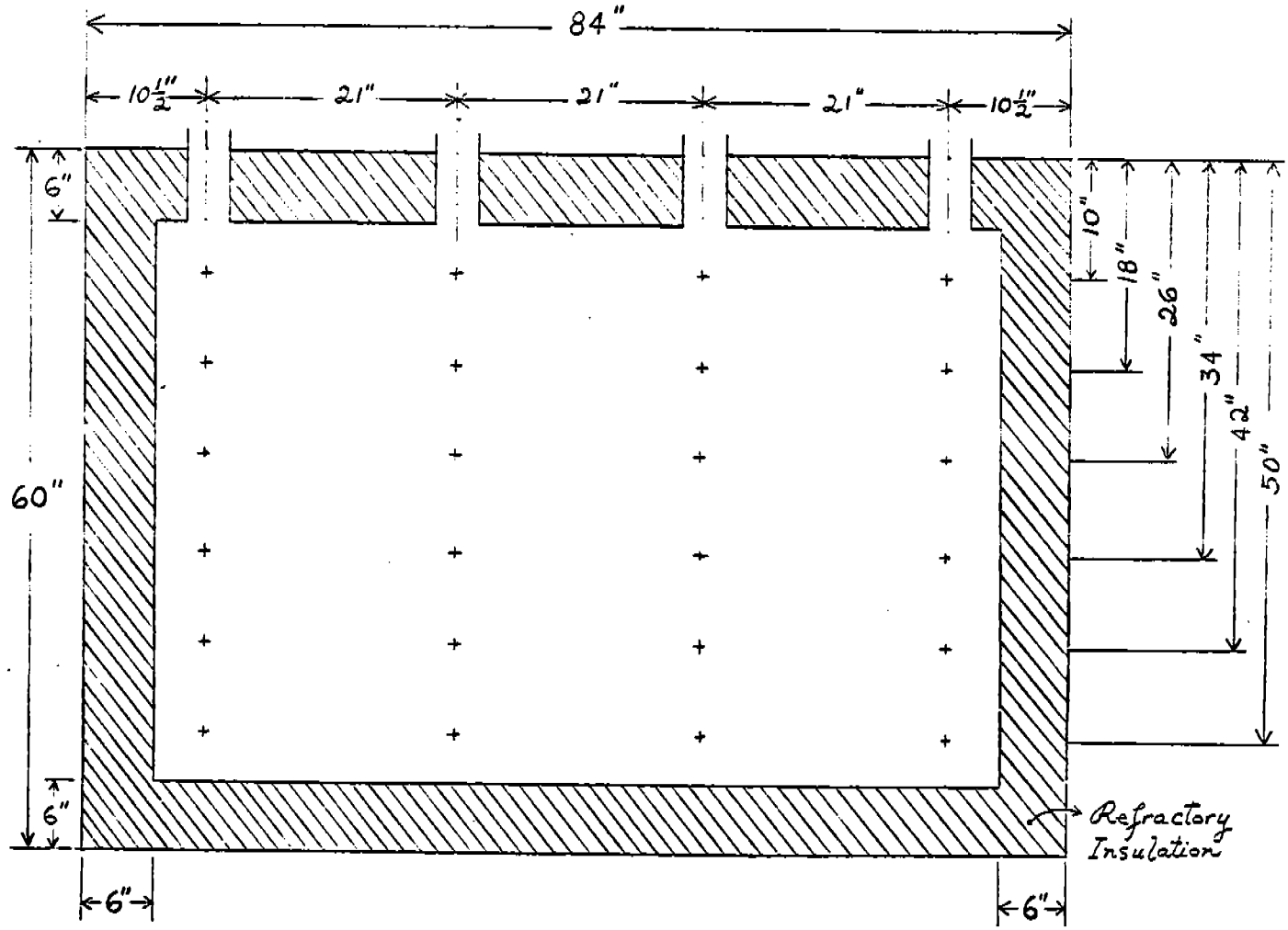
$57.6" = 4.8'$

Figure 2

ROANOKE PLANT

COOLING TOWER INLET DUCT

SAMPLING TRAVERSE POINTS



Plan View

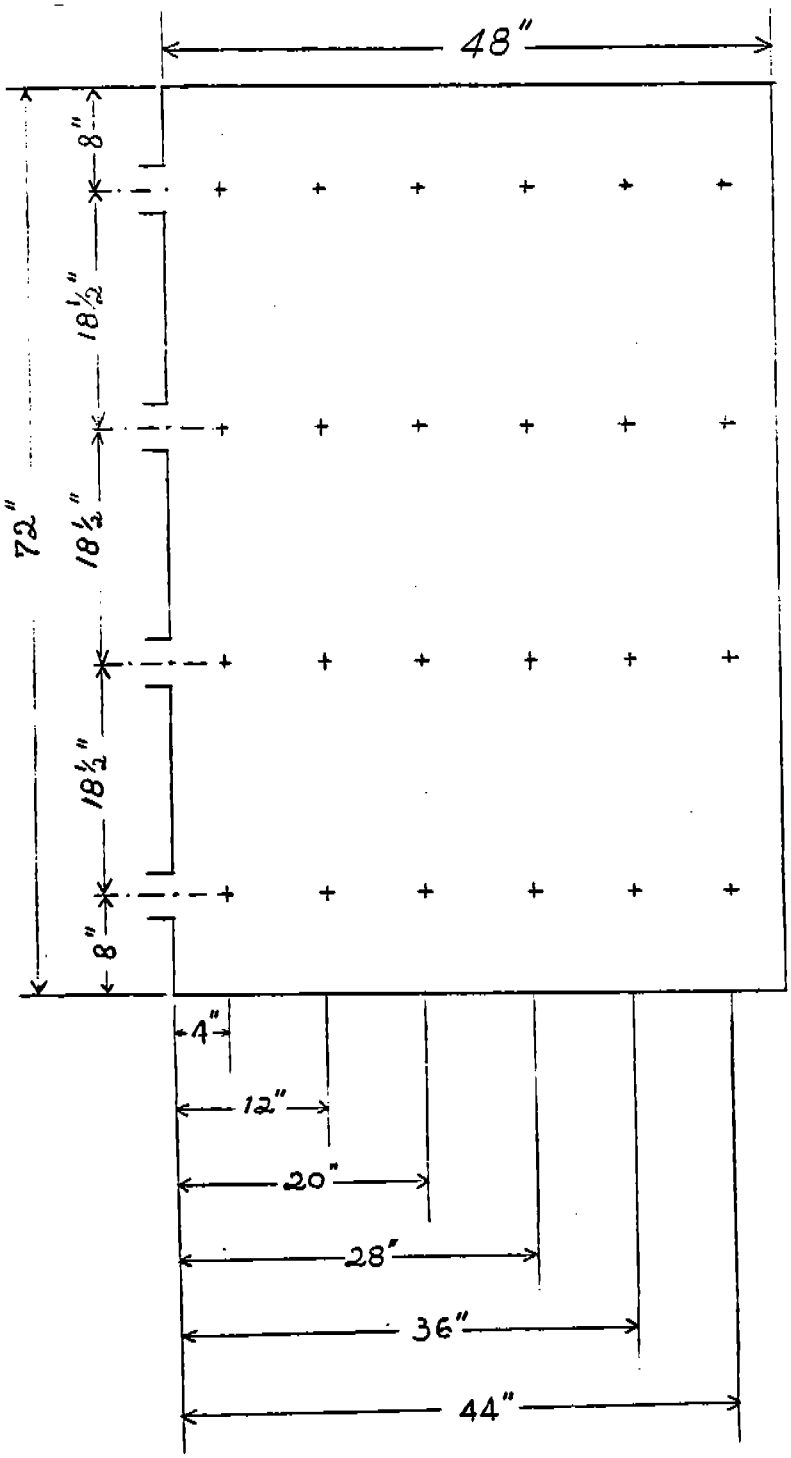
Cross Sectional Area - 24 ft^2

Figure 3

ROANOKE PLANT

COOLING TOWER OUTLET DUCT

SAMPLING TRAVERSE POINTS



Plan View

Cross Sectional Area = 24 ft^2

Fig. 4

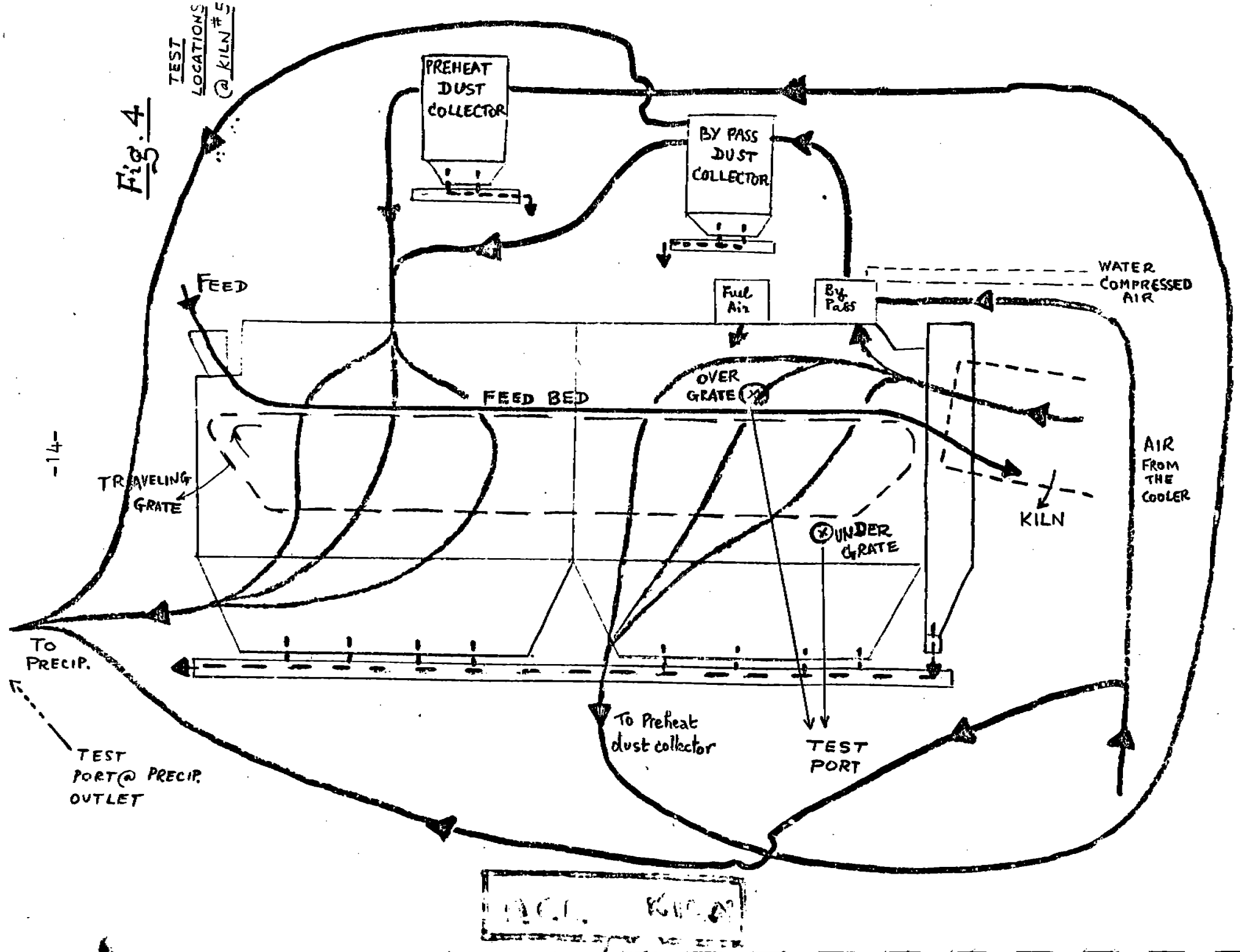

TEST LOCATIONS @ KILN #5
PREHEAT DUST COLLECTOR
BY PASS DUST COLLECTOR
WATER
COMPRESSED AIR
FEED
Fuel Air
By Pass
FEED BED
OVER GRATE
TRAVELING GRATE
UNDER GRATE
KILN
AIR FROM THE COOLER
To PRECIP.
TEST PORT@ PRECIP. OUTLET
To Preheat dust collector
TEST PORT

Figure 5

SO_x & NO_x Levels @ Precip. Outlet (Kiln #5)

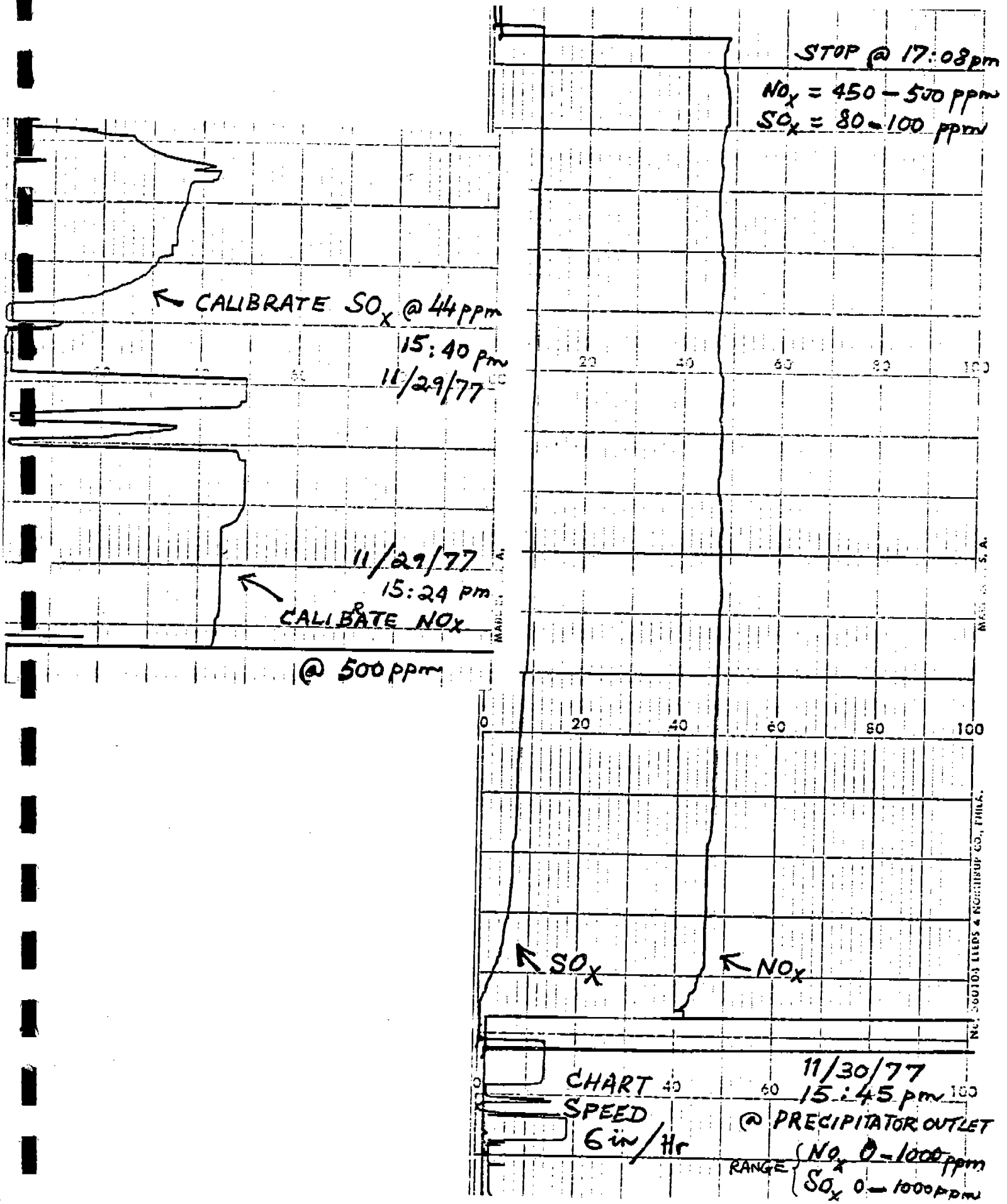


Figure 6

SO_x & NO_x Levels @ Under Grate (Kiln #5)

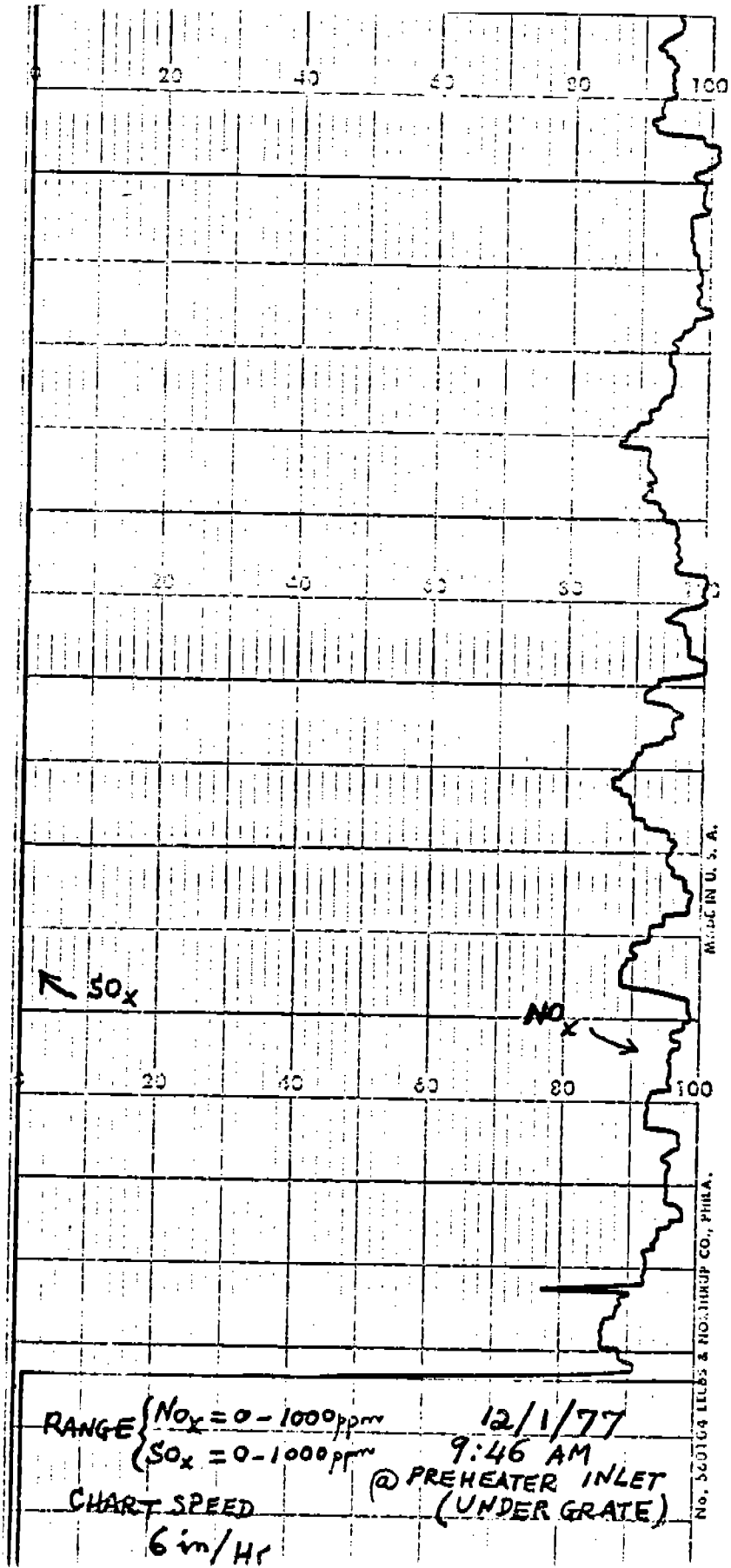
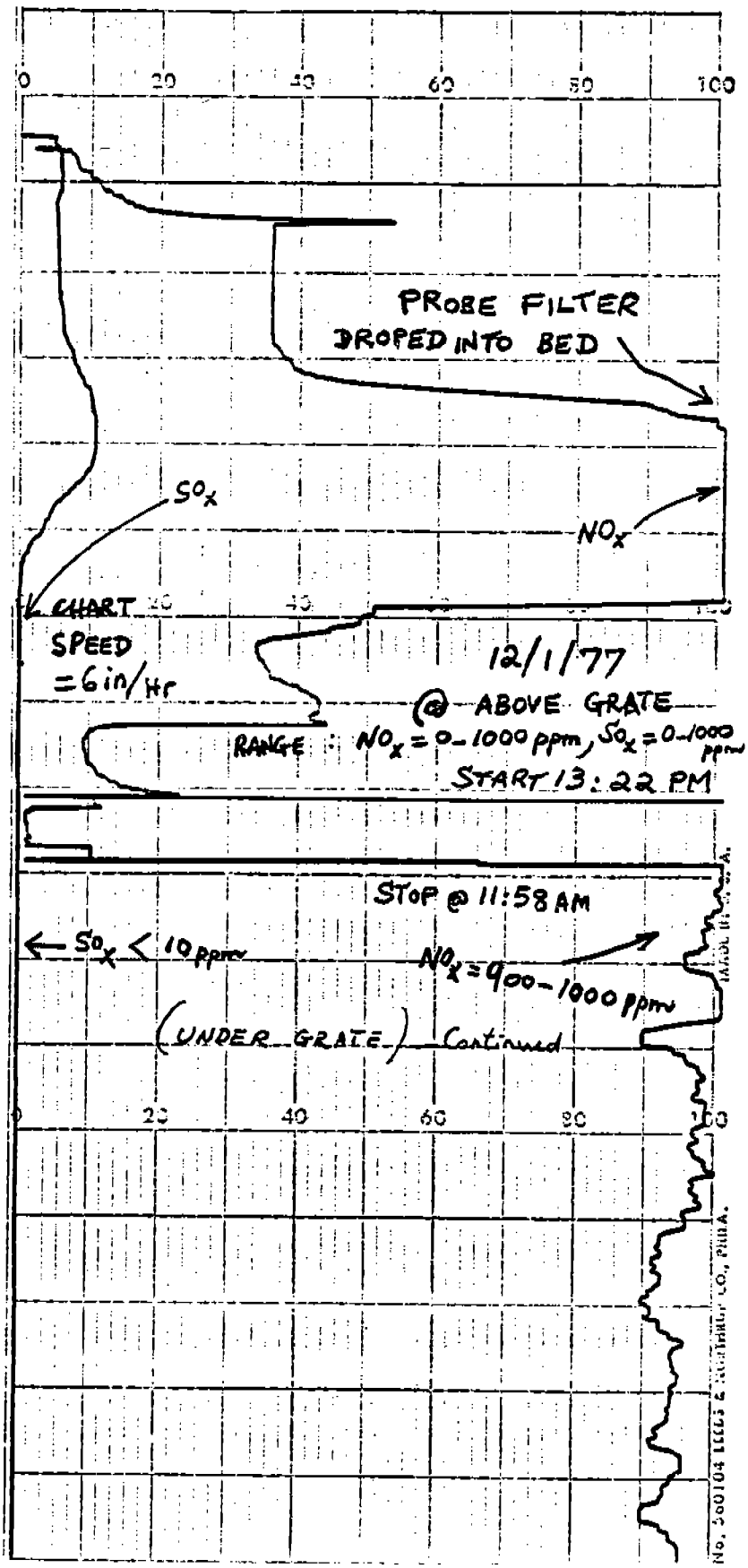


Figure 7

SO_x & NO_x Levels @ Over Grate (Kiln #5)



Interoffice Memo

LONE STAR INDUSTRIES, INC.

P. O. Box 2148, Houston, Texas 77001

Originating Office: Central Research Laboratory

Date: December 22, 1977

TO: Mr. George Messinger

FROM: C. W. Moore

SUBJECT: Volume Measurements and SOX and NOX Monitoring
Mr. Vu's Report of December 7 on Roanoke

CC: Mr. C. D. Fehnel
Mr. W. W. Hurst
Mr. D. V. Vu

Earlier this month, I forwarded Duc Van Vu's report on volume measurements and SOX and NOX measurements dated December 7, 1977. Under the circumstances of time and expediency the work appears to have accomplished its objectives, and the report is a good report for our internal use, which was the only intent of the process oriented work.

The lack of suitable test ports seriously affects the conclusions that may be drawn from the data, and they must be interpreted with close attention to the test conditions and locations. Stewart Fritts has given me comments on the report, which I attach. I would suggest appending them to the report when it is transmitted to Bill Cavanaugh.

Clyde

CWM/po

1 Encl.

LONE STAR INDUSTRIES, INC.
One Greenwich Plaza, Greenwich, Connecticut 06830

December 8, 1977

Interoffice Memo

TO: Clyde Moore

FROM: Stewart S. Fritts

SUBJECT: Roanoke Report - Volume Measurements - Duc V. Vu

I have had the opportunity to review Duc's excellent report covering recent testing at the Roanoke, Va. Plant. The report has been well presented and covers the essential facts as requested by Bill Cavanaugh.

However, it should be emphasized the data as developed is predicated on less than favorable testing conditions and any conclusions based on the data should be accepted with reservation.

As an example the test locations for Kilns 1 and 4 are not favorable for securing the best flow patterns and hence subject to questionable interpretation regarding velocities and volumes even though the velocity patterns appear to be in line - and certainly better than the flow patterns indicated by the recent Nazareth testing.

Duc notes the testing program was initiated with the objective of measuring flow rates of the exit gases from both Kilns # 1 and # 4; but because testing ports were not available (in accordance with good testing practice) it was agreed to test the Inlet to Cooling Tower # 1 and the Outlet from Cooling Tower # 4 and to assume the operating conditions were comparable for all kilns.

This basic assumption is not correct because each kiln - in any plant and more especially at Roanoke - does not operate comparably at any one time and most certainly they do not operate uniformly all of the time. Therefore we can never assume operating conditions for Kiln # 1 will obtain at the same time as Kiln # 4 ; and any conclusions based on this assumption would be subject to critical examination.

At Roanoke the No. 4 Kiln system has a potential capacity of 20 T/H while the No. 1 Kiln system rarely exceeds 18 T/H. While the kilns are all of the same size the Cooler and Kiln Exhaust Fan for the No. 4 System is some 15 to 20 percent greater than the Cooler and Kiln Exhaust Fan for the No. 1 Kiln system. Again I must emphasize the two systems are not comparable.

It is of course disturbing to note - in the interest of expediency - we accepted testing conditions that were not in compliance with the best testing practice; and I refer specificately to the fact that there were insufficient testing ports - at the proper location - for good sound tests.

As you and I well know any testing program does not develop without a respectable expenditure of time and money; and it serves little purpose to make a study of opera ting conditions without first of all securing the fundamental factors that will contribute to the development of the best known facts upon which our conclusions must be based.

I refer especially to the testing conditions that existed at Roanoke were the test ports were not adequate not were they at the proper location; and the Roanoke situation is not singular since we noted a similar condition at the Nazareth Plant.

At Nazareth we accepted inadequate test ports and staging and now find our test results are very questionable even after some five months of concentrated efforts to reach responsible conclusions. The Nazareth situation is even more disturbing because we are confronted with the spectre of possible non-compliance with regulations promulgated by State environmental authorities and having to accept data based on less than favorable testing conditions.

In the final analysis I do not believe we can afford - economically - not to do the best job we know how and to present our data in the most favorable light but to do this job we must insist on having the proper number of test ports and at the best - but at the same time a reasonably practical - location.

With your transmittal of Duc's report to Bill Cavanaugh I would suggest you specially call to Bill's attention the fact that adequate test ports were <u>not available</u> and that the test data for Kilns #1 and # 4 should be accepted with considerable reservation even though Duc and his group performed their task with the highest efficiency and dispatch under the limited circumstances.

1-12-78

Bill:

I Believe I had sent you a copy of Duc Vu's "Volume Measurement and SOx and NOx Monitoring Report." (12-7-77)

As I recall, we had discussed it over the phone and you stated that the information had been requested strictly as an "in-house" basis.

Just in a way of caution on the use of the data I'm enclosing a copy of a commentary letter on the report written by Stew Fritts.-

Best Regards

George Messinger

PARTICULATE EMISSION

TESTING AT ROANOKE

1979

Interoffice Memo

LONE STAR CEMENT INC.
P. O. Box 27, Cloverdale, Virginia 24077

Originating Office: Central Research Laboratory

Date: November 1, 1979

PERSONAL & BUSINESS CONFIDENTIAL

TO: W. J. Cavanaugh

FROM: W. W. Hurst

SUBJECT: Particulate Emission Testing at Roanoke Plant

CC: G. F. Messinger
C. D. Fehnel
C. W. Moore

Stack particulate emissions were tested on days between July 22 and October 12. Survey included 45 complete runs associated with Kiln System Nos. 1-5. Testing was conducted in accordance with EPA Methods 1-5 for Stationary Sources as given in Fed. Register, Vol. 35, No. 247; dated December 23, 1971, and amended August 18, 1977, and modified so as to meet the requirements of the Commonwealth of Virginia State Air Pollution Control Board.

Objectives were:

(1) Determine normal level of stack particulate emissions.

(2) Observe stack gas opacity during course of stack particulate testing on Stacks 1 - 5. Observations to be made by Virginia Air Control Board and Lone Star plant personnel.

(3) Obtain Lear Siegler continuous monitor average readings from strip chart during particulate source testing of stack by E.P.A. Method 5.

Results showed average conditions for each Kiln System as follows:

Location Kiln Stack	Temp. °F	Volume ACFM	Emission Lbs/Hr	Opacity Lear Sieg.	Opacity OBS
			D SCFM		
1	401	65,700	28.4	34	
2			Postponed		
3	420	60,700	23.6	25	15.7
4	413	70,900	28.9	31	19.9
5 *	332	288,600	161,700 38.4	14	
5 **	326	192,000	108,150 20.3	14	
5 ***	296	86,650	52580 12.2	11	

TABLE 5

* No Gas Bypass
** Gas Bypass to one Raw Mill
*** Gas Bypass to two Raw Mills

Respectfully submitted,

W. W. Hurst, P. E.

WWH/tab

I. Introduction

Since our last testing period during the summer of 1978, a Sonic Spray System was added to each of the cooling towers and Kilns No. 1-4, as well as a major modification to the No. 5 Kiln System. All process alterations cited above were implemented so as to lower the particulate stack emission burden and improve to emission rate. Upon completion of these process modifications, the plan, which was conceived with the participation of the V.A.C.B., was to retest all stacks so as to realistically evaluate the process upgrading.

Upon the request of Mr. Cavanaugh, Roanoke Plant Manager, personnel of the Lone Star Central Research Laboratory conducted particulate emission test on the stacks during the period of August 4 - October 12, 1979. The V.A.C.B. was advised of our plans prior to each test so that they might be available for testing and/or opacity observations. The V.A.C.B. personnel performed opacity observations during some of our test but not all.

The purpose of this report is to present test data and evaluate the results. In the case of stack emissions, results are viewed in light of present source standards for the Commonwealth of Virginia and the Environmental Protection Agency.

The test program consisted of complete runs utilizing Isokinetic Sampling Techniques for particulate loads at the stacks. In general, the aim was to conduct three good sets of simultaneous tests at each of the locations. Some tests were lost due to operational manfunction--usually as a result of equipment breakage during testing.

Kiln No. 3 which averaged 23.6 lbs/hr. emissions was in compliance since the allowable was 34.8 lbs/hr. All testing results of this operation were consistently in the range of the average.

Kiln No. 4 averaged 28.9 lbs/hr. emissions with an allowable of 40.2 lbs/hr. The No. 4 kiln was somewhat larger than Kilns 1-3 and thus the increased allowable. Kiln 4, as in the case of Kiln 3, showed consistent results varying little from the average.

The allowable for No. 5 Kiln Stack was 41.9 lbs/hr., whereas, emissions varied between 38.4 and 12.2 lbs/hr. depending on the amount of stack gas bypassed to the Raw Mill for heating purposes.

TABLE I

ROANOKE STACK EMISSION

PARTICULATE EMISSION

1979

Run No.	Date 1979	Exhaust Gas Temp. °F	Volume ACFM	% H_2O	Particulate Emission Rates Mgs/M^3 Std. Cond.	Grains/ SCF Dry	Lbs./SCF Dry (10^{-6})	Lbs/ Hr.
I-Kiln Stack #1 :								
45	9-29	404	60,600	17.1	117	0.051	7.3	12.9
46	9-29	408	62,200	18.8	131	0.057	8.2	14.5
47	9-30	386	53,700	16.5	164	0.071	10.2	16.4
48	9-30	399	65,800	17.3	153	0.067	9.5	18.4
49	10-1	406	73,900	16.6	357	0.156	22.2	48.0
50	10-1	403	77,900	17.9	430	0.187	26.8	60.2
Ave.		401	65,700	17.4	225	0.098	14.0	28.4
II-Kiln Stack #2 :								
		POSTPONED						
III-Kiln Stack #3 :								
51	10-4	417	61,600	17.3	195	0.085	12.2	21.4
52	10-4	422	60,100	16.6	260	0.113	16.2	28.0
53	10-11	432	59,800	15.8	241	0.105	15.0	25.7
54	10-11	415	61,200	16.4	209	0.091	13.0	23.0
55	10-12	416	59,600	16.3	210	0.091	13.0	22.5
56	10-12	415	61,600	16.6	189	0.082	11.8	20.8
Ave.		420	60,700	16.5	217	0.095	13.5	23.6
IV-Kiln Stack #4 :								
39	9-19	423	74,000	13.0	206	0.090	12.8	26.9
40	9-19	421	73,000	12.5	244	0.106	15.2	30.5
41	9-20	428	71,000	12.8	216	0.094	13.5	29.0
42	9-20	412	69,000	13.3	23	0.101	1.4	29.6
43	9-27	401	68,200	14.7	205	0.089	12.7	26.5
44	9-27	395	70,100	15.8	235	0.102	14.6	31.0
Ave.		413	70,900	13.7	188	0.082	11.7	28.9

TABLE I (CONT'D)

ROANOKE STACK EMISSION - 1979

PARTICULATE EMISSION

Run No.	Date 1979	Temp. °F	Volume ACFM	% H_2O	Mgs/M^3 Std. Cond.	Grains/ SCF Dry	Lbs./SCF Dry (10^{-6})	Lbs/ Hr.
V-Kiln Stack #5 (No Gas Bypass) :								
7	7-26	348	288,000	13.5	77	0.034	4.8	45.3
8	7-26	347	284,000	13.1	29	0.013	1.8	17.1
10	8-4	329	289,000	12.1	62	0.027	3.9	37.7
12	8-5	317	287,000	12.2	86	0.038	5.4	53.4
14	8-6	319	295,000	12.7	61	0.027	3.8	38.5
Ave.		332	288,600	12.7	63	0.028	3.9	38.4
VI-Kiln Stack #5 (Gas Bypass to One Raw Mill) :								
1	7-22	374	198,000	11.0	39	0.017	2.4	15.5
2	7-22	344	204,000	11.6	45	0.020	2.8	19.3
*3	7-24	337	199,000	11.2	41	0.018	2.6	17.5
4	7-24	336	200,000	12.7	32	0.014	2.0	13.6
5	7-25	346	145,000	13.0	90	0.039	5.6	27.0
*6	7-25	346	147,000	7.6	28	0.012	1.7	9.0
15	8-18	335	188,000	11.9	31	0.014	2.0	12.5
16	8-18	338	195,000	13.1	30	0.013	1.9	12.3
23	9-2	304	188,000	14.0	104	0.046	6.5	42.0
24	9-2	300	193,000	12.5	72	0.032	4.5	30.6
25	9-3	307	196,000	13.5	69	0.030	4.3	29.0
*26	9-3	301	179,000	4.8	22	0.010	1.4	9.5
31	9-4	302	201,000	15.1	58	0.025	3.6	24.7
32	9-4	301	204,000	12.0	47	0.021	2.9	21.3
Ave.		326	192,000	12.8	51	0.022	3.2	20.3
VII-Kiln Stack #5 (Gas Bypass to Two Raw Mills) :								
17	8-22	310	74,900	10.3	36	0.016	2.3	6.0
18	8-22	303	76,400	6.5	53	0.023	3.3	9.5
19	8-23	303	108,500	9.2	36	0.016	2.3	9.0
20	8-23	291	110,000	10.9	69	0.030	4.3	17.2
21	8-30	287	75,900	12.2	55	0.024	3.4	9.3
22	8-30	280	74,200	11.3	132	0.057	8.2	22.3
Ave.		296	86,650	10.1	64	0.028	4.0	12.2

* Data from Runs No. 3, 6, & 26 were not included for average due to breakdown of testing equipment.

TABLE 2

ROANOKE EMISSION SURVEY

SPECIAL DATA FOR

VIRGINIA STATE AIR POLLUTION CONTROL BOARD

Run No.	Date	Time of Day	Volume @ Stack (ACFM)	Fuel Coal (T/Hr.)	Kiln Feed (T/Hr.)	Particulate Emission (Lb./Hr.)	Stack Opacity (%) Observer State	Observer Plant	L.S. Recorder Average
Stack #1:									
45	9-29	9:38-12:10	60,600	3.3	21.0	12.9			30
46	9-29	9:42-12:14	62,200	3.3	21.9	14.5			30
47	9-30	8:11-10:36	53,700	3.4	20.7	16.4			31
48	9-30	8:15-10:40	65,800	3.4	20.7	18.4			31
49	10-1	10:00-12:25	73,900	3.4	21.0	48.0			42
50	10-1	10:04-12:29	77,900	3.4	21.0	60.2			42
Stack #2:									
	POSTPONED								
Stack #3:									
51	10-4	10:28-12:51	61,600	2.7	22.1	21.4		12.2	17
52	10-4	10:32-12:55	60,100	2.7	22.1	28.0		12.2	17
53	10-11	10:04-12:26	59,800	2.8	21.9	25.7		20.3	24
54	10-11	10:00-12:30	61,200	2.8	21.9	23.0		20.3	24
55	10-12	10:04-12:24	58,600	2.8	20.7	22.5		14.6	33
56	10-12	10:00-12:28	61,600	2.8	20.7	20.8		14.6	33
Stack #4:									
39	9-19	10:20-12:58	74,000	3.0	26.0	26.9		18.5	30
40	9-19	10:24-12:54	73,000	3.0	26.0	30.5		18.5	30
41	9-20	10:02-12:35	71,000	2.9	25.6	29.0		21.3	34
42	9-20	9:58-12:31	69,000	2.9	25.6	29.6		21.3	34
43	9-27	10:00-12:29	68,200	3.0	32.1	26.5			28
44	9-27	10:04-12:33	70,100	3.0	32.1	31.0			28

TABLE 2 - CONT'D

SPECIAL DATA FOR VIRGINIA STATE AIR POLLUTION CONTROL BOARD — ROANOKE EMISSION SURVEY - 1979

Run No.	Date	Time of Day	Volume @ Stack (ACFM)	Fuel Coal (T/Hr.)	Kiln Feed (T/Hr.)	Particulate Emission (Lb./Hr.)	Stack Opacity (%) Observer State	Observer Plant	L.S. Recorder Average
Stack #5 (No Gas Bypass):									
7	7-26	8:42-11:47	288,000	9.5	102	45.3			11
8	7-26	8:45-11:50	284,000	9.5	102	17.1			11
10	8-4	9:10-12:17	289,000	9.3	100	37.7			14
12	8-5	7:56-10:44	287,000	9.5	102	53.4			16
14	8-6	9:40-12:30	295,000	9.3	105	38.5			17
				9.4	102.2				
Stack #5 (Gas Bypass to one Raw Mill):									
1	7-22	9:39-13:04	198,000	8.5	95	15.5			13
2	7-22	9:42-13:07	204,000	8.5	95	19.3			13
3	7-24	10:05-13:47	199,000	9.3	105	17.5			13
4	7-24	10:08-13:50	200,000	9.3	105	13.6			13
5	7-25	10:44-13:44	145,000	9.4	105	27.0			12
6	7-25	10:47-13:47	147,000	9.4	105	9.0			12
15	8-18	7:55-10:53	188,000	9.9	105	12.5			13
16	8-18	7:58-10:56	195,000	9.9	105	12.3			13
23	9-2	7:57-10:46	188,000	9.8	110	42.0			18
24	9-2	8:00-10:49	193,000	9.8	110	30.6			18
25	9-3	8:23-11:11	196,000	9.5	110	29.0			15
26	9-3	8:26-11:14	179,000	9.5	110	9.5			15
31	9-4	10:04-12:52	201,000	9.4	110	24.7			15
32	9-4	10:07-12:55	204,000	9.4	110	21.3			15

Data from Run No. 3, 6, & 26 were not included for Average due to breakdown of testing equipment.

