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RESULTS OF THE MARCH 21 - 26, 1988 AIR EMISSION COMPLIANCE TEST ON THE NO. 2 BOILER AT THE RED WING STATION TEST IV (High Load)

Submitted to:

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APPENDICES:

ABBREVIATIONS

ACFM	actual cubic feet per minute
cc (ml)	cubic centimeter (milliliter)
DSCFM	standard cubic foot of dry gas per minute
DSML	dry standard milliliter
DEG-F (°F)	degrees Fahrenheit
DIA.	diameter
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/DSCM	milligrams 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
ug	micrograms
v/v	percent by volume
w/w	percent by weight

Standard conditions are defined as 68 °F (20 °C) and 29.92 IN. of mercury pressure.

I INTRODUCTION

1.1 General

During the period of March 21 - 26, 1988, Interpoll Laboratories conducted the high load air emission compliance test on the Northern States Power (NSP) Red Wing Station No. 2 Boiler which was converted from coal to cRDF-firing. The list of determinations performed were those specified by the Minnesota Pollution Control Agency (MPCA). On-site testing was performed by R. Rosenthal, J. Buresh, T. Johnson, C. Mosser, T. Hogan and D. Smith under the direction of Dr. P. Lonnes. Coordination between testing activities and plant operation was provided by Bob Evans of NSP.

1.2 Unit Description

The No. 2 Boiler is a water tube boiler with a spreader stoker and traveling grade and was originally equipped to fire coal. It was installed in 1949 by the Foster Wheeler Corporation with an extended surface economizer and superheater. It is a balanced draft boiler with a variable speed I.D. fan. Particulate emissions from the combustion process are controlled by a Western Precipitator mechanical dust collector in series with a Belco electrostatic precipitator which was installed in 1980. Cleaned flue gas is exhausted to the atmosphere by means of a radial steel stack, the top of which is 188 feet above grade elevation.

When the No. 2 Boiler was modified to fire cRDF, four 18-inch x 30-inch pneumatic air swept fuel spouts were installed across the front face. Hot air to the air swept spouts comes from the overfire air (OFA) system. Fuel dis-

tribution on the grate is controlled by rotating dampers on the OFA supply. The pulsating air and OFA system ensure uniform distribution of fuel from the front to the back of the furnace.

A plate-type air heater manufactured by North American Technologies was added to provide the hot combustion air required for the undergrate and overfire air systems. Both the undergrate and OFA system have been sized for 50% of the total air required. New FD and OFA fans were also installed to meet the greater air supply requirements. The air heater reduces the gas temperature to 450 ^{o}F which matches the existing electrostatic precipitator operating temperature.

The fuel is fed to the spouts by two live bottom bins. Each live bottom bin is equipped with six screw-type feeders and feeds two air spouts. The fuel feed rate is controlled by varying the speed of the screw feeders. Each fuel feed chute has a balanced draft damper to seal the boiler when a feeder is out of service; prevent backdrafts; and to reduce the chance of fires in the fuel feed system should furnace pressure fluctuate.

The furnace volume was also enlarged by extending it 14 feet lower to accommodate the design MCR of 15 tons/hour (360 TPD) and maintain the design furnace exit gas temperature of 1600 ^{o}F. This change required that the existing traveling grate be lowered 14 feet and that the grate speed be modified to 20 ft/hr. The natural gas firing capability of the boiler was maintained to provide heat for start up and for stand-by load carrying in the event RDF is not available.

The original superheater was also replaced in the modification. The new superheater is a counterflow single-pass design. The coolest steam is in the hottest gas path thereby minimizing tube metal temperatures. The new superheater reduced steam temperature from 850° to 700 °F which should reduce both the fouling and corrosion potential. Steam temperature is controlled by spray attemperation.

Typical performance characteristics of the boiler after the modification to cRDF-firing are summarized below:

Superheater steam outlet temp.	720 °F
Superheater outlet steam flow	109,000 lb/hr
Superheater outlet steam press.	604 psig
Economizer inlet feedwater temp.	340 °F
Furnace exit gas temp.	1480 °F
Boiler outlet gas temp.	660 °F
Economizer exit gas temp.	590 °F
Air heater exit gas temp.	420 °F
Undergrate air temp.	315 °F
Boiler efficiency	70%
Excess air	65%
MW	9.9
Overfire air static	23" H_2O
Undergrate delta P	1.3" H_2O

1.3 Particulates

Particulate loading determinations were performed simultaneously at the inlet and outlet of the electrostatic precipitator (ESP) on the No. 2 Boiler in accordance with EPA Methods 1 - 5, CFR Title 40, Part 60, Appendix A (revised July 1, 1987). The test at the ESP outlet was per-

formed in the stack. Previously collected data was used to select appropriate nozzle diameters for isokinetic sample withdrawal. An all-glass impinger assembly with distilled water was used in the back half of the sampling trains to provide samples for chloroform/diethyl ether extractions to determine total condensible organic compounds. The collected condensate samples were analyzed in accordance with the analytical protocol for condensibles promulgated by the MPCA.

1.4 PM-10

Determinations of the PM-10 concentration and the flyash particle size distribution were performed at both the stack and the ESP Inlet test locations. Samples at the ESP Inlet were isokinetically collected using a modified version of EPA Method 17. A stainless steel thimble filter holder was used in place of the standard Method 17 filter holder. The recovered flyash samples were then analyzed by X-ray Sedigraph.

Particle size distribution determinations in the stack were performed by sampling isokinetically using an EPA M5 sampling train with an eight stage cascade impactor attached to the instack end of the probe. Three determinations and one control were performed in accordance with PM-10 SIP Development Guideline USEPA - 450/2-86-001: Appendix C. Four separate impactor sets were used to collect the samples. The samples were returned to the laboratory, conditioned and weighed. The results were calculated in accordance with the impactor manufacturers recommendations using the provided 50% cut point calibration data.

1.5 Acidic Gases

Hydrogen chloride, hydrogen fluoride and sulfur dioxide, all acidic gases, were determined at the stack test location with a common sampling train using a modification of the EPA Method 6 large impinger version. An alkaline absorbing reagent was employed to quantitatively collect the gases. The recovered samples were returned to the laboratory and analyzed for chloride, fluoride and sulfate by ion chromatography after oxidation with peroxide.

1.6 Nitrogen Oxides

Oxides of nitrogen samples were collected from the stack in two-liter flasks using a separate sampling system with on-site evacuation of the flasks. The probe was purged with flue gas before each sample was collected. The collected samples were aged at $\geq$70 ^{o}F for more than 16 hours, shook to complete absorption, recovered from the flasks and analyzed for nitrate by ion chromatography as per EPA Method 7A.

1.7 Trace Metals

Trace metal samples were collected simultaneously at the ESP inlet and outlet test sites using Multi Metal Modified Method 5 (4M5) sampling trains currently under development by the US EPA and approved for use in Minnesota by the Minnesota Pollution Control Agency. A low metal-background glass fiber filter is used to collect particulates and 100 cc of a 5% HNO_3/10% H_2O_2 solution is used in the first two impingers with 1.5% $KMnO_4$/10% H_2SO_4 in the third impinger. After sampling, the HNO_3/H_2O_2 catch is combined with the front half catch and the extract analyzed for

arsenic, cadmium, chromium, lead, mercury and nickel by AA/GF using the standard additions method to eliminate sample matrix effects. The $KMnO_4/H_2SO_4$ catch is analyzed by cold vapor atomic absorption for mercury. Most of the elemental mercury is collected in the HNO_3/H_2O_2 catch.

1.8 Dioxins and Furans

Polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) sampling was also simultaneously conducted at the ESP inlet and outlet using Modified Method 5 (MM5) sampling trains with 32 g of purified XAD-2 resin in accordance with EPA Method 0010 (SW 846, 3rd Ed.). A 20 ng 1,2,3,4-TCDD-$^{13}C_{12}$ field spike provided by Battelle was added to the top of the XAD-2 resin in each MM5 sampling train immediately before each dioxin run. The field spikes provide an overall evaluation of the accuracy of sampling and analysis. The recovered PCDDs and PCDFs samples were returned to the laboratory, carefully packed and then shipped to Battelle Columbus Laboratories where they were analyzed for tetra-through octachlorodibenzodioxins and chlorodibenzofurans homolog groups as well as for all of the 2,3,7,8-isomers using EPA Method 8280 as a guideline. High resolution mass spectrometry was substituted for low resolution to target detection of 2,3,7,8-TCDD at the 0.01 ng/dsm^3 level (not possible with low resolution MS).

1.9 Polynuclear Aromatic Hydrocarbons

Polynuclear aromatic hydrocarbons (PAHs) sampling was conducted simultaneously with the dioxin samplings using the same Modified Method 5 trains. A field spike of 5 ug of d_{12}-benzo(e)pyrene and 5 ug of d_{12}-perylene provided by Bat-

telle was added to the XAD-2 resin before each PAH run. The PAH samples and field-biased blank were analyzed by Battelle by HRGC/LRMS in accordance with EPA Methods 610 and 8270.

1.10 Combustion Gases

Integrated flue gas samples were extracted simultaneously with each of the above-referenced sample trains using a specially designed gas sampling system. Integrated flue gas samples were collected in 44-liter Tedlar bags. 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.

After sampling was complete, the bags were sealed and returned to the laboratory for Orsat analysis. The integrated flue gas samples collected during the dioxin sampling were also analyzed for carbon monoxide in accordance with EPA Method 10 (NDIR).

1.11 ESP Inlet Sampling Protocol

Testing at the No. 2 Boiler ESP Inlet test site was conducted from six test ports located on the side of a horizontal section of ducting (See Appendix B). A 42-point traverse was used to collect the particulate, metals and dioxin samples. In the case of the particulate and metal determinations each traverse point was sampled 1.5 minutes for a total sampling time of 63 minutes per run. For the PCDDs, PCDFs and PAHs sampling, each traverse point was sampled 7 minutes for a total sampling time of 294 minutes per run.

1.12 Stack Sampling Protocol

All of the testing at the stack test site was performed from a set of four test ports. The location of these test ports are shown in Appendix B. The four test ports are oriented at 90 degrees on the radial steel gunnite-lined stack.

A 24-point traverse was utilized to isokinetically collect the particulate and trace metals samples. In each of these determinations, each traverse point was sampled five minutes to give a total sampling time of 60 minutes per run. Three one-hour runs were conducted for each of the specified pollutants. A 4-point traverse was used for PM-10 testing. Each traverse point was sampled 30 minutes for a total of 120 minutes per run. A 3-point traverse was used to collect the acid gases. Each traverse point was samples 20 minutes to give a total of 60 minutes per run.

Semivolatile organic compounds, which partition between the gaseous and solid state in exhaust gas streams, were also isokinetically sampled using a 24-point traverse. Each traverse point was sampled 10 minutes to give a total run time of 240 minutes.

1.13 Report Organization

A summary and discussion of all of the important results of this performance test is given in the following section. More detailed results are presented in Section 3 together with pertinent sampling parameters. Supplemental information such as field data sheets, laboratory results, procedures and calculation equations are presented in the appendices.

2 SUMMARY AND DISCUSSION

2.1 Particulate, Opacity and Gas Flow Testing

The results of the ESP particulate removal performance test are presented in Table 1. Soot was blown during Run 2 which resulted in a significant increase in emissions. The average particulate emission rate for normal operation was 5.69 LB/HR. During soot blowing, the particulate emission rate increased to 17.7 LB/HR. The steam load also increased during Run 2. The ESP particulate removal efficiency averaged 99.1% for normal operation. During soot blowing, the removal efficiency dropped to 98.1%.

The dry standard particulate concentration corrected to 12% CO_2 averaged 0.015 GR/DSCF during normal operation. This increased to 0.048 GR/DSCF during soot blowing. The particulate loading for this facility is restricted by state pollution control regulations to 0.10 GR/DSCF @ 12%CO_2. Based on the above results, it is seen that the particulate loadings from this cRDF-fired boiler are six to seven times less than the standard during normal operation and about two times less than the standard during soot blowing.

In the interpretation of the above results, it should be noted that the results include condensible organic compounds (the so called wet catch) as required by the MPCA. Secondly, caution should be used when reviewing the volumetric flow rates reported in Table 1. The flow rates were measured in the stack at a location where substantial large scale turbulence exists. This was shown in a previous study conducted by Interpoll Labs. When an S-type pitot tube is used to measure flow rate in regions of large scale

TABLE 1. Summary of the Results of the March 21, 1988 Particulate Removal Efficiency Test on the RDF-Fired No. 2 Boiler at the Northern States Power Red Wing Generating Station.

ITEM	RUN 1		RUN 2		RUN 3	
	Inlet	Stack	Inlet	Stack	Inlet	Stack
Date of test	03-21-88	03-21-88	03-21-88	03-21-88	03-21-88	03-21-88
Time runs were done (HRS)	1610/1723	1610/1723	1810/1931	1810/1926	2005/2211	2005/2206
Steam flow (KLB/HR)		106.7		114.6		106.1
Volumetric flow						
actual (ACFM)	83862	93218	82743	87682	82288	83316
standard (DSCFM)	40894	49427	40987	46734	41705	46156
Gas temperature (DEG-F)	416	367	417	369	407	340
Moisture content (%V/V)	16.46	16.07	14.96	15.37	14.03	15.20
Gas composition (%V/V,dry)						
carbon dioxide	12.30	11.84	11.60	11.00	12.30	11.01
oxygen	6.90	7.76	8.20	8.80	7.00	8.79
carbon monoxide	0.00	0.00	0.00	0.00	0.00	0.00
nitrogen	80.80	80.40	80.20	80.20	80.70	80.20
Isokinetic variation (%)	103.6	106.9	98.1	101.1	98.8	101.2
Particulate concentration						
actual (GR/ACF)	0.7515	0.0066	1.2981	0.02350	1.0156	0.00849
standard (GR/DSCF)	1.5416	0.0125	2.6216	0.04411	2.0046	0.01533
std @12%CO2(GR/DSCF)		.0127		.0481		.0167
Part. emission rate (LB/HR)	540.38	5.31	921.00	17.67	716.60	6.07
Emission factor (LB/MMBTU)	3.169	0.027	5.941	0.105	4.151	0.036
Part. removal efficiency (%)		99.02		98.08		99.15

* F-Factor = 9640 DSCF/MMBTU; Soot blown during Run 2.

** Dry catch only at the ESP Inlet; Dry + organic wet catch at the stack.

turbulence, the flow rate is always overestimated. The magnitude of this error can be as large as +40%. In the previous flow study on this boiler, the error was found to be approximately 37%, and thus the true volumetric flow rate is only about 40,000 DSCFM (76,500 ACFM).

The US EPA and the MPCA require that the flow rate obtained in the Method 5 particulate determination or in a Method 2 flow measurement be used to calculate pollutant mass emission rates. This being the case, all of the pollutant emission rates reported in this study are high by 37%, in as much as the pollutant emission rate is the product of the pollutant concentration and the volumetric flow rate. The correct emission rate can be obtained by multiplying the report result by 0.73.

A three hour visible emission determination was also performed in accordance with EPA Method 9 by a currently certified observer. The opacity readings were taken simultaneously with each of the first two one-hour particulate loading determinations. The last opacity determination could not be performed during the third particulate run due to darkness. The third opacity determination was performed during the third dioxin run. The average opacities for Runs 1, 2 and 3 were 2.3%, 1.3% and 0%, respectively.

2.2 PM-10 and Particle Size Distribution

The results of the PM-10 determinations performed at the No. 2 Boiler ESP inlet test site and the stack test site are summarized in Table 2. The total mass rate at the ESP inlet ranged from 675 to 756 LB/HR for the inlet PM-10 sample collections. These values are in close agreement with the average mass rates observed in the particulate emission compliance test (See Table 1) where the average mass rate of flyash at the ESP inlet was 726 LB/HR.

The size distribution analysis of these samples showed that about 37% by weight of the flyash aerosol at the ESP inlet had aerodynamic equivalent diameters (AED) less than 10 microns. The PM-10 mass rate of flyash into the ESP averaged 270 LB/HR. The results of the X-ray Sedigraph size distribution analyses were microscopically confirmed.

The total mass rate of flyash particles penetrating the ESP ranged from 4.6 to 15.6 LB/HR for the PM-10 in situ cascade impactor samplings. These values compare very closely with the particulate emission rates measured in the particulate emission compliance test (See Table 1). The size distribution results obtained from the in situ aerodynamic size classification indicate that anywhere from 79.2 to 92.4% by weight of the flyash particles penetrating the ESP are less than 10 microns. The PM-10 emission rate ranged from 3.6 to 14.4 LB/HR. The electrostatic precipitator exhibited a PM-10 removal rate ranging from 94.8 to 98.6% by weight.

Table 2. Summary of the March 26, 1988 PM-10 Measurements Performed on the No. 2 Boiler ESP at the NSP Red Wing Plant.

	Run 1	Run 2	Run 3
(INLET)			
Total mass rate (LB/HR)	730	756	675
% ≤ 10 um	37.79	38.46	35.85
PM-10 mass rate (LB/HR)	276	291	242
(STACK)			
Total mass rate (LB/HR)	15.59	4.62	4.57
% ≤ 10 um	92.37	90.56	79.20
PM-10 mass rate (LB/HR)	14.40	4.18	3.62
ESP PM-10 removal rate (% W/W)	94.8	98.6	98.5

2.3 Acid Gases

The results of all the common gaseous pollutant determinations are summarized in Table 2. Sulfur dioxide concentrations were very consistent and only varied from 132 - 167 ppm,d. The average sulfur dioxide emission rate was 76.7 LB/HR (55 LB/HR after correction for turbulence). The average hydrogen chloride emission rate was 99.7 LB/HR (72.8 LB/HR after correction for turbulence). The intra-run variations reflect, for the most part, changes in the composition of the cRDF and changes in burning rate, since the precision of the sampling and analytical method is only 3 - 5%.

Hydrogen fluoride emissions, which result from the combustion of fluorinated hydrocarbons in the RDF such as teflon and spray can propellants, were very low. The average hydrogen fluoride emission rate was 0.16 LB/HR (0.12 LB/HR after correction for turbulence).

Oxides of nitrogen in the exhaust gas arise from combustion of nitrogenous material in the RDF fuel as well from the chemical reaction of atmospheric nitrogen and oxygen in the combustion air which combine to form nitric oxide at high temperatures (1800 ^{o}F). The average oxides of nitrogen concentration was 135 ppm,w. The average emission rate was only 47.3 LB/HR (34.5 LB/HR after correction for turbulence).

Table 3. Results of the March 24, 1988 Sulfur Dioxide, Hydrochloric Acid, Hydrogen Fluoride, and Oxides of Nitrogen Determinations on the No. 2 Boiler at the NSP Red wing Station.

Item	Run 1	Run 2	Run 3
(Concentration ppm,w)			
Sulfur dioxide	150	132	167
Hydrochloric acid	210	407	403
Hydrogen fluoride	.47	1.3	1.3
Oxides of nitrogen	146	130	129
(Emission Rate LB/HR)			
Sulfur dioxide	75	68	87
Hydrochloric acid	60	119	120
Hydrogen fluoride	.073	.20	.21
Oxides of nitrogen	51	45	46

2.4 Carbon Monoxide

The results of the analyses of the carbon monoxide samples collected at the No. 2 Boiler ESP inlet and stack test sites during the dioxin samplings are given in Table 4. The carbon monoxide concentrations observed at the stack test site were significantly lower than those measured at the ESP. At first it was thought that these differences must be analytical artifacts, however, duplicate analyses were performed on all of the samples and the carbon dioxide and oxygen contents, as determined by Orsat analysis, showed that the samples had not been diluted by air inleakage.

Simultaneous carbon monoxide measurements at different points in an exhaust gas flow system are rarely performed, because it is generally believed that carbon monoxide levels are relatively stable at lower temperatures. The ESP will not affect concentration levels and thus it can only be speculated that the reduction in carbon monoxide levels is attributable to some undetected error, which is unlikely, or to continued reaction of carbon monoxide with oxygen.

We have only performed simultaneous carbon monoxide measurements on several different combustion systems. Interestingly, both systems exhibited this phenomenon. The first was a detailed diagnostic study on a coal and bark cofired boiler equipped with a mechanical collector and ESP. Pronounced carbon monoxide concentration increases and decreases were observed and confirmed in the exhaust gas flow system. The second combustor in which this was observed was a wood dryer consisting of a suspension burner and a rotary kiln. Carbon monoxide levels were found to increase and decrease depending on the operation of both the

Table 4. Results of the Carbon Monoxide Determinations Performed on the No. 2 Boiler at the NSP Red Wing Station.

Run	Concentration (ppm,d)		Emission Rate (LB/HR)	
	Inlet	Stack	Inlet	Stack
1	134	121	22	24
2	109	65	18	13
3	111	68	19	13

burner and the kiln. If these results are shown to be correct, carbon monoxide analyzers located far upstream of the stack may grossly overpredict carbon monoxide emission.

2.5 Trace Metal Pollutants

Eight different metals have been identified by the Minnesota Pollution Control Agency as potential toxic species of concern for this facility: arsenic, beryllium, cadmium, chromium, lead, mercury, nickel and selenium. The results of the simultaneous metal samplings at the ESP inlet and stack test sites are presented in Tables 5 and 6, respectively. It should be recalled that large scale turbulence exists at the stack test location and that the emission rates reported in Table 6 should be multiplied by 0.73 to obtain the best estimate of the true emission rates.

Table 7 is a summary of the trace metal mass rates measured at the inlet and outlet of the electrostatic precipitator. The mass rates of metals penetrating the ESP have been corrected for large scale turbulence in this table and thus the reported removal efficiencies represent best estimates of the true ESP removal efficiencies. The major trace metal constituents in the cRDF flyash are lead, cadmium, chromium and nickel. Matrix interferences due to high salt levels in the determination of selenium resulted in high analytical detection limits, and thus the significance of selenium emissions is unclear.

The ESP removal efficiency of the individual trace metals varies significantly with the poorest removal rates exhibited for nickel. The high removal efficiencies were observed for lead and cadmium. These species-dependent ESP removal rates alter the relative abundance of the trace metals such that nickel is the most predominant emission to the atmosphere followed by chromium and lead.

Table 5. Results of the March 22, 1988 Trace Metal Determinations on the No. 2 Boiler ESP Inlet at the NSP Red Wing Station.

Item	Run 1	Run 2	Run 3
(Concentration ug/dscm)			
Arsenic	104	324	170
Beryllium	1.9	1.2	1.9
Cadmium	740	930	690
Chromium	437	284	392
Lead	27540	17250	26140
Mercury	125	113	173
Nickel	389	294	322
Selenium	< 206	< 508	<1105
(Emission Rate 10^{-3}LB/HR)			
Arsenic	16	46	24
Beryllium	.29	.17	.27
Cadmium	110	130	100
Chromium	67	404	56
Lead	4197	2452	3763
Mercury	19	16	25
Nickel	59	42	46
Selenium	< 29	< 72	< 145

Table 6. Results of the March 22, 1988 Trace Metal Determinations on the No. 2 Boiler Stack at the NSP Red Wing Station.

Item	Run 1	Run 2	Run 3
(Concentration ug/dscm)			
Arsenic	22	14	1.1
Beryllium	< .17	< .17	< .17
Cadmium	5.0	2.5	.086
Chromium	135	60	9.5
Lead	69	36	25
Mercury	30	15	26
Nickel	213	84	54
Selenium	< 213	143	< 43
(Emission Rate 10^{-3}LB/HR)			
Arsenic	4.0	2.5	.20
Beryllium	< .03	< .03	< .03
Cadmium	.90	.45	.015
Chromium	24	11	1.7
Lead	12	6.6	4.4
Mercury	5.4	2.3	4.6
Nickel	38	15	9.6
Selenium	< 38	26	< 7.6

It is also interesting to note the high removal rate measured for mercury. This indicates that a majority of the mercury is present as a salt rather than in the elemental vapor phase.

Table 7. Summary of the March 22, 1988 Trace Metal Removal Performance Test on the No. 2 Boiler ESP at the NSP Red Wing Station.

	Mass Rates (10^{-3}LB/HR)								
	Run 1		Efficiency	Run 2		Efficiency	Run 3		Efficiency
Metal	IN	OUT	(% w/w)	IN	OUT	(% w/w)	IN	OUT	(% w/w)
Arsenic	16	2.9	82	46	1.8	96	24	.15	99.4
Beryllium	.29	<.02	> 97	.17	<.02	> 87	.27	< .02	> 92
Cadmium	110	.66	99.4	130	.33	99.75	100	.011	99.99
Chromium	67	18	74	40	8.0	80	56	1.2	98
Lead	4197	8.8	99.79	2452	4.8	99.80	3763	3.2	99.91
Mercury	19	3.9	79	16	1.7	90	25	3.4	87
Nickel	59	28	53	42	11	74	46	7.0	85
Selenium	< 29	< 38	NA	< 72	< 26	NA	< 145	< 7.6	NA

2.6 Polynuclear Aromatic Hydrocarbons

Polynuclear aromatic hydrocarbons (PAHs) are products of incomplete combustion (PICs) and are flame synthesized in fuel rich combustion zones which may occur in any combustion process. PAHs emissions are of concern because of the possible mutagenic and carcinogenic properties of some of the PAHs and the known carcinogenicity of several components of this organic class of compounds. A selected group of PAHs were determined in the stack samples collected with the Modified Method 5 (SEMIVOST) sampling trains at the inlet and outlet of the No. 2 Boiler ESP. The results of the ESP inlet and ESP outlet analyses are presented in Tables 8 and 9, respectively. The emission rates reported in Table 9 have not been corrected for the effect of large scale turbulence.

The PAH meass rates from both the ESP inlet and stack test locations are also summarized in Table 10. The mass rates reported for the stack test site in Table 10 have been corrected for large scale turbulence so that the best estimate of the true ESP removal efficiency could be calculated. Removal efficiencies for the various PAHs vary tremendously not only from compound to compound but also from run to run. In many cases, PAH generation appears to occur rather than removal. In general, the concentration and emission rates of the PAHs appear to track those of the dioxins. A more detailed discussion of removal and generation rates is presented below with the dioxin results.

Table 8. Results of the March 23-25, 1988 PAH Determinations on the No. 2 Boiler ESP Inlet at the NSP Red Wing Station.

ITEM	Run 1	Run 2	Run 3
(Concentration ug/dsm^3)			
Napthalene	6.5	< .10	1.3
Acenaphthylene	.46	.013	.013
Acenapthene, dihydro	.017	.012	.019
Fluorene	< .073	< .071	< .071
Phenanthrene	1.9	.20	.078
Anthracene	.036	.0081	.0067
Fluoranthene	.44	.024	< .010
Pyrene	.44	< .040	< .04
Benz(a)anthracene	<.0080	< .0078	< .0078
Chrysene	.023	< .0031	.011
Benzfluoranthenes	.024	< .011	< .045
Benzo(a)pyrene	< .017	< .016	< .016
Indenopyrene	.0024	< .0078	< .0078
Dibenz(ah)anthracene	<.0039	< .0038	< .0038
Benzo(g,h,i)perylene	.021	<.00085	<.00086
(Emission Rate 10^{-6}g/sec)			
Napthalene	117	< 1.8	24
Acenaphthylene	8.3	.24	.24
Acenapthene, dihydro	.31	.22	.35
Fluorene	< 1.3	< 1.3	< 1.3
Phenanthrene	34	3.6	1.4
Anthracene	.65	.15	.12
Fluoranthene	7.9	.44	< .18
Pyrene	7.9	< .73	< .73
Benz(a)anthracene	< .14	< .14	< .14
Chrysene	.42	< .056	.20
Benzfluoranthenes	.43	< .20	< .82
Benzo(a)pyrene	< .31	< .29	< .29
Indenopyrene	.043	< .14	< .14
Dibenz(ah)anthracene	< .070	< .069	< .069
Benzo(g,h,i)perylene	.38	< .015	< .016

Table 9. Results of the March 23-25, 1988 PAH Determinations on the No. 2 Boiler Stack at the NSP Red Wing Station.

ITEM	Run 1	Run 2	Run 3
(Concentration ug/dsm^3)			
Napthalene	18	1.9	1.3
Acenaphthylene	9.9	.014	.012
Acenapthene, dihydro	.12	< .036	< .037
Fluorene	.64	< .14	< .14
Phenanthrene	5.2	.044	.029
Anthracene	.16	.0012	.0079
Fluoranthene	1.3	.0061	.040
Pyrene	1.4	< .0013	.018
Benz(a)anthracene	.016	< .0022	< .0023
Chrysene	.030	.0010	.00042
Benzfluoranthenes	.042	<.00091	<.00094
Benzo(a)pyrene	<.0040	.0044	.0050
Indenopyrene	.0095	< .0024	< .0025
Dibenz(ah)anthracene	<.0016	< .0016	< .0017
Benzo(g,h,i)perylene	.024	< .0048	< .0050
(Emission Rate 10^{-6}g/sec)			
Napthalene	384	40	26
Acenaphthylene	211	.30	.24
Acenapthene, dihydro	2.6	< .76	< .75
Fluorene	14	< 3.0	< 2.8
Phenanthrene	111	.93	.59
Anthracene	3.4	.025	.16
Fluoranthene	28	.13	.81
Pyrene	30	< .028	.36
Benz(a)anthracene	.34	< .047	< .046
Chrysene	.64	.021	.0085
Benzfluoranthenes	.90	< .019	< .019
Benzo(a)pyrene	< .085	.093	.10
Indenopyrene	.20	< .051	< .051
Dibenz(ah)anthracene	< .034	< .034	< .034
Benzo(g,h,i)perylene	.51	< .10	< .10

Table 10. Summary of the March 23-25, 1988 PAH Removal Performance Test on the No. 2 Boiler ESP at the NSP Red Wing Station.

Mass Rates (10^{-6}g/sec)

Homolog Group	Run 1 IN	Run 1 OUT	Efficiency (% w/w)	Run 2 IN	Run 2 OUT	Efficiency (% w/w)	Run 3 IN	Run 3 OUT	Efficiency (% w/w)
Napthalene	117	280	(140)	< 1.8	29	(>1500)	24	19	21
Acenaphthylene	8.3	154	-(1800)	.24	.22	9	.24	.18	27
Acenaphyhene, dihydro	.31	1.9	(510)	.22	< .55	NA	.35	< .55	(<56)
Fluorene	< 1.3	10	(>690)	< 1.3	< 2.2	NA	< 1.3	< 2.0	NA
Phenanthrene	34	81	(140)	3.6	.68	81	1.4	.43	69
Anthracene	.65	2.5	(280)	.15	.018	98	.12	.12	0
Fluoranthene	7.9	20	(160)	.44	.095	78	< .18	.59	(>230)
Pyrene	7.9	22	(180)	< .73	<.020	NA	< .73	.26	NA
Benz(a)anthracene	< .14	.25	(>77)	< .14	<.034	NA	< .14	<.034	NA
Chrysene	.42	.47	(11)	<.056	.015	< 73	.20	.0062	97
Benzfluoranthenes	.43	.66	(53)	< .20	<.014	NA	< .82	<.014	NA
Benzo(a)pyrene	< .31	<.062	NA	< .29	.068	< 77	< .29	.073	NA
Indenopyreneacene	.043	.15	(240)	< .14	<.037	NA	< .14	<.037	NA
Dibenz(ah)anthracene	<.070	<.025	NA	<.069	<.025	NA	<.069	<.025	NA
Benzo(g,h,i)perylene	.38	.37	2	<.015	<.073	NA	<.016	<.073	NA

2.7 Dioxins and Furans

Polychlorinated dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs) are two series of tricyclic, almost planar aromatic compounds that exhibit very similar physical, chemical, and biological properties. The number of chlorine atoms in these compounds can vary between one and eight to produce 75 PCDD and 135 PCDF positional isomers. These compounds have been the subject of much concern in many countries in recent years. PCDDs and PCDFs were recently identified in trace levels as products of incomplete combustion (PICs) in the ash from municipal solid waste combustors in the National Dioxin Study (Tier IV) performed by the US EPA.

Because of the extreme toxicity of some of the PCDD and PCDF isomers as well as the large variation in toxicity between closely related congeners, highly selective, specific, and sensitive analytical techniques are required for the measurements. Detection levels several orders of magnitude lower than those required for other environmental pollutants are needed to detect ecologically significant masses of these compounds.

The analysis of these compounds at such low levels is complicated by the presence of a multitude of other interfering compounds. The most specific and sensitive method for these compounds is based on high resolution mass spectrometry. This method was employed in this work to analyze representative stack gas samples collected from the gas stream entering the No. 2 Boiler ESP and stack gas samples collected from the gas stream exhausted from the ESP

just before it is released into the atmosphere. In addition, flyash samples collected from the ESP hopper during each of the gas stream sampling were also analyzed.

The results of the dioxin and furan tests performed at the ESP inlet and stack test sites presented by homolog or chlorination level are given Tables 11 and 12, respectively. The results of the 2,3,7,8-isomer specific analyses are presented in Tables 13 and 14.

The US EPA has published toxicity equivalence factors (TEFs) for the various non 2,3,7,8-polychlorinated isomers and 2,3,7,8-polychlorinated isomers. These factors may be used to convert the weight of these moieties to an equivalent weight of 2,3,7,8-tetrachlorodibenzo-p-dioxin. After the equivalent weights are calculated, they may be summed to give a single estimate of the toxic impact of the entire group of compounds based on the equivalence of each isomer group to 2,3,7,8-TCDD. This analysis has been performed in Table 15 and 16 using the latest US EPA TEFs.

Examination of these results show that the concentration of 2,3,7,8-TCDD equivalents from the cRDF-fired Boiler were less than 0.27 ng/dsm^3 for all three of the four-hour tests using state of the art sampling and analytical procedures. The minimum detection levels obtained for 2,3,7,8-TCDD in this study are amongst the lowest levels ever reported in the world (<.002 ng/dsm^3). The total 2,3,7,8-TCDD equivalent emission rate (not corrected for large scale turbulence) averaged $\leq 0.48\ 10^{-8}$g/sec which is equivalent to $\leq$0.15 g/year. When corrected for large scale turbulence, this emission rate is only 0.11 g/year.

Table 11. Results of the March 23-25, 1988 **Dioxin Homolog Analysis** on the No. 2 Boiler ESP Inlet at the NSP Red Wing Station.

Homolog	Run 1	Run 2	Run 3
(Concentration ng/dsm^3)			
TCDD	4.1	.20	.17
PeCDD	8.2	.55	.45
HxCDD	8.7	.38	.22
HpCDD	12	.40	.24
OCDD	9.0	.31	.16
TCDF	41	6.6	6.2
PeCDF	27	3.3	3.1
HxCDF	15	1.7	1.4
HpCDF	10	.88	.74
OCDF	2.7	.097	.059
	137.7	14.4	12.7
(Emission Rate 10^{-8}g/sec)			
TCDD	7.4	.36	.31
PeCDD	15	1.0	.82
HxCDD	16	.69	.40
HpCDD	22	.73	.44
OCDD	16	.56	.29
TCDF	74	12	11
PeCDF	49	6.0	5.7
HxCDF	27	3.1	2.6
HpCDF	18	1.6	1.4
OCDF	4.9	.18	.11

Table 12. Results of the March 23-25, 1988 Dioxin Homolog Analysis on the No. 2 Boiler Stack at the NSP Red Wing Station.

Homolog	Run 1	Run 2	Run 3
(Concentration ng/dsm^3)			
TCDD	.50	.57	.54
PeCDD	1.6	1.6	1.8
HxCDD	1.8	1.7	1.9
HpCDD	3.0	2.8	3.5
OCDD	2.8	2.4	3.1
TCDF	3.4	3.8	4.6
PeCDF	3.2	3.6	4.8
HxCDF	3.0	3.2	4.2
HpCDF	2.4	2.8	3.5
OCDF	.91	.97	.1.3
	22.6	23.44	29.24
(Emission Rate 10^{-8}g/sec)			
TCDD	1.1	1.2	1.1
PeCDD	3.4	3.4	3.6
HxCDD	3.8	3.6	3.8
HpCDD	6.4	5.9	7.1
OCDD	6.0	5.1	6.3
TCDF	7.2	8.1	9.3
PeCDF	6.8	7.6	9.7
HxCDF	6.4	6.8	8.5
HpCDF	5.1	5.9	7.1
OCDF	1.9	2.1	2.6

Table 13. Results of the March 23-25, 1988 2,3,7,8-Isomer Analysis on the No. 2 Boiler ESP Inlet at the NSP Red Wing Station.

Isomer	Run 1	Run 2	Run 3
(Concentration ng/dsm^3)			
2,3,7,8-TCDD	.036	<.00090	<.0021
1,2,3,7,8-PeCDD	.53	< .036	.029
1,2,3,4,7,8-HxCDD	.60	.024	.0083
1,2,3,6,7,8-HxCDD	.60	.023	.014
1,2,3,7,8,9-HxCDD	1.1	.034	.021
1,2,3,4,6,7,8-HpCDD	5.8	.19	.11
2,3,7,8-TCDF	5.6	.71	.67
1,2,3,7,8-PeCDF	.77	.088	.038
2,3,4,7,8-PeCDF	1.3	.14	.11
1,2,3,4,7,8-HxCDF	2.9	.22	.17
1,2,3,6,7,8-HxCDF	2.9	.20	.12
1,2,3,7,8,9-HxCDF	1.9	.13	.083
2,3,4,6,7,8-HpCDF	.43	.024	.029
1,2,3,4,6,7,8-HpCDF	6.8	.36	.22
1,2,3,4,7,8,9-HpCDF	.44	.033	.029
(Emission Rate 10^{-8}g/sec)			
2,3,7,8-TCDD	.065	< .0016	<.0038
1,2,3,7,8-PeCDD	.96	< .065	.053
1,2,3,4,7,8-HxCDD	1.1	.044	.015
1,2,3,6,7,8-HxCDD	1.1	.042	.026
1,2,3,7,8,9-HxCDD	2.0	.062	.038
1,2,3,4,6,7,8-HpCDD	10	.35	.20
2,3,7,8-TCDF	10	1.3	1.2
1,2,3,7,8-PeCDF	1.4	.16	.069
2,3,4,7,8-PeCDF	2.3	.25	.20
1,2,3,4,7,9-HxCDF	5.2	.40	.31
1,2,3,6,7,8-HxCDF	5.2	.36	.22
1,2,3,7,8,9-HxCDF	3.4	.24	.15
2,3,4,6,7,8-HxCDF	.78	.044	.053
1,2,3,4,6,7,8-HpCDF	12	.65	.40
1,2,3,4,7,8,9-HpCDF	.79	.060	.053

Table 14. Results of the March 23-25, 1988 2,3,7,8-Isomer Analysis on the No. 2 Boiler Stack at the NSP Red Wing Station.

Isomer	Run 1	Run 2	Run 3
(Concentration ng/dsm^3)			
2,3,7,8-TCDD	<.0022	<.0026	<.0029
1,2,3,7,8-PeCDD	.085	.075	.087
1,2,3,4,7,8-HxCDD	.093	.091	.10
1,2,3,6,7,8-HxCDD	.16	.15	.16
1,2,3,7,8,9-HxCDD	.22	.19	.25
1,2,3,4,6,7,8-HpCDD	.16	1.5	1.9
2,3,7,8-TCDF	.68	.81	1.0
1,2,3,7,8-PeCDF	.11	.13	.12
2,3,4,7,8-PeCDF	.28	.30	.37
1,2,3,4,7,8-HxCDF	.58	.67	.83
1,2,3,6,7,8-HxCDF	.54	.67	.85
1,2,3,7,8,9-HxCDF	.40	.48	.58
2,3,4,6,7,8-HpCDF	.20	.13	.19
1,2,3,4,6,7,8-HpCDF	1.4	1.5	1.8
1,2,3,4,7,8,9-HpCDF	.30	.36	.50
(Emission Rate 10^{-8}g/sec)			
2,3,7,8-TCDD	<.0047	<.0055	<.0059
1,2,3,7,8-PeCDD	.18	.16	.18
1,2,3,4,7,8-HxCDD	.20	.19	.20
1,2,3,6,7,8-HxCDD	.34	.32	.32
1,2,3,7,8,9-HxCDD	.47	.40	.51
1,2,3,4,6,7,8-HpCDD	3.4	3.2	3.8
2,3,7,8-TCDF	1.4	1.7	2.0
1,2,3,7,8-PeCDF	.23	.28	.24
2,3,4,7,8-PeCDF	.60	.64	.75
1,2,3,4,7,9-HxCDF	1.2	1.4	1.7
1,2,3,6,7,8-HxCDF	1.2	1.4	1.7
1,2,3,7,8,9-HxCDF	.85	1.0	1.2
2,3,4,6,7,8-HxCDF	.43	.28	.38
1,2,3,4,6,7,8-HpCDF	3.0	3.2	3.6
1,2,3,4,7,8,9-HpCDF	.64	.76	1.0

The significance of the concentration of 2,3,7,8-TCDD equivalents found in the exhaust gas from the No. 2 Boiler Stack is best judged against a background of values measured at other RDF incineration facilities. In the United States, concentrations ranging generally from 0.1 to 1300 ng/dsm^3 have been reported. From this perspective, the concentrations of dioxins emitted from the No. 2 Boiler at the time this study was performed are seen to be amongst the lowest reported for similar facilities.

Table 15. Results of the March 1988 Dioxin Determination on the No. 2 Boiler ESP Inlet at the NSP Red Wing Station (presented in 2,3,7,8-TCDD Equivalents).

		2,3,7,8-TCDD Equivalents		
	TEF	Run 1	Run 2	Run 3
Concentration	**(ng/dsm^3)**			
2,3,7,8-TCDD	1	.036	< .00090	< .0021
Other TCDDs	.01	.041	< .0020	< .0017
2,3,7,8-PeCDD	.5	.27	< .018	.015
Other PeCDDs	.005	.040	< .0026	.0021
2,3,7,8-HxCDD	.04	.092	.0032	.0017
Other HxCDDs	.0004	.0026	.00012	.000072
2,3,7,8-HpCDD	.001	.0058	.00019	.00011
Other HpCDDs	.00001	.000062	.0000021	.0000013
2,3,7,8-TCDF	.1	.56	.071	.067
Other TCDFs	.001	.035	.0059	.0055
2,3,7,8-PeCDF	.1	.21	.023	.015
Other PeCDFs	.001	.025	.0031	.0030
2,3,7,8-HxCDF	.01	.081	.0057	.0040
Other HxCDFs	.0001	.00069	.00011	.00010
2,3,7,8-HpCDF	.001	.0072	.00039	.00025
Other HpCDFs	.00001	.000028	.0000049	.0000049
Total		1.4	≤ .14	≤ .12
Emission Rate (10^{-8} g/sec)				
2,3,7,8-TCDD	1	.065	< .0016	< .0038
Other TCDDs	.01	.073	< .0036	< .0031
2,3,7,8-PeCDD	.5	.48	< .033	.027
Other PeCDDs	.005	.070	< .0047	.0039
2,3,7,8-HxCDD	.04	.17	.0060	.0032
Other HxCDDs	.0004	.0048	.00022	.00013
2,3,7,8-HpCDD	.001	.010	.00035	.00020
Other HpCDDs	.00001	.00012	.0000038	.0000024
2,3,7,8-TCDF	.1	1.0	.13	.12
Other TCDFs	.001	.064	.011	.0098
2,3,7,8-PeCDF	.1	.37	.041	.027
Other PeCDFs	.001	.045	.0056	.0054
2,3,7,8-HxCDF	.01	.15	.010	.0073
Other HxCDFs	.0001	.0012	.00021	.00019
2,3,7,8-HpCDF	.001	.013	.00071	.00045
Other HpCDFs	.00001	.000050	.0000089	.0000095
Total		2.5	≤ .25	≤ .21

TEF = Toxicity equivalence factor

Table 16. Results of the March 1988 Dioxin Determination on the No. 2 Boiler Stack at the NSP Red Wing Station (presented in 2,3,7,8-TCDD Equivalents).

		2,3,7,8-TCDD Equivalents		
	TEF	Run 1	Run 2	Run 3
Concentration	**($ng/dscm^3$)**			
2,3,7,8-TCDD	1	< .0022	< .0026	< .0029
Other TCDDs	.01	< .0050	< .0057	< .0054
2,3,7,8-PeCDD	.5	.043	.038	.044
Other PeCDDs	.005	.0075	.0075	.0085
2,3,7,8-HxCDD	.04	.019	.017	.020
Other HxCDDs	.0004	.00052	.00096	.00056
2,3,7,8-HpCDD	.001	.00016	.0015	.0019
Other HpCDDs	.00001	.000028	.000013	.000016
2,3,7,8-TCDF	.1	.068	.081	.10
Other TCDFs	.001	.0027	.0030	.0036
2,3,7,8-PeCDF	.1	.039	.043	.049
Other PeCDFs	.001	.0028	.0032	.0043
2,3,7,8-HxCDF	.01	.017	.020	.025
Other HxCDFs	.0001	.00013	.00012	.00017
2,3,7,8-HpCDF	.001	.0017	.00036	.0023
Other HpCDFs	.00001	.0000070	.000024	.000012
Total		≤ .21	≤ .22	≤ .27
Emission Rate (10^{-8} g/sec)				
2,3,7,8-TCDD	1	< .0047	< .0055	< .0059
Other TCDDs	.01	< .011	< .011	< .011
2,3,7,8-PeCDD	.5	.090	.080	.090
Other PeCDDs	.005	.016	.016	.017
2,3,7,8-HxCDD	.04	.040	.036	.040
Other HxCDDs	.0004	.0011	.0011	.0011
2,3,7,8-HpCDD	.001	.0034	.0032	.0038
Other HpCDDs	.00001	.000030	.000027	.000033
2,3,7,8-TCDF	.1	.14	.17	.20
Other TCDFs	.001	.0058	.0064	.0073
2,3,7,8-PeCDF	.1	.083	.092	.099
Other PeCDFs	.001	.0060	.0067	.0087
2,3,7,8-HxCDF	.01	.037	.041	.050
Other HxCDFs	.0001	.00027	.00027	.00035
2,3,7,8-HpCDF	.001	.0036	.0040	.0046
Other HpCDFs	.00001	.000015	.000019	.000025
Total		≤ .44	≤ .47	≤ .54

TEF = Toxicity equivalence factor

2.8 Dioxin and Furan ESP Removal Efficiencies

A summary of the dioxin and furan homolog mass rates measured at the ESP inlet and outlet test sites is presented in Table 17. The mass rates reported for the outlet of the ESP in Table 17 have been corrected for the discrepancies caused by the large scale turbulence which has been previously shown to exist at this test site, since the corrected values represent the best estimate of the true mass rates. These rates were then used to calculate the removal rate of the No. 2 Boiler electrostatic precipitator for each of the individual homolog groups.

The dioxin mass rates and ESP removal rates measured in this study exhibit some very interesting characteristics. Firstly, the removal efficiency appears to decrease as the chlorination number (i.e. molecular weight) increases for both the PCDDs and PCDFs. Secondly, the mass rates of PCDDs and PCDFs at the stack test location appear to be constant from run to run (day to day) even though the inlet loading changed radically from Day 1 to Day 2.

At first glance, it would appear that the ESP is generating dioxins and furans on Days 2 and 3, since the removal efficiencies are almost entirely negative. It is interesting to note that Runs 2 and 3 exhibit the same correlation with chlorination level as seen in Run 1. In the case of the dioxins, the "generation rate" (negative removal efficiency) increases rapidly from 140 to 160% for the TCDDs to 570 to 1500% for OCDD. In the case of the PCDFs, the removal efficiency drops from 38 to 51% for TCDF to an apparent generation rate of 750 to 1600% for OCDF.

Table 17. Summary of the March 23-25, 1988 Dioxin & Furan Removal Performance Test on the No. 2 Boiler ESP at the NSP Red Wing Station.

	Mass Rates (10^{-8}g/sec)								
Homolog Group	Run 1 IN	Run 1 OUT	Efficiency (% w/w)	Run 2 IN	Run 2 OUT	Efficiency (% w/w)	Run 3 IN	Run 3 OUT	Efficiency (% w/w)
TCDD	7.4	.80	89	.36	.88	(140)	.31	.80	(160)
PCDD	15	2.5	83	1.0	2.5	(150)	.82	2.6	(220)
HxCDD	16	2.8	83	.69	2.6	(280)	.40	2.8	(590)
HpCDD	22	4.7	79	.73	4.3	(490)	.44	5.2	(1100)
OCDD	16	4.4	73	.56	3.7	(560)	.29	4.6	(1500)
TCDF	74	5.3	93	12	5.9	51	11	6.8	38
PCCD	49	5.0	90	6.0	5.5	8	5.7	7.1	(24)
HxCCD	27	4.7	83	3.1	5.0	(60)	2.6	6.2	(140)
HpCCD	18	3.7	79	1.6	4.3	(170)	1.4	5.2	(270)
OCDF	4.9	1.4	72	.18	1.5	(750)	.11	1.9	(1600)
STACK GAS TEMP (^{o}F)	421	379		424	379		431	388	

When the dioxin and furan mass rates at the stack test site are looked at on the whole, no statistically significant intra-run variation appears to exist. However, when Runs 1 and 2 are compared to Run 3, Run 3 mass rates appear to be slightly larger and seem to correlate with flue gas temperatures (See Table 17).

It is purported that similar results have been reported by other investigators. It seems highly unlikely that any process in the electrostatic precipitator could give rise to such effects on the basis of cross-sectional, concentration and statistical considerations. Chemical rearrangements or any other forms of chemical generation are also highly unlikely on the basis of temperature and concentration considerations.

If the above suppositions are correct, the effect must be due to some physical equilibrium mechanism which is temperature and molecular weight dependent. Physical adsorption, although not normally studied at such high temperatures, may explain the observed phenomena. The chlorinated dioxin and furans are high molecular weight compounds with extremely low vapor pressures. The vapor pressure are exponentially dependent on temperature and inversely dependent on molecular weight.

At this particular facility, the distance between the inlet test location and the stack test location is quite large due to geometrical constraints when the ESP was retrofitted to the boiler. The large surface area of dust laden surfaces in the ESP and the downstream ducting provide an extremely large surface area for adsorption. The design of the ducts provides for sufficiently high linear velocity such that the gas flow falls in the range of "fully

developed turbulent flow". This being the case, the residence time in the ducts is probably sufficient to ensure a dynamic temperature-dependent equilibrium of high molecular weight low volatility compounds with stationary surfaces. An equilibrium of this type would account for the heretofor unexplained observations in this study and purported observations in other studies.

It should also be noted that the dioxins exist in equilibrium with the fine flyash particulate material suspended in the exhaust gas. Studies on the Modified Method 5 sampling train shown that even in the case of the most volatile dioxin homolog, 35 - 45% of the TCDD is collected with the particulates on the filter (See also Section 2.9 of this report).* Thus when the mass rate of dioxins and furans generated in the combustor are high, the mass rate measured at the inlet to the dust collector are high. Further, since most of the PCDDs and PCDFs are associated with the particulate material, positive collection efficiencies are observed.

Conversely, when the mass rate of PCDDs and PCDFs generated in the combustor are quite low, the equilibrium shifts and the clean exhaust gases desorbs adsorbed compounds from the downstream particulate-laden surfaces. The high deposition (adsorption) rates of the higher molecular weight moieties during periods of higher inlet concentrations and mass rates results in higher doping of these materials during periods of lower inlet concentrations and mass rates.

* Chlorinated Dioxins and Dibenzofurans in Perspective, Lewis Publishers, Inc, Chelsea, Michigan, 1986, p 99.

Additional research is needed to confirm the existence of an adsorption/condensation-like equilibrium. The effect of such an equilibrium, if it in fact exists, is to reduce temporal concentration variations downstream of a pollution control device. It also predicts lower dioxin emissions from PC systems with lower exhaust gas temperatures.

2.9 Ash Sampling

The results of the dioxin and furan analysis of the composite flyash samples collected by NSP personnel from the hoppers of the ESP during the three dioxin test runs are presented in Tables 18 and 19. The 2,3,7,8-TCDD equivalent concentration of the flyash is only 2.8 ng/g (ppb, w/w).

It is interesting to note, in light of the above proposed thermal equilibrium of PCDDs and PCDFs with the flyash particulate material, the strong molecular weight-dependent association of the CDDs and CDFs with the flyash:

	Concentration (ng/g)		
	Run 1	Run 2	Run 3
TCDD	6.4	3.4	3.4
PeCDD	17	18	18
HxCDD	17	32	46
HpCDD	110	130	390
OCDD	200	240	460
TCDF	40	35	32
PeCDF	39	46	51
HxCDF	21	44	58
HpCDF	51	71	250
OCDF	65	84	171

567

2862

1440 ng/m³

Table 18. Results of the Dioxin and Furan Analysis of the Flyash Samples Collected from the ESP Hoppers During the March 23-25, 1988 Dioxin Stack Test on No. 2 Boiler at the NSP Red Wing Station.

Isomer	Run 1	Run 2	Run 3
(Concentration ng/g)			
TCDD	6.4	3.4	3.4
(2378)	.18	.16	.14
PeCDD	17	18	18
(12378)	.97	1.4	1.6
HxCDD	17	32	46
(123478)	.80	1.8	2.6
(123678)	1.2	2.2	4.4
(123789)	1.4	2.8	4.5
HpCDD	110	130	390
(1234678)	48	58	180
OCDD	200	240	460
TCDF	40	35	32
(2378)	6.1	5.3	5.0
PeCDF	39	46	51
(12378)	1.5	2.2	2.4
(23478)	2.7	4.0	4.0
HxCDF	21	44	58
(123478)	4.2	8.1	11
(123678)	4.1	9.1	13
(234678)	2.5	6.1	7.5
(123789)	.69	1.7	1.9
HpCDF	51	71	250
(1234678)	28	39	137
(1234678)	3.9	5.3	22
OCDF	65	84	171

Table 19. Results of the Dioxin and Furan HRGC/HRMS Analysis of the Flyash Samples Collected During the March 23-25, 1988 Dioxin Stack Test (2,3,7,8-TCDD Equivalents).

		2,3,7,8-TCDDEquivalents (ng/g)		
Moiety	TEF	Run 1	Run 2	Run 3
2,3,7,8-TCDD	1	.18	.16	.14
Other TCDDs	.01	.062	.032	.033
2,3,7,8-PeCDD	.5	.49	.70	.80
Other PeCDDs	.005	.080	.085	.080
2,3,7,8-HxCDD	.04	.14	.27	.48
Other HxCDDs	.0004	.0056	.010	.014
2,3,7,8-HpCDD	.001	.048	.058	.18
Other HpCDDs	.00001	.00062	.00072	.0021
2,3,7,8-TCDF	.1	.61	.53	.50
Other TCDFs	.001	.034	.030	.027
2,3,7,8-PeCDF	.1	.42	.62	.64
Other PeCDFs	.001	.035	.040	.045
2,3,7,8-HxCDF	.01	.11	.25	.33
Other HxCDFs	.0001	.0010	.0019	.0025
2,3,7,8-HpCDF	.001	.032	.044	.16
Other HpCDFs	.00001	.00019	.00027	.00091
Total		2.2	2.8	3.4

TEF = Toxicity equivalence factor

3 RESULTS

The results of all field and laboratory evaluations are presented in this section. Gas composition results (Orsat and moisture) are presented first followed by the computer printout of the particulate, particle sizing, sulfur dioxide, hydrogen chloride, hydrogen fluoride, oxides of nitrogen, opacity, arsenic, beryllium, cadmium, chromium, lead, mercury nickel, PCDD and PCDF results. Preliminary measurements including test port locations are given in the appendices.

The results have been calculated on an IBM PC Computer using programs written in Extended BASIC specifically for source testing calculations. EPA-published dry F-Factor for the stated fuel.

3.1 Results of Orsat and Moisture Analyses

Test No. 1 (Particulate)
Unit 2 ESP Inlet

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

Date of run	Run 1 03-21-88	Run 2 03-21-88	Run 3 03-21-88
Dry basis (orsat)			
carbon dioxide.....	12.30	11.60	12.30
oxygen.....	6.90	8.20	7.00
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	80.80	80.20	80.70
Wet basis (orsat)			
carbon dioxide.....	10.27	9.86	10.57
oxygen.....	5.76	6.97	6.02
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	67.50	68.20	69.37
water vapor.....	16.46	14.96	14.03
Dry molecular weight.....	30.24	30.18	30.25
Wet molecular weight.....	28.23	28.36	28.53
Specific gravity.....	0.975	0.980	0.985
Water mass flow.....(LB/HR)	22609	20230	19098
FO	1.138	1.095	1.130

Test No. 1 (Particulate)
Unit 2 Stack

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

	Run 1	Run 2	Run 3
Date of run	03-21-88	03-21-88	03-21-88
Dry basis (orsat)			
carbon dioxide.....	11.84	11.00	11.01
oxygen.....	7.76	8.80	8.79
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	80.40	80.20	80.20
Wet basis (orsat)			
carbon dioxide.....	9.94	9.31	9.34
oxygen.....	6.51	7.45	7.45
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	67.48	67.87	68.01
water vapor.....	16.07	15.37	15.20
Dry molecular weight.....	30.20	30.11	30.11
Wet molecular weight.....	28.24	28.25	28.27
Specific gravity.....	0.976	0.976	0.977
Water mass flow.....(LB/HR)	26553	23812	23202
FO	1.110	1.100	1.100

Test No. 2 (Acid Gas)
Unit 2 Stack

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

Date of run	Run 1 03-24-88	Run 2 03-24-88	Run 3 03-24-88
Dry basis (orsat)			
carbon dioxide.....	12.00	10.80	12.00
oxygen.....	7.80	8.60	7.82
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	80.20	80.60	80.18
Wet basis (orsat)			
carbon dioxide.....	10.72	9.45	10.26
oxygen.....	6.97	7.52	6.69
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	71.63	70.49	68.55
water vapor.....	10.69	12.54	14.51
Dry molecular weight.....	30.23	30.07	30.23
Wet molecular weight.....	28.92	28.56	28.46
Specific gravity.....	0.999	0.986	0.983
FO	1.092	1.139	1.090

Test No. 3 (Metals)
Unit 2 ESP Inlet

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

Date of run	Run 1 03-22-88	Run 2 03-22-88	Run 3 03-22-88
Dry basis (orsat)			
carbon dioxide.....	12.33	12.79	12.60
oxygen.....	7.66	7.08	7.23
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	80.01	80.13	80.17
Wet basis (orsat)			
carbon dioxide.....	10.43	10.79	10.67
oxygen.....	6.48	5.97	6.12
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	67.66	67.59	67.87
water vapor.....	15.43	15.65	15.34
Dry molecular weight.....	30.28	30.33	30.31
Wet molecular weight.....	28.38	28.40	28.42
Specific gravity.....	0.980	0.981	0.982
FO	1.074	1.081	1.085

Test No. 3 (Metals)
Unit 2 Stack

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

Date of run	Run 1 03-22-88	Run 2 03-22-88	Run 3 03-22-88
Dry basis (orsat)			
carbon dioxide.....	11.60	12.18	12.00
oxygen.....	8.41	8.02	8.00
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	79.99	79.80	80.00
Wet basis (orsat)			
carbon dioxide.....	9.76	10.42	10.27
oxygen.....	7.07	6.86	6.84
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	67.29	68.26	68.44
water vapor.....	15.88	14.46	14.45
Dry molecular weight.....	30.19	30.27	30.24
Wet molecular weight.....	28.26	28.50	28.47
Specific gravity.....	0.976	0.984	0.983
FO	1.077	1.057	1.075

Test No. 4 (Dioxins)
Unit 2 ESP Inlet

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

Date of run	Run 1 03-23-88	Run 2 03-24-88	Run 3 03-25-88
Dry basis (orsat)			
carbon dioxide.....	12.01	12.09	12.32
oxygen.....	8.04	8.08	7.91
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	79.95	79.83	79.77
Wet basis (orsat)			
carbon dioxide.....	10.26	10.34	10.45
oxygen.....	6.87	6.91	6.71
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	68.29	68.28	67.65
water vapor.....	14.59	14.47	15.19
Dry molecular weight.....	30.24	30.26	30.29
Wet molecular weight.....	28.46	28.48	28.42
Specific gravity.....	0.983	0.984	0.982
FO	1.071	1.060	1.054

Test No. 4 (Dioxins)
Unit 2 Stack

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

Date of run	Run 1 03-23-88	Run 2 03-24-88	Run 3 03-25-88
Dry basis (orsat)			
carbon dioxide.....	11.00	11.21	11.39
oxygen.....	9.02	8.99	8.99
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	79.98	79.80	79.62
Wet basis (orsat)			
carbon dioxide.....	9.43	9.65	9.65
oxygen.....	7.73	7.74	7.61
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	68.53	68.72	67.43
water vapor.....	14.31	13.88	15.31
Dry molecular weight.....	30.12	30.15	30.18
Wet molecular weight.....	28.39	28.47	28.32
Specific gravity.....	0.981	0.983	0.978
FO	1.080	1.062	1.046

Test No. 5 (Particle Sizing)
Unit 2 ESP Inlet

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

	Run 1	Run 2	Run 3
Date of run	03-26-88	03-26-88	03-26-88
Dry basis (orsat)			
carbon dioxide.....	12.90	12.88	12.96
oxygen.....	7.03	7.10	7.04
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	80.07	80.02	80.00
Wet basis (orsat)			
carbon dioxide.....	10.93	10.82	11.02
oxygen.....	5.95	5.96	5.98
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	67.82	67.22	67.99
water vapor.....	15.29	15.99	15.01
Dry molecular weight.....	30.35	30.34	30.36
Wet molecular weight.....	28.46	28.37	28.50
Specific gravity.....	0.983	0.980	0.984
Water mass flow.....(LB/HR)	20462	22745	20792
FO	1.075	1.071	1.069

Test No. 5 (Particle Sizing)
Unit 2 Stack

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

Date of run	Run 1 03-26-88	Run 2 03-26-88	Run 3 03-26-88
Dry basis (orsat)			
carbon dioxide.....	12.00	12.39	12.15
oxygen.....	8.03	7.74	7.85
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	79.97	79.87	80.00
Wet basis (orsat)			
carbon dioxide.....	10.08	10.47	10.08
oxygen.....	6.74	6.54	6.51
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	67.15	67.49	66.37
water vapor.....	16.03	15.50	17.03
Dry molecular weight.....	30.24	30.29	30.26
Wet molecular weight.....	28.28	28.39	28.17
Specific gravity.....	0.977	0.981	0.973
Water mass flow.....(LB/HR)	24621	23928	26371
FO	1.073	1.062	1.074

3.2 Results of Particulate Loading Determinations

Test No. 1
Unit 2 ESP Inlet

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

	Run 1	Run 2	Run 3
Date of run	03-21-88	03-21-88	03-21-88
Time run start/end.....(HRS)	1610/1723	1810/1931	2005/2211
Static pressure.....(IN.WC)	-6.50	-6.50	-6.50
Cross sectional area (SQ.FT)	24.29	24.29	24.29
Pitot tube coefficient.....	.840	.840	.840
Water in sample gas			
condenser.....(ML)	0.0	0.0	0.0
impingers.....(GRAMS)	203.0	176.0	172.0
desiccant.....(GRAMS)	33.0	24.0	18.0
total.....(GRAMS)	236.0	200.0	190.0
Total particulate material..			
.....collected(grams)	5.6407	9.1055	7.1292
Gas meter coefficient.....	1.0021	1.0021	1.0021
Barometric pressure..(IN.HG)	29.44	29.44	29.44
Avg. orif.pres.drop..(IN.WC)	2.87	2.63	2.74
Avg. gas meter temp..(DEF-F)	85.9	94.4	94.2
Volume through gas meter....			
at meter conditions...(CF)	58.80	56.72	58.04
standard conditions.(DSCF)	56.46	53.59	54.87
Total sampling time....(MIN)	63.00	63.00	63.00
Nozzle diameter.....(IN)	.307	.307	.307
Avg.stack gas temp ..(DEG-F)	416	417	407
Volumetric flow rate.....			
actual.....(ACFM)	83862	82743	82288
dry standard.....(DSCFM)	40894	40987	41705
Isokinetic variation.....(%)	103.6	98.1	98.8
Particulate concentration...			
actual.....(GR/ACF)	0.75146	1.29808	1.01559
dry standard.....(GR/DSCF)	1.54165	2.62160	2.00464
Particle mass rate...(LB/HR)	540.38	921.00	716.60

Test No. 1
Unit 2 Stack

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

	Run 1	Run 2	Run 3
Date of run	03-21-88	03-21-88	03-21-88
Time run start/end.....(HRS)	1610/1723	1810/1926	2005/2206
Static pressure.....(IN.WC)	-0.55	-0.55	-0.55
Cross sectional area (SQ.FT)	72.45	72.45	72.45
Pitot tube coefficient.....	.840	.840	.840
Water in sample gas			
condenser.....(ML)	0.0	0.0	0.0
impingers.....(GRAMS)	162.0	143.0	143.0
desiccant.....(GRAMS)	23.0	14.0	10.0
total.....(GRAMS)	185.0	157.0	153.0
Total particulate material..			
.....collected(grams)	0.0370	0.1165	0.0400
Gas meter coefficient.....	0.9980	0.9980	0.9980
Barometric pressure..(IN.HG)	29.64	29.64	29.64
Avg. orif.pres.drop..(IN.WC)	2.14	1.74	1.70
Avg. gas meter temp..(DEF-F)	105.3	112.9	115.5
Volume through gas meter....			
at meter conditions...(CF)	49.08	44.55	44.21
standard conditions.(DSCF)	45.54	40.75	40.25
Total sampling time....(MIN)	60.00	60.00	60.00
Nozzle diameter.....(IN)	.437	.437	.437
Avg.stack gas temp ..(DEG-F)	367	369	340
Volumetric flow rate.....			
actual.....(ACFM)	93218	87682	83316
dry standard.....(DSCFM)	49427	46734	46156
Isokinetic variation.....(%)	106.9	101.1	101.2
Particulate concentration...			
actual.....(GR/ACF)	0.00664	0.02350	0.00849
dry standard.....(GR/DSCF)	0.01254	0.04411	0.01533
Particle mass rate...(LB/HR)	5.31	17.67	6.07

3.3 Results of the Particle Size Distribution Determination

Northern States Power Company
Red Wing, Minnesota
Sample Log No. #5978-181/182/183

Results of the Particle Size Distribution Determination

Sample Identification: Unit 2 ESP Inlet Particulate Sample (Test 5)
Assigned Density: 1.0 g/cc
Date Analyzed: April 8, 1988

Diameter	Relative Cumulative Frequency Percent by Mass Greater Than		
(um)	Run 1	Run 2	Run 3
220	3.90	3.12	4.38
93	18.80	17.40	20.91
89	18.89	17.71	22.00
74	19.36	19.79	22.25
59	20.66	22.19	24.93
44	25.02	28.17	30.29
30	34.30	36.55	41.02
22	40.61	41.94	46.38
15	52.21	51.52	53.75
11.9	58.24	57.50	61.13
10.0*	62.21	61.54	64.15
8.9	67.06	66.48	67.83
7.4	71.70	71.27	70.51
5.9	75.87	74.86	74.53
4.4	80.98	80.25	78.55
3.0	87.01	86.23	84.58
1.5	93.50	93.42	91.96
1.2	95.59	95.81	93.97
0.74	98.84	98.80	97.32

Analysis on a Micromeritics X-Ray Sedigraph.
*Interpolated values.

Results of the Particle Size Distribution Determination

Sample Identification: Unit 2 ESP Inlet Particulate Sample (Test 5)
Assigned Density: 1.0 g/cc
Date Analyzed: April 8, 1988

Diameter	Relative Cumulative Frequency Percent by Mass Greater Than		
(um)	Run 1	Run 2	Run 3
10	7.63	9.44	20.80
6.6	7.88	10.66	21.25
4.2	7.96	11.06	21.86
2.6	8.15	11.88	22.36
1.6	8.42	12.82	22.36
1.0	8.82	14.36	23.10
.64	10.38	14.84	23.47
.36	19.25	16.65	25.53

3.4 Results of Sulfur Dioxide Determinations

Test No. 2
Unit 2 Stack

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

	Run 1	Run 2	Run 3
Date of run	03-24-88	03-24-88	03-24-88
Time run start/end.....(HRS)	1000/1103	1115/1216	1232/1333
Barometric pressure..(IN.HG)	28.76	28.76	28.76
Meter temperature....(DEG-F)	71.75	77.21	79.13
Meter correction coefficient	1.0002	1.0002	1.0002
Volume through gas meter....			
at meter conditions...(CF)	43.970	45.040	44.940
standard conditions..(SCF)	42.159	42.746	42.500
Total sampling time....(MIN)	60.0	60.0	60.0
Moisture content.....(%V/V)	10.69	12.54	14.51
Oxygen content....(%V/V DRY)	0.00	0.00	0.00
Milliequivalents of SO4 in..			
gas sample.....	16.6000	15.2000	19.5000
<u>Sulfur dioxide concentration</u>			
(GR/DSCF).....	0.1946	0.1758	0.2268
(MG/DSCM).....	445	402	519
(PPM-DRY).....	167	151	195
(PPM-WET).....	150	132	167
SO2 Emission rate....(LB/HR)	75.07	67.79	87.47

Test No. 2
Unit 2 Stack

Results of HCl Determinations

	Run 1	Run 2	Run 3
Date of run	03-24-88	03-24-88	03-24-88
Time run start/end.....(HRS)	1000-1103	1115-1216	1232-1333
Barometric pressure..(IN.HG)	28.76	28.76	28.76
Meter temperature....(DEG-F)	71.75	77.21	79.13
Meter correction coefficient	1.0002	1.0002	1.0002
Volume through gas meter.... at meter conditions...(CF)	43.970	45.040	44.940
Total sampling time....(MIN)	60.0	60.0	60.0
Moisture content.....(%V/V)	10.69	12.54	14.51
Volumetric flow rate (DSCFM)	45000	45000	45000
HCl in sample.....(mG)	424.74	853.60	858.74
HCl concentration.....			
(GR/DSCF).....	0.1554	0.3080	0.3117
(MG/DSCM).....	355.90	705.42	713.79
(PPM-DRY).....	234.75	465.30	470.82
(PPM-WET).....	209.66	406.95	402.51
HCl emission rate....(LB/HR)	59.933	118.793	120.203

HCl = Hydrogen chloride

A trailing '<' symbol indicates that the true value is less than or equal to the reported value

Test No. 2
Unit 2 Stack

Results of HF Determinations

	Run 1	Run 2	Run 3
Date of run	03-24-88	03-24-88	03-24-88
Time run start/end.....(HRS)	1000-1103	1115-1216	1232-1333
Barometric pressure..(IN.HG)	28.76	28.76	28.76
Meter temperature....(DEG-F)	71.75	77.21	79.13
Meter correction coefficient	1.0002	1.0002	1.0002
Volume through gas meter.... at meter conditions...(CF)	43.970	45.040	44.940
Total sampling time....(MIN)	60.0	60.0	60.0
Moisture content.....(%V/V)	10.69	12.54	14.51
Volumetric flow rate (DSCFM)	45000	45000	45000
HF in sample.....(uG)	517.00	517.00	1527.00
HF concentration.....			
(GR/DSCF).....	0.0002	0.0005	0.0006
(MG/DSCM).....	0.43	1.20	1.27
(PPM-DRY).....	0.52	1.45	1.53
(PPM-WET).....	0.47	1.27	1.30
HF emission rate.....(LB/HR)	0.073	0.203	0.214

HF = Hydrogen fluoride

A trailing '<' symbol indicates that the true value is less than or equal to the reported value

3.5 Results of Oxides of Nitrogen Determinations

Test No. 1
Unit 2 Stack

Results of Oxides of Nitrogen (NOx) Determinations---------Method 7

	Run 1A	Run 1B	Run 1C	Run 1D
Date of run.....	03-21-88	03-21-88	03-21-88	03-21-88
Time of run.....(HRS)	1618	1643	1700	1715
Flask number.....	1	2	3	4
Volume of flask.....(ML)	2086	2063	2055	2116
Data: time of sampling				
flask temperature..(DEG-F)	44.00	42.00	42.00	42.00
bar. press.....(IN.HG)	29.64	29.64	29.64	29.64
flask vacuum.....(IN.HG)	28.60	28.50	28.50	28.50
flask abs. press...(IN.HG)	1.04	1.14	1.14	1.14
Data: Time of Flask Opening				
flask temperature..(DEG-F)	71.00	71.00	71.00	71.00
lab. bar. press....(IN.HG)	29.10	29.10	29.10	29.10
flask static press.(IN.HG)	1.80	2.25	2.15	2.15
flask abs. press...(IN.HG)	30.90	31.35	31.25	31.25
Volume gas sampled....(DSML)	2041	2041	2026	2087
Moisture content.....(%V/V)	16.07	16.07	16.07	16.07
Oxygen content....(%V/V,DRY)	7.76	7.76	7.76	7.76
Nitrate in gas sample...(uG)	870.0	980.0	890.0	945.0
NO2 in gas sample.....(uG)	645.5	727.1	660.4	701.2
<u>NOx Concentration</u>				
(GR/DSCF).....	0.1382	0.1557	0.1424	0.1468
(MG/DSCM).....	316	356	326	336
(PPM-DRY).....	165	186	170	176
(PPM-WET).....	139	156	143	147
NOX Emission rate....(LB/HR)	48.46	54.58	49.93	51.46
NOx emission factor..... .....(LB/MMBTU)*	0.303	0.341	0.312	0.322

* F = 9640 DSCF/MMBTU

Test No. 1
Unit 2 Stack

Results of Oxides of Nitrogen (NOx) Determinations----------Method 7

	Run 2A	Run 2B	Run 2C	Run 2D
Date of run.....	03-21-88	03-21-88	03-21-88	03-21-88
Time of run.....(HRS)	1800	1815	1830	1845
Flask number.....	5	6	43	44
Volume of flask.....(ML)	2057	2100	2088	2090
Data: time of sampling				
flask temperature..(DEG-F)	42.00	42.00	44.00	44.00
bar. press.....(IN.HG)	29.64	29.64	29.64	29.64
flask vacuum.....(IN.HG)	28.40	28.30	28.40	28.40
flask abs. press...(IN.HG)	1.24	1.34	1.24	1.24
Data: Time of Flask Opening				
flask temperature..(DEG-F)	71.00	71.00	71.00	71.00
lab. bar. press....(IN.HG)	29.10	29.10	29.10	29.10
flask static press.(IN.HG)	2.00	2.00	1.40	1.40
flask abs. press...(IN.HG)	31.10	31.10	30.50	30.50
Volume gas sampled....(DSML)	2011	2046.	2001	2003
Moisture content.....(%V/V)	15.37	15.37	15.37	15.37
Oxygen content....(%V/V,DRY)	8.80	8.80	8.80	8.80
Nitrate in gas sample...(uG)	710.0	805.0	850.0	830.0
NO2 in gas sample.....(uG)	526.8	597.3	630.7	615.8
<u>NOx Concentration</u>				
(GR/DSCF).....	0.1145	0.1276	0.1378	0.1344
(MG/DSCM).....	262	292	315	308
(PPM-DRY).....	137	153	165	161
(PPM-WET).....	116	129	139	136
NOX Emission rate....(LB/HR)	40.22	44.82	48.40	47.21
NOx emission factor..... .....(LB/MMBTU)*	0.272	0.303	0.328	0.320

* F = 9640 DSCF/MMBTU

Test No. 1
Unit 2 Stack

Results of Oxides of Nitrogen (NOx) Determinations---------Method 7

	Run 3A	Run 3B	Run 3C*	Run 3D
Date of run.....	03-21-88	03-21-88	03-21-88	03-21-88
Time of run.....(HRS)	1900	1915	1930	1945
Flask number.....	45	46	47	48
Volume of flask.....(ML)	2086	2090	2090	2102
Data: time of sampling				
flask temperature..(DEG-F)	44.00	44.00	44.00	44.00
bar. press.....(IN.HG)	29.64	29.64	29.64	29.64
flask vacuum.....(IN.HG)	28.50	28.40	28.40	28.40
flask abs. press...(IN.HG)	1.14	1.24	1.24	1.24
Data: Time of Flask Opening				
flask temperature..(DEG-F)	71.00	71.00	71.00	71.00
lab. bar. press....(IN.HG)	29.10	29.10	29.10	29.10
flask static press.(IN.HG)	2.40	2.00	2.65	1.90
flask abs. press...(IN.HG)	31.50	31.10	31.75	31.00
Volume gas sampled....(DSML)	2074	2044	2088	2049
Moisture content.....(%V/V)	15.20	15.20	15.20	15.20
Oxygen content....(%V/V,DRY)	8.79	8.79	8.79	8.79
Nitrate in gas sample...(uG)	830.0	770.0	182.0	825.0
NO2 in gas sample.....(uG)	615.8	571.3	135.0	612.1
<u>NOx Concentration</u>				
(GR/DSCF).....	0.1297	0.1222	0.0283	0.1306
(MG/DSCM).....	297	280	65	299
(PPM-DRY).....	155	146	34	156
(PPM-WET).....	132	124	29	132
NOX Emission rate....(LB/HR)	46.38	43.67	10.10	46.67
NOx emission factor..... .....(LB/MMBTU)*	0.308	0.290	0.067	0.310

* F = 9640 DSCF/MMBTU

** Results from this sample invalidated. During shaking the top of the flask came off.

3.6 Results of Opacity Observatons

Test No. 1 Run 1
Unit 2 Stack

Results of Opacity Observations ---------- EPA Method 9

PERCENT OPACITY	OPTICAL DENSITY	RELATIVE FREQUENCY (%)
0	0.0000	62.92
5	0.0223	28.75
10	0.0458	8.33
15	0.0706	0.00
20	0.0969	0.00
25	0.1249	0.00
30	0.1549	0.00
35	0.1871	0.00
40	0.2219	0.00
45	0.2596	0.00
50	0.3010	0.00
55	0.3468	0.00
60	0.3979	0.00
65	0.4559	0.00
70	0.5229	0.00
75	0.6021	0.00
80	0.6690	0.00
85	0.8239	0.00
90	1.0000	0.00
95	1.3010	0.00
99	2.0000	0.00
Avg Opac 2.27	Avg OD 0.0102	Time average

Observer: C. Mosser
Cert. Date: 10-21-87
Date of Observation: 03-21-88
Time of Observation: 1610-1710

Test No. 1 Run 2
Unit 2 Stack

Results of Opacity Observations ---------- EPA Method 9

PERCENT OPACITY	OPTICAL DENSITY	RELATIVE FREQUENCY (%)
0	0.0000	74.20
5	0.0223	25.80
10	0.0458	0.00
15	0.0706	0.00
20	0.0969	0.00
25	0.1249	0.00
30	0.1549	0.00
35	0.1871	0.00
40	0.2219	0.00
45	0.2596	0.00
50	0.3010	0.00
55	0.3468	0.00
60	0.3979	0.00
65	0.4559	0.00
70	0.5229	0.00
75	0.6021	0.00
80	0.6690	0.00
85	0.8239	0.00
90	1.0000	0.00
95	1.3010	0.00
99	2.0000	0.00

Avg Opac 1.29 Avg OD 0.0058 Time average

Observer: C. Mosser
Cert. Date: 10-21-87
Date of Observation: 03-21-88
Time of Observation: 1730-1800

Test No. 4 Run 3
Unit 2 Stack

Results of Opacity Observations ---------- EPA Method 9

PERCENT OPACITY	OPTICAL DENSITY	RELATIVE FREQUENCY (%)
0	0.0000	100.00
5	0.0223	0.00
10	0.0458	0.00
15	0.0706	0.00
20	0.0969	0.00
25	0.1249	0.00
30	0.1549	0.00
35	0.1871	0.00
40	0.2219	0.00
45	0.2596	0.00
50	0.3010	0.00
55	0.3468	0.00
60	0.3979	0.00
65	0.4559	0.00
70	0.5229	0.00
75	0.6021	0.00
80	0.6690	0.00
85	0.8239	0.00
90	1.0000	0.00
95	1.3010	0.00
99	2.0000	0.00

Avg Opac 0.00 Avg OD 0.0000 Time average

Observer: J. Buresh
Cert. Date: 10-21-87
Date of Observation: 03-25-88
Time of Observation: 1345-1445

3.7 Results of Arsenic Determinations

Test No. 3
Unit 2 ESP Inlet

Results of Arsenic Determinations---------- Method 108

	Run 1	Run 2	Run 3
Date of run	03-22-88	03-22-88	03-22-88
Time run start/end.....(HRS)	0947-1143	1225-1335	1410-1519
Barometric pressure..(IN.HG)	29.19	29.19	29.19
Meter temperature....(DEG-F)	90.60	100.60	104.60
Meter correction coefficient	1.0021	1.0021	1.0021
Volume through gas meter....			
at meter conditions...(CF)	39.570	37.710	38.330
standard conditions (DSCF)	37.216	34.822	35.146
Total sampling time....(MIN)	63.0	63.0	63.0
Moisture content.....(%V/V)	15.43	15.65	15.34
Volumetric flow rate (DSCFM)	40723	37971	38461
As in sample.....(uG)	109.00	319.00	169.00
As concentration.....			
(GR/10^3DSCF).....	0.0452	0.1414	0.0742
(uG/DSCM).....	103.50	323.75	169.93
As emis. rate....(10^{-3}LB/HR)	15.77	46.00	24.46

As = Arsenic

A trailing '<' symbol indicates that the true value is less than or equal to the reported value

Test No. 3
Unit 2 Stack

Results of Arsenic Determinations---------- Method 108

	Run 1	Run 2	Run 3
Date of run	03-22-88	03-22-88	03-22-88
Time run start/end.....(HRS)	0945-1144	1225-1311	1410-1515
Barometric pressure..(IN.HG)	29.02	29.02	29.02
Meter temperature....(DEG-F)	111.80	117.10	120.80
Meter correction coefficient	0.9980	0.9980	0.9980
Volume through gas meter....			
at meter conditions...(CF)	46.200	47.050	46.440
standard conditions (DSCF)	41.487	41.868	41.056
Total sampling time....(MIN)	60.0	60.0	60.0
Moisture content.....(%V/V)	15.88	14.46	14.45
Volumetric flow rate (DSCFM)	47703	48792	47316
As in sample.....(uG)	26.00	16.00	1.30
As concentration.....			
(GR/10^{3}DSCF).....	0.0097	0.0059	0.0005
(uG/DSCM).....	22.15	13.51	1.12
As emis. rate....(10^{-3}LB/HR)	3.95	2.47	0.20

As = Arsenic

A trailing '<' symbol indicates that the true value is less than or equal to the reported value

3.8 Results of Beryllium Detminations

Test No. 3
Unit 2 ESP Inlet

Results of Beryllium Determinations----------Method 104

	Run 1	Run 2	Run 3
Date of run	03-22-88	03-22-88	03-22-88
Time run start/end.....(HRS)	0947-1143	1225-1335	1410-1519
Barometric pressure..(IN.HG)	29.19	29.19	29.19
Meter temperature....(DEG-F)	90.60	100.60	104.60
Meter correction coefficient	1.0021	1.0021	1.0021
Volume through gas meter....			
at meter conditions...(CF)	39.570	37.710	38.330
standard conditions (DSCF)	37.216	34.822	35.146
Total sampling time....(MIN)	63.0	63.0	63.0
Moisture content.....(%V/V)	15.43	15.65	15.34
Volumetric flow rate (DSCFM)	40723	37971	38461
Beryllium in sample.....(uG)	2.000	1.200	1.900
Beryllium concentration.....			
(GR/10^{3}DSCF).....	0.0008	0.0005	0.0008
(uG/DSCM).....	1.90	1.22	1.91
Beryllium emission rate.....			
(10^{-3}LB/HR).....	0.29	0.17	0.27

A trailing '<' symbol indicates that the true value
is less than or equal to the reported value

Test No. 3
Unit 2 Stack

Results of Beryllium Determinations----------Method 104

	Run 1	Run 2	Run 3
Date of run	03-22-88	03-22-88	03-22-88
Time run start/end.....(HRS)	0945-1144	1225-1311	1410-1515
Barometric pressure..(IN.HG)	29.02	29.02	29.02
Meter temperature....(DEG-F)	111.80	117.10	120.80
Meter correction coefficient	0.9980	0.9980	0.9980
Volume through gas meter....			
at meter conditions...(CF)	46.200	47.050	46.440
standard conditions (DSCF)	41.487	41.868	41.056
Total sampling time....(MIN)	60.0	60.0	60.0
Moisture content.....(%V/V)	15.88	14.46	14.45
Volumetric flow rate (DSCFM)	47703	48792	47316
Beryllium in sample.....(uG)	0.200<	0.200<	0.200<
Beryllium concentration.....			
($GR/10^3DSCF$).....	0.0001<	0.0001<	0.0001<
(uG/DSCM).....	0.17<	0.17<	0.17<
Beryllium emission rate.....			
($10^{-3}LB/HR$).....	0.03<	0.03<	0.03<

A trailing '<' symbol indicates that the true value is less than or equal to the reported value

3.9 Results of Cadmium Determinations

Test No. 3
Unit 2 ESP Inlet

Results of Cadmium Determinations----------Modified Method 12

	Run 1	Run 2	Run 3
Date of run	03-22-88	03-22-88	03-22-88
Time run start/end.....(HRS)	0947-1143	1225-1335	1410-1519
Barometric pressure..(IN.HG)	29.19	29.19	29.19
Meter temperature....(DEG-F)	90.60	100.60	104.60
Meter correction coefficient	1.0021	1.0021	1.0021
Volume through gas meter....			
at meter conditions...(CF)	39.570	37.710	38.330
standard conditions (DSCF)	37.216	34.822	35.146
Total sampling time....(MIN)	63.0	63.0	63.0
Moisture content.....(%V/V)	15.43	15.65	15.34
Volumetric flow rate (DSCFM)	40723	37971	38461
Cd in sample.....(uG)	780.00	920.00	690.00
Cd concentration.....			
(GR/DSCF).....	0.0003	0.0004	0.0003
(MG/DSCM).....	0.74	0.93	0.69
Cd emission rate.....(LB/HR)	0.11	0.13	0.10

Cd = Cadmium

A trailing '<' symbol indicates that the true value is less than or equal to the reported value

Test No. 3
Unit 2 Stack

Results of Cadmium Determinations---------Modified Method 12

	Run 1	Run 2	Run 3
Date of run	03-22-88	03-22-88	03-22-88
Time run start/end.....(HRS)	0945-1144	1225-1311	1410-1515
Barometric pressure..(IN.HG)	29.02	29.02	29.02
Meter temperature....(DEG-F)	111.80	117.10	120.80
Meter correction coefficient	0.9980	0.9980	0.9980
Volume through gas meter....			
at meter conditions...(CF)	46.200	47.050	46.440
standard conditions (DSCF)	41.487	41.868	41.056
Total sampling time....(MIN)	60.0	60.0	60.0
Moisture content.....(%V/V)	15.88	14.46	14.45
Volumetric flow rate (DSCFM)	47703	48792	47316
Cd in sample.....(uG)	5.90	2.90	0.10
Cd concentration.....			
(GR/10^{3}DSCF).....	0.0022	0.0011	0.00004
(uG/DSCM).....	5.03	2.45	0.09
Cd emis. rate....(10^{-3}LB/HR)	0.90	0.45	0.015

Cd = Cadmium

A trailing '<' symbol indicates that the true value is less than or equal to the reported value

3.10 Results of Chromium Determinations

Test No. 3
Unit 2 ESP Inlet

Results of Chromium Determinations--------Modified Method 12

	Run 1	Run 2	Run 3
Date of run	03-22-88	03-22-88	03-22-88
Time run start/end.....(HRS)	0947-1143	1225-1335	1410-1519
Barometric pressure..(IN.HG)	29.19	29.19	29.19
Meter temperature....(DEG-F)	90.60	100.60	104.60
Meter correction coefficient	1.0021	1.0021	1.0021
Volume through gas meter....			
at meter conditions...(CF)	39.570	37.710	38.330
standard conditions (DSCF)	37.216	34.822	35.146
Total sampling time....(MIN)	63.0	63.0	63.0
Moisture content.....(%V/V)	15.43	15.65	15.34
Volumetric flow rate (DSCFM)	40723	37971	38461
Cr in sample.....(uG)	460.00	280.00	390.00
Cr concentration.....			
(GR/10^{3}DSCF).....	0.1907	0.1241	0.1712
(uG/DSCM).....	436.81	284.16	392.15
Cr emis. rate....(10^{-3}LB/HR)	66.57	40.38	56.44

Cr = Chromium

A trailing '<' symbol indicates that the true value is less than or equal to the reported value

Test No. 3
Unit 2 Stack

Results of Chromium Determinations--------Modified Method 12

	Run 1	Run 2	Run 3
Date of run	03-22-88	03-22-88	03-22-88
Time run start/end.....(HRS)	0945-1144	1225-1311	1410-1515
Barometric pressure..(IN.HG)	29.02	29.02	29.02
Meter temperature....(DEG-F)	111.80	117.10	120.80
Meter correction coefficient	0.9980	0.9980	0.9980
Volume through gas meter....			
at meter conditions...(CF)	46.200	47.050	46.440
standard conditions (DSCF)	41.487	41.868	41.056
Total sampling time....(MIN)	60.0	60.0	60.0
Moisture content.....(%V/V)	15.88	14.46	14.45
Volumetric flow rate (DSCFM)	47703	48792	47316
Cr in sample.....(uG)	158.00	71.00	11.00
Cr concentration.....			
(GR/10^{3}DSCF).....	0.0588	0.0262	0.0041
(uG/DSCM).....	134.59	59.93	9.47
Cr emis. rate....(10^{-3}LB/HR)	24.03	10.94	1.68

Cr = Chromium

A trailing '<' symbol indicates that the true value is less than or equal to the reported value

3.11 Results of Lead Determinations

Test No. 3
Unit 2 ESP Inlet

Results of Lead Determinations----------Method 12

	Run 1	Run 2	Run 3
Date of run	03-22-88	03-22-88	03-22-88
Time run start/end.....(HRS)	0947-1143	1225-1335	1410-1519
Barometric pressure..(IN.HG)	29.19	29.19	29.19
Meter temperature....(DEG-F)	90.60	100.60	104.60
Meter correction coefficient	1.0021	1.0021	1.0021
Volume through gas meter....			
at meter conditions...(CF)	39.570	37.710	38.330
standard conditions (DSCF)	37.216	34.822	35.146
Total sampling time....(MIN)	63.0	63.0	63.0
Moisture content.....(%V/V)	15.43	15.65	15.34
Volumetric flow rate (DSCFM)	40723	37971	38461
Lead in sample.....(uG)	29000	17000	26000
Lead concentration.....			
(GR/DSCF).....	0.0120	0.0075	0.0114
(MG/DSCM).....	27.54	17.25	26.14
Lead emission rate...(LB/HR)	4.197	2.452	3.763

A trailing '<' symbol indicates that the true value
is less than or equal to the reported value

Test No. 3
Unit 2 Stack

Results of Lead Determinations----------Method 12

	Run 1	Run 2	Run 3
Date of run	03-22-88	03-22-88	03-22-88
Time run start/end.....(HRS)	0945-1144	1225-1311	1410-1515
Barometric pressure..(IN.HG)	29.02	29.02	29.02
Meter temperature....(DEG-F)	111.80	117.10	120.80
Meter correction coefficient	0.9980	0.9980	0.9980
Volume through gas meter....			
at meter conditions...(CF)	46.200	47.050	46.440
standard conditions (DSCF)	41.487	41.868	41.056
Total sampling time....(MIN)	60.0	60.0	60.0
Moisture content.....(%V/V)	15.88	14.46	14.45
Volumetric flow rate (DSCFM)	47703	48792	47316
Lead in sample.....(uG)	81.00	43.00	29.00
Lead concentration.....			
(GR/10^{5}DSCF).....	0.0301	0.0158	0.0109
(uG/DSCM).....	69.00	36.30	24.96
Lead emis. rate..(10^{-5}LB/HR)	12.317	6.627	4.420

A trailing '<' symbol indicates that the true value is less than or equal to the reported value

3.12 Results of Mercury Determinations

Test No. 3
Unit 2 ESP Inlet

Results of Mercury Determinations----------Method 101A

	Run 1	Run 2	Run 3
Date of run	03-22-88	03-22-88	03-22-88
Time run start/end.....(HRS)	0947-1143	1225-1335	1410-1519
Barometric pressure..(IN.HG)	29.19	29.19	29.19
Meter temperature....(DEG-F)	90.60	100.60	104.60
Meter correction coefficient	1.0021	1.0021	1.0021
Volume through gas meter....			
at meter conditions...(CF)	39.570	37.710	38.330
standard conditions (DSCF)	37.216	34.822	35.146
Total sampling time....(MIN)	63.0	63.0	63.0
Moisture content.....(%V/V)	15.43	15.65	15.34
Volumetric flow rate (DSCFM)	40723	37971	38461
Hg in sample.....(uG)	132.00	111.00	172.00
Hg concentration.....			
(GR/10^{5}DSCF).....	0.0547	0.0492	0.0755
(uG/DSCM).....	125.35	112.65	172.95
Hg emis. rate....(10^{-5}LB/HR)	19.10	16.01	24.89

Hg = Mercury

A trailing '<' symbol indicates that the true value is less than or equal to the reported value

Test No. 3
Unit 2 Stack

Results of Mercury Determinations----------Method 101A

	Run 1	Run 2	Run 3
Date of run	03-22-88	03-22-88	03-22-88
Time run start/end.....(HRS)	0945-1144	1225-1311	1410-1515
Barometric pressure..(IN.HG)	29.02	29.02	29.02
Meter temperature....(DEG-F)	111.80	117.10	120.80
Meter correction coefficient	0.9980	0.9980	0.9980
Volume through gas meter....			
at meter conditions...(CF)	46.200	47.050	46.440
standard conditions (DSCF)	41.487	41.868	41.056
Total sampling time....(MIN)	60.0	60.0	60.0
Moisture content.....(%V/V)	15.88	14.46	14.45
Volumetric flow rate (DSCFM)	47703	48792	47316
Hg in sample.....(uG)	35.30	17.90	30.40
Hg concentration.....			
(GR/10^{3}DSCF).....	0.0131	0.0066	0.0114
(uG/DSCM).....	30.07	15.11	26.17
Hg emis. rate....(10^{-3}LB/HR)	5.37	2.76	4.63

Hg = Mercury

A trailing '<' symbol indicates that the true value is less than or equal to the reported value

3.13 Results of Nickel Determinations

Test No. 3
Unit 2 ESP Inlet

Results of Nickel Determinations----------Modified Method 12

	Run 1	Run 2	Run 3
Date of run	03-22-88	03-22-88	03-22-88
Time run start/end.....(HRS)	0947-1143	1225-1335	1410-1519
Barometric pressure..(IN.HG)	29.19	29.19	29.19
Meter temperature....(DEG-F)	90.60	100.60	104.60
Meter correction coefficient	1.0021	1.0021	1.0021
Volume through gas meter....			
at meter conditions...(CF)	39.570	37.710	38.330
standard conditions (DSCF)	37.216	34.822	35.146
Total sampling time....(MIN)	63.0	63.0	63.0
Moisture content.....(%V/V)	15.43	15.65	15.34
Volumetric flow rate (DSCFM)	40723	37971	38461
Ni in sample.....(uG)	410.00	290.00	320.00
Ni concentration.....			
(GR/10^{3}DSCF).....	0.1700	0.1285	0.1405
(uG/DSCM).....	389.33	294.31	321.76
Ni emis. rate....(10^{-3}LB/HR)	59.33	41.82	46.31

Ni = Nickel

A trailing '<' symbol indicates that the true value is less than or equal to the reported value

Test No. 3
Unit 2 Stack

Results of Nickel Determinations----------Modified Method 12

	Run 1	Run 2	Run 3
Date of run	03-22-88	03-22-88	03-22-88
Time run start/end.....(HRS)	0945-1144	1225-1311	1410-1515
Barometric pressure..(IN.HG)	29.02	29.02	29.02
Meter temperature....(DEG-F)	111.80	117.10	120.80
Meter correction coefficient	0.9980	0.9980	0.9980
Volume through gas meter....			
at meter conditions...(CF)	46.200	47.050	46.440
standard conditions (DSCF)	41.487	41.868	41.056
Total sampling time....(MIN)	60.0	60.0	60.0
Moisture content.....(%V/V)	15.88	14.46	14.45
Volumetric flow rate (DSCFM)	47703	48792	47316
Ni in sample.....(uG)	250.00	99.00	63.00
Ni concentration.....			
(GR/10^{3}DSCF).....	0.0930	0.0365	0.0237
(uG/DSCM).....	212.96	83.56	54.23
Ni emis. rate....(10^{-3}LB/HR)	38.02	15.26	9.60

Ni = Nickel

A trailing '<' symbol indicates that the true value is less than or equal to the reported value

3.14 Results of PCDD and PCDF Determinations

Test No. 4
Unit 2 ESP Inlet

Results of PCDD and PCDF Determinations----SW846 Method 0010

Date of run	Run 1 03-23-88	Run 2 03-24/25-88	Run 3 03-25-88
Time run start/end.....(HRS)	1130/1656	945/1002	1340/1904
Static pressure.....(IN.WC)	-6.00	-6.00	-6.00
Cross sectional area (SQ.FT)	24.29	24.29	24.29
Pitot tube coefficient.....	.840	.840	.840
Water in sample gas			
condensate trap.....(ML)	493.0	492.0	521.0
impingers.....(GRAMS)	-4.0	0.0	0.0
desiccant.....(GRAMS)	41.0	43.0	45.0
total.....(GRAMS)	530.0	535.0	566.0
Mass of TTE in sample...(ng)	5.79	≤ .59	≤ .51
Gas meter coefficient.....	1.0021	1.0021	1.0021
Barometric pressure..(IN.HG)	29.01	28.75	28.60
Avg. orif.pres.drop..(IN.WC)	0.92	0.94	0.98
Avg. gas meter temp..(DEF-F)	99.6	98.6	108.4
Volume through gas meter....			
at meter conditions...(CF)	159.05	163.24	166.81
standard conditions.(DSCF)	146.09	148.87	148.74
standard conditions.(DSCM)	4.134	4.213	4.209
Total sampling time....(MIN)	294.00	294.00	294.00
Nozzle diameter.....(IN)	.241	.241	.241
Avg.stack gas temp ..(DEG-F)	421	424	431
Volumetric flow rate.....			
actual.....(ACFM)	78387	79764	81960
dry standard.....(DSCFM)	38296	38573	38772
Isokinetic variation.....(%)	99.6	100.7	100.1
TTE concentration..(ng/DSM3)	1.4	≤ .14	≤ .12
TTE emission rate..... .....(10^{-8} g/sec)	2.5	≤ .25	≤ .21

TTE = total 2,3,7,8 TCDD equivalents

Toxicity Equivalence Factors (TEFs) used in the calculation of the above TTEs are those currently recommended by "Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-Dioxins and Dibenzofurans (CDDs and CDFs)", J.S. Bellin and D.G. Barnes, USEPA Risk Assessment Forum, October 1986.

Test No. 4
Unit 2 ESP Inlet

Results of PCDD and PCDF HRGC/HRMS Analysis----------

	Field Blank
Sample log number	5978-(84-87)
Date of run	
Time run start/end.....(HRS)	
PCDD Isomer distribution....	
2,3,7,8-TCDD.....(ng)	<.0066
1,2,3,7,8-PeCDD.....(ng)	< .13
1,2,3,4,7,8-HxCDD.....(ng)	< .041
1,2,3,6,7,8-HxCDD.....(ng)	< .041
1,2,3,7,8,9-HxCDD.....(ng)	< .056
1,2,3,4,6,7,8-HpCDD...(ng)	< .16
PCDF Isomer distribution....	
2,3,7,8-TCDF.....(ng)	< .048
1,2,3,7,8-PeCDF.....(ng)	< .076
2,3,4,7,8-PeCDF.....(ng)	< .063
1,2,3,4,7,8-HxCDF.....(ng)	< .033
1,2,3,6,7,8-HxCDF.....(ng)	< .074
1,2,3,7,8,9-HxCDF.....(ng)	< .041
2,3,4,6,7,8-HxCDF.....(ng)	< .033
1,2,3,4,6,7,8-HpCDF...(ng)	< .081
1,2,3,4,7,8,9-HpCDF...(ng)	< .043

Test No. 4
Unit 2 ESP Inlet

Results of PCDD and PCDF HRGC/HRMS Analysis----------

	Run 1	Run 2	Run 3
Sample log number	5978-(88-91)	(92-96)	(97-100)
Date of run	03-23-88	03-24/25-88	03-25-88
Time run start/end.....(HRS)	1130/1656	945/1002	1340/1904
PCDD Isomer distribution....			
2,3,7,8-TCDD.....(ng)	.15	<.0038	<.0089
1,2,3,7,8-PeCDD.....(ng)	2.2	< .15	.12
1,2,3,4,7,8-HxCDD.....(ng)	2.5	.10	.035
1,2,3,6,7,8-HxCDD.....(ng)	2.5	.096	.061
1,2,3,7,8,9-HxCDD.....(ng)	4.6	.16	.089
1,2,3,4,6,7,8-HpCDD...(ng)	24	.81	.47
PCDF Isomer distribution....			
2,3,7,8-TCDF.....(ng)	23	3.0	2.8
1,2,3,7,8-PeCDF.....(ng)	3.2	.37	.16
2,3,4,7,8-PeCDF.....(ng)	5.3	.60	.46
1,2,3,4,7,8-HxCDF.....(ng)	12	.94	.70
1,2,3,6,7,8-HxCDF.....(ng)	12	.85	.50
1,2,3,7,8,9-HxCDF.....(ng)	7.9	.56	.35
2,3,4,6,7,8-HxCDF.....(ng)	1.8	.10	.12
1,2,3,4,6,7,8-HpCDF...(ng)	28	1.5	.92
1,2,3,4,7,8,9-HpCDF...(ng)	1.8	.14	.12

Test No. 4
Unit 2 ESP Inlet

Results of PCDD and PCDF HRGC/HRMS Analysis----------

	Field Blank
Sample log number	5978-(84-87)
Date of run	
Time run start/end.....(HRS)	
PCDD homolog distribution...	
TCDD.....(ng)	< .007
PeCDD.....(ng)	< .13
HxCDD.....(ng)	< .041
HpCDD.....(ng)	< .16
OCDD.....(ng)	.19
PCDF homolog distribution...	
TCDF.....(ng)	< .048
PeCDF.....(ng)	< .076
HxCDF.....(ng)	< .033
HpCDF.....(ng)	< .081
OCDF.....(ng)	< .063

Test No. 4
Unit 2 ESP Inlet

Results of PCDD and PCDF HRGC/HRMS Analysis----------

	Run 1	Run 2	Run 3
Sample log number	5978-(88-91)	(92-96)	(97-100)
Date of run	03-23-88	03-24/25-88	03-25-88
Time run start/end.....(HRS)	1130/1656	945/1002	1340/1904
PCDD homolog distribution...			
TCDD.....(ng)	17	.85	.72
PeCDD.....(ng)	34	2.3	1.9
HxCDD.....(ng)	36	1.6	.92
HpCDD.....(ng)	48	1.7	1.0
OCDD.....(ng)	37	1.3	.68
PCDF homolog distribution...			
TCDF.....(ng)	170	28	26
PeCDF.....(ng)	110	14	13
HxCDF.....(ng)	64	7.1	5.9
HpCDF.....(ng)	42	3.7	3.1
OCDF.....(ng)	11	.41	.25

Test No. 4
Unit 2 Stack

Results of PCDD and PCDF Determinations----SW846 Method 0010

Date of run	Run 1 03-23-88	Run 2 03-24/25-88	Run 3 03-25-88
Time run start/end.....(HRS)	1130/1644	945/ 958	1340/1840
Static pressure.....(IN.WC)	-0.55	-0.55	-0.55
Cross sectional area (SQ.FT)	72.45	72.45	72.45
Pitot tube coefficient.....	.840	.840	.840
Water in sample gas			
condensate trap.....(ML)	588.0	558.0	604.0
impingers.....(GRAMS)	0.0	0.0	0.0
desiccant.....(GRAMS)	35.0	41.0	48.0
total.....(GRAMS)	623.0	599.0	652.0
Mass of TTE in sample...(ng)	≤ 1.04	≤ 1.09	≤ 1.30
Gas meter coefficient.....	0.9980	0.9980	0.9980
Barometric pressure..(IN.HG)	29.01	28.75	28.60
Avg. orif.pres.drop..(IN.WC)	1.46	1.44	1.37
Avg. gas meter temp..(DEF-F)	124.6	116.3	115.3
Volume through gas meter....			
at meter conditions...(CF)	200.28	198.48	193.36
standard conditions.(DSCF)	175.61	174.96	169.82
standard conditions.(DSCM)	4.969	4.951	4.805
Total sampling time....(MIN)	288.00	288.00	288.00
Nozzle diameter.....(IN)	.425	.425	.425
Avg.stack gas temp ..(DEG-F)	379	379	388
Volumetric flow rate.....			
actual.....(ACFM)	86530	86452	85078
dry standard.....(DSCFM)	45195	44974	42839
Isokinetic variation.....(%)	99.3	99.4	101.3
TTE concentration..(ng/DSM3)	≤ .21	≤ .22	≤ .27
TTE emission rate.... .....(10^{-8} g/sec)	≤ .44	≤ .47	≤ .54

TTE = total 2,3,7,8 TCDD equivalents

Toxicity Equivalence Factors (TEFs) used in the calculation of the above TTEs are those currently recommended by "Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-Dioxins and Dibenzofurans (CDDs and CDFs)", J.S. Bellin and D.G. Barnes, USEPA Risk Assessment Forum, October 1986.

