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Reference:	67
Title:	Results of the March 1990 Trace Metal Characterization Study on Unit 3 at the Sherburne County Generating Station. Interpoll Laboratories, Circle Pines, Minnesota. June 7, 1990.

Reg 9

RESULTS OF THE MARCH 1990 TRACE METAL CHARACTERIZATION STUDY ON UNIT 3 AT THE SHERBURNE COUNTY GENERATING STATION

interpoll

Interpoll Laboratories, Inc.
4500 Ball Road N.E.
Circle Pines, Minnesota 55014-1819

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FAX: (612) 786-7854

RESULTS OF THE MARCH 1990 TRACE METAL CHARACTERIZATION STUDY ON UNIT 3 AT THE SHERBURNE COUNTY GENERATING STATION

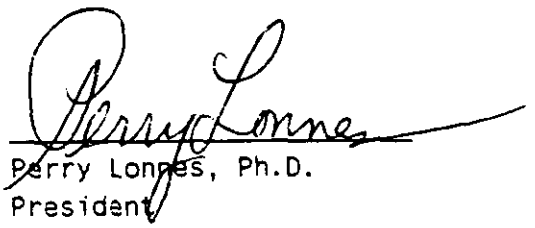
Submitted to:

NORTHERN STATES POWER COMPANY
West of Highway 10
Becker, Minnesota 55308

Attention:

Bob Catron

Approved by:



Perry Lonnes, Ph.D.
President

Report Number 0-3005
June 7, 1990
PL/prp

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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/10^6BTU	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.

Jeff Cole, RTI, says this is a dry bottom boiler, according to the UDI/EEI database. Jeff has been working with the NSP data for five years and, therefore, I am taking his word on this.

Jj

1 INTRODUCTION

On March 27, 1990, Interpoll Laboratories personnel conducted a trace metal characterization study on the Unit 3 Dry Scrubbing System at the Northern States Power Company (NSP) Sherburne County Generating Station located in Becker, Minnesota. On-site testing was performed by D. Van Hoever, E. Trowbridge, M. Kaehler and S. Bainville. Coordination between testing activities and plant operation was provided by Bob Catron of NSP.

Unit 3 is a Babcock and Wilcox 860 MW boiler which came on line in 1987. The boiler is fired with pulverized subbituminous coal from Montana. Particulate and sulfur dioxide emissions are controlled by a dry scrubber consisting of a spray dryer absorber (SDA) and baghouse. Scrubbed flue gas is exhausted to the atmosphere by a 650-foot high radial brick-lined concrete stack.

Multi-Metal Modified Method 5 (4M5) sampling train was used to isokinetically collect solid and vapor phase trace metals. The samples were collected and analyzed as per the EPA Draft Method "Methodology for the Determination of Metals Emissions in Exhaust Gases from Stationary Source Combustion Processes". The aerosol or solid phase trace metal samples were collected on high purity Pallflex® filters. The vapor phase trace metals were collected in an all glass impinger train. The first and second impingers each contained 100 cc of a mixture of 5% HNO_3 and 10% H_2O_2. The third and fourth impingers contained 100 cc of a mixture of 4% $KMnO_4$ and 10% H_2SO_4. These impingers collect any elemental mercury which might penetrate the first two impingers.

The recovered four-part trace metal samples were returned to the laboratory where the probe rinse, filter and nitric acid impinger catch were combined, dissolved in acid (including the glass fiber filter) and analyzed by Inductively Coupled Argon Plasma Emission Spectrometry (ICP).

In some cases, the same were reanalyzed by graphite furnace atomic absorption spectrometry for greater sensitivity. The permanganate mercury catch and an aliquot of the front half catch were analyzed by cold vapor atomic absorption spectrometry (CV/AA). Two field-biased blanks were collected and recovered at each test site and analyzed with the field samples.

The Cr(VI) samples were collected with a Modified Method 13 sampling train without the optional filter. Pallflex® Type 2500 QAT ultrapure filters were used in the post-impinger filter holder in place of the normal glass fiber filters. The sampling train was rigorously cleaned prior to sampling to remove any traces of organic materials which react rapidly to reduce Cr(VI) to Cr(III). In addition, nonorganic vacuum grease was used to seal all ground glass joints in the sampling train.

A heated glass-lined sampling probe was used to extract the samples from the stack. The first two impingers were charged with 1 N NaOH which acts as a preservative. The samples were collected following Method 5 sampling protocol. After completion of sampling, the front half of the train was recovered using 0.5% Na_2CO_3. The backhalf was recovered using 0.1 N NaOH. The recovered samples were stored at 4 ^{0}C until analysis.

In the laboratory, the three-part field sample was combined, pH adjusted, APDC chelating agent added and extracted with MiBK. The MiBK was then evaporated and the residue taken up in nitric acid. The extract was then analyzed by ICP in accordance with EPA Method 6010.

An integrated flue gas sample was extracted simultaneously with each particulate and sulfur dioxide sample using a specially designed gas sampling system. Integrated flue gas samples were collected in 44-liter Tedlar bags housed in a protective aluminum housing. 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 SDA Inlet was conducted using a single point traverse. Each test run was 60 minutes in duration. Testing on the Stack was conducted from four test ports oriented at 90 degrees. These test ports are located seven stack diameters downstream of the breeching inlet and eleven diameters upstream of the stack exit. A 16-point traverse was used to extract representative trace metals and chromium VI samples. Each traverse point was sampled four minutes to give a total sampling time 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 results of the trace metals determinations are summarized in Tables 1 and 2. Chromium VI results are presented in Table 3.

The mass rates of trace metals determined at the Inlet sampling location, when stoichiometrically converted to the appropriate or actual species, and adjusted for unanalyzed species such SiO_2, TiO_2 SO_3 and P_2O_5 give total particulate mass flow rates which agree very well with the total inlet particulate mass flows measured on August 9, 1988 when a complete duct traverse (48-points) was performed as shown below:

	Particulate Mass Rate LB/HR	
	Calculated from Trace Metals	Measured
Run	3-27-90	8-9-88
1	32300	44300
2	47200	44200
3	39500	-
Average	39700	42300

The above calculated mass rates for 3-27-90 do not exhibit good agreement with the particulate mass rate calculated directly from a gravimetric analysis of the trace metal samples (71,000, 67000 and 98000 LB/HR). This is not surprising inasmuch as the 3-27-90 sampling consisted of a 3-point traverse. This data suggests a severe stratification of particulate mass flow in the inlet ducting.

Some contamination occurred of the Run 1 sample collected at the stack test site which invalidated the Run 1 results for arsenic, cadmium and zinc. This contamination did not effect other trace elements nor was it observed in the subsequent test runs.

No other difficulties were encountered in the field or in the laboratory evaluation of the samples. On the basis of this fact and a complete review of the entire data and results, it is our opinion, subject to the above qualifications, that the results reported herein are accurate and closely reflect the actual values which existed at the time the test was performed.

Table 1. Results of the March 27, 1990 Trace Metal Determinations on the Unit 3 Dry Scrubber System at the NSP Sherburne County Station in Becker, Minnesota.

	Concentration (ug/Nm^3)					
	Run 1		Run 2		Run 3	
Element	Inlet	Stack	Inlet	Stack	Inlet	Stack
Aluminum	$1.39X10^5$	261	$2.56X10^5$	67	$1.87X10^5$	101
Arsenic	69.6	x	66.0	<.056	83.6	<.056
Boron	8430	2620	8270	445	10900	1890
Barium	10300	<6.5	15800	<6.5	10300	<6.5
Beryllium	22.9	.0022	24.9	.0067	26.5	.0135
Calcium	$3.33X10^5$	465?	$6.06X10^5$	259	$3.97X10^5$	251
Cadmium	8.15	x	8.23	11.8?	7.34	6.84
Chromium	266	15.6	281	9.26	316	7.07
Copper	587	108	555	52.2	748	25.6
Iron	$1.38X10^5$	143	$1.10X10^5$	103	$1.58X10^5$	33.7
Potassium	51700	251	48500	84.8	58300	81.9
Magnesium	20000	40.3	30000	16.7	30400	29.2
Manganese	5450	7.73	5210	51.9	6280	5.16
Molybdenum	64.5	<4.4	47.2	<4.4	87.1	<4.4
Sodium	84900	949?	$1.12X10^5$	627	$1.19X10^5$	653
Nickel	204	10.9?	174	10.0	237	3.59
Lead	640	16.9	494	5.35	654	<4.5
Selenium	45.4	<2.72	32.2	<2.79	58.5	<2.81
Antimony	83.8	.97	58.1	0.22	93.9	<.20
Strontium	19900	1.63	11700	5.58	24700	5.61
Vanadium	704	<.11	643	<.11	836	<.11
Zinc	264	x	258	35.6	256	23.4
Mercury	7.88	5.62	7.56	2.34	4.95	4.6
Silver	2.29	<.33	2.31	<.33	2.30	<.34

x = Result invalidated due to field contamination
? = Result may be high due to field contamination

Table 2. Results of the March 27, 1990 Trace Metal Removal Efficiency Determinations (Based on Mass Flow) on the Unit 3 Dry Scrubber System at the NSP Sherburne County Station in Becker, Minnesota.

	Mass Flow (LB/HR)						
	Run 1		Run 2		Run 3		Avg. Removal
Element	Inlet	Stack	Inlet	Stack	Inlet	Stack	Eff. (%w/w)
Aluminum	1168	1.91	2119	.493	1553	.742	99.935
Arsenic	.585	x	.546	$<4.12X10^{-4}$	.694	$<4.12X10^{-4}$	>99.93
Boron	70.8	19.1	68.5	3.28	90.5	13.9	84.2
Barium	86.6	<.048	131	<.049	85.5	<.050	>99.950
Beryllium	.192	$1.61X10^{-5}$	.206	$4.93X10^{-5}$	.220	$9.92X10^{-5}$	99.973
Calcium	2799	3.40?	5017	1.91	3296	1.85	99.936
Cadmium	.0684	x	.0681	.0869?	.0609	.0503	
Chromium	2.24	.114	2.33	.0682	2.62	.0520	96.74
Copper	4.93	.789	4.59	.384	6.21	.188	91.35
Iron	1160	1.04	911	.759	1312	.248	99.939
Potassium	434	1.83	402	.624	484	.602	99.77
Magnesium	168	.294	248	.123	252	.215	99.91
Manganese	45.8	.0565	43.1	.382	52.1	.0379	99.66
Molybdenum	.542	<.032	.391	<.033	.723	<.033	>93.63
Sodium	714	6.93?	927	4.62	988	4.80	99.38
Nickel	1.71	.0796?	1.44	.0736	1.97	.0264	96.49
Lead	5.38	.123	4.09	.0394	5.43	<.033	>98.71
Selenium	.382	<.0199	.267	<.0205	.486	<.0207	94.62
Antimony	.704	$7.09X10^{-3}$	.481	$1.62X10^{-3}$	.780	$<1.6X10^{-3}$	>99.48
Strontium	167	.0119	96.9	.0411	205	.0412	99.98
Vanadium	5.92	$<8.04X10^{-4}$	5.32	$<8.10X10^{-4}$	6.94	$<8.09X10^{-4}$	99.987
Zinc	2.22	x	2.14	.262	2.13	.172	89.97
Mercury	.0662	.0411	.0626	.0172	.0411	.0338	42.85
Silver	.0192	$2.41X10^{-3}$	.0191	$<2.43X10^{-3}$	.0191	$2.50X10^{-3}$	>87

x = Result invalidated due to field contamination
? = Result may be high due to field contamination

Table 3 Summary of the Results of the March 27, 1990 Hexavalent Chromium (CrVI) Determinations on the Unit 3 Stack at the NSP Sherburne County Station.

Test/Run	Concentration (ug/Nm^3)	Emission Rate (LB/HR)
2/1	1.30	0.0095
2/2	0.39	0.0028
2/3	1.41	0.0100
Avg	1.03	0.0074

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 trace metals and chromium VI sampling data. Preliminary measurements including test port locations are given in the appendices.

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 emission rates have been calculated using the product of the concentration times flow method.

3.1 Results of Orsat and Moisture Analyses

Test No. 1
Unit 3 SDA Inlet

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

	Run 1	Run 2	Run 3
Date of run	03-27-90	03-27-90	03-27-90
Dry basis (orsat)			
carbon dioxide.....	13.30	13.40	13.50
oxygen.....	6.70	6.50	6.40
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	80.00	80.10	80.10
Wet basis (orsat)			
carbon dioxide.....	12.03	12.05	12.06
oxygen.....	6.06	5.84	5.72
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	72.38	72.02	71.54
water vapor.....	9.53	10.09	10.68
Dry molecular weight.....	30.40	30.40	30.42
Wet molecular weight.....	29.21	29.15	29.09
Specific gravity.....	1.009	1.007	1.005
Water mass flow.....(LB/HR)	662829	695254	743527

[illegible]	1.068	1.075	1.074

Test No. 1
Unit 3 Stack

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

	Run 1	Run 2	Run 3
Date of run	03-27-90	03-27-90	03-27-90
Dry basis (orsat)			
carbon dioxide.....	13.50	13.80	13.90
oxygen.....	6.50	6.20	6.10
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	80.00	80.00	80.00
Wet basis (orsat)			
carbon dioxide.....	11.43	11.75	11.89
oxygen.....	5.50	5.28	5.22
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	67.70	68.13	68.42
water vapor.....	15.37	14.84	14.47
Dry molecular weight.....	30.42	30.46	30.47
Wet molecular weight.....	28.51	28.61	28.66
Specific gravity.....	0.985	0.988	0.990
Water mass flow.....(LB/HR)	0.00	0.00	0.00
FD	1.067	1.065	1.065

Test No. 2
Unit 3 Stack

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

	Run 1	Run 2	Run 3
Date of run	03-27-90	03-27-90	03-27-90
Dry basis (orsat)			
carbon dioxide.....	13.60	13.60	13.60
oxygen.....	6.10	6.10	6.00
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	80.30	80.30	80.40
Wet basis (orsat)			
carbon dioxide.....	11.68	11.61	11.58
oxygen.....	5.24	5.21	5.11
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	68.98	68.55	68.46
water vapor.....	14.10	14.63	14.85
Dry molecular weight.....	30.42	30.42	30.42
Wet molecular weight.....	28.67	28.60	28.57
Specific gravity.....	0.990	0.988	0.987
Water mass flow.....(LB/HR)	0.00	0.00	0.00

