Background Report Reference

AP-42 Section Number:	11.23
Background Chapter:	4
Reference Number:	39
Title:	Results of the August 20,1985 Particulate and SO2 Emissio Test on the No. 1 Machine Wind Box and Hood Exhaust No. 3 Scrubber Stack at the Hibbing Taconite Company plant

Interpoll, Inc.

Interpoll, Inc.

August 1985

RSF Re 4-39

AP-42 Section 11.23
Reference —
Report Sect. 4
Reference 39

Interpoll Inc.
4500 Ball Road N.E.
Circle Pines, Minnesota 55014

Telephone (612) 786-6020

RESULTS OF THE AUGUST 20, 1985, PARTICULATE AND SO_2 EMISSION TEST ON THE NO. 1 MACHINE WIND BOX AND HOOD EXHAUST NO. 3 SCRUBBER STACK AT THE HIBBING TACONITE COMPANY PLANT

Submitted to:

HIBBING TACONITE COMPANY
P. O. Box 589
Hibbing, Minnesota 55754

Atention: Bob Ives

Approved by:

Perry Lonnes, Ph.D.
President

Report Number 5-2066
August 30, 1985

TACON 3

Source category: Taconite ore processing
Plant name : Hibbing Taconite Co.
Test date : August 20, 1985
Process : Traveling grate

Date:
Location:
Ref. No.:

Basis for process rate :

Source	Type of control	Pollutant	Run No.	Emission rate, lb/hr	Process rate, ton/hr	Emission factor	
						kg/Mg	lb/ton
Traveling grate (petroleum coke and natural gas fired) Line 1 Stack 3	Multi-cyclone and wet venturi scrubber	filt. PM	1	24.97		ERR	ERR
		AVERAGE					
		SO2	1	119.80		ERR	ERR
		AVERAGE				ERR	ERR
		CO2	1	7227.0		ERR	ERR
		AVERAGE				ERR	ERR

No process data provided.

Traveling grate assumed from TACON 1

4/28

- Delete TACON 3

- NO PROCESS DATA
- ONLY 1 RUN

Interpoll Inc.
4500 Ball Road N.E.
Circle Pines, Minnesota 55014

Telephone (612) 786-6020

TACON 3
4/23

DELETE
- NO PROCESS DATA
- ONLY 1 RUN

RESULTS OF THE AUGUST 20, 1985, PARTICULATE AND SO_2 EMISSION TEST ON THE NO. 1 MACHINE WIND BOX AND HOOD EXHAUST NO. 3 SCRUBBER STACK AT THE HIBBING TACONITE COMPANY PLANT

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TABLE OF CONTENTS

APPENDICES:

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 (^{o}F)	degrees Fahrenheit
DIA.	diameter
FT/SEC	feet per second
GPM	gallons per minute
GR/ACF	grains per actual cubic foot
GR/DSCF	grains per dry standard cubic foot
g	gram
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
MW	megawatt
mg/DSCM	milligrams per dry standard cubic meter
microns (μm)	micrometer
MIN.	minutes
ohm-cm	ohm-centimeter
PPH	pounds per hour
PPM	parts per million
PSI	pounds per square inch
SQ. FT.	square feet
v/v	percent by volume
w/w	percent by weight

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

1 INTRODUCTION

On August 20, 1985, Interpoll Inc. personnel conducted a particulate and SO_2 emission test on the No. 1 Machine Wind Box and Hood Exhaust No. 3 Scrubber at the Hibbing Taconite Company Plant located in Hibbing, Minnesota. On-site testing was performed by a two-man team under the direction of Dr. P. Lonnes. Coordination between plant operation and testing activities was provided by Steve Rogers and other plant personnel of the Hibbing Taconite Company.

Evaluations were performed in accordance with EPA Methods 1-6, CFR Title 40, Part 60, Appendix A (revised July 1, 1984). Previously collected data was used to select the appropriate nozzle diameter required for isokinetic sample withdrawal. An Interpoll sampling train which meets or exceeds specifications in the above-cited reference was used to collect the samples by means of a heated stainless steel-lined probe. Sulfur dioxide determinations were performed in accordance with the large impinger version of EPA Method 6 using the back half of the Method 5 sampling train.

An integrated flue gas sample was extracted simultaneously with each particulate sample using a specially designed gas sampling system. Integrated flue gas samples were collected in 44-liter Tedlar bags. After sampling was complete, the bags were sealed and returned to the laboratory for Orsat analysis.

Testing on the No. 3 Machine Wind Box and Hood Exhaust No. 4 Scrubber was conducted from two test ports oriented at 90 degrees approximately 76 feet downstream of a transition breeching and 14 feet upstream of the stack outlet. A 12-point traverse was used to collect representative flyash samples from the scrubber stack. Each traverse point was sampled five minutes to give a total sampling time of 60 minutes per run.

