Note: This is a reference cited in *AP 42, Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources.* AP42 is located on the EPA web site at www.epa.gov/ttn/chief/ap42/

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February 4, 1988

FINAL REPORT

STACK TESTING FOR TOTAL CHROMIUM AND HEXAVALENT CHROMIUM EMISSIONS FROM CHROME PLATING TANKS

EPA Contract No. 68-02-4346
Work Assignment 01
Technical Directive 2

Test Site
Consolidated Engravers Corporation
Charlotte, North Carolina

Prepared for:

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SECTION 1.0
INTRODUCTION

The U.S. Environmental Protection Agency (EPA) is currently evaluating whether air emissions of chromium and other potentially toxic metals should be regulated. Chromium emissions are not included in the New Source Performance Standards (NSPS) for stationary sources or the National Emissions Standards for Hazardous Air Pollutants (NESHAP).

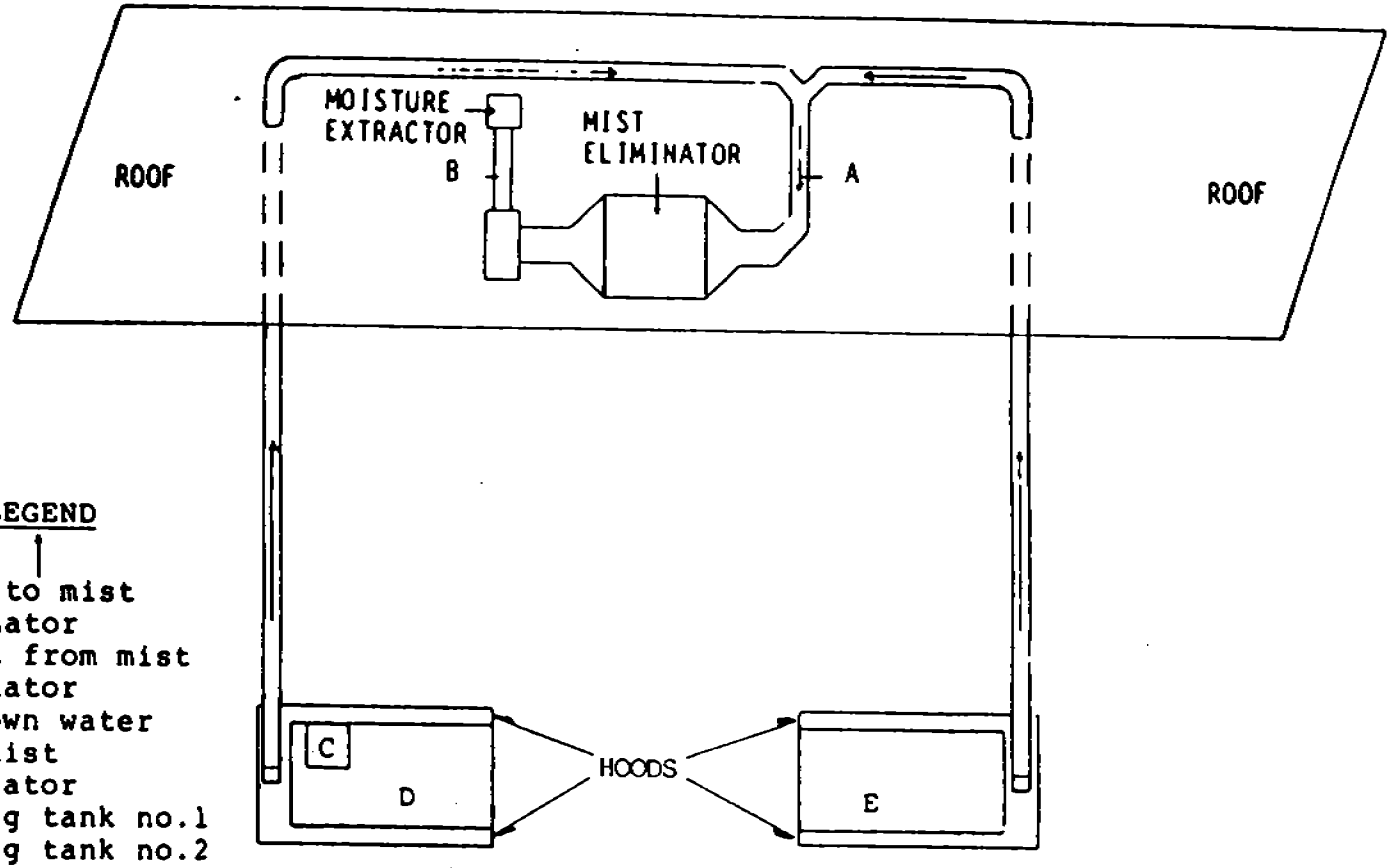
As part of this study, the EPA is evaluating uncontrolled emissions from hard chromium plating operations. The purpose of these tests is to characterize the emission rate and size distribution of uncontrolled emissions of hexavalent chromium (Cr^{+6}) and total chromium (Cr) from a representative industrial operation. Consolidated Engravers Corporation of Charlotte, North Carolina, was the selected site at which these tests were performed. The Consolidated Engravers facility was chosen because it is a captive shop that performs hard chromium electroplating of industrial rolls. Based on operating parameters such as current, voltage, plating time and chromic acid concentration, the plating tank could be considered typical of other hard chromium plating operations. The results from the Consolidated Engravers Test Program will be used to characterize the uncontrolled emissions from hard chrome plating operations and to revise or confirm uncontrolled emission factors for this type of process developed during another phase of the test program.

In an effort to obtain this data, tests were conducted at the Consolidated Engravers Corporation, Charlotte, North Carolina, plant on May 11 through 15, 1987, under contract to the Emission Measurement Branch (EMB) of the EPA's Environmental Standards and Engineering Division. Test team members were PEER Consultants, P.C., located in Dayton, Ohio; Pacific Environmental Services, Inc., (PES), located in Cincinnati, Ohio; and Midwest Research

Institute (MRI) located in Raleigh, North Carolina. Triplicate tests using the Modified Method 13B (MM 13B) sampling train and the Andersen 8-stage impactor were performed on the exhaust gas stream at the inlet and outlet of the mist eliminator servicing chromium plating Tanks 1 and 2.

Chromium emissions from both tanks are vented to a chevron-blade mist eliminator that is equipped with a single set of overlapping-type, chevron-blade baffles and is installed on the roof of the plant. Figure 1-1 represents a process diagram. The results of these tests were used to determine Cr^{+6} and total Cr emissions. In addition to the emissions sampling, samples were taken of the chromium plating solution from each plating tank at intervals during each emission sample run and analyzed for Cr^{+6} and Cr.

The remainder of this report describes the process and its operation in Section 2.0; Section 3.0 presents a summary and discussion of results; Section 4.0 describes the sampling locations and test methods while quality assurance is discussed in Section 5.0. Appendix A presents process monitoring data summary; Appendix B presents analytical methods for Total Chromium and Hexavalent Chromium; Appendix C presents the field data sheets for each test; Appendix D presents the calculations; Appendix E contains laboratory and analytical results; Appendix F contains sampling, sample recovery and analytical procedures; Appendix G contains equipment calibration data; Appendix H presents a list of project participants and an activities log and Appendix I contains particle size sampling and sample recovery procedures.



LEGEND

Gasflow - ↑

A - Inlet to mist eliminator

B - Outlet from mist eliminator

C - Washdown water from mist eliminator

D - Plating tank no.1

E - Plating tank no.2

Figure 1-1. Process diagram.

SECTION 2.0
PROCESS DESCRIPTION

2.1 PROCESS DESCRIPTION

The Consolidated Engravers plant located in Charlotte, North Carolina, manufactures and refurbishes industrial rolls for the packaging and textile industries. The plant operates six hard chromium plating tanks. Hard chromium plate is applied to the industrial rolls as the final, finishing stage to provide a wear-resistant surface and protection from corrosion. The facility tested consists of two hard chromium plating tanks that are controlled by a chevron-blade mist eliminator with a single set of blades. The tanks are operated from 8 to 10 hours per day, 5 days per week, 51 weeks per year. The chromic acid consumption for the two tanks is about 63 kilograms (140 pounds) per month.

Based on size; operating parameters such as current, voltage, and plating time; and chromic acid concentration of the plating bath, the tanks are typical of other hard chromium plating tanks used in the electroplating industry. Tank 1 is 1.52 meters (m) (5.0 feet [ft]) long, 0.7 m (2.3 ft) wide, and 1.8 m (6.0 ft) deep and holds about 1,780 liters (ℓ) (470 gallons [gal]) of plating solution. Tank 2 is 1.8 m (6.0 ft) long, 0.7 m (2.5 ft) wide, and 1.8 m (6.0 ft) deep and holds about 2,350 ℓ (620 gal) of plating solution. The chromic acid concentration of the plating baths is 210 grams per liter (28 ounces per gallon) of solution. The normal operating temperature of the plating baths ranges from 43°C (110°F) to 54°C (130°F). Both tanks are equipped with a circulating water cooling system.

Tank 1 contains two work stations each of which is equipped with a 3,000-ampere rectifier. Tank 2 is equipped with one 5,000-ampere rectifier. Typically, one industrial roll is plated for about 45 minutes in each tank; however, two industrial rolls can be plated at a time in each tank. The operating voltage and current for each roll typically ranges from 10 to 15 volts and 1,200 to 1,600 amperes, respectively. About 13 micrometers (0.5 mil) of chromium plate is applied to each roll plated.

2.2 AIR POLLUTION CONTROL

The ventilation system and chevron-blade mist eliminator were manufactured and installed by Duall Industries, Inc., in January 1987 to control chromic acid and emissions from the two hard chromium plating tanks tested. A diagram of the capture and control system for the two tanks is presented in Figure 2-1.

Both tanks are equipped with double-sided lateral exhaust hoods. The hood on each side of Tank No. 1 has one slot that is 1.5 m (4.8 ft) long and 8.9 centimeters (cm) (3.5 [in]) wide. The hood on each side of Tank 2 has three slots. Each slot is 0.4 m (1.3 ft) long and 5.1 cm (2.0 in.) wide.

Exhaust gases from both tanks are ducted together and vented to a horizontal-flow chevron-blade mist eliminator. The mist eliminator contains a single set of overlapping-type blades and is located on the roof of the plating shop. Diagrams of the mist eliminator and overlapping-type blades are presented in Figures 2-2 and 2-3, respectively. The overlapping-type blade design changes the direction of the gas flow four times, causing chromic acid droplets to impinge on the blades by inertial force. The overlapping edges of the blades act as collection troughs that provide a central location for droplet collection and facilitate drainage of the droplets into the collection sump at the bottom of the mist eliminator. The blades are spaced about 3.20 cm (1.25 in) apart. The blade section is 1.1 m (3.6 ft) in height and width and 20 cm (8 in.) in depth.

Design parameters of the mist eliminator include a gas flow rate of 226 standard cubic meters per minute (m^3/min) (7980 standard cubic feet per minute [ft^3/min]), gas stream velocity through the blade section of about 190 meters per minute (m/min) (620 feet per minute [ft/min], and pressure drop of 0.19 kilopascal (kPa) (0.75 inch of water column [in. w.c.]). During emission testing, the gas flow rate averaged 154 actual m^3/min (5,450 actual ft^3/min), the gas velocity was about 130 m/min (425 ft/min), and the pressure drop averaged 0.05 kPa (0.20 in. w.c.).

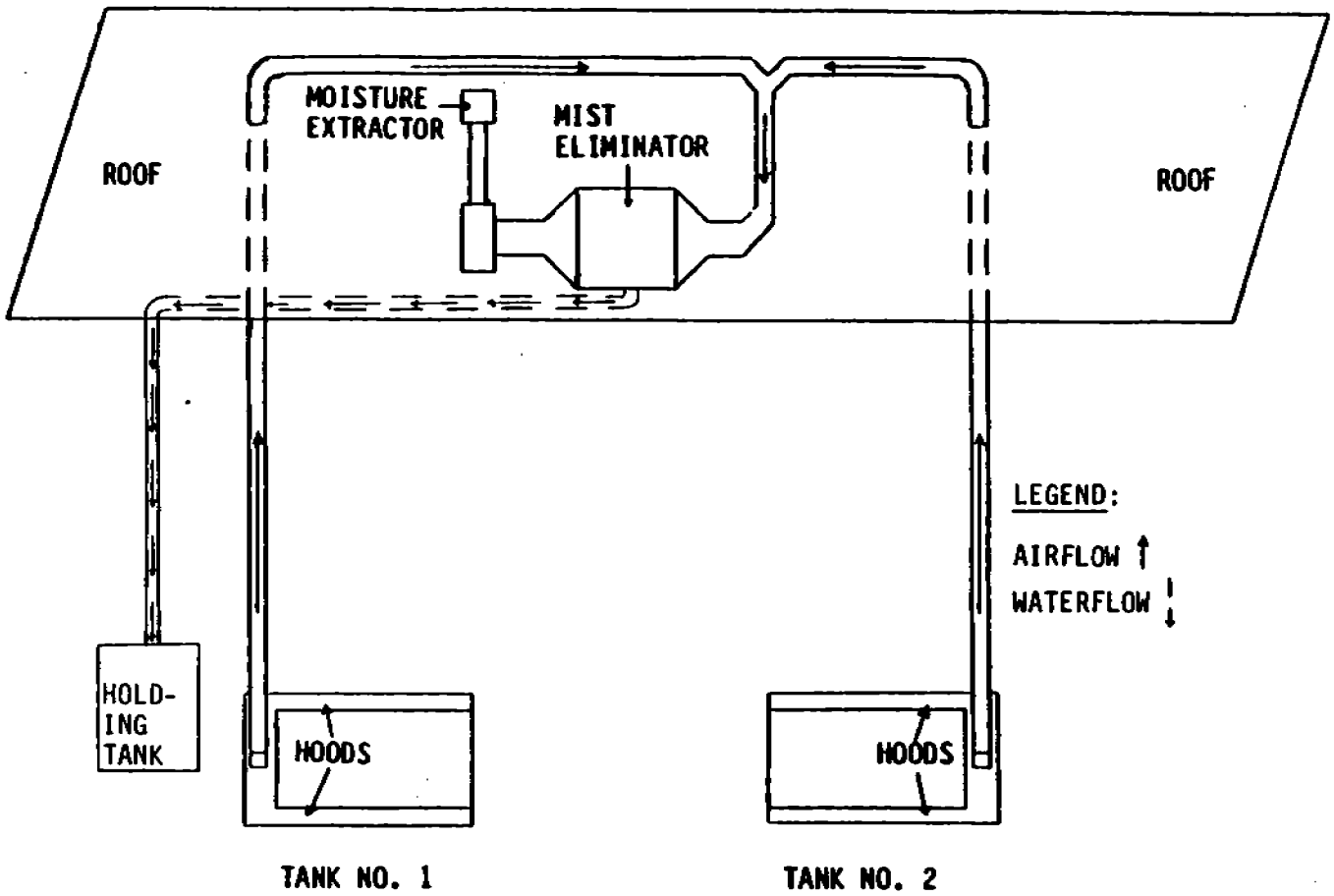


Figure 2-1. Diagram of capture and control system for two hard chromium plating tanks tested at Consolidated Engravers.

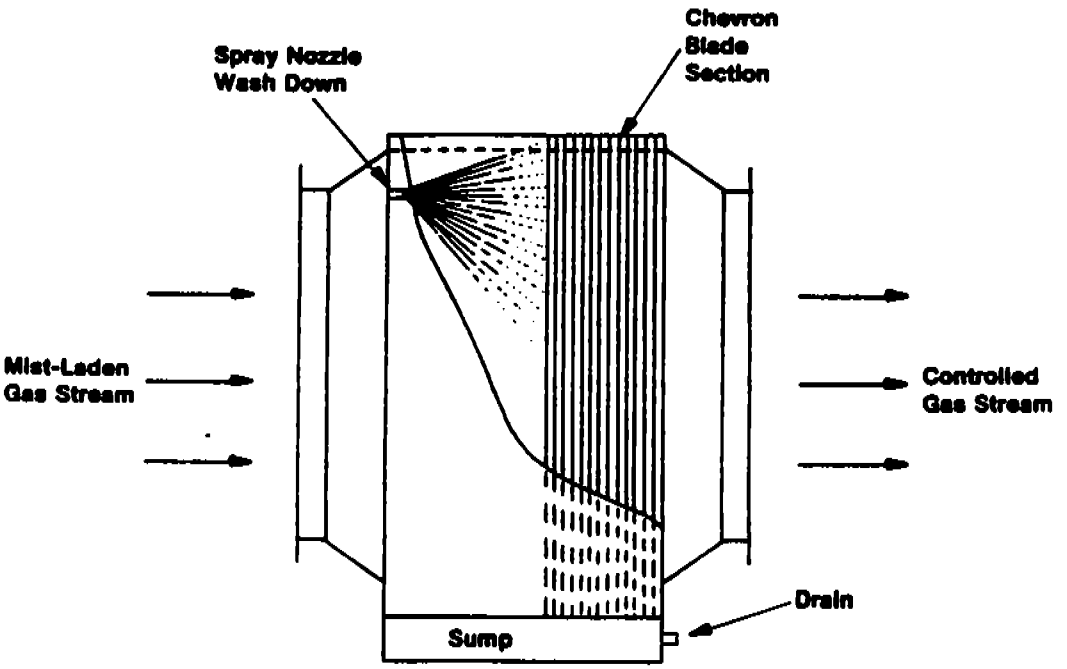


Figure 2-2. Diagram of horizontal-flow chevron-blade mist eliminator with a single set of blades.

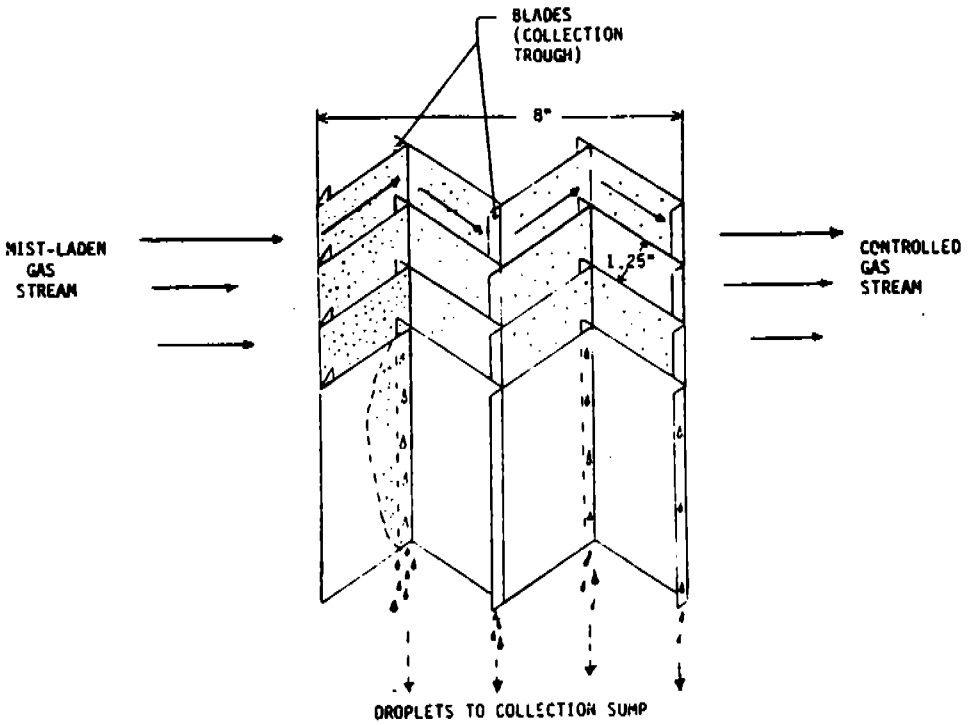


Figure 2-3. Diagram of overlapping-type chevron-blade design.

A moisture extractor is installed in the stack to control chromium emissions that may be drawn through the mist eliminator. The mist eliminator and moisture extractor are equipped with a spray washdown system. The washdown water is drained into a 340-ℓ (90-gal) holding tank and then into the plating tanks to make up for plating solution evaporation losses. The mist eliminator and moisture extractor are washed down one or two times per day depending on the amount of plating solution makeup needed.

2.3 PROCESS CONDITIONS DURING TESTING

Three emission and three particle size distribution tests were conducted at the inlet and outlet of the mist eliminator to characterize uncontrolled emissions and the performance of the mist eliminator. Inlet and outlet testing was conducted simultaneously. The emission tests were conducted for 180 minutes each. The first particle size distribution test was conducted for 190 min, the second test for 180 min, and the third test for 240 min.

Process operating parameters such as the voltage, current, and plating solution temperature were monitored and recorded during each test. Descriptions (dimensions and surface areas) and plating time of each individual roll plated also were recorded during each test. Process data sheets documenting the process and control device operating parameters during emission testing (test run Nos. I-1 through I-3 and O-1 through O-3) and particle size distribution testing (PSI-1 through PSI-3 and PSO-1 through PSO-3) are presented in Appendix A. The average operating conditions recorded during each emission test run are presented in Table 2-1.

Grab samples of the plating solution in each tank and the mist eliminator washdown water were taken to determine the concentration of chromic acid in the plating baths and washdown water, respectively. Grab samples of the plating solution in each tank were taken at the beginning, middle, and end of each test run to obtain a composite sample for each tank. The mist eliminator was washed down with about 230 ℓ (60 gal) of water each morning before testing began. Grab samples of the mist

TABLE 2-1. AVERAGE OPERATING CONDITIONS RECORDED DURING EACH EMISSION TEST RUN

Test run No. / Inlet/outlet	Tank No.	Work-station No.	Operating voltage, volts	Operating current, amperes	Temp. of plating solution, °C (°F)
I-1/0-1	1	1	15.5	1,600	68 (155)
	1	2	13.0	1,250	68 (155)
	2	1 and 2	10.0	2,050	55 (132)
I-2/0-2	1	1	15.5	1,460	62 (144)
	1	2	13.0	1,270	62 (144)
	2	1 and 2	9.8	2,210	58 (136)
I-3/0-3	1	1	12.6	1,265	67 (152)
	1	2	11.4	1,250	67 (152)
	2	1 and 2	9.8	2,170	55 (132)

eliminator washdown water were taken from the holding tank after the mist eliminator was washed down. The analytical results for each sample are presented in Section 3.0 of this report.

Industrial rolls used in the textile and packaging industries were chromium plated during testing. Typically, the time required to plate one roll in each work station ranged from 45 to 60 minutes. Dummy rolls were plated during testing when the workload was insufficient to operate the two tanks at full capacity. Two dummy rolls were plated in Tank 1 during all of run Nos. 1 and 3 and for 72 minutes of run No. 2, and one dummy roll was plated in Tank 2 for 38 minutes of run No. 3. Two dummy rolls were plated in Tank 1 during all three particle size distribution tests.

During testing, the bath temperature of both plating tanks was somewhat higher than normal. The temperature of Tank 1 ranged from 54°C (130°F) to greater than 71°C (160°F), and the temperature of Tank 2 ranged from 50°C (122°F) to 64°) (148°F). The cooling systems for the tanks were unable to maintain the normal operating temperatures when the tanks were operated at full capacity. Although the bath temperatures were higher than normal, the higher temperatures did not adversely affect the plating process.

The MM13B runs were shut down approximately 15 to 20 minutes to change test ports. The first particle size distribution test (PSI-1/PSO-1) was interrupted for 12 minutes because of a low process workload and the second and third particle size tests (PSI-2 and PSI-3/PSO-2 and PSO-3) were not interrupted.

The total amount of current supplied to the tanks during each emission test run is calculated in ampere-hours and included in Appendix A. A tabular summary of the total current values is presented in Table 2-2.

TABLE 2-2. TOTAL CURRENT SUPPLIED TO THE PLATING TANKS DURING EACH EMISSION TEST RUN

Test run No. Inlet/outlet	Tank No.	Work-station No.	Total current, ampere-hours Inlet	Outlet
I-1/O-1	1	1	4,829	4,839
	1	2	3,724	3,731
	2	1 and 2	6,471	6,513
	TOTAL		15,024	15,083
I-2/O-2	1	1	3,948	4,032
	1	2	3,550	3,555
	2	1 and 2	6,579	6,576
	TOTAL		14,077	14,163
I-3/O-3	1	1	3,791	3,784
	1	2	3,730	3,722
	2	1 and 2	6,591	6,590
	TOTAL		14,112	14,096

SECTION 3.0
SUMMARY OF RESULTS

3.1 INTRODUCTION

Table 3-1 presents the testing schedule along with the sample and analytical parameters. The samples collected from the triplicate MM 13B tests performed at the inlet and outlet of the mist eliminator, and the plating solution samples from Tanks 1 and 2 were analyzed for Cr and Cr^{+6}. The size distribution samples were analyzed only for total Cr. The Cr^{+6} analysis was performed using the procedures outlined in "Determination of Hexavalent Chromium Emissions From Stationary Sources." This method is presented in Appendix B. The total Cr concentration was determined by the Inductively Coupled Argon Plasmography (ICAP) Analytical Procedures. This procedure is outlined in Method 3050 of the EPA manual, SW-846 "Test Methods for Evaluating Solid Waste," and is also presented in Appendix B of this report. The results of these analytical procedures are presented in the remainder of this section.

3.2 HEXAVALENT AND TOTAL CHROMIUM EMISSIONS RESULTS

Table 3-2 summarizes pertinent sample and flue gas data for the chromium tests, and Table 3-3 presents the Cr^{+6} and total Cr emissions results. Sample volumes are expressed in dry normal cubic meters (dNm^3) and dry standard cubic feet (dscf) . Volumetric flow rates are corrected to standard conditions (20°C and 760 mm Hg [68°F and 29.92 inches Hg] and zero percent moisture) and are expressed as dry normal cubic meters per minute (dNm^3/min) and dry standard cubic feet per minute (dscfm).

Concentrations of Cr^{+6} and total Cr are expressed in milligrams per dry normal cubic meter (mg/dNm^3) and grains per dry standard cubic foot (gr/dscf).

TABLE 3-1. TEST SCHEDULE FOR CR^{+6} and Cr EMISSIONS AT CONSOLIDATED ENGRAVERS, CHARLOTTE, NORTH CAROLINA

Run No.	Date/Time (1987)	Sample Parameter		Analytical Parameter		
		MM 13B	Size Distribution	Cr^{+6} Diphenylcarbazide Colorimetric Method	Total Cr ICAP	Gravimetric Analysis
I-1	5/12 0952 - 1309	X		X	X	
O-1	5/12 0955 - 1312	X		X	X	
IPS-1	5/12 1427 - 1749		X		X	X
OPS-1	5/12 1429 - 1751		X		X	X
I-2	5/13 0925 - 1245	X		X	X	
O-2	5/13 0928 - 1248	X		X	X	
IPS-2	5/13 1327 - 1657		X		X	X
OPS-2	5/13 1329 - 1659		X		X	X
I-3	5/14 0845 - 1200	X		X	X	
O-3	5/14 0848 - 1203	X		X	X	
IPS-3	5/14 1232 - 1632		X		X	X
OPS-3	5/14 1234 - 1634		X		X	X

TABLE 3-2. SUMMARY OF SAMPLE AND FLUE GAS CONDITIONS (CONSOLIDATED ENGRAVERS CORPORATION, CHARLOTTE, NORTH CAROLINA)

Run No.	Date (1987)	Sample Location	Sample Parameter: Sample Volume dNM^3	Sample Parameter: Sample Volume dscf	Sample Parameter: Percent Isokinetic	Volumetric Flow Rate dNm^3/min	Volumetric Flow Rate dscf/min	Flue Gas Conditions: Temperature °F	Flue Gas Conditions: Temperature °C	Flue Gas Conditions: Moisture Content %	Flue Gas Conditions: Static Pressure in. H_2O
I-1	5/12	Inlet	3.82	134.899	101.6	143	5,038	81	27	2.26	-3.7
I-2	5/13	Inlet	3.54	125.009	94.4	142	5,026	79	26	2.25	-4.1
I-3	5/14	Inlet	3.81	134.472	100.0	145	5,105	73	23	2.02	-3.7
O-1	5/12	Outlet	3.83	135.409	103.1	142	5,028	84	29	2.25	-0.39
O-2	5/13	Outlet	3.80	134.305	100.9	144	5,095	83	28	2.06	-0.39
O-3	5/14	Outlet	4.01	141.618	102.7	149	5,277	76	24	1.89	-0.39
IPS-1	5/12	Inlet	2.72	96.002	101.8	*	*	*		*	*
IPS-2	5/13	Inlet	3.27	115.377	108.2	*	*	*		*	*
IPS-3	5/14	Inlet	3.59	126.915	105.1	*	*	*		*	*
OPS-1	5/12	Outlet	2.71	95.556	106.8	*	*	*		*	*
OPS-2	5/13	Outlet	3.25	114.921	105.9	*	*	*		*	*
OPS-3	5/14	Outlet	3.75	132.559	106.6	*	*	*		*	*

* This parameter not measured during size distribution run

TABLE 3-3. SUMMARY OF Cr^{+6} AND TOTAL CR EMISSION DATA (CONSOLIDATED ENGRAVERS, CHARLOTTE, NORTH CAROLINA)

			Concentration				Mass Emission Rate			
			Cr^{+6}		Total Cr		Cr^{+6}		Total Cr	
Run No.	Date (1987)	Sample Location	mg/dNm3	gr/dscf	mg/dNm3	gr/dscf	kg/h	lb/h	kg/h	lb/h
I-1	5/12	Inlet	1.815	0.00079	1.449	0.00063	0.0155	0.0342	0.0124	0.0273
I-2	5/13	Inlet	1.731	0.00075	0.937	0.00041	0.0148	0.0326	0.0080	0.0177
I-3	5/14	Inlet	1.746	0.00076	0.419	0.00018	0.0152	0.0333	0.0036	0.0080
Average			1.764	0.00077	0.935	0.00041	0.0152	0.0333	0.0080	0.0177
O-1	5/12	Outlet	0.0885	0.00004	0.092	0.00004	0.0008	0.0017	0.0008	0.0017
O-2	5/13	Outlet	0.2237	0.00010	0.143	0.00006	0.0019	0.0042	0.0012	0.0027
O-3	5/14	Outlet	0.1346	0.00006	0.118	0.00005	0.0012	0.0026	0.0011	0.0023
Average			0.1493	0.00007	0.118	0.00005	0.0013	0.0028	0.0010	0.0022

Mass emissions rates are expressed in kilograms per hour (kg/hr) and pounds per hour (lb/hr). Each sample was recovered in a polyethylene bottle and the sample consisted of the rinseate from the nozzle and probe combined with the impinger solutions and the rinseate from all connecting glassware.

As reported in Table 3-2, dry gas meter volumes were consistent and ranged from 3.540 to 3.820 dNm^3 (125.009 to 134.899 dscf) for the inlet MM 13B runs and 3.803 to 4.011 dNm^3 (134.305 to 141.618 dscf) for the outlet MM 13B runs. The isokinetic variation ranged from 94.4 to 101.6 percent for the inlet and 100.9 to 103.1 percent for the outlet, all within the acceptable range of 90 to 110 percent. The sample volume and isokinetic variation for the size distribution sampling is also summarized in this table. The field data sheets for this sampling program are presented in Appendix C. The calculations for the emission rates and size distribution data are presented in Appendix D.

3.2.1 Mist Eliminator Inlet

At the mist eliminator inlet the average volumetric flowrate at standard conditions was 143 dNm^3/min (5056 dscfm). Flue gas temperatures ranged from 23 to 27°C and averaged 25°C (73 to 81°F and averaged 78°F). The moisture content of the gas stream averaged 2.18 percent for the inlet. The static pressure was checked during the collection of preliminary data and recorded using a 0- to 10-inch H_2O manometer during each test. The static pressure was measured from the negative side of the pitot tube and measured 3.7 to 4.1 inches H_2O. Analysis of the gas stream composition was not performed because by the nature of the process, it was emitting essentially air. The molecular weight was assigned a value of 29.0 lb/lb-mole.

The Cr^{+6} concentration of the gas stream at the inlet to the mist eliminator ranged from 1.731 to 1.815 mg/dNm^3 (0.00075 to 0.00079 gr/dscf) and averaged 1.764 mg/ dNm^3 (0.00077 gr/dscf) for the three tests. The average mass emission rate for Cr^{+6} was 0.0152 kg/hr (0.0333) lb/hr.

The total Cr concentration ranged from 0.419 to 1.449 mg/dNm^3 (0.00018 to 0.00063 gr/dscf) and averaged 0.935 mg/dNm^3 (0.00041 gr/dscf). The average mass emission rate for Cr was 0.0080 kg/hr (0.0177 lb/hr).

The total mass of Cr^{+6} that was captured in the sample trains during each test was 6.93 mg for Run I-1, 6.13 mg for Run I-2 and 6.65 mg for Run I-3. The mass of total Cr contained in the sample train for these runs was 5.54 mg, 3.32 mg and 1.59 mg, respectively. Note that the Cr^{+6} concentration in the samples is higher than the total Cr concentration. Due to the fact that two different analytical methods were used, i.e., colorimetric for Cr^{+6} and ICAP for total Cr, the analytical results are slightly different. In Section 5.0 of this report it is demonstrated that the percent recovery of Cr^{+6} in the colorimetric method exceeds that of the ICAP method for total Cr. In that sense, the colorimetry is more "accurate" than ICAP. In any case, the data indicate that the majority of Cr in these samples is in the form of Cr^{+6}. The calculation sheets for the Cr^{+6} and total chrome concentrations and emission rates are presented in Appendix D.

3.2.2 Mist Eliminator Outlet

At the mist eliminator outlet, the average volumetric flow at standard conditions was 145 dNm^3/min (5133 dscfm). Flue gas temperatures ranged from 24 to 29°C and averaged 27°C (76 to 84°F and averaged 81°F). The static pressure was checked during collection of preliminary data and recorded using a 0- to 10-inch H_2O manometer during each test. The static pressure was measured from the negative side of the pitot tube and measured 9.91 mm of H_2O (0.39 inches of H_2O). The molecular weight was assigned a value of 29.0 lb/lb-mole, because the process was emitting essentially air.

The Cr^{+6} content of the gas stream at the outlet to the mist eliminator ranged from 0.09 to 0.22 mg/dNm^3 (0.00004 to 0.00010 gr/dscf) and averaged 0.15 mg/dNm^3 (0.00007 gr/dscf) for the three tests. The average mass emission rate for Cr^{+6} was 0.0028 lb/hr. The total Cr

concentration ranged from 0.092 to 0.143 mg/dNm^3 (0.000040 to 0.000063 gr/dscf). The average mass emission rate for Cr was 0.0010 kg/hr (0.0022 lb/hr).

The total mass of Cr^{+6} that was captured in the sample trains during each test was 0.339 mg (7.48 x 10^{-7} lb) for Run O-1, 0.851 mg (18.80 x 10^{-7} lb) for Run O-2, and 0.544 mg (12.00 x 10^{-7} lb) for Run O-3. The mass of total Cr contained in the sample train for these runs was 0.352 mg (7.80 x 10^{-7} lb), 0.546 mg (12.00 x 10^{-7}) and 0.472 mg (10.40 x 10^{-7} lb), respectively. Note that the Cr^{+6} concentration in the samples is higher than the total Cr concentration. Such apparent discrepancies are due to the fact that two different analytical methods are used, namely colorimetric for Cr^{+6} and ICAP for total Cr. In Section 5.0 of this report it is demonstrated that the percent recovery of Cr^{+6} in the colorimetric method exceeds that of the ICAP method for total Cr. In that sense, the colorimetry is a more "accurate" method. The data indicate that the majority of Cr in these samples is in the form of Cr^{+6}. Table 3-4 represents a summary of Cr^{+6} and total Cr removal efficiency of the mist eliminator according to the results of this test.

3.3 CHROMIUM DISTRIBUTION

Triplicate chromium distribution measurements were made at the inlet and outlet location following each MM 13B run. The samples were collected using the Andersen Mark III, 8-stage impactor. The impactor was modified such that Stages 1, 4, 7 and backup were the first four stages. All remaining Stages 0, 2, 3, 5 and 6 were assembled to follow these four in order to provide for correct spacing within the impactor unit. This procedures is discussed in more detail in Section 4.3.2. These tests were designed to characterize total Cr emissions by size fraction. The Cr distribution was determined by gravimetric analysis of the filters and stage rinses with the addition of the masses calculated from the chemical analysis of the filters and stage rinses. To determine the average net gain on the filter stages, the net gain from the cutpoints were combined by stage for each sample location. The stage rinses for each cutpoint were combined, by stage, for each sample

TABLE 3-4. SUMMARY FOR Cr^{+6} AND TOTAL Cr REMOVAL EFFICIENCIES AT CONSOLIDATED ENGRAVERS CORPORATION, CHARLOTTE, NORTH CAROLINA

Run No.	Date (1987)	Sample Location	Cr^{+6} Emission Rate (lb/hr)	Cr^{6} Removal Efficiency	Total Cr Emission Rate (lb/hr)	Total Cr Removal Efficiency
I-1	5/12	Inlet	0.0342	95.0%	0.0273	93.4%
O-1	5/12	Outlet	0.0017		0.0017	
I-2	5/13	Inlet	0.0326	87.1%	0.0177	84.7%
O-2	5/13	Outlet	0.0042 3		0.0027 8	
I-3	5/14	Inlet	0.0338 4	92.2%	0.0080	71.3%
O-3	5/14	Outlet	0.0026 7		0.0023 4	
Average				91.4%		83.1%

location, and those samples were evaporated to determine the total weight gain of each designated stage. The total gain was calculated by summing the average net gain from the stage filter and the net gain of the respected stage rinse evaporations. The data are presented in Table 3-5.

The stage filters from each of the three inlet samples, were combined by stage cutpoint, digested and then analyzed for total chromium concentration using the ICAP Method. Similarly, the stage rinses were combined and an aliquot of each stage rinse was also analyzed using the ICAP method. The outlet samples were analyzed by the same technique. These data are presented in Table 3-6. The results from the filter analysis were reported in milligrams. The results from the stage rinse analysis were reported in mg/ℓ. The mass of total chromium in stage rinses was calculated by multiplying the reported concentration (mg/ℓ) by the sample volume (liters). This calculation yielded the total milligrams collected in the stage rinse. Hence, the mass of chromium from the filter analysis was added to the mass of chromium in the stage rinse. This calculation yielded the total mass of chromium collected in each stage cutpoint.

It must be noted that the analytical results presented, both gravimetric and chemical methods, do not include the results from the analysis of the nozzle rinse. These data are not presented because it is suspected that as the gas stream enters the nozzle, chrome "particles" immediately adhere to the exposed inside surfaces of the nozzle and the cone section of the impactor. There is no reason to suspect that such adhesion would be size dependent, so it was assumed that the size distribution of the particles captured at the nozzle is the same as that passing into the impactor stages. The nozzle rinse data are therefore not included with the first stage so as to not bias the size separation data. The gas stream that enters the subsequent sections of the impactor would be divided by size fraction and considered representative of the Cr distribution in the full gas stream. For example, if 70 percent of the chrome in the gas stream was collected in the nozzle and cone section, the size distribution of the remaining 30 percent would be representative of the distribution characteristics of the chrome in the gas stream as a whole.

TABLE 3-5. SUMMARY OF NET GAINS FROM GRAVIMETRIC ANALYSIS OF PARTICLE SIZE SAMPLES

Stage	Filter Net Gain (mg)	Stage Rinse Net Gain (mg)	Total Gain (mg)
INLET - RUNS 1, 2, 3			
1*	0.50	2.009	2.509
4	0.67	0.005	0.675
7	2.43	-0.016	2.414
Backup	0.55	0.012	0.562
OUTLET RUNS 1, 2, 3			
1*	-0.76	-0.011	0
4	0.08	-0.007	0.073
7	1.07	-0.020	1.050
Backup	0.30	-0.045	0.255

All reported values have been blank corrected
* Does not include nozzle rinse

TABLE 3-6. SUMMARY OF NET CHROMIUM GAINS BY CHEMICAL ANALYSIS

Stage	Filter (mg)	Stage Rinse (mg)	Total mg Of Chromium
INLET RUNS 1, 2, 3			
1*	0.557	0.030	0.587
4	0.485	0.021	0.506
7	2.053	ND	2.053
Backup	0.233	ND	0.233
OUTLET RUNS 1, 2, 3			
1*	0.010	ND	0.010
4	0.019	ND	0.019
7	0.905	ND	0.905
Backup	0.239	ND	0.239

Does not include nozzle rinse
All reported values have been blank corrected
ND = Non-detectable

The actual flow rate through the impactor for Run IPS-1 was 0.5168 ACFM, IPS-2 was 0.5547 ACFM, and IPS-3 was 0.5393 ACFM. The average flow rate was 0.5369 ACFM through the inlet impactor. The actual flow rate through the impactor for Run OPS-1 was 0.5413 ACFM, OPS-2 was 0.5572 ACFM and 0.5618 ACFM for OPS-3. The average flowrate was 0.5534 ACFM through the outlet impactor.

The stage cutpoint diameter was determined using Figure 3-1.[1] A summary of the distribution data for the inlet is presented in Table 3-7. This table presents the data generated from both analytical methods. The outlet data are summarized similarly in Table 3-8. The results were plotted on logarithmic probability paper with the particle diameter as the ordinate and the cumulative percent by weight as the abscissa. Figures 3-2 and 3-3 are graphical presentations of the chromium distribution for the inlet and Figures 3-4 and 3-5 are are a graphical presentations of the particle size chromium data for the outlet.

3.4 PROCESS SAMPLE ANALYSIS

Table 3-9 summarizes results for Cr^{+6} and total Cr from the plating tank solutions collected during each test period. Plating tank solutions from Tanks 1 and 2 were collected and composited in separate bottles for each tank. The samples were taken at three equal intervals during each of the MM 13B and the size distribution tests. Results for both Cr^{+6} and total Cr are expressed in milligrams per liter (mg/ℓ). Analytical procedures were similar to those used for the actual emission samples with the Cr^{+6} determined by the diphenylcarbazide colorimetric method and total Cr by ICAP.

3.5 WASHDOWN WATER ANALYSIS

Table 3-10 summarizes the results for Cr^{+6} and Cr analysis of the water used in the daily washdown of the mist eliminator. These samples were collected prior to the beginning of testing every day when the trapped emissions from the previous day were purged from the system. Results for both Cr^{+6} and total Cr are expressed in milligrams per liter (mg/ℓ). Analytical procedures were similar to those used for the actual emission samples with Cr^{+6} concentration determined by diphenylcarbazide colorimetric method and total Cr concentration by the ICAP method.

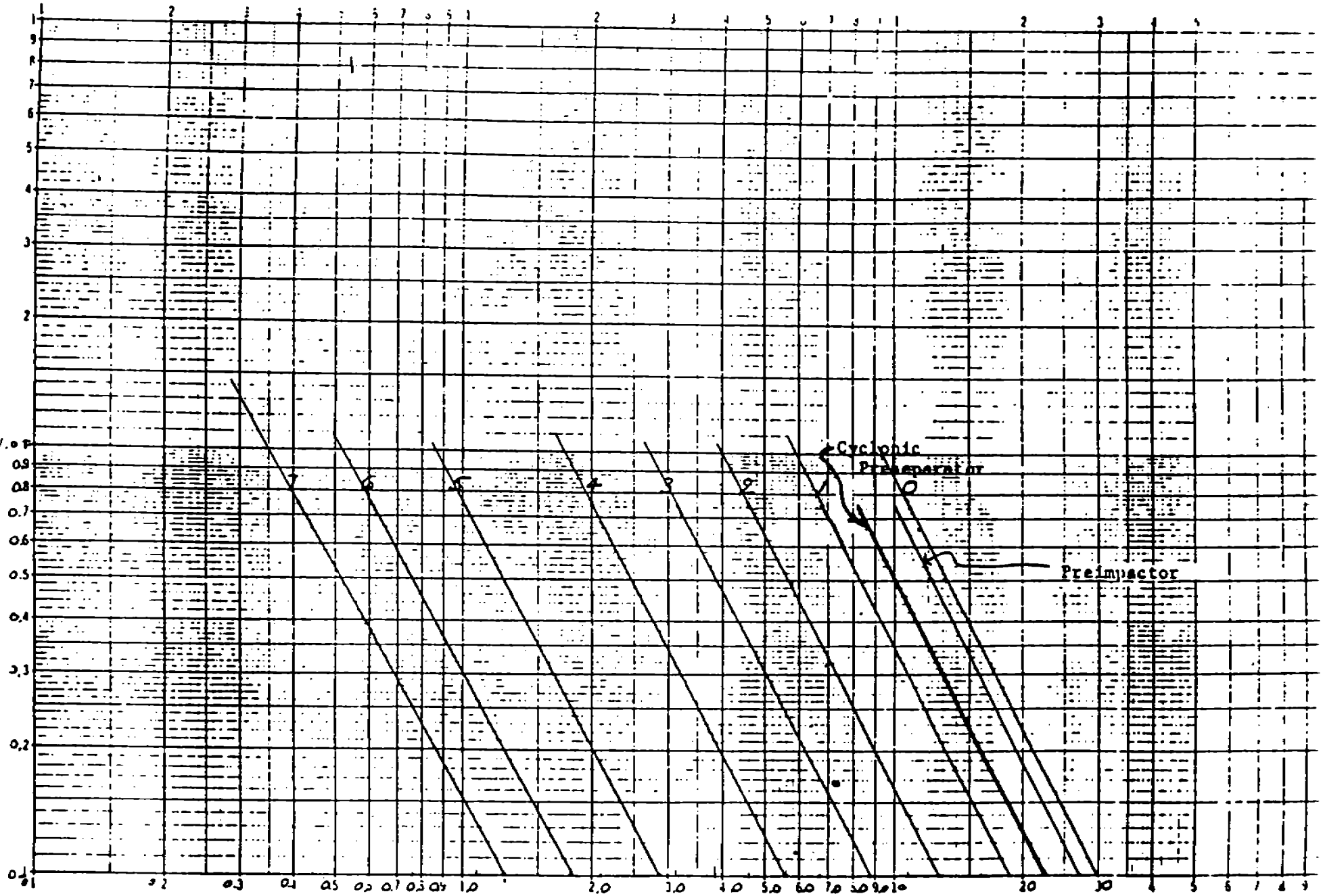


Figure 3-1. Determination of stage cutpoint diameter.

TABLE 3-7. SUMMARY OF INLET DISTRIBUTION DATA

GRAVIMETRIC ANALYSIS

INLET

	Net Gain (mg)	% of Total Particles	Cumulative % Less Than	Effective Cutpoint Diameter (micron)
Stage 1*	2.509	40.73	59.27	8.0
Stage 4	0.675	10.96	48.31	2.4
Stage 7	2.414	39.19	9.12	0.5
Backup	0.562	9.12	0	less than 0.5

CHEMICAL ANALYSIS

INLET

	Net Cr (mg)	% of Total Cr	Cumulative % Less Than	Effective Cutpoint Diameter (micron)
Stage 1*	0.587	17.37	82.63	8.0
Stage 4	0.506	14.97	67.66	2.4
Stage 7	2.053	60.76	6.90	0.5
Backup	0.233	6.90	0	less than 0.5

* Does not include nozzle rinse

TABLE 3-8. SUMMARY OF OUTLET DISTRIBUTION DATA

GRAVIMETRIC ANALYSIS

OUTLET

	Net Gain (mg)	% of Total Particles	Cumulative % Less Than	Effective Cutpoint Diameter (micron)
Stage 1*	-0.771	0	100.00	7.90
Stage 4	0.073	5.29	94.71	2.35
Stage 7	1.050	76.21	18.50	0.49
Backup	0.255	18.49	0	less than 0.49

CHEMICAL ANALYSIS

OUTLET

	Net Cr (mg)	% of Total Cr	Cumulative % Less Than	Effective Cutpoint Diameter (micron)
Stage 1*	0.010	0.85	99.15	7.90
Stage 4	0.019	1.62	97.50	2.35
Stage 7	0.905	77.15	20.38	0.49
Backup	0.239	20.38	0	less than 0.49

* Does not include nozzle rinse

Company: Consolidated Engr.-Mist Elim.Inlet - Chemical Analysis

Application: Andersen Mark III, Modified 4-stage

Particle Size Distribution Data:

Particle Diameter (Microns)	Percent In Size Range	Cumulative Percent Less Than
8.0	17.37	82.63
2.4	14.97	67.66
0.5	60.76	6.90

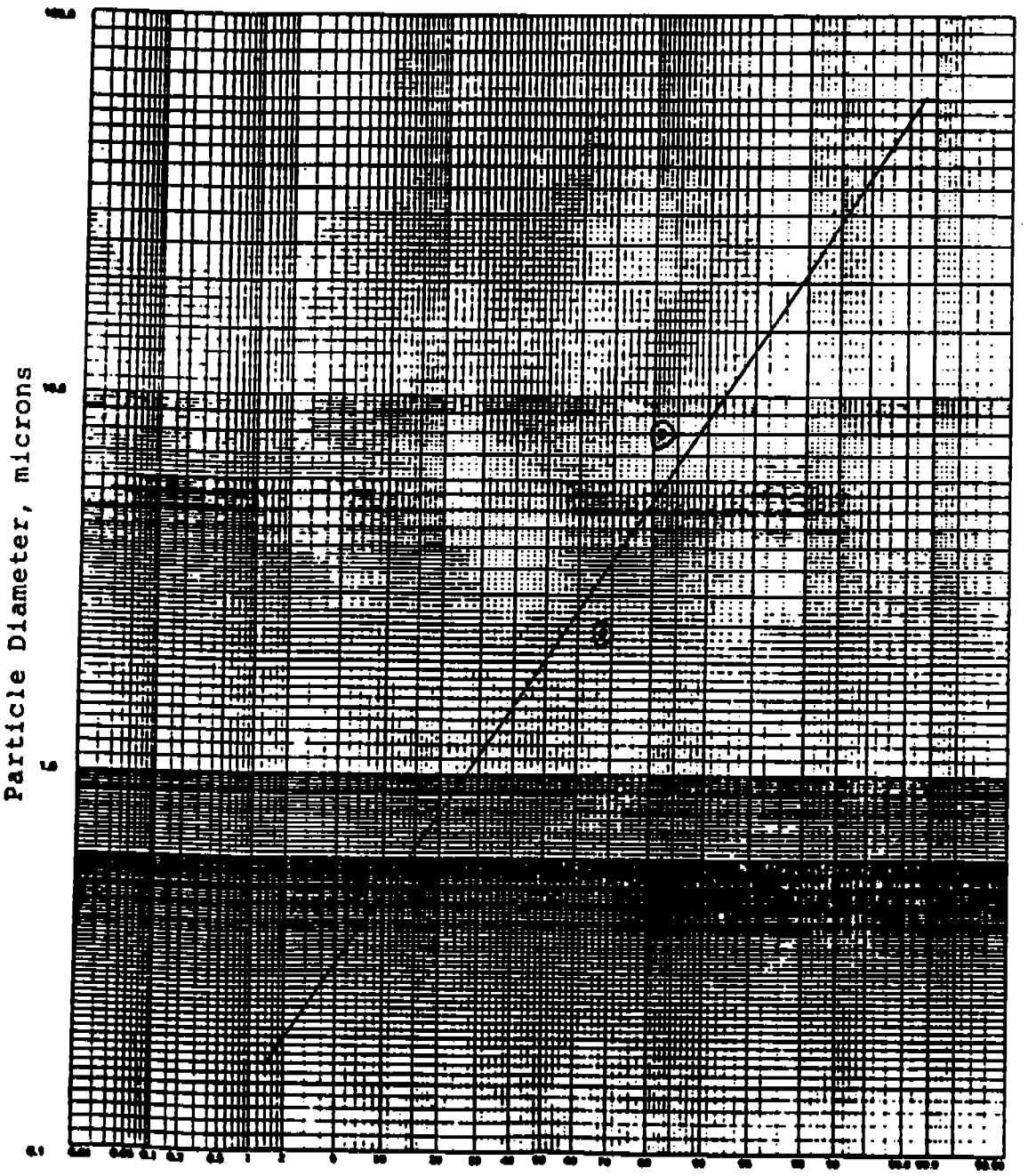


Figure 3-2. Graphical presentation of inlet chromium distribution.

