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Background Report Reference

AP-42 Section Number: 10.6.1

Background Report Section: 2

Reference Number: 11

Title: Stationary Source Sampling
Report Reference No. 6041A
Weyerhaeuser Company,
Moncure, NC

Entropy Environmentalists, Inc.

October 1988

Harden (1988)



State of North Carolina
Department of Environment, Health, and Natural Resources
Division of Environmental Management
512 North Salisbury Street • Raleigh, North Carolina 27611

James G. Martin, Governor
William W. Cobey, Jr., Secretary

AIR QUALITY SECTION

George T. Everett, Ph.D.
Director

November 13, 1990

Mr. Bob Blaszcak
Control Technology Center
MD-13
U.S. Environmental Protection Agency
Research Triangle Park, North Carolina 27711

Subject: Waferboard Plant Study Data
Weyerhaeuser Company and Georgia Pacific Corporation
Stationary Source Test Reports

Dear Mr. Blaszcak:

Enclosed are copies of reports of stationary source tests performed at Weyerhaeuser Paper Company and Georgia Pacific Corporation facilities in North Carolina.

If you have any questions or need assistance, please do not hesitate to call me at (919)733-3340.

Sincerely,

A handwritten signature in cursive script that reads "Shannon M. Vogel".

Shannon M. Vogel

Enclosure

Pollution Prevention Pays

P.O. Box 27687, Raleigh, North Carolina 27611-7687 Telephone 919-733-7015

An Equal Opportunity Affirmative Action Employer

AIR QUALITY SECTION

November 13, 1990

Mr. Bob Blaszcak
Control Technology Center
MD-13

U.S. Environmental Protection Agency
Research Triangle Park, North Carolina 27711

Subject: W. F. Howard Plant Study Data
Vandalia Paper Company and Georgia Pacific Corporation
Stationary Source Test Reports

Dear Mr. Blaszcak:

Enclosed for you are copies of reports of stationary source tests performed at
Vandalia Paper Company and Georgia Pacific Corporation facilities in North
Carolina.

If you have any questions or need assistance, please do not hesitate to
call me at (919) 733-1212.

Sincerely,

Steven H. Vogel

ENTROPY

ENVIRONMENTALISTS INC.

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RESEARCH TRIANGLE PARK
NORTH CAROLINA 27709-2291
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JUL 13 1989
RALEIGH REGIONAL OFFICE

STATIONARY SOURCE SAMPLING REPORT REFERENCE NO. 6041A

WEYERHAEUSER COMPANY
MONCURE, NORTH CAROLINA

PARTICULATE EMISSIONS AND PLUME OPACITY TESTING

SURFACE LINE ELECTRIFIED
FILTER BED INLET AND STACK

Performed For: Carl Schenck, AG

OCTOBER 20, 1988

RECEIVED
JUL 18 1989

AIR QUALITY TECH SERVICES

REPORT CERTIFICATION

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

Date November 8, 1988

Signature Neill M. Harden

Neill M. Harden

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

Date November 8, 1988

Signature D. James Grove

D. James Grove, P.E.

ENTROPY

TABLE OF CONTENTS

	<u>PAGE</u>
INTRODUCTION	
1.1 Outline of Test Program	1-1
1.2 Test Participants	1-1
SUMMARY OF RESULTS	
2.1 Presentation	2-1
2.2 Guarantee Allowable Emissions	2-1
PROCESS DESCRIPTION AND OPERATION	
3.1 General	3-1
3.2 Source Air Flow	3-1
3.3 Operation During Testing	3-1
SAMPLING AND ANALYTICAL PROCEDURES	
4.1 General	4-1
4.2 Sampling Points	4-1
4.3 Volumetric Air Flow Rates	4-1
4.3.1 Flue Gas Velocity	4-1
4.3.2 Flue Gas Composition	4-1
4.3.3 Flue Gas Moisture	4-1
4.4 Emissions Determinations	4-1
4.4.1 Filterable	4-1
4.4.2 Condensable	4-4
4.5 Plume Opacity	4-4
4.6 Equipment Calibration	4-4
APPENDICES	
A. Test Results	
1. EFB Inlet Particulate	1
2. Stack Particulate	4
3. Plume Opacity	7
4. Example Calculations	17
B. Field and Analytical Data	
1. EFB Inlet Particulate	21
2. Stack Particulate	30
3. Plume Opacity	40
C. Calibration Data	45
D. Sampling and Analytical Procedures	63

INTRODUCTION

1.1 Outline of Test Program. Stationary source sampling was performed for Carl Schenck, AG at Weyerhaeuser Company in Moncure, North Carolina, on October 20, 1988. Three sets of concurrent EPA Method 5 runs were performed at the surface line electrified filter bed (EFB) inlet and stack to determine the particulate emissions. The particulate emissions results were used to determine the EFB/baghouse capture efficiencies. Along with the Method 5 testing, concurrent EPA Method 9 testing was performed at the stack to determine the plume opacity. The testing was conducted for compliance and guarantee purposes.

1.2 Test Participants. Table 1-1 lists the personnel present during the test program.

TABLE 1-1
TEST PARTICIPANTS

Carl Schenck, AG	Fritz Bossler Test Coordinator
Laboratorium Himmelheber GmbH & Co., KG	Gerhard C. Trutter, Dipl. Ing. FH Test Coordinator
Schenkman & Piel GmbH & Co., KG	Alfred H. Schenkman Test Observer
Clarke's Sheet Metal, Inc.	Bill Firneisz Test Observer
North Carolina Department of Natural Resources and Community Development	David Y. Daniel Test Observer
Entropy Environmentalists, Inc.	Neill M. Harden Project Manager
	Barry F. Rudd Sampling Team Leader
	W. Todd Langdon Sampling Team Leader
	Dennis D. Holzschuh Engineering Technician
	Leslie C. Murray Engineering Technician
	Keith R. Hazel Plume Opacity Observer

SUMMARY OF RESULTS

2.1 Presentation. Table 2-1 presents test results and EFB/baghouse capture efficiencies for the testing performed October 20, 1988, at the surface line EFB inlet and stack. Run-by-run summaries for the EFB inlet and stack particulate tests are presented in Tables 2-2 and 2-3, respectively. The plume opacity summary is presented in Table 2-4. Detailed test results are presented in Appendix A; field and analytical data are given in Appendix B.

2.2 Guarantee Allowable Emissions. The allowable filterable particulate concentration is 0.065 and 0.004 grains per actual cubic foot (Gr/ACF) for the EFB inlet and stack, respectively. The allowable plume opacity is 20%.