Test No. 4
Unit 2 Stack

Results of PCDD and PCDF HRGC/HRMS Analysis----------

	Field Blank
Sample log number	5978-(104-107)
Date of run	
Time run start/end.....(HRS)	
PCDD Isomer distribution....	
2,3,7,8-TCDD.....(ng)	<.0057
1,2,3,7,8-PeCDD.....(ng)	< .077
1,2,3,4,7,8-HxCDD.....(ng)	< .037
1,2,3,6,7,8-HxCDD.....(ng)	< .032
1,2,3,7,8,9-HxCDD.....(ng)	< .035
1,2,3,4,6,7,8-HpCDD...(ng)	< .12
PCDF Isomer distribution....	
2,3,7,8-TCDF.....(ng)	< .021
1,2,3,7,8-PeCDF.....(ng)	< .045
2,3,4,7,8-PeCDF.....(ng)	< .033
1,2,3,4,7,8-HxCDF.....(ng)	< .033
1,2,3,6,7,8-HxCDF.....(ng)	< .038
1,2,3,7,8,9-HxCDF.....(ng)	< .026
2,3,4,6,7,8-HxCDF.....(ng)	< .040
1,2,3,4,6,7,8-HpCDF...(ng)	< .054
1,2,3,4,7,8,9-HpCDF...(ng)	< .026

Test No. 4
Unit 2 Stack

Results of PCDD and PCDF HRGC/HRMS Analysis----------

	Run 1	Run 2	Run 3
Sample log number	5978-(108-111)	(117-120)	(122-125)
Date of run	03-23-88	03-24/25-88	03-25-88
Time run start/end.....(HRS)	1130/1644	945/ 958	1340/1840
PCDD Isomer distribution....			
2,3,7,8-TCDD.....(ng)	< .011	< .013	< .014
1,2,3,7,8-PeCDD.....(ng)	.42	.37	.42
1,2,3,4,7,8-HxCDD.....(ng)	.46	.45	.49
1,2,3,6,7,8-HxCDD.....(ng)	.81	.76	.77
1,2,3,7,8,9-HxCDD.....(ng)	1.1	.96	1.2
1,2,3,4,6,7,8-HpCDD...(ng)	8.1	7.6	9.3
PCDF Isomer distribution....			
2,3,7,8-TCDF.....(ng)	3.4	4.0	4.9
1,2,3,7,8-PeCDF.....(ng)	.53	.64	.59
2,3,4,7,8-PeCDF.....(ng)	1.4	1.5	1.8
1,2,3,4,7,8-HxCDF.....(ng)	2.9	3.3	4.0
1,2,3,6,7,8-HxCDF.....(ng)	2.7	3.3	4.1
1,2,3,7,8,9-HxCDF.....(ng)	2.0	2.4	2.8
2,3,4,6,7,8-HxCDF.....(ng)	1.0	.66	.91
1,2,3,4,6,7,8-HpCDF...(ng)	6.8	7.2	8.8
1,2,3,4,7,8,9-HpCDF...(ng)	1.5	1.8	2.4

Test No. 4
Unit 2 Stack

Results of PCDD and PCDF HRGC/HRMS Analysis----------

	Field Blank
Sample log number	5978-(84-87)
Date of run	
Time run start/end.....(HRS)	

PCDD homolog distribution...

TCDD.....(ng)	< .006
PeCDD.....(ng)	< .077
HxCDD.....(ng)	< .032
HpCDD.....(ng)	< .12
OCDD.....(ng)	.26

PCDF homolog distribution...

TCDF.....(ng)	< .021
PeCDF.....(ng)	< .045
HxCDF.....(ng)	< .033
HpCDF.....(ng)	< .054
OCDF.....(ng)	< .049

Test No. 4
Unit 2 Stack

Results of PCDD and PCDF HRGC/HRMS Analysis----------

	Run 1	Run 2	Run 3
Sample log number	5978-(108-111)	(117-120)	(122-125)
Date of run	03-23-88	03-24/25-88	03-25-88
Time run start/end.....(HRS)	1130/1644	945/ 958	1340/1840
PCDD homolog distribution...			
TCDD.....(ng)	2.5	2.8	2.6
PeCDD.....(ng)	8.0	7.9	8.6
HxCDD.....(ng)	8.7	8.3	9.2
HpCDD.....(ng)	15	14	17
OCDD.....(ng)	14	12	15
PCDF homolog distribution...			
TCDF.....(ng)	17	19	22
PeCDF.....(ng)	16	18	23
HxCDF.....(ng)	15	16	20
HpCDF.....(ng)	12	14	17
OCDF.....(ng)	4.5	4.8	6.4

No. 2 Incinerator

Results of PCDD and PCDF HRCG/HRMS Analysis----------

	3/23/88	3/24-25/88	3/25/88
Sample description	ESP Hopper ASh	ESP Conveyor Ash	ESP Conveyor Ash
Date of run	3/23/88	3/24-25/88	3/25/88
Time run start/end.....(HRS)			
PCDD homolog distribution...			
TCDD.....(ppb)	6.4	3.4	3.4
PeCDD.....(ppb)	17	18	18
HxCDD.....(ppb)	17	32	46
HpCDD.....(ppb)	110	130	390
OCDD.....(ppb)	200	240	460
PCDF homolog distribution...			
TCDF.....(ppb)	40	35	32
PeCDF.....(ppb)	39	46	51
HxCDF.....(ppb)	21	44	58
HpCDF.....(ppb)	51	71	250
OCDF.....(ppb)	65	84	171

No. 2 Incinerator

Results of PCDD and PCDF HRCG/HRMS Analysis----------

	3/23/88	3/24-25/88	3/25/88
Sample description	ESP Hopper Ash	ESP Conveyor Ash	ESP Conveyor Ash
Date of run	3/23/88	3/24-25/88	3/25/88
Time run start/end.....(HRS)			
PCDD Isomer distribution....			
2,3,7,8-TCDD.....(ppb)	.18	.16	.14
1,2,3,7,8-PeCDD.....(ppb)	.97	1.4	1.6
1,2,3,4,7,8-HxCDD....(ppb)	.80	1.8	2.6
1,2,3,6,7,8-HxCDD....(ppb)	1.2	2.2	4.4
1,2,3,7,8,9-HxCDD....(ppb)	1.4	2.8	4.5
1,2,3,4,6,7,8-HpCDD..(ppb)	48	58	180
PCDF Isomer distribution....			
2,3,7,8-TCDF.....(ppb)	6.1	5.3	5.0
1,2,3,7,8-PeCDF.....(ppb)	1.5	2.2	2.4
2,3,4,7,8-PeCDF.....(ppb)	2.7	4.0	4.0
1,2,3,4,7,8-HxCDF....(ppb)	4.2	8.1	11
1,2,3,6,7,8-HxCDF....(ppb)	4.1	9.1	13
1,2,3,7,8,9-HxCDF....(ppb)	2.5	6.1	7.5
2,3,4,6,7,8-HxCDF....(ppb)	.69	1.7	1.9
1,2,3,4,6,7,8-HpCDF..(ppb)	28	39	137
1,2,3,4,7,8,9-HpCDF..(ppb)	3.9	5.3	22

APPENDIX A

SAMPLING TRAIN CALIBRATION DATA

Interpoll Laboratories
(612) 786-6020

Meter Box Calibration
Data Sheet

Date of Calibration: March 4, 1988
Technician: J. Buresh
Barometric Pressure: 29.45 IN.HG.

Meter Box No.: 9
Dry Test Meter Serial No.: 964550
Wet Test Meter No.: AL-20

Delta H Actual (in. WC)	Gas Volume Wet Meter (cf)	Cal. Index (%)	Diff. Wet Test Meter (in.WC)	Gas Volume Dry Test Meter Vdi (cf)	Gas Volume Dry Test Meter Vdf (cf)	Gas Temperature of Meters Wet Tw (deg-F)	Gas Temperature of Meters Dry Test Tdi (deg-F)	Gas Temperature of Meters Dry Test Tdo (deg-F)	Time (min/ sec)	Meter Coef.	Orifice Constant (in. WC)
.5	2	99.87	.04	346.20	348.20	77	88	72	5/08.25	.9929	1.90
1.2	3	99.88	.06	342.80	345.80	77	86	71	4/56.56	.9984	1.88
2.0	3	99.89	.07	339.00	341.95	77	82	70	3/51.49	1.0087	1.92
3.3	5	99.90	.085	349.00	354.00	77	92	73	5/01.67	1.0008	1.92
4.7	5	99.95	.12	354.50	359.45	77	93	74	4/16.99	1.0097	1.97
									Average:	1.0021	1.92

Interpoll Laboratories
(612) 786-6020

Meter Box Calibration Data Sheet

Date of Calibration: April 6, 1988
Technician: J. Buresh
Barometric Pressure: 29.27 IN.HG.

Meter Box No.: 9
Dry Test Meter Serial No.: 964550
Wet Test Meter No.: AL-20

Delta H Actual (in. WC)	Gas Volume Wet Meter (cf)	Cal. Index (%)	Diff. Wet Test Meter (in.WC)	Gas Volume Dry Test Meter Vdi (cf)	Gas Volume Dry Test Meter Vdf (cf)	Gas Temperature of Meters Wet Tw (deg-F)	Gas Temperature of Meters Dry Test Tdi (deg-F)	Gas Temperature of Meters Dry Test Tdo (deg-F)	Time (min/ sec)	Meter Coef.	Orifice Constant (in. WC)
.5	2	99.87	.04	430.30	432.27	79.9	85	72	5/00.08	1.0099	1.84
1.2	3	99.88	.06	424.70	427.66	80.3	86	73	4/53.66	1.0076	1.88
2.0	3	99.89	.07	418.00	420.95	80.5	81	72	3/47.34	1.0031	1.89
3.3	5	99.90	.085	433.00	437.93	79.9	92	73	5/00.94	1.0095	1.94
4.7	5	99.95	.12	438.50	443.42	79.5	92	73	4/13.59	1.0092	1.95
									Average:	1.0079	1.90

Interpoll Laboratories
(612) 786-6020

Meter Box Calibration and Usage Status

Date of Report: March 21, 1988

Meter Box No.: 9 (Rockwell Dry Test Meter Serial No. 964550)

Date of Last Calibration: March 4, 1988
Calibration Technician: J. Buresh
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 21-26, 1988	8-2526	369.80	1388.69	1028.89	1028.89

* Total volume through meter since last calibration

Interpoll Laboratories
(612) 786-6020

Nozzle Calibration
Data Sheet

Date of Calibration: March 21, 1988 Nozzle Number 4-5
Technician: J. Buresh

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

Position	Diameter (inches)
1	.308
2	.307
3	.306
Average:	.307

Interpoll Laboratories
(612) 786-6020

Nozzle Calibration
Data Sheet

Date of Calibration: March 22, 1988 Nozzle Number 4-4
Technician: J. Buresh

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

Position	Diameter (inches)
1	.256
2	.252
3	.253
Average:	.254

Interpoll Laboratories
(612) 786-6020

Nozzle Calibration
Data Sheet

Date of Calibration: March 23, 1988 Nozzle Number 8-4
Technician: D. Smith

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

Position	Diameter (inches)
1	.242
2	.241
3	.240
Average:	.241

Interpoll Laboratories
(612) 786-6020

Nozzle Calibration
Data Sheet

Date of Calibration: March 26, 1988 Nozzle Number 4-4
Technician: D. Smith

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

Position	Diameter (inches)
1	.254
2	.253
3	.252
Average:	.253

Interpoll Laboratories
(612)786-6020

S-Type Pitot Tube Inspection Sheet

Pitobe No. 8-16

Pitot tube dimensions:

1. External tubing diameter (D_t) .316 IN.
2. Base to Side A opening plane (P_A) .463 IN.
3. Base to Side B opening plane (P_B) .462 IN.

Alignment:

4. α_1 <10° 0
5. α_2 <10° 0

6. B_1 < 5° 1°
7. B_2 < 5° 1°

8. Z <.125" .02
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 IN.
12. Pitot to thermocouple (parallel to probe) _____ IN.
13. Pitot to thermocouple (perpendicular to probe) _____ IN.

Date of Inspection: January 3, 1986

Inspected by: E. Trowbridge

S-348(1)

Interpoll Laboratories
(612) 786-6020

Meter Box Calibration
Data Sheet

Date of Calibration: March 4, 1988
Technician: E. Trowbridge
Barometric Pressure: 29.45

Meter Box No.: 8
Dry Test Meter Serial No.: 964552
Wet Test Meter No.: AL-20

Delta H Actual (in. WC)	Gas Volume Wet Meter (cf)	Cal. Index (%)	Diff. Wet Test Meter (in.WC)	Gas Volume Dry Test Meter Vdi (cf)	Gas Volume Dry Test Meter Vdf (cf)	Gas Temperature of Meters Wet Tw (deg-F)	Gas Temperature of Meters Dry Test Tdi (deg-F)	Gas Temperature of Meters Dry Test Tdo (deg-F)	Time (min/ sec)	Meter Coef.	Orifice Constant (in. WC)
.5	2	99.87	.04	77,000	79,000	75	86	70	5/09.77	1.0029	1.91
1.2	3	99.88	.06	73,500	76,502	75	84	68	4/53.10	.9968	1.83
2.0	3	99.89	.07	80,000	83,020	75	90	70	3/53.95	.9964	1.93
3.3	5	99.90	.085	83,500	88,533	75	94	72	5/08.31	.9988	1.98
4.7	5	99.95	.12	89,000	94,045	75	96	72	4/19.08	.9952	1.98
									Average:	.9980	1.92

Interpoll Laboratories
(612) 786-6020

Meter Box Calibration
Data Sheet

Date of Calibration: April 5, 1988
Technician: J. Buresh
Barometric Pressure: 29.08

Meter Box No.: 8
Dry Test Meter Serial No.: 964552
Wet Test Meter No.: AL-20

Delta H Actual (in. WC)	Gas Volume Wet Meter (cf)	Cal. Index (%)	Diff. Wet Test Meter (in.WC)	Gas Volume Dry Test Meter Vdi (cf)	Gas Volume Dry Test Meter Vdf (cf)	Gas Temperature of Meters Wet Tw (deg-F)	Gas Temperature of Meters Dry Test Tdi (deg-F)	Gas Temperature of Meters Dry Test Tdo (deg-F)	Time (min/ sec)	Meter Coef.	Orifice Constant (in. WC)
.5	2	99.87	.04	373.50	375.49	78.5	86	72	5/06.02	1.0032	1.91
1.2	3	99.88	.06	370.30	373.30	78.5	87	72	4/52.45	.9975	1.86
2.0	3	99.89	.07	367.00	370.00	78.6	84	72	3/49.42	.9926	1.91
3.3	5	99.90	.085	376.00	380.99	78.5	93	73	4/59.33	1.0008	1.92
4.7	5	99.95	.12	381.50	386.50	78.5	95	73	4/13.98	.9975	1.96
									Average:	.9983	1.91

Interpoll Laboratories
(612) 786-6020

Meter Box Calibration and Usage Status

Date of Report: March 21, 1988

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

Date of Last Calibration: March 4, 1988
Calibration Technician: E. Trowbridge
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 21-26, 1988	8-2526	102.30	1216.57	1114.27	1114.27

* Total volume through meter since last calibration

Interpoll Laboratories
(612) 786-6020

Nozzle Calibration
Data Sheet

Date of Calibration: March 21, 1988 Nozzle Number 7-7
Technician: R. Rosenthal

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

Position	Diameter (inches)
1	.436
2	.438
3	.437
Average:	.437

Interpoll Laboratories
(612) 786-6020

Nozzle Calibration
Data Sheet

Date of Calibration: March 22, 1988 Nozzle Number 7-7
Technician: R. Rosenthal

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

Position	Diameter (inches)
1	.435
2	.438
3	.437
Average:	.437

Interpoll Laboratories
(612) 786-6020

Nozzle Calibration
Data Sheet

Date of Calibration: March 24, 1988 Nozzle Number 7-7
Technician: R. Rosenthal

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

Position	Diameter (inches)
1	.425
2	.423
3	.427
Average:	.425

Interpoll Laboratories
(612) 786-6020

Nozzle Calibration
Data Sheet

Date of Calibration: March 26, 1988 Nozzle Number 7-7
Technician: J. Buresh

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

Position	Diameter (inches)
1	.353
2	.353
3	.353
Average:	.353

Interpoll Laboratories
(612)786-6020

S-Type Pitot Tube Inspection Sheet

Pitobe No. 4-17

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) .462 IN.

Alignment:

4. α_1 <10° 0
5. α_2 <10° 0

6. B_1 < 5° 0
7. B_2 < 5° 1°

8. Z <.125" .02
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 IN.
12. Pitot to thermocouple (parallel to probe) _____ IN.
13. Pitot to thermocouple (perpendicular to probe) _____ IN.

Date of Inspection: January 3, 1986

Inspected by: E. Trowbridge

S-348(1)

Interpoll Laboratories
(612) 786-6020

Meter Box Calibration Data Sheet

Date of Calibration: March 4, 1988
Technician: E. Trowbridge
Barometric Pressure: 29.45

Meter Box No.: 6
Dry Test Meter Serial No.: 676477
Wet Test Meter No.: AL-20

Delta H Actual (in. WC)	Gas Volume Wet Meter (cf)	Cal. Index (%)	Diff. Wet Test Meter (in.WC)	Gas Volume Dry Test Meter Vdi (cf)	Gas Volume Dry Test Meter Vdf (cf)	Gas Temperature of Meters Wet Tw (deg-F)	Gas Temperature of Meters Dry Test Tdi (deg-F)	Gas Temperature of Meters Dry Test Tdo (deg-F)	Time (min/ sec)	Meter Coef.	Orifice Constant (in. WC)
.5	2	99.87	.04	885.000	887.004	77	84	76	5/08.44	1.0009	1.90
1.2	3	99.88	.06	881.000	883.992	77	82	76	4/55.00	1.0020	1.86
2.0	3	99.89	.07	887.500	890.515	77	92	76	3/50.94	1.0017	1.88
3.3	5	99.90	.085	891.500	896.470	77	98	78	4/55.09	1.0048	1.81
4.7	5	99.95	.12	898.000	903.090	77	98	80	4/15.53	.9918	1.92
									Average:	1.0002	1.87

Interpoll Laboratories
(612) 786-6020

Meter Box Calibration and Usage Status

Date of Report: March 24, 1988

Meter Box No.: 6 (Rockwell Dry Test Meter Serial No. 676477)

Date of Last Calibration: March 4, 1988
Calibration Technician: E. Trowbridge
Wet Test Meter No.: American Meter AL-20

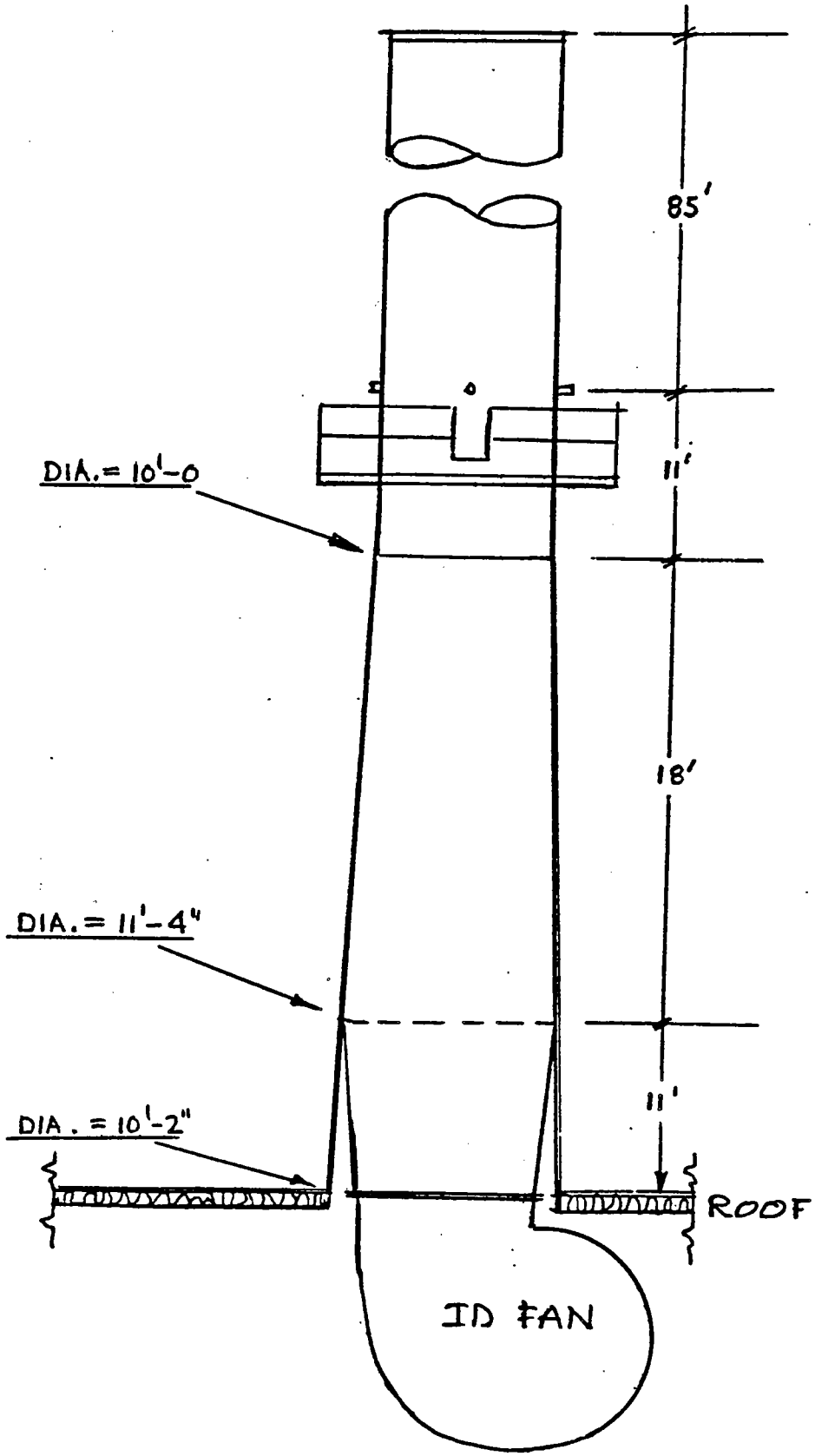
Date of Use	Report No.	Initial Meter Reading	Final Meter Reading	Volume/Job (cu. ft.)	Total Volume* (cu. ft.)
March 24, 1988	8-2526	903.20	1037.14	133.94	133.94

* Total volume through meter since last calibration

APPENDIX B

LOCATION OF TEST PORTS

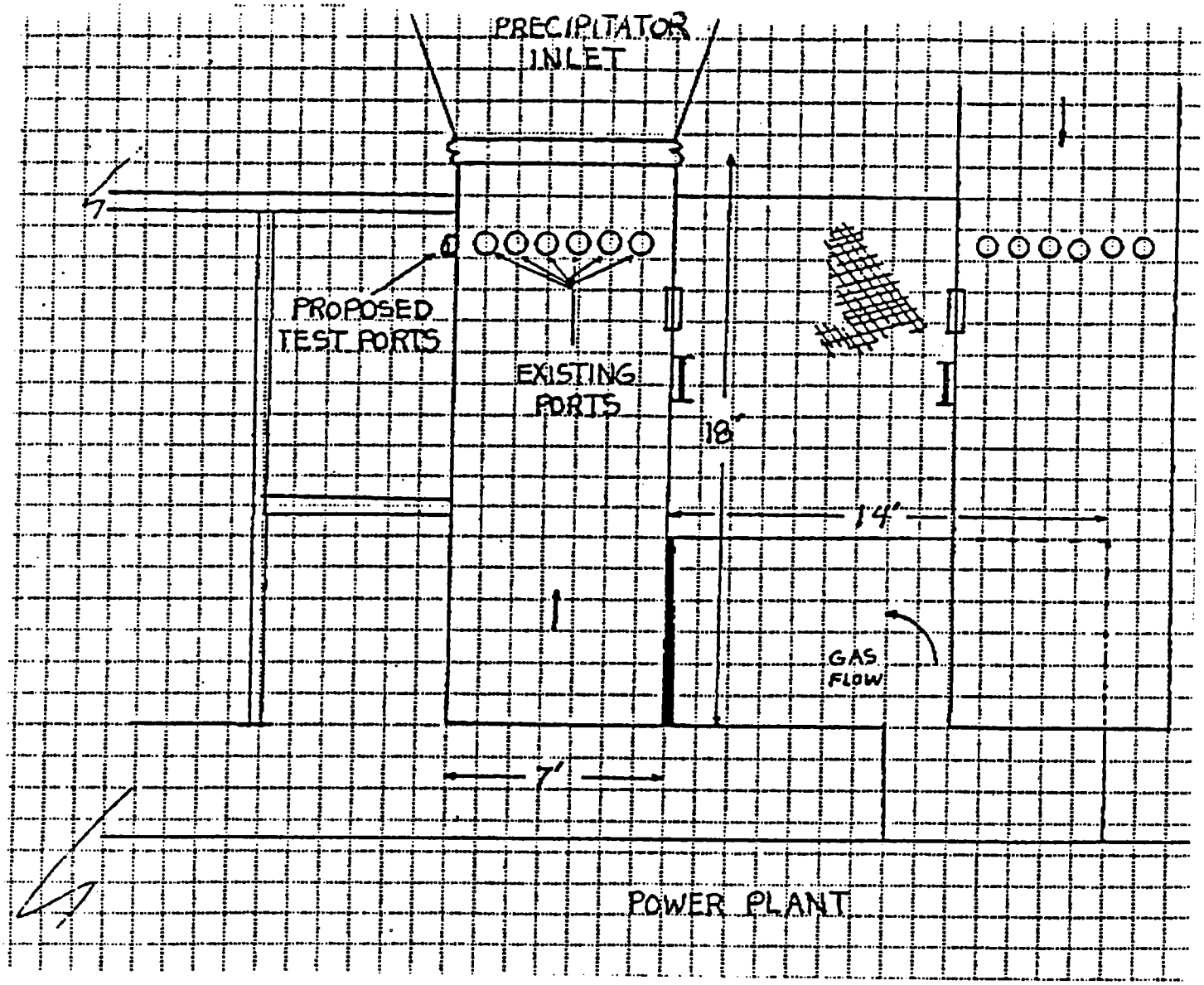
NSP RED WING
TEST PORT LOCATION
RDF INCINERATOR STACKS



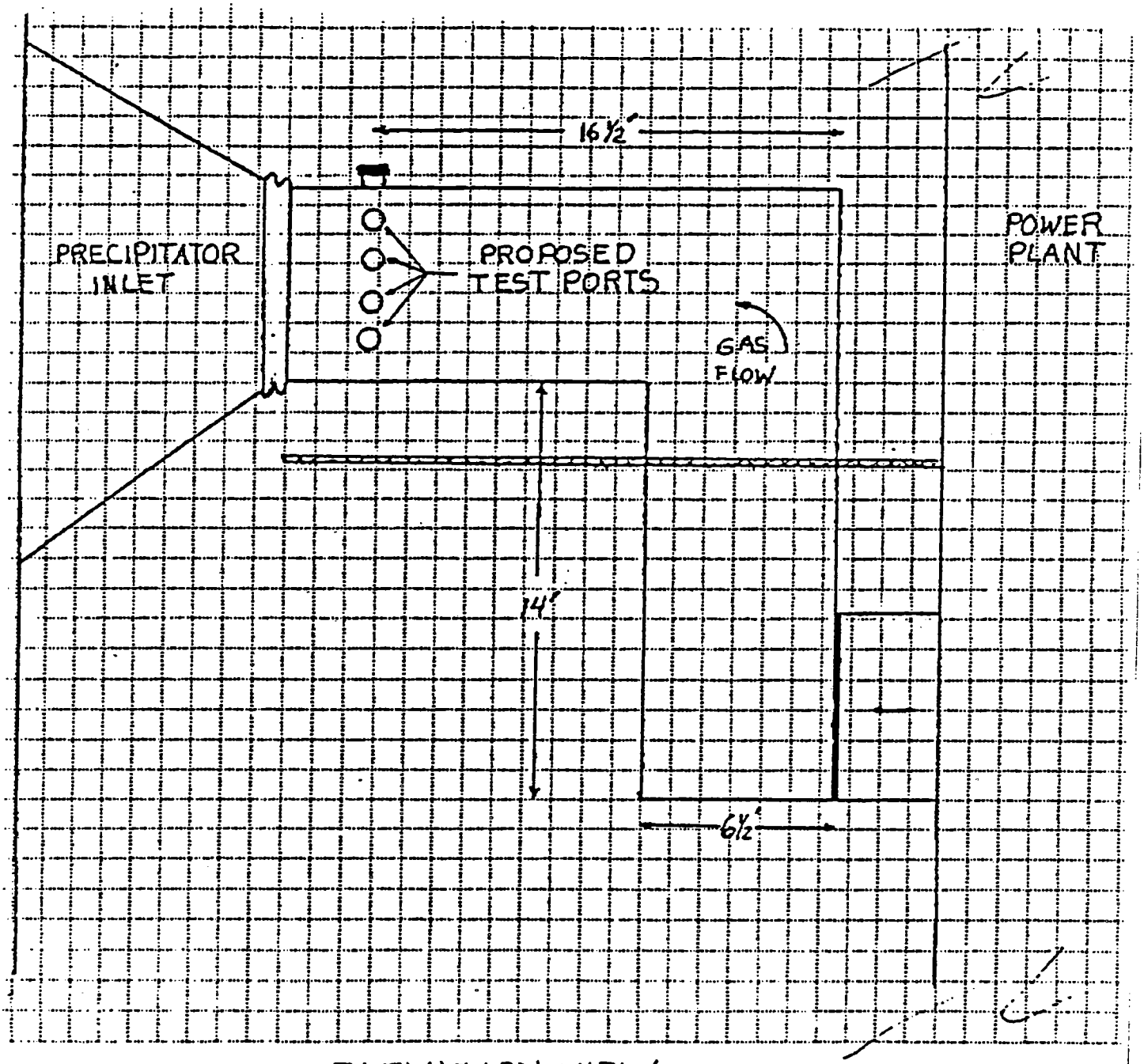
REV 1 /88

NOT TO SCALE

PLAN VIEW



UNIT 2 ESP INLET SITE
NSP RED WING



ELEVATION VIEW

UNIT 2 ESP INLET SITE

NSP RED WING

APPENDIX C

METHOD 5 SAMPLING TRAIN FIELD DATA SHEETS

INTERPOLL LABORATORIES EPA METHOD 2 FIELD DATA SHEET

Job NSP REDWING

Source UNIT 2 ESP INLET

Test 1 Run 1 Date 3-21-88

Stack dimen. 53" x 66" IN.

Dry bulb _____ deg-F

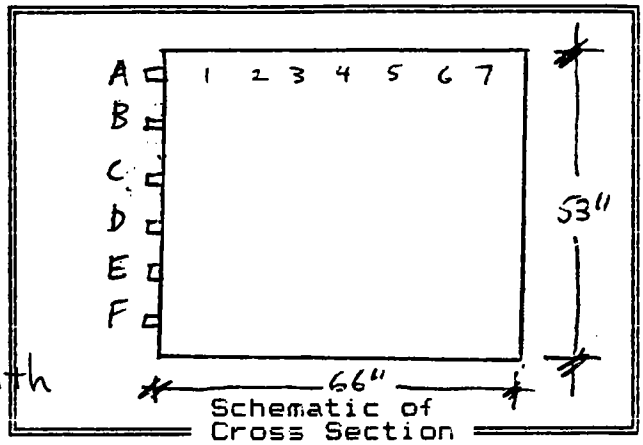
Wet bulb _____ deg-F

Barometric pressure 29.44 in Hg

Static pressure -6.5 in WC

Operators J BURESH + D SMITH (WAYNE)

Pitot No. 8-16 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 (deg-F)
		Port length: 18 in.		Time start:	hrs
A 1		4.71	22.71	.50	
2		14.15	32.13	.57	
3		23.57	41.72	.64	
4		33.00	51.14	.69	
5		42.43	60.56	.72	
6		51.86	69.98	.69	
7		61.29	79.4	.75	
B 1					
2					
3					
4					
5					
6					
7					
C 1					
2					
3					
4					
5					
6					
7					
D 1					
2					
3					
4					
Temp. measure device:				Time end:	hrs

INTERPOLL LABORATORIES EPA METHOD 2 FIELD DATA SHEET

Job _____

Source _____

Test ___ Run ____ Date _____

Stack dimen. _____ IN.

Dry bulb _____ deg-F

Wet bulb _____ deg-F

Barometric pressure _____ in Hg

Static pressure _____ in WC

Operators _____

Pitot No. _____ Cp _____

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 (deg-F)
		Port length: in.		Time start: hrs	
5					
6					
7					
E 1					
2					
3					
4					
5					
6					
7					
F 1					
2					
3					
4					
5					
6					
7					
Temp. measure device:				Time end: hrs	

INTERPOLL LABORATORIES EPA METHOD 5/17 SAMPLE LOG SHEET

Job NSP REDWING Date 3-21-88 Test 1 Run 1
Source UNIT 2 ESP INLET No. of traverse points 24
Method 5 Filter holder: GLASS Filter type: GLASS FIBER

Sample Train Leak Check:

Pretest: < 0.02 cfm at 15 in. Hg. (vac) ☒
Postest: 0.00 cfm at 18 in. Hg. (vac) ☒

Particulate Catch Data:

No.s of filters used: 0078

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

No. of probe wash bottles: 2
Sample recovered by: DWAYNE A. SMITH

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impinger No. 1	696	493	203
Impinger No. 2			
Impinger No. 3			
Condenser			
Desiccant	1358	1325	33
Total			236

Integrated Gas Sampling Data:

Bag Pump No. B-8 Box No. 18 Bag No. 1

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

Pretest leak check: 0.00 cc/min at 14 in. Hg.

Time start: 1611 (HRS) Time end: 1723 (HRS)

Sampling rate: 600 cc/min Operator: JB

S/N of O_2 Analyzer used to monitor train outlet: 5

CF-023

CF-011

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job USP Redwing
Source Unit 2 INLET TO ESP
Date 3-21-88 Test 1 Run 1

Operators JB & DS
Meter Box No. 9
Gamma coeff. 1.0021

Pitot No. V16-8 Cp .840
Bar. Press. 29.44 inHg H2O 12 X
Nozzle No. 4-5 Nozzle Dia .302 IN.

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dev. Vol. (cf)	VAC. inHg	Temperatures (°F)						Oxygen
							Stack	Probe	Oven	Impg.	Gas/In	Gas/Out	(v/v)
	160	359.80											
A 7	1.5	361.34	.75	3.56	1.34	9.0	418	250	250	45	84	71	11.0
6	3	362.78	.67	3.14	2.78	7.7	418			45	86	73	9.2
5	4.5	364.17	.63	2.95	4.18	7.8	418			46	87	74	8.4
4	6	365.62	.67	3.14	5.62	8.5	418	250	250	47	89	76	7.3
3	7.5	367.10	.66	3.9	7.10	9.0	414			48	90	77	3.5
2	9.0	368.53	.62	3.00	8.53	8.5	415			48	90	77	3.4
1	10.5	369.90	.58	2.78	9.90	8.1	409			49	92	77	6.0
B 7	12	371.32	.61	2.93	1.32	8.5	407			49	92	78	5.5
6	13.5	372.75	.63	3.01	2.75	9.0	413			50	92	78	10.0
5	15	374.23	.67	3.19	4.23	10.0	414	250	250	50	93	78	8.0
4	16.5	375.73	.69	3.29	5.73	10.8	414			51	94	78	6.2
3	18	377.17	.64	3.06	7.17	11.0	414			51	94	78	6.3
2	19.5	378.59	.61	2.91	8.59	10.1	414			52	94	78	8.5
1	21	379.92	.54	2.60	9.92	9.0	409	250	250	52	94	78	7.4
C 7	22.5	381.30	.58	2.77	1.30	9.8	415			51	94	78	6.6
6	24	382.69	.59	2.82	2.69	10.0	415			52	95	79	3.9
5	25.5	384.08	.60	2.87	4.09	10.4	415			52	95	79	5.9
4	27	385.50	.62	2.96	5.52	11.1	415	250	250	52	95	79	5.6
3	28.5	386.97	.64	3.06	6.97	11.5	415			52	95	79	8.1
2	30	388.50	.72	3.44	8.50	13.1	415			53	96	79	8.8
1	31.5	389.87	.57	2.73	9.87	10.6	415			53	96	80	8.1
D 7	33	391.24	.57	2.73	1.24	11.0	415	250	250	53	95	80	6.1
6	34.5	392.54	.53	2.54	2.56	10.6	415			51	96	80	6.2
5	36	393.92	.56	2.68	3.92		415			52	96	80	7.1
	θ =	Vm =		ΔH =							Avg. =		

C-4

C-5

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job NSP REDWING
Source UNIT 2 ESP INLET
Date 3-21-88 Test 1 Run 1

Operators D. SMITH & T. HOGAN
Meter Box No: _____
Coeunter coeff. _____

Pitot No. _____ Cp .84
Bar. Press. _____ inHg H2O _____ X
Nozzle No. _____ Nozzle Dia _____ IN.

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dem. Vol. (cf)	VAC. inHg	Temperatures (°F)						Oxygen
							Stack	Probe	Oven	Impg.	Gas/In	Gas/Out	(%v/v)
	( )	(393.92)											
4	37.5	395.31	.59	2.81	5.31	11.7	419	250	250	51	96	80	6.6
3	39	396.79	.67	3.19	6.79	13.2	420			52	96	80	6.4
2	40.5	398.31	.72	3.43	8.33	14.8	420			53	96	80	3.2
1	42	399.82	.68	3.24	9.82	14.6	420	250	250	53	96	81	8.6
E 7	43.5	401.07	.47	2.25	1.06	9.9	418			54	94	80	8.8
6	45	402.29	.46	2.20	2.29	9.6	416			55	95	81	9.3
5	46.5	403.60	.52	2.49	3.60	10.0	416	250	250	55	96	81	5.3
4	48	404.96	.56	2.68	4.96	11.5	416			56	96	81	8.7
3	49.5	406.39	.62	2.97	6.39	13.1	416			57	97	81	7.7
2	51	407.89	.68	3.26	7.89	15.0	416			57	97	81	4.6
1	52.5	409.31	.64	3.07	9.31	14.7	416			57	97	81	3.9
F 7	54	410.64	.51	2.45	0.64	11.2	416	250	250	57	96	82	8.2
6	55.5	411.95	.52	2.49	1.95	11.5	416			57	96	82	7.8
5	57	413.26	.52	2.49	3.26	11.6	416			57	97	82	6.0
4	58.5	414.61	.55	2.64	4.61	12.0	416			57	98	82	6.9
3	60	415.95	.54	2.59	5.95	11.9	416			57	98	82	7.4
2	61.5	417.29	.54	2.59	7.29	13.0	417	250	250	57	98	82	6.0
1	63	418.60	.52	2.49	8.60	12.4	418			57	98	82	7.4
	(1723)												
	θ = 63	Vm = 58.88		ΔH = 2.80							Avg. = 85.9		

INTERPOLL LABORATORIES EPA METHOD 5/17 SAMPLE LOG SHEET

Job NSP REDWING — Date 3-21-88 Test 1 Run 2
Source UNIT 2 ESP INLET — No. of traverse points 24
Method 5 Filter holder: GLASS — Filter type: GLASS FIBER

Sample Train Leak Check:

Pretest: ≤ 0.02 cfm at 15 in. Hg. (vac) ☑
Postest: 0.00 cfm at 17 in. Hg. (vac) ☑

Particulate Catch Data:

No.s of filters used: 0079

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

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

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impinger No. 1	670	494	176
Impinger No. 2			
Impinger No. 3			
Condenser			
Desiccant	1339	1315	24
Total			200

Integrated Gas Sampling Data:

Bag Pump No. B-8 Box No. 18 Bag No. 2

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

Pretest leak check: 0.00 cc/min at 14 in. Hg.

Time start: 1811 (HRS) Time end: 1930 (HRS)

Sampling rate: 600 cc/min Operator: JB

S/N of O_2 Analyzer used to monitor train outlet: 5

CF-023

S-0046RR

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job NSP REDWING
Source Unit 2 ESP INLET
Date 3-21-89 Test 1 Run 2

Operators JB + DSmith
Meter Box No. 1
Calibrator coeff. 1.0021

Pitot No. V16-10 Cp .840
Bar. Press. 29.44 inHg H2O 16 X
Nozzle No. 4-5 Nozzle Dia .307 IN.

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dec. Vol. (cf)	VAC. inHg	Temperatures (°F) Stack	Probe	Oven	Impg.	Gas/In	Gas/Out	Oxygen (v/v)
	1810	418.88											
A 7	1.5	420.21	.64	2.80	0.21	8.1	424	250	240	56	92	84	7.0
6	3	421.66	.65	2.86	1.61	8.1	424			56	96	84	4.0
5	4.5	423.08	.71	3.13	3.08	9.0	424			56	98	84	5.2
4	6	424.56	.71	3.14	4.56	9.0	424	250	245	56	100	84	7.8
3	7.5	425.92	.61	2.69	5.92	8.3	428			56	100	84	10.5
2	9	427.23	.57	2.52	7.24	8.0	428			56	101	84	8.3
1	10.5	428.56	.57	2.52	8.56	8.0	428			56	102	84	6.2
B 7	12	429.93	.61	2.70	9.93	8.5	426	250	250	57	101	84	10.0
6	13.5	431.29	.61	2.70	1.30	8.5	426			57	102	84	7.4
5	15	432.59	.54	2.39	2.59	8.0	426			57	102	84	9.4
4	16.5	434.00	.64	2.85	4.00	8.9	422			57	103	85	7.8
3	18	435.34	.58	2.59	5.34	8.7	422	250	250	57	103	85	8.4
2	19.5	436.64	.55	2.45	6.64	8.6	422			57	104	86	9.2
1	21	437.92	.52	2.32	7.92	8.5	422			57	104	86	6.2
C 7	22.5	439.38	.68	3.07	9.38	10.1	413	250	250	57	102	86	4.6
6	24	440.83	.68	3.05	0.83	11.0	415			57	102	86	4.6
5	25.5	442.20	.60	2.70	2.20	10.4	415			57	103	86	9.7
4	27	443.49	.53	2.38	3.49	9.7	415			57	104	87	11.8
3	28.5	444.77	.52	2.34	4.77	9.8	415			57	104	87	10.2
2	30	446.19	.64	2.88	6.19	11.0	415	250	250	56	104	87	10.1
1	31.5	447.45	.51	2.29	7.45	9.8	417			56	104	87	12.0
D 7	33	448.74	.53	2.31	8.74	9.3	416			56	104	87	9.1
6	34.5	450.06	.55	2.47	0.06	9.8	417			57	104	87	11.0
5	36	451.31	.50	2.25	1.31	9.0	417				104	88	8.9
	θ =	Va =		^H =							Avg. =		

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job NSP REDWING
Source UNIT 2 ESP INLET
Date 3-21-89 Test 1 Run 2

Operators D. SMITH & T. HOGEN Pitot No. _____ Cp .84
Meter Box No. _____ Bar. Press. _____ inHg H2O _____ X
Gasmeter coeff. _____ Nozzle No. _____ Nozzle Dia _____ IN.

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dev. Vol. (cf)	VAC. inHg	Temperatures (°F)						Oxygen
							Stack	Probe	Oven	Impg.	Gas/In	Gas/Out	(x v/v)
	( )	(451.31)											
4	37.5	452.57	.50	2.28	2.57	9.0	407	250	250	56	104	88	11.3
3	39	453.88	.54	2.46	3.88	9.9	407			56	104	88	12.3
2	40.5	455.22	.56	2.55	5.22	9.8	407			56	100	88	9.8
1	42	456.59	.60	2.72	6.59	10.9	407			56	101	88	6.4
F 7	43.5	457.90	.54	2.45	7.90	10.5	406	250	245	56	101	88	4.9
6	45	459.16	.50	2.26	9.16	10.0	413			56	102	88	3.2
5	46.5	460.46	.54	2.44	0.46	10.3	413			56	102	88	4.3
4	48	461.89	.65	2.93	1.89	13.2	413			56	102	88	6.3
3	49.5	463.42	.75	3.38	3.42	15.4	413	250	245	56	103	89	10.3
2	51	464.77	.58	2.61	4.77	19.0	416			55	103	89	9.8
1	52.5	466.13	.59	2.66	6.13	12.1	416			55	103	89	10.1
F 7	54	467.61	.70	3.15	7.61	14.0	416			55	102	89	11.3
6	55.5	469.06	.67	3.01	9.06	14.1	416	250	245	55	102	89	9.3
5	57	470.56	.72	3.24	0.56	15.2	416			55	103	89	9.2
4	58.5	471.90	.57	2.57	1.90	13.0	416			55	103	89	7.7
3	60	473.16	.50	2.25	3.16	12.0	416			55	103	89	5.8
2	61.5	474.38	.47	2.12	4.38	11.0	416	250	245	55	103	89	4.8
1	63	475.55	.44	1.98	5.55	10.0	416			56	103	89	7.4
	(1931)												
	θ = 63	Vm = 56.72		ΔH = 26							Avg. = 9.4		

INTERPOLL LABORATORIES EPA METHOD 5/17 SAMPLE LOG SHEET

Job NSP REDWING Date 3-21-88 Test 1 Run 3
Source UNIT 2 ESP INLET No. of traverse points 24
Method 5 Filter holder: GLASS Filter type: GLASS FIBER

Sample Train Leak Check:

Pretest: < 0.02 cfm at 15 in. Hg. (vac) ☑
Postest: 0.00 cfm at 13 in. Hg. (vac) ☑

Particulate Catch Data:

No.s of filters used: 0080

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

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

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impinger No. 1	666	494	172
Impinger No. 2			
Impinger No. 3			
Condenser			
Desiccant	1376	1358	18
Total			190

Integrated Gas Sampling Data:

Bag Pump No. B8 Box No. 18 Bag No. 3

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

Pretest leak check: 0.00 cc/min at 14 in. Hg.

Time start: 2006 (HRS) Time end: 2210 (HRS)

Sampling rate: 600 cc/min Operator: JB

S/N of O_2 Analyzer used to monitor train outlet: 5

CF-023

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job NSP REDWING
Source Unit 2 - ESP INLET
Date 3-21-89 Test C Run 1

Operators JB + DSMITH
Meter Box No. 9
Coeff. 1.0021

Pitot No. U16-8 Cp .840
Bar. Press. 29.44 inHg H2O 15 X
Nozzle No. 4-5 Nozzle Dia .357 IN.

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dev. Vol. (cf)	VAC. inHg	Temperatures (°F) Stack	Probe	Oven	Impg.	Gas/In	Gas/Out	Oxygen (v/v)
	2005	475.80											
A-7	1.5	477.24	.65	3.01	7.24	7.5	407	250	230	60	100	89	5.3
6	3	478.66	.63	2.91	8.66	7.0	407	250	235	60	103	89	7.2
5	4.5	480.15	.68	3.15	0.15	8.2	407			55	103	89	7.5
4	6	481.68	.73	3.38	1.68	9.0	407				103	89	4.3
3	7.5	483.13	.64	2.97	3.12	8.0	407				103	89	5.7
2	9	484.49	.58	2.69	4.49	7.1	407	240	225		100	90	4.5
1	10.5	485.87	.59	2.74	5.87	7.3	405				102	90	5.3
B 7	12	487.15	.50	2.33	7.15	6.9	405			57	102	90	6.3
6	13.5	488.42	.50	2.33	8.42	6.9	405				103	90	3.3
5	15	489.83	.61	2.84	9.83	8.3	406			50	103	90	3.3
4	16.5	491.34	.73	3.43	1.38	9.2	395	245	240		98	89	5.5
3	18	492.79	.62	2.88	2.79	8.2	401			50	98	89	8.0
2	19.5	494.15	.57	2.65	4.15	7.9	401				99	89	11.4
1	21	495.40	.48	2.24	5.40	6.9	401				100	89	18.8
C 7	22.5	496.84	.64	2.98	6.84	8.7	400				100	89	8.4
6	24	498.21	.58	2.69	8.21	8.0	404			51	101	89	7.4
5	25.5	499.60	.60	2.78	9.60	8.5	405	245	250		102	89	5.9
4	27	500.98	.59	2.74	0.98	8.6	405				103	89	7.2
3	28.5	502.42	.64	2.96	2.42	9.6	409				104	89	5.6
2	30	503.92	.70	3.24	3.92	10.8	409			50	104	89	6.3
1	31.5	505.22	.52	2.41	5.22	7.4	409				104	89	6.8
D 7	33	506.54	.54	2.51	6.54	8.0	406	250	250		103	89	9.1
6	34.5	507.89	.56	2.60	7.89	8.3	406				104	89	8.1
5	36	509.19	.52	2.42	9.19	8.0	406				104	89	9.0
	θ =	Vs =		^H =							Avg. =		

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job NSP REDWING
Source UNIT 2 ESP INLET
Date 3-21-88 Test 1 Run 3

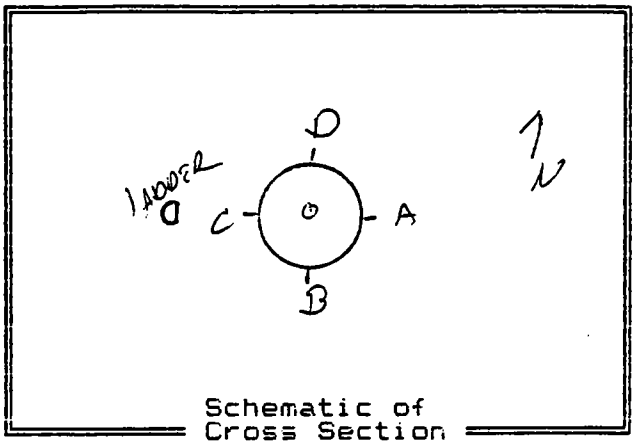
Operators D. SMITH & T. HOGAN
Meter Box No.
Gamma Coeff.

Pitot No. Cp .84
Bar. Press. inHg H2O X
Nozzle No. Nozzle Dia IN.

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dev. Vol. (cf)	VAC. inHg	Temperatures (°F) Stack	Probe	Oven	Impg.	Gas/In	Gas/Out	Oxygen (xv/v)
	( )	(509.19)											
4	37.5	510.53	.55	2.56	0.53	8.4	406	250	250	50	105	90	8.5
3	39	511.95	.62	2.89	1.95	9.5	406				105	90	8.9
2	40.5	513.47	.71	3.30	3.47	11.7	406				105	90	6.8
1	42	514.91	.64	2.98	4.91	10.4	406				105	90	5.6
E 7	43.5	516.23	.53	2.47	6.23	8.8	405	245	250	50	104	90	6.9
6	45	517.52	.51	2.36	7.52	8.3	405				104	90	5.0
5	46.5	518.87	.56	2.60	8.87	9.5	407				105	90	4.3
4	48	520.25	.59	2.73	0.25	10.0	410				105	90	7.3
3	49.5	521.68	.63	2.91	1.68	11.0	412	250	250	50	105	90	9.3
2	51	523.12	.65	3.00	3.12	11.4	414				106	90	9.1
1	52.5	524.54	.62	2.86	4.54	11.0	414				106	90	7.7
F 7	54	525.81	.50	2.31	5.81	9.0	413				105	91	8.2
6	56.5	527.05	.47	2.18	7.05	8.7	410				105	91	5.7
5	57	528.38	.54	2.51	8.38	9.7	410	250	250	50	106	91	7.1
4	58.5	529.80	.62	2.88	9.80	11.2	411				106	91	5.4
3	60	531.18	.59	2.74	1.18	11.0	411				106	91	7.1
2	61.5	532.51	.54	2.51	2.51	10.4	411				106	91	5.3
1	63	533.84	.55	2.55	3.84	10.7	411				106	91	4.7
	(2211)												
	θ = 2211	Va = 580.4		ΔH = 2.74							Avg. = 9.2		

INTERPOLL LABORATORIES EPA METHOD 2 FIELD DATA SHEET

Job NSP/Red Wing
Source Unit #2 STACK
Test 1 Run 1-3 Date 3-21-88
Stack dimen. 115.25 IN.
Dry bulb 380 deg-F
Wet bulb _____ deg-F
Barometric pressure 29.64 in Hg
Static pressure -.55 in WC
Operators Ron Rosenthal/T.J. Johnson
Pitot No. 4-17 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 (deg-F)
		Port length: in.		Time start: hrs	
A- 1		2.42	8.42	.05	375
2		7.80	14.80	.06	375
3		13.60	19.60	.07	380
4		20.40	26.40	.07	380
5		28.81	34.81	.08	380
6		41.03	47.03	.09	380
B- 1				.05	375
2				.06	375
3				.07	380
4				.08	380
5				.09	380
6				.10	380
C- 1				.05	380
2				.06	380
3				.08	380
4				.09	380
5				.10	385
6				.11	385
D- 1				.04	375
2				.05	375
3				.06	380
4				.06	380
5				.08	380
6				.09	380
Temp. measure device:				Time end: hrs	

INTERFOLL LABORATORIES EPA METHOD 5/17 SAMPLE LOG SHEET

Job USP/Red Wing Date 3-21-88 Test 1 Run 1
Source Unit #2 Stack No. of traverse points 24
Method m-5 Filter holder: 4" glass Filter type: 4" glass

Sample Train Leak Check:

Pretest: < 0.02 cfm at 15 in. Hg. (vac) ☒
Postest: .00 cfm at 10 in. Hg. (vac) ☒

Particulate Catch Data:

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

☒ acetone
☐ other(s)

No. of probe wash bottles:
Sample recovered by:

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impinger No. 1	657	495	162
Impinger No. 2			
Impinger No. 3			
Condenser			
Desiccant	1382	1359	23
			185
Total			

1152

Integrated Gas Sampling Data:

Bag Pump No. B4 Box No. 6 Bag No. 1
Bag Material: 5-layer Aluminized Tedlar Size: 44 L
Pretest leak check: .00 cc/min at 10 in. Hg.
Time start: 1610 (HRS) Time end: 1723 (HRS)
Sampling rate: 400 cc/min Operator: RR
S/N of O_2 Analyzer used to monitor train outlet: 8

CF-023

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job USP/Red Wing
Source UNIT #2 STACK
Date 3-21-88 Test 1 Run 1

Operators DR & T.J.
Meter Box No. 8
Coeff. .9980

Pitot No. 4-417 Cp .84
Bar. Press. 29.64 inHg H2O 10 x
Nozzle No. 7-5 Nozzle Dia .437 IN.

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dev. Vol. (cf)	VAC. inHg	Temperatures (°F) Stack	Probe	Oven	Impg.	Gas/In	Gas/Out	Oxygen (xx/v)
	1610	102.30											
B 6	2.5	104.50	.11	2.65	4.56	6.5	330	250	250	55	100	94	8.4
5	5	106.71	.10	2.42	6.73	7.0	330			55	102	94	7.8
4	7.5	108.73	.095	2.19	8.80	7.0	370			55	106	94	4.8
3	10	110.71	.08	1.86	0.71	7.0	370	250	250	55	107	94	5.6
2	12.5	112.60	.08	1.86	2.62	6.5	370			55	108	94	10.7
1	15	114.53	.08	1.86	4.53	6.5	370			55	110	95	10.7
6	17.5	116.68	.10	2.33	6.67	7.0	370	250	250	55	110	95	8.7
5	20	118.80	.10	2.33	8.81	7.0	370			57	111	95	7.9
4	22.5	120.83	.09	2.10	0.84	7.0	370			57	112	96	7.6
3	25	122.78	.08	1.86	2.76	6.5	372	250	250	57	113	96	5.1
2	27.5	124.55	.07	1.63	4.56	6.0	372			57	114	97	6.9
1	30	126.36	.07	1.64	6.36	6.0	372			57	115	97	6.9
6	32.5	128.66	.12	2.80	8.71	9.0	372	250	250	58	115	97	6.9
5	35	130.92	.11	2.57	0.97	9.0	372			58	116	97	6.9
4	37.5	133.11	.10	2.34	3.12	8.5	372			58	118	97	7.8
3	40	135.08	.08	1.88	5.05	8.5	372	250	250	58	119	98	6.2
2	42.5	136.87	.07	1.64	6.86	6.5	372			59	120	98	9.2
1	45	138.54	.06	1.41	8.54	6.5	372			59	120	98	10.1
6	47.5	141.10	.13	3.08	1.01	9.0	365	250	250	59	120	98	9.2
5	50	143.30	.11	2.60	3.29	8.0	365			60	120	99	5.4
4	52.5	145.60	.11	2.61	5.56	8.0	365			60	120	100	9.6
3	55	147.68	.09	2.12	7.62	7.0	370	250	250	60	120	100	7.4
2	57.5	149.60	.08	1.89	9.56	6.0	370			60	120	100	7.6
1	60	151.38	.07	1.65	1.38	6.0	370				120	100	8.5
	θ = 60	Vm = 49.08		^H = 2.14							Avg. = 105.3		

(1723)

INTERPOLL LABORATORIES EPA METHOD 5/17 SAMPLE LOG SHEET

Job USP/Red Wing Date 3-21-88 Test 1 Run 2
Source UNIT #2 STACK No. of traverse points 24
Method M-5 Filter holder: 4" glass Filter type: 4" glass

Sample Train Leak Check:

Pretest: 0.02 cfm at 15 in. Hg. (vac)
Postest: .00 cfm at 10 in. Hg. (vac)

Particulate Catch Data:

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

☒ acetone
☐ other(s)

No. of probe wash bottles:
Sample recovered by:

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impinger No. 1	635	492	143
Impinger No. 2			
Impinger No. 3			
Condenser			
Desiccant	1349	1335	14
Total			157

1130

Integrated Gas Sampling Data:

Bag Pump No. B4 Box No. 6 Bag No. 2
Bag Material: 5-layer Aluminized Tedlar Size: 44 L
Pretest leak check: .00 cc/min at 10 in. Hg.
Time start: 1810 (HRS) Time end: 1926 (HRS)
Sampling rate: 400 cc/min Operator: RR
S/N of O_2 Analyzer used to monitor train outlet: 8

CF-023

S-0046RR

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job USP/Red Wing
Source Unit #2 STACK
Date 3-21-88 Test 1 Run 2

Operators RR & T.J T.H
Meter Box No. 8
Coeeeter coeff. .9980

Pitot No. 4-17 Cp .84
Bar. Press. 29.64 inHg H2O X
Nozzle No. 2-7 Nozzle Dia .432 IN.

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dev. Vol. (cf)	VAC. inHg	Temperatures (°F) Stack	Probe	Oven	Impg.	Gas/In	Gas/Out	Oxygen (x/x)
	1810	151.55											
C-6	2.5	153.70	.11	2.34	3.70	6.5	370	250	250	52	120	102	8.3
5	5	155.75	.10	2.15	5.71	2.0	370			52	118	102	5.7
4	7.5	157.74	.09	1.93	7.74	6.5	370			52	119	102	8.0
3	10	159.55	.08	1.72	9.59	6.0	370	250	250	52	118	103	8.0
2	12.5	161.32	.07	1.51	1.32	5.5	370			53	119	103	9.9
1	15	162.98	.06	1.29	2.93	5.5	370			53	120	102	11.1
D-6	17.5	164.95	.0	2.15	5.01	5.5	370	250	250	53	118	103	9.8
5	20	166.95	.09	1.94	6.97	6.5	370			53	120	103	9.3
4	22.5	168.78	.07	1.52	8.72	6.0	365			53	121	104	5.3
3	25	170.50	.07	1.52	0.47	6.0	365	250	250	53	121	104	5.6
2	27.5	172.10	.06	1.30	2.08	5.0	365			53	122	104	8.9
1	30	173.72	.06	1.33	3.72	5.0	348			53	122	104	13.8
B-6	32.5	175.85	.11	2.44	5.93	5.0	348	250	250	55	120	105	11.6
5	35	178.01	.10	2.15	8.01	8.0	374			55	122	106	10.4
4	37.5	179.89	.08	1.72	9.87	6.0	374			55	123	106	9.9
3	40	181.01	.07	1.51	1.61	6.0	374	250	250	55	125	108	12.7
2	42.5	183.35	.06	1.30	3.23	5.5	374			57	125	108	7.3
1	45	184.85	.06	1.30	4.85	5.0	374			57	120	108	10.5
A-6	47.5	186.90	.10	2.15	6.93	6.0	374	250	250	57	120	108	4.7
5	50	188.85	.09	1.94	8.91	6.2	374			57	120	108	8.5
4	52.5	190.78	.09	1.94	0.88	6.5	374			57	120	108	10.6
3	55	192.77	.08	1.72	2.74	6.0	374	250	250	57	122	108	10.4
2	57.5	194.54	.07	1.51	4.49	5.5	374			57	122	108	11.2
1	60	196.10	.06	1.29	6.10	5.5	374			57	122	108	10.6
	θ = 60 (1926)	Vs = 44.55		^H = 1.74							Avg. = 112.9		

INTERPOLL LABORATORIES EPA METHOD 5/17 SAMPLE LOG SHEET

Job NSP/Red Wing
Source UNIT #2 STACK
Method M-5 Filter holder: 4" glass

Date 3-21-88 Test 1 Run 3
No. of traverse points 24
Filter type: 4" glass

Sample Train Leak Check:

Pretest: < 0.02 cfm at 15 in. Hg. (vac) ☒
Postest: 100 cfm at 10 in. Hg. (vac) ☒

Particulate Catch Data:

No.s of filters used: _____

Recovery solvent(s)

☒ acetone
☐ other(s) _____

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

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impinger No. 1	635	492	143
Impinger No. 2			
Impinger No. 3			
Condenser			
Desiccant	1392	1382	10
Total			153

1130

Integrated Gas Sampling Data:

Bag Pump No. B4 Box No. 6 Bag No. 3

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

Pretest leak check: .00 cc/min at 10 in. Hg.

Time start: 2005 (HRS) Time end: 2206 (HRS)

Sampling rate: 400 cc/min Operator: RR

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

CF-023

S-0046RR

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job USP/Red WTNS
Source Unit #2 STACK
Date 3-21-88 Test 1 Run 3

Operators R.R, T.S. + T.H.
Meter Box No. 8
Coeffs. .9980

Pitot No. 4-17 Cp .840
Bar. Press. 29.64 inHg H2O .15 X
Nozzle No. 7-7 Nozzle Dia .431 IN.

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dec. Vol. (cf)	VAC. inHg	Temperatures (°F) Stack	Probe	Oven	Impg.	Gas/In	Gas/Out	Oxygen (x v/v)	
	2005	196.25												
B-6	2.5	196.32	.10	2.15	8.32	6.0	374	250	250	50	115	108	6.4	
5	5	200.20	.08	1.72	0.17	6.0	374			50	118	108	8.2	
4	7.5	202.03	.08	1.72	203	6.0	374			50	120	108	5.6	
3	10	203.75	.07	1.51	3.78	5.5	374	250	250	51	118	108	5.7	
2	12.5	205.45	.07	1.51	5.52	5.0	374			51	119	108	7.4	
1	15	207.13	.06	1.29	2.13	5.0	374			51	120	108	7.8	← Shut down I.D. SAM TRIP
A-6	17.5	209.20	.11	2.37	9.31	2.0	374	250	250	51	120	108	6.9	
5	20	21'.05	.08	1.72	1.17	6.0	374			51	116	109	6.7	
4	22.5	212.75	.06	1.29	2.78	5.0	374			51	117	109	10.9	
3	25	21'4.45	.07	1.64	4.60	5.0	304	250	250	51	118	110	8.1	
2	27.5	21 P.17	.06	1.41	6.28	5.5	304			51	119	110	5.8	
1	30	217.97	.06	1.42	7.97	6.5	304		250	51	119	110	9.1	
D-6	32.5	229.95	.09	2.12	0.04	6.5	304			51	120	110	9.1	
5	35	222.10	.09	2.12	2.10	7.0	304			51	120	110	8.9	
4	37.5	223.80	.06	1.41	3.71	5.5	309	250	250	51	124	110	8.9	
3	40	225.37	.05	1.10	5.34	4.9	309	250	250	51	124	110	9.4	
2	42.5	227.29	.08	1.89	2.29	5.5	309			52	124	110	15.3	
1	45	228.80	.06	1.42	8.99	5.5	309			52	124	110	15.3	
C-6	47.5	231.11	.10	2.36	1.17	2.5	304	250	250	52	124	110	10.7	
5	50	233.04	.09	2.13	3.24	8.0	304			53	126	111	8.4	
4	52.5	235.12	.09	1.99	5.25	7.0	360			53	127	112	10.4	
3	55	232.09	.08	1.77	7.14	7.5	360	250	250	53	127	112	17.3	
2	57.5	238.90	.07	1.55	8.92	6.5	360			53	127	112	9.9	
1	60	241.46	.05	1.11	0.42	5.0	360			53	127	112	7.4	
	θ = 60	Vm = 44.21		^H = 1.70							Avg. = 115.5			

(2206)

APPENDIX D

PARTICLE SIZE DISTRIBUTION DATA FOR THE NO. 2 BOILER ESP INLET

INTERPOLL LABORATORIES EPA METHOD 2 FIELD DATA SHEET

Job NSP REDWING

Source UNIT 2 ESP INLET

Test 5 Run 1 Date 3-26-88

Stack dimen. 53 x 66 IN.

Dry bulb _____ deg-F

Wet bulb _____ deg-F

Barometric pressure 28.85 in Hg

Static pressure -6.0 in WC

Operators D. SMITH & T. HOGAN

Pitot No. B-10 Cp .84

Schematic of Cross Section

257

Traverse Point No.	Fraction of Diameter	Distance from Stack Wall (in)	Distance from End of Port (in)	Velocity Pressure (in WC)	Temperature of gas (deg-F)
		Port length: 28 in.		Time start:	hrs
A - 1		3.79	31.79		
2		11.36	39.36		
3		18.93	46.93		
4		26.50	54.50		
5		34.07	62.07		
6		41.64	69.64		
7		49.21	77.21		
Temp. measure device:				Time end:	hrs

INTERPOLL LABORATORIES EPA METHOD 5/17 SAMPLE LOG SHEET

Job NSP REDWING Date 3-26-88 Test 5 Run 1
Source UNIT 2 ESP INLET No. of traverse points 42
Method 17 Filter holder: INVERTEDSS Filter type: SS

Sample Train Leak Check:

Pretest: ≤ 0.02 cfm at 15 in. Hg. (vac) ☒
Postest: 0 cfm at 7 in. Hg. (vac) ☐

Particulate Catch Data:

No.s of filters used: 1 (#18)

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

No. of probe wash bottles: 1
Sample recovered by: DWAYNE A. SMITH

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impinger No. 1			
Impinger No. 2			
Impinger No. 3			
Condenser	365	100	265
Desiccant	1401	1386	15
Total			280

Integrated Gas Sampling Data:

Bag Pump No. B8 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: 1016 (HRS) Time end: 1252 (HRS)
Sampling rate: 300 cc/min Operator: D SMITH
S/N of O_2 Analyzer used to monitor train outlet: 5

CF-023

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job NSP REDWING
Source UNIT 2 ESP INLET
Date 3-26-88 Test 5 Run 1

Operators D. SMITH & T. HOGAN
Meter Box No. 9
Gamma Coeff. 1.0021

Pitot No. 8-10 Cp .84
Bar. Press. 28.85 inHg H2O 15 x
Nozzle No. 4-4 Nozzle Dia .253 IN.

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dec. Vol. (cf)	VAC. inHg	Temperatures (°F)						Oxygen
							Stack	Probe	Oven	Impg.	Gas/In	Gas/Out	(xv/v)
	(1015)	(143.50)											
A - 7	3	145.16	.48	1.00	5.16	3.0	420	250			87	75	5.3
6	6	146.84	.48	1.00	6.83	3.0	418				91	76	6.6
5	9	148.62	.55	1.15	8.63	4.0	415				92	76	5.8
4	12	150.48	.58	1.22	0.48	4.0	417	250			94	76	5.8
3	15	152.31	.57	1.19	2.31	4.0	420				95	77	5.8
2	18	153.85	.40	0.84	3.85	3.0	420				96	78	10.0
1	21	155.39	.40	0.84	5.39	3.0	420	250			90	78	10.0
B - 7	24	156.97	.52	0.59	6.97	3.0	410				90	80	5.6
6	27	158.74	.53	1.12	8.74	4.0	410				94	80	6.6
5	30	160.54	.52	1.13	0.52	4.0	402	250			96	80	5.9
4	33	162.39	.58	1.25	2.39	4.0	402				97	80	9.1
3	36	164.25	.57	1.22	4.25	4.0	403				98	80	4.8
2	39	166.19	.62	1.33	6.19	4.2	403	250			98	80	5.4
1	42	167.79	.42	0.90	7.79	3.2	405				99	80	6.4
C - 7	45	169.67	.58	1.25	9.67	3.9	404				97	81	5.0
6	48	171.52	.56	1.20	1.52	3.8	404	250			98	82	7.4
5	51	173.33	.54	1.16	3.33	3.7	407				100	82	7.2
4	54	175.20	.58	1.24	5.21	4.2	408				100	82	4.5
3	57	177.24	.68	1.46	7.24	5.0	410	250			100	82	6.4
2	60	179.24	.66	1.41	9.24	4.8	410				100	82	5.2
1	63	180.	.42	0.90	0.84	3.4	411				101	83	5.6
	θ =	Va =		^H =							Avg. =		

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job NSP REDWING
Source UNIT 2 ESP INLET
Date 3-26-88 Test 5 Run 1

Operators D. SMITH & T. HOGAN
Meter Box No. 9
Cosmeter coeff. 1.0021

Pitot No. 8-10 Cp .84
Bar. Press. 28.85 inHg H2O 65 %
Nozzle No. 4-4 Nozzle Dia .253 IN.

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dec. Vol. (cf)	VAC. inHg	Temperatures (°F)						Oxygen
							Stack	Probe	Oven	Impg.	Gas/In	Gas/Out	(xx/x)
D - 7	66	182.79	.63	1.35	2.80	4.5	408	250			100	83	6.2
6	69	184.79	.65	1.40	4.79	4.8	408				100	83	6.9
5	72	186.78	.64	1.38	6.78	4.8	404				101	84	5.5
4	75	188.78	.66	1.43	8.79	5.0	405	250			101	84	7.9
3	78	190.73	.61	1.32	0.73	4.6	402				102	84	5.7
2	81	192.77	.68	1.47	2.78	5.1	402				102	84	7.0
1	84	194.85	.70	1.51	4.85	5.2	408	250			102	84	5.8
E - 7	87	196.82	.64	1.38	6.83	4.8	410				100	84	8.7
6	90	198.75	.60	1.29	8.75	4.6	405				101	84	5.1
5	93	200.79	.68	1.47	0.79	5.2	406	250			101	84	4.1
4	96	202.93	.75	1.61	2.93	5.7	408				101	84	6.6
3	99	204.92	.64	1.38	4.91	5.0	409				102	85	6.4
2	102	206.83	.60	1.29	6.83	4.8	409	250			102	85	5.0
1	105	208.53	.47	1.01	8.53	4.1	410				102	85	6.5
F - 7	108	210.63	.73	1.57	0.64	5.8	411				100	85	5.6
6	111	212.70	.70	1.50	2.70	5.5	413	250			101	85	5.9
5	114	214.78	.71	1.52	4.78	5.6	413				102	85	6.1
4	117	216.79	.65	1.39	6.78	5.4	412				102	85	7.0
3	120	218.68	.58	1.24	8.66	5.2	413	250			102	85	4.6
2	123	220..54	.58	1.24	0.54	5.2	413				102	85	7.3
1	126	222.01	.35	0.75	2.01	4.0	413				102	85	5.7
	(1253)												
	θ =	Vs = 78.51		ΔH = 1.24							Avg. = 90.2		

INTERPOLL LABORATORIES EPA METHOD 5/17 SAMPLE LOG SHEET

Job NSP REDWING Date 3-26-88 Test 5 Run 2
Source UNIT 2 ESP INLET No. of traverse points 42
Method 17 Filter holder: INVERTED SS Filter type: SS

Sample Train Leak Check:

Pretest: ≤ 0.02 cfm at 15 in. Hg. (vac) ☒
Postest: 0 cfm at 7 in. Hg. (vac) ☐

Particulate Catch Data:

No.s of filters used: 1 (#28)

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

No. of probe wash bottles: 1
Sample recovered by: DWAYNE A. SMITH

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impinger No. 1			
Impinger No. 2			
Impinger No. 3			
Condenser	460	200	260
Desiccant	1455	1401	54
Total			314

Integrated Gas Sampling Data:

Bag Pump No. 68 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: 1327 (HRS) Time end: 1542 (HRS)
Sampling rate: 300 cc/min Operator: D.S.
S/N of O_2 Analyzer used to monitor train outlet: 5

CF-023

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job NSP REDWING
Source UNIT 2 ESP INLET
Date 3-26-88 Test 5 Run 2

Operators D. SMITH & T. HOGAN
Meter Box No. 9
Coefficient coeff. 1.0021

Pitot No. S-10 Cp .84
Bar. Press. 28.35 inHg H2O .75 x
Nozzle No. 4-4 Nozzle Dia .253 IN.

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dec. Vol. (cf)	VAC. inHg	Temperatures (°F) Stack	Probe	Oven	Impg.	Gas/In	Gas/Out	Oxygen (x v/v)
	(1325)	(222.30)											
F - 7	3	224.45	.78	1.66	4.46	2.8	412	250			96	84	6.0
6	6	226.63	.78	1.67	6.64	3.0	410				100	84	6.6
5	9	228.80	.76	1.63	8.79	3.0	412				101	85	6.1
4	12	230.85	.70	1.50	0.85	3.0	411	250			102	85	6.7
3	15	232.79	.60	1.29	2.77	2.8	410				102	85	6.4
2	18	234.78	.66	1.42	4.78	3.0	411				103	85	7.5
1	21	236.39	.42	0.90	6.39	2.0	413	250			103	85	6.4
E - 7	24	238.49	.72	1.55	8.49	3.0	412				102	85	6.1
6	27	240.48	.65	1.39	0.48	3.0	413				103	85	6.5
5	30	242.58	.72	1.55	2.58	3.2	411	250			103	86	5.4
4	33	244.72	.75	1.61	4.72	3.5	412				103	86	6.1
3	36	246.80	.70	1.50	6.74	3.2	413				103	86	8.0
2	39	248.76	.63	1.36	8.76	3.0	411	250			104	86	7.3
1	42	250.55	.52	1.12	0.55	2.8	412				104	86	5.0
D - 7	45	252.55	.65	1.40	2.55	3.0	413				102	86	4.9
6	48	254.59	.68	1.46	4.59	3.5	412	250			103	86	5.4
5	51	256.56	.63	1.35	6.56	3.4	414				104	86	4.1
4	54	258.64	.70	1.50	8.63	3.5	413				104	87	7.7
3	57	260.82	.78	1.68	0.82	3.8	414	250			104	87	7.4
2	60	262.97	.75	1.61	2.96	3.7	415				104	87	7.1
1	63	265.	.72	1.54	5.06	3.6	417				104	87	8.7
	θ =	Va =		^H =							Avg. =		

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job NSP REDWING
Source UNIT 2 ESP INLET
Date 3-26-88 Test 5 Run 2

Operators D.SMITH & T.HOGAN
Meter Box No. 9
Coeff. 1.0021

Pitot No. 8-10 Cp .84
Bar. Press. 28.75 inHg H2O .25 X
Nozzle No. 9-4 Nozzle Dia .253 IN.

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dec. Vol. (cf)	VAC. inHg	Temperatures (°F) Stack	Probe	Oven	Impg.	Gas/In	Gas/Out	Oxygen (x v/v)
C - 7	66	267.26	.78	1.68	7.25	3.9	413	250			102	87	8.5
6	69	269.40	.75	1.61	9.39	4.0	413				103	87	7.6
5	72	271.44	.68	1.47	1.44	3.8	410				104	87	5.6
4	75	273.57	.74	1.59	3.57	4.0	413	250			104	87	7.6
3	78	275.65	.70	1.51	5.65	3.9	413				104	87	7.3
2	81	277.85	.78	1.68	7.84	4.2	413				104	87	6.8
1	84	279.79	.62	1.33	9.79	3.8	414	250			104	87	7.0
B - 7	87	281.63	.55	1.19	1.63	3.5	411				102	87	5.4
6	90	283.53	.58	1.24	3.52	3.8	415				103	87	7.5
5	93	285.38	.56	1.20	5.37	3.8	415	250			103	87	8.2
4	96	287.25	.58	1.24	7.25	3.8	416				104	87	8.2
3	99	289.28	.67	1.44	9.28	4.0	416				104	87	5.7
2	102	291.28	.65	1.39	1.28	4.0	417	250			104	87	4.5
1	105	293.30	.67	1.43	3.30	4.2	421				104	87	9.7
A - 7	108	295.06	.50	1.07	5.05	3.0	418				103	87	7.7
6	111	296.85	.53	1.13	6.85	3.6	420	250			103	87	9.5
5	114	298.71	.57	1.22	8.71	3.9	417				104	87	5.6
4	117	300.71	.66	1.41	0.72	4.2	417				104	87	5.5
3	120	302.67	.62	1.33	2.67	4.2	418	250			104	87	6.6
2	123	304.69	.67	1.43	4.69	4.6	421				104	87	8.1
1	126	306.47	.52	1.11	6.47	4.0	422				104	87	3.4
	(1543)												
	θ =	Vm = 84.17		ΔH = 1.41							Avg. = 94.7		

INTERPOLL LABORATORIES EPA METHOD 5/17 SAMPLE LOG SHEET

Job NSP REDWING Date 3-26 Test 5 Run 3
Source UNIT 2 ESP INLET No. of traverse points 42
Method 17 Filter holder: INVERTED SS Filter type: SS

Sample Train Leak Check:

Pretest: < 0.02 cfm at 15 in. Hg. (vac) ☑
Postest: 0 cfm at 7 in. Hg. (vac) ☑

Particulate Catch Data:

No.s of filters used: 1 (#3)

Recovery solvent(s)
☑ acetone
other(s)

No. of probe wash bottles: 1
Sample recovered by: DUAYNE A. SMITH

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impinger No. 1			
Impinger No. 2			
Impinger No. 3			
Condenser	366	100	266
Desiccant	1472	1455	17
Total			283

Integrated Gas Sampling Data:

Bag Pump No. B8 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: 1622 (HRS) Time end: 1838 (HRS)
Sampling rate: 300 cc/min Operator: D. SMITH
S/N of O_2 Analyzer used to monitor train outlet: 5

CF-023

S-0046RR

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job NSP REDWING
Source UNIT 2 ESP INLET
Date 2-26-88 Test 5 Run 3

Operators D. SMITH & T. HOGAN
Meter Box No. 9
Gamma Coeff. 1.0021

Pitot No. 8-10 Cp .84
Bar. Press. 28.85 inHg H2O 15 X
Nozzle No. 4-4 Nozzle Dia .253 IN.

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dec. Vol. (cf)	VAC. inHg	Temperatures (°F)						Oxygen
							Stack	Probe	Oven	Impg.	Gas/In	Gas/Out	(v/v)
	(1620)	(306.80)											
A - 7	3	308.58	.52	1.11	8.58	2.9	419	250			97	86	9.2
6	6	310.35	.52	1.11	0.35	2.9	416				100	86	5.6
5	9	312.22	.58	1.24	2.23	3.9	416				102	87	5.3
4	12	314.22	.65	1.38	4.22	4.2	420	250			103	87	6.3
3	15	316.14	.60	1.28	6.13	4.1	418				104	87	7.1
2	18	318.03	.58	1.24	8.02	4.0	417				104	87	5.7
1	21	319.70	.46	0.98	9.70	3.4	417	250			104	87	5.8
B - 7	24	321.52	.54	1.15	1.52	3.8	418				102	87	5.9
6	27	323.34	.54	1.15	3.33	3.8	419				103	87	6.6
5	30	325.28	.62	1.32	5.28	4.5	418	250			103	87	6.0
4	33	327.28	.66	1.41	7.28	4.8	418				103	87	6.5
3	36	329.27	.65	1.38	9.27	4.8	421				104	87	7.0
2	39	331.14	.57	1.22	1.14	4.2	418	250			104	87	7.5
1	42	332.93	.52	1.11	2.93	3.5	419				102	87	7.5
C - 7	45	334.78	.56	1.20	4.78	4.0	415				102	87	6.5
6	48	336.61	.55	1.18	6.61	4.0	414	250			103	87	7.4
5	51	338.51	.58	1.25	8.50	4.5	412				103	87	4.5
4	54	340.47	.63	1.35	0.47	4.8	414				104	87	8.8
3	57	342.52	.69	1.48	2.53	5.0	413	250			104	87	6.0
2	60	344.57	.68	1.46	4.57	5.0	414				104	87	6.5
1	63	346.52	.62	1.33	6.52	4.8	415				104	87	5.6
	θ =	Va =		^H =							Avg. =		

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job NSP REDWING
Source UNIT 2 ESP INLET
Date 3-26-88 Test 5 Run 3

Operators D. SMITH & T. MOGAN
Meter Box No. 9
Gas meter coeff. 1.0021

Pitot No. S-10 Cp .84
Bar. Press. 28.75 inHg H2O .15 X
Nozzle No. 4-4 Nozzle Dia .253 IN.

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dec. Vol. (cf)	VAC. inHg	Temperatures (°F) Stack	Probe	Oven	Impg.	Gas/In	Gas/Out	Oxygen (xv/v)
D - 7	66	348.66	.75	1.61	8.67	5.2	417	250			103	88	7.9
6	69	350.74	.70	1.50	0.74	5.0	417				104	88	6.6
5	72	352.81	.71	1.53	2.83	5.0	415				104	88	6.9
4	75	354.86	.67	1.44	4.85	4.9	416	250			104	88	6.5
3	78	356.91	.68	1.46	6.90	5.0	415				104	88	7.1
2	81	358.94	.68	1.46	8.94	5.1	416				105	88	5.6
1	84	360.66	.48	1.03	0.66	4.0	416	250			105	88	9.1
E - 7	87	362.73	.70	1.51	2.74	5.2	411				103	88	6.6
6	90	364.84	.73	1.57	4.86	5.3	411				104	88	8.0
5	93	366.98	.73	1.57	6.98	5.3	413	250			104	88	9.5
4	96	369.14	.75	1.62	9.14	5.8	411				104	88	6.1
3	99	371.29	.75	1.62	1.29	5.8	411				104	88	6.0
2	102	373.27	.63	1.36	3.26	5.0	412	250			104	88	6.4
1	105	375.08	.52	1.12	5.05	4.8	413				104	88	7.4
F - 7	108	377.19	.75	1.61	7.20	5.8	413				104	88	7.8
6	111	379.36	.76	1.64	9.36	6.0	413	250			104	88	8.1
5	114	381.39	.67	1.44	1.40	5.4	412				104	88	6.9
4	117	383.38	.64	1.38	3.38	5.4	411				104	88	5.8
3	120	385.23	.55	1.18	5.23	5.0	413	250			104	88	6.9
2	123	386.98	.49	1.06	6.97	4.8	412				104	88	5.3
1	126	388.69	.48	1.03	8.69	4.6	413				104	88	8.6
	(1839)												
	θ = 126	Vm = 81.89		ΔH = 1.34							Avg. = 95.4		

The results of the X-ray Sedigraph Size Distribution analysis must be converted from a density of 2.2 to 1.0 for PM-10 which is based on the "aerodynamic equivalent diameter".

$$D_2 = D_1 \left(\frac{\rho_1}{\rho_2}\right)^{1/2}$$

$$\frac{D_2}{D_1} = \left(\frac{2.2}{1.0}\right)^{1/2} = 1.483$$

$$D_2 = 1.483\ D_1$$

where: D_2 = particle diameter at density ρ_2

D_1 = particle diameter at density ρ_1

ρ = particle density

Diameter in um at ρ = 2.2g/cc	Diameter in um at ρ = 1.0g/cc
150	220
63	93
50	74
40	59
30	44
20	30
15	22
10	15
8	11.9
6	8.9
5	7.4
4	5.9
3	4.4
2	3.0
1	1.5
.8	1.2
.5	.74

Test No. 5
Unit 2 ESP Inlet

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

Date of run	Run 1 03-26-88	Run 2 03-26-88	Run 3 03-26-88
Dry basis (orsat)			
carbon dioxide.....	12.90	12.88	12.96
oxygen.....	7.03	7.10	7.04
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	80.07	80.02	80.00
Wet basis (orsat)			
carbon dioxide.....	10.93	10.82	11.02
oxygen.....	5.95	5.96	5.98
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	67.82	67.22	67.99
water vapor.....	15.29	15.99	15.01
Dry molecular weight.....	30.35	30.34	30.36
Wet molecular weight.....	28.46	28.37	28.50
Specific gravity.....	0.983	0.980	0.984
Water mass flow.....(LB/HR)	20462	22745	20792
FO	1.075	1.071	1.069

Test No. 5
Unit 2 ESP Inlet

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

	Run 1	Run 2	Run 3
Date of run	03-26-88	03-26-88	03-26-88
Time run start/end.....(HRS)	1015/1253	1325/1543	1620/1839
Static pressure.....(IN.WC)	-6.00	-6.00	-6.00
Cross sectional area (SQ.FT)	24.29	24.29	24.29
Pitot tube coefficient.....	.840	.840	.840
Water in sample gas			
condenser.....(ML)	265.0	260.0	266.0
impingers.....(GRAMS)	0.0	0.0	0.0
desiccant.....(GRAMS)	15.0	54.0	17.0
total.....(GRAMS)	280.0	314.0	283.0
Total particulate material..			
.....,collected(grams)	9.9894	10.4311	9.1873
Gas meter coefficient.....	1.0021	1.0021	1.0021
Barometric pressure..(IN.HG)	28.85	28.85	28.85
Avg. orif.pres.drop..(IN.WC)	1.24	1.41	1.34
Avg. gas meter temp..(DEF-F)	90.2	94.7	95.4
Volume through gas meter....			
at meter conditions...(CF)	78.51	84.17	81.89
standard conditions.(DSCF)	73.00	77.66	75.45
Total sampling time....(MIN)	126.00	126.00	126.00
Nozzle diameter.....(IN)	.253	.253	.253
Avg.stack gas temp ..(DEG-F)	410	414	406
Volumetric flow rate.....			
actual.....(ACFM)	82594	88283	85186
dry standard.....(DSCFM)	40336	42535	41914
Isokinetic variation.....(%)	100.0	100.9	99.5
Particulate concentration...			
actual.....(GR/ACF)	1.03074	0.99810	0.92407
dry standard.....(GR/DSCF)	2.11142	2.07245	1.87884
Particle mass rate...(LB/HR)	729.99	755.57	675.00

APPENDIX E

PM-10 DATA FOR THE NO. 2 BOILER STACK

INTERPOLL LABORATORIES EPA METHOD 2 FIELD DATA SHEET

Job NSP REDWING

Source UNIT 2 OUTLET

Test 5 Run 1 Date 3-26-89

Stack dimen. 115.25 IN.

Dry bulb _____ deg-F

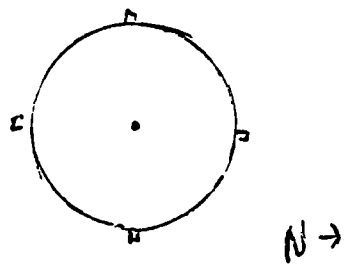
Wet bulb _____ deg-F

Barometric pressure 28.94 in Hg

Static pressure -.5 in WC

Operators JB+RR

Pitot No. U17-2½ 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 ____ (deg-F)
		Port length:	in.	Time start:	hrs
Temp. measure device:				Time end:	hrs

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PM-10 TRAVERSE POINT SELECTION DATA SHEET

Job NSP REDWING
Source UNIT 2 OUTLET
Test 5 Run 1
Date 3-26-88
Operator RR + JB

Pitot Tube No. UN-2½
Barometric pres. 28.94 in.Hg
Duct shape: ✓ Round ___ Rect.
Duct dimensions _____ in.
Length of port _____ in.

PM-10 Guidelines require that the velocity at each of the four selected traverse points be within ± 20%. Record the velocity pressure of the traverse points and perform the indicated calculations. The values in the last column must fall within range of 80 - 120.

Traverse Point	Gas Temp. (deg-F)	Velocity Pressure ΔP (in. WC)	$\sqrt{\Delta P}$	$\frac{100\sqrt{\Delta P}}{(\sqrt{\Delta P})_{Avg}}$
A-1	385	.077	.2775	98.26
B-1	385	.079	.2811	99.54
C-1	385	.083	.2881	102.02
D-1	385	.080	.2828	100.14
Averages	385		.2824	

The average velocity pressure to be used for the sizing run may now be calculated from the following expression:

VEI 20.60

$$\Delta P = (\sqrt{\Delta P}_{Avg})^2 = \frac{.0797}{.080} = .07986 \text{ in. WC}$$

Traverse points on round ducts: .15 D and .85 D
Distance from the duct wall: 2 ____ in.
Distance from the end of port: 23.39 — in.

.84 ACFM

DP .3534

CF-016

INTERPOLL LABORATORIES EPA METHOD 5/17 SAMPLE LOG SHEET

Job NSP RED WING — Date 3-26-88 Test 5 Run 1
Source UNIT 2 OUTLET — No. of traverse points 24
Method PM-10 / M-5 Filter holder: IMPACTOR / Glass — Filter type: Impactor + G.F. Filter

Sample Train Leak Check:

Pretest: < 0.02 cfm at 15 in. Hg. (vac) ☑
Postest: 0.00 cfm at 7 in. Hg. (vac) ☑

GLASSWARE PROBE ONLY

Particulate Catch Data:

No.s of filters used: 0069

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

No. of probe wash bottles: 2
Sample recovered by: JB+RR

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impinger No. 1			
Impinger No. 2			
Impinger No. 3			
Condenser	154	0	154
Desiccant	1414	1351	63
Total			217

Integrated Gas Sampling Data:

Bag Pump No. B4 Box No. 1 Bag No. 1

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

Pretest leak check: 0.00 cc/min at 15 in. Hg.

Time start: 1016 (HRS) Time end: 1253 (HRS)

Sampling rate: 300 cc/min Operator: JB

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

CF-023

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job NSP RED WING — Operator JB + TJ — Nozzle No. — Pitot No. V17-2½
Source UNIT 2 OUTLET — Meter Box No. 8 — Nozzle Dia. .353 in. — Cp .840
Date 3-26-98 Test 5 Run 1 — Gasmeter coeff. .9980 ΔH 1.92 — Bar. Pres. 28.85" in. Hg — H_2O 15 %

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	Cond.	Gas/In	Gas/Out	Oxygen (%v/v)
	1015	976.93											
D - 1	5	979.31	.08	.73	9.36	1.7	385	255	248	50	103	96	6.2
1	10	981.75	.08	.73	1.75	1.8	380	250	248	50	106	96	6.3
1	15	984.21	.08	.73	4.23	1.8	380			50	108	96	6.6
1	20	986.68	.08	.73	6.68	1.9	380			50	110	96	5.9
1	25	989.10	.08	.74	9.14	2.0	370	250	255	50	110	96	5.6
1	30	991.61	.08	.74	1.61	2.0	370			50	114	98	6.2
C 1	35	994.10	.08	.75	4.09	2.0	370			52	112	98	7.5
1	40	996.59	.08	.75	6.59	2.0	370	247	255	52	114	99	6.8
1	45	999.04	.08	.75	9.04	2.0	370			52	116	99	7.3
1	50	1001.53	.08	.75	1.53	2.0	370			52	118	100	7.5
1	55	1004.02	.08	.75	4.02	2.0	370			52	118	100	6.6
1	60	1006.51	.08	.75	6.51	2.0	370	250	253	52	118	100	7.6
B 1	65	1009.01	.08	.76	9.01	2.0	365			52	115	100	7.6
1	70	1011.50	.08	.76	1.50	2.4	365			52	117	100	7.1
1	75	1014.08	.08	.76	4.00	2.4	365			52	118	100	7.1
1	80	1016.49	.08	.76	6.49	2.4	365	250	255	52	119	100	7.6
1	85	1018.99	.08	.76	8.99	2.4	365			52	119	100	8.4
1	90	1021.50	.08	.76	1.50	2.4	365			52	120	100	6.9
A 1	95	1024.00	.08	.76	4.00	2.4	365			52	115	101	7.1
1	100	1026.51	.08	.77	6.51	2.4	355	250	255	52	117	102	7.0
1	105	1029.02	.08	.77	9.02	3.5	355			52	118	102	6.9
1	110	1031.54	.08	.77	1.54	3.5	355			53	119	102	7.6
1	115	1034.04	.08	.77	4.06	3.5	355			53	119	102	7.3
1	120	1036.58	.08	.77	6.58		355	253	255	53	119	102	6.2
	(1253)												
	θ= 120	Va= 59.65		^H=.75							Avg.= 107.2		

Run 4 is the control

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Cascade Impactor Laboratory Data Sheet

Job NSP/Red Wing — Date of test 3-26-88

Source Unit # 2 STACK — Test 5 Run 1

Analyst [signature] Impactor No. 1 — Substrate used SS

Stage No.	Weight (g)					Cum. Weight (g)	% v/v	Part Dia. (um)
	Tare	Final	Uncorr. Mass	Control	Corr. Mass			
Preimpact.	49.85483	49.86601	0.01118	.00070	.01048	.01048	7.63	10
1	1.88104	1.88136	0.00041	.00007	.00034	.01082	7.88	6.6
2	1.86987	1.87005	0.00018	.00006	.00012	.01094	7.96	4.2
3	1.86998	1.87028	0.00030	.00005	.00025	.01119	8.15	2.6
4	1.84696	1.84740	0.00044	.00006	.00038	.01157	8.42	1.6
5	1.85257	1.85313	0.00056	.00002	.00054	.01211	8.82	1.0
6	1.93530	1.93747	0.00217	.00002	.00215	.01426	10.38	.64
7	1.94553	1.95775	0.01222	.00004	.01218	.02644	19.25	.36
Filter	—	0.11123	0.11123	.00030	.11093	.13737		

Sampling rate data:

V_{std} = 53.52 DSCF — P_b = 28.85 in. Hg

t_m = 367 °F — P_g = .01 in. WC

θ = 120 min. — MC = 16.03 % v/v

$$q_a = \frac{5.67\ V_{std}\ (t_m + 460)}{\theta\ (P_b + P_g/13.6)(100 - MC)}$$

$$q_a = \frac{5.67 \times (53.52) \times (367 + 460)}{(120) \times (28.85 + .01 / 13.6) \times (100 - 16.03)} = 0.863 \text{ acfm}$$

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PM-10 TRAVERSE POINT SELECTION DATA SHEET

Job NSP RED WING
Source UNIT 2 OUTLET
Test 5 Run 2
Date 3-26-88
Operator RR + JE

Pitot Tube No. U17 - 2½
Barometric pres. 28.94 in.Hg
Duct shape: ✓ Round ___ Rect.
Duct dimensions _____ in.
Length of port _____ in.

PM-10 Guidelines require that the velocity at each of the four selected traverse points be within ± 20%. Record the velocity pressure of the traverse points and perform the indicated calculations. The values in the last column must fall within range of 80 - 120.

Traverse Point	Gas Temp. (deg-F)	Velocity Pressure ΔP (in. WC)	$\sqrt{\Delta P}$	$\frac{100\sqrt{\Delta P}}{(\sqrt{\Delta P})_{avg}}$
A-1	370	.078	.2793	98.90
B-1	370	.079	.2811	99.54
C-1	370	082	.2863	101.38
D-1	370	.080	.2828	100.14
Averages	370		.2824	

The average velocity pressure to be used for the sizing run may now be calculated from the following expression:

$$\Delta P = (\sqrt{\Delta P}_{avg})^2 = .0797 \text{ in. WC}$$

Traverse points on round ducts: .15 D and .85 D
Distance from the duct wall: 17.29 _____ in.
Distance from the end of port: 23.29 _____ in.

CF-016

INTERPOLL LABORATORIES EPA METHOD 5/17 SAMPLE LOG SHEET

Job USP REDWING Date 3-26-88 Test 5 Run 2
Source UNIT 2 OUTLET No. of traverse points 24
Method PM-10 Filter holder: IMPACTOR Filter type: IMPACTOR Aperture

Sample Train Leak Check:

Pretest: (0.02 cfm at 15 in. Hg. (vac) ☐
Postest: 0.00 cfm at 8 in. Hg. (vac) ☑ GLASSWARE PROBE ONLY

Particulate Catch Data:

No.s of filters used: 0066

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

No. of probe wash bottles: 2
Sample recovered by: JB+ER

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impinger No. 1			
Impinger No. 2			
Impinger No. 3			
Condenser	153	0	153
Desiccant	1379	1324	55
Total			208

Integrated Gas Sampling Data:

Bag Pump No. B4 Box No. 1 Bag No. 2
Bag Material: 5-layer Aluminized Tedlar Size: 44 L
Pretest leak check: 0.00 cc/min at 14 in. Hg.
Time start: 1325 (HRS) Time end: 1533 (HRS)
Sampling rate: 300 cc/min Operator: JB
S/N of O_2 Analyzer used to monitor train outlet: 8

CF-023

S-0046RR

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job NSPREDWING — Operators JB+RR+DJ — Nozzle No. — Pitot No. 017/5'
Source UNIT 2 OUTLET — Meter Box No. 8 — Nozzle Dia. .353 in. — Cp .840
Date 3-26-88 Test 5 Run 2 — Gasmeter coeff. .9980 ΔH 1.92 — Bar. Pres. 28.95 in. Hg — H_2O 16 %

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	Cond.	Gas/In	Gas/Out	Oxygen (%v/v)
	(1225)	36.04											
A 1	5	38.53	.08	.75	8.53	2.0	355	250	245	50	110	102	7.5
1	10	40.99	.08	.75	0.99	2.0	355			50	116	102	8.4
1	15	43.48	.08	.75	3.48	2.0	355			50	116	102	8.3
1	20	45.97	.08	.75	5.97	2.0	355			50	117	102	8.0
1	25	48.47	.08	.75	8.47	2.4	355	250	255	50	118	102	7.5
1	30	50.96	.08	.75	0.96	2.4	355			52	119	102	6.7
B 1	35	53.46	.08	.75	3.46	2.4	355			52	116	102	7.1
1	40	55.60	.08	.75	5.95	2.4	355	250	247	52	118	102	7.1
1	45	58.44	.08	.75	8.44	2.4	355			52	118	102	7.1
1	50	60.94	.08	.75	0.94	2.4	355			52	119	102	7.0
1	55	63.43	.08	.75	3.43	2.4	355	250	245	51	120	103	7.0
1	60	65.93	.08	.76	5.93	2.4	355			51	120	103	7.0
C 1	65	68.43	.08	.76	8.43	2.4	355			51	119	105	8.0
1	70	70.93	.08	.75	0.93	2.4	355			51	120	103	9.0
1	75	73.41	.08	.76	3.43	2.4	355	250	250	51	121	103	9.3
1	80	75.94	.08	.76	5.94	2.4	355			52	121	103	8.6
1	85	78.39	.08	.76	8.44	2.4	355			52	121	104	7.9
1	90	80.94	.08	.76	0.94	2.4	355	245	250	52	121	104	8.8
D 1	95	83.45	.08	.76	3.45	2.4	355			53	117	104	7.7
1	100	85.95	.08	.75	5.85	2.4	355			53	119	104	10.5
1	105	88.45	.08	.76	8.45	2.4	355	240	250	53	120	104	8.8
1	110	90.95	.08	.76	0.95	2.4	355			53	121	104	5.2
1	115	93.45	.08	.76	3.45	24	355			53	121	104	6.1
1	120	95.96	.08	.76	5.96	2.4	355			53	121	104	10.4
	(1530)												
θ=		Va= 54.92		ΔH=.75							Avg.= 110.8		

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Cascade Impactor Laboratory Data Sheet

Job NSP/Red Wing — Date of test _____

Source Unit #2 — Test 5 — Run 2

Analyst [signature] — Impactor No. 2 — Substrate used SS

Stage No.	Weight (g)					Cum. Weight (g)	% v/v	Part Dia. (um)
	Tare	Final	Uncorr. Mass	Control	Corr. Mass			
Preimpact.	48.73102	48.73552	0.00450	.00070	.00380	.00380	9.44	10
1	1.90135	1.90186	0.00056	.00007	.00049	.00429	10.66	6.6
2	1.88613	1.88635	0.00022	.00006	.00016	.00445	11.06	4.2
3	1.84402	1.84440	0.00038	.00005	.00033	.00478	11.88	2.6
4	1.84028	1.84072	0.00044	.00006	.00038	.00516	12.82	1.6
5	1.89484	1.89548	0.00064	.00002	.00062	.00578	14.36	1.6
6	1.90643	1.90664	0.00021	.00002	.00019	.00597	14.84	.64
7	1.92790	1.92867	0.00077	.00004	.00073	.00670	16.65	.36
Filter	—	0.03388	0.03388	.00030	.03354	.04024		

Sampling rate data:

V_{std} = 53.42 DSCF — P_b = 28.85 in. Hg

t_m = 355 °F — P_g = .01 in. WC

θ = 120 min. — MC = 15.50 % v/v

$$q_a = \frac{5.67\ V_{std}\ (t_m + 460)}{\theta\ (P_b + P_g/13.6)(100 - MC)}$$

$$q_a = \frac{5.67 \times (53.42) \times (355 + 460)}{(120) \times (28.85 + .01 / 13.6) \times (100 - 15.50)} = 0.844 \text{ acfm}$$

Rev. 1 CF-028

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PM-10 TRAVERSE POINT SELECTION DATA SHEET

Job NSP REDWING
Source UNIT 2 OUTLET
Test 5 Run 3
Date 8-26-88
Operator RR + JB

Pitot Tube No. V17-2 1/2
Barometric pres. 28.94 in.Hg
Duct shape: ✓ Round ___ Rect.
Duct dimensions 115.25 in.
Length of port 6 in.

PM-10 Guidelines require that the velocity at each of the four selected traverse points be within ± 20%. Record the velocity pressure of the traverse points and perform the indicated calculations. The values in the last column must fall within range of 80 - 120.

Traverse Point	Gas Temp. (deg-F)	Velocity Pressure ΔP (in. WC)	$\sqrt{\Delta P}$	$\frac{100\sqrt{\Delta P}}{(\sqrt{\Delta P})_{avg}}$
A-1	365	.078	.2793	98.76
B-1	365	080	.2828	100.0
C-1	365	.081	.2846	100.64
D-1	365	.081	.2846	100.64
Averages	365		.2828	

The average velocity pressure to be used for the sizing run may now be calculated from the following expression:

$$\Delta P = (\sqrt{\Delta P}_{avg})^2 = .080 \text{ in. WC}$$

Traverse points on round ducts: .15 D and .85 D
Distance from the duct wall: 17.29 ____ in.
Distance from the end of port: 23.29 ____ in.

