Note: This is a reference cited in *AP 42, Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources.* AP42 is located on the EPA web site at www.epa.gov/ttn/chief/ap42/

The file name refers to the reference number, the AP42 chapter and section. The file name "ref02_c01s02.pdf" would mean the reference is from AP42 chapter 1 section 2. The reference may be from a previous version of the section and no longer cited. The primary source should always be checked.

AP-42 Section Number: 9.10.1.2

Reference Number: 9

Title: Particulate Emission Testing Performed For Monitor Bay Sugar Company, Bay City, Michigan, on the Pulp Dryer 2 Exhaust

Network Environmental, Inc.

Network Environmental, Inc.

October 1992

AP-42 Section 9.10.1.2
Reference 9
Report Sect.
Reference

Report of...

Particulate Emission Testing

performed for...

Monitor Sugar Company
Bay City, Michigan

on the

Pulp Dryer 2 Exhaust

October 13, 1992

022.06

Network Environmental, Inc.
Grand Rapids, MI

SOURCE EMISSION TESTING

at

MONITOR SUGAR COMPANY

BAY CITY, MICHIGAN

PULP DRYER #2

DATE: 10/13/92

Network Environmental, Inc.
P.O. Box 2021
Grand Rapids, MI 49501

INTRODUCTION

Network Environmental, Inc. was retained by the Monitor Sugar Company of Bay City, Michigan to perform a particulate emissions compliance test on the number two beet pulp dryer exhaust. The purpose of the testing was to document the particulate emissions from the dryer exhaust.

The testing was performed by R. Scott Cargill, and Bertram J. Smith of Network Environmental, Inc. on October 13, 1992 by employing Michigan Department of Natural Resources (MDNR) Method 5B. Mr. William Rogers, Jr. of the MDNR, Air Quality Division was present to observe the testing and source operation. Assisting in the study was Mr. Allan Sauer of the Monitor Sugar Company.

Network Environmental, Inc.

EMISSION SOURCE SUMMARY

STANDARD ANALYSIS

COMPANY NAME: MONITOR SUGAR COMPANY TEST DATE: 10/13/92

COMPANY LOCATION: BAY CITY, MICHIGAN

SOURCE NAME: PULP DRYER #2

SAMPLING STAFF: CARGILL/SMITH

STACK RADIUS, inches		33.0
AREA OF STACK, sq. ft.		23.76
STATIC PRESSURE IN STACK, in. H2O		0.98-
STACK GAS TEMPERATURE, deg. F		178
PERCENT MOISTURE AT TEST LOCATION		39.24
DRY GAS COMPOSITION:	% OXYGEN	16.33
	% CARBON DIOXIDE	2.53
	% CARBON MONOXIDE	0.00
	% NITROGEN	81.13
DENSITY, WET, @ STP, lbs./cu.ft.		0.0639
MOLECULAR WEIGHT, DRY, @ STP, lbs./mole		29.07
AVERAGE GAS VELOCITY, feet/min.		2935
STACK GAS FLOW RATE:	ACFM	69725
	SCFM	55643
	SCFM, DRY	33805

EMISSIONS:	
LBS. PARTICULATE/1000 LBS. GAS, ACTUAL(1)	0.0614
LBS. PARTICULATE/1000 LBS. GAS, DRY(2)	0.0614
GRAINS/DSCF(4)	0.0452
LBS./HOUR	13.09

1. 'ACTUAL' MEANS AT THE CONDITIONS FOUND AT THE SAMPLING LOCATION.
2. 'DRY' INCLUDES ONLY THE NATURAL MOISTURE THAT WOULD BE EMITTED FROM THE PROCESS. MOISTURE ADDED OR SUBTRACTED BY THE COLLECTOR IS NOT INCLUDED.
3. 'WET' INCLUDES THE MOISTURE AS MEASURED AT THE SAMPLING LOCATION.
4. 'DSCF' IS UNDER TOTALLY DRY CONDITIONS, ALL MOISTURE REMOVED.

Network Environmental, Inc.

SUMMARY OF PARTICULATE EMISSIONS

COMPANY NAME: MONITOR SUGAR COMPANY TEST DATE: 10/13/92

COMPANY LOCATION: BAY CITY, MICHIGAN

SOURCE NAME: PULP DRYER #2

SAMPLING STAFF: CARGILL/SMITH

SAMPLE NUMBER	1	2	3
STANDARD ANALYSIS			
E1. TOTAL WEIGHT COLLECTED, grams	0.125	0.125	0.126
E2. LBS. PARTICULATE/1000 LBS. GAS, ACTUAL(1)	0.061	0.063	0.060
E3. LBS. PARTICULATE/1000 LBS. GAS, DRY(2)	0.061	0.063	0.060
E6. GRAINS/DSCF(4)	0.044	0.047	0.045
E7. LBS./HOUR	12.68	13.34	13.24

1. 'ACTUAL' MEANS AT THE CONDITIONS FOUND AT THE SAMPLING LOCATION.
2. 'DRY' INCLUDES ONLY THE NATURAL MOISTURE THAT WOULD BE EMITTED FROM THE PROCESS. MOISTURE ADDED OR SUBTRACTED BY THE COLLECTOR IS NOT INCLUDED.
3. 'WET' INCLUDES THE MOISTURE AS MEASURED AT THE SAMPLING LOCATION.
4. 'DSCF' IS UNDER TOTALLY DRY CONDITIONS, ALL MOISTURE REMOVED.

Network Environmental, Inc.

SUMMARY OF EXHAUST GAS PARAMETERS

COMPANY NAME: MONITOR SUGAR COMPANY TEST DATE: 10/13/92

COMPANY LOCATION: BAY CITY, MICHIGAN

SOURCE NAME: PULP DRYER #2

SAMPLING STAFF: CARGILL/SMITH

	SAMPLE NUMBER	1	2	3
G1.	STACK RADIUS, inches	33.0	33.0	33.0
G2.	AREA OF STACK, sq. ft.	23.76	23.76	23.76
G3.	BAROMETRIC PRESSURE, in. HG.	28.80	28.80	28.80
G4.	STATIC PRESSURE IN STACK, in. H2O	0.98-	0.98-	0.98-
G5.	STACK GAS TEMPERATURE, deg. F	171	180	182
G6.	AVG. SQRT VELOCITY PRESSURE OF POINTS SAMPLED	0.685	0.698	0.726
G7.	PERCENT MOISTURE AT TEST LOCATION	38.54	39.55	39.63
G8.	PERCENT MOISTURE BEFORE COLLECTOR	38.54	39.55	39.63
G9.	DRY GAS COMPOSITION: % OXYGEN	16.40	16.60	16.00
	% CARBON DIOXIDE	2.20	2.47	2.93
	% CARBON MONOXIDE	0.00	0.00	0.00
	% NITROGEN	81.40	80.93	81.07
G10.	PERCENT EXCESS AIR AT TEST LOCATION			
	DENSITY AND MOLECULAR WEIGHT OF STACK GAS:			
G11.	DRY, @ STP, lbs./cu.ft.	0.0750	0.0751	0.0753
G12.	WET, @ STP, lbs./cu.ft.	0.0640	0.0638	0.0639
G13.	WET, @ STACK CONDITIONS, lbs./cu.ft.	0.0516	0.0507	0.0506
G14.	MOLECULAR WEIGHT, DRY, @ STP, lbs./mole	29.02	29.07	29.12
G15.	AVERAGE GAS VELOCITY, feet/min.	2842	2922	3040
	STACK GAS FLOW RATE:			
G16.	STACK CONDITIONS, ACFM	67,529	69,415	72,232
G17.	STANDARD CONDITIONS, SCFM	54,467	55,208	57,255
G18.	STANDARD CONDITIONS, DRY SCFM	33,475	33,376	34,565

STANDARD TEMPERATURE AND PRESSURE (STP) = 29.92 inches HG, 70 deg. F

Network Environmental, Inc.