TABLE 2-1
TEST RESULTS AND EFB/BAGHOUSE CAPTURE EFFICIENCIES
Surface Line EFB Inlet and Stack

	Test Set			Average
	1	2	3	
<u>EFB Inlet</u>				
Concentration, Gr/ACF				
Filterable	0.0398	0.0371	0.0289	0.0353
Filterable + Condensable	0.0576	0.0537	0.0463	0.0525
Emission Rate, lb/hr				
Filterable	21.7	20.4	15.4	19.2
Filterable + Condensable	31.3	29.5	24.7	28.5
<u>Stack</u>				
Concentration, Gr/ACF				
Filterable	0.00279	0.00254	0.00142	0.00225
Filterable + Condensable	0.0161	0.0120	0.0123	0.0135
Emission Rate, lb/hr				
Filterable	1.52	1.40	0.775	1.23
Filterable + Condensable	8.77	6.59	6.71	7.36
Plume Opacity				
Highest 6-min. Average, %	7	1	5	
Highest Single Reading, %	10	5	15	
EFB/Baghouse Capture Efficiency, %*	93.00	93.14	94.97	93.70

* Capture efficiency (CE) calculated as follows:

$$CE = \frac{\text{Inlet Emission} - \text{Stack Emission}}{\text{Inlet Emission}} \cdot 100$$

$$CE = \frac{21.7 - 1.52}{21.7} \cdot 100 = 93.00 \%$$

Note: Capture efficiencies calculated using filterable emission rates.

TABLE 2-2

PARTICULATE TESTS SUMMARY

Surface Line EFB Inlet

	M5-SL-I-1	M5-SL-I-2	M5-SL-I-3
	-----	-----	-----
Test Date	10/20/88	10/20/88	10/20/88
Run Start Time	1115	1304	1440
Run Finish Time	1223	1410	1547
<u>Test Train Parameters</u>			
Volume of Dry Gas Sampled, SCF*	30.682	30.844	30.365
Percent Isokinetic	97.4	97.0	97.1
<u>Flue Gas Parameters</u>			
Temperature, Degrees F	232	233	233
Volumetric Air Flow Rates			
SCFM*, Dry	40,938	41,323	40,652
ACFM*, Wet	63,397	64,010	62,096
<u>Particulate Results</u>			
Filterable			
Catch Weight, mg	122.7	115.0	86.7
Concentration, Gr/DSCF*	0.0617	0.0575	0.0441
Concentration, Gr/ACF	0.0398	0.0371	0.0289
Emission Rate, lb/hr	21.7	20.4	15.4
Filterable + Condensable			
Catch Weight, mg	177.4	166.2	139.4
Concentration, Gr/DSCF*	0.0892	0.0832	0.0708
Concentration, Gr/ACF	0.0576	0.0537	0.0463
Emission Rate, lb/hr	31.3	29.5	24.7

* 68 Degrees F -- 29.92 Inches of Mercury (Hg)

TABLE 2-3

PARTICULATE TESTS SUMMARY

Surface Line Stack

	M5-SL-O-1	M5-SL-O-2	M5-SL-O-3
	-----	-----	-----
Test Date	10/20/88	10/20/88	10/20/88
Run Start Time	1116	1305	1440
Run Finish Time	1219	1406	1545
<u>Test Train Parameters</u>			
Volume of Dry Gas Sampled, SCF*	30.180	54.742	54.057
Percent Isokinetic	108.4	98.9	94.9
<u>Flue Gas Parameters</u>			
Temperature, Degrees F	215	222	221
Volumetric Air Flow Rates			
SCFM*, Dry	41,913	42,260	43,482
ACFM*, Wet	63,590	64,199	63,731
<u>Particulate Results</u>			
Filterable			
Catch Weight, mg	8.3	13.7	7.3
Concentration, Gr/DSCF*	0.00424	0.00386	0.00208
Concentration, Gr/ACF	0.00279	0.00254	0.00142
Emission Rate, lb/hr	1.52	1.40	0.775
Filterable + Condensable			
Catch Weight, mg	47.7	64.7	63.1
Concentration, Gr/DSCF*	0.0244	0.0182	0.0180
Concentration, Gr/ACF	0.0161	0.0120	0.0123
Emission Rate, lb/hr	8.77	6.59	6.71

* 68 Degrees F -- 29.92 Inches of Mercury (Hg)

TABLE 2-4
SIX-MINUTE AVERAGE PLUME OPACITY OBSERVATIONS SUMMARY
Surface Line Stack

Run Number	<u>M9-SL-0-1</u>	<u>M9-SL-0-2</u>	<u>M9-SL-0-3</u>
Highest 6-Minute Average Opacity, %	7	1	5
Highest Single Opacity Reading, %	10	5	15

----- Run M9-SL-0-1 -----

Set	Time		Avg. %
<u>No.</u>	<u>Start</u>	<u>End</u>	<u>Opacity</u>
1	1133	1139	0
2	1139	1145	1
3	1145	1151	1
4	1151	1157	D
5	1157	1203	7
6	1203	1209	4
7	1209	1215	4
8	1215	1221	4
9	1221	1227	4
10	1227	1233	2

----- Run M9-SL-0-2 -----

Set	Time		Avg. %
<u>No.</u>	<u>Start</u>	<u>End</u>	<u>Opacity</u>
1	1306	1312	1
2	1312	1318	0
3	1318	1324	0
4	1324	1330	0
5	1330	1336	0
6	1336	1342	0
7	1342	1348	0
8	1348	1354	0
9	1354	1400	0
10	1400	1406	0

----- Run M9-SL-0-3 -----

Set	Time		Avg. %
<u>No.</u>	<u>Start</u>	<u>End</u>	<u>Opacity</u>
1	1442	1448	0
2	1448	1554	0
3	1554	1600	P
4	1600	1606	P
5	1606	1612	0
6	1612	1618	0
7	1618	1624	5
8	1624	1630	P
9	1630	1636	P
10	1636	1642	3

D = Interference from dust cloud emitted from device at base of stack.

P = Interference from plume emitted from other stack.

PROCESS DESCRIPTION AND OPERATION

3.1 General. Weyerhaeuser Company in Moncure, North Carolina operates surface line and core line sander dust burners for drying wood chips. For this program, the surface line was tested.

The primary fuel for the surface line burner is 100% sander dust. Potential emissions include the products of complete and incomplete combustion of the fuel and any extraneous materials present. The emissions are controlled by four cyclones, an electrified filter bed, and a baghouse.

3.2 Source Air Flow. Figure 3-1 is an air flow schematic showing the passage of the flue gases through the surface line.

3.3 Operation During Testing. The method for determining the system feed rate is accomplished by measuring the dryer conveyor belt speed. According to Weyerhaeuser Company, the surface line was operated at an average setting of 80% during testing, which is the maximum capacity setting. The maximum load is 17,000 pounds per hour. Thus, the feed rate during testing is calculated as follows:

