Background Report Reference

AP-42 Section Number: 9.10.1.2

Background Chapter: 4

Reference Number: 11

Title: Western Sugar - Final Report. Emissions Testing Analysis at Billings, Montana Refinery

Radian Corporation

.Radian Corporation

March 1991

APPENDIX K

REPORT EXCERPTS FROM REFERENCE 11

(Western Sugar Company, March 1991)

Western Sugar

Final Report

Emissions Testing and Analysis at Billings, Montana Refinery

March 26, 1991

RADIAN
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CORPORATION

Project Number 238-019

Final Draft Report

EMISSIONS TESTING AND ANALYSIS AT BILLINGS, MONTANA REFINERY

Prepared for:

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22 March 1991

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Table 3-5.

Results of Emissions Testing at Western Sugar's
Billings, Montana Facility

Pulp Dryer—North Stack

Test No.	RM5-4-2N	RM5-4-3N	RM5-4-4N	
Date	01-25-91	01-25-91	01-25-91	
Test Time	1047-1237	1630-1759	1909-2053	Average
Effluent Conditions				
Gas Velocity (fps)	16.18	15.10	15.43	15.57
Flow Rate (acfm)	36,941	34,473	35,219	35544
Flow Rate (dscfm)	17,391	17,032	16,884	17102
Gas Temperature (F)	185	163	166	171
Moisture (%)	35.1	35.0	36.6	35.6
Isokinetics (%)	102.54	104.58	108.90	105.34
Sample Volume (dscf)	35.06	35.02	36.15	35.41
Analysis (mg)				
Filter	139.1	95.2	115.5	116.6
Probe Wash	24.9	14.3	25.5	21.6
Condensables	77.3	60.0	63.4	66.9
Concentration (gr/dscf)				
Filter	0.06123	0.04195	0.04931	0.05083
Probe Wash	0.01096	0.00630	0.01089	0.00938
Condensables	0.03403	0.02644	0.02706	0.02918
Emission Rate (lb/hr)				
Filter	9.13	6.12	7.14	7.46
Probe Wash	1.63	0.92	1.58	1.38
Condensables	5.07	3.86	3.92	4.28

3.2 Pulp Dryer

Particulate emissions were evaluated at the outlet stacks of the pulp dryer operations. Sample collection at the outlet stacks was performed January 23-25, 1991, utilizing the procedures detailed in EPA Reference Method 5. Both outlet stacks were tested simultaneously to assist in determining the total particulate emissions from the process.

After sampling, an unusually high moisture value was reported to plant personnel. This very high moisture level was also responsible for the "out-of-range" isokinetics. Plant engineers determined that the spray nozzles were partially plugged. The sample set on January 23 was invalidated and, due to stormy weather, sampling was not resumed until January 25. Three sets of samples were taken on January 25.

A process upset was experienced during test RM5-4-2 when the mist eliminator spray lines froze. Plant personnel thawed the frozen lines and sampling continued. No further process upsets were experienced during the remaining tests.

Tables 3-5 and 3-6 present the results of the particulate emission sampling at the two pulp dryer outlet stacks. Each table provides the measured effluent conditions, the total particulate mass collected, and the calculated particulate emissions. Based upon the reported emission results, the outlet stack identified as the North Stack consistently demonstrated a higher particulate emission than the South Stack.

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Table 3-6.

Results of Emissions Testing at Western Sugar's
Billings, Montana Facility

Pulp Dryer—South Stack

Test No.	RM5-4-2S	RM5-4-3S	RM5-4-4S	
Date	01-25-91	01-25-91	01-25-91	
Test Time	1047-1237	1630-1759	1909-2053	Average
Effluent Conditions				
Gas Velocity (fps)	14.36	14.21	14.51	14.36
Flow Rate (acfm)	32,769	32,445	33,118	32777
Flow Rate (dscfm)	16,800	16,374	16,467	16547
Gas Temperature (F)	177	165	164	169
Moisture (%)	31.0	33.4	34.5	33.0
Isokinetics (%)	106.80	103.52	108.57	106.30
Sample Volume (dscf)	35.28	33.32	35.15	34.58
Analysis (mg)				
Filter	85.4	72.9	75.9	78.1
Probe Wash	8.4	12.9	25.7	15.7
Condensables	29.9	62.1	82.9	58.3
Concentration (gr/dscf)				
Filter	0.03736	0.03376	0.03332	0.03481
Probe Wash	0.00367	0.00597	0.01128	0.00698
Condensables	0.01308	0.02876	0.03640	0.02608
Emission Rate (lb/hr)				
Filter	5.38	4.74	4.70	4.94
Probe Wash	0.53	0.84	1.59	0.99
Condensables	1.88	4.04	5.14	3.69

3.3 Pellet Cooler

The pellet cooler was evaluated for particulate emission compliance on January 26, 1991, during normal operations of the process. All testing was performed using the procedures detailed in EPA Reference Method 5. No process upsets or sampling errors were experienced during the evaluation of this source.

The results of the emission evaluation performed at the pellet cooler exhaust stack are presented in Table 3-7. The table provides the results of the triplicate test series and details the measured effluent conditions during each test, the total particulate mass collected, and the calculated mass emission rates on a sample train component basis. The variability between the three tests was slight, and this source represents the lowest particulate emission of all the processes evaluated in this program.

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Table 3-7.

Results of Emissions Testing at Western Sugar's
Billings, Montana Facility

Pellet Cooler

Test No.	RM5-5-1	RM5-5-2	RM5-5-3	
Date	01-26-91	01-26-91	01-26-91	
Test Time	1113-1230	1434-1551	1647-1806	Average
Effluent Conditions				
Gas Velocity (fps)	51.80	50.34	49.68	50.61
Flow Rate (acfm)	21,968	21,349	21,071	21,463
Flow Rate (dscfm)	17,476	16,764	16,533	16,924
Gas Temperature (F)	114	121	118	118
Moisture (%)	2.3	2.3	3.0	2.6
Isokinetics (%)	96.65	100.84	102.56	100.02
Sample Volume (dscf)	58.64	58.68	58.87	58.73
Analysis (mg)				
Filter	14.6	18.3	20.0	17.6
Probe Wash	10.9	6.0	4.8	7.2
Condensables	7.9	8.4	3.3	6.5
				31.3
Concentration (gr/dscf)				
Filter	3.84E-03	4.81E-03	5.24E-03	4.63E-03
Probe Wash	2.87E-03	1.58E-03	1.26E-03	1.90E-03
Condensables	2.08E-03	2.21E-03	8.65E-04	1.72E-03
				.00835 GR/DSCF
Emission (lb/hr)				
Filter	0.58	0.69	0.74	0.67
Probe Wash	0.43	0.23	0.18	0.28
Condensables	0.31	0.32	0.12	0.25
				1.20
Emission (gr/sec)				
Filter	0.73	0.87	0.94	0.84
Probe Wash	0.54	0.29	0.22	0.35
Condensables	0.39	0.40	0.15	0.32
				1.51

4.0 PROCESS DESCRIPTION

The following section presents a brief description of the beet processing procedures, a discussion of the stack schematics, and a description of the air pollution control equipment.

4.1 Beet Process Description

The following is a description of the processes used by Western Sugar at their Billings, Montana site:

Process 1 -- Power Boiler/Wet Scrubber Unit: Low-sulfur coal is fired in three separate power boilers (stoker feeders). After the useful heat has been removed from the combustion gases, the flue gases are combined and passed through two parallel (north and south) wet venturi scrubbers for particulate removal (see Figure 4-1). Maximum coal firing rate: 18 tons of coal per hour (total in the three boilers; firing rate is read once per shift).

Process 2 -- Pulp Dryer: Processed wet beet pulp is sent to a natural gas fired dryer and pelletized for stock feed. Oil is used as an emergency backup fuel for the pulp dryer. The wet pressed pulp is fed at an average rate of 34 tons per hour; however, the pulp is not routinely weighed, nor is the pellet production weighed (except for loads leaving the facility). Therefore, the only direct measure of the production rate is the natural gas feed rate. Maximum natural gas feed rate is 1600 cubic feet per minute.