The important results of the tests are summarized in Section 2. Detailed results are presented in Section 3. Results of preliminary measurements, field data and all other supporting information are presented in the appendices.

2 SUMMARY AND DISCUSSION

The important results of the particulate emission test is summarized in Table 1. As will be noted, only one particulate concentration determination was performed due to plant difficulties. The results of the sulfur dioxide test is summarized in Table 2.

No difficulties were encountered in the field or in the laboratory evaluation of the flue gas, particulate and sulfur dioxide samples. On the basis of this fact and a complete review of the entire data and results, it is our opinion that the emission rates and emission factors reported herein are accurate and closely reflect the actual values which existed at the time the tests were performed.

TABLE 1. SUMMARY OF THE RESULTS OF THE 8-20-85 PARTICULATE EMISSION TEST ON THE LINE 1 NO. 3 SCRUBBER STACK AT THE HIBBING TACONITE COMPANY LOCATED IN HIBBING, MINNESOTA

ITEM	RUN 1
DATE OF TEST	8-20-85
TIME OF TEST (HRS)	1535/1640
PROCESS RATE *	--------
VOLUMETRIC FLOW	
ACTUAL (ACFM)	160000
STANDARD (DSCFM)	132000
GAS TEMPERATURE (DEG-F)	109
GAS MOISTURE CONTENT (% V/V)	7.28
GAS COMPOSITION (% V/V, DRY)	
CARBON DIOXIDE	.80
OXYGEN	19.60
NITROGEN	79.60
ISOKINETIC VARIATION (%)	100.5
PARTICULATE CONCENTRATION	
ACTUAL (GR/ACF)	.018
STANDARD (GR/DSCF)	.022
PARTICULATE EMISSION RATE (LB/HR)	24.97

*Not provided by time of report preparation.

TABLE 2. SUMMARY OF THE RESULTS OF THE AUGUST 20, 1985 SULFUR DIOXIDE EMISSION TEST ON THE LINE 1 NO. 3 SCRUBBER STACK AT THE HIBBING TACONITE COMPANY LOCATED IN HIBBING, MINNESOTA

ITEM	RUN 1
TIME OF TEST (HRS)	1535-1640
SO2 CONCENTRATION	
(PPM/DRY)	91
(PPM/WET)	84
SO2 MASS RATE (LB/HR)	120
SO2 EMISSION FACTOR (LB/MMBTU)*	
F-FACTOR METHOD	2.31

*Emission factor calculated based on an estimated F-Factor = 9499 DSCF/10^6BTU

3 RESULTS

The results of all field and laboratory evaluations are presented in this section. Gas composition results (Orsat and moisture) are presented first followed by the computer printout of the particulate and sulfur dioxide emission determinations. Preliminary measurements including test port locations are given in the appendices.

The results have been calculated on an IBM PC 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 (as recommended by the EPA) rather than the ratio of areas method. The dry particulate emission factor has been calculated by the Oxygen F-Factor Method using the latest EPA-published dry F-Factor for the stated fuel.

TEST NO. 1
LINE 1 NO. 3 SCRUBBER STACK

3.1 RESULTS OF ORSAT & MOISTURE ANALYSES -- METHOD 3 & 4 (% V/V)

	RUN 1
DATE OF RUN	8-20-85
DRY BASIS (ORSAT)	
CARBON DIOXIDE	.80
OXYGEN	19.60
CARBON MONOXIDE	0
NITROGEN	79.60
WET BASIS (ORSAT)	
CARBON DIOXIDE	.74
OXYGEN	18.17
CARBON MONOXIDE	0
NITROGEN	73.81
MOISTURE CONTENT	7.28
DRY MOLECULAR WEIGHT	28.91
WET MOLECULAR WEIGHT	28.12
SPECIFIC GRAVITY (RELATIVE TO AIR)	.9713
VELOCITY WEIGHTED AND TIME-AVERAGED OXYGEN DURING METHOD 5 RUNS	19.27

FO	1.62

TEST NO. 1
LINE 1 NO. 3 SCRUBBER STACK

3.2 RESULTS OF PARTICULATE LOADING DETERMINATIONS -- METHOD 5

		RUN 1
DATE OF RUN		8-20-85
TIME RUN START/END(HRS)		1535/1640
PITOT TUBE COEFFICIENT		.840
WATER IN SAMPLE		
CONDENSATE	(ML)	50.6
SILICA GEL	(GRAMS)	25.0
TOTAL PARTICULATE MATERIAL COLLECTED	(GRAMS)	.0651
VM	(MCF)	47.16
Y		1.0094
PBAR	(IN.HG)	28.52
DELTA-H	(IN.WC)	2.11
TM	(DEG-F)	70.70
VMSTD	(DSCF)	45.37
TOTAL SAMPLING TIME	(MIN)	60.0
NOZZLE DIAMETER	(IN)	.251
AVG STACK GAS TEMP	(DEG=F)	109
VOLUMETRIC FLOW		
ACTUAL	(ACFM)	160494
DRY STANDARD ...	(DSCFM)	131610
ISOKINETIC VARIATION	(%)	100.5
PARTICLE CONCENTRATION*		
ACTUAL	(GR/ACF)	.0182
DRY STANDARD .	(GR/DSCF)	.0221
PARTICLE MASS FLOW	(LB/HR)	24.97

