AP-42 Section 11.23
Reference
Report Sect. 4
Reference 26

Interpoll Laboratories, Inc.
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RESULTS OF THE JANUARY 25, 1990 PARTICULATE AND SULFUR DIOXIDE ENGINEERING EMISSION TEST ON THE LINE 7 GRATE KILN AT THE USX MINNESOTA ORE OPERATION FACILITY

Submitted to:

USS, A DIVISION OF USX CORPORATION
P.O. Box 417
Mt. Iron, Minnesota 55768

Attention: Nick Brascugli
Supervisor of Facility Engineering

Approved by:

Kathleen Eickstadt

Kathleen Eickstadt
Senior Data Analyst
Field Testing Division

Report Number 0-2935
March 7, 1990
KE/des

TABLE OF CONTENTS

ABBREVIATIONS

ACFM	actual cubic feet per minute
cc (ml)	cubic centimeter (milliliter)
DSCFM	standard cubic foot of dry gas per minute
DSML	dry standard milliliter
DEG-F (^{0}F)	degrees Fahrenheit
DIA.	diameter
FP	finished product for plant
FT/SEC	feet per second
g	gram
GPM	gallons per minute
GR/ACF	grains per actual cubic foot
GR/DSCF	grains per dry standard cubic foot
g/dscm	grams per dry standard cubic meter
HP	horsepower
HRS	hours
IN.	inches
IN.HG.	inches of mercury
IN.WC.	inches of water
LB	pound
LB/DSCF	pounds per dry standard cubic foot
LB/HR	pounds per hour
LB/10^{6}BTU	pounds per million British Thermal Units heat input
LB/MMBTU	pounds per million British Thermal Units heat input
LTPD	long tons per day
MW	megawatt
mg/Nm^{3}	milligrams per dry standard cubic meter
ug/Nm^{3}	micrograms per dry standard cubic meter
microns (um)	micrometer
MIN.	minutes
ng	nanograms
ohm-cm	ohm-centimeter
PM	particulate matter
PPH	pounds per hour
PPM	parts per million
ppmC	parts per million carbon
ppm,d	parts per million, dry
ppm,w	parts per million, wet
ppt	parts per trillion
PSI	pounds per square inch
SQ.FT.	square feet
TPD	tons per day
ug	micrograms
v/v	percent by volume
w/w	percent by weight
<	$\leq$ (when following a number)

Standard conditions are defined as 68 ^{0}F (20 ^{0}C) and 29.92 IN. of mercury pressure.

1 INTRODUCTION

On January 25, 1990, Interpoll Laboratories personnel conducted a particulate and sulfur dioxide emission engineering test on the Line 7 Grate Kiln at the USX Minnesota Ore Operation Facility in Mt. Iron, Minnesota. On-site testing was performed by D. Van Hoever and C. Mosser. Coordination between testing activities and plant operation was provided by Nick Brascugli of USX.

Particulate determinations were performed in accordance with EPA Methods 1 - 6, CFR Title 40, Part 60, Appendix A (revised July 1, 1988). Appropriate nozzle diameters for isokinetic sampling were selected from previous flow data. An Interpoll Labs sampling train which meets or exceeds specifications in the above-cited reference was used to extract particulate samples by means of a heated glass-lined probe. Sulfur dioxide samples were collected in the back half of the Method 5 sampling train in accordance with the large impinger version of Method 6 without the isopropanol. In addition, the probe wash and filter catches were combined and analyzed for sulfate by ion chromatography.

Integrated flue gas samples were extracted simultaneously with each particulate and sulfur dioxide sample using a specially designed gas sampling system. The integrated flue gas samples were collected in 44-liter Tedlar bags housed in a protective aluminum container. After sampling was complete, the bags were sealed and returned to the laboratory for Orsat analysis. Prior to sampling, the Tedlar bags are leak checked at 15 IN.HG. vacuum with an in-line rotameter. Bags with any detectable inleakage are discarded.

Testing on the waste gas stack was conducted from a set of four test ports oriented at 90^0. The test ports are located 3.4 diameters downstream of the nearest flow disturbance and 2.3 diameters upstream of the stack

exit. A 24-point traverse was used to collect the particulate samples. Each traverse point was sampled 2.5 minutes for a total of 64 minutes per run.

The important results of the test are summarized in Section 2. Detailed results are presented in Section 3. Field data and all other supporting information are presented in the appendices.

2 SUMMARY AND DISCUSSION

The important results of the particulate emission engineering test are summarized in Table 1. As will be noted, the particulate emission factor averaged 0.20 LB/10^5BTU.

A summary of the sulfur dioxide results is presented in Table 2. The sulfur dioxide concentration averaged 7 ppm,w with a corresponding average emission rate of 27 LB/HR.

The results of the sulfate analysis conducted on the particulate catch were as follows:

Run	Sulfur Content % by Weight
1	64.0
2	42.6
3	46.6

TABLE 1. Summary of the Results of the January 25, 1990 Particulate Emission Engineering Test on the No. 7 Waste Gas Stack at the United States Steel Plant in Mt. Iron, Minnesota.

ITEM		Run 1	Run 2	Run 3
Date of test		01-25-90	01-25-90	01-25-90
Time runs were done	(HRS)	1010/1118	1140/1245	1303/1408
Process Rate	(LTPH)	557 624	566 634	573 642
Volumetric flow				
actual	(ACFM)	446526	452674	452524
standard	(DSCFM)	369986	376138	376339
Gas temperature	(DEG-F)	103	103	103
Moisture content	(%V/V)	7.19	6.92	6.88
Gas composition	(%V/V,dry)			
carbon dioxide		3.60	3.70	4.00
oxygen		17.10	17.00	16.80
nitrogen		79.30	79.30	79.20
Isokinetic variation	(%)	98.9	91.4	91.9
Particulate concentration				
actual	(GR/ACF)	.0151	.0136	.0155
standard	(GR/DSCF)	.0182	.0164	.0186
Part. emission rate	(LB/HR)	57.66	52.97	60.06
Emission factor				
By Ratio	(LB/MMBTU)	0.210	0.190	0.213
By F-Fact.	(LB/MMBTU)			

NOTE: Dry catch only

Table 2. Summary of the Results of the January 25, 1990 Sulfur Dioxide Determinations on the No. 7 Waste Gas Stack at the United States Steel Plant in Mt. Iron, Minnesota.

Test/Run	Concentration (ppm,w)	Emission Rate (LB/HR)
1/1	6	22
1/2	7	28
1/3	8	30
Avg.	7	27

3 RESULTS

The results of all field and laboratory evaluations are presented in this section. Gas composition (Orsat and moisture) are presented first followed by the computer printout of the particulate and sulfur dioxide results.

The results have been calculated on a personal computer using programs written in Extended BASIC specifically for source testing calculations. EPA-published equations have been used as the basis of the calculation techniques in these programs. The particulate emission rate has been calculated using the product of the concentration times flow method.

3.1 Results of Orsat and Moisture Analyses

Test No. 1
No. 7 Waste Gas Stack

Results of Orsat & Moisture Analyses-----Methods 3 & 4(%v/v)

	Run 1	Run 2	Run 3
Date of run	01-25-90	01-25-90	01-25-90
Dry basis (orsat)			
carbon dioxide.....	3.60	3.70	4.00
oxygen.....	17.10	17.00	16.80
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	79.30	79.30	79.20
Wet basis (orsat)			
carbon dioxide.....	3.34	3.44	3.72
oxygen.....	15.87	15.82	15.64
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	73.60	73.81	73.75
water vapor.....	7.19	6.92	6.88
Dry molecular weight.....	29.26	29.27	29.31
Wet molecular weight.....	28.45	28.49	28.53
Specific gravity.....	0.983	0.984	0.986
Water mass flow.....(LB/HR)	80416	78469	78033
FD	1.056	1.054	1.025

3.2 Results of Particulate Loading Determinations

Test No. 1
No. 7 Waste Gas Stack

Results of Particulate Loading Determinations-------Method 5

	Run 1	Run 2	Run 3
Date of run	01-25-90	01-25-90	01-25-90
Time run start/end.....(HRS)	1010/1118	1140/1245	1303/1408
Static pressure.....(IN.WC)	-0.26	-0.26	-0.26
Cross sectional area (SQ.FT)	201.06	201.06	201.06
Pitot tube coefficient.....	.840	.840	.840
Water in sample gas			
condenser.....(ML)	0.0	0.0	0.0
impingers.....(GRAMS)	72.0	48.0	48.0
desiccant.....(GRAMS)	16.0	9.0	8.0
total.....(GRAMS)	88.0	56.0	56.0
Total particulate material..			
.....collected(grams)	0.0631	0.0378	0.0431
Gas meter coefficient.....	0.9942	0.9942	0.9942
Barometric pressure..(IN.HG)	28.50	28.50	28.50
Avg. orif.pres.drop..(IN.WC)	2.90	1.28	1.30
Avg. gas meter temp..(DEF-F)	85.9	85.8	88.4
Volume through gas meter....			
at meter conditions...(CF)	58.05	38.64	39.06
standard conditions.(DSCF)	53.55	35.50	35.72
Total sampling time....(MIN)	60.00	60.00	60.00
Nozzle diameter.....(IN)	.300	.252	.252
Avg.stack gas temp ..(DEG-F)	103	103	103
Volumetric flow rate.....			
actual.....(ACFM)	446526	452674	452524
dry standard.....(DSCFM)	369986	376138	376339
Isokinetic variation.....(%)	98.9	91.4	91.9
Particulate concentration...			
actual.....(GR/ACF)	0.01506	0.01365	0.01548
dry standard.....(GR/DSCF)	0.01818	0.01643	0.01862
Particle mass rate...(LB/HR)	57.66	52.97	60.06

