MMSD-South Shore Plant

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#19

ENTROPY
ENVIRONMENTALISTS, INC.

SPECIALISTS IN AIR POLLUTION MEASUREMENT & MANAGEMENT

Dec, 80

STATIONARY SOURCE SAMPLING REPORT

CITY OF MILWAUKEE SOUTH SHORE TREATMENT PLANT
MILWAUKEE, WISCONSIN

PARTICULATE EMISSIONS COMPLIANCE TESTING
NICHOLS HERRESCHOFF SLUDGE INCINERATOR

performed for

NICHOLS ENGINEERING & RESEARCH CORPORATION

DECEMBER 1980

P.O. Box 12291, Research Triangle Park, North Carolina 27709
Phone 919-781-3550

INTRODUCTION

Stationary source sampling was performed at the City of Milwaukee's South Shore Waste Water Treatment Plant on December 17, 1980. Three EPA Method 5 and three EPA Method 9 tests were performed at the outlet stack of the Nichols Herreschoff Sludge Incinerator to determine the particulate and visible emissions. Patrick J. Brady from the State of Wisconsin Department of Natural Resources was present to observe the testing.

Immediately following is the "Summary of Results" section which summarizes the results from the tests. For a more detailed account of each test, see Appendices A and C. A description of the source and an air flow schematic appear in the "Process Description and Operation" section. Process data is included in Appendix D. The last section, "Sampling and Analytical Procedures," contains a brief discussion of the sampling methods. Detailed descriptions of the equipment and procedures used appear in Appendix F. Pertinent calibration data is presented in Appendix G.

SUMMARY OF RESULTS

Table 1 presents a summary of the particulate emissions and process information. The average particulate discharge was 0.73 pounds per ton of dry sludge.

A summary of the three particulate tests is presented in Table 2. For a detailed account of each test, see Appendix A. Table 3 presents the results of the analyses run on the three sludge samples and two ash samples.

During each of the three particulate tests, visible emissions readings were taken, resulting in average opacities of less than 0.2% for each run. For a detailed presentation of the visible emission data, see Appendix C.

TABLE 1

PARTICULATE EMISSIONS AND PROCESS INFORMATION

Test Number	Particulates lbs/hr	Wet Sludge lbs/hr	Dry Solids Percent[1]	Dry Sludge lbs/hr	ton/hr	Particulates Discharge lbs/dry ton[2]
1	0.22	1485	41.60	617.8	3089	.71
2	0.21	1409	44.10	621.4	.3107	.68
3	0.31	1459	54.10	789.3	.3946	.79
Average	0.25	1451	46.6	676.2	.338	.73

[1] 100 - % moisture from Table 3

[2] $$\text{lbs/ton} = \frac{\text{2000 lbs/ton x particulate lbs/hr}}{\text{dry sludge lbs/hr}}$$

TABLE 2

PARTICULATE TESTS SUMMARY OF RESULTS

Incinerator Stack

	1	2	3
RUN DATE	12/17/80	12/17/80	12/17/80
TEST TRAIN PARAMETERS:			
VOLUME OF DRY GAS SAMPLED, SCF*	65.050	62.998	65.038
PERCENT ISOKINETIC	99.4	95.2	96.9
STACK PARAMETERS:			
TEMPERATURE, DEG. F	132	136	139 22 17
AIR FLOW RATES SCFM*, DRY	3965 ave 3,864	4,034	3,996
ACFM, WET	4,477	4,408	4,391
METHOD 5 TEST RESULTS:			
CATCH, MILLIGRAMS	28.1	24.3	37.8
GRAINS PER DSCF*	0.0067	0.0060	0.0090
LBS PER HOUR	0.22	0.21	0.31

* 68 Deg. F. - 29.92 in. Hg.

TABLE 3

SLUDGE AND ASH ANALYSIS RESULTS
(dry basis)

Sample	Moisture(%)	Volatiles(%)	Btu Per Pound
1	58.4	45.8	3433
2	55.9	39.8	2726
3	45.9	34.6	3620
Ash 1	<0.1	0.46	-
Ash 2	<0.1	<0.1	-

PROCESS DESCRIPTION AND OPERATION

The Waste Water Treatment Plant in Milwaukee, Wisconsin operates a Nichols Herreschoff Sludge Incinerator. The incinerator consists of six vertically stacked hearths. Material is fed into the top hearth and is moved from hearth to hearth by a center shaft with attached arms and teeth which divert the flow of material through the incinerator. Air is forced through the center shaft and arms to protect them from the high temperatures in the incinerator. Once through the incinerator, this cooling air enters the stack prior to the test ports.

From the incinerator, the gases pass through a venturi-scrubber system and an induced draft fan before reaching the stack, as shown in Figure 1. During the testing, the furnace feed rates for runs 1, 2, and 3 were 1485, 1409, and 1458.5 wet pounds per hour, respectively. The average moisture content was 53.4 percent. Appendix D contains process data taken by Nichols during the testing.

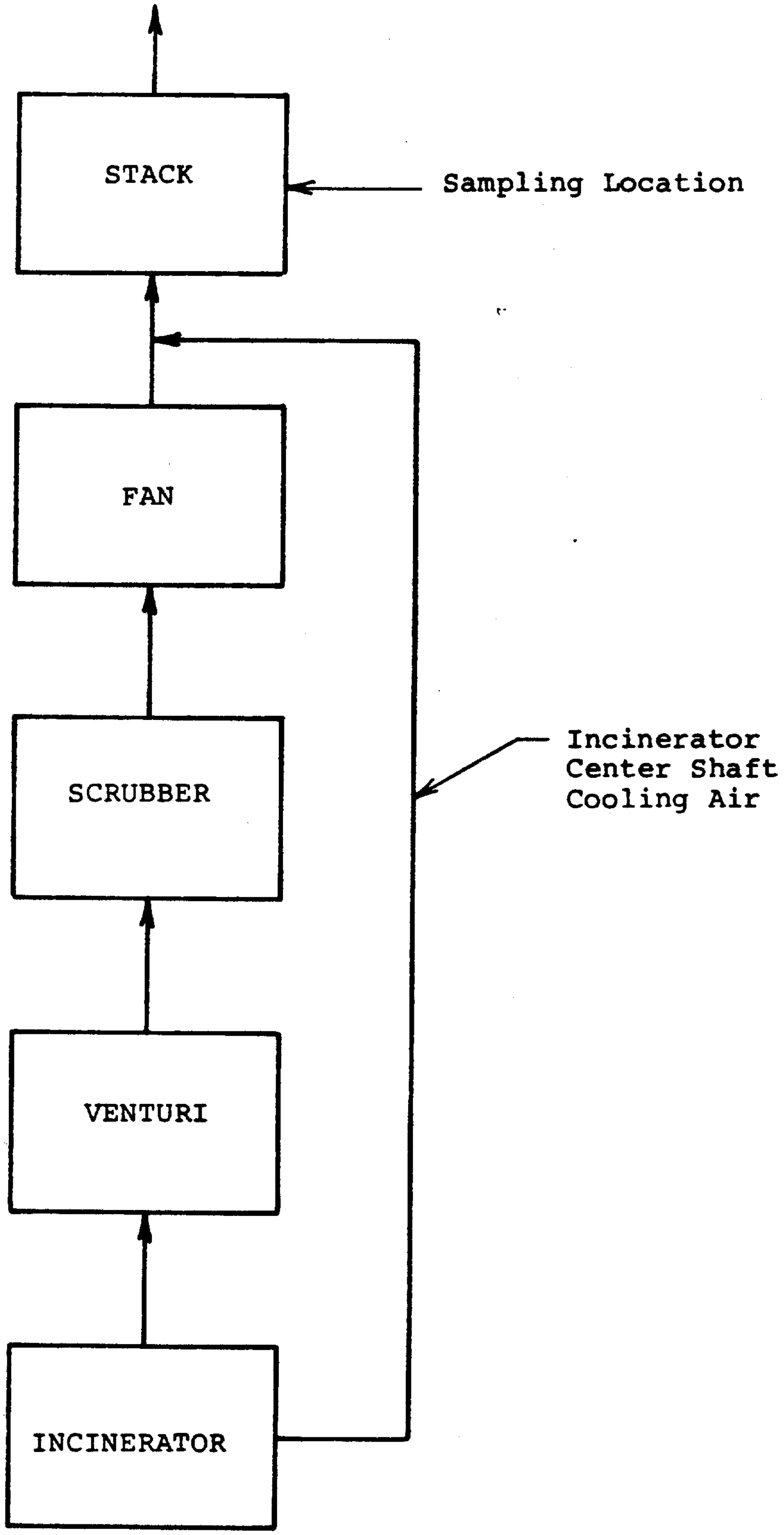


FIGURE 1. PROCESS AIR FLOW SCHEMATIC SHOWING SAMPLING LOCATION.

SAMPLING AND ANALYTICAL PROCEDURES

All sampling and analytical procedures used were those generally recommended by the United States Environmental Protection Agency and the Wisconsin Department of Natural Resources. Complete details of the equipment and procedures used are described in Appendix F, which is extracted from the Federal Register, August 18, 1977.

The number of sampling points was based on the distance of the sampling ports from disturbances in the gas flow as described in Method 1. The stack cross section was divided into 24 equal areas with 12 points on each of two traverse axes, as shown in Figures 2 and 3. Each point was sampled for three minutes, resulting in 72 - minute tests.

Velocity measurements were made according to Method 2 procedures, while Method 3 was followed in determining the flue gas composition, molecular weight, and percent excess air. Method 5 was used for particulate emission determinations. Visible emission readings were taken by a certified smoke reader according to Method 9.

All sampling equipment used was manufactured by either Nutech Corporation or Entropy Environmentalists, Inc.

