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PROCESS EMISSION TESTS
AT THE U.S. GYPSUM COMPANY
GYPSUM WALLBOARD PLANT
FORT DODGE, IOWA

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PREFACE

The work reported here was conducted by personnel from TRC - Environmental Consultants, Inc., Radian Corporation, United States Gypsum Company of Fort Dodge, Iowa, and the U.S. Environmental Protection Agency.

The scope of work, issued under EPA Contract No. 68-02-3543, Work Assignment No. 5, was under the supervision of the TRC Work Assignment Manager, Mr. Willard A. Wade III. Mr. Leigh Gammie of TRC served as Project Engineer and, with Mr. Eric A. Pearson, was responsible for summarizing the test and analytical data in this report. Analysis of the samples was performed at the TRC laboratories under the direction of Ms. Margaret Fox of TRC.

Mr. Michael Palazzolo of Radian Corporation was responsible for monitoring the process operations during the testing program. Radian personnel were also responsible for preparing Section 3 of this report, Process Description and Operations.

Members of U.S. Gypsum Company, Fort Dodge, Iowa, whose assistance and guidance contributed greatly to the success of the test program, include Mr. Daniel Nootens, Plant Manager.

Mr. Dennis Holzschuh, Office of Air Quality Planning and Standards, Emission Measurement Branch, EPA, served as Task Manager and was responsible for coordinating the emission test program. His representative on-site for the tests was Mr. King Wu.

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NOTE: Mention of trade names or commercial products in this publication does not constitute endorsement or recommendation for use by the United States Environmental Protection Agency.

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1.0 INTRODUCTION

1.1 Background

Section 111 of the Clean Air Act of 1970 charges the Administrator of the U.S. Environmental Protection Agency (EPA) with the responsibility of establishing Federal standards of performance for new stationary sources which may significantly contribute to air pollution. When promulgated, these standards of performance for new stationary sources (SPNSS) are to reflect the degree of emission limitation achievable through application of the best demonstrated emission control technology. EPA uses emission data, obtained from controlled sources in the particular industry under consideration, as a partial basis for SPNSS.

EPA's Office of Air Quality Planning and Standards (OAQPS) selected the U.S. Gypsum Company gypsum wallboard manufacturing plant at Fort Dodge, Iowa as a site for an emission test program. The test program was designed to provide a portion of the emission database required for SPNSS for the processes associated with the production of gypsum wallboard. EPA engaged TRC to measure particulate emissions, particle size distributions, and plume opacities at a continuous and batch-kettle calciner, the board end sawing and paper scoring operation, and the mixing and bagging operation.

1.2 Measurement Program

The measurement program was conducted at the U.S. Gypsum Company gypsum wallboard plant in Fort Dodge, Iowa, from October 27 to 31, 1980. The emission tests were designed to characterize and quantify uncontrolled and controlled particulate emissions from the gypsum wallboard production process and to determine control equipment efficiency.

TRC personnel were responsible for sampling and analyzing process emissions. Concurrently Radian was responsible for monitoring pertinent process operation parameters. The chronology of the emission tests is contained in Appendix D. The components of the measurement program are as follows:

1.2.1 Continuous and Batch Kettle Calciner No. 5

- Particulate Emissions

  Three runs of concurrent emission tests were performed in the baghouse inlet and outlet during continuous operation and during batch operation.

- Visible Emissions

  The opacity of the calciner baghouse plume was monitored during the particulate emission tests.

- Particle Size Distribution

  Filter particulate catches from the six baghouse inlet emission tests were analyzed for particle size distribution using a Bahco centrifugal separator.

1.2.2 Board End Saw and Paper Scoring

- Particulate Emissions

  Three emission test runs were performed at the baghouse outlet.

- Visible Emissions and Fugitive Emissions

  The opacity of the baghouse plume and fugitive emissions from the sawing operation were monitored during the particulate emission tests.

- Particle Size Distribution

  One test run was performed at the baghouse outlet between the second and third emission tests, using an in-train impactor.

1.2.3 Mixing and Bagging Baghouse

The opacities of the stucco conveyor baghouse outlet plume and the bagging operation baghouse plume were monitored during the particulate emission tests at the board end saw.

1.3 Description of Report Sections

The remaining sections of this report present the Summary of Results (Section 2), Process Description and Operations (Section 3), Location of Sampling Points (Section 4), and the Sampling and Analytical Methods (Section 5). Detailed descriptions of methods and procedures, field laboratory data and calculations are presented in the various appendices, as noted in the Table of Contents.

2.0 SUMMARY OF RESULTS

This section presents summary tables of the results of the emission tests. EPA Method 5 particulate emission tests were performed on the gas stream entering and exiting the kettle calciner No. 5 baghouse during batch and continuous gypsum production, and on the gas stream exiting the board end saw and paper scoring baghouse. Visible emissions from these two baghouses and from the mixing and bagging operation baghouses were monitored during the particulate emission tests.

2.1 Kettle Calciner No. 5 Particulate Emissions

A summary of the baghouse inlet and outlet test results for the batch and continuous production modes is shown in Table 2-1. These data show a baghouse particulate removal efficiency of 99.9 percent and 99.8 percent for batch and continuous production modes, respectively.

Table 2-2 shows the results for the kettle calciner No. 5 batch mode tests alone. The data on the first two tests show similar air flow, temperature and moisture conditions, but the inlet grain loading of Run 2 was 34 percent lower than that of Run 1. For inlet Run 3 the air flow decreased by 12 percent while the moisture and temperature increased significantly, which affected the isokinetic sampling rate unfavorably. Nozzle and probe plugging were a persistent problem at the inlet, requiring reduced sampling times. Because of anisokinetic sampling conditions on October 29, outlet Run 3 was repeated on October 31. The latter test results are presented here. The low grain loading for outlet Run 2 is due to the fact that no particulate was caught on the in-train filter; the particulate catch for this run was all in the probe wash. The reason for the lack of particulate on the filter is not evident.

TABLE 2-1

AVERAGE VALUES FROM PARTICULATE TESTS ON THE
KETTLE CALCINER NO. 5 INLET AND OUTLET
AT U.S. GYPSUM COMPANY
FORT DODGE, IOWA

Production Mode	Batch		Continuous	
Sampling Location	Inlet	Outlet	Inlet	Outlet
Volume of Gas Sampled (DSCF)[a]	16.92	98.88	9.72	41.96
Percent Moisture by Volume	37.55	25.95	59.77	51.72
Average Gas Temperature (^{o}F)	168	161	261	232
Stack Flow Rate, ACFM	2825	2900	3070	2830
(DSCFM)[b]	(1510)	(1820)	(920)	(1050)
Production Rate (tons/hr)	4.9	4.9	11.0	11.0
Percent Isokinetic	115.4	103.6	98.5	102.2
Net Sampling Time (minutes)	25.8	160.0	20.0	69.0
Concentration				
Gr/ACF[c]	12.29	0.0152	16.26	0.0345
Gr/DSCF[d]	22.62	0.0245	54.42	0.0935
Mass Rate				
lb/hr	303.6	0.380	428.2	0.840
lb/ton	61.96	0.08	39.92	0.08
Collection Efficiency	99.9		99.8	

[a] dry standard cubic feet at 68^{o}F, 29.92 inches Hg
[b] dry standard cubic feet per minute
[c] grains per actual cubic foot
[d] grains per dry standard cubic foot

TABLE 2-2

SUMMARY OF RESULTS OF PARTICULATE TESTS ON GASES ENTERING AND EXITING THE KETTLE CALCINER NO. 5 BAGHOUSE DURING BATCH OPERATION AT U.S. GYPSUM COMPANY, FORT DODGE, IOWA

Run Number	Run 1		Run 2		Run 3		Average	
Sampling Location	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
Date	10-28-80	10-28-80	10-28-80	10-28-80	10-29-80	10-31-80		
Time	1400-1600	1400-1600	1640-1940	1730-2015	0940-1210	0945-1233		
Production Mode	Batch	Batch	Batch	Batch	Batch	Batch		
Vol. of Gas Sampled (DSCF)[a]	27.70	95.43	11.69	101.50	11.37	99.70	16.92	98.88
Percent Moisture by Volume	32.72	25.12	33.02	23.60	46.91	29.14	37.55	25.95
Average Gas Temperature (^{o}F)	166	154	161	154	176	176	168	161
Stack Flow Rate, ACFM	2927	2911	2988	2852	2560	2922	2825	2895
(DSCFM)[b]	(1675)	(1860)	(1716)	(1881)	(1140)	(1724)	(1510)	(1821)
Production Rate (tons/hr)								
Percent Isokinetic	109.4	97.8	98.1	102.9	138.8	110.0	115.4	103.6
Net Sampling Time (minutes)	40.0	160.0	18.5	160.0	19.0	160.0	25.8	160.0
Concentration								
Gr/ACF[c]	18.16	0.0253	11.18	0.0026	6.92	0.0178	12.29	0.0152
Gr/DSCF[d]	31.73	0.0393	20.58	0.0040	15.54	0.0302	22.62	0.0245
Mass Rate								
lb/hr	455.6	0.628	303.1	0.065	152.1	0.446	303.6	0.380
lb/ton								

[a] dry standard cubic feet at 68^{o}F, 29.92 inches Hg
[b] dry standard cubic feet per minute
[c] grains per actual cubic foot
[d] grains per dry standard cubic foot

The test data for the kettle calciner No. 5 continuous mode tests alone are shown in Table 2-3. These data show a much higher gas stream moisture content and temperature than do the batch mode data, while air flow rates are very similar to those measured in the batch mode tests. Inlet Run 4 was repeated late in the day on October 30 because of the anisokinetic sampling conditions experienced earlier. The data from the repeat run are presented here.

2.2 Comparison of Inlet Run 3 Batch Particulate Mass Emission Rates Calculated by Sample Concentration and Area Ratio Methods

Table 2-4 shows a comparison of the emission rates for batch inlet Run 3 as calculated by two methods. The sample concentration method of calculating the mass emission rate uses Equation 2-1 as follows:

$$MER = \frac{M}{V} * Q * k \qquad (2\text{-}1)$$

where:
- MER = mass emission rate, pounds/hour
- M = mass of particulate captured, mg
- V = sample volume, dry standard cubic feet
- Q = volumetric flow rate, dry standard cubic feet/minute
- K = units correction factor = 1.32×10^{-4}

This equation is valid only for isokinetic sampling; that is, when the velocity of gas entering the nozzle (U_n) is within 90 percent of the velocity of the gas stream (U_s). Under conditions of anisokinetic sampling ($U_n < 0.9U_s$ or $U_n > 1.1U_s$), particle inertia causes sampling biases that produce nonrepresentative emission rate values if the sample concentration calculation method is used. In cases like batch Run 3, where the sampling rate was super-isokinetic, the gas stream around the nozzle is drawn into the nozzle but the large particles do not follow because of their inertia. Thus,

TABLE 2-3

SUMMARY OF RESULTS OF PARTICULATE TESTS ON GASES ENTERING AND EXITING THE KETTLE CALCINER NO. 5 BAGHOUSE DURING CONTINUOUS OPERATION AT U.S. GYPSUM COMPANY, FORT DODGE, IOWA

Run Number	Run 4		Run 5		Run 6		Average	
Sampling Location	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
Date	10-30-80	10-30-80	10-30-80	10-30-80	10-30-80	10-30-80		
Time	0930-1018	1704-1810	1312-1404	1230-1350	1523-1603	1452-1559		
Production Mode	Continuous	Continuous	Continuous	Continuous	Continuous	Continuous		
Vol. of Gas Sampled (DSCF)[a]	10.0	38.10	9.96	48.72	9.19	39.05	9.72	41.96
Percent Moisture By Volume	59.1	53.03	58.8	51.08	61.4	51.05	59.77	51.72
Average Gas Temperature (^{o}F)	258	235	260	230	256	232	261	232
Stack Flow Rate, ACFM	3156	2801	3182	2845	2865	2851	3068	2832
(DSCFM)[b]	(963)	(1004)	(967)	(1072)	(825)	(1070)	(918)	(1049)
Production Rate (tons/hr)								
Percent Isokinetic	96.5	106.1	95.6	100.0	103.4	100.4	98.5	102.2
Net Sampling Time (minutes)	20.0	63.0	20.0	80.0	20.0	64.0	20.0	69.0
Concentration								
Gr/ACF[c]	15.11	0.0344	17.65	0.0356	16.03	0.0336	16.26	0.0345
Gr/DSCF[d]	49.50	0.0961	58.07	0.0950	55.68	0.0895	54.42	0.0935
Mass Rate								
lb/hr	408.6	0.827	481.9	0.872	394.2	0.821	428.2	0.840
lb/ton								

[a] dry standard cubic feet at 68^{o}F, 29.92 inches Hg
[b] dry standard cubic feet per minute
[c] grains per actual cubic foot
[d] grains per dry standard cubic foot

TABLE 2-4

COMPARISON OF PARTICULATE EMISSION CALCULATIONS FOR RUN 3
AT THE KETTLE CALCINER NO. 5 BAGHOUSE INLET
DURING BATCH PRODUCTION AT U.S. GYPSUM COMPANY
FORT DODGE, IOWA

(Calculated by the Sample Concentration
and Area Ratio Methods)

Sample Volume, V, (DSCF)[a]	11.37
Particulate Captured, M (mg)	11460.84
Stack Volumetric Flow Rate, Q, (DSCFM)[b]	2560
Sampling Time, t (hours)	0.3167
Area of Stack, A_s (ft^2)	0.99
Area of Nozzle, A_n (ft^2)	0.000374

Calculation Method	Sample Concentration	Area Ratio	Average
Mass Emission Rate, MER (Lb/Hr)	152.1	211.0	181.6

[a] dry standard cubic feet at 68°F, 29.92 inches Hg
[b] dry standard cubic feet per minute

the particulate concentration is less than the true value and the emission rate calculated by the sample concentration method is too low.

The area ratio method of calculating emission rates is based on Equation 2-2 as follows:

$$MER = \frac{M}{t} * \frac{A_s}{A_n} \qquad (2\text{-}2)$$

where: MER = mass emission rate, pounds per hour
t = sampling time, hours
A_s = cross-sectional area of stack, ft^2
A_n = cross-sectional area of nozzle, ft^2

Since the mass of collected particulate is accurate, (that is, only particles in the plane of the nozzle enter the nozzle), the area ratio technique provides a correct emission rate value for super-isokinetic conditions.

As predicted by these theoretical considerations, the batch inlet Run 3 MER calculated by the latter method is in fact greater than the MER calculated by the sample concentration method (shown in Table 2-2). An examination of batch Runs 1 and 2 inlet particulate MERs calculated by the area ratio method will show agreement within 10 percent of the values calculated by the sample concentration technique. Both of these runs were within the acceptable isokinetic range.

2.3 Board End Sawing and Paper Scoring (BES/PS) Baghouse Emissions

A summary of the results of the BES/PS outlet emission tests is shown in Table 2-5. These data show that over the three test runs, air flow rates varied by less than 2.5 percent and emission rates varied by less than 40 percent. Moisture and temperature values are within expected ranges for ambient air. This air is drawn from the saw area through the baghouse in order to reduce dust levels in the vicinity of the saw.

TABLE 2-5

SUMMARY OF RESULTS OF PARTICULATE TESTS ON GASES
EXITING THE BOARD END SAW BAGHOUSE AT
U.S. GYPSUM COMPANY, FORT DODGE, IOWA

Run Number	Run 7	Run 8	Run 9	
Date	10-31-80	10-31-80	10-31-80	
Time	1115-1200	1310-1415	1607-1655	Average
Volume of Gas Sampled (DSCF)[a]	45.4	43.8	45.1	44.7
Percent Moisture By Volume	1.17	1.48	0.716	1.12
Average Gas Temperature (^{o}F)	71	75	70	72
Stack Flow Rate, ACFM	4026	3930	3951	3969
(DSCFM)[b]	(4029)	(3897)	(3982)	(3969)
Production Rate (tons/hr)	30.7	30.7	30.7	30.7
Percent Isokinetic	96.8	93.6	97.3	95.9
Net Sampling Time (minutes)	40	40	40	40
Concentration				
Gr/ACF[c]	0.0090	0.0079	0.0135	0.0101
Gr/DSCF[d]	0.0092	0.0084	0.0136	0.0104
Mass Rate				
lb/hr	0.318	0.280	0.466	0.354
lb/ton	0.010	0.009	0.015	0.011

[a] dry standard cubic feet at 68^{o}F, 29.92 inches Hg
[b] dry standard cubic feet per minute
[c] grains per actual cubic foot
[d] grains per dry standard cubic foot

2.4 Board End Saw Particle Size Test

One particle size sampling test run was performed in the board end saw baghouse outlet. A frequency distribution of the particle size measurements is shown in Figure 2-1. The values used to construct this distribution are shown in Table 2-6. The D_{P50} for the particulate matter captured during this one test is approximately 2.5 microns.

2.5 Kettle Calciner No. 5 Baghouse Inlet Particle Size Tests

The in-train filter particulate catches from the three batch and three continuous emission test runs performed at the kettle calciner baghouse inlet were analyzed for particle size distribution. These analyses were performed with a Bahco centrifugal separator. Use of an in-train cascade impactor was impractical because of high grain loadings and moisture content. The particle size frequency distributions for the three batch test runs and the three continuous test runs are shown in Figures 2-2 and 2-3, respectively. The data used to construct these distributions are shown in Table 2-7. The D_{P50} is approximately 7.0 microns for batch operations and approximately 5.7 microns for continuous operations.

2.6 Visible Emissions

The opacities of the kettle calciner No. 5 baghouse outlet plume, the BES/PS baghouse plume, the stucco conveyor baghouse plume and the bagging operation baghouse plume were monitored during the particulate emission tests by a certified visible emission observer. All observation locations conform to the guidelines of EPA Method 9.

The kettle calciner No. 5 baghouse outlet plume was monitored for approximately 9.5 hours over 4 days, and all 15-second observations were zero (clean

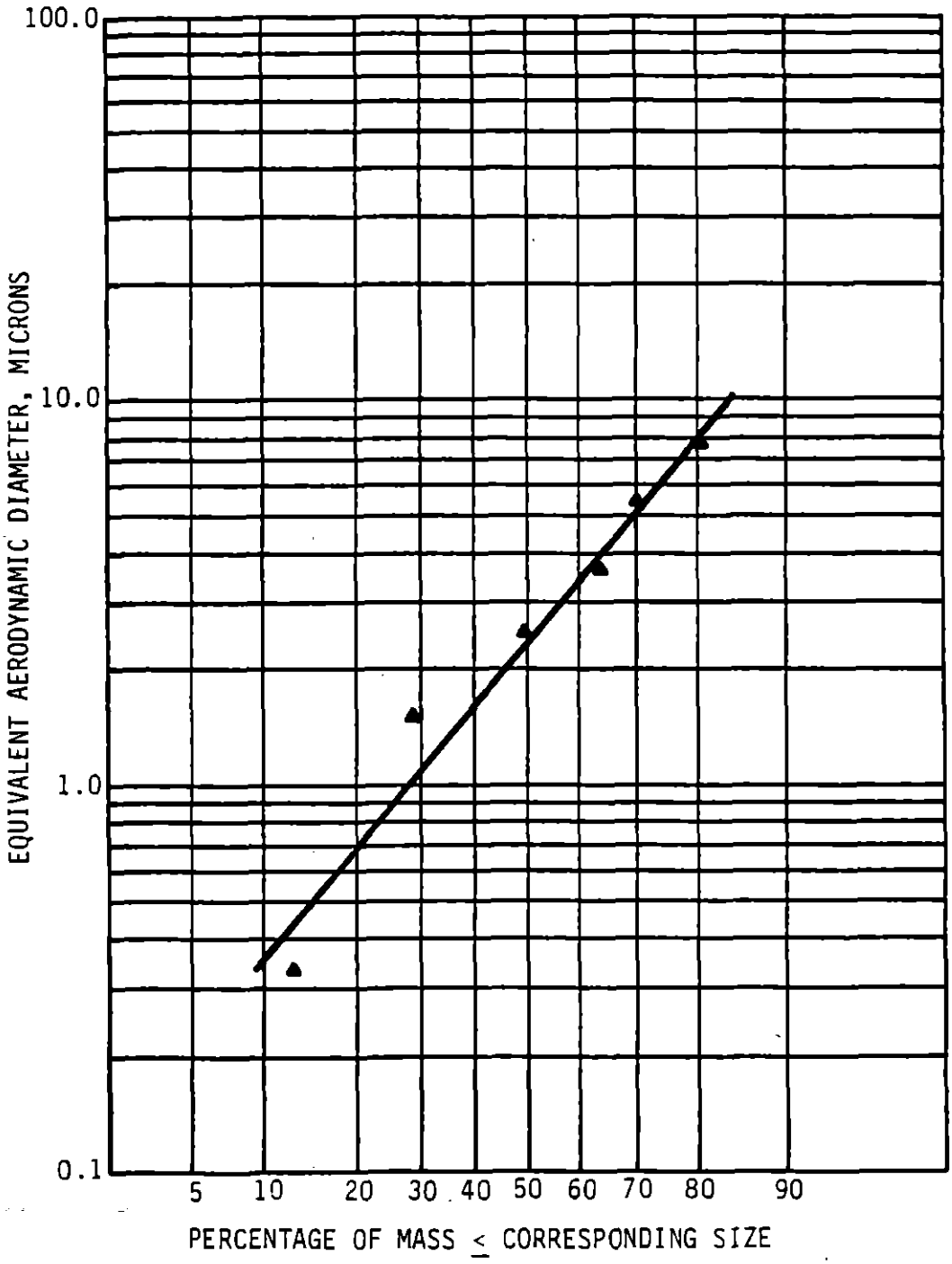


FIGURE 2-1: CUMULATIVE SIZE DISTRIBUTION OF PARTICULATE IN BOARD END SAW BAGHOUSE OUTLET AT U.S. GYPSUM COMPANY FORT DODGE, IOWA

TABLE 2-6

SUMMARY OF BOARD END SAW BAGHOUSE OUTLET
PARTICLE SIZING TEST RESULTS
AT U.S. GYPSUM COMPANY
FORT DODGE, IOWA

Test Date Time	Particulate Concentration (grains/DSCF*)	Aerodynamic Size Range (microns)	Mass Fraction in Size Range (%)	Cumulative Percent
10-31-80	0.000413	>7.96	17.4	99.9
1710-1840		5.47-7.96	11.6	82.5
		3.69-5.47	6.5	70.9
		2.51-3.69	14.1	64.4
		1.61-2.51	21.0	50.3
		0.33-1.61	17.0	29.3
		<0.33	12.3	12.3

* Grains per dry standard cubic foot at 68°F, 29.92 inches Hg

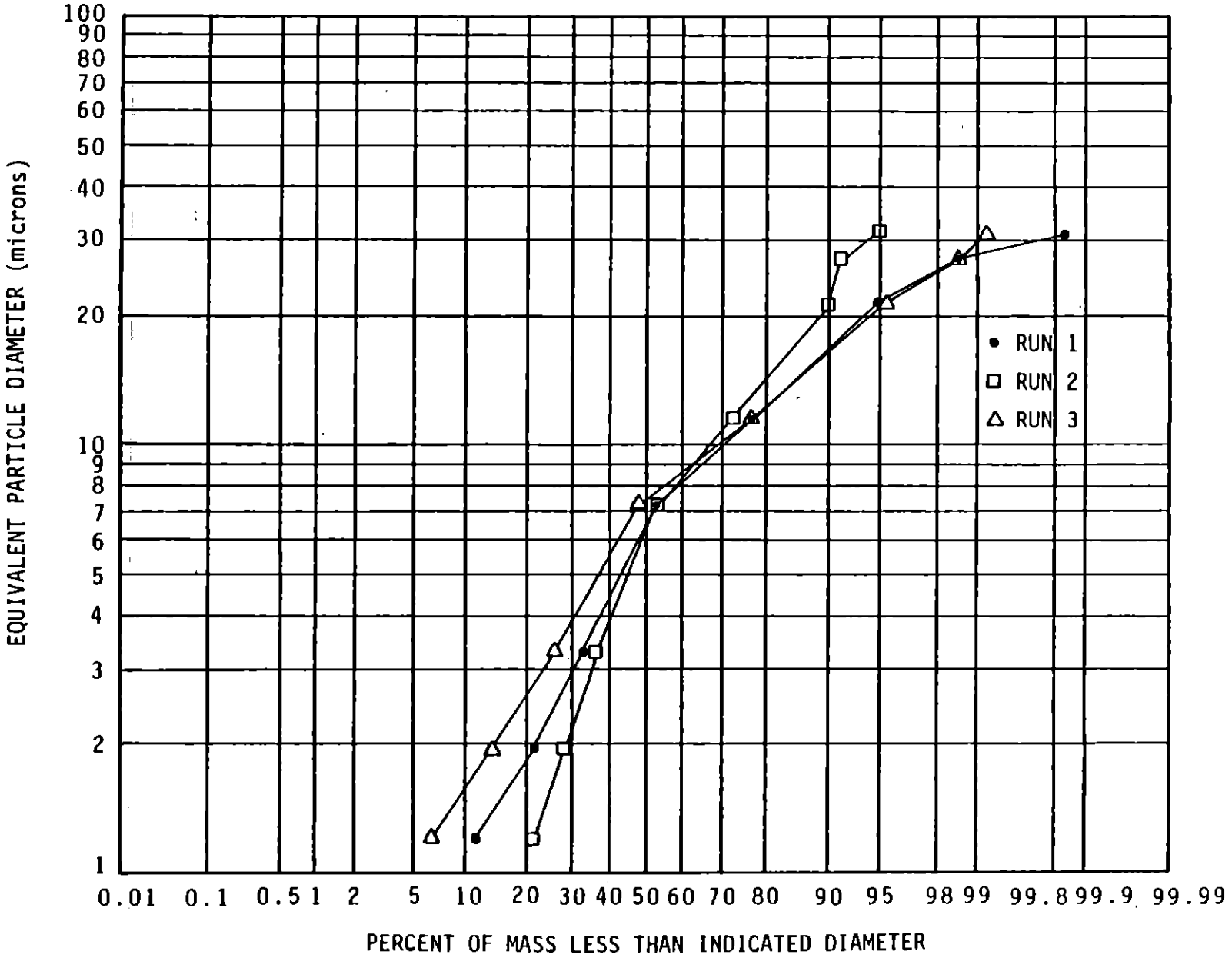


FIGURE 2-2: CUMULATIVE SIZE DISTRIBUTION OF PARTICULATE IN KETTLE CALCINER NO.5 BAGHOUSE INLET DURING BATCH OPERATIONS AT U.S. GYPSUM COMPANY FORT DODGE, IOWA.

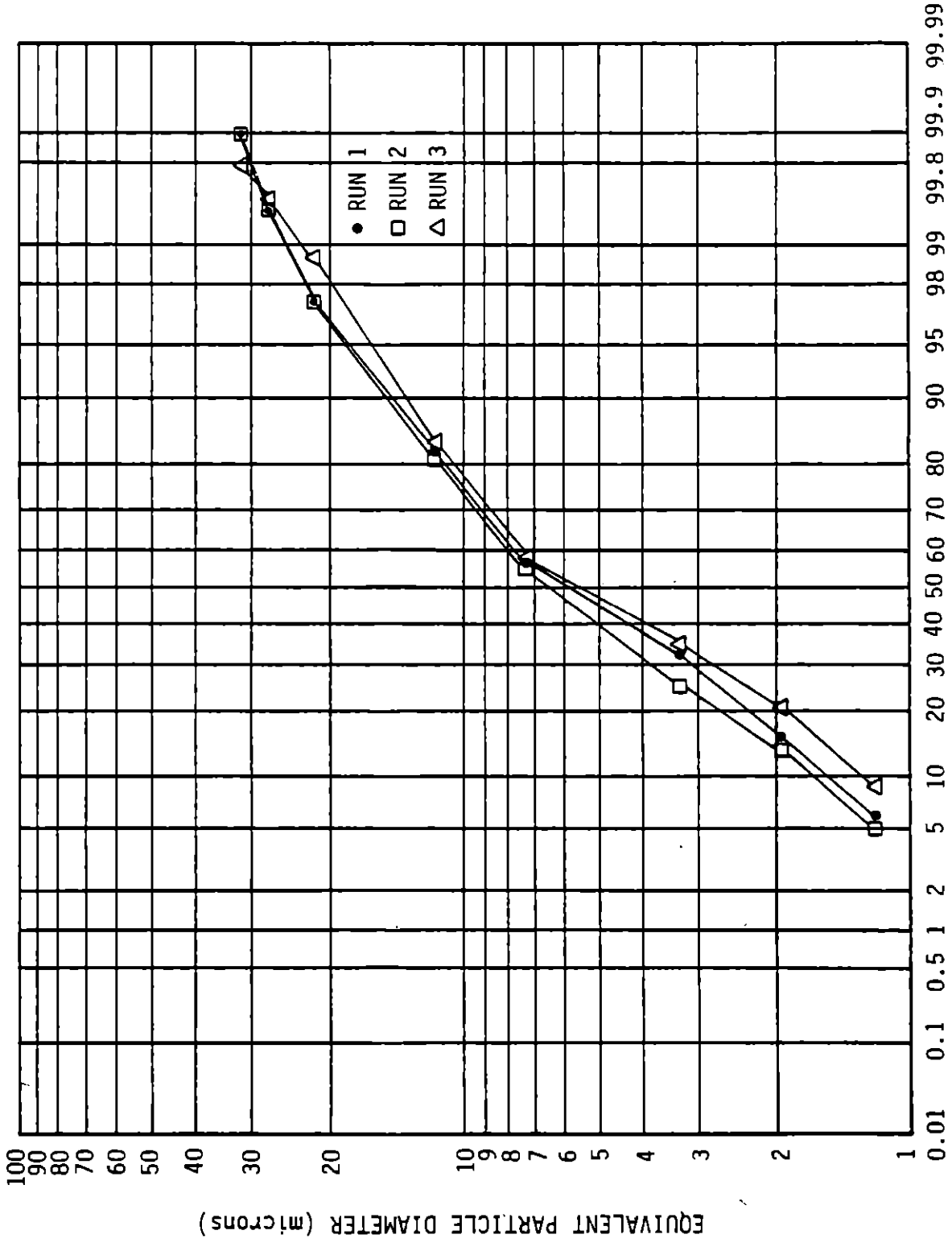


FIGURE 2-3: CUMULATIVE SIZE DISTRIBUTION OF PARTICULATE IN KETTLE CALCINER NO.5 BAGHOUSE INLET DURING CONTINUOUS OPERATIONS AT U.S. GYPSUM FORT DODGE, IOWA.

TABLE 2-7

SUMMARY OF KETTLE CALCINER NO. 5 BAGHOUSE INLET
BAHCO PARTICLE SIZE TEST RESULTS
AT U.S. GYPSUM COMPANY, FORT DODGE, IOWA

Run No.	Test Date	Operation Mode		Equivalent Particle Size Range (microns)								
				<1.20	1.20-1.95	1.95-3.30	3.30-7.15	7.15-11.60	11.60-21.32	21.32-27.00	27.00-31.01	>31.01
1	10-28-80	batch	a	11.6	9.2	12.6	19.7	24.3	17.7	3.5	0.5	0.1
			b	11.6	20.8	33.4	53.1	77.4	95.1	98.6	99.9	100.0
2	10-28-80	batch	a	21.4	6.2	8.7	16.7	19.7	17.2	3.5	1.6	5.0
			b	21.4	27.6	36.3	53.0	72.7	89.9	93.4	95.0	100.0
3	10-29-80	batch	a	6.6	7.3	12.6	21.2	29.3	18.4	3.2	0.6	0.8
			b	6.6	13.9	26.5	47.7	77.0	95.4	98.6	99.2	100.0
4	10-30-80	continuous	a	6.0	9.7	17.4	26.0	24.2	14.4	1.8	0.4	0.1
			b	6.0	15.7	33.1	59.1	83.3	97.7	99.5	99.9	100.0
5	10-30-80	continuous	a	5.1	8.6	11.6	31.7	24.6	15.9	2.0	0.4	0.1
			b	5.1	13.7	25.3	57.0	81.6	97.5	99.5	99.9	100.0
6	10-30-80	continuous	a	8.8	11.8	14.5	22.4	16.7	14.6	0.8	0.2	0.2
			b	8.8	20.6	35.1	57.5	84.2	98.8	99.6	99.8	100.0

a Mass fraction in size range (%)

b Cumulative percent

steam plume). The board end saw baghouse plume was monitored for approximately 5 hours during 1 day, and all 15-second observations were zero. The data for these two baghouse plume observations are shown in Appendix C.

The stucco conveyor baghouse plume was monitored for 3 hours over 2 days. The 6-minute average opacities ranged from zero to 4 percent. These 6-minute averages are shown in Table 2-8 and are plotted in Figure 2-4.

The bagging operation baghouse plume was monitored for approximately 3.5 hours over 3 days during the operation of baggers No. 2 and No. 3. All 15-second observations were zero. These data are shown in Appendix C.

Visible fugitive emissions originating directly from the board end saw were monitored for approximately 3 hours during 1 day. Observations were made by certified visible emission observers following the guidelines of EPA Method 22. Visible emissions occurred during approximately 17 minutes of the monitoring period. These data are shown in Table 2-9.

TABLE 2-8

SIX-MINUTE AVERAGE OPACITIES OF THE
STUCCO CONVEYOR BAGHOUSE PLUME
AT U.S. GYPSUM COMPANY
FORT DODGE, IOWA

Day	6-Minute Time Period	Average Opacity (%)
10-29-80	1400-1405	0
	1406-1411	0
	1412-1417	0
	1418-1423	0
	1424-1429	0
	1430-1435	0
	1436-1441	0
	1442-1447	0
	1448-1453	0
	1454-1459	0
10-30-80	0903-0908	0
	0909-0914	0
	0915-0920	0
	0921-0926	0
	0927-0932	0
	0933-0938	1.0
	0939-0944	0.6
	0945-0950	1.0
	0951-0956	1.0
	0957-1002	0
	1003-1009	0.4
	1009-1014	0.8
	1015-1020	0.8
	1021-1026	0.4
	1027-1032	0.8
	1033-1038	1.9
	1039-1044	1.7
	1045-1050	1.3
	1051-1056	4.0
	1057-1102	1.7

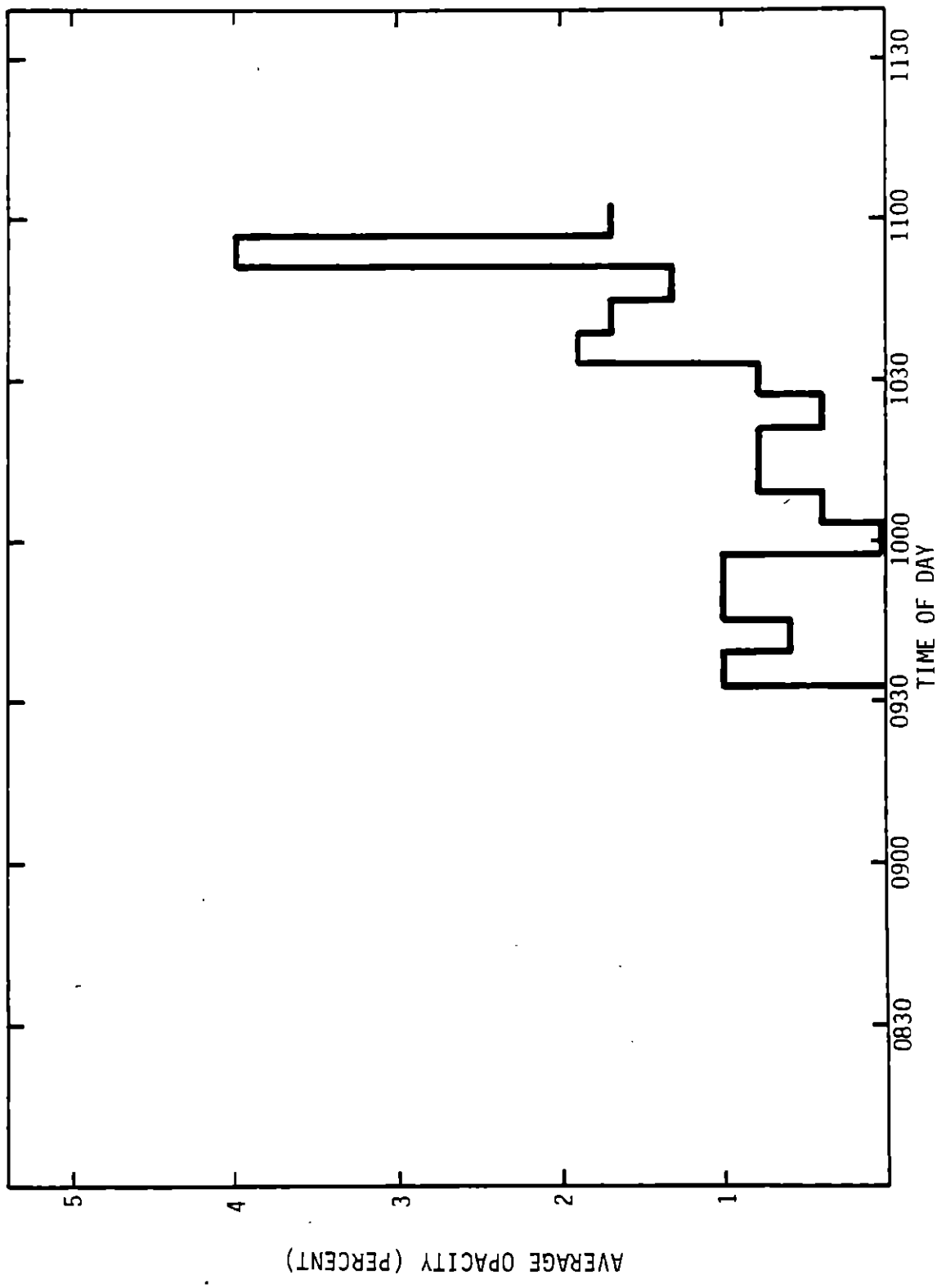


FIGURE 2-4: SIX-MINUTE AVERAGE OPACITY ON OCTOBER 30, 1980 OF STUCCO CONVEYOR BAGHOUSE PLUME AT U.S. GYPSUM COMPANY, FORT DODGE, IOWA.

TABLE 2-9

VISIBLE FUGITIVE EMISSIONS FROM BOARD END SAW
AT U.S. GYPSUM COMPANY, FORT DODGE, IOWA

Date	Observation Start Time	Observation Period (minutes)	Accumulated Emissions Time During Observation Period (minutes: seconds)
10-31-80	1415	20	2:20
	1430	15	1:41.5
	1600	20	3:20
	1620	20	2:57
	1640	20	3:16
	1700	20	1:16.5
	1725	20	0:32.5
	1750	40	1:42.5
	TOTAL	175	17:06

3.0 PROCESS DESCRIPTION AND OPERATIONS

3.1 General Plant Description

The United States Gypsum Company plant at Fort Dodge, Iowa, produces wallboard and plaster products from gypsum ore mined about 1 mile from the plant. A simplified flow diagram for the process used at the Fort Dodge plant is shown in Figure 3-1. Ore stockpiled at the plant is crushed to about 5 cm (2 inches) and then dried to remove surface moisture. The dry ore is further ground to about 90 percent 100 mesh in a grinding mill. The ground crude gypsum, primarily calcium sulfate dihydrate ($CaSO_4 \cdot 2H_2O$), is heated to about 150C (300°F) to remove 75 percent of its water of hydration in a process known as calcining, thus forming calcium sulfate hemihydrate ($CaSO_4 \cdot 1/2\ H_2O$), or stucco. The stucco is mixed with starch, water and other additives to form a slurry. The slurry is spread between two paper sheets and formed into wet wallboard. The wallboard is subsequently dried in a multideck kiln, trimmed to the correct size, and shipped to distributors.

3.2 Process Equipment Description

Kettle Calciner

The calciner tested at the Fort Dodge plant is a kettle calciner that has been modified to operate in both batch or continuous modes. In continuous calcining, as finely ground gypsum (land plaster) is fed to the kettle, hot combustion gases are passed through the flues inside the kettle to provide an indirect transfer of heat to the land plaster. This heating causes the release of chemically-bound water, producing stucco. In batch calcining, the kettle is filled and heated through a cycle to remove this water, producing a stucco more suitable for use as a plaster product. A schematic diagram of the calcining kettle is shown in Figure 3-2.

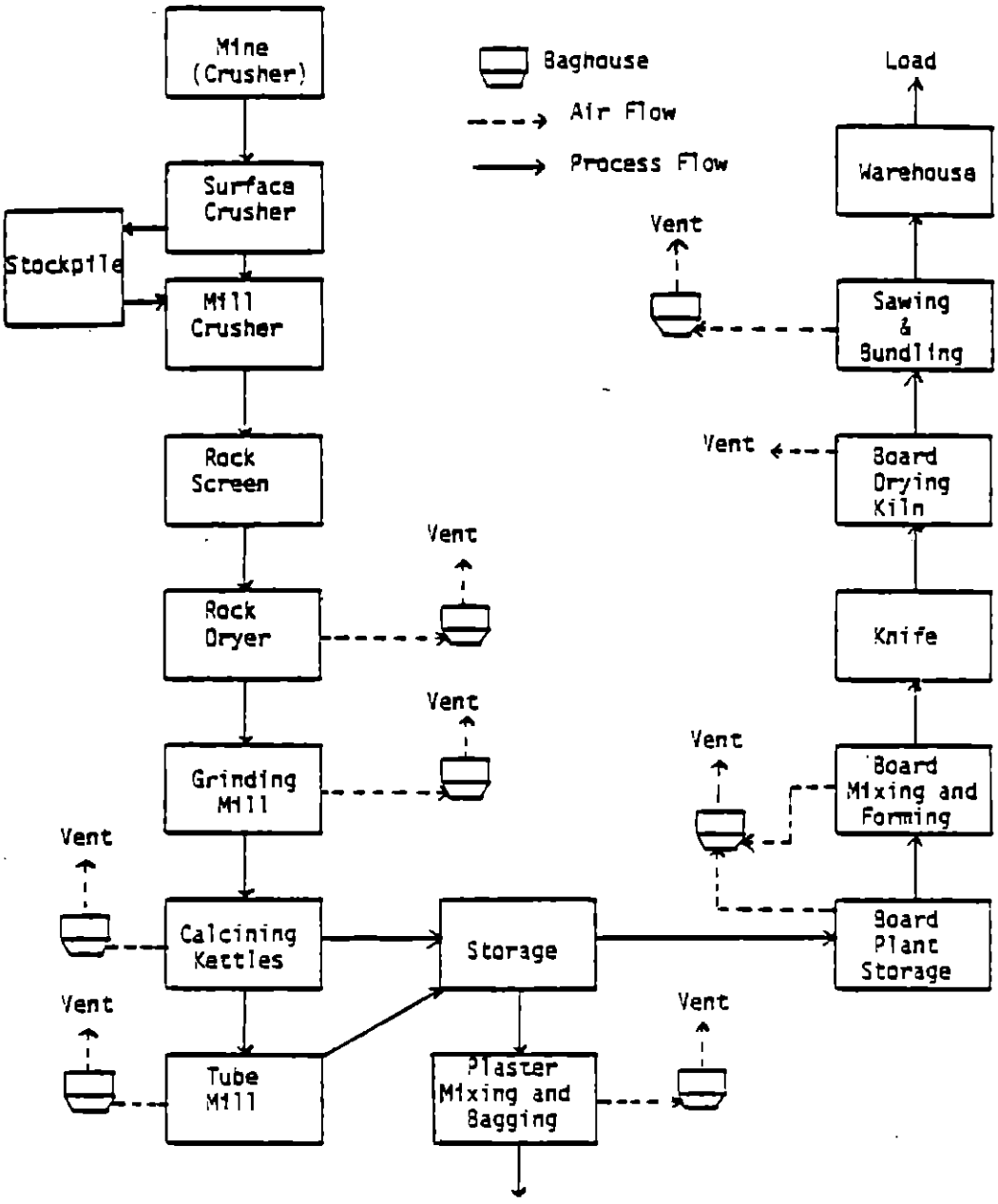


FIGURE 3-1: GYPSUM WALLBOARD PRODUCTION PROCESS AT U.S. GYPSUM COMPANY, FORT DODGE, IOWA.

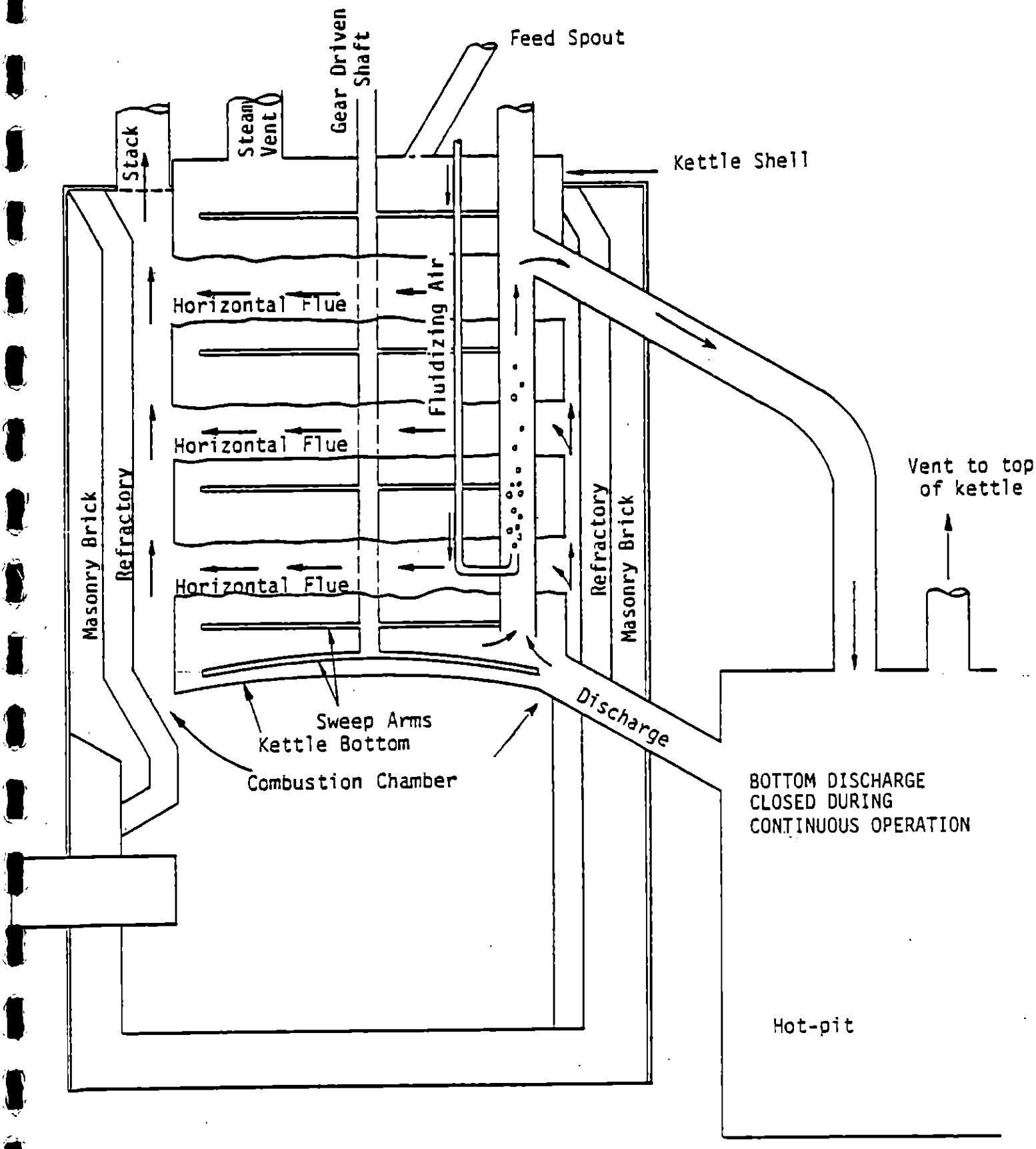


FIGURE 3-2: CALCINING KETTLE AT U.S. GYPSUM COMPANY, FORT DODGE, IOWA.

Land Plaster and Stucco Conveying

The land plaster and stucco conveying system tested at the plant includes 5 land plaster screw conveyors, 2 stucco screw conveyors, and 2 stucco bucket elevators.

Board End Sawing and Paper Scoring

The boardline tested at the Fort Dodge plant is capable of producing approximately 26.6 million square meters (286 million square feet) of 1/2-inch wallboard annually. The board end sawing and paper scoring operations tested on this boardline are typical of those operating in the gypsum industry.

Mixing and Bagging

The plaster mixing and bagging unit tested at the Fort Dodge plant is typical of those found throughout the gypsum industry. The mixer capacity is 1,500 pounds per batch.

3.3 Emission Controls

Baghouse dust collectors are used at the Fort Dodge plant to control gypsum particulate emissions. Dust-laden gases exiting the kettle calciner are vented to a pulse-jet baghouse. Emissions from conveyors and bucket elevators are vented to baghouse dust collectors. Boardline emissions from paper scoring and board end sawing are also controlled by baghouses. Emissions from each plaster mixing and bagging operation are vented to a single, separate baghouse.

Design and operating parameters for the baghouses tested at the Fort Dodge plant are given in Table 3-1. The bag replacement schedule and history for the dust collectors tested are shown in Table 3-2.

TABLE 3-1

EMISSION CONTROL EQUIPMENT PARAMETERS
AT U.S. GYPSUM COMPANY, FORT DODGE, IOWA

Process Unit Name	Baghouse Manufacturer (Cleaning Type)	Number of Bags	Bag Dimensions (diam x length in inches)	Cloth Area ($ft.^2$)	Fabric Type	Design Air Flow (ACFM)	Design Air to Cloth Ratio (feet/minute)	Duration of Cleaning Cycle (sec)	Frequency of cleaning[a]	Pressure of pulse (psig)
Batch and Continuous Kettle Calciner	Flex Kleen (reverse pulse)	80	6 x 60	628	Nomex	4,000	6.4:1	0.1	4.5 sec	105
Board End Sawing and Paper Scoring	Pangborn (shaker)	288[b]	6 x 50	1,872[b]	Cotton	5,000	2.7:1	60	24 min	N/A
Mixing and Bagging	Pangborn (shaker)	210	19 x 48	4,178	Cotton	4,000	1:1	180	60 min	N/A
Land Plaster and Stucco Transfer	Flex Kleen (reverse pulse)	80	6 x 60	628	Dacron	4,000	6.4:1	0.1	9.6 sec	90

[a] Frequency at which one row of bags is pulsed.

[b] This baghouse has two compartments.

TABLE 3-2

BAGHOUSE BAG REPLACEMENT SCHEDULE
AT U.S. GYPSUM COMPANY, FORT DODGE, IOWA

Process Unit Name	Last Date of Bag Replacement	Estimated Normal Replacement Frequency (months)
Kettle Calciner	9-10-80	6
Board End Sawing and Paper Scoring	10-6-80	4
Land Plaster and Stucco Conveying	9-25-80	12
Mixing and Bagging	unknown	36

3.4 Process Conditions During the Emission Tests

While all process equipment operated normally during the emission testing, the emission control equipment on the calciner operated at less than peak performance during the tests. The operating conditions of the process and emission control equipment are discussed in this section.

Kettle Calciner

During emission testing of the kettle calciner, full capacity operation was maintained, with production at 11.8 Mg (13 tons) of stucco for each batch and at 10 Mg/hr (11 TPH) of stucco when operated continuously. Kettle production rates were supplied by plant personnel and were based on previous kettle production records. The length of each batch cycle was approximately 2 hours and 40 minutes which is normal for the kettle tested.

The kettle was operated normally during all particulate sampling runs. Process data collected during batch kettle testing are shown in Table 3-3. Process data collected during continuous kettle testing are shown in Table 3-4. Batch test Run 3 was initially performed on October 29, 1980. Because of anisokinetic sampling conditions the outlet portion of this run was repeated on October 31, 1980. The outlet portion of continuous test Run 4 was repeated at the conclusion of the other continuous test runs on October 30, 1980, also because of anisokinetic sampling conditions.

During the calciner testing, the kettle was being fired with natural gas. The average heat use of the unit during continuous operation was 0.9 kJ/g (0.8 million Btu/ton) and was 1.2 kJ/g (1.0 million Btu/ton) during batch operation. The temperature of the kettle is varied throughout a batch kettle cycle. Continuous temperature records for two of the batch test runs are shown in Figure 3-3.

TABLE 3-3

PROCESS DATA FROM BATCH KETTLE CALCINER NO. 5
AT U.S. GYPSUM COMPANY, FORT DODGE, IOWA

Test Run	Date	Local Time	Flue Gas[a] Temperature (°F)	Stucco Temperature East (°F)	Stucco Temperature West (°F)	Fire Box Draft[b] (inches of water)	Fabric Filter Pressure Drop (inches of water)
1	10-28-80	1350	455	235	227	0.39	1.1
		1357	455	235	230	0.39	1.1
		1407	455	238	232	0.39	1.1
		1413	460	242	237	0.34	1.2
		1441	500	330	320	0.30	1.2
		1445		Kettle Dumped			
		1452	520	250	235	0.28	1.4
		1513	510	245	245	0.31	1.4
		1525		Kettle Full			
		1527	500	245	238	0.31	1.4
		1533	495	245	233	--	1.2
		1609	490	235	223	0.32	1.2
		1620	490	235	226	0.32	1.1
		1632	490	235	228	0.36	1.1
		1639	485	235	228	0.36	1.1

[a] Measured at point where flue gas leaves kettle.

[b] Static pressure at point where process gas leaves kettle.

TABLE 3-3 (Continued)

PROCESS DATA FROM BATCH KETTLE CALCINER NO. 5
AT U.S. GYPSUM COMPANY, FORT DODGE, IOWA

Test Run	Date	Local Time	Flue Gas[a] Temperature (°F)	Stucco Temperature East (°F)	Stucco Temperature West (°F)	Fire Box Draft[b] (inches of water)	Fabric Filter Pressure Drop (inches of water)
2	10-28-80	1718	480	295	274	0.36	1.2
		1740		Kettle Dumped			
		1740	500	365	350	0.33	1.3
		1757	500	245	230	0.36	1.4
		1810		Kettle Full			
		1817	480	240	236	0.36	1.3
		1827	470	245	233	0.36	1.3
		1837	470	240	227	0.37	1.3
		1904	470	235	223	0.38	1.1
		1926	470	235	223	0.37	1.0
		1938	470	235	226	0.37	1.0
		1951	470	240	230	0.36	1.0
		2003	480	245	237	0.32	1.0
		2008	490	250	243	0.31	1.0
		2023	550	295	285	0.30	1.1

[a] Measured at point where flue gas leaves kettle.

[b] Static pressure at point where process gas leaves kettle.

TABLE 3-3 (Continued)

PROCESS DATA FROM BATCH KETTLE CALCINER NO. 5
AT U.S. GYPSUM COMPANY, FORT DODGE, IOWA

Test Run	Date	Local Time	Flue Gas[a] Temperature (°F)	Stucco Temperature East (°F)	Stucco Temperature West (°F)	Fire Box Draft[b] (inches of water)	Fabric Filter Pressure Drop (inches of water)
3R*	10-31-80	0932	495	245	237	0.36	1.4
		0935		Kettle Full			
		1016	485	245	235	0.37	1.3
		1026	483	245	234	0.36	1.3
		1127	490	290	270	0.36	1.3
		1140		Kettle Dumped			
		1143	510	340	287	0.35	1.4
		1154	515	250	241	0.36	1.5
		1209	500	246	245	0.38	1.5
		1215		Kettle Full			
		1228	490	245	230	0.37	1.3

* Repeat of outlet emission test only

[a] Measured at point where flue gas leaves kettle.

[b] Static pressure at point where process gas leaves kettle.

TABLE 3-4

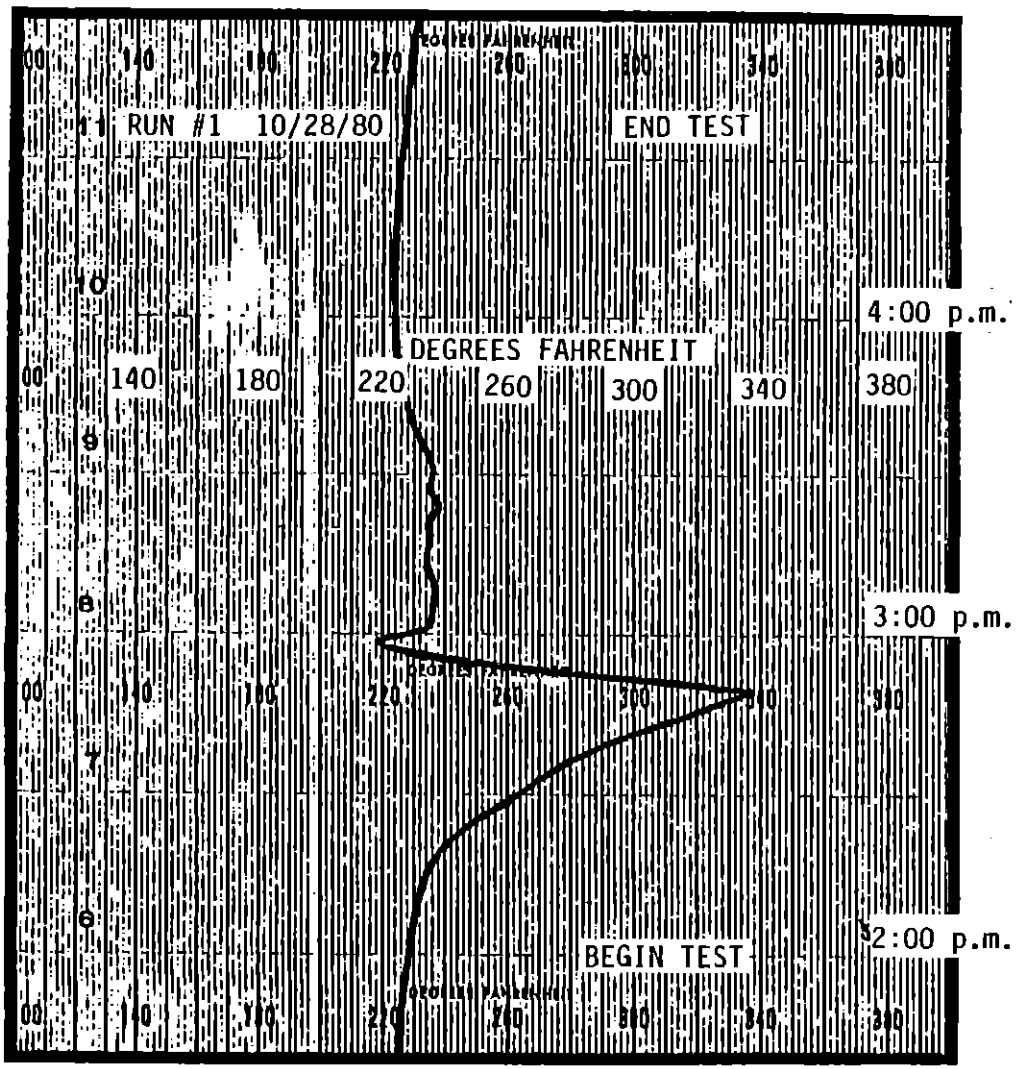
PROCESS DATA FROM CONTINUOUS KETTLE CALCINER NO. 5
AT U.S. GYPSUM COMPANY, FORT, DODGE, IOWA

Test Run	Date	Local Time	Flue Gas[a] Temperature (°F)	Stucco Temperature East (°F)	Stucco Temperature West (°F)	Fire Box Draft[b] (inches of water)	Fabric Filter Pressure Drop (inches of water)
4	10-30-80	0845	620	327	310	0.19	1.2
		0903	620	327	310	0.18	1.2
		0929	620	327	310	0.18	1.2
		1012	620	327	310	--	---
		1033	620	327	310	0.18	1.2
		1123	620	327	310	0.19	1.3
5		1230	620	327	310	0.19	1.2
		1251	620	327	310	0.19	1.2
		1330	620	327	310	0.19	1.3
		1348	620	325	-	0.19	1.2
		1400	620	325	-	0.19	1.3
6		1445	618	321	309	0.19	1.3
		1457	618	321	309	0.19	1.3
		1538	618	321	309	0.19	1.3
		1615	618	322	309	0.19	1.3
4R*		1623	618	325	309	0.19	1.3
		1705		Process fuel rate increased slightly			
		1712	620	325	309	0.19	1.3
		1724	625	325	309	0.19	1.3
		1743	625	325	309	0.19	1.4
		1755	628	325	309	0.18	1.4
		1809	630	325	309	0.18	1.4
		1820	628	326	309	0.18	1.4

* Repeat of outlet emission test only.

[a] Measured at point where flue gas leaves kettle.

[b] Static pressure at point where process gas leaves kettle.