SUMMARY OF PARTICULATE TRAIN PARAMETERS

COMPANY NAME: MONITOR SUGAR COMPANY TEST DATE: 10/13/92

COMPANY LOCATION: BAY CITY, MICHIGAN

SOURCE NAME: PULP DRYER #2

SAMPLING STAFF: CARGILL/SMITH

	SAMPLE NUMBER	1	2	3
P1.	NUMBER OF POINTS SAMPLED	12	12	12
P2.	DURATION OF SAMPLE, minutes	60.00	60.00	60.00
P3.	NOZZLE DIAMETER, inches	0.313	0.313	0.313
P4.	NOZZLE AREA, sq. ft.	0.00053	0.00053	0.00053
P5.	PITOT CALIBRATION FACTOR	0.860	0.860	0.860
P6.	METER CALIBRATION FACTOR	0.998	0.998	0.998
P7.	AVERAGE FILTER TEMPERATURE, deg. F	0	0	0
P8.	AVERAGE METER TEMPERATURE, deg. F	69.7	70.6	71.1
P9.	AVERAGE METER PRESSURE, inches of water	1.963	1.871	2.001
P10.	METER VOLUME, ACTUAL READING, cu.ft.	45.09	42.78	44.98
P11.	METER VOLUME, @ STP, cu.ft.	43.54	41.23	43.32
P12.	LIQUID VOLUME OF WATER CONDENSED, mls.	576.0	569.0	600.0
P13.	VAPOR VOLUME OF WATER CONDENSED, @ STP, cu.ft.	27.30	26.97	28.44
P14.	TOTAL GAS SAMPLED, @ STP, cu.ft.	70.84	68.20	71.76
P15.	WEIGHT OF GAS SAMPLED, DRY, lbs.	3.27	3.10	3.26
P16.	WEIGHT OF GAS SAMPLED, WET, lbs.	4.53	4.35	4.58
P17.	PERCENT ISOKINETICS	96.7	91.8	93.2

CONCENTRATION CONVERSION FACTORS:

P18.	50 % EXCESS AIR, AFTER COLLECTOR			
P19.	50 % EXCESS AIR, BEFORE COLLECTOR			
P20.	MOISTURE CONDITIONS BEFORE COLLECTOR	1.00	1.00	1.00

STANDARD TEMPERATURE AND PRESSURE (STP) = 29.92 inches HG, 70 deg. F

DISCUSSION OF RESULTS

The particulate emission concentrations for the three samples were 0.061 Lbs/1000 Lbs for sample one, 0.063 Lbs/1000 Lbs for sample two, and 0.060 Lbs/1000 Lbs for sample three. The average exhaust particulate concentration was 0.0614 Lbs/1000 Lbs.

The particulate mass emission rates were 12.68 Lbs/Hr for sample one, 13.34 Lbs/Hr for sample two, and 13.24 Lbs/Hr for sample three. The average mass emission rate was 13.09 Lbs/Hr.

SOURCE DESCRIPTION

The source tested was the number two beet pulp dryer. The rotary dryer is fired by natural gas and dries the pulp with direct contact. The pulp is fed into the dryer at the beginning of the rotary section. The pulp is passed through the rotary dryer where most of the moisture is removed. The particulate laden exhaust is then passed through a multiclone collector and then a scrubber for particulate removal before it is exhausted to the atmosphere.

Process operating information for the day of the sampling can be found in Appendix A.

SAMPLING AND ANALYTICAL PROTOCOL

The sampling location was on the 66 inch I.D. exhaust stack at a distance that meets the eight duct diameter downstream two duct diameter upstream requirement of U.S. EPA Reference Method 1.

Particulate

The particulate sampling and analysis were performed in accordance with MDNR Reference Method 5B, and the methods referenced therein. Three (3) samples, each sixty (60) minutes in duration, were collected from the exhaust stack. All the quality control and quality assurance requirements specified in the methods were incorporated in the sampling and analysis. No alterations were incorporated in the testing or analysis. Figure 1 shows a schematic of the particulate sampling train.

Exhaust Gas Parameters

The exhaust gas parameters (air flow rate, temperature, moisture, and density) were determined by employing U.S. EPA Reference Methods 1 through 4. All the quality control and quality assurance procedures specified in the methods were incorporated in the sampling and analysis. No alterations were incorporated in the sampling and analysis.

This report was prepared by:

David D. Engelhardt
Vice President

This report was reviewed by:

Stephan K. Byrd
President

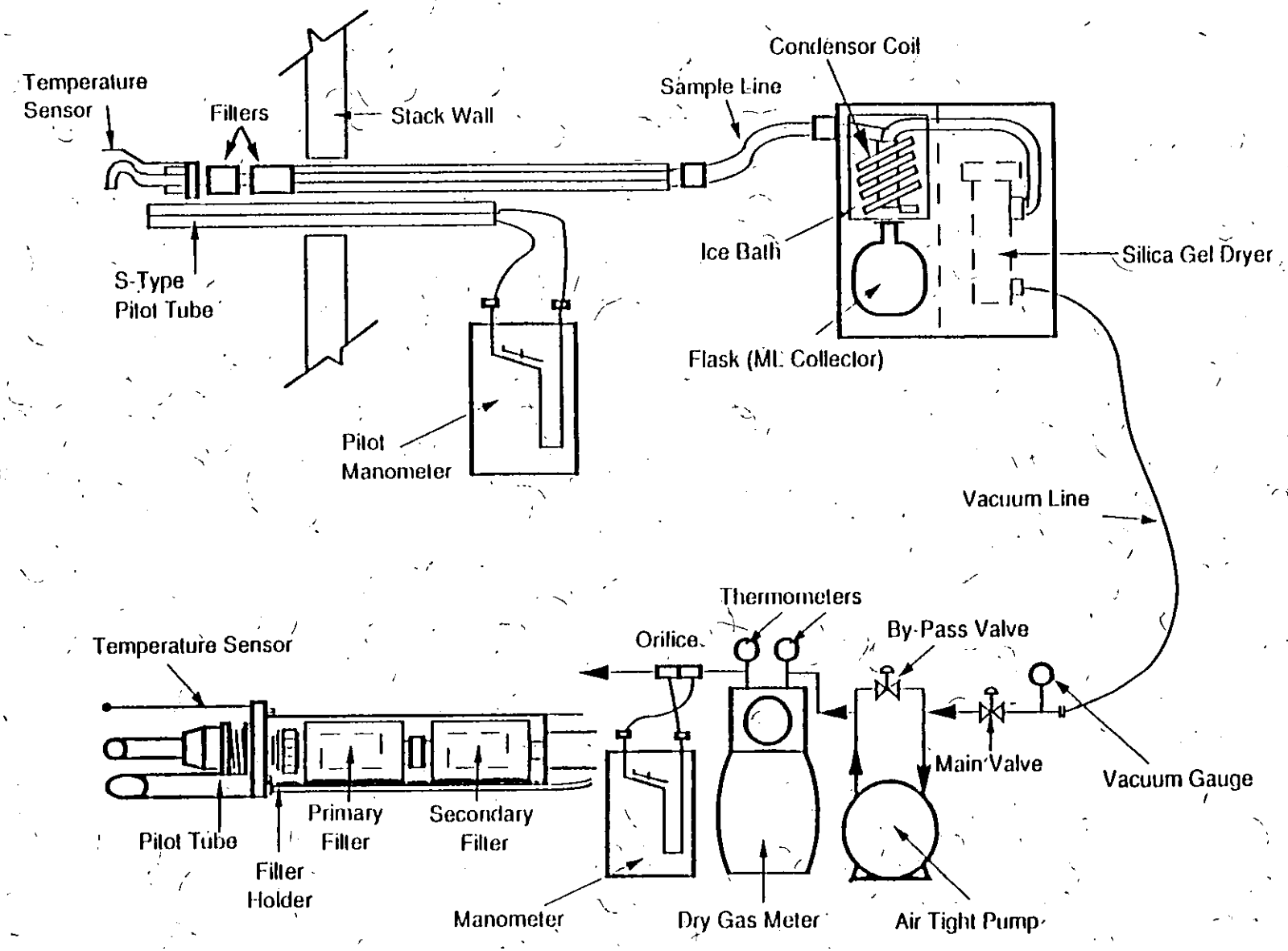


Figure 1

Particulate Sampling Train

APPENDIX A

FIELD DATA

Network Environmental, Inc.