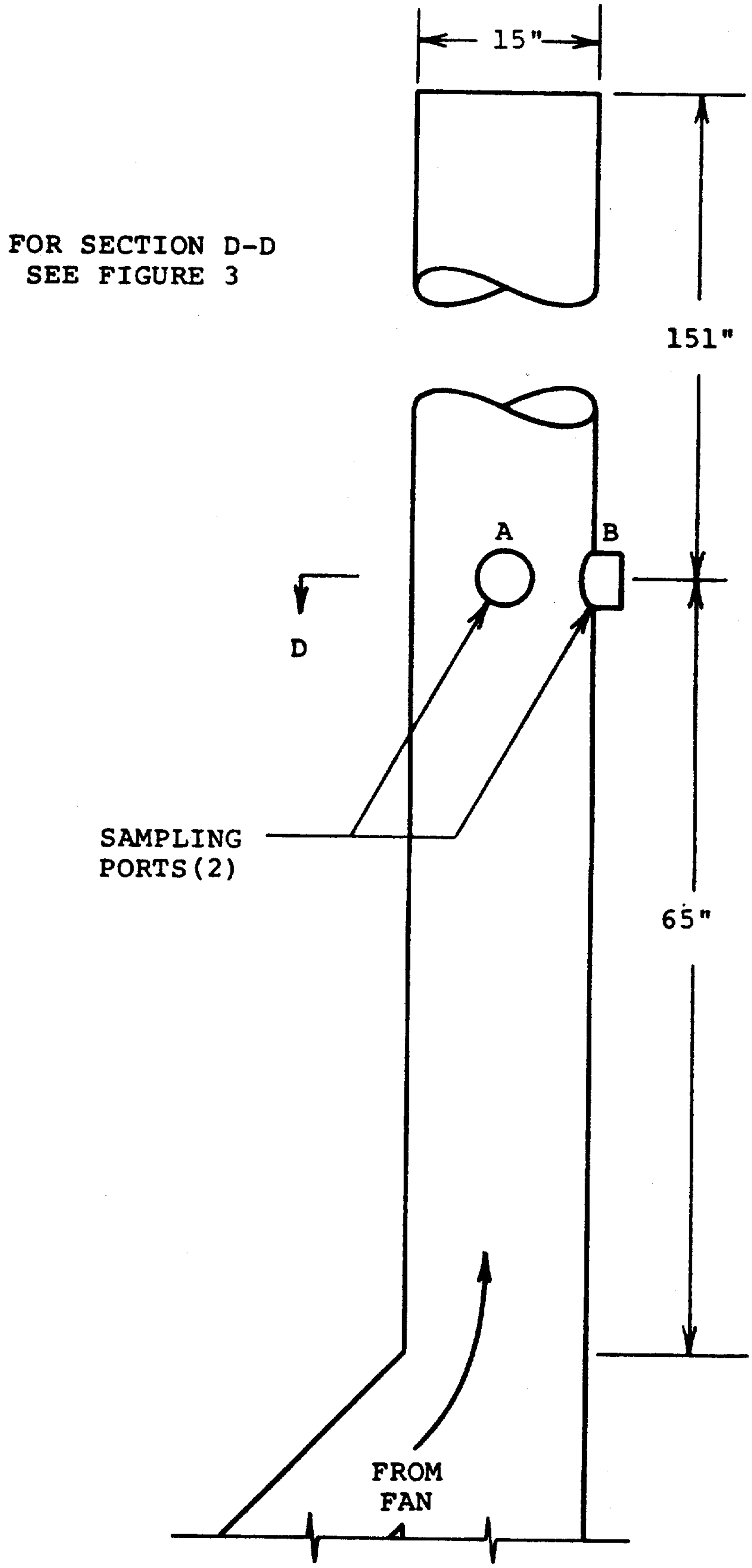


FIGURE 2. STACK DIMENSIONS AND SAMPLING PORT LOCATIONS

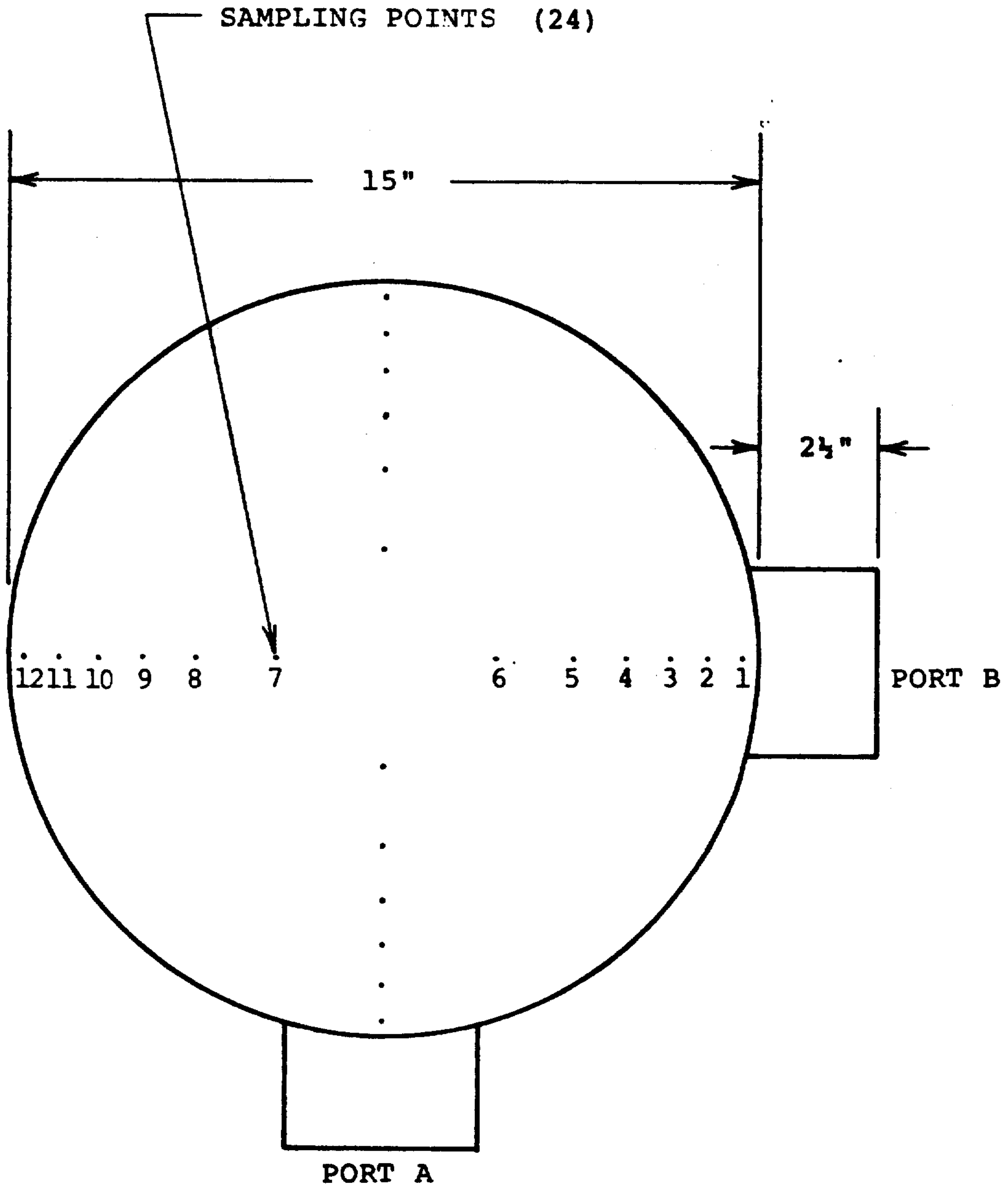


FIGURE 3. STACK CROSS-SECTION SHOWING SAMPLING POINT LOCATIONS.

APPENDICES

APPENDIX A

(COMPUTER PRINTED)

PARTICULATE TESTS RESULTS

WITH EXAMPLE CALCULATIONS

ENTROPY
ENVIRONMENTALISTS, INC.

PARTICULATE FIELD DATA & RESULTS TABULATION

PLANT: Nichols Engineering, (Grunau Co.), Milwaukee, Wis.

RUN	SAMPLING LOCATION	TEST TEAM LEADER
1	Incinerator Stack	John T. Nash
2	Incinerator Stack	John T. Nash
3	Incinerator Stack	John T. Nash

		1	2	3
	RUN DATE	12/17/80	12/17/80	12/17/80
	RUN START TIME	900	1035	1155
	RUN FINISH TIME	1014	1137	1257
	NET SAMPLING POINTS	24	24	24
Theta	NET RUN TIME, MINUTES	60.00	60.00	60.00
Dia	NOZZLE DIAMETER, INCHES	.250 0.252	.250 0.248	.25 0.251
Cp	PITOT TUBE COEFFICIENT	0.840	0.840	0.840
Y	DRY GAS METER CAL. FACTOR	0.990	0.990	0.990
Pbar	BAROMETRIC PRESSURE, IN. HG.	29.60	29.60	29.60
Delta H	AVG. PRESS. DIFFERENTIAL OF ORIFICE METER, IN. H2O	4.170	3.890	4.160
Vm	VOLUME OF METERED GAS SAMPLE DRY ACTUAL CUBIC FEET	70.378	68.084	70.616
tm	DRY GAS METER TEMP., DEG. F	105	104	107
Vm(std)	VOLUME OF METERED GAS SAMPLE @ DRY STD. COND., DSCF*	65.050	62.998	65.038
Vlc	VOLUME OF WATER CATCH IN IMPINGERS & SIL. GEL.,ML	30.5	37.0	39.0
Vw(std)	VOLUME OF WATER VAPOR, SCF*	1.436	1.742	1.836
%H2O	MOISTURE, PERCENT BY VOLUME	2.2	2.7	2.7
Mfd	DRY MOLE FRACTION	0.978	0.973	0.973

(continued next page)

		1	2	3
%CO2	PERCENT CO2 BY VOLUME, DRY	3.8	3.8	3.5
%O2	PERCENT O2 BY VOLUME, DRY	16.8	16.1	16.2
%CO	PERCENT CO BY VOLUME, DRY	0.0	0.0	0.0
%N2	PERCENT N2 BY VOLUME, DRY	79.4	80.1	80.3
Md	DRY MOLECULAR WT, LB/LB-MOLE	29.28	29.25	29.21
Ms	WET MOLECULAR WT, LB/LB-MOLE	29.04	28.95	28.90
Pg	STACK STATIC PRESS., IN H2O	-.6 ~~+0.1~~	-.6 ~~+29.6~~	-.6 ~~+29.6~~
Ps	ABSOLUTE STACK PRESS., IN HG	29.56 ~~29.60~~	29.56 ~~31.78~~	29.56 ~~31.78~~
ts	STACK TEMPERATURE, DEG. F	132	136	139
Delta p	AVG VELOCITY HEAD, IN. H2O	1.0378	1.0693	1.0538
vs	STACK GAS VELOCITY, FT/SEC	60.7	59.8	59.5
A	STACK AREA, SQUARE INCHES	177.0	177.0	177.0
Qsd	STACK FLOW RATE, DRY SCFM*	3,864	4,034	3,996
Qaw	STACK FLOW RATE, WET ACFM	4,477	4,408	4,391
%I	PERCENT ISOKINETIC	99.4	95.2	96.9
	METHOD 5 RESULTS:			
mg	CATCH, MILLIGRAMS	28.1	24.3	37.8
Gn/DSCF	CONCEN., GRAINS PER DSCF*	0.0067	0.0060	0.0090
Lb/Hr	EMISSION RATE, LBS/HOUR	0.22	0.21	0.31

* 68 Deg. F - 29.92 in. Hg.

EXAMPLE PARTICULATE TEST CALCULATIONS NO. 1

Incinerator Stack

VOLUME OF DRY GAS SAMPLED AT STANDARD CONDITIONS

$$Vm(std) = 17.64 * Y * Vm * \frac{(Pbar + Delta\ H/13.6)}{(460 + tm)}$$

$$Vm(std) = 17.64 * 0.989 * 70.378 * \frac{(29.60 + 4.170/13.6)}{(460 + 105)} = 65.050 \text{ DSCF}$$

VOLUME OF WATER VAPOR AT STANDARD CONDITIONS

$Vw(std) = 0.04707 * Vlc$

$Vw(std) = 0.04707 * 30.5 = 1.436$ SCF

PERCENT MOISTURE, BY VOLUME, AS MEASURED IN STACK GAS

$\%H2O = 100 * Vw(std) / (Vw(std) + Vm(std))$

$$\%H2O = \frac{1.436}{1.436 + 65.050} * 100 = 2.2\ \%$$

DRY MOLE FRACTION OF STACK GAS

$Mfd = 1 - \%H2O/100$

$Mfd = 1 - 2.2/100 = 0.978$

DRY MOLECULAR WEIGHT OF STACK GAS

$Md = \%CO2 * 0.44 + \%O2 * 0.32 + (\%N2 + \%CO) * 0.28$

$Md = 3.8*0.44 + 16.8*0.32 + (79.4+0.0)*0.28 = 29.28$ LB/LB-MOLE

WET MOLECULAR WEIGHT OF STACK GAS

$Ms = (Md * Mfd) + (0.18 * \%H2O)$

$Ms = 29.28 * 0.978 + (0.18 * 2.2) = 29.04$ LB/LB-MOLE

ABSOLUTE STACK GAS PRESSURE

$$Ps = Pbar + Pg / 13.6$$

$$Ps = 29.60 + (0.0 / 13.6) = 29.60 \text{ IN. HG.}$$

AVERAGE STACK GAS VELOCITY [Note: (Delta p)avg is square of avg sq. root]

$$vs = 85.49 * Cp * \text{SQRT}\left[\frac{(\text{Delta } p)avg * (460 + ts)}{Ps * Ms}\right]$$

$$vs = 85.49 * 0.840 * \text{SQRT}\left[\frac{1.0378 * (460 + 132)}{29.60 * 29.04}\right] = 60.7 \text{ FT/SEC}$$

DRY VOLUMETRIC STACK GAS FLOW RATE @ STANDARD CONDITIONS

$$Qsd = \frac{60}{144} * Mfd * vs * A * \frac{Tstd}{ts + 460} * \frac{Ps}{Pstd}$$

$$Qsd = \frac{60}{144} * 0.978 * 60.7 * 177.0 * \frac{528}{132 + 460} * \frac{29.60}{29.92}$$

$$Qsd = 3{,}864 \text{ SCFM}$$

WET VOLUMETRIC STACK GAS FLOW RATE @ STACK CONDITIONS

$$Qaw = 60 / 144 * vs * A$$

$$Qaw = 60 / 144 * 60.7 * 177.0 = 4{,}477 \text{ ACFM}$$

PERCENT ISOKINETIC OF SAMPLING RATE

$$\%I = \frac{Pstd}{Tstd} * \frac{100}{60} * \frac{(ts + 460) * Vm(std)}{Ps * vs * Mfd * Theta * \text{Area-nozzle, sq.ft.}}$$

$$\%I = \frac{29.92}{528} * \frac{100}{60} * \frac{(132 + 460) * 65.050}{29.60 * 60.7 * 0.978 * 60.00 * 0.0003464}$$

$$\%I = 99.4 \%$$

GRAINS PER DRY STANDARD CUBIC FOOT

$$\text{Gn/DSCF} = \frac{7000}{453{,}592} * \frac{\text{mgs}}{\text{Vm(std)}}$$

$$\text{Gn/DSCF} = \frac{7000}{453{,}592} * \frac{28.1}{65.050} = 0.0067 \quad \text{GN/DSCF}$$

POUNDS PER HOUR

$$\text{Lb/Hr} = 60 \;/\; 7000 \; * \; \text{Gn/DSCF} \; * \; \text{Qsd}$$

$$\text{Lb/Hr} = 60/7000 \; * \; 0.0067 \; * \; 3{,}864 = 0.22 \quad \text{LB/HR}$$

APPENDIX B

Preliminary Field Data

PLANT NAME MILWAUKEE - SOUTH SHORE

LOCATION MILWAUKEE, WIS.