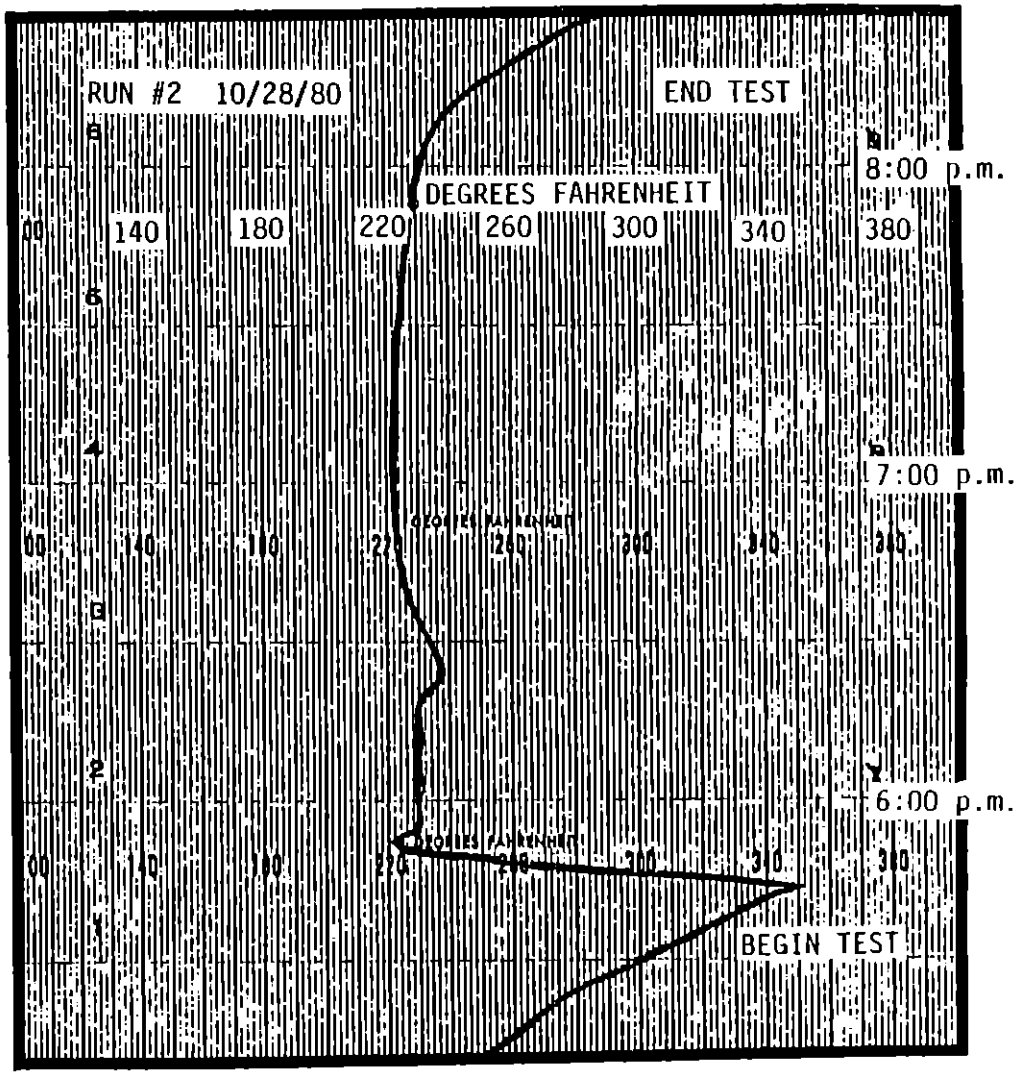


FIGURE 3-3: WEST STUCCO DUST TEMPERATURE DURING BATCH KETTLE TEST - RUNS 1 AND 2 AT U.S. GYPSUM COMPANY, FORT DODGE, IOWA.

During batch kettle testing, condensation occurred in the baghouse dust collector. The condensation was evident through plugging of the sampling probes on inlet sampling with a gypsum "paste". At the completion of the measurement program, plant maintenance personnel inspected the baghouse and found the following:

1. All of the filter bags has become blinded with gypsum and required laundering.
2. Three of the "cups" to which the bags were attached required recaulking.
3. The rachet and clamps on two filter bags had become sufficiently loosened to allow some inlet gases to pass through the baghouse untreated.

The existence of these three problems, in spite of the kettle operating in a normal manner, indicates that the baghouse was not operating at peak performance during the tests.

Uncontrolled emissions from batch kettle calciners vary throughout the batch cycle, with highest emissions occuring during loading of the kettle, immediately after loading, and during unloading of the kettle. Due to the sampling probe pasting problem mentioned above, the sampling time on the inlet to the collector during batch testing was reduced from 60 minutes to 20 to 40 minutes. Since the normal batch cycle is 2 hours and 40 minutes, the inlet batch kettle sampling did not characterize the full-batch cycle. Therefore, these results are not representative of uncontrolled batch kettle calciner emissions. Results of inlet testing during continuous kettle operation, however, are representative of uncontrolled emissions from a continuous kettle calciner.

During the batch and continuous kettle tests, an undetached steam plume existed at the outlet of the baghouse stack. Water vapor in the exit gases condensed on contact with the cool ambient air (30 to 40^{o}F).

Land Plaster and Stucco Conveying

The transfer system was operating at normal capacity during the emission testing, transferring approximately 41 Mg (45 tons) of land plaster and stucco each hour.

Board End Saw and Paper Scoring

During the board end saw testing, the boardline was running regular 1/2-inch board, 12 feet in length. The line was operating at a rate of 143 feet a minute. Emissions from both the board end sawing and paper scoring operations on this boardline were ducted to the baghouse that was tested. The baghouse operated normally during the testing.

Mixing and Bagging

The plaster mixing and bagging operation was operating at full capacity during the testing, producing about 250 80-pound bags of plaster each hour (10 tons an hour).

4.0 LOCATION OF SAMPLING POINTS

This section presents descriptions of the sampling locations used during the emission testing program conducted at the U.S. Gypsum Company gypsum wallboard plant in Fort Dodge, Iowa, in October 1980. An overhead view of the plant site and pertinent process facilities is shown in Figure 4-1.

4.1 Kettle Calciner No. 5 Baghouse

4.1.1 Baghouse Inlet

The kettle calciner No. 5 baghouse inlet sampling location was located in a 13 1/2-inch i.d. section of metal duct inclined approximately 20 degrees from the vertical. A schematic diagram of this inlet is shown in Figure 4-2. Two 3-inch nipples were positioned 90 degrees apart in a plane perpendicular to the duct and were located 7 feet 9 inches (6.9 duct diameters) downstream from a bend in the duct and 18 inches (1.3 duct diameters) upstream from another bend. This sampling location did not meet the eight-and-two diameters cri- teria of EPA Method 1, so 10 sampling points were used on each of the two traverse axes, for a total of 20 sampling points.

4.1.2 Baghouse Outlet

The kettle calciner No. 5 baghouse outlet sampling location was located in a 11-inch ID vertical section of metal duct, as shown in Figure 4-3. Two 3-inch nipples were positioned 90 degrees apart in a horizontal plane and were located 80 inches (7.3 diameters) downstream from the fan exit elbow and 52 inches (4.7 diameters) upstream from the top of the stack. This sampling location did not meet the eight-and-two diameters criteria of Method 1, so 8 sampling points were used on each of the two traverse axes, for a total of 16 sampling points.

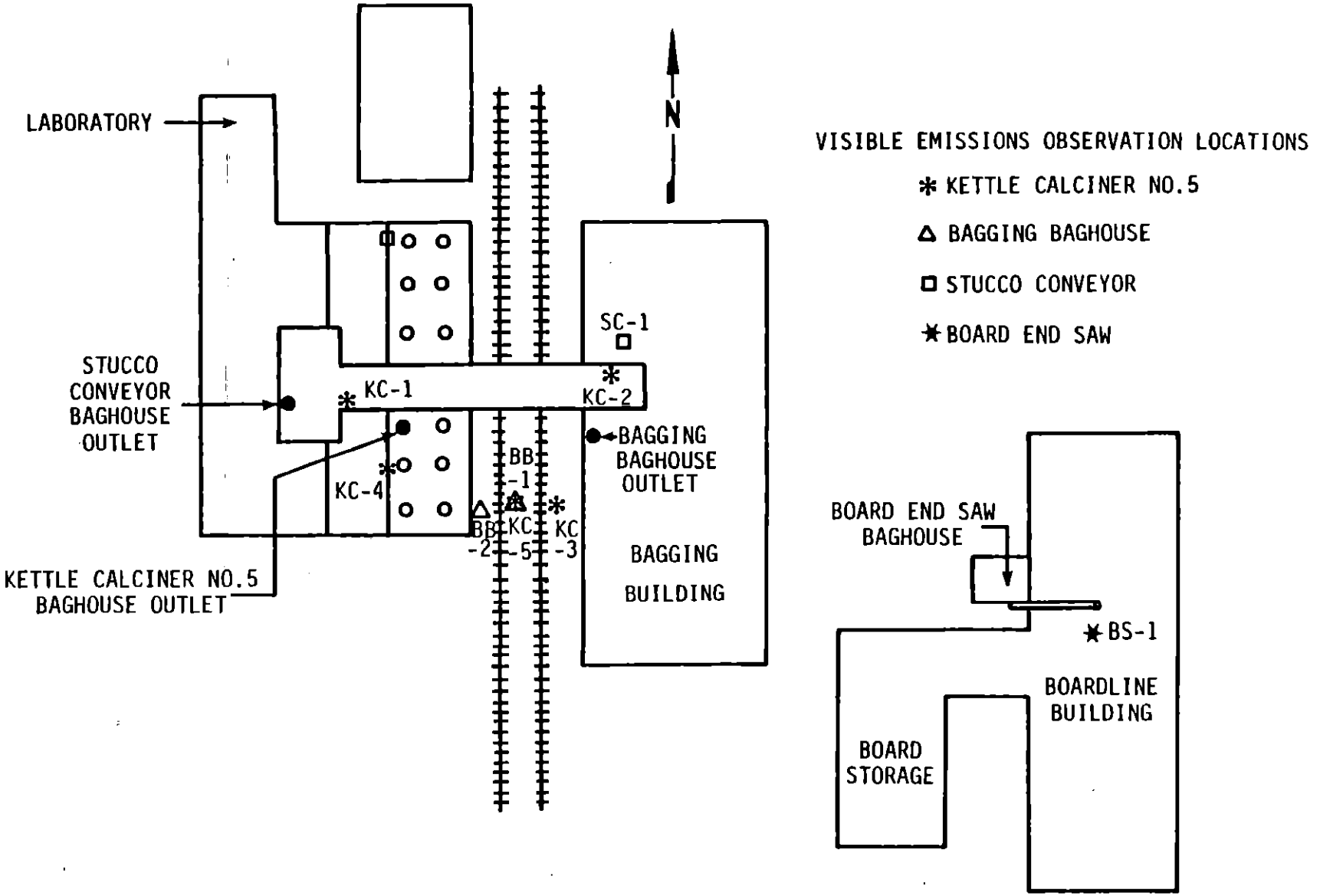
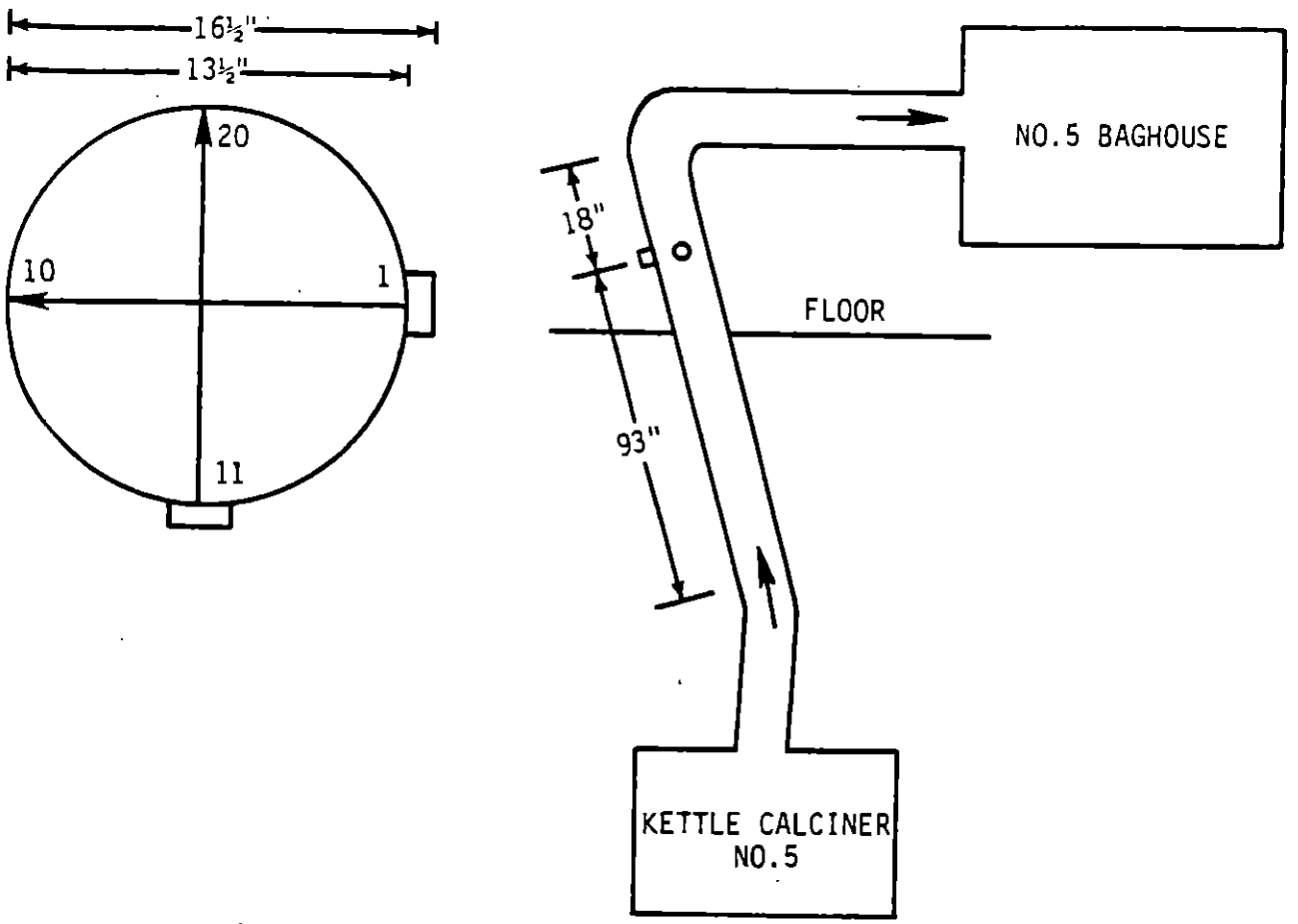
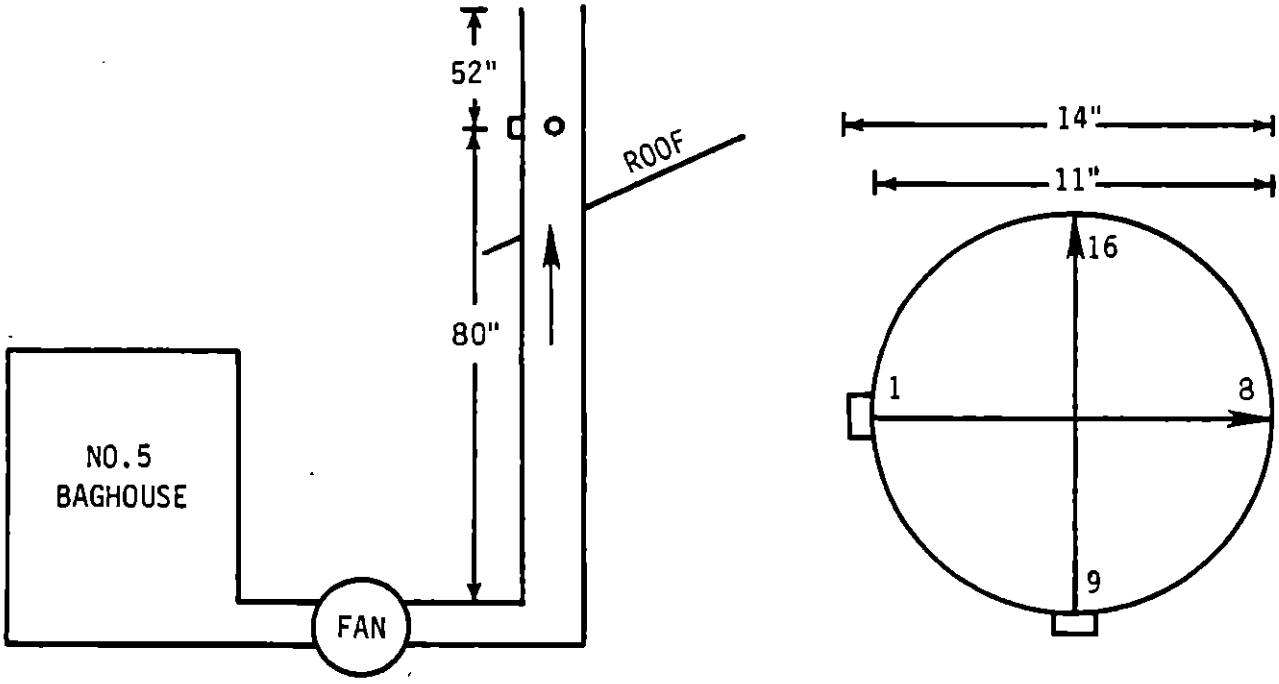


FIGURE 4-1: PLANT LAYOUT AT U.S. GYPSUM COMPANY
FORT DODGE, IOWA



TRAVERSE POINT LOCATIONS	
TRAVERSE POINT NUMBER	TRAVERSE POINT LOCATION FROM DUCT WALL (INCHES)
1	0.5
2	1.1
3	2.0
4	3.1
5	4.6
6	8.9
7	10.5
8	11.5
9	12.4
10	13.0

FIGURE 4-2: KETTLE CALCINER NO.5 BAGHOUSE INLET SAMPLING LOCATION AT U.S. GYPSUM COMPANY FORT DODGE, IOWA



TRAVERSE POINT LOCATIONS	
TRAVERSE POINT NUMBER	TRAVERSE POINT LOCATION FROM DUCT WALL (INCHES)
1	0.5
2	1.2
3	2.1
4	3.6
5	7.4
6	8.9
7	9.8
8	10.5

FIGURE 4-3: KETTLE CALCINER NO.5 BAGHOUSE OUTLET SAMPLING LOCATION AT U.S. GYPSUM COMPANY FORT DODGE, IOWA

4.2 Board End Saw Baghouse Outlet

The board end saw baghouse outlet sampling location was located in an 11-1/2 inch ID horizontal section of sheet metal duct, as shown in Figure 4-4. Two 3-inch nipples were positioned 90 degrees apart in a vertical plane and were located more than eight duct diameters downstream from an elbow and more than 2 duct diameters from the discharge end of the duct. Six sampling points were used on each traverse axis for a total of 12 sampling points, in accordance with EPA Method 1.

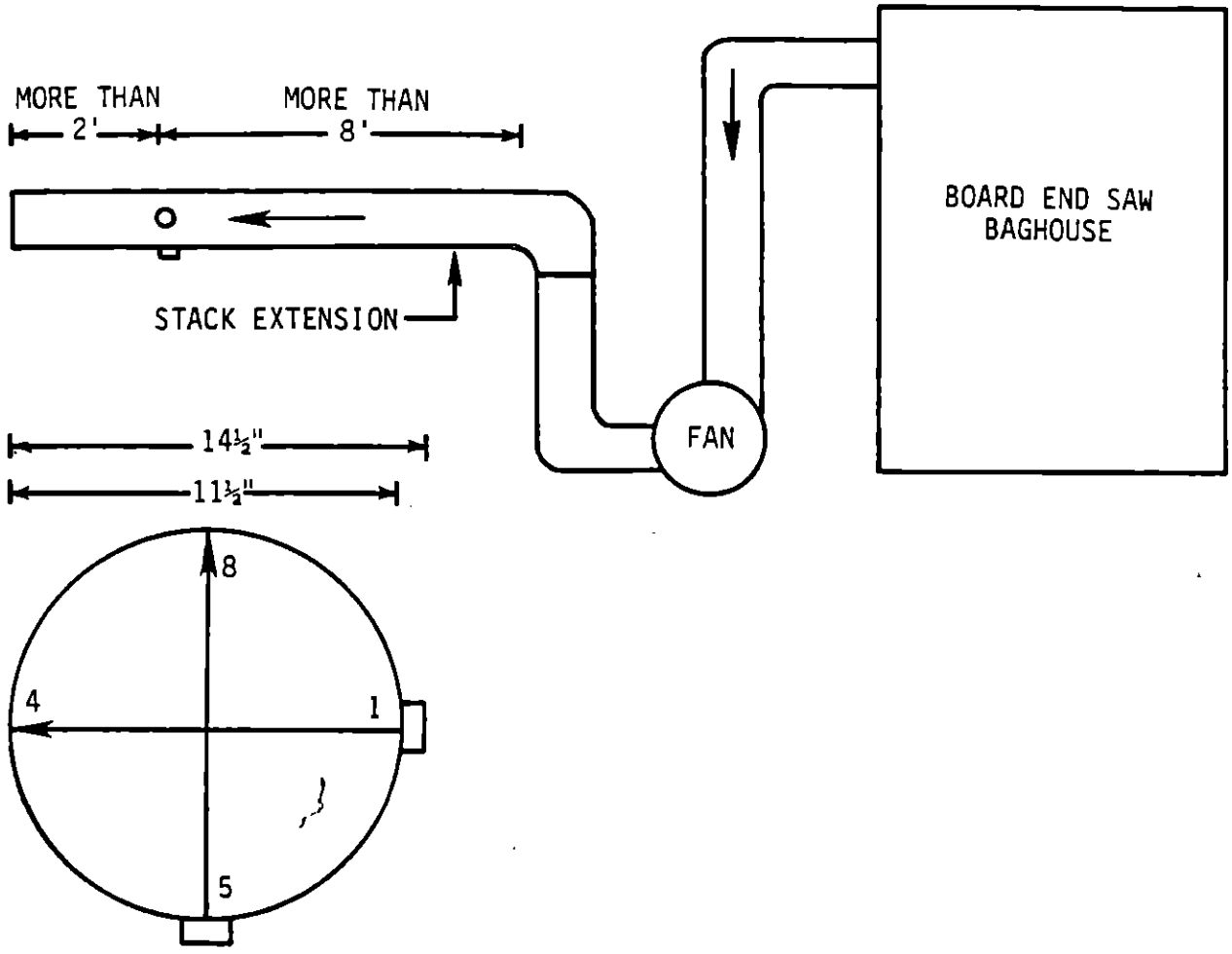
One particle size test was performed at this location. The sample was extracted from a single point at the centroid of the duct using an Andersen cascade impactor with a Method 5 train.

4.3 Visible Emission Observation Locations

The kettle calciner No. 5 baghouse plume was observed from five locations on the ground and on the roofs of buildings around the baghouse. The board end saw baghouse plume was observed from one location atop the boardline building roof. The stucco conveyor baghouse plume was observed from two locations atop buildings near the baghouse. The bagging operation baghouse plume was observed from two ground-level locations.

All observation locations were chosen to conform to the guidelines of EPA Method 9. All locations are shown in Figure 4-1 and are described in Table 4-1.

Fugitive emission observations at the board end saw were made from a position 30 feet from the saw. This location conformed to the guidelines of EPA Method 22.



TRAVERSE POINT LOCATIONS	
TRAVERSE POINT NUMBER	TRAVERSE POINT LOCATION FROM DUCT WALL (INCHES)
1	0.8
2	2.9
3	8.6
4	10.7

FIGURE 4-4: BOARD END SAW BAGHOUSE OUTLET SAMPLING LOCATION AT U.S. GYPSUM COMPANY FORT DODGE, IOWA

TABLE 4-1

VISIBLE EMISSION OBSERVATION LOCATIONS
AT U.S. GYPSUM COMPANY
FORT DODGE, IOWA

Observor Location	Direction From Discharge Point	Distance From Discharge Point (feet)	Height Above Ground (feet)	Discharge Description
KC-1	NW	25	62	Kettle Calciner #5 Baghouse Outlet
KC-2	NE	100	57	
KC-3	SE	200	0	
KC-4	SW	23	60	
KC-5	SE	60	0	
BB-1	SW	60	0	Bagging Baghouse Outlet
BB-2	SW	75	0	
SC-1	NE	100	100	Stucco Conveyor Baghouse Outlet
SC-2	NNE	30	70	
BS-1	S	20	30	Board End Saw Baghouse Outlet

5.0 SAMPLING AND ANALYSIS METHODS

This section presents general descriptions of sampling and analysis procedures employed during the emissions testing program conducted at the U.S. Gypsum Company gypsum wallboard plant in Fort Dodge, Iowa, during October 1980. Details of sampling and analysis procedures are contained in the appendices.

5.1 EPA Reference Methods Used

The following EPA Reference Methods were used during this emission testing program. These methods are taken from "Standards of Performance for New Stationary Sources", Appendix A, Federal Register, Volume 42, (No. 160), Thursday, August 18, 1977, pp 41755 ff.

- Method 1 - Sample and Velocity Traverses for Stationary Sources

  This method specifies the number and location of sampling points within a duct, taking into account duct size and shape and local flow disturbances.

- Method 2 - Determination of Stack Gas Velocity and Volumetric Flow Rate

  This method specifies the measurement of gas velocity and flow rate using a pitot tube, manometer and temperature sensor. The physical dimensions of the pitot tube and its spatial relationship to the temperature sensor and any sample probe are also specified.

- Method 4 - Determination of Moisture Content in Stack Gases

  This method describes the extraction of a gas sample from a stack and the removal and measurement of the moisture in that sample by condensation impingers. The assembly and operation of the required sampling train is specified.

- Method 5 - Determination of Particulate Emissions from Stationary Sources

  This method specifies the isokinetic sampling of particulate matter from a gas stream using techniques introduced in the above three methods. Sample collection and recovery, sampling train cleaning and calibration, and gas stream flow rate calculation procedures are specified.

- Method 9 - Visual Determination of the Opacity of Emissions from Stationary Sources

  Certified personnel conducted visual tests to determine plume opacity in accordance with the guidelines of EPA Method 9. (See Appendix C.2).

- Method 22 - Visual Determination of Fugitive Emissions from Material Processing Sources

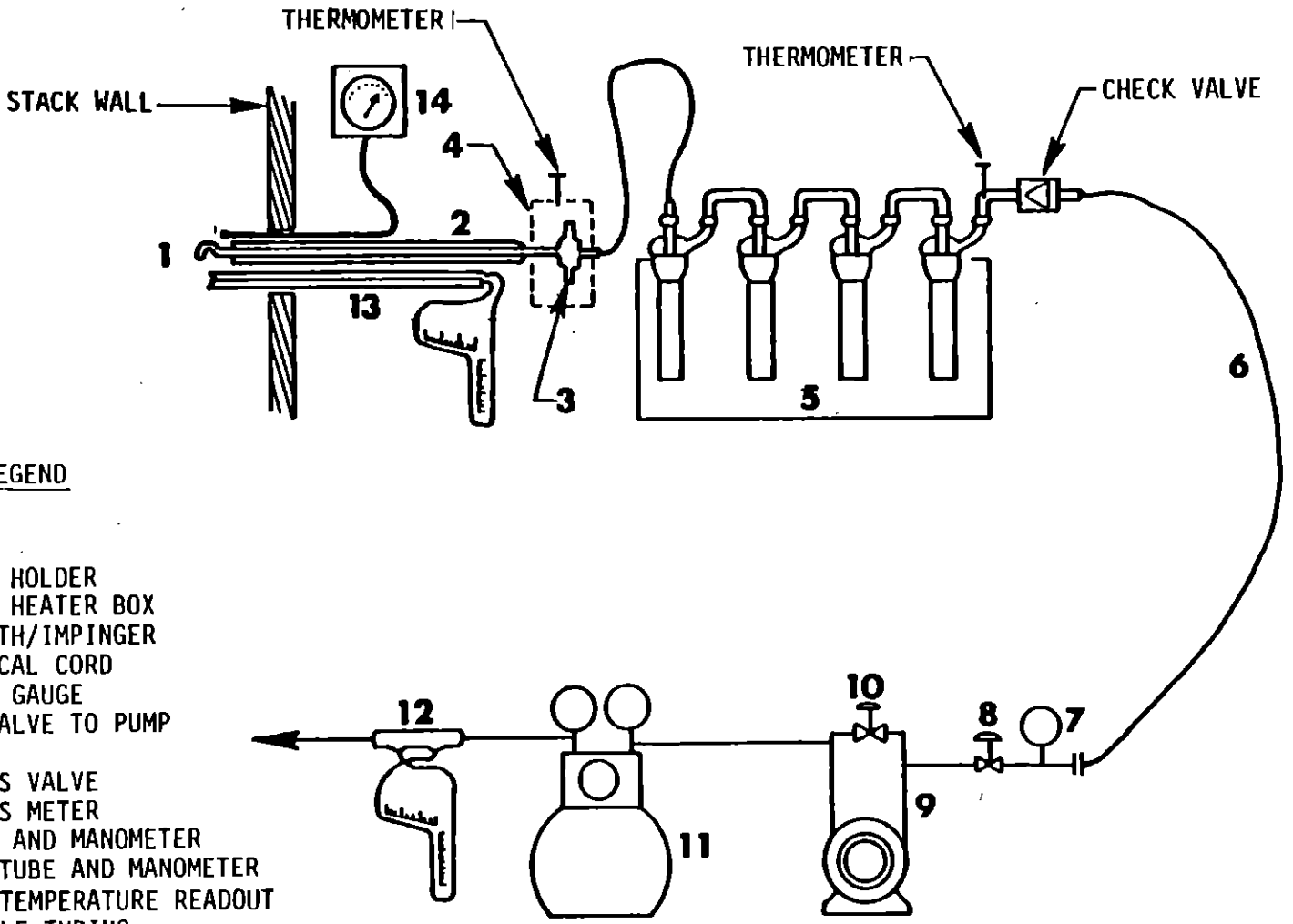
  The frequency of occurrence of fugitive emissions was determined in accordance with the guidelines of EPA Method 22. (See Appendix C.2).

5.2 Particulate Emissions Sampling and Analysis

5.2.1 Sampling Methods

Particulate emissions from the kettle calciner No. 5 baghouse inlet and outlet and the board end saw baghouse outlet were sampled at points located in accordance with EPA Method 1. Duct gas velocities were measured using S-type pitot tubes constructed and calibrated in accordance with EPA Method 2.

The sampling train used on this program is shown in Figure 5-1 and is a modification of the particulate sampling train specified in EPA Method 5. The modification consists of the addition of a flexible line between the heated filter and the impingers. The sampling train consisted of a nozzle, probe, heated filter holder, four impingers, vacuum pump, dry gas meter, and an orifice flow meter. The nozzle was stainless steel and of buttonhook shape. The nozzle was connected to a 5/8-inch stainless steel glass-lined probe wrapped with nichrome heating wire and jacketed. Following the probe, the gas stream passed through a heated preweighed 4 1/2-inch glass-fiber filter and then into the ice bath/impinger system. The impinger system consisted of four impingers in series. The first two impingers each contained 100 milliliters of deionized, distilled water. The third impinger was empty, and the fourth impinger contained 200 grams of indicating silica gel. Leaving the last impinger, the sample stream flowed through flexible tubing, a vacuum gauge,



LEGEND

1 - NOZZLE
2 - PROBE
3 - FILTER HOLDER
4 - FILTER HEATER BOX
5 - ICE BATH/IMPINGER
6 - UMBILICAL CORD
7 - VACUUM GAUGE
8 - MAIN VALVE TO PUMP
9 - PUMP
10 - BY-PASS VALVE
11 - DRY GAS METER
12 - ORFICE AND MANOMETER
13 - PITOT TUBE AND MANOMETER
14 - STACK TEMPERATURE READOUT
15 - FLEXABLE TUBING

FIGURE 5-1: MODIFIED EPA PARTICULATE SAMPLING TRAIN
(AUGUST 18, 1977 FEDERAL REGISTER)

needle valve, pump and a dry gas meter. A calibrated orifice and inclined manometer completed the train. The stack velocity pressure was measured with a pitot tube and inclined manometer. Stack temperature was monitored with a thermocouple attached to the probe and connected to a potentiometer. A nomograph was used to determine the orifice pressure drop required for any pitot velocity pressure and stack temperature in order to maintain isokinetic sampling conditions.

Test data recorded at each sampling point included test time, sampling duration at each traverse point, pitot pressure, stack temperature, dry gas meter volume and inlet-outlet temperature, probe temperature, and orifice pressure drop.

5.2.2 Sample Recovery and Preparation

At the completion of each test run, the sampling train was leak-checked. Samples were recovered and placed in containers as follows:

- o Container No. 1: Filter from the filter holder.
- o Container No. 2: Acetone wash of the nozzle, probe and front half of filter holder.
- o Container No. 3: Silica gel from the fourth impinger.

The volume of the contents of the first three impingers was measured for moisture gain and then the contents were discarded.

5.2.3 Sample Analysis

The sample containers were returned to the TRC laboratory and were analyzed as follows:

- Container No. 1: The filter and any loose material in the sample container were desiccated and weighed to a constant weight.

- Container No. 2: The acetone washings were transferred to a tared beaker and evaporated to dryness at ambient temperature and pressure. The material that remained was then desiccated and weighed to a constant weight.

- Container No. 3: The silica gel was weighed for moisture gain.

A sample of the acetone used to wash the probe and nozzle was also returned from the field. The volume of this acetone blank was measured and the blank was then evaporated to dryness, desiccated and weighed.

5.3 Sampling and Analysis Problems During Particulate Emission Tests

The primary problem encountered at the No. 5 kettle calciner baghouse was due to variation in stack gas moisture content during the batch cycle. Because of changes in the rate of heating and length of cooking time of each cycle, the total amount of moisture collected during the test run varied. The variation in moisture collected often resulted in anisokinetic sampling conditions because nomograph settings were based either on moisture content measured in previous runs or on preliminary moisture tests.

Outlet test Runs 3 (batch) and 4 (continuous) were repeated because of anisokinetic sampling conditions. Batch inlet Run 3 was adversely affected by the increased moisture content due to a shortened cooking time but Radian decided that this test should not be repeated. The high particulate concentrations at the inlet necessitated changing the filter between ports. Probe and nozzle plugging problems were encountered during all batch inlet tests. To reduce the effects of the high loadings the sampling times were reduced and, within the constraints of isokinetic sampling considerations, the largest nozzles possible were used for these inlet tests. Sampling could not

be performed at some traverse end points because of nozzle plugging and heavy particulate buildup on the stack walls. The moisture content and particulate loadings prevented doing in-stack particle size tests at the inlet as originally planned. Instead the desiccated filter particulate catches were analyzed with a Bahco centrifugal separator.

The moisture content (60 percent) at the kettle calciner No. 5 baghouse inlet during the continuous production mode was in excess of the nomograph maximum value of 50 percent. It was therefore necessary to use the isokinetic rate equation to adjust sampling rates to isokinetic values instead of using the nomograph.

No problems were encountered during the board end saw baghouse outlet tests.

5.4 Particle Size Distribution Tests

5.4.1 Board End Saw Baghouse Outlet

One particle size test was performed at the board end saw baghouse outlet using an Andersen Mark II cascade impactor with a preimpactor. The impactor was operated in its in-stack mode in accordance with the manufacturer's procedures. A schematic diagram of the impactor sampling train is shown in Figure 5-2. Because of the low moisture content in this outlet (1 percent), only one impinger with silica gel was needed in the train.

Prior to the initiation of sampling, the impactor was leak-tested and placed in the duct for 20 minutes to allow it to heat to duct temperature to prevent condensation. Sampling began immediately upon rotation of the nozzle into the flow stream. Sampling was performed isokinetically from a single point at the centroid of the duct. The test lasted for 90 minutes, with sampling parameter values recorded every 5 minutes.

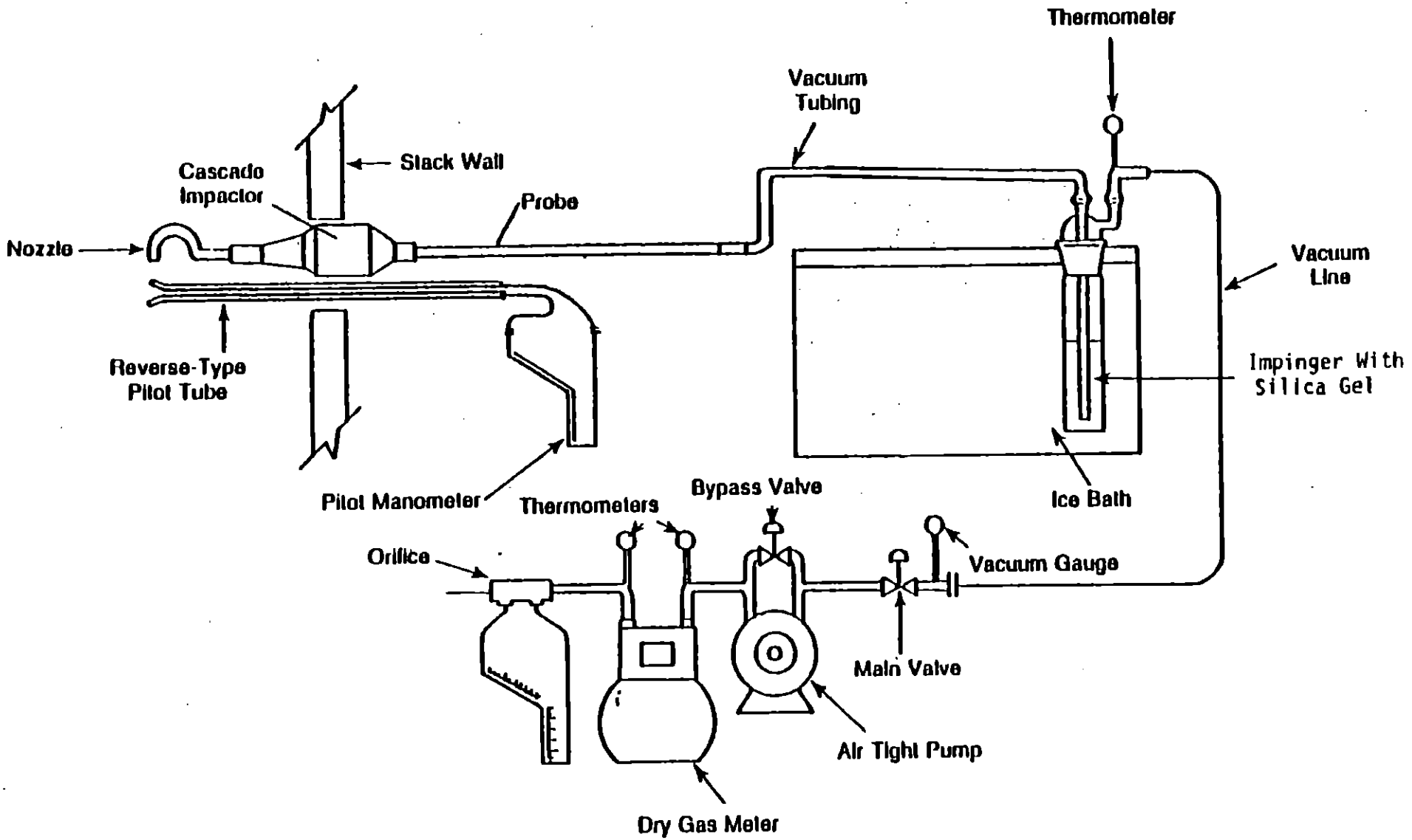


FIGURE 5-2: PARTICLE SIZE DISTRIBUTION SAMPLING TRAIN

The impactor was loaded before the test run with preweighed glass fiber collection substrates. Upon completion of the test run, the substrates were removed in a secluded, clean area and placed in petri dishes and sealed. The cyclone preseparator contents were brushed into a tared sample jar and sealed. These samples were brought to the TRC laboratory and were weighed on an analytical balance to 0.01 mg in a constant-humidity environment.

5.4.2 Kettle Calciner No. 5 Baghouse Inlet

The high moisture and heavy grain loading at this location precluded the use of the Andersen cascade impactor for particle size tests. Instead, the desiccated filter catches from the six Method 5 inlet test runs (3 batch mode and 3 continous mode) were analyzed with a Bahco centrifugal separator following ASME Power Test Code 28. These Bahco analyses were performed by a subcontractor retained by TRC. The analysis method and data are presented in Appendix B.

5.5 Visible Emission Observations

Visible emission observations of the plumes from the kettle calciner No. 5 baghouse, the board end saw baghouse, the stucco conveyor baghouse, and the bagging operation baghouse were conducted by a certified observer. Observation locations, as described in Section 4.3, were choosen to conform to the guidelines of EPA Method 9. The gray plant buildings and blue sky were used as backgrounds. During an observation period, opacity readings were taken and recorded at 15-second intervals. Six-minute averages were calculated from these 15-second observations.

The only problems encountered during the visible emissions observations were associated with the kettle calciner No. 5 baghouse outlet plume. The

high moisture content of the exiting gas stream, in conjunction with relatively cool ambient air temperatures (ranging from 40°F to 70°F), caused the formation of a heavy steam plume. With westerly winds the plume was blown through a line of stacks (see Figure 4-2). This occasionally caused some difficulty in estimating plume opacity at the point where the steam plume dissipated.

Visible fugitive emssions from the board end saw were observed by certified visible emission observers over a period of 3 hours following the guidelines of EPA Method 22. The amount of time during which emissions were observed was measured and recorded.

APPENDIX A

FIELD DATA SHEETS FOR PARTICULATE EMISSION TESTS

SAMPLIN ASK LOG

Plant U.S. Gypsum
Date 10/28/3[illegible]

Plant Location Fort Dodge
Recorded by [illegible]

Baghouse No. 5 Inlet

Comments	Run	Sampling location (Port)	Pollutant	Clock Time Began	Clock Time Ended	Elapsed Time (min)	Sample Nos.
	1	A inlet	Part	1420	1422	2	
Slipped last pt. on Riser port due	1 →	B		1530	1548	18	
to plugging →							
	2	B	Part	1640	1657	17.5	
Severe plugging problems	2	A		1820	1821	1.0	

SAMPLING TASK LOG

Plant U.S GYPSUM / EPA
Date 10/28/80

Plant Location Fort Dodge Iowa
Recorded by EPA

Baghouse No. 5 outlet

Comments	Run	Sampling location (Port)	Pollutant	Clock Time Began	Clock Time Ended	Elapsed Time (min)	Sample Nos.
Start Test #1 on Port #1	1	1	Particulate	1400	1520	80	
1435 Temp in Stack Dropped From 116 to 112		"					
No Steam coming out of Stack outlet		"					
1446 Temp in stack increasing and steam also increasing in volume		"					
Shut down Port #1 change to Port 2.	1	2			1520		
Start Port #2		2		1524			
End Test #1 Port #2		2			1644	80	
START Test #2 on Kettle #5 outlet	2	1		1730		80	
End Port #1 change to port #2		1			1850		
Start Port #2		2		1856			
End Test #2 on kettle #5		2			2011		

TRAVERSE POINT LOCATION FOR CIRCULAR DUCTS

PLANT US Gypsum
DATE 10/27/93
SAMPLING LOCATION Baghouse #5 Inlet
INSIDE OF FAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE A) ~~22.5~~ 16.5
INSIDE OF NEAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE B) ~~9.0~~ 3.0
STACK I.D., (DISTANCE A - DISTANCE B) 13.5
NEAREST UPSTREAM DISTURBANCE 1.25
NEAREST DOWNSTREAM DISTURBANCE 28.0
CALCULATOR J. Canoca

SCHEMATIC OF SAMPLING LOCATION

TRAVERSE POINT NUMBER	FRACTION OF STACK I.D.	STACK I.D.	PRODUCT OF COLUMNS 2 AND 3 (TO NEAREST 1/8 INCH)	DISTANCE B	TRAVERSE POINT LOCATION FROM OUTSIDE OF NIPPLE (SUM OF COLUMNS 4 & 5)
1	.026	13.5"	~~.35~~ 0.5	~~9.0~~ 3.0	~~9.35~~ 3.5
2	.082		1.12		~~10.12~~ 4.12
3	.140		1.97		~~10.97~~ 4.97
4	.226		~~4.61~~ 3.05		~~12.05~~ 6.05
5	.342		4.61		~~13.61~~ 7.61
6	.658		8.88		~~17.88~~ 11.88
7	.774		10.45		~~19.45~~ 13.45
8	.854		11.53		~~20.53~~ 14.53
9	.918		12.39		~~21.39~~ 15.39
10	.974	✓	~~13.15~~ 13.0	✓	~~22.15~~ 16.0

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TRAVERSE POINT LOCATION FOR CIRCULAR DUCTS

PLANT U.S GYPSOM
DATE October 28 1980 DONT USE OTHER
SAMPLING LOCATION Kettle 5 outlet
INSIDE OF FAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE A) 18.5"
INSIDE OF NEAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE B) 7.5"
STACK I.D., (DISTANCE A - DISTANCE B) 11.0"
NEAREST UPSTREAM DISTURBANCE
NEAREST DOWNSTREAM DISTURBANCE
CALCULATOR FDD

SCHEMATIC OF SAMPLING LOCATION

TRAVERSE POINT NUMBER	FRACTION OF STACK I.D.	STACK I.D.	PRODUCT OF COLUMNS 2 AND 3 (TO NEAREST 1/8 INCH)	DISTANCE B	TRAVERSE POINT LOCATION FROM OUTSIDE OF NIPP (SUM OF COLUMNS 4 & 5
1	0.032	11	0.352 to 0.5	~~7.5~~ 3.0	~~8.0~~ 3.5
2	0.105		~~11.55~~ 1.155		8.655 4.15
3	0.194		2.134		9.634 5.134
4	0.323		3.553		11.053 6.55
5	0.677		7.447		14.947 10.447
6	0.806		8.866		16.366 11.86
7	0.895		9.845		17.345 12.845
8	0.968		10.648 10.5	✓	18.00 13.5

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PRELIMINARY VELOCITY TRAVERSE

PLANT US Gypsum
DATE 10/28/80 J
LOCATION Kiln #5 - Inlet
STACK I.D. 13.5 in
BAROMETRIC PRESSURE, in. Hg 30.34
STACK GAUGE PRESSURE, in. H_2O -2.30
OPERATORS JC / DE
Cp .84

SCHEMATIC OF TRAVERSE POINT LAYOUT

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
	.53	160
2	.58	
3	.54	
4	.65	
5	.62	
6	.64	
7	.65	
8	.73	
9	.72	
10	.70	
1	.45	160
2	.45	
3	.50	
4	.64	
5	.65	
6	.70	
7	.70	
8	.85	
9	.84	
10	.85	
AVERAGE	0.807	160

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
AVERAGE		

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PRELIMINARY VELOCITY TRAVERSE

PLANT US GYPSUM
DATE October 28, 1980
LOCATION Kettle #5 outlet
STACK I.D. ~~12"~~ 11" A: .66 ft² (1) nipple 7½
BAROMETRIC PRESSURE, in. Hg 29.95
STACK GAUGE PRESSURE, in. H_2O -0.61
OPERATORS EDA
Cp .844 (3)
PROBE 29

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
1	~~1.05~~ 1.1	~~120~~ 121
2	1.5	169
3	1.55	170
4	~~1.45~~ 1.5	~~160~~ 170
5	1.4	173
6	1.35	176
7	1.35	176
8	1.4	173
AVERAGE	1.379	166

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SCHEMATIC OF TRAVERSE POINT LAYOUT

2

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
1	1.1	~~156~~ 160
2	1.4	169
3	1.45	179
4	1.45	181
5	1.6	181
6	1.8	182
7	1.85	183
8	1.7	183
AVERAGE	1.539	177
TOTAL	1.209	172

09

NOMOGRAPH DATA

PLANT U.S Gypsum

DATE 10/23/90

SAMPLING LOCATION K+75 Inlet

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.98
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m_{avg.}}$	70
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{wo}	2.5
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	30.34
STATIC PRESSURE IN STACK, in. Hg ($P_m \pm 0.073$ x STACK GAUGE PRESSURE in in. H_2O)	P_s	-2.30
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	.944
AVERAGE STACK TEMPERATURE, °F	$T_{s_{avg.}}$	170
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	.85
C FACTOR	.74	
CALCULATED NOZZLE DIAMETER, in.	.25	
ACTUAL NOZZLE DIAMETER, in.	.261	
REFERENCE Δp, in. H_2O	.60	

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NOMOGRAPH DATA

PLANT U.S GYPSUM

DATE October 28, 1980

SAMPLING LOCATION Kettle NO.8 Outlet

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	2.14
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m_{avg.}}$	75
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{wo}	25%
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	29.95
STATIC PRESSURE IN STACK, in. Hg ($P_m \pm 0.073$ x STACK GAUGE PRESSURE in in. H_2O)	P_s	-0.64
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	N/A
AVERAGE STACK TEMPERATURE, °F	$T_{s_{avg.}}$	172 °F
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	1.209
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	1.8
C FACTOR	0.73	
CALCULATED NOZZLE DIAMETER, in.	0.20	
ACTUAL NOZZLE DIAMETER, in.	0.1992	
REFERENCE Δp, in. H_2O	1.	

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TRC Environmental Consultants, Inc.

FIELD DATA SHEET

Firm Name U.S. Gypsum
Plant Location Fort Dodge Iowa
Test Number 1
Sampling Location Kettle #5 - Baghouse Outlet
TRC Project No. 1523-E80
Date 10/22/80
Tester JC / DE

Orifice No. T-1
Ambient Temp. 64 °F
Bar. Press. 30.34 "Hg
Probe Ident. No. 28
Filter Ident. No. 00062
Duct Area ~~177.79~~ 183.5 ft²

Nozzle No. & Dia. 3-2 .262 in.
Assumed Moisture 25 %
Test Duration ~~60~~ 10 min.
Traverse Point Interval 2.0 min.
Probe Heater Setting 260 °F
Filter Temp. Setting 260 °F
Dry Gas Meter Y 1.00

Nomograph C Factor .75
Pitot Coefficient .860
Orifice ΔH_A 1.78
Test Start Time 1400
Test Final Time 1600
Leak Test Start 1005 CFM@ 15 "Hg
Leak Test Final 1005 CFM@ 20 "Hg

Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle β	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %
A	1	3	.57	1.80	62	60	-.230	161	452.50		NA	275	60	5.0	230		
	2	3	.57	1.80	62	60		161	454.53			263	60	7.0			
	3	2	.57	1.80	61	62		165	456.62			270	60	9.0			
	4		.63	1.95	63	61		162	458.00			270	60	10			
	5		.72	2.20	63	61		157	459.41			266	60	12			
	6		.63	1.95	63	61		155	460.93			265	60	12			
	7		.66	2.05	63	61		155	462.40			269	60	13			
	8		.75	2.30	63	61		150	463.85			268	60	15			
	9		.40	1.28	63	61		150	465.40			268	60	11			
	10	↓	.40	1.28	63	61		150	466.60			268					
									467.66								
B	1	3	.52	1.62	65	63		184	468.22			270	60	11			
	2		.55	1.72	65	63		187	469.35			270	60	11			
↓	3	↓	.55	1.72	65	63		166	470.63		↓				↓		
Average			Σ√ΔP														

H_2O Collected 278 ml
SG Condition
SG Weight 8 gm
Total Volume Collected 286 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2
	20.9		79.1

COMMENTS:

TRC Environmental Consultants, Inc.

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FIELD DATA SHEET

Firm Name: US Gypsum
Plant Location: East Dodge
Test Number: 1
Sampling Location: Kettle #5 - Baghouse Inlet
TRC Project No.: 1563-E30
Date: 10/28/80
Tester: TC / DE

Orifice No.: I-1
Ambient Temp.: 65 °F
Bar. Press.: 30.34 "Hg
Probe Ident. No.: 28
Filter Ident. No.: 10062 / 10062
Duct Area: 0.99 ft² (13.5 in)

Nozzle No. & Dia.: 3-2 .263 in.
Assumed Moisture: 25 %
Test Duration: ~~45~~ 40 min.
Traverse Point Interval: 2.0 min.
Probe Heater Setting: 270 °F
Filter Temp. Setting: 270 °F
Dry Gas Meter Y: 1.0

Nomograph C Factor: .75
Pitot Coefficient: .862
Orifice ΔH_A: 1.98
Test Start Time: 1400
Test Final Time: 1600
Leak Test Start: .005 CFM @ 15 "Hg
Leak Test Final: .005 CFM @ 20 "Hg

Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle ϕ	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %
B	4	20	60	1.80	65	63	-2.30	180	471.93		NA	270	~~260~~	17	230		
	5	0	64	1.95	65	63		184	473.12			270	60	9	230		
	6		60	1.80	65	63		184	474.68			270	60	11			
	7		56	1.75	65	63		176	476.10			270	60	13			
	8		42	1.30	65	63		170	477.47			270	60	13			
	9		25	0.80	65	63		165	478.72			270	60	15			
↓	10	~~20~~					↓		480.00		↓				↓		
Average			$\Sigma\sqrt{\Delta P}$ 7.49	1.73	64	62	-2.30	166	26.94								

H_2O Collected: 278 ml
SG Condition:
SG Weight: 8 gm
Total Volume Collected: 286 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2
	20.9		79.1

COMMENTS:

TRC Environ... Consult... Inc.

FIELD DATA SHT. PAGE #1 OF 3

Firm Name U.S GYPSUM
Plant Location Fort Dodge, Iowa
Test Number #1
Sampling Location Kettle #5 outlet
TRC Project No. 1532-EB0-20
Date October 28, 1980
Tester EDA/MAA

Orifice No. T-2
Ambient Temp. 60 °F
Bar. Press. 30.08 "Hg
Probe Ident. No. 49
Filter Ident. No. 10061
Duct Area 0.66 ft²
Duct DIA 11"

Nozzle No. & Dia. 1-1 0.1992 in.
Assumed Moisture 25 %
Test Duration 160 min.
Traverse Point Interval 5 min.
Probe Heater Setting 250±15 °F
Filter Temp. Setting 250±15 °F
Dry Gas Meter Y 1.01

Nomograph C Factor 0.73
Pitot Coefficient 0.856
Orifice ΔH_A 2.14
Test Start Time 1400
Test Final Time 1630
Leak Test Start 0.000 CFM @ -11 "Hg
Leak Test Final 0.000 CFM @ -10 "Hg

Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle β	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %	
1	1	5	1.0	1.0	72	71	-.52	148	677.55	1		269	50	2	264			1400
	2		1.3	1.3	71	71		147	680.19			265	50	2.5	253			
	3		1.35	1.35	71	71		147	683.12			266	50	2.5	258			
	4		1.35	1.35	70	71	- -.52	141	686.15			273	51	2.5	269			
	5		1.45	1.45	71	71		137	689.17			262	51	3.0	262			
	6		1.50	1.50	71	72		142	692.28			284	50	3.3	225			
	7		1.50	1.50	71	72		130	695.40			280	50	3.5	270			☆
	8		1.60	1.60	71	72		112	699.82			251	50	3.8	230			
	8		1.60	1.60	71	71		123	701.80			259	50	4.0	256			
	7		1.60	1.60	71	72		129	704.58			257	50	4.0	245			☆
	6		1.45	1.45	71	72		162	708.48			258	50	3.8	245			
	5		1.38	1.38	71	72		169	711.52			258	50	3.8	258			
	4		1.40	1.40	71	72		171	714.66			258	50	4.0	231			
	3	▼	1.30	1.30	71	72	▲	168	717.71			257	50	4.0	270			
Average			$\Sigma\sqrt{\Delta P}$															

H_2O Collected 656 ml
SG Condition
SG Weight 23.8 gm
Total Volume Collected 6798 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2
	20.9		79.1

COMMENTS:

TRC Environ... Consult... Inc.

FIELD DATA SHEET

Firm Name: US GYPSUM
Plant Location: Fort Dodge, Iowa
Test Number: Test #1
Sampling Location: Kettle #5 outlet
TRC Project No.: 1532-E80-20
Date: October 28, 1980
Tester: EDA

Orifice No.: T-2
Ambient Temp.: 60 °F
Bar. Press.: 30.08 "Hg
Probe Ident. No.: 49
Filter Ident. No.: 10061
Duct Area: 11" 4.6 ft²

Nozzle No. & Dia.: 1-1 0.1992in.
Assumed Moisture: 25 %
Test Duration: 160 min.
Traverse Point Interval: 5 min.
Probe Heater Setting: 250 ± 15 °F
Filter Temp. Setting: 250 ± 15 °F
Dry Gas Meter Y: 1.01

Nomograph C Factor: 073
Pitot Coefficient: 0.856
Orifice ΔH_A: 2.14
Test Start Time: 1400
Test Final Time: 1630
Leak Test Start: 0.000 CFM @ -11 "Hg
Leak Test Final: 0.000 CFM @ -10 "Hg

Page #2 of #3

Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M In °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle ∅	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %	
	2	5	100	099	72	72	-52	160	720742	1		257	50	3.8	283			1510
	1	10	110	110	72	72	"	154	723664			257	50	3.8	288			
	8								726632									1520
	1	10	110	110	73	73	-52	155	726632			254	50	3.8	240			1524
	2	10	110	110	72	72	"	168	728778			255	50	3.8	264			
	3	10	110	110	72	72	"	170	731804			258	50	4.0	289			
	4	10	110	110	72	73	"	169	734544			254	50	4.0	250			
	5	13	135	135	71	72	"	168	737124			257	50	4.8	261			
	6	13	130	130	71	72	"	165	740204			256	50	4.8	280			
	7	13	138	138	71	72	"	162	743421			256	50	4.0	280			
	8	14	140	140	71	71	"	162	746626			258	50	4.0	278			
	8	14	140	140	71	71	"	161	749136			257	50	4.2	273			
	7	14	145	145	71	71	"	162	752300			258	50	4.5	250			
Average			Σ√ΔP															

H_2O Collected: 656 ml
SG Condition:
SG Weight: 23.8 gm
Total Volume Collected: 679.8 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2
	20.9		79.1

COMMENTS:

TRC Environmental Consultants, Inc.

FIELD DATA SHT

Firm Name: U.S. GYPSUM
Plant Location: Fort Dodge, Iowa
Test Number: Test #1
Sampling Location: Kettle #5 outlet
TRC Project No.: 1532-E80-20
Date: October 28, 1980
Tester: EDA/MAA

Orifice No.: T-2
Ambient Temp.: 60 °F
Bar. Press.: 30.08 "Hg
Probe Ident. No.: 49
Filter Ident. No.: 10061
Duct Area: ~~11~~ .66 ft²
DIA: 11"

Nozzle No. & Dia.: 1-1 0.1992 in.
Assumed Moisture: 25 %
Test Duration: 160 min.
Traverse Point Interval: 5 min.
Probe Heater Setting: 250 °F
Filter Temp. Setting: 250 °F
Dry Gas Meter Y: 1.01

Nomograph C Factor: 0.73
Pitot Coefficient: 0.856
Orifice ΔH@: 2.14
Test Start Time: 1400
Test Final Time: 1630
Leak Test Start: 0.000 CFM @ -11 "Hg
Leak Test Final: 0.000 CFM @ -10 "Hg

Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %
	6	5	1.45	1.45	71	71	-.52	162	75537			255	50	4.5	240		
	5		1.10	1.10	71	71		161	75840			256	50	4.5	274		
	4		0.85	0.85	71	71		158	76156			256	52	4.0	273		
	3		0.80	0.80	71	71		162	76380			257	52	3.8	277		
	2		1.05	1.05	71	71		154	76610			256	52	4.5	271		
	1	↓	1.30	1.30	71	71	↓	152	76890			254	52	5.0	240		
									77184								
Average			$\Sigma\sqrt{\Delta P}$ 11.392	1.28	71	72	-.52	154	94129								

1644

H_2O Collected: 656 ml
SG Condition:
SG Weight: 23.8 gm
Total Volume Collected: 679.8 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2
	20.9		79.1

COMMENTS:

TRC Environmental Consultants, Inc.

FIELD DATA SH.

Firm Name US Gypsum
Plant Location Fort Dodge
Test Number 2
Sampling Location Reflo 5 - Baghouse ~~Outlet~~ INLET
TRC Project No. 1583-E20
Date 10/22/80
Tester JC / DE

Orifice No. H-1
Ambient Temp. 60 °F
Bar. Press. 30.34 "Hg
Probe Ident. No. 39
Filter Ident. No. 10069
Duct Area 19 ft² 13.5

Nozzle No. & Dia. 1-2 .261 in.
Assumed Moisture 25 %
Test Duration 40 18.5 min.
Traverse Point Interval 2.0 min.
Probe Heater Setting 270 °F
Filter Temp. Setting 270 °F
Dry Gas Meter Y 1.00

Nomograph C Factor .75
Pitot Coefficient .84
Orifice ΔH_A 1.92
Test Start Time 1640
Test Final Time 1821
Leak Test Start .005 CFM 20 "Hg
Leak Test Final .005 CFM 20 "Hg

Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PITOT	Cyc. Angle β	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %
B	1	20	54	1.65	65	64	-2.20	166	483.060		MA	270	55	5.0	220		
	2		54	1.65	65	64		167	488.195			270	55	5.0			
	3		56	1.75	65	64		168	493.330			273	60	5.0			
	4		54	1.65	65	64		168	498.468			273	60	5.0			
	5		56	1.65	65	64		168	503.599			273	60	5.0			
	6		54	1.65	65	64		168	508.730			270	60	6.0			
	7		55	1.70	65	64		158	513.865			270	60	7.0			
	8		36	1.10	65	64		150	519.010			270	60	8.0			
	9	46	35	1.10	65	64		150	524.000			270	60	15			
	10	00	00	0.00	65	64	↓	150	~~529.155~~ 491.600			270	60	~~5.00~~			
A	1	10	40	1.15	65	64			492.556			270	60	6.0			
	2								493.000								
	3										↓				↓		
Average		18.5	Σ-√ΔP 7.76	1.62	65	64	-2.2	162	11.44								

H_2O Collected 119 ml
SG Condition
SG Weight 3.3 gm
Total Volume Collected 122.3 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2
	20.9		79.1

COMMENTS: Stop test because of plugging

TRC Environ Consult Inc.