1.088 1.088 1.096

3.2 Results of the Multi Metal Modified Method 5 (4M5) Sampling

Test No. 1
Unit 3 SDA Inlet

Results of the Multi Metal Modified Method 5 (4M5) Sampling

	Run 1	Run 2	Run 3
Date of run	03-27-90	03-27-90	03-27-90
Time run start/end.....(HRS)	840/ 940	1025/1125	1210/1310
Static pressure.....(IN.WC)	-13.20	-13.20	-13.20
Cross sectional area (SQ.FT)	1090.00	1090.00	1090.00
Pitot tube coefficient.....	.840	.840	.840
Water in sample gas			
condenser.....(ML)	0.0	0.0	0.0
impingers.....(GRAMS)	65.0	82.0	90.0
desiccant.....(GRAMS)	28.0	16.0	15.0
total.....(GRAMS)	93.0	98.0	105.0
Gas meter coefficient.....	0.9992	0.9992	0.9992
Barometric pressure..(IN.HG)	29.12	29.12	29.12
Avg. orif.pres.drop..(IN.WC)	1.69	1.67	1.70
Avg. gas meter temp..(DEF-F)	81.7	87.5	90.4
Volume through gas meter....			
at meter conditions...(CF)	43.75	43.76	44.20
standard conditions.(DSCF)	41.63	41.20	41.39
Total sampling time....(MIN)	60.00	60.00	60.00
Nozzle diameter.....(IN)	.249	.249	.249
Avg.stack gas temp ..(DEG-F)	280	280	280
Volumetric flow rate.....			
actual.....(ACFM)	3691895	3660354	3697315
dry standard.....(DSCFM)	2243426	2209850	2216340
Isokinetic variation.....(%)	99.7	100.2	100.4

Test No. 1
Unit 3 Stack

Results of the Multi Metal Modified Method 5 (4M5) Sampling

	Run 1	Run 2	Run 3
Date of run	03-27-90	03-27-90	03-27-90
Time run start/end.....(HRS)	840/ 954	1025/1139	1210/1324
Static pressure.....(IN.WC)	-0.72	-0.72	-0.72
Cross sectional area (SQ.FT)	683.49	683.49	683.49
Pitot tube coefficient.....	.840	.840	.840
Water in sample gas			
condenser.....(ML)	0.0	0.0	0.0
impingers.....(GRAMS)	115.0	110.0	109.0
desiccant.....(GRAMS)	10.0	7.0	4.0
total.....(GRAMS)	125.0	117.0	113.0
Gas meter coefficient.....	0.9980	0.9980	0.9980
Barometric pressure..(IN.HG)	28.98	28.98	28.98
Avg. orif.pres.drop..(IN.WC)	0.88	0.83	0.83
Avg. gas meter temp..(DEF-F)	63.4	62.8	64.0
Volume through gas meter....			
at meter conditions...(CF)	33.22	32.38	32.27
standard conditions.(DSCF)	32.45	31.67	31.49
Total sampling time....(MIN)	64.00	64.00	64.00
Nozzle diameter.....(IN)	.178	.178	.178
Avg.stack gas temp ..(DEG-F)	167	166	166
Volumetric flow rate.....			
actual.....(ACFM)	2829194	2829323	2811269
dry standard.....(DSCFM)	1950168	1965867	1962255
Isokinetic variation.....(%)	102.9	99.6	99.2

3.3 Results of the Hexavalent Chromium (Cr VI) Sampling

Test No. 2
Unit 3 Stack

Results of Hexavalent Chromium (Cr VI) Sampling

	Run 1	Run 2	Run 3
Date of run	03-27-90	03-27-90	03-27-90
Time run start/end.....(HRS)	1430/1540	1550/1659	1710/1820
Static pressure.....(IN.WC)	-0.72	-0.72	-0.72
Cross sectional area (SQ.FT)	683.49	683.49	683.49
Pitot tube coefficient.....	.840	.840	.840
Water in sample gas			
condenser.....(ML)	0.0	0.0	108.0
impingers.....(GRAMS)	104.0	106.0	8.0
desiccant.....(GRAMS)	5.0	8.0	0.0
total.....(GRAMS)	109.0	114.0	116.0
Gas meter coefficient.....	0.9980	0.9980	0.9980
Barometric pressure..(IN.HG)	28.80	28.80	28.80
Avg. orif.pres.drop..(IN.WC)	0.83	0.83	0.84
Avg. gas meter temp..(DEF-F)	70.1	67.2	74.1
Volume through gas meter....			
at meter conditions...(CF)	32.66	32.55	32.92
standard conditions.(DSCF)	31.30	31.37	31.32
Total sampling time....(MIN)	64.00	64.00	64.00
Nozzle diameter.....(IN)	.178	.178	.178
Avg.stack gas temp ..(DEG-F)	164	164	163
Volumetric flow rate.....			
actual.....(ACFM)	2801458	2808571	2804604
dry standard.....(DSCFM)	1957528	1950487	1944863
Isokinetic variation.....(%)	98.9	99.5	99.6

APPENDIX A

SAMPLING TRAIN CALIBRATION DATA

Interpoll Laboratories, Inc.
(612) 786-6020

Meter Box Calibration and Usage Status

Date of Report: June 13, 1990

Meter Box No. : 4 (Rockwell Dry Test Meter Serial No. 964551)

Date of Last Calibration: March 5, 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.)
March 6, 1990	0-2967	865.30	1022.55	157.25	157.25
March 27, 1990	0-3005	25.00	166.50	141.50	298.75

* Total volume through meter since last calibration.

Date 3/5/90

Bar. Press. 29.36 in. Hg

INTERPOLL LABORATORIES, INC.
METER CALIBRATION SHEET
EPA METHOD 5

Control Module No. 4
Serial No. DTM 964553
Wet Test Meter No. AL-20
Technician [signature]

ΔH (in. WC)		Gas Volume Wet Test Meter (ft^3)	* Cal. Index θ (x)	* 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. ΔH@	C_f
							Wet Test	Dry Test					
nominal	actual				V_{di}	V_{df}	t_w (°F)	t_{di} (°F)	t_{do} (°F)				
0.5	.5	2	99.70	0.01	857.48	859.50	70	74	68	4/59.62	.9877	1.78	
1.2	1.2	3	99.77	0.03	853.97	856.98	70	75	68	4/58.76	.9941	1.90	
2.0	2.0	3	99.87	0.05	834.22	840.60	70	69	62	8/58.89	1.0027	1.55	
3.3	3.3	5	100.00	0.08	842.58	847.58	70	73	65	5/01.89	1.0017	1.92	
4.7	4.7	5	100.20	0.11	848.51	853.47	70	75	67	4/15.86	.9999	1.74	
		8	8	8	6	7	0	0	10	11/13	.9992	1.88	

Meter was in tolerance ☒
Meter was not in tolerance ☐; readjusted linkage
Meter was not in tolerance ☐; changed dry test meters

Approved by Perry Lonnes Date 3-5-90

* 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: March 27, 1990 Nozzle Number 5-4
Technician: E. Trowbridge

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

Position	Diameter (inches)
1	0.249
2	0.250
3	0.249
Average:	0.249

Interpoll Laboratories
(612)786-6020

S-Type Pitot Tube Inspection Sheet

Pitobe No. 16-17

Pitot tube dimensions:

1. External tubing diameter (D_t) .316 IN.
2. Base to Side A opening plane (P_A) .460 IN.
3. Base to Side B opening plane (P_B) .461 IN.

Alignment:

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

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

8. Z <.125" .02
9. W <.0625" .02

Distance from Pitot to Probe Components:

10. Pitot to 0.500 IN. nozzle .758 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) .760 IN.

Date of Inspection: 12-8-89

Inspected by: E Trowbridge

S-348(1)

Interpoll Laboratories, Inc.
(612) 786-6020

Meter Box Calibration and Usage Status

Date of Report: June 13, 1990

Meter Box No. : 8 (Rockwell Dry Test Meter Serial No. 964552)

Date of Last Calibration: March 7, 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.)
March 15, 1990	0-2995	175.17	292.18	117.01	117.01
March 22, 1990	0-3000	294.00	511.10	217.10	334.11
March 27, 1990	0-3005	511.57	719.85	208.28	542.39

* Total volume through meter since last calibration.

Date 3/7/90

Bar. Press. 29.56 in. Hg

INTERPOLL LABORATORIES, INC.
METER CALIBRATION SHEET
EPA METHOD 5

Control Module No. 8
Serial No. DTM 964.552
Wet Test Meter No. AL-20
Technician [signature]

ΔH (in. WC)		Gas Volume Wet Test Meter (ft^3)	* Cal. Index Y (%)	* 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
							Wet Test	Dry Test					
nominal	actual				V_{di}	V_{df}	t_w (°F)	t_{di} (°F)	t_{do} (°F)				
0.5	0.5	2	99.70	0.01	161.76	163.78	73.0	81	77	5/5.24	.9970	1.84	
1.2	1.2	~~2~~ 10.5	99.77	0.03	164.29	174.95	73.1	83	78	17/16.71	.9933	1.84	
2.0	2.0	3	99.87	0.05	141.20	144.21	73.6	79	75	3/5.40	.9966	1.87	
3.3	3.3	5	100.00	0.08	146.22	151.23	73.5	82	76	5/2.82	.9998	1.90	
4.7	4.7	5	100.20	0.11	152.22	157.22	73.3	84	77	4/17.27	1.0035	1.94	
		8	8	8	8	8	7	8	8	10	11/13	.9980	1.88

Meter was in tolerance ☒
Meter was not in tolerance ☐; readjusted linkage
Meter was not in tolerance ☐; changed dry test meters

Approved by Perry Lonnes Date 3-15-90

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

Interpoll Laboratories, Inc.
(612) 786-6020

Nozzle Calibration
Data Sheet

Date of Calibration: March 27, 1990 Nozzle Number 4-3
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	0.175
2	0.177
3	0.180
Average:	0.178

Interpoll Laboratories
(612)786-6020

S-Type Pitot Tube Inspection Sheet

Pitobe No. 8-14

Pitot tube dimensions:

1. External tubing diameter (D_t) .316 IN.
2. Base to Side A opening plane (P_A) .462 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. $B_1 < 5^0$ 1
7. $B_2 < 5^0$ 1

8. Z <.125" .03
9. W <.0625" .02

Distance from Pitot to Probe Components:

10. Pitot to 0.500 IN. nozzle .760 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: _____

S-348(1)

Interpoll Laboratories, Inc.
(612) 786-6060

EPA Method 5 Gas Metering System Quality Control Check Data Sheet

Job NSP/SHERCO Date 3-26-90

Operator E Trankley Module No. 4

Instructions: Operate the control module at a flow rate equal to ^H@ for 10 minutes before attaching the umbilical. Record the following data:

Bar press 29.30 in. Hg. Y = .9992 ^H@ 1.88 in. W.C.

Time (min)	Volume (CF)	Meter Temp. (°F)	
		Inlet	Outlet
[redacted]	(26.00)	[redacted]	
2.5	27.86	71	66
5.0	29.72	75	68
7.5	31.60	78	70
10	33.46	80	71
[redacted]	V_m= 7.46	Avg(t_m)=	72.3°F

Calculate Y_{cn} as follows:

$$Y_{cn} = \frac{1.786}{Y\ V_m}\left[\frac{(t_m + 460)}{P_b}\right]^{0.5}$$

$$Y_{cn} = \frac{1.786}{(.9992)(7.46)}\left[\frac{(72.3) + 460}{(29.30)}\right]^{0.5}$$

Y_{cn} = 1.02

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

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

S-432R

Interpoll Laboratories, Inc.
(612) 786-6060

EPA Method 5 Gas Metering System Quality Control Check Data Sheet

Job NSP / SHERCO Date 3-26-90

Operator S. BAINVILLE Module No. 8

Instructions: Operate the control module at a flow rate equal to ^H@ for 10 minutes before attaching the umbilical. Record the following data:

Bar press 29.03 in. Hg. τ = .9980 ^H@ 1.88 in. W.C.

Time (min)	Volume (CF)	Meter Temp. (°F)	
		Inlet	Outlet
[redacted]	(511.57)	[redacted]	
2.5	513.46	56	55
5.0	515.33	58	56
7.5	517.21	60	56
10	519.11	62	57
[redacted]	V_m= 7.54	Avg(t_m) =	57.5 °F

Calculate Y_{cn} as follows:

$$Y_{cn} = \frac{1.786}{\tau\ V_m}\left[\frac{(t_m + 460)}{P_b}\right]^{0.5}$$

$$Y_{cn} = \frac{1.786}{(.9980)(7.54)}\left[\frac{(57.5) + 460}{(29.03)}\right]^{0.5}$$

$$Y_{cn} = 1.0019$$

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

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

S-432R

Interpoll Laboratories, Inc.
(612) 786-6060

EPA Method 5 Gas Metering System Quality Control Check Data Sheet

Job N.S.P. SHERCO Date 3/28/90

Operator Duane Van Hoever Module No. 8

Instructions: Operate the control module at a flow rate equal to ^H@ for 10 minutes before attaching the umbilical. Record the following data:

Bar press 28.83 in. Hg. γ = .9980 ^H@ 1.90 in. W.C.

Time (min)	Volume (CF)	Meter Temp. (°F)	
		Inlet	Outlet
[redacted]	(856)	[redacted]	
2.0	857.53	90	82
4.0	859.13	91	83
6.0	860.64	92	84
10	863.79	92	84
[redacted]	V_m= 7.79	Avg(t_m)=	87.25 °F

Calculate Y_{cn} as follows:

$$Y_{cn} = \frac{1.786}{\gamma\ V_m}\left[\frac{(t_m + 460)}{P_b}\right]^{0.5}$$

$$Y_{cn} = \frac{1.786}{(\ .998\ )(\quad)}\left[\frac{(\quad) + 460}{(\quad)}\right]^{0.5}$$

$$Y_{cn} = 1.0008$$

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

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

S-432R

Interpoll Laboratories, Inc.

