AP-42 Section Number: 9.10.1.2

Reference Number: 6

Title: Results of an Emission Compliance Test on the North Dryer #2 at Southern Minnesota Beet Sugar Cooperative, Renville, Minnesota

MMT Environmental, Inc.

MMT Environmental, Inc.

December 1988

Rec'd 11/9/94

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Reference 6
Report Sect.
Reference

MMT Environmental Services, Inc.
4643 North Chatsworth Street
St. Paul, MN 55112

RESULTS OF AN EMISSION COMPLIANCE TEST ON THE NORTH DRYER #2 AT SOUTHERN MINNESOTA BEET SUGAR COOPERATIVE RENVILLE, MINNESOTA 56284

December 14, 1988

Submitted to:

Southern Minnesota Beet Sugar Cooperative
P. O. Box 500
Renville, Minnesota 56284

Attention: Mr. W. D. DeBelly

Prepared by:

Clifford E. Mohs
Manager, Technical Services

Approved by:

for Milos Tomaides, Ph.D., P.E.

Report Number 8722
Project Number 8202

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RESULTS OF AN EMISSION COMPLIANCE TEST ON THE NORTH DRYER #2 AT SOUTHERN MINNESOTA BEET SUGAR COOPERATIVE RENVILLE, MINNESOTA 56284

December, 1988

Report Number 8722
Project Number 8202

1 INTRODUCTION

On December 14, 1988, MMT Environmental Services, Inc. performed a source emission compliance test on one of the four cyclones used to remove the particulates from the exhaust gas of drum dryer "B". The cyclone tested is designated "B2", it is the only cyclone of the four that has straightening vanes in the discharge. Testing of the other cyclones, without flow straightening vanes, would be invalid due to turbulence and cyclonic flow patterns. The tests were performed at the request of Mr. W. D. DeBelly.

The MMT sampling team consisted of Clifford E. Mohs, Robert A. Laska and Ted Gibbons.

MPCA officials were notified of the compliance test but elected not to observe the on-site testing, but were present doing other onsite visiting business.

2 TEST RESULTS

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

2.1 Particulate Emissions

Table 2.1 presents the results of the particulate emission tests. Particulate emissions of the three runs averaged .0893 gr/DSCF.

2.2 Visible Emissions

Attempts were made to make visible emissions observation during all three of the test runs but because of the high moisture content of the gas and the close proximity of the other stacks, it was impossible to make V. E. reading.

2.3 Cyclone B2 Particulate Removal

Table 2.3.1 presents the result of the pulp material collected at the bottom of the cyclone B2. Collected material averaged 195 lb/hr.

Table 2.3.2 presents the cyclone removal efficiency. The average efficiency was determined as 96.2%.

2.4 Comments

No problems were encountered during the acquisition and analysis of the samples and the results should be representative of the process during the test period.

The analysis of the fuel oil used for heating is presented in the Process Data Appendix.

TABLE 2.1 SUMMARY OF PARTICULATE EMISSION TEST RESULTS

PROJECT NUMBER: 8202 COMPANY: SOUTHERN MN SUGAR BEET COOP
TEST NUMBER: 1 SOURCE: NORTH CYCLONE DRYER #2

TEST PARAMETER	RUN 1	RUN 2	RUN 3
TEST DATE	12/14/88	12/14/88	12/14/88
TIME OF TEST, HR;			
START	0928	1044	1204
FINISH	1029	1147	1310
EFFLUENT TEMPERATURE, °DEGREES F	292	279	259
EFFLUENT MOISTURE CONTENT, % V/V	29.8	30.6	30.5
EFFLUENT COMPOSITION, % V/V DRY;			
CARBON DIOXIDE	5.2	5.2	5.2
OXYGEN	14.9	14.9	14.9
CARBON MONOXIDE	0.0	0.0	0.0
EFFLUENT VOLUMETRIC FLOW RATE;			
ACTUAL CONDITIONS, ACFM	20741	20401	20739
STANDARD CONDITIONS, SCFM	14031	14025	14657
DRY STANDARD CONDITIONS, DSCFM	9847	9733	10183
ISOKINETIC VARIATION, %	96.6	99.4	95.0
EFFLUENT PARTICULATE CONCENTRATION;			
ACTUAL CONDITIONS, GR/ACF	0.0424	0.0400	0.0462
STANDARD CONDITIONS, GR/SCF	0.0627	0.0582	0.0654
DRY STANDARD CONDITIONS, GR/DSCF	0.0894	0.0839	0.0941
SOURCE PARTICULATE EMISSION RATE;			
CLASSICAL METHOD, LB/HR	7.55	7.01	8.22
RATIO OF AREAS METHOD, LB/HR	7.29	6.96	7.80

9921

0.0891 in sample

7.59, 7.35

PARTICULATE CONCENTRATION AND EMISSION RATES BASED ON ANALYSIS OF THE SAMPLING TRAIN FRONT AND BACK CATCHES.

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

700 ≤ .0520 - allow 0.0892

CYCLONE BOTTOM COLLECTION

Table 2.3.1

Start: 9:05	End: 13:06	4 Hours.
Wheelbarrow Tare Weight	44 lbs	46 lbs
Wheelbarrow & Pulp Weight	77 lbs	78 lbs
	77 lbs	78 lbs
	76 lbs	78 lbs
	77 lbs	78 lbs
	77 lbs	78 lbs
	79 lbs	84 lbs
	84 lbs	81 lbs
	83 lbs	86 lbs
	82 lbs	83 lbs
	82 lbs	88 lbs
	94 lbs	96 lbs
	76 lbs	
	964 lbs	908 lbs
	-(12 x 47)	-(11 x 48)
	400 lbs	380 lbs

Total 400 lbs + 380 lbs = 780/4 hours = 195.0 lbs/hr

CYCLONE "B2" REMOVAL EFFICIENCY

Table 2.3.2

	lb/hr	lb/hr	*Efficiency
Run #1	7.63	195.0	96.2%
Run #2	7.08	195.0	96.5%
Run #3	8.31	195.0	95.9%
Average	7.67	195.0	96.2%

$$* \; E = 100 - \left(\frac{\text{Emissions (lb/hr)}}{\text{Bottom Collection (lb/hr)} = \text{Emission (lb/hr)}} \text{X } 100 \right)$$

3 EMISSION 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, 1985. 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 (Figure 3.1). 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 particulate test run. Analysis of the sample was performed with a standard Orsat analyzer using commercially prepared solutions.

Figure 3.1 Description of Sampling Location

Duct cross-sectional dimensions at the sampling location: 47.5

Equivalent diameter (rectangular duct only): _____

Distance from sampling ports to the nearest flow disturbance;

Before sampling ports: 5.6 = _____ duct diameters

After sampling ports: 2.0 = _____ duct diameters

Number of sampling points;