CF-016

INTERPOLL LABORATORIES EPA METHOD 5/17 SAMPLE LOG SHEET

Job NSP REDWING Date 3-26-88 Test 5 Run 3
Source UNIT 2 OUTLET No. of traverse points 4
Method PM-10 Filter holder: IMPACTOR Filter type: Impactor - Apiezon H

Sample Train Leak Check:

Pretest: (0.02 cfm at 15 in. Hg. (vac) ☐ Glassware + Probe Only
Postest: 0.00 cfm at 6 in. Hg. (vac) ☑

Particulate Catch Data:

No.s of filters used: 0070

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

No. of probe wash bottles: 2
Sample recovered by: JB+RR

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impinger No. 1			
Impinger No. 2			
Impinger No. 3			
Condenser	167	0	167
Desiccant	1374	1308	66
Total			233

Integrated Gas Sampling Data:

Bag Pump No. 34 Box No. 1 Bag No. 3
Bag Material: 5-layer Aluminized Tedlar Size: 44 L
Pretest leak check: 6.00 cc/min at 14 in. Hg.
Time start: 1620 (HRS) Time end: 1830 (HRS)
Sampling rate: 300 cc/min Operator: JR
S/N of O_2 Analyzer used to monitor train outlet: 8

CF-023

S-0046RR

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job NSPREDWING
Source UNIT 2 OUTLET
Date 3-26-82 Test 5 Run 3

Operators JB+RR+TJ
Meter Box No. 8
Gasmeter coeff. .9980 ΔH 1.92

Nozzle No. -
Nozzle Dia. .353 In.
Bar. Pres. 28.85 In. Hg

Pitot No. VI2-2½
Cp .840
H_2O 6.5 %

Traverse Point No.		Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dev. Vol. (cf)	VAC. inHg	Temperatures (°F) Stack	Probe	Oven	Cond.	Gas/In	Gas/Out	Oxygen (%v/v)
		(1620)	96.30											
D	1	5	98.77	.080	.74	8.77	2.4	355	245	250	50	111	104	9.3
	1	10	101.21	.080	.74	1.24	2.4	355			50	114	105	9.3
	1	15	103.71	.080	.74	3.71	2.4	355			50	116	105	8.9
	1	20	106.19	.080	.74	6.19	2.4	355			50	118	105	7.9
	1	25	108.67	.080	.74	8.67	2.4	355	248	253	50	118	105	10.6
	1	30	111.15	.080	.74	1.15	2.4	355			50	119	105	7.5
C	1	35	113.65	.080	.75	3.65	2.4	355			50	119	106	7.5
	1	40	116.15	.080	.75	6.15	2.4	355			50	121	106	8.5
	1	45	118.66	.080	.76	8.66	2.4	355	245	255	51	122	106	5.8
	1	50	121.17	.080	.76	1.17	2.4	355			51	123	107	8.2
	1	55	123.65	.080	.76	3.69	2.4	355			52	123	107	7.8
	1	60	126.19	.080	.76	6.19	2.6	355			52	123	107	5.9
B	1	65	128.75	.080	.78	8.73	2.7	355	255	257	51	122	107	7.4
	1	70	131.28	.080	.78	1.28	2.7	355			51	123	108	7.4
	1	75	133.85	.080	.78	3.82	2.7	355			51	123	108	7.0
	1	80	136.39	.080	.77	6.39	2.7	360			51	124	108	7.9
	1	85	138.92	.080	.77	8.90	2.7	360	255	257	52	124	108	7.8
A	1	90	141.44	.080	.77	1.44	2.7	360			52	124	108	7.7
	1	95	143.97	.080	.76	3.97	2.7	360			52	122	109	9.6
	1	100	146.51	.080	.76	6.49	2.7	360			52	124	109	6.4
	1	105	149.02	.080	.76	9.02	2.7	360	255	259	52	124	109	9.6
	1	110	151.54	.080	.76	1.54	2.7	360			52	125	109	7.2
	1	115	154.07	.080	.77	4.07	2.7	360			52	125	109	8.6
	1	120	156.60	.080	.77	6.60	2.7	360			52	125	109	7.0
		(1830)												
		θ= 120	Va= 60.30		ΔH= .76							Avg.= 114.1		

Interpoll Laboratories
(612)786-6020

Cascade Impactor Laboratory Data Sheet

Job NSP/Red Wing — Date of test 3-26-84

Source Unit 2 — Test 5 — Run 3

Analyst [signature] — Impactor No. 3 — Substrate used SS

Stage No.	Weight (g)					Cum. Weight (g)	% v/v >	Part Dia. (um)
	Tare	Final	Uncorr. Mass	Control	Corr. Mass			
Preimpact.	46.64523	46.65434	0.00911	.00070	.00841	.00841	20.80	10
1	1.78712	1.78723	0.00025	.00007	.00018	.00859	21.25	6.6
2	1.86393	1.86424	.00031	.00006	.00025	.00884	21.86	4.2
3	1.91923	1.91948	.00025	.00005	.00020	.00904	22.36	2.6
4	1.83681	1.83683	.00002	.00006	—	.00904	22.36	1.6
5	1.89770	1.89802	.00032	.00002	.00030	.00934	23.10	1.0
6	1.92650	1.92667	.00017	.00002	.00015	.00949	23.47	.64
7	1.87146	1.87227	.00087	.00004	.00083	.01032	25.53	.36
Filter	—	0.03041	0.03041	.00030	.03011	.04043		

Sampling rate data:

V_{mcd} = 53.45 DSCF — P_b = 28.85 in. Hg

t_m = 357 °F — P_g = .01 in. WC

θ = 120 min. — MC = 17.03 % v/v

$$q_a = \frac{5.67\ V_{mcd}\ (t_m + 460)}{\theta\ (P_b + P_g/13.6)(100 - MC)}$$

$$q_a = \frac{5.67 \times (53.45) \times (357 + 460)}{(120) \times (28.85 + .01 / 13.6) \times (100 - 17.03)} = 0.862 \text{ acfm}$$

Rev. 1 CF-028

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(612) 786-6020

PM-10 TRAVERSE POINT SELECTION DATA SHEET

Job NSP REDWING
Source UNIT 2 OUTLET
Test 5 Run 4
Date 3-26-88
Operator RR + JB

Pitot Tube No. U17-2 1/2
Barometric pres. 28.94 in.Hg
Duct shape: ✓ Round ___ Rect.
Duct dimensions 115.25 in.
Length of port 6 in.

PM-10 Guidelines require that the velocity at each of the four selected traverse points be within ± 20%. Record the velocity pressure of the traverse points and perform the indicated calculations. The values in the last column must fall within range of 80 - 120.

Traverse Point	Gas Temp. (deg-F)	Velocity Pressure ΔP (in. WC)	$\sqrt{\Delta P}$	$\frac{100\sqrt{\Delta P}}{(\sqrt{\Delta P})_{Avg}}$
A - 1	370	.079	.2793	98.45
B - 1	370	.079	.2811	99.08
C - 1	370	.083	.2881	101.55
D - 1	370	.080	.2828	99.68
Averages	370		.2837	

The average velocity pressure to be used for the sizing run may now be calculated from the following expression:

$$\Delta P = (\sqrt{\Delta P}_{Avg})^2 = .080 \text{ in. WC}$$

Traverse points on round ducts: .15 D and .85 D
Distance from the duct wall: 17.29 ____ in.
Distance from the end of port: 23.29 ____ in.

CF-016

INTERPOLL LABORATORIES EPA METHOD 5 SAMPLE LOG SHEET

Job DSP REDWING Date 3-26-85 Test 5 Run 4
Source UNIT 2 OUTLET No. of traverse points 4
Cyclone: ☑ Yes ☐ No Filter holder: MM5 Filter type: 4" Glass fiber
Analytes: CONTROL FOR 9M-10 IMPACTOR.
Field recovery spike added: N/A ☐ Yes ☐ No Reference:

Sample Train Leak Check:

Pretest: < 0.02 cfm at 15 in. Hg. (vac) ☑ Glassware + Probe
Postest: 0.00 cfm at 8 in. Hg. (vac) ☑

Semivolatile Catch Data: N/A

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

☐ MeCl2 * MeOH (50:50 v/v)
☑ other(s) ACETONE

No. of bottles for condensate trap catch: N/A
Samples recovered by: JB

Condensate Data:

Item	Weight (g)		
	Final	Tare	Difference
Condensate trap	NA	NA	
Condensate trap	NA	NA	
Condensate trap	NA	NA	
condenser	144	0	144
Desiccant	1375	1348	60
Total			204

Integrated Gas Sampling Data:

Bag Pump No. B4 Box No. 9 Bag No. 1

Bag Material: 4-layer Aluminized Tedlar Size: 44 L

Pretest leak check: -0.00 cc/min at 17 in. Hg.

Time start: 1926 (HRS) Time end: 2124 (HRS)

Sampling rate: 300 cc/min Operator: JB

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

INTERPOLL LABORATORIES EPA [illegible] METHOD 5 FIELD DATA SHEET

Job NSP Redwing — Operators JB+RR+TJ — Nozzle No. CONTROL — Pitot No. V17-2½
Source UNIT 2 OUTLET — Meter Box No. B — Nozzle Dia. .375 in. — Cp .840
Date 8-26-88 Test 5 Run 4 — Gasmeter coeff. .9980 — Bar. Pres. 28.65 in. Hg — H_2O 14 %

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	Imp.	Gas/In	Gas/Out	Oxygen (%v/v)
		(1925)	156.18											
A	1	5	158.69	.080	.76	8.69	2.5	355	250	255	50	112	106	DO
	1	10	161.18	.080	.75	1.18	2.7	355			50	118	107	9.0
	1	15	163.63	.080	.75	3.67	2.7	355			50	119	107	8.4
	1	20	166.18	.080	.76	6.18	2.7	355			50	119	107	7.5
	1	25	168.68	.080	.76	8.68	2.7	355	250	255	50	120	107	6.8
	1	30	171.19	.080	.76	1.18	3.0	355			50	120	107	5.4
B	1	35	173.65	.080	.76	3.70	3.2	355			50	120	107	7.8
	1	40	176.20	.080	.76	6.21	3.2	355	250	255	50	121	107	6.4
	1	45	178.74	.080	.77	8.74	3.4	355			50	122	107	9.1
	1	50	181.27	.080	.77	1.27	3.4	355			50	122	107	6.4
	1	55	183.80	.080	.77	3.80	3.5	355			50	122	107	8.6
	1	60	186.37	.080	.77	6.33	3.7	355	250	255	50	122	107	5.7
	1	65	188.86	.080	.77	8.86	3.7	355			50	122	107	7.4
	1	70	191.41	.080	.77	1.39	3.7	355			51	123	107	7.3
	1	75	193.90	.080	.76	3.90	3.7	355			51	123	107	6.3
	1	80	196.42	.080	.76	6.42	3.7	355	250	255	51	123	108	6.7
	1	85	198.94	.080	.76	8.94	3.7	355			51	123	108	7.8
	1	90	201.46	.080	.76	1.46	3.7	355			51	123	108	7.8
	1	95	203.98	.080	.76	3.98	3.7	355	250	250	51	123	108	7.9
	1	100	206.48	.080	.76	6.49	3.7	355			51	123	108	7.8
	1	105	209.01	.080	.76	9.01	3.7	355			51	123	108	7.6
	1	110	211.53	.080	.76	1.53	3.7	355			51	123	108	5.8
	1	115	214.06	.080	.76	4.05	3.7	355	250	250	50	123	109	5.6
	1	120	216.57	.080	.76	6.57	3.7	356			52	123	109	9.7
		(2135)												
		θ=	Vm= 60.39		ΔH= .76							Avg.=	114.2	

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CF-025

CONTROL

Interpoll Laboratories
(612)786-6020

Cascade Impactor Laboratory Data Sheet

Job NSP/Red Wing — Date of test 3-26-88

Source Unit # 2 / Stack — Test 5 — Run 4

Analyst ZZ — Impactor No. 0 — Substrate used SS foil

Stage No.	Weight (g)					Cum. Weight (g)	% v/v	Part Dia. (um)
	Tare	Final	Uncorr. Mass	Control	Corr. Mass			
Preimpact.	49.62884	49.62954	0.00070					
1	1.90009	1.90016	0.00007					
2	1.90051	1.90057	0.00006					
3	1.77268	1.77273	0.00005					
4	1.73957	1.73963	0.00006					
5	1.87172	1.87174	0.00002					
6	1.90640	1.90642	0.00002					
7	1.90130	1.90134	0.00004					
Filter	—	0.00030	0.00030					

Sampling rate data:

V_{mstd} = _____ DSCF — P_b = _____ in. Hg

t_m = _____ °F — P_g = _____ in. WC

θ = _____ min. — MC = _____ % v/v

$$q_m = \frac{5.67\ V_{mstd}\ (t_m + 460)}{\theta\ (P_b + P_g/13.6)(100 - MC)}$$

$$q_a = \frac{5.67 \times (\_\_\_\_\_) \times (\_\_\_\_\_ + 460)}{(\_\_\_\_) \times (\_\_\_\_\_ + \_\_\_\_\_ / 13.6) \times (100 - \_\_\_\_\_)} = \_\_\_\_\_ \text{ acfm}$$

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Extrapolation of 50% Cut Point for Impactor (um)

Stage No.	300 °F	360 °F	500 °F
7	.34	.36	.375
6	.60	.64	.67
5	.96	1.01	1.04
4	1.50	1.57	1.61
3	2.45	2.57	2.65
2	3.90	4.2	4.4
1	6.2	6.62	6.9
P.I.	9.8	9.98	10.1

Test No. 5
Unit 2 Stack

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

Date of run	Run 1 03-26-88	Run 2 03-26-88	Run 3 03-26-88
Dry basis (orsat)			
carbon dioxide.....	12.00	12.39	12.15
oxygen.....	8.03	7.74	7.85
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	79.97	79.87	80.00
Wet basis (orsat)			
carbon dioxide.....	10.08	10.47	10.08
oxygen.....	6.74	6.54	6.51
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	67.15	67.49	66.37
water vapor.....	16.03	15.50	17.03
Dry molecular weight.....	30.24	30.29	30.26
Wet molecular weight.....	28.28	28.39	28.17
Specific gravity.....	0.977	0.981	0.973
FD	1.073	1.062	1.074

Test No. 5
Unit 2 Stack

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

	Run 4
Date of run	03-26-88
Dry basis (orsat)	
carbon dioxide.....	12.24
oxygen.....	7.96
carbon monoxide.....	0.00
nitrogen.....	79.80
Wet basis (orsat)	
carbon dioxide.....	10.38
oxygen.....	6.75
carbon monoxide.....	0.00
nitrogen.....	67.66
water vapor.....	15.22
Dry molecular weight.....	30.28
Wet molecular weight.....	28.41
Specific gravity.....	0.981

FO 1.057

Test No. 5
Unit 2 Stack

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

	Run 1	Run 2	Run 3
Date of run	03-26-88	03-26-88	03-26-88
Time run start/end.....(HRS)	1015/1253	1325/1533	1620/1830
Static pressure.....(IN.WC)	-0.50	-0.50	-0.50
Cross sectional area (SQ.FT)	72.45	72.45	72.45
Pitot tube coefficient.....	.840	.840	.840
Water in sample gas			
condenser.....(ML)	154.0	153.0	167.0
impingers.....(GRAMS)	0.0	0.0	0.0
desiccant.....(GRAMS)	63.0	55.0	66.0
total.....(GRAMS)	217.0	208.0	233.0
Total particulate material..			
.....:collected(grams)	0.1374	0.0402	0.0404
Gas meter coefficient.....	0.9980	0.9980	0.9980
Barometric pressure..(IN.HG)	28.85	28.85	28.85
Avg. orif.pres.drop..(IN.WC)	0.75	0.75	0.76
Avg. gas meter temp..(DEF-F)	107.2	110.8	114.1
Volume through gas meter....			
at meter conditions...(CF)	59.65	59.92	60.30
standard conditions.(DSCF)	53.52	53.42	53.45
Total sampling time....(MIN)	120.00	120.00	120.00
Nozzle diameter.....(IN)	.353	.353	.353
Avg.stack gas temp ..(DEG-F)	367	355	357
Volumetric flow rate.....			
actual.....(ACFM)	88962	88129	88570
dry standard.....(DSCFM)	45911	46463	45741
Isokinetic variation.....(%)	103.6	102.2	103.9
Particulate concentration...			
actual.....(GR/ACF)	0.02044	0.00612	0.00602
dry standard.....(GR/DSCF)	0.03962	0.01161	0.01166
Particle mass rate...(LB/HR)	15.59	4.62	4.57

Test No. 5
Unit 2 Stack

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

	Run 4
Date of run	03-26-88
Time run start/end.....(HRS)	1925/2135
Static pressure.....(IN.WC)	0.00
Cross sectional area (SQ.FT)	72.45
Pitot tube coefficient.....	.840
Water in sample gas	
condenser.....(ML)	144.0
impingers.....(GRAMS)	0.0
desiccant.....(GRAMS)	60.0
total.....(GRAMS)	204.0
Total particulate material..	
.....collected(grams)	0.0000
Gas meter coefficient.....	0.9980
Barometric pressure..(IN.HG)	28.85
Avg. orif.pres.drop..(IN.WC)	0.76
Avg. gas meter temp..(DEF-F)	114.2
Volume through gas meter....	
at meter conditions...(CF)	60.39
standard conditions.(DSCF)	53.52
Total sampling time....(MIN)	120.00
Nozzle diameter.....(IN)	.353
Avg.stack gas temp ..(DEG-F)	355
Volumetric flow rate.....	
actual.....(ACFM)	88097
dry standard.....(DSCFM)	46598
Isokinetic variation.....(%)	102.1
Particulate concentration...	
actual.....(GR/ACF)	0.00000
dry standard.....(GR/DSCF)	0.00000
Particle mass rate...(LB/HR)	0.00

APPENDIX F

ACID GASES FIELD DATA SHEETS

INTERPOLL LABORATORIES EPA METHOD 2 FIELD DATA SHEET

Job: NSP RED WING

Source: UNIT 2 STACK

Test: 2 Run: 1 Date: 3-24-88

Stack dimen.: 115.25 IN.

Dry bulb: ______ deg-F

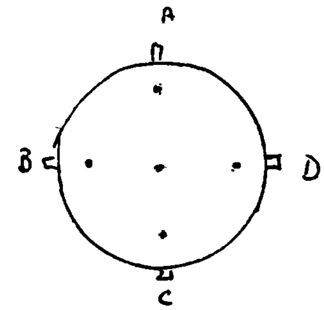
Wet bulb: ______ deg-F

Barometric pressure: 28.75 in Hg

Static pressure: ______ in WC

Operators: J BURESH

Pitot No.: ______ Cp: .840



Schematic of Cross Section

3 points 1/6, 3/6, 5/6 Diameter of stack

Traverse Point No.	Fraction of Diameter	Distance from Stack Wall (in)	Distance from End of Port (in)	Velocity Pressure (in WC)	Temperature of gas (deg-F)
		Port length: 18 in.		Time start: hrs	
1	0.33	19.21	37.21		
2	0.50	57.62	75.62		
3	0.83	96.04	114.04		
Temp. measure device:				Time end: hrs	

S-392

CF-012

INTERPOLL LABORATORIES EPA METHOD 4 AND 6 FIELD DATA SHEET

Job NSP REDWING
Source Unit 2 Stack
Date 3-24-88 Test 2 Run 1

Operator(s) JB + TJ
Meter Box No. 6 Gasmeter coef. 1.0002
Barometric Pressure 28.96 in.Hg

Sample Train Leak Check:
Pretest: < 0.02 cfm at 15 in. Hg. ☒
Posttest: _____ cfm at ____ in. Hg. ☐

Trav. Point No.	Samp. Time (min)	Sample Volume (cf)	Orif. Meter (inWC)	VAC. inHg	Temperatures (°F)					Oxygen
					Probe	Oven	Impg.	Gas/In	Gas/Out	(%v/v)
	1000	903.20								
B-2	5	906.93	1.87	6.3	248	255	54	67	64	7.4
2	10	910.68	1.87	6.1	250	255	55	68	63	8.1
2	15	914.14	1.87	6.6	250	260	54	72	63	9.0
2	20	917.72	1.87	6.8	250	260	54	75	63	9.3
B 1	25	921.40	1.87	7.0	250	260	55	78	64	6.8
1	30	924.99	1.87	7.0	250	260	55	79	64	8.1
1	35	928.67	1.87	7.0	250	260	55	81	65	7.5
1	40	932.37	1.87	7.0	250	255	54	82	66	9.2
D 1	45	936.13	1.87	7.0	250	250	53	80	68	8.1
	θ=	V_m=	^H=					$(t_m)_{avg.}$=		

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impingers	555	495	60
Condenser			
Desiccant	1362	1315	47
			107

Preliminary results of SO2 concentration determination	
Vstd =	DSCF
Moisture =	%v/v
SO2, dry =	ppm
SO2, wet =	ppm
LB/MMBtu =	

CF-019

INTERPOLL LABORATORIES EPA METHOD 4 AND 6 FIELD DATA SHEET

Job NSP RED WING
Source UNIT 2 STACK
Date 3-24-88 Test 2 Run 1

Operator(s) JB+TJ
Meter Box No. 6 Gasmeter coef. 1.0002
Barometric Pressure 28.76 in.Hg

Sample Train Leak Check:
Pretest: < 0.02 cfm at 15 in. Hg. ☑
Posttest: 0.00 cfm at 10 in. Hg. ☑

Trav. Point No.	Samp. Time (min)	Sample Volume (cf)	Orif. Meter (inWC)	VAC. inHg	Temperatures (°F)					Oxygen (%v/v)
					Probe	Oven	Impg.	Gas/In	Gas/Out	
0 1	50	939.85	1.87	7.0	250	255	54	84	68	9.2
1	55	943.51	1.87	7.0	250	255	54	85	69	8.0
1	60	947.17	1.87	7.0	250	255	53	85	69	7.5
	(1103)									
	θ= 60	V_m= 43.97	$\sqrt{\Delta H}$= 1.87					$(t_m)_{avg.}$= 71.75		

Condensate Data:

Item	Weight (g)		
	Final	Tare	Difference
Impingers			
Condenser			
Desiccant			

Preliminary results of SO2 concentration determination	
Vstd =	DSCF
Moisture =	%v/v
SO2, dry =	ppm
SO2, wet =	ppm
LB/MMBtu =	

CF-019

INTERPOLL LABORATORIES EPA METHOD 4 AND 6 FIELD DATA SHEET

Job NSP REDWING
Source UNIT 2 STACK
Date 3-24-88 Test 2 Run 2

Operator(s) JB+TJ
Meter Box No. 6 Gasmeter coef. 1.0002
Barometric Pressure 28.76 in.Hg

Sample Train Leak Check:
Pretest: < 0.02 cfm at 15 in. Hg. ☑
Posttest: _____ cfm at _____ in. Hg. ☐

Trav. Point No.	Samp. Time (min)	Sample Volume (cf)	Orif. Meter (inWC)	VAC. inHg	Temperatures (°F)					Oxygen
					Probe	Oven	Impg.	Gas/In	Gas/Out	(%v/v)
	(1115)	947.30								
C 2	5	950.81	1.87	6.3	250	254	50	80	70	7.1
2	10	954.42	1.87	6.4	250	255	51	84	70	6.3
2	15	958.60	1.87	6.5	260	255	51	84	70	7.5
2	20	962.40	1.87	6.5	260	254	51	84	70	8.2
C 1	25	965.90	1.87	6.5	260	255	51	85	70	7.3
1	30	969.60	1.87	6.5	260	255	52	84	71	7.1
1	35	973.60	1.87	6.5	260	255	52	84	71	7.3
1	40	977.50	1.87	6.5	258	255	52	85	72	5.0
A 1	45	981.17	1.87	6.5	258	250	52	83	71	6.5
	θ=	V_m=	^H=					$(t_m)_{avg.}$=		

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impingers	606	496	110
Condenser			
Desiccant	1362	1342	20
			130

Preliminary results of SO2 concentration determination	
Vstd =	DSCF
Moisture =	%v/v
SO2, dry =	ppm
SO2, wet =	ppm
LB/MMBtu =	

CF-019

INTERPOLL LABORATORIES EPA METHOD 4 AND 6 FIELD DATA SHEET

Job NSP RED WING
Source UNIT 2 STACK
Date 3-24-88 Test 2 Run 2

Operator(s) JB + TJ
Meter Box No. 6 Gasmeter coef. 1.0002
Barometric Pressure 28.76 in.Hg

Sample Train Leak Check:
Pretest: < 0.02 cfm at 15 in. Hg. ☑
Posttest: 0.00 cfm at 8 in. Hg. ☑

Trav. Point No.	Samp. Time (min)	Sample Volume (cf)	Orif. Meter (inWC)	VAC. inHg	Temperatures (°F) Probe	Oven	Impg.	Gas/In	Gas/Out	Oxygen (%v/v)
								83	71	6.2
1	50	985.07	1.87	6.5	250	250	51	84	71	10.3
1	55	988.60	1.87	6.5	255	255	52	84	72	
1	60	992.34	1.87	6.5	255	255	53			
	(1216)									
	Θ=60	V_m= 4/5.04	ΔH= 1.87					$(t_m)_{avg.}$ = 77.21		

Condensate Data:

Item	Weight(g) Final	Tare	Difference
Impingers			
Condenser			
Desiccant			

Preliminary results of SO2 concentration determination	
Vstd =	DSCF
Moisture =	%v/v
SO2, dry =	ppm
SO2, wet =	ppm
LB/MMBtu =	

CF-015

S-287RR a

INTERPOLL LABORATORIES EPA METHOD 4 AND 6 FIELD DATA SHEET

Job NSP REDWING
Source UNIT 2 STACK
Date 3-24-88 Test 2 Run 3

Operator(s) JB+TJ
Meter Box No. 6 Gasmeter coef. 1.0002
Barometric Pressure 28.76 in.Hg

Sample Train Leak Check:
Pretest: < 0.02 cfm at 15 in. Hg. ☑
Posttest: _____ cfm at ____ in. Hg. ☐

Trav. Point No.	Samp. Time (min)	Sample Volume (cf)	Orif. Meter (inWC)	VAC. inHg	Temperatures (°F)					Oxygen (%v/v)
					Probe	Oven	Impg.	Gas/In	Gas/Out	
	1232	992.20								
C 2	5	996.01	1.87	6.3	245	255	50	78	72	7.1
2	10	999.91	1.87	6.2	250	255	51	81	72	7.4
2	15	1003.70	1.87	6.2	245	255	51	84	72	7.0
2	20	1007.46	1.87	6.4	245	250	51	83	72	7.4
C 1	25	1011.21	1.87	6.5	245	250	51	85	72	8.0
1	30	1015.02	1.87	6.5	250	255	52	85	72	7.2
1	35	1018.63	1.87	6.5	255	260	52	86	73	7.0
1	40	1022.32	1.87	6.5	255	260	53	87	74	7.4
A 1	45	1026.01	1.87	6.5	255	260	53	87	74	8.0
	θ=	V_m=	^H=					$(t_m)_{avg.}$=		

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impingers			
Condenser			
Desiccant			

Preliminary results of SO2 concentration determination	
Vstd =	DSCF
Moisture =	%v/v
SO2, dry =	ppm
SO2, wet =	ppm
LB/MMBtu =	

CF-019

INTERPOLL LABORATORIES EPA METHOD 4 AND 6 FIELD DATA SHEET

Job USP REDWING
Source UNIT 2
Date 3-24-88 Test 2 Run 3

Operator(s) JB+TJ
Meter Box No. 6 Gasmeter coef. 1.0002
Barometric Pressure 28.76 in.Hg

Sample Train Leak Check:
Pretest: < 0.02 cfm at 15 in. Hg. ☑
Posttest: 0.00 cfm at 8 in. Hg. ☑

Trav. Point No.	Samp. Time (min)	Sample Volume (cf)	Orif. Meter (inWC)	VAC. inHg	Temperatures (°F) Probe	Oven	Impg.	Gas/In	Gas/Out	Oxygen (%v/v)
										7.8
1	50	1029.73	1.87	6.6	255	260	53	88	74	
1	55	1033.43	1.87	6.8	255	260	53	89	75	8.2
1	60	1037.14	1.87	6.9	255	260	54	89	75	8.0
	(1333)									
	θ= 60	V_m= 4494	^H= 1.87					$(t_m)_{ave}$ = 79.13		

Condensate Data:

Item	Weight(g) Final	Tare	Difference
Impingers	615	494	121
Condenser			
Desiccant	1421	1389	32
			153

Preliminary results of SO2 concentration determination	
Vstd =	DSCF
Moisture =	%v/v
SO2, dry =	ppm
SO2, wet =	ppm
LB/MMBtu =	

CF-019

APPENDIX G

METHOD 7 FIELD DATA SHEET

Interpoll Laboratories
(612)786-6020

EPA Method 7 Sample Collection
Field Data Sheet

Job NSP Red Wing Date 3-21-88 Bar. Pressure 29.64 IN.HG.
Test Location Unit #2 Fuel Type RDF Sample Train No. 2
Stack Technician TJ Pump No. 9

No.	Test Run Point	Flask No.	Time (HRS)	Vacuum (IN.HG.)	Flask Temp. (°F)	Leak Rate <0.4 IN.HG./MIN.
1	1-1-A	1	1618	28.60	44°	☒ Yes ☐ No
2	1-1-B	2	1643	28.50	42°	☒ Yes ☐ No
3	1-1-C	3	1700	28.50	42°	☒ Yes ☐ No
4	1-1-D	4	1715	28.50	42°	☒ Yes ☐ No
5	1-2-A	5	1800	28.40	42°	☒ Yes ☐ No
6	1-2-B	6	1815	28.30	42°	☒ Yes ☐ No
7	1-2-C	43	1830	28.40	44°	☒ Yes ☐ No
8	1-2-D	44	1845	28.40	44°	☒ Yes ☐ No
9	1-3-A	45	1900	28.50	44°	☒ Yes ☐ No
10	1-3-B	46	1915	28.40	44°	☒ Yes ☐ No
11	1-3-C	47	1930	28.40	44°	☒ Yes ☐ No
12	1-3-D	48	1945	28.40	44°	☒ Yes ☐ No
13	Blank	79				☐ Yes ☐ No
14	Blank	80				☐ Yes ☐ No
15						☐ Yes ☐ No
16						☐ Yes ☐ No
17						☐ Yes ☐ No
18						☐ Yes ☐ No
19						☐ Yes ☐ No
20						☐ Yes ☐ No
21						☐ Yes ☐ No
22						☐ Yes ☐ No
23						☐ Yes ☐ No
24						☐ Yes ☐ No
25						☐ Yes ☐ No
26						☐ Yes ☐ No
27						☐ Yes ☐ No

APPENDIX H

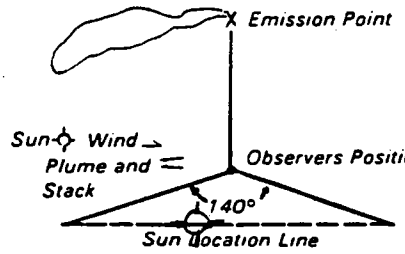
METHOD 9 FIELD DATA SHEETS

Interpoll Inc.
(612)786-6020

Visible Emissions Form

SOURCE NAME: NSP / REDWING
ADDRESS:
CITY: REDWING | STATE: MN | ZIP:
PHONE: | SOURCE ID NUMBER: UNIT 2 BOILER
PROCESS EQUIPMENT: | OPERATING MODE: 100%
CONTROL EQUIPMENT: ESP | OPERATING MODE: 100%
DESCRIBE EMISSION POINT: START STACK EXIT STOP SAME
HEIGHT ABOVE GROUND LEVEL: START 200' STOP 200' | HEIGHT RELATIVE TO OBSERVER: START 600' STOP 600'
DISTANCE FROM OBSERVER: START 400' STOP 400' | DIRECTION FROM OBSERVER: START NE STOP SAME
DESCRIBE EMISSIONS: START LOOPING STOP SAME
EMISSION COLOR: START GRAY STOP SAME | PLUME TYPE: CONTINUOUS ☐ FUGITIVE ☐ INTERMITTENT ☑
WATER DROPLETS PRESENT: NO ☑ YES ☐ | IF WATER DROPLET PLUME: ATTACHED ☐ DETACHED ☐
POINT IN THE PLUME AT WHICH OPACITY WAS DETERMINED: START STACK EXIT STOP SAME
DESCRIBE BACKGROUND: START SKY STOP SAME
BACKGROUND COLOR: START LT. BLUE STOP SAME | SKY CONDITIONS: START PTLY CLDY STOP
WIND SPEED: START 10 STOP 10 | WIND DIRECTION: START E STOP E
AMBIENT TEMP: START 42 STOP 42 | WET BULB TEMP: | RH percent:

Source Layout Sketch — Draw North Arrow



OBSERVATION DATE: 3-21-88 | START TIME: 1610 | STOP TIME: 1710

MIN \ SEC	0	15	30	45	MIN \ SEC	0	15	30	45
1	0	5	0	0	31	5	5	5	5
2	0	0	0	0	32	0	5	5	5
3	0	5	0	5	33	5	0	5	0
4	0	0	0	0	34	0	0	5	0
5	0	10	0	0	35	5	5	0	0
6	0	0	10	0	36	5	0	5	5
7	0	0	0	0	37	0	0	0	0
8	10	10	5	0	38	0	5	0	0
9	0	0	0	0	39	0	0	0	5
10	0	0	10	0	40	0	0	5	0
11	0	0	0	0	41	0	0	0	0
12	10	0	0	0	42	0	0	0	0
13	0	5	5	5	43	0	0	0	0
14	0	5	10	10	44	5	5	5	5
15	5	5	5	5	45	5	5	5	5
16	10	5	0	0	46	5	5	5	5
17	0	5	5	0	47	0	5	5	5
18	5	0	0	0	48	0	0	0	0
19	0	5	5	0	49	0	0	0	0
20	0	0	0	0	50	5	5	0	0
21	5	5	0	0	51	0	0	0	0
22	0	0	0	0	52	5	0	0	5
23	0	0	0	0	53	0	5	0	0
24	0	0	0	0	54	0	5	5	0
25	10	10	5	10	55	0	0	0	0
26	10	10	10	10	56	5	5	0	0
27	5	5	5	5	57	0	0	0	0
28	10	10	10	10	58	0	0	0	0
29	5	5	0	0	59	0	0	0	0
30	0	0	0	0	60	0	0	0	0

AVERAGE OPACITY FOR HIGHEST PERIOD: 10
NUMBER OF READINGS ABOVE 5 % WERE: 12
RANGE OF OPACITY READINGS: 0 MINIMUM 10 MAXIMUM
OBSERVER'S NAME (PRINT): Curtis Mosser
OBSERVER'S SIGNATURE: Curtis Mosser | DATE: 3-21-88
ORGANIZATION: Interpoll Labs
CERTIFIED BY: MACA | DATE: 10-21-87
VERIFIED BY: | DATE:

COMMENTS:

I HAVE RECEIVED A COPY OF THESE OPACITY OBSERVATIONS
SIGNATURE | TITLE | DATE

S-0079R

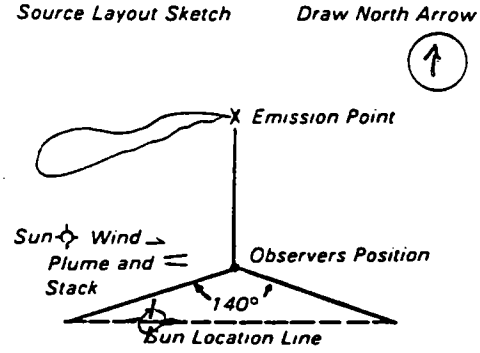
Interpoll Inc.
(612)786-6020

Visible Emissions Form

SOURCE NAME: NSP / REDWING	OBSERVATION DATE: 3-21-88	START TIME: 1730
ADDRESS:		STOP TIME: 1800
CITY: REDWING	STATE: MN	ZIP:
PHONE:	SOURCE ID NUMBER: UNIT 2 BOILER	
PROCESS EQUIPMENT:	OPERATING MODE: 100%	
CONTROL EQUIPMENT: ESP	OPERATING MODE: 100%	
DESCRIBE EMISSION POINT: START Stack Exit STOP		
HEIGHT ABOVE GROUND LEVEL: START 200' STOP 200'	HEIGHT RELATIVE TO OBSERVER: START 600' STOP 600'	
DISTANCE FROM OBSERVER: START 400' STOP 400'	DIRECTION FROM OBSERVER: START NE STOP Same	
DESCRIBE EMISSIONS: START Looping STOP Same		
EMISSION COLOR: START Gray STOP Same	PLUME TYPE: CONTINUOUS ☐ FUGITIVE ☐ INTERMITTENT ☑	
WATER DROPLETS PRESENT: NO ☑ YES ☐	IF WATER DROPLET PLUME: ATTACHED ☐ DETACHED ☐	
POINT IN THE PLUME AT WHICH OPACITY WAS DETERMINED: START Stack Exit STOP Same		
DESCRIBE BACKGROUND: START SKY STOP Same		
BACKGROUND COLOR: START Lt. Blue STOP Same	SKY CONDITIONS: START Clear STOP Same	
WIND SPEED: START 10 STOP 10	WIND DIRECTION: START E STOP E	
AMBIENT TEMP: START 38 STOP 38	WET BULB TEMP:	RH percent:

SEC / MIN	0	15	30	45	SEC / MIN	0	15	30	45
1	0	0	0	0	31				
2	0	0	0	0	32				
3	0	0	5	0	33				
4	0	0	0	0	34				
5	5	0	5	5	35				
6	0	5	0	0	36				
7	5	5	0	0	37				
8	0	0	5	0	38				
9	0	0	0	0	39				
10	0	0	0	0	40				
11	5	0	0	5	41				
12	5	5	0	0	42				
13	0	0	0	0	43				
14	0	0	5	0	44				
15	0	0	0	0	45				
16	0	5	0	0	46				
17	0	0	5	5	47				
18	5	0	0	0	48				
19	5	5	0	0	49				
20	0	0	0	0	50				
21	5	5	5	0	51				
22	5	5	0	0	52				
23	0	0	0	0	53				
24	0	5	5	0	54				
25	0	0	5	5	55				
26	0	0	0	0	56				
27	0	0	5	0	57				
28	0	0	0	0	58				
29	0	5	5	0	59				
30	0	0	0	0	60				

Source Layout Sketch — Draw North Arrow



AVERAGE OPACITY FOR HIGHEST PERIOD	NUMBER OF READINGS ABOVE % WERE
RANGE OF OPACITY READINGS: MINIMUM	MAXIMUM
OBSERVER'S NAME (PRINT): Curtis Mosser	
COMMENTS: TOO DARK TO GET AN ACCURATE READING	OBSERVER'S SIGNATURE: Curtis Mosser — DATE: 3/21/88
	ORGANIZATION:
I HAVE RECEIVED A COPY OF THESE OPACITY OBSERVATIONS SIGNATURE	CERTIFIED BY: MPCA — DATE: 10-21-88
TITLE — DATE	VERIFIED BY — DATE

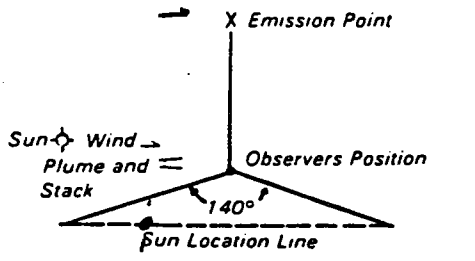
S-0079R

Interpoll Inc.
(612)786-6020

Visible Emissions Form

SOURCE NAME	NSP RED WING
ADDRESS	Redw
CITY	Red Wing
STATE	Minn
ZIP	
PHONE	
SOURCE ID NUMBER	
PROCESS EQUIPMENT	RDF Boiler
OPERATING MODE	+90%
CONTROL EQUIPMENT	ESP
OPERATING MODE	
DESCRIBE EMISSION POINT START	One Dia. above stack
DESCRIBE EMISSION POINT STOP	Same
HEIGHT ABOVE GROUND LEVEL START	150'
HEIGHT ABOVE GROUND LEVEL STOP	Same
HEIGHT RELATIVE TO OBSERVER START	150'
HEIGHT RELATIVE TO OBSERVER STOP	Same
DISTANCE FROM OBSERVER START	500'
DISTANCE FROM OBSERVER STOP	Same
DIRECTION FROM OBSERVER START	NE
DIRECTION FROM OBSERVER STOP	Same
DESCRIBE EMISSIONS START	Invisible
DESCRIBE EMISSIONS STOP	
EMISSION COLOR START	Clear
EMISSION COLOR STOP	Same
PLUME TYPE: CONTINUOUS ☐	
FUGITIVE ☐ INTERMITTENT ☐	
WATER DROPLETS PRESENT: NO ☒ YES ☐	
IF WATER DROPLET PLUME: ATTACHED ☐ DETACHED ☐	
POINT IN THE PLUME AT WHICH OPACITY WAS DETERMINED START	
POINT IN THE PLUME AT WHICH OPACITY WAS DETERMINED STOP	
DESCRIBE BACKGROUND START	Clear & Partly cloudy
DESCRIBE BACKGROUND STOP	
BACKGROUND COLOR START	White
BACKGROUND COLOR STOP	
SKY CONDITIONS START	P.C.
SKY CONDITIONS STOP	
WIND SPEED START	30
WIND SPEED STOP	Same
WIND DIRECTION START	NW
WIND DIRECTION STOP	Same
AMBIENT TEMP START	50
AMBIENT TEMP STOP	50
WET BULB TEMP	
RH percent	

Source Layout Sketch — Draw North Arrow



OBSERVATION DATE	START TIME	STOP TIME
3-25-85	13-15	1745

SEC / MIN	0	15	30	45	SEC / MIN	0	15	30	45
1	0	0	0	0	31	0	0	0	0
2	0	0	0	0	32	0	0	0	0
3	0	0	0	0	33	0	0	0	0
4	0	0	0	0	34	0	0	0	0
5	0	0	0	0	35	0	0	0	0
6	0	0	0	0	36	0	0	0	0
7	0	0	0	0	37	0	0	0	0
8	0	0	0	0	38	0	0	0	0
9	0	0	0	0	39	0	0	0	0
10	0	0	0	0	40	0	0	0	0
11	0	0	0	0	41	0	0	0	0
12	0	0	0	0	42	0	0	0	0
13	0	0	0	0	43	0	0	0	0
14	0	0	0	0	44	0	0	0	0
15	0	0	0	0	45	0	0	0	0
16	0	0	0	0	46	0	0	0	0
17	0	0	0	0	47	0	0	0	0
18	0	0	0	0	48	0	0	0	0
19	0	0	0	0	49	0	0	0	0
20	0	0	0	0	50	0	0	0	0
21	0	0	0	0	51	0	0	0	0
22	0	0	0	0	52	0	0	0	0
23	0	0	0	0	53	0	0	0	0
24	0	0	0	0	54	0	0	0	0
25	0	0	0	0	55	0	0	0	0
26	0	0	0	0	56	0	0	0	0
27	0	0	0	0	57	0	0	0	0
28	0	0	0	0	58	0	0	0	0
29	0	0	0	0	59	0	0	0	0
30	0	0	0	0	60	0	0	0	0

AVERAGE OPACITY FOR HIGHEST PERIOD	0
NUMBER OF READINGS ABOVE	20
% WERE	0
RANGE OF OPACITY READINGS MINIMUM	0
RANGE OF OPACITY READINGS MAXIMUM	0
OBSERVER'S NAME (PRINT)	John F. Burgess
OBSERVER'S SIGNATURE	John F. Burgess
DATE	3-25-85
ORGANIZATION	INTERPOLL
CERTIFIED BY	MPCA
DATE	10-87
VERIFIED BY	
DATE	

COMMENTS: No Plume, No opacity

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SIGNATURE
TITLE
DATE

S-0079R

APPENDIX I

FIELD DATA SHEETS FOR METALS SAMPLING TRAIN

INTERPOLL LABORATORIES EPA METHOD 2 FIELD DATA SHEET

Job NSP REDWING

Source Unit 2 INLET TO ESP

Test 3 Run 1 Date 3-22-88

Stack dimen. 66 x 53 IN.

Dry bulb _____ deg-F

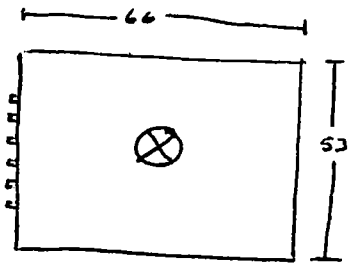
Wet bulb _____ deg-F

Barometric pressure 29.19 in Hg

Static pressure -6.5 in WC

Operators J BURESH + THORAU + D. SMITH

Pitot No. U16-6 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 (deg-F)
		Port length:	in.	Time start:	hrs
A - 1		4.71	22.71	.50	
2		14.13	32.13	.64	
3		23.72	41.72	.65	
4		33.14	51.14	.72	
5		42.56	60.56	.68	
6		51.98	69.98	.69	
7		61.40	79.40	.67	
Temp. measure device:				Time end:	hrs

INTERPOLL LABORATORIES EPA METHOD 5/17 SAMPLE LOG SHEET

Job NSP REDWING Date 3-22-88 Test 1 3 Run 1
Source UNIT 2 No. of traverse points 42
Method 4M5 Filter holder: GLASS Filter type: G.F. FILTER

Sample Train Leak Check:

Pretest: ≤ 0.02 cfm at 15 in. Hg. (vac) ☑
Postest: 0.00 cfm at 8 in. Hg. (vac) ☐

Particulate Catch Data:

No.s of filters used: 0081

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

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

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impinger No. 1	632	498	134
Impinger No. 2			
Impinger No. 3	307	306	1
Condenser			
Desiccant	1343	1334	9
Total			144

Integrated Gas Sampling Data:

Bag Pump No. 38 Box No. 8 Bag No. 1
Bag Material: 5-layer Aluminized Tedlar Size: 44 L
Pretest leak check: 0.00 cc/min at 15 in. Hg.
Time start: 6946 (HRS) Time end: _____ (HRS)
Sampling rate: 600 cc/min Operator: JB
S/N of O_2 Analyzer used to monitor train outlet: 5

CF-023

S-0046RR

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job NSP REDWING
Source UNIT 2 ESP INLET
Date 3-22-88 Test 2 Run 1

Operators JB + DS + TH
Meter Box No. 9
Coeff. 1.0021

Pitot No. VL-6 Cp .840
Bar. Press. 29.17 inHg H2O 1.5 X
Nozzle No. 4-4 Nozzle Dia .354 IN.

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dec. Vol. (cf)	VAC. inHg	Temperatures (°F) Stack	Probe	Oven	Impg.	Gas/In	Gas/Out	Oxygen (x v/v)
	0947	534.80											
A - 7	1.5	535.79	.67	1.43	5.79	4.5	406	250	240	50	88	79	7.6
6	3	536.80	.69	1.48	6.80	4.5	407			50	90	79	7.6
5	4.5	537.81	.68	1.47	7.81	4.5	407				91	78	8.1
4	6	538.84	.72	1.55	8.84	4.5	409				92	79	7.3
3	7.5	539.83	.65	1.40	9.83	4.4	412	250	250	58	93	80	6.3
2	9	540.80	.64	1.37	0.80	4.3	414				94	80	3.8
1	10.5	541.67	.50	1.07	1.67	4.0	413				94	80	6.4
B 7	12	542.63	.61	1.32	2.63	4.1	408	250	250	55	94	80	8.0
6	13.5	543.58	.60	1.29	3.58	4.1	410				95	80	7.5
5	15	544.59	.68	1.46	4.59	4.7	414				95	80	4.1
4	16.5	545.66	.77	1.65	5.66	5.1	416			56	96	80	5.8
3	18	546.60	.59	1.26	6.60	4.0	417				97	81	6.6
2	19.5	547.55	.60	1.29	7.55	4.1	416				97	81	2.9
1	21	548.45	.54	1.16	8.45	3.8	417				97	81	3.4
C 7	22.5	549.35	.54	1.16	9.35	3.8	417	250	250	55	97	82	7.4
6	24	550.28	.57	1.24	0.28	4.1	410				98	82	10.7
5	25.5	551.25	.62	1.35	1.25	4.6	409				98	82	7.9
4	27	552.23	.64	1.39	2.23	4.9	409				98	82	5.6
3	28.5	553.20	.61	1.32	3.20	4.7	409	250	250		98	82	7.1
2	30	554.21	.68	1.47	4.21	5.0	410			54	98	82	7.2
1	31.5	555.12	.54	1.17	5.12	4.4	410				98	82	6.2
D 7	33	556.04	.56	1.22	6.04	4.5	406				98	82	7.4
6	34.5	556.93	.51	1.11	6.93	4.5	407				98	82	10.4
5	36	557.91	.64	1.39	7.91	5.0	409				99	83	9.1
	θ =	Vm =		ΔH =							Avg. =		

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job NSP RED WING
Source Un. 2 INLET TO ESP
Date 3-22-88 Test 3 Run 1

Operators JB - DS - TH
Meter Box No. 9
Coeff. 1.0021

Pitot No. V16-6 Cp .84
Bar. Press. 29.19 inHg H2O 15 X
Nozzle No. 4-4 Nozzle Dia .454 IN.

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dev. Vol. (cf)	VAC. inHg	Temperatures (°F)						Oxygen
							Stack	Probe	Oven	Impg.	Gas/In	Gas/Out	(xx/x)
		(557.91)											
4	31.5	558.89	.62	1.35	8.89	4.9	408	250	250	52	100	84	11.2
3	39	559.84	.59	1.29	9.84	4.2	407			51	95	86	9.2
2	40.5	560.83	.65	1.42	0.83	5.0	407				96	86	5.5
1	42	561.74	.54	1.18	1.74	4.2	407				97	86	8.1
E 7	43.5	562.61	.49	1.07	2.61	4.0	410	260	250	55	98	86	4.8
6	45	563.49	.51	1.11	3.49	4.2	410				99	87	4.6
5	46.5	564.35	.48	1.05	4.35	4.0	410				100	87	4.7
4	48	565.25	.53	1.16	5.25	4.2	410				100	87	6.6
3	49.5	566.20	.58	1.26	6.20	5.0	414	250	260	52	101	87	8.3
2	51	567.18	.63	1.37	7.18	5.3	415				101	87	4.7
1	52.5	568.14	.61	1.33	8.14	5.1	415				102	88	5.5
P 7	54	568.99	.45	.99	8.99	4.3	409				102	88	9.7
6	55.5	569.82	.46	1.00	9.82	4.3	413	250	255	52	102	88	5.0
5	57	570.76	.57	1.24	0.76	5.3	414				103	88	6.4
4	58.5	571.71	.59	1.29	1.71	5.4	414				104	88	9.3
3	60	572.64	.56	1.22	2.64	5.3	414				104	88	9.3
2	61.5	573.52	.50	1.09	3.52	5.0	414	250	250	53	104	88	8.2
1	63	574.37	.47	1.03	4.37	4.7	414				104	88	5.8
	(1143)												
	θ = 63	Vm = 39.57		ΔH = 1.27							Avg. = 90.6		

INTERPOLL LABORATORIES EPA METHOD 5/17 SAMPLE LOG SHEET

Job NSP RED WING Date 3-22-88 Test 3 Run 2
Source UNIT 2 ESP INLET No. of traverse points 42
Method 4M 5 Filter holder: Glass Filter type: GF Filter

Sample Train Leak Check:

Pretest: 0.02 cfm at 15 in. Hg. (vac) ☑
Postest: 0.00 cfm at 8 in. Hg. (vac) ☑

Particulate Catch Data:

No.s of filters used: 0082

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

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

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impinger No. 1	628	499	129
Impinger No. 2			
Impinger No. 3			
Condenser	306	305	1
Desiccant	1346	1339	7
Total			137

Integrated Gas Sampling Data:

Bag Pump No. 8-8 Box No. 8 Bag No. 2
Bag Material: 5-layer Aluminized Tedlar Size: 44 L
Pretest leak check: 0.00 cc/min at 16 in. Hg.
Time start: 1226 (HRS) Time end: 1334 (HRS)
Sampling rate: 600 cc/min Operator: JB
S/N of O_2 Analyzer used to monitor train outlet: 5

CF-023

S-0046RR

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job: USP RED WING
Source: UNIT 2 ESP INLET
Date: 9-22-85 Test: 2 Run: 2

Operators: JB + DS
Meter Box No.: 9
Gasmeter coeff.: 1.0021

Pitot No.: UK-6 Cp: .840
Bar. Press.: 29.19 inHg H2O 1.5 X
Nozzle No.: 4-4 Nozzle Dia: .264 IN.

Traversed Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dev. Vol. (cf)	VAC. inHg	Temperatures (°F) Stack	Probe	Oven	Impg.	Gas/In	Gas/Out	Oxygen (x v/v)
	(225)	574.60											
A-7	1.5	575.57	.62	1.35	5.57	4.0	407	250	225	53	100	92	10.5
6	3	576.57	.65	1.42	6.57	4.0	413				101	92	6.3
5	4.5	577.56	.63	1.38	7.56	4.0	414				102	92	6.5
4	6	578.57	.66	1.44	8.57	4.1	415				102	92	6.1
3	7.5	579.52	.59	1.28	9.52	4.0	420	250	230	54	103	92	5.6
2	9	580.43	.54	1.17	0.43	3.7	420				104	92	6.7
1	10.5	581.30	.48	1.04	1.30	3.4	420				104	92	8.9
B 7	12	582.20	.53	1.16	2.20	3.7	417				104	92	8.6
6	13.5	583.11	.53	1.16	3.11	3.7	417				105	92	5.6
5	15	584.05	.57	1.25	4.05	4.0	416	250	250	51	106	92	6.7
4	16.5	585.03	.62	1.36	5.03	4.2	416				106	92	6.3
3	18	586.00	.60	1.31	6.00	4.1	416				106	92	5.2
2	19.5	586.95	.58	1.27	6.95	4.0	416				106	92	5.1
1	21	587.74	.40	.87	7.71	3.0	416	250	250	52	107	93	6.2
C 7	22.5	588.64	.52	1.14	8.64	4.0	414				107	93	6.7
6	24	589.54	.51	1.12	9.54	4.0	417				108	93	5.0
5	25.5	590.40	.48	1.05	0.40	3.8	417				108	93	7.4
4	27	591.32	.53	1.16	1.32	4.0	417	250	250	53	108	94	7.5
3	28.5	592.23	.53	1.16	2.23	4.1	417				108	94	5.6
2	30	593.16	.55	1.21	3.16	4.2	417				109	94	5.2
1	31.5	594.07	.53	1.16	4.07	4.1	417				109	94	4.6
D 7	33	594.96	.50	1.10	4.96	4.0	414	250	250	53	108	94	5.6
6	34.5	595.81	.47	1.03	5.81	3.9	420				109	94	6.3
5	36	596.68	.48	1.05	6.68	4.0	420				109	94	4.9
	θ =	Vs =		^H =							Avg. =		

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job NSP REDWING
Source UNIT 2 ESP INLET
Date 3-22-88 Test 3 Run 2

Operators JB + DS + TH
Meter Box No. 9
Gasmeter coeff. 1.0021

Pitot No. V16-6 Cp .840
Bar. Press. 28.19 inHg H2O 1.5 %
Nozzle No. 4-4 Nozzle Dia .254 IN.

Traverse Point No.	Sampling Time (min)	Sample Values (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dev. Vol. (cf)	VAC. inHg	Temperatures (°F)						Oxygen
							Stack	Probe	Oven	Impg.	Gas/In	Gas/Out	(Xv/v)
		(596.68)											
4	37.5	597.52	.45	.98	7.52	3.8	420	250	250	51	110	94	6.0
3	39	598.47	.57	1.25	8.47	4.8	420				110	94	7.2
2	40.5	599.44	.60	1.31	9.44	5.0	420				110	94	6.1
1	42	600.33	.51	1.12	0.33	4.1	420				110	94	6.3
E 7	43.5	601.17	.45	.99	1.17	4.0	413	250	250	53	109	95	5.0
6	45	602.60	.43	.95	2.00	4.0	413				110	95	5.8
5	46.5	602.93	.44	.97	2.83	4.0	415				110	95	5.6
4	48	603.70	.48	1.06	3.70	4.2	415				110	95	6.9
3	49.5	604.63	.54	1.19	4.63	4.9	417	250	250	54	110	95	6.3
2	51	605.55	.54	1.19	5.55	4.9	417				110	95	7.7
1	52.5	606.44	.50	1.10	6.44	4.7	417				110	96	8.5
F 7	54	607.21	.41	.90	7.24	4.0	417				110	96	6.4
6	55.5	608.03	.39	.86	8.03	4.0	412	250	250	54	110	96	7.6
5	57	608.89	.46	1.02	8.89	4.8	412				110	96	6.6
4	58.5	609.80	.53	1.17	9.80	4.9	415				110	96	6.1
3	60	610.68	.49	1.08	0.68	4.5	415				110	96	6.4
2	61.5	611.50	.42	.93	1.50	4.1	415				110	96	7.4
1	63	612.31	.42	.93	2.31	4.1	415	250	250	53	110	96	7.2
	(1335)												
	θ = 63	Vm = 37.71		ΔH = 1.13							Avg. = 100.6		

INTERPOLL LABORATORIES EPA METHOD 5/17 SAMPLE LOG SHEET

Job NSP RED WING Date 3-22-88 Test 3 Run 3
Source UNIT 2 ESP INLET No. of traverse points 42
Method 5/17 Filter holder: Glass Filter type: G.P. Filter

Sample Train Leak Check:

Pretest: < 0.02 cfm at 15 in. Hg. (vac) ☑
Postest: 0.00 cfm at 10 in. Hg. (vac) ☐

Particulate Catch Data:

No.s of filters used: 0099

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

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

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impinger No. 1	626	499	127
Impinger No. 2			
Impinger No. 3	307	306	1
Condenser			
Desiccant	1350	1343	7
Total			135

Integrated Gas Sampling Data:

Bag Pump No. B-8 Box No. 8 Bag No. 3

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

Pretest leak check: 0.00 cc/min at 17 in. Hg.

Time start: _____ (HRS) Time end: _____ (HRS)

Sampling rate: 600 cc/min Operator: JB

S/N of O_2 Analyzer used to monitor train outlet: 5

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CF-D11

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job: NSP RED WING
Source: UNIT 2 ESP INLET
Date: 3-22-88 Test 3 Run 3

Operators: JB + TH + DS
Meter Box No. 9
Gasmeter coeff. 1.0031

Pitot No. U16-6 Cp .840
Bar. Press. 29.19 inHg H2O 1.5 X
Nozzle No. 4-4 Nozzle Dia .254 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)
	(1410)	612.60											
A - 7	1.5	613.59	.62	1.39	3.59	3.5	410	250	230	53	106	96	10.1
6	3	614.59	.64	1.41	4.59	3.8	414				106	96	6.3
5	4.5	615.60	.64	1.41	5.60	3.8	414				107	97	8.5
4	6	616.59	.63	1.39	6.59	3.8	414				108	97	8.6
3	7.5	617.55	.58	1.28	7.55	3.4	414	250	255	56	108	97	9.9
2	9	618.50	.57	1.26	8.50	3.2	414				108	97	6.7
1	10.5	619.37	.48	1.06	9.37	3.0	414				108	97	5.4
B 7	12	620.27	.51	1.13	0.27	3.5	410				109	96	9.1
6	13.5	621.18	.52	1.15	1.18	3.6	411	250	240	54	110	97	7.2
5	15	622.15	.59	1.30	2.15	4.0	416				110	97	5.1
4	16.5	623.16	.65	1.43	3.16	4.3	417				110	97	3.8
3	18	624.10	.56	1.23	4.10	4.0	417				110	97	6.0
2	19.5	625.04	.56	1.23	5.04	4.0	417				111	97	10.3
1	21	625.92	.48	1.06	5.92	3.8	417	250	245	55	111	97	7.0
C 7	22.5	626.83	.53	1.17	6.83	4.0	417				110	97	2.3
6	24	627.73	.51	1.13	7.73	3.9	412				111	97	9.1
5	25.5	628.64	.51	1.13	8.64	4.0	412				111	97	6.5
4	27	629.56	.53	1.18	9.56	4.0	412	250	247	54	111	97	7.8
3	28.5	630.49	.55	1.21	0.49	4.1	416				112	97	6.4
2	30	631.49	.63	1.39	1.49	5.0	416				112	97	6.1
1	31.5	632.33	.44	.97	2.33	4.0	416				112	97	4.9
D 7	33	633.24	.52	1.15	3.24	4.1	415				112	97	6.7
6	34.5	634.13	.50	1.11	4.13	4.2	416				112	98	7.2
5	36	634.97	.44	.97	4.97	4.0	417				112	98	6.9
	θ =	Vm =		^H =							Avg. =		

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job NSP REDWING
Source UNIT 2 ESP INLET
Date 3-29-88 Test 2 Run 3

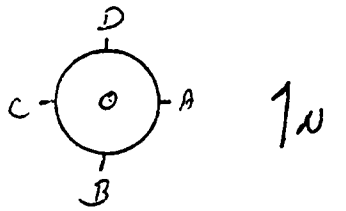
Operators JB + TH + DS
Meter Box No. 9
Cosmeter coeff. 1.0021

Pitot No. V16-6 Cp .840
Bar. Press. 29.19 inHg H2O .15 X
Nozzle No. 4-4 Nozzle Dia .354 IN.

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dec. Vol. (cf)	VAC. inHg	Temperatures (°F) Stack	Probe	Oven	Impg.	Gas/In	Gas/Out	Oxygen (%v/v)
		634.97											
4	37.5	635.79	.43	.95	5.78	3.6	415	250	240	56	113	98	7.8
3	39	636.72	.54	1.20	6.72	4.5	415				113	98	8.4
2	40.5	637.69	.59	1.31	7.69	4.8	415	250	250	56	113	98	8.4
1	42	638.64	.56	1.24	8.64	4.7	415				114	98	5.9
E 7	43.5	639.52	.48	1.06	9.51	4.3	416				113	99	6.4
6	45	640.37	.46	1.03	0.37	4.2	411				113	99	8.4
5	46.5	641.22	.44	.98	1.22	4.2	412	250	250	55	114	99	7.6
4	48	642.13	.52	1.16	2.13	4.7	412				114	99	7.4
3	49.5	643.09	.57	1.27	3.09	5.0	412				114	99	6.5
2	51	644.09	.62	1.38	4.09	5.4	412				114	99	6.3
1	52.5	644.96	.48	1.07	4.96	4.8	412				114	99	6.6
F 7	54	645.77	.40	.89	5.77	4.0	415				114	99	7.5
6	55.5	646.55	.39	.84	6.55	3.8	415	250	240	55	114	99	8.2
5	57	647.39	.44	.98	7.39	4.3	415				114	99	7.6
4	58.5	648.31	.53	1.18	8.31	5.0	415				114	99	6.7
3	60	649.18	.48	1.07	9.19	5.0	415				114	99	6.9
2	61.5	650.07	.49	1.09	0.07	5.0	415				114	99	5.0
1	63	650.93	.46	1.02	0.93	4.7	415				114	93	6.2
	(1519)												
	θ = 63	Vm = 38.33		ΔH = 1.16							Avg. =	104.6	

INTERPOLL LABORATORIES EPA METHOD 2 FIELD DATA SHEET

Job NSP/Red Wing
Source UNIT #2 STACK
Test 3 Run 1-3 Date 3-22-88
Stack dimen. 115.25 IN.
Dry bulb 380 deg-F
Wet bulb _____ deg-F
Barometric pressure 29.02 in Hg
Static pressure -.55 in WC
Operators Ron Rosenthal T.J. Johnson
Pitot No. 4-17 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 (deg-F)
		Port length:	in.	Time start:	hrs
A - 6		2.42	8.42		
5		7.80	14.80		
4		13.60	19.60		
3		20.40	26.40		
2		28.81	34.81		
1		41.03	47.03		
B 6					
5					
4					
3					
2					
1					
C 6					
5					
4					
3					
2					
1					
D - 6					
5					
4					
3					
2					
1					
Temp. measure device:				Time end:	hrs

INTERPOLL LABORATORIES EPA METHOD 5/17 SAMPLE LOG SHEET

Job NSP/Red Wing Date 3-22-88 Test 2 Run 1
Source UNIT #2 STACK No. of traverse points 24
Method 17-5 Filter holder: 4" GLASS Filter type: 4" GLASS

Sample Train Leak Check:

Pretest: ≤ 0.02 cfm at 15 in. Hg. (vac) ☒
Postest: .00 cfm at 10 in. Hg. (vac) ☐

Particulate Catch Data:

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

☒ acetone
☐ other(s)

No. of probe wash bottles:
Sample recovered by:

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impinger No. 1	643	495	148
Impinger No. 2			
Impinger No. 3	305	302	3
Condenser			
Desiccant	1385	1370	15
Total			166

1138

Integrated Gas Sampling Data:

Bag Pump No. B4 Box No. 14 Bag No. 1
Bag Material: 5-layer Aluminized Tedlar Size: 44 L
Pretest leak check: .00 cc/min at 10 in. Hg.
Time start: 945 (HRS) Time end: 1144 (HRS)
Sampling rate: 400 cc/min Operator: RR
S/N of O_2 Analyzer used to monitor train outlet: 6

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S-0046RR

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job USP/Red Wing Operators RR & T.J. Pitot No. 4-V17 Cp .84
Source Unit #2 STACK Meter Box No. 8 Bar. Press. 29.02 inHg H2O 15 x
Date 3-22-88 Test 2 Run 1 Gamma coeff. .9980 Nozzle No. 2.7 Nozzle Dia .437 IN.

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dev. Vol. (cf)	VAC. inHg	Temperatures (°F) Stack	Probe	Oven	Impg.	Gas/In	Gas/Out	Oxygen (x+/-)
	945	240.65											
B- 6	2.5	242.84	.11	2.36	2.82	7.0	340	250	250	43	109	102	9.0
5	5	244.92	.10	2.27	4.96	7.0	305			43	110	102	8.9
4	7.5	246.93	.09	2.05	6.99	7.0	305			43	111	103	8.0
3	10	248.90	.08	1.82	8.92	7.0	305	250	245	43	113	103	5.6
2	12.5	250.73	.07	1.66	0.75	6.5	277			43	114	104	8.5
1	15	252.54	.07	1.66	2.59	6.5	277			43	116	104	9.7
A- 6	17.5	254.70	.09	2.14	4.68	7.0	277	250	250	43	116	104	9.0
5	20	256.95	.10	2.35	6.87	7.0	285			45	118	104	4.3
4	22.5	258.90	.08	1.88	8.83	7.0	285			45	120	105	9.1
3	25	260.75	.07	1.65	0.67	7.0	285	250	250	45	120	106	8.9
2	27.5	262.40	.06	1.42	2.38	6.0	282			45	120	106	7.0
1	30	263.94	.05	1.19	3.94	5.5	282			45	121	106	8.9
D- 6	32.5	266.04	.10	2.37	6.14	7.5	282	250	250	45	121	106	7.8
5	35	268.15	.09	2.14	8.24	6.0	282			45	122	107	9.9
4	37.5	270.10	.07	1.67	0.09	5.5	282			55	115	108	9.0
3	40	271.84	.06	1.42	1.79	5.5	282	250	250	55	116	108	6.8
2	42.5	273.30	.05	1.21	3.37	5.0	268			55	117	108	7.3
1	45	274.94	.05	1.21	4.94	5.0	268			55	119	108	6.8
C 6	47.5	277.30	.11	2.66	7.28	8.5	268	250	250	55	119	108	8.7
5	50	279.52	.10	2.42	9.50	8.4	268			55	120	108	6.6
4	52.5	281.78	.08	1.94	1.50	7.5	268			55	121	109	10.9
3	55	283.51	.08	1.94	3.49	7.5	268	250	250	55	121	109	6.1
2	57.5	285.28	.06	1.46	5.23	6.5	268			55	122	109	10.1
1	60	287.85	.05	1.21	6.81	6.5	268			55	122	109	9.5
	θ = (1144)	Vm = 46.20		ΔH = 1.84							Avg. = 111.8		

STOP 1029
10W 1040 1115

INTERPOLL LABORATORIES EPA METHOD 5/17 SAMPLE LOG SHEET

Job NSP/Red Wing
Source Unit #2 STACK
Method 5/17-5 Filter holder: 4" glass

Date 3-22-88 Test 3 Run 2
No. of traverse points 24
Filter type: 4" glass

Sample Train Leak Check:

Pretest: < 0.02 cfm at 15 in. Hg. (vac) ☒
Postest: .00 cfm at 10 in. Hg. (vac) ☒

Particulate Catch Data:

No.s of filters used: _____ _____

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

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

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impinger No. 1	628	495	133
Impinger No. 2			
Impinger No. 3	303	302	1
Condenser			
Desiccant	1365	1349	16
Total			150

1123

Integrated Gas Sampling Data:

Bag Pump No. B4 Box No. 14 Bag No. 2
Bag Material: 5-layer Aluminized Tedlar Size: 44 L
Pretest leak check: .00 cc/min at 10 in. Hg.
Time start: 1225 (HRS) Time end: 1311 (HRS)
Sampling rate: 400 cc/min Operator: RR
S/N of O_2 Analyzer used to monitor train outlet: 8

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INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job USP/Red Wing
Source Unit #2 STACK
Date 3-22-88 Test 3 Run 2

Operators RR & T.J.
Meter Box No. 8
Coemeter coeff. .9980

Pitot No. 4-017 Cp .84
Bar. Press. 29.03 inHg H2O 1.5 x
Nozzle No. 7-2 Nozzle Dia .437 IN.

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dev. Vol. (cf)	VAC. inHg	Temperatures (°F) Stack	Probe	Oven	Impg.	Gas/In	Gas/Out	Oxygen (x v/v)
	1225	287.15											
D-6	2.5	289.36	.10	2.41	9.36	7.0	270	250	250	55	115	108	10.3
5	5	291.53	.09	2.19	1.48	6.5	260			55	115	109	7.6
4	7.5	293.50	.08	1.95	3.48	5.5	260			55	117	109	6.0
3	10	295.47	.08	1.96	5.48	5.5	260	250	250	55	118	109	8.0
2	12.5	297.24	.06	1.47	7.22	5.0	260			55	120	109	10.4
1	15	298.80	.05	1.23	8.80	5.0	260			55	120	110	8.5
A-6	17.5	300.90	.09	2.21	0.83	6.0	260	250	250	55	120	110	9.8
5	20	302.93	.08	1.96	2.94	6.0	260			59	122	110	6.2
4	22.5	304.68	.06	1.48	4.69	5.0	260			59	123	110	7.7
3	25	306.50	.07	1.72	6.57	5.0	260	250	250	59	124	110	5.8
2	27.5	308.26	.06	1.48	8.32	5.0	260			59	124	110	9.4
1	30	309.92	.05	1.23	9.92	5.0	260			59	125	110	6.8
B-6	32.5	312.02	.09	2.22	2.06	6.0	260	250	250	59	125	110	7.3
5	35	314.01	.08	1.96	4.07	6.0	265			59	126	110	8.6
4	37.5	316.00	.08	1.96	6.08	6.0	265			59	127	110	6.4
3	40	317.94	.07	1.72	7.96	5.5	265	250	250	63	128	110	7.5
2	42.5	319.80	.08	1.72	9.85	5.5	265			63	128	111	7.5
1	45	321.60	.06	1.47	1.60	5.0	265			63	128	111	7.2
C-6	47.5	323.90	.11	2.70	3.96	7.5	265	250	250	60	128	112	7.0
5	50	326.15	.10	2.46	6.22	7.5	265			60	128	112	7.4
4	52.5	328.42	.10	2.46	8.47	7.5	265			60	128	112	8.6
3	55	330.57	.09	2.21	0.61	7.0	265	250	250	60	128	112	7.6
2	57.5	332.56	.07	1.72	2.50	6.5	265			60	129	113	8.8
1	60	334.20	.06	1.48	4.26	6.0	265			60	129	113	7.7
	θ = 60	Vm = 47.11		^H = 1.89							Avg. = 117		

(13 11)

INTERPOLL LABORATORIES EPA METHOD 5/17 SAMPLE LOG SHEET

Job NSP / Red Wing Date 3-22-88 Test 2 Run 3
Source UNIT #2 STACK No. of traverse points 24
Method 4M-5 Filter holder: 4" glass Filter type: 4" glass

Sample Train Leak Check:

Pretest: < 0.02 cfm at 15 in. Hg. (vac)
Postest: .00 cfm at 10 in. Hg. (vac)

Particulate Catch Data:

No.s of filters used: _____

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

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

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impinger No. 1	622		130
Impinger No. 2			
Impinger No. 3	308	302	6
Condenser			
Desiccant	1396	1385	11
Total			147

1117

Integrated Gas Sampling Data:

Bag Pump No. 134 Box No. 14 Bag No. 3
Bag Material: 5-layer Aluminized Tedlar Size: 44 L
Pretest leak check: .00 cc/min at 10 in. Hg.
Time start: 1410 (HRS) Time end: 1515 (HRS)
Sampling rate: 400 cc/min Operator: RR
S/N of O_2 Analyzer used to monitor train outlet: 8

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S-0046RR

CF-D11

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job NSP/Red Wing
Source Unit #2 STACK
Date 3-22-88 Test 2 Run 3

Operators RR & T.J.
Meter Box No. 8
Gamma Meter coeff. .9986

Pitot No. 4-v17 Cp .84
Bar. Press. 29.02 inHg H2O x
Nozzle No. S-7 Nozzle Dia .437 IN.

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dec. Vol. (cf)	VAC. inHg	Temperatures (°F)						Oxygen
							Stack	Probe	Oven	Impg.	Gas/In	Gas/Out	(v/v)
	1410	335.40											
B-6	2.5	337.20	.10	2.49	7.66	7.0	265	250	250	50	120	112	7.3
5	5	339.94	.10	2.49	9.92	6.8	265			50	120	112	6.4
4	7.5	342.08	.09	2.27	2.08	6.2	255			50	121	113	7.8
3	10	344.10	.08	2.02	4.12	5.5	255	250	250	50	123	113	8.6
2	12.5	34?.03	.07	1.77	6.04	5.5	255			50	126	113	7.6
1	15	347.66	.05	1.27	7.66	5.0	255			50	126	113	8.6
A-6	17.5	349.80	.09	2.28	9.84	6.0	255	250	250	50	126	113	7.6
5	20	351.85	.08	2.03	1.89	6.0	255			50	127	114	9.8
4	22.5	353.89	.08	~~3.94~~	3.94	6.0	255			50	127	114	7.1
3	25	355.85	.07	1.78	5.86	6.0	255	250	250	50	127	114	6.7
2	27.5	357.67	.06	1.48	7.62	6.0	275			50	128	114	7.3
1	30	359.19	.05	1.18	9.19	5.0	310			54	129	114	8.0
D-6	32.5	361.35	.10	2.36	1.41	6.5	310	250	250	54	129	114	6.8
5	35	363.46	.09	2.13	3.51	6.5	310			54	129	114	8.4
4	37.5	365.50	.08	1.89	5.49	6.0	310			54	130	115	7.7
3	40	367.30	.06	1.42	7.22	6.0	310	250	250	54	130	115	8.8
2	42.5	369.00	.06	1.42	8.94	5.0	310			54	130	115	x.9
1	45	370.77	.05	1.18	0.51	4.5	310			54	130	115	8.0
C-6	47.5	372.73	.10	2.37	2.77	5.5	310	250	250	54	130	115	8.1
5	50	374.90	.07	2.13	4.84	5.5	310			54	130	115	6.7
4	52.5	377.89	.08	1.90	6.83	5.5	310			54	131	115	6.3
3	55	378.73	.07	1.66	8.69	5.0	310	250	250	56	132	115	8.0
2	57.5	380.30	.05	1.19	0.26	5.0	310			56	132	115	8.7
1	60	381.84	.05	1.19	1.84	5.0	310			55	132	115	2.5
	θ = (1515)	Vm = 46.44		^H = 1.83							Avg. = 120.8		

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APPENDIX J

FIELD DATA SHEETS FOR THE MM5 SAMPLING TRAIN

INTERPOLL LABORATORIES EPA METHOD 2 FIELD DATA SHEET

Job NSP REDWING

Source UNIT 2 ESP INLET

Test 4 Run 1 Date 3-23-88

Stack dimen. 53 x 66 IN.

Dry bulb _____ deg-F

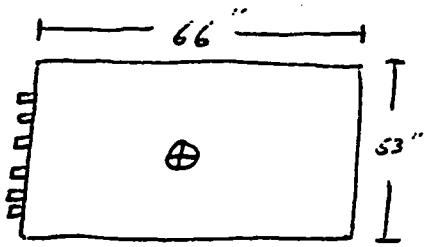
Wet bulb _____ deg-F

Barometric pressure 29.01 in Hg

Static pressure -6.0 in WC

Operators D. SMITH & T. HOGAN

Pitot No. 6MM5 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 (deg-F)
		Port length: 18 in.		Time start:	hrs
A - 1		4.71	22.71	.50	
2		14.13	32.13	.64	
3		23.72	41.72	.65	
4		33.14	51.14	.72	
5		42.56	60.56	.68	
6		51.98	69.98	.69	
7		61.40	79.40	.67	
Temp. measure device:				Time end:	hrs

INTERPOLL LABORATORIES EPA MODIFIED METHOD 5 SAMPLE LOG SHEET

Job NSP REDWING
Source UNIT 2 ESP INLET
Cyclone: ☒ Yes ☐ No Filter holder: MM5
Analytes: DIOXSINS & FURANNS
Field recovery spike added: ☒ Yes ☐ No

Date 3-23-88 Test 4 Run 1
No. of traverse points 84
Filter type: 4" Glass fiber
XAD-2 resin: 32 g Batch No. 14
Reference: EPA SW-846 Method 0010

Sample Train Leak Check:

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

Semivolatile Catch Data:

No.s of filters used: 1 (0104)

Recovery solvent(s)
☒ MeCl2 * MeOH (50:50 v/v)
☐ other(s) _____

No. of bottles for condensate trap catch: 1
Samples recovered by: JOHN BURESH

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Condensate trap	886	393	493
Condensate trap			
Condensate trap			
Impingers	196	200	-4
Desiccant	1333	1292	41
Total			530g

Integrated Gas Sampling Data:

Bag Pump No. B8 Box No. 17 Bag No. 1

Bag Material: 4-layer Aluminized Tedlar Size: 44 L

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

Time start: 1132 (HRS) Time end: 1655 (HRS)

Sampling rate: 100 cc/min O2 Analyzer S/N: 5

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INTERPOLL LABORATORIES EPA MODIFIED METHOD 5 FIELD DATA SHEET

Job NSP REDWING
Source UNIT 2 ESP INLET
Date 3-23-88 Test 4 Run 1

Operators D. SMITH & T. HOGAN
Meter Box No. 9
Gasmeter coeff. 1.0021

Nozzle No. 8-4
Nozzle Dia. .241 In.
Bar. Pres. 25.01 In. Hg

Pitot No. 6-mm S
Cp .84
H_2O 15 %

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dec. Vol. (cf)	VAC. inHg	Temperatures (°F)							Oxygen (%v/v)
							Stack	Probe	Oven	XAD2	Imp.	Meter (In/Out)		
	(1130)	(653.00)												
A - 7	3.5	655.02	.67	1.09	5.02	6.9	426	250	230	50	58	96	87	8.0
7	7	657.22	.73	1.26	7.22	8.0	426					98	87	8.6
6	10.5	659.44	.75	1.28	9.44	9.0	444					100	88	5.0
6	14	661.37	.56	0.96	1.37	8.8	438	250	250	40	56	102	88	6.3
5	17.5	663.65	.78	1.34	3.65	9.8	437					102	88	8.4
5	21	665.60	.57	0.98	5.60	9.0	435					103	88	11.6
4	24.5	667.52	.55	0.95	7.52	9.0	435	260	250	40.2	50	103	88	8.7
4	28	669.39	.52	0.90	9.39	9.0	436					104	89	6.4
3	31.5	671.40	.60	1.04	1.40	9.6	433					105	90	8.5
3	35	673.60	.72	1.25	3.61	11.2	434	270	245	37.5	52	106	90	10.6
2	38.5	675.71	.65	1.13	5.71	11.2	431					106	91	9.4
2	42	677.51	.48	0.84	7.51	9.0	432					106	91	7.5
1	45.5	679.34	.49	0.85	9.34	8.9	431	272	240	39.5	54	106	92	7.0
1	49	681.20	.50	0.87	1.19	8.8	433					106	92	8.2
B - 7	52.5	683.33	.68	1.18	3.33	11.0	435					106	92	8.0
7	56	685.45	.66	1.15	5.45	11.8	431	270	240	42.5	55	108	93	6.0
6	59.5	687.48	.60	1.05	7.48	11.8	429					108	94	7.6
6	63	689.51	.60	1.05	9.51	11.8	431					108	94	12.4
5	66.5	691.68	.68	1.20	1.68	12.8	423	265	250	41	54	108	94	11.6
5	70	693.66	.56	1.00	3.66	10.8	417					108	94	9.6
4	73.5	695.83	.68	1.21	5.83	12.6	420					108	94	8.0
4	77	697.95	.65	1.15	7.96	12.8	419	250	260	40	53	108	94	2.6
3	80.5	700.00	.60	1.07	0.01	13.0	417					108	95	9.4
3	84	702.21	.70	1.24	2.21	13.2	424					108	95	6.0
2	87.5	704.36	.67	1.19	4.36	13.2	423	256	250	41	54	108	95	7.2
	θ=	Va=		^H=								Avg.=		

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INTERPOLL LABORATORIES EPA MODIFIED METHOD 5 FIELD DATA SHEET

Job NSP REDWING
Source UNIT 2 ESP INLET
Date 3-23-88 Test 4 Run 1

Operators D. SMITH & T. HOGAN
Meter Box No. 9
Gasmeter coeff. 1.0021

Nozzle No. 8-Y
Nozzle Dia. .241 in.
Bar. Pres. 29.01 in. Hg

Pitot No. 6MM5
Cp .84
H_2O 15 %

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	XAD2	Imp.	Meter(In/Out)		Oxygen (%v/v)
B - 2	91	706.51	.67	1.19	6.52	13.4	423	245	260	39.5	53	108	96	8.8
1	94.5	708.27	.44	0.78	8.27	10.6	423					108	96	7.0
1	98	709.83	.35	0.62	9.83	9.0	419					108	96	7.8
C - 7	101.5	711.67	.48	0.86	1.67	10.2	413	250	255	41	54	108	96	6.4
7	105	713.41	.47	0.84	3.49	10.8	415					108	96	6.9
6	108.5	715.25	.44	0.79	5.25	10.2	414					108	96	6.6
6	112	717.03	.45	0.81	7.03	10.8	412	245	250	39	56	108	96	8.6
5	115.5	718.83	.46	0.83	8.83	11.0	410					108	96	7.3
6	119	720.67	.48	0.86	0.67	11.3	409					109	96	7.1
4	122.5	722.48	.46	0.83	2.48	11.2	410	255	250	40.5	56	109	96	5.6
4	126	724.34	.49	0.88	4.34	12.0	412					109	96	4.5
3	129.5	726.23	.51	0.91	6.23	12.2	414					110	96	8.6
3	133	728.02	.45	0.81	8.02	11.8	411	250	250	40	55	110	96	8.4
2	136.5	729.93	.51	0.93	9.93	12.0	400					110	96	8.4
2	140	731.84	.51	0.93	1.84	12.5	398					110	96	6.9
1	143.5	733.56	.41	0.75	3.56	11.6	399	255	250	40.5	55	110	96	7.4
1	147	735.21	.38	0.69	5.21	10.5	398					109	96	8.3
D - 7	150.5	736.92	.41	0.74	6.92	10.2	408					108	96	8.2
7	154	738.66	.43	0.77	8.66	10.9	411	248	250	38.5	58	109	96	7.5
6	157.5	740.40	.43	0.77	0.40	11.2	413					109	96	8.4
6	161	742.13	.42	0.75	2.13	11.2	411					110	97	5.8
5	164.5	743.91	.45	0.81	3.91	12.0	413	250	250	39.5	56	110	97	5.7
5	168	745.67	.44	0.79	5.67	12.0	415					110	97	7.7
4	171.5	747.48	.46	0.82	7.48	12.2	414					110	97	8.6
4	175	749.30	.47	0.84	9.30	12.6	412	250	250	40.5	58	110	97	7.8
	θ=	Va=		^H=								Avg.=		

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EPA MODIFIED METHOD 5 FIELD DATA SHEET

Job NSP REDWING
Source UNIT 2 ESP INLET
Date 3-23-88 Test 4 Run 1

Operators D. SMITH & T. HOGAN
Meter Box No. 9
Gasmeter coeff. 1.0021

Nozzle No. 8-4
Nozzle Dia. .241 in.
Bar. Pres. 29.01 in. Hg

Pitot No. 6MM5
Cp .84
H_2O 15 %

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Des. Vol. (cf)	VAC. inHg	Temperatures (°F)							Oxygen (%v/v)
							Stack	Probe	Oven	XAD2	Imp.	Meter(In/Out)		
D - 3	178.5	751.27	.55	0.99	1.27	13.6	413	250	250	40.5	58	110	97	8.6
3	182	753.28	.57	1.02	3.28	14.2	413					110	97	8.2
2	185.5	755.59	.75	1.35	5.59	15.0	411					110	97	7.0
2	189	757.77	.68	1.21	7.77	14.9	419	250	250	39	56	110	97	8.7
1	192.5	759.73	.55	0.98	9.73	14.7	420					108	97	7.6
1	196	761.70	.55	0.98	1.70	14.7	420					107	96	7.2
E - 7	199.5	763.45	.44	0.78	3.45	12.0	417	250	250	38.5	55	106	96	7.8
7	203	765.22	.45	0.80	5.22	12.5	420					106	96	7.4
6	206.5	766.99	.45	0.80	6.99	12.5	422					107	96	7.8
6	210	768.76	.45	0.80	8.76	12.5	423	250	250	38.5	55	107	96	7.0
5	213.5	770.54	.46	0.81	0.54	12.8	423					108	96	7.1
5	217	772.35	.47	0.83	2.35	13.5	424					108	96	8.7
4	220.5	774.22	.50	0.88	4.22	13.8	424	255	250	39	56	108	96	10.1
4	224	776.23	.58	1.03	6.23	14.5	421					108	96	8.1
3	227.5	778.05	.48	0.85	8.05	14.0	424					108	96	6.4
3	231	779.92	.50	0.88	9.92	14.2	425	250	250	38.5	55	107	96	12.0
2	234.5	781.92	.58	1.03	1.92	14.6	421					107	96	6.7
2	238	784.00	.62	1.10	4.00	15.0	420					107	96	7.7
1	241.5	785.87	.50	0.89	5.87	14.7	420	250	250	39	56	106	96	10.9
1	245	787.79	.53	0.94	7.79	14.8	419					106	96	9.2
F - 7	248.5	789.54	.44	0.78	9.54	13.0	421					106	96	6.4
7	252	791.26	.43	0.76	1.26	13.2	427	250	250	40	58	106	96	10.0
6	255.5	792.97	.42	0.74	2.97	13.3	426					106	96	6.5
6	259	794.65	.41	0.72	4.65	13.3	428					106	96	8.8
5	262.5	796.	.50	0.88	6.50	14.2	431	250	250	39.5	56	106	96	6.8
	θ=	Va=		^H=								Avg.=		

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...ERPOLL LABORATORIES EPA MODIFIED METHOD 5 FIELD DATA SHEET

Job NSP REDWING
Source UNIT 2 ESP INLET
Date 3-23-88 Test 4 Run 1

Operators D. SMITH & T. HOGAN
Meter Box No. 9
Gasmeter coeff. 1.0021

Nozzle No. 8-4
Nozzle Dia. .241 In.
Bar. Pres. 29.01 In. Hg

Pitot No. 6MM5
Cp .84
H_2O 15 %

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dev. Vol. (cf)	VAC. inHg	Temperatures (°F)							Oxygen
							Stack	Probe	Oven	XAD2	Imp.	Meter (In/Out)		(%V/V)
F- 5	266	798.30	.47	0.82	8.30	14.4	432	250	250	38.5	56	107	95	9.1
4	269.5	800.29	.58	1.01	0.29	14.9	434					107	95	7.4
4	273	802.17	.52	0.90	2.17	14.7	439					108	96	8.4
3	276.5	803.77	.37	0.65	3.77	13.2	434	250	250	38.5	55	106	96	7.5
3	280	805.34	.36	0.63	5.34	13.0	426					106	96	7.5
2	283.5	806.92	.36	0.63	6.92	13.0	426					106	96	7.6
2	287	808.67	.44	0.78	8.67	14.0	420	250	250	38	54	106	96	7.5
1	290.5	810.34	.40	0.71	0.34	13.8	419					106	96	8.2
1	294	812.05	.42	0.75	2.05	13.9	419					106	96	6.8
	(1656)	(159.05)												
	θ= 294	Vm= 159.05		^H= .92								Avg.= 99.6		

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INTERPOLL LABORATORIES EPA MODIFIED METHOD 5 SAMPLE LOG SHEET

Job NSP RED WING
Source UNIT 2 ESP INLET
Cyclone: ☒ Yes ☐ No Filter holder: MM5
Analytes: DIOXINS & FURANNS
Field recovery spike added: ☒ Yes ☐ No

Date 3-24-88 Test 4 Run 2
No. of traverse points 84
Filter type: 4" Glass fiber
XAD-2 resin: 32 g Batch No. 14
Reference: EPA SW-846 Method 0010

Sample Train Leak Check:

Pretest: < 0.02 cfm at 15 in. Hg. (vac) ☑
Postest: 0.00 cfm at 12 in. Hg. (vac) ☐

Semivolatile Catch Data:

No.s of filters used: 2 (0105, 0107)

Recovery solvent(s)
☒ MeCl2 * MeOH (50:50 v/v)
☐ other(s) _____

No. of bottles for condensate trap catch: 1
Samples recovered by: JOHN BURESH

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Condensate trap	885	393	492
Condensate trap			
Condensate trap			
Impingers	200	200	0
Desiccant	1319	1276	43
Total			535

Integrated Gas Sampling Data:

Bag Pump No. B8 Box No. 17 Bag No. 2

Bag Material: 4-layer Aluminized Tedlar Size: 44 L

Pretest leak check: 15 cc/min at 0 in. Hg.
0945 - 1312 / 0820 - 1002
Time start: ~~0945~~ (HRS) Time end: _____ (HRS)

Sampling rate: 100 cc/min O2 Analyzer S/N: 5

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INTERPOLL LABORATORIES EPA MODIFIED METHOD 5 FIELD DATA SHEET

Job NSP REDWING Operators D SMITH & T. HOGAN Nozzle No. 8-4 Pitot No. 6M45
Source UNIT 2 ESP INLET Meter Box No. 9 Nozzle Dia. .241 in. Cp .84
Date 3-24-88 Test 4 Run 2 Gasmeter coeff. 1.0021 Bar. Pres. 28.75 In. Hg H_2O 15 %

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	XAD2	Imp.	Meter (In/Out)		Oxygen (%v/v)
	(0945)	(812.60)												
A - 7	3.5	814.80	.73	1.27	4.80	8.3	415	240	250	43.5	60	91	82	11.2
7	7	816.67	.54	0.93	6.69	7.0	422					92	82	7.6
6	10.5	818.70	.61	1.06	8.71	8.0	420					95	82	5.8
6	14	820.72	.58	1.01	0.68	8.2	419	256	255	42.5	55	96	83	8.1
5	17.5	822.72	.61	1.06	2.71	9.5	418					98	84	6.9
5	21	824.81	.65	1.13	4.81	9.8	420					100	84	7.5
4	24.5	826.75	.55	0.96	6.74	8.8	423	295	255	41	50	100	84	7.1
4	28	828.71	.58	1.01	8.72	9.0	425					102	84	8.2
3	31.5	830.53	.50	0.87	0.56	8.5	426					102	85	7.7
3	35	832.38	.50	0.87	2.40	8.5	425	281	260	41	49	103	86	6.9
2	38.5	834.09	.42	0.73	4.09	7.9	422					104	86	7.1
2	42	835.95	.50	0.87	5.95	8.6	422					104	87	7.9
1	45.5	837.78	.49	0.86	7.78	8.8	421	275	260	43	50	104	87	10.0
1	49	839.52	.44	0.77	9.52	8.3	421					104	87	8.2
B - 7	52.5	841.52	.58	1.02	1.52	10.5	422					104	88	7.2
7	56	843.49	.57	0.99	3.49	10.5	429	275	275	42	52	104	88	9.4
6	59.5	845.43	.55	0.96	5.43	10.4	427					105	88	8.8
6	63	847.37	.55	0.96	7.37	10.4	426					106	89	6.4
5	66.5	849.37	.58	1.01	9.37	10.9	427	275	275	41.5	50	106	90	7.4
5	70	851.38	.59	1.03	1.38	11.2	428					106	90	7.1
4	73.5	853.35	.56	0.98	3.35	11.7	426					106	90	6.8
4	77	855.42	.62	1.09	5.41	12.2	426	275	275	42.5	54	106	90	6.8
3	80.5	857.31	.52	0.91	7.31	11.0	428					106	91	7.7
3	84	859.31	.58	1.02	9.31	11.5	427					106	92	5.9
2	87.5	861.13	.48	0.84	1.13	10.2	429	275	275	41.5	50	107	92	9.3
	θ=	Va=		^H=								Avg.=		

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INTERPOLL LABORATORIES EPA MODIFIED METHOD 5 FIELD DATA SHEET

Job NSP REDWING
Source UNIT 2 ESP INLET
Date 3-24-88 Test 4 Run 2

Operators D SMITH & T. HOGAN
Meter Box No. 9
Gasmeter coeff. 1.0021

Nozzle No. 8-4
Nozzle Dia. .241 in.
Bar. Pres. 28.75 in. Hg

Pitot No. 6MM5
Cp .84
H_2O 15 %

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Gas. Vol. (cf)	VAC. inHg	Temperatures (°F) Stack	Probe	Oven	XAD2	Imp.	Meter (In/Out)		Oxygen (xv/v)
B - 2	91	863.08	.55	0.97	3.08	11.9	423	275	275	41.5	49	107	92	8.4
1	94.5	864.79	.42	0.74	4.79	10.0	425					108	92	7.3
1	98	866.50	.42	0.74	6.50	10.0	424					108	92	10.8
C - 7	101.5	868.49	.57	1.00	8.49	12.5	425	275	275	40.5	48	106	93	7.4
7	105	870.45	.58	1.02	0.49	12.3	429					108	94	9.4
6	108.5	872.48	.57	1.00	2.48	12.3	428					108	94	6.8
6	112	874.43	.55	0.96	4.44	12.3	430	275	275	41.5	50	108	94	5.4
5	115.5	876.47	.60	1.05	6.47	13.0	434					108	94	11.3
5	119	878.52	.60	1.05	8.51	13.1	431					108	94	6.2
4	122.5	880.60	.62	1.09	0.59	14.8	428	275	275	41.5	50	108	94	7.3
4	126	882.63	.60	1.05	2.62	14.5	435					108	94	9.8
3	129.5	884.62	.58	1.02	4.62	13.8	431					107	94	5.7
3	133	886.62	.58	1.01	6.63	13.8	432	275	275	40.5	48	107	94	7.5
2	136.5	888.69	.62	1.09	8.70	14.5	429					107	94	6.4
2	140	890.78	.62	1.09	0.78	14.6	424					107	94	7.5
1	143.5	892.61	.48	0.85	2.61	12.5	424	275	275	41	48	106	94	8.6
1	147	894.42	.47	0.83	4.42	12.0	421					106	94	7.7
D - 7	150.5	896.32	.52	0.91	6.32	12.5	426					106	94	6.8
7	154	898.18	.50	0.88	8.18	12.2	429	270	265	41	50	106	94	9.4
6	157.5	900.00	.48	0.84	0.00	12.5	427					106	94	7.5
6	161	901.85	.49	0.86	1.85	12.8	427					107	94	8.0
5	164.5	903.75	.52	0.91	3.75	13.2	426	265	260	42	48	107	94	6.3
5	168	905.65	.52	0.91	5.65	13.4	428					107	94	7.8
4	171.5	907.55	.52	0.91	7.55	13.6	432					106	94	8.2
4	175	909.48	.54	0.95	9.48	14.2	427	260	260	42	50	106	94	6.9
	θ=	Vm=		^H=								Avg.=		

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CAP... LABORATORIES EPA MODIFIED METHOD 5 FIELD DATA SHEET

Job NSP REDWING
Source UNIT 2 ESP INLET
Date 3-24/last-88 Test 4 Run 2

Operators D. SMITH & T. HOGAN
Meter Box No. 9
Gasmeter coeff. 1.0021

Nozzle No. B-4
Nozzle Dia. .241 in.
Bar. Pres. 28.60 in. Hg (28.75)

Pitot No. 6.445
Cp .84
H=O .15 %

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	XAD2	Imp.	Meter (In/Out)		Oxygen (%V/V)
D - 3	178.5	911.53	.60	1.05	1.52	15.0	427	260	260	42	50	106	94	7.3
3	182	913.61	.63	1.11	3.61	16.2	425					106	94	7.1
2	185.5	915.78	.67	1.18	5.77	17.4	423					104	94	6.9
2	189	917.93	.67	1.18	7.92	17.6	427	260	265	41.5	52	104	94	8.6
1	192.5	919.87	.55	0.96	9.87	15.6	427					103	94	8.2
1	196	921.83	.55	0.96	1.82	15.4	426					102	94	7.6
E - 7	199.5	925.84	.46	0.82	5.84	8.3	410	275	260	44	58	99	89	7.3
7	203	927.63	.46	0.81	7.63	8.0	411					102	90	8.0
6	206.5	929.38	.44	0.78	9.38	7.5	410					104	90	8.0
6	210	931.14	.44	0.78	1.14	7.5	410	270	250	44	55	104	90	7.4
5	213.5	932.94	.46	0.82	2.94	8.0	414					106	90	6.8
5	217	934.72	.45	0.80	4.72	8.0	415					106	90	8.3
4	220.5	936.68	.55	0.97	6.68	9.2	416	265	260	44	53	107	91	7.5
4	224	938.64	.55	0.97	8.64	9.2	418					108	92	7.5
3	227.5	940.66	.58	1.03	0.66	9.9	417					108	92	6.2
3	231	942.64	.55	0.97	2.63	9.3	419	265	260	44	53	108	92	8.0
2	234.5	944.69	.60	1.06	4.69	10.2	419					108	93	6.5
2	238	946.72	.59	1.05	6.72	10.2	414					109	94	6.8
1	241.5	948.55	.47	0.84	8.55	8.9	418	260	260	43	52	109	94	6.3
1	245	950.37	.47	0.84	0.37	8.9	418					109	94	6.8
F - 7	248.5	952.14	.44	0.78	2.14	9.0	416					108	94	7.8
7	252	953.82	.40	0.71	3.82	8.5	420	265	260	44	52	109	94	6.8
6	255.5	955.48	.39	0.69	5.48	8.4	421					109	94	6.9
6	259	957.13	.38	0.67	7.12	8.4	423					110	94	6.8
5	262.5	958.90	.45	0.80	8.90	9.3	421	265	260	45	53	110	94	7.7
	θ=	Va=		^H=								Avg.=		

CHANG FILTER & DELAY —

CHANGE FILTERS NEW Volume
~~923~~-84
ΔV=2.01
924.04
ΔV=2.21

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CF-025

EAPC... LABO...ORIES EPA MODIFIED METHOD 5 FIELD DATA SHEET

Job NSP REDWING
Source UNIT 2 ESP INLET
Date 3-~~24~~/88 3-~~24~~/25/88 Test 4 Run 2

Operators D. SMITH & T. HOGAN
Meter Box No. 9
Gasmeter coeff. 1.0021

Nozzle No. 8-4
Nozzle Dia. .241 in.
Bar. Pres. 2 in. Hg

Pitot No. 6MMS
Cp .84
H_2O 15 %

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dev. Vol. (cf)	VAC. inHg	Temperatures (°F) Stack	Probe	Oven	XAD2	Imp.	Meter (In/Out)		Oxygen (%V/V)
F - 5	266	960.63	.42	0.74	0.63	9.0	422	265	260	45	53	110	95	8.2
4	269.5	962.62	.56	0.99	2.62	10.9	422					110	95	5.7
4	273	964.62	.57	1.01	4.62	11.1	423					110	95	9.6
3	276.5	966.46	.48	0.85	6.46	10.0	426	280	240	45	55	110	95	8.3
3	280	968.40	.53	0.94	8.40	10.8	424					110	96	4.5
2	283.5	970.27	.50	0.88	0.27	10.7	427					110	96	5.8
2	287	972.15	.50	0.88	2.15	10.8	426	275	250	45	55	110	96	5.7
1	290.5	973.99	.48	0.85	3.99	10.8	426					111	96	8.6
1	294	975.84	.48	0.85	5.84	10.8	426					111	96	8.2
221	(1002)													
	Vf =	973.63												
	θ=	Vm= 163.24		^H= .94								Avg.= 98.6		

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INTERPOLL LABORATORIES EPA MODIFIED METHOD 5 SAMPLE LOG SHEET

Job NSP RED WING
Source UNIT 2 ESP INLET
Cyclone: ☒ Yes ☐ No Filter holder: MM5
Analytes: DIOXINS & FURANNS
Field recovery spike added: ☒ Yes ☐ No

Date 3-25-88 Test 4 Run 3
No. of traverse points 84
Filter type: 4" Glass fiber
XAD-2 resin: 32 g Batch No.
Reference: EPA SW-846 Method 0010

Sample Train Leak Check:

Pretest: ≤ 0.02 cfm at 15 in. Hg. (vac) ☒
Postest: 0 cfm at 17 in. Hg. (vac) ☐

Semivolatile Catch Data:

No.s of filters used: 1 (108)

Recovery solvent(s)
☒ MeCl2 * MeOH (50:50 v/v)
☐ other(s)

No. of bottles for condensate trap catch: 1
Samples recovered by: JOHN BURESH

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Condensate trap	914	393	521
Condensate trap			
Condensate trap			
Impingers	200	200	0
Desiccant	1337	1292	45
Total			566

Integrated Gas Sampling Data:

Bag Pump No. B.8 Box No. 17 Bag No. 2

Bag Material: 4-layer Aluminized Tedlar Size: 44 L

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

Time start: 1342 (HRS) Time end: 1903 (HRS)

Sampling rate: 100 cc/min O2 Analyzer S/N: 5

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INTERPOLL LABORATORIES EPA MODIFIED METHOD 5 FIELD DATA SHEET

Job NSP REDWING
Source UNIT 2 ESP INLET
Date 3-28-88 Test 4 Run 3

Operators D. SMITH & T. HOGAN
Meter Box No. 9
Gasmeter coeff. 1.0021

Nozzle No. 8-4
Nozzle Dia. .241 in.
Bar. Pres. 28.60 in. Hg

Pitot No. 6MM5
Cp .84
H_2O 15 %

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	XAD2	Imp.	Meter (In/Out)		Oxygen (%v/v)
	(1340)	976.30												
A - 7	3.5	978.44	.66	1.17	8.45	7.0	423	260	250	47.5	60	107	97	8.6
7	7	980.64	.69	1.21	0.65	8.0	430					108	97	7.4
6	10.5	982.89	.71	1.25	2.88	8.8	430					110	98	8.3
6	14	985.08	.69	1.22	5.08	9.2	431	260	250	47.5	60	110	98	8.0
5	17.5	987.29	.69	1.22	7.29	9.5	427					111	98	8.8
5	21	989.44	.66	1.16	9.44	9.8	430					112	98	7.0
4	24.5	991.55	.63	1.11	1.55	9.8	432	260	250	45.5	59	112	98	4.4
4	28	993.75	.68	1.20	3.74	10.9	431					113	98	9.0
3	31.5	995.93	.68	1.20	5.93	11.0	432					113	98	8.9
3	35	998.16	.70	1.23	8.15	11.8	436	250	250	45.5	59	114	99	9.1
2	38.5	1000.28	.63	1.11	0.26	10.8	436					114	100	5.0
2	42	1002.37	.62	1.10	2.36	10.8	433					114	100	9.7
1	45.5	1004.16	.46	0.81	4.16	8.8	435	250	250	45	58	114	100	9.3
1	49	1005.87	.41	0.72	5.87	8.0	435					114	100	12.2
B - 7	52.5	1007.90	.58	1.03	7.90	10.5	432					112	100	7.2
7	56	1009.92	.57	1.01	9.91	10.5	432	260	255	46	59	113	100	7.5
6	59.5	1011.93	.57	1.01	1.92	10.5	432					113	100	11.7
6	63	1013.89	.55	0.97	3.89	10.2	431					114	100	8.0
5	66.5	1016.03	.64	1.14	6.03	11.8	428	260	255	45.5	58	114	100	8.4
5	70	1018.20	.66	1.17	8.20	12.2	431					114	100	7.3
4	73.5	1020.37	.66	1.17	0.36	12.2	431					115	101	10.5
4	77	1022.63	.72	1.28	2.63	13.2	432	260	250	45	58	115	101	9.6
3	80.5	1024.61	.55	0.97	4.61	10.2	432					115	101	7.8
3	84	1026.61	.56	0.99	6.61	10.4	430					115	101	4.8
2	87.5	1028.71	.62	1.11	8.72	11.8	426	260	250	45	58	115	101	8.9
	θ=	Va=		^H=								Avg.=		

INTERPOLL LABORATORIES EPA MODIFIED METHOD 5 FIELD DATA SHEET

Job NSP REDWING
Source UNIT 2 ESP INLET
Date 3-25-88 Test 4 Run 3

Operators D.SMITH & T.HOGAN
Meter Box No. 9
Gasmeter coeff. 1.0021

Nozzle No. 8-4
Nozzle Dia. .241 in.
Bar. Pres. 28.60 in. Hg

Pitot No. 6MM5
Cp .84
H_2O 15 %

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dec. Vol. (cf)	VAC. inHg	Temperatures (°F)							Oxygen (%v/v)
							Stack	Probe	Oven	XAD2	Imp.	Meter(In/Out)		
B - 2	91	1030.86	.64	1.14	0.86	12.4	429	260	250	45	58	115	101	7.5
1	94.5	1032.68	.46	0.82	2.67	9.4	428					115	101	9.4
1	98	1034.36	.40	0.71	4.36	8.6	429					115	101	5.4
C - 7	101.5	1036.43	.59	1.05	6.42	11.8	432	255	250	44	59	115	101	6.8
7	105	1038.39	.55	0.97	8.39	10.6	437					116	102	8.4
6	108.5	1040.42	.58	1.02	0.42	11.0	437					116	102	8.0
6	112	1042.43	.56	0.99	2.42	10.8	438	260	255	45	58	116	102	9.4
5	115.5	1044.40	.55	0.97	4.40	10.8	435					116	102	7.8
5	119	1046.40	.56	0.99	6.40	10.9	431					116	102	7.1
4	122.5	1048.39	.55	0.98	8.39	10.9	429	260	250	46	59	116	102	8.4
4	126	1050.38	.54	0.96	0.36	10.9	430					116	102	7.5
3	129.5	1052.43	.60	1.06	2.43	12.4	434					116	102	8.8
3	133	1054.22	.45	0.80	4.22	10.5	433	260	245	46.5	60	116	103	9.2
2	136.5	1055.96	.42	0.75	5.96	10.5	424					116	103	6.3
2	140	1057.96	.55	0.98	7.96	12.5	427					117	103	10.2
1	143.5	1059.72	.43	0.77	9.72	10.8	427	255	250	46	59	117	103	8.3
1	147	1061.46	.42	0.75	1.46	10.8	427					117	103	8.2
D - 7	150.5	1063.47	.56	1.00	3.47	10.8	427					116	103	5.4
7	154	1065.45	.55	0.97	5.45	10.8	435	260	260	47	60	116	103	6.9
6	157.5	1067.39	.53	0.93	7.39	11.0	433					117	104	6.4
6	161	1069.36	.54	0.96	9.36	11.3	433					117	104	7.4
5	164.5	1071.32	.53	0.94	1.31	11.2	434	260	260	47	59	117	103	6.4
5	168	1073.29	.55	0.98	3.29	12.4	434					117	104	6.9
4	171.5	1075.29	.55	0.98	5.28	12.6	434					117	104	8.1
4	175	1077.27	.55	0.98	7.27	12.8	434	260	260	46	59	117	104	6.3
	θ=	Vm=		^H=								Avg.=		

SAMPLE SPLIT 1021

J-14

Rev. 1

CF-023

Job NSP REDWING
Source UNIT 2 ESP INLET
Date 3-25-88 Test 4 Run 3

Operators D. SMITH & T. HOGAN
Meter Box No. 9
Gasmeter coeff. 1.0021

Nozzle No. S-4
Nozzle Dia. .247 In.
Bar. Pres. 28.60 In. Hg

Pitot No. 6MM5
Cp .84
H_2O 15 %

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Des. Vol. (cf)	VAC. inHg	Temperatures (°F)							Oxygen (%v/v)
							Stack	Probe	Oven	XAD2	Imp.	Meter(In/Out)		
D - 3	178.5	1079.43	.65	1.16	9.43	13.6	433	260	260	46	59	117	104	7.1
3	182	1081.47	.58	1.03	1.47	13.0	431					117	104	6.8
2	185.5	1083.63	.65	1.16	3.63	13.6	430					116	104	7.0
2	189	1085.81	.66	1.18	5.81	13.8	428	265	260	47	59	116	104	7.4
1	192.5	1087.86	.58	1.04	7.86	13.8	427					116	104	5.6
1	196	1089.91	.58	1.04	9.91	13.9	427					116	104	8.8
E - 7	199.5	1091.80	.50	0.89	1.80	11.8	432	260	250	48	60	114	104	7.6
7	203	1093.70	.50	0.89	3.70	11.8	431					115	104	8.1
6	206.5	1095.55	.48	0.85	5.55	11.8	432					116	104	6.1
6	210	1097.39	.47	0.84	7.39	11.9	431	255	250	48.5	60	116	104	7.2
5	213.5	1099.29	.50	0.89	9.29	12.5	431					116	103	10.2
5	217	1101.23	.52	0.93	1.22	13.2	430					116	103	8.5
4	220.5	1103.23	.56	0.99	3.22	13.8	432	255	260	48	60	116	103	8.4
4	224	1105.23	.56	1.00	5.23	14.0	430					116	104	6.9
3	227.5	1107.27	.58	1.03	7.27	14.5	429					116	104	7.0
3	231	1109.35	.60	1.07	9.35	15.0	427	255	255	48	62	116	104	6.7
2	234.5	1111.57	.68	1.21	1.57	16.5	429					114	104	8.6
2	238	1113.59	.56	1.01	3.58	15.0	422					114	104	6.9
1	241.5	1115.57	.54	0.97	5.55	14.9	424	255	255	48	60	114	104	7.1
1	245	1117.53	.54	0.97	7.53	15.0	424					114	104	6.5
F - 7	248.5	1119.29	.43	0.76	9.29	8.0	431					113	103	6.7
7	252	1121.11	.47	0.83	1.12	9.2	433	260	250	48	58	114	103	6.0
6	255.5	1122.89	.44	0.78	2.89	9.5	433					115	103	6.4
6	259	1124.64	.43	0.76	4.64	9.8	434					116	103	6.5
5	262.5	1126.48	.48	0.85	6.49	11.2	435	260	250	45	58	117	103	7.9
	θ=	Va=		ΔH=								Avg.=		

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TEAM LABORATORIES EPA MODIFIED METHOD 5 FIELD DATA SHEET

Job NSP REDWING
Source UNIT 2 ESP INLET
Date 3-25-88 Test 4 Run 3

Operators D. SMITH & T. HOGAN
Meter Box No. 9
Gasmeter coeff. 1.0021

Nozzle No. 8-4
Nozzle Dia. .341 In.
Bar. Pres. 28.60 In. Hg

Pitot No. 6MM5
Cp .84
H_2O 15 %

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Des. Vol. (cf)	VAC. inHg	Temperatures (°F)							Oxygen (%v/v)
							Stack	Probe	Oven	XAD2	Imp.	Meter(In/Out)		
F - 5	266	1128.38	.50	0.89	8.39	11.8	433	260	250	45	58	117	103	6.9
4	269.5	1130.12	.42	0.74	0.12	10.5	434					117	103	6.4
4	273	1132.11	.55	0.98	2.11	12.6	432					117	103	6.5
3	276.5	1133.86	.42	0.75	3.85	11.6	432	260	250	44	56	116	103	8.3
3	280	1135.66	.45	0.80	5.65	12.3	431					116	103	6.0
2	283.5	1137.38	.42	0.75	7.38	11.8	432					116	103	7.8
2	287	1139.28	.50	0.89	9.28	13.0	429	255	255	43	56	116	103	7.0
1	290.5	1141.17	.49	0.87	1.16	13.0	427					116	103	6.8
1	294	1143.11	.45	0.80	2.96	13.2	427					116	103	9.4
	(1904)													
	θ=	Va= 166.81		ΔH= .98								Avg.= 108.4		

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INTERPOLL LABORATORIES EPA MODIFIED METHOD 5 SAMPLE LOG SHEET

Job USP/Red Wing Date 3-23-88 Test 4 Run 1
Source UNIT #2 STACK No. of traverse points 24
Cyclone: ☐ Yes ☒ No Filter holder: MM5 Filter type: 4" Glass fiber
Analytes: XAD-2 resin: ___ g Batch No. ___
Field recovery spike added: ☒ Yes ☐ No Reference: EPA SW-846 Method 0010

Sample Train Leak Check:

Pretest: < 0.02 cfm at 15 in. Hg. (vac) ☒
Postest: .00 cfm at 12 in. Hg. (vac) ☒

Semivolatile Catch Data:

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

___ ☒ MeCl2 * MeOH (50:50 v/v)
___ ☐ other(s) ___

No. of bottles for condensate trap catch: ___
Samples recovered by: ___

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Condensate trap	981	393	588
Condensate trap			
Condensate trap			
Impingers	250	250	0
Desiccant	1423	1388	35
Total			623

Integrated Gas Sampling Data:

Bag Pump No. B4 Box No. 12 Bag No. 1

Bag Material: 4-layer Aluminized Tedlar Size: 44 L

Pretest leak check: .00 cc/min at 10 in. Hg.