Company: Consolidated Engr. - Mist Elim. Inlet - Gravimetric Analysis

Application: Andersen Mark III, Modified 4-stage

Particle Size Distribution Data:

Particle Diameter (Microns)	Percent In Size Range	Cumulative Percent Less Than
8.0	40.73	59.27
2.4	10.96	48.31
0.5	39.19	9.12

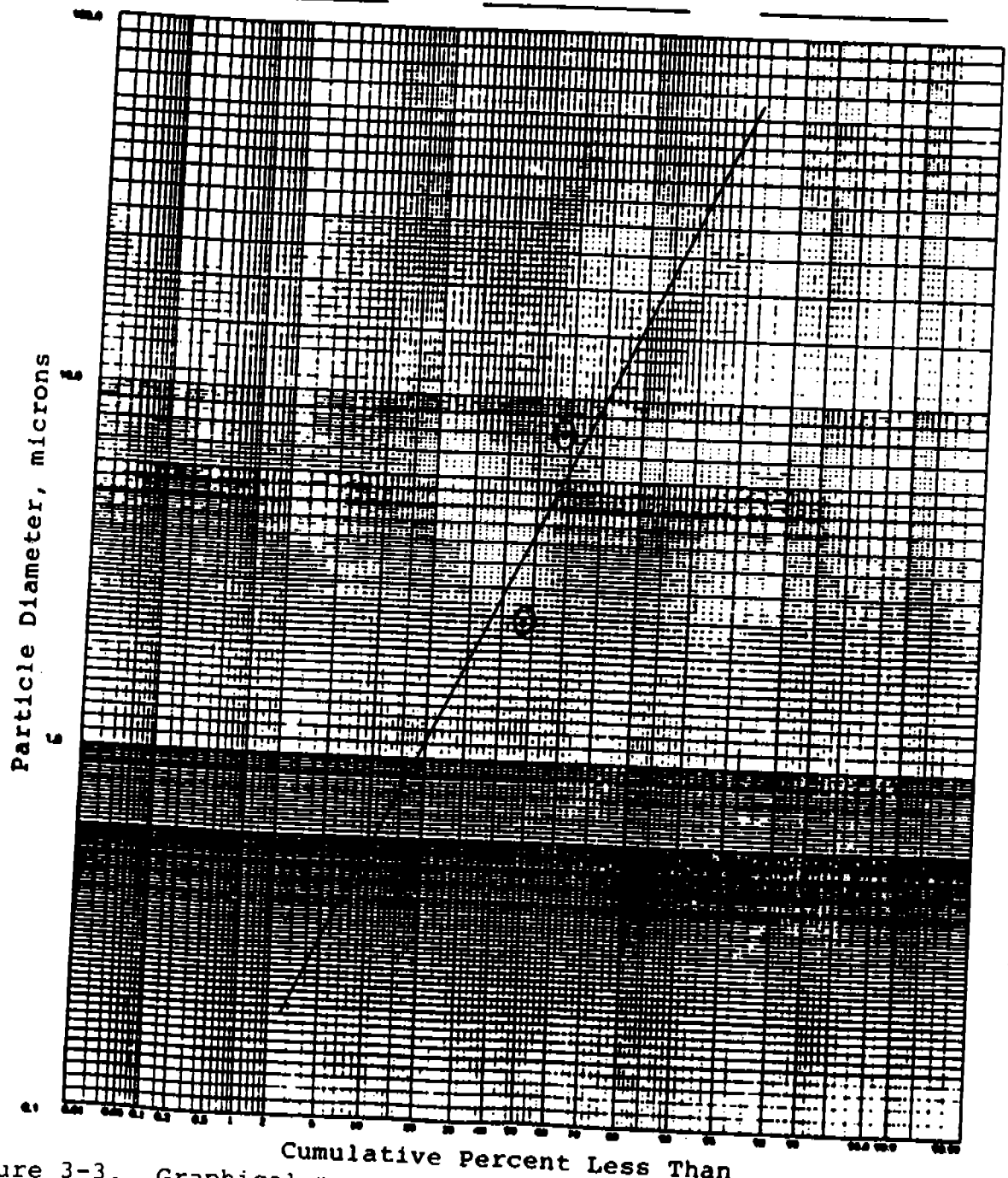


Figure 3-3. Graphical presentation of inlet chromium distribution.

Company: Consolidated Engr. - Mist Elim. Outlet - Chemical Analysis

Application: Andersen Mark III, Modified 4-stage

Particle Size Distribution Data:

Particle Diameter (Microns)	Percent In Size Range	Cumulative Percent Less Than
7.90	0.85	99.15
2.35	1.62	97.50
0.49	77.15	20.38

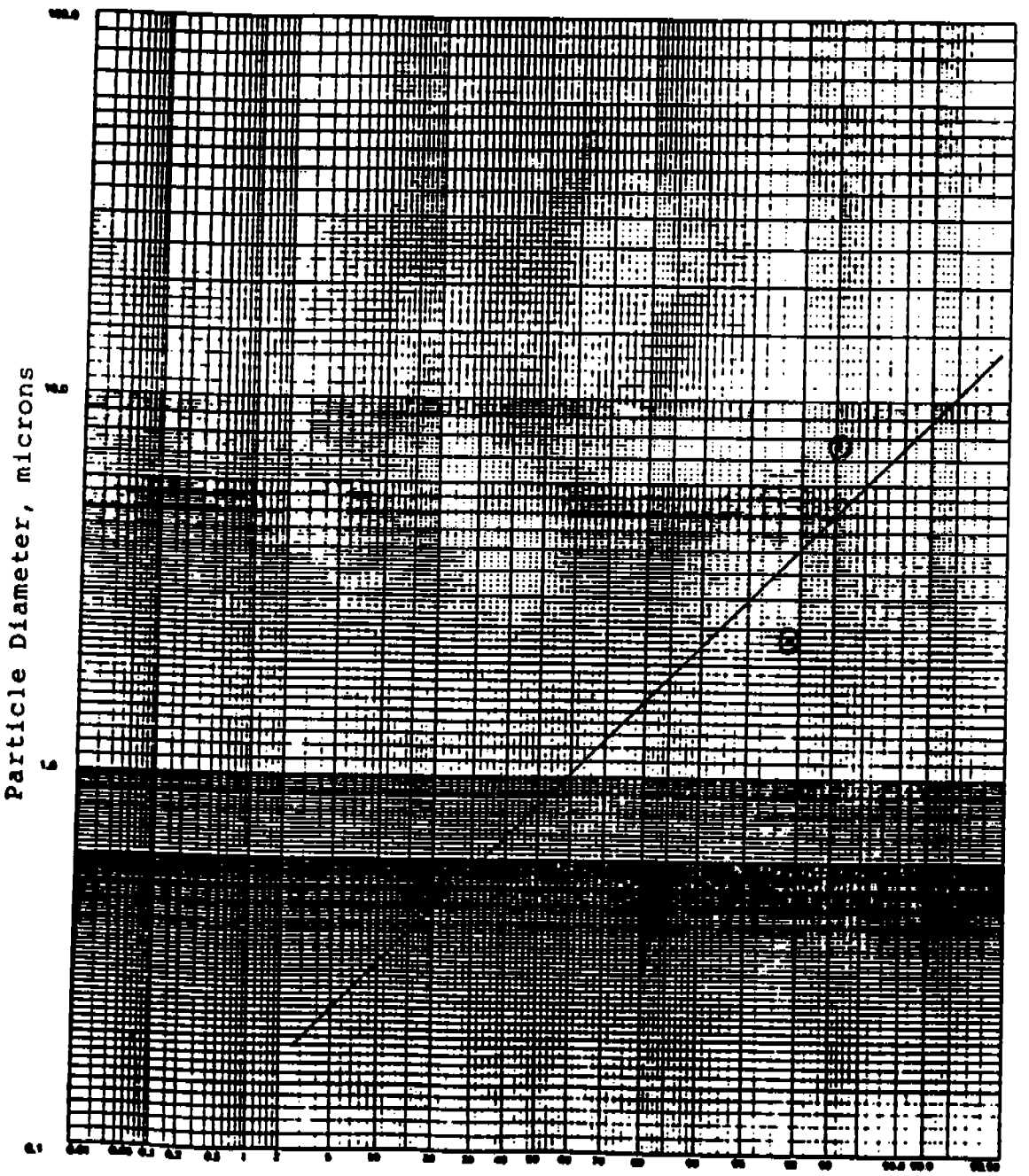


Figure 3-4. Graphical presentation of outlet chromium distribution.

Company: Consolidated Engr. - Mist Elim. Outlet - Gravimetric Analysis

Application: Andersen Mark III, Modified 4-stage

Particle Size Distribution Data:

Particle Diameter (Microns)	Percent In Size Range	Cumulative Percent Less Than
7.90	0.0	100.00
2.35	5.29	94.71
0.49	76.21	18.50

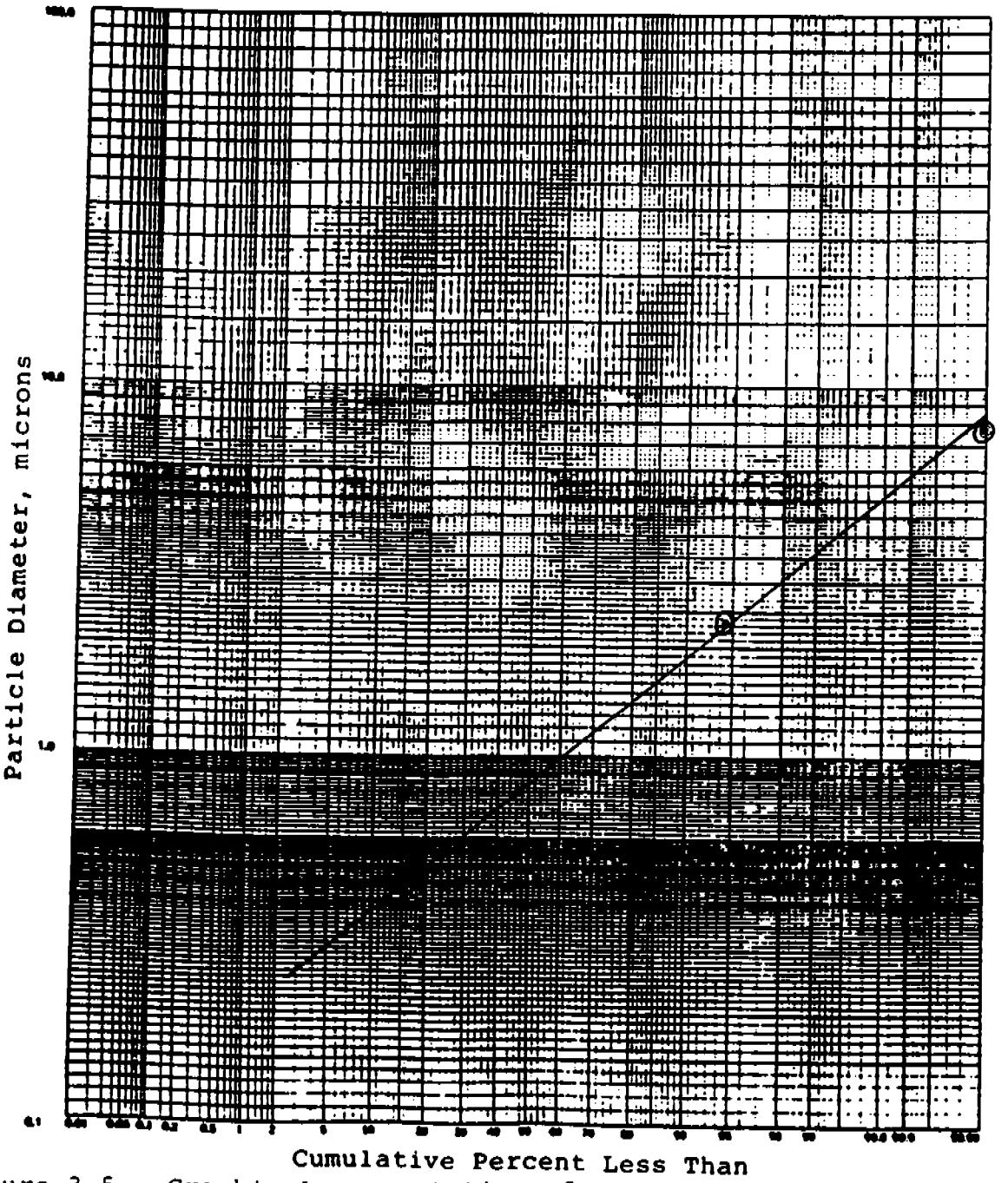


Figure 3-5. Graphical presentation of outlet chromium distribution.

TABLE 3-9. SUMMARY OF RESULTS FROM THE LABORATORY ANALYSIS OF PLATING TANK SOLUTIONS

Sample	Cr^{+6} (mg/ℓ)	Total Cr (mg/ℓ)
Runs I-1 and O-1		
Tank 1	118,000	115,000
Tank 2	128,000	108,000
Runs I-2 and O-2		
Tank 1	128,000	111,000
Tank 2	135,000	106,000
Runs I-3 and O-3		
Tank 1	122,000	116,000
Tank 2	124,000	105,000
Runs IPS-1 and OPS-1		
Tank 1	115,000	109,000
Tank 2	136,000	108,000
Runs IPS-2 and OPS-2		
Tank 1	123,000	115,000
Tank 2	131,000	105,000
Runs IPS-3 and OPS-3		
Tank 1	134,000	117,000
Tank 2	128,000	101,000

TABLE 3-10. SUMMARY OF RESULTS FROM LABORATORY ANALYSIS OF WASHDOWN WATER FROM THE MIST ELIMINATOR

Sample	Total Cr (mg/ℓ)	Cr+6 (mg/ℓ)
Washdown 5/12	108,000	93,300
Washdown 5/13	58,400	61,600
Washdown 5/14	54,800	62,700

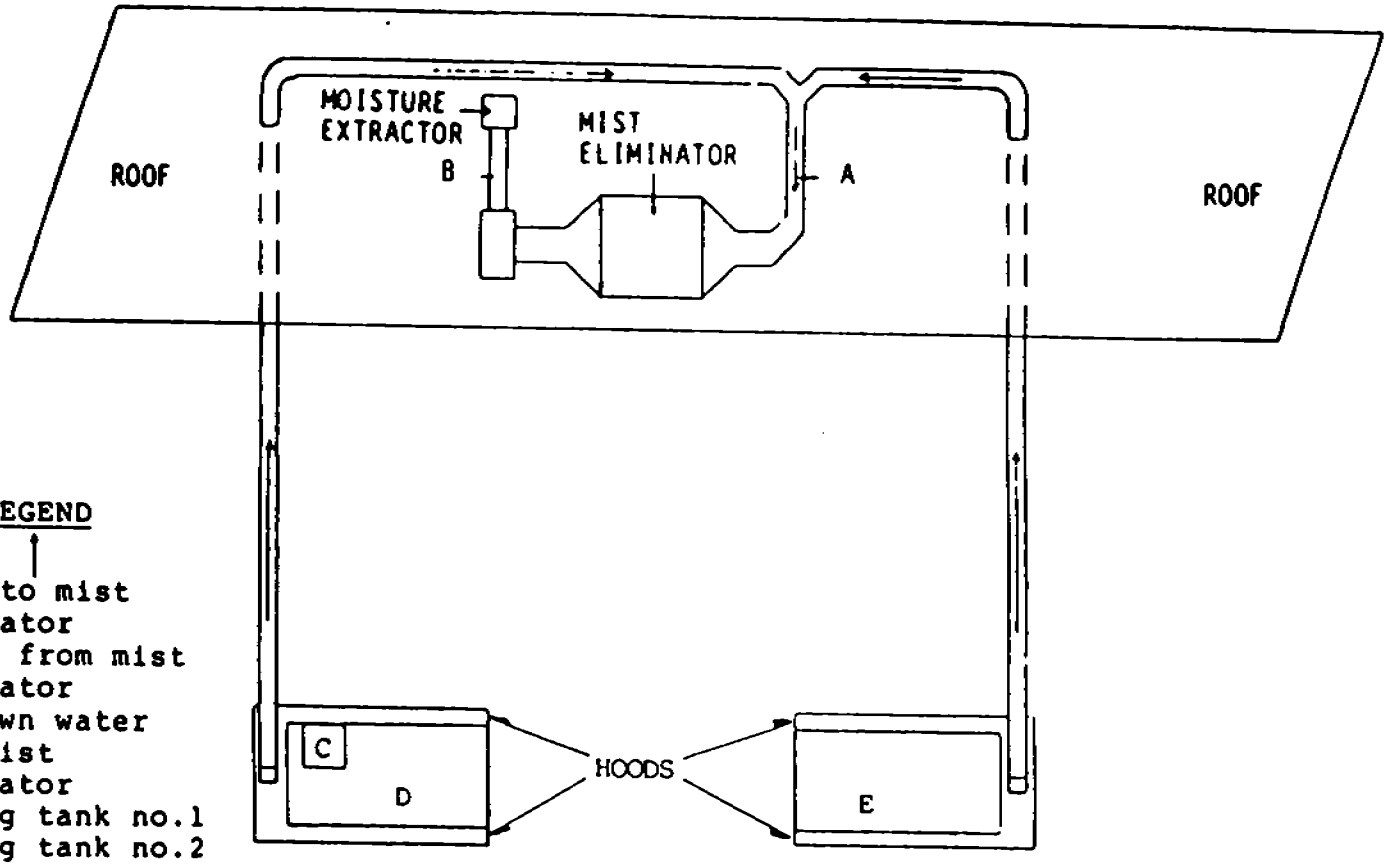
SECTION 4.0
SAMPLE LOCATIONS AND TEST METHODS USED

The test program consisted of simultaneous sampling of the inlet to and the outlet from the mist eliminator for plating Tanks 1 and 2. A flow diagram for the hard chrome plating Tanks 1 and 2 at the Consolidated Engravers facility is shown in Figure 4-1. The sampling location for the chromium and size distribution tests are designated in Figure 4-1. Location A designates the sample location on the inlet to the mist eliminator and Location B designates the sample location on the outlet from the mist eliminator.

4.1 MIST ELIMINATOR INLET

Emission sampling was performed on the 19-5/8-inch diameter duct using a filterless Method 13B impinger train and a cascade impactor. As presented in Figure 4-2, the location of one of the sample ports on the inlet required that a vertical traverse be made during the MM 13B tests. To accomplish this, a sample box was modified to allow the sample probe to be connected vertically and suspended above the port with a hoist, allowing the sample train to be raised and lowered to reach all traverse points. The inlet duct had a straight run of 79-1/2 inches. Two 3-1/2 inch diameter sampling ports were installed on the inlet duct. One sample port (J) was installed on the vertical axis and the second (K) was located 90 degrees from Sample Port J. These ports were located 58 inches (approximately 2.9 duct diameters) downstream from the point where the exhaust ducts from Plating Tanks 1 and 2 join to a common duct. The inlet sample ports were located 21-1/2 inches (1.1 duct diameter) upstream from the nearest disturbance, i.e., 90-degree horizontal bend into the mist eliminator.

Table 4-1 presents a summary of traverse point locations. The minimum number of traverse points for the test was 24, as specified in EPA Reference Method 1. The sample time per point was 7.5 minutes for a total test time



LEGEND

Gasflow - ↑

A - Inlet to mist eliminator

B - Outlet from mist eliminator

C - Washdown water from mist eliminator

D - Plating tank no.1

E - Plating tank no.2

Figure 4-1. Flow diagram for the chromium plating Tanks 1 and 2 at the Consolidated Engraver's facility.

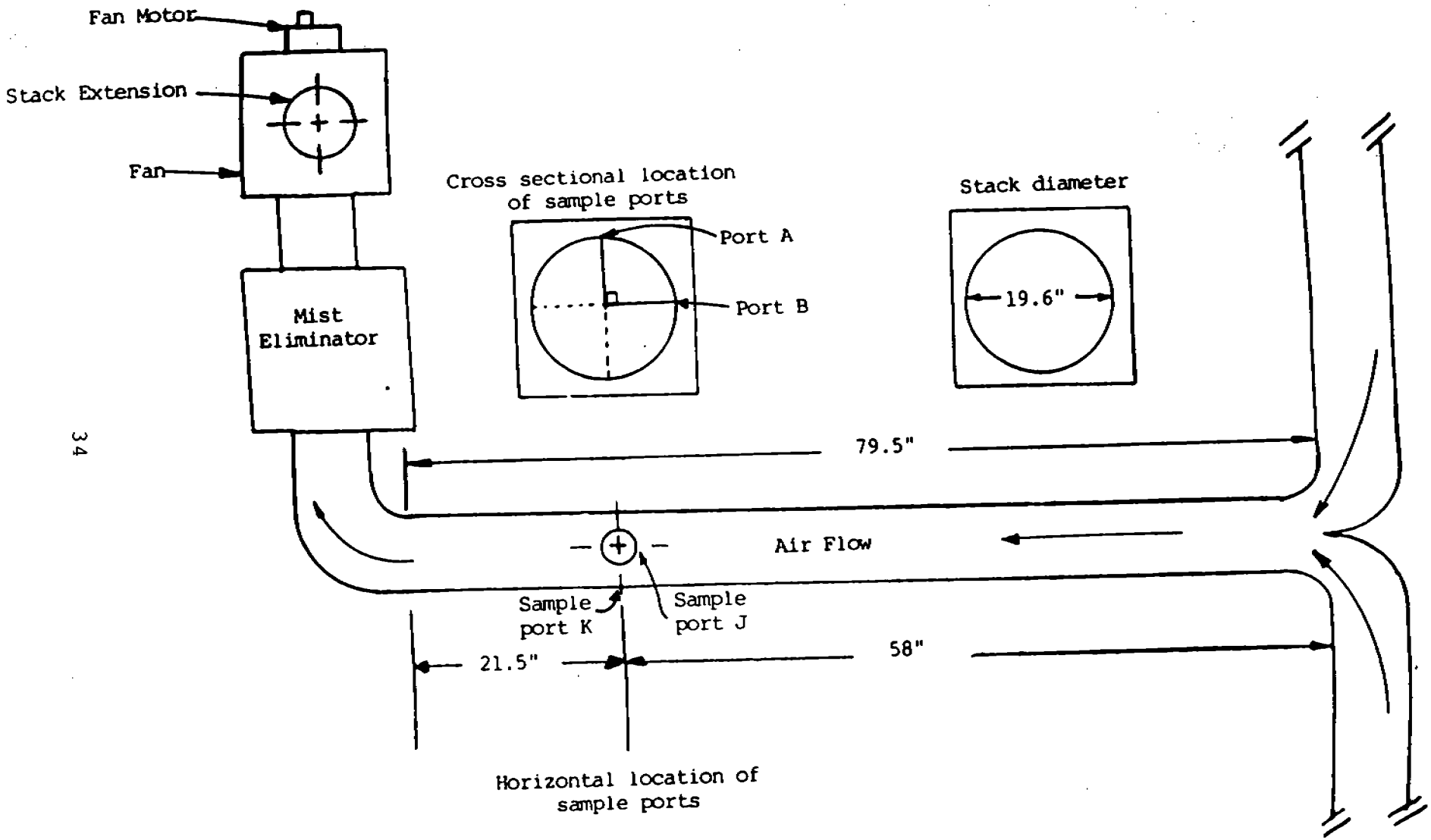


Figure 4-2. Orthogonal sketch of inlet sampling location.

TABLE 4-1. SUMMARY OF TRAVERSE POINT LOCATIONS

Point No.	Inlet Location (in.)	Outlet Location (in.)
	Stack Inner Diameter = 19.625 inches	
1	0.5	0.5
2	1.3	1.3
3	2.3	2.3
4	3.5	3.5
5	4.9	4.9
6	7.0	7.0
7	12.6	12.6
8	14.7	14.7
9	16.1	16.1
10	17.3	17.3
11	18.3	18.3
12	19.2	19.2

of 180 minutes for each MM 13B on the inlet. This sample time was based on a similar sampling program conducted for the EMB. Traverse Point 1, as calculated, was located close to the sample ports and introduced the possibility of ambient air entering the gas stream and diluting the sample. To eliminate this problem Traverse Point 2 was sampled for 15 minutes to complete the 24-point traverse. The relocation of traverse points was discussed and accepted by the EPA task manager. Particle size sampling was also performed on the inlet duct using an Andersen Mark III 8-stage impactor with a straight nozzle. The length of the three size distribution runs were 190, 210, and 240 minutes in duration following the chromium sampling. The

length of the particle size run was based on previous testing conducted in a similar test program in which the sampling team suspected that their sampling times may have been insufficient at 90 minutes.

4.2 MIST ELIMINATOR OUTLET

Figure 4-3 shows an orthogonal sketch of the outlet sampling location. Emission sampling was performed on the 19.63-inch diameter duct using a filterless Method 13B impinger train and a cascade impactor. Prior to sampling, the outlet duct was modified by removing the existing 30-inch long duct and the moisture extractor and replacing them with a 70-inch long extension from the transition duct. Since the moisture extractor was not subject to evaluation, it was not connected to the 70-inch extension.

Two 3.5-inch diameter sampling ports were installed on the modified outlet duct at 50 inches (2.5 duct diameters) downstream from the induced-draft fan and 20 inches (1 duct diameter) upstream from the atmosphere. The sample ports were configured on the horizontal axis, 90 degrees apart. A total of 24 traverse points were required in sampling the outlet duct. The sampling time per traverse point was 7.5 minutes for a total sampling time of 180 minutes. The triplicate size distribution sampling runs were 180, 210 and 240 minutes in duration following the MM 13B runs.

Outlet testing was conducted simultaneously with inlet testing. The sampling protocol for the outlet was the same as that for the inlet. Traverse Point 1, as calculated, was located close to the sampling ports and introduced the possibility of ambient air entering the gas stream and diluting the sample. To eliminate this problem, Traverse Point 2 was sampled for 15 minutes to complete the 24-point traverse. The relocation of traverse points was discussed and accepted by the EPA task manager.

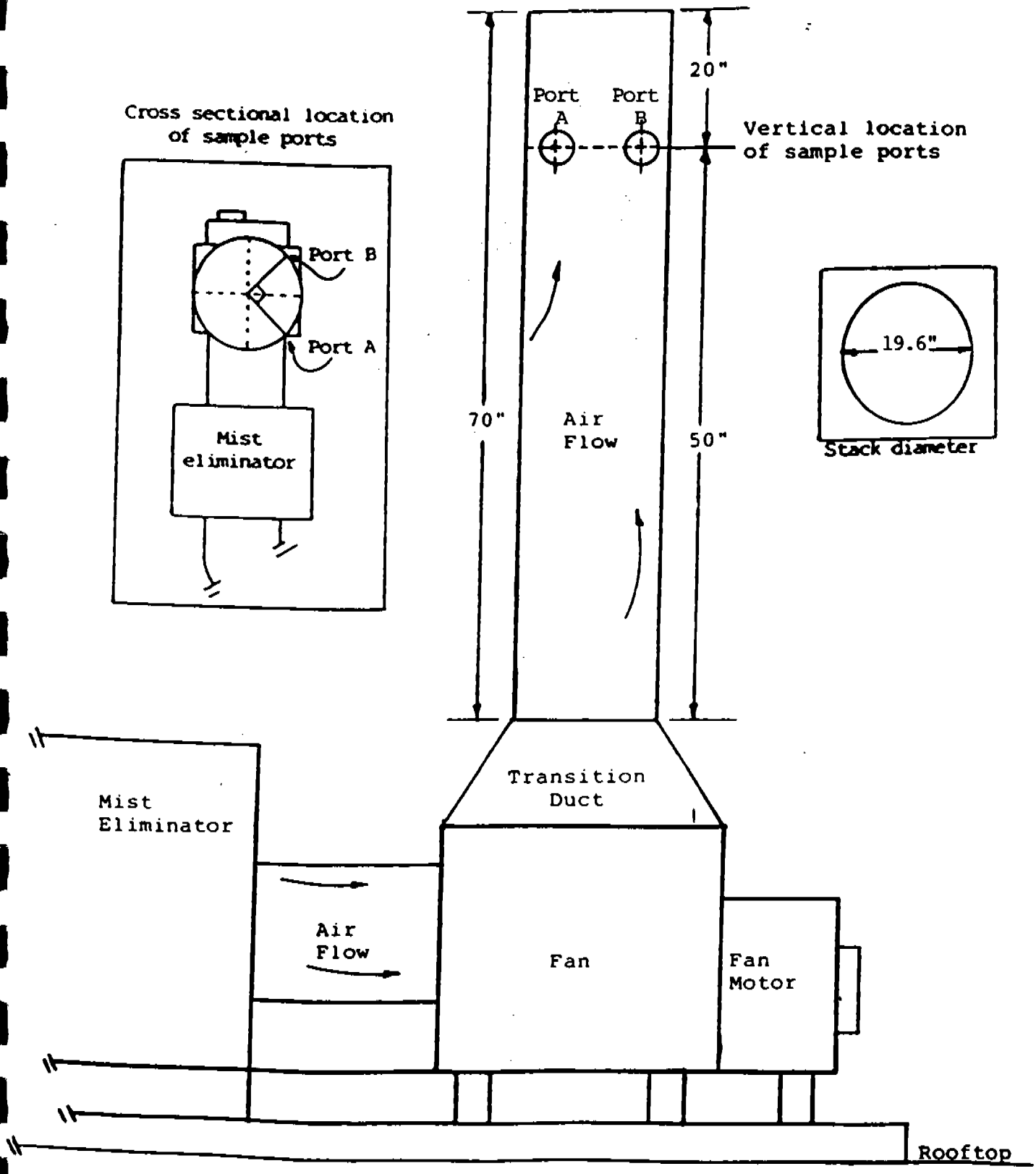


Figure 4-3. Orthogonal sketch of outlet sampling location.

4.3 HEXAVALENT AND TOTAL CHROMIUM SAMPLE EXTRACTION AND ANALYSIS

Prior to sampling, velocity, static pressure, moisture content, and temperature were measured to define sampling rates and nozzle sizes as described in the EPA Reference Methods 1, 2 and 4.[2] The stack gas molecular weight was not determined by EPA Method 3. Alternatively, the molecular weight was assigned the value of 29.0 lb/lb mole, as stated in the EPA Method 2, paragraph 3.6. A "spot" check to verify the absence of cyclonic flow at the inlet and outlet was conducted. This check indicated acceptable flow patterns in the gas stream. The presence of cyclonic flow was not suspected because prior tests with similarly configured control equipment showed no cyclonic flow. Hence, sampling was performed by conducting triplicate tests at the inlet and outlet of the mist eliminator. Samples were collected to determine the uncontrolled Cr^{+6} and Cr emissions from this source.

4.3.1 Modified Method 13B

An EPA MM 13B[3] sample train was used to collect the Cr^{+6} and total Cr samples. The sample train consisted of a 316-stainless steel, button-hook design nozzle, an unheated Pyrex glass-lined probe, and a series of impingers. The first, third and fourth impingers were of the Greenburg-Smith design, modified by replacing the tip with a 1/2-inch inside diameter glass tube extending to 1/2-inch from the bottom of the flask. The second impinger was a Greenburg-Smith impinger with the standard tip. One hundred mℓ of 0.1N NaOH was placed in each of the first, second and third impingers, and approximately 200 grams of silica gel was placed in the fourth impinger. The balance of the sampling system consisted of a vacuum pump, dry gas meter, calibrated orifice, and related temperature and pressure indicating apparatus with which to determine dry gas sample volume, stack gas temperature, volumetric flow rate and isokinetic sampling rates. During sampling, stack gas temperature and the gas temperature exiting the fourth impinger were monitored with thermocouples.

The impingers were weighed before and after each test to determine the moisture content of the flue gas stream. These weights were recorded on "Sample Recovery and Integrity Sheets." The sample recovery data is contained in Appendix C. The contents of the impingers were placed in a polyethylene container. All connecting glassware, the nozzle and probe were rinsed with 0.1 N NaOH and combined with the impinger solution in the polyethylene sample bottle. The liquid level was marked on each sample bottle and the pH was checked with pH paper to verify that the pH was above 7.0. Appropriate blank solutions were collected in the field for submission to the laboratory for analysis with the samples. The samples were transported to the laboratory where total volumes of each sample were measured. The volume recovered from Run I-1 was 899 mℓ, Run I-2 was 502 mℓ and 844 mℓ was recovered from Run I-3. The volume recovered from O-1 was 360 mℓ, Run O-2 was 887 mℓ and 555 mℓ was recovered from O-3. Each sample, including blanks, was analyzed for Cr^{+6} and total Cr concentrations using analytical methodology recently developed by the EPA. A copy of the draft method entitled "Determination of Hexavalent Chromium Emissions From Stationary Sources" is contained in Appendix B of this report. This method entails the extraction of the sample with alkaline solution, followed by the diphenylcarbazide colorimetric method.[4]

At the completion of the Cr^{+6} analysis, a separate portion of each sample was digested and analyzed for total Cr by use of ICAP analytical techniques.[5] Appendix B of this report contains the detailed analytical methodology used for this analysis.

4.3.2 Size Distribution

Three size distribution runs were performed at the inlet to and the outlet from the mist eliminator. This data was used to determine the size distribution of the total Cr emissions. All size distribution tests were performed in accordance with procedures detailed in the equipment manufacturer's operations manual, and through consultation with the manufacturer.

Samples for size distribution measurements were collected using an Andersen Mark III 8-stage impactor with glass-fiber filters as the substrate media. This in-stack impactor consisted of eight cutpoint stages and backup filter. the impactor was reconfigured by using Stages 1, 4, 7 and the backup with glass fiber substrates followed by Stages 2, 3, 5, 6 and 8 for spacing purposes. The purpose of this technique was to reduce the number of particle cutpoints, thereby increasing the mass of particles collected on each stage. Validity of this procedure was discussed with and accepted by the manufacturer of the impactor as well as by the EPA task manager. The sampled gas stream enters the system through the precutter. Particles with sufficient inertia are impacted against the sides of the precutter. Smaller particles flow with the gas stream, exit the precutter, and enter the main impactor. Then, particles with sufficient inertia are impacted on the front of the zero stage plate (no filter), smaller particles pass through the holes in the zero stage plate, and the portion of these particles with sufficient inertia impacts on the zero stage filter. The remainder of the particles pass through the holes in the first stage plate and similarly on to each succeeding stage. Finally, a glass-fiber backup filter removes all particles remaining in the gas stream downstream of the final, seventh stage plate.

The modified Andersen impactor was used to collect samples at a point of average velocity and temperature, at both the inlet and outlet sample locations. Sampling times ranged from 190 to 240 minutes for the inlet and 180 to 240 minutes for the outlet.

Isokinetic sampling rates were set initially, based on the average gas velocity measured during the MM 13B runs. At the completion of each test, the impactor samples were recovered according to procedures described in Appendix I.

Each recovered fraction was subjected to a gravimetric analysis using procedures similar to those in the EPA Method 5. At the completion of the gravimetric analysis, samples were combined by location and stage cutpoint

for analysis of total Cr. Analytical procedures followed those previously described.

All particle size results are based on a particle density of 1 g/cm^3. Moisture contents and gas molecular weights were obtained from MM 13B Cr tests. Size distribution curves were established to represent the total weight percent of particulate matter smaller than the indicated aerodynamic particle diameter in micrometers.

4.4 PROCESS SAMPLES

Grab samples were collected from each of the two chromium plating tanks during the chromium test runs and during the particle size run. Sample aliquots were taken at three equal intervals during each period of air sampling, namely at the beginning, midpoint and the end of each three- hour test. These samples were analyzed for Cr and Cr^{+6} concentrations.

4.5 WASHDOWN WATER

A grab sample of the mist eliminator washdown water was collected during the morning following each sampling period. These samples were also analyzed for total Cr and Cr^{+6}.

SECTION 5.0
PROJECT QUALITY ASSURANCE

The application of quality assurance procedures to source emission measurement ensures accurate emission-testing results. Quality assurance guidelines provide the detailed procedures and actions necessary for defining and producing acceptable data. In this project, three documents were used in the preparation of a site test plan that would ensure the collection of acceptable data:

1. "Quality Assurance Handbook for Air Pollution Measurement Systems," Volume III; Stationary Source-Specific Methods," EPA-600/4-77-027B;

2. PEI Laboratory Quality Assurance Plan;

3. Determination of Hexavalent Chromium Emissions From Stationary Sources, December 13, 1984. (This method has recently been developed by the EPA.)

In this specific test program, which was reviewed by the EPA's Emission Measurement Branch, the following steps were taken to ensure that the testing and analytical procedures produced quality data:

- On-site quality assurance checks, such as leak checks of the sampling train and velocity measuring apparatus, detailed information on these checks is presented in Appendix C. On-site quality assurance checks were performed on all test equipment prior to its use.

- Triplicate micrometer measurements of the sampling nozzle. These measurements were recorded on the field data sheets (Appendix C).

- Use of sampling equipment as designated in EPA Method 13B.

- Standard forms were used for recording the data and for calculations of data.

- The sample recovery was performed in a warehouse located on site, isolated from contamination.

- Collected samples were placed in polyethylene sample bottles. Polyethylene bottles are recommended for storing and shipping of corrosive materials.

- Samples were secured upon completion of the sample recovery activities. The samples and blanks were placed in a designated space in the cleanup area. The area was locked when unattended. For transportation, the samples and blanks were secured in boxes. No special storage was required for these samples.

- Samples were in the custody of PEER Consultants, P.C., at all times until transfer to the analytical laboratory. When the samples were transported to the laboratory the Sample Custodian acknowledged the laboratory's receipt of the samples (Appendix C).

- All glassware and sample bottles were rinsed with 10 percent nitric acid before use in the field.

- External contaminated surfaces (probe, nozzle and pitot tube) were rinsed with tap water prior to sample recovery. This was done to eliminate the risk of sample contamination.

- A polyethylene dipper was used to take samples of the chrome plating solution.

- While sampling, the ports were capped and the accessed port was sealed with a rag to prevent the introduction of ambient air into the duct.

- All field-sampling equipment was calibrated. The pretest and post-test calibration data for the equipment used in the field is contained in Appendix G.

- Duplicate and spiked samples were analyzed in the laboratory.

Table 5-1 list the specific sampling equipment used to perform the MM 13B sampling program. The calibration data for this equipment is presented in detail in Appendix G.

TABLE 5-1. EQUIPMENT USED IN THE MM 13B SAMPLING PROGRAM

Equipment	Identification
Meter Boxes	RAC 1065, MB-4
Thermometers	
- meter box	RAC-1, RAC-2
- sample head	SH-1, SH-2
Pitot Tubes	S-1, S-3
Thermocouple	3-T-1A, 3T-2A

On-site calculations were made by the EPA Task Manager on the emissions sampling data to determine the isokinetic variation and moisture content of the stack gas. All final calculations were done after the post-test calibrations had been performed on the equipment following the return from the field test. The final calculations are presented in Appendix D. The following summarizes the quality assurance activities performed during the analytical phase of this project.

Emission and process samples were analyzed in the same batches. Reagent blanks that were set-up in the field were analyzed with the actual sample. The blank results are presented in Table 5-2.

TABLE 5-2. SUMMARY OF BLANK ANALYSES

Blank I.D. No.	Cr^{+6} (mg/ℓ)	Total Cr (mg/ℓ)
B1 Run I-1 & O-1	Less than 0.009	0.011
B1 Run I-2 & O-2	Less than 0.009	0.011
B1 Run I-2 & O-2	Less than 0.009	0.013

In addition to the analysis of the submitted samples and blanks, duplicate and spiked samples were analyzed. Table 5-3 summarizes the result of these QA/QC checks.

TABLE 5-3. SUMMARY OF ANALYTICAL RESULTS FROM DUPLICATE AND SPIKED SAMPLES

Sample I.D. No.	Type of Sample	Results
	Cr^{+6}	(mg/ℓ)
Washdown 5/13	Duplicate	69,500 61,600
Plating solution Tank No. 1, 5/13/87	Duplicate	128,000 128,000
MM 13B, Run I-2	Duplicate	3.1 7.64
	Total Cr	(mg/ℓ)
Washdown 5/13	Duplicate	59,200 54,800
Plating solution Tank No. 1, 5/13/87	Duplicate	110,000 111,000
MM 13B, Run I-2	Duplicate	4.93 4.16

REFERENCES

1. Andersen Samplers Inc., Mark III 8-Stage Cascade Impactor Operations Manual, February 1984.

2. 40 CFR Part 60, Appendix A, EPA Reference Methods 1,2,4, July 1986.

3 40 CFR part 60, Appendix A, EPA Reference Method 13, July 1987

4 "Test Methods for Evaluating Solid Waste," U.S. EPA SW-846, 2nd Edition, July 1982, Method 3060

5 "Test Methods for Evaluating Solid Waste," U.S. EPA SW-846, 2nd Edition, July 1982, Method 3050.

APPENDIX A

Process Monitoring Data

AMPERE-HOUR CALCULATIONS
TEST RUN NO.
INLET: I-1; OUTLET: O-1
TANK NO. 1 WORK-STATION NO. 1

Time (24-h clock)		Time interval, min		Current, amperes	Ampere-hours	
Inlet	Outlet	Inlet	Outlet		Inlet	Outlet
09:52	09:55					
10:02	10:02	10	7	1,500	250	175
10:12	10:12	10	10	1,500	250	250
10:22	10:22	10	10	1,550	258	258
10:32	10:32	10	10	1,550	258	258
10:42	10:42	10	10	1,600	267	267
10:52	10:52	10	10	1,600	267	267
11:02	11:02	10	10	1,600	267	267
11:12	11:12	10	10	1,600	267	267
11:22	11:22	10	10	1,600	267	267
	11:25	0	3	1,600	0	80
Subtotal		90	90		2,351	2,356
11:39						
11:42	11:42	3	0	1,600	80	0
11:52	11:52	10	10	1,650	275	275
12:02	12:02	10	10	1,650	275	275
12:12	12:12	10	10	1,650	275	275
12:22	12:22	10	10	1,650	275	275
12:32	12:32	10	10	1,650	275	275
12:42	12:42	10	10	1,650	275	275
12:52	12:52	10	10	1,650	275	275
13:02	13:02	10	10	1,650	275	275
13:09	13:12	7	10	1,700	198	283
Subtotal		90	90		2,478	2,483
TOTAL		180	180		4,829	4,839

AMPERE-HOUR CALCULATIONS
TEST RUN NO.
INLET: I-1; OUTLET: O-1
TANK NO. 1 WORK-STATION NO. 2

Time (24-h clock)		Time interval, min		Current, amperes	Ampere-hours	
Inlet	Outlet	Inlet	Outlet		Inlet	Outlet
09:52	09:55					
10:02	10:02	10	7	1,150	192	134
10:12	10:12	10	10	1,150	192	192
10:22	10:22	10	10	1,200	200	200
10:32	10:32	10	10	1,200	200	200
10:42	10:42	10	10	1,200	200	200
10:52	10:52	10	10	1,200	200	200
11:02	11:02	10	10	1,200	200	200
11:12	11:12	10	10	1,250	208	208
11:22	11:22	10	10	1,250	208	208
	11:25	0	3	1,250	0	63
Subtotal		90	90		1,800	1,805
11:39						
11:42	11:42	3	0	1,250	63	0
11:52	11:52	10	10	1,250	208	208
12:02	12:02	10	10	1,250	208	208
12:12	12:12	10	10	1,250	208	208
12:22	12:22	10	10	1,300	217	217
12:32	12:32	10	10	1,300	217	217
12:42	12:42	10	10	1,300	217	217
12:52	12:52	10	10	1,300	217	217
13:02	13:02	10	10	1,300	217	217
13:09	13:12	7	10	1,300	152	217
Subtotal		90	90		1,924	1,926
TOTAL		180	180		3,724	3,731

AMPERE-HOUR CALCULATIONS
TEST RUN NO.
INLET: I-1; OUTLET: O-1
TANK NO. 2 WORK-STATION NOS. 1 and 2

Time (24-h clock)		Time interval, min		Current, amperes	Ampere-hours	
Inlet	Outlet	Inlet	Outlet		Inlet	Outlet
09:52	09:55					
10:02	10:02	10	7	2,100	350	245
10:12	10:12	10	10	2,100	350	350
10:22	10:22	10	10	2,100	350	350
10:32	10:32	10	10	2,200	367	367
10:36	10:36	4	4	2,200	147	147
10:42	10:42	6	6	1,100	110	110
10:44	10:44	2	2	2,200	73	73
10:49	10:49	5	5	1,200	100	100
10:52	10:52	3	3	2,200	110	110
11:02	11:02	10	10	2,250	375	375
11:12	11:12	10	10	2,300	383	383
11:22	11:22	10	10	2,300	383	383
	11:25	0	3	2,300	0	115
Subtotal		90	90		3,098	3,108
11:39						
11:40		1	0	2,300	38	0
11:42	11:42	2	0	1,450	48	0
11:44	11:44	2	2	1,450	48	48
11:46	11:46	2	2	2,250	75	75
11:51	11:51	5	5	1,500	125	125
12:02	12:02	11	11	2,300	422	422
12:12	12:12	10	10	2,300	383	383
12:22	12:22	10	10	2,350	392	392
12:32	12:32	10	10	2,350	392	392
12:42	12:42	10	10	2,350	392	392
12:52	12:52	10	10	2,350	392	392
13:02	13:02	10	10	2,350	392	392
13:09	13:12	7	10	2,350	274	392
Subtotal		90	90		3,373	3,405
TOTAL		180	180		6,471	6,513

AMPERE-HOUR CALCULATIONS
TEST RUN NO.
INLET: I-2; OUTLET: O-2
TANK NO. 1 WORK-STATION NO. 1

Time (24-h clock)		Time interval, min		Current, amperes	Ampere-hours	
Inlet	Outlet	Inlet	Outlet		Inlet	Outlet
09:25	09:28					
09:35	09:35	10	7	1,350	225	157
09:45	09:45	10	10	1,350	225	225
09:52	09:52	7	7	1,350	157	157
Subtotal		27	24		607	539
10:01	10:01					
10:05	10:05	4	4	1,350	90	90
10:15	10:15	10	10	1,350	225	225
10:25	10:25	10	10	1,400	233	233
10:35	10:35	10	10	1,400	233	233
10:45	10:45	10	10	1,450	242	242
10:55	10:55	10	10	1,450	242	242
	10:58	0	3	1,450	0	72
Subtotal		54	57		1,265	1,337
11:20	11:20					
11:25	11:25	5	5	1,500	125	125
11:35	11:35	10	10	1,500	250	250
11:45	11:45	10	10	1,500	250	250
11:55	11:55	10	10	1,500	250	250
Subtotal		35	35		875	875
12:00	12:00					
12:05	12:05	5	5	1,600	133	133
12:15	12:15	10	10	1,600	267	267
12:25	12:25	10	10	1,600	267	267
12:35	12:35	10	10	1,600	267	267
12:45	12:45	10	10	1,600	267	267
	12:48	0	3	1,600	0	80
Subtotal		45	48		1,201	1,281
TOTAL		161	164		3,948	4,032

AMPERE-HOUR CALCULATIONS
TEST RUN NO.
INLET: I-2; OUTLET: O-2
TANK NO. 1 WORK-STATION NO. 2

Time (24-h clock)		Time interval, min		Current, amperes	Ampere-hours	
Inlet	Outlet	Inlet	Outlet		Inlet	Outlet
09:25	09:28					
09:35	09:35	10	7	1,250	208	146
09:44	09:44	9	9	1,250	187	187
Subtotal		19	16		395	333
09:54	09:54					
10:05	10:05	11	11	1,200	220	220
10:15	10:15	10	10	1,250	208	208
10:25	10:25	10	10	1,300	217	217
10:35	10:35	10	10	1,300	217	217
10:45	10:45	10	10	1,300	217	217
10:55	10:55	10	10	1,300	217	217
	10:58	0	3	1,300	0	65
Subtotal		61	64		1,296	1,361
11:15	11:18					
11:25	11:25	10	7	1,300	217	152
11:35	11:35	10	10	1,300	217	217
11:45	11:45	10	10	1,350	225	225
11:55	11:55	10	10	1,400	233	233
12:05	12:05	10	10	1,400	233	233
12:15	12:15	10	10	1,400	233	233
12:25	12:25	10	10	1,450	242	242
12:32	12:32	7	7	1,450	169	169
Subtotal		77	74		1,769	1,704
12:41	12:41					
12:45	12:48	4	7	1,350	90	157
Subtotal		4	7		90	157
TOTAL		161	161		3,550	3,555

AMPERE-HOUR CALCULATIONS
TEST RUN NO.
INLET: I-2; OUTLET: O-2
TANK NO. 2 WORK-STATION NOS. 1 and 2

Time (24-h clock)		Time interval, min		Current, amperes	Ampere-hours	
Inlet	Outlet	Inlet	Outlet		Inlet	Outlet
09:25	09:28					
09:35	09:35	10	7	2,300	383	268
09:45	09:45	10	10	2,300	383	383
09:55	09:55	10	10	2,300	383	383
10:05	10:05	10	10	2,300	383	383
10:15	10:15	10	10	2,350	392	392
10:22	10:22	7	7	2,350	274	274
10:30	10:30	8	8	1,600	213	213
10:31	10:31	1	1	2,350	39	39
10:40	10:40	9	9	1,450	217	217
10:45	10:45	5	5	2,350	196	196
10:55	10:55	10	10	2,350	392	392
	10:58	0	3	2,350	0	117
Subtotal		90	90		3,255	3,257
11:15	11:18					
11:25	11:25	10	7	2,400	400	280
11:35	11:35	10	10	2,400	400	400
11:40	11:40	5	5	2,400	200	200
11:47	11:47	7	7	1,500	175	175
11:48	11:48	1	1	2,400	40	40
11:54	11:54	6	6	1,550	155	155
12:05	12:05	11	11	2,300	422	422
12;15	12:15	10	10	2,300	383	383
12:25	12:25	10	10	2,300	383	383
12:35	12:35	10	10	2,300	383	383
12:45	12:45	10	10	2,300	383	383
	12:48	0	3	2,300	0	115
Subtotal		90	90		3,324	3,319
TOTAL		180	180		6,579	6,576

AMPERE-HOUR CALCULATIONS
TEST RUN NO.
INLET: I-3; OUTLET: O-3
TANK NO. 1 WORK-STATION NO. 1

Time (24-h clock)		Time interval, min		Current, amperes	Ampere-hours	
Inlet	Outlet	Inlet	Outlet		Inlet	Outlet
08:45	08:48					
08:55	08:55	10	7	1,300	217	152
09:05	09:05	10	10	1,350	225	225
09:15	09:15	10	10	1,350	225	225
09:25	09:25	10	10	1,350	225	225
09:35	09:35	10	10	1,375	229	229
09:45	09:45	10	10	1,375	229	229
09:55	09:55	10	10	1,375	229	229
10:05	10:05	10	10	1,375	229	229
10:15	10:15	10	10	1,375	229	229
	10:18	0	3	1,375	0	69
Subtotal		90	90		2,037	2,041
10:30	10:33					
10:38	10:38	8	5	1,350	180	112
10:40	10:40	2	2	1,150	38	38
10:50	10:50	10	10	1,150	192	192
11:00	11:00	10	10	1,150	192	192
11:10	11:10	10	10	1,150	192	192
11:20	11:20	10	10	1,150	192	192
11:30	11:30	10	10	1,150	192	192
11:40	11:40	10	10	1,150	192	192
11:50	11:50	10	10	1,150	192	192
12:00	12:00	10	10	1,150	192	192
	12:03	0	3	1,150	0	57
Subtotal		90	90		1,754	1,743
TOTAL		180	180		3,791	3,784

AMPERE-HOUR CALCULATIONS
TEST RUN NO.
INLET: I-3; OUTLET: O-3
TANK NO. 1 WORK-STATION NO. 2

Time (24-h clock)		Time interval, min		Current, amperes	Ampere-hours	
Inlet	Outlet	Inlet	Outlet		Inlet	Outlet
08:45	08:48					
08:55	08:55	10	7	1,300	217	152
09:05	09:05	10	10	1,300	217	217
09:15	09:15	10	10	1,350	225	225
09:25	09:25	10	10	1,350	225	225
09:35	09:35	10	10	1,400	233	233
09:45	09:45	10	10	1,400	233	233
09:55	09:55	10	10	1,400	233	233
10:05	10:05	10	10	1,400	233	233
10:15	10:15	10	10	1,400	233	233
	10:18	0	3	1,400	0	70
Subtotal		90	90		2,049	2,054
10:30	10:33					
10:38	10:38	8	5	1,350	180	112
10:40	10:40	2	2	1,100	37	37
10:50	10:50	10	10	1,100	183	183
11:00	11:00	10	10	1,100	183	183
11:10	11:10	10	10	1,100	183	183
11:20	11:20	10	10	1,100	183	183
11:30	11:30	10	10	1,100	183	183
11:40	11:40	10	10	1,100	183	183
11:50	11:50	10	10	1,100	183	183
12:00	12:00	10	10	1,100	183	183
	12:03	0	3	1,100	0	55
Subtotal		90	90		1,681	1,668
TOTAL		180	180		3,730	3,722

AMPERE-HOUR CALCULATIONS
TEST RUN NO.
INLET: I-3; OUTLET: O-3
TANK NO. 2 WORK-STATION NOS. 1 and 2

Time (24-h clock)		Time interval, min		Current, amperes	Ampere-hours	
Inlet	Outlet	Inlet	Outlet		Inlet	Outlet
08:45	08:48					
08:55	08:55	10	7	2,400	400	280
09:05	09:05	10	10	2,400	400	400
09:15	09:15	10	10	2,400	400	400
09:25	09:25	10	10	2,400	400	400
09:33	09:33	8	8	2,400	320	320
09:35	09:35	2	2	1,500	50	50
09:45	09:45	10	10	1,500	250	250
09:52	09:52	7	7	1,500	175	175
09:55	09:55	3	3	2,200	110	110
10:05	10:05	10	10	2,250	375	375
10:15	10:15	10	10	2,250	375	375
	10:18	0	3	2,250	0	112
Subtotal		90	90		3,255	3,247
10:30	10:33					
10:40	10:40	10	7	2,250	375	262
10:50	10:50	10	10	2,250	375	375
11:00	11:00	10	10	2,300	383	383
11:10	11:10	10	10	2,300	383	383
11:12	11:12	2	2	2,300	77	77
11:17	11:17	5	5	1,550	129	129
11:18	11:18	1	1	2,200	37	37
11:24	11:24	6	6	1,500	150	150
11:30	11:30	6	6	2,350	235	235
11:40	11:40	10	10	2,350	392	392
11:50	11:50	10	10	2,400	400	400
12:00	12:00	10	10	2,400	400	400
	12:03	0	3	2,400	0	120
Subtotal		90	90		3,336	3,343
TOTAL		180	180		6,591	6,590

SOURCE SAMPLING PROGRAM PROCESS DATA SHEET

Place: Consolidated Engravers
Date: May 12, 1987
Tank No.: 1
Work-station No.: 1
Sample type: Total and hexavalent chromium

Test run No.		Test start time		Test stop time	
Inlet:	I-1	Inlet:	09:52	Inlet:	13:09
Outlet:	O-1	Outlet:	09:55	Outlet:	13:12

Time (24-h clock) Inlet	Outlet	Temp., (°C) °F	Voltage, volts	Current, amperes	Pressure drop, kPa (in. w.c.)	Notes[a]
09:52	09:55	60 (140)	15.5	1,500		Started plating at 09:50
10:02	10:02	61 (142)	15.5	1,500	0.05 (0.20)	Started testing inlet at 09:52 and outlet at 09:55
10:12	10:12	62 (144)	15.5	1,500		Work plated: one industrial roll (dummy)
10:22	10:22	63 (146)	15.5	1,550		• Length = 127 cm (50 in.)
10:32	10:32	64 (148)	15.5	1,550		• Width = 14.6 cm (5.75 in.) outside diameter
10:42	10:42	66 (150)	15.5	1,600	0.05 (0.20)	• Surface area = 5,827.5 sq cm (903.2 sq in.)
10:52	10:52	68 (154)	15.5	1,600		
11:02	11:02	69 (156)	15.5	1,600	0.05 (0.20)	Grab samples of plating solution taken at 10:07
11:12	11:12	70 (158)	15.5	1,600	0.05 (0.20)	
11:22	11:22	90 (158)	15.5	1,600		Stopped testing inlet at 11:22 and outlet at 11:25 to change test ports
	11:25	70 (158)	15.5	1,600		
11:39		70 (158)	15.5	1,600		Started testing inlet at 11:39 and outlet at 11:42
11:42	11:42	70 (158)	15.5	1,600		Work plated: Same as above
11:52	11:52	71 (160)	15.5	1,650	0.05 (0.20)	Grab samples of plating solution taken at 11:30
12:02	12:02	71 (160)	15.5	1,650		
12:12	12:12	71 (160)	15.5	1,650	0.05 (0.20)	
12:22	12:22	71 (160)	15.5	1,650		
12:32	12:32	71 (160)	15.5	1,650		
12:42	12:42	71 (160)	15.5	1,650		
12:52	12:52	71 (160)	15.5	1,650	0.05 (0.20)	Grab samples of plating solution taken at 12:59
13:02	13:02	71 (160)	15.5	1,650		
13:09	13:12	71 (160)	15.5	1,650		Stopped testing inlet at 13:09 and outlet at 13:12

[a]The mist eliminator was washed down before testing began.

