Background Report Reference

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CS Ohm Manufacturing Company

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Office of Air Quality
Planning and Standards
Research Triangle Park NC 27711

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December 1985

ELECTROPLATING
REF. 4-58

Air

EPA

Neshap Screening Study Chromium

Emission Test Report C. S. Ohm Manufacturing Company Sterling Heights, MI

Source category:	Electroplating	Filename: ELEC_R58.WQ1	Date: 12/15/94
Plant name:	C.S. Ohm Manufacturing	Location: Sterling Heights, MI	Ref. No.: 4-58
Process:	Decorative chrome	Test date: June 17-21, 1985	Process rate basis: production

Source	Type of control	Pollutant	Run No.	Test Method	Samp. time, min	Isokinetic, %	Gas volume, DSCF	Volum. flow rate, DSCFM	Mass, ug	Concen., gr/DSCF	Emission rate, lb/hr	Process rate, A-hr	Emission factor		
													mg/A-hr	gr/A-hr	Rat.
Decorative chrome tank	FS	total Cr	1	Imping.	320	98.7	234.39	11,947	80.5	5.3E-06	0.00054	25,000	0.053	0.00081	
		total Cr	4		320	98.6	234.82	11,980	45.4	3.0E-06	0.00031	22,100	0.034	0.00052	
		total Cr	7		320	98.4	234.253	11,983	88.9	5.9E-06	0.00060	26,300	0.055	0.00085	
												Average	0.047	0.00073	NR
		Cr+6	4		320	98.7	234.388	11,947	15.6	1.0E-06	0.00011	25,000	0.010	0.00016	
		Cr+6	5		320	98.6	234.821	11,980	13.4	8.8E-07	9.0E-05	22,100	0.0099	0.00015	
		Cr+6	6		320	98.4	234.253	11,983	20.8	1.4E-06	0.00014	26,300	0.013	0.00020	
												Average	0.011	0.00017	NR
	FS	filt. PM	2	5	320	97.6	230.186	11,416	8,300	0.00056	0.0544	25,000	5.3	0.081	
		filt. PM	5		320	100.6	229.972	11,065	1,300	8.7E-05	0.0083	22,100	0.91	0.014	
		filt. PM	8		320	99.2	240.408	11,719	6,700	0.00043	0.0432	26,300	4.0	0.061	
												Average	3.4	0.052	A
		total Cr	2	5	320	97.6	230.186	11,416	3,500	0.00023	0.02296	25,000	2.2	0.034	
		total Cr	5		320	100.6	229.972	11,065	10,800	0.00072	0.06874	22,100	7.5	0.12	
		total Cr	8		320	99.2	240.408	11,719	16,200	0.00104	0.10446	26,300	9.6	0.15	
												Average	6.5	0.10	NR
		Cr+6	2		320	97.6	230.186	11,416	800	5.4E-05	0.00525	25,000	0.51	0.0078	
		Cr+6	5		320	100.6	229.972	11,065	2,800	0.00019	0.0178	22,100	2.0	0.030	
		Cr+6	8		320	99.2	240.408	11,719	4,200	0.00027	0.02708	26,300	2.5	0.038	
												Average	1.6	0.025	NR
	FS/PBS	filt. PM	3	5	288	94.2	275.95	12,477				23,300			
		filt. PM	6		288	94.6	276.54	12,443	4,100	0.00023	0.02440	20,500	2.6	0.040	
		filt. PM	9		288	94.5	275.27	12,404		0.0E+00		23,400			
												Average	2.6	0.040	NR
		total Cr	3	5	320	94.2	275.95	12,477	18,800	0.00105	0.11244	23,300	12	0.18	
		total Cr	6		320	94.6	276.54	12,443	14,300	0.00080	0.08511	20,500	10	0.15	
		total Cr	9		320	94.5	275.27	12,404	14,800	0.00083	0.08822	23,400	9.1	0.14	
												Average	10	0.16	NR
		Cr+6	3	5	320	98.7	275.95	12,477	2,100	0.00012	0.01256	23,300	1.3	0.020	
		Cr+6	6		320	98.6	276.54	12,443	2,700	0.00015	0.01607	20,500	1.9	0.029	
		Cr+6	9		320	98.4	275.27	12,404	3,200	0.00018	0.01907	23,400	2.0	0.030	
												Average	1.7	0.027	NR

Basis for rating: For chromium, outlet factors higher than inlet factors; for outlet PM, only one run performed.

EMISSION TEST REPORT

C. S. OHM MANUFACTURING COMPANY
STERLING HEIGHTS, MICHIGAN

ESED 85/02

EMB 85-CHM-10

by

Entropy Environmentalists, Inc.
Post Office Box 12291
Research Triangle Park, North Carolina 27709

Contract No. 68-02-3852
Work Assignments No. 18, 21, and 23
PN: 3023

EPA Task Manager
Dan Bivins

U. S. ENVIRONMENTAL PROTECTION AGENCY
EMISSION MEASUREMENT BRANCH
EMISSION STANDARDS AND ENGINEERING DIVISION
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

January 1986

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1.0 INTRODUCTION

During the week of June 17-21, 1985, Entropy Environmentalists, Inc. conducted an emission measurement program at C. S. Ohm Manufacturing Company's chromium plating plant located in Sterling Heights, Michigan. The purpose of this program was to provide data for a screening study to determine the quantity and form of chromium emissions associated with decorative chromium plating.

Comprehensive testing was conducted on a decorative chromium plating tank whose emissions are controlled by a packed-bed wet scrubber. This fume scrubber controlling emissions from the decorative chromium plating tank at the plant was selected for source testing for the following reasons:

- The plating tank appears to be typical of other automated decorative plating tanks in the chromium plating industry, based on operating parameters such as temperature, current, voltage, and plating time. The automatic hoist is programmed to change the rack in the chromium plating tank every 4.5 minutes. Electrolysis occurs in this tank for 1.5 minutes during each cycle, or 33 percent of the time. A demisting agent called MSP-1, manufactured by Harshaw Chemicals, is used in the tank to suppress misting. The use of demisting agents is common practice for decorative platers.
- The emissions capture system is highly efficient in directing fumes from the plating tank to the control device. The tank is equipped with a push-pull ventilation system that draws 16,000 scfm across a total tank surface area of 90 ft^2. (Included in this area is a storage tank used to concentrate chromic acid solutions from the rinse tank and the fume scrubber. No electrolysis occurs in this tank.)
- The emissions control device used at C. S. Ohm is typical of control devices in use at other decorative plating facilities. Most decorative plating facilities use impingement-type mist eliminators or packed-bed fume scrubbers to control chromic acid emissions. Emission data from testing at the outlet of the Viron wet packed-bed fume scrubber at this facility will represent emissions controlled by a typical fume scrubber.

Particulate concentrations and mass emission rates were measured at the scrubber inlet and outlet using U. S. Environmental Protection Agency (EPA) Reference Method 5.* Total chromium concentrations and hexavalent chromium concentrations were measured at the same locations by further analysis of the Method 5 samples using the alternate sample preparation and analytical procedures as described in Appendix C. Flue gas flow rates, temperature, moisture content, and composition [oxygen (O_2), carbon dioxide (CO_2), and carbon monoxide (CO)] were measured in conjunction with the particulate tests. In addition, an impinger train was run concurrent with the Method 5 train at the scrubber inlet to determine impinger collection efficiency for total and hexavalent chromium. And for approximately 8 1/2 hours on the second day of testing, a special high volume, constant rate, single point sampling run was conducted at the scrubber inlet using a Method 5 train.

Ms. Barbara Duletsky [Midwest Research Institute (MRI)] monitored process operation throughout the test period. Mr. Dan Bivins (EPA Task Manager) of the Emission Measurement Branch (EMB) and Mr. Al Vervaert of the Industrial Studies Branch (ISB) observed the test program. Mr. Robert Waters, Plating Plant Manager served as the contact for C. S. Ohm Manufacturing.

This report is organized into several sections addressing various aspects of the testing program. Immediately following this introduction is the "Process Operation" section which includes a description of the process and control device tested. Following this is the "Summary of Results" section which presents table summaries of the test data and discusses these results. The next section, "Sampling Locations and Test Methods" describes and

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*40 CFR 60, Appendix A, Reference Method 5, July 1, 1980.

illustrates the sampling locations for emissions testing and then explains the sampling strategies used. The final section, "Quality Assurance," notes the procedures used to ensure the integrity of the sampling program. The Appendices present the complete Test Results and Example Calculations (Appendix A); Field and Analytical Data (Appendix B); Sampling and Analytical Procedures (Appendix C); Calibration Data (Appendix D); MRI Process Data (Appendix E); and Test Participants and Observers (Appendix F).

2.0 PROCESS OPERATION

2.1 PROCESS DESCRIPTION

The C. S. Ohm Manufacturing Company manufactures bumpers for use in the automotive industry. The company has a captive plating shop that performs decorative nickel-chromium plating of the bumpers. The plating plant operates 24 hours per day, 6 days per week, 52 weeks per year, with the exception of Wednesday mornings from midnight to 6:00 a.m., when the operation ceases for maintenance purposes.

The decorative plating line consists of 36 tanks that contain various plating and cleaning solutions. The sequence of tanks is shown in Figure 2-1. The line is serviced by an automatically controlled hoist that transfers each rack of bumpers through the various tanks in the plating line.

The chromium plating segment of the line is comprised of one plating tank, one evaporation tank, and three rinse tanks. Emissions from the chromium plating tank were measured during this source test program. The tank measures 3.0 meters (m) (10 feet [ft]) in length, 1.4 m (4.5 ft) in width, 2.4 m (8 ft) in depth, and holds 10,600 liters (ℓ) (2,800 gallons) of plating solution. The solution contains chromic acid in a concentration of 330 to 340 grams per liter (g/ℓ) (44 to 46 ounces per gallon [oz/gal]). This is in the range of 220 to 370 g/ℓ (30 to 50 oz/gal) typically used by decorative chromium platers. Sulfuric acid is used in the solution as a catalyst in a concentration of 1.0 to 1.2 g/ℓ (0.14 to 0.16 oz/gal). The proper concentration of constituents is maintained by adding chromic acid and sulfuric acid every other day, and by adding make-up solution from the evaporation tank on alternate days. The total chromic acid consumption at C. S. Ohm is about 8,200 kilograms (18,000 pounds) per year.

Typically, a rack remains in the chromium plating tank for 4 minutes and 20 seconds. The normal operating temperature of the tank is between 46° and 63°C (115° and 145°F). The electrodes are charged by a single transformer/rectifier set that automatically controls the operating voltage and current. During a typical plating cycle, the tank operates at 2.5 volts (V) and 1,500 amperes (A) for 15 seconds to activate the nickel-plated surfaces. Then, the voltage increases to 12.4 V and the

Tank sequence	Description
1	Soap tank
2	Power spray
3	Electro-cleaner No. 1
4	Electro-cleaner No. 2
5	Water rinse
6	Water rinse
7	Anodic etch (contains H_2)
	Anodic etch (contains H_2)
8	Rinse
9	Rinse
10	Rinse
11	Electro-cleaner No. 3
12	Rinse
13	Muriatic acid
14	Rinse
15	Nickel strike
16	Dull nickel plate
	Dull nickel plate
	Dull nickel plate
	Dull nickel plate
	Dull nickel plate
	Dull nickel plate
	Dull nickel plate
	Dull nickel plate
17	Bright nickel plate
	Bright nickel plate
18	Micro-porous (MP) nickel plate
19	Nickel reclaim
20	Rinse
21	Activator chrome
	Chromium plate (evaporation tank)
22	Chromium plate
23	Chromic acid reclaim
24	Rinse
25	Rinse
26	Hot water rinse

Figure 2-1. Sequence of tanks on the decorative plating line at C. S. Ohm Manufacturing Company

current increases to 12,000 to 16,000 A for 90 seconds, during which chromium is deposited on the activated surfaces. This 90-second period is called "electrolysis." The current required during electrolysis is dependent on the surface area being plated and is automatically adjusted for each new rack of bumpers.

2.2 AIR POLLUTION CONTROL

A fume suppressant called "MSP-1" is used in the chromium plating tank to inhibit the release of gases generated during electrolysis. The suppressant is manufactured by Harshaw Chemical Company. It contains a fluorocarbon that decreases the surface tension of the plating solution, thus, decreasing the generation of mist. There are no test data available showing the emission reduction achieved by using this fume suppressant, although it is used commonly in the electroplating industry to preclude misting.

The chromium plating tank and evaporation tank are equipped with a push-pull ventilation system. Air jets on one end of the tanks push mist across the plating solution to a 1.2-m-high (4-foot-high) hood on the other end. An induced draft fan driven by a 20-horsepower motor draws emissions away from the tanks to the control device.

The control device is a wet, double-packed-bed scrubber manufactured by Viron International (Model HSDP-2000). The scrubber is designed to treat about 7.6 cubic meters per second (m^3/s) (16,765 standard cubic feet per minute [scfm]) of plating tank exhaust gases. Chromic acid is removed from the gas stream by impacting on two 30-cm-deep (12-inch-deep) beds of filter media that are continuously sprayed with scrubbing liquid. The spent liquid drains into a remote holding tank from which it is recirculated through the scrubber. The holding tank is emptied once every 2 or 3 days and refilled with fresh water. The holding tank has an estimated volume of 500 ℓ (132 gal) and pumps about 91 ℓ/min (24 gal/min) of liquid to the scrubber.

The scrubber also contains a mist eliminator stage for the final removal of liquid droplets from the gas stream. This stage consists of a "Chevron-type" arrangement of baffles that change the direction of gas flow several times. The entire scrubbing unit has a design removal efficiency of 99 percent for chromic acid.

2.3 PROCESS CONDITIONS DURING TESTING

The process was operating normally during the source test program. Process operating parameters such as temperature, voltage, and current were monitored during each test run and are recorded on the process data sheets in Appendix E. No operating parameters were monitored for the scrubber; however, there were no indications of any malfunction in the system during the testing.

Normal operating conditions allowed all three test runs to be performed without interruption. A scheduled 10-minute break in operation occurred each day at 10:30 a.m., but this was not considered cause to suspend testing because it was of short duration. Inlet and outlet testing were performed simultaneously.

The total current supplied to the tank during each test run is calculated in terms of ampere-seconds and included in Appendix E. A summary of the total current values is presented in terms of ampere-seconds and ampere-hours in Table 2-1.

TABLE 2-1. TOTAL CURRENT SUPPLIED TO TANK DURING SOURCE TESTS

Test No.	Total current, ampere-seconds Inlet	Total current, ampere-seconds Outlet	Total current, ampere-hours Inlet	Total current, ampere-hours Outlet
1	90,000,000	83,900,000	25,000	23,300
2	79,590,000	73,740,000	22,100	20,500
3	94,620,000	84,350,000	26,300	23,400

3.0 SUMMARY OF RESULTS

Particulate matter (EPA Method 5) tests were conducted at the inlet and the outlet of the packed-bed wet scrubber controlling the decorative chromium plating tank. Because the emissions were chromic acid fumes, "impinger train" tests were run at the scrubber inlet to evaluate the use of Method 5 for sample collection. An additional run using the Method 5 train was conducted at a high sampling rate (HV) for eight hours at a single point. The data is presented for the high volume run but not discussed since the other tests were quantifiable and conducted isokinetically at all points. Table 3.1 summarizes the testing schedule for this testing program.

In brief, from the results of the Method 5 testing, the uncontrolled emissions from the tank averaged 0.035 pounds per hour of particulate matter, 0.000017 pounds per hour of hexavalent chromium, and 0.000065 pounds per hour of total chromium. Based on the Method 5 results, the controlled emissions averaged 0.024 pounds per hour of particulate matter, 0.000016 pounds per hour of hexavalent chromium, and 0.000095 pounds per hour of total chromium. Also based on the Method 5 results, the collection efficiency of the wet scrubber appeared to be low, however, this is inconclusive due to questionable data quality as indicated by the methods evaluation comparison with the impinger train. The impinger train samples were not analyzed for particulate matter. The collection efficiency of the impinger train indicated that essentially all the chromium was collected by the impingers and the impinger train results for hexavalent chromium at 0.00011 pounds per hour averaged about seven times greater than those from the Method 5 train.

TABLE 3.1. TESTING SCHEDULE FOR C. S. OHM

Date (1985)	Sample Type	Scrubber Inlet		Scrubber Inlet (Impinger Train)*		Scrubber Outlet	
		Run No.	Test Time 24 h clock	Run No.	Test Time 24 h clock	Run No.	Test Time 24 h clock
6/18	Particulate	2	1004-1529	1	1005-1530	3	1003-1505
6/19	Particulate Particulate (HV)**	5 SR	0838-1404 1419-2247	4	0839-1405	6	0837-1336
6/20	Particulate	8	0855-1420	7	0856-1421	9	0855-1350

*Runs 1, 4, and 7 utilized an impinger train.

**Special high volume, constant rate, single point, run (SR).

In the following sections, the results addressed above and additional results are presented and discussed in detail according to the emission type and sampling location. The computer printouts of the emission calculations can be found in Appendix A. The original field data sheets and the analytical data are located in Appendix B.

3.1 PARTICULATE MATTER, HEXAVALENT CHROMIUM, AND TOTAL CHROMIUM

Particulate matter tests (EPA Method 5) along with the determination of the associated flue gas flow rates were conducted at both the scrubber inlet and outlet; impinger train method evaluation tests were conducted at the scrubber inlet. The particulate matter samples were initally analyzed using gravimetric techniques to determine the mass of particulate matter. Then the samples were further analyzed for hexavalent and total chromium. The impinger train samples were analyzed for hexavalent and total chromium only. Complete descriptions of each sampling location and the sampling and analytical procedures are given in Chapter 4 (and Appendix C).

3.1.1 Scrubber Inlet (EPA Method 5)

The results for the scrubber inlet (EPA Method 5) represent the uncontrolled emissions from the plating tank as measured by EPA Method 5. The circular vertical inlet duct was traversed with both an EPA Method 5 sampling train and an impinger train. The results from these two trains should be compared for methods evaluation purposes as a check on the ability of the EPA Method 5 sample train to collect chromic acid fumes.

Flue Gas Conditions and Isokinetic Sampling Rate - A summary of the flue gas conditions at the scrubber inlet (EPA Method 5 and impinger train) and the scrubber outlet (EPA Method 5 train) is presented in Table 3.2. The volumetric

TABLE 3.2. SUMMARY OF FLUE GAS CONDITIONS

Run No.	Date (1985)	Test Time 24 h clock	Volumetric Flow Rate				Stack Temperature		Moisture %	O_2 %	CO_2 %	CO %	Isokinetic %
			Actual[a]		Standard[b]								
			acmh × 10^6	acfh × 10^6	dscmh × 10^6	dscfh × 10^6	°C	°F					
Scrubber Inlet (Impinger Train)													
1	6/18	1005-1530	0.0216	0.764	0.0203	0.717	25	77	1.0	20.9	0.0	0.0	98.7
4	6/19	0839-1405	0.0215	0.759	0.0204	0.719	24	76	1.0	20.9	0.0	0.0	98.6
7	6/20	0856-1421	0.0216	0.764	0.0204	0.719	26	79	1.0	20.9	0.0	0.0	98.4
Average			0.0216	0.762	0.0204	0.718	25	77	1.0	20.9	0.0	0.0	
Scrubber Inlet (Method 5)													
2	6/18	1004-1529	0.0206	0.728	0.0194	0.685	25	77	0.8	20.9	0.0	0.0	97.6
5	6/19	0838-1404	0.0200	0.705	0.0188	0.664	25	77	1.3	20.9	0.0	0.0	100.6
8	6/20	0855-1420	0.0212	0.748	0.0199	0.703	26	79	1.2	20.9	0.0	0.0	99.2
Average			0.0206	0.727	0.0194	0.684	25	78	1.1	20.9	0.0	0.0	
Scrubber Inlet - Special Run													
SR	6/19	1419-2247	0.0197	0.695	0.0187	0.660	26	79	0.2	20.9	0.0	0.0	79.8
Scrubber Outlet													
3	6/18	1003-1505	0.0222	0.785	0.0212	0.749	20	68	1.4	20.9	0.0	0.0	94.2
6	6/19	0837-1336	0.0221	0.780	0.0211	0.747	20	68	1.7	20.9	0.0	0.0	94.6
9	6/20	0855-1350	0.0222	0.783	0.0211	0.744	22	72	1.8	20.9	0.0	0.0	94.5
Average			0.0222	0.783	0.0211	0.747	21	69	1.6	20.9	0.0	0.0	

[a] Volumetric flow rate in actual cubic meters per hour (acmh) and actual cubic feet per hour (acfh) at stack conditions.
[b] Volumetric flow rate in dry standard cubic meters per hour (dscmh) and dry standard cubic feet per hour (dscfh).

flow rates for the inlet Method 5 tests were fairly consistent and averaged 20,600 actual cubic meters per hour (727,000 actual cubic feet per hour).

The flue gas temperature averaged 25°C (78°F), with a moisture content of 1.1 percent. The oxygen, carbon dioxide, and carbon monoxide content was that of air at 20.9, 0.0, and 0.0 percent, respectively. The volumetric flow rate at standard conditions averaged 19,400 dry standard cubic meters per hour (684,000 dry standard cubic feet per hour). Standard conditions are 20°C (68°F), 760 mm Hg (29.92 in. Hg), and dry. The isokinetic sampling rate was within the allowable range for all three sample runs.

Particulate Emissions - The particulate emissions from the plating tank (see Table 3.3) were variable. The particulate emissions for the inlet runs averaged 0.82 milligrams per dry standard cubic meter (0.00036 grains per dry standard cubic foot) and 0.016 kilograms per hour (0.035 pounds per hour). The variability was likely due to sampling and analytical error in measuring the extremely low pollutant concentrations.

Hexavalent Chromium Emissions - The hexavalent chromium emissions for each test run (see Table 3.3) were also variable with the corresponding particulate run. They averaged 95, 2150, and 633 milligrams of hexavalent chromium per gram of particulate emissions for runs 2, 5, and 8, respectively. The hexavalent chromium emissions for the inlet tests averaged 0.39×10^{-3} milligrams per dry standard cubic meter (0.17×10^{-6} grains per dry standard cubic foot) and 7×10^{-6} kilograms per hour (17×10^{-6} pounds per hour).

Total Chromium Emissions - The total chromium emissions for each test run (see Table 3.3) were variable with respect to the corresponding particulate run and averaged 423, 8290, and 2429 milligrams of total chromium per gram of

TABLE 3.3. SUMMARY OF PARTICULATE, HEXAVALENT CHROMIUM, AND TOTAL CHROMIUM EMISSIONS

Run No.	Date (1985)	Particulate				Hexavalent Chromium				Total Chromium			
		concentration		mass emissions		concentration		mass emissions		concentration		mass emissions	
		mg/dscm	gr/dscf	kg/h	lb/h	mg/dscm $\times 10^{-3}$	gr/dscf $\times 10^{-3}$	kg/h $\times 10^{-3}$	lb/h $\times 10^{-3}$	mg/dscm $\times 10^{-3}$	gr/dscf $\times 10^{-3}$	kg/h $\times 10^{-3}$	lb/h $\times 10^{-3}$
Scrubber Inlet (Impinger Train)													
1	6/18	(not analyzed)				2.35	0.00103	0.048	0.10	12.13	0.0053	0.246	0.543
4	6/19					2.02	0.00088	0.041	0.09	6.83	0.0030	0.139	0.306
7	6/20					3.14	0.00137	0.064	0.14	13.40	0.0059	0.273	0.602
Average						2.50	0.00109	0.051	0.11	10.8	0.0047	0.22	0.48
Scrubber Inlet (Method 5)													
2	6/18	1.27	0.00056	0.025	0.054	0.12	0.00005	0.002	0.005	0.537	0.00023	0.010	0.023
5	6/19	0.20	0.00009	0.004	0.008	0.43	0.00019	0.008	0.018	1.658	0.00072	0.031	0.069
8	6/20	0.98	0.00043	0.020	0.043	0.62	0.00027	0.012	0.027	2.380	0.00104	0.047	0.104
Average		0.82	0.00036	0.016	0.035	0.39	0.00017	0.007	0.017	1.52	0.0007	0.029	0.065
Scrubber Inlet (Special Run)													
SR	6/19	0.226	0.00010	0.004	0.009	0.36	0.00016	0.007	0.015	0.91	0.0004	0.017	0.038
Scrubber Outlet													
3	6/18	*	*	*	*	0.27	0.00012	0.006	0.013	2.406	0.00105	0.051	0.112
6	6/19	0.524	0.00023	0.011	0.024	0.34	0.00015	0.007	0.016	1.826	0.00080	0.039	0.085
9	6/20	*	*	*	*	0.41	0.00018	0.009	0.019	1.899	0.00083	0.040	0.088
Average		0.524	0.00023	0.011	0.024	0.34	0.00015	0.007	0.016	2.04	0.0009	0.043	0.095

*Particulate catch was not quantifiable.

particulate. The total chromium emissions averaged 1.52 x 10^{-3} milligrams per dry standard cubic meter (0.7 x 10^{-6} grams per dry standard cubic foot) and 0.029 x 10^{-3} kilograms per hour (0.065 x 10^{-3} pounds per hour).

3.1.2 Scrubber Inlet (Impinger Train)

The results for the scrubber inlet (impinger train) represent the uncontrolled emissions from the plating tank as measured by the impinger train. The Method 5 and impinger train sampling were conducted simultaneously in the vertical circular duct prior to the packed bed scrubber. The impinger train tests wree conducted to evaluate the use of the Method 5 train for the reference method collection of the chromic acid fumes for the chromium plating industry. The results of the Method 5 and impinger train testing should be comparable.

Flue Gas Conditions and Isokinetic Sampling Rate - A summary of the flue gas conditions at the scrubber inlet (impinger train) is presented in Table 3.2. The volumetric flow rate results for both the Method 5 train and impinger train were within standard measurement error of each other. The isokinetic sampling rate was within the allowable range for all three impinger train sample runs.

Particulate Emissions - The collected samples were not analyzed for particulate emissions since all of the impinger contents would have had to be taken to dryness. Also, it would have made the analysis for hexavalent and total chromium more difficult in the sample preparation phase.

Hexavalent Chromium Emissions - The hexavalent chromium emissions were fairly consistent averaging 2.5 x 10^{-3} milligrams per dry standard cubic meter (1.1 x 10^{-6} grains per dry standard cubic foot) and 51 x 10^{-6} kilograms per hour (110 x 10^{-6} pounds per hour). This was about seven times greater than the hexavalent chromium emissions measured by the EPA Method 5 train. The reason for the extremely poor agreement is not known.

Total Chromium Emissions - The total chromium emissions averaged 10.8 x 10^{-3} milligrams per dry standard cubic meter (4.7 x 10^{-6} grains per dry standard cubic foot) and 0.22 x 10^{-3} kilograms per hour (0.48 x 10^{-3} pounds per hour). This was about eight times greater than the total chromium emissions measured by the EPA Method 5 train. This is in agreement with the comparison of the hexavalent chromium results between the two sampling trains.

3.1.3 Scrubber Outlet

The scrubber outlet represents the controlled emissions from the chromium plating tank as measured by EPA Method 5; no impinger train tests were conducted at the scrubber outlet. A four-inch filter and larger than normal size nozzle were used in an effort to collect the maximum sample volume under isokinetic sampling conditions.

Flue Gas Conditions and Isokinetic Sampling Rate - A summary of flue gas conditions at the scrubber outlet is presented in Table 3.2. The volumetric flow rates for the three outlet runs were very consistent. The outlet volumetric flow rate averaged 22,200 actual cubic meters per hour (783,000 actual cubic feet per hour) with a flue gas temperature of 21°C (69°F) and a moisture content of 1.6 percent. The oxygen, carbon dioxide, and carbon monoxide concentrations were that of ambient air at 20.9, 0.0, and 0.0 percent, respectively. The volumetric flow rate at standard conditions averaged 21,100 dry standard cubic meters per hour (747,000 dry standard cubic feet per hour). Standard conditions are 20°C (68°F), 760 mm Hg (29.92 in. Hg), and dry.

The isokinetic sampling rates were well within the allowable range for all runs.

Particulate Emissions - The particulate emissions exiting from the control equipment to the atmosphere were not quantifiable (see Table 3.3) for two of the three runs. For the one run which had quantifiable results, the particulate emissions averaged 0.5 milligrams per dry standard cubic meter (0.0002 grains per dry standard cubic foot) and 0.01 kilograms per hour (0.02 pounds per hour). The other two runs had negative sample weights. Method 5 was intended to accurately measure pollutant concentrations at these low levels.

Hexavalent Chromium Emissions - The hexavalent chromium emissions for each test run were fairly consistent and averaged 0.34×10^{-3} milligrams per dry standard cubic meter (0.15×10^{-6} grains per dry standard cubic feet) and 7×10^{-6} kilograms per hour (16×10^{-6} pounds per hour). These results were similar in magnitude to the Method 5 uncontrolled results.

Total Chromium Emissions - The total chromium emissions were fairly consistent and averaged 2.04×10^{-3} milligrams per dry standard cubic meter (0.9×10^{-6} grams per dry standard cubic foot) and 0.043×10^{-3} kilograms per hour (0.095×10^{-3} pounds per hour). These results were greater than the controlled emissions as measured by the EPA Method 5 train.

3.2 EMISSIONS IN UNITS OF PROCESS RATE AND CONTROL EQUIPMENT COLLECTION EFFICIENCY

The emission rates in units of process rate are given in terms of milligrams of emissions per hour per square foot of tank surface area, and in units of milligrams of emissions per amperage input to the plating operation. To determine the collection efficiency of the scrubber, the milligrams per hour per square foot (uncontrolled emissions and controlled emissions) were used for the calculations.

3.2.1 Emissions in Units of Process Rate

Two process parameters were used to determine the emissions in terms of units of the process rate as shown in Table 3.4. The first was milligrams of emissions per amperage input to the plating operation. The second was milligrams of emissions per hour per square foot of tank surface area. The surface area of the tank was 45 ft^2 for all tests.

TABLE 3.4. SUMMARY OF EMISSION RATES IN UNITS OF PROCESS RATE AND EFFICIENCY

Run Nos.	Process Rate current supplied to tank in amps/hr	Uncontrolled Emissions						Controlled Emissions						Collection Efficiency**		
		particulate		hexavalent chromium		total chromium		particulate		hexavalent chromium		total chromium		particulate %	hexavalent chromium %	total chromium %
		mg/amp	mg/hr/ft²	mg/amp hr	mg/hr/ft²	mg/amp	mg/hr/ft²	mg/amp	mg/hr/ft²	mg/amp	mg/hr/ft²	mg/amp	mg/hr/ft²			
							Scrubber Inlet (Impinger Train)									
1	25,000	not analyzed	not analyzed	0.0019	1.07	0.0098	5.46	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	22,100			0.0019	0.91	0.0063	3.09									
7	26,300			0.0024	1.42	0.0104	6.07									
Average				0.0021	1.13	0.0088	4.87									
							Scrubber Inlet (Method 5)									
2	25,000	0.0010	556	0.00008	0.04	0.0004	0.22	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5	22,100	0.0002	89	0.00036	0.18	0.0014	0.69									
8	26,300	0.0008	444	0.00046	0.27	0.0018	1.04									
Average		0.0007	363	0.00030	0.16	0.0012	0.65									
							Scrubber Outlet (Method 5)									
3	23,300	N/A	N/A	N/A	N/A	N/A	N/A	no val	no val	0.00026	0.13	0.0022	1.13	no val	---	---
6	20,500							0.00054	244	0.00034	0.16	0.0019	0.87	---	11.1	---
9	23,400							no val	no val	0.00038	0.20	0.0017	0.89	no val	25.9	14.4
Average								0.00054	244	0.00033	0.16	0.0019	0.96	32.8***	0***	---***

*Emission rate in units of milligrams of emissions per hour per square foot of tank surface using a tank surface of 45 ft^2 for all tests.

**Air pollution control efficiency calculations are based on uncontrolled and controlled emissions in units of mg/hr/ft^2.

***Calculated based on averages of *uncontrolled and controlled emissions.*

3.2.2 Control Equipment Collection Efficiency

The collection efficiency of the packed-bed scrubber (see Table 3.4) was extremely low based on the EPA Method 5 results. The control equipment collection efficiency was 32.8 percent for particulate and was zero percent for hexavalent chromium. The measured emissions for total chromium were greater after the scrubber than prior to the scrubber. The validity of the results are questionable based on the methods evaluation tests and should not be used as an accurate indication of collection efficiency.

3.3 SUMMARY OF ANALYTICAL RESULTS FOR HEXAVALENT AND TOTAL CHROMIUM

The summary of analytical results for the hexavalent chromium and total chromium analyses of samples collected is presented in Table 3.5. The analytical data sheets are contained in Appendix B. The results shown in Table 3.5 for hexavalent and total chromium are the results obtained using the EPA tentative method for "Determination of Hexavalent Chromium Emissions from Stationary Sources" and the "EPA Protocol for Emissions Sampling for Both Hexavalent and Total Chromium" (see Appendix C). When, for total chromium analysis, the table indicates that the sample "residue" was analyzed, then the values presented for total chromium content are a sum of (1) the hexavalent chromium in the sample filtrate from the extraction of the sample and (2) the chromium in the residue from the extraction as measured by Neutron Activation Analysis. When the table indicates that the "total" sample was analyzed, then the values presented for total chromium content are from the direct analysis of the total sample for total chromium by Neutron Activation Analysis. A table showing the total chromium calculations for each sample can be found at the end of Appendix A of this report.

The collection efficiency of hexavalent chromium by the impinger train is believed to be greater than 99%. The efficiency was determined by analyzing the impinger contents separately as shown in Table 3.5.

TABLE 3.5 SUMMARY OF ANALYTICAL RESULTS FOR HEXAVALENT AND TOTAL CHROMIUM

Run No.	Sample Type	Sample No. Analyzed	Amount of Sample Analyzed	Hexavalent Chromium Results µg	Hexavalent Chromium Concentration µg/g	Amount of Sample Analyzed	Total Chromium Results µg	Total Chromium Concentration µg/g or µg/ml
	Scrubber Inlet (Impinger Train)							
1	1st Impinger Contents	C-255	Total	15.6	15.6 µg total†	Half	77.38*	80.5 µg total†
1	2nd Impinger Contents	C-256	Total	< 0.2		Half	2.56*	
1	3rd Impinger Contents	C-257	Total	< 0.2		Half	2.26*	
4	1st Impinger Contents	C-258	Total	13.2	13.4 µg total†	Half	40.54*	45.4 µg total†
4	2nd Impinger Contents	C-259	Total	< 0.2		Half	2.82*	
4	3rd Impinger Contents	C-260	Total	0.2		Half	4.26*	
7	1st Impinger Contents	C-261	Total	19.4	20.8 µg total†	Half	71.70*	88.9 µg total†
7	2nd Impinger Contents	C-262	Total	0.7		Half	8.84*	
7	3rd Impinger Contents	C-263	Total	0.7		Half	10.36*	
	Scrubber Inlet (Method 5 and High Volume Train)							
2	Particulate Front Half	C-241	8.3 mg	0.8	96	Residue	2.5	301.2
2	Impinger Contents	C-249	Total	< 0.2	negligible	Half	1.0	----
5	Particulate Front Half	C-242	1.3 mg	2.8	2150	Residue	9.4	7230.8
5	Impinger Contents	C-250	Total	< 0.2	negligible	Half	1.4	----
8	Particulate Front Half	C-243	6.7 mg	4.2	627	Residue	16.2	2417.9
8	Impinger Contents	C-251	Total	< 0.2	negligible	Half	----	----
SR	Particulate Front Half	C-244	3.7 mg	5.9	1590	Residue	14.9	4027.0
SR	Impinger Contents	C-267	Total	< 0.2	negligible	Half	----	----
	Scrubber Outlet							
3	Particulate Front Half	C-245	**	2.1	**	Residue	18.8	----
3	Impinger Contents	C-252	Total	< 0.2	negligible	Half	----	----
6	Particulate Front Half	C-246	4.1 mg	2.7	659	Residue	14.3	3487.8
6	Impinger Contents	C-253	Total	< 0.2	negligible	Half	----	----
9	Particulate Front Half	C-247	**	3.2	**	Residue	14.8	----
9	Impinger Contents	C-254	Total	< 0.2	negligible	Half	----	----
	Scrubber Water Discharge (liquids)							
	Scrubber H_2O	C-265	--	--	5.09 µg/ml	1.0 ml	12.7	12.7 µg/ml
	Blank Samples							
	Particulate Filter	C-248	--	1.1		Residue	6.7	----
	Distilled H_2O w/Acetone	C-264	--	--	< 0.2 µg/ml	1.0 ml	2.0	2.0 µg/ml

*Not blank corrected. **Particulate catch was not quantifiable.

† The concentration in terms of µg/g could not be calculated since the mass collected by the impingers was not determined; the value represents the total weight of chromium collected in all three impingers.

Both the quantity of the particulate and the hexavalent chromium analyzed were extremely low and, under these circumstances, both sets of analytical results are subject to greater analytical error.

Quality assurance audit samples were analyzed for both the hexavalent and total chromium methods. As shown in Table 3.6, no bias was present and the results are considered acceptable.

There is some sample analysis variability due to the small amount of hexavalent chromium present. However, the average values for the runs are believed to be fairly accurate.

TABLE 3.6. SUMMARY OF ANALYTICAL RESULTS FOR HEXAVALENT AND TOTAL CHROMIUM QUALITY ASSURANCE SAMPLES

Run No.	Sample Type	Sample No.	True Value	Hexavalent Chromium		Total Chromium	
				Results µg/ml	% Dev.	Results µg	% Dev.
Quality Assurance Samples							
--	Quality Assurance	C-266	50 µg/ml Cr^{+6}	52.4	+4.8	----	----
--	Quality Assurance	QA-16	50 µg Cr	----	----	45.69	-8.6
--	Quality Assurance	QA-17	100 µg Cr	----	----	96.49	-3.5
--	Quality Assurance	QA-18	150 µg Cr	----	----	146.4	-2.4

4.0 SAMPLING LOCATIONS AND TEST METHODS

This section describes the sampling locations and test methods used to characterize emissions from the decorative chromium plating tank at C. S. Ohm Manufacturing Company in Sterling, Michigan. Two sampling locations were used in the emission testing program. At each sampling location (one at the scrubber inlet and one at the scrubber outlet), emissions testing was conducted for particulate matter, total chromium content, and hexavalent chromium content. Sampling for chromium and an impinger collection efficiency determination was also conducted at the scrubber inlet using an impinger train. One special high volume, constant flow rate, single point sampling run was conducted at the inlet, also. The relative positions and the type of testing conducted at each location are shown in the simplified process flow diagram (see Figure 4-1) and accompanying Table 4.1. The subsections which follow further describe each sampling location and applicable test methods.

4.1 SCRUBBER INLET (SAMPLING LOCATION A)

Particulate matter, hexavalent chromium, and total chromium were measured at the inlet to the packed-bed scrubber controlling emissions from the decorative chromium plating tank as shown in Figure 4-2. Two sampling ports were installed 90° apart in the vertical circular duct (32 inches in diameter). These ports were located 26 inches (0.81 duct diameters) upstream of a bend in the duct to the scrubber and 168 inches (5.25 duct diameters) downstream from another bend.