Required by EPA Method 1: 26

Actually used: Only used 20 because straightening vanes were installed

Number of ports: 2

Points per port: 10

Sketch of sampling location: Not to Scale

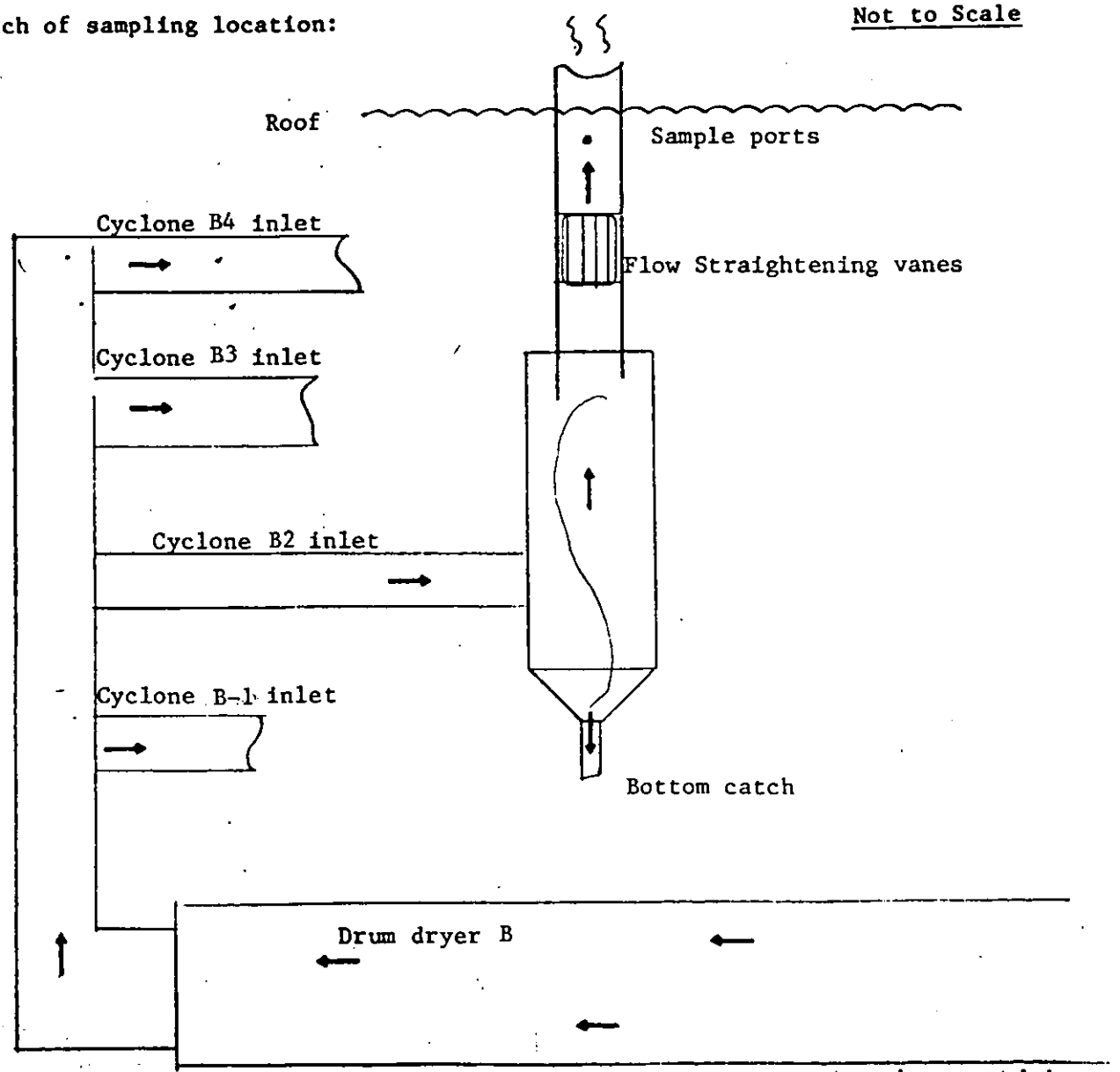
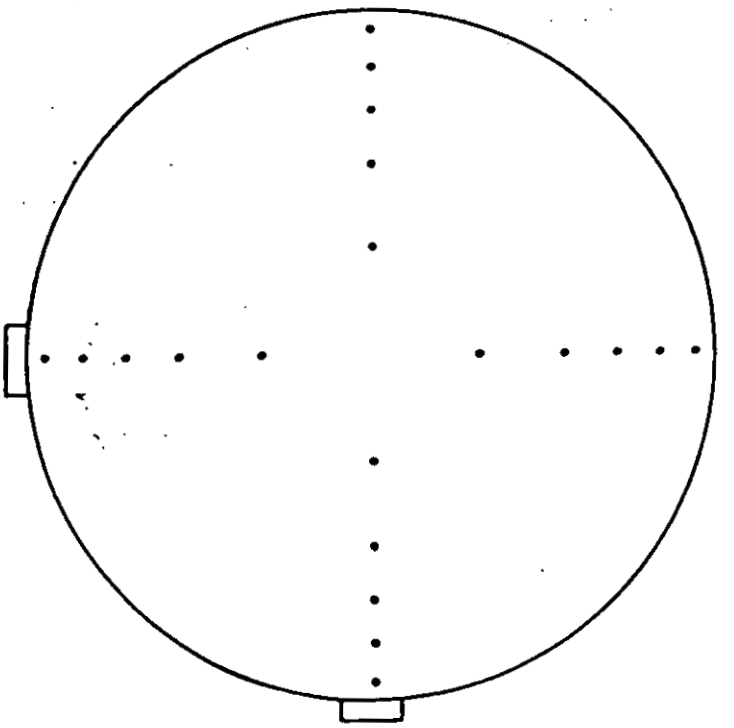


Figure 3.2 Sampling Point Locations Within the Duct

Sketch: 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	2.53	1.2	13		
2	8.21	3.9	14		
3	14.5	6.9	15		
4	22.5	10.7	16		
5	34.1	16.2	17		
6	65.9	31.3	18		
7	77.5	36.8	19		
8	85.5	40.6	20		
9	91.8	43.6	21		
10	97.5	46.3	22		
11			23		
12			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. (See Comment Section)

3.6 Effluent Particulate Concentration

The effluent particulate concentration was determined per EPA Method 5. In this procedure, particulate matter is isokinetically withdrawn from the source and collected on a glass-fiber filter. Organic vapors and other condensibles which pass through the filter are collected in an ice-cooled impinger trap. The particulate mass, which includes any material which condenses at the filtration temperature, is determined gravimetrically after removal of any uncombined water.

The sampling train (Figure 3.3) 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, pressure indicator and all operating controls. The thermocouple is connected to a separately housed temperature readout.

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 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.

Figure 3.3 Particulate Sampling Train

Sampling train;

Manufacturer: RAC (Research Appliance Company)

Model: Stak Samplr

Hot box set-up;

Cyclone: NA

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

Filtration temperature, °F: +250°F

Cold box set-up;

Impinger Number	Type*	Contents
1	M	Deionized - Distilled H_2O
2	S	Deionized - Distilled H_2O
3	M	Empty
4	M	Silica Gel
5		

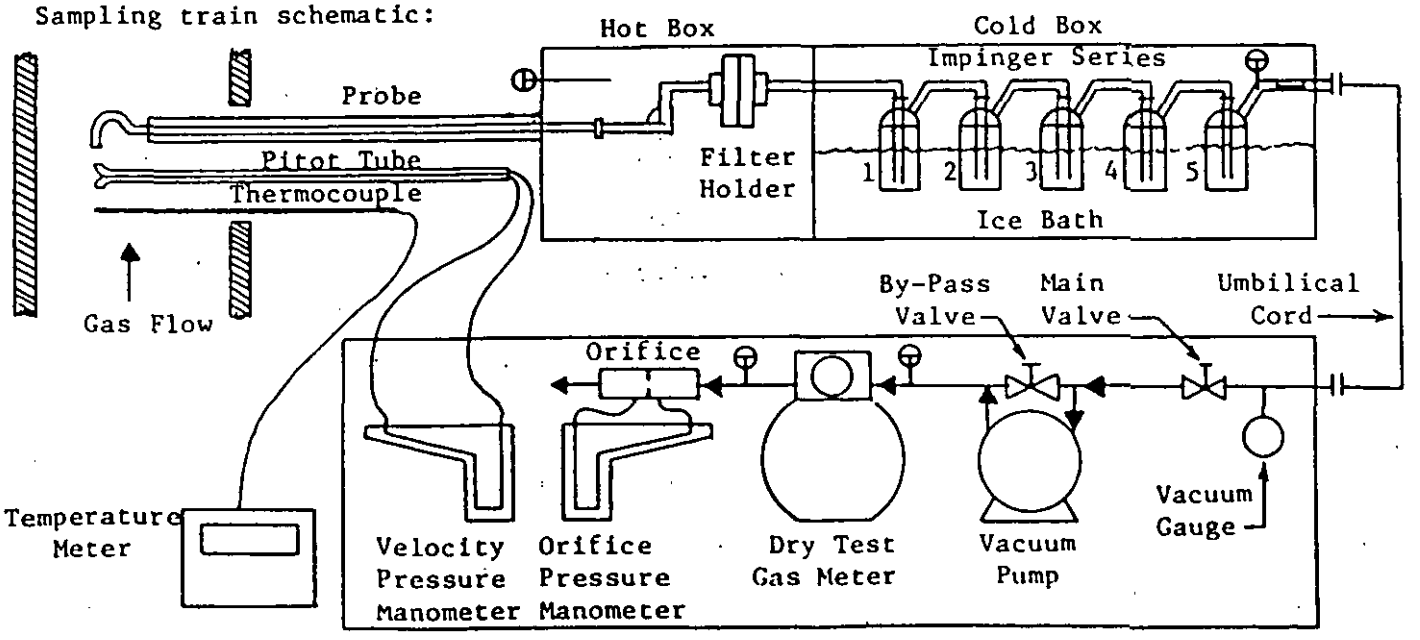
* S: Standard Greenburg-Smith design
M: Modified Greenburg-Smith design (straight tip)

Probe: 5 foot with stainless steel liner.

Nozzle: stainless steel, .375 inch nominal diameter

Sampling time: 60 minutes per point; 5 minutes per test run.

Sampling train schematic:



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 (if used) and all connecting glassware in front of the filter was quantitatively transferred to Container #2 by means of distilled water wash followed by an acetone wash. A stiff brush was used in the probe cleaning step to help dislodge deposits. The water collected in each of the impingers (desiccant column excluded) was measured and transferred to container #3. The desiccant column was then weighed and its contents were transferred to a waste desiccant container.

Sample analysis was performed at MMT's laboratory. The filter was dried in a 105 degree C oven for 3 hours and then desiccated to constant weight. The contents of Container #2 was transferred to a tared beaker, evaporated to near dryness, and desiccated to a constant weight. Organic particulate matter was extracted (separatory funnel) from the impinger solution in Container #3 with three (3) 25 ml portions of chloroform followed by three (3) 25 ml portions of ethyl ether. The ether and chloroform extracts were combined in a tared dish, evaporated to near dryness, and then desiccated to constant weight. The total mass of particulate matter collected during each test run is the sum of the front catch, filter catch and back catch.

3.7 Source Plume Opacity

Visible emissions were not made, see comment 2.2.

4 CYCLONE DISCHARGE PROCEDURE

Two preweighed wheelbarrows were alternately placed under the cyclone B2 bottom discharge pipe. Approximately every 10 minutes the wheelbarrow under the discharge pipe would be replaced with the other wheelbarrow and then weighed. This was done continuously during the test period, including the change over time between each of the runs. The weights are presented in the Process Data Appendix.