SOURCE SAMPLING PROGRAM PROCESS DATA SHEET

Place: Consolidated Engravers
Date: May 12, 1987
Tank No.: 1
Work-station No.: 2
Sample type: Total and hexavalent chromium

Test run No.		Test start time		Test stop time	
Inlet:	I-1	Inlet:	09:52	Inlet:	13:09
Outlet:	O-1	Outlet:	09:55	Outlet:	13:12

Time (24-h clock) Inlet	Time (24-h clock) Outlet	Temp., (°C) °F	Voltage, volts	Current, amperes	Pressure drop, kPa (in. w.c.)	Notes[a]
09:52	09:55	60 (140)	13.0	1,150		Started plating at 09:50
10:02	10:02	61 (142)	13.0	1,150	0.05 (0.20)	Started testing inlet at 09:52 and outlet at 09:55
10:12	10:12	62 (144)	13.0	1,150		Work plated: one industrial roll (dummy)
10:22	10:22	63 (146)	13.0	1,200		• Length = 127 cm (50 in.)
10:32	10:32	64 (148)	13.0	1,200		• Width = 13.3 cm (5.25 in.) outside diameter
10:42	10:42	66 (150)	13.0	1,200	0.05 (0.20)	• Surface area = 5,321 sq cm (824.7 sq in.)
10:52	10:52	68 (154)	13.0	1,200		
11:02	11:02	69 (156)	13.0	1,200	0.05 (0.20)	Grab samples of plating solution taken at 10:07
11:12	11:12	70 (158)	13.0	1,250	0.05 (0.20)	
11:22	11:22	70 (158)	13.0	1,250		
	11:25	70 (158)	13.0	1,250		Stopped testing inlet at 11:22 and outlet at 11:25 to change test ports
11:39		70 (158)	13.0	1,250		Started testing inlet at 11:39 and outlet at 11:42
11:42	11:42	70 (158)	13.0	1,250		Work plated: Same as above
11:52	11:52	71 (160)	13.0	1,250	0.05 (0.20)	Grab samples of plating solution taken at 11:30
12:02	12:02	71 (160)	13.0	1,250		
12:12	12:12	71 (160)	13.0	1,250	0.05 (0.20)	
12:22	12:22	71 (160)	13.0	1,300		
12:32	12:32	71 (160)	13.0	1,300		
12:42	12:42	71 (160)	13.0	1,300		
12:52	12:52	71 (160)	13.0	1,300	0.05 (0.20)	Grab samples of plating solution taken at 12:59
13:02	13:02	71 (160)	13.0	1,300		
13:09	13:12	71 (160)	13.0	1,300		Stopped testing inlet at 13:09 and outlet at 13:12

[a]The mist eliminator was washed down before testing began.

SOURCE SAMPLING PROGRAM PROCESS DATA SHEET

Place: Consolidated Engravers
Date: May 12, 1987
Tank No.: 2
Work-station Nos.: 1 and 2
Sample type: Total and hexavalent chromium

Test run No.		Test start time		Test stop time	
Inlet:	I-1	Inlet:	09:52	Inlet:	13:09
Outlet:	O-1	Outlet:	09:55	Outlet:	13:12

Time (24-h clock) Inlet	Outlet	Temp., (°C) °F	Voltage, volts	Current, amperes	Pressure drop, kPa (in. w.c.)	Notes[a]
09:52	09:55	52 (126)	10.0	2,100		Started plating at 09:42
10:02	10:02	52 (126)	10.0	2,100	0.05 (0.20)	Started testing inlet at 09:52 and outlet at 09:55
10:12	10:12	52 (126)	10.0	2,100		Work plated in work-station (WS) 1: one industrial roll
10:22	10:22	52 (126)	10.0	2,100		• Length = 127 cm (50 in.)
10:32	10:32	52 (126)	10.0	2,200		• Width = 12.2 cm (4.75 in.) outside diameter (O.D.)
10:36	10:36	52 (126)	10.0	2,200		• Surface area = 4,814 sq cm (746.1 sq in.)
10:37	10:37	52 (126)	10.2	1,100		Work plated in WS 2: one industrial roll
10:42	10:42	52 (126)	10.2	1,100	0.05 (0.20)	• Length = 127 cm (50 in.)
10:44	10:44	52 (126)	10.0	2,200		• Width = 13.3 cm (5.25 in.) O.D.
10:46	10:46	52 (126)	10.2	1,200		• Surface area = 5,321 sq cm (824.7 sq in.)
10:49	10:49	52 (126)	9.7	1,200		Grab samples of plating solution taken at 10:10
10:52	10:52	52 (126)	9.7	2,200		WS 1: stopped plating at 10:37, started plating one
11:02	11:02	54 (130)	9.6	2,250	0.05 (0.20)	industrial roll at 10:42; length = 127 cm (50 in.),
11:12	11:12	54 (130)	9.6	2,300	0.05 (0.20)	width = 14 cm (5.5 in.) O.D.
11:22	11:22	54 (130)	9.6	2,300		surface area = 5,574 sq cm (864 sq in.)
	11:25	54 (130)	9.6	2,300		WS 2: stopped plating at 10:44, started plating one industrial roll at 10:49; length = 127 cm (50 in.), width = 13.3 cm (5.25 in.) O.D., surface area = 5,321 sq cm (924.7 sq in.)
						Stopped testing inlet at 11:22 and outlet at 11:25 to change test ports
						Grab samples of plating solution taken at 11:32
11:39		54 (130)	9.6	2,300		Started testing inlet at 11:39 and outlet at 11:40
11:40	11:40	54 (130)	10.2	2,300		
11:42	11:42	54 (130)	10.2	1,450		WS 2: stopped plating at 11:40, started plating one
11:44	11:44	56 (132)	10.2	1,450		industrial roll at 11:44; length = 127 cm (50 in.),
11:46	11:46	58 (136)	10.2	2,250		width = 13.3 cm (5.25 in.) O.D., surface area = 5,321 sq cm
11:51	11:51	59 (138)	9.6	1,500		(824.7 sq in.)
11:52	11:52	59 (138)	9.6	2,300	0.05 (0.20)	WS 1: stopped plating at 11:46, started plating one
12:02	12:02	60 (140)	9.6	2,300		industrial roll at 11:51; length = 127 cm (50 in.),
12:12	12:12	60 (140)	9.6	2,300	0.05 (0.20)	width = 13.3 cm (5.25 in.) O.D., surface area = 5,321 sq cm
12:22	12:22	60 (140)	9.6	2,350		(824.7 sq in.)
12:32	12:32	61 (142)	9.6	2,350		Grab samples of plating solution taken at 13:01
12:42	12:42	62 (144)	9.6	2,350		
12:52	12:52	63 (146)	9.6	2,350	0.05 (0.20)	
13:02	13:02	63 (146)	9.6	2,350		Stopped testing inlet at 13:09 and outlet at 13:12
13:09	13:12	64 (148)	9.6	2,350		

[a]The mist eliminator was washed down before testing began.

SOURCE SAMPLING PROGRAM PROCESS DATA SHEET

Place: Consolidated Engravers
Date: May 13, 1987
Tank No.: 1
Work-station No.: 1
Sample type: Total and hexavalent chromium

Test run No.		Test start time		Test stop time	
Inlet:	I-2	Inlet:	09:25	Inlet:	12:45
Outlet:	O-2	Outlet:	09:28	Outlet:	12:48

Time (24-h clock) Inlet	Time (24-h clock) Outlet	Temp. (°C) °F	Voltage, volts	Current, amperes	Pressure drop, kPa (in. w.c.)	Notes[a] [b]
09:25	09:28	47 (116)	16.0	1,250		Started plating at 09:20
09:35	09:35	47 (116)	16.0	1,350	0.07 (0.30)	Started testing inlet at 09:25 and outlet at 09:28
09:45	09:455	0 (122)	16.0	1,350		Work plated: one industrial roll (dummy)
09:52	09:52	54 (130)	16.0	1,350		• Length = 127 cm (50 in.) outside diameter (O.D.)
						• Width = 13.3 cm (5.25 in.)
						• Surface area = 5,321 sq cm (824.7 sq in.)
						Stopped plating at 09:52
10:01	10:01	54 (130)	16.0	1,350		Started plating one industrial roll at 10:01
10:05	10:05	54 (130)	16.0	1,350	0.05 (0.20)	• Length = 152.4 cm (60 in.)
10:15	10:15	54 (130)	16.0	1,350		• Width = 12.7 cm (5.0 in.) O.D.
10:25	10:25	60 (140)	16.0	1,400		• Surface area = 6,081 sq cm (942.5 sq in.)
10:35	10:35	61 (142)	16.0	1,400	0.05 (0.20)	
10:45	10:45	62 (144)	15.5	1,450		
10:55	10:55	62 (144)	15.5	1,450	0.05 (0.20)	Stopped testing inlet at 10:55 and outlet at 10:58 to change test ports
	10:58	62 (144)	15.5	1,450		Grab samples of plating solution taken at 10:58
						Stopped plating at 11:04
11:15	11:18					Started testing inlet at 11:15 and outlet at 11:18
11:20	11:20	64 (148)	15.5	1,450		Started plating same industrial roll at 11:20
11:25	11:25	64 (148)	15.5	1,500	0.05 (0.20)	
11:35	11:35	64 (148)	15.5	1,500		
11:45	11:45	64 (148)	15.5	1,500		
11:55	11:55	66 (150)	15.5	1,500		Stopped plating at 11:55
12:00	12:00	67 (152)	15.5	1,550	0.05 (0.20)	Started plating one dummy industrial roll at 12:00
12:05	12:05	68 (154)	15.5	1,600		• Length = 127 cm (50 in.)
12:15	12:15	69 (156)	15.5	1,600		• Width = 14.6 cm (5.75 in.) O.D.
12:25	12:25	70 (158)	15.5	1,600	0.05 (0.20)	• Surface area = 5,827 sq cm (903.2 sq in.)
12:35	12:35	71 (160)	15.0	1,600		Grab samples of plating solution taken at 12:28
12:45	12:45	71 (160)	15.0	1,600		Stopped testing inlet at 12:45 and outlet at 12:48
	12:48	71 (160)	15.0	1,600		

[a]The mist eliminator was washed down with 248 liters (65.5 gallons) of water at 08:20. A grab sample of the washdown water was taken from the holding tank after the washdown was completed.
[b]Fifty pounds of chromic acid were added to tank No. 1 at 09:00.

SOURCE SAMPLING PROGRAM PROCESS DATA SHEET

Place: Consolidated Engravers
Date: May 13, 1987
Tank No.: 1
Work-station No.: 2
Sample type: Total and hexavalent chromium

Test run No.		Test start time		Test stop time	
Inlet:	I-2	Inlet:	09:25	Inlet:	12:45
Outlet:	O-2	Outlet:	09:28	Outlet:	12:48

Time (24-h clock) Inlet	Time (24-h clock) Outlet	Temp., (°C) °F	Voltage, volts	Current, amperes	Pressure drop, kPa (in. w.c.)	Notes[a] [b]
09:25	09:28	47 (116)	13.0	1,150		Started plating at 09:20
09:35	09:35	47 (116)	13.0	1,250	0.70 (0.30)	Started testing inlet at 09:25 and outlet at 09:28
09:44	09:44	50 (122)	13.0	1,250		Work plated: one industrial roll (dummy) • Length = 127 cm (50 in.) • Width = 14.6 cm (5.75 in.) outside diameter (O.D.) • Surface area = 5,827.5 sq cm (903.2 sq in.) Stopped plating at 09:44
09:54	09:54	54 (130)	13.0	1,200		Started plating one industrial roll at 09:54
10:05	10:05	54 (130)	13.0	1,200	0.05 (0.20)	• Length = 152.4 cm (60 in.) • Width = 12.7 cm (5.0 in.) O.D. • Surface area = 6,081 sq cm (942.5 sq in.)
10:15	10:15	54 (130)	13.0	1,250		
10:25	10:25	60 (140)	13.0	1,300		
10:35	10:35	61 (142)	13.0	1,300	0.05 (0.20)	
10:45	10:45	62 (144)	13.0	1,300		
10:55	10:55	62 (144)	13.0	1,300	0.05 (0.20)	Stopped testing inlet at 10:55 and outlet at 10:58 to change test ports
	10:58	62 (144)	13.0	1,300		Grab samples of plating solution taken at 10:58 Stopped plating at 11:04 Started plating same roll at 11:14
11:15	11:18	64 (148)	12.5	1,300		Started testing inlet at 11:15 and outlet at 11:18
11:25	11:25	64 (148)	12.5	1,300	0.05 (0.20)	
11:35	11;35	64 (148)	12.5	1,300		
11:45	11:45	64 (148)	12.5	1,350		
11:55	11:55	66 (150)	12.5	1,400		
12:05	12:05	68 (154)	12.5	1,400	0.05 (0.20)	
12:15	12:15	69 (156)	12.5	1,400		
12:25	12:25	70 (158)	12.5	1,450	0.05 (0.20)	Grab samples of plating solution taken at 12:28
12:32	12:32	71 (160)	12.5	1,450		Stopped plating at 12:32
12:41	12:41	71 (160)	12.5	1,350		Started plating one industrial roll (dummy) at 12:41
12:45	12:48	71 (160)	12.5	1,350		• Length = 127 cm (50 in.) • Width = 13.3 cm (5.25 in.) O.D. • Surface area = 5,321 sq cm (824.7 sq in.) Stopped testing inlet at 12:45 and outlet at 12:48

[a]The mist eliminator was washed down with 248 liters (65.5 gallons) of water at 08:20. A grab sample of the washdown water was taken from the holding tank after the washdown was completed.
[b]Fifty pounds of chromic acid were added to tank No. 1 at 09:00.

SOURCE SAMPLING PROGRAM PROCESS DATA SHEET

Place: Consolidated Engravers
Date: May 13, 1987
Tank No.: 2
Work-station Nos.: 1 and 2
Sample type: Total and hexavalent chromium

Test run No.	Test start time	Test stop time
Inlet: I-2	Inlet: 09:25	Inlet: 12:45
Outlet: O-2	Outlet: 09:28	Outlet: 12:48

Time (24-h clock) Inlet	Time (24-h clock) Outlet	Temp., (°C) °F	Voltage, volts	Current, amperes	Pressure drop, kPa (in. w.c.)	Notes[a]
09:25	09:28	50 (122)	9.6	2,250		Started testing inlet at 09:25 and outlet at 09:28
09:35	09:35	51 (124)	9.6	2,300	0.07 (0.30)	Work plated at WS 1 and WS 2: one industrial roll in each WS
09:45	09:45	52 (126)	9.6	2,300		• Length = 127 cm (50 in.)
09:55	09:55	53 (128)	9.6	2,300		• Width = 140.0 cm (5.5 in.) outside diameter (O.D.)
10:05	10:05	54 (130)	9.6	2,300	0.05 (0.20)	• Surface area = 5,574 sq cm (864 sq in.)
10:15	10:15	54 (130)	9.6	2,350		Grab samples of plating solution taken at 09:40
10:22	10:22	54 (130)	9.6	2,350		WS 1: stopped plating at 10:22, started plating one roll at 10:30
10:30	10:30	54 (130)	10.2	1,600		
10:31	10:31	54 (130)	9.8	2,350	0.05 (0.20)	• Length = 127 cm (50 in.)
10:40	10:40	58 (136)	10.2	1,450		• Width = 14.0 cm (5.5 in.) O.D.
10:45	10:45	58 (136)	10.0	2,350		• Surface area = 5,574 sq cm (864 sq in.)
10:55	10:55	58 (136)	10.0	2,350	0.05 (0.20)	WS 2: stopped plating at 10:31, started plating one roll at 10:40
	10:58	58 (136)	10.0	2,350		• Length = 127 cm (50 in.)
						• Width = 14.0 cm (5.5 in.) O.D.
						• Surface area = 5,574 sq cm (864 sq in.)
						Stopped testing inlet at 10:55 and outlet at 10:58 to change test ports
						Grab samples of plating solution taken at 11:01
11:15	11:18	59 (138)	9.4	2,400		Started testing inlet at 11:15 and outlet at 11:18
11:25	11:25	60 (140)	9.4	2,400	0.05 (0.20)	
11:35	11:35	60 (140)	9.4	2,400		
11:40	11:40	60 (140)	9.4	2,400		WS 2: stopped plating at 11:40, started plating one roll at 11:47
11:47	11:47	60 (140)	10.2	1,500		
11:48	11:48	60 (140)	10.0	2,400		• Length = 127 cm (50 in.)
11:54	11:54	60 (140)	10.2	1,550		• Width = 12.4 cm (4.875 in.) O.D.
12:05	12:05	61 (142)	10.0	2,300	0.05 (0.20)	• Surface area = 4,941 sq cm (765.8 sq in.)
12:15	12:15	62 (144)	10.0	2,300		WS 1: stopped plating at 11:48, started plating one roll at 11:54
12:25	12:25	62 (144)	10.0	2,300	0.05 (0.20)	
12:35	12:35	63 (146)	10.0	2,300		• Length = 127 cm (50 in.)
12:45	12:45	64 (148)	10.0	2,300		• Width = 13.3 cm (5.25 in.) O.D.
	12:48	64 (148)	10.0	2,300		• Surface area = 5,321 sq cm (824.7 sq in.)
						Grab samples of plating solution taken at 12:30
						Stopped testing inlet at 12:45 and outlet at 12:48

[a]The mist eliminator was washed down with 248 liters (65.5 gallons) of water at 08:20. A grab sample of the washdown water was taken from the holding tank after the washdown was completed.

SOURCE SAMPLING PROGRAM PROCESS DATA SHEET

Place: Consolidated Engravers
Date: May 14, 1987
Tank No.: 1
Work-station No.: 1
Sample type: Total and hexavalent chromium

Test run No.		Test start time		Test stop time	
Inlet:	I-3	Inlet:	08:45	Inlet:	12:00
Outlet:	O-3	Outlet:	08:48	Outlet:	12:03

Time (24-h clock) Inlet	Outlet	Temp., (°C) °F	Voltage, volts	Current, amperes	Pressure drop, kPa (in. w.c.)	Notes[a] [b]
08:45	08:48	52 (126)	13.5	1,300		Started testing inlet at 09:45 and outlet at 08:48
08:55	08:55	58 (136)	13.5	1,300	0.05 (0.20)	Work plated: one industrial roll (dummy)
09:05	09:05	60 (140)	13.5	1,350		• Length = 127 cm (50 in.)
09:15	09:15	61 (142)	13.5	1,350		• Width = 13.3 cm (5.25 in.) outside diameter
09:25	09:25	61 (142)	13.5	1,350	0.05 (0.20)	• Surface area = 5,321 sq cm (824.7 sq in.)
09:35	09:35	63 (146)	13.5	1,375		Grab samples of plating solution taken at 08:50
09:45	09:45	67 (152)	13.5	1,375		
09:55	09:55	67 (152)	13.5	1,375		
10:05	10:05	67 (152)	13.5	1,375	0.05 (0.20)	
10:15	10:15	68 (154)	13.5	1,375		Stopped testing inlet at 10:15 and outlet at 10:18 to change test ports
	10:18	68 (154)	13.5	1,375		
10:30	10:33	69 (156)	13.5	1,350		Started testing inlet at 10:30 and outlet at 10:33
10:38	10:38	70 (158)	13.5	1,350	0.04 (0.15)	Current lowered at 10:38 to cool plating bath
10:40	10:40	70 (158)	11.5	1,150		Grab samples of plating solution taken at 10:30
10:50	10:50	70 (158)	11.5	1,150		
11:00	11:00	70 (158)	11.5	1,150		
11:10	11:10	70 (158)	11.5	1,150	0.04 (0.15)	
11:20	11:20	70 (158)	11.5	1,150		
11:30	11:30	70 (158)	11.5	1,150		
11:40	11:40	70 (158)	11.5	1,150	0.05 (0.20)	
11:50	11:50	70 (158)	11.5	1,150		Grab samples of plating solution taken at 11:50
12:00	12:00	70 (158)	11.5	1,150	0.05 (0.20)	Stopped testing inlet at 12:00 and outlet at 12:03
	12:03	70 (158)	11.5	1,150		

[a]The mist eliminator was washed down with 216 liters (57 gallons) of water at 08:00. A grab sample of the washdown water was taken from the holding tank after the washdown was completed.
[b]The mist eliminator was washed down after the particle size test was completed at the end of the day with 223 liters (59 gallons) of water. A grab sample of the washdown water was taken from the holding tank after the washdown was completed.

SOURCE SAMPLING PROGRAM PROCESS DATA SHEET

Place: Consolidated Engravers
Date: May 14, 1987
Tank No.: 1
Work-station No.: 2
Sample type: Total and hexavalent chromium

Test run No.		Test start time		Test stop time	
Inlet:	I-3	Inlet:	08:45	Inlet:	12:00
Outlet:	O-3	Outlet:	08:48	Outlet:	12:03

Time (24-h clock) Inlet	Time (24-h clock) Outlet	Temp., (°C) °F	Voltage, volts	Current, amperes	Pressure drop, kPa (in. w.c.)	Notes[a] [b]
08:45	08:48	52 (126)	13.0	1,300		Started testing inlet at 08:45 and outlet at 08:48
08:55	08:55	58 (136)	13.0	1,300	0.05 (0.20)	Work plated: one industrial roll (dummy)
09:05	09:05	60 (140)	13.0	1,300		• Length 127 cm (50 in.)
09:15	09:15	61 (142)	12.75	1,350		• Width = 14.6 cm (5.75 in.) outside diameter
09:25	09:25	61 (142)	12.75	1,350	0.05 (0.20)	• Surface area = 5,826 sq cm (903 sq in.)
09:35	09:35	63 (146)	12.75	1,400		Grab samples of plating solution taken at 08:50
09:45	09:45	67 (152)	12.75	1,400		
09:55	09:55	67 (152)	12.75	1,400		
10:05	10:05	67 (152)	12.75	1,400	0.05 (0.20)	
10:15	10:15	68 (154)	12.75	1,400		Stopped testing inlet at 10:15 and outlet at 10:18 to change test ports
	10:18	68 (154)	12.75	1,400		
10:30	10:33	69 (156)	12.75	1,350		Started testing inlet at 10:30 and outlet at 10:33
10:38	10:38	70 (158)	10.75	1,350	0.04 (0.15)	Current lowered at 10:38 to cool plating bath
10:40	10:40	70 (158)	10.75	1,100		Grab samples of plating solution taken at 10:30
10:50	10:50	70 (158)	10.75	1,100		
11:00	11:00	70 (158)	10.75	1,100		
11:10	11:10	70 (158)	10.75	1,100	0.04 (0.15)	
11:20	11:20	70 (158)	10.75	1,100		
11:30	11:30	70 (158)	10.75	1,100		
11:40	11:40	70 (158)	10.75	1,100	0.05 (0.20)	
11:50	11:50	70 (158)	10.75	1,100		Grab samples of plating solution taken at 11:50
12:00	12:00	70 (158)	10.75	1,100	0.05 (0.20)	Stopped testing inlet at 12:00 and outlet at 12:03
	12:03	70 (158)	10.75	1,100		

[a]The mist eliminator was washed down with 216 liters (57 gallons) of water at 08:00. A grab sample of the washdown water was taken from the holding tank after the washdown was completed.
[b]The mist eliminator was washed down after the particle size test was completed at the end of the day with 223 liters (59 gallons) of water. A grab sample of the washdown water was taken from the holding tank after the washdown was completed.

SOURCE SAMPLING PROGRAM PROCESS DATA SHEET

Place: Consolidated Engravers
Date: May 14, 1987
Tank No.: 2
Work-station Nos.: 1 and 2
Sample type: Total and hexavalent chromium

Test run No.		Test start time		Test stop time	
Inlet:	I-3	Inlet:	08:45	Inlet:	12:00
Outlet:	O-3	Outlet:	08:48	Outlet:	12:03

Time (24-h clock) Inlet	Time (24-h clock) Outlet	Temp., (°C) °F	Voltage, volts	Current, amperes	Pressure drop, kPa (in. w.c.)	Notes[a] [b]
08:45	08:48	48 (118)	9.6	2,350		Started testing inlet at 08:45 and outlet at 08:48
08:55	08:55	49 (120)	9.6	2,400	0.05 (0.20)	Work plated in WS 1: one industrial roll
09:05	09:05	50 (122)	9.6	2,400		• Length = 132 cm (52 in.)
09:15	09:15	51 (124)	9.6	2,400		• Width = 15.9 cm (6.25 in.) outside diameter (O.D.)
09:25	09:25	51 (124)	9.6	2,400	0.05 (0.20)	• Surface area = 6,587 sq cm (1,021 sq in.)
09:33	09:33	51 (124)	9.6	2,400		Work plated in WS 2: one idustrial roll (dummy)
09:35	09:35	52 (126)	10.2	1,500		• Length = 132 cm (52 in.)
09:45	09:45	53 (128)	10.2	1,500		• Width = 12.4 cm (4.875 in.) O.D.
09:52	09:52	53 (128)	10.2	1,500		• Surface area = 5,138 sq cm (796.4 sq in.)
09:55	09:55	53 (128)	9.8	2,200		Grab samples of plating solution taken at 08:55
10:05	10:05	53 (128)	9.8	2,250	0.05 (0.20)	WS 1: stopped plating at 09:33, started plating one roll at 09:52
10:15	10:15	54 (130)	9.8	2,250		• Length 127 cm (50 in.)
	10:18	54 (130)	9.8	2,250		• Width = 11.7 cm (4.6 in.) O.D.
						• Surface area = 4,665 sq cm (723 sq in.)
						Stopped testing inlet at 10:15 and outlet at 10:18 to change test ports
10:30	10:33	56 (132)	9.8	2,250		Started testing inlet at 10:30 and outlet at 10:33
10:40	10:40	56 (132)	9.8	2,250	0.04 (0.15)	Grab samples of plating solution taken at 10:30
10:50	10:50	57 (134)	9.8	2,250		
11:00	11:00	57 (134)	9.8	2,300		
11:10	11:10	58 (136)	9.8	2,300		
11:12	11:12	59 (138)	9.8	2,300	0.04 (0.15)	WS 1: stopped plating at 11:12, started plating one roll at 11:17
11:17	11:17	60 (140)	10.2	1,550		• Length = 127 cm (50 in.)
11:18	11:18	60 (140)	9.8	2,200		• Width = 13.3 cm (5.25 in.) O.D.
11:24	11:24	61 (142)	10.2	1,500		• Surface area = 5,321 sq cm (824.7 sq in.)
11:30	11:30	62 (144)	9.8	2,350		
11:40	11:40	63 (146)	9.8	2,350	0.05 (0.20)	WS 2: stopped plating dummy roll at 11:18, started plating one roll at 11:24
11:50	11:50	63 (146)	9.8	2,400		• Length = 127 cm (50 in.)
12:00	12:00	63 (146)	9.8	2,400	0.05 (0.20)	• Width = 13.0 cm (5.125 in.) O.D.
	12:03	63 (146)	9.8	2,400		• Surface area = 5,194 sq cm (805 sq in.)
						Grab samples of plating solution taken at 11:50
						Stopped testing inlet at 12:00 and outlet at 12:03

[a]The mist eliminator was washed down with 216 liters (57 gallons) of water at 08:00. A grab sample of the washdown water was taken from the holding tank after the washdown was completed.
[b]The mist eliminator was washed down after the particle size test was completed at the end of the day with 223 liters (59 gallons) of water. A grab sample of the washdown water was taken from the holding tank after the washdown was completed.

SOURCE SAMPLING PROGRAM PROCESS DATA SHEET

Place: Consolidated Engravers
Date: May 12, 1987
Tank No.: 1
Work-station No.: 1
Sample type: Particle size distribution

Test run No.		Test start time		Test stop time	
Inlet:	IPS-1	Inlet:	14:27	Inlet:	17:49
Outlet:	OPS-1	Outlet:	14:29	Outlet:	17:51

Time (24-h clock) Inlet	Outlet	Temp., (°C) °F	Voltage, volts	Current, amperes	Pressure drop, kPa (in. w.c.)	Notes
14:27	14:29	71 (160)	16.0	1,350		Started testing inlet at 14:27 and outlet at 14:29
14:42	14:42	71 (160)	16.0	1,450	0.05 (0.20)	Work plated: one industrial roll (dummy) • Length = 127 cm (50 in.) • Width = 14.6 cm (5.75 in.) outside diameter • Surface area = 5,827.5 sq cm (903.2 sq in.) Stopped plating at 14:42 to cool plating bath Stopped testing at 15:27 because of low workload in plating tanks Started testing at 15:39
16:36	16:36	60 (140)	16.0	1,350	0.05 (0.20)	Started plating same dummy roll at 16:36
16:56	16:56	62 (144)	16.0	1,450		Grab samples of plating solution taken at 14:50, 15:57, and 17:22
17:16	17:16	63 (146)	16.0	1,450	0.05 (0.20)	
17:27	17:29	64 (148)	16.0	1,450		
17:49	17:51	64 (148)	16.0	1,450		Stopped testing inlet at 17:49 and outlet at 17:51

SOURCE SAMPLING PROGRAM PROCESS DATA SHEET

Place: Consolidated Engravers
Date: May 12, 1987
Tank No.: 1
Work-station No.: 2
Sample type: Particle size distribution

Test run No.		Test start time		Test stop time	
Inlet:	IPS-1	Inlet:	14:27	Inlet:	17:49
Outlet:	OPS-1	Outlet:	14:29	Outlet:	17:51

Time (24-h clock) Inlet	Outlet	Temp., (°C) °F	Voltage, volts	Current, amperes	Pressure drop, kPa (in. w.c.)	Notes
14:27	14:29	71 (160)	14.0	1,000		Started testing inlet at 14:27 and outlet at 14:29
14:42	14:42	71 (160)	14.0	1,050	0.05 (0.20)	Work plated: one industrial roll (dummy) • Length = 127 cm (50 in.) • Width = 13.3 cm (5.25 in.) outside diameter (O.D.) • Surface area = 5,319 sq cm (824.7 sq in.) Stopped plating at 14:42 to cool plating bath Stopped testing at 15:27 because of low workload in plating tanks
15:38	15:38	53 (128)	14.0	1,000		Started plating at 15:38
15:58	15:58	55 (132)	14.0	1,050	0.05 (0.20)	Started testing at 15:39
16:10	16:10	57 (134)	14.0	1,050		Work plated: one industrial roll
16:20	16:20	58 (136)	14.0	1,050		• Length = 127 cm (50 in.) • Width = 13.3 cm (5.25 in.) O.D. • Surface area = 5,319 sq cm (824.7 sq in.) Stopped plating at 16:20
16:33	16:33	60 (140)	14.0	1,150		Started plating at 16:33
16:56	16:56	62 (144)	14.0	1,250		Work plated: same dummy roll described above
16:16	16:16	63 (146)	14.0	1,250	0.05 (0.20)	Grab samples of plating solution taken at 14:50, 15:57, and 17:22
17:27	17:29	64 (148)	13.0	1,250		
17:49	17:51	64 (148)	13.0	1,250		Stopped testing inlet at 17:49 and outlet at 17:51

SOURCE SAMPLING PROGRAM PROCESS DATA SHEET

Place: Consolidated Engravers
Date: May 12, 1987
Tank No.: 2
Work-station Nos.: 1 and 2
Sample type: Particle size distribution

Test run No.		Test start time		Test stop time	
Inlet:	IPS-1	Inlet:	14:27	Inlet:	17:49
Outlet:	OPS-1	Outlet:	14:29	Outlet:	17:51

Time (24-h clock) Inlet	Time (24-h clock) Outlet	Temp., (°C) °F	Voltage, volts	Current, amperes	Pressure drop, kPa (in. w.c.)	Notes
14:27	14:29	54 (130)	10.2	2,150		Started testing inlet at 14:27 and outlet at 14:29
14:42	14:42	54 (130)	10.2	2,150	0.05 (0.20)	Work plated in WS 1: one industrial roll
15:04	15:04	55 (132)	10.2	2,150		• Length = 101.6 cm (40 in.)
15:15	15:15	57 (134)	10.0	2,200	0.05 (0.20)	• Width = 13.3 cm (5.25 in.) outside diameter (O.D.)
15:23	15:23	57 (134)	10.0	2,200		• Surface area = 4,255 sq cm (659.7 sq in.)
15:25	15:25	57 (134)	10.0	2,200		Work plated in WS 2: one industrial roll with same dimensions
15:27	15:27	57 (134)	10.6	1,400		as roll plated in WS 1
						Grab samples of plating solution taken at 14:54
						Stopped plating WS 1 at 15:25 and WS 2 at 15:27, stopped
						testing at 15:27 because of low workload in plating tanks
15:39	15:39	57 (134)	10.2	2,100		WS 1: started plating one industrial roll with same dimen-
15:58	15:58	58 (136)	10.2	2,100	0.05 (0.20)	sions as described above at 15:28
16:10	16:10	58 (136)	10.2	2,100		WS 2: started platig one roll with same dimensions as
16:20	16:20	58 (136)	10.2	2,100		described above at 15:32
16:27	16:27	58 (136)	10.2	1,400		Started testing at 15:39
16:30	16:30	58 (136)	10.6	1,400		Grab samples of plating solution taken at 16:00
17:10	17:10	58 (136)	10.6	1,400	0.05 (0.20)	WS 2: stopped plating at 16:20, started plating one roll
						with same dimensions as described above at 16:27
						WS 1: stopped plating at 16:30
						WS 2: stopped plating at 17:10
						Stopped testing inlet at 17:49 and outlet at 17:51

SOURCE SAMPLING PROGRAM PROCESS DATA SHEET

Place: Consolidated Engravers
Date: May 13, 1987
Tank No.: 1
Work-station No.: 1
Sample type: Particle size distribution

Test run No.		Test start time		Test stop time	
Inlet:	IPS-2	Inlet:	13:27	Inlet:	16:57
Outlet:	OPS-2	Outlet:	13:29	Outlet:	16:59

Time (24-h clock) Inlet	Outlet	Temp., (°C) °F	Voltage, volts	Current, amperes	Pressure drop, kPa (in. w.c.)	Notes
13:27	13:29	71 (160)	15.0	1,650	0.05 (0.20)	Started testing inlet at 13:27 and outlet at 13:29
14:08	14:08	71 (160)	15.0	1,650		Work plated: one industrial roll (dummy)
14:47	14:47	71 (160)	15.0	1,700	0.05 (0.20)	• Length = 127 cm (50 in.)
15:08	15:08	71 (160)	15.0	1,750	0.05 (0.20)	• Width = 13.3 cm (5.75 in.) outside diameter
15:28	15:28	71 (160)	15.0	1,750		• Surface area = 5,827.5 sq cm (903.2 sq in.)
15:52	15:52	71 (160)	15.0	1,750	0.05 (0.20)	Grab samples of plating solution taken at 14:13, 15:30, and 17:40
16:10	16:10	71 (160)	15.0	1,750		
16:11	16:11	71 (160)	11.0	1,200	0.05 (0.20)	Reduced current to cool tank at 16:10
16:57	16:59	71 (160)	11.0	1,200		Stopped testing inlet at 16:57 and outlet at 16:59

SOURCE SAMPLING PROGRAM PROCESS DATA SHEET

Place: Consolidated Engravers
Date: May 13, 1987
Tank No.: 1
Work-station No.: 2
Sample type: Particle size distribution

Test run No.	Test start time	Test stop time
Inlet: IPS-2	Inlet: 13:27	Inlet: 16:57
Outlet: OPS-2	Outlet: 13:29	Outlet: 16:59

Time (24-h clock) Inlet	Outlet	Temp., (°C) °F	Voltage, volts	Current, amperes	Pressure drop, kPa (in. w.c.)	Notes
13:27	13:29	71 (160)	12.5	1,350	0.05 (0.20)	Started testing inlet at 13:27 and outlet at 13:29
14:08	14:08	71 (160)	12.5	1,400		Work plated: one industrial roll (dummy)
14:47	14:47	71 (160)	12.5	1,450	0.05 (0.20)	• Length = 127 cm (50 in.)
15:08	15:08	71 (160)	12.5	1,500	0.05 (0.20)	• Width = 13.3 cm (5.25 in.) outside diameter
15:28	15:28	71 (160)	12.5	1,500		• Surface area = 5,319 sq cm (824.7 sq in.)
15:52	15:52	71 (160)	12.5	1,500	0.05 (0.20)	Grab samples of plating solution taken at 14:13, 15:30, and 17:40
16:10	16:10	71 (160)	12.5	1,500		
16:11	16:11	71 (160)	10.0	1,100	0.05 (0.20)	Reduced current to cool tank at 16:10
16:57	16:59	71 (160)	10.0	1,100		Stopped testing inlet at 16:57 and outlet at 16:59

SOURCE SAMPLING PROGRAM PROCESS DATA SHEET

Place: Consolidated Engravers
Date: May 13, 1987
Tank No.: 2
Work-station Nos. 1 and 2
Sample type: Particle size distribution

Test run No.		Test start time		Test stop time	
Inlet:	IPS-2	Inlet:	13:27	Inlet:	16:57
Outlet:	OPS-2	Outlet:	13:29	Outlet:	16:59

Time (24-h clock) Inlet	Outlet	Temp., (°C) °F	Voltage, volts	Pressure Current, amperes	drop, kPa (in. w.c.)	Notes
14:00	14:00	60 (140)	10.2	1,200		Started testing inlet at 13:27 and outlet at 13:29
14:07	14:07	60 (140)	10.2	2,100		WS 1: started plating one industrial roll at 14:00
14:47	14:47	60 (140)	10.2	2,100	0.05 (0.20)	• Length = 101.6 cm (40 in.)
14:57	14:57	60 (140)	10.4	1,400		• Width = 13.3 cm (5.25 in.) outside diameter
15:01	15:01	60 (140)	10.4	1,400		• Surface area = 4,255.3 sq cm (659.7 sq in.)
15:07	15:07	60 (140)	10.2	2,100	0.05 (0.20)	WS 2: started plating one industrial roll at 14:07 with same dimensions as roll in WS 1
15:28	15:28	60 (140)	10.2	2,150		
15:52	15:52	60 (140)	10.2	2,150	0.05 (0.20)	Grab samples of plating solution taken at 14:15, 15:33, and 17:43
						WS 1: stopped plating at 14:57, started plating one roll with same dimensions as described above at 15:01
						WS 2: stopped plating at 15:01, started plating one roll with same dimensions as described above at 15:07
						WS 1 and WS 2: stopped plating at 15:52
16:12	16:12	60 (140)	10.4	1,350	0.05 (0.20)	WS 1: started plating one industrial roll at 16:12
16:57	16:59	60 (140)	10.4	1,400		Stopped testing inlet at 16:57 and outlet at 16:59

SOURCE SAMPLING PROGRAM PROCESS DATA SHEET

Place: Consolidated Engravers
Date: May 14, 1987
Tank No.: 1
Work-station No.: 1
Sample type: Particle size distribution

Test run No.		Test start time		Test stop time	
Inlet:	IPS-3	Inlet:	12:32	Inlet:	16:32
Outlet:	OPS-3	Outlet:	12:34	Outlet:	16:34

Time (24-h clock) Inlet	Outlet	Temp., (°C) °F	Voltage, volts	Current, amperes	Pressure drop, kPa (in. w.c.)	Notes
12:32	12:34	64 (148)	11.5	1,100		Started testing inlet at 12:32 and outlet at 12:34
12:42	12:42	64 (148)	11.5	1,100	0.05 (0.20)	Work plated: one industrial roll (dummy)
12:52	12:52	64 (148)	11.5	1,100		• Length = 127 cm (50 in.)
13:02	13:02	64 (148)	11.5	1,100		• Width = 14.6 cm (5.75 in.) outside diameter
13:22	13:22	64 (148)	11.5	1,150	0.06 (0.25)	• Surface area = 5,827.5 sq cm (903.2 sq in.)
13:32	13:32	64 (148)	11.5	1,150		
13:42	13:42	64 (148)	11.5	1,150		Grab samples of plating solution taken at 12:50, 14:32, and 16:20
13:52	13:52	65 (150)	11.5	1,150		
14:12	14:12	65 (150)	11.5	1,150	0.07 (0.30)	
14:42	14:42	68 (154)	11.5	1,150	0.07 (0.30)	
15:02	15:02	68 (154)	11.5	1,150		
16:02	16:02	69 (156)	11.5	1,150	0.07 (0.30)	
16:20	16:20	69 (156)	11.5	1,150	0.05 (0.20)	
16:30	16:30	70 (158)	11.5	1,150	0.07 (0.30)	
16:32	16:34	70 (158)	11.5	1,150		Stopped testing inlet at 16:32 and outlet at 16:34

SOURCE SAMPLING PROGRAM PROCESS DATA SHEET

Place: Consolidated Engravers
Date: May 14, 1987
Tank No.: 1
Work-station No.: 2
Sample type: Particle size distribution

Test run No.		Test start time		Test stop time	
Inlet:	IPS-3	Inlet:	12:32	Inlet:	16:32
Outlet:	OPS-3	Outlet:	12:34	Outlet:	16:34

Time (24-h clock) Inlet	Time (24-h clock) Outlet	Temp., (°C) °F	Voltage, volts	Current, amperes	Pressure drop, kPa (in. w.c.)	Notes
12:32	12:34	64 (148)	11.0	1,100		Started testing inlet at 12:32 and outlet at 12:34
12:42	12:42	64 (148)	11.0	1,100	0.05 (0.20)	Work plated: one industrial roll (dummy)
12:52	12:52	64 (148)	11.0	1,100		• Length = 127 cm (50 in.)
13:02	13:02	64 (148)	11.0	1,100		• Width = 13.3 cm (5.25 in.) outside diameter
13:22	13:22	64 (148)	11.0	1,100	0.06 (0.25)	• Surface area = 5,321 sq cm (824.7 sq in.)
13:32	13:32	64 (148)	11.0	1,100		
13:42	13:42	64 (148)	11.0	1,100		Grab samples at plating solution taken at 12:50, 14:32 and 16:20
13:52	13:52	65 (150)	11.0	1,100		
14:12	14:12	65 (150)	11.0	1,100	0.07 (0.30)	
14:42	14:42	68 (154)	11.0	1,100	0.07 (0.30)	
15:02	15:02	68 (154)	11.0	1,100		
16:02	16:02	69 (156)	11.0	1,100	0.07 (0.30)	
16:20	16:20	69 (156)	11.0	1,100	0.05 (0.20)	
16:30	16:30	70 (158)	11.0	1,100	0.07 (0.30)	
16:32	16:34	70 (158)	11.0	1,100		Stopped testing inlet at 16:32 and outlet at 16:34

SOURCE SAMPLING PROGRAM PROCESS DATA SHEET

Place: Consolidated Engravers
Date: May 14, 1987
Tank No.: 2
Work-station Nos.: 1 and 2
Sample type: Particle size distribution

Test run No.	Test start time	Test stop time
Inlet: IPS-3	Inlet: 12:32	Inlet: 16:32
Outlet: OPS-3	Outlet: 12:34	Outlet: 16:34

Time (24-h clock) Inlet	Time (24-h clock) Outlet	Temp., (°C) °F	Voltage, volts	Current, amperes	Pressure drop, kPa (in. w.c.)	Notes
12:32	12:34	55 (132)	9.8	2,400		Started testing inlet at 12:32 and outlet at 12:34
12:42	12:42	57 (134)	9.8	2,400	0.05 (0.20)	WS 1: stopped plating at 12:44, started plating one industrial roll at 12:53
12:44	12;44	57 (134)	9.8	2,400		• Length = 162.6 cm (64 in.)
12:53	12:53	57 (134)	10.2	1,500		• Width = 12.4 cm (4.875 in.) outside diameter (O.D.)
13:00	13:00	58 (136)	10.4	1,300		• Surface area = 6,322.3 sq cm (980.2 sq in.)
13:02	13:02	58 (136)	10.4	1,300		
13:22	13:22	59 (138)	9.8	2,200	0.06 (0.25)	WS 2: stopped plating one roll at 12:53, started plating one roll at 13:22
13:32	13:32	59 (138)	9.8	2,300		• Length = 127 cm (50 in.)
13:48	13:48	59 (138)	9.8	2,300		• Width = 12.7 cm (5.0 in.) O.D.
13:54	13:54	59 (138)	10.2	1,600		• Surface area = 5,065.8 sq cm (785.4 sq in.)
14:04	14:04	59 (138)	10.4	1,300		
14:12	14:12	60 (140)	9.8	2,200	0.07 (0.30)	WS 1: stopped plating at 13:48, started plating one roll with same dimensions as described for WS 1 above at 13:54
14:42	14:42	60 (140)	10.0	2,400	0.07 (0.30)	
14:54	14:54	60 (140)	10.0	2,400		WS 2: stopped plating at 13:54, started plating one roll with same dimensions as described for WS 1 above at 14:04
15:00	15:00	60 (140)	10.8	1,500		
15:50	15:50	61 (142)	10.6	2,500		WS 1: stopped plating at 14:54, started plating one roll at 15:00
						• Length = 132 cm (52 in.)
						• Width = 14.6 cm (5.75 in.) O.D.
						• Surface area = 6,058.7 sq cm (939.3 sq in.)
						WS 1 and WS 2: stopped plating at 15:50
15:55	15:55	61 (142)	10.8	1,600		WS 1: started plating one industrial roll at 15:55
16:20	16:20	61 (142)	10.8	1,600	0.05 (0.20)	• Length = 127 cm (50 in.)
16:32	16:34	61 (142)	10.8	1,600	0.07 (0.30)	• Width = 14.6 cm (5.75 in.) O.D.
						• Surface area = 5,827.5 sq cm (903.2 sq in.)
						Started testing inlet at 16:32 and outlet at 16:24
						Grab samples of plating solution taken at 12:55, 14:35, and 16:25

MSW-Estimate Costs-September

Task	Labor (Hours) B. Aurand	C. Lang	S. Schliesser	G. Smith	G. Taylor	L. Taylor	M. Upchurch	D. Wallace	Labor dollars	ODC's dollars	Fee dollars	Total dollars
1. Development Plan		4	20	23.5		4.5		80	6926	554	449	7929
2. Project Plan		4	16	27		2		10	3135	251	203	3589
3. Testing Coordination			32	1		1.3			1724	138	112	1974
4. OSW Questionnaire input	5	4	3	3	26	2		8	2017	161	131	2309
5. Marion County Test Review and Recommendations	10	2	40	1		2		0.2	2622	210	170	3002
6. Millbury Trip Report		1	8	0.3		0.4			470	38	30	538
7. 114 Questionnaire		2		0.5	16	0.8			683	55	44	782
8. Develop Plant Survey Plan	15	2	10	1.3	15	1.7			1689	135	109	1933
9. Monthly Report			1	0.1	3	0.2			170	14	11	195
10. Canadian Workshop								40	2042	1000		3042
11. Docket			2	1.6		1.2	40		1313	105	85	1503
Approved 1000 carry over from August, ODC's for S. Schliesser's trip to Conn./Mass.										1000		1000
TOTAL	30	19	132	59.3	60	16.1	40	138.2	22791	2661	1344	26796

APPENDIX B

Analytical Methods For Determining Total Chromium and Hexavalent Chromium

Method - Determination of Hexavalent Chromium

Emissions from Stationary Sources

1. Applicability and Principle.

1.1 Applicability. This method applies to the determination of hexavalent chromium (Cr^{+6}) emissions from specified stationary sources only.

1.2 Principle. Particulate emissions are collected from the source by use of Method 5 (Appendix A, 40 CFR Part 60). The collected samples are digested in an alkaline solution and analyzed by the diphenylcarbazide colorimetric method.

2. Range, Sensitivity, Precision, and Interferences.

2.1 Range. A straight line response curve was obtained in the range 5 μg Cr^{+6}/100 ml to 250 μg Cr^{+6}/100 ml. For a minimum analytical accuracy of ±10 percent, the lower limit of the range is 50 μg/100 ml. The upper limit can be extended by appropriate dilution.

2.2 Sensitivity. A minimum detection limit of 1 μg Cr^{+6}/100 ml has been observed.

2.3 Precision. The overall precision for sample collection and analysis for Cr^{+6} was tested at a ferrochrome smelter, a chemical plant, and a refractory brick plant. Replicate Method 5 filters with both high and low particulate loadings were analyzed. The relative standard deviation was 4.4, 8.3, and 13.3 percent, respectively.