SAMPLING LOCATION INCINERATOR

DUCT DEPTH

FROM INSIDE FAR WALL TO OUTSIDE OF PORT 17½"

NIPPLE LENGTH 2½"

DEPTH OF DUCT 15"

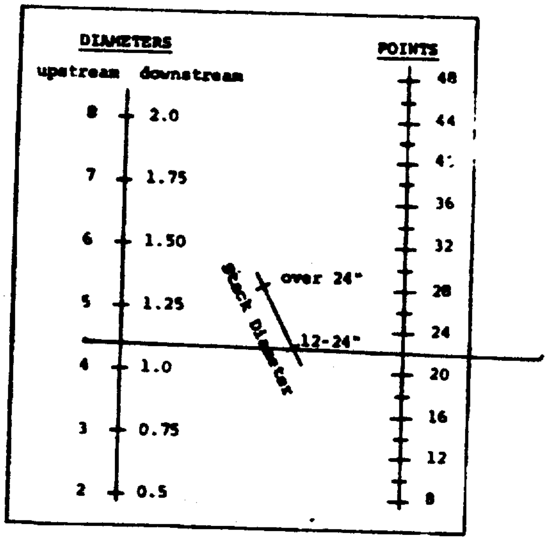
WIDTH (RECTANGULAR DUCT) ______

EQUIVALENT DIAMETER:

$$D_E = \frac{2 \times \text{DEPTH} \times \text{WIDTH}}{\text{DEPTH} + \text{WIDTH}} = \frac{2(\quad)(\quad)}{(\quad + \quad)} = \_\_\_\_$$

DISTANCE FROM PORTS TO NEAREST FLOW DISTURBANCE:	UPSTREAM	DOWNSTREAM
FEET	65"	75"
STACK DIAMETERS	4.33	5

STACK AREA = $(7.5)^2(\pi)$ = 177 IN²



Point	% OF DIAMETER	DISTANCE FROM INSIDE WALL	DISTANCE FROM OUTSIDE OF PORT
1	2.1	½"	3"
2	6.7	1"	3½"
3	11.8	1¾"	4¼"
4	17.7	2⅝"	5⅛"
5	25.0	3¾"	6¼"
6	35.6	5⅜"	7⅞"
7	64.4	9⅝"	12⅛"
8	75.0	11¼"	13¾"
9	82.3	12⅜"	14⅞"
10	88.2	13¼"	15¾"
11	93.3	14"	16½"
12	97.9	14½"	17
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			

LOCATION OF TRAVERSE POINTS IN CIRCULAR STACKS

	4	6	8	10	12	14	16	18	20	22	24
1	6.7	4.4	3.2	2.6	2.1	1.8	1.6	1.4	1.3	1.1	1.1
2	25.0	14.6	10.5	8.2	6.7	5.7	4.9	4.4	3.9	3.5	3.2
3	75.0	29.6	19.4	14.6	11.8	9.9	8.5	7.5	6.7	6.0	5.5
4	93.3	70.4	32.3	22.6	17.7	14.6	12.5	10.9	9.7	8.7	7.9
5		85.4	67.7	34.2	25.0	20.1	16.9	14.6	12.9	11.6	10.5
6		95.6	80.6	65.8	35.6	26.9	22.0	18.8	16.5	14.6	13.2
7			89.5	77.4	64.4	36.6	28.3	23.6	20.4	18.0	16.1
8			96.8	85.4	75.0	63.4	37.5	29.6	25.0	21.8	19.4
9				91.8	82.3	73.1	62.5	38.2	30.6	26.2	23.0
10				97.4	88.2	79.9	71.7	61.8	38.8	31.5	27.2
11					93.3	85.4	78.0	70.4	61.2	39.3	32.3
12					97.9	90.1	83.1	76.4	69.4	60.7	39.8
13						94.3	87.5	81.2	75.0	68.5	60.2
14						98.2	91.5	85.4	79.6	73.8	67.7
15							95.1	89.1	83.5	78.2	72.8
16							98.4	92.5	87.1	82.0	77.0
17								95.6	90.3	85.4	80.6
18								98.6	93.3	88.4	83.9
19									96.1	91.3	86.8
20									98.7	94.0	89.5
21										96.5	92.1
22										98.9	94.5
23											96.8
24											98.9

LOCATION OF TRAVERSE POINTS IN RECTANGULAR STACKS

	2	3	4	5	6	7	8	9	10	11	12
1	25.0	16.7	12.5	10.0	8.3	7.1	6.3	5.6	5.0	4.5	4.2
2	75.0	50.0	37.5	30.0	25.0	21.4	18.8	16.7	15.0	13.6	12.5
3		83.3	62.5	50.0	41.7	35.7	31.3	27.8	25.0	22.7	20.8
4			87.5	70.0	58.3	50.0	43.8	38.9	35.0	31.8	29.2
5				90.0	75.0	64.3	56.3	50.0	45.0	40.9	37.5
6					91.7	78.6	68.8	61.1	55.0	50.0	45.8
7						92.9	81.3	72.2	65.0	59.1	54.2
8							93.8	83.3	75.0	68.2	62.5
9								94.4	85.0	77.3	70.8
10									95.0	86.4	79.2
11										95.5	87.5
12											95.8

ENTROPY

ENVIRONMENTALISTS

ORSAT FIELD DATA

Plant Name NICHOLS-MILWAUKEE

Sampling Location INCINERATOR Fuel Type

Run and/or Sample No. 1 Leak Test? ✓ Date 12/17/80 Operator JTN

Time of Sample Collection	Time of Analysis	CO_2 Reading A	O_2 Reading B	CO Reading C	%O_2 B-A	%CO C-B	%N_2 100-C
09:00-10:14	13:30	3.8	20.6	20.6	16.8	0	—
	13:47	3.8	20.6	20.6	16.8	0	—
	14:00	3.8	20.6	20.6	16.8	0	—
	Avg.	3.8		Avg.	16.8	0	79.4

Run and/or Sample No. 2 Leak Test? ✓ Date 12/17/80 Operator JTN

Time of Sample Collection	Time of Analysis	CO_2 Reading A	O_2 Reading B	CO Reading C	%O_2 B-A	%CO C-B	%N_2 100-C
10:35-11:37	14:45	3.8	19.9	19.9	16.1	0	
	15:05	3.8	19.9	19.9	16.1	0	
	15:20	3.8	19.9	19.9	16.1	0	—
	Avg.	3.8		Avg.	16.1	0	80.1

Run and/or Sample No. 3 Leak Test? ✓ Date 12/17/80 Operator JTN

Time of Sample Collection	Time of Analysis	CO_2 Reading A	O_2 Reading B	CO Reading C	%O_2 B-A	%CO C-B	%N_2 100-C
11:55-12:57	15:30	3.5	19.7	19.7	16.2	0	—
	15:45	3.5	19.7	19.7	16.2	0	—
	16:00	3.5	19.7	19.7	16.2	0	
	Avg.	3.5		Avg.	16.2	0	80.3

Run # 1

Company Name NICHOLS-SOUTH SHORE PLANT
Time Start 09:00
Address MILWAUKEE, WISCONSIN
Time Finish 10:14
Sampling Location INCINERATOR STACK
Date 12/17/80 Team Leader JTN Technicians JPW
Barometric Pressure, in. Hg 29.60 Static Pressure, in. H_2O +.05
Sampling Train Leak Test Vacuum, in. Hg 15 15.0
Sampling Train Leak Rate, cu. ft./min. .005 .000

EQUIPMENT CHECKS

- ✓ Pitots, pre-test
- ✓ Pitots, post-test
- ✓ Orsat Sampling System
- ✓ Tedlar Bag
- ✓ Thermocouple @ 130 °F

IDENTIFICATION NUMBERS

Reagent Box 0205 Nozzle 404 Diameter .252
Meter Box N-1
Umbilical —
Sample Box R-4
Probe 4-7
T/C Readout HH8
T/C Probe 4'
Orsat Pump 4
Tedlar Bag 4

Filter #	Tare
7726	.4862

NOMOGRAPH SET-UP Nomograph # JTN

$\Delta H_@$ 1.68
Meter Temp [illegible] 110
% Moisture 2
C Factor ~~0.98~~ 1.00 1.02
Stack Temp 130
Ref. ΔP .47 .46 *

Sample Point	Clock Time, Min.	Dry Gas Meter Reading, Cu. Ft.	Pitot Reading (Δp), In. H_2O	Orifice Setting (ΔH), In. H_2O Ideal	Orifice Setting (ΔH), In. H_2O Actual	Gas Meter Temp. °F	Pump Vacuum In. Hg Gauge	Filter Box Temp. °F	Imp. Exit Temp. °F	Stack Temp. °F
A1	0/0	891.637	0.75	2.94	2.94	105	9.0	225	75	127
2	2½	894.09	0.78	3.05	3.05	108	9.5	235	70	131
3	5	896.67	0.88	3.44	3.44	109	11.0	245	70	132
4	7½	899.28	0.85	3.33	3.33	110	11.0	245	70	132
5	10	901.99	0.98	3.83	3.83	110	14.0	250	70	131
6	12½	904.77	0.98	3.83	3.83	110	15.0	250	70	132
7	15	907.76	0.95	3.80	3.80	104	1.0	250	66	131
8	17½	910.98	1.00	4.00	4.00	104	1.0	265	66	132
9	20	913.86	1.18	4.72	4.72	105	2.0	260	66	132
10	22½	917.00	1.25	5.00	5.00	105	2.5	240	70	132
11	25	920.16	1.30	5.20	5.20	105	2.5	240	70	133
12	27½	923.40	1.34	5.36	5.36	105	2.5	245	70	132
B1	30/0	926.701	1.02	4.08	4.08	103	2.0	255	72	128
2	2½	929.71	1.15	4.60	4.60	103	2.0	250	70	132
3	5	932.79	1.20	4.80	4.80	104	2.0	250	70	132
4	7½	935.93	1.20	4.80	4.80	105	2.0	250	70	133
5	10	939.07	1.25	5.00	5.00	105	2.5	250	70	133
6	12½	942.28	1.25	5.00	5.00	104	2.5	250	70	133
7	15	945.48	1.05	4.20	4.20	104	2.5	255	72	133
8	17½	948.40	0.95	3.80	3.80	104	2.0	255	72	133
9	20	951.22	0.95	3.80	3.80	103	2.0	255	72	132
10	22½	954.07	0.92	3.68	3.68	103	2.0	255	72	133
11	25	956.86	0.98	3.92	3.92	103	2.5	255	72	133
12	27½	959.67	0.95	3.80	3.80	104	2.5	255	75	134
	60/OFF	962.502								