$$(0.80 / 0.80) * 17,000 = 17,000 \text{ pounds per hour}$$

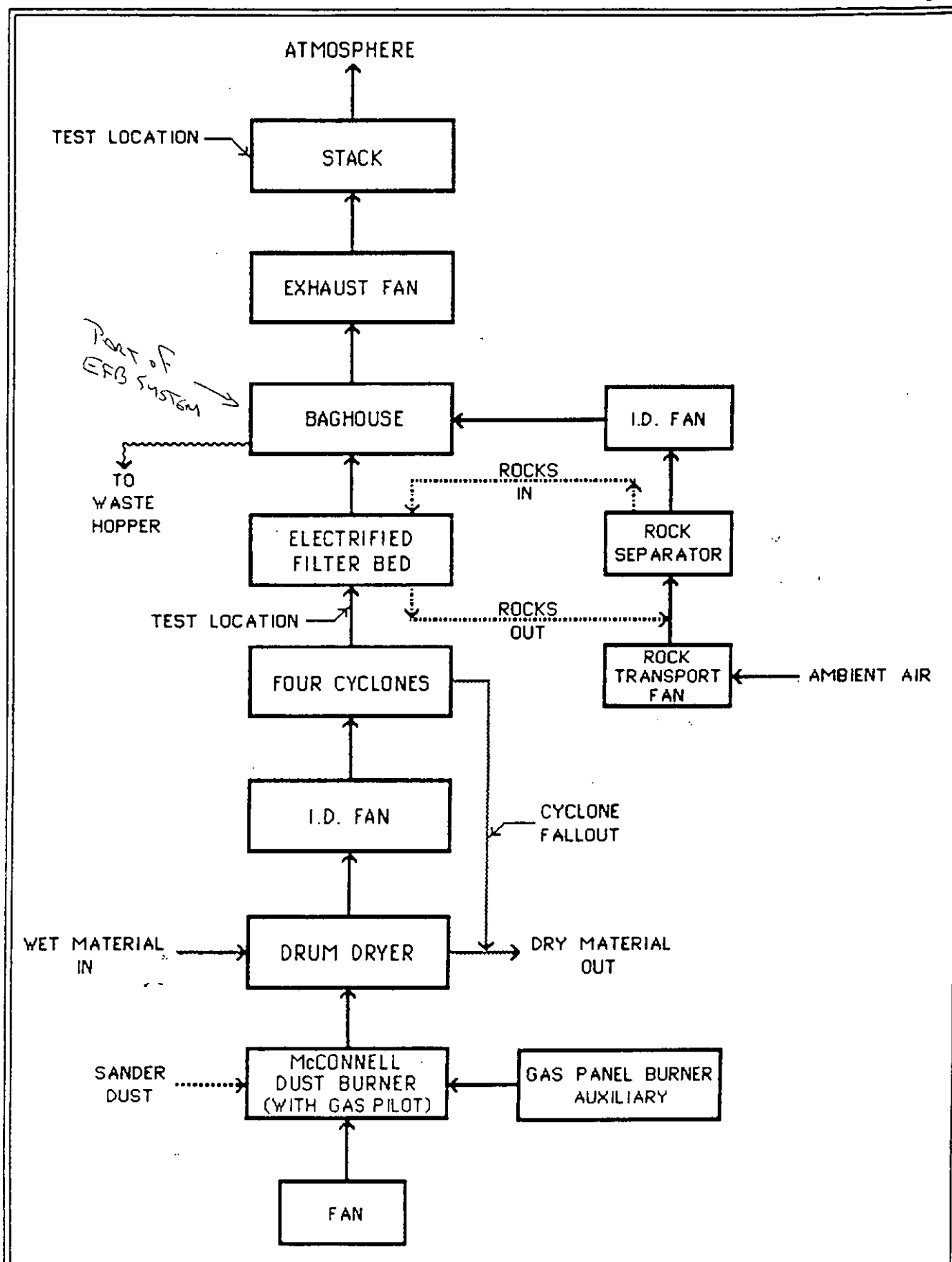


FIGURE 3-1. SURFACE LINE PROCESS/AIR FLOW SCHEMATIC.

SAMPLING AND ANALYTICAL PROCEDURES

4.1 General. All sampling and analytical procedures were those recommended by the United States Environmental Protection Agency and the North Carolina Department of Natural Resources and Community Development. Descriptions of the sampling equipment and procedures (extracted from 40 CFR 60) are provided in Appendix D.

4.2 Sampling Points. The number and location of the sampling points were determined according to EPA Method 1. The EFB inlet cross section was divided into 24 equal areas with 12 sampling points on each of two traverse axes, as shown in Figure 4-1. The stack cross section was divided into 12 equal areas with six sampling points on each of two traverse axes, as shown in Figure 4-2.

4.3 Volumetric Air Flow Rates

4.3.1 Flue Gas Velocity. EPA Method 2 was used to take the velocity measurements during the traverses of the EFB inlet and stack cross sections.

4.3.2 Flue Gas Composition. Multipoint, integrated flue gas samples were collected at the stack and analyzed using EPA Method 3 to determine the flue gas composition and molecular weight for each run. The results were also used for the EFB inlet.

4.3.3 Flue Gas Moisture. Moisture content was determined by analyzing the sampling train impinger reagents according to the procedures outlined in EPA Method 5.

4.4 Emissions Determinations. EPA Method 5 sampling procedures were used to determine the particulate emissions. At the EFB inlet, each of the 24 points was sampled for 2.5 minutes, resulting in a net run time of 60 minutes. At the stack, each of the 12 points was sampled for five minutes, also resulting in a net run time of 60 minutes.