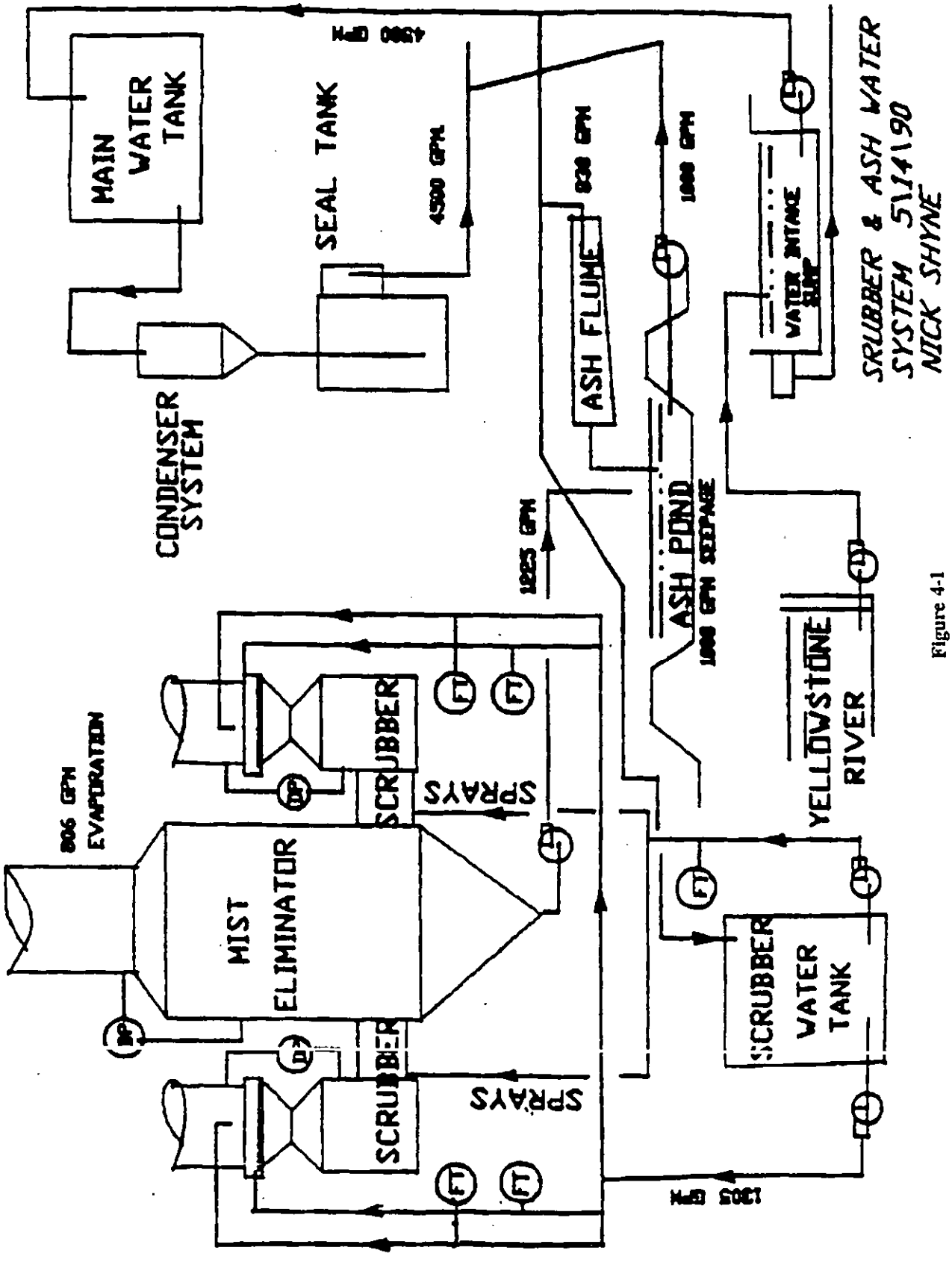
MAIN WATER TANK
SEAL TANK
CONDENSER SYSTEM
ASH FLUME
ASH POND
SCRUBBER
SPRAYS
MIST ELIMINATOR
SCRUBBER
SPRAYS
SCRUBBER WATER TANK
YELLOWSTONE RIVER
SRUBBER & ASH WATER SYSTEM 5/14/90 NICK SHYNE

Figure 4-1

Filename: BEET11.WQ1
Date: 08-Dec-94
Facility: Western Sugar Company
Location: Billings, Montana
Source: Pulp Dryer
Natural gas-fired rotary drum beet pulp dryer controlled with a wet scrubber
Test date: Jan. 23-25, 1991

Test ID	Parameter	Units	Values reported Run 1	Run 2	Run 3	Run 4
1	Stack temperature	Deg F	185	163	166	
NORTH STACK	Pressure	in. HG	ND	ND	ND	
	Moisture	%	35.1	35	36.6	
	Oxygen	%	ND	ND	ND	
	Volumetric flow, actual	acfm	36941	34473	35219	
	Volumetric flow, standard*	dscfm	17391	17032	16884	
	Isokinetic variation	%	102.54	104.58	108.9	
Circle: Production or feed rate Feed to dryer ~~entering drum~~		TPH	34.00	34.00	34.00	
	Pollutant concentrations:					
	Filterable PM	G/dscf	0.0722	0.04825	0.0602	
	Condensible inorganic PM	G/dscf	0.034030	0.02644	0.02706	
	Pollutant mass flux rates:					
	Filterable PM	lb/hr	10.76	7.04	8.71	
	Condensible inorganic PM	lb/hr	5.073	3.860	3.916	
	Emission factors (ENGLISH UNITS):					AVERAGE
	Filterable PM	lb/ton	0.317	0.207	0.256	0.260
	Condensible inorganic PM	lb/ton	0.149	0.114	0.115	0.126
	Emission factors (METRIC UNITS):					AVERAGE
	Filterable PM	kg/Mg	0.158	0.104	0.128	0.130
	Condensible inorganic PM	kg/Mg	0.0746	0.0568	0.0576	0.0630

Test ID	Parameter	Units	Values reported Run 1	Run 2	Run 3	Run 4
2	Stack temperature	Deg F	177	165	164	
SOUTH STACK	Pressure	in. HG	ND	ND	ND	
	Moisture	%	31	33.4	34.5	
	Oxygen	%	ND	ND	ND	
	Volumetric flow, actual	acfm	32769	32445	33118	
	Volumetric flow, standard*	dscfm	16800	16374	16467	
	Isokinetic variation	%	106.8	103.52	108.57	
Circle: Production or feed rate Capacity:		TPH	34.00	34.00	34.00	
	Pollutant concentrations:					
	Filterable PM	G/dscf	0.04103	0.03973	0.0446	
	Condensible inorganic PM	G/dscf	0.01308	0.02876	0.03640	
	Pollutant mass flux rates:					
	Filterable PM	lb/hr	5.91	5.58	6.30	
	Condensible inorganic PM	lb/hr	1.88	4.04	5.14	
	Emission factors (ENGLISH UNITS):					AVERAGE
	Filterable PM	lb/ton	0.174	0.164	0.185	0.174
	Condensible inorganic PM	lb/ton	0.0554	0.119	0.151	0.108
	Emission factors (METRIC UNITS):					AVERAGE
	Filterable PM	kg/Mg	0.0869	0.0820	0.0926	0.0872
	Condensible inorganic PM	kg/Mg	0.0277	0.0594	0.0756	0.0542

TOTAL EMISSION FACTORS FOR BOTH STACKS	Emission factors (ENGLISH UNITS):					AVERAGE
	Filterable PM	lb/ton	0.490	0.371	0.441	0.434
	Condensible inorganic PM	lb/ton	0.205	0.232	0.266	0.234
	Emission factors (METRIC UNITS):					AVERAGE
	Filterable PM	kg/Mg	0.245	0.186	0.221	0.217
	Condensible inorganic PM	kg/Mg	0.102	0.116	0.133	0.117

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
3	Stack temperature	Deg F	114	121	118	
PELLET	Pressure	in. HG	ND	ND	ND	
COOLER	Moisture	%	2.3	2.3	3	
	Oxygen	%	ND	ND	ND	
	Volumetric flow, actual	acfm	21968	21349	21071	
	Volumetric flow, standard*	dscfm	17476	16764	16533	
	Isokinetic variation	%	96.65	100.84	102.56	
Circle: Production or feed rate Wet pulp feed to dryer		TPH	34.00	34.00	34.00	
	Pollutant concentrations:					
	Filterable PM	G/dscf	0.00671	0.00639	0.00650	
	Condensible inorganic PM	G/dscf	0.00208	0.00221	0.000865	
	Pollutant mass flux rates:					
	Filterable PM	lb/hr	1.01	0.918	0.921	
	Condensible inorganic PM	lb/hr	0.312	0.318	0.123	
	Emission factors (ENGLISH UNITS):					AVERAGE
	Filterable PM	lb/ton	0.0296	0.0270	0.0271	0.0279
	Condensible inorganic PM	lb/ton	0.00916	0.00934	0.00361	0.00737
	Emission factors (METRIC UNITS):					AVERAGE
	Filterable PM	kg/Mg	0.0148	0.0135	0.0135	0.0139
	Condensible inorganic PM	kg/Mg	0.00458	0.00467	0.00180	0.00368

Emission factors based on feed rate to DRYER...may not be useful.

1.0 INTRODUCTION

Radian Corporation was retained by Western Sugar Company to perform particulate matter and sulfur dioxide (SO_2) emission compliance testing at their sugar beet processing facility in Billings, Montana. Three process operations were evaluated during the compliance test program:

- Pellet cooler;
- Pulp dryer (two outlet stacks); and
- Power boiler/wet scrubber unit.

Each of the processes identified was evaluated for particulate emission compliance. The power boiler/wet scrubber unit was the only source evaluated for SO_2 emissions.

In order to demonstrate particulate emission compliance, U.S. Environmental Protection Agency (EPA) Reference Method 5 was performed in triplicate at each source location. The emission results presented in this report are pursuant to an agreement between Western Sugar and the State of Montana. The test results are reported in the following formats:

- Front-half mass (filter mass plus probe-and-nozzle wash mass);
- Back-half mass (condensable particulate collected in impinger train);
- Sum of the front- and back-half mass.

Table 1-1.

Summary of Results of Emissions Testing at
Western Sugar's Billings, Montana Facility
January 1991

Unit	Pollutant	Condition	Front-Half Average[a] (lb/hr)[b]	(lb/MMBtu)[c]	Back-Half Average[a] (lb/hr)	(lb/MMBtu)	Total Average Emission Rate (lb/hr)	(lb/MMBtu)
Power Boilers/ Scrubber	PM[d]	Normal	72.74	0.2065	11.09	0.0315	83.83	0.2380
Power Boilers/ Scrubber	PM	Low Water Flow	87.34	0.2448	7.29	0.0204	94.63	0.2652
Power Boilers/ Scrubber	PM	Low Pressure	89.27	0.2365	8.76	0.0232	98.03	0.2597
Power Boilers/ Scrubber	SO_2[e]	Normal	---	---	---	---	126.4[f]	---
Pulp Dryer North	PM	Normal	8.8	---	4.3	---	13.1	---
Pulp Dryer South	PM	Normal	5.9	---	3.7	---	9.6	---
Pellet Cooler	PM	Normal	0.95	---	0.25	---	1.20	---

[a]Average of three valid runs.
[b]lb/hr = pounds per hour.
[c]lb/MMBtu = pounds per million Btu of coal fired.
[d]PM = particulate matter.
[e]SO_2 = sulfur dioxide.
[f]Average of four valid runs.

