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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Work Assignment 3

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FINAL REPORT

MODIFIED METHOD 13B AND THE CHROMIUM SCREENING METHOD SAMPLING PROGRAM DESCRIPTION

DETERMINATION OF THE EFFECTS OF CHEMICAL FUME SUPPRESSANTS ON HEXAVALENT CHROMIUM EMISSIONS

Automatic Die Casting
St. Clair Shores, Michigan

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SECTION 1.0
INTRODUCTION

During the weeks of April 18 and 25, 1987, an emission measurement program was conducted at the Automatic Die Casting facility located in St. Clair Shores, Michigan. The primary purposes of this program were to collect data to support the development of regulations for hexavalent chromium (Cr^{+6}) emissions from chromium plating operations that use chemical fume suppressants as a method of emission control and to verify the efficiency of the chromium screening method that is currently being developed by the EPA.

The principal reason for selecting Automatic Die Casting for source testing was that the plant was willing to operate the chromium plating tank under three different conditions:

1. without fume suppressants;
2. with the addition of a foam blanket; and
3. with the addition of a foam blanket and wetting agent.

The plant is representative of other plants in the industry that perform decorative chromium electroplating with an automated plating line. Based on the operating parameters such as current, voltage, chromic acid concentration and plating time, their chromium plating tank is typical of those used in the industry.

Cr^{+6} emissions were measured prior to entering the inlet to the scrubber serving the chromium plating line and the chromium rework tank. Figure 1-1 is a diagram showing the sampling location (Segment A_2). Testing was performed using the EPA Modified Method 13B (MM13B) and the EPA Screening Method. On-site analysis of the samples was performed using the diphenylcarbazide colorimetric method which will be discussed in Section 4.0 of this report. PEER Consultants P.C., from Dayton, Ohio, and Pacific Environmental Services, Inc., (PES) from Cincinnati, Ohio, conducted the MM13B sampling and on-site analysis. Midwest Research Institute (MRI) from