4.4.1 Filterable. EPA Method 5 analytical procedures were used to analyze the filterable particulate.

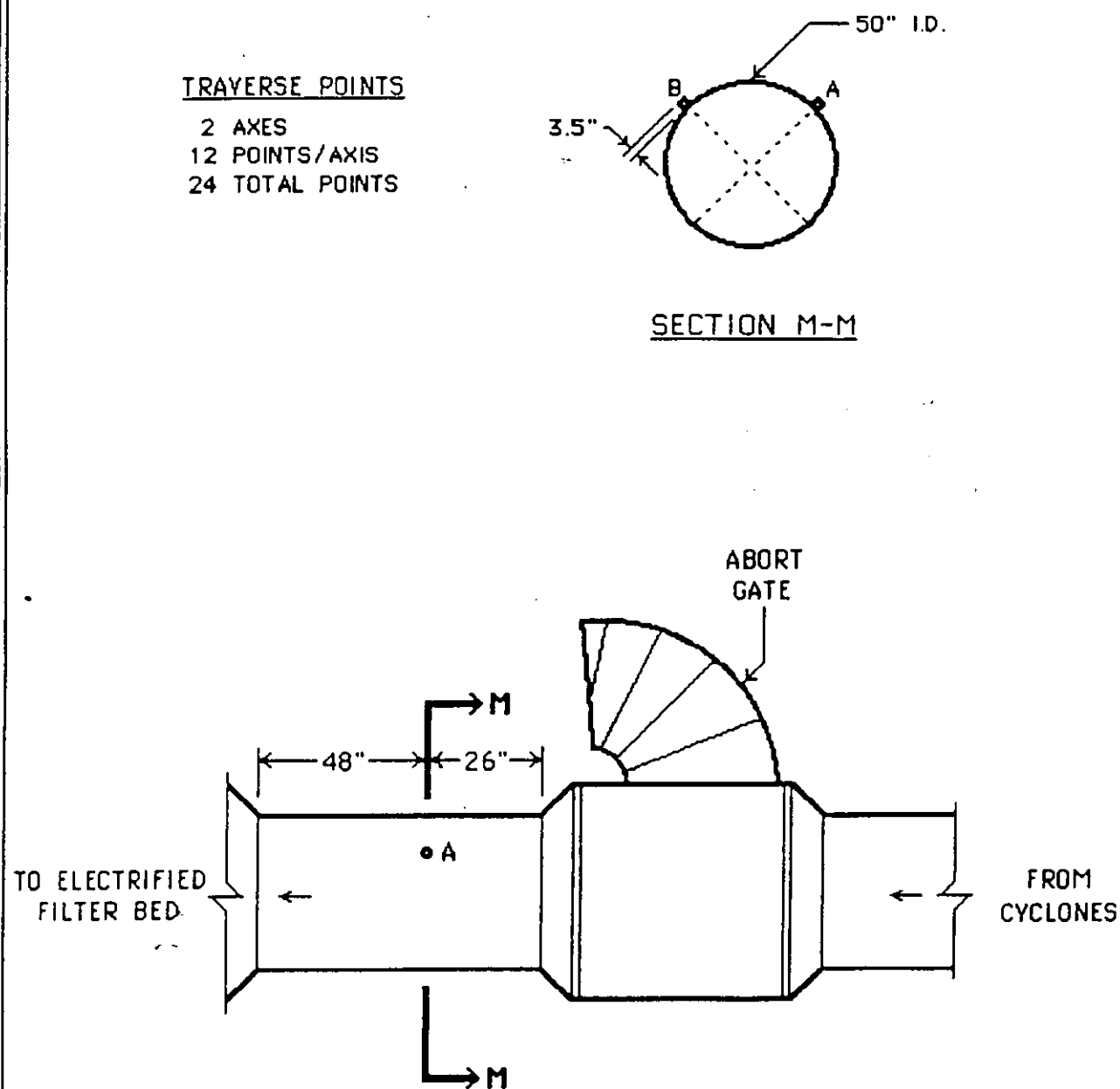


FIGURE 4-1. SURFACE LINE ELECTRIFIED FILTER BED INLET TEST LOCATION.

TRAVERSE POINTS

2 AXES
6 POINTS/AXIS
12 TOTAL POINTS

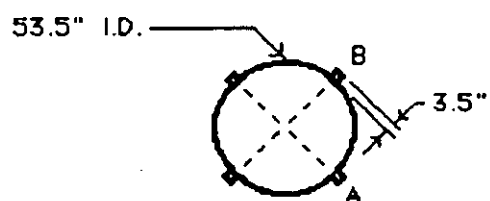
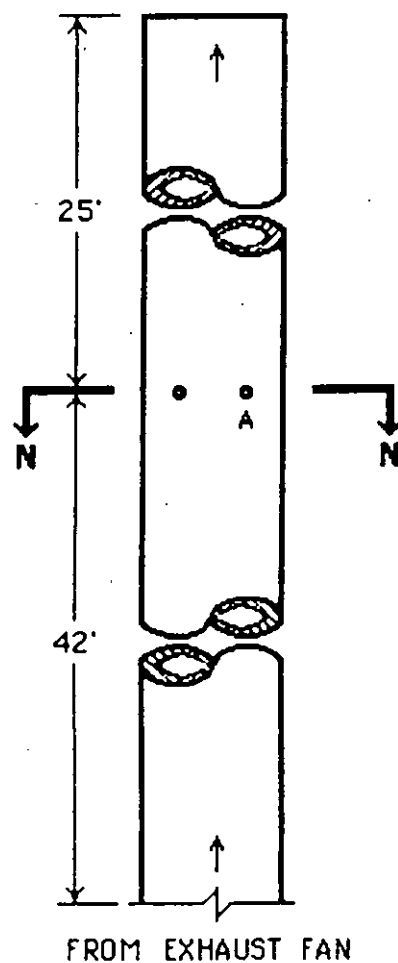
SECTION N-N

FIGURE 4-2. SURFACE LINE STACK TEST LOCATION.

4.4.2 Condensable. The sampling train distilled water reagent and acetone rinses were analyzed to determine the condensable particulate emissions. For each run, the impingers' water was extracted three times with chloroform and then extracted three times with ether. The acetone rinses and the pooled chloroform and ether phases were evaporated to dryness at room temperature and desiccated. After extraction, the water phase was evaporated to dryness on a steam bath and desiccated. Following desiccation, a gravimetric analysis was performed on each phase to determine the weight of the residue.

4.5 Plume Opacity. The procedures outlined in EPA Method 9 were followed in determining the plume opacity.

4.6 Equipment Calibration. Pertinent calibration data are provided in Appendix C.

A. TEST RESULTS

1. EFB Inlet Particulate

FIELD DATA AND RESULTS TABULATION

2

PLANT: Weyerhaeuser Company, Moncure, North Carolina

SAMPLING LOCATION: Surface Line EFB Inlet

		M5-SL-I-1	M5-SL-I-2	M5-SL-I-3
		10/20/88	10/20/88	10/20/88
	Test Date			
	Run Start Time	1115	1304	1440
	Run Finish Time	1223	1410	1547
	Net Traversing Points	24	24	24
Theta	Net Run Time, Minutes	60	60	60
Dia	Nozzle Diameter, Inches	0.179	0.179	0.179
Cp	Pitot Tube Coefficient	0.84	0.84	0.84
Y	Dry Gas Meter Calibration Factor	0.9993	0.9993	0.9993
Pbar	Barometric Pressure, Inches Hg	29.7	29.7	29.7
Delta-H	Avg. Pressure Differential of Orifice Meter, Inches H2O	0.928	0.944	0.897
Vm	Volume Of Metered Gas Sample, Dry ACF	30.755	31.328	30.729
tm	Dry Gas Meter Temperature, Degrees F	66	73	71
Vm(std)	Volume Of Metered Gas Sample, Dry SCF*	30.682	30.844	30.365
Vlc	Total Volume of Liquid Collected in Impingers & Silica Gel, ml	115.0	115.0	102.5
Vw(std)	Volume of Water Vapor, SCF*	5.413	5.413	4.825
%H2O	Moisture Content, Percent by Volume	15.0	14.9	13.7
Mfd	Dry Mole Fraction	0.850	0.851	0.863
%CO2	Carbon Dioxide, Percent By Volume, Dry	2.1	2.2	2.1
%O2	Oxygen, Percent By Volume, Dry	18.5	18.4	18.5
%CO+N2	CO + N2, Percent By Volume, Dry	79.4	79.4	79.4
Md	Gas Molecular Weight, Lb/Lb-Mole, Dry	29.08	29.09	29.08
Ms	Gas Molecular Weight, Lb/Lb-Mole, Wet	27.42	27.44	27.56
Pg	Flue Gas Static Pressure, Inches H2O	1.20	1.25	1.25
Ps	Absolute Flue Gas Pressure, Inches Hg.	29.79	29.79	29.79
ts	Flue Gas Temperature, Degrees F	232	233	233
Delta-p	Average Velocity Head, Inches H2O	1.375	1.401	1.324
vs	Flue Gas Velocity, Feet/Second	77.51	78.26	75.92
A	Stack/Duct Area, Square Inches	1,963	1,963	1,963
Qsd	Volumetric Air Flow Rate, Dry SCFM*	40,938	41,323	40,652
Qaw	Volumetric Air Flow Rate, Wet ACFM	63,397	64,010	62,096
%I	Isokinetic Sampling Rate, Percent	97.4	97.0	97.1