FIELD DATA SHEET

Firm Name U.S GYPSUM
Plant Location Fort Dodge, Iowa
Test Number Test #2
Sampling Location kettle #5 outlet
TRC Project No. 1532-E80-20
Date October 28, 1980
Tester EDA/MAA

Orifice No. T-2
Ambient Temp. 50 °F
Bar. Press. 30.08 "Hg
Probe Ident. No. 29
Filter Ident. No. 10055
Duct Area .66 ft²
DIA 11"

Nozzle No. & Dia. 1-1 - 0.1992 in.
Assumed Moisture 25 %
Test Duration 160 min.
Traverse Point Interval 5 min.
Probe Heater Setting 250±15 °F
Filter Temp. Setting 250 °F
Dry Gas Meter Y 1.01

Nomograph C Factor 0.8
Pitot Coefficient .844
Orifice ΔH_A 2.14
Test Start Time 1730
Test Final Time 2015
Leak Test Start 0.002 CFM @ -11 "Hg
Leak Test Final 0.000 CFM @ -6 "Hg

PAGE #1 OF 3

Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle ø	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %	
1	1	5	1.35	1.55	68	67	-.37	120	772066	2		265	52	3.0	250			1730
	2		1.4	1.6	67	67		123	775299			270	52	3.5	250			
	3		1.4	1.6	66	67		152	778555			265	52	3.5	264			
	4		1.4	1.6	67	66		165	781800			269	52	3.5	258			
	5		1.45	1.65	69	67		164	785005			270	52	3.5	259			
	6		1.50	1.70	66	69		164	788444			269	52	3.5	250			
	7		1.50	1.70	69	67		158	791693			267	52	3.5	250			
	8		1.45	1.65	70	67		149	795033			261	52	3.5	250			
	8		1.50	1.70	70	67		139	798311			263	54	4.0	255			
	7		1.50	1.70	70	67		155	801884			264	54	4.0	255			
	6		1.30	1.50	70	67		171	805071			262	54	4.0	255			
	5		1.2	1.35	71	67		172	808122			261	54	4.0	255			
	4		1.3	1.5	69	68		168	811106			260	54	4.5	260			
	3		1.2	1.35	69	67		162	814200			261	54	4.0	250			
Average			$\Sigma\sqrt{\Delta P}$															

H_2O Collected 643 ml
SG Condition
SG Weight 24.3 gm
Total Volume Collected 667.3 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2
	20.9		79.1

COMMENTS:

TRC Environ Consult Inc.

FIELD DATA SHT.

Firm Name: U S GYPSUM
Plant Location: Fort Dodge Iowa
Test Number: Test #2
Sampling Location: Kettle #5 outlet
TRC Project No.: 1532-E00-20
Date: October 28, 1980
Tester: EDA/MAA

Orifice No.: T-2
Ambient Temp.: 56 °F
Bar. Press.: 30.08 "Hg
Probe Ident. No.: 29
Filter Ident. No.: 100155
Duct Area: .66 ft²
DIA: 11"

Nozzle No. & Dia.: 11 0.1992 in.
Assumed Moisture: 25 %
Test Duration: 160 min.
Traverse Point Interval: 5 min.
Probe Heater Setting: 250 ± 15 °F
Filter Temp. Setting: 250 ± 15 °F
Dry Gas Meter Y: 1.01

Nomograph C Factor: 0.8
Pitot Coefficient: 0.844
Orifice ΔH_A: 2.14
Test Start Time: 1730
Test Final Time: 2015
Leak Test Start: 0.002 CFM @ -11 "Hg
Leak Test Final: 0.000 CFM @ -6 "Hg

Page #2 of 3

Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle ø	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %
1	2	5	1.1	1.25	68	67	-.37	143	817.23			261	5.4	4.5	260		
	1	5	0.88	1.00	69	67		139	820.16			262	5.4	4.5	260		
									822.78								
2	1		1.25	1.45	69	68		155	822.78			255	52	4.8	250		1856
	2		1.20	1.40	70	68		156	825.87			262	52	4.8	245		
	3		1.25	1.45	70	68		159	828.95			272	52	4.8	230		
	4		1.30	1.50	71	69		158	832.10			263	52	4.8	240		
	5		1.45	1.65	71	69		161	835.17			264	52	4.8	240		
	6		1.55	1.75	70	69		159	838.40			270	52	5.0	138		
	7		1.55	1.75	70	69		159	841.80			268	54	5.0	135		
	8		1.60	1.80	73	70		159	845.19			271	54	5.0	135		
	8		1.50	1.70	73	71		159	848.70			268	54	5.5	140		
	7		1.50	1.70	73	70		159	852.17			268	54	5.5	138		
	6		0.97	0.95	73	70		159	855.51			271	54	5.0	135		
Average			Σ√ΔP					148									

H_2O Collected: 643 ml
SG Condition:
SG Weight: 24.3 gm
Total Volume Collected: 6673 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2
	20.9		79.1

COMMENTS:

TRC Environ Consult Inc.

FIELD DATA SHEET

Firm Name: US GYPSUM
Plant Location: Ft. Dodge IOWA
Test Number: Test #2
Sampling Location: Kettle #5 Outlet
TRC Project No.: 1532-E80-20
Date: OCTOBER-28-1980
Tester: EPA/MMA

Orifice No.: T-2
Ambient Temp.: 56 °F
Bar. Press.: 30.08 "Hg
Probe Ident. No.: 29
Filter Ident. No.: 10055
Duct Area: 1.66 ft²
DN: 11"

Nozzle No. & Dia.: 14 0.1992 in.
Assumed Moisture: 25 %
Test Duration: 160 min.
Traverse Point Interval: 5 min.
Probe Heater Setting: 250 ± 15 °F
Filter Temp. Setting: 250 ± 15 °F
Dry Gas Meter Y: 1.01

Nomograph C Factor: 0.8
Pitot Coefficient: 0.844
Orifice ΔH_a: 2.14
Test Start Time: 1730
Test Final Time: 2015
Leak Test Start: 0.002 CFM @ -11 "Hg
Leak Test Final: 0.000 CFM @ -6 "Hg

Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle Ø	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %
	5	5	087	098	73	70		159	85810			270	54	4.5	135		
	4		085	097	73	71		159	86070			270	54	4.5	139		
	3		097	110	73	71		156	86324			271	55	4.5	141		
	2		097	110	73	71		146	86500			270	57	4.5	145		
	1		120	146	73	71		135	86878			272	57	4.5	140		
									87194								
Average			$\Sigma\sqrt{\Delta P}$ 1.132	147	70	48	-37	154	99.88								

H_2O Collected: 643 ml
SG Condition:
SG Weight: 24.3 gm
Total Volume Collected: 667.3 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2
	20.9		79.1

COMMENTS:

SAMPLIN[illegible] ASK LOG

Plant U.S. Gypsum — Plant Location Fort Dodge
Date 10/29/32 — Recorded by J Landa

Comments	Run	Sampling location (Port)	Pollutant	Clock Time Began	Clock Time Ended	Elapsed Time (min)	Sample Nos.
Had to run test only at the end of a batch when the stream was dryer.	3	A		0940	0948	8	
	3	A		1145	1153	8	
	3	B		1202	1210	8	
- used only 1 filter							
- " 2 nozzles							

SAMPLING TASK LOG

Plant US GYPSUM
Date 10/28/00

Plant Location Fort Dodge, Iowa
Recorded by EDA

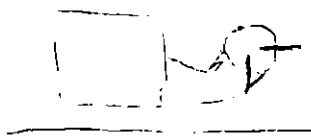
Comments	Run	Sampling location (Port)	Pollutant	Clock Time Began	Clock Time Ended	Elapsed Time (min)	Sample Nos.
START Test #3 on Kettle #5		1	PARTICULATE	0945	1105	80	
STOP change PORTS from 1 to 2		1	"		1105		
START PORT #2, Test #3		2	"	1113	1233		
END PORT #2 Test #3 on Kettle #5		2	"		1233	80	

25

PRELIMINARY VELOCITY TRAVERSE

Vs 2660 ft/min

PLANT U.S Gypsum
DATE 10/29/20
LOCATION Kettle #2 - Baghouse Inlet
STACK I.D. 15.5 .99
BAROMETRIC PRESSURE, in. Hg 30.40
STACK GAUGE PRESSURE, in. H_2O -2
OPERATORS JC / DE
Cp .84



SCHEMATIC OF TRAVERSE POINT LAYOUT

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
Post A 1	.55	290
2	.55	290
3	.57	295
4	.58	295
5	.52	295
6	.48	295
7	.40	295
8	.35	285
9	.20	285
10	.20	285
AVERAGE	0.65	291

506.72

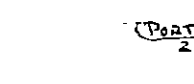
TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
AVERAGE		

EPA (Dur) 233
4/72

PRELIMINARY VELOCITY TRAVERSE

$V_S = 2290$

PLANT U.S GYPSUM
DATE October 29 1980
LOCATION Kettle #2 - Outlet
STACK I.D. duct 5 in. 1.23
BAROMETRIC PRESSURE, in. Hg 30.26
STACK GAUGE PRESSURE, in. H_2O −0.61
OPERATORS EPA / MRA
Cp 0.844
PROBE 29



HOUSE TYPE AREA

SCHEMATIC OF TRAVERSE POINT LAYOUT

PORT 1

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
1	.325	157
2	.33	167
3	.34	249
4	.34	250
5	.39	254
6	.40	264
7	.40	265
8	.42	265
9	.41	266
10	.42	266
AVERAGE		

PORT 2

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
1	25	163
2	.26	173
3	.31	250
4	.31	254
5	.30	259
6	.33	262
7	.35	263
8	.39	264
9	.40	266
10	.41	266
AVERAGE	0.59	241

352
41

EPA (Dur) 233
4/72

NOMOGRAPH DATA

PLANT U.S GYPSUM

DATE 10/29/80

SAMPLING LOCATION Kettle #5 outlet

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	2.14
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m\,avg.}$	70
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{wo}	25
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	30.37
STATIC PRESSURE IN STACK, in. Hg ($P_m \pm 0.073$ x STACK GAUGE PRESSURE in in. H_2O)	P_s	-0.45 ~~-.45~~
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	
AVERAGE STACK TEMPERATURE, °F	$T_{s\,avg.}$	154
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	1.209
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	1.6
C FACTOR	0.80	
CALCULATED NOZZLE DIAMETER, in.	0.205	
ACTUAL NOZZLE DIAMETER, in.		
REFERENCE Δp, in. H_2O	1.6	

EPA (Dur) 234
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TRC Environmental Consultants, Inc.

FIELD DATA SHEET

p. 1 of 2

Firm Name: US Gypsum
Plant Location: Fort Dodge
Test Number: 3
Sampling Location: Kettle #5 - Baghouse Inlet
TRC Project No.: 1583-E80
Date: 10/29/80
Tester: JC/DE

Orifice No.: T-1
Ambient Temp.: 50 °F
Bar. Press.: 30.40 "Hg
Probe Ident. No.: 23
Filter Ident. No.: 10072
Duct Area: .99 ft² (13.5)

Nozzle No. & Dia.: 3-2 .262 in.
Assumed Moisture: 30 %
Test Duration: 19 min.
Traverse Point Interval: 1.0 min.
Probe Heater Setting: 270 °F
Filter Temp. Setting: 270 °F
Dry Gas Meter Y: 1.0

Nomograph C Factor: .75
Pitot Coefficient: .862
Orifice ΔH_A: 1.98
Test Start Time: 0940
Test Final Time: 1210
Leak Test Start: .003 CFM @ 20 "Hg
Leak Test Final: .005 CFM @ 20 "Hg

Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle β	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %
A	1	20	.62	1.90	50	51	-.22	170	499.497		N A	255	50	5	230		
	2	10	.69	2.06	50	50		170	499.645								
	3		.54	1.65	56	55		176	499.732								
	4		.36	1.10	56	55		176	499.797								
	5		.36	1.10	56	55		183	499.853								
	6		.40	1.25	56	55		183	499.906								
	7		.40	1.25	56	55		183	499.968								
	8		.36	1.10	56	55		180	500.032								
	9		.36	1.10	56	55		185	500.092								
	10		.36	1.10	56	55		184	500.143								
									501.191								
B	1	10	.45	1.40	56	55		170	501.191								
	2		.32	1.00	57	56		170	502.232								
	3		.25	.77	57	56		170	502.296								
Average			$\Sigma\sqrt{\Delta P}$														

H_2O Collected: 210 ml
SG Condition:
SG Weight: 3.3 gm
Total Volume Collected: 213.3 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2
	20.9		79.2

COMMENTS:

TRC Environmental Consultants, Inc.

FIELD DATA SHEET

F 2 B 2

Firm Name US Gypsum
Plant Location Fort Dodge
Test Number 3
Sampling Location Kiln #5 - Inlet
TRC Project No. 1583-E30
Date 10/29/80
Tester JL / DE

Orifice No. T-1
Ambient Temp. 60 °F
Bar. Press. 30.40 "Hg
Probe Ident. No. 29
Filter Ident. No. 10072
Duct Area .99 ft² 135

Nozzle No. & Dia. 3-1 .261 in.
Assumed Moisture 30 %
Test Duration 19 min.
Traverse Point Interval 1.0 min.
Probe Heater Setting 270 °F
Filter Temp. Setting 270 °F
Dry Gas Meter Y 1.0

Nomograph C Factor .75
Pitot Coefficient .862
Orifice ΔH$_A$ 1.78
Test Start Time 0540
Test Final Time 1210
Leak Test Start .005 CFM 20 "Hg
Leak Test Final .005 CFM 20 "Hg

Port	Point	Time Min.	Velocity ΔP in H_2O	Δh in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle ϕ	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %
B	4		.25	.77	57	56	-2.20	173	503.400			267	50	7.0	217		
	5		.30	.95	57	56		173	503.833					9			
	6		.34	1.05	57	56		170	504.337					10			
	7		.38	1.20	57	56		174	504.900					11			
	8		.40	1.25	57	56		172	505.413								
	9								505.866								
	10																
Average			Σ√ΔP 1.623	1.22	56	55	-2.20	176	10.89								

H_2O Collected 210 ml
SG Condition
SG Weight 3.3 gm
Total Volume Collected 218.3 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2
	20.9		79.1

COMMENTS:

TRC Environmental Consultants, Inc.

FIELD DATA SHEET

Firm Name U.S GYPSUM
Plant Location Fort Dodge, Iowa
Test Number #3
Sampling Location Kettle #5 Outlet
TRC Project No. 1532-E80-20
Date October 29, 1980
Tester EDA / MAR

Orifice No. T-2
Ambient Temp. 44 °F
Bar. Press. 30.37 "Hg
Probe Ident. No. 49
Filter Ident. No. 10074
Duct Area .66 ft²
DIA 11"

Nozzle No. & Dia. 1-1 0.1992 in.
Assumed Moisture 25 %
Test Duration 160 min.
Traverse Point Interval 5 min.
Probe Heater Setting 250 ± 15 °F
Filter Temp. Setting 250 ± 15 °F
Dry Gas Meter Y 1.01

Nomograph C Factor 0.80
Pitot Coefficient ~~0.859~~ 0.856
Orifice ΔH_A 2.14
Test Start Time 0945
Test Final Time 1223
Leak Test Start 0.000 CFM @ -11 "Hg
Leak Test Final 0.000 CFM @ -11 "Hg

PAGE # 1 OF 3

Port	Point	Time Min.	Velocity ΔP in H_2O	Δh in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle β	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %
1	1	5	.85	.098	67	66	-.45	110	873377	1		273	52	2.0	243		
	2		.94	.11	68	66		110	875996			270	52	2.5	275		
	3		.98	.115	68	67		109	878900			274	52	2.5	267		
	4		.98	.115	68	66		135	881290			273	52	2.5	249		
	5		1.10	.125	69	67		135	884077			274	54	2.5	266		
	6		1.10	.125	70	68		127	886977			273	54	3.0	266		
	7		1.10	.125	70	68		141	889901			275	54	3.0	266		
	8		1.10	.125	70	68		140	892840			274	54	3.0	268		
	8		1.10	.125	71	69		136	895771			275	54	3.0	268		
	7		1.10	.125	71	69		134	898864			276	54	3.0	267		
	6		1.10	.125	72	70		143	901488			275	54	3.0	267		
	5		.889	.105	73	70		163	904385			270	54	3.0	267		
	4		.071	.084	72	70		172	907044			272	54	3.0	268		
	3		.070	.082	73	71		173	909455	Y		271	58	2.0	268		
Average			$\Sigma\sqrt{\Delta P}$														

H_2O Collected 786 ml
SG Condition
SG Weight 33.4 gm
Total Volume Collected 819.4 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2
	20.9		79.2

COMMENTS: This test Repeated on 10-31-81

TRC Environ... Consul... Inc.

FIELD DATA SHEET

Firm Name U.S GYPSUM
Plant Location Fort Dodge, Iowa
Test Number #3
Sampling Location Kettle #5 Outlet
TRC Project No. 1832-580-20
Date October 29, 1980
Tester EDA/MAA

Orifice No. T-2
Ambient Temp. 44 °F
Bar. Press. 30.37 "Hg
Probe Ident. No. 49
Filter Ident. No. 16074
Duct Area 16 ft²
DIA 11"

Nozzle No. & Dia. 1-1 0.1992 in.
Assumed Moisture 25 %
Test Duration 160 min.
Traverse Point Interval 5 min.
Probe Heater Setting 250 ± 15 °F
Filter Temp. Setting 250 ± 15 °F
Dry Gas Meter Y 1.01

Nomograph C Factor 0.80
Pitot Coefficient ~~0.84~~ 0.856
Orifice ΔH_A 2.14
Test Start Time 0945
Test Final Time 1223
Leak Test Start 0.002 CFM -11 "Hg
Leak Test Final 0.00 CFM -11 "Hg

Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle β	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %	
1	2	5	61	72	73	70	-45	174	918.383	1		265	58	3.5	268			
↓	1	↓	64	75	73	71	-45	171	914.088	↓		271	58	4.0	261			1110
									916.388									
2	1	5	59	69	73	71	-.19	172	916.388			273	58	4.0	267			1113
	2		62	72	74	72		167	918.860			260	58	4.0	265			
	3		61	72	74	72		170	920.847			262	58	4.0	257			
	4		64	75	75	73		174	923.107			258	58	4.0	250			
	5		74	86	75	73		173	925.411			255	58	4.0	250			
	6		68	78	74	74		172	927.801			259	60	4.0	235			
	7		75	87	76	74		174	930.156			259	61	4.0	254			
	8		100	115	76	74		173	932.611			260	62	4.0	275			
	8		88	100	76	74		172	935.411			260	62	4.0	250			
	7		80	95	75	75		174	938.107			259	62	4.0	235			
↓	6	↓	70	83	75	75		175	940.555	↓		260	63	4.0	274			
Average			$\Sigma\sqrt{\Delta P}$															

H_2O Collected 786 ml
SG Condition
SG Weight 33.4 gm
Total Volume Collected 819.4 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2

COMMENTS:

TRC Environmental Consultants, Inc.

FIELD DATA SHEET

Firm Name U.S. GYPSUM
Plant Location Fort Dodge, Iowa
Test Number #3
Sampling Location Kettle #5 Outlet
TRC Project No. 182-E80-20
Date October 29, 1980
Tester EDA / MAA

Orifice No. T-2
Ambient Temp. 44 °F
Bar. Press. 30.37 "Hg
Probe Ident. No. 49
Filter Ident. No. 10074
Duct Area .66 ft²
DIA 11"

Nozzle No. & Dia. 1-1 0.1992 in.
Assumed Moisture 25 %
Test Duration 160 min.
Traverse Point Interval 5 min.
Probe Heater Setting 250 ± 15 °F
Filter Temp. Setting 250 ± °F
Dry Gas Meter Y 1.01

Nomograph C Factor 0.80
Pitot Coefficient ~~0.854~~ 0.856
Orifice ΔH_A 2.14
Test Start Time 0945
Test Final Time 1223
Leak Test Start 0.00 CFM @ 11 "Hg
Leak Test Final 0.000 CFM @ 11 "Hg

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Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle β	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %
	5	5	~~.80~~ .80	~~2.2~~ 2.5	75	75		174	94296			259	63	4.0	280		
	4		.60	.72	75	75		162	94540			257	63	3.0	278		
	3		.55	.65	75	75		160	94780			256	63	3.0	280		
	2		.45	.53	75	75		160	95010			237	63	2.5	277		
	1	✓	.48	.55	75	75		156	95217			255	64	2.5	272		
									95425								1223
									80988								
Average			$\Sigma\sqrt{\Delta P}$ .89.2	.938	73	71	-.32	156									

H_2O Collected 786 ml
SG Condition
SG Weight 33.4 gm
Total Volume Collected 819.4 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2
	20.9		79.1

COMMENTS:

SAMPLIN(.ASK LOG

Plant U.S. GYPSUM
Date 10-30-80

Plant Location FT DODGE IOWA
Recorded by JEC / DDE

Comments	Run	Sampling location (Port)	Pollutant	Clock Time Began	Clock Time Ended	Elapsed Time (min)	Sample Nos.
Baghouse No. 5 unit							
START TEST 4 ON KETTLE #5 CONTINUOUS	4	B		0930	0940	10	
MODE				[illegible]			
SAM CHANGED TO PORT B	4	A		0940	1008		
RESUMED TEST	4			1008			
FINISHED TEST 4	4	A			1018	10	
STARTED TEST 5 PORT A	5	A		1312			
FINISHED PORT A	5	A			1322	10	
BEGAN PORT B	5	B		1354			
FINISHED TEST 5	5	B			1404	10	
STARTED TEST 6 AT PORT B	6	B		1523	1		
FINISHED PORT B	6	B			1533	10	
SWITCHED TO PORT A	6	A		1553			
FINISHED TEST 6	6	A			1603	10	

SAMPLII ASK LOG

Plant US Gypsum
Date 10/30/86

Plant Location
Recorded by EDA/MBA

Baghouse No. 5 outlet

Comments	Run	Sampling location (Port)	Pollutant	Clock Time Began	Clock Time Ended	Elapsed Time (min)	Sample Nos.
Start Test #4 on Kettle #5 continuous	#4	2		0935			
mode		2			1015	40	
Shut Down To change ports and wait		1		~~1035~~			
for ice							
Start on Port 1 Test #1 on Kettle #5		1		1035			
End Test #4 on Kettle #5					1115	40	
						TOTAL 80	
START Test #5 on kettle #5 outlet	5	1		1230			
change Ports from 1 to 2		1			1310	40	
Start Port 2		2		1310		40	
End Test #5 at		2			1350		
Start Test #6 on Kettle #5 outlet	6	2		1452		32	
shut down Port 2 change to Port 1	6	2			1524		
Start up on Port #1	6			1527			
shut down on Port #1 End of Test #6	6				1559	32	

SAMPLING TASK LOG

Plant US Gypsum — Plant Location Ft. Dodge, Iowa

Date 10-30-80 — Recorded by MAA

Baghouse #5 outlet

Comments	Run	Sampling location (Port)	Pollutant	Clock Time Began	Clock Time Ended	Elapsed Time (min)	Sample Nos.
Start Test #4B Kettle #5 outlet in continus mode.	#4B	#1		1704	1737	33	
Stopped pump to change probe from port #1 to port #2 (1737) Back in port 1740. Finished at 1810		#2		1740	1810	30	

NOMOGRAPH DATA

PLANT US Gypsum

DATE 10/30/80

SAMPLING LOCATION Kettle #5 (Continuous) Baghouse Inlet

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.98
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m_{avg.}}$	62
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{wo}	60
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	30.50
STATIC PRESSURE IN STACK, in. Hg ($P_m \pm 0.073$ x STACK GAUGE PRESSURE in in. H_2O)	P_s	-2.30
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	
AVERAGE STACK TEMPERATURE, °F	$T_{s_{avg.}}$	250
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	.55
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	.65
C FACTOR K-Factor = 1.646	N/A	
CALCULATED NOZZLE DIAMETER, in.	0.3127	≈ 2-E
ACTUAL NOZZLE DIAMETER, in.	—	
REFERENCE Δp, in. H_2O	N/A	

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NOMOGRAPH DATA

PLANT U.S GYPSUM

DATE 10/30/80

SAMPLING LOCATION ~~Kettle~~ #5 outlet

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	2.14
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m_{avg.}}$	85.5
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{wo}	50
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	30.09
STATIC PRESSURE IN STACK, in. Hg ($P_m \pm 0.073$ x STACK GAUGE PRESSURE in in. H_2O)	P_s	-0.28
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	N/A
AVERAGE STACK TEMPERATURE, °F	$T_{s_{avg.}}$	232
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	.98
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	1.2
C FACTOR	N/A	
CALCULATED NOZZLE DIAMETER, in.	0.2622	
ACTUAL NOZZLE DIAMETER, in.	0.2622	
REFERENCE Δp, in. H_2O	N/A	

EPA (Dur) 234
4/72

TRC Environmental Consultants, Inc.

FIELD DATA SHEET

Firm Name US Gypsum
Plant Location Fort Dodge
Test Number #4
Sampling Location Kettle #5 (Continuous) Baghouse Inlet
TRC Project No. 1532-E80
Date 10/30/80
Tester SE/DE

Orifice No. T-1
Ambient Temp. 65 °F
Bar. Press. 30.50 "Hg
Probe Ident. No. 28
Filter Ident. No. 10073 10072
Duct Area 0.99 ft²

Nozzle No. & Dia. 2-8 · 3127 in.
Assumed Moisture 6.2 %
Test Duration 20 min.
Traverse Point Interval 1.0 min.
Probe Heater Setting 270 °F
Filter Temp. Setting 270 °F
Dry Gas Meter Y 1.002

Nomograph Factor 1.646
Pitot Coefficient .8502
Orifice ΔH_A 1.98
Test Start Time 0930 - 0950
Test Final Time 1003 - 1618
Leak Test Start .01 CFM @ 20 "Hg
Leak Test Final .01 CFM @ 20 "Hg

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Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle ø	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %
A	1	10	.62	1.00	59	58	-1.60	266	513.69			270	50	5.0	240		
	2		.62	1.00	59	58		261	518.24			271	50	5.0			
	3		.63	1.02	59	58		261	523.73			271	50	6.0			
	4		.61	.99	59	58		255	528.28			270	50	6.0			
	5		.59	.95	59	58		267	533.85					10			
	6		.55	.90	59	58		265	538.34					10			
	7		.56	.82	59	58		255	543.85					10			
	8		.54	.82	59	58		256	548.30					12			
	9		.58	.78	59	58		248	553.84					12			
	10		.58	.78	59	58		249	558.32					12			
									563.71								
B	1		.55	.90	62	61		264	569.17			265	50	5			
	2		.56	.92	62	61		255	574.72			274	50	5			
	3	V	.56	.92	62	61	V	252	580.23			270	50	6	V		
Average			$\Sigma\sqrt{\Delta P}$														

H_2O Collected 304 ml
SG Condition
SG Weight 3.5 gm
Total Volume Collected 307.5 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2
	20.9		79.1

COMMENTS:

TRC Environmental Consultants, Inc.

FIELD DATA SHEET

Firm Name: US Gypsum
Plant Location:
Test Number: 4
Sampling Location: Set #5 (Cont) Baghouse Inlet
TRC Project No.: 1582-E30
Date: 10/31/30
Tester: JC/DE

Orifice No.: I-1
Ambient Temp.: 60 °F
Bar. Press.: 30.50 "Hg
Probe Ident. No.: 23
Filter Ident. No.: RC-73 / 10073
Duct Area: 0.99 ft² (0.5in)

Nozzle No. & Dia.: B-8 .3127 in.
Assumed Moisture: 6.0 %
Test Duration: 80 min.
Traverse Point Interval: 1.0 min.
Probe Heater Setting: 270 °F
Filter Temp. Setting: 270 °F
Dry Gas Meter Y: 1.0 (P.202)

Nomograph C Factor: 1.646
Pitot Coefficient: 0.862
Orifice ΔH@: 1.98
Test Start Time: 0930 - 0953
Test Final Time: 1008 - 1010
Leak Test Start: 0.01 CFM @ 20 "Hg
Leak Test Final: .005 CFM @ 15 "Hg

Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle ø	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %
	4	10	58	95	62	61	-1.80	270	520.724			264	50	7.0	240		
	5		55	90	62	61		273	521.26								
	6		40	66	62	61		269	521.67								
	7		40	66	62	61		250	522.17								
	8		30	50	62	61		250	522.57								
	9		20	50	62	61		250	522.96								
	10	↓	28	50	62	61		250	523.34			↓	↓	↓	↓		
									523.80								
Average			Σ√ΔP						9.65								

H_2O Collected: 304 ml
SG Condition:
SG Weight: 3.5 gm
Total Volume Collected: 307.5 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2
	20.9		79.1

COMMENTS:

TRC Environmental Consultants, Inc.

FIELD DATA SHT

Firm Name US GYPSUM
Plant Location Fort Dodge, Iowa
Test Number #4
Sampling Location Kettle #5 outlet continued
TRC Project No. 1532-EBD-20
Date 10/20/00
Tester EAD / MAH

Orifice No. T-2
Ambient Temp. 40 °F
Bar. Press. 30.12 "Hg
Probe Ident. No. 49
Filter Ident. No. 10075
Duct Area .66 ft²

Nozzle No. & Dia. 1-B 0.3127 in.
Assumed Moisture 60 %
Test Duration 80 min.
Traverse Point Interval 5 min.
Probe Heater Setting 250±25 °F
Filter Temp. Setting 250 ± 25 °F
Dry Gas Meter Y 1.01

Nomograph C Factor N/A
Pitot Coefficient 0.856
Orifice ΔH$_A$ 2.14
Test Start Time 0935
Test Final Time 1115
Leak Test Start 0.008 CFM @ -11 "Hg
Leak Test Final 0.005 CFM @ -10 "Hg

PAGE #1 of 2

Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle ∅	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %	
2	1	5	0.74	1.45	69	68	-.27	207	95354.36			249	54	3.0	288			0935
	2		0.76	1.50	69	68		207	95865.4			250	54	4.0	261			
	3		0.79	1.50	70	68		219	96174.4			260	54	4.5	245			
	4		0.91	1.75	71	68		222	96495.5			270	56	4.5	250			
	5		1.10	2.10	72	69		224	96849.9			289	66	7.5	300			
	6		1.10	2.10	72	69		230	97210.0			277	68	7.5	278			
	7		1.10	2.10	76	71		229	97582.2			279	68	8.0	250			
	8		1.10	2.10	79	71		227	97968.8			276	68	8.5	250			
									98331.1									1015
1	1	5	0.77	1.50	76	73	-.48	224	98332.2			250	60	5.0	250			1035
	2		0.78	1.50	78	74		223	98651.1			250	58	6.0	245			
	3		0.96	1.85	79	75		232	98972.2			278	57	7.0	257			
	4		1.10	2.10	80	76		227	99325.5			278	54	8.0	298			
	5		1.05	2.00	78	76		229	99669.6			270	55	6.0	276			
Average			$\leq\sqrt{\Delta P}$															

H_2O Collected 1242 ml
SG Condition
SG Weight 34.9 gm
Total Volume Collected 1276.9 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2
	20.9		79.1

COMMENTS: This test was repeated at end of day

TRC Environmental Consultants, Inc.

FIELD DATA SHEET

Firm Name U.S GYPSUM
Plant Location Fort Dodge, Iowa
Test Number #4
Sampling Location Kettle #5 outlet condenser
TRC Project No. 1532-EDO-20
Date 10/30/86
Tester EDO / MAA

Orifice No. T-2
Ambient Temp. 40 °F
Bar. Press. 30.12 "Hg
Probe Ident. No. 49
Filter Ident. No. 100975
Duct Area .66 ft²
Dia 11"

Nozzle No. & Dia. 1-B 0.3127 in.
Assumed Moisture 60 %
Test Duration 80 min.
Traverse Point Interval 5 min.
Probe Heater Setting 250±25 °F
Filter Temp. Setting 250±25 °F
Dry Gas Meter Y 1.01

Nomograph C Factor N/A
Pitot Coefficient .0856
Orifice ΔH_A 2.14
Test Start Time 0935
Test Final Time 1115
Leak Test Start 0008 CFM 0 -11 "Hg
Leak Test Final 0.005 CFM 0 -10 "Hg

PAGE #2 OF 2

Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle ø	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %
1	6	5	1.10	2.10	74	76	-.48	228	100063			274	54	7.5	260		
	7	↓	.98	1.9	71	76	↓	234	100435			285	54	8.5	259		
	8	↓	.96	1.85	71	75	↓	232	100792			247	57	9.0	249		
									101143								
Average			$\Sigma\sqrt{\Delta P}$ .975	1.84	74	72	-.38	225	56.04								

H_2O Collected 1242 ml
SG Condition
SG Weight 34.9 gm
Total Volume Collected 1276.9 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2
	20.9		79.1

COMMENTS:

TRC Environmental Consultants, Inc.

FIELD DATA SHEET

Firm Name: US Gypsum
Plant Location: East Dodge
Test Number: 5
Sampling Location: Ref # 5 (Cont) Baghouse Inlet
TRC Project No.: 1532-E20
Date: 10/30/20
Tester: JC/DE

Orifice No.: T-1
Ambient Temp.: 60.5 °F
Bar. Press.: 30.50 "Hg
Probe Ident. No.: 28
Filter Ident. No.: 100 30 / 12x67
Duct Area: .99 ft²

Nozzle No. & Dia.: 2-8 .3127 in.
Assumed Moisture: 6.2 %
Test Duration: 20 min.
Traverse Point Interval: 1.0 min.
Probe Heater Setting: 270 °F
Filter Temp. Setting: 270 °F
Dry Gas Meter Y: 1.00

Nomograph K Factor: 1.6416
Pitot Coefficient: .860
Orifice ΔH_A: 1.98
Test Start Time: 1312 -- 1325
Test Final Time: 1354 - 1404
Leak Test Start: .005 CFM @ 20 "Hg
Leak Test Final: .005 CFM @ 20 "Hg

p. 1 of 2

Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle ∅	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %
A	1	10	47	77	70	70	-1.0	274	52477			275	60	5.0	240		
	2		47	77	70	70		266	52553.0			295		5			
	3		47	77	70	70		271	52579			262		5.0			
	4		44	73	70	70		267	52624			261		6			
	5		66	110	70	70		272	52670					10			
	6		80	130	70	70		271	52722					14			
	7		65	105	70	70		268	52790					15			
	8		68	110	70	70		265	52836					18			
	9		68	110	70	70		267	52892					20			
	10		70	115	70	70		266	52945					20			
									53011								
B	1		54	82	74	73		267	53058			260		5			
	2		56	82	74	73		271	53107								
	3		50	82	74	73		270	53155								
Average			$\Sigma\sqrt{\Delta P}$														

H_2O Collected: 295 ml
SG Condition:
SG Weight: 6.6 gm
Total Volume Collected: 240.6 + 301.6 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2
	20.9		79.1

COMMENTS:

TRC Environmental Consultants, Inc.

FIELD DATA SHEET

Firm Name: US Gypsum
Plant Location: Fort Dodge
Test Number: 5
Sampling Location: Kot #5 (Cont) Baghouse Inlet
TRC Project No.: 1532-1330
Date: 10/26/30
Tester: JC/DE

Orifice No.: T-1
Ambient Temp.: 65 °F
Bar. Press.: 30.50 "Hg
Probe Ident. No.: 23 / 80830
Filter Ident. No.: 101107
Duct Area: .99 ft²

Nozzle No. & Dia.: 28 .3127 in.
Assumed Moisture: 62 %
Test Duration: 20 min.
Traverse Point Interval: 1.0 min.
Probe Heater Setting: 270 °F
Filter Temp. Setting: 270 °F
Dry Gas Meter Y: 1.00

Nomograph Factor: 1.646
Pitot Coefficient: .862
Orifice ΔH_A: 1.93
Test Start Time: 1312 - 1325
Test Final Time: 1354 - 1404
Leak Test Start: .005 CFM @ 20 "Hg
Leak Test Final: .005 CFM @ 20 "Hg

6.282

Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle Ø	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %
	4		.54	.86	74	73	-1.02	274	532.03			270	60	8			
	5		.48	.78	74	73		271	532.52			270	60	10			
	6		.40	.67	74	73		266	533.01			270	60	11			
	7		.34	.56	74	73		263	533.47			264	60	12			
	8		.40	.61	74	73		263	533.88			264	60	12			
	9		.26	.43	74	73		265	534.33			269	60	12			
	10		.26	.43	74	73		265	534.70			269	60	12			
									535.06								
Average			$\Sigma\sqrt{\Delta P}$ 7.06	.85	72	72	-1	268	9.82								

H_2O Collected: ~~284~~ 225 ml
SG Condition:
SG Weight: 6.6 gm
Total Volume Collected: ~~240~~ 301.6 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2
	20.9		M.I

COMMENTS:

TRC Environmental Consultants, Inc.

FIELD DATA SH

Firm Name U.S GYPSUM
Plant Location Fort Dodge, Iowa
Test Number [illegible] 5
Sampling Location Kettle #5 out-let
TRC Project No. 1532-EPD-
Date 10-30-81
Tester MAA/EDA

Orifice No. DT-2
Ambient Temp. 60 °F
Bar. Press. 30.14 "Hg
Probe Ident. No. 49
Filter Ident. No. 10071
Duct Area .66 ft²

Nozzle No. & Dia. 3-2 0.2622 in.
Assumed Moisture 50 %
Test Duration 80 min.
Traverse Point Interval 5 min.
Probe Heater Setting 250 ± 25 °F
Filter Temp. Setting 250 ± 25 °F
Dry Gas Meter Y 1.01

Nomograph C Factor N/A
Pitot Coefficient 0.856
Orifice ΔH_A 2.14
Test Start Time 1230
Test Final Time 1350
Leak Test Start 0.000 CFM @ 10 "Hg
Leak Test Final 0.000 CFM @ 10 "Hg

Page # 1 of 2

Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle ø	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %
1	1	5	70	98	73	79		228	01166			241	60	3.0	239		
	2		75	105	76	78	-4	231	01436			280	58	4.0	225		
	3		91	125	77	76		230	01720			260	58	5.0	234		
	4		100	130	79	77		229	02010			240	57	5.0	280		
	5		110	150	79	77		229	02200			225	57	5.0	249		
	6		105	145	81	79		230	02606			248	52	5.0	273		
	7		105	145	81	79		229	02920			244	50	5.5	255		
	8		99	135	82	80		232	03241			242	50	6.0	270		
									03560								
2	1		75	107	83	80		225	03573			244	50	4.5	272		
	2		85	120	84	81		230	03850			245	50	5.0	258		
	3		95	130	84	81		231	04137			246	50	5.5	230		
	4		105	145	84	81		233	04435			242	50	6.0	225		
	5		105	145	84	81		232	04750			245	50	6.5	225		
Average			$\Sigma\sqrt{\Delta P}$														

H_2O Collected 1065 ml
SG Condition
SG Weight 14.9 gm
Total Volume Collected 1079.9 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2
	20.9		79.1

COMMENTS:

TRC Environ... Consult... Inc.

FIELD DATA SHEET

Firm Name: US GYPSUM
Plant Location: Ft. Dodge, Iowa
Test Number: #2.5
Sampling Location: Kuhlers out-let
TRC Project No.: 1532-E80-20
Date: 10-30-80
Tester: MAH/EDA

Orifice No.: T-2
Ambient Temp.: 60 °F
Bar. Press.: 30.14 "Hg
Probe Ident. No.: 49
Filter Ident. No.: 10071
Duct Area: .66 ft²

Nozzle No. & Dia.: 3-2 0.2622 in.
Assumed Moisture: 5.0 %
Test Duration: 360 min.
Traverse Point Interval: 5 min.
Probe Heater Setting: 250 ± 25 °F
Filter Temp. Setting: 250 ± 25 °F
Dry Gas Meter Y: 1.01

Nomograph C Factor: N/A
Pitot Coefficient: 0.856
Orifice ΔH_A: 2.14
Test Start Time: 1230
Test Final Time: 1350
Leak Test Start: 0.000 CFM @ 10 "Hg
Leak Test Final: 0.000 CFM @ 10 "Hg

Page # 2 of 2

Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle β	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %
2	6	5	1.10	1.50	86	82	-.4	234	050600			256	50	7.0	244		
	7		1.25	1.75	86	82		233	053860			245	53	7.0	238		
	8		1.25	1.75	86	83		232	057210			244	55	8.0	261		
									060680								
Average			$\Sigma\sqrt{\Delta P}$ 9.9	1.36	82	80	-.4	230	48.89								

H_2O Collected: 1065 ml
SG Condition:
SG Weight: 14.9 gm
Total Volume Collected: 1079.9 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2
	20.9		79.1

COMMENTS:

TRC Environmental Consultants, Inc.

FIELD DATA SHEET

Firm Name: US Gypsum
Plant Location: Ft Dodge
Test Number: 6
Sampling Location: Ket #5 (Coal) Baghouse Inlet
TRC Project No.: 1552-1E80
Date: 6/30/80
Tester: JC/DE

Orifice No.: T-1
Ambient Temp.: 70 °F
Bar. Press.: 30.32 "Hg
Probe Ident. No.: 28
Filter Ident. No.: 10076 / 10074
Duct Area: .99 ft²

Nozzle No. & Dia.: 2B .327 in.
Assumed Moisture: 02 %
Test Duration: 20 min.
Traverse Point Interval: 1.0 min.
Probe Heater Setting: 270 °F
Filter Temp. Setting: 270 °F
Dry Gas Meter Y: 1.00

Nomograph K Factor: 1.65
Pitot Coefficient: .862
Orifice ΔH@: 1.98
Test Start Time: 1523 - 1533
Test Final Time: 1553 - 1603
Leak Test Start: .005 CFM @ 20 "Hg
Leak Test Final: .005 CFM @ 15 "Hg

p. 1 of 2

Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle ∅	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %
B	1	1	50	82	75	76	-1.10	274	536.16		N/A	270	60	5	246		
	2		50	82	75	76		274	536.55					6			
	3		50	82	75	76		273	537.23					6			
	4		50	81	75	76		273	537.73					6			
	5		48	78	75	76		273	538.21					7			
	6		36	63	78	79		271	538.70					8			
	7		32	53	78	79		271	539.14					8			
	8		27	45	78	77		266	539.54					8			
	9		27	45	78	79		266	539.92					8			
	10		27	45	78	79		266	540.30					9			
									540.68								
A	1		41	67	78	79		267	541.00					5			
	2		32	64	78	79		272	541.48					4			
	3	V	40	67	78	79			541.92		V	V	V	0	V		
Average			$\Sigma\sqrt{\Delta P}$														

H_2O Collected: ~~854~~ 306 ml
SG Condition: ~~10.7~~ 3.7 gm
Total Volume Collected: ~~864.7~~ 309.7 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2
	20.9		79.1

COMMENTS:

TRC Environmental Consultants, Inc.

FIELD DATA SHEET

Firm Name US Gypsum
Plant Location Fort Dodge
Test Number 6
Sampling Location Kut #5 Inlet
TRC Project No. 1532-E20
Date 10/20/80
Tester JC/RE

Orifice No. T-1
Ambient Temp. 70 °F
Bar. Press. 30.32 "Hg
Probe Ident. No. 28
Filter Ident. No. 10076 (60.79)
Duct Area 99 ft²

Nozzle No. & Dia. 2-8 .3127 in.
Assumed Moisture 62 %
Test Duration 20 min.
Traverse Point Interval 1.0 min.
Probe Heater Setting 270 °F
Filter Temp. Setting 270 °F
Dry Gas Meter Y 1.00

K Nomograph Factor 1.05
Pitot Coefficient .862
Orifice ΔH_A 1.98
Test Start Time 1523 - 1533
Test Final Time 1553 - 1603
Leak Test Start 0.005 CFM @ 20 "Hg
Leak Test Final .005 CFM @ 15 "Hg

0.212

Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle ø	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %
	4	1.0	48	.69	79	80	-1.20	274	542.38		NA	268	66	9	240		
	5		42	.69	79	80		274	542.82					10			
	6		42	.69	79	80		269	543.29					10			
	7		45	.75	79	80		270	543.74					10			
	8		42	.69	79	80		265	544.21					11			
	9		40	.67	79	80		260	544.68					11			
	10		40	.67	79	80		260	545.12			↓	✓		↓		
									541.570								
Average			$\Sigma\sqrt{\Delta P}$ 6.35	.674	78	79	-1.15	256	9.22								

H_2O Collected 854 306 ml
SG Condition
SG Weight 10.7 3.7 gm
Total Volume Collected 864.7 309.7 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2
	20.9		79.1

COMMENTS:

TRC Environ Consult

FIELD DATA SHEET

Firm Name US GYPSUM
Plant Location Fort Dodge, Iowa
Test Number #6
Sampling Location #5 Kettle Outlet
TRC Project No. 1532-E80-20
Date 10/30/80
Tester EDA/MAA

Orifice No. T-2
Ambient Temp. 65 °F
Bar. Press. 30.09 "Hg
Probe Ident. No. 49
Filter Ident. No. ~~10084~~
Duct Area .66 ft²
DIA 11"

Nozzle No. & Dia. 3-2 0.2622 in.
Assumed Moisture 50 %
Test Duration 64 min.
Traverse Point Interval 4 min.
Probe Heater Setting 250±25 °F
Filter Temp. Setting 250±25 °F
Dry Gas Meter Y 1.01

Nomograph C Factor N/A
Pitot Coefficient 0.856
Orifice ΔH_A 2.14
Test Start Time 1452
Test Final Time ~~1824~~ 1559
Leak Test Start 0.005 CFM @ -11 "Hg
Leak Test Final 0.002 CFM @ -9 "Hg

PAGE #1 of 2

Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle β	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %
2	1	4	079	11	86	83	-36	226	6149			257	64	4.0	259		
4	2	1	078	096	91	83		229	6372			253	64	4.0	246		
8	3	1	089	125	86	83		231	6580			254	52	5.0	271		
12	4	1	090	125	85	83		233	6810			253	52	5.5	263		
16	5	1	11	155	86	83		232	7047			261	50	7.0	277		
20	6	1	12	170	86	83		232	7306			260	50	8.0	269		
24	7	1	12	170	86	83		232	7581			263	50	8.0	270		
28	8	1	12	170	86	83		232	7856			268	50	8.5	268		
32									8134								
1	1	4	085	92	87	84	-20	230	8134			263	50	5.0	274		
4	2	1	081	115	87	84		230	8341			261	50	6.0	267		
8	3	1	096	135	87	84		235	8566			261	50	7.5	272		
12	4	1	11	155	88	84		234	8812			263	50	8.0	268		
16	5	1	10	140	87	84		235	9073			262	50	8.0	268		
Average			$\Sigma\sqrt{\Delta P}$														

1527

H_2O Collected 854 ml
SG Condition
SG Weight 10.7 gm
Total Volume Collected 864.7 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2
	20.9		79.1

COMMENTS:

TRC Environ Consult Inc.

FIELD DATA SHEET

Firm Name U.S. Gypsum
Plant Location Fort Dodge, Iowa
Test Number #6
Sampling Location #5 Kettle Outlet
TRC Project No. 5532-E80-20
Date 10/30/80
Tester EDA/MAA

Orifice No. T-2
Ambient Temp. 65 °F
Bar. Press. 30.09 "Hg
Probe Ident. No. 49
Filter Ident. No. 10091
Duct Area 1.66 ft²
Dia 11"

Nozzle No. & Dia. 3-2 0.2622 in.
Assumed Moisture 50 %
Test Duration 64 min.
Traverse Point Interval 4 min.
Probe Heater Setting 250±25 °F
Filter Temp. Setting 250±25 °F
Dry Gas Meter Y 1.01

Nomograph C Factor N/A
Pitot Coefficient 0.856
Orifice ΔH_A 2.14
Test Start Time 1452
Test Final Time 1559
Leak Test Start 0.005 CFM @ -11 "Hg
Leak Test Final 0.002 CFM @ -9 "Hg

Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle ø	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %
20	1	4	1.1	1.55	87	84	-.26	234	96.326			262	50	8.5	268		
24	7		1.1	1.55	88	84		232	99.591			262	50	8.5	268		
28	8		1.0	1.40	88	85		233	98.53			262	50	8.0	268		
32									101.07								
Average			$\Sigma\sqrt{\Delta P}$ 9.9	1.38	87	84	-.28	232	39.58								

H_2O Collected 854 ml
SG Condition
SG Weight 101.7 gm
Total Volume Collected 864.7 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2
	20.9		79.1

COMMENTS:

TRC Environmental Consultants, Inc.

FIELD DATA SHEET

P-172

Firm Name: US Gypsum
Plant Location: E. Dodge, Iowa
Test Number: 4A
Sampling Location: Kothe 5 over-fire
TRC Project No.: 1532-80
Date: 10-30-80
Tester: MAA/EDA

Orifice No.: T-2
Ambient Temp.: 55 °F
Bar. Press.: 30.09 "Hg
Probe Ident. No.: 49
Filter Ident. No.: 100184
Duct Area: Dia 11" = 0.66 ft²

Nozzle No. & Dia.: 3-2, .2622 in.
Assumed Moisture: 50 %
Test Duration: 64 min.
Traverse Point Interval: 4 min.
Probe Heater Setting: 250 ± 25 °F
Filter Temp. Setting: 250 ± 25 °F
Dry Gas Meter Y: 1.01

Nomograph C Factor: N/A
Pitot Coefficient: .856
Orifice ΔH_A: 2.14
Test Start Time: 1704
Test Final Time: 1810
Leak Test Start: 0.000 CFM @ 10 "Hg
Leak Test Final: 0.002 CFM @ 9 "Hg

Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PRODE	Cyc. Angle β	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %
4	1	4	.70	1.00	84	83	-.45	229	101.178			249	56	4.0	262		
8	2		.67	.95	84	83		232	103.978			266	53	4.0	247		
12	3		.92	1.30	83	83		236	105.978			260	52	5.0	263		
16	4		.92	1.30	83	83		236	108.334			260	50	5.5	274		
20	5		.98	1.38	83	83		236	110.070			261	50	7.0	255		
24	6		1.05	1.48	83	82		236	111.317			261	50	7.0	260		
28	7		1.00	1.40	83	82		236	111.575			262	50	7.0	260		
32	8		1.00	1.40	84	82		236	111.823			261	50	7.5	256		
36									120.172								
40	1		.63	.88	84	82		232	120.172			268	50	5.5	259		
	2		.78	1.10	84	82		234	122.172			261	50	6.0	261		
48	3		.90	1.28	84	82		236	124.994			261	49	7.0	257		
52	4		.86	1.23	84	82		237	127.300			261	49	7.0	258		
56	5		1.10	1.50	84	82		238	129.655			262	49	7.0	261		
	Average		$\Sigma\sqrt{\Delta P}$														

H_2O Collected: 904 ml
SG Condition:
SG Weight: 9.55 gm
Total Volume Collected: 913.55 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2
	20.9		79.1

COMMENTS: Report of Test 4 outlet

TRC Environmental Consultants, Inc.

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FIELD DATA SHEET

Firm Name: US Gypsum
Plant Location: EI Dodge Tower
Test Number: #2 U/R
Sampling Location: Kehl #5 outlet
TRC Project No.: 1532E80
Date: 10-30-80
Tester: MAA/EDA

Orifice No.: T-2
Ambient Temp.: 55 °F
Bar. Press.: 30.09 "Hg
Probe Ident. No.: 49
Filter Ident. No.: 10084
Duct Area (Dia.): 11" 1/16 ft²

Nozzle No. & Dia.: 3-2 .2622 in.
Assumed Moisture: 50 %
Test Duration: 64 min.
Traverse Point Interval: 4 min.
Probe Heater Setting: 250 °F
Filter Temp. Setting: 250 °F
Dry Gas Meter Y: 1.01

Nomograph C Factor: N/A
Pitot Coefficient: .856
Orifice ΔH_A: 2.14
Test Start Time: 1704
Test Final Time: 1810
Leak Test Start: 0.000 CFM @ 10 "Hg
Leak Test Final: 0.000 CFM @ -7 "Hg

	Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %
20		6	4	1.15	1.60	85	83	-.45	238	132.20			260	48	7.0	261		
24		7	↓	1.20	1.70	84	83	↓	237	134.84			262	50	9.0	257		
28		8	↓	1.20	1.70	84	83	↓	237	137.54			262	50	9.5	2		
										140.25								
Average				$\Sigma\sqrt{\Delta P}$ 9.66	1.325	84	82	-.45	235	38.47								

H_2O Collected: 704 ml
SG Condition:
SG Weight: 9.55 gm
Total Volume Collected: 913.55 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2
	20.9		79.1

COMMENTS:

SAMPLING TASK LOG

Plant U.S. Gypsum
Date 10-31-90

Plant Location Fort Dodge Iowa
Recorded by EDA

Comments	Run	Sampling location (Port)	Pollutant	Clock Time Began	Clock Time Ended	Elapsed Time (min)	Sample Nos.
Repeat of RUN 3 Kettle 5 outlet	3R			0945	1233		
Board end saw baghouse outlet	7	A		1115	1135		
		B		1140	1200		
Board end saw	8	B		1310	1330		
		A		1355	1415		
Board end saw	9	A		1607	1627		
		B		1635	1655		

NOMOGRAPH DATA

PLANT U.S GYPSUM

DATE 10/21/80

SAMPLING LOCATION Kettle #5 outlet

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	2.14
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m_{avg.}}$	80
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{wo}	26.9
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	30.05
STATIC PRESSURE IN STACK, in. Hg ($P_m \pm 0.073$ x STACK GAUGE PRESSURE in in. H_2O)	P_s	-0.52
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	
AVERAGE STACK TEMPERATURE, °F	$T_{s_{avg.}}$	172
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	1.3
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	1.55
C FACTOR	0.80	
CALCULATED NOZZLE DIAMETER, in.	0.2	
ACTUAL NOZZLE DIAMETER, in.	0.1992	
REFERENCE Δp, in. H_2O	1.65	

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TRC Environmental Consultants, Inc.

FIELD DATA SHEET

Firm Name US GYPSUM
Plant Location Fort Dodge, Iowa
Test Number Run 3R
Sampling Location Kettle #5 Baghouse Outlet
TRC Project No. 1582-E8020
Date 10/24/80
Tester Eder/Mena

Orifice No. T-2
Ambient Temp. 65 °F
Bar. Press. 30.05 "Hg
Probe Ident. No. 49
Filter Ident. No. 10060
Duct Area .66 ft²

Nozzle No. & Dia. 1-1 0.1992 in.
Assumed Moisture 26.9 %
Test Duration 160 min.
Traverse Point Interval 5 min.
Probe Heater Setting 250±25 °F
Filter Temp. Setting 250±25 °F
Dry Gas Meter Y 1.01

Nomograph C Factor 0.8
Pitot Coefficient 0.856
Orifice ΔH_A 2.14
Test Start Time 0945
Test Final Time
Leak Test Start 0.000 CFM @ -11 "Hg
Leak Test Final 0.000 CFM @ 10 "Hg

Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle ∅	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %
	1	5	1.1	1.25	72	71	-.51	179	140837			263	46	2	253		
	2	10	1.1	1.25	72	71		179	143788			259	46	2	251		
	3	15	1.1	1.30	72	72		178	146607			254	46	2.0	251		
	4	20	1.1	1.25	72	71		182	149677			259	46	2.0	251		
	5	25	1.35	1.50	74	73		176	152599			260	46	3.5	248		
	6	30	1.50	1.70	76	73		178	155578			257	46	4.5	250		
	7	35	1.55	1.75	78	74		177	159118			254	46	5.0	250		
	8	40	1.50	1.70	79	75		176	162744			256	46	4.5	234		
	8	45	1.55	1.75	80	76	-.53	176	166607			277	46	5.0	255		
	7	50	1.50	1.70	81	77		176	169514			278	46	4.5	259		
	6	55	1.50	1.70	82	77		175	172944			279	44	5.0	253		
	5	60	1.40	1.60	83	78		175	176377			278	44	4.5	293		
	4	65	1.25	1.40	84	79		174	179717			277	44	4.5	253		
	3	70	1.20	1.35	86	80		173	182887			274	44	4.0	250		
Average			$\Sigma\sqrt{\Delta P}$														

H_2O Collected 225 ml
SG Condition
SG Weight 15.7 gm
Total Volume Collected 870.7 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2

COMMENTS: Repeat of Test 3 on 10/24

TRC Environmental Consultants, Inc.

FIELD DATA SHEET

Firm Name: US GYPSUM
Plant Location: Fort Dodge, Iowa
Test Number: ~~Run~~ 3R
Sampling Location: Kettle #5 Outlet Duct
TRC Project No.: 1522-EDO-20
Date: 10/6/80
Tester: EDO / MAA

Orifice No.: T-2
Ambient Temp.: 65 °F
Bar. Press.: 30.05 "Hg
Probe Ident. No.: 49
Filter Ident. No.: 10000
Duct Area: .66 ft²

Nozzle No. & Dia.: 1-1 0.192 in.
Assumed Moisture: 26.9 %
Test Duration: 160 min.
Traverse Point Interval: 5 min.
Probe Heater Setting: 250±25 °F
Filter Temp. Setting: 250±25 °F
Dry Gas Meter Y: 1.01

Nomograph C Factor: 0.8
Pitot Coefficient: 0.856
Orifice ΔH_A: 2.14
Test Start Time: 0945
Test Final Time:
Leak Test Start: 0000 CFM@ -11 "Hg
Leak Test Final: 0.000 CFM@ 10 "Hg

P2D3

Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle Ø	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %
2	2	5	0.93	1.05	81	81	-.53	172	185.93			280	44	4.0	250		
	1	↓	0.91	1.05	87	81	↓	168	188.69			266	44	4.0	248		
									191.37								
	1		0.75	0.85	87	83		167	191.37			266	44	4.0	284		
	2		1.10	1.25	88	83		168	193.98			255	44	4.0	285		
	3		1.30	1.47	87	83		162	196.93			264	44	4.5	235		
	4		1.35	1.50	88	83		152	200.15			260	42	4.5	225		
	5		1.30	1.48	87	83		149	203.45			280	42	4.5	225		
	6		1.40	1.60	87	83		153	206.70			280	42	5.0	225		
	7		1.50	1.70	87	83		174	210.00			285	42	5.0	230		
	8		1.35	1.52	87	83		195	213.40			266	43	5.0	267		
	8		1.35	1.52	87	83		199	216.74			240	44	5.0	265		
	7		1.30	1.48	87	83		198	220.04			225	44	5.0	242		
	6		1.35	1.52	87	83		193	223.33			241	44	5.0	225		
Average			$\Sigma\sqrt{\Delta P}$														

H_2O Collected: 855 ml
SG Condition:
SG Weight: 15.7 gm
Total Volume Collected: 870.7 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2

COMMENTS: * Temp dropping and no visible steam coming from stack

TRC Environmental Consultants, Inc.

FIELD DATA SHEET

Firm Name US GYPSUM
Plant Location Ft Dodge Iowa
Test Number ~~#~~ 3R
Sampling Location Kettle #5 outlet Baich
TRC Project No. 1532-E80
Date 10-31-80
Tester MAA/EOA

Orifice No. T-2
Ambient Temp. 65 °F
Bar. Press. 30.05 "Hg
Probe Ident. No. 47
Filter Ident. No. 10060
Duct Area 1.66 ft²

Nozzle No. & Dia. 1-1 0.1992 in.
Assumed Moisture 26.9 %
Test Duration 160 min.
Traverse Point Interval 5 min.
Probe Heater Setting 250 ± 25 °F
Filter Temp. Setting 250 ± 25 °F
Dry Gas Meter Y 1.01

Nomograph C Factor 0.8
Pitot Coefficient 0.856
Orifice ΔH_A 2.14
Test Start Time 0945
Test Final Time 1233
Leak Test Start 0.000 CFM @ 10 "Hg
Leak Test Final 0.000 CFM @ 10 "Hg

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Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle β	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %
	5	5	1.35	1.52	87	83		184	226.63			266	45	5.0	248		
	4		1.40	1.60	88	84		173	229.90			236	45	5.0	225		
	3		1.05	1.30	88	84		174	233.24			264	46	5.0	230		
	2		0.78	.82	88	84		181	236.45			265	46	5.0	225		
	1	↓	0.68	0.78	88	84		181	238.80			261	46	5.0	225		
									241.20								
Average			$\Sigma\sqrt{\Delta P}$ 1.88	1.40	88	84		-52	176								

100.37

H_2O Collected _____ ml
SG Condition _____
SG Weight _____ gm
Total Volume Collected _____ ml

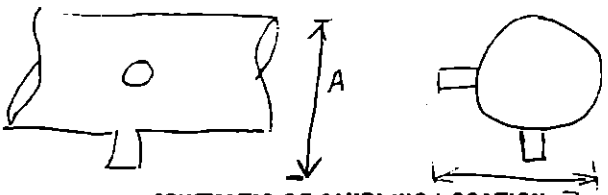
Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2
	20.9		79.1

COMMENTS: _____

TRAVERSE POINT LOCATION FOR CIRCULAR DUCTS

PLANT U.S. Gypsum
DATE 5/2/20
SAMPLING LOCATION Board Exit Saver Baghouse Outlet
INSIDE OF FAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE A) 17.5
INSIDE OF NEAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE B) 17.5
STACK I.D., (DISTANCE A - DISTANCE B) 11.5
NEAREST UPSTREAM DISTURBANCE < 2 Duct Dia
NEAREST DOWNSTREAM DISTURBANCE < 8 Duct Dia
CALCULATOR LAG



SCHEMATIC OF SAMPLING LOCATION

TRAVERSE POINT NUMBER	FRACTION OF STACK I.D.	STACK I.D.	PRODUCT OF COLUMNS 2 AND 3 (TO NEAREST 1/8 INCH)	DISTANCE B	TRAVERSE POINT LOCATION FROM OUTSIDE OF NIPPLE (SUM OF COLUMNS 4 & 5)
1	0.067	11.5	.7705	6 in	6.7705
2	0.250	↓	2.875	↓	8.875
3	0.750	↓	8.625	↓	14.625
4	0.933	↓	10.73	↓	16.73

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PRELIMINARY VELOCITY TRAVERSE

PLANT US Gypsum
DATE 10/31/80
LOCATION Board End Sawer - baghouse Outlet
STACK I.D. 11.5
BAROMETRIC PRESSURE, in. Hg 30.40
STACK GAUGE PRESSURE, in. H_2O -0.10
OPERATORS JC
Cp .86

SCHEMATIC OF TRAVERSE POINT LAYOUT

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
1	2.7	68
2	3.0	68
3	2.8	68
4	2.7	68
AVERAGE	1.67	68

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
AVERAGE		

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NOMOGRAPH DATA

PLANT US Gypsum

DATE 10/31/80

SAMPLING LOCATION Board End Sawer Baghouse Outlet

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.98
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m_{avg.}}$	80
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{wo}	3
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	30.50
STATIC PRESSURE IN STACK, in. Hg ($P_m \pm 0.073$ x STACK GAUGE PRESSURE in in. H_2O)	P_s	-.10
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	
AVERAGE STACK TEMPERATURE, °F	$T_{s_{avg.}}$	70
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	2.80
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	3.00
C FACTOR		1.05
CALCULATED NOZZLE DIAMETER, in.		.15
ACTUAL NOZZLE DIAMETER, in.		.19
REFERENCE Δp, in. H_2O		1.05

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TRC Environmental Consultants, Inc.