2.4 Interference. Very large quantities of iron, molybdenum, vanadium, and mercury can interfere with the analysis. No interference was observed at the sources listed in Section 2.3.

3. Apparatus.

3.1 Sampling Train. Same as Method 5, Section 2.1.

3.2 Sample Recovery. Same as Method 5, Section 2.2.

3.3 Analysis. The following equipment is needed.

3.3.1 Beakers. Borosilicate, 250 ml, with watchglass covers.

3.3.2 Filtration Apparatus. Vacuum unit with 47 mm diameter, 3.0 μ pore size Teflon filters.

3.3.3 Volumetric Flasks. 100 ml and other appropriate volumes.

3.3.4 Hot Plate.

3.3.5 Pipettes. Assorted sizes, as needed.

3.3.6 Spectrophotometer. To measure absorbance at 540 nm.

4. Reagents.

4.1 Sampling. Same as Method 5, Section 3.1.

4.2 Sample Recovery. Same as Method 5, Section 3.2.

4.3 Analysis. The following reagents are required.

4.3.1 Sodium Carbonate. Na_2CO_3, anhydrous, analytical reagent grade.

4.3.2 Sodium Hydroxide. NaOH, analytical reagent grade.

4.3.3 Potassium Dichromate. $K_2Cr_2O_7$, analytical reagent grade.

4.3.4 Water. Deionized distilled, meeting American Society for Testing and Materials (ASTM) specifications for type 3 reagent - ASTM Test Method D 1193-77 (incorporated by reference - see § 61.18). If high concentrations of organic matter are not expected to be present, the analyst may eliminate the $KMnO_4$ test for oxidizable organic matter.

4.3.5 Digestion Solution. Dissolve 20.0 g NaOH and 30.0 g Na_2CO_3 in deionized distilled water in a 1-liter volumetric flask and dilute to the mark. Store the solution in a tightly capped polyethylene bottle and prepare fresh monthly.

4.3.6 Potassium Dichromate Stock Solution. Dissolve 141.4 mg of dried $K_2Cr_2O_7$ in deionized distilled water and dilute to 1 liter (1 ml = 50 μg Cr^{+6}).

4.3.7 Potassium Dichromate Standard Solution. Dilute 10.00 ml $K_2Cr_2O_7$ stock solution to 100 ml (1 ml = 5 μg Cr^{+6}) with deionized distilled water.

4.3.8 Sulfuric Acid, 10 Percent (v/v). Dilute 10 ml of reagent grade H_2SO_4 to 100 ml in deionized distilled water.

4.3.9 Diphenylcarbazide Solution. Dissolve 250 mg of 1, 5-diphenylcarbizide in 50 ml acetone. Store in a brown bottle. Discard when the solution becomes discolored.

4.3.10 Acetone. Same as Method 5, Section 3.2.

5. Procedure.

5.1 Sampling. Same as Method 5, Section 4.1.

5.2 Sample Recovery. Same as Method 5, Section 4.2.

5.3 Preservation. Tests with the source samples described in Section 2.3 demonstrated that Cr^{+6} is stable in particulate form. Nevertheless, all samples should be protected from extreme heat, and should be analyzed within 1 month of collection.

5.4 Sample Digestion and Preparation. Place the contents of Container Number 1 (the filter) and Container Number 2 (the acetone probe rinse) in a 250 ml beaker. Evaporate to dryness. Add 40 ml of digestion solution (Section 4.2.5). Cover the beaker with the watchglass and heat to near boiling on a hot plate with constant stirring for 30 minutes. Do not allow the solution to evaporate to dryness.

Cool the solution and transfer it quantitatively to the filtration apparatus with deionized distilled water. Filter the solution through the 47 mm Teflon filter. Transfer the filtrate from the filter flask quantitatively to a 100 ml volumetric flask. Fill to the mark with deionized, distilled water.

5.5 Reagent Blank Preparation. Place a 47 mm diameter filter in a 100 ml beaker. Proceed as in Section 5.4.

5.6 Silica Gel Weighing. Weigh the spent silica gel (Container Number 3) or silica gel plus impinger to the nearest 0.5 g using a balance. This step may be conducted in the field.

5.7 Analysis.

5.7.1 Color Development and Measurement. Transfer 50 ml aliquot of the prepared sample to a 100 ml volumetric flask. Add 2.0 ml of diphenylcarbazide solution. Adjust the pH to 2 $\pm$ 0.5 with 10 percent H_2SO_4 and dilute to volume with deionized distilled water. Allow the solution to stand about 10 minutes for color development. Transfer a portion of the sample to a 1-cm absorption cell and measure the absorbance at the optimum wavelength (Section 6.2.1), using the blank solution as a zero reference.

Dilute the sample and the blank with equal volumes of deionized distilled water if the absorbance exceeds A_d, the absorbance of the 250 μg Cr^{+6} standard as determined in Section 6.2.2. Use deionized, distilled water to zero the instrument.

5.7.2 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), the analyst shall check at least one sample from each source using the method of additions as follows:

Add or spike an equal volume of standard solution to an aliquot of the sample solution, then measure the absorbance of the resulting solution and the absorbance of an aliquot of unspiked sample.

Next, calculate the Cr^{+6} concentration C_s, in ug/ml of the sample solution by using the following equation:

$$C_s = C_a \frac{A_s}{A_t - A_s} \qquad \text{Eq. G-1}$$

Where:

C_a = Cr^{+6} concentration of the standard solution g/ml.

A_s = Absorbance of the sample solution.

A_t = Absorbance of the spiked sample solution.

Volume corrections will not be required if the solutions as analyzed have been made to the same final volume. Therefore, C_s and C_a represent Cr^{+6}

concentrations before dilutions. If the results of the method of additions procedure used on the single source sample do not agree to within 5 percent of the value obtained by the routine spectrophotometric analysis, then reanalyze all samples from the source using this method of additions procedure.

6. Calibration.

6.1 Sampling Train. Perform all of the calibrations described in Method 5, Section 5.

6.2 Spectrophotometer Calibration.

6.2.1 Optimum Wavelength Determination. Calibrate the wavelength scale of the spectrophotometer every 6 months. The calibration may be accomplished by using an energy source with an intense line emission such as a mercury lamp, or by using a series of glass filters spanning the measuring range of the spectrophotometer. Calibration materials are available commercially and from the National Bureau of Standards. Specific details on the use of such materials should be supplied by the vendor; general information about calibration techniques can be obtained from general reference books on analytical chemistry. The wavelength scale of the spectrophotometer must read correctly within ±5 nm at all calibration points; otherwise, the spectrophotometer shall be repaired and recalibrated. Once the wavelength scale of the spectrophotometer is in proper calibration, use 540 nm as the optimum wavelength for the measurement of the absorbance of the standards and samples.

Alternatively, a scanning procedure may be employed to determine the proper measuring wavelength. If the instrument is a double-beam spectrophotometer, scan the spectrum between 530 and 550 nm using a 250 ug Cr^{+6} standard solution in the sample cell and a blank solution in the reference cell. If a peak does not occur, the spectrophotometer is malfunctioning and should be repaired. When a peak is obtained within the 530 to 550 nm range, the wavelength at which this peak occurs shall be the optimum wavelength for the measurement of absorbance of both the standards and the samples. For a single-beam spectrophotometer, follow the scanning procedure described above, except that the blank and standard solutions shall be scanned separately. The optimum wavelength shall be the wavelength at which the maximum difference in absorbance between the standard and the blank occurs.

6.2.2 Determination of Spectrophotometer Calibration Factor K_c. Add 0.0 ml, 10 ml, 20 ml, 30 ml, and 50 ml of the working standard solution (1 ml = 5 ug Cr^{+6}) to a series of five 100-ml volumetric flasks. Analyze these calibration standards as in Section 5.7.1. This calibration procedure must be repeated on each day that samples are analyzed. Calculate the spectrophotometer calibration factor as follows:

$$K_c = 100 \frac{A_1 + 2A_2 + 3A_3 + 4A_4}{A_1^2 + A_2^2 + A_3^2 + A_4^2} \qquad \text{Eq. G-2}$$

Where:

K_c = Calibration factor.

A_1 = Absorbance of the 50 Cr^{+6} standard.

A_2 = Absorbance of the 100 Cr^{+6} standard.

A_3 = Absorbance of the 150 Cr^{+6} standard.

A_4 = Absorbance of the 250 Cr^{+6} standard.

7. Emission Calculations.

Carry out the calculations, retaining at least one extra decimal figure beyond that of the acquired data. Round off figures after final calculations.

7.1 Total Cr^{+6} in Sample. Calculate m, the total µg Cr^{+6} in each sample, as follows:

$$m = K_c \, 2AF \qquad \text{Eq. G-3}$$

Where:

2 = Factor to correct 50 ml aliquot analyzed to 100 ml 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).

7.2 Average Dry Gas Meter Temperature and Average Orifice Pressure Drop. Same as Method 5, Section 6.2.

7.3 Dry Gas Volume, Volume of Water Vapor, Moisture Content. Same as Method 5, Sections 6.3, 6.4, and 6.5, respectively.

7.4 Cr^{+6} Emission Concentration. Calculate c_s (g/dscm), the Cr^{+6} concentration in the stack gas, dry basis, corrected to standard conditions, as follows:

$$c_s = (0.001\ g/mg)(m/V_{m(std)}) \qquad \text{Eq. G-4}$$

7.5 Isokinetic Variation, Acceptable Results. Same as Method 5, Sections 6.11 and 6.12, respectively.

8. Bibliography.

1. Test Methods for Evaluating Solid Waste. U.S. Environmental Protection Agency. SW-846, 2nd Edition. July 1982.

2. Cox, X.B., R.W. Linton, F.E. Butler. Determination of Chromium Speciation in Environmental Particles - A Multitechnique Study of Ferrochrome Smelter Dust. Accepted for publication in Environmental Science and Technology.

3. Same as Method 5, Citations 2 to 5 and 7 of Section 7.

4.3 Drying ovens that can be maintained at 30° C.

4.4 Thermometer that covers range of 0° to 200° C.

4.5 Whatman No. 42 filter paper or equivalent.

5.0 Reagents

5.1 ASTM Type II water (ASTM D1193): Water should be monitored for impurities.

5.2 Concentrated nitric acid: Acid should be analyzed to determine level of impurities. If impurities are detected, all analyses should be blank corrected.

5.3 Concentrated hydrochloric acid: Acid should be analyzed to determine level of impurities. If impurities are detected, all analyses should be blank corrected.

5.4 Hydrogen peroxide (30%): Oxidant should be analyzed to determine level of impurities. If impurities are detected, all analyses should be blank corrected.

6.0 Sample Collection, Preservation, and Handling

6.1 All samples must have been collected using a sampling plan that addresses the considerations discussed in Section One of this manual.

6.2 All sample containers must be prewashed with detergents, acids, and distilled deionized water. Plastic and glass containers are both suitable.

6.3 Nonaqueous samples shall be refrigerated when possible, and analyzed as soon as possible.

7.0 Procedure

7.1 Weigh and transfer to a 250-ml conical Phillips' beaker a 1.0-g portion of sample which has been dried at 60° C, pulverized, and thoroughly mixed.

7.2 Add 10 ml of 1:1 nitric acid (HNO_3), mix the slurry, and cover with a watch glass. Heat the sample at 95° C and reflux for 10 min. Allow the sample to cool, add 5 ml of conc. HNO_3, replace the watch glass, and reflux for 30 min. Do not allow the volume to be reduced to less than 5 ml while maintaining a covering of solution over the bottom of the beaker.

7.3 After the second reflux step has been completed and the sample has cooled, add 2 ml of Type II water and 3 ml of 30% hydrogen peroxide (H_2O_2). Return the beaker to the hot plate for warming to start the peroxide reaction. Care must be taken to ensure that losses do not occur due to excessively vigorous effervescence. Heat until effervescence subsides, and cool the beaker.

7.4 Continue to add 30% H_2O_2 in 1-ml aliquots with warming until the effervescence is minimal or until the general sample appearance is unchanged. (NOTE: Do not add more than a total of 10 ml 30% H_2O_2.)

7.5 If the sample is being prepared for the furnace analysis of Ag and Sb or direct aspiration analysis of Ag, Sb, Be, Cd, Cr, Cu, Pb, Ni, Tl, and Zn, add 5 ml of 1:1 HCl and 10 ml of Type II water, return the covered beaker to the hot plate, and heat for an additional 10 min. After cooling, filter through Whatman No. 42 filter paper (or equivalent) and dilute to 100 ml with Type II water (or centrifuge the sample). The diluted sample has an approximate acid concentration of 2.5% (v/v) HCl and 5% (v/v) HNO_3 and is now ready for analysis.

7.6 If the sample is being prepared for the furnace analysis of As, Be, Cd, Cr, Cu, Pb, Ni, Se, Tl, and Zn, continue heating the acid-peroxide digestate until the volume has been reduced to approximately 2 ml, add 10 ml of Type II water, and warm the mixture. After cooling, filter through Whatman No. 42 filter paper (or equivalent) and dilute to 100 ml with Type II water (or centrifuge the sample). The diluted digestate solution contains approximately 2% (v/v) HNO_3. For analysis, withdraw aliquots of appropriate volume, add any required reagent or matrix modifier, and analyze by method of standard additions.

8.0 Quality Control

8.1 For each group of samples processed, procedural blanks (Type II water and reagents) should be carried throughout the entire sample-preparation and analytical process. These blanks will be useful in determining if samples are being contaminated.

8.2 Duplicate samples should be processed on a routine basis. Duplicate samples will be used to determine precision. The sample load will dictate the frequency, but 10% is recommended.

8.3 Spiked samples or standard reference materials should be employed to determine accuracy. A spiked sample should be included with each group of samples processed and whenever a new sample matrix is being analyzed.

8.4 The concentration of all calibration standards should be verified against a quality control check sample obtained from an outside source.

8.5 The method of standard addition shall be used for the analysis of all EP extracts and whenever a new sample matrix is being analyzed.

APPENDIX C

Field Data Sheets

TRAVERSE POINT LOCATION FOR CIRCULAR DUCTS

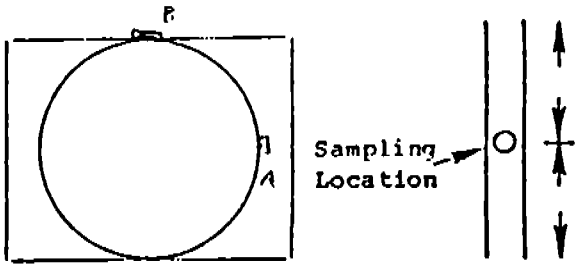
PLANT CON. ENGRAVING
DATE 3-17-87
SAMPLING LOCATION SCRUBBER INLET
INSIDE OF FAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE A) 15 5/8"
INSIDE OF NEAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE B) ---
STACK I.D., (DISTANCE A - DISTANCE B) 15 5/8"
NEAREST UPSTREAM DISTURBANCE 40" (2.1 dia's)
NEAREST DOWNSTREAM DISTURBANCE 32" (1.6 dia's)
CALCULATOR T. MILLER

SCHEMATIC OF SAMPLING LOCATION

TRAVERSE POINT NUMBER	FRACTION OF STACK I.D.	STACK I.D.	PRODUCT OF COLUMNS 2 AND 3 (TO NEAREST 1/8 INCH)	DISTANCE B	TRAVERSE POINT LOCATION FROM OUTSIDE OF NIPPLE (SUM OF COLUMNS 4 & 5)
1	0.021	19.6	0.4	---	0.5
2	0.067		1.3		1.3
3	0.118		2.3		2.3
4	0.177		3.5		3.5
5	0.250		4.9		4.9
6	0.356		7.0		7.0
7	0.644		12.6		12.6
8	0.750		14.7		14.7
9	0.823		16.1		16.1
10	0.882		17.3		17.3
11	0.933		18.3		18.3
12	0.979		19.2		19.2

PRELIMINARY VELOCITY TRAVERSE

Plant: CON ENGRAVING
Date: 5-11-87
Location: SCRUBBER INLET
Stack I.D.: 19 5/8"
Barometric Pressure, in. Hg: 29.50
Stack Gauge Pressure, in. H_2O: -3.70
Operators: TM & A
Pitot Tube I.D. Number: S-1
Temperature Readout I.D.: OMEGA 650
Pitot Tube Leak Check: OK



Schematic of Traverse Point Layout

P_s -3.7" H_2O

Traverse Point Number	Velocity Head (Δp_s) in. H_2O	Stack Temp. (T_s), °F	Cyclonic Flow Check ° from Null
A-1	0.20	82	
2	0.20	82	
3	0.63	81	
4	0.50	81	
5	0.51	81	
6	0.55	81	
7	0.61	80	
8	0.62	81	
9	0.62	79	
10	0.63	79	
11	0.66	79	
12	0.67	79	
			< 8°
Average			

Traverse Point Number	Velocity Head (Δp_s) in. H_2O	Stack Temp. (T_s), °F	Cyclonic Flow Check ° from Null
B 1	0.95	80	
2	0.95	80	
3	0.69	75	
4	0.57	79	
5	0.53	78	
6	0.52	77	
7	0.65	77	
8	0.71	77	
9	0.78	77	
10	0.85	77	
11	0.91	76	
12	0.90	77	
Average			

NOMOGRAPH DATA

Plant: CONSOLIDATED ENGRAVERS Date: 5-12-87

Sampling Location: SCRUBBER INLET

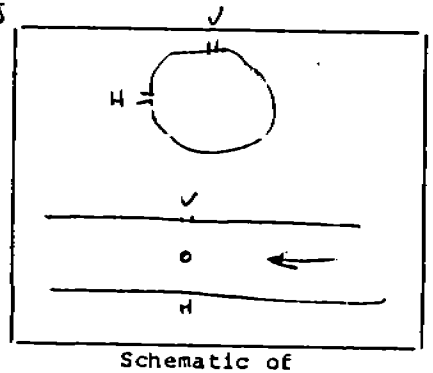
RAC 106.5 Pb 29.43

Calibrated Pressure Differential Across Orifice, in. H_2O	$\Delta H_@$	1.84
Average Meter Temperature (ambient + 20°F), °F	$T_{m_{avg}}$	110
Percent Moisture in Gas Stream by Volume	B_{wo}	2
Barometric Pressure at Meter, in. Hg.	P_m	29.57
Static Pressure in Stack, in. Hg. ($P_m \pm 0.073$ x stack gauge pressure in in. H_2O)	P_s	29.16
Ratio of Static Pressure to Meter Pressure	P_s/P_m	0.986
Average Stack Temperature, °F	$T_{s_{avg}}$	79
Average Velocity Head, in. H_2O	Δp_{avg}	0.69
Maximum Velocity Head, in. H_2O	Δp_{max}	0.91
C Factor	1.13	
Calculated Nozzle Diameter, in.	0.218	
Actual Nozzle Diameter, in.	0.237	
Reference Δp, in. H_2O	0.50	

SAMPLE BOX 2

FIELD DATA

Plant CONSOLIDATED ENGRAVERS
Date 5-12-87
Sampling Location DEMISTER INLET
Sample Type MM 13.3
Run Number I-1
Operator F MEADOWS - T. MILLER
Ambient Temperature 73 °F
Barometric Pressure 29.43 "Hg
Static Pressure (P_s) -3.70 "H2O
Filter Number(s) N/A
Pretest Leak Rate =0.001 cfm @ 10 in. Hg
Pretest Pitot Leak Check OK
Pretest Orsat Leak Check N/A
Read and Record all Data Every 7.5 Minutes



Schematic of Traverse Point Layout

Probe Length and Type 2' PYREX UNHEATED
Pitot Tube I.D. No.
Nozzle I.D. .238, .236, .236 AVG = .237
Assumed Moisture, % 2
Temp. Readout S/N OMEGA 450
Meter Box Number RAC 1065
Meter $\Delta H_@$ 1.84
C Factor 1.13
Meter Gamma 0.951 / 0.994
Heater Box Setting N/A
Reference Δp 0.50
Post Test Leak Rate = ___ cfm @ ___ in. Hg
Post Test Pitot Leak Check
Post Test Orsat Leak Check N/A

3T-2A

SH-1

Traverse Point Number	Sampling Time, (min)	/ Clock Time / (24-hour clock)	Gas Meter Reading (V_m) ft^3	Velocity Head (ΔP_s) in. H_2O	Orifice Pres. Differential (ΔH) in. H_2O Desired	Actual	Stack Temp. (T_s) °F	Dry Gas Meter Temp. Inlet ($T_{m_{in}}$) °F	Outlet ($T_{m_{out}}$) °F	Pump Vacuum in. Hg	Sample Box Temp. Filter Temp. °F	Impinger Temp. °F	ΔP across DEMISTER "H2O
	0	10952	702.191								N/A		
V-12	7.5	10959.5	708.976	0.75	2.80	2.80	72	80	71	12.9		46	
11	15.0	1007.0	715.300	0.73	2.70	2.70	75	96	75	12.2		54	0.20
10	22.5	1014.5	722.508	0.72	2.70	2.70	76	105	79	12.7		62	
9	30.0	1022.0	729.131	0.66	2.45	2.45	80	110	84	11.4		63	
8	37.5	1029.5	735.700	0.60	2.20	2.20	78	114	88	9.6		60	
7	45.0	1037.0	741.231	0.55	2.00	2.00	80	116	91	8.3		58	0.20
6	52.5	1044.5	747.550	0.53	1.95	1.95	79	111	93	8.2		59	
5	60.0	1052.0	753.237	0.53	1.95	1.95	79	111	94	8.2		55	
4	67.5	1059.5	759.350	0.48	1.75	1.75	77	108	94	7.3		57	0.20
3	75.0	1107.0	765.441	0.60	2.00	2.00	80	110	95	8.6		56	
2	82.5	1114.5	771.470	0.54	1.97	1.97	79	111	96	8.2		55	0.20
1	90.0	1122.0	777.600	0.55	2.00	2.00	80	113	97	8.3		56	
		/											
		/											
		/	Leak	check	0.001	cfm @	13.2	"Hg					
		/	2.00	0.02	OK								
		/											
		/											
		/											
		/											
		/											
		/											
		/											

PACIFIC ENVIRONMENTAL SERVICES, INC.

SAMPLE RECOVERY DATA

Plant: Consolidated Engravers

Date: 5/11/87

Sampling Location: Mist eliminator - inlet

Sample Type: Modified M13B

Run Number: I-1 M113B

Sample Box Number: sample box #2

Clean-up Man: HO/FJH

Job Number:

Comments:

FRONT HALF

Filter Number:

Description of Filter:

MOISTURE

	#1	#2	#3
Impingers			
Final Volume:	1635.9 g ~~ml~~	590.5 g ~~ml~~	556.8 g ~~ml~~
Initial Volume:	~~534.9~~ 1611.8 g ~~ml~~	578.1 g ~~ml~~	554.9 g ~~ml~~
Net Volume:	24.1 ml	12.4 ml	1.9 ml
Total H_2O:			
Silica Gel			
Final Volume:	802.4 g	g	g
Initial Volume	774.7 g	g	g
Net Volume	27.7 g	g	g
Total Moisture:		total wt gain cols	

Description of Impinger Catch:

NOMOGRAPH DATA

Plant: CONSOLIDATED ENGRAVERS Date: 5-13-87

Sampling Location: RUN I-2 DEMISTER INLET

Pb: 29.49 "Hg

Calibrated Pressure Differential Across Orifice, in. H_2O	$\Delta H_@$	1.84
Average Meter Temperature (ambient + 20°F), °F	$T_{m_{avg}}$	100
Percent Moisture in Gas Stream by Volume	B_{wo}	2
Barometric Pressure at Meter, in. Hg.	P_m	29.63
Static Pressure in Stack, in. Hg. ($P_m \pm 0.073$ x stack gauge pressure in in. H_2O)	P_s	29.22
Ratio of Static Pressure to Meter Pressure	P_s/P_m	0.986
Average Stack Temperature, °F	$T_{s_{avg}}$	80
Average Velocity Head, in. H_2O	Δp_{avg}	0.55
Maximum Velocity Head, in. H_2O	Δp_{max}	
C Factor		1.10
Calculated Nozzle Diameter, in.		0.233
Actual Nozzle Diameter, in.		0.237
Reference Δp, in. H_2O		0.52

SAMPLE BOX #2

FIELD DATA

Plant CONSOLIDATED ENGRAVERS
Date 5-13-87
Sampling Location DEMISTER INLET
Sample Type MM 13B
Run Number I-2
Operator F. MENDOUS - T. MILLER
Ambient Temperature 75°F
Barometric Pressure 27.49 "Hg
Static Pressure (P_s) -4.1
Filter Number(s) N/A
Pretest Leak Rate = 0.000 cfm @ 15 in. Hg
Pretest Pitot Leak Check OK
Pretest Orsat Leak Check N/A
Read and Record all Data Every 7.5 Minutes

Schematic of Traverse Point Layout

Probe Length and Type 3' PYREX UNHEATED
Pitot Tube I.D. No.
Nozzle I.D. 0.236, 0.236, 0.238 AVG 0.237
Assumed Moisture, % 2
Temp. Readout S/N OMEGA 650
Meter Box Number RAC 1065
Meter $\Delta H_@$ 1.54
C Factor 1.10
Meter Gamma 0.981 / 0.994
Heater Box Setting N/A
Reference Δp 0.52
Post Test Leak Rate = ___ cfm @ ___ in. Hg
Post Test Pitot Leak Check
Post Test Orsat Leak Check N/A

PAGE 1 of 2

3T-2A

S4-1

Traverse Point Number	Sampling Time, (min) / Clock Time (24-hour clock)	Gas Meter Reading (V_m) ft^3	Velocity Head (ΔP_s) in. H_2O	Orifice Pres. Differential (ΔH) in. H_2O Desired	Actual	Stack Temp. (T_s) °F	Dry Gas Meter Temp. Inlet ($T_{m_{in}}$) °F	Outlet ($T_{m_{out}}$) °F	Pump Vacuum in. Hg	Sample Box Temp. Filter Temp. °F	Im-pinger Temp. °F	DEMISTER ΔP "H_2O
	0 / 0925	955.726										
V-12	7.5 / 0932.5	962.100	0.84	2.95	2.95	72	81	75	19.0	N/A	51	0.30
11	15.0 / 0940.0	968.199	0.79	2.80	2.80	74	105	79	14.5	—	62	
10	22.5 / 0947.5	974.252	0.75	2.68	2.68	75	114	84	13.9	—	65	
9	30.0 / 0955	980.153	0.69	2.45	2.45	75	118	88	13.0	—	66	
8	37.5 / 1002.5	985.710	0.62	2.15	2.15	76	120	89	10.3	—	66	
7	45.0 / 1010	991.122	0.58	2.05	2.05	77	121	95	9.61	—	66	0.20
6	52.5 / 1017.5	996.292	0.50	1.80	1.80	78	124	97	8.2	—	65	
5	60.0 / 1025	1001.349	0.49	1.75	1.75	80	122	101	7.9	—	62	
4	67.5 / 1032.5	1007.175	0.63	2.22	2.22	79	122	99	10.9	—	59	0.20
3	75.0 / 1040.0	1012.977	0.64	2.25	2.25	79	125	102	10.8	—	60	
2	82.5 / 1047.5	1018.185	0.46	1.62	1.62	78	118	102	7.4	—	59	0.20
2	90.0 / 1055	1023.450	0.46	1.62	1.62	78	118	101	7.4	—	59	
	/											
	/											
	/		leak check		0.000	@	20" Hg					
	/											
	/		PITOT TUBE		NOT	DISCONNECTED						
	/											
	/											
	/											
	/											
	/											
	/											

PACIFIC ENVIRONMENTAL SERVICES, INC.

Plant Name: CONSOLIDATED ENGRAVERS

Run Number: I-2

Test Date: 5-13-87

Operator: F. MEADOWS - T. MILLER

Page 2 of 2

Leak check .002 @ 15" Hg

Traverse Point Number	Sampling Time, (min) / Clock Time (24-hour clock)	Gas Meter Reading (V_m) ft^3	Velocity Head (ΔP_s) in. H_2O	Orifice Pres. Differential (ΔH) in. H_2O Desired	Orifice Pres. Differential (ΔH) in. H_2O Actual	Stack Temp. (T_s) °F	Dry Gas Meter Temp. Inlet ($T_{m_{in}}$) °F	Dry Gas Meter Temp. Outlet ($T_{m_{out}}$) °F	Pump Vacuum in. Hg	Sample Box Temp. Filter Temp. °F	Impinger Temp. °F	
	90.0 / 1115	1023.725										
H-12	97.5 / 1122.5	1030.210	0.64	2.28	2.28	80	100	93	10.7	N/A	51	
11	105.0 / 1130.0	1036.570	0.63	2.22	2.22	82	112	93	10.0	—	50	0.20
10	112.5 / 1137.5	1042.718	0.59	2.10	2.10	82	114	94	9.0	—	53	
9	120.0 / 1145.0	1048.631	0.54	1.90	1.90	82	113	94	8.1	—	52	
8	127.5 / 1152.5	1054.535	0.54	1.90	1.90	82	112	94	8.1	—	52	
7	135.0 / 1200	1060.553	0.55	1.95	1.95	81	114	96	8.6	—	53	0.20
6	142.5 / 1207.5	[illegible]	0.51	1.82	1.82	[illegible]	114	92	[illegible]	—	54	
5	150.0 / 1215.0	1072.117	0.45	[illegible]	[illegible]	[illegible]	111	97	7.0	—	54	
4	157.5 / 1222.5	1077.500	0.39	1.40	1.40	81	110	97	6.4	—	55	0.20
3	165.0 / 1230.0	1082.690	0.36	1.30	1.30	82	108	97	5.8	—	55	
2	172.5 / 1237.5	1088.030	0.39	1.40	1.40	79	107	97	6.4	—	55	
1	180.0 / 1245.0	1093.477	0.41	1.45	1.45	79	112	97	6.6	—	54	
	/											
	/											
	/		POST TEST LEAK CHECK									
	/						0.000 @ 12.5 "Hg					
	/		P TOT TUBE LEAK CHECK				OK					
	/											
	180 / 200	137.476	$\sqrt{\Delta P}$ 0.7440	1.99	1.99	79.0	113°F	94°F	9.5		55°F	
	/											
	/		$\overline{\Delta P}$ 0.554			529°R		554°R ~~104°R~~				
	/											
	/											
	/											
	/											
	/											
	/											
	/											
	/											

PACIFIC ENVIRONMENTAL SERVICES, INC.

SAMPLE RECOVERY DATA

Plant: [illegible]

Date: [illegible]

Sampling Location: [illegible]

Sample Type: [illegible]

Run Number: [illegible]

Sample Box Number: [illegible]

Clean-up Man: [illegible]

Job Number:

Comments:

FRONT HALF

Filter Number:

Description of Filter:

MOISTURE

Impingers

Final Volume:	[illegible] ml	[illegible] ml	[illegible] ml
Initial Volume:	[illegible] ml	[illegible] ml	[illegible] ml
Net Volume:	23.7g ml	12.6g ml	1.7g ml
Total H_2O:			

Silica Gel

Final Volume:	[illegible] g	g	g
Initial Volume	[illegible] g	g	g
Net Volume	230 g	g	g
Total Moisture:		total col gain 0.10 g	

Description of Impinger Catch:

NOMOGRAPH DATA

Plant: CONSOLIDATED ENGRAVERS Date: 5-14-87

Sampling Location: MIST ELIMINATOR INLET I-3

P_b = 29.61 "Hg

Calibrated Pressure Differential Across Orifice, in. H_2O	$\Delta H_@$	1.84
Average Meter Temperature (ambient + 20°F), °F	$T_{m_{avg}}$	100
Percent Moisture in Gas Stream by Volume	B_{wo}	2
Barometric Pressure at Meter, in. Hg.	P_m	29.75
Static Pressure in Stack, in. Hg. ($P_m \pm 0.073$ x stack gauge pressure in in. H_2O)	P_s -3.7	29.34
Ratio of Static Pressure to Meter Pressure	P_s/P_m	0.986
Average Stack Temperature, °F	$T_{s_{avg}}$	80
Average Velocity Head, in. H_2O	Δp_{avg}	0.55
Maximum Velocity Head, in. H_2O	Δp_{max}	
C Factor	1.10	
Calculated Nozzle Diameter, in.		
Actual Nozzle Diameter, in.	0.237	
Reference Δp, in. H_2O	0.52	

FIELD DATA

Plant CONSOLIDATED ENGRAVERS
Date 5-14-87
Sampling Location DEMISTER INLET
Sample Type MM 13B
Run Number I-3
Operator F. MEADOWS - T. MILLER
Ambient Temperature 67°F
Barometric Pressure 29.61 "Hg
Static Pressure (P_s) -3.7 "H_2O
Filter Number(s) —
Pretest Leak Rate = 0.001 cfm @ 15 in. Hg
Pretest Pitot Leak Check OK
Pretest Orsat Leak Check N/A
Read and Record all Data Every 7.5 Minutes

Schematic of Traverse Point Layout

Probe Length and Type 3' PYREX UNHEATED
Pitot Tube I.D. No.
Nozzle I.D. 0.236, .235, .236 AVG = .237
Assumed Moisture, % 2
Temp. Readout S/N OMEGA 650
Meter Box Number RAC 1065
Meter $\Delta H_@$ 1.84
C Factor 1.10
Meter Gamma 0.981 / 0.994
Heater Box Setting N/A
Reference Δp 0.52
Post Test Leak Rate = ___ cfm @ ___ in. Hg
Post Test Pitot Leak Check
Post Test Orsat Leak Check

PAGE 1 of 2

3T-2A

SH-1

Traverse Point Number	Sampling Time, (min) / Clock Time (24-hour clock)	Gas Meter Reading (V_m) ft^3	Velocity Head (ΔP_s) in. H_2O	Orifice Pres. Differential (ΔH) in. H_2O Desired	Orifice Pres. Differential (ΔH) in. H_2O Actual	Stack Temp. (T_s) °F	Dry Gas Meter Temp. Inlet ($T_{m_{in}}$) °F	Dry Gas Meter Temp. Outlet ($T_{m_{out}}$) °F	Pump Vacuum in. Hg	Sample Box Temp. Filter Temp. °F	Impinger Temp. °F	MIST ELIM ΔP "H_2O
	0 / 0845	217.772										
V-12	7.5 / 0852.5	224.550	0.79	2.80	2.80	73	71	60	14.4	N/A	50	
11	15.0 / 0900	231.262	0.75	2.65	2.65	73	84	61	13.3	—	55	0.20
10	22.5 / 0907.5	237.970	0.74	2.62	2.62	74	94	64	13.3	—	60	
9	30.0 / 0915	244.680	0.67	2.40	2.40	72	101	70	12.2	—	63	
8	37.5 / 0922.5	250.745	0.60	2.10	2.10	73	101	72	9.5	—	61	
7	45.0 / 0930	256.814	0.56	2.00	2.00	75	99	75	9.3	—	62	0.20
6	52.5 / 0937.5	262.661	0.53	1.85	1.85	74	99	76	8.3	—	62	
5	60.0 / 0945	268.657	0.55	1.95	1.95	74	102	78	8.8	—	62	
4	67.5 / 0952.5	274.500	0.53	1.85	1.85	73	106	82	8.2	—	62	
3	75.0 / 1000	280.707	0.60	2.10	2.10	73	108	85	9.5	—	63	0.20
2	82.5 / 1007.5	286.522	0.51	1.80	1.80	70	107	87	7.8	—	62	
2	90.0 / 1015	292.427	0.51	1.80	1.80	70	109	88	7.8	—	61	
	/											
	/		Leak check 0.000 @ 14.4 "Hg									
	/											
	/		PITOT TUBE NOT DISCONNECTED									
	/											
	/											
	/											
	/											
	/											
	/											

PACIFIC ENVIRONMENTAL SERVICES, INC.

Plant Name: CONSOLIDATED ENGRNERS

Run Number: I-3

Test Date: 5-14-87

Operator: F. MEADOWS - A. WIESMAN

Page 2 of 2

Leak check 0.000 @ 15" Hg

Traverse Point Number	Sampling Time, (min) / Clock Time (24-hour clock)	Gas Meter Reading (V_m) ft^3	Velocity Head (ΔP_s) in. H_2O	Orifice Pres. Differential (ΔH) in. H_2O Desired	Orifice Pres. Differential (ΔH) in. H_2O Actual	Stack Temp. (T_s) °F	Dry Gas Meter Temp. Inlet ($T_{m_{in}}$) °F	Dry Gas Meter Temp. Outlet ($T_{m_{out}}$) °F	Pump Vacuum in. Hg	Sample Box Temp. Filter Temp. °F	Impinger Temp. °F	MIST ELIM. ΔP "H2O
	90.0 / 1030	292.782										
H-12	97.5 / 1037.5	299.157	0.65	2.30	2.30	75	96	88	10.6	N/A	53	0.15
11	105.0 / 1045	305.460	0.62	2.15	2.15	75	108	89	9.4	—	50	
10	112.5 / 1052.5	301.643	0.60	2.10	2.10	75	110	90	9.0	—	54	
9	120.0 / 1100	317.771	0.55	2.05	2.05	75	112	92	8.8	—	53	
8	127.5 / 1107.5	323.800	0.55	1.95	1.95	76	112	93	8.3	—	53	0.15
7	135.0 / 1115	329.839	0.56	1.98	1.98	75	112	94	8.3	—	53	
6	142.5 / 1122.5	335.890	0.56	1.98	1.98	75	113	94	8.3	—	54	
5	150 / 1130	341.741	0.50	1.80	1.80	74	114	95	7.7	—	53	
4	157.5 / 1137.5	347.323	0.43	1.50	1.50	72	114	95	6.8	—	52	0.20
3	165 / 1145	352.634	0.40	1.40	1.40	70	113	96	6.0	—	51	
2	172.5 / 1152.5	357.865	~~0.40~~ / 0.38	~~1.40~~ / 1.30	~~1.40~~ / 1.30	70	112	96	5.8	—	51	
2	180 / 1200	363.050	0.38	1.30	1.30	69	110	96	5.8	—	51	0.20
	/											
	/											
	/	~~145.275~~	POST TEST LEAK CHECK					OCC @ 12" Hg				
	/	14-923										
	/		PITOT TUBE LEAK CHECK					OK				
	/	NDP										
	180 / 195	0.7481										
	/	ΔP										
	/	0.56		1.99	1.99	73°F	104°F	84°F			56°F	
	/											
	/					533°R		544°F				
	/							554°R				
	/											
	/											
	/											
	/											
	/											
	/											

PACIFIC ENVIRONMENTAL SERVICES, INC.

SAMPLE RECOVERY DATA

Plant: Consolidated Chemicals

Date: 14 MAY 1981

Sampling Location: Wm Chemicals - Inlet

Sample Type: Moisture Train B

Run Number: 1-3 Train B

Sample Box Number: Sample Box # 2

Clean-up Man:

Job Number:

Comments:

FRONT HALF

Filter Number:

Description of Filter:

MOISTURE

Impingers	#1		#2		#3	
Final Volume:	630.9 g	~~ml~~	543.2 g	~~ml~~	558.9 g	~~ml~~
Initial Volume:	612.8 g	~~ml~~	531.1 g	~~ml~~	556.6	~~ml~~
Net Volume:	18.1 g	~~ml~~	12.1 g	~~ml~~	2.3	ml
Total H_2O:						

Silica Gel						
Final Volume:	809.2	g		g		g
Initial Volume	782.7	g		g		g
Net Volume	26.5	g		g		g
Total Moisture:			total wt. gain 510 g			

Description of Impinger Catch:

IPS-1

NOMOGRAPH DATA

Plant: CONSOLIDATED ENGRAVERS Date: 5-12-87

Sampling Location: DEMISTER INLET

Calibrated Pressure Differential Across Orifice, in. H_2O	$\Delta H_@$	1.84
Average Meter Temperature (ambient + 20°F), °F	$T_{m_{avg}}$	110
Percent Moisture in Gas Stream by Volume	B_{wo}	2
Barometric Pressure at Meter, in. Hg.	P_m	29.57
Static Pressure in Stack, in. Hg. ($P_m \pm 0.073$ x stack gauge pressure in in. H_2O)	P_s	29.16
Ratio of Static Pressure to Meter Pressure	P_s/P_m	0.986
Average Stack Temperature, °F	$T_{s_{avg}}$	80
Average Velocity Head, in. H_2O	Δp_{avg}	0.56
Maximum Velocity Head, in. H_2O	Δp_{max}	
C Factor	1.13	
Calculated Nozzle Diameter, in.		
Actual Nozzle Diameter, in.	0.195	
Reference Δp, in. H_2O	1.07	

Point V-7
12.6"

FIELD DATA

Plant CONSOLIDATED ENGRAVERS
Date 5-12-87
Sampling Location DEMISTER INLET
Sample Type PART SIZE
Run Number IPS-1
Operator E. MENDOZA
Ambient Temperature
Barometric Pressure 29.43 "Hg
Static Pressure (P_s)
Filter Number(s) —
Pretest Leak Rate = 0.00 cfm @ 15 in. Hg
Pretest Pitot Leak Check N/A
Pretest Orsat Leak Check N/A
Read and Record all Data Every 10 Minutes

Schematic of Traverse Point Layout

Probe Length and Type 4' SS
Pitot Tube I.D. No.
Nozzle I.D. 0.195
Assumed Moisture, % 2
Temp. Readout S/N OMEGA 650
Meter Box Number RAC 1065
Meter $\Delta H_@$ 1.84
C Factor 1.15
Meter Gamma 0.981 / 0.994
Heater Box Setting N/A
Reference Δp 1.07
Post Test Leak Rate = — cfm @ — in. Hg
Post Test Pitot Leak Check N/A
Post Test Orsat Leak Check N/A

3T-2A

Traverse Point Number	Sampling Time, (min) / Clock / Time (24-hour clock)	Gas Meter Reading (V_m) ft^3	Velocity Head (ΔP_s) in. H_2O	Orifice Pres. Differential (ΔH) in. H_2O Desired	Orifice Pres. Differential (ΔH) in. H_2O Actual	Stack Temp. (T_s) °F	Dry Gas Meter Temp. Inlet ($T_{m_{in}}$) °F	Dry Gas Meter Temp. Outlet ($T_{m_{out}}$) °F	Pump Vacuum in. Hg	Sample Box Temp. Filter Temp. °F	SH-1 Impinger Temp. °F	
	0 / 1427	850.347										
V-7	10 / 1437	856.061	0.55	0.94	0.94		89	84	2.5	N/A	68	
	20 / 1447	861.970	0.55	0.94	0.94		95	85	2.5	—	67	0.20
	30 / 1457	867.720	0.55	0.94	0.94		96	86	2.5	—	64	
	40 / 1507	873.475	0.55	0.94	0.94		98	88	2.5	—	63	
	50 / 1517	879.246	0.55	0.94	0.94		101	89	2.5	—	63	
	60 / 1527	885.020	0.55	0.94	0.94		105	90	2.5	—	64	0.20
	/ 1539											
	70 / 1549	890.800	0.55	0.94	0.94		92	87	2.5	—	60	
	80 / 1559	896.545	0.55	0.94	0.94		103	55	2.5	—	62	
	90 / 1609	902.195	0.55	0.94	0.94		108	89	2.5	—	64	0.20
	100 / 1619	907.785	0.55	0.94	0.94		109	90	2.5	—	64	
	110 / 1629	913.250	0.55	0.94	0.94		112	93	2.5	—	62	
	120 / 1639	918.365	0.55	0.94	0.94		111	94	2.5	—	63	
	130 / 1649	923.652	0.55	0.94	0.94		111	96	2.5	—	63	0.20
	140 / 1659	928.951	0.55	0.94	0.94		109	97	2.5	—	64	
	150 / 1709	934.275	0.55	0.94	0.94		110	97	2.5	—	65	0.20
	160 / 1719	939.550	0.55	0.94	0.94		107	98	2.5	—	64	
	170 / 1729	944.800	0.55	0.94	0.94		106	97	2.5	—	64	
	180 / 1739	950.060	0.55	0.94	0.94		103	96	2.5	—	66	
	190 / 1749	955.286	0.55	0.94	0.94		103	97	2.5	—	66	
	/		NDP									
	190 / 202	104.939	0.7416	0.94	0.94		104°F	92	2.5		64°F	
	/						98°F					
							558°R					

0.195
0.195
0.195

IMPACTOR # 2

ANDERSEN IMPACTOR RECOVERY AND INTEGRITY SHEET

Plant: CONSOLIDATED ENGRAVERS Sample date: 5-12-87

Sample location: DEMISTER ~~OUTLET~~ ~~INLET~~ INLET Recovery date: 5-12-87

Run number: ~~OPS-1~~ IPS-1 Recovered by: [illegible]

RECOVERY SAMPLE

cyclone particulate Liquid level

container no. _____ marked _____

cyclone and nozzle rinse Liquid level

container no. _____ marked _____

nozzle (and inlet chamber) Liquid level

container no. ~~OPS-1~~ IPS-1 marked ✓

acetone blank Liquid level

container no. _____ marked _____

Samples stored and locked _____

FILTERS

Stage	Filter No	Container No	Container Sealed	Comments
~~0~~ 1	P-19	P-19	✓	
~~1~~ 4	P-16	P-16	✓	
~~2~~ 7	P-17	P-17	✓	
~~3~~ BU	P-11	P-11	✓	
~~4~~ 2	—	—		
~~5~~ 3	—	—		
~~6~~ 6	—	—		
~~7~~ 5	~~P-15~~	~~P-15~~		
~~Backup~~ 8	~~P-4~~	~~P-4~~		

Samples stored and locked _____

Remarks _____

LABORATORY CUSTODY

Received by _____ Date _____

Remarks _____

IPS-2

NOMOGRAPH DATA

Plant: CONSOLIDATED ENGRAVERS Date: 5-13-87

Sampling Location: DEMISTER INLET

Pb = 29.53

Calibrated Pressure Differential Across Orifice, in. H_2O	$\Delta H_@$	1.84
Average Meter Temperature (ambient + 20°F), °F	$T_{m_{avg}}$	105
Percent Moisture in Gas Stream by Volume	B_{wo}	2
Barometric Pressure at Meter, in. Hg.	P_m	29.67
Static Pressure in Stack, in. Hg. ($P_m \pm 0.073$ x stack gauge pressure in in. H_2O)	P_s -4.1	29.23
Ratio of Static Pressure to Meter Pressure	P_s/P_m	0.985
Average Stack Temperature, °F	$T_{s_{avg}}$	80
Average Velocity Head, in. H_2O	Δp_{avg}	0.58
Maximum Velocity Head, in. H_2O	Δp_{max}	
C Factor	1.10	
Calculated Nozzle Diameter, in.	0.230	
Actual Nozzle Diameter, in.	0.195	
Reference Δp, in. H_2O	1.10	

Point V-7

FIELD DATA

Plant CONSOLIDATED ENGRAVERS
Date 5-13-87
Sampling Location DEMISTER INLET
Sample Type PART. SIZE
Run Number IPS-2
Operator F. MEADOWS
Ambient Temperature
Barometric Pressure 29.53" Hg
Static Pressure (P_s) -4.1" H_2O
Filter Number(s) —
Pretest Leak Rate = .006 cfm @ 15 in. Hg
Pretest Pitot Leak Check —
Pretest Orsat Leak Check —
Read and Record all Data Every 10 Minutes

Schematic of Traverse Point Layout

Probe Length and Type 4' SS
Pitot Tube I.D. No. —
Nozzle I.D. 0.195
Assumed Moisture, % 2
Temp. Readout S/N OMEGA 650
Meter Box Number RAC 1065
Meter $\Delta H_@$ 1.84
C Factor 1.10
Meter Gamma 0.981 / 0.994
Heater Box Setting —
Reference Δp 1.10
Post Test Leak Rate = — cfm @ ___ in. Hg
Post Test Pitot Leak Check —
Post Test Orsat Leak Check —

3T-3A

Traverse Point Number	Sampling Time, (min)	/ Clock Time / (24-hour clock)	Gas Meter Reading (V_m) ft^3	Velocity Head (ΔP_s) in. H_2O	Orifice Pres. Differential (ΔH) in. H_2O Desired	Actual	Stack Temp. (T_s) °F	Dry Gas Meter Temp. Inlet ($T_{m_{in}}$) °F	Outlet ($T_{m_{out}}$) °F	Pump Vacuum in. Hg	Sample Box Temp. Filter Temp. °F	Impinger Temp. °F	DEMISTER ΔP "H_2O
	0	/ 1327	93.136										
V-7	10	/ 1337	99.560	0.58	0.97	0.97		83	83	5.3	N/A	61	
	20	/ 1347	105.450	0.58	0.97	0.97		89	83	5.3	—	62	0.20
	30	/ 1357	111.310	0.58	0.97	0.97		94	84	5.3	—	62	
	40	/ 1407	117.200	0.58	0.97	0.97		95	86	5.3	—	62	
	50	/ 1417	123.152	0.58	0.97	0.97		94	86	5.3	—	62	
	60	/ 1427	129.050	0.58	0.97	0.97		94	85	5.3	—	63	0.20
	70	/ 1437	134.955	0.58	0.97	0.97		96	85	5.3	—	63	
	80	/ 1447	140.855	0.58	0.97	0.97		98	86	5.3	—	63	
	90	/ 1457	146.780	0.58	0.97	0.97		98	88	5.3	—	63	
	100	/ 1507	152.693	0.58	0.97	0.97		100	89	5.3	—	63	0.20
	110	/ 1517	158.610	0.58	0.97	0.97		97	88	5.3	—	66	
	120	/ 1527	164.516	0.58	0.97	0.97		96	88	5.3	—	66	
	130	/ 1537	170.425	0.58	0.97	0.97		96	88	5.3	—	68	
	140	/ 1547	176.351	0.58	0.97	0.97		91	87	5.3	—	63	0.20
	150	/ 1557	182.270	0.58	0.97	0.97		93	86	5.3	—	62	
	160	/ 1607	188.162	0.58	0.97	0.97		93	85	5.3	—	61	
	170	/ 1617	194.050	0.58	0.97	0.97		93	85	5.3	—	61	
	180	/ 1627	199.940	0.58	0.97	0.97		96	84	5.3	—	61	
	190	/ 1637	205.835	0.58	0.97	0.97		94	84	5.3	—	63	0.20
	200	/ 1647	211.730	0.58	0.97	0.97		91	83	5.3	—	62	
	210	/ 1657	217.617	0.58	0.97	0.97		92	83	5.3	—	62	
		/		$\sqrt{\Delta P}$									
	210	/ 2C	123.581	0.7616	0.97	0.97		94	86			63	

~~80~~°F
550°R

PACIFIC ENVIRONMENTAL SERVICES, INC.