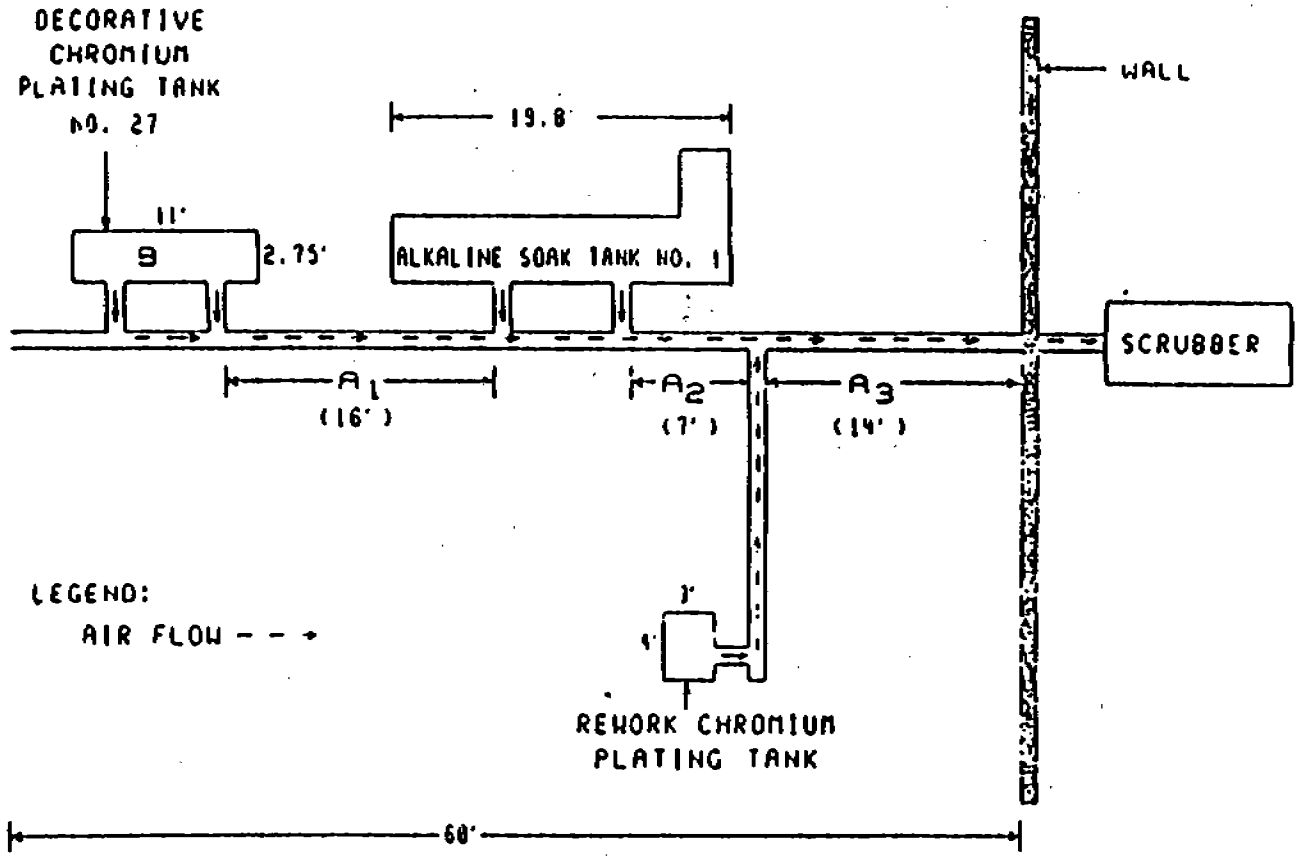


Figure 1.1. Diagram showing sampling location, Segment A_2.

Raleigh, North Carolina, monitored the process conditions, and the U.S. EPA Technical Support Division conducted the chromium screening method, set up the on-site computer center and observed the test program.

This report is organized into several sections each addressing specific aspects of the test program. Section 2.0 describes the process and its operation. Section 3.0 presents a summary and discussion of results. Section 4.0 describes the sampling location and test methods and Section 5.0 presents the QA/QC measures. Appendix A presents process monitoring data sheets; Appendix B, the field data sheets for each test, Appendix C, calculation sheets for each test; Appendix D, the hexavalent chromium analytical method; Appendix E, chain-of-custody data sheets; Appendix F, equipment calibration sheets; and Appendix G, project participants and activity log.