3.3 Results of Sulfur Dioxide Determinations

Test No. 1
No. 7 Waste Gas Stack

Results of Sulfur Dioxide Determinations----------Method 6

	Run 1	Run 2	Run 3
Date of run	01-25-90	01-25-90	01-25-90
Time run start/end.....(HRS)	1010-1118	1140-1245	1303-1408
Barometric pressure..(IN.HG)	28.50	28.50	28.50
Meter temperature....(DEG-F)	85.90	85.80	88.40
Meter correction coefficient	0.9942	0.9942	0.9942
Volume through gas meter....			
at meter conditions...(CF)	58.050	38.640	39.060
standard conditions..(SCF)	53.548	35.502	35.720
Total sampling time....(MIN)	60.0	60.0	60.0
Moisture content.....(%V/V)	7.19	6.92	6.88
Oxygen content....(%V/V DRY)	17.10	17.00	16.80
Milliequivalents of SO4 in..			
gas sample.....	0.7648	0.6269	0.6770
Sulfur dioxide concentration			
(GR/DSCF).....	0.0071	0.0087	0.0094
(MG/DSCM).....	16	20	21
(PPM-DRY).....	6	8	8
(PPM-WET).....	6	7	8
SO2 Emission rate....(LB/HR)	22.39	28.14	30.22

APPENDIX A

SAMPLING TRAIN CALIBRATION DATA

Interpoll Laboratories, Inc.
(612) 786-6020

Meter Box Calibration and Usage Status

Date of Report: March 7, 1990

Meter Box No. : 3 (Rockwell Dry Test Meter Serial No. 35303)

Date of Last Calibration: January 16, 1990
Calibration Technician: D. Van Hoever
Wet Test Meter No.: American Meter AL-20

Date of Use	Report No.	Initial Meter Reading	Final Meter Reading	Volume/Job (cu. ft.)	Total Volume* (cu. ft.)
January 25, 1990	0-2935	713.10	857.36	144.26	144.26

* Total volume through meter since last calibration.

Date 1/16/90

Bar. Press. 29.07 in. Hg

INTERPOLL LABORATORIES, INC.
METER CALIBRATION SHEET
EPA METHOD 5

Control Module No. 3

Serial No. DTM 35303

Wet Test Meter No. AL-20

Technician [signature]

ΔH (in. WC)		Gas Volume Wet Test Meter (ft^3)	* Cal. Index θ (%)	* Diff. Wet Test Meter ΔP_w (in.WC)	Gas Volume Dry test meter (ft^3)		Gas temperatures			Time θ (min/sec)	Meter Coeff. Y	Orifice Const. ΔHθ	C_f
nominal	actual				V_{di}	V_{df}	Wet Test t_w (°F)	Dry Test t_{di} (°F)	Dry Test t_{do} (°F)				
0.5	.5	2	99.70	0.01	709.74	711.76	70	77	71	5/0.86	.9933	1.81	
1.2	1.2	3	99.77	0.03	704.70	709.24	70	77	70	7/26.43	.9923	1.89	
2.0	2.0	3	99.87	0.05	688.72	691.71	70.5	73	65	3/50.88	.9941	1.91	
3.3	3.3	5	100.00	0.08	692.70	697.70	70.5	76	68	5/01.97	.9943	1.93	
4.7	4.7	5	100.20	0.11	698.70	703.70	70	78	70	4/11.85	.9974	1.89	
2	3	4	5		6	7	8	9	10	11/12	.9942	1.89	

Meter was in tolerance ☒

Meter was not in tolerance ☐; readjusted linkage

Meter was not in tolerance ☐; changed dry test meters

Approved by [signature] Date 1-17-90

* Based on AL-20 wet test meter calibration in August 1989 against Bell Prover (NBS Traceable) - Carl Poe Co.

S0102R 8/89

Interpoll Laboratories. Inc.
(612) 786-6020

Nozzle Calibration
Data Sheet

Date of Calibration: January 25, 1990 Nozzle Number 8-5
Technician: D. Van Hoever

Nozzle rotated by 60 degree increments and diameter measured to nearest 0.001 inch. Observed readings and average:

Position	Diameter (inches)
1	0.293
2	0.303
3	0.302
Average:	0.300

Interpoll Laboratories, Inc.
(612) 786-6020

Nozzle Calibration
Data Sheet

Date of Calibration: January 25, 1990 Nozzle Number 8-4
Technician: D. Van Hoever

Nozzle rotated by 60 degree increments and diameter measured to nearest 0.001 inch. Observed readings and average:

Position	Diameter (inches)
1	0.258
2	0.248
3	0.250
Average:	0.252

Interpoll Laboratories
(612)786-6020

S-Type Pitot Tube Inspection Sheet

Pitobe No. 6-21

Pitot tube dimensions:

1. External tubing diameter (D_t) .316 IN.
2. Base to Side A opening plane (P_A) .464 IN.
3. Base to Side B opening plane (P_B) .462 IN.

Alignment:

4. $\alpha_1 < 10^0$ 0
5. $\alpha_2 < 10^0$ 0

6. $B_1 < 5^0$ 2
7. $B_2 < 5^0$ 1

8. Z <.125" 2
9. W <.0625" 2

Distance from Pitot to Probe Components:

10. Pitot to 0.500 IN. nozzle .762 IN.
11. Pitot to probe sheath 3.00 IN.
12. Pitot to thermocouple (parallel to probe) 3.00 IN.
13. Pitot to thermocouple (perpendicular to probe) .762 IN.

Date of Inspection: 12-8-89

Inspected by: [signature]

S-348(1)

Interpoll Laboratories, Inc.
(612) 786-6020

EPA Method 5 Gas Metering System
Quality Control Check Data Sheet

* Control module never used since latest calibration

Module No. 3 Date 1/25/90

Job USX - Minntac Operator [signature]

Instructions: Operate the control module at ΔHe for 10 minutes without the umbilical. Note the following data:

Barometric pressure (P_b) 28.50 IN.HG. ΔHe 1.90 IN.WC.

Time (MIN)	Volume (CF)	Gas Meter Temperature (°F)	
		Inlet	Outlet
0	(713.10)	64	60
2	714.57	69	63
4	716.02	70	63
6	717.49	74	67
8	718.95	77	70
10	(720.43)	82	76
	V_m = 7.33 CF	Average Meter Temp (t_m) = 69.5°F	

Calculate Y_{cn} as follows:

18.5818

$$Y_{cn} = \frac{1.786}{\gamma V_m}\left[\frac{(t_m + 460)}{P_b}\right]^{1/2} = \frac{1.786}{7.2575}\left[\frac{(69.5 + 460)}{28.50}\right]^{1/2} = \frac{1.786}{7.2575}\left[4.3106\right]^{1/2} = 1.03$$

If Y_{cn} is not within the range of 0.97 to 1.03, "the volume metering system should be investigated before beginning the test".

CFR Title 40, Part 60, Appendix A, Method 5, Section 4.4.1

Interpoll Laboratories, Inc.

Temperature Measurement Device
Calibration Sheet

Unit under test:
Vendor AITKINS
Model 39658-K
Range -112.6 to 1999 °F
Date of Calibration 12/11/89

PDT 5
Serial Number 881021528-197
Thermocouple Type TYPE K
Technician D. SMITH

Method of Calibration:

☐ Comparison against ASTM mercury in glass thermometer using a thermostatted and insulated aluminum block designed to provide uniform temperature. The temperature is adjusted by adjusting the voltage on the block heater cartridge.

