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Title: Results of a Source Emission Compliance Test at Minn-Dak Farmers Cooperative, Wahpeton, North Dakota

MMT Environmental, Inc.

MMT Environmental, Inc.

November 1983

MMT Environmental, Inc.
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RESULTS OF A SOURCE EMISSION COMPLIANCE TEST AT MINN-DAK FARMERS COOPERATIVE WAHPETON, NORTH DAKOTA OCTOBER, 1983

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Submitted to:

Minn-Dak Farmers Cooperative
Post Office Box 10
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Attention: Mr. John E. Groneman

Prepared by:

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President

Report Number 3531
Project Number 3915

November 1, 1983

RESULTS OF A SOURCE
EMISSION COMPLIANCE TEST AT
MINN-DAK FARMERS COOPERATIVE
WAHPETON, NORTH DAKOTA
OCTOBER, 1983

Report Number 3531
Project Number 3915

1 INTRODUCTION

On October 18, 1983, MMT Environmental, Inc. performed a series of source emission tests at Minn-Dak Farmers Cooperative, Wahpeton, North Dakota. The tests were performed at the request of Mr. John Groneman of Minn-Dak Farmers Cooperative.

The cooperative processes sugar beets. Pressed beet pulp (80% moisture) is dried to less than 10% moisture in a rotary drum dryer. The heat source for the dryer is a spreader stoker, lignite coal fired furnace which can also burn waste gas from an anaerobic waste water treatment plant. The combustion gases come into direct contact with the beet pulp and then pass through an array of 28 cyclones. Prior to entering the discharge stack, a portion of the exhaust gas can be recycled to the furnace and another portion can be removed as a heat source for the flume water heater. A schematic of the process is presented in Figure 1.1.

Three replicate EPA Method 5 particulate and EPA Method 6 sulfur dioxide emission tests were performed simultaneously on the pulp dryer stack and on the flume water heater stack. The results generated by the test program are presented in this report.

The MMT sampling team consisted of Messrs. Alan Trowbridge, Robert Laska and Timothy Puffer. Mr. John Hauges represented Minn-Dak Farmers Cooperative. Messrs. Chuck McDonald and Joe Selnekovic of the North Dakota State Department of Health witnessed the on-site testing.