Coal samples were collected through the entire sampling period at the power boiler/wet scrubber stack. Each of the samples collected was composited to provide a sample representative of each day of operation. The composited coal samples were evaluated for total energy content (measured as British thermal units, Btu). No variation in the coal's Btu content was observed from the analysis of the composited samples. The Btu content of the coal was determined to be 11,000 Btu per pound of coal.

2.2 Pulp Dryer

Particulate emission testing was performed at the two pulp dryer outlet stacks. For identification, these stacks were labeled as the north and south pulp dryer stacks. Four tests were performed simultaneously at each outlet stack of the pulp dryer. The first test series was not a valid test due to errors in isokinetic sampling and process upsets. The remaining three tests performed at the outlet stacks were valid.

The results of the particulate emission evaluation performed at the two pulp dryer stacks are provided in Table 2-3. The reported results are the arithmetic average of the triplicate test series. As with the boiler stack, the results are presented as the front-half, back-half, and the total combined emissions.

2.3 Pellet Cooler

The particulate emission test results for the pellet cooler stack are provided in Table 2-4. The results presented are the arithmetic average of the triplicate test series performed at the pellet cooler exhaust stack. The emissions are presented in pounds per hour for the front-half, back-half, and total emissions.

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Table 2-3.

Particulate Emission Test Results
Western Sugar - Pulp Dryer Stacks

Stack ID	Front Half Emission (lb/hr)[a]	Back Half Emission (lb/hr)	Total Emission (lb/hr)
North	8.84	4.28	13.13
South	5.93	3.69	9.62

[a]lb/hr = pounds per hour.

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Table 2-4.

Particulate Emission Test Results
Western Sugar - Pellet Cooler

Front Half Emission (lb/hr)[a]	Back Half Emission (lb/hr)	Total Emission (lb/hr)
0.949	0.250	1.20

[a]lb/hr = pounds per hour.

Process 3 -- Pellet Cooler: The hot pelletized stock feed is cooled by an induced-draft fan drawing ambient air through the hot pellets. There is no routine measure of the rate of air flow, or the number of pellets going through the device. All pellets from the pulp dryer pass through the cooler.

4.2 Stack Schematic

Figure 4-2 (power boiler/wet scrubber stack) and Figure 4-3 (two identical pulp dryer stacks) are attached.

4.3 Air Pollution Control Equipment

The following is a description of the air pollution control equipment utilized by Western Sugar at their Billings, Montana site:

Process 1 -- Power Boiler/Wet Scrubber Unit: After the useful heat has been extracted, the flue gases from the three power boilers are combined and passed through two parallel wet venturi scrubbers for particulate removal (see Figure 4-1). The normal operating conditions are:

- Gas flow: 6.33×10^8 dry standard cubic feet per hour (dscfh);
- Water injection rate: 1,305 gallons per minute (gpm); and
- Pressure drop: Nominally, 5 inches of water.

The scrubber was designed and built by Western Sugar Company in 1977.

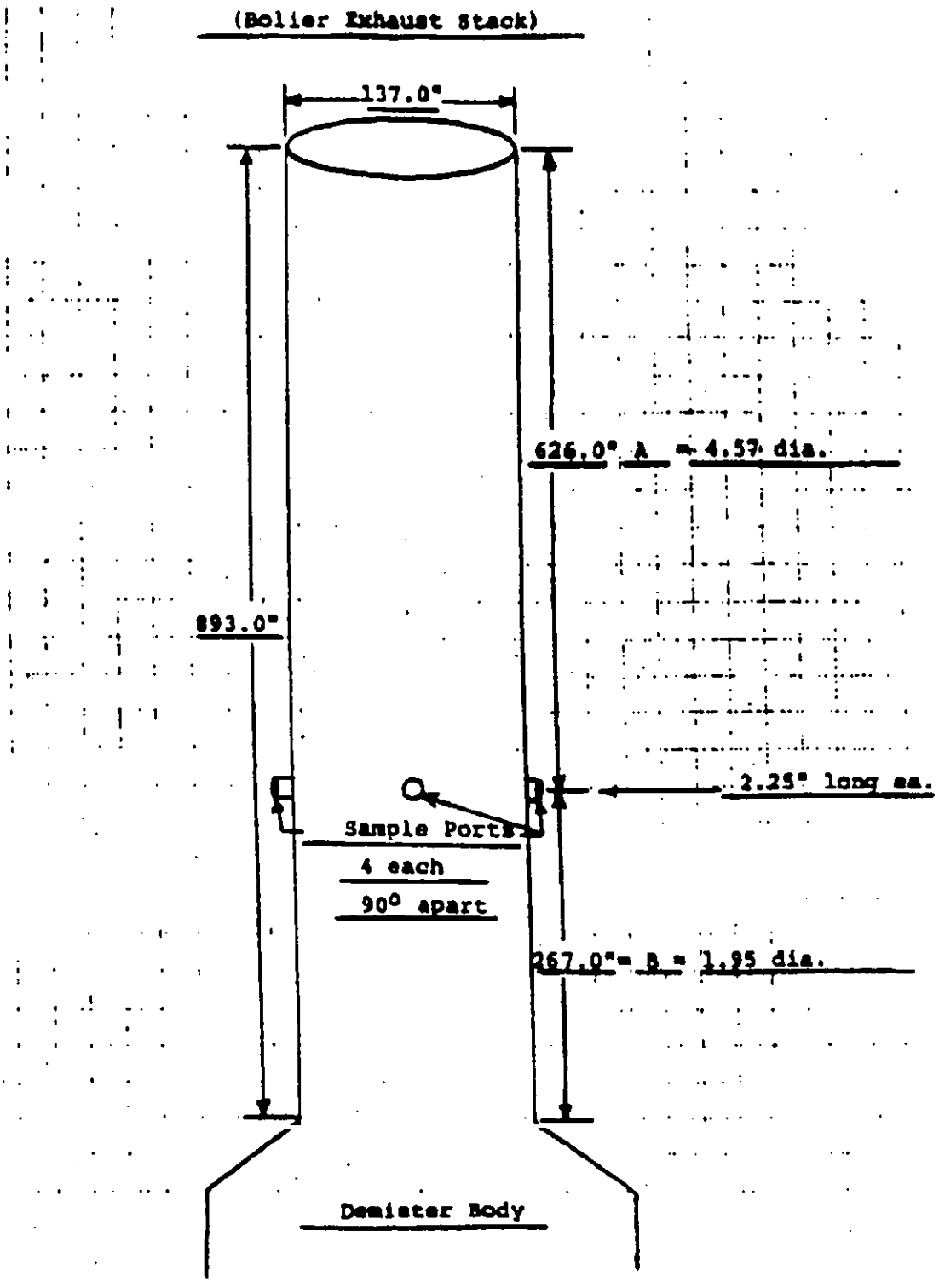
(Boiler Exhaust Stack)
137.0"
626.0" A = 4.57 dia.
893.0"
2.25" long ea.
Sample Ports
4 each
90° apart
267.0" = B = 1.95 dia.
Demister Body

Figure 4-2

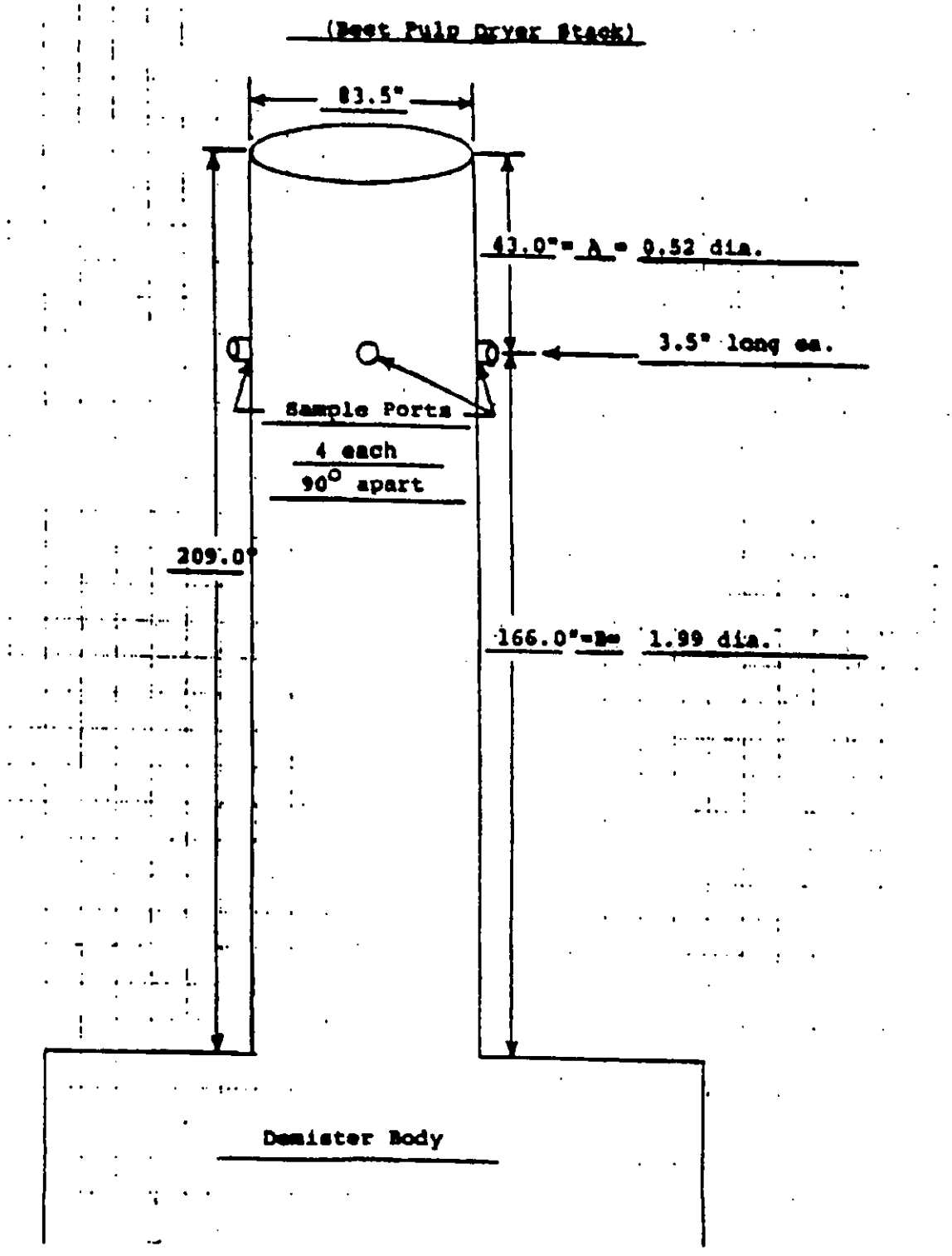
(Beet Pulp Dryer Stack)
83.5"
43.0" = A = 0.52 dia.
3.5" long ea.
Sample Ports
4 each
90° apart
209.0"
166.0" = B = 1.99 dia.
Demister Body