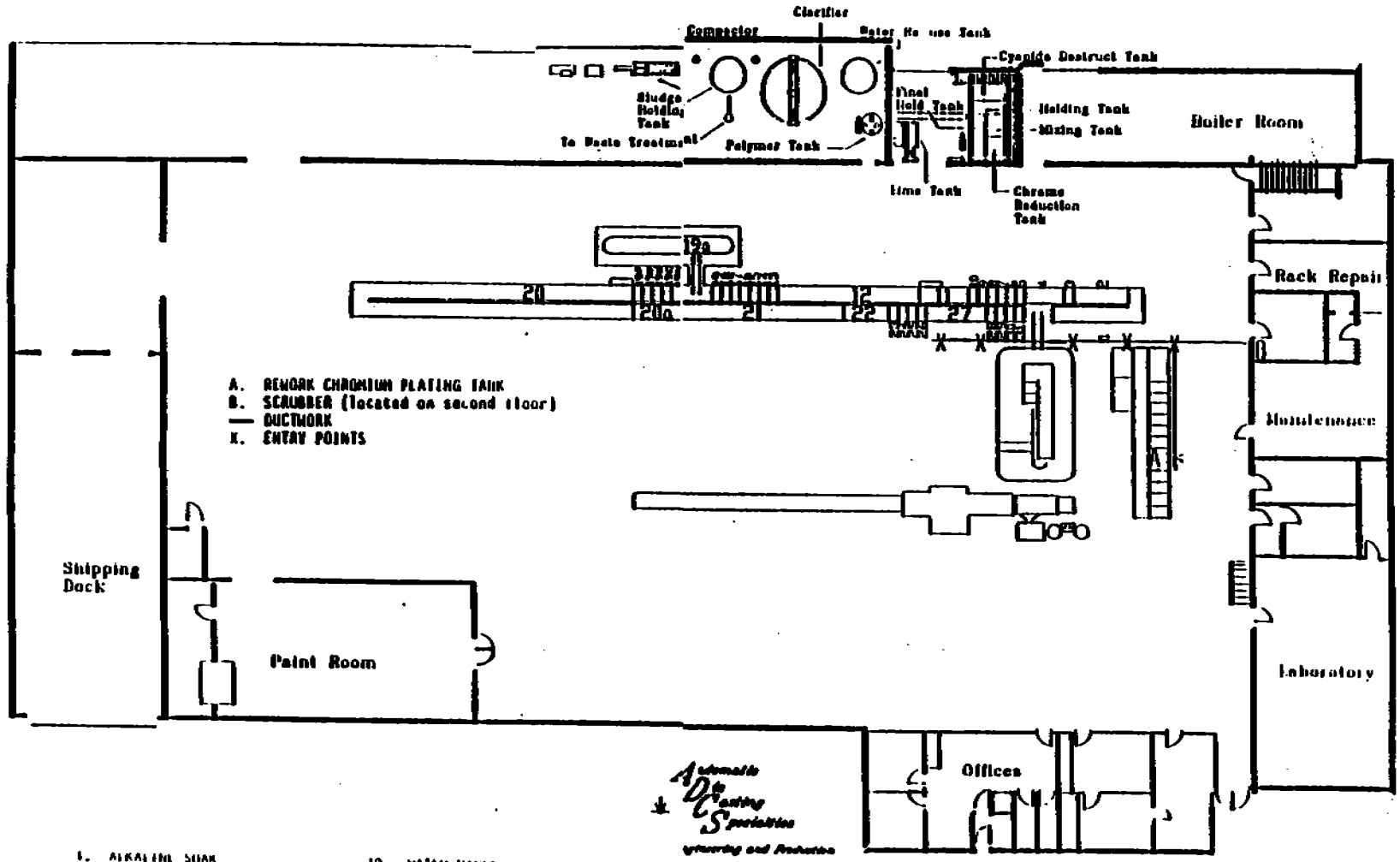
SECTION 2.0
PROCESS OPERATION

2.1 PROCESS DESCRIPTION

Automatic Die Casting Specialities, Inc., is a small job shop that performs decorative chromium electroplating of automotive trim. The plating facility consists of two decorative chromium plating lines: the main plating line and a rework plating line.

The chromium plating tank in the main plating line was tested to measure the performance of fume suppressants in reducing chromic acid mist. The process layout for the main plating line is shown in Figure 2.1. The main plating line consists of a series of tanks used for cleaning and plating the parts. Parts are plated with layers of copper and nickel before they are chromium plated. The chromium plating segment of the line consists of a chromium predip, a plating tank, a chromium saver tank, and three bisulfite rinse tanks. The plating line is serviced by an automatically controlled overhead conveyor that transfers racks of parts to each tank in a programmed sequence.

The chromium plating tank is 3.35 m (11.0 ft) long, 0.85 m (2.8 ft) wide, and 1.5 m (5.0 ft) deep and is divided into six cells that are each 0.55 m (1.8 ft) long. The plating tank holds approximately 3,860 liters (1,020 gallons) of plating solution, which contains chromic acid in a concentration of 280 grams per liter (37 ounces per gallon) of water. The plating solution contains both fluoride and sulfuric acid catalysts. The temperature of the plating bath is maintained between 43°C and 47°C (110°F and 116°F). Based on size, operating parameters (such as current, voltage, and plating time), and chromic acid concentration, the tank is typical of other decorative chromium plating tanks used in the electroplating industry.