ANDERSEN IMPACTOR RECOVERY AND INTEGRITY SHEET

Plant: CONSOLIDATED ENGRAVERS Sample date: 5-13-87
Sample location: DEMISTER INLET Recovery date: 5-13-87
Run number: IPS-2 Recovered by: [signature]

RECOVERY SAMPLE

cyclone particulate container no. _____ Liquid level marked _____
cyclone and nozzle rinse container no. _____ Liquid level marked _____
nozzle (and inlet chamber) container no. IPS-2 Liquid level marked ✓
acetone blank container no. _____ Liquid level marked _____
Samples stored and locked _____

FILTERS

Stage	Filter No	Container No	Container Sealed	Comments
~~0~~ 1	P-39	P-39	✓	
~~1~~ 4	P-36	P-36	✓	
~~2~~ 7	P-37	P-37	✓	
~~3~~ Bu	P-31	P-31	✓	
4				
5				
6				
7				
Backup				

Samples stored and locked _____
Remarks _____

LABORATORY CUSTODY

Received by _____ Date _____
Remarks _____

IPS-3

NOMOGRAPH DATA

Plant: CONSOLIDATED ENGRAVERS Date: 5-14-87

Sampling Location: MIST ELIMINATOR INLET

P_b = 29.61

Calibrated Pressure Differential Across Orifice, in. H_2O	$\Delta H_@$	1.84
Average Meter Temperature (ambient + 20°F), °F	$T_{m_{avg}}$	100
Percent Moisture in Gas Stream by Volume	B_{wo}	2
Barometric Pressure at Meter, in. Hg.	P_m	29.75
Static Pressure in Stack, in. Hg. ($P_m \pm 0.073$ x stack gauge pressure in in. H_2O)	P_s	29.34
Ratio of Static Pressure to Meter Pressure	P_s/P_m	0.986
Average Stack Temperature, °F	$T_{s_{avg}}$	80
Average Velocity Head, in. H_2O	Δp_{avg}	0.56
Maximum Velocity Head, in. H_2O	Δp_{max}	
C Factor	1.10	
Calculated Nozzle Diameter, in.		
Actual Nozzle Diameter, in.	0.195	
Reference Δp, in. H_2O	1.10	

FIELD DATA

Plant CONSOLIDATED ENGRAVERS
Date 5-14-87
Sampling Location MIST ELIM. INLET
Sample Type PART. SIZE
Run Number IPS-3
Operator F. MEADOWS - T. MILLER
Amoient Temperature
Barometric Pressure 29.61 "Hg
Static Pressure (P_s) -4.1
Filter Number(s) —
Pretest Leak Rate = .006 cfm @ 15 in. Hg
Pretest Pitot Leak Check N/A
Pretest Orsat Leak Check N/A
Read and Record all Data Every 10 Minutes

Schematic of Traverse Point Layout

Probe Length and Type 4' SS
Pitot Tube I.D. No.
Nozzle I.D. 0.195
Assumed Moisture, % 2
Temp. Readout S/N OMEGA 650
Meter Box Number RAC 1065
Meter $\Delta H_@$ 1.54
C Factor 1.10
Meter Gamma 0.931 / 0.940
Heater Box Setting N/A
Reference Δp 1.1
Post Test Leak Rate = — cfm @ — in. Hg
Post Test Pitot Leak Check N/A
Post Test Orsat Leak Check N/A

PAGE 1 OF 2

3T-2A

Traverse Point Number	Sampling Time, (min) / Clock Time (24-hour clock)	Gas Meter Reading (V_m) ft^3	Velocity Head (ΔP_s) in. H_2O	Orifice Pres. Differential (ΔH) in. H_2O Desired	Orifice Pres. Differential (ΔH) in. H_2O Actual	Stack Temp. (T_s) °F	Dry Gas Meter Temp. Inlet ($T_{m_{in}}$) °F	Dry Gas Meter Temp. Outlet ($T_{m_{out}}$) °F	Pump Vacuum in. Hg	Sample Box Temp. Filter Temp. °F	Impinger Temp. °F	MIST ELIMINATOR ΔP "H_2O
	0 / 1232	363.293										
V-7	10 / 1242	369.190	0.56	0.92	0.92		85	86	4.6	N/A	55	
	20 / 1252	374.746	0.56	0.92	0.92		95	86	4.6	—	55	0.20
	30 / 1302	380.455	0.56	0.92	0.92		99	87	4.6	—	54	
	40 / 1312	386.240	0.56	0.92	0.92		104	90	4.6	—	54	
	50 / 1322	392.002	0.56	0.92	0.92		108	92	4.6	—	54	
	60 / 1332	397.800	0.56	0.92	0.92		109	94	4.6	—	57	0.25
	70 / 1342	403.520	0.56	0.92	0.92		106	94	4.6	—	56	
	80 / 1352	407.270	0.56	0.92	0.92		102	92	4.6	—	55	
	90 / 1402	415.061	0.56	0.92	0.92		101	92	4.6	—	53	
	100 / 1412	420.932	0.56	0.92	0.92		101	92	4.6	—	55	
	110 / 1422	426.550	0.56	0.92	0.92		106	93	4.6	—	56	0.30
	120 / 1432	432.322	0.56	0.92	0.92		106	94	4.6	—	56	
	130 / 1442	438.183	0.56	0.92	0.92		107	95	4.6	—	57	0.30
	140 / 1452	443.896	0.56	0.92	0.92		108	96	4.6	—	57	
	150 / 1502	449.662	0.56	0.92	0.92		109	97	4.6	—	58	
	160 / 1512	455.420	0.56	0.92	0.92		109	98	4.6	—	57	
	170 / 1522	461.198	0.56	0.92	0.92		112	98	4.6	—	66	0.30
	180 / 1532	466.977	0.56	0.92	0.92		107	98	4.6	—	59	
	/											
	/											
	/											
	/											
	/											

CONTINUED on next page

Plant Name: CONSOLIDATED ENGRAVERS

Test Date: 5-14-87

Run Number: I-3

Operator: F. MEADOWS — T. MILLER

Traverse Point Number	Sampling Time, (min) / Clock Time (24-hour clock)	Gas Meter Reading (V_m) ft^3	Velocity Head (ΔP_s) in. H_2O	Orifice Pres. Differential (ΔH) in. H_2O Desired	Orifice Pres. Differential (ΔH) in. H_2O Actual	Stack Temp. (T_s) °F	Dry Gas Meter Temp. Inlet ($T_{m_{in}}$) °F	Dry Gas Meter Temp. Outlet ($T_{m_{out}}$) °F	Pump Vacuum in. Hg	Sample Box Temp. Filter Temp. °F	Im-pinger Temp. °F	
A-6	180 / 1532	466.977	—	—	—	—	—	—	—	—	—	
	190 / 1542	472.8 —	0.56	0.92	0.92		115	98	4.6	—	58	
	200 / 1552	478.542	0.56	0.92	0.92		106	97	4.6	—	58	0.30
	210 / 1602	484.328	0.56	0.92	0.92		106	97	4.6	—	58	
	220 / 1612	490.112	0.56	0.92	0.92		106	97	4.6	—	58	0.20
	230 / 1622	495.898	0.56	0.92	0.92		109	97	4.6	—	56	
	240 / 1632	501.683	0.56	0.92	0.92		111	97	4.6	—	58	0.30
	/											
	/		$\sqrt{\Delta P}$									
	240 / 240	138.390	0.7483	0.92	0.92		105	94			56	
	/											
	/		$\overline{\Delta P}$					100 cf				
	/		0.56					560 °R				
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PACIFIC ENVIRONMENTAL SERVICES, INC.

ANDERSEN IMPACTOR RECOVERY AND INTEGRITY SHEET

Plant: CONSOLIDATED ENGINEERS Sample date: 5-14-87
Sample location: DEMISTER INLET Recovery date: 5-14-87
Run number: IPS-3 Recovered by: [signature]

RECOVERY SAMPLE

cyclone particulate Liquid level
container no. _____ marked _____
cyclone and nozzle rinse Liquid level
container no. _____ marked _____
nozzle (and inlet chamber) Liquid level
container no. IPS-3 marked _____
acetone blank Liquid level
container no. _____ marked _____
Samples stored and locked _____

FILTERS

Stage	Filter No	Container No	Container Sealed	Comments
~~0~~ 1	P-53	P-53	✓	
~~1~~ 4	P-42	P-42	✓	
2 7	P-43	P-43	✓	
~~3~~ Bu	P-51	P-51	✓	
~~4~~ 2				
5 3				
~~6~~ 6				
7 5				
Backup 8				

Samples stored and locked ✓
Remarks _____

LABORATORY CUSTODY

Received by _____ Date _____
Remarks _____

TRAVERSE POINT LOCATION FOR CIRCULAR DUCTS

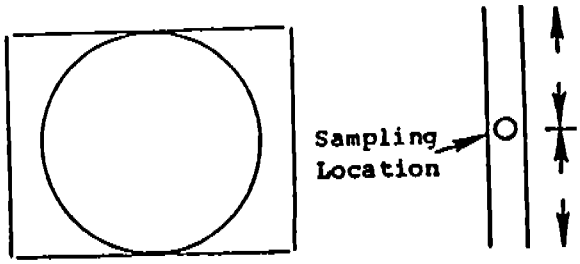
PLANT CON. ENGRAVING
DATE 5-11-87
SAMPLING LOCATION SCRUBBER OUTLET
INSIDE OF FAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE A) 19 5/8"
INSIDE OF NEAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE B) —
STACK I.D., (DISTANCE A - DISTANCE B) 19 5/8"
NEAREST UPSTREAM DISTURBANCE 43 1/2" (2.2 dias)
NEAREST DOWNSTREAM DISTURBANCE 27" (1.4 dias)
CALCULATOR T. MILLER

SCHEMATIC OF SAMPLING LOCATION

TRAVERSE POINT NUMBER	FRACTION OF STACK I.D.	STACK I.D.	PRODUCT OF COLUMNS 2 AND 3 (TO NEAREST 1/8 INCH)	DISTANCE B	TRAVERSE POINT LOCATION FROM OUTSIDE OF NIPPLE (SUM OF COLUMNS 4 & 5)
1	0.021	19.6	0.4	0	0.50
2	0.067		1.3		1.30
3	0.118		2.3		2.3
4	0.177		3.5		3.5
5	0.250		4.9		4.9
6	0.356		7.0		7.0
7	0.644		12.6		12.6
8	0.750		14.7		14.7
9	0.823		16.1		16.1
10	0.882		17.3		17.3
11	0.933		18.3		18.3
12	0.979		19.2		19.1

PRELIMINARY VELOCITY TRAVERSE

Plant: CAN. ENGRAVING
Date: 5-11-87
Location: SCRUBBER OUTLET
Stack I.D.: 19.625"
Barometric Pressure, in. Hg: 29.50
Stack Gauge Pressure, in. H_2O: -0.39
Operators: T.M. & A.W.
Pitot Tube I.D. Number: S-1
Temperature Readout I.D.: OMEGA 650
Pitot Tube Leak Check: OK



Schematic of Traverse Point Layout

P_s = -0.39 "H_2O

Traverse Point Number	Velocity Head (Δp_s) in. H_2O	Stack Temp. (T_s), °F	Cyclonic Flow Check ° from Null
1	~~0.43~~	~~80~~	
2	0.43	80	
3	0.41	80	
4	0.42	80	
5	0.41	80	
6	0.49	77	
7	0.70	78	
8	0.81	82	
9	0.82	80	
10	0.85	79	
11	0.85	79	
12	0.86	77	
			< 6°
Average			

Traverse Point Number	Velocity Head (Δp_s) in. H_2O	Stack Temp. (T_s), °F	Cyclonic Flow Check ° from Null
1	~~0.47~~	~~83~~	
2	0.61 ~~0.77~~	81 ~~83~~	
3	0.68 ~~0.76~~	81	
4	0.70 ~~0.77~~	81	
5	0.73 ~~0.79~~	80	
6	0.74 ~~0.73~~	80	
7	0.69	79	
8	0.70	79	
9	0.71	80	
10	0.79	80	
11	0.81	79	
12	0.81	79	
			< 6°
Average			

0-1

NOMOGRAPH DATA

Plant: CONSOLIDATED ENGRAVERS Date: 5-12-87

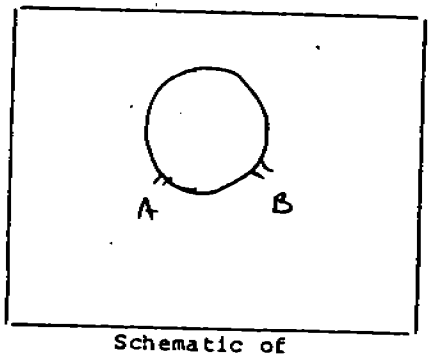
Sampling Location: SCRUBBER OUTLET

MB-4 29.43

Calibrated Pressure Differential Across Orifice, in. H_2O	$\Delta H_@$	1.51
Average Meter Temperature (ambient + 20°F), °F	$T_{m_{avg}}$	110
Percent Moisture in Gas Stream by Volume	B_{wo}	2
Barometric Pressure at Meter, in. Hg.	P_m	29.54
Static Pressure in Stack, in. Hg. ($P_m \pm 0.073$ x stack gauge pressure in in. H_2O)	P_s	29.40
Ratio of Static Pressure to Meter Pressure	P_s/P_m	0.995
Average Stack Temperature, °F	$T_{s_{avg}}$	80
Average Velocity Head, in. H_2O	Δp_{avg}	0.68
Maximum Velocity Head, in. H_2O	Δp_{max}	0.86
C Factor	0.93	
Calculated Nozzle Diameter, in.	0.230	
Actual Nozzle Diameter, in.	0.236	
Reference Δp, in. H_2O	0.62	

FIELD DATA

Plant CONSOLIDATED ENGRAVERS
Date 5-12-87
Sampling Location OUTLET
Sample Type MM 13B
Run Number D-1
Operator H. OWENS - A. WIESMAN
Ambient Temperature 73°F
Barometric Pressure 29.43 "Hg
Static Pressure (P_s) -0.39 "H2O
Filter Number(s) N/A
Pretest Leak Rate = 0.002 cfm @ 10 in. Hg
Pretest Pitot Leak Check OK
Pretest Orsat Leak Check N/A
Read and Record all Data Every 7.5 Minutes



Schematic of Traverse Point Layout

Probe Length and Type 3' PYREX - ~~HEATED~~ (no heat used)
Pitot Tube I.D. No.
Nozzle I.D. 0.236, .236, .237 AVG = .236
Assumed Moisture, % 2
Temp. Readout S/N OMEGA 650
Meter Box Number MB-4
Meter $\Delta H_@$ 1.51
C Factor 0.93
Meter Gamma 1.035, 1.038
Heater Box Setting N/A
Reference Δp 0.67
Post Test Leak Rate = 0 cfm @ 5 in. Hg
Post Test Pitot Leak Check okay
Post Test Orsat Leak Check N/A
Sample box #1

Traverse Point Number	Sampling Time, (min) / Clock / Time (24-hour clock)	488.085 Gas Meter Reading (V_m) ft^3	Velocity Head (ΔP_s) in. H_2O	Orifice Pres. Differential (ΔH) in. H_2O Desired	Actual	Stack Temp. (T_s) °F (3T-1A)	Dry Gas Meter Temp. Inlet ($T_{m_{in}}$) °F	Outlet ($T_{m_{out}}$) °F	Pump Vacuum in. Hg	Sample Box Temp. Filter Temp. °F	Impinger Temp. °F (SH-2)
	0 / 0955	487.572									
A-12	7.5 / 1002.5	494.486	0.7	2.10	2.1	82	76	74	5.0		51
11	15.0 / 1010	500.998	0.72	2.15	2.15	~~90~~	~~77~~ 90	77	5.0		51
10	22.5 / 1017.5	506.983	0.56	1.70	1.70	82	101	82	4.0		57
9	30.0 / 1025	512.724	0.53	1.60	1.60	82	106	88	4.0		63
8	37.5 / 1032.5	518.254	0.48	1.45	1.45	82	112	93	3.5		59
7	45.0 / 1040	523.83	0.48	1.45	1.45	82	113	96	3.5		55
6	52.5 / 1047.5	529.756	0.57	1.70	1.70	84	116	101	4.0		56
5	60 / 1055	535.482	0.62	1.85	1.85	84	120	104	4.0		56
4	67.5 / 1102.5	542.223	0.61	1.81	1.81	84	121	106	4.0		58
3	75.0 / 1110	548.351	0.58	1.75	1.75	83	123	~~123~~ 109	4.0		57
2	82.5 / 1117.5	554.266	0.53	1.60	1.60	85	121	110	4.0		54
1	90.0 / 1125	560.108	0.52	1.55	1.55	85	125	111	4.0		62
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PACIFIC ENVIRONMENTAL SERVICES, INC.

Plant Name: CONSOLIDATED ENGRAVERS

Run Number: 0-1

Test Date: 5-12-87

Operator: H. OWENS - A. WIESMAN.

P_b = 29.43" Hg

Traverse Point Number	Sampling Time, (min) / Clock Time (24-hour clock)	Gas Meter Reading (V_m) ft^3	Velocity Head (ΔP_s) in. H_2O	Orifice Pres. Differential (ΔH) in. H_2O Desired	Orifice Pres. Differential (ΔH) in. H_2O Actual	Stack Temp. (T_s) °F	Dry Gas Meter Temp. Inlet ($T_{m_{in}}$) °F	Dry Gas Meter Temp. Outlet ($T_{m_{out}}$) °F	Pump Vacuum in. Hg	Sample Box Temp. Filter Temp. °F	Impinger Temp. °F
	/ 1142										
B-12	7.5 97.5 ~~1142~~ 1149.5	667.059	0.79	2.30	2.30	85	104	104	5.0		47
11	15.0 105 1149.5 1157	573.994	0.76	2.30	2.30	86	118	106	5.0		52
10	22.5 1127 1204.5	580.797	0.72	2.15	2.15	84	125	108	5.0		54
9	120.0 / 1212	587.396	0.67	2.01	2.01	84	128	110	4.5		53
8	127.5 / 1219.5	593.592	0.58	1.75	1.75	86	128	112	4.0		55
7	135.0 / 1227	599.975	0.43	1.30	1.30	85	126	113	3.0		55
6	142.5 / 1234.5	608.021	0.39	1.18	1.18	85	125	112	3.0		55
5	150.0 / 1242	608.938	0.36	1.10	1.10	85	121	113	3.0		55
4	157.5 / 1249.5	614.227	0.43	1.30	1.30	87	120	113	3.0		57
3	165.0 / 1257	619.626	0.46	1.37	1.37	88	120	113	3.0		58
2	172.5 / 1304.5	625.310	0.49	1.47	1.47	88	118	111	3.0		58
1	180.0 / 1312	630.879	0.48	1.45	1.45	88	119	111	3.0		58
	/										
	/										
	/										
	/										
	180 / 197	142.794	NOP 0.74-49	1.68	1.68	84°F	115.7°F	105.5°F	3.9		58°F
	/						109 °F				
	/		ΔP			544°R	569 °R				
	/		0.55								
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SAMPLE RECOVERY DATA

Plant: Consolidated Engravers

Date: 5/11/87

Sampling Location: outlet - mist eliminator

Sample Type: Modified MIBB

Run Number: 0-1 MM13B

Sample Box Number: #1

Clean-up Man: HJO/FJH/AWW

Job Number:

Comments:

FRONT HALF

Filter Number:

Description of Filter:

MOISTURE

Impingers			
Final Volume:	614.9 ml	588.8 g ml	585.0 g ml
Initial Volume:	590.6 g ~~ml~~	577.4 g ~~ml~~	582.1 g ~~ml~~
Net Volume:	24.3 ml	11.4 ml	2.9 ml
Total H_2O:			
Silica Gel			
Final Volume:	789.1 g	g	g
Initial Volume	761.6 g	g	g
Net Volume	27.5 g	g	g
Total Moisture:		total wt gain 66.1 g	

Description of Impinger Catch:

#1	#2	#3	#4
Initial 590.6	577.4	582.1	

NOMOGRAPH DATA

Plant: CONSOLIDATED ENGINEERS Date: 5-13-87

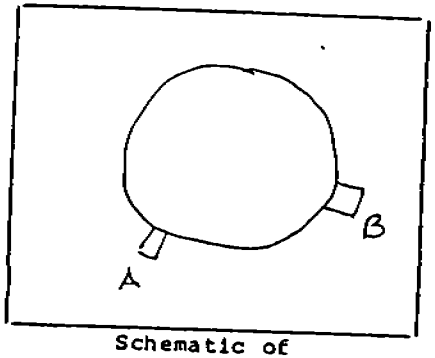
Sampling Location: RUN 0-2 DEMISTER OUTLET

P_b = 29.49 "Hg

Calibrated Pressure Differential Across Orifice, in. H_2O	$\Delta H_@$	1.51
Average Meter Temperature (ambient + 20°F), °F	$T_{m_{avg}}$	100
Percent Moisture in Gas Stream by Volume	B_{wo}	2
Barometric Pressure at Meter, in. Hg.	P_m	29.60
Static Pressure in Stack, in. Hg. ($P_m \pm 0.073$ x stack gauge pressure in in. H_2O)	P_s	29.46
Ratio of Static Pressure to Meter Pressure	P_s/P_m	0.995
Average Stack Temperature, °F	$T_{s_{avg}}$	80
Average Velocity Head, in. H_2O	Δp_{avg}	0.55
Maximum Velocity Head, in. H_2O	Δp_{max}	
C Factor	0.90	
Calculated Nozzle Diameter, in.	0.246	
Actual Nozzle Diameter, in.	0.236	
Reference Δp, in. H_2O	0.650	

FIELD DATA

Plant CONSOLIDATED ENGRAVERS
Date 5-13-87
Sampling Location DEMISTER OUTLET
Sample Type MM13B
Run Number 0-2
Operator H. OWENS - A. WIESMANN
Ambient Temperature 75°F
Barometric Pressure 29.49 "Hg
Static Pressure (P_s) -0.39 "H_2O
Filter Number(s) N/A
Pretest Leak Rate = 0 cfm @ 5 in. Hg
Pretest Pitot Leak Check OK
Pretest Orsat Leak Check N/A
Read and Record all Data Every 7.5 Minutes



Schematic of Traverse Point Layout

Probe Length and Type 2' PYREX - UNHEATED
Pitot Tube I.D. No.
Nozzle I.D. 0.236, 0.236, 0.237 AVG = 0.236
Assumed Moisture, % 2
Temp. Readout S/N OMEGA 650
Meter Box Number MB-4
Meter $\Delta H_@$ 1.51
C Factor 0.90
Meter Gamma 1.031 / 1.038
Heater Box Setting N/A
Reference Δp 0.650
Post Test Leak Rate = 0 cfm @ 7 in. Hg
Post Test Pitot Leak Check OKay
Post Test Orsat Leak Check N/A

PAGE 1 of 2

Traverse Point Number	Sampling Time, (min)	Clock Time (24-hour clock)	Gas Meter Reading (V_m) ft^3	Velocity Head (ΔP_s) in. H_2O	Orifice Pres. Differential (ΔH) in. H_2O Desired	Orifice Pres. Differential (ΔH) in. H_2O Actual	Stack Temp. (T_s) °F (3T-1A)	Dry Gas Meter Temp. Inlet ($T_{m_{in}}$) °F	Dry Gas Meter Temp. Outlet ($T_{m_{out}}$) °F	Pump Vacuum in. Hg	Sample Box Temp. Filter Temp. °F	Impinger Temp. °F (SH-2)
	0	10928	732.090									
A-12	7.5	10935.5	738.146	0.66	1.90	1.90	78	84	80	5.5	N/A	50
11	15.0	10943	~~740.44~~ 744.341	0.68	1.91	1.91	79	95	81	6.0	N/A	56
10	22.5	10950.5	750.449	0.63	1.80	1.80	79	107	86	5.5	N/A	62
9	30.0	10958	756.161	0.55	1.57	1.57	79	114	92	5.0	N/A	59
8	37.5	10965.5	761.571	0.42	1.35	1.35	80	114	98	4.0	N/A	57
7	45.0	10973	766.997	0.46	1.31	1.31	82	122	102	4.0	N/A	56
6	52.5	10980.5	772.994	0.59	1.68	1.69	83	127	107	5.0	N/A	57
5	60.0	10988	779.291	0.60	1.70	1.70	83	131	112	5.5	N/A	58
4	67.5	10995.5	785.647	0.65	1.85	1.85	83	133	114	5.0	N/A	58
3	75.0	11003	793.389	0.74	2.10	2.10	83	135	116	6.0	N/A	59
2	82.5	11010.5	798.635	0.51	1.69	1.69	81	133	118	5.0	N/A	58
1	90	11018	804.847	0.57	~~1.62~~ 1.63	~~1.62~~ 1.63	81	133	118	5.0	N/A	56

PACIFIC ENVIRONMENTAL SERVICES, INC.

SAMPLE RECOVERY DATA

Plant: CONSOLIDATED ENGRAVERS

Date: 5/12/87

Sampling Location: MIST ELIMINATOR OUTLET

Sample Type: MODIFIED M13B

Run Number: ~~D~~ 0-2

Sample Box Number: SAMPLE BOX #1

Clean-up Man: H Owens / F. Hood

Job Number:

Comments:

FRONT HALF

Filter Number:

Description of Filter:

MOISTURE

	#1	#2	#3
Impingers			
Final Volume:	615.8 g	626.2 g	549.2 g
Initial Volume:	590.9 g	580.1 g	582.6 g 552.6
Net Volume:	24.9 g	46.1 g	-33.4 g
Total H_2O:			
Silica Gel			
Final Volume:	811.1 g	g	g
Initial Volume	788.6 g	g	g
Net Volume	22.5 g	g	g
Total Moisture:		total wt. gain 60.1 g	

Description of Impinger Catch:

* NEGATIVE WEIGHT HAS RESULTED BECAUSE OF A BACKFLASH PROBLEM THAT OCCURRED DURING THE POST-TEST LEAK CHECK

NOMOGRAPH DATA

Plant: CONSOLIDATED ENGRAVERS Date: 5-14-87

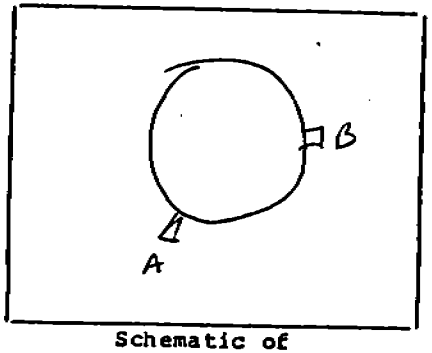
Sampling Location: MIST ELIMINATOR OUTLET 0-3

P_b = 29.61 "Hg

Calibrated Pressure Differential Across Orifice, in. H_2O	$\Delta H_@$	1.51
Average Meter Temperature (ambient + 20°F), °F	$T_{m_{avg}}$	~~105~~ ~~110~~ 105
Percent Moisture in Gas Stream by Volume	B_{wo}	2
Barometric Pressure at Meter, in. Hg.	P_m	29.72
Static Pressure in Stack, in. Hg. ($P_m \pm 0.073$ x stack gauge pressure in in. H_2O)	P_s -.39	29.58
Ratio of Static Pressure to Meter Pressure	P_s/P_m	0.995
Average Stack Temperature, °F	$T_{s_{avg}}$	80
Average Velocity Head, in. H_2O	Δp_{avg}	
Maximum Velocity Head, in. H_2O	Δp_{max}	0.56
C Factor	0.90	
Calculated Nozzle Diameter, in.		
Actual Nozzle Diameter, in.	0.236	
Reference Δp, in. H_2O	0.65	

FIELD DATA

Plant CONSOLIDATED ENGRNEERS
Date 5-14-87
Sampling Location DEMISTER OUTLET
Sample Type MM13B
Run Number 0-3
Operator H. OWENS - A. WIESMAN
Ambient Temperature 67°F
Barometric Pressure 29.61" Hg
Static Pressure (P_s) -0.39" H_2O
Filter Number(s) —
Pretest Leak Rate = .002 cfm @ 13 in. Hg
Pretest Pitot Leak Check OK
Pretest Orsat Leak Check N/A
Read and Record all Data Every 7.5 Minutes



Schematic of Traverse Point Layout

Probe Length and Type 2' PYREX- UNHEATED
Pitot Tube I.D. No.
Nozzle I.D. 0.237, .236, .236 AVG = .236
Assumed Moisture, % 2
Temp. Readout S/N OMEGA 650
Meter Box Number MB-4
Meter $\Delta H_@$ 1.51
C Factor 0.90
Meter Gamma 1.031 / 1.038
Heater Box Setting N/A
Reference Δp 0.65
Post Test Leak Rate = 0 cfm @ 5.5 in. Hg
Post Test Pitot Leak Check ok
Post Test Orsat Leak Check N/A

PAGE 1 of 2

Traverse Point Number	Sampling Time, (min)	Clock / Time (24-hour clock)	Gas Meter Reading (V_m) ft^3	Velocity Head (ΔP_s) in. H_2O	Orifice Pres. Differential (ΔH) in. H_2O Desired	Actual	Stack Temp. (T_s) °F	Dry Gas Meter Temp. Inlet ($T_{m_{in}}$) °F	Outlet ($T_{m_{out}}$) °F	Pump Vacuum in. Hg	Sample Box Temp. Filter Temp. °F	Impinger Temp. °F (3T-1A, 5H-1, 5H-2)
	0	1048	997.604	~~0.71~~	~~2.05~~	~~2.05~~	~~74~~	~~62~~	~~62~~	~~4.5~~	—	49
A-12	7.5	1055.5	1003.924	~~0.76~~ 0.71	~~2.00~~ 2.00	~~2.00~~ 2.00	74	~~95~~ 62	~~62~~ 60	~~4.0~~ 4.5	—	47
11	15.0	1063	1010.194	0.70	2.00	2.00	74	75	62	4.0	—	51
10	22.5	1070.5	1016.354	0.67	1.90	1.90	74	88	67	4.0	—	62
9	30.0	1078	1022.131	0.56	1.60	1.60	74	~~92~~ 92	70	4.0	—	63
8	37.5	1085.5	1027.694	0.49	1.41	1.41	75	96	75	3.5	—	62
7	45.0	1093	1032.076	0.46	1.37	1.37	76	98	80	3.0	—	62
6	52.5	1100.5	1036.419	0.59	1.70	1.70	75	104	84	4.0	—	61
5	60.0	1108	1045.276	0.65	1.88	1.88	75	106	88	4.0	—	63
4	67.5	1115.5	1051.718	0.68	1.91	1.91	76	110	91	4.0	—	64
3	75.0	1123	1058.174	0.68	1.91	1.91	77	113	94	4.0	—	64
2	82.5	1130.5	1064.097	0.55	1.60	1.60	76	113	96	3.5	—	63
~~10~~ 12	90.0	1138	1070.028	0.55	1.60	1.60	78	114	98	3.5	—	63
		/										
		/										
		/										
		/										
		/										
		/										
		/										
		/										
		/										
		/										

PACIFIC ENVIRONMENTAL SERVICES, INC.

Plant Name: CONSOLIDATED ENGRAVERS

Run Number: 0-3

Test Date: 5-14-87

Operator: H. OWENS - A. WIESMAN

Traverse Point Number	Sampling Time, (min) / Clock Time (24-hour clock)	Gas Meter Reading (V_m) ft^3	Velocity Head (ΔP_s) in. H_2O	Orifice Pres. Differential (ΔH) in. H_2O Desired	Orifice Pres. Differential (ΔH) in. H_2O Actual	Stack Temp. (T_s) °F	Dry Gas Meter Temp. Inlet ($T_{m_{in}}$) °F	Dry Gas Meter Temp. Outlet ($T_{m_{out}}$) °F	Pump Vacuum in. Hg	Sample Box Temp. Filter Temp. °F	Impinger Temp. °F
	/ 1033	-	-	-	-	-	-	-	-	-	-
B-12	97.5 / 1040.5	1076.804	0.80	2.26	2.26	76	97	94	5.0	—	47
11	105 / 1048	1083.952	0.83	2.30	2.30	77	108	94	5.0	—	52
10	112.5 / 1055.5	1090.981	0.80	2.26	2.26	77	117	98	5.0	—	55
9	120 / 1103	1097.787	0.73	2.10	2.10	76	118	99	4.6	—	54
8	127.5 / 1110.5	1104.351	0.68	1.95	1.95	77	119	101	4.3	—	55
7	135 / 1118	1110.623	0.62	1.78	1.78	78	119	102	4.0	—	55
6	142.5 / 1125.5	1116.999	0.45	1.30	1.30	78	118	103	3.0	—	56
5	150 / 1133	1121.259	0.38	1.10	1.10	76	116	104	3.0	—	52
4	157.5 / 1140.5	1126.471	0.41	1.20	1.20	77	116	104	3.0	—	51
3	165 / 1148	1131.791	0.43	1.25	1.25	77	115	105	3.0	—	51
2	172.5 / 1155.5	1137.511	0.53	1.55	1.55	77	117	105	3.0	—	51
1	180 / 1203	1143.154	0.48	1.40	1.40	79	117	105	3.0	—	52
	/										
	/										
	/										57°F
	180 / 195	145.550	$\sqrt{\Delta P}$	1.73	1.73	76	106.2°F	96.8°F			
	/		0.7715				98°F				
	/					536°R	558°R				
	/		$\overline{\Delta P}$								
	/		0.60								
	/										
	/										
	/										
	/										
	/										
	/										
	/										
	/										
	/										
	/										

SAMPLE RECOVERY DATA

Plant: CONSOLIDATED ENGRAVERS

Date: 14 MAY 1987

Sampling Location: MIST ELIMINATOR OUTLET

Sample Type: MODIFIED M13B

Run Number: 0-3 M13B

Sample Box Number: SAMPLE BOX #1

Clean-up Man:

Job Number:

Comments:

FRONT HALF

Filter Number:

Description of Filter:

MOISTURE

	#1	#2	#3
Impingers			
Final Volume:	616.7 ~~ml~~	590.2 g ~~ml~~	585.9 ml
Initial Volume:	593.1 g ~~ml~~	579.3 g ~~ml~~	582.1 g ~~ml~~
Net Volume:	17.6 g ~~ml~~	10.9 g ~~ml~~	3.8 g ~~ml~~
Total H_2O:			
Silica Gel			
Final Volume:	746.1 g	g	g
Initial Volume	720.7 g	g	g
Net Volume	25.7 g	g	g
Total Moisture:		total wt. gain 58.0	

Description of Impinger Catch:

OPS-1

NOMOGRAPH DATA

Plant: CONSOLIDATED ENGRAVERS Date: 5-12-87

Sampling Location: DEMISTER OUTLET

Calibrated Pressure Differential Across Orifice, in. H_2O	$\Delta H_@$	1.51
Average Meter Temperature (ambient + 20°F), °F	$T_{m_{avg}}$	110
Percent Moisture in Gas Stream by Volume	B_{wo}	2
Barometric Pressure at Meter, in. Hg.	P_m	29.54
Static Pressure in Stack, in. Hg. ($P_m \pm 0.073$ x stack gauge pressure in in. H_2O)	P_s	29.40
Ratio of Static Pressure to Meter Pressure	P_s/P_m	0.995
Average Stack Temperature, °F	$T_{s_{avg}}$	80
Average Velocity Head, in. H_2O	Δp_{avg}	0.55
Maximum Velocity Head, in. H_2O	Δp_{max}	
C Factor	0.93	
Calculated Nozzle Diameter, in.		
Actual Nozzle Diameter, in.	0.195	
Reference Δp, in. H_2O		

POINT A-10

~~12"~~ 17.3"

FIELD DATA

Plant CONSOLIDATED ENGRAVERS
Date 5-12-87
Sampling Location DEMISTER OUTLET
Sample Type PART SIZE
Run Number OPS-1
Operator F MEADOWS
Ambient Temperature
Barometric Pressure 29.43
Static Pressure (P_s)
Filter Number(s) N/A
Pretest Leak Rate = 0.001 cfm @ 15 in. Hg
Pretest Pitot Leak Check N/A
Pretest Orsat Leak Check N/A
Read and Record all Data Every 10 Minutes

Schematic of Traverse Point Layout

Probe Length and Type 4' SS
Pitot Tube I.D. No.
Nozzle I.D. 0.195
Assumed Moisture, % 2
Temp. Readout S/N OMEGA 650
Meter Box Number MB-4
Meter $\Delta H_@$ 1.51
C Factor 0.93
Meter Gamma 1.031 / 1.038
Heater Box Setting N/A
Reference Δp 1.30
Post Test Leak Rate = — cfm @ — in. Hg
Post Test Pitot Leak Check N/A
Post Test Orsat Leak Check N/A

SH-2

Traverse Point Number	Sampling Time, (min) / Clock Time (24-hour clock)	Gas Meter Reading (V_m) ft^3	Velocity Head (ΔP_s) in. H_2O	Orifice Pres. Differential (ΔH) in. H_2O Desired	Orifice Pres. Differential (ΔH) in. H_2O Actual	Stack Temp. (T_s) °F	Dry Gas Meter Temp. Inlet ($T_{m_{in}}$) °F	Dry Gas Meter Temp. Outlet ($T_{m_{out}}$) °F	Pump Vacuum in. Hg	Sample Box Temp. Filter Temp. °F	Impinger Temp. °F
	0 / 1429	631.045									
A-10	10 / 1439	636.705	0.55	0.80	0.80		95	92	4.0	N/A	67
	20 / 1449	642.273	0.55	0.80	0.80		104	93	4.0	—	65
	30 / 1459	647.871	0.55	0.80	0.80		107	95	4.0	—	63
	40 / 1509	653.490	0.55	0.80	0.80		108	97	4.0	—	64
	50 / 1519	659.130	0.55	0.80	0.80		111	99	4.0	—	62
	60 / 1529	664.778	0.55	0.80	0.80		113	107	4.0	—	63
	~~70~~ / 1546	~~664.778~~	—	—							
	70 / 1551	670.407	0.55	0.80	0.80		107	101	4.0	—	62
	80 / 1601	675.905	0.55	0.80	0.80		112	102	4.0	—	63
	90 / 1611	681.615	0.55	0.80	0.80		115	104	4.0	—	64
	* 100 / 1621	687.250	0.55	0.80	0.80		120	108	4.0	—	65
	~~110 / 1631~~		0								
	Restarted / 1631	688.100									
	110 / 1641	692.490	0.55	0.80	0.80		112	107	4.0	—	64
	120 / 1651	697.812	0.55	0.80	0.80		115	108	4.0	—	64
	130 / 1701	703.376	0.55	0.80	0.80		119	109	4.0	—	64
	140 / 1711	709.110	0.55	0.80	0.80		122	112	4.0	—	63
	150 / 1721	714.865	0.55	0.80	0.80		121	113	4.0	—	63
	160 / 1731	720.590	0.55	0.80	0.80		121	113	4.0	—	63
	170 / 1741	726.318	0.55	0.80	0.80		118	112	4.0	—	63
	180 / 1751	732.024	0.55	0.80	0.80		118	111	4.0	—	63
	/		NOP								
	180 / 202	100.989	.7416	0.80	0.80		113°F	104°F	4.0		64°F

* STOPPED - GLASS CONNECTOR TO 1st IMPINGER BROKEN 109°F 569°R

[redacted]

PACIFIC ENVIRONMENTAL SERVICES, INC.

0.195
0.195
0.195

IMPACTOR # 1

ANDERSEN IMPACTOR RECOVERY AND INTEGRITY SHEET

Plant: CONSOLIDATED ENGRAVERS Sample date: 5-12-87

Sample location: SCRUBBER ~~OUTLET~~ OUTLET Recovery date: 5-12-87

Run number: OPS-1 Recovered by: [illegible]

RECOVERY SAMPLE

cyclone particulate Liquid level

container no. _____ marked _____

cyclone and nozzle rinse Liquid level

container no. _____ marked _____

nozzle (and inlet chamber) Liquid level

container no. OPS-1 marked ✓

acetone blank Liquid level

container no. _____ marked _____

Samples stored and locked _____

FILTERS

Stage		Filter No	Container No	Container Sealed	Comments
~~0~~	1	P-13	P-13	✓	
~~1~~	4	P-7	P-7	✓	
2	7	P-8	P-8	✓	
3	8u	P-1	P-1	✓	
4	2	~~P-6~~	~~P-6~~		
5	3	~~P-5~~	~~P-5~~		
6	6	~~P-4~~	~~P-4~~		
7	5	~~P-3~~	~~P-3~~		
Backup	8	~~P-2~~	~~P-2~~		

Samples stored and locked _____

Remarks _____

LABORATORY CUSTODY

Received by _____ Date _____

Remarks _____

NOMOGRAPH DATA

Plant: CONSOLIDATED ENGRAVERS Date: 5-13-87

Sampling Location: DEMISTER OUTLET DPS 2

$P_b = 29.53$

Calibrated Pressure Differential Across Orifice, in. H_2O	$\Delta H_@$	1.51
Average Meter Temperature (ambient + 20°F), °F	$T_{m_{avg}}$	110
Percent Moisture in Gas Stream by Volume	B_{wo}	2
Barometric Pressure at Meter, in. Hg.	P_m	29.64
Static Pressure in Stack, in. Hg. ($P_m \pm 0.073$ x stack gauge pressure in in. H_2O)	P_s -.39	29.50
Ratio of Static Pressure to Meter Pressure	P_s/P_m	0.995
Average Stack Temperature, °F	$T_{s_{avg}}$	80
Average Velocity Head, in. H_2O	Δp_{avg}	0.59
Maximum Velocity Head, in. H_2O	Δp_{max}	
C Factor		0.90
Calculated Nozzle Diameter, in.		0.240
Actual Nozzle Diameter, in.		0.195
Reference Δp, in. H_2O		1.37

A-6

7.0"

FIELD DATA

Plant CONSOLIDATED ENGRAVERS
Date 5-13-87
Sampling Location DEMISTER ~~INLET~~ OUTLET
Sample Type PART. SIZE
Run Number OPS-2
Operator F. MEADOWS
Ambient Temperature
Barometric Pressure 29.53" Hg
Static Pressure (P_s) -0.39" H_2O
Filter Number(s) —
Pretest Leak Rate = .009 cfm @ 15 in. Hg
Pretest Pitot Leak Check —
Pretest Orsat Leak Check —
Read and Record all Data Every 10 Minutes

Schematic of Traverse Point Layout

Probe Length and Type 4' SS
Pitot Tube I.D. No. —
Nozzle I.D. 0.195
Assumed Moisture, % 2
Temp. Readout S/N OMEGA 650
Meter Box Number MB-4
Meter $\Delta H_@$ 1.51
C Factor 0.90
Meter Gamma 1.031 / 1.035
Heater Box Setting —
Reference Δp 1.37
Post Test Leak Rate = — cfm @ — in. Hg
Post Test Pitot Leak Check —
Post Test Orsat Leak Check —

SH-2

Traverse Point Number	Sampling Time, (min) / Clock Time (24-hour clock)	Gas Meter Reading (V_m) ft^3	Velocity Head (ΔP_s) in. H_2O	Orifice Pres. Differential (ΔH) in. H_2O Desired	Orifice Pres. Differential (ΔH) in. H_2O Actual	Stack Temp. (T_s) °F	Dry Gas Meter Temp. Inlet ($T_{m_{in}}$) °F	Dry Gas Meter Temp. Outlet ($T_{m_{out}}$) °F	Pump Vacuum in. Hg	Sample Box Temp. Filter Temp. °F	Impinger Temp. °F
	0 / 1329	875.418									
~~[illegible]~~	10 / 1339	881.141	0.59	0.82	0.82		98	98	3.8	N/A	57
	20 / 1349	886.885	0.59	0.82	0.82		108	100	3.8	—	56
	30 / 1359	892.671	0.59	0.82	0.82		113	103	3.8	—	59
	40 / 1409	898.463	0.59	0.82	0.82		117	106	3.8	—	55
	50 / 1419	904.262	0.59	0.82	0.82		118	108	3.8	—	57
	60 / 1429	910.000	0.59	0.82	0.82		120	110	3.8	—	57
	70 / 1439	915.890	0.59	0.82	0.82		120	112	3.8	—	57
	80 / 1449	921.710	0.59	0.82	0.82		122	113	3.8	—	57
	90 / 1459	927.545	0.59	0.82	0.82		123	114	3.8	—	59
	100 / 1509	933.375	0.59	0.82	0.82		123	115	3.8	—	60
	110 / 1519	939.225	0.59	0.82	0.82		123	115	3.8	—	60
	120 / 1529	945.031	0.59	0.82	0.82		123	116	3.8	—	61
	130 / 1539	950.900	0.59	0.82	0.82		123	116	3.8	—	60
	140 / 1549	956.773	0.59	0.82	0.82		122	115	3.8	—	60
	150 / 1559	962.605	0.59	0.82	0.82		120	112	3.8	—	59
	160 / 1609	968.455	0.59	0.82	0.82		120	113	3.8	—	59
	170 / 1619	974.300	0.59	0.82	0.82		117	112	3.8	—	60
	180 / 1629	980.115	0.59	0.82	0.82		117	111	3.8	—	62
	190 / 1639	985.923	0.59	0.82	0.82		115	110	3.8	—	62
	200 / 1649	991.727	0.59	0.82	0.82		114	108	3.8	—	60
	210 / 1659	997.520	0.59	0.82	0.82		113	107	3.8	—	
	/		$\sqrt{\Delta P}$								59°F
	210 / 210	122.102	0.7681	0.82	0.82		118 °F	110 °F			

cor 114 °F
57 °F

PACIFIC ENVIRONMENTAL SERVICES, INC.

IMPACTOR #1

ANDERSEN IMPACTOR RECOVERY AND INTEGRITY SHEET

Plant: CONSOLIDATED ENGRAVERS Sample date: 5-13-87

Sample location: DEMISTER OUTLET Recovery date: 5-13-87

Run number: OPS-2 Recovered by: [illegible]

RECOVERY SAMPLE

cyclone particulate Liquid level

container no. _____ marked _____

cyclone and nozzle rinse Liquid level

container no. _____ marked _____

nozzle (and inlet chamber) Liquid level

container no. OPS-2 marked ✓

acetone blank Liquid level

container no. _____ marked _____

Samples stored and locked _____

FILTERS

Stage	Filter No	Container No	Container Sealed	Comments
0 1	P-35	B P-35	✓	
1 4	P-34	P-34	✓	
2 7	P-33	P-33	✓	
3 B4	P-41	P-41	✓	
4 2	—			
5 3	—			
6 6	—			
7 5	—			
~~Backup~~ 8	—			

Samples stored and locked _____

Remarks _____

LABORATORY CUSTODY

Received by _____ Date _____

Remarks _____

OPS-3

NOMOGRAPH DATA

Plant: CONSOLIDATED ENGRAVERS Date: 5-14-87

Sampling Location: MIST ELIMINATOR OUTLET

Calibrated Pressure Differential Across Orifice, in. H_2O	$\Delta H_@$	1.51
Average Meter Temperature (ambient + 20°F), °F	$T_{m_{avg}}$	105
Percent Moisture in Gas Stream by Volume	B_{wo}	2
Barometric Pressure at Meter, in. Hg.	P_m	29.72
Static Pressure in Stack, in. Hg. ($P_m \pm 0.073$ x stack gauge pressure in in. H_2O)	P_s	29.58
Ratio of Static Pressure to Meter Pressure	P_s/P_m	0.995
Average Stack Temperature, °F	$T_{s_{avg}}$	80
Average Velocity Head, in. H_2O	Δp_{avg}	0.59
Maximum Velocity Head, in. H_2O	Δp_{max}	
C Factor	0.90	
Calculated Nozzle Diameter, in.		
Actual Nozzle Diameter, in.	0.195	
Reference Δp, in. H_2O	1.35	

FIELD DATA

Plant CONSOLIDATED ENGRAVERS
Date 5-14-87
Sampling Location MIST ELIM. OUTLET
Sample Type PART SIZE
Run Number OPS-3
Operator F. MENDRUS - A. WIESMAN
Ambient Temperature
Barometric Pressure 29.61
Static Pressure (P_s)
Filter Number(s) —
Pretest Leak Rate = .004 cfm @ 15 in. Hg
Pretest Pitot Leak Check
Pretest Orsat Leak Check N/A
Read and Record all Data Every 10 Minutes

Schematic of Traverse Point Layout

Probe Length and Type 4' SS
Pitot Tube I.D. No.
Nozzle I.D. 0.195
Assumed Moisture, % 2
Temp. Readout S/N OMEGA 650
Meter Box Number MB-4
Meter $\Delta H_@$ 1.51
C Factor 0.90
Meter Gamma 1.031 / 1.038
Heater Box Setting N/A
Reference Δp 1.35
Post Test Leak Rate = — cfm @ — in. Hg
Post Test Pitot Leak Check —
Post Test Orsat Leak Check —

SH-2

Traverse Point Number	Sampling Time, (min)	Clock Time (24-hour clock)	Gas Meter Reading (V_m) ft^3	Velocity Head (ΔP_s) in. H_2O	Orifice Pres. Differential (ΔH) in. H_2O Desired	Actual	Stack Temp. (T_s) °F	Dry Gas Meter Temp. Inlet ($T_{m_{in}}$) °F	Outlet ($T_{m_{out}}$) °F	Pump Vacuum in. Hg	Sample Box Temp. Filter Temp. °F	Impinger Temp. °F
	0	1234	143.344									
A-6	10	1244	149.985	0.59	0.82	0.82		96	95	2.8	N/A	56
	20	1254	154.850	0.59	0.82	0.82		103	95	2.8	—	56
	30	1304	160.605	0.59	0.82	0.82		108	97	2.8	—	55
	40	1314	166.395	0.59	0.82	0.82		110	100	2.8	—	57
	50	1324	172.165	0.59	0.82	0.82		112	102	2.8	—	56
	60	1334	177.935	0.59	0.82	0.82		115	104	2.8	—	55
	70	1344	183.705	0.59	0.82	0.82		115	106	2.8	—	55
	80	1354	189.535	0.59	0.82	0.82		117	107	2.8	—	55
	90	1404	195.340	0.59	0.82	0.82		118	108	2.8	—	55
	100	1414	201.140	0.59	0.82	0.82		119	110	2.8	—	55
	110	1424	206.465	0.59	0.82	0.82		120	110	2.8	—	55
	120	1434	212.774	0.59	0.82	0.82		120	111	2.8	—	56
	130	1444	218.605	0.59	0.82	0.82		120	111	2.8	—	56
	140	1454	224.415	0.59	0.82	0.82		119	111	2.8	—	56
	150	1504	230.244	0.59	0.82	0.82		118	111	2.8	—	57
	160	1514	236.050	0.59	0.82	0.82		118	111	2.8	—	57
	170	1524	241.895	0.59	0.82	0.82		119	111	2.8	—	58
	180	1534	247.735	0.59	0.82	0.82		119	111	2.8	—	58

Continued on next page

PACIFIC ENVIRONMENTAL SERVICES, INC.

Plant Name: CONSOLIDATED ENGRAVERS

Run Number: OPS-3

Test Date: 5-14-87

Operator: F. MEADOWS, T. MILLER

Traverse Point Number	Sampling Time, (min) / Clock Time (24-hour clock)	Gas Meter Reading (V_m) ft^3	Velocity Head (ΔP_s) in. H_2O	Orifice Pres. Differential (ΔH) in. H_2O Desired	Actual	Stack Temp. (T_s) °F	Dry Gas Meter Temp. Inlet ($T_{m_{in}}$) °F	Outlet ($T_{m_{out}}$) °F	Pump Vacuum in. Hg	Sample Box Temp. Filter Temp. °F	Impinger Temp. °F
A-6	180 / 1534	247.735	—	—	—	—	—	—	—	—	—
	190 / 1544	253.585	0.59	0.82	0.82	—	119	111	2.8	—	58
	200 / 1554	259.439	0.59	0.82	0.82	—	119	111	2.8	—	58
	210 / 1604	265.300	0.59	0.82	0.82	—	119	111	2.8	—	57
	220 / 1614	271.140	0.59	0.82	0.82		120	111	2.8	—	57
	230 / 1624	277.000	0.59	0.82	0.82		121	111	2.8	—	59
	240 / 1634	282.838	0.59	0.82	0.82		121	111	2.8	—	59
	/										
	/		$\sqrt{\Delta P}$								
	240 / 240	139.484	0.7681	0.82	0.82		116°F	107°F			57°F
	/						110°F				
	/		$\overline{\Delta P}$				570°R				
	/		0.59								
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PACIFIC ENVIRONMENTAL SERVICES, INC.

ANDERSEN IMPACTOR RECOVERY AND INTEGRITY SHEET

Plant: CONSOLIDATED QUGRAVERS Sample date: 5-14-87

Sample location: DEMISTER ~~INLET~~ OUTLET Recovery date: 5-14-87

Run number: OPS-3 Recovered by: [signature]

RECOVERY SAMPLE

cyclone particulate container no. _____ Liquid level marked _____

cyclone and nozzle rinse container no. _____ Liquid level marked _____

nozzle (and inlet chamber) container no. OPS-3 Liquid level marked _____

acetone blank container no. _____ Liquid level marked _____

Samples stored and locked _____

FILTERS

Stage	Filter No	Container No	Container Sealed	Comments
~~0~~ 1	P-25	P-25	✓	
~~1~~ 4	P-22	P-22	✓	
~~2~~ 7	P-23	P-23	✓	
~~3~~ Bu	P-21	P-21	✓	
~~4~~ 2				
~~5~~ 3				
~~6~~ 6				
~~7~~ 5				
Backup 8			✓	

Samples stored and locked _____

Remarks _____

LABORATORY CUSTODY

Received by _____ Date _____

Remarks _____

SAMPLE CHAIN OF CUSTODY

Plant: Consolidated Engravers Test Number: ME-inlet

Date Sampled: 5/12/87 Run Number: I-1 MM13B

SAMPLE RECOVERY

Container Code	Description
Inlet-Run I-1 MM13B	Nozzle, probe rinses impinger catch and connecting glassware rinses

Person Engaged in Sample Recovery

Signature: [illegible]

Title: Site [illegible]

Location at which Recovery was Done: @ plant

Date and Time of Recovery: 5/12/87 - 1500

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature:

Title:

Date and Time of Receipt:

Sample Storage:

Laboratory Person Receiving Sample

Signature: Lauri Rotella

Title: Sample Custodian

Date and Time of Receipt: 5/19/87

Sample Storage: Walkin Refrigerator

ANALYSIS

Container Code	Method of Analysis	Date and Time of Analysis	Signature of Analyst

SAMPLE CHAIN OF CUSTODY

Plant: Consolidated Engravers

Test Number: HF-outlet

Date Sampled: 5/12/87

Run Number: D-1 HM13B

SAMPLE RECOVERY

Container Code	Description
OUTLET-D-1 HM13B	Nozzle & probe rinses, impinger catch & rinse, connecting glassware rinse

Person Engaged in Sample Recovery

Signature: [illegible]

Title: Subcontractor

Location at which Recovery was Done: @ plant

Date and Time of Recovery: 5/12/87 1600

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature:

Title:

Date and Time of Receipt:

Sample Storage:

Laboratory Person Receiving Sample

Signature: Laura Rotella

Title: Sample Custodian

Date and Time of Receipt: 5/19/87

Sample Storage: Walkin refrigerator

ANALYSIS

Container Code	Method of Analysis	Date and Time of Analysis	Signature of Analyst

SAMPLE CHAIN OF CUSTODY

Plant: Consolidated Engravers Test Number: HF-inlet&outlet

Date Sampled: 5/12/87 Run Number: I&O-1

SAMPLE RECOVERY

Container Code	Description
0.1N NaOH Blank Run #1	0.1 N NaOH Solution used for sample train set-up

Person Engaged in Sample Recovery

Signature: [illegible]

Title: Sales Engr.