Figure 4-3

Process 2 -- Pulp Dryer: The off gases from the natural gas combustor are used to dry the wet beet pulp mass and the off gases are subsequently passed through a wet, concurrent water spray scrubber for particulate removal. The normal operating conditions are:

- Gas flow: 2.56×10^6 dscfh; and
- Water circulation rate: 600 gpm (Note: this rate is not measured; however, the pump is rated at 600 gpm).

The scrubber was designed and built by Western Sugar Company and installed in 1971. The scrubber was upgraded by Western Sugar in 1988.

Process 3 -- Pellet Cooler: The warm stock feed pellets are collected in a cooler where ambient air is drawn through them for cooling. A multiclone cyclone exists on the outlet of the unit (downstream of the induced-draft fan) for particulate control. No data are routinely collected that could be used to characterize the operational level of the unit. The cyclone was built by Aerotech.

Western Sugar

Final Report

Emissions Testing and Analysis at Billings, Montana Refinery

March 26, 1991

RADIAN
CORPORATION

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CORPORATION

Project Number 238-019

Final Draft Report

EMISSIONS TESTING AND ANALYSIS

AT BILLINGS, MONTANA REFINERY

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22 March 1991

RADIAN CORPORATION

EMISSIONS TESTING AND ANALYSIS AT BILLINGS, MONTANA REFINERY

TABLE OF CONTENTS

1.0 INTRODUCTION

1.0 INTRODUCTION

Radian Corporation was retained by Western Sugar Company to perform particulate matter and sulfur dioxide (SO_2) emission compliance testing at their sugar beet processing facility in Billings, Montana. Three process operations were evaluated during the compliance test program:

- Pellet cooler;
- Pulp dryer (two outlet stacks); and
- Power boiler/wet scrubber unit.

Each of the processes identified was evaluated for particulate emission compliance. The power boiler/wet scrubber unit was the only source evaluated for SO_2 emissions.

In order to demonstrate particulate emission compliance, U.S. Environmental Protection Agency (EPA) Reference Method 5 was performed in triplicate at each source location. The emission results presented in this report are pursuant to an agreement between Western Sugar and the State of Montana. The test results are reported in the following formats:

- Front-half mass (filter mass plus probe-and-nozzle wash mass);
- Back-half mass (condensable particulate collected in impinger train);
- Sum of the front- and back-half mass.

Table 1-1.

Summary of Results of Emissions Testing at
Western Sugar's Billings, Montana Facility
January 1991

Unit	Pollutant	Condition	Front-Half Average[a] (lb/hr)[b]	(lb/MMBtu)[c]	Back-Half Average[a] (lb/hr)	(lb/MMBtu)	Total Average Emission Rate (lb/hr)	(lb/MMBtu)
Power Boilers/ Scrubber	PM[d]	Normal	72.74	0.2065	11.09	0.0315	83.83	0.2380
Power Boilers/ Scrubber	PM	Low Water Flow	87.34	0.2448	7.29	0.0204	94.63	0.2652
Power Boilers/ Scrubber	PM	Low Pressure	89.27	0.2365	8.76	0.0232	98.03	0.2597
Power Boilers/ Scrubber	SO_2[e]	Normal	---	---	---	---	126.4[f]	---
Pulp Dryer North	PM	Normal	8.8	---	4.3	---	13.1	---
Pulp Dryer South	PM	Normal	5.9	---	3.7	---	9.6	---
Pellet Cooler	PM	Normal	0.95	---	0.25	---	1.20	---

[a]Average of three valid runs.
[b]lb/hr = pounds per hour.
[c]lb/MMBtu = pounds per million Btu of coal fired.
[d]PM = particulate matter.
[e]SO_2 = sulfur dioxide.
[f]Average of four valid runs.

2.0 SUMMARY OF RESULTS

2.0 SUMMARY OF RESULTS

Summarized in this section are the particulate and SO_2 emission compliance test results. The reported emission rates are the arithmetic average of the triplicate test series performed at each source location. The particulate emission data are provided for the front-half, back-half, and total particulate collected.

2.1 Power Boiler/Wet Scrubber

The power boiler/wet scrubber emissions were evaluated for particulate and SO_2 emissions. In addition to the emission evaluation, coal samples were collected for the determination of energy content.

Particulate emissions were evaluated during three separate process conditions. The first test series was performed during normal operation of the boilers and wet scrubber. The second test series was performed with a reduced water flow to the wet scrubber. The third test series was performed with a reduced pressure drop across the wet scrubber. Each test condition was evaluated for particulate emissions in triplicate. The results of the particulate emission tests are presented in Table 2-1. This table provides the arithmetic average of the triplicate test series performed during each process condition. The results are presented as the front-half and back-half particulate emission, as well as the total emission in pounds per hour.

The SO_2 testing was performed during normal operations of the wet scrubber. This represents test condition No. 1. Four tests were performed for this evaluation, and each sample was analyzed using an ion chromatograph. The results of the SO_2 emission evaluation are presented in Table 2-2 and are the arithmetic average of the four tests performed at the stack outlet.

Table 2-1.

Summary of Particulate Emission Test Results
Western Sugar - Power Boiler/Wet Scrubber

Test Condition	Front-Half (lb/hr)[a]	Front-Half (lb/MMBtu)[b]	Back-Half (lb/hr)	Back-Half (lb/MMBtu)	Total (lb/hr)	Total (lb/MMBtu)
Normal	72.74	0.2065	11.09	0.0315	83.83	0.2380
Low Water[c]	87.34	0.2448	7.29	0.0204	94.63	0.2652
Low Pressure[c]	89.27	0.2365	8.76	0.0232	98.03	0.2597

[a]lb/hr = pounds per hour.
[b]lb/MMBtu = pounds per million Btu of coal fired.
[c]The water flow and pressure were deliberately lowered to simulate conditions under partial equipment failure.

NOTE: Emission rate per Btu calculated based on 11,000 Btu/lb as fired and the following coal feed rates (tons per day): 1/18, 382.96; 1/19, 385.06; 1/20, 389.72; and 1/21, 411.76.

Table 2-2.

SO_2 Emission Test Results
Western Sugar - Power Boiler/Wet Scrubber

Process Condition	Sulfur Dioxide Concentration (mg/dscf)[a]	Sulfur Dioxide Emission (lb/hr)[b]	(lb/MMBtu)[c]
Normal	9.17	126.4	0.373

[a]mg/dscf = milligrams per dry standard cubic foot.
[b]lb/hr = pounds per hour.
[c]lb/MMBtu = pounds per million Btu of coal fired.

Coal samples were collected through the entire sampling period at the power boiler/wet scrubber stack. Each of the samples collected was composited to provide a sample representative of each day of operation. The composited coal samples were evaluated for total energy content (measured as British thermal units, Btu). No variation in the coal's Btu content was observed from the analysis of the composited samples. The Btu content of the coal was determined to be 11,000 Btu per pound of coal.

2.2 Pulp Dryer

Particulate emission testing was performed at the two pulp dryer outlet stacks. For identification, these stacks were labeled as the north and south pulp dryer stacks. Four tests were performed simultaneously at each outlet stack of the pulp dryer. The first test series was not a valid test due to errors in isokinetic sampling and process upsets. The remaining three tests performed at the outlet stacks were valid.

The results of the particulate emission evaluation performed at the two pulp dryer stacks are provided in Table 2-3. The reported results are the arithmetic average of the triplicate test series. As with the boiler stack, the results are presented as the front-half, back-half, and the total combined emissions.

2.3 Pellet Cooler

The particulate emission test results for the pellet cooler stack are provided in Table 2-4. The results presented are the arithmetic average of the triplicate test series performed at the pellet cooler exhaust stack. The emissions are presented in pounds per hour for the front-half, back-half, and total emissions.