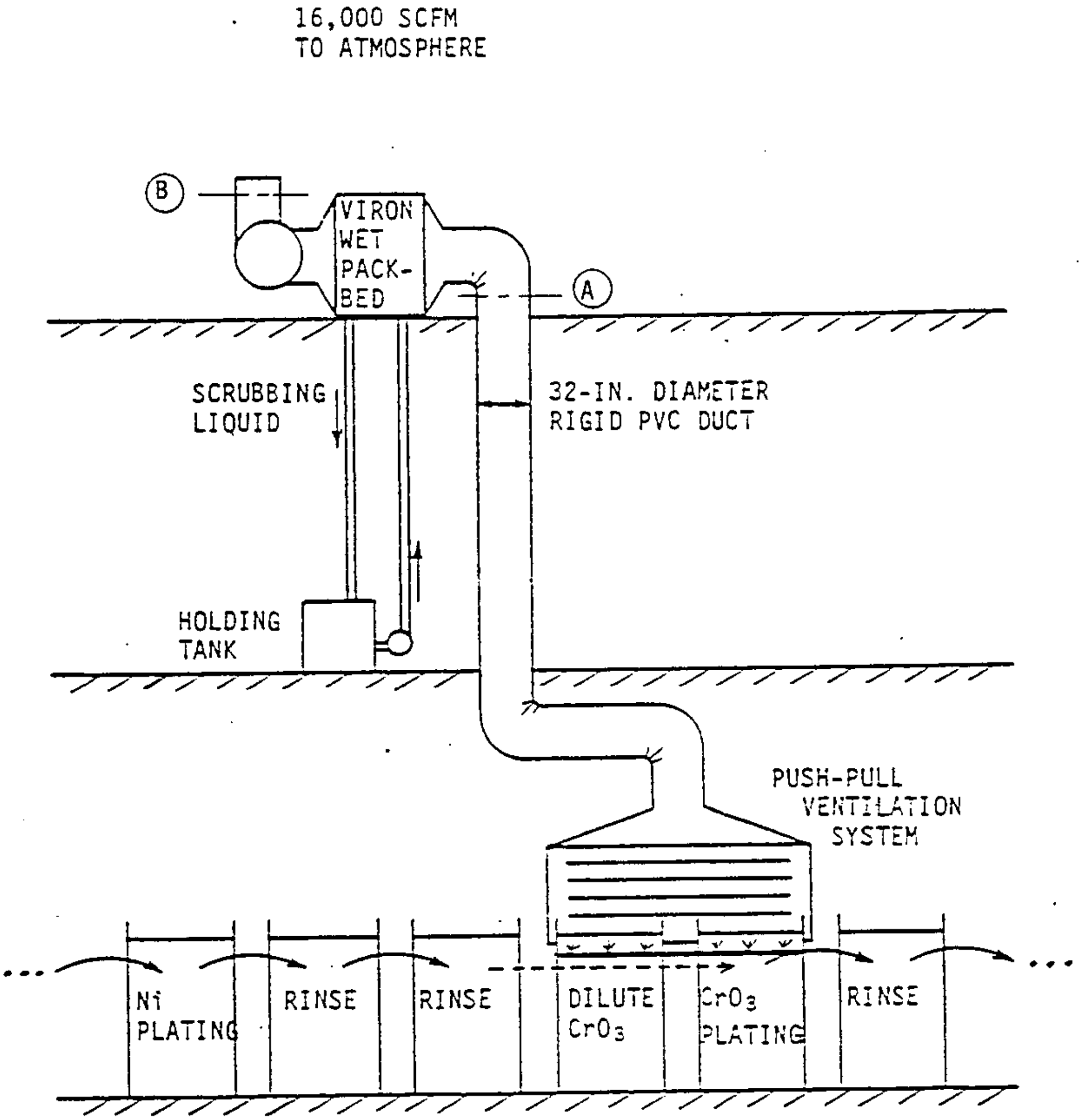


Figure 4-1. Diagram of decorative chromium plating line and emissions control system at C. S. Ohm Manufacturing Company.

TABLE 4.1. SAMPLING PLAN FOR C. S. OHM

Sample Type	Sampling Locations	Number of Samples	Methods
Particulate matter	A, B	3 (M5) 1 (M5 HV, at A)	EPA Method 5 or EPA Method 5 High Volume
Hexavalent chromium	A, B	3 (M5) 1 (M5 HV, at A)	EPA Method 5 or EPA Method 5 High Volume using Tentative EPA Method for Hexavalent Chromium
Total chromium	A, B	3 (M5) 1 (M5 HV, at A)	EPA Method 5 or EPA Method 5 High Volume using EPA Protocol for Total Chromium
Chromium (Impinger efficiency)	A	3	Impinger Train using Tentative EPA Method for Hexavalent Chromium and EPA Protocol for Total Chromium

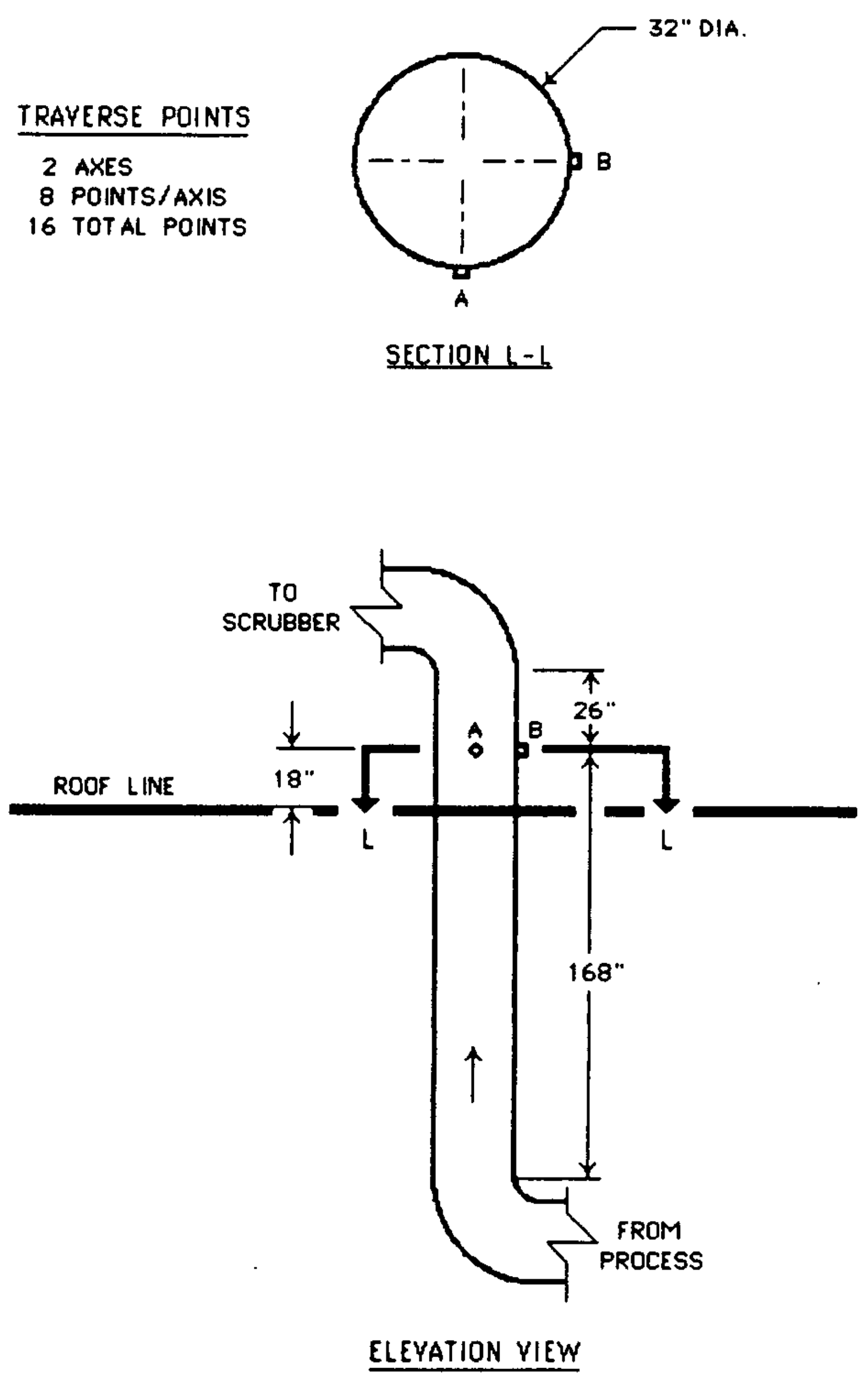


FIGURE 4-2. SCRUBBER INLET (SAMPLING LOCATION A)

For the Method 5 testing, (used for particulate matter, hexavalent chromium, and total chromium determinations) and the impinger train testing, a total of 16 points, as per Method 1, were sampled. Each of the 16 points was sampled for 20 minutes for a total of 320 minutes of sampling per run. Each of three Method 5 and three impinger train runs were conducted to coincide with the sampling at the scrubber outlet location.

4.2 SCRUBBER OUTLET STACK (SAMPLING LOCATION B)

Particulate matter, hexavalent chromium, and total chromium were measured at the scrubber outlet as shown in Figure 4-3. Four sampling ports were installed along the shorter side of the 26 1/2 by 34 3/4 inch vertical rectangular stack. The ports were located about 8 inches (0.025duct diameters) upstream from the stack exit and 32 1/4 inches (1.07 duct diameters) downstream from the fan. Because of the close proximity of the flow disturbance (stack exit) downstream of the ports, this location did not meet EPA Method 1 sampling requirements; a planned stack extension was refused by EPA for reasons of excessive additional cost.

For the EPA Method 5 sampling (used for particulate matter, hexavalent chromium, and total chromium determinations), a total of 24 points, 6 per axis, were sampled. Each point was sampled for 12 minutes for a total sampling time of 288 minutes.

4.3 VELOCITY AND GAS TEMPERATURE

A type S pitot tube and an inclined draft gauge manometer or two differential pressure gauges in-parallel were used to measure the gas velocity pressure (p). Velocity pressures were measured at each sampling point across

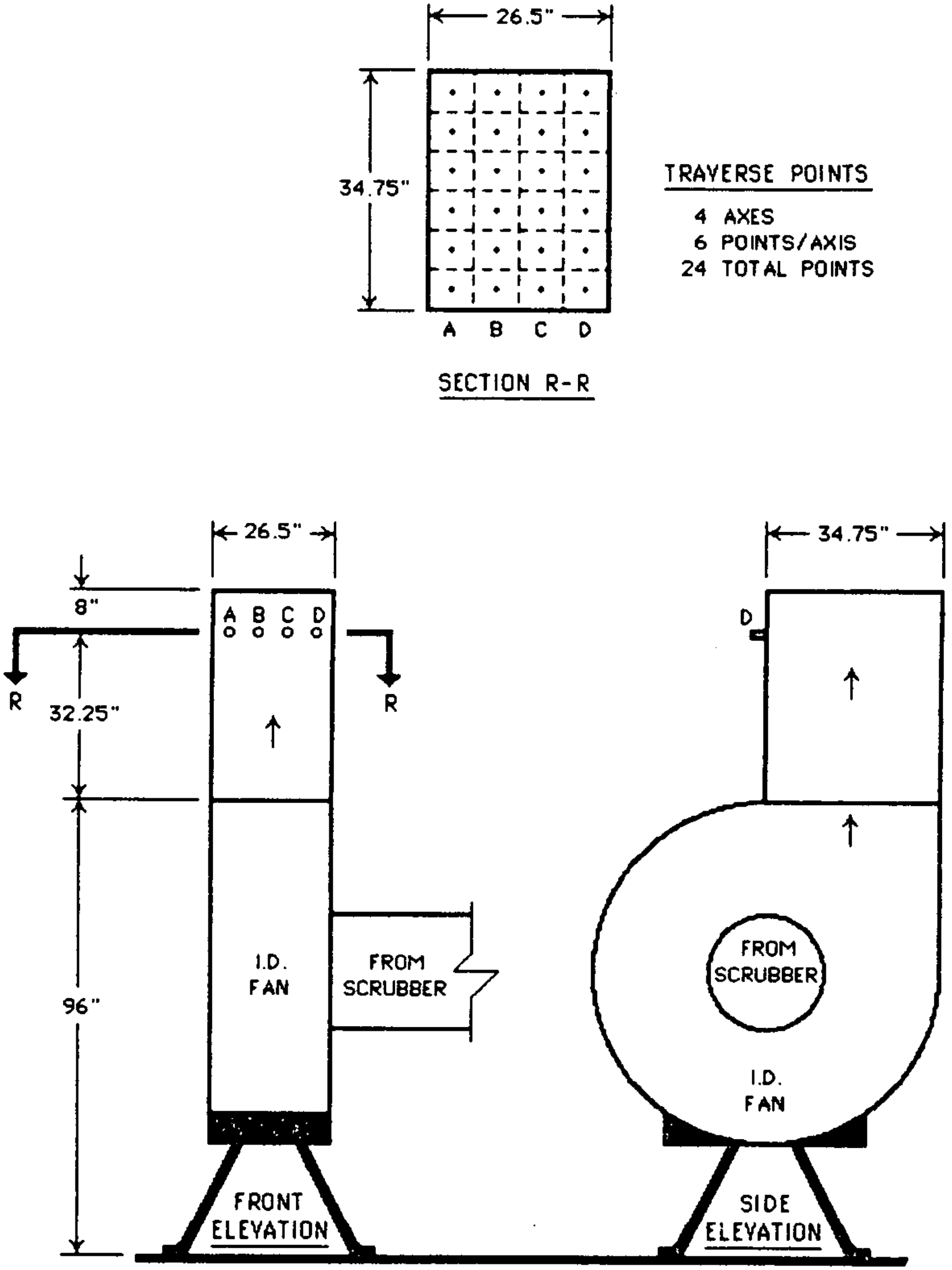


FIGURE 4-3. SCRUBBER OUTLET (SAMPLING LOCATION B)

the duct to determine an average value according to the procedures outlined in Method 2 of the Federal Register.* The temperature at each sampling point was measured using a thermocouple and digital readout.

4.4 MOLECULAR WEIGHT

Flue gas composition was essentially that of the ambient air drawn in from above the plating tank. Therefore, the dry molecular weight and composition of air was used.

4.5 PARTICULATE MATTER

Method 5, as described in the Federal Register,* was used to measure particulate grain loading at locations A and B. All tests (except the special high volume run) were conducted isokinetically by traversing the cross-sectional area of the stack and regulating the sample flow rate relative to the flue gas flow rate as measured by the pitot tube attached to the sample probe. A sampling train consisting of a heated, glass-lined probe, 79 mm (3 inch) [or 102 mm (4 inch) for the high volume run] diameter Teflon filter (Schleicher & Schuell), and a series of Greenburg-Smith impingers was employed for each test. An acetone rinse and a water rinse of the nozzle, probe, and filter holder portions of the sample train were made at the end of each test. The particulate caught on the filter media was dried at room temperature, the combined acetone and water rinse was taken to dryness in an oven; both were desiccated to a constant weight, and weighed on an analytical balance. Total filterable particulate matter was determined by adding these three values. See Appendix C for detailed sampling procedures.

4.6 IMPINGER COLLECTION EFFICIENCY

A sample train similar to that used for EPA Methods 1-5 was used to measure the impinger collection efficiency at the scrubber inlet. The train did not contain any filter, instead a filter bypass was inserted in the line and three Greenburg-Smith impingers each containing 100 ml of distilled water were used to collect the emissions. The impinger train tests were run simultaneously with the Method 5 tests and were conducted isokinetically by traversing the cross-sectional area of the stack and regulating the sample flow rate relative to the flue gas flow rate as measured by the pitot tube attached to the sample probe. The contents of each impinger were recovered separately at the end of each test. Each impinger was rinsed first with acetone and then with water; these rinses were then added to the corresponding impinger contents. The probe and filter bypass were also rinsed with both acetone and water and these rinses were added to the first impinger contents. The contents and rinses from each impinger were concentrated and analyzed for hexavalent and total chromium content.

4.7 HEXAVALENT CHROMIUM CONTENT

Hexavalent chromium content was determined utilizing procedures described in the tentative EPA Method "Determination of Hexavalent Chromium Emissions from Stationary Sources" (see Appendix C). The Method 5 filter catches collected and weighed for each Method 5 run and the impinger train impinger catches were taken and analyzed for hexavalent chromium content using this method. It was also used to determine the hexavalent chromium content in the first impinger for representative Method 5 runs.

• 40 CFR 60, Appendix A, Reference Methods 2, 3, and 5, July 1, 1980.

4.8 TOTAL CHROMIUM CONTENT

Total chromium content was determined using procedures described in the "EMB Prototcol for Sample Preparation and Emission Calculation of Field Samples for Total Chromium" in combination with Neutron Activation Analysis (NAA) (see Appendix C). Samples collected during Method 5 and impinger train runs and first submitted for analysis for hexavalent chromium were then analyzed for total chromium using this method.

5.0 QUALITY ASSURANCE

Because the end product of testing is to produce representative emission results, quality assurance is one of the main facets of stack sampling. Quality assurance guidelines provide the detailed procedures and actions necessary for defining and producing acceptable data. Two such documents were used in this test program to ensure the collection of acceptable data and to provide a definition of unacceptable data. These documents are: the EPA Quality Assurance Handbook Volume III, EPA-600/4-77-027 and Entropy's "Quality Assurance Program Plan" which has been approved by the U. S. EPA, EMB.

Relative to this test program, the following steps were taken to ensure that the testing and analytical procedures produce quality data.

- Calibration of field sampling equipment. (Appendix D describes calibration guidelines in more detail.)
- Checks of train configuration and on calculations.
- On-site quality assurance checks such as sampling train, pitot tube, and Orsat line leak checks, and quality assurance checks of all test equipment prior to use.
- Use of designated analytical equipment and sampling reagents.

Table 5-1 summarizes the on-site audit data sheets for the sampling equipment used for particulate testing at each sampling location, including deviation limits. In addition to the pre- and post-test calibration audits, a field audit was performed on the meter boxes used for sampling. Entropy used the procedures described in the December 14, 1983 <u>Federal Register</u> (48FR55670). In addition, the analytical balance used for filter weighing was audited with Class "S" weights. Appendix D includes the audit run data sheets for each dry gas meter used for particulate testing and audit data sheets for the other sampling equipment.

TABLE 5.1. FIELD EQUIPMENT CALIBRATION

Equipment	Reference	Allowable Error	Actual Error	Within Allowable Limits
Scrubber Inlet				
Meter box (N-5)	Wet test meter	Y ± 0.03Y	+0.025	✓
Meter box thermometer	ASTM-3F at ambient temperature	5°F	+1°F	✓
Trip balance	IOLM standard weight	0.5 grams	0.1 gram	✓
Analytical balance	Class "S" standard weight	0.1 mg	0.02 mg	✓
Scrubber Inlet (Impinger Train)				
Meter box (N-6)	Wet test meter	Y ± 0.03Y	+0.0158	✓
Meter box thermometer	ASTM-3F at ambient temperature	5°F	-2°F	✓
Trip balance	IOLM standard weight	0.5 grams	0.1 gram	✓
Analytical balance	Class "S" standard weight	0.1 mg	0.02 mg	✓
Scrubber Outlet				
Meter box (N-8)	Wet test meter	Y ± 0.03Y	+0.016	✓
Meter box thermometer	ASTM-3F at ambient temperature	5°F	0°F	✓
Trip balance	IOLM standard weight	0.1 gram	0.1 gram	✓
Analytical balance	Class "S" standard weight	0.1 mg	0.02 mg	✓

Audit solutions prepared by the EPA were used to check the analytical procedures of the laboratories conducting the hexavalent and total chromium analyses. Table 5-2 presents the results of these analytical audits. The audit tests show that the analytical techniques were good.

The sampling equipment, reagents, and analytical procedures for this test series were in compliance with all necessary guidelines set forth for accurate test results as described in Volume III of the Quality Assurance Handbook.

TABLE 5.2. AUDIT REPORT CHROMIUM ANALYSIS

Plant: C.S. Ohm Task No.: 3021
Date samples received: 7/2/85 Date analyzed: 7/12/85
Sample analyzed by: RTI
Reviewed by: Peter Grohse Date of review:

Sample Number	µg/ml Cr^{+6} or Cr	Source of Sample	Audit Value	Relative error, %
C-266	50 µg/ml	QAD	52.4	+4.8%
QA-16	50 µg Cr	NBS	45.69	-8.6%
QA-17	100 µg Cr	NBS	96.49	-3.5%
QA-18	150 µg Cr	NBS	146.4	-2.4%

APPENDIX A.
TEST RESULTS AND EXAMPLE CALCULATIONS

ANT	C. S. Ohm	DATE	06/18/95
SAMPLING LOCATION	Scrubber Inlet	RUN NUMBER	1
ERATOR	BB	PROBE LENGTH, ft.	4' 5"
R. PRESS., in. Hg	29.000	ASSUMED MOISTURE, %	2
STATIC PRESS., in. H20	-2.000	NOZZLE #	405
FILTER NUMBER(S)		NOZZLE DIAMETER, in.	0.252
TOT TUBE COEFF.	0.840	METER BOX ΔH@	1.8
AK RATE, CFM	0.000	SAMPLE BOX NUMBER	24
LEAK TEST VACUUM, in.Hg	10.000	METER BOX NUMBER	N-5

Trav. int. No.	Sample Time (Min.)	Gas Meter Reading (Cu.Ft.)	Velocity Head (in.H20)	Orifice ΔH (in. H20) Desired	Actual	Gas Meter Temp. (deg. F)	Pump Vac. (in.Hg)	Filter Box Temp. (deg.F)	Imp. Exit Temp. (deg.F)	Stack Temp. (deg.F)	Leak Check
	ON/0	698.200	0.300	1.38	1.38	90	3.0	95	60	52	
	10.0	704.770	0.300	1.38	1.38	94	3.0	92	60	65	
	20.0	711.250	0.300	1.38	1.38	96	3.0	92	60	66	
	30.0	717.830	0.300	1.38	1.38	97	3.0	92	60	66	
	40.0	724.430	0.300	1.38	1.38	98	3.0	90	60	76	
	50.0	731.040	0.300	1.38	1.38	99	3.0	90	60	76	
	60.0	738.150	0.350	1.58	1.58	100	3.0	90	60	79	
	70.0	745.100	0.350	1.58	1.58	100	3.0	90	60	80	
	80.0	752.060	0.350	1.58	1.58	100	3.0	90	60	78	
	90.0	758.750	0.350	1.58	1.58	100	3.0	90	60	78	
	100.0	765.800	0.350	1.58	1.58	100	3.0	90	60	78	
	110.0	772.960	0.350	1.58	1.58	100	3.0	90	60	78	
	120.0	779.920	0.350	1.58	1.58	100	3.0	90	60	82	
	130.0	786.960	0.350	1.58	1.58	100	3.0	93	60	80	
	140.0	794.050	0.350	1.58	1.58	100	3.0	93	60	80	
	150.0	801.140	0.350	1.58	1.58	100	3.0	93	60	80	
A	160/0	808.238	0.500	2.30	2.30	96	5.0	90	60	75	808.238
	10.0	816.840	0.550	2.53	2.53	98	5.0	90	60	75	808.300
	20.0	825.750	0.550	2.53	2.53	98	5.0	90	60	78	
	30.0	834.760	0.550	2.53	2.53	98	5.0	90	60	76	
	40.0	843.780	0.550	2.53	2.53	96	5.0	90	60	75	
	50.0	852.740	0.550	2.53	2.53	96	5.0	90	60	73	
	60.0	861.750	0.550	2.53	2.53	96	5.0	90	60	80	
	70.0	871.000	0.550	2.53	2.53	96	5.0	90	60	82	
	80.0	879.770	0.550	2.53	2.53	95	5.0	90	60	80	
	90.0	888.800	0.550	2.53	2.53	95	5.0	90	60	80	
	100.0	897.780	0.550	2.53	2.53	95	5.0	90	60	80	
	110.0	906.850	0.550	2.53	2.53	95	5.0	90	60	82	
	120.0	915.950	0.550	2.53	2.53	95	5.0	90	60	81	
	130.0	925.050	0.550	2.53	2.53	95	5.0	90	60	79	
	140.0	934.120	0.550	2.53	2.53	95	5.0	90	60	80	
	150.0	943.190	0.550	2.53	2.53	95	5.0	90	60	80	
NAL	320/OFF	952.429									
DIFF/AVG.		254.167	0.43205		2.010	97				77	0.062

PLANT	C. S. Ohm	DATE	06/19/85
SAMPLING LOCATION	Scrubber Inlet	RUN NUMBER	4
OPERATOR	BB	PROBE LENGTH, ft.	4' 5"
BAR. PRESS., in. Hg	29.200	ASSUMED MOISTURE, %	2
STATIC PRESS., in. H20	-1.900	NOZZLE #	406
FILTER NUMBER(S)		NOZZLE DIAMETER, in.	0.252
PITOT TUBE COEFF.	0.840	METER BOX ΔH@	1.8
LEAK RATE, CFM	0.000	SAMPLE BOX NUMBER	24
LEAK TEST VACUUM, in.Hg	10.000	METER BOX NUMBER	N-5

Trav. Point. No.	Sample Time (Min.)	Gas Meter Reading (Cu.Ft.)	Velocity Head (in.H20)	Orifice ΔH (in. H20) Desired	Actual	Gas Meter Temp. (deg. F)	Pump Vac. (in.Hg)	Filter Box Temp. (deg.F)	Imp. Exit Temp. (deg.F)	Stack Temp. (deg.F)	Leak Check
B	ON/0	952.700	0.330	1.45	1.45	68	3.0	90	60	75	
	10.0	959.350	0.330	1.45	1.45	75	3.0	90	60	75	
	20.0	966.400	0.330	1.45	1.45	80	3.0	90	60	76	
	30.0	972.800	0.360	1.58	1.58	82	3.0	90	60	75	
	40.0	979.880	0.360	1.58	1.58	82	3.0	90	60	74	
	50.0	986.930	0.360	1.58	1.58	84	3.0	90	60	79	
	60.0	994.000	0.360	1.58	1.58	85	3.0	90	60	75	
	70.0	1001.050	0.360	1.58	1.58	85	3.0	90	60	76	
	80.0	1001.100	0.360	1.58	1.58	85	3.0	90	60	76	
	90.0	1015.170	0.360	1.58	1.58	85	3.0	90	60	75	
	100.0	1022.250	0.400	1.75	1.75	85	3.0	90	60	76	
	110.0	1029.680	0.400	1.75	1.75	85	3.0	90	60	76	
	120.0	1037.160	0.400	1.75	1.75	85	3.0	90	60	76	
	130.0	1044.610	0.400	1.75	1.75	86	3.0	90	60	77	
	140.0	1052.110	0.380	1.65	1.56	87	3.0	90	60	76	
	150.0	1059.500	0.380	1.66	1.66	87	3.0	90	60	77	
A	160/0	1066.755	0.480	2.10	2.10	86	5.0	90	60	68	1066.755
	10.0	1075.030	0.480	2.10	2.10	88	5.0	90	60	73	1066.850
	20.0	1083.300	0.480	2.10	2.10	89	5.0	90	60	75	
	30.0	1091.570	0.480	2.10	2.10	88	5.0	90	60	73	
	40.0	1099.840	0.480	2.10	2.10	88	5.0	90	60	73	
	50.0	1108.100	0.480	2.10	2.10	88	5.0	90	60	74	
	60.0	1116.340	0.480	2.10	2.10	88	5.0	90	60	78	
	70.0	1124.550	0.480	2.10	2.10	87	5.0	90	60	77	
	80.0	1132.790	0.520	2.27	2.27	86	6.0	90	60	77	
	90.0	1141.180	0.520	2.27	2.27	86	6.0	90	60	79	
	100.0	1149.600	0.520	2.27	2.27	86	7.0	90	60	79	
	110.0	1158.000	0.520	2.27	2.27	87	7.0	90	60	79	
	120.0	1166.440	0.520	2.27	2.27	88	7.0	90	60	79	
	130.0	1174.880	0.520	2.27	2.27	89	7.0	90	60	79	
	140.0	1183.350	0.520	2.27	2.27	90	7.0	90	60	84	
	150.0	1191.820	0.520	2.27	2.27	90	7.0	90	60	84	
FINAL	320/OFF	1200.318									
DIFF/AVG.		247.523	0.43056		1.897	85				76	0.095

PLANT	C. S. Ohm	DATE	05/20/85
SAMPLING LOCATION	Scrubber Inlet	RUN NUMBER	7
ERATOR	BB	PROBE LENGTH, ft.	4'5"
AR. PRESS., in. Hg	29.200	ASSUMED MOISTURE, %	2
STATIC PRESS., in. H20	-1.950	NOZZLE #	406
LTER NUMBER(S)		NOZZLE DIAMETER, in.	0.252
TOT TUBE COEFF.	0.840	METER BOX ΔH@	1.8
LEAK RATE, CFM	0.000	SAMPLE BOX NUMBER	24
AK TEST VACUUM, in.Hg	5.000	METER BOX NUMBER	N-5

av. int. No.	Sample Time (Min.)	Gas Meter Reading (Cu.Ft.)	Velocity Head (in.H20)	Orifice ΔH (in. H20) Desired	Actual	Gas Meter Temp. (deg. F)	Pump Vac. (in.Hg)	Filter Box Temp. (deg.F)	Imp. Exit Temp. (deg.F)	Stack Temp. (deg.F)	Leak Check
	ON/0	215.600	0.310	1.39	1.39	78	3.0	90	60	73	
	10.0	222.050	0.310	1.39	1.39	83	3.0	90	60	73	
	20.0	228.520	0.310	1.39	1.39	90	3.0	90	60	77	
	30.0	235.000	0.330	1.48	1.48	93	3.0	90	60	79	
	40.0	241.950	0.330	1.48	1.48	96	4.0	90	60	79	
	50.0	248.780	0.330	1.48	1.48	98	4.0	90	60	79	
	60.0	255.670	0.330	1.48	1.48	100	4.0	90	60	83	
	70.0	262.510	0.330	1.48	1.48	102	4.0	90	60	82	
	80.0	269.570	0.360	1.61	1.61	102	4.0	90	60	78	
	90.0	276.620	0.360	1.61	1.61	102	4.0	90	60	81	
	100.0	283.820	0.360	1.61	1.61	102	4.0	90	60	80	
	110.0	291.010	0.390	1.75	1.75	103	4.0	90	60	81	
	120.0	298.500	0.390	1.75	1.75	103	4.0	90	60	80	
	130.0	306.000	0.390	1.75	1.75	103	4.0	90	60	30	
	140.0	313.460	0.390	1.75	1.75	102	4.0	90	60	78	
	150.0	320.960	0.390	1.75	1.75	100	4.0	90	60	79	
A	160/0	328.515	0.520	2.33	2.33	97	5.0	90	60	74	328.515
	10.0	336.820	0.520	2.33	2.33	99	5.0	90	60	70	328.600
	20.0	345.380	0.520	2.33	2.33	99	5.0	90	60	76	
	30.0	353.950	0.520	2.33	2.33	99	5.0	90	60	77	
	40.0	362.710	0.520	2.33	2.33	98	6.0	90	60	78	
	50.0	371.480	0.520	2.33	2.33	95	6.0	90	60	78	
	60.0	380.320	0.520	2.33	2.33	95	6.0	90	60	80	
	70.0	388.800	0.520	2.33	2.33	93	6.0	90	60	79	
	80.0	397.480	0.520	2.33	2.33	93	6.0	90	60	79	
	90.0	406.120	0.520	2.33	2.33	93	6.0	90	60	80	
	100.0	414.750	0.520	2.33	2.33	93	6.0	90	60	81	
	110.0	423.320	0.520	2.33	2.33	93	6.0	90	60	82	
	120.0	431.900	0.520	2.33	2.33	94	6.0	90	60	85	
	130.0	440.480	0.550	2.47	2.47	94	6.0	90	60	82	
	140.0	449.500	0.550	2.47	2.47	93	6.0	90	60	79	
	150.0	458.190	0.550	2.47	2.47	92	6.0	90	60	79	
FINAL	320/OFF	467.551									
DIFF/AVG.		251.866	0.43331		1.964	96				79	0.085

PARTICULATE FIELD DATA & RESULTS TABULATION

PLANT: C.S. Ohm, Detroit, Michigan

RUN	SAMPLING LOCATION	TEST TEAM LEADER
1	Scrubber Inlet	Gerard M. Carty
4	Scrubber Inlet	Gerard M. Carty
7	Scrubber Inlet	Gerard M. Carty

		1	4	7
	RUN DATE	06/18/85	06/19/85	06/20/85
	RUN START TIME	1005	839	856
	RUN FINISH TIME	1530	1405	1421
	NET SAMPLING POINTS	32	32	32
Theta	NET RUN TIME, MINUTES	320.00	320.00	320.00
Dia	NOZZLE DIAMETER, INCHES	0.252	0.252	0.252
Cp	PITOT TUBE COEFFICIENT	0.840	0.840	0.840
Y	DRY GAS METER CAL. FACTOR	0.999	0.999	0.999
Pbar	BAROMETRIC PRESSURE, IN. HG.	29.00	29.20	29.20
Delta H	AVG. PRESS. DIFFERENTIAL OF ORIFICE METER, IN. H2O	2.010	1.897	1.964
Vm	VOLUME OF METERED GAS SAMPLE DRY ACTUAL CUBIC FEET	254.167	247.523	251.866
tm	DRY GAS METER TEMP., DEG. F	97	85	96
Vm(std)	VOLUME OF METERED GAS SAMPLE @ DRY STD. COND., DSCF*	234.388	234.821	234.253
Vlc	VOLUME OF WATER CATCH IN IMPINGERS & SIL. GEL.,ML	50.0	50.0	50.0
Vw(std)	VOLUME OF WATER VAPOR, SCF*	2.354	2.354	2.354
%H2O	MOISTURE, PERCENT BY VOLUME	1.0	1.0	1.0
Mfd	DRY MOLE FRACTION	0.990	0.990	0.990

(continued next page)

		1	4	7
Md	DRY MOLECULAR WT, LB/LB-MOLE	28.84	28.84	28.84
Ms	WET MOLECULAR WT, LB/LB-MOLE	28.73	28.73	28.73
Pg	GAS STATIC PRESS., IN. H20	-2.0	-1.9	-2.0
Ps	ABSOLUTE GAS PRESS., IN. HG.	28.85	29.06	29.06
ts	GAS TEMPERATURE, DEG. F	77	76	79
Delta p	AVG VELOCITY HEAD, IN. H20	0.4321	0.4306	0.4333
vs	FLUE GAS VELOCITY, FT/SEC	38.0	37.8	38.0
A	STACK/DUCT AREA, SQUARE IN.	804.2	804.2	804.2
Qsd	GAS FLOW RATE, DRY SCFM *	11,947	11,980	11,983
Qaw	GAS FLOW RATE, WET ACFM	12,731	12,652	12,728
%I	PERCENT ISOKINETIC	98.7	98.6	98.4
	METHOD 5 RESULTS: **			
mg	CATCH, MILLIGRAMS	1.0	1.0	1.0
gr/DSCF	CONCEN., GRAINS PER DSCF*	0.0001	0.0001	0.0001
Lb/Hr	EMISSION RATE, LBS/HOUR	0.01	0.01	0.01
	HEXAVALENT CHROMIUM:			
	CATCH, MILLIGRAMS	(15.6)	(13.4)	(20.8)
	TOTAL CHROMIUM:			
	CATCH, MILLIGRAMS	(80.5)	(45.4)	(88.9)

* 68 Deg. F - 29.92 in. Hg.

** Efficiency run impinger catches were not gravemetrically analyzed for particulate determination. The value of 1.0 mg was entered for calculation purposes only and does not represent a true value.

( ) = x 10^{-3}

RUN NUMBER	1	4	7	
FLUE GAS TEMPERATURE:				
Degrees Fahrenheit	77	76	79	deg. F
Degrees Centigrade	25	24	26	deg. C
AIR FLOW RATES x million:				
Actual Cubic Meters/hr	0.0216	0.0215	0.0216	acmh
Actual Cubic Feet/hr	0.7639	0.7591	0.7637	acfh
Dry Std. Cubic Meters/hr	0.0203	0.0204	0.0204	dscmh
Dry Std. Cubic Feet/hr	0.7168	0.7188	0.7190	dscfh
PARTICULATE: **				
Concentration, mg/dscm	0.151	0.150	0.151	mg/dscm
Concentration, gr/dscf	0.00007	0.00007	0.00007	gr/dscf
Emissions, kg/hr	0.003	0.003	0.003	kg/hr
Emissions, lb/hr	0.007	0.007	0.007	lb/hr
HEXAVALENT CHROMIUM:				
Concentration, mg/dscm	(2.350)	(2.015)	(3.136)	mg/dscm
Concentration, gr/dscf	(0.00103)	(0.00088)	(0.00137)	gr/dscf
Emissions, kg/hr	(0.048)	(0.041)	(0.064)	kg/hr
Emissions, lb/hr	(0.105)	(0.090)	(0.141)	lb/hr
TOTAL CHROMIUM:				
Concentration, mg/dscm	(12.129)	(6.828)	(13.402)	mg/dscm
Concentration, gr/dscf	(0.00530)	(0.00298)	(0.00586)	gr/dscf
Emissions, kg/hr	(0.246)	(0.139)	(0.273)	kg/hr
Emissions, lb/hr	(0.543)	(0.306)	(0.602)	lb/hr

** Efficiency run impinger catches were not gravemetrically analyzed for particulate determination. The value of 1.0 mg was entered for calculation purposes only and does not represent a true value.