PITOT TRAVERSE DATA

COMPANY NAME: MONITOR SUGAR COMPANY TEST DATE: 10/13/92

COMPANY LOCATION: BAY CITY, MICHIGAN

SOURCE NAME: PULP DRYER #2

SAMPLING STAFF: CARGILL/SMITH

RUN NUMBER:	1	% CARBON DIOXIDE:	
STACK RADIUS, in.:	33	% OXYGEN:	
GAS TEMPERATURE, Deg F:	170	% CARBON MONOXIDE:	
STATIC PRESSURE, in. H2O:	-.98	PITOT FACTOR:	.86
BAROMETRIC PRESSURE:	28.8		

PT. #	POINT LOCATION, INCHES	VELOCITY PRESSURE, INCHES OF WATER PORT 1	PORT 2
1	2.90	0.40	0.38
2	9.70	0.61	0.66
3	19.47	0.64	0.58
4	46.53	0.26	0.69
5	56.30	0.64	0.80
6	63.10	0.82	0.80

Network Environmental, Inc.

SAMPLING TRAIN DATA

COMPANY NAME: MONITOR SUGAR COMPANY TEST DATE: 10/13/92

COMPANY LOCATION: BAY CITY, MICHIGAN

SOURCE NAME: PULP DRYER #2

SAMPLING STAFF: CARGILL/SMITH

SAMPLE NUMBER:	1	IMPINGER BOX #:	1	GAS METER START:	301.11
TYPE OF TRAIN:	5B	FILTER SET #:	29	METER CAL. FACTOR:	.9976
NOZZLE DIA, in:	.3125	PRIM. FILTER #:	DH-374	CLOCK TIME START:	11:25
VENTURI NUMBER:		SEC. FILTER #:	BH-374	METER TIME START:	0
CONTROL BOX #:	3072	BAROMETRIC PRESS:	28.8	METER TIME STOP:	1
		PITOT CAL. FACTOR:	.86		

PORT	POINT	VELOCITY PRESSURE IN. H2O	RATE MTR PRESSURE IN. H2O	GAS METER READING CU. FT.	PUMP VAC. IN. HG	GAS METER TEMP., F IN	GAS METER TEMP., F OUT	STACK TEMP. F
1	1	0.53	2.15	304.870	2.50	67	67	180
	2	0.52	2.05	308.810	3.00	64	66	180
	3	0.21	0.84	311.450	2.50	69	67	168
	4	0.62	2.50	315.280	4.50	71	67	168
	5	0.76	3.07	320.250	5.50	74	67	169
	6	0.57	2.31	324.450	3.50	74	67	169
2	1	0.42	1.70	327.860	3.00	75	68	170
	2	0.61	2.48	332.000	4.00	72	68	168
	3	0.37	1.50	335.340	3.00	74	68	169
	4	0.20	0.81	337.960	2.50	74	68	170
	5	0.38	1.54	341.330	3.50	75	68	170
	6	0.64	2.60	346.200	5.00	75	68	170

Network Environmental, Inc.

SAMPLING TRAIN DATA

COMPANY NAME: MONITOR SUGAR COMPANY TEST DATE: 10/13/92

COMPANY LOCATION: BAY CITY, MICHIGAN

SOURCE NAME: PULP DRYER #2

SAMPLING STAFF: CARGILL/SMITH

SAMPLE NUMBER:	2	IMPINGER BOX #:	1	GAS METER START:	346.53
TYPE OF TRAIN:	5B	FILTER SET #:	9	METER CAL. FACTOR:	.9976
NOZZLE DIA, in:	.3125	PRIM. FILTER #:	DH-379	CLOCK TIME START:	12:51
VENTURI NUMBER:		SEC. FILTER #:	BH-379	METER TIME START:	0
CONTROL BOX #:	3072	BAROMETRIC PRESS:	28.8	METER TIME STOP:	1
		PITOT CAL. FACTOR:	.86		

PORT	POINT	VELOCITY PRESSURE IN. H2O	RATE MTR PRESSURE IN. H2O	GAS METER READING CU. FT.	PUMP VAC. IN. HG	GAS METER TEMP., F IN	GAS METER TEMP., F OUT	STACK TEMP. F
2	1	0.42	1.57	349.920	2.00	68	69	168
	2	0.62	2.33	353.770	2.00	69	68	168
	3	0.40	1.50	357.210	3.50	72	68	183
	4	0.45	1.69	360.080	2.50	75	68	185
	5	0.33	1.24	363.790	2.00	75	69	182
	6	0.67	2.51	368.010	2.00	77	69	181
1	1	0.56	2.10	370.860	3.50	70	69	184
	2	0.42	1.57	374.220	2.50	72	68	183
	3	0.21	0.78	376.720	2.00	74	68	183
	4	0.64	2.40	380.870	3.00	74	68	181
	5	0.67	2.51	386.250	3.00	74	68	180
	6	0.60	2.25	389.310	3.00	74	68	180

Network Environmental, Inc.

SAMPLING TRAIN DATA

COMPANY NAME: MONITOR SUGAR COMPANY TEST DATE: 10/13/92

COMPANY LOCATION: BAY CITY, MICHIGAN

SOURCE NAME: PULP DRYER #2

SAMPLING STAFF: CARGILL/SMITH

SAMPLE NUMBER:	3	IMPINGER BOX #:	1	GAS METER START:	389.57
TYPE OF TRAIN:	5B	FILTER SET #:	21	METER CAL. FACTOR:	.9976
NOZZLE DIA, in:	.3125	PRIM. FILTER #:	DH-385	CLOCK TIME START:	14:07
VENTURI NUMBER:		SEC. FILTER #:	BH-385	METER TIME START:	0
CONTROL BOX #:	3072	BAROMETRIC PRESS:	28.8	METER TIME STOP:	1
		PITOT CAL. FACTOR:	.86		

PORT	POINT	VELOCITY PRESSURE IN. H2O	RATE MTR PRESSURE IN. H2O	GAS METER READING CU. FT.	PUMP VAC. IN. HG	GAS METER TEMP., F IN	OUT	STACK TEMP. F
1	1	0.60	2.25	393.420	3.00	66	66	183
	2	0.64	2.40	397.640	3.00	70	65	181
	3	0.21	0.77	400.050	2.00	71	66	180
	4	0.62	2.27	404.030	3.00	73	68	181
	5	0.72	2.64	408.040	3.00	75	67	180
	6	0.64	2.40	412.580	3.00	76	68	177
2	1	0.47	1.72	416.080	2.50	73	69	184
	2	0.62	2.27	420.220	3.00	75	69	183
	3	0.33	1.21	423.240	2.00	77	69	185
	4	0.29	1.06	426.460	2.00	77	70	186
	5	0.63	2.31	430.140	3.00	77	70	183
	6	0.74	2.71	434.550	3.00	79	70	181

Network Environmental, Inc.