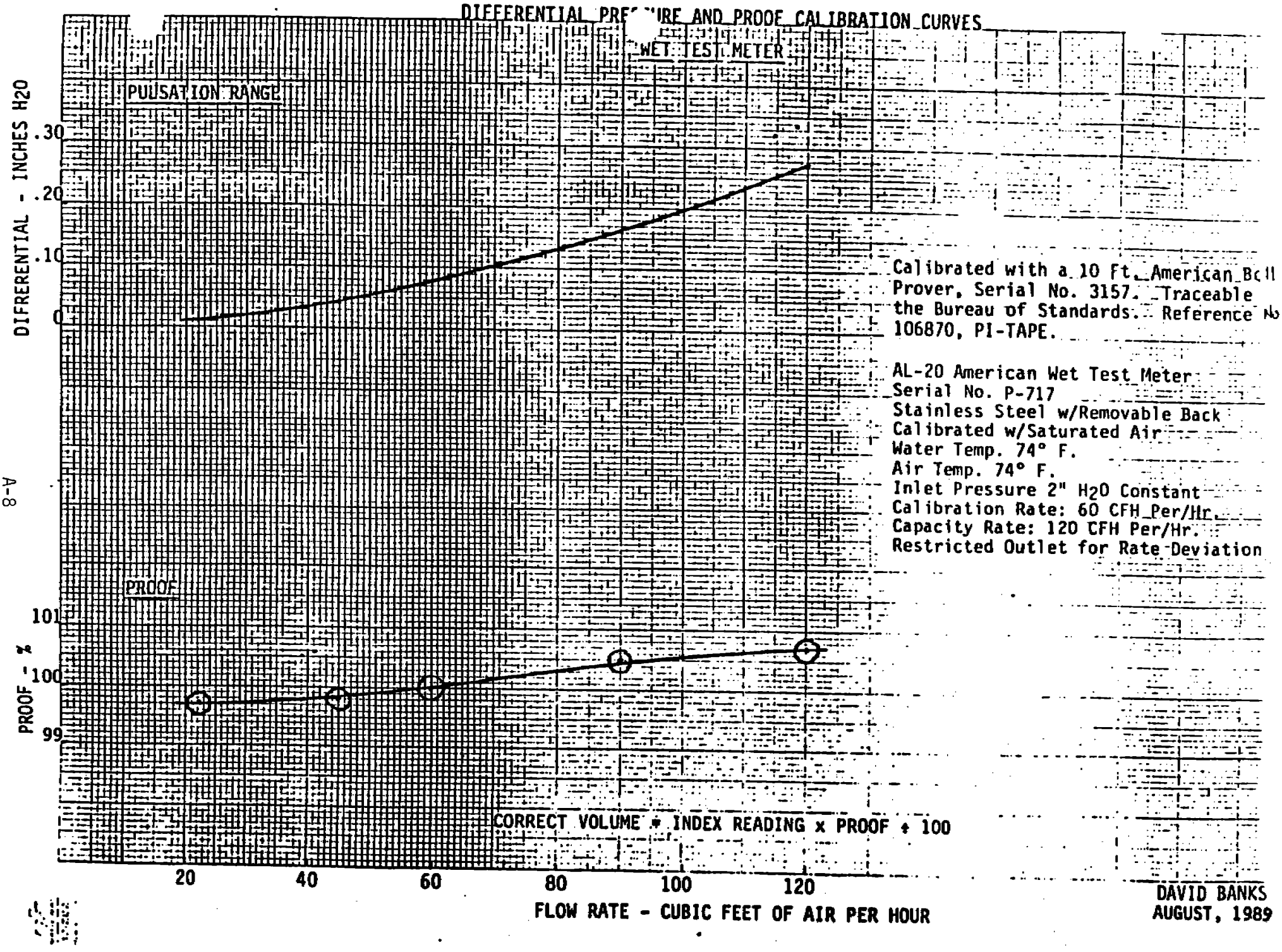
☐ Omega Model CL-300 Type K Thermocouple Simulator which provides 22 precise temperature equivalent millivolt signals. The CL-300 is cold junction compensated. Calibration accuracy is ± 0.1% of span (2100 °F) ± 1 degree (for negative temperatures add ± 2 degrees. The CL-300 simulates exactly the millivoltage of a Type K thermocouple at the indicated temperature.

Desired Temp (°F) Nominal	Temperature of Standard or Simulated Temp (°F)	Response of Unit Under Test (°F)	Deviation Δt (°F)	Deviation (%)
0	0	0.1	.1	.022
100	100	97.4	2.6	.46
200	200	200	0	0
300	300	298	2	.36
400	400	395	5	.58
500	500	494	6	.63
600	600	596	4	.38
700	700	695	5	.43
800	800	800	0	0
900	900	901	1	.07
1000	1000	1004	4	.27
1100	1100	1107	7	.45
1200	1200	1211	11	.66
1300	1300	1310	10	.57
1400	1400	1413	13	.70
1500	1500	1509	9	.46
1600	1600	1608	8	.39
1700	1700	1702	2	.09
1800	1800	1798	2	.08
1900	1900	1889	11	.47
2000	2000	1982	18	.73
2100	2100	OFF	—	—
		Averages:	5.75	.37

OF = off scale response by unit under test (°F)
% dev = 100 Δt / (460 + $\frac{1}{2}$t)

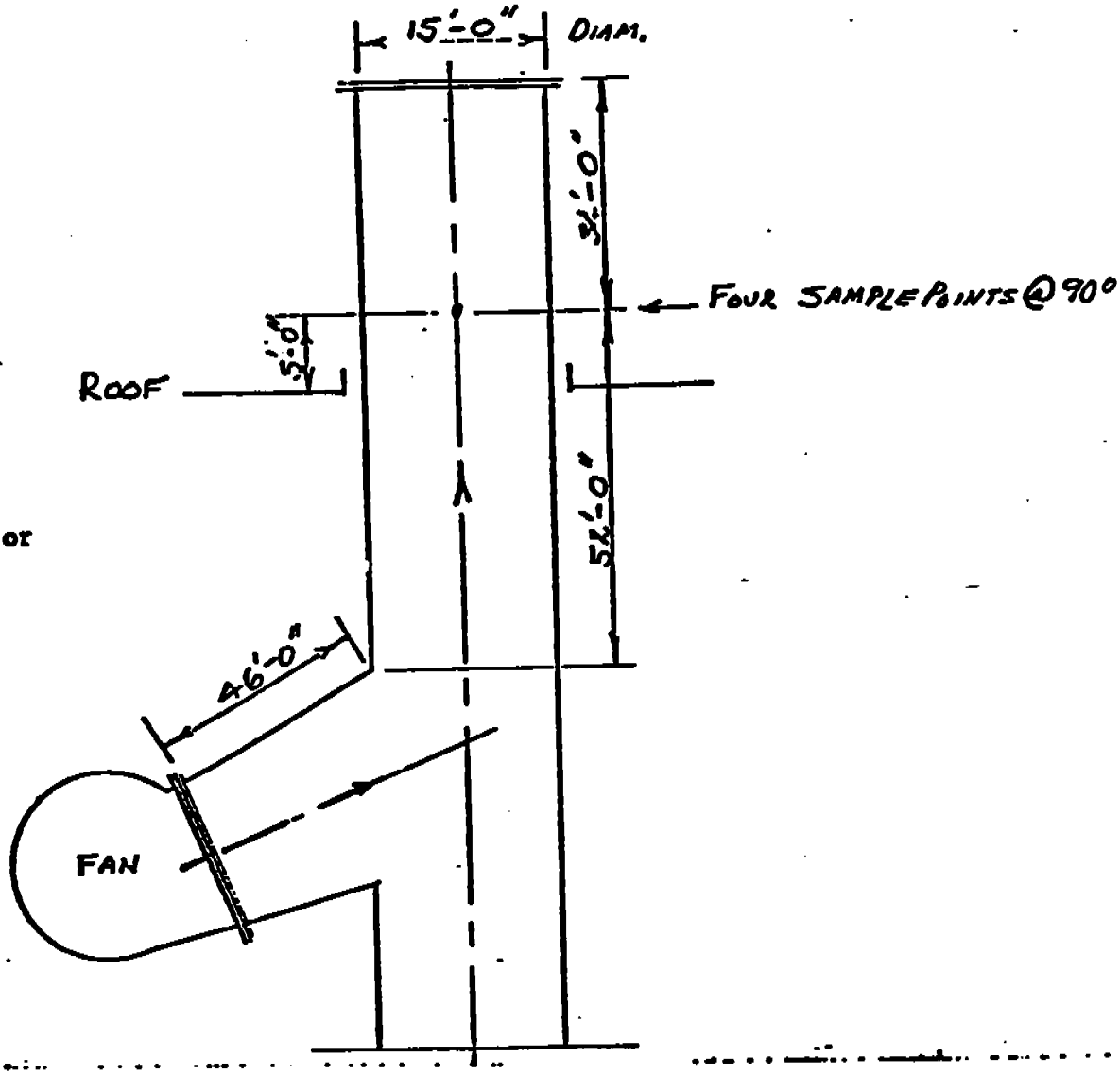
☒ Unit in tolerance
☐ Unit was not in tolerance; recalibrated - See new calibration sheet.

S-433


DIFFERENTIAL PRESSURE AND PROOF CALIBRATION CURVES
WET TEST METER
PULSATION RANGE
DIFRERENTIAL - INCHES H2O
.30
.20
.10
0
PROOF
101
100
99
PROOF - %
CORRECT VOLUME = INDEX READING x PROOF ÷ 100
20
40
60
80
100
120
FLOW RATE - CUBIC FEET OF AIR PER HOUR
Calibrated with a 10 Ft. American Bell Prover, Serial No. 3157. Traceable the Bureau of Standards. Reference No 106870, PI-TAPE.
AL-20 American Wet Test Meter
Serial No. P-717
Stainless Steel w/Removable Back
Calibrated w/Saturated Air
Water Temp. 74° F.
Air Temp. 74° F.
Inlet Pressure 2" H2O Constant
Calibration Rate: 60 CFH Per/Hr.
Capacity Rate: 120 CFH Per/Hr.
Restricted Outlet for Rate Deviation
DAVID BANKS
AUGUST, 1989

APPENDIX B

LOCATION OF TEST PORTS



Step II
Agglomerator
Waste Gas

Elevation View

1. Emission Source Number - 8,21
2. " " Flow Sheet Number
3. Stack Diameter - 15.0'.
4. " Design Gas Velocity - 52.3FPS
5. " " " Volume - 591,000 CFM
6. " " " Temperature - 125 to 150°F
7. Pollutant - Taconite Dust
8. Stack Loading - 0.061 GR./Cubic Ft
9. Traverse Points - 38