Stack #5 (Gas Bypass to two Raw Mills):									
17	8-22	8:24-11:28	74,900	9.5	105	6.0			13
18	8-22	8:27-11:31	76,400	9.5	105	9.5			13
19	8-23	10:03-12:57	108,500	9.7	105	9.0			12
20	8-23	10:06-13:00	110,000	9.7	105	17.2			12
21	8-30	10:07-13:04	75,900	8.7	110	9.3		2.4	9
22	8-30	10:10-13:07	74,200	8.7	110	22.3		2.4	9

TABLE 3

ROANOKE EMISSION SURVEY

PROCESS RATE, CONSUMPTION AND PRODUCTION

1979

Run No.	Date	Kiln No.	Fuel Rate T/H	% Water In Coal	Feed Rate T/H	% Water In Raw Mix	Clinker Production Rate T/H	Cooling Water Gal/Min
45-46	9-29	1	3.3	6.9	21.9	0.42	14.6	22
47-48	9-30	1	3.4	5.6	20.7	0.39	13.8	25
49-50	10-1	1	3.4	8.8	21.0	0.56	14.0	26
Average (Kiln #1)			3.4	7.1	21.2	0.46	14.1	24
		2						
		2	POSTPONED					
		2						
Average (Kiln #2)								
51-52	10-4	3	2.7	7.3	22.1	0.53	14.7	26
53-54	10-11	3	2.8	7.2	21.9	0.52	14.6	25
55-56	10-12	3	2.8	7.4	20.7	0.48	13.8	24
Average (Kiln #3)			2.8	7.3	21.6	0.51	14.4	25
39-40	9-19	4	3.0	5.4	26.0	0.45	17.3	24
41-42	9-20	4	2.9	6.3	25.6	0.38	18.4	25
43-44	9-27	4	3.0	6.6	32.1	0.38	21.4	29
Average (Kiln #4)			3.0	6.1	27.9	0.40	19.0	26
1-2	7-22	5	8.5	4.9	95	0.30	59	37
3-4	7-24	5	9.3	5.0	105	0.28	66	48
5-6	7-25	5	9.4	7.3	105	0.32	66	49
15-16	8-18	5	9.9	5.2	105	0.34	66	49
23-24	9-2	5	9.8	6.8	110	0.38	69	50
25-26	9-3	5	9.5	5.1	110	0.42	69	50
31-32	9-4	5	9.4	6.6	110	0.38	69	51
7-8	7-26	5	9.5	5.0	102	0.29	64	44
10	8-4	5	9.3	5.2	100	0.36	63	61
12	8-5	5	9.5	4.8	102	0.32	64	46
14	8-6	5	9.3	8.3	105	0.38	66	47
17-18	8-22	5	9.5	3.7	105	0.36	66	45
19-20	8-23	5	9.7	7.2	105	0.38	66	44
21-22	8-30	5	8.7	4.4	110	0.52	69	51
Average (Kiln #5)			9.4	5.7	105	0.36	66	48

TABLE 4

ROANOKE EMISSION STUDY

EXHAUST GAS CHARACTERISTICS

1979

Run No.	Kiln No.	Location	Date	Temperature (^{o}R)	% Water	Gas Density (Lb/Lb-Mole)	Static Pressure ("H_2O)
45	1	Stack	9-29	864	17.1	28.30	+0.16
46	1	"	9-29	868	18.8	28.09	+0.16
47	1	"	9-30	846	16.5	28.38	+0.11
48	1	"	9-30	859	17.3	28.20	+0.19
49	1	"	10-1	866	16.6	28.77	+0.22
50	1	"	10-1	863	17.9	28.60	+0.37
	2	Stack					
	2	"					
	2	"	POSTPONED				
	2	"					
	2	"					
	2	"					
51	3	Stack	10-4	877	17.3	28.34	+0.12
52	3	"	10-4	882	16.6	28.43	+0.09
53	3	"	10-11	892	15.8	28.36	+0.10
54	3	"	10-11	875	16.4	28.29	+0.06
55	3	"	10-12	876	16.3	28.77	+0.09
56	3	"	10-12	875	16.6	28.73	+0.11
39	4	Stack	9-19	883	13.0	29.35	+0.27
40	4	"	9-19	881	12.5	29.42	+0.32
41	4	"	9-20	888	12.8	29.47	+0.30
42	4	"	9-20	872	13.3	29.40	+0.27
43	4	"	9-27	861	14.7	29.20	+0.34
44	4	"	9-27	855	15.8	29.05	+0.31
* 7	5	Stack	7-26	808	13.5	28.73	+0.62
8	5	"	7-26	807	13.1	28.77	+0.56
10	5	"	8-4	789	12.1	28.75	+0.72
12	5	"	8-5	777	12.2	28.82	+0.74
14	5	"	8-6	779	12.7	28.76	+0.65

*No Exhaust Gas was Bypass to Raw Mill for Runs 7, 8, 10, 12 & 14.

TABLE 4 - (CONT'D)

EXHAUST GAS CHARACTERISTICS

ROANOKE EMISSION STUDY - 1979

Run No.	Kiln No.	Location	Date	Temperature (^{o}R)	% Water	Gas Density (Lb/Lb-Mole)	Static Pressure ("H_2O)
**1	5	Stack	7-22	834	11.0	28.63	+0.51
2	5	"	7-22	804	11.6	28.63	+0.52
3	5	"	7-24	797	11.2	28.85	+0.52
4	5	"	7-24	796	12.7	28.66	+0.59
5	5	"	7-25	806	13.0	28.56	+0.55
6	5	"	7-25	806	7.6	29.21	+0.62
15	5	"	8-18	795	11.9	28.90	+0.50
16	5	"	8-18	798	13.1	28.75	+0.51
23	5	"	9-2	764	14.0	28.61	+0.53
24	5	"	9-2	760	12.5	28.79	+0.49
25	5	"	9-3	767	13.5	28.73	+0.47
26	5	"	9-3	761	4.8	29.80	+0.61
31	5	"	9-4	762	15.1	28.42	+0.43
32	5	"	9-4	761	12.0	28.80	+0.49

**Exhaust gas was bypass to one raw mill for Runs 1-6, 15-16, 23-26 & 31-32.

***17	5	Stack	8-22	770	10.3	28.84	+0.36
18	5	"	8-22	763	6.5	29.30	+0.36
19	5	"	8-23	763	9.2	28.50	+0.38
20	5	"	8-23	751	10.9	28.31	+0.36
21	5	"	8-30	747	12.2	28.70	+0.29
22	5	"	8-30	740	11.3	28.81	+0.27

***Exhaust gas was bypass to two raw mills for runs 17-22.

TABLE 5

ROANOKE EMISSION SURVEY

EXHAUST GAS FLOW RATE

1979

Run No.	Date	Kiln No.	Location	Δ P ("H_2O)	Velocity (Ft/Sec)	Volume (ACFM)	Volume @ Std. Cond. CFH x 10^6 (Dry)
45	9-29	1	Stack	0.39	28.23	60,600	1.77
46	9-29	1	"	0.39	28.99	62,200	1.78
47	9-30	1	"	0.35	25.03	53,700	1.61
48	9-30	1	"	0.42	30.63	65,800	1.93
49	10-1	1	"	0.47	34.42	73,900	2.16
50	10-1	1	"	0.50	36.28	77,900	2.25
		2	Stack				
		2	"				
		2	"	POSTPONED			
		2	"				
		2	"				
		2	"				
51	10-4	3	Stack	0.39	28.70	61,600	1.76
52	10-4	3	"	0.38	28.00	60,100	1.73
53	10-11	3	"	0.37	27.85	59,800	1.71
54	10-11	3	"	0.39	28.50	61,200	1.77
55	10-12	3	"	0.38	27.75	59,600	1.72
56	10-12	3	"	0.39	28.70	61,600	1.77
39	9-19	4	Stack	0.45	32.48	74,000	2.10
40	9-19	4	"	0.44	32.19	73,000	2.01
41	9-20	4	"	0.44	33.05	71,000	2.15
42	9-20	4	"	0.45	32.29	69,000	2.12
43	9-27	4	"	0.44	31.73	68,200	2.07
44	9-27	4	"	0.46	32.63	70,100	2.12
7	7-26	5	Stack	0.87	61.05	288,000	9.41
8	7-26	5	"	0.86	60.27	284,000	9.34
10	8-4	5	"	0.88	61.40	289,000	9.71
12	8-5	5	"	0.89	60.98	287,000	9.96
14	8-6	5	"	0.91	62.67	295,000	10.10
							9.70

No Bypass

No exhaust gas was bypass to Raw Mill for Runs 7, 8, 10, 12, & 14.

161700 DSCFM

TABLE 5 - CONT'D

T-5 Cont'd

EXHAUST GAS FLOW RATE

ROANOKE EMISSION SURVEY - 1979

Run No.	Date	Kiln No.	Location	P ("H_2O)	Velocity (Ft/Sec)	Volume (ACFM)	Volume @ Std. Cond. CFH x 10^6 (Dry)
** 1	7-22	5	Stack	0.59	42.02	198,000	6.48
2	7-22	5	"	0.62	43.38	204,000	6.89
3	7-24	5	"	0.61	42.27	199,000	6.82
4	7-24	5	"	0.61	42.38	200,000	6.85
5	7-25	5	"	0.44	30.86	145,000	4.81
6	7-25	5	"	0.45	31.20	147,000	5.16
15	8-18	5	"	0.61	39.84	188,000	6.37
16	8-18	5	"	0.64	41.50	195,000	6.53
23	9-2	5	"	0.58	39.88	188,000	6.47
24	9-2	5	"	0.60	40.94	193,000	6.79
25	9-3	5	"	0.61	41.70	196,000	6.76
26	9-3	5	"	0.57	38.05	179,000	6.86
31	9-4	5	"	0.62	32.48	201,000	6.83
32	9-4	5	"	0.64	32.19	204,000	7.22
							6.49
							108150 DSCF

* Exhaust gas was bypass to one Raw Mill for Runs 1-6, 15-16, 23-26, & 31-32.

***17	8-22	5	Stack	0.25	15.91	74,900	2.67
18	8-22	5	"	0.26	16.22	76,400	2.87
19	8-23	5	"	0.34	23.04	108,500	3.95
20	8-23	5	"	0.34	23.35	110,000	3.99
21	8-30	5	"	0.24	16.12	75,900	2.73
22	8-30	5	"	0.24	15.75	74,200	2.72
							3.155
							52580

***Exhaust gas was bypass to two Raw Mills to Runs 17-22.

TABLE 6

ROANOKE EMISSION SURVEY

GAS SAMPLING AND TESTING PARAMETERS

1979

* Test Period (= 128 min. for Stacks 1, 2, 3 and 4
(= 144 min. for Stack 5

Run No.	Kiln No.	Test Nozzle Size (Sq.Ft.)	Meter Temp. (^oR)	H ("H_2O)	Meter Vol. (Cu.Ft.)	Meter Vol. @ STD. Cond. (Cu. Ft.)	% ISO--Kinetic
45	1	0.000314	538	0.31	35.64	33.73	102.1
46	1	"	528	0.32	35.32	34.06	103.1
47	1	"	539	0.25	31.78	29.96	99.8
48	1	"	521	0.37	39.49	38.52	107.4
49	1	"	540	0.46	43.43	40.77	101.4
50	1	"	524	0.52	46.84	45.32	108.3
	2	0.000314					
	2	"					
	2	"	POSTPONED				
	2	"					
	2	"					
	2	"					
51	3	0.000314	540	0.30	35.18	33.02	100.7
52	3	"	526	0.26	34.95	33.68	104.8
53	3	"	534	0.25	34.43	32.62	102.5
54	3	"	532	0.30	35.39	33.66	102.2
55	3	"	535	0.25	34.60	32.60	102.0
56	3	"	538	0.31	35.73	33.48	101.6
39	4	0.000314	546	0.38	39.35	36.78	93.9
40	4	"	538	0.34	40.10	38.04	97.1
41	4	"	544	0.44	42.34	39.99	99.8
42	4	"	529	0.38	42.22	41.00	103.6
43	4	"	542	0.40	40.40	38.19	98.9
44	4	"	528	0.38	42.16	40.91	103.6
*7	5	0.000289	534	0.82	68.43	65.29	79.0
8	5	"	533	0.82	73.71	70.46	85.8
10	5	"	541	1.22	87.30	82.62	96.7
12	5	"	541	1.26	88.00	82.62	94.3
14	5	"	543	1.31	83.92	79.16	87.8

*No exhaust gas was bypass to raw mill for runs 7, 8, 10, 12 & 14.

TABLE 6 (CONT'D)

ROANOKE EMISSION SURVEY

GAS SAMPLING AND TESTING PARAMETERS - 1979

Run No.	Kiln No.	Test Nozzle Size (Sq.Ft.)	Meter Temp. (^{o}R)	H ("H2O)	Meter Vol. (Cu.Ft.)	Meter Vol. @ STD. Cond. (Cu. Ft.)	% ISO--Kinetic
**1	5	0.000289	537	0.75	65.24	62.26	109.1
2	5	"	537	0.78	71.62	68.35	112.7
3	5	"	535	0.71	65.25	62.57	104.2
4	5	"	534	0.68	66.69	64.07	108.0
5	5	"	538	0.46	51.09	48.55	114.7
6	5	"	537	0.48	56.08	53.39	117.2
15	5	"	533	0.59	57.55	55.21	98.5
16	5	"	533	0.66	61.50	59.01	102.7
23	5	0.000309	531	0.81	64.35	61.92	101.7
24	5	"	532	0.75	67.33	64.65	101.2
25	5	"	537	0.86	66.20	62.86	98.8
26	5	"	537	0.68	63.61	60.50	93.4
31	5	"	542	0.89	67.14	63.19	98.4
32	5	"	543	0.81	69.74	65.51	96.4

**Exhaust gas was bypass to one raw mill for runs 1-6, 15-16, 23-26 & 31-32.

***17	5	0.000289	539	0.12	23.93	22.66	96.6
18	5	"	538	0.11	25.02	23.73	93.9
19	5	0.000739	536	1.33	82.08	78.37	91.5
20	5	"	537	1.47	91.96	87.67	94.0
21	5	"	544	0.77	61.50	57.69	97.6
22	5	"	545	0.73	64.97	60.83	95.9

***Exhaust gas was bypass to two raw mills for runs 17-22.

TABLE 7

ROANOKE EMISSION SURVEY

ORSAT ANALYSIS

1979

Run No.	Date	Kiln No.	Location	CO_2	O_2	N_2
45-46	9-29	1	Stack	12.0	12.6	75.4
47-48	9-30	1	"	12.0	12.8	75.2
49-50	10-1	1	"	15.4	11.2	73.4
		2	Stack	POSTPONED		
		2	"			
		2	"			
51-52	10-4	3	Stack	12.4	13.0	74.6
53-54	10-11	3	"	11.0	13.6	75.4
55-56	10-12	3	"	15.4	10.0	74.6
39-40	9-19	4	Stack	16.4	10.6	73.0
41-42	9-20	4	"	17.2	10.0	72.8
43-44	9-27	4	"	17.2	9.4	73.4
7-8	7-26	5	Stack	11.4	14.4	74.2
10	8-4	5	"	10.2	15.0	74.8
12	8-5	5	"	10.8	15.0	74.2
14	8-6	5	"	10.8	15.0	74.2
1-2	7-22	5	Stack	8.2	15.8	76.0
3-4	7-24	5	"	10.0	15.4	74.6
5-6	7-25	5	"	9.6	15.0	75.4
15-16	8-18	5	"	11.2	14.4	74.4
23-24	9-2	5	"	11.2	13.6	75.2
25-26	9-3	5	"	11.4	14.4	74.2
31-32	9-4	5	"	10.6	14.5	74.9
17-18	8-22	5	Stack	9.2	15.4	75.4
19-20	8-23	5	"	5.4	17.6	77.0
21-22	8-30	5	"	9.8	15.6	74.6

TABLE 8

ROANOKE STACK EMISSIONS

CHEMICAL ANALYSIS

1979

	SiO_2	AL_2O_3	Fe_2O_3	CAO	MgO	SO_3	K_2O	Na_2O	Loss
Kiln Feed Composite No. 1-4	14.24	2.80	2.28	43.03	2.10	0.99	0.58	0.19	34.53
Clinker Composite No. 1-4	22.08	4.62	3.82	64.03	3.00	1.70	0.81	0.23	0.29
Waste Dust Composite No. 1-4	13.86	5.18	2.24	44.20	1.59	5.64	3.20	0.30	24.22
Kiln Feed Composite No. 5	14.44	3.24	1.50	42.85	2.15	0.82 0.4	0.62	0.19	34.91
Clinker Composite No. 5	22.75	5.30	2.48	64.64	3.30	0.49	0.74	0.25	0.37
Waste Dust Composite No. 5	18.24	5.48	2.32	51.80	2.73	4.58	3.35	0.45	11.74

TABLE 9

ROANOKE EMISSION SURVEY

METEOROLOGICAL CONDITIONS

1979

Run No.	Date	Kiln No.	Location	Ambient Temp. (°F.)	Baro. Pressure (In. Hg.)	Relative Humidity (%)
45-46	9-29	1	Stack	73	28.73	77
47-48	9-30	1	"	66	28.67	84
49-50	10-1	1	"	70	28.59	78
		2	Stack			
		2	"	POSTPONED		
		2	"			
51-52	10-4	3	Stack	56	28.60	82
53-54	10-11	3	"	45	28.55	85
55-56	10-12	3	"	55	28.44	70
39-40	9-19	4	Stack	72	28.79	69
41-42	9-20	4	"	63	28.98	70
43-44	9-27	4	"	67	28.90	72
7-8	7-26	5	Stack	73	28.71	90
10	8-4	5	"	68	28.82	86
12	8-5	5	"	70	28.86	83
14	8-6	5	"	77	28.82	60
1-2	7-22	5	Stack	70	28.85	71
3-4	7-24	5	"	71	28.92	95
5-6	7-25	5	"	71	28.84	90
15-16	8-18	5	"	67	28.83	72
23-24	9-2	5	"	71	28.79	90
25-26	9-3	5	"	73	28.73	87
31-32	9-4	5	"	71	28.74	90
17-18	8-22	5	Stack	68	28.81	85
19-20	8-23	5	"	69	28.80	100
21-22	8-30	5	"	71	28.76	90

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III. Operating Equipment and Process Parameters

A. Old Plant

Four medium size, dry process clinker kilns are operated--each with its own flue gas transporting ducts, gas conditioning equipment, and dust abatement equipment--with the cleaned and cooled flue gas fed to an individual stack for waste gas dissemination. In all, there are 4 kilns each with its individual stack. Each stack is supplied gas by the same configuration as described herein.

Flue gases leave the kilns at 1100° - 1200° F. and are initially conditioned with water at the kiln exit area so that gases enter the cooling tower at approximately 900° F. In the cooling tower, additional water spraying is done to raise the moisture level of the gases to around 15% and lower the temperature to 650° F. range.

Gases leaving the cooling-conditioning tower are fed to a group of 4 - 4 1/2' Buell Multiclones operated in parallel to achieve capacity requirements. Each multiclone unit (4-4 1/2' cyclones) is designed to handle 67,000 CFM @ 700° F. to give approximately 80% separating efficiency for medium size particles at 50 microns. No grain loading of the gases was specified in the performance guarantee. After a portion of the coarser dust is removed by the multiclones, the gases are fed to electrostatic precipitators.

Though Koppers electrostatic precipitators installed at Roanoke have been in operation since startup dating back to 1951, they were extensively reconditioned and modernized in 1967. Precipitators on Kiln Systems 1, 2, 3 were the same size but the precipitator associated with No. 4 Kiln System was somewhat larger. All units were designed to handle 65,000 CFM @ 600° F. at a 2" negative water pressure. Each precipitator consists of

a north and south section with a total collecting surface of 20,088 sq. ft. for Units 1-3 and 22,320 sq. ft. for Unit No. 4. Correspondingly, the discharge electrode has an effective length of 13,392 ft. for Units 1-3 and 14,880 ft. for No. 4.

The precipitator design throughput velocity was 2.4 ft/sec. for Units 1-3 and 2.17 ft/sec. for Unit 4. This provides for a resident period of 7.5 sec. for the smaller precipitators and 8.3 sec. for No. 4 Unit. System design allowed for moisture in the gas by volume at 15% minimum. The guaranteed collection efficiency was 99.6% for Units 1-3 and 99.8% for Unit 4. The designed input grain loading for Unit 1-3 was 5.0 grains/cu. ft. and 9.0 grains/cu. ft. for Unit 4. Expected output grain loading for all units was 0.02 grains/cu. ft.

Stack discharge location was 105'-3" above foundation. (Foundation 1433"-11½" above sea level.) Test ports were located 56'-3" above foundation where the stack diameter was 81". Each stack had two - 4" test ports placed at 90° apart and in the same elevation plane. At the 56'-3" elevation, ports were 6.3 flue diameters from the stack input ducts in the upwind direction and 6.13 flue diameters from discharge on the downwind side of ports. See Sketch, Fig. 1, for details. Accordingly, the upwind direction becomes the most critical with respect to duct disturbance. Using E.P.A. chart-flue diameters vs. test points on traverse - we estimate stack traverse should have 16 test points with locations as shown in Sketch Fig. 2.

B. New Plant

The new kiln is a high efficiency, Allis-Chalmers rotary unit operated in conjunction with a preheater-pelletizer utilizing the Lepol system. The kiln is rated at 110 T/H raw mix feed and is currently operated at this rate or about 100% of rated capacity. Gases with airborne particulates leave the preheater and enter the precipitator at about 385° F. and approximately 12% water by volume. As a result of efficient heat recuperation and "bleeding air" for system stability, the precipitator input gases have been degraded from combustion composition at 1-2% oxygen and dry to about 15% oxygen and wet.

The kiln system electrostatic precipitator is a double chamber, four field unit of Koppers manufacture. The unit is designed to handle 286,000 ACFM @ 250° F. and 10% water vapor by volume AT-8" VWC. The input dust concentration is rated at 5 grains/cu. ft. (actual) or 12,214 Lbs/Hr. Residual dust should be 0.009 grains/ACF or 21.84 Lbs/Hr. to give a guaranteed efficiency of 99.82+. Pressure drop across the unit is 1/2" water with a throughput gas velocity of 3 ft/sec. for a resident time of 12 seconds.

IV. Test Equipment and Testing Procedures

The Sampling Train used for source testing was basically a Model AP-5000 "Stac-O-Lator" manufactured by Scientific Glass and Instruments, Inc. of Houston and has been E.P.A. approved. The impinger type and charge was in accordance with E.P.A. recommendation except we use somewhat more silica gel than E.P.A. suggests so as to be sure of absorbing all water vapor.

We also use 5 impingers instead of the required 4. The 5th impinger is a modified Smith-Greenfield placed in the train ahead of the usual first impinger and connected in a "reverse" configuration. The reverse arrangement acts as a trap to collect water from the first impinger in the event of an unexpected back pressure in the system. Such a system in no way detracts from the intended function of the impinger train and prevents the fouling (wetting) of the filter and loss of moisture in the event of a sudden momentary back pressure in the system. The glass fiber filters were 4" Gelman, Type A, with a retentions factor of 99.7% @ 0.3 micron particle size.

We used the E.P.A. sampling procedure as presribed in the "Commonwealth of Virginia - Procedures for Emission Testing" dated April 21, 1977. Each test was 2-3 hours long generally sampling at 0.5 CFM dry gas. Each of the stack tests gathered well over 30 cu. ft. The train was leak checked at the start and end of each run at about 17" Hg. rather than 15" Hg. as required by E.P.A. Our control valves are at equilibrium with pump at 17" Hg. rather than 15" Hg.

Teflon heated probe liners were used for stack testing. Probes, filter assemblies, and nozzle were thoroughly washed with acetone following each test with nozzle removed. Reassembled clean probes were leak checked @ 25" Hg. vacuum with no noticeable leaks tolerated.

We operate out of a 30' mobile laboratory so that all sample recovery, such as weighing, evaporating, and washing is done within the air-conditioned mobile laboratory and not at testing area.

Laboratory analysis are performed strictly in accordance with E.P.A. Our analytical balance for weighing filters and beakers is a Mettler H-6. Our impinger weighing balance is a Mettler P-1200. We use 4 large desiccators for storing and keeping filters and beakers at constant weight. We generally run blanks on each acetone and distilled water lot but seldom find enough residue for significant modification of results. For the record, our current acetone residue per 500 ml. is 0.5 mg. and our distilled water residue is 1.9 mg. per 500 ml.

We use two Thermo Electric digital thermocouple indicators, Model ELPA with a 1^{o} accuracy. The indicators are electrically connected through switching to a Thermo Electric "Minimite" which is used to calibrate the temperature range of interest per test. The "Minimite" has an accuracy of $\pm$ 1/4%. Calibration of thermocouple indicators occurs at the beginning of each plant run and more often if it seems necessary or a significant change occurs in the range of testing interest.

Five dry test Rockwell meters are calibrated at the start of each plant test. Part of the mobile laboratory equipment is a Precision Wet Test Meter, Serial No. AA-9 which is used to standardize the dry test meters. The wet test meter is calibrated annually by equipment traceable to the Bureau of Standards.

The orifice used for "Δ H" readings is calibrated at random periods whenever the "Δ H" vs. CFM relationship show significant variation. The "Δ H" orifice plate has a 3/16" orifice working in a 3/4" pipe duct. Δ H @ = 1.79 at .75 CFM, 68° F. and 29.92" Hg.

Near the beginning and toward the end of each two hour (approx.) run, we collect a gas sample (GRAB) for determining the gas composition. The two analyses are averaged but seldom show much variation. The analysis is performed with the Orsat equipment. Considerable effort is devoted toward keeping the Orsat equipment in top operating condition.

Pitot tubes were calibrated in Houston during March, 1979, before starting our annual plant tour. Each tube was calibrated in our 12" wind tunnel at the approximate velocity anticipated in the field where the Pitot tube was to be used. Our wind tunnel was capable of producing air attaining 100 ft/sec. velocity and could be throttled by a system of screen grinds that not only induce resistance to diminish the flow of air but also acted as straightening vanes to minimize eddy currents produced by the fan. Pitot tubes were only used during the course of a single testing assignment per specifications.

During calibration, Pitot tubes ("S" type) values were compared to values produced by a standard pitot tube which had been certified with a correction factor of .99. Both standard and "S" type tubes were moved across the wind tunnel duct diameter on a 12 point traverse while readings were taken on a duplex manometer for direct comparison of the "Δ P" values - standard vs. "S" type Pitot tubes. Both "forward" and "reverse" tube orientation readings were taken with each "S" type Pitot tube. Reverse tube modifications were made, if necessary, to assure "Δ P" values in both directions agreed within 1%. We make our own Pitot tubes and design tube openings configuration more oval than round. Our Pitot tubes meet require-

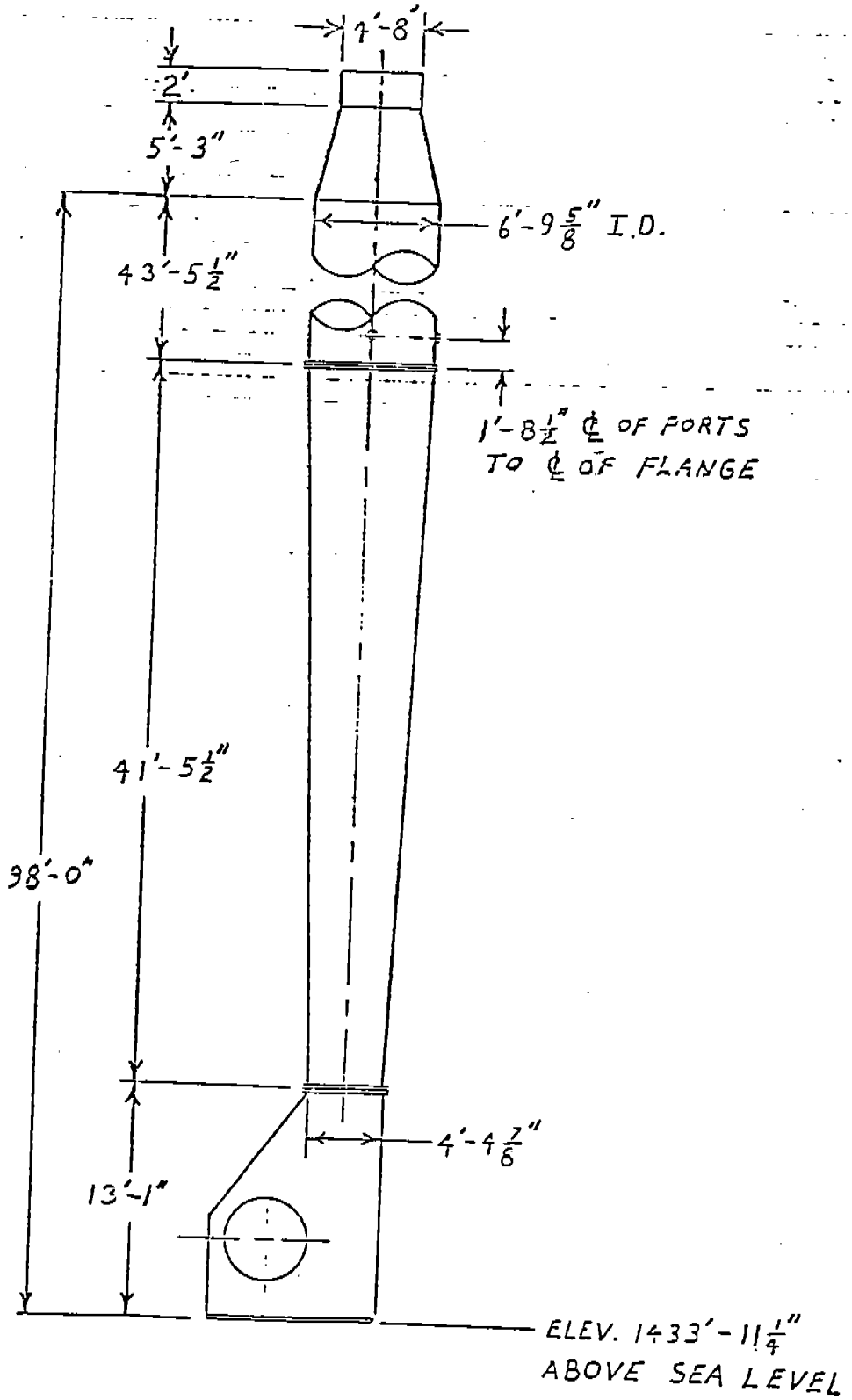
ments as outlined in E.P.A. Method 2, Standards of Performance for New Stationary Sources.

Figure 1

F-1

OLD PLANT

Roanoke Plant Stacks Emission Test Location



Cross Sectional Area @ Test Ports = 35.78 Sq.Ft.

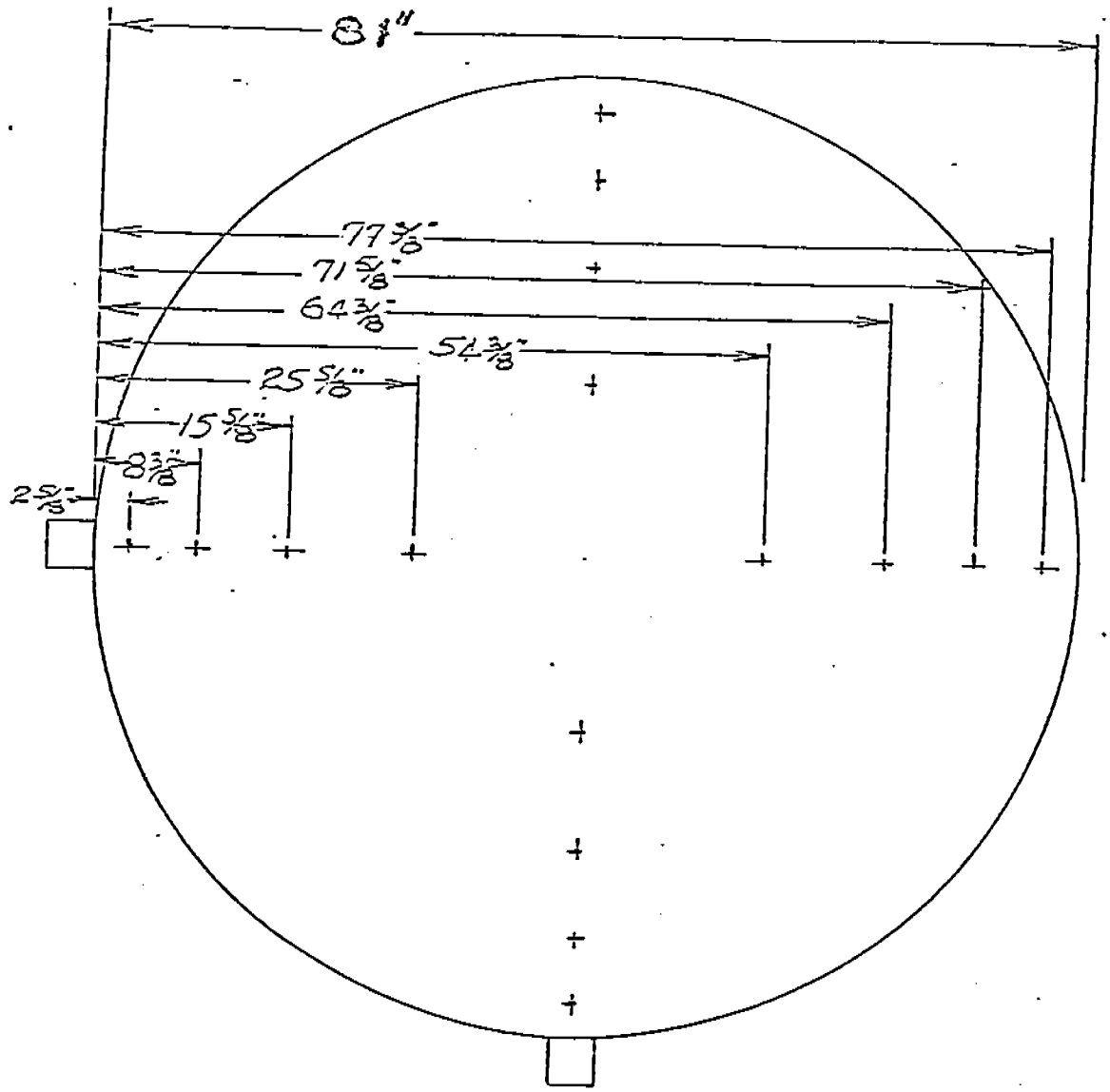
FIG. 2

ROANOKE DUST SURVEY

STACK

VELOCITY & PARTICULATE SAMPLING

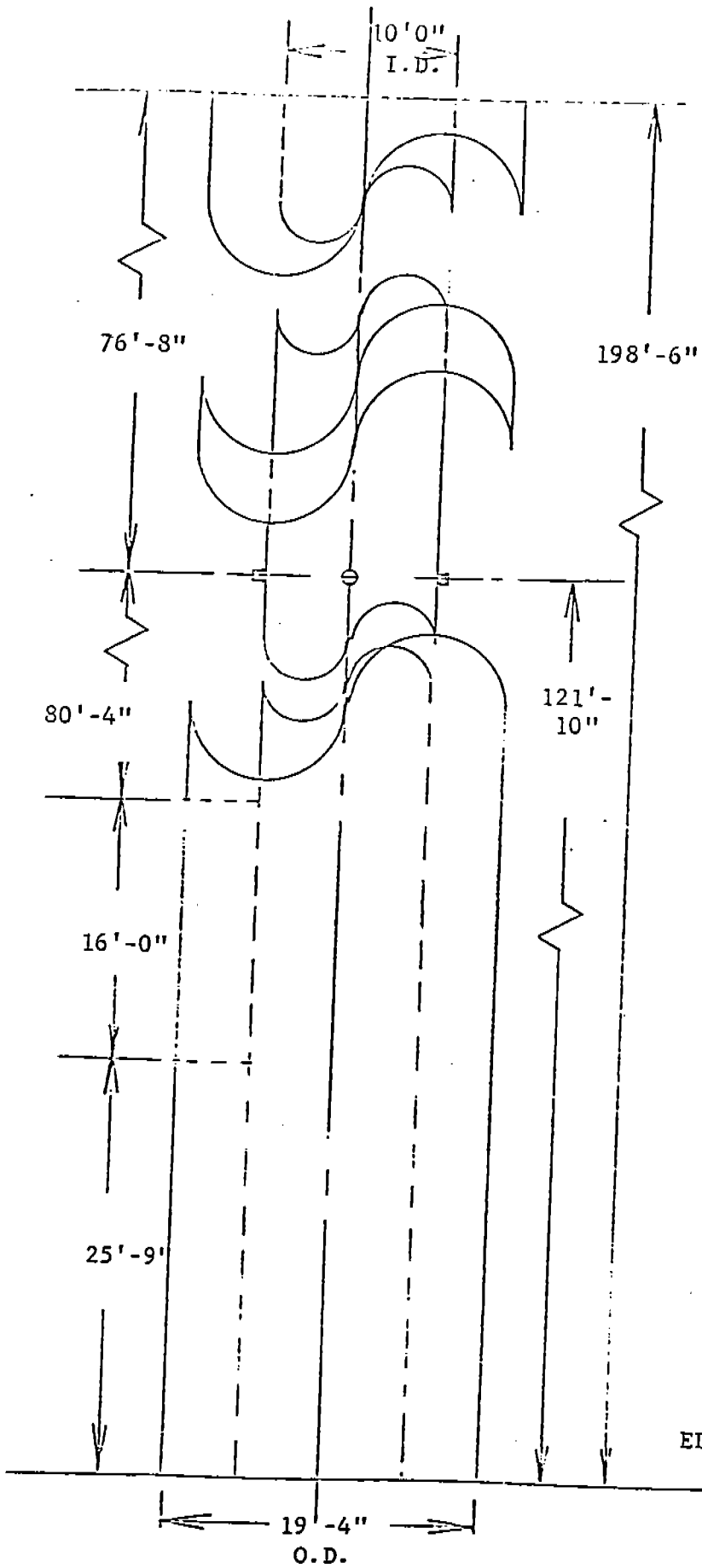
OLD PLANT



PLAN VIEW

CROSS SECTIONAL AREA - 35.78 Sq. Ft.

FIGURE 4
KILN STACK EMISSION SAMPLING

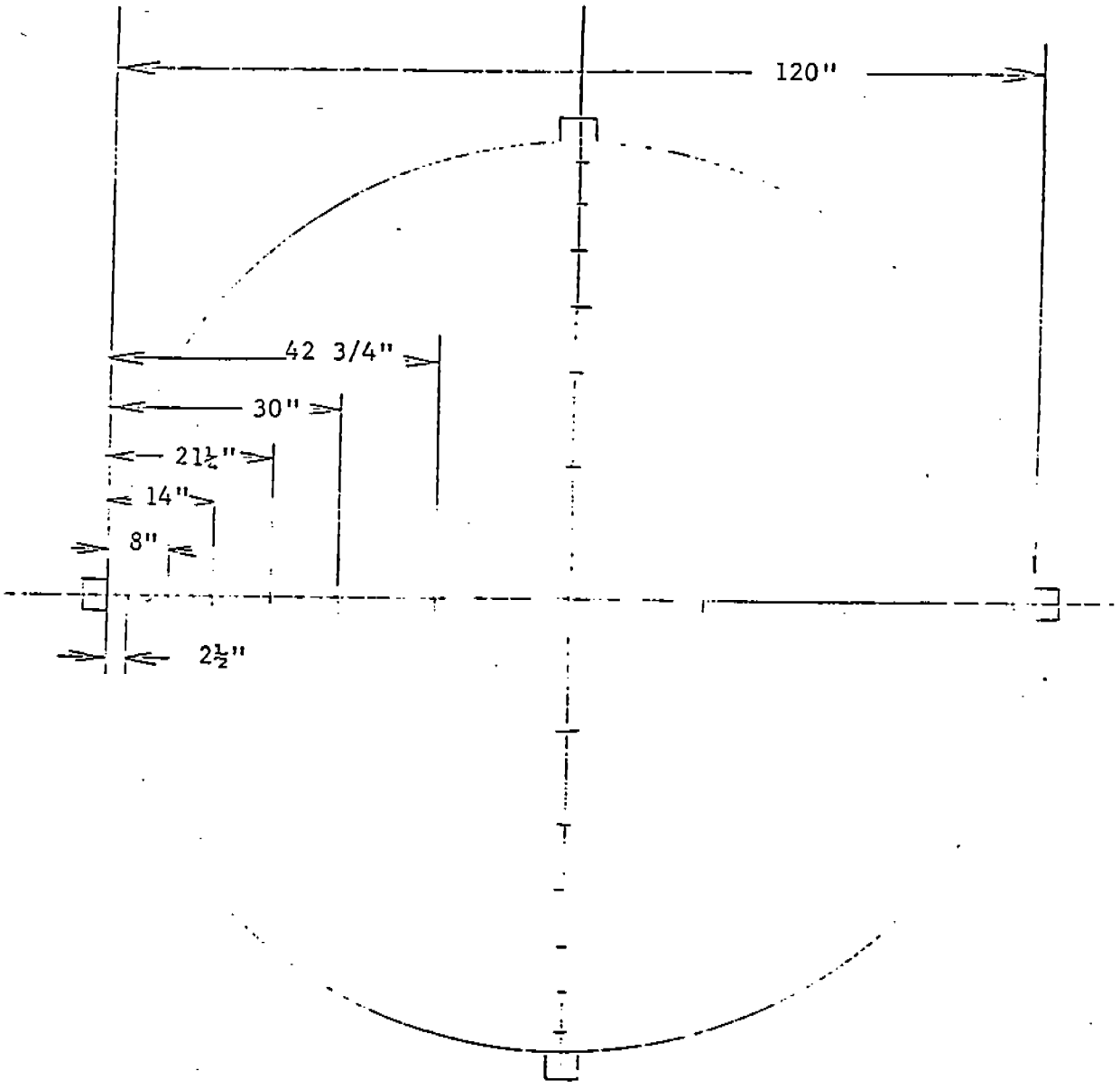


KILN STACK

VELOCITY & PARTICULATE

SAMPLING TRAVERSE

FIGURE 5



PLAN VIEW

CROSS SECTIONAL AREA = 78.5 SQ. FT.

SAMPLE CALCULATION FOR STACK RUN I

NOMENCLATURE

A_n	-	Cross-sectional area of sample nozzle, sq. ft.
A	-	Cross-sectional area of stack, ft.^{3}
B_{wo}	-	Proportion by volume of water vapor in the gas stream, dimensionless
C_p	-	Pitot tube coefficient, dimensionless
$C_{p\ std.}$	-	Pitot tube coef. of standard type tube @ .99
$C_{p\ test}$	-	Pitot tube coefficient of type "S" pitot tube
c'_s	-	Concentration of particulate matter in stack gas, gr./s.c.f. dry basis
c_s	-	Concentration of particulate matter in stack gas, lb/s.c.f.
D_s	-	Inside diameter of stack at sample port, Ft.
E	-	Particulate emission rate
ΔH	-	Average pressure drop across the orifice meter, inches H_2O
I	-	Percent of Iso Kinetic sampling. Test acceptable between 90% - I - 110%
K_p	-	85.48 $\frac{\text{ft.}}{\text{sec.}}$ $\frac{\text{lbs.}}{\text{lb-mole } ^\circ R}$
M_d	-	Dry molecular weight of stack gas
M_{H_2O}	-	Molecular weight of water, 18 lb/lb-mole
M_s	-	Molecular weight of stack gas (wet basis) lbs/lb-mole $M_d\ (1-B_{wo}) + 18\ B_{wo}$
M_n	-	Total amount of particule matter collected, mg.
P_{bar}	-	Barometric pressure at the orifice meter, inches Hg.
$P_{std.}$	-	Absolute pressure at standard conditions, 29.92 inches Hg.
P_s	-	Absolute stack gas pressure, inches Hg.