ORSAT ANALYSIS DATA

COMPANY NAME: MONITOR SUGAR COMPANY TEST DATE: 10/13/92

COMPANY LOCATION: BAY CITY, MICHIGAN

SOURCE NAME: PULP DRYER #2

SAMPLING STAFF: CARGILL/SMITH

DATE OF ANALYSIS: 10/13/92 METHOD: MULTIPOINT INTEGRATED SAMPLE

PART SMPL #	CONT #	RUN #	CARBON DIOXIDE			OXYGEN			CARBON MONOXIDE		
			FINAL	INIT.	%	FINAL	INIT.	%	FINAL	INIT.	%
1	1	1	2.2	0.0	2.2	18.6	2.2	16.4	18.6	18.6	0.0
		2	2.2	0.0	2.2	18.6	2.2	16.4	18.6	18.6	0.0
		3	2.2	0.0	2.2	18.6	2.2	16.4	18.6	18.6	0.0
2	2	1	2.4	0.0	2.4	19.0	2.4	16.6	19.0	19.0	0.0
		2	2.4	0.0	2.4	19.0	2.4	16.6	19.0	19.0	0.0
		3	2.6	0.0	2.6	19.2	2.6	16.6	19.2	19.2	0.0
3	3	1	2.8	0.0	2.8	18.8	2.8	16.0	18.8	18.8	0.0
		2	3.0	0.0	3.0	19.0	3.0	16.0	19.0	19.0	0.0
		3	3.0	0.0	3.0	19.0	3.0	16.0	19.0	19.0	0.0

Network Environmental, Inc.

LABORATORY ANALYSIS REPORT

COMPANY NAME: MONITOR SUGAR COMPANY TEST DATE: 10/13/92

COMPANY LOCATION: BAY CITY, MICHIGAN

SOURCE NAME: PULP DRYER #2

SAMPLING STAFF: CARGILL/SMITH

DATE SUBMITTED TO LAB: 10/15/92 RECEIVED BY: BJS

DATE REPORTED FROM LAB: 10/16/92 CHEMIST(S): BJS

PARTICULATE TRAIN SAMPLE NUMBER 1

LAB IDENT. NO.	SAMPLE IDENT. MARK	-----PARTICULATE WEIGHT GAIN, MGS.----- STD. ANAL.	ALT 1	ALT 2	CAPTURED WATER S. GEL GRAMS	CONDSR MLS.
1	DH-374	87.00			8.0	568.0
	BH-374	14.90				
	NW-1	22.90				
TOTALS		124.80	0.00	0.00	8.0	568.0

PARTICULATE TRAIN SAMPLE NUMBER 2

LAB IDENT. NO.	SAMPLE IDENT. MARK	-----PARTICULATE WEIGHT GAIN, MGS.----- STD. ANAL.	ALT 1	ALT 2	CAPTURED WATER S. GEL GRAMS	CONDSR MLS.
2	DH-379	92.30			13.0	556.0
	BH-379	9.60				
	NW-2	22.80				
TOTALS		124.70	0.00	0.00	13.0	556.0

PARTICULATE TRAIN SAMPLE NUMBER 3

LAB IDENT. NO.	SAMPLE IDENT. MARK	-----PARTICULATE WEIGHT GAIN, MGS.----- STD. ANAL.	ALT 1	ALT 2	CAPTURED WATER S. GEL GRAMS	CONDSR MLS.
3	DH-385	104.60			10.0	590.0
	BH-385	6.90				
	NW-3	14.10				
TOTALS		125.60	0.00	0.00	10.0	590.0