1. ALKALINE SOAK
2. MILD ALKALINE POWER SPRAY
3. SPRAY RINSE
4. ALKALINE SOAK-SECONDARY
5. WATER RINSE
6. ELECTROCLEAN
7. WATER RINSE
8. SULFURIC ACID DIP
9. WATER RINSE
10. WATER RINSE
11. COPPER STRIKE
12. COPPER CYANIDE
13. COPPER SAVER
14. WATER RINSE
15. WATER RINSE
16. ELECTROCLEAN
17. WATER RINSE
18. WATER RINSE
19. WATER RINSE
19a. ACID COPPER
19b. WATER RINSE
19c. WATER RINSE
19d. SULFURIC ACID DIP
19e. WATER RINSE
19f. WATER RINSE
20. SEMI-BRIGHT NICKEL
20a. HIGH-SULFUR NICKEL
21. BRIGHT NICKEL
22. MICROPOROUS NICKEL
23. WATER RINSE
24. WATER RINSE
25. WATER RINSE
26. CHROMIUM DIP
27. CHROMIUM PLATING TANK
28. CHROMIUM SAVER
29. BISULFITE RINSE
30. BISULFITE RINSE
31. BISULFITE RINSE

Figure 2.1. Plan view of the decorative chromium plating shop at Automatic Die Casting Specialists, Inc., St. Clair Shores, Michigan.

The plating line operates 20 hours per day, 4 days per week. Six racks of parts are plated in the chromium plating tank at a time with a retention time of 3 minutes and 35 seconds for each rack. The tank is equipped with three rectifiers. For the first 15 seconds of plating, the parts are activated. During activation, the rectifier connected to Cell No. 1 is operated at 0 to 5 volts and 0 to 200 amperes. After activation, the racks are automatically moved toward the center of the plating tank. During plating, the rectifier connected to cells No. 2 through 5 is set at 5.2 volts and 3,000 amperes. The rectifier connected to cell No. 6 is set at 3.0 volts and minimal to no current.

2.2 AIR POLLUTION CONTROL

The chromium plating tank is equipped with a single-sided draft hood. The exhaust gases captured by the hood are ducted to a vertical-flow single packed-bed scrubber. Two other tanks, the alkaline soak tank in the main plating line and the chromium plating tank in the rework plating line, are also vented to the scrubber through a common duct. Figure 2.2 presents a diagram of the ventilation and control system. The total airflow rate to the scrubber from the three hoods is 130 actual cubic meters per minute (4,700 actual cubic feet per minute). The hood on the alkaline soak tank was blocked off during testing to increase the airflow rate through the hood on the chromium plating tank.

A fume suppressant, Quin-Tec Cam Nos. 3 and 4, manufactured by 3M Corporation and sold by Quin-Tec, Inc., in Warren, Michigan, is normally used to reduce chromic acid mist from the chromium plating tank. During the source test, the chromium plating tank was operated under three different conditions: (1) without a fume suppressant, (2) with a foam blanket, and (3) with a "combination" fume suppressant consisting of a foam blanket and a wetting agent. The foam blanket forms a layer of foam approximately 2.4 centimeters (1.0 inch) thick over the plating solution when the plating tank is charged. The foam blanket reduces chromic acid mist by entrapping the mist in the foam layer. The "combination" fume suppressant forms a layer of foam 2.5 cm (1.0 in.) thick over the surface of the plating solution and lowers the surface tension of the plating solution from 70 dynes/centimeter