( ) = x 10^{-3}

PLANT	C. S. Ohm	DATE	06/19/85
AMPLING LOCATION	Scrubber Inlet	RUN NUMBER	2
ERATOR	BB	PROBE LENGTH, ft.	4' 1"
AR. PRESS., in. Hg	29.000	ASSUMED MOISTURE, %	2
STATIC PRESS., in. H20	-2.000	NOZZLE #	405
LTER NUMBER(S)	T025	NOZZLE DIAMETER, in.	0.257
TOT TUBE COEFF.	0.840	METER BOX ΔH@	1.68
LEAK RATE, CFM	0.000	SAMPLE BOX NUMBER	25
AK TEST VACUUM, in.Hg	10.000	METER BOX NUMBER	N-14

ov. int. No.	Sample Time (Min.)	Gas Meter Reading (Cu.Ft.)	Velocity Head (in.H20)	Orifice ΔH (in. H20) Desired	Actual	Gas Meter Temp. (deg. F)	Pump Vac. (in.Hg)	Filter Box Temp. (deg.F)	Imp. Exit Temp. (deg.F)	Stack Temp. (deg.F)	Leak Check
	ON/0	515.500	0.350	1.53	1.53	90	5.0	95	60	62	
	10.0	522.810	0.350	1.53	1.53	94	5.0	92	60	65	
A2	20.0	530.060	0.400	1.75	1.75	98	6.0	92	60	66	
	30.0	538.050	0.400	1.75	1.75	100	6.0	92	60	66	
	40.0	545.720	0.520	2.28	2.28	102	7.0	90	60	76	
	50.0	554.440	0.520	2.28	2.28	105	7.0	90	60	76	
	60.0	564.000	0.340	1.49	1.49	103	5.0	90	60	79	
	70.0	571.750	0.340	1.49	1.49	100	5.0	90	60	80	
A5	80.0	579.500	0.370	1.62	1.62	98	5.0	90	60	79	
	90.0	585.600	0.370	1.62	1.62	100	5.0	90	60	78	
	100.0	593.210	0.430	1.88	1.88	100	6.0	90	60	79	
	110.0	601.360	0.430	1.88	1.88	102	6.0	90	60	79	
A7	120.0	609.700	0.430	1.88	1.88	102	6.0	90	60	82	
	130.0	618.110	0.430	1.88	1.88	103	6.0	92	60	80	
	140.0	626.650	0.430	1.88	1.88	104	6.0	92	60	80	
	150.0	634.310	0.430	1.88	1.88	104	6.0	92	60	80	
B1	160/0	642.534	0.250	1.10	1.10	100	5.0	90	60	75	642.534
	10.0	649.030	0.250	1.10	1.10	101	5.0	90	60	75	642.602
B2	20.0	655.380	0.250	1.10	1.10	100	5.0	90	60	78	
	30.0	661.710	0.250	1.10	1.10	100	5.0	90	60	76	
	40.0	668.160	0.250	1.10	1.10	100	5.0	90	60	75	
	50.0	674.420	0.250	1.10	1.10	100	5.0	90	60	73	
B4	60.0	680.800	0.320	1.40	1.40	100	5.0	90	60	80	
	70.0	688.510	0.320	1.40	1.40	100	5.0	90	60	82	
	80.0	695.090	0.450	1.97	1.97	100	6.0	90	60	80	
	90.0	704.000	0.450	1.97	1.97	100	6.0	90	60	80	
B6	100.0	711.900	0.550	2.41	2.41	102	7.0	90	60	80	
	110.0	721.150	0.550	2.41	2.41	103	7.0	90	60	82	
	120.0	731.200	0.550	2.41	2.41	104	7.0	90	60	81	
	130.0	739.850	0.550	2.41	2.41	104	7.0	90	60	78	
	140.0	749.250	0.500	2.19	2.19	104	7.0	90	60	80	
	150.0	758.000	0.500	2.19	2.19	104	7.0	90	60	80	
FINAL	320/OFF	765.885									
DIFF/AVG.		251.317	0.39302		1.749	101				77	0.068

PLANT	C. S. Ohm	DATE	06/19/85
SAMPLING LOCATION	Scrubber Inlet	RUN NUMBER	5
OPERATOR	BB	PROBE LENGTH, ft.	4' 1"
BAR. PRESS., in. Hg	29.200	ASSUMED MOISTURE, %	2
STATIC PRESS., in. H20	-1.900	NOZZLE #	405
FILTER NUMBER(S)		NOZZLE DIAMETER, in.	0.257
PITOT TUBE COEFF.	0.840	METER BOX ΔH@	1.69
LEAK RATE, CFM	0.000	SAMPLE BOX NUMBER	25
LEAK TEST VACUUM, in.Hg	10.000	METER BOX NUMBER	N-14

Trav. Point. No.	Sample Time (Min.)	Gas Meter Reading (Cu.Ft.)	Velocity Head (in.H20)	Orifice ΔH (in. H20) Desired	Orifice ΔH (in. H20) Actual	Gas Meter Temp. (deg. F)	Pump Vac. (in.Hg)	Filter Box Temp. (deg.F)	Imp. Exit Temp. (deg.F)	Stack Temp. (deg.F)	Leak Check
A-1	ON/0	767.202	0.370	1.62	1.62	68	5.0	90	60	75	
	10.0	774.550	0.370	1.62	1.62	76	5.0	90	60	75	
A-2	20.0	782.410	0.520	2.28	2.28	82	5.0	90	60	76	
	30.0	790.090	0.520	2.28	2.28	86	6.0	90	60	75	
A-3	40.0	799.600	0.520	2.29	2.28	86	6.0	90	60	74	
	50.0	808.310	0.480	2.10	2.10	86	6.0	90	60	79	
A-4	60.0	817.000	0.350	1.53	1.53	86	6.0	90	60	75	
	70.0	824.410	0.350	1.53	1.53	84	6.0	90	60	75	
A-5	80.0	831.800	0.350	1.53	1.53	84	6.0	90	60	76	
	90.0	839.150	0.350	1.53	1.53	84	6.0	90	60	76	
A-6	100.0	846.500	0.400	1.75	1.75	84	6.0	90	60	76	
	110.0	854.000	0.400	1.75	1.75	84	6.0	90	60	76	
A-7	120.0	862.500	0.400	1.75	1.75	86	6.0	90	60	76	
	130.0	869.920	0.400	1.75	1.75	86	6.0	90	60	77	
A-8	140.0	878.000	0.400	1.75	1.75	86	6.0	90	60	76	
	150.0	885.610	0.400	1.75	1.75	86	5.0	90	60	77	
B-1	160/0	893.500	0.220	0.96	0.96	84	4.0	90	60	68	893.500
	10.0	899.510	0.270	1.18	1.18	84	4.0	90	60	73	893.550
B-2	20.0	905.910	0.220	0.96	0.96	84	4.0	90	60	75	
	30.0	911.910	0.220	0.96	0.96	83	4.0	90	60	75	
B-3	40.0	917.900	0.220	0.96	0.96	82	4.0	90	60	73	
	50.0	924.600	0.220	0.96	0.96	82	4.0	90	60	74	
B-4	60.0	929.810	0.300	1.31	1.31	84	4.0	90	60	78	
	70.0	936.700	0.300	1.31	1.31	86	4.0	90	60	77	
B-5	80.0	943.570	0.370	1.62	1.62	84	5.0	90	60	77	
	90.0	951.100	0.370	1.62	1.62	82	5.0	90	60	79	
B-6	100.0	958.630	0.400	1.75	1.75	82	5.0	90	60	79	
	110.0	966.530	0.440	1.93	1.93	82	5.0	90	60	79	
B-7	120.0	974.850	0.570	2.50	2.50	83	6.0	90	60	79	
	130.0	984.160	0.570	2.50	2.50	84	6.0	90	60	79	
B-8	140.0	993.610	0.390	1.71	1.71	86	5.0	90	60	84	
	150.0	1001.370	0.390	1.71	1.71	86	5.0	90	60	84	
FINAL	320/OFF	1009.129									
DIFF/AVG.		241.876	0.37002		1.648	84				77	0.05

PLANT	C. S. Ohm	DATE	06/20/85
AMPLING LOCATION	Scrubber Inlet	RUN NUMBER	8
ERATOR	EB	PROBE LENGTH, ft.	4'1"
AR. PRESS., in. Hg	29.200	ASSUMED MOISTURE, %	2
STATIC PRESS., in. H20	-2.000	NOZZLE #	405
LTER NUMBER(S)	T-0.2-1	NOZZLE DIAMETER, in.	0.257
TOT TUBE COEFF.	0.840	METER BOX ΔH@	1.67
LEAK RATE, CFM	0.000	SAMPLE BOX NUMBER	25
AK TEST VACUUM, in.Hg	5.000	METER BOX NUMBER	N-6

av. int. No.	Sample Time (Min.)	Gas Meter Reading (Cu.Ft.)	Velocity Head (in.H20)	Orifice ΔH (in. H20) Desired	Actual	Gas Meter Temp. (deg. F)	Pump Vac. (in.Hg)	Filter Box Temp. (deg.F)	Imp. Exit Temp. (deg.F)	Stack Temp. (deg.F)	Leak Check
	ON/0	73.752	0.400	1.75	1.75	80	4.0	90	60	73	
	10.0	81.500	0.400	1.75	1.75	85	4.0	90	60	73	
A2	20.0	89.200	0.470	2.06	2.05	91	5.0	90	60	77	
	30.0	97.450	0.470	2.06	2.06	94	5.0	90	60	79	
	40.0	105.750	0.520	2.28	2.28	97	5.0	90	60	79	
	50.0	115.100	0.520	2.28	2.28	100	5.0	90	60	79	
	60.0	123.020	0.520	2.28	2.28	101	5.0	90	60	83	
	70.0	130.620	0.520	2.28	2.28	102	5.0	90	60	82	
A5	80.0	139.850	0.400	1.75	1.75	103	4.0	90	60	78	
	90.0	148.600	0.400	1.75	1.75	103	4.0	90	60	81	
	100.0	156.270	0.400	1.75	1.75	103	4.0	90	60	80	
	110.0	163.940	0.400	1.75	1.75	102	4.0	90	60	81	
A7	120.0	171.850	0.470	2.06	2.06	103	4.0	90	60	80	
	130.0	180.310	0.470	2.06	2.06	103	5.0	90	60	80	
	140.0	188.850	0.450	1.97	1.97	102	5.0	90	60	78	
	150.0	197.260	0.450	1.97	1.97	101	5.0	90	60	79	
B1	150/0	205.688	0.370	1.62	1.62	97	4.0	90	60	74	205.688
	10.0	213.410	0.250	1.10	1.10	98	4.0	90	60	70	205.736
B2	20.0	220.000	0.250	1.10	1.10	96	4.0	90	60	76	
	30.0	226.500	0.250	1.10	1.10	95	3.0	90	60	77	
	40.0	233.000	0.250	1.10	1.10	94	3.0	90	60	79	
	50.0	239.500	0.250	1.10	1.10	91	3.0	90	60	78	
B4	60.0	245.850	0.300	1.31	1.31	90	3.0	90	60	80	
	70.0	252.250	0.300	1.31	1.31	88	3.0	90	60	79	
	80.0	259.120	0.400	1.75	1.75	89	4.0	90	60	79	
	90.0	267.060	0.400	1.75	1.75	90	4.0	90	60	80	
B6	100.0	275.020	0.550	2.41	2.41	90	5.0	90	60	81	
	110.0	284.080	0.550	2.41	2.41	91	5.0	90	60	82	
	120.0	293.100	0.570	2.49	2.49	92	5.0	90	60	85	
	130.0	302.300	0.570	2.49	2.49	94	5.0	90	60	82	
	140.0	311.510	0.500	2.19	2.19	93	5.0	90	60	79	
	150.0	319.990	0.500	2.19	2.19	92	5.0	90	60	79	
FINAL	320/OFF	328.829									
DIFF/AVG.		255.029	0.41599		1.851	95				79	0.048

PARTICULATE FIELD DATA & RESULTS TABULATION

PLANT: C.S. Ohm, Detroit, Michigan

RUN	SAMPLING LOCATION	TEST TEAM LEADER
2	Scrubber Inlet	Gerard M. Carty
5	Scrubber Inlet	Gerard M. Carty
8	Scrubber Inlet	Gerard M. Carty

		2	5	8
	RUN DATE	06/18/85	06/19/85	06/20/85
	RUN START TIME	1004	838	855
	RUN FINISH TIME	1529	1404	1420
	NET SAMPLING POINTS	32	32	32
Theta	NET RUN TIME, MINUTES	320.00	320.00	320.00
Dia	NOZZLE DIAMETER, INCHES	0.257	0.257	0.257
Cp	PITOT TUBE COEFFICIENT	0.840	0.840	0.840
Y	DRY GAS METER CAL. FACTOR	1.000	1.000	1.011
Pbar	BAROMETRIC PRESSURE, IN. HG.	29.00	29.20	29.20
Delta H	AVG. PRESS. DIFFERENTIAL OF ORIFICE METER, IN. H2O	1.749	1.648	1.851
Vm	VOLUME OF METERED GAS SAMPLE DRY ACTUAL CUBIC FEET	251.317	241.876	255.029
tm	DRY GAS METER TEMP., DEG. F	101	84	95
Vm(std)	VOLUME OF METERED GAS SAMPLE @ DRY STD. COND., DSCF*	230.186	229.972	240.408
Vlc	VOLUME OF WATER CATCH IN IMPINGERS & SIL. GEL.,ML	37.2	65.3	62.2
Vw(std)	VOLUME OF WATER VAPOR, SCF*	1.751	3.074	2.928
%H2O	MOISTURE, PERCENT BY VOLUME	0.8	1.3	1.2
Mfd	DRY MOLE FRACTION	0.992	0.987	0.988

(continued next page)

		2	5	8
Md	DRY MOLECULAR WT, LB/LB-MOLE	28.84	28.84	28.84
Ms	WET MOLECULAR WT, LB/LB-MOLE	28.75	28.69	28.71
Pg	GAS STATIC PRESS., IN. H2O	-2.0	-1.9	-2.0
Ps	ABSOLUTE GAS PRESS., IN. HG.	28.85	29.06	29.05
ts	GAS TEMPERATURE, DEG. F	77	77	79
Delta p	AVG VELOCITY HEAD, IN. H2O	0.3930	0.3700	0.4159
vs	FLUE GAS VELOCITY, FT/SEC	36.2	35.1	37.2
A	STACK/DUCT AREA, SQUARE IN.	804.2	804.2	804.2
Qsd	GAS FLOW RATE, DRY SCFM *	11,416	11,065	11,719
Qaw	GAS FLOW RATE, WET ACFM	12,136	11,746	12,475
%I	PERCENT ISOKINETIC	97.6	100.6	99.2
	METHOD 5 RESULTS:			
mg	CATCH, MILLIGRAMS	8.3	1.3	6.7
gr/DSCF	CONCEN., GRAINS PER DSCF*	0.0006	0.0001	0.0004
Lb/Hr	EMISSION RATE, LBS/HOUR	0.05	0.01	0.04
	HEXAVALENT CHROMIUM:			
	CATCH, MILLIGRAMS	(0.8)	(2.8)	(4.2)
	TOTAL CHROMIUM:			
	CATCH, MILLIGRAMS	(3.5)	(10.8)	(16.2)

* 68 Deg. F - 29.92 in. Hg.

( ) = x 10^{-3}

RUN NUMBER	2	5	8	
FLUE GAS TEMPERATURE:				
Degrees Fahrenheit	77	77	79	deg. F
Degrees Centigrade	25	25	26	deg. C
AIR FLOW RATES x million:				
Actual Cubic Meters/hr	0.0206	0.0200	0.0212	acmh
Actual Cubic Feet/hr	0.7282	0.7048	0.7485	acfh
Dry Std. Cubic Meters/hr	0.0194	0.0188	0.0199	dscmh
Dry Std. Cubic Feet/hr	0.6850	0.6639	0.7032	dscfh
PARTICULATE:				
Concentration, mg/dscm	1.273	0.200	0.984	mg/dscm
Concentration, gr/dscf	0.00056	0.00009	0.00043	gr/dscf
Emissions, kg/hr	0.025	0.004	0.020	kg/hr
Emissions, lb/hr	0.054	0.008	0.043	lb/hr
HEXAVALENT CHROMIUM:				
Concentration, mg/dscm	(0.123)	(0.430)	(0.617)	mg/dscm
Concentration, gr/dscf	(0.00005)	(0.00019)	(0.00027)	gr/dscf
Emissions, kg/hr	(0.002)	(0.008)	(0.012)	kg/hr
Emissions, lb/hr	(0.005)	(0.018)	(0.027)	lb/hr
TOTAL CHROMIUM:				
Concentration, mg/dscm	(0.537)	(1.658)	(2.380)	mg/dscm
Concentration, gr/dscf	(0.00023)	(0.00072)	(0.00104)	gr/dscf
Emissions, kg/hr	(0.010)	(0.031)	(0.047)	kg/hr
Emissions, lb/hr	(0.023)	(0.069)	(0.104)	lb/hr

( ) = x 10^{-3}

EXAMPLE PARTICULATE TEST CALCULATIONS NO. 2

Scrubber Inlet

VOLUME OF DRY GAS SAMPLED AT STANDARD CONDITIONS

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

$$Vm(std) = 17.64 * 1.000 * 251.317 * \frac{(29.00 + 1.749/13.6)}{(460 + 101)} = 230.186\ DSCF$$

VOLUME OF WATER VAPOR AT STANDARD CONDITIONS

$$Vw(std) = 0.04707 * Vlc$$

$$Vw(std) = 0.04707 * 37.2 = 1.751\ SCF$$

PERCENT MOISTURE, BY VOLUME, AS MEASURED IN FLUE GAS

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

$$\%H2O = \frac{1.751}{1.751 + 230.186} * 100 = 0.8\ \%$$

DRY MOLE FRACTION OF FLUE GAS

$$Mfd = 1 - \%H2O/100$$

$$Mfd = 1 - 0.8/100 = 0.992$$

WET MOLECULAR WEIGHT OF FLUE GAS

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

$$Ms = 28.84 * 0.992 + (0.18 * 0.8) = 28.75\ LB/LB\text{-}MOLE$$

ABSOLUTE FLUE GAS PRESSURE

```
Ps = Pbar  +  Pg / 13.6

Ps = 29.00  + ( -2.0 / 13.6) =  28.85  IN. HG.
```

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

```
                         (Delta p)avg * (460 + ts)
vs = 85.49 * Cp * SQRT[-------------------------]
                                Ps * Ms

                            0.3930 * (460 +   77)
vs = 85.49 * 0.840 * SQRT[---------------------] =  36.2  FT/SEC
                               28.85 * 28.75
```

DRY VOLUMETRIC FLUE GAS FLOW RATE @ STANDARD CONDITIONS

```
       60                         Tstd       Ps
Qsd = ---- * Mfd * vs * A * -------- * ------
      144                      ts + 460    Pstd

       60                                          528         28.85
Qsd = ---    * 0.992 *  36.2 *      804.2 * ---------- * -----
      144                                        77 + 460    29.92

Qsd =     11,416  SCFM
```

WET VOLUMETRIC STACK GAS FLOW RATE @ FLUE GAS CONDITIONS

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

Qaw = 60 / 144  *   36.2  *      804.2  =    12,136  ACFM
```

PERCENT ISOKINETIC OF SAMPLING RATE

```
     Pstd   100                  (ts + 460) * Vm(std)
%I = ---- * --- * ------------------------------------------
     Tstd    60   Ps * vs * Mfd * Theta * Area-nozzle, sq.ft.

     29.92  100                 (  77 + 460) * 230.186
%I = ----- * --- * ------------------------------------------
      528    60   28.85 *  36.2 * 0.992 * 320.00 * 0.0003602