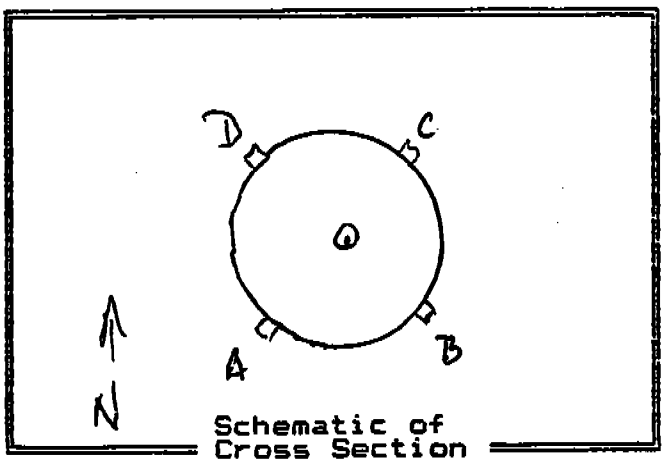
Step II Agglomerator
Minnesota Ore Operations
Minntac, Mt. Iron, Minnesota

APPENDIX C

METHODS 2-6 FIELD DATA SHEETS

INTERPOLL LABORATORIES EPA METHOD 2 FIELD DATA SHEET

Job USX - MINNTAC
Source No. 7 Waste Gas Stack
Test 1 Run ____ Date 1/25/90
Stack dimen. 192" IN.
Dry bulb ____ °F Wet bulb ____ °F
Manometer: [X] Reg. [ ] Exp. [ ] Elec.
Barometric pressure 28.50 in Hg
Static pressure -.26 in WC
Operators D. VanHoever & C. Masser
Pitot No. V21-6 Cp .84



Schematic of Cross Section

Traverse Point No.	Fraction of Diameter	Distance from Stack Wall (in)	Distance from End of Port (in)	Velocity Pressure (in WC)	Temperature of gas (°F)
		Port length: 5.5 in.		Time start:	hrs
A 1	.021	4.03	9.53	36	
2	.067	12.86	18.36	.41	
3	.118	22.66	28.16	.40	103
4	.177	33.98	39.48	.38	
5	.250	48	53.5	.35	
6	.356	68.35	73.85	.35	
B 1					
2					
3					
4					
5					
6					
C 1					
2					
3					
4					
5					
6					
D 1					
2					
3					
4					
5					
6					
Temp. meas. tool & S/N: PDT-5				Time end:	hrs

R or nothing= reg. manometer; S= expanded; E = electronic

S-392.1

INTERPOLL LABORATORIES EPA METHOD 5/17 SAMPLE LOG SHEET

Job U.S.X
Source #7 Waste Recovery Stack
Method 5+6 Filter holder: S.S

Date 1/25/90 Test 1 Run 1
No. of traverse points 24
Filter type: glass fiber

Sample Train Leak Check:

Pretest: < 0.02 cfm at 15 in. Hg. (vac) ☒
Postest: 0 cfm at 15 in. Hg. (vac) ☒

Particulate Catch Data:

No.s of filters used: 1802

Recovery solvent(s)
☒ acetone
☐ other(s)

No. of probe wash bottles: 1
Sample recovered by: DH

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impinger No. 1			
Impinger No. 2	272	200	72
Impinger No. 3			
Condenser			
Desiccant	1360	1344	16
Total			88

Integrated Gas Sampling Data:

Bag Pump No. 38 Box No. 12 Bag No. 1
Bag Material: 5-layer Aluminized Tedlar Size: 44 L
Pretest leak check: 0 cc/min at 15 in. Hg.
Time start: 10^16 (HRS) Time end: 11^17 (HRS)
Sampling rate: 400 cc/min Operator: DH
S/N of O_2 Analyzer used to monitor train outlet: 3

CF-023

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job USX — Operators DH & C.M — Pitot No. V21-6 — Cp .84
Source #7 Waste Gas Stack — Meter Box No. 3 — ΔH 1.89 IN WC — Bar. Press. 28.50 inHg — H2O % x
Date 1/25/90 — Test 1 — Run 1 — Cmeter coeff. .9942 — Nozzle No. B3 — Nozzle Dia .302 IN.

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dec. Vol. (cf)	VAC. inHg	Temperatures (°F) Stack	Probe	Oven	Impg.	Gas/In	Gas/Out	Oxygen (x v/v)
	10 40	720.8											
A 6	2.5	723.04	.34	2.51	3.02	8	102	243	256	40	79	79	
5	5	725.17	.31	2.32	5.18	8	102				88	85	16.3
4	7.5	727.46	.34	2.58	7.47	8	102				90	84	18.7
3	10	729.82	.36	2.74	9.83	8	102				91	86	16.4
2	12.5	732.16	.35	2.66	2.16	9	103				91	87	16.6
1	15	734.48	.35	2.67	4.49	9	103				90	86	16.8
B 6	17.5	736.83	.34	2.59	6.79	9	103	249	258	38	90	88	16.9
5	20	739.12	.35	2.67	9.12	9	103				89	87	17.0
4	22.5	741.44	.34	2.59	1.41	9	103				88	86	17.6
3	25	743.83	.37	2.81	3.8	11	103				90	88	17.7
2	27.5	746.28	.40	3.05	6.30	12	103				89	87	17.4
1	30	748.62	.35	2.66	8.62	9	103				89	86	17.0
C 6	32.5	751.03	.37	2.81	1.01	9	104	258	255	37	90	88	16.8
5	35	753.33	.36	2.74	3.38	9	104				88	86	16.5
4	37.5	755.85	.41	3.10	5.89	13	104				89	88	16.6
3	40	758.55	.47	3.57	8.58	14	105				88	86	16.6
2	42.5	761.20	.47	3.56	1.27	14	103				85	84	16.7
1	45	763.82	.43	3.25	3.83	14	103				85	83	16.6
D 6	47.5	766.38	.37	2.79	6.21	11	103				84	81	16.6
5	50	768.66	.37	2.79	8.57	11	103	254	256	33	83	81	16.8
4	52.5	771.05	.42	3.16	1.09	13	103				83	81	16.7
3	55	773.72	.47	3.53	3.76	14	103				84	82	16.6
2	57.5	776.26	.43	3.24	6.31	14	103				84	82	16.8
1	60	778.85	.44	3.31	8.89		103				84	82	16.5
	(11 18)												
	θ = 60	Vm = 58.05		ΔH 2.90							Avg. = 85.9		

C-3

S-0037R

INTERPOLL LABORATORIES EPA METHOD 5/17 SAMPLE LOG SHEET

Job USX Minntac
Source #7 Waste Gas Stack
Method 5-6 Filter holder: 5.5

Date 1/25/90 Test 1 Run 2
No. of traverse points 24
Filter type: glass fiber

Sample Train Leak Check:

Pretest: < 0.02 cfm at 15 in. Hg. (vac) ☒
Postest: 0 cfm at 8 in. Hg. (vac) ☒

Particulate Catch Data:

No.s of filters used: 1838

Recovery solvent(s)
☒ acetone
☐ other(s)

No. of probe wash bottles: 1
Sample recovered by: [illegible]

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impinger No. 1			
Impinger No. 2	248	200	48
Impinger No. 3			
Condenser			
Desiccant	1447	1439	8
Total			56

Integrated Gas Sampling Data:

Bag Pump No. B8 Box No. 12 Bag No. 2

Bag Material: 5-layer Aluminized Tedlar Size: 44 L

Pretest leak check: 0 cc/min at 15 in. Hg.

Time start: 1145 (HRS) Time end: 1245 (HRS)

Sampling rate: 400 cc/min Operator: [illegible]

S/N of O_2 Analyzer used to monitor train outlet: 3

CF-023

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job U.S.X
Source #1 Waste Recovery Stack
Date 1/25/90 Test 1 Run 2

Operators DM & C.M
Meter Box No. 3 ΔH 1.87 IN WC
Counter coeff. .9942

Pitot No. U21-6 Cp .84
Bar. Press. 28.50 inHg H2O 7 x
Nozzle No. S-4 Nozzle Dia .252 IN.