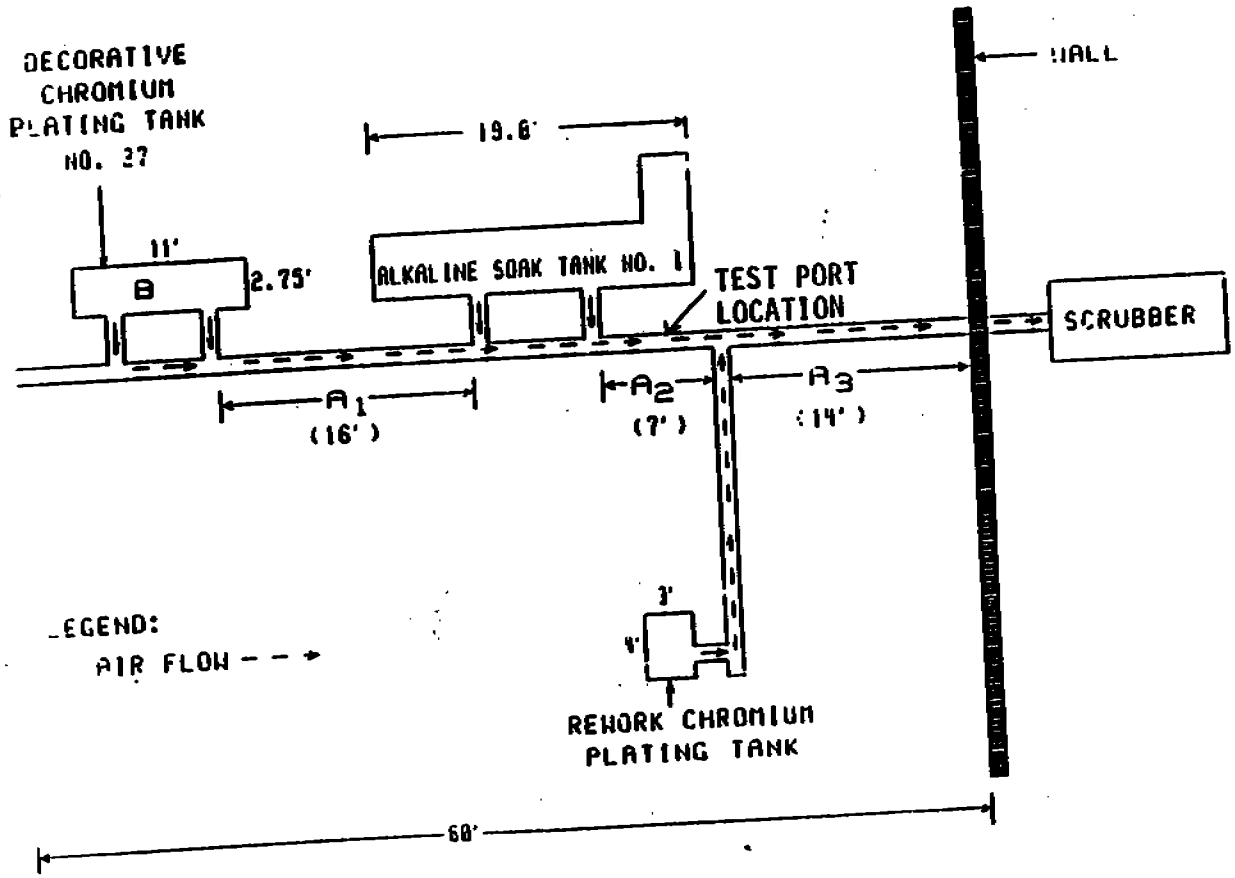


Figure 2.2. Diagram of ventilation and control system for chromium plating tank No. 27.

to below 40 dynes/centimeter. Because the tension of the bath is lower, the gases escape the surface with less of a "bursting" effect and thus, less mist is formed. The foam layer captures any mist which is formed.

The foam blanket and the "combination" fume suppressant used in the plating tank during the source test were, Zero-Mist™ HT and Zero-Mist™ HT-2, respectively. Both of these fume suppressants are manufactured and sold by OMI/Udylite® International Corporation in Warren, Michigan. These fume suppressants were selected for use during the source test because they are representative of the types and brands of fume suppressants widely used in the decorative chromium electroplating industry. The technical data sheets for each fume suppressant are provided in Appendix A.