$\Delta P_{std.}$	-	Velocity head measured by standard type pitot tube
ΔP_{test}	-	Velocity head measured by type "S" pitot tube
$\sqrt{\Delta P}_{ave.}$	-	Ave. velocity head of stack gas, inches H_2O
Q_s	-	Volumetric flow rate, dry basis, standard conditions, $ft.^3/hr.$
R	-	Ideal gas constant
°R	-	Degrees of temperature, Rankin (F+460)
ρ_{H_2O}	-	Density of water, 1 gm./ml.
$(T_s)_{ave}$	-	Average absolute stack gas temperature, °R
$T_{std.}$	-	Absolute temperature at standard conditions, 530°R
T_m	-	Average dry gas meter temperature, °R
θ	-	Total sampling time, min.
$V_{m\ std.}$	-	Volume of gas sample through the dry gas meter (standard conditions), cu. ft.
$V_{s\ (ave)}$	-	Stack gas velocity, feet per second (f.p.s.)
V_m	-	Volume of gas sample through the dry gas meter (meter conditions) cu. ft.
V_{ic}	-	Total volume of liquid collected in impingers and silica gel
17.71	-	°R per inch. Hg @ std. cond. of 530 & 29.92
24.1	-	Liters water per gram-mole
28.3	-	Liters dry air per cu. ft.
1.667	-	100/60 min/sec
13.6	-	Specific gravity of mercury
$2.205X10^{-6}$	-	mg/lb.
0.0154	-	Grains per mg.
32	-	Molecular weight of oxygen

1. - Velocity of Stack Gas

$$V_s \text{ (ave)} = K_p \times C_p \times \sqrt{\Delta P_{ave.}} \times \sqrt{\frac{T_s \text{ ave.}}{P_s \times M_s}}$$

$$= (85.49)\ (0.83)\ (0.59) \times \sqrt{\frac{834}{(28.89)\ (28.63)}}$$

$$= \underline{42.02} \text{ ft/sec.}$$

2. - Volume of Gas (Actual) from Stack:

$$\text{Volume} = (V_s \text{ ave})\ (A)\ (60)$$
$$= (42.02)\ (78.5)\ (60)$$
$$= 198{,}000 \text{ACFM}$$

3. - Volume Dry Gas @Standard Conditions:

$$Q_s = 3600\ (1-B_{wo})\ (V_s \text{ ave.})\ (A)\ \left(\frac{T_{std}}{T_s \text{ ave.}}\right)\ \left(\frac{P_s}{P_{std}}\right)$$

$$= 3600\ (1-0.110)\ (42.02)\ (78.5)\ \left(\frac{530}{834}\right)\ \left(\frac{28.89}{29.92}\right)$$

$$= 6.48 \times 10^6 \text{ SCFH}$$

4. - Sample Gas Volume @Standard Conditions:

$$V_{m\ std.} = 17.71 \times V_m \left(\frac{P_{bar} + \Delta H/13.6}{T_m}\right)$$

$$= 17.71 \times 65.24 \times \left(\frac{28.85 + 0.75/13.6}{537}\right)$$

$$= 62.26 \text{ Cu. Ft.}$$

5. - Percent of Isokinetic - EPA Method:

$$I = \frac{(1.667 \times T_s)\left[(0.00267)\ (V_{ic}) + \left(\frac{V_m}{T_m}\ (P_{bar} + \Delta H/13.6)\right)\right]}{(\theta)\ (V_s)\ (P_s)\ (A_n)}$$

$$= \frac{(1.667)\ (834)\ [(0.00267)\ (169) + (3.516)]}{(144)\ (42.02)\ (28.89)\ (0.000289)}$$

$$= \underline{109.1}$$

% Isokinetic for all runs were calculated using the same method as above, and are presented in Table 8.

6. - Dust Concentration Calculations:

The particulate weight collected for Run No. 1 was 182.7 mg; therefore:

(a) Concentration in Grain/SCF is

$$= \frac{67.8}{V_{m\ std}} \times 0.0154$$

$$= \frac{67.8}{62.26} \times 0.0154$$

$$= \underline{0.0168} \text{ Grain/SCF}$$

(b) Concentration in Lb/SCF is:

$$= \frac{0.0168}{7000} = \underline{2.4 \times 10^{-6}} \text{ Lb/SCF}$$

(c) Concentration in Lb/Hr. is:

$$= 2.4 \times 10^{-6} \times Q_s$$

$$= (2.4 \times 10^{-6}) \times (6.48 \times 10^{6})$$

$$= \underline{15.5} \text{ Lb/Hr.}$$

(d) Concentration in mg/m^3 :

$$= 0.0168 \frac{\text{grain/SCF}}{\checkmark} \times 22\ 83 \text{ (conversion factor)}$$

$$= \frac{103}{39} \text{ mg/m}^3 \text{ @ Std. Cond.}$$

MATERIAL BALANCE CALCULATIONS

(Sample Calculation for Stack No. 5)

I - Fuel Consumption Calculation - Molal Basis

A. Coal Analysis

See Appendix for the copy of letter enclosed from Pittsburgh Testing Laboratory showing ultimate analysis of average sample gathered during testing, on the dry basis. Accordingly, ultimate coal analysis corrected for moisture of 7.13% is:

% Component	Dry Basis	Coal Mill Feed "as used"*
Carbon	74.56	69.24
Hydrogen	4.94	4.59
Nitrogen	0.03	0.03
Oxygen	7.14	6.63
Sulfur	1.78	1.65
Water	-	7.13
Ash	11.55	10.73

* "As used" refers to coal as fed to coal mill. Coal "as fired" would be coal condition after the coal mill via the burner pipe to the kiln and burning process.

B. Distribution of Combustable and Products

Line	Constituent	Lbs. per 100 Lbs. Coal	Mol. Wt. Divisor	Moles Fuel Constituent	O_2 Multiplier	O_2 Moles Theo. Req'd.	CO_2	SO_2	O_2	N_2	H_2O
		Fuel, Oxygen & Air per 100 Lbs. Coal					Moles/100 Lbs. Coal As Used				
1	C to CO_2	69.24	12	5.77	1	5.77	5.77	- -	- -	- -	- -
2	H_2 to H_2O	4.59	2	2.30	0.5	1.15	- -	- -	- -	- -	2.30
3	S to SO_2	1.65	32	0.05	1	0.05	- -	0.05	- -	- -	- -
4	O_2 (Deduct)	6.63	32	0.21	---	0.21	- -	- -	- -	- -	- -
5	N_2	0.03	28	0.00	---	0	- -	- -	- -	0.00	- -
6	Water	7.13	18	0.40	---	0	- -	- -	- -	- -	0.40
7	Ash	10.73	--	- -	---	0	- -	- -	- -	- -	- -
8	Total	100	--	- -	---	7.18	5.77	0.05	- -	0.00	2.70
9	Therfore, O_2 required, Line 8 -7.18										
10	Recall, Mole Ratio of N_2 to O_2 in Air is 3.76										
11	Then, N_2 with Air - 7.18 x 79/21 = 27.01									27.01	
12	Dry Air supplied (Line 9+11) - 7.18 + 27.01 = 34.19										
13	H_2O in Air - *0.0195 x 34.19 = 0.67										0.67
14	Wet Air supplied (Line 12+13) - 34.86										
15	Flue Gas Constituents (Line 1 to 14) Total						5.77	0.05		27.01	3.37

Total Moles Dry Flue Gas / 100 Lbs. Coal As Used - 32.83

Total Moles Wet Flue Gas / 100 Lbs. Coal As Used - 36.20

*Molal Humidity For Ambient Air @ 68°F & 82 % Relative Humidity

- Theoretical Combustion Gas Quantities (No Excess Air)

1. - The average fuel coal used by kiln #1 during testing was 9.4 T/Hr., or:

$$\frac{(9.4)(2000)}{(60)} = 313 \text{ Lb/min.}$$

Accordingly, 100 lbs. coal supplies fuel for:

$$\frac{100}{313} = 0.319 \text{ min. of kiln operation}$$

2. - Therefore, referring to I-B:
(a) Theoretical dry air supplied for total combustion:

$$\frac{(32.20)(387)}{(0.319)} = 39045 \text{ SCFM}$$

(Standard Conditions: 70° F and 29.92 in. Hg.)

Wet Air Supplied:

$$\frac{(32.83)(387)}{(0.319)} = 39806.38 \text{ SCFM}$$

H_2O in air = 39806 - 39045
= 761 SCFM

(b) Flue Gas Components:

$$CO_2 = \frac{(5.77)(44)}{(0.319)} = \underline{795.49} \text{ Lb/min.}$$

$$H_2O = \frac{(3.37)(18)}{(0.319)} = \underline{183.02} \text{ Lb/min.}$$

$$N_2 = \frac{(27.01)(28)}{(0.319)} = \underline{2231.81} \text{ Lb/min.}$$

$$SO_2 = \frac{(0.05)(64)}{(0.319)} = \underline{10.34} \text{ Lb/min.}$$

3. - Breakdown of Water Source:

(a) Combustion Water:

$$\frac{(2.30)(18)}{(0.319)} = 129.44 \text{ Lb/min.}$$

(b) Water in coal as used:

$$\frac{(0.323)(18)}{(0.319)} = 18.17 \text{ Lb/min.}$$

(3) Water in supplied air:

$$\frac{(0.628)(18)}{(0.319)} = \underline{35.41} \text{ Lb/min.}$$

TOTAL 183 Lb/min., for combustion process

III - Other Sources for CO_2 and H_2O :

(a) Liberation of CO_2 from kiln feed:

Average raw mix feed rate during test was 102.3 T/hr. or 3410 Lb/min. dry solids;
Kiln feed chemical analysis (Table 10) was used to determine the available CO_2 liberated from $CaCO_3$ and $MgCO_3$:

$$(\%\ CaO) \times \frac{100}{56} = (\%\ CaCO_3)$$

$$= (42.85) \times \frac{100}{56} = 76.52\ \%\ CaCO_3$$

$$(\%\ MgO) \times \frac{84}{40} = (\%\ MgCO_3)$$

$$= (2.15) \times \frac{84}{40} = 4.52\%\ MgCO_3$$

From $CaCO_3$, CO_2 $= \frac{(76.52)\ (44)}{(100)} = 33.67$ Lb/100 Lb. kiln feed

From $MgCO_3$, CO_2 $= \frac{(4.52)\ (44)}{(84)} = 2.37$ Lb/100 Lb. kiln feed

Total CO_2 = 36.03 Lb/100 Lb. kiln feed
or,
CO_2 liberated from kiln feed $= \frac{(36.03)\ (3410)}{(100)}$

$= \underline{1228}$ Lb/min.

(b) H_2O from kiln feed and cooling process:

Average moisture in kiln feed is 0.34 %, therefore water from kiln feed:

$$785 \times \frac{(0.34)}{(100-0.34)} = \underline{11.63}\ \text{Lb/min.}$$

During normal operation conditions, Roanoke Plant used approximately 22.5 Gal/min. of water to cool kiln exit gases. Water from cooling process:

$(49.5)(8.33) = \underline{412}$ Lb/min.

IV - Theoretical Kiln Exit Gas (No Excess Air)

1. - Total Exit Gas Quantities (per min. of kiln operation)

Source	CO_2 (Lb)	H_2O (Lb)	N_2 (Lb)
(a) Combustion Process	795.49	183.02	2231.81
(b) Kiln Feed Liberation	1228.72	11.63	-
(c) Cooling Process	-	412.34	-
TOTAL	2024.21	606.99	2231.81

2. - Exit Gas Analysis - Wet Basis

CO_2 (moles) $= \frac{2024.21}{44} = 46.00$

H_2O (moles) $= \frac{606.99}{18} = 33.72$

N_2 (moles) $= \frac{2231.81}{28} = 79.70$

TOTAL 159.43 Moles/min.

Hence:

$CO_2 = \frac{46.00}{159.43} = 28.86\%$

$H_2O = \frac{33.72}{159.42} = 21.15\%$

$N_2 = \frac{79.70}{159.43} = 49.99\%$

3. - Exit Gas Analysis - Dry Basis

$CO_2 = \frac{28.86}{(100-21.15)} = 36.60\%$

$N_2 = \frac{49.99}{(100-21.15)} = 63.40\%$

4. - Theoretical Exit Gas Volume:

At standard conditions ($70^{\circ}F$ and 29.92 "Hg)

Volume = (159.43)(387) = 61701 SCFM (wet)

or = (61701)(100-21.15) = 48650 SCFM (dry)

V - Actual Stack Gas at Sampling Ports (Calculated):

1. - Exhaust gas included not only theoretical combustion flue gas but also excess air for actual combustion and infiltrated air at location such as kiln exit, precipitator, etc. From here forward, the term "Excess Air" will be used to indicate "Excess and Infiltrated Air".

2. - Average Orsat Analysis taken from exhaust gas is showing along with theoretical gas analysis:

Orsat Analysis (Dry)		Theoretical Analysis (Dry)	
CO_2 -	10.8	CO_2 -	36.60
O_2 -	14.85	O_2 -	0
N_2 -	74.35	N_2 -	63.40

3. - Excess Air Calculation:

(a) CO_2 Balance (using above analysis)

(Vol. Comb. Gas) (% CO_2) + (Vol. Excess Air) (%CO_2) = (Vol. Actual Gas) (%CO_2)

Let X = Vol. Combustion Gas (Relative)
(100-X) = Vol. Excess Air (Relative)
100 = Vol. Actual Gas (Relative)

then,

$$(X)\ (36.60) = (100-X)\ (0) = (100)\ (\ 10.8$$
$$63.40\ X = 1080$$
$$X = 29.51\%\ \text{(Comb. Gas)}$$
$$(100-X) = 70.49\%\ \text{(Excess Air)}$$

From IV-4 above, the theoretical dry exit gas was 48650 SCFM, therefore actual kiln exit gas (dry) would be:

$$\frac{48650}{0.2951} = 164850 \quad \text{SCFM (dry)}$$

and Excess Air: 164850 - 48650.70
= 116199 SCFM (dry)

(b) Oxygen Balance (using above analysis)

(Vol. Comb. Gas) (% O_2) + (Vol. Excess Air) (% O_2) = (Vol. Actual Gas) (% O_2)

Using the same symbol X as above,

$(X)(0) = (100-X)(21)$ $= (100)(14.85)$

$X = \frac{2100 - 1485}{21}$

$= 29.29\%$ (Comb. Gas)

$(100-X) = 70.71\%$ (Excess Air)

Hence,

Actual kiln exit gas volume $= \frac{48650}{0.2929}$

$= 166124$ SCFM (dry)

Excess Air $= (166124) - 48650$

$= 117473$ SCFM (dry)

(c) Reconciliation of Balance:

The CO_2 and O_2 balance should give the same quantity of excess air for a given location. They did not agree exactly due to experimental error, but the average of the balances may represent the true condition;

(Average) Excess Air $= \frac{116199 + 117473}{2}$

$= 116836$ SCFM (dry)

4. - Excess Air Components:

Lb/min. of kiln operation:

$O_2 = \frac{(116836)(.21)(32)}{(387)} = 2028$ Lb/min.

$N_2 = \frac{(116836)(.79)(28)}{(387)} = 6678$ Lb/min.

$H_2O = \frac{(116836)(0.0195)(18)}{(387)} = 105$ Lb/min

or $(116836)(0.0195) = 2278$ SCFM

(Recall was the average molal humidity of air @ testing period)

5. - Actual Stack Exit Gas Volume:

(a) Theoretical kiln exit gas (IV-4) $= 61701$ SCFM (wet)

(b) Excess Air (V-3 and V-4) $= 116836 \div 2278$

$= 119115.05$ SCFM (wet)

(c) Actual Stack Exit Gas @ Standard conditions ($70^{\circ}F$ and 29.92 "Hg) $= 61701 \div 119115$

$= 180816$ SCFM (wet)

(d) Actual Stack Exit Gas @ Stack conditions ($332^{\circ}F$ and 28.87 "Hg) $= \frac{(180816.10)(792)(29.92)}{(530)(28.87)}$

$= 280027$ ACFM (wet)

VI - Actual Stack Gas (Measured)

1. - Gas Volume:
Average volume of stack gas measured was 288600 ACFM (wet) @ average stack conditions of 332 ^{o}F (or 792 ^{o}R) and 28.87 "Hg. Therefore, at standard conditions (70 ^{o}F and 29.92 "Hg.), stack gas volume is:

$$\frac{(288600)\ (530)\ (28.87)}{(792)\ (29.92)} = 186351 \quad \text{SCFM (wet)}$$

2. - Gas Components:

(a) On the average, 12.7 % of stack gas was water vapor based on condensate collected during test. This was 12.7 % by volume since we compared moisture content of stack gas while water was in vapor state. Therefore, stack gas contained:

$$(186351)\ (0.127) = 23666 \quad \text{SCFM}$$

or,

$$\frac{(23666)\ (18)}{(387)} = 1100 \text{ Lb/min.}$$

(b) Orsat analysis shows 10.8% CO_2, 14.85% O_2, and 74.35% N_2 on the dry basis. With 12.7% H_2O, the analysis can be reported on the wet basis as follows:

CO_2	:	(10.8) (1-0.127)	= 9.43
O_2	:	(14.85) (1- 0.127)	= 12.96
N_2	:	(74.35) (1- 0.127)	= 64.91
H_2O	:		= 12.70
		TOTAL	100

(c) From VI-1 above, the total volume of stack gas was measured as 186351 SCFM (wet). The rate of each gaseous component emitted from the stack can be calculated as follows:

$$CO_2 = \frac{(186351)\ (0.0943)\ (44)}{(387)} = 1997 \text{ Lb/min.}$$

$$O_2 = \frac{(186351)\ (0.1296)\ (32)}{(387)} = 1997 \text{ Lb/min.}$$

$$N_2 = \frac{(186351)\ (0.6491)\ (28)}{(387)} = 8751 \text{ Lb/min.}$$

H_2O = 1100 Lb/min. (from VI - 2(a))

VII - Gas Balance:

(1) CO_2 :

CO_2 Input = 2024 Lb/min. (from IV - 1)
CO_2 Output = 1997 Lb/min. (from VI - 2 - c)

Measuring Efficiency ($^O/I$) = 98.69 %

(2) O_2 :

O_2 Input = 2028 Lb/min. (from V-4)
O_2 Output = 1997 Lb/min. (from VI-2-c)

Measuring Efficiency ($^O/I$) = 98.46 %

(3) N_2 :

N_2 Input = 8909 Lb/min. (from IV-1 and V-4)
N_2 Output = 8751 Lb/min. (from VI-2-c)

Measuring Efficiency ($^O/I$) = 98.22 %

(4) Water:

H_2O Input = 712 Lb/min. (from IV-1 and V-4)
H_2O Output = 1100 Lb/min. (from VI-2-c)

Measuring Efficiency ($^O/I$) = 154.3%

(5) Total Gas Volume:

Calculated Gas Volume = 280027 ACFM (from V-5)
Measured Gas Volume = 288600 ACFM (from VI-1)
Measuring Efficiency = 103 %

MATERIAL BALANCE CALCULATIONS FOR KILN OPERATED WITH COAL AS FUEL

EMISSION TESTING AT ROANOKE PLANT, July - Oct./1979

RUNS 45, 46, 47, 48, 49, and 50 (Stack No. 1)

DATA INPUT

CARBON WEIGHT% IN COAL= 69.24
HYDROGEN WEIGHT% IN COAL= 4.59
NITROGEN WEIGHT% IN COAL= 0.03
OXYGEN WEIGHT% IN COAL= 6.63
SULFUR WEIGHT% IN COAL= 1.65
WATER WEIGHT% IN COAL= 7.13
CAO WEIGHT% IN RAW MIX = 43.03
MGO WEIGHT% IN RAW MIX = 2.10
H2O RATE FOR COOLING PROCESS, GAL/MIN = 24.0
H2O% IN KILN FEED = 0.46
CO2 VOL.%, ORSAT ANALYSIS = 13.13
OXY VOL.%, ORSAT ANALYSIS = 12.20
N2 VOL.%, ORSAT ANALYSIS = 74.67
AVE.RAW FEED, TON/HR = 21.2
AVE.CLINKER PRODUCED, TON/HR = 14.1
AVE.FUEL COAL RATE, TON/HR= 3.4
MOLAL HUMIDITY OF AMBIENT AIR = 1.95000000E-02
AVE.VOL.OF STACK GAS (WET), ACFM = 65700
AVE.VOL.% OF H2O IN STACK GAS = 17.4
AVE.TEMP.OF STACK GAS, DEG.R = 861
AVE.PRES.OF STACK GAS, IN.HG.= 28.68

RESULTS

BASIS 100 LB FUEL COAL (AS USED)

THEORETICAL AIR REQUIRED :
DRY AIR = 14122.66 SCFM
WET AIR = 14398.05 SCFM

EXCESS AIR CALCULATED :
BASED ON CO2 BALANCE, DRY = 20439.36 SCFM
BASED ON OXY BALANCE, DRY = 22089.03 SCFM
AVERAGE, DRY = 21264.19 SCFM
AVERAGE, WET = 21678.84 SCFM

CARBON DIOXIDE BALANCE :

CO2 LIBERATED FROM RAW MIX	=	255.24	LB/MIN
TOTAL INPUT	=	542.97	LB/MIN
CO2 MEASURED FROM STACK	=	478.02	LB/MIN
TOTAL OUTPUT	=	478.02	LB/MIN
MEASURING EFFICIENCY (O/I)	=	88.04	%

OXYGEN BALANCE :

O2 IN EXCESS AIR	=	369.24	LB/MIN
TOTAL INPUT	=	369.24	LB/MIN
O2 MEASURED FROM STACK	=	323.02	LB/MIN
TOTAL OUTPUT	=	323.02	LB/MIN
MEAS. EFFICIENCY (O/I)	=	87.48	%

NITROGEN BALANCE :

N2 IN COMBUSTION AIR	=	807.25	LB/MIN
N2 IN EXCESS AIR	=	1215.4	LB/MIN
TOTAL INPUT	=	2022.66	LB/MIN
N2 MEASURED FROM STACK	=	1729.93	LB/MIN
TOTAL OUTPUT	=	1729.93	LB/MIN
MEAS. EFFICIENCY (O/I)	=	85.53	%

WATER BALANCE :

H2O FROM COMBUSTION PROCESS	=	46.82	LB/MIN
H2O IN COMBUSTION AIR	=	12.81	LB/MIN
H2O IN EXCESS AIR	=	19.29	LB/MIN
H2O FROM COOLING PROCESS	=	199.92	LB/MIN
H2O IN FUEL COAL	=	8.08	LB/MIN
H2O IN KILN FEED	=	3.27	LB/MIN
TOTAL INPUT	=	290.18	LB/MIN
H2O MEASURED FROM STACK	=	313.74	LB/MIN
TOTAL OUTPUT	=	313.74	LB/MIN
MEASURING EFFICIENCY (O/I)	=	108.12	%

TOTAL THEO. VOLUME OF STACK GAS (WET)	=	43436.12	SCFM
TOTAL MEAS. VOLUME OF STACK GAS (WET)	=	38766.42	SCFM
TOTAL GAS MEAS. EFFICIENCY	=	89.25	%

MATERIAL BALANCE CALCULATIONS FOR KILN OPERATED WITH COAL AS FUEL

EMISSION TESTING AT ROANOKE PLANT, July - Oct./1979

RUNS 51, 52, 53, 54, 55, and 56 (Stack No. 3)

DATA INPUT

CARBON WEIGHT% IN COAL= 69.24
HYDROGEN WEIGHT% IN COAL= 4.59
NITROGEN WEIGHT% IN COAL= 0.03
OXYGEN WEIGHT% IN COAL= 6.63
SULFUR WEIGHT% IN COAL= 1.65
WATER WEIGHT% IN COAL= 7.3
CAO WEIGHT% IN RAW MIX = 43.03
MGO WEIGHT% IN RAW MIX = 2.10
H2O RATE FOR COOLING PROCESS, GAL/MIN =25
H2O% IN KILN FEED = 0.51
CO2 VOL.%, ORSAT ANALYSIS = 12.93
OXY VOL.%, ORSAT ANALYSIS = 12.20
N2 VOL.%, ORSAT ANALYSIS = 74.87
AVE.RAW FEED, TON/HR = 21.6
AVE.CLINKER PRODUCED, TON/HR = 14.4
AVE.FUEL COAL RATE, TON/HR= 2.8
MOLAL HUMIDITY OF AMBIENT AIR = 195000000E-02
AVE.VOL.OF STACK GAS (WET), ACFM = 60700
AVE.VOL.% OF H2O IN STACK GAS = 16.5
AVE.TEMP.OF STACK GAS, DEG.R = 880
AVE.PRES.OF STACK GAS, IN.HG.= 28.54

RESULTS

BASIS 100 LB FUEL COAL (AS USED)

THEORETICAL AIR REQUIRED :
DRY AIR = 11630.43 SCFM
WET AIR = 11857.22 SCFM

EXCESS AIR CALCULATED :
BASED ON CO2 BALANCE, DRY = 20248.78 SCFM
BASED ON OXY BALANCE, DRY = 18798.93 SCFM
AVERAGE, DRY = 19523.85 SCFM
AVERAGE, WET = 19904.57 SCFM

CARBON DIOXIDE BALANCE :

CO2 FROM COMBUSTION

CO2 LIBERATED FROM RAW MIX	=	260.06	LB/MIN
TOTAL INPUT	=	497.01	LB/MIN
CO2 MEASURED FROM STACK	=	428.06	LB/MIN
TOTAL OUTPUT	=	428.06	LB/MIN
MEASURING EFFICIENCY (O/I)	=	86.13	%

OXYGEN BALANCE :

O2 IN EXCESS AIR	=	339.02	LB/MIN
TOTAL INPUT	=	339.02	LB/MIN
O2 MEASURED FROM STACK	=	293.74	LB/MIN
TOTAL OUTPUT	=	293.74	LB/MIN
MEAS. EFFICIENCY (O/I)	=	86.64	%

NITROGEN BALANCE :

N2 IN COMBUSTION AIR	=	664.80	LB/MIN
N2 IN EXCESS AIR	=	1115.94	LB/MIN
TOTAL INPUT	=	1780.73	LB/MIN
N2 MEASURED FROM STACK	=	1577.30	LB/MIN
TOTAL OUTPUT	=	1577.30	LB/MIN
MEAS. EFFICIENCY (O/I)	=	88.58	%

WATER BALANCE :

H2O FROM COMBUSTION PROCESS	=	38.56	LB/MIN
H2O IN COMBUSTION AIR	=	10.55	LB/MIN
H2O IN EXCESS AIR	=	17.71	LB/MIN
H2O FROM COOLING PROCESS	=	208.25	LB/MIN
H2O IN FUEL COAL	=	6.81	LB/MIN
H2O IN KILN FEED	=	3.69	LB/MIN
TOTAL INPUT	=	285.57	LB/MIN
H2O MEASURED FROM STACK	=	267.62	LB/MIN
TOTAL OUTPUT	=	267.62	LB/MIN
MEASURING EFFICIENCY (O/I)	=	93.72	%

TOTAL THEO. VOLUME OF STACK GAS (WET)	=	39223.41	SCFM
TOTAL MEAS. VOLUME OF STACK GAS (WET)	=	34871.79	SCFM
TOTAL GAS MEAS. EFFICIENCY	=	88.91	%

MATERIAL BALANCE CALCULATIONS FOR KILN OPERATED WITH COAL AS FUEL

EMISSION TESTING AT ROANOKE PLANT, July - October/1979

RUNS 39, 40, 41, 42, 43, and 44 (Stack No. 4)

DATA INPUT

CARBON WEIGHT% IN COAL= 69.24
HYDROGEN WEIGHT% IN COAL= 4.59
NITROGEN WEIGHT% IN COAL= 0.03
OXYGEN WEIGHT% IN COAL= 6.63
SULFUR WEIGHT% IN COAL= 1.65
WATER WEIGHT% IN COAL= 6.1
CAO WEIGHT% IN RAW MIX = 43.03
MGO WEIGHT% IN RAW MIX = 2.10
H2O RATE FOR COOLING PROCESS, GAL/MIN = 26
H2O% IN KILN FEED = 0.40
CO2 VOL.%, ORSAT ANALYSIS = 16.93
OXY VOL.%, ORSAT ANALYSIS = 10
N2 VOL.%, ORSAT ANALYSIS = 73.07
AVE.RAW FEED, TON/HR = 27.9
AVE.CLINKER PRODUCED, TON/HR = 19.0
AVE.FUEL COAL RATE, TON/HR= 3.0
MOLAL HUMIDITY OF AMBIENT AIR = 1.95000000E-02
AVE.VOL.OF STACK GAS (WET), ACFM = 70900
AVE.VOL.% OF H2O IN STACK GAS = 13.7
AVE.TEMP.OF STACK GAS, DEG.R = 873
AVE.PRES.OF STACK GAS, IN.HG.= 28.91

RESULTS

BASIS 100 LB FUEL COAL (AS USED)

THEORETICAL AIR REQUIRED :
DRY AIR = 12461.17 SCFM
WET AIR = 12704.16 SCFM

EXCESS AIR CALCULATED :
BASED ON CO2 BALANCE, DRY = 15608.47 SCFM
BASED ON OXY BALANCE, DRY = 13665.64 SCFM
AVERAGE, DRY = 14637.05 SCFM
AVERAGE, WET = 14922.48 SCFM

CARBON DIOXIDE BALANCE :

CO2 FROM COMBUSTION PROCESS = 253.88 LB/MIN

CO2 LIBERATED FROM RAW MIX	=	335.91	LB/MIN
TOTAL INPUT	=	589.79	LB/MIN
CO2 MEASURED FROM STACK	=	690.88	LB/MIN
TOTAL OUTPUT	=	690.88	LB/MIN
MEASURING EFFICIENCY (O/I)	=	117.14	%

OXYGEN BALANCE :

O2 IN EXCESS AIR	=	254.16	LB/MIN
TOTAL INPUT	=	254.16	LB/MIN
O2 MEASURED FROM STACK	=	296.79	LB/MIN
TOTAL OUTPUT	=	296.79	LB/MIN
MEAS. EFFICIENCY (O/I)	=	116.77	%

NITROGEN BALANCE :

N2 IN COMBUSTION AIR	=	712.28	LB/MIN
N2 IN EXCESS AIR	=	836.62	LB/MIN
TOTAL INPUT	=	1548.90	LB/MIN
N2 MEASURED FROM STACK	=	1897.54	LB/MIN
TOTAL OUTPUT	=	1897.54	LB/MIN
MEAS. EFFICIENCY (O/I)	=	122.51	%

WATER BALANCE :

H2O FROM COMBUSTION PROCESS	=	41.31	LB/MIN
H2O IN COMBUSTION AIR	=	11.30	LB/MIN
H2O IN EXCESS AIR	=	13.28	LB/MIN
H2O FROM COOLING PROCESS	=	216.58	LB/MIN
H2O IN FUEL COAL	=	6.10	LB/MIN
H2O IN KILN FEED	=	3.73	LB/MIN
TOTAL INPUT	=	292.30	LB/MIN
H2O MEASURED FROM STACK	=	265.02	LB/MIN
TOTAL OUTPUT	=	265.02	LB/MIN
MEASURING EFFICIENCY (O/I)	=	90.67	%

TOTAL THEO. VOLUME OF STACK GAS (WET)	=	35953.76	SCFM
TOTAL MEAS. VOLUME OF STACK GAS (WET)	=	41590.52	SCFM
TOTAL GAS MEAS. EFFICIENCY	=	115.68	%

MATERIAL BALANCE CALCULATIONS FOR KILN OPERATED WITH COAL AS FUEL

EMISSION TESTING AT ROANOKE PLANT, July - October/1979

RUNS 7, 8, 10, 12, and 14 (Stack No. 5)

DATA INPUT

CARBON WEIGHT% IN COAL= 69.24
HYDROGEN WEIGHT% IN COAL= 4.59
NITROGEN WEIGHT% IN COAL= 0.03
OXYGEN WEIGHT% IN COAL= 6.63
SULFUR WEIGHT% IN COAL= 1.65
WATER WEIGHT% IN COAL= 5.8
CAO WEIGHT% IN RAW MIX = 42.85
MGO WEIGHT% IN RAW MIX = 2.15
H2O RATE FOR COOLING PROCESS, GAL/MIN = 49.5
H2O% IN KILN FEED = 0.34
CO2 VOL.%, ORSAT ANALYSIS = 10.8
OXY VOL.%, ORSAT ANALYSIS = 14.85
N2 VOL.%, ORSAT ANALYSIS = 74.35
AVE.RAW FEED, TON/HR = 102.3
AVE.CLINKER PRODUCED, TON/HR = 64.3
AVE.FUEL COAL RATE, TON/HR= 9.4
MOLAL HUMIDITY OF AMBIENT AIR = 1.95000000E-02
AVE.VOL.OF STACK GAS (WET), ACFM = 288600
AVE.VOL.% OF H2O IN STACK GAS = 12.7
AVE.TEMP.OF STACK GAS, DEG.R = 792
AVE.PRES.OF STACK GAS, IN.HG.= 28.87

RESULTS

BASIS 100 LB FUEL COAL (AS USED)

THEORETICAL AIR REQUIRED :
DRY AIR = 39045.00 SCFM
WET AIR = 39806.38 SCFM

EXCESS AIR CALCULATED :
BASED ON CO2 BALANCE, DRY = 116199.82 SCFM
BASED ON OXY BALANCE, DRY = 117473.65 SCFM
AVERAGE, DRY = 116836.74 SCFM
AVERAGE, WET = 119115.05 SCFM

CARBON DIOXIDE BALANCE :

CO2 FROM COMBUSTION PROCESS = 795.40 LB/HR

CO2 LIBERATED FROM RAW MIX	= 1228.72	LB/MIN
TOTAL INPUT	= 2024.21	LB/MIN
CO2 MEASURED FROM STACK	= 1997.62	LB/MIN
TOTAL OUTPUT	= 1997.62	LB/MIN
MEASURING EFFICIENCY (O/I)	= 98.69	%

OXYGEN BALANCE :

O2 IN EXCESS AIR	= 2028.79	LB/MIN
TOTAL INPUT	= 2028.79	LB/MIN
O2 MEASURED FROM STACK	= 1997.62	LB/MIN
TOTAL OUTPUT	= 1997.62	LB/MIN
MEAS. EFFICIENCY (O/I)	= 98.46	%

NITROGEN BALANCE :

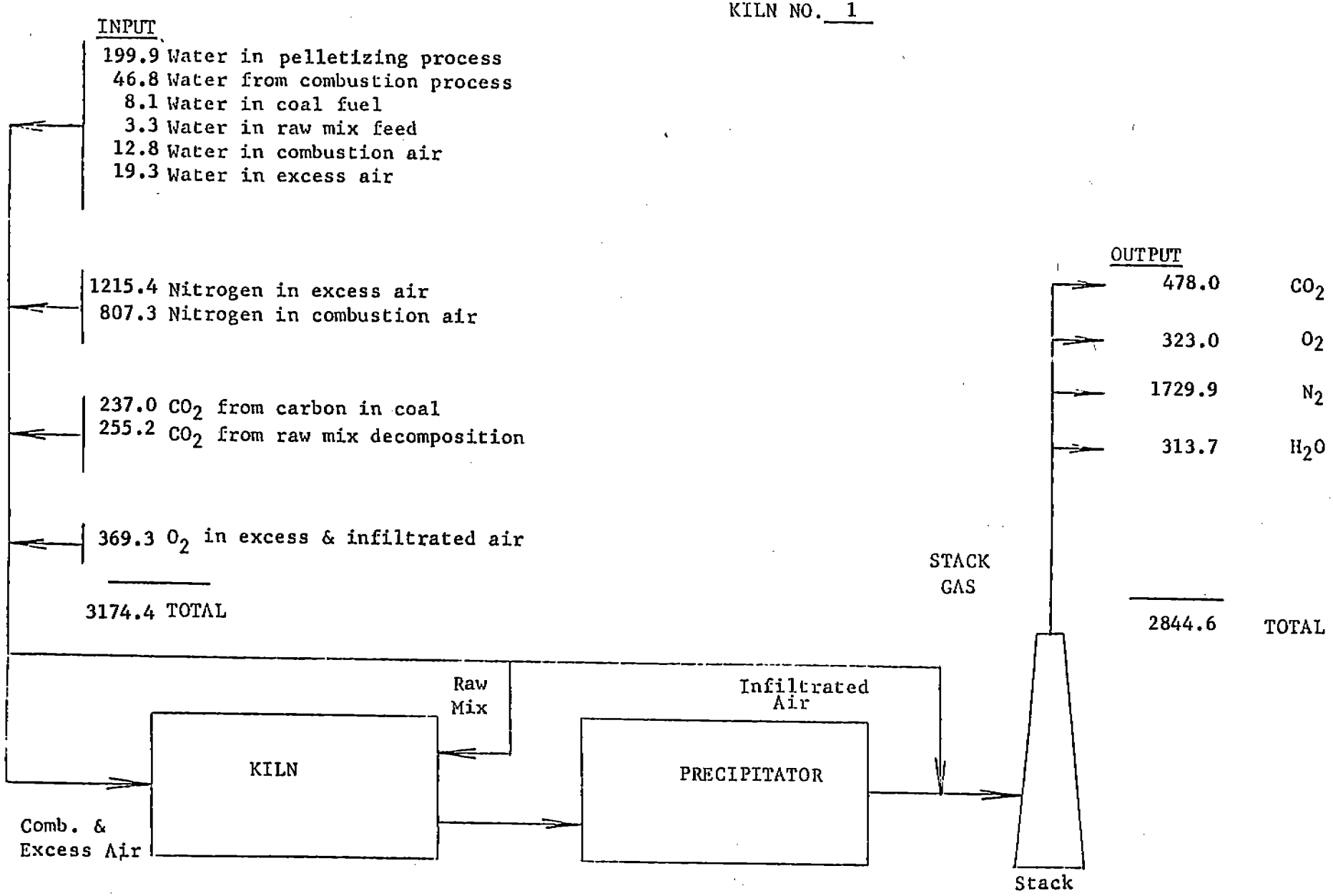
N2 IN COMBUSTION AIR	= 2231.81	LB/MIN
N2 IN EXCESS AIR	= 6678.11	LB/MIN
TOTAL INPUT	= 8909.92	LB/MIN
N2 MEASURED FROM STACK	= 8751.34	LB/MIN
TOTAL OUTPUT	= 8751.34	LB/MIN
MEAS. EFFICIENCY (O/I)	= 98.22	%

WATER BALANCE :

H2O FROM COMBUSTION PROCESS	= 129.44	LB/MIN
H2O IN COMBUSTION AIR	= 35.41	LB/MIN
H2O IN EXCESS AIR	= 105.97	LB/MIN
H2O FROM COOLING PROCESS	= 412.34	LB/MIN
H2O IN FUEL COAL	= 18.17	LB/MIN
H2O IN KILN FEED	= 11.63	LB/MIN
TOTAL INPUT	= 712.96	LB/MIN
H2O MEASURED FROM STACK	= 1100.77	LB/MIN
TOTAL OUTPUT	= 1100.77	LB/MIN
MEASURING EFFICIENCY (O/I)	= 154.39	%

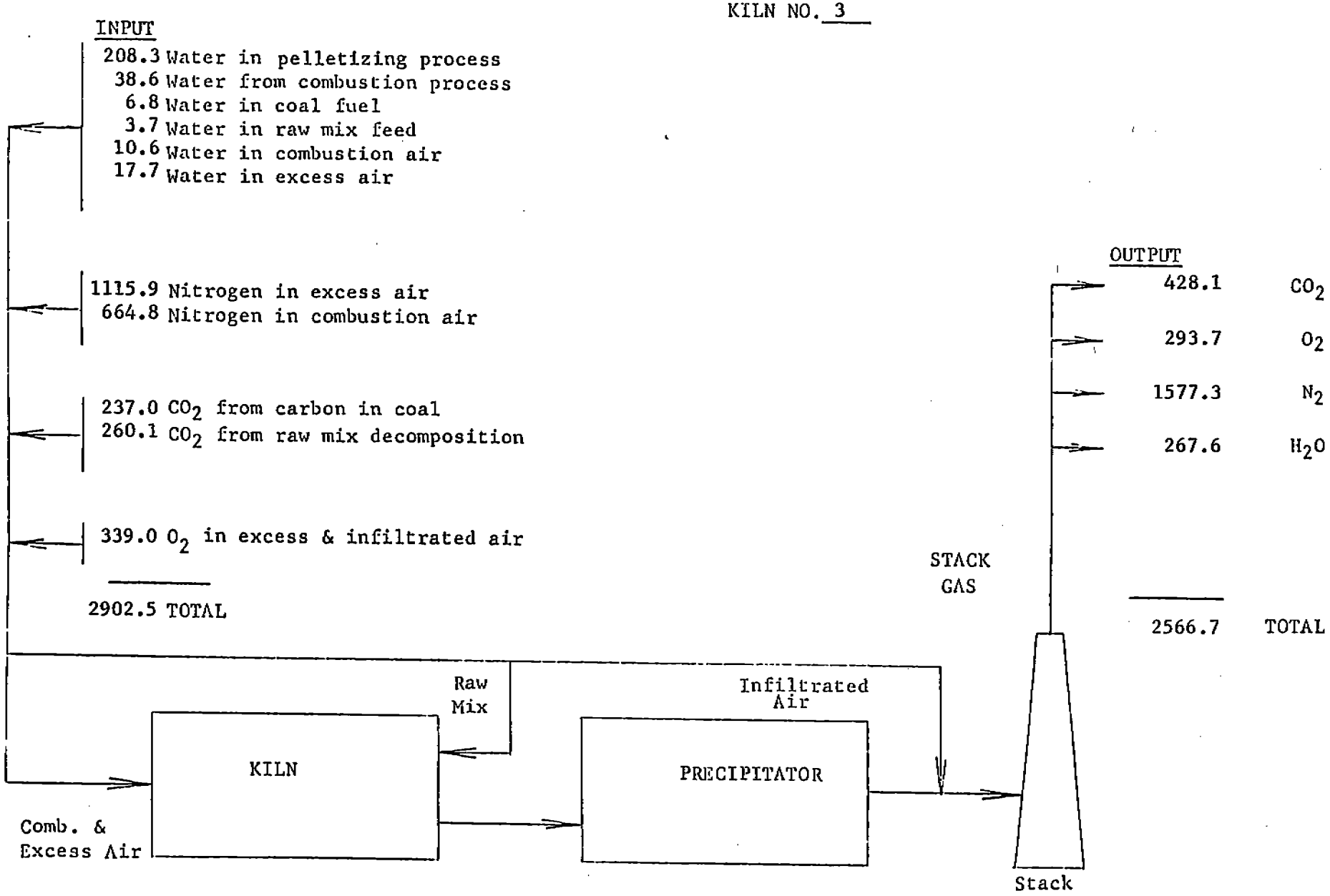
TOTAL THEO. VOLUME OF STACK GAS (WET)	= 180816.10	SCFM
TOTAL MEAS. VOLUME OF STACK GAS (WET)	= 186351.21	SCFM
TOTAL GAS MEAS. EFFICIENCY	= 103.06	%