Time start: 1130 (HRS) Time end: 1644 (HRS)

Sampling rate: 100 cc/min O2 Analyzer S/N: 8

INTERPOLL LABORATORIES EPA MODIFIED METHOD 5 FIELD DATA SHEET

Job USP/Red Wing Operators RR & TJ. Nozzle No. -7 Pitot No. 4-mm5
Source UNIT #2 STACK Meter Box No. 8 Nozzle Dia. .425 in. Cp .84
Date 3-23-88 Test 4 Run 1 Gasmeter coeff. .9980 Bar. Pres. 29.01 in. Hg H_2O 15 %

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	XAD2	Imp.	Meter (In/Out)		Oxygen (%v/v)
	1130	383.31												
D - 6	40	386.49	.10	1.95	6.51	8.5	350	275	245	36.8	50	116	110	8.2
6	8.0	389.60	.10	1.87	9.64	8.5	394	270		37	50	118	110	11.2
6	12	392.71	.10	1.87	2.78	9.0	382			42	50	120	110	6.1
5	16	395.56	.08	1.50	5.59	8.0	382	265	245	42	50	122	110	7.1
5	20	398.54	.09	1.69	8.58	8.5	382			42	50	124	110	6.4
5	24	401.50	.09	1.69	1.57	8.5	382			42	50	126	111	8.1
4	28	404.20	.08	1.38	4.16	7.5	382	250	236	41.9	48	126	112	10.2
4	32	406.88	.07	1.33	6.82	7.0	380			41.9	48	127	112	6.2
4	36	409.53	.07	1.33	9.47	7.0	380			41.9	48	128	112	7.5
3	40	412.20	.07	1.33	2.13	6.5	380	250	236	41.9	48	129	113	10.2
3	44	414.65	.06	1.14	4.60	6.0	380			41.8	50	130	114	8.2
3	48	417.04	.06	1.14	7.08	6.0	380		240	41.8	50	130	114	9.9
2	52	419.20	.07	1.33	9.75	6.5	380	235	240	41.8	50	131	115	8.1
2	56	422.38	.07	1.34	2.42	7.0	380			41.8	50	132	115	8.9
2	60	425.04	.07	1.34	5.10	7.0	380			41.8	50	132	116	10.4
1	64	427.60	.06	1.15	7.58	6.5	375	230	260	41.8	50	132	116	8.2
1	68	430.07	.06	1.15	0.07	6.5	375			41.8	50	132	116	10.8
1	72	432.56	.06	1.15	2.56	6.5	375			41.8	50	132	116	14.1
A - 6	76	435.70	.10	1.92	5.77	10.1	375	272	260	41.8	50	128	117	9.2
6	80	438.72	.09	1.70	8.78	9.5	387			41.6	50	130	117	6.2
6	84	441.75	.09	1.70	1.80	9.5	387			41.6	50	130	117	9.3
5	88	444.70	.08	1.52	4.65	9.5	387	270	260	41.6	50	132	118	7.8
5	92	447.56	.08	1.52	7.51	9.0	387			41.6	50	132	118	8.2
5	96	450.20	.07	1.33	0.18	8.0	387			41.6	50	132	118	7.4
4	100	452.88	.07	1.33	2.85	7.5	385	275	275	39.5	38	132	118	8.7
	θ=	Vm=		^H=								Avg.=		

INTERPOLL LABORATORIES EPA MODIFIED METHOD 5 FIELD DATA SHEET

Job NSP/Red Wing
Source UNIT #2 STACK
Date 3-23-88 Test 1 Run 1

Operators RR & TJ.
Meter Box No. 8
Gasmeter coeff. .9980

Nozzle No.
Nozzle Dia. .475 in.
Bar. Pres. 29.01 in. Hg

Pitot No. 4-mm
Cp .84
H_2O 15 %

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	XAD2	Imp.	Meter (In/Out)		Oxygen (%v/v)
	1320													
4	104	455.47	.07	1.33	5.53	7.0	385			39.5	38	132	118	8.2
4	108	458.01	.06	1.14	8.01	7.0	385			39.5	38	133	119	7.4
3	112	460.54	.06	1.14	0.49	7.0	385	270	275	39.5	48	134	119	6.4
3	116	463.04	.06	1.16	2.99	7.0	375			39.5	48	134	119	8.0
3	120	465.53	.06	1.16	5.49	6.5	375			39.5	48	135	120	8.4
2	124	468.03	.06	1.16	7.99	6.5	375	270	250	39.5	48	135	120	8.3
2	128	470.30	.05	.97	0.28	6.0	375			39.5	50	135	120	7.5
2	132	472.58	.05	.97	2.56	5.0	375			39.5	50	135	120	5.8
1	136	474.79	.05	.97	4.85	5.0	375	270	230	39.5	50	135	120	5.3
1	140	476.84	.04	.77	6.90	4.5	375			39.5	50	135	120	9.8
1	144	478.94	.04	.77	8.94	4.5	375			39.6	50	135	120	9.0
B - 6	148	482.00	.09	1.74	2.00	10.0	375			39.6	50	132	120	7.3
6	152	485.22	.10	1.93	5.22	10.7	375	272	285	39.6	50	132	120	9.0
6	156	488.24	.09	1.74	8.27	10.0	375			39.7	51	133	120	8.9
5	160	491.11	.08	1.54	1.15	9.6	377			39.7	52	134	120	8.4
5	164	494.14	.09	1.74	4.21	10.0	377	272	275	40.7	55	134	120	9.6
5	168	497.25	.09	1.76	7.28	10.0	367			40.7	55	134	120	6.5
4	172	500.20	.08	1.56	0.18	9.0	367			40.7	55	134	121	6.6
4	176	503.10	.08	1.56	3.08	9.0	367	265	270	40.7	55	134	121	7.9
4	180	506.15	.09	1.76	6.16	9.5	367			41.5	54	134	121	8.0
3	184	508.90	.07	1.37	8.87	8.0	367			41.5	54	134	121	8.8
3	188	511.59	.07	1.37	1.59	8.0	367	265	275	41.5	54	134	122	8.2
3	192	514.44	.08	1.56	4.49	8.5	367			41.5	54	134	122	7.3
2	196	517.16	.07	1.36	7.21	8.0	370			41.5	54	135	122	8.3
2	200	519.92	.07	1.36	9.92	8.0	370	265	260	41.5	54	135	122	9.1
	θ=	Vm=		^H=								Avg.=		

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...TERFORD LABORATORIES EPA MODIFIED METHOD 5 FIELD DATA SHEET

Job NSP/Red Wing
Source UNIT #3 STACK
Date 3-23-88 Test 4 Run 1

Operators RR & T.J.
Meter Box No. 8
Gasmeter coeff. .9980

Nozzle No. 2mm5-7
Nozzle Dia. .425 In.
Bar. Pres. 29.01 In. Hg

Pitot No.
Cp .84
H_2O 14 %

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Des. Vol. (cf)	VAC. inHg	Temperatures (°F)							Oxygen
							Stack	Probe	Oven	XAD2	Imp.	Meter(In/Out)		(%V/V)
2	204	522.68	.07	1.36	2.64	8.0	370	270	245	40.5	58	136	122	11.7
1	208	525.20	.06	1.17	5.15	8.0	370			40.8	56	136	122	9.9
1	212	527.87	.07	1.32	7.87	8.1	370			40.8	56	136	122	8.6
1	216	530.39	.06	1.17	0.39	7.7	370		240	40.8	56	136	122	8.9
C- 6	220	533.63	.10	1.95	3.63	11.0	370			40.8	56	132	122	8.4
6	224	536.85	.10	1.93	6.85	11.0	375			40.7	56	134	122	12.3
6	228	540.01	.10	1.91	0.06	11.0	385	270	230	40.7	56	134	122	9.0
5	232	543.20	.10	1.91	3.27	11.0	385			40.7	56	134	122	6.0
5	236	546.48	.10	1.91	6.48	11.0	385			40.7	56	134	122	11.2
5	240	549.70	.10	1.91	9.69	11.0	385	275	260	40.7	56	134	122	7.2
4	244	552.78	.09	1.71	2.73	10.5	391			43.0	56	134	122	8.7
4	248	555.80	.09	1.71	5.76	10.0	391			43.0	56	134	122	11.6
4	252	558.89	.09	1.71	8.80	10.0	391	275	260	43.0	56	134	122	12.8
3	256	561.88	.09	1.71	1.83	10.0	391			43.0	56	134	122	7.4
3	260	564.72	.08	1.52	4.70	9.0	391			43.0	56	134	122	6.7
3	264	567.78	.09	1.72	7.74	9.5	386	265	266	40.9	56	134	122	10.7
2	268	570.65	.08	1.53	0.61	9.0	386			40.9	56	134	122	8.1
2	272	573.51	.08	1.53	3.48	9.0	386			40.9	56	134	122	9.5
2	276	576.32	.08	1.53	6.36	9.0	386	265	266	40.9	56	134	122	10.0
1	280	579.04	.07	1.34	9.04	8.5	386			40.9	56	134	122	7.7
1	284	581.32	.05	0.96	1.32	7.0	386			40.9	56	135	122	7.9
1	288	583.59	.05	.96	3.59	7.0	386			40	56	133	122	7.2
	(16.36)													
	(16.44)													
	θ= 288	Vm=200.28		^H=1.46								Avg.= 124.6		

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INTERPOLL LABORATORIES EPA MODIFIED METHOD 5 SAMPLE LOG SHEET

Job NSP/Red Wing
Source Unit #2 STACK
Cyclone: ☐ Yes ☒ No Filter holder: MM5
Analytes:
Field recovery spike added: ☒ Yes ☐ No

Date 3-24-88 Test 4 Run 2
No. of traverse points 24
Filter type: 4" Glass fiber
XAD-2 resin: 32 g Batch No. 14
Reference: EPA SW-846 Method 0010

Sample Train Leak Check:

Pretest: < 0.02 cfm at 15 in. Hg. (vac) ☒
Postest: 100 cfm at 15 in. Hg. (vac) ☒

Semivolatile Catch Data:

No.s of filters used:

Recovery solvent(s)

☒ MeCl2 * MeOH (50:50 v/v)
☐ other(s)

No. of bottles for condensate trap catch:
Samples recovered by:

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Condensate trap	951	393	558
Condensate trap			
Condensate trap			
Impingers	250	250	0
Desiccant	1341	1300	41
Total			599

Integrated Gas Sampling Data:

Bag Pump No. B4 Box No. 12 Bag No. 2

Bag Material: 4-layer Aluminized Tedlar Size: 44 L

Pretest leak check: .00 cc/min at 10 in. Hg.

Time start: 945 (HRS) 3-24-88 Time end: 958 (HRS) 3-25-88

Sampling rate: 100 cc/min O2 Analyzer S/N: 8

Rev.1 CF-026

INTERPOLL LABORATORIES EPA MODIFIED METHOD 5 FIELD DATA SHEET

Job NSP/Red Wing
Source Unit #2 STACK
Date 3-24-88 Test 4 Run 2

Operators RR & T.J.
Meter Box No. 8
Gasmeter coeff. .9980

Nozzle No. mm-5-7
Nozzle Dia. .425 in.
Bar. Pres. 28.75 in. Hg

Pitot No. 4-mm
Cp .84
H_2O 15 %

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	XAD2	Imp.	Meter (In/Out)		Oxygen (%v/v)
	945	583.82												
C - 6	4	586.97	.10	1.93	7.01	8.0	350	235	240	44	50	110	106	8.7
6	8	590.07	.10	1.87	0.14	8.5	377			44	50	112	106	9.3
6	12	593.20	.10	1.87	3.27	9.0	377	264	215	41.3	48	114	106	10.1
5	16	596.21	.09	1.67	6.24	9.0	383			41.3	48	116	106	7.9
5	20	599.30	.10	1.86	9.38	9.5	383		260	41.3	48	117	106	8.7
5	24	602.45	.10	1.86	2.51	9.5	383	264		41.3	48	120	106	5.7
4	28	605.43	.09	1.68	5.50	9.5	383			41.3	48	120	106	7.2
4	32	608.45	.09	1.68	8.48	9.5	383			42	46	120	106	8.0
4	36	611.48	.09	1.69	1.48	9.5	378	285	275	42	46	120	107	9.4
3	40	614.38	.08	1.51	4.30	9.0	378			42	46	122	107	6.4
3	44	617.22	.08	1.51	7.14	9.0	378			42	46	123	107	7.7
3	48	619.99	.08	1.52	9.98	9.0	373	250	230	40.2	46	124	107	7.8
2	52	622.66	.07	1.33	2.64	8.0	373			40.2	46	128	108	7.5
2	56	625.28	.07	1.34	5.32	8.0	373			40.2	46	128	108	9.2
2	60	627.90	.07	1.34	7.99	8.0	373	250	245	40.2	46	128	108	8.1
1	64	630.40	.06	1.14	0.47	7.5	373			40.2	46	128	109	9.7
1	68	632.90	.06	1.15	2.95	7.5	373			40.2	46	128	110	7.5
1	72	635.43	.06	1.15	5.43	7.5	373	250	245	40.2	46	128	110	7.5
D 6	76	638.45	.09	1.72	8.46	9.5	373			40.2	46	120	112	7.8
6	80	641.48	.09	1.71	1.48	9.8	373			40.2	47	122	112	8.1
6	84	644.42	.09	1.70	4.48	10.0	373	250	245	40.2	47	124	112	7.3
5	88	647.35	.08	1.53	7.34	9.0	373			40.2	47	124	112	7.3
5	92	650.24	.08	1.53	0.19	9.0	373			44.6	45	124	112	7.7
5	96	653.10	.08	1.51	3.03	9.0	384	275	240	44.6	45	125	112	7.1
4	100	655.90	.08	1.51	5.87	9.0	384			44.6	45	125	112	9.7
	θ=	Va=		^H=								Avg.=		

INTERPOLL LABORATORIES EPA MODIFIED METHOD 5 FIELD DATA SHEET

Job NSP/Red Wing
Source UNIT #2 STACK
Date 3-24-88 Test 4 Run 2
Operators RR & TJ
Meter Box No. 7
Gasmeter coeff. .9980
Nozzle No. mm-5 - 7
Nozzle Dia. .423 in.
Bar. Pres. 28.75 in. Hg
Pitot No. 4-mm
Cp .84
H_2O 14 %

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	XAD2	Imp.	Meter (In/Out)		Oxygen (%V/V)
4	104	658.60	.07	1.32	8.53	8.5	384			44.6	45	125	112	?3
4	108	661.24	.07	1.32	1.19	8.5	384			44.6	45	125	112	7.4
3	112	663.83	.07	1.32	3.85	8.5	384	250	250	44.6	45	126	112	7.4
3	116	666.44	.07	1.32	6.51	8.0	384			43.5	45	126	112	5.6
3	120	669.07	.07	1.32	9.17	8.5	384			43.5	45	126	112	11.3
2	124	671.60	.06	1.13	1.64	8.0	384	265	245	43.5	45	127	113	6.0
2	128	674.15	.06	1.15	4.12	8.0	375			43.5	45	127	113	.4
2	132	676.65	.06	1.15	6.60	8.0	375			43.5	45	127	113	9.4
1	136	678.87	.05	.95	8.87	7.0	375	260	250	43.5	45	127	113	8.5
1	140	681.18	.05	.95	1.14	6.5	375			43.5	45	127	113	7.6
1	144	683.41	.05	.95	3.41	6.5	375			42.8	46	127	113	9.0
B- 6	148	686.56	.10	1.91	6.61	11.1	375	265	245	42.8	45	123	114	8.3
6	152	689.77	.10	1.90	9.80	11.1	375			42.9	45	124	114	7.8
6	156	692.91	.10	1.91	2.99	11.2	375			42.9	45	124	114	7.3
5	160	696.02	.09	1.72	6.02	10.5	375	260	245	42.9	45	125	114	8.2
5	164	699.04	.09	1.68	9.02	10.5	394			43	49	126	114	8.9
5	168	702.08	.09	1.68	2.02	10.5	394			43	49	126	114	4.6
4	172	704.90	.08	1.49	4.85	10.	394	260	245	43	49	126	114	12.0
4	176	707.73	.08	1.52	7.71	10.0	394			43	49	127	114	8.0
4	180	710.54	.08	1.52	0.58	10.0	394			43	49	127	114	7.5
3	184	713.25	.07	1.33	3.25	8.7	394	260	250	43	49	127	114	7.8
3	188	715.93	.07	1.33	5.93	9.0	394			42.3	47	128	114	9.0
3	192	718.60	.07	1.35	8.63	8.5	385			42.3	47	128	114	7.5
2	196	721.11	.06	1.16	1.12	8.5	385	260	250	42.3	47	128	114	7.5
2	200	723.60	.06	1.17	3.64	7.5	374			45	50	112	107	7.4
	θ=	Vm=		^H=								Avg.=		

START 820 3-25-88

* STOP 1545 3-24-88

NEW Volume = 719.40

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...ERPCC LABORATORIES EPA MODIFIED METHOD 5 FIELD DATA SHEET

Job USP/Red Wing
Source Unit #2 Stack
Date 3-25-88 Test 4 Run 2

Operators RP & T.J.
Meter Box No. 6
Gasmeter coeff. .9980

Nozzle No. mm5-7
Nozzle Dia. .425 in.
Bar. Pres. 28.60 in. Hg

Pitot No.
Cp .84
H_2O 14 %

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Des. Vol. (cf)	VAC. inHg	Temperatures (°F)							Oxygen (%v/v)
							Stack	Probe	Oven	XAD2	Imp.	Meter (In/Out)		
2	204	726.04	.06	1.15	6.11	8.0	374	236	275	38.8	49	115	106	9.5
1	208	728.33	.05	.96	8.37	7.0	374			38.8	49	117	107	9.5
1	212	730.59	.05	.96	0.63	7.0	374			38.8	49	118	107	8.6
1	216	732.90	.05	.96	2.90	7.0	374	242	250	38.8	49	119	107	8.2
A- 6	220	735.84	.09	1.73	5.94	9.0	374			38.8	49	119	107	9.9
6	224	739.15	.10	1.93	9.15	10.0	370			38.8	49	120	107	5.9
6	228	742.10	.09	1.74	2.19	10.0	370	242	250	38.8	49	120	107	8.8
5	232	745.15	.09	1.74	5.24	10.5	370			38.8	49	120	107	7.6
5	236	748.29	.09	1.74	8.29	10.5	370			38.8	49	120	108	8.3
5	240	751.20	.08	1.53	1.15	9.5	380	270	275	41.6	48	121	108	6.9
4	244	754.01	.08	1.53	4.01	9.0	380			41.6	48	121	108	9.9
4	248	756.95	.08	1.53	6.87	9.0	380			41.6	48	121	108	8.0
4	252	759.61	.07	1.34	9.55	9.0	380	276	275	41.6	48	121	108	7.6
3	256	762.28	.07	1.34	2.23	8.5	380			40.6	50	122	109	7.3
3	260	765.01	.07	1.34	4.92	8.5	380			40.6	50	123	109	8.5
3	264	767.61	.07	1.35	7.60	8.5	380	276	275	40.6	50	123	109	9.4
2	268	770.11	.06	1.15	0.09	8.0	380			40.6	50	123	109	5.3
2	272	772.58	.06	1.15	2.58	8.0	380			40.6	50	123	109	5.8
2	276	775.27	.07	1.35	5.27	8.5	380	260	265	40.6	50	123	109	7.5
1	280	777.53	.05	.96	7.54	7.5	380			40.6	50	124	109	5.4
1	284	780.03	.06	1.15	0.03	8.0	380			40.6	50	124	109	6.3
1	288	782.30	.05	.96	2.30	7.5	380			40.6	50	124	109	5.8
	(0958)													
	θ=288	Va=198.48		^H=1.44								Avg.=116.3		

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INTERPOLL LABORATORIES EPA MODIFIED METHOD 5 SAMPLE LOG SHEET

Job NSP/Red Wing
Source Unit #2 STACK
Cyclone: ☐ Yes ☒ No Filter holder: MM5
Analytes:
Field recovery spike added: ☒ Yes ☐ No

Date 3-25-88 Test 4 Run 3
No. of traverse points 24
Filter type: 4" Glass fiber
XAD-2 resin: g Batch No.
Reference: EPA SW-846 Method 0010

Sample Train Leak Check:

Pretest: < 0.02 cfm at 15 in. Hg. (vac) ☒
Postest: .00 cfm at 15 in. Hg. (vac) ☒

Semivolatile Catch Data:

No.s of filters used:

Recovery solvent(s)

☐ MeCl2 * MeOH (50:50 v/v)
☐ other(s)

No. of bottles for condensate trap catch:
Samples recovered by:

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Condensate trap	997	393	604
Condensate trap			
Condensate trap			
Impingers	200	200	0
Desiccant	1512	1464	48
Total			652

Integrated Gas Sampling Data:

Bag Pump No. B4 Box No. 12 Bag No. 3

Bag Material: 4-layer Aluminized Tedlar Size: 44 L

Pretest leak check: .00 cc/min at 10 in. Hg.

Time start: 1340 (HRS) Time end: 1840 (HRS)

Sampling rate: 100 cc/min O2 Analyzer S/N: 8

INTERPOLL LABORATORIES EPA MODIFIED METHOD 5 FIELD DATA SHEET

Job NSP/Red Wing
Source Unit #2 STACK
Date 3-25-88 Test 4 Run 3

Operators RR & T.J.
Meter Box No. 8
Gasmeter coeff. .9880

Nozzle No. mm5-7
Nozzle Dia. .425 in.
Bar. Pres. 28.60 in. Hg

Pitot No. 4-mm5
Cp .84
H_2O 14 %

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Des. Vol. (cf)	VAC. inHg	Temperatures (°F)							Oxygen (%v/v)
							Stack	Probe	Oven	XAD2	Imp.	Meter (In/Out)		
	1340	782.31												
A-6	4	785.30	.09	1.73	5.35	10.0	380	250	225	40.6	50	110	104	7.9
6	8	788.44	.10	1.87	8.49	10.5	390			40.6	50	112	104	8.5
6	12	791.55	.10	1.87	1.63	10.5	390			40.6	50	113	104	8.7
5	16	794.62	.09	1.69	4.62	10.0	390	250	245	40.6	50	114	104	9.3
5	20	797.54	.09	1.69	7.60	9.5	390			41.3	53	114	104	6.1
5	24	800.52	.09	1.69	0.59	9.5	390			41.3	53	114	104	6.5
4	28	803.49	.08	1.50	3.41	9.5	390	275	240	41.3	53	114	104	10.6
4	32	806.30	.08	1.51	6.24	9.5	387			41.3	53	114	104	7.4
4	36	808.91	.07	1.32	8.88	9.0	387			41.3	53	115	104	7.8
3	40	811.60	.07	1.32	1.52	9.0	387	270	240	39.8	49	115	105	9.3
3	44	814.23	.07	1.32	4.17	9.0	387			39.8	49	115	105	5.8
3	48	816.90	.07	1.32	6.82	9.0	387			39.8	49	115	105	10.7
2	52	819.27	.06	1.13	9.27	8.5	387	270	243	34.8	49	116	106	12.0
2	56	821.80	.06	1.13	1.73	8.5	387			39.8	49	118	106	11.3
2	60	824.24	.06	1.14	4.19	8.5	387			39.8	49	118	106	7.2
1	64	826.53	.05	.95	6.44	8.0	387	275	240	42.4	51	118	106	9.6
1	68	828.69	.05	.95	8.68	9.0	387			42.4	51	118	106	7.2
1	72	830.93	.05	.95	6.93	9.0	387			42.4	51	118	106	10.5
B-6	76	834.10	.10	1.89	4.10	11.0	387	275	240	42.4	51	118	106	8.0
6	80	837.20	.10	1.89	7.27	11.0	387			42.4	51	118	106	9.3
6	84	840.35	.10	1.89	0.44	11.0	387			43	52	118	106	10.0
5	88	843.40	.09	1.71	3.46	11.0	385	260	245	43	52	118	106	9.2
5	92	846.43	.09	1.70	6.46	11.0	391			43	52	118	106	7.4
5	96	849.32	.08	1.51	9.29	10.5	391			43.0	52	118	106	9.7
4	100	852.10	.08	1.51	2.12	10.5	391	274	235	40.8	55	118	106	8.6
	θ=	Va=		ΔH=1.37								Avg.=	115.3	

INTERPOLL LABORATORIES EPA MODIFIED METHOD 5 FIELD DATA SHEET

Job USO/Red Wing
Source Unit #2 STACK
Date 3-25-88 Test 4 Run 3

Operators RR & TJ.
Meter Box No. 8
Gasmeter coeff. .9980

Nozzle No. M5-2
Nozzle Dia. .425 in.
Bar. Pres. 28.60 in. Hg

Pitot No. M5-4
Cp .84
H_2O 14 %

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dev. Vol. (cf)	VAC. inHg	Temperatures (°F)							Oxygen (%v/v)
							Stack	Probe	Oven	XAD2	Imp.	Meter (In/Out)		
4	104	854.99	.08	1.51	4.95	9.5	391			40.8	55	119	108	5.5
4	108	857.79	.08	1.51	7.79	9.5	391			40.8	55	119	108	8.8
3	112	860.42	.07	1.32	0.48	9.8	391	274	240	40.8	55	119	108	7.7
3	116	863.06	.07	1.32	3.11	9.8	391			40.8	55	120	108	9.1
3	120	865.73	.07	1.32	5.77	10.5	391			40.8	55	120	108	6.2
2	124	868.23	.06	1.13	8.23	10.5	391	274	240	40.6	54	120	108	9.0
2	128	870.64	.06	1.13	0.69	10.5	392			40.6	54	120	108	9.3
2	132	873.10	.06	1.13	3.16	10.0	392			40.6	54	120	108	7.0
1	136	875.56	.06	1.13	5.62	10.0	392	270	245	40.6	54	121	109	8.6
1	140	877.90	.05	.95	7.87	10.0	392			40.6	54	122	109	8.1
1	144	880.12	.05	.95	0.12	10.0	392			40.6	54	122	109	12.5
C-6	148	883.31	.10	1.89	3.31	12.0	392	270	245	40.6	54	122	110	8.9
6	152	886.49	.10	1.89	6.49	12.0	392			41	53	122	110	8.2
6	156	889.67	.10	1.89	9.67	12.0	392			41	53	122	110	7.2
5	160	892.55	.08	1.52	2.52	11.0	392	270	245	41	53	122	110	5.8
5	164	895.35	.08	1.52	5.37	11.0	392			41	53	122	110	7.9
5	168	898.24	.08	1.52	8.22	11.0	392			41	53	122	110	7.5
4	172	900.90	.07	1.33	0.90	10.5	387	265	240	45.4	56	123	110	8.1
4	176	903.56	.07	1.34	3.57	10.5	387			45.4	56	123	110	7.3
4	180	906.25	.07	1.34	6.25	10.5	387			45.4	56	124	110	7.8
3	184	908.93	.07	1.34	8.93	10.5	387	265	240	45.4	56	124	110	7.4
3	188	911.10	.08	1.53	1.80	11.5	387			45.4	56	124	110	7.7
3	192	914.42	.07	1.34	4.48	10.5	387			45.4	56	124	110	8.2
2	196	917.00	.06	1.15	6.96	10.0	387	250	240	45.4	56	124	110	7.3
2	200	919.50	.06	1.15	9.44	10.0	384			45.2	55	124	110	7.8
	θ=	Vm=		^H=								Avg.=		

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CF-025

EAP... LAB... ORIL... EPA MODIFIED METHOD 5 FIELD DATA SHEET

Job USA/Red Wing
Source WOOD #2 STACK
Date 3-25-88 Test 4 Run 3

Operators RR & T.S.
Meter Box No. 8
Gasmeter coeff. .9950

Nozzle No. M5 - ?
Nozzle Dia. .425 In.
Bar. Pres. 28.60 In. Hg

Pitot No.
Cp .84
H_2O 14 %

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	XAD2	Imp.	Meter (In/Out)		Oxygen (%v/v)
2	204	922.00	.06	1.15	1.93	10.0	384			45.2	55	124	111	7.5
1	208	924.25	.05	.96	4.20	9.0	384			45.2	55	124	111	10.5
1	212	926.48	.05	.96	6.48	9.0	384	250	250	45.2	55	124	111	8.9
1	216	928.75	.05	.96	8.75	9.0	384			45.2	55	124	111	7.6
D-6	220	931.76	.09	1.73	1.79	12.5	384			45.2	55	124	112	8.5
6	224	934.80	.09	1.73	4.84	12.5	384	255	250	45.2	55	124	112	7.3
6	228	937.85	.09	1.73	7.89	12.7	384			45.2	55	125	113	7.5
5	232	940.76	.08	1.54	0.76	12.0	384			45.2	55	125	113	6.8
5	236	943.64	.08	1.54	3.64	12.0	384	251	250	45.2	55	125	114	8.8
5	240	946.53	.08	1.55	6.53	12.0	380			45.2	55	125	114	7.7
4	244	949.23	.07	1.35	9.23	11.5	380			45.2	55	126	114	8.1
4	248	952.12	.08	1.54	2.15	12.0	380	254	245	45.2	55	126	114	5.5
4	252	954.85	.07	1.37	4.88	11.4	380			45.2	55	127	114	9.4
3	256	957.37	.06	1.15	7.37	11.0	388	260	265	46.1	50	127	114	8.9
3	260	960.05	.07	1.34	0.07	11.5	388			46.1	50	127	115	7.2
3	264	962.56	.06	1.15	2.56	11.0	384			46.1	50	128	116	8.6
2	268	965.07	.06	1.15	5.07	11.0	388			46.1	50	128	116	9.5
2	272	967.56	.06	1.15	7.57	11.0	388	265	265	46.1	50	129	116	8.3
2	276	970.07	.06	1.15	0.07	11.0	388			46.0	50	130	116	6.9
1	280	972.12	.04	.77	2.12	9.0	388			46.0	50	130	117	7.2
1	284	973.91	.03	.58	3.90	7.8	388	265	265	46.0	50	130	117	8.7
1	288	975.67	.03	.58	5.67	7.1	388			46.0	50	130	117	8.2
	(1840)													
	θ=288	Va=193.36		^H= 1.37								Avg.= 115.3		

Rev. 1

APPENDIX K

LABORATORY DATA SHEETS

EPA METHOD 3

LABORATORY REPORT

SUMMARY OF ORSAT DATA

Job: NSP/RedWing
Sampling Location: Unit #2/ESP Inlet
Sampling Date: 3-21-88
Analysis Date: 3-24-88
Technician:

Test 1
Run 1, 2, 3

(Particulate)

TEST NO. AND DATE	RUN NO.	RESULTS						
		INTEGRATED (BAG)			GRAB (BULB)			O_2 ANALYZER
		% CO_2	% O_2	% CO	% CO_2	% O_2	% CO	% O_2
3-24-88 / 1	1	12.30	6.90					
/ 1	2	11.60	8.20					
/ 1	3	12.30	7.00	—				

LSC-05

Interpoll Inc.
(612)786-6020

EPA Method 3 Data Sheet (Orsat Analysis)

Technician Timothy Tuttle Thyra Donnell (Jr)
Orsat Analyzer No. 3
Job NSP/Red Wing
City/State _____ Fuel Type _____

Date of Analysis 3-24-88
Leak Check Performed ☒ YES ☐ NO
Source Unit #2
Test Site ESP Inlet

Sample Identification		Test/Run	Analysis No.	Buret Readings (cc)			Concentration (% v/v,dry)		F_o
				Zero Point	After CO_2	After O_2	CO_2	O_2	
Ambient Air				0.00	0.00	20.90	0.00	20.90	
5978-13	F	1/1	1	0.00	12.30	19.20	12.30	6.90	1.139
	B		2	0.00	12.30	19.20	12.30	6.90	1.139
			3						
			AVG				12.30	6.90	
-14	F	1/2	1	0.00	11.60	19.80	11.60	8.20	1.095
	B		2	0.00	11.60	19.80	11.60	8.20	1.095
			3						
			AVG				11.60	8.20	
-15	F	1/3	1	0.00	12.30	19.30	12.30	7.00	1.130
	B		2	0.00	12.30	19.30	12.30	7.00	1.130
			3						
			AVG				12.30	7.00	

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

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

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

(EPA Method 5) Impinger Wash (Wet Catch)
Gravimetric Analysis Lab: Organics/Inorganics

Date of Analysis 3-28-88 Data Sheet FR 42(160)

Technician MK Project No. _____

interpoll

Job USP REDWING Date 3-21-88
City/State REDWING MN. Log # 5978-03
Source UNIT 2
Test Site ESP INLET
Sample type WETCATCH Tech D.S.
Remarks: BLANK Test/Run 1/0
1 of 1

Special Handling _____

☑ Organics
Evap. Dish No. 2
Blk. (Solv) Wt. _____ g
E. Dish Tare Wt. ^{1}48.7666 g
E. Dish + Sample Wt. $^{2}_{3}$ g 48.7666

☐ Inorganics
Evap. Dish No. _____
E. Dish Tare Wt. _____ g
E. Dish + Sample Wt. $^{1}_{2}$ g

Comments _____

interpoll

Job _____ Date _____
City/State _____ J/N _____
2 Source _____
Test Site _____
Sample type _____ Tech _____
Remarks: Test/Run _____
_____ of _____

Special Handling _____

☐ Organics
Evap. Dish No. _____
Blk. (Solv) Wt. _____ g
E. Dish Tare Wt. ^{1} g
E. Dish + Sample Wt. $^{2}_{3}$ g

☐ Inorganics
Evap. Dish No. _____
E. Dish Tare Wt. _____ g
E. Dish + Sample Wt. $^{1}_{2}$ g

Comments _____

interpoll

Job _____ Date _____
City/State _____ J/N _____
3 Source _____
Test Site _____
Sample type _____ Tech _____
Remarks: Test/Run _____
_____ of _____

Special Handling _____

☐ Organics
Evap. Dish No. _____
Blk. (Solv) Wt. _____ g
E. Dish Tare Wt. ^{1} g
E. Dish + Sample Wt. $^{2}_{3}$ g

☐ Inorganics
Evap. Dish No. _____
E. Dish Tare Wt. _____ g
E. Dish + Sample Wt. $^{1}_{2}$ g

Comments _____

RESULTS:

	1	2	3
ORGANICS	0.0000		
INORGANICS	—		

K-3

LSC-03G

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

Date of Analysis 3-27-88
Technician [signature]

EPA-M5 Acetone R.B SPEC ≤ 7.8 µg/cc
Actual acetone residue blank 2.67 µg/cc

(1)

interpoll

Job NSP REDWING Date 3-21-88
City/State REDWING MN. Log # 5978-02
Source UNIT 2
Test Site ESP INLET
Sample type P.W. Tech D.S.
Remarks: BLANK Test/Run 1/0
1 of 1

Special Handling Required
Evaporating Dish No. 17
Volume of acetone 75 (1) cc
E. Dish Tare Wt. 49.1014 (2) g
E. Dish + Sample Wt. 49.1016 (3) g
Comments

(2)

interpoll

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

Special Handling Required
Evaporating Dish No.
Volume of acetone (1) cc
E. Dish Tare Wt. (2) g
E. Dish + Sample Wt. (3) g
Comments

(3)

interpoll

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

Special Handling Required
Evaporating Dish No.
Volume of acetone (1) cc
E. Dish Tare Wt. (2) g
E. Dish + Sample Wt. (3) g
Comments

RESULTS:

1	2	3

LSC-01Y

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

Date of Analysis 3-27-88

Technician [signature]

---

(1)

interpoll

Job NSP/Red Wing Date 3-21-88
City/State ____ Log# 59780T
Source Unit # 2
Test Site ESP Inlet
Sample type ____ Tech D.S./JB
Remarks: Test/Run 1/0
1 of 1

Special Handling Required ____

Filter No. 0084
Filter Type 41
Filter Tare Wt. 0.9532 g (1)
Filter + Sample Wt. 0.9532 g (2)
Comments ____

---

(2)

interpoll

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

Special Handling Required ____

Filter No. ____
Filter Type ____
Filter Tare Wt. ____ g (1)
Filter + Sample Wt. ____ g (2)
Comments ____

---

(3)

interpoll

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

Special Handling Required ____

Filter No. ____
Filter Type ____
Filter Tare Wt. ____ g (1)
Filter + Sample Wt. ____ g (2)
Comments ____

RESULTS:

1	2	3

LSC-02P

(EPA Method 5) Impinger Wash (Wet Catch)
Gravimetric Analysis Lab: Organics/Inorganics
Date of Analysis 3-28-88 Data Sheet FR 42(160)

Technician MK Project No. _____

interpoll

(1)
Job NSP REDWING Date 3-21-88
City/State REDWING MN. Log # 5178-06
Source UNIT 2
Test Site ESP INLET
Sample type WETCATCH Tech D.S.
Remarks: Test/Run 1/1
1 of 1

Special Handling _____
☑ Organics
Evap. Dish No. 10
Blk. (Solv) Wt. 0.0000 g
E. Dish Tare Wt. 46.2551 g
E. Dish + Sample Wt. 48.2628 g
☐ Inorganics
Evap. Dish No. _____
E. Dish Tare Wt. _____ g
E. Dish + Sample Wt. _____ g
Comments _____

interpoll

(2)
Job NSP REDWING Date 3-21-88
City/State REDWING MN. Log # -09
Source UNIT 2
Test Site ESP INLET
Sample type WETCATCH Tech D.S.
Remarks: Test/Run 1/2
1 of 1

Special Handling _____
☑ Organics
Evap. Dish No. 12
Blk. (Solv) Wt. 0.0000 g
E. Dish Tare Wt. 46.3768 g
E. Dish + Sample Wt. 46.3848 g
☐ Inorganics
Evap. Dish No. _____
E. Dish Tare Wt. _____ g
E. Dish + Sample Wt. _____ g
Comments _____

interpoll

(3)
Job NSP REDWING Date 3-21-88
City/State REDWING MN. Log # -12
Source UNIT 2
Test Site ESP INLET
Sample type WETCATCH Tech D.S.
Remarks: Test/Run 1/3
1 of 1

Special Handling _____
☑ Organics
Evap. Dish No. 13
Blk. (Solv) Wt. 0.0000 g
E. Dish Tare Wt. 45.0094 g
E. Dish + Sample Wt. 45.0175 g
☐ Inorganics
Evap. Dish No. _____
E. Dish Tare Wt. _____ g
E. Dish + Sample Wt. _____ g
Comments _____

RESULTS:

	1	2	3
ORGANICS	0.0077	0.0080	0.0081
INORGANICS	—	—	—

LSC-03G

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

Date of Analysis 3-27-88
Technician [signature]

EPA-M5 Acetone R.B SPEC ≤ 7.8 µg/cc
Actual acetone residue blank 2.67 µg/cc

(1)

interpoll

Job NSP REDWING
City/State Redwing Minn
Source Unit 2 Inlet to ESP
Test Site INLET DUCT
Sample type PW
Remarks: M-5

Date 3-21-88
Log # 5928-05
Tech JB
Test/Run 1/1
1 of 12

Special Handling Required
Evaporating Dish No. 73
Volume of acetone 275 cc
E. Dish Tare Wt. 74.0953 g
E. Dish + Sample Wt. 78.5100 g
Comments

(2)

interpoll

Job NSP REDWING
City/State REDWING MN
Source UNIT 2
Test Site ESP INLET
Sample type PW
Remarks:

Date 3-21-88
Log # -03
Tech D.S.
Test/Run 1/2
1 of 1

Special Handling Required
Evaporating Dish No. 74
Volume of acetone 200 cc
E. Dish Tare Wt. 77.3084 g
E. Dish + Sample Wt. 85.1821 g
Comments

(3)

interpoll

Job NSP REDWING
City/State REDWING MN.
Source UNIT 2
Test Site ESP INLET
Sample type PW
Remarks:

Date 3-21-88
Log # -11
Tech D.S.
Test/Run 1/3
1 of 1

Special Handling Required
Evaporating Dish No. 75
Volume of acetone 175 cc
E. Dish Tare Wt. 80.8197 g
E. Dish + Sample Wt. 86.8390 g
Comments

RESULTS:

1/4.4140 K-factor 2/7.8730 3/6.0188

LSC-01Y

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

Date of Analysis 3-27-88
Technician [signature]

---

(1)

interpoll

Job NSP/RedWing Date 3-21-88
City/State _____ Log# 5978-04
Source Unit # 2
Test Site ESP Inlet
Sample type _____ Tech JB
Remarks: Test/Run 1/1
1 of 1

Special Handling Required _____

Filter No. 0078
Filter Type 4"
Filter Tare Wt. 0.9427 (1) g
Filter + Sample Wt. 2.1617 (2) g
Comments _____

---

(2)

interpoll

Job NSP/RedWing Date 3-21-88
City/State _____ Log# -07
Source Unit # 2
Test Site ESP Inlet
Sample type _____ Tech JB
Remarks: Test/Run 1/2
1 of 1

Special Handling Required _____

Filter No. 0079
Filter Type 4"
Filter Tare Wt. 0.9600 (1) g
Filter + Sample Wt. 2.1845 (2) g
Comments _____

---

(3)

interpoll

Job NSP/RedWing Date 3-21-88
City/State _____ Log# -10
Source Unit #2
Test Site ESP Inlet
Sample type _____ Tech JB
Remarks: Test/Run 1/3
1 of 1

Special Handling Required _____

Filter No. 0080
Filter Type 4"
Filter Tare Wt. 0.9630 (1) g
Filter + Sample Wt. 2.0653 (2) g
Comments _____

RESULTS:

1	2	3
1.2190	1.2245	1.1023

LSC-02P

EPA METHOD 3

LABORATORY REPORT

SUMMARY OF ORSAT DATA

Job: NSP/RedWing
Sampling Location: Unit #2 / Stack
Sampling Date: 3-21-88
Analysis Date: 3-24-88
Technician:

(Particulate) (NO_x)

TEST NO. AND DATE	RUN NO.	RESULTS						
		INTEGRATED (BAG)			GRAB (BULB)			O_2 ANALYZER
		% CO_2	% O_2	% CO	% CO_2	% O_2	% CO	% O_2
3-21-88 / /	1	11.84	7.76					
/ /	2	11.00	8.80					
/ /	3	11.01	8.79					

LSC-05

Interpoll Inc.
(612)786-6020

EPA Method 3 Data Sheet (Orsat Analysis)

Technician (Jr.) Timothy Fallon McDonald
Date of Analysis 3-24-88
Orsat Analyzer No. #3
Leak Check Performed ☑ YES ☐ NO
Job NSP/Red Wing
Source Unit #2
City/State ——— Fuel Type ———
Test Site Stack

Sample Identification		Test/Run	Analysis No.	Buret Readings (cc)			Concentration (% v/v,dry)		F_o
				Zero Point	After CO_2	After O_2	CO_2	O_2	
Ambient Air				0.00	0.00	20.90	0.00	20.90	
5978 25	F	1/1	1	0.00	11.84	19.60	11.84	7.76	1.109
	B		2	0.00	11.84	19.60	11.84	7.76	1.109
			3						
			AVG				11.84	7.76	
26	F	1/2	1	0.00	11.00	19.80	11.00	8.80	1.100
	B		2	0.00	11.00	19.80	11.00	8.80	1.100
			3						
			AVG				11.00	8.80	
27	F	1/3	1	0.00	11.01	19.80	11.01	8.79	1.098
	B		2	0.00	11.01	19.80	11.01	8.79	1.098
			3						
			AVG				11.01	8.79	

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

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

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

(EPA Method 5) Impinger Wash (Wet Catch)
Gravimetric Analysis Lab: Organics/Inorganics
Date of Analysis 3-28-88 Data Sheet FR 42(160)
Technician MK Project No. _____

interpoll

(1)
Job NSP/Red Wing Date 3-21-88
City/State _____ Log # 5978-18
Source UNIT #2
Test Site STACK
Sample type WET CATCH Tech RR
Remarks: BLANK. Test/Run 1/0
1 of 1

Special Handling _____
☑ Organics
Evap. Dish No. B
Blk. (Solv) Wt. _____ g
E. Dish Tare Wt. ^{1}48.6994 g
E. Dish + Sample Wt. $^{2}_{3}$ g 48.6994
☐ Inorganics
Evap. Dish No. _____
E. Dish Tare Wt. _____ g
E. Dish + Sample Wt. $^{1}_{2}$ g
Comments _____

interpoll

(2)
Job _____ Date _____
City/State _____ J/N _____
Source _____
Test Site _____
Sample type _____ Tech _____
Remarks: Test/Run _____
_____ of _____

Special Handling _____
☐ Organics
Evap. Dish No. _____
Blk. (Solv) Wt. _____ g
E. Dish Tare Wt. ^{1} g
E. Dish + Sample Wt. $^{2}_{3}$ g
☐ Inorganics
Evap. Dish No. _____
E. Dish Tare Wt. _____ g
E. Dish + Sample Wt. $^{1}_{2}$ g
Comments _____

interpoll

(3)
Job _____ Date _____
City/State _____ J/N _____
Source _____
Test Site _____
Sample type _____ Tech _____
Remarks: Test/Run _____
_____ of _____

Special Handling _____
☐ Organics
Evap. Dish No. _____
Blk. (Solv) Wt. _____ g
E. Dish Tare Wt. ^{1} g
E. Dish + Sample Wt. $^{2}_{3}$ g
☐ Inorganics
Evap. Dish No. _____
E. Dish Tare Wt. _____ g
E. Dish + Sample Wt. $^{1}_{2}$ g
Comments _____

RESULTS:

	1	2	3
ORGANICS	0.0000		
INORGANICS	—		

LSC-03G

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

Date of Analysis 3-27-88
Technician [signature]

EPA-M5 Acetone R.B SPEC ≤ 7.8 µg/cc
Actual acetone residue blank 0 µg/cc

1

interpoll

Job USP/Red Wing Date 3-21-88
City/State ____ Log # 5973-17
Source UNIT #2
Test Site STACK
Sample type PW Tech RR
Remarks: BLANK Test/Run 1/0
1 of 1

Special Handling Required ____

Evaporating Dish No. 50
Volume of acetone 100 cc (1)
E. Dish Tare Wt. 51.6434 g (2)
E. Dish + Sample Wt. 51.6434 g (3)
Comments ____

2

interpoll

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

Special Handling Required ____

Evaporating Dish No. ____
Volume of acetone ____ cc (1)
E. Dish Tare Wt. ____ g (2)
E. Dish + Sample Wt. ____ g (3)
Comments ____

3

interpoll

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

Special Handling Required ____

Evaporating Dish No. ____
Volume of acetone ____ cc (1)
E. Dish Tare Wt. ____ g (2)
E. Dish + Sample Wt. ____ g (3)
Comments ____

RESULTS:

1	2	3

ISC-01Y

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

Date of Analysis 3-27-88

Technician [signature]

1

interpoll

Job NSP/Red Wing — Date 3-21-88
City/State [illegible] — Log# 5978-16
Source Unit # 2
Test Site Stack
Sample type _____ — Tech RR
Remarks: — Test/Run 1/0
1 of 1

Special Handling Required _____

Filter No. 0064
Filter Type 41
Filter Tare Wt. 0.9423_1 g
Filter + Sample Wt. 0.9423_2 g
Comments _____

2

interpoll

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

Special Handling Required _____

Filter No. _____
Filter Type _____
Filter Tare Wt. $_{\_\_\_\_}$ g
Filter + Sample Wt. $_{\_\_\_\_}$ g
Comments _____

3

interpoll

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

Special Handling Required _____

Filter No. _____
Filter Type _____
Filter Tare Wt. $_{\_\_\_\_}$ g
Filter + Sample Wt. $_{\_\_\_\_}$ g
Comments _____

RESULTS:

1	2	3

LSC-02P

(EPA Method 5) Impinger Wash (Wet Catch)
Gravimetric Analysis Lab: Organics/Inorganics

Date of Analysis 3-28-88 Data Sheet FR 42(160)

Technician RR Project No. _____

interpoll

Job USP/Red Wing Date 3-21-88
City/State _____ Log # 5938-19.2
Source UNIT #2
Test Site STACK
Sample type Wet Catch Tech RR
Remarks: Test/Run 1/1
1 of 1

Special Handling _____

☑ Organics
Evap. Dish No. 44
Blk. (Solv) Wt. 0.0000 g
E. Dish Tare Wt. 47.6241 g
E. Dish + Sample Wt. $\frac{2}{3}$ g 47.6303

☐ Inorganics
Evap. Dish No. _____
E. Dish Tare Wt. _____ g
E. Dish + Sample Wt. $\frac{1}{2}$ g

Comments _____

interpoll

Job USP/Red Wing Date 3-21-88
City/State _____ Log # -21
Source UNIT #2
Test Site STACK
Sample type Wet Catch Tech RR
Remarks: Test/Run 1/2
1 of 1

Special Handling _____

☑ Organics
Evap. Dish No. 46
Blk. (Solv) Wt. 0.0000 g
E. Dish Tare Wt. 45.4237 g
E. Dish + Sample Wt. $\frac{2}{3}$ g 45.4301

☐ Inorganics
Evap. Dish No. _____
E. Dish Tare Wt. _____ g
E. Dish + Sample Wt. $\frac{1}{2}$ g

Comments _____

interpoll

Job USP/Red Wing Date 3-21-88
City/State _____ Log # -24
Source UNIT #2 STACK
Test Site STACK
Sample type WET CATCH Tech RR
Remarks: Test/Run 1/3
1 of 1

Special Handling _____

☑ Organics
Evap. Dish No. 49
Blk. (Solv) Wt. 0.0000 g
E. Dish Tare Wt. 48.6909 g
E. Dish + Sample Wt. $\frac{2}{3}$ g 48.6955

☐ Inorganics
Evap. Dish No. _____
E. Dish Tare Wt. _____ g
E. Dish + Sample Wt. $\frac{1}{2}$ g

Comments _____

RESULTS:

	1	2	3
ORGANICS	☑ 0.0062	☑ 0.0064	☑ 0.0046
INORGANICS	☑ —	☑ —	☑ —

LSC-03G

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

Date of Analysis 3-27-88
Technician [signature]

EPA-M5 Acetone R.B SPEC ≤ 7.8 µg/cc
Actual acetone residue blank 0 µg/cc

(1) interpoll

Job USP/Red Wing — Date 3-21-88
City/State — Log # 5975-191
Source UNIT #2
Test Site STACK
Sample type PW — Tech RR
Remarks: — Test/Run 1/1
1 of 1

Special Handling Required
Evaporating Dish No. 62
Volume of acetone 200 cc
E. Dish Tare Wt. 52.3028 g
E. Dish + Sample Wt. 52.3252 g
Comments

(2) interpoll

Job USP/Red Wing — Date 3-21-88
City/State — Log # -20
Source UNIT #2
Test Site STACK
Sample type PW — Tech RR
Remarks: — Test/Run 1/2
1 of 1

Special Handling Required
Evaporating Dish No. 66
Volume of acetone 225 cc
E. Dish Tare Wt. 48.3095 g
E. Dish + Sample Wt. 48.4204 g
Comments

(3) interpoll

Job USP/Red Wing — Date 3-21-88
City/State — Log # -23
Source UNIT #2
Test Site STACK
Sample type PW — Tech RR
Remarks: — Test/Run 1/3
1 of 1

Special Handling Required
Evaporating Dish No. 72
Volume of acetone 175 cc
E. Dish Tare Wt. 48.0392 g
E. Dish + Sample Wt. 48.1126 g
Comments

RESULTS:

1/ 0.0224 K-15 2/ 0.1109 3/ 0.0234

LSC-01Y

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

Date of Analysis 3-27-88

Technician [signature]

---

(1)

interpoll

Job NSP/Red Wing — Date 3-21-88
City/State [illegible] — Log# 5978-19
Source Unit #2
Test Site Stack
Sample type _____ — Tech RR
Remarks: — Test/Run 1/1
1 of 1

Special Handling Required _____

Filter No. 4"
Filter Type 0056
Filter Tare Wt. 0.9391 g
Filter + Sample Wt. 0.9475 g (1, 2)
Comments _____

---

(2)

interpoll

Job NSP/Red Wing — Date 3-21-88
City/State [illegible] — Log# -19.5
Source Unit #2
Test Site Stack
Sample type _____ — Tech RR
Remarks: — Test/Run 1/2
1 of 1

Special Handling Required _____

Filter No. 0061
Filter Type 4"
Filter Tare Wt. 0.9432 g
Filter + Sample Wt. 0.9424 g (1, 2)
Comments _____

---

(3)

interpoll

Job NSP/Red Wing — Date 3-21-88
City/State [illegible] — Log# -22
Source Unit #2
Test Site Stack
Sample type _____ — Tech RR
Remarks: — Test/Run 1/3
1 of 1

Special Handling Required _____

Filter No. 0062
Filter Type 4"
Filter Tare Wt. 0.9482 g
Filter + Sample Wt. 0.9602 g (1, 2)
Comments _____

RESULTS:

1	2	3
0.0084	-0.0008	0.0120

LSC-02P

Interpoll Inc.
(612)786-6020

EPA Method 7 Recovery and Analysis Data Sheet (1)

**********SOURCE**********	**********RECOVERY**********	**********ANALYTICAL**********
Job NSP/Red Wing	Date of Recovery 3-23-88	Date of Analysis 3-30-88
Source Unit #2	Recovered by TJK	Analyst BJN
Date of Sampling 3-21-88	Recovery volume 500 ml	Eluent ASIA
Test No(s) 1	Barometric at time 29.10 IN.HG.	Chromatograph: Dionex System 10

Samples collected in accordance with EPA Method 7, CFR Title 40, Part 60, Appendix A. Samples analyzed in accordance with EPA Method 7A by ion chromatography. Mercury manometers used to measure flask pressures/vacuums in sampling and in recovery. Thommen Model TX 19 jewel barometer calibrated against laboratory mercury in glass barometer used to measure field barometric pressure. Three field blanks are prepared and the average used to correct measured nitrate concentrations. All samples are analyzed as a batch using an IBM Instruments Inc. Model LC/9540 Chromatograph Data Integrator. The integrator is programmed to give the actual concentration of the 500 ml recovered sample even if a subsequent dilution was made. The dilution is indicated here as well as on the chromatogram.

$$C_{RS} = DF(C_{DS}) \qquad M_{NO_3^-} = (C_{RS} - \overline{C}_B)V_R \qquad \overline{C}_B = (C_{B1} + C_{B2} + C_{B3})/3$$

where:

C_{RS} = concentration of nitrate in 500 ml recovered sample in ug/ml

DF = dilution factor

C_{DS} = concentration of nitrate of a 500 ml recovered sample which has been diluted by a factor of DF to bring it into the proper range for the ion chromatograph. This value is an intermediate number and is not outputted by the electronic integrator which is programmed to output the concentration of the original undiluted 500 ml recovered sample.

$M_{NO_3^-}$ = total mass of nitrate in micrograms in the 500 ml recovered sample and/or in the 2L flask.

$\overline{C}_B$ = average conc. of nitrate in 500 ml recovered samples from the three field blanks (ug/ml)

C_{B1}, C_{B2}, C_{B3} = conc. of nitrate in 500 ml recovered samples from the three field blanks (ug/ml)

V_R = recovery volume for samples and field blanks in ml

Interpoll Inc.
(612)786-6020

EPA Method 7 Recovery and Analysis Data Sheet (2)

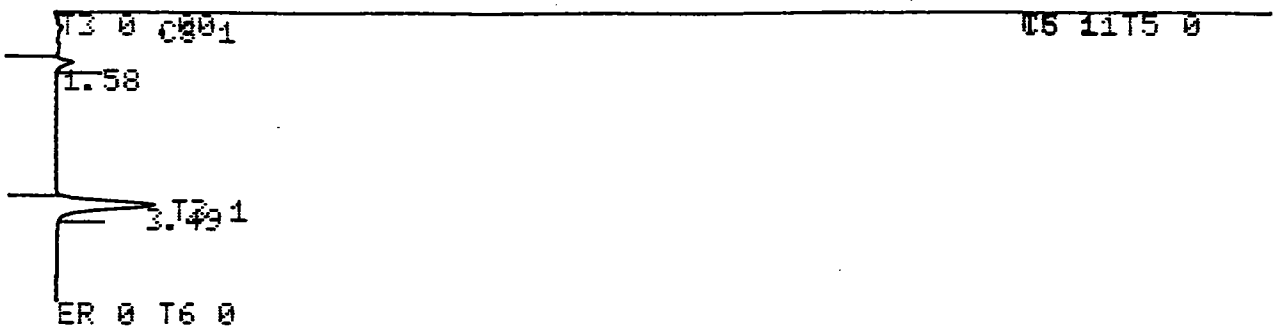
357

	Sample Log ID No.	Flask No.	Test/ Run	Final Flask Conditions t_f (°F)	+	-	Δ Pg (IN.HG.)	~~Chrom~~ Run No.	DF	Nitrate Concentration (ug/ml) Uncorr. for blank C_{RS}	Corr. for blank ($C_{RS} - \bar{C}_B$)	Total nitrate in Sample (ug) ($M_{NO_3^-}$)
1	5978-193	1	1-1-A	71°	✓		1.80	9	1X	1.74	1.74	870
2	-194	2	-B	|	✓		2.25	10	|	1.96	1.96	980
3	-195	3	-C	|	✓		2.15	11	|	1.78	1.78	890
4	-204	4	-	|	✓		2.15		|	1.89	1.89	945
5	-196	5	-D	|	✓		2.00	13	|	1.42	1.42	710
6	-197	6	2-1-A	|	✓		2.00	14	|	1.61	1.61	805
7	-198	43	-B	|	✓		1.40	15	|	1.70	1.70	850
8	-199	44	-C	|	✓		1.40	16	|	1.66	1.66	830
9	-200	45	-D	|	✓		2.40	17	|	1.66	1.66	830
10	-201	46	1-3-A	|	✓		2.00	19	|	1.54	1.54	770
11	-202	47	-B	|	✓		2.65	20	|	0.365	0.365	182
12	-203	48	-C	|	✓		1.90	21	|	1.65	1.65	825
13												
14												
15												
16												
17												
18												
19												
20												
21												
22												
23												
24												
25												
26												
27												
Blank 1	5978-204	79	Blank	71°	✓		0.80		1	CB1 <0.025		
Blank 2	-205	80	"	|	✓		1.10		1	CB2 <0.025		$\bar{C}_B$ = <0.025
Blank 3									1	CB3		

K-18

S-340(2) R-9/85

CHANNEL A INJECT 03/30/88 15:53:17



NOX 03/30/88 15:53:17 CH= "A" PS= 1.

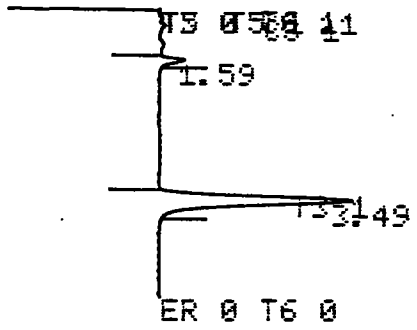
FILE 2. METHOD 5. RUN 1 INDEX 1 CALIB

ANALYST: BJN

NAME	TOTAL UG	RT	PK HT BC	RF
NO3	0.443	3.49	74219 01	
TOTALS	0.443		86269	

12 1

CHANNEL A INJECT 03/30/88 15:58:47



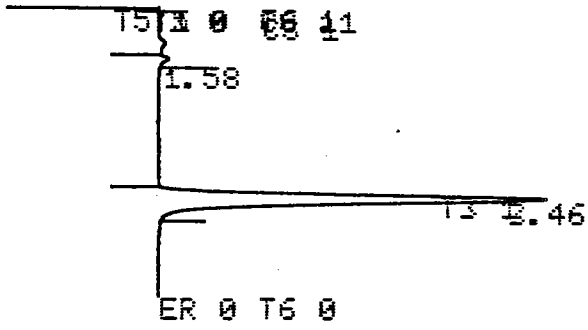
NOX 03/30/88 15:58:47 CH= "A" PS= 1.

FILE 2. METHOD 5. RUN 2 INDEX 2 CALIB

ANALYST: BJN

NAME	TOTAL UG	RT	PK HT	BC	RF
NO3	0.885	3.49	147829	01	
TOTALS	0.885		166083		

CHANNEL A INJECT 03/30/88 16:04:17



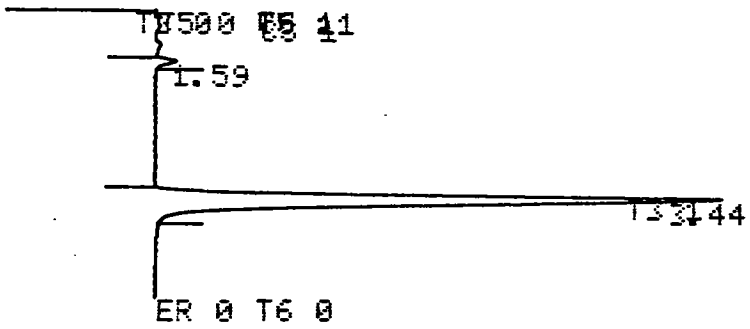
NOX 03/30/88 16:04:17 CH= "A" PS= 1.

FILE 2. METHOD 5. RUN 3 INDEX 3 CALIB

ANALYST: BJN

NAME	TOTAL UG	RT	PK HT	BC	RF
NO3	1.771	3.46	292413	01	
TOTALS	1.771		298953		

CHANNEL A INJECT 03/30/88 16:09:47



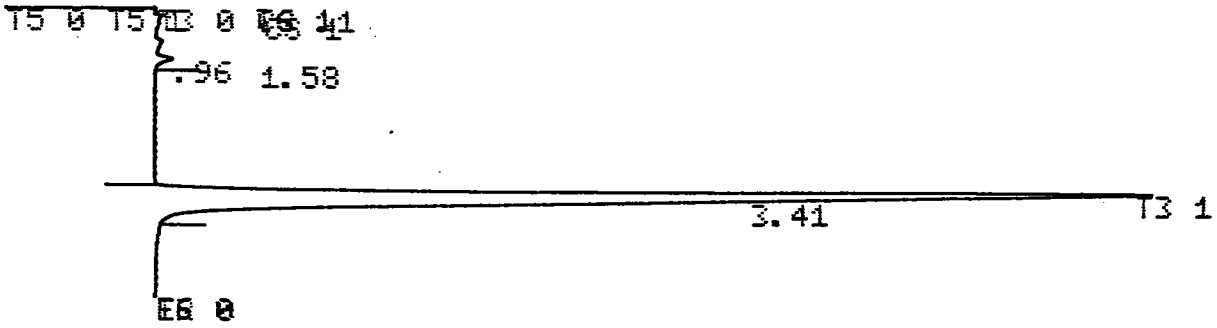
NOX 03/30/88 16:09:47 CH= "A" PS= 1.

FILE 2. METHOD 5. RUN 4 INDEX 4 CALIB

ANALYST: BJN

NAME	TOTAL UG	RT	PK HT	BC	RF
NO3	2.656	3.44	428859	01	
TOTALS	2.656		444120		

CHANNEL A INJECT 03/30/88 16:15:17



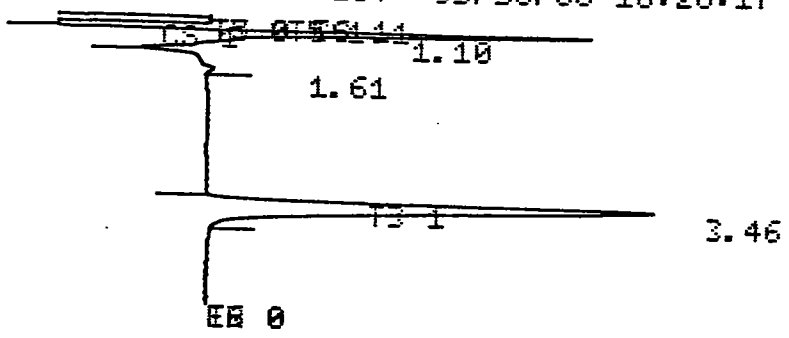
NOX 03/30/88 16:15:17 CH= "A" PS= 1.

FILE 2. METHOD 5. RUN 5 INDEX 5 CALIB

ANALYST: BJN

NAME	TOTAL UG	RT	PK HT	BC	RF
NO3	4.87	3.41	759909	01	
TOTALS	4.87		779261		

CHANNEL A INJECT 03/30/88 16:26:17



NOX 03/30/88 16:26:17 CH= "A" PS= 1.

FILE 2. METHOD 5. RUN 7 INDEX 2

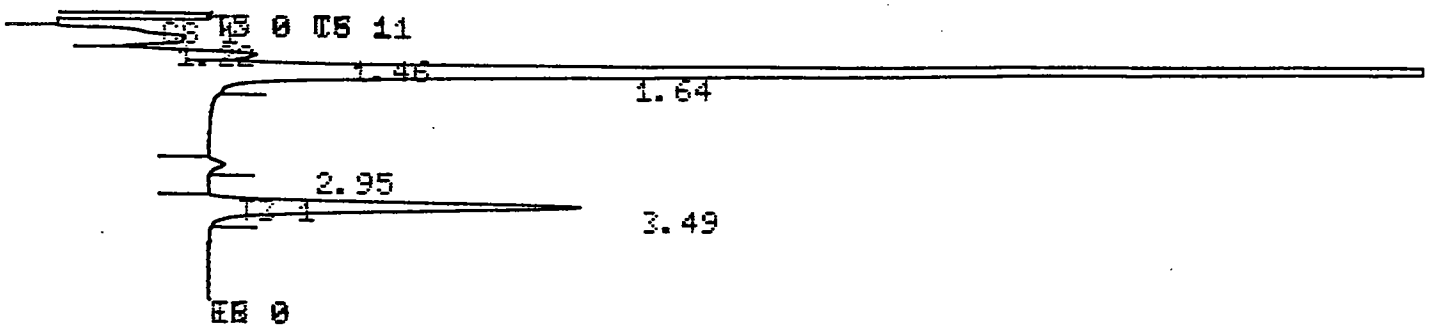
ANALYST: BJN

SAMPLE 2 EPA 378-2

SA	IS	XF
1.	0.	1.

NAME	TOTAL UG	RT	PK HT BC	RF
NO3	2.098	3.46	336544 01	160411.821
TOTALS	2.098		743835	

CHANNEL A INJECT 03/30/88 16:37:17



NOX 03/30/88 16:37:17 CH= "A" PS= 1.

FILE 2. METHOD 5. RUN 9 INDEX 4

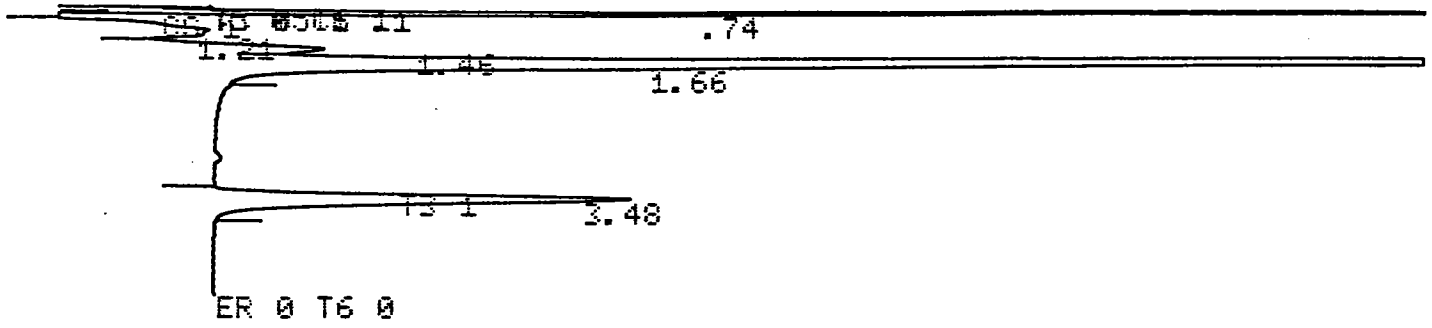
ANALYST: BJN

SAMPLE 4 5978-193

SA	IS	XF
1.	0.	1.

NAME	TOTAL UG	RT	PK HT	BC	RF
NO3	1.738	3.49	280853	01	161595.704
TOTALS	1.738		1548365		

CHANNEL A INJECT 03/30/88 16:42:47



NOX 03/30/88 16:42:47 CH= "A" PS= 1.

FILE 2. METHOD 5. RUN 10 INDEX 5

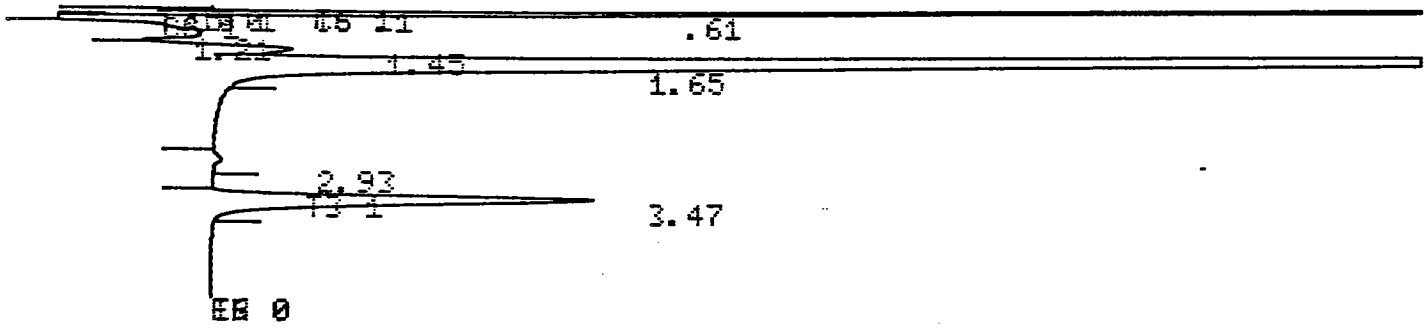
ANALYST: BJN

SAMPLE 5 5978-194

SA	IS	XF
1.	0.	1.

NAME	TOTAL UG	RT	PK HT	BC	RF
NO3	1.955	3.48	314363	01	160799.318
TOTALS	1.955		2733497		

CHANNEL A INJECT 03/30/88 16:48:17



NOX 03/30/88 16:48:17 CH= "A" PS= 1.

FILE 2. METHOD 5. RUN 11 INDEX 6

ANALYST: BJN

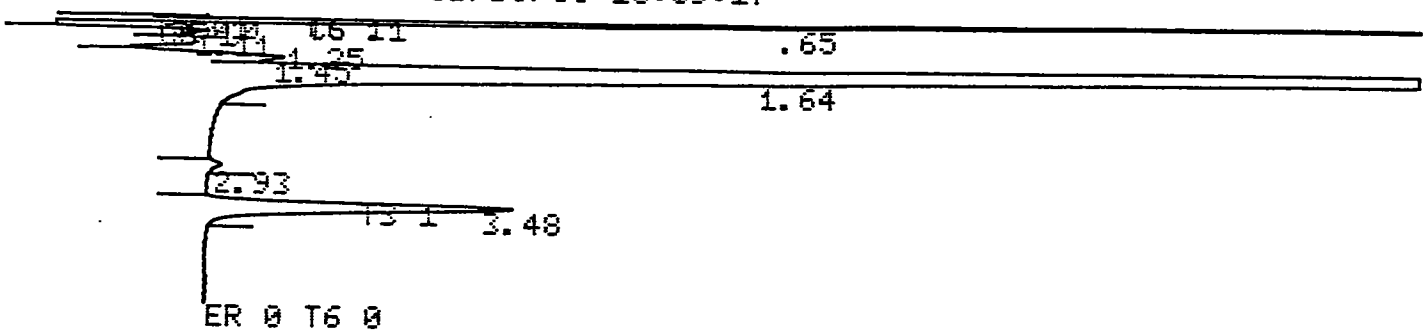
SAMPLE 6 5978-195

SA	IS	XF
1.	0.	1.

NAME	TOTAL UG	RT	PK HT	BC	RF
NO3	1.782	3.47	287704	01	161450.056
TOTALS	1.782		2687563		

13.5

CHANNEL A INJECT 03/30/88 16:59:17



NOX 03/30/88 16:59:17 CH= "A" PS= 1.

FILE 2. METHOD 5. RUN 13 INDEX 8

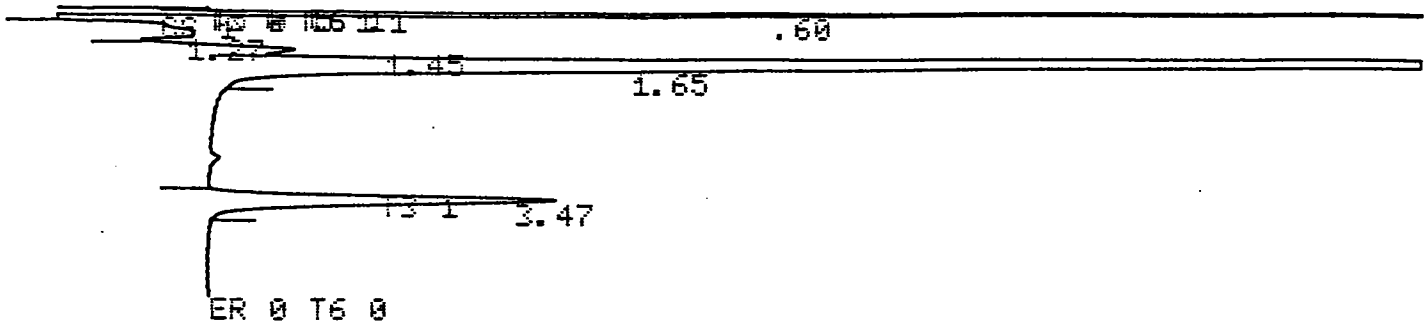
ANALYST: BJN

SAMPLE 8 5978-196

SA	IS	XF
1.	0.	1.

NAME	TOTAL UG	RT	PK HT	BC	RF
NO3	1.418	3.48	231373	01	163168.782
TOTALS	1.418		2744817		

CHANNEL A INJECT 03/30/88 17:04:47



NOX 03/30/88 17:04:47 CH= "A" PS= 1.

FILE 2. METHOD 5. RUN 14 INDEX 9

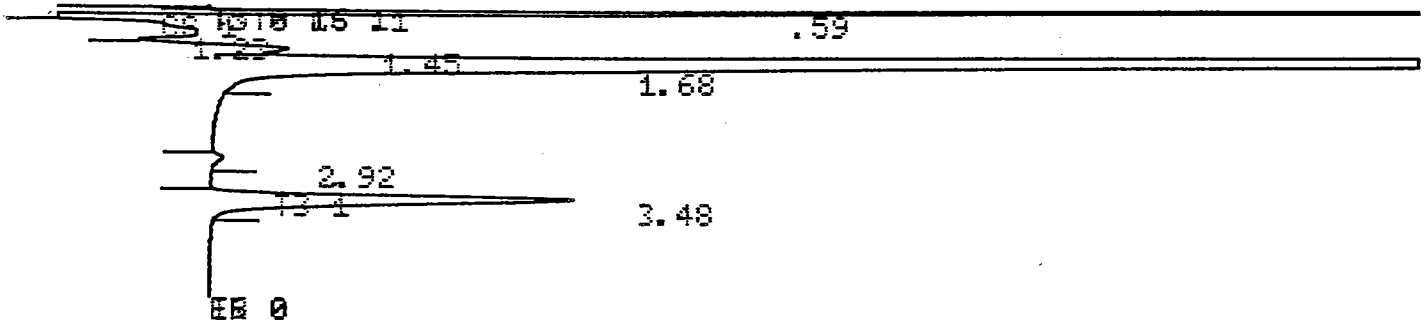
ANALYST: BJN

SAMPLE 9 5978-197

SA	IS	XF
1.	0.	1.

NAME	TOTAL UG	RT	PK HT	BC	RF
NO3	1.611	3.47	261147	01	162102.214
TOTALS	1.611		2654885		

CHANNEL A INJECT 03/30/88 17:10:17



NOX 03/30/88 17:10:17 CH= "A" PS= 1.

FILE 2. METHOD 5. RUN 15 INDEX 10

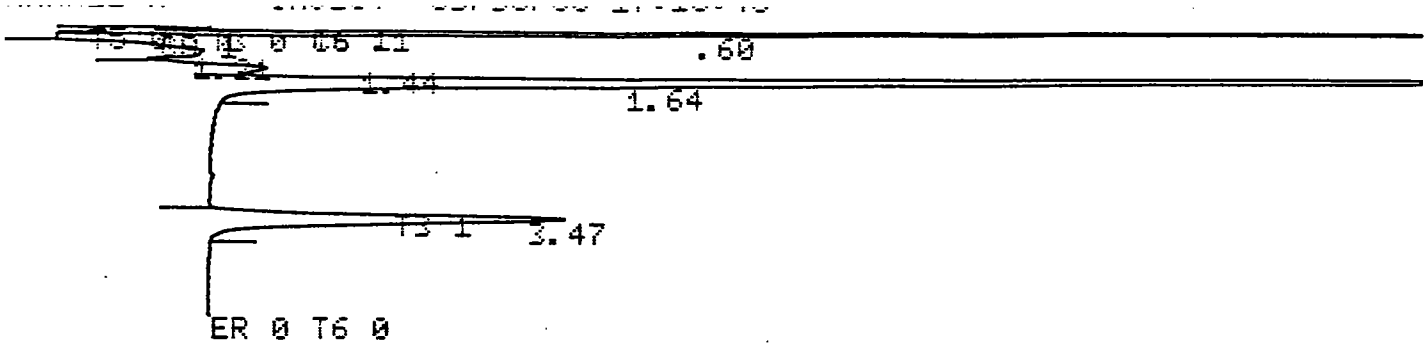
ANALYST: BJN

SAMPLE 10 5978-198

SA	IS	XF
1.	0.	1.

NAME	TOTAL UG	RT	PK HT	BC	RF
NO3	1.695	3.48	274197	01	161768.338
TOTALS	1.695		2684024		

137



NOX 03/30/88 17:15:48 CH= "A" PS= 1.

FILE 2. METHOD 5. RUN 16 INDEX 11

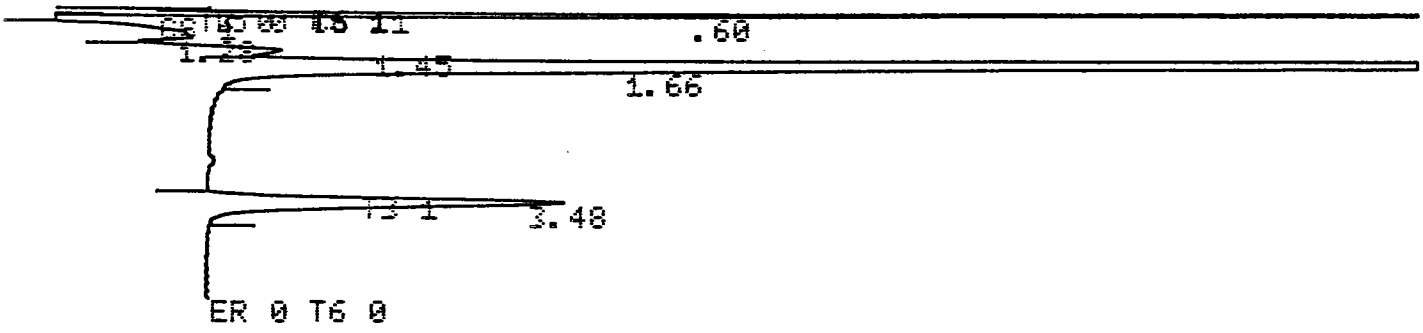
ANALYST: BJN

SAMPLE 11 5978-199

SA	IS	XF
1.	0.	1.

NAME	TOTAL UG	RT	PK HT	BC	RF
NO3	1.664	3.47	269469	01	161940.705
TOTALS	1.664		2645603		

CHANNEL A INJECT 03/30/88 17:21:18



NOX 03/30/88 17:21:18 CH= "A" PS= 1.

FILE 2. METHOD 5. RUN 17 INDEX 12

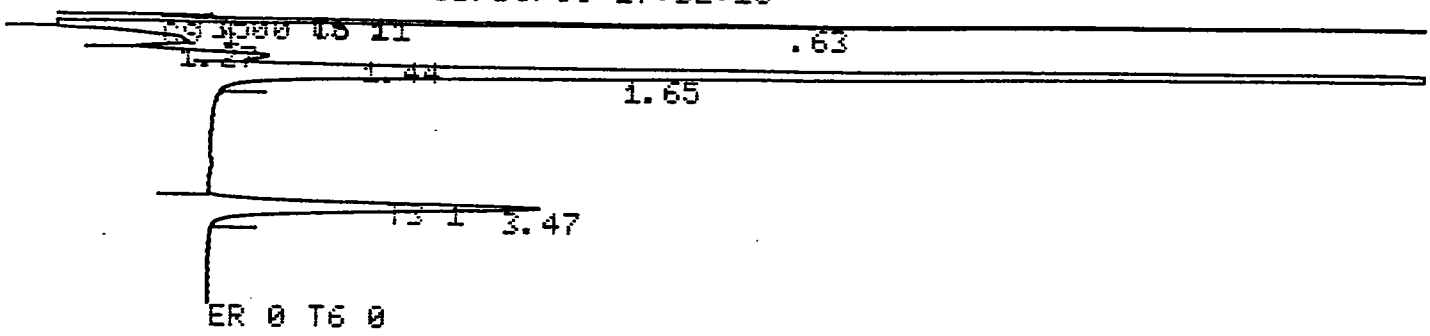
ANALYST: BJN

SAMPLE 12 5978-200

SA	IS	XF
1.	0.	1.

NAME	TOTAL UG	RT	PK HT	BC	RF
NO3	1.662	3.48	269032	01	161872.443
TOTALS	1.662		2652376		

CHANNEL A INJECT 03/30/88 17:32:18



NOX 03/30/88 17:32:18 CH= "A" PS= 1.

FILE 2. METHOD 5. RUN 19 INDEX 14

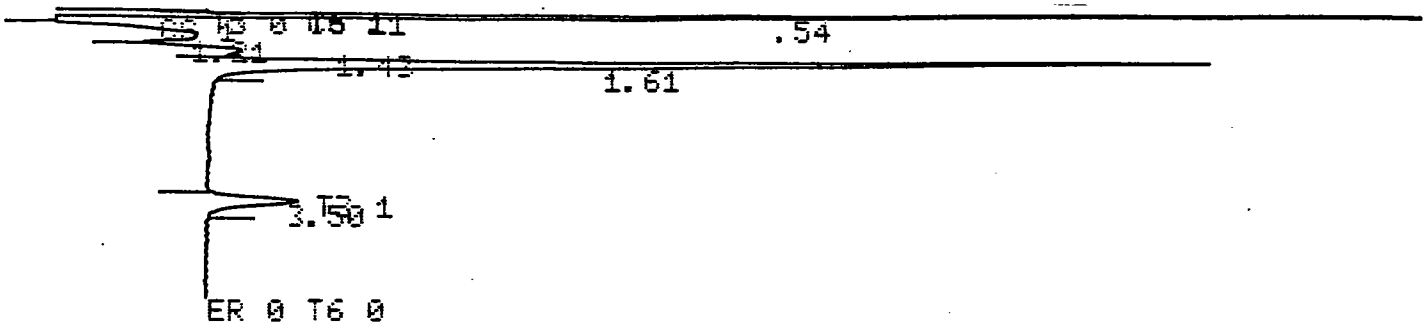
ANALYST: BJN

SAMPLE 14 5978-201

SA	IS	XF
1.	0.	1.

NAME	TOTAL UG	RT	PK HT	BC	RF
NO3	1.536	3.47	249552	01	162468.75
TOTALS	1.536		2621528		

CHANNEL A INJECT 03/30/88 17:37:48



NOX 03/30/88 17:37:48 CH= "A" PS= 1.

FILE 2. METHOD 5. RUN 20 INDEX 15

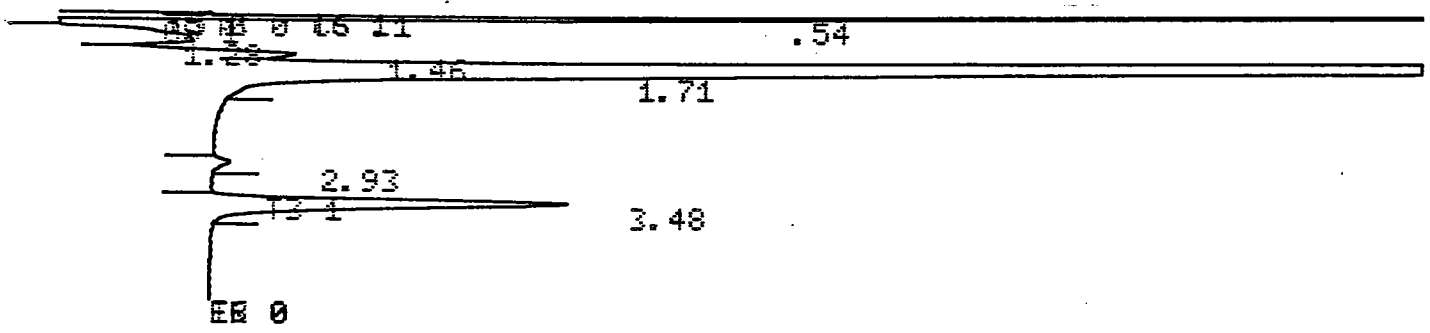
ANALYST: BJN

SAMPLE 15 5978-202

SA	IS	XF
1.	0.	1.

NAME	TOTAL UG	RT	PK HT	BC	RF
NO3	0.365	3.5	68648	01	188076.712
TOTALS	0.365		2131048		

CHANNEL A INJECT 03/30/88 17:43:18



NOX 03/30/88 17:43:18 CH= "A" PS= 1.

FILE 2. METHOD 5. RUN 21 INDEX 16

ANALYST: BJN

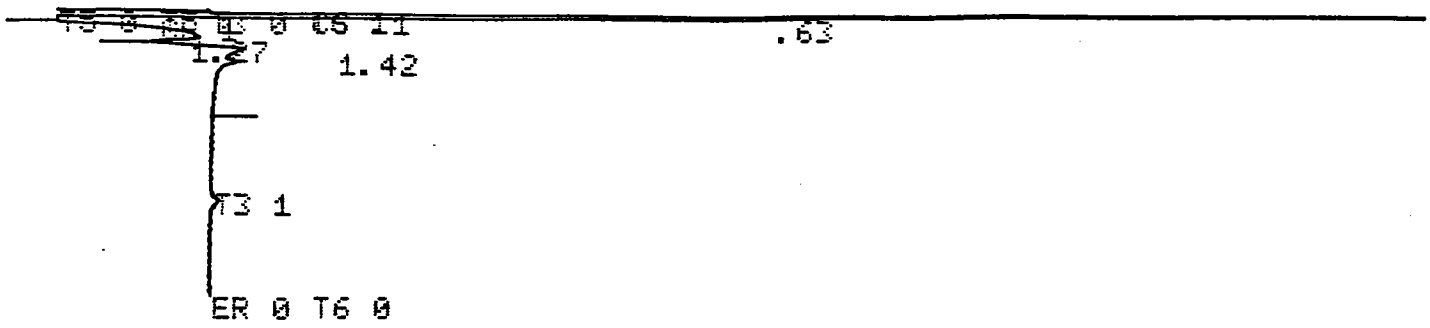
SAMPLE 16 5978-203

SA	IS	XF
1.	0.	1.

NAME	TOTAL UG	RT	PK HT	BC	RF
NO3	1.653	3.48	267765	01	161987.497
TOTALS	1.653		2684231		

14 0

CHANNEL A INJECT 03/30/88 17:48:48



NOX 03/30/88 17:48:48 CH= "A" PS= 1.

FILE 2. METHOD 5. RUN 22 INDEX 17

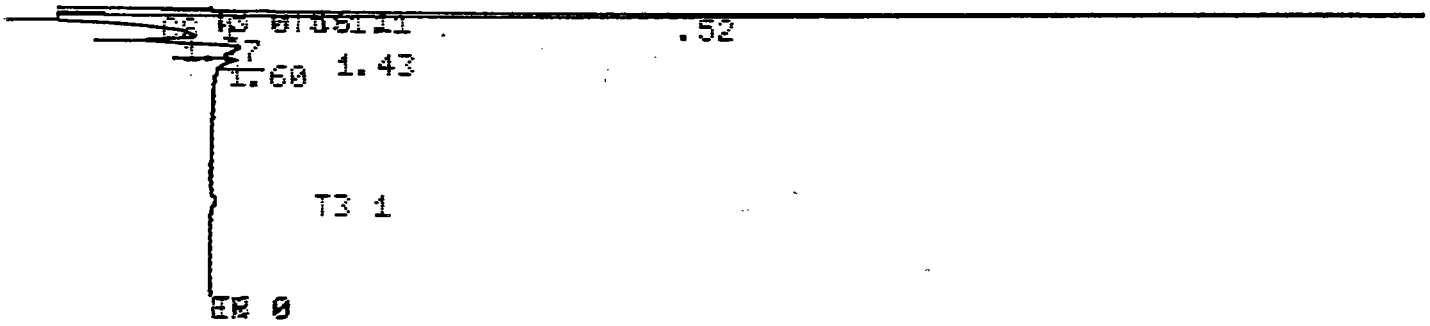
ANALYST: BJN

SAMPLE 17 BLANK*****

SA	IS	XF
1.	0.	1.

NAME	TOTAL UG	RT	PK HT BC	RF
TOTALS	0.	1274931		

CHANNEL A INJECT 03/30/88 17:54:18



NOX 03/30/88 17:54:18 CH= "A" PS= 1.

FILE 2. METHOD 5. RUN 23 INDEX 18

ANALYST: BJN

SAMPLE 18 BLANK*****

SA	IS	XF
1.	0.	1.

NAME	TOTAL UG	RT	PK HT BC	RF
TOTALS	0.	1283432		

14 1

EPA METHOD 3

LABORATORY REPORT

SUMMARY OF ORSAT DATA

Job: WSP/Reducing
Sampling Location: Unit # 2/Stack
Sampling Date: 3-22-88
Analysis Date: 3-24-88
Technician: [signature]

(Acid gas testing)

TEST NO. AND DATE	RUN NO.	RESULTS						
		INTEGRATED (BAG)			GRAB (BULB)			O_2 ANALYZER
		% CO_2	% O_2	% CO	% CO_2	% O_2	% CO	% O_2
3-22-88 2	1	12.00	7.80					
2	2	10.80	8.60					
2	3	12.00	7.82					

LSC-05

Interpoll Inc.
(612)786-6020

EPA Method 3 Data Sheet (Orsat Analysis)

Technician Timothy Kolle Tya Donald (Tya) Date of Analysis 3-24-89

Orsat Analyzer No. _____ Leak Check Performed ☒ YES ☐ NO

Job NSP/Red Wing Source Unit #2

City/State _____ Fuel Type RDF Test Site stack

Sample Identification		Test/Run	Analysis No.	Buret Readings (cc)			Concentration (% v/v,dry)		F_o
				Zero Point	After CO_2	After O_2	CO_2	O_2	
Ambient Air				0.00	0.00	20.90	0.00	20.90	
5978-32	F		1	0.00	12.00	19.80	12.00	7.80	1.092
	B ✓	2/1	2	0.00	12.00	19.80	12.00	7.80	1.092
			3						
			AVG				12.00	7.80	
-33	F		1	0.00	10.80	19.40	10.80	8.60	1.139
	B ✓	2/2	2	0.00	10.80	19.40	10.80	8.60	1.139
			3						
			AVG				10.80	8.60	
-34	F		1	0.00	12.00	19.82	12.00	7.82	1.090
	B ✓	2/3	2	0.00	12.00	19.82	12.00	7.82	1.090
			3						
			AVG				12.00	7.82	

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

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

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

Interpoll Inc.
(612)786-6020

IC Anion Analysis Laboratory

Dionex Model 10 With Hollow Fiber Suppressor

Analyst: BNT GWH

Date of Analysis: 4/4/88

Scale setting: 3

Eluent flow: 2 ml/min.

Job: NSP/Redwing (Acid Gases)

Suppressor/acid flow rate: 5 ml/min.

Detector:

Recorder:

Results of Fluoride Determination

Sample Name	Log No.	Chr. No.	Sample Vol. (cc)	Concentration (ppm)	Mass (mg)	Mass (meq)
Blank T2R0	5978-28		500	0.185	0.093	
T2R1	" -29		500	1.22	0.610	
T2R2	" -30		500	3.10	1.55	
T2R3	" -31		500	3.25	1.62	

LSC-08

Interpoll Inc.
(612)786-6020

IC Anion Analysis Laboratory

Dionex Model 10 With Hollow Fiber Suppressor

Analyst: BNt GWH

Suppressor/acid flow rate: 5 ml/min.

Date of Analysis: 4/4/88

Detector:

Scale setting: 3

Recorder:

Eluent flow: 2 ml/min.

Job: NSP/Redwing (Acid Gases)

Results of Chloride Determination

Sample Name	Log No.	Chr. No.	Sample Vol. (cc)	Concentration (ppm)	Mass (mg)	Mass (meq)
Blank T2R0	5978-28		500	0.048	0.024	
T2R1	" -29		500	827	413	
T2R2	" -30		500	1660	830	
T2R3	" -31		500	1670	835	

LSC-08

Interpoll Inc.
(612)786-6020

IC Anion Analysis Laboratory

Dionex Model 10 With Hollow Fiber Suppressor

Analyst: BNT GWH

Suppressor/acid flow rate: 5 ml/min.

Date of Analysis: 4/4/88

Detector:

Scale setting: 3

Recorder:

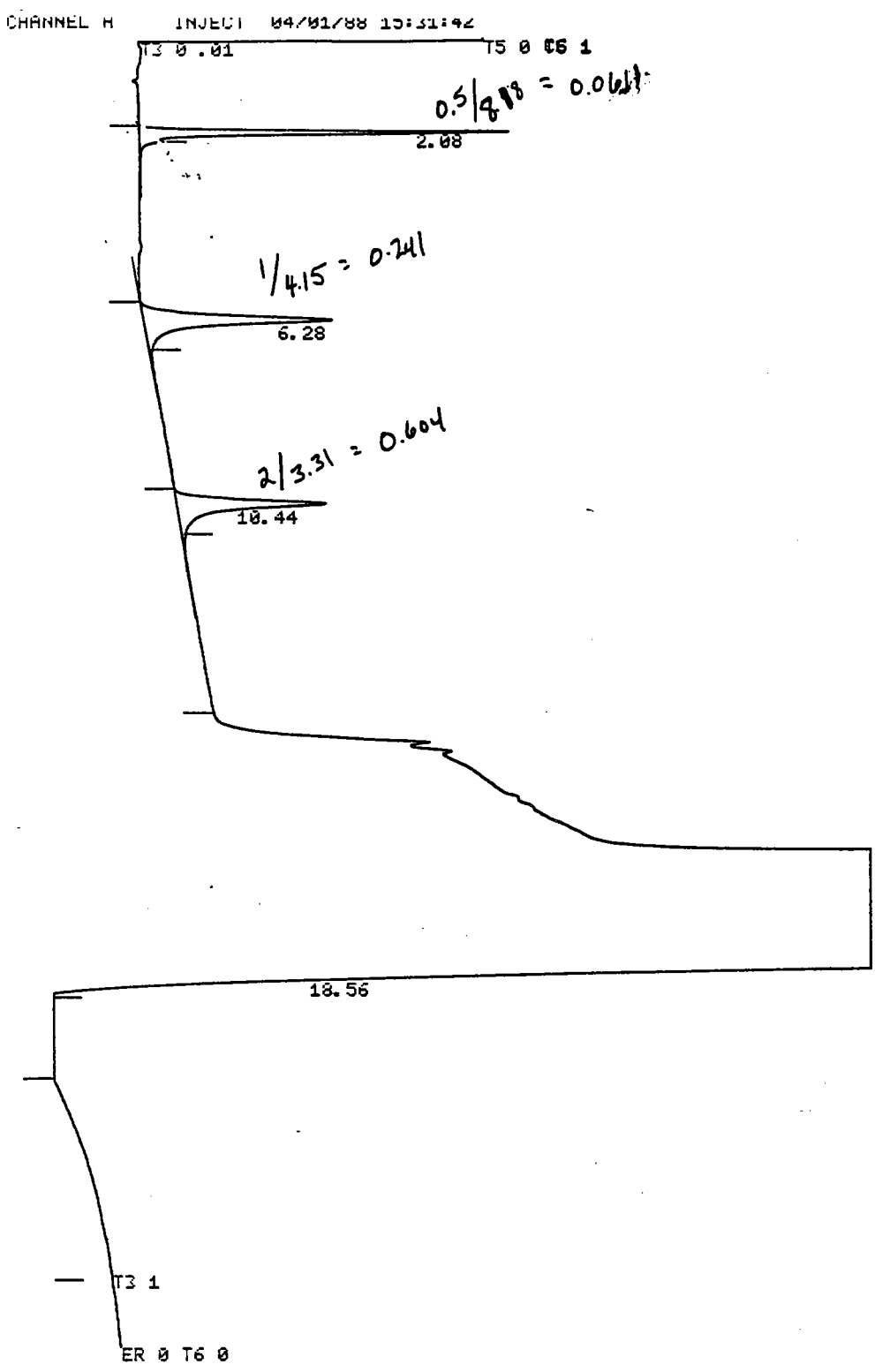
Eluent flow: 2 ml/min.

Job: NSP/Redwing (Acid Gases)

Results of Sulfate Determination

Sample Name	Log No.	Chr. No.	Sample Vol. (cc)	Concentration (ppm)	Mass (mg)	Mass (meq)
Blank T2R0	5978-28		500	<0.025	<0.012	<0.00025
T2R1	" -29		500	1590	795	16.6
T2R2	" -30		500	1460	730	15.2
T2R3	" -31		500	1870	935	19.5

LSC-08



040

ACID GASES 04/01/88 15:31:42 CH= "A" PS= 1.

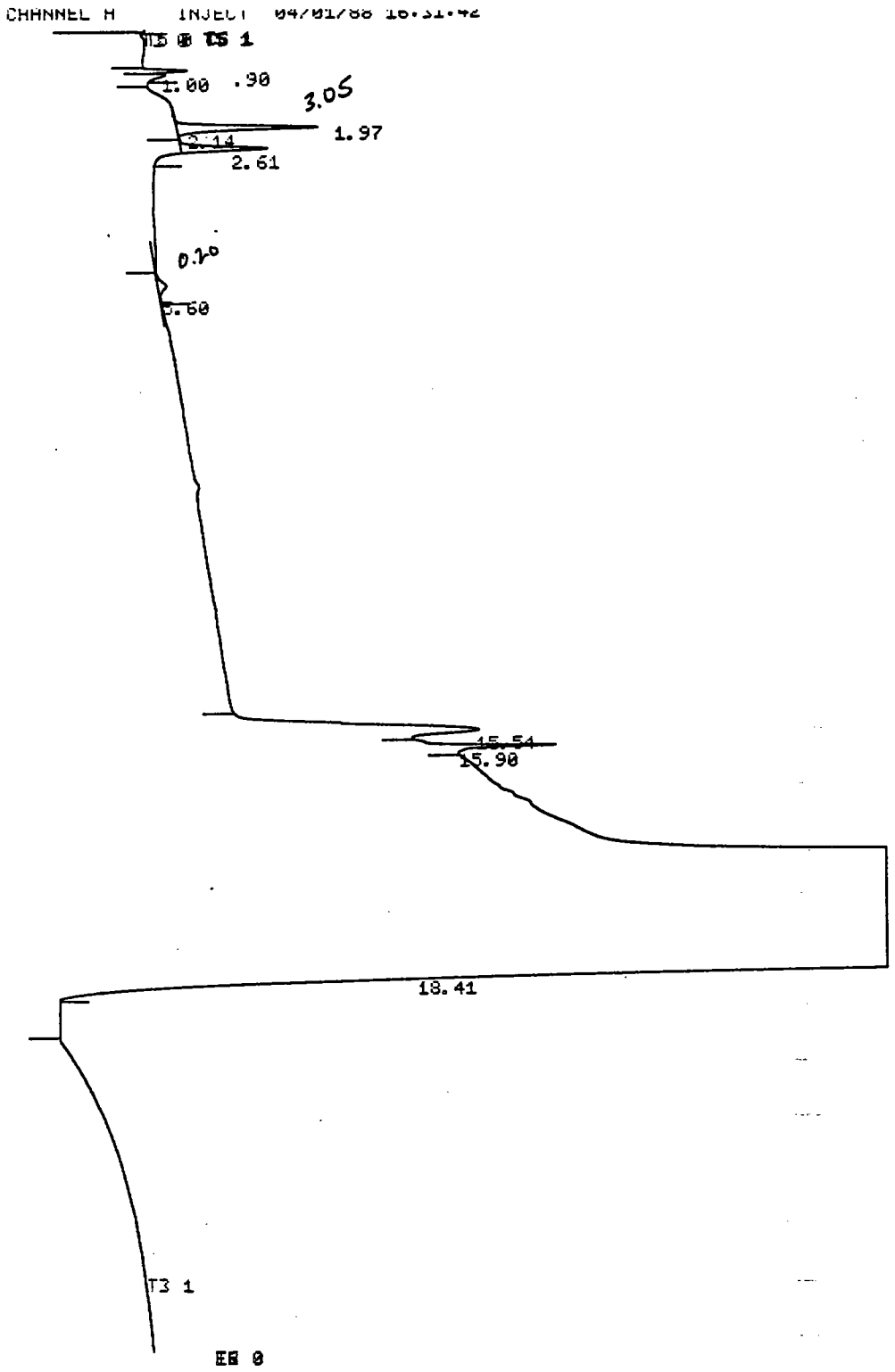
FILE 6. METHOD 5. RUN 1 INDEX 8 CALIB

ANALYST: BJN

NAME	UG/ML	RT	PK HT	BC	RF
F	0.5	2.08	455595	01	911189.333
CL	1.	6.28	233123	01	233122.667
BR	2.	10.44	181913	01	90956.333
TOTALS	3.5		2125495		

NEW FILE:

NAME	RF	RT
F	877676.444	2.1
CL	272062.5	6.34
BR	37459.125	10.57



043

ACID GASES 04/01/88 16:31:42 CH= "A" PS= 1.