Temperature Measurement Device Calibration Sheet

Unit under test:
Vendor ATKINS
Model 39658 Serial Number PDT-1
Range −112.0°F to +1999°F °F Thermocouple Type
Date of Calibration 2-5-90 Technician E.T KOWBRIDGE

Method of Calibration:

☐ Comparison against ASTM mercury in glass thermometer using a thermostatted and insulated aluminum block design 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 millivo 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	2.9	2.9	.63
100	100	100.0	—	—
200	200	203	3	.45
300	300	301	1	.13
400	400	398	2	.23
500	500	497	3	.31
600	600	599	1	.09
700	700	699	1	.08
800	800	803	3	.23
900	900	905	5	.36
1000	1000	1008	8	.54
1100	1100	1111	11	.70
1200	1200	1216	16	.96
1300	1300	1315	15	.85
1400	1400	1418	18	.96
1500	1500	1514	14	.71
1600	1600	1614	14	.67
1700	1700	1708	8	.37
1800	1800	1804	4	.17
1900	1900	1895	5	.21
2000	2000	1988	12	.48
2100				
		Averages:	6.4	.43

OF = off scale response by unit under test (°F)
% dev = 100 Δt / (460 + t)

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

S-4

Interpoll Laboratories, Inc.

Temperature Measurement Device Calibration Sheet

Unit under test:

Vendor ATKINS

Model 3658-K — Serial Number PDT-4

Range −112.0 °F to +1999 °F °F — Thermocouple Type CL-30D

Date of Calibration 2-2-90 — Technician E Trumbull

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	−2.7	2.7	.58
100	100	95	5	.89
200	200	198	2	.30
300	300	296	4	.52
400	400	392	8	.93
500	500	491	9	.93
600	600	592	8	.75
700	700	692	8	.68
800	800	796	4	.31
900	900	897	3	.22
1000	1000	1000	—	—
1100	1100	1102	2	.12
1200	1200	1207	7	.42
1300	1300	1305	5	.28
1400	1400	1408	8	.43
1500	1500	1505	5	.25
1600	1600	1603	3	.14
1700	1700	1697	3	.13
1800	1800	1793	7	.30
1900	1900	1883	17	.72
2000	2000	1977	23	.93
2100			—	—
		Averages:	6.36	.46

OF = off scale response by unit under test (°F)

% dev = 100 Δt / (460 + t)

☒ Unit in tolerance

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

S-433

Interpoll Laboratories, Inc.

Temperature Measurement Device
Calibration Sheet

Unit under test:

Vendor GORDON

Model 5310K — Serial Number PDT-10

Range -112°F TO 1999°F °F — Thermocouple Type K

Date of Calibration 3-5-90 — Technician S. BAINVILLE

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	.8	.8	.17
100	100	97.7	2.3	.41
200	200	201	1	.15
300	300	298	2	.26
400	400	395	5	.58
500	500	494	6	.62
600	600	596	4	.38
700	700	696	4	.34
800	800	800	0	—
900	900	901	1	.07
1000	1000	1004	4	.37
1100	1100	1106	6	.38
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	.09
1900	1900	1889	11	.47
2000	2000	1983	17	.69
2100	2100	OF	OF	OF
		Averages:	6.0	.39%

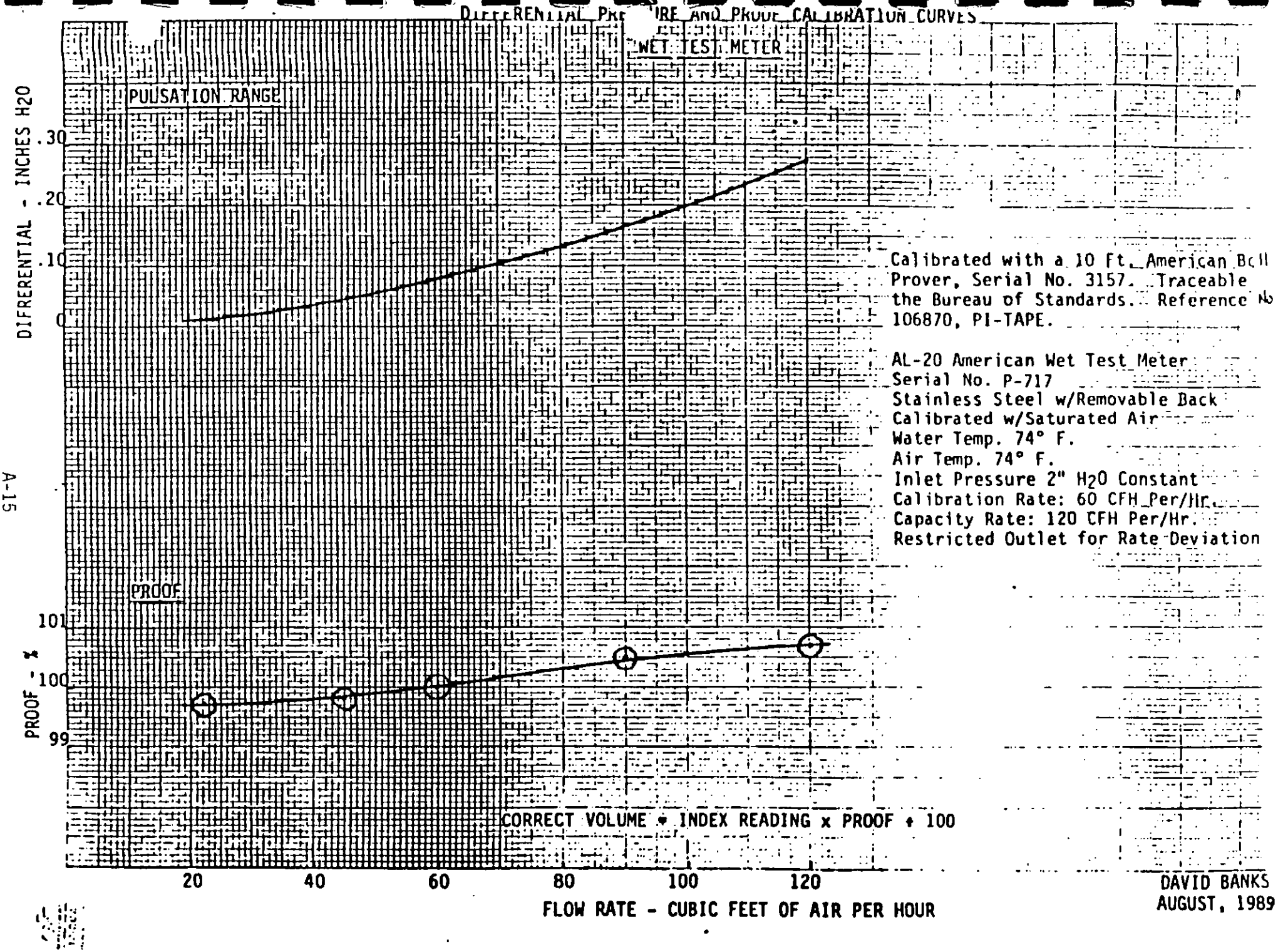
OF = off scale response by unit under test (°F)

% dev = 100 Δt / (460 + t)

☒ Unit in tolerance

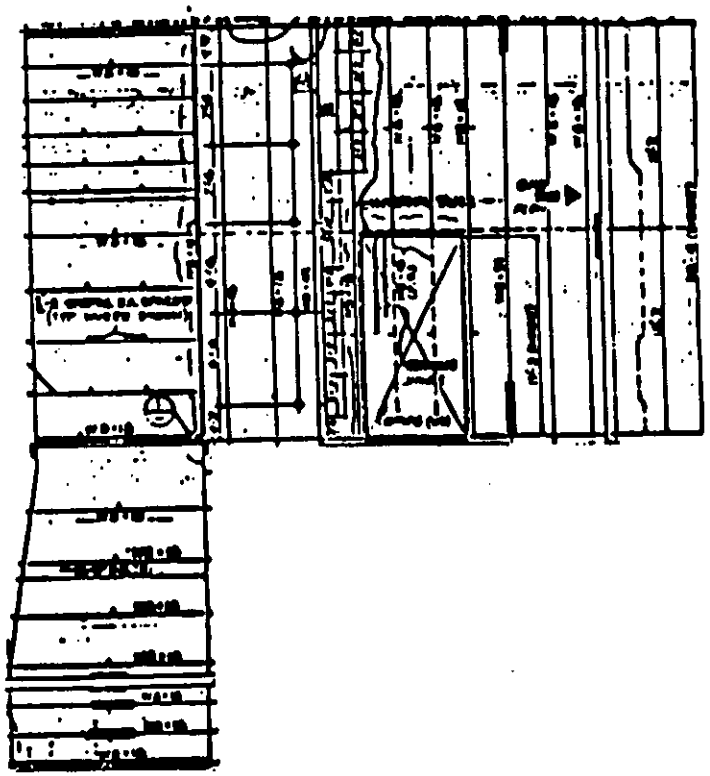
☐ Unit was not in tolerance: recalibrated - See new calibration sheet.

S-43

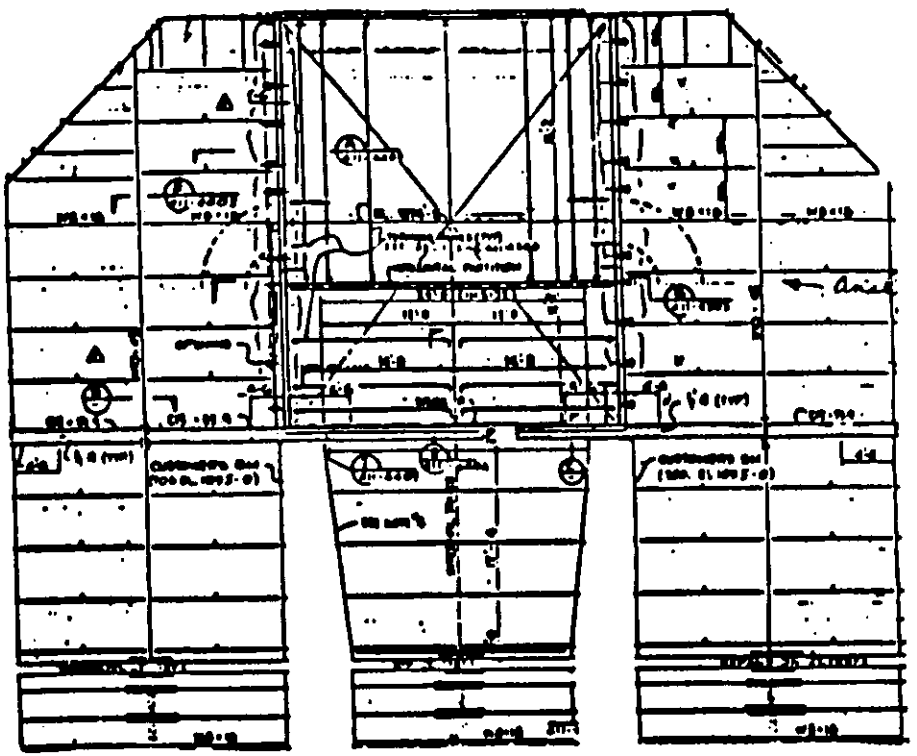

DIFFERENTIAL PRESSURE AND PROOF CALIBRATION CURVES
WET TEST METER
PULSATION RANGE
DIFFERENTIAL - INCHES H20
.30
.20
.10
0
PROOF
PROOF - %
101
100
99
Calibrated with a 10 Ft. American Bell Prover, Serial No. 3157. Traceable the Bureau of Standards. Reference No 106870, PI-TAPE.
AL-20 American Wet Test 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
CORRECT VOLUME = INDEX READING x PROOF ÷ 100
20
40
60
80
100
120
FLOW RATE - CUBIC FEET OF AIR PER HOUR
DAVID BANKS
AUGUST, 1989

APPENDIX B

LOCATION OF TEST PORTS



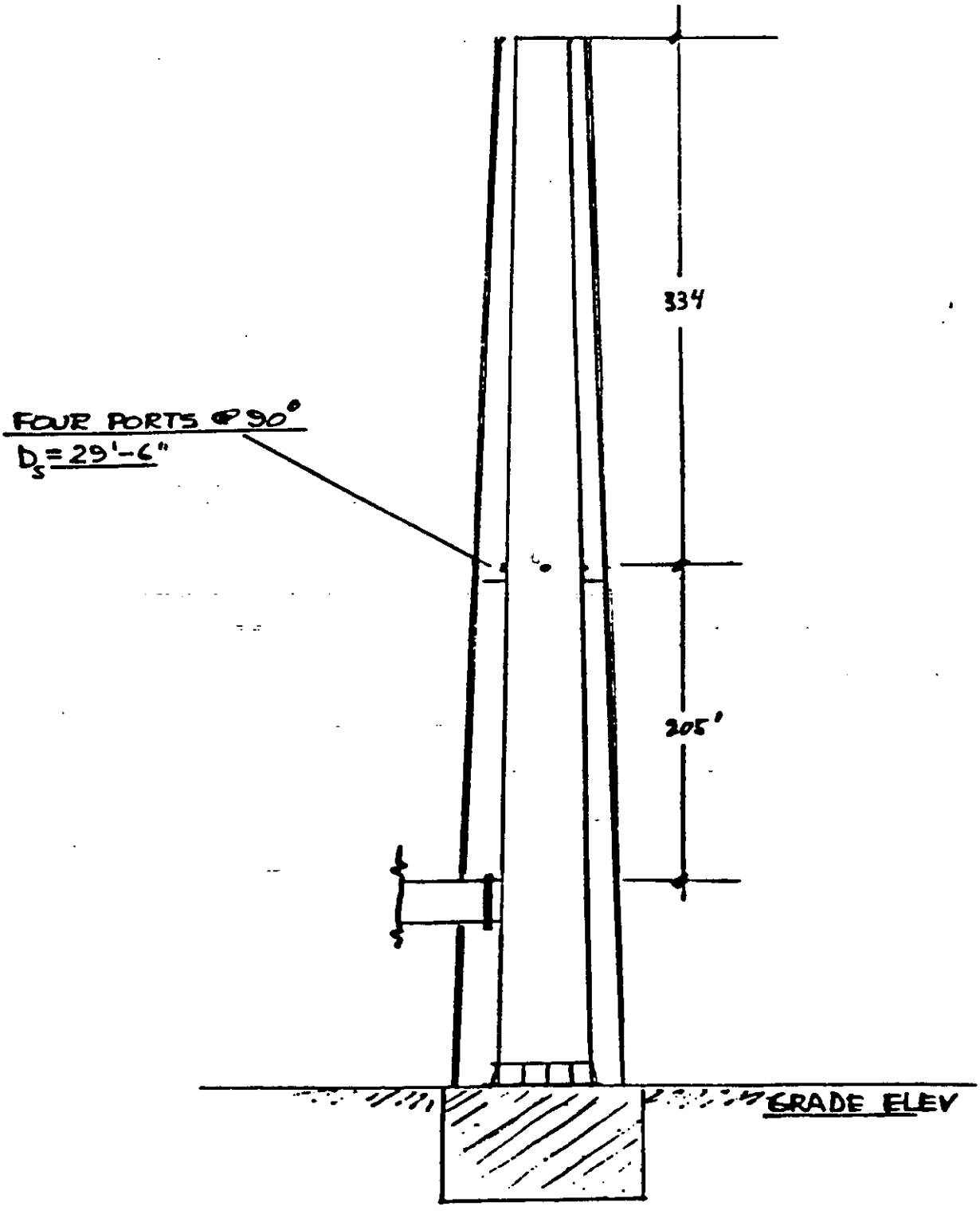
SIDE ELEVATION



FRONT ELEVATION

NSP SHERCO UNIT 3 AIR HEATER OUTLET TEST SITE

NSP SHERCO UNIT 3



NOT TO SCALE

LP 11/87
REV 3/88

APPENDIX C

4M5 FIELD DATA SHEETS - SDA INLET

INTERPOLL LABORATORIES EPA METHOD 2 FIELD DATA SHEET

Job NSP-SHERCO

Source UNIT 3 SDA INLET

Test 1 Run 1 Date 3-27-90

Stack dimen. 360 X 436 IN.