STACK EMISSIONS
SUMMARY SCHEMATIC
UNITS: LB/MIN.
KILN NO. 1



MEASURING EFFICIENCY = $\frac{2844.6}{3174.4}$ = 89.6

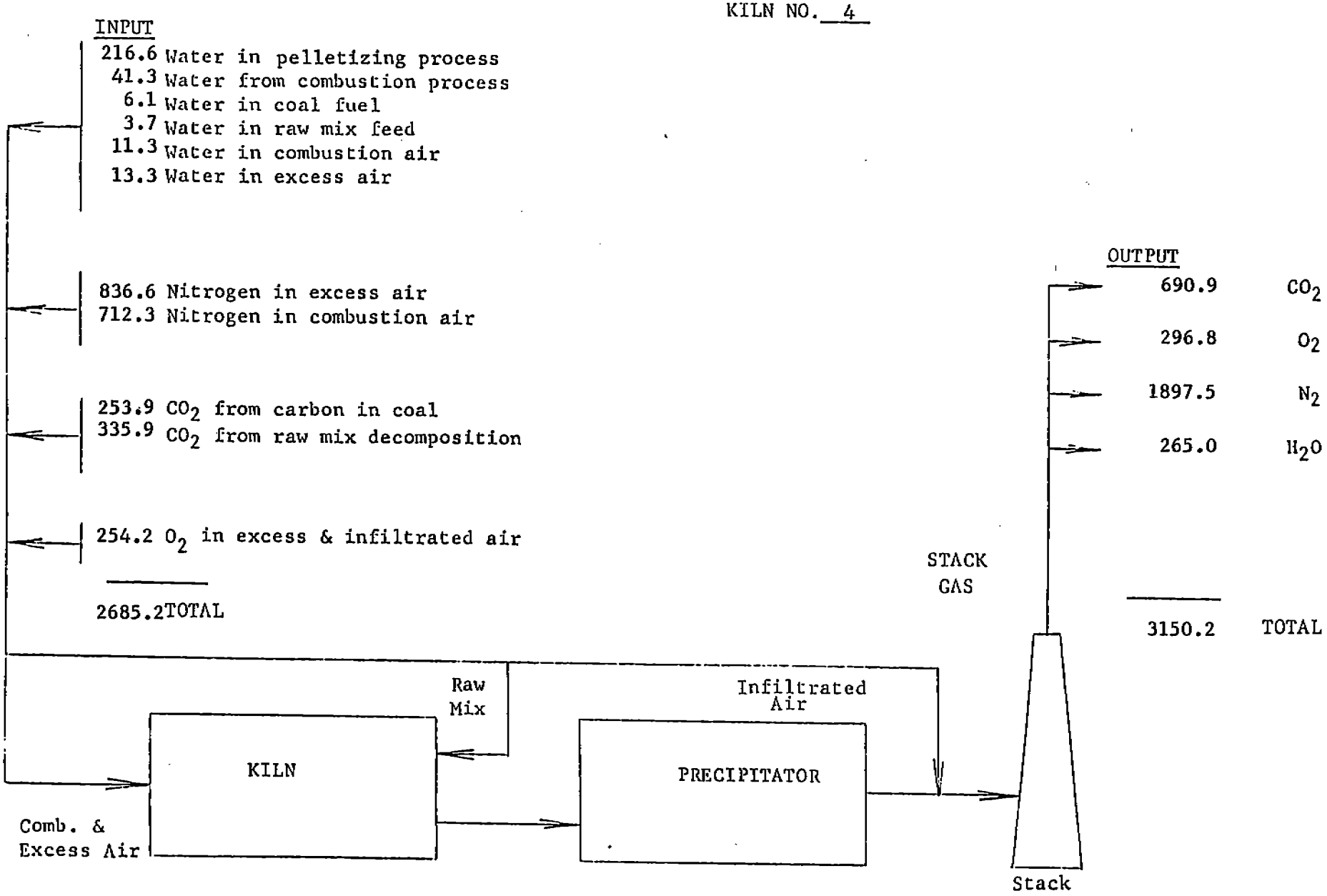
STACK EMISSIONS
SUMMARY SCHEMATIC
UNITS: LB/MIN.
KILN NO. 3



MEASURING EFFICIENCY = $\frac{2567}{2903}$ = 88.4

[redacted]OAN [redacted]DUS [redacted]URV[redacted]

STACK EMISSIONS
SUMMARY SCHEMATIC
UNITS: LB/MIN.
KILN NO. 4



MEASURING EFFICIENCY = $\frac{3150.2}{2685.2}$ = 117.3

[redacted] STACK EMISSIONS
SUMMARY SCHEMATIC
UNITS: LB/MIN.
KILN NO. 5

INPUT

412.3 Water in pelletizing process
129.4 Water from combustion process
18.2 Water in coal fuel
11.6 Water in raw mix feed
35.4 Water in combustion air
105.9 Water in excess air

6678.1 Nitrogen in excess air
2231.8 Nitrogen in combustion air

795.5 CO_2 from carbon in coal
1228.7 CO_2 from raw mix decomposition

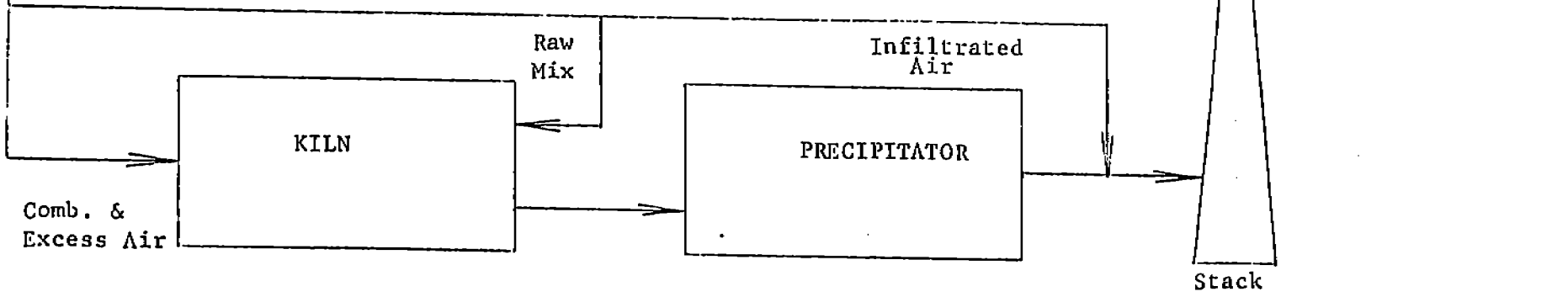
2028.8 O_2 in excess & infiltrated air

13675.7 TOTAL

OUTPUT

1997.6 CO_2
1997.6 O_2
8751.3 N_2
1100.8 H_2O

13847.3 TOTAL



MEASURING EFFICIENCY = $\frac{13847.3}{13675.7}$ = 101.25

FORM 407 REV. 2-G

PITTSBURGH TESTING LABORATORY

ESTABLISHED 1881
850 POPLAR STREET, PITTSBURGH, PA. 15220
PLEASE REPLY TO:
P. O. BOX 1646
PITTSBURGH, PA. 15230
AREA CODE 412 TELEPHONE 922-4000

LABORATORY No. 800852

CLIENT'S No. P.O. #V-15921

ORDER No. PG-12577

REPORT

Oct. 12, 1979

Sample Description: C O A L

Submitted by: Lone Star Cement Inc.

Reported to: Lone Star Cement Inc.
Roanoke Plant
P. O. Box 27
Cloverdale, VA. 24077

	As Received	Dry Basis
Moisture	1.36%	--
B.T.U. Per Pound	13,140	13,321
Carbon	--	74.56%
Hydrogen	--	4.94%
Oxygen	--	7.14%
Nitrogen	--	0.03%
Sulfur	--	1.78%
Ash	--	11.55%

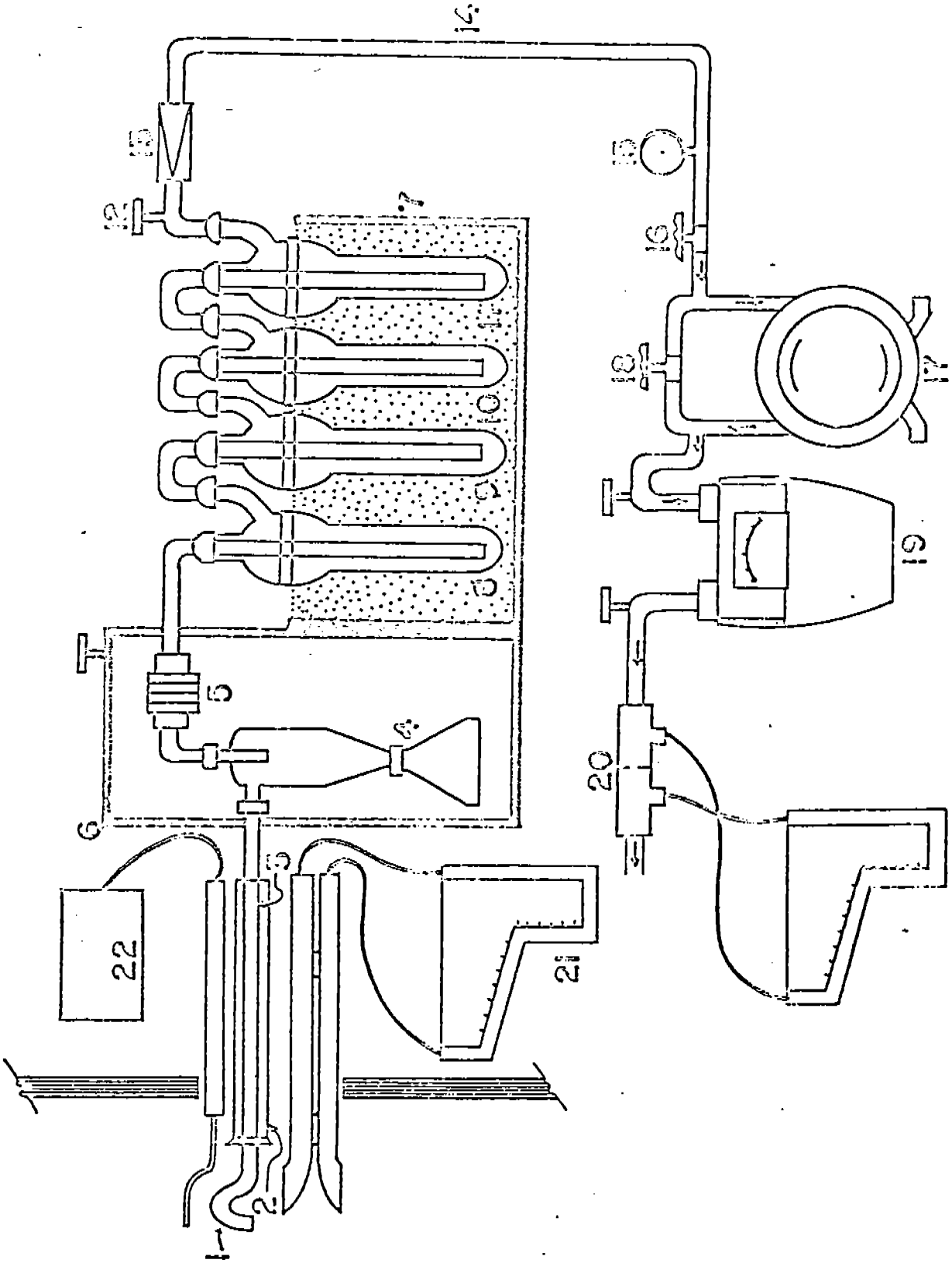
PITTSBURGH TESTING LABORATORY

William S. Carlson
Manager, Chemical Department

2-Client
Attn: W. W. Hurst

ear

EPA METHOD 5
Particulate Sampling Train



EPA METHOD 5 SAMPLING TRAIN

1. Sampling Nozzle
2. Sampling probe sheath
3. Heated sample probe liner
4. Cyclone assembly (proposed regulations do not require this cyclone)
5. Out of stack filter assembly
6. Heated filter compartment maintained about 250°F (proposed = $\leq$ 248°F $\pm$ 25°F)
7. Impinger case
8. First impinger filled with H_2O (100 ml)
9. Greenburg-Smith (or modified Greenburg-Smith) impinger filled with H_2O (100 ml)
10. Third impinger - Dry
11. Fourth impinger - filled with H_2O absorption media (200 - 300 gm)
12. Impinger exit gas thermometer
13. Check valve to prevent back pressure
14. Umbilical cord - vacuum line
15. Pressure guage
16. Coarse adjustment valve
17. Leak free pump
18. By-pass valve
19. Dry gas meter with inlet and outlet dry gas meter thermometer
20. Orifice meter with manometer
21. "S" type pitot tube with manometer
22. Stack temperature sensor

PARTICULATE FIELD DATA

68°F W.B

Run No. 1
Location KILN STK. NO. 5
Date 7/22/79
Operator RL-CP CHW Larry

Amb. Temp. °F 70°F
Bar. Press. "Hg. 28.85
Assumed Moist 10%
Test Periods 24 @ 6 min ea = 144 min TOTAL

Probe Tip Dia., In. 1/4"
Probe Length 8'
Inp. Nos. 1 - 4
Sample Box No. 1
f = 1.28

250°F Heater Box Setting

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
		260.92	ΔP	√ΔP	Desired	Actual	Inlet	Outlet						
NW-1	9:39/45	263.34	0.21	0.46	0.59	0.56	74	74	0.0	247	80	156	384	
2	51	265.83	0.21	0.46	0.59	0.59	75	76	0.0	251	87	175	401	
3	57	268.56	0.36	0.60	0.77	0.71	75	77	0.0	240	91	189	412	
4	10:03	271.43	0.41	0.64	0.82	0.79	77	79	1.0	246	90	288	403	
5	09	274.33	0.41	0.64	0.82	0.80	76	80	1.5	272	90	338	398	
6	15	277.30	0.45	0.67	0.86	0.85	75	79	1.5	260	81	365	385	+0.51
NE-1	10:29/35	279.83	0.25	0.50	0.64	0.64	73	75	0.0	227	78	216	375	
2	41	282.47	0.27	0.52	0.67	0.67	73	75	0.5	268	77	187	375	
3	47	285.34	0.43	0.66	0.84	0.79	75	76	2.0	232	81	212	360	
4	53	288.33	0.47	0.69	0.88	0.86	74	78	2.5	255	83	275	375	
5	59	291.36	0.49	0.70	0.90	0.88	72	78	2.5	246	80	323	370	
6	11:05	294.41	0.45	0.67	0.86	0.89	72	77	2.5	264	75	348	355	
SE-1	11:34/40	296.87	0.25	0.50	0.64	0.58	73	74	2.0	280	82	226	398	
2	46	299.46	0.25	0.50	0.64	0.64	73	74	2.0	256	79	193	330	
3	52	302.29	0.42	0.65	0.83	0.77	76	78	2.5	256	88	202	401	
4	58	305.30	0.45	0.67	0.86	0.87	73	76	3.0	224	80	231	331	
5	12:04	308.32	0.47	0.69	0.88	0.89	73	77	3.0	295	79	284	329	
6	10	311.36	0.52	0.72	0.92	0.89	72	77	3.5	257	75	315	329	
SW-1	12:28/34	313.90	0.14	0.37	0.61	0.62	77	79	2.5	273	79	220	748	
2	40	316.43	0.14	0.37	0.61	0.61	78	80	2.5	246	79	177	270	
3	46	319.10	0.30	0.55	0.70	0.68	78	80	3.0	246	85	150	385	
4	52	321.94	0.38	0.62	0.79	0.77	79	81	3.0	213	82	233	317	
5	58	324.86	0.43	0.66	0.84	0.81	79	83	3.5	243	82	288	336	
6	13:04	327.80	0.42	0.65	0.83	0.83	82	86	3.5	269	88	311	326	
TOTAL		[illegible]		19.16	15.21	17.95		[illegible]					8163	
AVERAGE				0.59	0.77	0.75	75.2	[illegible]					373.5	

76.5 Meter Volume

Dry Meter Calibration Factor

CORRECTED SAMPLE VOLUME = [illegible] Ft.3 X 0.9756 = 65.24 Ft.3

RUN NO. 1

PARTICULATE & WATER CATCH

IMPINGER NO. 1
Final Weight 673.39
Initial Weight 538.30
Increase

IMPINGER NO. 2
Final Weight 576.71
Initial Weight
Increase 564.67

IMPINGER NO. 3
Final Weight 458.71
Initial Weight
Increase 456.40

IMPINGER NO. 4
Final Weight 758.15
Initial Weight
Increase 738.54

FILTER NO. 3
Final Weight 7960
Initial Weight
Part. Catch 7745
.0215

SOLID WEIGHT GAIN

BEAKER NO. 14
Final Weight 143.1327
Initial Weight 143.0178
Increase .1149

BEAKER NO.
Final Weight
Initial Weight
Increase

BEAKER NO.
Final Weight
Initial Weight
Increase

BEAKER NO. 18 PROBE WASH
Final Weight 143.7030
Initial Weight 143.6567
Increase .0463

WATER WEIGHT GAIN

IMPINGER 1 135.09
IMPINGER 2 12.04
IMPINGER 3 2.31
IMPINGER 4 19.61
TOTAL 169.05

ORSAT

4% CO_2 8.2
32 O_2 15.8
CO 0
28 N_2 76.0

Filter .0215
.0463
BEAKER [illegible]
BEAKER .0678
Total [illegible]
BEAKER 5
BEAKER .1149
TOTAL .1827

Moisture Content: Sample Vol. 65.24 ft.^{3} x $\frac{460 + 40}{460 + \text{Meter Temp.}}$ (530 / 536.5) X 28.3 L/ft.^{3} = 1823.9 L Dry Gas

Water Weight $\frac{169.05 \text{ gm.}}{18 \frac{\text{gm.}}{\text{mol.}}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 226.3 L H_2O Vapor

Total = 2050.3 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{226.3 \text{ L}}{2050.3 \text{ L}}$ x 100 = 11.0 %

PARTICULATE FIELD DATA

68° WB

250°F

Run No. 2 | Amb. Temp. °F 70°F | Probe Tip Dia., In. 1/4" | Heater Box Setting

Location KILN STK NO.5 | Bar. Press. "Hg. 28.85 | Probe Length 8' | FILL IN ALL BLANKS

Date 7/22/79 | Assumed Moist 10% | Inp. Nos. 5-8 | READ & RECORD AT THE

Operator Phil Bill Chu | Test Periods 24 @ 6 min 144 min TOTAL | Sample Box No. 2 | START OF EACH TEST POINT

f = 1.28

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O Q_m x3.45		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
		617.45	ΔP	√ΔP	Desired	Actual	Inlet	Outlet						
SE-1	9:42/47	619.57	0.26	0.51	0.65	0.62	74	75	3.5	295	78	161	361	
2	54	622.32	0.35	0.50	0.64	0.53	73	74	3.5	261	76	195	365	
3	10:00	625.04	0.42	0.65	0.83	0.71	75	78	4.5	240	80	229	386	
4	06	627.97	0.52	0.72	0.92	0.82	75	79	5.5	272	82	262	389	
5	12	631.08	0.49	0.70	0.90	0.93	73	78	6.0	250	77	314	388	
6	18	634.28	0.52	0.72	0.92	0.98	74	81	7.0	263	85	365	384	
SW-1	10:32/38	636.70	0.22	0.47	0.60	0.56	72	75	3.5	250	80	230	356	
2	44	639.21	0.24	0.49	0.63	0.60	71	74	4.0	252	79	191	347	+0.52
3	50	641.98	0.38	0.62	0.79	0.74	72	77	5.0	236	85	177	356	
4	56	644.90	0.45	0.67	0.86	0.82	71	77	6.0	283	79	242	354	
5	11:02	648.08	0.49	0.70	0.90	0.97	72	79	7.0	250	80	314	362	
6	08	651.15	0.53	0.73	0.93	0.90	71	79	7.0	250	80	338	348	
NW-1	11:37/43	653.77	0.29	0.54	0.69	0.66	72	73	4.5	254	79	201	326	
2	49	656.35	0.26	0.51	0.65	0.64	72	75	5.0	251	79	207	328	
3	55	659.06	0.26	0.60	0.77	0.70	72	76	5.5	316	80	176	328	
4	12:01	661.96	0.42	0.65	0.83	0.81	71	76	5.5	283	76	193	331	
5	07	664.97	0.47	0.69	0.88	0.87	71	78	6.5	223	81	270	329	
6	13	668.11	0.52	0.72	0.92	0.94	70	79	7.5	238	75	312	327	
NE-1	12:31/37	670.62	0.22	0.47	0.60	0.60	81	83	4.5	293	84	195	294	
2	43	673.13	0.21	0.46	0.59	0.60	77	79	5.0	271	78	188	292	
3	49	675.95	0.41	0.64	0.82	0.76	81	85	6.0	246	88	175	316	
4	55	679.04	0.50	0.71	0.91	0.92	80	86	7.0	240	86	180	331	
5	1:01	682.37	0.54	0.73	0.94	1.06	85	91	8.5	184	83	288	337	
6	07	685.52	0.50	0.73	0.94	0.95	76	84	8.0	238	78	309	327	
TOTAL		68.07		14.13	14.11	13.89	1442	1512					5302	
AVERAGE				0.62	0.80	0.78	73.3	78.8					341.2	

76.5

CORRECTED SAMPLE VOLUME = 68.07 Ft.3 (Meter Volume) X 1.0521 (Dry Meter Calibration Factor) = 71.62 Ft.3

RUN NO. 2

PARTICULATE & WATER CATCH

IMPINGER NO. 5	Final Weight 696.35 Initial Weight 542.40 Increase	WATER WEIGHT GAIN	IMPINGER 1 153.95
			IMPINGER 2 15.3
IMPINGER NO. 6	Final Weight 559.71 Initial Weight Increase 544.41		IMPINGER 3 2.31
			IMPINGER 4 24.18
IMPINGER NO. 7	Final Weight 466.71 Initial Weight Increase 464.40		TOTAL 195.74
			ORSAT
IMPINGER NO. 8	Final Weight 775.04 Initial Weight Increase 750.86		CO_2 8.2
			O_2 15.8
FILTER NO. 4	Final Weight 8145 Initial Weight Part. Catch 7781 .0364		CO 0
			N_2 76.0
	SOLID WEIGHT GAIN		FiCh -.0364
BEAKER NO. 16	Final Weight 142.3236 Initial Weight 142.2322 Increase .0914		BEAKER 23 .0504
			~~BEAKER~~ .0868
BEAKER NO.	Final Weight Initial Weight Increase		BEAKER 3
			BEAKER 16 .0914
			TOTAL .1782
BEAKER NO.	Final Weight Initial Weight Increase		
BEAKER NO. 23 PROBE WASH	Final Weight 146.0268 Initial Weight 145.9764 Increase .0504		

Moisture Content: Sample Vol. 21.62 ft.^{3} x $\frac{\text{530}}{\text{460 + 70}}$ / $\frac{\text{460 + Meter}}{\text{536.5 Temp.}}$ X 28.3 L/ft.^{3} = 202.3 L Dry Gas

Water Weight $\frac{195.74 \text{ gm.}}{18 \frac{\text{gm.}}{\text{mol.}}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 262.1 L H_2O Vapor

Total = 264.3 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{262.1 \text{ L}}{264.3}$ x 100 = 14.6 %

CECIL

PARTICULATE FIELD DATA

70° WB

Run No. 3 | Amb. Temp. °F 71°F | Probe Tip Dia., In. 1/4" | Heater Box Setting

Location No. 5 Kiln Stack | Bar. Press. "Hg. 28.92 | Probe Length 8' |

Date 7/24/79 | Assumed Moist 10% | Inp. Nos. 9-12 |

Operator CEWH | Test Periods 24@6min 144 | Sample Box No. 1 | t = 1.15

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
	10:05	328.47	ΔP	$\sqrt{\Delta P}$	Desired	Actual	Inlet	Outlet						
S-1	10:11	330.82	.27	.52	60	.55	68	69	0	299	80	216	330	
S-2	10:17	333.51	.37	.60	70	.69	68	71	0	267	83	225	343	
S-3	10:23	338.93	.45	.67	77	—	66	71	1.0	228	78	238	343	
S-4	42	341.70	.50	.71	81	.73	68	73	1.0	217	85	259	334	
S-5	48	344.63	.56	.75	86	.82	68	74	1.5	270	79	301	334	
S-6	54	347.57	.54	.73	.85	.83	69	75	1.5	245	81	324	334	
E-1	11:09 15	349.95	.23	.48	.55	.54	73	75	1.0	140	88	157	343	
2	21	352.58	.36	.60	.69	.66	71	74	1.0	200	86	145	336	+0.5
3	27	355.21	.36	60	.69	.66	72	76	1.0	222	84	214	345	
4	33	357.85	.36	.60	.69	.66	74	75	1.0	288	88	303	346	
5	39	360.62	.48	.69	.80	.74	70	75	1.0	262	81	340	347	
6	45	363.53	.48	.69	.80	.81	75	80	1.0	236	88	347	345	
N-1	12:13 23	365.61	.18	.42	.49	43	69	70	1.0	340	82	150	313	
N-2	29	368.39	.31	.56	.64	.74	71	73	2.0	229	82	153	391	
N-3	35	370.03	.36	.60	.69	.67	70	73	1.5	260	85	227	329	
N-4	41	373.77	41	.64	74	.72	69	73	1.5	234	85	282	330	
N-5	47	376.43	.41	.64	.74	.68	70	25	2.0	250	91	297	324	
N-6	53	379.50	.43	.66	.78	.90	70	76	2.5	291	82	313	320	
W-1	13:11 17	381.74	.18	.42	.49	.48	84	86	1.0	262	95	130	308	
2	23	384.28	.29	.53	.67	67	83	86	1.5	250	94	170	334	
3	29	387.00	.36	.60	.69	.71	83	86	1.5	260	93	184	378	
4	35	389.50	.43	.66	.75	.60	81	85	1.5	240	93	250	328	
5	41	392.51	43	.66	.75	87	85	89	1.5	220	98	291	329	
6	49	395.30	.49	.70	.81	.75	86	91	2.0	245	89	306	324	
TOTAL														
AVERAGE				.61	71	71	73	77					337	

535 797

Post Check Leaks - Broken Glass Connect.

Meter Volume | Dry Meter Calibration Factor

CORRECTED SAMPLE VOLUME = 66.88 Ft.^{3} x 0.9756 = 65.25 Ft.^{3}

RUN NO. ~~#~~3

PARTICULATE & WATER CATCH

IMPINGER NO. 9	Final Weight 690.80	WATER WEIGHT GAIN	IMPINGER 1 147.17
	Initial Weight 543.63		IMPINGER 2 6.74
IMPINGER NO. 10	Final Weight 576.20		IMPINGER 3 1.66
	Initial Weight 569.46		IMPINGER 4 16.85
IMPINGER NO. 11	Final Weight 454.45		TOTAL 172.4 ✓
	Initial Weight 452.79		
IMPINGER NO. 12	Final Weight 751.84		ORSAT
	Initial Weight 734.99		CO_2 10.0
FILTER NO. ~~#~~5	Final Weight .7959		O_2 15.4
	Initial Weight 7768		CO —
	Part. Catch .0191		N_2 74.6
	SOLID WEIGHT GAIN		28.85
BEAKER NO. 22	Final Weight 145.1889		Filter .0191
	Initial Weight 145.1289		BEAKER 25 .0539
	Increase .0600		~~BEAKER 2~~ .0730
BEAKER NO. ____	Final Weight ____		BEAKER 22 .0600
	Initial Weight ____		BEAKER 4 ____
	Increase ____		TOTAL .1330
BEAKER NO. ____	Final Weight ____		
	Initial Weight ____		
	Increase ____		
BEAKER NO. 25 PROBE WASH	Final Weight 148.6878		
	Initial Weight 148.6339		
	Increase .0539		

.0600 / .0191

Moisture Content: Sample Vol. 65.23 ft.^{3} x $\frac{530 + 70}{460 + \text{Meter Temp.}}$ X 28.3 L/ft.^{3} = 1829 L Dry Gas

Water Weight $\frac{172.4 \text{ gm.}}{18 \frac{\text{gm.}}{\text{mol.}}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 230.8 L H_2O Vapor

Total = 2060 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{231 \text{ L}}{2060 \text{ L}}$ x 100 = 11.2 %

BOB

PARTICULATE FIELD DATA

70°F WB

Run No. 4
Location No.5 KILNSTACK
Date 7-24-79
Operator [illegible]

Amb. Temp. °F 71°F
Bar. Press. "Hg. 28.92
Assumed Moist 10%
Test Periods 24 @ 6 min
144 TOT.

Probe Tip Dia., In. 1/4"
Probe Length 8'
Inp. Nos. 13-16
Sample Box No. 2
f = 1.15

Heater Box Setting

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
	10:08	686.05	ΔP	$\sqrt{\Delta P}$	Desired	Actual	Inlet	Outlet						
N-1	14	688.01	.17	.41	.47	.37	66	70	3.0	220	80	130	259	
N-2	20	690.27	.23	.48	.55	.49	66	69	3.0	230	81	140	359	
N-3	33	692.44	.27	.52	.60	.45	66	69	3.0	287	79	157	339	
N-4	45	694.69	.32	.52	.65	.49	66	70	3.0	293	82	217	368	
N-5	51	696.94	.42	.65	.75	.49	66	70	3.0	175	80	342	335	
N-6	57	699.55	.40	.63	.73	.65	67	72	4.0	250	80	380	327	
W-1	11:12 18	701.87	.27	.52	.60	.52	69	71	4.0	269	84	184	296	
2	24	704.51	.23	.48	.55	.66	71	74	5.0	250	97	159	344	
3	30	707.10	.30	.55	.63	.64	69	73	5.0	220	90	270	373	
4	36	709.72	.30	.55	.63	.67	67	71	6.0	212	82	301	341	
5	42	712.52	.38	.62	.71	.75	70	74	6.0	205	88	326	345	
6	48	715.49	.40	.63	.73	.85	70	75	6.0	231	88	342	337	+59
S-1	12:32 32	717.80	.20	.45	.51	.51	67	69	4.0	375	81	95	342	
2	32	720.47	.36	.60	.69	.68	69	71	6.0	317	89	149	354	
3	38	723.38	.43	.66	.75	.81	67	71	6.0	342	82	227	329	
4	44	726.11	.48	.69	.80	.71	69	74	6.5	307	84	290	322	
5	50	729.12	.54	.73	.85	.87	69	73	6.5	263	85	318	324	
6	56	732.28	.52	.72	.83	.96	69	76	7.0	230	80	319	326	
E-1	13:14 20	734.55	.27	.52	.60	.49	80	83	6.0	335	94	159	314	
2	26	737.42	.49	.70	.81	.79	84	86	7.0	290	100	182	352	
3	32	740.45	.53	.73	.84	.88	81	86	7.0	223	97	200	335	
4	38	743.40	.50	.71	.81	.53	82	86	7.0	242	93	274	331	
5	44	746.42	.61	.78	.90	.89	84	88	7.0	250	110	321	332	
6	50	749.44	.61	.78	.90	.89	83	87	7.0	280	98	329	354	
TOTAL													336	
AVERAGE				.61		.68	.72	75					796	

Post Check O.K.

53% Meter Volume

CORRECTED SAMPLE VOLUME = 63.39 Ft.3 x Dry Meter Calibration Factor 1.052 = 66.69 Ft.3

RUN NO. 4

PARTICULATE & WATER CATCH

IMPINGER NO. 13	Final Weight 722.17 Initial Weight 544.11 Increase	WATER WEIGHT GAIN	IMPINGER 1 178.06
IMPINGER NO. 14	Final Weight 568.89 Initial Weight 562.58 Increase		IMPINGER 2 6.31
IMPINGER NO. 15	Final Weight 463.43 Initial Weight 462.91 Increase		IMPINGER 3 0.52
IMPINGER NO. 16	Final Weight 787.84 Initial Weight 770.58 Increase		IMPINGER 4 17.26
FILTER NO. 6	Final Weight .7288 Initial Weight .7200 Part. Catch .0088		TOTAL 202.15
	SOLID WEIGHT GAIN		ORSAT
BEAKER NO. ~~22~~ 21	Final Weight 117.7054 Initial Weight 117.5752 Increase .1342		CO_2 10.0
			O_2 15.4
			CO —
			N_2 74.6 28.66
			Fe-Cl4 .0088
BEAKER NO.	Final Weight Initial Weight Increase		BEAKER ~~28~~ 0489
			~~BEAKER~~ 2 .0577
			BEAKER 21 .1347
			BEAKER 4
			TOTAL .1919
BEAKER NO.	Final Weight Initial Weight Increase		
BEAKER NO. ~~28~~ 8 PROBE WASH	Final Weight 145.9239 Initial Weight 145.8750 Increase .0489		

Moisture Content: Sample Vol. 66.39 ft.^{3} x $\frac{530}{460 + 70}$ / $\frac{460 + 535}{\text{Meter Temp.}}$ X 28.3 L/ft.^{3} = 1861 L Dry Gas

Water Weight $\frac{202.15 \text{ gm.}}{18 \text{ gm./mol.}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 270.6 L H_2O Vapor

Total = 2132 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{271 \text{ L}}{2132 \text{ L}}$ x 100 = 12.7 %

Laney

PARTICULATE FIELD DATA

69°F WB

Run No. 5
Location No. 5 Kiln Stack
Date 7/25/79
Operator CRWH

Amb. Temp. °F 71°F
Bar. Press. "Hg. 28.84
Assumed Moist 12%
Test Periods 24 @ 6 min
144 Total

Probe Tip Dia., In. 1/4"
Probe Length ~~12~~ 8'
Inp. Nos. 12-20
Sample Box No. 1
f- 1.04

Heater Box Setting 250

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
	10:44	399.13	ΔP	√ΔP	Desired	Actual	Inlet	Outlet						
W-1	50	400.98	.10	.32	.33	.33	72	74	.0	286	77	158	328	
2	56	407.98	.16	.40	.42	.38	71	75	1.0	237	87	148	374	
3	11:02	405.30	.20	.45	.47	.51	70	74	1.0	259	90	222	326	
4	8	407.50	.21	.46	.48	.46	73	77	1.5	289	88	293	325	
5	14	409.80	.21	.46	.48	.51	75	79	1.5	258	89	310	328	
6	20	412.12	.23	.48	.50	.52	74	79	1.5	240	88	321	315	
N-1	11:39 35	414.04	.12	.35	.36	.35	78	81	1.5	252	95	181	306	
2	41	416.13	.18	.42	.44	.42	78	82	1.5	251	97	245	378	
3	47	418.31	.21	.46	.48	.46	78	78	2.0	314	92	225	330	
4	53	420.56	.23	.48	.50	.49	80	84	2.0	301	98	235	333	
5	59	422.90	.24	.49	.51	.52	72	77	2.0	253	87	305	331	
6	12:05	425.13	.24	.49	.51	.48	71	75	2.0	222	84	321	327	0.5
E-1	12:32 28	427.07	.12	.35	.36	.36	78	81	2.0	320	97	220	338	
2	34	429.21	.20	.45	.47	.44	74	76	2.0	329	91	215	346	
3	40	431.45	.22	.47	.49	.48	74	77	2.0	304	92	237	347	
4	46	433.74	.23	.48	.50	.50	78	81	2.0	302	98	269	350	
5	52	436.04	.23	.48	.50	.51	75	78	2.0	243	92	316	348	
6	58	438.36	.24	.49	.51	.52	71	75	2.0	209	83	333	347	
S-1	13:08 17	440.25	.10	.32	.33	.34	72	76	2.0	273	80	173	344	
2	20	442.35	.18	.42	.44	.42	84	88	2.0	255	95	217	392	
3	26	444.52	.18	.42	.44	.45	78	82	2.0	207	91	170	382	
4	32	446.63	.20	.45	.47	.43	85	88	2.0	247	98	287	385	
5	38	448.82	.27	.52	.54	.55	77	81	2.0	254	90	375	370	
6	44	451.50	.30	.55	.57	.59	77	81	2.0	207	90	369	356	
TOTAL							76	79					346	
AVERAGE				.44		.46							806	

538

Meter Volume 52.37 Ft.³

Dry Meter Calibration Factor 0.979

CORRECTED SAMPLE VOLUME [illegible] 51[illegible] F[illegible]

RUN NO. 5

PARTICULATE & WATER CATCH

IMPINGER NO. 17	Final Weight 729.81 Initial Weight 555.66 Increase	WATER WEIGHT GAIN	IMPINGER 1 174.15
IMPINGER NO. 18	Final Weight 518.13 Initial Weight 550.43 Increase		IMPINGER 2 -32.3
IMPINGER NO. 19	Final Weight 467.15 Initial Weight 460.98 Increase		IMPINGER 3 1.17
IMPINGER NO. 20	Final Weight 822.34 Initial Weight 806.59 Increase		IMPINGER 4 15.75
FILTER NO. 7	Final Weight .8421 Initial Weight .7807 Part. Catch .0614		TOTAL 158.77
	SOLID WEIGHT GAIN		ORSAT
BEAKER NO. 1	Final Weight 135.5230 Initial Weight 135.4855 Increase .0375		CO_2 9.6
BEAKER NO.	Final Weight Initial Weight Increase		O_2 15.0
BEAKER NO.	Final Weight Initial Weight Increase		CO -
BEAKER NO. 40 PROBE WASH	Final Weight 154.2094 Initial Weight 154.1471 Increase .0623		N_2 75.4 28.5

Filter .0614
BEAKER 40 .0623
BEAKER 2 .1237
BEAKER 1 .0375
BEAKER 4 ____
TOTAL .1612

Moisture Content: Sample Vol. 51.09 ft.^{3} x $\frac{460 + 530 \text{ Temp.}}{460 + \text{Meter}}$ x 28.3 L/ft.^{3} = 1424 L Dry Gas

Water Weight $\frac{158.77 \text{ gm.}}{18 \text{ gm./mol.}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 212.6 L H_2O Vapor

Total = 1637 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{212.6 \text{ L}}{1637 \text{ L}}$ x 100 = 13.0%

BOB

PARTICULATE FIELD DATA

69°F WB

Run No. 6
Location Mo. 5 Kiln Stack
Date 7/25/79
Operator [illegible]

Amb. Temp. °F 71°F
Bar. Press. "Hg. ~~29.74~~ 28.84
Assumed Moist 12%
Test Periods 24 @ 5 min
Tot. 14%

Probe Tip Dia., In. 1/4
Probe Length 8'
Inp. Nos. 21 - 24
Sample Box No. 2
f - 1.04

Heater Box Setting 250

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O @ 3.45		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
	10:47	750.48	ΔP	√ΔP	Desired	Actual	Inlet	Outlet						
S-1	53	752.31	.14	.37	39	.32	71	73	0	240	85	100	341	
2	59	754.60	.21	.46	.48	.50	72	76	0	272	92	153	349	
3	11:05	756.94	.23	.48	.50	.52	75	79	0	286	93	236	352	
4	11	759.28	.24	.49	.51	.52	69	74	0	216	80	315	325	
5	17	761.69	.26	.51	.53	.56	76	82	0	262	93	330	332	
6	23	764.18	.27	.52	.54	.59	72	78	0	228	89	325	330	
E-1	11:33 38	766.13	.13	.36	.37	.36	75	78	0	286	93	186	313	
2	44	768.22	.15	.39	.40	.42	77	81	0	219	96	216	318	
3	50	770.43	.25	.50	.52	.47	71	75	0	195	91	267	333	
4	56	772.83	.27	.52	.54	.55	70	75	0	212	88	290	330	
5	12:02	775.33	.27	.52	.54	.60	71	76	0	246	87	307	328	0.62
6	08	777.63	.27	.52	54	51	69	78	0	231	93	326	338	
N-1	12:35 31	779.72	.13	36	.37	.42	76	78	0	320	92	162	320	
2	37	781.82	.18	.42	.44	.42	72	76	0	301	87	202	332	
3	43	783.97	.22	.47	.49	.44	72	75	0	260	86	209	342	
4	49	786.37	.22	.47	49	.55	78	81	0	245	94	243	345	
5	55	788.60	.23	.48	.50	.48	78	81	0	222	90	286	349	
6	13:01	790.90	.23	.48	.50	.51	71	76	0	193	75	310	356	
W-1	13:11 17	792.80	.10	.32	.33	.35	83	85	0	278	89	182	366	
2	23	794.71	.15	.39	.40	.35	82	85	0	237	92	160	384	
3	29	796.75	.16	.40	.42	.40	85	89	0	227	97	180	395	
4	35	798.97	.20	.45	.47	.47	83	85	0	262	90	307	384	
5	41	801.28	.23	.48	.50	.51	76	79	0	227	86	318	364	
6	47	803.79	.26	.51	.53	.60	82	82	0	256	92	337	369	
TOTAL							75	79					346	
AVERAGE				.45		.49		77					806	

Post Leak Check Showed Leak - Broken Glass Connector

537

Meter Volume

Dry Meter Calibration Factor

CORRECTED SAMPLE VOLUME = 53.31 Ft.3 x 1.0521 = 56.08 Ft 3

RUN NO. 6

PARTICULATE & WATER CATCH

IMPINGER NO. 21	Final Weight 609.56 Initial Weight 538.07 Increase	WATER WEIGHT GAIN	IMPINGER 1 71.49
IMPINGER NO. 22	Final Weight 549.31 Initial Weight Increase 541.91		IMPINGER 2 7.4
IMPINGER NO. 23	Final Weight 457.80 Initial Weight Increase 456.91		IMPINGER 3 0.89
IMPINGER NO. 24	Final Weight 817.3x Initial Weight Increase 800.40		IMPINGER 4 16.9x
			TOTAL 96.7x
			ORSAT
			CO_2 9.6
			O_2 15.0
			CO —
			N_2 75.4
			29.21
FILTER NO. 8	Final Weight .7946 Initial Weight .7863 Part. Catch .0083		Filt .0083
	SOLID WEIGHT GAIN		
BEAKER NO. 35	Final Weight 15J.3848 Initial Weight 15J.3460 Increase .0388		BEAKER 21 .0341
			BEAKER 2 .0424
			BEAKER 35 .0388
BEAKER NO. ____	Final Weight ____ Initial Weight Increase ____	LOST	BEAKER 4 ____
			TOTAL .0812
BEAKER NO. 32	Final Weight ____ Initial Weight Increase ____		
BEAKER NO. 32 PROBE WASH	Final Weight 147.0458 Initial Weight 147.0117 Increase .0341		

Moisture Content: Sample Vol. 56.08 ft.^{3} x $\frac{530}{460 + 70}$ / $\frac{460 + \text{Meter}}{537 \text{ Temp.}}$ X 28.3 L/ft.^{3} = 1566 L Dry Gas

Water Weight 96.7x gm. / 18 gm./mol. x 24.1 L/mol. = 129.5 L H_2O Vapor

Total = 1696 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{129.5 \text{ L}}{1696 \text{ L}}$ x 100 = 7.6 %

BRUCE

PARTICULATE FIELD DATA

71°F WB

Run No. 7 | Amb. Temp. °F 73°F | Probe Tip Dia., In ¼" | Heater Box Setting 250

Location Kiln No 5 Stack | Bar. Press. "Hg. 28.71 | Probe Length 8'

Date 7/26/79 | Assumed Moist 12% | Inp. Nos. 25 - 28

Operator W.W.H | Test Periods 24 @ 6 min = 144 min | Sample Box No. 1 | f-.95

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
	8:42	452.13	ΔP	√ΔP	Desired	Actual	Inlet	Outlet						
5-1	48	454.71	.48	.69	.66	.64	74	74	0	200	73	160	344	
2	54	457.57	.77	.88	.83	.78	68	71	0	213	76	122	355	
3	9:00	460.58	.95	.97	.93	.86	71	73	0	279	75	230	362	
4	6	463.75	.98	.99	.94	.96	72	75	1.5	207	78	340	355	
5	12	467.05	.95	.97	.93	1.04	72	75	2.0	236	78	355	356	
6	18	470.25	.98	.99	.94	.98	71	76	2.0	247	78	353	348	
R 1	9:33 38	472.81	.48	.69	.66	.63	70	72	0.5	253	75	148	337	
2	44	475.64	.75	.87	.82	.77	72	74	1.0	314	82	222	350	
3	50	478.70	.87	.93	.89	.90	71	74	1.5	264	80	309	351	
4	56	481.85	.90	.95	.90	.95	70	74	2.0	237	78	328	352	
5	10:02	484.81	.95	.97	.93	.84	72	77	2.0	182	79	347	350	
6	08	488.08	.95	.97	.93	1.02	72	77	2.5	205	80	346	350	+.6
W-1	10:28 38	490.43	.33	.57	.55	.53	69	71	1.0	310	73	147	314	
2	34	493.09	.63	.79	.75	.68	70	73	1.5	249	78	178	343	
3	40	495.93	.68	.82	.78	.77	72	75	2.0	214	78	227	346	
4	46	498.82	.73	.85	.81	.80	73	77	2.0	227	81	279	348	
5	52	501.78	.82	.91	.86	.84	71	76	2.0	235	75	325	345	
6	58	504.83	.82	.91	.86	.89	74	78	2.0	209	84	338	346	
W-1	11:11 17	507.29	.41	.64	.61	.58	69	71	1.5	320	72	143	335	
2	23	510.07	.68	.82	.78	.74	71	73	1.5	259	75	143	346	
3	29	513.07	.76	.87	.83	.86	72	75	2.5	285	79	237	347	
4	35	516.25	.83	.91	.87	.97	74	78	4.0	256	82	300	347	
5	41	519.25	.92	.96	.91	.86	73	77	4.5	213	83	330	341	
6	47	522.28	.92	.96	.91	.88	75	79	4.5	249	86	336	337	
TOTAL							72	75					348	
AVERAGE				.87		.87	534						809	

Meter Volume [redacted]15 [redacted] ft.3 | Dry Meter Calibration Factor [redacted]9975 [redacted]68[redacted]3

[redacted] CORRECTED SAMPLE VOLUME [redacted]

RUN NO. 7

PARTICULATE & WATER CATCH

IMPINGER NO. 25	Final Weight 736.40 Initial Weight 554.94 Increase	WATER WEIGHT GAIN	IMPINGER 1 181.46
IMPINGER NO. 26	Final Weight 559.53 Initial Weight Increase 544.78		IMPINGER 2 14.75
IMPINGER NO. 27	Final Weight 459.74 Initial Weight Increase 457.43		IMPINGER 3 2.31
IMPINGER NO. 28	Final Weight 787.65 Initial Weight Increase 761.88		IMPINGER 4 25.77
			TOTAL 224.29
			ORSAT
			CO_2 11.4
			O_2 14.4
			CO —
FILTER NO. 23	Final Weight .8053 Initial Weight .7310 Part. Catch .0743		N_2 74.2
			98.73

SOLID WEIGHT GAIN

			Tefr .0743
BEAKER NO. 2	Final Weight 144.6148 Initial Weight Increase 144.4551 .1597		BEAKER 1 .0685
			BEAKER 2 .1428
			BEAKER 3 —
BEAKER NO. —	Final Weight — Initial Weight Increase —		BEAKER 2 .1597
			TOTAL .3025
BEAKER NO. —	Final Weight — Initial Weight Increase —		
BEAKER NO. 30 PROBE WASH	Final Weight 142.9775 Initial Weight 142.9094 Increase .0685		

Moisture Content: Sample Vol 68.43 ft.^{3} x $\frac{460 + 70}{460 + \text{Meter Temp.}}$ (53) X 28.3 L/ft.^{3} = 1922 Dry Gas

Water Weight $\frac{224.29 \text{ gm.}}{18 \frac{\text{gm.}}{\text{mol.}}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 300.29 L H_2O Vapor

Total = 2222

$\frac{H_2O \text{ Vol. } 300.29 \text{ L}}{\text{Total}}$ x 100 = 13.5%

BOB

PARTICULATE FIELD DATA

71°F WB

Run No. 8
Location Kiln No 5 Stack
Date 2/26/79
Operator CEW D

Amb. Temp. °F 73°F
Bar. Press. "Hg. 28.71
Assumed Moist 12%
Test Periods 24 @ 6 min each
144 min TOT.