907.174
907.549

L.T.
926.813

* CHAN
NOM

70.378	1.0398	4.17	105	132
V_m	$(\sqrt{\Delta p})^2$	$\overline{\Delta H}$	$\overline{T_m}$	$\overline{T_s}$

PARTICULATE FIELD DATA

Run # 2

Company Name NICHOLS - SOUTH SHORE PLANT Time Start 10:35
Address MILWAUKEE, WISCONSIN Time Finish 11:37
Sampling Location INCINERATOR
Date 12/17/80 Team Leader JTN Technicians JPW
Barometric Pressure, in. Hg 29.60 Static Pressure, in. H_2O -.6
Sampling Train Leak Test Vacuum, in. Hg 15 2.0
Sampling Train Leak Rate, cu. ft./min. .000 .003

EQUIPMENT CHECKS

- ✓ Pitots, pre-test
- ✓ Pitots, post-test
- ✓ Orsat Sampling System
- ✓ Tedlar Bag
- ✓ Thermocouple @ 130°F

IDENTIFICATION NUMBERS

Reagent Box 0205 Nozzle 405 Diameter .248
Meter Box N-1 T/C Readout HH8
Umbilical — T/C Probe 4'
Sample Box R-6 Orsat Pump 4
Probe 4-1 Tedlar Bag 5

Filter #	Tare

NOMOGRAPH SET-UP Nomograph # JTN

ΔH@ 1.68 C Factor 1.01
Meter Temp 105 Stack Temp 130
% Moisture 2 Ref. ΔP 0.51

Sample Point	Clock Time, Min.	Dry Gas Meter Reading, Cu. Ft.	Pitot Reading (Δp), In. H_2O	Orifice Setting (ΔH), In. H_2O		Gas Meter Temp. °F	Pump Vacuum In. Hg Gauge	Filter Box Temp. °F	Imp. Exit Temp. °F	Stack Temp. °F
				Ideal	Actual					
A1	0/0	962.959	0.68	2.45	2.45	97	1.0	250	60	127
2	2½	965.26	0.75	2.71	2.71	97	1.0	250	60	132
3	5	967.65	0.82	2.96	2.96	97	1.0	240	55	133
4	7½	970.13	0.90	3.25	3.25	98	1.0	240	58	133
5	10	972.74	0.98	3.54	3.54	100	1.0	240	58	135
6	12½	975.45	0.95	3.43	3.43	101	1.0	240	60	136
7	15	978.13	1.02	3.68	3.68	102	1.0	250	60	137
8	17½	980.90	1.10	3.97	3.97	104	1.0	250	60	137
9	20	983.79	1.20	4.33	4.33	105	1.0	250	60	137
10	22½	986.80	1.20	4.33	4.33	105	1.0	250	60	135
11	25	989.76	1.32	4.76	4.76	105	1.0	250	60	136
12	27½	992.79	1.32	4.76	4.76	106	1.0	250	60	136
B1	30/0	995.979	0.98	3.54	3.54	105	1.0	250	60	136
2	2½	998.71	[illegible].20	4.33	4.33	105	2.0	250	60	135
3	5	1001.73	1.34	4.83	4.83	106	2.0	250	60	137
4	7½	1004.99	1.35	4.87	4.87	107	2.0	250	60	137
5	10	1008.07	1.34	4.83	4.83	108	2.0	250	60	137
6	12½	1011.24	1.20	4.33	4.33	108	2.0	250	60	138
7	15	1014.20	1.10	3.97	3.97	108	2.0	250	60	137
8	17½	1017.08	1.05	3.79	3.79	108	2.0	250	60	138
9	20	1019.94	0.98	3.54	3.54	108	2.0	250	62	137
10	22½	1022.65	0.98	3.54	3.54	108	2.0	250	62	137
11	25	1025.37	1.05	3.79	3.79	108	2.0	250	62	138
12	27½	1028.21	1.05	3.79	3.79	108	2.0	250	62	138
	60/OFF	1031.043								

68.084	1.0693	3.89	104	136
V_m	$(\sqrt{\Delta p})^2$	$\overline{\Delta H}$	$\overline{T_m}$	$\overline{T_s}$

PARTICULATE FIELD DATA

Run # 3

Company Name NICHOLS - SOUTH SHORE PLANT
Time Start 11:55
Address MILWAUKEE, WISCONSIN
Time Finish 12:57
Sampling Location INCINERATOR STACK
Date 12/17/80 Team Leader JTN Technicians JPW
Barometric Pressure, in. Hg 29.60 Static Pressure, in. H_2O -.6
Sampling Train Leak Test Vacuum, in. Hg 15 3.0
Sampling Train Leak Rate, cu. ft./min. .004 .000

EQUIPMENT CHECKS

- ✓ Pitots, pre-test
- ✓ Pitots, post-test
- ✓ Orsat Sampling System
- ✓ Tedlar Bag
- ✓ Thermocouple @ 130°F

IDENTIFICATION NUMBERS

Reagent Box 0205 Nozzle 406 Diameter .251
Meter Box N-1
T/C Readout HH8
Umbilical —
T/C Probe 4'
Sample Box R-10
Orsat Pump 4
Probe 4-3
Tedlar Bag —

Filter #	Tare
7725	.4958

NOMOGRAPH SET-UP Nomograph # JTN

$\Delta H_@$ 1.68
C Factor 1.01
Meter Temp 105
Stack Temp 130
% Moisture 2
Ref. ΔP 0.47

Sample Point	Clock Time, Min.	Dry Gas Meter Reading, Cu. Ft.	Pitot Reading (Δp), In. H_2O	Orifice Setting (ΔH), In. H_2O		Gas Meter Temp. °F	Pump Vacuum In. Hg Gauge	Filter Box Temp. °F	Imp. Exit Temp. °F	Stack Temp. °F
				Ideal	Actual					
A1	0/0	32.164	0.68	2.66	2.66	103	1.0	240	75	128
2	2½	34.57	0.75	2.94	2.94	103	1.0	240	66	135
3	5	37.08	0.85	3.33	3.33	104	1.0	240	64	138
4	7½	39.73	0.94	3.68	3.68	105	1.0	245	64	140
5	10	42.53	0.94	3.68	3.68	105	1.0	245	64	140
6	12½	45.32	0.96	3.76	3.76	105	1.0	245	62	139
7	15	48.18	0.95	3.72	3.72	106	1.0	245	62	137
8	17½	50.95	1.05	4.11	4.11	106	1.0	245	62	137
9	20	53.87	1.20	4.70	4.70	107	2.0	250	62	140
10	22½	56.98	1.30	5.09	5.09	107	2.0	250	62	140
11	25	60.25	1.35	5.28	5.28	107	2.0	250	62	141
12	27½	63.57	1.35	5.28	5.28	107	2.0	250	66	141
B1	30/0	66.856	1.00	3.91	3.91	107	2.0	255	66	136
2	2½	69.74	1.10	4.31	4.31	107	2.0	255	66	137
3	5	72.74	1.25	4.89	4.89	108	2.0	255	66	138
4	7½	75.92	1.32	5.17	5.17	108	2.5	255	66	140
5	10	79.21	1.27	4.97	4.97	108	2.5	250	72	141
6	12½	82.38	1.20	4.70	4.70	108	2.5	250	72	141
7	15	85.51	1.05	4.11	4.11	108	2.5	250	72	141
8	17½	88.44	0.95	3.72	3.72	108	2.5	250	72	142
9	20	91.27	0.98	3.84	3.84	108	2.5	250	72	142
10	22½	94.13	0.96	3.76	3.76	108	2.5	250	72	140
11	25	96.94	1.04	4.07	4.07	108	3.0	250	75	140
12	27½	99.86	1.04	4.07	4.07	108	3.0	250	75	142
	60/OFF	102.780								

70.616	1.0538	4.16	107	139
V_m	$(\sqrt{\Delta p})^2$	$\overline{\Delta H}$	$\overline{T_m}$	$\overline{T_s}$

PARTICULATE SAMPLING CLEANUP SHEET

REAGENT BOX(ES)# 0205

Plant NICHOLS

Date Received 12/18/80

Sampling Location SOUTHSIDE INCINERATOR STACK OUTLET

Date Analyzed 12/19/80

Run #	1	2	3
Run Date	12/17	12/17	12/17

ANALYSIS OF MOISTURE CATCH

Final Water Volume, ml.	210	218	222
Tared Volume, ml.	200	200	200
CONDENSED WATER, ml.	10	18	22
Final Silica Gel Wt., g.	220.5	219.0	217.0
Tared Wt., g.	200.0	200.0	200.0
ABSORBED WATER, g.	20.5	19.0	17.0
TOTAL WATER COLLECTED, ml.	30.5	37.0	39.0

ANALYSIS OF CATCH FROM NOZZLE TO FILTER, INCLUSIVE

Filter + Particulate, mg.	510.9	515.0	508.9
Filter Tare, mg.	486.2	495.8	484.7
Filter Catch, mg.	24.7	19.2	24.2
Separate Rinsings, mg.	4.5	6.3	14.7
FILTER CATCH + RINSINGS, mg.	29.2	25.5	38.9
Acetone Volume, ml.	150	175	150
Acetone Residue, mg.	1.1	1.2	1.1
TOTAL PARTICULATE CATCH, mg.	28.1	24.3	37.8

ANALYSIS OF IMPINGER WATER

Extraction wt., mg.			
Boildown wt., mg.			
Impinger Rinse wt. mg.			
Acetone Volume, ml.			
Acetone Residue, mg.			
Water Volume, ml.			
Water Residue, mg.			
TOTAL IMPINGER CATCH, mg.			
TOTAL TRAIN CATCH			

BLANK CALCULATION

	Acetone	Water
Volume, ml.	200	
Residue, mg.	1.4	
Concen., mg/ml	.007	

NOTES AND COMMENTS

EPA-5

CUSTODY SHEET FOR REAGENT BOX # 205

Date of Makeup 12-10-80 Initials MH Locked? ✓

Individual Tare of Reagent: 200 mls. of H_2O

Individual Tare of Reagent: ______ mls. of ______

Individual Silica Gel Tare Weight 200 gms.

PLANT NAME Nichols (south side incenator)

SAMPLING LOCATION ℄ stack outlet

Run Number	Date Used	Initials	Locked?	Date Cleanup	% S. Gel Spent	Initials	Locked?
1	12/17	JPW	✓	12/17	100%	JPW	✓
2	12/17	JPW	✓	12/17	97%	JPW	✓
3	12/17	JPW	✓	12/17	95%	JPW	✓

Received in Lab Date 12/18 Initials MEG Locked? ✓

Sampling Method: EPA M-5

Zero & Span Balance Initials MEG

Remarks:

Filter #	Tare Weight (mgms)	Used on Test
7726	486.2	1
7725	495.8	2
7724	484.7	3

ENTROPY ENVIRONMENTALISTS, INC.

APPENDIX C

ENTROPY
ENVIRONMENTALISTS, INC.