Table 2-3.

Particulate Emission Test Results
Western Sugar - Pulp Dryer Stacks

Stack ID	Front Half Emission (lb/hr)[a]	Back Half Emission (lb/hr)	Total Emission (lb/hr)
North	8.84	4.28	13.13
South	5.93	3.69	9.62

[a]lb/hr = pounds per hour.

Table 2-4.

Particulate Emission Test Results
Western Sugar - Pellet Cooler

Front Half Emission (lb/hr)[a]	Back Half Emission (lb/hr)	Total Emission (lb/hr)
0.949	0.250	1.20

[a]lb/hr = pounds per hour.

2.4 Operating Conditions

During the testing, the coal input was determined daily. Samples were taken during the testing and composited each day for energy content testing. The results of this testing are given in Table 2-5.

Table 2-5.

Documentation of Coal Use Rate
and Energy Content

	1/18/91	1/19/91	1/20/91	1/21/91
Feed rate (tons/day)	382.96	385.06	389.72	411.76
Energy Content[a] (Btu/lb)	11,000	11,000	11,000	11,000

[a]As fired.

3.0 DISCUSSION OF RESULTS

3.0 DISCUSSION OF RESULTS

This section provides a detailed discussion of the emission results in terms of individual test runs. The emission compliance program performed at the Western Sugar facility utilized standard EPA Reference Method test procedures. Any modifications to the Reference Method procedures due to sampling or process conditions are described in this section. All testing for this program was performed according to accepted and established procedures. Descriptions of the Reference Method procedures, as well as the laboratory analysis of collected samples, is provided in Section 5.0 of this report.

3.1 Power Boiler/Wet Scrubber Unit

The emission program for the power boiler/wet scrubber unit operations involved the collection of samples for particulate and SO_2 compliance verification. All samples were collected from the main outlet stack from the wet scrubber system.

The scope of work for the power boiler system detailed the collection of samples during three distinct wet scrubber operating conditions: normal operations, reduced water flow to the scrubber, and reduced pressure drop across the scrubber.

Sample collection for the particulate emission evaluation was performed January 18-19, 1991 using standard Reference Method procedures. Test RM5-1-1 was invalidated due to a problem with the sample collection. During the final leak check of the sample train, the third impinger, containing 3% hydrogen peroxide, was back-purged into the second impinger, contaminating the sample. This sample contamination invalidated the test run due to the required analysis of the back-half particulate, which was collected in the first two impingers of the sample train. The remaining samples collected at the outlet stack were valid with no further sampling problems.

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Table 3-1.
Results of Emissions Testing at Western Sugar's
Billings, Montana Facility

Power Boilers/Wet Scrubber Stack
Normal Operating Conditions; 1/18/91-1/19/91

Test No.	RM5-1-2	RM5-1-3	RM5-1-4	
Date	01-18-91	01-19-91	01-19-91	
Test Time	1602-1731	1015-1210	1534-1704	Average
Effluent Conditions				
Gas Velocity (fps)	23.24	22.54	23.14	22.97
Flow Rate (acfm)	142,816	138,507	142,188	141,170
Flow Rate (dscfm)	103,292	101,673	103,014	102,660
Gas Temperature (F)	119	120	119	119
Moisture (%)	11.0	10.2	11.4	10.9
Isokinetics (%)	98.95	107.36	100.45	102.25
Sample Volume (dscf)	55.98	59.79	56.67	57.48
Analysis (mg)				
Filter	333.3	329.2	247.9	303.47
Probe Wash	2.9	5.4	5.2	4.50
Condensables	32.2	31.5	76.2	46.63
Concentration (gr/dscf)				
Filter	0.0919	0.0850	0.0675	0.0815
Probe Wash	0.0008	0.0014	0.0014	0.0012
Condensables	0.0089	0.0081	0.0208	0.0126
Emission Rate (lb/hr)				
Filter	81.36	74.07	59.61	71.68
Probe Wash	0.71	1.21	1.25	1.06
Condensables	7.86	7.09	18.32	11.09
Emission Rate (lb/MMBtu)*				
Filter	0.23179	0.20983	0.16887	0.2035
Probe Wash	0.00202	0.00343	0.00354	0.0030
Condensables	0.02239	0.02008	0.05190	0.0315

*Based on a coal feed rate of 382.96 tons/day; 11,000 Btu/lb on 1-18
Based on a coal feed rate of 385.06 tons/day; 11,000 Btu/lb on 1-19

Table 3-2.

Results of Emissions Testing at Western Sugar's
Billings, Montana Facility

Power Boilers/Wet Scrubber Stack
Low Water Flow Condition; 1/20/91

Test No.	RM5-2-1	RM5-2-2	RM5-2-3	
Date	01-20-91	01-20-91	01-20-91	
Test Time	1123-1259	1516-1642	1714-1842	Average
Effluent Conditions				
Gas Velocity (fps)	24.49	23.68	24.18	24.12
Flow Rate (acfm)	150,530	145,508	148,590	148,209
Flow Rate (dscfm)	107,126	103,332	105,157	105,205
Gas Temperature (F)	125	124	126	125
Moisture (%)	12.4	12.7	12.7	12.6
Isokinetics (%)	97.28	98.21	99.22	98.24
Sample Volume (dscf)	57.08	55.58	57.15	56.60
Analysis (mg)				
Filter	348.5	345.7	353.9	349.4
Probe Wash	4.3	7.2	5.9	5.8
Condensables	30.8	28.0	30.1	29.6
Concentration (gr/dscf)				
Filter	0.09421	0.09598	0.09557	0.09525
Probe Wash	0.00116	0.00200	0.00159	0.00158
Condensables	0.00833	0.00777	0.00813	0.00808
Emission Rate (lb/hr)				
Filter	86.51	85.01	86.14	85.89
Probe Wash	1.07	1.77	1.44	1.42
Condensables	7.65	6.89	7.33	7.29
Emission Rate (lb/MMBtu)*				
Filter	0.2422	0.2380	0.2412	0.2404
Probe Wash	0.0030	0.0050	0.0040	0.0040
Condensables	0.0214	0.0193	0.0205	0.0204

*Based on a coal feed rate of 389.72 tons/day; 11,000 Btu/lb.

Table 3-3.

Results of Emissions Testing at Western Sugar's
Billings, Montana Facility

Power Boilers/Wet Scrubber Stack
Low Venturi Pressure Drop Condition; 1/21/91

Test No.	RM5-3-1	RM5-3-2	RM5-3-3	
Date	01-21-91	01-21-91	01-21-91	
Test Time	1018-1143	1241-1412	1651-1821	Average
Effluent Conditions				
Gas Velocity (fps)	23.32	23.72	22.90	23.31
Flow Rate (acfm)	143,296	145,795	140,733	143,275
Flow Rate (dscfm)	103,629	104,960	101,021	103,203
Gas Temperature (F)	121	123	121	122
Moisture (%)	11.1	11.3	11.8	11.4
Isokinetics (%)	97.30	98.11	100.51	98.64
Sample Volume (dscf)	55.23	56.40	55.61	55.75
Analysis (mg)				
Filter	340.2	351.8	357.8	349.9
Probe Wash	11.6	9.5	23.0	14.7
Condensables	42.2	37.2	27.6	35.7
Concentration (gr/dscf)				
Filter	0.09506	0.09626	0.09929	0.09687
Probe Wash	0.00324	0.00260	0.00638	0.00407
Condensables	0.01179	0.01018	0.00766	0.00988
Emission Rate (lb/hr)				
Filter	84.44	86.60	85.98	85.67
Probe Wash	2.88	2.34	5.53	3.58
Condensables	10.47	9.16	6.63	8.75
Emission Rate (lb/MMBtu)*				
Filter	0.2237	0.2295	0.2278	0.2270
Probe Wash	0.0076	0.0062	0.0146	0.0095
Condensables	0.0278	0.0243	0.0176	0.0232

*Based on a coal feed rate of 411.76 tons/day; 11,000 Btu/lb.

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Table 3-4.

Results of Sulfur Dioxide Testing at Western Sugar's
Billings, Montana Facility

Power Boilers/Wet Scrubber Stack
Normal Operating Condition/ 1/18/91-1/19/91

Test No.	SO2-1-1	SO2-1-2	SO2-1-3	SO2-1-4	
Date	01-18-91	01-18-91	01-19-91	01-19-91	
Test Time	1208-1318	1631-1751	1047-1147	1600-1720	Average
Effluent Conditions					
Gas Velocity (fps)	24.47	23.24	22.54	23.14	23.35
Flow Rate (acfm)	150,378	142,816	138,507	142,188	143,472
Flow Rate (dscfm)	109,691	103,292	101,673	103,014	104,418
Gas Temperature (F)	117	119	120	119	119
Moisture (%)	10.5	11.0	10.2	11.4	10.8
Isokinetics (%)	92.37	98.95	107.36	100.45	99.78
Sample Volume (dscf)	35.46	36.63	28.63	36.66	34.35
Analysis (mg)					
SO2	320	237	396	269	305.5
Concentration (mg/dscf)					
SO2	9.02	6.47	13.83	7.34	9.17
Emission Rate (lb/hr)					
SO2	131.0	88.4	186.1	100.0	126.4

3.2 Pulp Dryer

Particulate emissions were evaluated at the outlet stacks of the pulp dryer operations. Sample collection at the outlet stacks was performed January 23-25, 1991, utilizing the procedures detailed in EPA Reference Method 5. Both outlet stacks were tested simultaneously to assist in determining the total particulate emissions from the process.