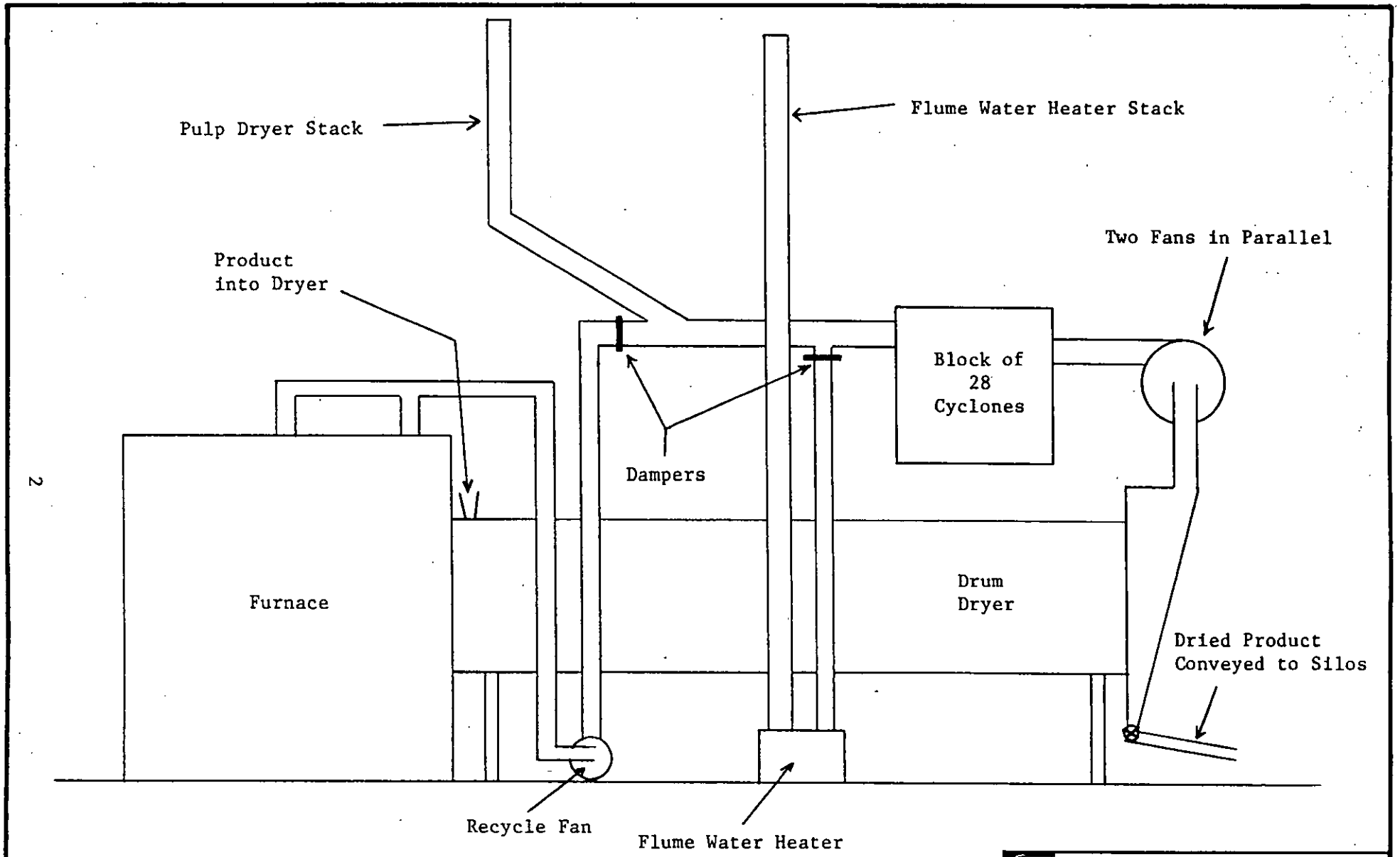


Figure 1.1 Process Schematic

2 TEST RESULTS

The significant results generated by the test program are presented in this section.

2.1 Particulate Emissions

The results of the particulate emission tests are presented in Tables 2.1, 2.2 and 2.3. The data indicates an average total dryer emission rate of 79.56 pounds per hour.

Based on a total process weight rate of 76.1 tons per hour (Table 2.6), North Dakota Air Pollution Control Law 33-15-05 (Table 2.7) states that the particulate emission rate shall not exceed 48.58 pounds per hour. The test data indicates that the dryer emissions as tested are not in compliance with this standard.

2.2 Sulfur Dioxide Emissions

Tables 2.1, 2.4 and 2.5 present the results of the sulfur dioxide emission tests. The data indicates an average total dryer emission rate of 90.40 pounds per hour or 0.72 pounds per million BTU of heat imput.

2.3 Comments

No problems were encountered during the sample acquisition or evaluation. Based on this fact and on a review of the entire data, it is MMT's opinion that the results presented in this report are accurate and can be used for determining the compliance status of the source tested.

Table 2.1 SUMMARY OF TEST RESULTS

Project Number : 3915 Company: Minn-Dak Farmers Cooperative

Parameter	SOURCE		
	Pulp Dryer Stack	Flume Water Heater Stack	The Two Stacks Combined
Effluent volumetric flow rate; SCFM	104174	20219	124393
Particulate Emissions;			
LB/HR	67.57	11.99	79.56
LB/MBTU	0.54	0.10	0.64
Sulfur Dioxide Emissions;			
LB/HR	88.74	1.66	90.40
LB/MBTU	0.71	0.01	0.72

Note: Data for each stack is average of 3 test runs.

Thermal emission factors are based on a heat input rate of 125.5 MBTU/HR.

TABLE 2.2 SUMMARY OF PARTICULATE EMISSION TEST RESULTS

PROJECT NUMBER: 3915 COMPANY: MINN-DAK FARMERS COOPERATIVE
TEST NUMBER: 1 SOURCE: PULP DRYER

TEST PARAMETER	RUN 1	RUN 2	RUN 3
TEST DATE	10/18/83	10/18/83	10/18/83
TIME OF TEST, HR:			
START	1019	1311	1606
FINISH	1157	1441	1741
EFFLUENT TEMPERATURE, DEGREES F	257	241	247
EFFLUENT MOISTURE CONTENT, % V/V	35.1	33.1	34.7
EFFLUENT COMPOSITION, % V/V DRY:			
CARBON DIOXIDE	5.1	5.6	5.3
OXYGEN	15.1	14.6	14.9
EFFLUENT VOLUMETRIC FLOW RATE:			
ACTUAL CONDITIONS, ACFM	148865	140178	140673
STANDARD CONDITIONS, SCFM	106967	103078	102478
DRY STANDARD CONDITIONS, DSCFM	69443	68937	66883
ISOKINETIC VARIATION, %	92.0	93.6	95.0
EFFLUENT PARTICULATE CONCENTRATION:			
ACTUAL CONDITIONS, GR/ACF	0.0625	0.0566	0.0513
STANDARD CONDITIONS, GR/SCF	0.0869	0.0770	0.0704
DRY STANDARD CONDITIONS, GR/DSCF	0.1339	0.1151	0.1078
SOURCE PARTICULATE EMISSION RATE:			
CLASSICAL METHOD, LB/HR	79.76	68.05	61.86
RATIO OF AREAS METHOD, LB/HR	73.31	63.69	58.72

PARTICULATE CONCENTRATION AND EMISSION RATES BASED ON ANALYSIS OF THE SAMPLING TRAIN FRONT CATCH ONLY.

STANDARD CONDITIONS: 68 DEGREES FAHRENHEIT, 29.92 INCHES OF MERCURY.