%I =  97.6  %
```

GRAINS PER DRY STANDARD CUBIC FOOT

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

$$\text{gr/DSCF} = \frac{7000}{453{,}592} * \frac{8.3}{230.186} = 0.0006 \ \text{gr/DSCF}$$

POUNDS PER HOUR

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

$$\text{Lb/Hr} = 60/7000 \ * \ 0.0006 \ * \ 11{,}416 \ = \ 0.05 \ \text{LB/HR}$$

PLANT	C. S. Ohm	DATE	05/18/85
SAMPLING LOCATION	Scrubber Outlet Stack	RUN NUMBER	3
OPERATOR	BB	PROBE LENGTH, ft.	5'3"
BAR. PRESS., in. Hg	29.000	ASSUMED MOISTURE, %	3
STATIC PRESS., in. H20	-0.380	NOZZLE #	407
FILTER NUMBER(S)	T-0.252	NOZZLE DIAMETER, in.	0.309
PITOT TUBE COEFF.	0.840	METER BOX ΔH@	1.61
LEAK RATE, CFM	0.000	SAMPLE BOX NUMBER	19
LEAK TEST VACUUM, in.Hg	13.000	METER BOX NUMBER	N-8

Trav. Point. No.	Sample Time (Min.)	Gas Meter Reading (Cu.Ft.)	Velocity Head (in.H20)	Orifice ΔH (in. H20) Desired	Actual	Gas Meter Temp. (deg. F)	Pump Vac. (in.Hg)	Filter Box Temp. (deg.F)	Imp. Exit Temp. (deg.F)	Stack Temp. (deg.F)	Leak Check
A-1	ON/0	687.800	0.950	7.95	7.10	70	12.0	100	63	66	
A-2	12.0	706.180	0.670	5.60	5.60	90	9.0	100	60	67	
A-3	24.0	722.750	0.440	3.68	3.68	88	5.0	100	61	66	
A-4	36.0	736.260	0.270	2.26	2.26	85	4.0	100	61	66	
A-5	48.0	746.950	0.150	1.25	1.25	80	1.0	100	56	66	
A-6	60.0	750.330	0.280	2.34	2.34	78	1.0	100	65	66	
B-1	72/0	766.705	0.530	4.43	4.43	79	6.0	100	53	66	
B-2	12.0	781.460	0.500	4.18	4.18	82	6.0	100	60	68	
B-3	24.0	795.860	0.260	2.17	2.17	83	3.0	100	60	68	
B-4	36.0	806.330	0.080	0.67	0.67	79	1.0	100	60	68	
B-5	45.0	812.330	0.060	0.50	0.50	79	1.0	100	60	68	825.590
B-6	68.0	817.450	0.210	1.76	1.76	79	1.0	100	60	71	826.700
C-1	144/0	826.590	0.450	3.76	3.76	79	5.0	100	60	71	
C-2	12.0	840.300	0.730	6.11	6.11	83	9.0	100	60	69	
C-3	24.0	857.530	0.360	3.01	3.01	84	5.0	100	60	71	
C-4	36.0	869.820	0.100	0.84	0.84	83	1.0	100	60	70	
C-5	48.0	876.580	0.070	0.59	0.59	82	1.0	100	60	68	
C-6	60.0	880.250	0.290	2.43	2.43	81	1.0	100	60	68	
D-1	216/0	893.139	0.370	3.09	3.09	80	5.0	100	60	68	
D-2	12.0	905.140	0.550	4.60	4.60	84	6.0	100	60	68	
D-3	24.0	920.200	0.700	5.85	5.85	85	8.0	100	60	68	
D-4	36.0	937.150	0.470	3.93	3.93	88	6.0	100	60	69	
D-5	48.0	951.040	0.420	3.51	3.51	86	5.0	100	60	69	
D-6	60.0	964.260	0.490	4.10.	4.10	85	6.0	100	60	69	
FINAL	288/OFF	978.482									
DIFF/AVG.		290.572	0.35444		3.240	82				68	0.11

LANT	C. S. Ohm	DATE	06/19/85
SAMPLING LOCATION	Scrubber Outlet Stack	RUN NUMBER	6
ERATOR	BB	PROBE LENGTH, ft.	5'3"
R. PRESS., in. Hg	29.200	ASSUMED MOISTURE, %	3
STATIC PRESS., in. H20	-0.370	NOZZLE #	407
LTER NUMBER(S)	T-0.253	NOZZLE DIAMETER, in.	0.309
TOT TUBE COEFF.	0.840	METER BOX ΔH@	1.61
AK RATE, CFM	0.000	SAMPLE BOX NUMBER	19
LEAK TEST VACUUM, in.Hg	12.000	METER BOX NUMBER	N-8

ov. int. No.	Sample Time (Min.)	Gas Meter Reading (Cu.Ft.)	Velocity Head (in.H20)	Orifice ΔH (in. H20) Desired	Actual	Gas Meter Temp. (deg. F)	Pump Vac. (in.Hg)	Filter Box Temp. (deg.F)	Imp. Exit Temp. (deg.F)	Stack Temp. (deg.F)	Leak Check
1	ON/0	979.100	0.900	7.53	7.10	71	11.0	90	55	62	
2	12.0	997.700	0.670	5.60	5.60	88	8.0	95	59	64	
A-3	24.0	1014.400	0.450	3.76	3.76	80	6.0	95	60	66	
4	36.0	27.910	0.280	2.34	2.34	75	4.0	97	61	67	
5	48.0	38.610	0.170	1.42	1.42	71	1.0	98	62	66	
A-6	60.0	46.880	0.290	2.43	2.43	71	4.0	99	62	66	
B-1	72/0	57.765	0.540	4.52	4.52	71	7.0	100	62	67	
2	12.0	72.600	0.460	3.85	3.85	82	6.0	100	62	67	
3	24.0	86.330	0.260	2.17	2.17	86	4.0	100	62	69	
B-4	36.0	96.770	0.090	0.75	0.75	76	1.0	100	62	67	
5	48.0	103.200	0.070	0.58	0.58	72	1.0	100	62	68	
6	60.0	103.760	0.210	1.76	1.76	71	3.0	100	62	67	
C-1	144/0	117.979	0.420	3.51	3.51	70	5.0	100	62	67	117.979
C-2	12.0	131.240	0.700	5.85	5.85	74	9.0	100	62	67	118.100
3	24.0	147.870	0.360	1.89	1.89	75	2.0	100	61	68	
4	36.0	157.480	0.100	0.83	0.83	73	1.0	100	61	68	
C-5	48.0	164.120	0.070	0.58	0.58	71	1.0	100	61	68	
6	60.0	169.620	0.290	2.43	2.43	73	4.0	100	61	71	
1	216/0	180.566	0.370	3.09	3.09	75	5.0	100	61	72	
D-2	12.0	193.120	0.520	4.35	4.35	79	6.0	100	61	72	
D-3	24.0	207.680	0.700	5.85	5.85	80	9.0	100	61	72	
4	36.0	224.520	0.500	4.18	4.18	83	6.0	100	60	71	
5	48.0	238.850	0.380	3.18	3.18	81	5.0	100	60	72	
D-6	60.0	251.440	0.460	3.85	3.85	82	6.0	100	60	71	
AL	288/OFF	1265.287									
F/AVG.		285.066	0.35183		3.161	76				68	0.121

PLANT	C. S. Ohm	DATE	06/20/95
SAMPLING LOCATION	Scrubber Outlet Stack	RUN NUMBER	9
OPERATOR	BB	PROBE LENGTH, ft.	5'3"
BAR. PRESS., in. Hg	29.200	ASSUMED MOISTURE, %	3
STATIC PRESS., in. H20	-0.250	NOZZLE #	407
FILTER NUMBER(S)	T-0.251	NOZZLE DIAMETER, in.	0.309
PITOT TUBE COEFF.	0.840	METER BOX ΔH@	1.61
LEAK RATE, CFM	0.000	SAMPLE BOX NUMBER	19
LEAK TEST VACUUM, in.Hg	12.000	METER BOX NUMBER	N-8

Trav. Point. No.	Sample Time (Min.)	Gas Meter Reading (Cu.Ft.)	Velocity Head (in.H20)	Orifice ΔH (in. H20) Desired	Actual	Gas Meter Temp. (deg. F)	Pump Vac. (in.Hg)	Filter Box Temp. (deg.F)	Imp. Exit Temp. (deg.F)	Stack Temp. (deg.F)	Leak Check
A-1	ON/0	284.100	0.940	7.86	6.80	75	12.0	100	66	71	
A-2	12.0	302.120	0.650	5.44	5.44	88	9.0	100	64	71	
A-3	24.0	318.390	0.410	3.43	3.43	87	6.0	100	63	71	
A-4	36.0	331.270	0.280	2.34	2.34	82	4.0	100	62	71	
A-5	48.0	341.950	0.160	1.34	1.34	82	2.0	100	62	71	
A-6	60.0	350.060	0.310	2.59	2.59	83	5.0	100	62	72	
B-1	72/0	361.440	0.540	4.52	4.52	84	7.0	100	62	73	
B-2	12.0	376.320	0.480	4.01	4.01	84	7.0	100	62	72	
B-3	24.0	390.430	0.260	2.17	2.17	85	4.0	100	62	73	
B-4	36.0	400.360	0.100	0.84	0.84	82	1.0	100	62	74	
B-5	48.0	407.570	0.080	0.67	0.67	81	1.0	100	62	74	
B-6	60.0	413.620	0.230	1.92	1.92	80	4.0	100	62	74	
C-1	144/0	423.462	0.420	3.51	3.51	79	6.0	100	62	72	423.462
C-2	12.0	436.830	0.690	5.77	5.77	84	10.0	100	62	73	423.600
C-3	24.0	453.650	0.350	2.93	2.93	86	5.0	100	62	72	
C-4	36.0	465.660	0.080	0.67	0.67	82	1.0	100	62	72	
C-5	48.0	471.780	0.060	0.50	0.50	81	1.0	100	62	74	
C-6	60.0	476.880	0.280	2.34	2.34	82	4.0	100	62	73	
D-1	216/0	487.240	0.350	2.93	2.93	82	5.0	100	65	74	
D-2	12.0	499.330	0.500	4.18	4.18	82	7.0	100	67	70	
D-3	24.0	513.840	0.700	5.85	5.85	85	9.0	100	64	71	
D-4	36.0	530.820	0.500	4.18	4.18	88	7.0	100	65	71	
D-5	48.0	545.040	0.440	3.68	3.68	85	6.0	102	66	71	
D-6	60.0	556.220	0.480	4.01	4.01	85	7.0	102	66	70	
FINAL	288/OFF	572.682									
DIFF/AVG.		288.444	0.35225		3.192	83				72	0.138

PARTICULATE FIELD DATA & RESULTS TABULATION

PLANT: C.S. Ohm, Detroit, Michigan

RUN	SAMPLING LOCATION	TEST TEAM LEADER
3	Scrubber Outlet	Henry B. Long
6	Scrubber Outlet	Henry B. Long
9	Scrubber Outlet	Henry B. Long

		3	6	9
	RUN DATE	06/18/85	06/19/85	06/20/85
	RUN START TIME	1003	837	855
	RUN FINISH TIME	1505	1336	1350
	NET SAMPLING POINTS	24	24	24
Theta	NET RUN TIME, MINUTES	288.00	288.00	288.00
Dia	NOZZLE DIAMETER, INCHES	0.309	0.309	0.309
Cp	PITOT TUBE COEFFICIENT	0.840	0.840	0.840
Y	DRY GAS METER CAL. FACTOR	0.998	0.998	0.998
Pbar	BAROMETRIC PRESSURE, IN. HG.	29.00	29.20	29.20
Delta H	AVG. PRESS. DIFFERENTIAL OF ORIFICE METER, IN. H2O	3.240	3.161	3.193
Vm	VOLUME OF METERED GAS SAMPLE DRY ACTUAL CUBIC FEET	290.572	286.066	288.444
tm	DRY GAS METER TEMP., DEG. F	82	76	83
Vm(std)	VOLUME OF METERED GAS SAMPLE @ DRY STD. COND., DSCF*	275.953	276.540	275.266
Vlc	VOLUME OF WATER CATCH IN IMPINGERS & SIL. GEL.,ML	85.1	103.3	104.6
Vw(std)	VOLUME OF WATER VAPOR, SCF*	4.006	4.862	4.924
%H2O	MOISTURE, PERCENT BY VOLUME	1.4	1.7	1.8
Mfd	DRY MOLE FRACTION	0.986	0.983	0.982

(continued next page)

		3	6	9
Md	DRY MOLECULAR WT, LB/LB-MOLE	28.84	28.84	28.84
Ms	WET MOLECULAR WT, LB/LB-MOLE	28.68	28.65	28.65
Pg	GAS STATIC PRESS., IN. H2O	-0.4	-0.4	-0.3
Ps	ABSOLUTE GAS PRESS., IN. HG.	28.97	29.17	29.18
ts	GAS TEMPERATURE, DEG. F	68	68	72
Delta p	AVG VELOCITY HEAD, IN. H2O	0.3544	0.3518	0.3523
vs	FLUE GAS VELOCITY, FT/SEC	34.1	33.9	34.0
A	STACK/DUCT AREA, SQUARE IN.	921.0	921.0	921.0
Qsd	GAS FLOW RATE, DRY SCFM *	12,477	12,443	12,404
Qaw	GAS FLOW RATE, WET ACFM	13,077	12,992	13,049
%I	PERCENT ISOKINETIC	94.2	94.6	94.5
	METHOD 5 RESULTS: **			
mg	CATCH, MILLIGRAMS	1.0	4.1	1.0
gr/DSCF	CONCEN., GRAINS PER DSCF*	0.0001	0.0002	0.0001
Lb/Hr	EMISSION RATE, LBS/HOUR	0.01	0.02	0.01
	HEXAVALENT CHROMIUM:			
	CATCH, MILLIGRAMS	(2.1)	(2.7)	(3.2)
	TOTAL CHROMIUM:			
	CATCH, MILLIGRAMS	(18.8)	(14.3)	(14.8)

* 68 Deg. F - 29.92 in. Hg.

** Particulate catches for run Nos. 3 and 9 were not quantifiable. The value of 1.0 mg was entered for calculation purposes only and does not represent a true value.

( ) = x 10^{-3}

RUN NUMBER	3	6	9	
FLUE GAS TEMPERATURE:				
Degrees Fahrenheit	68	68	72	deg. F
Degrees Centigrade	20	20	22	deg. C
AIR FLOW RATES x million:				
Actual Cubic Meters/hr	0.0222	0.0221	0.0222	acmh
Actual Cubic Feet/hr	0.7846	0.7795	0.7829	acfh
Dry Std. Cubic Meters/hr	0.0212	0.0211	0.0211	dscmh
Dry Std. Cubic Feet/hr	0.7486	0.7466	0.7443	dscfh
PARTICULATE: **				
Concentration, mg/dscm	0.128	0.524	0.128	mg/dscm
Concentration, gr/dscf	0.00006	0.00023	0.00006	gr/dscf
Emissions, kg/hr	0.003	0.011	0.003	kg/hr
Emissions, lb/hr	0.006	0.024	0.006	lb/hr
HEXAVALENT CHROMIUM:				
Concentration, mg/dscm	(0.269)	(0.345)	(0.411)	mg/dscm
Concentration, gr/dscf	(0.00012)	(0.00015)	(0.00018)	gr/dscf
Emissions, kg/hr	(0.006)	(0.007)	(0.009)	kg/hr
Emissions, lb/hr	(0.013)	(0.016)	(0.019)	lb/hr
TOTAL CHROMIUM:				
Concentration, mg/dscm	(2.406)	(1.826)	(1.899)	mg/dscm
Concentration, gr/dscf	0.00105	0.00080	0.00083	gr/dscf
Emissions, kg/hr	0.051	0.039	0.040	kg/hr
Emissions, lb/hr	0.112	0.085	0.088	lb/hr

** Particulate catches for run Nos. 3 and 9 were not quantifiable. The value of 1.0 mg was entered for calculation purposes only and does not represent a true value.

( ) = x 10^{-3}

PLANT	C. S. Ohm	DATE	06/19/85
SAMPLING LOCATION	Scrubber inlet	RUN NUMBER	SPECIAL
OPERATOR	BB	PROBE LENGTH, ft.	4'4"
BAR. PRESS., in. Hg	29.200	ASSUMED MOISTURE, %	3
STATIC PRESS., in. H2O	-1.900	NOZZLE #	711
FILTER NUMBER(S)	T-0.2-2	NOZZLE DIAMETER, in.	0.354
PITOT TUBE COEFF.	0.840	METER BOX ΔH@	1.58
LEAK RATE, CFM	0.000	SAMPLE BOX NUMBER	8
LEAK TEST VACUUM, in.Hg	12.000	METER BOX NUMBER	N-14

Trav. Point. No.	Sample Time (Min.)	Gas Meter Reading (Cu.Ft.)	Velocity Head (in.H2O)	Orifice ΔH (in. H2O) Desired	Actual	Gas Meter Temp. (deg. F)	Pump Vac. (in.Hg)	Filter Box Temp. (deg.F)	Imp. Exit Temp. (deg.F)	Stack Temp. (deg.F)	Leak Check
A5	ON/0	10.132	0.350	6.40	6.40	80	11.0	90	60	79	
	508.0	624.935	0.370	2.60	2.60	110	6.0	130	35	78	
DIFF/AVG.		614.803	0.35993		4.500	95				79	

PARTICULATE FIELD DATA & RESULTS TABULATION

PLANT: C.S. Ohm, Detroit, Michigan

RUN	SAMPLING LOCATION	TEST TEAM LEADER
SR	Scrubber Inlet	Robert W. Bridges

		SR
	RUN DATE	06/19/85
	RUN START TIME	1419
	RUN FINISH TIME	2247
	NET SAMPLING POINTS	2
Theta	NET RUN TIME, MINUTES	508.00
Dia	NOZZLE DIAMETER, INCHES	0.364
Cp	PITOT TUBE COEFFICIENT	0.840
Y	DRY GAS METER CAL. FACTOR	1.000
Pbar	BAROMETRIC PRESSURE, IN. HG.	29.20
Delta H	AVG. PRESS. DIFFERENTIAL OF ORIFICE METER, IN. H2O	4.500
Vm	VOLUME OF METERED GAS SAMPLE DRY ACTUAL CUBIC FEET	614.803
tm	DRY GAS METER TEMP., DEG. F	95
Vm(std)	VOLUME OF METERED GAS SAMPLE @ DRY STD. COND., DSCF*	577.057
Vlc	VOLUME OF WATER CATCH IN IMPINGERS & SIL. GEL.,ML	27.6
Vw(std)	VOLUME OF WATER VAPOR, SCF*	1.299
%H2O	MOISTURE, PERCENT BY VOLUME	0.2
Mfd	DRY MOLE FRACTION	0.998

(continued next page)

		SR
Md	DRY MOLECULAR WT, LB/LB-MOLE	28.84
Ms	WET MOLECULAR WT, LB/LB-MOLE	28.81
Pg	GAS STATIC PRESS., IN. H2O	-1.9
Ps	ABSOLUTE GAS PRESS., IN. HG.	29.06
ts	GAS TEMPERATURE, DEG. F	79
Delta p	AVG VELOCITY HEAD, IN. H2O	0.3599
vs	FLUE GAS VELOCITY, FT/SEC	34.6
A	STACK/DUCT AREA, SQUARE IN.	804.2
Qsd	GAS FLOW RATE, DRY SCFM *	10,991
Qaw	GAS FLOW RATE, WET ACFM	11,582
%I	PERCENT ISOKINETIC	79.8
	METHOD 5 RESULTS:	
mg	CATCH, MILLIGRAMS	3.7
gr/DSCF	CONCEN., GRAINS PER DSCF*	0.0001
Lb/Hr	EMISSION RATE, LBS/HOUR	0.01
	HEXAVALENT CHROMIUM:	
	CATCH, MILLIGRAMS	(5.9)
	TOTAL CHROMIUM:	
	CATCH, MILLIGRAMS	(14.9)

* 68 Deg. F - 29.92 in. Hg.

( ) = x 10^{-3}

RUN NUMBER	SR	
FLUE GAS TEMPERATURE:		
Degrees Fahrenheit	79	deg. F
Degrees Centigrade	26	deg. C
AIR FLOW RATES x million:		
Actual Cubic Meters/hr	0.0197	acmh
Actual Cubic Feet/hr	0.6949	acfh
Dry Std. Cubic Meters/hr	0.0187	dscmh
Dry Std. Cubic Feet/hr	0.6595	dscfh
PARTICULATE:		
Concentration, mg/dscm	0.226	mg/dscm
Concentration, gr/dscf	0.00010	gr/dscf
Emissions, kg/hr	0.004	kg/hr
Emissions, lb/hr	0.009	lb/hr
HEXAVALENT CHROMIUM:		
Concentration, mg/dscm	(0.361)	mg/dscm
Concentration, gr/dscf	(0.00016)	gr/dscf
Emissions, kg/hr	(0.007)	kg/hr
Emissions, lb/hr	(0.015)	lb/hr
TOTAL CHROMIUM:		
Concentration, mg/dscm	(0.912)	mg/dscm
Concentration, gr/dscf	(0.00040)	gr/dscf
Emissions, kg/hr	(0.017)	kg/hr
Emissions, lb/hr	(0.038)	lb/hr

( ) = x 10^{-3}

TOTAL CHROMIUM ANALYSIS CALCULATION

			Cr Analysis of Sample			Cr Analysis of Residue								
(A) Sample No.	(B) Total Wt of Sample mg	(C) NAA Results of Cr µg	(D) Wt of Sample Analyzed mg	(E) Aliquot Factor	(F) Cr In Sample w/Blank µg	(G) Wt of Residue Analyzed mg	(H) Aliquot Factor	(J) Cr In Sample Residue µg	(K) Cr^{+6} from Filtrate µg	(L) Cr In Sample w/Blank µg	(M) Blank Value µg	(N) Cr In Sample Blank Corrected µg	(P) Cr Conc. µg/g
241	8.3	9.20				Total	1	9.20	<0.2	9.2	6.7	2.5	301.2
242	1.3	13.27				Total	1	13.27	2.8	16.1	6.7	9.4	7,230.8
243	6.7	18.74				Total	1	18.74	4.2	22.9	6.7	16.2	2,417.9
244	3.7	15.65				Total	1	15.65	5.9	21.6	6.7	14.9	4,027.0
245	•	23.44				Total	1	23.44	2.1	25.5	6.7	18.8	----
246	4.1	18.27				Total	1	18.27	2.7	21.0	6.7	14.3	3,487.8
247	*	18.31				Total	1	18.31	3.2	21.5	6.7	14.8	----
248	Blank	5.56				Total	1	5.56	1.1	6.7	---	----	
249	Total	1.12				Half	2	2.24	0.8	3.0	2.0	1.0	----
250	Total	1.68				Half	2	3.36	<0.2	3.4	2.0	1.4	----
251	Total	0.60				Half	2	1.20	<0.2	1.2	2.0	----	----
252	Total	0.94				Half	2	1.88	<0.2	1.9	2.0	----	----
253	Total	0.84				Half	2	1.68	<0.2	1.7	2.0	----	----
254	Total	0.72				Half	2	1.44	<0.2	1.4	2.0	----	----
255	Total	30.89				Half	2	61.78	15.6	82.5	2.0	80.5	----
256	Total	1.28				Half	2	2.56	<0.2				
257	Total	1.13				Half	2	2.26	<0.2				
258	Total	13.67				Half	2	27.34	13.2	47.4	2.0	45.4	----
259	Total	1.41				Half	2	2.82	<0.2				
260	Total	2.03				Half	2	4.06	0.2				
261	Total	26.15				Half	2	52.30	19.4	90.9	2.0	88.9	----
262	Total	4.07				Half	2	8.14	0.7				
263	Total	4.83				Half	2	9.66	0.7				
264	Blank	0.99				Half	2	1.98	<0.2	2.0	---	----	
265	1 mL	12.69	Total	1	12.7						---	12.7	12.7 µg/ml
267	Total	0.79				Half	2	1.58	<0.2	1.6	2.0	----	----

*Particulate catch was not quantifiable.

EXPLANATION OF TOTAL CHROMIUM ANALYSIS CALCULATION TABLE

Column	
A	(Sample Number) - Used to identify samples transferred to RTI and NCSU for hexavalent and total chromium analysis. Samples are identified on the Request for Analysis sheets in Appendix B.
B	(Total Weight of Sample in mg) - Given for Method 5 and particle sizing samples (filters and catch or precutter contents). Taken from Particulate Sampling Laboratory Results and Particle Sizing Laboratory Data found in Appendix B.
C	(NAA Results for Cr in μg) - Reported results for total chromium in the sample. Taken from computer printout of results found in Appendix B.
D	(Weight of Sample Analyzed in mg) - If only a portion of the total sample was taken for NAA, the weight was recorded here. This weight was taken from the Sample Preparation and Analysis Data Form which is transferred with the samples for NAA (found in Appendix B).
E	(Aliquot Factor) - The ratio of the total weight of the sample to amount of sample analyzed; should be 1 in all cases.
F	(Cr in Sample with Blank in μg) - Total chromium in sample as measured by NAA; blank value, if any, has not been subtracted out. Results are taken from computer printout in Appendix B or Column C of this table.
G	(Weight of Residue Analyzed in mg) - In some cases (i.e., Method 5, particle size, and some impinger samples), the hexavalent chromium was first extracted from the sample before it was submitted for NAA. The remainder of the sample following the hexavalent chromium extraction is termed the "residue." This column gives the weight of the residue analyzed and is taken from the Sample Preparation and Analysis Data Form found in Appendix B.
H	(Aliquot Factor) - The ratio of the total weight of the sample to the amount of residue analyzed. This number multiplied by the total chromium results yields the total chromium in the sample residue.
J	(Cr in Sample Residue in μg) - Total chromium content of the sample residue calculated by multiplying the total chromium results by NAA (column C) times the aliquot factor (column H). Thus, H x C = J.
K	(Cr^{+6} in the Filtrate in μg) - Amount of hexavalent chromium in the filtrate extracted from the sample. This value must be added to the total chromium measured by NAA to get the total chromium in the sample. The hexavalent chromium value is taken from the Wet Chemical Analysis Sheets found in Appendix B.
L	(Cr in Sample with Blank in μg) - Total chromium in sample; blank value, if any, has not been subtracted out. This value is the sum of the hexavalent chromium in the sample filtrate (column K) and the total chromium in the sample residue (column J). Thus, K + J = L.
M	(Blank Value in μg) - Total chromium value for the appropriate sample blank, if any.
N	(Cr in Sample, Blank Corrected in μg) - Total chromium in sample with value of sample blank, if any, subtracted out. Thus, L - M = N.
P	(Cr Concentration in μg/g) - Chromium concentration in sample calculated by dividing the total chromium content of the sample by the sample weight: N ÷ B = P or N ÷ D = P.

APPENDIX B.

FIELD AND ANALYTICAL DATA

Preliminary Field Data

PLANT NAME C. S. OHM
LOCATION DETROIT, MICH
SAMPLING LOCATION SCRUBBER INLET

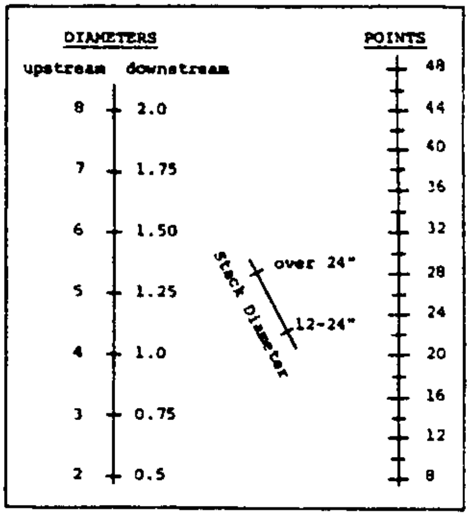
DUCT DEPTH
FROM INSIDE FAR WALL TO OUTSIDE OF PORT 32 1/4"
NIPPLE LENGTH 1/4"
DEPTH OF DUCT 32"
WIDTH (RECTANGULAR DUCT) ______

EQUIVALENT DIAMETER:

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

DISTANCE FROM PORTS TO NEAREST FLOW DISTURBANCE:	UPSTREAM	DOWNSTREAM
FEET	14' = 168"	2'2" = 26"
STACK DIAMETERS	5.25	0.81

STACK AREA = $(32/2)^2 \pi$ = ______ = 804.2[illegible] IN^2



Point	% OF DIAMETER	DISTANCE FROM INSIDE WALL	DISTANCE FROM OUTSIDE OF PORT
1	3.2	1"	1 1/4
2	10.5	3 3/8	3 5/8
3	19.4	6 1/4	6 1/2
4	32.3	10 3/8	10 5/8
5	67.7	21 5/8	21 7/8
6	80.6	25 3/4	26
7	89.5	28 5/8	28 7/8
8	96.8	~~30~~ 31	31 1/4
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			

LOCATION OF TRAVERSE POINTS IN CIRCULAR STACKS

	4	6	8	10	12	14	16	18	20	22	24
1	6.7	4.4	3.2	2.6	2.1	1.8	1.6	1.4	1.3	1.1	1.1
2	25.0	14.6	10.5	8.2	6.7	5.7	4.9	4.4	3.9	3.5	3.2
3	75.0	29.6	19.4	14.6	11.9	9.9	8.5	7.5	6.7	6.0	5.5
4	93.3	70.4	32.3	22.6	17.7	14.6	12.5	10.9	9.7	8.7	7.9
5		85.4	67.7	34.2	25.0	20.1	16.9	14.6	12.9	11.6	10.5
6		95.6	80.6	65.8	35.6	26.9	22.0	18.8	16.5	14.6	13.2
7			89.5	77.4	64.4	36.6	28.3	23.6	20.4	18.0	16.1
8			96.8	85.4	75.0	63.4	37.5	29.6	25.0	21.8	19.4
9				91.8	82.3	73.1	62.5	38.2	30.6	26.2	23.0
10				97.4	88.2	79.9	71.7	61.8	38.8	31.5	27.2
11					93.3	85.4	78.0	70.4	61.2	39.3	32.3
12					97.9	90.1	83.1	76.4	69.4	60.7	39.8
13						94.3	87.5	81.2	75.0	68.5	60.2
14						98.2	91.5	85.4	79.6	73.8	67.7
15							95.1	89.1	83.5	78.2	72.8
16							98.4	92.5	87.1	82.0	77.0
17								95.6	90.3	85.4	80.6
18								98.6	93.3	88.4	83.9
19									96.1	91.3	86.8
20									98.7	94.0	89.5
21										96.5	92.1
22										98.9	94.5
23											96.8
24											98.9

LOCATION OF TRAVERSE POINTS IN RECTANGULAR STACKS

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

ENTROPY ENVIRONMENTALISTS, INC.

PARTICULATE FIELD DATA

COMPANY NAME C.S. OHM
RUN NUMBER 1
ADDRESS DETROIT, MICH.
TIME START 1005
SAMPLING LOCATION SCRUBBER INLET
TIME FINISH 1530
DATE 6·18·85
TEAM LEADER gm
TECHNICIANS B.B.
BAROMETRIC PRESSURE, IN. HG 29.0
STATIC PRESSURE, IN. H_2O -2.00
SAMPLING TRAIN LEAK TEST VACUUM, IN. HG 15 10 10
SAMPLING TRAIN LEAK RATE, CU. FT./MIN. 0.000 0.000 0.000

EQUIPMENT CHECKS

✓ PITOTS, PRE-TEST
PITOTS, POST-TEST
NA ORSAT SAMPLING SYSTEM
NA TEDLAR BAG
✓ THERMOCOUPLE @ 80 °F

IDENTIFICATION NUMBERS

REAGENT BOX 216
NOZZLE 406
DIAMETER 0.252
METER BOX N-5
T/C READOUT 04
UMBILICAL U-52
T/C PROBE 5-8
SAMPLE BOX 24
ORSAT PUMP NA
PROBE 4-5
TEDLAR BAG NA

FILTER # **TARE**

NOMOGRAPH SET-UP
NOMOGRAPH # gm

ΔH@ 1.80
C FACTOR 1.10
METER TEMP 100
STACK TEMP 80
% MOISTURE 2
REF. ΔP 0.40

SAMPLE POINT	CLOCK TIME, MIN.	DRY GAS METER READING, CU. FT.	PITOT READING (ΔP), IN. H_2O	ORIFICE SETTING (ΔH), IN. H_2O IDEAL	ORIFICE SETTING (ΔH), IN. H_2O ACTUAL	GAS METER TEMP. °F	PUMP VACUUM IN. HG GAUGE	FILTER BOX TEMP. °F	IMP. EXIT TEMP. °F	STACK TEMP. °F	LK. CHECK READINGS
B	0/0	698.200	0.30	1.38	1.38	90	3	95	60	62	
	10	704.77	0.30	1.38	1.38	94	3	92	60	65	
	20	711.25	0.30	1.38	1.38	96	3	92	60	66	
	30	717.83	0.30	1.38	1.38	97	3	92	60	66	
	40	724.43	0.30	1.38	1.38	98	3	90	60	76	
	50	731.04	0.30	1.38	1.38	99	3	90	60	76	
	60	738.15	0.35	1.58	1.58	100	3	90	60	79	
	70	745.10	0.35	1.58	1.58	100	3	90	60	80	
	80	752.06	0.35	1.58	1.58	100	3	90	60	78	
	90	758.75	0.35	1.58	1.58	100	3	90	60	78	
	100	765.80	0.35	1.58	1.58	100	3	90	60	78	
	110	772.86	0.35	1.58	1.58	100	3	90	60	78	
	120	779.92	0.35	1.58	1.58	100	3	90	60	82	
	130	786.96	0.35	1.58	1.58	100	3	93	60	80	
	140	794.05	0.35	1.58	1.58	100	3	93	60	80	
	150	801.14	0.35	1.58	1.58	100	3	93	60	80	
A	160/0	808.238	0.60	2.30	2.30	96	5	90	60	75	808.238
A	10	816.84	0.55	2.53	2.53	98	5	90	60	75	808.300
	20	825.75	0.55	2.53	2.53	98	5	90	60	78	
	30	834.76	0.55	2.53	2.53	98	5	90	60	76	
	40	843.78	0.55	2.53	2.53	96	5	90	60	75	
	50	852.74	0.55	2.53	2.53	96	5	90	60	73	
	60	861.75	0.55	2.53	2.53	96	5	90	60	80	
	70	871.00	0.55	2.53	2.53	96	5	90	60	82	
	80	879.77	0.55	2.53	2.53	95	5	90	60	80	

V_M	$(\overline{\sqrt{\Delta P}})^2$	ΔH	T_M	T_S
			97	77

PARTICULATE FIELD DATA

PAGE 2

COMPANY NAME C. S. OHM **RUN #** 1

SAMPLING LOCATION Scrubber INLET **DATE** 6.18.85

SAMPLE POINT	CLOCK TIME, MIN.	DRY GAS METER READING, CU. FT.	PITOT READING (ΔP), IN. H_2O	ORIFICE SETTING (ΔH), IN. H_2O IDEAL	ORIFICE SETTING (ΔH), IN. H_2O ACTUAL	GAS METER TEMP. °F	PUMP VACUUM IN. HG GAUGE	FILTER BOX TEMP. °F	IMP. EXIT TEMP. °F	STACK TEMP. °F	LEAK TEST READINGS
	90	888.80	0.55	2.53	2.53	95	5	90	60	80	
	100	897.78	0.65	2.53	2.53	95	5	90	60	80	
	110	906.85	0.55	2.53	2.53	95	5	90	60	82	
	120	915.95	0.65	2.53	2.53	95	5	90	60	81	
	130	925.05	0.55	2.53	2.53	95	5	90	60	78	
	140	934.12	0.55	2.53	2.53	95	5	90	60	80	
	160	943.19	0.55	2.53	2.53	95	5	90	60	80	
	320/off	952.429									

254.167 V_M

0.4321 $(\sqrt{\Delta P})^2$

2.010 $\overline{\Delta H}$

97 $\overline{T_M}$

77 $\overline{T_S}$

ENTROPY

PARTICULATE FIELD DATA

COMPANY NAME C.S. OHM
RUN NUMBER 4
ADDRESS DETROIT, MICH.
TIME START 0839
SAMPLING LOCATION Scrubber INLET
TIME FINISH 1405
DATE 6·19·85
TEAM LEADER gk
TECHNICIANS BB
BAROMETRIC PRESSURE, IN. HG 29.2
STATIC PRESSURE, IN. H_2O −1.90
SAMPLING TRAIN LEAK TEST VACUUM, IN. HG 15 10
SAMPLING TRAIN LEAK RATE, CU. FT./MIN. 0.000 0.000

EQUIPMENT CHECKS

✓ PITOTS, PRE-TEST
PITOTS, POST-TEST
NA ORSAT SAMPLING SYSTEM
NA TEDLAR BAG
✓ THERMOCOUPLE @ 80 °F

IDENTIFICATION NUMBERS

REAGENT BOX 216
NOZZLE 406
DIAMETER .252
METER BOX N-5
T/C READOUT 04
UMBILICAL U-25
T/C PROBE 5-8
SAMPLE BOX 24
ORSAT PUMP NA
PROBE 4-5
TEDLAR BAG NA

FILTER #	TARE
—	—

NOMOGRAPH SET-UP

NOMOGRAPH # gk
ΔH@ 1.80
C FACTOR 1.08
METER TEMP 80
STACK TEMP 80
% MOISTURE 2
REF. ΔP 0.42

SAMPLE POINT	CLOCK TIME, MIN.	DRY GAS METER READING, CU. FT.	PITOT READING (ΔP), IN. H_2O	ORIFICE SETTING (ΔH), IN. H_2O IDEAL	ORIFICE SETTING (ΔH), IN. H_2O ACTUAL	GAS METER TEMP. °F	PUMP VACUUM IN. HG GAUGE	FILTER BOX TEMP. °F	IMP. EXIT TEMP. °F	STACK TEMP. °F	LK. CHECK READINGS
B	0	952.700	0.33	1.45	1.45	68	3	90	60	75	
	10	959.35	0.33	1.45	1.45	75	3	90	60	75	
	20	966.40	0.33	1.45	1.45	80	3	90	60	76	
	30	972.80	0.36	1.68	1.58	82	3	90	60	75	
	40	979.88	0.36	1.58	1.58	82	3	90	60	74	
	50	986.93	0.36	1.58	1.58	84	3	90	60	79	
	60	994.00	0.36	1.58	1.58	85	3	90	60	75	
	70	1008.05	0.36	1.58	1.58	85	3	90	60	76	
	80	1008.10	0.36	1.58	1.58	85	3	90	60	76	
	90	1015.17	0.36	1.58	1.58	85	3	90	60	76	
	100	1022.25	0.40	1.75	1.75	85	3	90	60	76	
	110	1029.68	0.40	1.75	1.75	85	3	90	60	76	
	120	1037.16	0.40	1.75	1.75	85	3	90	60	76	
	130	1044.61	0.40	1.75	1.75	86	3	90	60	77	
	140	1052.11	0.38	1.66	1.66	87	3	90	60	76	
	150	1059.50	0.38	1.66	1.66	87	3	90	60	77	
A	160/0	1066.755	0.48	2.10	2.10	86	3	90	60	68	1066.755
	10	1075.03	0.48	2.10	2.10	88	5	90	60	73	1066.850
	20	1083.30	0.48	2.10	2.10	88	5	90	60	75	
	30	1091.57	0.48	2.10	2.10	88	5	90	60	73	
	40	1099.84	0.48	2.10	2.10	88	5	90	60	73	
	50	1108.10	0.48	2.10	2.10	88	5	90	60	74	
	60	1116.34	0.48	2.10	2.10	88	5	90	60	78	
	70	1124.55	0.48	2.10	2.10	87	5	90	60	77	
	80	1132.79	0.52	2.27	2.27	86	5	90	60	77	

V_M	$(\sqrt{\Delta P})^2$	ΔH	T_M	T_S
			85	77

ENTROPY

PARTICULATE FIELD DATA

PAGE 2

COMPANY NAME ~~O.S.~~ C.S. OHM RUN # 4

SAMPLING LOCATION Scrubber INLET DATE 6.19.85

SAMPLE POINT	CLOCK TIME, MIN.	DRY GAS METER READING, CU. FT.	PITOT READING (ΔP), IN. H_2O	ORIFICE SETTING (ΔH), IN. H2O IDEAL	ORIFICE SETTING (ΔH), IN. H2O ACTUAL	GAS METER TEMP. °F	PUMP VACUUM IN. HG GAUGE	FILTER BOX TEMP. °F	IMP. EXIT TEMP. °F	STACK TEMP. °F	LEAK TEST READINGS
	90	1141.18	0.52	2.27	2.27	86	5	90	60	79	
	100	1149.60	0.52	2.27	2.27	86	5	90	60	79	
	110	1158.00	0.52	2.27	2.27	87	5	90	60	79	
	120	1166.44	0.52	2.27	2.27	88	5	90	60	79	
	130	1174.88	0.52	2.27	2.27	89	5	90	60	79	
	140	1183.35	0.52	2.27	2.27	90	5	90	60	84	
	150	1191.82	0.52	2.27	2.27	90	5	90	60	84	
	320/off	1200.318									

V_M	$(\sqrt{\Delta P})^2$	$\overline{\Delta H}$	$\overline{T_M}$	$\overline{T_S}$
247.518 247.527	0.4306	1.897	85	76

ENTROPY

PARTICULATE FIELD DATA

COMPANY NAME C.S. OHM
RUN NUMBER 7
ADDRESS DETROIT, MICH.
TIME START 0856
SAMPLING LOCATION SCRUBBER INLET
TIME FINISH 1421
DATE 6.20.85
TEAM LEADER SM
TECHNICIANS B.B
BAROMETRIC PRESSURE, IN. HG 29.2
STATIC PRESSURE, IN. H_2O -1.95
SAMPLING TRAIN LEAK TEST VACUUM, IN. HG 15 6 6
SAMPLING TRAIN LEAK RATE, CU. FT./MIN. 0.000 0.000 0.000

EQUIPMENT CHECKS

✓ PITOTS, PRE-TEST
___ PITOTS, POST-TEST
NA ORSAT SAMPLING SYSTEM
NA TEDLAR BAG
✓ THERMOCOUPLE @ 80 °F

IDENTIFICATION NUMBERS

REAGENT BOX 216
NOZZLE 406
DIAMETER 0.252
METER BOX N-5
T/C READOUT 04
UMBILICAL U-25
T/C PROBE 5-8
SAMPLE BOX 24
ORSAT PUMP NA
PROBE 4-5
TEDLAR BAG NA

FILTER #	TARE
–	–

NOMOGRAPH SET-UP

NOMOGRAPH # SM
$\Delta H_@$ 1.80
C FACTOR ~~1.08~~ 1.09
METER TEMP 90
STACK TEMP 80
% MOISTURE 2
REF. ΔP 0.41

SAMPLE POINT	CLOCK TIME, MIN.	DRY GAS METER READING, CU. FT.	PITOT READING (ΔP), IN. H_2O	ORIFICE SETTING (ΔH), IN. H_2O		GAS METER TEMP. °F	PUMP VACUUM IN. HG GAUGE	FILTER BOX TEMP. °F	IMP. EXIT TEMP. °F	STACK TEMP. °F	LK. CHECK READINGS
				IDEAL	ACTUAL						
B	0/0	215.600	0.31	1.39	1.39	78	3	90	60	73	
	10	222.05	0.31	1.39	1.39	83	3	90	60	73	
	20	228.52	0.31	1.39	1.39	90	3	90	60	77	
	30	236.00	0.33	1.48	1.48	93	3	90	60	79	
	40	241.95	0.33	1.48	1.48	96	4	90	60	79	
	50	248.78	0.33	1.48	1.48	98	4	90	60	79	
	60	255.67	0.33	1.48	1.48	100	4	90	60	83	
	70	262.51	0.33	1.48	1.48	102	4	90	60	82	
	80	269.57	0.36	1.61	1.61	102	4	90	60	78	
	90	276.62	0.36	1.61	1.61	102	4	90	60	81	
	100	283.82	0.36	1.61	1.61	102	4	90	60	80	
	110	291.01	0.39	1.75	1.75	103	4	90	60	81	
	120	298.50	0.39	1.75	1.75	103	4	90	60	80	
	130	306.00	0.39	1.75	1.75	103	4	90	60	80	
	140	313.46	0.39	1.75	1.75	102	4	90	60	78	
	150	320.96	0.39	1.75	1.75	100	4	90	60	79	
A	160/0	328.515	0.52	2.33	2.33	97	5	90	60	74	328.515
	10	336.82	0.52	2.33	2.33	99	5	90	60	70	328.600
	20	346.38	0.52	2.33	2.33	99	5	90	60	76	
	30	353.95	0.52	2.33	2.33	99	5	90	60	77	
	40	362.71	0.52	2.33	2.33	98	6	90	60	78	
	50	371.48	0.52	2.33	2.33	95	6	90	60	78	
	60	380.32	0.52	2.33	2.33	95	6	90	60	80	
	70	388.80	0.52	2.33	2.33	93	6	90	60	79	
	80	397.48	0.52	2.33	2.33	93	6	90	60	79	

V_M ____ $(\overline{\sqrt{\Delta P}})^2$ ____ ΔH ____ T_M ____ T_S ____

ENTROPY

PARTICULATE FIELD DATA

PAGE 2

COMPANY NAME O. S. OHM **RUN #** 7

SAMPLING LOCATION Scrubber inlet **DATE** 6·20·84

SAMPLE POINT	CLOCK TIME, MIN.	DRY GAS METER READING, CU. FT.	PITOT READING (ΔP), IN. H_2O	ORIFICE SETTING (ΔH), IN. H2O		GAS METER TEMP. °F	PUMP VACUUM IN. HG GAUGE	FILTER BOX TEMP. °F	IMP. EXIT TEMP. °F	STACK TEMP. °F	LEAK TEST READINGS
				IDEAL	ACTUAL						
	90	406.12	0.52	2.33	2.33	93	6	90	60	80	
	100	414.75	0.52	2-33	2.33	93	6	90	60	81	
	110	423.32	0.52	2.33	2.33	93	6	90	60	82	
	120	431.90	0.52	2.33	2.33	94	6	90	60	85	
	130	440.48	0.55	2.47	2.47	94	6	90	60	82	
	140	449-50	0.55	2.47	2.47	93	6	90	60	79	
	150	458-19	0.55	2.47	2.47.	92	6	90	60	79	
	320/off	467.551									

251.866 V_M

0.4333 $(\sqrt{\Delta P})^2$

1.964 $\overline{\Delta H}$

96 $\overline{T_M}$

79 $\overline{T_S}$

ENTROPY

PARTICULATE FIELD DATA

COMPANY NAME C.S. OHM
ADDRESS DETROIT, MICH.
SAMPLING LOCATION SCRUBBER INLET
DATE 6·18·85
TEAM LEADER gme
TECHNICIANS B.B.
RUN NUMBER 2
TIME START 1004
TIME FINISH 1529
BAROMETRIC PRESSURE, IN. HG 29.0
STATIC PRESSURE, IN. H_2O -2.00
SAMPLING TRAIN LEAK TEST VACUUM, IN. HG 15 10 10
SAMPLING TRAIN LEAK RATE, CU. FT./MIN. 0.000 0.000 0.000

EQUIPMENT CHECKS

- ✓ PITOTS, PRE-TEST
- ___ PITOTS, POST-TEST
- NA ORSAT SAMPLING SYSTEM
- NA TEDLAR BAG
- ✓ THERMOCOUPLE @ ______ °F

IDENTIFICATION NUMBERS

REAGENT BOX 228
NOZZLE 405
DIAMETER 0.257
METER BOX N-14
T/C READOUT 04
UMBILICAL U-50
T/C PROBE T-0
SAMPLE BOX 25
ORSAT PUMP NA
PROBE 4-1
TEDLAR BAG NA

FILTER #	TARE
T025	.4576

NOMOGRAPH SET-UP

NOMOGRAPH # gme
ΔH@ 1.68
C FACTOR 1.03
METER TEMP 100
STACK TEMP 80
% MOISTURE 2
REF. ΔP 0.42

SAMPLE POINT	CLOCK TIME, MIN.	DRY GAS METER READING, CU. FT.	PITOT READING (ΔP), IN. H_2O	ORIFICE SETTING (ΔH), IN. H_2O IDEAL	ORIFICE SETTING (ΔH), IN. H_2O ACTUAL	GAS METER TEMP. °F	PUMP VACUUM IN. HG GAUGE	FILTER BOX TEMP. °F	IMP. EXIT TEMP. °F	STACK TEMP. °F	LK. CHECK READINGS
A 1	0/0	515.500	0.35	1.53	1.53	90	5	95	60	62	
	10	522.81	0.35	1.53	1.53	94	5	92	60	65	
2	20	530.06	0.40	1.75	1.75	98	6	92	60	66	
	30	538.05	0.40	1.75	1.75	100	6	92	60	66	
3	40	645.72	0.52	2.28	2.28	102	7	90	60	76	
	50	554.44	0.52	2.28	2.28	105	7	90	60	76	
4	60	564.00	0.34	1.49	1.49	103	5	90	60	79	
	70	571.75	0.34	1.49	1.49	100	5	90	60	80	
5	80	579.50	0.37	1.62	1.62	98	5	90	60	78	
	90	585.60	0.37	1.62	1.62	100	5	90	60	78	
6	100	593.21	0.43	1.88	1.88	100	6	90	60	79	
	110	601.36	0.43	1.88	1.88	102	6	90	60	79	
7	120	609.70	0.43	1.88	1.88	102	6	90	60	82	
	130	618.11	0.43	1.88	1.88	103	6	92	60	80	
8	140	626.65	0.43	1.88	1.88	104	6	92	60	80	
	150	634.31	0.43	1.88	1.88	104	6	92	60	80	
B 1	160/0	642.534	0.25	1.10	1.10	100	5	90	60	75	642.534
B	10	649.03	0.25	1.10	1.10	101	5	90	60	75	642.602
2	20	655.38	0.25	1.10	1.10	100	5	90	60	78	
	30	661.71	0.25	1.10	1.10	100	5	90	60	76	
3	40	668.16	0.25	1.10	1.10	100	5	~~935~~90	60	75	
	50	674.42	0.25	1.10	1.10	100	5	90	60	73	
4	60	680.80	0.32	1.40	1.40	100	5	90	60	80	
	70	688.51	0.32	1.40	1.40	100	5	90	60	82	
5	80	695.09	0.45	1.97	1.97	100	6	90	60	80	

V_M	$(\sqrt{\Delta P})^2$	ΔH	T_M	T_S
251.317			101	77

ENTROPY

PARTICULATE FIELD DATA

PAGE 2

COMPANY NAME C.S. OHM **RUN #** 2

SAMPLING LOCATION SCRUBBER INLET **DATE** 6.18.85

SAMPLE POINT	CLOCK TIME, MIN.	DRY GAS METER READING, CU. FT.	PITOT READING (ΔP), IN. H_2O	ORIFICE SETTING (ΔH), IN. H_2O		GAS METER TEMP. °F	PUMP VACUUM IN. HG GAUGE	FILTER BOX TEMP. °F	IMP. EXIT TEMP. °F	STACK TEMP. °F	LEAK TEST READINGS
				IDEAL	ACTUAL						
	90	704.00	0.45	1.97	1.97	100	6	90	60	80	
6	100	711.90	0.55	2.41	2.41	102	7	90	60	80	
	110	721.15	0.55	2.41	2.41	103	7	90	60	82	
7	120	731.20	0.55	2.41	2.41	104	7	90	60	81	
	130	739.85	0.55	2.41	2.41	104	7	90	60	78	
8	140	749.25	0.50	2.19	2.19	104	7	90	60	80	
	160	758.00	0.50	2.19	2.19	104	7	90	60	80	
	320/off	766.885									

251.317	0.3930	1.749	101	77
V_M	$(\sqrt{\Delta P})^2$	$\overline{\Delta H}$	$\overline{T_M}$	$\overline{T_S}$

ENTROPY

PARTICULATE FIELD DATA

COMPANY NAME C.S. OHM
RUN NUMBER 5
ADDRESS DETROIT, MICH.
TIME START 0838
SAMPLING LOCATION Scrubber inlet
TIME FINISH 1404
DATE 6·19·85
TEAM LEADER
TECHNICIANS B.B
BAROMETRIC PRESSURE, IN. HG 29.2
STATIC PRESSURE, IN. H_2O -1.90
SAMPLING TRAIN LEAK TEST VACUUM, IN. HG 15 10
SAMPLING TRAIN LEAK RATE, CU. FT./MIN. 0.000 0.000

EQUIPMENT CHECKS

✓ PITOTS, PRE-TEST
✓ PITOTS, POST-TEST
NA ORSAT SAMPLING SYSTEM
NA TEDLAR BAG
✓ THERMOCOUPLE @ 80 °F

IDENTIFICATION NUMBERS

REAGENT BOX 228
NOZZLE 4065
DIAMETER .257
METER BOX N-14
T/C READOUT 04
UMBILICAL U-50
T/C PROBE 9-4
SAMPLE BOX 25
ORSAT PUMP NA
PROBE 4-1
TEDLAR BAG NA

FILTER #	TARE
T-0-2-3	.4721

NOMOGRAPH SET-UP

NOMOGRAPH #

$\Delta H_@$ 1.68
C FACTOR 1.0
METER TEMP 80
STACK TEMP 80
% MOISTURE 2
REF. ΔP 0.42

SAMPLE POINT	CLOCK TIME, MIN.	DRY GAS METER READING, CU. FT.	PITOT READING (ΔP), IN. H_2O	ORIFICE SETTING (ΔH), IN. H_2O IDEAL	ORIFICE SETTING (ΔH), IN. H_2O ACTUAL	GAS METER TEMP. °F	PUMP VACUUM IN. HG GAUGE	FILTER BOX TEMP. °F	IMP. EXIT TEMP. °F	STACK TEMP. °F	LK. CHECK READINGS
A 1	0/0	767.202	0.37	1.62	1.62	68	5	90	60	75	
	10	774.55	0.37	1.62	1.62	76	5	90	60	75	
2	20	782.41	0.52	2.28	2.28	82	6	90	60	76	
	30	790.09	0.52	2.28	2.28	86	6	90	60	75	
3	40	799.60	0.52	2.28	2.28	86	6	90	60	74	
	50	808.31	0.48	2.10	2.10	86	6	90	60	79	
4	60	817.00	0.35	1.53	1.53	86	6	90	60	75	
	70	824.41	0.35	1.53	1.53	84	6	90	60	76	
5	80	831.80	0.35	1.53	1.53	84	6	90	60	76	
	90	839.15	0.35	1.53	1.53	84	6	90	60	76	
6	100	846.50	0.40	1.75	1.75	84	6	90	60	76	
	110	854.00	0.40	1.75	1.75	84	6	90	60	76	
7	120	862.50	0.40	1.75	1.75	86	6	90	60	76	
	130	869.92	0.40	1.75	1.75	86	6	90	60	77	
8	140	878.00	0.40	1.75	1.75	86	6	90	60	76	
	150	885.61	0.40	1.75	1.75	86	6	90	60	77	
B 1	160/0	893.500	0.22	0.96	0.96	84	4	90	60	68	893.500
	10	899.51	0.27	1.18	1.18	84	4	90	60	73	893.550
2	20	905.91	0.22	0.96	0.96	84	4	90	60	75	
	30	911.91	0.22	0.96	0.96	83	4	90	60	75	
3	40	917.90	0.22	0.96	0.96	82	4	90	60	73	
	50	924.60	0.22	0.96	0.96	82	4	90	60	74	
4	60	929.81	0.30	1.31	1.31	84	4	90	60	78	
	70	936.70	0.30	1.31	1.31	86	4	90	60	77	
5	80	943.57	0.37	1.62	1.62	84	5	90	60	77	

V_M	$(\sqrt{\Delta P})^2$	ΔH	T_M	T_S
			84	77

PARTICULATE FIELD DATA

page 2

Company Name C. S. OHM Run # 5

Sampling Location Scrubber INLET Date 6·19·85

Sample Point	Clock Time, Min.	Dry Gas Meter Reading, Cu. Ft.	Pitot Reading (Δp), In. H_2O	Orifice Setting (ΔH), In. H_2O		Gas Meter Temp. °F	Pump Vacuum In. Hg Gauge	Filter Box Temp. °F	Imp. Exit Temp. °F	Stack Temp. °F
				Ideal	Actual					
	90	951.10	0.37	1.62	1.62	82	5	90	60	79
6	100	958.63	0.40	1.75	1.75	82	5	90	60	79
	110	966.53	0.44	1.93	1.93	82	5	90	60	79
7	120	974.85	0.57	2.50	2.50	83	6	90	60	79
	130	984.16	0.57	2.50	2.50	84	6	90	60	79
8	140	993.61	0.39	1.71	1.71	86	5	90	60	84
	150	1001.37	0.39	1.71	1.71	86	5	90	60	84
	320/off	1009.128								

241.876	0.3700	1.648	84	77
V_m	$(\overline{\sqrt{\Delta p}})^2$	$\overline{\Delta H}$	$\overline{T}_m$	$\overline{T}_s$

PARTICULATE FIELD DATA

COMPANY NAME C.S. OHM
ADDRESS DETROIT, MICH.
SAMPLING LOCATION SCRUBBER INLET
DATE 6·20·85 TEAM LEADER gmc TECHNICIANS B.B
RUN NUMBER 8
TIME START 0855
TIME FINISH 1420
BAROMETRIC PRESSURE, IN. HG 29.2 STATIC PRESSURE, IN. H_2O -2.00
SAMPLING TRAIN LEAK TEST VACUUM, IN. HG 15 6 5
SAMPLING TRAIN LEAK RATE, CU. FT./MIN. 0.000 0.000 0.000

EQUIPMENT CHECKS

✓ PITOTS, PRE-TEST
___ PITOTS, POST-TEST
NA ORSAT SAMPLING SYSTEM
NA TEDLAR BAG
✓ THERMOCOUPLE @ 80 °F

IDENTIFICATION NUMBERS

REAGENT BOX 228 NOZZLE 405 DIAMETER 0.257
METER BOX N.6 T/C READOUT 04
UMBILICAL U-50 T/C PROBE 9-4
SAMPLE BOX 25 ORSAT PUMP NA
PROBE 4-1 TEDLAR BAG NA

FILTER #	TARE
T-0.2-1	.4696

NOMOGRAPH SET-UP NOMOGRAPH # gmc

$\Delta H_@$ 1.67 C FACTOR 1.00
METER TEMP 90 STACK TEMP 80
% MOISTURE 2 REF. ΔP 0.42

SAMPLE POINT	CLOCK TIME, MIN.	DRY GAS METER READING, CU. FT.	PITOT READING (ΔP), IN. H_2O	ORIFICE SETTING (ΔH), IN. H_2O IDEAL	ORIFICE SETTING (ΔH), IN. H_2O ACTUAL	GAS METER TEMP. °F	PUMP VACUUM IN. HG GAUGE	FILTER BOX TEMP. °F	IMP. EXIT TEMP. °F	STACK TEMP. °F	LK. CHECK READINGS
A 1	0/0	73.752	0.40	1.75	1.75	80	4	90	60	73	
	10	81.60	0.40	1.75	1.75	85	4	90	60	73	
2	20	89.20	0.47	2.06	2.06	91	5	90	60	77	
	30	97.45	0.47	2.06	2.06	94	5	90	60	79	
3	40	106.75	0.52	2.28	2.28	97	5	90	60	79	
	50	115.10	0.52	2.28	2.28	100	5	90	60	79	
4	60	123.02	0.52	2.28	2.28	101	5	90	60	83	
	70	130.62	0.52	2.28	2.28	102	5	90	60	82	
5	80	139.85	0.40	1.75	1.75	103	4	90	60	78	
	90	148.60	0.40	1.75	1.75	103	4	90	60	81	
6	100	156.27	0.40	1.76	1.75	103	4	90	60	80	
	110	163.94	0.40	1.75	1.75	102	4	90	60	81	
7	120	171.85	0.47	2.06	2.06	103	4	90	60	80	
	130	180.31	0.47	2.06	2.06	103	5	90	60	80	
8	140	188.85	0.45	1.97	1.97	102	5	90	60	78	
	150	197.26	0.45	1.97	1.97	101	5	90	60	79	
B 1	160/0	205.688	0.37	1.62	1.62	97	4	90	60	74	205.628 205.736
	10	213.41	0.25	1.10	1.10	98	4	90	60	70	
2	20	220.00	0.25	1.10	1.10	96	4	90	60	76	
	30.	226.50	0.25	1.10	1.10	95	3	90	60	77	
3	40	233.00	0.25	1.10	1.10	94	3	90	60	78	
	50	239.50	0.25	1.10	1.10	91	3	90	60	78	
4	60	245.85	0.30	1.31	1.31	90	3	90	60	80	
	70	252.25	0.30	1.31	1.31	88	3	90	60	79	
5	80	259.12	0.40	1.75	1.75	89	4	90	60	79	

V_M $(\overline{\sqrt{\Delta P}})^2$ ΔH T_M T_S

ENTROPY

PARTICULATE FIELD DATA

PAGE 2

COMPANY NAME C.S. OHM **RUN #** 8

SAMPLING LOCATION SCRUBBER INLET **DATE** 6·20·85

SAMPLE POINT	CLOCK TIME, MIN.	DRY GAS METER READING, CU. FT.	PITOT READING (ΔP), IN. H_2O	ORIFICE SETTING (ΔH), IN. H_2O IDEAL	ORIFICE SETTING (ΔH), IN. H_2O ACTUAL	GAS METER TEMP. °F	PUMP VACUUM IN. HG GAUGE	FILTER BOX TEMP. °F	IMP. EXIT TEMP. °F	STACK TEMP. °F	LEAK TEST READINGS
	90	267.06	0.40	1.75	1.75	90	4	90	60	80	
6	100	275.02	0.55	2.41	2.41	90	5	90	60	81	
	110	284.08	0.55	2.41	2.41	91	5	90	60	82	
7	120	293.10	0.57	2.49	2.49	92	5	90	60	85	
	130	302.30	0.57	2.49	2.49	94	5	90	60	82	
8	140	311.51	0.50	2.19	2.19	93	5	90	60	79	
	150	319.99	0.50	2.19	2.19	92	5	90	60	79	
	320/off	328.229									

255.029	0.4159	1.851	95	79
V_M	$(\sqrt{\Delta P})^2$	$\overline{\Delta H}$	$\overline{T_M}$	$\overline{T_S}$

ENTROPY

PARI E FIELD DATA

COMPANY NAME C.S. OHM
RUN NUMBER SPECIAL RUN
ADDRESS DETROIT, MICH.
TIME START 1419
SAMPLING LOCATION Scrubber INLET
TIME FINISH 2247
DATE 6·19·85
TEAM LEADER gmc
TECHNICIANS B.B
BAROMETRIC PRESSURE, IN. HG 29.2
STATIC PRESSURE, IN. H_2O -1.40
SAMPLING TRAIN LEAK TEST VACUUM, IN. HG 15
SAMPLING TRAIN LEAK RATE, CU. FT./MIN. 0.000

EQUIPMENT CHECKS

✓ PITOTS, PRE-TEST
PITOTS, POST-TEST
NA ORSAT SAMPLING SYSTEM
NA TEDLAR BAG
✓ THERMOCOUPLE @ 80 °F

IDENTIFICATION NUMBERS

REAGENT BOX
NOZZLE 711
DIAMETER .364
METER BOX N-14
T/C READOUT 04
UMBILICAL U-50
T/C PROBE 9-4
SAMPLE BOX 8
ORSAT PUMP NA
PROBE 4-4
TEDLAR BAG NA

FILTER #	TARE
T-8.2.2	.4973

NOMOGRAPH SET-UP

NOMOGRAPH # gmc
ΔH@ 1.68
C FACTOR 1.00
METER TEMP 80
STACK TEMP 80
% MOISTURE 3
REF. ΔP 0.102

SAMPLE POINT	CLOCK TIME, MIN.	DRY GAS METER READING, CU. FT.	PITOT READING (ΔP), IN. H_2O	ORIFICE SETTING (ΔH), IN. H_2O		GAS METER TEMP. °F	PUMP VACUUM IN. HG GAUGE	FILTER BOX TEMP. °F	IMP. EXIT TEMP. °F	STACK TEMP. °F	LK. CHECK READINGS
				IDEAL	ACTUAL						
A-5	0/0	610.132	0.35	6.40	6.40	80	11	90	60	79	
	508	6249.35	0.37	2.60	2.60	110	6	130	30	75	

V_M	$(\sqrt{\Delta P})^2$	ΔH	T_M	T_S
614.803	0.3599	4.5	95	79

Preliminary Field Data

PLANT NAME C.S. OHM
LOCATION Detroit, Michigan
SAMPLING LOCATION Scrubber Stack

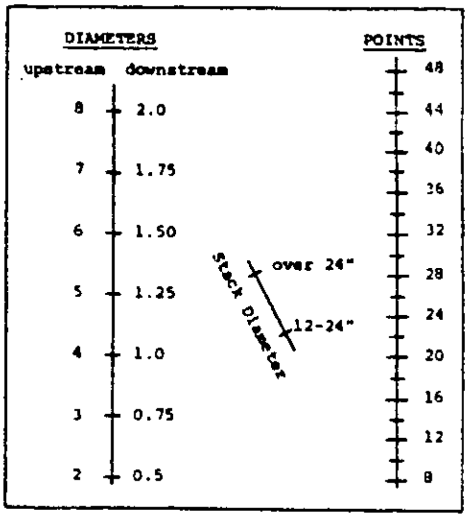
DUCT DEPTH FROM INSIDE FAR WALL TO OUTSIDE OF PORT 35"
NIPPLE LENGTH ¼"
DEPTH OF DUCT 34¾"
WIDTH (RECTANGULAR DUCT) 26½"

EQUIVALENT DIAMETER:

$$D_E = \frac{2 \times \text{DEPTH} \times \text{WIDTH}}{\text{DEPTH} + \text{WIDTH}} = \frac{2(34\tfrac{3}{4})(26\tfrac{1}{2})}{(34\tfrac{3}{4} + 26\tfrac{1}{2})} = 30''$$

DISTANCE FROM PORTS TO NEAREST FLOW DISTURBANCE:	UPSTREAM	DOWNSTREAM
~~FEET~~	32¼"	8"
STACK DIAMETERS	1.07	0.25

STACK AREA = (34¾)(26½) = 921 IN²



Point	% OF DIAMETER	DISTANCE FROM INSIDE WALL	DISTANCE FROM OUTSIDE OF PORT
1	8.3	2.88	3⅛"
2	25.0	8.68	9"
3	41.7	14.49	14¾"
4	58.3	20.26	20½"
5	75.0	26.06	26⅜"
6	91.7	31.87	32⅛"
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			

LOCATION OF TRAVERSE POINTS IN CIRCULAR STACKS

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

LOCATION OF TRAVERSE POINTS IN RECTANGULAR STACKS

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

ENTROPY
ENVIRONMENTALISTS, INC.

PARTICULATE FIELD DATA

COMPANY NAME C. S. OHM
RUN NUMBER 3
ADDRESS Detroit, Mi.
TIME START 10:03
SAMPLING LOCATION Scrubber Outlet Stack
TIME FINISH 15:05
DATE 6/18/85
TEAM LEADER HBL
TECHNICIANS BR
BAROMETRIC PRESSURE, IN. HG 29.0
STATIC PRESSURE, IN. H_2O -.38
SAMPLING TRAIN LEAK TEST VACUUM, IN. HG 15 12 13
SAMPLING TRAIN LEAK RATE, CU. FT./MIN. .00 .00 .00

EQUIPMENT CHECKS

✓ PITOTS, PRE-TEST
✓ PITOTS, POST-TEST
NA ORSAT SAMPLING SYSTEM
NA TEDLAR BAG
✓ THERMOCOUPLE @ 76 °F

IDENTIFICATION NUMBERS

REAGENT BOX 0224
NOZZLE 407
DIAMETER .309
METER BOX N-8
T/C READOUT 0004
UMBILICAL U-102
T/C PROBE 7-7
SAMPLE BOX 19
ORSAT PUMP NA
PROBE 5-3
TEDLAR BAG NA

FILTER #	TARE
T-0.252	.7180

NOMOGRAPH SET-UP

NOMOGRAPH # WN
ΔH@ 1.61
C FACTOR 0.92
METER TEMP 80
STACK TEMP 70
% MOISTURE 3
REF. ΔP 0.~~25~~ 0.22

SAMPLE POINT	CLOCK TIME, MIN.	DRY GAS METER READING, CU. FT.	PITOT READING (ΔP), IN. H_2O	ORIFICE SETTING (ΔH), IN. H_2O IDEAL	ORIFICE SETTING (ΔH), IN. H_2O ACTUAL	GAS METER TEMP. °F	PUMP VACUUM IN. HG GAUGE	FILTER BOX TEMP. °F	IMP. EXIT TEMP. °F	STACK TEMP. °F	LK. CHECK READINGS
A 1	ON/0	687.800	.95	7.95	7.10	70	12	100	63	66	
2	12	706.18	.67	5.60	5.60	90	9	100	60	67	
3	24	722.75	.44	3.68	3.68	88	5	100	61	66	
4	36	736.26	.27	2.26	2.26	85	4	160	61	66	
5	48	746.95	.15	1.25	1.25	80	1	100	66	66	
6	60	750.33	28	2.34	2.34	78	1	100	65	66	
B 1	72/0	766.705	.53	4.43	4.43	79	6	100	63	66	
2	12	781.46	.50	4.18	4.18	82	6	100	60	68	
3	24	795.86	.26	2.17	2.17	83	3	100	60	68	L. C.
4	36	806.33	.08	0.67	0.67	79	1	100	60	68	
5	48	812.33	.06	.50	.50	79	1	100	60	68	826.590
6	60	817.45	.21	1.76	1.76	79	1	100	60	71	826.700
C 1	144/0	826.590	.45	3.76	3.76	79	5	100	60	71	
2	12	840.30	.73	6.11	6.11	83	9	100	60	68	
3	24	857.53	.36	3.01	3.01	84	5	100	60	71	
4	36	869.82	.10	.84	.84	83	1	100	60	70	
5	48	876.58	.07	.59	.59	82	1	100	60	68	
6	60	882.25	29	0.43	2.43	81	1	100	60	68	
D 1	216/0	893.139	37	3.09	3.09	80	5	100	60	68	
2	12	905.14	.55	4.60	4.60	84	6	100	60	68	
3	24	920.20	.70	5.85	5.85	85	8	100	60	68	
4	36	937.15	.47	3.93	3.93	88	6	100	60	69	
5	48	951.04	.42	3.51	3.51	86	5	100	60	69	
6	60	964.26	.49	4.10	4.10	85	6	100	60	69	
	288/off	978.482									

V_M	$(\overline{\sqrt{\Delta P}})^2$	ΔH	T_M	T_S
290.572	0.3544	3.24	82	68

ENTROPY

PARTICULATE FIELD DATA

COMPANY NAME C.S. OHM
RUN NUMBER 6
ADDRESS Detroit, Mi.
TIME START 8:37
SAMPLING LOCATION Scrubber Outlet Stack
TIME FINISH 13:36
DATE 6/19/85
TEAM LEADER HBL
TECHNICIANS BB
BAROMETRIC PRESSURE, IN. HG 29.2
STATIC PRESSURE, IN. H_2O -.37
SAMPLING TRAIN LEAK TEST VACUUM, IN. HG 15 13 12
SAMPLING TRAIN LEAK RATE, CU. FT./MIN. .00 .00 .00

EQUIPMENT CHECKS

✓ PITOTS, PRE-TEST
✓ PITOTS, POST-TEST
NA ORSAT SAMPLING SYSTEM
NA TEDLAR BAG
✓ THERMOCOUPLE @ 70 °F

IDENTIFICATION NUMBERS

REAGENT BOX
NOZZLE 407
DIAMETER .309
METER BOX N-8
T/C READOUT 0004
UMBILICAL U-102
T/C PROBE 7-7
SAMPLE BOX 19
ORSAT PUMP NA
PROBE 5-3
TEDLAR BAG NA

FILTER #	TARE
T-0.2-53	.6983

NOMOGRAPH SET-UP

NOMOGRAPH # WN
ΔH@ 1.61
C FACTOR .92
METER TEMP 80
STACK TEMP 70
% MOISTURE 3
REF. ΔP .22

SAMPLE POINT	CLOCK TIME, MIN.	DRY GAS METER READING, CU. FT.	PITOT READING (ΔP), IN. H_2O	ORIFICE SETTING (ΔH), IN. H_2O IDEAL	ORIFICE SETTING (ΔH), IN. H_2O ACTUAL	GAS METER TEMP. °F	PUMP VACUUM IN. HG GAUGE	FILTER BOX TEMP. °F	IMP. EXIT TEMP. °F	STACK TEMP. °F	LK. CHECK READINGS
A 1	0/0	979.100	.90	7.53	7.10	71	11	90	55	62	
2	12	997.70	.67	5.60	5.60	88	8	95	59	64	
3	24	1014.40	.45	3.76	3.76	80	6	95	60	66	
4	36	027.91	.28	2.34	2.34	75	4	97	61	67	
5	48	038.61	.17	1.42	1.42	71	1	98	62	66	
6	60	046.88	.29	2.43	2.43	71	4	99	62	66	
B 1	72/0	057.765	.54	4.52	4.52	71	7	180	62	67	
2	12	072.60	.46	3.85	3.85	82	6	100	62	67	
3	24	086.33	.26	2.17	2.17	86	4	100	62	68	
4	36	096.77	.09	.75	.75	76	1	100	62	67	
5	48	103.20	.07	.58	.58	72	1	100	62	68	
6	60	108.76	.21	1.76	1.76	71	3	100	62	67	Leak Check
C 1	144/0	117.979	.42	3.51	3.51	76	5	100	62	67	117.979
2	12	131.24	.70	5.85	5.85	74	9	100	62	67	118.100
3	24	147.87	.36	1.89	1.89	75	2	100	61	68	
4	36	157.48	.10	.83	.83	73	1	100	61	68	
5	48	164.12	.07	.58	.58	71	1	100	61	68	
6	60	169.62	.29	2.43	2.43	73	4	100	61	71	
D 1	216/0	180.566	.37	3.09	3.09	75	5	100	61	72	
2	12	193.12	.52	4.35	4.35	79	6	100	61	72	
3	24	207.68	.70	5.85	5.85	80	9	100	61	72	
4	36	224.52	.50	4.18	4.18	83	6	100	60	71	
5	48	238.85	.38	3.18	3.18	81	5	100	60	72	
6	60	251.44	.46	3.85	3.85	82	6	100	60	71	
	288/off	1265.287									

✓ ~~286.066~~ 0.3518 3.161 71 68

V_M $\overline{(\sqrt{\Delta P})}^2$ ΔH T_M T_S

~~286.308~~
286.066

PARTICULATE FIELD DATA

COMPANY NAME C.S. OHM's
RUN NUMBER 9
ADDRESS Detroit, Mi.
TIME START 8:55
SAMPLING LOCATION Scrubber Outlet Stack
TIME FINISH 13:50
DATE 6/20/85 TEAM LEADER HRL TECHNICIANS BB
BAROMETRIC PRESSURE, IN. HG 29.2 STATIC PRESSURE, IN. H_2O -0.25
SAMPLING TRAIN LEAK TEST VACUUM, IN. HG 15 12 12
SAMPLING TRAIN LEAK RATE, CU. FT./MIN. .00 0.00 0.000

EQUIPMENT CHECKS

✓ PITOTS, PRE-TEST
PITOTS, POST-TEST
NA ORSAT SAMPLING SYSTEM
NA TEDLAR BAG
✓ THERMOCOUPLE @ 70 °F

IDENTIFICATION NUMBERS

REAGENT BOX 6224 NOZZLE 407 DIAMETER .309
METER BOX N-8 T/C READOUT 8520-40
UMBILICAL U-102 T/C PROBE 7-71
SAMPLE BOX 19 ORSAT PUMP NA
PROBE 5-3 TEDLAR BAG NA

FILTER #	TARE
T-0-2-51	.7526

NOMOGRAPH SET-UP NOMOGRAPH # WN

ΔH@ 1.61 C FACTOR 0.92
METER TEMP 80 STACK TEMP 70
% MOISTURE 3 REF. ΔP 0.22

SAMPLE POINT	CLOCK TIME, MIN.	DRY GAS METER READING, CU. FT.	PITOT READING (ΔP), IN. H_2O	ORIFICE SETTING (ΔH), IN. H_2O		GAS METER TEMP. °F	PUMP VACUUM IN. HG GAUGE	FILTER BOX TEMP. °F	IMP. EXIT TEMP. °F	STACK TEMP. °F	LK. CHECK READINGS
				IDEAL	ACTUAL						
A 1	on/0	284.100	.94	7.86	6.80	75	12	100	66	71	
2	12	302.12	.65	5.44	5.44	88	9	100	64	71	
3	24	318.39	.41	3.43	3.43	87	6	100	63	71	
4	36	331.27	.28	2.34	2.34	82	4	100	62	71	
5	48	341.95	.16	1.34	1.34	82	2	100	62	71	
6	60	350.06	.31	2.59	2.59	83	5	100	62	72	
B 1	72/0	361440	.54	4.52	4.52	84	7	100	62	73	
2	12	376.32	.48	4.01	4.01	84	7	100	62	72	
3	24	39043	.26	2.17	2.17	85	4	100	62	73	
4	36	40086	.10	.836	0.84	82	1	100	62	74	
5	48	407.57	.08	.67	.67	81	1	100	62	74	
6	60	41362	.23	1.92	1.92	80	4	100	62	74	
C 1	144/0	423.462	.42	3.51	3.51	79	6	100	62	72	423.462
2	12	436.83	.69	5.77	5.77	84	10	100	62	73	423.600
3	24	453.65	.35	2.93	2.93	86	5	100	62	72	
4	36	465.66	.08	.67	.67	82	1	100	62	72	
5	48	471.78	.06	.50	.50	81	1	100	62	74	
6	60	476.88	.28	2.34	2.34	82	4	100	62	73	
D 1	216/0	487.240	.35	2.93	2.93	82	5	100	65	74	
2	12	499.33	.50	4.18	4.18	82	7	100	67	70	
3	24	513.84	.70	5.85	5.85	85	9	100	64	71	
4	36	530.82	.50	4.18	4.18	88	7	100	65	71	
5	48	545.04	.44	3.68	3.68	85	6	102	66	71	
6	60	556.22	.48	4.01	4.01	85	7	102	66	70	
	218/off	572.682									

V_M	$(\overline{\sqrt{\Delta P}})^2$	ΔH	T_M	T_S
288.444	0.3523	3.193	83	72

ENTROPY

PARTICULATE SAMPLING LABORATORY RESULTS

Plant Name C.S. OHM (E.M.B.) EEI Ref. # 3018
Sampling Location
Date Received 6/21/85 Date Analyzed Reagent Box(es) 0228

Run Number	2	5	8
Run Date	6/18	6/19	6/20

SUMMARY OF PARTICULATE ANALYSES

Sum of Particulate, mg.	466.1	473.6	476.6
Total Filter Tare mg.	457.6	472.1	469.6
Blank Residue, mg.	(100 ml) 0.2	(100 ml) 0.2	(150 ml) 0.3
TOTAL PARTICULATE CATCH, mg.	8.3	1.3	6.7

ANALYSIS OF MOISTURE CATCH

Reagent 1 (DISTILLED H_2O):			
Final Weight, g.	186.0	215.0	208.0
Tared Weight, g.	200.0	200.0	200.0
Water Catch, g.	-14.0	15.0	8.0
Reagent 2 ( ):			
Final Weight, g.	—	—	—
Tared Weight, g.	—	—	—
Water Catch, g.	—	—	—
CONDENSED WATER, g.	-14.0	15.0	8.0
Silica Gel:			
Final Weight, g.	251.2	250.3	254.2
Tared Weight, g.	200.0	200.0	200.0
ABSORBED WATER, g.	51.2	50.3	54.2
TOTAL WATER COLLECTED, g.	37.2	65.3	62.2

Blank Beaker #	28
Final wt. mg.	57431.6
Tare wt. mg.	57431.2
Residue, mg.	0.4
Volume, ml.	200
Concen., mg/ml.	.002

--- Legend ---

✓ = Final Weight
L = Loose Particulate
F = Filter D = Dish
R = Rinse P = Pan

Notes and Comments

LABORATORY SAMPLE WEIGHT CALCULATIONS

Plant Name C.S. OHM EEI Ref. # 3018

Run Number	2	5	8
Run Date	6/18	6/19	6/20
Sample ID/Container #	F&R 386	F&R 407	F&R 409
Tare Wt., g.	133.5764 ✓ 133.5760 133.1099	120.8795 ✓120.8793 120.4057	113.9622 ✓113.9619 113.9625 113.9630 113.4853
SAMPLE WT., g.	.4661	.4736	.4766
Sample ID/Container #			
Tare Wt., g.			
SAMPLE WT., g.			
Sample ID/Container #			
Tare Wt., g.			
SAMPLE WT., g.			
Sample ID/Container #			
Tare Wt., g.			
SAMPLE WT., g.			

PARTICULATE SAMPLING LABORATORY RESULTS

Plant Name C. S. OHM (EMB) EEI Ref. # 3018

Sampling Location

Date Received 6/21/85 Date Analyzed Reagent Box(es) 0224

Run Number	3	6	9
Run Date	6/18	6/19	6/20

SUMMARY OF PARTICULATE ANALYSES

Sum of Particulate, mg.	685.9	702.6	709.6
Total Filter Tare mg.	718.0	698.3	752.6
Blank Residue, mg.	(100 ml) 0.2	(100 ml) 0.2	(150 ml) 0.3
TOTAL PARTICULATE CATCH, mg.	-32.3	4.1	-43.3

ANALYSIS OF MOISTURE CATCH

Reagent 1 (DI. H_2O):			
Final Weight, g.	234.0	248.0	252.0
Tared Weight, g.	200.0	200.0	200.0
Water Catch, g.	34.0	48.0	52.0
Reagent 2 ( ):			
Final Weight, g.	–	–	–
Tared Weight, g.	–	–	–
Water Catch, g.	–	–	–
CONDENSED WATER, g.	34.0	48.0	52.0
Silica Gel:			
Final Weight, g.	251.1	255.3	252.6
Tared Weight, g.	200.0	200.0	200.0
ABSORBED WATER, g.	51.1	55.3	52.6
TOTAL WATER COLLECTED, g.	85.1	103.3	104.6

Blank Beaker # 28

Final wt. mg. 57431.6

Tare wt. mg. 57431.2

Residue, mg. 0.4

Volume, ml. 200

Concen., mg/ml. .002

---- Legend ---

✓ = Final Weight

L = Loose Particulate

F = Filter D = Dish

R = Rinse P = Pan

Notes and Comments

LABORATORY SAMPLE WEIGHT CALCULATIONS

Plant Name C.S. OHM **EEI Ref. #** 3018

Run Number	3	6	9
Run Date	6/18	6/19	6/20
Sample ID/Container #	F&R 410	F&R 424	F&R 431
	118.1259 ✓118.1259 118.1262	126.5506 ✓126.5501 126.5507	126.2014 ✓126.2010 126.2019
Tare Wt., g.	117.4400	125.8475	125.4914
SAMPLE WT., g.			
	.6859	.7026	.7096
Sample ID/Container #			
Tare Wt., g.			
SAMPLE WT., g.			
Sample ID/Container #			
Tare Wt., g.			
SAMPLE WT., g.			
Sample ID/Container #			
Tare Wt., g.			
SAMPLE WT., g.			

ENTROPY
ENVIRONMENTALISTS, INC.

PARTICULATE SAMPLING LABORATORY RESULTS

Plant Name C.S. OHM (EMB) EEI Ref. # 3018

Sampling Location

Date Received 6/21/85 Date Analyzed Reagent Box(es) 0218

Run Number	SPECIAL INLET		
Run Date	6/19		

SUMMARY OF PARTICULATE ANALYSES

Sum of Particulate, mg.	501.2		
Total Filter Tare mg.	497.3		
Blank Residue, mg.	(75 ml) 0.2	(ml)	(ml)
TOTAL PARTICULATE CATCH, mg.	3.7		

ANALYSIS OF MOISTURE CATCH

Reagent 1 (DI. H_2O):			
Final Weight, g.	200.0		
Tared Weight, g.	200.0		
Water Catch, g.	0		
Reagent 2 ( ):			
Final Weight, g.	—		
Tared Weight, g.	—		
Water Catch, g.	—		
CONDENSED W	0		
Silica G	427 6		
Final			
Tared	400.0		
ABSORBED WATER, g.	27.6		
TOTAL WATER COLLECTED, g.	27.6		

NOTE:
SILICA GEL WAS
SPILLED IN FIELD
& WAS NOT ALL
RECOVERED

Blank Beaker #	28
Final wt. mg.	57431.6
Tare wt. mg.	57431.2
Residue, mg.	0.4
Volume, ml.	200
Concen., mg/ml.	.002

--- Legend ---

✓ = Final Weight

L = Loose Particulate

F = Filter D = Dish

R = Rinse P = Pan

Notes and Comments

LABORATORY SAMPLE WEIGHT CALCULATIONS

Plant Name C.S. OHM (EMB) EEI Ref. # 3018

Run Number	SPECIAL INLET		
Run Date	6/19		
Sample ID/Container #	F&R 433		
Tare Wt., g.	124.0933 ✓124.0931 124.0937 123.5919		
SAMPLE WT., g.	.5012		
Sample ID/Container #			
Tare Wt., g.			
SAMPLE WT., g.			
Sample ID/Container #			
Tare Wt., g.			
SAMPLE WT., g.			
Sample ID/Container #			
Tare Wt., g.			
SAMPLE WT., g.			

1 OF 2

ENTROPY
ENVIRONMENTALISTS INC

POST OFFICE BOX 12291
RESEARCH TRIANGLE PARK
NORTH CAROLINA 27709-2291
919-781-3550

REQUEST FOR ANALYSIS

REFERENCE ~~PURCHASE~~ ORDER # 3018 JOB NAME: EMB 3018

LABORATORY: RTI ATT BILL GUTKNECKT OR PETER GROHSE

DATE SAMPLES WERE TRANSMITTED: 7/2/85 EXPECTED DATE OF RESULTS: 7/12/85

SAMPLE MATRIX:

TYPE OF ANALYSIS REQUESTED: Cr^{+6} AND PREPARE FOR NAA

SAMPLE #	RUN #	SAMPLE I.D.	BASIS
C-241	2	M-5-3" - INLET	Concentrate — total µg
C-242	5	M-5-3" - INLET	" "
C-243	8	M-5-3" - INLET	" "
C-244	SPECIAL	M-5-3" - INLET	" "
C-245	3	M-5-4" - OUTLET	" "
C-246	6	M-5-4" - OUTLET	" "
C-247	9	M-5-4" - OUTLET	" "
C-248	BLANK	M-5-4"	
C-249	2	IMPINGER REAGENT	Concentrate to 50ml - µg/ml
C-250	5	IMPINGER REAGENT	" "
C-251	8	IMPINGER REAGENT	"
C-~~252~~ 267	SPECIAL	IMPINGER REAGENT	" "

SUBMITTED BY: CONTINUED

REQUEST FOR ANALYSIS

PURCHASE
ORDER # 3018

PAGE 2 OF 2

SAMPLE #	RUN #	SAMPLE ID	BASIS
C-252	3	IMPINGER REAGENT	" "
C-253	6	IMPINGER REAGENT	" "
C-254	9	IMPINGER REAGENT	" "
* C-255	1	1ST IMPINGER REAG.	Concentrate to 10 ml – μg/ml
* C-256	1	2nd IMPINGER "	" "
* C-257	1	3rd IMPINGER "	" "
* C-258	4	1ST IMPINGER "	" "
* C-259	4	2nd IMPINGER "	" "
* C-260	4	3rd IMPINGER "	" "
* C-261	7	1ST IMPINGER "	" "
* C-262	7	2ND IMPINGER "	" "
* C-263	7	3rd IMPINGER "	" "
* C-264	BLANK	DISTILLED H_2O	" "
C-265		SCRUBBER H_2O	μg/ml
C-266	G5	QA	μg/ml

* CONTAINS ACETONE

Origional Sample Volume - Impingers

C-249	460 mL
C-250	345 mL
C-251	350 mL
C-252	360 mL
C-253	380 mL
C-254	350 mL
C-255	385 mL
C-256	193 mL
C-257	230 mL
C-258	400 mL
C-259	193 mL
C-260	230 mL
C-261	390 mL
C-262	190 mL
C-263	201 mL
C-264	192 mL
C-267	295 mL

WET CHEMICAL ANALYSIS SHEETS

DATE RECEIVED: 7/8/85 DATE ANALYZED 7/12/85

ANALYST: RTI CLIENT: ENTROPY

ANALYTE: Cr^{+6}

RTI #	CLIENT #	SAMPLE CONCENTRATION Total ug	ug/g	ug/mL
C-241		<0.2		
C-242		2.79		
C-243		4.17		
C-244		5.94		
C-245		2.13		
C-246		2.73		
C-247		3.24		
C-248		1.12		
C-249		~~0.43~~ 8.63		
C-250		<0.2		
C-251		<0.2		
C-252		<0.2		
C-253		<0.2		
C-254		<0.2		
C-255		15.57		
C-256		<0.2		
C-257		<0.2		
C-258		13.23		
C-259		<0.2		
C-260		0.21		
C-261		19.38		
C-262		0.69		
C-263		0.74		
C-264		~~<0.2~~		<0.2
C-265				5.09
C-266				52.37
C-267		<0.2		

Figure 1. Sample Preparation and Analysis Data Form

Sample No.[a]	Particulate Sample				Solid Process Sample		Liquid Process Samples			Sample Weight µg of Cr+6 [i]	Results by NAA µg of Cr[j]
	Filter/Rinse[b]		Impinger[c]								
	Residue	Filtrate	Volume	Aliquot	Weight of Sample, mg[d]	Sample Concentration[e]	Initial Volume[f]	Final Volume[g]	Aliquot[h]		
C-241	Total										
thru	↓				↑						
C-248											
C-249			400	230[k]							
C-250			345	173[k]							
C-251			350	175[k]	100 µg						
C-252			360	180[k]							
C-253			380	190[k]							
C-254			350	175[k]							
C-255			385	193[k]							
C-256			193	97[k]							
C-257			230	125[k]							
C-258			400	200[k]	↓						
C-259			193	97[k]							

[a] Sample number marked on sample vial or sample container.

[b] Mark whether the particulate sample is a sample residue or filtrate sample aliquot.

[c] Record exact volume impinger sample after concentrate and indicate that the sample is 2.0 ml aliquot.

[d] The weight in mg of the process sample analyzed will be recorded by NAA personnel.

[e] Concentration of process sample in terms of µg/g of Cr^{+6} for process sample when the NAA facility is to weigh sample.

[f] Record initial volume of liquid sample if liquid sample is concentrated.

[g] Record final volume of liquid sample if liquid sample is concentrated.

[h] Indicate that the sample is a 2.0 ml aliquot of a liquid process sample.

[i] Total mass of hexavalent chromium in sample vial in µg.

[j] Analytical results by NAA in terms of µg of Cr per sample vial.

[k] concentrated to less than 2.5 mL

Figure 1. Sample Preparation and Analysis Data Form

	Particulate Sample				Solid Process Sample		Liquid Process Samples				
	Filter/Rinse[b]		Impinger[c]								
Sample No.[a]	Residue	Filtrate	Volume	Aliquot	Weight of Sample, mg[d]	Sample Concentration[e]	Initial Volume[f]	Final Volume[g]	Aliquot[h]	Sample Weight μg of Cr^{+6}[i]	Results by NAA μg of Cr[j]
C-260			230	125[k]							
C-261			390	195[k]	100μg						
C-262			190	95[k]							
C-263			201	101[k]							
C-264			192	96[k]							
C-265									1 mL	5.07μg	
C-267			295	118[k]							
C-268					140.7	50					
C-269					112.8						
C-270					133.3						
C-271					145.1						
C-272					135.7						
C-273					138.0						
C-274					103.6						
C-275					103.9						
C-276					113.3						
C-277					100.9						

[a] Sample number marked on sample vial or sample container.

[b] Mark whether the particulate sample is a sample residue or filtrate sample aliquot.

[c] Record exact volume impinger sample after concentrate and indicate that the sample is 2.0 ml aliquot.

[d] The weight in mg of the process sample analyzed will be recorded by NAA personnel.

[e] Concentration of process sample in terms of μg/g of Cr^{+6} for process sample when the NAA facility is to weigh sample.

[f] Record initial volume of liquid sample if liquid sample is concentrated.

[g] Record final volume of liquid sample if liquid sample is concentrated.

[h] Indicate that the sample is a 2.0 ml aliquot of a liquid process sample.

[i] Total mass of hexavalent chromium in sample vial in μg.

[j] Analytical results by NAA in terms of μg of Cr per sample vial.

[k] concentrated to less than 2.5 mL

Figure 1. Sample Preparation and Analysis Data Form

Sample No.[a]	Particulate Sample				Solid Process Sample		Liquid Process Samples			Sample Weight µg of Cr^{+6} [i]	Results by NAA µg of Cr[j]
	Filter/Rinse[b]		Impinger[c]		Weight of Sample, mg[d]	Sample Concentration[e]	Initial Volume[f]	Final Volume[g]	Aliquot[h]		
	Residue	Filtrate	Volume	Aliquot							
C-324					119,2						
C-325					116.1						
C-326 through	Total										
C-334	↓										
C-336	Total										
C-337	(QA-16)				250					50	
C-338	(QA-19)				250					50	
C-339	(QA-17)	[illegible]			500					100	
C-340	(QA-25)				500					100	
C-341	(QA-12)				750					150	
C-342	(QA-20)				1000					200	

[a] Sample number marked on sample vial or sample container.
[b] Mark whether the particulate sample is a sample residue or filtrate sample aliquot.
[c] Record exact volume impinger sample after concentrate and indicate that the sample is 2.0 ml aliquot.
[d] The weight in mg of the process sample analyzed will be recorded by NAA personnel.
[e] Concentration of process sample in terms of µg/g of Cr^{+6} for process sample when the NAA facility is to weigh sample.
[f] Record initial volume of liquid sample if liquid sample is concentrated.
[g] Record final volume of liquid sample if liquid sample is concentrated.
[h] Indicate that the sample is a 2.0 ml aliquot of a liquid process sample.
[i] Total mass of hexavalent chromium in sample vial in µg.
[j] Analytical results by NAA in terms of µg of Cr per sample vial.