FILE 6. METHOD 5. RUN 3 INDEX 2

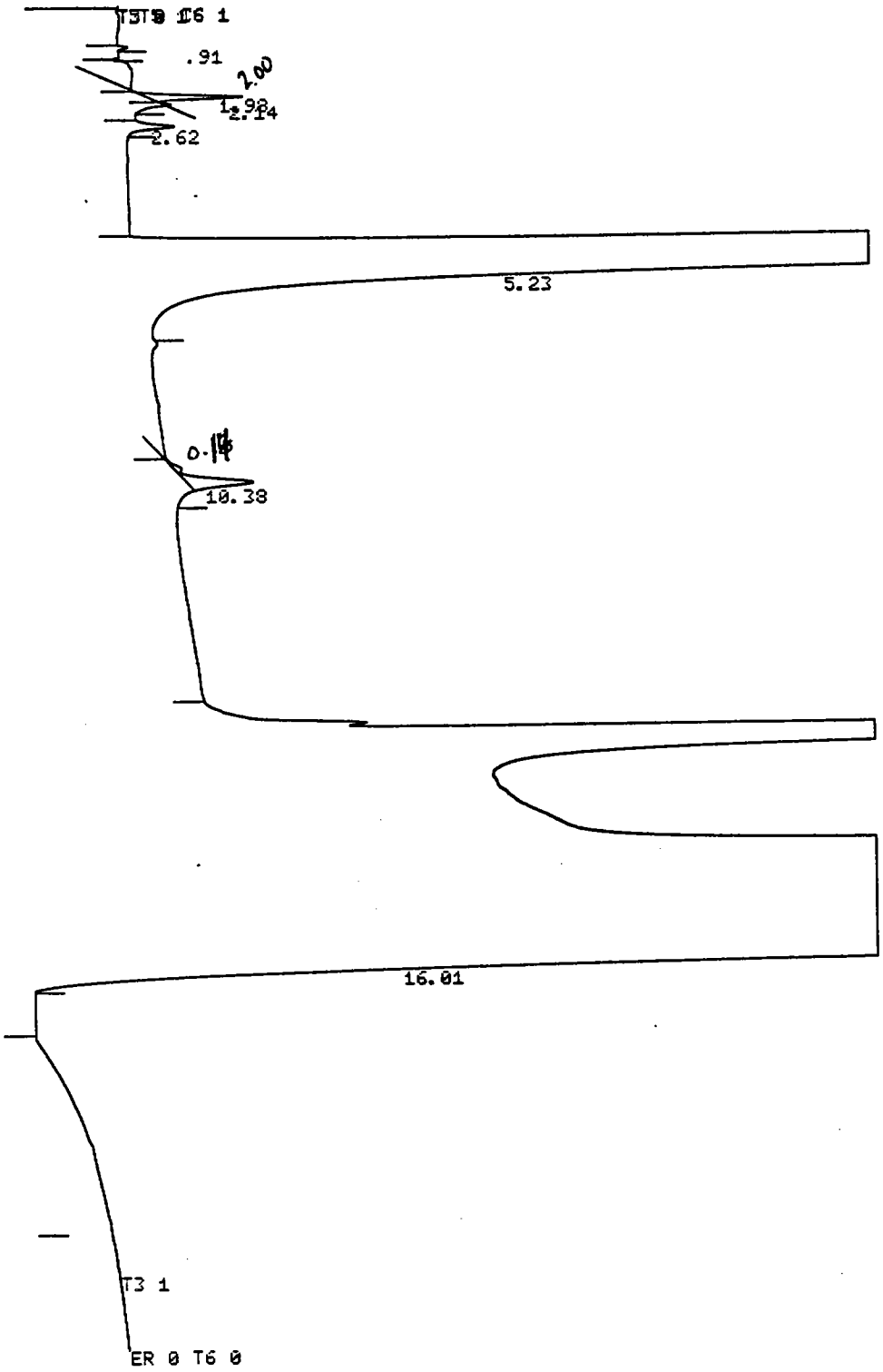
ANALYST: BJN

SAMPLE 2 5978-28

SA	IS	XF
1.	0.	1.

NAME	UG/ML	RT	PK HT	BC	RF
F	0.185	2.14	204253	02	877676.444
Cl	0.048	5.6			
TOTALS	0.233		2288575		

CHANNEL A INJECT 04/01/88 17:01:42



044

ACID GASES 04/01/88 17:01:42 CH= "A" PS= 1.

FILE 6. METHOD 5. RUN 4 INDEX 3

ANALYST: BJN

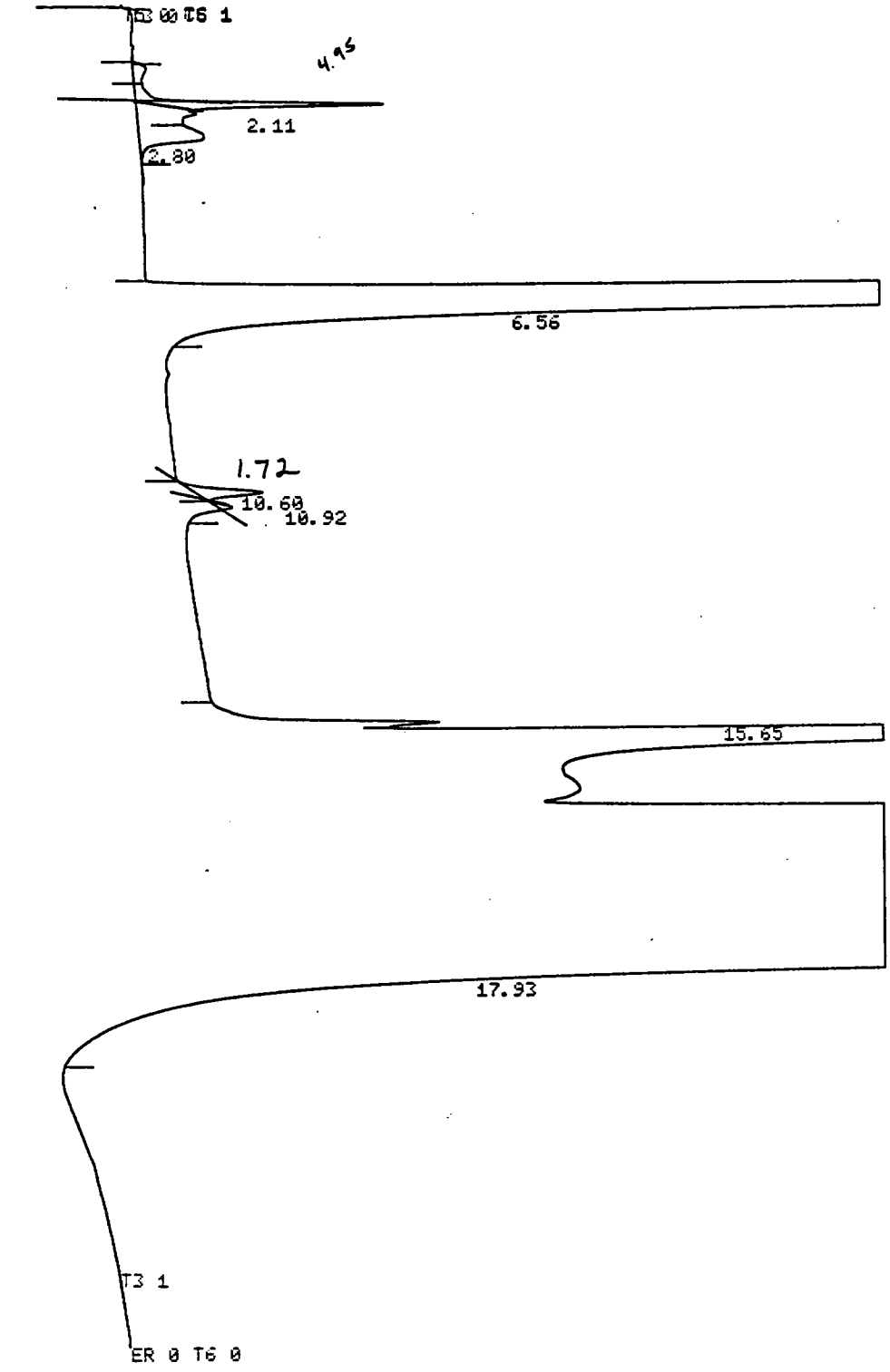
SAMPLE 3 5978-29

SA	IS	XF
1.	0.	10.

NAME	UG/ML	RT	PK HT	BC	RF
F	1.22	1.98	45235	03	877676.444
BR	0.846		99683	01	37459.125
TOTALS	27.126		2431683		

045

CHANNEL A INJECT 04/04/88 09:15:05



069

ACID GASES 04/04/88 09:15:05 CH= "A" PS= 1.

FILE 6. METHOD 5. RUN 3 INDEX 2

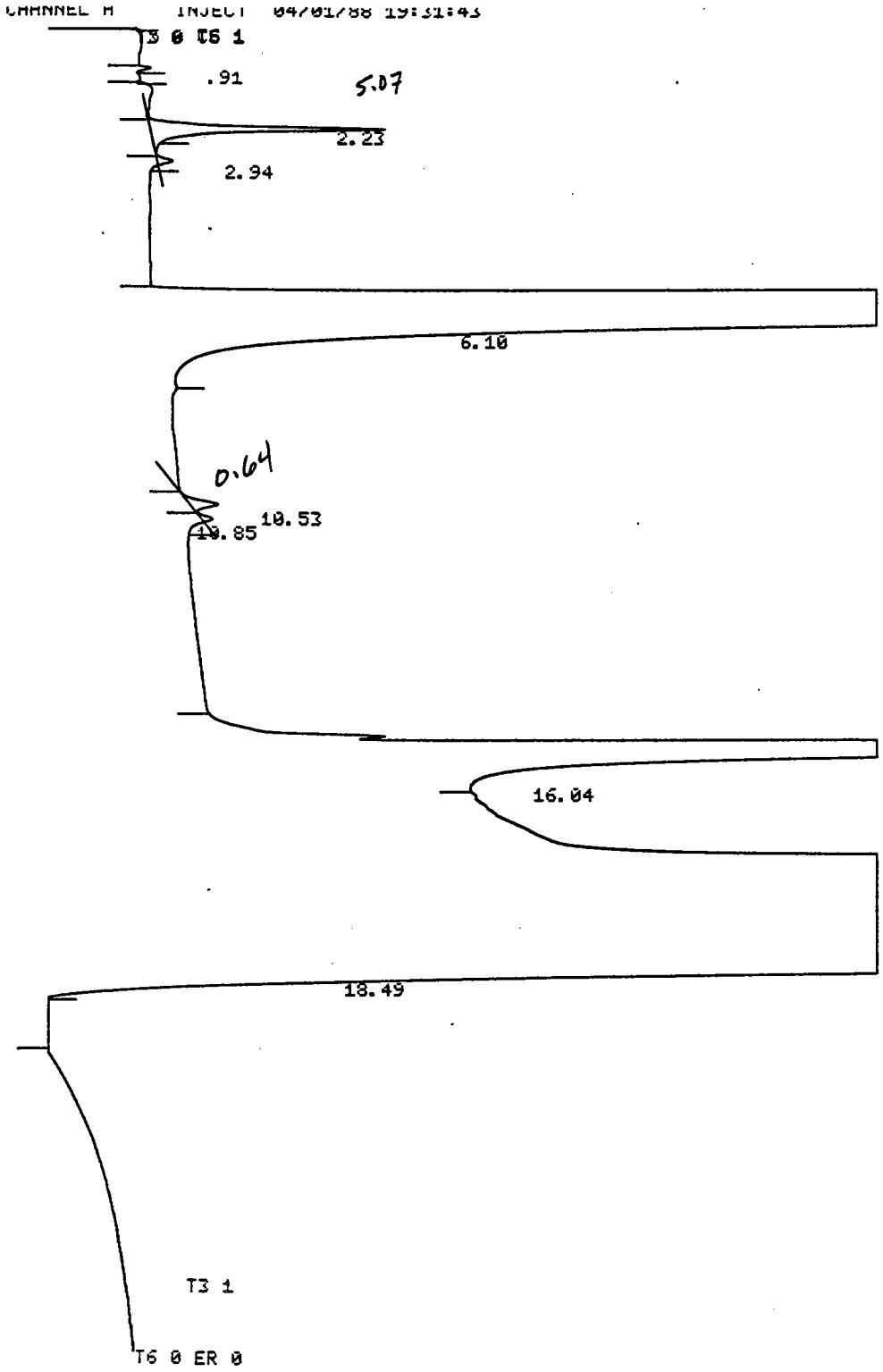
ANALYST: BJN

SAMPLE 2 5978-29S

SA	IS	XF
1.	0.	~~100~~ 20

NAME		UG/ML	RT	PK HT	BC	RF	Recovery
F	6.05	~~28.474~~	2.11	280537	02	986634.666	96.6%
CL		380.715	6.56	1019043	01	267665.333	99.8%
BR	20.8	~~101.297~~	10.6	101692	02	100390.	
TOTALS		510.446		2877913			

070



051

ACID GASES 04/01/88 19:31:43 CH= "A" PS= 1.

FILE 6. METHOD 5. RUN 9 INDEX 8

ANALYST: BJN

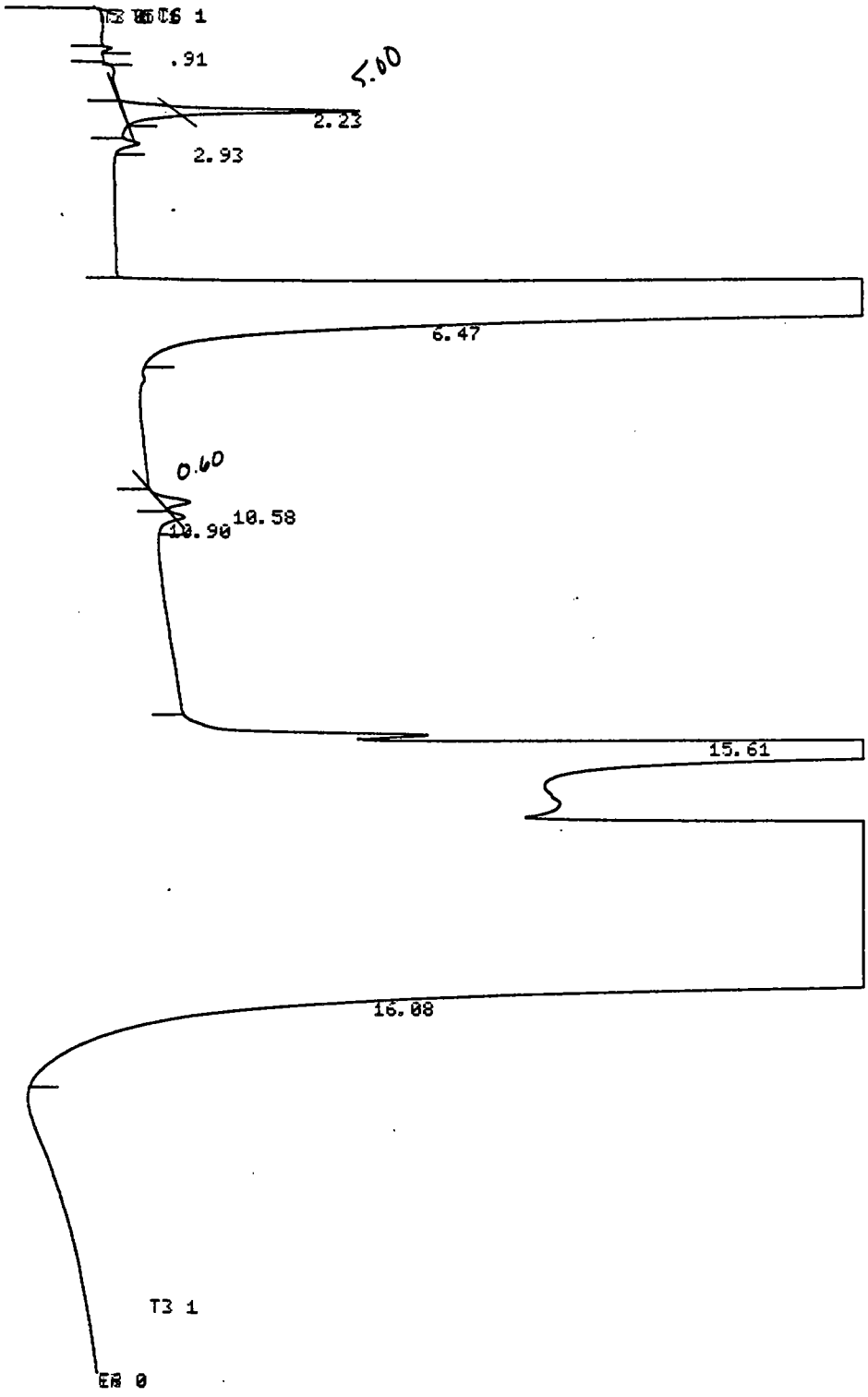
SAMPLE 8 5978-30

SA	IS	XF
1.	0.	10.

NAME		UG/ML	RT	PK HT BC	RF
F	3.10	~~3.10~~	2.23	284005 01	877676.444
CL		~~5.07~~	6.1	1023283 01	272062.5 over
BR	3.87	~~3.87~~	10.53	45179 02	37459.125
TOTALS		52.909		3514758	

052

CHANNEL A INJECT 04/04/88 09:45:05



071

ACID GASES 04/04/88 09:45:05 CH= "A" PS= 1.

FILE 6. METHOD 5. RUN 4 INDEX 3

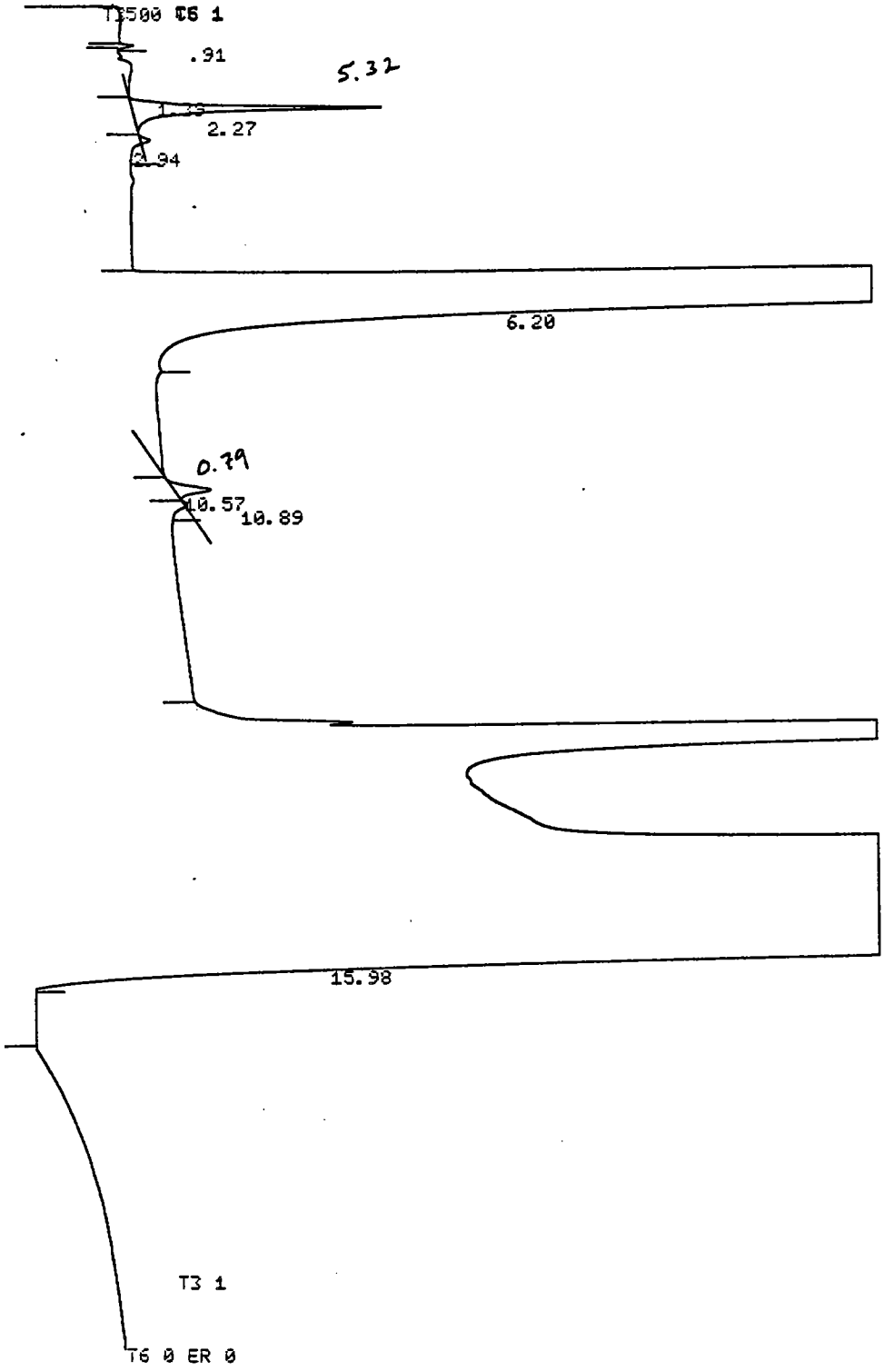
ANALYST: BJN

SAMPLE 3 5978-30

SA	IS	XF
1.	0.	10.

NAME	UG/ML	RT	PK HT	BC	RF
F	3.06	2.23	284376	01	986634.666
CL	[illegible]	6.47	1017461	01	267665.333
BR	3.62	10.58	46769	02	100390.
TOTALS	45.553		2774786		

CHANNEL A INJECT 04/01/88 22:01:43



058

ACID GASES 04/01/88 22:01:43 CH= "A" PS= 1.

FILE 6. METHOD 5. RUN 14 INDEX 13

ANALYST: BJN

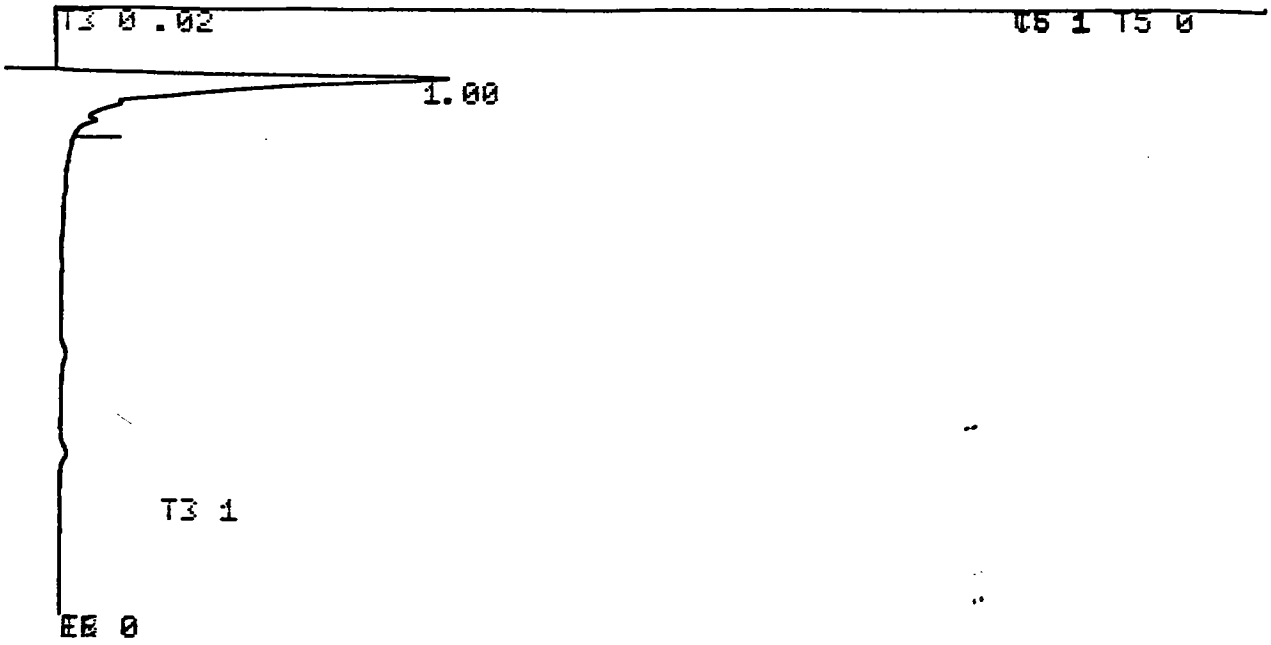
SAMPLE 13 5978-31

SA	IS	XF
1.	0.	10.

NAME		UG/ML	RT	PK HT	BC	RF
F	3.25	[illegible]	2.27	293284	02	[illegible]
CL		[illegible]	6.2	1022357	01	[illegible]
BR		[illegible]	10.57	55228	02	[illegible]
TOTALS		55.663		2518559		

059

CHANNEL A INJECT 03/31/88 09:46:45



ANIONS AS4A 03/31/88 09:46:45 CH= "A" PS= 1.

FILE 1. METHOD 5. RUN 1 INDEX 1

ANALYST: BJN

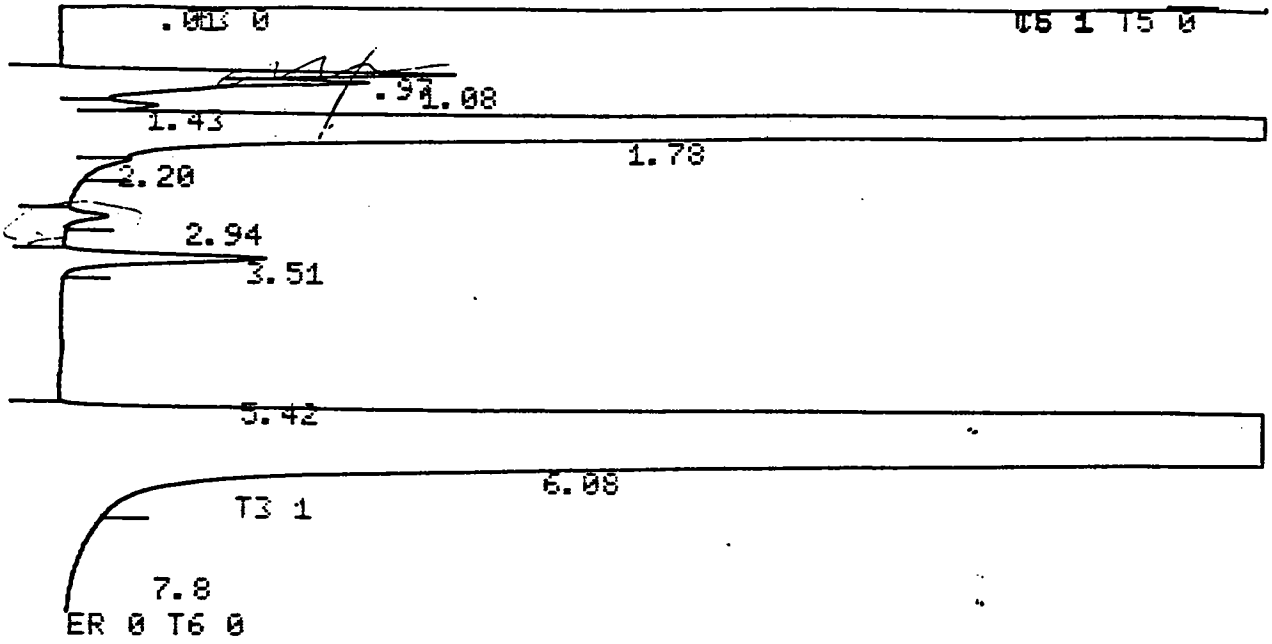
SAMPLE 1 5978-28

SA	IS	XF
1.	0.	10.

NAME	MG/L	RT	PK HT BC	RF
F	3.645	1.	290907 01	79809.785
TOTALS	3.645		818093	

15 A

CHANNEL A INJECT 03/31/88 12:06:22



ANIONS AS4A 03/31/88 12:06:22 CH= "A" PS= 1.

FILE 1. METHOD 5. RUN 1 INDEX 10

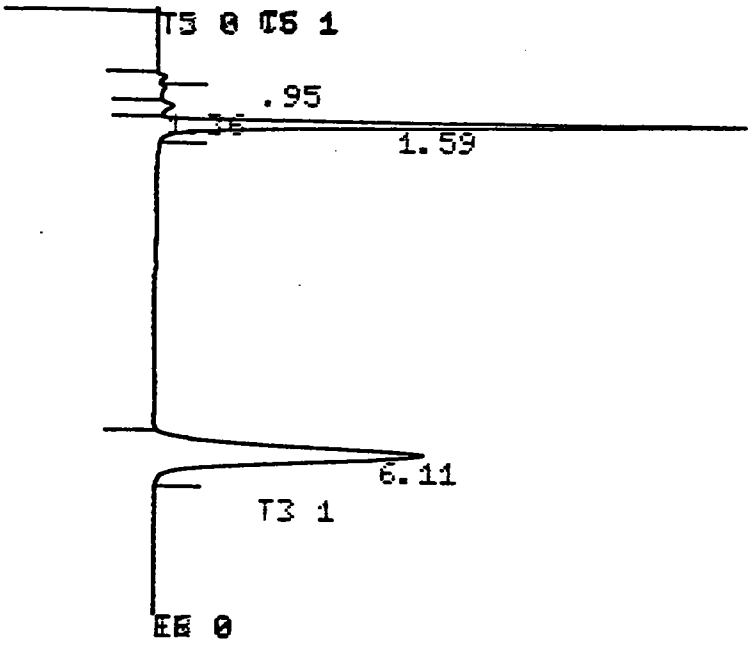
ANALYST: BJN

SAMPLE 1 5978-29

SA	IS	XF
1.	0.	10.

NAME	MG/L	RT	PK HT BC	RF
F	2.927	1.08	231768 02	79182.781
CL	19.691	1.78	1043240 02	52980.55
BR	2.191	2.94	30771 01	14044.12
NO3	9.595	3.51	153605 01	16008.894
SO4	80.627	6.08	1036827 01	12859.547
TOTALS	115.031		3426720	

CHANNEL A INJECT 03/31/88 10:13:45



ANIONS AS4A 03/31/88 10:13:45 CH= "A" PS= 1.

FILE 1. METHOD 5. RUN 4 INDEX 4

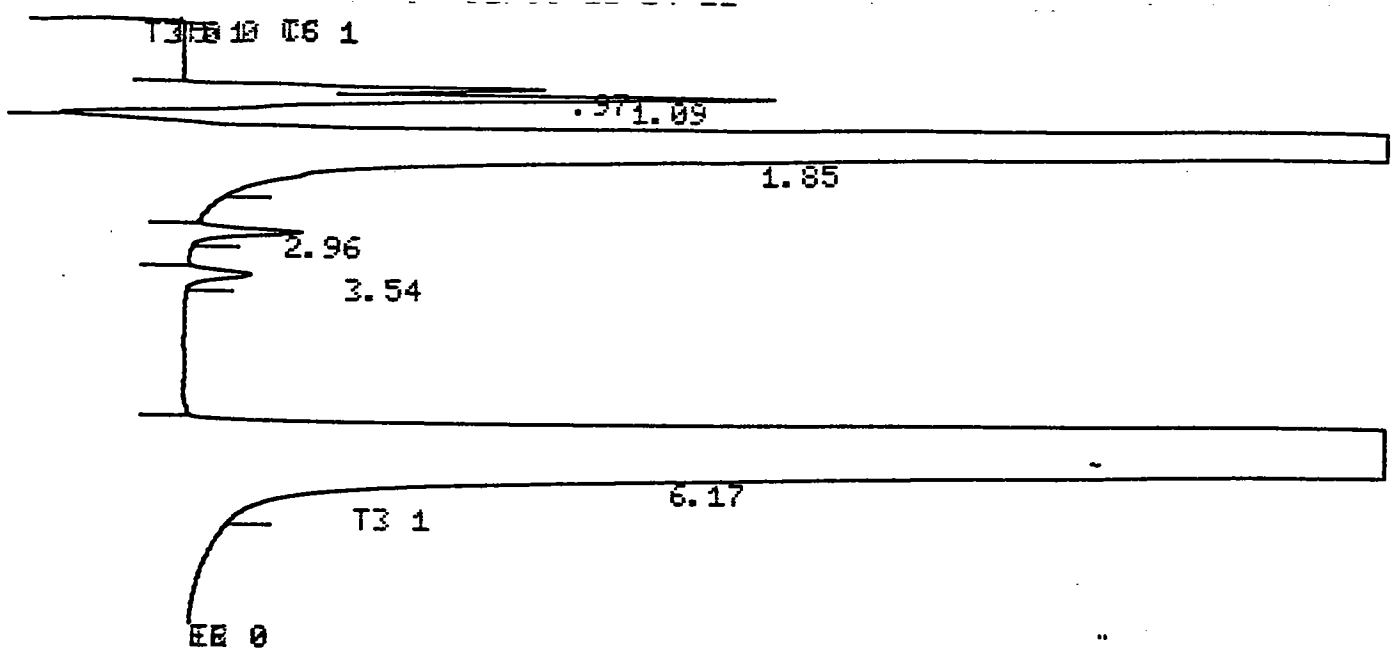
ANALYST: BJN

SAMPLE 4 5978-29

SA	IS	XF
1.	0.	1000.

NAME	MG/L	RT	PK HT BC	RF
CL	827.199	1.59	446805 03	540.142
SO4	1594.697	6.11	202840 01	127.197
TOTALS	2421.896		663504	

15 6



ANIONS AS4A 03/31/88 12:24:22 CH= "A" PS= 1.

FILE 1. METHOD 5. RUN 3 INDEX 12

ANALYST: BJN

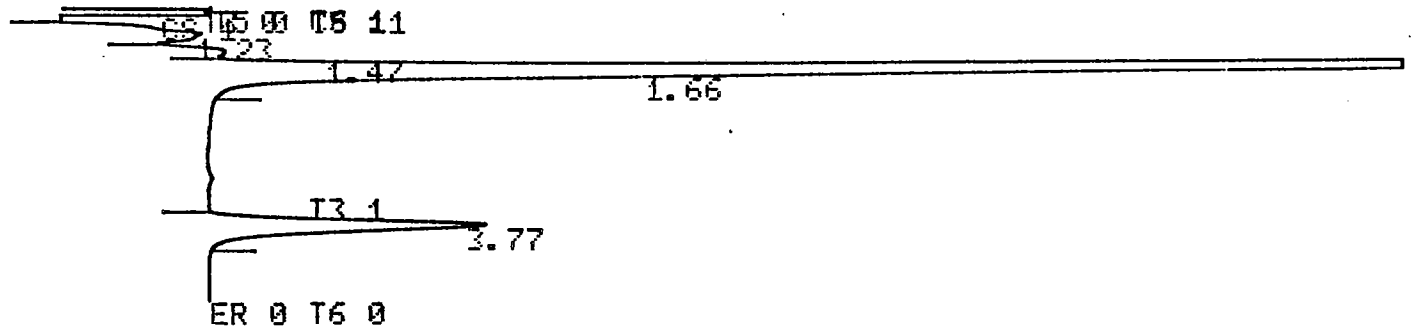
SAMPLE 3 5978-30

SA	IS	XF
1.	0.	10.

NAME	MG/L	RT	PK HT	BC	RF
F	6.387	1.09	516979	02	80942.331
NO2	33.486	1.85	1084272	03	32379.86
BR	5.307	2.96	81723	01	15399.033
NO3	2.729	3.54	47645	01	17458.898
SO4	80.428	6.17	1034259	01	12859.435
TOTALS	128.337		3056992		

16 2

CHANNEL A INJECT 04/19/88 09:51:55



NOX 04/19/88 09:51:55 CH= "A" PS= 1.

FILE 2. METHOD 5. RUN 8 INDEX 3

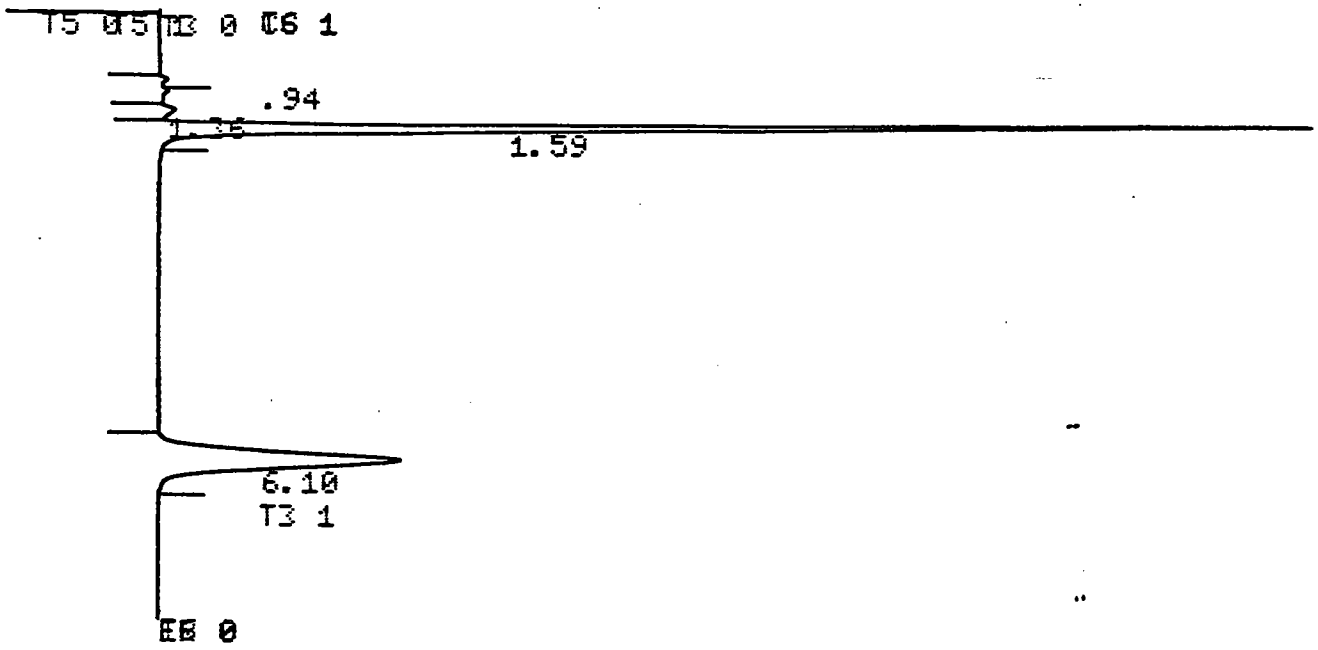
ANALYST: BJN

SAMPLE 3 NSP-47

SA	IS	XF
1.	0.	1.

NAME	TOTAL UG	RT	PK HT	BC	RF
NO3	1.886	3.77	212696	01	112776.246
TOTALS	1.886		1466835		

CHANNEL A INJECT 03/31/88 10:31:45



ANIONS AS4A 03/31/88 10:31:45 CH= "A" PS= 1.

FILE 1. METHOD 5. RUN 6 INDEX 6

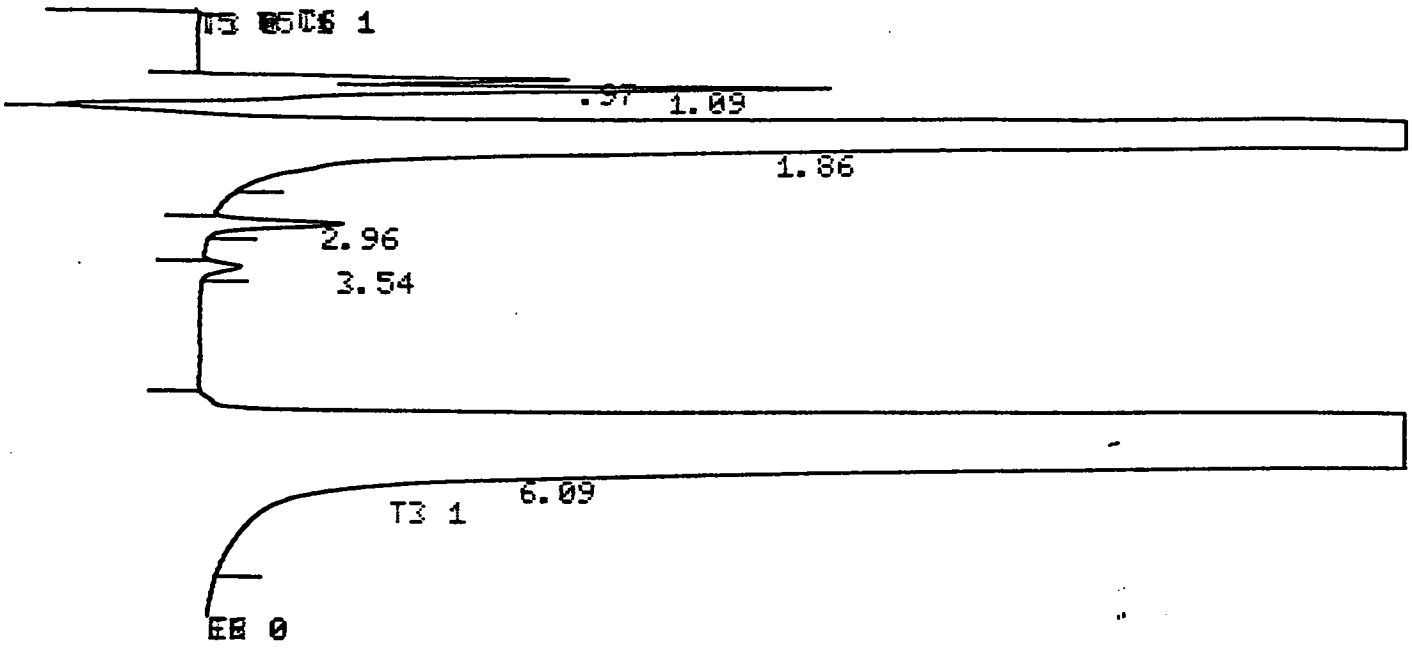
ANALYST: BJN

SAMPLE 6 5978-30

SA	IS	XF
1.	0.	1000.

NAME	MG/L	RT	PK HT BC	RF
CL	1657.374	1.59	880424 03	531.216
SO4	1463.097	6.1	185871 01	127.04
TOTALS	3120.471		1081267	

157



16 3

ANIONS AS4A 03/31/88 12:42:22 CH= "A" PS= 1.

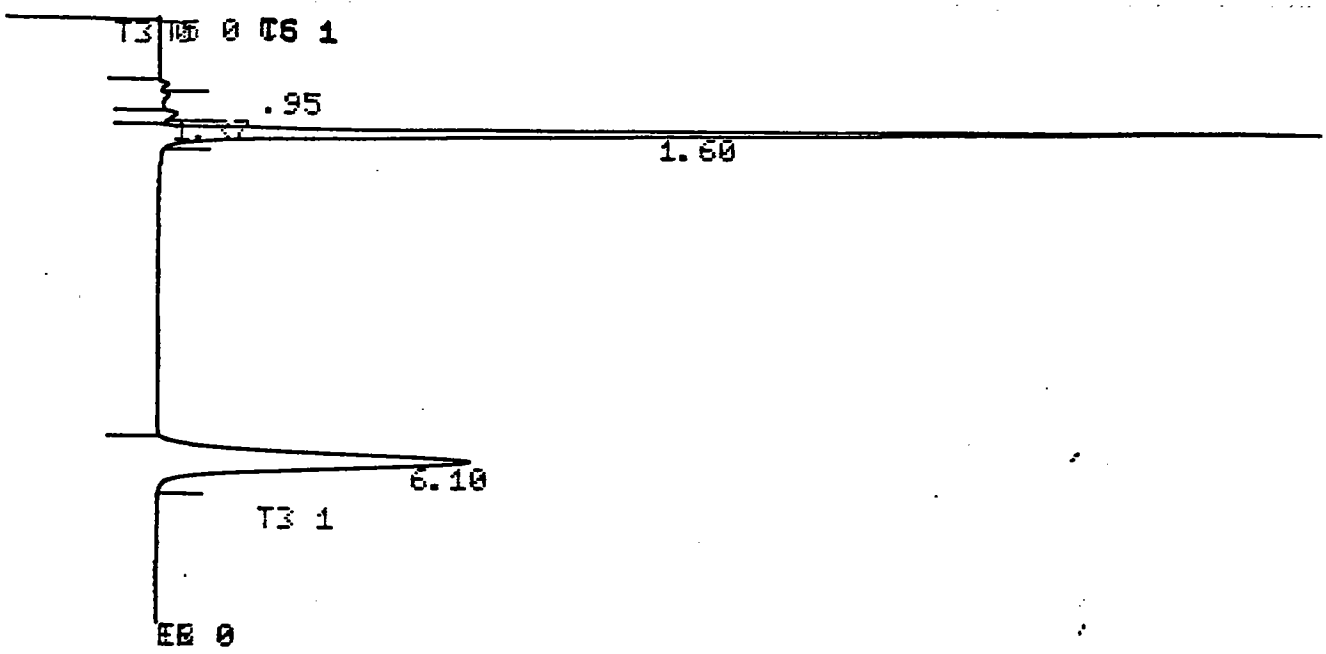
FILE 1. METHOD 5. RUN 5 INDEX 14

ANALYST: BJN

SAMPLE 5 5978-31

SA	IS	XF
1.	0.	10.

NAME	MG/L	RT	PK HT	BC	RF
F	6.845	1.09	554731	02	81041.734
NO2	33.778	1.86	1093797	03	32381.945
BR	6.352	2.96	98816	01	15556.675
NO3	1.404	3.54	27195	01	19369.421
SO4	81.49	6.09	1047959	01	12859.966
TOTALS	129.869		3122823		



ANIONS AS4A 03/31/88 10:49:45 CH= "A" PS= 1.

FILE 1. METHOD 5. RUN 8 INDEX 8

ANALYST: BJN

SAMPLE 8 5978-31

SA	IS	XF
1.	0.	1000.

NAME	MG/L	RT	PK HT BC	RF
CL	1668.785	1.6	686384 01	531.155
SO4	1869.81	6.1	238313 01	127.453
TOTALS	3538.595		1138827	

EPA METHOD 3

LABORATORY REPORT

SUMMARY OF ORSAT DATA

Job: NSP/RedWing
Sampling Location: Unit #2 / ESP Inlet
Sampling Date: 3-22-88
Analysis Date: 3-24-88
Technician: JK

Test #3
Run 1, 2, 3
(Metals testing)

TEST NO. AND DATE	RUN NO.	RESULTS						
		INTEGRATED (BAG)			GRAB (BULB)			O_2 ANALYZER
		% CO_2	% O_2	% CO	% CO_2	% O_2	% CO	% O_2
3-22-88 3	1	12.33	7.66					
3	2	12.79	7.08					
3	3	12.60	7.23					

LSC-05

Interpoll Inc.
(612)786-6020

EPA Method 3 Data Sheet (Orsat Analysis)

Technician MK
Orsat Analyzer No. #1
Job NSP / Reducing
City/State _____ Fuel Type _____

Date of Analysis 3-24-88
Leak Check Performed ☑ YES ☐ NO
Source Unit #2
Test Site ESP Inlet

Sample Identification		Test/Run	Analysis No.	Buret Readings (cc)			Concentration (% v/v,dry)		F_o
				Zero Point	After CO_2	After O_2	CO_2	O_2	
Ambient Air				0.00	0.00	20.90	0.00	20.90	
5978-51	F / B ~	3/1	1	0.00	12.33	19.99	12.33	7.66	1.074
			2	0.00	12.33	19.99	12.33	7.66	1.074
			3						
			AVG				12.33	7.66	
-52	F / B ~	3/2	1	0.00	12.79	19.87	12.79	7.08	1.081
			2	0.00	12.79	19.87	12.79	7.08	1.081
			3						
			AVG				12.79	7.08	
-53	F / B ~	3/3	1	0.00	12.60	19.83	12.60	7.23	1.085
			2	0.00	12.60	19.83	12.60	7.23	1.085
			3						
			AVG				12.60	7.23	

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

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

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

EPA METHOD 3

LABORATORY REPORT

SUMMARY OF ORSAT DATA

Job: NSP/Red Wing
Sampling Location: Unit # 2/stack
Sampling Date: 3-22-85
Analysis Date: 3-24-85
Technician: JH

Test #3
Run 1,2,3 (metals testing)

TEST NO. AND DATE	RUN NO.	RESULTS						
		INTEGRATED (BAG)			GRAB (BULB)			O_2 ANALYZER
		% CO_2	% O_2	% CO	% CO_2	% O_2	% CO	% O_2
1-22-85 3	1	11.60	8.41					
3	2	12.18	8.02					
3	3	12.00	8.00					

LSC-05

Interpoll Inc.
(612)786-6020

EPA Method 3 Data Sheet (Orsat Analysis)

Technician MK
Orsat Analyzer No. #1
Job NSP/Redwing
City/State _____ Fuel Type _____

Date of Analysis 3-24-88
Leak Check Performed ☑ YES ☐ NO
Source Unit #2
Test Site Stack

Sample Identification		Test/Run	Analysis No.	Buret Readings (cc)			Concentration (% v/v,dry)		F_o
				Zero Point	After CO_2	After O_2	CO_2	O_2	
Ambient Air				0.00	0.00	20.90	0.00	20.90	
5978-70	F	3/1	1	0.00	11.60	20.01	11.60	8.41	1.077
	B ✓		2	0.00	11.60	20.01	11.60	8.41	1.077
			3						
			AVG				11.60	8.41	
-71	F	3/2	1	0.00	12.18	20.20	12.18	8.02	1.057
	B ✓		2	0.00	12.18	20.20	12.18	8.02	1.057
			3						
			AVG				12.18	8.02	
-72	F	3/3	1	0.00	12.00	20.00	12.00	8.00	1.075
	B ✓		2	0.00	12.00	20.00	12.00	8.00	1.075
			3						
			AVG				12.00	8.00	

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

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

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

EPA METHOD 3

LABORATORY REPORT

SUMMARY OF ORSAT DATA

Job: NSP/Red Wing
Sampling Location: Unit # 2/ESP Inlet
Sampling Date: 3-23,24,25-88
Analysis Date: 3-29-88
Technician: D

Test # 4
Run 1,2,3
MM-5 Train (Dioxins)

TEST NO. AND DATE	RUN NO.	RESULTS						
		INTEGRATED (BAG)			GRAB (BULB)			O_2 ANALYZER
		% CO_2	% O_2	% CO	% CO_2	% O_2	% CO	% O_2
3-23-88 4	1	12.01	8.04					
3-24-88 4	2	12.09	8.08					
3-25-88 4	3	12.32	7.91					

LSC-05

Interpoll Inc.
(612)786-6020

EPA Method 3 Data Sheet (Orsat Analysis)

Technician MK
Orsat Analyzer No. #1
Job USP/Redwing
City/State _____ Fuel Type _____

Date of Analysis 3-29-88
Leak Check Performed ☑ YES ☐ NO
Source Unit #2
Test Site ESP Inlet

Sample Identification		Test/Run	Analysis No.	Buret Readings (cc)			Concentration (% v/v,dry)		F_o
				Zero Point	After CO_2	After O_2	CO_2	O_2	
Ambient Air				0.00	0.00	20.90	0.00	20.90	
5978-101	F	4/1	1	0.00	12.01	20.05	12.01	8.04	1.070
			2	0.00	12.01	20.05	12.01	8.04	1.070
			3						
			AVG				12.01	8.04	
-102	F	4/2	1	0.00	12.09	20.17	12.09	8.08	1.060
			2	0.00	12.09	20.17	12.09	8.08	1.060
			3						
			AVG				12.09	8.08	
-103	F	4/3	1	0.00	12.32	20.23	12.32	7.91	1.054
			2	0.00	12.32	20.23	12.32	7.91	1.054
			3						
			AVG				12.32	7.91	

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

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

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

EPA METHOD 3

LABORATORY REPORT

SUMMARY OF ORSAT DATA

Job: NSP/RedWing
Sampling Location: Unit #2 | Stack
Sampling Date: 3-23,24,25-88
Analysis Date: 3-29-88
Technician: ZK

Test # 4
Run 1,2,3
mm-5 train (Dioxins)

TEST NO. AND DATE	RUN NO.	RESULTS						
		INTEGRATED (BAG)			GRAB (BULB)			O_2 ANALYZER
		% CO_2	% O_2	% CO	% CO_2	% O_2	% CO	% O_2
3-23-88 4	1	11.00	9.02	|				
3-24-88 4	2	11.21	8.99	|				
3-25-88 4	3	11.39	8.99	|				

LSC-05

Interpoll Inc.
(612)786-6020

EPA Method 3 Data Sheet (Orsat Analysis)

Technician MK
Orsat Analyzer No. #1
Job Redwing/NSP
City/State _____ Fuel Type _____

Date of Analysis 3-29-88
Leak Check Performed ☑ YES ☐ NO
Source Unit #2
Test Site Stack

Sample Identification	F/B	Test/Run	Analysis No.	Buret Readings (cc) Zero Point	After CO_2	After O_2	Concentration (% v/v,dry) CO_2	O_2	F_o
Ambient Air				0.00	0.00	20.90	0.00	20.90	
5978-126	F	4/1	1	0.00	11.00	20.02	11.00	9.02	1.080
			2	0.00	11.00	20.02	11.00	9.02	1.080
			3						
			AVG				11.00	9.02	
-127	F	4/2	1	0.00	11.21	20.20	11.21	8.99	1.062
			2	0.00	11.21	20.20	11.21	8.99	1.062
			3						
			AVG				11.21	8.99	
-128	F	4/3	1	0.00	11.39	20.38	11.39	8.99	1.046
			2	0.00	11.39	20.38	11.39	8.99	1.046
			3						
			AVG				11.39	8.99	

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

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

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

Interpoll Laboratories
(612)786-6020

EPA METHOD 10 ANALYSIS DATA SHEET

Job Name NSP REDWING
Source ESP INLET (UNIT 2)
Date of NDIR Analysis 3/30/88

NDIR Model: ACS 3300 Range: ☐ 0-500 ppm ☒ 0-1000 ppm
NDIR Flow Rate 1000 cc/min
Technician DWAYNE A. SMITH

SAMPLE NAME	SAMPLE LOG NO.	CARBON DIOXIDE % v/v ($B'CO_2$)	MOISTURE CONTENT % v/v ($B'H_2O$)	CARBON MONODIXE CONCENTRATION (PPM)						
				Trial 1		Trial 2		AVG		WET BASIS
				DF	PPM	DF	PPM	DF	PPM	
ZERO GAS	PRETEST			1	0	1	0	1	0	
597 PPM SPAN				1	597	1	597	1	597	
299 PPM				1	300	1	300	1	300	
T4 R1				1	134	1	134	1	134	
T4 R2				1	109	1	109	1	109	
T4 R3				1	111	1	111	1	111	

ZERO GAS: 99.999 % N_2
CAL GAS(ES): 299 PPM CO & 597 PPM CO SOURCE: SCOTT SPECIALTY

DF = dilution factor

Note 1: The ACS (Fugi) Model 3300 NDIR has a rejection ratio for CO to CO_2 greater than 100,000:1 and thus CO_2 removal is not required.
Note 2: The analyzer must be zeroed and spanned immediately before and after analysis. Additional Zero and span values may be made between analyses if required. Record all zero and span values after initial calibration is complete.
Note 3: Calculation Equations: CO-WET = CO-DRY $(1-B'_{H_2O}/100)$

S-305RRR

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(612)786-6020

EPA METHOD 10 ANALYSIS DATA SHEET

Job Name NSP REDWING
Source UNIT 2 STACK
Date of NDIR Analysis 3/30/88

NDIR Model: ACS 3300 Range: ☐ 0-500 ppm ☒ 0-1000 ppm
NDIR Flow Rate 1000 cc/min
Technician DWAYNE A. SMITH

SAMPLE NAME	SAMPLE LOG NO.	CARBON DIOXIDE % v/v (B'CO_2)	MOISTURE CONTENT % v/v (B'H_2O)	CARBON MONODIXE CONCENTRATION (PPM)						
				Trial 1		Trial 2		AVG		WET BASIS
				DF	PPM	DF	PPM	DF	PPM	
T4 R1				1	121	1	121	1	121	
T4 R2				1	65	1	65	1	65	
T4 R3				1	68	1	68	1	68	
ZERO GAS	Post Test			1	0	1	0	1	0	
597 PPM SPAN				1	598	1	598	1	598	
299 PPM				1	303	1	303	1	303	

DF = dilution factor

ZERO GAS: 99.999 % N_2
CAL GAS(ES): 299 PPM CO & 597 PPM Co SOURCE: SCOTT SPECIALTY

Note 1: The ACS (Fugi) Model 3300 NDIR has a rejection ratio for CO to CO_2 greater than 100,000:1 and thus CO_2 removal is not required.
Note 2: The analyzer must be zeroed and spanned immediately before and after analysis. Additional Zero and span values may be made between analyses if required. Record all zero and span values after initial calibration is complete.
Note 3: Calculation Equations: CO-WET = CO-DRY $(1-B'_{H_2O}/100)$

S-305RRR

EPA METHOD 3

LABORATORY REPORT

SUMMARY OF ORSAT DATA

Job: NSP/Red Wing
Sampling Location: Unit #2/ESP Inlet
Sampling Date: 3-26-88
Analysis Date: 3-29-88
Technician:

Test 5
Run 1, 2, 3

(Particle Sizing)

TEST NO. AND DATE	RUN NO.	RESULTS						
		INTEGRATED (BAG)			GRAB (BULB)			O_2 ANALYZER
		% CO_2	% O_2	% CO	% CO_2	% O_2	% CO	% O_2
3-26-88 5	1	12.90	7.03					
5	2	12.88	7.10					
5	3	12.96	7.04					

LSC-05

Interpoll Inc.
(612)786-6020

EPA Method 3 Data Sheet (Orsat Analysis)

Technician MK
Orsat Analyzer No. #1
Job NSP / Redwing
City/State _____ Fuel Type _____

Date of Analysis 3-29-88
Leak Check Performed ☑ YES ☐ NO
Source Unit #2
Test Site ESP Inlet Duct

Sample Identification		Test/Run	Analysis No.	Buret Readings (cc)			Concentration (% v/v,dry)		F_o
				Zero Point	After CO_2	After O_2	CO_2	O_2	
Ambient Air				0.00	0.00	20.90	0.00	20.90	
5978-178	F	5/1	1	0.00	12.90	19.93	12.90	7.03	1.075
	B ✓		2	0.00	12.90	19.93	12.90	7.03	1.075
			3						
			AVG				12.90	7.03	
-179	F	5/2	1	0.00	12.88	19.98	12.88	7.10	1.071
	B ✓		2	0.00	12.88	19.98	12.88	7.10	1.071
			3						
			AVG				12.88	7.10	
-180	F	5/3	1	0.00	12.96	20.00	12.96	7.04	1.069
	B ✓		2	0.00	12.96	20.00	12.96	7.04	1.069
			3						
			AVG				12.96	7.04	

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

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

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

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

Date of Analysis 3-28-88
Technician MK

interpoll

(1)
Job NSP REDWING Date 3-26-88
City/State REDWING MN. Log #5978-168
Source UNIT 2 ESP INLET
Test Site INLET DUCT
Sample type SS FILTER Tech D.S.
Remarks: BLANK Test/Run 5/0
____ of ____

Special Handling Required ____
Filter No. 22
Filter Type S.S.
Filter Tare Wt. 41.3202 g (1)
Filter + Sample Wt. 41.3203 g (2)
Comments ____

interpoll

(2)
Job ____ Date ____
City/State ____ Log# ____
Source ____
Test Site ____
Sample type ____ Tech ____
Remarks: Test/Run ____
____ of ____

Special Handling Required ____
Filter No. ____
Filter Type ____
Filter Tare Wt. ____ g (1)
Filter + Sample Wt. ____ g (2)
Comments ____

interpoll

(3)
Job ____ Date ____
City/State ____ Log# ____
Source ____
Test Site ____
Sample type ____ Tech ____
Remarks: Test/Run ____
____ of ____

Special Handling Required ____
Filter No. ____
Filter Type ____
Filter Tare Wt. ____ g (1)
Filter + Sample Wt. ____ g (2)
Comments ____

RESULTS:

1	2	3

LSC-02P

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

Date of Analysis 3-28-88
Technician MK

EPA-M5 Acetone R.B SPEC ≤ 7.8 µg/cc
Actual acetone residue blank 0 µg/cc

(1)

interpoll

Job NSP REDWING Date 3-26-88
City/State REDWING MN. Log # 5978-172
Source UNIT 2 ESP INLET
Test Site INLET DUCT
Sample type PW Tech D.S.
Remarks: Test/Run 5/1
of

Special Handling Required
Evaporating Dish No. 61
Volume of acetone 20 (1) cc
E. Dish Tare Wt. 44.5907 (2) g
E. Dish + Sample Wt. 44.6427 (3) g
Comments

(2)

interpoll

Job NSP REDWING Date 3-26-88
City/State REDWING MN. Log # -173
Source UNIT 2 ESP INLET
Test Site INLET DUCT
Sample type PW Tech D.S.
Remarks: Test/Run 5/2
of

Special Handling Required
Evaporating Dish No. 65
Volume of acetone 60 (1) cc
E. Dish Tare Wt. 46.9756 (2) g
E. Dish + Sample Wt. 47.0024 (3) g
Comments

(3)

interpoll

Job NSP REDWING Date 3-26-88
City/State REDWING MN. Log # -174
Source UNIT 2 ESP INLET
Test Site INLET DUCT
Sample type PW Tech D.S.
Remarks: Test/Run 5/3
of

Special Handling Required
Evaporating Dish No. 67
Volume of acetone 60 (1) cc
E. Dish Tare Wt. 47.4848 (2) g
E. Dish + Sample Wt. 47.5267 (3) g
Comments

RESULTS:

1/ 0.0520 K-64 2/ 0.0268 3/ 0.0419

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

Date of Analysis 3-28-88

Technician MK

---

interpoll

(1)

Job NSP REDWING Date 3-26-88
City/State REDWING MN. Log # 5978-169
Source UNIT 2 ESP INLET
Test Site INLET DUCT
Sample type SS FILTER Tech D.S.
Remarks: Test/Run 5/1
____ of ____

Special Handling Required ____

Filter No. 18
Filter Type S.S.
Filter Tare Wt. 40.9035 g
Filter + Sample Wt. 50.8409 g
Comments ____

---

interpoll

(2)

Job NSP REDWING Date 3-26-88
City/State REDWING MN. Log # -170
Source UNIT 2 ESP INLET
Test Site INLET DUCT
Sample type SS FILTER Tech D.S.
Remarks: Test/Run 5/2
____ of ____

Special Handling Required ____

Filter No. 28
Filter Type S.S.
Filter Tare Wt. 41.2482 g
Filter + Sample Wt. 51.6525 g
Comments ____

---

interpoll

(3)

Job NSP REDWING Date 3-26-88
City/State REDWING MN. Log # -171
Source UNIT 2 ESP INLET
Test Site INLET DUCT
Sample type SS FILTER Tech D.S.
Remarks: Test/Run 5/3
____ of ____

Special Handling Required ____

Filter No. 3
Filter Type S.S.
Filter Tare Wt. 39.2720 g
Filter + Sample Wt. 48.4174 g
Comments ____

RESULTS:

1 / 9.9374	2 / 10,4043	3 / 9.1454
9.9894	10.4311	9.1873

EPA METHOD 3

LABORATORY REPORT

SUMMARY OF ORSAT DATA

Job: NSP/Red Wing
Sampling Location: Unit #2/Stack
Sampling Date: 3-26-88
Analysis Date: 3-29-88
Technician: TK

Test 5
Run 0, 1, 2, 3
(particle sizing)

TEST NO. AND DATE	RUN NO.	RESULTS						
		INTEGRATED (BAG)			GRAB (BULB)			O_2 ANALYZER
		% CO_2	% O_2	% CO	% CO_2	% O_2	% CO	% O_2
3-26-88 5	0	12.00	8.03					
5	1	12.39	7.74					
5	2	12.15	7.85					
5	3	12.24	7.96					

LSC-05

Interpoll Inc.
(612)786-6020

EPA Method 3 Data Sheet (Orsat Analysis)

Technician MK
Orsat Analyzer No. #1
Job NSP/Redwing
City/State _____ Fuel Type _____

Date of Analysis 3-29-88
Leak Check Performed ☑ YES ☐ NO
Source Unit #2 Outlet
Test Site Stack

Sample Identification		Test/Run	Analysis No.	Buret Readings (cc)			Concentration (% v/v,dry)		F_o
				Zero Point	After CO_2	After O_2	CO_2	O_2	
Ambient Air				0.00	0.00	20.90	0.00	20.90	
	F								
	B	5/0	1	0.00	12.00	20.03	12.00	8.03	1.072
			2	0.00	12.00	20.03	12.00	8.03	1.072
			3						
			AVG				12.00	8.03	
	F								
	B		1						
			2						
			3						
			AVG						
	F								
	B		1						
			2						
			3						
			AVG						

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

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

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

* PM-10 Blank Run EPA M-3

LSC-04B

Interpoll Inc.
(612)786-6020

EPA Method 3 Data Sheet (Orsat Analysis)

Technician MK
Orsat Analyzer No. #1
Job NSP/Redwing
City/State _____ Fuel Type _____

Date of Analysis 3-29-88
Leak Check Performed ☑ YES ☐ NO
Source Unit #2 Outlet
Test Site Stack

Sample Identification		Test/Run	Analysis No.	Buret Readings (cc)			Concentration (% v/v,dry)		F_o
				Zero Point	After CO_2	After O_2	CO_2	O_2	
Ambient Air				0.00	0.00	20.90	0.00	20.90	
	F	5/1	1	0.00	12.39	20.13	12.39	7.74	1.062
	B		2	0.00	12.39	20.13	12.39	7.74	1.062
			3						
			AVG				12.39	7.74	
	F	5/2	1	0.00	12.15	20.00	12.15	7.85	1.074
	B		2	0.00	12.15	20.00	12.15	7.85	1.074
			3						
			AVG				12.15	7.85	
	F	5/3	1	0.00	12.24	20.20	12.24	7.96	1.057
	B		2	0.00	12.24	20.20	12.24	7.96	1.057
			3						
			AVG				12.24	7.96	

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

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

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

APPENDIX L

LABORATORY RESULTS FOR METALS ANALYSIS ON STACK SAMPLES AND FLYASH

interpoll

INTERPOLL LABORATORIES
4500 BALL ROAD N.E.
CIRCLE PINES, MINNESOTA 55014-1819
TEL: 612/786-6020
FAX: 612/786-7854

Interpoll Laboratories
Field Testing Department

Attention: Dr. Perry Lonnes

PROJECT: NSP/Red Wing

LABORATORY REPORT: #5978 May 9, 1988

Enclosed is the laboratory analysis report on samples we received March 25, 1988.

If you have any questions concerning this report, please feel free to contact me.

Respectfully submitted,

Richard R. Dahl,
Director of Analytical Services

RRD/cg

Enclosures

interpoll

INTERPOLL LABORATORIES
4500 BALL ROAD N.E.
CIRCLE PINES, MINNESOTA 55014-1819
TEL: 612/786-6020
FAX: 612/786-7854

Interpoll Laboratories
Field Testing Department

Attention: Dr. Perry Lonnes

PROJECT: NSP/Red Wing

LABORATORY REPORT: #5978 May 9, 1988

SAMPLES COLLECTED: March 22, 1988
SAMPLES RECEIVED: March 23, 1988

Sample Identification:			T3R0 Unit 2 ESP Inlet	T3R1 Unit 2 ESP Inlet	T3R2 Unit 2 ESP Inlet	T3R3 Unit 2 ESP Inlet
Sample Type:			Comp. Blank*	Composite*	Composite*	Composite*
Laboratory Log Number:			5978-188	5978-185	5978-186	5978-187
Parameter	Units	EPA Method				
Arsenic	Total ug	SW-846, 7060	1.0	110	320	170
Beryllium	Total ug	SW-846, 7091	< 0.02	2.0	1.2	1.9
Cadmium	Total ug	SW-846, 7131	0.14	780	920	690
Chromium	Total ug	SW-846, 7191	1.2	460	280	390
Nickel	Total ug	249.1	0.75	410	290	230
Lead	Total ug	SW-846, 7421	5.0	29000	17000	26000
Selenium	Total ug	SW-846, 7740	< 0.1	< 200	< 500	< 1000
Mercury	Total ug	M-101A	< 0.2	130	110	170

Sample Identification:			T3R0 Unit 2 ESP Inlet Permanganate Imp. Catch Blank	T3R1 Unit 2 ESP Inlet Permanganate Impinger Catch	T3R2 Unit 2 ESP Inlet Permanganate Impinger Catch	T3R3 Unit 2 ESP Inlet Permanganate Impinger Catch
Sample Type:						
Laboratory Log Number:			5978-38	5878-42	5978-46	5978-50
Parameter	Units	EPA Method				
Mercury	Total ug	M-101A	< 0.2	1.7	0.60	1.7

Sample Identification:			T3R0 Unit 2 Stack	T3R1 Unit 2 Stack	T3R2 Unit 2 Stack	T3R3 Unit 2 Stack
Sample Type:			Comp. Blank*	Composite*	Composite*	Composite*
Laboratory Log Number:			5978-192	5978-189	5978-190	5978-191
Parameter	Units	EPA Method				
Arsenic	Total ug	SW-846, 7060	< 0.5	26	16	1.3
Beryllium	Total ug	SW-846, 7091	< 0.2	< 0.2	< 0.2	< 0.2
Cadmium	Total ug	SW-846, 7131	1.3	7.2	4.2	1.4
Chromium	Total ug	SW-846, 7191	1.7	160	73	13
Nickel	Total ug	249.1	0.64	250	100	64
Lead	Total ug	SW-846, 7421	0.83	82	44	30
Selenium	Total ug	SW-846, 7740	< 0.1	< 250	170	< 50
Mercury	Total ug	M-101A	< 0.2	30	16	26

Sample Identification:			T3R0 Unit 2 Stack Permanganate Imp. Catch Blank	T3R1 Unit 2 Stack Permanganate Impinger Catch	T3R2 Unit 2 Stack Permanganate Impinger Catch	T3R3 Unit 2 Stack Permanganate Impinger Catch
Sample Type:						
Laboratory Log Number:			5978-57	5878-61	5978-65	5978-69
Parameter	Units	EPA Method				
Mercury	Total ug	M-101A	0.60	5.9	2.5	5.0

Sample Identification:			T3R1 ESP Conveyor Fly Ash Composite	T3R2 ESP Conveyor Fly Ash Composite	T3R3 ESP Conveyor Fly Ash Composite
Sample Type:					
Laboratory Log Number:			5978-206	5978-207	5978-208
Parameter	Units	EPA Method			
Arsenic	mg/kg	SW-846, 7060	45	56	44
Beryllium	mg/kg	SW-846, 7091	0.45	0.99	0.87
Cadmium	mg/kg	SW-846, 7131	140	260	180
Chromium	mg/kg	SW-846, 7191	91	96	77
Nickel	mg/kg	249.1	140	73	60
Lead	mg/kg	SW-846, 7421	4800	6500	5900
Selenium	mg/kg	SW-846, 7740	< 10	< 10	< 10
Mercury	mg/kg	M-101A	23	18	28

Sample Identification:			T2R0 Imp. Catch Blank	T2R1 Impinger Catch	T2R2 Impinger Catch	T2R3 Impinger Catch
Sample Type:						
Laboratory Log Number:			5978-28	5878-29	5978-30	5978-31
Parameter	Units	EPA Method				
Acid Gases:						
Fluoride	Total ug	300	93	610	1550	1620
Chloride	Total ug	300	24	413000	830000	835000
Bromide	Total ug	300	< 25	412	1940	2380
Sulfate	Total ug	300	< 12	795000	730000	935000

Respectfully submitted,

Gregg W. Holman,
Inorganic Chemistry Department Manager

GWH/cg
< = less than

*Composite of filter, probe wash and impinger catch.

All analyses were performed using EPA or other recognized methodologies.
All units are on an "as received" basis unless otherwise indicated.

APPENDIX M

BATTELLE LABORATORY RESULTS

TABLE 1. TOTAL PCDF RESULTS FOR INLET MM5 SAMPLES (ng/sample) (a)

	Run 0	Run 1	Run 2	Run 3	Laboratory Method Blank
TCDF	(0.048)	170	28	26	(0.015)
PCDF	(0.076)	110	14	13	(0.040)
HxCDF	(0.033)	64	7.1	5.9	(0.026)
HpCDF	(0.081)	42	3.7	3.1	(0.037)
OCDF	(0.063)	11	0.41	0.25	(0.026)

(a) Parentheses indicate analyte not detected; value within parentheses represents detection limit.

TABLE 2. TOTAL PCDD RESULTS FOR INLET MM5 SAMPLES (ng/sample) (a)

	Run 0	Run 1	Run 2	Run 3	Laboratory Method Blank
TCDD	(0.007)	17	0.85	0.72	(0.008)
PCDD	(0.13)	34	2.3	1.9	(0.052)
HxCDD	(0.041)	36	1.6	0.92	(0.051)
HpCDD	(0.16)	48	1.7	1.0	(0.095)
OCDD	0.19	37	1.3	0.68	(0.088)

(a) Parentheses indicate analyte not detected; value within parentheses represents detection limit.

TABLE 3. 2,3,7,8-PCDF RESULTS FOR INLET MM5 SAMPLES (ng/sample) (a)

	Run 0	Run 1	Run 2	Run 3	Laboratory Method Blank
2,3,7,8-TCDF	(0.048)	23	3.0	2.8	(0.015)
1,2,3,7,8-PCDF	(0.076)	3.2	0.37	0.16	(0.040)
2,3,4,7,8-PCDF	(0.063)	5.3	0.60	0.46	(0.022)
1,2,3,4,7,8-HxCDF	(0.033)	12	0.94	0.70	(0.026)
1,2,3,6,7,8-HxCDF	(0.074)	12	0.85	0.50	(0.042)
1,2,3,7,8,9-HxCDF	(0.041)	7.9	0.56	0.35	(0.031)
2,3,4,6,7,8-HxCDF	(0.033)	1.8	0.10	0.12	(0.024)
1,2,3,4,6,7,8-HpCDF	(0.081)	28	1.5	0.92	(0.037)
1,2,3,4,7,8,9-HpCDF	(0.043)	1.8	0.14	0.12	(0.021)

(a) Parentheses indicate analyte not detected; value within parentheses represents detection limit.

TABLE 4. 2,3,7,8-PCDD RESULTS FOR INLET MM5 SAMPLES (ng/sample) (a)

	Run 0	Run 1	Run 2	Run 3	Laboratory Method Blank
2,3,7,8-TCDD	(0.0066)	0.15	(0.0038)	(0.0089)	(0.0085)
1,2,3,7,8-PCDD	(0.13)	2.2	(0.15)	0.12	(0.052)
1,2,3,4,7,8-HxCDD	(0.041)	2.5	0.10	0.035	(0.040)
1,2,3,6,7,8-HxCDD	(0.041)	2.5	0.096	0.061	(0.052)
1,2,3,7,8,9-HxCDD	(0.056)	4.6	0.16	0.089	(0.046)
1,2,3,4,6,7,8-HpCDD	(0.16)	24	0.81	0.47	(0.095)

(a) Parentheses indicate analyte not detected; value within parentheses represents detection limit.

TABLE 5. TOTAL PCDF RESULTS FOR OUTLET MM5 SAMPLES (ng/sample) (a)

	Run 0	Run 1	Run 2	Run 3	Laboratory Method Blank
TCDF	(0.021)	17	19	22	(0.015)
PCDF	(0.045)	16	18	23	(0.040)
HxCDF	(0.033)	15	16	20	(0.026)
HpCDF	(0.054)	12	14	17	(0.037)
OCDF	(0.049)	4.5	4.8	6.4	(0.026)

(a) Parentheses indicate analyte not detected; value within parentheses represents detection limit.

TABLE 6. TOTAL PCDD RESULTS FOR OUTLET MM5 SAMPLES (ng/sample) (a)

	Run 0	Run 1	Run 2	Run 3	Laboratory Method Blank
TCDD	(0.006)	2.5	2.8	2.6	(0.008)
PCDD	(0.077)	8.0	7.9	8.6	(0.052)
HxCDD	(0.032)	8.7	8.3	9.2	(0.051)
HpCDD	(0.12)	15	14	17	(0.095)
OCDD	0.26	14	12	15	(0.088)

(a) Parentheses indicate analyte not detected; value within parentheses represents detection limit.

TABLE 7. 2,3,7,8-PCDF RESULTS FOR OUTLET MM5 SAMPLES (ng/sample) (a)

	Run 0	Run 1	Run 2	Run 3	Laboratory Method Blank
2,3,7,8-TCDF	(0.021)	3.4	4.0	4.9	(0.015)
1,2,3,7,8-PCDF	(0.045)	0.53	0.64	0.59	(0.040)
2,3,4,7,8-PCDF	(0.033)	1.4	1.5	1.8	(0.022)
1,2,3,4,7,8-HxCDF	(0.033)	2.9	3.3	4.0	(0.026)
1,2,3,6,7,8-HxCDF	(0.038)	2.7	3.3	4.1	(0.042)
1,2,3,7,8,9-HxCDF	(0.026)	2.0	2.4	2.8	(0.031)
2,3,4,6,7,8-HxCDF	(0.040)	1.0	0.66	0.91	(0.024)
1,2,3,4,6,7,8-HpCDF	(0.054)	6.8	7.2	8.8	(0.037)
1,2,3,4,7,8,9-HpCDF	(0.026)	1.5	1.8	2.4	(0.021)

(a) Parentheses indicate analyte not detected; value within parentheses represents detection limit.

TABLE 8. 2,3,7,8-PCDD RESULTS FOR OUTLET MM5 SAMPLES (ng/sample) (a)

	Run 0	Run 1	Run 2	Run 3	Laboratory Method Blank
2,3,7,8-TCDD	(0.0057)	(0.011)	(0.013)	(0.014)	(0.0085)
1,2,3,7,8-PCDD	(0.077)	0.42	0.37	0.42	(0.052)
1,2,3,4,7,8-HxCDD	(0.037)	0.46	0.45	0.49	(0.040)
1,2,3,6,7,8-HxCDD	(0.032)	0.81	0.76	0.77	(0.052)
1,2,3,7,8,9-HxCDD	(0.035)	1.1	0.96	1.2	(0.046)
1,2,3,4,6,7,8-HpCDD	(0.12)	8.1	7.6	9.3	(0.095)

(a) Parentheses indicate analyte not detected; value within parentheses represents detection limit.

TABLE 9. TOTAL PCDF RESULTS FOR ASH SAMPLES (ng/g)

	Ash 3/23/88	Ash 3/24-25/88	Ash 3/25/88	Laboratory Method Blank
TCDF	40	35	32	(0.001)
PeCDF	39	46	51	(0.004)
HxCDF	21	44	58	(0.001)
HpCDF	51	71	250	(0.002)
OCDF	65	84	171	(0.003)

(a) Parentheses indicate analyte not detected; value represents detection limit.

TABLE 10. TOTAL PCDD RESULTS FOR ASH SAMPLES (ng/g) (a)

	Ash 3/23/88	Ash 3/24-25/88	Ash 3/25/88	Laboratory Method Blank
TCDD	6.4	3.4	3.4	(0.001)
PeCDD	17	18	18	(0.008)
HxCDD	17	32	46	(0.005)
HpCDD	110	130	390	(0.004)
OCDD	200	240	460	(0.006)

(a) Parentheses indicate analyte not detected; value represents detection limit.

TABLE 11. 2,3,7,8-PCDF RESULTS FOR ASH SAMPLES (ng/g) (a)

	Ash 3/23/88	Ash 3/24-25/88	Ash 3/25/88	Laboratory Method Blank
2,3,7,8-TCDF	6.1	5.3	5.0	(0.0015)
1,2,3,7,8-PeCDF	1.5	2.2	2.4	(0.0041)
2,3,4,7,8-PeCDF	2.7	4.0	4.0	(0.0041)
1,2,3,4,7,8-HxCDF	4.2	8.1	11	(0.0011)
1,2,3,6,7,8-HxCDF	4.1	9.1	13	(0.0042)
1,2,3,7,8,9-HxCDF	2.5	6.1	7.5	(0.0023)
2,3,4,6,7,8-HxCDF	0.69	1.7	1.9	(0.0026)
1,2,3,4,6,7,8-HpCDF	28	39	137	(0.0019)
1,2,3,4,7,8,9-HpCDF	3.9	5.3	22	(0.0019)

(a) Parentheses indicate analyte not detected; value represents detection limit.

TABLE 12. 2,3,7,8-PCDD RESULTS FOR ASH SAMPLES (ng/g) (a)

	Ash 3/23/88	Ash 3/24-25/88	Ash 3/25/88	Laboratory Method Blank
2,3,7,8-TCDD	0.18	0.16	0.14	(0.0014)
1,2,3,7,8-PeCDD	0.97	1.4	1.6	(0.0079)
1,2,3,4,7,8-HxCDD	0.80	1.8	2.6	(0.0043)
1,2,3,6,7,8-HxCDD	1.2	2.2	4.4	(0.0048)
1,2,3,7,8,9-HxCDD	1.4	2.8	4.5	(0.0070)
1,2,3,4,6,7,8-HpCDD	48	58	180	(0.0037)

(a) Parentheses indicate analyte not detected; value represents detection limit.

TABLE 13. PAH RESULTS FOR MM5 SAMPLES (µg/sample)

Compound	Inlet				Outlet				Laboratory Method Blank
	Run 0	Run 1	Run 2	Run 3	Run 0	Run 1	Run 2	Run 3	
Naphthalene	3.7	31	3.5	9.2	3.7	94	13	10	0.22
Acenaphthylene	0.042	1.9	0.095	0.095	0.039	49	0.11	0.098	0.0099
Acenaphthene	0.079	0.15	0.13	0.16	0.10	0.68	0.074	0.19	0.070
Fluorene	0.50	0.36	0.32	0.27	0.50	3.7	0.23	0.69	0.056
Phenanthrene	0.77	8.6	1.6	1.1	0.59	27	0.81	0.73	0.24
Anthracene	0.036	0.19	0.070	0.064	0.021	0.80	0.027	0.059	0.015
Fluoranthene	0.29	2.1	0.39	0.27	0.10	6.6	0.13	0.29	0.045
Pyrene	0.22	2	0.21	0.22	0.073	7.0	0.070	0.16	0.020
Benz(a)anthracene	0.029	0.044	0.019	0.024	0.015	0.096	0.0087	0.0087	0.0025
Chrysene	0.034	0.13	0.028	0.082	0.015	0.16	0.020	0.017	0.0045
Benzfluoranthenes	0.037	0.14	0.016	0.045	0.015	0.22	0.014	0.012	0.0067
Benzo(a)pyrene	0.054	0.012	BQL	ND	BQL	BQL	0.022	0.024	0.0016
Indeno(1,2,3-cd)pyrene	0.018	0.028	0.0029	0.0063	0.012	0.059	0.0051	0.0046	0.0034
Dibenz(a,h)anthracene	0.014	0.0048	ND	0.0048	0.0059	0.0063	0.0005	0.0037	0.0043
Benzo(g,h,i)perylene	0.023	0.11	0.0039	0.025	0.021	0.14	0.0087	0.0063	0.0034

TABLE 14. PAH RESULTS FOR ASH SAMPLES (μg/g)

Compound	Ash Sample 3/23/88	Ash Sample 3/24-25/88	Ash Sample 3/25/88	Laboratory Method Blank
Naphthalene	3.9	1.4	0.88	0.013
Acenaphthylene	0.072	0.020	0.027	0.0017
Acenaphthene	0.0033	0.0029	0.0038	0.0039
Fluorene	0.0026	0.0024	0.0026	0.0023
Phenanthrene	1.4	0.32	0.19	0.017
Anthracene	0.031	0.0064	0.0042	0.00080
Fluoranthene	0.36	0.16	0.075	0.0074
Pyrene	0.31	0.10	0.052	0.0033
Benz(a)anthracene	0.0093	0.0030	0.0015	0.00025
Chrysene	0.026	0.0085	0.0045	0.00045
Benzfluoranthenes	0.014	0.0049	0.0018	0.00082
Benzo(a)pyrene	ND	0.00012	0.00012	0.00041
Indeno(1,2,3-cd)pyrene	0.0012	0.00038	0.00017	0.00029
Dibenz(a,h)anthracene	0.00059	ND	ND	0.00048
Benzo(g,h,i)perylene	0.0027	0.00077	0.00038	0.00029

APPENDIX N

RESULTS OF FUEL ANALYSIS
(as submitted by NSP)

NSP *Internal Correspondence*

TESTING LABORATORY

DATE: April 11, 1988

FROM: D E Pinke

LOCATION: CSC-2

TO: Bob Evans

LOCATION: 414-G02

SUBJECT: RDF ANALYSIS

	3-21-88 Start 1510 End 2125		3-22-88 Start 0900		3-23-88 Start 0805	
	As Rcvd	Dry	As Rcvd	Dry	As Rcvd	Dry
Moisture %	26.36		21.14		24.89	
Ash %	10.07	13.67	12.89	16.35	12.74	16.96
Sulfur %	0.27	0.37	0.36	0.46	0.44	0.59
Hydrogen %	4.19	5.69	4.26	5.41	4.06	5.40
Carbon %	30.80	41.83	32.05	40.64	29.98	39.92
Oxygen %	27.53	37.38	28.56	36.22	27.06	36.04
Chlorine %	0.24	0.32	0.24	0.30	0.21	0.27
Nitrogen %	0.54	0.73	0.50	0.63	0.62	0.82
BTU/Lb	5428	7370	6078	7707	5334	7101
>6 inch %	8.8		3.8		5.9	
NonFerrous %	1.2		1.1		1.0	

26 RDF

25 RDF

	3-25-88 Start 0730 End 1100 5A		3-22-88 6 & 6A		3-23-88 Start 1130 5B	
	As Rcvd	Dry	As Rcvd	Dry	As Rcvd	Dry
Moisture %	28.61		23.14		24.18	
Ash %	10.58	14.82	12.98	16.89	11.05	14.57
Sulfur %	0.30	0.42	0.42	0.55	0.32	0.42
Hydrogen %	3.91	5.48	4.14	5.38	4.20	5.54
Carbon %	30.37	42.54	31.35	40.79	30.80	40.62
Oxygen %	25.50	35.71	27.27	35.48	28.69	37.85
Chlorine %	0.21	0.30	0.20	0.26	0.24	0.31
Nitrogen %	0.52	0.73	0.50	0.65	0.51	0.67
BTU/Lb	5311	7439	5617	7308	5400	7122

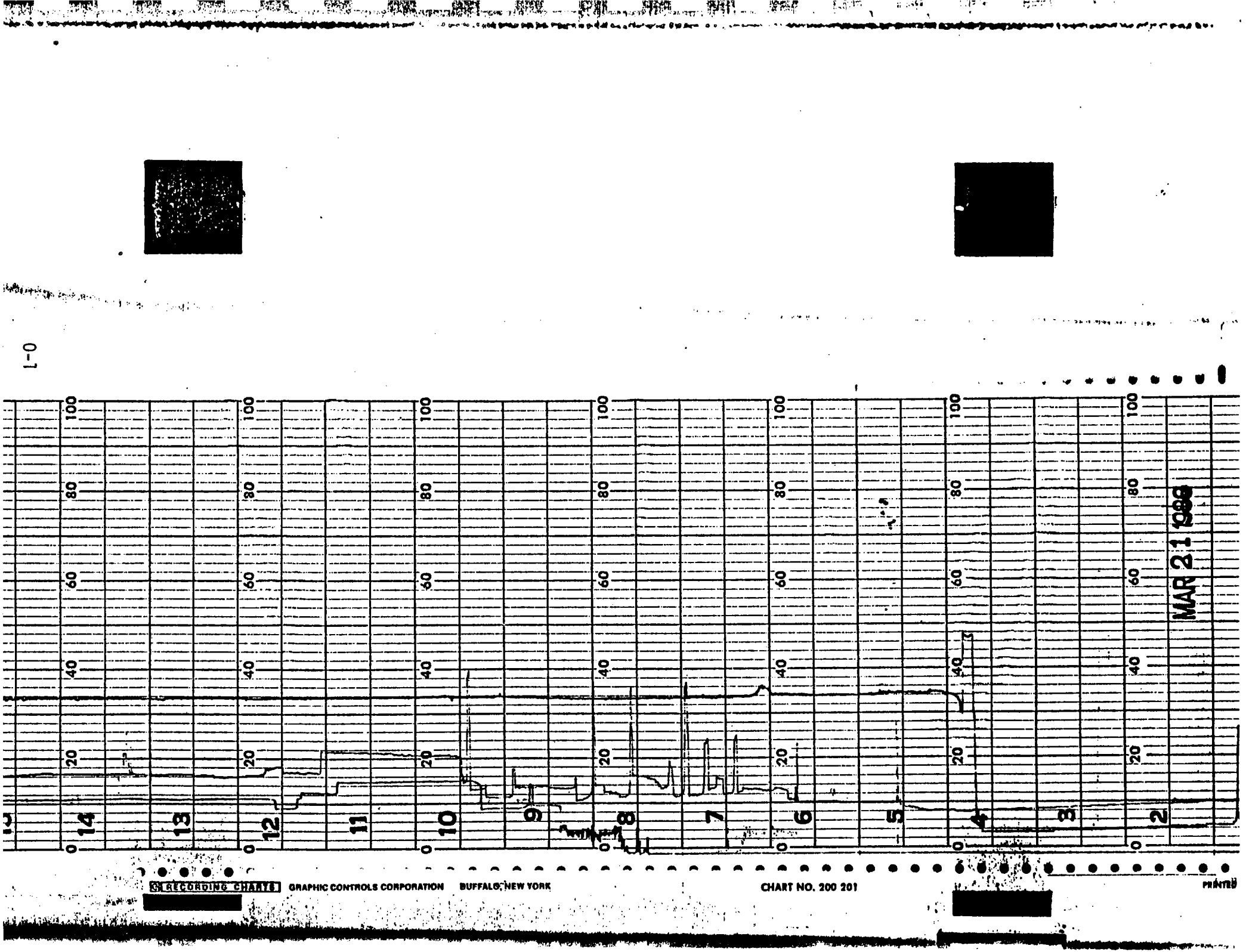
	3-25-88 Start 0730 5A End 1100		3-22-88 6 & 6A		3-23-88 Start 1130 5B	
	As Rcvd	Dry	As Rcvd	Dry	As Rcvd	Dry
>6 inch %	7.4		3.4		8.9	
NonFerrous %	1.5		1.5		9.6	

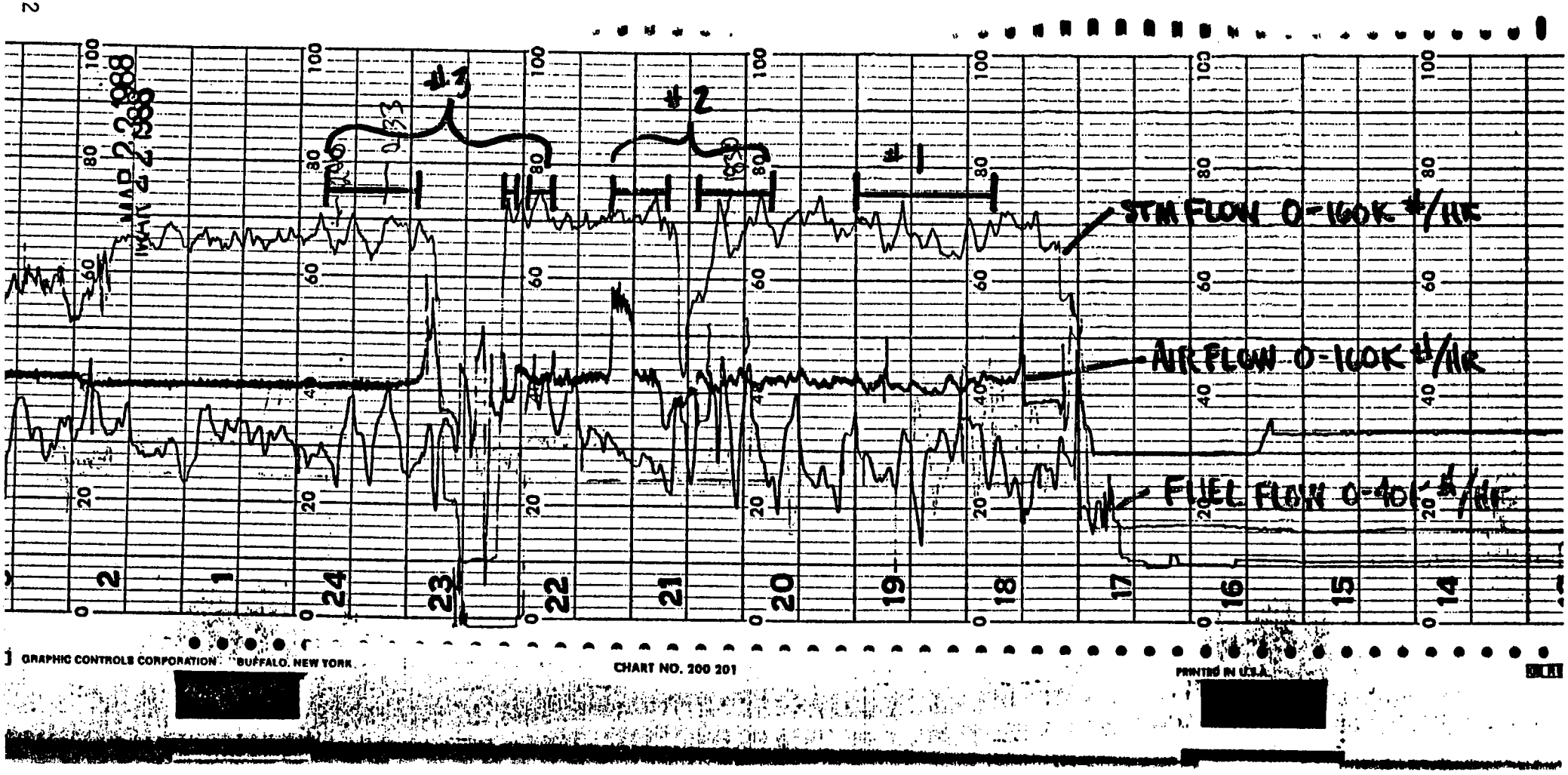
BY S. R. Haller
Steve Haller
Lab Spec

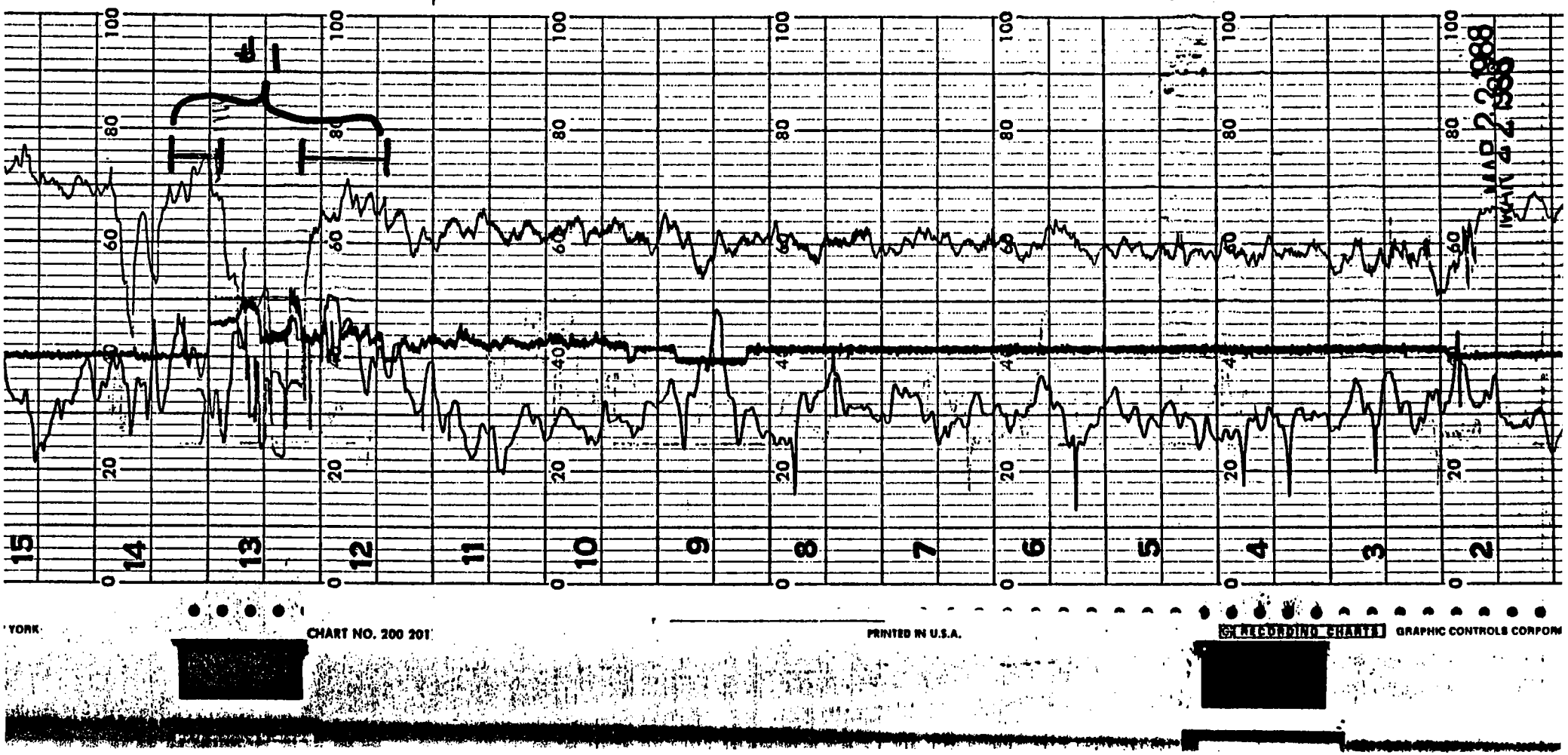
SH/jgb

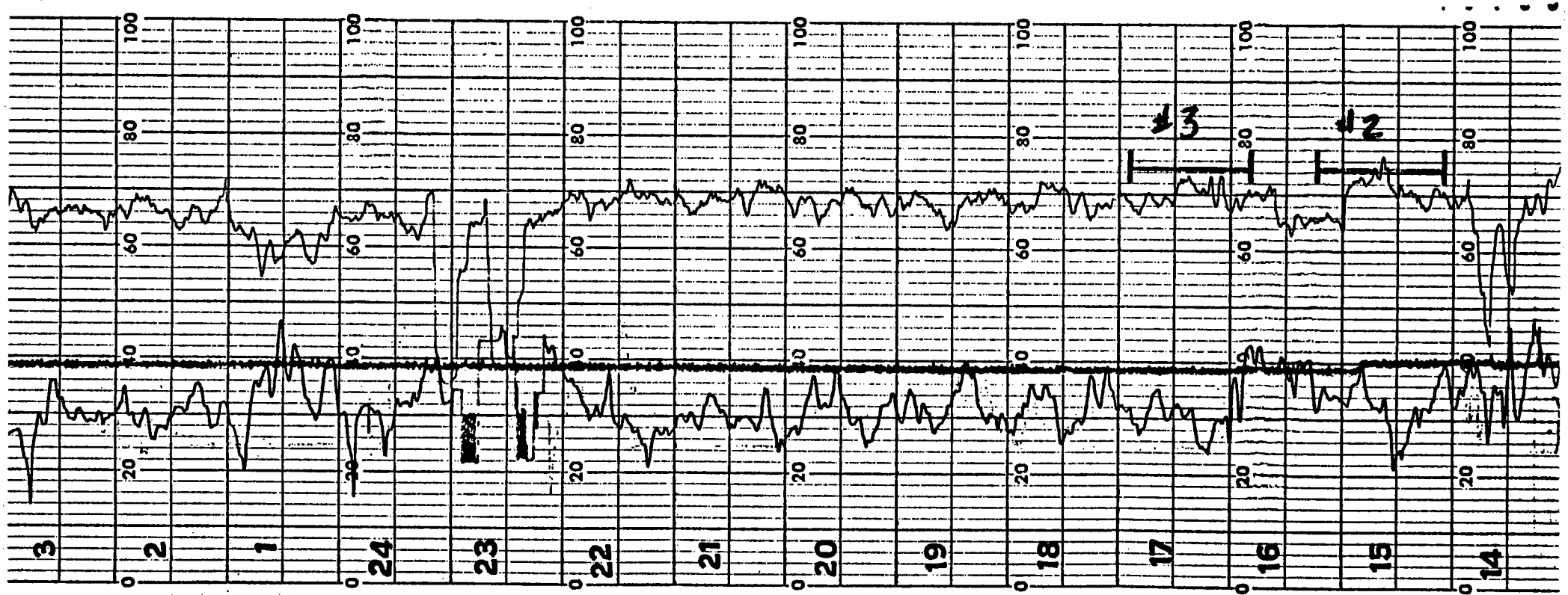
APPENDIX O

STEAM FLOW AND FEED RATE DATA
(as submitted by NSP)


MAR 21 1988
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
CHART NO. 200 201


MAY 2 2 1988
#1
#2
STM FLOW 0-160K #/HR
AIR FLOW 0-160K #/HR
FUEL FLOW 0-40K #/HR
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
CHART NO. 200 201
PRINTED IN U.S.A.