APPENDIX A

CALCULATIONS

DEFINITION OF UNIT ABBREVIATIONS

ACFM ..... ACTUAL CUBIC FEET PER MINUTE

DEG F ..... DEGREES FAHRENHEIT

DCF ..... DRY CUBIC FEET

DSCF ..... DRY STANDARD CUBIC FEET

DSCFM ..... DRY STANDARD CUBIC FEET PER MINUTE

FPS ..... FEET PER SECOND

G ..... GRAMS

GR/ACF ..... GRAINS PER ACTUAL CUBIC FOOT

GR/DSCF ..... GRAINS PER DRY STANDARD CUBIC FOOT

GR/SCF ..... GRAINS PER STANDARD CUBIC FOOT

IN ..... INCHES

IN HG ..... INCHES OF MERCURY

IN WC ..... INCHES OF WATER

LB/HR ..... POUNDS PER HOUR

LB/LB-MOLE .. POUND PER POUND-MOLE

MIN ..... MINUTES

ML ..... MILLILITERS

SCF ..... STANDARD CUBIC FEET

SCFM ..... STANDARD CUBIC FEET PER MINUTE

SF ..... SQUARE FEET

% V/V DRY ... PERCENT BY VOLUME, DRY BASIS

DEFINITION OF STANDARD CONDITIONS

STANDARD TEMPERATURE ..... 68 DEGREES FAHRENHEIT

STANDARD PRESSURE ..... 29.92 INCHES OF MERCURY

DEFINITION OF VARIABLES

An .... CROSS-SECTIONAL AREA OF NOZZLE, SF
As .... CROSS-SECTIONAL AREA OF STACK, SF
Bwp ... EFFLUENT MOISTURE CONTENT, PERCENT BY VOLUME
Bws ... EFFLUENT MOISTURE CONTENT, PROPORTION BY VOLUME
Ca* ... EFFLUENT PARTICULATE CONCENTRATION AT ACTUAL CONDITIONS, GR/ACF; *=f,b,t; Caf: FRONT CATCH ONLY; Cab: BACK CATCH ONLY; Cat: TOTAL CATCH
CD .... EFFLUENT CARBON DIOXIDE CONCENTRATION, % V/V DRY
CM .... EFFLUENT CARBON MONOXIDE CONCENTRATION, % V/V DRY
Cp .... PITOT TUBE COEFFICIENT, DIMENSIONLESS
Cs* ... EFFLUENT PARTICULATE CONCENTRATION AT DRY STANDARD CONDITIONS, GR/DSCF; *=f,b,t; Csf: FRONT CATCH ONLY; Csb: BACK CATCH ONLY; Cst: TOTAL CATCH
Cw* ... EFFLUENT PARTICULATE CONCENTRATION AT STANDARD CONDITIONS, GR/SCF; *=f,b,t; Cwf: FRONT CATCH ONLY; Cwb: BACK CATCH ONLY; Cwt: TOTAL CATCH
Dn .... NOZZLE DIAMETER, IN
I ..... ISOKINETIC VARIATION, %
Md .... EFFLUENT MOLECULAR WEIGHT, LB/LB-MOLE, DRY BASIS
Ms .... EFFLUENT MOLECULAR WEIGHT, LB/LB-MOLE, WET BASIS
NI .... EFFLUENT NITROGEN CONCENTRATION, % V/V DRY
OX .... EFFLUENT OXYGEN CONCENTRATION, % V/V DRY
Pb .... BAROMETRIC PRESSURE, IN HG
Pg .... STACK STATIC PRESSURE, IN WC
Po .... AVERAGE PRESSURE DROP ACROSS THE METERING ORIFICE, IN WC
Ps .... STACK ABSOLUTE PRESSURE, IN HG
Pv .... AVERAGE SQUARE-ROOT VELOCITY PRESSURE, IN WC
Qa .... EFFLUENT FLOW RATE AT ACTUAL CONDITIONS, ACFM
Qs .... EFFLUENT FLOW RATE AT STANDARD CONDITIONS, SCFM
Qsd ... EFFLUENT FLOW RATE AT STANDARD CONDITIONS, DRY BASIS, DSCFM
Rc* ... SOURCE PARTICULATE EMISSION RATE, CLASSICAL METHOD, LB/HR; *=f,b,t; Rcf: FRONT CATCH ONLY; Rcb: BACK CATCH ONLY; Rct: TOTAL CATCH
Rr* ... SOURCE PARTICULATE EMISSION RATE, RATIO OF AREAS METHOD, LB/HR; *=f,b,t; Rrf: FRONT CATCH ONLY; Rrb: BACK CATCH ONLY; Rrt: TOTAL CATCH
Sl .... STACK DIAMETER OR LENGTH, IN
Sw .... STACK WIDTH, IN
Ti .... TOTAL SAMPLING TIME, MIN
Tm .... AVERAGE DRY GAS METER TEMPERATURE, DEG F
Ts .... AVERAGE EFFLUENT TEMPERATURE, DEG F
Vl .... VOLUME OF LIQUID COLLECTED, ML
Vm .... VOLUME OF GAS SAMPLED AT METER CONDITIONS, DCF
Vms ... VOLUME OF GAS SAMPLED AT STANDARD CONDITIONS, DSCF
Vs .... AVERAGE EFFLUENT VELOCITY, FPS
Vw .... VOLUME OF WATER VAPOR COLLECTED AT STANDARD CONDITIONS, SCF
Wb .... MASS OF PARTICULATE MATTER COLLECTED IN THE BACK (WET) CATCH, G
Wf .... MASS OF PARTICULATE MATTER COLLECTED IN THE FRONT (DRY) CATCH, G
Wt .... TOTAL MASS OF PARTICULATE MATTER COLLECTED, G
Y ..... DRY GAS METER COEFFICIENT, DIMENSIONLESS

EQUATIONS USED TO CALCULATE PARTICULATE EMISSIONS

An = 0.005454154 * Dn * Dn

As = 0.005454154 * Sl * Sl (FOR ROUND STACKS)

As = Sl * Sw / 144.0 (FOR RECTANGULAR STACKS)

Ps = Pb + Pg/13.6

NI = 100.0 - CD - OX - CM

Wt = Wf + Wb

Vms = (528/29.92) * Vm * Y * (Pb + Po/13.6) / (Tm + 460.0)

Vw = 0.04707 * Vl

Bws = Vw / (Vw * Vms)

Bwp = 100.0 * Bws

Md = 0.440 * CD + 0.320 * OX + 0.280 * (NI + CM)

Ms = Md * (1.0 - Bws) + 18.0 * Bws

Vs = 85.49 * Cp * Pv * SQRT((Ts+460.0)/(Ms*Ps))

Qa = 60.0 * Vs * As

Qs = Qa * (528/29.92) * Ps / (Ts + 460.0)

Qsd = Qs * (1.0 - Bws)

I = 0.09450 * (Ts+460.0) * Vms / (Ps * Vs * An * Ti * (1.0-Bws))

Csf = 15.42 * Wf / Vws
Csb = 15.42 * Wb / Vws
Cst = 15.42 * Wt / Vws

Cwf = Csf / (1.0 - Bws)
Cwb = Csb / (1.0 - Bws)
Cwt = Cst / (1.0 - Bws)

Caf = Cwf * (29.92/528.0) * (Ts+460.0) / Ps
Cab = Cwb * (29.92/528.0) * (Ts+460.0) / Ps
Cat = Cwt * (29.92/528.0) * (Ts+460.0) / Ps

Rcf = 0.008578 * Csf * Qsd
Rcb = 0.008578 * Csb * Qsd
Rct = 0.008578 * Cst * Qsd

Rrf = 0.008578 * Csf * (Vms/Ti) * (As/An)
Rrb = 0.008578 * Csb * (Vms/Ti) * (As/An)
Rrt = 0.008578 * Cst * (Vms/Ti) * (As/An)

PARTICULATE EMISSION TEST CALCULATIONS

PROJECT NUMBER: B202 COMPANY: SOUTHERN MN SUGAR BEET COOP
TEST NUMBER: 1 SOURCE: NORTH CYCLONE DRYER #2
RUN NUMBER: 1 TIME: 12/14/88 0928-1029

TEST DATA

GAS METER COEFFICIENT	0.9985	Y	VOLUME OF LIQUID COLLECTED, ML	317.6	Vl
PITOT TUBE COEFFICIENT	0.833	Cp			
NOZZLE DIMENSIONS;			GAS COMPOSITION, % V/V DRY;		
DIAMETER, IN	0.373	Dn	CARBON DIOXIDE	5.20	CD
AREA, SF	0.000759	An	OXYGEN	14.90	OX
			CARBON MONOXIDE	0.00	CM
			NITROGEN (BY DIFFERENCE)	79.90	NI
STACK DIMENSIONS;					
DIAMETER/LENGTH, IN	47.50	Sl	AVE. TRAVERSE POINT DATA;		
WIDTH, IN	0.00	Sw	STACK TEMP., DEG F	292	Ts
AREA, SF	12.306	As	METER TEMP., DEG F	101	Tm
			ORIFICE PRESSURE, IN WC	1.188	Po
BAROMETRIC PRESSURE, IN HG	28.82	Pb	SQRT VELOCITY P., IN WC	0.394	Pv
STACK PRESSURES;			MASS OF PARTICULATE MATTER		
STATIC, IN WC	0.00	Pg	COLLECTED, G;		
ABSOLUTE, IN HG	28.82	Ps	FRONT CATCH (81.7%)	0.1666	Wf
			BACK CATCH (18.3%)	0.0374	Wb
SAMPLING TIME, MIN	60.00	Ti	TOTAL CATCH	0.2040	Wt
VOLUME OF GAS SAMPLED AT METER, DCF	38.732	Vm			

CALCULATED RESULTS

VOLUME OF GAS SAMPLED AT METER, DSCF	35.184	Vms	GAS MOLECULAR WEIGHT;		
			DRY BASIS, LB/LB-MOLE	29.43	Md
			WET BASIS, LB/LB-MOLE	26.02	Ms
EQUIVALENT VOLUME OF WATER VAPOR COLLECTED, SCF	14.949	Vw	AVERAGE GAS VELOCITY, FPS	28.09	Vs
GAS MOISTURE CONTENT;			GAS VOLUMETRIC FLOW RATE;		
VOLUME FRACTION	0.2982	Bws	ACTUAL, ACFM	20741	Qa
PERCENT BY VOLUME	29.82	Bwp	STANDARD, SCFM	14031	Qs
			DRY STANDARD, DSCFM	9847	Qsd
			ISOKINETIC VARIATION, %	96.63	I