* DRY CATCH ONLY

TEST NO. 1
LINE 1 NO. 3 SCRUBBER STACK

3.3 RESULTS OF SULFUR DIOXIDE DETERMINATIONS -- METHOD 6

	RUN 1
DATE OF RUN	8/20/85
TIME RUN START/END (HRS)	1535/1640
BAROMETRIC PRESSURE (IN.HG.)	28.52
METER TEMPERATURE (DEG-F)	70.70
METER CORRECTION COEFFICIENT	1.0094
VOLUME THROUGH GAS METER	
AT METER CONDITIONS...(CF)	47.160
STANDARD CONDITIONS..(SCF)	45.372
TOTAL SAMPLING TIME (MIN)	60.0
MOISTURE CONTENT (%V/V)	7.28
OXYGEN CONTENT (%V/V DRY)	19.60
MILLIEQUIVALENTS OF SO4 IN GAS SAMPLE	9.7215
SULFUR DIOXIDE CONCENTRATION	
(GR/DSCF)	.1059
(MG/DSCM)	242
(PPM-DRY)	91
(PPM-WET)	84
DRY STANDARD VOLUMETRIC FLOW (DSCFM)	132000
SULFUR DIOXIDE MASS RATE (LB/HR)	119.80

APPENDIX A

SAMPLING TRAIN CALIBRATION DATA

Interpoll Inc.
(612)786-6020

Meter Box Calibration and Usage Status

Date of Report: August 20, 1985

Meter Box No.: 3

Date of Last Calibration: May 22, 1985
Calibration Technician: E. Trowbrridge
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.)
July 16, 1985	5-2040	659.17	824.46	165.29	165.29
July 30, 1985	5-2046	824.80	981.17	156.37	321.66
August 20, 1985	5-2066	981.64	1028.80	47.16	368.82