Probe Tip Dia., In. 1/4"
Probe Length 8'
Inp. Nos. 29 - 32
Sample Box No. 2
f - .95

Heater Box Setting 250

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time 8:45	Dry Gas Meter C.F. 804.97	Pitot In. H_2O ΔP	Pitot In. H_2O $\sqrt{\Delta P}$	Orifice ΔH In. H_2O Desired (Qm²×3.45)	Orifice ΔH In. H_2O Actual	Dry Gas Temp. °F Inlet	Dry Gas Temp. °F Outlet	Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
W-1	51	807.44	.40	.63	.60	.59	74	75	0	272	81	180	376	
2	57	810.18	.68	.82	.78	.72	73	74	0	236	80	161	359	
3	9:03	813.12	.82	.91	.86	.81	72	74	0	218	77	265	356	
4	9	816.45	.77	.88	.83	1.06	72	76	1.0	272	78	317	355	
5	15	819.62	.88	.94	.89	96	71	76	1.0	240	75	342	355	
6	21	822.91	.88	.94	.89	1.04	70	76	1.0	225	75	350	354	
S-1	9:35 41	825.06	.50	.71	.67	.67	71	73	1.0	195	76	161	346	
2	47	827.84	.75	.87	.82	74	69	72	0	252	75	187	350	
3	53	830.97	.87	.93	.89	94	70	75	1.0	297	77	280	349	
4	59	834.19	.93	.96	.92	.99	69	75	1.0	218	74	317	348	.56
5	10:05	837.19	.93	.96	.92	.86	69	76	1.0	220	74	335	347	
6	11	840.19	.90	.95	.90	.86	73	79	1.0	208	82	345	348	
E-1	10:35 37	842.75	.48	.69	.66	.63	70	73	0	276	75	188	337	
2	37	845.57	.70	.84	.80	.76	70	74	1.0	233	80	224	342	
3	43	848.69	.85	.92	.88	.93	71	75	1.5	314	83	311	343	
4	49	851.89	.90	.95	.90	.98	70	76	1.5	240	77	324	342	
5	55	855.01	.92	.96	.91	.93	71	77	1.5	278	78	338	344	
6	11:01	858.07	.87	.93	.89	.90	70	77	1.5	248	78	342	344	
N-1	11:14 20	860.56	.40	.63	.60	.59	71	73	1.5	255	72	211	335	
2	26	863.17	.56	.75	.71	.65	75	78	1.5	201	80	175	342	
3	32	865.94	.65	.81	.76	.74	71	75	1.5	253	75	274	340	
4	38	868.98	.73	.85	.81	89	76	76	1.5	281	75	302	338	
5	44	871.75	.81	.90	.86	.94	71	77	1.5	244	77	327	337	
6	50	875.03	.90	.95	.90	1.03	70	75	1.5	225	75	320	332	
TOTAL													947	
AVERAGE				.86	.92	.82	71	75					807	

537

Meter Volume [redacted] 6 [redacted] t. 3 [redacted]

Dry Meter Calibration Factor [redacted] 1.[redacted]2 [redacted] [redacted] 73 [redacted] F

RUN NO. 8

PARTICULATE & WATER CATCH

IMPINGER NO. 29	Final Weight 745.65 Initial Weight 573.17 Increase	WATER WEIGHT GAIN	IMPINGER 1 172.48
IMPINGER NO. 30	Final Weight 564.71 Initial Weight Increase 541.08		IMPINGER 2 23.63
IMPINGER NO. 31	Final Weight 479.00 Initial Weight Increase 475.74		IMPINGER 3 3.26
IMPINGER NO. 32	Final Weight 837.33 Initial Weight Increase 803.97		IMPINGER 4 33.34
FILTER NO. 28	Final Weight Initial Weight 7594 Part. Catch ~~.2310~~ 7290 .0304		TOTAL 232.73
	SOLID WEIGHT GAIN		ORSAT
BEAKER NO. 7	Final Weight 140.5254 Initial Weight Increase 140.3494 .1760		CO_2 11.4
BEAKER NO.	Final Weight Initial Weight Increase		O_2 14.4
BEAKER NO.	Final Weight Initial Weight Increase		CO —
BEAKER NO. 29 PROBE WASH	Final Weight 144.4896 Initial Weight 144.3615 Increase .0281		N_2 74.2 28.77
			Full .0304
			BEAKER 1 .0281
			~~BEAKER~~ 2 .0585
			BEAKER 3 .1760
			BEAKER 4
			TOTAL .2345

Moisture Content: Sample Vol. 73.71 ft.^{3} x $\frac{460 + 70}{460 + 533}$ (530 Meter Temp.) X 28.3 L/ft.^{3} = 2074 L Dry Gas

Water Weight $\frac{232.73 \text{ gm.}}{18 \text{ gm./mol.}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 311.59 L H_2O Vapor

Total = 2385 L

$\frac{H_2O \text{ Vol}}{\text{Total}}$ $\frac{311.59 \text{ L}}{2385 \text{ L}}$ x 100 = 13.06%

PARTICULATE FIELD DATA

Run No. 15 | Amb. Temp. °F 61 WB / 67 DB | Probe Tip Dia., In 1/4" | Heater Box Setting 250°F

Location STACK #5 | Bar. Press. "Hg. 28.83" | Probe Length 8'

Date 8/18/79 | Assumed Moist 12% | Inp. Nos.

Operator CHN/BRUCE | Test Periods ~~6~~ 144 Min. | Sample Box No.

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
		805.32	ΔP	√ΔP	Desired	Actual	Inlet	Outlet						
S-1	7:55/8:01	807.00	0.21	0.46	0.33	0.28	68	68	0.0.	260	70	124	321	
2	07	809.24	0.32	0.57	0.51	0.50	68	69	0.5	260	74	139	337	
3	13	811.67	0.40	0.63	0.63	0.59	68	68	2.0	252	71	175	338	
4	19	814.31	0.42	0.65	0.67	0.70	66	69	3.0.	244	68	221	337	
5	25	816.94	0.43	0.66	0.68	0.70.	67	71	3.0	284	72	305	337	
6	31	819.57	0.48	0.66	0.70	0.70	67	71	3.0	243	69	325	334	
W-1	8:40/46	821.33	0.19	0.44	0.30	0.31	67	69	0.0.	224	69	178	307	
2	52	823.43	0.30.	0.55	0.48.	0.44.	68	71	1.0	273	70	656	325	+0.50
3	58	825.87	0.36	0.60	0.57	0.60	68	72	3.0	247	73	178	385	
4	9:04	828.33	0.38	0.62	0.60	0.61	67	70	3.0	248	70	256	332	
5	10	830.79	0.39	0.62	0.61	0.61	68	72	3.5	261	73	311	333	
6	16	833.39	0.44	0.66	0.70	0.68	68	72	4.0	242	75	311	333	
N-1	9:24/30	835.30	0.23	0.48	0.36	0.37	74	77	2.0	218	70	165	323	
2	36	837.62	0.37	0.61	0.58	0.58	74	78	3.0	259	873	162	338	
3	42	840.10	0.40	0.63	0.63	0.62	75	79	4.0.	230	75	169	345	
4	48	842.78	0.47	0.69	0.74	0.72	74	78	4.0	260	73	258	343	
5	54	845.53	0.48	0.69	0.75	0.76	77	82	5.0.	247	76	385	341	
6	10:00	848.35	0.50	0.71	0.79	0.80	75	79	5.5	277	72	335	336	
E-1	10:17/23	850.17	0.21	0.46	0.33	0.33	77	78	1.0.	218	72	198	328	
2	29	852.48	0.36	0.60	0.57	0.54	76	77	4.0	273	75	196	334	
3	35	~~854.95~~ 854.95	0.41	0.64	0.64	0.61	78	80	5.0.	248	81	203	344	
4	41	857.57	0.46	0.68	0.72	0.69	78	82	5.0.	264	82	283	346	
5	47	860.28	0.47	0.69	0.74	0.74	78	81	6.0	241	80	325	350	
6	53	863.07	0.48	0.69	0.75	0.78	76	82	6.0.	282	79	330	343	
TOTAL				14.69	14.38	14.22	1720	1773					8040	
AVERAGE		57.75		0.612	0.600	0.593	71.7	73.88					335	

533°R | 72.8 Meter Volume | Dry Meter Calibration Factor | 795°R

[redacted] CORRECTED [redacted] VOLUME [redacted] ft.3 [redacted] 0.[redacted]6 [redacted] [redacted]5[redacted] F[redacted]

RUN NO. 15

PARTICULATE & WATER CATCH

IMPINGER NO. 61	Final Weight 680.29	WATER WEIGHT GAIN	IMPINGER 1 139.87
	Initial Weight 540.42		IMPINGER 2 9.7
IMPINGER NO. 62	Final Weight 557.11		IMPINGER 3 1.17
	Initial Weight 549.41		IMPINGER 4 15.75
IMPINGER NO. 63	Final Weight 443.03		TOTAL 164.49
	Initial Weight 444.86		ORSAT
IMPINGER NO. 64	Final Weight 832.65		CO_2 11.2
	Initial Weight 816.90		O_2 14.4
FILTER NO. 7	Final Weight .7990		CO —
	Initial Weight .7770		N_2 74.4
	Part. Catch .0220		
	SOLID WEIGHT GAIN		Filter .0220
BEAKER NO. 38 smf.	Final Weight 141.753		BEAKER 1 —
	Initial Weight 141.0291		BEAKER 9 .0271
	.0462		BEAKER ~~38~~ ~~.0462~~
BEAKER NO. ____	Final Weight ____		Total DP BEAKER 3 .0491
	Initial Weight ____		BEAKER 38 .0462
	Increase ____		Rest TOTAL .0953
BEAKER NO. ____	Final Weight ____		
	Initial Weight ____		
	Increase ____		
BEAKER NO. 9 PROBE WASH	Final Weight 121.6172		
	Initial Weight 121.5901		
	Increase .0271		

Moisture Content: Sample Vol. 57.55 ft.^{3} x $\frac{530}{460 + 70}$ (~~460 + Meter~~ 533 Temp.) X 28.3 L/ft.^{3} = 1625.7 L Dry Gas

Water Weight $\frac{164.49 \text{ gm.}}{18 \frac{\text{gm.}}{\text{mol.}}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 220.2 L H_2O Vapor

Total = 1845.9 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{220.2 \text{ L}}{1845.9 \text{ L}}$ x 100 = 11.9 %

PARTICULATE FIELD DATA

Run No. 16
Location STACK
Date 8/18/79
Operator CHH / BOB

Amb. Temp. °F 61 WB / 67 DB
Bar. Press. "Hg. 28.83"
Assumed Moist 12%
Test Periods 144 MIN.

Probe Tip Dia., In 1/4"
Probe Length 8'
Inp. Nos.
Sample Box No.

Heater Box Setting 250°F

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
		121.68	ΔP	$\sqrt{\Delta P}$	Desired	Actual	Inlet	Outlet						
N-1	7:58/8:04	123.64	0.27	0.52	0.43	0.39	68	69	0.0	243	69	169	335	
2	10	126.22	0.42	0.65	0.67	0.67	67	69	1.0	258	70	182	340	
3	16	128.98	0.50	0.71	0.79	0.77	65	68	1.5	237	69	206	340	
4	22	131.88	0.51	0.71	0.81	0.85	65	70	2.0	246	69	207	335	
5	28	134.81	0.53	0.73	0.84	0.86	66	72	2.0	260	65	308	340	
6	34	137.72	0.53	0.71	0.84	0.85	65	73	2.0	249	70	328	339	
E-1	8:43/49	139.81	0.25	0.50	0.40	0.44	65	69	0.0	252	65	218	322	
2	55	142.41	0.42	0.65	0.67	0.68	65	74	1.5	~~256~~ 248	70	175	333	
3	9:01	145.17	0.46	0.68	0.73	0.77	65	71	2.0	255	68	213	336	
4	07	147.87	0.45	0.67	0.71	0.73	66	73	2.0	245	72	285	337	+0.51
5	13	150.64	0.48	0.69	0.75	0.77	66	73	2.5	250	71	311	334	
6	19	153.41	0.50	0.71	0.79	0.77	69	76	2.5	240	77	338	343	
S-1	9:27/33	155.52	0.24	0.49	0.38	0.45	73	77	1.0	261	75	231	329	
2	39	157.87	0.35	0.59	0.55	0.55	73	77	2.0	253	72	184	339	
3	45	160.31	0.38	0.62	0.60	0.60	74	79	2.0	255	74	206	346	
4	51	162.98	0.42	0.65	0.66	0.72	73	79	2.5	236	73	289	343	
5	57	165.74	0.48	0.69	0.75	0.77	72	78	3.0	250	77	312	337	
6	10,03	168.48	0.48	0.69	0.75	0.75	71	78	3.0	281	72	326	333	
W-1	10,20/26	170.41	0.20	0.45	0.31	0.37	98	80	1.5	290	79	142	329	
2	32	172.65	0.32	0.57	0.50	0.51	76	79	2.0	241	74	127	338	
3	38	175.00	0.35	0.59	0.55	0.55	77	81	2.5	244	75	175	344	
4	44	177.50	0.40	0.63	0.63	0.63	76	80	2.5	256	75	277	344	
5	50	180.07	0.42	0.65	0.66	0.66	76	79	3.0	268	72	315	342	
6	56	182.83	0.48	0.69	0.75	0.77	74	80	3.0	237	73	335	346	
TOTAL				15.24	15.52	15.88	1685	1801					8099	
AVERAGE		61.15		0.635	0.647	0.662	70.2	75.04					337.5	

533°R 72.6 Meter Volume Dry Meter Calibration Factor 797.5°R

CO[redacted]TE[redacted]MPL[redacted]LUM[redacted] [redacted]t.3[redacted]1.0[redacted]7[redacted] [redacted]61[redacted]

RUN NO. 15

PARTICULATE & WATER CATCH

IMPINGER NO. 57	Final Weight 734.59 Initial Weight 523.63 Increase	WATER WEIGHT GAIN	IMPINGER 1 210.96
IMPINGER NO. 58	Final Weight 514.23 Initial Weight Increase 550.51		IMPINGER 2 -36.28 IMPINGER 3 1.12
IMPINGER NO. 59	Final Weight 445.78 Initial Weight Increase 444.66		IMPINGER 4 18.66 TOTAL 194.46
IMPINGER NO. 60	Final Weight 807.18 Initial Weight Increase 788.52		ORSAT CO_2 11.2
FILTER NO. 28	Final Weight .7631 Initial Weight .7300 Part. Catch .0331		O_2 14.4 CO — N_2 74.4
		SOLID WEIGHT GAIN	Filter .0331
BEAKER NO. 13	Final Weight 140.5870 Initial Weight 140.5757 Increase .0113		BEAKER #6 .0175 Total DB BEAKER #2 .0506 BEAKER #3 .0113
BEAKER NO. ____	Final Weight ____ Initial Weight Increase ____		BEAKER 4 ____
			Wet TOTAL .0619
BEAKER NO. ____	Final Weight ____ Initial Weight Increase ____		
BEAKER NO. 6a PROBE WASH	Final Weight 144.6153 Initial Weight 144.5978 Increase .0175		

Moisture Content: Sample Vol. 61.50 ft.^{3} x $\frac{530}{460 + 70}$ / $\frac{\text{Meter}}{533 \text{ Temp.}}$ X 28.3 L/ft.^{3} = 1730.7 L Dry Gas

Water Weight $\frac{194.46 \text{ gm.}}{18 \frac{\text{gm.}}{\text{mol.}}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 260.4 L H_2O Vapor

Total = 1991.0 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{260.4 \text{ L}}{1991.0 \text{ L}}$ x 100 = 13.1 %

PARTICULATE FIELD DATA

Run No. 17 | Amb. Temp. °F 65 WB 68 DB | Probe Tip Dia., In. 1/4" | Heater Box Setting 250°F

Location STACK | Bar. Press. "Hg. 28.81" | Probe Length 8'

Date 8/22/79 | Assumed Moist 12% | Inp. Nos.

Operator CHU / BRUCE | Test Periods 144 MIN | Sample Box No.

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Km = 0.6265

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O Qm=3.9		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
		869.66	ΔP	√ΔP	Desired	Actual	Inlet	Outlet						
NB-1	8:24/30	871.43	0.19	0.44	0.33	0.34	69	69	0.0	271	64	225	314	
2	36	872.93	0.14	0.37	0.25	0.25	71	71	0.0	250	67	219	316	
3	42	874.10	0.09	0.30	0.16	0.15	71	71	0.0	265	78	166	315	
4	48	875.15	0.07	0.26	0.12	0.12	74	75	0.0.	237	80	212	316	
5	4:55	876.36	0.07	0.26	0.12	0.12	75	81	0.0	260.	82	268	314	
6	9:00	877.37	0.09	0.30	0.16	0.16	79	81	0.0.	260	82	303	315	
E-1	9:11/12	878.06	0.03	0.17	0.05	0.05	82	84	0.0	239	80	169	297	+0.36
2	23	879.00	0.05	0.22	0.09	0.10	86	87	0.0	255	79	151	324	
3	29	879.99	0.06	0.25	0.11	0.11	82	83	0.0.	267	88	175	318	
4	35	881.10	0.07	0.26	0.12	0.14	84	86	0.0	245	82	228	329	
5	41	882.28	0.08	0.28	0.14	0.15	85	87	0.0.	269	85	291	329	
6	47	883.46	0.11	0.33	0.20	0.15	82	83	0.0.	260	81	310	321	
S-1	9:10:02/08	884.35	0.05	0.22	0.09	0.09	83	82	0.0	209	76	127	307	
2	14	885.02	0.03	0.17	0.05	0.05	84	85	0.0	268	80	130	299	
3	20	885.68	0.03	0.17	0.05	0.05	71	76	0.0.	243	80	128	295	
4	26	886.32	0.03	0.17	0.05	0.05	75	76	0.0	244	70	166	302	
5	32	887.23	0.05	0.22	0.09	0.09	73	75	0.0	273	75	205	308	
6	38	888.27	0.06	0.25	0.11	0.12	77	76	0.0	250	77	283	311	
WS-1	10:52/58	888.90	0.03	0.17	0.05	0.04	80	82	0.0.	221	82	129	261	
2	11:04	889.71	0.04	0.20	0.07	0.07	80	81	0.0.	238	81	195	308	
3	10	890.74	0.06	0.25	0.11	0.12	75	76	0.0.	244	85	151	309	
4	16	891.68	0.05	0.22	0.09	0.10	83	84	0.0.	262	81	209	319	
5	22	892.61	0.05	0.22	0.09	0.10	76	79	0.0.	259	75	263	305	
6	28	893.67	0.07	0.26	0.12	0.12	83	85	0.0.	243	82	291	315	
TOTAL	144			5.96	2.82	2.84	1870	1914					7947	
AVERAGE	6			0.248	0.118	0.118	77.9	79.8					310.3	

10:40 power off PPTR

10:50 power off PPTR

539°R 78.8 Meter Volume

Dry Meter Calibration Factor 770.3°R

[redacted] CORRECTED SAMPLE VOLUME [redacted] 0 [redacted] ft.3 [redacted] X 0.[redacted]6 [redacted] = [redacted]23[redacted] Ft.[redacted]

RUN NO. 17

PARTICULATE & WATER CATCH

IMPINGER NO. 65	Final Weight 611.87	WATER WEIGHT GAIN	IMPINGER 1 45.82
	Initial Weight 565.89	457.09	
	Increase 45.98	451.95	IMPINGER 2 0.82
		464.12	
IMPINGER NO. 66	Final Weight 511.41		IMPINGER 3 0.47
	Initial Weight		
	Increase 510.59		IMPINGER 4 9.73
	.82		53.84
IMPINGER NO. 67	Final Weight 464.53		TOTAL 56.82
	Initial Weight		
	Increase 464.06		ORSAT
	.47		
IMPINGER NO. 68	Final Weight 791.87		CO_2 9.2
	Initial Weight		
	Increase 782.14		O_2 15.4
	9.73		
FILTER NO. 10	Final Weight .7864		CO —
	Initial Weight		
	Part. Catch .7790		N_2 75.4
	.0074		

SOLID WEIGHT GAIN

Filter .0074

BEAKER NO. 5	Final Weight 14.0839	BEAKER 1 —
	Initial Weight	
	Increase 14.0051	BEAKER 2 0155
	.0788	
BEAKER NO. —	Final Weight —	Total BEAKER 3 0233
	Initial Weight	
	Increase —	BEAKER 5 .0788
BEAKER NO. —	Final Weight —	Wet TOTAL .1021
	Initial Weight	
	Increase —	
BEAKER NO. 24 PROBE WASH	Final Weight 148.4473	
	Initial Weight	
	Increase .4314	
	.0159	

Moisture Content: Sample Vol. 23.93 ft.^{3} x $\frac{530}{460 + 70}$ / $\frac{530}{460 + \text{Meter Temp.}}$ X 28.3 L/ft.^{3} = 665.9 L Dry Gas

Water Weight $\frac{56.82 \text{ gm.}}{18 \frac{\text{gm.}}{\text{mol.}}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 76.1 L H_2O Vapor

Total = 742.01 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{76.1 \text{ L}}{742.01 \text{ L}}$ x 100 = 10.3 %

PARTICULATE FIELD DATA

Run No. 18
Location STACK
Date 8/22/79
Operator CHM/BOB

Amb. Temp. °F 65 WB / 68 DB
Bar. Press. "Hg. 28.81"
Assumed Moist 12%
Test Periods 144 MIN

Probe Tip Dia., In. 1/4"
Probe Length 81
Inp. Nos.
Sample Box No.
K_m = 0.6713

Heater Box Setting 250 °F

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O Q_m 33.45		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
S		188.96	ΔP	√ΔP	Desired	Actual	Inlet	Outlet						
S-1	8:27/33	191.68	0.28	0.95	0.31	0.28	76	78	0.0	261	25	181	290	
2	39	193.07	0.09	0.30	0.14	0.19	70	72	0.0	270	21	192	703	
3	45	193.87	0.06	0.25	0.09	0.06	76	77	0.0	253	80	180	319	
4	51	194.88	0.07	0.26	0.11	0.10	80	82	0.0	289	82	202	314	
5	57	195.90	0.07	0.26	0.11	0.10	75	76	0.0	240	86	205	311	
6	9:03	197.14	0.09	0.30	0.14	0.15	77	79	0.0	258	86	269	719	
W-1	9:14/20	198.03	0.05	0.22	0.08	0.08	81	82	0.0	256	80	230	293	
2	26	199.11	0.07	0.26	0.11	0.11	84	85	0.0	238	78	172	310	
3	32	200.30	0.08	0.28	0.13	0.14	81	83	0.0	268	80	174	317	+0.36
4	38	201.43	0.08	0.28	0.13	0.12	85	85	0.0	245	80	215	326	
5	44	202.68	0.09	0.30	0.14	0.15	77	84	0.0	278	85	269	315	
6	50	203.78	0.07	0.38	0.14	0.12	76	78	0.0	242	80	202	716	
N-1	10:05/11	204.70	0.05	0.22	0.08	0.08	79	79	0.0	242	82	170	240	
2	17	205.38	0.04	0.20	0.06	0.06	75	70	0.0	271	80	158	250	
3	23	206.17	0.03	0.17	0.05	0.06	75	75	0.0	282	78	150	298	
4	29	207.12	0.06	0.25	0.09	0.09	71	72	0.0	258	70	196	302	
5	35	208.22	0.07	0.26	0.11	0.12	75	76	0.0	232	75	232	310	
6	41	209.31	0.07	0.26	0.11	0.11	71	74	0.0	270	75	269	306	
E-1	10:55/11:4	209.96	0.03	0.17	0.05	0.04	82	82	0.0	218	75	171	293	
2	07	210.83	0.04	0.20	0.08	0.07	76	79	0.0	200	80	184	301	
3	13	211.96	0.06	0.25	0.09	0.12	72	74	0.0	215	75	146	306	
4	19	212.82	0.05	0.22	0.08	0.07	74	76	0.0	257	85	202	308	
5	25	213.78	0.05	0.22	0.08	0.09	79	81	0.0	230	82	249	309	
6	31	214.84	0.07	0.26	0.11	0.11	81	84	0.0	253	83	284	311	
TOTAL	144			6.14	2.62	2.60	1848	1883					7261	
AVERAGE	6			0.256	0.109	0.108	77	78.5					302.5	

10:40 Power off PPTR
10:50 Power off PPTR

537.7°R 77.7 Meter Volume

Dry Meter Calibration Factor 762.5°R

CORRECTED SAMPLE VOLUME = 2948 Ft.³ × 0.9957 = 2935 Ft.³

RUN NO. 18

PARTICULATE & WATER CATCH

IMPINGER NO. 69	Final Weight 561.30	WATER WEIGHT GAIN	IMPINGER 1 27.8
	Initial Weight 533.48	460.90	
	Increase 27.8	456.42	IMPINGER 2 .38
		476.71	
IMPINGER NO. 70	Final Weight 515.47		IMPINGER 3 .10
	Initial Weight 515.09		
	Increase .38		IMPINGER 4 7.85
IMPINGER NO. 71	Final Weight 477.15		TOTAL 35.67 36.15
	Initial Weight 477.05		
	Increase .10		ORSAT
IMPINGER NO. 72	Final Weight 812.95		CO_2 9.2
	Initial Weight 805.10		
	Increase 7.85		O_2 15.4
FILTER NO. 11	Final Weight 7914		CO —
	Initial Weight 7826		
	Part. Catch .0088		N_2 75.4

SOLID WEIGHT GAIN

			Filter .0088
301.44 142.03 159.41 131.39 27.82 BEAKER NO. 15	Final Weight 142.0810		BEAKER 3 .0268
	Initial Weight 142.0331	Total Dry	BEAKER 2 0352
	Increase .0479		BEAKER 3 —
BEAKER NO. —	Final Weight —		BEAKER 15 .0479
	Initial Weight —		Weat TOTAL 0835
	Increase —		
BEAKER NO. —	Final Weight —		
	Initial Weight —		
	Increase —		
BEAKER NO. 3 PROBE WASH	Final Weight 135.4480		
	Initial Weight .4212		
	Increase .0268		

Moisture Content: Sample Vol. 25.02 ft.^{3} x $\frac{460 + 70}{460 + 538}$ Meter Temp. X 28.3 L/ft.^{3} = 697.5 L Dry Gas

Water Weight $\frac{36.15 \text{ gm.}}{18 \frac{\text{gm.}}{\text{mol.}}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 48.4 L H_2O Vapor

Total = 745.9 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{48.4 \text{ L}}{745.9 \text{ L}}$ x 100 = 6.5 %

PARTICULATE FIELD DATA

Run No. 19
Location STACK
Date 8/23/79
Operator CHU / BRUCE

Amb. Temp. °F 69 DB / 69 WB
Bar. Press. "Hg. 28.80"
Assumed Moist 12%
Test Periods 144 min

Probe Tip Dia., In 3/8"
Probe Length 8'
Inp. Nos.
Sample Box No.

Heater Box Setting 250°F

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O $Q_m \times 3\%$		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
		894.21	ΔP	$\sqrt{\Delta P_{0.3}}$	Desired	Actual	Inlet	Outlet						
W-1	10:03/08	897.85	0.14	0.37	1.64	1.46	77	77	4.5	245	75	180	314	
2	45	902.11	0.22	0.47	2.56	2.00	76	78	7.0	285	74	155	313	
3	21	906.40	0.20	0.45	2.32	2.02	74	76	8.0	281	75	176	312	
4	27	910.51	0.13	0.36	1.51	1.86	76	79	7.0	228	78	224	309	
5	33	914.60	0.12	0.35	1.40	1.84	75	77	7.0	257	82	271	303	
6	39	918.43	0.14	0.37	1.63	1.61	80	90	6.0	285	90	295	303	
S-1	10:47/53	920.65	0.05	0.22	0.58	0.54	70	72	0.0	235	80	166	284	
2	59	923.39	0.08	1.28	0.93	0.83	68	69	2.0	274	75	126	291	10.38
3	11:05	926.35	0.08	0.28	0.93	0.96	69	76	2.5	234	82	125	297	
4	11	929.38	0.09	0.30	1.05	1.01	67	72	3.0	254	75	224	292	
5	17	932.75	0.12	0.36	1.40	1.25	69	74	4.0	253	74	272	295	
6	23	936.45	0.12	0.35	1.40	1.51	71	77	5.0	242	76	286	296	
E-1	10:33/39	939.14	0.07	0.26	0.81	0.80	70	72	0.0	257	76	263	296	
2	45	942.79	0.13	0.36	1.51	1.47	76	80	8.0	245	81	175	307	
3	51	946.57	0.13	0.36	1.51	1.57	80	83	0.0	242	87	181	307	
4	57	950.46	0.14	0.37	1.63	1.66	77	83	0.0	253	82	210	309	
5	11:03	954.29	0.14	0.37	1.63	1.57	79	85	0.0	209	86	232	314	
6	09	957.38	0.10	0.32	1.16	1.08	74	81	0.0	264	77	276	305	
N-1	11:21/27	959.67	0.05	0.22	0.58	0.50	71	72	2.0	251	70	171	257	
2	33	962.84	0.10	0.32	1.16	1.18	75	78	4.0	259	78	143	302	
3	39	966.35	0.12	0.35	1.40	1.36	76	77	5.0	242	75	184	312	
4	45	969.63	0.10	0.32	1.16	1.18	79	82	5.0	215	89	199	318	
5	51	973.15	0.13	0.36	1.51	1.36	74	80	5.5	238	82	278	312	
6	57	976.57	0.10	0.32	1.16	1.29	75	82	5.5	247	90	303	312	
TOTAL				8.08	32.58	31.84	1778	1872					7260	
AVERAGE				0.337	1.358	1.327	74.08	78.00					302.5	

536°R (76°C) Meter Volume

Dry Meter Calibration Factor 763°R

[redacted] CO[redacted]TED[redacted]MPLI[redacted]LUM[redacted] [redacted]36[redacted]t.3[redacted] O[redacted]6[redacted] [redacted]82[redacted]F[redacted]

RUN NO. 19

PARTICULATE & WATER CATCH

IMPINGER NO. 73	Final Weight 648.20 Initial Weight 540.49 Increase	WATER WEIGHT GAIN	IMPINGER 1 107.71
IMPINGER NO. 74	Final Weight 563.55 Initial Weight Increase 540.67		IMPINGER 2 22.88 +7.14
IMPINGER NO. 75	Final Weight 456.59 Initial Weight Increase 451.33		IMPINGER 3 5.26
IMPINGER NO. 26	Final Weight 799.87 Initial Weight Increase 768.68		IMPINGER 4 31.19
			TOTAL 174.18 ~~[illegible]~~
			ORSAT
			CO_2 5.4
			O_2 17.6
FILTER NO. 12	Final Weight 8413 Initial Weight 7815 Part. Catch .0598		CO —
			N_2 77.0

SOLID WEIGHT GAIN

Fell .0598

BEAKER NO. 11 ~~28~~	Final Weight 137.6867 Initial Weight Increase 137.5827 .1040		BEAKER 17 .0209 ~~Dry~~ BEAKER 2 .0807
BEAKER NO. ____	Final Weight ____ Initial Weight Increase ____		BEAKER 3 ____ BEAKER ~~14~~ .1060
			Wet TOTAL .1847
BEAKER NO. ____	Final Weight ____ Initial Weight Increase ____		
BEAKER NO. 17 PROBE WASH	Final Weight 142.6074 Initial Weight 142.5865 Increase .0209 530		

Moisture Content: Sample Vol. 82.08 ft.^{3} x $\frac{\text{~~460 + 70~~}}{\text{~~460 + Meter~~ 536 Temp.}}$ X 28.3 L/ft.^{3} = 2296.9 L Dry Gas

Water Weight $\frac{\text{~~[illegible]~~ 174.18 gm.}}{18 \text{ gm./mol.}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = $\frac{\text{~~233.6~~ 233.2 L}}{\text{L } H_2O \text{ Vapor}}$

Total = 2530.1 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{\text{~~233.6~~ 233.2 L}}{2530.1 \text{ L}}$ x 100 = 9.2 %

PARTICULATE FIELD DATA

Run No. 20
Location STACK
Date 6/23/79
Operator CHH/BOB

Amb. Temp. °F 69 DB / 69 WB
Bar. Press. "Hg. 28.80"
Assumed Moist 12%
Test Periods 144

Probe Tip Dia., In. 3/8"
Probe Length 8'
Inp. Nos.
Sample Box No.

Heater Box Setting 250°F

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
	10:06/12	215.41	ΔP	$\sqrt{\Delta P}$	Desired	Actual	Inlet	Outlet						
E-1		220.33	0.22	0.47	2.60	2.32	79	79	6.5	247	82	159	295	
2	18	225.83	0.35	0.59	4.13	3.90	82	85	9.0	200	82	163	317	
3	24	231.29	0.19	0.44	2.24	2.86	79	86	9.0	215	87	205	308	
4	30	236.74	0.14	0.37	1.65	2.85	80	89	9.5	243	87	210	309	
5	36	241.84	0.15	0.39	1.77	2.49	75	80	9.5	225	89	202	310	
6	42	246.79	0.15	0.39	1.77	0.83	72	77	2.0	233	86	227	307	
N-1	10:50/56	247.24	0.05	0.22	0.59	0.58	70	72	0.5	261	70	181	213	
2	11:02	249.88	0.06	0.24	0.71	0.72	73	74	2.0	289	80	220	284	+0.36
3	08	253.75	0.13	0.36	1.53	1.36	68	73	2.5	236	77	184	307	
4	14	257.23	0.12	0.35	1.42	1.52	72	80	4.0	283	80	284	296	
5	20	261.81	0.14	0.37	1.65	1.60	69	76	5.5	257	79	263	298	
6	26	265.91	0.14	0.38	1.65	1.61	71	78	4.5	222	75	280	296	
W-1	10:36/42	268.80	0.07	0.26	0.83	0.80	72	79	2.5	248	80	286	254	
2	48	272.62	0.12	0.35	1.42	1.40	73	79	3.5	250	85	180	296	
3	54	276.60	0.12	0.35	1.42	1.52	75	83	4.5	235	86	186	301	
4	12:00	280.67	0.13	0.36	1.53	1.59	70	78	5.0	264	81	258	301	
5	06	284.25	0.11	0.33	1.30	1.23	76	83	4.0	223	85	286	307	
6	12	287.89	0.11	0.33	1.30	1.27	68	78	4.5	267	80	295	302	
S-1	12:24/30	290.36	0.05	0.22	0.59	0.58	74	77	2.0	272	75	155	209	
2	36	293.38	0.08	0.28	0.94	0.87	78	82	3.0	238	85	168	286	
3	42	296.44	0.07	0.26	0.83	0.90	72	77	3.0	268	77	150	303	
4	48	299.73	0.09	0.30	1.06	1.04	84	85	3.5	234	88	212	319	
5	54	303.23	0.10	0.32	1.18	1.17	76	83	4.0	272	82	268	310	
6	13:00	306.85	0.10	0.32	1.18	1.26	83	86	4.5	276	85	294	314	
TOTAL				8.24	35.29	35.27	1791	1898					6992	
AVERAGE				0.343	1.470	1.470	74.6	79.08					291.3	

537°R 76.9 Meter Volume

Dry Meter Calibration Factor 751°R

[redacted] CO[redacted]TED [redacted]IPLE [redacted]LUM[redacted] [redacted]44[redacted]t.3[redacted] x [redacted]005[redacted] [redacted]9[redacted] Ft.