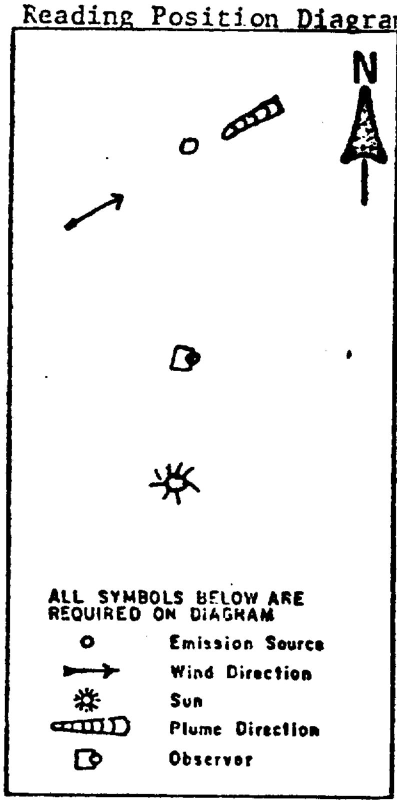
I.D.# ____________
Company City of Milwaukee
Location Milwaukee Wisconsin
Date 12-17-80

EIS Em. Pt. N/A
Type Facility waste incinerator
Control Device venturie + mist eliminat
Hgt. of Discharge Pt. 70 feet

Operating Rate N/A
Type Fuel/Waste Ngas. /partic
New Fire/Soot Blowing Yes [✓ N
Stack Test Run# 1 (If applic

	Initial	Final
Clock Time	9 00 am	10:14 Am
Observer Location		
Distance to Discharge	225 ft.	225 ft.
Direction from Discharge	East	East
Height of Observation Pt.	ground level	ground level
Background Descript.	Cloudy	Cloudy
Weather Conditions		
Wind Direction	from S Swest	from SSwest
Wind Speed	13 mph	15 mph
Ambient Temperature	25°F	25°F
Relative Humidity	78%	78%
Plume Description		
Color	light gray	light gray
Distance Visible	100%	100%
Conditions	Cloudy overcast	Cloudy Overcast

Reading Position Diagram



Summary of Average Opacity

Set Number	Time		Opacity	
	Start	End	Sum	Avg
1	9:00 am	10:14 am	.55	0.18

Readings ranged from 0 to 15 % Opacit
REGULATIONS VIOLATED =

X Bryant T. Foust
Observer's Signature
Obs Certification Date 08-01-80
Obs Affiliation Visible Evaluator

Hr	Min	Seconds				Steam Plume If Applicable	
		0	15	30	45	Attach	Detach
9:00	0	0	0	0	0	N/A	N/A
	1	0	0	0	0		
	2	0	0	0	0		
	3	0	0	0	0		
	4	0	0	0	0		
	5	0	0	0	0		
	6	0	0	0	0		
	7	0	0	0	0		
	8	0	0	0	0		
	9	0	0	0	0		
	10	0	0	0	0		
	11	0	0	0	0		
	12	0	0	0	0		
	13	0	0	0	0		
	14	0	0	0	0		
	15	0	0	0	0		
	16	0	0	0	0		
	17	0	0	0	0		
	18	0	0	0	0		
	19	0	0	0	0		
	20	0	0	0	0		
	21	0	0	0	0		
	22	0	0	0	0		
	23	0	0	0	0		
	24	0	0	0	0		
	25	0	0	0	0		
	26	0	0	0	0		
	27	0	0	0	0		

Hr	Min	Seconds				Steam Plume If Applicable	
		0	15	30	45	Attach	Detac
	30	0	0	0	0		
	31	0	0	0	0		
	32	0	0	0	0		
	33	0	0	0	0		
	34	0	0	0	0		
	35	0	0	0	0		
	36	0	0	0	0		
	37	0	0	0	0		
	38	0	0	0	0		
	39	0	0	0	0		
	40	0	0	0	0		
	41	0	0	0	0		
	42	0	0	0	0		
	43	0	0	0	0		
	44	0	0	0	0		
	45	0	0	0	0		
	46	0	0	0	0		
	47	0	0	0	0		
	48	0	0	0	0		
	49	0	0	0	0		
	50	0	0	0	0		
	51	0	0	0	0		
	52	0	0	0	0		
	53	0	0	0	0		
	54	0	0	0	0		
	55	0	0	0	0		
	56	0	0	0	0		

ENTROPY
ENVIRONMENTALISTS, INC.

I.D.# ______
Company *City of Milwaukee*
Location *Milwaukee, Wisconsin*
Date *12-17-80*

EIS Em. Pt. ______
Type Facility ______
Control Device ______
Hgt. of Discharge Pt. ______

Operating Rate ______
Type Fuel/Waste ______
New Fire/Soot Blowing Yes N
Stack Test Run# *1* (If applic

	Initial	Final
Clock Time		
Observer Location		
Distance to Discharge		
Direction from Discharge		
Height of Observation Pt.		
Background Descript.		
Weather Conditions		
Wind Direction		
Wind Speed		
Ambient Temperature		
Relative Humidity		
Plume Description		
Color		
Distance Visible		
Conditions		

Reading Position Diagram

N

ALL SYMBOLS BELOW ARE REQUIRED ON DIAGRAM
○ Emission Source
→ Wind Direction
☼ Sun
▭ Plume Direction
◘ Observer

Summary of Average Opacity

Set Number	Time		Opacity	
	Start	End	Sum	Avg

Readings ranged from to %Opaci
REGULATIONS VIOLATED=

______
______

x *Bryant I. Foust*
Observer's Signature
Obs Certification Date *08-01-80*
Obs Affiliation *Visible Evaluation*

Hr	Min	Seconds				Steam Plume If Applicable	
		0	15	30	45	Attach	Detach
10:00	0	*0*	*0*	*0*	*0*		
	1	*0*	*0*	*0*	*0*		
	2	*0*	*0*	*0*	*0*		
	3	*0*	*0*	*0*	*0*		
	4	*0*	*5*	*15*	*0*		
	5	*0*	*0*	*0*	*0*		
	6	*0*	*0*	*10*	*15*		
	7	*10*	*0*	*0*	*0*		
	8	*0*	*0*	*0*	*0*		
	9	*0*	*0*	*0*	*0*		
	10	*0*	*0*	*0*	*0*		
	11	*0*	*0*	*0*	*0*		
End	12	*0*	*0*	*0*	*0*		
10:14	13	*0*	*0*	*0*	*0*		
	14	*0*	*0*	*0*	*0*		
	15	*0*	*10*	*10*	*5*		
	16	*0*	*0*	*0*	*0*		
	17						
	18						
	19						
	20						
	21						
	22						
	23						
	24						
	25						
	26						
	27						

Hr	Min	Seconds				Steam Plume If Applicable	
		0	15	30	45	Attach	Detac
	30						
	31						
	32						
	33						
	34						
	35						
	36						
	37						
	38						
	39						
	40						
	41						
	42						
	43						
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	52						
	53						
	54						
	55						
	56						

ENTROPY ENVIRONMENTALISTS, INC.

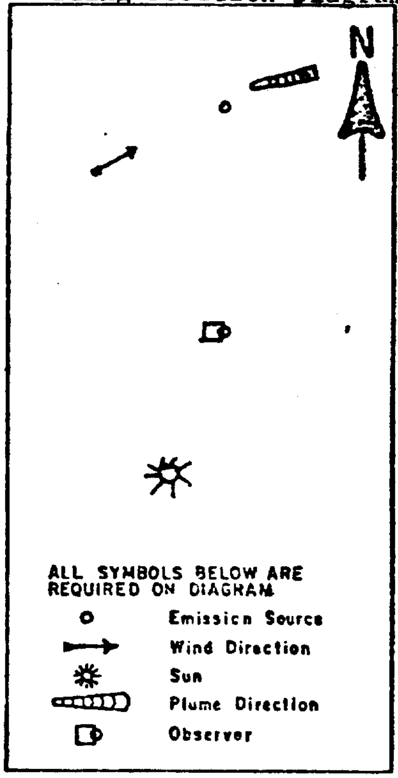
I.D.#
Company City of Milwaukee
Location Milwaukee, Wisconsin
Date 12-17-80

EIS Em. Pt. N/A
Type Facility waste incinerator
Control Device Venturie + mist eliminator
Hgt. of Discharge Pt. 20 ft

Operating Rate N/A
Type Fuel/Waste [illegible]/cont.
New Fire/Soot Blowing Yes [✓ No]
Stack Test Run #2 (If applica

	Initial	Final
Clock Time	10:35 am	11:37 am
Observer Location		
Distance to Discharge	225ft	225ft
Direction from Discharge	East	East
Height of Observation Pt.	ground	ground
Background Descript. Weather Conditions	cloudy Gray sky	cloudy Gray sky
Wind Direction	from SSW	from SSW
Wind Speed	13mph	15mph
Ambient Temperature	25°F	25°F
Relative Humidity	78%	78%
Plume Description		
Color	light gray	light gray
Distance Visible	100%	100%
S Conditions	cloudy gray sky	cloudy gray sky

Reading Position Diagram



Summary of Average Opacity

Set Number	Time Start	Time End	Opacity Sum	Opacity Avg
2	10:35am	11:37am	0	0

Readings ranged from 0 to 0 %Opacity
REGULATIONS VIOLATED=

x Bryant T. Ford
Observer's Signature
Obs Certification Date 08-01-80
Obs Affiliation Visible Evaluator

Hr	Min	Seconds 0	15	30	45	Steam Plume If Applicable Attach	Detach
	0	0	0	0	0	N/A	N/A
10:35am	1	0	0	0	0		
	2	0	0	0	0		
	3	0	0	0	0		
	4	0	0	0	0		
	5	0	0	0	0		
	6	0	0	0	0		
	7	0	0	0	0		
	8	0	0	0	0		
	9	0	0	0	0		
	10	0	0	0	0		
	11	0	0	0	0		
	12	0	0	0	0		
	13	0	0	0	0		
	14	0	0	0	0		
	15	0	0	0	0		
	16	0	0	0	0		
	17	0	0	0	0		
	18	0	0	0	0		
	19	0	0	0	0		
	20	0	0	0	0		
	21	0	0	0	0		
	22	0	0	0	0		
	23	0	0	0	0		
	24	0	0	0	0		
	25	0	0	0	0		
	26	0	0	0	0		
	27						

Hr	Min	Seconds 0	15	30	45	Steam Plume If Applicable Attach	Detach
	30	0	0	0	0		
	31	0	0	0	0		
	32	0	0	0	0		
	33	0	0	0	0		
	34	0	0	0	0		
	35	0	0	0	0		
	36	0	0	0	0		
	37	0	0	0	0		
	38	0	0	0	0		
	39	0	0	0	0		
	40	0	0	0	0		
	41	0	0	0	0		
	42	0	0	0	0		
	43	0	0	0	0		
	44	0	0	0	0		
	45	0	0	0	0		
	46	0	0	0	0		
	47	0	0	0	0		
	48	0	0	0	0		
	49	0	0	0	0		
	50	0	0	0	0		
	51	0	0	0	0		
	52	0	0	0	0		
	53	0	0	0	0		
	54	0	0	0	0		
	55	0	0	0	0		
	56	0	0	0	0		

ENTROPY
ENVIRONMENTALISTS, INC.

I.D.# ______
Company City of Milwaukee
Location Milwaukee Wisconsin
Date 12-17-80

EIS Em. Pt. N/A
Type Facility ______
Control Device ______
Hgt. of Discharge Pt. ______

Operating Rate N/A
Type Fuel/Waste nat.gas/part
New Fire/Soot Blowing Yes [✓ No]
Stack Test Run #2 (If applica

	Initial	Final
Clock Time		
Observer Location		
Distance to Discharge		
Direction from Discharge		
Height of Observation Pt.		
Background Descript.		
Weather Conditions		
Wind Direction		
Wind Speed		
Ambient Temperature		
Relative Humidity		
Plume Description		
Color		
Distance Visible		
Sky Conditions		

Reading Position Diagram

N

ALL SYMBOLS BELOW ARE REQUIRED ON DIAGRAM
- o Emission Source
- → Wind Direction
- ☼ Sun
- Plume Direction
- Observer

Summary of Average Opacity

Set Number	Time Start	Time End	Opacity Sum	Opacity Avg

Readings ranged from to %Opacity
REGULATIONS VIOLATED=

x Bryant T. Ford
Observer's Signature
Obs Certification Date 08-01-80
Obs Affiliation Visible Evaluator

Hr	Min	Seconds 0	15	30	45	Steam Plume If Applicable Attach	Detach
11:56	0	0	0	0	0		
11:57	1	0	0	0	0		
end	2	0	0	0	0		
	3	0	0	0	0		
	4	0	0	0	0		
	5	0	0	0	0		
	6	0	0	0			
	7						
	8						
	9						
	10						
	11						
	12						
	13						
	14						
	15						
	16						
	17						
	18						
	19						
	20						
	21						
	22						
	23						
	24						
	25						
	26						
	27						

Hr	Min	Seconds 0	15	30	45	Steam Plume If Applicable Attach	Detach
	30						
	31						
	32						
	33						
	34						
	35						
	36						
	37						
	38						
	39						
	40						
	41						
	42						
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	51						
	52						
	53						
	54						
	55						
	56						

NTROPY
NVIRONMENTALISTS, INC.