*Total volume through meter since last calibration

Interpoll Inc.
(612)786-6020

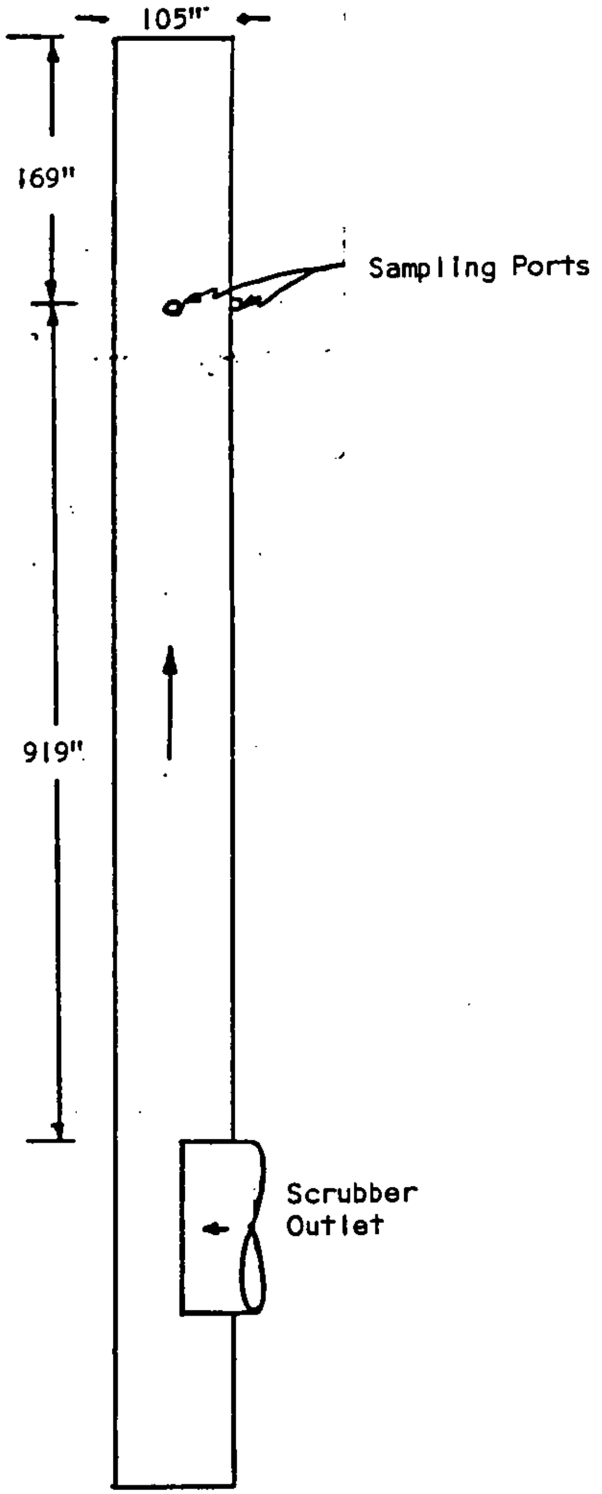
Nozzle Calibration Data Sheet

Date of Calibration: August 20, 1985 Nozzle Number 7-2
Technician: E. Trowbridge

Nozzle rotated by 36 degree increments and diameter measured to nearest 0.001 inch. Observed readings and average:

Position	Diameter (inches)
1	.250
2	.251
3	.251
Average:	.251

HOOD AND WINDBOX EXHAUST STACK



NOT TO SCALE

Preliminary Data — Method 2

— Interpoll Inc. —

Job HIBBING TACONITE LINE 1 No 3

Source SCRUBBER STACK **Date** 8-20-85

Test No. 1 **Run No.** 1

Stack dimensions: 105 in.

Dry bulb ____ °F **Wet bulb** ____ °F

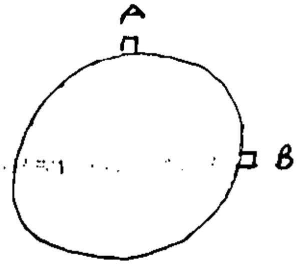
Rel. hum. ____ % B_{wo} 6-7 %

Barometric pressure (P_b) 28.52 in. Hg

Static pressure (P_g) -.19 in. WC ____ in. Hg

Operators R HOLTZ C MOSSER

Pitot No. EPA SPEC C_p .84 **Por Length** 6 3/8



Schematic of Stack Cross Section

(____)

Traverse Point No.	Distance from Stack wall	Distance from End of Port	Velocity Head (in. WC)	Temperature (°F)
A- 1	4.62	11.0		
2	15.33	21.7		
3	30.98	37.36		
4	73.92	80.3		
5	89.67	96.05		
6	100.38	106.76		
B - 1				
2				
3				
4				
5				
6				
25				avg. 107

S-0034R

Sample Log Sheet

Job Hibbing Taconite
Unit and Sampling Location No. 1 Machine (Induration Furnace) W&H Exhaust No. 3 Scrubber Stack
Date 8-20-85 **Test** 1 **Run** 1

Sample Train: Leak check pretest :< 0.02 cfm at 15 in. Hg. (vac.) ☒
posttest: 0 **cfm at** 9 **in. Hg. (vac.)**

Particulate Sample Type and Number	Weights		
	Final	Tare	Difference
FILTER No. 5572			
PW			
Total (Mn)	▨	▨	g

Impinger ☒ **Condenser** ☐

Impinger Number	Weights		
	Final	Tare	Difference
IMPINGERS	315.0	264.4	50.6
DESICCANT	1327	1302	25
Total (M_{wo})	▨	▨	75.6 g

Integrated Flue Gas Sampling Data

FG Train No. B-1 **Box No.** 2 **Bag No.** 1
Bag Material TEDLAR **Bag Volume** 44 **L**
Pretest leak check 0 **cc/min at 15 in. Hg.** **320-P No.** 7

Time	cc/min.	Time	cc/min.
(1535)	▨		
	400		
	↓		
(1640)			

Operator R Holtz **320-P Reading** ______ **% v/v**

PA od ld Sh

Job HIBBING TACONITE
Source NO. 1 MACHINE W&H EXHAUST NO. 3 SCRUBBER STACK
Date 8-20-85 Test 1 Run 1

Operators R HOLTZ C MOSSER
Sampling Train No. 3 ΔH@ 1.87
Gasmeter coeff. 1.0094 Amb. Temp. 58 °F

Pitot No. EPA SPEC C_p .84
Bar. Press. 28.52 in.Hg. B_{wo} 6 %
Nozzle No. 7-2 Nozzle Dia. .251 in.