FIELD DATA SHEET

Firm Name: US Gypsum
Plant Location: Fort Dodge
Test Number: 7
Sampling Location: Board End Saw / Baghouse Outlet
TRC Project No.: 4532-1E30
Date: 10/31/90
Tester: JC / DE

Orifice No.: T-1
Ambient Temp.: 65 °F
Bar. Press.: 30.50 "Hg
Probe Ident. No.: 28
Filter Ident. No.: 10083
Duct Area: 11.5 .72 ft²

Nozzle No. & Dia.: 3-1 .1760 in.
Assumed Moisture: 3 %
Test Duration: 40 min.
Traverse Point Interval: 5 min.
Probe Heater Setting: 250 °F
Filter Temp. Setting: 250 °F
Dry Gas Meter Y: 1.00

Nomograph C Factor: 1.05
Pitot Coefficient: .862
Orifice ΔH_A: 1.98
Test Start Time: 1115-1135
Test Final Time: 1140-1200
Leak Test Start: .001 CFM @ 10 "Hg
Leak Test Final: .00 CFM @ 8 "Hg

Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle ∅	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %
S	1	5	270	4.60	53	52	-.60	72	558735		NA	240	50	7	230		
	2		250	4.20	53	52		71	564335			245	50	6	235		
	3		270	4.60	53	52		71	569725			255	50	6	235		
	4		250	4.20	53	52		71	575205			255	50	6	235		
									586533								
B	1		280	4.20	53	52	-.30	71	580533			244	50	6	220		
	2		300	5.20	56	54		71	585905			245	50	8	220		
	3		280	4.80	58	57		71	591543			245	50	7	220		
	4		250	4.20	58	57		71	597222		V	253	50	7	220		
									602533								
Average			$\Sigma\sqrt{\Delta P}$ 1.12 7	4.55	55	53	-.45	71	4378								

54

H_2O Collected: 0 ml
SG Condition:
SG Weight: 11.4 gm
Total Volume Collected: 11.4 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2
	20.9		77.1

COMMENTS:

TRC Environmental Consultants, Inc.

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FIELD DATA SHEET

Firm Name: US Gypsum
Plant Location: Fort Dodge
Test Number: 1
Sampling Location: Board End Saver Exhaust outlet
TRC Project No.: 1532-E80
Date: 10/31/80
Tester: JC/DE

Orifice No.: T-1
Ambient Temp.: 65 °F
Bar. Press.: 30.50 "Hg
Probe Ident. No.: 3C9
Filter Ident. No.: [illegible]-1
Duct Area: 11.5 ft²

Nozzle No. & Dia.: 2-1 .199 in.
Assumed Moisture: 3 %
Test Duration: 40 min.
Traverse Point Interval: 5 min.
Probe Heater Setting: 250 °F
Filter Temp. Setting: 250 °F
Dry Gas Meter Y: 1.00

Nomograph C Factor: 1.15 / 485
Pitot Coefficient: .84
Orifice ΔH_A: 1.98
Test Start Time: 1310 - 1330
Test Final Time: 1415
Leak Test Start: .002 CFM @ 10 "Hg
Leak Test Final: 002 CFM @ 10 "Hg

Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle ø	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %
B	1	5	.38	.48	65	64	-.20	76	60.310			240	50	5	220		
	2	5	.36	.52	65	64		76	66.370			238	50	6	220		
	3	5	.25	.39	67	65		76	71.460			245	50	6	220		
	4	5	.32	.35	67	65		76	76.195			242	50	5	220		
									82.468								
A	1	5	.29	.45	67	65		76	82.468			236	52	5	220		
	2	5	.30	.48	67	65		72	87.290			240	50	6	220		
	3	5	.25	.39	67	65		72	92.357			246	50	7	220		
	4	5	.21	.25	67	65	✓	72	96.480			246	50	7	220		
									96.542								
Average			$\xi\sqrt{\Delta P}$ 1.63	.423	66.5	64.15	-.20	74.5	42.32								

H_2O Collected: 0 ml
SG Condition:
SG Weight: 13.99 gm
Total Volume Collected: 13.99 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2
	20.9		79.1

COMMENTS:

TRC Environ... Consult... Inc.

FIELD DATA SHEET

Firm Name US Gypsum
Plant Location Fort Dodge
Test Number 9
Sampling Location Beard End Saver Baghouse Outlet
TRC Project No. 1522-E30
Date 10/31/86
Tester JC/DE

Orifice No. T-1
Ambient Temp. 65 °F
Bar. Press. 30.50 "Hg
Probe Ident. No. 28
Filter Ident. No.
Duct Area .72 ft² (11.5)

Nozzle No. & Dia. 3-1 .196 in.
Assumed Moisture 3 %
Test Duration 40 min.
Traverse Point Interval 5 min.
Probe Heater Setting 250 °F
Filter Temp. Setting 250 °F
Dry Gas Meter Y 1.00

Nomograph C Factor 1.05
Pitot Coefficient .862
Orifice ΔH_A 1.98
Test Start Time 1607 - 1627
Test Final Time 1635 - 1655
Leak Test Start .001 CFM @ "Hg
Leak Test Final .001 CFM @ 10 "Hg

Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle β	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %
A	1	5	2.50	4.20	65	66	-.20	70	64.566		NA	150	50	7	220		
	2		3.00	5.20	65	66		70	650.88			175	50	7	220		
	3		2.40	4.05	65	66		70	656.73			190	50	7	220		
	4		2.20	3.75	65	66		70	662.05			200	50	7	220		
									667.55								
B	1	5	2.60	4.40	65	66		70	672.05			215	50	7	220		
	2		2.80	4.60	65	66		70	677.55			220	50	7			
	3		2.60	4.40	65	66		70	683.12			232	50	7			
	4		2.40	4.05	65	66		70	688.65		V	245	50	7			
									694.14								
Average			$\Sigma\sqrt{\Delta P}$ 11.6	4.33	65	66	-.20	70	43.54								

H_2O Collected -6 ml
SG Condition
SG Weight 12.9 gm
Total Volume Collected 6.9 ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2

COMMENTS:

APPENDIX B

PARTICLE SIZE TESTS

Includes:

B.1 Anderson Cascade Impactor Test
B.2 Bahco Centrifugal Separator Tests

APPENDIX B.1

ANDERSON CASCADE IMPACTOR TEST

TRC Environmental Consultants, Inc.

FIELD DATA SHEET

Firm Name US Gypsum
Plant Location Ft Dodge
Test Number 10 - Part Size
Sampling Location Board End Sawer Baghouse Outlet
TRC Project No. 1532-E80
Date 10/31/80
Tester JC/DE

Orifice No. T-1
Ambient Temp. 65 °F
Bar. Press. 30.50 "Hg
Probe Ident. No. —
Filter Ident. No. —
Duct Area 11.5 ft²

Nozzle No. & Dia. 2-1 .199 in.
Assumed Moisture 3 %
Test Duration 90 min.
Traverse Point Interval 5 min.
Probe Heater Setting NA °F
Filter Temp. Setting NA °F
Dry Gas Meter Y 1.00

Nomograph C Factor 1.05
Pitot Coefficient .84
Orifice ΔH_A 1.78
Test Start Time 1710-1840
Test Final Time 1840
Leak Test Start .02 CFM 15 "Hg
Leak Test Final .02 CFM 15 "Hg

p. 1 of 2

Port	Point	Time Min.	Velocity ΔP in H_2O	Δh in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle ø	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %
S	3	5.0	.02	.45	65	65	-.020	70	698.45								
					65	65			703.85								
					65	65			709.40								
					65	65			714.95								
					63	63			720.50								
					60	60			725.20								
					60	60			731.50								
					60	60			736.15								
					60	60			742.62								
					60	60			746.05								
					60	60			753.70								
					57	57			759.23								
					57	57			764.75								
					56	56			770.28								
Average			$\Sigma\sqrt{\Delta P}$														

H_2O Collected ____ ml
SG Condition ____
SG Weight ____ gm
Total Volume Collected ____ ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2

COMMENTS: ____

TRC Environ[illegible] Consult[illegible] Inc.

FIELD DATA SH

Firm Name US Gypsum
Plant Location Ft Dodge
Test Number 10 -- Part Size
Sampling Location Board End Sander Baghouse Outlet
TRC Project No. 1532-080
Date 10/31/80
Tester JC/DE

Orifice No. T-1
Ambient Temp. 65 °F
Bar. Press. 30.50 "Hg
Probe Ident. No.
Filter Ident. No.
Duct Area ft²

Nozzle No. & Dia. in.
Assumed Moisture %
Test Duration min.
Traverse Point Interval min.
Probe Heater Setting °F
Filter Temp. Setting °F
Dry Gas Meter Y

Nomograph C Factor
Pitot Coefficient
Orifice ΔH_A
Test Start Time
Test Final Time
Leak Test Start CFM "Hg
Leak Test Final .02 CFM 15 "Hg

p. 2 of 2

Port	Point	Time Min.	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M out °F	P_{Stack} in H_2O	T_{Stack} °F	Gas Sample Volume cu. ft.	PROBE	Cyc. Angle Ø	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 %	CO_2 %
		50		450	56	56	-0.20	70	775.80					12			
		↓		↓	56	56	↓	↓	781.40								
					56	56			786.85								
		↓		↓	56	56	↓	↓	792.40								
									796.83								
Average			$\Sigma\sqrt{\Delta P}$														

H_2O Collected ml
SG Condition
SG Weight gm
Total Volume Collected ml

Orsat Bag Sample Triplicate Analysis, %

CO_2	O_2	CO	N_2

COMMENTS:

DISCUSSION OF PARTICLE SIZE TESTING AT THE BOARD END SAW BAGHOUSE OUTLET

An Anderson Mark II In-Stack Cascade Sampler was operated in its instack mode and attached directly to the front end of a standard EPA Method 5 train. Sampling was performed isokinetically, and data was recorded in much the same manner as for the EPA Method 5 train with the exception that sampling was performed at only one point.

The impact unit consists of a cyclone preseparator and seven impactor stages followed by a built-in backup filter stage. All parts are constructed of stainless steel. The unit is designed to hold eight pre-weighed radially-slotted glass fiber filters and one glass backup filter.

An impactor with particle collector filters on each stage was used because it offered low tare weights and caused minimal particle retainment (compared to steel plate collection). The sampled air stream accelerates through four radial slots on every stage. A particle will pass through each stage until it acquires sufficient momentum to impact on one of the collector filter. The backup filter is designed to capture all particles which do not deposit on a stage filter. The particle size cutoff for all stages depends on the operating conditions during a test. The equations used to calculate the particle size cutoff for the impaction stages are as follows (Equations B-1 through B-6):

$$D_p50 = 10^4 \times \frac{18\mu\ \Psi_N \Pi\ D_c^3}{4\ C\rho_p Q} \qquad \text{Eq. B-1}$$

Where:

D_p50	=	50% effective cutoff diameter of particle, μm
μ	=	gas viscosity, poise
Ψ	=	dimensionless inertial impaction parameter, 0.14
N	=	number of jets per plate
D_c	=	jet diameter, cm
C	=	Cunningham slip correction factor
ρ_p	=	density of particle, gm/cm^3
Q	=	volumetric flow rate, cm^3/sec

ANDERSON CASCADE IMPACTOR PARTICLE SIZING TEST RESULTS
AT U.S. GYPSUM COMPANY, FORT DODGE, IOWA

Run Number:	Board End Saw Baghouse Outlet
Date:	10-31-80
Total Mass Collected (mg)	2.76
Total Meter Volume (ft^3)	98.38
Barometric Pressure (inches Hg)	30.50
Orifice Pressure Drop (inches Hg)	4.50
Meter Temperature (^oF)	59.83
Dry Gas Fraction -- $(1 - \frac{\%H_2O}{100})$	0.989 (From Particulate Tests)
Stack Temperature (^oF)	70
Static Pressure (inches Hg)	-0.20
Time (minutes)	90
Molecular Weight (grams/gram-mole)	28.73
Particle Density (grams/cc)	1.00
Cyclone (milligrams collected)	0.48
Stage 0 (milligrams collected)	ND (None Detected)
Stage 1 (milligrams collected)	0.32
Stage 2 (milligrams collected)	0.18
Stage 3 (milligrams collected)	0.39
Stage 4 (milligrams collected)	0.58
Stage 5 (milligrams collected)	0.47
Stage 6 (milligrams collected)	ND
Stage 7 (milligrams collected)	ND
Backup Filter (milligrams collected)	0.34
Volume of Gas Sampled (DSCF)	102.98
Particulate Concentration (gr/DSCF)	0.000413
Volumetric Flowrate (ACFM)	1.14
η (micropoise)	182.2
λ (μm)	0.066
Cyclone	7.957
Cutoff Stage 0 (p = 1.0)μm	8.778
Cutoff Stage 1 (p = 1.0)μm	5.469
Cutoff Stage 2 (p = 1.0)μm	3.699
Cutoff Stage 3 (p = 1.0)μm	2.514
Cutoff Stage 4 (p = 1.0)μm	1.606
Cutoff Stage 5 (p = 1.0)μm	0.796
Cutoff Stage 6 (p = 1.0)μm	0.486
Cutoff Stage 7 (p = 1.0)μm	0.327

Where:

Q	=	volumetric flow rate through impactor, acfm
Vm	=	dry gas meter volume, ft^3
DGF	=	dry gas fraction
Ts	=	stack temp, ^oR
Ps	=	stack pressure, inches Hg
Tm	=	meter temp, ^oR
Pm	=	meter pressure, inches Hg
t	=	time, minutes
DGF	=	1 - % H_2O/100.

The cascade impactor determined the aerodynamic particle size distribution. Aerodynamic particle sizing differs from geometric sizing in that a mass of particles containing various shapes and densities is fractionated and collected according to each particles aerodynamic characteristics. A particle collected on a given stage is aerodynamically equivalent in size to the unit density sphere (1 g/cc) collected on that stage during calibration.

Particle size distributions are normally plotted cumulatively on log-normal graph paper. In this format, the total mass W_i on each stage, including the backup filter, is added up and the percent of the total mass that collected on a given stage and on all smaller D_p stages is plotted against the D_p for that stage. The size is typically plotted on terms of "Equivalent Aerodynamic Diameter": the size of a spherical particle of unit density which has the same terminal settling velocity as the sampled particle.

Each of the eight filters was placed in a petri dish and transferred to the laboratory for analysis. Each filter was desiccated and weighed repeatedly until a constant weight was obtained. The contents of the cyclone preseparator sample container were collected in a glass jar, transferred to a preweighted beaker, desiccated, and weighed to a constant weight. Results are reported to the nearest 0.01 mg.

Where:

C = Cunningham slip correction factor

$$C = 1 + \frac{2\lambda}{D_p}\ 1.257 + 0.40 \exp\ (-1.10\ D_p/2\lambda) \qquad \text{Eq. B-2}$$

$$C = 1 + (0.16 \times 10^{-4} D_p) \qquad \text{Eq. B-3}$$

for normal temperatures and pressures

ρ = particle density, 1 gm/cm^3
Q = actual gas flow rate, cm^3/sec
λ = mean free path for gas molecules, μm

and

$$\mu = \frac{BT^{3/2}}{T + S} \qquad \text{Eq. B-4}$$

Where:

B = 14.58 μg sec^{-1}cm^{-1} (^{o}K)$^{-1/2}$
S = 110.4^{o}K
T = ^{o}K

Where:

d = particle diam, μm
λ = mean free path, μm

and

$$2\lambda = 2.3 \times 10^{-4} \times \frac{\mu}{p}\ \frac{T}{m}^{1/2} \qquad \text{Eq. B-5}$$

Where:

T = gas temp, ^{o}K = ^{o}C + 273
p = pressure, atmospheres
m = gas molecular wt (wet), g/g-mole

Note that gravitational constant, gc, is not shown.

and

$$Q = \frac{Vm}{DGF}\ \frac{Ts}{Ps}\ \frac{Pm}{Tm}\ \frac{1}{t} \qquad \text{Eq. B-6}$$

APPENDIX B.2

BAHCO CENTRIFUGAL SEPARATOR TESTS

York Wastewater Consultants, Inc.

One Research Drive
Stamford, Connecticut 06906
Telephone: (203) 325-1371
TWX: 710-474-3947

01-3081-192

TRC ENVIRONMENTAL CONSULTANTS, INC.

PURPOSE AND RESULTS:

Six (6) gypsum samples were submitted to the Analytical Laboratories Division of York Wastewater Consultants, Inc. for particle size distribution analysis. The samples were pre-sieved and analyzed according to the American Society of Mechanical Engineers Power Test Code 28. The results are attched hereto.

Prepared by: Robert B Shepherd

Robert B. Shepherd
Laboratory Technician

SIEVE ANALYSIS AND BAHCO PARTICLE CLASSIFICATION

Job No. 01-3081-192 TRC

Date: 12/12/80

Sample Description: #54219; KTS-I-6 (#100% #10079 - contact w/M&O)

Initial Weight of Sample: 11.0849

Spec. Grav. of Sample: 2.96

BAHCO APPARATUS

Throttle No.	18	17	16	14	12	8	4	0
No. Weight 44 Microns (g)	1.158	1.158	1.158	1.158	1.158	1.158	1.158	1.158
Weight Remaining (g)	1.056	0.9194	0.7517	0.4925	0.1827	0.0145	.0043	0.0025
Net Weight Smaller (g)	0.102	0.2386	0.4063	0.6655	0.9753	1.1435	1.1537	1.1555
Terminal Velocity (In/Min)	0.32	0.85	3.40	11.4	28.8	102	160	210
Equivalent Micron Size, D_p	1.20	1.95	3.30	7.15	11.60	21.32	22.00	31.01
% Less Than D_p	8.81	20.60	35.09	57.47	84.22	98.7%	99.63	99.78

STANDARD SIEVES

Equivalent Micron Size	763	463, 745	445	
Initial Weight (g)	11.0849	11.0849	11.0849	
Weight Remaining (g)	4.6249	5.302	1.158	
% Remained	41.72	47.83	10.44	

Analyst: Robert B Shepherd

Approved: RBS

SIEVE ANALYSIS AND BAECO PARTICLE CLASSIFICATION

Job No. 01-3081-192 TRC

Date: 12/17/80

Sample Description: *54218; KT-5-I-5 C (#10069 Possible contact w/#80) #10080

Initial Weight of Sample: 10.1503

Spec. Grav. of Sample: 2.96

BAECO APPARATUS

Throttle No.	18	17	16	14	12	8	4	0
No. Weight 44 Microns (g)	6.6664	6.6664	6.6664	6.6664	6.6664	6.6664	6.6664	6.6664
Weight Remaining (g)	6.3237	5.751	4.9822	2.8698	1.2255	0.1679 ~~0.687~~	0.0338	0.0086
Net Weight Smaller (g)	0.3427	0.9154	1.6842	3.7966	5.4409	6.4985	6.6326	6.6578
Terminal Velocity (In/Min)	0.32	0.85	3.40	11.4	28.8	102	160	210
Equivalent Micron Size, D_p	1.20	1.95	3.30	7.15	11.60	21.32	27.06	31.01
% Less Than D_p	5.14	13.73	25.26	56.95	81.62	97.48	99.49	99.87

STANDARD SIEVES

Equivalent Micron Size	763	463, 745	245	
Initial Weight (g)	10.1503	10.1503	10.1503	
Weight Remaining (g)	1.6669	1.817	6.6664	
% Retained	16.42	17.90	65.68	

Analyst: Robert B Shepherd

Approved: RBS

SIEVE ANALYSIS AND BAECO PARTICLE CLASSIFICATION

Job No. 01-3081-192 TRC

Date: 12/17/80

Sample Description: # 54217; K75-I-4 (#10073 - contact w/ H_2O) #10078

Initial Weight of Sample: _____

Spec. Grav. of Sample: 2.96

BAECO APPARATUS

Throttle No.	18	17	16	14	12	8	4	0
Wt. Weight 44 Microns (g)	5.0085	5.0085	5.0085	5.0085	5.0085	5.0085	5.0085	5.0085
Weight Remaining (g)	4.7073	4.2236 ~~4.1954~~	3.3497	2.0507	0.838	0.1194	0.023	-0083 ~~.00489~~
Net Weight Smaller (g)	0.3012	0.7849	1.6588	2.9578	4.1705	4.8911	4.9855	5.002
Terminal Velocity (In/Min)	0.32	0.85	3.40	11.4	28.8	102	160	210
Equivalent Micron Size, D_p	1.20	1.95	3.30	7.15	11.60	21.32	29.00	31.01
% Less Than D_p	6.01	15.67	33.12	59.06	83.27	97.66	99.54	99.87

STANDARD SIEVES

Equivalent Micron Size	763	463,745	245	
Initial Weight (g)	9.9284	9.9284	9.9284	
Weight Remaining (g)	2.3976	2.5223	5.0085	
% Retained	24.15	25.40	50.45	

Analyst: Robert B Shepherd

Approved: BJH

SIEVE ANALYSIS AND BAHCO PARTICLE CLASSIFICATION

Job No. 1-3081-192 TRL

Date: 12/17/80

Sample Description: KTS-I-3; *100% contact w/H_2O #54216

Initial Weight of Sample: 10.081

Spec. Grav. of Sample: 2.96

BAHCO APPARATUS

Throttle No.	18	17	16	14	12	8	4	0
Wo. Weight 44 Microns (g)	3.1156	3.1156	3.1156	3.1156	3.1156	3.1156	3.1156	3.1156
Weight Remaining (g)	2.9097	2.6833	2.2898	1.61	0.7169	0.1436	0.0422	0.0245
Net Weight Smaller (g)	0.2059	0.4323	0.8258	1.5056	2.3987	2.972	3.0734	3.0911
Terminal Velocity (In/Min)	0.32	0.85	3.40	11.4	28.8	102	160	210
Equivalent Micron Size, D_p	1.20	1.95	3.30	7.15	11.60	21.32	27.00	31.01
% Less Than D_p	6.61	13.88	26.50	47.70	76.99	95.39	98.64	99.21

STANDARD SIEVES

Equivalent Micron Size	>63	263,>45	<45	
Initial Weight (g)	10.081	10.081	10.081	
Weight Remaining (g)	5.8035	1.1619	3.1156	
% Retained	57.88	11.53	30.91	

Analyst: Robert B Shepherd

Approved: OB

SIEVE ANALYSIS AND BAHCO PARTICLE CLASSIFICATION

Job No. 1-3081-192, TRC

Date: 12/16/80

Sample Description: #54215; KT-5-2 #10069 #10070

Initial Weight of Sample: 10.0732

Spec. Grav. of Sample: 2.96

BAHCO APPARATUS

Throttle No.	18	17	16	14	12	8	4	0
No. Weight 44 Microns (g)	3.0088	3.0088	3.0088	3.0088	3.0088	3.0088	3.0088	3.0088
Weight Remaining (g)	2.3655	2.1987	1.9158	1.4445	0.8225	0.3048	0.1972	0.1505
Net Weight Smaller (g)	0.6433	0.8301	1.093	1.5943	2.1863	2.704	2.8116	2.8583
Terminal Velocity (In/Min)	0.32	0.85	3.40	11.4	28.8	102	160	210
Equivalent Micron Size, D_p	1.20	1.95	3.30	7.15	11.60	21.32	27.00	31.01
% Less Than D_p	21.38	27.59	36.34	52.99	72.66	89.87	93.44	95.00

STANDARD SIEVES

Equivalent Micron Size	763	463,749	145	
Initial Weight (g)	10.0732	10.0732	10.0732	
Weight Remaining (g)	5.6953	1.3691	3.0088	
% Remained	56.54	13.59	29.87	

Analyst: Robert B Shepherd

Approved: RBS

SIEVE ANALYSIS AND BAECO PARTICLE CLASSIFICATION

Job No. 01-3081-192 TRC

Date: 12/16/80

Sample Description: #5414; K75-I-1 #10061 #10068

Initial Weight of Sample: 11.9954

Spec. Grav. of Sample: 2.96

BAECO APPARATUS

Throttle No.	18	17	16	14	12	8	4	0
Wo. Weight 44 Microns (g)	9.0768	9.0768	9.0768	9.0768	9.0768	9.0768	9.0768	9.0768
Weight Remaining (g)	8.0226	7.1862	6.0424	4.2704	2.0558	0.4429	0.1276	0.00686
Net Weight Smaller (g)	1.0542	1.8906	3.0344	4.8064	7.021	8.6339	8.9492	9.06994
Terminal Velocity (In/Min)	0.32	0.85	3.40	11.4	28.8	102	160	210
Equivalent Micron Size, D_p	1.20	1.95	3.30	7.15	11.60	21.32	27.06	31.01
% Less Than D_p	11.61	20.82	33.43	53.13	77.35	95.12	98.59	99.92

STANDARD SIEVES

Equivalent Micron Size	763	463,745	245	
Initial Weight (g)	11.9954	11.9954	11.9954	
Weight Remaining (g)	1.6384	1.2802	9.0768	
% Retained	13.66	10.67	75.67	

Analyst: Robert B Shepherd

Approved: (GB)

Measuring the Properties of Fine Particulate Matter

POWER TEST CODES

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
United Engineering Center
345 East 47th Street New York, N.Y. 10017

SECTION 4, TEST METHODS

4.01 The following test methods shall be employed to determine those physical and chemical properties of dust defined in Section 2 of this Code.

4.02 – METHOD FOR THE DETERMINATION OF TERMINAL VELOCITY DISTRIBUTION

Apparatus:

1. Centrifugal Classifier, conforming to the description in the Appendix, see Figs. 1 and 2.
2. Chemical Balance.
3. Scoop, spatula, soft brush, large sheets of glazed paper.
4. Sieve, 100 mesh (U.S. Sieve Size).

Procedure:

1. Dry the sample in a drying oven at a temperature of 105–110 C to constant weight. Cool in a desiccator. Weigh out a portion of the dried sample of approximately 10 grams. Record the weight to the nearest 0.01 gram as W_s. See Note 3.
2. Screen the weighed sample through the 100 mesh sieve. Weigh the portion of the sample passing through the sieve. Record the weight as W_o.
3. Insert the largest throttle spacer, Throttle *A*, under the grading member of the Centrifugal Classifier and secure.
4. Transfer the portion of the sample weighed in Step 2 to the feed hopper. Replace the hopper cover and secure.
5. Start the rotor motor. When the rotor reaches maximum speed, start the nitrogen flow. See Note 4. Turn on the vibrator and brush motor. The vibrator may be controlled by the rheostat.
6. After approximately five minutes of operation, switch off the brush motor and the vibrator. Turn off the nitrogen flow. Remove the cover from the feed hopper. Estimate the quantity of sample that has been fed into the classifier and ascertain whether the feed rate is within limits. See Note 5. If the adjustable slide and the brush have been properly positioned, the feed rate can be adjusted to the correct value by means of the vibrator rheostat.
7. Replace the cover on the feed hopper. Start the nitrogen supply. Turn on the vibrator and the brush motor. Adjust the vibrator to obtain correct feed rate.
8. Continue operation until the feed hopper is empty. Switch off the brush motor and the vibrator. Turn off the nitrogen flow. Switch off the rotor motor and stop the rotor by gently applying the brake.
9. Swing the cover casing up out of the way. Remove the knurled locking ring. Raise the upper rotor assembly out of the lower section and place it on a large sheet of clean glazed paper.
10. Brush the adhering dust to the bottom of the catch basin. Detach the catch basin. Collect the dust from the catch basin plus any that spills on the glazed paper and weigh. Record the weight as W_a.
11. Reassemble the catch basin and the upper rotor assembly and secure the knurled locking ring. Replace the throttle spacer with the next smaller size, Throttle B.
12. Transfer the sample weighed in Step 10 to the feed hopper. Repeat Steps 5 through 10, recording the weight of sample as W_b. See Note 5.
13. Repeat Steps 5 through 12 for each of the remaining throttles, using as feed the residue from the preceeding run. Record the weights as W_c, W_d, W_e, etc.

Calculations:

1. Calculate the Weight Per Cent Smaller Than Indicated Size corresponding to the Terminal Velocity values for each throttle as follows, using the terminal velocity values obtained for each throttle during calibration of the Centrifugal Classifier.

$F_a = 100\,(W_o - W_a)/W_s$, and

$F_b = 100\,(W_o - W_b)/W_s$, and

$F_c = 100\,(W_o - W_c)/W_s$, etc., where

F_a, F_b, F_c, etc. = fraction of sample in weight per cent, having terminal velocities less than U_a, U_b, etc.

U_a, U_b, U_c, etc. = Terminal Velocity values in inches per minute, assigned to Throttles *A*, *B*, *C*, etc.

W_s = weight of sample.

W_o = weight of that portion of the sample passing through 100 mesh sieve.

W_a, W_b, W_c, etc. = weights of sample remaining after fractionation using Throttles *A*, *B*, *C*, etc. respectively.

2. The data obtained above should be plotted on logarithmic probability graph paper, the logarithm of the Terminal Velocity (in inches per minute) versus the Weight Per Cent Smaller Than Indicated Size. A typical curve is shown in Fig. 3 in the Appendix.

Notes:

1. Prior to conducting any terminal velocity distribution analyses in accordance with this Code, the Centrifugal Classifier should be installed and calibrated in accordance with the procedure described in the Appendix. The calibration should be checked periodically by testing a portion of material previously tested which has a known terminal velocity distribution.
2. Clean the Centrifugal Classifier thoroughly before each test, making sure that no films remain which would cause dust particles to adhere to the surface of the apparatus.
3. Particular care should be taken to insure that the 10 gram sample used in this test is representative of the gross sample in respect to particle size.
4. The nitrogen gas pressure should not exceed one-half inch of mercury as registered on the manometer. Higher pressures will tend to blow the sample out of the cup section in the upper rotor. This will contaminate the sample on the stop ring. If this condition exists, it will be indicated by a fine coating of material on the lock ring.
5. The sample need not be inspected during the subsequent runs (Steps 6 and 7) once the proper feed rate has been obtained. A feed rate of approximately 1 gram per minute is desirable. With higher feed rates, the sample may not be properly deagglomerated. If sufficient gross sample is available, the correct feed rate can be established on a portion of the material prior to the actual test on the 10 gram sample. Otherwise the feed rate should be determined by using a sample having similar characteristics.
6. All weights should be recorded to the nearest 0.01 gram.

4.03 – METHOD FOR THE DETERMINATION OF SPECIFIC GRAVITY

References:

1. ASTM Designation C 188-44, "Method of Test for Specific Gravity of Hydraulic Cement."

Apparatus and Reagents:

1. Le Chatelier Flask, conforming to the dimensions shown in Fig. 11.
2. Funnel, long stem (approximately 150 mm).
3. Constant temperature Water Bath.
4. Chemical Balance.
5. Kerosene or Naphtha, water free, having a specific gravity not lighter than 62 degrees API.
6. Thermometers, small spatula, and scoop.

5.01 Note: The term "weight" is used in this Code in accordance with the general practice although the term "mass" would be technically correct. "Weight" is by definition a force of gravitational attraction which changes with location and altitude. "Mass" is a property of matter independent of the force of gravitational attraction.

5.02 Description of Centrifugal Classifier. A Centrifugal Classifier shall be used for the determination of Terminal Velocity Distribution. The instrument is a combination air centrifuge-elutriator consisting of a rotor assembly driven by a totally enclosed electrical motor. The rotor is enclosed in a housing which also supports the sample feed mechanism. A typical instrument of this type is shown in Fig. 1. The motor operates at 3500 rpm creating precisely controlled air velocities within the air spiral and sifting chamber of the centrifuge. The unit employs the following operating principle:

5.03 The sample is introduced into a spiral shaped air current flowing toward the center. The spiral current of air has suitable values of tangential and radial velocities so that a certain part of the sample is accelerated by the centrifugal force toward the periphery of the whirl, the other part of the sample being carried by the air current toward the center of the whirl by means of friction between the air and the dust particle. The size, shape, and weight of the particles determines which direction they will take in the air current. By varying the air flow, it is possible to change the terminal velocity limit of division and thus the material can be divided into a number of fractions with limited terminal velocity ranges.

5.04 By referring to Fig. 2, the operation can be followed in greater detail. The sample passes from the feed hopper (5) down the funnel and enters the feed hole (12) in the upper rotor assembly along with an extremely small quantity of air moving at high velocity. In the small rotary duct (11) the air velocity is rapidly reduced as the radius increases and the conveyance of the material is taken over by centrifugal force. During the passage through the narrow duct (11), where the rotation of the air is high owing to the friction against the walls, the particles are also given a preliminary velocity in the direction of rotation of the air in the sifting chamber (19), to which the sample is introduced through the slot (8).

5.05 The spiral of air operating in the sifting chamber (19) is created by the vanes (22) of the fan wheel in the upper rotary assembly. These vanes draw air between the grading member (15) and the lower rotor assembly casting (1). As the fan runs at a constant speed, the position of the grading member as set by the horseshoe shaped throttle spacing piece (14) produces a predetermined flow of air which is easily altered by the exchange of throttles.

5.06 After entering the annular opening the air passes through a bank of closely spaced disks (18) which impart the necessary symmetrical rotation to the air by the friction against the disks. The air then passes in a spiral through the sifting chamber and is driven out through the vaned fan wheel. The design is such that a homogeneous gyratory field is established in the sifting chamber with streamlines having the same inclination towards the radius and the same velocity at every point of an arbitrary circle within the sifting chamber.

5.07 The sample enters the sifting chamber symmetrically from the duct mentioned above and is divided into two fractions. The lighter fraction is borne by the spiral air out through the fan to stop ring where most of it is deposited due to the strong centrifugal force and the relatively low radial air velocity at this point. The heavier fraction is carried by centrifugal force out against the rotating wall of the catch basin (20) where it forms a drift uniformly distributed around the entire periphery.

5.08 As all the surfaces have approximately the velocity of the air, the treatment of the material is gentle so that it is not worn during its repeated passages through the apparatus.

5.09 The method of introducing the sample into the air stream insures good deagglomeration and dispersion without fracture. The feed hopper is shaken by the vibrator (3), the amplitude of the vibration being controlled by a rheostat. The sample passes slowly under the adjustable slide (4) where the revolving brush (6) aids in passing the sample into the feed tube (7). The sample then passes into the rotary duct (11) through the

feed hole (12). Nitrogen gas, under low pressure, is admitted to the brush chamber through the small tube shown at the right to assist in transporting the sample. The amplitude of the vibration, the position of the adjustable slide, the position of the revolving brush, and the nitrogen flow rate are so adjusted as to insure uniform sample flowrate with good deagglomeration.

5.10 Various models of this instrument are available, each incorporating various modifications of the feed mechanism and housing. However, the operating principles remain the same. Dimensional differences between various models will produce different ranges of air velocity and centrifugal force at the point where the sample enters the sifting chamber from the feed slot. The actual values of these parameters are not critical as long as the terminal velocity cut-points available with the throttles supplied provide an adequate number of test points to permit the plotting of a smooth terminal velocity distribution curve over the range of 0.1 to 100 inches per minute.

5.11 Installation and Calibration of Centrifugal Classifier.

Installation:

The Centrifugal Classifier should be assembled in accordance with the manufacturer's instructions and installed on a firm table or bench away from ovens, heaters, or direct drafts. The instrument should be located in a room having a dust-free atmosphere with a temperature range of 65–75 F and relative humidity of less than 50 per cent.

Calibration:

The Centrifugal Classifier should be operated in accordance with the manufacturer's instructions and the "Method for the Determination of Terminal Velocity Distribution" during the calibration procedure except for the following modifications and supplementary steps.

1. Determine the weight of one of the three samples in the Standard Sample Set to the nearest 0.01 grams. The samples have been screened and dried during preparation so that these steps are to be omitted during the calibration operation.

2. Using the first throttle, feed the entire sample through the centrifugal Classifier. Weigh the collected fraction of the sample (the fraction larger than the throttle cut-point). Calculate the weight per cent of the sample smaller than the cut-point value. Using a data sheet similar to that shown in Fig. 4, enter this value, to the nearest 0.1 per cent, opposite the appropriate throttle number in the column labelled Test No. 1.

3. Using the second throttle, feed the entire collected fraction from the previous run through the classifier. Weigh the collected fraction of the sample. Calculate the total weight per cent of the original sample smaller than this cut-point. Enter this value opposite the appropriate throttle number in the same column.

4. Repeat as above, using successively all the throttles. Enter the cumulative weight per cents smaller than the indicated throttle cut-points in the Test No. 1 column.

5. Repeat the above procedure using the second sample of the set. Enter the test data in the column labelled Test No. 2.

6. Repeat the above procedure using the third sample of the set. Enter test data in the column labelled Test No. 3.

7. Average the data in the three columns to the nearest 0.1 per cent for each of the throttles and enter the averages in the column labelled Test Avg.

8. Plot the terminal velocity data enclosed with the Standard Samples as shown in the example in Fig. 5.

9. On the graph draw a vertical line up to the terminal velocity distribution curve from the appropriate weight per cent for the first throttle. From the intersection of this line and the curve, draw a horizontal line to the terminal velocity scale on the left. Indicate the throttle designation in the margin opposite this horizontal line.

10. Repeat the above steps for each of the other throttles. The terminal velocity values intercepted by the horizontal lines are the calibration points for the respective throttle numbers. Enter these values to three significant figures in the Term. Vel. column on the data sheet.

11. The terminal velocity cut-point for the throttles, thus obtained, shall be used in the determination of the Terminal Velocity Distribution of

dust samples in accordance with the test method described in this Code.

5.12 Standard Samples For Calibration of Centrifugal Classifier.

The distribution of standard samples is limited. In order to obtain a sample set, the following qualifications must be met:

(1) User possesses a centrifugal classifier of the type specified in this Code,

(2) Standard samples are to be used in conjunction with the elevation of air pollution control equipment, and

(3) No more than one set of samples is acquired per year unless a major repair has been made on the centrifugal classifier.

Address all requests for standard samples to Chairman, Power Test Code Committee No. 28, c/o The American Society of Mechanical Engineers, 345 East 47th Street, New York, N.Y. 10017, along with $5.00, to cover handling and mailing expenses.

5.13 Relationship Between Terminal Velocity and Particle Diameter. Terminal Velocity Distribution, defined elsewhere in this Code, is a property of dust that has a major effect on the performance of many types of dust separating apparatus, in particular, those which utilize inertial or centrifugal forces to separate the dust from the gas stream. For this type of equipment, the particle Terminal Velocity is a more significant parameter than the actual particle dimensions because it includes the effect of particle shape and specific gravity for each particle. This is especially important for heterogeneous dusts that are composed of particles of varying shape and specific gravity. For example, a portion of dust may consist of hollow particles with an effective specific gravity considerably lower than the average value as determined by analysis of the bulk sample. From microscopic measurement of the particle dimensions, combined with the average specific gravity value, one might conclude that a given piece of dust separating apparatus would collect these particles, whereas in fact, these particles would have a much lower Terminal Velocity than calculated and would escape separation.

5.14 However, since dust "size distributions" are commonly given in terms of particle size rather than Terminal Velocity, Fig. 6 is included in this Code as a means of converting Terminal Velocity values to equivalent solid spherical particle diameters, for a given specific gravity. Whenever this conversion is used, the resulting particle diameter should be clearly labeled as an "Equivalent Solid Spherical Particle Diameter based on Stokes' Law and a specific gravity of - - - -"

5.15 This interrelation of particle dimensions, shape, and specific gravity is the basic reason why "particle size" analyses determined by different methods can seldom be correlated although each method may give consistent and reproducible values of the particular dust property which is measured.

Notes:

If it is desired to use the Stokes' Law formula given on Fig. 6, it may be more convenient to use the following units with a conversion factor rather than the basic cgs system of units.

$$V = \frac{KD^2(\rho_1 - \rho_2)}{\eta} \times 10^{-6}$$

where:

V = terminal velocity, in in./min.

D = particle diameter, in microns

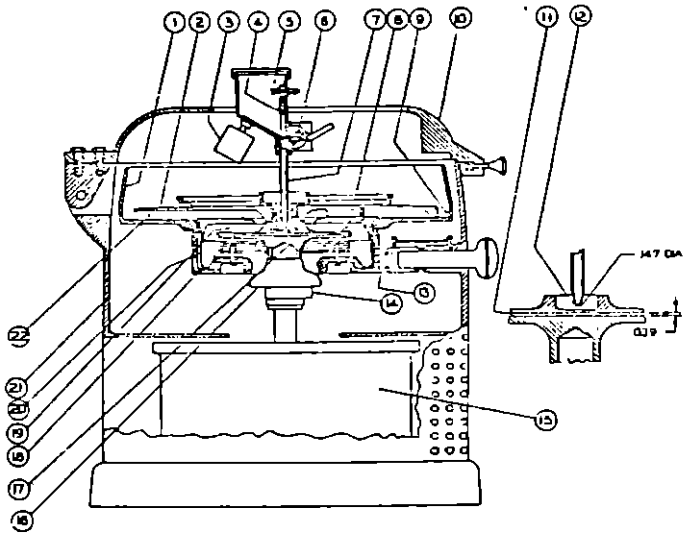
ρ_1 = specific gravity of particle relative to water at 4 C.

ρ_2 = specific gravity of fluid relative to water at 4 C.

η = viscosity of fluid, in poises

K = 12.93 = conversion factor for units used.

FIG. 1 CENTRIFUGAL CLASSIFIER

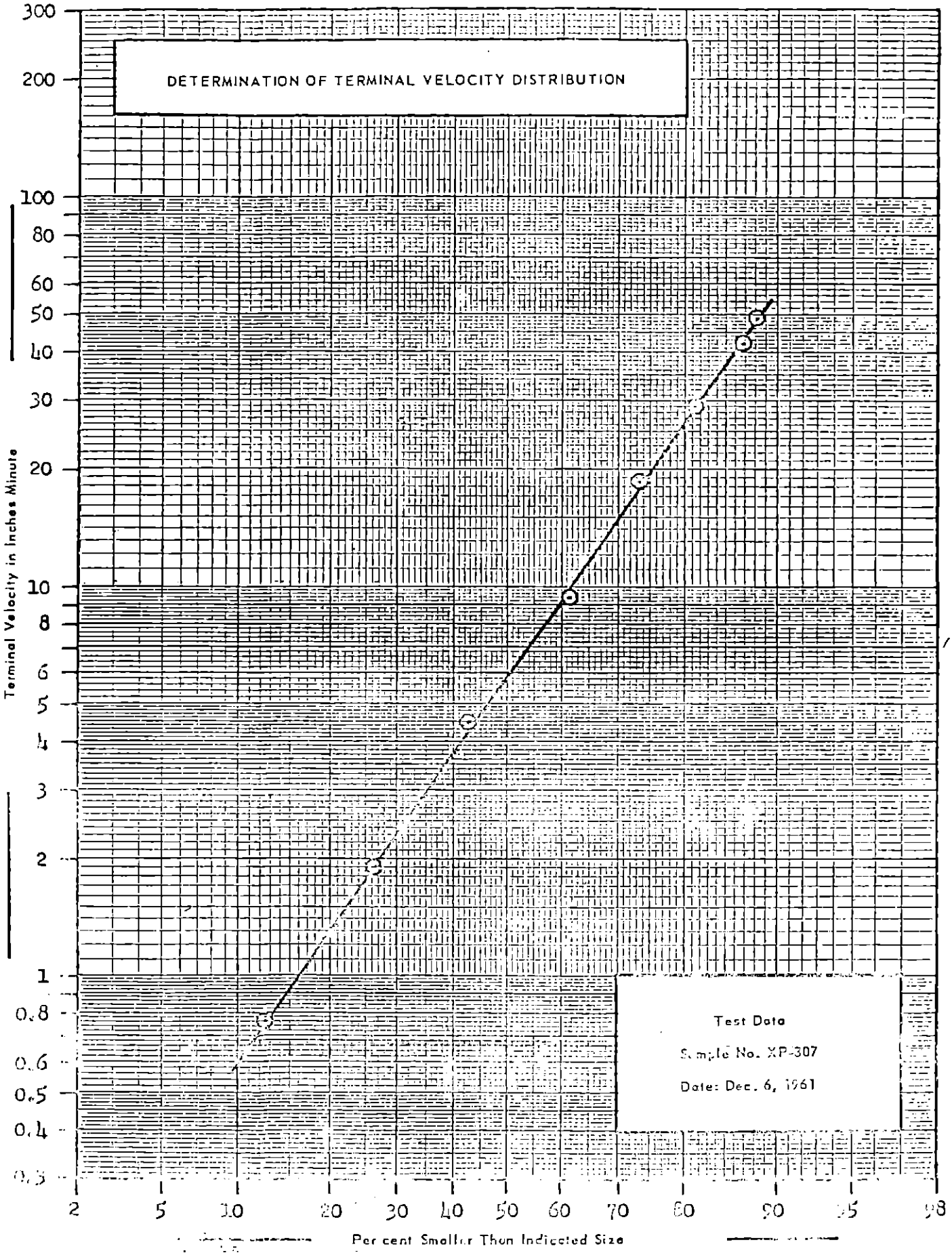


1. ROTOR CASTING
2. FAN
3. VIBRATOR
4. ADJUSTABLE SLIDE
5. FEED HOPPER
6. REVOLVING BRUSH
7. FEED TUBE
8. FEED SLOT
9. FAN WHEEL OUTLET
10. COVER
11. ROTARY DUCT
12. FEED HOLE
13. BRAKE
14. THROTTLE SPACER
15. MOTOR-3520 RPM
16. GRADING MEMBER
17. THREADED SPINDLE
18. SYMMETRICAL DISC
19. SIFTING CHAMBER
20. CATCH BASIN
21. HOUSING
22. RADIAL VANES

FIG. 2 CROSS SECTION OF CENTRIFUGAL CLASSIFIER

TEST REPORT

FIG. 3



THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Power Test Code 28

TEST RESULTS

Test: Calibration of Bahco Centrifugal Classifier

Sample: Standard Sample Set No. 976

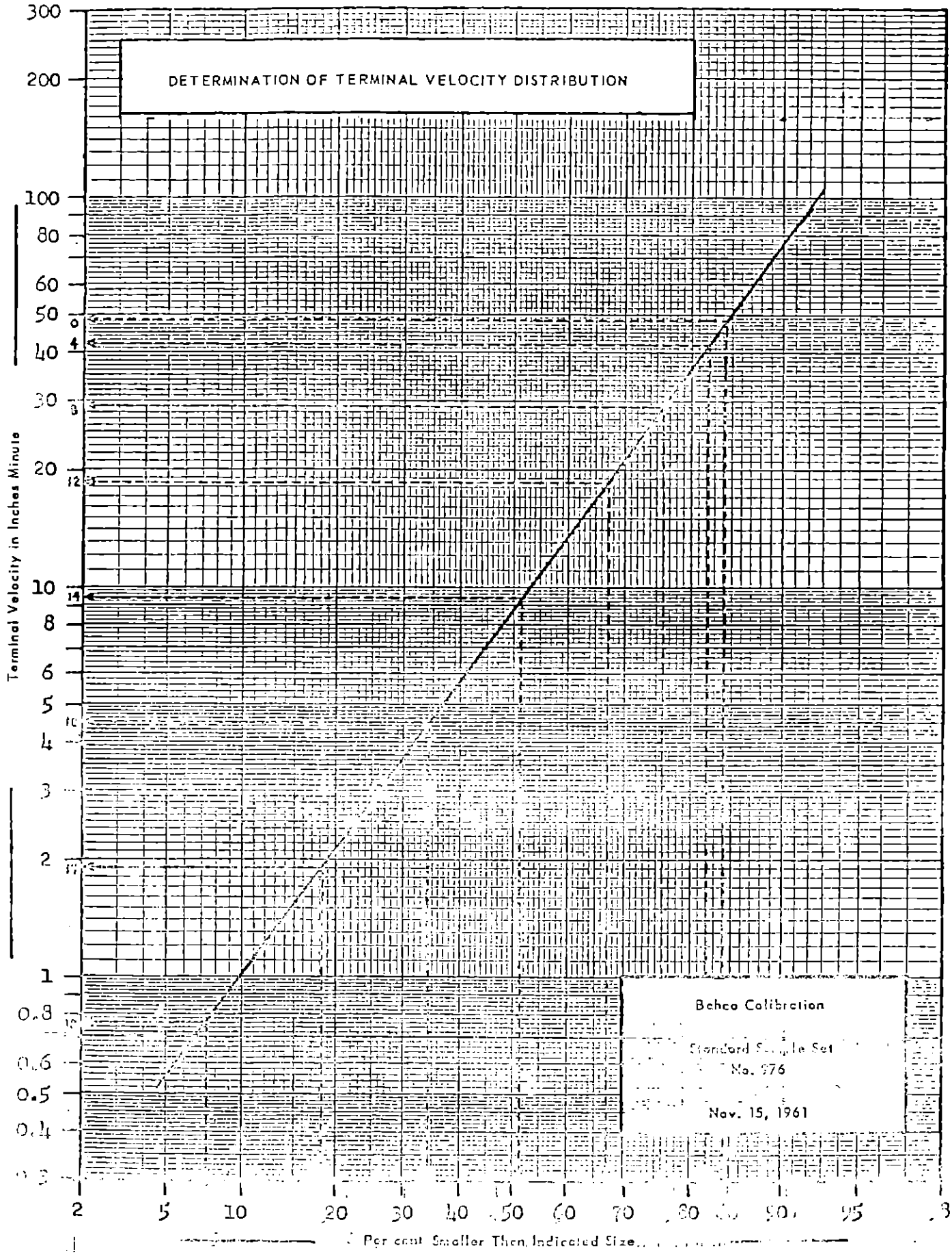
Date: Nov. 15, 1941

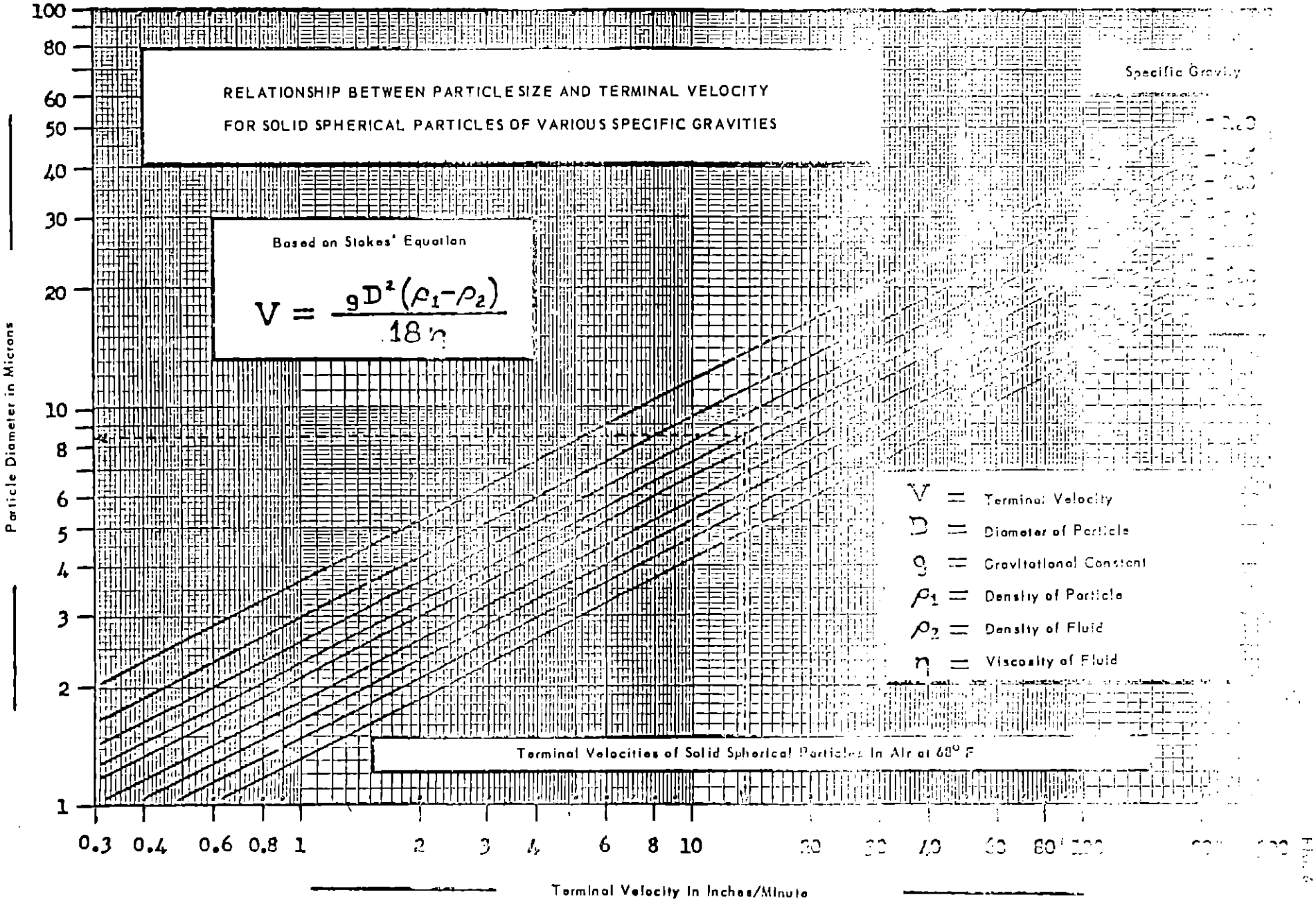
Throttle No.	Term. Vel., Inches/Min.	Percent Smaller Than Indicated Size: Test No. 1.	Test No. 2.	Test No. 3.	Test Avg.
18	0.76	7.7	7.3	7.2	7.4
17	1.90	18.1	18.3	18.5	18.3
16	4.60	34.0	34.6	34.6	34.4
14	9.40	51.5	51.6	51.1	51.4
12	18.5	67.6	66.9	67.1	67.2
8	29.0	75.8	75.7	76.5	76.0
4	42.0	82.3	82.7	81.9	82.3
0	49.0	84.6	84.1	84.2	84.3

FIG. 4

TEST REPORT

FIG. 5




RELATIONSHIP BETWEEN PARTICLE SIZE AND TERMINAL VELOCITY
FOR SOLID SPHERICAL PARTICLES OF VARIOUS SPECIFIC GRAVITIES
Based on Stokes' Equation
$V = \frac{gD^2(\rho_1-\rho_2)}{18\eta}$
Specific Gravity
V = Terminal Velocity
D = Diameter of Particle
g = Gravitational Constant
ρ_1 = Density of Particle
ρ_2 = Density of Fluid
η = Viscosity of Fluid
Terminal Velocities of Solid Spherical Particles in Air at 68° F
Particle Diameter in Microns
100
80
60
50
40
30
20
10
8
6
5
4
3
2
1
0.3
0.4
0.6
0.8
1
2
3
4
6
8
10
Terminal Velocity in Inches/Minute

APPENDIX C

VISIBLE EMISSIONS

Includes:

C.1 Observer Certificates
C.2 EPA Method 9 and Method 22
C.3 Field Data Sheets

APPENDIX C.1

OBSERVER CERTIFICATES

COLORADO

DEPARTMENT OF HEALTH

This Certifies that RANDALL L. KAUFFMAN

has satisfactorily completed a course in observing and recording the density of smoke and is qualified to determine and grade visible emissions in terms of opacity.

Valid until 11/8/81

Division Director

Coordinator

APPENDIX C.2

EPA METHOD 9 AND METHOD 22

METHOD 9—VISUAL DETERMINATION OF THE OPACITY OF EMISSIONS FROM STATIONARY SOURCES

Many stationary sources discharge visible emissions into the atmosphere; these emissions are usually in the shape of a plume.

This method involves the determination of plume opacity by qualified observers. The method includes procedures for the training and certification of observers, and procedures to be used in the field for determination of *plume opacity*. The appearance of a plume as viewed by an observer depends upon a number of variables, some of which may be controllable and some of which may not be controllable in the field. Variables which can be controlled to an extent to which they no longer exert a significant influence upon plume appearance include: Angle of the observer with respect to the plume; angle of the observer with respect to the sun; point of observation of attached and detached steam plume; and angle of the observer with respect to a plume emitted from a rectangular stack with a large length to width ratio. The method includes specific criteria applicable to these variables.

Other variables which may not be controllable in the field are luminescence and color contrast between the plume and the background against which the plume is viewed. These variables exert an influence upon the appearance of a plume as viewed by an observer, and can affect the ability of the observer to accurately assign opacity values to the observed plume. Studies of the theory of plume opacity and field studies have demonstrated that a plume is most visible and presents the greatest apparent opacity when viewed against a contrasting background. It follows from this, and is confirmed by field trials, that the opacity of a plume, viewed under conditions where a contrasting background is present can be assigned with the greatest degree of accuracy. However, the potential for a positive error is also the greatest when a plume is viewed under such contrasting conditions. Under conditions presenting a less contrasting background, the apparent opacity of a plume is less and approaches zero as the color and luminescence contrast decrease toward zero. As a result, significant negative bias and negative errors can be made when a plume is viewed under less contrasting conditions. A negative bias decreases rather than increases the possibility that a plant operator will be cited for a violation of opacity standards due to observer error.

Studies have been undertaken to determine the magnitude of positive errors which can be made by qualified observers while reading plumes under contrasting conditions and using the procedures set forth in this method. The results of these studies (field trials) which involve a total of 769 sets of 25 readings each are as follows:

(1) For black plumes (133 sets at a smoke generator), 100 percent of the sets were read with a positive error[1] of less than 7.5 percent opacity; 99 percent were read with a positive error of less than 5 percent opacity.

(2) For white plumes (170 sets at a smoke generator, 168 sets at a coal-fired power plant, 298 sets at a sulfuric acid plant), 99 percent of the sets were read with a positive error of less than 7.5 percent opacity; 95 percent were read with a positive error of less than 5 percent opacity.

The positive observational error associated with an average of twenty-five readings is therefore established. The accuracy of the method must be taken into account when determining possible violations of applicable opacity standards.

[1] For a set, positive error = average opacity determined by observers' 25 observations — average opacity determined from transmissometer's 25 recordings.

1. *Principle and applicability.*

1.1 Principle. The opacity of emissions from stationary sources is determined visually by a qualified observer.

1.2 Applicability. This method is applicable for the determination of the opacity of emissions from stationary sources pursuant to § 60.11(b) and for qualifying observers for visually determining opacity of emissions.

2. *Procedures.* The observer qualified in accordance with paragraph 3 of this method shall use the following procedures for visually determining the opacity of emissions:

2.1 Position. The qualified observer shall stand at a distance sufficient to provide a clear view of the emissions with the sun oriented in the 140° sector to his back. Consistent with maintaining the above requirement, the observer shall, as much as possible, make his observations from a position such that his line of vision is approximately perpendicular to the plume direction, and when observing opacity of emissions from rectangular outlets (e.g. roof monitors, open baghouses, noncircular stacks), approximately perpendicular to the longer axis of the outlet. The observer's line of sight should not include more than one plume at a time when multiple stacks are involved, and in any case the observer should make his observations with his line of sight perpendicular to the longer axis of such a set of multiple stacks (e.g. stub stacks on baghouses).

2.2 Field records. The observer shall record the name of the plant, emission location, type facility, observer's name and affiliation, and the date on a field data sheet (Figure 9–1). The time, estimated distance to the emission location, approximate wind direction, estimated wind speed, description of the sky condition (presence and color of clouds), and plume background are recorded on a field data sheet at the time opacity readings are initiated and completed.

2.3 Observations. Opacity observations shall be made at the point of greatest opacity in that portion of the plume where condensed water vapor is not present. The observer shall not look continuously at the plume, but instead shall observe the plume momentarily at 15-second intervals.

2.3.1 Attached steam plumes. When condensed water vapor is present within the plume as it emerges from the emission outlet, opacity observations shall be made beyond the point in the plume at which condensed water vapor is no longer visible. The observer shall record the approximate distance from the emission outlet to the point in the plume at which the observations are made.

2.3.2 Detached steam plume. When water vapor in the plume condenses and becomes visible at a distinct distance from the emission outlet, the opacity of emissions should be evaluated at the emission outlet prior to the condensation of water vapor and the formation of the steam plume.

2.4 Recording observations. Opacity observations shall be recorded to the nearest 5 percent at 15-second intervals on an observational record sheet. (See Figure 9–2 for an example.) A minimum of 24 observations shall be recorded. Each momentary observation recorded shall be deemed to represent the average opacity of emissions for a 15-second period.

2.5 Data Reduction. Opacity shall be determined as an average of 24 consecutive observations recorded at 15-second intervals. Divide the observations recorded on the record sheet into sets of 24 consecutive observations. A set is composed of any 24 consecutive observations. Sets need not be consecutive in time and in no case shall two sets overlap. For each set of 24 observations, calculate the average by summing the opacity of the 24 observations and dividing this sum by 24. If an applicable standard specifies an averaging time requiring more than 24 observations, calculate the average for all observations made during the specified time period. Record the average opacity on a record sheet. (See Figure 9–1 for an example.)

3. *Qualifications and testing.*

3.1 Certification requirements. To receive certification as a qualified observer, a candidate must be tested and demonstrate the ability to assign opacity readings in 5 percent increments to 25 different black plumes and 25 different white plumes, with an error not to exceed 15 percent opacity on any one reading and an average error not to exceed 7.5 percent opacity in each category. Candidates shall be tested according to the procedures described in paragraph 3.2. Smoke generators used pursuant to paragraph 3.2 shall be equipped with a smoke meter which meets the requirements of paragraph 3.3.

The certification shall be valid for a period of 6 months, at which time the qualification procedure must be repeated by any observer in order to retain certification.

3.2 Certification procedure. The certification test consists of showing the candidate a complete run of 50 plumes—25 black plumes and 25 white plumes—generated by a smoke generator. Plumes within each set of 25 black and 25 white runs shall be presented in random order. The candidate assigns an opacity value to each plume and records his observation on a suitable form. At the completion of each run of 50 readings, the score of the candidate is determined. If a candidate fails to qualify, the complete run of 50 readings must be repeated in any retest. The smoke test may be administered as part of a smoke school or training program, and may be preceded by training or familiarization runs of the smoke generator during which candidates are shown black and white plumes of known opacity.