* 68 Degrees F -- 29.92 Inches of Mercury (Hg)

(Continued next page)

PLANT: Weyerhaeuser Company, Moncure, North Carolina

SAMPLING LOCATION: Surface Line EFB Inlet

		<u>M5-SL-I-1</u>	<u>M5-SL-I-2</u>	<u>M5-SL-I-3</u>
<u>Filterable Particulate Results</u>				
mg	Catch Weight, Milligrams	122.7	115.0	86.7
Gr/DSCF	Concentration, Grains/DSCF*	0.0617	0.0575	0.0441
Gr/ACF	Concentration, Grains/ACF	0.0398	0.0371	0.0289
Lbs/Hr	Emission Rate, Lbs/Hr	21.7	20.4	15.4
<u>Filterable + Condensable Particulate Results</u>				
mg	Catch Weight, Milligrams	177.4	166.2	139.4
Gr/DSCF	Concentration, Grains/DSCF*	0.0892	0.0832	0.0708
Gr/ACF	Concentration, Grains/ACF	0.0576	0.0537	0.0463
Lbs/Hr	Emission Rate, Lbs/Hr	31.3	29.5	24.7

* 68 Degrees F -- 29.92 Inches of Mercury (Hg)

A. TEST RESULTS

2. Stack Particulate

PLANT: Weyerhaeuser Company, Moncure, North Carolina

SAMPLING LOCATION: Surface Line Stack

		M5-SL-0-1	M5-SL-0-2	M5-SL-0-3
	Test Date	10/20/88	10/20/88	10/20/88
	Run Start Time	1116	1305	1440
	Run Finish Time	1219	1406	1545
	Net Traversing Points	12	12	12
Theta	Net Run Time, Minutes	60	60	60
Dia	Nozzle Diameter, Inches	0.178	0.250	0.250
Cp	Pitot Tube Coefficient	0.84	0.84	0.84
Y	Dry Gas Meter Calibration Factor	0.9907	0.9907	0.9907
Pbar	Barometric Pressure, Inches Hg	29.7	29.7	29.7
Delta-H	Avg. Pressure Differential of Orifice Meter, Inches H2O	0.780	2.92	2.86
Vm	Volume Of Metered Gas Sample, Dry ACF	31.222	56.440	55.845
tm	Dry Gas Meter Temperature, Degrees F	78	79	80
Vm(std)	Volume Of Metered Gas Sample, Dry SCF*	30.180	54.742	54.057
Vlc	Total Volume of Liquid Collected in Impingers & Silica Gel, ml	113.5	193.0	145.5
Vw(std)	Volume of Water Vapor, SCF*	5.342	9.085	6.849
%H2O	Moisture Content, Percent by Volume	15.0	14.2	11.2
Mfd	Dry Mole Fraction	0.850	0.858	0.888
%CO2	Carbon Dioxide, Percent By Volume, Dry	2.1	2.2	2.1
%O2	Oxygen, Percent By Volume, Dry	18.5	18.4	18.5
%CO+N2	CO + N2, Percent By Volume, Dry	79.4	79.4	79.4
Md	Gas Molecular Weight, Lb/Lb-Mole, Dry	29.08	29.09	29.08
Ms	Gas Molecular Weight, Lb/Lb-Mole, Wet	27.42	27.52	27.84
Pg	Flue Gas Static Pressure, Inches H2O	-0.50	-0.69	-0.64
Ps	Absolute Flue Gas Pressure, Inches Hg.	29.66	29.65	29.65
ts	Flue Gas Temperature, Degrees F	215	222	221
Delta-p	Average Velocity Head, Inches H2O	1.077	1.090	1.088
vs	Flue Gas Velocity, Feet/Second	67.89	68.54	68.04
A	Stack/Duct Area, Square Inches	2,248	2,248	2,248
Qsd	Volumetric Air Flow Rate, Dry SCFM*	41,913	42,260	43,482
Qaw	Volumetric Air Flow Rate, Wet ACFM	63,590	64,199	63,731
%I	Isokinetic Sampling Rate, Percent	108.4	98.9	94.9

* 68 Degrees F -- 29.92 Inches of Mercury (Hg)

(Continued next page)

PLANT: Weyerhaeuser Company, Moncure, North Carolina

SAMPLING LOCATION: Surface Line Stack

		<u>M5-SL-0-1</u>	<u>M5-SL-0-2</u>	<u>M5-SL-0-3</u>
<u>Filterable Particulate Results</u>				
mg	Catch Weight, Milligrams	8.3	13.7	7.3
Gr/DSCF	Concentration, Grains/DSCF*	0.00424	0.00386	0.00208
Gr/ACF	Concentration, Grains/ACF	0.00279	0.00254	0.00142
Lbs/Hr	Emission Rate, Lbs/Hr	1.52	1.40	0.775
<u>Filterable + Condensable Particulate Results</u>				
mg	Catch Weight, Milligrams	47.7	64.7	63.1
Gr/DSCF	Concentration, Grains/DSCF*	0.0244	0.0182	0.0180
Gr/ACF	Concentration, Grains/ACF	0.0161	0.0120	0.0123
Lbs/Hr	Emission Rate, Lbs/Hr	8.77	6.59	6.71

* 68 Degrees F -- 29.92 Inches of Mercury (Hg)

A. TEST RESULTS

3. Plume Opacity

Name of Source: Weyerhaeuser, Moncure, North Carolina

Observer: Keith Hazel

File Name: M9-SL-0-1

Start Time: 1133

Stop Time: 1233

Date of Test: 10-20-1988

- ORIGINAL DATA -

Sec>> Min	00	15	30	45	Sec>> Min	00	15	30	45
1	0	0	0	0	31	5	5	5	5
2	0	0	0	0	32	5	5	5	5
3	0	0	0	0	33	5	5	5	5
4	0	0	0	0	34	5	0	0	0
5	0	5	5	0	35	0	0	5	5
6	0	0	0	0	36	0	0	5	5
7	0	0	0	0	37	0	5	5	5
8	0	0	0	0	38	10	10	5	5
9	0	0	0	0	39	5	5	10	10
10	0	0	0	0	40	5	5	5	0
11	0	0	0	0	41	0	0	0	0
12	5	5	5	0	42	0	0	0	0
13	0	0	5	0	43	5	0	5	5
14	0	0	0	0	44	0	0	5	5
15	0	0	0	0	45	5	5	5	5
16	0	0	0	5	46	5	5	5	5
17	0	0	0	5	47	5	5	5	5
18	0	0	0	0	48	5	5	5	5
19	5	0	0	0	49	5	5	5	5
20	5	0	0	0	50	5	5	5	5
21	5	5	0	~5	51	5	5	5	5
22	~5	~5	~5	~5	52	5	5	5	5
23	~5	~5	5	5	53	5	0	0	0
24	5	5	5	5	54	0	0	0	0
25	5	5	5	5	55	0	0	0	5
26	5	5	5	10	56	0	0	5	5
27	10	10	5	5	57	5	5	5	5
28	5	10	10	5	58	5	5	5	0
29	5	10	5	5	59	0	0	0	0
30	10	10	5	5	60	0	0	0	0

NOTE: G = INTERFERENCE FROM DUST CLOUD EMITTED FROM DEVICE LOCATED
AT BASE OF STACK.