Traverse Point No.	Sampling Time (min)	Sample Volume (ft3)	Velocity Head (in. WC)	Orifice Meter (in. WC)	ΔV (mcf)	Vac. (inHg)	1 Stack Temp (°F)	2 Probe Temp (°F)	3 Oven Temp (°F)	4 Oxygen (% v/v)	Gasmeter temp 5 IN (°F)	6 OUT (°F)
	(1535)	(981.64)										
A- 6	5	985.78	.62	2.39	4.14	5	105	240	255	19.2	60	60
5	10	989.86	.60	2.31	4.07	6	105			19.1	72	60
4	15	994.01	.61	2.36	4.14	6	110			19.1	76	62
3	20	998.06	.58	2.26	4.06	6	108			19.2	77	63
2	25	001.94	.52	2.04	3.86	6	107	240	245	19.2	78	63
1	30	005.76	.51	1.99	3.82	6	110			19.1	78	63
B- 6	35	9.44	.47	1.83	3.67	6	110			19.3	76	62
5	40	13.17	.48	1.87	3.70	6	109			19.4	79	64
4	45	17.04	.53	2.07	3.90	6	110			19.5	82	66
3	50	21.11	.57	2.24	4.06	6	109			19.4	85	66
2	55	25.19	.57	2.24	4.07	6	110			19.4	86	67
1	60	1028.80	.45	1.77	3.63	6	110			19.4	86	67
	(1640)											
	θ = 60	V_m = 47.16		$\overline{\Delta H}$ = 2.11							$\overline{t_m}$ =	70.7

— Interpoll Inc —

S-0037R

APPENDIX D

LABORATORY DATA SHEETS

1502

Interpoll Inc.
(612)786-6020

Pg ___ of ___

Chain of Custody
Sample Deposition Sheet

Job HIBBING TACONITE

Site LINE 1 No.3 SCRUBBER STACK

Team Leader R HOLTZ

Priority NORMAL

Date Submitted 8-22-85

Received by ___

Test No(s). 1

Number of Runs Completed 1

No. of Samples	Type of Sample	Analysis Required	Date Analyzed	Other Information or Special Instructions
1	Probe Wash Solvent(s):	☒ As per EPA 5 ☐ ___		
1	Filter: ☒ 4" glass fiber ☐ Stainless steel ☐ ERC	☒ As per EPA 5 ☐ ___		
3	Wet Catch	☐ Organic ☐ Inorganic ☒ SO_2 Other: ___		
1	Orsat	CO_2/O_2		
1	SO_2			
	NO_x			
	Fuel Sample			

Source Information

1) Type of source: ☐ Boiler ☐ Asphalt Plant ☐ Incinerator ☒ Other FURNACE
2) Fuel: ☐ Coal ☐ Wood ☒ Gas ☐ Oil ☒ Other COKE
3) Is sample combustible? ☐ No ☒ Yes
4) Does sample need special desiccating? ☒ No ☐ Yes If yes, explain ___
5) Is particle size analysis required ☒ No ☐ Yes If yes, how many run(s)? ___

run preference ___

S-278RR

INTERPOLL INC.
EPA Method 5 Probe (Cyclone) Wash
Gravimetric Analysis Laboratory Data Sheet
(CFR Title 40 Part 60 Appendix A)

Date of Analysis 8-26-85
Technician RCV

EPA-M5 Acetone R.B SPEC ≤ 7.8 μg/cc
Actual acetone residue blank 6.3 μg/c

---

①

interpoll

Job HIB TAC **Date** 8-20-85
City/State Log # 2502-01
Source LINE 1 NO 3 SCRUBBER
Test Site STACK
Sample type PW **Tech** RH
Remarks: **Test/Run** 1/1
of

Special Handling Required

Evaporating Dish No. 66
Volume of acetone 85 c
E. Dish Tare Wt. 84.2729 g
E. Dish + Sample Wt. 84.3250 g
Comments

---

②

interpoll

Job Date
City/State Log#
Source
Test Site
Sample type Tech
Remarks: Test/Run
of

Special Handling Required

Evaporating Dish No.
Volume of acetone cc
E. Dish Tare Wt. g
E. Dish + Sample Wt. g
Comments

---

③

interpoll

Job Date
City/State Log#
Source
Test Site
Sample type Tech
Remarks: Test/Run
of

Special Handling Required

Evaporating Dish No.
Volume of acetone cc
E. Dish Tare Wt. g
E. Dish + Sample Wt. g
Comments

RESULTS:

1/ 0.0516

2/

3/

L-0185/Y R

(EPA Method 5) Filter
Gravimetric Analysis Lab
Data Sheet
FR 42(160)

Date of Analysis 8-26-85
Technician RCV

---

①

interpoll

Job Hibbing Taconite **Date** 8-20-85
City/State ______ **Log#** 2502-02
Source Line 1 No 3 Scrubber
Test Site Stack
Sample type ______ **Tech** RH
Remarks: **Test/Run** 1/1
______ **of** ______

Special Handling Required ______

Filter No. 5572
Filter Type 4"G
Filter Tare Wt. 0.64924 g
Filter + Sample Wt. 0.66278 g
2
Comments ______

---

②

interpoll

Job ______ **Date** ______
City/State ______ **Log#** ______
Source ______
Test Site ______
Sample type ______ **Tech** ______
Remarks: **Test/Run** ______
______ **of** ______

Special Handling Required ______

Filter No. ______
Filter Type ______
Filter Tare Wt. ______ g
1
Filter + Sample Wt. ______ g
2
Comments ______

---

③

interpoll

Job ______ **Date** ______
City/State ______ **Log#** ______
Source ______
Test Site ______
Sample type ______ **Tech** ______
Remarks: **Test/Run** ______
______ **of** ______

Special Handling Required ______

Filter No. ______
Filter Type ______
Filter Tare Wt. ______ g
1
Filter + Sample Wt. ______ g
2
Comments ______

RESULTS:

1 0.01354	2	3
.0651		

D-3

INTERPOLL INC.