Dry bulb ____ °F Wet bulb ____ °F

Manometer: ☒ Reg. ☐ Exp. ☐ Elec.

Barometric pressure 29.12 in Hg

Static pressure -13.2 in WC

Operators E.TROWBRIDGE-M.KACHAL

Pitot No. 17-16Y Cp .840

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: 20 in.		Time start: 0800 hrs	
E	1		30	50	.75	283
	2		60	80	.72	280
	3		90	110	.68	276
Temp. meas. tool & S/N: PYT-4					Time end: 0810 hrs	

R or nothing= reg. manometer; S= expanded; E = electronic S-392.1

INTERPOLL LABORATORIES EPA METHOD 5/17 SAMPLE LOG SHEET

Job NSP/SHERCO
Source UNIT 3 SO4 INLET
Method 5/17 Filter holder: In-STACK SS

Date 3-27-90 Test 1 Run 1
No. of traverse points 3
Filter type: SS INSTACK

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: SS #20

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

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

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impinger No. 1	-	200	
Impinger No. 2		100	
Impinger No. 3		200	65
Condenser			
Desiccant	1391	1363	28
Total			93

Integrated Gas Sampling Data:

Bag Pump No. 89 Box No. 20 Bag No. 1

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

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

Time start: 0841 (HRS) Time end: 0959 (HRS)

Sampling rate: 400 cc/min Operator: ET

S/N of O_2 Analyzer used to monitor train outlet: 7

CF-023

CF-011

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job NSP/SNECO
Source SDA INLET
Date 3-27-90 Test 1 Run 1

Operators E.TROWBRIDGE-M.KADDER
Meter Box No. 9 ^H@ 1.85 IN WC
Gasmeter coeff. .9992

Pitot No. 12-16Y Cp .840
Bar. Press. 29.12 inHg H2O x
Nozzle No. 5-4 Nozzle Dia .249 IN.

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Des. Vol. (cf)	VAC. inHg	Temperatures (°F) Stack	Probe	Oven	Impg.	Con/In	Con/Out	Oxygen (%v/v)
	0840	33.90											
3	5	37.70	.75	1.85	7.72	12.5	280	250	IN-STACK	40	82	77	5.0
3	10	41.50	.78	1.90	1.57	13.0	282	253		40	83	78	5.7
3	15	45.30	.76	1.85	5.38	13.3	284	248		41	83	79	5.9
3	20	49.10	.70	1.71	9.06	14.0	280	249		42	84	80	5.9
2	25	52.85	.76	1.86	2.88	14.0	283	251		42	84	80	5.5
2	30	56.40	.72	1.76	6.61	14.0	281	250		42	84	80	5.7
2	35	60.40	.74	1.81	0.38	14.1	283	248		43	84	80	5.6
2	40	64.10	.70	1.72	4.06	14.1	280	248		43	84	81	6.6
1	45	67.45	.58	1.43	7.43	14.0	275	250		44	84	81	6.0
1	50	70.80	.58	1.43	0.79	14.0	275	250		44	84	81	5.9
1	55	74.23	.60	1.48	4.21	14.0	277	247		44	84	81	5.8
1	60	77.45	.60	1.48	7.63	14.0	275	248		44	84	81	5.4
	(0940)												
	Θ = 60	Vm = 43.55		^H = 1.69							Avg. = 81.7		

S-0037R

INTERPOLL LABORATORIES EPA METHOD 5/17 SAMPLE LOG SHEET

Job NSP/SHERCO Date 3-27-90 Test 1 Run 3
Source UNIT 3 SDA INLET No. of traverse points 3
Method 5/17 Filter holder: IN STACK-SS Filter type: SS

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: SS# 23

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

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

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impinger No. 1	80	100	80
Impinger No. 2		100	2
Impinger No. 3	2	200	
Condenser			
Desiccant	1411	1395	16
Total			98

Integrated Gas Sampling Data:

Bag Pump No. 39 Box No. 20 Bag No. 2
Bag Material: 5-layer Aluminized Tedlar Size: 44 L
Pretest leak check: 0 cc/min at 15 in. Hg.
Time start: 1026 (HRS) Time end: 1124 (HRS)
Sampling rate: 400 cc/min Operator: ET
S/N of O_2 Analyzer used to monitor train outlet: 7

CF-023

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job NSP/SHERCO
Source Unit 3 ESP INLET
Date 3-27-90 Test 1 Run 2

Operators ET-MK
Meter Box No. 4 ΔH 1.88 IN WC
Counter coeff. .9992

Pitot No. 12-16V Cp .840
Bar. Press. 28.12 inHg H2O x
Nozzle No. 5-0 Nozzle Dia .278 IN.

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Des. Vol. (cf)	VAC. inHg	Temperatures (°F) Stack	Probe	Oven	Impg.	Gas/In	Gas/Out	Oxygen (x v/v)
	1025	78.30											
3	✓	82.10	.72	1.76	2.02	13.0	282	248	IN-STACK	40	86	82	5.9
3	10	85.90	.74	1.82	5.81	13.1	280	250		40	87	82	5.8
3	15	89.62	.72	1.77	9.55	13.3	283	251		40	88	83	5.9
3	20	93.40	.74	1.82	3.35	13.4	284	247		42	90	85	6.0
2	25	97.10	.68	1.69	7.02	13.2	280	249		42	91	85	5.8
2	30	100.94	.72	1.78	0.76	13.5	284	250		42	91	85	5.7
2	35	104.60	.70	1.73	4.49	13.5	282	248		42	91	85	✓.7
2	40	108.20	.68	1.69	8.16	13.5	280	250		43	92	86	✓.8
1	45	111.70	.60	1.50	1.62	13.0	277	250		43	92	86	6.0
1	50	115.14	.60	1.50	5.08	13.0	275	246		43	92	86	5.8
1	55	118.64	.62	1.55	8.60	13.0	276	245		43	92	86	✓.8
1	60	122.06	.58	1.45	2.00	13.0	275	246		43	92	86	✓.8
	1125												
	θ = 60	Vm = 43.76		ΔH = 1.67							Avg. = 87.5		

INTERPOLL LABORATORIES EPA METHOD 5/17 SAMPLE LOG SHEET

Job NSP/SHARCO
Source Unit 3 SDA INLET
Method 5/17 Filter holder: EN STACK-55

Date 3-27-90 Test 1 Run 3
No. of traverse points 3
Filter type: 55

Sample Train Leak Check:

Pretest: (0.02 cfm at 15 in. Hg. (vac)
Postest: 0 cfm at 14 in. Hg. (vac)

Particulate Catch Data:

No.s of filters used: 55 #15

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

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

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impinger No. 1	-		
Impinger No. 2			88
Impinger No. 3			2
Condenser			
Desiccant	1419	1404	15
Total			105

Integrated Gas Sampling Data:

Bag Pump No. 159 Box No. 20 Bag No. 3

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

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

Time start: 1211 (HRS) Time end: 1309 (HRS)

Sampling rate: 440 cc/min Operator: ET

S/N of O_2 Analyzer used to monitor train outlet: 7

CF-023

CF-011

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job NSP/SHERCO
Source UNIT 3 SDA INLET
Date 3-27-90 Test 1 Run 3

Operators ET-MK
Meter Box No. 4 ^HB 1.88 IN WC
Cassette coeff. .999X

Pitot No. 12-16V Cp .840
Bar. Press. 29.12 inHg H2O x
Nozzle No. 5-4 Nozzle Dia .249 IN.

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Des. Vol. (cf)	VAC. inHg	Temperatures (°F) Stack	Probe	Oven	Impg.	Gas/In	Gas/Out	Oxygen (%v/v)
	1210	122.30											
3	5	126.80	.70	1.72	5.99	9.0	282	249	IN-STACK	42	88	87	5.9
3	10	129.90	.74	1.83	3.82	9.5	283	250		42	90	87	5.9
3	15	133.69	.76	1.87	3.67	9.5	291	250		42	93	88	6.0
3	20	137.45	.74	1.82	7.49	9.5	283	247		42	94	88	5.9
2	25	141.40	.76	1.87	1.35	10.0	285	249		43	94	88	5.7
2	30	145.15	.74	1.83	5.18	10.0	280	250		44	94	88	5.8
2	35	148.92	.72	1.78	8.95	10.0	282	246		44	94	88	5.8
2	40	152.75	.72	1.78	2.73	10.0	280	250		44	94	88	5.9
1	45	156.27	.62	1.54	6.23	10.0	279	252		44	94	88	5.9
1	50	159.70	.60	1.49	9.69	10.0	277	249		44	94	88	5.8
1	55	163.10	.57	1.42	3.06	9.8	275	250		44	94	88	6.0
1	60	166.50	.58	1.44	6.47	9.8	275	248		44	94	88	5.9
	(1310)												
	θ = 60	Vm = 44.20		^H = 1.70							Avg. = 90.4		

S-0037P

APPENDIX D

4M5 FIELD DATA SHEETS - STACK

INTERPOLL LABORATORIES EPA METHOD 2 FIELD DATA SHEET

Job NSP / SHERCO

Source UNIT #3 STACK

Test 1 Run 0 Date 3-27-90

Stack dimen. 354 IN.

Dry bulb ____ °F Wet bulb ____ °F

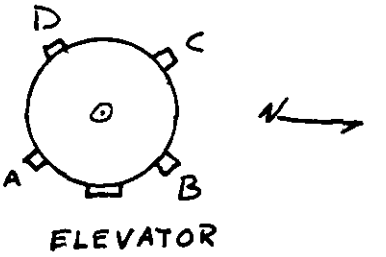
Manometer: ☒ Reg. ☐ Exp. ☐ Elec.

Barometric pressure 28.58 in Hg

Static pressure -.72 in WC

Operators DBH & SLB

Pitot No. 14-8 Cp .840



ELEVATOR

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: 40 in.		Time start:	hrs
A	1	.032	11.33	51.33		
	2	.105	37.17	77.17		
	3	.194	68.68	108.68		
	4	.323	114.34	154.34		
B	1					
	2					
	3					
	4					
C	1					
	2					
	3					
	4					
D	1					
	2					
	3					
	4					
Temp. meas. tool & S/N:					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 NSP / SHERCO
Source UNIT 43
Method 4MS Filter holder: SS

Date 3-27-90 Test 1 Run 1
No. of traverse points 16
Filter type: glass fiber - paper

Sample Train Leak Check:

Pretest: < 0.02 cfm at 15 in. Hg. (vac) ☒
Postest: 0 cfm at 5 in. Hg. (vac) ☒

Particulate Catch Data:

No.s of filters used: 4MS-0209

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

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

Condensate Data:

Item	Weight (g)		
	Final	Tare	Difference
Impinger No. 1	-	400	
Impinger No. 2	515		115
Impinger No. 3			
Condenser			
Desiccant	1498	1438	10
Total			125

Integrated Gas Sampling Data:

Bag Pump No. B3 Box No. 17 Bag No. 1

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

Pretest leak check: 0 cc/min at 14 in. Hg.

Time start: 0846 (HRS) Time end: 0953 (HRS)

Sampling rate: 460 cc/min Operator:

S/N of O_2 Analyzer used to monitor train outlet: 8

CF-023

CF-011

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job NSP / SHERCO
Source UNIT 3 STACK
Date 3-27-90 Test 1 Run 1

Operators DW4 & SLB
Meter Box No: 8 ΔH 1.88 IN WC
Coeffic coeff: .9980

Pitot No. V14-8 Cp .840
Bar. Press. 28.58 inHg H2O 12 X
Nozzle No. 4-3 Nozzle Dia .178 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.	Cen/In	Cen/Out	Oxygen (x v/v)
	(0840)	(521.78)											
A 4	4	521.93	1.25	.89	1.87	2.5	168	239	252	42	63	63	5.0
3	8	524.04	1.30	.94	4.01	2.5	167				69	65	6.1
2	12	526.22	1.35	.98	6.22	3	167				71	66	6.4
1	16	528.38	1.25	.91	8.34	2.5	167	243	256	37	69	65	6.5
B 4	20	530.43	1.20	.87	0.42	2.5	167				65	62	6.6
3	24	532.45	1.20	.87	2.49	2.5	166				64	61	6.5
2	28	534.54	1.15	.83	4.51	2.5	166	244	255	38	65	62	6.6
1	32	536.50	1.10	.79	6.48	2.5	166				63	60	6.6
C 4	36	538.54	1.20	.86	8.54	2.5	166				59	57	6.7
3	40	540.56	1.20	.86	0.49	2.5	166	251	254	38	61	59	6.6
2	44	542.53	1.10	.79	2.55	2.5	167				63	59	6.6
1	48	544.50	1.10	.79	4.52	2.5	167				64	59	6.6
D 4	52	546.61	1.25	.90	6.62	2.5	167				65	60	6.6
3	56	548.73	1.30	.93	8.76	2.5	167	252	253	37	68	61	6.6
2	60	550.89	1.30	.94	0.91	2.5	167				69	62	6.6
1	64	553.00	1.20	.87	2.99	2.5	167				70	62	6.6
	(0954)												
	θ = 64	Vm = 33.22		ΔH = .88							Avg. = 63.4		

S-0037R

INTERPOLL LABORATORIES EPA METHOD 5/17 SAMPLE LOG SHEET

Job N.S.P SHERCO III Date 3/27/90 Test 1 Run 2
Source UNIT #3 Stack No. of traverse points 16
Method 17/5 Filter holder: SS Filter type: glass fiber - pall

Sample Train Leak Check:

Pretest: ~~(0.02 cfm at 15 in. Hg. (vac)~~
Postest: ~~.005 cfm at 6 in. Hg. (vac)~~

Particulate Catch Data:

No.s of filters used: 0210

Recovery solvent(s)
~~acetone~~
other(s) NITRIC

No. of probe wash bottles: 1
Sample recovered by: ~~DUH~~ a S.LB

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impinger No. 1	-		
Impinger No. 2	510	400	110
Impinger No. 3			
Condenser			
Desiccant	1341	1334	7
Total			117

Integrated Gas Sampling Data:

Bag Pump No. B3 Box No. 17 Bag No. 1

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

Pretest leak check: 0 cc/min at 14 in. Hg.