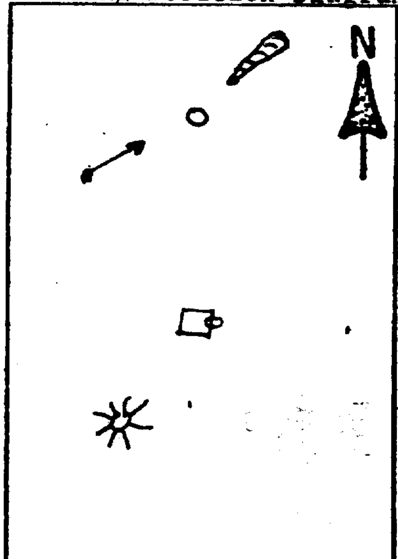
I.D.# ______________________
Company City of Milwaukee
ation Milwaukee Wisconsin
Date 12-17-80

EIS Em. Pt. N/A
Type Facility waste incinerator
Control Device Venturi & mist eliminator
Hgt. of Discharge Pt. 20ft.

Operating Rate N/A
Type Fuel/Waste Ngas/part.
New Fire/Soot Blowing Yes [✓ No]
Stack Test Run#3 (If applic

	Initial	Final
Clock Time	11:55pm	12:57pm
Observer Location		
Distance to Discharge	225ft.	225ft.
Direction from Discharge	East	East
Height of Observation Pt.	ground	ground
Background Descript.	Cloudy grey sky	Cloudy grey sky
Weather Conditions		
Wind Direction	from SSW	from SSW
Wind Speed	15mph	15mph
Ambient Temperature	25°F	25°F
Relative Humidity	78%	78%
Plume Description		
Color	light gray	light gray
Distance Visible	100%	100%
S Conditions	cloudy grey sky	cloudy grey sky

Reading Position Diagram



ALL SYMBOLS BELOW ARE REQUIRED ON DIAGRAM
- ○ Emission Source
- → Wind Direction
- ✹ Sun
- ▭ Plume Direction
- ▭○ Observer

Summary of Average Opacity

Set Number	Time Start	Time End	Opacity Sum	Opacity Avg
3	11:55am	12:57pm	15	0.06

Readings ranged from 0 to 5 %Opacit
REGULATIONS VIOLATED=

____
____

x Bryant T. Foust
Observer's Signature
Obs Certification Date 08-01-80
Obs Affiliation Visible Evaluator

Hr	Min	Seconds 0	Seconds 15	Seconds 30	Seconds 45	Steam Plume If Applicable Attach	Steam Plume If Applicable Detach
11:55am	0	0	0	0	0	N/A	N/A
	1	0	0	0	0		
	2	0	0	0	0		
	3	0	0	0	0		
	4	0	0	0	0		
	5	0	0	0	0		
	6	0	0	0	0		
	7	0	0	0	0		
	8	0	0	0	0		
	9	0	0	0	0		
	10	0	0	0	0		
	11	0	0	0	0		
	12	0	5	0	0		
	13	0	0	0	0		
	14	0	0	0	0		
	15	0	0	0	0		
	16	0	0	0	0		
	17	0	0	0	0		
	18	0	0	0	0		
	19	0	0	0	0		
	20	0	0	0	0		
	21	0	0	0	0		
	22	0	0	0	0		
	23	0	0	0	0		
	24	0	0	0	0		
	25	0	0	0	0		
	26	0	0	0	0		
	27	0	0	0	0		

Hr	Min	Seconds 0	Seconds 15	Seconds 30	Seconds 45	Steam Plume If Applicable Attach	Steam Plume If Applicable Detac
	30	0	0	0	0		
	31	0	0	0	0		
	32	0	0	0	0		
	33	0	0	0	0		
	34	0	0	0	0		
	35	0	0	0	0		
	36	0	0	0	0		
	37	0	0	0	0		
	38	0	0	0	0		
	39	0	0	0	0		
	40	0	0	0	0		
	41	0	0	0	0		
	42	0	0	0	0		
	43	0	0	0	0		
	44	0	0	0	0		
	45	0	0	0	0		
	46	0	0	0	0		
	47	0	5	5	0		
	48	0	0	0	0		
	49	0	0	0	0		
	50	0	0	0	0		
	51	0	0	0	0		
	52	0	0	0	0		
	53	0	0	0	0		
	54	0	0	0	0		
	55	0	0	0	0		
	56	0	0	0	0		
	57						

ENTROPY
ENVIRONMENTALISTS, INC.

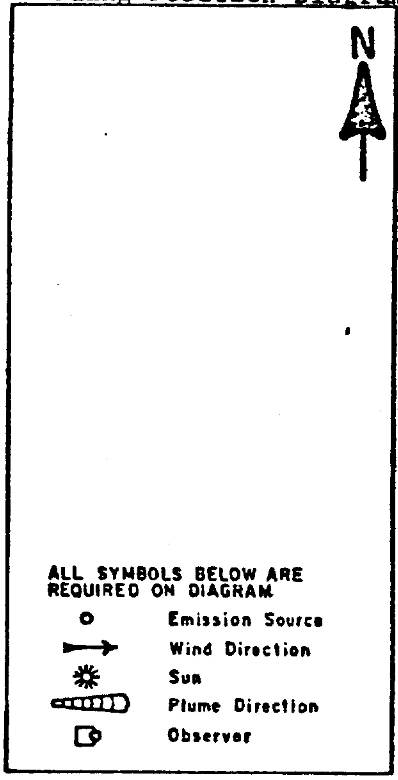
I.D.# ____________
Company *City of Milwaukee*
Location *Milwaukee, Wisconsin*
Date *12-17-80*

EIS Em. Pt. ____________
Type Facility ____________
Control Device ____________
Hgt. of Discharge Pt. ____________

Operating Rate ____________
Type Fuel/Waste ____________
New Fire/Soot Blowing Yes N
Stack Test Run# *5* (If applic

	Initial	Final
Clock Time		
Observer Location		
Distance to Discharge		
Direction from Discharge		
Height of Observation Pt.		
Background Descript.		
Weather Conditions		
Wind Direction		
Wind Speed		
Ambient Temperature		
Relative Humidity		
Plume Description		
Color		
Distance Visible		
S Conditions		

Reading Position Diagram



Summary of Average Opacity

Set Number	Time		Opacity	
	Start	End	Sum	Avg

Readings ranged from to %Opacit
REGULATIONS VIOLATED=
____
____

x *Bryant R. Foust*
Observer's Signature
Obs Certification Date *08-01-80*
Obs Affiliation *Visible Evaluator*

Hr	Min	Seconds				Steam Plume If Applicable	
		0	15	30	45	Attach	Detach
12:56	0	0	0	0	0		
12:57	1	0	0	0	0		
end	2	0	0	0	0		
	3	0	0	0	0		
	4	0	0	0	0		
	5	0	0	0	0		
	6	0	0	0	0		
	7						
	8						
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	22						
	23						
	24						
	25						
	26						
	27						

Hr	Min	Seconds				Steam Plume If Applicable	
		0	15	30	45	Attach	Detac
	30						
	31						
	32						
	33						
	34						
	35						
	36						
	37						
	38						
	39						
	40						
	41						
	42						
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	57						

APPENDIX D

ENTROPY ENVIRONMENTALISTS, INC.

Milwaukee
Metropolitan
Sewerage
District

12/17/80
Milwaukee, Wisc.
Nichols Eng.

Samples

Feed sample - 1 per Test
- % H_2O
- % Solids
- % Volatiles #/dry solids.
- BTU #/combustibles (dry)

Ash.

2 samples

- % Volatiles.
- % Moisture.

Milwaukee
Metropolitan
Sewerage
District

12/17/80
Milwaukee, Wisc.
Nichols Eng.

Feed RATES.

		Time	Totalizer	
Test #1				
	START	0900	356278	
	STOP	1014	358110	1489 Lb/Hr
		1.23 hr	1832#	
TEST #2				
	START	1035	358394	
	STOP	1137	359850	1414 Lb/Hr
		1.033	1456#	
TEST #3				
	START	1155	360070	
	STOP	1300	361650	1463 Lb/Hr
		1.08	1580#	

APPENDIX E

TEST PARTICIPANTS

JOHN T. NASH	PROJECT DIRECTOR
JEFFREY P. WRENN	ENGINEERING TECHNICIAN
BRYANT T. FOUST	CERTIFIED VISIBLES EVALUAT

APPENDIX F

METHOD 9—VISUAL DETERMINATION OF THE OPACITY OF EMISSIONS FROM STATIONARY SOURCES

Many stationary sources discharge visible emissions into the atmosphere; these emissions are usually in the shape of a plume. This method involves the determination of plume opacity by qualified observers. The method includes procedures for the training and certification of observers, and procedures to be used in the field for determination of plume opacity. The appearance of a plume as viewed by an observer depends upon a number of variables, some of which may be controllable and some of which may not be controllable in the field. Variables which can be controlled to an extent to which they no longer exert a significant influence upon plume appearance include: Angle of the observer with respect to the plume; angle of the observer with respect to the sun; point of observation of attached and detached steam plume; and angle of the observer with respect to a plume emitted from a rectangular stack with a large length to width ratio. The method includes specific criteria applicable to these variables.

Other variables which may not be controllable in the field are luminescence and color contrast between the plume and the background against which the plume is viewed. These variables exert an influence upon the appearance of a plume as viewed by an observer, and can affect the ability of the observer to accurately assign opacity values to the observed plume. Studies of the theory of plume opacity and field studies have demonstrated that a plume is most visible and presents the greatest apparent opacity when viewed against a contrasting background. It follows from this, and is confirmed by field trials, that the opacity of a plume, viewed under conditions where a contrasting background is present can be assigned with the greatest degree of accuracy. However, the potential for a positive error is also the greatest when a plume is viewed under such contrasting conditions. Under conditions presenting a less contrasting background, the apparent opacity of a plume is less and approaches zero as the color and luminescence contrast decrease toward zero. As a result, significant negative bias and negative errors can be made when a plume is viewed under less contrasting conditions. A negative bias decreases rather than increases the possibility that a plant operator will be cited for a violation of opacity standards due to observer error.

Studies have been undertaken to determine the magnitude of positive errors which can be made by qualified observers while reading plumes under contrasting conditions and using the procedures set forth in this method. The results of these studies (field trials) which involve a total of 769 sets of 25 readings each are as follows:

(1) For black plumes (133 sets at a smoke generator), 100 percent of the sets were read with a positive error[1] of less than 7.5 percent opacity; 99 percent were read with a positive error of less than 5 percent opacity.

(2) For white plumes (170 sets at a smoke generator, 168 sets at a coal-fired power plant, 298 sets at a sulfuric acid plant), 99 percent of the sets were read with a positive error of less than 7.5 percent opacity; 95 percent were read with a positive error of less than 5 percent opacity.

The positive observational error associated with an average of twenty-five readings is therefore established. The accuracy of the method must be taken into account when determining possible violations of applicable opacity standards.

1. *Principle and applicability.*

1.1 Principle. The opacity of emissions from stationary sources is determined visually by a qualified observer.

1.2 Applicability. This method is applicable for the determination of the opacity of emissions from stationary sources pursuant to § 60.11(b) and for qualifying observers for visually determining opacity of emissions.