Location at which Recovery was Done: @ plant

Date and Time of Recovery: 5/12/87 1705

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature:

Title:

Date and Time of Receipt:

Sample Storage:

Laboratory Person Receiving Sample

Signature: Laura Rotella

Title: Sample Custodian

Date and Time of Receipt: 5/19/87

Sample Storage: Walk in Refrigerator

ANALYSIS

Container Code	Method of Analysis	Date and Time of Analysis	Signature of Analyst

SAMPLE CHAIN OF CUSTODY

Plant: Consolidated Engravers Test Number: MM13B-1

Date Sampled: 5/12/87 Run Number: 1

SAMPLE RECOVERY

Container Code	Description
	plating solution tank #1
	composite sample

Person Engaged in Sample Recovery

Signature: Frances J Hazel

Title: STAFF ENGINEER - PEEE CONSULTANTS PC

Location at which Recovery was Done: Plating Tank #1

Date and Time of Recovery: 12 May 1987 12:30 pm

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature:

Title:

Date and Time of Receipt:

Sample Storage:

Laboratory Person Receiving Sample

Signature: Lauri Rotello

Title: Sample Custodian

Date and Time of Receipt: 5/19/87

Sample Storage: Within Refrigerator

ANALYSIS

Container Code	Method of Analysis	Date and Time of Analysis	Signature of Analyst

SAMPLE CHAIN OF CUSTODY

Plant: Consolidated Engravers Test Number: MM13-B -1

Date Sampled: 5/12/87 Run Number: 1

SAMPLE RECOVERY

Container Code	Description
	plating solution tank #2
	composite

Person Engaged in Sample Recovery

Signature: Francis J Hood

Title: STAFF ENGINEER - DEEP CONSULTANTS PC

Location at which Recovery was Done: Plating TANK 2

Date and Time of Recovery: 12 May 1987 [redacted] 12:30

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature:

Title:

Date and Time of Receipt:

Sample Storage:

Laboratory Person Receiving Sample

Signature: Laura Rotelli

Title: Sample Custodian

Date and Time of Receipt: 5/19/87

Sample Storage: Walkin Refrigerator

ANALYSIS

Container Code	Method of Analysis	Date and Time of Analysis	Signature of Analyst

SAMPLE CHAIN OF CUSTODY

Plant: CONSOLIDATED ENGRAVERS Test Number: Particle Size TEST

Date Sampled: 12 May 1987 Run Number: 1

SAMPLE RECOVERY

Container Code	Description
	Plating Solution Tank #1
	Composite Sample

Person Engaged in Sample Recovery

Signature: Frances J Hood

Title: STAFF ENGINEER - PEER CONSULTANTS PC

Location at which Recovery was Done:

Date and Time of Recovery: 12 May 1987 - 17:30

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature:

Title:

Date and Time of Receipt:

Sample Storage:

Laboratory Person Receiving Sample

Signature: Lauri Rotella

Title: Sample Custodian

Date and Time of Receipt: 5/19/87

Sample Storage: Walkin Refrigerator

ANALYSIS

Container Code	Method of Analysis	Date and Time of Analysis	Signature of Analyst

SAMPLE CHAIN OF CUSTODY

Plant: Consolidated Engravers Test Number: Particle Size Test

Date Sampled: 12 May 1987 Run Number: #1

SAMPLE RECOVERY

Container Code	Description
	Plating Solution Tank #2
	Composite Sample

Person Engaged in Sample Recovery

Signature: Francis J Hood

Title: Staff Engineer - PEEP Consultants PC

Location at which Recovery was Done: Plating Tank #2

Date and Time of Recovery: 12 May 1987 - 17:30

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature:

Title:

Date and Time of Receipt:

Sample Storage:

Laboratory Person Receiving Sample

Signature: Laura Rotella

Title: Sample Custodian

Date and Time of Receipt: 5/19/87

Sample Storage: Walkin Refrigerator

ANALYSIS

Container Code	Method of Analysis	Date and Time of Analysis	Signature of Analyst

SAMPLE CHAIN OF CUSTODY

Plant: Consolidated Engravers Test Number: Post M013B-1 & Particle Size

Date Sampled: 13 May 1987 Run Number: Post 1 & 2

SAMPLE RECOVERY

Container Code	Description
	Washdown capture tank
	grab sample

Person Engaged in Sample Recovery

Signature: Frances J Hood

Title: Staff Engineer - PEEP Consultants PC

Location at which Recovery was Done: Washdown capture tank

Date and Time of Recovery: 13 May 1987 08 30

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature:

Title:

Date and Time of Receipt:

Sample Storage:

Laboratory Person Receiving Sample

Signature: Laura Rotella

Title: Sample Custodian

Date and Time of Receipt: 5/19/87

Sample Storage: Walk in Refrigerator

ANALYSIS

Container Code	Method of Analysis	Date and Time of Analysis	Signature of Analyst

SAMPLE CHAIN OF CUSTODY

Plant: Consolidated Engravers Test Number: MM13B (Mist eliminator)

Date Sampled: 5/13/87 Run Number: I-2 MM13B

SAMPLE RECOVERY

Container Code	Description
I-2 MM13B	Nozzle, probe rinse
	impinger catch & rinse
	connecting glassware rinse
	0.1 N NaOH

Person Engaged in Sample Recovery

Signature: Helen Owens

Title: Site Crew mgr.

Location at which Recovery was Done: @ plant

Date and Time of Recovery: 5/13/87 1500

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature:

Title:

Date and Time of Receipt:

Sample Storage:

Laboratory Person Receiving Sample

Signature: Lauri Rotella

Title: Sample custodian

Date and Time of Receipt: 5/19/87

Sample Storage: Walkin Refrigerator

ANALYSIS

Container Code	Method of Analysis	Date and Time of Analysis	Signature of Analyst

SAMPLE CHAIN OF CUSTODY

Plant: Consolidated Engravers Test Number: MM13B

Date Sampled: 5/13/85 Run Number: O-2 MM13B

SAMPLE RECOVERY

Container Code	Description
O-2 MM13B	nozzle & probe rinse
	impinger catch & rinses
	connecting glassware rinse
	0.1N NaOH

Person Engaged in Sample Recovery

Signature: Helen Owens

Title: Sales mgr.

Location at which Recovery was Done: @ plant

Date and Time of Recovery: 5/13/87 1530

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature:

Title:

Date and Time of Receipt:

Sample Storage:

Laboratory Person Receiving Sample

Signature: Lauri Rotella

Title: & Sampler Custodian

Date and Time of Receipt: 5/19/87

Sample Storage: Walkin Refrigerator

ANALYSIS

Container Code	Method of Analysis	Date and Time of Analysis	Signature of Analyst

SAMPLE CHAIN OF CUSTODY

Plant: Consolidated Engravers Test Number: MM13B-

Date Sampled: 5/13/87 Run Number: I-2 & O-2 MM13B

SAMPLE RECOVERY

Container Code	Description
~~[illegible]~~	
I-2 & O-2 MM13B	0.1N NaOH Blank

Person Engaged in Sample Recovery

Signature: Helen Owens

Title: Site [illegible] mgr

Location at which Recovery was Done: @ plant

Date and Time of Recovery: 5/13/87 1600

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature:

Title:

Date and Time of Receipt:

Sample Storage:

Laboratory Person Receiving Sample

Signature: Laura Rotella

Title: Sample Custodian

Date and Time of Receipt: 5/19/87

Sample Storage: Walkin Refrigerator

ANALYSIS

Container Code	Method of Analysis	Date and Time of Analysis	Signature of Analyst

SAMPLE CHAIN OF CUSTODY

Plant: Consolidated Engravers Test Number: Modified 13B

Date Sampled: 13 MAY 1987 Run Number: 2

SAMPLE RECOVERY

Container Code	Description
	Plating Tank #1
	Composite Sample

Person Engaged in Sample Recovery

Signature: Frances J Hool

Title: State Engineer - Pacific Consultants PC

Location at which Recovery was Done: Plating Tank #1

Date and Time of Recovery: 13 May 1987 - 12:00

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature:

Title:

Date and Time of Receipt:

Sample Storage:

Laboratory Person Receiving Sample

Signature: Laura Rotella

Title: Sample Custodian

Date and Time of Receipt: 5/19/87

Sample Storage: Walkin Refrigerator

ANALYSIS

Container Code	Method of Analysis	Date and Time of Analysis	Signature of Analyst

. SAMPLE CHAIN OF CUSTODY

Plant: Consolidated Engravers Test Number: Modified 13B

Date Sampled: 13 May 1987 Run Number: 2

SAMPLE RECOVERY

Container Code	Description
	Plating Solution Tank #2
	Composite Sample

Person Engaged in Sample Recovery

Signature: Frances J Hood

Title: Staff Engineer - PEER Consultants PC

Location at which Recovery was Done: Plating Tank #2

Date and Time of Recovery: 13 May 1987 12:00

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature:

Title:

Date and Time of Receipt:

Sample Storage:

Laboratory Person Receiving Sample

Signature: Lauri Rotella

Title: Sample Custodian

Date and Time of Receipt: 5/19/87

Sample Storage: Walkin Refrigerator

ANALYSIS

Container Code	Method of Analysis	Date and Time of Analysis	Signature of Analyst

SAMPLE CHAIN OF CUSTODY

Plant: Consolidated Engravers Test Number: Particle Size Test

Date Sampled: 13 May 1987 Run Number: 2

SAMPLE RECOVERY

Container Code	Description
	Plating Solution Tank #1
	Composite Sample

Person Engaged in Sample Recovery

Signature: Francis J Hood

Title: Staff Engineer - Peer Consultants PC

Location at which Recovery was Done: Plating Tank #1

Date and Time of Recovery: 13 May 1987 - 17:00

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature:

Title:

Date and Time of Receipt:

Sample Storage:

Laboratory Person Receiving Sample

Signature: Laura Rotella

Title: Sample Custodian

Date and Time of Receipt: 5/19/87

Sample Storage: Walk-in Refrigerator

ANALYSIS

Container Code	Method of Analysis	Date and Time of Analysis	Signature of Analyst

SAMPLE CHAIN OF CUSTODY

Plant: Consolidated Engravers Test Number: Particle Size Test

Date Sampled: 13 MAY 1987 Run Number: 7

SAMPLE RECOVERY

Container Code	Description
	Plating Solution Tank #7
	Composite Sample

Person Engaged in Sample Recovery

Signature: James J Hood

Title: Staff Engineer - Peer Consultants PC

Location at which Recovery was Done: Plating Tank #2

Date and Time of Recovery: 13 MAY 1987 1700

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature:

Title:

Date and Time of Receipt:

Sample Storage:

Laboratory Person Receiving Sample

Signature: Lara Rotella

Title: Sample Custodian

Date and Time of Receipt: 5/19/87

Sample Storage: Walkin Refrigerator

ANALYSIS

Container Code	Method of Analysis	Date and Time of Analysis	Signature of Analyst

SAMPLE CHAIN OF CUSTODY

Plant: Consolidated Engravers Test Number: Post M013B & Particle Size ~~[illegible]~~ Tests

Date Sampled: 13 May 1987 Run Number: 2

SAMPLE RECOVERY

Container Code	Description
	Washdown from Washdown Tank
	Grab Sample

Person Engaged in Sample Recovery

Signature: Francis J Hood

Title: Staff Engineer - Peer Consultants PC

Location at which Recovery was Done: Washdown Tank

Date and Time of Recovery: 14 May 1987 - 08:30

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature:

Title:

Date and Time of Receipt:

Sample Storage:

Laboratory Person Receiving Sample

Signature: Layn Rotello

Title: Sample Custodian

Date and Time of Receipt: 5/19/87

Sample Storage: Walkin Refrigerator

ANALYSIS

Container Code	Method of Analysis	Date and Time of Analysis	Signature of Analyst

SAMPLE CHAIN OF CUSTODY

Plant: Consolidated Engravers

Test Number: MM13B

Date Sampled: 5/14/87

Run Number: I-3 MM13B

SAMPLE RECOVERY

Container Code	Description
I-3 MM13B	Nozzle rinse, probe rinse, impinger catch & rinse, connecting glassware rinse - 0.1N NaOH

Person Engaged in Sample Recovery

Signature: [illegible]

Title: Site Crew Engr

Location at which Recovery was Done: @ plant

Date and Time of Recovery: 5/14/87 1430

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature:

Title:

Date and Time of Receipt:

Sample Storage:

Laboratory Person Receiving Sample

Signature: Lauri Rotella

Title: Sample Custodian

Date and Time of Receipt: 5/19/87

Sample Storage: Walkin Refrigerator

ANALYSIS

Container Code	Method of Analysis	Date and Time of Analysis	Signature of Analyst

SAMPLE CHAIN OF CUSTODY

Plant: Consolidated Engravers Test Number: MH13-B

Date Sampled: 5/14/87 Run Number: O-3 MH13B

SAMPLE RECOVERY

Container Code	Description
O-3 MH13B	NOZZLE & PROBE RINSE, IMPINGER CATCH & RINSE,
	connecting glassware rinse
	0.1N H2SO4

Person Engaged in Sample Recovery

Signature: [illegible]

Title: Silk screening

Location at which Recovery was Done: @ plant

Date and Time of Recovery: 5/14/87 1330

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature:

Title:

Date and Time of Receipt:

Sample Storage:

Laboratory Person Receiving Sample

Signature: Laura Rotella

Title: Sample Custodian

Date and Time of Receipt: 5/19/87

Sample Storage: Walkin Refrigerator

ANALYSIS

Container Code	Method of Analysis	Date and Time of Analysis	Signature of Analyst

SAMPLE CHAIN OF CUSTODY

Plant: Consolidated Engravers Test Number: MM13B

Date Sampled: 5/14/87 Run Number: I-3 & O-3 MM13B

SAMPLE RECOVERY

Container Code	Description
O-3 & I-3 MM13B	Blank - 0.1 N NaOH

Person Engaged in Sample Recovery

Signature: _____

Title: _____

Location at which Recovery was Done: _____

Date and Time of Recovery: _____

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature: _____

Title: _____

Date and Time of Receipt: _____

Sample Storage: _____

Laboratory Person Receiving Sample

Signature: Karen Rotella

Title: Sample Custodian

Date and Time of Receipt: 5/19/87

Sample Storage: Walkin Refrigerator

ANALYSIS

Container Code	Method of Analysis	Date and Time of Analysis	Signature of Analyst

SAMPLE CHAIN OF CUSTODY

Plant: Consolidated Engravers Test Number: Modified 13B

Date Sampled: 14 May 1987 Run Number: 3

SAMPLE RECOVERY

Container Code	Description
	Plating Solution Tank #1
	Composite Sample

Person Engaged in Sample Recovery

Signature: Frances J Hood

Title: Staff Engineer - PEC Consultants, PC

Location at which Recovery was Done: Plating Tank #1

Date and Time of Recovery: 14 May 1987 - 12:00

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature:

Title:

Date and Time of Receipt:

Sample Storage:

Laboratory Person Receiving Sample

Signature: Lani Rotella

Title: Sample Custodian

Date and Time of Receipt: 5/19/87

Sample Storage: Walker Refrigerator

ANALYSIS

Container Code	Method of Analysis	Date and Time of Analysis	Signature of Analyst

SAMPLE CHAIN OF CUSTODY

Plant: CONSOLIDATED ENGRAVERS Test Number: MODIFIED 13B

Date Sampled: 14 MAY 1987 Run Number: 3

SAMPLE RECOVERY

Container Code	Description
	PLATING SOLUTION TANK #2
	COMPOSITE SAMPLE

Person Engaged in Sample Recovery

Signature: Francis J Hood

Title: STAFF ENGINEER - JEFF CONSULTANTS INC

Location at which Recovery was Done: PLATING TANK #2

Date and Time of Recovery: 14 MAY 1987 12:00

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature:

Title:

Date and Time of Receipt:

Sample Storage:

Laboratory Person Receiving Sample

Signature: Laura Rotella

Title: Sample cus to dian

Date and Time of Receipt: 5/19/87

Sample Storage: Walkin Refrigerator

ANALYSIS

Container Code	Method of Analysis	Date and Time of Analysis	Signature of Analyst

SAMPLE CHAIN OF CUSTODY

Plant: CONSOLIDATED ENGRAVERS Test Number: PARTICLE SIZE TEST

Date Sampled: 14 MAY 1987 Run Number: 3

SAMPLE RECOVERY

Container Code	Description
	PLATING SOLUTION TANK #1
	COMPOSITE SAMPLE

Person Engaged in Sample Recovery

Signature: Frances J Hood

Title: STAFF ENGINEER - TEEP CONSULTANTS PC

Location at which Recovery was Done: PLATING TANK #1

Date and Time of Recovery: 14 MAY 1987 - 16:15

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature:

Title:

Date and Time of Receipt:

Sample Storage:

Laboratory Person Receiving Sample

Signature: Lauri Rotella

Title: Sample Custodian

Date and Time of Receipt: 5/19/87

Sample Storage: Walkin Refrigerator

ANALYSIS

Container Code	Method of Analysis	Date and Time of Analysis	Signature of Analyst

SAMPLE CHAIN OF CUSTODY

Plant: Consolidated Engravers Test Number: Particle Size Test

Date Sampled: 14 May 1987 Run Number: 3

SAMPLE RECOVERY

Container Code	Description
	Plating Solution Tank #2
	Composite Sample

Person Engaged in Sample Recovery

Signature: Frances J Hood

Title: Staff Engineer - Air Consultants Inc

Location at which Recovery was Done: Plating Tank #2

Date and Time of Recovery: 14 May 1987 - 11:15

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature:

Title:

Date and Time of Receipt:

Sample Storage:

Laboratory Person Receiving Sample

Signature: Laura Rotella

Title: Sample Custodian

Date and Time of Receipt: 5/19/87

Sample Storage: Walkin Refrigerator

ANALYSIS

Container Code	Method of Analysis	Date and Time of Analysis	Signature of Analyst

SAMPLE CHAIN OF CUSTODY

Plant: CONSOLIDATED ENGRAVERS Test Number: ~~EPA~~ M013B & PARTICLE SIZE

Date Sampled: 14 MAY 1987 Run Number: 3

SAMPLE RECOVERY

Container Code	Description
	WASHDOWN SOLUTION AT WASHDOWN TANK
	GRAB SAMPLE

Person Engaged in Sample Recovery

Signature: Francis J Hood

Title: STAFF ENGINEER - PEER CONSULTANTS PC

Location at which Recovery was Done: WASHDOWN TANK

Date and Time of Recovery: 15 MAY - 08:30

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature:

Title:

Date and Time of Receipt:

Sample Storage:

Laboratory Person Receiving Sample

Signature: Laura Ratelle

Title: Sample Custodian

Date and Time of Receipt: 5/19/87

Sample Storage: walk in Refrigerator

ANALYSIS

Container Code	Method of Analysis	Date and Time of Analysis	Signature of Analyst

PES

SAMPLE CHAIN OF CUSTODY

Plant: Consolidated Engravers Test Number:

Date Sampled: 5/12-14/87 Run Number: IPS

SAMPLE RECOVERY Combined 6/1/87

Container Code	Description
IPS- Stage 1- Combined	- P-19, P-39, P-53 (0.1N NaOH) - Filters P-19, P-39, P-53
" Stage 4- "	P-16, P-36, P-42 (0.1N NaOH) - Filters P-16, P-36, P-42
" Stage 7- "	P-17, P-37, P-43 (0.1N NaOH) - Filters P-17, P-37, P-43
" Stage BU- "	P-11, P-31, P-51 (0.1N NaOH) - Filters P-11, P-31, P-51
IPS Nozzle Rinse	Combined Nozzle rinses from IPS 1, 2 & 3 (0.1N NaOH)

Person Engaged in Sample Recovery

Signature: Arlen Owens

Title: Site Coordinator

Location at which Recovery was Done: office

Date and Time of Recovery: 6/1/87 1300 (combining)

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature: Lani Potella

Title: Sample Custodian

Date and Time of Receipt: 6/2/87 11:45

Sample Storage: Walk in Refrigerator

Laboratory Person Receiving Sample

Signature:

Title: See Above

Date and Time of Receipt:

Sample Storage:

ANALYSIS

Container Code	Method of Analysis	Date and Time of Analysis	Signature of Analyst

PACIFIC ENVIRONMENTAL SER

PES

SAMPLE CHAIN OF CUSTODY

Plant: Consolidated Engravers Test Number:

Date Sampled: 5/12-14/87 Run Number: OPS

SAMPLE RECOVERY 6/1/87 (Comb)

Container Code	Description
OPS-stage 1-combined	P-13, P-35, P-25 (0.1N NaOH)-Filters. P-13, P-35, P-25
" stage 1- "	P-7, P-34, P-22 (0.1N NaOH)-Filters. P-7, P-34, P-22
" stage 7- "	P-8, P-33, P-23 (0.1N NaOH)-Filters. P-8, P-33, P-23
" stage BU- "	P-1, P-41, P-21 (0.1N NaOH)-Filters P-1, P-41, P-21
OPS Nozzle Rinse	Nozzle rinseate (0.1N NaOH) from OPS 1, 2 & 3 combined

Person Engaged in Sample Recovery

Signature: Helen Owens

Title: Site cert mgr.

Location at which Recovery was Done: office

Date and Time of Recovery: 6/1/87 1345

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature: Dawn Rotello

Title: Sample Custodian

Date and Time of Receipt: 6/2/87 11:45

Sample Storage: walker Refrigerator

Laboratory Person Receiving Sample

Signature: See Above

Title:

Date and Time of Receipt:

Sample Storage:

ANALYSIS

Container Code	Method of Analysis	Date and Time of Analysis	Signature of Analyst

PES

SAMPLE CHAIN OF CUSTODY

Plant: Consolidated Engineers Test Number:

Date Sampled: 5/12-14/87 Run Number: IPS & OPS Blanks

SAMPLE RECOVERY (6/1/87 combined)

Container Code	Description
0.1N NaOH Blank	IPS-OPS [redacted]ination of blanks from ps runs
IPS/OPS stage 1 & 7 Blanks	- small center filters
" " " 4 "	- large center filters
" " BU "	- backup filters

Person Engaged in Sample Recovery

Signature: Alan Owens

Title: Site crew mgr.

Location at which Recovery was Done: Office (combination)

Date and Time of Recovery: 6/1/87 1400

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature: Lam Pdell

Title: Sample Custodian

Date and Time of Receipt: 6/2/87 11:45

Sample Storage: Walkin Refrigerator

Laboratory Person Receiving Sample

Signature:

Title: See Above

Date and Time of Receipt:

Sample Storage:

ANALYSIS

Container Code	Method of Analysis	Date and Time of Analysis	Signature of Analyst

SAMPLE CHAIN OF CUSTODY

Plant: Consolidated Engravers Test Number: _____

Date Sampled: 5/12-14/87 Run Number: _____

SAMPLE RECOVERY

Container Code	Description
screening methods (SM) filters & NaOH rinses	

Person Engaged in Sample Recovery

Signature: John Brown (HO)

Title: EPA technician

Location at which Recovery was Done: @ plant

Date and Time of Recovery: 5/12-14/87 PM.

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature: L. Potilla

Title: Sample Custodian

Date and Time of Receipt: 5/19/87

Sample Storage: refrigerator #1

Laboratory Person Receiving Sample

Signature: _____

Title: _____

Date and Time of Receipt: _____

Sample Storage: _____

ANALYSIS

Container Code	Method of Analysis	Date and Time of Analysis	Signature of Analyst

APPENDIX D

Calculations

EMISSION TEST CALCULATIONS

PLANT Consolidated Cigarettes SOURCE/RUN MM13B / 1-1 DATE 5-12-87

1. Leakage Correction for Volume Metered

$V_{m_c} = V_m - (Lp-La)\theta = V_m - (Lp-0.02)\theta = (\quad)-(\quad -0.02)\ (\quad)$

V_{m_c} = _____ ft^3

2. Volume Metered, Standard Conditions (68°F, 29.92 in.Hg)

$$V_{m_{std}} = 17.64\ V_{m_c} Y \left(\frac{P_{bar} + \Delta H / 13.6}{T_m}\right) = 17.64\ (\ 141.571)(0.931)\frac{(29.43)+(2.00)/13.}{(\ 500\ )}$$

$V_{m_{std}}$ = 134.8971 dscf ✓

3. Volume Water Vapor Collected, Standard Conditions

Impingers = V_{wc} = 0.04707 $(V_f - V_i)$ = 0.04707 (38.4) = 1.8075 scf

Silica Gel = V_{ws_g} = 0.04715 $(W_f - W_i)$ = 0.04715 (27.7) = 1.3061 scf

$V_{w_{std}} = V_{wc} + V_{ws_g}$ = 3.1136 scf

4. Percent Moisture, By Volume

$$B_{w_s} = \frac{V_{w_{std}}}{V_{w_{std}} + V_{m_{std}}} = \frac{(3.1136)}{(3.1136)+(134.8971)} = 0.0226$$

5. Molecular Weight, Stack Gas

Dry Molecular Weight, $M_d = 0.440\ (\%CO_2) + 0.320(\%O_2) + 0.280\ (\%N_2 + \%CO)$

$= 0.440\ (\quad) + 0.320(\quad) + 0.280\ (\quad)$

M_d = 29.0 lb/lb - mole

Percent Excess Air, %EA =

$$\left[\frac{\%O_2 - 0.5\ \%CO}{0.264(\%N_2)-(\%O_2-0.5\ \%CO)}\right] X100 \left[\frac{(\quad)-0.5(\quad)}{0.264(\quad)-(\quad -0.5(\quad)}\right] X\ 100$$

%EA = _____

$M_s = M_d\ (1-B_{ws}) + 18.0\ (B_{ws})$ = (29.0)(1-0.0226) + 18.0 (0.0226) = 28.75 lb/lb-mole ✓

6. Stack Gas Velocity, Average

$$V_{s_{avg}} = 85.49 C_p \left(\sqrt{\Delta P}\right)_{avg} \sqrt{\frac{T_s}{P_s M_s}} = 85.49 \ (0.84) \ (0.0706) \sqrt{\frac{(541)}{(29.16)(28.15)}}$$

$V_{s_{avg}}$ = 43.127 ft/s

7. Stack Volumetric Flow Rate, Actual Conditions (Stack Temperature and Pressure)

$$Q_a(\text{circular}) = \left(\frac{60 \times V_s \ (\pi d^2/4)}{144}\right) = 60 \times V_s \ (5.454 \times 10^{-3}) \ (d^2)$$

$$= 60 \times 43.1271 \ (5.454 \times 10^{-3}) \ (\ 16 \ )^2$$

"or" $Q_a(\text{rectangular}) = 60 \times V_s \left(\frac{L \times W}{144}\right) = 60 \times V_s \ (L \times W) \ 6.944 \times 10^{-3}$

$$= 60 \times ____ \ (____ \times ____) \ 6.944 \times 10^{-3}$$

Q_a = 5,421.016 acfm

8. Stack Volumetric Flow Rate, Standard Conditions (68°F, 29.92 in. Hg)

$$Q_{std} = 17.64 \ Q_a (1-B_{ws}) \left(\frac{P_s}{T_s}\right) = 17.64 \ (5,421.016) \ (1-0.0226) \left(\frac{29.16}{541}\right)$$

Q_{std} = 5,038.369 dscfm

9. Isokinetic Variation

$$\%I = K \frac{T_s \ V_{m(std)}}{P_s \ V_s \ \lambda_n \ \theta \ 1-B_{ws}}$$

$$= 0.0944 \ \frac{(541) \ (134.871)}{(29.16) \ (43.1271) \ (3.063 \times 10^{-4}) \ (180) \ (1-0.0226)}$$

= 101.6 %

EMISSION RATE CALCULATIONS

Plant Consolidated Eng. Run No. I-1 Date 5/12/87

Parameter measured Total Chromium

Sample volume $V_{m\ std}$ 134.8991 dscf
Sample concentration (C_s) 6.18 mg/ℓ
Blank concentration (C_b) 0.021 mg/ℓ
Solution volume (V_{sol}) 0.899 ℓ
Volumetric flow rate Q_{std} 5038.369 ft^3/min

1. Total mass in sample (mg): $(C_s - C_b)\ (V_{sol})$

$$\frac{6.18}{\ell}\ \text{mg} - \frac{0.021}{\ell}\ \text{mg}\ (0.899\ \ell) = 5.537\ \text{mg}$$

2. Concentration (gr/dscf): $\dfrac{(\text{mg})\ \dfrac{0.0154\ \text{gr}}{\text{mg}}}{Vm_{std}} = \text{gr/dscf}$

$$\frac{(5.537\ \text{mg})\ \dfrac{0.0154\ \text{gr}}{\text{mg}}}{134.8991\ \text{dscf}} = 0.00063\ \text{gr/dscf}$$

3. Emission rate (lb/hr):

$$\frac{(\text{gr})}{\text{dscf}}\ \frac{1\ \text{lb}}{7000\ \text{g}}\ \frac{(\text{ft}^3)}{\text{min}}\ \frac{60\ \text{min}}{\text{hr}} = \text{lb/hr}$$

$$\frac{(0.00063\ \text{gr})}{\text{dscf}}\ \frac{1.43\text{x}10^{-4}\ \text{lb}}{\text{gr}}\ \frac{(5038.369\ \text{ft}^3)}{\text{min}}\ \frac{60\ \text{min}}{\text{hr}} = 0.0273\ \text{lb/hr}$$

Emission rate (kg/hr) = (lb/hr) (0.4539 kg/lb) = kg/hr

$$\frac{(0.0273}{\text{hr}}\ \text{lb})\ \frac{0.4539\ \text{kg}}{\text{lb}} = 0.0124\ \text{kg/hr}$$

0037S

EMISSION RATE CALCULATIONS

Plant Consolidated Eng. Run No. I-1 Date 5/12/87

Parameter measured Hexavalent Chromium

Sample volume $V_{m\ std}$ 134.8991 dscf
Sample concentration (C_s) 7.72 mg/ℓ
Blank concentration (C_b) <0.009 mg/ℓ
Solution volume (V_{sol}) 0.899 ℓ
Volumetric flow rate Q_{std} 5038.369 ft^3/min

1. Total mass in sample (mg): $(C_s - C_b)(V_{sol})$

$$\frac{7.72}{\ell}\ \text{mg} - \frac{<0.009}{\ell}\ \text{mg}\ (0.899\ \ell) = 6.932\ \text{mg}$$

2. Concentration (gr/dscf): $\dfrac{(\text{mg})\ \dfrac{0.0154\ \text{gr}}{\text{mg}}}{Vm_{std}} = \text{gr/dscf}$

$$\frac{(6.932\ \text{mg})\ \dfrac{0.0154\ \text{gr}}{\text{mg}}}{134.8991\ \text{dscf}} = 0.00079\ \text{gr/dscf}$$

3. Emission rate (lb/hr):

$$\frac{(\text{gr})}{\text{dscf}}\ \frac{1\ \text{lb}}{7000\ \text{g}}\ \frac{(\text{ft}^3)}{\text{min}}\ \frac{60\ \text{min}}{\text{hr}} = \text{lb/hr}$$

$$\frac{(0.00079\ \text{gr})}{\text{dscf}}\ \frac{1.43\times10^{-4}\ \text{lb}}{\text{gr}}\ \frac{(5038.369\ \text{ft}^3)}{\text{min}}\ \frac{60\ \text{min}}{\text{hr}} = 0.0342\ \text{lb/hr}$$

Emission rate (kg/hr) = (lb/hr) (0.4539 kg/lb) = kg/hr

$$\frac{(0.0342\ \text{lb})}{\text{hr}}\ \frac{0.4539\ \text{kg}}{\text{lb}} = 0.0155\ \text{kg/hr}$$

0037S

EMISSION TEST CALCULATIONS

PLANT Consolidated Engineers SOURCE/RUN mm 13B / I-2 DATE 5-13-87

1. Leakage Correction for Volume Metered

$V_{m_c} = V_m - (L_p - L_a)\theta = V_m - (L_p - 0.02)\theta = (\quad)-(\quad -0.02)(\quad)$

$V_{m_c} =$ _____ ft^3

2. Volume Metered, Standard Conditions (68°F, 29.92 in.Hg)

$$V_{m_{std}} = 17.64\ V_{m_c} Y \left(\frac{P_{bar} + \Delta H / 13.6}{T_m}\right) = 17.64\ (134.400)(0.981)\frac{(29.49)+(1.99)/13.6}{(560)}$$

$V_{m_{std}} =$ 125.0085 dscf

3. Volume Water Vapor Collected, Standard Conditions

Impingers $= V_{wc} = 0.04707\ (V_f - V_i) = 0.04707\ (330) =$ 1.5531 scf

Silica Gel $= V_{wsg} = 0.04715\ (W_f - W_i) = 0.04715\ (23.0) =$ 1.0845 scf

$V_{w_{std}} = V_{wc} + V_{wsg} =$ 2.6130 scf

4. Percent Moisture, By Volume

$$B_{ws} = \frac{V_{w_{std}}}{V_{w_{std}} + V_{m_{std}}} = \frac{(2.6130)}{(2.6130)+(125.0085)} = 0.0225$$

5. Molecular Weight, Stack Gas

Dry Molecular Weight, $M_d = 0.440\ (\%CO_2) + 0.320(\%O_2) + 0.280\ (\%N_2 + \%CO)$

$= 0.440(\quad) + 0.320(\quad) + 0.280(\quad)$

$M_d =$ 29.0 lb/lb - mole

Percent Excess Air, %EA =

$$\left[\frac{\%O_2 - 0.5\ \%CO}{0.264(\%N_2)-(\%O_2-0.5\ \%CO)}\right] X100 \left[\frac{(\quad)-0.5(\quad)}{0.264(\quad)-(\quad -0.5(\quad))}\right] X\ 100$$

%EA = _____

$M_s = M_d\ (1-B_{ws}) + 18.0\ (B_{ws}) = (29.0)(1-0.0225) + 18.0\ (0.0225) =$ 28.575 lb/lb-mole

6. Stack Gas Velocity, Average

$$V_{s_{avg}} = 85.49 C_p \left(\sqrt{\Delta P}\right)_{avg} \sqrt{\frac{T_s}{P_s M_s}} = 85.49 \ (0.84) \ (0.7446) \sqrt{\frac{(539)}{(29.1885)(28.1525)}}$$

$V_{s_{avg}}$ = 42.817 ft/s ✓

7. Stack Volumetric Flow Rate, Actual Conditions (Stack Temperature and Pressure)

$$Qa(\text{circular}) = \left(\frac{60 \times V_s \ (\pi d^2/4)}{144}\right) = 60 \times V_s \ (5.454 \times 10^{-3}) \ (d^2)$$

$$= 60 \times \underline{42.817} \ (5.454 \times 10^{-3}) \ (\underline{19.0})^2$$

"or" $Qa(\text{rectangular}) = 60 \times V_s \left(\frac{L \times W}{144}\right) = 60 \times V_s \ (L \times W) \ 6.944 \times 10^{-3}$

$$= 60 \times ____ \ (____ \times ____) \ 6.944 \times 10^{-3}$$

Qa = ~~5,390.313~~ acfm 5203.538 5246.657

8. Stack Volumetric Flow Rate, Standard Conditions (68°F, 29.92 in. Hg)

$$Q_{std} = 17.64 \ Q_a (1-B_{ws}) \left(\frac{P_s}{T_s}\right) = 17.64 \ (5,390.313) \ (1-0.0215) \left(\frac{29.1885}{539}\right)$$

Q_{std} = ~~5,038.963~~ dscfm
5026.146

9. Isokinetic Variation

$$\%I = K \frac{T_s \ V_{m(std)}}{P_s \ V_s \ A_n \ \theta \ 1-B_{ws}}$$

$$= 0.0944 \frac{(539) \ (125.0085)}{(29.1885) \ (42.817) \ (3.068E-04) \ (180) \ (1-0.0215)}$$ 67,379.581

= 94.4 % ✓

EMISSION RATE CALCULATIONS

Plant Consolidated Eng. Run No. I-2 Date 5/13/87

Parameter measured Total Chromium

Sample volume $V_{m\ std}$ 125.0085 dscf
Sample concentration (C_s) 4.16 mg/ℓ
Blank concentration (C_b) 0.021 mg/ℓ
Solution volume (V_{sol}) 0.803 ℓ
Volumetric flow rate Q_{std} 5026.146 ft^3/min

1. Total mass in sample (mg): $(C_s - C_b)\ (V_{sol})$

$$\frac{4.16}{\ell}\ \text{mg} - \frac{0.021}{\ell}\ \text{mg}\ (0.803\ \ell) = 3.324\ \text{mg}$$

2. Concentration (gr/dscf):

$$\frac{(\text{mg})\ \frac{0.0154\ \text{gr}}{\text{mg}}}{Vm_{std}} = \text{gr/dscf}$$

$$\frac{(3.324\ \text{mg})\ \frac{0.0154\ \text{gr}}{\text{mg}}}{125.0085\ \text{dscf}} = 0.00041\ \text{gr/dscf}$$

3. Emission rate (lb/hr):

$$\frac{(\text{gr})}{\text{dscf}}\ \frac{1\ \text{lb}}{7000\ \text{g}}\ \frac{(\text{ft}^3)}{\text{min}}\ \frac{60\ \text{min}}{\text{hr}} = \text{lb/hr}$$

$$\frac{(0.00041\ \text{gr})}{\text{dscf}}\ \frac{1.43\text{x}10^{-4}\ \text{lb}}{\text{gr}}\ \frac{(5026.146\ \text{ft}^3)}{\text{min}}\ \frac{60\ \text{min}}{\text{hr}} = 0.0177\ \text{lb/hr}$$

Emission rate (kg/hr) = (lb/hr) (0.4539 kg/lb) = kg/hr

$$\frac{(0.0177\ \text{lb})}{\text{hr}}\ \frac{0.4539\ \text{kg}}{\text{lb}} = 0.0080\ \text{kg/hr}$$

0037S

EMISSION RATE CALCULATIONS

Plant Consolidated Engr. Run No. I-2 Date 5/13/87

Parameter measured Hexavalent Chromium

Sample volume $V_{m\ std}$ 125.0085 dscf
Sample concentration (C_s) 7.64 mg/ℓ
Blank concentration (C_b) <0.009 mg/ℓ
Solution volume (V_{sol}) 0.803 ℓ
Volumetric flow rate Q_{std} 5026.146 ft^3/min

1. Total mass in sample (mg): $(C_s - C_b)(V_{sol})$

$$\frac{7.64}{\ell}\ \text{mg} - \frac{0.009}{\ell}\ \text{mg}\ (0.803\ \ell) = 6.13\ \text{mg}$$

2. Concentration (gr/dscf): $\dfrac{(\text{mg})\ \frac{0.0154\ \text{gr}}{\text{mg}}}{Vm_{std}} = \text{gr/dscf}$

$$\frac{(6.13\ \text{mg})\ \frac{0.0154\ \text{gr}}{\text{mg}}}{125.0085\ \text{dscf}} = 0.0008\ 76\ \text{gr/dscf}$$

3. Emission rate (lb/hr):

$$\frac{(\text{gr})}{\text{dscf}}\ \frac{1\ \text{lb}}{7000\ \text{g}}\ \frac{(\text{ft}^3)}{\text{min}}\ \frac{60\ \text{min}}{\text{hr}} = \text{lb/hr}$$

$$\frac{(0.0008\ \text{gr})}{\text{dscf}}\ \frac{1.43\times10^{-4}\ \text{lb}}{\text{gr}}\ \frac{(5026.146\ \text{ft}^3)}{\text{min}}\ \frac{60\ \text{min}}{\text{hr}} = 0.0326\ \text{lb/hr}$$

Emission rate (kg/hr) = (lb/hr) (0.4539 kg/lb) = kg/hr

$$\frac{(0.0326\ \text{lb})}{\text{hr}}\ \frac{0.4539\ \text{kg}}{\text{lb}} = 0.0148\ \text{kg/hr}$$

0037S

EMISSION TEST CALCULATIONS

PLANT CONSOLIDATED ENGRAVERS SOURCE/RUN MM13B / 1 3 DATE 5-14-87

1. Leakage Correction for Volume Metered

$V_{m_c} = V_m - (Lp-La)\theta = V_m - (Lp-0.02)\theta = (\quad)-(\quad -0.02)\ (\quad)$

V_{m_c} = _____ ft^3

2. Volume Metered, Standard Conditions (68°F, 29.92 in.Hg)

$$V_{m_{std}} = 17.64\ V_{m_c} Y \left(\frac{P_{bar} + \Delta H / 13.6}{T_m}\right) = 17.64\ (144.923)(0.981)\frac{(29.61)+(1.30)/13.}{(554)}$$

$V_{m_{std}}$ = 134.472 dscf ✓

3. Volume Water Vapor Collected, Standard Conditions

Impingers = $V_{wc} = 0.04707\ (V_f - V_i) = 0.04707\ (32.5) = 1.5295$ scf

Silica Gel = $V_{wsg} = 0.04715\ (W_f - W_i) = 0.04715\ (26.5) = 1.2475$ scf

$V_{w_{std}} = V_{wc} + V_{ws_g}$ = 2.7793 scf ✓

4. Percent Moisture, By Volume

$$B_{w_s} = \frac{V_{w_{std}}}{V_{w_{std}} + V_{m_{std}}} = \frac{(2.7793)}{(2.7793)+(134.472)} = 0.0202$$ ✓

5. Molecular Weight, Stack Gas

Dry Molecular Weight, $M_d = 0.440\ (\%CO_2) + 0.320(\%O_2) + 0.280\ (\%N_2 + \%CO)$

$= 0.440\ (\quad) + 0.320(\quad) + 0.280\ (\quad)$

M_d = 29.0 lb/lb - mole

Percent Excess Air, %EA =

$$\left[\frac{\%O_2 - 0.5\ \%CO}{0.264(\%N_2)-(\%O_2-0.5\ \%CO)}\right] X100 \left[\frac{(\quad)-0.5(\quad)}{0.264(\quad)-(\quad -0.5(\quad)}\right] X\ 100$$

%EA = _____

$M_s = M_d\ (1-B_{ws}) + 18.0\ (B_{ws}) = (29.0)(1-0.0202) + 18.0\ (0.0202) = 28.775$ lb/lb-mole ✓

Run 1-3

6. Stack Gas Velocity, Average

$$V_{s_{avg}} = 85.49 C_p \left(\sqrt{\Delta P}\right)_{avg} \sqrt{\frac{T_s}{P_s M_s}} = 85.49 \ (0.84) \ (0.7481) \sqrt{\frac{(533)}{(29.34)(28.718)}}$$

$V_{s_{avg}}$ = 42.683 ft/s ✓

7. Stack Volumetric Flow Rate, Actual Conditions (Stack Temperature and Pressure)

$$Q_a(\text{circular}) = \left(\frac{60 \times V_s \ (\pi d^2/4)}{144}\right) = 60 \times V_s \ (5.454 \times 10^{-3}) \ (d^2)$$

$$= 60 \times \underline{42.683} \ (5.454 \times 10^{-3}) \ (\underline{14.0})^2$$

"or" $Q_a(\text{rectangular}) = 60 \times V_s \left(\frac{L \times W}{144}\right) = 60 \times V_s \ (L \times W) \ 6.944 \times 10^{-3}$

$$= 60 \times \underline{\quad} \ (\underline{\quad} \times \underline{\quad}) \ 6.944 \times 10^{-3}$$

Q_a = 5,365.787 acfm ✓

8. Stack Volumetric Flow Rate, Standard Conditions (68°F, 29.92 in. Hg)

$$Q_{std} = 17.64 \ Q_a (1 - B_{ws}) \left(\frac{P_s}{T_s}\right) = 17.64 \ (5,365.787) \ (1 - 0.0200) \left(\frac{29.34}{533}\right)$$

Q_{std} = 5,105.075 dscfm ✓

9. Isokinetic Variation

$$\%I = K \frac{T_s \ V_{m(std)}}{P_s \ V_s \ \Lambda_n \ \Theta \ 1-B_{ws}}$$

$$= 0.0944 \frac{(533)(134.472)}{(29.34)(42.683)(3.063E^{-04})(180)(1-0.0200)} \qquad \frac{71,673.576}{67.603}$$

= 100.0 % ✓

EMISSION RATE CALCULATIONS

Plant Consolidated Eng Run No. I-3 Date 5/14/87

Parameter measured Total Chromium

Sample volume $V_{m\ std}$ 134.472 dscf
Sample concentration (C_s) 1.91 mg/ℓ
Blank concentration (C_b) 0.021 mg/ℓ
Solution volume (V_{sol}) 0.844 ℓ
Volumetric flow rate Q_{std} 5105.078 ft^3/min

Sig fig.