```
01-OCT-85 @ 17:26:52                              Report Listing By Sample                                                          Page     2

Legend:    < - Below Minimum Detectable limit         > - Over Instrument analytical range      * - Nonreportable constituent
      "No value" - No data value present          "Fit fail" - Curve fit failure

   Value     Constituent      Value     Constituent      Value     Constituent      Value     Constituent      Value     Constituent
------------------------  ------------------------  ------------------------  ------------------------  ------------------------

CR5      #   231   C0231          85/ 9/ 4  @  14:23:28   by NAA002   (JPL)   Multiplier:  1.401E+00                          (  1 )
   No Value   Cd             5.533E-01   Cr                 No Value   Ni

CR5      #   232   C0232          85/ 9/ 4  @  14:25: 8   by NAA002   (JPL)   Multiplier:  1.191E+00                          (  2 )
   No Value   Cd             3.912E-01   Cr                 No Value   Ni

CR5      #   233   C0233          85/ 9/ 4  @  14:23:33   by NAA002   (JPL)   Multiplier:  1.401E+00                          (  3 )
   No Value   Cd             1.926E+00   Cr                 No Value   Ni

CR5      #   234   C0234          85/ 9/ 4  @  14:23:48   by NAA002   (JPL)   Multiplier:  1.401E+00                          (  4 )
   No Value   Cd             6.195E-01   Cr                 No Value   Ni

CR5      #   235   C0235          85/ 9/ 4  @  14:22:33   by NAA002   (JPL)   Multiplier:  1.044E+00                          (  5 )
   No Value   Cd             1.068E+00   Cr                 No Value   Ni

CR5      #   236   C0236          85/ 9/ 4  @  14:19:28   by NAA002   (JPL)   Multiplier:  1.023E+00                          (  6 )
   No Value   Cd             1.320E+00   Cr                 No Value   Ni

CR5      #   237   C0237          85/ 9/ 4  @  14:20:48   by NAA002   (JPL)   Multiplier:  1.410E+00                          (  7 )
   No Value   Cd             8.784E+03   Cr                 No Value   Ni

CR5      #   238   C0238          85/ 9/ 4  @  14:17:33   by NAA002   (JPL)   Multiplier:  1.097E+00                          (  8 )
   No Value   Cd             8.899E+04   Cr                5.467E+02   Ni

CR5      #   239   C0239          85/ 9/ 4  @  14:19:58   by NAA002   (JPL)   Multiplier:  1.424E+00                          (  9 )
   No Value   Cd             1.088E+01   Cr                 No Value   Ni

CR5      #   240   C0240          85/ 9/ 4  @  14:21:48   by NAA002   (JPL)   Multiplier:  1.046E+00                          ( 10 )
   No Value   Cd             4.125E+02   Cr                 No Value   Ni

CR5      #   241   C0241          85/ 9/ 4  @  14:22:48   by NAA002   (JPL)   Multiplier:  1.100E+00                          ( 11 )
   No Value   Cd             9.201E+00   Cr                 No Value   Ni

CR5      #   242   C0242          85/ 9/ 4  @  14:21:58   by NAA002   (JPL)   Multiplier:  1.046E+00                          ( 12 )
   No Value   Cd             1.327E+01   Cr                 No Value   Ni

CR5      #   243   C0243          85/ 9/ 4  @  14:19:18   by NAA002   (JPL)   Multiplier:  1.023E+00                          ( 13 )
   No Value   Cd             1.874E+01   Cr                5.824E+01   Ni

CR5      #   244   C0244          85/ 9/ 4  @  14:17: 8   by NAA002   (JPL)   Multiplier:  1.000E+00                          ( 14 )
   No Value   Cd             1.563E+01   Cr                9.645E+01   Ni

CR5      #   245   C0245          85/ 9/ 4  @  14:26:38   by NAA002   (JPL)   Multiplier:  1.940E+00                          ( 15 )
   No Value   Cd             2.344E+01   Cr                 No Value   Ni

CR5      #   246   C0246          85/ 9/ 4  @  14:17:18   by NAA002   (JPL)   Multiplier:  1.000E+00                          ( 16 )
   No Value   Cd             1.827E+01   Cr                 No Value   Ni
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01-OCT-85  @  17:25:52                                     Report Listing By Sample                                    Page      3
  Value       Constituent        Value       Constituent        Value       Constituent       Value       Constituent       Value       Constituent
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CR5       #  247   C0247               85/ 9/ 4  @  14:22: 8   by NAA002   (JPL)   Multiplier:  1.046E+00                       (  17 )
   No Value   Cd              1.331E+01   Cr                No Value   Ni

CR5       #  248   C0248               85/ 9/ 4  @  14:22:53   by NAA002   (JPL)   Multiplier:  1.100E+00                       (  18 )
   No Value   Cd              5.563E+00   Cr                No Value   Ni

CR5       #  249   C0249               85/ 9/13  @  15:52: 3   by NAA002   (JPL)   Multiplier:  1.055E+00                       (  19 )
   No Value   Cd              1.119E+00   Cr                No Value   Ni

CR5       #  250   C0250               85/ 9/ 4  @  14:20:13   by NAA002   (JPL)   Multiplier:  1.424E+00                       (  20 )
   No Value   Cd              1.679E+00   Cr                No Value   Ni

CR5       #  251   C0251               85/ 9/13  @  16:50:33   by NAA002   (JPL)   Multiplier:  3.160E+00                       (  21 )
   No Value   Cd              6.010E-01   Cr               5.615E+00   Ni

CR5       #  252   C0252               85/ 9/13  @  15:53:48   by NAA002   (JPL)   Multiplier:  1.401E+00                       (  22 )
   No Value   Cd              9.448E-01   Cr                No Value   Ni

CR5       #  253   C0253               85/ 9/13  @  16:52:13   by NAA002   (JPL)   Multiplier:  5.250E+00                       (  23 )
   No Value   Cd              8.384E-01   Cr                No Value   Ni

CR5       #  254   C0254               85/ 9/ 4  @  14:22:13   by NAA002   (JPL)   Multiplier:  1.000E+00                       (  24 )
   No Value   Cd              7.172E-01   Cr                No Value   Ni

CR5       #  255   C0255               85/ 9/13  @  16:47:23   by NAA002   (JPL)   Multiplier:  1.360E+00                       (  25 )
   No Value   Cd              3.089E+01   Cr                No Value   Ni

CR5       #  256   C0256               85/ 9/13  @  16:54:38   by NAA002   (JPL)   Multiplier:  1.217E+00                       (  26 )
   No Value   Cd              1.280E+00   Cr               3.870E+00   Ni

CR5       #  257   C0257               85/ 9/ 4  @  14:23: 8   by NAA002   (JPL)   Multiplier:  1.044E+00                       (  27 )
   No Value   Cd              1.129E+00   Cr                No Value   Ni

CR5       #  258   C0258               85/ 9/13  @  16:49:33   by NAA002   (JPL)   Multiplier:  1.055E+00                       (  28 )
   No Value   Cd              1.367E+01   Cr                No Value   Ni

CR5       #  259   C0259               85/ 9/13  @  16:54:58   by NAA002   (JPL)   Multiplier:  4.380E+00                       (  29 )
   No Value   Cd              1.409E+00   Cr               3.002E+00   Ni

CR5       #  260   C0260               85/ 9/ 4  @  14:24: 8   by NAA002   (JPL)   Multiplier:  1.401E+00                       (  30 )
   No Value   Cd              2.029E+00   Cr                No Value   Ni

CR5       #  261   C0261               85/ 9/13  @  16:48:48   by NAA002   (JPL)   Multiplier:  1.185E+00                       (  31 )
   No Value   Cd              2.615E+01   Cr               3.967E+01   Ni

CR5       #  262   C0262               85/ 9/13  @  16:48:18   by NAA002   (JPL)   Multiplier:  1.750E+00                       (  32 )
   No Value   Cd              4.067E+00   Cr                No Value   Ni

CR5       #  263   C0263               85/ 9/13  @  16:51:33   by NAA002   (JPL)   Multiplier:  1.390E+00                       (  33 )
   No Value   Cd              4.833E+00   Cr                No Value   Ni
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   Value      Constituent     Value      Constituent     Value      Constituent     Value      Constituent     Value      Constituent
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CR5       #   264    C0264           85/ 9/13  @  16:51:23    by NAA002    (JPL)   Multiplier:  1.009E+00                        ( 34 )
   No Value   Cd            9.945E-01    Cr              6.505E+00    Ni

CR5       #   265    C0265           85/ 9/ 4  @  14:24:43    by NAA002    (JPL)   Multiplier:  1.263E+00                        ( 35 )
   No Value   Cd            1.269E+01    Cr                No Value   Ni

CR5       #   267    C0267           85/ 9/13  @  16:53: 3    by NAA002    (JPL)   Multiplier:  1.401E+00                        ( 36 )
   No Value   Cd            7.853E-01    Cr                No Value   Ni

CR5       #   268    C0268           85/ 9/13  @  16:50: 8    by NAA002    (JPL)   Multiplier:  1.272E+00                        ( 37 )
   No Value   Cd            7.670E+00    Cr                No Value   Ni

CR5       #   269    C0269           85/ 9/ 4  @  14:20:58    by NAA002    (JPL)   Multiplier:  1.410E+00                        ( 38 )
   No Value   Cd            4.769E+00    Cr                No Value   Ni

CR5       #   270    C0270           85/ 9/13  @  16:48:23    by NAA002    (JPL)   Multiplier:  1.185E+00                        ( 39 )
   No Value   Cd            6.343E+00    Cr                No Value   Ni

CR5       #   271    C0271           85/ 9/13  @  16:47:38    by NAA002    (JPL)   Multiplier:  1.000E+00                        ( 40 )
   No Value   Cd            9.830E+00    Cr                No Value   Ni

CR5       #   272    C0272           85/ 9/ 4  @  14:23:53    by NAA002    (JPL)   Multiplier:  1.470E+00                        ( 41 )
   No Value   Cd            9.076E+00    Cr                No Value   Ni

CR5       #   273    C0273           85/ 9/ 4  @  14:21: 8    by NAA002    (JPL)   Multiplier:  1.410E+00                        ( 42 )
   No Value   Cd            9.803E+00    Cr                No Value   Ni

CR5       #   274    C0274           85/ 9/13  @  16:49:48    by NAA002    (JPL)   Multiplier:  1.055E+00                        ( 43 )
   No Value   Cd            3.525E+00    Cr                No Value   Ni

CR5       #   275    C0275           85/ 9/13  @  16:53:38    by NAA002    (JPL)   Multiplier:  1.556E+00                        ( 44 )
   No Value   Cd            3.261E+00    Cr                No Value   Ni

CR5       #   276    C0276           85/ 9/ 4  @  14:21:18    by NAA002    (JPL)   Multiplier:  1.410E+00                        ( 45 )
   No Value   Cd            3.995E+00    Cr                No Value   Ni

CR5       #   277    C0277           85/ 9/13  @  16:52:58    by NAA002    (JPL)   Multiplier:  1.401E+00                        ( 46 )
   No Value   Cd            1.963E+00    Cr                No Value   Ni

CR5       #   278    C0278           85/ 9/ 4  @  14:17:48    by NAA002    (JPL)   Multiplier:  1.097E+00                        ( 47 )
   No Value   Cd            2.387E+00    Cr                No Value   Ni