RUN NO. 20

PARTICULATE & WATER CATCH

IMPINGER NO. 77	Final Weight 588.28 WATER WEIGHT GAIN Initial Weight 561.65 Increase	IMPINGER 1	26.63
		IMPINGER 2	164.34
IMPINGER NO. 78	Final Weight 731.26 Initial Weight Increase 566.92	IMPINGER 3	5.33
		IMPINGER 4	39.07
IMPINGER NO. 79	Final Weight 461.80 Initial Weight Increase 456.47	TOTAL	235.37
		ORSAT	
IMPINGER NO. 80	Final Weight 843.93 Initial Weight Increase 804.8C	CO_2	5.4
		O_2	17.6
FILTER NO. 13	Final Weight .9845 Initial Weight 8650 Part. Catch .1195	CO	—
		N_2	77.0

SOLID WEIGHT GAIN

		Filter -	.1195
BEAKER NO. 4	Final Weight 143.0340 Initial Weight 142.9120 Increase .1220	BEAKER 12	0523
		Dup BEAKER 2	.1718
BEAKER NO. ____	Final Weight ____ Initial Weight Increase ____	BEAKER 3	____
		BEAKER 4	.1220
		wet TOTAL	.2938
BEAKER NO. ____	Final Weight ____ Initial Weight Increase ____		
BEAKER NO. 12 PROBE WASH	Final Weight 138.5669 Initial Weight 5146 Increase 0523		

Moisture Content: Sample Vol. 91.96 ft.^{3} x $\frac{530}{460 + 70}$ / $\frac{}{460 + \text{Meter}}$ $\frac{530}{537}$ Temp. X 28.3 L/ft.^{3} = 2568.5 L Dry Gas

Water Weight $\frac{235.37 \text{ gm.}}{18 \text{ gm./mol.}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 315.1 L H_2O Vapor

Total = 2883.6 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{315.1 \text{ L}}{2883.6 \text{ L}}$ x 100 = 10.9 %

PARTICULATE FIELD DATA

Run No. 21 | Amb. Temp. °F ~~69 WB~~ 71 DB | Probe Tip Dia., In 3/8" | Heater Box Setting 250°F

Location STACK | Bar. Press. "Hg. 28.76" | Probe Length 8'

Date 8/30/79 | Assumed Moist 10% | Inp. Nos.

Operator CHU / BRUCE | Test Periods 144 min | Sample Box No.

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O $Q_{std} \times 3.9$		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
		977.55	ΔP	$\sqrt{\Delta P}$	Desired	Actual	Inlet	Outlet						
N-1	10:07/13	979.72	0.05	0.22	0.61	0.52	75	72	3.0	263	82	122	290	
2	19	982.87	0.11	0.33	1.34	1.09	77	80	8.0	2~~15~~	95	163	289	
3	25	986.13	0.14	0.37	1.70	1.17	77	81	10.0	247	95	165	296	
4	31	989.36	0.13	0.36	1.58	1.15	78	81	10.0	263	100	203	307	
5	37	992.61	0.14	0.37	1.70	1.16	79	85	10.0	213	105	269	301	
6	43	995.94	0.13	0.36	1.58	1.22	79	86	10.0	250	95	290	296	
~~E~~-1	10:55/11:0	999.38	0.05	0.22	0.61	1.30	79	83	10.0	216	95	197	296	
2	07	1002.78	0.08	0.28	0.97	1.27	80	83	11.0	250	98	165	297	
3	13	1006.25	0.08	0.28	0.97	1.32	80	85	11.0	270	98	166	296	+0.29
4	19	1009.63	0.03	0.17	0.37	1.26	81	87	11.5	256	100	288	286	
5	25	1011.49	0.03	0.17	0.37	0.38	81	86	2.5	210	100	261	287	
6	31	1013.31	0.03	0.17	0.37	0.36	83	87	2.5	243	102	278	284	
S-1	11:45/51	1015.13	0.03	0.17	0.37	0.36	82	86	2.5	268	87	170	288	
2	57	1017.21	0.04	0.20	0.49	0.48	84	87	3.5	242	100	136	284	
3	14:03	1019.34	0.04	0.20	0.49	0.50	85	88	4.0	272	95	107	294	
4	09	1021.64	0.05	0.22	0.61	0.58	91	87	5.0	236	95	205	281	
5	15	1023.83	0.04	0.20	0.49	0.53	85	88	4.5	247	96	238	287	
6	21	1026.17	0.05	0.22	0.61	0.60	89	92	5.0	224	98	265	276	
W-1	12:28/34	1027.98	0.03	0.17	0.37	0.36	85	91	3.0	191	96	183	277	
2	40	1030.12	0.04	0.20	0.49	0.50	88	89	4.0	267	99	171	280	
3	46	1032.26	0.04	0.20	0.49	0.50	90	92	4.5	193	97	150	295	
4	52	1034.57	0.05	0.22	0.61	0.59	89	92	5.0	259	97	181	291	
5	58	1036.90	0.05	0.22	0.61	0.60	90	93	5.5	227	95	207	278	
6	1:04	1039.26	0.05	0.22	0.61	0.61	89	93	5.5	238	94	268	273	
TOTAL	144			5.74	18.41	18.41	1983	2069					6895	
AVERAGE	6			0.239	0.767	0.767	82.6	86.2					287.3	

(544°R) 84.4 Meter Volume — Dry Meter Calibration Factor (747°R)

[redacted] CO[redacted]TED [redacted]MPL[redacted]LUM[redacted] [redacted]t.3 [redacted] 0.[redacted]66 [redacted] 6[redacted]

RUN NO. 21

PARTICULATE & WATER CATCH

IMPINGER NO. 81	Final Weight 674.62	WATER WEIGHT GAIN	IMPINGER 1 131.52
	Initial Weight 543.10		
	Increase		IMPINGER 2 20.46
IMPINGER NO. 82	Final Weight 562.26		IMPINGER 3 2.14
	Initial Weight 546.77		
	Increase		IMPINGER 4 21.07
IMPINGER NO. 83	Final Weight 446.24		TOTAL 175.19
	Initial Weight 444.10		
	Increase		ORSAT
IMPINGER NO. 84	Final Weight 814.92		CO_2 9.8
	Initial Weight 793.85		
	Increase		O_2 15.6
FILTER NO. 14	Final Weight .8999		CO —
	Initial Weight		
	Part. Catch .8534		N_2 74.6
	.0465		
	SOLID WEIGHT GAIN		Fedr .0465
BEAKER NO. 6	Final Weight 117.0487		BEAKER C .0436
	Initial Weight 117.0051		~~BEAKER 1 .0436~~
	Increase .0436		BEAKER 2 .0890
BEAKER NO. ____	Final Weight ____		BEAKER 3 ____
	Initial Weight		
	Increase ____		BEAKER ~~3~~ .0436
			TOTAL .1326
BEAKER NO. ____	Final Weight ____		
	Initial Weight		
	Increase ____		
BEAKER NO. 39 PROBE WASH	Final Weight 150.5344		
	Initial Weight 150.4919		
	Increase .0425		

Moisture Content: Sample Vol. 61.5 ft.^{3} x $\frac{530}{460 + 70}$ / $\frac{}{460 + \text{Meter Temp.}}$ X 28.3 L/ft.^{3} = 1735.7 L Dry Gas

Water Weight $\frac{176.19 \text{ gm.}}{18 \frac{\text{gm.}}{\text{mol.}}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 234.55 H_2O Vapor

Total = 1930.2 L

$\frac{H_2O \text{ Vol}}{\text{Total}}$ $\frac{234.55 \text{ L}}{1930.2 \text{ L}}$ x 100 = 12.2 %

PARTICULATE FIELD DATA

Run No. 22
Location STACK
Date 8/30/79
Operator CHH/BOB

Amb. Temp. °F 69 WB / 71 DB
Bar. Press. "Hg. 28.76"
Assumed Moist 10%
Test Periods 144 min

Probe Tip Dia., In 3/8"
Probe Length 8'
Inp. Nos.
Sample Box No.

Heater Box Setting 250°F

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
		307.41	ΔP	√ΔP	Desired	Actual	Inlet	Outlet						
S-1	10:10/06	310.48	0.07	0.26	0.86	0.90	80	81	1.5	297	83	175	275	
2	22	313.96	0.09	0.30	1.11	1.16	80	81	2.0	248	93	196	288	
3	28	317.71	0.10	0.32	1.23	1.35	77	81	2.5	186	87	185	299	
4	34	321.60	0.11	0.33	1.60	1.45	77	85	3.0	238	89	181	303	
5	40	325.14	0.10	0.32	1.23	1.20	77	85	2.5	271	87	246	298	
6	46	328.96	0.12	0.35	1.48	1.40	76	85	3.0	247	86	273	293	
W-1	10:58/11:04	331.47	0.05	0.22	0.62	0.60	81	86	0.5	310	90	197	287	
2	10	334.62	0.08	0.28	0.98	0.95	82	89	2.0	275	95	182	282	+0.27
3	16	337.40	0.06	0.24	0.73	0.74	77	85	2.0	215	95	169	274	
4	22	339.70	0.04	0.20	0.49	0.51	78	86	1.0	242	92	204	280	
5	28	341.98	0.04	0.20	0.49	0.50	82	89	0.5	236	95	248	288	
6	34	344.26	0.04	0.20	0.49	0.50	84	89	0.5	282	102	266	285	
N-1	11:48/54	346.23	0.03	0.17	0.37	0.37	83	87	0.0	298	86	199	277	
2	12:00	348.72	0.04	0.22	0.62	0.59	83	88	1.5	261	88	168	264	
3	06	351.27	0.05	0.22	0.62	0.62	85	89	1.5	232	92	150	287	
4	12	353.80	0.05	0.22	0.62	0.61	85	90	1.5	266	95	185	284	
5	18	356.33	0.05	0.22	0.62	0.61	84	88	1.5	238	95	190	287	
6	24	358.72	0.04	0.20	0.49	0.55	86	92	1.5	248	98	216	278	
E-1	12:31/37	360.70	0.03	0.17	0.37	0.38	87	90	0.5	226	96	219	257	
2	43	362.70	0.03	0.17	0.21	0.38	89	91	0.5	261	98	191	266	
3	49	364.91	0.04	0.20	0.49	0.47	90	92	1.5	296	103	180	229	
4	55	367.40	0.05	0.22	0.62	0.59	88	91	2.0	258	97	221	271	
5	1:01	369.75	0.04	0.20	0.49	0.53	89	92	2.0	235	93	196	283	
6	07	372.01	0.04	0.20	0.49	0.49	91	92	2.0	210	98	273	282	
TOTAL	144			5.63	17.48	17.65	1943	2087					6715	
AVERAGE	6			0.235	0.728	0.727	83.04	86.96					279.8	

545°K

85°F Meter Volume

740°R

Dry Meter Calibration Factor

[redacted] CORRECTED SAMPLE VOLUME [redacted] 60 [redacted] t. [redacted] 0.9855 [redacted] 64.97 [redacted]

RUN NO. 22

PARTICULATE & WATER CATCH

IMPINGER NO. 85	Final Weight 665.50 Initial Weight 537.84 Increase	WATER WEIGHT GAIN	IMPINGER 1 127.66
IMPINGER NO. 86	Final Weight 580.16 Initial Weight Increase 567.84		IMPINGER 2 12.32
IMPINGER NO. 87	Final Weight 462.58 Initial Weight Increase 461.07		IMPINGER 3 1.51
IMPINGER NO. 88	Final Weight 834.80 Initial Weight Increase 815.71		IMPINGER 4 19.09 + 10.00
FILTER NO. 15	Final Weight .9042 Initial Weight Part. Catch .8634		TOTAL 170.58
	.0408		ORSAT
	SOLID WEIGHT GAIN		CO_2 9.8
			O_2 15.6
			CO —
			N_2 74.6
		Frehr	.0408
BEAKER NO. 8	Final Weight 147.7844 Initial Weight 147.6282 Increase .1562	BEAKER 8	.1867
		Total BEAKER 2	.2965
BEAKER NO. ____	Final Weight ____ Initial Weight Increase ____	BEAKER 3	____
		BEAKER 40	.1562
		TOTAL	.3827
BEAKER NO. ____	Final Weight ____ Initial Weight Increase ____		
BEAKER NO. 40 PROBE WASH	Final Weight 154.3318 Initial Weight 154.1461 Increase .1857		

Moisture Content: Sample Vol. 64.97 ft.^{3} x $\frac{460 + 53}{460 + 54}$ X 28.3 L/ft.^{3} = 1788.0 L Dry Gas

Water Weight 170.58 gm. x $\frac{24.1 \text{ L}}{18 \text{ gm.}}$ = 228.39 L H_2O Vapor

Total = 2016.4 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{228.39 \text{ L}}{2016.4 \text{ L}}$ x 100 = 11.3 %

PARTICULATE FIELD DATA

Run No. RUN 22
Location STACK
Date 9/2/79
Operator CHI/BRUCE

Amb. Temp. °F 69 WB / 71 DB
Bar. Press. "Hg. 28.79"
Assumed Moist 11%
Test Periods 144 min

Probe Tip Dia., In ½"
Probe Length 8'
Inp. Nos.
Sample Box No.

Heater Box Setting 250°F

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
		39.79	ΔP	√ΔP	Desired	Actual	Inlet	Outlet						
W-1	7:57/8:03	41.81	0.20	0.45	0.47	0.45	60	61	0.0.	255	65	169	289	
2	09	44.28	0.30	0.55	0.70	0.67	61	62	0.5	280	64	170	296	
3	15	46.97	0.35	0.59	0.82	0.80	61	63	3.0	296	65	231	291	
4	21	49.86	0.39	0.62	0.91	0.92	61	64	3.5	277	66	262	297	
5	27	53.09	0.43	0.66	1.01	1.15	63	67	5.0	215	67	280	289	
6	33	56.98	0.42	0.65	0.98	0.92	63	69	4.5	276	69	287	300	
S-1	8:40/46	58.12	0.22	0.47	0.52	0.50	65	68	2.2	237	70	191	300	
2	52	60.80	0.25	0.59	0.82	0.79	67	71	3.5	258	72	150	304	+0.53
3	58	63.66	0.27	0.61	0.87	0.90	69	74	4.0	258	76	151	305	
4	9:04	66.70	0.42	0.65	0.98	1.02	69	75	5.0	275	77	227	306	
5	10	69.73	0.43	0.66	1.01	1.01	71	77	5.5	238	80	277	309	
6	16	72.55	0.37	0.61	0.87	0.87	72	78	5.0	264	81	301	306	
E-1	9:22/28	74.75	0.24	0.49	0.56	0.53	72	76	3.0	238	75	223	307	
2	34	77.44	0.35	0.59	0.82	0.80	72	75	4.5	245	77	175	306	
3	40	80.29	0.39	0.62	0.91	0.89	73	76	5.5	239	80	190	310	
4	46	83.33	0.41	0.64	0.96	1.02	71	77	6.0	233	82	254	312	
5	52	86.09	0.43	0.66	1.01	0.84	72	77	6.0	249	80	291	307	
6	58	89.07	0.35	0.59	0.82	0.98	72	77	5.5	276	78	305	305	
N-1	10:10/16	91.14	0.19	0.44	0.45	0.47	74	75	3.0	269	74	176	306	
2	22	93.51	0.28	0.53	0.61	0.62	74	75	3.0	254	78	149	312	
3	28	96.15	0.32	0.57	0.75	0.77	76	77	4.0	280	82	152	314	
4	34	98.85	0.36	0.60	0.84	0.80	75	77	4.5	254	80	216	315	
5	40	101.77	0.39	0.62	0.91	0.94	74	78	5.0	240	81	278	313	
6	46	104.36	0.31	0.56	0.73	0.74	74	77	4.5	280	877	303	307	
TOTAL	144			14.02	19.38	19.40	1661	1796					7304	
AVERAGE	6			0.584	0.808	0.808	69.2	72.8					304.3	

(531°R) 71.0 Meter Volume — Dry Meter Calibration Factor (764°R)

CORRECTED SAMPLE VOLUME 64.57 Ft.³ 0.996 64.3 F³

RUN NO. 23

PARTICULATE & WATER CATCH

IMPINGER NO. 89	Final Weight 733.87 Initial Weight 567.0x Increase	WATER WEIGHT GAIN	IMPINGER 1 166.83
			IMPINGER 2 20.60
IMPINGER NO. 90	Final Weight 584.56 Initial Weight Increase 563.96		IMPINGER 3 1.22
			IMPINGER 4 28.67
IMPINGER NO. 91	Final Weight 452.56 Initial Weight Increase 448.34		TOTAL 220.32
			ORSAT
IMPINGER NO. 92	Final Weight 310.01 Initial Weight Increase 281.34		CO_2 11.2
			O_2 13.6
FILTER NO. _____	Final Weight 1.0048 Initial Weight Part. Catch .8714 .1334		CO —
			N_2 25.2
	SOLID WEIGHT GAIN		Filter .1334
BEAKER NO. 26	Final Weight 144.6951 Initial Weight 144.5962 Increase .0989		BEAKER 38 .0495
		Total Dry	BEAKER 2 .1829
BEAKER NO. _____	Final Weight _____ Initial Weight Increase _____		BEAKER 3 _____
			BEAKER 26 .0989
		Total Wet	TOTAL .2818
BEAKER NO. _____	Final Weight _____ Initial Weight Increase _____		
BEAKER NO. 38 PROBE WASH	Final Weight 141.0695 Initial Weight 141.0200 Increase .0495		

Moisture Content: Sample Vol. 64.35 ft.^{3} x $\frac{460 + 70}{460 + \text{Meter Temp.}}$ ($\frac{530}{531}$) X 28.3 L/ft.^{3} = 1817.7 L Dry Gas

Water Weight $\frac{220.32 \text{ gm.}}{18 \text{ gm./mol.}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 295.0 L H_2O Vapor

Total = 2112.7 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{295.0 \text{ L}}{2112.7 \text{ L}}$ x 100 = 14.0 %

PARTICULATE FIELD DATA

Run No. RUN 24
Location STACK
Date 9/2/79
Operator CHH/BOB

Amb. Temp. °F 69 WB / 71 DB
Bar. Press. "Hg. 28.79"
Assumed Moist 11%
Test Periods 144 min

Probe Tip Dia., In 1/4"
Probe Length 8'
Inp. Nos.
Sample Box No.

Heater Box Setting 250°F

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O (Δ H x 3.45)		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
		372.57	ΔP	√ΔP	Desired	Actual	Inlet	Outlet						
E-1	8:00/06	375.09	0.28	0.53	0.57	0.61	61	62	0.5	230	63	134	288	
2	12	377.86	0.38	0.62	0.78	0.74	61	63	1.0	258	63	169	298	
3	18	380.77	0.40	0.63	0.82	0.81	62	65	1.5	285	64	199	303	
4	24	383.87	0.44	0.66	0.90	0.92	61	66	2.5	283	65	197	300	
5	30	387.05	0.45	0.67	0.92	0.97	62	70	2.5	256	68	263	303	
6	36	390.03	0.41	0.66	0.90	0.85	64	72	2.5	239	68	200	304	
N-1	8:43/49	392.20	0.22	0.47	0.45	0.45	66	72	0.5	207	70	226	263	
2	55	394.85	0.34	0.58	0.69	0.67	68	73	2.0	282	71	281	291	
3	9:01	397.65	0.36	0.60	0.73	0.75	70	76	2.0	293	73	275	304	+0.49
4	07	400.47	0.37	0.61	0.75	0.76	70	76	2.0	271	73	231	301	
5	13	403.42	0.39	0.62	0.80	0.83	73	80	3.0	269	78	279	304	
6	19	406.43	0.41	0.64	0.84	0.87	73	80	3.0	290	76	290	308	
W-1	9:25/31	408.50	0.20	0.45	0.41	0.41	72	75	1.5	277	72	243	278	
2	37	411.04	0.32	0.57	0.65	0.62	74	78	2.0	252	76	188	300	
3	43	413.73	0.33	0.57	0.67	0.69	73	77	2.5	267	76	192	304	
4	49	416.98	0.35	0.59	0.71	0.72	74	79	2.5	251	79	243	310	
5	8:55	419.36	0.34	0.62	0.80	0.79	74	79	3.0	249	78	277	307	
6	10:01	422.32	0.40	0.63	0.82	0.84	73	78	3.0	266	75	300	308	
S-1	10:13/19	424.63	0.24	0.49	0.49	0.51	73	75	1.5	194	73	199	225	
2	25	427.43	0.38	0.62	0.78	0.75	77	79	2.5	209	79	147	305	
3	31	430.38	0.39	0.62	0.80	0.83	75	78	2.5	276	76	157	311	
4	37	433.41	0.40	0.65	0.86	0.88	77	81	3.0	260	80	216	316	
5	43	436.30	0.46	0.68	0.94	0.80	78	82	3.5	297	82	272	316	
6	49	439.52	0.46	0.68	0.94	0.99	73	78	6.5	270	79	301	311	
TOTAL	144			19.46	18.02	18.06	1684	1794					7207	
AVERAGE	6			0.603	0.751	0.753	70.2	74.8					300.3	

(532°R) 72.5 Meter Volume — Dry Meter Calibration Factor (460°R)

CORRECTED SAMPLE VOLUME 66.95 Ft.³ 1.0057 67.33 Ft.³

RUN NO. 24

PARTICULATE & WATER CATCH

IMPINGER NO. 93	Final Weight 691.38 Initial Weight 545.46 Increase	WATER WEIGHT GAIN IMPINGER 1 145.92
IMPINGER NO. 94	Final Weight 562.33 Initial Weight 544.42 Increase	IMPINGER 2 17.91 IMPINGER 3 10.64
IMPINGER NO. 95	Final Weight 474.64 Initial Weight 464.00 Increase	IMPINGER 4 28.37 TOTAL 202.84
IMPINGER NO. 96	Final Weight 830.37 Initial Weight 802.00 Increase	ORSAT CO_2 11.2
FILTER NO. 17	Final Weight .9796 Initial Weight .8681 Part. Catch .1115	O_2 13.6 CO – N_2 75.2

SOLID WEIGHT GAIN

BEAKER NO. 13	Final Weight 140.6973 Initial Weight 140.5887 Increase .1086	Filt. .1115 BEAKER 1 ____ BEAKER 2 .0210
BEAKER NO. ____	Final Weight ____ Initial Weight ____ Increase ____	Total BEAKER 3 .1325 BEAKER 3 .1086
BEAKER NO. ____	Final Weight ____ Initial Weight ____ Increase ____	Total Cat TOTAL .2411
BEAKER NO. 24 PROBE WASH	Final Weight 148.4490 Initial Weight 148.4280 Increase .0210	

Moisture Content: Sample Vol. 67.33 ft.^{3} x $\frac{530}{460 + 70}$ X 28.3 L/ft.^{3} = 1898.3 L Dry Gas

532 Temp.

Water Weight $\frac{202.84 \text{ gm.}}{18 \text{ gm./mol.}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 271.6 L H_2O Vapor

Total = 2169.9 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{271.6 \text{ L}}{2169.9 \text{ L}}$ x 100 = 12.5 %

PARTICULATE FIELD DATA

Run No. 1C
Location STACK
Date 9/3/79
Operator CHU / BRUCE

Amb. Temp. °F 70 WB / 73 DB
Bar. Press. "Hg. 28.73"
Assumed Moist 12%
Test Periods 48 min

Probe Tip Dia., In 1/4"
Probe Length 8'
Inp. Nos.
Sample Box No. one Mill

250°F
Heater Box Setting

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
		104.89	ΔP	$\sqrt{\Delta P}$	Desired	Actual	Inlet	Outlet						
N-1	8:23/79	106.99	0.23	0.48	0.48	0.49	72	72	3.0	266	75	163	297	
2	35	109.55	0.34	0.58	0.78	0.72	72	75	4.5	292	80	173	318	
3	41	112.27	0.35	0.59	0.80	0.81	73	73	5.5	268	81	184	317	
4	47	115.20	0.40	0.63	0.92	0.94	79	82	7.0	294	85	226	316	
5	53	118.14	0.41	0.64	0.94	0.95	72	76	7.0	297	76	285	315	
6	59	121.27	0.47	0.69	1.08	1.08	74	79	8.0	256	79	309	304	
W-1	9:05/11	123.53	0.25	0.50	0.57	0.56	74	79	3.0	285	84	185	314	
2	17	126.37	0.39	0.62	0.89	0.89	72	76	6.0	267	75	166	312	+0.47
3	23	129.30	0.41	0.64	0.94	0.94	79	82	6.5	250	88	168	315	
4	29	132.36	0.46	0.69	1.08	1.07	75	79	8.5	230	88	233	315	
5	35	135.42	0.47	0.69	1.08	1.10	78	82	8.5	264	86	285	309	
6	41	138.70	0.47	0.69	1.08	1.11	81	85	8.5	227	89	306	307	
S-1	9:49/55	141.10	0.28	0.53	0.62	0.63	81	83	4.5	250	84	175	312	
2	10:01	143.81	0.36	0.60	0.82	0.81	73	76	5.0	240	85	132	309	
3	07	146.76	0.42	0.65	0.96	0.96	76	79	7.0	242	88	143	310	
4	13	149.62	0.42	0.65	0.96	0.90	74	77	5.5	261	85	232	307	
5	19	152.65	0.47	0.69	1.08	1.01	74	80	8.0	245	86	281	291	
6	25	155.82	0.47	0.69	1.08	1.11	75	81	10.0	244	88	298	295	
E-1	10:35/41	157.64	0.15	0.39	0.34	0.36	73	76	3.0	231	86	169	282	
2	47	160.80	0.28	0.53	0.64	0.61	74	76	5.0	282	75	191	302	
3	53	162.68	0.33	0.57	0.76	0.79	75	77	6.0	238	82	152	308	
4	59	165.37	0.37	0.61	0.85	0.80	74	78	7.0	280	76	233	307	
5	11:05	168.28	0.41	0.64	0.94	0.93	74	79	8.0	240	78	273	296	
6	11	171.32	0.43	0.66	0.98	1.02	79	81	9.0	268	74	294	301	
TOTAL	144			14.65	20.69	20.51	1798	1583					7371	
AVERAGE	6			0.610	0.862	0.856	74.9	78.5					307.1	

537°R 767°R Meter

Dry Meter Calibration Factor 767°R

CORRECTED SAMPLE VOLUME [redacted] 43 Ft.3 [redacted] 0.996 [redacted] 66 [redacted] 3

RUN NO. 25

PARTICULATE & WATER CATCH

IMPINGER NO. 97	Final Weight 710.20 Initial Weight 546.87 Increase	WATER WEIGHT GAIN	IMPINGER 1 165.33
IMPINGER NO. 98	Final Weight 572.89 Initial Weight Increase 554.44		IMPINGER 2 18.45
IMPINGER NO. 99	Final Weight 465.41 Initial Weight Increase 462.18		IMPINGER 3 3.23
IMPINGER NO. 100	Final Weight 851.35 Initial Weight Increase 826.67		IMPINGER 4 21.68 ÷ 3 TOTAL 219.69
FILTER NO. #18	Final Weight 0.9771 Initial Weight Part. Catch 0.8724 .1047		ORSAT CO_2 11.4 O_2 14.4 CO – N_2 74.2

SOLID WEIGHT GAIN

BEAKER NO. 4	Final Weight 143.0075 Initial Weight 142.8987 Increase .1088	BEAKER ~~#~~ 7 0.0179 Filter #18 BEAKER 2 0.1047 Total Dry BEAKER ~~5~~ 0.1226 BEAKER ~~4~~ 4 0.1088 TOTAL 0.2314
BEAKER NO. _____	Final Weight _____ Initial Weight Increase _____	
BEAKER NO. _____	Final Weight _____ Initial Weight Increase _____	231.4 mg
BEAKER NO. 17 PROBE WASH	Final Weight 142.6050 Initial Weight 142.5871 Increase .0179	

Moisture Content: Sample Vol. 66.2 ft.^{3} x $\frac{460 + 70}{460 + \text{Meter Temp. } 537}$ X 28.3 L/ft.^{3} = 1849.2 L Dry Gas

Water Weight $\frac{\text{247.69 gm.}}{\text{18 gm./mol.}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 287.4 L H_2O Vapor

Total = 2136.5 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{287.4 \text{ L}}{2136.5 \text{ L}}$ x 100 = 13.5 %

PARTICULATE FIELD DATA

Run No. 26
Location STACK
Date 9/3/79
Operator Chief Bill

Amb. Temp. °F 70 WB / 73 DB
Bar. Press. "Hg. 28.73'
Assumed Moist 12%
Test Periods 144 min / One Hr.

Probe Tip Dia., In. 1/4"
Probe Length 8'
Inp. Nos.
Sample Box No.

Heater Box Setting 250°F

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
		940.08	ΔP	$\sqrt{\Delta P}$	Desired	Actual	Inlet	Outlet						
S-1	8:26/32	942.29	0.19	0.44	0.46	0.47	73	74	0.5	244	76	247	289	
2	38	944.78	0.30	0.55	0.60	0.59	77	76	0.5	239	82	164	307	
3	44	947.51	0.36	0.60	0.72	0.71	73	74	1.5	295	81	141	313	
4	50	950.41	0.41	0.64	0.82	0.81	75	76	2.0	251	79	197	319	
5	56	953.50	0.45	0.67	0.90	0.92	78	84	2.5	246	83	250	324	
6	9:02	956.75	0.48	0.69	0.96	1.01	73	80	3.0	259	79	293	313	
E-1	9:08/14	958.58	0.15	0.39	0.30	0.32	74	78	0.0	300	82	239	273	
2	20	960.95	0.25	0.50	0.50	0.49	73	79	0.5	280	82	195	293	+0.61
3	26	963.58	0.32	0.57	0.64	0.66	75	79	1.0	267	82	166	308	
4	32	966.32	0.35	0.59	0.70	0.72	73	80	1.5	238	80	220	314	
5	38	969.03	0.35	0.59	0.70	0.70	75	79	1.0	278	80	259	304	
6	44	972.03	0.42	0.65	0.84	0.86	82	89	2.0	277	85	271	307	
N-1	9:52/58	973.71	0.16	0.37	0.28	0.27	74	76	6.0	278	79	241	293	
2	10:04	976.07	0.25	0.50	0.50	0.53	74	76	0.5	280	76	164	286	
3	10	978.60	0.30	0.55	0.60	0.61	73	76	0.5	291	76	132	302	
4	16	981.30	0.36	0.60	0.72	0.70	74	78	1.0	212	76	154	305	
5	22	984.17	0.36	0.60	0.72	0.79	72	78	2.0	289	76	222	303	
6	28	987.02	0.38	0.62	0.76	0.78	75	81	2.0	290	78	261	308	
W-1	10:36/44	989.13	0.21	0.46	0.42	0.43	73	76	0.5	297	77	190	293	
2	50	991.62	0.30	0.55	0.62	0.59	74	77	1.0	237	75	149	303	
3	56	994.51	0.37	0.61	0.74	0.80	77	80	2.0	286	81	152	308	
4	11:02	997.47	0.41	0.64	0.82	0.84	74	78	2.5	247	76	201	306	
5	08	580.32	0.42	0.65	0.84	0.78	76	82	2.5	221	76	298	308	
6	14	503.33	0.41	0.64	0.82	0.87	74	80	2.5	271	70	276	305	
TOTAL	144			13.67	15.96	16.30	1791	1887					7235	
AVERAGE	6			0.570	0.665	0.679	74.6	78.6					301.5	

(537°R) 76.6

Glass broken

Meter Volume [redacted] Ft.³

Dry Meter Calibration Factor (761°R) [redacted] 60.81

RUN NO. 16 Broken glassware

PARTICULATE & WATER CATCH

IMPINGER NO. 1	Final Weight 599.31 Initial Weight 555.67 Increase	WATER WEIGHT GAIN	IMPINGER 1 43.64
IMPINGER NO. 2	Final Weight 537.72 Initial Weight Increase 532.91		IMPINGER 2 4.81
IMPINGER NO. 3	Final Weight 452.77 Initial Weight Increase 451.42		IMPINGER 3 1.35
IMPINGER NO. 4	Final Weight 796.48 Initial Weight Increase 779.36		IMPINGER 4 17.12
			TOTAL 66.92
FILTER NO. # 19	Final Weight 0.8700 Initial Weight Part. Catch 0.8629 .0071		ORSAT
			CO_2 11.4
			O_2 14.4
			CO —
			N_2 74.2

SOLID WEIGHT GAIN

BEAKER NO. 15	Final Weight 142.0274 Initial Weight 142.0259 Increase .0015	BEAKER 15 0.0309 Filter + 19 BEAKER 11 0.0071 Total Dry BEAKER 13 0.0380
BEAKER NO. ____	Final Weight ____ Initial Weight Increase ____	BEAKER 15 0.0015
		TOTAL 0.0395
BEAKER NO. ____	Final Weight ____ Initial Weight Increase ____	39.5 mg
BEAKER NO. 11 PROBE WASH	Final Weight 137.5989 Initial Weight 137.5680 Increase .0309	

Moisture Content: Sample Vol. 6.61 ft.^{3} x $\frac{530 + 460}{460 + 537}$ Meter Temp. X 28.3 L/ft.^{3} = 177.67 L Dry Gas

Water Weight $\frac{66.9 \text{ gm.}}{18 \text{ gm./mol.}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 89.6 L H_2O Vapor

Total = 186.3 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{89.6 \text{ L}}{186.3 \text{ L}}$ x 100 = 48 %

PARTICULATE FIELD DATA

Run No. 31
Location STACK
Date 9/4/79
Operator CHU / BRUCE

Amb. Temp. °F 69 WB / 71 DB
Bar. Press. "Hg. 28.74"
Assumed Moist 13%
Test Periods 144 min.

Probe Tip Dia., In. 1/4"
Probe Length 81
Inp. Nos.
Sample Box No.

Heater Box Setting 250°F

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
		173.48	ΔP	√ΔP	Desired	Actual	Inlet	Outlet						
A-1	10:04/10	175.56	0.20	0.45	0.45	0.48	67	69	0.5	232	168	185	277	
2	16	177.98	0.30	0.55	0.68	0.69	66	70	2.0	251	73	189	293	
3	22	180.66	0.34	0.58	0.77	0.79	67	69	2.5	243	75	185	296	
4	28	183.41	0.37	0.61	0.84	0.83	69	72	3.0	263	72	240	296	
5	34	186.23	0.40	0.63	0.91	0.87	70	76	3.5	254	76	277	293	
6	40	189.23	0.43	0.66	0.98	0.99	71	77	4.0	269	80	272	296	
B-1	10:47/53	191.67	0.30	0.55	0.68	0.65	79	82	2.5	221	82	206	298	+0.43
2	59	194.41	0.37	0.61	0.84	0.83	79	83	3.5	235	87	155	302	
3	11:05	197.34	0.41	0.64	0.93	0.94	78	83	4.0	255	87	173	301	
4	11	200.55	0.52	0.72	1.18	1.13	85	90	5.0	290	88	223	310	
5	17	204.04	0.75	0.87	1.70	1.66	81	86	8.0	251	87	290	304	
6	23	208.36	0.75	0.87	1.70	1.69	87	89	8.5	249	88	298	297	
C-1	11:29/35	210.66	0.26	0.51	0.59	0.58	85	89	3.0	233	87	223	299	
2	41	213.35	0.34	0.58	0.77	0.80	85	87	3.5	249	89	174	304	
3	47	216.16	0.40	0.63	0.91	0.87	89	92	4.0	263	96	199	312	
4	53	219.09	0.42	0.65	0.95	0.94	86	90	4.0	270	97	245	304	
5	59	222.08	0.45	0.67	1.02	0.98	88	93	4.1	260	95	288	304	
6	12:05	225.01	0.42	0.65	0.95	0.94	81	86	5.0	269	98	299	310	
N-1	12:16/22	227.14	0.02	0.46	0.48	0.50	83	84	3.0	243	88	181	296	
2	28	229.65	0.30	0.55	0.68	0.69	87	89	3.0	290	94	160	311	
3	34	232.32	0.35	0.59	0.79	0.78	84	86	3.5	269	92	151	310	
4	40	235.09	0.39	0.62	0.88	0.84	87	89	4.5	290	94	228	321	
5	46	238.13	0.40	0.63	0.91	1.01	81	84	6.0	272	90	286	309	
6	52	240.85	0.42	0.65	0.95	0.81	85	88	6.5	272	90	306	308	
TOTAL	144			10.98	21.52	21.24	1915	2003					7251	
AVERAGE	6			0.622	0.897	0.885	79.8	83.5					302.1	

542°R

81.6 Meter Volume

Dry Meter Calibration Factor 762°K

CORRECTED SAMPLE VOLUME [redacted] Ft.3 [redacted]

RUN NO. 31

PARTICULATE & WATER CATCH

IMPINGER NO. 21	Final Weight 704.43 Initial Weight 554.51 Increase	WATER WEIGHT GAIN	IMPINGER 1 185.92
IMPINGER NO. 22	Final Weight 571.03 Initial Weight 549.61 Increase		IMPINGER 2 22.42
IMPINGER NO. 23	Final Weight 468.64 Initial Weight Increase 463.2x		IMPINGER 3 5.40
IMPINGER NO. 24	Final Weight 811.89 Initial Weight Increase 809.33		IMPINGER 4 32.56
FILTER NO. 20	Final Weight 0.9479 Initial Weight Part. Catch 0.8634 .0845		TOTAL 246.30

ORSAT

CO_2	10.6
O_2	14.5
CO	—
N_2	74.9

SOLID WEIGHT GAIN

BEAKER NO. 12	Final Weight 138.5780 Initial Weight Increase 138.5091 .0689	BEAKER ~~5~~ 0.0193 Filter #20 BEAKER 2 0.0845 Total Dry ~~BEAKER~~ 3 0.1038 BEAKER ~~12~~ 0.0689 TOTAL 0.1727
BEAKER NO. ____	Final Weight ____ Initial Weight Increase ____	
BEAKER NO. ____	Final Weight ____ Initial Weight Increase ____	172.7 mg
BEAKER NO. 5 PROBE WASH	Final Weight 141.0298 Initial Weight 141.0105 .0193 Increase	

Moisture Content: Sample Vol. 67.14 ft.^{3} x $\frac{460 + 70}{460 + \text{Meter Temp.}}$ (530 / 527) X 28.3 L/ft.^{3} = 1858.0 L Dry Gas

Water Weight $\frac{246.3 \text{ gm.}}{18 \frac{\text{gm.}}{\text{mol.}}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 329.8 L H_2O Vapor

Total = 2187.8 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{329.8 \text{ L}}{2187.8 \text{ L}}$ x 100 = 15.1 %

PARTICULATE FIELD DATA

Run No. 32
Location STACK
Date 9/4/79
Operator Chu / Bob

Amb. Temp. °F 69 WB / 71 DB
Bar. Press. "Hg. 28.74"
Assumed Moist 13%
Test Periods 1 1/4 hrs one mill

Probe Tip Dia., In 1/4"
Probe Length 8'
Inp. Nos.
Sample Box No.

Heater Box Setting 250°F

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
		504.48	ΔP	$\sqrt{\Delta P}$	Desired	Actual	Inlet	Outlet						
E-6	10:07/13	507.72	0.51	0.71	1.01	1.01	67	74	3.5	301	80	202	300	
5	19	510.97	0.52	0.72	1.03	1.01	67	72	3.5	238	69	298	302	
4	25	514.11	0.50	0.71	0.99	0.95	72	75	3.5	255	75	279	300	
3	31	517.03	0.41	0.64	0.81	0.82	71	75	3.0	237	67	285	299	
2	37	519.68	0.35	0.59	0.69	0.67	69	76	2.5	273	69	257	296	
1	43	522.09	0.27	0.52	0.53	0.56	71	77	2.5	239	72	214	277	
N-6	10:50/56	525.38	0.47	0.69	0.93	1.04	79	85	6.0	294	86	286	309	
5	11:02	528.36	0.47	0.69	0.93	0.85	85	90	2.5	278	89	316	316	+0.49
4	08	531.30	0.43	0.66	0.85	0.83	87	92	3.5	262	90	289	305	
3	14	534.55	0.49	0.70	0.97	1.01	78	86	4.0	290	80	284	299	
2	20	537.62	0.47	0.69	0.93	0.90	84	90	3.5	233	85	293	300	
1	26	540.33	0.36	0.60	0.71	0.70	81	87	3.0	276	85	202	278	
W-6	11:32/38	543.33	0.45	0.67	0.89	0.86	85	91	3.5	270	95	233	305	
5	44	546.39	0.42	0.65	0.83	0.90	86	90	3.5	282	100	271	304	
4	50	549.07	0.37	0.61	0.73	0.69	82	88	3.0	266	95	294	298	
3	56	551.68	0.33	0.57	0.65	0.65	88	92	2.5	260	100	289	304	
2	12:02	554.11	0.28	0.53	0.55	0.57	89	94	2.5	282	93	286	306	
1	08	556.06	0.20	0.45	0.39	0.36	86	89	2.0	249	85	209	284	
S-6	12:19/25	559.21	0.50	0.71	0.99	0.95	85	86	3.5	289	90	264	306	
5	31	562.44	0.50	0.71	0.99	1.00	87	90	4.0	251	90	293	312	
4	37	565.67	0.50	0.71	0.99	1.00	82	86	4.0	247	89	306	312	
3	43	568.62	0.43	0.66	0.85	0.83	88	93	3.5	279	93	295	320	
2	49	571.33	0.36	0.60	0.71	0.70	81	80	3.0	295	88	236	309	
1	55	573.82	0.27	0.52	0.53	0.57	89	93	2.5	239	92	184	288	
TOTAL	144			15.31	19.48	19.43	1939	2057					7231	
AVERAGE	6			0.638	0.812	0.810	80.8	85.7					301.3	

(553°R) 83.3' Meter Volume Dry Meter Calibration Factor (761°R)

CORRECTED SAMPLE VOLUME 69.39 Ft.³ × 1.057 = 69.74 Ft.³

RUN NO. 32

PARTICULATE & WATER CATCH

IMPINGER NO. 25	Final Weight 715.26 Initial Weight 550.80 Increase	WATER WEIGHT GAIN	IMPINGER 1 164.46
IMPINGER NO. 26	Final Weight 559.54 Initial Weight Increase 556.66		IMPINGER 2 2.88
IMPINGER NO. 27	Final Weight 646.74 Initial Weight Increase 461.39		IMPINGER 3 2.35
IMPINGER NO. 28	Final Weight 820.03 Initial Weight Increase 794.41		IMPINGER 4 25.62
FILTER NO. 21	Final Weight 0.8618 Initial Weight Part. Catch 0.8183 .0435		TOTAL 195.31

ORSAT

CO_2	10.6
O_2	14.5
CO	—
N_2	74.9

SOLID WEIGHT GAIN

BEAKER NO. 9	Final Weight 121.6440 Initial Weight 121.5838 Increase .0602		BEAKER 3 0.0443 Filter #21 ~~BEAKER 2~~ 0.0435 Total Dry ~~BEAKER 3~~ 0.0878 BEAKER 9 0.0602 TOTAL 0.1480 148 mg
BEAKER NO. ____	Final Weight ____ Initial Weight ____ Increase ____		
BEAKER NO. ____	Final Weight ____ Initial Weight ____ Increase ____		
BEAKER NO. 3 PROBE WASH	Final Weight 135.4489 Initial Weight 135.4046 .0443 Increase		

Moisture Content: Sample Vol. 69.74 ft.^{3} x $\frac{530}{460 + 70}$ / $\frac{}{460 + \text{Meter}}$ 54.3 Temp. X 28.3 L/ft.^{3} = 1926.9 L Dry Gas

Water Weight $\frac{1953}{18}$ gm./mol. x 24.1 L/mol. = 261.5 L H_2O Vapor

Total = 2187.9 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{261.5 \text{ L}}{2187.9 \text{ L}}$ x 100 = 12.0 %

$K_m = 0.6216$

PARTICULATE FIELD DATA

Run No. 39 | Amb. Temp. °F 65 WB 72 DB | Probe Tip Dia., In 1/4" | Heater Box Setting 250°F

Location OLD PLANT STACK 4 | Bar. Press. "Hg. 28.79" | Probe Length 6'

Date 9/19/79 | Assumed Moist 19% | Inp. Nos.