3.3 Smoke generator specifications. Any smoke generator used for the purposes of paragraph 3.2 shall be equipped with a smoke meter installed to measure opacity across the diameter of the smoke generator stack. The smoke meter output shall display instack opacity based upon a pathlength equal to the stack exit diameter, on a full 0 to 100 percent chart recorder scale. The smoke meter optical design and performance shall meet the specifications shown in Table 9–1. The smoke meter shall be calibrated as prescribed in paragraph 3.3.1 prior to the conduct of each smoke reading test. At the completion of each test, the zero and span drift shall be checked and if the drift exceeds ±1 percent opacity, the condition shall be corrected prior to conducting any subsequent test runs. The smoke meter shall be demonstrated, at the time of installation, to meet the specifications listed in Table 9–1. This demonstration shall be repeated following any subsequent repair or replacement of the photocell or associated electronic circuitry including the chart recorder or output meter, or every 6 months, whichever occurs first.

TABLE 9–1—SMOKE METER DESIGN AND PERFORMANCE SPECIFICATIONS

Parameter:	*Specification*
a. Light source	Incandescent lamp operated at nominal rated voltage.
b. Spectral response of photocell	Photopic (daylight spectral response of the human eye—reference 4.3).
c. Angle of view	15° maximum total angle.
d. Angle of projection	15° maximum total angle.
e. Calibration error	±3% opacity, maximum.
f. Zero and span drift	±1% opacity, 30 minutes.
g. Response time	≤5 seconds.

3.3.1 Calibration. The smoke meter is calibrated after allowing a minimum of 30 minutes warmup by alternately producing simulated opacity of 0 percent and 100 percent. When stable response at 0 percent or 100 percent is noted, the smoke meter is adjusted to produce an output of 0 percent or 100 percent, as appropriate. This calibration shall be repeated until stable 0 percent and 100 percent readings are produced without adjustment. Simulated 0 percent and 100 percent opacity values may be produced by alternately switching the power to the light source on and off while the smoke generator is not producing smoke.

3.3.2 Smoke meter evaluation. The smoke meter design and performance are to be evaluated as follows:

3.3.2.1 Light source. Verify from manufacturer's data and from voltage measurements made at the lamp, as installed, that the lamp is operated within ±5 percent of the nominal rated voltage.

3.3.2.2 Spectral response of photocell. Verify from manufacturer's data that the photocell has a photopic response; i.e., the spectral sensitivity of the cell shall closely approximate the standard spectral-luminosity curve for photopic vision which is referenced in (b) of Table 9–1.

3.3.2.3 Angle of view. Check construction geometry to ensure that the total angle of view of the smoke plume, as seen by the photocell, does not exceed 15°. The total angle of view may be calculated from: $\theta = 2 \tan^{-1} d/2L$, where θ = total angle of view; d = the sum of the photocell diameter + the diameter of the limiting aperture; and L = the distance from the photocell to the limiting aperture. The limiting aperture is the point in the path between the photocell and the smoke plume where the angle of view is most restricted. In smoke generator smoke meters this is normally an orifice plate.

3.3.2.4 Angle of projection. Check construction geometry to ensure that the total angle of projection of the lamp on the smoke plume does not exceed 15°. The total angle of projection may be calculated from: $\theta = 2 \tan^{-1} d/2L$, where θ = total angle of projection; d = the sum of the length of the lamp filament + the diameter of the limiting aperture; and L = the distance from the lamp to the limiting aperture.

3.3.2.5 Calibration error. Using neutral-density filters of known opacity, check the error between the actual response and the theoretical linear response of the smoke meter. This check is accomplished by first calibrating the smoke meter according to 3.3.1 and then inserting a series of three neutral-density filters of nominal opacity of 20, 50, and 75 percent in the smoke meter pathlength. Filters calibarted within ±2 percent shall be used. Care should be taken when inserting the filters to prevent stray light from affecting the meter. Make a total of five nonconsecutive readings for each filter. The maximum error on any one reading shall be 3 percent opacity.

3.3.2.6 Zero and span drift. Determine the zero and span drift by calibrating and operating the smoke generator in a normal manner over a 1-hour period. The drift is measured by checking the zero and span at the end of this period.

3.3.2.7 Response time. Determine the response time by producing the series of five simulated 0 percent and 100 percent opacity values and observing the time required to reach stable response. Opacity values of 0 percent and 100 percent may be simulated by alternately switching the power to the light source off and on while the smoke generator is not operating.

4. *References.*

4.1 Air Pollution Control District Rules and Regulations, Los Angeles County Air Pollution Control District, Regulation IV, Prohibitions, Rule 50.

4.2 Weisburd, Melvin I., Field Operations and Enforcement Manual for Air, U.S. Environmental Protection Agency, Research Triangle Park, N.C., APTD–1100, August 1972, pp. 4.1–4.36.

4.3 Condon, E. U., and Odishaw, H., Handbook of Physics, McGraw-Hill Co., N.Y., N.Y., 1958, Table 3.1, p. 6–52.

[Appendix A, Method 9]

FIGURE 9-1
RECORD OF VISUAL DETERMINATION OF OPACITY

PAGE___of___

COMPANY_____
LOCATION_____
TEST NUMBER_____
DATE_____
TYPE FACILITY_____
CONTROL DEVICE_____

HOURS OF OBSERVATION_____
OBSERVER_____
OBSERVER CERTIFICATION DATE_____
OBSERVER AFFILIATION_____
POINT OF EMISSIONS_____
HEIGHT OF DISCHARGE POINT_____

	Initial			Final
CLOCK TIME				
OBSERVER LOCATION Distance to Discharge				
Direction from Discharge				
Height of Observation Point				
BACKGROUND DESCRIPTION				
WEATHER CONDITIONS Wind Direction				
Wind Speed				
Ambient Temperature				
SKY CONDITIONS (clear, overcast, % clouds, etc.)				
PLUME DESCRIPTION Color				
Distance Visible				
OTHER INFORMATION				

SUMMARY OF AVERAGE OPACITY

Set Number	Time Start--End	Opacity Sum	Opacity Average

Readings ranged from ____ to ____ % opacity

The source was/was not in compliance with ____ at the time evaluation was made.

FIGURE 9-2 OBSERVATION RECORD PAGE ___ OF ___

COMPANY _____ OBSERVER _____
LOCATION _____ TYPE FACILITY _____
TEST NUMBER _____ POINT OF EMISSIONS _____
DATE _____

Hr.	Min.	Seconds 0	15	30	45	STEAM PLUME (check if applicable) Attached	Detached	COMMENTS
	0							
	1							
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							
	11							
	12							
	13							
	14							
	15							
	16							
	17							
	18							
	19							
	20							
	21							
	22							
	23							
	24							
	25							
	26							
	27							
	28							
	29							

FIGURE 9-2 OBSERVATION RECORD (Continued) PAGE ___ OF ___

COMPANY _____ OBSERVER _____
LOCATION _____ TYPE FACILITY _____
TEST NUMBER _____ POINT OF EMISSIONS _____
DATE _____

Hr.	Min.	Seconds 0	15	30	45	STEAM PLUME (check if applicable) Attached	Detached	COMMENTS
	30							
	31							
	32							
	33							
	34							
	35							
	36							
	37							
	38							
	39							
	40							
	41							
	42							
	43							
	44							
	45							
	46							
	47							
	48							
	49							
	50							
	51							
	52							
	53							
	54							
	55							
	56							
	57							
	58							
	59							

Appendix A - Reference Methods

* * * * *

METHOD 22--VISUAL DETERMINATION OF FUGITIVE EMISSIONS FROM MATERIAL PROCESSING SOURCES

Preamble

This method involves the visual determination of fugitive emissions; i.e., emissions not emitted directly from a process stack or duct. Fugitive emissions include such emissions as those: (1) escaping capture by process equipment exhaust hoods; (2) emitted during material transfer; (3) emitted from buildings housing material processing or handling equipment; (4) emitted directly from process equipment.

This method does not require that the opacity of emissions be determined. Instead, this method determines the amount of time that any visible emissions occur during the observations period; i.e., the accumulated emission time. Since this procedure requires only the determination of whether or not visible emissions exist and does not require the determination of opacity levels, no special inspector training is required.

1. Principle. Fugitive emissions produced during material processing, handling, and transfer operations are visibly determined by an observer without the aid of instruments.

2. Applicability. This method is applicable for the determination of the frequency of fugitive emissions from stationary sources only when specified as the test method for determining compliance with new source performance standards. This method is applicable to emission sources located indoors or outdoors.

3. Definitions

3.1 Emission Frequency. The percent of time emissions are visible during the observation period.

3.2 Emission Time. The accumulated amount of time that emissions are visible during the observation period.

3.3 Fugitive Emission. The pollutant generated by an affected facility which is not collected by a capture system and is released to the atmosphere.

3.4 Observation Period. The accumulated time period during which observations are conducted, not to be less than 6 minutes.

4. Equipment

4.1 Stopwatch. Accumulative type stopwatch with a sweep second hand and unit divisions of at least one-half second; two required.

4.2 Light Meter. Light meter capable of measuring illuminance in the 50 to 200 lux (lx.) range; required for indoor observations only.

5. Procedure

5.1 General. The inspector surveys the affected facility or building or structure housing the process unit to be observed and determines the locations of potential emissions. The observer then chooses a suitable observation position. If the affected facility is located inside a building the observer chooses an observation location which permits observation of

the emissions in a manner consistent with the requirements of the applicable regulation (i.e., outside observation of emissions escaping the building/structure or inside observation of emissions directly emitted from the affected facility process unit).

5.2 Position. The observer stands in a position which enables a clear view of the potential emission point(s) of the affected facility or of the building or structure housing the affected facility, as appropriate for the applicable subpart. A position of at least 15 feet but no more than one-quarter mile from the emission source is recommended. For outdoor locations the observer should be positioned so that the sun is not directly in the observer's eyes.

5.3 Field Records

5.3.1 Outdoor Location. The observer shall record the following information on the field data sheet (Figure 1): company name, industry, process unit, observer's name, observer's affiliation, and date. Weather conditions, including estimated wind speed, wind direction, and sky condition will be recorded. The observer shall sketch the process unit being observed and shall note his location relative to the source and the sun. The potential and actual fugitive emission points should be indicated on the sketch.

5.3.2 Indoor Location. The observer shall record the following information on the field data sheet (Figure 2): company name, industry, process unit, observer's name, observer's affiliation, and date. The type, location, and intensity of lighting will be recorded as appropriate on the data sheet. The observer shall sketch the process unit being observed and shall note his location relative to the source. The potential and actual fugitive emission points should be indicated on the sketch.

FUGITIVE EMISSION INSPECTION
OUTDOOR LOCATION

Company _____	Inspector _____
Location _____	Affiliation _____
Company Rep. _____	Date _____
Sky Conditions _____	Wind Direction _____
Precipitation _____	Wind Speed _____
Industry _____	Process Unit _____

Sketch process unit, indicate observer position relative to source and sun; indicate emission points and/or actual emission points.

OBSERVATIONS

	Clock Time	Observation Period Duration (Min: Sec)	Accumulated Emission Time (Min: Sec)
Begin Observation			
End Observation			

FIGURE 1

APPENDIX C.3

FIELD DATA SHEETS

SUMMARY
RECORD OF VISIBLE EMISSIONS

METHOD 5 TEST #1

Type of Plant _____ Date 10-28-80

Company Name US GYPSUM Hours of Observation 1359-1642

Plant Address FORT DODGE, IOWA Observer RANDY KAUFFMAN
Randall L. Kauffman

Type of Discharge (STACK) OTHER _____

Discharge Location OUTLET - #5 BATCH KETTLE

Height of Point of Discharge 60' FROM GROUND

Observer's Location:

Distance to Discharge Point 25'

Height of Observation Point 62' FROM GROUND

Direction from Discharge Point NW

Background Description PLANT BUILDINGS

Weather: Clear Overcast (Partly Cloudy) Other _____ Color _____

Wind Direction NW Wind Velocity 5-10 mi/hr

42°F

Plume Description:

Detached: (Yes) No

Color: Black (White) Other _____

Plume Dispersion Behavior: Looping (Coning) Fanning

Lofting Fumigating Other _____

Estimated Distance Plume Visible 30'

Summary of Observations:

Opacity	Aggregate Time @ Opacity		Opacity	Aggregate Time @ Opacity
	min.	sec.		
0			55	
5			60	
10			65	
15			70	
20			75	
25			80	
30			85	
35			90	
40			95	
45			100	
50				

DIAGRAMS ON REVERSE SIDE OF THIS PAGE

RECORD OF VISIBLE EMISSIONS

METHOD 5 TEST #1

Company Name: US GYPSUM
Plant Address: FORT DODGE, IOWA
Stack Location: #5 BATCH KETTLE
Weather Conditions: PARTLY CLOUDY 42°F
OUTLET STACK

Date: 10-28-80
Observer: R. KAUFFMAN
Observer's Location: 25' NW OF OUTLET STACK

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
1359	00	0	0	0	0	WIND NW 5-10 MPH
1400	01	0	0	0	0	42°F
	02	0	0	0	0	
	03	0	0	0	0	CLEAN STEAM
	04	0	0	0	0	PLUME
	05	0	0	0	0	
1405	06	0	0	0	0	
	07	0	0	0	0	
	08	0	0	0	0	
	09	0	0	0	0	
	10	0	0	0	0	
1410	11	0	0	0	0	
	12	0	0	0	0	
	13	0	0	0	0	
	14	0	0	0	0	CLEAN STEAM
	15	0	0	0	0	PLUME
1415	16	0	0	0	0	
	17	0	0	0	0	
	18	0	0	0	0	
	19	0	0	0	0	
	20	0	0	0	0	
1420	21	0	0	0	0	
	22	0	0	0	0	
	23	0	0	0	0	
	24	0	0	0	0	
	25	0	0	0	0	
1425	26	0	0	0	0	
	27	0	0	0	0	
	28	0	0	0	0	
	29	0	0	0	0	
	30	0	0	0	0	CLEAN STEAM PLUME
1430	31	0	0	0	0	
	32	0	0	0	0	
	33	0	0	0	0	STEAM NOT PRESENT
	34	0	0	0	0	AT THIS TIME
	35	0	0	0	0	
1435	36	0	0	0	0	
	37	0	0	0	0	
	38	0	0	0	0	
	39	0	0	0	0	
	40	0	0	0	0	
1440	41	0	0	0	0	
	42	0	0	0	0	
	43	0	0	0	0	STEAM BACK AGAIN
	44	0	0	0	0	
	45	0	0	0	0	CLEAN STEAM PLUME
1445	46	0	0	0	0	
	47	0	0	0	0	STEAM NOT PRESENT
	48	0	0	0	0	STEAM BACK AGAIN
	49	0	0	0	0	
	50	0	0	0	0	
1450	51	0	0	0	0	
	52	0	0	0	0	
	53	0	0	0	0	
	54	0	0	0	0	
	55	0	0	0	0	
1455	56	0	0	0	0	
	57	0	0	0	0	
	58	0	0	0	0	
1458	59	0	0	0	0	CLEAN STEAM PLUME

Comments:
Unable to see short stack from ground with sun behind observer back. Observer looking NW of stack with sun blocked by building.

METHOD 5 TEST # 1

RECORD OF VISIBLE EMISSIONS

Company Name: US GYPSUM
Plant Address: FORT DODGE, IOWA
Stack Location: OUTLET-#5 BATCH KETTLE
Weather Conditions: PARTLY CLOUDY

Date: 10-28-80
Observer: R. KAUFFMAN Kendall L. Kauffman
Observer's Location: 25' NW OF OUTLET STACK

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
						WIND NW 5-10MPH
1459	00	0	0	0	0	
1500	01	0	0	0	0	
	02	0	0	0	0	
	03	0	0	0	0	
	04	0	0	0	0	CLEAN STEAM PLUME
	05	0	0	0	0	
1505	06	0	0	0	0	SUN BEHIND BUILDING
	07	0	0	0	0	DROPPING TO THE
	08	0	0	0	0	FAR SW POSITION
	09	0	0	0	0	
	10	0	0	0	0	
1510	11	0	0	0	0	
	12	0	0	0	0	
	13	0	0	0	0	
	14	0	0	0	0	
	15	0	0	0	0	
1515	16	0	0	0	0	
	17	0	0	0	0	
	18	0	0	0	0	
	19	0	0	0	0	
	20	0	0	0	0	
1520	21	0	0	0	0	
	22	0	0	0	0	
	23	0	0	0	0	
	24	0	0	0	0	CLEAN STEAM PLUME
	25	0	0	0	0	
1525	26	0	0	0	0	
	27	0	0	0	0	
	28	0	0	0	0	
	29	0	0	0	0	
	30	0	0	0	0	
1530	31	0	0	0	0	
	32	0	0	0	0	
	33	0	0	0	0	
	34	0	0	0	0	CLEAN STEAM PLUME
	35	0	0	0	0	
1535	36	0	0	0	0	
	37	0	0	0	0	
	38	0	0	0	0	
	39	0	0	0	0	
	40	0	0	0	0	
1540	41	0	0	0	0	
	42	0	0	0	0	
	43	0	0	0	0	
	44	0	0	0	0	
	45	0	0	0	0	
1545	46	0	0	0	0	
	47	0	0	0	0	
	48	0	0	0	0	
	49	0	0	0	0	
	50	0	0	0	0	
1550	51	0	0	0	0	
	52	0	0	0	0	
	53	0	0	0	0	
	54	0	0	0	0	
	55	0	0	0	0	
1555	56	0	0	0	0	CLEAN STEAM PLUME
	57	0	0	0	0	
	58	0	0	0	0	
1558	59	0	0	0	0	

Comments:

RECORD OF VISIBLE EMISSIONS

METHOD 5 TEST #1

Company Name: U S GYPSUM
Plant Address: FORT DODGE, IOWA
Stack Location: OUTLET, #5 BATCH KETTLE
Weather Conditions: CLEAR - BLUE SKY

Date: 10-28-80
Observer: R. KAUFFMAN - Randall L. Kauffman
Observer's Location: 25' NW OF OUTLET STACK

TIME HR	TIME MIN	SECONDS 00	15	30	45	COMMENTS
1559	00	0	0	0	0	WIND NW 5-10 MPH
1600	01	0	0	0	0	
	02	0	0	0	0	
	03	0	0	0	0	
	04	0	0	0	0	
	05	0	0	0	0	CLEAN STEAM PLUME
1605	06	0	0	0	0	
	07	0	0	0	0	
	08	0	0	0	0	
	09	0	0	0	0	
	10	0	0	0	0	
1610	11	0	0	0	0	
	12	0	0	0	0	
	13	0	0	0	0	
	14	0	0	0	0	
	15	0	0	0	0	
1615	16	0	0	0	0	
	17	0	0	0	0	
	18	0	0	0	0	
	19	0	0	0	0	
	20	0	0	0	0	
1620	21	0	0	0	0	
	22	0	0	0	0	
	23	0	0	0	0	
	24	0	0	0	0	
	25	0	0	0	0	
1625	26	0	0	0	0	
	27	0	0	0	0	
	28	0	0	0	0	
	29	0	0	0	0	
1630	30	0	0	0	0	
	31	0	0	0	0	
	32	0	0	0	0	
	33	0	0	0	0	CLEAN STEAM PLUME
	34	0	0	0	0	
	35	0	0	0	0	
1635	36	0	0	0	0	
	37	0	0	0	0	
	38	0	0	0	0	
	39	0	0	0	0	
	40	0	0	0	0	
1640	41	0	0	0	0	
	42	0	0	0	0	
1642	43	0	0	0		END OF TEST
	44					
	45					
	46					
	47					
	48					
	49					
	50					
	51					
	52					
	53					
	54					
	55					
	56					
	57					
	58					
	59					

Comments:

METHOD 5 TEST #3

SUMMARY
RECORD OF VISIBLE EMISSIONS

Type of Plant _____ Date 10-29-80

Company Name U S GYPSUM Hours of Observation 0858-1057

Plant Address FORT DODGE, IOWA Observer R. KAUFFMAN
Randall L. Kauffman

Type of Discharge (STACK) OTHER _____

Discharge Location OUTLET #5 BATCH KETTLE

Height of Point of Discharge 60' FROM GROUND

Observer's Location:

Distance to Discharge Point ~~50'~~ 100'

Height of Observation Point 57' FROM GROUND - ON ROOF TOP

Direction from Discharge Point NE

Background Description _____

Weather: Clear Overcast (Partly Cloudy) Other _____ Color _____

Wind Direction SW Wind Velocity 5 mi/hr

Plume Description:

Detached: Yes (No)

Color: Black (White) Other _____

Plume Dispersion Behavior: Looping Coning Fanning

(Lofting) Fumigating Other _____

Estimated Distance Plume Visible 100'

Summary of Observations:

Opacity	Aggregate Time @ Opacity	Opacity	Aggregate Time @ Opacity
0	min. sec.	55	
5		60	
10		65	
15		70	
20		75	
25		80	
30		85	
35		90	
40		95	
45		100	
50			

DIAGRAMS ON REVERSE SIDE OF PAGE

METHOD 5 TEST #3

RECORD OF VISIBLE EMISSIONS

Company Name: US GYPSUM Date: 10-27-86
Plant Address: FORT DODGE, IOWA Observer: S. KAUFFMAN Kimball Z. Kauffman
Stack Location: OUTLET - #5 BATCH KETTLE Observer's Location: 100' NE OF OUTLET 1ST FLOOR
Weather Conditions: PARTLY CLOUDY

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
0858	00	0	0	0	0	WIND SW - 5MPH
	01	0	0	0	0	
0900	02	0	0	0	0	
	03	0	0	0	0	
	04	0	0	0	0	CLEAN STEAM PLUME
	05	0	0	0	0	
	06	0	0	0	0	
0905	07	0	0	0	0	
	08	0	0	0	0	
	09	0	0	0	0	
	10	0	0	0	0	
	11	0	0	0	0	
0910	12	0	0			STOP HERE - CHANGE
	13					POSITIONS - STEAM
	14					BLOCKING VIEW
	15					OF STACK
	16					
0915	17					
	18	0	0	0	0	START AGAIN HERE *
	19	0	0	0	0	
	20	0	0	0	0	
	21	0	0	0	0	
0920	22	0	0	0	0	
	23	0	0	0	0	
	24	0	0	0	0	
	25	0	0	0	0	
	26	0	0	0	0	
0925	27	0	0	0	0	
	28	0	0	0	0	
	29	0	0	0	0	

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
	30	0	0	0	0	
	31	0	0	0	0	CLEAN STEAM PLUME
0930	32	0	0	0	0	
	33	0	0	0	0	
	34	0	0	0	0	
	35	0	0	0	0	
	36	0	0	0	0	
0935	37	0	0	0	0	
	38	0	0	0	0	
	39	0	0	0	0	
	40	0	0	0	0	
	41	0	0	0	0	
0940	42	0	0	0	0	
	43	0	0	0	0	
	44	0	0	0	0	STEAM PLUME VISIBLE
	45	0	0	0	0	ONLY 25' TO 30 FEET
	46	0	0	0	0	
0945	47	0	0	0	0	
	48	0	0	0	0	
	49	0	0	0	0	
	50	0	0	0	0	
	51	0	0	0	0	
0950	52	0	0	0	0	
	53	0	0	0	0	
	54	0	0	0	0	
	55	0	0	0	0	
	56	0	0	0	0	
0955	57	0	0	0	0	
	58	0	0	0	0	
0957	59	0	0	0	0	

Comments: * DIAGRAM ON BACK OF NEW POSITION

NEW POSITION - BLUE SKY BACKGROUND
WIND SW 5MPH
0915

METHOD 5 TEST #3

RECORD OF VISIBLE EMISSIONS

Company Name: US GYPSUM Date: 10-29-90

Plant Address: FORT DODGE, IOWA Observer: L. Kauffman - Kimball L. Kauffman

Stack Location: OUTLET - #5 BATCH KETTLE Observer's Location: NW SE OF OUTLET ON GROUND LEVEL

Weather Conditions: PARTLY CLOUDY

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
0958	00"	0	0	0	0	CLEAN STEAM
	01 '	0	0	0	0	PLUME
1000	02	0	0	0	0	WIND - SW 5-MPH
	03	0	0	0	0	
	04	0	0	0	0	
	05 '	0	0	0	0	
	06	0	0	0	0	
1005	07	0	0	0	0	
	08	0	0	0	0	
	09	0	0	0	0	
	10"	0	0	0	0	
	11	0	0	0	0	
1010	12	0	0	0	0	
	13	0	0	0	0	
	14	0	0	0	0	
	15"	0	0	0	0	
	16 '	0	0	0	0	
1015	17	0	0	0	0	
	18	0	0	0	0	
	19	0	0	0	0	
	20 '	0	0	0	0	
	21	0	0	0	0	
1020	22	0	0	0	0	
	23	0	0	0	0	
	24	0	0	0	0	
	25 '	0	0	0	0	
	26	0	0	0	0	
1025	27	0	0	0	0	
	28	0	0	0	0	
	29	0	0	0	0	

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
	30"	0	0	0	0	
	31 '	0	0	0	0	
1030	32	0	0	0	0	CLEAN STEAM PLUME
	33	0	0	0	0	
	34	0	0	0	0	
	35 '	0	0	0	0	WIND SW 10 MPH
	36	0	0	0	0	
1035	37	0	0	0	0	
	38	0	0	0	0	
	39	0	0	0	0	
	40"	0	0	0	0	
	41	0	0	0	0	
1040	42	0	0	0	0	
	43	0	0	0	0	
	44	0	0	0	0	
	45"	0	0	0	0	
	46 '	0	0	0	0	
1045	47	0	0	0	0	
	48	0	0	0	0	
	49	0	0	0	0	
	50	0	0	0	0	
	51	0	0	0	0	
1050	52	0	0	0	0	
	53	0	0	0	0	
	54	0	0	0	0	
	55	0	0	0	0	
	56	0	0	0	0	
1055	57	0	0	0	0	
	58	0	0	0	0	
1057	59	0	0	0	0	

Comments:

SUMMARY
RECORD OF VISIBLE EMISSIONS

Type of Plant _____ Date 10-30-80

Company Name US GYPSUM Hours of Observation BKFAK: 1350-1440 / 1250-1639

Plant Address FORT DODGE, IOWA Observer K.E. KAUFFMAN
Randall E. Kauffman

Type of Discharge (STACK) OTHER _____

Discharge Location OUTLET - UNIT #5 KETTLE

Height of Point of Discharge 60' FROM GROUND

Observer's Location:

Distance to Discharge Point 12'

Height of Observation Point SAME AS OUTLET OF STACK

Direction from Discharge Point SW

Background Description BLUE SKY

Weather: (Clear) Overcast Partly Cloudy Other _____ Color _____

Wind Direction W-NW Wind Velocity 10 mi/hr

Plume Description:

Detached: (Yes) No

Color: Black (White) Other _____

Plume Dispersion Behavior: (Looping) Coning Fanning
Lofting Fumigating Other _____

Estimated Distance Plume Visible 30-40 FEET

Summary of Observations:

Opacity	Aggregate Time @ Opacity	Opacity	Aggregate Time @ Opacity
0	min. sec.	55	
5		60	
10		65	
15		70	
20		75	
25		80	
30		85	
35		90	
40		95	
45		100	
50			

RECORD OF VISIBLE EMISSIONS

Company Name: US GYPSUM
Plant Address: FORT DODGE, IOWA
Stack Location: OUTLET - UNIT #5 KETTLE
Weather Conditions: CLEAR - BLUE SKY

Date: 10-30-90
Observer: R.L. KAUFFMAN Randall R. Kauffman
Observer's Location: 12' FROM OUTLET STACK

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
1250	00	0	0	0	0	WIND W-NW
	01	0	0	0	0	10 MPH
	02	0	0	0	0	
	03	0	0	0	0	CLEAN STEAM
	04	0	0	0	0	PLUME
1255	05	0	0	0	0	
	06	0	0	0	0	
	07	0	0	0	0	
	08	0	0	0	0	
	09	0	0	0	0	
1300	10	0	0	0	0	
	11	0	0	0	0	
	12	0	0	0	0	
	13	0	0	0	0	
	14	0	0	0	0	
1305	15	0	0	0	0	
	16	0	0	0	0	
	17	0	0	0	0	
	18	0	0	0	0	
	19	0	0	0	0	
1310	20	0	0	0	0	
	21	0	0	0	0	
	22	0	0	0	0	
	23	0	0	0	0	
	24	0	0	0	0	
1315	25	0	0	0	0	
	26	0	0	0	0	
	27	0	0	0	0	
	28	0	0	0	0	
	29	0	0	0	0	

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
1320	30	0	0	0	0	
	31	0	0	0	0	
	32	0	0	0	0	
	33	0	0	0	0	CLEAN STEAM
	34	0	0	0	0	PLUME
1325	35	0	0	0	0	
	36	0	0	0	0	
	37	0	0	0	0	
	38	0	0	0	0	
	39	0	0	0	0	
1330	40	0	0	0	0	
	41	0	0	0	0	
	42	0	0	0	0	
	43	0	0	0	0	
	44	0	0	0	0	
1335	45	0	0	0	0	
	46	0	0	0	0	
	47	0	0	0	0	
	48	0	0	0	0	
	49	0	0	0	0	
1340	50	0	0	0	0	
	51	0	0	0	0	
	52	0	0	0	0	
	53	0	0	0	0	
	54	0	0	0	0	
1345	55	0	0	0	0	
	56	0	0	0	0	
	57	0	0	0	0	
	58	0	0	0	0	
1349	59	0	0	0	0	

BREAK HERE 1350

Comments:
HEAVY STEAM PLUME - NOT ABLE TO DETECT ANY DUST PARTICLES IN STEAM PLUME - LOOKS CLEAN - RLK

IF, AT THE POINT WHERE I AM READING OPACITY IT IS DIRT INSTEAD OF STEAM THE OPACITY WOULD BE LESS THAN 5% - RLK

RECORD OF VISIBLE EMISSIONS

Company Name: US GYPSUM
Plant Address: FORT DODGE, IOWA
Stack Location: OUTLET #5 KETTLE
Weather Conditions: CLEAR - BLUE SKY

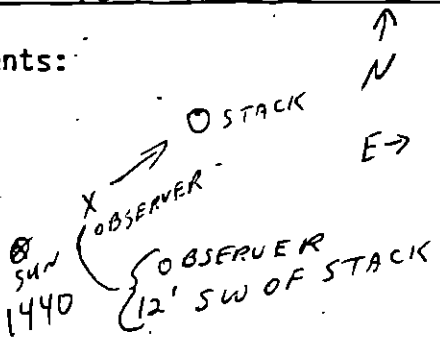
Date: 10-30-80
Observer: K. KAUFFMAN Kenneth L. Kauffman
Observer's Location: 12' FROM OUTLET STACK ON ROOF TOP

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
1440 ~~1355~~	00	0	0	0	0	WIND NW
	01	0	0	0	0	5-10 MPH
	02	0	0	0	0	
	03	0	0	0	0	CLEAN STEAM
	04	0	0	0	0	PLUME
1445 ~~1400~~	05	0	0	0	0	
	06	0	0	0	0	
	07	0	0	0	0	
	08	0	0	0	0	
	09	0	0	0	0	
1450 ~~1405~~	10	0	0	0	0	
	11	0	0	0	0	
	12	0	0	0	0	
	13	0	0	0	0	
	14	0	0	0	0	
1455 ~~1410~~	15	0	0	0	0	
	16	0	0	0	0	
	17	0	0	0	0	
	18	0	0	0	0	
	19	0	0	0	0	
1500 ~~1415~~	20	0	0	0	0	
	21	0	0	0	0	
	22	0	0	0	0	
	23	0	0	0	0	
	24	0	0	0	0	
1505 ~~1420~~	25	0	0	0	0	
	26	0	0	0	0	
	27	0	0	0	0	
	28	0	0	0	0	
	29	0	0	0	0	

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
1510 ~~1425~~	30	0	0	0	0	
	31	0	0	0	0	
	32	0	0	0	0	
	33	0	0	0	0	
	34	0	0	0	0	
1515	35	0	0	0	0	
	36	0	0	0	0	
	37	0	0	0	0	
	38	0	0	0	0	CLEAN STEAM
	39	0	0	0	0	PLUME
1520	40	0	0	0	0	
	41	0	0	0	0	
	42	0	0	0	0	
	43	0	0	0	0	
	44	0	0	0	0	
1525	45	0	0	0	0	
	46	0	0	0	0	
	47	0	0	0	0	
	48	0	0	0	0	
	49	0	0	0	0	
1530	50	0	0	0	0	
	51	0	0	0	0	
	52	0	0	0	0	
	53	0	0	0	0	
	54	0	0	0	0	
1535	55	0	0	0	0	
	56	0	0	0	0	
	57	0	0	0	0	
	58	0	0	0	0	
1539	59	0	0	0	0	

Comments:

SAME POSITION AS 1250 - 1349 WHEN STEAM HAS GONE AWAY (25 to 30 FEET DOWNSTREAM OF STACK) - NO DUST IS VISIBLE.



RECORD OF VISIBLE EMISSIONS

Company Name: US GYPSUM
Plant Address: FORT DODGE, IOWA
Stack Location: OUTLET - #5 KETTLE
Weather Conditions: CLEAR - BLUE SKY

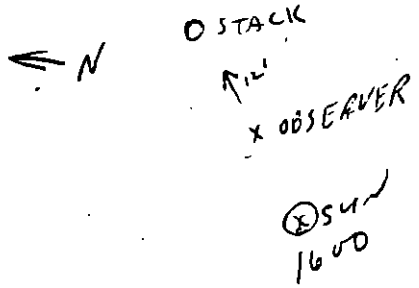
Date: 10-30-90
Observer: K. KAUFFMAN - Kenneth L. Kauffman
Observer's Location: 12' SW OF OUTLET ON ROOF TOP

TIME HR	TIME MIN	SECONDS 00	15	30	45	COMMENTS
1540	00	0	0	0	0	BLUE SKY BACKGROUND
	01	0	0	0	0	WIND - NW 25 MPH
	02	0	0	0	0	
	03	0	0	0	0	
	04	0	0	0	0	CLEAN STEAM
1545	05	0	0	0	0	PLUME
	06	0	0	0	0	
	07	0	0	0	0	
	08	0	0	0	0	
	09	0	0	0	0	
1550	10	0	0	0	0	
	11	0	0	0	0	
	12	0	0	0	0	
	13	0	0	0	0	
	14	0	0	0	0	
1555	15	0	0	0	0	
	16	0	0	0	0	
	17	0	0	0	0	
	18	0	0	0	0	
	19	0	0	0	0	
1600	20	0	0	0	0	
	21	0	0	0	0	
	22	0	0	0	0	
	23	0	0	0	0	
	24	0	0	0	0	
1605	25	0	0	0	0	
	26	0	0	0	0	
	27	0	0	0	0	
	28	0	0	0	0	
	29	0	0	0	0	

TIME HR	TIME MIN	SECONDS 00	15	30	45	COMMENTS
1610	30	0	0	0	0	
	31	0	0	0	0	
	32	0	0	0	0	
	33	0	0	0	0	
	34	0	0	0	0	
1615	35	0	0	0	0	
	36	0	0	0	0	CLEAN STEAM
	37	0	0	0	0	PLUME
	38	0	0	0	0	
	39	0	0	0	0	
1620	40	0	0	0	0	
	41	0	0	0	0	
	42	0	0	0	0	
	43	0	0	0	0	
	44	0	0	0	0	
1625	45	0	0	0	0	
	46	0	0	0	0	
	47	0	0	0	0	
	48	0	0	0	0	
	49	0	0	0	0	
1630	50	0	0	0	0	
	51	0	0	0	0	
	52	0	0	0	0	
	53	0	0	0	0	
	54	0	0	0	0	
1635	55	0	0	0	0	
	56	0	0	0	0	
	57	0	0	0	0	
	58	0	0	0	0	
1639	59	0	0	0	0	

STOP HERE FOR TODAY

Comments:



SUMMARY
RECORD OF VISIBLE EMISSIONS

Type of Plant _____ Date 10-31-80

Company Name US GYPSUM Hours of Observation 0909-1108

Plant Address FORT DODGE, IOWA Observer K. E. KAUFFMAN
Randall L. Kauffman

Type of Discharge (STACK) OTHER _____

Discharge Location OUTLET - #5 BATCH KETTLE

Height of Point of Discharge 60' FROM GROUND

Observer's Location:

Distance to Discharge Point 75'

Height of Observation Point GROUND LEVEL

Direction from Discharge Point SE

Background Description BLUE SKY

Weather: (Clear) Overcast Partly Cloudy Other _____ Color _____

Wind Direction SE Wind Velocity 2-5 mi/hr

Plume Description:

Detached: (Yes) No

Color: Black (White) Other _____

Plume Dispersion Behavior: Looping (Coning) Fanning

Lofting Fumigating Other _____

Estimated Distance Plume Visible 25-30 FEET

Summary of Observations:

Opacity	Aggregate Time @ Opacity	Opacity	Aggregate Time @ Opacity
0	min. sec.	55	
5		60	
10		65	
15		70	
20		75	
25		80	
30		85	
35		90	
40		95	
45		100	
50			

DIAGRAMS ON BACK

RECORD OF VISIBLE EMISSIONS

Company Name: US GYPSUM
Plant Address: FORT DODGE, IOWA
Stack Location: OUTLET - #5 KETTLE
Weather Conditions: CLEAR - BLUE SKY

Date: 10-31-90
Observer: K. KAUFFMAN
Observer's Location: 75' SE OF OUTLET ON GROUND

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
0909	00	0	0	0	0	WIND - SE 2MPH
	01	0	0	0	0	
	02	0	0	0	0	BLUE SKY BACKGROUND
	03	0	0	0	0	CLEAN STEAM PLUME
	04	0	0	0	0	
	05	0	0	0	0	
0915	06	0	0	0	0	
	07	0	0	0	0	
	08	0	0	0	0	WIND - CALM
	09	0	0	0	0	
	10	0	0	0	0	
0920	11	0	0	0	0	
	12	0	0	0	0	
	13	0	0	0	0	
	14	0	0	0	0	
	15	0	0	0	0	
0925	16	0	0	0	0	
	17	0	0	0	0	
	18	0	0	0	0	
	19	0	0	0	0	
	20	0	0	0	0	
0930	21	0	0	0	0	
	22	0	0	0	0	
	23	0	0	0	0	
	24	0	0	0	0	
	25	0	0	0	0	
0931	26	0	0	0	0	
	27	0	0	0	0	
	28	0	0	0	0	
	29	0	0	0	0	

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
	30	0	0	0	0	
0940	31	0	0	0	0	CLEAN STEAM
	32	0	0	0	0	PLUME
	33	0	0	0	0	WIND SE - 0-2 MPH
	34	0	0	0	0	
	35	0	0	0	0	
0945	36	0	0	0	0	
	37	0	0	0	0	
	38	0	0	0	0	
	39	0	0	0	0	
	40	0	0	0	0	
0950	41	0	0	0	0	
	42	0	0	0	0	
	43	0	0	0	0	
	44	0	0	0	0	
	45	0	0	0	0	
0955	46	0	0	0	0	
	47	0	0	0	0	
	48	0	0	0	0	
	49	0	0	0	0	
	50	0	0	0	0	
1000	51	0	0	0	0	
	52	0	0	0	0	
	53	0	0	0	0	
	54	0	0	0	0	
	55	0	0	0	0	
1005	56	0	0	0	0	
	57	0	0	0	0	
	58	0	0	0	0	
1008	59	0	0	0	0	

Comments:

CHANGED POSITION AT 0918 - SEE DIAGRAM
BACK TO ORIGINAL POSITION AT 0935

RECORD OF VISIBLE EMISSIONS

Company Name: U S GYPSUM
Plant Address: FORT DODGE, IOWA
Stack Location: OUTLET - #5 KETTLE
Weather Conditions: CLEAR - BLUE SKY

Date: 10-31-80
Observer: R. KAUFFMAN Kimball R. Kauffman
Observer's Location: 75' SE OF OUTLET ON GROUND

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
1009	00	0	0	0	0	CLEAR - BLUE SKY
	01	0	0	0	0	BACKGROUND
	02	0	0	0	0	
	03	0	0	0	0	WIND SW - 0-2 mph
	04	0	0	0	0	
	05	0	0	0	0	CLEAN STEAM PLUME
1015	06	0	0	0	0	
	07	0	0	0	0	
	08	0	0	0	0	
	09	0	0	0	0	
	10	0	0	0	0	
1020	11	0	0	0	0	
	12	0	0	0	0	
	13	0	0	0	0	
	14	0	0	0	0	
	15	0	0	0	0	
1025	16	0	0	0	0	
	17	0	0	0	0	
	18	0	0	0	0	
	19	0	0	0	0	
	20	0	0	0	0	WIND - West 3-5 mph
1030	21	0	0	0	0	
	22	0	0	0	0	
	23	0	0	0	0	
	24	0	0	0	0	
	25	0	0	0	0	
1035	26	0	0	0	0	
	27	0	0	0	0	
	28	0	0	0	0	
	29	0	0	0	0	
1040	30	0	0	0	0	
	31	0	0	0	0	
	32	0	0	0	0	
	33	0	0	0	0	
	34	0	0	0	0	CLEAN STEAM
	35	0	0	0	0	PLUME
1045	36	0	0	0	0	
	37	0	0	0	0	
	38	0	0	0	0	
	39	0	0	0	0	
	40	0	0	0	0	
1050	41	0	0	0	0	
	42	0	0	0	0	
	43	0	0	0	0	
	44	0	0	0	0	
	45	0	0	0	0	
1055	46	0	0	0	0	
	47	0	0	0	0	
	48	0	0	0	0	
	49	0	0	0	0	
	50	0	0	0	0	
1100	51	0	0	0	0	
	52	0	0	0	0	
	53	0	0	0	0	
	54	0	0	0	0	
	55	0	0	0	0	
1105	56	0	0	0	0	
	57	0	0	0	0	
	58	0	0	0	0	
1108	59	0	0	0	0	STOP HERE

Comments:

SUMMARY
RECORD OF VISIBLE EMISSIONS

Type of Plant _____ Date 10-31-80

Company Name U S GYPSUM Hours of Observation 1125-1215
1310-1355
1317-1647

Plant Address FORT DODGE, IOWA Observer R.E. KAUFFMAN
Randall L. Kauffman

Type of Discharge (STACK) OTHER _____

Discharge Location OUTLET - BOARD END SAWING

Height of Point of Discharge 40' FROM GROUND

Observer's Location:

Distance to Discharge Point 20' SOUTH

Height of Observation Point 30-32' FROM GROUND

Direction from Discharge Point SOUTH

Background Description BLUE SKY

Weather: (Clear) Overcast Partly Cloudy Other _____ Color _____

Wind Direction W-SW Wind Velocity 2-5 mi/hr

Plume Description:

Detached: Yes No NO PLUME

Color: Black White Other N/A

Plume Dispersion Behavior: Looping Coning Fanning

Lofting Fumigating Other N/A

Estimated Distance Plume Visible N/A

Summary of Observations:

Opacity	Aggregate Time @ Opacity	Opacity	Aggregate Time @ Opacity
0	min. sec.	55	
5		60	
10		65	
15		70	
20		75	
25		80	
30		85	
35		90	
40		95	
45		100	
50			

SEE DIAGRAM ON REVERSE SIDE

RECORD OF VISIBLE EMISSIONS

Company Name: U S GYPSUM
Plant Address: FORT DODGE, IOWA
Stack Location: OUTLET
Weather Conditions: CLEAR - BLUE SKY

Date: 10-31-80
Observer: R. KAUFFMAN Randall R. Kauffman
Observer's Location: 20' S. OF OUTLET

TIME HR	TIME MIN	SECONDS 00	15	30	45	COMMENTS
1125	00	0	0	0	0	WIND - W - SW
	01	0	0	0	0	0 - 2 MPH
	02	0	0	0	0	BLUE SKY BACKGROUND
	03	0	0	0	0	
	04	0	0	0	0	NO PLUME
1130	05	0	0	0	0	
	06	0	0	0	0	
	07	0	0	0	0	
	08	0	0	0	0	
	09	0	0	0	0	
1135	10	0	0	0	0	
	11	0	0	0	0	
	12	0	0	0	0	
	13	0	0	0	0	
	14	0	0	0	0	
1140	15	0	0	0	0	
	16	0	0	0	0	
	17	0	0	0	0	
	18	0	0	0	0	
	19	0	0	0	0	
1145	20	0	0	0	0	
	21	0	0	0	0	
	22	0	0	0	0	
	23	0	0	0	0	
	24	0	0	0	0	
1150	25	0	0	0	0	
	26	0	0	0	0	
	27	0	0	0	0	
	28	0	0	0	0	
	29	0	0	0	0	

TIME HR	TIME MIN	SECONDS 00	15	30	45	COMMENTS
1155	30	0	0	0	0	
	31	0	0	0	0	
	32	0	0	0	0	
	33	0	0	0	0	
	34	0	0	0	0	
1200	35	0	0	0	0	
	36	0	0	0	0	
	37	0	0	0	0	
	38	0	0	0	0	
	39	0	0	0	0	
1205	40	0	0	0	0	
	41	0	0	0	0	
	42	0	0	0	0	
	43	0	0	0	0	
	44	0	0	0	0	
1210	45	0	0	0	0	
	46	0	0	0	0	
	47	0	0	0	0	
	48	0	0	0	0	
	49	0	0	0	0	
1215	50	0	0	0	0	
	51					
	52					
	53					
	54					
1220	55					
	56					
	57					
	58					
1224	59					

Comments:

RECORD OF VISIBLE EMISSIONS

Company Name: U.S. GYPSUM Date: 10-31-80
Plant Address: FORT DODGE, IOWA Observer: K. KAUFFMAN - Kendall L. Kauffman
Stack Location: OUTLET - BOARD END SAWING Observer's Location: 20' S. OF OUTLET
Weather Conditions: CLEAR - BLUE SKY

TIME HR	TIME MIN	SECONDS 00	15	30	45	COMMENTS	TIME HR	TIME MIN	SECONDS 00	15	30	45	COMMENTS
1310	00	0	0	0	0	BLUE SKY BACKGROUND	1340	30					
	01	0	0	0	0	WIND -		31	0	0	0	0	
	02	0	0	0	0	W - 5 MPH		32	0	0	0	0	
	03	0	0	0	0			33	0	0			UNIT DOWN HERE
	04	0	0	0	0			34					
1315	05	0	0	0	0		1345	35					
	06	0	0	0	0			36					
	07	0	0	0	0			37					
	08	0	0	0	0			38					
	09	0	0	0	0			39					
1320	10	0	0	0	0		1350	40					
	11	0	0	0	0			41					
	12	0	0	0	0			42					
	13	0	0	0	0			43					
	14	0	0	0	0			44					
1325	15	0	0	0	0		1355	45					
	16	0	0	0	0			46					
	17	0	0	0	0			47					
	18	0	0	0	0			48					
	19	0	0	0	0			49					
1330	20	0	0	0	0		1400	50					
	21	0	0	0	0			51					
	22	0	0	0	0			52					
	23	0	0	0	0			53					
	24	0	0	0	0	STOP HERE		54					
1335	25					UNIT DOWN	1405	55					
	26							56					
	27							57					
	28							58					
	29						1409	59					

Comments:

SUN 1310

RECORD OF VISIBLE EMISSIONS

Company Name: U S GYPSUM Date: 10-31-90

Plant Address: FORT DODGE, IOWA Observer: R. KAUFFMAN - Kendall K. Kauffman

Stack Location: OUTLET - BOARD END SAWMILL Observer's Location: 20' S. OF OUTLET

Weather Conditions: ~~CLEAR~~ ~~CLEAR SKY~~ OVERCAST -

TIME						COMMENTS	TIME						COMMENTS
HR	MIN	SECONDS					HR	MIN	SECONDS				
		00	15	30	45				00	15	30	45	
1517	00	0	0	0	0	WHITE BACKGROUND		30	0	0	0	0	
	01	0	0	0	0			31	0	0	0	0	
	02	0	0	0	0	WIND - W - 5-10MPH		32	0	0	0	0	
1520	03	0	0	0	0		1550	33	0	0	0	0	
	04	0	0	0	0	NO PLUME		34	0	0	0	0	
	05	0	0	0	0			35	0	0	0	0	
	06	0	0	0	0			36	0	0	0	0	
	07	0	0	0	0			37	0	0	0	0	
1525	08	0	0	0	0		1555	38	0	0	0	0	
	09	0	0	0	0			39	0	0	0	0	
	10	0	0	0	0			40	0	0	0	0	
	11	0	0	0	0			41	0	0	0	0	
	12	0	0	0	0			42	0	0	0	0	
1530	13	0	0	0	0		1600	43	0	0	0	0	
	14	0	0	0	0			44	0	0	0	0	
	15	0	0	0	0			45	0	0	0	0	
	16	0	0	0	0			46	0	0	0	0	
	17	0	0	0	0			47	0	0	0	0	
1535	18	0	0	0	0		1605	48	0	0	0	0	
	19	0	0	0	0	BLUE BACKGROUND		49	0	0	0	0	
	20	0	0	0	0			50	0	0	0	0	
	21	0	0	0	0			51	0	0	0	0	
	22	0	0	0	0			52	0	0	0	0	
1540	23	0	0	0	0		1610	53	0	0	0	0	
	24	0	0	0	0			54	0	0	0	0	
	25	0	0	0	0			55	0	0	0	0	
	26	0	0	0	0			56	0	0	0	0	
	27	0	0	0	0			57	0	0	0	0	
1545	28	0	0	0	0			58	0	0	0	0	
	29	0	0	0	0		1616	59	0	0	0	0	

Comments:

EVEN AT CLOSE RANGE (1 FOOT), NOT ABLE TO DETECT ANY DUST COMING FROM OUTLET STACK

RECORD OF VISIBLE EMISSIONS

Company Name: US GYPSUM Date: 10-31-80
Plant Address: FORT DODGE, IOWA Observer: K. KAUFFMAN Kenneth L. Kauffman
Stack Location: OUTLET - BOARD END SAWING Observer's Location: 20' S. OF OUTLET
Weather Conditions: PARTLY CLOUDY

TIME HR	TIME MIN	SECONDS 00	15	30	45	COMMENTS
		00	15	30	45	
1617	00 15	0	0	0	0	BLUE BACKGROUND
	01 1	0	0	0	0	WIND - W - 5MPH
	02	0	0	0	0	
1620	03	0	0	0	0	
	04	0	0	0	0	
	05 5	0	0	0	0	
	06	0	0	0	0	
	07	0	0	0	0	
1625	08	0	0	0	0	
	09	0	0	0	0	
	10 10	0	0	0	0	
	11	0	0	0	0	
	12	0	0	0	0	
1630	13	0	0	0	0	
	14	0	0	0	0	
	15 15	0	0	0	0	
	16 1	0	0	0	0	
	17	0	0	0	0	
1635	18	0	0	0	0	
	19	0	0	0	0	
	20 5	0	0	0	0	
	21	0	0	0	0	
	22	0	0	0	0	
1640	23	0	0	0	0	
	24	0	0	0	0	
	25 10	0	0	0	0	
	26	0	0	0	0	
	27	0	0	0	0	
1645	28	0	0	0	0	
	29 14	0	0	0	0	

TIME HR	TIME MIN	SECONDS 00	15	30	45	COMMENTS
		00	15	30	45	
	30 11	0	0	0	0	STOP HERE
	31 1					
	32					
1650	33					
	34					
	35 5					
	36					
	37					
	38					
	39					
	40 10					
	41					
	42					
	43					
	44					
	45 15					
	46					
	47					
	48					
	49					
	50					
	51					
	52					
	53					
	54					
	55					
	56					
	57					
	58					
	59					

Comments:

FUGITIVE EMISSION INSPECTION
INDOOR LOCATION

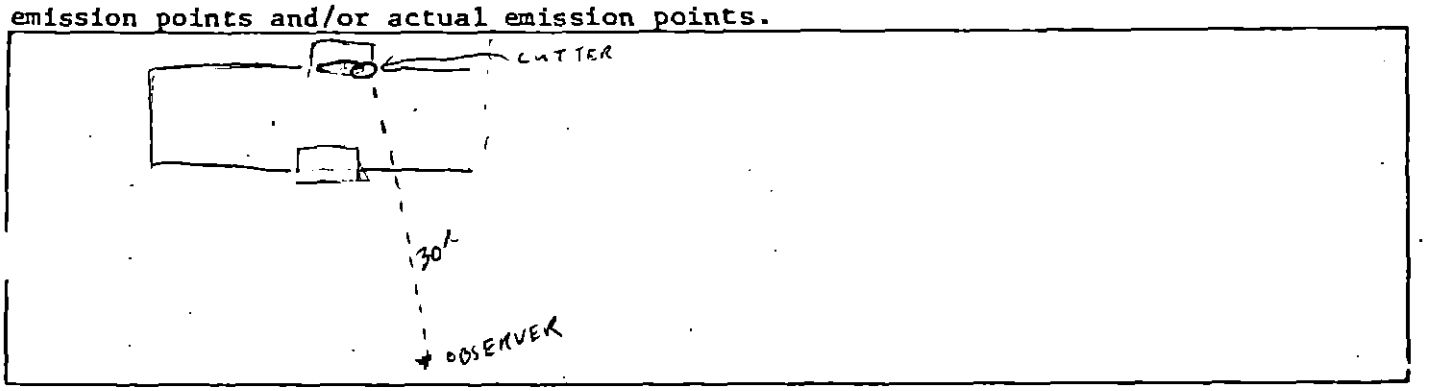
Company U.S. Gypsum
Location Fort Dodge Iowa
Company Rep. _____

Inspector S.M. Reynolds / R. Kauffman
Affiliation T.R.C.
Date October 31, 1980

Industry Gypsum wallboard
Process Unit Board End Saw

Light type (fluorescent, incandescent, natural) fluorescent
Light location (overhead, behind observer, etc.) Over Head
Illuminance (lux or footcandles) _____

Sketch process unit, indicate observer position relative to source; indicate potential emission points and/or actual emission points.