CR5       #   279    C0279           85/ 9/ 4  @  14:18:28    by NAA002    (JPL)   Multiplier:  1.097E+00                        ( 48 )
   No Value   Cd            2.246E+00    Cr                No Value   Ni

CR5       #   280    C0280           85/ 9/13  @  16:54: 8    by NAA002    (JPL)   Multiplier:  1.289E+00                        ( 49 )
   No Value   Cd            6.922E+00    Cr                No Value   Ni

CR5       #   281    C0281           85/ 9/ 4  @  14:20: 8    by NAA002    (JPL)   Multiplier:  1.424E+00                        ( 50 )
   No Value   Cd            9.539E+00    Cr                No Value   Ni
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01-OCT-85 @ 17:26:52                              Report Listing By Sample                                               Page    5
    Value     Constituent      Value     Constituent      Value     Constituent      Value     Constituent      Value     Constituent
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CR5        #   282    C0282         85/ 9/ 4  @  14:25:28   by NAA002   (JPL)   Multiplier:  1.587E+00                  (  51 )
   No Value    Cd             2.427E+00    Cr                No Value    Ni

CR5        #   283    C0283         85/ 9/ 4  @  14:26:43   by NAA002   (JPL)   Multiplier:  1.818E+00                  (  52 )
   No Value    Cd             3.067E+00    Cr                No Value    Ni

CR5        #   284    C0284         85/ 9/ 4  @  14:18:53   by NAA002   (JPL)   Multiplier:  1.023E+00                  (  53 )
   No Value    Cd             3.775E+00    Cr                No Value    Ni

CR5        #   285    C0285         85/ 9/ 4  @  14:16:38   by NAA002   (JPL)   Multiplier:  1.000E+00                  (  54 )
   No Value    Cd             3.186E+00    Cr                No Value    Ni

CR5        #   286    C0286         85/ 9/ 4  @  14:26:53   by NAA002   (JPL)   Multiplier:  1.940E+00                  (  55 )
   No Value    Cd             1.445E+02    Cr                No Value    Ni
              287             1.26
CR5        #   28~~8~~    C0287         85/ 9/13  @  16:51:18   by NAA002   (JPL)   Multiplier:  1.059E+00                  (  56 )
   No Value    Cd             6.765E+01    Cr                No Value    Ni

CR5        #   289    C0289   64.7  85/ 9/ 4  @  14:25:38   by NAA002   (JPL)   Multiplier:  7.135E+01                  (  57 )
   No Value    Cd             ~~2.577E+01~~    Cr                No Value    Ni

CR5        #   290    C0290         85/ 9/ 4  @  14:25:48   by NAA002   (JPL)   Multiplier:  1.792E+00                  (  58 )
   No Value    Cd             4.426E+01    Cr                No Value    Ni

CR5        #   291    C0291         85/ 9/ 4  @  14:24:53   by NAA002   (JPL)   Multiplier:  1.263E+00                  (  59 )
   No Value    Cd             4.250E+01    Cr                No Value    Ni

CR5        #   292    C0292         85/ 9/ 4  @  14:19: 8   by NAA002   (JPL)   Multiplier:  1.023E+00                  (  60 )
   No Value    Cd             7.026E+01    Cr                No Value    Ni

CR5        #   293    C0293         85/ 9/ 4  @  14:25:58   by NAA002   (JPL)   Multiplier:  1.587E+00                  (  61 )
   No Value    Cd             1.016E+01    Cr                No Value    Ni

CR5        #   294    C0294         85/ 9/ 4  @  14:18: 3   by NAA002   (JPL)   Multiplier:  1.097E+00                  (  62 )
   No Value    Cd             1.256E+02    Cr                No Value    Ni

CR5        #   295    C0295         85/ 9/ 4  @  14:26: 8   by NAA002   (JPL)   Multiplier:  1.587E+00                  (  63 )
   No Value    Cd             4.464E+00    Cr                No Value    Ni

CR5        #   337    C0337         85/ 9/ 4  @  14:18:13   by NAA002   (JPL)   Multiplier:  1.097E+00                  (  64 )
   No Value    Cd   (QA-16)   4.569E+01    Cr                No Value    Ni

CR5        #   338    C0338         85/ 9/ 4  @  14:21:28   by NAA002   (JPL)   Multiplier:  1.410E+00                  (  65 )
   No Value    Cd   (QA-19)   5.230E+01    Cr                No Value    Ni

CR5        #   339    C0339         85/ 9/ 4  @  14:16:53   by NAA002   (JPL)   Multiplier:  1.000E+00                  (  66 )
   No Value    Cd   (QA-17)   9.649E+01    Cr                No Value    Ni

CR5        #   340    C0340         85/ 9/ 4  @  14:18:43   by NAA002   (JPL)   Multiplier:  1.023E+00                  (  67 )
   No Value    Cd             9.722E+01    Cr                No Value    Ni
                    (QA-20)
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09-SEP-85 @ 12:14:11                          Report Listing By Sample
                                                                                                                      Page      4
   Value       Constituent      Value      Constituent      Value      Constituent      Value      Constituent      Value      Constituent
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CR5       #   327    C0327           85/ 8/23  @  11:15:23    by NAA002   (JPL)  Multiplier:  1.351E+00                          ( 34 )
   No Value   Cd              1.940E+04   Cr              No Value    Ni
CR5       #   329    C0329           85/ 8/23  @  11:13:13    by NAA002   (JPL)  Multiplier:  1.056E+00                          ( 35 )
   No Value   Cd              2.543E+04   Cr              No Value    Ni
CR5       #   330    C0330           85/ 8/23  @  11:11: 3    by NAA002   (JPL)  Multiplier:  1.000E+00                          ( 36 )
   No Value   Cd              1.479E+04   Cr              No Value    Ni
CR5       #   332    C0332           85/ 8/23  @  11:11:13    by NAA002   (JPL)  Multiplier:  1.000E+00                          ( 37 )
   No Value   Cd              3.017E+02   Cr              No Value    Ni
CR5       #   333    C0333           85/ 8/23  @  11:12: 3    by NAA002   (JPL)  Multiplier:  1.025E+00                          ( 38 )
   No Value   Cd              5.247E+02   Cr              No Value    Ni
CR5       #   334    C0334           85/ 8/23  @  11:13:23    by NAA002   (JPL)  Multiplier:  1.056E+00                          ( 39 )
   No Value   Cd              4.340E+03   Cr              No Value    Ni
CR5       #   336    C0336           85/ 8/23  @  11:12:13    by NAA002   (JPL)  Multiplier:  1.025E+00                          ( 40 )
   No Value   Cd              8.445E+01   Cr              No Value    Ni
CR5       #   341    C0341           85/ 8/23  @  11:20:13    by NAA002   (JPL)  Multiplier:  9.970E-01                          ( 41 )
   No Value   Cd  (QA-18)     1.464E+02   Cr              No Value    Ni
CR5       #   342    C0342           85/ 8/23  @  11:20:53    by NAA002   (JPL)  Multiplier:  1.476E+00                          ( 42 )
   No Value   Cd  (QA-21)     2.001E+02   Cr              No Value    Ni
CR5       #   770    C328A           85/ 8/23  @  11:16:13    by NAA002   (JPL)  Multiplier:  1.216E+00                          ( 43 )
   No Value   Cd              5.635E+03   Cr              No Value    Ni
CR5       #   771    C328B           85/ 8/23  @  11:16:23    by NAA002   (JPL)  Multiplier:  1.216E+00                          ( 44 )
   No Value   Cd              3.526E+03   Cr              No Value    Ni
CR5       #   772    C331B           85/ 8/23  @  11:17:33    by NAA002   (JPL)  Multiplier:  1.013E+00                          ( 45 )
   No Value   Cd              3.211E+03   Cr              No Value    Ni
CR5       #   773    C331A           85/ 8/23  @  11:18:43    by NAA002   (JPL)  Multiplier:  1.012E+00                          ( 46 )
   No Value   Cd              5.207E+03   Cr              No Value    Ni
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APPENDIX C.

SAMPLING AND ANALYTICAL PROCEDURES

DETERMINATION OF TOTAL PARTICULATE EMISSIONS

All particulate samples were collected using an EPA Method 5 sampling train, and Method 5 sampling procedures, as described in the Federal Register*.

SAMPLING APPARATUS

The particulate sampling train used in these tests met design specifications established by the EPA. The sampling apparatus, which was assembled by Entropy personnel, consisted of the following:

Nozzle - Stainless steel (316) with sharp, tapered leading edge and accurately measured round opening.

Probe - Borosilicate glass with a heating system capable of maintaining a minimum gas temperature of 121°C (250°F) at the exit end during sampling.

Pitot Tube - A type S pitot tube that met all geometric standards was attached to a probe to monitor stack gas velocity pressure.

Temperature Gauge - A Chromel/Alumel type-K thermocouple (or equivalent) was attached to the pitot tube, in an interference-free arrangement, to monitor stack gas temperature within 1.5°C (5°F) using a digital readout.

Filter Holder - The filter holder was made of Pyrex glass, with heating system capable of maintaining a filter temperature of approximately 121°C (250°F).

Filter - A 79-mm (3-in.) diameter Teflon filter (Scheicher & Schuell) was used.

Draft Gauge - The draft was measured with two in-parallel Magnehelic^R gauges (made by Dwyer) with subdivisions of 0.25 mm (0.01 in.) H_2O in the 0 to 12.5 mm (0 to 0.5 in.) H_2O range and 1.25 mm (0.05 in.) subdivisions in the 12.5 to 50 mm (0.5 to 2 in.) range.

Impingers - Four Greenburg-Smith design impingers were connected in series with screw-type connectors. The first, third, and fourth impingers were modified by removing the tip and extending the tube to within 1.3 cm (0.5 in.) of the bottom of the flask.

Metering System - The metering system consisted of a vacuum gauge, a leak-free pump, thermometers capable of measuring temperature to within 1.5°C (5°F), a calibrated dry gas meter, and related equipment, to

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*40 CFR 60, Appendix A, Reference Method 5, July 1, 1980.

maintain an isokinetic sampling rate and to determine sample volume. The dry gas meter was made by Rockwell, and the fiber vane pump was made by Gast.

Barometer - An aneroid type barometer was used to measure atmospheric pressures to 0.3 kPa (0.1 in. Hg).

SAMPLING PROCEDURES

After the sampling site and minimum number of traverse points were selected, the stack pressure, temperature, moisture, and range of velocity head were measured according to procedures described in the Federal Register.*

Approximately 200 grams of silica gel was weighed and placed in a sealed impinger prior to each test. Teflon filters were desiccated for at least 24 hours to a constant weight and weighed to the nearest 0.1 mg on an analytical balance. One hundred (100) milliliters of deionized-distilled water was placed in each of the first two impingers; the third impinger was initially empty; and the fourth impinger containing the silica gel was placed next in series. The train was set up as shown in Figure C-1. The sampling train was leak-checked at the sampling site prior to each test run by plugging the inlet to the nozzle and pulling a 50 kPa (15 in. Hg) vacuum, and at the conclusion of the test by plugging the inlet to the nozzle and pulling a vacuum equal to the highest vacuum reached during the test run.

The pitot tube and lines were leak-checked at the test site prior to each test run and at the conclusion of each test run. The check was made by blowing into the impact opening of the pitot tube until 7.6 cm (3 in.) or more of water was recorded on the Magnehelic^R gauge and then capping the impact opening and holding it for 15 seconds to assure it was leak-free. The same procedure was used to leak-check the static pressure side of the pitot tube, except suction

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*40 CFR 60, Appendix A, Methods 1, 2, 3, and 4, July 1, 1980.

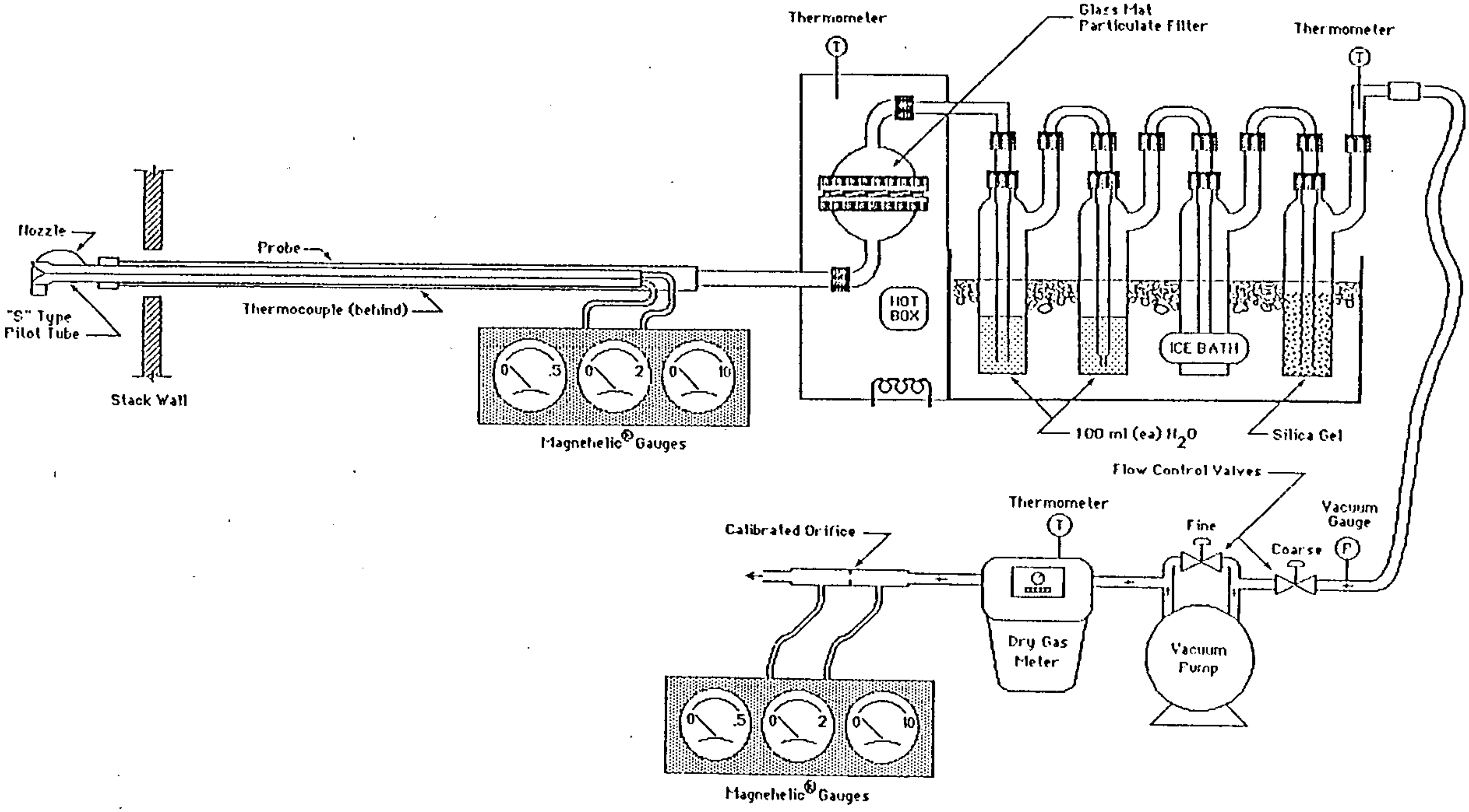

Figure C-1. Method 5 sample train.

was used to obtain the 7.6 cm (3 in.) H_2O manometer reading. Crushed ice was placed around the impingers to ensure that the temperature of the gases leaving the last impinger was at 20°C (68°F) or less.

During the sampling, stack gas and sampling train data were recorded at each sampling point and whenever significant changes in stack flow conditions occurred. Isokinetic sampling rates were set throughout the sampling period with the aid of a nomograph or calculator. All sampling data were recorded on the field data sheets.

SAMPLE RECOVERY PROCEDURES

The sampling train was carefully moved from the test site to the cleanup area. The volume of water from the first three impingers was measured, and the silica gel from the fourth impinger was weighed to the nearest 0.1 gram. Sample fractions were recovered as follows:

Container No. 1 - The filter was removed from its holder and placed in a petri dish and sealed.

Container No. 2 - Loose particulate and acetone washings from all sample-exposed surfaces prior to the filter were placed in a glass or polyethylene jar, sealed, and labeled. Particulate was removed from the probe with the aid of a brush and acetone rinsing. The sample-exposed surfaces prior to the filter were also washed with distilled water. These washings were added to the glass jar. The liquid level was marked after the container was sealed and labeled.

Container No. 3 - A minimum of 200 ml of acetone was taken for the blank analysis. The blank was obtained and treated in a manner similar to the acetone washing.

Container No. 4 - After being measured, distilled water in the impinger section of the sampling train was placed in a glass or polyethylene container. The impingers and connecting glassware were rinsed with distilled H_2O and this rinse was added to the container for shipment to the laboratory.

Container No. 5 - A minimum of 200 ml of distilled water was taken for the blank analysis. The blank was obtained and treated in a manner similar to the water rinse.

Container No. 6 - An unused Teflon filter was taken for blank analysis.

Data was recorded on the appropriate sample recovery and laboratory data sheets.

ANALYTICAL PROCEDURES

The following procedures were used and followed the methods described in the Federal Register*.

Container No. 1 - The filter and any loose particulate matter from this sample container were placed into a tared glass weighing dish, desiccated for 24 hours to a constant weight, and weighed to the nearest 0.1 mg.

Container No. 2 - The acetone and water washings were transferred to a tared beaker, evaporated to dryness in an oven, desiccated for 24 hours to a constant weight, and weighed to the nearest 0.1 mg.

Container No. 3 - The acetone blank was transferred to a tared beaker and evaporated to dryness at ambient temperature and pressure. The blank was then desiccated for 24 hours to a constant weight and weighed to the nearest 0.1 mg.

Container No. 4 - The impinger contents were marked with the sample run number and saved for chromium analysis.

Container No. 5 - The distilled water blank was saved for chromium analysis.

Container No. 6 - The unused glass fiber filter was treated in an identical manner as the filter in Container No. 1.

The term "constant weight" referred to above means a difference of no more than 0.5 mg or 1 percent of total weight less tare weight, whichever is greater between two consecutive readings, with no less than 6 hours of desiccation between weighings. All analytical data were recorded on the analytical data sheets.

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*40 CFR 60, Appendix A, Reference Method 5, July 1, 1980.

DETERMINATION OF HEXAVALENT CHROMIUM EMISSIONS
(DRAFT METHOD)

Particulate samples collected using the EPA Method 5 sampling train and Method 5 sampling procedures* were analyzed for hexavalent chromium using the tentative method "Determination of Hexavalent Chromium Emissions from Stationary Sources" (dated December 13, 1984) by digesting in an alkaline solution and assaying with the diphenylcarbazide colorimetric method.

SAMPLING APPARATUS

The sampling train used in these tests were the same as for the particulate (Method 5) tests. These trains met design specifications established by the U. S. EPA and were assembled by Entropy personnel.

SAMPLING PROCEDURES

The sampling procedures were performed according to Method 5. All sampling data were recorded on the field data sheets.

SAMPLE RECOVERY PROCEDURES

Sample recovery was done according to Method 5. Data was recorded on the appropriate sample recovery and laboratory data sheets.

SAMPLE AND REAGENT PREPARATION

Samples for analysis and reagents were prepared as described in the following subsections.

Reagents

All reagents conformed to the specifications established by the Committee on Analytical Reagents of the American Chemical Society. In all cases, the water used was deionized and distilled and met the ASTM specifications for

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*40 CFR 60, Appendix A, Reference Method 5, July 1, 1980.

type 2 reagent - ASTM Test Method D 1193-77. Solutions were made as follows:

Digestion Solution - 20.0 g of NaOH and 30.0 g anhydrous Na_2CO_3 were dissolved in water in a 1-liter volumetric flask, and this solution diluted to the mark. It was stored in a tightly capped polyethylene bottle and was prepared fresh monthly.

Potassium Dichromate Stock Solution - 141.4 mg of analytical reagent grade $K_2Cr_2O_7$ was dissolved in water, and this solution diluted to 1 liter (1 ml = 50 μg Cr^{+6}).

Potassium Dichromate Standard Solution - 10.00 ml of $K_2Cr_2O_7$ stock solution was diluted to 100 ml (1 ml = 5 μg Cr^{+6}) with water.

Sulfuric Acid - A ten percent (v/v) solution was made by diluting 10 ml H_2SO_4 to 100 ml in water.

Acetone - Same as Method 5.

Diphenylcarbazide Solution - 250 mg of 1, 5-diphenylcarbizide was dissolved in 50 ml acetone and stored in a brown bottle. The solution was discarded whenever it became discolored.

Sample Preparation

To prevent the possibility of sample deterioration, all samples were protected from extreme heat, were kept dry, and were analyzed within one month of collection. Sample preparation involved digestion and filtration. The contents of Container No. 2 (the acetone probe rinse) was placed in a 250 ml beaker and evaporated to dryness. Following this, the contents of Container No. 1 (with the filter cut into small pieces) was added to the beaker; digestion solution (40 ml) was added and the beaker covered with a watch glass. Using a hot plate, this solution was heated to near boiling with constant stirring for 30 minutes; it was not allowed to evaporate to dryness.

The solution was then cooled and transferred quantitatively to the filtration apparatus with water. This apparatus consists of a vacuum unit constructed of plastic or glass which accommodates a 47 mm diameter, 3.0 μm pore size Teflon filter. The solution was filtered and transferred quantitatively to a 100 ml volumetric flask which was then filled to the mark with water.

To serve as a blank, a representative amount of acetone and a blank Method 5 filter were prepared in the same manner as the sample described above.

The spent silica gel (in Container No. 3) was weighed to the nearest 0.5 g using a balance.

SAMPLE ANALYSIS

Analysis of the samples involved four basic elements: (1) color development and measurement, (2) a check for matrix results on the Cr^{+6} results, (3) calibration of the spectrophotometer, and (4) calculation of the results.

Color Development and Measurement

An aliquot of the prepared sample 50 ml or smaller was transferred to a 100 ml volumetric flask and diluted with sufficient water to bring the volume to approximately 80 ml. The pH was adjusted to 2 ± 0.5 with 10 percent H_2SO_4, 2.0 ml of diphenylcarbazide solution was added, and this solution diluted to volume with water. The solution then stood about 10 minutes for color development. For each set of samples analyzed, an identical aliquot of reagent blank solution was treated in the same way.

To measure, a portion of the sample was transferred to a 1-cm absorption cell, and the absorbance read at the optimum wavelength as determined during spectrophotometer calibration. After each sample measurement, the reagent blank absorbance reading, if any, was subtracted to obtain a net reading. If the absorbance of the sample exceeded the absorbance of the 100 g Cr^{+6} standard as determined during calibration, the sample and the reagent blank were diluted with equal volumes of water.

Check for Matrix Effects on the Cr^{+6} Results

Since the analysis for Cr^{+6} by colorimetry is sensitive to the chemical composition of the sample (matrix effects), at least one sample from each source was checked using the method of additions as follows:

Two equal volume aliquots of the same sample solution were taken; each contained between 30 and 50 μg of Cr^{+6} (less if that was not possible). One of the aliquots was spiked with an aliquot of standard solution containing 30 to 50 μg of Cr^{+6}. Then both the spiked and unspiked sample aliquots were readied for measurement as described in the previous section.

The Cr^{+6} mass, C_s, in μg in the aliquot of the unspiked sample solution was then calculated using the following equation:

$$C_s = C_a \frac{A_s}{A_t - A_s} \qquad \text{Equation D-1}$$

Where:

C_a = Cr^{+6} in the standard solution, μg.

A_s = Absorbance of the unspiked sample solution.

A_t = Absorbance of the spiked sample solution.

Volume corrections were not required since the solutions as analyzed were made to the same final volume. When the results of the method of additions procedure used on the single source sample did not agree within 10 percent of the value obtained by the routine spectrophotometric analysis, all samples from the source were reanalyzed using the method of additions procedure.

SPECTROPHOTOMETER CALIBRATION

Calibration of the spectrophotometer involved two basic sets of operations and these are described below.

Optimum Wavelength Determination

Every 6 months, the wavelength scale of the spectrophotometer was calibrated using an energy source with an intense line emission or a series of glass filters spanning the measuring range of the spectrophotometer. The spectrophotometer was checked to see that the wavelength scale read within ±5 nm at all calibration points. After confirming that the wavelength scale of that the wavelength scale of the spectrophotometer was in proper calibration, 540 nm was used as the optimum wavelength for the measurement of the absorbance of the standards and samples.

In some cases, a scanning procedure was employed to determine the proper measuring wavelength. For both the blank and a 50 µg Cr^{+6} standard solution, the spectrum was scanned between 530 and 550 nm. The optimum wavelength was chosen as the wavelength at which the maximum difference in absorbance between the standard and the blank occurred.

Spectrophotometer Calibration

To calculate the spectrophotometer calibration factor, 0.0 ml, 1 ml, 2 ml, 5 ml, 10 ml, 15 ml, and 20 ml of the working standard solution (1 ml = 5 µg Cr^{+6}) were added to a series of seven 100-ml volumetric flasks. These calibration standards were analyzed as described in the section on color development and measurement. The calibration procedure was repeated on each day that samples were analyzed. The spectrophotometer calibration factor, K_c, was calculated using the following equation:

$$K_c = 5 \frac{A_1 + 2A_2 + 5A_3 + 10A_4 + 15A_5 + 20A_6}{A_1^2 + A_2^2 + A_3^2 + A_4^2 + A_5^2 + A_6^2}$$

Equation D-2

Where:

K_c = Calibration factor.

A_1 = Absorbance of the 5 µg Cr^{+6} standard.

A_2 = Absorbance of the 10 µg Cr^{+6} standard.

A_3 = Absorbance of the 25 µg Cr^{+6} standard.

A_4 = Absorbance of the 50 µg Cr^{+6} standard.

A_5 = Absorbance of the 75 µg Cr^{+6} standard.

A_6 = Absorbance of the 100 µg Cr^{+6} standard.

Spectrophotometer Calibration Quality Control

The absorbance value obtained for each standard was multiplied by the K_c factor (least squares slope) to determine the distance each calibration point was from the theoretical calibration line. To maintain quality control, it was assured that these concentration values did not differ from the actual concentrations (i.e., 5, 10, 25, 50, 75, and 100 μg Cr^{+6}) by more than 7 percent (to be determined) for five of the six standards.

EMISSION CALCULATIONS

All emission calculations were done retaining at least one extra decimal figure beyond that of the acquired data. Figures were rounded off after final calculations.

Total Cr^{+6} in Sample

The total μg Cr^{+6} in each sample, m, was calculated as follows:

$$m = \frac{100\ K_c\ AF}{v_a} \qquad \text{Equation D-3}$$

Where:

100 = Volume in ml of total sample.

A = Absorbance of sample.

F = Dilution factor (required only if sample dilution was needed to reduce the absorbance into the range of calibration.)

v_a = Volume in ml of aliquot analyzed.

Average Dry Gas Meter Temperature and Average Orifice Pressure Drop

The average dry gas meter temperature and average orifice pressure drop was calculated as described in Method 5.

Dry Gas Volume, Volume of Water Vapor, Moisture Content

The dry gas volume, volume of water vapor, and moisture content was calculated as described in Method 5.

Cr^{+6} Emission Concentration

The Cr^{+6} concentration in the stack gas, C_s (g/dscm), dry basis, corrected to standard conditions was calculated as follows:

$$C_s = (10^{-6} g/\mu g)\ (m/V_{m(std)}) \qquad \text{Equation D-4}$$

Isokinetic Variation, Acceptable Results

Isokinetic variation and acceptable results were calculated as described in Method 5.

DETERMINATION OF TOTAL CHROMIUM CONTENT
(DRAFT METHOD)

Particulate samples collected using the EPA Method 5 sampling train and Method 5 sampling procedures* or particle sizing equipment (see section on Determination of Particle Size Distribution) were prepared and analyzed for total chromium content using Neutron Activation Analysis (NAA). This was done following the procedures in the "EPA Protocol for Emissions Sampling for Both Hexavalent and Total Chromium," dated February 22, 1985.**

SAMPLING APPARATUS

The sampling train used in these tests were the same as for the Method 5 tests. No sample-exposed stainless steel or chrome-plated equipment was used with the exception of the sample nozzle. In some cases, paper filters were used for particulate testing or particle size testing. These trains met design specifications established by the U. S. EPA and were assembled by Entropy personnel.

SAMPLING PROCEDURES

The sampling procedures were performed according to Method 5 (or according to the particle size determination sampling procedures). All sampling data were recorded on the field data sheets.

SAMPLE RECOVERY PROCEDURES

Following sample recovery, all samples were kept dry, protected from extreme heat, and analyzed within one month of collection.

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*40 CFR 60, Appendix A, Reference Method 5, July 1, 1980.

**For Chromium Screening Study ESED No. 85/02 and 85/02a, U. S. Environmental Protection Agency, Emission Measurement Branch, Research Triangle Park, North Carolina.

SAMPLE PREPARATION

In all cases, samples collected using EPA Method 5 were analyzed first for hexavalent chromium content (as described in the previous section) and then for total chromium content. Most of the process samples collected were also treated in this manner. The exception to this was in respect to the solid process samples; in this case, the sample was made homogeneous and then representative portions were taken quantitatively and used separately in the analyses for hexavalent chromium and total chromium content.

All samples prepared for NAA were put into suitable sample vials which had been properly prepared. Procedures for this are described below. The subsections which follow describe the sample and blank preparation procedures used for the various categories of sample states.

Sample Preparation Apparatus

No chrome-plated or stainless steel equipment was used. The following items were also required:

Analytical Balance - To determine weight of material submitted for total chromium analysis to within 0.1 mg.

Polyethylene Sample Vials - Five (5) ml size to contain samples submitted for total chromium.

Teflon Spatula - To assist in sample transfer.

Teflon Gloves - To be used for sample handling.

Preparation of Sample Vials

For use in the analytical phase, sample vials were prepared in the following manner. All vials were initially cleaned with soap and water, rinsed with tap water, soaked for 48 hours in a rinse solution of 1 to 1 (v/v) water and concentrated nitric acid, and finally rinsed with deionized-distilled water. After the vials dried, each was marked on both sides with the appropriate sample identification number using a permanent pen (water insoluble). All sample identification numbers, volumes, and weights were recorded on the Sample Preparation and Analysis Data Forms.

Preparation and Analysis for Method 5 Samples

Initially, the entire sample was analyzed for hexavalent chromium by the EPA Cr^{+6} Method described in the previous section. The sample residue (particulate filter, filtration filter and insoluble materials) for each run was then transferred to a separate cleaned and marked sample vial. For samples with 2 to 10 grams of material, multiple 5 ml vials (least possible number) were used. For samples with greater than 10 grams of material, a portion of the filter catch (approximately 4-5 grams) were taken, weighed to the nearest 0.1 mg, and transferred to a sample vial. For one sample run at each emission test location, a 2.0 ml aliquot of the filtrate from the hexavalent chromium analysis was transferred to a cleaned and marked vial.

The sample blank consisted of the blank residue, including the acetone blank (the volume of the acetone blank being approximately equal to the average of the acetone rinse volume); a blank particulate filter; and a solution filtration filter that had been prepared in the same manner as the field samples. This was transferred to a separate cleaned/marked sample vial.

All samples were analyzed for total chromium in terms of μg of total chromium per sample vial.

Preparation and Analysis for Liquid Process Samples

Initially, a representative portion of the liquid process sample was analyzed for hexavalent chromium by the EPA Cr^{+6} method. For total chromium analysis, a separate representative sample (2.0 ml aliquot) that contained greater than 1 μg/ml of total chromium was transferred to a sample vial for analysis. When the liquid sample was below 1 μg/ml concentration, a representative sample was concentrated and then a 2.0 ml aliquot transferred to a sample vial for analysis. Representative portions were taken according to EPA Method 160.2 (EPA-600/4-79-020, March 1974). No sample blank was required.

Preparation and Analysis for Solid Process Samples

A representative sample of solid process samples was first taken and analyzed for hexavalent chromium by the EPA Cr^{+6} Method. A separate representative sample was taken for total chromium analyis. Two procedures were followed in preparing these samples for total chromium analysis: (1) a representative sample not exceeding the volume of the 5.0 ml sample vial and containing 5 to 100 µg of Cr^{+6} was taken and weighed to the nearest 0.1 mg, or (2) a representative sample (about 10 to 20 grams) was taken and placed in a marked and cleaned polyethylene container, then the exact sample fraction and weight analyzed was selected and performed by the NAA staff. The concentration of the process material in terms of µg/g of hexavalent chromium was included on the sample log to provide the NAA staff with the information necessary to make the proper sample size selection. When the sample concentration was unknown, the second procedure was followed. An estimate of sample concentration was then determined by NAA prior to the actual sample analysis.

For samples that completely passed through a 200 mesh screen, a representative portion was obtained by thoroughly mixing the entire sample. For samples with material greater than 200 mesh, the sample was initially screened and then all materials that did not pass through the screen were ground, using a technique that would not provide chromium contamination, until all material passed through the screen. The sample was then thoroughly mixed and a representative sample taken. No sample blank was required.

For sludge process samples, the entire sample was thoroughly mixed and then a representative portion was taken.

Procedures to Reduce NAA Time

For all samples that were placed in sample vials, an estimate of the mass of chromium was included on the sample log to provide the NAA facility with the information necessary to select the proper sample irradiation time and strength. When possible, all samples were added to the sample vials in amounts that ensured the mass of chromium per sample was between 10 µg and 5,000 µg. When the total chromium value was not known, samples were prepared so that each sample vial contained between 5 µg and 100 µg of hexavalent chromium. These procedures were followed to allow all known value samples to be irradiated at the same time and strength.

When the sample concentration was unknown or possibly could have exceeded 5,000 µg of total chromium, such was noted on the sample log sheet. A preliminary run on the material was then made to estimate the sample concentration.

When liquid process sample or the 2.0 ml aliquot of the filtrate from the hexavalent analysis were below the 10 µg of total chromium value, total mass of chromium was recorded on the data sheet to allow these samples to be irradiated separately for a longer time and to allow for the selection of a lower concentration standard.

Quality Assurance Sample Analysis

With every set of 15 samples submitted for NAA, one audit sample was submitted to check the analytical technique.

SAMPLE ANALYSIS

Sample analysis for total chromium content was done using Neutron Activation Analysis (NAA) and was conducted by the Department of Nuclear

Engineering at North Carolina State University in Raleigh. In brief, NAA is based on the determination of the number and energy of gamma and/or x-rays emitted by radioisotopes produced in a sample matrix by neutron irradiation. Quantitative analysis is obtained by comparing the x- or gamma-rays of the sample with the number determined for a standard that has been subjected to the identical irradiation.

The samples (prepared as described) were heat-sealed in the 25 ml polyethylene vials. Chromium standards were similarly sealed in identical vials. Sets of samples and standards were irradiated for a predetermined neutron fluence. They were then allowed to radiate for a minimum of 10 days prior to analysis to eliminate possible inference from sodium and cobalt which have short half-lives. After this time, samples and standards were counted on a solid state detector connected to a multichannel analyzer.

Results were reported for samples in terms of total µg of chromium for the sample.

CALCULATIONS

Particulate and chromium emissions and concentrations were calculated as described below.

Emission Calculations for Particulate and Hexavalent Chromium

Particulate and hexavalent chromium emissions were calculated as described in the EPA Cr^{+6} Method (see previous section).

Emission Calculations for Total Chromium

The total chromium emissions, C_s (µg/dscm), were calculated as follows:

$$C_s = (m_r - m_b) + (m_h) / V_{m(std)} \qquad \text{Equation C-5}$$

Where:

C_s = Stack gas concentration, g/dscm.

m_r = Mass of Cr in each particulate residue sample, μg.

m_b = Mass of Cr in each particulate residue blank, μg.

m_h = Mass of Cr in filtrate solution (Cr^{+6}) minus blank, μg.

$V_{m(std)}$ = Volume of gas sampled, corrected to standard conditons, dscm.

Note: In some cases, the mass of Cr was calculated separately, for the filter/rinse sample and impinger contents sample, or the masses of both samples and both blanks were added to obtain the total concentration.

Calculation of Chromium in Solid Process Samples

The chromium concentration in solid process samples, C_o (μg/g), was calculated as follows:

$$C_o = (m_s - m_b)/wt \qquad \text{Equation C-6}$$

Where:

C_o = Concentration of chromium in process sample, μg/g.

m_s = Mass of Cr in process sample, μg.

m_b = Mass of Cr in blank sample (if applicable), μg.

wt = Weight of sample analyzed, g.

Calculation of Chromium in Liquid Process Samples

The chromium concentration in liquid process samples, C_l (μg/ml), was calculated as follows:

$$C_l = (m_s/2)\ (V_f/V_i) \qquad \text{Equation C-7}$$

Where:

C_l = Concentration of chromium in liquid sample, μg/ml.

m_s = Mass of Cr in liquid process sample, μg.

2 = 2.0 ml aliquot analyzed.

V_f = Final volume if a sample is concentrated, ml.

V_i = Initial volume of sample concentrated, ml.

APPENDIX D

CALIBRATION DATA

CALIBRATIONS

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

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

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

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

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

Magnehelic^R Gauges - After each field use, each Magnehelic^R Gauge is calibrated against an inclined manometer at three different settings (low, medium, high) over the range of the individual gauges. If the readings differ more than ± 5% from the manometer readings, the Magnehelics^R are recalibrated.