TABLE 2.3 SUMMARY OF SULFUR DIOXIDE EMISSION TEST RESULTS

PROJECT NUMBER: 3915 COMPANY: MINN-DAK FARMERS COOPERATIVE
TEST NUMBER: 1 SOURCE: PULP DRYER

PARAMETER	RUN 1	RUN 2	RUN 3
SULFUR DIOXIDE CONCENTRATION:			
LB/DSCF	0.00002292	0.00002171	0.00002242
mg/DSCM	367	348	359
PPM	138	131	135
SULFUR DIOXIDE MASS EMISSION RATE:			
CLASSICAL METHOD, LB/HR	95.51	89.78	89.96
RATIO OF AREAS METHOD, LB/HR	87.78	84.01	85.40

TABLE 2.4 SUMMARY OF PARTICULATE EMISSION TEST RESULTS

PROJECT NUMBER: 3915 COMPANY: MINN-DAK FARMERS COOPERATIVE
TEST NUMBER: 2 SOURCE: FLUME WATER HEATER

TEST PARAMETER	RUN 1	RUN 2	RUN 3
TEST DATE	10/18/83	10/18/83	10/18/83
TIME OF TEST, HR:			
START	1018	1311	1605
FINISH	1154	1442	1741
EFFLUENT TEMPERATURE, DEGREES F	118	121	124
EFFLUENT MOISTURE CONTENT, % V/V	11.9	13.9	16.1
EFFLUENT COMPOSITION, % V/V DRY:			
CARBON DIOXIDE	5.1	5.6	5.3
OXYGEN	15.1	14.6	14.9
EFFLUENT VOLUMETRIC FLOW RATE:			
ACTUAL CONDITIONS, ACFM	22809	23424	22050
STANDARD CONDITIONS, SCFM	20363	20809	19484
DRY STANDARD CONDITIONS, DSCFM	17948	17925	16343
ISOKINETIC VARIATION, %	105.1	100.7	105.7
EFFLUENT PARTICULATE CONCENTRATION:			
ACTUAL CONDITIONS, GR/ACF	0.0480	0.1020	0.0297
STANDARD CONDITIONS, GR/SCF	0.0538	0.1148	0.0336
DRY STANDARD CONDITIONS, GR/DSCF	0.0610	0.1333	0.0401
SOURCE PARTICULATE EMISSION RATE:			
CLASSICAL METHOD, LB/HR	9.39	20.49	5.62
RATIO OF AREAS METHOD, LB/HR	9.87	20.62	5.94

PARTICULATE CONCENTRATION AND EMISSION RATES BASED ON ANALYSIS OF THE SAMPLING TRAIN FRONT CATCH ONLY.

STANDARD CONDITIONS: 68 DEGREES FAHRENHEIT, 29.92 INCHES OF MERCURY.

TABLE 2.5 SUMMARY OF SULFUR DIOXIDE EMISSION TEST RESULTS

PROJECT NUMBER: 3915 COMPANY: MINN-DAK FARMERS COOPERATIVE
TEST NUMBER: 2 SOURCE: FLUME WATER HEATER

PARAMETER	RUN 1	RUN 2	RUN 3
SULFUR DIOXIDE CONCENTRATION;			
LB/DSCF	0.00000155	0.00000149	0.0000016
mg/DSCM	25	24	2
PPM	9	9	1
SULFUR DIOXIDE MASS EMISSION RATE;			
CLASSICAL METHOD, LB/HR	1.67	1.60	1.6
RATIO OF AREAS METHOD, LB/HR	1.75	1.61	1.7

Table 2.6 PROCESS DATA*

Test Number	Average Dryer Temperature, °F		Average Product Moisture Content, %		Average Dryer Through-Put, LB/HR	
	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
1	1722	259	81.6	3.6	140000	26722
2	1675	258	82.4	3.6	133714	24413
3	1718	253	81.9	9.7	139625	27987
Average	1705	257	82.0	5.6	137780	26374

Note: Average coal feed rate: 14414 lb/hr (124.0 MBTU/HR)
Average gas feed rate: 3000 cf/hr (1.5 MBTU/HR)
Average furnace heat input rate: 125.5 MBTU/HR
Average process weight rate (beet pulp and coal): 76.1 tons/hr

* Data furnished by Mr. Hohn Hauges of Minn-Dak Farmers Cooperative

TABLE 2.7 NORTH DAKOTA STATE REGULATION

PROJECT NUMBER: 2725 COMPANY: MINN-DAK FARMERS COOPERATIVE

AIR POLLUTION CONTROL LAW 33-15-05

Maximum Allowable Rates of Emission of
Particulate Matter from Industrial Processes

Process Weight Rate	Allowable Emission Rate
tons/hr	lb/hr
0.05	0.551
0.25	1.62
0.50	2.58
2.50	7.58
5.00	12.05
10.00	19.18
25.00	35.43
50.00	44.58
250.00	60.96
500.00	68.96
1000.00	77.59
2500.00	90.06

Interpolation of the data in this table for process weight rates up to 30 tons/hr shall be accomplished by the use of the equation:

$$E = 4.10\ p^{0.67}$$

and interpolation and extrapolation of the data for process weight rates in excess of 30 tons/hr shall be accomplished by the use of the equation:

$$E = 55.0\ p^{0.11} - 40$$

where E = allowable emission rate in lb/hr and p = process weight rate in tons/hr.