2. *Procedures.* The observer qualified in accordance with paragraph 3 of this method shall use the following procedures for visually determining the opacity of emissions:

2.1 Position. The qualified observer shall stand at a distance sufficient to provide a clear view of the emissions with the sun oriented in the 140° sector to his back. Consistent with maintaining the above requirement, the observer shall, as much as possible, make his observations from a position such that his line of vision is approximately perpendicular to the plume direction, and when observing opacity of emissions from rectangular outlets (e.g. roof monitors, open baghouses, noncircular stacks), approximately perpendicular to the longer axis of the outlet. The observer's line of sight should not include more than one plume at a time when multiple stacks are involved, and in any case the observer should make his observations with his line of sight perpendicular to the longer axis of such a set of multiple stacks (e.g. stub stacks on baghouses).

2.2 Field records. The observer shall record the name of the plant, emission location, type facility, observer's name and affiliation, and the date on a field data sheet (Figure 9–1). The time, estimated distance to the emission location, approximate wind direction, estimated wind speed, description of the sky condition (presence and color of clouds), and plume background are recorded on a field data sheet at the time opacity readings are initiated and completed.

2.3 Observations. Opacity observations shall be made at the point of greatest opacity in that portion of the plume where condensed water vapor is not present. The observer shall not look continuously at the plume, but instead shall observe the plume momentarily at 15-second intervals.

2.3.1 Attached steam plumes. When condensed water vapor is present within the plume as it emerges from the emission outlet, opacity observations shall be made beyond the point in the plume at which condensed water vapor is no longer visible. The observer shall record the approximate distance from the emission outlet to the point in the plume at which the observations are made.

2.3.2 Detached steam plume. When water vapor in the plume condenses and becomes visible at a distinct distance from the emission outlet, the opacity of emissions should be evaluated at the emission outlet prior to the condensation of water vapor and the formation of the steam plume.

2.4 Recording observations. Opacity observations shall be recorded to the nearest 5 percent at 15-second intervals on an observational record sheet. (See Figure 9–2 for an example.) A minimum of 24 observations shall be recorded. Each momentary observation recorded shall be deemed to represent the average opacity of emissions for a 15-second period.

2.5 Data Reduction. Opacity shall be determined as an average of 24 consecutive observations recorded at 15-second intervals. Divide the observations recorded on the record sheet into sets of 24 consecutive observations. A set is composed of any 24 consecutive observations. Sets need not be consecutive in time and in no case shall two sets overlap. For each set of 24 observations, calculate the average by summing the opacity of the 24 observations and dividing this sum by 24. If an applicable standard specifies an averaging time requiring more than 24 observations, calculate the average for all observations made during the specified time period. Record the average opacity on a record sheet. (See Figure 9–1 for an example.)

3. *Qualifications and testing.*

3.1 Certification requirements. To receive certification as a qualified observer, a candidate must be tested and demonstrate the ability to assign opacity readings in 5 percent increments to 25 different black plumes and 25 different white plumes, with an error not to exceed 15 percent opacity on any one reading and an average error not to exceed 7.5 percent opacity in each category. Candidates shall be tested according to the procedures described in paragraph 3.2. Smoke generators used pursuant to paragraph 3.2 shall be equipped with a smoke meter which meets the requirements of paragraph 3.3.

The certification shall be valid for a period of 6 months, at which time the qualification procedure must be repeated by any observer in order to retain certification.

3.2 Certification procedure. The certification test consists of showing the candidate a complete run of 50 plumes—25 black plumes and 25 white plumes—generated by a smoke generator. Plumes within each set of 25 black and 25 white runs shall be presented in random order. The candidate assigns an opacity value to each plume and records his observation on a suitable form. At the completion of each run of 50 readings, the score of the candidate is determined. If a candidate fails to qualify, the complete run of 50 readings must be repeated in any retest. The smoke test may be administered as part of a smoke school or training program, and may be preceded by training or familiarization runs of the smoke generator during which candidates are shown black and white plumes of known opacity.

3.3 Smoke generator specifications. Any smoke generator used for the purposes of paragraph 3.2 shall be equipped with a smoke meter installed to measure opacity across the diameter of the smoke generator stack. The smoke meter output shall display in-stack opacity based upon a pathlength equal to the stack exit diameter, on a full 0 to 100 percent chart recorder scale. The smoke meter optical design and performance shall meet the specifications shown in Table 9–1. The smoke meter shall be calibrated as prescribed in paragraph 3.3.1 prior to the conduct of each smoke reading test. At the completion of each test, the zero and span drift shall be checked and if the drift exceeds ±1 percent opacity, the condition shall be corrected prior to conducting any subsequent test runs. The smoke meter shall be demonstrated, at the time of installation, to meet the specifications listed in Table 9–1. This demonstration shall be repeated following any subsequent repair or replacement of the photocell or associated electronic circuitry including the chart recorder or output meter, or every 6 months, whichever occurs first.

3.3.1 Calibration. The smoke meter is calibrated after allowing a minimum of 30 minutes warmup by alternately producing simulated opacity of 0 percent and 100 percent. When stable response at 0 percent or 100 percent is noted, the smoke meter is adjusted to produce an output of 0 percent or 100 percent, as appropriate. This calibration shall be repeated until stable 0 percent and 100 percent readings are produced without adjustment. Simulated 0 percent and 100 percent opacity values may be produced by alternately switching the power to the light source on and off while the smoke generator is not producing smoke.

---

[1] For a set, positive error = average opacity determined by observers' 25 observations − average opacity determined from transmissometer's 25 recordings.

APPENDIX G

CALIBRATIONS

GENERAL

All measuring equipment Entropy uses is initially calibrated before use. Equipment which can change calibration is both checked upon return from each field use and is also periodically recalibrated in full. When an instrument is found out of calibration, it is so noted in the report and appropriate adjustments are made to the final results. The equipment is then repaired and recalibrated or retired as needed. Specific equipment is handled as follows:

PITOT TUBE

All pitot tubes used by Entropy, whether separate or attached to a sampling probe, are constructed in-house or by Nutech Corporation. Prior to their initial usage, they are calibrated using EPA geometry standards. In general, if a type "S" pitot tube is assembled correctly, and positioned properly in relation to the probe nozzle, it will have an average Cp of 0.84. As long as it is not damaged, it should not change its calibration. The recalibration schedule for pitot tubes is related to the physical condition and usage of the pitot tube, not a fixed time schedule. Each pitot tube is inspected upon return to the laboratory from each field use.

DRY GAS METER AND ORIFICE METER

All Entropy meter boxes are calibrated upon purchase and at least once every six months against a secondary test meter (one calibrated against a wet test meter) according to their usage history. Basic procedures are outlined in the EPA Publication No. APTD-0576. The only differences are in the choice of flow rates used and the volumes metered at each flow rate. After each field use, quick checks are performed to insure AII@ changes of less than 5%. These checks compare the orifice against the dry gas meter. If greater than 5% changes occur, recalibration and repair are instituted.

NOZZLES

Each nozzle is calibrated upon purchase, and thereafter whenever it becomes apparent that the nozzle has become damaged. Each nozzle is inspected upon return to laboratory from each field use. The diameter is measured on four different axes, with the high and low readings differing by no more than 0.004 inches as a tolerance.

TEMPERATURE MEASURING INSTRUMENTS

After each field use, the thermocouples or thermometers are calibrated against an ASTM precision mercury-in-glass thermometer across a wide range of temperatures. If the initial reading is not within ± 1.5% of the absolute temperature reading of the standard thermometer, the instrument is adjusted until it is in the acceptable range.

MAGNEHELIC GAUGES

After each field use, each magnehelic gauge is calibrated against an inclined manometer at three different settings (low, medium, high) over the range of the individual gauges. If the readings differ more than ± 5% from the manometer readings, the magnehelics are recalibrated.

BAROMETER

After each field use, each barometer is checked against a mercury barometer.

DATE 11-21-79

DRY GAS METER IDENTIFICATION: # 1017057

BAROMETRIC PRESSURE (P_b): 29.74 in. Hg

APPROXIMATE FLOW RATE ($\bar{Q}$) ΔH / cfm	SPIROMETER ~~(WET METER)~~ GAS VOLUME (V_s) ft³	DRY GAS METER VOLUME (V_{dg}) ft³	TEMPERATURES SPIROMETER ~~(WET METER)~~ (t_s) °F/°R	TEMPERATURES DRY GAS METER (t_d) °F/°R	DRY GAS METER PRESSURE (Δp) in. H_2O / in. Hg	TIME (Θ) min.	FLOW RATE (Q) cfm	METER METER COEFFICIENT (Y_{ds})	AVERAGE METER COEFFICIENT ($\bar{Y}_{ds}$)
0.51, 0.4	1.000	1.005	530.5	532.5	-0.8	2.52	0.39	1.0008	1.0005
, 0.4	1,000	1,007	530.5	532.5	-0.8	2.52	.39	0.9988	
, 0.4	1,000	1,004	530.5	532.5	-0.8	2.52	.39	1.0018	
1.25 0.6	1,000	1.002	530.5	532	-1.3	1.62	.61	1.0041	0.9991
, 0.6	1.000	1.008	530.5	532	-1.3	1.63	.61	.9981	
, 0.6	1,000	1.011	530.5	532	-1.3	1.65	.60	.9951	
.18, 0.8	1,000	1.018	530.5	532.5	-1.8	1.27	.78	.9904	0.9947
0.8	1,000	1,013	530.5	532.5	-1.8	1.27	.78	.9953	
0.8	1.000	1,010	530.5	532.5	-1.8	1.27	.78	.9983	
3.3, 1.0	1,000	1,020	530	532.5	-2.3	1.02	.97	.9907	0.9920
, 1.0	1,000	1,021	530	532.5	-2.3	1.03	.96	.9897	
1.0	1.000	1.015	530	532.5	-2.3	1.03	.96	.9955	
4.8, 1.2	1,000	1.023	530	532.5	-3.1	0.88	1.12	.9897	0.9910
1.2	1.000	1,021	530	532.5	-3.1	0.87	1.14	.9917	
1.2	1.000	1,021	530	532.5	-3.1	0.87	1.14	.9917	

Average: .99544 .99546

$$Q = 17.65 \cdot \frac{V_s}{\Theta} \cdot \frac{P_b}{(t_s + 460)}$$

$$Y_{ds} = \frac{V_s}{V_{dg}} \cdot \frac{(t_d + 460)}{(t_s + 460)} \cdot \frac{P_b}{(P_b + \frac{\Delta p}{13.6})}$$

ENTROPY ENVIRONMENTALISTS, INC.

METER BOX CALIBRATION

METER BOX Nutech I

DATE 5-14-90

P_B 29.62

INITIALS LAT

Date*

P_B*

Initials*

ΔH	V_T	T_R	θ	T_M	V_M		
ORIFICE SETTING	TEST METER VOLUME cf	ROOM TEMP. °F	TIME, MINUTES M:SEC /M.dec	METER BOX TEMP °F	METER BOX VOLUME cf	Y	ΔH@
6.0	5	71	3:37 / 3.62	78	5.058	0.9869	1.764
4.0	5	71	4.31 / 4.52	88	5.118	0.9983	1.800
2.0	5	71	6:15 / 6.25	86	5.140	0.9914	1.727
1.5	5	70	7:00 / 7.00	78	5.063	1.0007	1.643
1.0	3	71	5:10 / 5.17	83	3.098	0.9878	1.650
0.7	3	71	6:13 / 6.22	82	3.110	0.9829	1.675
0.5	3	71	7:15 / 7.25	78	3.096	0.9805	1.638
0.3	2	70	6:04 / 6.07	72	2.025	0.9906	1.562
					AVERAGE	0.9899	1.682

* Indicates date of calibration

$$\Delta H@ = \frac{[(T_R + 460)\,\theta\,]^2\ (0.0317)\ (\Delta H)}{(V_T)^2\ (P_B)\ (T_M + 460)}$$

$$Y = \frac{(T_M + 460)\ (P_B)\ (V_T)}{(\Delta H/13.6 + P_B)(T_R + 460)(V_M)}$$

note: calculate $[(T_R + 460)\,\theta\,]^2$ first

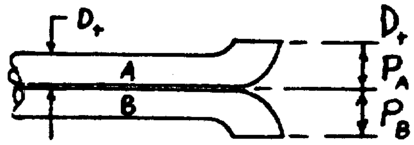
ENTROPY ENVIRONMENTALISTS, INC.