MONITOR SUGAR COMPANY

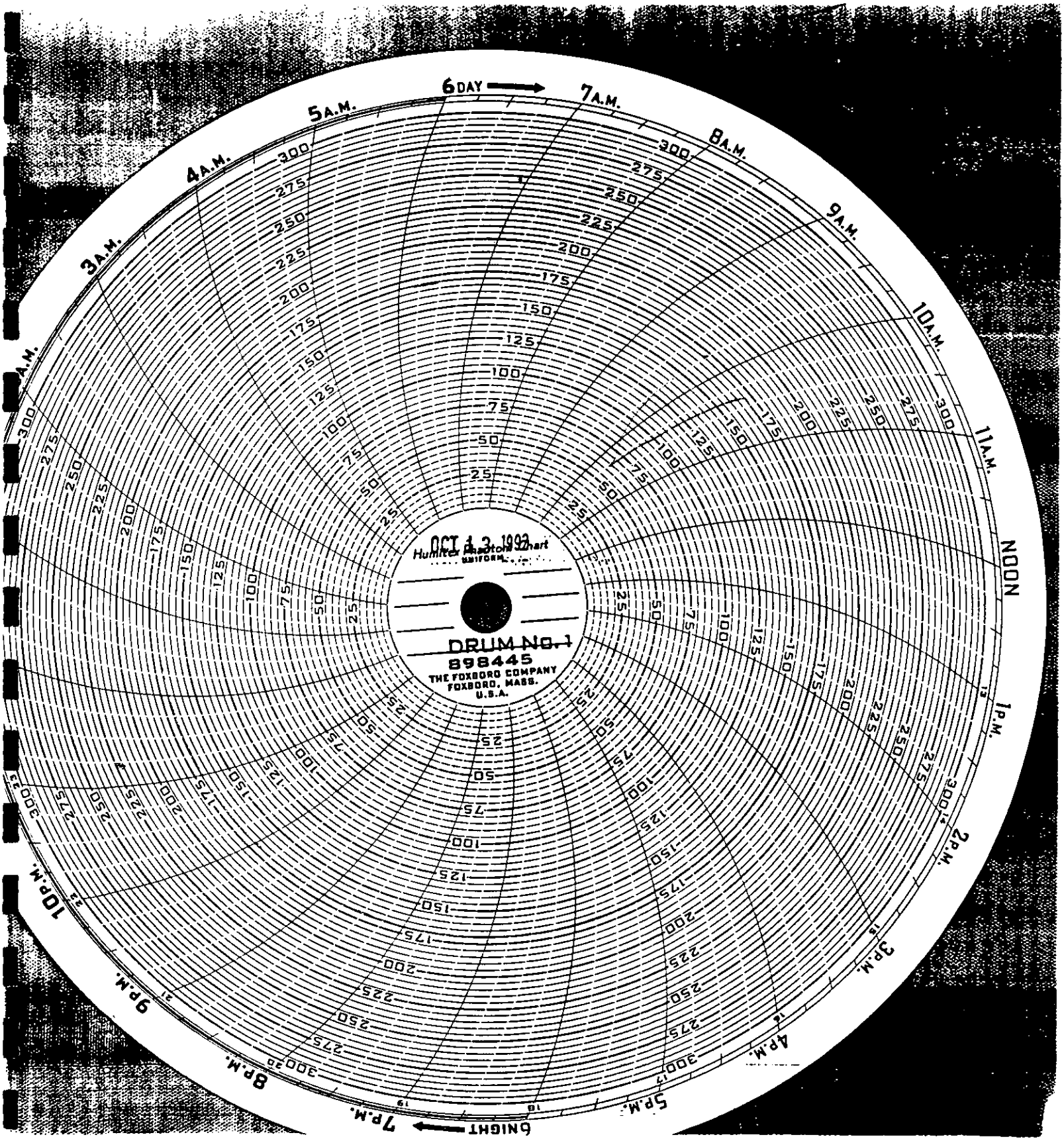
Operating Log
Pulp Driers Station

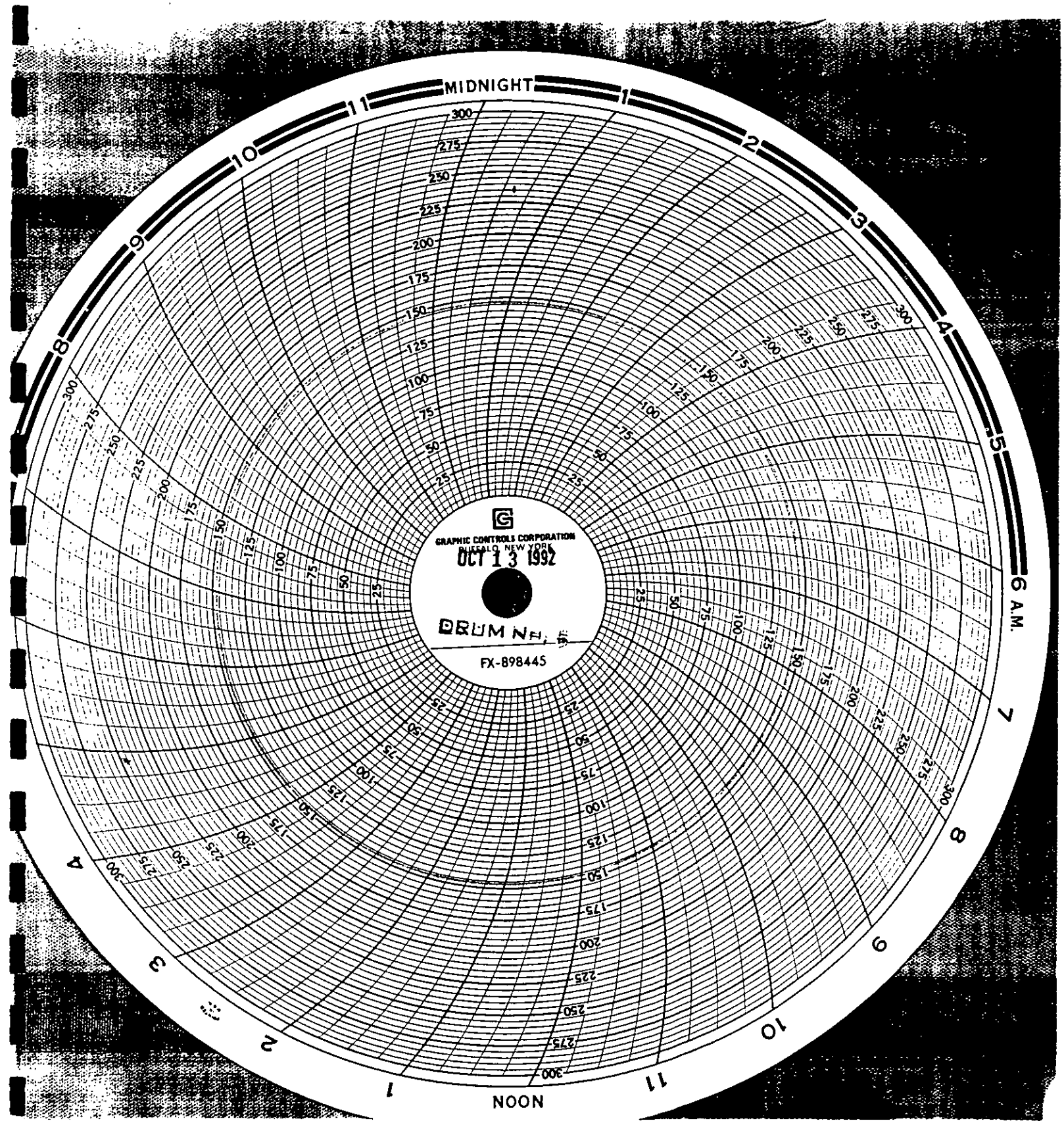
Day Ending: 10-13-92
Campaing Day: 20

Time	Inlet Temp. #1	Inlet Temp. #2	Inlet Temp. #3	Outlet Temp. #1	Outlet Temp. #2	Outlet Temp. #3	Moist. Plain #1	Moist. Plain #2	Moist. Plain #3	Moist. Pellets	Collectors Press. Drop #1	Collectors Press. Drop #2	Collectors Press. Drop #3	Collectors Press. Drop #4	Belt Scale Wet Pulp Ton/Hr.	Feed Conv. R.P.M. #1	Feed Conv. R.P.M. #2	Feed Conv. R.P.M. #3	Leading Scrolls % #1	Leading Scrolls % #2	Leading Scrolls % #3
7	[illegible]	860	[illegible]	170	145	125	9.5	[illegible]	10.1	10.3	4	4	4	4	80	[illegible]	[illegible]	98	60	41	53
8	780	[illegible]	[illegible]	170	145	125	9.5	11.0	8.6	10.1	4	4	4	4	63	240	192	98	[illegible]	[illegible]	53
9	460	1040	[illegible]	[illegible]	145	125	15.0	10.8	10.8	10.1	4	4	4	4	76	[illegible]	195	98	58	41	53
10	—	[illegible]	[illegible]	—	145	[illegible]	12.6	11.8	7.8	9.9	4	4	4	4	40	240	[illegible]	50	53	[illegible]	[illegible]
11	880	1000	880	170	145	125	11.8	12.3	8.6	10.3	4	4	4	4	55	240	200	100	60	41	51
12	820	930	860	170	145	125	11.5	12.4	10.1	10.5	4	4	4	4	85	[illegible]	[illegible]	[illegible]	[illegible]	41	51
1	800	[illegible]	[illegible]	170	[illegible]	125	13.2	11.3	10.6	9.9	4	4	[illegible]	4	85	[illegible]	[illegible]	80	[illegible]	41	53
2	760	[illegible]	900	170	[illegible]	[illegible]	12.0	13.2	[illegible]	10.0	4	4	4	4	87	[illegible]	[illegible]	[illegible]	[illegible]	41	[illegible]
3	580	920	900	170	145	125	10.5	10.6	11.0	10.8	4	4	3	3.75	70	[illegible]	[illegible]	100	[illegible]	40	56
4	680	900	800	170	145	125	10.8	11.0	9.6	9.5	4	4	3	3.75	61	240	[illegible]	96	60	40	56
5	780	800	800	170	145	125	10.2	11.8	10.0	9.2	4	4	3	3.75	69	240	205	88	60	40	58
6	700	880	820	170	145	125	9.8	12.4	10.2	9.2	4	4	3	3.75	67	[illegible]	190	[illegible]	[illegible]	[illegible]	50
7	720	940	840	170	145	125	8.5	10.8	11.8	9.5	4	4	3	3.75	71	[illegible]	[illegible]	[illegible]	[illegible]	42	50
8	700	[illegible]	880	170	145	125	7.6	10.3	8.2	9.7	4	4	3	3.75	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	54
9	720	900	840	170	145	125	11.0	11.4	10.8	9.2	4	4	3	3.75	67	[illegible]	180	90	58	42	54
10	800	940	900	170	145	125	8.9	11.0	11.3	9.9	4	4	3	3.75	[illegible]	240	200	[illegible]	57	42	54
11	780	920	860	170	145	125	10.0	9.8	9.6	10.1	4	4	3.5	3.75	71	240	200	98	60	42	50
12	720	940	880	170	145	125	10.6	12.2	9.8	9.9	4	4	3.5	[illegible]	65	[illegible]	200	[illegible]	[illegible]	42	50
1	780	900	860	170	145	125	11.8	11.6	11.3	10.[illegible]	4	4	3.5	3.75	81	240	200	[illegible]	[illegible]	42	[illegible]
2	800	920	880	170	145	[illegible]	11.3	9.8	10.6	10.1	4	4	3.5	3.75	76	240	200	98	[illegible]	[illegible]	54
3	720	920	880	170	145	125	10.8	10.1	9.9	9.5	4	4	3.5	3.75	79	240	200	98	[illegible]	42	54
4	[illegible]	960	860	170	145	[illegible]	10.2	9.8	11.0	9.5	4	4	3.5	[illegible]	83	240	200	[illegible]	—	[illegible]	54
5	820	960	860	170	145	125	9.5	10.1	8.6	9.7	4	4	3.5	3.75	69	240	200	98	58	42	54
6	800	960	860	170	145	125	10.0	11.1	9.8	10.3	4	4	3.5	3.75	67	240	200	98	60	42	56

FAC-042
(11-88)