OBSERVATIONS

		Clock Time	Observation Period Duration (Min: Sec)	Accumulated Emission Time (Min: Sec)
Begin Observation		1355	~~20~~	~~2:20~~
	START →	1415	20	2:20
		1430	15	1:41.5
		~~1430~~ 1600	20	3:20
		1620	20	2:57
		1640	20	3:16
R. KAUFFMAN AT 1700		1700	20	1:16.5
		1725 ~~1705~~	20	0:32.5
		1750	40 20	1:42.5
End Observation				

FIGURE 2

SUMMARY
RECORD OF VISIBLE EMISSIONS

Type of Plant _____ Date 10-29-90

Company Name US GYPSUM Hours of Observation 1400 - 1459

Plant Address FORT DODGE, IOWA Observer R. KAUFFMAN
Randall L. Kauffman

Type of Discharge (STACK) OTHER _____

Discharge Location OUTLET - STUCCO CONVEYOR BAGHOUSE

Height of Point of Discharge 100' FROM GROUND

Observer's Location:

Distance to Discharge Point 100'

Height of Observation Point 90' FROM GROUND

Direction from Discharge Point NE

Background Description BLUE SKY

Weather: (Clear) Overcast Partly Cloudy Other _____ Color BLUE SKY

Wind Direction SW Wind Velocity 5-10 mi/hr

Plume Description:

Detached: Yes No NO PLUME

Color: Black White Other N/A

Plume Dispersion Behavior: Looping Coning Fanning

Lofting Fumigating Other N/A

Estimated Distance Plume Visible N/A

Summary of Observations:

Opacity	Aggregate Time @ Opacity	Opacity	Aggregate Time @ Opacity
0	min. sec.	55	
5		60	
10		65	
15		70	
20		75	
25		80	
30		85	
35		90	
40		95	
45		100	
50			

DIAGRAM ON REVERSE SIDE

RECORD OF VISIBLE EMISSIONS

Company Name: U S GYPSUM
Plant Address: FORT DODGE, IOWA
Stack Location: OUTLET- STUCCO CONVEYOR
Weather Conditions: CLEAR- BLUE SKY

Date: 10-29-80
Observer: K. KAUFFMAN-Kenneth L. Kauffman
Observer's Location: 100' NE OF OUTLET STACK

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
		00	15	30	45	
1400	00	0	0	0	0	BLUE SKY BACKGROUND
	01	0	0	0	0	WIND-SW-5-10 MPH
	02	0	0	0	0	
	03	0	0	0	0	
	04	0	0	0	0	
1405	05	0	0	0	0	
	06	0	0	0	0	
	07	0	0	0	0	
	08	0	0	0	0	
	09	0	0	0	0	
1410	10	0	0	0	0	
	11	0	0	0	0	
	12	0	0	0	0	
	13	0	0	0	0	
	14	0	0	0	0	
1415	15	0	0	0	0	
	16	0	0	0	0	
	17	0	0	0	0	
	18	0	0	0	0	
	19	0	0	0	0	
1420	20	0	0	0	0	
	21	0	0	0	0	
	22	0	0	0	0	
	23	0	0	0	0	
	24	0	0	0	0	
1425	25	0	0	0	0	
	26	0	0	0	0	
	27	0	0	0	0	
	28	0	0	0	0	
	29	0	0	0	0	

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
		00	15	30	45	
1430	30	0	0	0	0	
	31	0	0	0	0	
	32	0	0	0	0	BLUE SKY BACKGROUND
	33	0	0	0	0	
	34	0	0	0	0	
1435	35	0	0	0	0	
	36	0	0	0	0	WIND SW -5-10 MPH
	37	0	0	0	0	
	38	0	0	0	0	
	39	0	0	0	0	
1440	40	0	0	0	0	
	41	0	0	0	0	
	42	0	0	0	0	
	43	0	0	0	0	
1445	44	0	0	0	0	
1545	45	0	0	0	0	
	46	0	0	0	0	
	47	0	0	0	0	
	48	0	0	0	0	
1450	49	0	0	0	0	
1550	50	0	0	0	0	
	51	0	0	0	0	
	52	0	0	0	0	
	53	0	0	0	0	
1455	54	0	0	0	0	
1555	55	0	0	0	0	
	56	0	0	0	0	
	57	0	0	0	0	
1459	58	0	0	0	0	
1559	59	0	0	0	0	

Comments:

SUMMARY
RECORD OF VISIBLE EMISSIONS

Type of Plant _____ Date 10-30-80

Company Name US GYPSUM Hours of Observation 0903 - 1102

Plant Address FORT DODGE, IOWA Observer R.E. Kauffman
Randall L. Kauffman

Type of Discharge (STACK) OTHER _____

Discharge Location OUTLET - STUCCO CONVEYOR BAGHOUSE

Height of Point of Discharge 100' FROM GROUND

Observer's Location:

Distance to Discharge Point 30

Height of Observation Point 70' FROM GROUND

Direction from Discharge Point N

Background Description BLUE SKY

Weather: Clear Overcast (Partly Cloudy) Other _____ Color _____

Wind Direction SW Wind Velocity 15 mi/hr

Plume Description:

Detached: Yes No NO PLUME

Color: Black White Other _____

Plume Dispersion Behavior: Looping Coning Fanning

Lofting Fumigating Other N/A

Estimated Distance Plume Visible N/A

Summary of Observations:

Opacity	Aggregate Time @ Opacity	Opacity	Aggregate Time @ Opacity
0	min. sec.	55	
5		60	
10		65	
15		70	
20		75	
25		80	
30		85	
35		90	
40		95	
45		100	
50			

RECORD OF VISIBLE EMISSIONS

Company Name: U S GYPSUM
Plant Address: FORT DODGE, IOWA
Stack Location: OUTLET STUCCO CONVEYOR
Weather Conditions: PARTLY CLOUDY

Date: 10-30-80
Observer: R. KEUFFMAN
Observer's Location: ~~CUPOLA~~ 30' N OF OUTLET ON ROOF TOP

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
0903	00	0	0	0	0	WIND SW-15 MPH
	01	0	0	0	0	NO PLUME
	02	0	0	0	0	BLUE SKY BACKGROUND
	03	0	0	0	0	
	04	0	0	0	0	
	05	0	0	0	0	
	06	0	0	0	0	
0910	07	0	0	0	0	
	08	0	0	0	0	
	09	0	0	0	0	
	10	0	0	0	0	
	11	0	0	0	0	
0915	12	0	0	0	0	
	13	0	0	0	0	
	14	0	0	0	0	
	15	0	0	0	0	
	16	0	0	0	0	
0920	17	0	0	0	0	
	18	0	0	0	0	
	19	0	0	0	0	
	20	0	0	0	0	
	21	0	0	0	0	
0925	22	0	0	0	0	
	23	0	0	0	0	
	24	0	0	0	0	
	25	0	0	0	0	
	26	0	0	0	0	
0930	27	0	0	0	0	
	28	0	0	0	0	
	29	0	0	0	0	

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
	30	0	0	5	0	PUFF
	31	0	0	0	5	PUFF
0935	32	0	0	0	0	
	33	0	0	0	5	
	34	0	0	0	0	
	35	0	5	5	0	
	36	0	0	0	5	
0940	37	0	5	0	0	
	38	0	0	5	0	
	39	0	0	0	0	
	40	0	0	0	0	
	41	0	0	0	0	
0945	42	0	0	0	0	
	43	5	0	5	0	
	44	0	0	0	0	
	45	5	5	0	0	
	46	0	0	5	0	
0950	47	0	0	0	0	
	48	5	0	0	0	
	49	0	0	0	0	
	50	0	0	0	0	
	51	0	5	5	0	
0955	52	0	0	0	10	
	53	0	0	0	0	
	54	0	0	0	0	
	55	0	0	0	0	
	56	0	0	0	0	
1000	57	0	0	0	0	
	58	0	0	0	0	
1002	59	0	0	0	0	

Comments:

RECORD OF VISIBLE EMISSIONS

Company Name: US GYPSUM
Plant Address: FORT DODGE, IOWA
Stack Location: OUTLET - STUCCO CONVEYOR
Weather Conditions: PARTLY CLOUDY

Date: 10-30-80
Observer: R. KAUFFMAN
Observer's Location: 30' N OF OUTLET ON ROOF TOP

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
1003	00	0	0	0	0	WIND SW - 15 MPH
	01	0	0	0	0	NO PLUME
	02	0	0	0	0	BLUE SKY BACKGROUND
	03	0	0	0	0	
	04	5	5	0	0	
	05	0	0	0	0	
	06	0	0	0	0	
1010	07	0	5	0	0	
	08	0	0	0	5	
	09	0	0	0	0	
	10	0	0	5	5	
	11	0	0	0	0	WIND WEST, SW
1015	12	10	0	0	0	15 MPH
	13	0	0	0	5	
	14	0	0	0	0	
	15	0	5	0	0	
	16	0	0	0	0	
1020	17	0	0	0	0	
	18	0	0	0	0	
	19	0	0	0	0	
	20	5	5	0	0	
	21	0	0	0	0	
1025	22	0	0	0	0	
	23	0	0	0	0	
	24	0	0	0	5	
	25	0	0	0	0	
	26	0	0	10	5	
1030	27	0	0	0	0	
	28	0	0	0	0	
	29	0	0	0	0	

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
	30	0	0	5	0	
	31	0	5	5	5	
1035	32	0	0	0	10	
	33	5	5	0	0	
	34	0	0	5	0	
	35	0	0	0	0	
	36	10	10	0	0	
1040	37	0	5	0	5	
	38	0	0	0	0	
	39	0	5	0	0	
	40	0	0	0	0	
	41	5	0	0	0	
1045	42	0	0	0	0	
	43	0	0	0	0	
	44	5	5	0	0	
	45	0	0	0	0	
	46	5	0	0	0	
1050	47	0	10	0	5	
	48	0	0	5	10	
	49	10	5	5	0	
	50	0	0	5	5	
	51	5	5	5	5	
1055	52	10	5	5	5	
	53	0	0	0	5	
	54	5	0	0	0	
	55	0	5	0	0	
	56	0	0	0	10	
1100	57	5	0	0	0	
	58	0	0	0	5	
1102	59	5	0	0	5	

Comments:

SUMMARY
RECORD OF VISIBLE EMISSIONS

Type of Plant _____ Date 10-29-80

Company Name US GYPSUM Hours of Observation 1128-1200

Plant Address FORT DODGE, IOWA Observer R. KAUFFMAN
Randall K. Kauffman

Type of Discharge (STACK) OTHER _____

Discharge Location OUTLET OF DUST COLLECTOR - BAGGING OPERATION BAGGER #3

Height of Point of Discharge 50' FROM GROUND

Observer's Location:

Distance to Discharge Point 75'

Height of Observation Point GROUND LEVEL

Direction from Discharge Point S & W

Background Description BLUE SKY

Weather: Clear Overcast (Partly Cloudy) Other _____ Color _____

Wind Direction SW Wind Velocity 5-10 mi/hr

Plume Description:

Detached: Yes No NONE

Color: Black White Other _____

Plume Dispersion Behavior: Looping Coning Fanning

Lofting Fumigating Other NONE

Estimated Distance Plume Visible N/A

Summary of Observations:

Opacity	Aggregate Time @ Opacity	Opacity	Aggregate Time @ Opacity
0	min. sec.	55	
5		60	
10		65	
15		70	
20		75	
25		80	
30		85	
35		90	
40		95	
45		100	
50			

DIAGRAM ON REVERSE SIDE

RECORD OF VISIBLE EMISSIONS

Company Name: US GYPSUM Date: 10-29-80
Plant Address: FORT DODGE, IOWA Observer: R. KAUFFMAN Randall L. Kauffman
Stack Location: OUTLET OF DUST COLLECTOR Observer's Location: 75' SW ON GROUND
Weather Conditions: PARTLY CLOUDY
BAGGING OPERATION - BAGGER #3

TIME HR	TIME MIN	SECONDS 00	15	30	45	COMMENTS
1128	00	0	0	0	0	BLUE SKY BACKGROUND
	01	0	0	0	0	WIND SW-5-10MPH
1130	02	0	0	0	0	
	03	0	0	0	0	NO STEAM OR DUST
	04	0	0	0	0	VISIBLE
	05	0	0	0	0	
	06	0	0	0	0	
1135	07	0	0	0	0	
	08	0	0	0	0	
	09	0	0	0	0	
	10	0	0	0	0	
	11	0	0	0	0	
1140	12	0	0	0	0	
	13	0	0	0	0	
	14	0	0	0	0	
	15	0	0	0	0	
	16	0	0	0	0	
1145	17	0	0	0	0	
	18	0	0	0	0	
	19	0	0	0	0	
	20	0	0	0	0	
	21	0	0	0	0	
1150	22	0	0	0	0	
	23	0	0	0	0	
	24	0	0	0	0	
	25	0	0	0	0	
	26	0	0	0	0	
1155	27	0	0	0	0	
	28	0	0	0	0	
	29	0	0	0	0	

TIME HR	TIME MIN	SECONDS 00	15	30	45	COMMENTS
	30	0	0	0	0	
	31	0	0	0	0	
1200	32	0	0	0	0	LUNCH BREAK
	33					
	34					
	35					
	36					
	37					
	38					
	39					
	40					
	41					
	42					
	43					
	44					
	45					
	46					
	47					
	48					
	49					
	50					
	51					
	52					
	53					
	54					
	55					
	56					
	57					
	58					
	59					

Comments:

SUMMARY
RECORD OF VISIBLE EMISSIONS

Type of Plant _____ Date 10-25-80

Company Name US GYPSUM Hours of Observation 1245-1344

Plant Address FORT DODGE, IOWA Observer R. KAUFFMAN
Randall L. Kauffman

Type of Discharge (STACK) OTHER _____

Discharge Location OUTLET OF DUST COLLECTOR - BAGGING OPERATION #3

Height of Point of Discharge 50' FROM GROUND

Observer's Location:

Distance to Discharge Point 75'

Height of Observation Point GROUND LEVEL

Direction from Discharge Point SE

Background Description BLUE SKY

Weather: Clear Overcast (Partly Cloudy) Other _____ Color _____

Wind Direction SW Wind Velocity 5 mi/hr

Plume Description:

Detached: Yes No NO PLUME

Color: Black White Other _____

Plume Dispersion Behavior: Looping Coning Fanning

Lofting Fumigating Other N/A

Estimated Distance Plume Visible N/A

Summary of Observations:

Opacity	Aggregate Time @ Opacity	Opacity	Aggregate Time @ Opacity
0	min. sec.	55	
5		60	
10		65	
15		70	
20		75	
25		80	
30		85	
35		90	
40		95	
45		100	
50			

DIAGRAM ON REVERSE SIDE

RECORD OF VISIBLE EMISSIONS

Company Name: US GYPSUM
Plant Address: FORT DODGE, IOWA
Stack Location: OUTLET OF DUST COLLECTOR
Weather Conditions: PARTLY CLOUDY BAGGING OPERATIONS

Date: 10-29-80
Observer: R. KAUFFMAN - Randall K. Kauffman
Observer's Location: 75' SW ON GROUND

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS	TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
1245	00	0	0	0	0	WIND SW-5 MPH	1315	30	0	0	0	0	
	01	0	0	0	0			31	0	0	0	0	
	02	0	0	0	0	NO PLUME		32	0	0	0	0	
	03	0	0	0	0			33	0	0	0	0	
	04	0	0	0	0	BLUE SKY BACKGROUND		34	0	0	0	0	
1250	05	0	0	0	0		1320	35	0	0	0	0	
	06	0	0	0	0			36	0	0	0	0	
	07	0	0	0	0			37	0	0	0	0	
	08	0	0	0	0			38	0	0	0	0	
	09	0	0	0	0			39	0	0	0	0	
1255	10	0	0	0	0		1325	40	0	0	0	0	
	11	0	0	0	0			41	0	0	0	0	
	12	0	0	0	0			42	0	0	0	0	
	13	0	0	0	0			43	0	0	0	0	
	14	0	0	0	0			44	0	0	0	0	
1300	15	0	0	0	0		1330	45	0	0	0	0	
	16	0	0	0	0			46	0	0	0	0	
	17	0	0	0	0			47	0	0	0	0	
	18	0	0	0	0			48	0	0	0	0	
	19	0	0	0	0			49	0	0	0	0	
1305	20	0	0	0	0		1335	50	0	0	0	0	
	21	0	0	0	0			51	0	0	0	0	
	22	0	0	0	0			52	0	0	0	0	
	23	0	0	0	0			53	0	0	0	0	
	24	0	0	0	0			54	0	0	0	0	
1310	25	0	0	0	0		1340	55	0	0	0	0	
	26	0	0	0	0			56	0	0	0	0	
	27	0	0	0	0			57	0	0	0	0	
	28	0	0	0	0			58	0	0	0	0	
	29	0	0	0	0		1344	59	0	0	0	0	CHANGED BAGGING MACHINES HERE

Comments:

SUMMARY
RECORD OF VISIBLE EMISSIONS

Type of Plant _____ Date 10-30-80

Company Name US GYPSUM Hours of Observation 1130-1155

Plant Address FORT DODGE, IOWA Observer R. KAUFFMAN
Randall L. Kauffman

Type of Discharge (STACK) OTHER _____

Discharge Location OUTLET - BAGGING # 2 UNIT

Height of Point of Discharge 50' FROM GROUND

Observer's Location:

Distance to Discharge Point 75'

Height of Observation Point GROUND LEVEL

Direction from Discharge Point SW

Background Description BLUE SKY

Weather: (Clear) Overcast Partly Cloudy Other _____ Color _____

Wind Direction WEST Wind Velocity 10-15 mi/hr

Plume Description:

Detached: Yes No NO PLUME

Color: Black White Other N/A

Plume Dispersion Behavior: Looping Coning Fanning

Lofting Fumigating Other N/A

Estimated Distance Plume Visible N/A

Summary of Observations:

Opacity	Aggregate Time @ Opacity	Opacity	Aggregate Time @ Opacity
0	min. sec.	55	
5		60	
10		65	
15		70	
20		75	
25		80	
30		85	
35		90	
40		95	
45		100	
50			

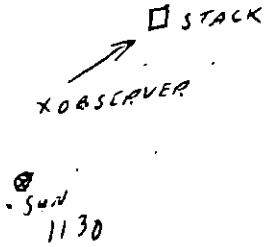
RECORD OF VISIBLE EMISSIONS

Company Name: U S GYPSUM
Plant Address: FORT DODGE, IOWA
Stack Location: OUTLET - BAGGING UNIT # 2
Weather Conditions: CLEAR - BLUE SKY
OUTLET OF DUST COLLECTOR

Date: 10-30-80
Observer: L. KAUFFMAN - Rand. M. L. Kauffman
Observer's Location: 75' SW OF OUTLET ON GROUND

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS	TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
1130	00	0	0	0	0	WIND - WEST 10-15 MPH	1200	30					
	01	0	0	0	0	BLUE SKY BACKGROUND		31					
	02	0	0	0	0			32					
	03	0	0	0	0	NO PLUME		33					
	04	0	0	0	0			34					
1135	05	0	0	0	0			35					
	06	0	0	0	0			36					
	07	0	0	0	0			37					
	08	0	0	0	0			38					
	09	0	0	0	0			39					
1140	10	0	0	0	0			40					
	11	0	0	0	0			41					
	12	0	0	0	0			42					
	13	0	0	0	0			43					
	14	0	0	0	0			44					
1145	15	0	0	0	0			45					
	16	0	0	0	0			46					
	17	0	0	0	0			47					
	18	0	0	0	0			48					
	19	0	0	0	0			49					
1150	20	0	0	0	0			50					
	21	0	0	0	0			51					
	22	0	0	0	0			52					
	23	0	0	0	0			53					
	24	0	0	0	0			54					
1155	25	0	0	0	0	LUNCH BREAK HERE		55					
	26							56					
	27							57					
	28							58					
	29							59					

Comments: Observer location same as 10-29-80. see diagram from 10-29-80



SUMMARY
RECORD OF VISIBLE EMISSIONS

Type of Plant _____ Date 10-31-80

Company Name U.S. GYPSUM Hours of Observation 0830-0852

Plant Address FORT DODGE, IOWA Observer R.E. KAUFFMAN
Randall L. Kauffman

Type of Discharge (STACK) OTHER _____

Discharge Location OUTLET OF DUST COLLECTORS - BAGGING OPERATION BAGGER #2

Height of Point of Discharge 50' FROM GROUND

Observer's Location:

Distance to Discharge Point 60'

Height of Observation Point GROUND LEVEL

Direction from Discharge Point SW

Background Description BLUE SKY

Weather: (Clear) Overcast Partly Cloudy Other _____ Color _____

Wind Direction CALM Wind Velocity _____ mi/hr

Plume Description:

Detached: Yes No NO PLUME

Color: Black White Other N/A

Plume Dispersion Behavior: Looping Coning Fanning

Lofting Fumigating Other N/A

Estimated Distance Plume Visible N/A

Summary of Observations:

Opacity	Aggregate Time @ Opacity	Opacity	Aggregate Time @ Opacity
0	min. sec.	55	
5		60	
10		65	
15		70	
20		75	
25		80	
30		85	
35		90	
40		95	
45		100	
50			

DIAGRAMS ON REVERSE SIDE

RECORD OF VISIBLE EMISSIONS

Company Name: U S GYPSUM Date: 10 - 31 - 90
Plant Address: FORT DODGE, IOWA Observer: R. KAUFFMAN - Randall R. Kauffman
Stack Location: OUTLET OF DUST COLLECTOR Observer's Location: 60' SW OF OUTLET STA ON GROUND
Weather Conditions: BAGGING OPERATION - BAGGER #2

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS	TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
0830	00	0	0	0	0	WIND - CALM		30					
	01	0	0	0	0			31					
	02	0	0	0	0			32					
	03	0	0	0	0			33					
	04	0	0	0	0			34					
0835	05	0	0	0	0			35					
	06	0	0	0	0			36					
	07	0	0	0	0			37					
	08	0	0	0	0			38					
	09	0	0	0	0			39					
0840	10	0	0	0	0			40					
	11	0	0	0	0			41					
	12	0	0	0	0			42					
	13	0	0	0	0			43					
	14	0	0	0	0			44					
0845	15	0	0	0	0			45					
	16	0	0	0	0			46					
	17	0	0	0		BAGGING STOP		47					
	18			0	0	HERE		48					
	19	0	0	0	0	START AGAIN		49					
0850	20	0	0	0	0			50					
	21	0	0	0	0			51					
0852	22	0				BAGGING STOP HERE		52					
	23							53					
	24							54					
0855	25							55					
	26							56					
	27							57					
	28							58					
	29							59					

Comments:

SUMMARY
RECORD OF VISIBLE EMISSIONS

Type of Plant _____ Date 10-31-80

Company Name U S GYPSUM Hours of Observation 0918-0935

Plant Address FORT DODGE, IOWA Observer R E KAUFFMAN

Type of Discharge (STACK) OTHER _____

Discharge Location OUTLET OF DUST COLLECTOR - BAGHOUSE

Height of Point of Discharge 50' FROM GROUND

Observer's Location:

Distance to Discharge Point 60'

Height of Observation Point GROUND LEVEL

Direction from Discharge Point SW

Background Description BLUE SKY

Weather: (Clear) Overcast Partly Cloudy Other _____ Color _____

Wind Direction CALM Wind Velocity _____ mi/hr

Plume Description:

Detached: Yes No NO PLUME

Color: Black White Other N/A

Plume Dispersion Behavior: Looping Coning Fanning

Lofting Fumigating Other N/A

Estimated Distance Plume Visible N/A

Summary of Observations:

Opacity	Aggregate Time @ Opacity	Opacity	Aggregate Time @ Opacity
0	min. sec.	55	
5		60	
10		65	
15		70	
20		75	
25		80	
30		85	
35		90	
40		95	
45		100	
50			

SEE DIAGRAM FROM 0830-0852

RECORD OF VISIBLE EMISSIONS

Company Name: US GYPSUM
Plant Address: FORT DODGE, IOWA
Stack Location: OUTLET OF DUST COLLECTOR
Weather Conditions: CLEAR - BLUE SKY
BAGGER # 2

Date: 10-31-90
Observer: R. KAUFFMAN - Randall L. Kauffman
Observer's Location: 60' SW OF OUTLET ON GROUND

TIME HR	TIME MIN	SECONDS 00	15	30	45	COMMENTS
0918	00	0	0	0	0	WIND - CALM
	01	0	0	0	0	
0920	02	0	0	0	0	BLUE BACKGROUND
	03	0	0	0	0	
	04	0	0	0	0	
	05	0	0	0	0	
	06	0	0	0	0	
0925	07	0	0	0	0	
	08	0	0	0	0	
	09	0	0	0	0	
	10	0	0	0	0	
	11	0	0	0	0	
0930	12	0	0	0	0	
	13	0	0	0	0	
	14	0	0	0	0	
	15	0	0	0	0	
	16	0	0	0	0	
0935	17	0	0	0		BAGGING STOPPED
	18					BAGGING SWITCHED
	19					TO BAGGER # 1
	20					HERE
	21					
0940	22					
	23					
	24					
	25					
	26					
	27					
	28					
	29					

TIME HR	TIME MIN	SECONDS 00	15	30	45	COMMENTS
	30					
	31					
	32					
	33					
	34					
	35					
	36					
	37					
	38					
	39					
	40					
	41					
	42					
	43					
	44					
	45					
	46					
	47					
	48					
	49					
	50					
	51					
	52					
	53					
	54					
	55					
	56					
	57					
	58					
	59					

Comments:

APPENDIX D

DAILY SAMPLING LOGS

Includes:

D.1 Daily Summary Log
D.2 Field Notebook

APPENDIX D.1

DAILY SUMMARY LOG

DAILY SUMMARY LOG FOR TESTS AT THE KETTLE CALCINER NO. 5
BAGHOUSE INLET AND OUTLET ON OCTOBER 28, 1980
AT U.S. GYPSUM COMPANY, FORT DODGE, IOWA

Time	Particulate Tests (Batch)		Stack Visible Emissions
	Inlet	Outlet	
1359			Observations began on batch kettle No. 5
1400	Began test #1	Began test #1	
1422	Stopped testing to change ports		
1520		Stopped testing to change ports	
1524		Resumed testing at port 2	
1530	Resumed testing at port 2		
1548	Finished test #1 except for last point due to plugging		
1640	Began test #2		
1642			Observations finished
1644		Finished test #1	
1657	Stopped testing to change ports		
1730		Began test #2	
1820	Resumed test at port 2		
1821	Test stopped due to plugging		
1850		Testing stopped to change ports	
1856		Resumed testing at port 2	
2011		Finished test #2	

DAILY SUMMARY LOG FOR TESTS AT THE KETTLE CALCINER NO. 5
BAGHOUSE INLET AND OUTLET ON OCTOBER 29, 1980
AT U.S. GYPSUM COMPANY, FORT DODGE, IOWA

Time	Particulate Tests (Batch)		Stack Visible Emissions
	Inlet	Outlet	
0858			Observations began on batch kettle No. 5
0940	Began test #3		
0943	Stopped testing because of steam		
0945		Began test #3	
1057			Observations finished
1105		Stopped testing to change ports	
1113		Resumed testing at second port	
1128			Observations began on Bagger #3
1145	Test began again		
1153	Testing stopped to change ports		
1200			Observations stopped
1202	Testing resumed at 2nd port		
1210	Finished test #3		
1233		Finished test #3	
1245			Observations continued on Bagger #3
1344			Observations finished
1400			Observations began on Stucco Conveyor Baghouse
1459			Observations finished

DAILY SUMMARY LOG FOR TESTS AT THE KETTLE CALCINER NO. 5
BAGHOUSE INLET AND OUTLET ON OCTOBER 30, 1980
AT U.S. GYPSUM COMPANY, FORT DODGE, IOWA

Time	Particulate Tests (Continuous) Inlet	Outlet	Stack Visible Emissions
0903			Observations began on Stucco Conveyor Baghouse
0930	Began test #4		
0935		Began test #4	
0940	Stopped testing to change ports		
1008	Resumed testing at 2nd port		
1015		Test stopped to change ports	
1018	Finished test #4		
1035		Resumed test at 2nd port	
1102			Observations finished
1115		Finished test #4	
1130			Observations began on Bagger #2
1155			Observations finished
1230		Began test #5	
1250			Observations began on Kettle #5
1310		Test stopped to change ports	
1312	Began test #5		
1322	Stopped test to change ports		
1350		Finished test #5	Observations stopped
1354	Resumed test at 2nd port		
1404	Finished test #5		
1440			Observations continued
1452		Began test #6	
1523	Began test #6		
1524		Test stopped to change ports	
1527		Resumed testing at 2nd port	
1533	Stopped test to change ports		
1553	Resumed testing at 2nd port		
1559		Finished test #6	
1603	Finished test #6		
1639			Observations finished
1704		Began test 4R	
1737		Stopped test to change ports	
1740		Resumed test at 2nd port	
1810		Finished test #4R	

DAILY SUMMARY LOG FOR BOARD END SAW AND KETTLE
CALCINER NO. 5 BAGHOUSE OUTLETS ON OCTOBER 31, 1980
AT U.S. GYPSUM COMPANY, FORT DODGE, IOWA

Time	Particulate Tests		Stack Visible Emissions	Fugitive Emissions
	Board End Saw	Batch Kettle No. 5 Outlet		
0830			Observations began at Bagger #2	
0852			Observations finished	
0909			Observations began at Batch Kettle #5	
0945		Began test 3R		
1105		Stopped testing to change ports		
1108			Observations finished	
1113		Resumed testing at 2nd port		
1115	Began test #7			
1125			Observations began at board end saw	
1135	Stopped testing to change ports			
1140	Resumed testing at 2nd port			
1200	Finished test #7			
1215			Observations stopped	
1233		Finished test 3R		
1310	Began test #8		Observation Continued	
1330	Stopped test to change ports			
1335			Observations stopped	
1415	Resumed testing at 2nd port			Observations began
1435	Finished test #8			
1517			Observations continued	
1607	Began test #9			
1627	Stopped test to change ports			
1635	Resumed test at 2nd port			
1647			Observations finished	
1655	Finished test #9			
1710	Began Particle Size test			
1830				Observations finished
1840	Finished Particle Size test			

APPENDIX D.2

FIELD NOTEBOOK

October 27, 1980

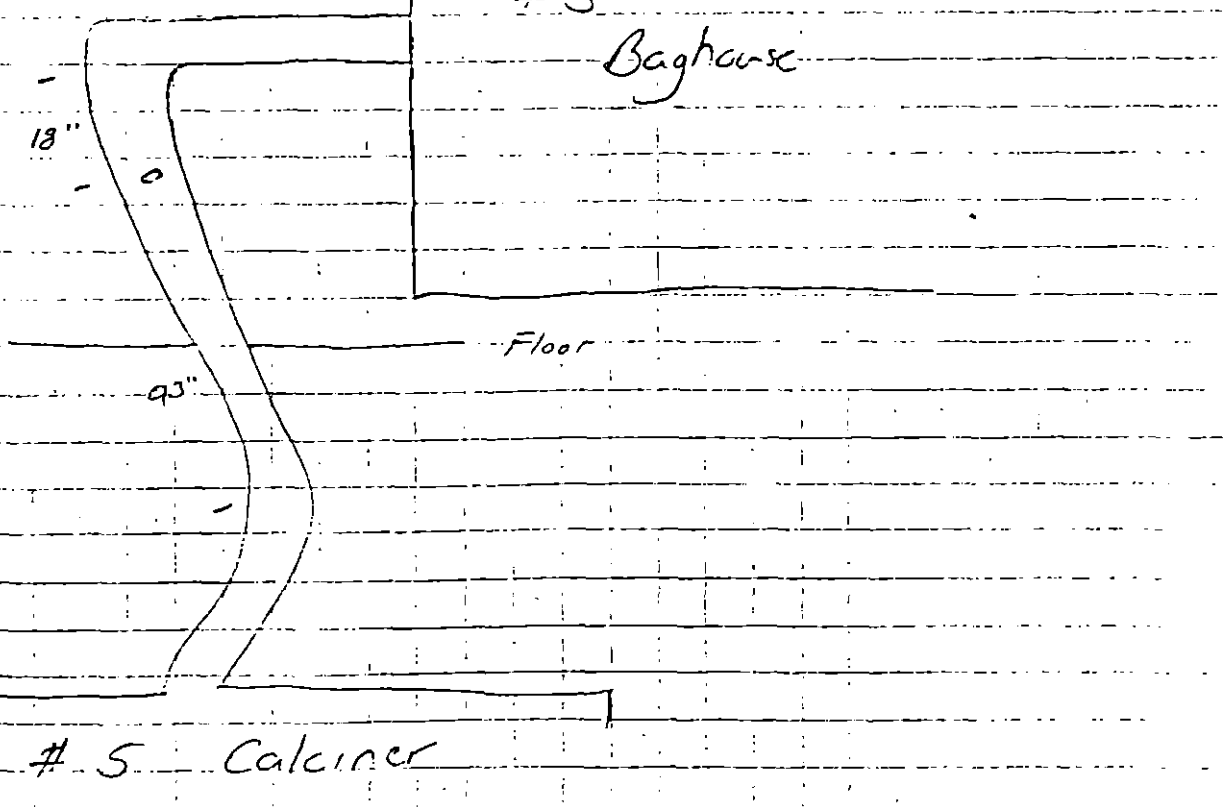
Arrived at plant and met Dan Dooley.

Started to set up equipment on the #5 Kettle Calciner. Radian wants to start on this calciner first.

Took duct measurements on both the inlet and outlet.

Inlet = ID = 13 1/2"

Upstream = 1.33 Duct Dia
Downstream = 6.9 " "
Total Pts = 20



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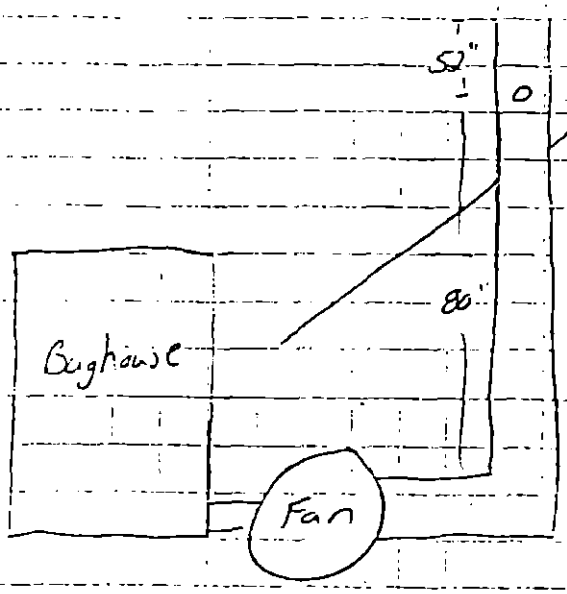
Outlet

Outlet - ID = ~~13~~ 11"

Upstream = ~~4.3~~ 4.7 Duct Dia.

Downstream = ~~6.7~~ 7.3 " "

Total Pts = 16



Outlet location will have to sample the entire cycle of the batch run. The run will last approximately 2 1/2 hours. The entire cycle consists of loading the kettle, heating gypsum to drive off water, and dumping of the kettle.

Two possibilities exist for sampling on the outlet as far as sampling time. We have to sample for as long as the cycle occurs.

16 pts @ 10 min = 160 mins (2 HR 40 min)

or

16 pts @ 8 min = 144 mins (2 HR 24 min)

will go with 160 mins with a double traverse run @ 5 mins per point per one single traverse. If the cycle stops before the total sample time then we will stop sampling. We may miss a few points.

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The inlet will go 20 points. We will run 3 or 2 min. per point which ever EPA agrees to.

Particle sizing is off on the inlet location. Maybe we can run a Bahco sample from the filter gain. We will try to run one particle size on the outlet.

Will have to see what EPA wants

LAG

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:0 Book No. TITLE 1532-E80-00 U.S. Gypsum

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October 28, 1980

Due to process problems we didn't start to test until 2:00 pm.

Normal process for the Batch operation is Charge - Cook - Dump

During Test #1 the outlet started during the cooking. Thus the cycle that Test #1 outlet saw was cook - dump - charge - cook. Test #1 lasted 160 min. For the inlet they only tested during the cooking cycle. No sampling was done during the charging and dumping. The first two points were sampled for 3 min. each, the sampling time was the decreased to 2 min. per point. This was done so that the sampling time would be cut overall. Heavy loadings caused filter To be changed during port changes. Due to nozzle plugging the last point on the second traverse was not sampled. The Test was stopped at that point. This completed Test #1 on the inlet.

We began Test #2 on the outlet. That test proceeded without any problems

However Test #2 on the inlet did run into problems. The first traverse started at 2 min. per point, on the 9th point the nozzle began to plug so The point was run for 1½ min. The 10th point was not run because of nozzle plugging and heavy loadings on the filter The filter had to be changed and sampling began on the 2nd port. Ten seconds into the second port the nozzle plugged. The nozzle was replaced and sampling resumed. This point lasted for 1.0 min. Due to heavy loadings the test was stopped. This concluded Test #2 on the inlet

There was a process upset in that the

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cooking process was ~~speed~~ applied up (by applying more heat) thus more moisture was given off at a faster rate. This heavy moisture caused the plugging. Normally the process is slower and the moisture is given off at a slower rate.

The more heat the faster the cooking the more the moisture

The less heat the less the cooking and less the moisture.

For 10/29 we will try for 2 tests on the inlet so that we get a full 3 tests

Measurements on #2 kettle were taken the stack ID for both inlet + outlet are different.

Outlet Stack 15" ID

Inlet Stack 13" ID

LAG

Witnessed & Understood by me,	Date	Invented by	Date
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October 29, 1980

Outlet location - started running @ 0945. No particle sizing on Kettle #5. This is because they want to switch over to continuous running will have do particle sizing tests on Kettle # 2.

Inlet location - started testing when the cycle temp started to rise. Figure the moisture content would be less. Sampled only the first two points and had to stop because they dumped the load. Will catch the next cycle when the temp starts to increase. We will finish the rte traverse and hope for a complete test with two traverses. (See Page 25)

CI #3 Loading

Stage	Filter No.
Back-Up	32
8	135
7	~~215~~ ~~135~~ 214
6	136
5	213
4	138
3	212
2	137
1	211

Witnessed & Understood by me,	Date	Invented by	Date
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CI # 1 Loading

Stage	Filter No.
Back-up	24
8	132
7	202
6	131
5	201
4	130
3	200
2	129
1	199

CI # 2 Loading

Stage	Filter No.
Back-up	28
8	124
7	194
6	123
5	193
4	122
3	192
2	121
1	190

Witnessed & Understood by me,	Date	Invented by	Date

Finished testing on the #5 kettle (Batch). The outlet had no problems. Moisture was consistent around 25%, for Tests #1-2.

The inlet resumed testing, once the cooling process started to increase in temperature. Hopefully the moisture will be lower and nozzle plugging can be avoided. Plus for this Test each point will be sampled for 1 minute. Started on the third point with no problems. They finished the port and changed nozzles. Changed ports and resumed testing! They almost completed a full traverse but had to stop due to nozzle plugging. This was the third test. The second test ~~on~~ from yesterday will count as a full test.

Another deviation in sampling at the inlet is that the 1st and last point on each traverse were not sampled, because of the heavy particulate on the duct wall. The 2nd and second to last points ~~are~~ were sampled twice as long to make up for not sampling at the first and last points.

This afternoon we will switch to the #2 kettle (continuous) and go for Test #1 on that kettle.

Preliminary moisture determination yielded a moisture content of 68%. The nomograph only goes up to 50%. Had to call Will to get an equation that gave us a constant (k) that could be multiplied by the ΔP to give us a proper ΔH so isokinetics could be run properly.

* Both Test #3 on the inlet and outlet were about isokinetics. The reason being the moisture increased substantially.

Inlet - moisture increase from 30% to 47%
Outlet - moisture " " 24% to 32%

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$$\Delta H = \left(\frac{C_p \times M_c}{4 \times K}\right)^2 \times \frac{M_m}{M_s} \times \frac{P_s}{P_m} \times \frac{T_m}{T_s} \times \Delta P \times D^4$$

C_p - pitot coef.

M_c - mole fraction of dry gas (1 - .60)

K - $\Delta H @$

M_s - stack molecular weight = 21.52 = $M_s = 29(M_c) + 1$

M_o - Dry molecular weight = 29.0

P_s - pressure at stack $\frac{P_s}{P_m} = I$

P_m - pressure at orifice

T_m - temp at meter (°R)

T_s - temp of stack (°R)

ΔP - of stack (in. H_2O)

D - nozzle diam in feet

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LE 1532-E80-60 U.S. Gypsum Book No.

m Page No. Call to Will

$$\Delta H = 45.068 \times \left(\frac{Cp}{K}\right)^2 \times \Delta P \times \frac{D^4}{T_s}$$

$$\Delta H = \left[\frac{(0.86)(0.32)}{(4)(1.96)}\right]^2 \times \frac{29}{21.50} \times 1 \times \frac{522}{530} \times \frac{(0.57)}{621} \times \Delta P$$

$$K = 846.72 \times D_N^4 \times \Delta H_@ \times C_p^2 \left(1 - B_w\right)^2 \times \frac{M_Q}{M_S} \times \frac{T_m}{T_s} \times \frac{P_s}{P_m}$$

$\Delta H = \Delta P \times K$

$$K = (846.72)\left(\frac{0.262}{72}\right)^4 (1.98)(0.86)^2 (0.67)^2 \left(\frac{29}{25.32}\right)\left(\frac{522}{621}\right)(1)$$

$K = 3.5$

$$K = (846.72)(D_N)^4 (1.98)(0.84)^2 (1-.68)^2 \left(\frac{29.0}{21.50}\right)\left(\frac{530}{750}\right)(1)$$

$K = 115.35 (D_N)^4$

$K = 0.544$ using 0.262 in. nozzle

$K = 2.43$ using 0.381 in. nozzle

$\Delta H = (k)(\Delta P)$ using 0.262 in. nozzle

$= (0.544)(.42)$

$= 0.23$

$= (2.43)(.42)$ using 0.381 in. nozzle

$= 1.02$

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October 30, 1990

The following equations and previous, are for sampling with a constant (k)
Tomorrow 10/30 we will move to #5 kettle because #2 kettle is to dirty so we will be testing #5 kettle continious.

Inlet Location

60% Moisture

$K = (846.72)(D_N)^4 \left(\frac{1.98}{\text{---}}\right)(0.86)^2(1-0.62)^2\left(\frac{29.0}{22.18}\right)\left(\frac{\text{---}}{750}\right)(1)$

$K = 172.11\,(D_N)^4$

$K = 172.11\,(0.38)^4$ using 0.38 nozzle

$= 3.59$

$\Delta H = (K)(\Delta P)$

$= (3.59)(0.65)$ $\Delta P = 0.65$

$\Delta H = 2.33$

~~$\Delta H = (K)(\text{---})$~~

$K = (172.11)(0.25)^4$ using 0.25 nozzle

$K = 0.672$

$\Delta H = (K)(\Delta P)$

$= (0.672)(0.65)$ $\Delta P = 0.65$

$\Delta H = 0.437$

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Inlet Location

$$K = (846.72)(O_N)^4(\Delta H_a)(C_p)^2(1-B_{wa})^2\left(\frac{P_a}{P_s}\right)\left(\frac{T_s}{T_m}\right)\left(\frac{P_s}{P_m}\right)$$

$$K = (846.72)(O_N)^4(1.98)(0.86)^2(1-.68)^2\left(\frac{29.0}{29.53}\right)\left(\frac{532}{750}\right)\left(\frac{1}{1}\right)$$

$K = 115.35(O_N)^4$ for Cp of 0.84

$K = 121.37(O_N)^4$ for Cp of 0.86

1) $K = 115.35(.38)^4$ 0.38 in. nozzle (3/8")

$= 2.41$

$\Delta H = (K)(\Delta P)$ Avg $\Delta P = 0.423$

$= (2.41)(0.423)$

$= 1.019$

2) $K = 121.37(.38)^4$ 0.38 in. nozzle

$= 2.53$

$\Delta H = (K)(\Delta P)$ Avg $\Delta P = 0.423$

$= (2.53)(0.423)$

$= 1.07$

3) $K = 115.35(0.3125)^4$ 0.3125 in. nozzle (5/16")

$= 1.10$

$\Delta H = (K)(\Delta P)$

$= (1.10)(0.423)$ Avg $\Delta P = 0.423$

$= 0.465$

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Inlet Location

October 30, 1980

$K = (172.11)(0.262)^4$ using 0.262" nozzle

$= 0.811$

$\Delta H = (K)(\Delta P)$

$= (0.811)(0.65)$ $\Delta P = 0.65$

$\Delta H = 0.527$

$K = (172.11)(0.3127)^4$ using 5/16" nozzle

$= 1.646$

$\Delta H = (K)(\Delta P)$

$= (1.646)(0.65)$ $\Delta P = 0.65$

$\Delta H = 1.069$

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Outlet Location

$$K = 846.72 (D_N)^4 (\Delta H_@)(C_P)^2 (1 - B_{wo})^2 \left(\frac{m_D}{m_3}\right)\left(\frac{T_m}{T_3}\right)\left(\frac{P_3}{P_m}\right)$$

$$K = 846.72 (D_N)^4 (2.14)(0.85)^2 (1 - .68)^2 \left(\frac{299.0}{21.50}\right)\left(\frac{532}{701}\right)(1)$$

$K = 137.10 (D_N)^4$ for C_P of 0.85

1) $K = 137.10 (.38)^4$ 0.38 in. nozzle (3/8")

$= 2.86$

$\Delta H = (K)(\Delta P)$ Avg $\Delta P = 0.348$

$= (2.86)(0.348)$

$= 0.995$

2) $K = 137.10 (0.3125)^4$ 0.3125 in. nozzle (5/16")

$= 1.31$

$\Delta H = (K)(\Delta P)$ Avg $\Delta P = 0.348$

$= (1.31)(0.348)$

$= 0.4558$

To Page No. _____

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by	

No sampling on #2 Kettle.
Batch cycle was tested on #5 Kettle
Continuous cycle was tested on #5 Kettle

All particle size work on the #5 Kettle will have to be done on a Bahco. Use the inlet particulate from the filter catch.

Both locations are using the K-factor for sampling their first tests under the continuous mode.

Inlet - K-factor = 1.646 5/16" nozzle
Outlet - K-factor = 1.868 5/16" nozzle

For 10/31

One outlet test on #5 under the Batch mode.

3 particulate tests on the Board End Saver
1 particle size test

Before test #2 under the continuous mode we will have check the isokinetics

Witnessed & Understood by me,	Date	Invented by	Date

Outlet Location (60% moisture)

$$K = (846.72)(D_N)^4(2.14)(0.856)^2(1-0.60)^2\left(\frac{60.0}{21.50^2}\right)\left(\frac{530}{680}\right)(1)$$

$$K = 201.37(D_N)^4$$

$K = (201.37)(0.38)^4$ using 3/8" nozzle

$= 4.20$

$\Delta H = (k)(\Delta P)$ $\Delta P = 0.97$

$= (4.20)(.97)$

$\Delta H = 4.07$

$K = (201.37)(0.3127)^4$ using 5/16" nozzle

$= 1.925$

$\Delta H = (k)(\Delta P)$ $\Delta P = 0.97$

$= (1.925)(0.97)$

$\Delta H = 1.868$

Outlet Location using (52% moisture)

$$K = (846.72)(D_N)^4(2.14)(0.856)^2(1-0.52)^2\left(\frac{29.0}{23.28}\right)\left(\frac{533}{685}\right)(1)$$

$K = 296.51(D_N)^4$

$K = (296.51)(0.2602)^4$ using 1/4" nozzle

$K = 1.401$

$\Delta H = (k)(\Delta P)$

$= (1.401)(0.95)$ $\Delta P = 0.95$

$\Delta H = 1.33$

To Page No.

Witnessed & Understood by me.	Date	Invented by	Date
		Recorded by	

From Page No. __

Results of Test #1 Kettle #5 Continuous mode

Inlet - 60 % moisture

96 % IK

Outlet - 50 % moisture

83 % IK

Outlet K factor was set at 60%. The 10% difference through the IK's off (too low). Actual moisture was 50% as shown above

The outlet location had to go to 6 impingers instead of the standard 4. The sequence changed to 1-2 100ml H_2O each, 3 empty, and the sixth contained 200 g of SG

Both K-factors seem to be OK now.

The K-factor on the outlet had to be changed from 1.868 to 1.401 so that the proper IK's could be maintained. As stated above the moisture changed from ~60% to ~50%

The inlet location has used 2 filters for each test. They are changing filters when they change ports. A leak test is performed after and before each filter change

Witnessed & Understood by me,	Date	Invented by	Date

File 1532-E80-00 U.S. Gypsum Book No.

Sub Proj. No.

Inlet Location for (57% Moisture)

$K = 168.00 (D_n)^4$

$K = 168.00 (0.3127)^4$ Wing 5/16" nozz

$K = 1.606$

$\Delta H = (K)(\Delta P)$ Avg. $\Delta P = 0.504$

$\Delta H = (1.606)(0.504)$

$\Delta H = 0.81$

To Page No.

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by	

Project No.
Book No. TITLE 1532-E20-00 U.S. Gypsum

From Page No.

Kettle #5 (continuous mode)
Summary

	% IK	% Moisture	K-factor	OSCF	Sample Time per pull
Inlet					
Test #1(4)	96.5	59	1.646	960	1
#2(5)	~~95.6~~	59	1.646	967	1
#3(6)	103.4	61	1.646	825	1
Outlet					
Test # 1(4)	83.5	52	~~1.868~~	1050	5
Test # 2(5)	100.0	51	1.401	1070	5
Test # 3(6)	100.4	51	1.401	1070	4
Test # 1R(4R)	104.4	53	1.401	1004	4

To Page No.

Witnessed & Understood by me,	Date	Invented by	Date

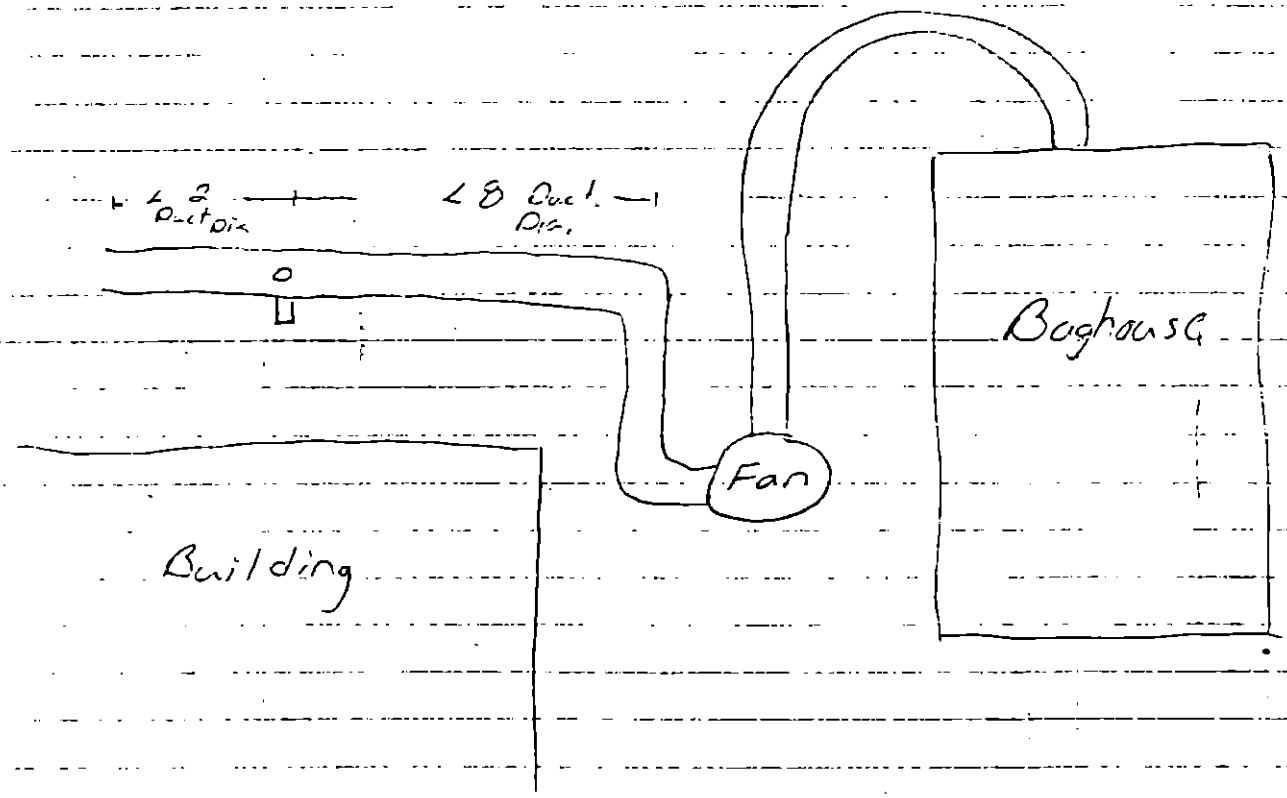
TITLE 1530-F80-00 U.S. Gypsum Book No.

From Page No.

October 31, 1980

Board End Sawing Baghouse Outlet

Stack ID = 11 1/2"



Ran 3 runs on the Board End Sawing Baghouse Outlet.

Test 1 - OK

Test 2 - Finished one part then the saw and board line went down. Resumed testing at 3:00 P.M. Finished test.

Test 3 - OK

Ran one particle size test on the outlet. We ran for 1 1/2 hours and collected 100 cubic feet. The outlet was so clean we should have run for

To Page No.

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by	

about 3 hours.

Ed ran a make up on #5 kettle under the Batch mode. High IX 110% due to moisture at 29%. Nomograph was set for 25%. The batch mode is so inconsistant with the percent moisture, If the operator excells the cooking then more moisture is given off over a shorter period of time.

Jim ran a total of 8 points (4 per traverse). Each point was sampled for 5 min each, for a total sample time 40 mins per test.

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by	

APPENDIX E

SAMPLING TRAIN CALIBRATION DATA

DATE 9/22/80 ORIFICE NO T-1 NAME G.GRIFFIN

BAROMETRIC PRESSURE 29.97 IN HG DRY GAS METER NO 1

ORIFICE MANOMETER SETTING IN WATER	GAS VOLUME WET TEST METER CU FT	GAS VOLUME DRY GAS METER CU FT	TEMPERATURE WET TEST METER F	TEMPERATURE DRY GAS METER INLET F	TEMPERATURE DRY GAS METER OUTLET F	TEMPERATURE DRY GAS METER AVERAGE F	TIME MIN	RATIO	DHO
0.5	5.0	4.98	79.0	85.0	85.0	85.0	12.8	1.01	1.85
1.0	5.0	5.00	79.0	83.0	84.0	83.5	9.3	1.01	1.96
2.0	10.0	10.05	79.0	86.0	86.0	86.0	13.4	1.00	2.02
3.0	10.0	10.12	79.0	86.0	86.0	86.0	11.1	0.99	2.08
						AVERAGE		1.00	1.98

DATE 9/22/80 ORIFICE NO T-2 NAME D.ETHIER

BAROMETRIC PRESSURE 29.97 IN HG DRY GAS METER NO 2

ORIFICE MANOMETER SETTING IN WATER	GAS VOLUME WET TEST METER CU FT	GAS VOLUME DRY GAS METER CU FT	TEMPERATURE WET TEST METER F	TEMPERATURE DRY GAS METER INLET F	TEMPERATURE DRY GAS METER OUTLET F	TEMPERATURE DRY GAS METER AVERAGE F	TIME MIN	RATIO	DHO
0.5	5.0	4.99	81.0	91.0	90.0	90.5	13.5	1.02	2.06
1.0	5.0	5.01	81.0	90.0	89.0	89.5	9.6	1.01	2.08
2.0	10.0	10.07	80.5	91.0	91.0	91.0	14.0	1.01	2.19
3.0	10.0	10.13	80.5	91.0	91.0	91.0	11.5	1.00	2.21
						AVERAGE		1.01	2.14

TRC ENVIRONMENTAL CONSULTANTS

CLIENT U.S.GYPSUM/E.P.A.
CHARGE NO. 1532-E80 TESTER ASTLE/ETHIER

CALIBRATION DATA
TYPE S PILOT TUBE

DATE 10/22/80 TEMP.(F)= 50.0 BARO.PRES.(IN.HG)=30.33

STANDARD PITOT NO. CE-1 SERIAL NO. 28

NO. OF SCREENS	STD DELTA P " W.C.	TYPE SA DELTA P " W.C.	COEFF *CP(S)	DEVIATION	ERROR
1	0.080	0.105	0.864	0.00	0.00
2	0.210	0.275	0.865	0.00	0.00
3	0.440	0.580	0.862	-0.00	0.00
4	0.610	0.800	0.864	0.00	0.00
5	0.815	1.090	0.856	-0.01	0.00

AVERAGE CP(S) 0.862

REVERSE (S) PITOT AND RERUN TEST

1	0.090	0.119	0.861	-0.00	0.00
2	0.220	0.290	0.862	0.00	0.00
3	0.455	0.600	0.862	0.00	0.00
4	0.625	0.828	0.860	-0.00	0.00
5	0.870	1.140	0.865	0.00	0.00

AVERAGE CP(S) 0.862

---

* CP(S)=0.99SQRT(DELTA P(STANDARD) / DELTA P(S))
DIFFERENCE OF AVERAGE CP(S) = 0.00

F$01 STOP 00000

TRC ENVIRONMENTAL CONSULTANTS

CLIENT U.S.GYPSUM/E.P.A.
CHARGE NO. 1532-E80 TESTER ASTLE/ETHIER

CALIBRATION DATA
TYPE S PILOT TUBE

DATE 10/22/80 TEMP.(F)= 50.0 BARO.PRES.(IN.HG)=30.33

STANDARD PITOT NO. CE-1 SERIAL NO. 29

NO. OF SCREENS	STD DELTA P ** W.C.	TYPE SA DELTA P ** W.C.	COEFF *CP(S)	DEVIATION	ERROR
1	0.095	0.130	0.846	0.00	0.00
2	0.210	0.290	0.842	-0.00	0.00
3	0.420	0.575	0.846	0.00	0.00
4	0.630	0.870	0.842	-0.00	0.00
5	0.830	1.145	0.843	-0.00	0.00

AVERAGE CP(S) 0.844

REVERSE (S) PITOT AND RERUN TEST

1	0.100	0.137	0.846	-0.00	0.00
2	0.210	0.285	0.850	0.00	0.00
3	0.410	0.560	0.847	0.00	0.00
4	0.610	0.830	0.849	0.00	0.00
5	0.815	1.125	0.843	-0.00	0.00

AVERAGE CP(S) 0.847

---

* CP(S)=0.99SQRT(DELTA P(STANDARD) / DELTA P(S))
DIFFERENCE OF AVERAGE CP(S) = 0.00

F$01 STOP 00000

TRC ENVIRONMENTAL CONSULTANTS

CLIENT U.S.GYPSUM/E.P.A.
CHARGE NO. 1532-E80 TESTER ASTLE/ETHIER

CALIBRATION DATA
TYPE S PILOT TUBE

DATE 10/22/80 TEMP.(F)= 50.0 BARO.PRES.(IN.HG)=30.03

STANDARD PITOT NO. CE-1 SERIAL NO. 39

NO. OF SCREENS	STD DELTA P ** W.C.	TYPE SA DELTA P ** W.C.	COEFF +CP(S)	DEVIATION	ERROR
1	0.095	0.130	0.846	0.01	0.00
2	0.205	0.285	0.840	-0.00	0.00
3	0.410	0.570	0.840	-0.00	0.00
4	0.615	0.860	0.837	-0.00	0.00
5	0.840	1.175	0.837	-0.00	0.00
		AVERAGE CP(S)	0.840		
		REVERSE (S) PITOT AND RERUN TEST			
1	0.060	0.083	0.842	-0.00	0.00
2	0.220	0.300	0.848	0.00	0.00
3	0.420	0.580	0.842	-0.00	0.00
4	0.630	0.865	0.845	0.00	0.00
5	0.810	1.120	0.842	-0.00	0.00
		AVERAGE CP(S)	0.844		

* CP(S)=0.99SQRT(DELTA P(STANDARD) / DELTA P(S))
DIFFERENCE OF AVERAGE CP(S) = 0.00

F$01 STOP 00000

TRC ENVIRONMENTAL CONSULTANTS

CLIENT U.S.GYPSUM/E.P.A.
CHARGE NO. 1532-E80 TESTER ASTLE/ETHIER

CALIBRATION DATA
TYPE S PILOT TUBE

DATE 10/22/80 TEMP.(F)= 50.0 BARO.PRES.(IN.HG)=30.03

STANDARD PITOT NO. CE-1 SERIAL NO. 49

NO. OF SCRLENS	STD DELTA P ** W.C.	TYPE SA DELTA P ** W.C.	COEFF *CP(S)	DEVIA-TION	ERROR
1	0.080	0.107	0.856	-0.00	0.00
2	0.205	0.275	0.855	-0.00	0.00
3	0.420	0.560	0.857	0.00	0.00
4	0.630	0.845	0.855	-0.00	0.00
5	0.830	1.105	0.856	0.00	0.00
		AVERAGE CP(S)	0.856		
		REVERSE (S) PITOT AND RERUN TEST			
1	0.075	0.101	0.853	0.00	0.00
2	0.210	0.285	0.850	-0.00	0.00
3	0.430	0.585	0.849	-0.00	0.00
4	0.640	0.860	0.854	0.00	0.00
5	0.860	1.170	0.849	-0.00	0.00
		AVERAGE CP(S)	0.851		

* CP(S)=0.99SQRT(DELTA P(STANDARD) / DELTA P(S))
DIFFERENCE OF AVERAGE CP(S) = 0.01

F$01 STOP 00000

DATE 11/29/77

INSPECTION REPORT

ELFRED MACHINE COMPANY

CUSTOMER TRC-THE RESEARCH CORP. CUSTOMER P.O. NO. 9964

S.O. NUMBER —

PURCHASED FROM ELFRED P.O. NO. _____

PART NO. 1-1

NO. PIECES ORDERED 1 NO. PIECES RECEIVED 1

TOOL NO. SET # 1

PART NAME ST/STL NOZZLE

TOOL NAME _____

Actual in 3 Places	Average	Date/Initls	Actual in 3 Places	Average	Date/Initls.
.1869 - .1870 - .1871	.1870	11/30/77			
.1872 - .1873 - .1873	.1873	3/1/79			
.1921 - .1922 - .1922	.1922	7/31/79			
.1882 - .1883 - .1884	NEW TIP .1883	11/9/79			
.1923 - .1923 - .1924	.1923	12/17/79			
.1953 - .1953 - .1954	.1954	5/13/80			
.1965 - .1965 - .1966	.1965	8/6/80			
.1991 - .1992 - .1992	.1992	8/20/80			

1st PIECE INSPECTION ☐

PARTIAL INSPECTION ☐

COMPLETE INSPECTION ☑

ACCEPTED ☐

REJECTED ☐

INSPECTOR

ELFRED MACHINE COMPANY
INS JORDAN LANE
WETHERSFIELD, CONN. 06109

NOV 30 ENT'D

FORM 13

DATE 11/29/79

INSPECTION REPORT

ELFRED MACHINE COMPANY

CUSTOMER TRC-THE RESEARCH CORP. CUSTOMER P.O. NO. 9964

S.O. NUMBER —

PURCHASED FROM ELFRED P.O. NO. _____

PART NO. 1-2

NO. PIECES ORDERED 1 NO. PIECES RECEIVED 1

TOOL NO. SET #1

PART NAME ST/STL NOZZLE

TOOL NAME _____

Actual in 3 Places	Average	Date/Initls	Actual in 3 Places	Average	Date/Initls.
.2547-.2551-.2552	.2550	11/30/79			
.2576-.2576-.2591	.2576	6/13/78			
.2590-.2590-.2590	.2590	7/3/78			
.2574-.2574-.2575	.2574	10/26/79			
.2581-.2580-.2581	.2581	9/26/79			
.2582-.2582-.2583	.2582	10/22/79			
.2590-.2591-.2592	.2591	12/11/79			
.2592-.2592-.2592	.2592	1/15/80			
.2604-.2605-.2606	.2605	5/6/80			
.2613.2613-.2613	.2613	9/29/80			

1st PIECE INSPECTION ☐

PARTIAL INSPECTION ☐

COMPLETE INSPECTION ☑

ACCEPTED ☑

REJECTED ☐

INSPECTOR

ELFRED MACHINE COMPANY
105 JORDAN LANE
WETHERSFIELD, CONN. 06109

NOV 30 ENTD

FORM 12

DATE 7/9/79

INSPECTION REPORT

ELFRED MACHINE COMPANY

CUSTOMER TRC-THE RESEARCH CORP. — CUSTOMER P.O. NO. 5032

S.O. NUMBER — — PURCHASED FROM ELFRED P.O. NO. —

PART NO. 1-8 — NO. PIECES ORDERED 1 NO. PIECES RECEIVED 1

TOOL NO. — — PART NAME ST/STL NOZZLE 5/16

TOOL NAME —

Actual in 3 Places	Average	Date/Initls	Actual in 3 Places	Average	Date/Initls.
.3127 -.3127.-.3127	.3127	7/9/79			
.3127 - .3128 -.3127	.3127	11/27/79			

1st PIECE INSPECTION ☐

PARTIAL INSPECTION ☐

COMPLETE INSPECTION ☑

ACCEPTED ☑

REJECTED ☐

INSPECTOR

ELFRED MACHINE COMPANY
165 JORDAN LANE
WETHERSFIELD, CONN. 06109
JUL 7 ENTD

FORM 13

DATE 11/2?/77

INSPECTION REPORT

ELFRED MACHINE COMPANY

CUSTOMER TRC-THE RESEARCH CORP. CUSTOMER P.O. NO. 9964

S.O. NUMBER —

PURCHASED FROM ELFRED P.O. NO. _____

PART NO. 2-1

NO. PIECES ORDERED 1 NO. PIECES RECEIVED 1

TOOL NO. SET #2

PART NAME ST/STL NOZZLE

TOOL NAME _____

Actual in 3 Places	Average	Date/Initls	Actual in 3 Places	Average	Date/Initls.
.1858-.1861-.1861	.1860	1/20/77			
.1896-.1891-.1896	.1896	6/13/[illegible]			
.1865-.1870-.1870	.1870	10/[illegible]			
.1882-.1883-.1884	.1883	10/26/76			
.1880-.1881-.1882	.1881	12/19/76			
.1892-.1893-.1893	.1893	5/17/79			
.1889-.1890.1891	.1890	7/3/79			
.1914-.1915-.1916	.1915	8/6/80			
.1911.1912.1911	.1911	8/20/80			

1st PIECE INSPECTION ☐

PARTIAL INSPECTION ☐

COMPLETE INSPECTION ☑

ACCEPTED ☑

REJECTED ☐

INSPECTOR

ELFRED MACHINE COMPANY
165 JORDAN LANE
WETHERSFIELD, CONN. 06109

FORM 10

DATE 7/9/79

INSPECTION REPORT

ELFRED MACHINE COMPANY

CUSTOMER TRC - THE RESEARCH CORP

S.O. NUMBER —

PART NO. 2-8

TOOL NO. —

CUSTOMER P.O. NO. 5032

PURCHASED FROM ELFRED P.O. NO. —

NO. PIECES ORDERED 1 NO. PIECES RECEIVED 1

PART NAME ST/STL NOZZLE - 5/16

TOOL NAME —

Actual in 3 Places	Average	Date/Initls	Actual in 3 Places	Average	Date/Initls.
.3127 - .3127 - .3127	.3127	7/9/79 [illegible]			
.3127 - .3127 - .3127	.3127	7/18/80 [illegible]			

1st PIECE INSPECTION ☐

PARTIAL INSPECTION ☐

COMPLETE INSPECTION ☑

ACCEPTED ☑

REJECTED ☐

INSPECTOR [illegible]

ELFRED MACHINE COMPANY
165 JORDAN LANE
WETHERSFIELD, CONN. 06109

JUL 7 ENTD

FORM 13

DATE 11/29/77

INSPECTION REPORT

ELFRED MACHINE COMPANY

CUSTOMER TRC - THE RESEARCH CORP. CUSTOMER P.O. NO. 9964

S.O. NUMBER —

PURCHASED FROM ELFRED P.O. NO. _____

PART NO. 3 - 1

NO. PIECES ORDERED 1 NO. PIECES RECEIVED 1

TOOL NO. SET # 3

PART NAME ST/STL NOZZLE

TOOL NAME _____

Actual in 3 Places	Average	Date/Initls	Actual in 3 Places	Average	Date/Initls.
.1854-.1856-.1855	.1855	11/30/77			
.1860-.1861-.1860	.1860	7/5/78			
.1901-.1901-.1901	.1901	illegible			
.1900-.1901-.1902	.1901	6/26/79			
.1940-.1941-.1941	.1941	8/28/79			
.1913-.1914-.1914	.1914	8/6/80			
.1960-.1960-.1960	.1960	9/20/80			

1st PIECE INSPECTION ☐

PARTIAL INSPECTION ☐

COMPLETE INSPECTION ☑

ACCEPTED ☑

REJECTED ☐

INSPECTOR

ELFRED MACHINE COMPANY
165 JORDAN LANE
WETHERSFIELD, CONN. 06109

NOV 30 ENT

FORM 12

DATE 11/29/77

INSPECTION REPORT

ELFRED MACHINE COMPANY

CUSTOMER TRC-THE RESEARCH CORP. CUSTOMER P.O. NO. 9964

S.O. NUMBER —

PURCHASED FROM ELFRED P.O. NO. _____

PART NO. 3-2

NO. PIECES ORDERED 1 NO. PIECES RECEIVED 1

TOOL NO. SET # 3

PART NAME ST/STL NOZZLE

TOOL NAME _____

Actual in 3 Places	Average	Date/Initls	Actual in 3 Places	Average	Date/Initls.
.2541-.2540-.2540	.2540	11/30/77			
.2575-.2575-.2576	.2575	2/4/78			
.2580-.2580-.2581	.2580	7/3/78			
.2595-.2594-.2595	.2595	8/11/78			
.2595-.2598-.2600	.2598	10/17/78			
.2600-.2602-.2603	.2602	3/1/79			
.2603-.2604-.2604	.2604	7/3/79			
.2622-.2622-.2625	.2622	4/1/80			

1st PIECE INSPECTION ☐

PARTIAL INSPECTION ☐

COMPLETE INSPECTION ☑

ACCEPTED ☑

REJECTED ☐

INSPECTOR

ELFRED MACHINE COMPANY
165 JORDAN LANE
WETHERSFIELD, CONN. 06109

NOV 30 ENT'D

FORM 12

APPENDIX F

SAMPLING PROCEDURE AND ANALYTICAL DATA

Includes:

F.1 EPA Method 5
F.2 Laboratory Data Summaries

APPENDIX F.1

EPA METHOD 5

3.2.2 Connect the probe, insert it into the stack, and sample at a constant rate of 2 lpm (0.071 cfm). Continue sampling until the dry gas meter registers about 30 liters (1.1 ft³) or until visible liquid droplets are carried over from the first impinger to the second. Record temperature, pressure, and dry gas meter readings as required by Figure 4-3.