3 TEST PROCEDURES

3.1 General

In order to determine the pollutant emission rate from stationary sources, the Environmental Protection Agency (EPA) has established a series of reference methods which specify the manner in which tests must be performed. These reference methods are found in the Code of Federal Regulations under Title 40 - Protection of Environment; Chapter 1 - Environmental Protection Agency; Subchapter C - Air Programs; Part 60 - Standards of Performance for New Stationary Sources; Appendix A - Reference Methods. Unless otherwise noted, the tests presented in this report were performed according to the EPA Reference Methods as revised on July 1, 1982. A brief description of the test procedures used follows.

3.2 Sampling Points

The sampling required for EPA Methods 2 and 5 was performed at numerous points across the duct cross-section. The number of sampling points and their locations within the duct were determined according to EPA Method 1 (see Figures 3.1 through 3.4). The number of points required is based on the distance of undisturbed flow both up and downstream of the sampling location.

3.3 Effluent Flow Rate

The effluent volumetric flow rate was determined per EPA Method 2. The effluent velocity pressure and temperature were measured at numerous points across the duct cross-section using an S-type pitot tube and a chromel-alumel thermocouple. The flow rate measurements were made simultaneously with each particulate concentration test run.

3.4 Effluent Composition (CO_2, O_2)

The carbon dioxide and oxygen content of the effluent was determined per EPA Method 3. One (1) multi-point integrated sample was collected simultaneously with each test run. Analysis of the samples was performed with a standard Orsat analyzer using commercially prepared solutions.

Figure 3.1 Description of Sampling Location

Pulp Dryer Stack

Duct cross-sectional dimensions at the sampling location: 58.6

Equivalent diameter (rectangular duct only): --

Distance from sampling ports to the nearest flow disturbance;

Before sampling ports: 12 ft = 2.46 duct diameters

After sampling ports: 19 ft = 3.89 duct diameters

Number of sampling points;

Required by EPA Method 1: 24

Actually used: 24

Number of ports: 2

Points per port: 12

Sketch of sampling location: Not to Scale

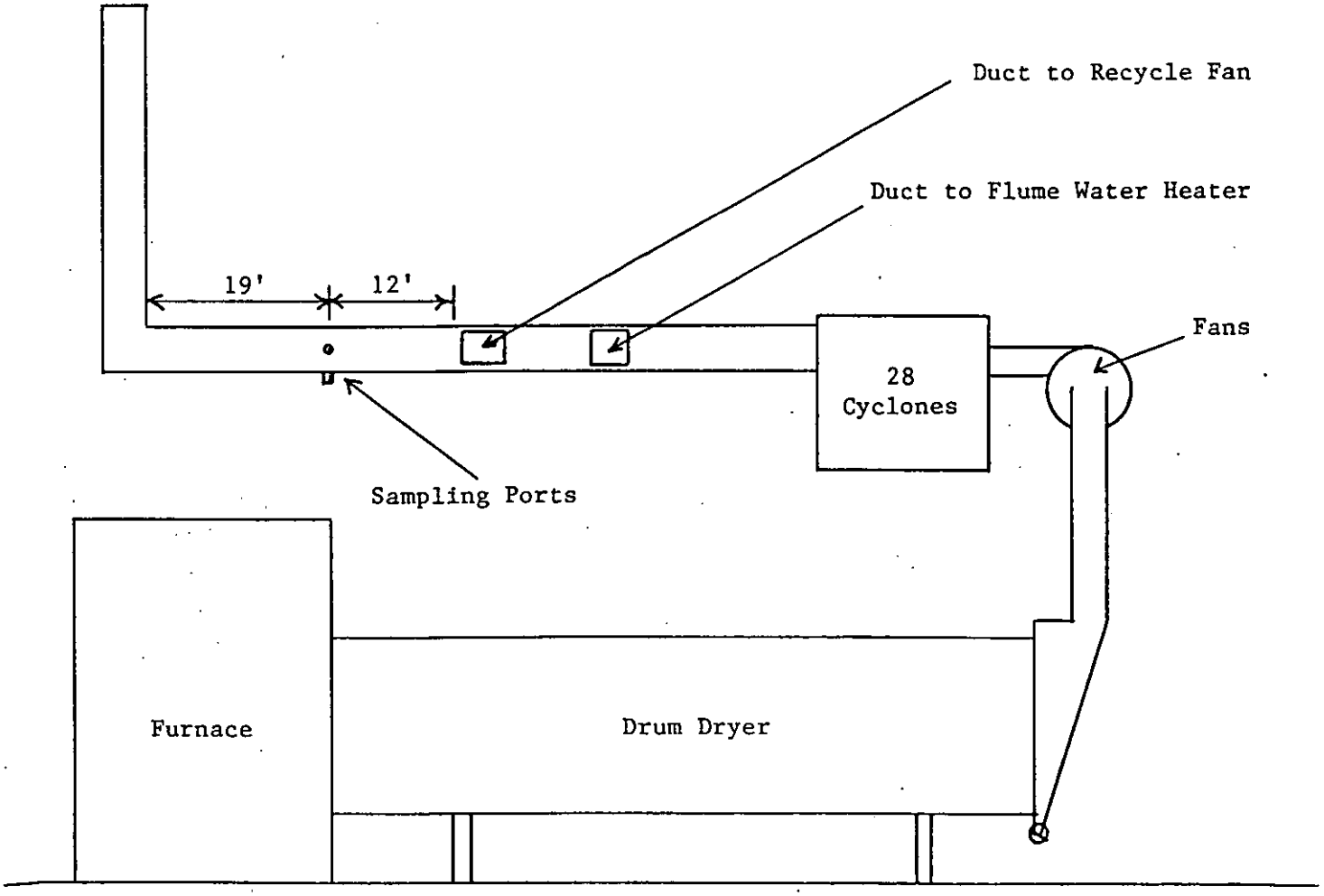
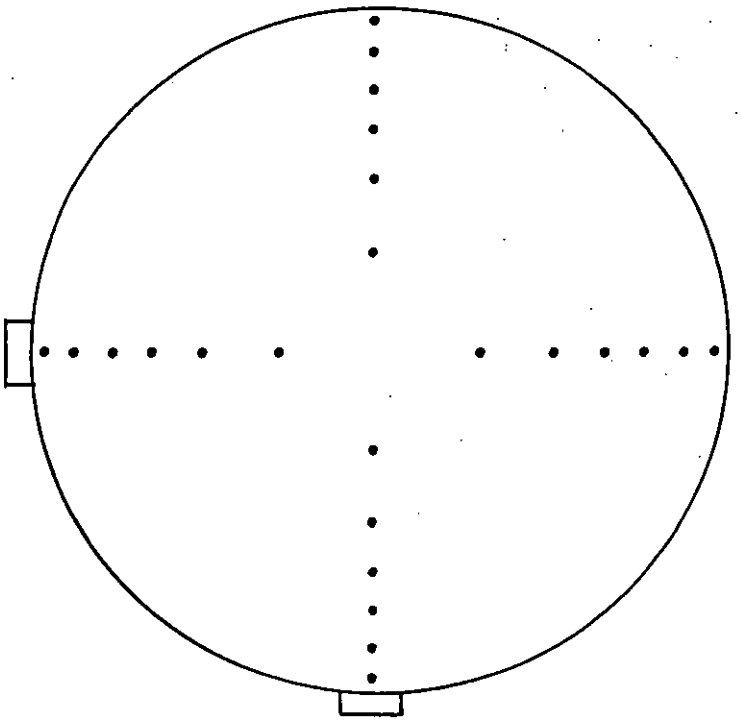