Time start: 10^{30} (HRS) Time end: 11^{39} (HRS)

Sampling rate: 400 cc/min Operator: ~~DUH~~

S/N of O_2 Analyzer used to monitor train outlet: 8

CF-023

CF-011

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job: N.S.P SHERCO
Source: UNIT #3 Stack
Date: 3/27/90 Test 1 Run 2

Operators: [illegible] & S CB
Meter Box No. 8 ^H@ 1.88 IN WC
Gasmeter coeff. .9980

Pitot No. 1114-8 Cp .84
Bar. Press. 28.78 inHg H2O 15 %
Nozzle No. 4-3 Nozzle Dia. .78 IN.

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Obs. Vol. (cf)	VAC. inHg	Temperatures (°F) Stack	Probe	Oven	Impg.	Gas/In	Gas/Out	Oxygen (%v/v)
	10 25	553.40											
D 4	4	555.43	1.25	.85	5.44	2.5	168	249	243	40	62	61	6.6
3	8	557.62	1.30	.88	7.53	2.5	165				68	63	6.5
2	12	559.76	1.35	.93	9.67	2.5	165				70	64	6.5
1	16	561.70	1.20	.83	1.69	2.5	165	255	248	37	72	64	6.5
C 4	20	563.74	1.20	.83	3.72	2.5	166				72	65	6.7
3	24	565.77	1.20	.83	5.74	2.5	166				75	67	6.6
2	28	567.84	1.20	.83	7.78	2.5	166				75	67	6.6
1	32	569.80	1.15	.80	9.78	2.5	166	255	252	37	71	64	6.6
B 4	36	571.72	1.15	.79	1.76	2.5	166				63	60	6.6
3	40	573.71	1.10	.75	3.68	2.5	166				63	59	6.6
2	44	575.63	1.10	.75	5.59	2.5	166				60	56	6.5
1	48	577.60	1.20	.81	7.58	2.5	166	250	254	39	60	56	6.5
A 4	52	579.60	1.25	.84	9.61	2.5	165				56	53	6.7
3	56	581.59	1.30	.87	1.66	2.5	165				57	54	6.6
2	60	583.78	1.30	.87	3.73	2.5	165	256	253	40	59	54	6.6
1	64	585.78	1.30	.88	5.79	2.5	165				64	57	6.6
	11 39												
	θ = 64	Vm = 32.38		^H = .83							Avg. = 62.8		

S-0037R

INTERPOLL LABORATORIES EPA METHOD 5/17 SAMPLE LOG SHEET

Job N.S.P. STEROO
Source UNIT # 3 Stack
Method 4M5 Filter holder: 5.5

Date 3/27/90 Test 1 Run 3
No. of traverse points 16
Filter type: glass fiber - pallflex

Sample Train Leak Check:

Pretest: 0.02 cfm at 15 in. Hg. (vac) ~~X~~
Postest: 0.00 cfm at 5 in. Hg. (vac) ~~X~~

Particulate Catch Data:

No.s of filters used: 0208

Recovery solvent(s)
~~X~~ acetone
X other(s) NITRIC

No. of probe wash bottles: 1
Sample recovered by: ~~DKH~~ S.CB

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impinger No. 1	-		
Impinger No. 2	509	400	109
Impinger No. 3			
Condenser			
Desiccant	1452	1448	4
Total			113

Integrated Gas Sampling Data:

Bag Pump No. B3 Box No. 17 Bag No. 3

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

Pretest leak check: 0 cc/min at 17 in. Hg.

Time start: 1210 (HRS) Time end: 1324 (HRS)

Sampling rate: 400 cc/min Operator: ~~DKH~~

S/N of O_2 Analyzer used to monitor train outlet: 8

CF-023

CF-D11

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job N.S.P. SHERCO
Source UNIT #3 STACK
Date 3/27/90 Test 1 Run 3

Operators ~~DH~~ & S.L.B
Meter Box No. 8 ΔH 1.88 IN WC
Calibrator coeff. .9980

Pitot No. P14-8 Cp = .84
Bar. Press. 25.48 inHg H2O 13.6 X
Nozzle No. #3 Nozzle Dia .178 IN.

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dep. Vol. (cf)	VAC. inHg	Temperatures (°F) Stack	Probe	Oven	Impg.	Gas In	Gas Out	Oxygen (v/v)
	12.10	586.2											
A 4	4	588.23	1.2	.82	8.2	2.5	166	252	247	42	59	59	6.3
3	8	590.35	1.30	.88	0.27	2.5	166				67	64	6.5
2	12	592.	1.30	.89	2.37	2.5	166				70	63	6.5
1	16	594.39	1.20	.82	4.39	2.5	166	253	248	42	72	63	6.4
B 4	20	596.42	1.25	.86	6.45	2.5	166				66	60	6.6
3	24	598.47	1.20	.82	8.46	2.5	166				67	61	6.5
2	28	600.38	1.15	.78	0.43	2.5	166	254	252	41	67	61	6.5
1	32	602.35	1.00	.68	2.27	2.5	166				65	59	6.5
C 4	36	604.33	1.15	.78	4.23	2.5	165				60	56	6.6
3	40	606.30	1.20	.81	6.22	2.5	165	253	253	41	63	58	6.6
2	44	608.32	1.30	.88	8.30	2.5	165				66	60	6.6
1	48	610.23	1.10	.75	0.22	2.5	165				69	61	6.6
D 4	52	612.28	1.20	.82	2.34	2.5	165	252	253	41	67	61	6.7
3	56	614.34	1.30	.89	4.33	2.5	165				71	63	6.6
2	60	616.45	1.30	.89	6.44	2.5	165				13	64	6.5
1	64	618.47	1.20	.83	8.47	2.5	165	253	253	41	74	65	6.5
	1324												
	θ = 64	Vm = 32.27		ΔH = .83							Avg. = 64		

D-7

S-0037R

APPENDIX E

CHROMIUM SAMPLING TRAIN FIELD DATA SHEETS

INTERPOLL LABORATORIES EPA METHOD 2 FIELD DATA SHEET

Job N.S.P. SHERCO

Source UNIT #3 Stack

Test 2 Run 0 Date 3/27/90

Stack dimen. 354 IN.

Dry bulb _____ °F Wet bulb _____ °F

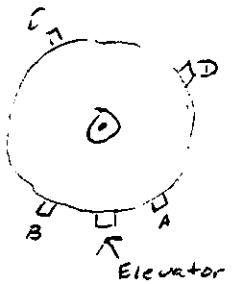
Manometer: ☒ Reg. ☐ Exp. ☐ Elec.

Barometric pressure 28.80 in Hg

Static pressure -.72 in WC

Operators D. VanHoever & S. Bainu. IIc

Pitot No. V14-8 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: 40 in.		Time start:	hrs
A 1	.032	11.33	51.33		
2	.105	37.17	77.17		
3	.194	68.68	108.68		
4	.323	114.34	154.34		
B 1					
2					
3					
4					
C 1					
2					
3					
4					
D 1					
2					
3					
4					

Temp. meas. tool & S/N: Time end: hrs

P or nothing= reg. manometer; S= expanded; E = electronic S-392

INTERPOLL LABORATORIES EPA METHOD 5/17 SAMPLE LOG SHEET

Job N.S.P. SHERCO Date 3/27/90 Test 2 Run 1
Source UNIT # 3 Stack No. of traverse points 16
Method ____ Filter holder: S.S. Filter type: teflon

Sample Train Leak Check:

Pretest: (0.02 cfm at 15 in. Hg. (vac) ☒
Postest: 0.00 cfm at 5 in. Hg. (vac) ☒

Particulate Catch Data:

No.s of filters used: Recovery solvent(s)

☐ acetone
☒ other(s) 1 N NAOH

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

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impinger No. 1	-	3200	
Impinger No. 2			104
Impinger No. 3			
Condenser			
Desiccant	1348	1343	5
Total			109

Integrated Gas Sampling Data:

Bag Pump No. B3 Box No. 22 Bag No. 1
Bag Material: 5-layer Aluminized Tedlar Size: 44 L
Pretest leak check: 0 cc/min at 14 in. Hg.
Time start: 1430 (HRS) Time end: 1540 (HRS)
Sampling rate: 400 cc/min Operator DWF
S/N of O_2 Analyzer used to monitor train outlet: 8

CF-023

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job N.S.P. SHERCO
Source UNIT #3 Stack
Date 3/27/92 Test 2 Run 1

Operators Duff & SLB
Meter Box No. 9 ΔH 1.88 TN WC
Cmeter cont. .9985

Pitot No. U14-8 Cp .84
Bar. Press. 28.x inHg H2O 75 %
Nozzle No. 4-3 Nozzle Dia .178 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.	Cen/In	Cen/Out	Oxygen (v/v)
	1430	620.04											
(1) 4	4	622.05	1.20	.82	2.04	2.5	164			39	64	64	6.7
3	8	624.19	1.30	.89	4.16	2.5	164				72	67	6.5
2	12	626.29	1.30	.90	6.29	2.5	164				75	68.0	6.4
1	16	628.30	1.15	.80	8.30	2.5	164				76	68	6.3
C 4	20	630.32	1.15	.8	0.31	2.5	164			38	75	69	6.5
3	24	632.37	1.20	.84	2.36	2.5	164				77	70	6.4
2	28	634.42	1.20	.84	4.42	2.5	164				78	70	6.4
1	32	636.49	1.20	.84	6.48	2.5	164			38	78	71	6.4
B 4	36	638.57	1.20	.84	8.54	2.5	164				74	69	6.4
3	40	640.48	1.10	.77	0.51	2.5	163				71	66	6.3
2	44	642.46	1.10	.76	2.46	2.5	163				70	66	6.3
1	48	644.45	1.10	.76	4.42	2.5	163				70	66	6.3
A 4	52	646.47	1.20	.83	6.45	2.5	163			37	70	65	6.3
3	56	648.50	1.30	.90	8.57	2.5	163				70	65	6.3
2	60	650.68	1.30	.9	0.69	2.5	163				72	67	6.3
1	64	652.70	1.15	.80	2.69	2.5	164				73	67	6.3
	(1540)												
	θ = 64	Vm = 32.66		ΔH = .83							Avg. = 70.1		

E-3

S-0037R

INTERPOLL LABORATORIES EPA METHOD 5/17 SAMPLE LOG SHEET

Job N.S.P. SHERCO
Source Unit #3 Stack
Method ____ Filter holder: S.S.
Date 3/27/90 Test 2 Run 2
No. of traverse points 16
Filter type: teflon

Sample Train Leak Check:

Pretest: (0.02 cfm at 15 in. Hg. (vac) ☒
Postest: 0.00 cfm at 5 in. Hg. (vac) ☒

Particulate Catch Data:

No.s of filters used: ____

Recovery solvent(s)

☐ acetone
☒ other(s) 0.1N NaOH

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

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impinger No. 1	-		
Impinger No. 2	406	300	106
Impinger No. 3			
Condenser			
Desiccant	1460	1452	8
Total			114

Integrated Gas Sampling Data:

Bag Pump No. B3 Box No. 22 Bag No. 2

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

Pretest leak check: 0 cc/min at 14 in. Hg.

Time start: 1550 (HRS) Time end: 1659 (HRS)

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

S/N of O_2 Analyzer used to monitor train outlet: 8

CF-023

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job N.S.P SHERCO
Source UNIT # 3 Stack
Date 3/27/90 Test 2 Run 2

Operator DHK & SCB
Meter Box No. 8 ΔH 1.88 IN WC
Barometer coeff. .9980

Pitot No. V14-8 Cp .84
Bar. Press. 25.50 inHg H2O 75 %
Nozzle No. #3 Nozzle Dia .18 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.	Cen/In	Cen/Out	Oxygen (xv/v)
	1530	653.50											
A 4	4	655.58	1.20	.83	5.54	2.5	164			40	68	66	6.5
3	8	657.62	1.20	.83	7.57	2.5	164				68	72	6.4
2	12	659.74	1.30	.9	9.70	2.5	164				74	68	6.3
1	16	661.77	1.20	.83	1.75	2.5	164			39	75	69	6.2
4	20	663.90	1.20	.84	3.81	2.5	163				72	68	6.4
3	24	665.93	1.15	.80	5.81	2.5	163				66	66	6.3
2	28	667.90	1.20	.83	7.85	3.0	163			38	66	62	6.3
1	32	669.79	1.10	.76	9.78	3.0	163				64	61	6.4
4	36	671.80	1.25	.86	1.84	3.0	163				64	61	6.3
3	40	673.89	1.20	.82	3.96	3.0	163			38	65	61	6.3
2	44	675.93	1.20	.82	5.88	3.0	164				67	62	6.4
1	48	677.82	1.10	.76	7.82	3.0	164				70	64	6.4
4	52	679.88	1.25	.86	9.89	3.0	164			38	70	64	6.4
3	56	682.00	1.30	.90	2.01	3.0	164				73	65	6.3
2	60	684.09	1.25	.86	4.08	3.0	164				75	66	6.4
1	64	686.05	1.10	.76	6.04	3.0	164			39	75	67	6.3
	(1659)												
	θ = 64	Vs = 32.6		ΔH = .83							Avg. = 67.2		

E-5

INTERPOLL LABORATORIES EPA METHOD 5/17 SAMPLE LOG SHEET

Job N.S.P. SHERCO Date 3/27/90 Test 2 Run 3
Source UNIT # 3 Stack No. of traverse points
Method Filter holder: S S Filter type: teflon

Sample Train Leak Check:

Pretest: 0.02 cfm at 15 in. Hg. (vac) ☒
Postest: 0.00 cfm at 5 in. Hg. (vac) ☒

Particulate Catch Data:

No.s of filters used:

Recovery solvent(s)

☐ acetone
☒ other(s) 1N NAOH

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

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impinger No. 1	-		
Impinger No. 2	408	300	108
Impinger No. 3			
Condenser			
Desiccant	1357	1349	8
Total			116

Integrated Gas Sampling Data:

Bag Pump No. B3 Box No. 22 Bag No. 3
Bag Material: 5-layer Aluminized Tedlar Size: 44 L
Pretest leak check: 0 cc/min at 14 in. Hg.
Time start: 1710 (HRS) Time end: 1820 (HRS)
Sampling rate: 400 cc/min Operator: DHH
S/N of O_2 Analyzer used to monitor train outlet: 8

CF-023

CF-D11

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job: N.S.P. SHERCO
Source: Unit #3 Stack
Date: 3/27/90 Test 2 Run 3

Operators: DVM + SLB
Meter Box No. 8 ^H@ 1.88 IN WC
Gasmeter coeff. .9980

Pitot No. VH-8 Cp .840
Bar. Press. 28.80 inHg H2O 15 %
Nozzle No. 4-3 Nozzle Dia .172 IN.