After sampling, an unusually high moisture value was reported to plant personnel. This very high moisture level was also responsible for the "out-of-range" isokinetics. Plant engineers determined that the spray nozzles were partially plugged. The sample set on January 23 was invalidated and, due to stormy weather, sampling was not resumed until January 25. Three sets of samples were taken on January 25.

A process upset was experienced during test RM5-4-2 when the mist eliminator spray lines froze. Plant personnel thawed the frozen lines and sampling continued. No further process upsets were experienced during the remaining tests.

Tables 3-5 and 3-6 present the results of the particulate emission sampling at the two pulp dryer outlet stacks. Each table provides the measured effluent conditions, the total particulate mass collected, and the calculated particulate emissions. Based upon the reported emission results, the outlet stack identified as the North Stack consistently demonstrated a higher particulate emission than the South Stack.

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Table 3-5.

Results of Emissions Testing at Western Sugar's
Billings, Montana Facility

Pulp Dryer—North Stack

Test No.	RM5-4-2N	RM5-4-3N	RM5-4-4N	
Date	01-25-91	01-25-91	01-25-91	
Test Time	1047-1237	1630-1759	1909-2053	Average
Effluent Conditions				
Gas Velocity (fps)	16.18	15.10	15.43	15.57
Flow Rate (acfm)	36,941	34,473	35,219	35544
Flow Rate (dscfm)	17,391	17,032	16,884	17102
Gas Temperature (F)	185	163	166	171
Moisture (%)	35.1	35.0	36.6	35.6
Isokinetics (%)	102.54	104.58	108.90	105.34
Sample Volume (dscf)	35.06	35.02	36.15	35.41
Analysis (mg)				
Filter	139.1	95.2	115.5	116.6
Probe Wash	24.9	14.3	25.5	21.6
Condensables	77.3	60.0	63.4	66.9
Concentration (gr/dscf)				
Filter	0.06123	0.04195	0.04931	0.05083
Probe Wash	0.01096	0.00630	0.01089	0.00938
Condensables	0.03403	0.02644	0.02706	0.02918
Emission Rate (lb/hr)				
Filter	9.13	6.12	7.14	7.46
Probe Wash	1.63	0.92	1.58	1.38
Condensables	5.07	3.86	3.92	4.28

Table 3-6.

Results of Emissions Testing at Western Sugar's
Billings, Montana Facility

Pulp Dryer—South Stack

Test No.	RM5-4-2S	RM5-4-3S	RM5-4-4S	
Date	01-25-91	01-25-91	01-25-91	
Test Time	1047-1237	1630-1759	1909-2053	Average
Effluent Conditions				
Gas Velocity (fps)	14.36	14.21	14.51	14.36
Flow Rate (acfm)	32,769	32,445	33,118	32777
Flow Rate (dscfm)	16,800	16,374	16,467	16547
Gas Temperature (F)	177	165	164	169
Moisture (%)	31.0	33.4	34.5	33.0
Isokinetics (%)	106.80	103.52	108.57	106.30
Sample Volume (dscf)	35.28	33.32	35.15	34.58
Analysis (mg)				
Filter	85.4	72.9	75.9	78.1
Probe Wash	8.4	12.9	25.7	15.7
Condensables	29.9	62.1	82.9	58.3
Concentration (gr/dscf)				
Filter	0.03736	0.03376	0.03332	0.03481
Probe Wash	0.00367	0.00597	0.01128	0.00698
Condensables	0.01308	0.02876	0.03640	0.02608
Emission Rate (lb/hr)				
Filter	5.38	4.74	4.70	4.94
Probe Wash	0.53	0.84	1.59	0.99
Condensables	1.88	4.04	5.14	3.69

3.3 Pellet Cooler

The pellet cooler was evaluated for particulate emission compliance on January 26, 1991, during normal operations of the process. All testing was performed using the procedures detailed in EPA Reference Method 5. No process upsets or sampling errors were experienced during the evaluation of this source.

The results of the emission evaluation performed at the pellet cooler exhaust stack are presented in Table 3-7. The table provides the results of the triplicate test series and details the measured effluent conditions during each test, the total particulate mass collected, and the calculated mass emission rates on a sample train component basis. The variability between the three tests was slight, and this source represents the lowest particulate emission of all the processes evaluated in this program.

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Table 3-7.

Results of Emissions Testing at Western Sugar's
Billings, Montana Facility

Pellet Cooler

Test No.	RM5-5-1	RM5-5-2	RM5-5-3	
Date	01-26-91	01-26-91	01-26-91	
Test Time	1113-1230	1434-1551	1647-1806	Average
Effluent Conditions				
Gas Velocity (fps)	51.80	50.34	49.68	50.61
Flow Rate (acfm)	21,968	21,349	21,071	21,463
Flow Rate (dscfm)	17,476	16,764	16,533	16,924
Gas Temperature (F)	114	121	118	118
Moisture (%)	2.3	2.3	3.0	2.6
Isokinetics (%)	96.65	100.84	102.56	100.02
Sample Volume (dscf)	58.64	58.68	58.87	58.73
Analysis (mg)				
Filter	14.6	18.3	20.0	17.6
Probe Wash	10.9	6.0	4.8	7.2
Condensables	7.9	8.4	3.3	6.5
				31.3
Concentration (gr/dscf)				
Filter	3.84E-03	4.81E-03	5.24E-03	4.63E-03
Probe Wash	2.87E-03	1.58E-03	1.26E-03	1.90E-03
Condensables	2.08E-03	2.21E-03	8.65E-04	1.72E-03
				.00825 gr/dscf
Emission (lb/hr)				
Filter	0.58	0.69	0.74	0.67
Probe Wash	0.43	0.23	0.18	0.28
Condensables	0.31	0.32	0.12	0.25
				1.20
Emission (gr/sec)				
Filter	0.73	0.87	0.94	0.84
Probe Wash	0.54	0.29	0.22	0.35
Condensables	0.39	0.40	0.15	0.32
				1.51

4.0 PROCESS DESCRIPTION

4.0 PROCESS DESCRIPTION

The following section presents a brief description of the beet processing procedures, a discussion of the stack schematics, and a description of the air pollution control equipment.

4.1 Beet Process Description

The following is a description of the processes used by Western Sugar at their Billings, Montana site:

Process 1 -- Power Boiler/Wet Scrubber Unit: Low-sulfur coal is fired in three separate power boilers (stoker feeders). After the useful heat has been removed from the combustion gases, the flue gases are combined and passed through two parallel (north and south) wet venturi scrubbers for particulate removal (see Figure 4-1). Maximum coal firing rate: 18 tons of coal per hour (total in the three boilers; firing rate is read once per shift).

Process 2 -- Pulp Dryer: Processed wet beet pulp is sent to a natural gas fired dryer and pelletized for stock feed. Oil is used as an emergency backup fuel for the pulp dryer. The wet pressed pulp is fed at an average rate of 34 tons per hour; however, the pulp is not routinely weighed, nor is the pellet production weighed (except for loads leaving the facility). Therefore, the only direct measure of the production rate is the natural gas feed rate. Maximum natural gas feed rate is 1600 cubic feet per minute.

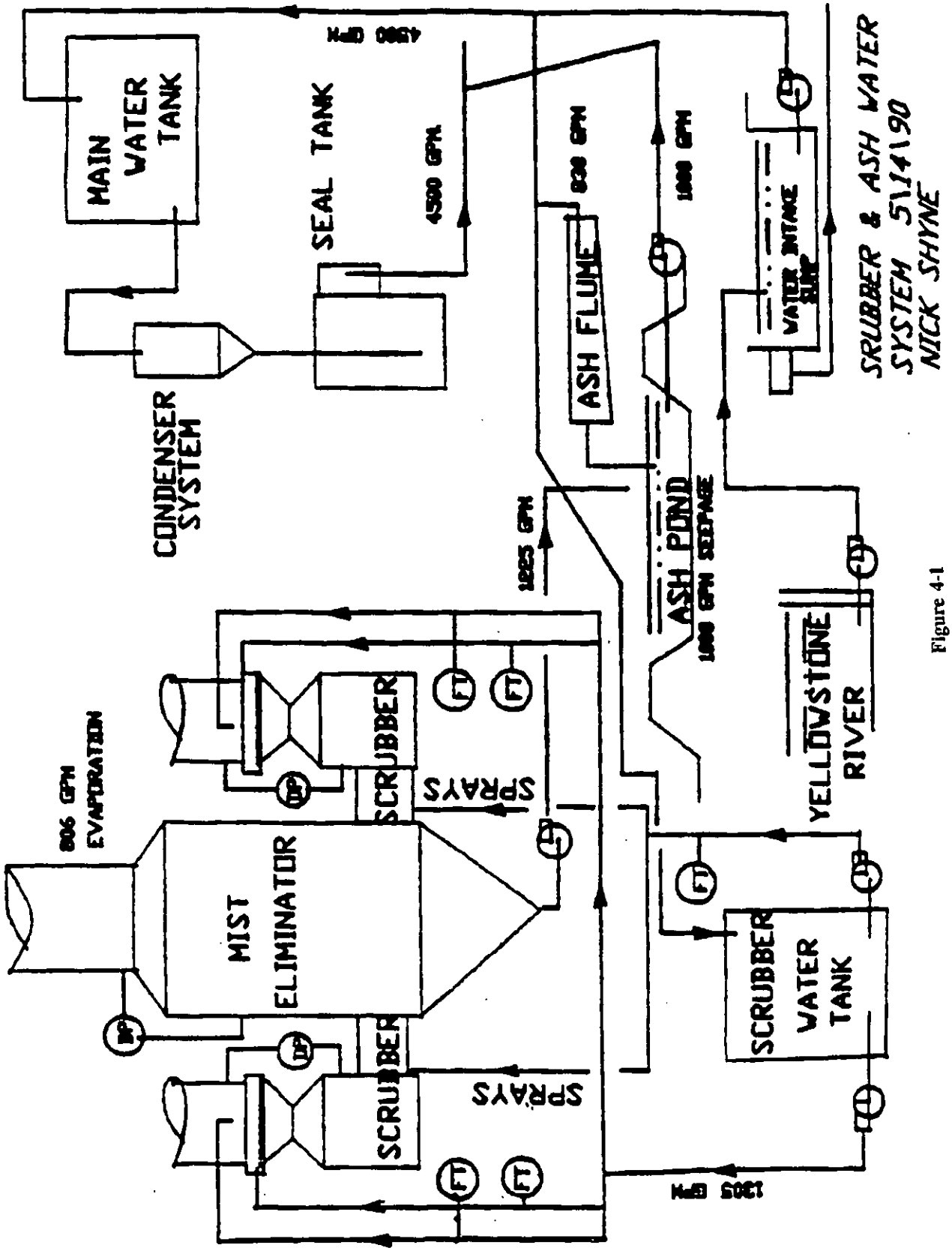
MAIN WATER TANK
SEAL TANK
4500 GPM
CONDENSER SYSTEM
ASH FLUME
ASH POND
WATER INTAKE PUMP
SCRUBBER & ASH WATER SYSTEM 5/14/90 NICK SHYNE
YELLOWSTONE RIVER
SCRUBBER
SPRAYS
MIST ELIMINATOR
SCRUBBER WATER TANK
FT
DP