DATE PRINT: 10-31-1988

TIME PRINT: 12:26:58

ENTROPY

Name of Source: Weyerhaeuser, Moncuré, North Carolina

Observer: Keith Hazel

File Name: M9-SL-0-1

Start Time: 1133

Stop Time: 1233

Date of Test: 10-20-1988

- ROLLING AVERAGES -

Sec>>	00	15	30	45	Sec>>	00	15	30	45
Min					Min				
1	-	-	-	-	31	7	7	7	7
2	-	-	-	-	32	7	7	7	6
3	-	-	-	-	33	6	6	6	6
4	-	-	-	-	34	6	6	5	5
5	-	-	-	-	35	5	4	4	4
6	-	-	-	0	36	4	4	4	4
7	0	0	0	0	37	3	3	3	3
8	0	0	0	0	38	4	4	4	4
9	0	0	0	0	39	4	4	4	4
10	0	0	0	0	40	4	4	5	5
11	0	0	0	0	41	5	5	4	4
12	0	0	1	1	42	4	4	4	4
13	1	1	1	1	43	4	4	4	4
14	1	1	1	1	44	3	3	3	3
15	1	1	1	1	45	3	3	3	3
16	1	1	1	1	46	3	3	3	3
17	1	1	1	1	47	3	3	3	4
18	1	1	1	1	48	4	4	4	4
19	1	1	1	1	49	4	5	5	5
20	1	1	1	1	50	5	5	5	5
21	1	1	1	~G	51	5	5	5	5
22	~G	~G	~G	~G	52	5	5	5	5
23	~G	~G	-	-	53	5	5	5	4
24	-	-	-	-	54	4	4	4	4
25	-	-	-	-	55	3	3	3	3
26	-	-	-	-	56	3	3	3	3
27	-	-	-	-	57	3	3	3	3
28	-	-	-	-	58	3	3	3	2
29	-	6	6	6	59	2	2	2	2
30	6	7	7	7	60	2	2	2	2

=====

BLOCK SIZE (for Rolling Averages) = 24 READINGS

*The highest BLOCK in this ROLLING AVERAGE is at 30 Min and 15 Sec

>> OPERATION WAS PERFORMED ON THE: original DATA. <<

NOTE: _____

DATE PRINT: 11-03-1988

TIME PRINT: 15:00:30

ENTROPY

Name of Source: Weyerhaeuser, Moncure, North Carolina

Observer: Keith Hazel

File Name: M9-SL-0-1

Start Time: 1133

Stop Time: 1233

Date of Test: 10-20-1988

- BLOCK AVERAGES -

Sec>>	00	15	30	45	Sec>>	00	15	30	45
Min					Min				
1	-	-	-	-	31	-	-	-	-
2	-	-	-	-	32	-	-	-	-
3	-	-	-	-	33	-	-	-	-
4	-	-	-	-	34	-	-	-	-
5	-	-	-	-	35	-	-	-	-
6	-	-	-	0	36	-	-	-	4
7	-	-	-	-	37	-	-	-	-
8	-	-	-	-	38	-	-	-	-
9	-	-	-	-	39	-	-	-	-
10	-	-	-	-	40	-	-	-	-
11	-	-	-	-	41	-	-	-	-
12	-	-	-	1	42	-	-	-	4
13	-	-	-	-	43	-	-	-	-
14	-	-	-	-	44	-	-	-	-
15	-	-	-	-	45	-	-	-	-
16	-	-	-	-	46	-	-	-	-
17	-	-	-	-	47	-	-	-	-
18	-	-	-	1	48	-	-	-	4
19	-	-	-	-	49	-	-	-	-
20	-	-	-	-	50	-	-	-	-
21	-	-	-	~G	51	-	-	-	-
22	~G	~G	~G	~G	52	-	-	-	-
23	~G	~G	-	-	53	-	-	-	-
24	-	-	-	-	54	-	-	-	4
25	-	-	-	-	55	-	-	-	-
26	-	-	-	-	56	-	-	-	-
27	-	-	-	-	57	-	-	-	-
28	-	-	-	-	58	-	-	-	-
29	-	-	-	-	59	-	-	-	-
30	-	-	-	7	60	-	-	-	2

BLOCK SIZE = 24 READINGS

>> OPERATION WAS PERFORMED ON THE: original DATA. <<

NOTE: _____

DATE PRINT: 11-03-1988

TIME PRINT: 15:01:10

ENTROPY

Name of Source: Weyerhaeuser, Moncure, North Carolina

Observer: Keith Hazel

File Name: M9-SL-0-2

Start Time: 1306

Stop Time: 1406

Date of Test: 10-20-1988

- ORIGINAL DATA -

Sec>>	00	15	30	45	Sec>>	00	15	30	45
Min					Min				
1	0	0	0	0	31	0	0	0	0
2	0	0	0	0	32	0	0	0	0
3	0	0	0	0	33	0	0	0	0
4	0	0	0	0	34	0	0	0	0
5	5	5	5	5	35	0	0	0	0
6	5	0	0	0	36	0	0	0	0
7	0	0	0	0	37	0	0	0	0
8	0	0	0	0	38	0	0	0	0
9	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
13	0	0	0	0	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
18	0	0	0	0	48	0	0	0	0
19	0	0	0	0	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
23	0	0	0	0	53	0	0	0	0
24	0	0	0	5	54	0	0	0	0
25	5	0	0	0	55	0	0	0	0
26	0	0	0	0	56	0	0	0	0
27	0	0	0	5	57	0	0	0	0
28	0	0	0	0	58	0	0	0	0
29	0	0	0	0	59	0	0	0	0
30	0	0	0	0	60	0	0	0	0

NOTE: _____

DATE PRINT: 10-31-1988

TIME PRINT: 13:37:08

ENTROPY

Name of Source: Weyerhaeuser, Moncure, North Carolina

Observer: Keith Hazel

File Name: M9-SL-0-2

Start Time: 1306

Stop Time: 1406

Date of Test: 10-20-1988

- R O L L I N G A V E R A G E S -

Sec>>	00	15	30	45	Sec>>	00	15	30	45
Min					Min				
1	-	-	-	-	31	0	0	0	0
2	-	-	-	-	32	0	0	0	0
3	-	-	-	-	33	0	0	0	0
4	-	-	-	-	34	0	0	0	0
5	-	-	-	-	35	0	0	0	0
6	-	-	-	1	36	0	0	0	0
7	1	1	1	1	37	0	0	0	0
8	1	1	1	1	38	0	0	0	0
9	1	1	1	1	39	0	0	0	0
10	1	1	1	1	40	0	0	0	0
11	1	1	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
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
18	0	0	0	0	48	0	0	0	0
19	0	0	0	0	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
23	0	0	0	0	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	1	57	0	0	0	0
28	1	1	1	1	58	0	0	0	0
29	1	1	1	1	59	0	0	0	0
30	1	1	1	0	60	0	0	0	0