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dgs. Vol. (cf)	VAC. inHg	Temperatures (°F) Stack	Probe	Oven	Imp.	Gas/In	Gas/Out	Oxygen (xv/v)
	(1710)	686.93								43	72	68	6.3
4	4	689.09	1.30	.90	9.04	3.0	164				76	69	6.3
3	8	691.08	1.25	.87	1.13	3.0	164				78	70	6.0
2	12	693.14	1.20	.84	3.19	3.0	163			42	79	71	5.9
1	16	695.11	1.10	.77	5.16	3.0	163				80	72	6.0
4	20	697.20	1.25	.88	7.27	3.0	163				81	72	6.0
3	24	699.30	1.20	.84	9.34	3.0	165			40	82	73	6.0
2	28	701.44	1.20	.84	1.41	3.0	163				82	74	6.0
1	32	703.35	1.10	.78	3.40	3.0	163				83	74	6.0
4	36	705.40	1.20	.85	5.48	3.0	163			40	83	75	6.1
3	40	707.51	1.10	.78	7.47	3.0	163				79	72	6.0
2	44	709.63	1.10	.78	9.46	3.0	164				71	67	5.9
1	48	711.49	1.20	.84	1.53	3.0	162			38	71	67	6.0
4	52	713.54	1.20	.83	3.58	3.0	162				73	68	5.9
3	56	715.67	1.30	.90	5.70	3.0	162				75	69	5.9
2	60	717.83	1.30	.91	7.84	3.0	162			38	76	70	6.0
1	64	719.85	1.15	.80	9.85	3.0	162						
	(1820)												
	θ = 64	Vm = 32.92		^H = .84							Avg. = 74.1		

S-0037R

APPENDIX F

LABORATORY DATA SHEETS FOR METHOD 3

Interpoll Laboratories
(612) 786-6020

Chain of Custody
Sample Deposition Sheet

Job NSP / SHERCO
Team Leader DVH
Date Submitted 3-27-90
Test No. 1

Source UNIT #3
Test Site STACK
Date of Test 3-27-90
No. of Runs Completed 3

No. of Samples	Type of Sample	Analysis Required	Comments
4	Probe Wash: ☒ Acetone ☐ D.I. Water	☐ As per EPA M-5 ☒ Other Metals	+ Blank
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 Metals	+ BLANK
4 pairs	Impinger Catch: ☐ D.I. Water ☐ 3% H_2O_2 ☐ 4M5 Hg Only ☒ 4M5 Metals ☐ 1.0 N NaOH ☒ Other Hg	☐ MN Protocol ☐ WI Protocol ☐ EPA M-6 or 8 ☐ Acid Gases ☐ Formaldehyde ☒ Metals ☒ Other Hg	//
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: NSP / Sherco
Team Leader: DVH
Date Submitted: 3-27-90
Test No.: 1
Date of Analysis: 3-28-90

Source: Unit #3
Test Site: Stack
Date of Test: 3-27-90
No. of Runs Completed: 3
Technician: RC

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	9242-36	1	0.00	13.50	20.00	13.50	6.50	1.07
		2	0.00	13.50	20.00	13.50	6.50	1.07
	☒B ☐F	Avg				13.50	6.50	
1/2	9242-37	1	0.00	13.80	20.00	13.80	6.20	1.07
		2	0.00	13.80	20.00	13.80	6.20	1.07
	☒B ☐F	Avg				13.80	6.20	
1/3	9242-38	1	0.00	13.90	20.00	13.90	6.10	1.07
		2	0.00	13.90	20.00	13.90	6.10	1.07
	☒B ☐F	Avg				13.90	6.10	
		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 $F_o = \frac{20.9 - O_2}{CO_2}$

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

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

LSC-04-BR

Interpoll Laboratories
(612) 786-6020

Chain of Custody
Sample Deposition Sheet

Job NSP/SHERCO
Team Leader E Thorbjornsen
Date Submitted 3-27-90
Test No. 1

Source Unit 3
Test Site SDA Inlet
Date of Test 3-27-90
No. of Runs Completed 3

No. of Samples	Type of Sample	Analysis Required	Comments
X	Probe Wash: ☒ Acetone ☐ D.I. Water	☐ As per EPA M-5 ☒ Other metals	
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	
8	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: NSP / Sherco
Team Leader: ET
Date Submitted: 3-27-96
Test No.: 1
Date of Analysis: 3-28-96

Source: Unit #3
Test Site: Inlet
Date of Test: 3-27-96
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	9242-17	1	0.00	13.30	20.00	13.30	6.70	1.07
		2	0.00	13.30	20.00	13.30	6.70	1.07
	☑ B ☐ F	Avg				13.30	6.70	
1/2	9242-18	1	0.00	13.40	19.90	13.40	6.50	1.07
		2	0.00	13.40	19.90	13.40	6.50	1.07
	☑ B ☐ F	Avg				13.40	6.50	
1/3	9242-19	1	0.00	13.50	19.90	13.50	6.40	1.07
		2	0.00	13.50	19.90	13.50	6.40	1.07
	☑ B ☐ F	Avg				13.50	6.40	
		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 $F_o = \frac{20.9 - O_2}{CO_2}$

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

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

LSC-04-BR

Interpoll Laboratories
(612) 786-6020

Chain of Custody
Sample Deposition Sheet

Job N.S.P. SHERCO
Team Leader ~~DOH~~
Date Submitted 3/27/90
Test No. 2

Source Unit #3
Test Site Stack
Date of Test 3/27/90
No. of Runs Completed 3

No. of Samples	Type of Sample	Analysis Required	Comments
	Probe Wash: ☐Acetone ☐D.I. Water	☐As per EPA M-5 ☐Other _____	
	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 _____	
4	Impinger Catch: ☐D.I. Water ☐3% H_2O_2 ☐4M5 Hg Only ☐4M5 Metals ☐1.0 N NaOH ☒Other Cr	☐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 NSP/Sherco
Team Leader DVH
Date Submitted 3-27-90
Test No. 2
Date of Analysis 3-28-90

Source Unit #3
Test Site Stack
Date of Test 3-27-90
No. of Runs Completed 3
Technician RL

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
2/1	9242-47	1	0.00	13.60	19.70	13.60	6.10	1.09
		2	0.00	13.60	19.70	13.60	6.10	1.09
	☑ B ☐ F	Avg				13.60	6.10	
2/2	9242-48	1	0.00	13.60	19.70	13.60	6.10	1.09
		2	0.00	13.60	19.70	13.60	6.10	1.09
	☑ B ☐ F	Avg				13.60	6.10	
2/3	9242-49	1	0.00	13.60	19.60	13.60	6.00	1.10
		2	0.00	13.60	19.60	13.60	6.00	1.10
	☑ B ☐ F	Avg				13.60	6.00	
		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 $F_o = \frac{20.9 - O_2}{CO_2}$

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

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

LSC-04-BR

APPENDIX G

RESULTS OF TRACE METAL ANALYSIS

INTERPOLL LABORATORIES, INC.
(612)786-6020

NSP/Sherco
Laboratory Log No. 9242

Results of Trace Metal Analysis

Test: 1
Source: Unit No. 3 Stack
Sample Type: 4M5 Train Catch

		Total Mass of Trace Metal in Sample (ug)			
Trace Metal	EPA Method	Field Blank	Run 1	Run 2	Run 3
(Log No.)		(9242-39)	(9242-40)	(9242-41)	(9242-42)
Aluminum	SW-846, 6010	270	510	330	360
Arsenic	SW-846, 7060	0.17	0.10	< 0.05	< 0.05
Boron	SW-846, 6010	33	2420	408	1690
Barium	SW-846, 6010	8.1	12.5	10.6	9.5
Beryllium	SW-846, 7091	0.018	0.020	0.024	0.030
Calcium	SW-846, 6010	247	608	413	405
Cadmium	SW-846, 6010	237	27	11	6.5
Chromium	SW-846, 6010	3.9	15	19	7.0
Copper	SW-846, 6010	40	102	50	26
Iron	SW-846, 6010	60	169	130	68
Potassium	SW-846, 6010	110	295	140	137
Magnesium	SW-846, 6010	25	62	40	51
Manganese	SW-846, 6010	15	7.6	47	5.1
Molybdenum	SW-846, 6010	26	32	28	30
Sodium	SW-846, 6010	540	1030	720	740
Nickel	SW-846, 6010	29	11	10	4.2
Lead	SW-846, 6010	5.2	19.5	8.8	5.9
Selenium	SW-846, 7740	< 2.5	< 2.5	< 2.5	< 2.5
Antimony	SW-846, 7041	0.21	1.1	0.41	0.17
Strontium	3500-Sr. B[1]	< 5	6.5	< 5	< 5
Vanadium	SW-846, 6010	< 0.1	< 0.1	< 0.1	< 0.1
Zinc	SW-846, 6010	180	117	41	30
Mercury	SW-846, 7470	< 0.1	0.96	< 0.4	< 0.2
Silver	SW-846, 6010	< 0.3	< 0.3	< 0.3	< 0.3

[1]Standard Methods, 17th Edition.

INTERPOLL LABORATORIES, INC.
(612)786-6020

NSP/Sherco
Laboratory Log No. 9242

Results of Trace Metal Analysis

Test: 1
Source: Unit No. 3 Stack
Sample Type: Permanganate Impinger Catch

		Total Mass of Trace Metal in Sample (ug)			
Trace Metal	EPA Method	Field Blank	Run 1	Run 2	Run 3
(Log No.)		(9242-23)	(9242-27)	(9242-31)	(9242-35)
Mercury	SW-846, 7470	0.80	5.0	2.9	4.9

INTERPOLL LABORATORIES, INC.
(612)786-6020

NSP/Sherco
Laboratory Log No. 9242

Results of Trace Metal Analysis

Test: 1
Source: Unit No. 3 SDA Inlet
Sample Type: Inlet Train Catch

		Total Mass of Trace Metal in Sample (ug)		
Trace Metal	EPA Method	Run 1	Run 2	Run 3
(Log No.)		(9242-06)	(9242-10)	(9242-14)
Aluminum	SW-846, 6010	164000	299000	219000
Arsenic	SW-846, 6010	82	77	98
Boron	SW-846, 6010	9940	9640	12820
Barium	SW-846, 6010	12150	18440	12100
Beryllium	SW-846, 6010	27	29	31
Calcium	SW-846, 6010	392000	707000	465000
Cadmium	SW-846, 6010	10	10	9
Chromium	SW-846, 6010	313	328	370
Copper	SW-846, 6010	695	650	880
Iron	SW-846, 6010	162000	128000	185000
Potassium	SW-846, 6010	60900	56600	68300
Magnesium	SW-846, 6010	23600	35100	35600
Manganese	SW-846, 6010	6420	6080	7360
Molybdenum	SW-846, 6010	109	88	135
Sodium	SW-846, 6010	100000	130000	139000
Nickel	SW-846, 6010	242	204	279
Lead	SW-846, 6010	758	580	770
Selenium	SW-846, 6010	56	40	71
Antimony	SW-846, 6010	99	68	110
Strontium	SW-846, 6010	23400	13700	28900
Vanadium	SW-846, 6010	830	750	980
Zinc	SW-846, 6010	320	310	320
Mercury	SW-846, 7470	0.29	0.32	< 0.25
Silver	SW-846, 6010	< 3.0	< 3.0	< 3.0

INTERPOLL LABORATORIES, INC.
(612)786-6020

NSP/Sherco
Laboratory Log No. 9242

Results of Trace Metal Analysis

Test: 1
Source: Unit No. 3 SDA Inlet
Sample Type: Permanganate Impinger Catch

		Total Mass of Trace Metal in Sample (ug)			
Trace Metal	EPA Method	Field Blank	Run 1	Run 2	Run 3
(Log No.)		(9242-50)	(9242-51)	(9242-52)	(9242-53)
Mercury	SW-846, 7470	0.22	9.8	9.3	6.6

NSP Sherco Unit 3
March 90

Method	All ICP Historical		Measured	Used	Run 1	Run 3	Run 3
ICP	375	Al	270	270	510	330	360
GF/AA	<5	As	0.17	.05	x	<.05	<.05
ICP	9	B	33	9	2420	408	1690
ICP	12	Ba	8.1	8.1	12.5	10.6	9.5
GF/AA	<.1	Be	.018	.018	.020	.024	.030
ICP	181	Ca	247	181	608?	413	405
ICP	<.4	Cd	237	<.4	x	11?	6.5
ICP	<.7	Cr	3.9	<.7	15	9	7
ICP	3.2	Cu	40	3.2	102	50	26
ICP	38	Fe	60	38	169	130	68
ICP	64	K	110	64	295	140	137
ICP	25	Mg	25	25	62	40	51
ICP	<.5	Mn	15	<.5	7.6	47	5.1
ICP	33	Mo	26	33	32	28	30
ICP	158	Na	540	158	1030?	720	740
ICP	<1	Ni	29	<1	11?	10	4.2
ICP	<4	Pb	5.2	<4	19.5	8.8	5.9
GF/AA	<5	Se	<2.5	<2.5	<2.5	<2.5	<2.5
GF/AA	<.5	Sb	.21	.21	1.1	0.41	0.17
GF/AA	<5	Sr	<5	<5	6.5	<5	<5
ICP	<.1	V	<.1	<.1	<.1	<.1	<.1
ICP	9.1	Zn	180	9.1	x	41	30
Cold Vapor	<.4	Hg	<.1	<.4	.96	<.4	<.2
ICP	<.6	Ag	<.3	<.3	<.3	<.3	<.3
Cold Vapor		Hg	.80	.8	5.0	2.9	4.9
Total Train		Hg	<.9	.8	5.96	2.9	4.9

x = Invalidated due to field contamination (3)
? = Result may be high due to field contamination (3)

*Prepared by P. Lonnes
May 1990
Total analyses = 72

APPENDIX H

RESULTS OF LIME ANALYSIS

INTERPOLL LABORATORIES, INC.
(612)786-6020

NSP/Sherco
Laboratory Log No. 9242

Results of Trace Metals Analysis

Source: Unit No. 3

Sample Type: Lime

Metal	EPA Method	Concentration of Trace Metal in Sample (ug/g)
(Log No.)		(9242-73)
Arsenic	SW-846, 6010	< 5.0
Beryllium	SW-846, 6010	< 0.1
Cadmium	SW-846, 6010	< 0.2
Chromium	SW-846, 6010	15.3
Nickel	SW-846, 6010	3.2
Lead	SW-846, 6010	< 2.5
Selenium	SW-846, 6010	< 5.0
Mercury	SW-846, 7470	0.07

APPENDIX I

RESULTS OF TRACE METALS ANALYSES ON COAL SAMPLE

INTERPOLL LABORATORIES, INC.
(612)786-6020

NSP/Sherco
Laboratory Log No. 9242

Results of Trace Metals Analysis

Source: Unit 3
Sample Type: Coal

Metal	Method[a]	Concentration of Trace Metal in Sample (ug/g)
(Log No.)		(9242-74)
Arsenic	SW-846, 7060	0.70
Beryllium	SW-846, 7091	0.32
Cadmium	SW-846, 7131	0.06
Chromium	SW-846, 6010	4.4
Nickel	SW-846, 6010	2.3
Lead	SW-846, 6010	9.1
Selenium	SW-846, 7740	< 1.6
Mercury	ASTM D3684	< 0.02

[a]Sample prepped by ASTM Method D3683.