PARTICULATE EMISSION PARAMETER	FRONT CATCH	BACK CATCH	TOTAL CATCH
PARTICULATE CONCENTRATION			
ACTUAL, GR/ACF	0.0347 Caf	0.0078 Cab	0.0424 Cat
STANDARD, GR/SCF	0.0512 Csf	0.0115 Csb	0.0627 Cst
DRY STANDARD, GR/DSCF	0.0730 Csf	0.0164 Csb	0.0894 Cst
PARTICULATE EMISSION RATE, LB/HR			
CLASSICAL METHOD	6.17 Rcf	1.38 Rcb	7.55 Rct
RATIO OF AREAS METHOD	5.96 Rrf	1.34 Rrb	7.29 Rrt

STANDARD CONDITIONS: 68 DEG F, 29.92 IN HG * NON-APPLICABLE DATA

TRAVERSE POINT DATA SUMMARY AND VELOCITY PROFILE

PROJECT NUMBER: 8202 COMPANY: SOUTHERN MN SUGAR BEET COOP
TEST NUMBER: 1 SOURCE: NORTH CYCLONE DRYER #2
RUN NUMBER: 1 TIME: 12/14/88 0928-1029

SAMPLING LOCATION PORT	POINT	TRAVERSE POINT DATA: VELOCITY PRESSURE IN WC	ORIFICE PRESSURE IN WC	TEMPERATURE, DEG.F STACK GAS	METER INLET	METER OUTLET	VELOCITY PROFILE: SQRT VELOCITY PRESSURE	GAS VELOCITY FT/SEC
A	1	0.160	1.220	295	88	88	0.400	28.58
A	2	0.160	1.220	295	87	92	0.400	28.58
A	3	0.170	1.290	295	88	92	0.412	29.46
A	4	0.160	1.220	295	88	97	0.400	28.58
A	5	0.150	1.140	295	90	101	0.387	27.67
A	6	0.150	1.140	291	90	102	0.387	27.60
A	7	0.150	1.140	290	92	105	0.387	27.58
A	8	0.140	1.070	290	93	105	0.374	26.65
A	9	0.130	0.990	289	94	106	0.361	25.66
A	10	0.100	0.760	288	95	107	0.316	22.49
B	1	0.160	1.220	289	96	102	0.400	28.47
B	2	0.180	1.370	290	97	108	0.424	30.22
B	3	0.180	1.370	295	99	111	0.424	30.32
B	4	0.180	1.370	296	99	114	0.424	30.34
B	5	0.180	1.370	298	101	112	0.424	30.38
B	6	0.180	1.370	299	102	114	0.424	30.40
B	7	0.170	1.290	298	103	115	0.412	29.52
B	8	0.160	1.220	294	103	115	0.400	28.56
B	9	0.140	1.070	283	104	115	0.374	26.52
B	10	0.120	0.910	271	104	115	0.346	24.36
AVERAGE		0.156	1.188	292	96	106	0.394	28.09

PARTICULATE EMISSION TEST CALCULATIONS

PROJECT NUMBER: 8202 COMPANY: SOUTHERN MN SUGAR BEET COOP
TEST NUMBER: 1 SOURCE: NORTH CYCLONE DRYER #2
RUN NUMBER: 2 TIME: 12/14/88 1044-1147

TEST DATA

GAS METER COEFFICIENT	2.9985 Y	VOLUME OF LIQUID COLLECTED, ML	335.2 Vl
PITOT TUBE COEFFICIENT	0.833 Cp		
NOZZLE DIMENSIONS;		GAS COMPOSITION, % V/V DRY;	
DIAMETER, IN	0.373 Dn	CARBON DIOXIDE	5.20 CD
AREA, SF	0.000759 An	OXYGEN	14.90 OX
		CARBON MONOXIDE	0.00 CM
		NITROGEN (BY DIFFERENCE)	79.90 NI
STACK DIMENSIONS;			
DIAMETER/LENGTH, IN	47.50 Sl	AVE. TRAVERSE POINT DATA;	
WIDTH, IN	0.00 Sw	STACK TEMP., DEG F	279 Ts
AREA, SF	12.306 As	METER TEMP., DEG F	104 Tm
		ORIFICE PRESSURE, IN WC	1.244 Po
BAROMETRIC PRESSURE, IN HG	28.80 Pb	SQRT VELOCITY P., IN WC	0.390 Pv
STACK PRESSURES;		MASS OF PARTICULATE MATTER	
STATIC, IN WC	0.00 Pg	COLLECTED, G;	
ABSOLUTE, IN HG	28.80 Ps	FRONT CATCH (79.7%)	0.1551 Wf
		BACK CATCH (20.3%)	0.0396 Wb
SAMPLING TIME, MIN	60.00 Ti	TOTAL CATCH	0.1947 Wt
VOLUME OF GAS SAMPLED AT METER, DCF	39.643 Vm		

CALCULATED RESULTS

VOLUME OF GAS SAMPLED AT METER, DSCF	35.778 Vms	GAS MOLECULAR WEIGHT;	
		DRY BASIS, LB/LB-MOLE	29.43 Md
		WET BASIS, LB/LB-MOLE	25.93 Ms
EQUIVALENT VOLUME OF WATER VAPOR COLLECTED, SCF	15.778 Vw	AVERAGE GAS VELOCITY, FPS	27.63 Vs
GAS MOISTURE CONTENT;		GAS VOLUMETRIC FLOW RATE;	
VOLUME FRACTION	0.3060 Bws	ACTUAL, ACFM	20401 Qa
PERCENT BY VOLUME	30.60 Bwp	STANDARD, SCFM	14025 Qs
		DRY STANDARD, DSCFM	9733 Qsd
		ISOKINETIC VARIATION, %	99.41 I

PARTICULATE EMISSION PARAMETER	FRONT CATCH	BACK CATCH	TOTAL CATCH
PARTICULATE CONCENTRATION			
ACTUAL, GR/ACF	0.0319 Caf	0.0081 Cab	0.0400 Cat
STANDARD, GR/SCF	0.0464 Csf	0.0118 Csb	0.0582 Cst
DRY STANDARD, GR/DSCF	0.0668 Csf	0.0171 Csb	0.0839 Cst
PARTICULATE EMISSION RATE, LB/HR			
CLASSICAL METHOD	5.58 Rcf	1.42 Rcb	7.01 Rct
RATIO OF AREAS METHOD	5.54 Rrf	1.42 Rrb	6.96 Rrt

STANDARD CONDITIONS: 68 DEG F, 29.92 IN HG * NON-APPLICABLE DATA

TRAVERSE POINT DATA SUMMARY AND VELOCITY PROFILE

PROJECT NUMBER: B202 COMPANY: SOUTHERN MN SUGAR BEET COOP
TEST NUMBER: 1 SOURCE: NORTH CYCLONE DRYER #2
RUN NUMBER: 2 TIME: 12/14/88 1044-1147

		TRAVERSE POINT DATA					VELOCITY PROFILE	
SAMPLING LOCATION PORT	POINT	VELOCITY PRESSURE IN WC	ORIFICE PRESSURE IN WC	TEMPERATURE, DEG.F STACK GAS	METER INLET	METER OUTLET	SQRT VELOCITY PRESSURE	GAS VELOCITY FT/SEC
A	1	0.190	1.560	284	100	98	0.436	30.98
A	2	0.160	1.300	288	99	107	0.400	28.51
A	3	0.170	1.380	285	99	108	0.412	29.33
A	4	0.160	1.300	287	100	108	0.400	28.49
A	5	0.170	1.380	289	100	108	0.412	29.41
A	6	0.170	1.380	291	100	108	0.412	29.44
A	7	0.160	1.300	290	101	108	0.400	28.55
A	8	0.170	1.380	284	102	108	0.412	29.31
A	9	0.150	1.220	280	102	106	0.387	27.45
A	10	0.150	1.220	270	103	108	0.387	27.27
B	1	0.150	1.220	285	102	102	0.387	27.55
B	2	0.150	1.220	286	101	110	0.387	27.57
B	3	0.150	1.220	282	101	108	0.387	27.49
B	4	0.160	1.300	279	101	108	0.400	28.34
B	5	0.170	1.380	274	101	108	0.412	29.11
B	6	0.160	1.300	270	101	109	0.400	28.16
B	7	0.150	1.220	270	101	109	0.387	27.27
B	8	0.120	0.980	268	101	109	0.346	24.36
B	9	0.110	0.890	264	101	108	0.332	23.26
B	10	0.090	0.730	260	102	107	0.300	20.98
AVERAGE		0.153	1.244	279	101	107	0.390	27.63

PARTICULATE EMISSION TEST CALCULATIONS

PROJECT NUMBER: 8202 COMPANY: SOUTHERN MN SUGAR BEET COOP
TEST NUMBER: 1 SOURCE: NORTH CYCLONE DRYER #2
RUN NUMBER: 3 TIME: 12/14/88 1204-1310