EPA Methods 6 & 8 Barium Perchlorate Titrant Standardization Sheet

Date of Standardization 8-26-85
Technician Rcv
Buret No. 5a2

The normality of the nominal .01 N barium titrant solution is verified by comparing it against a primary standard of 0.0100 N H_2SO_4 solution using Thorin I as the endpoint indicator.

1. Preparation of Primary Standard (.0100 N H_2SO_4)

   a. Quantitatively transfer the contents of one "Dilut-It" ampule (available from J. T. Baker Coom. No. 4699) to a clean 1 L volumetric flask and bring to volume with distilled water, and mix well by shaking and inverting. Solution is 0.100 N H_2SO_4 and is stable for one year or more if protected from evaporation.

   b. Using a 100 ml volumetric pipet, add 100.00 cc of 0.100 N H_2SO_4 solution to clean 1 L volumetric flask and bring to volume with distilled water and mix well be shaking and inverting. Transfer the contents to a standard reagent bottle and label as follows:

   .0100 N H_2SO_4
   Primary Standard

   Prepared on 7/03/85 by Rcv
   Prepared by dilution from "Dilut-It" ampule

2. Standardization of the Barium Perchlorate Titrant

   a. Pipet 25.00 cc of the 0.0100 N H_2SO_4 primary standard into each of the three clean 250 cc Erleymeyer flasks. Add 100 cc of checked absolute isopropanol to each flask 4,drops of Thorin I indicating solution and mix by swirling. Titrate these standards with the barium perchlorate titrant recording the starting and ending buret readings below.

   b. Prepare and titrate at least one blank in an identical manner (Pipet 25 ml of distilled water in place of the 0.0100 N H_2SO_4 standard). Record the results of this titration below also.

3. Standardization Data

   All buret readings should be read to the nearest 1/100 and an adequately long time period waited before reading to allow the liquid on the walls to flow down.

	Blank	1st Titr.	2nd Titr.	3rd Titr.
Initial reading (ml)	0.00	0.00	0.00	0.00
Final reading (ml)	0.02	25.20	25.20	25.20
Volume of titrant (ml)	V_b 0.02	V_1 25.20	V_2 25.20	V_3 25.20

4. Calculations

$$V_t = \frac{V_1 + V_2 + V_3}{3} = \frac{(25.20) + (25.20) + (25.20)}{3} = 25.20 \text{ ml}$$

$$N = \frac{0.25}{V_t - V_b} = \frac{0.25}{(25.20) - (.02)} = 0.00993 \text{ Normality}$$

L-214RRR

Job Name: Hibbing Taconite
Test/Run: 1/1

Interpoll Inc.
(612)786-6020

EPA Method 6
Barium/Thorin I Sulfate
Titration Data Sheet

Date of Analysis 8·26·85
Technician RW

Step 1 SAMPLE RECOVERY & PREPARATION

Original sample volume (______ Samp.+ Bottle)
- (65.5 Bottle) = ______ cc

pH of original sample 2.16 Ion exchanged: ☐ Yes ☑ No

Note 1: If pH >3.5 adjust with conc. perchloric acid to pH ~2.0

Note 2: If ion exchange is required, must use a 10 cc aliquot and wash this through with a 10 cc aliquot of distilled water. Add 80 cc of isopropyl alcohol and titrate.

SAMPLE IDENTIFICATION

interpoll

Job Hibbing Taconite **Date** 8-20-85
City/State ______ **Log #** 2502-04
Source Line 1 #3 Scrubber
Test Site Stack
Sample type ______ **Tech** RW
Remarks: **Test/Run** 1/1
____ **of** 1

Step 2 Orig. sample brought to volume (V_{soln}):
☐ 100 cc
☐ 250 cc
☑ 500 cc
☐ ___ cc

Step 3 Dilution procedure:
☑ No dilution (DF = 1)
☐ 10 → 100 (DF = 10)
☐ 10 → 250 (DF = 25)
☐ 5 → 250 (DF = 50)
☐ 1 → 250 (DF = 250)
☐ __ → ___ (DF = ___)

Step 4 Volume taken for titration (V_a):
☐ 1 cc
☐ 5 cc
☑ 10 cc
☐ 25 cc
☐ ___ cc

Step 5 TITRATION: Normality of titrant (N) 0.00993 Volume of titrant for blank (V_b) .02