MIDNIGHT
NOON
6 PM
TONS PER HOUR
GRAPHIC CONTROLS CORPORATION
BUFFALO NEW YORK
FEEDING RATE-GRIER
OCT 13 1992
FX 898915


6 DAY
7 A.M.
8 A.M.
9 A.M.
10 A.M.
11 A.M.
NOON
1 P.M.
2 P.M.
3 P.M.
4 P.M.
5 P.M.
6 NIGHT
7 P.M.
8 P.M.
9 P.M.
10 P.M.
3 A.M.
4 A.M.
5 A.M.
Hunter Chart
UNIFORM
DRUM No. 1
898445
THE FOXBORO COMPANY
FOXBORO, MASS.
U.S.A.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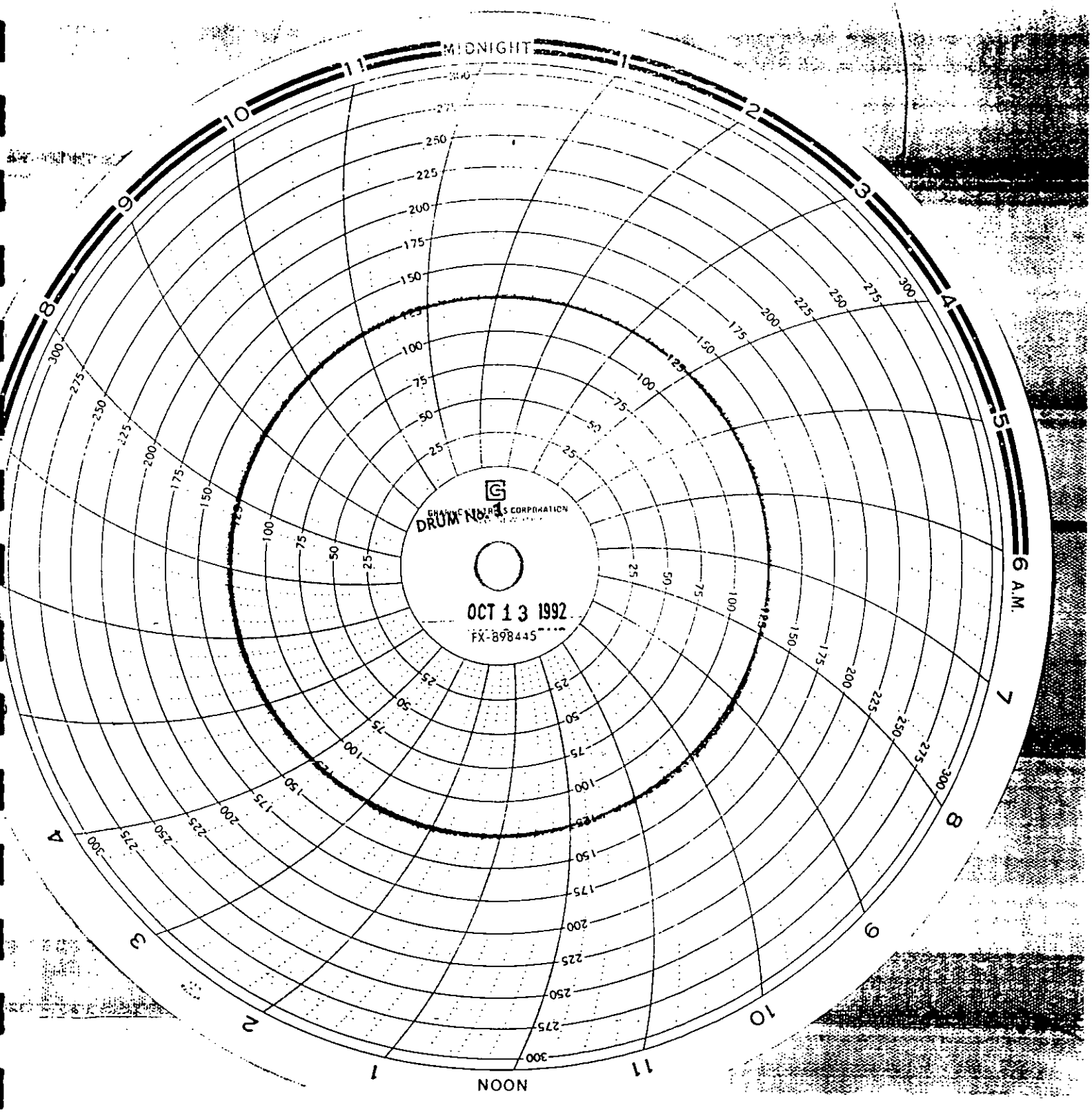
NOON
6 A.M.
GRAPHIC CONTROLS CORPORATION
BUFFALO, NEW YORK
OCT 13 1992
DRUM NO.
FX-898445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6 A.M.
NOON
DRUM No. 4
OCT 1 3 1992
FX-898445

APPENDIX B

CALCULATIONS

Network Environmental, Inc.

CALCULATION FORMULAS

MOISTURE TRAIN CALCULATIONS:

M1. BAROMETRIC PRESSURE, inches of Mercury

M2. DURATION OF SAMPLE, minutes

M3. METER CALIBRATION FACTOR

M4. AVERAGE METER TEMPERATURE, degrees F

M5. AVERAGE METER PRESSURE, inches of water

M6. METER VOLUME, ACTUAL, cubic feet

M7. METER VOLUME, STP, cubic feet

$$M7 = M3 * M6 * \frac{530}{M4 + 460} * \frac{M1 + .07355 * M5}{29.92}$$

M8. LIQUID VOLUME OF WATER CONDENSED, milliliters

M9. VAPOR VOLUME OF WATER CONDENSED, @ STP, cubic feet

$$M9 = M8 \bullet 0.0474$$

M10. TOTAL GAS SAMPLED, @ STP, cubic feet

$$M10 = M7 + M9$$

M11. PERCENT MOISTURE

$$M11 = \frac{M9}{M10} * 100$$

EXHAUST GAS CALCULATIONS:

G1. STACK DIMENSIONS, inches

G2. AREA OF STACK, square feet

$$G2\ (ROUND) = \frac{3.14159 * (DIA/2)^2}{144}$$

$$G2\ (RECT.) = \frac{WIDTH \bullet LENGTH}{144}$$

G3. BAROMETRIC PRESSURE, inches of Mercury

G4. STATIC PRESSURE IN STACK, inches of water

G5. STACK GAS TEMPERATURE, degrees F

G6. AVG. SQRT VELOCITY PRESSURE OF POINTS SAMPLED

G7. PERCENT MOISTURE AT TEST LOCATION

$$G7 = \frac{P13}{P14} * 100$$

Network Environmental, Inc.

CALCULATION FORMULAS CONTINUED

G8. PERCENT MOISTURE BEFORE COLLECTOR

G9. DRY GAS COMPOSITION, %O2, %CO2, %CO, %N2

G10. PERCENT EXCESS AIR AT TEST LOCATION

$$G10 = 100 * \frac{\%O2 - 0.5 * \%CO}{.264 * \%N2 - \%O2 + .5 * \%CO}$$

G11. DENSITY, DRY, @STP, lbs./cu. ft.

$$G11 = \frac{.0827 * \%O2 + .1137 * \%CO2 + (\%CO + \%N2) * .0724}{100}$$

G12. DENSITY, WET, @STP, lbs./cu. ft.

$$G12 = G11 * \frac{100 - G7}{100} + .0465 * \frac{G7}{100}$$

G13. DENSITY, WET, @ STACK CONDITIONS, lbs./cu. ft.

$$G13 = G12 * \frac{530}{G5 + 460} * \frac{G3 + .07355 * G4}{29.92}$$

G14. MOLECULAR WEIGHT, DRY, lbs./mole

$$G14 = G11 * 386.9$$

G15. AVERAGE GAS VELOCITY, feet/minute

$$G15 = P5 * G6 * \frac{1096}{SQRT(G13)}$$

G16. STACK GAS FLOW RATE, ACFM

$$G16 = G2 * G15$$

G17. STACK GAS FLOW RATE, SCFM

$$G17 = G16 * \frac{530}{G5 + 460} * \frac{G3 + .07355 * G4}{29.92}$$

G18. STACK GAS FLOW RATE, DRY, DSCFM

$$G18 = G17 * \frac{100 - G7}{100}$$

Network Environmental, Inc.