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dec. Vol. (cf)	VAC. inHg	Temperatures (°F) Stack	Probe	Oven	Impg.	Gas In	Gas Out	Oxygen (xx/v)
	11[40]	779.27											
D 6	2.5	780.80	.36	1.18	0.82	4	103	276	252	40	79	79	16.0
5	5	782.35	.37	1.19	2.37	4	103				81	79	16.3
4	7.5	784.00	.43	1.39	4.04	4.5	103				83	80	16.5
3	10	785.86	.51	1.65	5.87	5	103				84	80	16.8
2	12.5	787.61	.51	1.66	7.70	5	103				85	80	16.7
1	15	789.37	.43	141	9.38	4.5	103	273	258	37	85	80	16.6
C 6	17.5	790.99	.38	1.23	0.97	4	103				83	79	16.4
5	20	792.64	.44	1.43	2.66	4.5	103				83	80	16.6
4	22.5	794.35	.45	1.46	4.38	4.5	103				84	80	16.5
3	25	796.15	.48	1.56	6.16	5	103				86	82	16.6
2	27.5	797.89	.48	1.56	7.94	5	103				85	81	16.9
1	30	799.58	.42	1.37	9.60	4.3	103				82	79	16.7
B 6	32.5	801.09	.33	1.07	1.07	4	103	268	255	36	82	78	16.6
5	35	802.57	.35	1.03	2.59	4	103				84	80	16.9
4	37.5	804.10	.35	1.14	4.10	4	103				85	80	16.5
3	40	805.58	.34	1.10	5.60	4	103				86	81	16.3
2	42.5	807.12	.36	1.17	7.14	4	103				86	82	16.4
1	45	808.69	.38	1.24	8.73	4	103				86	82	16.5
A 6	47.5	810.20	.34	1.11	0.23	4	103				86	82	16.5
5	50	811.75	.36	1.17	1.78	4	103				86	82	16.6
4	52.5	813.27	.35	1.14	3.30	4	103	272	259	34	86	82	16.4
3	55	814.81	.35	1.14	4.83	4	103				86	83	16.5
2	57.5	816.40	.37	1.21	6.39	4	103				85	82	16.6
1	60	817.91	.35	1.14	7.91		103				85	82	16.5
	[1245]												
	θ = 60	Vm = 38.64		ΔH = 1.28							Avg. = 85.8		

C-5

S-

INTERPOLL LABORATORIES EPA METHOD 5/17 SAMPLE LOG SHEET

Job USX - MINNTAC Date 1/25/90 Test 1 Run 3
Source #7 Waste Gas Stack No. of traverse points 24
Method 5-6 Filter holder: 55 Filter type: glass fiber

Sample Train Leak Check:

Pretest: < 0.02 cfm at 15 in. Hg. (vac) [X]
Postest: 0 cfm at 8 in. Hg. (vac) [X]

Particulate Catch Data:

No.s of filters used: 1839

Recovery solvent(s)
[X] acetone
[ ] other(s)

No. of probe wash bottles: 1
Sample recovered by: DOL

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impinger No. 1			
Impinger No. 2	248	200	48
Impinger No. 3			
Condenser			
Desiccant	1368	1360	8
Total			56

Integrated Gas Sampling Data:

Bag Pump No. 38 Box No. 12 Bag No. 3
Bag Material: 5-layer Aluminized Tedlar Size: 44 L
Pretest leak check: 0 cc/min at 15 in. Hg.
Time start: 1308 (HRS) Time end: 1406 (HRS)
Sampling rate: 400 cc/min Operator: DOL
S/N of O_2 Analyzer used to monitor train outlet: 3

CF-023

CF-011

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job U.S.X — Operators JDH & C.M — Pitot No. V21-6 — Cp .84
Source #7 Waste Recovery Stack — Meter Box No. 3 — ΔH 1.89 IN WC — Bar. Press. 28.50 inHg — H2O 7 x
Date 4/25/90 — Test 1 — Run 3 — Coeaster coeff. .9942 — Nozzle No. S-4 — Nozzle Dia .252 IN.

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dec. Vol. (cf)	VAC. inHg	Temperatures (°F) Stack	Probe	Oven	Impg.	Gas/In	Gas/Out	Oxygen (v/v)
	1303	818.30											
A 6	2.5	819.82	.34	1.11	9.80	4	102				85	85	17.0
5	5	821.32	.34	1.11	1.31	4	102	254	259	50	86	84	16.8
4	7.5	822.87	.36	1.18	2.86	4	102				86	83	16.7
3	10	824.34	.35	1.14	4.38	4	102				85	82	16.7
2	12.5	825.86	.33	1.08	5.86	4	102				87	84	16.6
1	15	827.37	.32	1.05	7.33	4	102				89	85	16.5
B 6	17.5	828.88	.35	1.15	8.86	4	103				89	85	16.5
5	20	830.43	.36	1.18	0.41	4	103				91	87	16.6
4	22.5	831.97	.34	1.12	1.93	4	103	253	266	44	91	87	16.5
3	25	833.47	.32	1.05	3.40	4	103				91	87	16.6
2	27.5	834.97	.35	1.15	4.93	4	103				90	86	16.4
1	30	836.61	.39	1.28	6.55	5	103				90	86	16.3
C 6	32.5	838.19	.36	1.18	8.11	4	103				91	87	16.4
5	35	839.84	.41	1.35	9.77	4	103				91	86	16.4
4	37.5	841.50	.44	1.45	1.49	4.5	103				92	88	16.4
3	40	843.34	.51	1.68	3.35	5	103	257	258	41	92	88	16.6
2	42.5	845.20	.53	1.75	5.24	5	103				92	88	16.5
1	45	847.04	.48	1.58	7.05	5	103				91	87	16.8
D 6	47.5	848.66	.36	1.18	8.61	4	103				91	88	16.9
5	50	850.22	.40	1.32	0.25	4	103				93	90	16.7
4	52.5	851.91	.42	1.39	1.94	4.3	103				93	90	16.3
3	55	853.71	.50	1.65	3.78	5	103	256	257	43	94	90	16.4
2	57.5	855.63	.52	1.72	5.67	5	103				93	89	16.6
1	60	857.36	.44	1.45	7.39	4.5	103				92	88	16.9
	1408												
	θ = 60	Vs = 39.06		ΔH = 1.73							Avg. = 88.4		

C-7

S-0037R

APPENDIX D

LABORATORY DATA SHEETS

Interpoll Laboratories
(612) 786-6020

Chain of Custody
Sample Deposition Sheet

Job U.S.X
Team Leader [illegible]
Date Submitted 1/25/90
Test No. 1

Source #7 Waste Recovery Stack
Test Site Stack
Date of Test 1/25/90
No. of Runs Completed 3

No. of Samples	Type of Sample	Analysis Required	Comments
4 3	Probe Wash: ☒ Acetone ☐ D.I. Water	☒ As per EPA M-5 ☐ Other	1 Blank Sulfate Analysis
4	Filter: ☒ 4" G.F. ☐ S.S. Thimble ☐ 2.5" G.F. ☐ 47 mm G.F.	☒ As per EPA M-5 ☐ As per EPA M-17 ☐ Other	See proposal or Perry
4	Impinger Catch: ☐ D.I. Water ☒ 3% H_2O_2 ☐ 4M5 Hg Only ☐ 4M5 Metals ☐ 1.0 N NaOH ☐ Other	☐ MN Protocol ☐ WI Protocol ☒ EPA M-6 or 8 ☐ Acid Gases ☐ Formaldehyde ☐ Metals ☐ Other	
3	Integrated Gas sample	☒ As per EPA M-3 ☐ As per EPA M-10 ☐ Other	
	Oxides of Nitrogen (NO_x)	☐ As per EPA M-7A ☐ Other	Date Time(HRS)
	☐ Fuel Sample ☐ Aggregate	☐ Attached fuel Form #S-0163RRR	
	Particle Size	☐ X-Ray Sedigraph ☐ Bahco Method ☐ Other	
	Audit Samples ☐ Sulfur Dioxide ☐ Oxides of Nit. ☐ Other	☐ As per EPA M-6 ☐ As per EPA M-7A ☐ Other	

Source Information

1) Type of Source: ☐ Boiler ☐ Asphalt Plant ☐ Incinerator ☐ Dryer ☒ Other
2) Fuel: ☒ Coal ☐ Wood ☐ Gas ☐ Oil ☐ RDF ☐ Other
3) Is sample combustible? ☒ No ☐ Yes
4) Does sample need special handling? ☒ No ☐ Yes If yes, explain

S-278RRRR

Interpoll Laboratories
(612) 786-6020

EPA Method 3 Data Reporting Sheet
Orsat Analysis

Job USX
Team Leader DVT
Date Submitted 1-26-90
Test No. 1
Date of Analysis 1-26-90

Source #7 Waste Recovery
Test Site Stack
Date of Test 1-25-90
No. of Runs Completed 3
Technician RE

Test/Run	Sample Log Number and Type	No. of An.	Buret Readings (ml) Zero Pt.	After CO_2	After O_2	Conc. CO_2 %v/v Dry	Conc. O_2 %v/v Dry	F_o
1/1	8948-07	1	0.00	3.60	20.70	3.60	17.10	1.055
		2	0.00	3.60	20.70	3.60	17.10	1.055
	☑ B ☐ F	Avg				3.60	17.10	
1/2	8948-11	1	0.00	3.70	20.70	3.70	17.00	1.054
		2	0.00	3.70	20.70	3.70	17.00	1.054
	☑ B ☐ F	Avg				3.70	17.00	
1/3	8948-15	1	0.00	4.00	20.80	4.00	16.80	1.025
		2	0.00	4.00	20.80	4.00	16.80	1.025
	☑ B ☐ F	Avg				4.00	16.80	
		1						
		2						
	☐ B ☐ F	Avg						
		1						
		2						
	☐ B ☐ F	Avg						
		1						
		2						
	☐ B ☐ F	Avg						
		1						
		2						
	☐ B ☐ F	Avg						
		1						
		2						
	☐ B ☐ F	Avg						
		1						
		2						
	☐ B ☐ F	Avg						

☑ Ambient Air QA Check
☑ Orsat Analyzer System Leak Check
☐ F_o Within EPA M-3 Guidelines for fuel type.