0-3
100
80
60
40
20
0
15
14
13
12
11
10
9
8
7
6
5
4
3
2
MAR 2 1988
YORK
CHART NO. 200 201
PRINTED IN U.S.A.
RECORDING CHARTS
GRAPHIC CONTROLS CORPOR



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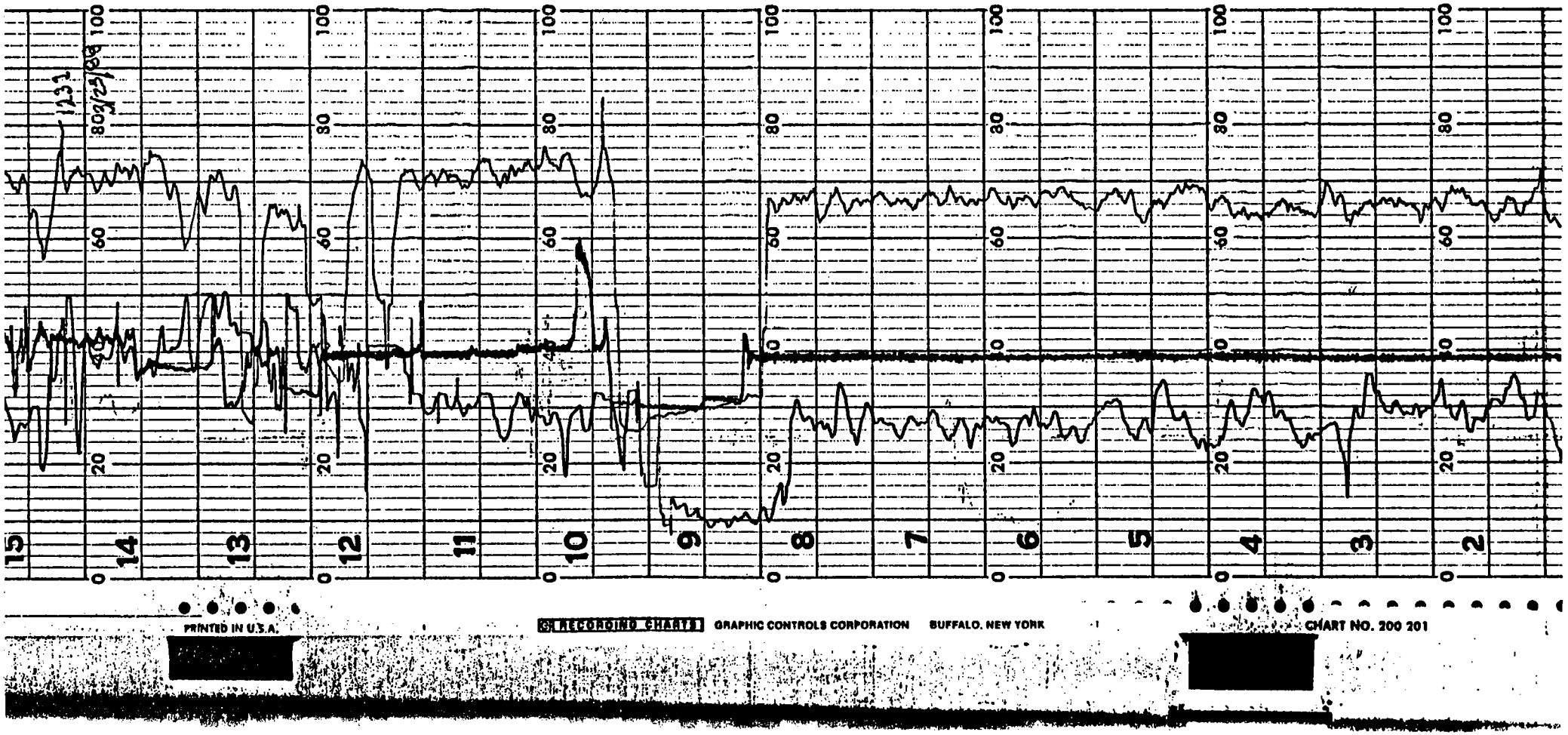
1231
8/23/89
100
80
60
40
20
0
15
14
13
12
11
10
9
8
7
6
5
4
3
2
PRINTED IN U.S.A.
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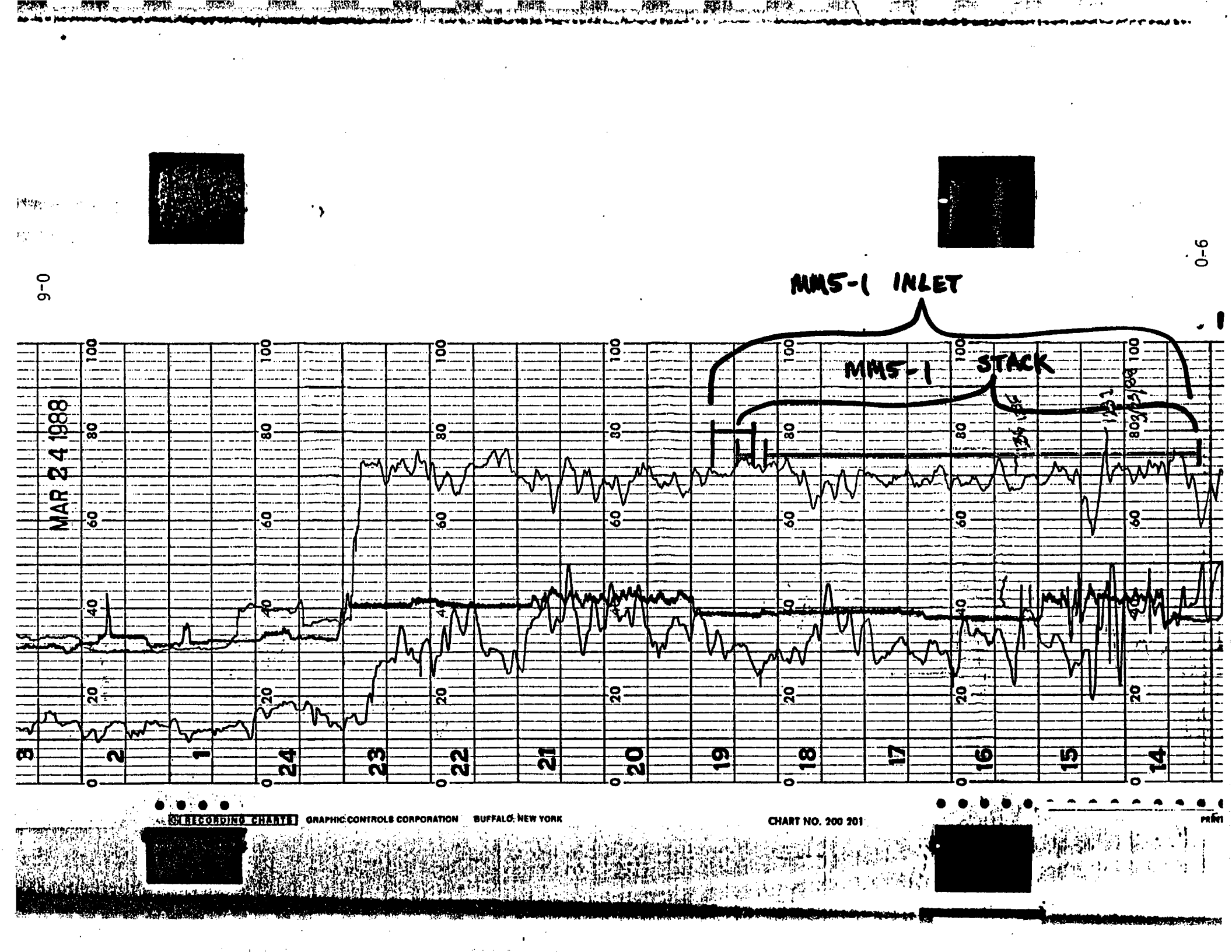
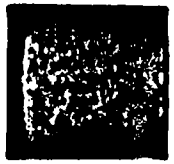
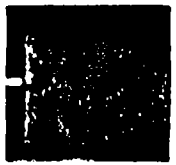
GRAPHIC CONTROLS CORPORATION
BUFFALO, NEW YORK
CHART NO. 200 201


MM5-1 INLET
MM5-1 STACK
MAR 24 1988
8
2
1
24
23
22
21
20
19
18
17
16
15
14
GRAPHIC CONTROLS CORPORATION
BUFFALO, NEW YORK
CHART NO. 200 201





0-7

0-7

MM5-2A

AG-3

AG-2

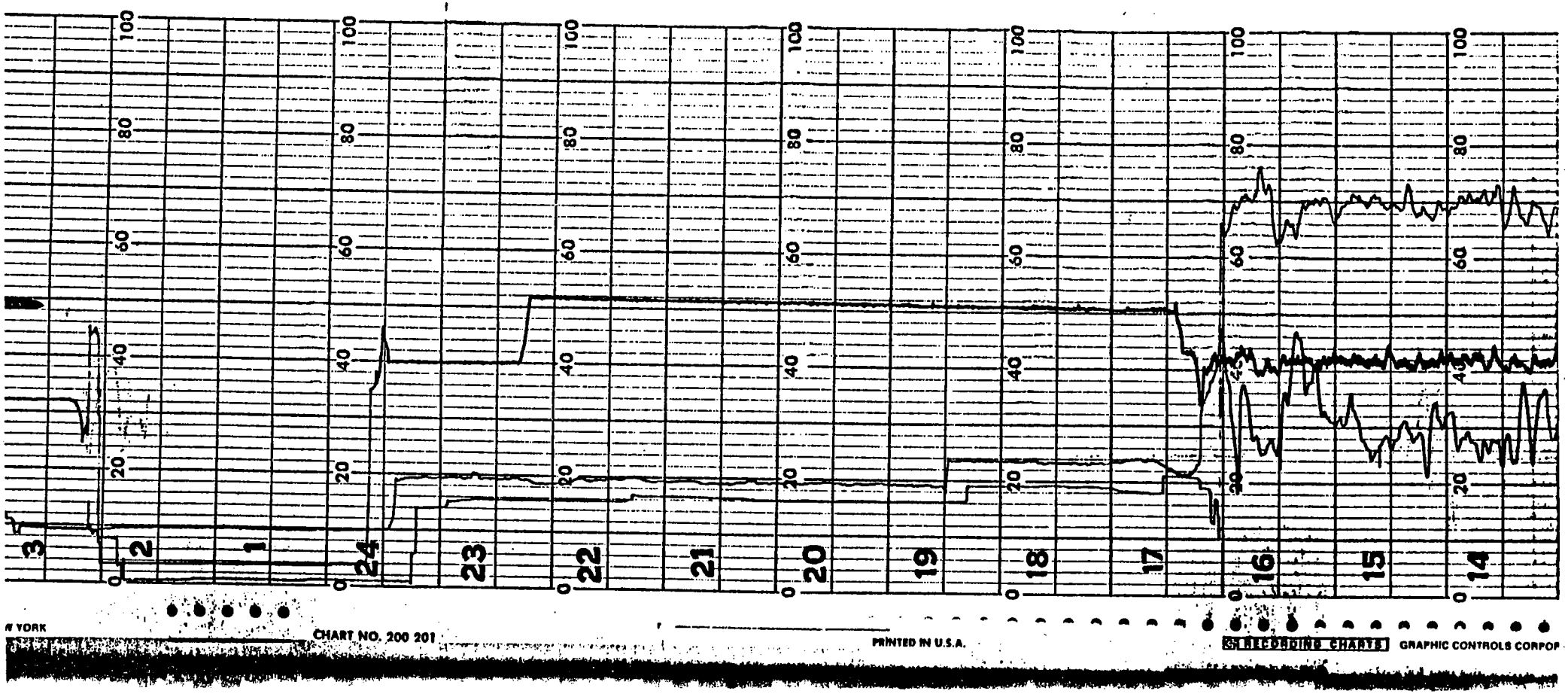
AG-

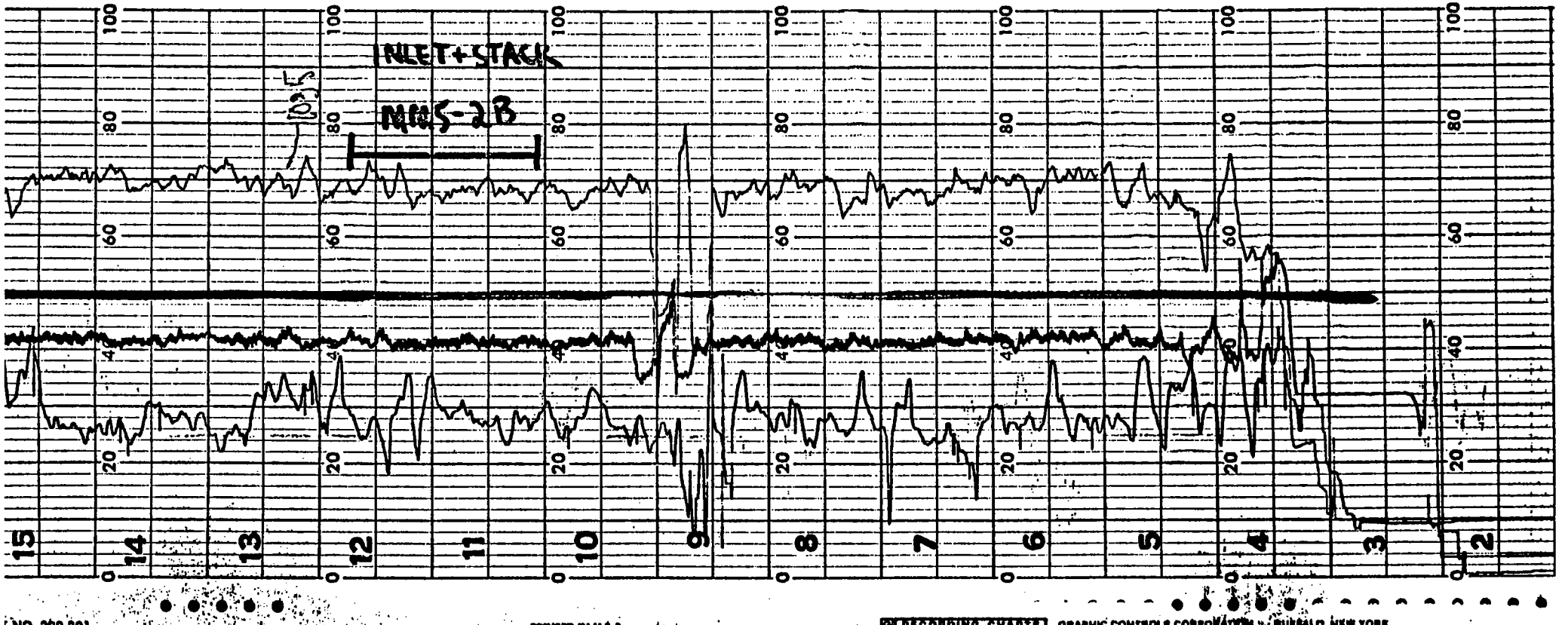
MAR 24 1988

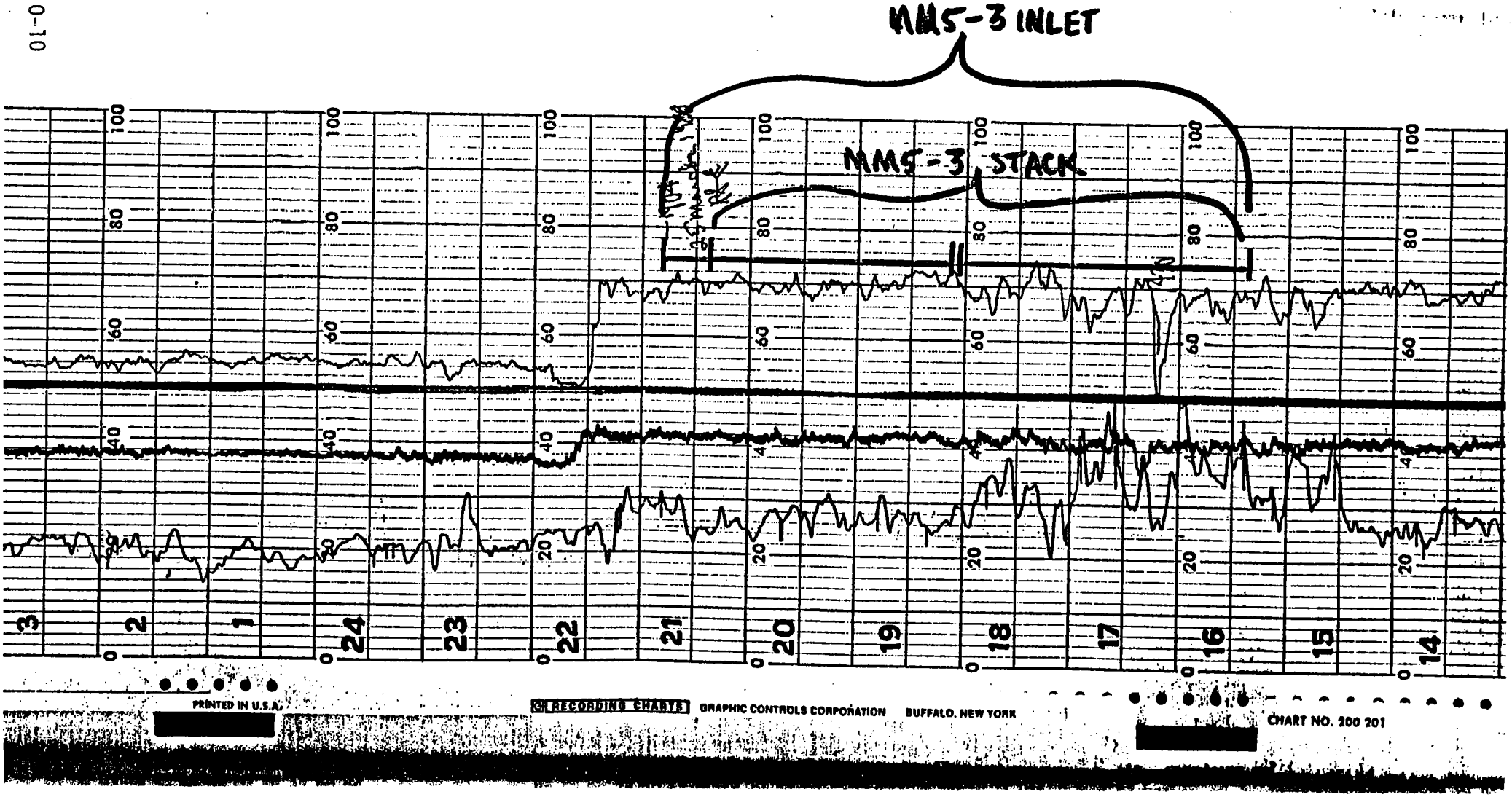
ECORDING CHARTS GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK

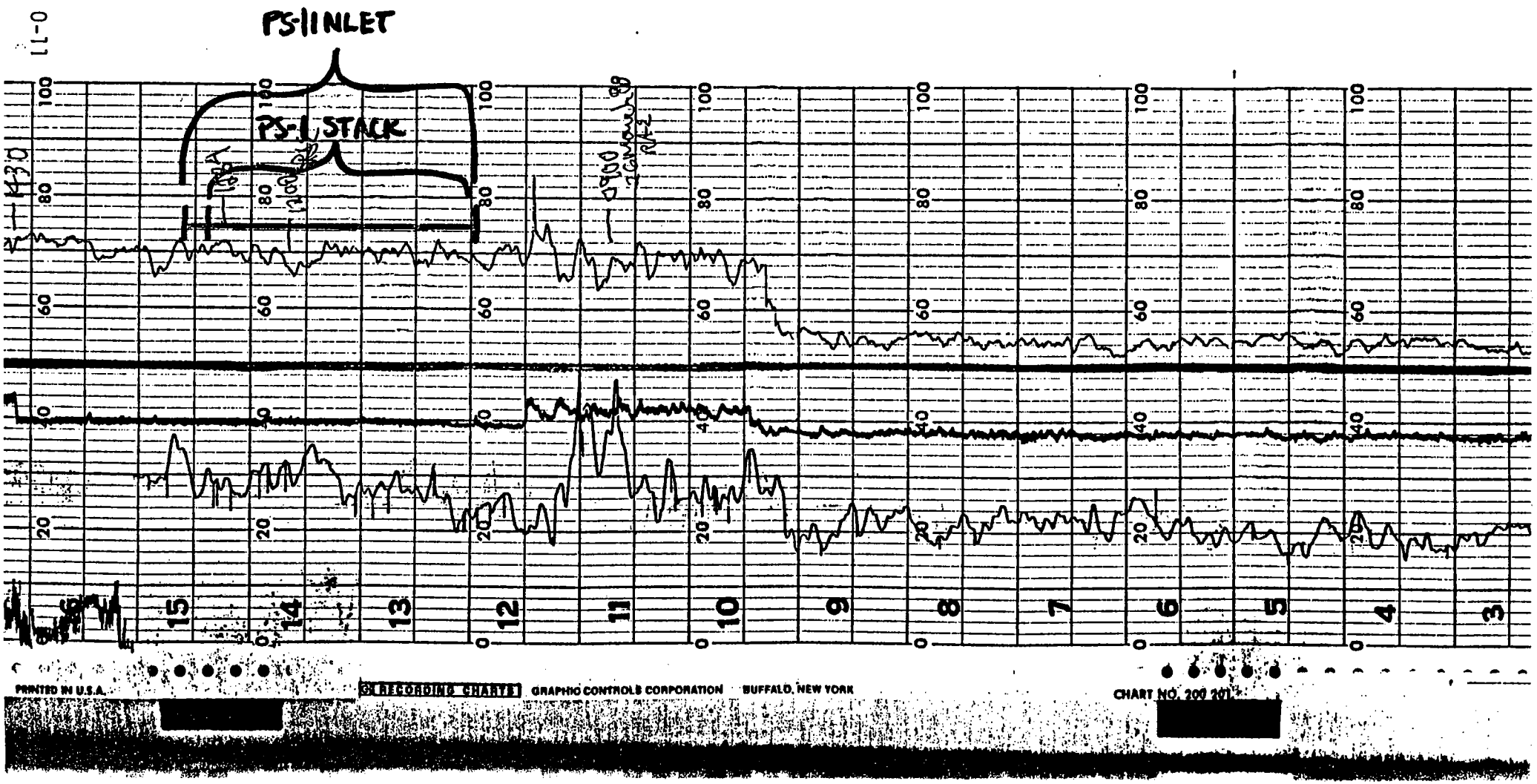
CHART NO. 200 201

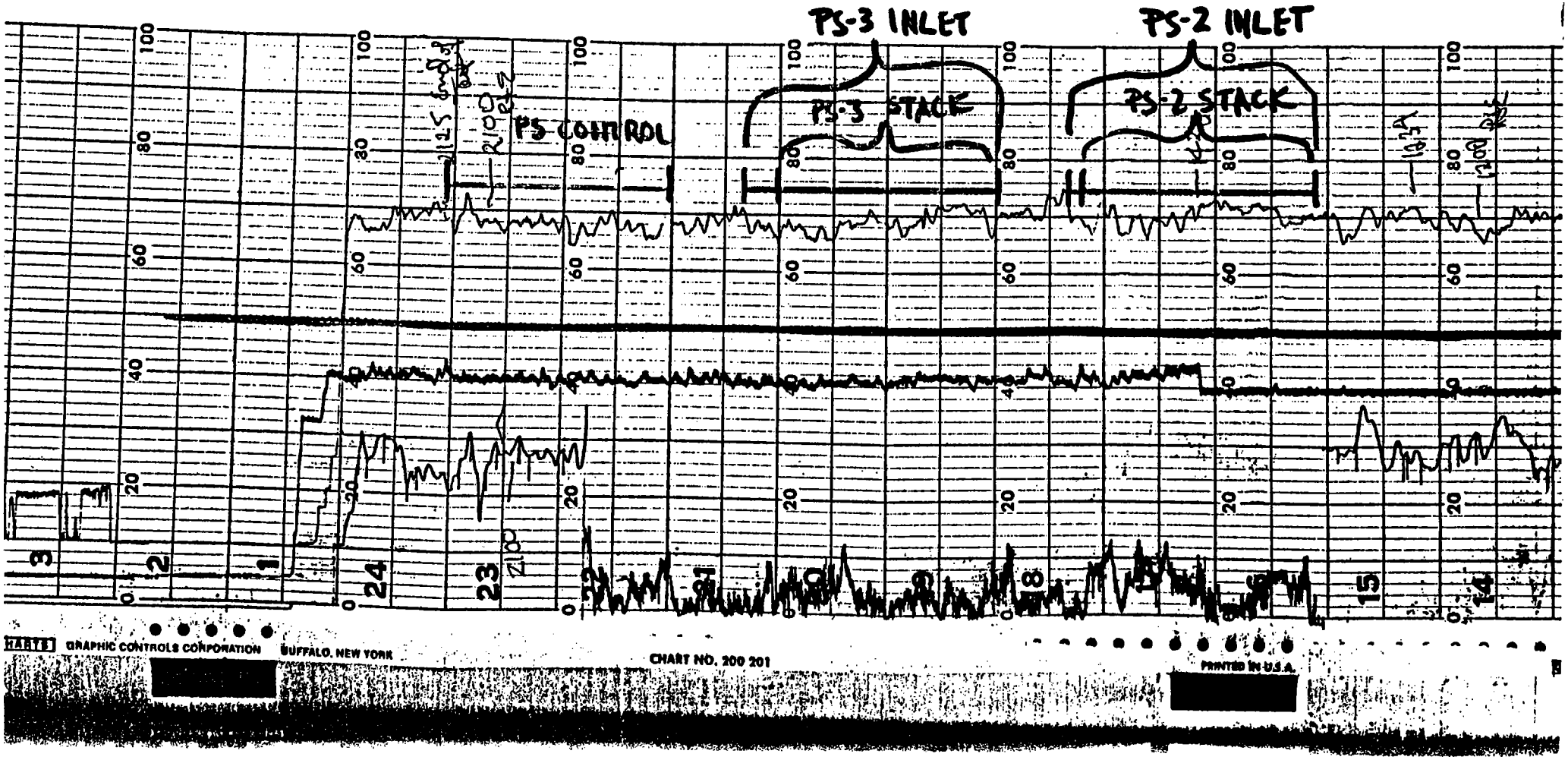
PRINTED IN U.S.A.


8-0
100
80
60
40
20
0
3
2
1
24
23
22
21
20
19
18
17
16
15
14
CHART NO. 200 201
PRINTED IN U.S.A.
GRAPHIC CONTROLS CORPOR


INLET + STACK
MW5-2B
100
80
60
40
20
0
15
14
13
12
11
10
9
8
7
6
5
4
3
2


MM5-3 INLET
MM5-3 STACK
100
80
60
40
20
0
3
2
1
24
23
22
21
20
19
18
17
16
15
14
PRINTED IN U.S.A.
RECORDING CHARTS
GRAPHIC CONTROLS CORPORATION
BUFFALO, NEW YORK
CHART NO. 200 201


PS-II INLET
PS-I STACK
11-0
100
80
60
40
20
0
15
14
13
12
11
10
9
8
7
6
5
4
3
PRINTED IN U.S.A.
RECORDING CHARTS
GRAPHIC CONTROLS CORPORATION
BUFFALO, NEW YORK
CHART NO. 200 201


PS-3 INLET
PS-2 INLET
PS-3 STACK
PS-2 STACK
PS CONTROL
HARTS GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
CHART NO. 200 201
PRINTED IN U.S.A.

21 March 1988 Run #1

			Time
~~#~~	3338722	(10^2 ~~lbs~~) Finish	~~Start~~ 1723
	3337424	Start	1610
	1298×10^2		73 min

Run #2 3340229 1840 (Start ~~Interrupt~~ @ 1845)

3339606 Start 1810

623

3340962 Finish @ 1925 ~~Start~~

3340515 Start 1904

447

3341067 Finish @ 1931 ~~Inlet~~

3340515 ~~Start~~ 1904

552

~~Start~~

$623+447 = 1070 \times 10^2$

Time

$1810-1845 = \overset{38}{\cancel{30}}$ min

$1904-1925 = 21$

~~56~~ min

~~Inlet~~

$623+552 = 1175$

$1810-1845 = 35$

$1904-1931 = 27$

62 min

Run #3

A) ~~Interrupt~~ @ 2015 3341884

~~Start~~ @ 2005 3341742

10 min 142

B. ~~Attempt~~ @ 2030 3342192

~~Start~~ @ 2020 3342002

10min 190

C. Complete @ ~~Attempt~~ @ 2206 3343453 Complete @ 2211 3343548

~~Start~~ @ 2115 3342528 2115 3342528

51 min 924 56min 1020

$924+190+142 = 1256\times10^2$ $1020+190+142 = 1352\times10^2$

$51+10+10 = 71$ min $56+10+10 = 76$ min

Run #1 = 106.7K lbs/hr

Run #2 ~~stack~~ ~~115.4K lbs/hr~~ ~~99.7K lbs/hr~~ inlet

$\frac{(1070\times10^2)}{(56/60)} = 114.6$K lbs/hr $\frac{(1175\times10^2)}{(62/60)} = 113.7$K lbs/hr

Run #3

stack $\frac{1256\times10^2}{(71/60)} = 106.1$K lbs/hr inlet $\frac{(1352\times10^2)}{(76/60)} = 106.7$K lbs/hr

OPERATING LOG: RED WING POWER PLANT UNIT #2

DATE: 21 March 1988

TIME (START)	TIME (FINISH)	DESCRIPTION OF EVENT	STEAM FLOW (START)	STEAM FLOW (FINISH)	OBSERVER
1610		Criteria PM & NOx Run #1 Start Fuel Sampling ✓ Steam Flow Reading	3337424		
1615		2nd ESP fallout			
1723		Run #1 Complete RIEH	37	3338722	
1803		2nd ESP Field In			
1810		Criteria PM & NOx Run #2 Start	3339606		
1840		Soot Blow Unit 2 Started			
1845		Steam Flow < 91K			
		Run Interrupt 1854 Steam interrupt soot blow interrupt	@1858 3340437		

OPERATING LOG: RED WING POWER PLANT UNIT #2

DATE: 21 March 1988

TIME (START)	TIME (FINISH)	DESCRIPTION OF EVENT	STEAM FLOW (START)	STEAM FLOW (FINISH)	OBSERVER
1904		resume ~~do not flow~~ & run #2	3340515		
1910	1914	~~steam flow~~ > 118 no interrupt			
1925		complete start Run #2		3340967	
1931		complete inlet Run #2		3341067	
2005		~~start~~ Criteria PM & NOx Run #3	3341742		
2015		Test ~~by~~ interrupted ~~to~~ Inlet steam power loss	3341884		
2020		Test resume	3342002		

PAGE: 2 OF 3

OPERATING LOG: RED WING POWER PLANT UNIT #2

DATE: 21 March

TIME (START)	TIME (FINISH)	DESCRIPTION OF EVENT	STEAM FLOW (START)	STEAM FLOW (FINISH)	OBSERVER
2030		Test Interrupt ID Fan Trip	3312192		
		2036 Gas burners on			
		2059 RDF feeders on			
2115		Pozzuolana testing	3342528		
2206		Complete "load" test group 1 Run #3		3343153	
2211		Complete inlet test Run #3		3343548	

PAGE: 3 OF 3

 R/ Evans 21 March 1988 2235

Acid Gas Runs

~~Steam~~ Flow Run #1

~~Finish~~ @ 1103 3404193

~~Start~~ @ 1000 3403396

1197 x 10^2

$$\frac{(1197 \times 10^2)}{(63/60)} = 114K \text{ lbs/hr}$$

~~Steam~~ Flow Run #2

~~Finish~~ @ 1225 3405450

~~Start~~ @ 1120 3404895

1255 x 10^2

$$\frac{(1255 \times 10^2)}{(65/60)} = 115.8K \text{ lbs/hr}$$

~~Steam~~ Flow

~~Finish~~ @ 1335 3407430

~~Start~~ @ 12:30 3406235

1195 x 10^2

$$\frac{(1195 \times 10^2)}{(65/60)} = 110.3K \text{ lbs/hr}$$

22 March 1988

Run # 1 3355696 interrupt @ 1030

3354869 start @ 940

827 50 min

3356709 finish @ 1143

3356165 start @ 1115

544 28 min

1371×10^2 lbs 78 min = 105.5K lbs/hr

Run # 2 3358669 finish @ 1335

3357380 start @ 1225

1289 70 min = 110.5K lbs/hr

Run # 3 3360555 Finish start 1515

3359300 start @ 1410

1255 65

$\frac{(1255 \times 10^2)}{(65/60)}$ = 115.8K lbs/hr

3360639 Finish @ 1519

3359300 start @ 1410

1339 69

$\frac{(1339 \times 10^2)}{(69/60)}$ = 116.4K lbs/hr

OPERATING LOG: RED WING POWER PLANT UNIT #2

DATE: 22 March 1988

TIME (START)	TIME (FINISH)	DESCRIPTION OF EVENT	STEAM FLOW (START)	STEAM FLOW (FINISH)	OBSERVER
0945		Hotdog Run Start Run #1 Inlet & Outlet (Start) Steam Flow @ 100K Soot Blow Start @ 0955	3354869		R+E
1030		2 Feeder off Test Interrupt <92K High CO level 1045 Gas On (Burner 4) Reduced <400 ppm	3355696		
		1050 Soot Blow Off 11:00 21 & 22 feeder reversed & cleaned 11:05 Gas off			
11:15		Resume Test #1 Steam Flow >92K		3356165	
1123	1126	Steam Flow >118K " " <118K no interrupt	3356322 (Start)		
1133	1138	Steam Flow 116K Steam Flow <118K no interrupt	3356525 (Start)		
1143		Hotdog & Outlet runs completed	3356709		

PAGE: 1 OF 2

OPERATING LOG: RED WING POWER PLANT UNIT #2

DATE: 22 March 1988

TIME (START)	TIME (FINISH)	DESCRIPTION OF EVENT	STEAM FLOW (START)	STEAM FLOW (FINISH)	OBSERVER
1025	1335	Start Run #2 (metals)	3357380	3358669	RJE/JLK
1410	1515	Start Run #3 (metals)	3359200	3360555 (1515) 2	JLK/RJE
		End stack @ 1515			
		End outlet @ 1519		330 3360639	

PAGE: 2 OF 2

R J Evans
22 March 1988

Revised 1/1/88

E

23 March 1988

MMK Run #1

~~start~~ interrupt @ 1631	3386726	
~~start~~ @ 1130	3381104	
301 min	5622	

~~start~~ Finish @ 1650	3387146	@ 1708	3387433	
~~start~~ @ 1638	3386860	1638	3386860	
28 min	286	30 min	573	

~~start~~

301 + 20 = 321 min

$$\frac{(5622+286)\times 10^2}{321/60} = 110.4\text{K lbs/hr}$$

@ ~~start~~

$$\frac{(5622+573)\times 10^2}{331/60} = 112.3\text{K lbs/hr}$$

@ inst

OPERATING LOG: RED WING POWER PLANT UNIT #2

DATE: 23 March 1988

TIME (START)	TIME (FINISH)	DESCRIPTION OF EVENT	STEAM FLOW (START)	STEAM FLOW (FINISH)	OBSERVER
1130		Start MMS Run #1	3381104		
1143	1147	~~Steam Flow~~ > 118K " " < 118K no test interrupt	3381353	3381445	
1215		2 Feeder Trip no test interrupt			
1234	1236	~~Steam Flow~~ > 118K ~~Steam Flow~~ < 118K no test interrupt			
1243	1245	~~Steam Flow~~ < 92K " " > 92K no test interrupt	3382498	3382529	
1631	1638	Conveyor problems with dumpers ~~test interrupt~~	RFG 3386726		
1639		~~Restart boiler~~ Stack finish @ 1650 & inlet	3386860	3387146	
		~~1642 @~~			

PAGE: 1 OF 2

OPERATING LOG: RED WING POWER PLANT UNIT #2

DATE: 23 March 1988

TIME (START)	TIME (FINISH)	DESCRIPTION OF EVENT	STEAM FLOW (START)	STEAM FLOW (FINISH)	OBSERVER
	1708	~~output shut off~~ Completed		3387433	

PAGE: 2 OF 2

R K Evans 23 March 1988

Steam flow Calculation MMS run 1 | 23 March 1988

Run #1

interrupt @ 1631 — 3386726
start @ 1130 — 3381104
30 min — 5622

Start
Complete @ 1650 — 3387146
restart @ 1638 — 3386860
12 min — 286

Shut
Complete @ 1708 — 3387433
restart @ 1638 — 3386860
30 min — 573

$$\frac{(5622+286)*10^2}{313/60} = 113.3 \text{ K lbs/hr}$$

$$\frac{5622+573 \times 10^2}{(331)/60}$$

$$= 112.3 \text{ K lbs/hr}$$

~~Mass Flow Calculations~~: MM5 runs 2-3

24-25 March 1988

Run #1

interrupt @ 1310 — 3406987
(24 March) ~~start~~ @ 0945 — 3403125
.205 min — 3862

~~start~~

25 March ~~Test Complete~~ @ 1000 — 3420325
" " ~~start~~ @ 0820 — 3418472
100 min — 1853

inlet

Complete @ 1002 — 3420375
~~start~~ @ 0820 — 3418472
10.2 min — 1903

Run #1 ~~start~~

$$\frac{(3862+1853)\times 10^2}{305/60} = 112.4\text{K lbs/hr}$$

Run #1 inlet

$$\frac{(3862+1903)\times 10^2}{(205+102)/60} = 112.7\text{K lbs/hr}$$

Run #3

~~interrupt~~ @ 1434 — 3425410
~~start~~ @ 1340 — 3424437
56 min — 973

~~interrupt~~ @ 1622 — 3427395
~~start~~ @ 1436 — 3425446
106 min — 1949

~~start~~

Complete @ 1840 — 3429999
~~start~~ @ 1626 — 3427486
134 min — 2513

inlet

Complete @ 1905 — 3430502
~~start~~ @ 1626 — 3427486
159 min — 3016

~~start~~

$$\frac{(973+1949+2513)\times 10^2}{(56+106+134)/60} = 110.2\text{K lbs/hr}$$

inlet

$$\frac{(973+1949+3016)\times 10^2}{(56+106+159)/60} = 111.0\text{K lbs/hr}$$

Steam Flow Calculations: Particle Trap Duct 26 March 1981

Run #1

Interrupt @ 1036 3444866
Start @ 1015 3444465
21 401

Start
Complete @ 1240 3447201
Restart @ 1050 3445139
110 2062

Inlet
Complete @ 1253 3447434
Restart @ 1050 3445139
123 2295

Start
$\frac{(2062+401)\times 10^2}{131/60}$ = 112.8K lbs/hr

Inlet
$\frac{(2295+401)\times 10^2}{144/60}$ = 112.3K lbs/hr

Run #2

Start
Complete @ 1533 3450410
Start @ 1324 3448028
2392

129 min

Start
$\frac{2392\times 10^2}{129/60}$ = 111.3K lbs/hr

Inlet
Complete @ 542 3450672
Start @ 1324 3448028
2584

38 min

Inlet
$\frac{(2584\times 10^2)}{138/60}$ = 112.3K lbs/hr

Run #3

Start
Complete @ 1823 3453630
Start @ 1620 3451328
2302

123 min

Start
$\frac{(2302\times 10^2)}{123/60}$ = 112.3K lbs/hr

Inlet
Complete @ 1340 3453970
Start @ 1620 3451328
2642

Inlet
$\frac{(2642\times 10^2)}{(140/60)}$ = 113.2K lbs/hr

Steam Flow Calculations: Particle Tight Test (Control Run)

Complete @ 2125 — 3456955
Start @ 1825 — 3454762
2193

$\frac{(2193) \times 10^2}{120/60} = 109.7$ K lbm/hr

APPENDIX P

PROCEDURES

Particulate Loadings and Emission Rates

The particulate emission rates were determined per EPA Methods 1-5, CFR title 40, Part 60, Appendix A (revised July 1, 1986). In this procedure, a preliminary velocity profile of the gases in the flue is obtained by means of a temperature and velocity traverse. On the basis of these values, sampling nozzles of appropriate diameter are selected to allow isokinetic sampling, a necessary prerequisite for obtaining a representative sample.

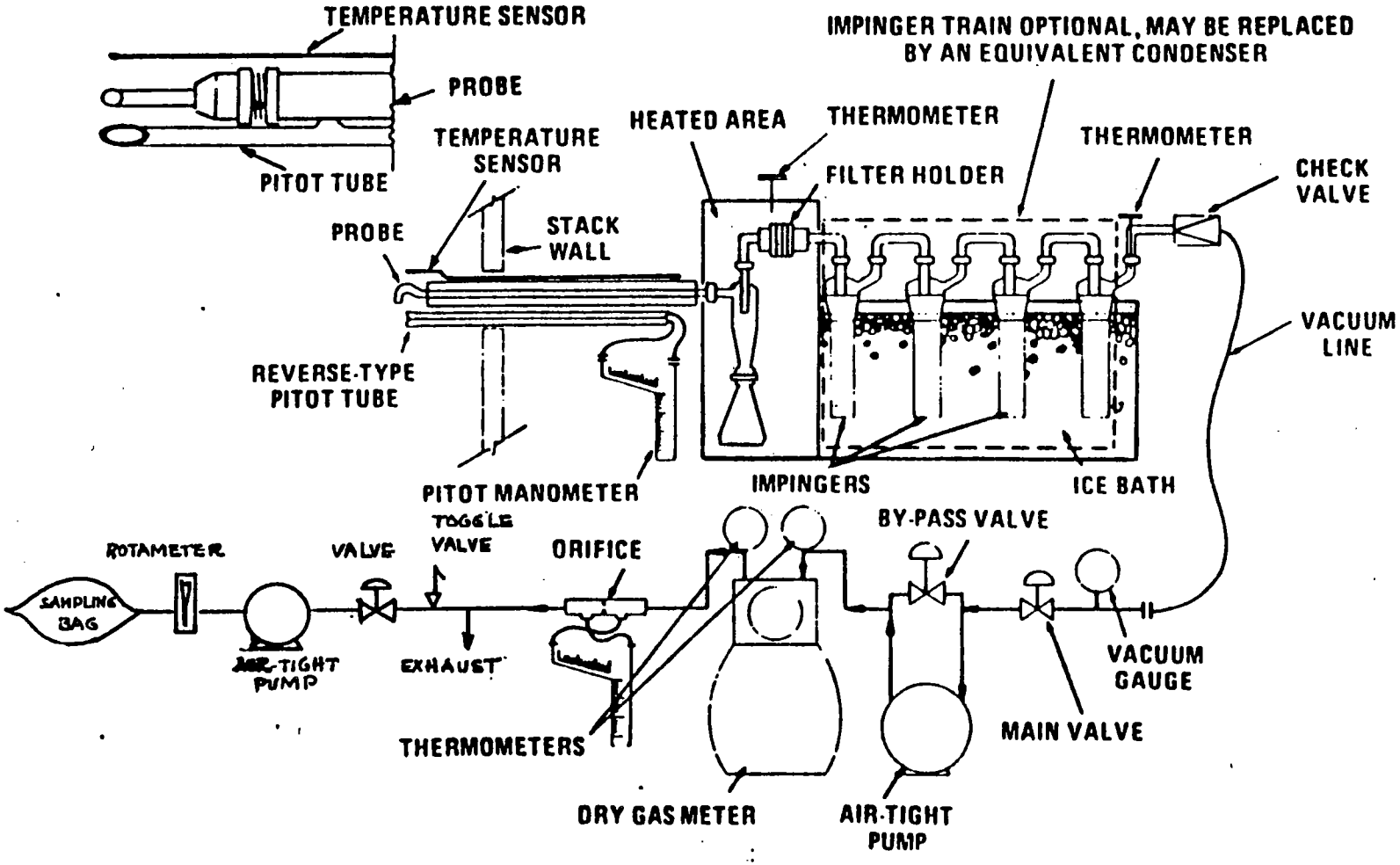
The sampling train consists of a heated glass or stainless steel-lined sampling probe equipped with a Type S pitot and a thermocouple. The probe is attached to a sampling module which houses the all-glass in line filter holder in a temperature controlled oven. In addition, the sampling module also houses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

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

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

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

Integrated flue gas samples for Orsat analysis were collected simultaneously from the stack and from the breeching at the inlet to the wet scrubber. The samples were collected in 15-liter gas sampling bags at a constant flow rate throughout each particulate run. The bags were then returned to the laboratory and analyzed by Orsat analysis. Standard commercially prepared solutions were used in the Orsat analyzer (sat. KOH for carbon dioxide and reduced methylene blue for oxygen).



Particulate sampling train.

Interpoll Laboratories
(612)786-6020

Condensible Organic Compounds Analysis

(State of Minnesota - MPCA Exhibit C)

Method II-8672-MN

Equipment: Separatory funnel - 500 cc with Teflon stopcock

Powder funnel - 75 mm ID with a 17 mm stem

Evaporating dish(es) - 200 cc or 250 cc beaker

Reagents: Diethyl ether - reagent grade

Chloroform - reagent grade

Sodium sulfate - (ACS) granular anhydrous

Toluene - (if 3% hydrogen peroxide is used to collect the samples)

Glass wool (Pyrex microfiber)

PREPARATION

1. Place 1 kg of granular anhydrous sodium sulfate in a shallow tray and heat to 200 ^{o}C for at least four hours. Store in a tightly sealed glass container.

2. Place a plug of clean glass wool in the stem of the powder funnel. The plug must be of sufficient size so that it is held snuggly in place by its own pressure. Add a one-inch layer of dry sodium sulfate.

SAMPLING

An all-glass impinger assembly is used in the back half of the EPA Method 5 sampling train when an organic wet catch is to be collected. The impinger assembly consists of a modified impinger, a Greenburg Smith impinger followed by another modified impinger. The third impinger should have a temperature measuring device at the outlet upstream of a final impinger or desiccant column to monitor the temperature of the outlet gas stream. Prior to the start of the test, each of the first two impingers should be charged with 100 g of Class I water. The Method 5 train should be operated as provided for in EPA Method 5. Ice should be added to the impinger bath to keep the temperature of the gas at the outlet at or less than 68 ^{o}F. After the post test leak check, the impinger train is removed and impinger contents poured into a tared all-glass sample bottle and closed with a Teflon-lined cap. The sample bottle is then weighed and the total condensate calculated by subtraction of the bottle tare weight and the weight of initial water added to the impingers (200 g). A label is affixed and the sample is returned to the laboratory for analysis. The sample should be stored at 4 ^{o}C if the analysis is not conducted within 48 hours.

ANALYSIS

I. Organics

Caution! Work in vented hood!!!

A. Organic Blank Determination

1. Pour 125 mL of ethyl ether and 125 mL of chloroform into a tared beaker.
2. Evaporate solvent in hood at 70 ^{o}F or less until no solvent remains.
3. Desiccate the sample in dish for two hours.
4. Weigh the sample to nearest 0.1 mg, record and report on Form LSC-036.

B. Organic Sample Determination

1. Test for peroxide in sample ether using KI strips. (If KI strip shows positive, contact your supervisor before proceeding.)
2. Transfer the sample solution quantitatively to a 500 mL separatory funnel. Use the first of three 25 mL chloroform aliquots to rinse the sample container.
3. Extract with three 25 mL portions of chloroform. (Shake and vent to release pressure about 4 to 5 times each.) Allow the phases to separate. (Bottom layer is chloroform.) Draw off the bottom layer, transferring the solvent with a funnel containing a plug of sodium sulfate into a tared beaker. (Do not draw off any of the aqueous layer.)

4. After the three chloroform extractions, use two 25 mL portions of chloroform to rinse the sodium sulfate, collecting the rinses in the same tared beaker as the extracts.

5. Next extract the sample three times with 25 mL aliquots of ethyl ether. (Shake and vent to release pressure about 4 to 5 times each.) Allow the phases to separate. (Top layer is ethyl ether.) Draw off the bottom layer (aqueous) into another separatory funnel taking less than 1 mL of the ethyl ether layer with. Decant the ethyl ether, passing it through sodium sulfate and collecting the ethyl ether in the same tared dish as the chloroform.

6. After the three ethyl ether extractions, take two 25 mL portions of ethyl ether and rinse the sodium sulfate collecting the rinses in the same tared beaker as the extracts.

7. Evaporate the solvents (chloroform and ethyl ether) in the tared beaker in the hood at 70 ^{o}F or less until no solvent remains. (Use no heat and have no sources of ignition in the hood when doing this procedure.) Do not evaporate so quickly as to allow evaporative cooling to lower the temperature of the container below the dew point of water, otherwise, water will be condensed out in the container.

8. Desiccate to constant weight (two hours). Record and report the final weight to the nearest 0.1 mg on Form LSC-036.

II. Inorganics

If inorganic residue information is required, the following procedure should be conducted:

A. Inorganic Blank Determination

1. Vent the remaining aqueous phase from the organic extraction in the hood to remove residual organic solvents (usually overnight).
2. Decant the impinger catch into a tared evaporating dish.
3. Evaporate all of the water in the sample in an oven at 100 ^{o}C. Take care not to boil to prevent bumping and loss of sample.
4. Cool the dried sample in the desiccator and desiccate until a constant weight is obtained.
5. Report the results to the nearest 0.1 mg on Form LSC-036.

B. Inorganic Sample Determination

Follow steps 1-5 in Section A above.

NOTES

1. For the organics determination, in the rare event that the impinger catch resulted from a Modified Method 6 determination (SO_2), whereby the solution contains dilute hydrogen peroxide ($\geq$ 3%), do not use ether as an extraction solvent. Substitute toluene for ethyl ether in Section I. (Ether in the presence of peroxide forms explosive hydroperoxide.)

2. In the organics determination, more than three extractions may be required to extract all of the organics. Additional extractions should be performed if the aqueous phase is still cloudy.

3. Special state requirements:

   Michigan - Total sample evaporated in tared evaporating dish on steam bath.

   Iowa - Organics and inorganics separately, as required.

   Wisconsin - Use Method II-8672-WI.

   Rest of states - Organics only.

REFERENCES

Proposed Standards of Performance for New Stationary Sources, Federal Register 36(159) Part II, August 1, 1979.

Minnesota Pollution Control Agency, Exhibit C.

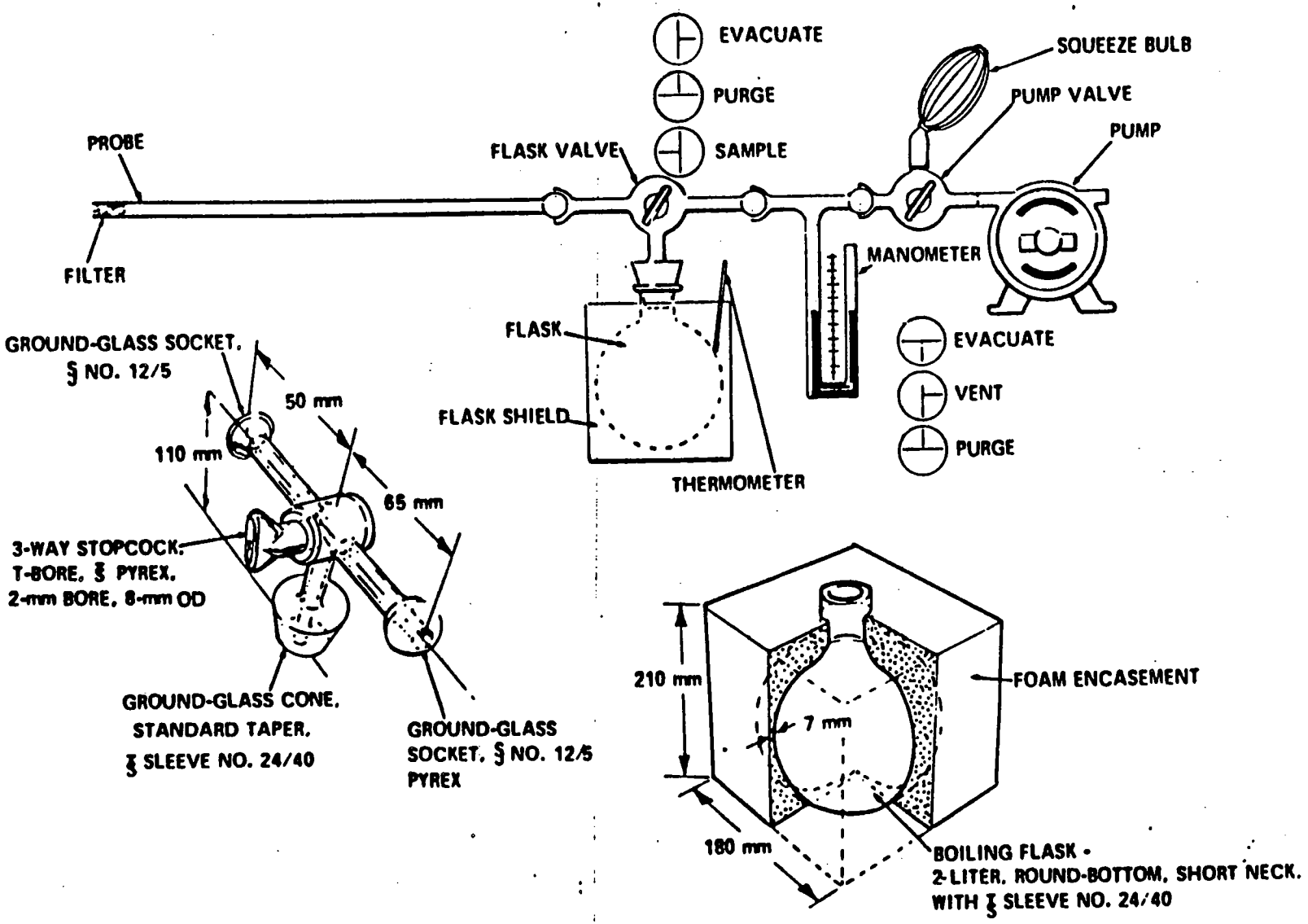
Interpoll Laboratories
(612)786-6020

Hydrogen Chloride, Hydrogen Fluoride and Sulfur Dioxide Determinations Method II-8899

Hydrogen chloride (HCl), hydrogen fluoride (HF) and sulfur dioxide (SO_2) were determined in a separate sampling train using a modification of the EPA Method 6 large impinger version (CFR Title 40, Part 60, Appendix A). This sampling train is identical to the Method 5 sampling train except that the first two impingers are each charged with 100 cc of 0.1 N NaOH which quantitatively collects both HCl,HF and SO_2. Particulate material is removed prior to the impingers by a heated all-glass cyclone and filter holder assembly (four-inch glass-fiber filter) which is kept at 250 $\pm$ 25 ^{o}F. After sampling is complete (20-60 minutes), the impinger catch is quantitatively recovered into an all-glass sample bottle and closed with a Teflon-lined cap. The recovered samples are returned to the laboratory where they are analyzed for chloride and sulfate by ion chromatography (IC). Prior to analysis, the samples are made 3% in hydrogen peroxide (by the addition of 30% H_2O_2) to convert all sulfite to sulfate. The sulfite peak is monitored in the analysis to ensure quantitative conversion. A field blank is analyzed with the samples to correct for impurities in the reagents, sample recovery fluids and the sample containers.

Oxides of Nitrogen Emissions

The oxides of nitrogen concentrations were determined per Method 7, CFR Title 40, Part 60, Appendix A (Revised July 1, 1986). In this procedure, 25 cc of acidified peroxide solution are added to two liter all-glass gas sampling bulbs which are then evacuated and a sample of stack gas drawn into the evacuated flask by means of a glass probe through a plug of glass wool to remove any flyash. The bulb is then sealed by closing a stopcock and set aside for at least sixteen hours until all of the nitric oxide is oxidized to nitrogen dioxide and absorbed in the peroxide solution. The resulting nitrate solution is then analyzed by the phenol disulfonic acid (PDS) method. Results are reported as nitrogen dioxide.



Sampling train, flask valve, and flask.

METHOD 10—DETERMINATION OF CARBON MONOXIDE EMISSIONS FROM STATIONARY SOURCES

1. *Principle and Applicability.*

1.1 *Principle.* An integrated or continuous gas sample is extracted from a sampling point and analyzed for carbon monoxide (CO) content using a Luft-type nondispersive infrared analyzer (NDIR) or equivalent.

1.2 *Applicability.* This method is applicable for the determination of carbon monoxide emissions from stationary sources only when specified by the test procedures for determining compliance with new source performance standards. The test procedure will indicate whether a continuous or an integrated sample is to be used.

2. *Range and sensitivity.*

2.1 Range. 0 to 1,000 ppm.

2.2 Sensitivity. Minimum detectable concentration is 20 ppm for a 0 to 1,000 ppm span.

3. *Interferences.*

Any substance having a strong absorption of infrared energy will interfere to some extent. For example, discrimination ratios for water (H_2O) and carbon dioxide (CO_2) are 3.5 percent H_2O per 7 ppm CO and 10 percent CO_2 per 10 ppm CO, respectively, for devices measuring in the 1,500 to 3,000 ppm range. For devices measuring in the 0 to 100 ppm range, interference ratios can be as high as 3.5 percent H_2O per 25 ppm CO and 10 percent CO_2 per 50 ppm CO. The use of silica gel and ascarite traps will alleviate the major interference problems. The measured gas volume must be corrected if these traps are used.

4. *Precision and accuracy.*

4.1 Precision. The precision of most NDIR analyzers is approximately ±2 percent of span.

4.2 Accuracy. The accuracy of most NDIR analyzers is approximately ±5 percent of span after calibration.

5. *Apparatus.*

5.1 Continuous sample (Figure 10-1).

5.1.1 Probe. Stainless steel or sheathed Pyrex[1] glass, equipped with a filter to remove particulate matter.

5.1.2 Air-cooled condenser or equivalent. To remove any excess moisture.

5.2 Integrated sample (Figure 10-2).

5.2.1 Probe. Stainless steel or sheathed Pyrex glass, equipped with a filter to remove particulate matter.

5.2.2 Air-cooled condenser or equivalent. To remove any excess moisture.

5.2.3 Valve. Needle valve, or equivalent, to to adjust flow rate.

5.2.4 Pump. Leak-free diaphragm type, or equivalent, to transport gas.

5.2.5 Rate meter. Rotameter, or equivalent, to measure a flow range from 0 to 1.0 liter per min. (0.035 cfm).

[1]Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.

5.2.6 Flexible bag. Tedlar, or equivalent, with a capacity of 60 to 90 liters (2 to 3 ft^3). Leak-test the bag in the laboratory before using by evacuating bag with a pump followed by a dry gas meter. When evacuation is complete, there should be no flow through the meter.

5.2.7 Pitot tube. Type S, or equivalent, attached to the probe so that the sampling rate can be regulated proportional to the stack gas velocity when velocity is varying with the time or a sample traverse is conducted.

5.3 Analysis (Figure 10-3).

5.3.1 Carbon monoxide analyzer. Nondispersive infrared spectrometer, or equivalent. This instrument should be demonstrated, preferably by the manufacturer, to meet or exceed manufacturer's specifications and those described in this method.

5.3.2 Drying tube. To contain approximately 200 g of silica gel.

5.3.3 Calibration gas. Refer to paragraph 6.1.

5.3.4 Filter. As recommended by NDIR manufacturer.

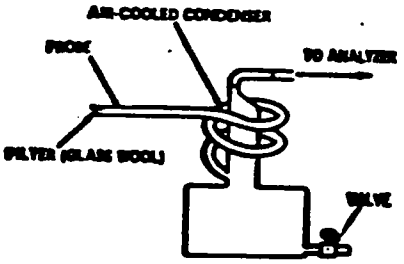


Figure 10-1. Continuous sampling train.

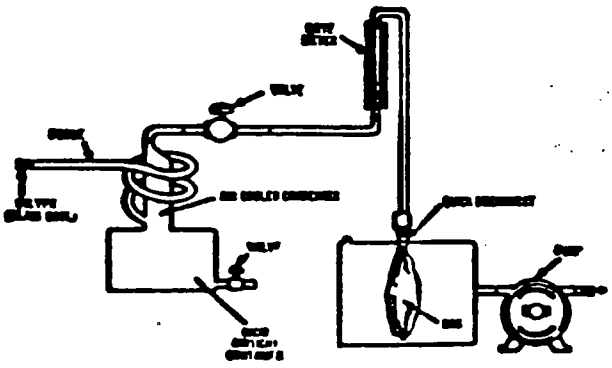


Figure 10-2. Integrated gas-sampling train.

5.3.5 CO_2 removal tube. To contain approximately 500 g of ascarite.

5.3.6 Ice water bath. For ascarite and silica gel tubes.

5.3.7 Valve. Needle valve, or equivalent, to adjust flow rate

5.3.8 Rate meter. Rotameter or equivalent to measure gas flow rate of 0 to 1.0 liter per min. (0.035 cfm) through NDIR.

5.3.9 Recorder (*optional*). *To provide permanent record of NDIR readings.*

6. *Reagents.*

6.1 Calibration gases. Known concentration of CO in nitrogen (N_2) for instrument span, prepurified grade of N_2 for zero, and two additional concentrations corresponding approximately to 60 percent and 30 percent span. The span concentration shall not exceed 1.5 times the applicable source performance standard. The calibration gases shall be certified by the manufacturer to be within ±2 percent of the specified concentration.

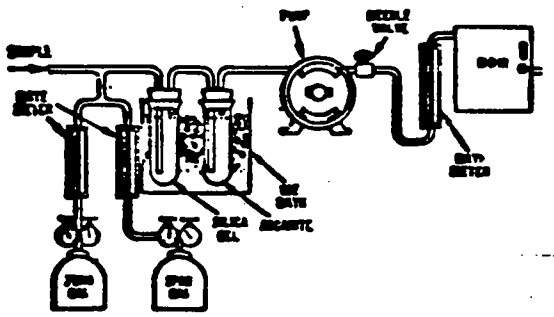


Figure 10-3. Analytical equipment.

6.2 Silica gel. Indicating type, 6 to 16 mesh, dried at 175° C (347° F) for 2 hours.

6.3 Ascarite. Commercially available.

7. *Procedure.*

7.1 Sampling.

7.1.1 Continuous sampling. Set up the equipment as shown in Figure 10-1 making sure all connections are leak free. Place the probe in the stack at a sampling point and purge the sampling line. Connect the analyzer and begin drawing sample into the analyzer. Allow 5 minutes for the system to stabilize, then record the analyzer reading as required by the test procedure. (See ¶ 7.2 and 8). CO_2 content of the gas may be determined by using the Method 3 integrated sample procedure (36 FR 24886), or by weighing the ascarite CO_2 removal tube and computing CO_2 concentration from the gas volume sampled and the weight gain of the tube.

7.1.2 Integrated sampling. Evacuate the flexible bag. Set up the equipment as shown in Figure 10-2 with the bag disconnected. Place the probe in the stack and purge the

sampling line. Connect the bag, making sure that all connections are leak free. Sample at a rate proportional to the stack velocity. CO_2 content of the gas may be determined by using the Method 3 integrated sample procedures (36 FR 24886), or by weighing the ascarite CO_2 removal tube and computing CO_2 concentration from the gas volume sampled and the weight gain of the tube.

7.2 CO Analysis. Assemble the apparatus as shown in Figure 10-3, calibrate the instrument, and perform other required operations as described in paragraph 8. Purge analyzer with N_2 prior to introduction of each sample. Direct the sample stream through the instrument for the test period, recording the readings. Check the zero and span again after the test to assure that any drift or malfunction is detected. Record the sample data on Table 10-1.

8. *Calibration.*

Assemble the apparatus according to Figure 10-3. Generally an instrument requires a warm-up period before stability is obtained. Follow the manufacturer's instructions for specific procedure. Allow a minimum time of 1 hour for warm-up. During this time check the sample conditioning apparatus, i.e., filter, condenser, drying tube, and CO_2 removal tube, to ensure that each component is in good operating condition. Zero and calibrate the instrument according to the manufacturer's procedures using, respectively, nitrogen and the calibration gases.

TABLE 10-1—FIELD DATA

	Comments
Location	
Test	
Date	
Operator	

Clock time	Rotameter setting, liters per minute (cubic feet per minute)

9. *Calculation.*

Concentration of carbon monoxide. Calculate the concentration of carbon monoxide in the stack using equation 10-1.

$$C_{CO\ stack} = C_{CO\ NDIR}(1 - F_{CO_2})$$

where:

$C_{CO\ stack}$ = concentration of CO in stack, ppm by volume (dry basis).

$C_{CO\ NDIR}$ = concentration of CO measured by NDIR analyzer, ppm by volume (dry basis).

F_{CO_2} = volume fraction of CO_2 in sample, i.e., percent CO_2 from Orsat analysis divided by 100.

10. *Bibliography.*

10.1 McElroy, Frank, The Intertech NDIR-CO Analyzer, Presented at 11th Methods Conference on Air Pollution, University of California, Berkeley, Calif., April 1, 1970.

10.2 Jacobs, M. B., et al., Continuous Determination of Carbon Monoxide and Hydrocarbons in Air by a Modified Infrared Analyzer, J. Air Pollution Control Association, 9(2): 110-114, August 1959.

10.3 MSA LIRA Infrared Gas and Liquid Analyzer Instruction Book, Mine Safety Appliances Co., Technical Products Division, Pittsburgh, Pa.

10.4 Models 215A, 315A, and 415A Infrared Analyzers, Beckman Instruments, Inc., Beckman Instructions 1635-B, Fullerton, Calif., October 1967.

10.5 Continuous CO Monitoring System, Model A5611, Intertech Corp., Princeton, N.J.

10.6 UNOR Infrared Gas Analyzers, Bendix Corp., Ronceverte, West Virginia.

ADDENDA—A. PERFORMANCE SPECIFICATIONS FOR NDIR CARBON MONOXIDE ANALYZERS.

Range (minimum)	0-1000 ppm.
Output (minimum)	0-10mV.
Minimum detectable sensitivity.	20 ppm.
Rise time, 90 percent (maximum).	30 seconds.
Fall time, 90 percent (maximum).	30 seconds.
Zero drift (maximum)	10% in 8 hours.
Span drift (maximum)	10% in 8 hours.
Precision (minimum)	±2% of full scale.
Noise (maximum)	±1% of full scale.
Linearity (maximum deviation)	2% of full scale.
Interference rejection ratio	CO_2—1000 to 1, H_2O—500 to 1.

B. *Definitions of Performance Specifications.*

Range—The minimum and maximum measurement limits.

Output—Electrical signal which is proportional to the measurement; intended for connection to readout or data processing devices. Usually expressed as millivolts or milliamps full scale at a given impedance.

Full scale—The maximum measuring limit for a given range.

Minimum detectable sensitivity—The smallest amount of input concentration that can be detected as the concentration approaches zero.

Accuracy—The degree of agreement between a measured value and the true value; usually expressed as ± percent of full scale.

Time to 90 percent response—The time interval from a step change in the input concentration at the instrument inlet to a reading of 90 percent of the ultimate recorded concentration.

Rise Time (90 percent)—The interval between initial response time and time to 90 percent response after a step increase in the inlet concentration.

Fall Time (90 percent)—The interval between initial response time and time to 90 percent response after a step decrease in the inlet concentration.

Zero Drift—The change in instrument output over a stated time period, usually 24 hours, of unadjusted continuous operation when the input concentration is zero; usually expressed as percent full scale.

Span Drift—The change in instrument output over a stated time period, usually 24 hours, of unadjusted continuous operation when the input concentration is a stated upscale value; usually expressed as percent full scale.

Precision—The degree of agreement between repeated measurements of the same concentration, expressed as the average deviation of the single results from the mean.

Noise—Spontaneous deviations from a mean output not caused by input concentration changes.

Linearity—The maximum deviation between an actual instrument reading and the reading predicted by a straight line drawn between upper and lower calibration points.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Environmental Monitoring Systems Laboratory
Research Triangle Park, North Carolina 27711

Date: July 7, 1987

Subject: Recommended Sampling Train for Multiple Metals Determination

From: Larry D. Johnson, Research Chemist LDJ
Source Branch/QAD/EMSL-RTP (MD-7A)

To: Addressees:

In my April 21 letter to C. Johnson, I described a research train currently under validation for multiple metals sampling. As I mentioned in that letter, some of the train components were for research purposes, and not necessary for a working version of the train. I have had several further conversations with Tom E. Ward, the project officer in charge of the validation, and we are ready to recommend a simpler train.

The train we recommend for normal field use consists of a Method 5 probe and filter followed by either four or five impingers, depending upon source moisture content. The contents of the impingers are as follows:

1. Empty (for condensate collection, may be omitted for dry source)
2. 5% HNO_3 and 10% H_2O_2 (will be reduced to 0.1N HNO_3 if research shows it to be adequate)
3. Same as 2
4. 1.5% $KMnO_4$ and 10% H_2SO_4
5. Silica gel (to protect the pump and meter)

The rest of the train is the usual Method 5 equipment, pump, meter, et cetera.

The train is being validated for collection of the following metals, and is expected to be effective for that purpose: As, Be, Cd, Se, P, Zn, Cu, Mn, Pb, Cr, Ni, and Hg. It will undoubtedly collect many other metals well, but no plans have been made to perform validation studies with respect to them.

The proposed analysis methods are inductively coupled argon plasma spectroscopy (ICAP) or atomic absorption spectroscopy (AA) where more appropriate. Although most of the metals will be found primarily on the filter, it is necessary at present to analyze all of the impinger catch for all metals of interest. The validation studies may prove some of this to be unnecessary. The permangenate impinger catch should be analyzed for mercury emissions, except when it is proven that any mercury emitted is incorporated into filterable particulate materials.

SW-846

Although this train is expected to be an efficient collection device for chromium, and therefore produces samples appropriate for total Cr analysis, it is not designed to preserve rigorously the Cr+6 to Cr+3 ratio. If one is willing to assume that all the Cr is caught on the filter, and that the oxidation state does not change during shipment and handling before analysis, then it is possible to perform the Cr+6 analysis on the filter sample. These are usually good assumptions, but if a higher degree of certainty is required, then a separate sampling train is necessary for the Cr+6/Cr+3. In the event that the multiple metals train is used for Cr+6 analysis, at least two filter samples need to be taken, in order to have one for Cr+6 and one for total metals.

As discussed in the April 21 letter, we feel that HCl can be adequately collected with this train by adding another impinger filled with NaOH. This impinger should follow the empty one and precede the HNO_3. Some metal precipitation may occur in this impinger, and care must be taken that all metals whatever their form are recovered for analysis. In addition, it is necessary that the aliquot taken for HCl (Cl^-) analysis is representative. This means that any heavy precipitate needs to be redissolved in the lab before aliquoting is done, and that the impinger needs to be thoroughly acid rinsed whether a visible precipitate forms or not. The NaOH concentration used in the impinger for HCl collection is usually 0.1M unless special considerations force a different strength.

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Beth Graham, EPA Region 4
Sonya Stelmack, EPA, OSW, WH-563
David Friedman, EPA, OSW, WH-562B
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Robin Anderson, EPA, OSW, WH-563
Bob Mournighan, EPA, HWERL, MD-179
Bob Olexsey, EPA, HWERL, MD-179
Bob Thurnau, EPA, HWERL, MD-179
Joe McSorley, EPA, AEERL, MD-65
Howard Schiff, Alliance Technologies
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COLLECTION OF SEMIVOLATILE COMPOUNDS

EPA METHOD 0010

(Interpoll Method II-8788 - Version 1.0)

EPA Method SW846 USEPA Office of Solid Waste and Emergency Response 3rd Ed., November 1986: Test Methods for Evaluating Solid Waste Volume 2: Field Manual Physical/Chemical Methods Method 0010.

METHOD 0010

MODIFIED METHOD 5 SAMPLING TRAIN

1.0 SCOPE AND APPLICATION

1.1 This method is applicable to the determination of Destruction and Removal Efficiency (DRE) of semivolatile Principal Organic Hazardous Compounds (POHCs) from incineration systems (PHS, 1967). This method also may be used to determine particulate emission rates from stationary sources as per EPA Method 5 (see References at end of this method).

2.0 SUMMARY OF METHOD

2.1 Gaseous and particulate pollutants are withdrawn from an emission source at an isokinetic sampling rate and are collected in a multicomponent sampling train. Principal components of the train include a high-efficiency glass- or quartz-fiber filter and a packed bed of porous polymeric adsorbent resin. The filter is used to collect organic-laden particulate materials and the porous polymeric resin to adsorb semivolatile organic species. Semivolatile species are defined as compounds with boiling points >100°C.

2.2 Comprehensive chemical analyses of the collected sample are conducted to determine the concentration and identity of the organic materials.

3.0 INTERFERENCES

3.1 Oxides of nitrogen (NO_x) are possible interferents in the determination of certain water-soluble compounds such as dioxane, phenol, and urethane; reaction of these compounds with NO_x in the presence of moisture will reduce their concentration. Other possibilities that could result in positive or negative bias are (1) stability of the compounds in methylene chloride, (2) the formation of water-soluble organic salts on the resin in the presence of moisture, and (3) the solvent extraction efficiency of water-soluble compounds from aqueous media. Use of two or more ions per compound for qualitative and quantitative analysis can overcome interference at one mass. These concerns should be addressed on a compound-by-compound basis before using this method.

4.0 APPARATUS AND MATERIALS

4.1 Sampling train:

4.1.1 A schematic of the sampling train used in this method is shown in Figure 1. This sampling train configuration is adapted from EPA Method 5 procedures, and, as such, the majority of the required equipment

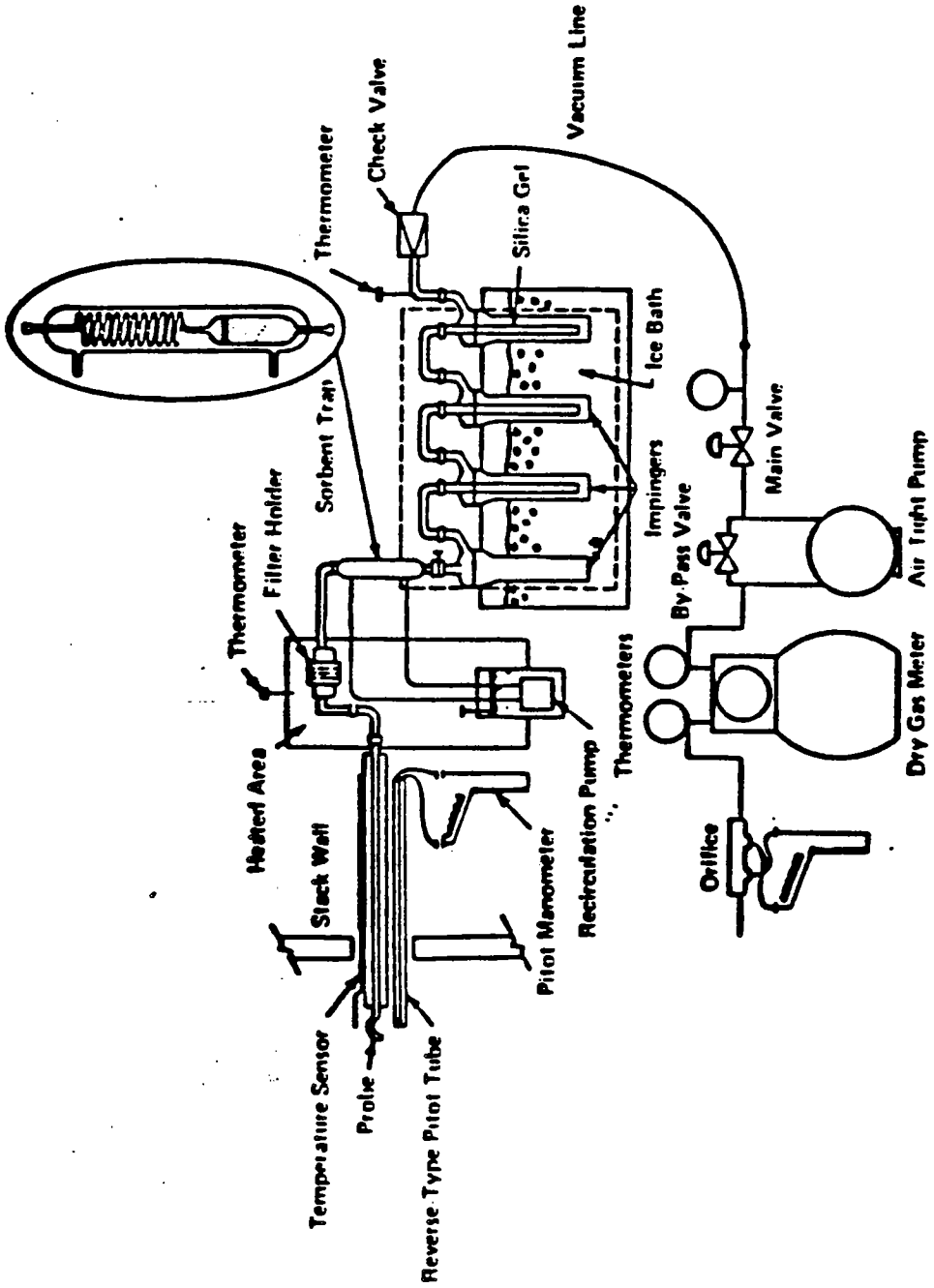

Figure 1. Modified Method 5 Sampling Train.

is identical to that used in EPA Method 5 determinations. The new components required are a condenser coil and a sorbent module, which are used to collect semivolatile organic materials that pass through the glass- or quartz-fiber filter in the gas phase.

4.1.2 Construction details for the basic train components are given in APTD-0581 (see Martin, 1971, in Section 13.0, References); commercial models of this equipment are also available. Specifications for the sorbent module are provided in the following subsections. Additionally, the following subsections list changes to APTD-0581 and identify allowable train configuration modifications.

4.1.3 Basic operating and maintenance procedures for the sampling train are described in APTD-0576 (see Rom, 1972, in Section 13.0, References). As correct usage is important in obtaining valid results, all users should refer to APTD-0576 and adopt the operating and maintenance procedures outlined therein unless otherwise specified. The sampling train consists of the components detailed below.

4.1.3.1 Probe nozzle: Stainless steel (316) or glass with sharp, tapered (30° angle) leading edge. The taper shall be on the outside to preserve a constant I.D. The nozzle shall be buttonhook or elbow design and constructed from seamless tubing (if made of stainless steel). Other construction materials may be considered for particular applications. A range of nozzle sizes suitable for isokinetic sampling should be available in increments of 0.16 cm (1/16 in.), e.g., 0.32-1.27 cm (1/8-1/2 in.), or larger if higher volume sampling trains are used. Each nozzle shall be calibrated according to the procedures outlined in Paragraph 9.1.

4.1.3.2 Probe liner: Borosilicate or quartz-glass tubing with a heating system capable of maintaining a gas temperature of 120 ± 14°C (248 ± 25°F) at the exit end during sampling. (The tester may opt to operate the equipment at a temperature lower than that specified.) Because the actual temperature at the outlet of the probe is not usually monitored during sampling, probes constructed according to APTD-0581 and utilizing the calibration curves of APTD-0576 (or calibrated according to the procedure outlined in APTD-0576) are considered acceptable. Either borosilicate or quartz-glass probe liners may be used for stack temperatures up to about 480°C (900°F). Quartz liners shall be used for temperatures between 480 and 900°C (900 and 1650°F). (The softening temperature for borosilicate is 820°C (1508°F), and for quartz 1500°C (2732°F).) Water-cooling of the stainless steel sheath will be necessary at temperatures approaching and exceeding 500°C.

4.1.3.3 Pitot tube: Type S, as described in Section 2.1 of EPA Method 2, or other appropriate devices (Vollaro, 1976). The pitot tube shall be attached to the probe to allow constant monitoring of the stack-gas velocity. The impact (high-pressure) opening plane of the pitot tube shall be even with or above the nozzle entry plane (see EPA Method 2, Figure 2-6b) during sampling. The Type S pitot tube assembly shall have a known coefficient, determined as outlined in Section 4 of EPA Method 2.

4.1.3.4 Differential pressure gauge: Inclined manometer or equivalent device as described in Section 2.2 of EPA Method 2. One manometer shall be used for velocity-head (ΔP) readings and the other for orifice differential pressure (ΔH) readings.

4.1.3.5 Filter holder: Borosilicate glass, with a glass frit filter support and a sealing gasket. The sealing gasket should be made of materials that will not introduce organic material into the gas stream at the temperature at which the filter holder will be maintained. The gasket shall be constructed of Teflon or materials of equal or better characteristics. The holder design shall provide a positive seal against leakage at any point along the filter circumference. The holder shall be attached immediately to the outlet of the cyclone or cyclone bypass.

4.1.3.6 Filter heating system: Any heating system capable of maintaining a temperature of 120 ± 14°C (248 ± 25°F) around the filter holder during sampling. Other temperatures may be appropriate for particular applications. Alternatively, the tester may opt to operate the equipment at temperatures other than that specified. A temperature gauge capable of measuring temperature to within 3°C (5.4°F) shall be installed so that the temperature around the filter holder can be regulated and monitored during sampling. Heating systems other than the one shown in APTD-0581 may be used.

4.1.3.7 Organic sampling module: This unit consists of three sections, including a gas-conditioning section, a sorbent trap, and a condensate knockout trap. The gas-conditioning system shall be capable of conditioning the gas leaving the back half of the filter holder to a temperature not exceeding 20°C (68°F). The sorbent trap shall be sized to contain approximately 20 g of porous polymeric resin (Rohm and Haas XAD-2 or equivalent) and shall be jacketed to maintain the internal gas temperature at 17 ± 3°C (62.5 ± 5.4°F). The most commonly used coolant is ice water from the impinger ice-water bath, constantly circulated through the outer jacket, using rubber or plastic tubing and a peristaltic pump. The sorbent trap should be outfitted with a glass well or depression, appropriately sized to accommodate a small thermocouple in the trap for monitoring the gas entry temperature. The condensate knockout trap shall be of sufficient size to collect the condensate following gas conditioning. The organic module components shall be oriented to direct the flow of condensate formed vertically downward from the conditioning section, through the adsorbent media, and into the condensate knockout trap. The knockout trap is usually similar in appearance to an empty impinger directly underneath the sorbent module; it may be oversized but should have a shortened center stem (at a minimum, one-half the length of the normal impinger stems) to collect a large volume of condensate without bubbling and overflowing into the impinger train. All surfaces of the organic module wetted by the gas sample shall be fabricated of borosilicate glass, Teflon, or other inert materials. Commercial versions of the

complete organic module are not currently available, but may be assembled from commercially available laboratory glassware and a custom-fabricated sorbent trap. Details of two acceptable designs are shown in Figures 2 and 3 (the thermocouple well is shown in Figure 2).

4.1.3.8 Impinger train: To determine the stack-gas moisture content, four 500-mL impingers, connected in series with leak-free ground-glass joints, follow the knockout trap. The first, third, and fourth impingers shall be of the Greenburg-Smith design, modified by replacing the tip with a 1.3-cm (1/2-in.) I.D. glass tube extending about 1.3 cm (1/2 in.) from the bottom of the outer cylinder. The second impinger shall be of the Greenburg-Smith design with the standard tip. The first and second impingers shall contain known quantities of water or appropriate trapping solution. The third shall be empty or charged with a caustic solution, should the stack gas contain hydrochloric acid (HCl). The fourth shall contain a known weight of silica gel or equivalent desiccant.

4.1.3.9 Metering system: The necessary components are a vacuum gauge, leak-free pump, thermometers capable of measuring temperature to within 3°C (5.4°F), dry-gas meter capable of measuring volume to within 1%, and related equipment, as shown in Figure 1. At a minimum, the pump should be capable of 4 cfm free flow, and the dry-gas meter should have a recording capacity of 0-999.9 cu ft with a resolution of 0.005 cu ft. Other metering systems capable of maintaining sampling rates within 10% of isokineticity and of determining sample volumes to within 2% may be used. The metering system must be used in conjunction with a pitot tube to enable checks of isokinetic sampling rates. Sampling trains using metering systems designed for flow rates higher than those described in APTD-0581 and APTD-0576 may be used, provided that the specifications of this method are met.

4.1.3.10 Barometer: Mercury, aneroid, or other barometer capable of measuring atmospheric pressure to within 2.5 mm Hg (0.1 in. Hg). In many cases the barometric reading may be obtained from a nearby National Weather Service station, in which case the station value (which is the absolute barometric pressure) is requested and an adjustment for elevation differences between the weather station and sampling point is applied at a rate of minus 2.5 mm Hg (0.1 in. Hg) per 30-m (100 ft) elevation increase (vice versa for elevation decrease).

4.1.3.11 Gas density determination equipment: Temperature sensor and pressure gauge (as described in Sections 2.3 and 2.4 of EPA Method 2), and gas analyzer, if necessary (as described in EPA Method 3). The temperature sensor ideally should be permanently attached to the pitot tube or sampling probe in a fixed configuration such that the tip of the sensor extends beyond the leading edge of the probe sheath and does not touch any metal.

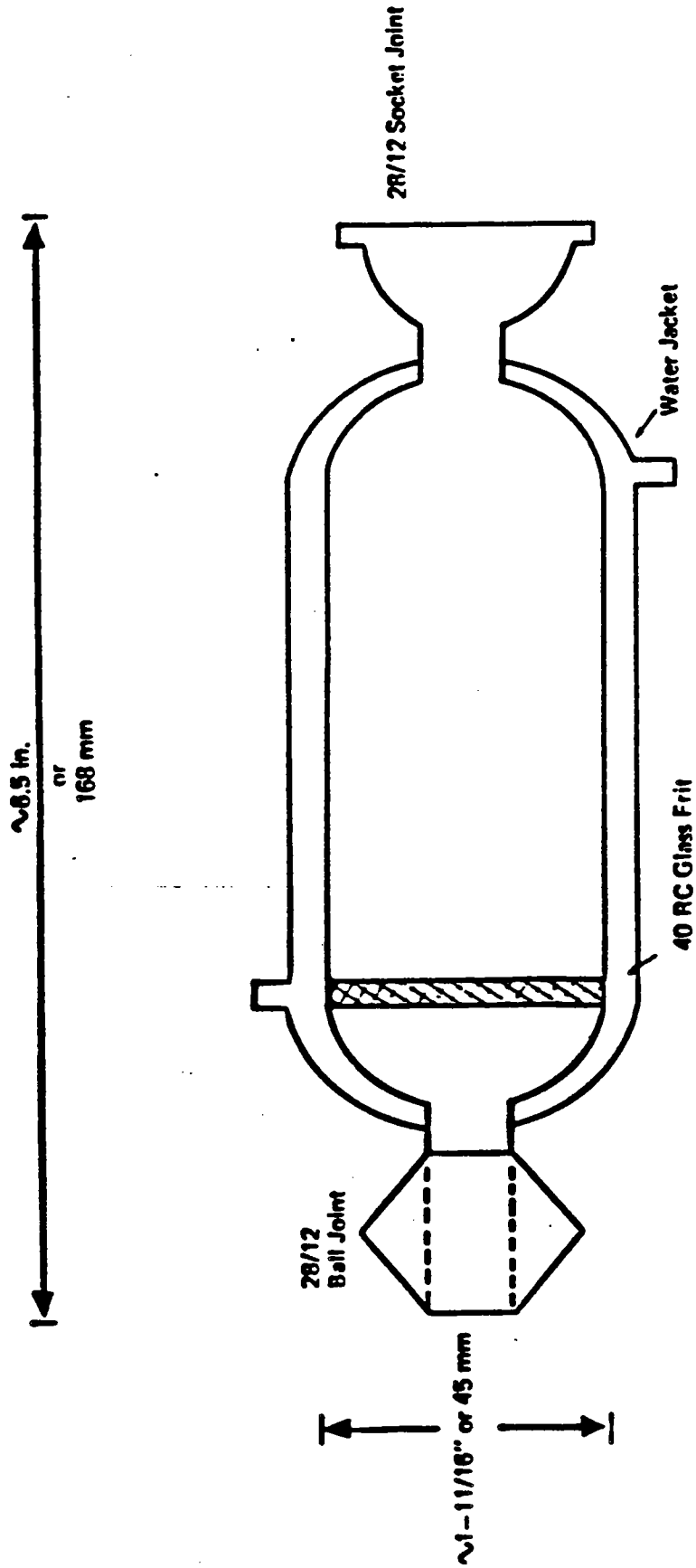

Figure 2. Adsorbent Sampling System.

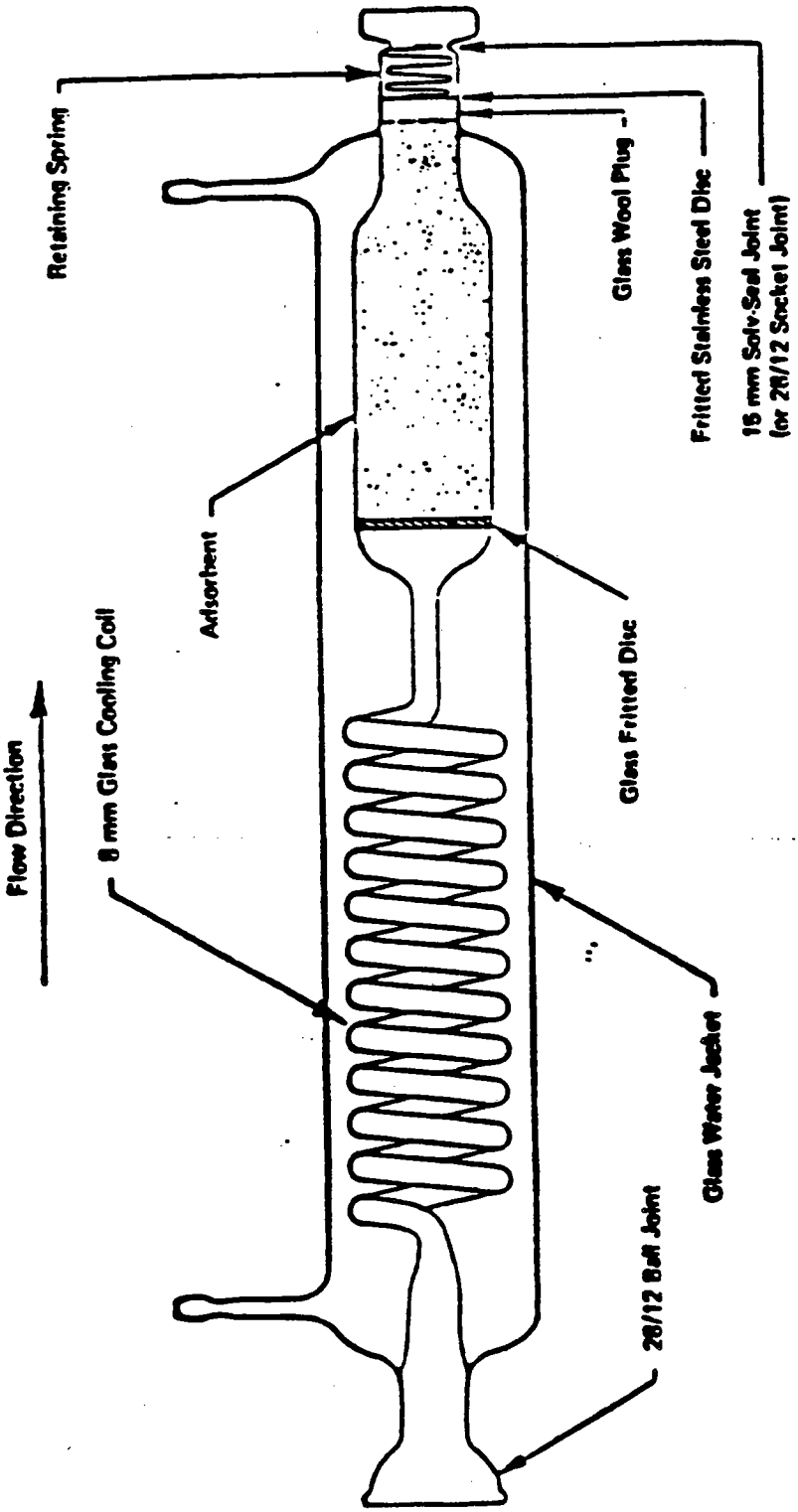

Figure 3. Adsorbent Sampling System.

Alternatively, the sensor may be attached just prior to use in the field. Note, however, that if the temperature sensor is attached in the field, the sensor must be placed in an interference-free arrangement with respect to the Type S pitot tube openings (see EPA Method 2, Figure 2-7). As a second alternative, if a difference of no more than 1% in the average velocity measurement is to be introduced, the temperature gauge need not be attached to the probe or pitot tube.

4.1.3.12 Calibration/field-preparation record: A permanently bound laboratory notebook, in which duplicate copies of data may be made as they are being recorded, is required for documenting and recording calibrations and preparation procedures (i.e., filter and silica gel tare weights, clean XAD-2, quality assurance/quality control check results, dry-gas meter, and thermocouple calibrations, etc.). The duplicate copies should be detachable and should be stored separately in the test program archives.

4.2 Sample Recovery:

4.2.1 Probe liner: Probe nozzle and organic module conditioning section brushes; nylon bristle brushes with stainless steel wire handles are required. The probe brush shall have extensions of stainless steel, Teflon, or inert material at least as long as the probe. The brushes shall be properly sized and shaped to brush out the probe liner, the probe nozzle, and the organic module conditioning section.

4.2.2 Wash bottles: Three. Teflon or glass wash bottles are recommended; polyethylene wash bottles should not be used because organic contaminants may be extracted by exposure to organic solvents used for sample recovery.

4.2.3 Glass sample storage containers: Chemically resistant, borosilicate amber and clear glass bottles, 500-mL or 1,000-mL. Bottles should be tinted to prevent action of light on sample. Screw-cap liners shall be either Teflon or constructed so as to be leak-free and resistant to chemical attack by organic recovery solvents. Narrow-mouth glass bottles have been found to exhibit less tendency toward leakage.

4.2.4 Petri dishes: Glass, sealed around the circumference with wide (1-in.) Teflon tape, for storage and transport of filter samples.

4.2.5 Graduated cylinder and/or balances: To measure condensed water to the nearest 1 mL or 1 g. Graduated cylinders shall have subdivisions not >2 mL. Laboratory triple-beam balances capable of weighing to ± 0.5 g or better are required.

4.2.6 Plastic storage containers: Screw-cap polypropylene or polyethylene containers to store silica gel.

4.2.7 Funnel and rubber policeman: To aid in transfer of silica gel to container (not necessary if silica gel is weighed in field).

4.2.8 Funnels: Glass, to aid in sample recovery.

4.3 Filters: Glass- or quartz-fiber filters, without organic binder, exhibiting at least 99.95% efficiency (<0.05% penetration) on 0.3-um dioctyl phthalate smoke particles. The filter efficiency test shall be conducted in accordance with ASTM standard method D2986-71. Test data from the supplier's quality control program are sufficient for this purpose. In sources containing SO_2 or SO_3, the filter material must be of a type that is unreactive to SO_2 or SO_3. Reeve Angel 934 AH or Schleicher and Schwell #3 filters work well under these conditions.

4.4 Crushed ice: Quantities ranging from 10-50 lb may be necessary during a sampling run, depending on ambient air temperature.

4.5 Stopcock grease: Solvent-insoluble, heat-stable silicone grease. Use of silicone grease upstream of the module is not permitted, and amounts used on components located downstream of the organic module shall be minimized. Silicone grease usage is not necessary if screw-on connectors and Teflon sleeves or ground-glass joints are used.

4.6 Glass wool: Used to plug the unfritted end of the sorbent module. The glass-wool fiber should be solvent-extracted with methylene chloride in a Soxhlet extractor for 12 hr and air-dried prior to use.

5.0 REAGENTS

5.1 Adsorbent resin: Porous polymeric resin (XAD-2 or equivalent) is recommended. These resins shall be cleaned prior to their use for sample collection. Appendix A of this method should be consulted to determine appropriate precleaning procedure. For best results, resin used should not exhibit a blank of higher than 4 mg/kg of total chromatographable organics (TCO) (see Appendix B) prior to use. Once cleaned, resin should be stored in an airtight, wide-mouth amber glass container with a Teflon-lined cap or placed in one of the glass sorbent modules tightly sealed with Teflon film and elastic bands. The resin should be used within 4 wk of the preparation.

5.2 Silica gel: Indicating type, 6-16 mesh. If previously used, dry at 175°C (350°F) for 2 hr before using. New silica gel may be used as received. Alternatively, other types of desiccants (equivalent or better) may be used, subject to the approval of the Administrator.

5.3 Impinger solutions: Distilled organic-free water (Type II) shall be used, unless sampling is intended to quantify a particular inorganic gaseous species. If sampling is intended to quantify the concentration of additional species, the impinger solution of choice shall be subject to Administrator approval. This water should be prescreened for any compounds of interest. One hundred mL will be added to the specified impinger; the third impinger in the train may be charged with a basic solution (1 N sodium hydroxide or sodium acetate) to protect the sampling pump from acidic gases. Sodium acetate should be used when large sample volumes are anticipated because sodium hydroxide will react with carbon dioxide in aqueous media to form sodium carbonate, which may possibly plug the impinger.

5.4 Sample recovery reagents:

5.4.1 Methylene chloride: Distilled-in-glass grade is required for sample recovery and cleanup (see Note to 5.4.2 below).

5.4.2 Methyl alcohol: Distilled-in-glass grade is required for sample recovery and cleanup.

NOTE: Organic solvents from metal containers may have a high residue blank and should not be used. Sometimes suppliers transfer solvents from metal to glass bottles; thus blanks shall be run prior to field use and only solvents with low blank value (<0.001%) shall be used.

5.4.3 Water: Water (Type II) shall be used for rinsing the organic module and condenser component.

6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

6.1 Because of complexity of this method, field personnel should be trained in and experienced with the test procedures in order to obtain reliable results.

6.2 Laboratory preparation:

6.2.1 All the components shall be maintained and calibrated according to the procedure described in APTD-0576, unless otherwise specified.

6.2.2 Weigh several 200- to 300-g portions of silica gel in airtight containers to the nearest 0.5 g. Record on each container the total weight of the silica gel plus containers. As an alternative to preweighing the silica gel, it may instead be weighed directly in the impinger or sampling holder just prior to train assembly.

6.2.3 Check filters visually against light for irregularities and flaws or pinhole leaks. Label the shipping containers (glass Petri dishes) and keep the filters in these containers at all times except during sampling and weighing.

6.2.4 Desiccate the filters at 20 ± 5.6°C (68 ± 10°F) and ambient pressure for at least 24 hr, and weigh at intervals of at least 6 hr to a constant weight (i.e., <0.5-mg change from previous weighing), recording results to the nearest 0.1 mg. During each weighing the filter must not be exposed for more than a 2-min period to the laboratory atmosphere and relative humidity above 50%. Alternatively (unless otherwise specified by the Administrator), the filters may be oven-dried at 105°C (220°F) for 2-3 hr, desiccated for 2 hr, and weighed.

6.3 Preliminary field determinations:

6.3.1 Select the sampling site and the minimum number of sampling points according to EPA Method 1 or as specified by the Administrator. Determine the stack pressure, temperature, and range of velocity heads using EPA Method 2. It is recommended that a leak-check of the pitot lines (see EPA Method 2, Section 3.1) be performed. Determine the stack-gas moisture content using EPA Approximation Method 4 or its alternatives to establish estimates of isokinetic sampling-rate settings. Determine the stack-gas dry molecular weight, as described in EPA Method 2, Section 3.6. If integrated EPA Method 3 sampling is used for molecular weight determination, the integrated bag sample shall be taken simultaneously with, and for the same total length of time as, the sample run.

6.3.2 Select a nozzle size based on the range of velocity heads so that it is not necessary to change the nozzle size in order to maintain isokinetic sampling rates. During the run, do not change the nozzle. Ensure that the proper differential pressure gauge is chosen for the range of velocity heads encountered (see Section 2.2 of EPA Method 2).

6.3.3 Select a suitable probe liner and probe length so that all traverse points can be sampled. For large stacks, to reduce the length of the probe, consider sampling from opposite sides of the stack.

6.3.4 A minimum of 3 dscm (105.9 dscf) of sample volume is required for the determination of the Destruction and Removal Efficiency (DRE) of POHCs from incineration systems. Additional sample volume shall be collected as necessitated by analytical detection limit constraints. To determine the minimum sample volume required, refer to sample calculations in Section 10.0.

6.3.5 Determine the total length of sampling time needed to obtain the identified minimum volume by comparing the anticipated average sampling rate with the volume requirement. Allocate the same time to all traverse points defined by EPA Method 1. To avoid timekeeping errors, the length of time sampled at each traverse point should be an integer or an integer plus one-half min.

6.3.6 In some circumstances (e.g., batch cycles) it may be necessary to sample for shorter times at the traverse points and to obtain smaller gas-sample volumes. In these cases, the Administrator's approval must first be obtained.

6.4 Preparation of collection train:

6.4.1 During preparation and assembly of the sampling train, keep all openings where contamination can occur covered with Teflon film or aluminum foil until just prior to assembly or until sampling is about to begin.

6.4.2 Fill the sorbent trap section of the organic module with approximately 20 g of clean adsorbent resin. While filling, ensure that the trap packs uniformly, to eliminate the possibility of channeling. When freshly cleaned, many adsorbent resins carry a static charge, which will cause clinging to trap walls. This may be minimized by filling the trap in the presence of an antistatic device. Commercial antistatic devices include Model-204 and Model-210 manufactured by the 3M Company, St. Paul, Minnesota.

6.4.3 If an impinger train is used to collect moisture, place 100 mL of water in each of the first two impingers, leave the third impinger empty (or charge with caustic solution, as necessary), and transfer approximately 200-300 g of preweighed silica gel from its container to the fourth impinger. More silica gel may be used, but care should be taken to ensure that it is not entrained and carried out from the impinger during sampling. Place the container in a clean place for later use in the sample recovery. Alternatively, the weight of the silica gel plus impinger may be determined to the nearest 0.5 g and recorded.

6.4.4 Using a tweezer or clean disposable surgical gloves, place a labeled (identified) and weighed filter in the filter holder. Be sure that the filter is properly centered and the gasket properly placed to prevent the sample gas stream from circumventing the filter. Check the filter for tears after assembly is completed.

6.4.5 When glass liners are used, install the selected nozzle using a Viton-A O-ring when stack temperatures are <260°C (500°F) and a woven glass-fiber gasket when temperatures are higher. See APTD-0576 (Rom, 1972) for details. Other connecting systems utilizing either 316 stainless steel or Teflon ferrules may be used. When metal liners are used, install the nozzle as above, or by a leak-free direct mechanical connection. Mark the probe with heat-resistant tape or by some other method to denote the proper distance into the stack or duct for each sampling point.

6.4.6 Set up the train as in Figure 1. During assembly, do not use any silicone grease on ground-glass joints that are located upstream of the organic module. A very light coating of silicone grease may be used on all ground-glass joints that are located downstream of the organic module, but it should be limited to the outer portion (see APTD-0576) of the ground-glass joints to minimize silicone-grease contamination. Subject to the approval of the Administrator, a glass cyclone may be used between the probe and the filter holder when the total particulate catch is expected to exceed 100 mg or when water droplets are present in the stack. The organic module condenser must be maintained at a temperature of 17 ± 3°C. Connect all temperature sensors to an appropriate potentiometer/display unit. Check all temperature sensors at ambient temperature.

6.4.7 Place crushed ice around the impingers and the organic module condensate knockout.

6.4.8 Turn on the sorbent module and condenser coil coolant recirculating pump and begin monitoring the sorbent module gas entry temperature. Ensure proper sorbent module gas entry temperature before proceeding and again before any sampling is initiated. It is extremely important that the XAD-2 resin temperature never exceed 50°C (122°F), because thermal decomposition will occur. During testing, the XAD-2 temperature must not exceed 20°C (68°F) for efficient capture of the semivolatile species of interest.

6.4.9 Turn on and set the filter and probe heating systems at the desired operating temperatures. Allow time for the temperatures to stabilize.

6.5 Leak-check procedures

6.5.1 Pre-test leak-check:

6.5.1.1 Because the number of additional intercomponent connections in the Semi-VOST train (over the M5 Train) increases the possibility of leakage, a pre-test leak-check is required.

6.5.1.2 After the sampling train has been assembled, turn on and set the filter and probe heating systems at the desired operating temperatures. Allow time for the temperatures to stabilize. If a Viton A O-ring or other leak-free connection is used in assembling the probe nozzle to the probe liner, leak-check the train at the sampling site by plugging the nozzle and pulling a 381-mm Hg (15-in. Hg) vacuum.
(NOTE: A lower vacuum may be used, provided that it is not exceeded during the test.)

6.5.1.3 If an asbestos string is used, do not connect the probe to the train during the leak-check. Instead, leak-check the train by first attaching a carbon-filled leak-check impinger (shown in Figure 4) to the inlet of the filter holder (cyclone, if applicable) and then plugging the inlet and pulling a 381-mm Hg (15-in. Hg) vacuum. (Again, a lower vacuum may be used, provided that it is not exceeded during the test.) Then, connect the probe to the train and leak-check at about 25-mm Hg (1-in. Hg) vacuum; alternatively, leak-check the probe with the rest of the sampling train in one step at 381-mm Hg (15-in. Hg) vacuum. Leakage rates in excess of 4% of the average sampling rate or >0.00057 m^3/min (0.02 cfm), whichever is less, are unacceptable.

6.5.1.4 The following leak-check instructions for the sampling train described in APTD-0576 and APTD-0581 may be helpful. Start the pump with fine-adjust valve fully open and coarse-adjust valve completely closed. Partially open the coarse-adjust valve and slowly close the fine-adjust valve until the desired vacuum is reached. Do not reverse direction of the fine-adjust valve; this will cause water to back up into the organic module. If the desired vacuum is exceeded, either leak-check at this higher vacuum or end the leak-check, as shown below, and start over.

CROSS SECTIONAL VIEW

Leak Testing Apparatus

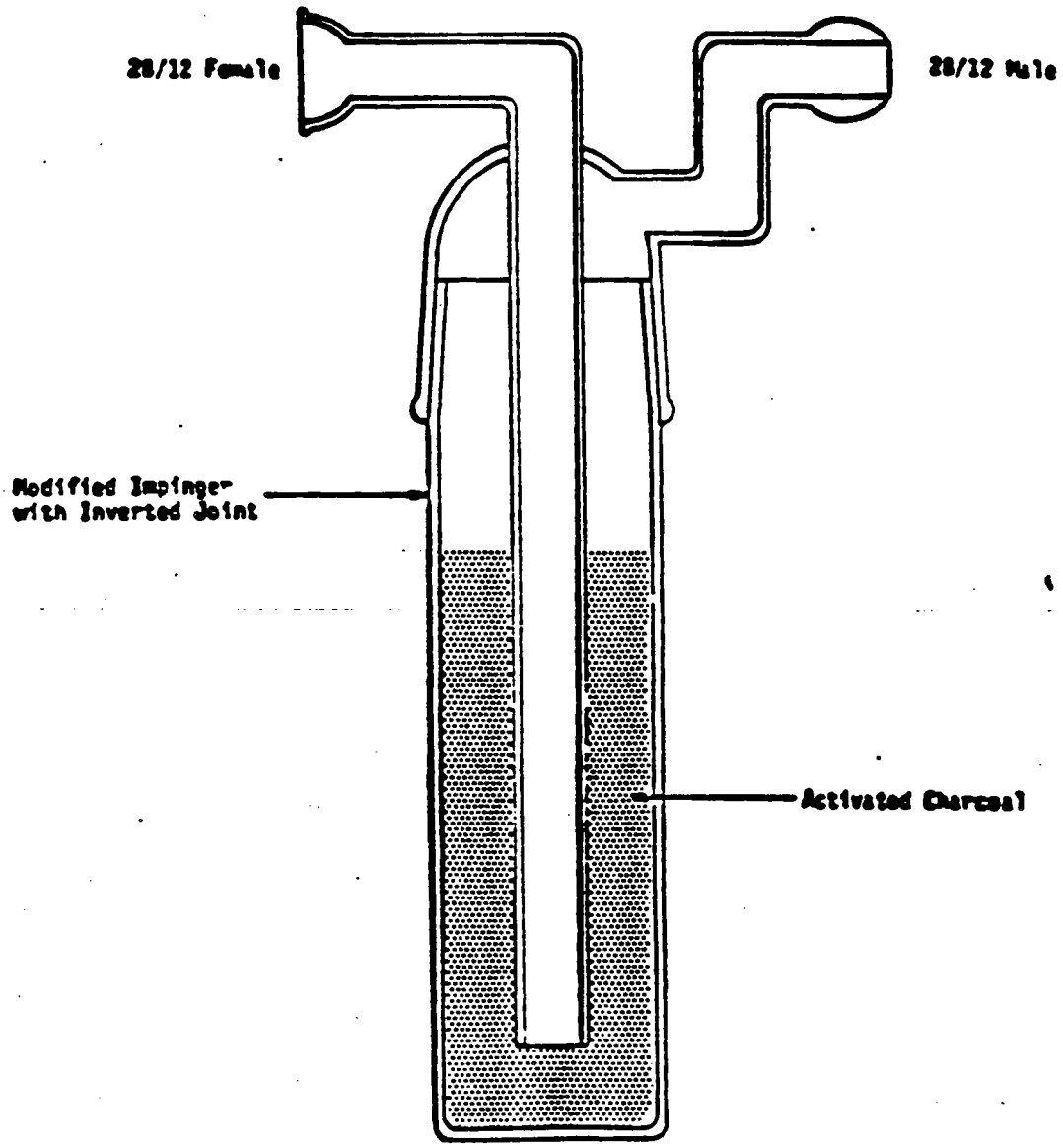

Figure 4. Leak-check impinger.