3.2.3 After collecting the sample, combine the contents of the two impingers and measure the volume to the nearest 0.5 ml.

3.3 Calculations. The calculation method presented is designed to estimate the moisture in the stack gas; therefore, other data, which are only necessary for accurate moisture determinations, are not collected. The following equations adequately estimate the moisture content, for the purpose of determining isokinetic sampling rate settings.

3.3.1 Nomenclature.

B_{wa} = Approximate proportion, by volume, of water vapor in the gas stream leaving the second impinger, 0.025.

B_{ws} = Water vapor in the gas stream, proportion by volume.

M_w = Molecular weight of water, 18.0 g/g-mole (18.0 lb/lb-mole)

P_m = Absolute pressure (for this method, same as barometric pressure) at the dry gas meter.

P_{std} = Standard absolute pressure, 760 mm Hg (29.92 in. Hg).

R = Ideal gas constant, 0.06236 (mm Hg) (m³)/(g-mole) (°K) for metric units and 21.85 (in. Hg) (ft³)/lb-mole) (°R) for English units.

T_m = Absolute temperature at meter, °K (°R)

T_{std} = Standard absolute temperature, 293° K (528° R)

V_f = Final volume of impinger contents, ml.

V_i = Initial volume of impinger contents, ml.

V_m = Dry gas volume measured by dry gas meter, dcm (dcf).

$V_{m(std)}$ = Dry gas volume measured by dry gas meter, corrected to standard conditions, dscm (dscf).

$V_{w(std)}$ = Volume of water vapor condensed, corrected to standard conditions, scm (scf).

ρ_w = Density of water, 0.9982 g/ml (0.002201 lb/ml).

Y = Dry gas meter calibration factor.

3.3.2 Volume of water vapor collected.

$$V_{ws} = \frac{(V_f - V_i)\rho_w R T_{std}}{P_{std} M_w}$$

$$= K_1 (V_f - V_i)$$

Equation 4-5

where:

K_1 = 0.001333 m³/ml for metric units

= 0.04707 ft³/ml for English units.

$$V_{m(std)} = V_m Y \left(\frac{P_m}{P_{std}}\right)\left(\frac{T_{std}}{T_m}\right) = K_2 Y \frac{V_m P_m}{T_m}$$

Equation 4-6

where:

K_2 = 0.3858 °K/mm Hg for metric units

= 17.64 °R/in. Hg for English units

3.3.4 Approximate moisture content.

$$B_{ws} = \frac{V_{w(std)}}{V_{w(std)} + V_{m(std)}} = B_{wa} + \frac{V_{w(std)}}{V_{w(std)} + V_{m(std)}} + (0.025)$$

Equation 4-7

4. *Calibration*

4.1 For the reference method, calibrate equipment as specified in the following sections of Method 5: Section 5.3 (metering system); Section 5.5 (temperature gauges); and Section 5.7 (barometer). The recommended leak check of the metering system (Section 5.6 of Method 5) also applies to the reference method. For the approximation method, use the procedures outlined in Section 5.1.1 of Method 6 to calibrate the metering system, and the procedure of Method 5, Section 5.7 to calibrate the barometer.

5. *Bibliography*

1. Air Pollution Engineering Manual (Second Edition). Danielson, J. A. (ed.). U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, N.C. Publication No. AP-40. 1973.

2. Devorkin, Howard, et al. Air Pollution Source Testing Manual. Air Pollution Control District, Los Angeles, Calif. November, 1963.

3. Methods for Determination of Velocity, Volume, Dust and Mist Content of Gases. Western Precipitation Division of Joy Manufacturing Co., Los Angeles, Calif. Bulletin WP-50. 1968.

METHOD 5—DETERMINATION OF PARTICULATE EMISSIONS FROM STATIONARY SOURCES

1. *Principle and Applicability*

1.1 Principle. Particulate matter is withdrawn isokinetically from the source and collected on a glass fiber filter maintained at a temperature in the range of 120±14° C (248±25° F) or such other temperature as specified by an applicable subpart of the standards or approved by the Administrator, U.S. Environmental Protection Agency, for a particular application. The particulate mass, which includes any material that condenses at or above the filtration temperature, is determined gravimetrically after removal of uncombined water.

1.2 Applicability. This method is applicable for the determination of particulate emissions from stationary sources.

2. *Apparatus*

2.1 Sampling Train. A schematic of the sampling train used in this method is shown in Figure 5-1. Complete construction details are given in APTD-0581 (Citation 2 in Section 7); commercial models of this train are also available. For changes from APTD-0581 and for allowable modifications of the train shown in Figure 5-1, see the following subsections.

The operating and maintenance procedures for the sampling train are described in APTD-0576 (Citation 3 in Section 7). Since correct usage is important in obtaining valid results, all users should read APTD-0576 and adopt the operating and maintenance procedures outlined in it, unless otherwise specified herein. The sampling train consists of the following components:

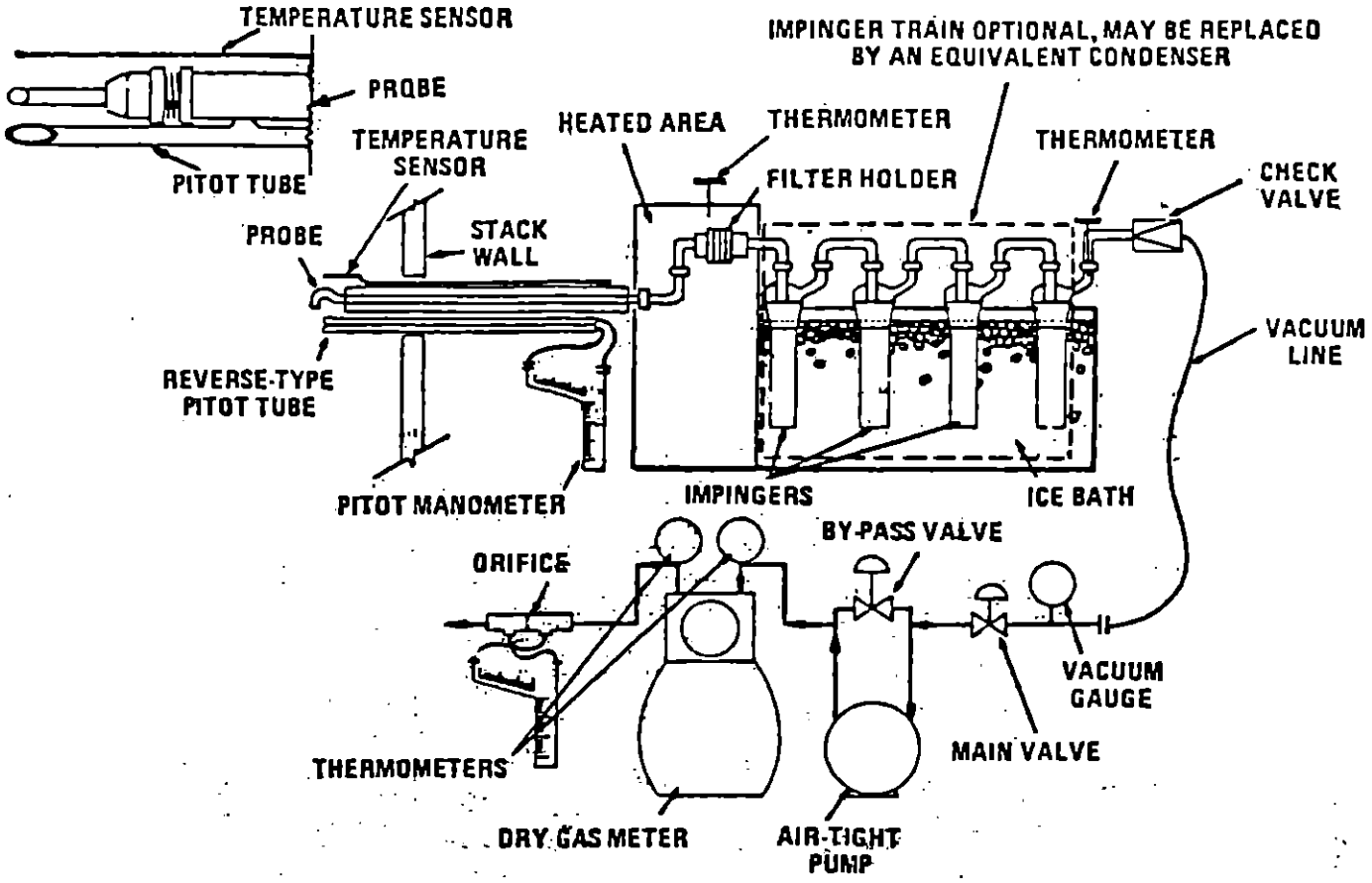


Figure 5 1. Particulate-sampling train.

2.1.1 Probe Nozzle. Stainless steel (316) or glass with sharp, tapered leading edge. The angle of taper shall be ≤30° and the taper shall be on the outside to preserve a constant internal diameter. The probe nozzle shall be of the button-hook or elbow design, unless otherwise specified by the Administrator. If made of stainless steel, the nozzle shall be constructed from seamless tubing; other materials of construction may be used, subject to the approval of the Administrator.

A range of nozzle sizes suitable for isokinetic sampling should be available, e.g., 0.32 to 1.27 cm (⅛ to ½ in.)—or larger if higher volume sampling trains are used—inside diameter (ID) nozzles in increments of 0.16 cm (1/16 in.). Each nozzle shall be calibrated according to the procedures outlined in Section 5.

2.1.2 Probe Liner. Borosilicate or quartz glass tubing with a heating system capable of maintaining a gas temperature at the exit end during sampling of 120±14° C (248±25° F), or such other temperature as specified by an applicable subpart of the standards or approved by the Administrator for a particular application. (The tester may opt to operate the equipment at a temperature lower than that specified.) Since the actual temperature at the outlet of the probe is not usually monitored during sampling, probes constructed according to APTD-0581 and utilizing the calibration curves of APTD-0576 (or calibrated according to the procedure outlined in APTD-0576) will be considered acceptable.

Either borosilicate or quartz glass probe liners may be used for stack temperatures up to about 480° C (900° F); quartz liners shall be used for temperatures between 480 and 900° C (900 and 1,650° F). Both types of liners may be used at higher temperatures than specified for short periods of time, subject to the approval of the Administrator. The softening temperature for borosilicate is 820° C (1,508° F), and for quartz it is 1,500° C (2,732° F).

Whenever practical, every effort should be made to use borosilicate or quartz glass probe liners. Alternatively, metal liners (e.g., 316 stainless steel, Incoloy 825,[1] or other corrosion resistant metals) made of seamless tubing may be used, subject to the approval of the Administrator.

2.1.3 Pitot Tube. Type S, as described in Section 2.1 of Method 2, or other device approved by the Administrator. The pitot tube shall be attached to the probe (as shown in Figure 5-1) to allow constant monitoring of the stack gas velocity. The impact (high pressure) opening plane of the pitot tube shall be even with or above the nozzle entry plane (see Method 2, Figure 2-6b) during sampling. The Type S pitot tube assembly shall have a known coefficient, determined as outlined in Section 4 of Method 2.

2.1.4 Differential Pressure Gauge. Inclined manometer or equivalent device (two), as described in Section 2.2 of Method 2. One manometer shall be used for velocity head (Δp) readings, and the other, for orifice differential pressure readings.

2.1.5 Filter Holder. Borosilicate glass, with a glass frit filter support and a silicone rubber gasket. Other materials of construction (e.g., stainless steel, Teflon, Viton) may be used, subject to approval of the Administrator. The holder design shall provide a positive seal against leakage from the outside or around the filter. The holder shall be attached immediately at the outlet of the probe (or cyclone, if used).

2.1.6 Filter Heating System. Any heating system capable of maintaining a temperature around the filter holder during sampling of 120±14° C (248±25° F), or such other temperature as specified by an applicable subpart of the standards or approved by the Administrator for a particular application. Alternatively, the tester may opt to operate the equipment at a temperature lower than that specified. A temperature gauge capable of measuring temperature to within 3° C (5.4° F) shall be installed so that the temperature around the filter holder can be regulated and monitored during sampling. Heating systems other than the one shown in APTD-0581 may be used.

2.1.7 Condenser. The following system shall be used to determine the stack gas moisture content: Four impingers connected in series with leak-free ground glass fittings or any similar leak-free non-contaminating fittings. The first, third, and fourth impingers shall be of the Greenburg-Smith design, modified by replacing the tip with 1.3 cm (½ in.) ID glass tube extending to about 1.3 cm (½ in.) from the bottom of the flask. The second impinger shall be of the Greenburg-Smith design with the standard tip. Modifications (e.g., using flexible connections between the impingers, using materials other than glass, or using flexible vacuum lines to connect the filter holder to the condenser) may be used, subject to the approval of the Administrator. The first and second impingers shall contain known quantities of water (Section 4.1.3), the third shall be empty, and the fourth shall contain a known weight of silica gel, or equivalent desiccant. A thermometer, capable of measuring temperature to within 1° C (2° F) shall be placed at the outlet of the fourth impinger for monitoring purposes.

Alternatively, any system that cools the sample gas stream and allows measurement of the water condensed and moisture leaving the condenser, each to within 1 ml or 1 g may be used, subject to the approval of the Administrator. Acceptable means are to measure the condensed water either gravimetrically or volumetrically and to measure the moisture leaving the condenser by: (1) monitoring the temperature and pressure at the exit of the condenser and using Dalton's law of partial pressures; or (2) passing the sample gas stream through a tared silica gel (or equivalent desiccant) trap with exit gases kept below 20° C (68° F) and determining the weight gain.

If means other than silica gel are used to determine the amount of moisture leaving the condenser, it is recommended that silica gel (or equivalent) still be used between the condenser system and pump to prevent moisture condensation in the pump and metering devices and to avoid the need to make corrections for moisture in the metered volume.

NOTE.—If a determination of the particulate matter collected in the impingers is desired in addition to moisture content, the impinger system described above shall be used, without modification. Individual States or control agencies requiring this information shall be contacted as to the sample recovery and analysis of the impinger contents.

2.1.8 Metering System. Vacuum gauge, leak-free pump, thermometers capable of measuring temperature to within 3° C (5.4° F), dry gas meter capable of measuring volume to within 2 percent, and related equipment, as shown in Figure 5-1. Other metering systems capable of maintaining sampling rates within 10 percent of isokinetic and of determining sample volumes to within 2 percent may be used, subject to the approval of the Administrator. When the metering system is used in conjunction with a pitot tube, the system shall enable checks of isokinetic rates.

Sampling trains utilizing metering systems designed for higher flow rates than that described in APTD-0581 or APTD-0576 may be used provided that the specifications of this method are met.

2.1.9 Barometer. Mercury, aneroid, or other barometer capable of measuring atmospheric pressure to within 2.5 mm Hg (0.1 in. Hg). In many cases, the barometric reading may be obtained from a nearby national weather service station, in which case the station value (which is

[1] Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.

the absolute barometric pressure) shall be requested and an adjustment for elevation differences between the weather station and sampling point shall be applied at a rate of minus 2.5 mm Hg (0.1 in. Hg) per 30 m (100 ft) elevation increase or vice versa for elevation decrease.

2.1.10 Gas Density Determination Equipment. Temperature sensor and pressure gauge, as described in Sections 2.3 and 2.4 of Method 2, and gas analyzer, if necessary, as described in Method 3. The temperature sensor shall, preferably, be permanently attached to the pitot tube or sampling probe in a fixed configuration, such that the tip of the sensor extends beyond the leading edge of the probe sheath and does not touch any metal. Alternatively, the sensor may be attached just prior to use in the field. Note, however, that if the temperature sensor is attached in the field, the sensor must be placed in an interference-free arrangement with respect to the Type S pitot tube openings (see Method 2, Figure 2-7). As a second alternative, if a difference of not more than 1 percent in the average velocity measurement is to be introduced, the temperature gauge need not be attached to the probe or pitot tube. (This alternative is subject to the approval of the Administrator.)

2.2 Sample Recovery. The following items are needed:

2.2.1 Probe-Liner and Probe-Nozzle Brushes. Nylon bristle brushes with stainless steel wire handles. The probe brush shall have extensions (at least as long as the probe) of stainless steel, Nylon, Teflon, or similarly inert material. The brushes shall be properly sized and shaped to brush out the probe liner and nozzle.

2.2.2 Wash Bottles—Two. Glass wash bottles are recommended; polyethylene wash bottles may be used at the option of the tester. It is recommended that acetone not be stored in polyethylene bottles for longer than a month.

2.2.3 Glass Sample Storage Containers. Chemically resistant, borosilicate glass bottles, for acetone washes, 500 ml or 1000 ml. Screw cap liners shall either be rubber-backed Teflon or shall be constructed so as to be leak-free and resistant to chemical attack by acetone. (Narrow mouth glass bottles have been found to be less prone to leakage.) Alternatively, polyethylene bottles may be used.

2.2.4 Petri Dishes. For filter samples, glass or polyethylene, unless otherwise specified by the Administrator.

2.2.5 Graduated Cylinder and/or Balance. To measure condensed water to within 1 ml or 1 g. Graduated cylinders shall have subdivisions no greater than 2 ml. Most laboratory balances are capable of weighing to the nearest 0.5 g or less. Any of these balances is suitable for use here and in Section 2.3.4.

2.2.6 Plastic Storage Containers. Air-tight containers to store silica gel.

2.2.7 Funnel and Rubber Policeman. To aid in transfer of silica gel to container; not necessary if silica gel is weighed in the field.

2.2.8 Funnel. Glass or polyethlene, to aid in sample recovery.

2.3 Analysis. For analysis, the following equipment is needed.

2.3.1 Glass Weighing Dishes.

2.3.2 Desiccator.

2.3.3 Analytical Balance. To measure to within 0.1 mg.

2.3.4 Balances. To measure to within 0.5 g.

2.3.5 Beakers. 250 ml.

2.3.6 Hygrometer. To measure the relative humidity of the laboratory environment.

2.3.7 Temperature Gauge. To measure the temperature of the laboratory environment.

3. *Reagents*

3.1 Sampling. The reagents used in sampling are as follows:

3.1.1 Filters. Glass fiber filters, without organic binder, exhibiting at least 99.95 percent efficiency (≤0.05 percent penetration) on 0.3-micron dioctyl phthalate smoke particles. The filter efficiency test shall be conducted in accordance with ASTM standard method D 2986-71. Test data from the supplier's quality control program are sufficient for this purpose.

3.1.2 Silica Gel. Indicating type, 6 to 16 mesh. If previously used, dry at 175° C (350° F) for 2 hours. New silica gel may be used as received. Alternatively, other types of desiccants (equivalent or better) may be used, subject to the approval of the Administrator.

3.1.3 Water. When analysis of the material caught in the impingers is required, distilled water shall be used. Run blanks prior to field use to eliminate a high blank on test samples.

3.1.4 Crushed Ice.

3.1.5 Stopcock Grease. Acetone-insoluble, heat-stable silicone grease. This is not necessary if screw-on connectors with Teflon sleeves, or similar, are used. Alternatively, other types of stopcock grease may be used, subject to the approval of the Administrator.

3.2 Sample Recovery. Acetone—reagent grade, ≤0.001 percent residue, in glass bottles—is required. Acetone from metal containers generally has a high residue blank and should not be used. Sometimes, suppliers transfer acetone to glass bottles from metal containers; thus, acetone blanks shall be run prior to field use and only acetone with low blank values (≤0.001 percent) shall be used. In no case shall a blank value of greater than 0.001 percent of the weight of acetone used be subtracted from the sample weight.

3.3 Analysis. Two reagents are required for the analysis:

3.3.1 Acetone. Same as 3.2.

3.3.2 Desiccant. Anhydrous calcium sulfate, indicating type. Alternatively, other types of desiccants may be used, subject to the approval of the Administrator.

4. *Procedure*

4.1 Sampling. The complexity of this method is such that, in order to obtain reliable results, testers should be trained and experienced with the test procedures.

4.1.1 Pretest Preparation. All the components shall be maintained and calibrated according to the procedure described in APTD-0576, unless otherwise specified herein.

Weigh several 200 to 300 g portions of silica gel in air-tight containers to the nearest 0.5 g. Record the total weight of the silica gel plus container, on each container. As an alternative, the silica gel need not be preweighed, but may be weighed directly in its impinger or sampling holder just prior to train assembly.

Check filters visually against light for irregularities and flaws or pinhole leaks. Label filters of the proper diameter on the back side near the edge using numbering machine ink. As an alternative, label the shipping containers (glass or plastic petri dishes) and keep the filters in these containers at all times except during sampling and weighing.

Desiccate the filters at 20±5.6° C (68±10° F) and ambient pressure for at least 24 hours and weigh at intervals of at least 6 hours to a constant weight, i.e., <0.5 mg change from previous weighing; record results to the nearest 0.1 mg. During each weighing the filter must not be exposed to the laboratory atmosphere for a period greater than 2 minutes and a relative humidity above 50 percent. Alternatively (unless otherwise specified by the Administrator), the filters may be oven dried at 105° C (220° F) for 2 to 3 hours, desiccated for 2 hours, and weighed. Procedures other than those described, which account for relative humidity effects, may be used, subject to the approval of the Administrator.

4.1.2 Preliminary Determinations. Select the sampling site and the minimum number of sampling points according to Method 1 or as specified by the Administrator. Determine the stack pressure, temperature, and the range of velocity heads using Method 2; it is recommended that a leak-check of the pitot lines (see Method 2, Section 3.1) be performed. Determine the moisture content using Approximation Method 4 or its alternatives for the purpose of making isokinetic sampling rate settings. Determine the stack gas dry molecular weight, as described in Method 2, Section 3.6; if integrated Method 3 sampling is used for molecular weight determination, the integrated bag sample shall be taken simultaneously with, and for the same total length of time as, the particulate sample run.

Select a nozzle size based on the range of velocity heads, such that it is not necessary to change the nozzle size in order to maintain isokinetic sampling rates. During the run, do not change the nozzle size. Ensure that the proper differential pressure gauge is chosen for the range of velocity heads encountered (see Section 2.2 of Method 2).

Select a suitable probe liner and probe length such that all traverse points can be sampled. For large stacks, consider sampling from opposite sides of the stack to reduce the length of probes.

Select a total sampling time greater than or equal to the minimum total sampling time specified in the test procedures for the specific industry such that (1) the sampling time per point is not less than 2 min (or some greater time interval as specified by the Administrator), and (2) the sample volume taken (corrected to standard conditions) will exceed the required minimum total gas sample volume. The latter is based on an approximate average sampling rate.

It is recommended that the number of minutes sampled at each point be an integer or an integer plus one-half minute, in order to avoid timekeeping errors. The sampling time at each point shall be the same.

In some circumstances, e.g., batch cycles, it may be necessary to sample for shorter times at the traverse points and to obtain smaller gas sample volumes. In these cases, the Administrator's approval must first be obtained.

4.1.3 Preparation of Collection Train. During preparation and assembly of the sampling train, keep all openings where contamination can occur covered until just prior to assembly or until sampling is about to begin.

Place 100 ml of water in each of the first two impingers, leave the third impinger empty, and transfer approximately 200 to 300 g of preweighed silica gel from its container to the fourth impinger. More silica gel may be used, but care should be taken to ensure that it is not entrained and carried out from the impinger during sampling. Place the container in a clean place for later use in the sample recovery. Alternatively, the weight of the silica gel plus impinger may be determined to the nearest 0.5 g and recorded.

Using a tweezer or clean disposable surgical gloves, place a labeled (identified) and weighed filter in the filter holder. Be sure that the filter is properly centered and the gasket properly placed so as to prevent the sample gas stream from circumventing the filter. Check the filter for tears after assembly is completed.

When glass liners are used, install the selected nozzle using a Viton A O-ring when stack temperatures are less than 260° C (500° F) and an asbestos string gasket when temperatures are higher. See APTD-0576 for details. Other connecting systems using either 316 stainless steel or Teflon ferrules may be used. When metal liners are used, install the nozzle as above or by a leak-free direct mechanical connection. Mark the probe with heat resistant tape or by some other method to denote the proper distance into the stack or duct for each sampling point.

Set up the train as in Figure 5-1, using (if necessary) a very light coat of silicone grease on all ground glass joints, greasing only the outer portion (see APTD-0576) to avoid possibility of contamination by the silicone grease. Subject to the approval of the Administrator, a glass cyclone may be used between the probe and filter holder when the total particulate catch is expected to exceed 100 mg or when water droplets are present in the stack gas.

Place crushed ice around the impingers.

4.1.4 Leak-Check Procedures.

4.1.4.1 Pretest Leak-Check. A pretest leak-check is recommended, but not required. If the tester opts to conduct the pretest leak-check, the following procedure shall be used.

After the sampling train has been assembled, turn on and set the filter and probe heating systems at the desired operating temperatures. Allow time for the temperatures to stabilize. If a Viton A O-ring or other leak-free connection is used in assembling the probe nozzle to the probe liner, leak-check the train at the sampling site by plugging the nozzle and pulling a 380 mm Hg (15 in. Hg) vacuum.

NOTE.—A lower vacuum may be used, provided that it is not exceeded during the test.

If an asbestos string is used, do not connect the probe to the train during the leak-check. Instead, leak-check the train by first plugging the inlet to the filter holder (cyclone, if applicable) and pulling a 380 mm Hg (15 in. Hg) vacuum (see Note immediately above). Then connect the probe to the train and leak-check at about 25 mm Hg (1 in. Hg) vacuum; alternatively, the probe may be leak-checked with the rest of the sampling train, in one step, at 380 mm Hg (15 in. Hg) vacuum. Leakage rates in excess of 4 percent of the average sampling rate or 0.00057 m³/min (0.02 cfm), whichever is less, are unacceptable.

The following leak-check instructions for the sampling train described in APTD-0576 and APTD-0581 may be helpful. Start the pump with bypass valve fully open and coarse adjust valve completely closed. Partially open the coarse adjust valve and slowly close the bypass valve until the desired vacuum is reached. Do not reverse direction of bypass valve; this will cause water to back up into the filter holder. If the desired vacuum is exceeded, either leak-check at this higher vacuum or end the leak check as shown below and start over.

When the leak-check is completed, first slowly remove the plug from the inlet to the probe, filter holder, or cyclone (if applicable) and immediately turn off the vacuum pump. This prevents the water in the impingers from being forced backward into the filter holder and silica gel from being entrained backward into the third impinger.

4.1.4.2 Leak-Checks During Sample Run. If, during the sampling run, a component (e.g., filter assembly or impinger) change becomes necessary, a leak-check shall be conducted immediately before the change is made. The leak-check shall be done according to the procedure outlined in Section 4.1.4.1 above, except that it shall be done at a vacuum equal to or greater than the maximum value recorded up to that point in the test. If the leakage rate is found to be no greater than 0.00057 m³/min (0.02 cfm) or 4 percent of the average sampling rate (whichever is less), the results are acceptable, and no correction will need to be applied to the total volume of dry gas metered; if, however, a higher leakage rate is obtained, the tester shall either record the leakage rate and plan to correct the sample volume as shown in Section 6.3 of this method, or shall void the sampling run.

Immediately after component changes, leak-checks are optional; if such leak-checks are done, the procedure outlined in Section 4.1.4.1 above shall be used.

4.1.4.3 Post-test Leak-Check. A leak-check is mandatory at the conclusion of each sampling run. The leak-check shall be done in accordance with the procedures outlined in Section 4.1.4.1, except that it shall be conducted at a vacuum equal to or greater than the maximum value reached during the sampling run. If the leakage rate is found to be no greater than 0.00057 m³/min (0.02 cfm) or 4 percent of the average sampling rate (whichever is less), the results are acceptable, and no correction need be applied to the total volume of dry gas metered. If, however, a higher leakage rate is obtained, the tester shall either record the leakage rate and correct the sample volume as shown in Section 6.3 of this method, or shall void the sampling run.

4.1.5 Particulate Train Operation. During the sampling run, maintain an isokinetic sampling rate (within 10 percent of true isokinetic unless otherwise specified by the Administrator) and a temperature around the filter of 120±14° C (248±25° F), or such other temperature as specified by an applicable subpart of the standards or approved by the Administrator.

For each run, record the data required on a data sheet such as the one shown in Figure 5-2. Be sure to record the initial dry gas meter reading. Record the dry gas meter readings at the beginning and end of each sampling time increment, when changes in flow rates are made, before and after each leak check, and when sampling is halted.

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Take other readings required by Figure 5-2 at least once at each sample point during each time increment and additional readings when significant changes (20 percent variation in velocity head readings) necessitate additional adjustments in flow rate. Level and zero the manometer. Because the manometer level and zero may drift due to vibrations and temperature changes, make periodic checks during the traverse.

Clean the portholes prior to the test run to minimize the chance of sampling deposited material. To begin sampling, remove the nozzle cap, verify that the filter and probe heating systems are up to temperature, and that the pitot tube and probe are properly positioned. Position the nozzle at the first traverse point with the tip pointing directly into the gas stream. Immediately start the pump and adjust the flow to isokinetic conditions. Nomographs are available, which aid in the rapid adjustment of the isokinetic sampling rate without excessive computations. These nomographs are designed for use when the Type S pitot tube coefficient is 0.85 ± 0.02, and the stack gas equivalent density (dry molecular weight) is equal to 29 ± 4. APTD-0576 details the procedure for using the nomographs. If C_p and M_s are outside the above stated ranges do not use the nomographs unless appropriate steps (see Citation 7 in Section 7) are taken to compensate for the deviations.

PLANT _____
LOCATION _____
OPERATOR _____
DATE _____
RUN NO. _____
SAMPLE BOX NO. _____
METER BOX NO. _____
METER $\Delta H@$ _____
C FACTOR _____
PITOT TUBE COEFFICIENT, C_p _____

SCHEMATIC OF STACK CROSS SECTION

AMBIENT TEMPERATURE _____
BAROMETRIC PRESSURE _____
ASSUMED MOISTURE, % _____
PROBE LENGTH, m (ft) _____
NOZZLE IDENTIFICATION NO. _____
AVERAGE CALIBRATED NOZZLE DIAMETER, cm (in.) _____
PROBE HEATER SETTING _____
LEAK RATE, m^3/min (cfm) _____
PROBE LINER MATERIAL _____
STATIC PRESSURE, mm Hg (in. Hg) _____
FILTER NO. _____

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	VACUUM mm Hg (in. Hg)	STACK TEMPERATURE (T_s) °C (°F)	VELOCITY HEAD (ΔP_s), mm (H_2O)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER mm H_2O (in. H_2O)	GAS SAMPLE VOLUME m^3 (ft^3)	GAS SAMPLE TEMPERATURE AT DRY GAS METER		FILTER HOLDER TEMPERATURE, °C (°F)	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER, °C (°F)
							INLET °C (°F)	OUTLET °C (°F)		
TOTAL							Avg.	Avg.		
AVERAGE							Avg.			

Figure 5-2. Particulate field data.

When the stack is under significant negative pressure (height of impinger stem), take care to close the coarse adjust valve before inserting the probe into the stack to prevent water from backing into the filter holder. If necessary, the pump may be turned on with the coarse adjust valve closed.

When the probe is in position, block off the openings around the probe and porthole to prevent unrepresentative dilution of the gas stream.

Traverse the stack cross-section, as required by Method 1 or as specified by the Administrator, being careful not to bump the probe nozzle into the stack walls when sampling near the walls or when removing or inserting the probe through the portholes; this minimizes the chance of extracting deposited material.

During the test run, make periodic adjustments to keep the temperature around the filter holder at the proper level; add more ice and, if necessary, salt to maintain a temperature of less than 20° C (68° F) at the condenser/silica gel outlet. Also, periodically check the level and zero of the manometer.

If the pressure drop across the filter becomes too high, making isokinetic sampling difficult to maintain, the filter may be replaced in the midst of a sample run. It is recommended that another complete filter assembly be used rather than attempting to change the filter itself. Before a new filter assembly is installed, conduct a leak-check (see Section 4.1.4.2). The total particulate weight shall include the summation of all filter assembly catches.

A single train shall be used for the entire sample run, except in cases where simultaneous sampling is required in two or more separate ducts or at two or more different locations within the same duct, or, in cases where equipment failure necessitates a change of trains. In all other situations, the use of two or more trains will be subject to the approval of the Administrator.

Note that when two or more trains are used, separate analyses of the front-half and (if applicable) impinger catches from each train shall be performed, unless identical nozzle sizes were used on all trains, in which case, the front-half catches from the individual trains may be combined (as may the impinger catches) and one analysis of front-half catch and one analysis of impinger catch may be performed. Consult with the Administrator for details concerning the calculation of results when two or more trains are used.

At the end of the sample run, turn off the coarse adjust valve, remove the probe and nozzle from the stack, turn off the pump, record the final dry gas meter reading, and conduct a post-test leak-check, as outlined in Section 4.1.4.3. Also, leak-check the pitot lines as described in Method 2, Section 3.1; the lines must pass this leak-check, in order to validate the velocity head data.

4.1.6 Calculation of Percent Isokinetic. Calculate percent isokinetic (see Calculations, Section 6) to determine whether the run was valid or another test run should be made. If there was difficulty in maintaining isokinetic rates due to source conditions, consult with the Administrator for possible variance on the isokinetic rates.

4.2 Sample Recovery. Proper cleanup procedure begins as soon as the probe is removed from the stack at the end of the sampling period. Allow the probe to cool.

When the probe can be safely handled, wipe off all external particulate matter near the tip of the probe nozzle and place a cap over it to prevent losing or gaining particulate matter. Do not cap off the probe tip tightly while the sampling train is cooling down as this would create a vacuum in the filter holder, thus drawing water from the impingers into the filter holder.

Before moving the sample train to the cleanup site, remove the probe from the sample train, wipe off the silicone grease, and cap the open outlet of the probe. Be careful not to lose any condensate that might be present. Wipe off the silicone grease from the filter inlet where the probe was fastened and cap it. Remove the umbilical cord from the last impinger and cap the impinger. If a flexible line is used between the first impinger or condenser and the filter holder, disconnect the line at the filter holder and let any condensed water or liquid drain into the impingers or condenser. After wiping off the silicone grease, cap off the filter holder outlet and impinger inlet. Either ground-glass stoppers, plastic caps, or serum caps may be used to close these openings.

Transfer the probe and filter-impinger assembly to the cleanup area. This area should be clean and protected from the wind so that the chances of contaminating or losing the sample will be minimized.

Save a portion of the acetone used for cleanup as a blank. Take 200 ml of this acetone directly from the wash bottle being used and place it in a glass sample container labeled "acetone blank."

Inspect the train prior to and during disassembly and note any abnormal conditions. Treat the samples as follows:

Container No. 1. Carefully remove the filter from the filter holder and place it in its identified petri dish container. Use a pair of tweezers and/or clean disposable surgical gloves to handle the filter. If it is necessary to fold the filter, do so such that the particulate cake is inside the fold. Carefully transfer to the petri dish any particulate matter and/or filter fibers which adhere to the filter holder gasket, by using a dry Nylon bristle brush and/or a sharp-edged blade. Seal the container.

Container No. 2. Taking care to see that dust on the outside of the probe or other exterior surfaces does not get into the sample, quantitatively recover particulate matter or any condensate from the probe nozzle, probe

fitting, probe liner, and front half of the filter holder by washing these components with acetone and placing the wash in a glass container. Distilled water may be used instead of acetone when approved by the Administrator and shall be used when specified by the Administrator; in these cases, save a water blank and follow the Administrator's directions on analysis. Perform the acetone rinses as follows.

Carefully remove the probe nozzle and clean the inside surface by rinsing with acetone from a wash bottle and brushing with a Nylon bristle brush. Brush until the acetone rinse shows no visible particles, after which make a final rinse of the inside surface with acetone.

Brush and rinse the inside parts of the Swagelok fitting with acetone in a similar way until no visible particles remain.

Rinse the probe liner with acetone by tilting and rotating the probe while squirting acetone into its upper end so that all inside surfaces will be wetted with acetone. Let the acetone drain from the lower end into the sample container. A funnel (glass or polyethylene) may be used to aid in transferring liquid washes to the container. Follow the acetone rinse with a probe brush. Hold the probe in an inclined position, squirt acetone into the upper end as the probe brush is being pushed with a twisting action through the probe; hold a sample container underneath the lower end of the probe, and catch any acetone and particulate matter which is brushed from the probe. Run the brush through the probe three times or more until no visible particulate matter is carried out with the acetone or until none remains in the probe liner on visual inspection. With stainless steel or other metal probes, run the brush through in the above prescribed manner at least six times since metal probes have small crevices in which particulate matter can be entrapped. Rinse the brush with acetone, and quantitatively collect these washings in the sample container. After the brushing, make a final acetone rinse of the probe as described above.

It is recommended that two people be used to clean the probe to minimize sample losses. Between sampling runs, keep brushes clean and protected from contamination.

After ensuring that all joints have been wiped clean of silicone grease, clean the inside of the front half of the filter holder by rubbing the surfaces with a Nylon bristle brush and rinsing with acetone. Rinse each surface three times or more if needed to remove visible particulate. Make a final rinse of the brush and filter holder. Carefully rinse out the glass cyclone, also (if applicable). After all acetone washings and particulate matter have been collected in the sample container, tighten the lid on the sample container so that acetone will not leak out when it is shipped to the laboratory. Mark the height of the fluid level to determine whether or not leakage occurred during transport. Label the container to clearly identify its contents.

Container No. 3. Note the color of the indicating silica gel to determine if it has been completely spent and make a notation of its condition. Transfer the silica gel from the fourth impinger to its original container and seal. A funnel may make it easier to pour the silica gel without spilling. A rubber policeman may be used as an aid in removing the silica gel from the impinger. It is not necessary to remove the small amount of dust particles that may adhere to the impinger wall and are difficult to remove. Since the gain in weight is to be used for moisture calculations, do not use any water or other liquids to transfer the silica gel. If a balance is available in the field, follow the procedure for container No. 3 in Section 4.2.

Impinger Water. Treat the impingers as follows: Make a notation of any color or film in the liquid catch. Measure the liquid which is in the first three impingers to within ±1 ml by using a graduated cylinder or by weighing it to within ±0.5 g by using a balance (if one is available). Record the volume or weight of liquid present. This information is required to calculate the moisture content of the effluent gas.

Discard the liquid after measuring and recording the volume or weight, unless analysis of the impinger catch is required (see Note, Section 2.1.7).

If a different type of condenser is used, measure the amount of moisture condensed either volumetrically or gravimetrically.

Wherever possible, containers should be shipped in such a way that they remain upright at all times.

4.3 Analysis. Record the data required on a sheet such as the one shown in Figure 5-3. Handle each sample container as follows:

Container No. 1. Leave the contents in the shipping container or transfer the filter and any loose particulate from the sample container to a tared glass weighing dish. Desiccate for 24 hours in a desiccator containing anhydrous calcium sulfate. Weigh to a constant weight and report the results to the nearest 0.1 mg. For purposes of this Section, 4.3, the term "constant weight" means a difference of no more than 0.5 mg or 1 percent of total weight less tare weight, whichever is greater, between two consecutive weighings, with no less than 6 hours of desiccation time between weighings.

Plant _____

Date _____

Run No. _____

Filter No. _____

Amount liquid lost during transport _____

Acetone blank volume, ml _____

Acetone wash volume, ml _____

Acetone blank concentration, mg/mg (equation 5-4) _____

Acetone wash blank, mg (equation 5-5) _____

CONTAINER NUMBER	WEIGHT OF PARTICULATE COLLECTED, mg		
	FINAL WEIGHT	TARE WEIGHT	WEIGHT GAIN
1			
2			
TOTAL			
		Less acetone blank	
		Weight of particulate matter	

	VOLUME OF LIQUID WATER COLLECTED		
	IMPINGER VOLUME, ml.	SILICA GEL WEIGHT, g	
FINAL			
INITIAL			
LIQUID COLLECTED			
TOTAL VOLUME COLLECTED		g*	ml

* CONVERT WEIGHT OF WATER TO VOLUME BY DIVIDING TOTAL WEIGHT INCREASE BY DENSITY OF WATER (1g/ml):

$$\frac{\text{INCREASE, g}}{\text{1 g/ml}} = \text{VOLUME WATER, ml}$$

Figure 5-3. Analytical data.

[Appendix A, Method 5]

Alternatively, the sample may be oven dried at 105° C (220° F) for 2 to 3 hours, cooled in the desiccator, and weighed to a constant weight, unless otherwise specified by the Administrator. The tester may also opt to oven dry the sample at 105 ° C (220 ° F) for 2 to 3 hours, weigh the sample, and use this weight as a final weight.

Container No. 1. Note the level of liquid in the container and confirm on the analysis sheet whether or not leakage occurred during transport. If a noticeable amount of leakage has occurred, either void the sample or use methods, subject to the approval of the Administrator, to correct the final results. Measure the liquid in this container either volumetrically to ±1 ml or gravimetrically to ±0.5 g. Transfer the contents to a tared 250-ml beaker and evaporate to dryness at ambient temperature and pressure. Desiccate for 24 hours and weigh to a constant weight. Report the results to the nearest 0.1 mg.

Container No. 2. Weigh the spent silica gel (or silica gel plus impinger) to the nearest 0.5 g using a balance. This step may be conducted in the field.

"Acetone Blank" Container. Measure acetone in this container either volumetrically or gravimetrically. Transfer the acetone to a tared 250-ml beaker and evaporate to dryness at ambient temperature and pressure. Desiccate for 24 hours and weigh to a constant weight. Report the results to the nearest 0.1 mg.

NOTE.—At the option of the tester, the contents of Container No. 2 as well as the acetone blank container may be evaporated at temperatures higher than ambient. If evaporation is done at an elevated temperature, the temperature must be below the boiling point of the solvent; also, to prevent "bumping," the evaporation process must be closely supervised, and the contents of the beaker must be swirled occasionally to maintain an even temperature. Use extreme care, as acetone is highly flammable and has a low flash point.

5. *Calibration*

Maintain a laboratory log of all calibrations.

5.1 Probe Nozzle. Probe nozzles shall be calibrated before their initial use in the field. Using a micrometer, measure the inside diameter of the nozzle to the nearest 0.025 mm (0.001 in.). Make three separate measurements using different diameters each time, and obtain the average of the measurements. The difference between the high and low numbers shall not exceed 0.1 mm (0.004 in.). When nozzles become nicked, dented, or corroded, they shall be reshaped, sharpened, and recalibrated before use. Each nozzle shall be permanently and uniquely identified.

5.2 Pitot Tube. The Type S pitot tube assembly shall be calibrated according to the procedure outlined in Section 4 of Method 2.

5.3 Metering System. Before its initial use in the field, the metering system shall be calibrated according to the procedure outlined in APTD–0576. Instead of physically adjusting the dry gas meter dial readings to correspond to the wet test meter readings, calibration factors may be used to mathematically correct the gas meter dial readings to the proper values. Before calibrating the metering system, it is suggested that a leak-check be conducted. For metering systems having diaphragm pumps, the normal leak-check procedure will not detect leakages within the pump. For these cases the following leak-check procedure is suggested: make a 10-minute calibration run at 0.00057 m³/min (0.02 cfm); at the end of the run, take the difference of the measured wet test meter and dry gas meter volumes; divide the difference by 10, to get the leak rate. The leak rate should not exceed 0.00057 m³/min (0.02 cfm).

After each field use, the calibration of the metering system shall be checked by performing three calibration runs at a single, intermediate orifice setting (based on the previous field test), with the vacuum set at the maximum value reached during the test series. To adjust the vacuum, insert a valve between the wet test meter and the inlet of the metering system. Calculate the average value of the calibration factor. If the calibration has changed by more than 5 percent, recalibrate the meter over the full range of orifice settings, as outlined in APTD–0576.

Alternative procedures, e.g., using the orifice meter coefficients, may be used, subject to the approval of the Administrator.

NOTE.—If the dry gas meter coefficient values obtained before and after a test series differ by more than 5 percent, the test series shall either be voided, or calculations for the test series shall be performed using whichever meter coefficient value (i.e., before or after) gives the lower value of total sample volume.

5.4 Probe Heater Calibration. The probe heating system shall be calibrated before its initial use in the field according to the procedure outlined in APTD–0576. Probes constructed according to APTD–0581 need not be calibrated if the calibration curves in APTD–0576 are used.

5.5 Temperature Gauges. Use the procedure in Section 4.3 of Method 2 to calibrate in-stack temperature gauges. Dial thermometers, such as are used for the dry gas meter and condenser outlet, shall be calibrated against mercury-in-glass thermometers.

5.6 Leak Check of Metering System Shown in Figure 5–1. That portion of the sampling train from the pump to the orifice meter should be leak checked prior to initial use and after each shipment. Leakage after the pump will result in less volume being recorded than is actually sampled. The following procedure is suggested (see Figure 5–4): Close the main valve on the meter box. Insert a one-hole rubber stopper with rubber tubing attached into the orifice exhaust pipe. Disconnect and vent the low side of the orifice manometer. Close off the low side orifice tap. Pressurize the system to 13 to 18 cm (5 to 7 in.) water column by blowing into the rubber tubing. Pinch off the tubing and observe the manometer for one minute. A loss of pressure on the manometer indicates a leak in the meter box; leaks, if present, must be corrected.

5.7 Barometer. Calibrate against a mercury barometer.

6. *Calculations*

Carry out calculations, retaining at least one extra decimal figure beyond that of the acquired data. Round off figures after the final calculation. Other forms of the equations may be used as long as they give equivalent results.

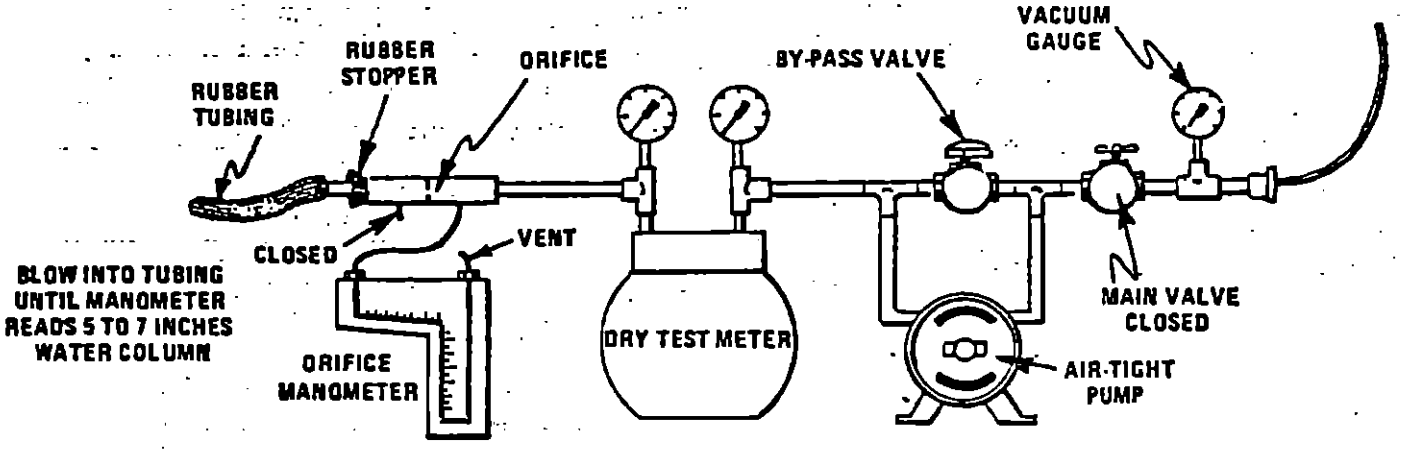

Figure 5-4. Leak check of meter box.

6.1 Nomenclature

A_n = Cross-sectional area of nozzle, m² (ft²).
B_{ws} = Water vapor in the gas stream, proportion by volume.
C_a = Acetone blank residue concentration, mg/g.
c_s = Concentration of particulate matter in stack gas, dry basis, corrected to standard conditions, g/dscm (g/dscf).
I = Percent of isokinetic sampling.
L_a = Maximum acceptable leakage rate for either a pretest leak check or for a leak check following a component change; equal to 0.00057 m³/min (0.02 cfm) or 4 percent of the average sampling rate, whichever is less.
L_i = Individual leakage rate observed during the leak check conducted prior to the "i^{th}" component change (i=1, 2, 3 . . . . n), m³/min (cfm).
L_p = Leakage rate observed during the post-test leak check, m³/min (cfm).
m_a = Total amount of particulate matter collected, mg.
M_w = Molecular weight of water, 18.0 g/g-mole (18.0 lb/lb-mole).
m_a = Mass of residue of acetone after evaporation, mg.
P_{bar} = Barometric pressure at the sampling site, mm Hg (in. Hg).
P_s = Absolute stack gas pressure, mm Hg (in. Hg).
P_{std} = Standard absolute pressure, 760 mm Hg (29.92 in. Hg).
R = Ideal gas constant, 0.06236 mm Hg-m³/°K-g-mole (21.85 in. Hg-ft³/° R-lb-mole).
T_m = Absolute average dry gas meter temperature (see Figure 5–2), °K (°R).
T_s = Absolute average stack gas temperature (see Figure 5–2), °K (°R).
T_{std} = Standard absolute temperature, 293° K (528° R).
V_a = Volume of acetone blank, ml.
V_{aw} = Volume of acetone used in wash, ml.
V_{lc} = Total volume of liquid collected in impingers and silica gel (see Figure 5–3), ml.
V_m = Volume of gas sample as measured by dry gas meter, dcm (dcf).
$V_{m(std)}$ = Volume of gas sample measured by the dry gas meter, corrected to standard conditions, dscm (dscf).
$V_{w(std)}$ = Volume of water vapor in the gas sample, corrected to standard conditions, scm (scf).
V_s = Stack gas velocity, calculated by Method 2, Equation 2–9, using data obtained from Method 5, m/sec (ft/sec).
W_a = Weight of residue in acetone wash, mg.
Y = Dry gas meter calibration factor.
ΔH = Average pressure differential across the orifice meter (see Figure 5–2), mm H_2O (in. H_2O).
ρ_a = Density of acetone, mg/ml (see label on bottle).
ρ_w = Density of water, 0.9982 g/ml (0.002201 lb/ml).
θ = Total sampling time, min.
θ_1 = Sampling time interval, from the beginning of a run until the first component change, min.
θ_2 = Sampling time interval, between two successive component changes, beginning with the interval between the first and second changes, min.
θ_p = Sampling time interval, from the final (n^{th}) component change until the end of the sampling run, min.
13.6 = Specific gravity of mercury.
60 = Sec/min.
100 = Conversion to percent.

6.2 Average dry gas meter temperature and average orifice pressure drop. See data sheet (Figure 5–7).

6.3 Dry Gas Volume. Correct the sample volume measured by the dry gas meter to standard conditions (20° C, 760 mm Hg or 68° F, 29.92 in. Hg) by using Equation 5–1.

$$V_{m(std)} = V_m Y \left(\frac{T_{std}}{T_m}\right)\left[\frac{P_{bar} + \frac{\Delta H}{13.6}}{P_{std}}\right]$$

$$= K_1 V_m Y \frac{P_{bar} + (\Delta H/13.6)}{T_m}$$

Equation 5–1

where:
K_1 = 0.3456 °K/mm Hg for metric units
= 17.64 °R/in. Hg for English units

NOTE.—Equation 5-1 can be used as written unless the leakage rate observed during any of the mandatory leak checks (i.e., the post-test leak check or leak checks conducted prior to component changes) exceeds L_a. If L_a or L_i exceeds L_a, Equation 5-1 must be modified as follows:

(a) Case I. No component changes made during sampling run. In this case, replace V_m in Equation 5-1 with the expression:

$$V_m - (L_p - L_a)\theta]$$

(b) Case II. One or more component changes made during the sampling run. In this case, replace V_m in Equation 5-1 by the expression:

$$\left[V_m - (L_1 - L_a)\theta_1 - \sum_{i=2}^{n}(L_i - L_a)\theta_i - (L_p - L_a)\theta_p\right]$$

and substitute only for those leakage rates (L_i or L_p) which exceed L_a.

6.4 Volume of water vapor.

$$V_{w(std)} = V_{lc}\left(\frac{\rho_w}{M_w}\right)\left(\frac{RT_{std}}{P_{std}}\right) = K_2 V_{lc} \qquad \text{Equation 5-2}$$

where:
K_2 = 0.001333 m³/ml for metric units.
= 0.04707 ft³/ml for English units.

6.5 Moisture Content.

$$B_{ws} = \frac{V_{w(std)}}{V_{m(std)} + V_{w(std)}} \qquad \text{Equation 5-3}$$

NOTE.—In saturated or water droplet-laden gas streams, two calculations of the moisture content of the stack gas shall be made, one from the impinger analysis (Equation 5-3), and a second from the assumption of saturated conditions. The lower of the two values of B_{ws} shall be considered correct. The procedure for determining the moisture content based upon assumptions of saturated conditions is given in the Note of Section 1.2 of Method 4. For the purposes of this method, the average stack gas temperature from Figure 5-2 may be used to make this determination, provided that the accuracy of the in-stack temperature sensor is ± 1° C (2° F).

6.6 Acetone Blank Concentration.

$$C_a = \frac{m_a}{V_a \rho_a} \qquad \text{Equation 5-4}$$

6.7 Acetone Wash Blank.

$$W_a = C_a V_{aw} \rho_a \qquad \text{Equation 5-5}$$

6.8 Total Particulate Weight. Determine the total particulate catch from the sum of the weights obtained from containers 1 and 2 less the acetone blank (see Figure 5-3). NOTE.—Refer to Section 4.1.3 to assist in calculation of results involving two or more filter assemblies or two or more sampling trains.

6.9 Particulate Concentration.

$$c_s = (0.001\ g/mg)\ (m_n/V_{m(std)}) \qquad \text{Equation 5-6}$$

6.10 Conversion Factors:

From	To	Multiply by
scf	m³	0.02832
g/ft³	gr/ft³	15.43
g/ft³	lb/ft³	2.205×10^{-3}
g/ft³	g/m³	35.31

6.11 Isokinetic Variation.

6.11.1 Calculation From Raw Data.

$$I = \frac{100\, T_s\, [K_3\, V_{lc} + (V_m\, Y/T_m)\,(P_{bar} + \Delta H/13.6)]}{60\, \theta\, v_s\, A_n\, P_s} \qquad \text{Equation 5-7}$$

where:
K_3 = 0.0[illegible] mm Hg−m³/ml−°K for metric units.
= 0.0[illegible] in. Hg−ft³/ml−°R for English units.

6.11.2 Calculation From Intermediate Values.

$$I = \frac{T_s V_{m(std)} P_{std}\, 100}{T_{std}\, v_s\, \theta\, A_n P_s\, 60(1 - B_{ws})}$$

$$= \frac{T_s\, V_{m(std)}}{\theta\, v_s\, A_n\, P_s\, K_4 (1 - B_{ws})}$$

Equation 5-8

where:
K_4 = 4.320 for metric units
= 0.09450 for English units.

6.12 Acceptable Results. If 90 percent ≤ I ≤ 110 percent, the results are acceptable. If the results are low in comparison to the standard and I is beyond the acceptable range, or, if I is less than 90 percent, the Administrator may opt to accept the results. Use Citation 4 to make judgments. Otherwise, reject the results and repeat the test.

7. *Bibliography*

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METHOD 6—DETERMINATION OF SULFUR DIOXIDE EMISSIONS FROM STATIONARY SOURCES

1. *Principle and Applicability*

1.1 Principle. A gas sample is extracted from the sampling point in the stack. The sulfuric acid mist (including sulfur trioxide) and the sulfur dioxide are separated. The sulfur dioxide fraction is measured by the barium-thorin titration method.

1.2 Applicability. This method is applicable for the determination of sulfur dioxide emissions from stationary sources. The minimum detectable limit of the method has been determined to be 3.4 milligrams (mg) of SO_2 (2.12×10⁻⁷ lb/ft³). Although no upper limit has been established, tests have shown that concentrations as high as 80,000 mg/m³ of SO_2 can be collected efficiently in two midget impingers, each containing 15 milliliters of 3 percent hydrogen peroxide, at a rate of 1.0 l/min for 20 minutes. Based on theoretical calculations, the upper concentration limit in a 20-liter sample is about [illegible] mg/m³.

Possible interferents are free ammonia, water-soluble cations, and fluorides. The cations and fluorides are removed by glass wool filters and an isopropanol bubbler, and hence do not affect the SO_2 analysis. When samples are being taken from a gas stream with high concentrations of very fine metallic fumes (such as in inlets to control devices), a high-efficiency glass fiber filter must be used in place of the glass wool plug (i.e., the one in the probe) to remove the cation interference.

Free ammonia interferes by reacting with SO_2 to form particulate sulfite and by reacting with the indicator. If free ammonia is present (this can be determined by knowledge of the process and noticing white particulate matter in the probe and isopropanol bubbler), alternative methods, subject to the approval of the Administrator, U.S. Environmental Protection Agency, are required.

2. *Apparatus*

APPENDIX F.2

LABORATORY DATA SUMMARIES

TRC — THE RESEARCH CORPORATION OF NEW ENGLAND

Report of Chemical Analysis 321

Client: U.S. Gypsum Co.

Laboratory No: ~~320~~-80(11)

Contract No: 1532-E80-30

Date Received: 11-6-80

Reviewed by: S. Chu

Date Reported: 11-17-80

Report to: W. Wade

Source	Test No.	Sample No.	mg Total Particulate	g Moisture	Condensibles mg Organic	Condensibles mg Inorganic	mg Particulate Acetone Wash	Total ug NO_x as NO_2	SO_2 $(V_t-V_{tb})(N)$ (Vsoln/Va)	Others
KT5-O	1	#10061	4.74							
		PW	238.64	243.38						
KT5-I	1	#10062	21,658.48							
		#10063	26,006.70	57012.72						
		PW	9,347.34							
KT5-O	2	#10055	0.00000	26.48						
		PW	26.48							
KT5-I	2	#10069	2,976.92							
		#10070	1,046.84	15600.72						
		PW	11,576.96							
KT5-O	3	#10074	31.13							
		PW	47.02	78.15						
KT5-I	3	#10072	4,136.20							
		PW	7,324.64	11460.84						
KT5-O	4	#10075	248.25	338.99						
		PW	90.74							
KT5-I	4	#10073	11,820.62							
		#10078	12,807.53	32107.51						
		PW	7,479.36							
KT5-O	5	#10071	225.16							
		PW	7487	300.03						

[redacted]

Report of Chemical Analysis

Client: U.S. Gypsum Co.
Contract No: 1532 - EB0.30
Reviewed by: J. Cha
Report to: W. Wiele

Laboratory No: 321 320-80(11)
Date Received: 11-6-80
Date Reported: 11-17-80

Source	Test No.	Sample No.	mg Total Particulate	g Moisture	Condensibles mg Organic	Condensibles mg Inorganic	mg Particulate Acetone Wash	Total ug NO_x as NO_2	SO_2 $(V_t - V_{tb})(N)(V_{soln}/V_a)$	Others
KTS-I	5	#10067	13,731.91							
		#10080	18,148.82	37511.2						
		PW	5,630.47							
KTG-O	6	#10082	152.70	226.67						
		PW	73.97							
KTS-I	6	#10079	15,376.04							
		#10076	11,279.38	33187.03						
		PW	6,531.61							
KTS-O	3R	#10060	86.61							
		PW	108.44	195.05						
KTS-O	4R	#10084	180.78							
		PW	56.66	237.44						
BS-O	7	#10083	0.66							
		PW	26.39	27.05						
BS-O	8	#10081	836							
		PW	15.44	23.8						
BS-O	9	#10058	30.17							
		PW	9.70	39.87						

Notes: PW = Probe Wash

Analyzed by [illegible]

TRC — THE RESEARCH CORPORATION OF NEW ENGLAND

Report of Chemical Analysis

Client: U.S. Gypsum Co.