CALCULATION FORMULAS CONTINUED

PARTICULATE TRAIN CALCULATIONS:

P1. NUMBER OF POINTS SAMPLED

P2. DURATION OF SAMPLE, minutes

P3. NOZZLE DIAMETER, inches

P4. NOZZLE AREA, square feet

$$P4 = \frac{3.14159 * (P3/2)^2}{144}$$

P5. PITOT CALIBRATION FACTOR

P6. METER CALIBRATION FACTOR

P7. AVERAGE FILTER TEMPERATURE, degrees F

P8. AVERAGE METER TEMPERATURE, degrees F

P9. AVERAGE METER PRESSURE, inches of water

P10. METER VOLUME, ACTUAL, cubic feet

P11. METER VOLUME, @ STP, cubic feet

$$P11 = P10 * P6 * \frac{530}{P8 + 460} * \frac{G3 + .07355 * P9}{29.92}$$

P12. LIQUID VOLUME OF WATER CONDENSED, milliliters

P13. VAPOR VOLUME OF WATER CONDENSED, @ STP, cubic feet

$$P13 = P12 * 0.0474$$

P14. TOTAL GAS SAMPLED, @ STP, cubic feet

$$P14 = P11 + P13$$

P15. WEIGHT OF GAS SAMPLED, DRY, pounds

$$P15 = P11 * G11$$

P16. WEIGHT OF GAS SAMPLED, WET, pounds

$$P16 = P14 * G12$$

P17. PERCENT ISOKINETICS

$$P17 = \frac{100 * 29.92 * (G5 + 460) * P14}{530 * (G3 + .07355 * G4) * P2 * P4 * G15}$$

Network Environmental, Inc.

CALCULATION FORMULAS CONTINUED

CONCENTRATION CONVERSION FACTORS:

P18. 50 % EXCESS AIR, AFER COLLECTOR

$$P18 = \frac{G14 + 18 * G7/(100 - G7)}{.1826 \bullet \%N2 - 2.0592 * \%O2 + G14 + 18 \bullet G7/(100 - G7)}$$

P19. 50 % EXCESS AIR, BEFORE COLLECTOR

$$P19 = \frac{G14 + 18 * G7/(100 - G7)}{.1826 \bullet \%N2 - 2.0592 * \%O2 + G14 + 18 * G8/(100 - G8)}$$

P20. MOISTURE BEFORE COLLECTOR

$$P20 = \frac{G14 + 18 * G7/(100 - G7)}{G14 + 18 * G8/(100 - G8)}$$

PARTICULATE EMISSION CALCULATIONS:

E1. TOTAL WEIGHT PARTICULATE COLLECTED, grams

E2. LBS. PARTICULATE/1000 LBS. GAS, ACTUAL

$$E2 = E1 * \frac{1000}{454 \bullet P16}$$

E3. LBS. PARTICULATE/1000 LBS. GAS, DRY

$$E3 = E2 * P20$$

E4. LBS. PARTICULATE/1000 LBS. GAS, WET, 50% EA

$$E4 = E2 * P18$$

E5. LBS. PARTICULATE/1000 LBS. GAS, DRY, 50% EA

$$E5 = E2 * P19$$

E6. GRAINS/DRY STANDARD CUBIC FOOT

$$E6 = \frac{E1 * 7000 * 100}{454 \bullet P14 \bullet (100 - G7)}$$

E7. POUNDS/HOUR

$$E7 = \frac{G17 * G12 * 1000 * E1 * .06}{454 \bullet P16}$$

E8. POUNDS/MILLION BTU

$$E8 = \frac{E7}{\text{CAPACITY, MM BTU/HR}}$$

APPENDIX C

RAW DATA

NETWORK ENVIRONMENTAL INCORPORATED

Date: 10-13-92

Clients: MONITOR SUGAR

Pitot Traverse Data Form

Proj. No.:

Plant: (Bay City) MONITOR SUGAR

Source: Dryer # 2

Staff: CARGILL & SMITH

Stack Size, Inches 66"

Barometric Pressure, "Hg 28.8

Gas Temperature, °F 170 D 169 W

Static Pressure, "H_2O -.98

Pitot Tube ☐ Standard ☒ S-Type

%O_2 %CO_2

#1

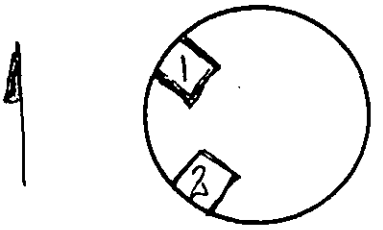
Point Location Inches	1 Port	Velocity Pressure "H_2O	2 Port	Velocity Pressure "H_2O	Port	Velocity Pressure "H_2O	Port	Velocity Pressure "H_2O
	1	.40	1	.38	1		1	
	2	.61	2	.66	2		2	
	3	.64	3	.58	3		3	
	4	.26	4	.69	4		4	
	5	.64	5	.80	5		5	
	6	.82	6	.80	6		6	
	7		7		7		7	
	8		8		8		8	
	9		9		9		9	
	10		10		10		10	
	11		11		11		11	
	12		12		12		12	
	13		13		13		13	
	14		14		14		14	

$\sqrt{\Delta P} = .73$

Wall Thickness	
Zero Point	
Port Size/Type	

1-4-6

4-8-9



NETWORK ENVIRONMENTAL, INC.

Date: 10-13-92
Client: MONITOR SUGAR

Plant: MONITOR SUGAR (BAY CITY)
Source: DRYER # 2 Staff: CARGILL & SMITH

PITOT #1

Sample #	#1	Filter Set #	29	Barometric Press	28.8
Nozzle #	.3125	Primary Filter #	DH-374	Initial Gas Read	301.11
Rate Meter #		Secondary Filter #	DH 374	Clock Meter Start	11:25
Control Box #	3072	Type Train	5B	Time Meter Start	0
Condenser Box #	1	Mls. H_2O Cond.	568	Time Meter Stop	1

Port	Point	Vel Press "H_2O	P Venturi "H_2O	Gas Meter Reading	Pump Vac. "Hg	Meter Temp °F In	Meter Temp °F Out	Stack Temp °F	Box Temp °F	Gas Bag #
1	1	.53	2.15	304.87	2.5	67	67	180		Dryer # 1
	2	.52	2.05	308.81	3	64	66	180		Notes
	3	.21	.84	311.45	2.5	69	67	168		0.000 cu ft @ 5" in. Hg Vaccum Leak check
	4	.62	2.50	315.28	4.5	71	67	168		
	5	.76	3.07	320.25	5.5	74	67	169		
	6	.57	2.31	324.45	3.5	74	67	169		
2	1	.42	1.70	327.86	3	75	68	170		End of Test #1 @ 12:35 PM
	2	.61	2.48	332.00	4	72	68	168		
	3	.37	1.50	335.34	3	74	68	169		
	4	.20	.81	337.96	2.5	74	68	170		Final Leak check 0.000 cu ft @ 5 in. Hg Vaccum
	5	.38	1.54	341.33	3.5	75	68	170		
	6	.64	2.60	346.20	5	75	68	170		

45.09 cu ft

NETWORK ENVIRONMENTAL, INC.