Operator CHU/BROWE | Test Periods 128 min. | Sample Box No.

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O @ K_m X 3%		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
		283.74	ΔP	√ΔP	Desired	Actual	Inlet	Outlet						
A-1	10:20/28	286.38	0.22	0.47	0.41	0.42	81	82	1.0	238	101	165	406	
2	36	289.16	0.26	0.51	0.49	0.47	81	84	2.0	240	103	222	430	
3	44	292.05	0.28	0.53	0.52	0.54	82	85	2.0	217	96	174	426	
4	52	294.97	0.29	0.54	0.54	0.52	82	86	2.0	272	96	228	428	
5	11:00	297.38	0.19	0.44	0.35	0.35	82	88	1.5	282	99	396	435	
6	08	299.67	0.17	0.41	0.32	0.32	83	88	0.5	225	100	411	417	
7	16	302.05	0.19	0.44	0.35	0.35	83	90	0.5	278	103	417	417	+0.27
8	24	303.99	0.11	0.33	0.20	0.23	84	89	0.0	258	109	402	417	
B-1	11:54/12:00	305.85	0.13	0.36	0.24	0.21	85	87	0.0	196	84	416	414	
2	10	307.86	0.11	0.33	0.20	0.25	85	87	0.0	192	86	134	419	
3	18	310.09	0.18	0.42	033	0.30	85	88	1.0	267	95	158	425	
4	26	312.61	0.22	0.47	0.41	0.39	86	89	1.5	269	94	281	428	
5	34	315.28	0.23	0.48	0.43	0.43	86	91	2.0	240	97	396	432	
6	42	318.09	0.23	0.48	0.43	0.46	86	91	2.5	239	92	418	430	
7	50	320.66	0.25	0.48	0.43	0.42	87	92	2.5	203	94	425	428	
8	58	323.27	0.23	0.48	0.43	0.42	87	94	2.5	248	96	420	421	
TOTAL				7.17	6.08	6.08	1345	1411					6773	
AVERAGE				0.448	0.380	0.380	84.1	88.2					423	

(896°R) 96°F

Meter Volume [redacted] Ft.³

Dry Meter Calibration Factor [redacted]

(883°R)

CORRECTED SAMPLE VOLUME [redacted]

RUN NO. 39

PARTICULATE & WATER CATCH

IMPINGER NO. 53	Final Weight 670.35 Initial Weight 570.53 Increase	WATER WEIGHT GAIN	IMPINGER 1 99.82
IMPINGER NO. 54	Final Weight 661.88 Initial Weight 554.90 Increase		IMPINGER 2 6.98 IMPINGER 3 0.19
IMPINGER NO. 55	Final Weight 457.45 Initial Weight 457.210 Increase		IMPINGER 4 13.70 TOTAL 120.69
IMPINGER NO. 56	Final Weight 825.25 Initial Weight 811.55 Increase		ORSAT CO_2 16.4 O_2 10.6
FILTER NO. 22	Final Weight 0.9651 Initial Weight 0.8141 Part. Catch = 0.1510		CO — N_2 73.0

SOLID WEIGHT GAIN

BEAKER NO. 16	Final Weight 142.2763 Initial Weight 142.2339 Increase = 0.0424	BEAKER 1 0.0635 Filter BEAKER 2 0.1690 Total Dry BEAKER 3 0.2145 BEAKER 16 0.0424 TOTAL 0.2569
BEAKER NO. ____	Final Weight ____ Initial Weight ____ Increase ____	
BEAKER NO. ____	Final Weight ____ Initial Weight ____ Increase ____	
BEAKER NO. 7 PROBE WASH	Final Weight 140.4108 Initial Weight 140.3473 Increase = 0.0635	

Moisture Content: Sample Vol. 39.3 ft.^{3} x $\frac{530}{460 + 70}$ / $\frac{530}{460 + 546}$ Temp. X 28.3 L/ft.^{3} = 1081.6 L Dry Gas

Water Weight $\frac{120.69 \text{ gm.}}{18 \text{ gm./mol.}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 161.6 L H_2O Vapor

Total = 1242.6 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{161.6 \text{ L}}{1242.6 \text{ L}}$ x 100 = 13.0%

$K_m = 0.6714$

PARTICULATE FIELD DATA

Run No. 90
Location OLD PLANT STACK
Date 9/19/79
Operator Ethan/BOB

Amb. Temp. °F 62 WB 72 DB
Bar. Press. "Hg. 28.79
Assumed Moist 14%
Test Periods 128 min

Probe Tip Dia., In 1/4"
Probe Length 6'
Inp. Nos.
Sample Box No.

250 °F
Heater Box Setting

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O $\Delta H_{@} \times 3.95$		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
		724.78	ΔP	$\sqrt{\Delta P}$	Desired	Actual	Inlet	Outlet						
B-1	10:24/32	726.83	0.11	0.33	0.21	0.23	70	71	0.00	294	111	177	498	
2	40	729.22	0.17	0.41	0.32	0.31	70	72	0.50	300	75	204	412	
3	48	731.77	0.20	0.45	0.39	0.38	74	76	1.0	270	75	213	422	
4	56	734.13	0.19	0.44	0.31	0.30	71	76	1.0	270	74	355	421	
5	11:04	736.59	0.21	0.46	0.34	0.33	74	78	1.5	291	75	403	418	
6	12	739.31	0.25	0.50	0.41	0.40	82	87	2.0	306	85	423	423	+0.32
7	20	742.16	0.25	0.50	0.41	0.42	82	86	2.0	267	82	425	424	
8	28	744.69	0.23	0.48	0.38	0.36	83	85	2.5	268	93	421	412	
A-1	11:50/58	747.20	0.21	0.46	0.34	0.34	79	81	2.0	282	89	267	412	
2	12:06	749.89	0.25	0.50	0.41	0.39	79	80	2.5	246	98	174	418	
3	14	752.79	0.27	0.52	0.48	0.45	79	82	2.5	284	89	227	432	
4	22	755.52	0.25	0.50	0.41	0.40	80	84	2.5	256	95	365	434	
5	30	758.00	0.17	0.41	0.32	0.33	76	80	2.5	209	90	404	417	
6	38	760.48	0.17	0.41	0.32	0.33	79	78	2.5	308	90	418	422	
7	46	762.59	0.15	0.39	0.25	0.24	74	78	2.5	252	95	412	406	
8	54	764.65	0.13	0.36	0.27	0.23	81	81	2.5	276	103	418	418	
TOTAL				7.12	5.41	5.41	1228	1282					6776	
AVERAGE				0.445	0.338	0.338	76.75	80.13					423	

538°R 78.4°F

Meter Volume 39.87 Ft.³

Dry Meter Calibration Factor 1.005

881°R

CORRECTED SAMPLE VOLUME [redacted] 40.10 [redacted]³

RUN NO. 40

PARTICULATE & WATER CATCH

IMPINGER NO. 37	Final Weight 664.49 Initial Weight 565.39 Increase	WATER WEIGHT GAIN	IMPINGER 1 99.10
IMPINGER NO. 38	Final Weight 571.78 Initial Weight Increase 564.74		IMPINGER 2 7.04
IMPINGER NO. 39	Final Weight 468.21 Initial Weight Increase 468.00		IMPINGER 3 0.21
IMPINGER NO. 40	Final Weight 852.73 Initial Weight Increase 840.33		IMPINGER 4 12.4
FILTER NO. 29	Final Weight 0.8853 Initial Weight Part. Catch 0.7068 = 0.1785		TOTAL 118.75
			ORSAT
			CO_2 16.4
			O_2 10.6
			CO —
			N_2 73

SOLID WEIGHT GAIN

BEAKER NO. 23	Final Weight 146.0141 Initial Weight 145.9801 Increase = 0.0340	BEAKER 25 0.0840 Filter 29 0.1785 ~~BEAKER 3~~ Total Dry 0.2965 BEAKER 23 0.0340
BEAKER NO. ____	Final Weight ____ Initial Weight Increase ____	
BEAKER NO. ____	Final Weight ____ Initial Weight Increase ____	
BEAKER NO. 25 PROBE WASH	Final Weight 148.7178 Initial Weight 148.6338 Increase = 0.0840	TOTAL 0.2965

Moisture Content: Sample Vol. 40.10 ft.^{3} x $\frac{530}{460 + 70}$ X 28.3 L/ft.^{3} = 1118.0 L Dry Gas

538 Temp.

Water Weight $\frac{118.75 \text{ gm.}}{18 \frac{\text{gm.}}{\text{mol.}}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 159.0 L H_2O Vapor

Total = 1277.0 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{159.0 \text{ L}}{1277.0 \text{ L}}$ x 100 = 12.5 %

PARTICULATE FIELD DATA

Run No. C-1
Location 9/20/19 STACK #4
Date 9/20/19
Operator CHA/BRUCE

Amb. Temp. °F 57 WB / 63 DB
Bar. Press. "Hg. 28.98"
Assumed Moist 13%
Test Periods 128 min.

Probe Tip Dia., In. 1/4"
Probe Length 6'
Inp. Nos.
Sample Box No.

Heater Box Setting 250°F

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
		323.91	ΔP	√ΔP	Desired	Actual	Inlet	Outlet						
A-1	10:02/10	326.02	0.13	0.36	0.27	0.27	78	79	0.0	263	78	142	420	
2	18	328.42	0.17	0.42	0.35	0.35	78	79	0.0	263	78	157	430	
3	26	331.17	0.23	0.48	0.48	0.46	79	81	0.0	270	80	186	433	
4	34	334.06	0.23	0.48	0.48	0.51	79	81	0.0	279	81	344	432	
5	42	336.97	0.25	0.50	0.52	0.52	80	83	0.0	284	82	398	431	
6	50	339.88	0.25	0.50	0.52	0.52	82	84	0.0	241	84	420	431	
7	58	342.72	0.24	0.49	0.50	0.49	83	85	0.0	270	87	425	428	+0.30
8	11:06	345.45	0.21	0.46	0.44	0.45	84	86	0.0	263	79	425	424	
B-1	11:31/44	348.28	0.25	0.50	0.52	0.49	85	87	0.0	284	79	129	426	
2	47	351.36	0.28	0.53	0.58	0.58	85	86	0.5	327	75	164	431	
3	55	354.19	0.30	0.55	0.62	0.60	86	87	1.0	272	77	199	434	
4	12:03	357.55	0.26	0.51	0.54	0.56	86	88	1.5	269	79	330	436	
5	11	360.05	0.17	0.42	0.35	0.37	87	89	0.5	294	86	393	430	
6	19	362.25	0.15	0.39	0.31	0.29	87	88	0.5	232	86	414	424	
7	27	364.34	0.13	0.36	0.27	0.27	87	89	0.5	260	85	418	419	
8	35	366.45	0.13	0.36	0.27	0.27	88	90	0.5	235	86	415	414	
TOTAL				7.31	7.02	7.00	1334	1363					6843	
AVERAGE				0.457	0.439	0.438	83.37	85.19					427.7	

CO_2 17.2 %
O_2 10 %
N_2 72.8 %

514°R (888°R) 84.28°F

Meter Volume [redacted] Ft.³

Dry Meter Calibration Factor [redacted]

[redacted] CORRECTED SAMPLE VOLUME [redacted] Ft.³ [redacted]

RUN NO. C-1

PARTICULATE & WATER CATCH

IMPINGER NO. 61	Final Weight 753.35 Initial Weight 524.92 Increase	WATER WEIGHT GAIN	IMPINGER 1 178.43
			IMPINGER 2 - 69.79
IMPINGER NO. 62	Final Weight 694.10 Initial Weight Increase ~~566.31~~ 563.89	181.75 138.69 3.06	IMPINGER 3 2.56
			IMPINGER 4 16.24
IMPINGER NO. 63	Final Weight 961.35 Initial Weight Increase 481.79	561.85 1.04 563.89	TOTAL 107.44
			ORSAT
IMPINGER NO. 64	Final Weight 785.42 Initial Weight Increase 769.18		CO_2 17.2
			O_2 1.0
FILTER NO. 30	Final Weight 0.8863 Initial Weight Part. Catch 0.7097 = 0.1766		~~CO~~
			N_2 72.8

SOLID WEIGHT GAIN

BEAKER NO. 19	Final Weight 143.6222 Initial Weight 143.6214 = 0.0008	BEAKER 30 ~~0.0682~~
		Filter #30 BEAKER 2 0.1766
BEAKER NO.	Final Weight Initial Weight Increase	Total Dry ~~BEAKER 3~~ 0.2448
		BEAKER 19 0.0008
		TOTAL 0.2456
BEAKER NO.	Final Weight Initial Weight Increase	
BEAKER NO. ~~30~~ PROBE WASH	Final Weight 182.9810 Initial Weight 182.9128 = 0.0682	

Moisture Content: Sample Vol. 42.34 ft.^{3} x $\frac{530}{460 + 70}$ x 28.3 L/ft.^{3} = 1167.4 L Dry Gas

(74 Meter Temp.)

Water Weight $\frac{107.44 \text{ gm.}}{18 \text{ gm./mol.}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 170.6 L H_2O Vapor

Total = 1338.0 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{170.6 \text{ L}}{1338.0 \text{ L}}$ x 100 = 12.8 %

PARTICULATE FIELD DATA

Run No. 42 | Amb. Temp. °F 65 DB 57 WB | Probe Tip Dia., In. 1/4" | Heater Box Setting 350 °F

Location Stack #4 | Bar. Press. "Hg. 28.38" | Probe Length 6'

Date 5/20/79 | Assumed Moist 12% | Inp. Nos.

Operator [redacted] | Test Periods 12 5 Min | Sample Box No.

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
		765.20	ΔP	$\sqrt{\Delta P}$	Desired	Actual	Inlet	Outlet						
B-1	9:58/10:00	767.92	0.23	0.48	0.42	0.40	67	67	0.0	255	63	139	419	
2	14	770.97	0.28	0.53	0.52	0.50	66	67	0.0	255	61	267	425	
3	22	774.20	0.29	0.54	0.53	0.56	65	69	0.5	267	62	363	424	
4	30	777.32	0.29	0.54	0.53	0.52	64	70	0.5	243	63	387	425	
5	38	779.79	0.19	0.44	0.35	0.33	65	72	0.0	203	66	413	421	
6	46	782.20	0.16	0.40	0.29	0.31	67	74	0.0	206	69	420	417	
7	54	784.32	0.13	0.36	0.24	0.24	68	73	0.0	209	70	418	406	+0.27
8	11:02	786.52	0.13	0.36	0.24	0.26	68	74	0.0	259	73	416	403	
A-1	11:27/35	788.48	0.[illegible]	0.36	0.24	0.21	66	68	0.5	319	63	99	395	
2	43	790.85	0.15	0.39	0.28	0.30	67	68	3.0	263	62	158	407	
3	51	793.49	0.20	0.45	0.37	0.38	67	70	2.0	265	65	299	410	
4	59	796.13	0.20	0.45	0.37	0.38	66	70	2.0	253	64	360	409	
5	12:07	798.99	0.22	0.47	0.41	0.43	66	71	2.5	236	64	397	416	
6	15	801.59	0.22	0.47	0.41	038	66	72	2.5	280	63	408	407	
7	23	804.48	0.23	0.48	0.42	0.44	68	74	2.5	228	66	410	406	
8	31	807.18	0.23	0.48	0.42	0.40	68	74	3.0	244	67	410	404	
TOTAL				7.20	6.04	6.04	1064	1133					6585	
AVERAGE				0.450	0.378	0.378	66.5	70.8					411.8	

529.2 | 68.7 | Meter Volume [redacted] 98 Ft.³ | Dry Meter Calibration Factor 872 .[redacted]5 | CORRECTED SAMPLE VOLUME [redacted] 4[redacted]

RUN NO. 12

PARTICULATE & WATER CATCH

IMPINGER NO. 64	Final Weight 723.69 Initial Weight 575.15 Increase	WATER WEIGHT GAIN	IMPINGER 1 150.54
IMPINGER NO. 66	Final Weight 525.85 Initial Weight 574.79 Increase		IMPINGER 2 -38.94 IMPINGER 3 4.24
IMPINGER NO. 67	Final Weight 419.17 Initial Weight 441.93 Increase		IMPINGER 4 21.39 TOTAL 137.23
IMPINGER NO. 68	Final Weight 789.01 Initial Weight 767.82 Increase		ORSAT CO_2 17.2 O_2 1.0
FILTER NO. 31	Final Weight 0.9051 = 0.1961 Initial Weight Part. Catch 0.7090		CO N_2 72.8

SOLID WEIGHT GAIN

BEAKER NO. 37	Final Weight 139.2826 Initial Weight 139.2252 = 0.0544 Increase	BEAKER 35 0.0662 Filter #31 BEAKER 2 0.1961 Total Dry BEAKER 3 0.2625 ~~BEAKER 37~~ 0.0544 TOTAL 0.3167
BEAKER NO. _____	Final Weight _____ Initial Weight _____ Increase _____	
BEAKER NO. _____	Final Weight _____ Initial Weight _____ Increase _____	
BEAKER NO. 35 PROBE WASH	Final Weight 155.9094 Initial Weight 155.3432 Increase = 0.0662	

Moisture Content: Sample Vol. 42.2 ft.^{3} x $\frac{530}{460 + 70}$ / $\frac{460 + \text{Meter}}{529 \text{ Temp.}}$ X 28.3 L/ft.^{3} = 1197.1 L Dry Gas

Water Weight $\frac{137.23}{18}$ gm. x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 183.7 L H_2O Vapor

Total = 1380.8 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{183.7 \text{ L}}{1380.8 \text{ L}}$ x 100 = 13.3 %

$K_n = 0.63$

PARTICULATE FIELD DATA

Run No. 43
Location STACK # 4
Date 9/27/79
Operator CHA/BRUCE

Amb. Temp. °F 61 WB / 67 DB
Bar. Press. "Hg. 28.90
Assumed Moist 18%
Test Periods 12 MIN

Probe Tip Dia., In 1/4"
Probe Length 6'
Inp. Nos.
Sample Box No.

Heater Box Setting 250°F

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O x3.9		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In.H_2O
		367.77	ΔP	$\sqrt{\Delta P}$	Desired	Actual	Inlet	Outlet						
B-1	10:00/08	370.59	0.23	0.48	0.47	0.48	75	76	0.0	268	78	200	397	
2	16	373.61	0.28	0.53	0.57	0.56	78	78	0.0	274	80	184	403	
3	24	376.70	0.28	0.53	0.57	0.58	77	78	0.0	274	84	219	407	
4	32	379.61	0.26	0.51	0.53	0.52	78	79	0.0	270	83	344	408	
5	40	382.02	0.19	0.44	0.32	0.35	78	80	0.0	237	82	397	405	
6	48	384.24	0.15	0.39	0.30	0.30	79	81	0.0	269	81	405	402	
7	56	386.25	0.12	0.35	0.24	0.25	80	82	0.0	262	83	401	399	+0.34
8	11:04	387.99	0.09	0.30	0.18	0.18	81	83	0.0	251	87	404	392	
A-1	11:25/33	390.02	0.18	0.35	0.24	0.25	85	87	0.0	277	89	76	375	
2	41	392.43	0.17	0.42	0.36	0.35	87	89	0.0	287	84	78	403	
3	49	395.05	0.20	0.45	0.41	0.42	83	89	0.0	294	82	175	405	
4	57	8397.77	0.21	0.46	0.43	0.44	84	86	0.0	288	82	220	412	
5	12:05	400.44	0.23	0.48	0.47	0.45	84	86	0.0	304	88	360	406	
6	13	403.32	0.25	0.50	0.51	0.51	85	87	0.0	290	82	388	401	
7	21	405.99	0.20	0.45	0.41	0.42	85	87	0.0	261	87	400	401	
8	29	408.36	0.19	0.44	0.39	0.39	86	88	0.0	277	87	404	402	
TOTAL				7.08	6.36	6.41	1298	1327					6413	
AVERAGE				0.443	0.398	0.401	81.1	82.9					400.8	

542°R 82°F Meter Volume Dry Meter Calibration Factor 867°R

CORRECTED SAMPLE VOLUME [illegible] Ft.3 [illegible]

RUN NO. 43

PARTICULATE & WATER CATCH

WATER WEIGHT GAIN

IMPINGER NO. 69: Final Weight 664.35, Initial Weight 536.84, Increase

IMPINGER NO. 70: Final Weight 578.28, Initial Weight, Increase 561.48

IMPINGER NO. 71: Final Weight 477.31, Initial Weight, Increase 475.67

IMPINGER NO. 72: Final Weight 840.42, Initial Weight, Increase 817.93

FILTER NO. 32: Final Weight 0.8578, Initial Weight, Part. Catch 0.7017 = 0.1816

IMPINGER 1	127.51
IMPINGER 2	16.80
IMPINGER 3	1.64
IMPINGER 4	22.19
TOTAL	144.31

ORSAT

CO_2	17.2
O_2	9.4
CO	
N_2	73.4

26.6

SOLID WEIGHT GAIN

BEAKER NO. 29: Final Weight 144.3816, Initial Weight 144.3638, Increase = 0.0178

BEAKER NO. ____: Final Weight ____, Initial Weight ____, Increase ____

BEAKER NO. ____: Final Weight ____, Initial Weight ____, Increase ____

BEAKER NO. 27 PROBE WASH: Final Weight 146.4172, Initial Weight 146.3769, Increase = 0.0403

BEAKER ~~27~~ 29	0.0~~403~~ 178
Filter #32 BEAKER 2	0.1816
Total Dry ~~BEAKER 3~~	0.~~2219~~
BEAKER 29	0.0178
TOTAL	0.2397

Moisture Content: Sample Vol. 4040 ft.^{3} x $\frac{530}{460 + 70}$ / $\frac{460 + \text{Meter}}{492 \text{ Temp.}}$ X 28.3 L/ft.^{3} = 1118.0 L Dry Gas

Water Weight $\frac{144.31 \text{ gm.}}{18 \frac{\text{gm.}}{\text{mol.}}}$ x $\frac{24.1 \text{ L}}{\text{mol.}}$ = 193.2 L H_2O Vapor

Total = 1311.2

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{193.2 \text{ L}}{1311.2 \text{ L}}$ x 100 = 14.7 %

ftm = 0.714

PARTICULATE FIELD DATA

61 WB

Run No. 4A
Location STACK #4
Date 9/27/79
Operator CHH/BLL

Amb. Temp. °F 67 DB
Bar. Press. "Hg. 28.90"
Assumed Moist 4%
Test Periods 12 5 MIN

Probe Tip Dia., In. 1/4"
Probe Length 6'
Inp. Nos.
Sample Box No.

250°F
Heater Box Setting

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
		807.72	ΔP	√ΔP	Desired	Actual	Inlet	Outlet						
A-1	10:04/12	810.28	0.18	0.42	0.32	0.35	64	65	0.5	253	67	150	393	
2	20	812.73	0.19	0.44	0.34	0.32	65	67	0.5	247	67	194	394	
3	28	815.28	0.20	0.45	0.36	0.35	64	68	0.5	299	72	198	395	
4	36	817.97	0.22	0.47	0.40	0.39	63	67	0.5	272	66	318	398	
5	44	820.76	0.22	0.47	0.40	0.42	65	71	1.0	295	70	327	394	
6	52	823.48	0.23	0.48	0.41	0.40	66	73	1.5	297	67	369	400	
7	11:00	826.26	0.23	0.48	0.41	0.42	67	74	2.0	299	70	396	398	+0.31
8	08	828.82	0.20	0.45	0.36	0.35	68	75	2.0	295	74	393	393	
B-1	11:29/37	831.56	0.22	0.47	0.40	0.40	68	70	2.0	297	75	150	396	
2	45	834.50	0.28	0.53	0.50	0.47	68	70	2.5	299	72	194	405	
3	53	837.74	0.31	0.56	0.56	0.57	69	73	3.0	230	75	231	407	
4	12:01	840.88	0.29	0.54	0.52	0.53	65	70	3.0	241	68	339	394	
5	09	843.33	0.19	0.44	0.34	0.32	67	73	3.0	241	70	379	397	
6	17	845.59	0.15	0.39	0.27	0.28	65	66	2.5	287	66	385	389	
7	25	847.62	0.13	0.36	0.23	0.22	66	71	2.0	243	71	385	385	
8	33	849.64	0.12	0.35	0.22	0.22	61	72	2.0	271	70	382	380	
TOTAL				7.30 ~~5.70~~	6.04	6.01	105.7	112.5					6324	
AVERAGE				0.456	0.378	0.376	66.1	70.3					395	

(535°R) 65.2°F Meter

Dry Meter Calibration Factor (855°R)

CORRECTED SAMPLE VOLUME [redacted] Ft.³ [redacted] [redacted] 42.6 [redacted]

RUN NO. 44

PARTICULATE & WATER CATCH

IMPINGER NO. 73
Final Weight 702.49
Initial Weight 570.69
Increase

IMPINGER NO. 74
Final Weight 558.69
Initial Weight 545.51
Increase

IMPINGER NO. 75
Final Weight 462.31
Initial Weight
Increase 461.58

IMPINGER NO. 76
Final Weight 810.17
Initial Weight
Increase 787.94

FILTER NO. 33
Final Weight 0.8880
Initial Weight
Part. Catch 0.7065 = 0.1815

WATER WEIGHT GAIN

IMPINGER 1 131.8
IMPINGER 2 13.18
IMPINGER 3 0.73
IMPINGER 4 22.23
TOTAL 167.94

ORSAT
CO_2 17.2
O_2 9.4
~~CO~~
N_2 73.4

SOLID WEIGHT GAIN

BEAKER NO. 33
Final Weight 146.1934
Initial Weight
Increase 146.0857
= 0.1077

BEAKER NO.
Final Weight
Initial Weight
Increase

BEAKER NO.
Final Weight
Initial Weight
Increase

BEAKER NO. 32 PROBE WASH
Final Weight 147.1062
Initial Weight
Increase 147.0160
= 0.0902

0.0902 BEAKER 32 ~~0.0767~~
0.1815 Filter #33 ~~0.1077~~
~~BEAKER 2 0.0767~~
0.2717 Total Dry ~~BEAKER 3 0.1150~~
0.1077 BEAKER 33 ~~0.0847~~
0.3794 TOTAL 0.3794

Moisture Content: Sample Vol. 42.16 ft.^{3} x $\frac{\text{~~460~~ 530 + 70}}{\text{~~460~~ 528 + Meter Temp.}}$ X 28.3 L/ft.^{3} = 1197 L Dry Gas

Water Weight $\frac{167.94 \text{ gm.}}{18 \text{ gm./mol.}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 224.9 L H_2O Vapor

Total = 1422.5 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{224.9 \text{ L}}{1422.5 \text{ L}}$ x 100 = 15.8 %

PARTICULATE FIELD DATA

68 WB

Run No. 45 | Amb. Temp. °F 73 DB | Probe Tip Dia., In. 1/4" | Heater Box Setting 250°F

Location STACK # 1 | Bar. Press. "Hg. 28.73" | Probe Length 6' | FILL IN ALL BLANKS

Date 9/29/79 | Assumed Moist 14% | Inp. Nos. | READ & RECORD AT THE START OF EACH TEST POINT

Operator CHH / BRUCE | Test Periods 12 MIN | Sample Box No.

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O (Cal 1.83 x 3.96)		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
		356.66	ΔP	√ΔP	Desired	Actual	Inlet	Outlet						
A-1	9:38/46	358.80	0.18	.36	0.27	0.28	75	75	0.0	247	76	130	396	
2	54	361.17	0.16	0.40	0.33	0.35	76	76	0.0	278	76	205	405	
3	10:02	363.43	0.16	0.40	0.33	0.32	76	77	0.0	252	76	217	410	
4	10	365.67	0.15	0.39	0.31	0.31	77	79	0.0	236	75	362	407	
5	18	368.27	0.21	0.46	0.43	0.42	77	80	0.0	252	76	396	410	
6	26	370.98	0.18	0.42	0.37	0.45	76	81	0.0	286	71	405	407	
7	34	373.23	0.20	0.45	0.41	0.31	77	81	0.0	242	85	412	407	
8	42	375.22	0.10	0.32	0.21	0.25	77	82	0.0	294	77	406	397	+0.16
B-8	11:06/14	377.09	0.10	0.32	0.21	0.22	77	78	0.0	287	82	310	380	
7	22	379.21	0.14	0.37	0.29	0.28	77	79	0.0	280	82	379	404	
6	30	381.38	0.14	0.37	0.29	0.29	77	79	0.0	285	76	401	403	
5	38	383.60	0.15	0.39	0.31	0.31	78	81	0.0	255	79	413	410	
4	46	385.93	0.16	0.40	0.33	0.34	78	82	0.0	240	84	409	CHH	
3	54	388.27	0.16	0.40	0.33	0.34	78	83	0.0	274	90	378	411	
2	11:02	390.67	0.13	0.36	0.27	0.30	79	83	0.0	280	89	313	407	
1	10	392.92	0.11	0.33	0.23	0.24	78	83	0.0	257	89	219	401	
TOTAL				6.17	4.96	5.01	1233	1376					6986	
AVERAGE				0.386	0.310	0.313	77.1	79.8					404	

538°R 78.2°F Meter Volume 356 Ft.³ Dry Meter Calibration Factor 0.9964 (564°R)

CORRECTED SAMPLE VOLUME [redacted] Ft.³

RUN NO. 45

PARTICULATE & WATER CATCH

IMPINGER NO. 77	Final Weight 677.18	WATER WEIGHT GAIN	IMPINGER 1 138.00
	Initial Weight 539.18		IMPINGER 2 3.21
IMPINGER NO. 78	Final Weight 567.00		IMPINGER 3 0.44
	Initial Weight 563.85		IMPINGER 4 11.03
IMPINGER NO. 79	Final Weight 463.41		TOTAL 152.68
	Initial Weight 462.97		ORSAT
IMPINGER NO. 80	Final Weight 817.17		CO_2 12.0
	Initial Weight 806.14		O_2 12.6
FILTER NO. 34	Final Weight .7954		CO —
	Initial Weight 7100		N_2 75.4
	Part. Catch .0854		
	SOLID WEIGHT GAIN		Filter #34 .0854
BEAKER NO. 1	Final Weight 135.5454		BEAKER 3 .0259
	Initial Weight 135.4803		~~BEAKER 2~~
	Increase .0651		Total Dry BEAKER 3 0.1113
BEAKER NO. ____	Final Weight ____		BEAKER #1 0.0651
	Initial Weight ____		TOTAL .1764
	Increase ____		
BEAKER NO. ____	Final Weight ____		
	Initial Weight ____		
	Increase ____		
BEAKER NO. 31 PROBE WASH	Final Weight 146.3052		
	Initial Weight 146.2793		
	Increase .0259		

Moisture Content: Sample Vol. 35.6d ft.^{3} x $\frac{530}{460 + 70}$ (~~460 + Meter~~ 538 Temp.) X 28.3 L/ft.^{3} = 993.6 L Dry Gas

Water Weight $\frac{152.68 \text{ gm.}}{18 \text{ gm. mol.}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 204.4 L H_2O Vapor

Total = 1198.0 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{204.4 \text{ L}}{1198.0 \text{ L}}$ x 100 = 17.1 %

PARTICULATE FIELD DATA

Run No. 4b
Location Stack #1
Date 9/29/19
Operator Chris / Bill

Amb. Temp. °F 68 WB 73 DB
Bar. Press. "Hg. 28.73"
Assumed Moist 14%
Test Periods 28 Final

Probe Tip Dia., In. 1/4"
Probe Length 6'
Inp. Nos.
Sample Box No.

Heater Box Setting 250°F

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
		474.10	ΔP	√ΔP	Desired	Actual	Inlet	Outlet						
B-1	9:42/50	475.92	0.12	0.35	0.25	0.20	57	[illegible]	0.0	274	75	123	397	
2	58	478.20	0.13	0.36	0.27	0.32	61	67	0.0	281	80	127	405	
3	10:06	479.18	0.15	0.39	0.31	0.06	65	69	0.0	197	82	150	409	
4	14	480.16	0.17	0.41	0.35	0.06	61	68	0.0	288	85	260	411	
5	22	482.94	0.18	0.42	0.37	0.09	63	70	0.5	299	86	360	412	
6	30	486.68	0.13	0.36	0.27	0.87	67	77	0.0	258	77	[illegible] 392	410	
7	38	488.58	0.16	0.40	0.33	0.22	68	78	0.0	221	88	396	415	+0.16
8	46	490.10	0.11	0.33	0.23	0.14	69	73	0.0	281	86	404	412	
A-1	11:10/18	492.32	0.11	0.33	0.23	0.30	64	65	0.0	287	77	190	399	
2	26	493.97	0.13	0.36	0.27	0.17	65	68	0.0	290	80	129	407	
3	34	495.37	0.15	0.39	0.31	0.25	65	70	0.0	209	82	195	410	
4	42	498.58	0.18	0.42	0.37	0.42	65	73	0.0	276	85	290	412	
5	50	501.20	0.20	0.45	0.41	0.42	70	79	0.0	234	87	361	413	
6	58	503.80	0.20	0.45	0.41	0.42	67	77	0.0	273	96	392	407	
7	12:06	506.42	0.22	0.47	0.45	0.42	65	75	0.0	258	91	400	405	
8	14	508.93	0.17	0.41	0.35	0.39	68	78	0.0	298	86	394	400	
TOTAL				6.30	5.18	5.19	1033	1141					6526	
AVERAGE				0.394	0.324	0.324	66.6	71.3					408	

528° R 67.9°F Meter Volume [illegible] Dry Meter Calibration Factor 0.868 [illegible] 35[illegible]

RUN NO. 46

PARTICULATE & WATER CATCH

IMPINGER NO. 81	Final Weight 650.66 Initial Weight 542.31 Increase	WATER WEIGHT GAIN	IMPINGER 1 103.35
IMPINGER NO. 82	Final Weight 588.80 Initial Weight 546.37 Increase		IMPINGER 2 42.43 IMPINGER 3 13.70
IMPINGER NO. 83	Final Weight 492.57 Initial Weight Increase 478.85		IMPINGER 4 14.02 TOTAL 173.50
IMPINGER NO. 84	Final Weight 803.32 Initial Weight Increase 789.30		ORSAT CO_2 12.0
FILTER NO. 35	Final Weight .7878 Initial Weight .7040 Part. Catch .0838		O_2 12.6 CO — N_2 75.4

SOLID WEIGHT GAIN

BEAKER NO. 2	Final Weight 144.5079 Initial Weight 144.4482 Increase .0597	Filter .0838 BEAKER 1 ____ ~~BEAKER 22 .0838~~ Total Dry .0425 BEAKER 3 .0263 BEAKER ~~3~~ 2 .0597 TOTAL .1860
BEAKER NO. ____	Final Weight ____ Initial Weight Increase ____	
BEAKER NO. ____	Final Weight ____ Initial Weight Increase ____	
BEAKER NO. 22 PROBE WASH	Final Weight 145.1725 Initial Weight 145.1300 Increase .0425	

Moisture Content: Sample Vol. 35.32 ft.^{3} x $\frac{460 + 70}{460 + \text{Meter Temp. } 528}$ X 28.3 L/ft.^{3} = 1003.3 L Dry Gas

Water Weight $\frac{73.5 \text{ gm.}}{18 \frac{\text{gm.}}{\text{mol.}}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 232.3 L H_2O Vapor

Total = 1235.6 L

$\frac{H_2O \text{ Vol}}{\text{Total}}$ $\frac{232.3 \text{ L}}{1235.6 \text{ L}}$ x 100 = 18.8 %

PARTICULATE FIELD DATA

Run No. 47
Location STACK #1
Date 9/30/79
Operator CHRISTIANSEN

Amb. Temp. °F 63 WB / 66 DB
Bar. Press. "Hg. 28.67"
Assumed Moist 12 %
Test Periods 128 MIN

Probe Tip Dia., In. 1/4"
Probe Length 6'
Inp. Nos.
Sample Box No.

Heater Box Setting 350°F

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In.H_2O
		394.14	ΔP	$\sqrt{\Delta P}$	Desired	Actual	Inlet	Outlet						
B-8	8:11/19	395.35	0.05	0.22	0.10	0.09	74	74	0.0	239	70	394	344	
7	27	397.34	0.10	0.32	0.21	0.25	75	76	0.0	258	72	377	395	
6	35	399.05	0.10	0.32	0.21	0.18	76	77	0.0	259	78	400	401	
5	43	401.14	0.13	0.36	0.27	0.27	76	78	0.0	255	73	407	396	
4	51	403.00	0.15	0.39	0.31	0.32	77	80	0.0	253	73	407	402	
3	59	405.60	0.15	0.39	0.31	0.30	77	81	0.0	233	72	381	393	+0.11
2	9:07	407.71	0.14	0.37	0.29	0.29	78	83	0.0	232	71	309	357	
1	15	409.59	0.10	0.32	0.21	0.21	78	83	0.0	246	71	336	354	
A-8	9:32/40	411.20	0.08	0.28	0.17	0.17	79	81	0.0	267	80	410	382	
7	48	413.28	0.13	0.36	0.27	0.26	79	81	0.0	289	80	369	395	
6	56	415.52	0.15	0.39	0.31	0.31	79	81	0.0	261	78	396	378	
5	9/0:04	417.78	0.15	0.39	0.31	0.32	79	82	0.0	268	76	404	385	
4	12	420.03	0.15	0.39	0.31	0.31	79	83	0.0	252	80	404	401	
3	20	422.17	0.14	0.37	0.29	0.28	81	84	0.0	253	73	380	397	
2	28	424.18	0.12	0.35	0.25	0.25	81	83	0.0	253	74	322	394	
1	36	426.03	0.10	0.32	0.21	0.21	81	81	0.0	251	73	212	379	
TOTAL				5.54	4.03	4.02	1295	1319					6183	
AVERAGE				0.346	0.252	0.251	80.9	82.4					386	

(53°F) 79.5°F Meter Volume [redacted] Ft.³ Dry Meter Calibration Factor (896.2) [redacted]

RUN NO. 47

PARTICULATE & WATER CATCH

IMPINGER NO. 85	Final Weight 667.30 Initial Weight 560.17 Increase	WATER WEIGHT GAIN	IMPINGER 1 107.13
IMPINGER NO. 86	Final Weight 564.27 Initial Weight Increase 554.92		IMPINGER 2 9.35 IMPINGER 3 1.46
IMPINGER NO. 87	Final Weight 458.03 Initial Weight Increase 456.57		IMPINGER 4 12.78 TOTAL 130.72
IMPINGER NO. 88	Final Weight 784.00 Initial Weight Increase 771.22		ORSAT CO_2 12.0
FILTER NO. 36	Final Weight .2955 Initial Weight Part. Catch 7040 .0915		O_2 12.9 CO — N_2 75.2
	SOLID WEIGHT GAIN		
BEAKER NO. 10	Final Weight 134.1458 Initial Weight 134.0791 Increase .0667		Tech .0915 BEAKER 1 — BEAKER 4 .0477
BEAKER NO. ____	Final Weight ____ Initial Weight Increase ____		Total Dry BEAKER 3 0.1389 BEAKER 10 .0667
BEAKER NO. ____	Final Weight ____ Initial Weight Increase ____		TOTAL .2056
BEAKER NO. 14 PROBE WASH	Final Weight 143.0691 Initial Weight 143.0217 Increase .0474		

Moisture Content: Sample Vol. 31.78 ft.^{3} x $\frac{460 + 70}{460 + \text{Meter Temp. } 539}$ X 28.3 L/ft.^{3} = 884.4 L Dry Gas

Water Weight $\frac{130.72 \text{ gm.}}{18 \frac{\text{gm.}}{\text{mol.}}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 175.0 L H_2O Vapor

Total = 1059.4

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{175.0 \text{ L}}{1059.4 \text{ L}}$ x 100 = 16.5 %

PARTICULATE FIELD DATA

63 WK?

Run No. 48
Location STACK #1
Date 9/30/79
Operator CHH/JBE

Amb. Temp. °F 66 PB
Bar. Press. "Hg. 28.67"
Assumed Moist 14%
Test Periods 128 min.

Probe Tip Dia., In. 1/4"
Probe Length 6'
Inp. Nos.
Sample Box No.