2.3 PROCESS CONDITIONS DURING TESTING

Nine test runs were conducted to characterize uncontrolled emissions from a decorative chromium plating tank and to determine the performance of fume suppressants for controlling chromic acid mist. Three test runs were performed under each of the following conditions: (1) no chemical fume suppressant in the plating bath (uncontrolled); (2) a foam blanket, Zero-Mist™ HT, maintained in the plating bath; and (3) a "combination" fume suppressant, Zero-Mist™ HT-2, maintained in the plating bath.

The process was maintained within normal operating limits during each test run. The operating voltage, operating current, and plating solution temperature were monitored and recorded during each test run. The number of racks processed and the type of parts plated also were recorded during each test run. The operating conditions (average values) for each emission test run are presented in Table 2-1. In addition, grab samples of the plating solution were taken during each test run to determine the hexavalent chromium concentration. The analytical results for each sample are presented in Section 3. Data sheets documenting process operating conditions and the workload during each test run are presented in Appendix A.

TABLE 2-1. AVERAGE OPERATING PARAMETERS FOR EACH TEST RUN

Run Nos.	Operating temperature, °C (°F)	Operating voltage, volts	Operating current, amperes
1	48 (118)	5.2	2,680
2	48 (118)	4.9	2,390
3	48 (118)	5.0	2,770
Average	48 (118)	5.0	2,610
4	48 (118)	5.2	2,730
5	48 (118)	5.1	2,660
6	48 (118)	5.1	2,600
Average	48 (118)	5.1	2,660
7	48 (119)	5.1	2,820
8	49 (120)	5.1	2,880
9	49 (120)	5.1	2,800
Average	49 (120)	5.1	2,830

During the test, the initial addition (makeup) and maintenance additions of the fume suppressants were made according to vendor recommendations on the use of each fume suppressant. The makeup addition of the foam blanket, Zero Mist™ HT, was 910 g (2.0 lb), and the makeup addition of the "combination" fume suppressant, Zero-Mist™ HT-2, was 1,800 g (4.0 lb). For both fume suppressants a visual observation of the foam over the surface of the plating solution was used to determine when a maintenance addition was required. A foam blanket approximately 2.5 cm (1.0 in.) thick was maintained over the entire surface of the bath. For the "combination" fume suppressant, stalagmometer measurements to determine the surface tension plating bath were used in conjunction with visual observations for determining depletion of the fume suppressant. A surface tension measurement above 40 dynes/centimeter was specified as an indication of the need for maintenance additions of the fume suppressant. When signs of depletion were evident, a maintenance addition of the fume suppressant was made to the plating tank. The normal maintenance addition consisted of between 90 and 100 grams (0.2 and 0.3 lb) for both types of fume suppressants. Visual observations were made at 10 to 15 minute intervals for each test run. Surface tension measurements were performed on the plating solution composite samples at the end of test runs No. 1 through 9 and at the beginning of test runs No. 7 through 9. The measured surface tension (average) and the makeup and maintenance additions of fume suppressant for each test run are presented in Table 2-2.

All test runs were completed without a process interruption except test run No. 2, which was interrupted for 4 minutes because of downtime in the process line. All test runs were stopped 15 to 20 minutes to change test ports.

The total amount of current supplied to the tank during each test run is calculated in terms of ampere-hours and is included in Appendix A. A tabular summary of the total current values is presented in Table 2-3.

TABLE 2-2. AVERAGE PLATING SOLUTION AND FUME SUPPRESSANT PARAMETERS FOR EACH TEST RUN

Run No.	Test condition	Surface tension, dynes/cm	Fume suppressant additions	
			Makeup, g (lb)	Maintenance, g (lb)
1	Uncontrolled	66	0 (0)	0 (0)
2	Uncontrolled	72	0 (0)	0 (0)
3	Uncontrolled	74	0 (0)	0 (0)
4	Foam blanket[a]	67	910 (2.0)	0 (0)
5	Foam blanket[a]	71	0 (0)	140 (0.3)
6	Foam blanket[a]	72	0 (0)	450 (1.1)
7	Foam blanket/wetting agent[b]	40	1,800 (4.0)	450 (1.0)
8	Foam blanket/wetting agent[b]	38	0 (0)	590 (1.3)
9	Foam blanket/wetting agent[b]	38	0 (0)	200 (0.5)

[a]Zero Mist™ HT.
[b]Zero Mist™ HT-2.