6.5.1.5 When the leak-check is completed, first slowly remove the plug from the inlet to the probe, filter holder, or cyclone (if applicable). When the vacuum drops to 127 mm (5 in.) Hg or less, immediately close the coarse-adjust valve. Switch off the pumping system and reopen the fine-adjust valve. Do not reopen the fine-adjust valve until the coarse-adjust valve has been closed. This prevents the water in the impingers from being forced backward into the organic module and silica gel from being entrained backward into the third impinger.

6.5.2 Leak-checks during sampling run:

6.5.2.1 If, during the sampling run, a component (e.g., filter assembly, impinger, or sorbent trap) change becomes necessary, a leak-check shall be conducted immediately after the interruption of sampling and before the change is made. The leak-check shall be done according to the procedure outlined in Paragraph 6.5.1, except that it shall be done at a vacuum greater than or equal to the maximum value recorded up to that point in the test. If the leakage rate is found to be no greater than 0.00057 m^3/min (0.02 cfm) or 4% of the average sampling rate (whichever is less), the results are acceptable, and no correction will need to be applied to the total volume of dry gas metered. If a higher leakage rate is obtained, the tester shall void the sampling run. (It should be noted that any "correction" of the sample volume by calculation by calculation reduces the integrity of the pollutant concentrations data generated and must be avoided.)

6.5.2.2 Immediately after a component change, and before sampling is reinitiated, a leak-check similar to a pre-test leak-check must also be conducted.

6.5.3 Post-test leak-check:

6.5.3.1 A leak-check is mandatory at the conclusion of each sampling run. The leak-check shall be done with the same procedures as those with the pre-test leak-check, except that it shall be conducted at a vacuum greater than or equal to the maximum value reached during the sampling run. If the leakage rate is found to be no greater than 0.00057 m^3/min (0.02 cfm) or 4% of the average sampling rate (whichever is less), the results are acceptable, and no correction need be applied to the total volume of dry gas metered. If, however, a higher leakage rate is obtained, the tester shall either record the leakage rate, correct the sample volume (as shown in the calculation section of this method), and consider the data obtained of questionable reliability, or void the sampling run.

6.6 Sampling-train operation:

6.6.1 During the sampling run, maintain an isokinetic sampling rate to within 10% of true isokinetic, unless otherwise specified by the Administrator. Maintain a temperature around the filter of 120 ± 14°C (248 ± 25°F) and a gas temperature entering the sorbent trap at a maximum of 20°C (68°F).

6.6.2 For each run, record the data required on a data sheet such as the one shown in Figure 5. Be sure to record the initial dry-gas meter reading. Record the dry-gas meter readings at the beginning and end of each sampling time increment, when changes in flow rates are made before and after each leak-check, and when sampling is halted. Take other readings required by Figure 5 at least once at each sample point during each time increment and additional readings when significant changes (20% variation in velocity-head readings) necessitate additional adjustments in flow rate. Level and zero the manometer. Because the manometer level and zero may drift due to vibrations and temperature changes, make periodic checks during the traverse.

6.6.3 Clean the stack access ports prior to the test run to eliminate the chance of sampling deposited material. To begin sampling, remove the nozzle cap, verify that the filter and probe heating systems are at the specified temperature, and verify that the pitot tube and probe are properly positioned. Position the nozzle at the first traverse point, with the tip pointing directly into the gas stream. Immediately start the pump and adjust the flow to isokinetic conditions. Nomographs, which aid in the rapid adjustment of the isokinetic sampling rate without excessive computations, are available. These nomographs are designed for use when the Type S pitot-tube coefficient is 0.84 $\pm$ 0.02 and the stack-gas equivalent density (dry molecular weight) is equal to 29 $\pm$ 4. APTD-0576 details the procedure for using the nomographs. If the stack-gas molecular weight and the pitot-tube coefficient are outside the above ranges, do not use the nomographs unless appropriate steps (Shigehara, 1974) are taken to compensate for the deviations.

6.6.4 When the stack is under significant negative pressure (equivalent to the height of the impinger stem), take care to close the coarse-adjust valve before inserting the probe into the stack, to prevent water from backing into the organic module. If necessary, the pump may be turned on with the coarse-adjust valve closed.

6.6.5 When the probe is in position, block off the openings around the probe and stack access port to prevent unrepresentative dilution of the gas stream.

6.6.6 Traverse the stack cross section, as required by EPA Method 1 or as specified by the Administrator, being careful not to bump the probe nozzle into the stack walls when sampling near the walls or when removing or inserting the probe through the access port, in order to minimize the chance of extracting deposited material.

6.6.7 During the test run, make periodic adjustments to keep the temperature around the filter holder and the organic module at the proper levels; add more ice and, if necessary, salt to maintain a temperature of <20°C (68°F) at the condenser/silica gel outlet. Also, periodically check the level and zero of the manometer.

Plant _____
Location _____
Operator _____
Date _____
Run No. _____
Sample Box No. _____
Meter Box No. _____
Meter ΔH _____
C Factor _____
Pitot Tube Coefficient C_p _____

Schematic of Stack Cross Section

Ambient Temperature _____
Barometric Pressure _____
Assumed Moisture % _____
Probe Length, m (ft) _____
Nozzle Identification No. _____
Average Calibrated Nozzle Diameter, cm (in) _____
Probe Heater Setting _____
Leak Rate, m^3/min, (cfm) _____
Probe Liner Material _____
Static Pressure, mm Hg (in. Hg) _____
Filter No. _____

Traverse Point Number	Sampling Time (θ) min.	Vacuum mm Hg (in. Hg)	Stack Temperature (T_s) °C(°F)	Velocity Head (P_s) mm (in) H_2O	Pressure Differential Across Orifice Meter mm (H_2O) (in H_2O)	Gas Sample Volume m_3 (ft_3)	Gas Sample Temp. at Dry Gas Meter Inlet °C(°F)	Gas Sample Temp. at Dry Gas Meter Outlet °C(°F)	Filter Holder Temperature °C(F°)	Temperature of Gas Entering Sorbet Trap °C(F°)	Temperature of Gas Leaving Condenser or Last Impinger
Total							Avg.	Avg.			
Average											

Figure 5. Particulate field data.

6.6.8 If the pressure drop across the filter or sorbent trap becomes too high, making isokinetic sampling difficult to maintain, the filter/sorbent trap may be replaced in the midst of a sample run. Using another complete filter holder/sorbent trap assembly is recommended, rather than attempting to change the filter and resin themselves. After a new filter/sorbent trap assembly is installed, conduct a leak-check. The total particulate weight shall include the summation of all filter assembly catches.

6.6.9 A single train shall be used for the entire sample run, except in cases where simultaneous sampling is required in two or more separate ducts or at two or more different locations within the same duct, or in cases where equipment failure necessitates a change of trains. In all other situations, the use of two or more trains will be subject to the approval of the Administrator.

6.6.10 Note that when two or more trains are used, separate analysis of the front-half (if applicable) organic-module and impinger (if applicable) catches from each train shall be performed, unless identical nozzle sizes were used on all trains. In that case, the front-half catches from the individual trains may be combined (as may the impinger catches), and one analysis of front-half catch and one analysis of impinger catch may be performed.

6.6.11 At the end of the sample run, turn off the coarse-adjust valve, remove the probe and nozzle from the stack, turn off the pump, record the final dry-gas meter reading, and conduct a post-test leak-check. Also, leak-check the pitot lines as described in EPA Method 2. The lines must pass this leak-check in order to validate the velocity-head data.

6.6.12 Calculate percent isokineticity (see Section 10.8) to determine whether the run was valid or another test run should be made.

7.0 SAMPLE RECOVERY

7.1 Preparation:

7.1.1 Proper cleanup procedure begins as soon as the probe is removed from the stack at the end of the sampling period. Allow the probe to cool. When the probe can be safely handled, wipe off all external particulate matter near the tip of the probe nozzle and place a cap over the tip to prevent losing or gaining particulate matter. Do not cap the probe tip tightly while the sampling train is cooling down because this will create a vacuum in the filter holder, drawing water from the impingers into the sorbent module.

7.1.2 Before moving the sample train to the cleanup site, remove the probe from the sample train and cap the open outlet, being careful not to lose any condensate that might be present. Cap the filter inlet.

Remove the umbilical cord from the last impinger and cap the impinger. If a flexible line is used between the organic module and the filter holder, disconnect the line at the filter holder and let any condensed water or liquid drain into the organic module.

7.1.3 Cap the filter-holder outlet and the inlet to the organic module. Separate the sorbent trap section of the organic module from the condensate knockout trap and the gas-conditioning section. Cap all organic module openings. Disconnect the organic-module knockout trap from the impinger train inlet and cap both of these openings. Ground-glass stoppers, Teflon caps, or caps of other inert materials may be used to seal all openings.

7.1.4 Transfer the probe, the filter, the organic-module components, and the impinger/condenser assembly to the cleanup area. This area should be clean and protected from the weather to minimize sample contamination or loss.

7.1.5 Save a portion of all washing solutions (methanol/methylene chloride, Type II water) used for cleanup as a blank. Transfer 200 mL of each solution directly from the wash bottle being used and place each in a separate, prelabeled glass sample container.

7.1.6 Inspect the train prior to and during disassembly and note any abnormal conditions.

7.2 Sample containers:

7.2.1 Container no. 1: Carefully remove the filter from the filter holder and place it in its identified Petri dish container. Use a pair or pairs of tweezers to handle the filter. If it is necessary to fold the filter, ensure that the particulate cake is inside the fold. Carefully transfer to the Petri dish any particulate matter or filter fibers that adhere to the filter-holder gasket, using a dry nylon bristle brush or sharp-edged blade, or both. Label the container and seal with 1-in.-wide Teflon tape around the circumference of the lid.

7.2.2 Container no. 2: Taking care that dust on the outside of the probe or other exterior surfaces does not get into the sample, quantitatively recover particulate matter or any condensate from the probe nozzle, probe fitting, probe liner, and front half of the filter holder by washing these components first with methanol/methylene chloride (1:1 v/v) into a glass container. Distilled water may also be used. Retain a water and solvent blank and analyze in the same manner as with the samples. Perform rinses as follows:

7.2.2.1 Carefully remove the probe nozzle and clean the inside surface by rinsing with the solvent mixture (1:1 v/v methanol/-methylene chloride) from a wash bottle and brushing with a nylon bristle brush. Brush until the rinse shows no visible particles; then make a final rinse of the inside surface with the solvent mix. Brush and rinse the inside parts of the Swagelok fitting with the solvent mix in a similar way until no visible particles remain.

7.2.2.2 Have two people rinse the probe liner with the solvent mix by tilting and rotating the probe while squirting solvent into its upper end so that all inside surfaces will be wetted with solvent. Let the solvent drain from the lower end into the sample container. A glass funnel may be used to aid in transferring liquid washes to the container.

7.2.2.3 Follow the solvent rinse with a probe brush. Hold the probe in an inclined position and squirt solvent into the upper end while pushing the probe brush through the probe with a twisting action; place a sample container underneath the lower end of the probe and catch any solvent and particulate matter that is brushed from the probe. Run the brush through the probe three times or more until no visible particulate matter is carried out with the solvent or until none remains in the probe liner on visual inspection. With stainless steel or other metal probes, run the brush through in the above-prescribed manner at least six times (metal probes have small crevices in which particulate matter can be entrapped). Rinse the brush with solvent and quantitatively collect these washings in the sample container. After the brushing, make a final solvent rinse of the probe as described above.

7.2.2.4 It is recommended that two people work together to clean the probe to minimize sample losses. Between sampling runs, keep brushes clean and protected from contamination.

7.2.2.5 Clean the inside of the front half of the filter holder and cyclone/cyclone flask, if used, by rubbing the surfaces with a nylon bristle brush and rinsing with methanol/methylene chloride (1:1 v/v) mixture. Rinse each surface three times or more if needed to remove visible particulate. Make a final rinse of the brush and filter holder. Carefully rinse out the glass cyclone and cyclone flask (if applicable). Brush and rinse any particulate material adhering to the inner surfaces of these components into the front-half rinse sample. After all solvent washings and particulate matter have been collected in the sample container, tighten the lid on the sample container so that solvent will not leak out when it is shipped to the laboratory. Mark the height of the fluid level to determine whether leakage occurs during transport. Label the container to identify its contents.

7.2.3 Container no. 3: The sorbent trap section of the organic module may be used as a sample transport container, or the spent resin may be transferred to a separate glass bottle for shipment. If the sorbent trap itself is used as the transport container, both ends should be sealed with tightly fitting caps or plugs. Ground-glass stoppers or Teflon caps may be used. The sorbent trap should then be labeled, covered with aluminum foil, and packaged on ice for transport to the laboratory. If a separate bottle is used, the spent resin should be quantitatively transferred from the trap into the clean bottle. Resin that adheres to the walls of the trap should be recovered using a rubber policeman or spatula and added to this bottle.

7.2.4 Container no. 4: Measure the volume of condensate collected in the condensate knockout section of the organic module to within ±1 mL by using a graduated cylinder or by weighing to within ±0.5 g using a triple-beam balance. Record the volume or weight of liquid present and note any discoloration or film in the liquid catch. Transfer this liquid to a prelabeled glass sample container. Inspect the back half of the filter housing and the gas-conditioning section of the organic module. If condensate is observed, transfer it to a graduated or weighing bottle and measure the volume, as described above. Add this material to the condensate knockout-trap catch.

7.2.5 Container no. 5: All sampling train components located between the high-efficiency glass- or quartz-fiber filter and the first wet impinger or the final condenser system (including the heated Teflon line connecting the filter outlet to the condenser) should be thoroughly rinsed with methanol/methylene chloride (1:1 v/v) and the rinsings combined. This rinse shall be separated from the condensate. If the spent resin is transferred from the sorbent trap to a separate sample container for transport, the sorbent trap shall be thoroughly rinsed until all sample-wetted surfaces appear clean. Visible films should be removed by brushing. Whenever train components are brushed, the brush should be subsequently rinsed with solvent mixture and the rinsings added to this container.

7.2.6 Container no. 6: Note the color of the indicating silica gel to determine if it has been completely spent and make a notation of its condition. Transfer the silica gel from the fourth impinger to its original container and seal. A funnel may make it easier to pour the silica gel without spilling. A rubber policeman may be used as an aid in removing the silica gel from the impinger. It is not necessary to remove the small amount of dust particles that may adhere strongly to the impinger wall. Because the gain in weight is to be used for moisture calculations, do not use any water or other liquids to transfer the silica gel. If a balance is available in the field, weigh the container and its contents to 0.5 g or better.

7.3 Impinger water:

7.3.1 Make a notation of any color or film in the liquid catch. Measure the liquid in the first three impingers to within ±1 mL by using a graduated cylinder or by weighing it to within ±0.5 g by using a balance (if one is available). Record the volume or weight of liquid present. This information is required to calculate the moisture content of the effluent gas.

7.3.2 Discard the liquid after measuring and recording the volume or weight, unless analysis of the impinger catch is required (see Paragraph 4.1.3.7). Amber glass containers should be used for storage of impinger catch, if required.

7.3.3 If a different type of condenser is used, measure the amount of moisture condensed either volumetrically or gravimetrically.

7.4 Sample preparation for shipment: Prior to shipment, recheck all sample containers to ensure that the caps are well secured. Seal the lids of all containers around the circumference with Teflon tape. Ship all liquid samples upright on ice and all particulate filters with the particulate catch facing upward. The particulate filters should be shipped unrefrigerated.

8.0 ANALYSIS

8.1 Sample preparation:

8.1.1 General: The preparation steps for all samples will result in a finite volume of concentrated solvent. The final sample volume (usually in the 1- to 10-mL range) is then subjected to analysis by GC/MS. All samples should be inspected and the appearance documented. All samples are to be spiked with surrogate standards as received from the field prior to any sample manipulations. The spike should be at a level equivalent to 10 times the MDL when the solvent is reduced in volume to the desired level (i.e., 10 mL). The spiking compounds should be the stable isotopically labeled analog of the compounds of interest or a compound that would exhibit properties similar to the compounds of interest, be easily chromatographed, and not interfere with the analysis of the compounds of interest. Suggested surrogate spiking compounds are: deuterated naphthalene, chrysene, phenol, nitrobenzene, chlorobenzene, toluene, and carbon-13-labeled pentachlorophenol.

8.1.2 Condensate: The "condensate" is the moisture collected in the first impinger following the XAD-2 module. Spike the condensate with the surrogate standards. The volume is measured and recorded and then transferred to a separatory funnel. The pH is to be adjusted to pH 2 with 6 N sulfuric acid, if necessary. The sample container and graduated cylinder are sequentially rinsed with three successive 10-mL aliquots of the extraction solvent and added to the separatory funnel. The ratio of solvent to aqueous sample should be maintained at 1:3. Extract the sample by vigorously shaking the separatory funnel for 5 min. After complete separation of the phases, remove the solvent and transfer to a Kuderna-Danish concentrator (K-D), filtering through a bed of precleaned, dry sodium sulfate. Repeat the extraction step two additional times. Adjust the pH to 11 with 6 N sodium hydroxide and reextract combining the acid and base extracts. Rinse the sodium sulfate into the K-D with fresh solvent and discard the desiccant. Add Teflon boiling chips and concentrate to 10 mL by reducing the volume to slightly less than 10 mL and then bringing to volume with fresh solvent. In order to achieve the necessary detection limit, the sample volume can be further reduced to 1 mL by using a micro column K-D or nitrogen blow-down. Should the sample start to exhibit precipitation, the concentration step should be stopped and the sample redissolved with fresh solvent taking the volume to some finite amount. After adding a standard (for the purpose of quantitation by GC/MS), the sample is ready for analysis, as discussed in Paragraph 8.2.

8.1.3 Impinger: Spike the sample with the surrogate standards; measure and record the volume and transfer to a separatory funnel. Proceed as described in Paragraph 8.1.2.

8.1.4 XAD-2: Spike the resin directly with the surrogate standards. Transfer the resin to the all-glass thimbles by the following procedure (care should be taken so as not to contaminate the thimble by touching it with anything other than tweezers or other solvent-rinsed mechanical holding devices). Suspend the XAD-2 module directly over the thimble. The glass frit of the module (see Figure 2) should be in the up position. The thimble is contained in a clean beaker, which will serve to catch the solvent rinses. Using a Teflon squeeze bottle, flush the XAD-2 into the thimble. Thoroughly rinse the glass module with solvent into the beaker containing the thimble. Add the XAD-2 glass-wool plug to the thimble. Cover the XAD-2 in the thimble with a precleaned glass-wool plug sufficient to prevent the resin from floating into the solvent reservoir of the extractor. If the resin is wet, effective extraction can be accomplished by loosely packing the resin in the thimble. If a question arises concerning the completeness of the extraction, a second extraction, without a spike, is advised. The thimble is placed in the extractor and the rinse solvent contained in the beaker is added to the solvent reservoir. Additional solvent is added to make the reservoir approximately two-thirds full. Add Teflon boiling chips and assemble the apparatus. Adjust the heat source to cause the extractor to cycle 5-6 times per hr. Extract the resin for 16 hr. Transfer the solvent and three 10-mL rinses of the reservoir to a K-D and concentrate as described in Paragraph 8.1.2.

8.1.5 Particulate filter (and cyclone catch): If particulate loading is to be determined, weigh the filter (and cyclone catch, if applicable). The particulate filter (and cyclone catch, if applicable) is transferred to the glass thimble and extracted simultaneously with the XAD-2 resin.

8.1.6 Train solvent rinses: All train rinses (i.e., probe, impinger, filter housing) using the extraction solvent and methanol are returned to the laboratory as a single sample. If the rinses are contained in more than one container, the intended spike is divided equally among the containers proportioned from a single syringe volume. Transfer the rinse to a separatory funnel and add a sufficient amount of organic-free water so that the methylene chloride becomes immiscible and its volume no longer increases with the addition of more water. The extraction and concentration steps are then performed as described in Paragraph 8.1.2.

8.2 Sample analysis:

8.2.1 The primary analytical tool for the measurement of emissions from hazardous waste incinerators is GC/MS using fused-silica capillary GC columns, as described in Method 8270 in Chapter Four of this manual. Because of the nature of GC/MS instrumentation and the cost associated

with sample analysis, prescreening of the sample extracts by gas chromatography/flame ionization detection (GC/FID) or with electron capture (GC/ECD) is encouraged. Information regarding the complexity and concentration level of a sample prior to GC/MS analysis can be of enormous help. This information can be obtained by using either capillary columns or less expensive packed columns. However, the FID screen should be performed with a column similar to that used with the GC/MS. Keep in mind that GC/FID has a slightly lower detection limit than GC/MS and, therefore, that the concentration of the sample can be adjusted either up or down prior to analysis by GC/MS.

8.2.2 The mass spectrometer will be operated in a full scan (40-450) mode for most of the analyses. The range for which data are acquired in a GC/MS run will be sufficiently broad to encompass the major ions, as listed in Chapter Four, Method 8270, for each of the designated POHCs in an incinerator effluent analysis.

8.2.3 For most purposes, electron ionization (EI) spectra will be collected because a majority of the POHCs give reasonable EI spectra. Also, EI spectra are compatible with the NBS Library of Mass Spectra and other mass spectral references, which aid in the identification process for other components in the incinerator process streams.

8.2.4 To clarify some identifications, chemical ionization (CI) spectra using either positive ions or negative ions will be used to elucidate molecular-weight information and simplify the fragmentation patterns of some compounds. In no case, however, should CI spectra alone be used for compound identification. Refer to Chapter Four, Method 8270, for complete descriptions of GC conditions, MS conditions, and quantitative and quantitative identification.

9.0 CALIBRATION

9.1 Probe nozzle: Probe nozzles shall be calibrated before their initial use in the field. Using a micrometer, measure the inside diameter of the nozzle to the nearest 0.025 mm (0.001 in.). Make measurements at three separate places across the diameter and obtain the average of the measurements. The difference between the high and low numbers shall not exceed 0.1 mm (0.004 in.). When nozzles become nicked, dented, or corroded, they shall be reshaped, sharpened, and recalibrated before use. Each nozzle shall be permanently and uniquely identified.

9.2 Pitot tube: The Type S pitot tube assembly shall be calibrated according to the procedure outlined in Section 4 of EPA Method 2, or assigned a nominal coefficient of 0.84 if it is not visibly nicked, dented, or corroded and if it meets design and intercomponent spacing specifications.

9.3 Metering system:

9.3.1 Before its initial use in the field, the metering system shall be calibrated according to the procedure outlined in APTD-0576. Instead of physically adjusting the dry-gas meter dial readings to correspond to the wet-test meter readings, calibration factors may be used to correct the gas meter dial readings mathematically to the proper values. Before calibrating the metering system, it is suggested that a leak-check be conducted. For metering systems having diaphragm pumps, the normal leak-check procedure will not detect leakages within the pump. For these cases the following leak-check procedure is suggested: Make a 10-min calibration run at 0.00057 m^3/min (0.02 cfm); at the end of the run, take the difference of the measured wet-test and dry-gas meter volumes and divide the difference by 10 to get the leak rate. The leak rate should not exceed 0.00057 m^3/min (0.02 cfm).

9.3.2 After each field use, the calibration of the metering system shall be checked by performing three calibration runs at a single intermediate orifice setting (based on the previous field test). The vacuum shall be set at the maximum value reached during the test series. To adjust the vacuum, insert a valve between the wet-test meter and the inlet of the metering system. Calculate the average value of the calibration factor. If the calibration has changed by more than 5%, recalibrate the meter over the full range of orifice settings, as outlined in APTD-0576.

9.3.3 Leak-check of metering system: That portion of the sampling train from the pump to the orifice meter (see Figure 1) should be leak-checked prior to initial use and after each shipment. Leakage after the pump will result in less volume being recorded than is actually sampled. The following procedure is suggested (see Figure 6): Close the main valve on the meter box. Insert a one-hole rubber stopper with rubber tubing attached into the orifice exhaust pipe. Disconnect and vent the low side of the orifice manometer. Close off the low side orifice tap. Pressurize the system to 13-18 cm (5-7 in.) water column by blowing into the rubber tubing. Pinch off the tubing and observe the manometer for 1 min. A loss of pressure on the manometer indicates a leak in the meter box. Leaks, if present, must be corrected.

NOTE: If the dry-gas-meter coefficient values obtained before and after a test series differ by >5%, either the test series shall be voided or calculations for test series shall be performed using whichever meter coefficient value (i.e., before or after) gives the lower value of total sample volume.

9.4 Probe heater: The probe-heating system shall be calibrated before its initial use in the field according to the procedure outlined in APTD-0576. Probes constructed according to APTD-0581 need not be calibrated if the calibration curves in APTD-0576 are used.

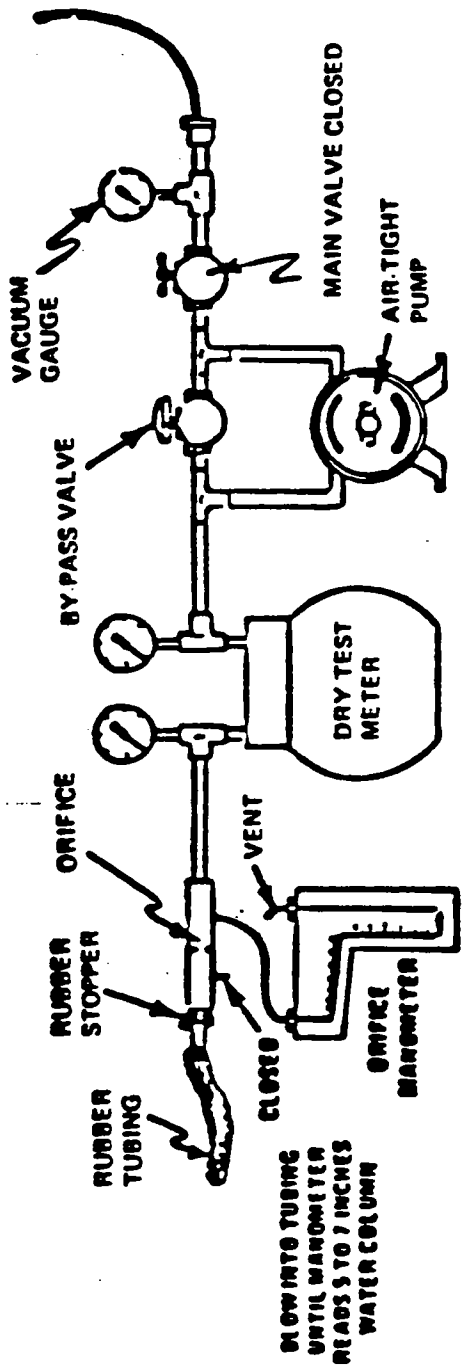

Figure 6. Leak-check of meter box.

9.5 Temperature gauges: Each thermocouple must be permanently and uniquely marked on the casting; all mercury-in-glass reference thermometers must conform to ASTM E-1 63C or 63F specifications. Thermocouples should be calibrated in the laboratory with and without the use of extension leads. If extension leads are used in the field, the thermocouple readings at ambient air temperatures, with and without the extension lead, must be noted and recorded. Correction is necessary if the use of an extension lead produces a change >1.5%.

9.5.1 Impinger, organic module, and dry-gas meter thermocouples: For the thermocouples used to measure the temperature of the gas leaving the impinger train and the XAD-2 resin bed, three-point calibration at ice-water, room-air, and boiling-water temperatures is necessary. Accept the thermocouples only if the readings at all three temperatures agree to ±2°C (3.6°F) with those of the absolute value of the reference thermometer.

9.5.2 Probe and stack thermocouple: For the thermocouples used to indicate the probe and stack temperatures, a three-point calibration at ice-water, boiling-water, and hot-oil-bath temperatures must be performed; it is recommended that room-air temperature be added, and that the thermometer and the thermocouple agree to within 1.5% at each of the calibration points. A calibration curve (equation) may be constructed (calculated) and the data extrapolated to cover the entire temperature range suggested by the manufacturer.

9.6 Barometer: Adjust the barometer initially and before each test series to agree to within ±25 mm Hg (0.1 in. Hg) of the mercury barometer or the corrected barometric pressure value reported by a nearby National Weather Service Station (same altitude above sea level).

9.7 Triple-beam balance: Calibrate the triple-beam balance before each test series, using Class-S standard weights; the weights must be within ±0.5% of the standards, or the balance must be adjusted to meet these limits.

10.0 CALCULATIONS

10.1 Carry out calculations. Round off figures after the final calculation to the correct number of significant figures.

10.2 Nomenclature:

A_n = Cross-sectional area of nozzle, m^2 (ft^2).

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

C_d = Type S pitot tube coefficient (nominally 0.84 ± 0.02), dimensionless.

I = Percent of isokinetic sampling.

L_a = Maximum acceptable leakage rate for a leak-check, either pre-test or following a component change; equal to 0.00057 m^3/min (0.02 cfm) or 4% of the average sampling rate, whichever is less.

L_i = Individual leakage rate observed during the leak-check conducted prior to the "i^{th}" component change (i = 1, 2, 3...n) m^3/min (cfm).

L_p = Leakage rate observed during the post-test leak-check, m^3/min (cfm).

M_d = Stack-gas dry molecular weight, g/g-mole (lb/lb-mole).

M_w = Molecular weight of water, 18.0 g/g-mole (18.0 lb/lb-mole).

P_{bar} = Barometric pressure at the sampling site, mm Hg (in. Hg).

P_s = Absolute stack-gas pressure, mm Hg (in. Hg).

P_{std} = Standard absolute pressure, 760 mm Hg (29.92 in. Hg).

R = Ideal gas constant, 0.06236 mm Hg-m^3/K-g-mole (21.85 in. Hg-ft^3/°R-lb-mole).

T_m = Absolute average dry-gas meter temperature (see Figure 6), K (°R).

T_s = Absolute average stack-gas temperature (see Figure 6), K (°R).

T_{std} = Standard absolute temperature, 293K (528°R).

V_{lc} = Total volume of liquid collected in the organic module condensate knockout trap, the impingers, and silica gel, mL.

V_m = Volume of gas sample as measured by dry-gas meter, dscm (dscf).

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

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

V_s = Stack-gas velocity, calculated by Method 2, Equation 2-9, using data obtained from Method 5, m/sec (ft/sec).

W_a = Weight of residue in acetone wash, mg.

γ = Dry-gas-meter calibration factor, dimensionless.

ΔH = Average pressure differential across the orifice meter (see Figure 2), mm H_2O (in. H_2O).

ρ_w = Density of water, 0.9982 g/mL (0.002201 lb/mL).

θ = Total sampling time, min.

θ_1 = Sampling time interval from the beginning of a run until the first component change, min.

θ_i = Sampling time interval between two successive component changes, beginning with the interval between the first and second changes, min.

θ_p = Sampling time interval from the final (n^{th}) component change until the end of the sampling run, min.

13.6 = Specific gravity of mercury.

60 = sec/min.

100 = Conversion to percent.

10.3 Average dry-gas-meter temperature and average orifice pressure drop: See data sheet (Figure 5, above).

10.4 Dry-gas volume: Correct the sample measured by the dry-gas meter to standard conditions (20°C, 760 mm Hg [68°F, 29.92 in. Hg]) by using Equation 1:

$$V_{m(std)} = V_m \left[\frac{T_{std}}{T_m}\right]\left[\frac{P_{bar} + \Delta H/13.6}{P_{std}}\right] = K_1 V_m \left[\frac{P_{bar} + \Delta H/13.6}{T_m}\right] \qquad (1)$$

where:

K_1 = 0.3858 K/mm Hg for metric units, or
K_1 = 17.64°R/in. Hg for English units.

It should be noted that Equation 1 can be used as written, unless the leakage rate observed during any of the mandatory leak-checks (i.e., the post-test leak-check or leak-checks conducted prior to component changes) exceeds L_a. If L_p or L_i exceeds L_a, Equation 1 must be modified as follows:

a. Case I (no component changes made during sampling run): Replace V_m in Equation 1 with the expression:

$$V_m - (L_p - L_a)$$

b. Case II (one or more component changes made during the sampling run): Replace V_m in Equation 1 by the expression:

$$V_m - (L_1 - L_a)\theta_1 - \sum_{i=2}^{n} (L_i - L_a)\theta_1 - (L_p - L_a)\theta_p$$

and substitute only for those leakage rates (L_1 or L_p) that exceed L_a.

10.5 Volume of water vapor:

$$V_{w(std)} = V_{lc} \frac{P_w}{M_w} \frac{RT_{std}}{P_{std}} = K_2 V_{lc} \qquad (2)$$

where:

$K_2 = 0.001333$ m^3/mL for metric units, or
$K_2 = 0.04707$ ft^3/mL for English units.

10.6 Moisture content:

$$B_{ws} = \frac{V_{w(std)}}{V_{m(std)} + V_{w(std)}} \qquad (3)$$

NOTE: In saturated or water-droplet-laden gas streams, two calculations of the moisture content of the stack gas shall be made, one from the impinger analysis (Equation 3) and a second from the assumption of saturated conditions. The lower of the two values of B_w shall be considered correct. The procedure for determining the moisture content based upon assumption of saturated conditions is given in the Note to Section 1.2 of Method 4. For the purposes of this method, the average stack-gas temperature from Figure 6 may be used to make this determination, provided that the accuracy of the in-stack temperature sensor is ±1°C (2°F).

10.7 Conversion factors:

From	To	Multiply by
scf	m^3	0.02832
g/ft^3	gr/ft^3	15.43
g/ft^3	lb/ft^3	2.205×10^{-3}
g/ft^3	g/m^3	35.31

10.8 Isokinetic variation:

10.8.1 Calculation from raw data:

$$I = \frac{100\ T_s[K_3 F_{1c} + (V_m/T_m)\ (P_{bar} + \Delta H/13.6)]}{60\theta V_s P_s A_n} \qquad (4)$$

where:

K_3 = 0.003454 mm Hg-m^3/mL-K for metric units, or
K_3 = 0.002669 in. Hg-ft^3/mL-°R for English units.

10.8.2 Calculation for intermediate values:

$$I = \frac{T_s V_{m(std)} P_{std} 100}{T_{std} V_s \theta A_n P_s 60(1-B_{ws})} = K_4 \frac{T_s V_{m(std)}}{P_s V_s A_n \theta (1-B_{ws})} \qquad (5)$$

where:

K_4 = 4.320 for metric units, or
K_4 = 0.09450 for English units.

10.8.3 Acceptable results: If 90% $\leq$ I $\leq$ 110%, the results are acceptable. If the results are low in comparison with the standard and I is beyond the acceptable range, or if I is less than 90%, the Administrator may opt to accept the results.

10.9 To determine the minimum sample volume that shall be collected, the following sequence of calculations shall be used.

10.9.1 From prior analysis of the waste feed, the concentration of POHCs introduced into the combustion system can be calculated. The degree of destruction and removal efficiency that is required is used to determine the maximum amount of POHC allowed to be present in the effluent. This may be expressed as:

$$\frac{(WF)\ (POHC_1\ conc)}{100} \quad \frac{(100-\%DRE)}{100} = \text{Max } POHC_1 \text{ Mass} \qquad (6)$$

where:

WF = mass flow rate of waste feed per hr, g/hr (lb/hr).

$POHC_1$ = concentration of Principal Organic Hazardous Compound (wt %) introduced into the combustion process.

DRE = percent Destruction and Removal Efficiency required.

Max POHC = mass flow rate (g/hr [lb/hr]) of POHC emitted from the combustion source.

10.9.2 The average discharge concentration of the POHC in the effluent gas is determined by comparing the Max POHC with the volumetric flow rate being exhausted from the source. Volumetric flow rate data are available as a result of preliminary Method 1-4 determinations:

$$\frac{\text{Max POHC}_1 \text{ Mass}}{DV_{eff(std)}} = \text{Max POHC}_1 \text{ conc} \qquad (7)$$

where:

$DV_{eff(std)}$ = volumetric flow rate of exhaust gas, dscm (dscf).

$POHC_1$ conc = anticipated concentration of the POHC in the exhaust gas stream, g/dscm (lb/dscf).

10.9.3 In making this calculation, it is recommended that a safety margin of at least ten be included:

$$\frac{LDL_{POHC} \times 10}{POHC_1 \text{ conc}} = V_{TBC} \qquad (8)$$

where:

LDL_{POHC} = detectable amount of POHC in entire sampling train.
NOTE: The whole extract from an XAD-2 cartridge is seldom if ever, injected at once. Therefore, if aliquoting factors are involved, the LDL_{POHC} is not the same as the analytical (or column) detection limit.

V_{TBC} = minimum dry standard volume to be collected at dry-gas meter.

10.10 Concentration of any given POHC in the gaseous emissions of a combustion process:

1) Multiply the concentration of the POHC as determined in Method 8270 by the final concentration volume, typically 10 mL.

C_{POHC} (ug/mL) x sample volume (mL) = amount (ug) of POHC in sample (9)

where:

C_{POHC} = concentration of POHC as analyzed by Method 8270.

2) Sum the amount of POHC found in all samples associated with a single train.

Total (ug) = XAD-2 (ug) + condensate (ug) + rinses (ug) + impinger (ug) (10)

3) Divide the total ug found by the volume of stack gas sampled (m^3).

(Total ug)/(train sample volume) = concentration of POHC (ug/m^3) (11)

11.0 QUALITY CONTROL

11.1 Sampling: See EPA Manual 600/4-77-027b for Method 5 quality control.

11.2 Analysis: The quality assurance program required for this study includes the analysis of field and method blanks, procedure validations, incorporation of stable labeled surrogate compounds, quantitation versus stable labeled internal standards, capillary column performance checks, and external performance tests. The surrogate spiking compounds selected for a particular analysis are used as primary indicators of the quality of the analytical data for a wide range of compounds and a variety of sample matrices. The assessment of combustion data, positive identification, and quantitation of the selected compounds are dependent on the integrity of the samples received and the precision and accuracy of the analytical methods employed. The quality assurance procedures for this method are designed to monitor the performance of the analytical method and to provide the required information to take corrective action if problems are observed in laboratory operations or in field sampling activities.

11.2.1 Field Blanks: Field blanks must be submitted with the samples collected at each sampling site. The field blanks include the sample bottles containing aliquots of sample recovery solvents, unused filters, and resin cartridges. At a minimum, one complete sampling train will be assembled in the field staging area, taken to the sampling area, and leak-checked at the beginning and end of the testing (or for the same total number of times as the actual test train). The filter housing and probe of the blank train will be heated during the sample test. The train will be recovered as if it were an actual test sample. No gaseous sample will be passed through the sampling train.

11.2.2 Method blanks: A method blank must be prepared for each set of analytical operations, to evaluate contamination and artifacts that can be derived from glassware, reagents, and sample handling in the laboratory.

11.2.3 Refer to Method 8270 for additional quality control considerations.

12.0 METHOD PERFORMANCE

12.1 Method performance evaluation: Evaluation of analytical procedures for a selected series of compounds must include the sample-preparation procedures and each associated analytical determination. The analytical procedures should be challenged by the test compounds spiked at appropriate levels and carried through the procedures.

12.2 Method detection limit: The overall method detection limits (lower and upper) must be determined on a compound-by-compound basis because different compounds may exhibit different collection, retention, and extraction efficiencies as well as instrumental minimum detection limit (MDL). The method detection limit must be quoted relative to a given sample volume. The upper limits for the method must be determined relative to compound retention volumes (breakthrough).

12.3 Method precision and bias: The overall method precision and bias must be determined on a compound-by-compound basis at a given concentration level. The method precision value would include a combined variability due to sampling, sample preparation, and instrumental analysis. The method bias would be dependent upon the collection, retention, and extraction efficiency of the train components. From evaluation studies to date using a dynamic spiking system, method biases of -13% and -16% have been determined for toluene and 1,1,2,2-tetrachloroethane, respectively. A precision of 19.9% was calculated from a field test data set representing seven degrees of freedom which resulted from a series of paired, unspiked Semivolatile Organic Sampling trains (Semi-VOST) sampling emissions from a hazardous waste incinerator.

13.0 REFERENCES

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PREPARATION OF XAD-2 SORBENT RESIN

1.0 SCOPE AND APPLICATION

1.1 XAD-2 resin as supplied by the manufacturer is impregnated with a bicarbonate solution to inhibit microbial growth during storage. Both the salt solution and any residual extractable monomer and polymer species must be removed before use. The resin is prepared by a series of water and organic extractions, followed by careful drying.

2.0 EXTRACTION

2.1 Method 1: The procedure may be carried out in a giant Soxhlet extractor. An all-glass thimble containing an extra-coarse frit is used for extraction of XAD-2. The frit is recessed 10-15 mm above a crenellated ring at the bottom of the thimble to facilitate drainage. The resin must be carefully retained in the extractor cup with a glass-wool plug and stainless steel screen because it floats on methylene chloride. This process involves sequential extraction in the following order.

Solvent	Procedure
Water	Initial rinse: Place resin in a beaker, rinse once with Type II water, and discard. Fill with water a second time, let stand overnight, and discard.
Water	Extract with H_2O for 8 hr.
Methyl alcohol	Extract for 22 hr.
Methylene chloride	Extract for 22 hr.
Methylene chloride (fresh)	Extract for 22 hr.

2.2 Method 2:

2.2.1 As an alternative to Soxhlet extraction, a continuous extractor has been fabricated for the extraction sequence. This extractor has been found to be acceptable. The particular canister used for the apparatus shown in Figure A-1 contains about 500 g of finished XAD-2. Any size may be constructed; the choice is dependent on the needs of the sampling programs. The XAD-2 is held under light spring tension between a pair of coarse and fine screens. Spacers under the bottom screen allow for even distribution of clean solvent. The three-necked flask should be of sufficient size (3-liter in this case) to hold solvent

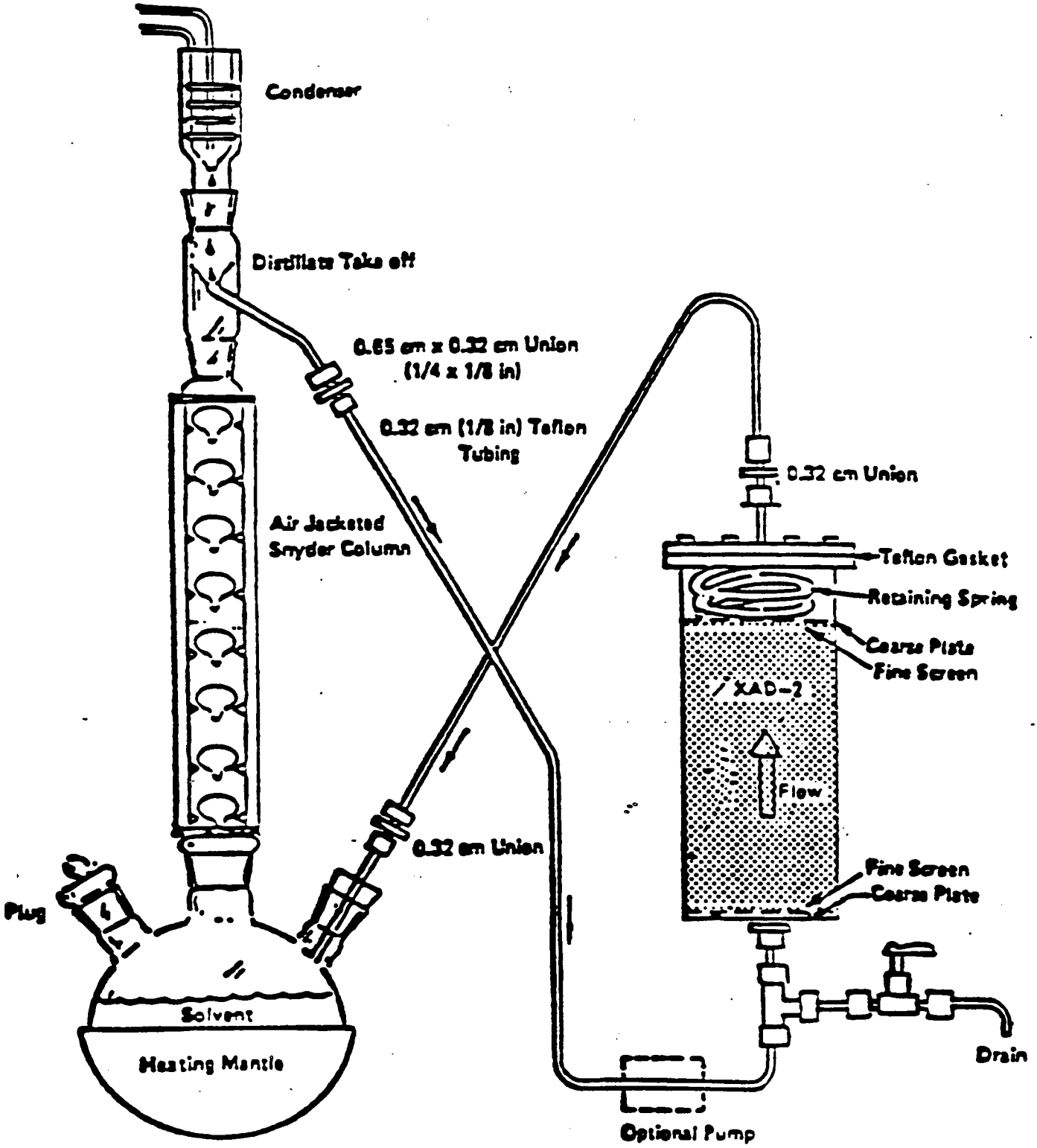

Figure A-1. XAD-2 cleanup extraction apparatus.

equal to twice the dead volume of the XAD-2 canister. Solvent is refluxed through the Snyder column, and the distillate is continuously cycled up through the XAD-2 for extraction and returned to the flask. The flow is maintained upward through the XAD-2 to allow maximum solvent contact and prevent channeling. A valve at the bottom of the canister allows removal of solvent from the canister between changes.

2.2.2 Experience has shown that it is very difficult to cycle sufficient water in this mode. Therefore the aqueous rinse is accomplished by simply flushing the canister with about 20 liters of distilled water. A small pump may be useful for pumping the water through the canister. The water extraction should be carried out at the rate of about 20-40 mL/min.

2.2.3 After draining the water, subsequent methyl alcohol and methylene chloride extractions are carried out using the refluxing apparatus. An overnight or 10- to 20-hr period is normally sufficient for each extraction.

2.2.4 All materials of construction are glass, Teflon, or stainless steel. Pumps, if used, should not contain extractable materials. Pumps are not used with methanol and methylene chloride.

3.0 DRYING

3.1 After evaluation of several methods of removing residual solvent, a fluidized-bed technique has proved to be the fastest and most reliable drying method.

3.2 A simple column with suitable retainers, as shown in Figure A-2, will serve as a satisfactory column. A 10.2-cm (4-in.) Pyrex pipe 0.6 m (2 ft) long will hold all of the XAD-2 from the extractor shown in Figure A-1 or the Soxhlet extractor, with sufficient space for fluidizing the bed while generating a minimum resin load at the exit of the column.

3.3 Method 1: The gas used to remove the solvent is the key to preserving the cleanliness of the XAD-2. Liquid nitrogen from a standard commercial liquid nitrogen cylinder has routinely proved to be a reliable source of large volumes of gas free from organic contaminants. The liquid nitrogen cylinder is connected to the column by a length of precleaned 0.95-cm (3/8-in.) copper tubing, coiled to pass through a heat source. As nitrogen is bled from the cylinder, it is vaporized in the heat source and passes through the column. A convenient heat source is a water bath heated from a steam line. The final nitrogen temperature should only be warm to the touch and not over 40°C. Experience has shown that about 500 g of XAD-2 may be dried overnight by consuming a full 160-liter cylinder of liquid nitrogen.

3.4 Method 2: As a second choice, high-purity tank nitrogen may be used to dry the XAD-2. The high-purity nitrogen must first be passed through a bed

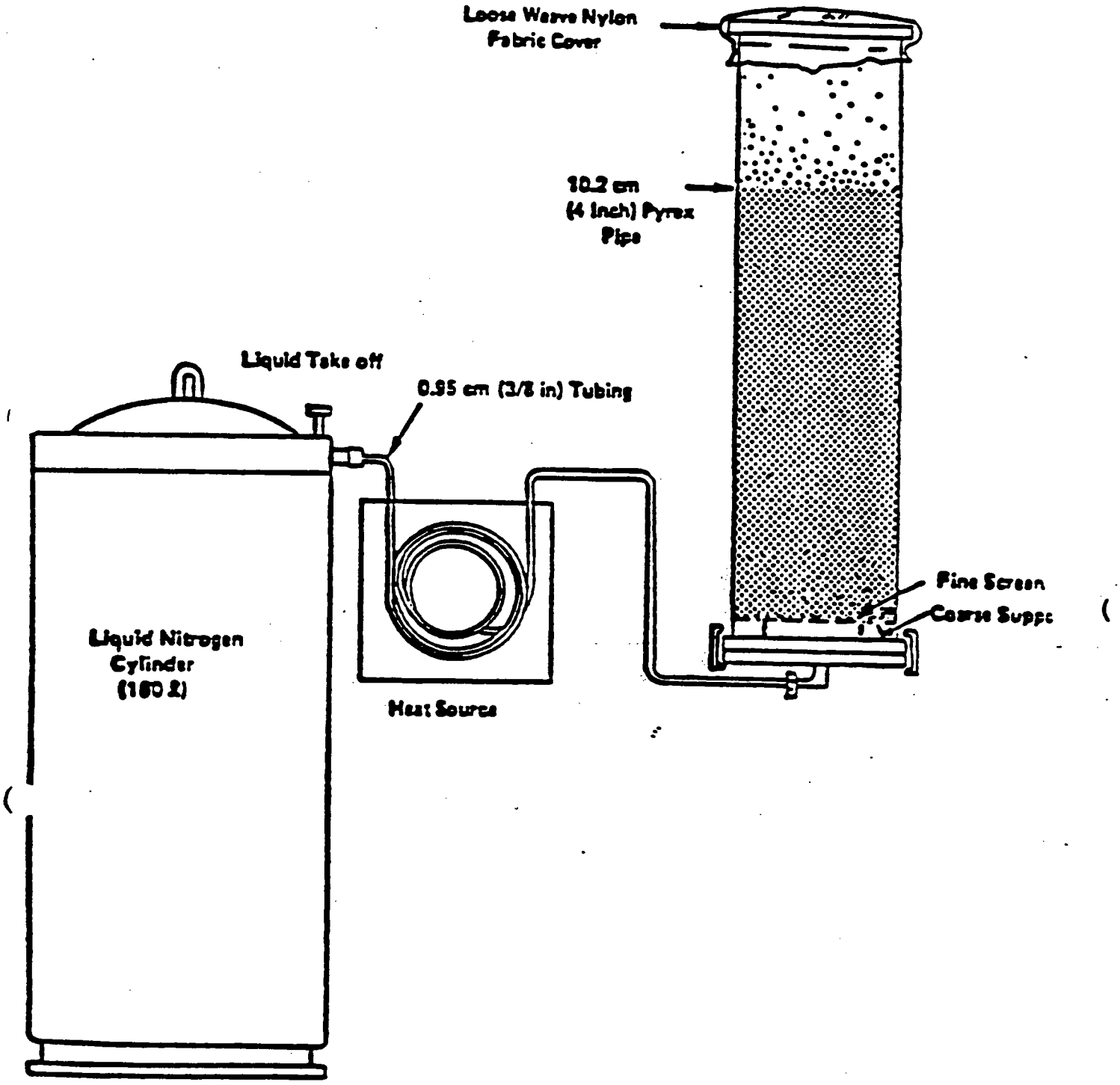

Figure A-2. XAD-2 fluidized-bed drying apparatus.

resin will float out unless well plugged.) The thimble containing the resin is extracted for 24 hr with 200-mL of pesticide- grade methylene chloride (Burdick and Jackson pesticide-grade or equivalent purity). The 200-mL extract is reduced in volume to 10-mL using a Kuderna-Danish concentrator and/or a nitrogen evaporation stream. Five uL of that solution are analyzed by gas chromatography using the TCO analysis procedure. The concentrated solution should not contain >20 ug/mL of TCO extracted from the XAD-2. This is equivalent to 10 ug/g of TCO in the XAD-2 and would correspond to 1.3 mg of TCO in the extract of the 130-g XAD-2 module. Care should be taken to correct the TCO data for a solvent blank prepared (200 mL reduced to 10 mL) in a similar manner.

4.4.2 Experimental: Use the TCO analysis conditions described in the revised Level 1 manual (EPA 600/7-78-201).

4.5 GC/MS Screen: The extract, as prepared in paragraph 4.4.1, is subjected to GC/MS analysis for each of the individual compounds of interest. The GC/MS procedure is described in Chapter Four, Method 8270. The extract is screened at the MDL of each compound. The presence of any compound at a concentration >25 ug/mL in the concentrated extract will require the XAD-2 to be recleaned by repeating the methylene chloride step.

4.6 Methodology for residual gravimetric determination: After the TCO value and GC/MS data are obtained for the resin batch by the above procedures, dry the remainder of the extract in a tared vessel. There must be <0.5 mg residue registered or the batch of resin will have to be extracted with fresh methylene chloride again until it meets this criterion. This level corresponds to 25 ug/g in the XAD-2, or about 3.25 mg in a resin charge of 130 g.

of activated charcoal approximately 150 mL in volume. With either type of drying method, the rate of flow should gently agitate the bed. Excessive fluidization may cause the particles to break up.

4.0 QUALITY CONTROL PROCEDURES

4.1 For both Methods 1 and 2, the quality control results must be reported for the batch. The batch must be reextracted if the residual extractable organics are >20 ug/mL by TCO analysis or the gravimetric residue is >0.5 mg/20 g XAD-2 extracted. (See also section 5.1, Method 0010.)

4.2 Four control procedures are used with the final XAD-2 to check for (1) residual methylene chloride, (2) extractable organics (TCO), (3) specific compounds of interest as determined by GC/MS, as described in Section 4.5 below, and (4) residue (GRAV).

4.3 Procedure for residual methylene chloride:

4.3.1 Description: A 1±0.1-g sample of dried resin is weighed into a small vial, 3 mL of toluene are added, and the vial is capped and well shaken. Five uL of toluene (now containing extracted methylene chloride) are injected into a gas chromatograph, and the resulting integrated area is compared with a reference standard. The reference solution consists of 2.5 uL of methylene chloride in 100 mL of toluene, simulating 100 ug of residual methylene chloride on the resin. The acceptable maximum content is 1,000 ug/g resin.

4.3.2 Experimental: The gas chromatograph conditions are as follows:

6-ft x 1/8-in. stainless steel column containing 10% OV-101 on 100/120 Supelcoport;

Helium carrier at 30 mL/min;

FID operated on 4 x 10^{-11} A/mV;

Injection port temperature: 250°C;

Detector temperature: 305°C;

Program: 30°C(4 min) 40°C/min 250°C (hold); and

Program terminated at 1,000 sec.

4.4 Procedure for residual extractable organics:

4.4.1 Description: A 20±0.1-g sample of cleaned, dried resin is weighed into a precleaned alundum or cellulose thimble which is plugged with cleaned glass wool. (Note that 20 g of resin will fill a thimble, and the

METHOD 0010, APPENDIX B

TOTAL CHROMATOGRAPHABLE ORGANIC MATERIAL ANALYSIS

1.0 SCOPE AND APPLICATION

1.1 In this procedure, gas chromatography is used to determine the quantity of lower boiling hydrocarbons (boiling points between 90° and 300°C) in the concentrates of all organic solvent rinses, XAD-2 resin and LC fractions - when Method 1 is used (see References, Method 0010) - encountered in Level 1 environmental sample analyses. Data obtained using this procedure serve a twofold purpose. First, the total quantity of the lower boiling hydrocarbons in the sample is determined. Then whenever the hydrocarbon concentrations in the original concentrates exceed 75 ug/m^3, the chromatography results are reexamined to determine the amounts of individual species.

The extent of compound identification is limited to representing all materials as normal alkanes based upon comparison of boiling points. Thus the method is not qualitative. In a similar manner, the analysis is semiquantitative; calibrations are prepared using only one hydrocarbon. They are replicated but samples routinely are not.

1.2 Application: This procedure applies solely to the Level 1 C7-C16 gas chromatographic analysis of concentrates of organic extracts, neat liquids, and of LC fractions. Throughout the procedure, it is assumed the analyst has been given a properly prepared sample.

1.3 Sensitivity: The sensitivity of this procedure, defined as the slope of a plot of response versus concentration, is dependent on the instrument and must be verified regularly. TRW experience indicates the nominal range is of the order of 77 uV·V·sec·uL/ng of n-heptane and 79 uV·sec·ul/ng of n-hexadecane. The instrument is capable of perhaps one hundredfold greater sensitivity. The level specified here is sufficient for Level 1 analysis.

1.4 Detection limit: The detection limit of this procedure as written is 1.3 ng/uL for a 1 uL injection of n-decane. This limit is arbitrarily based on defining the minimum detectable response as 100 uv·sec. This is an easier operational definition than defining the minimum detection limit to be that amount of material which yields a signal twice the noise level.

1.5 Range: The range of the procedure will be concentrations of 1.3 ng/uL and greater.

1.6 Limitations

1.6.1 Reporting limitations: It should be noted that a typical environmental sample will contain compounds which: (a) will not elute in the specified boiling ranges and thus will not be reported, and/or (b)

will not elute from the column at all and thus will not be reported. Consequently, the organic content of the sample as reported is a lower bound and should be regarded as such.

1.6.2 Calibration limitations: Quantitation is based on calibration with n-decane. Data should therefore be reported as, e.g., mg C8/m^3 as n-decane. Since response varies linearly with carbon number (over a wide range the assumption may involve a 20% error), it is clear that heptane (C7) detected in a sample and quantitated as decane will be overestimated. Likewise, hexadecane (C16) quantitated as decane will be underestimated. From previous data, it is estimated the error involved is on the order of 6-7%.

1.6.3 Detection limitations: The sensitivity of the flame ionization detector varies from compound to compound. However, n-alkanes have a greater response than other classes. Consequently, using an n-alkane as a calibrant and assuming equal responses of all other compounds tends to give low reported values.

2.0 SUMMARY OF METHOD

2.1 A mL aliquot of all 10-mL concentrates is disbursed for GC-TCO analysis. With boiling point-retention time and response-amount calibration curves, the data (peak retention times and peak areas) are interpreted by first summing peak areas in the ranges obtained from the boiling point-retention time calibration. Then, with the response-amount calibration curve, the area sums are converted to amounts of material in the reported boiling point ranges.

2.2 After the instrument is set up, the boiling point-retention time calibration is effected by injecting a mixture of n-C7 through n-C16 hydrocarbons and operating the standard temperature program. Response-quantity calibrations are accomplished by injecting n-decane in n-pentane standards and performing the standard temperature program.

2.3 Definitions

2.3.1 GC: Gas chromatography or gas chromatograph.

2.3.2 C7-C16 n-alkanes: Heptane through hexadecane.

2.3.3 GCA temperature program: 4 min isothermal at 60°C, 10°C/min from 60° to 220°C.

2.3.4 TRW temperature program: 5 min isothermal at room temperature, then program from 30°C to 250°C at 15°C/min.

3.0 INTERFERENCES

Not applicable.

4.0 APPARATUS AND MATERIALS

4.1 Gas chromatograph: This procedure is intended for use on a Varian 1860 gas chromatograph, equipped with dual flame ionization detectors and a linear temperature programmer. Any equivalent instrument can be used provided that electrometer settings, etc., be changed appropriately.

4.2 Gases:

4.2.1 Helium: Minimum quality is reactor grade. A 4A or 13X molecular sieve drying tube is required. A filter must be placed between the trap and the instrument. The trap should be recharged after every third tank of helium.

4.2.2 Air: Zero grade is satisfactory.

4.2.3 Hydrogen: Zero grade.

4.3 Syringe: Syringes are Hamilton 701N, 10 uL, or equivalent.

4.4 Septa: Septa will be of such quality as to produce very low bleed during the temperature program. An appropriate septum is Supelco Microsep 138, which is Teflon-backed. If septum bleed cannot be reduced to a negligible level, it will be necessary to install septum swingers on the instrument.

4.5 Recorder: The recorder of this procedure must be capable of not less than 1 mV full-scale display, a 1-sec time constant and 0.5 in. per min chart rate.

4.6 Integrator: An integrator is required. Peak area measurement by hand is satisfactory but too time-consuming. If manual integration is required, the method of "height times width at half height" is used.

4.7 Columns:

4.7.1 Preferred column: 6 ft x 1/8 in. O.D. stainless steel column of 10% OV-101 on 100/120 mesh Supelcoport.

4.7.2 Alternate column: 6 ft x 1/8 in. O.D. stainless steel column of 10% OV-1 (or other silicon phase) on 100/120 mesh Supelcoport.

4.8 Syringe cleaner: Hamilton syringe cleaner or equivalent connected to a suitable vacuum source.

5.0 REAGENTS

5.1 Pentane: "Distilled-in-Glass" (reg. trademark) or "Nanograde" (reg. trademark) for standards and for syringe cleaning.

5.2 Methylene chloride: "Distilled-in-Glass" (reg. trademark) or "Nanograde" (reg. trademark) for syringe cleaning.

6.0 SAMPLING HANDLING AND PRESERVATION

6.1 The extracts are concentrated in a Kuderna-Danish evaporator to a volume less than 10 mL. The concentrate is then quantitatively transferred to a 10-mL volumetric flask and diluted to volume. A 1-mL aliquot is taken for both this analysis and possible subsequent GC/MS analysis and set aside in the sample bank. For each GC-TCO analysis, obtain the sample sufficiently in advance to allow it to warm to room temperature. For example, after one analysis is started, return that sample to the sample bank and take the next sample.

7.0 PROCEDURES

7.1 Setup and checkout: Each day, the operator will verify the following:

7.1.1 That supplies of carrier gas, air and hydrogen are sufficient, i.e., that each tank contains > 100 psig.

7.1.2 That, after replacement of any gas cylinder, all connections leading to the chromatograph have been leak-checked.

7.1.3 That the carrier gas flow rate is 30 ± 2 mL/min, the hydrogen flow rate is 30 ± 2 mL/min, and the air flow rate is 300 ± 20 mL/min.

7.1.4 That the electrometer is functioning properly.

7.1.5 That the recorder and integrator are functioning properly.

7.1.6 That the septa have been leak-checked (leak-checking is effected by placing the soap bubble flow meter inlet tube over the injection port adaptors), and that no septum will be used for more than 20 injections.

7.1.7 That the list of samples to be run is ready.

7.2 Retention time calibration:

7.2.1 To obtain the temperature ranges for reporting the results of the analyses, the chromatograph is given a normal boiling point-retention time calibration. The n-alkanes, their boiling points, and data reporting ranges are given in the table below:

	NBP, °C	Reporting Range, °C	Report As
n-heptane	98	90-110	C7
n-octane	126	110-140	C8
n-nonane	151	140-160	C9
n-decane	174	160-180	C10
n-undecane	194	180-200	C11
n-dodecane	214	200-220	C12
n-tridecane	234	220-240	C13
n-tetradecane	252	240-260	C14
n-pentadecane	270	260-280	C15
n-hexadecane	288	280-300	C16

7.2.2 Preparation of standards: Preparing a mixture of the C7-C16 alkanes is required. There are two approaches: (1) use of a standards kit (e.g., Polyscience Kit) containing bottles of mixtures of selected n-alkanes which may be combined to produce a C7-C16 standard; or (2) use of bottles of the individual C7-C16 alkanes from which accurately known volumes may be taken and combined to give a C7-C16 mixture.

7.2.3 Procedure for retention time calibration: This calibration is performed at the start of an analytical program; the mixture is chromatographed at the start of each day. To attain the required retention time precision, both the carrier gas flow rate and the temperature program specifications must be observed. Details of the procedure depend on the instrument being used. The general procedure is as follows:

7.2.3.1 Set the programmer upper limit at 250°C. If this setting does not produce a column temperature of 250°C, find the correct setting.

7.2.3.2 Set the programmer lower limit at 30°C.

7.2.3.3 Verify that the instrument and samples are at room temperature.

7.2.3.4 Inject 1 uL of the n-alkane mixture.

7.2.3.5 Start the integrator and recorder.

7.2.3.6 Allow the instrument to run isothermally at room temperature for five min.

7.2.3.7 Shut the oven door.

7.2.3.8 Change the mode to Automatic and start the temperature program.

7.2.3.9 Repeat Steps 1-9 a sufficient number of times so that the relative standard deviation of the retention times for each peak is <5%.

7.3 Response calibration:

7.3.1 For the purposes of a Level 1 analysis, response-quantity calibration with n-decane is adequate. A 10-uL volume of n-decane is injected into a tared 10 mL volumetric flask. The weight injected is obtained and the flask is diluted to the mark with n-pentane. This standard contains about 730 ng n-decane per uL n-pentane. The exact concentration depends on temperature, so that a weight is required. Two serial tenfold dilutions are made from this standard, giving standards at about 730, 73, and 7.3 ng n-decane per uL n-pentane, respectively.

7.3.2 Procedure for response calibration: This calibration is performed at the start of an analytical program and monthly thereafter. The most concentrated standard is injected once each day. Any change in calibration necessitates a full calibration with new standards. Standards are stored in the refrigerator locker and are made up monthly.

7.3.2.1 Verify that the instrument is set up properly.

7.3.2.2 Set electrometer at 1×10^{-10} A/mV.

7.3.2.3 Inject 1 uL of the highest concentration standard.

7.3.2.4 Run standard temperature program as specified above.

7.3.2.5 Clean syringe.

7.3.2.6 Make repeated injections of all three standards until the relative standard deviations of the areas of each standard are ≤5%.

7.4 Sample analysis procedure:

7.4.1 The following apparatus is required:

7.4.1.1 Gas chromatograph set up and working.

7.4.1.2 Recorder, integrator working.

7.4.1.3 Syringe and syringe cleaning apparatus.

7.4.1.4 Parameters: Electrometer setting is 1×10^{-10} A/mV; recorder is set at 0.5 in./min and 1 mV full-scale.

7.4.2 Steps in the procedure are:

7.4.2.1 Label chromatogram with the data, sample number, etc.

7.4.2.2 Inject sample.

7.4.2.3 Start integrator and recorder.

7.4.2.4 After isothermal operation for 5 min, begin temperature program.

7.4.2.5 Clean syringe.

7.4.2.6 Return sample; obtain new sample.

7.4.2.7 When analysis is finished, allow instrument to cool. Turn chromatogram and integrator output and data sheet over to data analyst.

7.5 Syringe cleaning procedure:

7.5.1 Remove plunger from syringe.

7.5.2 Insert syringe into cleaner; turn on aspirator.

7.5.3 Fill pipet with pentane; run pentane through syringe.

7.5.4 Repeat with methylene chloride from a separate pipet.

7.5.5 Flush plunger with pentane followed by methylene chloride.

7.5.6 Repeat with methylene chloride.

7.6 Sample analysis decision criterion: The data from the TCO analyses of organic extract and rinse concentrates are first used to calculate the total concentration of C7-C16 hydrocarbon-equivalents (Paragraph 7.7.3) in the sample with respect to the volume of air actually sampled, i.e., ug/m^3. On this basis, a decision is made both on whether to calculate the quantity of each n-alkane equivalent present and on which analytical procedural pathway will be followed. If the total organic content is great enough to warrant continuing the analysis -- >500 ug/m^3 -- a TCO of less than 75 ug/m^3 will require only LC fractionation and gravimetric determinations and IR spectra to be obtained on each fraction. If the TCO is greater than 75 ug/m^3, then the first seven LC fractions of each sample will be reanalyzed using this same gas chromatographic technique.

7.7 Calculations:

7.7.1 Boiling Point - Retention Time Calibration: The required data for this calibration are on the chromatogram and on the data sheet. The data reduction is performed as follows:

7.7.1.1 Average the retention times and calculate relative standard deviations for each n-hydrocarbon.

7.7.1.2 Plot average retention times as abscissae versus normal boiling points as ordinates.

7.7.1.3 Draw in calibration curve.

7.7.1.4 Locate and record retention times corresonding to boiling ranges 90-100, 110-140, 140-160, 160-180, 180-200, 200-220, 220-240, 240-260, 260-280, 280-300°C.

7.7.2 Response-amount calibration: The required data for this calibration are on the chromatogram and on the data sheet. The data reduction is performed as follows:

7.7.2.1 Average the area responses of each standard and calculate relative standard deviations.

7.7.2.2 Plot response (uv·sec) as ordinate versus ng/uL as abscissa.

7.7.2.3 Draw in the curve. Perform least squares regression and obtain slope (uV·sec·uL/ng).

7.7.3 Total C7-C16 hydrocarbons analysis: The required data for this calculation are on the chromatogram and on the data sheet. The data reduction is performed as follows:

7.7.3.1 Sum the areas of all peaks within the retention time range of interest.

7.7.3.2 Convert this area (uV·sec) to ng/uL by dividing by the weight response for n-decane (uV·sec.uL/ng).

7.7.3.3 Multiply this weight by the total concentrate volume (10 mL) to get the weight of the C7-C16 hydrocarbons in the sample.

7.7.3.4 Using the volume of gas sampled or the total weight of sample acquired, convert the result of Step 7.7.3.3 above to ug/m^3.

7.7.3.5 If the value of total C7-C16 hydrocarbons from Step 7.7.3.4 above exceeds 75 ug/m^3, calculate individual hydrocarbon concentrations in accordance with the instructions in Paragraph 7.7.5.5 below.

7.7.4 Individual C7-C16 n-Alkane Equivalent Analysis: The required data from the analyses are on the chromatogram and on the data sheet. The data reduction is performed as follows:

7.7.4.1 Sum the areas of peaks in the proper retention time ranges.

7.7.4.2 Convert areas (uV·sec) to ng/uL by dividing by the proper weight response (uV·sec·uL/ng).

7.7.4.3 Multiply each weight by total concentrate volume (10 mL) to get weight of species in each range of the sample.

7.7.4.4 Using the volume of gas sampled on the total weight of sample acquired, convert the result of Step 7.7.4.3 above to ug/m^3.

8.0 QUALITY CONTROL

8.1 Appropriate QC is found in the pertinent procedures throughout the method.

9.0 METHOD PERFORMANCE

9.1 Even relatively comprehensive error propagation analysis is beyond the scope of this procedure. With reasonable care, peak area reproducibility of a standard should be of the order of 1% RSD. The relative standard deviation of the sum of all peaks in a fairly complex waste might be of the order of 5-10%. Accuracy is more difficult to assess. With good analytical technique, accuracy and precision should be of the order of 10-20%.

10.0 REFERENCES

1. Emissions Assessment of Conventional Stationary Combustion Systems: Methods and Procedure Manual for Sampling and Analysis, Interagency Energy/Environmental R&D Program, Industrial Environmental Research Laboratory, Research Triangle Park, NC 27711, EPA-600/7-79-029a, January 1979.

PM-10 Emissions and Particle Size Testing

Three (3) determinations of the PM-10 concentration and the flyash particle size distribution were performed at both the stack and the ESP Inlet test locations. The proposed methodologies for each of the two test locations are necessarily different and are described below in detail.

Stack

The PM-10 concentration and the size distribution were determined in accordance with EPA's interim "Guidelines for Source Testing for Size Specific Particulate Emissions," (1) using an inertial cascade impactor currently manufactured by Anderson 2000 Inc., the exact model of which is known as "Flow Sensor."

The Flow Sensor impactor is a high flow rate (10-30 LPM) eight-stage cascade impactor which is equipped with a special high capacity preimpactor to collect particles approximately 10 microns and larger (50% cut point at 0.6 ACFM). This preimpactor has an inlet which is at 90 degrees to the exit.

Since the complete size distribution is required as well as the PM-10 concentration, the entire cascade impactor with the preimpactor is used in conjunction with an EPA Method 5 sampling train except that the final filter and its support are removed from the impactor.

The preimpactor and cascade impactor is attached to the in-stack end of the probe. The classifier is equipped with the appropriate "straight" type nozzle and nozzle plug and inserted into the stack gas to preheat for a 20-minute period to prevent condensation prior to initiating sampling. The exact nozzle diameter is selected based on a pretest velocity traverse.

A simple four point sampling grid is used. If the velocities at the four traverse points are ± 20% of one another, one sampler is used to sample each of the four grid points. Otherwise a separate sample is required for each traverse point which does not fall in the ± 20% velocity range. Experience has shown that this requirement is not as stringent as it appears and one sampler can usually be used for all four points.

(1) PM-10 SIP Development Guideline USEPA EPA-450/2-86-001, June 1987: Appendix C.

The velocity pressure, stack gas temperature, moisture content and static pressure for each traverse point from a preliminary test is used together with the impactor 50% cut point curves to select the appropriate nozzle required to give isokinetic sampling with the desired 50% cut points. If the site meets the ± 20% velocity requirements, sampling is initiated after a 20 minute warm up period by uncapping the nozzle and positioning the in-situ impactor nozzle at the first traverse point. The pump is activated and the flow is rapidly adjusted using the calibrated orifice to the desired rate. The data recording by the operator during the test is identical tc that for Method 5 sampling except that the flow rate is held constant. Sampling is continued until all four points are sampled.

After sampling is complete, the coarse valve is closed, the pump turned off and the probe withdrawn from the stack. The preimpactor sample is recovered in the field and the impactor catch is returned in tact to the laboratory for gravimetric analysis. The Method 5 Sampling train is also processed up and through the glass fiber filter since the in-stack filter in the impactor is not being used. The EPA Method 5 probe rinse and filter catch are then substituted for the impactor filter catch in the calculations.

The impactor may be operated with bare collection plates or with a coating. The PM-10 Guidelines recommends that a coating be used. A very light film of high temperature silicone grease is applied to each stage before conditioning and weighing. Chemical reactions can occur with this coating which could alter the apparent weight collected by each stage. A control sampling of the same duration is run with an in-stack filter assembly in place of the preimpactor. The instack filter is discarded at the end of the run. The control sample is collected and processed in an identical manner as the other impactor samplings. The change in weight in the stages in the control run is then used to correct the subsequent determinations.

Impactors are not designed in a manner such that they will meet a Method 5 leak check, nor need they be. The maximum pressure drop across the housing is only a few hundredths IN.WC. since the flow has free access to the inside of the impactor through the open nozzle. For this reason, the pre- and post test leak checks are conducted prior to and after removing the impactor assembly from the end of the probe. The standard EPA Method 5 leak specifications are then used for this portion of the sampling train.

Inlet

The particle size distribution of the flyash aerosol at the inlet to the electrostatic precipitator is very broad and the loading is quite high. A cascade impactor will not provide accurate data in this application due to rapid overloading and subsequent particle bounce off resulting in a biased size distribution. Fifteen years of development at Interpoll Laboratories, has however, resulted in a technique which has proven to be extremely accurate and reliable and has been used successfully for hundreds of studies involving dust collector selection and sizing and dust collector performance diagnostics.

This method relies on a modified Method 17 collection of the flyash aerosol. In place of the standard Method 17 filter holder, an all stainless steel thimble filter holder is used. The actual filter medium is an all stainless steel filter thimble which is manufactured from bundled stainless steel microfibers. The surface of the thimble is very smooth, and thus near quantitative recovery of the collected flyash is easily accomplished by tapping the thimble on any solid surface. The mechanical shock breaks the filter cake much like the shakers of pulse jets on a fabric filter.

The recovered flyash sample is examined by stereozoom microscopy to get some estimate of the particle size range. A representative aliquot is then taken and sized by X-ray Sedigraph in the range of 0.5 - 60 microns as per the below described test protocol. If particles larger than 60 microns are present, the sample is wet sieved (acetone) to allow classification of the >60 micron portion of the sample. The results of this classification and the X-ray Sedigraph analysis are then mathematically recombined to provide a complete size distribution profile.

The X-ray Sedigraph is calibrated monthly with a garnet standard to ensure accuracy. In seven years, no shift in particle size has been noted in this quality assurance step. The results of the X-ray Sedigraph-determined size distribution are compared with the microscopic observation to ensure the accuracy of the analysis and to determine whether the redispersion in the sedimentation liquid was complete. In the case of flyash samples, redispersion has not been a problem in the more than five hundred samples analyzed. Other aerosols such as food products and/or resinous materials cannot be accurately sized by this method but this is readily determined apriori by several simple tests.

In order that the data from the ESP inlet and outlet be directly comparable, a density of 1.0 g/cc will be assigned to the flyash aerosol at the inlet test location so that the data can be reported as

aerodynamic equivalent diameters. The Sedigraph analysis is performed using Sedisperse A-11 as a sedimentation liquid, a hydrocarbon liquid with known density and viscosity designed for optimal redispersion.

The principle on which this method of particle size analysis is based is the differing terminal settling velocities of particles of different sizes as described by Stoke's Law. A polydisperse powder or particulate sample is homogeneously dispersed in a specially designed cell in a liquid of lesser density. Constant agitation is maintained until the sedimentation process is allowed to begin. The progression of the sedimentation is then followed by means of a finely collimated x-ray beam, the attenuation of which is mathematically relatable to the concentration of particulate material in the path of the beam (particles larger than a certain size are removed by sedimentation thus lowering the mass concentration). In order to shorten the analysis time, the cell is moved downward through the x-ray beam such that the effective sedimentation height is decreased at a rate inversely proportional to the analysis time. The net effect of this is to decrease the effective sedimentation times such that a typical analysis in water for particles of density 2.6 g/cc in a size range of 50 to 0.18 microns can be performed in about 100 minutes.

In the actual analysis, a particulate or powder sample with known or assigned density is dispersed in a sedimentation liquid with a known viscosity and density. The beaker containing the dispersed sample is placed in a compartment in the x-ray Sedigraph where a stirrer is used to keep the sample dispersed during the loading operation. A built-in peristatic pump provides sample circulation into the sample cell. A calculation is then performed to determine the rate setting of the instrument which is a function of the density of the sample and the density and viscosity of the sedimentation liquid. The instrument is then set to automatically control the cell movement and the position of the pen on the X-axis of the X-Y recorder such that the instantaneous concentration is recorded at the proper equivalent spherical diameter corresponding to the elapsed time and instantaneous sedimentation depth.

During the analysis, a scintillation detector monitors the x-ray intensity transmitted through the sample cell producing a current proportional to the logarithm of the x-ray intensity. A net output signal is generated when the cell is filled with sample which is directly proportional to the particle concentration at the depth of the x-ray beam. The signal which is then fed to the X-Y recorder positions the pen along the Y-axis to show percent concentration. Zero percent indicates pure liquid with no suspended particles while 100 percent cor-

responds to the starting concentration in the cell before sedimentation is allowed to occur. The size distribution (100 to .01 micrometers) is automatically graphed on 3-cycle semi-log chart paper.

The sample compartment is maintained at constant temperature by built-in heaters and proportional temperature control circuitry to maintain constant density and viscosity in the sedimentation liquid. This close temperature control together with the reduced time of analysis allow reliable analysis down to submicron particle diameters.

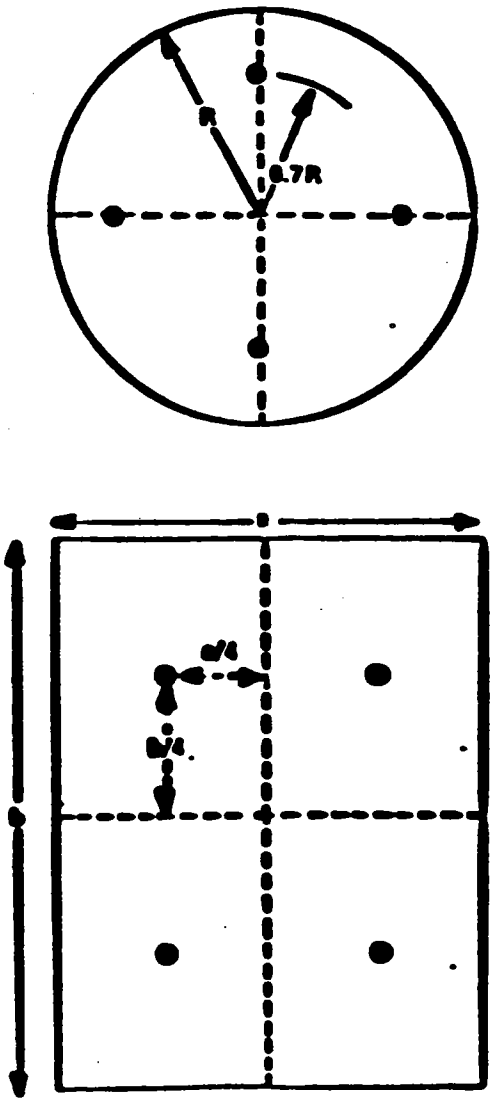

FIGURE 1. RECOMMENDED SAMPLING POINTS FOR CIRCULAR AND SQUARE OR RECTANGULAR DUCTS.

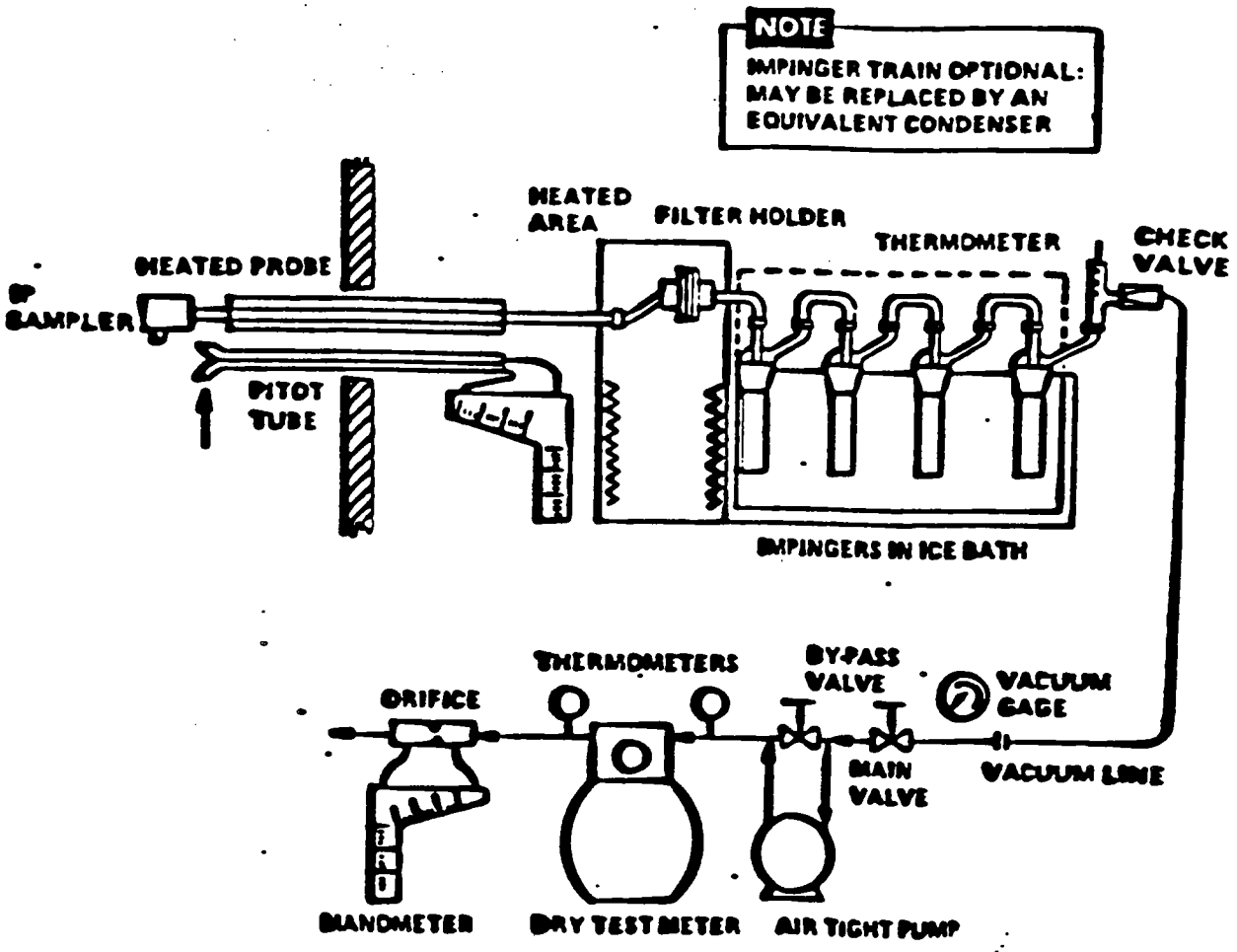

FIGURE 2. PM 10 PARTICULATE SAMPLING TRAIN FOR CONDENSIBLE AND NONCONDENSIBLE PARTICULATE (MODIFIED EPA METHOD 5 TRAIN).

TABLE II

50% EFFECTIVE CUT DIAMETER, μ
PARTICLE DENSITY - 1.0 gm/cm^3

FLOW ACFM	PREIMPACTOR	STAGE NO. 1	STAGE NO. 2	STAGE NO. 3	STAGE NO. 4	STAGE NO. 5	STAGE NO. 6	STAGE NO. 7
				AIR TEMP = 70.0°F				
0.1	24.3	15.6	9.8	6.3	3.8	2.5	1.7	0.95
0.2	17.2	11.0	7.0	4.5	2.7	1.8	1.1	0.66
0.3	14.0	9.0	5.6	3.6	2.2	1.4	0.92	0.53
0.4	12.2	7.8	4.9	3.1	1.9	1.2	0.78	0.45
0.5	11.0	7.0	4.4	2.8	1.7	1.1	0.70	0.40
0.6	10.0	6.4	4.0	2.6	1.6	1.0	0.64	0.36
0.7	9.2	6.0	3.7	2.4	1.4	0.92	0.58	0.33
0.75	9.0	5.7	3.6	2.3	1.4	0.89	0.56	0.32
				AIR TEMP = 150°F				
0.1	25.6	17.0	10.6	6.8	4.2	2.8	1.7	1.0
0.2	18.2	11.8	7.5	4.8	2.9	2.0	1.2	0.70
0.3	15.0	9.6	6.1	3.9	2.4	1.6	0.96	0.55
0.4	13.0	8.2	5.2	3.4	2.0	1.4	0.84	0.47
0.5	11.7	7.4	4.7	3.0	1.8	1.2	0.74	0.42
0.6	10.6	6.7	4.3	2.7	1.6	1.1	0.66	0.38
0.7	9.8	6.2	4.0	2.5	1.5	1.0	0.62	0.35
0.75	9.5	6.0	3.8	2.4	1.4	0.96	0.59	0.33
				AIR TEMP = 300°F				
0.1	28.1	18.0	11.3	7.2	4.7	3.1	1.8	1.1
0.2	20.0	13.0	8.1	5.2	3.2	2.3	1.3	0.76
0.3	16.2	10.3	6.6	4.2	2.6	1.7	1.0	0.60
0.4	14.2	9.0	5.7	3.6	2.3	1.5	0.90	0.52
0.5	12.8	8.1	5.1	3.2	2.0	1.3	0.80	0.46
0.6	11.6	7.4	4.7	2.9	1.8	1.2	0.73	0.44
0.7	10.8	6.8	4.3	2.7	1.7	1.1	0.67	0.39
0.75	10.5	6.6	4.2	2.6	1.6	1.0	0.65	0.37

(TABLE continued...)

TABLE II (continued)

AIR TEMP = 500°F								
0.1	31.0	20.0	11.9	8.0	4.8	3.3	2.1	1.2
0.2	22.0	14.0	8.7	5.6	3.4	2.3	1.5	0.83
0.3	17.8	11.4	7.1	4.5	2.7	1.8	1.2	0.66
0.4	15.3	9.8	6.1	3.9	2.4	1.6	1.0	0.56
0.5	13.9	8.8	5.5	3.5	2.1.	1.4	0.89	0.50
0.6	12.5	8.0	5.0	3.2	1.9	1.3	0.80	0.45
0.7	11.5	7.4	4.6	2.9	1.8	1.2	0.74	0.42
0.75	11.2	7.2	4.4	2.8	1.7	1.1	0.71	0.40
AIR TEMP = 1000°F								
0.1	34.6	22.2	14.0	9.0	5.4	3.6	2.3	1.4
0.2	24.6	15.7	9.8	6.3	3.8	2.6	1.6	0.94
0.3	20.0	12.8	8.0	5.2	3.2	2.1	1.3	0.75
0.4	17.2	11.0	6.9	4.5	2.7	1.8	1.1	0.64
0.5	15.6	9.9	6.2	4.0	2.4	1.6	1.0	0.57
0.6	10.4	9.0	5.6	3.6	2.2	1.5	0.91	0.52
0.7	10.3	8.3	5.2	3.4	2.0	1.4	0.84	0.47
0.75	10.3	8.0	5.0	3.3	2.0	1.3	0.80	0.46

APPENDIX Q

CALCULATION EQUATIONS

CALCULATION EQUATIONS

METHOD 2

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

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

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

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

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

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

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

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

CALCULATION EQUATIONS

METHOD 3

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

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

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

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

CALCULATION EQUATIONS

METHOD 5

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

γ = Dry test meter correction coefficient, dimensionless

ρ = Actual gas density, LB/ACF

CALCULATION EQUATIONS

METHOD 6

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

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

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

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

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

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

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

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

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

SYMBOLS

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

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

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

T_m = Absolute average dry gas meter temperature, ^oR

V_a = Volume of sample aliquot titrated, cc

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

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

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

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

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

CALCULATION EQUATIONS

METHOD 7

$$V_{m(std)} = 17.64\ (V_f - 25)\ \left[\frac{P_f}{T_f} - \frac{P_i}{T_i}\right]$$

$$C_s = 6.243 \times 10^{-5}\ \frac{M}{V_{m(std)}}$$

$$E = \frac{2090\ C_s F}{20.9 - \bar{B}'_{O_2}}$$

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

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

$$C_s\ (ppm\text{-}dry) = 8.37552 \times 10^{6}\ C_s$$

$$C_s\ (ppm\text{-}3\%\ O_2) = 8.37552 \times 10^{6}\ C_s \left\{1 + \left[\frac{\bar{B}'_{O_2} - 3}{20.9 - \bar{B}'_{O_2}}\right]\right\}$$

$$C_s\ (ppm\text{-}wet) = 8.37552 \times 10^{6}\ C_s \left(1 - \frac{MC}{100}\right)$$

CE6-1

SYMBOLS

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

C_s = Concentration of nitrogen oxides in flue gas, dry basis, corrected to standard conditions, LB/DSCF

C_s (GR/DSCF) = Concentration of nitrogen oxides in flue gas, dry basis, corrected to standard conditions, GR/DSCF

C_s (MG/DSCM) = Concentration of nitrogen oxides in flue gas, dry basis, corrected to standard conditions, MG/DSCM

E = Emission factor, LB/10^6BTU

F = F-Factor for given fuel type, DSCF/10^6BTU

M = Mass of nitrogen oxides as nitrogen dioxide in gas sample, µg

MC = Moisture content of flue gas, %

P_f = Final absolute pressure in flask, IN. HG

P_i = Initial absolute pressure in flask, IN. HG

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

C_s (ppm-3% O_2) = Concentration of nitrogen oxides in flue gas, dry basis, corrected to 3% O_2 , (v/v) ppm

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

T_f = Final absolute temperature in flask, ^{o}R

T_i = Initial absolute temperature in flask, ^{o}R

V_f = Volume of flask and valve, cc

$V_{m(std)}$ = Sample volume at standard conditions, dry basis, cc

CALCULATION EQUATIONS

Calculation Equations for Gas Concentrations

Dry Standard Volume (V_{std})

$$V_{std} = \frac{17.65\ V_m\ \gamma\ P_b}{(\bar{t}_m + 460)}$$

where; V_m = volume of gas as recorded on dry test meter in CF

γ = correction coefficient of dry test meter derived from calibration against standard wet test meter, dimensionless

P_b = barometric pressure in IN. HG.

$\bar{t}_m$ = average temperature of gas in dry test meter in ^oF

Gas Concentration of Component i (C_i)

$$C_i = \frac{.03531\ m_i\ K_i}{V_{std}}$$

where; C_i = concentration of gas in MG/DSCM

m_i = total amount of corresponding ion in the collected samples as reported by laboratory in µg.

K_i = stoichiometric conversion from ion to gas for component i ($K_{i=HF} = 1.05306$, $K_{i=HCl} = 1.02843$, $K_{i=H_2SO_4} = 1.02099$, $K_{i=NH_3} = 0.94412$)

Gas Concentration in GR/DSCF

$$GR/DSCF = 4.3705 \times 10^{-4} C_i$$

Gas Concentration in PPM-DRY

$$PPM\text{-}DRY = \frac{24.04\ C_i}{M_i}$$

where: M_i = molecular weight of component or gas i
($M_{i=HF} = 20.006$, $M_{i=HCl} = 36.461$, $M_{i=H_2SO_4} = 98.076$,
$M_{i=NH_3} = 17.031$)

Gas Emission or Mass Rate ($\dot{m}_i$)

$$\dot{m}_i = 8.5714 \times 10^{-3} (GR/DSCF)(Q_{s,d})$$

where: $\dot{m}_i$ = mass or emission rate of gas i in LB/HR

GR/DSCF = concentration of gas i in GR/DSCF, and

$Q_{s,d}$ = dry standard volumetric flow rate at point of concentration measurement in DSCFM

CALCULATION EQUATIONS

METHOD 10

$$CO\cdot PPM\cdot DRY = CO_{CO_2\text{-free,dry,avg}} \left(1 - CO_{2,d}/100\right)$$

$$CO\cdot PPM\cdot WET = CO\cdot PPM\cdot DRY \left(1 - MC/100\right)$$

$$GR/DSCF = 5.0885 \times 10^{-4} \left(CO\cdot PPM\cdot DRY\right)$$

$$mg/dscm = 1.165 \left(CO\cdot PPM\cdot DRY\right)$$

$$\dot{m} = 8.5714 \times 10^{-3} \left(GR/DSCF\right)\left(Q_{s,d}\right)$$

$$E = \frac{2.9857 \times 10^{-3} F_d \left(GR/DSCF\right)}{20.9 - O_{2,d}}$$

Where

$CO_{CO_2\text{-free,dry,avg}}$ = average of two determinations of carbon monoxide on a dry, CO_2-free integrated flue gas sample reported in ppm by volume

$CO_{2,d}$ = carbon dioxide concentration of flue gas on a dry percent by volume basis

$O_{2,d}$ = oxygen concentration of flue gas on a dry percent by volume basis

MC	= moisture content of flue gas on a percent by volume basis
CO•PPM•DRY	= carbon monoxide concentration in ppm by volume on a dry basis
CO•PPM•WET	= carbon monoxide concentration in ppm by volume on a wet or actual basis
GR/DSCF	= concentration of carbon monoxide in flue gas on a grains per dry standard cubic foot basis (68 ^{O}F, 29.92 IN.HG.)
mg/dscm	= concentration of carbon monoxide in flue gas on a milligrams per dry standard cubic meter basis (60 ^{O}F, 29.92 IN.HG.)
$\dot{m}$	= emission or mass rate of carbon monoxide on a LB/HR basis
$Q_{s,d}$	= volumetric flow rate of flue gas in dry standard cubic feet per minute
E	= emission factor of carbon monoxide in pounds of carbon monoxide emitted per million BTU heat input (LB/MMBTU)
F_d	= F-Factor of respective fuel in dry standard cubic feet of exhaust gas at 0% oxygen per million BTU of heat input (DSCF/MMBTU)

Field Blank-Based MDL Rather Than Analytical MDL

In those cases when the pollutant is not present in the gas stream, the samples may be less than or almost equal to the field blank. Under these circumstances the best estimate of the minimum detectable mass of analyte in the sample is not the analytical minimum detectable mass (MDL), rather the minimum detectable mass of analyte in the sample is estimated from a statistical analysis of the field blank and the field samples closely approximating or less than the mass of the analyte in the field blank. The best estimate of the true field blank is taken to be the average of the field blank and those field samples which closely approximate the field blank. The standard deviation of the "field blank samples" is then calculated. The minimum detectable mass of analyte in the sample is then reported as 3 times this standard deviation.

APPENDIX R

CHAIN OF CUSTODY SHEETS

Interpoll Laboratories
(612)786-6020

Field Sample Chain Of Custody Sheet

Job USP RED WING

Date of Sampling 3-21-88 Site UNIT 2 ESP INLET

Test 1 Runs 1,2,3 Team Leader John F. Burgess + Ron Rosenthal

Type of Sample Train: M-5

Sample Collection/Recovery

Person performing sample recovery:

Signature John F. Burgess Title FT ENGINEER

Location at which recovery was done ON site

Special transport/storage requirements? ———

	Sample Description	No. of Items	Assigned Log Number
1.	T1 R0 Glass Fiber Filter #	1	5978-01
2.	T1 R0 Probe Wash Blank	1	-02
3.	T1 R0 Wet catch Blank	1	-03
4.	T1 R1 Glass Fiber Filter # 0078	1	-04
5.	T1 R1 Probe Wash	1	-05
6.	T1 R1 Wet catch	1	-06
7.	T1 R2 Glass Fiber Filter # 0079	1	-07
8.	T1 R2 Probe Wash	1	-08
9.	T1 R2 Wet catch	1	-09
10.	T1 R3 Glass Fiber Filter # 0080	1	-10
11.	T1 R3 Probe Wash	1	-11
12.	T1 R3 Wet catch	1	-12
13.	T1 R1,2,3 Int. ORSAT	3	-13, 14, 15
14.			
15.			
16.			
17.			
18.			

Sample Transport

Method of transport IVECO TRUCK

Recipient of samples upon recovery (if not recovery person):

Signature _____ Title _____

Date of receipt _____ Time of receipt _____ HRS

S-0157RR-1

Sample Check-In at Interpoll Labs

Laboratory person receiving samples:
Signature Timothy Title Lab Analyst
Date of receipt 3-27-88 Time of receipt 1030 HRS
Sample storage location walk in cooler
Special storage conditions? _____

Analysis

	Sample Log No.	Date of Analysis	Method of Analysis	Initials of Analyst
1.	5978-01	3-28-88	EPA m-5	
2.	-02			
3.	-03			
4.	-04			
5.	-05			
6.	-06			
7.	-07			
8.	-08			
9.	-09			
10.	-10			
11.	-11			
12.	-12			
13.	-13	3-24-88	EPA m-3	
14.	-14		"	
15.	-15		"	
16.				
17.				
18.				

Signature of each analyst:

Initials	Signature
	Timothy Title Donald

S-0157RR-2

Interpoll Laboratories
(612)786-6020

Field Sample Chain Of Custody Sheet

Job NSP RED WING

Date of Sampling 3-24-88 Site UNIT 2 Outlet

Test 2 Run 1,2,3 Team Leader J BURESH + R. Rosenthal

Type of Sample Train: Acid Gas

Sample Collection/Recovery

Person performing sample recovery:

Signature [signature] Title PT ENGINEER

Location at which recovery was done ON SITE

Special transport/storage requirements? ———

	Sample Description	No. of Items	Assigned Log Number
1.	T_2R_0 Wet Catch Blank	1	5978-28
2.	T_2R_1 Wet Catch in .1N NaOH	1	-29
3.	T_2R_2 Wet Catch in .1N NaOH	1	-30
4.	T_2R_3 Wet Catch in .1N NaOH	1	-31
5.	$T_2R_{1,2,3}$ INT ORSAT	3	-32,33,34
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			
16.			
17.			
18.			

Sample Transport

Method of transport ———

Recipient of samples upon recovery (if not recovery person):

Signature ——— Title ———

Date of receipt ——— Time of receipt ——— HRS

S-0157RR-1

Sample Check-In at Interpoll Labs

Laboratory person receiving samples:
Signature Timothy Tolbert Title LAB analyst
Date of receipt 3-27-88 Time of receipt 1030 HRS
Sample storage location Walk in Cooler
Special storage conditions? _____

Analysis

	Sample Log No.	Date of Analysis	Method of Analysis	Initials of Analyst
1.	5978-28	4-1-88	EPA-300.1	BD
2.	-29	↓	↓	BD
3.	-30	↓	↓	BD
4.	-31	↓	↓	BD
5.	-32	3-24-88	EPA-m-3	TT
6.	-33	"	"	TT
7.	-34	"	"	TT
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				

Signature of each analyst:

Initials	Signature
BD	Bruce A Dyer
TT	Timothy Tolbert

S-0157RR-2

Interpoll Laboratories
(612)786-6020

Field Sample Chain Of Custody Sheet

Job NSP REDWING

Date of Sampling 3-22-88 Site UNIT 2 ESP INLET

Test 3 Run 1, 2, 3. Team Leader John Burosh + Ron Rosenthal

Type of Sample Train: 4 ~~M~~M-5

Sample Collection/Recovery

Person performing sample recovery:

Signature [signature] Title FT ENGINEER

Location at which recovery was done on site

Special transport/storage requirements? —

	Sample Description	No. of Items	Assigned Log Number
1.	T_3R_0 Glass Fiber Filter # 0103	1	5978- 35
2.	T_3R_0 Probe Wash	1	-36
3.	T_3R_0 Impingers 1-2	1	-37
4.	T_3R_0 Impingers 3	1	-38
5.	T_3R_1 Glass Fiber Filter # 0081	1	-39
6.	T_3R_1 Probe Wash	1	-40
7.	T_3R_1 Impingers 1-2	1	-41
8.	T_3R_1 Impinger #3	1	-42
9.	T_3R_2 Glass Fiber Filter # 0082	1	-43
10.	T_3R_2 Probe Wash	1	-44
11.	T_3R_2 Impingers 1-2	1	-45
12.	T_3R_2 Impinger 3	1	-46
13.	T_3R_3 Glass Fiber Filter # 0099	1	-47
14.	T_3R_3 Probe Wash	1	-48
15.	T_3R_3 Impingers 1-2	1	-49
16.	T_3R_3 Impinger #3	1	-50
17.	$T_3R_{1,2,3}$ INTORSAT	3	-51, 52, 53
18.			