Where $F_o = \frac{20.9 - O_2}{CO_2}$

EPA Method 3 Guidelines

Fuel Type	F0 Range
Coal:	
Anthracite/Lignite	1.016-1.130
Bituminous	1.083-1.230
Oil:	
Distillate	1.260-1.413
Residual	1.210-1.370
Gas:	
Natural	1.600-1.836
Propane	1.434-1.586
Butane	1.405-1.553
Wood/Wood Bark	1.000-1.130

F=Flask (250 cc all glass)
B=Tedlar Bag (5-layer)

LSC-04-BR

Interpoll Laboratories
(612) 786-6020

EPA Method 5 Data Reporting Sheet
Probe/Cyclone Wash

Job USX
Team Leader DVH
Date Submitted 1-26-90
Test No. 1
Date of Analysis 1-26-90
Transport Leakage ☑ None ☐ _____ ml

Source #7 Waste Recovery
Test Site Stack
Date of Test 1-25-90
No. of Runs Completed 3
Technician RE
Solvent acetone

0	Test 1 Run 0 Field Blank Log Number 8948-01 Vol. of Solvent 100 ml *Solvent Residue 2.0 ug/ml	Dish No. 100 Dish Tare Wt. 45.9678 g Dish+Sample Wt. 45.9680 g Sample Wt. 0.0002 g
1	Test 1 Run 1 Vol. of Solvent 120 ml Log Number 8948-04 Comments	Dish No. 101 Dish Tare Wt. 44.7949 g Dish+Sample Wt. 44.8210 g Sample Wt. 0.0261 g
2	Test 1 Run 2 Vol. of Solvent 90 ml Log Number 8948-08 Comments	Dish No. 102 Dish Tare Wt. 44.3236 g Dish+Sample Wt. 44.3340 g Sample Wt. 0.0104 g
3	Test 1 Run 3 Vol. of Solvent 95 ml Log Number 8948-12 Comments	Dish No. 105 Dish Tare Wt. 47.8621 g Dish+Sample Wt. 47.8772 g Sample Wt. 0.0151 g
4	Test _____ Run _____ Vol. of Solvent _____ ml Log Number _____ Comments	Dish No. _____ Dish Tare Wt. _____ g Dish+Sample Wt. _____ g Sample Wt. _____ g
5	Test _____ Run _____ Vol. of Solvent _____ ml Log Number _____ Comments	Dish No. _____ Dish Tare Wt. _____ g Dish+Sample Wt. _____ g Sample Wt. _____ g

*Solvent Residue 2.0 ug/ml = [(Sample Wt. _____ g)(10⁶)]/Vol. of Sol. _____ ml
EPA-M5 Acetone Residue Blank Spec. ≤ 7.8 ug/ml

Results:

Field Blk.	Run 1	Run 2	Run 3	Run 4	Run 5
	0.0259	0.0102 D-3	0.0149		

LSC-01YR

Interpoll Laboratories
(612) 786-6020

EPA Method 5 Data Reporting Sheet
Filter Gravimetrics

Job USX
Team Leader DVH
Date Submitted 1-26-90
Test No. 1
Date of Analysis 1-26-90

Source #7 Waste Recovery
Test Site Stack
Date of Test 1-25-90
No. of Runs Completed 3
Technician RE

0	Test 1 Run 0 Field Blank Log Number 8948-02 Comments	Filter No. 1804 Filter Type 4" GF Filter Tare Wt. .9401 g Filter+Sample Wt. .9402 g Sample Wt. .0001 g
1	Test 1 Run 1 Log Number 8948-05 Comments	Filter No. 1802 Filter Type 4" GF Filter Tare Wt. .9452 g Filter+Sample Wt. .9824 g Sample Wt. 0.0372 g
2	Test 1 Run 2 Log Number 8948-09 Comments	Filter No. 1838 Filter Type 4" GF Filter Tare Wt. .9565 g Filter+Sample Wt. .9841 g Sample Wt. 0.0276 g
3	Test 1 Run 3 Log Number 8948-13 Comments	Filter No. 1839 Filter Type 4" GF Filter Tare Wt. .9584 g Filter+Sample Wt. .9866 g Sample Wt. 0.0282 g
4	Test ____ Run ____ Log Number ____ Comments	Filter No. ____ Filter Type ____ Filter Tare Wt. ____ g Filter+Sample Wt. ____ g Sample Wt. ____ g
5	Test ____ Run ____ Log Number ____ Comments	Filter No. ____ Filter Type ____ Filter Tare Wt. ____ g Filter+Sample Wt. ____ g Sample Wt. ____ g

Results:

Field Blk.	Run 1	Run 2	Run 3	Run 4	Run 5
	0.0372	0.0276	0.0282		

Field Blk.	Run 1	Run 2	Run 3	Run 4	Run 5
	0.0631	0.0378	0.0431		

LSC-02PR

Interpoll Laboratories
(612) 786-6020

EPA Method 6 Sulfur Dioxide Titration Data Sheet

Job: USX
Team Leader: DVH
Date Submitted: 1-26-90
Test No.: 1
Date of Analysis: 1-29-90

Source: #7 Waste Recovery
Test Site: Stack
Date of Test: 1-25-90
No. of Runs Completed: 3
Technician: RE

Test/Run	Sample Log Number	pH of Original Sample *	Final Vol. (V_{soln})	Dilution Factor (DF)	Aliquot Titrated (V_a)	No. of An.	Start Vol. Buret (ml)	Final Vol. Buret (ml)	Volume of Tit. (V_t) (ml)
Field Blank 1/0	8948-03	☑ pH<3.5 ☐ pH___	☑ 500 ml ☐ 250 ml ☐ 100 ml ☐ ___ml	☑ 1 DF ☐ 10 DF ☐ 25 DF ☐ 50 DF ☐ ___DF	☐ 1 ml ☐ 5 ml ☐ 10 ml ☑ 20 ml ☐ ___ml	1	3.85	4.00	.15
						2	4.00	4.15	.15
						Avg			.15 V_b
1/1	8948-06	☑ pH<3.5 ☐ pH___	☑ 500 ml ☐ 250 ml ☐ 100 ml ☐ ___ml	☑ 1 DF ☐ 10 DF ☐ 25 DF ☐ 50 DF ☐ ___DF	☐ 1 ml ☐ 5 ml ☐ 10 ml ☑ 20 ml ☐ ___ml	1	4.20	7.50	3.30
						2	7.50	10.60	3.31
						Avg			3.20
1/2	8948-10	☑ pH<3.5 ☐ pH___	☑ 500 ml ☐ 250 ml ☐ 100 ml ☐ ___ml	☑ 1 DF ☐ 10 DF ☐ 25 DF ☐ 50 DF ☐ ___DF	☐ 1 ml ☐ 5 ml ☐ 10 ml ☑ 20 ml ☐ ___ml	1	10.60	13.30	2.70
						2	13.30	15.90	2.60
						Avg			2.65
1/3	8948-14	☑ pH<3.5 ☐ pH___	☑ 500 ml ☐ 250 ml ☐ 100 ml ☐ ___ml	☑ 1 DF ☐ 10 DF ☐ 25 DF ☐ 50 DF ☐ ___DF	☐ 1 ml ☐ 5 ml ☐ 10 ml ☑ 20 ml ☐ ___ml	1	16.00	18.95	2.95
						2	19.00	21.75	2.75
						Avg			2.85
		☐ pH<3.5 ☐ pH___	☐ 500 ml ☐ 250 ml ☐ 100 ml ☐ ___ml	☐ 1 DF ☐ 10 DF ☐ 25 DF ☐ 50 DF ☐ ___DF	☐ 1 ml ☐ 5 ml ☐ 10 ml ☐ 20 ml ☐ ___ml	1			
						2			
						Avg			
		☐ pH<3.5 ☐ pH___	☐ 500 ml ☐ 250 ml ☐ 100 ml ☐ ___ml	☐ 1 DF ☐ 10 DF ☐ 25 DF ☐ 50 DF ☐ ___DF	☐ 1 ml ☐ 5 ml ☐ 10 ml ☐ 20 ml ☐ ___ml	1			
						2			
						Avg			
		☐ pH<3.5 ☐ pH___	☐ 500 ml ☐ 250 ml ☐ 100 ml ☐ ___ml	☐ 1 DF ☐ 10 DF ☐ 25 DF ☐ 50 DF ☐ ___DF	☐ 1 ml ☐ 5 ml ☐ 10 ml ☐ 20 ml ☐ ___ml	1			
						2			
						Avg			
		☐ pH<3.5 ☐ pH___	☐ 500 ml ☐ 250 ml ☐ 100 ml ☐ ___ml	☐ 1 DF ☐ 10 DF ☐ 25 DF ☐ 50 DF ☐ ___DF	☐ 1 ml ☐ 5 ml ☐ 10 ml ☐ 20 ml ☐ ___ml	1			
						2			
						Avg			
		☐ pH<3.5 ☐ pH___	☐ 500 ml ☐ 250 ml ☐ 100 ml ☐ ___ml	☐ 1 DF ☐ 10 DF ☐ 25 DF ☐ 50 DF ☐ ___DF	☐ 1 ml ☐ 5 ml ☐ 10 ml ☐ 20 ml ☐ ___ml	1			
						2			
						Avg			
		☐ pH<3.5 ☐ pH___	☐ 500 ml ☐ 250 ml ☐ 100 ml ☐ ___ml	☐ 1 DF ☐ 10 DF ☐ 25 DF ☐ 50 DF ☐ ___DF	☐ 1 ml ☐ 5 ml ☐ 10 ml ☐ 20 ml ☐ ___ml	1			
						2			
						Avg			