Figure 3.2 Sampling Point Locations Within the Duct

Sketch: Pulp Dryer Stack Not to Scale



Location of sampling points within each port:

Point Number	Distance From Duct Inside Wall (by Port) to the Sampling Point: % of Duct Diameter	Inches	Point Number	Distance From Duct Inside Wall (by Port) to the Sampling Point: % of Duct Diameter	Inches
1	97.9	57.4	13		
2	93.3	54.6	14		
3	88.2	51.6	15		
4	82.3	48.1	16		
5	75.0	43.9	17		
6	64.5	37.7	18		
7	35.5	20.8	19		
8	25.0	14.6	20		
9	17.7	10.4	21		
10	11.8	6.9	22		
11	6.7	3.9	23		
12	2.1	1.2	24		

Figure 3.3 Description of Sampling Location
Flume Water Heater

Duct cross-sectional dimensions at the sampling location: 73.5

Equivalent diameter (rectangular duct only): ---

Distance from sampling ports to the nearest flow disturbance;

Before sampling ports: 20.5 ft = 3.35 duct diameters

After sampling ports: 30 ft = 4.90 duct diameters

Number of sampling points;

Required by EPA Method 1: 24

Actually used: 24

Number of ports: 2

Points per port: 12

Sketch of sampling location: Not to Scale

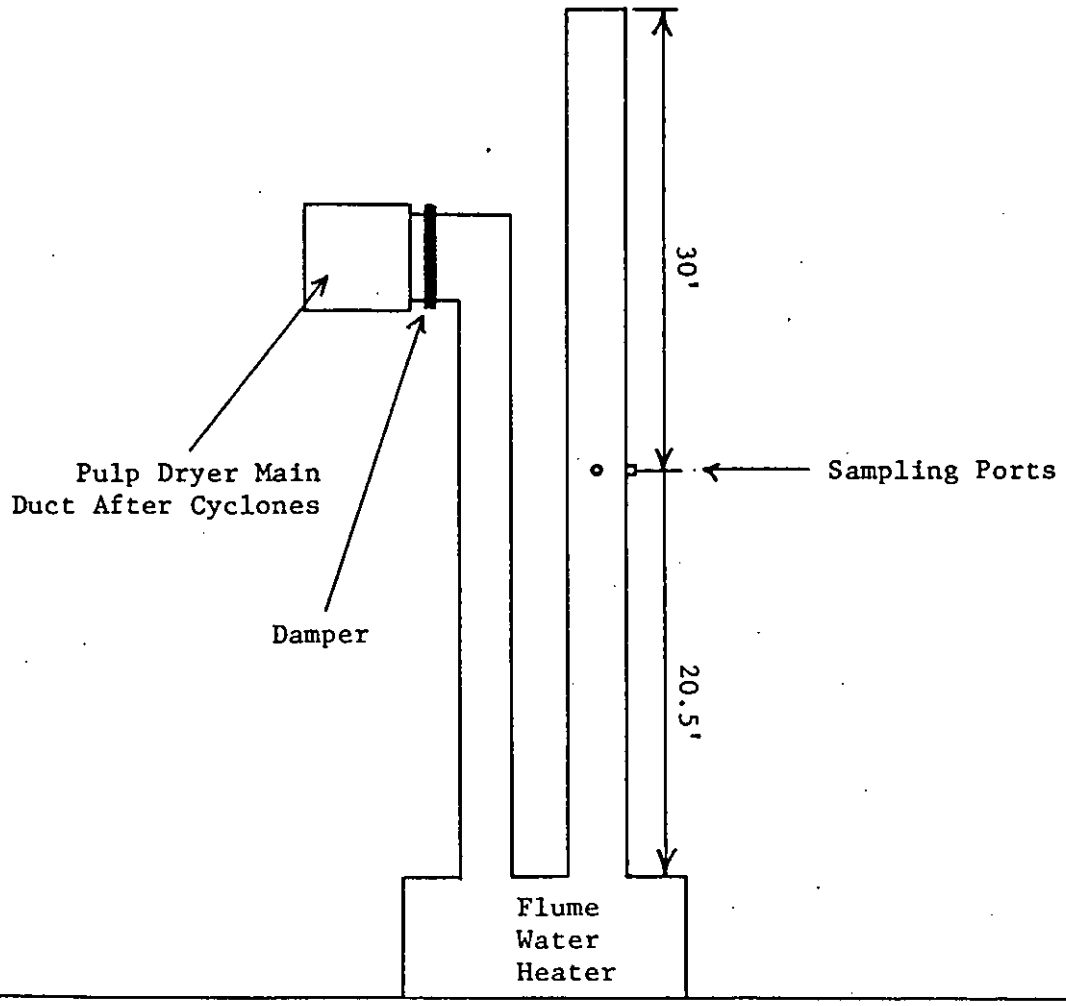
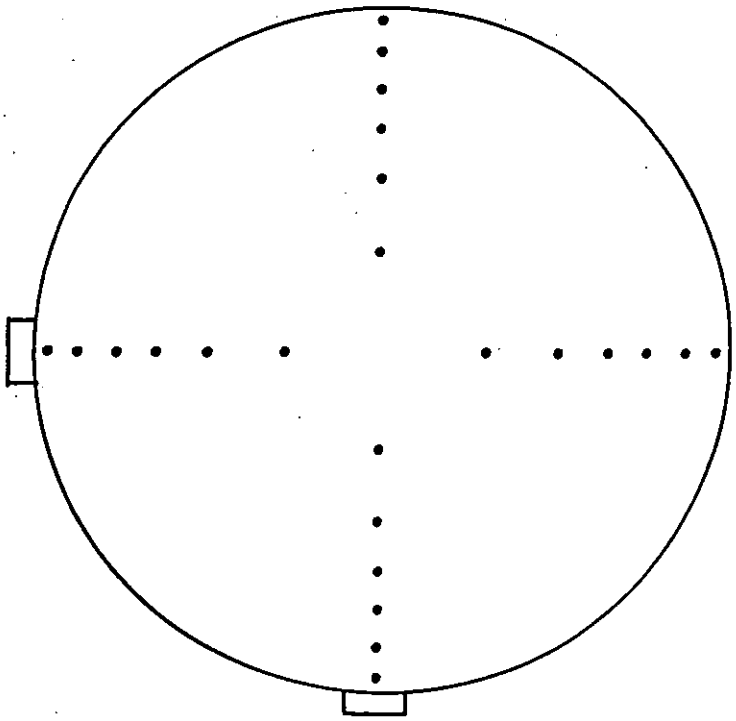


Figure 3.4 Sampling Point Locations Within the Duct

Sketch: Flume Water Heater Stack Not to Scale



Location of sampling points within each port:

Point Number	Distance From Duct Inside Wall (by Port) to the Sampling Point: % of Duct Diameter	Inches	Point Number	Distance From Duct Inside Wall (by Port) to the Sampling Point: % of Duct Diameter	Inches
1	97.9	72.0	13		
2	93.3	68.6	14		
3	88.2	64.8	15		
4	82.3	60.5	16		
5	75.0	55.1	17		
6	64.5	47.4	18		
7	35.5	26.1	19		
8	25.0	18.4	20		
9	17.7	13.0	21		
10	11.8	8.7	22		
11	6.7	4.9	23		
12	2.1	1.5	24		

3.5 Effluent Moisture Content

The effluent moisture content during each test run was determined simultaneously with the particulate concentration determination as per EPA Method 5. The moisture content was calculated from the volume and/or mass of condensed water collected in the cold box impingers and the volume of gas sampled.

3.6 Effluent Particulate and Sulfur Dioxide Concentrations

The particulate and sulfur dioxide (SO_2) concentrations were determined per EPA Method 5 and 6. In the combined procedure, the effluent is isokinetically withdrawn from the source. Particulate matter in the effluent is collected on a glass fiber filter which is maintained at a temperature of 248 $\pm$ 25 degrees Fahrenheit. The particulate mass, which includes any material which condenses at the filtration temperature, is determined gravimetrically after removal of uncombined water. Sulfur dioxide, which passes through the filter, is collected by bubbling the filtered effluent through an absorbing solution. The sulfur dioxide mass is determined by the barium-thorin titration method.