APPENDIX J

PROCEDURES

Trace Metals (4M5) Procedures

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11/7/89

METHODOLOGY FOR THE DETERMINATION OF METALS EMISSIONS IN EXHAUST GASES FROM STATIONARY SOURCE COMBUSTION PROCESSES

1. Applicability and Principle

1.1 Applicability. This method is applicable for the determination of total chromium (Cr), cadmium (Cd), arsenic (As), nickel (Ni), manganese (Mn), beryllium (Be), copper (Cu), zinc (Zn), lead (Pb), selenium (Se), phosphorus (P), thallium (Tl), silver (Ag), antimony (Sb), barium (Ba), and mercury (Hg) emissions from municipal waste incinerators, sewage sludge incinerators, and hazardous waste incinerators. This method may also be used for the determination of particulate emissions following the additional procedures described. Modifications to the sample recovery and analysis procedures described in this protocol for the purpose of determining particulate emissions may potentially impact the front half mercury determination.*

1.2 Principle. Particulate and gaseous metal emissions are withdrawn isokinetically from the source and collected on a heated filter, and in a series of chilled impingers containing a solution of dilute nitric acid in hydrogen peroxide in two impingers, and acidic potassium permanganate solution in two (or one) impingers. Sampling train components are recovered and digested in separate front and back half fractions. Materials collected in the sampling train are digested with acid solutions to dissolve inorganics and to remove organic constituents that may create analytical interferences. Acid digestion is performed using conventional Parr^{R} Bomb or microwave digestion techniques. The nitric acid and hydrogen peroxide impinger solution, the acidic potassium permanganate impinger solution, and the probe rinse and digested filter solutions are analyzed for mercury by cold vapor atomic absorption spectroscopy (CVAAS). Except for the permanganate solution, the

*Field tests to date have shown that of the total amount of mercury measured by the method, only 0 to <2% was measured in the front half. Therefore, it is tentatively concluded, based on the above data, that particulate emissions may be measured by this train, without significantly altering the mercury results.

This document is a preliminary draft. It has not been formally released by EPA and should not at this stage be construed to represent Agency policy. It is being circulated for comment on its technical accuracy and policy implications

remainder of the sampling train catches are analyzed for Cr, Cd, Ni, Mn, Be, Cu, Zn, Pb, Se, P, Tl, Ag, Sb, Ba, and As by inductively coupled argon plasma emission spectroscopy (ICAP) or atomic absorption spectroscopy (AAS). Graphite furnace atomic absorption spectroscopy (GFAAS) is used for analysis of antimony, arsenic, cadmium, lead, selenium, and thallium, if these elements require greater analytical sensitivity than can be obtained by ICAP. Additionally, if desired, the tester may use AAS for analyses of all metals if the detection limits meet the goal of the testing program. For convenience, aliquots of each digested sample fraction can be combined proportionally for a single analytical determination. The efficiency of the analytical procedure is quantified by the analysis of spiked quality control samples containing each of the target metals including actual sample matrix effects checks.

2. Range, Sensitivity, Precision, and Interferences

2.1 Range. For the analyses described in this methodology and for similar analyses, the ICAP response is linear over several orders of magnitude. Samples containing metal concentrations in the nanograms per milliliter (ng/ml) to micrograms per milliliter (ug/ml) range in the analytical finish solution can be analyzed using this technique. Samples containing greater than approximately 50 ug/ml of chromium, lead, or arsenic should be diluted before analysis. Samples containing greater than approximately 20 ug/ml of cadmium should be diluted before analysis.

2.2 Analytical Sensitivity. ICAP detection limits in the analytical solution (based on SW-846, Method 6010) are approximately as follows: Sb (32 ng/ml), As (53 ng/ml), Ba (2 ng/ml), Be (0.3 ng/ml), Cd (4 ng/ml), Cr (7 ng/ml), Cu (6 ng/ml), Pb (42 ng/ml), Mn (2 ng/ml), Ni (15 ng/ml), P (75 ng/ml), Se (75 ng/ml), Ag (7 ng/ml), Ti (40 ng/ml), and Zn (2 ng/ml). The actual method detection limits are sample dependent and may vary as the sample matrix may affect the limits. The detection limits for analysis by direct aspiration AAS (based on SW-846, Method 7000) are approximately as follows: Sb (200 ng/ml), As (2 ng/ml), Ba (100 ng/ml), Be (5 ng/ml), Cd (5 ng/ml), Cr (50 ng/ml), Cu (20 ng/ml), Pb (100 ng/ml), Mn (10 ng/ml), Ni (40 ng/ml), Se (2 ng/ml), Ag (10 ng/ml), Tl (100 ng/ml), and Zn (5 ng/ml). The detection limit for mercury by CVAAS is approximately 0.2 ng/ml. The use of GFAAS can give added sensitivity compared to the use of direct aspiration AAS for the following metals: Sb (3 ng/ml), As (1 ng/ml), Be (0.2 ng/ml), Cd (0.1 ng/ml),

Cr (1 ng/ml), Pb (1 ng/ml), Se (2 ng/ml), and Tl (1 ng/ml). To ensure the possibility of optimum ease in obtaining accurate measurements, the concentration of target metals in samples should be at least ten times the detection limit. Under certain conditions, and with greater care in the analytical procedure, this concentration can be as low as approximately three times the detection limit. However, the scatter of such data may render them unacceptable or may require many analyses before the desired reliability of analytical data is obtained.

Using the procedures described in this method, the theoretical analytical detection limits shown above, a volume of 300 ml for the front half and 150 ml for the back half samples, and a stack gas sample volume of 1.25 m^3, the corresponding in-stack detection limits are presented in Table A-1 and calculated as shown:

$$\frac{A \times B}{C} = D$$

where: A = analytical detection limit, ug/ml.
B = volume of sample prior to aliquot for analysis, ml.
C = stack sample volume, dscm, m^3.
D = in-stack detection limit, ug/m^3.

Values in Table A-1 are calculated for the front and back half and/or the total train.

Actual method in-stack detection limits are based on actual test values. If required, this method's in-stack detection limits listed can be improved for a specific test by using one or more of the following options:

- A normal 1-hour sampling run collects a stack gas sampling volume of about 1.25 m^3. If the sampling time is increased and 5 m^3 is collected, the in-stack method detection limits would be one fourth of the values shown above (this means that with this change, the method is four times more sensitive than normal).
- The in-stack detection limits assume that all of the sample is digested (with exception of the aliquot for mercury) and the final liquid volume for analysis is 300 ml for the front half and 150 ml for the back half sample. If the front half volume is reduced from 300 ml to 30 ml, the front half in-stack detection limits would be one tenth of the values shown above (ten times more sensitive). If the back half volume is reduced from 150 ml to 25 ml the in-stack detection limits would be one sixth of the above values. Matrix effects checks are necessary on

3 This document is a preliminary draft. It has not been formally released by EPA and should not at this stage be construed to represent Agency policy. It is being circulated for comment on its technical accuracy and policy implications.

TABLE A-1. IN-STACK METHOD DETECTION LIMITS (ug/m^3)
FOR TRAIN FRACTIONS USING ICAP AND AAS

Metal	Front Half Fraction 1 Probe and Filter	Back Half$_1$ Fraction 2 Impingers 1-3	Back Half$_2$ Fraction 3 Impingers 4-5	Total Train
Antimony	7.7 (0.7)*	3.8 (0.4)*		11.5 (1.1)*
Arsenic	12.7 (0.3)*	6.4 (0.1)*		19.1 (0.4)*
Barium	0.5	0.3		0.8
Beryllium	0.07 (0.05)*	0.04 (0.03)*		0.11 (0.08)*
Cadmium	1.0 (0.02)*	0.5 (0.01)*		1.5 (0.3)*
Chromium	1.7 (0.2)*	0.8 (0.1)*		2.5 (0.3)*
Copper	1.4	0.7		2.1
Lead	10.1 (0.2)*	5.0 (0.1)*		15.1 (0.3)*
Manganese	0.5 (0.2)*	0.2 (0.1)*		0.7 (0.3)*
Mercury	0.05**	0.03**	0.03**	0.11**
Nickel	3.6	1.8		5.4
Phosphorus	18	9		27
Selenium	18 (0.5)*	9 (0.3)*		27 (0.8)*
Silver	1.7	0.9		2.6
Thallium	9.6 (0.2)*	4.8 (0.1)*		14.4 (0.3)*
Zinc	0.5	0.3		0.8

( )* Detection limit when analyzed by GFAAS.
** Detection limit when analyzed by CVAAS.
Actual method in-stack detection limits are based on actual test values.

analyses of samples and typically are of greater significance for samples that have been concentrated below the normal sample volume. A volume less than 25 ml may not allow resolubilization of the residue and may increase interference by other compounds.

- When both of the above two improvements are used on one sample at the same time, the resultant improvements are multiplicative. For example, where stack gas volume is increased by a factor of five and the total liquid sample digested volume of both the front and back halves is reduced by factor of six, the in-stack method detection limit is reduced by a factor of thirty (the method is thirty times more sensitive).
- Conversely, reducing stack gas sample volume and increasing sample liquid volume will increase limits. The front half and back half$_1$ samples (Fractions 1 and 2) can be combined prior to analysis. The resultant liquid volume (excluding Fraction 3 which must be analyzed separately) is recorded. Combining the sample as described does not allow determination (whether front or back half$_1$) of where in the train

the sample was captured. The in-stack method detection limit then becomes a single value for all metals, except mercury for which the contribution of Fraction 3 must be considered.

- The above discussion assumes no blank correction. Blank corrections are discussed later in this method.

2.3 Precision. The precisions (relative standard deviation) for each metal detected in a method development test at a sewage sludge incinerator, are as follows: Sb (13.9%), As (13.5%), Ba (13.1%), Cd (11.5%), Cr (12.5%), Cu (11.9%), Pb (11.6%), Ni (7.7%), P (13.5%), Se (15.3%), Tl (12.3%), and Zn (11.8%). Beryllium, manganese and silver were not detected in the tests; however, based on the analytical sensitivity of the ICAP for these metals, it is assumed that their precisions should be similiar to those for the other metals.

2.4 Interferences. Iron can be a spectral interference during the analysis of arsenic, chromium, and cadmium by ICAP. Aluminum can be a spectral interference during the analysis of arsenic and lead by ICAP. Generally, these interferences can be reduced by diluting the sample, but this increases the method detection limit. Refer to EPA Method 6010 (SW-846) for details on potential interferences for this method. For all GFAAS analyses, matrix modifiers should be used to limit interferences, and standards should be matrix matched.

3. Apparatus

3.1 Sampling Train. A schematic of the sampling train is shown in Figure A-1. It is similar to the Method 5 train. The sampling train consists of the following components.

3.1.1 Probe Nozzle (Probe Tip) and Borosilicate or Quartz Glass Probe Liner. Same as Method 5, Sections 2.1.1 and 2.1.2. Glass nozzles are required unless an alternate probe tip prevents the possibility of contamination or interference of the sample with its materials of construction. If a probe tip other than glass is used, no correction of the stack sample test results can be made because of the effect on the results by the probe tip.

3.1.2 Pitot Tube and Differential Pressure Gauge. Same as Method 2, Sections 2.1 and 2.2, respectively.

3.1.3 Filter Holder. Glass, same as Method 5, Section 2.1.5, except that a Teflon filter support may be used, if desired, to replace the glass frit.