TEST DATA

GAS METER COEFFICIENT	0.9985 Y	VOLUME OF LIQUID COLLECTED, ML	333.7 Vl
PITOT TUBE COEFFICIENT	0.833 Cp	GAS COMPOSITION, % V/V DRY:	
NOZZLE DIMENSIONS:		CARBON DIOXIDE	5.20 CD
DIAMETER, IN	0.373 Dn	OXYGEN	14.90 OX
AREA, SF	0.000759 An	CARBON MONOXIDE	0.00 CM
STACK DIMENSIONS:		NITROGEN (BY DIFFERENCE)	79.90 NI
DIAMETER/LENGTH, IN	47.50 Sl	AVE. TRAVERSE POINT DATA:	
WIDTH, IN	0.00 Sw	STACK TEMP., DEG F	259 Ts
AREA, SF	12.306 As	METER TEMP., DEG F	104 Tm
		ORIFICE PRESSURE, IN WC	1.255 Po
BAROMETRIC PRESSURE, IN HG	28.80 Pb	SQRT VELOCITY P., IN WC	0.402 Pv
STACK PRESSURES:		MASS OF PARTICULATE MATTER COLLECTED, G:	
STATIC, IN WC	0.00 Pg	FRONT CATCH (85.5%)	0.1865 Wf
ABSOLUTE, IN HG	28.80 Ps	BACK CATCH (14.5%)	0.0317 Wb
SAMPLING TIME, MIN	60.00 Ti	TOTAL CATCH	0.2182 Wt
VOLUME OF GAS SAMPLED AT METER, DCF	39.633 Vm		

CALCULATED RESULTS

VOLUME OF GAS SAMPLED AT METER, DSCF	35.751 Vms	GAS MOLECULAR WEIGHT:	
		DRY BASIS, LB/LB-MOLE	29.43 Md
EQUIVALENT VOLUME OF WATER VAPOR COLLECTED, SCF	15.707 Vw	WET BASIS, LB/LB-MOLE	25.94 Ms
		AVERAGE GAS VELOCITY, FPS	28.09 Vs
GAS MOISTURE CONTENT:		GAS VOLUMETRIC FLOW RATE:	
VOLUME FRACTION	0.3052 Bws	ACTUAL, ACFM	20739 Qa
PERCENT BY VOLUME	30.52 Bwp	STANDARD, SCFM	14657 Qs
		DRY STANDARD, DSCFM	10183 Qsd
		ISOKINETIC VARIATION, %	94.95 I

PARTICULATE EMISSION PARAMETER	FRONT CATCH	BACK CATCH	TOTAL CATCH
PARTICULATE CONCENTRATION			
ACTUAL, GR/ACF	0.0395 Caf	0.0067 Cab	0.0462 Cat
STANDARD, GR/SCF	0.0559 Csf	0.0095 Csb	0.0654 Cst
DRY STANDARD, GR/DSCF	0.0804 Csf	0.0137 Csb	0.0941 Cst
PARTICULATE EMISSION RATE, LB/HR			
CLASSICAL METHOD	7.03 Rcf	1.19 Rcb	8.22 Rct
RATIO OF AREAS METHOD	6.67 Rrf	1.13 Rrb	7.80 Rrt

STANDARD CONDITIONS: 68 DEG F, 29.92 IN HG * NON-APPLICABLE DATA

TRAVERSE POINT DATA SUMMARY AND VELOCITY PROFILE

PROJECT NUMBER: 8202 COMPANY: SOUTHERN MN SUGAR BEET COOP
TEST NUMBER: 1 SOURCE: NORTH CYCLONE DRYER #2
RUN NUMBER: 3 TIME: 12/14/88 1204-1310

		TRAVERSE POINT DATA					VELOCITY PROFILE	
SAMPLING LOCATION PORT	POINT	VELOCITY PRESSURE IN WC	ORIFICE PRESSURE IN WC	TEMPERATURE, DEG.F STACK GAS	METER INLET	METER OUTLET	SQRT VELOCITY PRESSURE	GAS VELOCITY FT/SEC
A	1	0.170	1.310	265	97	97	0.412	28.93
A	2	0.170	1.310	268	98	101	0.412	28.98
A	3	0.170	1.310	264	98	101	0.412	28.91
A	4	0.180	1.390	260	97	101	0.424	29.66
A	5	0.160	1.240	260	97	99	0.400	27.96
A	6	0.150	1.160	260	98	100	0.387	27.08
A	7	0.150	1.160	260	97	101	0.387	27.08
A	8	0.130	1.000	256	97	107	0.361	25.14
A	9	0.130	1.000	250	97	108	0.361	25.03
A	10	0.120	0.930	248	98	109	0.346	23.88
B	1	0.190	1.470	260	98	106	0.436	30.47
B	2	0.180	1.390	265	101	114	0.424	29.76
B	3	0.180	1.390	265	101	115	0.424	29.76
B	4	0.190	1.470	265	102	116	0.436	30.58
B	5	0.170	1.310	266	103	117	0.412	28.95
B	6	0.180	1.390	266	103	117	0.424	29.78
B	7	0.190	1.470	260	104	117	0.436	30.47
B	8	0.160	1.240	255	105	116	0.400	27.87
B	9	0.170	1.310	250	105	117	0.412	28.62
B	10	0.110	0.850	248	106	114	0.332	22.99
AVERAGE		0.163	1.255	259	100	109	0.402	28.09

APPENDIX B

FIELD DATA FORMS

SOURCE EMISSION TEST
FIELD DATA SHEET

TEST: 1	RUN: 1
Page 1 of 1	

TEST IDENTIFICATION	EQUIPMENT IDENTIFICATION	NOMOGRAPH PARAMETERS
MMT Job Number: 8202	Control Unit No.: 2	ΔH@ 1.80
Date: 12-14-88	Gas Meter Coefficient: 1.006	TM 110
Company: So. MN Coop	Sample Box No.: 2	MC 33
Source: North Cyclone #2	Probe No.: 4-1 Length: 4 ft	PS/PM 1.00
Source Dimensions: 47½" ø	Pitot No.: 4-1 Coefficient: 0.84	C
Test Team: RL CM TG	Nozzle No.: S-3 Diameter: 0.373	TS 300
Test Procedure: EPA 1-5	Filter No.: 8190	R
Ambient Temp., °F:	Barometric Pressure, in.Hg 29.98 ≈ 30.00 − 0.82	Static Pressure, in.WC: 0.00

CLOCK TIME hours	TRAVERSE POINT NUMBER	SAMPLE TIME min.	SAMPLE VOLUME cu.ft.	VELOCITY HEAD in.WC	ORIFICE ΔH, in.WC REQ.	ORIFICE ΔH, in.WC ACT.	PUMP VAC. inHG	TEMPERATURE, DEG F STACK GAS	GAS METER IN	GAS METER OUT	OVEN	PROBE	LAST IMP.
0928	A-1	0	508.756	0.16	1.22	1.22	3	295	86	88	250	250	55
	2	3	10.7	0.16	1.22	1.22	3	295	87	92	265	250	55
	3	6	12.7	0.17	1.29	1.29	3	295	88	92	265	250	54
X	4	9	14.7	0.16	1.22	1.22	3	295	88	97	260	250	55
	5	12	16.7	0.15	1.14	1.14	3	295	90	101	260	255	56
50 X	6	15	18.6	0.15	1.14	1.14	3	291	90	102	265	255	57
Pot X	7	18	20.5	0.15	1.14	1.14	3	290	92	105	265	255	56
	8	21	22.4	0.14	1.07	1.07	3	290	93	105	266	255	57
	9	24	24.2	0.13	0.99	0.99	3	289	94	106	265	254	58
	10	27	26.0	0.10	0.76	0.76	3	288	95	107	260	253	59
0958	end A	30	527.55										
0959	B-1	0	27.55	0.16	1.22	1.22	3	289	96	102	255	251	54
	2	3	29.5	0.18	1.37	1.37	3	290	97	108	255	251	55
	3	6	31.6	0.18	1.37	1.37	4	295	99	111	254	252	56
X	4	9	33.7	0.18	1.37	1.37	4	296	99	114	255	251	56
Wb X	5	12	35.8	0.18	1.37	1.37	4	298	101	112	256	250	57
Pot X	6	15	37.9	0.18	1.37	1.37	4	299	102	114	255	250	58
	7	18	39.9	0.17	1.29	1.29	4	298	103	115	259	251	59
	8	21	42.0	0.16	1.22	1.22	4	294	103	115	259	251	61
	9	24	43.9	0.14	1.07	1.07	4	283	104	115	262	251	64
	10	27	45.8	0.12	0.91	0.91	4	271	104	115	265	255	66
1029	end B	30	547.488										
			38.732										

MOISTURE DETERMINATION					
IMPINGER	1	2	3	4	5
Final	3				X
Initial	100	100	0	869.2	
Difference					
Total Moisture Collected:					

SYSTEM LEAK CHECKS		
Time	Rate (cfm)	Vac. (in.Hg)
0900	0.004	10"
0930	0.002	8"

Impinger Catch Description:

DETERMINATION OF GAS COMPOSITION BY ORSAT ANALYSIS								
Sample Id:	Replicate 1		Replicate 2		Replicate 3		Average	
Bu #5	Buret Reading	Percent Volume	Buret Reading	Percent Volume	Buret Reading	Percent Volume	Compound	Percent Volume
Initial Reading	0.0	X	0.0	X	100	X	X	X
Carbon Dioxide	94.8	5.2	94.7	5.3	94.7	5.3	CO_2	5.2
Oxygen	79.1	14.9	79.8	14.9			O_2	

SOURCE EMISSION TEST
FIELD DATA SHEET

TEST: 1 | RUN: 2
Page 1 of 1

TEST IDENTIFICATION		EQUIPMENT IDENTIFICATION		NOMOGRAPH PARAMETERS
MMT Job Number:	8202	Control Unit No.:	2	ΔH@ 1.8
Date:	12-14-88	Gas Meter Coefficient:	1.006	TM 120
Company:	So. MN Coop	Sample Box No.:	2	MC 32
Source:	North Cyclone #2	Probe No.: 4-1	Length: 4 ft	PS/PM 1.00
Source Dimensions:	47.5" ø	Pitot No.: 4-1	Coefficient: 0.84	C
Test Team:	RL CM TG	Nozzle No.: S-3	Diameter: 0.373	TS [illegible]
Test Procedure:	EPA 1-5	Filter No.:	8191	R
Ambient Temp., °F:		Barometric Pressure, in.Hg: 28.80		Static Pressure, in.WC: 0.00