Sample Transport

Method of transport PUBLIC TRUCK

Recipient of samples upon recovery (if not recovery person):

Signature _____ Title _____

Date of receipt _____ Time of receipt _____ HRS

S-0157RR-1

Sample Check-In at Interpoll

Laboratory person receiving samples:
Signature Timothy Holliday Title Lab Analyst
Date of receipt 3-27-88 Time of receipt 1030 HRS
Sample storage location Secured Holding Area
Special storage conditions? —

Analysis

	Sample Log No.	Date of Analysis	Method of Analysis	Initials of Analyst
1.	5978-35	4-12-88	AA/GF EPA m-4MS	PMW
2.	36	4-12-88	〃	〃
3.	37	4-12-88	〃	〃
4.	38	4-6-88	AA/GV	〃
5.	39	4-12-88	AA/GF	〃
6.	40	〃	〃	〃
7.	41	〃	〃	〃
8.	42	4-6-88	AA/GV	〃
9.	43	4-12-88	AA/GF	〃
10.	44	〃	〃	〃
11.	45	〃	〃	〃
12.	46	4-6-88	AA/CV	〃
13.	47	4-12-88	AA/GF	〃
14.	48	〃	〃	〃
15.	49	〃	〃	〃
16.	50	4-6-88	AA/CV	〃
17.	51	3-26 to 4-6-88	EPA m-3	TH
18.	52	〃	〃	PMW
19	53	〃	〃	ED

Signature of each analyst:

Initials	Signature
ED PMW	Timothy Holliday
	Patrick M. Whitney

S-0157R-2

Interpoll Laboratories
(612)786-6020

Field Sample Chain Of Custody Sheet

Job NSP/Red Wing

Date of Sampling 3-22-88 Site UNIT #2 STACK

Test 3 Run 1-3 Team Leader Ron Rosenthal

Type of Sample Train: 4M-5 (METALS)

Sample Collection/Recovery

Person performing sample recovery:

Signature Ron Rosenthal Title Field Test Engineer

Location at which recovery was done STACK

Special transport/storage requirements? —

	Sample Description	No. of Items	Assigned Log Number
Test #3 1.	Run # 0 Filter Blank	1	5978-54
2.	Run # 0 PW Blank	1	-55
3.	Run # 0 Impinger #1&2 Catch Blank	1	-56
4.	Run # 0 Impinger 3&4 Catch Blank	1	-57
5.	Run #1 Filter	1	-58
6.	Run #1 PW	1	-59
7.	Run #1 Impinger #1&2 catch	1	-60
8.	Run #1 Impinger #3&4 catch	1	-61
9.	Run #2 Filter	1	-62
10.	Run #2 PW	1	-63
11.	Run #2 Impinger #1&2 Catch	1	-64
12.	Run #2 Impinger #3&4 Catch	1	-65
13.	Run #3 Filter	1	-66
14.	Run #3 PW	1	-67
15.	Run #3 Impinger #1&2 catch	1	-68
16.	Run #3 Impinger #3&4 Catch	1	-69
17.	Extra Reagent 5% HNO3/10% H2O2	1	-73
18.	1.5 KMnO4/10% HNO3	1	-74

Impinger #1&2 for all METALS
Impinger #3&4 for Hg

Sample Transport

Method of transport Company Truck #17

Recipient of samples upon recovery (if not recovery person):

Signature _____ Title _____

Date of receipt _____ Time of receipt _____ HRS

S-0157RR-1

Sample Check-In at Interpoll Labs

Laboratory person receiving samples:
Signature Timothy Fullerton Title LAB Analyst
Date of receipt 3-26-88 Time of receipt 1630 HRS
Sample storage location walk in Cooler
Special storage conditions? _____

Analysis

	Sample Log No.	Date of Analysis	Method of Analysis	Initials of Analyst
1.	5978 -54	4-12-88	AA/GF EPA M-4M5	PMW
2.	-55	↓	"	PMW
3.	-56	↓	"	PMW
4.	-57	4-6-88	AA/CV	PMW
5.	-58	4-12-88	AA/GF	PMW
6.	-59	↓	"	PMW
7.	-60	↓	"	PMW
8.	-61	4-6-88	AA/CV	PMW
9.	-62	4-12-88	AA/GF	PMW
10.	-63	↓	"	PMW
11.	-64	↓	"	PMW
12.	-65	4-6-88	AA/CV	PMW
13.	-66	4-12-88	AA/GF	PMW
14.	-67	↓	"	PMW
15.	-68	↓	"	PMW
16.	-69	4-6-88	AA/CV	PMW
17.	-73		Not analyzed	
18.	-74		" "	

Signature of each analyst:

Initials	Signature
PMW	Patrick M. Wallace

S-0157RR-2

Interpoll Laboratories
(612)786-6020

Field Sample Chain Of Custody Sheet

Job NSP REDWING

Date of Sampling 3-22-88 Site ESP Ash Conveyor

Test 3 Run 1,2,3 Team Leader

Type of Sample Train: N/A

Sample Collection/Recovery

Person performing sample recovery: see sheet

Signature Bob Evans on USP Title Test Coordinator

Location at which recovery was done ESP ASH conveyor

Special transport/storage requirements? Teflon Tape

	Sample Description	No. of Items	Assigned Log Number
1.	ESP ASH CONVEYOR 1A	1	5978-77
2.	" " 1B	1	-78
3.	" " 1C	1	-79
4.	" " 2A	1	-80
5.	" " 2B	1	-81
6.	" " 3A	1	-82
7.	" " 3B	1	-83
8.	Ash Composite	1	-206
9.	" "	1	-207
10.	" "	1	-208
11.			
12.			
13.			
14.			
15.			
16.			
17.			
18.			

Sample Transport

Method of transport TUECO

Recipient of samples upon recovery (if not recovery person):

Signature [signature] Title FIELD ENGINEER

Date of receipt 3-22-88 Time of receipt 1601 HRS

S-0157RR-1

Sample Check-In at Interpoll Labs

Laboratory person receiving samples:
Signature Timothy Fuller Title LAB Analyst
Date of receipt 3-27-88 Time of receipt 1030 HRS
Sample storage location Walk in cooler
Special storage conditions?

Analysis

	Sample Log No.	Date of Analysis	Method of Analysis	Initials of Analyst
1.	5976-77	3-30-88	Samples composited	PMW
2.	-78			
3.	-79			
4.	-80			
5.	-81			
6.	-82			
7.	-83			
8.	-206	4-12-88	AA/GF, Flame, CV	
9.	-207			
10.	-208			
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				

Signature of each analyst:

Initials	Signature
	Timothy Fuller
PMW	Patrick M. Woolsey

S-0157RR-2

Interpoll Laboratories
(612)786-6020

Field Sample Chain Of Custody Sheet

Job NSP RED WING

Date of Sampling 3-22-88 Site ESP INLET

Test 4 Run 0 Team Leader JBURESH + R ROSENTHAL

Type of Sample Train: MM-5

Sample Collection/Recovery

Person performing sample recovery:

Signature [signature] Title FT ENGINEER

Location at which recovery was done INTERPOLL FIELD LAB TRAILER

Special transport/storage requirements? TEFLON TAPE

	Sample Description	No. of Items	Assigned Log Number
Blank 1.	T4RO Glass Fiber Filter # 0102 1of4	1	5978 -84
Blank 2.	T4RO SOLVENT RINSE 2of4	1	-85
Blank 3.	T4RO XAD-2 RESIN 3of4	1	-86
Blank 4.	T4RO CONDENSATE TRAP 4of4	1	-87
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			
16.			
17.			
18.			

Sample Transport

Method of transport IVECO TRUCK

Recipient of samples upon recovery (if not recovery person):

Signature _____ Title _____

Date of receipt _____ Time of receipt _____ HRS

S-0157RR-1

Sample Check-In at Interpoll Labs

Laboratory person receiving samples:
Signature Timothy Fields III Title Lab Analyst
Date of receipt 3-22-88 Time of receipt 1030 HRS
Sample storage location Walk in cooler
Special storage conditions? _____

Analysis

	Sample Log No.	Date of Analysis	Method of Analysis	Initials of Analyst
1.	5978 -84			
2.	-85			
3.	-86			
4.	-87			
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				

Signature of each analyst:

Initials	Signature

S-0157RR-2

Interpoll Laboratories
(612)786-6020

Sample Custody Transfer Form

Job NSP/Red Wing Date 3-29-88

Interlaboratory transfer:
Person in custody of samples Timothy Zoller Donald Init. TZD
Person to receive custody _____ Init. _____

Out of laboratory transfer:
Date shipped 3-29-88 Date received 3/30/88
Method of shipment F. Express Carrier Air
Person releasing samples Timothy Zoller Donald Init. TZD
Person receiving custody Gerald Pitts Init. GP

	Sample Log Number	Initials of Person in Custody of Samples	Initials of Person Receiving Samples
1.	5778-84	TZD	GP
2.	-85	TZD	GP
3.	-86	TZD	GP
4.	-87	TZD	GP
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			
16.			
17.			
18.			

Field Blank 5
Inlet ESP

Storage Instructions: _____

Instructions for Receiving Laboratory:

1. Fill out form and return to Interpoll Laboratories.
2. Initiate your laboratory chain-of-custody. When analysis is complete, mail copy of your chain-of-custody documents with analytical results.
3. Store samples for four (4) months.

S-365

Interpoll Laboratories
(612)786-6020

Field Sample Chain Of Custody Sheet

Job NSP REDWING

Date of Sampling 3-23-88 Site UNIT 2 ESP INLET

Test 4 Run 1 Team Leader J BURESH + R. ROSENTHAL

Type of Sample Train: MM-5

Sample Collection/Recovery

Person performing sample recovery:

Signature John F. Buresh Title FT ENGINEER

Location at which recovery was done INTERPOLL FIELD LAB TRAILER

Special transport/storage requirements? TEFLON TAPE

	Sample Description		No. of Items	Assigned Log Number
1.	T_4R_1 Glass Fiber Filter # 01C4	1 of 4	1	5978 -89
2.	T_4R_2 Solvent Rinse	2 of 4	2	-89
3.	T_4R_3 XAD-2 RESIN	3 of 4	1	-90
4.	T_4R_4 Condensate Trap	4 of 4	1	-91
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				

Sample Transport

Method of transport IVECO TRUCK

Recipient of samples upon recovery (if not recovery person):

Signature _____ Title _____

Date of receipt _____ Time of receipt _____ HRS

S-0157RR-1

Sample Check-In at Interpoll Labs

Laboratory person receiving samples:

Signature Timothy Tollett Dell Title LAB Analyst

Date of receipt 3-26-88 Time of receipt 1030 HRS

Sample storage location walk in cooler

Special storage conditions? _____

Analysis

	Sample Log No.	Date of Analysis	Method of Analysis	Initials of Analyst
1.	5978 -88			
2.	-89			
3.	-90			
4.	-91			
5.				
6.				
7.				
8.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				

Signature of each analyst:

Initials	Signature

S-0157RR-2

Interpoll Laboratories
(612)786-6020

Sample Custody Transfer Form

Job NSP/Red Wing Date 3-23-88

Interlaboratory transfer:
Person in custody of samples Timothy Tollefsrud Init. TT
Person to receive custody _____ Init. _____

Out of laboratory transfer:
Date shipped 3-29-88 Date received 3/30/88
Method of shipment F. Expressed Carrier Air
Person releasing samples Timothy Tollefsrud Init. TT
Person receiving custody Gerald Pitts Init. GP

	Sample Log Number	Initials of Person in Custody of Samples	Initials of Person Receiving Samples
1.	5978-88	TT	GP
2.	-89	TT	GP
3.	-90	TT	GP
4.	-91	TT	GP
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			
16.			
17.			
18.			

T4
R1
Inlet ESP

Storage Instructions: _____

Instructions for Receiving Laboratory:

1. Fill out form and return to Interpoll Laboratories.
2. Initiate your laboratory chain-of-custody. When analysis is complete, mail copy of your chain-of-custody documents with analytical results.
3. Store samples for four (4) months.

S-365

Interpoll Laboratories
(612)786-6020

Field Sample Chain Of Custody Sheet

Job NSP REDWING

Date of Sampling 3-24,25-88 Site Unit 2 ESP Inlet

Test 4 Run 2 Team Leader Ron Rosenthal and John Buresh

Type of Sample Train: MM-5

Sample Collection/Recovery

Person performing sample recovery:

Signature [signature] Title FT ENGINEER

Location at which recovery was done Interpoll Field Lab Trailer

Special transport/storage requirements? Teflon Tape Seal

	Sample Description	No. of Items	Assigned Log Number
1.	T4R2 Glass Fiber Filters # 0105, 0107	2	5978-92
2.	T4R2 Solvent Rinse	1	-93
3.	T4R2 XAD-2 Resin	1	-94
4.	T4R2 Condensate Trap	1	-95
5.	T4R2 Impinger Catch	1	-96
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			
16.			
17.			
18.			

Sample Transport

Method of transport IUECO TRUCK

Recipient of samples upon recovery (if not recovery person):

Signature _____ Title _____

Date of receipt _____ Time of receipt _____ HRS

S-0157RR-1

Sample Check-In at Interpoll Labs

Laboratory person receiving samples:
Signature [signature] Title Lab Analyst
Date of receipt 3-27-88 Time of receipt 1030 HRS
Sample storage location Walk in Cooler
Special storage conditions? _____

Analysis

	Sample Log No.	Date of Analysis	Method of Analysis	Initials of Analyst
1.	5938-92			
2.	-93			
3.	-94			
4.	-95			
5.	-96			
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				

Signature of each analyst:

Initials	Signature

S-0157RR-2

Interpoll Laboratories
(612)786-6020

Sample Custody Transfer Form

Job NSP/Red Wing Date 3-29-88

Interlaboratory transfer:
Person in custody of samples [signature] Init. [initials]
Person to receive custody _____ Init. _____

Out of laboratory transfer:
Date shipped 3-29-88 Date received 3/30/88
Method of shipment Air Carrier F. Express
Person releasing samples [signature] Init. [initials]
Person receiving custody [signature] Init. [initials]

Test 4
Run 2
Inlet
ESP

	Sample Log Number	Initials of Person in Custody of Samples	Initials of Person Receiving Samples
1.	5978-92	[initials]	[initials]
2.	-93	[initials]	[initials]
3.	-94	[initials]	[initials]
4.	-95	[initials]	[initials]
5.	-96	[initials]	[initials]
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			
16.			
17.			
18.			

Storage Instructions: _____

Instructions for Receiving Laboratory:

1. Fill out form and return to Interpoll Laboratories.
2. Initiate your laboratory chain-of-custody. When analysis is complete, mail copy of your chain-of-custody documents with analytical results.
3. Store samples for four (4) months.

S-365

Interpoll Laboratories
(612)786-6020

Field Sample Chain Of Custody Sheet

Job NSP REDWING

Date of Sampling 3-25-88 Site UNIT 2 ESP INLET

Test 4 Run 3 Team Leader R.ROSENTHAL & J.BURGESS

Type of Sample Train: _____

Sample Collection/Recovery

Person performing sample recovery:

Signature John R. Jurek Title FT ENGINEER

Location at which recovery was done INTERPOLL FIELD LAB TRAILER

Special transport/storage requirements? TEFLON TAPE SEAL

	Sample Description	No. of Items	Assigned Log Number
1.	T4R3 Glass Fiber Filter # 0108	1	5978 -97
2.	T4R3 SOLVENT RINSE	2	-98
3.	T4R3 XAD-2 RESIN	1	-99
4.	T4R3 CONDENSATE TRAP	1	-100
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			
16.			
17.			
18.			

Sample Transport

Method of transport DIECO

Recipient of samples upon recovery (if not recovery person):

Signature _____ Title _____

Date of receipt _____ Time of receipt _____ HRS

S-0157RR-1

Sample Check-In at Interpoll Labs

Laboratory person receiving samples:
Signature Timothy J. McDonald Title LAB analyst
Date of receipt 3-27-88 Time of receipt 1030 HRS
Sample storage location walk in cooler
Special storage conditions? _____

Analysis

	Sample Log No.	Date of Analysis	Method of Analysis	Initials of Analyst
1.	5978 -97			
2.	-98			
3.	-99			
4.	-100			
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				

Signature of each analyst:

Initials	Signature

S-0157RR-2

Interpoll Laboratories
(612)786-6020

Sample Custody Transfer Form

Job NSP/Red Wing Date 3-29-88

Interlaboratory transfer:
Person in custody of samples Timothy Fuller Init. TF
Person to receive custody _____ Init. _____

Out of laboratory transfer:
Date shipped 3-29-88 Date received 3/30/88
Method of shipment Air Carrier E. Express
Person releasing samples Timothy Fuller Init. TF
Person receiving custody Gerald Pitts Init. GP

Test 4 Run 3 ESP Inlet

	Sample Log Number	Initials of Person in Custody of Samples	Initials of Person Receiving Samples
1.	5975-97	TF	GP
2.	-98	TF	GP
3.	-99	TF	GP
4.	-100	TF	GP
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			
16.			
17.			
18.			

Storage Instructions: _____

Instructions for Receiving Laboratory:

1. Fill out form and return to Interpoll Laboratories.
2. Initiate your laboratory chain-of-custody. When analysis is complete, mail copy of your chain-of-custody documents with analytical results.
3. Store samples for four (4) months.

S-365

Interpoll Laboratories
(612)786-6020

Field Sample Chain Of Custody Sheet

Job NSP RED WING

Date of Sampling 3-22-88 Site UNIT 2 ESP OUTLET (STACK)

Test 4 Run 0 Team Leader J BURESH & R. ROSENTHAL

Type of Sample Train: MM-5

Sample Collection/Recovery

Person performing sample recovery:

Signature John F. Bureh Title FT ENGINEER

Location at which recovery was done INTERPOLL FIELD LAB TRAILER

Special transport/storage requirements? TEFLON TAPE

	Sample Description		No. of Items	Assigned Log Number
1.	T4RO Glass Fiber Filter 0101	1 of 4	1	5978 -104
2.	T4RO Solvent Rinse	2 of 4	1	-105
3.	T4RO XAD-2 Resin	3 of 4	1	-106
4.	T4RO Condensate Trap	4 of 4	1	-107
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				

Sample Transport

Method of transport IVECO TRUCK

Recipient of samples upon recovery (if not recovery person):

Signature _____ Title _____

Date of receipt _____ Time of receipt _____ HRS

S-0157RR-1

Sample Check-In at Interpoll Labs

Laboratory person receiving samples:
Signature Timothy Gold Title Lab Analyst
Date of receipt 3-27-88 Time of receipt 1030 HRS
Sample storage location walk in cooler
Special storage conditions? _____

Analysis

	Sample Log No.	Date of Analysis	Method of Analysis	Initials of Analyst
1.	5978-104			
2.	105			
3.	106			
4.	107			
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				

Signature of each analyst:

Initials	Signature

S-0157RR-2

Interpoll Laboratories
(612)786-6020

Sample Custody Transfer Form

Job NSP/Red Wing Date 5-29-88

Interlaboratory transfer:
Person in custody of samples [signature] Init. [initials]
Person to receive custody _____ Init. _____

Out of laboratory transfer:
Date shipped 3-29-88 Date received 3/30/88
Method of shipment Air Carrier Fed. Express
Person releasing samples [signature] Init. [initials]
Person receiving custody [signature] Init. [initials]

	Sample Log Number	Initials of Person in Custody of Samples	Initials of Person Receiving Samples
1.	5978-104	[initials]	[initials]
2.	-105	[initials]	[initials]
3.	-106	[initials]	[initials]
4.	-107	[initials]	[initials]
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			
16.			
17.			
18.			

Test 4 Run 0 Field Blank Stack 5

Storage Instructions: _____

Instructions for Receiving Laboratory:

1. Fill out form and return to Interpoll Laboratories.
2. Initiate your laboratory chain-of-custody. When analysis is complete, mail copy of your chain-of-custody documents with analytical results.
3. Store samples for four (4) months.

S-365

Interpoll Laboratories
(612)786-6020

Field Sample Chain Of Custody Sheet

Job NSP REDWING

Date of Sampling 3-23-88 Site UNIT 2 ESP OUTLET (STACK)

Test 4 Run 1 Team Leader JBUREESH & RROSENTHAL

Type of Sample Train: MM-5

Sample Collection/Recovery

Person performing sample recovery:

Signature [signature] Title FT ENGINEER

Location at which recovery was done INTERPOL FIELD LAB TRAILER

Special transport/storage requirements? TEFLON TAPE

	Sample Description		No. of Items	Assigned Log Number
1.	T4R1 Glass Fiber Filter #0102	1of4	1	5978 - 103
2.	T4R1 Solvent Rinse	2of4	1	-109
3.	T4R1 XAD-2 Resin	3of4	1	-110
4.	T4R1 Condensate Trap	4of4	1	-111
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				

Sample Transport

Method of transport _____

Recipient of samples upon recovery (if not recovery person):

Signature _____ Title _____

Date of receipt _____ Time of receipt _____ HRS

S-0157RR-1

Sample Check-In at Interpoll Labs

Laboratory person receiving samples:
Signature Timothy Hall Title LAB analyst
Date of receipt 3/27/88 Time of receipt 1030 HRS
Sample storage location Walk in Cooler
Special storage conditions? _____

Analysis

	Sample Log No.	Date of Analysis	Method of Analysis	Initials of Analyst
1.	5978-108			
2.	-109			
3.	-110			
4.	-111			
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				

Signature of each analyst:

Initials	Signature

S-0157RR-2

Interpoll Laboratories
(612)786-6020

Sample Custody Transfer Form

Job NSP/Red Wing Date 3-29-88

Interlaboratory transfer:
Person in custody of samples Timothy Tollefsrud Init. TT
Person to receive custody _____ Init. _____

Out of laboratory transfer:
Date shipped 3-29-88 Date received 3/30/88
Method of shipment Air Carrier Fed. Express
Person releasing samples Timothy Tollefsrud Init. TT
Person receiving custody Harold Pilley Init. HP

Test 4 Run 1 Stack

	Sample Log Number	Initials of Person in Custody of Samples	Initials of Person Receiving Samples
1.	5978-108	TT	HP
2.	-109	TT	HP
3.	-110	TT	HP
4.	-111	TT	HP
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			
16.			
17.			
18.			

Storage Instructions: _____

Instructions for Receiving Laboratory:

1. Fill out form and return to Interpoll Laboratories.
2. Initiate your laboratory chain-of-custody. When analysis is complete, mail copy of your chain-of-custody documents with analytical results.
3. Store samples for four (4) months.

S-365

Interpoll Laboratories
(612)786-6020

Field Sample Chain Of Custody Sheet

Job NSP REDWING

Date of Sampling 3-24,25-88 Site UNIT 2 Outlet stack

Test 4 Run 2 Team Leader Ron Rosenthal + John Bureck

Type of Sample Train: MM-5

Sample Collection/Recovery

Person performing sample recovery:

Signature John F. Bureck Title FT ENGINEER

Location at which recovery was done Interpoll Field Lab Trailer

Special transport/storage requirements? Teflon Tape Seal

	Sample Description	No. of Items	Assigned Log Number
1.	T4R2 Glass fiber filter #0106	1	5978-117
2.	T4R2 Solvent Rinse	1	-118
3.	T4R2 XAD-2 RESIN	1	-119
4.	T4R2 Condensate TRAP	1	-120
5.	T4R2 IMPINGER CATCH	1	-121
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			
16.			
17.			
18.			

Sample Transport

Method of transport IVECO Truck

Recipient of samples upon recovery (if not recovery person):

Signature _____ Title _____

Date of receipt _____ Time of receipt _____ HRS

S-0157RR-1

Sample Check-In at Interpoll Labs

Laboratory person receiving samples:
Signature [signature] Title LAB Analyst
Date of receipt 3-27-88 Time of receipt 1030 HRS
Sample storage location Walk in Cooler
Special storage conditions? _____

Analysis

	Sample Log No.	Date of Analysis	Method of Analysis	Initials of Analyst
1.	5978 -117			
2.	-118			
3.	-119			
4.	-120			
5.	-121			
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				

Signature of each analyst:

Initials	Signature

S-0157RR-2

Interpoll Laboratories
(612)786-6020

Sample Custody Transfer Form

Job USP/Red Wing Date 3-29-88

Interlaboratory transfer:
Person in custody of samples [signature] Init. [initials]
Person to receive custody _____ Init. _____

Out of laboratory transfer:
Date shipped 3-29-88 Date received 3/30/88
Method of shipment Air Carrier Fed Express
Person releasing samples [signature] Init. [initials]
Person receiving custody Gerald Pitts Init. GP

	Sample Log Number	Initials of Person in Custody of Samples	Initials of Person Receiving Samples
1.	5978 -117	[initials]	GP
2.	-118	[initials]	GP
3.	-119	[initials]	GP
4.	-120	[initials]	GP
5.	-121	[initials]	GP
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			
16.			
17.			
18.			

Test 4 Run 2 Stack

Storage Instructions: _____

Instructions for Receiving Laboratory:

1. Fill out form and return to Interpoll Laboratories.
2. Initiate your laboratory chain-of-custody. When analysis is complete, mail copy of your chain-of-custody documents with analytical results.
3. Store samples for four (4) months.

S-365

Interpoll Laboratories
(612)786-6020

Field Sample Chain Of Custody Sheet

Job NSP REDWING

Date of Sampling 3-25-88 Site UNIT 2 OUTLET

Test 4 Run 3 Team Leader R. Rosenthal + J. BURESH

Type of Sample Train: MM-5

Sample Collection/Recovery

Person performing sample recovery:

Signature [signature] Title FT ENGINEER

Location at which recovery was done INTERPOLL FIELD LAB TRAILER

Special transport/storage requirements?

	Sample Description	No. of Items	Assigned Log Number
1.	T4R3 Glass Fiber Filter #0109	1	5979-122
2.	T4R3 Solvent Rinse	1	-123
3.	T4R3 XAD-2 RESIN	1	-124
4.	T4R3 Condensate TRAP	1	-125
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			
16.			
17.			
18.			

Sample Transport

Method of transport IVECO

Recipient of samples upon recovery (if not recovery person):

Signature _____ Title _____

Date of receipt _____ Time of receipt _____ HRS

S-0157RR-1

Sample Check-In at Interpoll Labs

Laboratory person receiving samples:
Signature [signature] Title Lab Analyst
Date of receipt 9-27-88 Time of receipt 1030 HRS
Sample storage location Walk in Cooler
Special storage conditions? _____

Analysis

	Sample Log No.	Date of Analysis	Method of Analysis	Initials of Analyst
1.	5978-122			
2.	-123			
3.	-124			
4.	-125			
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				

Signature of each analyst:

Initials	Signature

S-0157RR-2

Interpoll Laboratories
(612)786-6020

Sample Custody Transfer Form

Job NSP/Red Wing Date 3-29-88

Interlaboratory transfer:
Person in custody of samples Timothy Fuller Init.
Person to receive custody _____ Init._____

Out of laboratory transfer:
Date shipped 3-29-88 Date received 3/30/88
Method of shipment Air Carrier Fed Exp.
Person releasing samples Timothy Fuller Init.
Person receiving custody Harold Pitt Init.

	Sample Log Number	Initials of Person in Custody of Samples	Initials of Person Receiving Samples
1.	5978-122		
2.	-123		
3.	-124		
4.	-125		
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			
16.			
17.			
18.			

Test 4 Run 3 Stack

Storage Instructions: _____

Instructions for Receiving Laboratory:

1. Fill out form and return to Interpoll Laboratories.
2. Initiate your laboratory chain-of-custody. When analysis is complete, mail copy of your chain-of-custody documents with analytical results.
3. Store samples for four (4) months.

S-365

Interpoll Laboratories
(612)786-6020

Field Sample Chain Of Custody Sheet

Job NSP RED WING

Date of Sampling 3-26-88 Site UNIT 2 STACK

Test 5 Run 0 Team Leader J BURESH + R. Rosenthal

Type of Sample Train: IMPACTOR (control)

Sample Collection/Recovery

Person performing sample recovery: + T.T.M.

Signature J. Buresh + R. Rosenthal Title

Location at which recovery was done ON SITE +

Special transport/storage requirements? KEEP UPRIGHT position

	Sample Description	No. of Items	Assigned Log Number
1.	Collection foil 0-1	1	5978 -129
2.	0-2	1	-130
3.	0-3	1	-131
4.	0-4	1	-132
5.	0-5	1	-133
6.	0-6	1	-134
7.	0-7	1	-135
8.			
9.			
10.	T5RD PRE IMPACTOR WASH	1	-136
11.	T5RD PROBE WASH	1	-137
12.	T5RD Glass Fiber filter #	1	-138
13.			
14.			
15.			
16.			
17.			
18.			

Blank

Sample Transport

Method of transport IVECO

Recipient of samples upon recovery (if not recovery person):

Signature Title

Date of receipt Time of receipt HRS

S-0157RR-1

Sample Check-In at Interpoll Labs

Laboratory person receiving samples:
Signature Timothy Fallon Title LAB Analyst
Date of receipt 3-27-88 Time of receipt 1030 HRS
Sample storage location Secured Holding Area
Special storage conditions? _____

Analysis

	Sample Log No.	Date of Analysis	Method of Analysis	Initials of Analyst
1.	5976 -129	3-31-88	PM-10 USEPA-450/2-86-001 June 87	
2.	-130			
3.	-131			
4.	-132			
5.	-133			
6.	-134			
7.	-135			
8.	-136			
9.	-137			
10.	-138			
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				

Signature of each analyst:

Initials	Signature
	Timothy Fallon Donald

S-0157RR-2

Interpoll Laboratories
(612)786-6020

Field Sample Chain Of Custody Sheet

Job NSP RED WING

Date of Sampling 3-26-88 Site UNIT 2 STACK

Test 5 Run 1 Team Leader J BURESH & R. ROSENTHAL

Type of Sample Train: IMPACTOR

Sample Collection/Recovery

Person performing sample recovery:

Signature J. Burl, R. Rosenthal + TTM Title

Location at which recovery was done

Special transport/storage requirements? KEEP UPRIGHT POSITION

Test 5 Run 1

	Sample Description	No. of Items	Assigned Log Number
1.	collection Foil 1-1	1	5978 -139
2.	1-2	1	-140
3.	1-3	1	-141
4.	1-4	1	-142
5.	1-5	1	-143
6.	1-6	1	-144
7.	1-7	1	-145
8.			
9.			
10.	T5R1 PRE IMPACTOR WASH	1	-146
11.	T5R1 PROBE WASH	1	-147
12.	T5R1 Glass Fiber Filter # 0069	1	-148
13.			
14.			
15.			
16.			
17.			
18.			

Sample Transport

Method of transport TUECO

Recipient of samples upon recovery (if not recovery person):

Signature Title

Date of receipt Time of receipt HRS

S-0157RR-1

Sample Check-In at Interpoll Labs

Laboratory person receiving samples:
Signature [signature] Title Lab Analyst
Date of receipt 3-27-88 Time of receipt 1,030 HRS
Sample storage location Secured Holding Area
Special storage conditions? _____

Analysis

	Sample Log No.	Date of Analysis	Method of Analysis	Initials of Analyst
1.	5978 -139	3-31-88	PM-10 USEPA-450/2-76-001 June 77	[initials]
2.	-140			[initials]
3.	-141			[initials]
4.	-142			[initials]
5.	-143			[initials]
6.	-144			[initials]
7.	-145			[initials]
8.	-146			[initials]
9.	-147			[initials]
10.	-148			[initials]
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				

Signature of each analyst:

Initials	Signature
[initials]	[signature]

S-0157RR-2

Interpoll Laboratories
(612)786-6020

Field Sample Chain Of Custody Sheet

Job NSP RED WING

Date of Sampling 3-26-88 Site UNIT 2 STACK

Test 5 Run 2 Team Leader JBURESH & R Rosenthal

Type of Sample Train: Impactor

Sample Collection/Recovery

Person performing sample recovery:

Signature J Burt, R Rosenthal Title

Location at which recovery was done

Special transport/storage requirements?

	Sample Description	No. of Items	Assigned Log Number
1.	Collection foil 2-1	1	5978-149
2.	2-2	1	-150
3.	2-3	1	-151
4.	2-4	1	-152
5.	2-5	1	-153
6.	2-6	1	-154
7.	2-7	1	-155
8.			
9.			
10.	T5 R2 Preimpactor Wash	1	-156
11.	T5 R2 Probe WASH	1	-157
12.	T5 R2 Gluss Fiber Filter # 0066	1	-158
13.			
14.			
15.			
16.			
17.			
18.			

Test 5 Run 2

Sample Transport

Method of transport IVECO

Recipient of samples upon recovery (if not recovery person):

Signature Title

Date of receipt Time of receipt HRS

S-0157RR-1

Sample Check-In at Interpoll Labs

Laboratory person receiving samples:
Signature Timothy O'Donald III Title LAB Analyst
Date of receipt 3-27-88 Time of receipt 1030 HRS
Sample storage location Stevens Holding
Special storage conditions? _____

Analysis

	Sample Log No.	Date of Analysis	Method of Analysis	Initials of Analyst
1.	5978 -149	3-31-88	PM-10 USEPA-450/2-86-001 June 87	
2.	-150			
3.	-151			
4.	-152			
5.	-153			
6.	-154			
7.	-155			
8.	-156			
9.	-157			
10.	-158			
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				

Signature of each analyst:

Initials	Signature
	Timothy O'Donald

S-0157RR-2

Interpoll Laboratories
(612)786-6020

Field Sample Chain Of Custody Sheet

Job NSP RED WING

Date of Sampling 3-20-85 Site UNIT 2 STACK

Test 5 Run 3 Team Leader JBURESH + R. ROSENTHAL

Type of Sample Train: Impactor

Sample Collection/Recovery

Person performing sample recovery:

Signature J. Burnett + R. Rosenthal Title

Location at which recovery was done

Special transport/storage requirements?

	Sample Description	No. of Items	Assigned Log Number
1.	collection foil 3-1	1	5978-159
2.	3-2	1	-160
3.	3-3	1	-161
4.	3-4	1	-162
5.	3-5	1	-163
6.	3-6	1	-164
7.	3-7	1	-165
8.			
9.			
10.	T5R3 Pre impactor WASH	1	-166
11.	T5R3 Probe wash	1	-167
12.	T5R3 Glass Fiber Filter #0070	1	-K8
13.			
14.			
15.			
16.			
17.			
18.			

Sample Transport

Method of transport IVECO

Recipient of samples upon recovery (if not recovery person):

Signature Title

Date of receipt Time of receipt HRS

S-0157RR-1

Sample Check-In at Interpoll Labs

Laboratory person receiving samples:
Signature Timothy Fallon Title LAB Analyst
Date of receipt 3-27-88 Time of receipt 1030 HRS
Sample storage location Secured Holding Area
Special storage conditions?

Analysis

	Sample Log No.	Date of Analysis	Method of Analysis	Initials of Analyst
1.	5978 -159	3-31-88	PM-10 USEPA-450/2-86-001	
2.	-160			
3.	-161			
4.	-162			
5.	-163			
6.	-164			
7.	-165			
8.	-166			
9.	-167			
10.	-169			
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				

Signature of each analyst:

Initials	Signature
	Timothy Fallon

S-0157RR-2

Interpoll Laboratories
(612)786-6020

Field Sample Chain Of Custody Sheet

Job NSP REDWING

Date of Sampling 3-26-88 Site UNIT 2 ESP INLET

Test 5 Run 1, 2, 3 Team Leader DWAYNE A. SMITH

Type of Sample Train: METHOD 17

Sample Collection/Recovery

Person performing sample recovery:

Signature Dwayne A. Smith Title FIELD TEST ENGINEER

Location at which recovery was done 3RD FLOOR NSP REDWING

Special transport/storage requirements?

	Sample Description	No. of Items	Assigned Log Number
1.	TsRo STAINLESS STEEL FILTER # 22	1	-168A
2.	TsR1 STAINLESS STEEL FILTER # 18	1	-169
3.	TsR2 STAINLESS STEEL FILTER # 28	1	-170
4.	TsR3 STAINLESS STEEL FILTER # 3	1	-171
5.	TsRo PROBE WASH	1	-172
6.	TsR1 PROBE WASH	1	-173
7.	TsR2 PROBE WASH	1	-174
8.	TsR3 PROBE WASH	1	-175
9.	TsR123 INTEGRATED ORSAT	3	-176, 177, 178
10.			
11.			
12.			
13.			
14.			
15.			
16.			
17.			
18.			

Sample Transport

Method of transport TRUCK

Recipient of samples upon recovery (if not recovery person):

Signature _____ Title _____

Date of receipt _____ Time of receipt _____ HRS

S-0157RR-1

Sample Check-In at Interpoll Labs

Laboratory person receiving ~~samples~~:
Signature Timothy Title Lab Analyst
Date of receipt 3-27-88 Time of receipt 1036 HRS
Sample storage location Secured Holding
Special storage conditions?

Analysis

	Sample Log No.	Date of Analysis	Method of Analysis	Initials of Analyst
1.	5978 -168	3-28-88	EPA M-17	
2.	-169			
3.	-170			
4.	-171			
5.	-172			
6.	-173			
7.	-174			
8.	-175			
9.	-176	3-26-88	EPA M-3	
10.	-177		"	"
11.	-178			
12.				
13.				
14.				
15.				
16.				
17.				
18.				

Signature of each analyst:

Initials	Signature
	Timothy

S-0157RR-2

APPENDIX S

QA/QC REPORT

Interpoll Laboratories
(612)786-6020

Project: NSP/Red Wing Compliance Test
March 1988

Laboratory Log Number 5978

QUALITY ASSSURANCE\QUALITY CONTROL REPORT

A statement documenting the Quality Assurance activities associated with this report, signed by the Quality Assurance Manager for Interpoll Laboratories, is presented at the end of this report. Quality Control data are summarized in Table 1.

DETECTION LIMITS

The detection limits stated are based on the published instrument sensitivity. At the beginning of each analysis, a standard near the detection limit is analyzed to verify that the instrument is performing optimally.

CONTINUING CALIBRATION VERIFICATION

To assure calibration accuracy during each analysis run, a continuing calibration standard is analyzed for each analyte at a frequency of 10%. The standard is also analyzed for each analyte at the beginning of the run and after the last analytical sample. If the percent recovery of this standard is not between 90 and 100, the instrument is recalibrated and all samples since the last verification standard are rerun.

BLANKS

1. Calibration Blank Analysis

   A calibration blank is analyzed each time the instrument is calibrated, at the beginning and the end of the run, and at a frequency of 10% during the run.

2. Preparation Blank Analysis (Method Blank)

   At least one preparation blank (or reagent blank), consisting of deionized distilled water processed through the entire sample preparation procedure is prepared and analyzed with each batch of samples.

Table 1. Quality Control Results

Analyte	EPA Method	Detection Limit	Precision: Percent Relative Difference Result	Precision: Limit	Accuracy: Percent Recovery Result	Accuracy: Limits
Hg	M-101A	0.20 ug/L	2.9	27	100	95-118
F	300.0	0.60 ug	1.3	22	97	95-102
Br	300.0	0.80 ug	6.7	40	100	88-108
Cl	300.0	0.40 ug	1.2	16	105	91-111
SO_4	300.0	1.00 ug	0.13	2.5	106	71-127
NO_3	300.0	12.5 ug	0	12	105	66-148

ACCURACY

The accuracy of the method is determined by the analysis of spiked samples. Accuracy, expressed as percent recovery, is calculated by the following equation:

$$\text{Percent Recovery (PR)} = \frac{\text{(Final Result)} - \text{(Initial Result)}}{\text{Spike Concentration}} \times 100$$

where "Final Result" is the value obtained when the spiked sample was analyzed, "Initial Result" is the value obtained for the unspiked sample and "Spike Concentration" is the known quantity which was added to the sample.

Control limits are based on the mean percent recovery and the standard deviation of the percent recovery over time. Mean percent recovery and standard deviation are calculated according to the following equations:

$$\text{Mean percent recovery } (\overline{PR}) = \frac{\Sigma\, PR}{N}$$

where N is the number of spiked samples analyzed.

$$\text{Standard deviation} = \sqrt{\frac{\Sigma\, (PR - \overline{PR})^2}{N - 1}}$$

The lower control limit is set at the mean percent recovery minus three standard deviations and the upper control limit is set at the mean percent recovery plus three standard deviations.

It was not possible to match sample and standard matrices for the determination of metals and therefore, samples were analyzed by the method of standard additions. In this case, the sample was spiked at two levels and the spiked samples were used as the calibration standards. The concentration of the sample is back calculated from this calibration line. The percent recovery calculation and thus the control limits do not apply in this case.

The percent recoveries for the remaining determinations were within the established control limits.

PRECISION

The precision of a method is determined by the analysis of duplicate samples. At Interpoll Laboratories, precision is expressed as relative percent difference calculated by the following formula:

$$RPD = \frac{\text{Absolute difference}}{\text{Average value}} \times 100$$

The control limit is established by calculating the mean percent recovery and multiplying by a Shewart factor based on the number of observations in the sub-group, which in this case is two.

$$\overline{RPD} = \frac{\Sigma\ RPD}{N}$$

$$\text{Control limit} = 3.27\ (\overline{RPD})$$

Some of the precision control limits listed in Table 1 are higher than expected. This is due to the limited size of the data set for those determinations. Based on the performance of these determinations in the past, the control limits will be significantly lower as more data is collected. The precision data collected during this project is well below the established control limits.

Precision data is not available for the method of standard additions for the determination of metals.

QUALITY ASSURANCE STATEMENT

This study was reviewed by the Quality Assurance Unit prior to isssuance of the final report. To the best of my knowledge this data was collected in accordance with our Quality Assurance Plan using the methods described in the report. The quality control data accurately represents data generated during the study.

Respectfully submitted,

Suzanne M. Lee

Suzanne M. Lee
Quality Assurance Manager

SML/cg

Interpoll Laboratories
(612)786-6020

QUALITY ASSURANCE FOR EPA METHOD 6

1-4 Instructions for use of Environmental Protection Agency Compliance SO_2 samples (see back side).

5. INTERPOLL INSTRUCTIONS

Note 1 The 100 cc sample in the volumetric flask is the reference sample not the vial.

Note 2 Take a 20 cc aliquot from the reference sample for titration, add 80 cc of isopropanol, indicator and titrate with barium titrant.

$$C_{SO_2} = \frac{32.03\ (V_t - V_{tb})\ N\ V_{soln}}{V_{m_{std}}\ V_{aliq}}$$

If V_{soln} = 100 cc, V_{aliq} = 20 cc (normally) and $V_m = 21 \times 10^{-3}$

$$C_{SO_2} = 7626\ (V_t - V_{tb})\ N \quad (mg/dsm^3)$$

LABORATORY DATA

Sample No. A01413 Audit Date 4-6-88

Analyst TTM Aliquot Size (V_{aliq}) 20.00 cc

Vol. of titrant for blank V_{tb} .08 Normality of titrant 0.01003

Buret Readings:	Trial 1	Trial 2	Trial 3	
Start	0.00	0.00	0.00	
End	31.51	31.51	31.51	
Diff (V_t)	31.51	31.51	31.51	Avg. V_t 31.51

C_{SO2} = 7626 (31.51 - .08) (0.01003) = 2404 mg/dsm^3

Data Results Reported to Carolina Schutt of MPCA

By Kathy Eckstadt Date 4-12-88

Results ☒ Within ☐ Not Within Specifications

S-322R

Interpoll Laboratories
(612)786-6020

QUALITY ASSURANCE FOR EPA METHOD 6

1-4 Instructions for use of Environmental Protection Agency Compliance SO_2 samples (see back side).

5. INTERPOLL INSTRUCTIONS

Note 1 The 100 cc sample in the volumetric flask is the reference sample not the vial.

Note 2 Take a 20 cc aliquot from the reference sample for titration, add 80 cc of isopropanol, indicator and titrate with barium titrant.

$$C_{SO_2} = \frac{32.03\ (V_t - V_{tb})\ N\ V_{soln}}{V_{m_{std}}\ V_{aliq}}$$

If V_{soln} = 100 cc, V_{aliq} = 20 cc (normally) and $V_m = 21 \times 10^{-3}$

$$C_{SO_2} = 7626\ (V_t - V_{tb})\ N \quad (mg/dsm^3)$$

LABORATORY DATA

Sample No. A01061 Audit Date 4-6-88

Analyst TTM Aliquot Size (V_{aliq}) 20 cc

Vol. of titrant for blank V_{tb} ____ Normality of titrant .01003

Buret Readings:	Trial 1	Trial 2	Trial 3	
Start	0.00	0.00	0.00	
End	22.32	22.32	22.32	
Diff (V_t)	22.32	22.32	22.32	Avg. V_t 22.32

C_{SO2} = 7626 (22.32 - .08) (0.01003) = 1701 mg/dsm^3

Data Results Reported to Carolina Schutt of MPCA

By Kathy Eickstadt Date 4-12-88

Results ☒ Within ☐ Not Within Specifications

S-322R

Interpoll Laboratories
(612)786-6020

QUALITY ASSURANCE FOR EPA METHOD 7A

1-4 Instructions for use of Environmental Protection Agency Compliance NO_x Samples (see back side).

5. INTERPOLL INSTRUCTIONS

For IC evaluation: (Method 7A)

m = mass of NO_x as NO_3^- in ug in reference sample (500 cc volumetric)

$$C = \frac{FW\ (NO_2)}{FW\ (NO_3^-)} \frac{10^3 m}{2000} = 0.371m$$

where C = mg/dsm^3

Sample No. B00482 Audit Date 3-30-88

Analyst BJN

Mass of nitrate in reference sample (m) 1226 ug

C = 0.371 (1226) = 455 mg/dsm^3

Data Results Reported to Carolina Schutt of MPCA

By Kathy Eickstadt Date 4-12-88

Results ☒ Within ☐ Not Within Specifications

S-323RR

Interpoll Laboratories
(612)786-6020

QUALITY ASSURANCE FOR EPA METHOD 7A

1-4 Instructions for use of Environmental Protection Agency Compliance NO_x Samples (see back side).

5. INTERPOLL INSTRUCTIONS

For IC evaluation: (Method 7A)

m = mass of NO_x as NO_3^- in ug in reference sample (500 cc volumetric)

$$C = \frac{FW\ (NO_2)}{FW\ (NO_3^-)} \frac{10^3 m}{2000} = 0.371m$$

where C = mg/dsm^3

Sample No. B02612 Audit Date 3-30-88

Analyst BJN

Mass of nitrate in reference sample (m) 2692 ug

C = 0.371 (2692) = 999 mg/dsm^3

Data Results Reported to Carolina Schutt of MPCA

By Kathy Eickstadt Date 4-12-88

Results ☒ Within ☐ Not Within Specifications

S-323RR

Interpoll Inc.
(612)786-6020

Stack Sampling Department

MM5 Train XAD-2 Resin Batch Quality Assurance Form

Batch No. 14 Recheck Supplier Alltech Assoc.
Mesh 20/50

Residual Extractable Organics

Summary of Analysis: 20 g of resin is Soxhlet extracted in 200 ml of methylene chloride for 24 hours. After extraction, the methylene chloride is concentrated to 10 ml and 5 ul are analyzed by gas chromatography using the total chromatographable organics (TCO) analysis procedure.

Individual Performing Test Marcelynn J. Ediger
Results for Test < 10 ug/g Maximum allowable 10 ug/g
Date of Test 10 MAR 88

Marcelynn J. Ediger
Signature of Analyst

Residual Gravimetric Determination

Summary of Analysis: The concentrated methylene chloride from the residual extractable organics is then placed in a preweighed evaporating dish. The methylene chloride is evaporated off and the evaporating dish weighed. The preweighed evaporating dish is then subtracted from this. The weight from the residue is then corrected for the 5 ul taken out for the residual extractable organics.

Individual Performing Test Timothy Fuller McDonald
Results for Test < 25 ug/g Maximum allowable 25 ug/g
Date of Test 2-10-88

Timothy Fuller McDonald
Signature of Analyst

LSA-08

To: Kathy Eickstadt

From: Karen Riggs

Subject: Compounds/Amounts in Field Spiking Ampoules

Per your request, the field spiking ampoules for the Red Wing compliance test shipped to you on March 16, 1988 contained the following compounds:

Inlet Ampoule		Outlet Ampoule	
20 ng	1,2,3,4-TCDD-13C12	20 ng	1,2,3,4-TCDD-13C12
5.0 ug	d12-perylene	0.5 ug	d12-perylene
5.0 ug	d12-benzo(e)pyrene	0.5 ug	d12-benzo(e)pyrene

Please give me a call if you need any other information concerning these spiking ampoules.

END

Ce = Concentration of the compound in the sample extract as determined above (ng/uL)
V = Final volume of sample extract (uL)
F = Factor for extract splitting (0.25).

PAH results for MM5 samples duplicate the trend detected in the PCDD/PCDF results for these samples. Run 1 levels of PAH are significantly higher than PAH levels in Run 2 and 3 samples and are higher than levels previously detected in MM5 samples collected at Red Wing. PAH levels in Runs 2 and 3 are comparable to levels detected in previous tests. Inlet and outlet levels between runs are comparable although a direct comparison is limited because sample volume is not considered in these data. The laboratory method blank processed with these samples was relatively free of PAH contamination except for trace levels of naphthalene and phenanthrene.

4.0 QUALITY ASSURANCE/QUALITY CONTROL

A statement attesting to the QA/QC activities associated with this report, signed by Battelle's Quality Assurance Manager for this program, is presented at the end of this report. The quality control objectives established for the PCDD/PCDF and PAH analyses are presented in Table 15. For each analysis, estimated mass detection limits and accuracy, precision, and completeness goals are presented.

TABLE 15. QUALITY CONTROL OBJECTIVES

Analysis	Mass Detection Limit		QC Goals		
	Low Recovery	Expected Recovery	Accuracy	Precision	Completeness
PCDD/PCDF	40 pg	25 pg	±50%	±75%	100%
PAH	20 ng	12.5 ng	±50%	±75%	100%

4.1 MASS DETECTION LIMITS

The mass detection limit of 25 pg/sample for PCDD/PCDF was established specifically for 2,3,7,8-TCDD in MM5 samples. This detection limit was met for all MM5 samples analyzed. Detection limits achieved ranged from 14 pg/sample to 1.4 pg/sample.

For PAH analyses, an estimated quantification limit of 20 ng was achieved for all samples. The estimated quantification limit is based on the lowest concentration of standard used for calibration. Analytes can be detected but not quantified at levels lower than the quantification limit. The detection limit for PAH analyses is typically half the quantification limit. For these analyses, therefore, a detection limit of 10 ng was achieved which meets the QC objective of 12.5 ng.

4.2 ACCURACY

Analytical accuracy is determined by calculating the recoveries of the field spikes and internal standards added to the samples. Recoveries are calculated by the following equation.

$$\text{Percent Recoveries} = \frac{(X)}{T} \times 100\%$$

where X is the quantity of analyte determined by analysis of the spiked sample, and T is the known quantity of the analyte which was added before analysis. The field spikes included 1,2,3,4-tetra-CDD-$^{13}C_{12}$, d_{12}-benzo[e]pyrene, and d_{12}-perylene which were added to the XAD-2 resin of the MM5 trains in the field immediately before sampling. The internal standards added to the samples before extraction are listed in Section 2.1.1. The field spikes provide an evaluation of accuracy through sampling and analysis. The internal standards provide an estimate of the accuracy of the analytical procedure.

Recoveries of the PCDD/PCDF field spike and internal standards are presented in Table 16 and 17 for the MM5 and ash samples, respectively. Recoveries of PAH field spikes and internal standards are presented in Tables 18, 19, and 20 for the inlet MM5, outlet MM5, and ash samples, respectively.

Recoveries of the 1,2,3,4-TCDD-13C12 field spike were above 65 percent in all but one case. The exception was the Run 2 inlet MM5 sample which has a field spike recovery of 46 percent. Although this recovery does not meet the QC objective for this program, it is considered acceptable for a field spike of this nature. Recoveries of PCDD/PCDF laboratory internal standards for the MM5 samples were above 75 percent in all cases. The high PCDD/PCDF recoveries obtained for the MM5 samples indicate that the analytical method is accurate and that PCDD/PCDF are efficiently removed from the sample matrix.

PCDD/PCDF recoveries for the ash samples were variable and decreased with increasing level of chlorination. Recoveries for tetra- through hexa-CDD/CDF ranged from 15 to 75 percent, while recoveries for hepta- and octa-CDD/CDF ranged from 0 to 6 percent. For the 2,3,7,8-TCDD-13C12 internal standard, recoveries were acceptable and ranged from 48 to 75 percent. The laboratory method blank and native spike associated with this sample set had recoveries greater than 84 percent in all cases. These results indicate that the analytical method is performing within expectations and that the ash sample matrix is contributing to the variable recoveries for the ash samples. This result is supported by the PAH recoveries discussed below.

Recoveries of the PAH field spikes from the MM5 samples ranged from 35 to 100 percent. The QC requirement of 50 percent was met in all but two

cases. Recoveries of PAH laboratory internal standards from the MM5 samples ranged from 42 to 102 percent. The QC requirement of 50 percent was met in all but four cases. The outlying recoveries are within expected levels for this sample type. Overall, these results indicate that PAH are efficiently extracted from the sample matrix and that the analytical method is accurate as performed.

For the three ash samples, recoveries of the d12-chrysene ranged from 43 to 46 percent; recoveries of the d12-benzo[a]pyrene were below 1 percent. Recoveries of these PAH internal standards from the laboratory method blank were above 50 percent. As with the PCDD/PCDF recovery results, these PAH recoveries indicate that the method is performing within the stated QC objective although the sample matrix is interfering with efficient recovery of the analytes of interest.

4.3 PRECISION

Precision is determined by the following equation.

$$\text{Standard deviation } ( ) \text{ (absolute units)} = \frac{\sum_{i=1}^{n} (x_i - x)^2}{n-1}$$

where x_i is the experimentally determined value for the ith measurement, n is the number of measurements performed, and x is the mean of the experimentally determined values. The precision is reported in Table 21 as the relative standard deviation (RSD) or coefficient of variation which is the variation about the mean experimentally determined value, x, expressed as a percentage.

$$\text{RSD (\%)} = \frac{\quad}{x} \times 100\%$$

where is the standard deviation calculated from the preceding equation.

Precision was evaluated using results obtained for the laboratory

internal standards in Runs 1-3. Using native PCDF/PCDD or PAH to evaluate precision is inappropriate because the exact amount of these compounds in the samples will naturally vary across sampling runs. As shown, the precision for the PCDD/PCDF and PAH analyses was within the QC goal of ± 75 percent in all cases.

4.4 COMPLETENESS

Completeness in meeting the data recovery objectives was assessed by the following equation:

$$\text{Completeness (\%)} = (D_r/D_c) \times 100\%$$

where D_r is the number of samples for which valid results are reported and D_c is the number of samples which are received at Battelle for analysis during the study. For the Red Wing/Compliance Test, Battelle received eight MM5 and three composite ash samples for PCDD/PCDF and PAH analysis. PCDD/PCDF and PAH results are presented in this report for all eleven samples. Therefore, the QC goal for completeness of 100 percent has been met.

TABLE 16. PCDD/PCDF RECOVERIES FOR MM5 SAMPLES (%)

Compound	Inlet				Outlet				Laboratory Method Blank	Native Spike
	Run 0	Run 1	Run 2	Run 3	Run 0	Run 1	Run 2	Run 3		
Field Spike										
1,2,3,4-TCDD-$^{13}C_{12}$	65	66	46	66	80	67	74	78	98	NA
Laboratory Internal Standards										
TCDD-$^{13}C_{12}$	80	85	91	88	91	92	90	93	89	93
PeCDD-$^{13}C_{12}$	99	101	100	113	102	110	96	109	98	105
HxCDD-$^{13}C_{12}$	93	86	94	112	95	104	90	103	90	95
HpCDD-$^{13}C_{12}$	97	107	84	124	103	114	93	112	87	103
OCDD-$^{13}C_{12}$	87	110	84	115	93	106	94	108	86	101
TCDF-$^{13}C_{12}$	83	91	76	93	97	96	98	91	92	94
PeCDF-$^{13}C_{12}$	90	92	93	107	93	104	91	106	91	96
HxCDF-$^{13}C_{12}$	90	100	94	109	92	100	94	106	92	96
HpCDF-$^{13}C_{12}$	85	91	75	109	92	98	81	100	85	93

TABLE 17. PCDD/PCDF RECOVERIES FOR ASH SAMPLES (%)

	Ash 3/23/88	Ash 3/24-25/88	Ash 3/25/88	Laboratory Method Blank	Native Spike
TCDD-$^{13}C_{12}$	48	68	75	89	84
PeCDD-$^{13}C_{12}$	44	38	45	119	98
HxCDD-$^{13}C_{12}$	32	18	15	107	96
HpCDD-$^{13}C_{12}$	4	4	1	121	109
OCDD-$^{13}C_{12}$	1	1	0	108	92
TCDF-$^{13}C_{12}$	61	60	91	89	84
PeCDF-$^{13}C_{12}$	41	34	43	104	95
HxCDF-$^{13}C_{12}$	36	21	22	113	96
HpCDF-$^{13}C_{12}$	6	5	2	103	87

TABLE 18. PAH RECOVERIES FOR INLET MM5 SAMPLES (%)

	Run 0	Run 1	Run 2	Run 3	Laboratory Method Blank
Field Spikes					
d12-benzo[e]pyrene	99	50	81	100	NA
d12-perylene	55	35	61	59	NA
Laboratory Internal Standards					
d12-chrysene	101	48	100	99	94
d12-benzo[a]pyrene	79	42	88	89	48

TABLE 19. PAH RECOVERIES FOR OUTLET MM5 SAMPLES (%)

	Run 0	Run 1	Run 2	Run 3	Laboratory Method Blank
Field Spikes					
d12-benzo[e]pyrene	91	78	76	84	NA
d12-perylene	61	57	49	55	NA
Laboratory Internal Standards					
d12-chrysene	99	102	100	99	94
d12-benzo[a]pyrene	84	94	84	93	48

TABLE 20. PAH RECOVERIES FOR ASH SAMPLES (%)

	3/23/88	3/24-25/88	3/25/88	Laboratory Method Blank
d12-chrysene	43	46	44	103
d12-benzo[a]pyrene	0.47	0.24	0.24	51

GENERAL REVIEW GUIDE
FOR
EMISSION TEST REPORTS

Emission Test Report Title: Results of the March 21-26, 1988 Air Emission Compliance Test on the No. 2 Boiler at the Red Wing Station Test IV (High Load)*

Report Number: 8-2526

Project Title: Municipal Waste Combustion Study

Project number: 86/19a

PREPARED FOR U.S. ENVIRONMENTAL PROTECTION AGENCY
EMISSION STANDARDS AND ENGINEERING DIVISION
RESEARCH TRIANGLE PARK, NORTH CAROLINA

*Companion Analytical Report: PCDD/PCDF and PAH Analyses of Modified Method 5 and Ash Samples from Red Wing Compliance Test, by Battelle Columbus, April 26, 1988. Companion QA/QC Plan: Final Draft, Quality Assurance/Quality Control Plan, Analysis of Stack Emission Samples from Red Wing Power Plant, by Battelle Columbus, January 8, 1988.

TABLE OF CONTENTS

I. REVIEW SUMMARY

Title of report: Results of the March 21-26, 1988 Air Emission Compliance Test on the No. 2 Boiler at the Red Wing Station Test IV (High Load)

Plant name: Red Wing Power Station — Plant location: Red Wing, Minnesota

Report date: May 10, 1988 — Report number: 8-2526

Testing conducted by: Interpoll Laboratories/CDD/CDF/PAH Analysis by Battelle

Report issued by: Interpoll Laboratories/Companion Analytical & QA/QC Reports by Battelle

Process(s) Operation Tested	Sampling Location	Pollutants Sampled
1. Unit 2 Boiler - RDF	ESP Inlet	PM, PM-10, Trace Metals,
2.		CDD/CDF, PAH, O_2, CO_2, CO
3. Unit 2 Boiler - RDF	ESP Outlet/Stack	PM, PM-10, HCl, HF, SO_2,
4.		NO_x, Trace Metals, CDD/CDF
		PAH, O_2, CO_2, CO, VEO's

Purpose of test: Compliance testing for Minnesota Pollution Control Agency (MPCA)

Purpose of review: Add data to EPA's MWC standard setting data base following evaluation to determine if data meet EPA criteria.

Process operation during tests: Unit 2 is water tube boiler burning RDF with 360 TPD capacity and design steam flow of 109 klb/hr

Control equipment status during tests: Unit controlled by mechanical collecter/ESP system, which was in normal operation during test.

Sampling and analytical procedures: Brief descriptions with deviations noted in text. Full explanations in Appendices and companion analytical report and QA/QC Plan. The procedures are summarized below.

Pollutant(s)	Method(s)
PM	EPA Method 5 (Extraction/Gravimetric) included
Organic Condensibles	MPCA Method in PM total
HCl, HF, SO_2	EPA Method 6 with large impingers/IC analysis
NO_x	EPA Method 7A
Trace Metals	Multi Metals Train/GFAAS + CVAAS
CDD/CDF	MM5 Train (Method 0100)/EPA Method 8280 w/ HRMS
PAH	MM5 Train (Method 0100)/EPA Method 8270
O_2, CO_2, CO	EPA Method 3 Sample Collection/Orsat (CO_2,O_2) and Method 10 (CO)
PM-10	Inlet-Modified Method 17/X-ray Sedigraph analysis
	Stack-8-stage cascade impactor/Gravimetric

I. Review Summary (continued)

Summary of results The emission results are summarized in Section III of this review on the summary data sheet. The results presented in the report and in the summary table of this review have not been corrected to 12% CO_2. Based on the review, the data appear to be of good quality with exception of the inlet emission values of CDD/CDF. Comparison of the measured inlet and outlet emission values and emission values calculated from the particulate catch and CDD/CDF content of the ESP ash (see table below) show the outlet values with good agreement and the inlet values with very poor agreement. This comparison indicates that the inlet values reported may be low by 1 to 2 orders of magnitude, and it is recommended that they not be used for calculation of CDD/CDF control efficiency.

Recommendations and conclusions Data appear to be acceptable and should be used by the EPA, with the exception of use of the inlet CDD/CDF data for calculation of CDD/CDF control efficiency.

Total CDD/CDF (ng/dscm)

		Run 1	Run 2	Run 3
Inlet	Measured	137.7	14.4	12.7
	Calc	2,000	4,224	6,790
Outlet	Measured	22.6	23.4	29.2
	Calc	16.26	71.06	51.95

Report reviewed for (Individual, Agency, Department) Gene Riley/EMB/EPA

Reviewed by B. DeWees/R. Segall Firm Entropy Env. Date 11/18/88

Approved by _____ Date _____

II. REPORT REVIEW

A. INTRODUCTION

Item	Yes	No	OK	Comments*
1. Plant name and address	X			Northern States Power, Red Wing Station Red Wing, Minnesota
2. Plant representative	X			Bob Evans, NSP
3. Process operation identified	X			Water tube boiler burning RDF, see Section 1.2
4. Control device identified	X			Mechanical Collector/ESP See Section 1.2
5. Test dates	X			March 21-26, 1988
6. Test company	X			Interpoll Laboratories
7. Test observers		X		Not mentioned
8. Purpose of test	X			Compliance with state regulations
9. Analytical company	X			Batelle- CDD/CDF & PAH Interpoll- Remainder

* Place NA (Not Applicable) for items that do not apply.

II. REPORT REVIEW

B. SOURCE OPERATION

Item	Yes	No	OK	Comments*
1. Description of process	X			See Section 1.2
2. Flow diagram of process		X		
3. Rated capacity of process	X			360 TPD RDF 109 klb/hr steam flow
4. Process operation was monitored	X			See Table 1 and Appendix O (submitted by NSP)
5. Process data and results with example calculations	X			Calculations shown in Appendix O
6. Raw materials monitored	X			Fuel analysis submitted by NSP; see Appendix N
7. Description of control equipment	X			See Section 1.2
8. Control equipment was monitored		X		
9. Continuous monitors list:				N/A

* Place NA (Not Applicable) for items that do not apply.

II. REPORT REVIEW

C. TEST PROCEDURES AND RESULTS

Item	Yes	No	OK	Comments*
1. Pollutan sampled	X	X	X	Identify: Particulate, O_2, CO_2, CO, condensibles
2. Sampling location	X	X	X	Identify: ESP Inlet, Outlet Stack of Unit 2
3a. No. of sampling points	X	X	X	Number: 42 and 24, respectively
3b. As per method				Method 1
4. Schematic of sampling location	X			See Appendix B
5a. No. of test runs	X	X	X	Number: 3 each location
5b. Minimum sample volume	X			All greater than 40 dscf
6. Sampling procedures and equipment described	X			See Section 1.3 and Appendix P
7. Reference methods used	X			Method 5, Method 3, Method 10 analysis
8. Reference method deviations described	X			Distilled H_2O used in back half to allow MPCA method for condensible organics, condensibles added to PM results
9. Components calibrated	X			See Appendix A
10. Field and laboratory data recorded	X			See Appendices C and K
11. Sample recovery procedures described	X			See Appendix P
12. Sample collection system leak checked	X			See Appendix C
13. Sampling rate correct per method	X			Isokinetics OK for all 6 runs; see Table 1
14. Quality assurance procedures	X			
15. Analytical procedures described	X			See Section 1.3 and Appendix P
16. Sample blank correction				N/A
17. Emission results calculated correctly	X			Verified by reviewer

* Place NA (Not Applicable) for items that do not apply.

II. REPORT REVIEW

C. TEST PROCEDURES AND RESULTS

Item	Yes	No	OK	Comments*
1. Pollutan sampled				Identify: PM-10
2. Sampling location				Identify: ESP Inlet, Outlet Stack of Unit 2
3a. No. of sampling points				Number: 42 and 4, for inlet & outlet, respectively
3b. As per method				Method 1, N/A, for inlet & outlet, respectively
4. Schematic of sampling location	X			See Appendix B
5a. No. of test runs				Number: 3 each location
5b. Minimum sample volume				N/A
6. Sampling procedures and equipment described	X			See Section 1.4 and Appendix P
7. Reference methods used	X			Inlet: Modification of Method 17 Outlet: PM-10 SIP Development Guideline Method
8. Reference method deviations described	X			See Section 1.4 and Appendix P
9. Components calibrated	X			See Appendix A
10. Field and laboratory data recorded	X			See Appendices D and E
11. Sample recovery procedures described	X			See Appendix P
12. Sample collection system leak checked	X			See Appendices D and E
13. Sampling rate correct per method	X			Inlet: Isokinetics within ± 10% acceptable range Outlet: Isokinetics within ± 20% acceptable range
14. Quality assurance procedures				Unknown
15. Analytical procedures described	X			See Appendix P
16. Sample blank correction				N/A
17. Emission results calculated correctly	X			Verified by reviewer

* Place NA (Not Applicable) for items that do not apply.

II. REPORT REVIEW

C. TEST PROCEDURES AND RESULTS

Item	Yes	No	OK	Comments*
1. Pollutan sampled				Identify: HCl, HF, SO_2
2. Sampling location				Identify: Outlet Stack of Unit 2
3a. No. of sampling points				Number: 3 each run, 20 minutes per point
3b. As per method				Method 6
4. Schematic of sampling location	X			See Appendix B
5a. No. of test runs				Number: 3
5b. Minimum sample volume	X			Adequate
6. Sampling procedures and equipment described	X			See Section 1.5 and Appendix P
7. Reference methods used	X			Modification of EPA Method 6
8. Reference method deviations described	X			Large impingers and alkaline impinger reagent with analysis by IC. See Section 1.5 & Appendix P
9. Components calibrated	X			See Appendices A and K
10. Field and laboratory data recorded	X			See Appendices F and K
11. Sample recovery procedures described	X			See Section 1.5 and Appendix P
12. Sample collection system leak checked	X			See Appendix F
13. Sampling rate correct per method	X			
14. Quality assurance procedures	X			See Appendix F
15. Analytical procedures described	X			See Section 1.5 and Appendix P
16. Sample blank correction	X			According to Appendix P
17. Emission results calculated correctly	X			Verified by reviewer

* Place NA (Not Applicable) for items that do not apply.

II. REPORT REVIEW

C. TEST PROCEDURES AND RESULTS

Item	Yes	No	OK	Comments*
1. Pollutan sampled				Identify: NO_x
2. Sampling location				Identify: Outlet Stack of Unit 2
3a. No. of sampling points				Number: Single point
3b. As per method				Method 7A
4. Schematic of sampling location	X			See Appendix B
5a. No. of test runs				Number: 3
5b. Minimum sample volume	X			2 liter flasks
6. Sampling procedures and equipment described	X			See Section 1.6 and Appendix P
7. Reference methods used	X			Method 7A
8. Reference method deviations described		X		None
9. Components calibrated	X			See Appendix K
10. Field and laboratory data recorded	X			See Appendices G and K
11. Sample recovery procedures described	X			See Section 1.6 and Appendix P
12. Sample collection system leak checked	X			See Appendix G
13. Sampling rate correct per method	X			
14. Quality assurance procedures	X			See Appendix G
15. Analytical procedures described	X			See Section 1.6 and Appendix P
16. Sample blank correction	X			According to Method 7A
17. Emission results calculated correctly	X			Some numbers needed for verification not available. NO_x values seem slightly low.

* Place NA (Not Applicable) for items that do not apply.

II. REPORT REVIEW

C. TEST PROCEDURES AND RESULTS

Item	Yes	No	OK	Comments*
1. Pollutan sampled				Identify: Trace Metals**
2. Sampling location				Identify: ESP Inlet, Outlet Stack of Unit 2
3a. No. of sampling points				Number: 42 and 24, respectively
3b. As per method				Method 1
4. Schematic of sampling location	X			See Appendix B
5a. No. of test runs				Number: 3 each location
5b. Minimum sample volume	X			All greater than 30 dscf
6. Sampling procedures and equipment described	X			See Section 1.7 and Appendix P
7. Reference methods used		X		Draft EPA Methods Protocol approved by MCPA
8. Reference method deviations described	X			See Section 1.7 and Appendix P
9. Components calibrated	X			See Appendix A
10. Field and laboratory data recorded	X			See Appendices I and J
11. Sample recovery procedures described	X			See Section 1.7 and Appendix P
12. Sample collection system leak checked	X			See Appendix I
13. Sampling rate correct per method	X			Isokinetics within 100% ± 10% range
14. Quality assurance procedures	X			See Appendix I
15. Analytical procedures described	X			See Section 1.7 and Appendix P
16. Sample blank correction			X	OK. Field blank reported, but not used for correction
17. Emission results calculated correctly	X			Verified by reviewer

* Place NA (Not Applicable) for items that do not apply.
**As, Be, Cd, Cr, Pb, Hg, Ni, Se.

II. REPORT REVIEW

C. TEST PROCEDURES AND RESULTS FOR DIOXINS/FURANS (CDD/CDF)

Item	Yes	No	OK	Comments
1. CDD/CDF isomers measured				Identify: Total Tetra- thru Octa-CDD and CDF, plus all 2,3,7,8-substituted isomers
2. Sampling location				Identify: ESP Inlet, Outlet Stack of Unit 2
3. No. of sampling points				Number: 42 and 24, respectively
4. Schematic of sampling location	X			See Appendix B
5. No. of test runs				Number: 3 each location
6. Specific sampling & analytical protocol refer	X			Sampling: MM5 (Method 0100) Analysis: Method 8280 with HRMS See Section 1.8 and Appendix P
7. Sampling & analytical procedures described	X			Same as above
8. Sampling equipment calibrated	X			See Appendix A
9. Field data recorded	X			See Appendix J
10. Sampling rate correct per method	X			Isokinetics within 100% $\pm$ 10% range
11. Sample collection system leak checked	X			See Appendix J

C. TEST PROCEDURES AND RESULTS FOR DIOXINS/FURANS (cont.)

Item	Yes	No	OK	Comments
12. GC/MS calibrated	X			See Appendix B of Battelle analytical report
13. Analytical criteria used to verify data specified	X			According to Method 8280
14. Confirmation analysis conducted (which isomers)				Unknown
15. Appropriate internal standards	X			See Section 2.2.1 of Battelle report
16. Surrogate standards	X			Field spike of XAD-2
17. Recovery acceptable for standards	X			Internal standards all between 75% and 124% Field spikes between 46% and 80%
18. Equipment/ glassware preparation described		X		Not in text or Method 0100
19. Proof blank(s) taken for analysis		X		
20. Method blank(s) taken and analyzed	X			See QA/QC Plan and Appendix M
21. Field blank(s) taken and analyzed	X			See QA/QC Plan and Appendix M
22. Audit sample(s) analyzed		X		
23. Calculations correct & example provided	X			Verified by reviewer Examples in Battelle report

C. TEST PROCEDURES AND RESULTS FOR DIOXINS/FURANS (cont.)

Item	Yes	No	OK	Comments
24. Toxic equivalencies calculated	X			See Tables 15, 16, and 19
25. Process samples taken for CDD/CDF analysis	X			Ash Samples - Internal standard recoveries low for ash samples
26. Analytical procedures described for process samples	X			See Battelle analytical report

C. TEST PROCEDURES AND RESULTS FOR POLYAROMATIC HYDROCARBONS (PAH)

Item	Yes	No	OK	Comments
1. Cmpds measured				Identify: * See list below
2. Sampling location				Identify: ESP Inlet, Outlet Stack of Unit 2
3. No. of sampling points				Number: 42 and 24, respectively
4. Schematic of sampling location	X			See Appendix B
5. No. of test runs				Number: 3 each location
6. Specific sampling & analytical protocol refer	X			Sampling: MM5 - Method 0100 Analysis: Method 8270
7. Sampling & analytical procedures described	X			See Section 1.9 and Appendix P
8. Sampling equipment calibrated	X			See Appendix A
9. Field data recorded	X			See Appendix J
10. Sampling rate correct per method	X			Isokinetics within 100% $\pm$ 10% range
11. Sample collection system leak checked	X			See Appendix J

*Napthalene
Acenaphthylene
Acenapthene, dihydro
Fluorene
Phenanthrene
Anthracene
Fluoranthene
Pyrene
Benz(a)anthracene
Chrysene
Benzfluoranthenes
Benzo(a)pyrene
Indenopyrene
Dibenz(ah)anthracene
Benzo(g,h,i)perylene

C. TEST PROCEDURES AND RESULTS FOR PAH (cont.)

Item	Yes	No	OK	Comments
12. GC/MS calibrated	X			See Appendix C of Battelle analytical report
13. Analytical criteria used to verify data specified	X			According to Method 8270
14. Confirmation analysis conducted (which isomers)				N/A
15. Appropriate internal standards	X			Specified by Method 8270
16. Surrogate standards	X			Field spike of d_{12}-benzo(e)pyrene and d_{12}-perylene
17. Recovery acceptable for standards	X			Internal standards: 42% to 100% Field spikes: 35% to 100%
18. Equipment/ glassware preparation described		X		Not mentioned
19. Proof blank(s) taken for analysis		X		
20. Method blank(s) taken and analyzed	X			See Battelle analytical report
21. Field blank(s) taken and analyzed	X			See Battelle analytical report
22. Audit sample(s) analyzed		X		
23. Calculations correct & example provided		X		Computer printouts not provided for PAH in emission samples

C. TEST PROCEDURES AND RESULTS FOR PAH (cont.)

Item	Yes	No	OK	Comments
24. Toxic equivalencies calculated				N/A
25. Process samples taken for CDD/CDF analysis	X			Ash samples taken and analyzed, but results not reported by Interpoll (results are in Battelle report)
26. Analytical procedures described for process samples	X			See Battelle report

II. REPORT REVIEW

D. DOCUMENTATION

Item	Yes	No	OK	Comments*
1. Raw field data sheets	X			See Appendices C through J
2. Complete results with example calculations	X			See Section 3 and Appendix Q
3. Analytical raw data sheets	X			See Appendices K through N and Battelle analytical report
4. a) Process data with statement of process rate	X			See Appendix O
b) Control equipment log		X		
c) Continuous monitor data				N/A
5. Calibration procedures and data	X			Data in Appendix A
6. Test log		X		
7. Standard sampling and analytical procedures and methods	X			One draft method used
8. Visible emissions results concurrent with testing	X			Two 1-hr runs concurrent with PM tests One 1-hr run concurrent with CDD/CDF test
9. Particle size data	X			See Table 2 and Appendix D
10. Quality assurance data	X			See Appendix S
11. Discussion of data	X			See Section 2
12. Other miscellaneous data				Explain:

* Place NA (Not Applicable) for items which do not apply.

III. SUMMARY DATA SHEET

Plant name Red Wing Power Station Plant location (city) Red Wing, Minnesota

Report number 8-2526 Project number

Process operation	Sampling location	Control equipment	Test method	Pollutant			Run No.	CO_2 %	O_2 %		
				Type	Concentration	Mass emission rate					
MWC (Unit 2)	Inlet	Multiclone/ ESP	M5	PM[+,a]	1.54 gr/dscf	540.4 lb/hr	1	12.3	6.9		
					2.62	921.0	2	11.6	8.2		
					2.00	716.6	3	12.3	7.0		
	Outlet	Multiclone/ ESP	M5	PM[+,a]	0.0125 gr/dscf	5.31 lb/hr	1	11.8	7.8		
					0.0441	17.67	2	11.0	8.8		
					0.0153	6.07	3	11.0	8.8		
	Inlet	Multiclone/ ESP	M3/10	CO[c]	134 ppm,d	22 lb/hr	1				
					109	18	2				
					111	19	3				
	Outlet	Multiclone/ ESP	M3/10	CO[c]	121 ppm,d	24 lb/hr	1				
					65	13	2				
					68	13	3				

Remarks: Values reported are not corrected to 12% CO_2.

[+]Includes condensible emissions.

III. SUMMARY DATA SHEET, cont.

Plant name Red Wing Power Station — Plant location (city) Red Wing, Minnesota

Report number 8-2526 — Project number

Process operation	Sampling location	Control equipment	Test method	Pollutant			Run No.	CO_2 %	O_2 %		
				Type	Concentration	Mass emission rate					
MWC Unit 2	Inlet	Multiclone/ ESP	Mod. M 17	PM-10[e]		276 lb/hr	1	12.9	7.0		
						291	2	12.9	7.1		
						242	3	13.0	7.0		
	Outlet	Multiclone/ ESP	Cascade Impactor	PM-10[e]		14.4 lb/hr	1	12.0	8.0		
						4.18	2	12.4	7.7		
						3.62	3	12.2	7.9		
	Outlet	Multiclone/ ESP	M6	SO_2[d]	167 ppm,d	75 lb/hr	1	12.0	7.8		
					151	68	2	10.8	8.6		
					195	87	3	12.0	7.8		
	Outlet	Multiclone/ ESP	M6	HCl[d]	235 ppm,d	60 lb/hr	1				
					465	119	2				
					471	120	3				

Remarks:

III. SUMMARY DATA SHEET , (cont.)

Plant name Red Wing Power Station Plant location (city) Red Wing, Minnesota

Report number 8-2526 Project number

Process operation	Sampling location	Control equipment	Test method	Pollutant			Run No.	CO_2 %	O_2 %		
				Type	Concentration	Mass emission rate					
MWC Unit 2	Outlet	Multiclone/ ESP	M6	HF[d]	0.52 ppm,d	0.073 lb/hr	1				
					1.5	0.20	2				
					1.5	0.21	3				
	Outlet	Multiclone/ ESP	M7A	NO_x[a]	174 ppm,d	51 lb/hr	1				
					154	45	2				
					152	46	3				
	Inlet	Multiclone/ ESP	Multi-metals	Metals[b]	See Table	5 attached	1	12.3	7.7		
							2	12.8	7.1		
							3	12.6	7.2		
	Outlet	Multiclone/ ESP	Multi-metals	Metals[b]	See Table	6 attached	1	11.6	8.4		
							2	12.2	8.0		
							3	12.0	8.0		
	Inlet	Multiclone/ ESP	MM5	PAH[c]	See Table	8 attached	1	12.0	8.0		
							2	12.1	8.1		
							3	12.3	7.9		
	Oultet	Multiclone/ ESP	MM5	PAH[c]	See Table	9 attached	1	11.0	9.0		
							2	11.2	9.0		
							3	11.4	9.0		

Remarks:

III. SUMMARY DATA SHEET, (cont.)

Plant name Red Wing Power Station Plant location (city) Red Wing, Minnesota

Report number 8-2526 Project number

Process operation	Sampling location	Control equipment	Test method	Pollutant							
				Type	Concentration	Mass emission rate					
MWC Unit 2	Inlet	Multiclone/ ESP	MM5	CDD/[c] CDF	See Tables 11, 13,	and 15 attached					
	Outlet	Multiclone/ ESP	MM5	CDD/[c] CDF	See Tables 12, 14,	and 16 attached					
	ESP Hopper	Multiclone/ ESP	Grab Ash Sample	CDD/[c] CDF	See Tables 17, 18,	and 19 attached					

Remarks: [a]Samples collected simultaneously.
[b]Samples collected simultaneously.
[c]Samples collected simultaneously.
[d]Samples collected simultaneously.
[e]Samples collected simultaneously.

Table 5. Results of the March 22, 1988 Trace Metal Determinations on the No. 2 Boiler ESP Inlet at the NSP Red Wing Station.

Item	Run 1	Run 2	Run 3
(Concentration ug/dscm)			
Arsenic	104	324	170
Beryllium	1.9	1.2	1.9
Cadmium	740	930	690
Chromium	437	284	392
Lead	27540	17250	26140
Mercury	125	113	173
Nickel	389	294	322
Selenium	< 206	< 508	<1105
(Emission Rate 10^{-3}LB/HR)			
Arsenic	16	46	24
Beryllium	.29	.17	.27
Cadmium	110	130	100
Chromium	67	404	56
Lead	4197	2452	3763
Mercury	19	16	25
Nickel	59	42	46
Selenium	< 29	< 72	< 145

Table 6. Results of the March 22, 1988 Trace Metal Determinations on the No. 2 Boiler Stack at the NSP Red Wing Station.

Item	Run 1	Run 2	Run 3
(Concentration ug/dscm)			
Arsenic	22	14	1.1
Beryllium	< .17	< .17	< .17
Cadmium	5.0	2.5	.086
Chromium	135	60	9.5
Lead	69	36	25
Mercury	30	15	26
Nickel	213	84	54
Selenium	< 213	143	< 43
(Emission Rate 10^{-3}LB/HR)			
Arsenic	4.0	2.5	.20
Beryllium	< .03	< .03	< .03
Cadmium	.90	.45	.015
Chromium	24	11	1.7
Lead	12	6.6	4.4
Mercury	5.4	2.3	4.6
Nickel	38	15	9.6
Selenium	< 38	26	< 7.6

Table 8. Results of the March 23-25, 1988 PAH Determinations on the No. 2 Boiler ESP Inlet at the NSP Red Wing Station.

ITEM	Run 1	Run 2	Run 3
(Concentration ug/dsm^3)			
Napthalene	6.5	< .10	1.3
Acenaphthylene	.46	.013	.013
Acenapthene, dihydro	.017	.012	.019
Fluorene	< .073	< .071	< .071
Phenanthrene	1.9	.20	.078
Anthracene	.036	.0081	.0067
Fluoranthene	.44	.024	< .010
Pyrene	.44	< .040	< .04
Benz(a)anthracene	<.0080	< .0078	< .0078
Chrysene	.023	< .0031	.011
Benzfluoranthenes	.024	< .011	< .045
Benzo(a)pyrene	< .017	< .016	< .016
Indenopyrene	.0024	< .0078	< .0078
Dibenz(ah)anthracene	<.0039	< .0038	< .0038
Benzo(g,h,i)perylene	.021	<.00085	<.00086
(Emission Rate 10^{-6}g/sec)			
Napthalene	117	< 1.8	24
Acenaphthylene	8.3	.24	.24
Acenapthene, dihydro	.31	.22	.35
Fluorene	< 1.3	< 1.3	< 1.3
Phenanthrene	34	3.6	1.4
Anthracene	.65	.15	.12
Fluoranthene	7.9	.44	< .18
Pyrene	7.9	< .73	< .73
Benz(a)anthracene	< .14	< .14	< .14
Chrysene	.42	< .056	.20
Benzfluoranthenes	.43	< .20	< .82
Benzo(a)pyrene	< .31	< .29	< .29
Indenopyrene	.043	< .14	< .14
Dibenz(ah)anthracene	< .070	< .069	< .069
Benzo(g,h,i)perylene	.38	< .015	< .016

Table 9. Results of the March 23-25, 1988 PAH Determinations on the No. 2 Boiler Stack at the NSP Red Wing Station.

ITEM	Run 1	Run 2	Run 3
(Concentration ug/dsm^3)			
Napthalene	18	1.9	1.3
Acenaphthylene	9.9	.014	.012
Acenapthene, dihydro	.12	< .036	< .037
Fluorene	.64	< .14	< .14
Phenanthrene	5.2	.044	.029
Anthracene	.16	.0012	.0079
Fluoranthene	1.3	.0061	.040
Pyrene	1.4	< .0013	.018
Benz(a)anthracene	.016	< .0022	< .0023
Chrysene	.030	.0010	.00042
Benzfluoranthenes	.042	<.00091	<.00094
Benzo(a)pyrene	<.0040	.0044	.0050
Indenopyrene	.0095	< .0024	< .0025
Dibenz(ah)anthracene	<.0016	< .0016	< .0017
Benzo(g,h,i)perylene	.024	< .0048	< .0050
(Emission Rate 10^{-6}g/sec)			
Napthalene	384	40	26
Acenaphthylene	211	.30	.24
Acenapthene, dihydro	2.6	< .76	< .75
Fluorene	14	< 3.0	< 2.8
Phenanthrene	111	.93	.59
Anthracene	3.4	.025	.16
Fluoranthene	28	.13	.81
Pyrene	30	< .028	.36
Benz(a)anthracene	.34	< .047	< .046
Chrysene	.64	.021	.0085
Benzfluoranthenes	.90	< .019	< .019
Benzo(a)pyrene	< .085	.093	.10
Indenopyrene	.20	< .051	< .051
Dibenz(ah)anthracene	< .034	< .034	< .034
Benzo(g,h,i)perylene	.51	< .10	< .10

Table 11. Results of the March 23-25, 1988 Dioxin Homolog Analysis on the No. 2 Boiler ESP Inlet at the NSP Red Wing Station.

Homolog	Run 1	Run 2	Run 3
(Concentration ng/dsm^3)			
TCDD	4.1	.20	.17
PeCDD	8.2	.55	.45
HxCDD	8.7	.38	.22
HpCDD	12	.40	.24
OCDD	9.0	.31	.16
TCDF	41	6.6	6.2
PeCDF	27	3.3	3.1
HxCDF	15	1.7	1.4
HpCDF	10	.88	.74
OCDF	2.7	.097	.059
(Emission Rate 10^{-8}g/sec)			
TCDD	7.4	.36	.31
PeCDD	15	1.0	.82
HxCDD	16	.69	.40
HpCDD	22	.73	.44
OCDD	16	.56	.29
TCDF	74	12	11
PeCDF	49	6.0	5.7
HxCDF	27	3.1	2.6
HpCDF	18	1.6	1.4
OCDF	4.9	.18	.11

Table 12. Results of the March 23-25, 1988 Dioxin Homolog Analysis on the No. 2 Boiler Stack at the NSP Red Wing Station.

Homolog	Run 1	Run 2	Run 3
(Concentration ng/dsm^3)			
TCDD	.50	.57	.54
PeCDD	1.6	1.6	1.8
HxCDD	1.8	1.7	1.9
HpCDD	3.0	2.8	3.5
OCDD	2.8	2.4	3.1
TCDF	3.4	3.8	4.6
PeCDF	3.2	3.6	4.8
HxCDF	3.0	3.2	4.2
HpCDF	2.4	2.8	3.5
OCDF	.91	.97	.1.3
(Emission Rate 10^{-8}g/sec)			
TCDD	1.1	1.2	1.1
PeCDD	3.4	3.4	3.6
HxCDD	3.8	3.6	3.8
HpCDD	6.4	5.9	7.1
OCDD	6.0	5.1	6.3
TCDF	7.2	8.1	9.3
PeCDF	6.8	7.6	9.7
HxCDF	6.4	6.8	8.5
HpCDF	5.1	5.9	7.1
OCDF	1.9	2.1	2.6

Table 13. Results of the March 23-25, 1988 2,3,7,8-Isomer Analysis on the No. 2 Boiler ESP Inlet at the NSP Red Wing Station.

Isomer	Run 1	Run 2	Run 3
(Concentration ng/dsm^3)			
2,3,7,8-TCDD	.036	<.00090	<.0021
1,2,3,7,8-PeCDD	.53	< .036	.029
1,2,3,4,7,8-HxCDD	.60	.024	.0083
1,2,3,6,7,8-HxCDD	.60	.023	.014
1,2,3,7,8,9-HxCDD	1.1	.034	.021
1,2,3,4,6,7,8-HpCDD	5.8	.19	.11
2,3,7,8-TCDF	5.6	.71	.67
1,2,3,7,8-PeCDF	.77	.088	.038
2,3,4,7,8-PeCDF	1.3	.14	.11
1,2,3,4,7,8-HxCDF	2.9	.22	.17
1,2,3,6,7,8-HxCDF	2.9	.20	.12
1,2,3,7,8,9-HxCDF	1.9	.13	.083
2,3,4,6,7,8-HpCDF	.43	.024	.029
1,2,3,4,6,7,8-HpCDF	6.8	.36	.22
1,2,3,4,7,8,9-HpCDF	.44	.033	.029
(Emission Rate 10^{-8}g/sec)			
2,3,7,8-TCDD	.065	< .0016	<.0038
1,2,3,7,8-PeCDD	.96	< .065	.053
1,2,3,4,7,8-HxCDD	1.1	.044	.015
1,2,3,6,7,8-HxCDD	1.1	.042	.026
1,2,3,7,8,9-HxCDD	2.0	.062	.038
1,2,3,4,6,7,8-HpCDD	10	.35	.20
2,3,7,8-TCDF	10	1.3	1.2
1,2,3,7,8-PeCDF	1.4	.16	.069
2,3,4,7,8-PeCDF	2.3	.25	.20
1,2,3,4,7,9-HxCDF	5.2	.40	.31
1,2,3,6,7,8-HxCDF	5.2	.36	.22
1,2,3,7,8,9-HxCDF	3.4	.24	.15
2,3,4,6,7,8-HxCDF	.78	.044	.053
1,2,3,4,6,7,8-HpCDF	12	.65	.40
1,2,3,4,7,8,9-HpCDF	.79	.060	.053

Table 14. Results of the March 23-25, 1988 2,3,7,8-Isomer Analysis on the No. 2 Boiler Stack at the NSP Red Wing Station.

Isomer	Run 1	Run 2	Run 3
(Concentration ng/dsm^3)			
2,3,7,8-TCDD	<.0022	<.0026	<.0029
1,2,3,7,8-PeCDD	.085	.075	.087
1,2,3,4,7,8-HxCDD	.093	.091	.10
1,2,3,6,7,8-HxCDD	.16	.15	.16
1,2,3,7,8,9-HxCDD	.22	.19	.25
1,2,3,4,6,7,8-HpCDD	.16	1.5	1.9
2,3,7,8-TCDF	.68	.81	1.0
1,2,3,7,8-PeCDF	.11	.13	.12
2,3,4,7,8-PeCDF	.28	.30	.37
1,2,3,4,7,8-HxCDF	.58	.67	.83
1,2,3,6,7,8-HxCDF	.54	.67	.85
1,2,3,7,8,9-HxCDF	.40	.48	.58
2,3,4,6,7,8-HpCDF	.20	.13	.19
1,2,3,4,6,7,8-HpCDF	1.4	1.5	1.8
1,2,3,4,7,8,9-HpCDF	.30	.36	.50
(Emission Rate 10^{-8}g/sec)			
2,3,7,8-TCDD	<.0047	<.0055	<.0059
1,2,3,7,8-PeCDD	.18	.16	.18
1,2,3,4,7,8-HxCDD	.20	.19	.20
1,2,3,6,7,8-HxCDD	.34	.32	.32
1,2,3,7,8,9-HxCDD	.47	.40	.51
1,2,3,4,6,7,8-HpCDD	3.4	3.2	3.8
2,3,7,8-TCDF	1.4	1.7	2.0
1,2,3,7,8-PeCDF	.23	.28	.24
2,3,4,7,8-PeCDF	.60	.64	.75
1,2,3,4,7,9-HxCDF	1.2	1.4	1.7
1,2,3,6,7,8-HxCDF	1.2	1.4	1.7
1,2,3,7,8,9-HxCDF	.85	1.0	1.2
2,3,4,6,7,8-HxCDF	.43	.28	.38
1,2,3,4,6,7,8-HpCDF	3.0	3.2	3.6
1,2,3,4,7,8,9-HpCDF	.64	.76	1.0

Table 15. Results of the March 1988 Dioxin Determination on the No. 2 Boiler ESP Inlet at the NSP Red Wing Station (presented in 2,3,7,8-TCDD Equivalents).

		2,3,7,8-TCDD Equivalents		
	TEF	Run 1	Run 2	Run 3
Concentration	**($ng/dscm^3$)**			
2,3,7,8-TCDD	1	.036	< .00090	< .0021
Other TCDDs	.01	.041	< .0020	< .0017
2,3,7,8-PeCDD	.5	.27	< .018	.015
Other PeCDDs	.005	.040	< .0026	.0021
2,3,7,8-HxCDD	.04	.092	.0032	.0017
Other HxCDDs	.0004	.0026	.00012	.000072
2,3,7,8-HpCDD	.001	.0058	.00019	.00011
Other HpCDDs	.00001	.000062	.0000021	.0000013
2,3,7,8-TCDF	.1	.56	.071	.067
Other TCDFs	.001	.035	.0059	.0055
2,3,7,8-PeCDF	.1	.21	.023	.015
Other PeCDFs	.001	.025	.0031	.0030
2,3,7,8-HxCDF	.01	.081	.0057	.0040
Other HxCDFs	.0001	.00069	.00011	.00010
2,3,7,8-HpCDF	.001	.0072	.00039	.00025
Other HpCDFs	.00001	.000028	.0000049	.0000049
Total		1.4	≤ .14	≤ .12
Emission Rate (10^{-8} g/sec)				
2,3,7,8-TCDD	1	.065	< .0016	< .0038
Other TCDDs	.01	.073	< .0036	< .0031
2,3,7,8-PeCDD	.5	.48	< .033	.027
Other PeCDDs	.005	.070	< .0047	.0039
2,3,7,8-HxCDD	.04	.17	.0060	.0032
Other HxCDDs	.0004	.0048	.00022	.00013
2,3,7,8-HpCDD	.001	.010	.00035	.00020
Other HpCDDs	.00001	.00012	.0000038	.0000024
2,3,7,8-TCDF	.1	1.0	.13	.12
Other TCDFs	.001	.064	.011	.0098
2,3,7,8-PeCDF	.1	.37	.041	.027
Other PeCDFs	.001	.045	.0056	.0054
2,3,7,8-HxCDF	.01	.15	.010	.0073
Other HxCDFs	.0001	.0012	.00021	.00019
2,3,7,8-HpCDF	.001	.013	.00071	.00045
Other HpCDFs	.00001	.000050	.0000089	.0000095
Total		2.5	≤ .25	≤ .21

TEF = Toxicity equivalence factor

Table 16. Results of the March 1988 Dioxin Determination on the No. 2 Boiler Stack at the NSP Red Wing Station (presented in 2,3,7,8-TCDD Equivalents).

		2,3,7,8-TCDD Equivalents		
	TEF	Run 1	Run 2	Run 3
Concentration	**(ng/dscm^3)**			
2,3,7,8-TCDD	1	< .0022	< .0026	< .0029
Other TCDDs	.01	< .0050	< .0057	< .0054
2,3,7,8-PeCDD	.5	.043	.038	.044
Other PeCDDs	.005	.0075	.0075	.0085
2,3,7,8-HxCDD	.04	.019	.017	.020
Other HxCDDs	.0004	.00052	.00096	.00056
2,3,7,8-HpCDD	.001	.00016	.0015	.0019
Other HpCDDs	.00001	.000028	.000013	.000016
2,3,7,8-TCDF	.1	.068	.081	.10
Other TCDFs	.001	.0027	.0030	.0036
2,3,7,8-PeCDF	.1	.039	.043	.049
Other PeCDFs	.001	.0028	.0032	.0043
2,3,7,8-HxCDF	.01	.017	.020	.025
Other HxCDFs	.0001	.00013	.00012	.00017
2,3,7,8-HpCDF	.001	.0017	.00036	.0023
Other HpCDFs	.00001	.0000070	.000024	.000012
Total		≤ .21	≤ .22	≤ .27
Emission Rate (10^{-8} g/sec)				
2,3,7,8-TCDD	1	< .0047	< .0055	< .0059
Other TCDDs	.01	< .011	< .011	< .011
2,3,7,8-PeCDD	.5	.090	.080	.090
Other PeCDDs	.005	.016	.016	.017
2,3,7,8-HxCDD	.04	.040	.036	.040
Other HxCDDs	.0004	.0011	.0011	.0011
2,3,7,8-HpCDD	.001	.0034	.0032	.0038
Other HpCDDs	.00001	.000030	.000027	.000033
2,3,7,8-TCDF	.1	.14	.17	.20
Other TCDFs	.001	.0058	.0064	.0073
2,3,7,8-PeCDF	.1	.083	.092	.099
Other PeCDFs	.001	.0060	.0067	.0087
2,3,7,8-HxCDF	.01	.037	.041	.050
Other HxCDFs	.0001	.00027	.00027	.00035
2,3,7,8-HpCDF	.001	.0036	.0040	.0046
Other HpCDFs	.00001	.000015	.000019	.000025
Total		≤ .44	≤ .47	≤ .54

TEF = Toxicity equivalence factor

2.9 Ash Sampling

The results of the dioxin and furan analysis of the composite flyash samples collected by NSP personnel from the hoppers of the ESP during the three dioxin test runs are presented in Tables 18 and 19. The 2,3,7,8-TCDD equivalent concentration of the flyash is only 2.8 ng/g (ppb, w/w).

It is interesting to note, in light of the above proposed thermal equilibrium of PCDDs and PCDFs with the flyash particulate material, the strong molecular weight-dependent association of the CDDs and CDFs with the flyash:

	Concentration (ng/g)		
	Run 1	Run 2	Run 3
TCDD	6.4	3.4	3.4
PeCDD	17	18	18
HxCDD	17	32	46
HpCDD	110	130	390
OCDD	200	240	460
TCDF	40	35	32
PeCDF	39	46	51
HxCDF	21	44	58
HpCDF	51	71	250
OCDF	65	84	171

Table 18. Results of the Dioxin and Furan Analysis of the Flyash Samples Collected from the ESP Hoppers During the March 23-25, 1988 Dioxin Stack Test on No. 2 Boiler at the NSP Red Wing Station.

Isomer	Run 1	Run 2	Run 3
(Concentration ng/g)			
TCDD	6.4	3.4	3.4
(2378)	.18	.16	.14
PeCDD	17	18	18
(12378)	.97	1.4	1.6
HxCDD	17	32	46
(123478)	.80	1.8	2.6
(123678)	1.2	2.2	4.4
(123789)	1.4	2.8	4.5
HpCDD	110	130	390
(1234678)	48	58	180
OCDD	200	240	460
TCDF	40	35	32
(2378)	6.1	5.3	5.0
PeCDF	39	46	51
(12378)	1.5	2.2	2.4
(23478)	2.7	4.0	4.0
HxCDF	21	44	58
(123478)	4.2	8.1	11
(123678)	4.1	9.1	13
(234678)	2.5	6.1	7.5
(123789)	.69	1.7	1.9
HpCDF	51	71	250
(1234678)	28	39	137
(1234678)	3.9	5.3	22
OCDF	65	84	171

Table 19. Results of the Dioxin and Furan HRGC/HRMS Analysis of the Flyash Samples Collected During the March 23-25, 1988 Dioxin Stack Test (2,3,7,8-TCDD Equivalents).

		2,3,7,8-TCDDEquivalents (ng/g)		
Moiety	TEF	Run 1	Run 2	Run 3
2,3,7,8-TCDD	1	.18	.16	.14
Other TCDDs	.01	.062	.032	.033
2,3,7,8-PeCDD	.5	.49	.70	.80
Other PeCDDs	.005	.080	.085	.080
2,3,7,8-HxCDD	.04	.14	.27	.48
Other HxCDDs	.0004	.0056	.010	.014
2,3,7,8-HpCDD	.001	.048	.058	.18
Other HpCDDs	.00001	.00062	.00072	.0021
2,3,7,8-TCDF	.1	.61	.53	.50
Other TCDFs	.001	.034	.030	.027
2,3,7,8-PeCDF	.1	.42	.62	.64
Other PeCDFs	.001	.035	.040	.045
2,3,7,8-HxCDF	.01	.11	.25	.33
Other HxCDFs	.0001	.0010	.0019	.0025
2,3,7,8-HpCDF	.001	.032	.044	.16
Other HpCDFs	.00001	.00019	.00027	.00091
Total		2.2	2.8	3.4

TEF = Toxicity equivalence factor

Sampling and Analytical Procedures: Sampling and analytical procedures should be adequately described. Sampling location, equipment, sample recovery, analysis, calibrations, and quality assurance procedures should b reviewed. Each step of the sampling and analytical procedures should be properly documented. Generally, EPA reference and/or proposed methods should have been used if applicable. If EPA reference methods were not used, evaluate the test method used and compare to the applicable EPA reference method. This comparison should be in detail and should determine if a bias in the results is evident.

Sampling and analytical procedures for each pollutant should be evaluated separately. This includes but is not limited to visible emissions, particle size determinations, and process materials sampling.

Summary of Results: Summarize the emission data (average pollutant concentration, visible emissions, particle size distribution, etc.) applicable to the specific project. Extraneous data should not be included in this summary. Note any bias (positive or negative) in the results due to sampling or analytical procedures, process operation, etc. State why the results were biased.

Recommendations and Conclusions: Specifically state how the data contained in the report should be utilized in the project. Make concise recommendations on how to improve or alleviate the data deficiencies. Conclusions should address accuracy, precision, and reliability of the results. These judgments should be discussed in the conclusions.

C. REPORT DATA REVIEW INSTRUCTIONS

There are four sections to the review checklist: Introduction, Source Operation, Test Procedures and Results, and Documentation. A separate page has been provided for each section. The reviewer will have to use more than one page for portions of the review if multiple pollutant sampling, several test locations, and/or various process operating conditions are encountered. For example, if a source was tested for sulfur dioxide and particulate at a single location, use two separate pages for the Test Procedures and Results. In addition, a blank form has been provided to encourage additional item listing and review comments.

The reviewer should address each item by placing a check in the appropriate column(s) or by indicating that this item is not applicable by writing NA in the comments column.

The YES column should be checked if the report provides complete or partial information requested for the item and the NO column if the information was not provided. The OK column has been provided to indicate that the data presented in the report for the specific item met project requirements. All deficiencies or other observations should be entered in the comment column. Every item will not be applicable to the general review requirements. In this case, enter NA in the comment column for Not Applicable.

Project requirements should be established for each item in order to effectively review the emission test report. The reviewer should consult with the individual(s) for whom he is performing the review to establish the specific project requirements. This approach is recommended to minimize rejection of valid emission test reports/data due to report deficiencies not applicable to the project goals.

Following are some general guidelines and explanations for each section of the Report Review:

C 1. INTRODUCTION

This section determines if the report includes who, what, when, where, and why. All items in this section are self-explanatory.

C 2. SOURCE OPERATION

The emission test report should address the process and control equipment status during the test period. Item 2 and 6 of this section refer to process and control equipment monitoring. The emission test report should indicate that the test team and/or monitor were aware of the process and control equipment operating status. Statements in the report concerning normal process operation, process upsets, or control equipment malfunctions during testing are indications that process and control equipment monitoring were performed during the testing. The raw materials input to the process should be addressed. For example, the type of waste burned in an incinerator during the tests should be described and compared to the normal type of waste burned in the incinerator.

List any process, control equipment, or pollutant monitors mentioned in the emission test report. Comments should be made concerning operation and calibration status of the monitor.

C 3. TEST PROCEDURES AND RESULTS

Each page should address one type of pollutant and one sampling location. This approach should be used to organize and clarify the comments for a specific pollutant at a specific sampling location.

The emission test report should address the items listed in this section and the reviewer should be able to determine how each phase of the sampling and analysis were performed. For example, if the sampling method requires the sampling train to be purged, did the report mention this, along with how long the train was purged? If the sample pH has to be adjusted during sample recovery prior to analysis, did the report mention this was done?

Quality assurance procedures should be evident in the data presented if not specifically addressed. Were audit samples used by the laboratory? If samples were analyzed by another laboratory, were spike samples provided? Was the dry gas meter calibration checked in the field? These are all examples of quality assurance procedures. As a minimum, calibration requirements specified by the test method should have been performed.

C 4. DOCUMENTATION

All field and analytical data used in the calculations should be recorded on a data sheet. The reviewer should be able to perform the complete calculation procedure from the recorded data provided in the emission test report. Any assumptions, such as the exhaust gas was assumed to be air with a molecular weight of 29, should be specifically stated and validated.

All calibration procedures and data should have been provided in the emission test report. Pre- and post-test calibrations required by the test method should be available in the report.

D. SUMMARY DATA SHEET INSTRUCTIONS

This sheet has been provided to summarize the emission test report data. Blank columns have been provided for the reviewer to summarize data of specific interest to the project. This could be visible emissions, particle size data, or source stack conditions (percent moisture, stack temperature, etc.).

IV. INSTRUCTIONS FOR PERFORMING THE EMISSION TEST REPORT REVIEW

A. INTRODUCTION

Emission tests are conducted for a specific purpose and seldom address all areas concerned with a detailed emission evaluation. Related data and documentation such as process operation during the testing is seldom presented in emission test reports. The primary purpose of the emission report review is to evaluate the available data and to determine if the data can be used in support of the specific project. Project data requirements should be established before performing the emission test review. Data requirements differ for standard setting, supporting existing standards, and screening studies. Otherwise test data may be eliminated due to some minor deficiency unrelated to the specific project data requirements.

Deficiencies in the report should be noted and properly explained. Recommendations should be made for obtaining the desired information when the report does not meet the established project requirements. Perform additional visible emission observations, obtain a detailed process description, and contact the state observer for additional data are examples of recommendations. Important comments, observations, and determinations should be fully expressed and explained to support the recommendations.

The following instructions describe the parameters used in performing the emission test report review. If a section of this review is not applicable (used) in the review procedure, the reviewer should write NOT APPLICABLE across the entire page. Leave the instructions attached to the final review so that any reader can use the review. The instructions are listed in chronological order for reference.

B. REVIEW SUMMARY INSTRUCTIONS

This section is to briefly summarize the results of the report review. Each phase of the emission measurement program should be addressed; specifically the purpose of the test, process operation, control equipment operation, sampling and analytical procedures, and summary of results. Deficiencies should be noted and specific recommendations and conclusions made.

Two pages have been provided for the review summary. Additional attachments may have to be included for reports dealing with multiple pollutants or sources.

Purpose of Test: State the purpose of the emission test. The following are normal types of emission tests: compliance, control efficiency (manufacturer's guarantee), research, continuous monitor certification, etc.

Purpose of Review: Summarize what the data will be used for; such as in the specific project, New Source Performance Standard background information.

Process Operation During Tests: Determine if process operations met test requirements and summarize with conclusions. As a minimum, the report should provide a process description and flow diagram and state whether the process operated normally during the testing period. Summarize key process data such as rated capacity, type of fuel used and other raw materials, and if the process is cyclic, batch, or continuous.

Control Equipment Status During Testing: Summarize control equipment data contained in the report and determine information necessary to complete the specific project requirements. The report should ifentify the type, manufacturer, and operating status of the control equipment during the test period.