1. Total mass in sample (mg): $(C_s - C_b)\ (V_{sol})$

$$\frac{1.91}{\ell}\ \text{mg} - \frac{0.021}{\ell}\ \text{mg}\ (0.844\ \ell) = 1.59\ \text{mg}$$

2. Concentration (gr/dscf): $\dfrac{(\text{mg})\ \dfrac{0.0154\ \text{gr}}{\text{mg}}}{Vm_{std}} = \text{gr/dscf}$

$$\frac{(1.59\ \text{mg})\ \dfrac{0.0154\ \text{gr}}{\text{mg}}}{134.472\ \text{dscf}} = 0.0002^{182}\ \text{gr/dscf}$$

3. Emission rate (lb/hr):

$$\frac{(\text{gr})}{\text{dscf}}\ \frac{1\ \text{lb}}{7000\ \text{g}}\ \frac{(\text{ft}^3)}{\text{min}}\ \frac{60\ \text{min}}{\text{hr}} = \text{lb/hr}$$

$$\frac{(0.0002^{182}\ \text{gr})}{\text{dscf}}\ \frac{1.43\text{x}10^{-4}\ \text{lb}}{\text{gr}}\ \frac{(5105.078\ \text{ft}^3)}{\text{min}}\ \frac{60\ \text{min}}{\text{hr}} = 0.0080^{797}\ \text{lb/hr}\ ?$$

Emission rate (kg/hr) = (lb/hr) (0.4539 kg/lb) = kg/hr

$$\frac{(0.0080\ \text{lb})}{\text{hr}}\ \frac{0.4539\ \text{kg}}{\text{lb}} = 0.0036\ \text{kg/hr}$$

0037S

EMISSION RATE CALCULATIONS

Plant Consolidated Engravers Run No. I-3 Date 5/14/87

Parameter measured Hexavalent Chromium

Sample volume $V_{m\ std}$ 134.472 dscf
Sample concentration (C_s) 7.89 mg/ℓ
Blank concentration (C_b) <0.009 mg/ℓ
Solution volume (V_{sol}) 0.844 ℓ
Volumetric flow rate Q_{std} 5105.078 ft^3/min

1. Total mass in sample (mg): $(C_s - C_b)\ (V_{sol})$

$$\frac{7.89}{\ell}\ \text{mg} - \frac{0.009}{\ell}\ \text{mg}\ (0.844\ \ell) = 6.65\ \text{mg}$$

2. Concentration (gr/dscf): $\dfrac{(\text{mg})\ \dfrac{0.0154\ \text{gr}}{\text{mg}}}{Vm_{std}} = \text{gr/dscf}$

$$\frac{(6.65\ \text{mg})\ \dfrac{0.0154\ \text{gr}}{\text{mg}}}{134.472\ \text{dscf}} = 0.0008\ \text{gr/dscf}$$

3. Emission rate (lb/hr):

$$\frac{(\text{gr})}{\text{dscf}}\ \frac{1\ \text{lb}}{7000\ \text{g}}\ \frac{(\text{ft}^3)}{\text{min}}\ \frac{60\ \text{min}}{\text{hr}} = \text{lb/hr}$$

$$\frac{(0.0008\ \text{gr})}{\text{dscf}}\ \frac{1.43\times10^{-4}\ \text{lb}}{\text{gr}}\ \frac{(5105.078\ \text{ft}^3)}{\text{min}}\ \frac{60\ \text{min}}{\text{hr}} = 0.0334\ \text{lb/hr}$$

Emission rate (kg/hr) = (lb/hr) (0.4539 kg/lb) = kg/hr

$$\frac{(0.0334\ \text{lb})}{\text{hr}}\ \frac{0.4539\ \text{kg}}{\text{lb}} = 0.0152\ \text{kg/hr}$$

0037S

EMISSION TEST CALCULATIONS

PLANT CONSOLIDATED ENGRAVERS SOURCE/RUN IPS-1 DATE 5-12-87

1. Leakage Correction for Volume Metered

$V_{m_c} = V_m - (Lp-La)\theta = V_m - (Lp-0.02)\theta = (\quad\quad)-(\quad\quad -0.02)\ (\quad\quad)$

$V_{m_c} =$ _____ ft^3

2. Volume Metered, Standard Conditions (68°F, 29.92 in.Hg)

$$V_{m_{std}} = 17.64\ V_{m_c} Y \left(\frac{P_{bar} + \Delta H / 13.6}{T_m}\right) = 17.64\ (104.37)(.981)\ \frac{(29.43)+(0.94)/13.}{(558)}$$

$V_{m_{std}} =$ 96.002 dscf ✓

3. Volume Water Vapor Collected, Standard Conditions

Impingers $= V_{wc} = 0.04707\ (V_f - V_i) = 0.04707\ (\quad\quad) =$ _____ scf

Silica Gel $= V_{wsg} = 0.04715\ (W_f - W_i) = 0.04715\ (\quad\quad) =$ _____ scf

$V_{w_{std}} = V_{wc} + V_{wsg} =$ _____ scf

4. Percent Moisture, By Volume

$$B_{ws} = \frac{V_{w_{std}}}{V_{w_{std}} + V_{m_{std}}} = \frac{(\quad\quad)}{(\quad\quad)+(\quad\quad)} =$$ 0.0226 ✓

5. Molecular Weight, Stack Gas

Dry Molecular Weight, $M_d = 0.440\ (\%CO_2) + 0.320(\%O_2) + 0.280\ (\%N_2 + \%CO)$

$= 0.440\ (\quad\quad) + 0.320(\quad\quad) + 0.280\ (\quad\quad)$

$M_d =$ 29.0 lb/lb - mole

Percent Excess Air, %EA =

$$\left[\frac{\%O_2 - 0.5\ \%CO}{0.264(\%N_2)-(\%O_2-0.5\ \%CO)}\right] X100 \left[\frac{(\quad\quad)-0.5(\quad\quad)}{0.264(\quad\quad)-(\quad\quad -0.5(\quad\quad))}\right] X\ 100$$

%EA = _____

$M_s = M_d\ (1-B_{ws}) + 18.0\ (B_{ws}) = (29.0)(1-.0226) + 18.0\ (.0226) =$ 28.75 ✓ lb/lb-mole

IPS-1

6. Stack Gas Velocity, Average

$$V_{s_{avg}} = 85.49 C_p \left(\sqrt{\Delta P}\right)_{avg} \sqrt{\frac{T_s}{P_s M_s}} = 85.49\ (0.84)\ (0.1416) \sqrt{\frac{(538)}{(29.15)(28.75)}}$$

$V_{s_{avg}}$ = 42.669 ✓ ft/s

7. Stack Volumetric Flow Rate, Actual Conditions (Stack Temperature and Pressure)

$$Qa(\text{circular}) = \left(\frac{60 \times V_s\ (\pi d^2/4)}{144}\right) = 60 \times V_s\ (5.454 \times 10^{-3})\ (d^2)$$

$$= 60 \times \underline{42.669}\ (5.454 \times 10^{-3})\ (\underline{19.6})^2$$

"or" $Qa(\text{rectangular}) = 60 \times V_s \left(\frac{L \times W}{144}\right) = 60 \times V_s\ (L \times W)\ 6.944 \times 10^{-3}$

$= 60 \times$ _____ (_____ X _____) 6.944×10^{-3}

Qa = 5364 ✓ acfm

8. Stack Volumetric Flow Rate, Standard Conditions (68°F, 29.92 in. Hg)

$$Q_{std} = 17.64\ Q_a (1-B_{ws}) \left(\frac{P_s}{T_s}\right) = 17.64\ (5364)\ (1-.0226) \left(\frac{29.15}{538}\right)$$

Q_{std} = 5011 ✓ dscfm

9. Isokinetic Variation

$$\%I = K \frac{T_s\ V_{m(std)}}{P_s\ V_s\ \Lambda_n\ \Theta\ 1-B_{ws}}$$

$$= 0.0944 \frac{(538)\ (96.002)}{(29.15)\ (42.669)\ (2.074 \times 10^{-4})\ (190)\ (1-.0226)}$$

= 101.8 ✓ %

PES

EMISSION TEST CALCULATIONS

PLANT CONSOLIDATED EVERAVERS SOURCE/RUN IPS-2 DATE 5-13-87

1. Leakage Correction for Volume Metered

$V_{m_c} = V_m - (Lp-La)\theta = V_m - (Lp-0.02)\theta = (\quad\quad)-(\quad\quad -0.02)\ (\quad\quad)$

V_{m_c} = _____ ft^3

2. Volume Metered, Standard Conditions (68°F, 29.92 in.Hg)

$$V_{m_{std}} = 17.64\ V_{m_c} Y \left(\frac{P_{bar} + \Delta H / 13.6}{T_m}\right) = 17.64\ (123.551)(.981)\ \frac{(29.53)+(0.97)/13.6}{(550)}$$

$V_{m_{std}}$ = 115.377 dscf ✓

3. Volume Water Vapor Collected, Standard Conditions

Impingers = $V_{wc} = 0.04707\ (V_f - V_i) = 0.04707\ (\quad\quad) =$ _____ scf

Silica Gel = $V_{wsg} = 0.04715\ (W_f - W_i) = 0.04715\ (\quad\quad) =$ _____ scf

$V_{w_{std}} = V_{wc} + V_{wsg} =$ _____ scf

4. Percent Moisture, By Volume

$$B_{w_s} = \frac{V_{w_{std}}}{V_{w_{std}} + V_{m_{std}}} = \frac{(\quad\quad)}{(\quad\quad)+(\quad\quad)} = 0.0225 \checkmark$$

5. Molecular Weight, Stack Gas

Dry Molecular Weight, $M_d = 0.440\ (\%CO_2) + 0.320(\%O_2) + 0.280\ (\%N_2 + \%CO)$

$= 0.440\ (\quad\quad) + 0.320(\quad\quad) + 0.280\ (\quad\quad)$

M_d = 29.0 lb/lb - mole

Percent Excess Air, %EA =

$$\left[\frac{\%O_2 - 0.5\ \%CO}{0.264(\%N_2)-(\%O_2-0.5\ \%CO)}\right] X100 \left[\frac{(\quad\quad)-0.5(\quad\quad)}{0.264(\quad\quad)-(\quad\quad -0.5(\quad\quad))}\right] X\ 100$$

%EA = _____

$M_s = M_d\ (1-B_{ws}) + 18.0\ (B_{ws}) = (29.0)(1-.0225) + 18.0\ (.0225) =$ 28.75 lb/lb-mole ✓

JPS-2

6. Stack Gas Velocity, Average

$$V_{s_{avg}} = 85.49 C_p \left(\sqrt{\Delta P}\right)_{avg} \sqrt{\frac{T_s}{P_s M_s}} = 85.49\ (.84)\ (.7616) \sqrt{\frac{(538)}{(29.53)(28.75)}}$$

$V_{s_{avg}}$ = 43.537 ft/s

7. Stack Volumetric Flow Rate, Actual Conditions (Stack Temperature and Pressure)

$$Qa\,(\text{circular}) = \left(\frac{60 \times V_s\ (\pi d^2/4)}{144}\right) = 60 \times V_s\ (5.454 \times 10^{-3})\ (d^2)$$

$$= 60 \times 43.537\ (5.454 \times 10^{-3})\ (19.6)^2$$

"or" $Qa\,(\text{rectangular}) = 60 \times V_s \left(\frac{L \times W}{144}\right) = 60 \times V_s\ (L \times W)\ 6.944 \times 10^{-3}$

$$= 60 \times _____\ (_____ \times _____)\ 6.944 \times 10^{-3}$$

Qa = 5473 acfm

8. Stack Volumetric Flow Rate, Standard Conditions (68°F, 29.92 in. Hg)

$$Q_{std} = 17.64\ Q_a (1-B_{ws}) \left(\frac{P_s}{T_s}\right) = 17.64\ (5473)\ (1-.0225) \left(\frac{29.23}{538}\right)$$

Q_{std} = 5127 dscfm

9. Isokinetic Variation

$$\%I = K \frac{T_s\ V_{m(std)}}{P_s\ V_s\ \Lambda_n\ \Theta\ 1-B_{ws}}$$

$$= 0.0944 \frac{(538)\ (115.377)}{(29.23)\ (43.537)\ (2.074 \times 10^{-4})\ (210)\ (1-.0225)}$$

= 108.2 %

EMISSION TEST CALCULATIONS

PLANT CONSOLIDATED ENGRAVERS SOURCE/RUN TPS-3 DATE 5-14-87

1. Leakage Correction for Volume Metered

$V_{m_c} = V_m - (L_p - L_a)\theta = V_m - (L_p - 0.02)\theta = (\quad) - (\quad - 0.02)\ (\quad)$

$V_{m_c} =$ _____ ft^3

2. Volume Metered, Standard Conditions (68°F, 29.92 in.Hg)

$$V_{m_{std}} = 17.64\ V_{m_c} Y \left(\frac{P_{bar} + \Delta H / 13.6}{T_m}\right) = 17.64\ (136.390)(.981)\ \frac{(29.61) + (.92)/13.}{(560)}$$

$V_{m_{std}} =$ 126.915 dscf

3. Volume Water Vapor Collected, Standard Conditions

Impingers $= V_{wc} = 0.04707\ (V_f - V_i) = 0.04707\ (\quad) =$ _____ scf

Silica Gel $= V_{wsg} = 0.04715\ (W_f - W_i) = 0.04715\ (\quad) =$ _____ scf

$V_{w_{std}} = V_{wc} + V_{wsg} =$ _____ scf

4. Percent Moisture, By Volume

$$B_{w_s} = \frac{V_{w_{std}}}{V_{w_{std}} + V_{m_{std}}} = \frac{(\quad)}{(\quad) + (\quad)} = 0.0202$$

5. Molecular Weight, Stack Gas

Dry Molecular Weight, $M_d = 0.440\ (\%CO_2) + 0.320(\%O_2) + 0.280\ (\%N_2 + \%CO)$

$= 0.440\ (\quad) + 0.320(\quad) + 0.280\ (\quad)$

$M_d =$ 29.0 lb/lb - mole

Percent Excess Air, %EA =

$$\left[\frac{\%O_2 - 0.5\ \%CO}{0.264(\%N_2) - (\%O_2 - 0.5\ \%CO)}\right] X100 \left[\frac{(\quad) - 0.5(\quad)}{0.264(\quad) - (\quad - 0.5(\quad))}\right] X\ 100$$

%EA = _____

$M_s = M_d\ (1 - B_{ws}) + 18.0\ (B_{ws}) = (29.0)(1 - .0202) + 18.0\ (.0202) =$ 28.78 lb/lb-mole

IPS-3

6. Stack Gas Velocity, Average

$$V_{s_{avg}} = 85.49 C_p \left(\sqrt{\Delta P}\right)_{avg} \sqrt{\frac{T_s}{P_s M_s}} = 85.49\ (.34)\ (.7483) \sqrt{\frac{(538)}{(29.30)(28.78)}}$$

$V_{s_{avg}}$ = 42.922 ✓ ft/s

7. Stack Volumetric Flow Rate, Actual Conditions (Stack Temperature and Pressure)

$$Qa\,(\text{circular}) = \left(\frac{60 \times V_s\ (\pi d^2/4)}{144}\right) = 60 \times V_s\ (5.454 \times 10^{-3})\ (d^2)$$

$$= 60 \times \underline{42.922}\ (5.454 \times 10^{-3})\ (\underline{19.6})^2$$

"or" $Qa\,(\text{rectangular}) = 60 \times V_s \left(\frac{L \times W}{144}\right) = 60 \times V_s\ (L \times W)\ 6.944 \times 10^{-3}$

$$= 60 \times \underline{\quad}\ (\underline{\quad} \times \underline{\quad})\ 6.944 \times 10^{-3}$$

Qa = 5396 ✓ acfm

8. Stack Volumetric Flow Rate, Standard Conditions (68°F, 29.92 in. Hg)

$$Q_{std} = 17.64\ Q_a\,(1-B_{ws}) \left(\frac{P_s}{T_s}\right) = 17.64\ (5396)\ (1-.0202) \left(\frac{29.30}{538}\right)$$

Q_{std} = 5079 ✓ dscfm

9. Isokinetic Variation

$$\%I = K\ \frac{T_s\ V_{m(std)}}{P_s\ V_s\ A_n\ \theta\ 1-B_{ws}}$$

$$= 0.0944\ \frac{(538)\ (126.915)}{(29.30)\ (42.922)\ (2.074 \times 10^{-4})\ (240)\ (1-.0202)}$$

= 105.1 ✓ %

PES

EMISSION TEST CALCULATIONS

PLANT CONSOLIDATED ENGRAVING SOURCE/RUN 0-1 DATE 5-12-87

1. Leakage Correction for Volume Metered

$V_{m_c} = V_m - (L_p - L_a)\theta = V_m - (L_p - 0.02)\theta = (\quad) - (\quad - 0.02)\ (\quad)$

$V_{m_c} =$ _____ ft^3

2. Volume Metered, Standard Conditions (68°F, 29.92 in.Hg)

$$V_{m_{std}} = 17.64\ V_{m_c} Y \left(\frac{P_{bar} + \Delta H / 13.6}{T_m}\right) = 17.64\ (142.714)(1.035)\ \frac{(29.43) + (1.68)/13.6}{(.569)}$$

$V_{m_{std}} =$ 135.409 dscf

3. Volume Water Vapor Collected, Standard Conditions

Impingers $= V_{wc} = 0.04707\ (V_f - V_i) = 0.04707\ (38.6) =$ 1.8169 scf

Silica Gel $= V_{ws_g} = 0.04715\ (W_f - W_i) = 0.04715\ (27.5) =$ 1.2966 scf

$V_{w_{std}} = V_{wc} + V_{ws_g} =$ 3.114 scf

4. Percent Moisture, By Volume

$$B_{w_s} = \frac{V_{w_{std}}}{V_{w_{std}} + V_{m_{std}}} = \frac{(3.114)}{(3.114) + (135.409)} = 0.0225$$

5. Molecular Weight, Stack Gas

Dry Molecular Weight, $M_d = 0.440\ (\%CO_2) + 0.320(\%O_2) + 0.280\ (\%N_2 + \%CO)$

$= 0.440\ (\quad) + 0.320(\quad) + 0.280\ (\quad)$

$M_d =$ 29.0 lb/lb - mole

Percent Excess Air, %EA =

$$\left[\frac{\%O_2 - 0.5\ \%CO}{0.264(\%N_2) - (\%O_2 - 0.5\ \%CO)}\right] X100 \left[\frac{(\quad) - 0.5(\quad)}{0.264(\quad) - (\quad - 0.5(\quad))}\right] X\ 100$$

%EA = _____

$M_s = M_d\ (1 - B_{ws}) + 18.0\ (B_{ws}) = (29.0)(1 - .0225) + 18.0\ (.0225) =$ 28.75 lb/lb-mole

6-1

6. Stack Gas Velocity, Average

$$V_{s_{avg}} = 85.49 C_p \left(\sqrt{\Delta P}\right)_{avg} \sqrt{\frac{T_s}{P_s M_s}} = 85.49\ (.84)\ (.9991) \sqrt{\frac{(544)}{(29.40)(28.75)}}$$

$V_{s_{avg}}$ = 42.914 ft/s

7. Stack Volumetric Flow Rate, Actual Conditions (Stack Temperature and Pressure)

$$Qa\,(circular) = \left(\frac{60 \times V_s\ (\pi d^2/4)}{144}\right) = 60 \times V_s\ (5.454 \times 10^{-3})\ (d^2)$$

$$= 60 \times 42.914\ (5.454 \times 10^{-3})\ (19.6)^2$$

"or" $Qa\,(rectangular) = 60 \times V_s \left(\frac{L \times W}{144}\right) = 60 \times V_s\ (L \times W)\ 6.944 \times 10^{-3}$

$= 60 \times$ _____ (_____ X _____) 6.944×10^{-3}

Qa = 5395 acfm

8. Stack Volumetric Flow Rate, Standard Conditions (68°F, 29.92 in. Hg)

$$Q_{std} = 17.64\ Q_a (1-B_{ws}) \left(\frac{P_s}{T_s}\right) = 17.64\ (5395)\ (1-0.0225) \left(\frac{29.40}{544}\right)$$

Q_{std} = 5028 dscfm

5027.375

9. Isokinetic Variation

$$\%I = K \frac{T_s\ V_{m(std)}}{P_s\ V_s\ A_n\ \Theta\ 1-B_{ws}}$$

$$= 0.0944 \frac{(544)\ (135.409)}{(29.40)\ (42.914)\ (3.038 \times 10^{-4})\ (180)\ (1-.0225)}$$

= 103.1 %

EMISSION RATE CALCULATIONS

Plant Consolidated Engr. Run No. 0-1 Date 5/12/87

Parameter measured Total Chromium

Sample volume $V_{m\ std}$ 135.409 dscf
Sample concentration (C_s) 1.0 mg/ℓ
Blank concentration (C_b) 0.021 mg/ℓ
Solution volume (V_{sol}) 0.360 ℓ
Volumetric flow rate Q_{std} 5027.375 ft^3/min

1. Total mass in sample (mg): $(C_s - C_b)(V_{sol})$

$$\frac{1.0}{\ell}\ \text{mg} - \frac{0.021}{\ell}\ \text{mg}\ (0.360\ \ell) = 0.35\ \text{mg}$$

2. Concentration (gr/dscf):

$$\frac{(\text{mg})\ \frac{0.0154\ \text{gr}}{\text{mg}}}{Vm_{std}} = \text{gr/dscf}$$

$$\frac{(0.35\ \text{mg})\ \frac{0.0154\ \text{gr}}{\text{mg}}}{135.409\ \text{dscf}} = 0.00004\ \text{gr/dscf}$$

398

3. Emission rate (lb/hr):

$$\frac{(\text{gr})}{\text{dscf}}\ \frac{1\ \text{lb}}{7000\ \text{g}}\ \frac{(\text{ft}^3)}{\text{min}}\ \frac{60\ \text{min}}{\text{hr}} = \text{lb/hr}$$

$$\frac{(0.00004\ \text{gr})}{\text{dscf}}\ \frac{1.43\text{x}10^{-4}\ \text{lb}}{\text{gr}}\ \frac{(5027.375\ \text{ft}^3)}{\text{min}}\ \frac{60\ \text{min}}{\text{hr}} = 0.0017\ \text{lb/hr}$$

Emission rate (kg/hr) = (lb/hr) (0.4539 kg/lb) = kg/hr

$$\frac{(0.0017\ \text{lb})}{\text{hr}}\ \frac{0.4539\ \text{kg}}{\text{lb}} = 0.0008\ \text{kg/hr}$$

779

0037S

EMISSION RATE CALCULATIONS

Plant Consolidated Eng. Run No. 0-1 Date 5/12/87

Parameter measured Hexavalent Chromium

Sample volume $V_{m\ std}$ 135.409 dscf
Sample concentration (C_s) 0.951 mg/ℓ
Blank concentration (C_b) 0.009 mg/ℓ
Solution volume (V_{sol}) 0.360 ℓ
Volumetric flow rate Q_{std} 5027.375 ft^3/min

1. Total mass in sample (mg): $(C_s - C_b)\ (V_{sol})$

$$\frac{0.951}{\ell}\ \text{mg} - \frac{0.009}{\ell}\ \text{mg}\ (0.360\ \ell) = 0.34\ \text{mg}$$

2. Concentration (gr/dscf): $\dfrac{(\text{mg})\ \dfrac{0.0154\ \text{gr}}{\text{mg}}}{Vm_{std}} = \text{gr/dscf}$

$$\frac{(0.34\ \text{mg})\ \dfrac{0.0154\ \text{gr}}{\text{mg}}}{135.409\ \text{dscf}} = 0.00004\ \text{gr/dscf}$$

387

0.34mg

3. Emission rate (lb/hr):

$$\frac{(\text{gr})}{\text{dscf}}\ \frac{1\ \text{lb}}{7000\ \text{g}}\ \frac{(\text{ft}^3)}{\text{min}}\ \frac{60\ \text{min}}{\text{hr}} = \text{lb/hr}$$

$$\frac{(0.00004\ \text{gr})}{\text{dscf}}\ \frac{1.43\text{x}10^{-4}\ \text{lb}}{\text{gr}}\ \frac{(5027.375\text{ft}^3)}{\text{min}}\ \frac{60\ \text{min}}{\text{hr}} = 0.0017\ \text{lb/hr}$$

67

Emission rate (kg/hr) = (lb/hr) (0.4539 kg/lb) = kg/hr

$$\frac{(0.0017\ \text{lb})}{\text{hr}}\ \frac{0.4539\ \text{kg}}{\text{lb}} = 0.0008\ \text{kg/hr}$$

757

0037S

EMISSION TEST CALCULATIONS

PLANT CONSOLIDATED ENGRAVERS SOURCE/RUN 0-2 DATE 5-13-87

1. Leakage Correction for Volume Metered

$V_{m_c} = V_m - (L_p - L_a)\theta = V_m - (L_p - 0.02)\theta = (\quad)-(\quad -0.02)\ (\quad)$

$V_{m_c} =$ _____ ft^3

2. Volume Metered, Standard Conditions (68°F, 29.92 in.Hg)

$$V_{m_{std}} = 17.64\ V_{m_c} Y \left(\frac{P_{bar} + \Delta H / 13.6}{T_m}\right) = 17.64\ (143.016)(1.035)\frac{(29.41)+(1.64)/13.6}{(576)}$$

$V_{m_{std}} =$ 134,305 dscf ✓

3. Volume Water Vapor Collected, Standard Conditions

Impingers $= V_{wc} = 0.04707\ (V_f - V_i) = 0.04707\ (37.6) =$ 1.7698 scf

Silica Gel $= V_{wsg} = 0.04715\ (W_f - W_i) = 0.04715\ (22.5) =$ 1.0609 scf

$V_{w_{std}} = V_{wc} + V_{ws_g} =$ 2.831 scf ✓

4. Percent Moisture, By Volume

$$B_{w_s} = \frac{V_{w_{std}}}{V_{w_{std}} + V_{m_{std}}} = \frac{(2.831)}{(2.831)+(134.305)} = 0.0206$$ ✓

5. Molecular Weight, Stack Gas

Dry Molecular Weight, $M_d = 0.440\ (\%CO_2) + 0.320(\%O_2) + 0.280\ (\%N_2 + \%CO)$

$= 0.440\ (\quad) + 0.320(\quad) + 0.280\ (\quad)$

$M_d =$ 29.0 lb/lb - mole ✓

Percent Excess Air, %EA =

$$\left[\frac{\%O_2 - 0.5\ \%CO}{0.264(\%N_2)-(\%O_2-0.5\ \%CO)}\right] X100 \left[\frac{(\quad)-0.5(\quad)}{0.264(\quad)-(\quad -0.5(\quad)}\right] X\ 100$$

%EA = _____

$M_s = M_d\ (1-B_{ws}) + 18.0\ (B_{ws}) = (29.0)(1-.0206) + 18.0\ (.0206) =$ 28.77 lb/lb-mole ✓

0-8

6. Stack Gas Velocity, Average

$$V_{s_{avg}} = 85.49 C_p \left(\sqrt{\Delta P}\right)_{avg} \sqrt{\frac{T_s}{P_s M_s}} = 85.49\ (.84)\ (6.7522) \sqrt{\frac{(543)}{(29.46)(28.77)}}$$

$V_{s_{avg}}$ = 43,236 ft/s ✓

7. Stack Volumetric Flow Rate, Actual Conditions (Stack Temperature and Pressure)

$$Q_a(\text{circular}) = \left(\frac{60 \times V_s\ (\pi d^2/4)}{144}\right) = 60 \times V_s\ (5.454 \times 10^{-3})\ (d^2)$$

$$= 60 \times \underline{43,236}\ (5.454 \times 10^{-3})\ (\underline{19.6})^2$$

"or" $Q_a(\text{rectangular}) = 60 \times V_s \left(\frac{L \times W}{144}\right) = 60 \times V_s\ (L \times W)\ 6.944 \times 10^{-3}$

$= 60 \times$ _____ (_____ X _____) 6.944×10^{-3}

Qa = ~~5310~~ acfm 5435.306

8. Stack Volumetric Flow Rate, Standard Conditions (68°F, 29.92 in. Hg)

$$Q_{std} = 17.64\ Q_a (1-B_{ws}) \left(\frac{P_s}{T_s}\right) = 17.64\ (\cancel{5310}\ 5435.306)\ (1-.0206)\ \left(\frac{29.46}{543}\right)$$

Q_{std} = ~~4977~~ 5094.665 dscfm

9. Isokinetic Variation

$$\%I = K \frac{T_s\ V_{m(std)}}{P_s\ V_s\ \Lambda_n\ \Theta\ 1-B_{ws}}$$

$$= 0.0944 \frac{(543)\ (134.305)}{(29.46)\ (43.236)\ (3.038 \times 10^{-4})\ (180)\ (1-.0206)}$$

72 927.615

= 100.9 % ✓

EMISSION RATE CALCULATIONS

Plant Consolidated Engravers Run No. 0-2 Date 5/13/57

Parameter measured Total Chromium

Sample volume $V_{m\ std}$ 134.305 dscf
Sample concentration (C_s) 0.644 mg/ℓ
Blank concentration (C_b) 0.021 mg/ℓ
Solution volume (V_{sol}) 0.887 ℓ
Volumetric flow rate Q_{std} 5094.665 ft^3/min

1. Total mass in sample (mg): $(C_s - C_b)\ (V_{sol})$

$$\frac{0.644}{\ell}\ \text{mg} - \frac{0.021}{\ell}\ \text{mg}\ (0.887\ \ell) = 0.55\ \text{mg}$$

2. Concentration (gr/dscf):

$$\frac{(\text{mg})\ \frac{0.0154\ \text{gr}}{\text{mg}}}{Vm_{std}} = \text{gr/dscf}$$

$$\frac{(0.55\ \text{mg})\ \frac{0.0154\ \text{gr}}{\text{mg}}}{134.305\ \text{dscf}} = 0.0001\ \text{gr/dscf}$$

.0063

3. Emission rate (lb/hr):

$$\frac{(\text{gr})}{\text{dscf}}\ \frac{1\ \text{lb}}{7000\ \text{g}}\ \frac{(\text{ft}^3)}{\text{min}}\ \frac{60\ \text{min}}{\text{hr}} = \text{lb/hr}$$

$$\frac{(0.0001\ \text{gr})}{\text{dscf}}\ \frac{1.43\text{x}10^{-4}\ \text{lb}}{\text{gr}}\ \frac{(5094.665\ \text{ft}^3)}{\text{min}}\ \frac{60\ \text{min}}{\text{hr}} = 0.0028\ \text{lb/hr}$$

.76

Emission rate (kg/hr) = (lb/hr) (0.4539 kg/lb) = kg/hr

$$\frac{(0.0028\ \text{lb})}{\text{hr}}\ \frac{0.4539\ \text{kg}}{\text{lb}} = 0.0013\ \text{kg/hr}$$

.25

0037S

EMISSION RATE CALCULATIONS

Plant Consolidated Eng Run No. 0-2 Date 5/13/87

Parameter measured Hexavalent Chromium

Sample volume $V_{m\ std}$ 134.305 dscf
Sample concentration (C_s) 0.968 mg/ℓ
Blank concentration (C_b) 0.009 mg/ℓ
Solution volume (V_{sol}) 0.887 ℓ
Volumetric flow rate Q_{std} 5094.6665 ft^3/min

1. Total mass in sample (mg): $(C_s - C_b)\ (V_{sol})$

$$\frac{0.968}{\ell}\ \text{mg} - \frac{0.009}{\ell}\ \text{mg}\ (0.887\ \ell) = 0.8506\ \text{mg}$$

2. Concentration (gr/dscf): $\dfrac{(\text{mg})\ \dfrac{0.0154\ \text{gr}}{\text{mg}}}{Vm_{std}} = \text{gr/dscf}$

$$\frac{(0.8506\ \text{mg})\ \dfrac{0.0154\ \text{gr}}{\text{mg}}}{134.305\ \text{dscf}} = 0.0001\ \text{gr/dscf}$$

0.0975

3. Emission rate (lb/hr):

$$\frac{(\text{gr})}{\text{dscf}}\ \frac{1\ \text{lb}}{7000\ \text{g}}\ \frac{(\text{ft}^3)}{\text{min}}\ \frac{60\ \text{min}}{\text{hr}} = \text{lb/hr}$$

$$\frac{(0.0001\ \text{gr})}{\text{dscf}}\ \frac{1.43\text{x}10^{-4}\ \text{lb}}{\text{gr}}\ \frac{(5094.6665\text{ft}^3)}{\text{min}}\ \frac{60\ \text{min}}{\text{hr}} = 0.0043\ \text{lb/hr}$$

.26

Emission rate (kg/hr) = (lb/hr) (0.4539 kg/lb) = kg/hr

$$\frac{(0.0043\ \text{lb})}{\text{hr}}\ \frac{0.4539\ \text{kg}}{\text{lb}} = 0.00194\ \text{kg/hr}$$

0037S

EMISSION TEST CALCULATIONS

PLANT CONSOLIDATED ENGRMERS SOURCE/RUN 0-3 DATE 5-14-87

1. Leakage Correction for Volume Metered

$V_{m_c} = V_m - (L_p - L_a)\theta = V_m - (L_p - 0.02)\theta = (\quad) - (\quad - 0.02)\ (\quad)$

$V_{m_c} =$ _____ ft^3

2. Volume Metered, Standard Conditions (68°F, 29.92 in.Hg)

$$V_{m_{std}} = 17.64\ V_{m_c} Y \left(\frac{P_{bar} + \Delta H / 13.6}{T_m}\right) = 17.64\ (145.550)(1.035)\frac{(29.61) + (1.73)/13.6}{(558)}$$

$V_{m_{std}} =$ 141.618 dscf

3. Volume Water Vapor Collected, Standard Conditions

Impingers $= V_{wc} = 0.04707\ (V_f - V_i) = 0.04707\ (32.3) =$ 1.5204 scf

Silica Gel $= V_{wsg} = 0.04715\ (W_f - W_i) = 0.04715\ (25.7) =$ 1.2118 scf

$V_{w_{std}} = V_{wc} + V_{wsg} =$ 2.7322 scf ✓

4. Percent Moisture, By Volume

$$B_{w_s} = \frac{V_{w_{std}}}{V_{w_{std}} + V_{m_{std}}} = \frac{(2.732)}{(2.732) + (141.618)} = 0.0189$$ ✓

5. Molecular Weight, Stack Gas

Dry Molecular Weight, $M_d = 0.440\ (\%CO_2) + 0.320(\%O_2) + 0.280\ (\%N_2 + \%CO)$

$= 0.440\ (\quad) + 0.320(\quad) + 0.280\ (\quad)$

$M_d =$ 29.0 lb/lb - mole ✓

Percent Excess Air, %EA =

$$\left[\frac{\%O_2 - 0.5\ \%CO}{0.264(\%N_2) - (\%O_2 - 0.5\ \%CO)}\right] X100 \left[\frac{(\quad) - 0.5(\quad)}{0.264(\quad) - (\quad - 0.5(\quad))}\right] X\ 100$$

%EA = _____

$M_s = M_d\ (1 - B_{ws}) + 18.0\ (B_{ws}) = (29.0)(1 - .0189) + 18.0\ (.0189) =$ 28.79 lb/lb-mole ✓

0-3

6. Stack Gas Velocity, Average

$$V_{s_{avg}} = 85.49 C_p \left(\sqrt{\Delta P}\right)_{avg} \sqrt{\frac{T_s}{P_s M_s}} = 85.49\ (.84)(.7715)\sqrt{\frac{(536)}{(29.58)(28.79)}}$$

$V_{s_{avg}}$ = 43.953 ft/s ✓

7. Stack Volumetric Flow Rate, Actual Conditions (Stack Temperature and Pressure)

$$Qa\,(circular) = \left(\frac{60 \times V_s\ (\pi d^2/4)}{144}\right) = 60 \times V_s\ (5.454 \times 10^{-3})\ (d^2)$$

$$= 60 \times \underline{43.953}\ (5.454 \times 10^{-3})\ (\underline{19.6})^2$$

"or" $Qa\,(rectangular) = 60 \times V_s \left(\frac{L \times W}{144}\right) = 60 \times V_s\ (L \times W)\ 6.944 \times 10^{-3}$

$$= 60 \times _____\ (_____ \times _____)\ 6.944 \times 10^{-3}$$

Qa = ~~5525.~~ acfm 5525.499

8. Stack Volumetric Flow Rate, Standard Conditions (68°F, 29.92 in. Hg)

$$Q_{std} = 17.64\, Q_a (1-B_{ws}) \left(\frac{P_s}{T_s}\right) = 17.64\ (\overset{5525.499}{\cancel{5525}})\ (1-.0189)\left(\frac{29.58}{536}\right)$$

Q_{std} = ~~5277~~ 5277.361 dscfm

9. Isokinetic Variation

$$\%I = K \frac{T_s\ V_{m(std)}}{P_s\ V_s\ \Lambda_n\ \Theta\ 1-B_{ws}}$$

$$= 0.0944 \frac{(536)\ (141.618)}{(29.58)\ (43.954)\ (3.036 \times 10^{-4})\ (180)\ (1-.0189)}$$

= 102.7 % ✓

EMISSION RATE CALCULATIONS

Plant Consolidated Engr. Run No. 0-3 Date 5/14/87

Parameter measured Total Chromium

Sample volume $V_{m\ std}$ 141.618 dscf
Sample concentration (C_s) 0.879 mg/ℓ
Blank concentration (C_b) 0.021 mg/ℓ
Solution volume (V_{sol}) 0.555 ℓ
Volumetric flow rate Q_{std} 5277.361 ft^3/min

1. Total mass in sample (mg): $(C_s - C_b)(V_{sol})$

$$\frac{0.879}{\ell}\ \text{mg} - \frac{0.021}{\ell}\ \text{mg}\ (0.555\ \ell) = 0.48\ \text{mg}$$

2. Concentration (gr/dscf):

$$\frac{(\text{mg})\ \frac{0.0154\ \text{gr}}{\text{mg}}}{Vm_{std}} = \text{gr/dscf}$$

$$\frac{(0.48\ \text{mg})\ \frac{0.0154\ \text{gr}}{\text{mg}}}{141.618\ \text{dscf}} = 0.00005\ \text{gr/dscf}$$

22

3. Emission rate (lb/hr):

$$\frac{(\text{gr})}{\text{dscf}}\ \frac{1\ \text{lb}}{7000\ \text{g}}\ \frac{(\text{ft}^3)}{\text{min}}\ \frac{60\ \text{min}}{\text{hr}} = \text{lb/hr}$$

$$\frac{(0.00005\ \text{gr})}{\text{dscf}}\ \frac{1.43\text{x}10^{-4}\ \text{lb}}{\text{gr}}\ \frac{(5277.361\text{ft}^3)}{\text{min}}\ \frac{60\ \text{min}}{\text{hr}} = 0.0023\ \text{lb/hr}$$

6

Emission rate (kg/hr) = (lb/hr) (0.4539 kg/lb) = kg/hr

$$\frac{(0.0023}{\text{hr}}\ \text{lb})\ \frac{0.4539\ \text{kg}}{\text{lb}} = 0.00107\ \text{kg/hr}$$

0037S

EMISSION RATE CALCULATIONS

Plant Consolidated Engr. Run No. 0-3 Date 5/14/87

Parameter measured Hexavalent Chromium

Sample volume $V_{m\ std}$ 141.618 dscf
Sample concentration (C_s) 0.99 mg/ℓ
Blank concentration (C_b) 0.009 mg/ℓ
Solution volume (V_{sol}) 0.555 ℓ
Volumetric flow rate Q_{std} 5277.361 ft^3/min

1. Total mass in sample (mg): $(C_s - C_b)\ (V_{sol})$

$$\frac{0.99}{\ell}\ \text{mg} - \frac{0.009}{\ell}\ \text{mg}\ (0.555\ \ell) = 0.54\ \text{mg}$$

2. Concentration (gr/dscf): $\dfrac{(\text{mg})\ \dfrac{0.0154\ \text{gr}}{\text{mg}}}{Vm_{std}} = \text{gr/dscf}$

$$\frac{(0.54\ \text{mg})\ \dfrac{0.0154\ \text{gr}}{\text{mg}}}{141.618\ \text{dscf}} = 0.00006\ \text{gr/dscf}$$

584

3. Emission rate (lb/hr):

$$\frac{(\text{gr})}{\text{dscf}}\ \frac{1\ \text{lb}}{7000\ \text{g}}\ \frac{(\text{ft}^3)}{\text{min}}\ \frac{60\ \text{min}}{\text{hr}} = \text{lb/hr}$$

$$\frac{(0.00006\ \text{gr})}{\text{dscf}}\ \frac{1.43\text{x}10^{-4}\ \text{lb}}{\text{gr}}\ \frac{(5277.361\ \text{ft}^3)}{\text{min}}\ \frac{60\ \text{min}}{\text{hr}} = 0.0027\ \text{lb/hr}$$

66

Emission rate (kg/hr) = (lb/hr) (0.4539 kg/lb) = kg/hr

$$\left(\frac{0.0027}{\text{hr}}\ \text{lb}\right)\ \frac{0.4539\ \text{kg}}{\text{lb}} = 0.00121\ \text{kg/hr}$$

0037S

PES

EMISSION TEST CALCULATIONS

PLANT CONSOLIDATED ENGLAND SOURCE/RUN OPS-1 DATE 5-12-87

1. Leakage Correction for Volume Metered

$V_{m_c} = V_m - (L_p - L_a)\theta = V_m - (L_p - 0.02)\theta = (\quad) - (\quad - 0.02)(\quad)$

$V_{m_c} =$ _____ ft^3

2. Volume Metered, Standard Conditions (68°F, 29.92 in.Hg)

$$V_{m_{std}} = 17.64\ V_{m_c} Y \left(\frac{P_{bar} + \Delta H / 13.6}{T_m}\right) = 17.64\ (100.457)(1.035)\frac{(29.43) + (0.80)/13.6}{(569)}$$

$V_{m_{std}} =$ 95.556 dscf ✓

3. Volume Water Vapor Collected, Standard Conditions

Impingers $= V_{wc} = 0.04707\ (V_f - V_i) = 0.04707\ (\quad) =$ _____ scf

Silica Gel $= V_{ws_g} = 0.04715\ (W_f - W_i) = 0.04715\ (\quad) =$ _____ scf

$V_{w_{std}} = V_{wc} + V_{ws_g} =$ _____ scf

4. Percent Moisture, By Volume

$$B_{w_s} = \frac{V_{w_{std}}}{V_{w_{std}} + V_{m_{std}}} = \frac{(\quad)}{(\quad) + (95.556)} = 0.0225$$

5. Molecular Weight, Stack Gas

Dry Molecular Weight, $M_d = 0.440\ (\%CO_2) + 0.320(\%O_2) + 0.280\ (\%N_2 + \%CO)$

$= 0.440\ (\quad) + 0.320(\quad) + 0.280\ (\quad)$

$M_d =$ 29 lb/lb - mole

Percent Excess Air, %EA =

$$\left[\frac{\%O_2 - 0.5\ \%CO}{0.264(\%N_2) - (\%O_2 - 0.5\ \%CO)}\right] X100 \left[\frac{(\quad) - 0.5(\quad)}{0.264(\quad) - (\quad - 0.5(\quad))}\right] X\ 100$$

%EA = _____

$M_s = M_d\ (1 - B_{ws}) + 18.0\ (B_{ws}) = (29)(1 - .0225) + 18.0\ (.0225) =$ 28.75 lb/lb-mole ✓

OPS-1

6. Stack Gas Velocity, Average

$$V_{s_{avg}} = 85.49 C_p \left(\sqrt{\Delta P}\right)_{avg} \sqrt{\frac{T_s}{P_s M_s}} = 85.49\ (.84)\ (.816) \sqrt{\frac{(541)}{(29.40)(28.75)}}$$

$V_{s_{avg}}$ = 42.606 ft/s ✓

7. Stack Volumetric Flow Rate, Actual Conditions (Stack Temperature and Pressure)

$$Qa\,(\text{circular}) = \left(\frac{60 \times V_s\ (\pi\, d^2/4)}{144}\right) = 60 \times V_s\ (5.454 \times 10^{-3})\ (d^2)$$

$$= 60 \times 42.606\ (5.454 \times 10^{-3})\ (19.6)^2$$

"or" $Qa\,(\text{rectangular}) = 60 \times V_s \left(\frac{L \times W}{144}\right) = 60 \times V_s\ (L \times W)\ 6.944 \times 10^{-3}$

$$= 60 \times _____\ (_____ \times _____)\ 6.944 \times 10^{-3}$$

Qa = ~~5356~~ acfm 5356.108

8. Stack Volumetric Flow Rate, Standard Conditions (68°F, 29.92 in. Hg)

$$Q_{std} = 17.64\, Q_a (1-B_{ws}) \left(\frac{P_s}{T_s}\right) = 17.64\ (5356)\ (1-.0225) \left(\frac{29.40}{541}\right)$$

Q_{std} = ~~5019~~ 5018.971 dscfm

9. Isokinetic Variation

$$\%I = K \frac{T_s\ V_{m(std)}}{P_s\ V_s\ \Lambda_n\ \Theta\ 1-B_{ws}}$$

$$= 0.0944 \frac{(541)\ (95.556)}{(29.40)\ (42.606)\ (2.074 \times 10^{-4})\ (180)\ (1-.0225)}$$

= 106.8 % ✓

PES

EMISSION TEST CALCULATIONS

PLANT CONSOLIDATED ENGINEERS SOURCE/RUN OPS-2 DATE 5-13-87

1. Leakage Correction for Volume Metered

$V_{m_c} = V_m - (L_p - L_a)\theta = V_m - (L_p - 0.02)\theta = (\quad) - (\quad - 0.02)\ (\quad)$

$V_{m_c} =$ _____ ft^3

2. Volume Metered, Standard Conditions (68°F, 29.92 in.Hg)

$$V_{m_{std}} = 17.64\ V_{m_c} Y \left(\frac{P_{bar} + \Delta H / 13.6}{T_m}\right) = 17.64\ (112.102)(1.035)\frac{(29.53) + (0.82)/13.6}{(574)}$$

$V_{m_{std}} =$ 114,921 dscf ✓

3. Volume Water Vapor Collected, Standard Conditions

Impingers = $V_{wc} = 0.04707\ (V_f - V_i) = 0.04707\ (\quad) =$ _____ scf

Silica Gel = $V_{ws_g} = 0.04715\ (W_f - W_i) = 0.04715\ (\quad) =$ _____ scf

$V_{w_{std}} = V_{wc} + V_{ws_g} =$ _____ scf

4. Percent Moisture, By Volume

$$B_{w_s} = \frac{V_{w_{std}}}{V_{w_{std}} + V_{m_{std}}} = \frac{(\quad)}{(\quad) + (\quad)} = 0.0206$$ ✓

5. Molecular Weight, Stack Gas

Dry Molecular Weight, $M_d = 0.440\ (\%CO_2) + 0.320(\%O_2) + 0.280\ (\%N_2 + \%CO)$

$= 0.440\ (\quad) + 0.320(\quad) + 0.280\ (\quad)$

$M_d =$ 29.0 lb/lb - mole

Percent Excess Air, %EA =

$$\left[\frac{\%O_2 - 0.5\ \%CO}{0.264(\%N_2) - (\%O_2 - 0.5\ \%CO)}\right] X100 \left[\frac{(\quad) - 0.5(\quad)}{0.264(\quad) - (\quad - 0.5(\quad))}\right] X\ 100$$

%EA = _____

$M_s = M_d\ (1 - B_{ws}) + 18.0\ (B_{ws}) = (29.0)(1 - .0206) + 18.0\ (.0206) =$ 28.77 lb/lb-mole ✓

OPS-2

6. Stack Gas Velocity, Average

$$V_{s_{avg}} = 85.49 C_p \left(\sqrt{\Delta P}\right)_{avg} \sqrt{\frac{T_s}{P_s M_s}} = 85.49\ (.84)\ (.7681) \sqrt{\frac{(541)}{(29.50)(28.77)}}$$

$V_{s_{avg}}$ = 44.038 ft/s ✓

7. Stack Volumetric Flow Rate, Actual Conditions (Stack Temperature and Pressure)

$$Qa\,(circular) = \left(\frac{60 \times V_s\ (\pi d^2/4)}{144}\right) = 60 \times V_s\ (5.454 \times 10^{-3})\ (d^2)$$

$$= 60 \times \underline{44.038}\ (5.454 \times 10^{-3})\ (\underline{19.6})^2$$

"or" $Qa\,(rectangular) = 60 \times V_s \left(\frac{L \times W}{144}\right) = 60 \times V_s\ (L \times W)\ 6.944 \times 10^{-3}$

$$= 60 \times \underline{\quad}\ (\underline{\quad} \times \underline{\quad})\ 6.944 \times 10^{-3}$$

Qa = ~~5536~~ acfm 5536.159

8. Stack Volumetric Flow Rate, Standard Conditions (68°F, 29.92 in. Hg)

$$Q_{std} = 17.64\, Q_a (1-B_{ws}) \left(\frac{P_s}{T_s}\right) = 17.64\ (\overset{5536.159}{\cancel{5536}})\ (1-.0206)\ \left(\frac{29.50}{541}\right)$$

Q_{std} = ~~5215~~ 5215.453 dscfm

9. Isokinetic Variation

$$\%I = K \frac{T_s\ V_{m(std)}}{P_s\ V_s\ A_n\ \theta\ (1-B_{ws})}$$

$$= 0.0944 \frac{(541)\ (114.921)}{(29.50)\ (44.038)\ (2.074 \times 10^{-4})\ (210)\ (1-.0206)}$$

= 105.9 % ✓

EMISSION TEST CALCULATIONS

PLANT CONSOLIDATED ENGRAVERS SOURCE/RUN OPS-3 DATE 5-14-87

1. Leakage Correction for Volume Metered

$V_{m_c} = V_m - (L_p - L_a)\theta = V_m - (L_p - 0.02)\theta = (\quad)-(\quad -0.02)\ (\quad)$

$V_{m_c} =$ _____ ft^3

2. Volume Metered, Standard Conditions (68°F, 29.92 in.Hg)

$$V_{m_{std}} = 17.64\ V_{m_c} Y \left(\frac{P_{bar} + \Delta H / 13.6}{T_m}\right) = 17.64\ (131.444)(1.035)\ \frac{(29.61)+(0.42)/13.6}{(570)}$$

$V_{m_{std}} =$ 132.559 dscf ✓

3. Volume Water Vapor Collected, Standard Conditions

Impingers $= V_{wc} = 0.04707\ (V_f - V_i) = 0.04707\ (\quad) =$ _____ scf

Silica Gel $= V_{wsg} = 0.04715\ (W_f - W_i) = 0.04715\ (\quad) =$ _____ scf

$V_{w_{std}} = V_{wc} + V_{wsg} =$ _____ scf

4. Percent Moisture, By Volume

$$B_{ws} = \frac{V_{w_{std}}}{V_{w_{std}} + V_{m_{std}}} = \frac{(\quad)}{(\quad)+(\quad)} = 0.0189$$ ✓

5. Molecular Weight, Stack Gas

Dry Molecular Weight, $M_d = 0.440\ (\%CO_2) + 0.320(\%O_2) + 0.280\ (\%N_2 + \%CO)$

$= 0.440\ (\quad) + 0.320(\quad) + 0.280\ (\quad)$

$M_d =$ 29.0 lb/lb - mole

Percent Excess Air, %EA =

$$\left[\frac{\%O_2 - 0.5\ \%CO}{0.264(\%N_2)-(\%O_2-0.5\ \%CO)}\right] X100 \left[\frac{(\quad)-0.5(\quad)}{0.264(\quad)-(\quad -0.5(\quad)}\right] X\ 100$$

%EA = _____

$M_s = M_d\ (1-B_{ws}) + 18.0\ (B_{ws}) = (29.0)(1-.0189) + 18.0\ (.0189) =$ 28.79 lb/lb-mole ✓

OPS-3

6. Stack Gas Velocity, Average

$$V_{s_{avg}} = 85.49 C_p \left(\sqrt{\Delta P}\right)_{avg} \sqrt{\frac{T_s}{P_s M_s}} = 85.49\ (.84)(.7681)\sqrt{\frac{(541)}{(29.58)(28.79)}}$$

$V_{s_{avg}}$ = 43,963 ft/s ✓

7. Stack Volumetric Flow Rate, Actual Conditions (Stack Temperature and Pressure)

$$Qa\,(circular) = \left(\frac{60 \times V_s\ (\pi d^2/4)}{144}\right) = 60 \times V_s\ (5.454 \times 10^{-3})\ (d^2)$$

$$= 60 \times 43.963\ (5.454 \times 10^{-3})\ (19.6)^2$$

"or" $Qa\,(rectangular) = 60 \times V_s \left(\frac{L \times W}{144}\right) = 60 \times V_s\ (L \times W)\ 6.944 \times 10^{-3}$

$$= 60 \times _____\ (_____ \times _____)\ 6.944 \times 10^{-3}$$

Qa = ~~5527~~ 5526.747 acfm

8. Stack Volumetric Flow Rate, Standard Conditions (68°F, 29.92 in. Hg)

$$Q_{std} = 17.64\ Q_a (1-B_{ws}) \left(\frac{P_s}{T_s}\right) = 17.64\ (\cancel{5527}\ 5526.747)\ (1-.0189)\left(\frac{29.58}{541}\right)$$

Q_{std} = ~~5231.e~~ 5229.767 dscfm

9. Isokinetic Variation

$$\%I = K \frac{T_s\ V_{m(std)}}{P_s\ V_s\ \Lambda_n\ \Theta\ 1-B_{ws}}$$

$$= 0.0944 \frac{(541)\ (132.559)}{(29.58)\ (43.963)\ (2.074 \times 10^{-4})\ (240)\ (1-.0189)}$$

= 106.6 % ✓

APPENDIX E

Laboratory Analytical Results

IMPACTOR ANALYSIS
TARE WEIGHT

Analysis: PARTICLE SIZE

Solvent: N/A

Analysis Started: 5-27-87

Finished:

Project Number: 958

Project Name: PEER (CONSOLIDATED ENGINEERS)

Project Manager: MENDOZA

Item Weighed: GLASS SUBSTRATES

DATE DESICCATED 5/21/87

Field Sample Number	Substitute Wt.	Counter Tare	1st Wt.	2nd Wt.	3rd Wt.	4th Wt.	5th Wt.	6th Wt.	Final Wt. (mg)	Tare Wt. (mg)	Difference (mg)
Date			5/27/87	5/28/87	5/29/87						
R.H. (%)			—	—	—						
Temp. (°F)			—	—	—						
Std. Wt.			501.50	500.50	501.50						
Analyst			[illegible]	[illegible]	[illegible]						
	500	120									
IPS-1			15:13	10:51	10:46						
P-19			11.56	11.70	11.70				11.75	11.68	0.07
P-[illegible]			1.20	1.33	1.35				1.29	1.29	0
P-17			43.24	43.25	43.24				43.25	42.13	1.12
P-[illegible]			48.24	48.13	48.19				48.20	47.94	0.26
IPS-2			15:22	10:42	10:33						
P-34			47.35	47.43	47.48				47.49	46.94	0.55
P-31			-13.16	-13.19	-13.15				-13.17	-14.13	+0.96
P-37			14.13	14.11	14.06				14.10	10.69	3.41
P-31			66.74	66.71	66.80				66.76	66.06	0.70
IPS-3			14.3	11.2	10.25						
P-53			35.24	35.20	35.19				35.21	34.33	0.88
P-42			-10.81	-10.91	-11.01				-10.91	-11.96	1.05
P-43			14.[illegible]	14.[illegible]8	14.77				14.79	12.02	2.77
P-51			109.05	108.[illegible]4	109.02				109.02	108.32	0.70

IMPACTOR ANALYSIS
TARE WEIGHT

Analysis: PARTICLE SIZE

Solvent: N/A

Analysis Started: 5-27-87

Finished:

Project Number: 958

Project Name: PZER (CONSOLIDATED ENGINEERS) 958

Project Manager: MEADOWS

Item Weighed: GLASS SUBSTRATES

DATE DESICCATED 5/21/87

Date			5/27	5/28/87	5/29/87						
R.H. (%)			—	—							
Temp. (°F)			—	—							
Std. Wt.			50/50	50/50	50/50						
Analyst			JL	JL	JL						
Field Sample Number	Substitute Wt.	Counter Tare	1st Wt.	2nd Wt.	3rd Wt.	4th Wt.	5th Wt.	6th Wt.	Final Wt. (mg)	Tare Wt. (mg)	Difference (mg)
	500	120									
CPS-1 1401			14.01	11.33	09.50						
P-13			37.09	36.99	37.12				37.07	38.86	-1.79
P-7			33.98	34.00	34.03				34.00	34.06	-0.06
P-8			41.72	41.73	41.77				41.74	41.44	0.30
P-1			47.09	47.13	47.40				47.36	47.38	-0.02
CPS-2 1446			14.46	11.02	10.01						
P-35			-0.09	-0.09	-0.10				-0.09	-0.07	-0.02
P-34			1.97	2.00	1.910				1.98	1.86	0.12
P-33			14.30	14.30	14.33				14.30	12.74	1.60
P-41			27.57	27.56	27.54				27.56	27.20	0.36
CPS-3 1421			14.21	11.23	10.10						
P-25			38.57	38.73	38.81				38.70	39.17	-0.47
P-22			4.64	4.64	4.63				4.63	4.46	0.17
P-23			20.42	20.29	20.17				20.29	18.98	1.31
P-21			58.30	58.20	58.27				58.26	57.70	0.56

PEI Associates, Inc.
11499 Chester Rd.
Cincinnati, OH 45246
(513) 782-4700

Client: Peer Consultants
4134 Linden Avenue
Suite 202
Dayton, Ohio 45432

Attn: Ms. Helen Owens

Project No.: 4761
Requisition No.: T7-05-139
T7-05-140
Date Received: 5/19/87
Sampled by: Client
Date Reported: 7/9/87

Sample ID	PEI No.	Total Chromium, mg/l	Hexavalent Chromium, mg/l
Tank #1 279-3	01A	115,000	118,000
Tank #1 279-5	02A	109,000	115,000
Tank #1 279-8	03A	111,000	281,000
Tank #1 279-10	04A	115,000	123,000
Tank #1 279-13	05A	116,000	122,000
Tank #1 279-15	06A	117,000	134,000
Tank #2 279-1	07A	105,000	124,000
Tank #2 279-4	08A	108,000	128,000
Tank #2 279-6	09A	108,000	136,000
Tank #2 279-9	10A	106,000	135,000
Tank #2 279-11	11A	105,000	131,000
Tank #2 279-16	12A	101,000	128,000
Washdown # 279-7	13A	108,000	93,300
Washdown # 279-12	14A	58,400	61,600
Washdown # 279-17	15A	54,800	62,700
Blind A 279-1	16A	59,200	69,500
Blind B 279-2	17A	110,000	128,000
Blind C 279-27	18A	4.93	3.1
Run 0-1 279-22	19A	1.00	0.951
Run 0-2 279-24	20A	0.644	0.968
Run 0-3 279-25	21A	0.879	0.99
Run I-1 279-21	22A	6.18	7.72
Run I-2 279-23	23A	4.16	7.64
Run I-3 279-26	24A	1.91	7.89
Blank 1 279-18	25A	0.021	<0.009
Blank 2 279-19	26A	0.028	<0.009
Blank 3 279-20	27A	0.029	<0.009

Submitted by: Caprice Bender

JUL 13 1987

PEI Associates, Inc.
11499 Chester Rd.
Cincinnati, OH 45246
(513) 782-4700

Client: Peer Consultants
4134 Linden Avenue
Suite 202
Dayton, Ohio 45432

Attn: Ms. Helen Owens

Project No.: 4761
Requisition No.: T7-06-015
T7-06-016
Date Received: 6/2/87
Sampled by: Client
Date Reported: 7/9/87

Sample ID	PEI No.	Total Chromium, mg/l
IPS Nozzle Rinse	01A	33.3
IPS Stage 1	02A	0.2
IPS Stage 4	03A	0.13
IPS Stage 7	04A	<0.02
IPS Stage BU	05A	<0.02
OPS Nozzle Rinse	06A	0.61
OPS Stage 1	07A	0.027
OPS Stage 4	08A	0.028
OPS Stage 7	09A	0.021
OPS Stage BU	10A	<0.02
0.1N NaOH Blank	11A	0.021

		Total Chromium, ug
IPS Stage 1 Filters	01A	560
IPS Stage 4 Filters	02A	487
IPS Stage 7 Filters	03A	2056
OPS BU Filters	04A	242
OPS Stage 1 Filters	05A	13.3
OPS Stage 4 Filters	06A	21.4
OPS Stage 7 Filters	07A	908
OPS BU Filters	08A	248
IPS&OPS Stage 1&7	09A	3.3
IPS&OPS Stage 4	10A	2.4
IPS&OPS Stage BU	11A	9.4

Submitted by: Caprice Bearden

GRAVIMETRIC ANALYSIS
COMBINED STAGE RINSE EVAPORATIONS - REPORTED FINAL WEIGHTS

	Tare (gr)	No. 1	No. 2	No. 3	No. 4	Average Final (gr)
Inlet						
IPS Nozzle	101.5563	104.4501	104.4919	104.4957	104.4913	104.4823
Stage 1	101.5247	104.3954	104.4262	104.4168	104.4049	104.4108
Stage 4	102.9894	103.8776	103.8858	103.8654	103.8573	103.8715
Stage 7	100.5897	101.4569	101.4598	101.4472	101.4378	101.4504
Backup	106.5372	107.4299	107.4359	107.4226	107.4137	107.4255
Outlet						
OPS Nozzle	104.5767	106.8900	107.1837	107.2202	107.0568	107.0877
Stage 1	102.0927	102.9661	102.9669	102.9540	102.9540	102.9590
Stage 4	103.2698	104.1373	104.1443	104.1419	104.1350	104.1396
Stage 7	105.4505	106.3031	106.3238	106.3103	106.2939	106.3078
Backup	98.2074	99.0212	99.0590	99.0436	99.0323	99.0390
NaOH Blank	106.5695	107.4529	107.4486	107.4449	107.4392	107.4464 (0.8768)

GRAVIMETRIC ANALYSIS
COMBINED STAGE RINSE EVAPORATIONS - NET WEIGHT GAIN

Sample	Final Weight (Average gr)	Tare (gr)	Difference (gr)	Blank Correction (gr)
IPS Nozzle	104.4823	101.5563	2.9260	2.049
Stage 1	104.4108	101.5247	2.8861	2.009
Stage 4	103.8715	102.9894	0.8821	0.005
Stage 7	101.4504	100.5897	0.8607	-0.016
Backup	107.4255	106.5372	0.8883	0.012
OPS Nozzle	107.0877	104.5767	2.5110	1.6342
Stage 1	102.9590	102.0927	0.8663	-0.0106
Stage 4	104.1396	103.2698	0.8698	-0.0070
Stage 7	106.3078	105.4505	0.8573	-0.0195
Backup	99.0390	98.2074	0.8316	-0.0452
Blank	107.4464	106.5696	0.8768	

0069S

MASTER SAMPLE LOG

Plant Consolidated Engravers Page 1 of 2

Location Charlotte, North Carolina Project Number 279-01-02

Sample Number	Run Code	Date	Sample Type	Container Type #/Size	Identification ~~Disposition~~
279-1		5/14/87	5/13/87 WASHDOWN	poly / 1000ml	Blind-A *
279-2		5/14/87	plating solution ~~HM13B~~ -Tank 1 5/13	" "	Blind-B **
279-3		5/14/87	Tank 1 5/12/87 plating solu.	" "	5/12 (HM13B) tank 1 Solu
279-4		5/14/87	plating solu.	" "	5/12 (HM13B) Tank 2
279-5		5/14/87	" "	" "	5/12 Tank 1 (PS)
279-6		"	" "	" "	5/12 Tank 2 (PS)
279-7		"	WASHDOWN	" "	WASHDOWN 5/12
279-8		"	plating solu	" "	5/13 Tank 1 (13B)
279-9		"	" "	" "	5/13 Tank 2 (13B)
279-10		"	" "	" "	5/13 Tank 1 (PS)
279-11		"	" "	" "	5/13 Tank 2 (PS)
279-12		"	" "	" "	5/13 WASHDOWN
279-13		"	plating solu	" "	5/14 Tank 1 (13B)
279-14		"	" "	" "	5/14 Tank 2 (13B)
279-15		"	" "	" "	5/14 Tank 1 (PS)
279-16		"	" "	" "	5/14 Tank 2 (PS)
279-17		"	WASHDOWN	" "	5/14 WASHDOWN

* WASHDOWN - 5/13/87

** HM13B 5/13/87, plating solu. tank #1

MASTER SAMPLE LOG

Plant Consolidated Engineers Page 2 of 2

Location Charlotte, North Carolina Project Number ~~339~~-

Sample Number	Run Code	Date	Sample Type	Container Type #/Size	Ident. ~~Disposition~~
279-18		5/14/87	NaOH	poly / 1000 ml	Run 1 (13B) NaOH Blank
279-19		"	"	" "	Run 2 (13B) NaOH Blank
279-20		"	"	" "	Run 3 (13B) NaOH Blank
279-21	I-1	"	NaOH	" "	Inlet 13B 5/12
279-22	O-1	"	"	" "	Outlet 13B 5/12
279-23	I-2	"	"	" "	Inlet 13B 5/13
279-24	O-2	"	"	" "	Outlet 13B 5/13
279-25	I-3	"	"	" "	Inlet 13B 5/14
279-26	O-3	"	"	" "	Outlet 13B 5/14
279-27		"	"	" "	Blind C*
279-28**		5/19/87	filters & rinses	poly / 75 ml	
~~279-29~~	~~IPS-1~~	~~5/28/87~~	filters & rinses	Petri dish GLASS - 75 ml	INLET PART. SIZE 5/12
~~279-30~~	~~OPS-1~~	~~5/28/87~~	" "	"	OUTLET PART SIZE 5/12
~~279-31~~	~~IPS-2~~	~~5/28/87~~	" "	"	INLET PART SIZE 5/13
~~279-32~~	~~OPS-2~~	~~5/28/87~~	" "	"	OUTLET PART SIZE 5/13
~~279-33~~	~~IPS-3~~	~~5/28/87~~	" "	"	INLET PART SIZE 5/14
~~279-34~~	~~OPS-3~~	~~5/28/87~~	" "	"	OUTLET PART SIZE 5/14

* MM13B- Run I-2.