Normality of Titrant (N): .01003 N

Vol. Titrant for Field blank (V_b): 0.15 ml
Vol. Titrant for Method Blank: 0.15 ml

☐ Ion Exchange
☐ EPA Audit(s)
Audit No. ______
Audit No. ______

* If pH >3.5 Adjust with conc. perchloric acid to pH~2.0

S-421

APPENDIX E

RESULTS OF PARTICULATE CATCH SULFATE ANALYSES

Interpoll Laboratories, Inc.
(612)786-6020

Ion Chromatography Laboratory

DIONEX MODEL 40001 WITH ANION MICRO MEMBRANE SUPRESSION

Analyst: T.D.J. Date of Analysis: 2-19-90

Job: U.S.X. Source: No-7 Waste Recovery Site: Stack

Chromatography Conditions

Column		Flow Rate	Eluent	Flow Rate	Suppressor Acid
	AS3	ml/min	2.4 mM Na_2CO_3 & 3.0 mM $NaHCO_3$	10 ml/min	12.5 mM Sulfuric Acid
X	AS4A	2.0 ml/min	1.8 mM Na_2CO_3 & 1.7 mM $NaHCO_3$	ml/min	
	AS5	ml/min	100 mM NaOH	X	Isocratic
		ml/min			Gradient(List program below)

Gradient Program	Time (Min.)									
Eluent	0.0									
% A										
% B										

Results of Sulfate Determination

Sample Name	Interpoll Log Number	Tot. Sample Volume (ml)	Dilution	Solution Conc.(ug/ml)	Total ug Sulfate	meq of Sulfate
Field Blank T_1R_0	8948-16	100	1	0.507	50.7	0.00106
T_1R_1	-17	100	1	404	4.04×10^4	0.842
T_1R_2	-18	100	1	161	1.61×10^4	0.335
T_1R_3	-19	100	1	201	2.01×10^4	0.419

Total ug = (Sample Vol.) x (Dilution) x (Solution Conc.)
meq = Total ug / 48000

LSC-08RR

APPENDIX F

PROCESS DATA

Minntac Agglomerator Operating Data Summary
Interpoll Testing - January 25, 1990

		Fuel Rates*		Solid rates**		Moisture	Scrubber
Run	Time	Gas Std. MCF/hr	Coal lbs./hr	Feed rate Green Ball LTPH	Bentonite Pounds/hr	Green Ball %	GPM
1	0955-1100	107	11,638	624 557	7678	9.1	2900
2	1132-1238	106	11,975	634 566	7692	9.2	2900
3	1253-1359	108	12,100	642 573	7800	9.2	2900

* Rates are based on hourly log readings. All gas used was used in the Preheat burners. The kiln burners were firing 100% coal/coke blend.

** The green ball feed rates are close to the highest ever acheived on a Step 3 line.

APPENDIX G

PROCEDURES

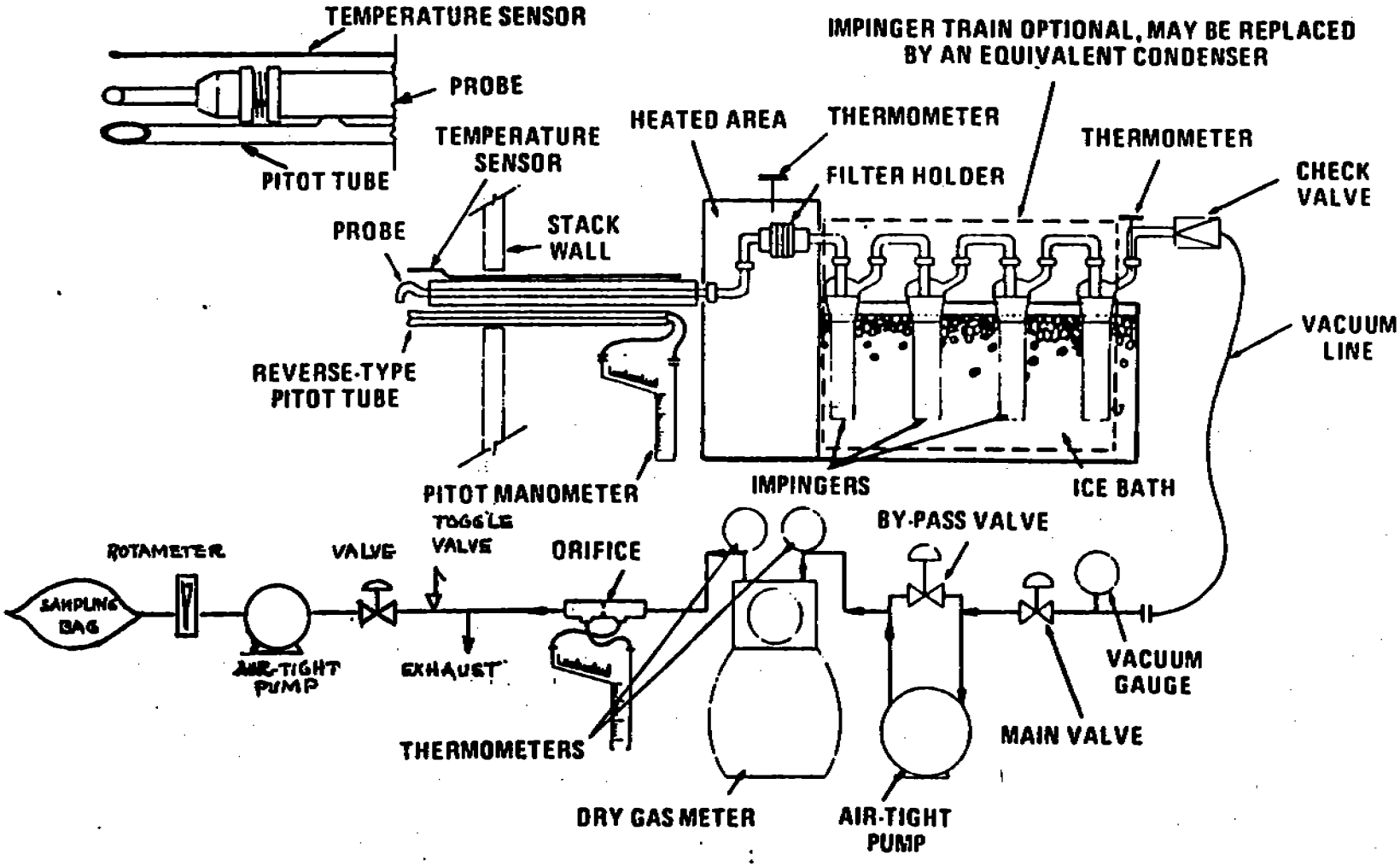
Particulate Loadings and Emission Rates

The particulate emission rates were determined per EPA Methods 1-5, CFR title 40, Part 60, Appendix A (revised July 1, 1988). In this procedure, a preliminary velocity profile of the gases in the flue is obtained by means of a temperature and velocity traverse. On the basis of these values, sampling nozzles of appropriate diameter are selected to allow isokinetic sampling, a necessary prerequisite for obtaining a representative sample.

The sampling train consists of a heated glass-lined sampling probe equipped with a Type S pitot and a thermocouple. The probe is attached to a sampling module which houses the all-glass in line filter holder in a temperature controlled oven. In addition, the sampling module also houses the impinger case and a Drierite drying column. The sampling module is connected by means of an umbilical cord to the control module which houses the dry test gasmeter, the calibrated orifice, a leakless pump, two inclined manometers, and all controls required for operating the sampling train.

Particulate samples were collected as follows: The sample gas was drawn in through the sampling probe isokinetically and passed through a 4-inch diameter Gelman Type A/E glass fiber filter. The particulates were removed at this point and collected on the filter. The gases then passed through an ice-cooled impinger train and a desiccant-packed drying column which quantitatively absorb all moisture from the sample gas stream after which the sample gas passes through the pump and the dry test gasmeter which integrates the sample gas flow throughout the course of the test. A calibrated orifice attached to the outlet of the gasmeter provides instantaneous flow rate data.

A representative particulate sample was acquired by sampling for equal periods of time at the centroid of a number of equal area regions in the duct. The sampling rate is adjusted at each site such that an isokinetic sampling condition prevails. Nomographs are used to aid in the rapid determination of the sampling rate.



Particulate-sampling train.

Sulfur Dioxide Emissions

The sulfur dioxide concentrations were determined per Method 6, CFR Title 40, Part 60, Appendix A (Revised July 1, 1987). In the procedure employed, the back half of the Method 5 sampling train was used to collect SO_2 samples during the particulate determinations. Each of the first two impingers was filled with 100 cc of freshly prepared 3% hydrogen peroxide. The samples were quantitatively recovered in the field and returned to the laboratory for sulfate analysis by a barium-thorin titration method.

APPENDIX H

CALCULATION EQUATIONS

CALCULATION EQUATIONS

METHOD 2

$$\bar{V}_s = 85.48\ C_p\ (\sqrt{\Delta p})_{avg}\ \sqrt{\frac{T_{s(avg)}}{P_s\ M_s}}$$

$$Q_{s,d} = 60(1 - B_{ws})\ \bar{V}_s\ A\ \left(\frac{528}{T_{s(avg)}}\right)\ \left(\frac{P_s}{29.92}\right)$$

$$Q_a = 60\ \bar{V}_s\ A$$

$$\dot{m}_g = \frac{4.995\ Q_{s,d}\ G_d}{1 - B_{ws}}$$

$$RH^* = 100\ (vp_{twb}\ 0.0003641\ P_s\ (T_{db} - T_{wb}))/vp_{tdb}$$

$$B^*_{ws} = RH(vp_{tdb})/P_s$$

$$= \frac{4.585 \times 10^{-2}\ P_s M_s}{T_{s\ (avg)}}$$

*Alternate equations for calculating moisture content from wet bulb and dry buld data.