Contract No: 1532-E80-30

Reviewed by: S. Cha

Report to: W. Wade

Laboratory No: ~~320~~ 321-80(11)

Date Received: 11-6-80

Date Reported: 11-17-80

~~Source~~ Cascades	Test No.	~~Sample~~ Filter No.	mg Total Particulate	g Moisture	mg Organic	Condensibles mg Inorganic	mg Particulate Acetone Wash	Total ug NO_x as NO_2	SO_2 $(V_t - V_{tb})(N)(V_{soln}/V_a)$	Others
		24	0.34							
		130	0.39							
		129	0.32							
		131	0.47							
		132	0							
		199	0							
		200	0.18							
		201	0.58							
		202	0							

[redacted]otes[redacted]

An[redacted]d:[redacted]

PARTICULATE TEST DATA

TEST 1 INLET TIME 1400-1600

LOCATION KETTLE #5 CAGHOUSE DATE 10-28-80

FIRM U.S. GYPSUM PROJECT NO. 1532-E80

Input A		
P bar	Barometric Pressure - in. Hg	30.34
As	Stack Area - Ft^2	.99
Dn	Nozzle Diameter - in.	.262
Time	Total Sampling Time - min.	40
Y	Calibration Factor	1.00
Cp	Pitot Coefficient	.86
$(\Delta P)^{1/2}$	Average Square Root of Velocity Head (in. H_2O)	.74
ΔH	Average Orifice Pressure Drop - in. H_2O	1.73
Tm	Average Meter Temperature °F	63
Pstk	Average Stack Pressure - in. H_2O	-2.3
Tstk	Average Stack Temperature °F	166
Vm	Meter Volume at Meter Conditions - Ft^3	26.94
Vl	Total Water Vapor Collected - ml	286
CO_2	% CO_2 in Stack Gas (Dry)	0
O_2	% O_2 in Stack Gas (Dry)	20.9
CO	% CO in Stack Gas (Dry)	0
Input B		
Mn	Total Particulate Catch - Mg	57012.72
Input C		
% H	% Hydrogen in Fuel	
% C	% Carbon in Fuel	
% S	% Sulfur in Fuel	
% N	% Nitrogen in Fuel	
% O	% Oxygen in Fuel	
GCV	Gross Califoric Volume of Fuel - BTU/lb	
Calculated		
Vm (std)	Meter Volume at Standard Conditions (Dry)-Ft^3	27.7
% H_2O	% H_2O Vapor in Stack Gas	32.72
Mws	Molecular Weight of Stack Gas (Wet)	25.29
Vs	Average Velocity of Stack Gas - FPM	2957
Qs	Actual Stack Gas Flowrate - ACFM	2927
Qs (std)	Stack Gas Flowrate (0.0% H_2O; STP) - DSCF	1675
% I	% Isokinetic (Avg. Nozzle Vel/Avg. Stk Vel)	109.4
Cs	Particulate Concentration-lb/DSCF	0.004538
Er	Particulate Emission Rate-lb/hour	456.0
F	F Factor - DSCF/MM BTU	
E	Particulate Emissions - lbs/MM BTU	

PARTICULATE TEST DATA

TEST 1 OUTLET TIME 1400 -1600

LOCATION KETTLE #5 - BAGHOUSE DATE 10-28-86

FIRM U.S. Gypsum PROJECT NO. 1532-E80

Input A		
P bar	Barometric Pressure - in. Hg	30.08
As	Stack Area - Ft^2	0.66
Dn	Nozzle Diameter - in.	.1942
Time	Total Sampling Time - min.	160
Y	Calibration Factor	1.01
Cp	Pitot Coefficient	.856
$(\Delta P)^{1/2}$	Average Square Root of Velocity Head (in. H_2O)	1.129
ΔH	Average Orifice Pressure Drop - in. H_2O	1.28
Tm	Average Meter Temperature °F	71.5
Pstk	Average Stack Pressure - in. H_2O	-5.2
Tstk	Average Stack Temperature °F	154
Vm	Meter Volume at Meter Conditions - Ft^3	94.29
Vl	Total Water Vapor Collected - ml	679.8
CO_2	% CO_2 in Stack Gas (Dry)	0
O_2	% O_2 in Stack Gas (Dry)	20.9
CO	% CO in Stack Gas (Dry)	0
Input B		
Mn	Total Particulate Catch - Mg	243.38
Input C		
% H	% Hydrogen in Fuel	
% C	% Carbon in Fuel	
% S	% Sulfur in Fuel	
% N	% Nitrogen in Fuel	
% O	% Oxygen in Fuel	
GCV	Gross Califoric Volume of Fuel - BTU/lb	
Calculated		
Vm (std)	Meter Volume at Standard Conditions (Dry)-Ft^3	95.43
% H_2O	% H_2O Vapor in Stack Gas	25.12
Mws	Molecular Weight of Stack Gas (Wet)	26.11
Vs	Average Velocity of Stack Gas - FPM	4411
Qs	Actual Stack Gas Flowrate - ACFM	2911
Qs (std)	Stack Gas Flowrate (0.0% H_2O; STP) - DSCF	1860
% I	% Isokinetic (Avg. Nozzle Vel/Avg. Stk Vel)	97.8
Cs	Particulate Concentration-lb/DSCF	0.00000 5623
Er	Particulate Emission Rate-lb/hour	0.6277
F	F Factor - DSCF/MM BTU	
E	Particulate Emissions - lbs/MM BTU	

PARTICULATE TEST DATA

TEST KT5-2 TIME 1646 1990

LOCATION BAGHOUSE OUTLET DATE 10-28-80

FIRM U.S GYPSUM PROJECT NO. 1532-E80

Input A		
P bar	Barometric Pressure - in. Hg	30.34
As	Stack Area - Ft^2	.99
Dn	Nozzle Diameter - in.	.261
Time	Total Sampling Time - min.	18.5
Y	Calibration Factor	1.00
Cp	Pitot Coefficient	.84
$(\Delta P)^{1/2}$	Average Square Root of Velocity Head (in. H_2O)	.776
ΔH	Average Orifice Pressure Drop - in. H_2O	1.67
Tm	Average Meter Temperature °F	64.5
Pstk	Average Stack Pressure - in. H_2O	-2.2
Tstk	Average Stack Temperature °F	161
Vm	Meter Volume at Meter Conditions - Ft^3	11.4
Vl	Total Water Vapor Collected - ml	122.3
CO_2	% CO_2 in Stack Gas (Dry)	0
O_2	% O_2 in Stack Gas (Dry)	20.9
CO	% CO in Stack Gas (Dry)	0
Input B		
Mn	Total Particulate Catch - Mg	15600.72
Input C		
% H	% Hydrogen in Fuel	
% C	% Carbon in Fuel	
% S	% Sulfur in Fuel	
% N	% Nitrogen in Fuel	
% O	% Oxygen in Fuel	
GCV	Gross Califoric Volume of Fuel - BTU/lb	
Calculated		
Vm (std)	Meter Volume at Standard Conditions (Dry)-Ft^3	11.69
% H_2O	% H_2O Vapor in Stack Gas	33.02
Mws	Molecular Weight of Stack Gas (Wet)	25.36
Vs	Average Velocity of Stack Gas - FPM	3018
Qs	Actual Stack Gas Flowrate - ACFM	2988
Qs (std)	Stack Gas Flowrate (0.0% H_2O; STP) - DSCF	1716
% I	% Isokinetic (Avg. Nozzle Vel/Avg. Stk Vel)	98.1
Cs	Particulate Concentration-lb/DSCF	0.002943
Er	Particulate Emission Rate-lb/hour	303.1
F	F Factor - DSCF/MM BTU	
E	Particulate Emissions - lbs/MM BTU	

PARTICULATE TEST DATA

TEST KT5-2 TIME 1730-2045

LOCATION BAGHOUSE OUTLET DATE 10-28-80

FIRM U.S GYPSUM PROJECT NO. 1532-E80

Input A		
P bar	Barometric Pressure - in. Hg	30.08
As	Stack Area - Ft^2	0.66
Dn	Nozzle Diameter - in.	0.1992
Time	Total Sampling Time - min.	160
Y	Calibration Factor	1.01
Cp	Pitot Coefficient	0.844
$(\Delta P)^{1/2}$	Average Square Root of Velocity Head (in. H_2O)	1.132
ΔH	Average Orifice Pressure Drop - in. H_2O	1.47
Tm	Average Meter Temperature °F	69
Pstk	Average Stack Pressure - in. H_2O	-.37
Tstk	Average Stack Temperature °F	154
Vm	Meter Volume at Meter Conditions - Ft^3	99.8
Vl	Total Water Vapor Collected - ml	667.3
CO_2	% CO_2 in Stack Gas (Dry)	0
O_2	% O_2 in Stack Gas (Dry)	20.9
CO	% CO in Stack Gas (Dry)	0
Input B		
Mn	Total Particulate Catch - Mg	26.48
Input C		
% H	% Hydrogen in Fuel	
% C	% Carbon in Fuel	
% S	% Sulfur in Fuel	
% N	% Nitrogen in Fuel	
% O	% Oxygen in Fuel	
GCV	Gross Califoric Volume of Fuel - BTU/lb	
Calculated		
Vm (std)	Meter Volume at Standard Conditions (Dry)-Ft^3	101.5
% H_2O	% H_2O Vapor in Stack Gas	23.6
Mws	Molecular Weight of Stack Gas (Wet)	26.27
Vs	Average Velocity of Stack Gas - FPM	4321
Qs	Actual Stack Gas Flowrate - ACFM	2852
Qs (std)	Stack Gas Flowrate (0.0% H_2O; STP) - DSCF	1881
% I	% Isokinetic (Avg. Nozzle Vel/Avg. Stk Vel)	102.9
Cs	Particulate Concentration-lb/DSCF	0.0000005575
Er	Particulate Emission Rate-lb/hour	0.0649
F	F Factor - DSCF/MM BTU	
E	Particulate Emissions - lbs/MM BTU	

PARTICULATE TEST DATA

TEST HT5-3 TIME 0940 - 1210

LOCATION BAGHOUSE INLET DATE 10-29-80

FIRM U.S. GYPSUM PROJECT NO. 1532-E80

Input A		
P bar	Barometric Pressure - in. Hg	30.40
As	Stack Area - Ft^2	.99
Dn	Nozzle Diameter - in.	.262
Time	Total Sampling Time - min.	19
Y	Calibration Factor	1.00
Cp	Pitot Coefficient	.86
$(\Delta P)^{1/2}$	Average Square Root of Velocity Head (in. H_2O)	.623
ΔH	Average Orifice Pressure Drop - in. H_2O	1.22
Tm	Average Meter Temperature °F	55.5
Pstk	Average Stack Pressure - in. H_2O	-2.2
Tstk	Average Stack Temperature °F	176
Vm	Meter Volume at Meter Conditions - Ft^3	10.89
Vl	Total Water Vapor Collected - ml	213.3
CO_2	% CO_2 in Stack Gas (Dry)	0
O_2	% O_2 in Stack Gas (Dry)	20.9
CO	% CO in Stack Gas (Dry)	0
Input B		
Mn	Total Particulate Catch - Mg	11460.84
Input C		
% H	% Hydrogen in Fuel	
% C	% Carbon in Fuel	
% S	% Sulfur in Fuel	
% N	% Nitrogen in Fuel	
% O	% Oxygen in Fuel	
GCV	Gross Califoric Volume of Fuel - BTU/lb	
Calculated		
Vm (std)	Meter Volume at Standard Conditions (Dry)-Ft^3	11.37
% H_2O	% H_2O Vapor in Stack Gas	46.91
Mws	Molecular Weight of Stack Gas (Wet)	23.75
Vs	Average Velocity of Stack Gas - FPM	2586
Qs	Actual Stack Gas Flowrate - ACFM	2560
Qs (std)	Stack Gas Flowrate (0.0% H_2O; STP) - DSCF	1146
% I	% Isokinetic (Avg. Nozzle Vel/Avg. Stk Vel)	138.8
Cs	Particulate Concentration-lb/DSCF	.002223
Er	Particulate Emission Rate-lb/hour	152.1
F	F Factor - DSCF/MM BTU	
E	Particulate Emissions - lbs/MM BTU	

PARTICULATE TEST DATA

TEST KT 5-3 TIME 0854 - 1223

LOCATION BAGHOUSE OUTLET DATE 10-29-80

FIRM U.S. GYPSUM PROJECT NO. 1532-E80

Input A		
P bar	Barometric Pressure - in. Hg	30.37
As	Stack Area - Ft^2	.66
Dn	Nozzle Diameter - in.	.1992
Time	Total Sampling Time - min.	160
Y	Calibration Factor	1.01
Cp	Pitot Coefficient	0.854
$(\Delta P)^{1/2}$	Average Square Root of Velocity Head (in. H_2O)	~~.829~~ .892
ΔH	Average Orifice Pressure Drop - in. H_2O	.933
Tm	Average Meter Temperature °F	72
Pstk	Average Stack Pressure - in. H_2O	-.32
Tstk	Average Stack Temperature °F	156
Vm	Meter Volume at Meter Conditions - Ft^3	80.88
Vl	Total Water Vapor Collected - ml	819.4
CO_2	% CO_2 in Stack Gas (Dry)	0
O_2	% O_2 in Stack Gas (Dry)	20.9
CO	% CO in Stack Gas (Dry)	0
Input B		
Mn	Total Particulate Catch - Mg	78.15
Input C		
% H	% Hydrogen in Fuel	
% C	% Carbon in Fuel	
% S	% Sulfur in Fuel	
% N	% Nitrogen in Fuel	
% O	% Oxygen in Fuel	
GCV	Gross Califoric Volume of Fuel - BTU/lb	
Calculated		
Vm (std)	Meter Volume at Standard Conditions (Dry)-Ft^3	82.5
% H_2O	% H_2O Vapor in Stack Gas	31.9
Mws	Molecular Weight of Stack Gas (Wet)	25.38
Vs	Average Velocity of Stack Gas - FPM	3494
Qs	Actual Stack Gas Flowrate - ACFM	2306
Qs (std)	Stack Gas Flowrate (0.0% H_2O; STP) - DSCF	1366
% I	% Isokinetic (Avg. Nozzle Vel/Avg. Stk Vel)	115.2
Cs	Particulate Concentration-lb/DSCF	0.00000020865
Er	Particulate Emission Rate-lb/hour	0.1712
F	F Factor - DSCF/MM BTU	
E	Particulate Emissions - lbs/MM BTU	

PARTICULATE TEST DATA

TEST KT5-3R - OUTLET TIME 0945-1233

LOCATION INLET DATE Oct. 31, 1980

FIRM U.S. GYPSUM PROJECT NO. 1532-E5C

Input A		
P bar	Barometric Pressure - in. Hg	30.05
As	Stack Area - Ft^2	.66
Dn	Nozzle Diameter - in.	.1992
Time	Total Sampling Time - min.	160
Y	Calibration Factor	1.01
Cp	Pitot Coefficient	.856
$(\Delta P)^{1/2}$	Average Square Root of Velocity Head (in. H_2O)	~~1.09~~ 1.11
ΔH	Average Orifice Pressure Drop - in. H_2O	1.41
Tm	Average Meter Temperature °F	81
Pstk	Average Stack Pressure - in. H_2O	-.52
Tstk	Average Stack Temperature °F	176
Vm	Meter Volume at Meter Conditions - Ft^3	100.37
Vl	Total Water Vapor Collected - ml	870.7
CO_2	% CO_2 in Stack Gas (Dry)	0
O_2	% O_2 in Stack Gas (Dry)	20.9
CO	% CO in Stack Gas (Dry)	0
Input B		
Mn	Total Particulate Catch - Mg	195.05
Input C		
% H	% Hydrogen in Fuel	
% C	% Carbon in Fuel	
% S	% Sulfur in Fuel	
% N	% Nitrogen in Fuel	
% O	% Oxygen in Fuel	
GCV	Gross Califoric Volume of Fuel - BTU/lb	
Calculated		
Vm (std)	Meter Volume at Standard Conditions (Dry)-Ft^3	99.7
% H_2O	% H_2O Vapor in Stack Gas	29.14
Mws	Molecular Weight of Stack Gas (Wet)	25.7
Vs	Average Velocity of Stack Gas - FPM	4428
Qs	Actual Stack Gas Flowrate - ACFM	2922
Qs (std)	Stack Gas Flowrate (0.0% H_2O; STP) - DSCF	1724
% I	% Isokinetic (Avg. Nozzle Vel/Avg. Stk Vel)	110
Cs	Particulate Concentration-lb/DSCF	0.000004312
Er	Particulate Emission Rate-lb/hour	0.4461
F	F Factor - DSCF/MM BTU	
E	Particulate Emissions - lbs/MM BTU	

PARTICULATE TEST DATA

TEST KTS-4 TIME

LOCATION ~~OUTLET~~ INLET DATE Oct 30 1980

FIRM U.S. Gypsum PROJECT NO. 1532-E80

Input A

P bar	Barometric Pressure - in. Hg	
As	Stack Area - Ft^2	
Dn	Nozzle Diameter - in.	
Time	Total Sampling Time - min.	
Y	Calibration Factor	
Cp	Pitot Coefficient	
$(\Delta P)^{1/2}$	Average Square Root of Velocity Head (in. H_2O)	
ΔH	Average Orifice Pressure Drop - in. H_2O	
Tm	Average Meter Temperature °F	
Pstk	Average Stack Pressure - in. H_2O	-1.7
Tstk	Average Stack Temperature °F	
Vm	Meter Volume at Meter Conditions - Ft^3	
Vl	Total Water Vapor Collected - ml	
CO_2	% CO_2 in Stack Gas (Dry)	
O_2	% O_2 in Stack Gas (Dry)	
CO	% CO in Stack Gas (Dry)	

Input B

Mn	Total Particulate Catch - Mg	32107.51

Input C

% H	% Hydrogen in Fuel	
% C	% Carbon in Fuel	
% S	% Sulfur in Fuel	
% N	% Nitrogen in Fuel	
% O	% Oxygen in Fuel	
GCV	Gross Califoric Volume of Fuel - BTU/lb	

Calculated

Vm (std)	Meter Volume at Standard Conditions (Dry)-Ft^3	10.0
% H_2O	% H_2O Vapor in Stack Gas	59.1
Mws	Molecular Weight of Stack Gas (Wet)	22.43
Vs	Average Velocity of Stack Gas - FPM	3188
Qs	Actual Stack Gas Flowrate - ACFM	3156
Qs (std)	Stack Gas Flowrate (0.0% H_2O; STP) - DSCF	963
% I	% Isokinetic (Avg. Nozzle Vel/Avg. Stk Vel)	96.5
Cs	Particulate Concentration-lb/DSCF	0.007071
Er	Particulate Emission Rate-lb/hour	408.6
F	F Factor - DSCF/MM BTU	
E	Particulate Emissions - lbs/MM BTU	

PARTICULATE TEST DATA

VOIDING

TEST KTS - 4 TIME

LOCATION OUTLET DATE Oct 30, 1980

FIRM U.S. GYPSUM PROJECT NO. 1532-E80

Input A

P bar	Barometric Pressure - in. Hg	30.12
As	Stack Area - Ft^2	.66
Dn	Nozzle Diameter - in.	.3127
Time	Total Sampling Time - min.	80
Y	Calibration Factor	1.01
Cp	Pitot Coefficient	.856
$(\Delta P)^{1/2}$	Average Square Root of Velocity Head (in. H_2O)	.975
ΔH	Average Orifice Pressure Drop - in. H_2O	1.84
Tm	Average Meter Temperature °F	73
Pstk	Average Stack Pressure - in. H_2O	-.375
Tstk	Average Stack Temperature °F	225
Vm	Meter Volume at Meter Conditions - Ft^3	56.04
Vl	Total Water Vapor Collected - ml	1276.4
CO_2	% CO_2 in Stack Gas (Dry)	0
O_2	% O_2 in Stack Gas (Dry)	20.9
CO	% CO in Stack Gas (Dry)	0

Input B

Mn	Total Particulate Catch - Mg	338.99

Input C

% H	% Hydrogen in Fuel	
% C	% Carbon in Fuel	
% S	% Sulfur in Fuel	
% N	% Nitrogen in Fuel	
% O	% Oxygen in Fuel	
GCV	Gross Califoric Volume of Fuel - BTU/lb	

Calculated

Vm (std)	Meter Volume at Standard Conditions (Dry)-Ft^3	56.7
% H_2O	% H_2O Vapor in Stack Gas	51.5
Mws	Molecular Weight of Stack Gas (Wet)	23.3
Vs	Average Velocity of Stack Gas - FPM	4235
Qs	Actual Stack Gas Flowrate - ACFM	2795
Qs (std)	Stack Gas Flowrate (0.0% H_2O; STP) - DSCF	1052
% I	% Isokinetic (Avg. Nozzle Vel/Avg. Stk Vel)	83.5
Cs	Particulate Concentration-lb/DSCF	0.0000 1318
Er	Particulate Emission Rate-lb/hour	0.8316
F	F Factor - DSCF/MM BTU	
E	Particulate Emissions - lbs/MM BTU	

PARTICULATE TEST DATA

TEST 4R-KT5 TIME 1704-1810

LOCATION Outlet DATE 10-30-80

FIRM U.S Gypsum PROJECT NO. 1532-280

Input A		
P bar	Barometric Pressure - in. Hg	30.09
As	Stack Area - Ft^2	.66
Dn	Nozzle Diameter - in.	.2622
Time	Total Sampling Time - min.	64
Y	Calibration Factor	1.01
Cp	Pitot Coefficient	.856
$(\Delta P)^{1/2}$	Average Square Root of Velocity Head (in. H_2O)	.966
ΔH	Average Orifice Pressure Drop - in. H_2O	1.325
Tm	Average Meter Temperature °F	83
Pstk	Average Stack Pressure - in. H_2O	-.45
Tstk	Average Stack Temperature °F	235
Vm	Meter Volume at Meter Conditions - Ft^3	38.45
Vl	Total Water Vapor Collected - ml	913.55
CO_2	% CO_2 in Stack Gas (Dry)	0
O_2	% O_2 in Stack Gas (Dry)	20.9
CO	% CO in Stack Gas (Dry)	0
Input B		
Mn	Total Particulate Catch - Mg	237.44
Input C		
% H	% Hydrogen in Fuel	
% C	% Carbon in Fuel	
% S	% Sulfur in Fuel	
% N	% Nitrogen in Fuel	
% O	% Oxygen in Fuel	
GCV	Gross Califoric Volume of Fuel - BTU/lb	
Calculated		
Vm (std)	Meter Volume at Standard Conditions (Dry)-Ft^3	38.1
% H_2O	% H_2O Vapor in Stack Gas	53.03
Mws	Molecular Weight of Stack Gas (Wet)	23.09
Vs	Average Velocity of Stack Gas - FPM	4245
Qs	Actual Stack Gas Flowrate - ACFM	2601
Qs (std)	Stack Gas Flowrate (0.0% H_2O; STP) - DSCF	1004
% I	% Isokinetic (Avg. Nozzle Vel/Avg. Stk Vel)	104.4
Cs	Particulate Concentration-lb/DSCF	0.00001374
Er	Particulate Emission Rate-lb/hour	0.8276
F	F Factor - DSCF/MM BTU	
E	Particulate Emissions - lbs/MM BTU	

PARTICULATE TEST DATA

TEST KIS-5 TIME 1312-1404

LOCATION INLET DATE 10-30-80

FIRM U.S. GYPSUM PROJECT NO. 1532-EBO

Input A		
P bar	Barometric Pressure - in. Hg	30.5
As	Stack Area - Ft^2	.99
Dn	Nozzle Diameter - in.	.3127
Time	Total Sampling Time - min.	20
Y	Calibration Factor	1.00
Cp	Pitot Coefficient	0.86
$(\Delta P)^{1/2}$	Average Square Root of Velocity Head (in. H_2O)	.706
ΔH	Average Orifice Pressure Drop - in. H_2O	.835
Tm	Average Meter Temperature °F	72
Pstk	Average Stack Pressure - in. H_2O	-1.0
Tstk	Average Stack Temperature °F	268
Vm	Meter Volume at Meter Conditions - Ft^3	9.82
Vl	Total Water Vapor Collected - ml	~~2406~~ 3016
CO_2	% CO_2 in Stack Gas (Dry)	0
O_2	% O_2 in Stack Gas (Dry)	20.9
CO	% CO in Stack Gas (Dry)	0
Input B		
Mn	Total Particulate Catch - Mg	37511.2
Input C		
% H	% Hydrogen in Fuel	
% C	% Carbon in Fuel	
% S	% Sulfur in Fuel	
% N	% Nitrogen in Fuel	
% O	% Oxygen in Fuel	
GCV	Gross Califoric Volume of Fuel - BTU/lb	
Calculated		
Vm (std)	Meter Volume at Standard Conditions (Dry)-Ft^3	9.96
% H_2O	% H_2O Vapor in Stack Gas	58.8
Mws	Molecular Weight of Stack Gas (Wet)	23.4
Vs	Average Velocity of Stack Gas - FPM	~~3172~~ 3214
Qs	Actual Stack Gas Flowrate - ACFM	~~3140~~ 3182
Qs (std)	Stack Gas Flowrate (0.0% H_2O; STP) - DSCF	~~1683~~ 967
% I	% Isokinetic (Avg. Nozzle Vel/Avg. Stk Vel)	~~95.4~~ 95.6
Cs	Particulate Concentration-lb/DSCF	0.008306
Er	Particulate Emission Rate-lb/hour	481.9
F	F Factor - DSCF/MM BTU	
E	Particulate Emissions - lbs/MM BTU	

PARTICULATE TEST DATA

TEST KT-5 KT5-5 TIME 1230-1350

LOCATION OUTLET DATE 10-30-90

FIRM U.S. Gypsum PROJECT NO. 1532-ES0

Input A		
P bar	Barometric Pressure - in. Hg	30.14
As	Stack Area - Ft^2	.66
Dn	Nozzle Diameter - in.	.2622
Time	Total Sampling Time - min.	80
Y	Calibration Factor	1.01
Cp	Pitot Coefficient	.856
$(\Delta P)^{1/2}$	Average Square Root of Velocity Head (in. H_2O)	.99
ΔH	Average Orifice Pressure Drop - in. H_2O	1.36
Tm	Average Meter Temperature °F	81
Pstk	Average Stack Pressure - in. H_2O	-.4
Tstk	Average Stack Temperature °F	230
Vm	Meter Volume at Meter Conditions - Ft^3	48.89
Vl	Total Water Vapor Collected - ml	1079.9
CO_2	% CO_2 in Stack Gas (Dry)	0
O_2	% O_2 in Stack Gas (Dry)	20.9
CO	% CO in Stack Gas (Dry)	0
Input B		
Mn	Total Particulate Catch - Mg	300.03
Input C		
% H	% Hydrogen in Fuel	
% C	% Carbon in Fuel	
% S	% Sulfur in Fuel	
% N	% Nitrogen in Fuel	
% O	% Oxygen in Fuel	
GCV	Gross Califoric Volume of Fuel - BTU/lb	
Calculated		
Vm (std)	Meter Volume at Standard Conditions (Dry)-Ft^3	48.72
% H_2O	% H_2O Vapor in Stack Gas	51.08
Mws	Molecular Weight of Stack Gas (Wet)	23.3
Vs	Average Velocity of Stack Gas - FPM	4311
Qs	Actual Stack Gas Flowrate - ACFM	2845
Qs (std)	Stack Gas Flowrate (0.0% H_2O; STP) - DSCF	1072
% I	% Isokinetic (Avg. Nozzle Vel/Avg. Stk Vel)	100.0
Cs	Particulate Concentration-lb/DSCF	0.00001358
Er	Particulate Emission Rate-lb/hour	0.8732
F	F Factor - DSCF/MM BTU	
E	Particulate Emissions - lbs/MM BTU	

PARTICULATE TEST DATA

TEST KT5-C TIME 1523-1603

LOCATION INLET DATE 10-30-20

FIRM US GYPSUM PROJECT NO. 15327-80

Input A		
P bar	Barometric Pressure - in. Hg	30.32
As	Stack Area - Ft^2	.99
Dn	Nozzle Diameter - in.	.3127
Time	Total Sampling Time - min.	20
Y	Calibration Factor	1.00
Cp	Pitot Coefficient	.86
$(\Delta P)^{1/2}$	Average Square Root of Velocity Head (in. H_2O)	.635
ΔH	Average Orifice Pressure Drop - in. H_2O	.674
Tm	Average Meter Temperature °F	78
Pstk	Average Stack Pressure - in. H_2O	-1.15
Tstk	Average Stack Temperature °F	256
Vm	Meter Volume at Meter Conditions - Ft^3	9.22
Vl	Total Water Vapor Collected - ml	~~364.7~~ 309.7
CO_2	% CO_2 in Stack Gas (Dry)	0
O_2	% O_2 in Stack Gas (Dry)	20.9
CO	% CO in Stack Gas (Dry)	0
Input B		
Mn	Total Particulate Catch - Mg	33187.03
Input C		
% H	% Hydrogen in Fuel	
% C	% Carbon in Fuel	
% S	% Sulfur in Fuel	
% N	% Nitrogen in Fuel	
% O	% Oxygen in Fuel	
GCV	Gross Califoric Volume of Fuel - BTU/lb	
Calculated		
Vm (std)	Meter Volume at Standard Conditions (Dry)-Ft^3	9.19
% H_2O	% H_2O Vapor in Stack Gas	61.4
Mws	Molecular Weight of Stack Gas (Wet)	22.19
Vs	Average Velocity of Stack Gas - FPM	2894
Qs	Actual Stack Gas Flowrate - ACFM	2865
Qs (std)	Stack Gas Flowrate (0.0% H_2O; STP) - DSCF	825
% I	% Isokinetic (Avg. Nozzle Vel/Avg. Stk Vel)	103.4
Cs	Particulate Concentration-lb/DSCF	0.00796
Er	Particulate Emission Rate-lb/hour	394.2
F	F Factor - DSCF/MM BTU	
E	Particulate Emissions - lbs/MM BTU	

PARTICULATE TEST DATA

TEST KT5-6 TIME 1452 1559

LOCATION Outlet DATE 10-30-90

FIRM U.S Gypsum PROJECT NO. 1532-E80

Input A		
P bar	Barometric Pressure - in. Hg	30.09
As	Stack Area - Ft^2	.66
Dn	Nozzle Diameter - in.	.2622
Time	Total Sampling Time - min.	64
Y	Calibration Factor	1.01
Cp	Pitot Coefficient	0.856
$(\Delta P)^{1/2}$	Average Square Root of Velocity Head (in. H_2O)	.99
ΔH	Average Orifice Pressure Drop - in. H_2O	1.38
Tm	Average Meter Temperature °F	85.5
Pstk	Average Stack Pressure - in. H_2O	-.28
Tstk	Average Stack Temperature °F	232
Vm	Meter Volume at Meter Conditions - Ft^3	39.55
Vl	Total Water Vapor Collected - ml	864.7
CO_2	% CO_2 in Stack Gas (Dry)	0
O_2	% O_2 in Stack Gas (Dry)	20.9
CO	% CO in Stack Gas (Dry)	0
Input B		
Mn	Total Particulate Catch - Mg	226.67
Input C		
% H	% Hydrogen in Fuel	
% C	% Carbon in Fuel	
% S	% Sulfur in Fuel	
% N	% Nitrogen in Fuel	
% O	% Oxygen in Fuel	
GCV	Gross Califoric Volume of Fuel - BTU/lb	
Calculated		
Vm (std)	Meter Volume at Standard Conditions (Dry)-Ft^3	39.05
% H_2O	% H_2O Vapor in Stack Gas	57.05
Mws	Molecular Weight of Stack Gas (Wet)	23.3
Vs	Average Velocity of Stack Gas - FPM	4320
Qs	Actual Stack Gas Flowrate - ACFM	2851
Qs (std)	Stack Gas Flowrate (0.0% H_2O; STP) - DSCF	1070
% I	% Isokinetic (Avg. Nozzle Vel/Avg. Stk Vel)	100.4
Cs	Particulate Concentration-lb/DSCF	0.00001290
Er	Particulate Emission Rate-lb/hour	0.8216
F	F Factor - DSCF/MM BTU	
E	Particulate Emissions - lbs/MM BTU	

PARTICULATE TEST DATA

TEST BS-7 TIME 1115-1200

LOCATION Outlet DATE Oct 31, 1980

FIRM U.S. Gypsum PROJECT NO. 1532-080-

Input A		
P bar	Barometric Pressure - in. Hg	30.5
As	Stack Area - Ft^2	.72
Dn	Nozzle Diameter - in.	.1960
Time	Total Sampling Time - min.	40
Y	Calibration Factor	1.00
Cp	Pitot Coefficient	.86
$(\Delta P)^{1/2}$	Average Square Root of Velocity Head (in. H_2O)	1.627
ΔH	Average Orifice Pressure Drop - in. H_2O	= 4.5
Tm	Average Meter Temperature °F	54
Pstk	Average Stack Pressure - in. H_2O	-.45
Tstk	Average Stack Temperature °F	71
Vm	Meter Volume at Meter Conditions - Ft^3	43.78
Vl	Total Water Vapor Collected - ml	11.4
CO_2	% CO_2 in Stack Gas (Dry)	0
O_2	% O_2 in Stack Gas (Dry)	20.9
CO	% CO in Stack Gas (Dry)	0
Input B		
Mn	Total Particulate Catch - Mg	27.05
Input C		
% H	% Hydrogen in Fuel	
% C	% Carbon in Fuel	
% S	% Sulfur in Fuel	
% N	% Nitrogen in Fuel	
% O	% Oxygen in Fuel	
GCV	Gross Califoric Volume of Fuel - BTU/lb	
Calculated		
Vm (std)	Meter Volume at Standard Conditions (Dry)-Ft^3	45.4
% H_2O	% H_2O Vapor in Stack Gas	1.17
Mws	Molecular Weight of Stack Gas (Wet)	28.7
Vs	Average Velocity of Stack Gas - FPM	5592
Qs	Actual Stack Gas Flowrate - ACFM	4026
Qs (std)	Stack Gas Flowrate (0.0% H_2O; STP) - DSCF	4027
% I	% Isokinetic (Avg. Nozzle Vel/Avg. Stk Vel)	96.8
Cs	Particulate Concentration-lb/DSCF	0.0000013 15
Er	Particulate Emission Rate-lb/hour	0.3179
F	F Factor - DSCF/MM BTU	
E	Particulate Emissions - lbs/MM BTU	

PARTICULATE TEST DATA

TEST BS-8 TIME 1310-1435

LOCATION Outlet DATE Oct 31, 1980

FIRM U S Ovesum PROJECT NO. 1532-E80

Input A		
P bar	Barometric Pressure - in. Hg	30.5
As	Stack Area - Ft^2	.71
Dn	Nozzle Diameter - in.	.197
Time	Total Sampling Time - min.	40
Y	Calibration Factor	1.00
Cp	Pitot Coefficient	.84
$(\Delta P)^{1/2}$	Average Square Root of Velocity Head (in. H_2O)	1.62
ΔH	Average Orifice Pressure Drop - in. H_2O	4.23
Tm	Average Meter Temperature °F	66
Pstk	Average Stack Pressure - in. H_2O	-.2
Tstk	Average Stack Temperature °F	74.5
Vm	Meter Volume at Meter Conditions - Ft^3	42.32
Vl	Total Water Vapor Collected - ml	13.99
CO_2	% CO_2 in Stack Gas (Dry)	0
O_2	% O_2 in Stack Gas (Dry)	20.9
CO	% CO in Stack Gas (Dry)	0
Input B		
Mn	Total Particulate Catch - Mg	23.8
Input C		
% H	% Hydrogen in Fuel	
% C	% Carbon in Fuel	
% S	% Sulfur in Fuel	
% N	% Nitrogen in Fuel	
% O	% Oxygen in Fuel	
GCV	Gross Califoric Volume of Fuel - BTU/lb	
Calculated		
Vm (std)	Meter Volume at Standard Conditions (Dry)-Ft^3	43.9
% H_2O	% H_2O Vapor in Stack Gas	1.48
Mws	Molecular Weight of Stack Gas (Wet)	28.68
Vs	Average Velocity of Stack Gas - FPM	5458
Qs	Actual Stack Gas Flowrate - ACFM	3930
Qs (std)	Stack Gas Flowrate (0.0% H_2O; STP) - DSCF	3897
% I	% Isokinetic (Avg. Nozzle Vel/Avg. Stk Vel)	93.6
Cs	Particulate Concentration-lb/DSCF	0.00000199
Er	Particulate Emission Rate-lb/hour	0.2864
F	F Factor - DSCF/MM BTU	
E	Particulate Emissions - lbs/MM BTU	

PARTICULATE TEST DATA

TEST BS-9 TIME 1607-1655

LOCATION Outlet DATE Oct 31, 1980

FIRM U.S Gypsum PROJECT NO. 1532-ESD

Input A

P bar	Barometric Pressure - in. Hg	30.5
As	Stack Area - Ft^2	.72
Dn	Nozzle Diameter - in.	.196
Time	Total Sampling Time - min.	40
Y	Calibration Factor	1.00
Cp	Pitot Coefficient	.86
$(\Delta P)^{1/2}$	Average Square Root of Velocity Head (in. H_2O)	1.6
ΔH	Average Orifice Pressure Drop - in. H_2O	4.33
Tm	Average Meter Temperature °F	65.5
Pstk	Average Stack Pressure - in. H_2O	-.2
Tstk	Average Stack Temperature °F	70
Vm	Meter Volume at Meter Conditions - Ft^3	43.54
Vl	Total Water Vapor Collected - ml	6.9
CO_2	% CO_2 in Stack Gas (Dry)	0
O_2	% O_2 in Stack Gas (Dry)	20.9
CO	% CO in Stack Gas (Dry)	0

Input B

Mn	Total Particulate Catch - Mg	39.87

Input C

% H	% Hydrogen in Fuel	
% C	% Carbon in Fuel	
% S	% Sulfur in Fuel	
% N	% Nitrogen in Fuel	
% O	% Oxygen in Fuel	
GCV	Gross Califoric Volume of Fuel - BTU/lb	

Calculated

Vm (std)	Meter Volume at Standard Conditions (Dry)-Ft^3	45.1
% H_2O	% H_2O Vapor in Stack Gas	0.716
Mws	Molecular Weight of Stack Gas (Wet)	28.8
Vs	Average Velocity of Stack Gas - FPM	5488
Qs	Actual Stack Gas Flowrate - ACFM	3951
Qs (std)	Stack Gas Flowrate (0.0% H_2O; STP) - DSCF	3982
% I	% Isokinetic (Avg. Nozzle Vel/Avg. Stk Vel)	97.3
Cs	Particulate Concentration-lb/DSCF	0.00000195
Er	Particulate Emission Rate-lb/hour	0.4660
F	F Factor - DSCF/MM BTU	
E	Particulate Emissions - lbs/MM BTU	

IMPINGER & SG VOLUMES

TEST #: 4/Final KTS

FIRM: L.S. Gypsum

DATE: 10-28-90

LOCATION Inlet Kettle Caleiner No.5 Baghouse Batch

SAMPLE CONTAINER CODES

	H_2O	Silica Gel	
Final Wt.	200 mls	200g	
Initial Wt.	478 mls	208.0g	
Δ Wt.	278 mls	8g	

TOTAL → 286

LOCATION Outlet

SAMPLE CONTAINER CODES

	H_2O	SilicaGel	
Final Wt.	856 mls	223.8	
Initial Wt.	200	200.0	
Δ Wt.	656 mls	23.8g	

TOTAL → 679.8

LOCATION _____

SAMPLE CONTAINER CODES

Final Wt.			
Initial Wt.			
Δ Wt.			

TOTAL → _____

LOCATION _____

SAMPLE CONTAINER CODES

Final Wt.			
Initial Wt.			
Δ Wt.			

TOTAL → _____

IMPINGER & SG VOLUMES

TEST #: 2

FIRM: U.S. Gypsum

DATE: 10-28-80

LOCATION Inlet

SAMPLE CONTAINER CODES

	H2O	SG	
Final Wt.	319 ml	203.3g	
Initial Wt.	200 ml	200.0	
Δ Wt.	119	3.3g	

TOTAL ——→ ____

LOCATION Outlet

SAMPLE CONTAINER CODES

	H2O	SG	
Final Wt.	843 mls	224.3	
Initial Wt.	200	200.0	
Δ Wt.	643	24.3	

TOTAL ——→ ____

LOCATION ____

SAMPLE CONTAINER CODES

Final Wt.			
Initial Wt.			
Δ Wt.			

TOTAL ——→ ____

LOCATION ____

SAMPLE CONTAINER CODES

Final Wt.			
Initial Wt.			
Δ Wt.			

TOTAL ——→ ____

IMPINGER & SG VOLUMES

TEST #: 3

FIRM: U.S. Gypsum

DATE: Oct 29, 1980

LOCATION Inlet

SAMPLE CONTAINER CODES

	H2O	SG	
Final Wt.	410	203.3g	
Initial Wt.	200ml	200g	
Δ Wt.	210ml	3.3g	

TOTAL 213.3

LOCATION Outlet

SAMPLE CONTAINER CODES

	H2O	SG	
Final Wt.	986	233.4	
Initial Wt.	200ml	200g	
Δ Wt.	786ml	33.4g	

TOTAL 819.4

LOCATION _____

SAMPLE CONTAINER CODES

Final Wt.			
Initial Wt.			
Δ Wt.			

TOTAL _____

LOCATION _____

SAMPLE CONTAINER CODES

Final Wt.			
Initial Wt.			
Δ Wt.			

TOTAL _____

IMPINGER & SG VOLUMES

TEST #: ~~3R~~ 3R KT5

FIRM: US Gypsum

DATE: 10-31-80

LOCATION: Outlet Kettle Calciner No. 5 Baghouse Batch

SAMPLE CONTAINER CODES

	H2O	SG	
Final Wt.	1,055 ml	215.7	
Initial Wt.	200	200g	
Δ Wt.	855 ml	15.7g	

TOTAL ——→ ____

LOCATION ____

SAMPLE CONTAINER CODES

Final Wt.			
Initial Wt.			
Δ Wt.			

TOTAL ——→ ____

LOCATION ____

SAMPLE CONTAINER CODES

Final Wt.			
Initial Wt.			
Δ Wt.			

TOTAL ——→ ____

LOCATION ____

SAMPLE CONTAINER CODES

Final Wt.			
Initial Wt.			
Δ Wt.			

TOTAL ——→ ____

IMPINGER & SG VOLUMES

TEST #: 4

FIRM: U.S. Aggregates

DATE: 12-20-96

LOCATION Inlet Kettle Caliciner No. 5 Baghouse continuous

SAMPLE CONTAINER CODES

	H2O	SG	
Final Wt.	504 ml	203.5 g	
Initial Wt.	200 ml	200	
Δ Wt.	304 ml	3.5	

TOTAL → ____

LOCATION Outlet

SAMPLE CONTAINER CODES

	H2O	SG	
Final Wt.	1,442	234.9	
Initial Wt.	200	200	
Δ Wt.	1,242 ml	34.9 g	

TOTAL → ____

LOCATION ____

SAMPLE CONTAINER CODES

Final Wt.			
Initial Wt.			
Δ Wt.			

TOTAL → ____

LOCATION ____

SAMPLE CONTAINER CODES

Final Wt.			
Initial Wt.			
Δ Wt.			

TOTAL → ____

IMPINGER & SG VOLUMES

TEST #: 4R = continuous

FIRM: U.S. Gypsum

DATE: 10-30-80

LOCATION Inlet

SAMPLE CONTAINER CODES

	H2O	SG	
Final Wt.			
Initial Wt.			
Δ Wt.			

TOTAL ____

LOCATION Outlet

SAMPLE CONTAINER CODES

	H2O	SG	
Final Wt.	1104	209.55	
Initial Wt.	200	200.00	
Δ Wt.	904	9.55	

TOTAL 913.6

LOCATION ____

SAMPLE CONTAINER CODES

Final Wt.			
Initial Wt.			
Δ Wt.			

TOTAL ____

LOCATION ____

SAMPLE CONTAINER CODES

Final Wt.			
Initial Wt.			
Δ Wt.			

TOTAL ____

IMPINGER & SG VOLUMES

TEST #: 5

FILE: [illegible]

DATE: [illegible]

LOCATION Inlet

SAMPLE CONTAINER CODES

	H2O	SG	
Final Wt.	434	206.6	
Initial Wt.	200 ml	200 g	
Δ Wt.	234 ml	6.6 g	

TOTAL → ____

LOCATION Outlet

SAMPLE CONTAINER CODES

	H2O	SG	
Final Wt.	1265	214.9	
Initial Wt.	200 ml	200 g	
Δ Wt.	1065 ml	14.9 g	

TOTAL → ____

LOCATION ____

SAMPLE CONTAINER CODES

Final Wt.			
Initial Wt.			
Δ Wt.			

TOTAL → ____

LOCATION ____

SAMPLE CONTAINER CODES

Final Wt.			
Initial Wt.			
Δ Wt.			

TOTAL → ____

IMPINGER & SG VOLUMES

TEST #: 6

FIRM: U S Gypsum

DATE: 12-30-86

LOCATION Inlet

SAMPLE CONTAINER CODES

	H2O	SG	
Final Wt.	506ml	203.7	
Initial Wt.	200ml	200	
Δ Wt.	306ml	3.7g	

TOTAL → 309.7

LOCATION Outlet

SAMPLE CONTAINER CODES

	H2O	SG	
Final Wt.	1054ml	210.7	
Initial Wt.	200	200.0	
Δ Wt.	854ml	10.7g	

TOTAL → 864.7

LOCATION _____

SAMPLE CONTAINER CODES

Final Wt.			
Initial Wt.			
Δ Wt.			

TOTAL → _____

LOCATION _____

SAMPLE CONTAINER CODES

Final Wt.			
Initial Wt.			
Δ Wt.			

TOTAL → _____

IMPINGER & SG VOLUMES

TEST #: 7

FIRM: [illegible]

DATE: [illegible]

LOCATION [illegible] Board End Stw

SAMPLE CONTAINER CODES

	H_2O_2		
Final Wt.	200	211.4	
Initial Wt.	200	200	
Δ Wt.	0	11.4	

TOTAL ——→ ____

LOCATION _____

SAMPLE CONTAINER CODES

Final Wt.			
Initial Wt.			
Δ Wt.			

TOTAL ——→ ____

LOCATION _____

SAMPLE CONTAINER CODES

Final Wt.			
Initial Wt.			
Δ Wt.			

TOTAL ——→ ____

LOCATION _____

SAMPLE CONTAINER CODES

Final Wt.			
Initial Wt.			
Δ Wt.			

TOTAL ——→ ____

IMPINGER & SG VOLUMES

TEST #: 8

FILE: [illegible]

DATE: [illegible]

LOCATION [illegible] Board End Saw

SAMPLE CONTAINER CODES

	[illegible]	[illegible]	
Final Wt.	200 ml	214.00	
Initial Wt.	200	200	
Δ Wt.	0	14.00	

TOTAL → ____

LOCATION ____

SAMPLE CONTAINER CODES

Final Wt.			
Initial Wt.			
Δ Wt.			

TOTAL → ____

LOCATION ____

SAMPLE CONTAINER CODES

Final Wt.			
Initial Wt.			
Δ Wt.			

TOTAL → ____

LOCATION ____

SAMPLE CONTAINER CODES

Final Wt.			
Initial Wt.			
Δ Wt.			

TOTAL → ____

IMPINGER & SG VOLUMES

TEST #: 9

FIRM: U.S. Gypsum

DATE: 10-31-80

LOCATION Outlet Board Exit Stack

SAMPLE CONTAINER CODES

	H2O	SG	
Final Wt.	194	212.9	
Initial Wt.	200	200	
Δ Wt.	-6 ml	12.9 g	

TOTAL ——→ ____

LOCATION ____

SAMPLE CONTAINER CODES

Final Wt.			
Initial Wt.			
Δ Wt.			

TOTAL ——→ ____

LOCATION ____

SAMPLE CONTAINER CODES

Final Wt.			
Initial Wt.			
Δ Wt.			

TOTAL ——→ ____

LOCATION ____

SAMPLE CONTAINER CODES

Final Wt.			
Initial Wt.			
Δ Wt.			

TOTAL ——→ ____

Project No. [illegible]

TLE U.S. Gypsum Book No. PAL 5

From Page No. 11-6-80 321-80(W)

Filters (EPA Method 5)

Filter ID	Bk #	Final wt.	FW₂			Avg. FW
KT5-O-1 #10061	65	116.17912 ✓	116.17917 ✓			116.17914
KT5-I-1 #10062	31	139.75091 ✓	139.75274 ✓			139.75182
KT5-I-1 #10068	130	141.44374 ✓	141.44730 ✓			141.44552
KT5-O-2 #10055	28	121.16762 ✓	121.16700 ✓			121.16731
KT5-I-2 #10069	6	122.79115 ✓	122.78978 ✓			122.79046
KT5-I-2 #10070	117	118.01034 ✓	118.00955 ✓			118.00994
KT5-~~I~~O-3 #10072	109	117.51850 ✓	117.51786 ✓			117.51818
KT5-O-#3 #10074	152	109.96073	109.95962 ✓	109.95979 ✓		109.95970
KT5-O-4 #10075	145	117.01031 ✓	117.00949 ✓			117.00990
KT5-I-4 #10073	156	124.98456 ✓	124.98889 ✓			124.98672
KT5-I-4 #10078	79	126.27667 ✓	126.28127 ✓			126.27897
KT5-O-5 #10071	29	112.61942 ✓	112.61864 ✓			112.61903
KT5-I-5 #10067	52	130.58550 ✓	130.57796 ✓			130.58173
KT5-I-5 #10080	78	134.94617 ✓	134.93401 ✓			134.94009
KT5-I-6 #10079	47	132.34768 ✓	132.34182 ✓			132.34475
KT5-I-6 #10076	107	130.34369 ✓	130.34012 ✓			130.34190

To Page No.

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by	

Project No. 1532-ES0-30

Book No. AM 5 TITLE U.S. Gypsum

Page No.

Sample ID	Bk #	Final Wt.	FW_2			Avg. FW
KT5-0-6 #10082	59	118.34537	118.34512			118.34524
3S-0-7 #10083	150	117.62679	117.62667			117.62673
3S-0-8 #10081	128	117.77417	117.77393			117.77405
BS-0-9 #10058	43	100.26210	100.26171			100.26190
KT5-0-3R #10060	92	114.82980	114.82929			114.82954
KT5-0-4R #10084	112	115.66481	115.66444			115.66462

11/17/80 FW. [illegible] & Clean

* Sample KT5-0-3R was wet when returned to the lab.

Cascades

	(Avg. Content) Initial Wt.	FW_1	FW_2	Avg. FW	Diff mg
24	0.18132	0.18156	0.18156	0.18156	0.34
130	0.12097	0.12136	0.12136	0.12136	0.39
129	0.11972	~~0.1978~~ 0.12015	0.11993	0.12004	0.32
131	0.11891	~~0.19~~ 0.11942	0.11934	0.11938	0.47
132	0.11959	0.11956	0.11951	0.11954	-0.05 (0)
199	0.13016	0.12899	0.12891	0.12895	-1.21 (0)
200	0.13065	0.13081	0.13085	~~0.13308~~ 0.13083	0.18
201	0.12976	0.13033	0.13035	0.13034	0.58 (0)
202	0.13046	0.13040	0.13048	0.13044	-0.02

To Page No.

Witnessed & Understood by me, Date

Invented by D. Allman Date 11-13-80

Recorded by

Project No. 1532-EFO-30
Book No. PAL 5 TITLE U. S. Gypsum Co.

Page No.

11-10-80
Particulate Test filters

KTS-O-1	116.17914 ✓	0.87252 ✓
#10061	-115.30662 ✓	-0.86778 ✓
	0.87252 ✓	0.00474 ✓
KTS-I-1	139.75182 ✓	22.52308 ✓
#10062	-117.22874 ✓	-0.86460 ✓
	22.52308 ✓	21.65848 ✓
KTS-I-1	141.44552 ✓	26.88130 ✓
#10068	-114.56422 ✓	-0.87440 ✓
	26.88130 ✓	26.00690 ✓
KTS-O-2	121.16731 ✓	0.86423 ✓
#10055	-120.30308 ✓	-0.86606 ✓
	0.86423 ✓	.00000 ✓
KTS-I-2	122.79046 ✓	3.83678 ✓
#10069	-118.95368 ✓	-0.85986 ✓
	3.83678 ✓	2.97692 ✓
KTS-I-2	118.00994 ✓	1.91092 ✓
#10070	-116.09902 ✓	-0.86408 ✓
	1.91092 ✓	1.04684 ✓
KTS-O-3	109.95910 ✓	0.90699 ✓
#10074	-109.05271 ✓	-0.87586 ✓
	0.90699 ✓	0.03113 ✓
KTS-I-3	117.51818 ✓	5.00496 ✓
#10072	-112.51322 ✓	-.86876 ✓
	5.00496 ✓	4.13620 ✓

To Page No.

Witnessed & Understood by me,	Date	Invented by	Date
[signature]	11/17/80	Recorded by	

TITLE U.S. Gypsum Co

Project No. [illegible] CAL-20

Book No. PAL 5

From Page No.

KT5-O-4	117.00990 ✓	1.12166 ✓
#10075	-115.88824 ✓	-.87341 ✓
	1.12166 ✓	0.24825 ✓
KT5-I-4	124.98672 ✓	12.70598 ✓
#10073	-112.28074 ✓	-0.88536 ✓
	12.70598 ✓	11.82062 ✓
KT5-I-4	126.27897 ✓	13.68773 ✓
#10078	-112.59124 ✓	-0.88020 ✓
	13.68773 ✓	12.80753 ✓
KT5-O-5	112.61903 ✓	1.09363 ✓
#10071	-111.52540 ✓	-.86847 ✓
	1.09363 ✓	0.22516 ✓
KT5-I-5	130.58173 ✓	14.59841 ✓
#10067	115.98332 ✓	0.86650 ✓
	14.59841 ✓	13.73191 ✓
KT5-I-5	134.94009 ✓	19.02286 ✓
#10080	115.91723 ✓	.87404 ✓
	19.02286 ✓	18.14882 ✓
KT5-I-6	132.34475 ✓	16.24420 ✓
#10079	116.10055 ✓	.86816 ✓
	16.24420 ✓	15.37604 ✓
KT5-I-6	130.34190 ✓	12.15434 ✓
#10076	118.18756 ✓	0.87496 ✓
	12.15434 ✓	11.27938 ✓
	118.34524 ✓	
KT5-O-6	~~117.32172~~	1.02352 ✓
#10082	117.32172 ✓	.87082 ✓
	1.02352 ✓	0.15270

To Page No.

Witnessed & Understood by me,	Date	Invented by	Date
S. Cha	11/17/[illegible]	D. C. Allison	11-15-90
		Recorded by	

Project No. 1532-F80-00
Book No. PAL-5 TITLE U.S. Magnum Co.

No.

Pentachlorotoluene

BS-0-7	117.62693 ✓	.86239 ✓
#10083	116.76454 ✓	.86173 ✓
	0.86239 ✓	0.00066 ✓
BS-0-8	117.77405 ✓	.88719 ✓
#10081	116.88686 ✓	.87883 ✓
	0.88719 ✓	0.00836 ✓
BS-0-9	100.26190 ✓	0.90247 ✓
#10058	99.35943 ✓	0.87230 ✓
	0.90247 ✓	0.03017 ✓
*KT5-0-3R	114.82954 ✓	0.95916 ✓
#10060	113.87038 ✓	0.87255 ✓
	0.95916 ✓	0.08661 ✓
KT5-0-4R	115.66462 ✓	1.04550 ✓
#10084	114.61912 ✓	0.86472 ✓
	1.04550 ✓	0.18078 ✓

* See note on p. 4/1

To Page No.

ed & Understood by me,	Date	Invented by	Date
	11/17/80	Recorded by	11-15-80

E U. S. Gypsum — Project No. — Book No. PH 5

From Page No. — 11-7-80

Probe Wash

Beaker #	Probe Wash #	(Avg Constant) Initial Wt.	Sample volume mls	FW1	FW2	FW3	(Avg Constant) FINAL wt	wt PW mg	wt%
144	KTS-O-1	110.23792	172	110.47987	110.47769	110.47631 / 110.47680	110.47656	238.64	0.24
116	KTS-I-4	112.47542	274	121.82689	121.82597 / 121.82299	121.82473 / 121.82452	121.82276	9,347.34	9.35
69	KTS-O-2	116.85286	170	116.88054	116.87946	116.87922	116.87934	26.48	0.03
142	KTS-I-2	110.48659	245	122.06637	122.06343	122.06367	122.06355	11576.96	11.58
159	KTS-I-3	115.84674	240	123.12543	123.12140	123.12136	123.12138	7,324.64	7.32
47	KTS-O-3	114.93662	132	114.98505	114.98328 / 114.98339	114.98273 / 114.98338	114.98364	47.02	0.05
73	KTS-O-4	116.66242	250	116.75295	116.75441	116.75326 / 116.75306	116.75316	90.74	0.09
101	KTS-I-4	116.15438	410	123.63354	123.63374	123.63374	123.63374	7,479.36	7.48
140	KTS-O-6	118.09936	256	118.16272	118.16354	118.16312	118.16333	73.97	0.07
143	KTS-I-6	110.45142 (3+5+4 / A4)	494	116.98566	116.98307	116.98299	116.98303	6,531.61	6.53
61	BS-O-7	115.42635	198	115.45269	115.45280		115.45274	26.39	0.03
1	BS-O-8	119.15022	275	119.16620	119.16569	119.16563	119.16566	15.44	0.02
102	BS-O-9	113.42162	250	113.43046	113.43156	113.43109	113.43132	9.70	0.01
96	KTS-O-3R	115.81774	245	115.92597	115.92642		115.92618	108.44	0.12 → 0.1
72	KTS-O-4R	117.33272	245	117.38220	117.38967		117.38938	56.66	0.06
49	KTS-O-5	116.81793	252	116.89194	116.89297	116.89263	116.89280	74.87	0.07
85	KT-5-I-5	114.98806	524	120.62074 → 120.68824	120.62178	120.61834 / 120.61872	120.61853	5,630.47	5.63

To Page No.

Witnessed & Understood by me, S. Cha — Date 11/17/80

Recorded by — Date 11-17-80

APPENDIX G

PROJECT PARTICIPANTS

PROJECT PARTICIPANTS

U.S. GYPSUM COMPANY,
FORT DODGE, IOWA
OCTOBER 27-31, 1980

TRC

Willard A. Wade III	Work Assignment Manager
Leigh A. Gammie	Project Engineer and Crew Chief
Edward A. Astle	Emission Tester
Mark A. Algier	Emission Tester
James E. Canora	Emission Tester
David D. Ethier	Emission Tester
Randall Kauffman	Visible Emissions Observer
Susan M. Reynolds	Data Reduction Technician
Eric A. Pearson	Project Scientist
Ellen Scanlon	Cleanup Technician

RADIAN

Michael Palazzolo	Project Engineer

U.S. GYPSUM COMPANY

Daniel Nootens	Plant Manager

EPA

Dennis P. Holzschuh	Task Manager
King Wu	Field Engineer

APPENDIX H

SCOPE OF WORK

- Work Assignment
- Technical Directives
- Associated Correspondence

WORK ASSIGNMENT

ENVIRONMENTAL PROTECTION AGENCY

Research Triangle Park, N.C. 27711

68-02-3543

CONTRACTOR: TRC Environmental Consultants

ASSIGNMENT NO: 5

ASSIGNMENT CHANGE NO:

TITLE: Method Development and Testing for the Gypsum Industry (5/12)

DATE: 16 OCT 1980

DESCRIPTION

The Contractor shall perform the following work areas for the gypsum industry in accordance with the basic contract scope of work.

- Method Field Evaluation
- Standard Development Field Tests
- Testing Documentation

Received 10/20/80

PROJECT 1532E80

ESED #80/16.

The Task Manager is Dennis Holzschuh, Mail Drop 13, EMB, ESED, OAQPS, Research Triangle Park, North Carolina 27711.

All reports shall be submitted directly to the Task Manager.

ESTIMATE OF	GOVERNMENT ESTIMATE	CONTRACTOR ESTIMATE
LABOR HOURS	1500 hours	
DURATION OF WORK	6 months	
COMPLETION DATE	March 10, 1981	

REQUESTER'S SIGNATURE	ORG CODE	TELEPHONE	DATE
Dennis Holzschuh	ESED/EMB	(919) 541-5243	10/10/80

APPROVALS (as applicable)	SIGNATURE	DATE
BRANCH CHIEF		
DIVISION CHIEF		10/15/80
PROJECT MANAGER		
CONTRACTING OFFICER		10/16/80

CONTRACTOR'S REPRESENTATIVE ACKNOWLEDGMENT

SIGNATURE	TITLE	DATE

EPA Form 1310/3

EMB File # 80/16

EMISSION MEASUREMENT BRANCH

TECHNICAL DIRECTIVE NO. 1

Task Title Wet Gypsum Test Facility Support Date 10/10/80

Contractor TPC

Contract Number 68-02-3543 Work Assignment Number _____

Task Manager Dan Pitchford

Verbal Directions Given to P. Kelly & R. Atkins

Directive: Talked with Richard and Pete about gypsum project and decided to have Leigh Cummings go to Fort Dodge Iowa for pre-survey of U.S. Gypsum plant for emission test. R. Atkins secured the following material from me to help bring Leigh up to date on this project.

1) Pre-survey report done by Weston on the Fort Dodge plant
2) Test Report on Fort Dodge plant
3) Draft Report Gold Bond Products, Wilmington, NC
4) Draft Report Gold Bond Products, Redwood, Calif.
5) Draft Report U.S Gypsum Co, Shieldalloy,

Initial Contact made with Mr Dan Darby of U.S. Gypsum concerning Leigh visit, week of Oct 14. Will confirm this next week after I have talked with Leigh on the phone Tuesday.

cc: Contractor Project Manager
Pete Kelly

Contractor Task Leader
Leigh Cummings

Dan Pitchford
Task Manager, EMB

Section Chief, EMB

EMISSION MEASUREMENT BRANCH

TECHNICAL DIRECTIVE NO. 2

Date 10/22/80

Task Title Method Development & Testing for Gypsum ESED Project No. 80/16

Contractor TRC

Contract Number 68-02-3543 Work Assignment No. 5

Task Manager Dennis P. Holzschuh

Verbal Directions Given to Leigh Cannon

Directive: Request given to Leigh to do source test at U.S. Gypsum Plant, Fort Dodge Iowa the Week of Oct 27-31. Last minute change Mr Craig Wells of EMB will monitor the test in place of Dennis Holzschuh.

cc: Pete Kalika
Contractor Project Manager

Dennis P. Holzschuh
Task Manager, EMB

Leigh Cannon
Contractor Task Leader

Section Chief, EMB

TRC Environmental Consultants, Inc.

125 Silas Deane Highway
Wethersfield CT 06109
(203) 563-1431

WAW

November 26, 1980

Mr. Dennis Holzshuh
U.S. Environmental Protection Agency
Room 730
North Carolina Mutual Building
411 W. Chapel Hill Street
Durham, NC 27701

Re: TRC Project #1532-E80-00
EPA Contract #68-02-3543
Work Assignment #5

Dear Dennis:

I have enclosed three (3) copies of our preliminary results for the #5 Kettle Baghouse Inlet - Batch which completes our preliminary data set for the tests done at U.S. Gypsum, Fort Dodge, Iowa.

As you will note, the isokinetic rate for Test #3 is outside the acceptable limits. This occurred as a result of the moisture content being much higher than we had measured in the first two tests. Mike Palazollo was informed by Leigh Gammie, our field team leader, of our desire to repeat this test since the outlet had to be redone as well for the same reason. He stated that he did not want us to redo the inlet despite the bad isokinetic value. In the draft report we will present the results from this test using the traditional calculation method, as done on the enclosed table, and by the ratio-of-areas technique to offset the anisokinetic bias. You may then choose which way you want us to present the results for this test in the final report.

As we agreed on 24 November our draft report will be sent to you on 12 December 1980.

If you have any questions, please call.

Sincerely,

TRC-Environmental Consultants, Inc.

Willard A. Wade III, P.E.
Work Assignment Manager

WAW/jjs
Enclosures