=====

BLOCK SIZE (for Rolling Averages) = 24 READINGS

*The highest BLOCK in this ROLLING AVERAGE is at 6 Min and 45 Sec

>> OPERATION WAS PERFORMED ON THE: original DATA. <<

NOTE: _____

DATE PRINT: 11-03-1988

TIME PRINT: 14:52:20

ENTROPY

Name of Source: Weyerhaeuser, Moncure, North Carolina

Observer: Keith Hazel

File Name: M9-SL-D-2

Start Time: 1306

Stop Time: 1406

Date of Test: 10-20-1988

- B L O C K A V E R A G E S -

Sec>>	00	15	30	45	Sec>>	00	15	30	45
Min					Min				
1	-	-	-	-	31	-	-	-	-
2	-	-	-	-	32	-	-	-	-
3	-	-	-	-	33	-	-	-	-
4	-	-	-	-	34	-	-	-	-
5	-	-	-	-	35	-	-	-	-
6	-	-	-	1	36	-	-	-	0
7	-	-	-	-	37	-	-	-	-
8	-	-	-	-	38	-	-	-	-
9	-	-	-	-	39	-	-	-	-
10	-	-	-	-	40	-	-	-	-
11	-	-	-	-	41	-	-	-	-
12	-	-	-	0	42	-	-	-	0
13	-	-	-	-	43	-	-	-	-
14	-	-	-	-	44	-	-	-	-
15	-	-	-	-	45	-	-	-	-
16	-	-	-	-	46	-	-	-	-
17	-	-	-	-	47	-	-	-	-
18	-	-	-	0	48	-	-	-	0
19	-	-	-	-	49	-	-	-	-
20	-	-	-	-	50	-	-	-	-
21	-	-	-	-	51	-	-	-	-
22	-	-	-	-	52	-	-	-	-
23	-	-	-	-	53	-	-	-	-
24	-	-	-	0	54	-	-	-	0
25	-	-	-	-	55	-	-	-	-
26	-	-	-	-	56	-	-	-	-
27	-	-	-	-	57	-	-	-	-
28	-	-	-	-	58	-	-	-	-
29	-	-	-	-	59	-	-	-	-
30	-	-	-	0	60	-	-	-	0

=====

BLOCK SIZE = 24 READINGS

>> OPERATION WAS PERFORMED ON THE: original DATA. <<

NOTE: _____

DATE PRINT: 11-03-1988

TIME PRINT: 14:53:45

ENTROPY

Name of Source: Weyerhaeuser, Moncure, North Carolina

Observer: Keith Hazel

File Name: M9-SL-0-3

Start Time: 1442

Stop Time: 1542

Date of Test: 10-20-1988

- ORIGINAL DATA -

Sec>>	00	15	30	45	Sec>>	00	15	30	45
Min					Min				
1	0	0	0	0	31	0	0	0	0
2	0	0	0	0	32	0	0	0	0
3	0	0	0	0	33	0	0	0	0
4	0	0	0	0	34	0	0	0	0
5	0	0	0	0	35	0	0	0	0
6	0	0	0	0	36	0	0	0	0
7	0	0	0	0	37	0	0	0	0
8	0	0	0	0	38	0	5	5	5
9	0	0	0	0	39	5	5	5	5
10	0	0	0	0	40	5	5	5	5
11	0	0	0	0	41	5	10	10	10
12	0	0	0	0	42	10	10	5	5
13	0	0	0	0	43	5	5	10	5
14	0	0	0	0	44	5	5	5	10
15	0	0	0	0	45	10	10	10	10
16	0	~G	~G	~G	46	15	10	10	15
17	~G	~G	0	0	47	10	10	10	~G
18	0	0	0	0	48	10	10	10	5
19	0	0	~G	~G	49	5	5	~G	~G
20	0	0	~G	0	50	~G	~G	~G	~G
21	0	0	0	0	51	5	10	5	5
22	0	0	0	0	52	5	5	5	5
23	0	0	0	0	53	5	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	5	5
28	0	0	0	0	58	5	0	0	5
29	0	0	0	0	59	5	5	5	5
30	0	0	0	0	60	5	5	5	5

NOTE: G = INTERFERENCE FROM PLUME EMITTED BY OTHER STACK.

DATE PRINT: 10-31-1988

TIME PRINT: 13:51:12

ENTROPY

Name of Source: Weyerhaeuser, Moncure, North Carolina

Observer: Keith Hazel

File Name: M9-SL-0-3

Start Time: 1442

Stop Time: 1542

Date of Test: 10-20-1988

- R O L L I N G A V E R A G E S -

Sec>>	00	15	30	45	Sec>>	00	15	30	45
Min					Min				
1	-	-	-	-	31	-0	-0	-0	-0
2	-	-	-	-	32	-0	-0	-0	-0
3	-	-	-	-	33	-0	-0	-0	-0
4	-	-	-	-	34	-0	-0	-0	-0
5	-	-	-	-	35	-0	-0	-0	-0
6	-	-	-	0	36	-0	-0	-0	-0
7	0	0	0	0	37	-0	-0	-0	-0
8	0	0	0	0	38	-0	0	0	1
9	0	0	0	0	39	1	1	1	1
10	0	0	0	0	40	2	2	2	2
11	0	0	0	0	41	2	3	3	4
12	0	0	0	0	42	4	5	5	5
13	0	0	0	0	43	5	5	6	6
14	0	0	0	0	44	6	6	6	6
15	0	0	0	0	45	7	7	7	7
16	0	~6	~6	~6	46	8	8	8	9
17	~6	~6	-	-	47	9	9	9	~6
18	-	-	-	-	48	-	-	-	-
19	-	-	~6	~6	49	-	-	~6	~6
20	-	-	~6	-	50	~6	~6	~6	~6
21	-	-	-	-	51	-	-	-	-
22	-	-	-	-	52	-	-	-	-
23	-	-	-	-	53	-	-	-	-
24	-	-	-	-	54	-	-	-	-
25	-	-	-	-	55	-	-	-	-
26	-	-	-0	-0	56	-	-	-	2
27	-0	-0	-0	-0	57	2	1	1	1
28	-0	-0	-0	-0	58	1	1	1	1
29	-0	-0	-0	-0	59	1	1	1	2
30	-0	-0	-0	-0	60	2	2	2	2