CALCULATION EQUATIONS

METHOD 3

$$\%EA = \frac{100(\%O_2 -).5\%\ CO)}{0.264\%\ N_2 - \%O_2 + 0.5\%\ CO}$$

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

$$M_s = M_d\ (I - B_{ws}) + 0.18\ B_{ws}$$

$$B_{ws} = \frac{V_{w(std)}}{V_{w(std)} + V_{m(std)}}$$

CALCULATION EQUATIONS

METHOD 5

$$V_{m(std)} = 17.65\ V_m\ \gamma\ \left(\frac{P_{bar} + \overline{\Delta H}/13.6}{T_{m(avg)}}\right)$$

$$V_{w(std)} = 0.0472\ V_{Is}$$

$$B_{ws} = \frac{V_{w(std)}}{V_{w(std)} + V_{m(std)}}$$

$$I = 0.0944\ \left(\frac{T_{s(avg)}\ V_{m(std)}}{P_s\ V_s\ A_n\ \theta\ (1 - B_{ws})}\right)$$

$$C_s = \frac{15.43\ M_p}{V_{m(std)}}$$

$$C_a = \frac{272.3\ M_p\ P_s}{T_{s(avg)}\ (V_{w(std)} + V_{m(std)})}$$

$$(\dot{m}_p)_1 = 8.5714 \times 10^{-3}\ C_s\ Q_{s,d}$$

$$(\dot{m}_p)_2 = \frac{1.3228 \times 10^{-1}\ M_p\ A}{\theta\ A_n}$$

$$\dot{m}_p = \frac{(\dot{m}_p)_1 + (\dot{m}_p)_2}{2}$$

SYMBOLS

A = Cross sectional area of stack, SQ. FT.

A_n = Cross sectional area of nozzle, SQ. FT.

B_{ws} = Water vapor in gas stream, proportion by volume

C_p = Pitot tube coefficient, dimensionless

C_a = Concentration of particulate matter in stack gas, wet basis, GR/ACF

C_s = Concentration of particulate matter in stack gas, dry basis, corrected to standard conditions, GR/DSCF

EA = Excess air, percent by volume

γ = Dry test meter correction factor, dimensionless

G_d = Specific gravity (relative to air), dimensionless

I = Isokinetic variation, percent by volume

M_d = Molecular weight of stack gas, dry basis, g/g - mole.

$\dot{m}_g$ = Mass flow of wet flue gas, LB/HR

$\dot{m}_p$ = Particulate mass flow, LB/HR

M_s = Molecular weight of stack gas, wet basis, g/g, mole.

M_p = Total amount of particulate matter collected, g

P_{bar} = Atmospheric pressure, IN. HG. (uncompensated)

P_g = Stack static gas pressure, IN. WC.

P_s = Absolute pressure of stack gas, IN.HG.

P_{std} = Standard absolute pressure, 29.92 IN. HG.

A_a = Actual volumetric stack gas flow rate, ACFM

$Q_{s,d}$ = Dry volumetric stack gas flow rate corrected to standard conditions, DSCFM

RH = Relative humidity, %

T_{db} = Dry bulb temperature of stack gas, ^{o}F

T_{wb} = Wet bulb temperature of stack gas, ^{o}F

$T_{m(avg)}$ = Absolute average dry gas meter temperature, ^{o}R

$T_{s(avg)}$ = Absolute average stack temperature, ^{o}F

T_{std} = Standard absolute temperature, 528 ^{o}F (68 ^{o}F)

θ = Total sampling time, min.

V_{lc} = Total volume of liquid collected in impingers and silica gel, ml

V_m = Volume of gas sample as measured by dry gas meter, CF

$V_{m(std)}$ = Volume of gas sample measured by the dry gas meter corrected to standard conditions, DSCF

$V_{w(std)}$ = Volume of water vapor in the gas sample corrected to standard conditions, SCF

$\overline{V}_s$ = Average actual stack gas velocity, FT/SEC

vp_{tdb} = Vapor pressure at T_{db}, IN. HG.

vP_{twb} = Vapor pressure at T_{wb}, IN. HG

$\overline{\Delta H}$ = Average pressure differential across the orifice meter, IN. WC.

ΔP = Velocity pressure of stack gas, IN. WC.

γ = Dry test meter correction coefficient, dimensionless

ρ = Actual gas density, LB/ACF

CALCULATION EQUATIONS

METHOD 6

$$V_{std} = 17.64 \frac{V_m P_{b\gamma}}{T_m} \quad \text{(MIDGET IMPINGER VERSION)}$$

$$V_{std} = \frac{17.64\ V_m\ (P_b + \frac{\overline{\Delta H}}{13.6})\gamma}{T_m} \quad \text{(LARGE IMPINGER VERSION)}$$

$$MEQ = (V_t - V_{tb})\ N\ (\frac{V_{soln}}{V_a})\ DF$$

$$C_s = \frac{7.06 \times 10^{-5}\ MEQ}{V_{std}}$$

$$E = \frac{20.90\ C_s F_d}{20.90 - \overline{B}'_{O_2}} = \frac{F_c C_s}{\overline{B}'_{CO_2}}$$

$$C_s\ (MG/DSCM) = 1.60186 \times 10^7\ C_s$$

$$C_s\ (GR/DSCF) = 7000\ C_s$$

$$C_s\ (ppm,\ dry) = 6.02119 \times 10^6\ C_s$$

$$C_s\ (ppm,\ wet) = 6.02119 \times 10^6\ C_s\ (1 - \frac{MC}{100})$$

SYMBOLS

$\overline{B'}_{O_2}$	=	Average oxygen content in flue gas, % v/v, dry
$\overline{B'}_{CO_2}$	=	Average carbon dioxide content in flue gas, % v/v, dry
C_s	=	Concentration of sulfur dioxide in flue gas, dry basis, corrected to standard conditions, LB/DSCF
C_s (GR/DSCF)	=	Concentration of sulfur dioxide in flue gas, dry basis, corrected to standard conditions, GR/DSCF
C_s (MG/DSCM)	=	Concentration of sulfur dioxide in flue gas, dry basis, corrected to standard conditions, MG/DSCM
DF	=	Dilution Factor
E	=	Emission factor, LB of $SO_2/10^6$BTU
F_d	=	Dry oxygen F-Factor for given fuel type, DSCF/10^6BTU
F_c	=	Carbon dioxide F-Factor for given fuel type, DSCF/10^6BTU
ΔH	=	Average pressure drop across calibrated orifice, IN. W.C.
γ	=	Dry test meter correction factor, dimensionless
MC	=	Moisture content of flue gas, % v/v
MEQ	=	Total milliequivalents of SO_2 in gas sample
N	=	Normality of barium perchlorate titrant
P_b	=	Barometric pressure at the dry gas meter, IN. HG.

C_s (ppm-dry) = Concentration of sulfur dioxide in flue gas, dry basis, (v/v), ppm

C_s (ppm-wet) = Concentration of sulfur dioxide in flue gas, wet basis, (v/v), ppm

T_m = Absolute average dry gas meter temperature, ^{o}R

V_a = Volume of sample aliquot titrated, cc

V_m = Dry gas volume as measured by the dry gas meter, DCF

V_{std} = Dry gas volume as measured by the dry gas meter, corrected to standard conditions (at 68 ^{o}F and 1 atmosphere), DSCF

V_{soln} = Total volume of the solution in which the sulfur dioxide sample is contained, cc

V_t = Volume of barium perchlorate titrant used for the sample, cc (average of replicate titrations)

V_{tb} = Volume of barium perchlorate titrant used for the blank, cc

Source category: Taconite ore processing
Plant name : USS Minnesota
Test date : January 25, 1990
Process : Grate kiln

Date: 10/24/96
Location: Mountain Iron, MN
Ref. No.: 26
Basis for process rate : production

Source	Type of control	Pollutant	Run No.	Emission rate, lb/hr	Process rate, ton/hr	Emission factor kg/Mg	Emission factor lb/ton	Volumetric flow rate, DSCFM	Concen %
Waste gas (coke/coal fired) grate/kiln	Wet scrubber	filt. PM	1	57.66	468.00	0.062	0.12		
		filt. PM	2	52.97	475.50	0.056	0.11		
		filt. PM	3	60.06	481.50	0.062	0.12		
				AVERAGE		0.060	0.12	RATING:	
		SO2	1	22.39	468.00	0.024	0.048		
		SO2	2	28.14	475.50	0.030	0.059		
		SO2	3	30.22	481.50	0.031	0.063		
				AVERAGE		0.028	0.057	RATING:	
		CO2	1	91425	468.00	98	195	369,986	3.60
		CO2	2	95527	475.50	100	201	376,138	3.70
		CO2	3	103328	481.50	107	215	376,339	4.00
				AVERAGE		102	204	RATING:	

Notes: Furnace production rates estimated as 75% of feed rates, based on information provided by MPCA (Reference 53)