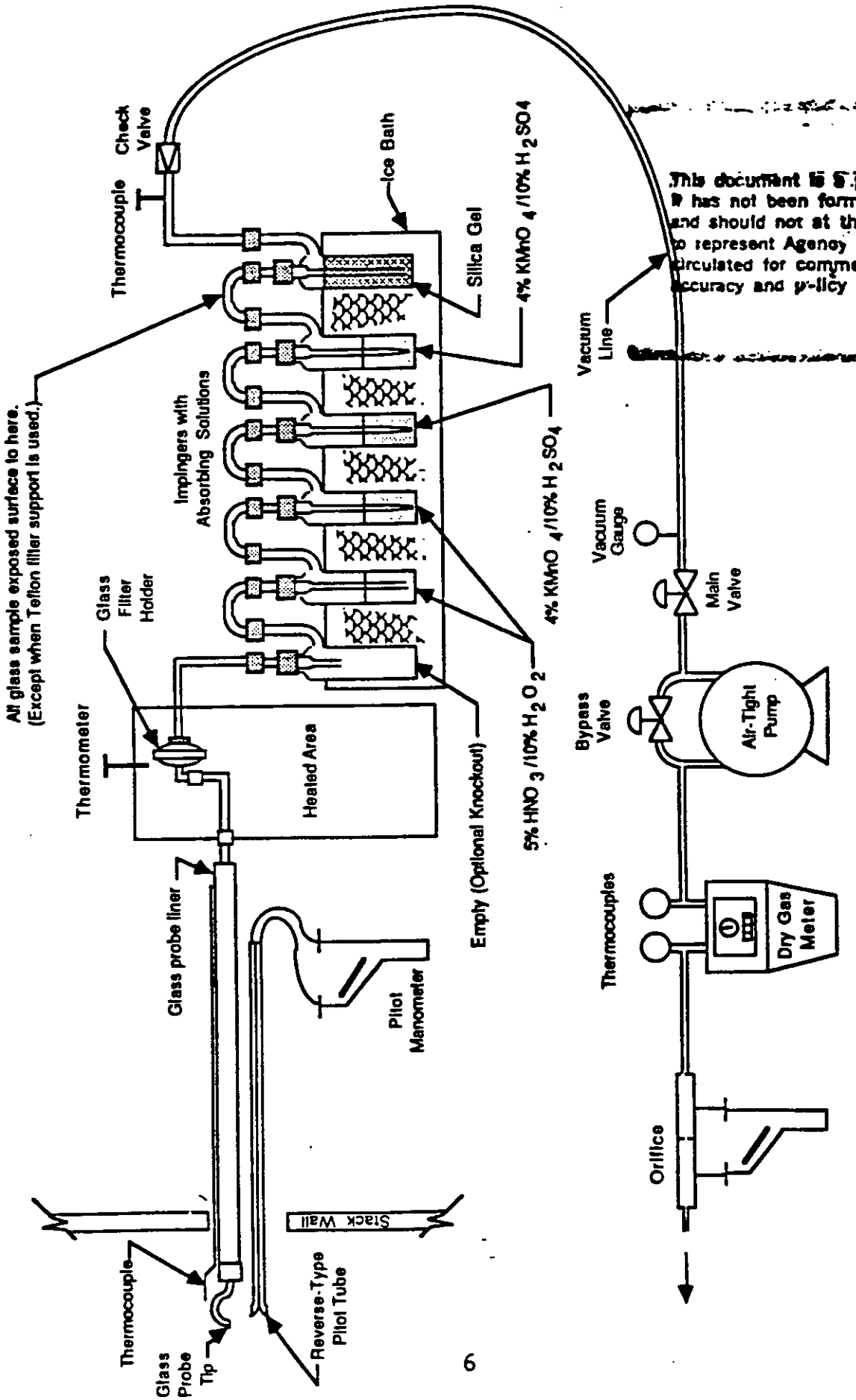

Figure A-1. Schematic of multiple metals sampling train.

Interpoll Laboratories, Inc.
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Determination of Hexavalent Chromium in Sampling Train Samples

Interpoll Method #: 6010-MM5
EPA Reference Method #: SW-846, 6010

Version 1.0
June 20, 1990

1 APPLICATION

This method is applicable to the determination of hexavalent chromium in stationary source samples collected by a sampling train.

Method No. 6010-MM5
Revision No. 0
Date June 20, 1990

2 RANGE

The range of this method extends from a detection limit of 0.05 ug to 50 ug. The upper range can be greatly extended through dilutions.

3 SAMPLE HANDLING AND PRESERVATION

3.1 Samples should be analyzed as soon as possible.

3.2 To retard the chemical activity of hexavalent chromium, the samples should be transported and stored until the time of analysis at $4^{0}C$.

Method No. 6010-MM5
Revision No. 0
Date June 20, 1990

4 SUMMARY OF METHOD

The probe wash and filter of the sampling train are combined, digested, and filtered. The filtrate is combined with the impinger catch, the pH of this solution is adjusted to 2.4, and chelated using APDC. Adjust the solution pH again to 2.8 and extract with MIBK. This isolates the Cr(VI) from the other Cr species. The MIBK is evaporated and the residue taken up in nitric acid. The solution is then analyzed by ICP or GF/AA.

5 INTERFERENCES

Cr(VI) reacts with most organic compounds and surfaces.

6 APPARATUS AND GLASSWARE

6.1 For GF/AA analysis:

6.1.1 Chromium hollow cathode lamp.

6.1.2 Wavelength: 357.9 nm.

6.1.3 Furnace Program:

Drying time	30 sec.
Drying temp.	125°C
Ashing time	30 sec.
Ashing temp.	1000°C
Atomizing time	10 sec.
Atomizing temp.	2700°C

6.2 For ICP analysis:

6.2.1 Thermo Jarrell Ash ICAP 61 Plasma Spectrometer.

6.2.2 Optical system: 0.75 meter Paschen-Runge mount with a 25 micron entrance slit and 50 micron exit slits.

6.2.3 Detectors: Hamamatsu Side Window 1/2 inch (1.3 cm) diameter; R300, R427, R306, R889.

6.2.4 Computer: IBM PC/AT 640K RAM, 30 MByte Winchester hard drive, 1.44 MByte floppy drive, enhanced color display.

6.3 Hot plate.

6.4 Volumetric flasks: 100 mL, 250 mL, and 1000 mL, for preparation of standards and sample dilution.

6.5 Graduated cylinders: For preparation of reagents.

6.6 Microwave digester: CEM MDS-81D, Teflon PFA vessels (120 mL size) with pressure relief valve, digestion turntable, capping station.

6.7 Beakers and watch glasses: 250 mL beakers for sample digestion with watchglasses to cover the tops.

6.8 Ring stands and clamps: For securing equipment.

6.9 Filter funnels.

6.10 Glass fiber filters.

6.11 Disposable pasteur pipets and bulbs.

6.12 Volumetric pipets.

6.13 Separatory funnels.

7 REAGENTS

7.1 Ammonium pyrrolidine dithiocarbamate (APDC) solution. Dissolve 1.0 gram APDC in demineralized water and dilute to 100 mL. Prepare fresh daily.

7.2 Potassium dichromate stock solution: Dissolve 141.4 mg of dried potassium dichromate, $K_2Cr_2O_7$ (analytical reagent grade), in Type II water and dilute to 1 liter (1 mL = 50 ug Cr).

7.3 Potassium dichromate standard solution: Dilute 10.00 mL potassium dichromate stock solution to 100 mL (1 mL = 5 ug Cr).

7.4 Sulfuric acid, 10 % (v/v): Dilute 10 mL of distilled reagent grade sulfuric acid, H_2SO_4, to 100 mL with Type I water.

7.5 Methyl isobutyl ketone (MIBK)

7.6 Sulfuric acid, 0.12M: Slowly add 6.5 mL concentrated H_2SO_4 to demineralized water and dilute to 1 liter.

7.7 Nitric acid, concentrated

7.8 Sodium Hydroxide solution, 1 M: Dissolve 40 grams NaOH in demineralized water and dilute to 1 liter.

7.9 Digestion Solution: Mix 20 grams NaOH and 30 grams Na_2CO_3 and dilute to 1 liter with demineralized water.

8 SAFETY

Normal, accepted laboratory safety practices should be followed. No known carcinogenic materials are used in this method.

9 PROCEDURE

9.1 Combine the probe rinse and the filter from the sample train in a beaker.

9.2 Add 40 mL of the digestion solution.

9.3 Heat beaker on hot plate for 30 minutes. The solution should not be taken to dryness.

9.4 After cooling, the mixture is filtered using a distilled-water prewashed glass fiber filter using vacuum filtration.

9.5 Combine the filtrate (which contains the CrVI) with the impinger catch and adjust the pH to 2.4 using H_2SO_4.

9.6 Add 5 mL of APDC per 100 mL of solution.

9.7 Transfer to separatory funnel and extract with 10 mL of MIBK per 100 mL of solution. Shake vigorously for 5 minutes. Allow layers to separate (10 - 15 minutes). Remove MIBK layer into a flask. Repeat the above two more times and put MIBK into the same flask.

9.8 Evaporate the MIBK on a hot plate almost to dryness.

9.9 Add 25 mL of 5% HNO_3 and heat for 45 minutes.

9.10 Transfer to a 25 mL volumetric flask and bring to volume with 5% HNO_3.

9.11 Analyze by ICP. (If samples are below the ICP detection limit, reanalyze by GF/AA with Zeeman background correction if required).

9.12 Sample Analysis: The prepared sample is analyzed by ICP for Hexavalent Chromium. The wavelength is 267.716 nm.

9.12.1 Instrument Set-up: The instrument is set-up and profiled as described in the ICP Standard Operating Procedure (Interpoll Method Number ICP-IL1).

9.12.2 Instrumental Calibration: Following set-up, the instrument is calibrated using a blank and a solution containing 100 mg/L of chromium.

10 CALCULATION

To calculate results in total ug, use the following equation:

ug/mL Cr x (Dilution Factor) x Volume of Sample (mL) = total ug

where:

ug/mL Cr = read off ICP printout

Volume of Sample = final volume of sample after preparation (Liters)

Dilution Factor = any dilutions required to bring the concentration of Cr within the calibration range or to remove interferences

11 QUALITY CONTROL PROCEDURES

11.1 To verify the absence of matrix interferences, at least one matrix spike must be performed. If not enough sample was submitted, an instrument spike must be run. Percent recovery must meet control limits for the method.

11.2 One spike must be performed in order to determine extraction efficiency.

11.3 One duplicate must be run per batch. The Percent Relative Difference must meet the control limits for the method. If there isn't enough sample, an instrument duplicate will be run.

11.4 A method blank must be run to verify that the method is performing to specifications.

11.5 Any sample above the linear range of the instrument must be diluted and reanalyzed.

11.6 Two calibration blanks are analyzed with each analytical batch. One is analyzed at the beginning of the run and the other at the end.

11.7 Two instrument check standards should be analyzed during an analytical run. One at the beginning and another at the end. These standards verify the accuracy of the instrument calibration.

12 ACCURACY AND PRECISION

12.1 The accuracy limits for this method are from 80 to 120 percent recovery.

12.2 The precision limit for this method is 10 relative percent difference.

12.3 Check standards must be within ± 10% of their true value or the data associated with them is considered invalid.

13 REFERENCES

13.1 EPA Method 6010; Test Methods for Evaluating Solid Waste (SW-846); U.S. EPA Office of Solid Waste and Emergency Response; November 1986.

13.2 EPA Method 7191; Test Methods for Evaluating Solid Waste (SW-846); U.S. EPA Office of Solid Waste and Emergency Response; November 1986.

13.3 EPA Method 7197; Test Methods for Evaluating Solid Waste (SW-846); U.S. EPA Office of Solid Waste and Emergency Response; November 1986.

13.4 Draft Method "Methodology for the Determination of Metals Emissions in Exhaust Gases from Stationary Sources of Combustion Processes"; received April, 1989 from Source Methods Standardization Branch, US EPA Atmospheric Research and Exposure Assessment Laboratory; Research Triangle Park, NC 27711.

APPENDIX K

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

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

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

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

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

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

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

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

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

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

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, ^oF

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

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

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

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

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

Job NSP Sherco Source UNIT 3 STACK Date of Test 3-27 [illegible]

Element	GF/AA	ICP	MICROGRAMS Field Blanks H	1	2	Analytical Detection Limit	Minimum Detectable Mass	Best Estimate of Field Blank	Total Mass in Sample (µg) (Not corrected for blank) Run 1	Run 2	Run 3	Total Mass in Sample (µg) (Corrected for blank) Run 1	Run 2	Run 3
Aluminum		X	375	270		2.5	≤ 24	270	510	330	360	240	60	90
Arsenic	X		≤5	0.17		.05	≤ .1	.05	.10	<.05	<.05	.10	<.1	<.1
Boron		X	9	33		.6	≤ 4	9	2420	408	1690	2411	379	1631
Barium		X	12	8.1		.1	≤ 6	8.1	12.5	10.6	9.5	≤ 6	≤ 6	≤ 6
Beryllium	X		<.1	.018		.004	≤ .02	.018	.020	.024	.030	.002	.006	.012
Calcium		X	181	247		1	≤ 41	181	608 ?	413	405	427	232	224
Cadmium		X	<.4	237		.4	≤ 1	.4	-27	11	6.5	[illegible]	10.6	6.1
Chromium		X	<.7	3.9		.7	≤ 1.4	.7	15	9	7	14.3	8.3	6.3
Copper		X	3.2	40		5	≤ 1.2	3.2	102	50	26	98.8	46.2	22.8
Iron		X	38	60		.5	≤ 24	38	169	130	68	131	72	30
Potassium		X	64	110		40	≤ 12	64	295	140	137	231	76	73
Magnesium		X	85	25		1	≤ 1.2	25	62	40	51	37	15	26
Manganese		X	<.5	15		.5	≤ 1	.5	7.6	47	5.1	7.1	46.5	4.6
Molybdenum		X	33	26		.5	≤ 4	33	32	28	30	≤ 4	≤ 4	≤ 4
Sodium		X	158	540		1	≤ 32	158	1030 ?	720	740	872	512	582
Nickel		X	<1	29		1	≤ 2	1	11 ?	10	4.2	10	9	5.2
Lead		X	<4	5.2		2.5	≤ 4	4	19.5	8.8	5.9	15.5	4.8	≤ 4
Selenium	X		<5	<2.5		2.5	≤ 2.5	2.5	< 2.5	<2.5	<2.5	≤2.5	≤2.5	≤2.5
Antimony	X		<.5	.21		.05	≤ .2	.21	1.1	0.41	0.17	.89	.2	<.2
Strontium	X		<5	<5		5	≤ 5	5	6.5	< 5	< 5	1.5	≤ 5	≤ 5
Vanadium		X	<.1	<.1		.1	≤ .1	.1	<.1	<.1	<.1	<.1	<.1	<.1
Zinc		X	9.1	180		.4	≤ 5	9.1	117	41	30	107	31.7	30.9
Mercury Front		CV/AA	<.4	<.1		.1	≤ .1	.4	.96	<.4	<.2	[illegible]	[illegible]	[illegible]
Mercury KMnO4			<.4	.80		.1	≤ .1	.8	5.0	2.9	4.9	[illegible]	[illegible]	[illegible]
Mercury Total			<.8	<.9		.1	≤ .2	.8	5.96	2.9	4.9	5.16	2.1	4.1
Silver		X	<.6	.3		.3	≤ .3	.3	<.3	<.3	<.3	<.3	<.3	<.3

H = historical average mass of the trace element in a Pallaflex quartz filter

X = [illegible] field contamination

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