Figure 4-1

Process 3 -- Pellet Cooler: The hot pelletized stock feed is cooled by an induced-draft fan drawing ambient air through the hot pellets. There is no routine measure of the rate of air flow, or the number of pellets going through the device. All pellets from the pulp dryer pass through the cooler.

4.2 Stack Schematic

Figure 4-2 (power boiler/wet scrubber stack) and Figure 4-3 (two identical pulp dryer stacks) are attached.

4.3 Air Pollution Control Equipment

The following is a description of the air pollution control equipment utilized by Western Sugar at their Billings, Montana site:

Process 1 -- Power Boiler/Wet Scrubber Unit: After the useful heat has been extracted, the flue gases from the three power boilers are combined and passed through two parallel wet venturi scrubbers for particulate removal (see Figure 4-1). The normal operating conditions are:

- Gas flow: 6.33×10^8 dry standard cubic feet per hour (dscfh);
- Water injection rate: 1,305 gallons per minute (gpm); and
- Pressure drop: Nominally, 5 inches of water.

The scrubber was designed and built by Western Sugar Company in 1977.

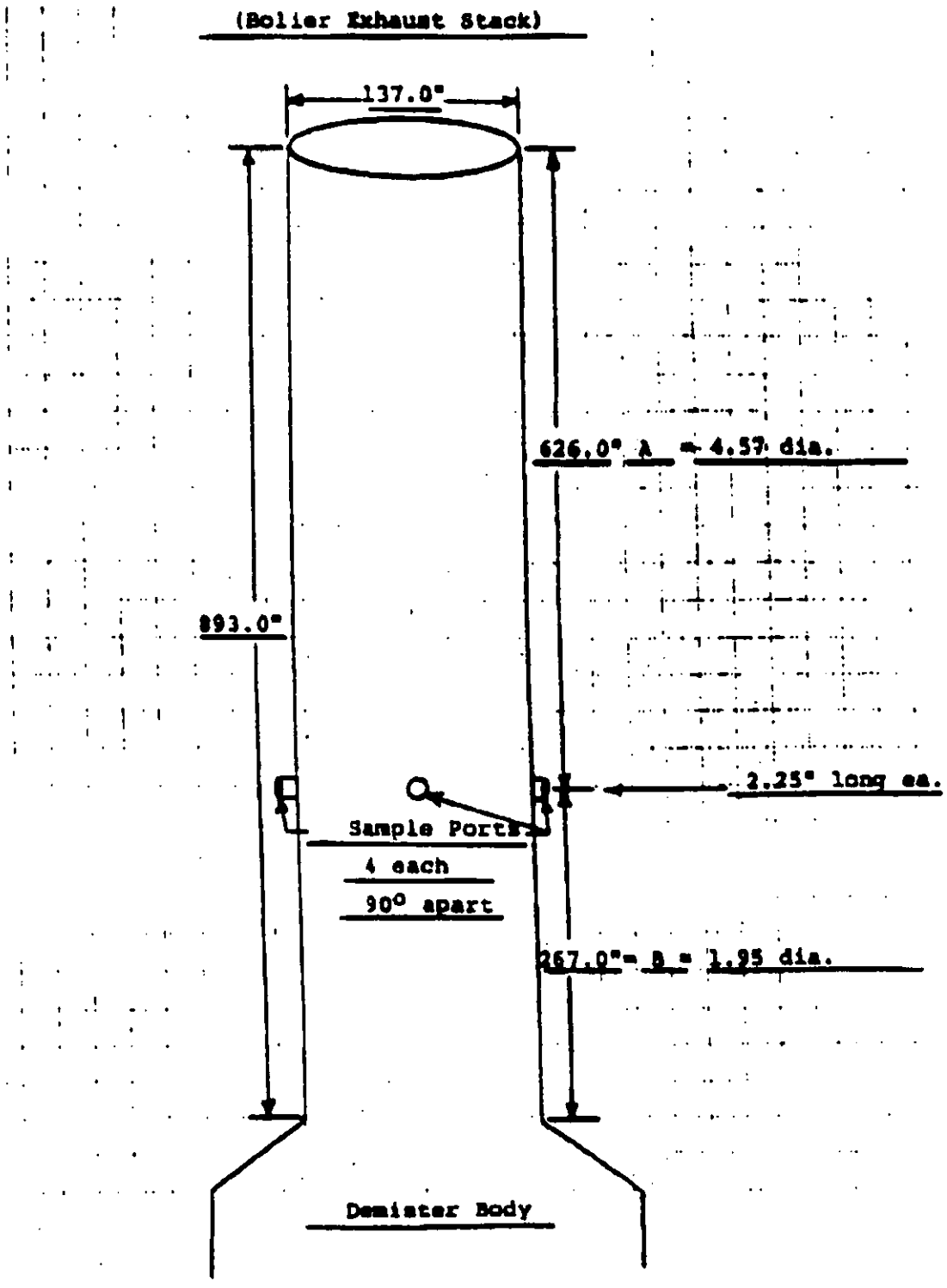
(Boiler Exhaust Stack)
137.0"
626.0" A = 4.57 dia.
893.0"
2.25" long ea.
Sample Ports
4 each
90° apart
267.0" = B = 1.95 dia.
Demister Body

Figure 4-2

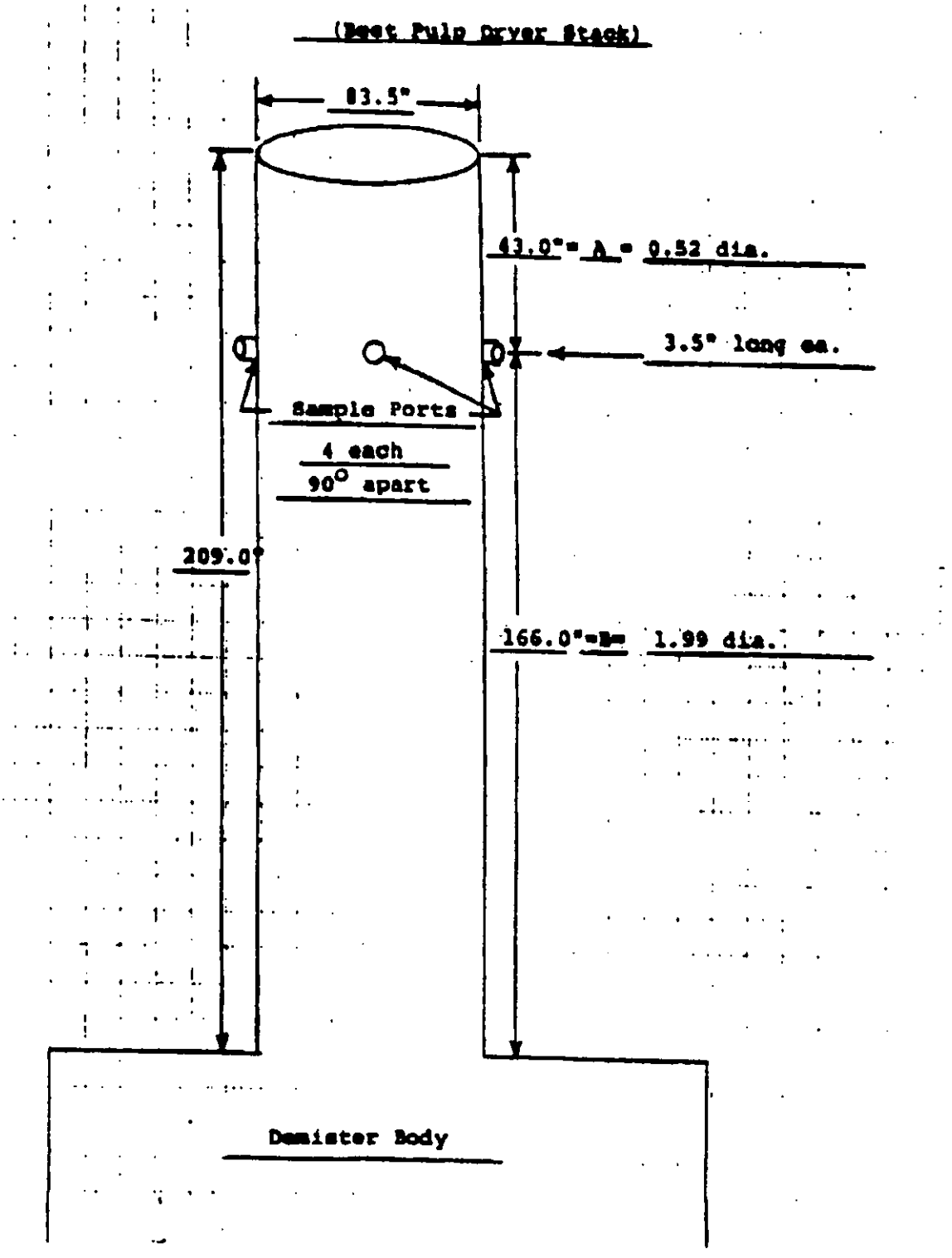
(Beet Pulp Dryer Stack)
83.5"
43.0"= A = 0.52 dia.
3.5" long ea.
Sample Ports
4 each
90° apart
209.0"
166.0"=B= 1.99 dia.
Demister Body