	Trial 1	Trial 2	Trial 3	Average
Starting volume of buret	0.00 cc	19.60 cc	0.00 cc	
Final volume of buret	19.60 cc	39.20 cc	19.60 cc	
Volume of titrant for aliquot (V_s)	19.60 cc	19.60 cc	19.60 cc	19.60 cc

L-230R

EPA METHOD 3

LABORATORY REPORT

SUMMARY OF ORSAT DATA

Job: Hibbing Taconite
Sampling Location: Line 1 No 3 Scrubber Stack
Sampling Date: 8-20-85
Analysis Date: 8-20-85
Technician: Rcv

TEST NO. AND DATE	RUN NO.	RESULTS						
		INTEGRATED (BAG) Bay Box #2			GRAB (BULB)			O_2 ANALYZER
		% CO_2	% O_2	% CO	% CO_2	% O_2	% CO	% O_2
2502-03 8-20-85	1	0.80	19.60					

Form #L-200 R

Interpoll Inc.
(612)786-6020

EPA Method 3 Data Sheet (Orsat Analysis)

Technician Rcl
Orsat Analyzer No. 3
Job Hibbing Taconit
City/State ______ Fuel Type ______

Date of Analysis 8-20-85
Leak Check Performed ☑ YES ☐ NO
Source Line 1 No 3 Scrubber Stack
Test Site ______

Sample Identification		Test/Run	Analysis No.	Buret Readings (cc)			Concentration (% v/v,dry)		F_o
				Zero Point	After CO_2	After O_2	CO_2	O_2	
Ambient Air				0.00	0.00	20.90	0.00	20.90	
2502-03	F B ✓	1/1	1	0.00	0.80	20.40	0.80	19.60	1.62
			2	0.00	0.80	20.40	0.80	19.60	1.62
			3						
			AVG				0.80	19.60	
	F B		1						
			2						
			3						
			AVG						
	F B		1						
			2						
			3						
			AVG						

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

Note 1 Analyses performed as per CFR title 40, Part 60, Appendix A, Method 3; KOH for CO_2 and reduced methylene blue for O_2 absorption using a Burrell Orsat Analyzer with a 100 cc buret.

Note 2 Use PC-3 Program "ORSAT" Version 6-85.

L-0192R

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, 1984). 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.

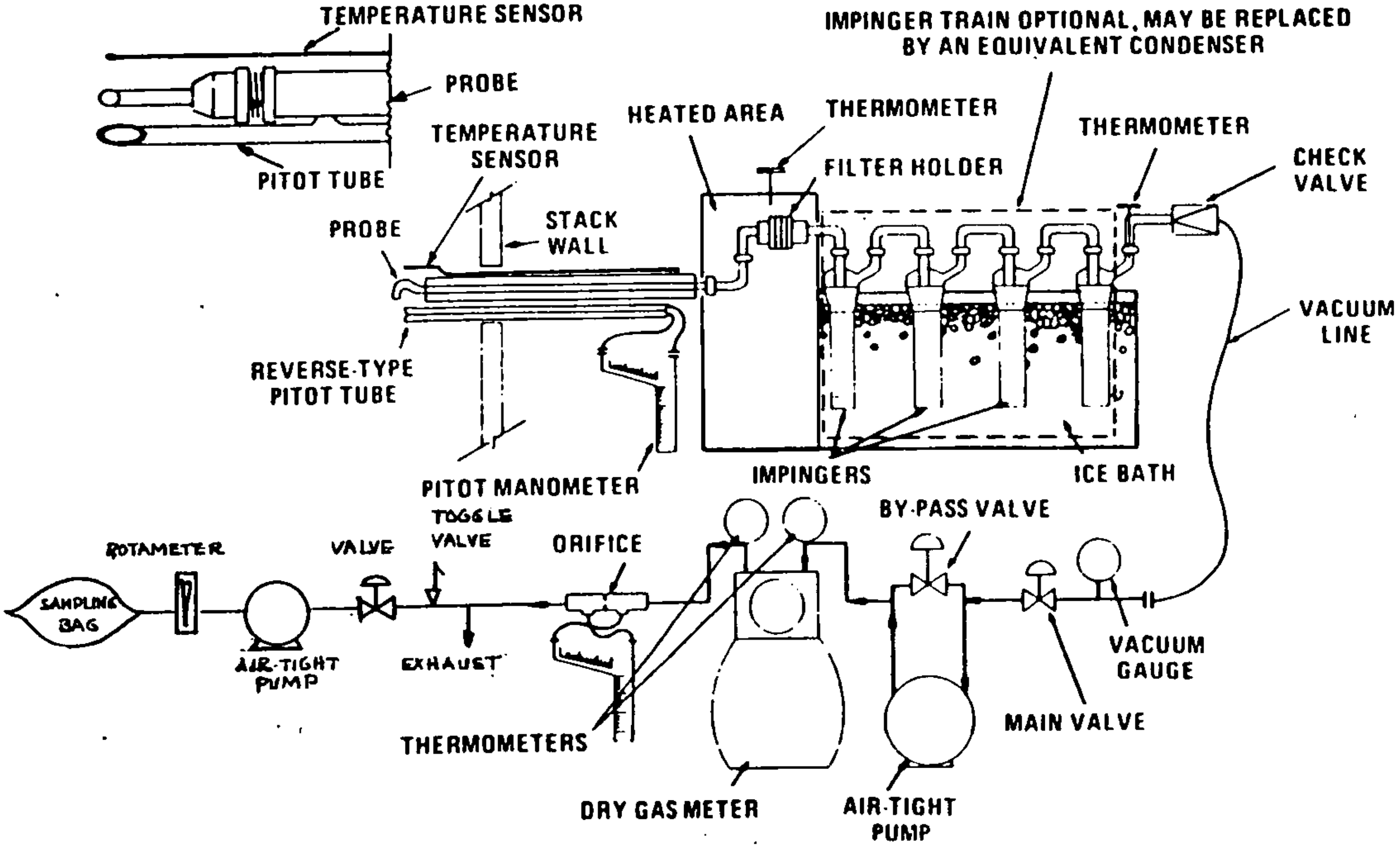
The sampling train consists of a heated stainless steel-lined sampling probe equipped with a Type S pitot and a thermocouple. The probe is attached to a sampling module which houses the all-glass in line filter holder in a temperature controlled oven. In addition, the sampling module also houses the 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.