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

CALIBRATION BY: MMF

METER BOX NUMBER: N 5

DATE: 11-6-84

BAROMETRIC PRESSURE (P_B): 29.5 IN. HG

*DATE:

*BAROMETRIC PRESSURE (P_B): ______ IN. HG

STANDARD METER NUMBER: 1017051

COEFFICIENT (Y_{DS}): 0.9942

NOMINAL FLOW RATE ($\tilde{Q}$) CFM	STANDARD DRY GAS METER			METER BOX METERING SYSTEM		
	GAS VOLUME (V_{DS}) FT³	TEMP. (T_{DS}) °F	TIME (θ) MIN.	ORIFICE SETTING (ΔH) IN. H_2O	GAS VOLUME (V_D) FT³	TEMP. (T_D) °F
0.4	4.379	66	10.0	.5	4.439	79
	4.004	66	10.0	.5	4.041	80
0.8	7.892	66	10.0	2.1	8.130	86
	7.883	66	10.0	2.1	8.109	87
1.2	12.179	66	10.0	4.8	12.354	78
	12.162	66	10.0	4.8	12.445	85

NOMINAL FLOW RATE ($\tilde{Q}$) CFM	METER BOX METERING SYSTEM			
	FLOW RATE (Q_D) CFM	ORIFICE FACTOR (OF)	COEFF. (Y_D)	ΔH@ IN. H_2O
0.4	0.3916	3.023	1.0038	1.761
	.3938	3.025	1.0101	1.737
0.8	.7762	6.234	.9966	1.857
	.7754	6.240	.9998	1.858
1.2	1.1979	9.356	.9906	1.809
	1.1962	9.417	.9948	1.791
	AVERAGE		.999	1.80

$$\Delta H_@ = \frac{0.0317 \cdot \Delta H}{P_b \cdot (t_d + 460)} \cdot \left[\frac{(t_{ds} + 460) \cdot \theta}{Y_{ds} \cdot V_{ds}}\right]^2$$

$$Y_d = \frac{Y_{ds} \cdot V_{ds} \cdot (t_d + 460) \cdot P_b}{V_d \cdot (t_{ds} + 460) \cdot (P_b + \Delta H/13.6)}$$

CALIBRATION BY: DR

METER BOX NUMBER: N6

DATE: 1-25-85

BAROMETRIC PRESSURE (P_B): 29.13 IN. HG

*DATE:

*BAROMETRIC PRESSURE (P_B): IN. HG

STANDARD METER NUMBER: 1017057

COEFFICIENT (Y_{DS}): 0.9942

NOMINAL FLOW RATE ($\tilde{Q}$) CFM	STANDARD DRY GAS METER			METER BOX METERING SYSTEM		
	GAS VOLUME (V_{DS}) FT³	TEMP. (T_{DS}) °F	TIME (θ) MIN.	ORIFICE SETTING (ΔH) IN. H_2O	GAS VOLUME (V_D) FT³	TEMP. (T_D) °F
0.4	4.198	68	10.0	0.50	4.124	70
	4.179	68	10.0	0.50	4.144	74
0.8	8.468	68	10.0	2.10	8.473	80
	8.446	68	10.0	2.10	8.515	84
1.2	12.529	69	10.0	4.80	12.661	89
	12.511	69	10.0	4.80	12.714	92

NOMINAL FLOW RATE ($\tilde{Q}$) CFM	METER BOX METERING SYSTEM			
	FLOW RATE (Q_D) CFM	ORIFICE FACTOR (OF)	COEFF. (Y_D)	ΔH@ IN. H_2O
0.4	0.4062	3.016	1.0146	1.643
	0.4043	3.028	1.0127	1.646
0.8	0.8193	6.239	1.0108	1.665
	0.8172	6.262	1.0107	1.661
1.2	1.2100	9.511	1.0088	1.716
	1.2082	9.537	1.0086	1.712
	AVERAGE		1.011	1.67

$$\Delta H_@ = \frac{0.0317 \cdot \Delta H}{P_b \cdot (t_d + 460)} \cdot \left[\frac{(t_{ds} + 460) \cdot \theta}{Y_{ds} \cdot V_{ds}}\right]^2$$

$$Y_d = \frac{Y_{ds} \cdot V_{ds} \cdot (t_d + 460) \cdot P_b}{V_d \cdot (t_{ds} + 460) \cdot (P_b + \Delta H/13.6)}$$

CALIBRATION BY: MH

METER BOX NUMBER: N8

DATE: 2-27-85

BAROMETRIC PRESSURE (P_B): 29.64 IN. HG

*DATE: ____

*BAROMETRIC PRESSURE (P_B): ____ IN. HG

STANDARD METER NUMBER: 1017057

COEFFICIENT (Y_{DS}): 0.9942

NOMINAL FLOW RATE ($\tilde{Q}$) CFM	STANDARD DRY GAS METER			METER BOX METERING SYSTEM		
	GAS VOLUME (V_{DS}) FT3	TEMP. (T_{DS}) °F	TIME (θ) MIN.	ORIFICE SETTING (ΔH) IN. H_2O	GAS VOLUME (V_D) FT3	TEMP. (T_D) °F
	4.165	69	10:00	0.50	4.248	89
	4.238	69	10:00	.5	4.324	87
	8.443	69	10:00	2.10	8.700	88
	8.475	69	10:00	2.1	8.742	90
	12.765	69	10:00	4.80	13.107	86
	12.702	69	10:00	4.8	13.077	89

NOMINAL FLOW RATE ($\tilde{Q}$) CFM	METER BOX METERING SYSTEM			
	FLOW RATE (Q_D) CFM	ORIFICE FACTOR (OF)	COEFF. (Y_D)	ΔH@ IN. H_2O
	0.4093	3.043	1.0104	1.590
	.4164	3.038	1.0063	1.541
	.8296	6.231	0.9943	1.628
	.8328	6.242	.9969	1.610
	1.2543	9.403	.9876	1.634
	1.2482	9.429	.9904	1.641
	AVERAGE		0.998	1.61

$$\Delta H_@ = \frac{0.0317 * \Delta H}{P_b * (t_d + 460)} * \left[\frac{(t_{ds} + 460) * \theta}{Y_{ds} * V_{ds}}\right]^2$$

$$Y_d = \frac{Y_{ds} * V_{ds} * (t_d + 460) * P_b}{V_d * (t_{ds} + 460) * (P_b + \Delta H/13.6)}$$

CALIBRATION BY: BDR

METER BOX NUMBER: N14

DATE: 10-26-84 BAROMETRIC PRESSURE (P_B): 29.86 IN. HG

*DATE: *BAROMETRIC PRESSURE (P_B): IN. HG

STANDARD METER NUMBER: 1017057 COEFFICIENT (Y_{DS}): 0.9942

NOMINAL FLOW RATE ($\tilde{Q}$) CFM	STANDARD DRY GAS METER			METER BOX METERING SYSTEM		
	GAS VOLUME (V_{DS}) FT³	TEMP. (T_{DS}) °F	TIME (θ) MIN.	ORIFICE SETTING (ΔH) IN. H_2O	GAS VOLUME (V_D) FT³	TEMP. (T_D) °F
0.4	4.185	72	10.00	0.50	4.202	75
	4.161	71	10.00	0.50	4.202	78
0.8	8.243	72	10.00	2.1	8.349	83
	8.201	72	10.00	2.1	8.368	88
1.2	12.517	72	10.00	4.8	12.620	92
	12.526	72	10.00	4.8	12.769	95

NOMINAL FLOW RATE ($\tilde{Q}$) CFM	METER BOX METERING SYSTEM			
	FLOW RATE (Q_D) CFM	ORIFICE FACTOR (OF)	COEFF. (Y_D)	$\Delta H@$ IN. H_2O
0.4	0.4120	2.993	0.9945	1.622
	0.4104	3.001	0.9963	1.626
0.8	0.8114	6.180	0.9967	1.730
	0.8073	6.208	0.9985	1.732
1.2	1.2321	9.420	1.0012	1.687
	1.2330	9.445	1.0056	1.676
	AVERAGE		1.000	1.68

$$\Delta H_@ = \frac{0.0317 \cdot \Delta H}{P_b \cdot (t_d + 460)} \cdot \left[\frac{(t_{ds} + 460) \cdot \theta}{Y_{ds} \cdot V_{ds}}\right]^2$$

$$Y_d = \frac{Y_{ds} \cdot V_{ds} \cdot (t_d + 460) \cdot P_b}{V_d \cdot (t_{ds} + 460) \cdot (P_b + \Delta H/13.6)}$$

ENTROPY

NOZZLE NUMBER: 405

Date	Initials	Dia. 1	Dia. 2	Dia. 3	Dia. 4	Dia. 5	Average
11-20-82	ST	.256	.259	.257	.257	.257	0.257
4-18-83	PLO	.260	.259	.260	.261	.258	0.260
7-05-83	PH	.260	.258	.257	.259	.260	0.259
3-8-84	JNC	.258	.257	.259	.257	.256	0.257"
7-9-84	JNC	.257	.257	.258	.256	.258	0.257

NOTE: All diameters measured in inches.

ENTROPY
ENVIRONMENTALISTS, INC.

NOZZLE NUMBER: 406

Date	Initials	Dia. 1	Dia. 2	Dia. 3	Dia. 4	Dia. 5	Average
11-30-82	ST	.253	.253	.254	.251	.252	0.253
7-05-83	PH	.252	.255	.253	.253	.253	0.253
3-8-84	JNC	.253	.252	.252	.252	.253	0.252"

NOTE: All diameters measured in inches.

NOZZLE NUMBER: 407

Date	Initials	Dia. 1	Dia. 2	Dia. 3	Dia. 4	Dia. 5	Average
11-30-82	ST	.321	.324	.322	.323	.322	0.322
4-18-83	PLO	.313	.316	.314	.313	.314	0.314
7-05-83	PH	.310	.312	.312	.313	.312	0.312
3-8-84	JNC	.312	.314	.312	.313	.312	0.313"
7-9-84	JNC	.313	.312	.312	.313	.313	0.313
2-19-85	JDE	.308	.309	.308	.310	.310	0.309

NOTE: All diameters measured in inches.

NOZZLE NUMBER: 711

Date	Initials	Dia. 1	Dia. 2	Dia. 3	Dia. 4	Dia. 5	Average
12-2-82	ST	.372	.372	.372	.373	.372	0.372
11-18-83	PLO	.371	.370	.370	.372	.369	0.370"
3-8-84	JNC	.368	.368	.370	.370	.368	0.369"
7-6-84	TTM	.369	.370	.370	.370	.369	0.370
10-23-84	ATM	.364	.365	.365	.365	.363	0.364

NOTE: All diameters measured in inches.

TEMPERATURE SENSING EQUIPMENT CALIBRATION DATA

BAROMETRIC PRESSURE: 29.72 DATE: 1-16-84 CALIBRATED BY: GJC

MERCURY-IN-GLASS REFERENCE NUMBER: 1962175-ASTM3F AMBIENT TEMP.: 63

CALIBRATION SYSTEM USED	POTENTIOMETER I.D. NUMBER	THERMOCOUPLE/ THERMOMETER I.D. NUMBER	REFERENCE THERMOMETER TEMPERATURE T_o (°F)		MEAN TEMPERATURE OF Hg COLUMN T_m (°F)	THERMOCOUPLE/ THERMOMETER TEMPERATURE T_t (°F)	ΔT^B $\leq 1.5\%$
			T_o (°F)	T_c (°F)			
ice water	01	4-3	33	33	51	32	0.2
	04	"	33	33	51	32	0.2
	05	"	33	33	51	30	0.4
	07	"	33	33	51	32	0.2
	09	"	33	33	51	32	0.2
	10	"	33	33	51	31	0.4
	Blue box	"	33	33	51	31	0.4
	Red box-1	"	33	33	51	31	0.4
	Red box-2	"	33	33	51	32	0.2
ambient air	01	"	63	63	63	61	0.4
	04	"	63	63	63	61	0.4
	05	"	63	63	63	61	0.4
	07	"	63	63	63	61	0.4
	09	"	63	63	63	61	0.4
	10	"	63	63	63	61	0.4
	Blue box	"	63	63	63	62	0.2
	Red box-1	"	63	63	63	61	0.4
	Red box-2	"	63	63	63	62	0.2
hot water	01	"	212	213	127	213	0.0
	04	"	212	213	127	213	0.0
	05	"	212	213	127	212	0.1
	07	"	212	213	127	213	0.0
	09	"	212	213	127	213	0.0
	10	"	212	213	127	212	0.1
	Blue box	"	212	213	127	212	0.1
	Red box-1	"	212	213	127	213	0.0
	Red box-2	"	212	213	127	213	0.0

CORRECTED TEMPERATURE = $T_c = T_o + .00009\,(T_o - 20)(T_o - T_m)$

TEMPERATURE DIFFERENCE = $\Delta T = \dfrac{[(T_c, {}^\circ F + 460) - (T_t, {}^\circ F + 460)]}{T_c, {}^\circ F + 460} \times 100 \leq 1.5\%$

TEMPERATURE SENSING EQUIPMENT CALIBRATION DATA

BAROMETRIC PRESSURE: 29.72 DATE: 1-16-84 CALIBRATED BY: DJC

MERCURY-IN-GLASS REFERENCE NUMBER: 1962175-ASTM3F AMBIENT TEMP.: 63

CALIBRATION SYSTEM USED	POTENTIOMETER I.D. NUMBER	THERMOCOUPLE/ THERMOMETER I.D. NUMBER	REFERENCE THERMOMETER TEMPERATURE		MEAN TEMPERATURE OF Hg COLUMN	THERMOCOUPLE/ THERMOMETER TEMPERATURE	ΔT^B $\leq 1.5\%$
			T_o (°F)	T_c (°F)	T_m (°F)	T_t (°F)	
hot oil	01	4-3	429	441	115	440	0.1
	04	"	429	441	115	434	0.2
	05	"	429	441	115	439	0.2
	07	"	429	441	115	441	0.0
	09	"	429	441	115	438	0.3
	10	"	429	441	115	440	0.1
	Blue box	"	429	441	115	440	0.1
	Red box-1	"	429	441	115	439	0.2
	Red box-2	"	429	441	115	439	0.2

CORRECTED TEMPERATURE = $T_c = T_o +-.00009\ (T_o-20)(T_o-T_m)$

TEMPERATURE DIFFERENCE = $\Delta T = \frac{[(T_c,{}^{\circ}F + 460) - (T_t,{}^{\circ}F + 460)]}{T_c,{}^{\circ}F + 460} \times 100 \leq 1.5\%$

TEMPERATURE SENSING EQUIPMENT CALIBRATION DATA

BAROMETRIC PRESSURE: 30.06 DATE: 1-13-84 CALIBRATED BY: GJC

MERCURY-IN-GLASS REFERENCE NUMBER: 196217S-ASTM3F AMBIENT TEMP.: 64

CALIBRATION SYSTEM USED	POTENTIOMETER I.D. NUMBER	THERMOCOUPLE/ THERMOMETER I.D. NUMBER	REFERENCE THERMOMETER TEMPERATURE		MEAN TEMPERATURE OF Hg COLUMN	THERMOCOUPLE/ THERMOMETER TEMPERATURE	ΔT^B $\leq 1.5\%$
			T_o (°F)	T_c (°F)	T_m (°F)	T_t (°F)	
ice water	DS-1	WC-10-3	32	32	51	32	0.0
ambient air	"	"	64	64	64	64	0.0
hot water	"	"	212	214	120	214	0.0
hot oil	"	"	364	371	138	370	0.1

CORRECTED TEMPERATURE = $T_c = T_o + -.00009\ (T_o - 20)(T_o - T_m)$

TEMPERATURE DIFFERENCE = $\Delta T = \frac{[(T_c, ^\circ F + 460) - (T_t, ^\circ F + 460)]}{T_c, ^\circ F + 460} \times 100 \leq 1.5\%$

ENTROPY

TEMPERATURE SENSING EQUIPMENT CALIBRATION DATA

BAROMETRIC PRESSURE: 29.72 DATE: 1-16-84 CALIBRATED BY: YJC

RCURY-IN-GLASS REFERENCE NUMBER: 1962175-ASTM3F AMBIENT TEMP.: 61

CALIBRATION SYSTEM USED	POTENTIOMETER I.D. NUMBER	THERMOCOUPLE/ THERMOMETER I.D. NUMBER	REFERENCE THERMOMETER TEMPERATURE		MEAN TEMPERATURE OF Hg COLUMN	THERMOCOUPLE/ THERMOMETER TEMPERATURE	ΔT^B $\leq 1.5\%$
			T_o (°F)	T_c (°F)	T_m (°F)	T_t (°F)	
ice water	DS-1	2-7	33	33	52	32	0.2
〃	〃	3-3-1	33	33	51	31	0.4
〃	〃	3-3-2	33	33	52	32	0.2
〃	〃	3-9	33	33	51	32	0.2
〃	〃	4-3	33	33	51	32	0.2
〃	〃	4-5	33	33	52	31	0.4
〃	〃	4-10	33	33	51	32	0.2
〃	〃	4-11	33	33	51	32	0.2
〃	〃	5-3	33	33	51	31	0.4
〃	〃	5-5	33	33	51	31	0.4
〃	〃	5-9	33	33	52	31	0.4
〃	〃	6	33	33	51	32	0.2
〃	〃	6-5	33	33	52	32	0.2
〃	〃	6-7	33	33	52	31	0.4
〃	〃	7-1	33	33	51	32	0.2
〃	〃	7-4	33	33	52	32	0.2
〃	〃	7-5	33	33	52	31	0.4
〃	〃	8-5	33	33	51	31	0.4
〃	〃	8-6	33	33	52	31	0.4
〃	〃	9	33	33	51	32	0.2
〃	〃	9-3	33	33	51	32	0.2
〃	〃	9-4	33	33	51	31	0.4
〃	〃	10-11	33	33	52	31	0.4
〃	〃	11	33	33	51	31	0.4
〃	〃	11-1	33	33	52	31	0.4
〃	〃	11-9	33	33	51	31	0.4
〃	〃	12-5	33	33	52	31	0.4
〃	〃	15-9	33	33	51	31	0.4
〃	〃	16-1	33	33	52	31	0.4
〃	〃	16-2	33	33	52	31	0.4

CORRECTED TEMPERATURE = $T_c = T_o + .00009\ (T_o-20)(T_o-T_m)$

TEMPERATURE DIFFERENCE = $\Delta T = \dfrac{[(T_c, {}^\circ F + 460) - (T_t, {}^\circ F + 460)]}{T_c, {}^\circ F + 460} \times 100 \leq 1.5\%$

TEMPERATURE SENSING EQUIPMENT CALIBRATION DATA

BAROMETRIC PRESSURE: 29.80 DATE: 1-17-84 CALIBRATED BY: GJC

MERCURY-IN-GLASS REFERENCE NUMBER: 1962175-ASTM3F AMBIENT TEMP.: 63

CALIBRATION SYSTEM USED	POTENTIOMETER I.D. NUMBER	THERMOCOUPLE/ THERMOMETER I.D. NUMBER	REFERENCE THERMOMETER TEMPERATURE		MEAN TEMPERATURE OF Hg COLUMN	THERMOCOUPLE/ THERMOMETER TEMPERATURE	ΔT^B $\leq 1.5\%$
			T_o (°F)	T_c (°F)	T_m (°F)	T_t (°F)	
ambient air	DS-1	2-7	63	63	63	61	0.4
	"	3-3-1	63	63	63	61	0.4
	"	3-3-2	63	63	63	61	0.4
	"	3-9	63	63	63	61	0.4
	"	4-3	63	63	63	61	0.4
	"	4-5	63	63	63	61	0.4
	"	4-10	63	63	63	61	0.4
	"	4-11	63	63	63	61	0.4
	"	5-3	63	63	63	61	0.4
	"	5-5	63	63	63	61	0.4
	"	5-9	63	63	63	61	0.4
	"	6	63	63	63	61	0.4
	"	6-5	63	63	63	61	0.4
	"	6-7	63	63	63	61	0.4
	"	7-1	63	63	63	61	0.4
	"	7-4	63	63	63	61	0.4
	"	7-5	63	63	63	61	0.4
	"	8-5	63	63	63	61	0.4
	"	8-6	63	63	63	61	0.4
	"	9	63	63	63	61	0.4
	"	9-3	63	63	63	61	0.4
	"	9-4	63	63	63	61	0.4
	"	10-11	63	63	63	61	0.4
	"	11	63	63	63	61	0.4
	"	11-1	63	63	63	61	0.4
	"	11-9	63	63	63	61	0.4
	"	12-5	63	63	63	61	0.4
	"	15-9	63	63	63	61	0.4
	"	16-1	63	63	63	61	0.4
	"	16-2	63	63	63	61	0.4

CORRECTED TEMPERATURE = $T_c = T_o + .00009\ (T_o - 20)\ (T_o - T_m)$

TEMPERATURE DIFFERENCE = $\Delta T = \dfrac{[(T_c, {}^\circ F + 460) - (T_t, {}^\circ F + 460)]}{T_c, {}^\circ F + 460} \times 100 \leq 1.5\%$

TEMPERATURE SENSING EQUIPMENT CALIBRATION DATA

ROMETRIC PRESSURE: 29.80 DATE: 1-17-84 CALIBRATED BY: YJC

MERCURY-IN-GLASS REFERENCE NUMBER: 1962175-ASTM3F AMBIENT TEMP.: 65

CALIBRATION SYSTEM USED	POTENTIOMETER I.D. NUMBER	THERMOCOUPLE/ THERMOMETER I.D. NUMBER	REFERENCE THERMOMETER TEMPERATURE		MEAN TEMPERATURE OF Hg COLUMN	THERMOCOUPLE/ THERMOMETER TEMPERATURE	ΔT^B $\leq 1.5\%$
			T_o (°F)	T_c (°F)	T_m (°F)	T_t (°F)	
boiling water	DS-1	2-7	213	214	142	215	-0.2
✓	"	3-3-1	213	214	147	214	0
	"	3-3-2	213	214	142	215	-0.2
	"	3-9	213	214	140	215	-0.2
	"	4-3	213	214	147	214	0
	"	4-5	213	214	144	214	0
	"	4-10	213	214	139	214	0
	"	4-11	213	214	146	214	0
	"	5-3	213	214	142	214	0
	"	5-5	213	214	148	215	-0.2
	"	5-9	213	214	142	215	-0.2
	"	6	213	214	142	215	-0.2
	"	6-5	213	214	149	214	0
	"	6-7	213	214	149	214	0
	"	7-1	213	214	149	215	-0.2
	"	7-4	214	215	142	214	0.2
	"	7-5	213	214	141	214	0
	"	8-5	213	214	144	215	-0.2
	"	8-6	213	214	144	215	-0.2
	"	9	213	214	144	214	0
	"	9-3	213	214	144	214	0
	"	9-4	213	214	148	215	-0.2
	"	10-11	214	215	143	216	-0.2
	"	11	213	214	142	214	0
	"	11-1	213	214	137	215	-0.2
	"	11-9	213	214	146	215	-0.2
	"	12-5	214	215	142	214	0.2
	"	15-9	213	214	148	214	0
	"	16-1	213	214	148	215	-0.2
	"	16-2	213	214	148	214	0

CORRECTED TEMPERATURE = $T_c = T_o + .00009\,(T_o - 20)(T_o - T_m)$

TEMPERATURE DIFFERENCE = $\Delta T = \dfrac{[(T_c, °F + 460) - (T_t, °F + 460)]}{T_c, °F + 460} \times 100 \leq 1.5\%$

TEMPERATURE SENSING EQUIPMENT CALIBRATION DATA

AROMETRIC PRESSURE: 29.80 DATE: 1-17-84 CALIBRATED BY: GJC

RCURY-IN-GLASS REFERENCE NUMBER: 196217S-ASTM3F AMBIENT TEMP.: 69

CALIBRATION SYSTEM USED	POTENTIOMETER I.D. NUMBER	THERMOCOUPLE/ THERMOMETER I.D. NUMBER	REFERENCE THERMOMETER TEMPERATURE T_o (°F)	T_c (°F)	MEAN TEMPERATURE OF Hg COLUMN T_m (°F)	THERMOCOUPLE/ THERMOMETER TEMPERATURE T_t (°F)	ΔT^B $\leq 1.5\%$
Hot oil	DS-1	2-7	299	304	102	301	0.4
	"	3-3-1	300	305	104	302	0.4
	"	3-3-2	298	303	102	300	0.4
	"	3-9	298	303	100	300	0.4
	"	4-3	298	303	100	299	0.5
	"	4-5	298	303	101	300	0.4
	"	4-10	298	303	104	300	0.4
	"	4-11	299	304	108	301	0.4
	"	5-3	298	303	103	300	0.4
	"	5-5	298	303	104	300	0.4
	"	5-9	298	303	104	300	0.4
	"	6	298	303	100	301	0.3
	"	6-5	298	303	104	299	0.5
	"	6-7	298	303	104	300	0.4
	"	7-1	298	303	103	300	0.4
	"	7-4	299	304	99	301	0.4
	"	7-5	299	304	106	301	0.4
	"	8-5	298	303	100	301	0.3
	"	8-6	300	305	104	302	0.4
	"	9	300	305	100	302	0.4
	"	9-3	300	305	106	302	0.4
	"	9-4	300	305	106	302	0.4
	"	10-11	298	303	104	301	0.3
	"	11	298	303	102	300	0.4
	"	11-1	298	303	102	301	0.3
	"	11-9	298	303	101	300	0.4
	"	12-5	298	303	103	300	0.4
	"	15-9	299	304	99	301	0.4
	"	16-1	300	305	106	302	0.4
	"	16-2	299	304	101	300	0.5

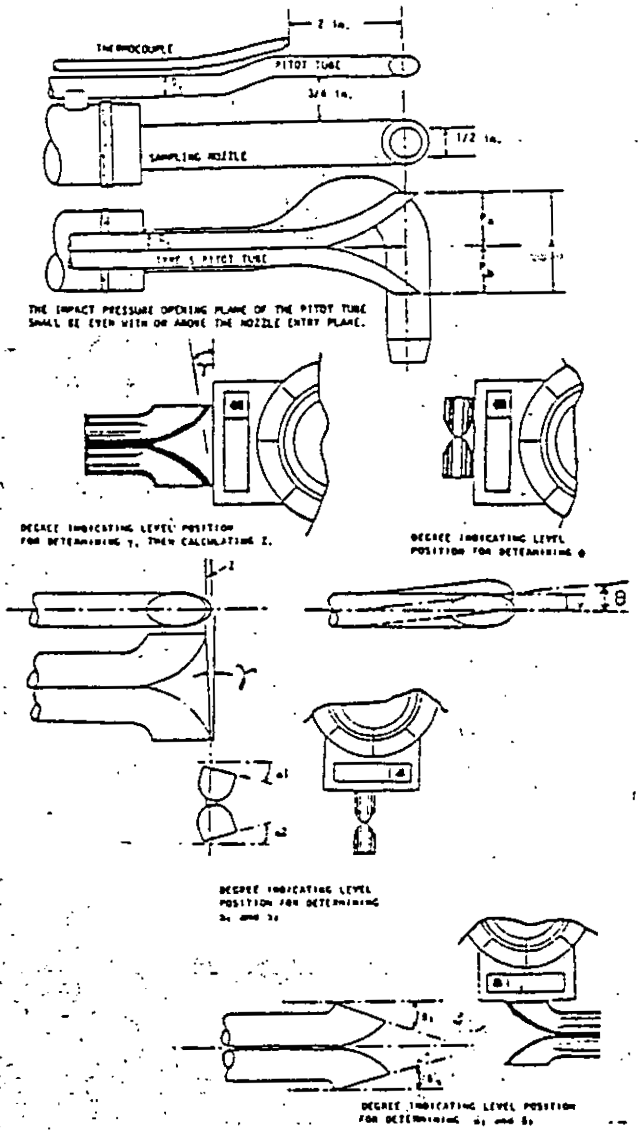
ORRECTED TEMPERATURE = $T_c = T_o + .00009\,(T_o - 20)(T_o - T_m)$

EMPERATURE DIFFERENCE = $\Delta T = \dfrac{[(T_c, {}^\circ F + 460) - (T_t, {}^\circ F + 460)]}{T_c, {}^\circ F + 460} \times 100 \leq 1.5\%$

PITOT TUBE INSPECTION DATA SHEET

Pre-sample Date 2-20-84

Post Sample Date ___________



YES	level?	
NO	obstructions?	
NO	damaged?	
2°	$-10° < \alpha_1 < +10°$	
0°	$-10° < \alpha_2 < +10°$	
1°	$-5° < \beta_1 < +5°$	
1°	$-5° < \beta_2 < +5°$	
1°	γ	
0	θ	
.890	A	
.458	$1.05\ D_t < P_a < 1.5\ D_t$	
.432	$1.05\ D_t < P_b < 1.5\ D_t$	
.375	$3/16" \leq D_t \leq 3/8"$	
.017	$A \tan \gamma < 0.125"$	
0	$A \tan \theta \leq 0.03125"$	
YES	$P_a = P_b \pm 0.063"$	

Comments: ________________________________

I certify that pitot tube/probe number 4-1 meets or exceeds all specifications, criteria and/or applicable design features* and is hereby assigned a pitot tube calibration factor of 0.84.

Signature Guido J. Carrara

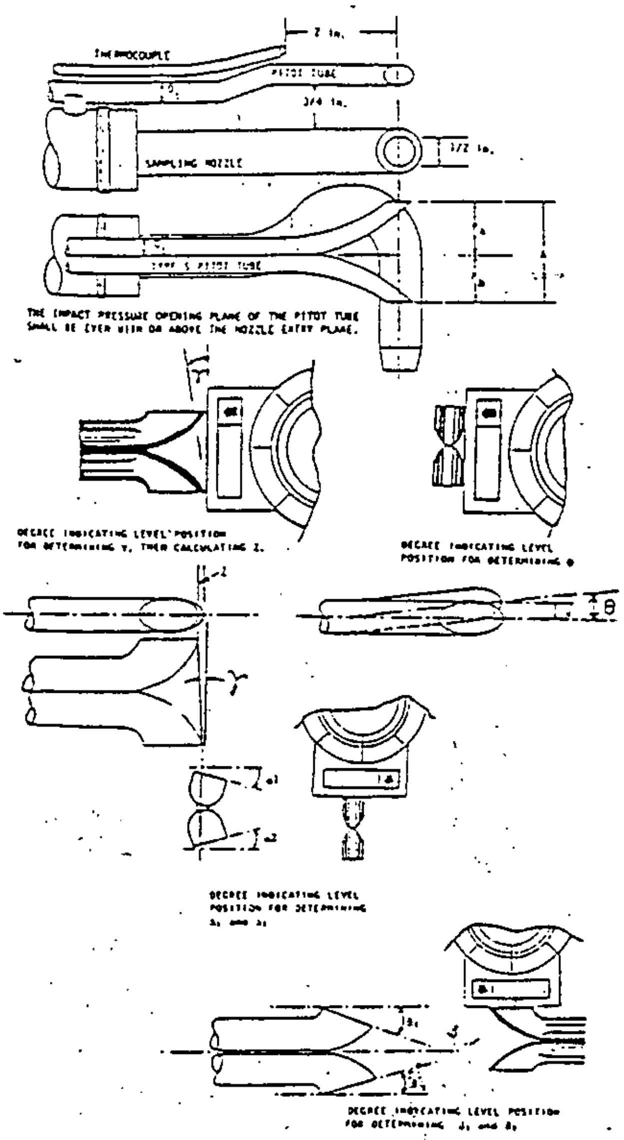
Date 2-20-84.

*See 40 CFR 60, Vol. 42, No. 160, Method 2. Verify the minimum 2 inch setback of the thermocouple and the minimum 3/4 inch separation between the pitot tube and the nozzle as shown at the top of this page.

PITOT TUBE INSPECTION DATA SHEET

Pre-sample Date 1/19/84

Post Sample Date ______



YES	level?	
No	obstructions?	
No	damaged?	
4°	$-10° < \alpha_1 < +10°$	
3°	$-10° < \alpha_2 < +10°$	
0°	$-5° < \beta_1 < +5°$	
2°	$-5° < \beta_2 < +5°$	
1°	γ	
0	θ	
.892	A	
.474	$1.05\ D_t < P_a < 1.5\ D_t$	
.418	$1.05\ D_t < P_b < 1.5\ D_t$	
.375	$3/16" \leq D_t \leq 3/8"$	
.016	$A \tan \gamma < 0.125"$	
0	$A \tan \theta < 0.03125"$	
YES	$P_a = P_b \pm 0.063"$	

Comments: ______

I certify that pitot tube/probe number 4-3 meets or exceeds all specifications, criteria and/or applicable design features* and is hereby assigned a pitot tube calibration factor of 0.84.

Signature Patrick L. Owen

Date 1/19/84

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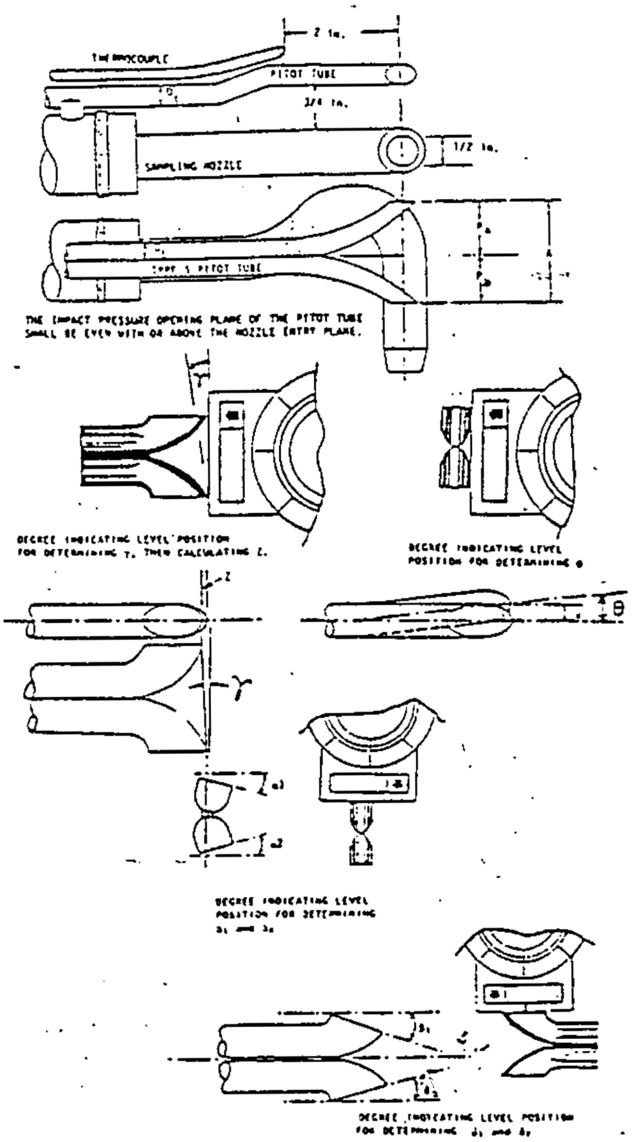
*See 40 CFR 60, Vol. 42, No. 160, Method 2. Verify the minimum 2 inch setback of the thermocouple and the minimum 3/4 inch separation between the pitot tube and the nozzle as shown at the top of this page.

PITOT TUBE INSPECTION DATA SHEET



Pre-sample		Post Sample
Date 1/19/84		Date
YES	level?	
No	obstructions?	
No	damaged?	
4°	$-10° < \alpha_1 < +10°$	
5°	$-10° < \alpha_2 < +10°$	
3°	$-5° < \beta_1 < +5°$	
3°	$-5° < \beta_2 < +5°$	
1°	γ	
0	θ	
.778	A	
.398	$1.05\ D_t < P_a < 1.5\ D_t$	
.380	$1.05\ D_t < P_b < 1.5\ D_t$	
.375	$3/16" < D_t < 3/8"$	
.014	$A \tan \gamma < 0.125"$	
0	$A \tan \theta < 0.03125"$	
YES	$P_a = P_b \pm 0.063"$	

Comments:

I certify that pitot tube/probe number 4-4 meets or exceeds all specifications, criteria and/or applicable design features* and is hereby assigned a pitot tube calibration factor of 0.84.

Signature Patrick L. Owen

Date 1/19/84

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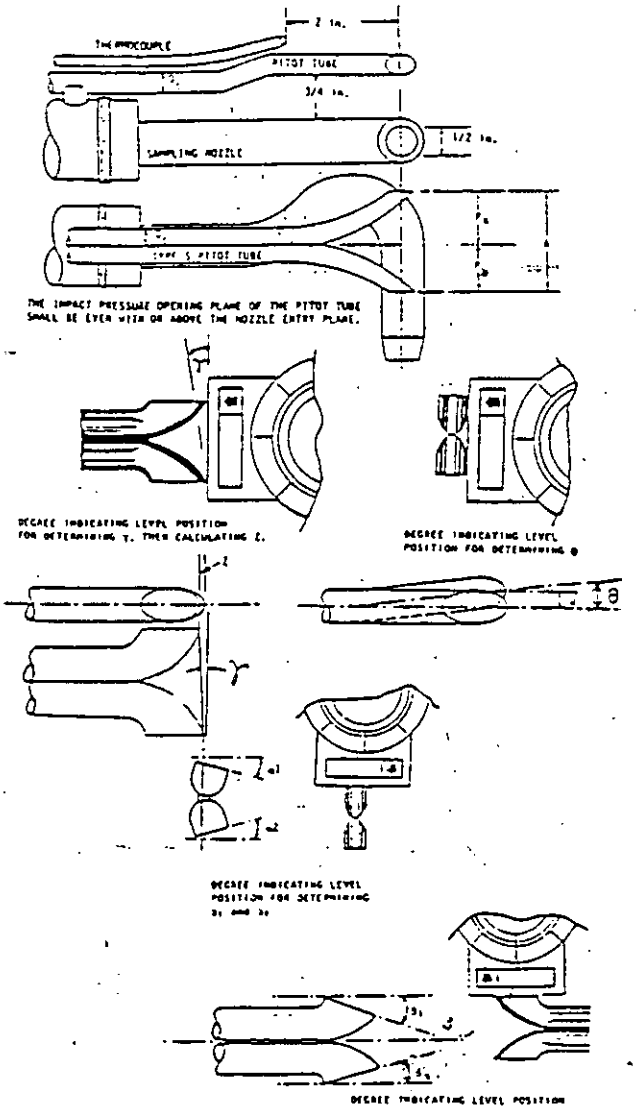
*See 40 CFR 60, Vol. 42, No. 160, Method 2. Verify the minimum 2 inch setback of the thermocouple and the minimum 3/4 inch separation between the pitot tube and the nozzle as shown at the top of this page.

PITOT TUBE INSPECTION DATA SHEET



Pre-sample Date 1/19/84

Post Sample Date ______

Pre-sample		Post Sample
YES	level?	
No	obstructions?	
No	damaged?	
4°	$-10° < \alpha_1 < +10°$	
3°	$-10° < \alpha_2 < +10°$	
2°	$-5° < \beta_1 < +5°$	
2°	$-5° < \beta_2 < +5°$	
0°	γ	
0°	θ	
.884	A	
.443	$1.05\ D_t < P_a < 1.5\ D_t$	
.441	$1.05\ D_t < P_b < 1.5\ D_t$	
.375	$3/16" \leq D_t \leq 3/8"$	
0	$A \tan \gamma < 0.125"$	
0	$A \tan \theta < 0.03125"$	
YES	$P_a = P_b \pm 0.063"$	

Comments: ______

I certify that pitot tube/probe number 4-5 meets or exceeds all specifications, criteria and/or applicable design features* and is hereby assigned a pitot tube calibration factor of 0.84.

Signature Patrick L. Owen

Date 1/19/84

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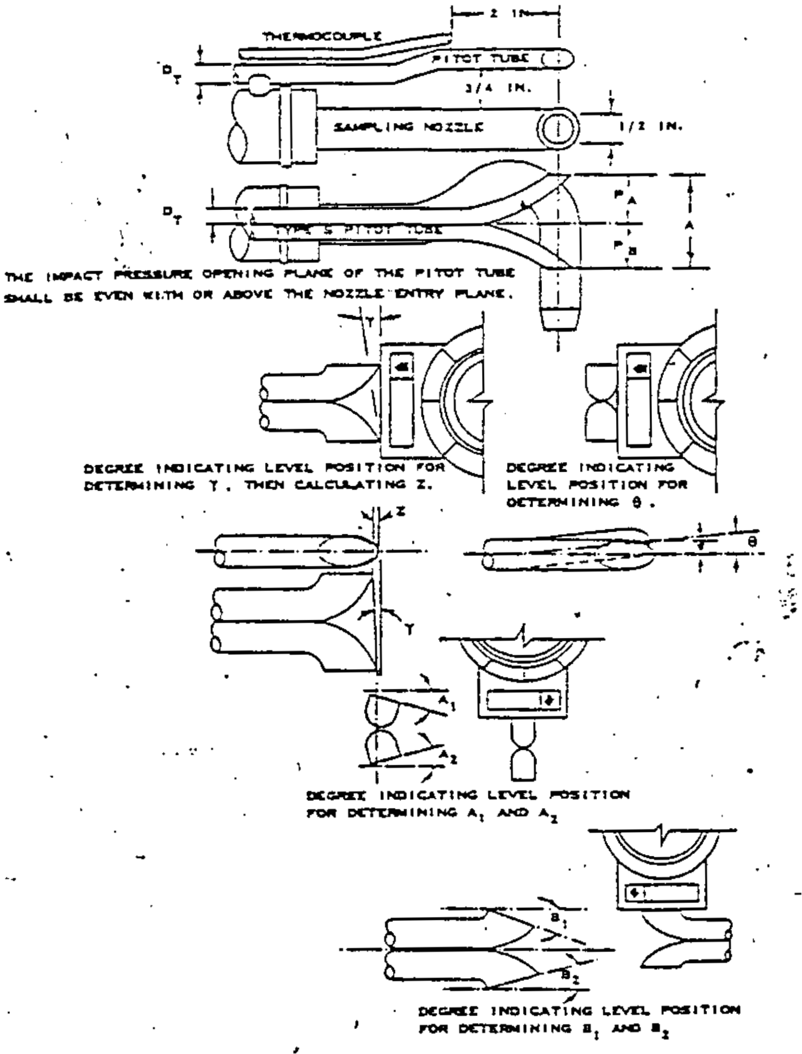
*See 40 CFR 60, Vol. 42, No. 160, Method 2. Verify the minimum 2 inch setback of the thermocouple and the minimum 3/4 inch separation between the pitot tube and the nozzle as shown at the top of this page.