CLOCK TIME hours	TRAVERSE POINT NUMBER	SAMPLE TIME min.	SAMPLE VOLUME cu.ft.	VELOCITY HEAD in.WC	ORIFICE ΔH, in.WC		PUMP VAC. inHG	TEMPERATURE, DEG F					
					REQ.	ACT.		STACK GAS	GAS METER IN	GAS METER OUT	OVEN	PROBE	LAST IMP.
1044	B-1	0	547.653	0.19	1.56	1.56	3	284	100	98	245	250	54
	2	3	49.8	0.16	1.30	1.30	3	288	99	107	251	255	55
	3	6	50.9	0.17	1.38	1.38	3	285	99	108	254	256	56
	4	9	54.0	0.16	1.30	1.30	3	287	100	109	257	257	58
	5	12	56.0	0.17	1.38	1.38	3	289	100	108	258	256	60
	6	15	58.1	0.17	1.38	1.38	4	291	100	108	259	255	62
	7	18	60.2	0.16	1.30	1.30	4	290	101	108	259	254	63
	8	21	62.2	0.17	1.38	1.38	4	284	102	108	260	253	64
	9	24	64.3	0.15	1.22	1.22	3.5	280	102	106	261	252	65
	10	27	66.3	0.15	1.22	1.22	3.8	270	103	108	261	251	66
1114	end B	30	68.28	~~~									
1117	A-1	0	68.3	0.15	1.22	1.22	3	285	102	105	261	251	60
	2	3	70.2	0.15	1.22	1.22	3	286	101	107	261	251	61
	3	6	72.2	0.15	1.22	1.22	3	282	101	108	262	252	62
	4	9	74.2	0.16	1.30	1.30	4	279	101	108	262	252	63
	5	12	76.2	0.17	1.38	1.38	5	274	101	108	263	253	65
	6	15	78.3	0.16	1.30	1.30	4.5	270	101	109	264	253	66
	7	18	80.3	0.15	1.22	1.22	4.5	270	101	109	265	252	69
	8	21	82.3	0.12	0.98	0.94	4	268	101	109	266	252	72
	9	24	84.1	0.11	0.89	0.89	4	264	101	108	267	251	75
	10	27	85.8	0.09	0.73	0.73	4	260	102	107	266	250	76
1147	end A	30	587.296	~~~									
			39.64										

MOISTURE DETERMINATION					
IMPINGER	1	2	3	4	5
Final					X
Initial	100	100	0	892.9	
Difference					
Total Moisture Collected:					

SYSTEM LEAK CHECKS		
Time	Rate (cfm)	Vac. (in.Hg)
1040	0.001	11"
1149	0.002	13"

Impinger Catch Description:

DETERMINATION OF GAS COMPOSITION BY ORSAT ANALYSIS								
Sample Id: Bag #5	Replicate 1		Replicate 2		Replicate 3		Average	
	Buret Reading	Percent Volume	Buret Reading	Percent Volume	Buret Reading	Percent Volume	Compound	Percent Volume
Initial Reading	100	X	100	X	100	X	X	X
Carbon Dioxide	96.5	3.5	96.0	4.0	95.9	4.1	CO2	4.0
Oxygen	80.0	16.5	80.6	15.4	80.5	15.4	O2	15.4

SOURCE EMISSION TEST
FIELD DATA SHEET

TEST: 1	RUN: 3
Page 1 of 1	

TEST IDENTIFICATION		EQUIPMENT IDENTIFICATION		NOMOGRAPH PARAMETERS
MMT Job Number:	8202	Control Unit No.:	2	ΔH@ 1.8
Date:	12-14-83	Gas Meter Coefficient:	1.006	TM 105
Company:	So. MN Coop	Sample Box No.:	2	MC 34
Source:	North Cyclone #2	Probe No.: 4-1	Length: 4 ft	PS/PM 1.0
Source Dimensions:	47.5" Ø	Pitot No.: 4-1	Coefficient: 0.84	C
Test Team:	CM RL TG	Nozzle No.: 5-3	Diameter: 0.373	TS 280
Test Procedure:	EPA 1-5	Filter No.:	8192	R
Ambient Temp., °F:		Barometric Pressure, in.Hg: 28.80		Static Pressure, in.WC: 0.00

CLOCK TIME hours	TRAVERSE POINT NUMBER	SAMPLE TIME min.	SAMPLE VOLUME cu.ft.	VELOCITY HEAD in.WC	ORIFICE ΔH, in.WC REQ.	ORIFICE ΔH, in.WC ACT.	PUMP VAC. inHG	TEMPERATURE, DEG F: STACK GAS	GAS METER IN	GAS METER OUT	OVEN	PROBE	LAST IMP.
1204	A-1	0	587.438	0.17	1.31	1.31	6	265	97	97	250	255	55
	2	3	89.5	0.17	1.31	1.31	6	268	98	101	255	255	62
	3	6	91.5	0.17	1.31	1.31	6.5	264	98	101	256	255	63
	4	9	93.5	0.18	1.39	1.39	7	260	97	101	255	255	64
	5	12	95.6	0.16	1.24	1.24	7	260	97	99	256	255	65
	6	15	97.6	0.15	1.16	1.16	7	260	98	100	257	255	66
	7	18	99.5	0.15	1.16	1.16	7	260	97	101	258	256	67
	8	21	601.4	0.13	1.00	1.00	6	256	97	107	259	256	68
	9	24	3.2	0.13	1.00	1.00	6	250	97	108	260	256	69
	10	27	5.0	0.12	0.93	0.93	6	240	98	109	260	255	70
1234	end A	30	606.674										
1240	B-1	0	6.6	0.19	1.47	1.47	8	260	98	106	260	255	64
	2	3	8.8	0.18	1.39	1.39	8	265	101	114	260	256	65
	3	6	10.9	0.18	1.39	1.39	8	265	101	115	260	255	66
	4	9	13.0	0.19	1.47	1.47	9	265	102	116	261	252	67
	5	12	15.2	0.17	1.31	1.31	8	266	103	117	260	251	68
	6	15	17.2	0.18	1.39	1.39	8	266	103	117	260	250	69
	7	18	19.3	0.19	1.47	1.47	9	260	104	117	261	250	72
	8	21	21.4	0.16	1.24	1.24	8	255	105	116	263	251	74
	9	24	23.4	0.17	1.31	1.31	8	250	105	117	261	255	75
	10	27	25.4	0.11	0.85	0.85	7	248	106	114	261	254	77
1310	end B	30	627.071										
			39.633										

MOISTURE DETERMINATION					
IMPINGER	1	2	3	4	5
Final					
Initial	100	100	0	883.2	
Difference					
Total Moisture Collected:					

SYSTEM LEAK CHECKS		
Time	Rate (cfm)	Vac. (in.Hg
1201	0.003	10"
1311	0.002	10"

Impinger Catch Description:

DETERMINATION OF GAS COMPOSITION BY ORSAT ANALYSIS								
Sample Id:	Replicate 1		Replicate 2		Replicate 3		Average	
	Buret Reading	Percent Volume	Buret Reading	Percent Volume	Buret Reading	Percent Volume	Compound	Percent Volume
Bag #3								
Initial Reading								
Carbon Dioxide							CO_2	5.2
Oxygen							O_2	14.9
Carbon Monoxide							CO	

B-3

APPENDIX C

LABORATORY REPORT

SUMMARY OF PARTICULATE EMISSION TEST LABORATORY DATA

PROJECT NUMBER: 8202 COMPANY: SOUTHERN MN SUGAR BEET COOP
TEST NUMBER: 1 SOURCE: NORTH CYCLONE DRYER #2

	MASS OF PARTICULATE MATTER COLLECTED, GRAMS							
	FRONT CATCH				BACK CATCH			TOTAL PARTICULATE MASS COLLECTED
RUN NUMBER	FRONT WASH	CYCLONE CATCH	FILTER CATCH	FRONT TOTAL	IMPINGER CATCH **	IMPINGER WASH	BACK TOTAL	
1	0.0429	0.0000	0.1237	0.1666	0.0235	0.0139	0.0374	0.2040
2	0.0225	0.0000	0.1326	0.1551	0.0221	0.0175	0.0396	0.1947
3	0.0465	0.0000	0.1400	0.1865	0.0103	0.0214	0.0317	0.2182