CALIBRATION DATA
PITOT-PROBE ASSEMBLY NO. 4-1

Date: Oct. 30, 1980 Initials: Tk

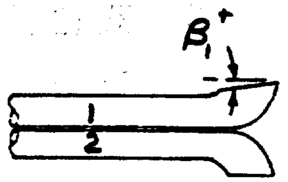
Instructions: If stated criteria is met, indicate (yes/ok ✓) on line provided.

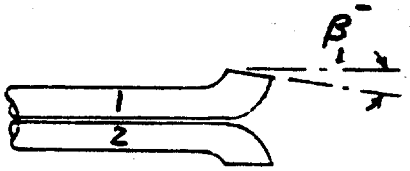
$P_A = P_B$? ✓



D_t: .375 in.
P_A: .428 in.
P_B: .428 in.

$D_t \le 0.375$ in. (3/8)? ✓
$D_t \ge 0.1875$ in. (3/16)? ✓
1.05 (.375): .394 ≤ P? ✓
1.50 ($\overset{D_t}{.375}$): .563 ≥ P? ✓

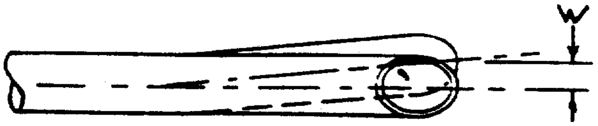




$\beta_1^{\pm}$: -1° < 5°? ✓
$\beta_2^{\pm}$: 0° < 5°? ✓

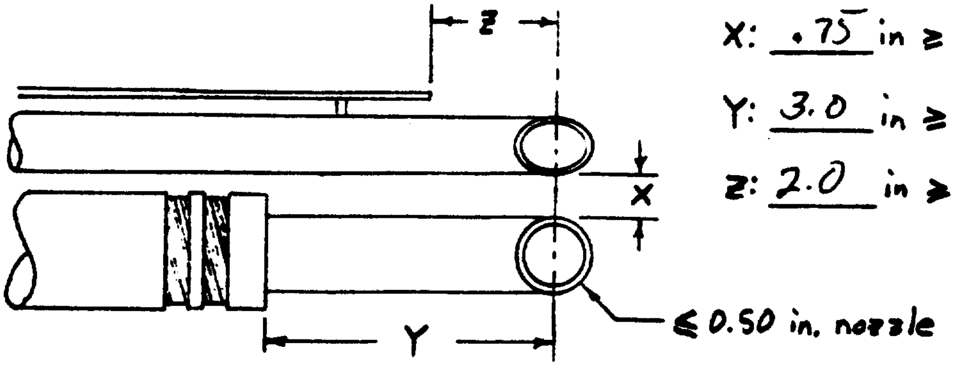
a_1: ____° < 10°? ✓
a_2: ____° < 10°? ✓

z: 0 in < 0.125 (1/8)? ✓



w: 0 in < 0.03125 (1/32)? ✓

X: .75 in ≥ 0.75 (3/4)? ✓
Y: 3.0 in ≥ 3.0? ✓
Z: 2.0 in ≥ 2.0? ✓



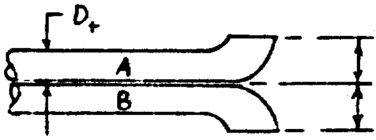
Is pitot impact pressure opening plane even with or above nozzle entry plane? ✓

ENTROPY ENVIRONMENTALISTS, INC.

CALIBRATION DATA
PITOT-PROBE ASSEMBLY NO. 4-3

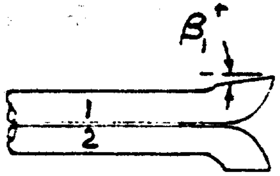
Date: OCT. 30, 1980 Initials: TI

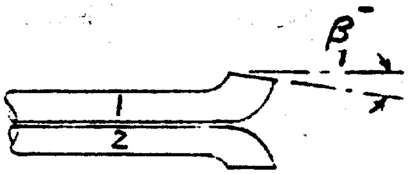
Instructions: If stated criteria is met, indicate (✓ yes OK) on line provided.



D_t: .375 in.
P_A: .408 in.
P_B: .408 in.

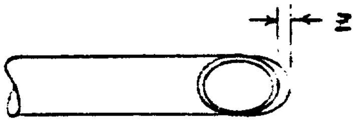
$P_A = P_B$? ✓
$D_t \le 0.375$ in. (3/8)? ✓
$D_t \ge 0.1875$ in. (3/16)? ✓
$1.05\,(.375)$: .394 $\le P$? ✓
$1.50\,(\overset{D_t}{.375})$: .563 $\ge P$? ✓



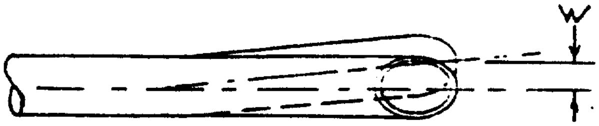


$\beta_1^{\pm}$: −1° < 5°? ✓
$\beta_2^{\pm}$: −1° < 5°? ✓

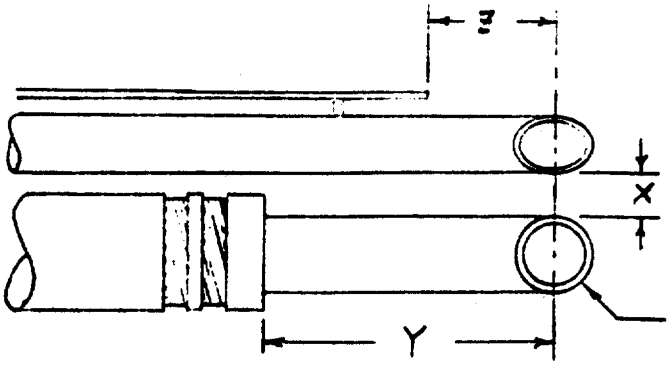
a_1: 0° < 10°? ✓
a_2: 0° < 10°? ✓



z: 0 in < 0.125 (1/8)? ✓



w: 0 in < 0.03125 (1/32)? ✓



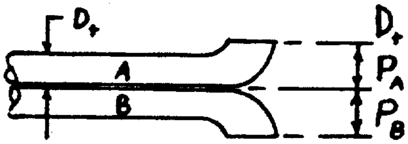
X: .75 in ≥ 0.75 (3/4)? ✓
Y: 3.0 in ≥ 3.0 ? ✓
Z: 2.0 in ≥ 2.0 ? ✓

Is pitot impact pressure opening plane even with or above nozzle entry plane? ✓

CALIBRATION DATA
PITOT-PROBE ASSEMBLY NO. 4-7

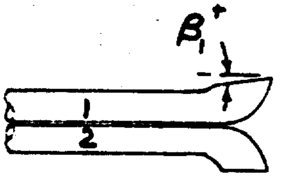
Date: OCT. 30, 1980 Initials: TI

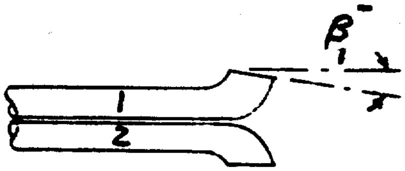
Instructions: If stated criteria is met, indicate (✓ yes OK) on line provided.



D_t: .375 in.
P_A: .402 in.
P_B: .402 in.

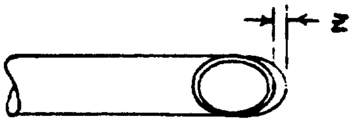
$P_A = P_B$? ✓
$D_t \leq 0.375$ in. (3/8) ? ✓
$D_t \geq 0.1875$ in. (3/16) ? ✓
1.05 (.375): .394 $\leq$ P ? ✓
1.50 (.375): .563 $\geq$ P ? ✓



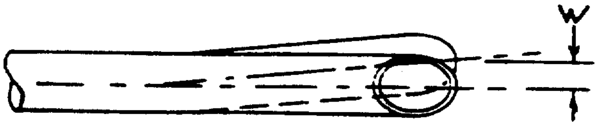


$\beta_1^\pm$: 0 ° < 5° ? ✓
$\beta_2^\pm$: 0 ° < 5° ? ✓

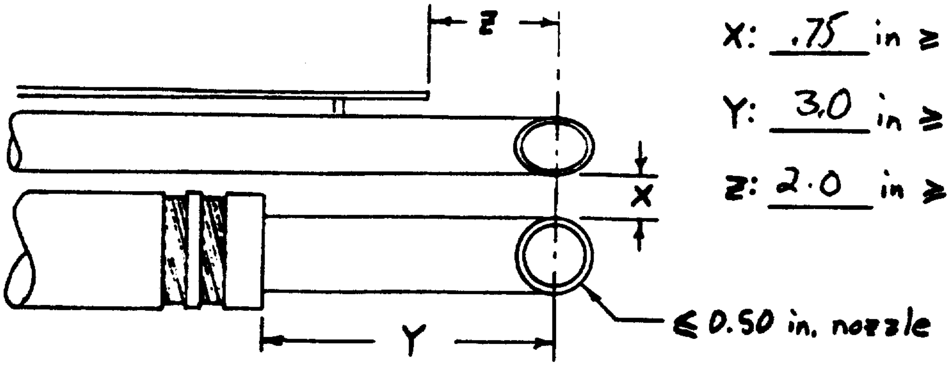
α_1: ____ ° < 10° ? ____
α_2: ____ ° < 10° ? ____



z: 0 in < 0.125 (1/8) ? ✓



w: 0 in < 0.03125 (1/32) ? ✓



X: .75 in ≥ 0.75 (3/4) ? ✓
Y: 3.0 in ≥ 3.0 ? ✓
Z: 2.0 in ≥ 2.0 ? ✓

Is pitot impact pressure opening plane even with or above nozzle entry plane? ✓

ENTROPY ENVIRONMENTALISTS, INC.

NOZZLE CALIBRATION DATA

NOZZLE # 404

		DIAMETER, in.				
DATE	INITIALS	1	2	3	4	AVERAGE
1-9-78	WN	.246	.247	.248	.246	.247
4-10-78	MH	.248	.249	.251	.247	.249
8-1-78	JLE	.249	.250	.248	.249	.249
1-5-79	DDN	.246	.248	.248	.249	.248
6-30-79	MH	.251	.249	.247	.251	.250
10-12-79	JTN	.247	.243	.245	.245	.245
1/5/80	WSN	.247	.243	.245	.246	.245
8/7/80	DJD	.248	.249	.250	.252	.250
9/18/80	BDR	.252	.251	.251	.253	.252

NOZZLE CALIBRATION DATA

NOZZLE # 405

DATE	INITIALS	DIAMETER, in. 1	2	3	4	AVERAGE
1-9-78	WN	.248	.250	.250	.250	.250
4-10-78	NMH	.251	251	.254	.253	.252
5-2-78	JLE	.250	.249	.252	.250	.250
8-1-78	JLE	.250	.250	.253	.252	.251
1-5-79	DDH	.251	.251	.250	.252	.251
8-30-79	NMH	.250	.249	.249	.248	.249
1/5/80	WSN	.245	.248	.248	.248	.247
1-31-80	NMH	.249	.248	.250	.250	.249
6/24/80	JTN	.245	.246	.249	.246	.246
8/7/80	DJD	.251	.250	.248	.250	.250
9/18/80	BDR	.247	.249	.249	.248	.248

NOZZLE CALIBRATION DATA

NOZZLE # 406

		DIAMETER, in.				
DATE	**INITIALS**	**1**	**2**	**3**	**4**	**AVERAGE**
1-9-78	CWN	.248	.249	.251	.249	.249
4-10-78	NMH	.253	.253	.252	.251	.252
8-1-78	JLE	.253	.251	.255	.251	.252
1-5-79	DDH	.250	.250	.253	.251	.251
1/5/80	WSN	.247	.247	.249	.249	.248
6/4/80	WZC	.250	.250	.250	.252	.251
9/18/80	BDR	.251	.249	.253	.250	.251