The sampling train (Figures 3.5 and 3.6) consists of a heated sampling probe with attached thermocouple and S-type pitot tube. The probe attaches to the front sample case (hot box) which houses a glass cyclone and an all-glass in-line filter holder in a temperature controlled environment. The back sample case (cold box) houses a series of impingers and a desiccant column in an ice bath. The sample case is connected via an umbilical cord to the control unit which contains the vacuum pump, dry-test meter, calibrated orifice, orifice pressure indicator, velocity pressure indicator, and all operating controls. The thermocouple is connected to a separately housed temperature readout.

Figure 3.5 Particulate Sampling Train

Pulp Dryer Test

Sampling train;

Manufacturer: Research Appliance Company

Model: RAC Staksamplr

Hot box set-up;

Cyclone: 5 micron cut-point

Filter media: Type A/E glass fiber
100 mm effective diameter

Filtration temperature, °F: 248 ± 25

NOTE: Cyclone used to keep water droplets from reaching the filter

Cold box set-up;

Impinger Number	Type*	Contents
1	M	100 ml 3% H_2O_2
2	S	100 ml 3% H_2O_2
3	S	Empty
4	M	Silica Gel Desiccant
5	not used	

* S: Standard Greenburg-Smith design
M: Modified Greenburg-Smith design (straight tip)

Probe: 5 foot with stainless steel liner.

Nozzle: stainless steel, 3/16 inch nominal diameter

Sampling time: 3 minutes per point; 96 minutes per test run.

Sampling train schematic:

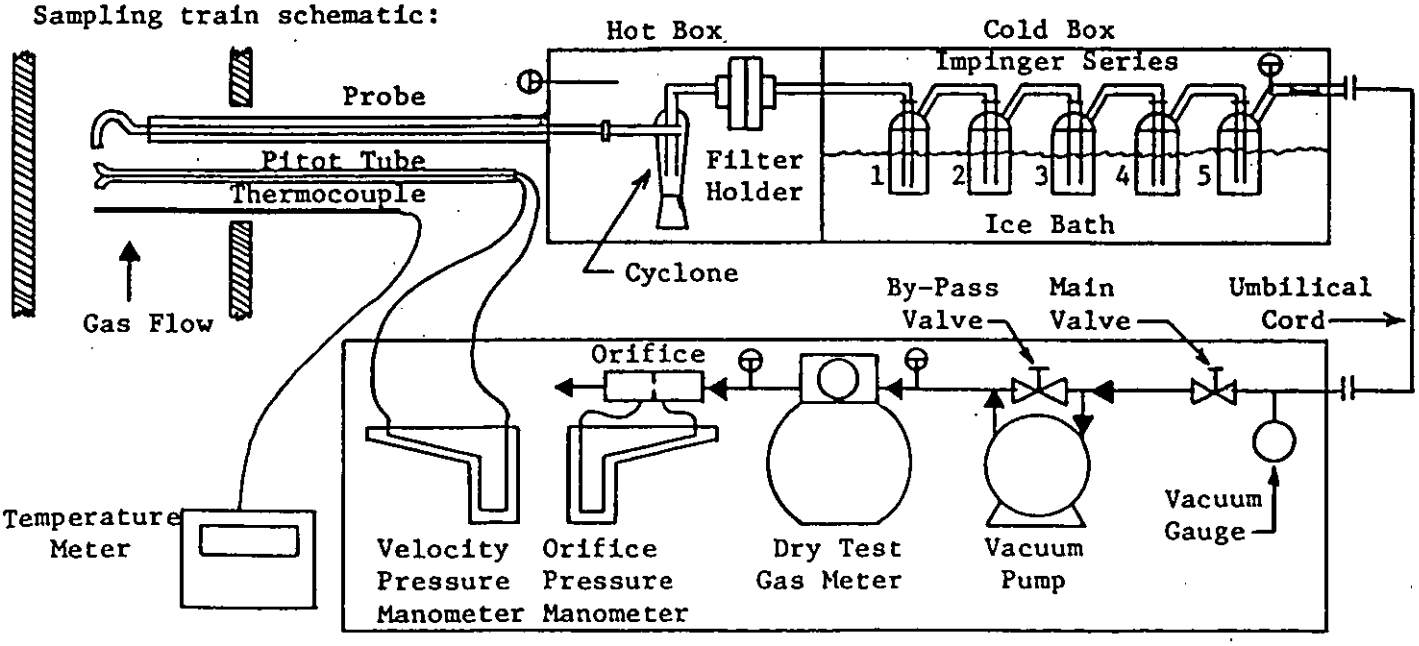


Figure 3.6 Particulate Sampling Train
Flume Water Heater Tests

Sampling train;

Manufacturer: Research Appliance Company

Model: RAC Staksamplr

Hot box set-up;

Cyclone: 5 micron cut-point

Filter media: Type A/E glass fiber
100 mm effective diameter

Filtration temperature, °F: 248 ± 25

NOTE: Cyclone used to keep water droplets from reaching the filter

Cold box set-up;

Impinger Number	Type*	Contents
1	M	100 ml 3% H_2O_2
2	S	100 ml 3% H_2O_2
3	S	Empty
4	M	Silica Gel Desiccant
5	not used	