Figure 4-3

Process 2 – Pulp Dryer: The off gases from the natural gas combustor are used to dry the wet beet pulp mass and the off gases are subsequently passed through a wet, concurrent water spray scrubber for particulate removal. The normal operating conditions are:

- Gas flow: 2.56×10^6 dscfh; and
- Water circulation rate: 600 gpm (Note: this rate is not measured; however, the pump is rated at 600 gpm).

The scrubber was designed and built by Western Sugar Company and installed in 1971. The scrubber was upgraded by Western Sugar in 1988.

Process 3 – Pellet Cooler: The warm stock feed pellets are collected in a cooler where ambient air is drawn through them for cooling. A multiclone cyclone exists on the outlet of the unit (downstream of the induced-draft fan) for particulate control. No data are routinely collected that could be used to characterize the operational level of the unit. The cyclone was built by Aerotech.

5.0 TEST METHODOLOGY

5.0 TEST METHODOLOGY

The following section presents the methodology used to collect emission samples for compliance testing. These procedures were selected to provide data of sufficient quality for compliance reporting.

5.1 Selection of Traverse Points

EPA Reference Method 1 (RM1), "Sample and Velocity for Stationary Sources," was used to determine the proper measurement points at the test location of each source based upon the existing test port locations of the stacks.

5.2 Flow Rate Determination

EPA Reference Method 2 (RM2), "Determination of Stack Gas Velocity and Volumetric Flow Rate," was followed to quantify the volumetric flow rate in the stack. As provided in the method, a stainless steel type-S pitot tube was connected to a magnehelic (differential pressure gauge) with an effective range of 0-1 inch (0.05 inch resolution) to determine the flow rate. In addition, effluent temperatures were measured with a type-K thermocouple attached at the measurement point of the pitot tube. The thermocouple was connected to a calibrated digital temperature indicator which provided the temperature measurements.

5.3 Gas Molecular Weight Determination

EPA Reference Method 3 (RM3), "Gas Analysis for Carbon Dioxide, Oxygen, Excess Air, and Dry Molecular Weight," was followed during the sampling. Gas samples were collected in Tedlar bags with a stainless steel probe and hand pump. The

estimates. At isokinetic conditions, the velocity of the stack gas entering the sample nozzle is equal to the effluent velocity at the sample point.

After the completion of each test sequence, the particulate samples were recovered. The collected sample included the particles that had been deposited inside the nozzle, heated probe, and filter holder, as well as the material collected on the filter substrate. The condensable particulate material was recovered independently from the impingers of the condenser assembly. For particulate recovery, the filter was removed from the filter holder with tweezers, placed in a labeled petri dish, and then sealed. The front-half components were washed with acetone and the washing collected in a glass jar. A probe brush was used to remove particulate matter from the inner walls of the front-half components. The back-half samples were recovered by quantitatively transferring the contents of the first two impingers of the condenser assembly to a labeled glass sample bottle. [Note: An early version of the test plan described the Method 5 train with only one water impinger, and that was changed. The train used had two distilled water impingers, a hydrogen peroxide impinger, a blank (empty) impinger, and a silica gel impinger--five impingers total].

All of the collected samples were transported to the Radian Austin, Texas laboratories for analysis. Filters from the individual test runs were removed from their containers and placed in desiccating chambers for conditioning for a minimum of 24 hours. After conditioning, the filters were weighed until a constant weight was achieved. A constant weight is defined as the difference of two consecutive weighings not deviating more than ± 0.5 milligrams.

The front-half washes were quantitatively transferred to conditioned and tared glass beakers. The final volumes of the collected washes were recorded and marked in the laboratory notebook. The beakers were placed under a fume hood and evaporated to dryness. After the samples evaporated, the beakers were returned to the

6.0 CALCULATIONS

6.0 CALCULATIONS

A brief discussion of the data reduction procedures required to support this compliance test program is provided in the following section. All calculations and data reduction procedures are compiled from Title 40 of the Code of Federal Regulations (CFR), Section 60, Appendix A for the specific Reference Methods.

Included with each calculation is a brief definition of terms and general nomenclature utilized in the data reduction process.

6.1 Flow Rate Determination

The average gas velocity in a stack is determined from the gas density and from measurement of the average velocity head with a pitot tube and magnahelic.

NOMENCLATURE

A	-	Cross sectional area of stack or duct, square feet
Cp	-	Pitot tube coefficient, dimensionless
MW (dry)	-	Molecular weight of gas, dry basis, pounds per pound-mole
MW (wet)	-	Molecular weight of gas, moisture corrected, lb/lb-mole
Pb	-	Uncorrected barometric pressure at testing site, inches mercury (Hg)
Pg	-	Static pressure of gas, inches Hg
Ps	-	Absolute pressure of gas, inches Hg
ACFM	-	Effluent flow in actual feet per second
SCFM	-	Effluent flow in standard cubic feet per minute
DSCFM	-	Effluent flow in dry standard cubic feet per minute
Ts	-	Absolute average gas temperature, ^{o}F
VPS	-	Average gas velocity, feet per second

Flow Rate (SCFM)

$$SCFM = 17.64 \times \left[\frac{(Ps)}{(Ts + 460)}\right] \times (ACFM)$$

Flow Rate (DSCFM)

$$DSCFM = 17.64 \times \left[\frac{(100 - \%\ H_2O)}{100}\right] \times \left[\frac{(Ps)}{(Ts + 460)}\right] \times (ACFM)$$

6.2 Moisture Determination

A gas sample is extracted from the source and moisture is removed from the sample stream and determined gravimetrically.

NOMENCLATURE

Bwo	- Water vapor in gas stream, proportion by volume
Pb	- Uncorrected barometric pressure at test location, inches Hg
Tm	- Absolute average dry gas meter temperature, °F
Vm	- Volume of gas sampled as measured by dry gas meter, dry cubic feet
Vmstd	- Volume of gas sampled corrected to standard conditions, dry standard cubic feet
VH_2O	- Volume of water collected in condenser system, milliliters
Vw	- Volume of water vapor, standard cubic feet
Yd	- Dry gas meter calibration factor, dimensionless
dH	- Average pressure differential, inches water

6.3 Particulate Emission Determination

Particulate matter is extracted isokinetically from a source and collected on a heated glass fiber filter. The particulate mass is determined gravimetrically after removal of uncombined water.

NOMENCLATURE

An	- Area of nozzle, square feet
Bwo	- Water vapor in gas stream, proportion by volume
Cpart	- Particulate mass collected, milligrams
dH	- Average orifice pressure drop, inches water
DSCFM	- Effluent flow, dry standard cubic feet per minute
La	- Allowable leak rate
Lp	- Final leak rate of sample train
Pb	- Barometric pressure (uncorrected), inches Hg
Ps	- Average duct static pressure, inches water
T	- Total sample time, minutes
Tm	- Average dry gas meter temperature, °F
Ts	- Average duct temperature, °F
VH_2O	- Volume of condensate collected, milliliters
Vm	- Total meter sample volume, cubic feet
Vs	- Average duct velocity, feet per minute
Vw	- Volume of water vapor, standard cubic feet
Yd	- Dry gas meter calibration factor, dimensionless
%I	- Isokinetic sampling rate, %
$\%O_2$	- Percent oxygen, %

7.0 QUALITY ASSURANCE/QUALITY CONTROL

7.0 QUALITY ASSURANCE/QUALITY CONTROL

EPA Methods 1-6 do not require extensive quality assurance/quality control (QA/QC) measures. The accuracy, precision, detection limits, and percent data capture have been evaluated by EPA. No duplicate samples or field spikes were performed. Radian collected field blanks at a rate greater than 15% of the samples. One field blank was collected on the pellet cooler stack and on each of the two pulp dryer stacks, and two were collected in association with the three sampling days on the power boiler/wet scrubber unit stack. A blank was also collected in association with EPA Method 6 testing.

For the purpose of this testing program, Radian defined a Method 5 field blank as:

- Probe and nozzle wash (from a clean probe and nozzle);
- An unused filter (loaded into a filter holder, sealed, then removed); and
- An impinger blank (water placed in a clean impinger and recovered without sample gas contact).

A Method 6 sample blank was performed by filling the impingers with 3% hydrogen peroxide solution and recovering the impingers according to the specified procedure.

All blanks were collected, transported, and analyzed using exactly the same protocol used for the samples. All blank values were relatively small and subtracted out of the weights of each component (e.g., probe wash, filter).

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