* NOT APPLICABLE

** CHLOROFORM/ETHYL ETHER EXTRACTION

Aluminum Trays wts

Date of weighing initial	Final	Sample Id	TARE wt	1st wt	2nd wt	3rd wt	★ Including extraction of the [illegible] wt gain	81 Use
12-15	12-16	8317	2.3529	2.3557	2.3560	2.3556	.0027	blank
12-15	12-16	8318	2.3574	2.3743	2.3761	2.3756	.2155	FW R-1 Kin
12-15	12-16	8319	2.3293	2.4786	2.4800	2.4803	.1483	FW R-2 Kin
12-15	12-16	8320	2.3625	2.6897	2.6900	2.6904	.3252	FW R-3 Kin
12-15	12-16	8321	2.3412	2.3461	2.3497	2.3499	.0037	BW R-1 Kin
12-15	12-16	8322	2.3506	2.3550	2.3542	2.3538	.0032	BW R-2 Kin
12-15	12-16	8323	2.3531	2.3555	2.3553	—	.0023	BW R-3 Kin
12-15	12-16	8324	2.3482	2.3497	2.3499	—	.0017	Extract R-1 Kin
12-15	12-16	8325	2.3545	2.3576	2.3571	2.3569	.0024	Extract R-2 Kin
12-15	12-16	8326	2.3497	2.3505	2.3509	2.3512	.0015	Extract R-3 Kin
12-15	12-16	8327	2.3423	2.3597	2.3607	2.3610	0.0160	FW R-1 bulk
12-15	12-16	8328	2.3481	2.3610	2.3609	2.3610	0.0102	FW R-2 bulk
12-15	12-16	8329	2.3660	2.3709	2.3711	2.3721	.0034	FW R-3 bulk
12-15	12-16	8330	2.3554	2.3642	2.3647	2.3650	.0096	BW R-1 bulk
12-15	12-16	8331	2.3464	2.3543	2.3533	2.3532	.0068	BW R-2 bulk
12-15	12-16	8332	2.3413	2.3488	2.3494	2.3493	.0080	BW R-3 bulk
12-15	12-16	8333	2.3419	2.3454	2.3456	2.3456	.0037	Extract R-1 bulk
12-15	12-16	8334	2.3512	2.3544	2.3543	2.3540	.0028	Extract R-2 bulk
12-15	12-16	8335	2.3530	2.3552	2.3555	2.3555	.0025	Extract R3 bulk
12-15	12-16	8336	2.3580	2.4048	2.4038	2.4036	.0429	FW R-1 Dryer
12-15	12-16	8337	2.3415	2.3671	2.3668	—	.0226	FW R-2 Dryer
12-15	12-16	8338	2.3281	2.3807	2.3783	2.3779	.0465	FW R-3 Dryer
12-15	12-16	8339	2.3267	2.3404	2.3406	—	.0139	BW R-1 Dryer
12-15	12-16	8340	2.3333	2.3520	2.3512	2.3508	.0175	BW R-2 Dryer
12-15	12-16	8341	2.3477	2.3696	2.3693	2.3691	.0214	BW R-3 Dryer
12-15	12-16	8342	2.3608	2.3843	2.3846	2.3843	.0235	Extract R1 Dryer
12-15	12-16	8343	2.3504	2.3751	2.3729	2.3725	.0221	Extract R2 Dryer
12-15	12-16	8344	2.3441	2.3563	2.3544	2.3544	.0103	Extract R3 Dryer
Calibration check			12-14-88	1g	= 1.0002g		calculated to	1.0000g

Dryer wts

Front wash probe rinse

Impinger acetone rinse

Impinger extract

From Log book

22

12-16

DATES

ID #	TARE Date	1st Date	2nd Date	3rd Date	Usage
8190	12-1-88	12-15-88	12-16	12-16	S Mn Coop
8191	12-1-88	12-15	12-16	12-16	S Mn Coop
8192	12-1-88	12-15	12-16	12-16-88	S Mn Coop
8193	12-1-88				
8194	12-1-88				
~~8195~~	12-1-88	1g = 1.0000g		Calibration	check
8195	12-9-88				
8196	12-9-88				
8197	12-9-88				
8198	12-9-88				
8199	12-9-88				
8200	12-9-88				
8201	12-9-88				

Weights

ID #	TARE wt	1st wt	2nd wt.	3rd wt.	weight GAIN	TEST RUN
8190	.6200	.7436	.7439	.7437	.1237	R-1 Dryer
8191	.6211	.7530	.7533	.7537	.1326	R-2 Dryer
8192	.6258	.7641	.7654	.7658	.1400	R-3 Dryer
8193	.6219					
8194	.6224					
~~8195~~						
8195	.6254					
8196	.6223					
8197	.6253					
8198	.6245					
8199	.6264					
8200	.6207					
8201	.6270					

Filters

From Lab Log book
Filter wts

APPENDIX D

CALIBRATION DATA

CALIBRATION
DRY TEST METER/ORIFICE METER

Date: 12-9-88 Barometric Pressure, in. Hg. (Pb): 29.54

EQUIPMENT IDENTIFICATION			
Control Unit	Dry Test Meter	Wet Test Meter	Calibration Type
Mfg: Andersen	Mfg: Rockwell	Mfg: GCA Corporation	General:
Model: Universal Stack Sampler	Model:	Model: Precision Wet Test Meter	Post-test: X
SN: 83	SN: 83	SN: 11 A H 12	

EQUIPMENT CALIBRATION

Orifice Pressure Drop in. WC H	Pump Vac. in.Hg	Wet Test Meter Volume, CF Initial V_{wi}	Wet Test Meter Volume, CF Final V_{wf}	Wet Test Meter Temp. °F T_w	Dry Test Meter Volume, CF Initial V_{di}	Dry Test Meter Volume, CF Final V_{df}	Dry Test Meter Temperature, °F Inlet Initial T_{ii}	Dry Test Meter Temperature, °F Inlet Final T_{if}	Dry Test Meter Temperature, °F Outlet Initial T_{oi}	Dry Test Meter Temperature, °F Outlet Final T_{of}	Elapsed Time, min. Q
0.5	0	53.874	61.662	68	249.692	257.925	93	94	91	107	20
1.0	0	8.738	19.742	68	202.893	214.082	74	85	78	108	20
2.0	0	19.742	35.197	68	214.082	230.091	85	92	89	115	20
3.0	0	35.197	53.874	68	230.091	249.692	92	98	99	120	20

COMPUTER PRINTOUT

H	Vw	Tw	Vd	Td	Q	C	Ha
0.5	7.788	68	8.233	96.3	20.0	0.9953	1.7735
1.0	11.004	68	11.189	84.5	20.0	1.0117	1.8150
2.0	15.455	68	16.009	95.3	20.0	1.0102	1.8046
3.0	18.677	68	19.601	102.3	20.0	1.0071	1.8304

AVERAGE CORRECTION FACTOR: C = 1.0061 ← Pretest Calib.
AVERAGE ORIFICE CONSTANT: Ha = 1.8059

EQUATIONS:
Vw = Vwf - Vwi
Vd = Vdf - Vdi
Td = (Tii + Tif + Toi + Tof) / 4
C = Vw * Pb * (Td+460) / (Vd * (Pb+H/13.6) * (Tw+460))
Ha = 0.0317 * H * ((Tw+460)*Q/Vw)^2 / (Pb * (Td+460))

Calibration Performed by:
T. J M / 11

CALIBRATION
DRY TEST METER/ORIFICE METER

Date: 12-15-88 Barometric Pressure, in. Hg. (Pb): 29.88

EQUIPMENT IDENTIFICATION			
Control Unit 2	Dry Test Meter	Wet Test Meter	Calibration Type
Mfg: Andersen	Mfg: Andersen	Mfg: GCA Corporation	General:
Model: Universal stack sampler	Model: U	Model: Precision Wet Test	Post-test: X
SN: 83	SN: 83	SN: 11 AH 12	

EQUIPMENT CALIBRATION

Orifice Pressure Drop in. WC H	Pump Vac. in.Hg	Wet Test Meter Volume, CF Initial V_{wi}	Wet Test Meter Volume, CF Final V_{wf}	Temp. °F T_w	Dry Test Meter Volume, CF Initial V_{di}	Dry Test Meter Volume, CF Final V_{df}	Temperature, °F Inlet Initial T_{ii}	Temperature, °F Inlet Final T_{if}	Temperature, °F Outlet Initial T_{oi}	Temperature, °F Outlet Final T_{of}	Elapsed Time, min. Q
0.5	0	0	7	62	627.127		78	82	58		
0.5	0	7.108	14.079	62	634.322	641.520	65	74	67	85	18
1.0	0	14.079	24.680	62	641.520	652.573	73	78	71	90	19.5
2.0	0	24.680	37.542	62	652.573	666.027	78	84	82	48	17
3.0	0	37.542	55.802	62	666.027	685.176	83	86	89	99	20

COMPUTER PRINTOUT

H	Vw	Tw	Vd	Td	Q	C	Hθ
0.5	6.971	62	7.198	72.8	18.0	0.9872	1.8089
1.0	10.601	62	11.053	78.0	19.5	0.9861	1.8181
2.0	12.862	62	13.454	85.5	17.0	0.9941	1.8516
3.0	18.260	62	19.149	89.3	20.0	0.9960	1.8942

AVERAGE CORRECTION FACTOR: C = 0.9909 ← Post test Calib.
AVERAGE ORIFICE CONSTANT: Hθ = 1.8432

EQUATIONS:

$V_w = V_{wf} - V_{wi}$
$V_d = V_{df} - V_{di}$
$T_d = (T_{ii} + T_{if} + T_{oi} + T_{of}) / 4$
$C = V_w * P_b * (T_d+460) / (V_d * (P_b+H/13.6) * (T_w+460))$
$H\theta = 0.0317 * H * ((T_w+460)*Q/V_w)^2 / (P_b * (T_d+460))$

$\frac{(1.0061 + .9909)}{2}$ Pretest / Post test

$= .9985 \pm .010$

Calibration Performed by:

D-2 (Print) Ted M. Gibbons

CALIBRATION

S-TYPE PITOT TUBE

Date: 8-19-88

S-Type Pitot Tube ID No.: 4-1

Ambient Temperature, °F: 74

Standard Pitot Tube ID No.: 24

Barometric Pressure, in. Hg.: 29.27

Standard Pitot Tube Coefficient: .995

PITOT TUBE EXAMINATION

Alignment Check	Pitot Tube Dimensions	Pitot Assembly Intercomponent Spacings
✓ α1<10°	External tubing diameter (D_t): 3/8	Pitot to ½" nozzle (X): .290
✓ α2<10°	Base to Side A opening plane (P_A): .422	Pitot to probe sheath (Y): 4.587
✓ β1< 5°	Base to Side B opening plane (P_B): .412	Pitot to thermocouple, along probe (W): 1.305
✓ β2< 5°		Pitot to thermocouple, perpendicular to probe (Z): 0
✓ Q<1/8 in.		
✓ R<1/32 in.		