* 58 samples from screening methods labelled @ 1 of 58 - etc.

APPENDIX F

Sampling, Sample Recovery and Analytical Procedures

APPENDIX D
DETERMINATION OF Cr^{+6} AND TOTAL Cr EMISSIONS

The following sample and analytical procedures were used during this test program. Sampling procedures generally followed those described in the EPA Test Method 13B (MM 13B).[1] The sample train used at the mist eliminator inlet and outlet locations was assembled by test crew personnel and consisted of the following items:

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

Probe - Borosilicate glass without a heating system.

Pitot Tube - Type-S pitot tube that meets all geometric standards. The tube was attached to the probe to monitor the stack gas velocity.

Thermocouple - Type-K thermocouple capable of measuring stack gas temperatures within 2 percent. This thermocouple was attached to the probe.

Draft Gauge - An incline manometer made by Dwyer with a range of 0 to 10 inches of H_2O.

Impingers - Four Greenburg-Smith impingers connected in series with glass ball joints. The second impinger was of the standard Greenburg-Smith design. The first, third, and fourth impingers were of the Greenburg- Smith design, but modified by replacing the tip with a

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[1] 40 CFR 60, Appendix A, Reference Method 13B, July 1985.

1/2-inch i.d. glass tube extending to 1/2-inch from the bottom of the flask.

Metering System - Vacuum gauge, dry gas meter, leak-free pump, thermometers and related equipment to maintain an isokinetic sampling rate and to determine the sample volume.

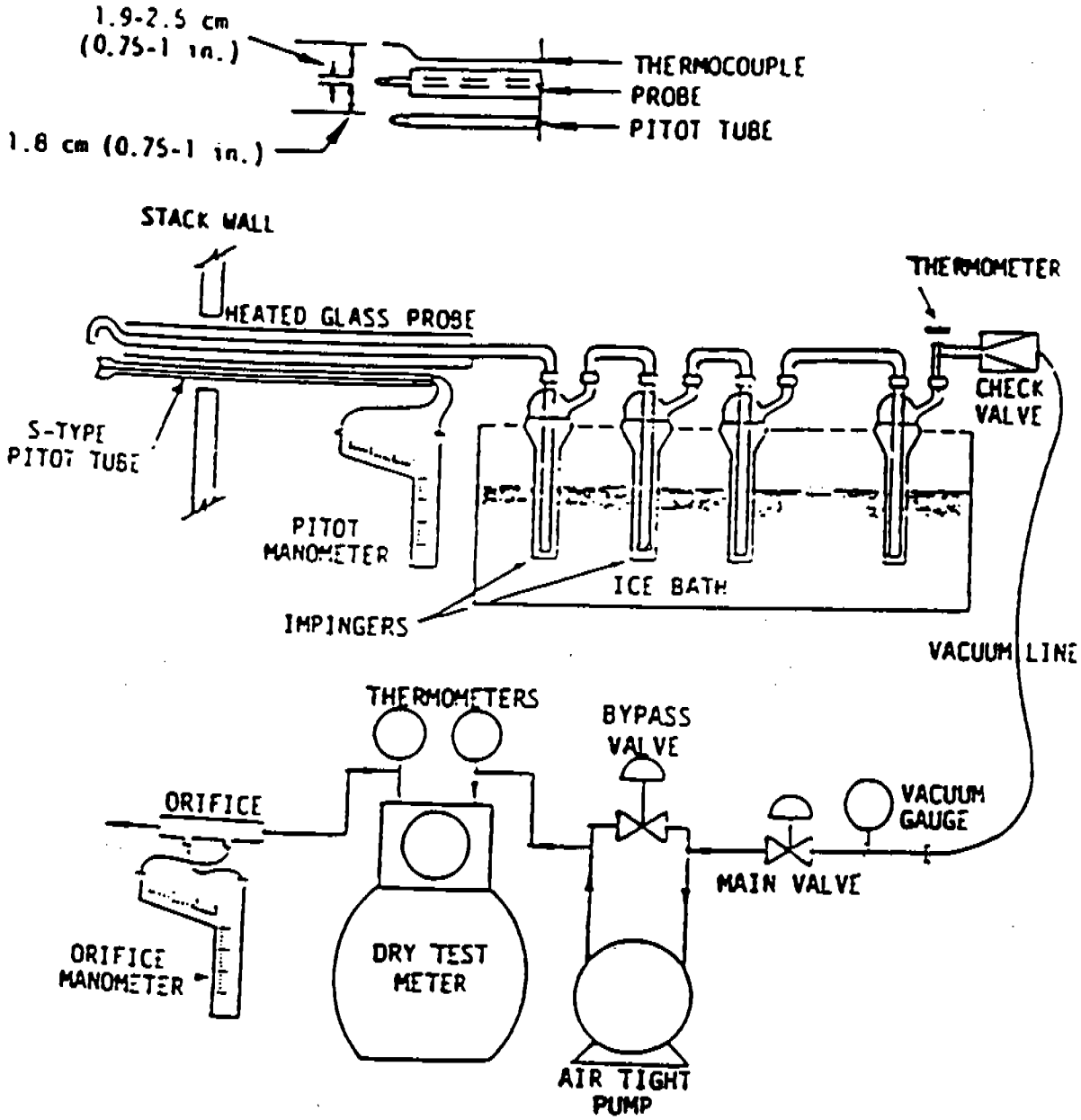
Barometer - Aneroid type to measure atmospheric pressures to within (approximately) 2.5 mm Hg (approximately 0.1 in. Hg).

Sampling Procedures

Prior to departure, all glassware used in this study was washed with 10 percent nitric acid to minimize the potential for contamination. One hundred ml of 0.1 N NaOH was placed in each of the first three impingers; approximately 200 g of silica gel was added to the fourth impinger. The train was set up with the probe as shown in Figure D-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 15 to 16-inch 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 and at the conclusion of each test run. The check was made by blowing into the impact opening of the pitot tube until three or more inches of water was recorded on the manometer and then capping the impact opening and holding it for 15 seconds to assure that it was leak free. The static pressure side of the pitot tube was leak checked using the same procedure, except suction was used to obtain the 3-inch H_2O manometer reading. Crushed ice was placed around the impingers to condense out any moisture and to keep the temperature of the gases leaving the impinger at 68°F (20°C) or less.

During sampling, stack gas and sampling train data were recorded at each sampling point to monitor when significant changes in stack gas



IMPINGER CONTENTS

1. 100 ml 0.1 N NaOH
2. 100 ml 0.1 N NaOH
3. 100 ml 0.1 N NaOH
4. 200 g SILICA GEL

Figure D-1. Cr^{+6}/Total Cr sampling train.

conditions occurred so proper adjustments could be made. Isokinetic sampling rates were set throughout the sampling period with the aid of a nomograph.

Sample Recovery Procedures

The MM 13B trains were moved carefully from the test site to the designated cleanup/recovery area. The cleanup area was located in a warehouse on plant property that was isolated from possible contamination.

Each impinger was weighed after each test to determine the percent of moisture in the stack gas. Sample fractions were recovered as follows:

Container No. 1 - The nozzle and probe were rinsed with 0.1N NaOH and brushed with a nylon brush. This rinseate was collected in a polyethylene bottle. The interconnecting glassware was rinsed with 0.1 NaOH and combined with the probe and nozzle rinses in the polyethylene bottle. After the impingers were weighed, their contents were combined with the rinseates from the nozzle, probe and glassware in the sample bottle. The impingers were also rinsed with 0.1N NaOH and this rinseate was combined with the rinses from the other sample train constituents in the polyethylene sample bottle.

Container No. 2 - Approximately 400 mℓ of 0.1 N NaOH was taken during each sample recovery activity for blank analysis.

The silica gel from the fourth impinger was weighed, and this value was recorded with other pertinent data on the Sample Recovery and Integrity Data Sheet.

Sample Analysis - Hexavalent Chromium

Each sample, including blanks, was analyzed for Cr^{+6} using analytical methodology recent developed by the EPA. A copy of the draft

method entitled "Determination of Hexavalent Chromium Emissions From Stationary Sources" is contained in Appendix G of this report. Procedures generally follow those described in EPA Method 3050.[2]

Sample Analysis - Total Chromium

The filtrates from the impinger contents (Container 1) were analyzed for total Cr using the processes described in EPA Method 3050.[2] Inductively Coupled Argon Plasma (ICAP) spectroscopy techniques were used for sample analysis. EPA Method 3050 is presented in Appendix G of this report.

DETERMINATION OF SIZE DISTRIBUTION

The following procedures were used to determine size distribution of total Cr. The sampling train was assembled by PEER and PES personnel and consisted of the following items:

Nozzle - Straight stainless steel with sharp, tapered leading edge and accurately measured round opening.

Impactor - Andersen 8-stage cascade impactor modified by rearranging the stages. The stages were arranged such that stage 0, 4, 7 and backup were used to make a 4-stage cascade impactor. On theory, this arrangement allows an increased collection of sample mass on 4 stages as opposed to distribution of the same mass of sample on 8 stages. The resultant increased mass per stage improves the accuracy of gravimetric analysis.

Probe - A steel tube with a 90 degree elbow.

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[2] Test Method for Evaluating Solid Waste, U.S. EPA SW-846, 2nd Edition, July 1982, Method 3050.

Draft Gauge - An incline manometer made by Dwyer with a range of 0 to 10 inches of H_2O.

Impingers - Four Greenburg-Smith impingers connected in series with glass ball joints were used for moisture removal.

Metering System - Vacuum gauge, dry gas meter, leak-free pump, thermometers and related equipment to maintain an isokinetic sampling rate and to determine the sample volume.

Barometer - Aneroid type to measure atmospheric pressures to within (approximately) 2.5 mm Hg (approximately 0.1 in. Hg).

Sampling Procedures

One traverse point from each port that represented the average gas velocity and temperature in each particular duct were selected as the sampling points for the determination. The Andersen Mark III impactor was assembled by alternating the stage plates, collection media, flat crossbars, and Inconel spacer rings needed to provide four cut sizes on stages 1, 4, 7, and backup. The collection substrates were tared glass-fiber filters desiccated to a constant weight, and weighed to the nearest 0.01 mg on an analytical balance.

The sampling train was assembled as shown in Figure D-2. It was leak checked at the sampling site prior to each test run by plugging the inlet to the impactor and pulling a 10-in. Hg vacuum. When the desired vacuum was reached, the leakage rate was checked at the dry gas meter for one minute. If the leak rate was less than 0.02 ft^3/min, the sampling train was used to obtain the samples. Excessive leaks were corrected prior to sampling. The impactor was then placed at the selected sampling point(s). Sampling times ranged between 180 and 240 minutes at the inlet and outlet locations. A post-test leak check was performed to avoid the possibility of dislodging the particles on individual stages.

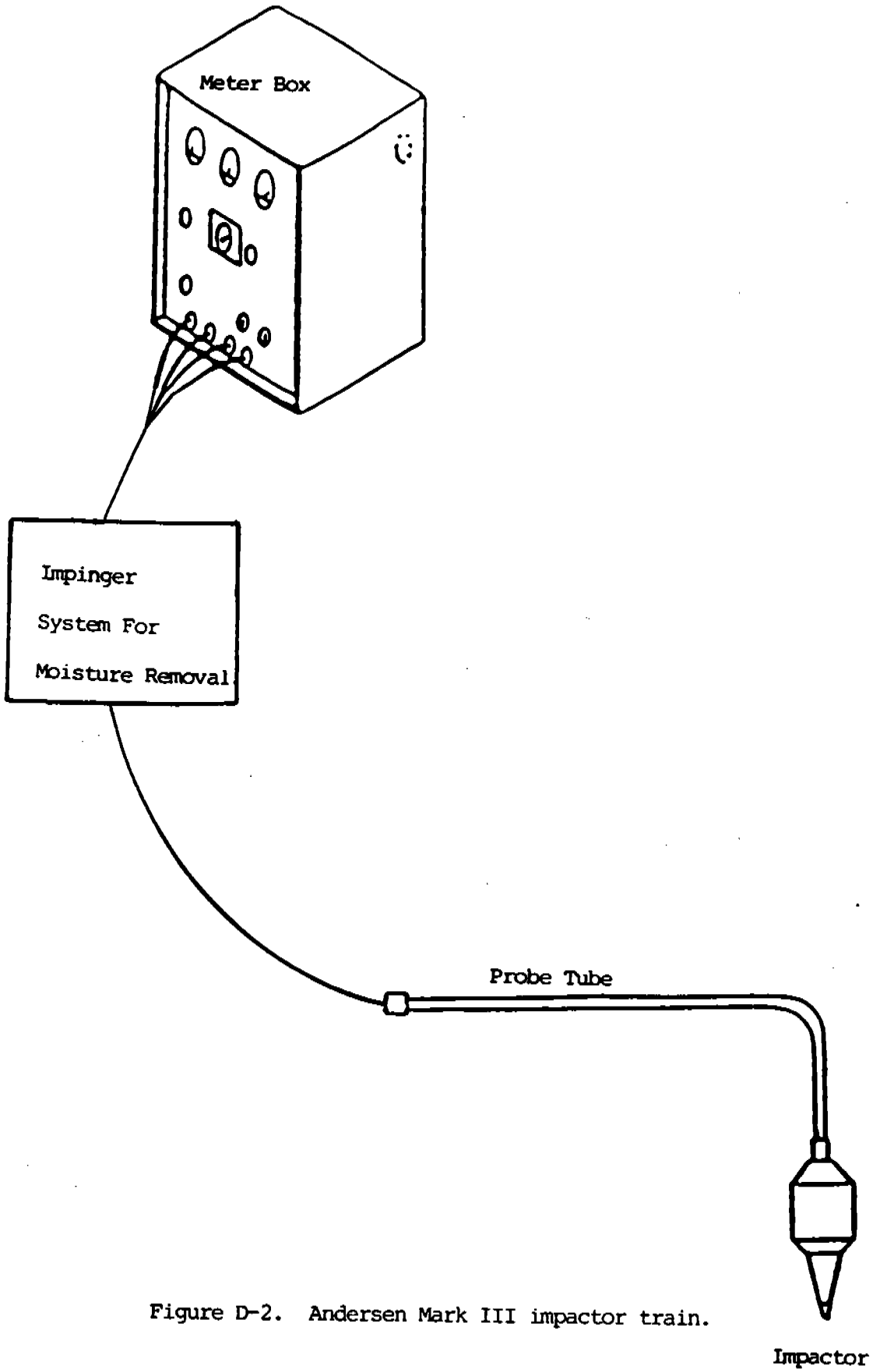

Figure D-2. Andersen Mark III impactor train.

During sampling, stack gas and sampling train data were recorded at 10-minute intervals. The isokinetic sampling rate was set initially, and constant cutpoint characterisitics were maintained throughout the sampling period.

Sampling Recovery Procedures

After each test was completed, the impactors were removed front he probe and carefully moved to the designated cleanup area; the impactors were kept in an upright position. All pertinent data were recorded on the Impactor Recovery and Integrity Data Sheets.

Mark III--

The nozzle and inlet chamber were brushed and rinsed with 0.1N NaOH to remove chrome into a polyethylene container. After the container was sealed and labeled, the liquid level was marked.

Each filter was removed from its stage and carefully placed in a petri dish. Loose particulate from the bottom side of the previous stage plate, the Inconel spacer, flat crossbar, and top side of the plate directly under the filter were brushed into the same petri dish as the respective filter. Each petri dish was sealed and labeled.

Gravimetric Analysis--

Filters - Each glass fiber filter was desiccated in its respective sample container for 24 hours to a constant weight and weighed to the nearest __ mg on an analytical balance.

NaOH Rinse - The volume of each NaOH rinse was measured and transferred to a tared breaker and analyzed for total Cr concentration by the same method used in the MM 13B tests. The sample was evaporated to dryness at ambient temperature and pressure, desiccated for 24 hours to a constant weight, and weighed to the nearles 0.01 mg.

The term "constant weight" means a difference of no more than 0.2 mg or no more than 1 percent of total weight less tare weight (whatever is greater) between two consecutive weighings, with no less than 6 hours of desiccation between weighings.

Data Reduction

For each test, size distribution curves were established representing the total weight percent of particulate matter smaller than the indicated aerodynamic particle diameter in micrometers (μm). Each data point indicates both the 50 percent effective cut size of each impactor stage and the cumulative weight percent of material collected in subsequent stages. Inhalable (less than 10 μm) and fine (less than 2.5 μm) size fractions are also reported.

All particle size results are based on a particle density of 1 g/cm^3.
Data reduction and intermediate results calculations for the impactors were performed with moisture contents obtained from the Method 13B tests.

Total Cr Analysis by Size Fraction

Upon completion of the gravimetric analysis, samples from each location were composited by stage cutpoint into a single inlet and outlet samples for each stage. The following procedures were used to determine total Cr by size fraction.

Total Cr--

The total Cr content of the Andersen filters were determined by means of digesting the filters and residue from the alkaline digestion using the acid digestion for sludges (Method 3050 SW846) and a final volume of 100 mℓ. The filters and residue from the alkaline digestion of the impinger solution solids and process sample solids were digested in the same manner.

The digestates were analyzed for Cr using an Inductively Coupled Plasma Emission Spectrometer. The instrument was calibrated and the calibration was checked using a reference solution obtained from the EPA.

APPENDIX G

Equipment Calibration

PRETEST CALIBRATION DATA

POSTTEST DRY GAS METER CALIBRATION DATA FORM

Date 3/25/87 Meter box number RAC-1065 Plant _____

Barometric pressure, P_b = 29.02 in. Hg Dry gas meter number _____ Pretest Y = 0.981

Orifice manometer setting, (ΔH), in. H_2O	Gas volume: Ref. meter (V_w), ft^3	Gas volume: Dry gas meter (V_d), ft^3	Temperature: Ref. meter (t_w), °F	Temperature: Dry gas meter: Inlet (t_{d_i}), °F	Temperature: Dry gas meter: Outlet (t_{d_o}), °F	Temperature: Dry gas meter: Average[a] (t_d), °F	Time (θ), min	Vacuum setting, in. Hg	Y_i	$Y_i \frac{V_w P_b (t_d + 460)}{V_d \left(P_b + \frac{\Delta H}{13.6}\right)(t_w + 460)}$
0.70	63.541	347.795	73	93	84					
	23.775	353.550	73	105	88		22	5	0.985	
0.70	23.775	353.550	73	122	95					
	24.244	361.453	73	125	93		22	5	0.981	
0.70	24.244	365.451	73	124	91					
	24.313	369.266	73	109	93		22	5	0.997	

Y = 0.988

[a] If there is only one thermometer on the dry gas meter, record the temperature under t_d.

V_w = Gas volume passing through the wet test meter, ft^3.

V_d = Gas volume passing through the dry gas meter, ft^3.

t_w = Temperature of the gas in the wet test meter, °F.

t_{d_i} = Temperature of the inlet gas of the dry gas meter, °F.

t_{d_o} = Temperature of the outlet gas of the dry gas meter, °F.

t_d = Average temperature of the gas in the dry gas meter, obtained by the average of t_{d_i} and t_{d_o}, °F.

ΔH = Pressure differential across orifice, in H_2O.

Y_i = Ratio of accuracy of wet test meter to dry gas meter for each run.

Y = Average ratio of accuracy of wet test meter to dry gas meter for all three runs; tolerance = pretest Y ±0.05Y

P_b = Barometric pressure, in. Hg.

θ = Time of calibration run, min.

TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 4-14-87 Thermocouple number RAC 1065

Ambient temperature 74 °F °C Barometric pressure 29.40 in. Hg

Calibrator FM Reference: mercury-in-glass ASTM 15-67 C

other

Reference point number[a]	Source[b] (specify)	Reference thermometer temperature, °C	Thermocouple potentiometer temperature, °C	Temperature difference,[c] %
METER INLET	MMB. MIR	74°F (23.3°C)	72°F (22.2°C)	0.37
METER OUTLET	MMB. MIR	74°F (23.3°C)	72°F (22.2°C)	0.37

[a]Every 30°C (50°F) for each reference point.

[b]Type of calibration system used.

[c] $\left[\frac{(\text{ref temp, °C} + 273) - (\text{test thermom temp, °C} + 273)}{\text{ref temp, °C} + 273}\right] 100 \leq 1.5\%.$

TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 4/11/87 Thermocouple number STACK 3 T-1H

Ambient temperature 73°F °C Barometric pressure 29.4 in. Hg

Calibrator HWW Reference: mercury-in-glass 15 KG7C

other

Reference point number[a]	Source[b] (specify)	Reference thermometer temperature, °C/F	Thermocouple potentiometer temperature, °C/F	Temperature difference,[c] %
1	ICE WATER	34°F	34°F	0
2	AMBIENT (AIR)	73°F	73°F	0
3	BOILING WATER	208°F	208°F	0
4	HEATED OIL	386°F	386°F	0

[a]Every 30°C (50°F) for each reference point.

[b]Type of calibration system used.

[c] $\left[\frac{(\text{ref temp, °C} + 273) - (\text{test thermom temp, °C} + 273)}{\text{ref temp, °C} + 273}\right] 100 \leq 1.5\%.$

TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 11/14/87 Thermocouple number SAMPLE HEAD 511-1

Ambient temperature 70 °C Barometric pressure 27.4 in. Hg

Calibrator AWW Reference: mercury-in-glass 15 16TC

other

Reference point number[a]	Source[b] (specify)	Reference thermometer temperature, °C	Thermocouple potentiometer temperature, °C	Temperature difference,[c] %
1	ICE WATER	35°F	35°F	0
2	AMBIENT (AIR)	70°F	70°F	0

[a]Every 30°C (50°F) for each reference point.

[b]Type of calibration system used.

[c] $\left[\frac{(\text{ref temp, °C} + 273) - (\text{test thermom temp, °C} + 273)}{\text{ref temp, °C} + 273}\right] 100 \leq 1.5\%.$

PES

PITOT TUBE CALIBRATION DATA SHEET

Calibrated By: [illegible]

Date: 3-15-87

Pitot I.D. No.: S-1

Effective Length: 2'

Pitot Tube Assembly Level? Yes ✓ No ____

Pitot Tube Openings Damaged? Yes (explain below) ____ No ✓

α_1 = 0 ° (<10°) α_2 = 1 ° (<10°)

β_1 = 1 ° (<5°) β_2 = 2 ° (<5°)

γ = ____ ° θ = ____ ° A = ____ °

z = A sin = .03 cm (in.) 0.32 cm (<1/8 in.)

w = A sin = 0 cm (in.) 0.08 cm (<1/32 in.)

P_A = 0.452 cm (in.)

P_B = 0.452 cm (in.)

D_t = 0.375 cm (in.)

Comments: ____

Calibration Required? Yes ____ No ✓

PITOT TUBE CALIBRATION DATA SHEET

Calibrated By: J Meadows

Date: 3/3/87

Pitot I.D. No.: S-3

Effective Length: TIP ONLY

Pitot Tube Assembly Level? Yes ✓ No

Pitot Tube Openings Damaged? Yes (explain below) No ✓

α_1 = 0 ° (<10°) α_2 = 0 ° (<10°)

β_1 = 1 ° (<5°) β_2 = 2 ° (<5°)

γ = 0 ° θ = 0 ° A = 0.936 IN

z = A sin = 0 cm (in.) 0.32 cm (<1/8 in.)

w = A sin = 0 cm (in.) 0.08 cm (<1/32 in.)

P_A = 0.468 cm (in.)

P_B = 0.468 cm (in.)

D_t = 0.375 cm (in.)

Comments: C_p assigned = 0.84

Calibration Required? Yes No ✓

POST-TEST CALIBRATION DATA

POSTTEST DRY GAS METER CALIBRATION DATA FORM

Test numbers I-1, I-2, I-3 Date 5-13-87 Meter box number RAC-1065 Plant CONSOLIDATED ENGRAVERS

Barometric pressure, P_b = 29.37 in. Hg Dry gas meter number _____ Pretest Y 0.981

Orifice manometer setting, (ΔH), in. H_2O	Gas volume: Wet test meter (V_w), ft^3	Gas volume: Dry gas meter (V_d), ft^3	Temperature: Wet test meter (t_w), °F	Temperature: Dry gas meter: Inlet (t_{d_i}), °F	Temperature: Dry gas meter: Outlet (t_{d_o}), °F	Temperature: Dry gas meter: Average[a] (t_d), °F	Time (Θ), min	Vacuum setting, in. Hg	Y_i	$Y_i \frac{V_w P_b (t_d + 460)}{V_d \left(P_b + \frac{\Delta H}{13.6}\right)(t_w + 460)}$
2.0	169.913	521.948	74	102	89	96	10.0	9.0	0.987	
	177.682	530.085	75	112	87					
2.0	177.682	530.085	75	112	87	102	10.0	9.0	0.992	
	185.463	538.272	76	118	90					
2.0	185.463	538.272	76	118	90	111	10.0	9.0	1.003	
	193.205	546.457	76	120	114					

Y = 0.994

[a] If there is only one thermometer on the dry gas meter, record the temperature under t_d.

V_w = Gas volume passing through the wet test meter, ft^3.

V_d = Gas volume passing through the dry gas meter, ft^3.

t_w = Temperature of the gas in the wet test meter, °F.

t_{d_i} = Temperature of the inlet gas of the dry gas meter, °F.

t_{d_o} = Temperature of the outlet gas of the dry gas meter, °F.

t_d = Average temperature of the gas in the dry gas meter, obtained by the average of t_{d_i} and t_{d_o}, °F.

ΔH = Pressure differential across orifice, in H_2O.

Y_i = Ratio of accuracy of wet test meter to dry gas meter for each run.

Y = Average ratio of accuracy of wet test meter to dry gas meter for all three runs; tolerance = pretest Y $\pm 0.05Y$

P_b = Barometric pressure, in. Hg.

Θ = Time of calibration run, min.

T. Miller

DRY GAS METER AND ORIFICE CALIBRATION

Date: 2/26/87 Box No.: MB-4

Barometric Pressure, P_b = 30.09 in. Hg Dry Gas Meter No.: _____

Orifice Manometer Setting, ΔH, in. H_2O	Gas Vol. Wet Test Meter V_w, ft^3	Gas Vol. Dry Gas Meter V_d, ft^3	Temperature: Wet Test Meter t_w, °F	Temperature: Dry Gas Meter Inlet t_{di}, °F	Temperature: Dry Gas Meter Outlet t_{do}, °F	Temperature: Dry Gas Meter Average t_d, °F	Time θ, min.	Y	ΔHθ
0.5	X								
1.0	7.040	6.937	77.0	96.5	81.5	89.0	12.0	1.035	1.608
2.0	9.498	8.398	77.0	101.5	84.5	93.0	10.0	1.037	1.521
4.0	12.080	11.989	77.0	105.5	87.5	96.5	10.0	1.034	1.496
6.0	X								
8.0	17.811	17.705	77.0	114.0	92.0	103.0	10.0	1.034	1.361
							Average	1.035	1.497

Calculations:

ΔH	$\frac{\Delta H}{13.6}$	Y: $\frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6}) (t_w + 460)}$	ΔHθ: $\frac{0.0317\ \Delta H}{P_b (t_d + 460)} \left[\frac{(t_w + 460)\ \theta}{V_w}\right]^2$
0.5	0.0368		
1.0	0.0737		
2.0	0.147		
4.0	0.294		
6.0	0.431		
8.0	0.588		

Y = ratio of accuracy of wet test meter to dry test meter. Tolerance = 0.01.

ΔHθ = orifice pressure differential that gives 0.75 cfm of air at 70°F and 29.92 inches of mercury, in. H_2O. Tolerance = 0.15.

POSTTEST DRY GAS METER CALIBRATION DATA FORM

Test numbers 0-1, 0-2, 0-3 Date 5-19-87 Meter box number MB-4 Plant CONSOLIDATED ENGRAVERS

Barometric pressure, P_b = 29.30 in. Hg Dry gas meter number S-200 Pretest Y 1.035

Orifice manometer setting, ΔH), in. H_2O	Gas volume: Wet test meter (V_w), ft^3	Gas volume: Dry gas meter (V_d), ft^3	Temperature: Wet test meter (t_w), °F	Temperature: Dry gas meter: Inlet (t_{d_i}), °F	Temperature: Dry gas meter: Outlet (t_{d_o}), °F	Temperature: Dry gas meter: Average[a] (t_d), °F	Time (θ), min	Vacuum setting, in. Hg	Y_i	Y_i $\frac{V_w P_b (t_d + 460)}{V_d \left(P_b + \frac{\Delta H}{13.6}\right)(t_w - 460)}$
1.8	325.301	297.307	74	88	90	91	15.0	4.0	1.037	
	337.995	309.705	74	107	87					
1.8	337.995	309.705	74	107	87	102	16.0	4.0	1.040	
	351.236	323.100	75	114	89					
1.8	351.236	323.100	75	114	98	110	15.0	4.0	1.038	
	363.678	335.846	76	123	106					
									Y = 1.038	

[a] If there is only one thermometer on the dry gas meter, record the temperature under t_d.

V_w = Gas volume passing through the wet test meter, ft^3.

V_d = Gas volume passing through the dry gas meter, ft^3.

t_w = Temperature of the gas in the wet test meter, °F.

t_{d_i} = Temperature of the inlet gas of the dry gas meter, °F.

t_{d_o} = Temperature of the outlet gas of the dry gas meter, °F.

t_d = Average temperature of the gas in the dry gas meter, obtained by the average of t_{d_i} and t_{d_o}, °F.

ΔH = Pressure differential across orifice, in H_2O.

Y_i = Ratio of accuracy of wet test meter to dry gas meter for each run.

Y = Average ratio of accuracy of wet test meter to dry gas meter for all three runs; tolerance = pretest Y ±0.05Y

P_b = Barometric pressure, in. Hg.

θ = Time of calibration run, min.

TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 4/11/87 Thermocouple number 3 T-1H STACK

Ambient temperature 73°F °C Barometric pressure 29.4 in. Hg

Calibrator [illegible] Reference: mercury-in-glass IS 16.7C

other

Reference point number[a]	Source[b] (specify)	Reference thermometer temperature, °C/F	Thermocouple potentiometer temperature, °C/F	Temperature difference,[c] %
1	ICE WATER	34°F	34°F	0
2	AMBIENT (AIR)	73°F	73°F	0
3	BOILING WATER	208°F	208°F	0
4	HEATED OIL	356°F	356°F	0

[a]Every 30°C (50°F) for each reference point.

[b]Type of calibration system used.

[c] $\left[\frac{(\text{ref temp, °C} + 273) - (\text{test thermom temp, °C} + 273)}{\text{ref temp, °C} + 273}\right] 100 \leq 1.5\%.$

TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 4/14/87 Thermocouple number 3-T-5H

Ambient temperature 73°F °C Barometric pressure 29.4 in. Hg

Calibrator AWW Reference: mercury-in-glass 15-16TC

other

Reference point number[a]	Source[b] (specify)	Reference thermometer temperature, °R F	Thermocouple potentiometer temperature, °C	Temperature difference,[c] %
1	ICE WATER	33°F	33°F	0
2	AMBIENT AIR (AIR)	73°F	73°F	0
3	BOILING WATER	209°F	209°F	0
4	HEATED OIL	377°F	377°F	0

[a]Every 30°C (50°F) for each reference point.

[b]Type of calibration system used.

[c] $\left[\frac{(\text{ref temp, °C} + 273) - (\text{test thermom temp, °C} + 273)}{\text{ref temp, °C} + 273}\right] 100 \leq 1.5\%.$

TEMPERATURE SENSOR CALIBRATION DATA FORM

SAMPLE HEAD

Date 3-15-87 Thermocouple number 514-1

Ambient temperature _____ °C Barometric pressure _____ in. Hg

Calibrator [illegible] Reference: mercury-in-glass _____

other _____

Reference point number[a]	Source[b] (specify)	Reference thermometer temperature, °C	Thermocouple potentiometer temperature, °C	Temperature difference,[c] %
1	AMBIENT	70.6°F (21.4)	71°F (21.7)	~~+2~~ 0.1

[a]Every 30°C (50°F) for each reference point.

[b]Type of calibration system used.

[c] $\left[\frac{(\text{ref temp, °C} + 273) - (\text{test thermom temp, °C} + 273)}{\text{ref temp, °C} + 273}\right] 100 \leq 1.5\%.$

TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 3-15-87 Thermocouple number SAMPLE SH-2

Ambient temperature _____ °C Barometric pressure _____ in. Hg

Calibrator [illegible] Reference: mercury-in-glass _____

other _____

Reference point number[a]	Source[b] (specify)	Reference thermometer temperature, °C	Thermocouple potentiometer temperature, °C	Temperature difference,[c] %
1	AMBIENT	70.2 °F (21.2)	70.0 °F (21.1)	.05 .03

[a]Every 30°C (50°F) for each reference point.

[b]Type of calibration system used.

[c] $\left[\frac{(\text{ref temp, °C} + 273) - (\text{test thermom temp, °C} + 273)}{\text{ref temp, °C} + 273}\right] 100 \leq 1.5\%.$

TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 3-13-87 Thermocouple number RAC 1 (RAC 1065)

Ambient temperature _____ °C Barometric pressure _____ in. Hg

Calibrator [illegible] Reference: mercury-in-glass _____

other _____

Reference point number[a]	Source[b] (specify)	Reference thermometer temperature, °C	Thermocouple potentiometer temperature, °C	Temperature difference,[c] %
Meter Inlet	AMBIENT	76 °F (24.4)	74 °F (23.3)	0.37
Meter Outlet		76° F (24.4)	76 °F (24.4)	0

[a]Every 30°C (50°F) for each reference point.

[b]Type of calibration system used.

[c] $\left[\frac{(\text{ref temp, °C} + 273) - (\text{test thermom temp, °C} + 273)}{\text{ref temp, °C} + 273}\right] 100 \leq 1.5\%.$

TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 3-13-87 Thermocouple number MB-4 RAC-2

Ambient temperature _____ °C Barometric pressure _____ in. Hg

Calibrator [illegible] Reference: mercury-in-glass _____

other _____

Reference point number[a]	Source[b] (specify)	Reference thermometer temperature, °C	Thermocouple potentiometer temperature, °C	Temperature difference,[c] %
Meter In	Ambient	76	75	
Meter Out		76	74	

[a]Every 30°C (50°F) for each reference point.

[b]Type of calibration system used.

[c] $\left[\frac{(\text{ref temp, °C} + 273) - (\text{test thermom temp, °C} + 273)}{\text{ref temp, °C} + 273}\right] 100 \leq 1.5\%.$

APPENDIX H

Project Participants and Activity Log

TABLE F-1. PROJECT PARTICIPANTS

Name	Title	Responsibility
F. Clay	Task Manager U.S. EPA - EMB	Coordinated test activity, on-site data reduction and calculations.
J. Swartzbaugh	PEER Consultants, P.C. Program Manager	Coordinated test activity with subcontractors and EPA, report preparation.
H. Owens	PEER Consultants, P.C. Project Leader	Coordinated test activity with EPA, MRI, PES and Consolidated personnel, report preparation.
A. Weisman	PEER Consultants, P.C. Technician	Site setup, sampling, sample recovery, equipment and sample transport and report preparation.
F. Hood	PEER Consultants, P.C. Staff Engineer	Collected process samples, sample recovery and data reduction.
F. Meadows	PES Project Leader	Site leader for mist eliminator testing, test activity coordination, data reduction
T. Miller	PES Technician	Site setup, sampling, sample recovery, equipment calibration.
R. Strait	MRI NSPS contractor	Monitored process operation and coordinated test activity.

Gravimetric Analysis

Inlet

	Net gain (mg)	percent of total particles	cumulative % less than	Effective (micron) Cutpoint Dia.
* Stage 1	2.509	40.73	59.27	8.0
Stage 4	0.675	10.96	48.31	2.4
Stage 7	2.414	39.19	9.12	0.5
Backup	0.562	9.12	0	< 0.5
	6.160	100.0		

40.27% > 8.0 μm

Outlet

Bartlett

* Stage 1		0
Stage 4		5
Stage 7		1
Backup		1

P.S. Data

Randy,
Do you have this?
al

* does not include wgt from nozzle rinse

↑ Is this a reasonable assumption?

total or Cr^{+6}?

Chemical Analysis

	net Cr (mg)	Percent of Total Cr	Cumulative % less than	(microns) Effective Cutpoint Dia.
Inlet				
Stage 1*	0.587	17.37	82.63	8.0
Stage 4	0.506	14.97	67.66	2.4
Stage 7	2.053	60.76	6.90	0.5
Backup	0.233	6.90	0	< 0.5
	3.379	100.0		
			17.4% > 8.0 um	
Outlet				
* Stage 1	0.010	0.85	99.15	7.90
Stage 4	0.019	1.62	97.5	2.35
Stage 7	0.905	77.15	20.38	0.49
Backup	0.239	20.38	0	< 0.49
	1.173	100.0		

* does not include Cr collected in nozzle rinse

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IMPACTOR ANALYSIS
TARE WEIGHT

Analysis: PARTICLE SIZE **Solvent:** N/A

Analysis Started: 5-27-87 **Finished:**

Project Number: 958 **Project Name:** PEER (CONSOLIDATED ENGINEERS)

Project Manager: MENDONS **Item Weighed:** GLASS SUBSTRATES

DATE DESICCATED 5/21/87

Date			5/27/87	5/28/87	5/29/87						
R.H. (%)			—	—	—						
Temp. (°F)			—	—	—						
Std. Wt.			501.50	50/50	50/50						
Analyst			[illegible]	[illegible]	[illegible]						
Field Sample Number	Substitute Wt.	Counter Tare	1st Wt.	2nd Wt.	3rd Wt.	4th Wt.	5th Wt.	6th Wt.	Final Wt. (mg)	Tare Wt. (mg)	Difference (mg)
	500	120									
IPS-1			15:13	10:51	10:46						
P-19			11.56	11.70	11.70				11.75	11.68	0.07
P-12			1.20	1.33	1.35				1.29	1.29	0
P-17			43.26	43.25	43.25				43.25	42.13	1.12
P-11			48.28	48.13	48.19				48.20	47.94	0.26
IPS-2			15:22	10:42	10:33						
P-39			47.55	47.43	47.48				47.49	46.94	0.55
P-36		—	13.16	-13.19	-13.15				-13.17	-14.11	+0.96
P-37			14.13	14.11	14.06				14.10	10.69	3.41
P-31			66.78	66.71	66.80				66.76	66.06	0.70
IPS-3			14:3	11:2	10:25						
P-53			35.26	35.20	35.19				35.21	34.33	0.88
P-42			-10.51	-10.91	-11.01				-10.91	-11.96	1.05
P-43			14.[illegible]	14.98	14.77				14.79	12.02	2.77
P-51			109.05	108.[illegible]	109.06				109.02	108.32	0.70

IMPACTOR ANALYSIS
TARE WEIGHT

Analysis: PARTICLE SIZE
Solvent: N/A
Analysis Started: 5-27-87
Finished:
Project Number: 958
Project Name: PEER (CONSOLIDATED ENGINEERS) 958
Project Manager: MEADOWS
Item Weighed: GLASS SUBSTRATES

DATE DESICCATED 5/21/87

Date			5/27/87	5/28/87	5/29/87						
R.H. (%)			—	—							
Temp. (°F)			—	—							
Std. Wt.			50/150	50/150	50/150						
Analyst			[illegible]	[illegible]	[illegible]						
Field Sample Number	Substitute Wt.	Counter Tare	1st Wt.	2nd Wt.	3rd Wt.	4th Wt.	5th Wt.	6th Wt.	Final Wt. (mg)	Tare Wt. (mg)	Difference (mg)
	500	120									
CPS-1 1401			14:01	11:33	09:50						
P-13			37.09	36.99	37.12				37.07	38.86	-1.79
P-7			33.98	34.00	34.03				34.00	34.06	-0.06
P-8			41.72	41.73	41.77				41.74	41.44	0.30
P-1			47.49	47.13	47.40				47.36	47.38	-0.02
CPS-2 1445			14:46	11:02	10:01						
P-35			-0.09	-0.09	-0.10				-0.09	-0.07	-0.02
P-34			1.97	2.00	1.99				1.98	1.86	0.12
P-33			14.34	14.34	14.33				14.34	12.74	1.60
P-41			27.57	27.56	27.54				27.56	27.20	0.36
CPS-3 1421			14:21	11:23	10:10						
P-25			38.57	38.73	38.81				38.70	39.17	-0.47
P-22			4.64	4.64	4.62				4.63	4.46	0.17
P-23			20.42	20.29	20.17				20.29	18.98	1.31
P-21			58.30	58.20	58.27				58.26	57.70	0.56

Gravimetric Analyses

Concept Stage [illegible] Evaporation – Reported [illegible]

Inlet

	tare (gr)	Final weights #1	#2	#3	#4	Average final gr
IPS Nozzle	101.5563	104.4501	104.4919	104.4957	104.4913	104.4823
Stage 1	101.5247	104.3954	104.4262	104.4168	104.4049	104.4108
Stage 4	102.9874	103.8776	103.8856	103.8654	103.8573	103.8715
Stage 7	100.5897	101.4567	101.4598	101.4472	101.4378	101.4504
Backup	106.5372	107.4299	107.4359	107.4226	107.4137	107.4255

Outlet

OPS. Nozzle	104.5767	106.8900	107.1827	107.2202	107.0568	107.0877
Stage 1	102.0927	102.9661	102.9669	102.9540	102.9488	102.9590
Stage 4	103.2698	104.1373	104.1443	104.1419	104.1350	104.1396
Stage 7	105.4505	106.3031	106.3238	106.3103	106.2939	106.3078
Backup	98.2074	99.0212	99.0590	99.0436	99.0323	99.0390
JaOH Blank	106.5696	107.4529	107.4486	107.4449	107.4392	107.4464

Gravimetric Analysis

Combined Stage Rinse Supernatants - Net weight gain

Sample	Final weight (mg)	Tare (g)	difference (g)	blank correction (g)
IPL Nozzle	104.4823	101.5963	2.886	2.049
Stage 1	104.4108	101.5247	2.886	2.009
4	103.8715	102.9894	0.8821	0.005
7	101.4504	100.5897	0.8607	-0.016
back-up	107.4255	106.5272	0.8983	0.012
blank	107.4464	106.5696	0.8768	
OPS-Nozzle	107.0877	104.5767	2.5110	1.6342
STAGE 1	102.9590	102.0927	0.8663	-0.0106
4	104.1396	103.2698	0.8698	-0.0070
7	106.3078	105.4505	0.8573	-0.0195
BACK-UP	99.0390	98.2074	0.8316	-0.0452

Chromium Content - particle size
Stage rinses

Sample	Volume	Total Cr (mg/l)
Inlet		
IPS 1,2,3 (Nozzle)	478	33.3
IPS Stage 1	184	0.20
IPS Stage 4	183	0.135
IPS Stage 7	181	<0.02
Backup	185	<0.02
Outlet		
OPS 1-2-3 (Nozzle)	468	0.61
OPS Stage 1	181	0.02
OPS Stage 4	177	0.02
OPS Stage 7	178	0.02
Backup	173	<0.02
NaOH Blank	180	0.02

Chromium Content - particle size

Filter Analysis

Sample	Total Cr (ug)
Inlet	
IPS Stage 1	560
IPS Stage 4	487
IPS Stage 7	2056
Backup	242
Outlet	
OPS Stage 1	13.3
OPS - Stage 4	21.4
OPS Stage 7	908
Backup	248
Filter blanks	
IPS & OPS Stage 1 & 7	3.3 ug
IPS & OPS Stage 4	2.4 ug
IPS & OPS backup	9.4 ug

[illegible] - [illegible]

[illegible] 0.[illegible] [illegible]

[illegible] [illegible] 0.004 [illegible]

[illegible]

[illegible]

$\frac{[illegible] mg}{l} (0.478 l) = [illegible]$ [illegible]

[illegible]

$\frac{0.20 mg}{l} (0.242) = 0.087 mg$ [illegible]

[illegible] 4

$\frac{0.125 mg}{l} (0.182 l) = 0.025 mg$ [illegible]

[illegible]

$\frac{0.02 mg}{l} (0.182 l) = 0.004$ ND*

Backup

$\frac{0.02 mg}{l} (0.125) = 0.004$ ND

* ND = non detectable

Size distribution - continued

[illegible]

OFC Hood

$\frac{0.6\ mg}{[illegible]} \times [illegible] = 0.2865\ mg$ [illegible]

Stage 1

$\left(\frac{0.02\ mg}{[illegible]}\right) \times [illegible] = 0.004\ mg$ ND

Stage 4

[illegible] ND

Stage 7

$\frac{0.02\ mg}{[illegible]} \times (0.73[illegible]) = 0.004\ mg$ ND

Backup

$\frac{0.02\ mg}{l} \times (0.73[illegible]) = 0.00[illegible]$ ND

* [illegible]

Flowrates (ACFM) through impactor @ stack conditions

Inlet

IPS-1	0.5364
IPS-2	0.5473
IPS-3	0.5396

IPS_{AVE} = 0.5411 ACFM

Outlet

OPS-1	0.5356
OPS-2	0.5536
OPS-3	0.5527

OPS_{AVE} = 0.5473 ACFM