=====

BLOCK SIZE (for Rolling Averages) = 24 READINGS

*The highest BLOCK in this ROLLING AVERAGE is at 47 Min and 0 Sec

>> OPERATION WAS PERFORMED ON THE: original DATA. <<

NOTE: _____

DATE PRINT: 11-03-1988

TIME PRINT: 14:50:39

ENTROPY

Name of Source: Weyerhaeuser, Moncure, North Carolina

Observer: Keith Hazel

File Name: M9-SL-0-3

Start Time: 1442

Stop Time: 1542

Date of Test: 10-20-1988

- B L O C K A V E R A G E S -

Sec>>	00	15	30	45	Sec>>	00	15	30	45
Min					Min				
1	-	-	-	-	31	-	-	-	-
2	-	-	-	-	32	-	-	-	-
3	-	-	-	-	33	-	-	-	-
4	-	-	-	-	34	-	-	-	-
5	-	-	-	-	35	-	-	-	-
6	-	-	-	0	36	-	-	-	0
7	-	-	-	-	37	-	-	-	-
8	-	-	-	-	38	-	-	-	-
9	-	-	-	-	39	-	-	-	-
10	-	-	-	-	40	-	-	-	-
11	-	-	-	-	41	-	-	-	-
12	-	-	-	0	42	-	-	-	5
13	-	-	-	-	43	-	-	-	-
14	-	-	-	-	44	-	-	-	-
15	-	-	-	-	45	-	-	-	-
16	-	~G	~G	~G	46	-	-	-	-
17	~G	~G	-	-	47	-	-	-	~G
18	-	-	-	-	48	-	-	-	-
19	-	-	~G	~G	49	-	-	~G	~G
20	-	-	~G	-	50	~G	~G	~G	~G
21	-	-	-	-	51	-	-	-	-
22	-	-	-	-	52	-	-	-	-
23	-	-	-	-	53	-	-	-	-
24	-	-	-	-	54	-	-	-	-
25	-	-	-	-	55	-	-	-	-
26	-	-	-	-	56	-	-	-	-
27	-	-	-	-	57	-	-	-	-
28	-	-	-	-	58	-	-	-	-
29	-	-	-	-	59	-	-	-	-
30	-	-	-	0	60	-	-	-	3

BLOCK SIZE = 24 READINGS

>> OPERATION WAS PERFORMED ON THE: original DATA. <<

NOTE: _____

DATE PRINT: 11-03-1988

TIME PRINT: 14:51:21

ENTROPY

A. TEST RESULTS

4. Example Calculations

EXAMPLE TEST CALCULATIONS

Surface Line EFB Inlet

Run Number: M5-SL-I-1

VOLUME OF DRY GAS SAMPLED AT STANDARD CONDITIONS

$$V_m(\text{std}) = 17.64 * Y * V_m * \frac{(P_{\text{bar}} + \Delta H/13.6)}{(460 + t_m)}$$

$$V_m(\text{std}) = 17.64 * 0.9993 * 30.755 * \frac{(29.7 + 0.928/13.6)}{(460 + 66)} = 30.682 \text{ DSCF}$$

VOLUME OF WATER VAPOR AT STANDARD CONDITIONS

$$V_w(\text{std}) = 0.04707 * V_{lc}$$

$$V_w(\text{std}) = 0.04707 * 115.0 = 5.413 \text{ SCF}$$

PERCENT MOISTURE, BY VOLUME, AS MEASURED IN FLUE GAS

$$\%H_2O = 100 * V_w(\text{std}) / (V_w(\text{std}) + V_m(\text{std}))$$

$$\%H_2O = 100 * 5.413 / (5.413 + 30.682) = 15.0 \%$$

DRY MOLE FRACTION OF FLUE GAS

$$M_{fd} = 1 - (\%H_2O / 100)$$

$$M_{fd} = 1 - (15.0 / 100) = 0.850$$

DRY MOLECULAR WEIGHT OF FLUE GAS

$$M_d = (\%CO_2 * 0.44) + (\%O_2 * 0.32) + (\%CO + \%N_2 * 0.28)$$

$$M_d = (2.1 * 0.44) + (18.5 * 0.32) + (79.4 * 0.28) = 29.08 \text{ lb/lb-mole}$$

WET MOLECULAR WEIGHT OF FLUE GAS

$$M_s = (M_d * M_{fd}) + (0.18 * \%H_2O)$$

$$M_s = (29.08 * 0.850) + (0.18 * 15.0) = 27.42 \text{ lb/lb-mole}$$

ABSOLUTE FLUE GAS PRESSURE

$$P_s = P_{bar} + (P_g / 13.6)$$

$$P_s = 29.7 + (1.20 / 13.6) = 29.79 \text{ inches Hg.}$$

AVERAGE FLUE GAS VELOCITY - Note: (Delta p) avg. is square of avg. sq root

$$v_s = 85.49 * C_p * \text{SQRT} \left[\frac{(\Delta p)_{avg} * (460 + t_s)}{P_s * M_s} \right]$$

$$v_s = 85.49 * 0.84 * \text{SQRT} \left[\frac{(1.375 * (460 + 232))}{29.79 * 27.42} \right] = 77.51 \text{ ft/sec}$$

DRY VOLUMETRIC FLUE GAS FLOW RATE AT STANDARD CONDITIONS

$$Q_{sd} = \frac{60}{144} * M_{fd} * v_s * A * \frac{T_{std}}{t_s + 460} * \frac{P_s}{P_{std}}$$

$$Q_{sd} = \frac{60}{144} * 0.850 * 77.51 * 1,963 * \frac{528}{232 + 460} * \frac{29.79}{29.92} = 40,938 \text{ SCFM}$$

WET VOLUMETRIC FLUE GAS FLOW RATE AT STACK CONDITIONS

$$Q_{aw} = 60 / 144 * v_s * A$$

$$Q_{aw} = 60 / 144 * 77.51 * 1,963 = 63,397 \text{ ACFM}$$

PERCENT ISOKINETIC OF SAMPLING RATE

$$\%I = \frac{P_{std}}{T_{std}} * \frac{100}{60} * \frac{(t_s + 460) * V_m(std)}{P_s * v_s * M_{fd} * \theta * \text{Area-nozzle, sq.ft.}}$$

$$\%I = \frac{29.92}{528} * \frac{100}{60} * \frac{(232 + 460) * 30.682}{29.79 * 77.51 * 0.850 * 60 * 0.0001748} = 97.4 \%$$

GRAINS PER DRY STANDARD CUBIC FOOT, PARTICULATE

$$\text{Gr/DSCF} = \frac{7,000}{453,592} \cdot \frac{\text{mg}}{\text{Vm(std)}}$$

$$\text{Gr/DSCF} = \frac{7,000}{453,592} \cdot \frac{122.7}{30.682} = 0.0617 \text{ Grains/DSCF}$$

GRAINS PER ACTUAL CUBIC FOOT, PARTICULATE

$$\text{Gr/ACF} = \frac{17.64 * \text{Gr/DSCF} * \text{Ps} * \text{Mfd}}{(\text{ts} + 460)}$$

$$\text{Gr/ACF} = \frac{17.64 * 0.0617 * 29.79 * 0.850}{232 + 460} = 0.0398 \text{ Gr/ACF}$$

POUNDS PER HOUR, PARTICULATE

$$\text{Lb/Hr} = (60 / 7000) * \text{Gr/DSCF} * \text{Qsd}$$

$$\text{Lb/Hr} = (60 / 7000) * 0.0617 * 40,938 = 21.7 \text{ Lb/Hr}$$