DESIRED CALIBRATION POINT		SIDE A CALIBRATION		SIDE B CALIBRATION	
Velocity ft/sec	P_{std} in. WC	P_{std} in. WC	P_s in. WC	P_{std} in. WC	P_s in. WC
20	0.09	0.09	0.15	0.09	0.15
40	0.37	0.37	0.49	0.37	0.53
60	0.82	0.82	1.0	0.82	1.10
80	1.45	1.40	1.60	1.45	1.90
100	2.30	—	—	—	—

COMPUTER PRINTOUT

SIDE A CALIBRATION				SIDE B CALIBRATION			
Pstd	Ps	Cp	Cp-Cp(A)	Pstd	Ps	Cp	Cp-Cp(B)
0.090	0.150	0.771	-0.096	0.090	0.150	0.771	-0.062
0.370	0.490	0.865	-0.002	0.370	0.530	0.831	-0.001
0.820	1.000	0.901	0.034	0.820	1.100	0.859	0.026
1.400	1.600	0.931	0.064	1.450	1.900	0.869	0.037

Cp(A) = 0.867

Cp(B) = 0.833 side used

Calibration Performed by:

(Print) Ted M. Gibbons

(Signature) Ted M. Gibbons

CALIBRATION

NOZZLE DIAMETER

Nozzle Number	Nominal Diameter, in.	Measured Diameter, in. D1	D2	D3	Nozzle* Diameter, in.
S1	3/4	.741	.738	.739	.740
S2	5/16	.300	.300	.300	.300
S3	3/8	.370	.373	.374	.373
S4	1/2	.500	.500	.500	.500
S5	11/32	.364	.367	.365	.365
S6	11/32	.367	.369	.366	.367
S7	3/16	.180	.183	.181	.181
S8	1/4	.235	.238	.236	.236
		→ Nozzle Used			

* Nozzle diameter = (D1 + D2 + D3)/3

Calibration Performed by:

(Print) Ted M. Gibbons

(Signature) Ted M. Gibbons

Date: 12-5-88

APPENDIX E

PROCESS DATA

Southern Minnesota Sugar Cooperative
P.O. BOX 500 - RENVILLE, MINNESOTA 56284 (612) 329-8305

December 28, 1988

MMT Environmental, Inc.
4643 N. Chatsworth St.
St. Paul, MN 55112

Attention: Clifford Mohs

Reference: Stack Tests - Lime Kiln, Boiler #1 and North Pulp Dryer

Dear Mr. Mohs;

Enclosed are the daily reports from the pulp dryer and lime kiln along with the temperature chart for the north pulp dryer, and charts for the No. 1 boiler. According to our Lab records, we used the following:

Coal	481 ton/day
Limerock	439 ton/day
Coke	26 ton/day
Fuel Oil (N. Drum)	8935 gal/day
Steam Generated	290,000 lb./hr.

As you review the data, please keep in mind the following: (1) The pulp dryer fuel oil flow meters are old and are used only to split the flow between the two units. The total flow to the dryer is determined by measuring the supply tank daily. (2) The steam load on the number one boiler will vary with our slice rate. Past experience indicates a normal boiler load would fall between 320,000 and 330,000 pounds per hour. The quantity of coke and limestone fed to the lime kiln is 108 lbs. of coke and 1800 lbs. of limestone per skip. (3) Pulp dryer drum feed rate is equal to 1 ton/hr. of pressed pulp for percentages point shown on dryer report.

Please include the enclosed data in your test report. Call me if you have any questions.

Sincerely,

SOUTHERN MINNESOTA SUGAR COOPERATIVE

Wm. Dean DeBelly
Manager, Purchasing & Engineering

WDD:sam
enc.

twin city testing
corporation
662 CROMWELL AVENUE
ST. PAUL, MN 55114
PHONE 612/645-3601

REPORT OF: CHEMICAL ANALYSIS

DATE: January 6, 1989

REPORTED TO: MMT Environmental Services, Inc.
Attn: Mr. Clifford Mohs
4643 Chatsworth St. N
Shoreview, MN 55112

LABORATORY NO. 4410 89-1528

INTRODUCTION

This report presents the results of the analyses performed on the sample received by TCT on December 15, 1989. The scope of the analyses were limited to determining the ash, moisture, sulfur and BTU content. The work was authorized by Mr. Clifford Mohs.

SAMPLE IDENTIFICATION

Sample Number	Sample Identity
103224	Fuel oil from Dryer

METHODOLOGY

The test procedures are described in the ASTM annual book of standards.

TEST AND RESULTS

Parameter	Test Method	Result	Date Analyzed
Moisture, %	ASTM: D95	2.0	12/28/88
Sulfur, %	ASTM: D129*	1.70	12/28/88
Ash, %	ASTM: D482	0.012	12/28/88
BTU/lb	ASTM: D240	16,854	12/28/88

* Modified procedure using ion chromatography on the bomb washings.

REMARKS

The sample was submitted by an employee of MMT Environmental Services, Inc. Thirty days from the date of this report the sample will be discarded unless instructions to the contrary are received.

TWIN CITY TESTING CORPORATION

Bill Garwood,
Petroleum Chemist

Ray A. Siery,
Manager, Inorganic Chemistry Dept.

BG/RAS/mk

DEC 1 5 1988

SOUTHERN MINNESOTA SUGAR CO-OP

DRYER REPORT

FORM 12
Rev 6 5?

	OPERATOR	BEET END 4MAN
SHIFT 1	Larry Mogk	
SHIFT 2	[illegible]	R. Kennedy
SHIFT 3	Sam	L. D. [illegible]

DAY ENDING 12/14/88 8 A.M.

TIME	A.M. 9	10	11	12	P.M. 1	2	3	4	5	6	7	8	9	10	11	12	A.M. 1	2	3	4	5	6	7	8
FEED RATE % NORTH	35	40	20	20	20	35	10	40	35	35	35	35	35	30	35	35	40	40	40	40	40	40	30	40
SOUTH	35	20	40	40	40	40	40	40	40	40	40	40	40	35	40	40	40	40	40	40	40	40	40	40
FURNACE TEMP. NORTH	1050	800	800	800	750	950	1050	1050	1050	1000	1000	1000	950	950	1000	950	1000	1000	1000	1000	1000	1000	1000	1000
SOUTH	1250	1300	1300	1300	1200	1200	1200	1200	1200	1250	1200	1200	1200	1150	1150	1200	1150	1150	1100	1100	1100	1100	1100	1100
EXIT TEMP. NORTH	310	280	270	270	270	300	310	310	310	310	310	310	305	305	305	305	310	310	310	310	310	310	310	310
SOUTH	325	335	335	335	335	330	330	330	330	330	330	330	330	325	325	325	325	325	320	320	320	320	320	320
MOISTURES									X	X	X	X	X	X	X	X								
PRESSED P.	74.2	74.2	73.8	73.6	75.0	74.4	74.0	74.2	73.8	69.8	73.6	72.2	72.0	73.6	72.0	72.4	74.2	73.6	73.4	73.6	73.4	73.6	73.6	73.4
DRIED P.	8.4	9.2	9.4	8.8	10.2	8.2	10.0	9.8	9.6	9.0	8.4	8.2	8.4	8.0	8.8	8.4	10.0	9.4	8.6	8.8	8.8	9.0	9.2	9.4
PELLETS	12.2	11.4	11.6	11.2	11.8	10.6	11.6	11.4	11.0	11.2	11.0	10.8	11.8	11.4	12.0	11.8	12.8	12.0	11.8	11.6	12.2	12.0	11.6	12.0
FUEL OIL USED NORTH METER	8 A.M. 220665				4 P.M. 222975								12 MID. 225894								8 A.M. 228835			
SOUTH METER	8 A.M. 861755				4 P.M. 865420								12 MID. 869138								8 A.M. 872635			
STORAGE BIN (E) OR (W)																								
PYROMETER NORTH	1050	800	800	800	750	950	1050	1050	1000	1000	1000	950	950	950	950	950	1000	1000	1000	1000	1000	1000	1000	[illegible]
SOUTH	1300	1350	1350	1350	1250	1250	1250	1250	1250	1300	1250	1250	1250	1200	1200	1250	1200	1200	1150	1150	1150	1150	1150	1150
FIRE VISIBLE EXIT END NORTH	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
SOUTH	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
CHEMICALS TO WATER TANK										X		X		X		X								

~~REASON FOR PULP TO FLOOR:~~

*COMMENTS:

Wild, Wild West

* NOTE TIMES FOR INSTALLATION OF NEW DIES AND ROLLERS.

Scale weights 1# Heavy - when empty

Cart	Weight
#1	47 #
#2	= 48 Lbs

12-14-88 Pulp mtls.

9:20	#1	77 #
9:35	#2	78#
9:42	#1	77#
9:50	#2	78#
10:00	#1	76#
10:07	#2	78#
10:16	#1	77#
1020	#2	78#
10:27	#1	77#
1035	#2	78#
10:46	#1	79#
1055	#2	84#
11:05	#1	84#
11:15	#2	81#
11:30	#1	83#
11:39	#2	86#
11:50	#1	82#
12:00	#2	83#
12:13	#1	82#
12:29	#2	88#
12:44	#1	94#
12:58	#2	96#
106	#1	76#