PITOT TUBE INSPECTION DATA SHEET



level?	YES
obstructions?	No
damaged?	No
$-10^\circ < \alpha_1 < +10^\circ$	-2°
$-10^\circ < \alpha_2 < +10^\circ$	0°
$-5^\circ < \beta_1 < +5^\circ$	2°
$-5^\circ < \beta_2 < +5^\circ$	1°
γ	0°
θ	0°
A	.848
$1.05\ D_t < p_a < 1.5\ D_t$	.431
$1.05\ D_t < P_b < 1.5\ D_t$	.417
$3/16" < D_t < 3/8"$	.369
$A \tan \gamma < 0.125"$	0
$A \tan \theta < 0.03125"$	0
$P_a = P_b \pm 0.063"$	Yes

Comments:

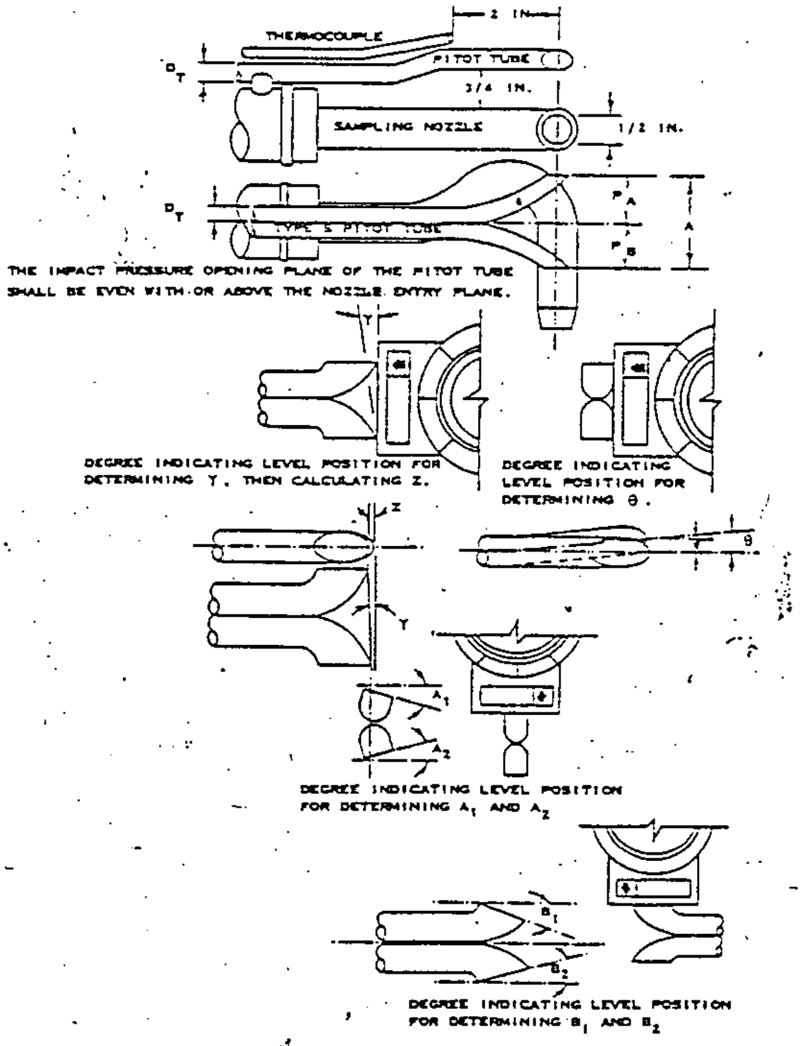
I certify that pitot tube/probe number S-3 meets or exceeds all specifications, criteria and/or applicable design features and is hereby assigned a pitot tube calibration factor of 0.84.

Signature Bruce [illegible]

Date 10/5/84

*SEE 40 CFR 60, VOL. 42 NO. 160 METHOD 2. VERIFY THE MINIMUM 2 INCH SETBACK OF THE THERMOCOUPLE AND THE MINIMUM 3/4 INCH SEPARATION BETWEEN THE PITOT TUBE AND THE NOZZLE AS SHOWN AT THE TOP OF THIS PAGE.

PITOT TUBE INSPECTION DATA SHEET



level?	YES
obstructions?	No
damaged?	NO
$-10^\circ < \alpha_1 < +10^\circ$	0'
$-10^\circ < \alpha_2 < +10^\circ$	1°
$-5^\circ < \beta_1 < +5^\circ$	3°
$-5^\circ < \beta_2 < +5^\circ$	0°
γ	0°
θ	0°
A	.863
$1.05\ D_t < p_a < 1.5\ D_t$	.412
$1.05\ D_t < p_b < 1.5\ D_t$	.451
$3/16" < D_t < 3/8"$	.374
$A \tan \gamma < 0.125"$	0
$A \tan \theta < 0.03125"$	0
$p_a = p_b \pm 0.063"$	YES

Comments: ______________________________

I certify that pitot tube/probe number 5-4 meets or exceeds all specifications, criteria and/or applicable design features and is hereby assigned a pitot tube calibration factor of 0.84.

Signature Bruce Hawks

Date 10/5/84

*SEE 40 CFR 60, VOL. 42 NO. 160 METHOD 2. VERIFY THE MINIMUM 2 INCH SETBACK OF THE THERMOCOUPLE AND THE MINIMUM 3/4 INCH SEPARATION BETWEEN THE PITOT TUBE AND THE NOZZLE AS SHOWN AT THE TOP OF THIS PAGE.

CALIBRATION BY: BDR

METER BOX NUMBER: NS

DATE: 6-21-85

BAROMETRIC PRESSURE (P_B): 29.62 IN. HG

*DATE: ____

*BAROMETRIC PRESSURE (P_B): ____ IN. HG

STANDARD METER NUMBER: 1017057

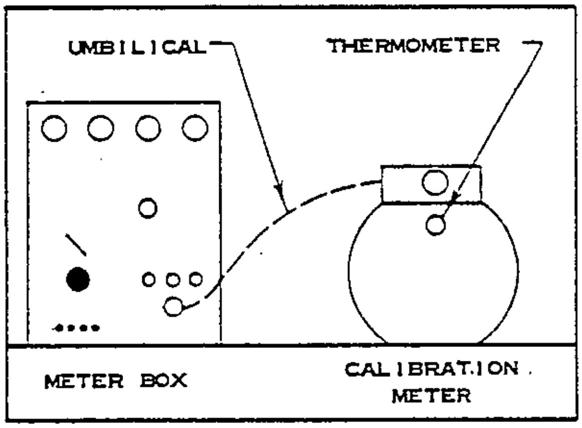
COEFFICIENT (Y_{DS}): 0.9942

POST-TEST METER BOX CALIBRATION

	STANDARD DRY GAS METER			METER BOX METERING SYSTEM		
NOMINAL FLOW RATE ($\tilde{Q}$) CFM	GAS VOLUME (V_{DS}) FT³	TEMP. (T_{DS}) °F	TIME (Θ) MIN.	ORIFICE SETTING (ΔH) IN. H_2O	GAS VOLUME (V_D) FT³	TEMP. (T_D) °F
	7.999	73	10.00	2.0	8.003	77
	7.981	73	10.00	2.0	8.011	80
	7.976	73	10.00	2.0	8.046	84

VACUUM = 6 IN. Hg

	METER BOX METERING SYSTEM			
NOMINAL FLOW RATE ($\tilde{Q}$) CFM	FLOW RATE (Q_D) CFM	ORIFICE FACTOR (OF)	COEFF. (Y_D)	$\Delta H@$ IN. H_2O
	0.7796	6.022	0.9962	1.790
	0.7778	6.038	0.9985	1.789
	0.7773	6.061	1.0009	1.778
	AVERAGE		0.999	1.79



SCHEMATIC OF EQUIPMENT SET-UP FOR FULL AND POST-TEST METER BOX CALIBRATIONS

$$\Delta H_@ = \frac{0.0317 * \Delta H}{P_b * (t_d + 460)} * \left[\frac{(t_{ds} + 460) * \theta}{Y_{ds} * V_{ds}}\right]^2$$

$$Y_d = \frac{Y_{ds} * V_{ds} * (t_d + 460) * P_b}{V_d * (t_{ds} + 460) * (P_b + \Delta H/13.6)}$$

CALIBRATION BY: BDR

METER BOX NUMBER: N6

DATE: 6-21-85 BAROMETRIC PRESSURE (P_B): 29.62 IN. HG

*DATE: ______ *BAROMETRIC PRESSURE (P_B): ______ IN. HG

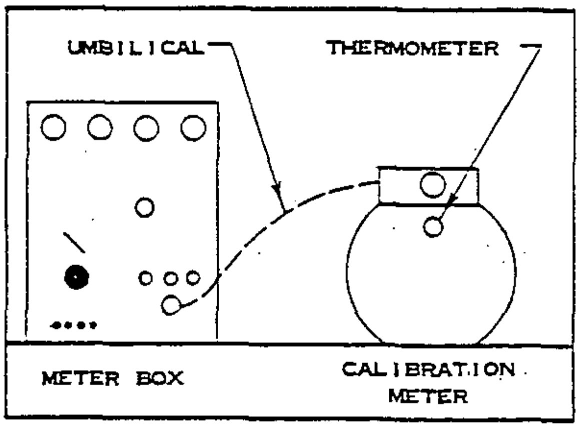
STANDARD METER NUMBER: 1017057 COEFFICIENT (Y_{DS}): 0.9942

POST-TEST METER BOX CALIBRATION

	STANDARD DRY GAS METER			METER BOX METERING SYSTEM		
NOMINAL FLOW RATE ($\tilde{Q}$) CFM	GAS VOLUME (V_{DS}) FT³	TEMP. (T_{DS}) °F	TIME (Θ) MIN.	ORIFICE SETTING (ΔH) IN. H_2O	GAS VOLUME (V_D) FT³	TEMP. (T_D) °F
	7.988	73	10.00	1.9	7.983	78
	7.969	74	10.00	1.9	8.007	82
	7.946	74	10.00	1.9	8.066	87

VACUUM = 5 IN. Hg

	METER BOX METERING SYSTEM			
NOMINAL FLOW RATE ($\tilde{Q}$) CFM	FLOW RATE (Q_D) CFM	ORIFICE FACTOR (OF)	COEFF. (Y_D)	$\Delta H@$ IN. H_2O
	0.7785	5.875	0.9994	1.702
	0.7752	5.896	0.9996	1.704
	0.7730	5.923	0.9985	1.699
	AVERAGE		0.999	1.70



SCHEMATIC OF EQUIPMENT SET-UP FOR FULL AND POST-TEST METER BOX CALIBRATIONS

$$\Delta H_{@} = \frac{0.0317 * \Delta H}{P_b * (t_d + 460)} * \left[\frac{(t_{ds} + 460) * \theta}{Y_{ds} * V_{ds}}\right]^2$$

$$Y_d = \frac{Y_{ds} * V_{ds} * (t_d + 460) * P_b}{V_d * (t_{ds} + 460) * (P_b + \Delta H/13.6)}$$

ENTROPY

CALIBRATION BY: BDR

METER BOX NUMBER: N8

DATE: 6-21-85

BAROMETRIC PRESSURE (P_B): 29.62 IN. HG

*DATE: ______

*BAROMETRIC PRESSURE (P_B): ______ IN. HG

STANDARD METER NUMBER: 1017057

COEFFICIENT (Y_{DS}): 0.9942

POST-TEST METER BOX CALIBRATION

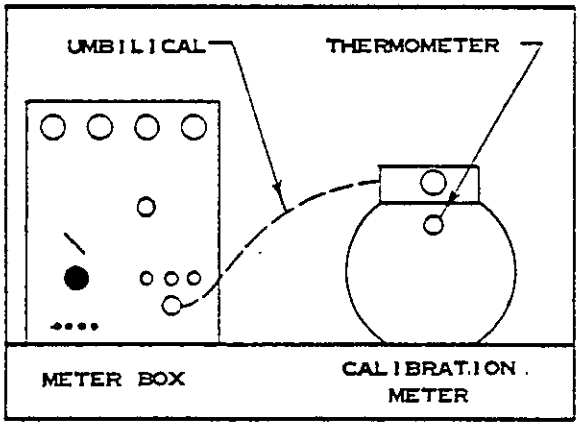
	STANDARD DRY GAS METER			METER BOX METERING SYSTEM		
NOMINAL FLOW RATE ($\tilde{Q}$) CFM	GAS VOLUME (V_{DS}) FT³	TEMP. (T_{DS}) °F	TIME (Θ) MIN.	ORIFICE SETTING (ΔH) IN. H_2O	GAS VOLUME (V_D) FT³	TEMP. (T_D) °F
	10.506	74	10.00	3.2	10.568	79
	10.498	74	10.00	3.2	10.603	86
	10.477	74	10.00	3.2	10.689	89

VACUUM = 12 IN. HG

	METER BOX METERING SYSTEM			
NOMINAL FLOW RATE ($\tilde{Q}$) CFM	FLOW RATE (Q_D) CFM	ORIFICE FACTOR (OF)	COEFF. (Y_D)	ΔH @ IN. H_2O
	1.0220	7.631	0.9898	1.661
	1.0212	7.680	0.9985	1.642
	1.0192	7.701	0.9940	1.640
	AVERAGE		0.994	1.65

$$\Delta H_@ = \frac{0.0317 * \Delta H}{P_b * (t_d + 460)} * \left[\frac{(t_{ds} + 460) * \theta}{Y_{ds} * V_{ds}}\right]^2$$

$$Y_d = \frac{Y_{ds} * V_{ds} * (t_d + 460) * P_b}{V_d * (t_{ds} + 460) * (P_b + \Delta H/13.6)}$$



SCHEMATIC OF EQUIPMENT SET-UP FOR FULL AND POST-TEST METER BOX CALIBRATIONS

CALIBRATION BY: BDR

METER BOX NUMBER: N14

DATE: 6-21-85

BAROMETRIC PRESSURE (P_B): 29.62 IN. HG

*DATE: ______

*BAROMETRIC PRESSURE (P_B): ______ IN. HG

STANDARD METER NUMBER: 1017057

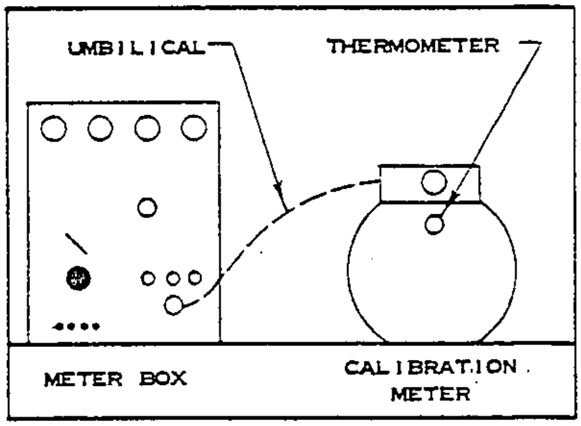
COEFFICIENT (Y_{DS}): 0.9942

POST-TEST METER BOX CALIBRATION

	STANDARD DRY GAS METER			METER BOX METERING SYSTEM		
NOMINAL FLOW RATE ($\tilde{Q}$) CFM	GAS VOLUME (V_{DS}) FT³	TEMP. (T_{DS}) °F	TIME (Θ) MIN.	ORIFICE SETTING (ΔH) IN. H_2O	GAS VOLUME (V_D) FT³	TEMP. (T_D) °F
	9.402	74	10.00	2.6	9.401	80
	9.382	75	10.00	2.6	9.438	85
	9.357	75	10.00	2.6	9.513	91

VACUUM = 11 IN. HG

	METER BOX METERING SYSTEM			
NOMINAL FLOW RATE ($\tilde{Q}$) CFM	FLOW RATE (Q_D) CFM	ORIFICE FACTOR (OF)	COEFF. (Y_D)	$\Delta H@$ IN. H_2O
	0.9146	6.885	0.9990	1.682
	0.9110	6.917	1.0003	1.680
	0.9085	6.955	1.0007	1.670
	AVERAGE		1.0000	1.68



SCHEMATIC OF EQUIPMENT SET-UP FOR FULL AND POST-TEST METER BOX CALIBRATIONS

$$\Delta H_@ = \frac{0.0317 * \Delta H}{P_b * (t_d + 460)} * \left[\frac{(t_{ds} + 460) * \theta}{Y_{ds} * V_{ds}}\right]^2$$

$$Y_d = \frac{Y_{ds} * V_{ds} * (t_d + 460) * P_b}{V_d * (t_{ds} + 460) * (P_b + \Delta H/13.6)}$$

TEMPERATURE SENSING EQUIPMENT CALIBRATION DATA

AROMETRIC PRESSURE: 29.62 DATE: 6-21-85 CALIBRATED BY: BA

ERCURY-IN-GLASS REFERENCE NUMBER: 1961851 AMBIENT TEMP.: 75

CALIBRATION SYSTEM USED	POTENTIOMETER I.D. NUMBER	THERMOCOUPLE/ THERMOMETER I.D. NUMBER	REFERENCE THERMOMETER TEMPERATURE		MEAN TEMPERATURE OF Hg COLUMN	THERMOCOUPLE/ THERMOMETER TEMPERATURE	ΔT^B $\leq 1.5\%$
			T_o (°F)	T_c (°F)	T_m (°F)	T_t (°F)	
ambient air	04	7-7	75	75	75	75	0.0
		5-8	75	75	75	74	0.2
		9-4	75	75	75	74	0.2
		7-0	75	75	75	75	0.0
	8520.40 (DS-1)	7-7	75	75	75	73	0.4

CORRECTED TEMPERATURE = $T_c = T_o + .00009\ (T_o - 20)(T_o - T_m)$

TEMPERATURE DIFFERENCE = $\Delta T = \dfrac{[(T_c, {}^\circ F + 460) - (T_t, {}^\circ F + 460)]}{T_c, {}^\circ F + 460} \times 100 \leq 1.5\%$

ENTROPY

Date: 6/20/85
Client: EMB
P_{bar}: 29.2 in. Hg.
ΔH@: 1.67

Time: 08:17 - 08:27
Auditor: WSN
Meter Box No.: N·6
Pretest Y: 1. 011

Orifice gauge reading ΔH@ in. H_2O	Dry gas meter reading V_i/V_f ft^3	Meter Temperatures T_i/T_f	Duration of run min.
1.67	65.400	62	10
	72.778	70	

Dry Gas meter volume V_m ft^3	Meter temperature average t_m °F	Pretest Y 0.97Y 1.03Y	Calculated Y_c	Audit $0.97Y < Y_c < 1.03Y$ Acceptable
7.378	66	.9807 1,041	1.027	YES

Calculated Y_c

$$\frac{10}{V_m}\left[\frac{0.0319\ (tm + 460)}{P_{bar}}\right]^{1/2} = \frac{10}{(\ 7.378\ )}\left[\frac{0.0319(\ 66\ + 460)}{(\ 29.2\ )}\right]^{1/2}$$

Date:	6/20/85	Time:	08:22 - 08:32
Client:	EMB	Auditor:	WSN
P_{bar}:	29.2 in. Hg.	Meter Box No.:	N.8
ΔH@:	1.61	Pretest Y:	.998

Orifice gauge reading ΔH@ in. H_2O	Dry gas meter reading V_i/V_f ft^3	Meter Temperatures T_i/T_f	Duration of run min.
1.61	276.550	64	10
	284.043	71	

Dry Gas meter volume V_m ft^3	Meter temperature average t_m °F	Pretest Y 0.97Y 1.03Y	Calculated Y_c	Audit $0.97Y < Y_c < 1.03Y$ Acceptable
7.493	68	.9681	1.014	YES
		1.028		

Calculated Y_c

$$\frac{10}{V_m}\left[\frac{0.0319\ (tm + 460)}{P_{bar}}\right]^{1/2} = \frac{10}{(7.493)}\left[\frac{0.0319(\ 68\ + 460)}{(\ 29.2\ )}\right]^{1/2}$$

ENTROPY

SAMPLE RECOVERY AND INTEGRITY DATA FORM

Plant C.S. OHM Sample date 6/18/85
Sample location SCRUBBER INLET Run number 2
Sample recovery person HL Recovery date 6/~~19~~ 18/85
Filter(s) number I-02-5 (0.4576)

MOISTURE

Impingers		**Silica gel**			
Final volume (wt)	186.0 ml (g)	Final wt	251.2 g		g
Initial volume (wt)	200.0 ml (g)	Initial wt	200.0 g		g
Net volume (wt)	-14.0 ml (g)	Net wt	51.2 g		g

Total moisture 37.2 g
Color of silica gel PINK
Description of impinger water CLEAR

RECOVERED SAMPLE

Blank filter container number CSO BLANK Sealed ✓
Filter container number #2 FILTER Sealed ✓
Description of particulate on filter

Acetone rinse container number #2 RINSE Liquid level marked? ✓
Acetone blank container number CSO BLANK Liquid level marked? ✓
Samples stored and locked
Remarks

Date of laboratory custody 6/21/85
Laboratory personnel taking custody
Remarks

SAMPLE RECOVERY AND INTEGRITY DATA FORM

Plant C.S. OHM Sample date 6/19/85
Sample location SCRUBBER INLET Run number 5
Sample recovery person HL Recovery date 6/19/85
Filter(s) number T-0.2-3 (0.4721)

MOISTURE

Impingers			**Silica gel**		
Final volume (wt)	215.0	ml (g)	Final wt	250.3 g	– g
Initial volume (wt)	200.0	ml (g)	Initial wt	200.0 g	– g
Net volume (wt)	15.0	ml (g)	Net wt	50.3 g	– g
Total moisture	65.3	g			

Color of silica gel BNK
Description of impinger water CLEAR

RECOVERED SAMPLE

Blank filter container number CSO BLANK Sealed ✓
Filter container number #5 FILTER Sealed ✓
Description of particulate on filter

Acetone rinse container number #~~2~~5 RINSE Liquid level marked? ✓
Acetone blank container number CSO RINSE BLANK Liquid level marked? ✓
Samples stored and locked ✓
Remarks

Date of laboratory custody 6/21/85
Laboratory personnel taking custody
Remarks

ENTROPY

SAMPLE RECOVERY AND INTEGRITY DATA FORM

Plant C.S. OHM Sample date 6/20/85
Sample location SCRUBBER INET Run number 8
Sample recovery person HL Recovery date 6/20/85
Filter(s) number T-0.2-1 (0.4696)

MOISTURE

Impingers		Silica gel		
Final volume (wt)	208.0 ml (g)	Final wt	254.2 g	– g
Initial volume (wt)	200.0 ml (g)	Initial wt	200.0 g	– g
Net volume (wt)	8.0 ml (g)	Net wt	54.2 g	– g
Total moisture	62.2 g			

Color of silica gel PINK
Description of impinger water CLEAR

RECOVERED SAMPLE

Blank filter container number CSO BLANK Sealed ✓
Filter container number # 8 FILTER Sealed ✓
Description of particulate on filter

Acetone rinse container number # 8 RINSE Liquid level marked? ✓
Acetone blank container number CSO BLANK Liquid level marked? ✓
Samples stored and locked ✓
Remarks

Date of laboratory custody 6/21/85
Laboratory personnel taking custody
Remarks

ENTROPY

SAMPLE RECOVERY AND INTEGRITY DATA FORM

Plant C.S. OHM Sample date 6/18/85
Sample location SCRUBBER OUTLET Run number 3
Sample recovery person HL Recovery date 6/18/85
Filter(s) number T-0.2-52 (0.7180)

MOISTURE

Impingers		Silica gel		
Final volume (wt)	234.0 ml (g)	Final wt	251.1 g	— g
Initial volume (wt)	200.0 ml (g)	Initial wt	200.0 g	— g
Net volume (wt)	34.0 ml (g)	Net wt	51.1 g	— g

Total moisture 85.1 g
Color of silica gel PINK
Description of impinger water CLEAR

RECOVERED SAMPLE

Blank filter container number CSO BLANK Sealed ✓
Filter container number #3 FILTER Sealed ✓
Description of particulate on filter

Acetone rinse container number #3 RINSE Liquid level marked? ✓
Acetone blank container number CSO BLANK Liquid level marked? ✓
Samples stored and locked ✓
Remarks

Date of laboratory custody 6/21/85
Laboratory personnel taking custody
Remarks

SAMPLE RECOVERY AND INTEGRITY DATA FORM

Plant C.S. OHM Sample date 6/19/85
Sample location SCRUBBER OUTLET Run number 6
Sample recovery person HL Recovery date 6/19/85
Filter(s) number T-0.2-53 (0.6983)

MOISTURE

Impingers			**Silica gel**		
Final volume (wt)	248.0 ml (g)		Final wt	255.3 g	- g
Initial volume (wt)	200.0 ml (g)		Initial wt	200.0 g	- g
Net volume (wt)	48.0 ml (g)		Net wt	55.3 g	- g
Total moisture	103.3 g				

Color of silica gel PINK
Description of impinger water CLEAR

RECOVERED SAMPLE

Blank filter container number CSO BLANK Sealed ✓
Filter container number #6 FILTER Sealed ✓
Description of particulate on filter

Acetone rinse container number #6 RINSE Liquid level marked? ✓
Acetone blank container number CSO RINSE Liquid level marked? ✓
Samples stored and locked ✓
Remarks

Date of laboratory custody 6/21/85
Laboratory personnel taking custody
Remarks

SAMPLE RECOVERY AND INTEGRITY DATA FORM

Plant C.S. OHM Sample date 6/20/85
Sample location SCRUBBER OUTLET Run number 9
Sample recovery person WSN Recovery date 6/20/85
Filter(s) number T-02-51 (0.7526)

MOISTURE

Impingers		Silica gel		
Final volume (wt)	252.0 ml (g)	Final wt	252.6 g	– g
Initial volume (wt)	200.0 ml (g)	Initial wt	200.0 g	– g
Net volume (wt)	52.0 ml (g)	Net wt	52.6 g	– g
Total moisture	104.6 g			

Color of silica gel PINK
Description of impinger water CLEAR

RECOVERED SAMPLE

Blank filter container number CSO BLANK Sealed ✓
Filter container number #9 FILTER Sealed ✓
Description of particulate on filter

Acetone rinse container number # 9 RINSE Liquid level marked? ✓
Acetone blank container number CSO RINSE Liquid level marked? ✓
Samples stored and locked ✓
Remarks

Date of laboratory custody 6/21/85
Laboratory personnel taking custody
Remarks

SAMPLE RECOVERY AND INTEGRITY DATA FORM

Plant	C.S. OHM	Sample date	6/19/85
Sample location	SCRUBBER INLET	Run number	SR
Sample recovery person	HL	Recovery date	6/19/85

Filter(s) number T- 0.2-2 (0.4973)

MOISTURE

Impingers		**Silica gel**		
Final volume (wt)	200.0 ml (g)	Final wt	267.2 g	160.4 g
Initial volume (wt)	200.0 ml (g)	Initial wt	200.0 g	200.0 g
Net volume (wt)	0.0 ml (g)	Net wt	67.2 g	-39.6 g
Total moisture	27.6 g			

Color of silica gel PINK

Description of impinger water CLEAR

RECOVERED SAMPLE

Blank filter container number	CSO BLANK	Sealed	✓
Filter container number	# SR FILTER	Sealed	✓

Description of particulate on filter

Acetone rinse container number	SR RINSE	Liquid level marked?	✓
Acetone blank container number	CSO BLANK	Liquid level marked?	✓

Samples stored and locked ✓

Remarks

Date of laboratory custody 6/21/85

Laboratory personnel taking custody

Remarks

CUSTODY SHEET FOR REAGENT BOX # 0216

Date of Makeup 6/14 Initials MS ✓ Locked? ✓

Individual Tare of Reagent: 300 mls.✓ of DISTILLED H_2O

Individual Tare of Reagent: ______ mls. of ______

Individual Silica Gel Tare Weight 200 gms.

PLANT NAME C.S. OHM

SAMPLING LOCATION SCRUBBER INLET

Run Number	Date Used	Initials	Locked?	Date Cleanup	% S. Gel Spent	Initials	Locked?
1	6/18/85	HL	✓	6/18/85	100	HL	✓
4	6/19/85	HL	✓	6/19/85	100	HL	✓
7	6/20/85	HL	✓	6/20/85	100	HL	✓

	Date	Initials	Locked?
Received in Lab	6/21	J.F.J.	✓

Zero & Span Balance Initials J.F.J.

Sampling Method: MOISTURES

Filter #	Tare Weight (mgms)	Used on Test

Remarks:

ENTROPY ENVIRONMENTALISTS, INC.

CUSTODY SHEET FOR REAGENT BOX # 0228

Date of Makeup 6/13 Initials GR Locked? ✓

Individual Tare of Reagent: 200 mls. of DI H_2O

Individual Tare of Reagent: ______ mls. of ______

Individual Silica Gel Tare Weight 200 gms.

PLANT NAME C.S. OHM

SAMPLING LOCATION Scrubber Inlet

Run Number	Date Used	Initials	Locked?	Date Cleanup	% S. Gel Spent	Initials	Locked?
2	6/18/85	HL	✓	6/18/85	100	HL	✓
5	6/19/85	HL	✓	6/19/85	95	HL	✓
8	6/20/85	HL	✓	6/20/85	90	HL	✓

Received in Lab Date 6/21 Initials MEX Locked? ✓

Sampling Method: M5

Remarks: Run 2 total H_2O 186 mls
Net - 14 mls

Zero & Span Balance Initials MEX

Filter #	Tare Weight (mgms)	Used on Test
T-0.2-5	.4576	2
T-0.2-3	.4721	5
T-0.2-1	.4696	8

ENTROPY ENVIRONMENTALISTS, INC.

CUSTODY SHEET FOR REAGENT BOX #0224

Date of Makeup 6/15 Initials MS Locked? ✓

Individual Tare of Reagent: 200 mls. of DISTILLED H_2O

Individual Tare of Reagent: ____ mls. of ____

Individual Silica Gel Tare Weight 200 gms.

PLANT NAME C.S. OHM Detroit

SAMPLING LOCATION Scrubber Outlet Stack

Run Number	Date Used	Initials	Locked?	Date Cleanup	% S. Gel Spent	Initials	Locked?
3	6/18/85	HL	✓	6/18/85	100	HL	✓
6	6/19/85	HL	✓	6/19/85	95	HL	✓
9	6/20/85	HL	✓	6/20/85	95	WSN	✓

	Date	Initials	Locked?
Received in Lab	6/21	J.F.J.	✓

Sampling Method: M 5 w/back half

Remarks: Run 3 - 34 mls Net H_2O catch
4 in teflon Filter

6 - 48 mls Net H_2O catch

Zero & Span Balance Initials J.F.J.

Filter #	Tare Weight (mgms)	Used on Test
T-0.252	.7180	3
T-0253	.6983	6
T-0.2-51	.7526	9

ENTROPY ENVIRONMENTALISTS, INC.

CUSTODY SHEET FOR REAGENT BOX # 0218

Date of Makeup 6/13 Initials GR Locked? ✓

Individual Tare of Reagent: 200 mls. of DI H_2O

Individual Tare of Reagent: ______ mls. of ______

Individual Silica Gel Tare Weight 200 gms.

PLANT NAME C.S. OHM

SAMPLING LOCATION Scrubber Inlet

Run Number	Date Used	Initials	Locked?	Date Cleanup	% S. Gel Spent	Initials	Locked?
Inlet Special	6/19/85	HL	✓	6/20/85	100	HL	✓

	Date	Initials	Locked?
Received in Lab	6/21	J.F.J	✓

Sampling Method: ______

Zero & Span Balance Initials J.F.J.

Filter #	Tare Weight (mgms)	Used on Test
T-0.2-2	.4973	SPECIAL INLET

Remarks: Double charge Silica gel wet + busted

ENTROPY ENVIRONMENTALISTS, INC.

APPENDIX E

MRI PROCESS DATA

SOURCE SAMPLING PROGRAM
Process data sheet

Place: C. S. Ohm Manufacturing Company Date: 6/18/85 Page: 1 of 3

Test start time: Inlet 1004 Outlet 1003

Test end time: Inlet 1529 Outlet 1505

Time, 24-h clock	Temperature, °F	Voltage, volts	Current, amps	Notes
1000	127	15s @ 2.5 90s @ 12.6	1,500 12,500	
1030	129	--	--	Shut down 1030-1040 for cleaning a nickel tank
1100	128	15s @ 2.5 90s @ 12.6	1,500 12,500	
1130	131	15s @ 2.5 90s @ 12.6	1,600 16,000	
1200	134	15s @ 2.5 90s @ 12.6	1,600 16,000	
1230	136	15s @ 2.5 90s @ 12.6	1,500 12,500	
1300	140	15s @ 2.5 90s @ 12.6	1,500 12,500	
1330	131	15s @ 2.5 90s @ 12.6	1,500 12,500	
1400	130	15s @ 2.5 90s @ 12.6	1,500 12,500	
1430	134	15s @ 2.5 90s @ 12.6	1,600 16,000	
1500	136	15s @ 2.5 90s @ 12.6	1,600 16,000	
1530	138	15s @ 2.5 90s @ 12.6	1,500 12,500	

Concentrations in chrome tank: chromic acid--44.1 oz/gal
sulfuric acid--0.14-0.16 oz/gal
(Measured by plant personnel at 0730 each morning.)

SOURCE SAMPLING PROGRAM
Process data sheet

Place: C. S. Ohm Manufacturing Company Date: 6/19/85 Page: 2 of 3

Test start time: Inlet 839 Test end time: Inlet 1405
Outlet 837 Outlet 1336

Time, 24-h clock	Temperature, °F	Voltage, volts	Current, amps	Notes
0830	130	15s @ 2.5 90s @ 13.0	1,500 12,500	
0900	132	15s @ 2.5 90s @ 13.0	1,500 12,800	Make-up solution pumped into Cr tank from evaporation tank.
0930	134	15s @ 2.5 90s @ 13.0	1,500 12,800	
1000	136	15s @ 2.5 90s @ 13.0	1,500 12,800	
1030	138	--	--	Shut down 1030-1050 for cleaning a nickel tank.
1100	138	15s @ 2.5 90s @ 12.5	1,800 14,000	
1130	135	15s @ 2.5 90s @ 12.5	1,800 14,000	
1200	128	15s @ 2.5 90s @ 12.6	1,800 12,000	
1230	126	15s @ 2.5 90s @ 11.6	1,500 11,000	Timing of racks was measured: a new rack enters the Cr tank every 4 min and 15 s.
1300	126	15s @ 2.5 90s @ 11.6	1,500 10,500	
1330	128	15s @ 2.5 90s @ 11.6	1,500 10,500	
1400	130	--	--	Shut down

Concentrations in chrome tank: chromic acid--43.65 oz/gal
sulfuric acid--0.16 oz/gal

SOURCE SAMPLING PROGRAM
Process data sheet

Place: C. S. Ohm Manufacturing Company Date: 6/20/85 Page: 3 of 3

Test start time: Inlet 855
Outlet 855

Test end time: Inlet 1420
Outlet 1350

Time, 24-h clock	Temperature, °F	Voltage, volts	Current, amps	Notes
0800	140	15s @ 2.5 90s @ 12.5	1,500 12,600	
0830	133	15s @ 2.5 90s @ 12.4	1,500 13,200	100 lb of CrO_3 added to tank at 0840.
0900	129	15s @ 2.5 90s @ 12.4	1,500 12,800	
0930	130	15s @ 2.5 90s @ 12.4	1,500 12,300	
1000	133	15s @ 2.5 90s @ 12.4	1,800 16,000	
1045	134	15s @ 2.5 90s @ 12.4	1,700 16,500	Shut down 1030-1045 for cleaning a nickel tank.
1100	136	15s @ 2.5 90s @ 12.4	1,700 16,500	
1130	140	15s @ 2.5 90s @ 12.4	1,700 16,500	
1200	142	15s @ 2.5 90s @ 12.4	1,300 12,800	
1230	136	15s @ 2.5 90s @ 12.4	1,300 12,400	
1300	132	15s @ 2.5 90s @ 12.4	1,300 13,000	
1330	134	15s @ 2.5 90s @ 12.4	1,600 15,400	
1400	136	15s @ 2.5 90s @ 12.4	1,800 16,600	
1430	138	15s @ 2.5 90s @ 12.4	1,800 17,000	

Concentrations in chrome tank: chromic acid--43.4 oz/gal
sulfuric acid--0.14-0.16 oz/gal

TEST NO. 1--CURRENT USAGE CALCULATIONS

Clock time	Seconds of operation Inlet	Seconds of operation Outlet	Current, amperes	Ampere-seconds ($\times 10^3$) Inlet	Ampere-seconds ($\times 10^3$) Outlet
1000	90	93	1,500	135	140
	540	561	12,500	6,750	7,010
1030	69	69	1,500	104	104
	415	415	12,500	5,190	5,190
1100	104	104	1,500	156	156
	623	623	12,500	7,790	7,790
1130	104	104	1,600	166	166
	623	623	16,000	9,970	9,970
1200	104	104	1,600	166	166
	623	623	16,000	9,970	9,970
1230	104	104	1,500	156	156
	623	623	12,500	7,790	7,790
1300	104	104	1,500	156	156
	623	623	12,500	7,790	7,790
1330	104	104	1,500	156	156
	623	623	12,500	7,790	7,790
1400	104	104	1,500	156	156
	623	623	12,500	7,790	7,790
1430	104	104	1,600	166	166
	623	623	16,000	9,970	9,970
1500	100	17	1,500	150	26
	602	104	12,500	7,525	1,300
TOTAL				90,000	83,900

$$\frac{90{,}000 \text{ amp-sec}}{7632 \text{ sec}} = 11.79 \text{ amps/sec}$$

$$(11.79 \text{ amps/sec})\left(60 \frac{\text{sec}}{\text{min}}\right)\left(60 \frac{\text{min}}{\text{hr}}\right)$$

$$= 42{,}453 \text{ amps/hr.}$$

$$\frac{83{,}900 \text{ amps}}{7075 \text{ sec}} = 11.86$$

$$(11.86)(\overset{3600}{1120}) = 42{,}696$$

TEST NO. 3--CURRENT USAGE CALCULATIONS

Clock time	Seconds of operation Inlet	 Outlet	Current, amperes	Ampere-seconds ($x10^3$) Inlet	 Outlet
0830	17	17	1,500	26	26
	104	104	13,200	1,370	1,370
0900	104	104	1,500	156	156
	623	623	12,800	7,970	7,970
0930	104	104	1,500	156	156
	623	623	12,300	7,660	7,660
1000	104	104	1,800	187	187
	623	623	16,000	9,970	9,970
1045	52	52	1,700	88	88
	312	312	16,500	5,150	5,150
1100	104	104	1,700	177	177
	623	623	16,500	10,280	10,280
1130	104	104	1,700	177	177
	623	623	16,500	10,280	10,280
1200	104	104	1,300	135	135
	623	623	12,800	7,970	7,970
1230	104	104	1,300	135	135
	623	623	12,400	7,730	7,730
1300	104	104	1,300	135	135
	623	623	13,000	8,100	8,100
1330	104	69	1,600	166	110
	623	415	15,400	9,590	6,390
1400	69	--	1,800	124	--
	415	--	16,600	6,890	--
TOTAL	7,512	6785		94,620	84,350

TEST NO. 2--CURRENT USAGE CALCULATIONS

Clock time	Seconds of operation		Current, amperes	Ampere-seconds ($\times 10^3$)	
	Inlet	Outlet		Inlet	Outlet
0830	73	80	1,500	110	120
	436	478	12,500	5,450	5,980
0900	104	104	1,500	156	156
	623	623	12,800	7,980	7,980
0930	104	104	1,500	156	156
	623	623	12,500	7,980	7,980
1000	104	104	1,500	156	156
	623	623	12,800	7,980	7,980
1030	34	34	1,500	51	51
	208	208	12,800	2,660	2,660
1100	104	104	1,800	187	187
	623	623	14,000	8,720	8,720
1130	104	104	1,800	187	187
	623	623	14,000	8,720	8,720
1200	104	104	1,800	187	187
	623	623	12,000	7,480	7,480
1230	104	104	1,500	156	156
	623	623	11,000	6,850	6,850
1300	104	104	1,500	156	156
	623	623	10,500	6,540	6,540
1330	121	21	1,500	182	32
	727	125	10,500	7,630	1,310
TOTAL				79,590	73,740

$\frac{94,620}{7512} = 12.60$

$(12.60)(3600) = 45,345$

$\frac{84350}{6785} = (12.43)(3600) =$

44,748

$\frac{79,590 \text{ amps}}{7415 \text{ sec}} = 10.73$

$(10.73)(3600) = 38,641$

$\frac{73,740}{6762} = 10.91$

$(10.91)(3600) = 39,258$

APPENDIX F

TEST PARTICIPANTS AND OBSERVERS

TEST PARTICIPANTS AND OBSERVERS

Name	Organization	Responsibility
Willis Nesbit	Entropy Environmentalists, Inc.	Field Coordinator
Henry Long	Entropy Environmentalists, Inc.	Sampling Team Leader
Gerry Carty	Entropy Environmentalists, Inc.	Sampling Team Leader
Bobby Bridges	Entropy Environmentalists, Inc.	Engineering Technician
Bill DeWees	Entropy Environmentalists, Inc.	Quality Assurance Observer
Barb Duletsky	Midwest Research Institute	Monitor Process Operation
Dan Bivins	EPA, Emission Measurement Branch	EPA Task Manager
Al Vervaert	EPA, Industrial Studies Branch	EPA Task Manager