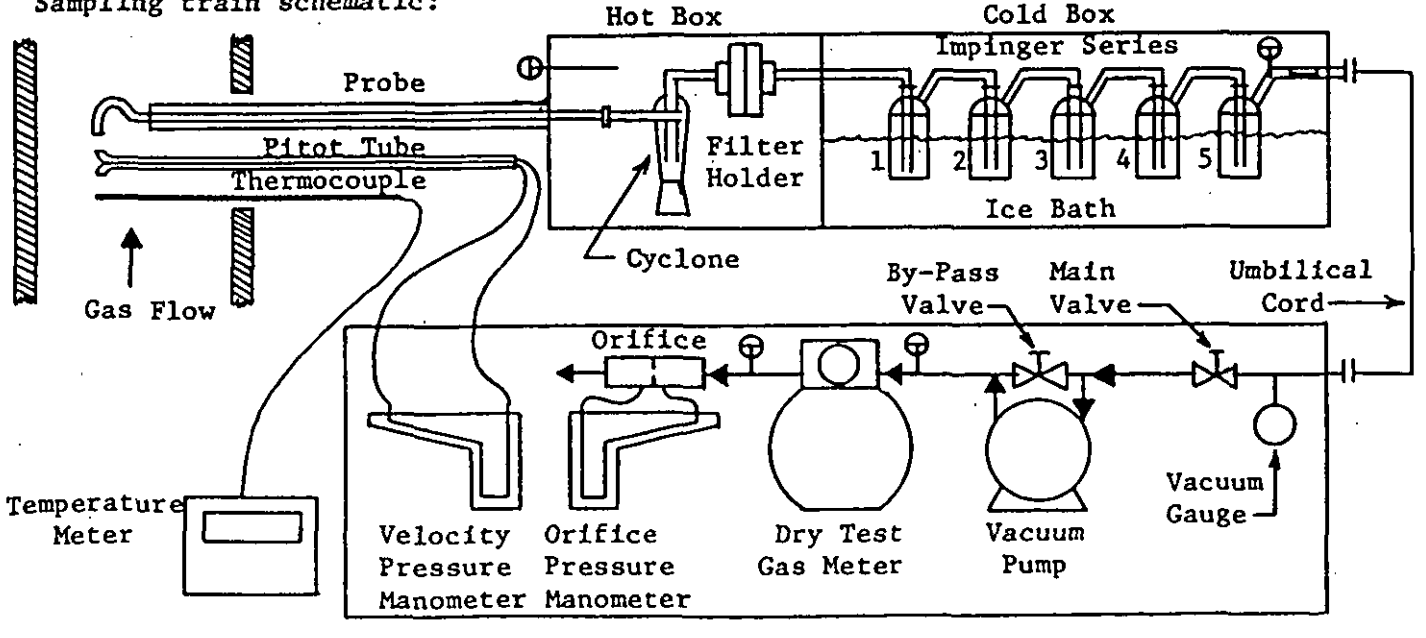
* S: Standard Greenburg-Smith design
M: Modified Greenburg-Smith design (straight tip)

Probe: 8 foot with stainless steel liner.

Nozzle: stainless steel, 3/8 inch nominal diameter

Sampling time: 2.5 minutes per point; 60 minutes for Run #1.
3.0 minutes per point; 72 minutes for Run #2 and #3.

Sampling train schematic:



A representative particulate sample was acquired by sampling for equal periods of time at the center of a number of equal area regions in the duct. At each sampling point, the gas velocity head and temperature were measured and the sampling rate rapidly adjusted to isokinetic conditions with the aid of a nomograph. Sample gas drawn into the nozzle flowed through the probe to the cyclone and glass fiber filter where the particulates were collected. The gases then passed through the ice-cooled condenser (impingers and desiccant column) which quantitatively sorbed all moisture from the gas stream. The gas then passed through the vacuum pump, the dry-test meter, and the calibrated orifice.

Leak checks to detect any dilution air being pulled into the sampling line were performed at the beginning and end of each test run and also when and if any sample line connections were broken.

After completion of each test run, the sampling train was removed to the clean-up area for sample recovery. The filter was removed from the filter holder and placed in Container #1. Particulate matter collected in the nozzle, probe, cyclone, and all connecting glassware in front of the filter was quantitatively transferred to Container #2 by means of a distilled water wash followed by an acetone wash. A stiff brush was used in the probe cleaning step to help dislodge deposits. The volume of liquid in each of the impingers (desiccant column excluded) was measured and quantitatively transferred to Container #3. These impingers and all the connecting glassware between the filter and the desiccant column were then rinsed with distilled water and the rinsings were added to Container #3. The desiccant column was then weighed and its contents transferred to a waste desiccant container.

Sample analysis was performed at MMT's laboratory. The filter was dried in a 105°C oven for 3 hours and then desiccated to constant weight. The contents of Container #2 (front wash) were transferred to a tared beaker, evaporated without heat to near dryness and desiccated to a constant weight. The total mass of particulate matter collected during the test run was the sum of the filter catch plus the front wash catch. The contents of Container #3 were made up to volume and an aliquot titrated using the barium-thorin method.