After sampling is complete, the filter is removed and placed in a clean container. The nozzle and inlet side of the filter holder are quantitatively washed with acetone and the washings are stored in a second container. A brush is often used in the cleaning step to help dislodge deposits. The samples are returned to the laboratory where they are logged in and analyzed. The volume of the acetone rinse ("probe wash") is noted and then the rinse is quantitatively transferred to a tared 120 cc porcelain evaporating dish and the acetone evaporated off at 97-105 °F. This temperature is used to prevent condensation of atmospheric moisture due to the cooling effect induced by the evaporation of acetone. The acetone-free sample is then transferred to an oven and dried at 105 °C for 30 minutes, cooled in a desiccator over Drierite, and then weighed to the nearest .01 mg. The filter sample is quantitatively transferred to a 6-inch watch glass and dried in an oven at 105 °C for two hours. The filter and watch glass are then cooled in a desiccator and the filter weighed to the nearest .01 mg. All weighings are performed in a balance room where the relative humidity is hydrostatted to less than 50% relative humidity. Microscopic examination of the samples is performed if any unusual characteristics are observed. The weight of the acetone rinse is corrected for the acetone blank. The Drierite column is weighed on-site and the water collected by Drierite is added to the condensate so that the total amount of absorbed water may be ascertained.

Integrated gas samples for Orsat analysis were collected at a constant flow rate throughout each particulate run. The gas samples were analyzed using al all-glass Orsat analyzer. Standard commercially prepared solutions were used in the Orsat analyzer (sat. KOH for carbon dioxide and reduced methylene blue for oxygen). In addition to the above, the oxygen content of the flue gas was measured at each traverse during the particulate determinations using a Teledyne Model 320P-4 Portable Oxygen Analyzer to sample the effluent from the Method 5 train.



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, 1984). 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. Samples were ion-exchanged using a cation exchanger in the hydrogen ion form to remove any interfering cations present.

CALCULATION EQUATIONS

METHOD 2

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

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

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

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

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

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

$$\rho = \frac{4.585 \times 10^{-2}\, P_s M_s}{T_s\ (avg)}$$

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

CALCULATION EQUATIONS

METHOD 3

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

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

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

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

CALCULATION EQUATIONS

METHOD 5

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

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

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

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

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

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

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

$$(\dot{m}_p)_2 = \frac{1.3228 \times 10^{-1}\ M_p\ \ A}{0\ A_n}$$

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

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

Y = 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_{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 buld temperature of stack gas, °F

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

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

$T_s(avg)$ = Absolute average stack temperature, °F

T_{std} = Standard absolute temperature, 528 °F (68 °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.

Y = Dry test meter correction coefficient, dimensionless

ρ = Actual gas density, LB/ACF

CALCULATION EQUATIONS

METHOD 6

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

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

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

$$C_s = \frac{7.06\text{x}10^{-5}\ (V_t - V_{tb})\ N\ (\frac{V_{soln}}{V_a})}{V_{std}}$$

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

C_s (MG/DSCM) = $1.60186\text{x}10^7\ C_s$

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

C_s (ppm, dry) = $6.02119\text{x}10^6\ C_s$

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

SYMBOLS

$\bar{B}'_{O_2}$ = Average oxygen content in flue gas, % v/v, dry

$\bar{B}'_{CO_2}$ = 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

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.

Y = 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, °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 °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