Date: 10-13-92
Client: MONITOR SUGAR

Plant: MONITOR SUGAR
Source: DRYER #2 Staff: CARGILL & SMITH
PITOT #1

Sample #	2	Filter Set #	9	Barometric Press	28.8
Nozzle #	.3125	Primary Filter #	DH 379	Initial Gas Read	346.53
Rate Meter #		Secondary Filter #	BH-379	Clock Meter Start	12:51
Control Box #	30	Type Train	5e	Time Meter Start	0
Condenser Box #	1	Mls. H_2O Cond.	556	Time Meter Stop	1

Port	Point	Vel Press "H_2O	P Venturi "H_2O	Gas Meter Reading	Pump Vac. "Hg	Meter Temp °F In	Meter Temp °F Out	Stack Temp °F	Box Temp °F	Gas Bag #
2	1	.42	1.57	349.92	2	68	69	163		Dryer # 4
	2	.62	2.33	353.77	2	69	68	168		Notes
	3	.40	1.50	357.21	33	72	68	183		INITIAL 0.000 cu.ft @ 28 in. Hg VACCUM LEAK CHECK
	4	.45	1.69	360.08	2.5	75	68	185		
	5	.33	1.24	363.79	2	75	69	182		
	6	.67	2.51	368.01	2	77	69	181		
1	1	.56	2.10	370.86	3.5	70	69	184		END OF TEST #2 @ 13:55
	2	.42	1.57	374.22	2.5	72	68	183		
	3	.21	.78	376.72	2	74	68	183		FINAL LEAK CHECK 0.000 cu. ft @ 5 in. Hg VACCUM
	4	.64	2.40	380.87	3	74	68	181		
	5	.67	2.51	386.25	3	74	68	180		
	6	.60	2.25	389.31	3	74	68	180		

42.78 cu.ft.

NETWORK ENVIRONMENTAL, INC.

Date: 10.13.92
Client: MONITOR SUGAR

Plant: MONITOR SUGAR
Source: DRYER # 2 Staff: CARGILL & SMITH
PITOT # 1

Sample # 3 Filter Set # 21 Barometric Press 28.8
Nozzle # .3125 Primary Filter # 385 Initial Gas Read 389.57
Rate Meter # Secondary Filter # 385 Clock Meter Start 14:07
Control Box # 3072 Type Train 58 Time Meter Start 0
Condenser Box # 1 Mls. H_2O Cond. 590 Time Meter Stop 1

Port	Point	Vel Press "H_2O	P Venturi "H_2O	Gas Meter Reading	Pump Vac. "Hg	Meter Temp °F In	Meter Temp °F Out	Stack Temp °F	Box Temp °F	Gas Bag #
1	1	.60	2.25	393.43	~~3~~	~~66~~	~~66~~	~~183~~		Dryer # 6
	2	.64	2.40	397.64	3	70	65	181		Notes
	3	.21	.77	400.05	2	71	66	180		INITIAL LEAK CHECK 0.000 cu. ft. @ 27 in. Hg VACCUM
	4	.62	2.27	404.03	3	73	68	181		
	5	.72	2.64	408.04	3	75	67	180		
	6	.64	2.40	412.58	3	76	68	177		
2	1	.47	1.72	416.08	2.5	73	69	184		END OF TEST # 3 @ 15:9
	2	.62	2.27	420.22	3	75	69	183		
	3	.33	1.21	423.24	2	77	69	185		
	4	.29	1.06	426.46	2	77	70	186		FINAL LEAK CHECK .000 cu. ft. @ 7 in. Hg VACCUM ✓
	5	.63	2.31	430.14	3	77	70	183		
	6	.74	2.71	434.55	3	79	70	181		

44.98 cu ft.

NETWORK ENVIRONMENTAL INCORPORATED

Date: 10/9/92 Calibration Meter Identification: #1 Yds. 1.000

Meter Box Identification: 3072 Barometric Pressure (P_b): 28.70

	Orifice Reading (ΔH) In H_2O	Calibration Meter Gas Volume (V_{ds}) ft^3	Meter Box Meter Gas Volume (V_d) ft^3	Temperature: Calibration Meter Average (t_{ds}) °F	Temperature: Meter Box Meter Average (t_d) °F	Calibration Meter Pressure (Δp) In H_2O	Time (Θ) min.	Orifice Pressure Differential ($\Delta H@$)	Meter Box Meter Coefficient (Yd)	K_d
Stop	0.50	1967.210	105.095	66.5	80.0	-0.30				
Start	0.50	1961.904	99.776	66.5	76.5	-0.30	13	1.7225	1.0185	0.13471
Average	0.50	5.306	5.319	66.5	78.25	-0.30				
Stop	1.0	1972.680	110.591	66.5	80.0	-0.50				
Start	1.0	1967.646	105.538	66.5	76.5	-0.50	9	1.8391	1.0159	0.13051
Average	1.0	5.034	5.053	66.5	78.25	-0.50				
Stop	2.0	1978.724	116.721	66.5	80.0	-0.70				
Start	2.0	1973.294	111.216	66.5	76.0	-0.70	7	1.9230	1.0028	0.12795
Average	2.0	5.430	5.505	66.5	78.0	-0.70				
Stop	3.0	1989.966	128.221	66.5	81.5	-1.00				
Start	3.0	1979.545	117.555	66.5	76.0	-1.00	11	1.9411	0.9921	0.12754
Average	3.0	10.421	10.666	66.5	78.75	-1.00				
Stop	4.0	2001.802	140.450	66.5	81.5	-1.30				
Start	4.0	1990.978	129.262	66.5	75.5	-1.30	10	1.9937	0.9795	0.12615
Average	4.0	10.824	11.188	66.5	78.5	-1.30				
Stop	5.0	2013.097	152.100	66.5	81.5	-1.50				
Start	5.0	2002.331	140.963	66.5	76.0	-1.50	9	2.0498	0.9767	0.12466
Average	5.0	10.766	11.137	66.5	78.75	-1.50				
							Average	1.9116	0.9976	0.12859

$$Yd = Yds\left(\frac{Vds}{Vd}\right)\left[\frac{(td + 460)}{(tds + 460)}\right]\left[\frac{Pb}{(Pb + (\frac{\Delta H}{13.6}))}\right] \qquad Kiso = \frac{27.40}{(Kd)^2}$$

$$Kd = Yds\left(\frac{Vds}{\Theta}\right)\sqrt{\frac{Pds}{Tds\ \Delta H}} \qquad Pds = \left[Pb + (\frac{\Delta P}{13.6})\right] \qquad \Delta H@ = 0.0319\ \Delta H\left(\frac{td}{Pb}\right)\left[\frac{\Theta^2}{Yd^2 Vd^2}\right]$$

Kiso= 1657.149569

NETWORK ENVIRONMENTAL

Pitot tube calibration data.

PITOT TUBE IDENTIFICATION NUMBER: #1 DATE: 12/13/91

CALIBRATED BY: RSC

"A" SIDE CALIBRATION				
RUN NO.	Δp_{std} cm H_2O (in. H_2O)	$\Delta p_{(s)}$ cm H_2O (in. H_2O)	$C_{p(s)}$	DEVIATION $C_{p(s)} - \bar{C}_p(A)$
1	.235	.305	.87	.01
2	.23	.305	.86	0
3	.23	.305	.86	0
		$\bar{C}_p$ (SIDE A)	.86	.003

"B" SIDE CALIBRATION				
RUN NO.	Δp_{std} cm H_2O (in. H_2O)	$\Delta p_{(s)}$ cm H_2O (in. H_2O)	$C_{p(s)}$	DEVIATION $C_{p(s)} - \bar{C}_p(B)$
1	.23	.315	.85	0
2	.23	.31	.85	0
3	.23	.315	.85	0
		$\bar{C}_p$ (SIDE B)	.85	0

$$\text{AVERAGE DEVIATION} = \sigma(A \text{ OR } B) = \frac{\sum_{1}^{3} \left| C_{p(s)} - \bar{C}_p(A \text{ OR } B) \right|}{3} \longrightarrow \text{MUST BE} \leq 0.01$$

$$\left| \bar{C}_p(\text{SIDE A}) - \bar{C}_p(\text{SIDE B}) \right| \longrightarrow \text{MUST BE} \leq 0.01$$