350°F
Heater Box Setting

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
		512.12	ΔP	$\sqrt{\Delta P}$	Desired	Actual	Inlet	Outlet						
A-1	8:15/23	514.29	0.12	0.35	0.25	0.29	55	56	0.0	247	50	49	389	
2	31	516.49	0.15	0.39	0.31	0.30	59	61	0.0	240	60	86	397	
3	39	518.75	0.16	0.40	0.33	0.32	59	62	0.0	247	58	117	407	
4	47	521.15	0.17	0.41	0.35	0.35	57	61	0.0	261	55	207	408	
5	55	523.88	0.22	0.47	0.45	0.46	58	62	0.5	272	61	360	407	
6	9:03	526.58	0.22	0.47	0.45	0.45	57	61	0.5	243	64	388	403	40.19
7	11	529.28	0.22	0.47	0.45	0.45	58	61	1.0	238	62	193	399	
8	19	531.78	0.19	0.44	0.39	0.39	59	62	1.0	260	64	393	395	
R-1	9:36/44	533.91	0.15	0.39	0.31	0.28	60	61	0.0	280	55	166	389	
2	52	536.64	0.19	0.44	0.45	0.46	62	64	0.5	257	66	179	399	
3	10:00	539.35	0.19	0.44	0.41	0.45	63	65	0.5	271	67	189	401	
4	08	191.97	0.20	0.45	0.41	0.42	61	63	0.5	257	63	212	403	
5	16	194.33	0.18	0.42	0.37	0.34	68	71	0.5	229	74	361	401	
6	24	196.72	0.17	0.41	0.35	0.35	61	63	0.5	206	63	385	398	
7	32	198.95	0.15	0.39	0.31	0.31	61	62	0.5	207	59	392	394	
8	40	551.06	6.19	0.37	0.29	0.28	66	67	0.5	284	64	391	390	
TOTAL				6.71	5.92	5.90	964	1002					6351	
AVERAGE				0.419	0.370	0.369	60.3	62.6					398.8	

(519°R) 61.4

Meter Volume

Dry Meter Calibration Factor (859°R)

[redacted] CO[redacted]TED [redacted]PLE [redacted]LUM[redacted] [redacted]94[redacted]t.3[redacted] [redacted]19[redacted] [redacted]39[redacted]

RUN NO. 48

PARTICULATE & WATER CATCH

IMPINGER NO. 89	Final Weight 686.93	WATER WEIGHT GAIN	IMPINGER 1 128.77
	Initial Weight 558.16		
	Increase		IMPINGER 2 21.22
IMPINGER NO. 90	Final Weight 554.48		IMPINGER 3 5.70
	Initial Weight 533.26		
	Increase		IMPINGER 4 21.97
IMPINGER NO. 91	Final Weight 466.35		TOTAL 177.66
	Initial Weight 460.65		
	Increase		ORSAT
IMPINGER NO. 92	Final Weight 822.49		CO_2 12.0
	Initial Weight 800.52		
	Increase		O_2 12.8
FILTER NO. 37	Final Weight .8055		CO —
	Initial Weight .6935		
	Part. Catch .1115		N_2 75.2
	SOLID WEIGHT GAIN		Filter .1115
BEAKER NO. 20	Final Weight 144.2600		BEAKER 36 .0555
	Initial Weight 144.2152		Total Dry ~~BEAKER 20~~ .1670
	Increase .0448		
BEAKER NO.	Final Weight		BEAKER 20 .0448
	Initial Weight		
	Increase		BEAKER 4
			TOTAL .2118
BEAKER NO. 36	Final Weight 145.3164		
	Initial Weight 145.2609		
	Increase .0555		
BEAKER NO. PROBE WASH	Final Weight		
	Initial Weight		
	Increase		

Moisture Content: Sample Vol. 39.49 ft.^{3} x $\frac{\text{~~460 + 70~~}}{\text{~~460 +~~ Meter Temp.}}$ (70. / 71) X 28.3 L/ft.^{3} = 1369 L Dry Gas

Water Weight $\frac{177.66 \text{ gm.}}{18 \text{ gm. mol.}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 237.9 L H_2O Vapor

Total = 1379.8 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{237.9 \text{ L}}{\text{L}}$ x 100 = 17.3 %

PARTICULATE FIELD DATA

Run No. 49
Location STACK #1
Date 10/1/79
Operator CHA/BRUCE

Amb. Temp. °F 65/68 70 DB
Bar. Press. "Hg. 28.59"
Assumed Moist 14%
Test Periods 128 MIN

Probe Tip Dia., In. 1/4"
Probe Length 6'
Inp. Nos.
Sample Box No.

Heater Box Setting 250 °F

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
		426.83	ΔP	√ΔP	Desired	Actual	Inlet	Outlet						
A-8	10:00/08	429.35	0.21	0.46	0.43	0.39	76	77	0.0	265	80	377	402	
7	16	432.51	0.26	0.51	0.54	0.62	76	77	0.0	296	82	408	406	
6	29	435.46	0.28	0.53	0.58	0.54	76	78	0.0	231	81	384	407	
5	32	438.36	0.26	0.51	0.54	0.52	76	79	0.0	272	82	389	411	
4	40	441.16	0.23	0.48	0.48	0.49	76	80	0.0	282	84	394	410	
3	48	443.80	0.21	0.46	0.43	0.43	76	81	0.0	238	79	382	403	
2	56	446.20	0.17	0.41	0.34	0.36	77	82	0.0	252	82	321	405	+0.22
1	11:04	448.45	0.15	0.39	0.31	0.31	77	82	0.0	271	80	219	396	
R-8	11:21/29	450.72	0.15	0.39	0.31	0.32	78	81	0.0	283	92	334	393	
7	37	453.35	0.21	0.46	0.43	0.43	79	82	0.0	258	95	366	402	
6	45	455.96	0.21	0.46	0.43	0.42	79	82	2.5	268	161	391	405	
5	53	458.68	0.22	0.47	0.45	0.46	79	83	3.0	242	93	399	410	
4	12:01	461.62	0.27	0.52	0.56	0.53	81	86	4.0	255	91	393	413	
3	09	464.76	0.29	0.54	0.60	0.61	81	87	4.5	263	87	402	414	
2	17	467.65	0.24	0.49	0.50	0.52	81	88	3.5	253	88	384	409	
1	25	470.41	0.23	0.48	0.48	0.47	81	88	4.5	281	85	280	407	
TOTAL				7.56	7.42	7.42	1209	1313					6498	
AVERAGE				0.473	0.464	0.464	78.1	82.1					406.1	

(540°R) 80°F

Meter Volume [redacted] Dry Meter Calibration Factor [redacted] (466°R)

[redacted] CO[redacted]TED [redacted]IPLE [redacted]LUM[redacted] [redacted]t.3[redacted] 0.[redacted] [redacted] 4[redacted] P[redacted]

RUN NO. 49

PARTICULATE & WATER CATCH

IMPINGER NO. 93	Final Weight 695.66	WATER WEIGHT GAIN	IMPINGER 1 146.01
	Initial Weight 549.65		IMPINGER 2 13.86
	Increase		IMPINGER 3 0.68
IMPINGER NO. 94	Final Weight 556.71		IMPINGER 4 18.96
	Initial Weight 542.85		TOTAL 179.51
	Increase		
IMPINGER NO. 95	Final Weight 1165.82		ORSAT
	Initial Weight 465.14		CO_2 15.4
	Increase		O_2 11.2
IMPINGER NO. 96	Final Weight 828.97		CO —
	Initial Weight 810.01		N_2 73.4
	Increase		
FILTER NO. 38	Final Weight 10300		Filter .3212
	Initial Weight		BEAKER 1
	Part. Catch .7088		BEAKER 2) .0907
	.3212		Total Dry BEAKER 3 .4119
	SOLID WEIGHT GAIN		BEAKER 4 .0224
BEAKER NO. 28	Final Weight 145.9028		TOTAL .4343
	Initial Weight 145.8804		
	Increase .0224		
BEAKER NO. ____	Final Weight ____		
	Initial Weight ____		
	Increase ____		
BEAKER NO. ____	Final Weight ____		
	Initial Weight ____		
	Increase ____		
BEAKER NO. 71 PROBE WASH	Final Weight 117.6683		
	Initial Weight 117.5776		
	Increase .0907		

Moisture Content: Sample Vol. 93.43 ft.^{3} x $\frac{520}{460 + 70}$ (460 + Meter Temp.) X 28.3 L/ft.^{3} = 1206.3L Dry Gas

Water Weight $\frac{179.51 \text{ gm.}}{18 \text{ gm./mol.}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 240.3L H_2O Vapor

Total = 1446.6L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{240.3\text{L}}{1446.6\text{L}}$ x 100 = 16.6 %

PARTICULATE FIELD DATA

Run No. 50
Location STACK #1
Date 10/11/79
Operator CHA/BOB

Amb. Temp. °F 65 WE 70 DE
Bar. Press. "Hg. 28.59" Hg
Assumed Moist 14%
Test Periods 128 MIN

Probe Tip Dia., In ¼"
Probe Length 6'
Inp. Nos.
Sample Box No.

Heater Box Setting 350°F

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
		551.93	ΔP	√ΔP	Desired	Actual	Inlet	Outlet						
B-1	10:04/12	554.70	0.23	0.48	0.48	0.47	58	61	0.0	303	70	82	400	
2	20	557.79	0.29	0.54	0.60	0.59	60	61	0.0	350	82	107	403	
3	28	561.00	0.31	0.56	0.64	0.64	62	65	0.0	366	84	198	408	
4	36	564.20	0.30	0.55	0.62	0.63	64	64	0.0	348	81	323	407	
5	44	567.22	0.25	0.50	0.52	0.56	59	63	0.0	345	80	380	408	
6	52	570.07	0.23	0.48	0.48	0.50	57	61	0.0	326	77	398	404	to 37
7	11:00	572.70	0.21	0.46	0.43	0.43	59	64	0.0	280	82	395	396	
8	08	575.11	0.18	0.42	0.37	0.36	61	65	0.0	294	85	389	389	
A-1	11:24/32	577.81	0.18	0.42	0.37	0.45	62	65	0.0	263	76	149	400	
2	41	580.20	0.20	0.45	0.42	0.35	64	68	0.0	269	71	101	405	
3	49	582.58	0.22	0.47	0.45	0.44	62	64	0.0	264	72	178	407	
4	57	585.81	0.25	0.50	0.52	0.53	64	65	0.5	299	81	398	409	
5	12:05	589.08	0.32	0.57	0.66	0.66	67	71	2.0	263	78	376	408	
6	13	592.24	0.30	0.55	0.62	0.62	64	68	2.0	253	76	395	406	
7	21	595.30	0.28	0.53	0.58	0.58	70	67	2.0	239	54	392	395	
8	29	598.12	0.23	0.48	0.48	0.49	61	63	2.0	261	71	399	397	
TOTAL				7.96	8.24	8.30	1000	1013					6043	
AVERAGE				0.498	0.515	0.519	62.5	63.2					403	

524°R 63.8

Meter Volume [redacted] Ft.³

Dry Meter Calibration Factor 1.63°R [redacted]

RUN NO. 50

PARTICULATE & WATER CATCH

IMPINGER NO. 97	Final Weight 718.11 Initial Weight 554.78 Increase	WATER WEIGHT GAIN	IMPINGER 1 163.33
IMPINGER NO. 98	Final Weight 561.33 Initial Weight Increase 532.640		IMPINGER 2 23.69
IMPINGER NO. 99	Final Weight 648.89 Initial Weight Increase 445.74		IMPINGER 3 2.15
IMPINGER NO. 100	Final Weight 813.22 Initial Weight Increase 785.92		IMPINGER 4 28.00
FILTER NO. 39	Final Weight 1.0643 Initial Weight Part. Catch .7038 .3605		TOTAL 218.17
			ORSAT
			CO_2 15.4
			O_2 11.2
			CO —
			N_2 73.4

SOLID WEIGHT GAIN

BEAKER NO. 18	Final Weight 143.6926 Initial Weight 143.6558 .0368	Filter .3605 BEAKER 1 ———
BEAKER NO. ———	Final Weight ——— Initial Weight Increase ———	BEAKER 2 .1907 Total Dry BEAKER 3 .5512 BEAKER 4 .0368
BEAKER NO. ———	Final Weight ——— Initial Weight Increase ———	TOTAL .5880
BEAKER NO. 34 PROBE WASH	Final Weight 146.7151 Initial Weight 146.5244 Increase .1907 520	

Moisture Content: Sample Vol. 46.84 ft.^{3} x $\frac{460 + 70}{460 + \text{Meter Temp.}}$ X 28.3 L/ft.^{3} = 1340.8 L Dry Gas

Water Weight $\frac{218.17 \text{ gm.}}{18 \frac{\text{gm.}}{\text{mol.}}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 292.1 L H_2O Vapor

Total = 1632.9 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{292.1 \text{ L}}{1632.9 \text{ L}}$ x 100 = 17.9 %

0.6-6

PARTICULATE FIELD DATA

Run No. 51
Location STACK #3
Date 10/4/79
Operator CHU/BRUCE

Amb. Temp. °F 53 WB / 56 DB
Bar. Press. "Hg. 28.60 Hg
Assumed Moist 15%
Test Periods 12 Min

Probe Tip Dia., In. 1/4"
Probe Length 6'
Inp. Nos.
Sample Box No.

Heater Box Setting 250°F

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
		410.46	ΔP	$\sqrt{\Delta P}$	Desired	Actual	Inlet	Outlet						
B-8	10:28½	412.69	0.12	0.35	0.24	0.30	74	75	0.0	221	78	885	413	
7	44	419.52	0.13	0.36	0.26	0.20	75	76	0.0	272	81	892	419	
6	52	427.02	0.20	0.45	0.39	0.38	76	77	0.0	271	82	881	430	
5	11:00	434.51	0.21	0.46	0.41	0.40	76	78	0.0	290	81	882	431	
4	8	441.97	0.18	0.42	0.35	0.35	77	79	0.0	292	81	79	424	
3	16	449.20	0.15	0.39	0.30	0.30	78	81	0.0	283	80	391	419	-10.12
2	24	456.25	0.13	0.36	0.26	0.26	79	81	0.0	246	80	320	413	
1	32	463.20	0.11	0.33	0.22	0.23	79	82	0.0	266	81	300	403	
A-8	11:47½	470.32	0.13	0.36	0.26	0.27	82	83	0.0	270	82	104	409	
7	12:03	477.41	0.14	0.37	0.28	0.27	82	83	0.0	284	88	112	417	
6	11	484.93	0.20	0.45	0.39	0.39	82	83	0.0	290	89	104	421	
5	19	492.44	0.20	0.45	0.39	0.38	82	83	0.0	290	89	100	425	
4	27	499.77	0.17	0.42	0.33	0.33	83	87	0.0	241	90	89	421	
3	35	506.98	0.15	0.39	0.30	0.30	84	85	0.0	236	88	97	416	
2	43	514.05	0.13	0.36	0.26	0.26	84	86	0.0	259	88	92	411	
1	51	521.80	0.09	0.30	0.18	0.19	86	87	0.0	247	88	98	401	
TOTAL				6.22	4.82	4.81	1236	1308					6673	
AVERAGE				0.389	0.301	0.301	77.3	81.7					417	

(460°R) 79.5 (877°R)

Leaks

[redacted] COMPLETED [redacted] SAMPLE VOLUME [redacted] Meter Volume [redacted] Dry Meter Calibration Factor [redacted] Ft.

RUN NO. 51

PARTICULATE & WATER CATCH

IMPINGER NO. 1	Final Weight 696.73 Initial Weight 564.25 Increase	WATER WEIGHT GAIN	IMPINGER 1 132.48
IMPINGER NO. 2	Final Weight 553.97 Initial Weight Increase 546.63		IMPINGER 2 7.34
IMPINGER NO. 3	Final Weight 463.84 Initial Weight Increase 455.12		IMPINGER 3 8.72
IMPINGER NO. 4	Final Weight 788.43 Initial Weight Increase 784.08		IMPINGER 4 4.35
			TOTAL 152.89
			ORSAT
			CO_2 12.4
			O_2 13.0
			CO —
			N_2 74.6
FILTER NO. ~~35~~ 40	Final Weight .8263 Initial Weight Part. Catch .7069 .1194		Tech .1194
	SOLID WEIGHT GAIN		
BEAKER NO. 4	Final Weight 142.9275 Initial Weight 142.8987 Increase .0288		BEAKER 5 .0632
			Dry Tech BEAKER 2 1826
BEAKER NO. ____	Final Weight ____ Initial Weight Increase ____		BEAKER 3 ____
			BEAKER 4 .0288
			Wet TOTAL 2114
BEAKER NO. ____	Final Weight ____ Initial Weight Increase ____		
BEAKER NO. 5 PROBE WASH	Final Weight 141.0737 Initial Weight 141.0105 Increase .0632		

Moisture Content: Sample Vol. 35.18 ft.^{3} x $\frac{460 + 70}{460 + \text{Meter Temp.}}$ (530 / 490) X 28.3 L/ft.^{3} = 997.2 L Dry Gas

Water Weight $\frac{152.89 \text{ gm.}}{18 \frac{\text{gm.}}{\text{mol.}}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 204.7 L H_2O Vapor

Total = 1181.9 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{204.7 \text{ L}}{1181.9 \text{ L}}$ x 100 = 17.3 %

0.674

PARTICULATE FIELD DATA

Run No. 52
Location Stack #3
Date 10/4/79
Operator Ethy / Larry

Amb. Temp. °F 53 WB 56 DB
Bar. Press. "Hg. 28.60
Assumed Moist 19 %
Test Periods 12 Actual

Probe Tip Dia., In 1/4"
Probe Length 6'
Inp. Nos.
Sample Box No.

Heater Box Setting 350 °F

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
		850.65	ΔP	$\sqrt{\Delta P}$	Desired	Actual	Inlet	Outlet						
A-1	10:32/40	852.87	0.10	0.32	0.20	0.27	61	62	0.0	293	66	172	406	
2	48	855.65	0.12	0.35	0.31	0.17	59	62	0.0	294	99	193	462	
3	56	856.875	0.15	0.39	0.26	0.24	59	62	0.0	298	97	248	459	
4	11:04	859.17	0.16	0.40	0.28	0.30	60	65	0.0	321	103	303	470	
5	12	861.17	0.18	0.42	0.31	0.32	61	67	0.0	277	68	411	417	
6	20	867.81	0.16	0.40	0.25	0.28	64	69	0.0	235	70	419	429	+0.09
7	28	865.91	0.14	0.37	0.24	0.24	63	70	0.0	251	71	414	412	
8	36	867.93	0.12	0.35	0.27	0.22	63	69	0.0	282	68	411	406	
R-1	11:51/59	869.67	0.09	0.30	0.16	0.16	67	68	0.0	289	69	165	397	
2	12:07	871.58	0.11	0.33	0.19	0.20	66	69	0.0	293	71	135	408	
3	15	873.67	0.13	0.36	0.23	0.21	67	69	0.0	265	69	115	413	
4	23	875.84	0.15	0.39	0.26	0.25	65	69	0.0	252	69	285	413	
5	31	878.39	0.20	0.45	0.31	0.35	66	71	1.0	297	70	351	414	
6	39	880.94	0.20	0.45	0.35	0.35	67	71	1.5	238	71	409	421	
7	47	883.23	0.16	0.40	0.28	0.28	66	71	1.5	239	74	417	415	
8	55	885.40	0.15	0.39	0.26	0.25	66	71	1.5	252	71	408	404	
TOTAL				6.07	4.07	4.12	1019	1057					6749	
AVERAGE				0.379	0.254	0.258	63.7	67.5					421.5	

(526.8) 65.8

Meter Volume [redacted]

Dry Meter Calibration Factor (.982 Y)

[redacted] CO[redacted]TED [redacted]MPLE [redacted]LUM[redacted] [redacted]5 [redacted]t.3[redacted] [redacted]5[redacted] [redacted]24[redacted] FE[redacted]

RUN NO. 52

PARTICULATE & WATER CATCH

IMPINGER NO. 5	Final Weight 685.57 Initial Weight 556.20 Increase	WATER WEIGHT GAIN	IMPINGER 1 129.37
IMPINGER NO. 6	Final Weight 564.05 Initial Weight Increase 557.04		IMPINGER 2 7.01
IMPINGER NO. 7	Final Weight 480.17 Initial Weight Increase 479.30		IMPINGER 3 0.87
IMPINGER NO. 8	Final Weight 836.12 Initial Weight Increase 825.68		IMPINGER 4 10.44
FILTER NO. 5X41	Final Weight .8586 Initial Weight .7091 Part. Catch .1495		TOTAL 147.69
	SOLID WEIGHT GAIN		ORSAT
BEAKER NO. 3	Final Weight 135.4545 Initial Weight 135.4046 Increase .0499		CO_2 12.4
BEAKER NO.	Final Weight Initial Weight Increase		O_2 13.0
BEAKER NO.	Final Weight Initial Weight Increase		CO —
BEAKER NO. 15 PROBE WASH	Final Weight 142.1240 Initial Weight 142.0259 Increase .0981		N_2 74.6

Tot 1495

BEAKER 15 .0981

Dry Total BEAKER 2 .2476

BEAKER 3 .0499

Wet Total BEAKER 4 _____

TOTAL .2975

Moisture Content: Sample Vol. 34.95 ft.^{3} x $\frac{460 + 70}{460 + \text{Meter Temp.}}$ ($\frac{530}{576}$) X 28.3 L/ft.^{3} = 996.6 L Dry Gas

Water Weight $\frac{147.69 \text{ gm.}}{18 \text{ gm. mol.}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 197.7 L H_2O Vapor

Total = 1194.3 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{197.7 \text{ L}}{1194.3 \text{ L}}$ x 100 = 16.6 %

PARTICULATE FIELD DATA

Run No. 53
Location STACK # 3
Date 10/11/79
Operator CHM / BRUCE

Amb. Temp. °F 43 DEG F / 45 DEG F
Bar. Press. "Hg. 28.55"
Assumed Moist 14%
Test Periods 120 MIN

Probe Tip Dia., In 1/4"
Probe Length 6'
Inp. Nos.
Sample Box No.

Heater Box Setting 250°F

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
		888.06	ΔP	$\sqrt{\Delta P}$	Desired	Actual	Inlet	Outlet						
B-1	10:04/12	890.12	0.13	0.36	0.23	0.23	72	75	0.0	223	71	293	486	
2	20	892.26	0.14	0.37	0.25	0.25	73	76	0.0	248	72	151	436	
3	28	894.55	0.16	0.40	0.28	0.28	72	76	0.0	254	73	291	436	
4	36	896.84	0.17	0.41	0.30	0.31	72	77	0.0	243	73	373	438	
5	44	899.32	0.18	0.42	0.32	0.31	73	78	0.0	241	74	415	440	
6	52	901.55	0.16	0.40	0.28	0.27	73	79	0.0	247	77	421	441	+0.10
7	11:00	903.59	0.13	0.36	0.23	0.21	72	78	0.0	253	79	422	423	
8	08	905.49	0.10	0.32	0.18	0.20	70	77	0.0	243	80	430	414	
A-1	11:22/30	907.95	0.12	0.35	0.21	0.21	73	75	0.0	234	67	185	405	
2	38	909.55	0.12	0.37	0.23	0.24	72	74	0.0	229	65	202	421	
3	46	911.83	0.16	0.40	0.28	0.28	71	75	0.0	237	68	272	427	
4	54	914.17	0.17	0.41	0.30	0.30	72	76	0.0	239	63	352	428	
5	12:02	916.39	0.16	0.40	0.28	0.27	71	77	0.0	223	63	401	433	
6	10	918.51	0.14	0.37	0.25	0.24	71	76	0.0	227	68	395	419	
7	18	920.56	0.12	0.35	0.21	0.23	70	75	0.0	226	60	416	421	
8	26	922.29	0.09	0.30	0.16	0.16	70	75	0.0	242	63	421	429	
TOTAL				5.99	4.01	3.99	1152	1230					6917	
AVERAGE				0.374	0.251	0.249	72	76.3					432	

Broken glassware

(520°R) 74.1 (892°K)

Meter Volume [redacted] Dry Meter Calibration Factor [redacted]

[redacted] CO[redacted]TED [redacted]MPLE [redacted]LUM[redacted] [redacted]2 [redacted]t.3[redacted] [redacted] [redacted]04[redacted]30[redacted]3 Pt.[redacted]

RUN NO. 53

PARTICULATE & WATER CATCH

IMPINGER NO. 9	Final Weight 691.43 Initial Weight 577.99 Increase	WATER WEIGHT GAIN	IMPINGER 1 113.44
IMPINGER NO. 10	Final Weight 558.55 Initial Weight Increase 550.48		IMPINGER 2 8.07 IMPINGER 3 1.47 IMPINGER 4 12.69
IMPINGER NO. 11	Final Weight 463.97 Initial Weight Increase 462.50		TOTAL 135.67
IMPINGER NO. 12	Final Weight 832.55 Initial Weight Increase 819.86		ORSAT CO_2 11.0 O_2 13.6
FILTER NO. 42	Final Weight .8386 Initial Weight Part. Catch .6999 .1387		CO — N_2 75.4
	SOLID WEIGHT GAIN		
BEAKER NO. 40	Final Weight 154.2071 Initial Weight 154.1463 Increase .0608		Filter .1387 BEAKER 1 — BEAKER 2 .0842
BEAKER NO. ____	Final Weight ____ Initial Weight Increase ____		Total BEAKER 3 .2229 BEAKER 4 .0608
BEAKER NO. ____	Final Weight ____ Initial Weight Increase ____		Total wt TOTAL .2837
BEAKER NO. 16 PROBE WASH	Final Weight 142.3124 Initial Weight 142.2282 Increase .0842		

Moisture Content: Sample Vol. 39.43 ft.^{3} x $\frac{460 + 70}{460 + \text{Meter Temp.}}$ (530 / 534) X 28.3 L/ft.^{3} = 967.1 L Dry Gas

Water Weight $\frac{135.67 \text{ gm.}}{18 \frac{\text{gm.}}{\text{mol.}}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 181.6 L H_2O Vapor

Total = 1148.7 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{181.6 \text{ L}}{1148.7 \text{ L}}$ x 100 = 15.8 %

PARTICULATE FIELD DATA

Run No. 5A
Location SIMIC #3
Date 10/11/79
Operator BHM/BOB

Amb. Temp. °F 93° WB / 97 DB
Bar. Press. "Hg. 28.57
Assumed Moist 14%
Test Periods 12 SMALL

Probe Tip Dia., In. 1/4"
Probe Length 6'
Inp. Nos.
Sample Box No.

Heater Box Setting 250 °F

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
		918.60	ΔP	$\sqrt{\Delta P}$	Desired	Actual	Inlet	Outlet						
A-8	10:00/08	950.56	0.13	0.36	0.26	0.23	65	67	0.0	277	85	370	436	
7	16	952.86	0.15	0.39	0.30	0.33	66	67	0.0	291	71	362	416	
6	24	955.19	0.17	0.41	0.34	0.33	66	68	0.0	299	73	388	417	
5	32	957.54	0.17	0.41	0.34	0.34	67	69	0.0	260	76	405	419	
4	40	959.95	0.18	0.42	0.36	0.35	68	69	0.0	260	73	403	422	
3	48	962.41	0.18	0.42	0.36	0.37	69	71	0.0	257	52	357	422	
2	56	964.98	0.13	0.36	0.26	0.26	70	72	0.0	256	88	259	399	+0.06
1	11:04	966.47	0.12	0.35	0.24	0.24	71	73	0.0	279	84	191	402	
B-8	11:26/34	968.52	0.13	0.36	0.26	0.26	73	75	0.0	279	72	322	404	
7	42	970.71	0.15	0.39	0.30	0.29	73	74	0.0	291	75	389	413	
6	50	973.00	0.15	0.39	0.30	0.32	74	75	0.0	258	73	404	416	
5	58	975.41	0.18	0.42	0.36	0.35	74	74	0.0	273	72	409	418	
4	12:06	977.89	0.18	0.42	0.36	0.37	75	76	0.0	279	72	410	420	
3	14	980.04	0.14	0.37	0.28	0.28	75	77	0.0	255	70	358	418	
2	22	982.21	0.14	0.37	0.28	0.28	76	77	0.0	272	69	339	415	
1	30	984.15	0.11	0.33	0.22	0.23	76	77	0.0	231	67	165	405	
TOTAL				6.17	4.82	4.83	1138	1162					6642	
AVERAGE				0.386	0.301	0.302	71.1	72.6					415	

(532°R) 71.9 Meter Volume

Dry Meter Calibration Factor (875°C)

[redacted] CO[redacted]TED [redacted]MPLE [redacted]LUM[redacted] [redacted]5 [redacted]t.3[redacted] [redacted] [redacted]3[redacted]9 [redacted]

RUN NO. 54

PARTICULATE & WATER CATCH

IMPINGER NO. 13	Final Weight 671.07 Initial Weight 560.07 Increase	WATER WEIGHT GAIN	IMPINGER 1 111.00
IMPINGER NO. 14	Final Weight 562.59 Initial Weight Increase 546.65		IMPINGER 2 15.94
IMPINGER NO. 15	Final Weight 465.89 Initial Weight Increase 461.85		IMPINGER 3 4.04
IMPINGER NO. 16	Final Weight 848.64 Initial Weight Increase 833.01		IMPINGER 4 15.63
FILTER NO. ~~8943~~	Final Weight 8676 Initial Weight 7088 Part. Catch .1588		TOTAL 146.61

ORSAT

CO_2 11.0

O_2 13.6

CO —

N_2 75.4

SOLID WEIGHT GAIN

Filter .1588

BEAKER NO. 26	Final Weight 144.6390 Initial Weight 144.5905 Increase .0485	BEAKER 25 .0404
BEAKER NO.	Final Weight Initial Weight Increase	BEAKER ~~5~~ ~~.0485~~
BEAKER NO.	Final Weight Initial Weight Increase	BEAKER 3 .1992
BEAKER NO. 25 PROBE WASH	Final Weight 148.6712 Initial Weight 148.6308 Increase .0404	BEAKER ~~26~~ .0485

Total Dry

Total wet TOTAL .2477

Moisture Content: Sample Vol. 35.39 ft.^{3} x $\frac{\text{~~460 + 70~~ 530}}{\text{~~460 +~~ 532 Meter Temp.}}$ X 28.3 L/ft.^{3} = 997.1 L Dry Gas

Water Weight $\frac{146.61 \text{ gm.}}{18 \text{ gm. mol.}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 196.3 L H_2O Vapor

Total = 1194.1 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{196.3 \text{ L}}{1194.1 \text{ L}}$ x 100 = 16.4 %

PARTICULATE FIELD DATA

Run No. 55
Location STACK # 3
Date 10/12/79
Operator CTH/BRUCE

Amb. Temp. °F 50 WB 55 DB
Bar. Press. "Hg. 28.49"
Assumed Moist 19%
Test Periods 12.8 MIN

Probe Tip Dia., In 1/4"
Probe Length 6'
Inp. Nos.
Sample Box No.

Heater Box Setting 250 °F

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
		923.25	ΔP	$\sqrt{\Delta P}$	Desired	Actual	Inlet	Outlet						
A-1	10:04/12	925.25	0.12	0.35	0.21	0.22	74	75	0.0.	210	80	185	415	
2	20	927.44	0.15	0.39	0.26	0.26	73	75	0.0.	218	77	188	409	
3	28	929.79	0.17	0.41	0.30	0.30	73	77	0.0.	215	78	263	434	
4	36	932.27	0.18	0.42	0.32	0.33	72	77	0.0	214	77	230	429	
5	44	934.53	0.16	0.40	0.28	0.28	71	77	0.0	232	77	365	425	
6	52	936.68	0.15	0.39	0.26	0.25	71	77	0.0	209	77	325	419	10.09
7	11:00	938.67	0.12	0.35	0.21	0.21	72	77	0.0.	235	80	410	413	
8	08	940.51	0.11	0.33	0.19	0.18	72	77	0.0.	246	92	413	417	
B-1	11:20/28	942.42	0.12	0.35	0.21	0.20	74	77	0.0.	218	78	189	369	
2	36	944.59	0.14	0.37	0.25	0.25	75	77	0.0	173	77	275	455	
3	44	946.84	0.16	0.40	0.28	0.27	74	77	0.0.	170	77	376	421	
4	52	949.23	0.17	0.41	0.30	0.31	73	78	0.0.	167	74	362	410	
5	12:00	951.64	0.18	0.42	0.32	0.31	72	77	0.0.	159	73	420	414	
6	8	953.84	0.15	0.39	0.26	0.26	73	78	0.0.	132	74	413	413	
7	16	955.80	0.12	0.35	0.21	0.21	72	77	0.0.	127	73	406	406	
C	24	957.65	0.10	0.32	0.18	0.18	72	77	0.0	138	76	408	402	
TOTAL				6.05	4.04	4.02	1163	1230					6650	
AVERAGE				0.378	0.253	0.251	73	77°					416	

535°R 74.8°F Meter Volume

876°R Dry Meter Calibration Factor

[redacted] COMPLETED [redacted] [redacted] [redacted]

RUN NO. 55

PARTICULATE & WATER CATCH

IMPINGER NO. 17	Final Weight 664.12	WATER WEIGHT GAIN	IMPINGER 1 116.31
	Initial Weight 547.81		IMPINGER 2 10.66
IMPINGER NO. 18	Final Weight 549.71		IMPINGER 3 0.50
	Initial Weight		IMPINGER 4 13.21
IMPINGER NO. 19	Increase 539.05		TOTAL 140.68
	Final Weight 445.59		
	Initial Weight		ORSAT
	Increase 445.09		CO_2 15.4
IMPINGER NO. 20	Final Weight 826.15		O_2 10.0
	Initial Weight		CO —
	Increase 812.94		N_2 74.6
FILTER NO. 44	Final Weight .8593		
	Initial Weight .7030		
	Part. Catch .1563		

SOLID WEIGHT GAIN

		Filter - 1563
BEAKER NO. 38	Final Weight 141.0790	BEAKER 1 —
	Initial Weight 141.0227	BEAKER 2 .0372
	Increase .0563	Total DP's BEAKER 3 .1935
BEAKER NO. —	Final Weight —	BEAKER 4 .0563
	Initial Weight —	Total Weeks TOTAL 2498
	Increase —	
BEAKER NO. —	Final Weight —	
	Initial Weight —	
	Increase —	
BEAKER NO. 39 PROBE WASH	Final Weight 150.5275	
	Initial Weight 150.4903	
	Increase .0372	

Moisture Content: Sample Vol. 34.6 ft.^{3} x $\frac{\text{~~460 + 70~~ 530}}{\text{460 + Meter Temp. 535}}$ X 28.3 L/ft.^{3} = 970.0 L Dry Gas

Water Weight $\frac{140.68 \text{ gm.}}{18 \text{ gm. mol.}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 188.4 L H_2O Vapor

Total = 1158.4 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{188.4 \text{ L}}{1158.4 \text{ L}}$ x 100 = 16.3 %

PARTICULATE FIELD DATA

Run No. 56
Location STACK #3
Date 10/12/79
Operator CHH/BOB

Amb. Temp. °F 50 WB 55 DB
Bar. Press. "Hg. 28.19"
Assumed Moist 19%
Test Periods 12.8 MIN

Probe Tip Dia., In. ¼"
Probe Length 6'
Inp. Nos.
Sample Box No.

Heater Box Setting 250°F

FILL IN ALL BLANKS
READ & RECORD AT THE START OF EACH TEST POINT

Point	Clock Time	Dry Gas Meter C.F.	Pitot In. H_2O		Orifice ΔH In. H_2O		Dry Gas Temp. °F		Vac. In. Hg Gage	Box Temp. °F	Imp. Temp. °F	Probe Temp. °F	Stack Temp. °F	Stack Press. In. H_2O
		485.02	ΔP	$\sqrt{\Delta P}$	Desired	Actual	Inlet	Outlet						
B-8	10:00/08	487.12	0.12	0.35	0.24	0.27	73	74	0.0	257	73	405	403	
7	16	489.40	0.16	0.40	0.32	0.32	73	73	0.0	255	77	405	413	
6	22	491.78	0.18	0.42	0.36	0.35	73	74	0.0	237	81	412	419	
5	32	494.14	0.17	0.41	0.34	0.34	74	75	0.0	238	77	410	421	
4	40	496.58	0.18	6.42	0.36	0.26	74	75	0.0	202	81	409	423	
3	48	498.82	0.16	0.40	0.32	0.31	75	77	0.0	260	78	367	420	+0.11
2	56	500.91	0.13	0.36	0.26	0.27	76	78	0.0	228	83	262	418	
1	11:04	502.83	0.12	0.35	0.24	0.22	78	78	0.0	234	83	179	414	
A-8	11:29/32	504.96	0.14	0.37	0.28	0.28	78	79	0.0	249	82	353	406	
7	40	507.04	0.13	0.36	0.26	0.26	78	80	0.0	202	90	392	420	
6	48	509.32	0.16	0.40	0.32	0.32	78	80	0.0	269	87	405	411	
5	56	511.79	0.17	0.41	0.34	0.35	80	80	0.0	264	86	407	417	
4	12:04	514.19	0.18	0.42	0.36	0.37	80	82	0.0	250	90	404	419	
3	12	516.52	0.18	0.42	0.36	0.33	81	82	0.0	208	86	380	417	
2	20	518.75	0.15	0.39	0.30	0.30	81	82	0.0	239	87	298	415	
1	28	520.92	0.14	0.37	0.28	0.29	81	83	0.0	250	85	289	410	
TOTAL				6.25	4.94	4.99	1231	1252					0.636	
AVERAGE				0.391	0.309	0.309	76.9	78.3					415	

537°R 77.6 535°R

Meter Volume [redacted] Dry Meter Calibration Factor [redacted]

[redacted] CO[redacted]TED [redacted]PLI[redacted]LUM[redacted] [redacted]t.3[redacted] [redacted]35[redacted]

RUN NO. 56

PARTICULATE & WATER CATCH

WATER WEIGHT GAIN

IMPINGER NO. 21	Final Weight	688.29
	Initial Weight	569.85
	Increase	
IMPINGER NO. 22	Final Weight	551.83
	Initial Weight	
	Increase	540.27
IMPINGER NO. 23	Final Weight	465.25
	Initial Weight	
	Increase	464.48
IMPINGER NO. 24	Final Weight	896.11
	Initial Weight	
	Increase	828.7x

IMPINGER 1	118.44
IMPINGER 2	11.56
IMPINGER 3	0.77
IMPINGER 4	17.37
TOTAL	148.14

ORSAT

CO_2	15.4
O_2	10.0
CO	-
N_2	74.6

FILTER NO. 45	Final Weight	.8548
	Initial Weight	.7006
	Part. Catch	.1442

SOLID WEIGHT GAIN

Filter .1442

BEAKER NO. 37	Final Weight	139.2764
	Initial Weight	139.2112
	Increase	.0652
BEAKER NO. ____	Final Weight	____
	Initial Weight	
	Increase	____
BEAKER NO. ____	Final Weight	____
	Initial Weight	
	Increase	____
BEAKER NO. 35 PROBE WASH	Final Weight	151.3757
	Initial Weight	151.3411
	Increase	.0346

BEAKER 1 ____

BEAKER ~~35~~ .0346

Total DRY BEAKER 3 .1788

BEAKER ~~37~~ .0652

Total wet TOTAL .2440

Moisture Content: Sample Vol. 35.73 ft.^{3} x $\frac{\text{~~460 + 70~~ 530}}{\text{~~460~~ + Meter 538 Temp.}}$ X 28.3 L/ft.^{3} = 996.1 L Dry Gas

Water Weight $\frac{148.14 \text{ gm.}}{18 \frac{\text{gm.}}{\text{mol.}}}$ x 24.1 $\frac{\text{L}}{\text{mol.}}$ = 198.3 L H_2O Vapor

Total = 1194.4 L

$\frac{H_2O \text{ Vol.}}{\text{Total}}$ $\frac{198.3 \text{ L}}{1194.4 \text{ L}}$ x 100 = 16.6 %

II. Regulations

Source standards for stack particulate emissions applicable to the Roanoke Old Plant section (Kilns 1-4) are regulated by the Virginia State Air Pollution Control Board Regulation Part IV "Emission Standards for Particulate Emissions from Manufacturing Operations," Rule EX-4, Part 4.40 - Manufacturing Operations, Section (b) (8) Portland Cement Plants.

This rule limits particulate emissions to rates contained in Table 4.40A based on "Process Weight Rate."

Interpolation of the Table data for Process Weights up to 30 tons/hr is expressed by the formula:

$$E = 4.10\ (P)^{0.67}$$

and for Process Weights in excess of 30 tons/hr by the formula:

$$E = 5.50\ (P)^{0.11} - 40$$

where E represents the allowable emission rate in lb./hr. and P the process weight in tons/hr.

"Process Weight" by definition is: "Total weight of all materials introduced into any source process unit which may cause any emission of pollutants. Process weight includes solid fuels charged, but does not include liquid and gaseous fuels charged or combustion air for all fuels."

Thus, for these test purposes, the "Process Weight" is the sum of the coal fuel rate and the kiln feed rate for each kiln. The following tabulation summarizes the average process weights, as listed in Table 3, and the compatible allowable emission rates for each kiln.

Stack No.	Coal T/H	Kiln Feed T/H	Process Weight T/H	Allowable Emisssion lb./Hr	EPA Allowable
1	3.4	21.2	24.6	35.1	7.38
2		------- POSTPONED -------			
3	2.8	21.6	24.4	34.8	7.32
4	3.0	27.9	30.9	40.2	9.27

In the case of the new No. 5 kiln, the State of Virginia requires compliance with the E.P.A. Standards of Performance for New Stationary Sources (40 CFR Part 60), Subpart F - Portland Cement Plants 40 CFR 60.60 thru 40 CFR 60.64.

This regulation limits particulate emissions from any kiln to 0.3 lb. per ton of kiln feed (dry basis) and from any clinker cooler 0.1 lb. per ton of kiln feed (dry basis). Since the clinker cooler gases are emitted through the same stack, the allowable mass particulate emissions equate to 0.4 lbs. per ton of kiln feed (dry basis).

Therefore, at a kiln feed rate of 105 ton/hr. with a moisture content of 0.36%, the allowable emission rate for the No. 5 kiln is:

$$(105)\ (1-0.0036)\ (0.4) = 41.8 \text{ lbs/hr}$$

As designated in "Procedures for Emission Testing" dated April 21, 1977, Virgina State Regulations require extensive data concerning process parameters, testing equipment details and sampling procedures. To comply, details of process parameters, operating equipment specifications, and test equipment and procedures are presented in the following report sections.

V. Discussion of Results

Results of stack particulate emission test tabulated in Table I seem consistent and represent the conditions at hand during the course of testing. Since there were several runs on each stack during different days, true average conditions should be reflected - especially - since essentially all the results for each stack were consistently close to the average for the various stacks.

Since our last work at Roanoke, we have adapted as a testing standard the operation of two testing systems simultaneously at the same location. Accordingly, we were afforded a standard for measuring the quality of our results since, theoretically, the results of simultaneous test should be identical. Please note runs made on the same date were the simultaneous runs. Though results for simultaneous runs are never the same, they were, in our opinion, reasonably close for the most part.

In the interest of adding creditability to the test performed and lessen the probability of a built-in bias influencing the results determined by E.P.A. Method 5, please refer to Table 2 for direct comparison of Method 5 results with Lear Siegler opacity meter results which are tabulated in the last two columns. Though the correlation between results was not completely proportional, there was excellent agreement when it was considered L/S results were eyeball integrated to arrive at the averages tabulated.

Kiln No. 1, which averaged 28.4 lbs/hr. particulate emissions, was in compliance since the allowable was 35.1 lbs/hr. (see section of Regulations). One of the three days tested, emissions were abnormally high which brought the average up considerably. Accordingly, the average probably was biased to the high side.