TABLE 2-3. TOTAL CURRENT SUPPLIED DURING EACH EMISSION TEST RUN

Run No.	Test time, hours	Total current, ampere-hours	Ampere-hours/h[a]
1	3.20	8,700	2,700
2	2.15	5,200	2,400
3	2.02	5,600	2,800
4	3.03	8,400	2,800
5	2.00	5,300	2,700
6	4.18	11,900	2,900
7	4.00	11,300	2,800
8	4.00	11,700	2,900
9	3.00	8,500	2,800

[a]Time-weighted average.

SECTION 3.0
SUMMARY OF RESULTS

3.1 INTRODUCTION

Modified Method 13B (MM13B) and the Screening Methods samples were collected in triplicate under each of the three different operating conditions of the plating tank. During each MM13B, a series of four screening samples were collected simultaneously in a port which was located 1/2 stack-diameter downstream from the MM13B sample location. MM13B run numbers 1, 2 and 3, and Screening Methods series 1A, 1B, 2A, 2B, 3A and 3B were conducted while the plating tank was operating without a foam blanket. MM13B run numbers 4, 5 and 6, and screening methods series 4A, 4B, 5U, 6U and 6P were conducted while the plating tank was being operated with a temporary-type fume suppressant. Run numbers 7, 8 and 9 of the MM13B and the screening methods series 7, 8 and 9 were conducted while the plating tank was being operated with the addition of a foam blanket combined with a wetting agent. All of the emission samples were analyzed on site for Cr^{+6} concentrations using the procedures outlined in "Draft Method - Determination of Hexavalent Chromium in Dry Particulate Emissions from Stationary Sources." This analytical method is presented in Appendix D.

In addition to the emission samples, grab samples of the plating bath were composited during each MM13B run and analyzed using the same procedures as for the emission samples.

Table 3-1. presents a schedule of the activities during the test program. The results from the analysis of the MM13B runs, the screening method runs and the plating tank solutions are presented in the remainder of this section.

TABLE 3-1. SCHEDULE OF ACTIVITIES

Date (1988)	Sample Type	Run No.	Test Time (24 hr. clock)	Parameter Measured
Condition 1 - (no fume suppressant)				
4/18	13B, PS	MM13B-1	1408-1738	Cr^{+6}
4/18	SM	1A Series	_____	Cr^{+6}
4/18	SM	1B Series	_____	Cr^{+6}
4/19	13B, PS	MM13B-2	0758-1026	Cr^{+6}
4/19	SM	2A Series	_____	Cr^{+6}
4/19	SM	2B Series	_____	Cr^{+6}
4/19	13B, PS	MM13B-3	1157-1508	Cr^{+6}
4/19	SM	3A Series	_____	Cr^{+6}
Condition 2 - (addition of temporary-type fume suppressant)				
4/20	13B, PS	MM13B-4	0932-1311	Cr^{+6}
4/20	SM	4A Series	_____	Cr^{+6}
4/20	SM	4B Series	_____	Cr^{+6}
4/20	13B, PS	MM13B-5	1415-1629	Cr^{+6}
4/20	SM	5U Series	_____	Cr^{+6}
4/21	13B, PS	MM13B-6	1010-1513	Cr^{+6}
4/21	SM	6U Series	_____	Cr^{+6}
4/21	SM	6P Series	_____	Cr^{+6}
Condition 3 - (addition of permanent-type fume suppressant)				
4/25	13B, PS	MM13B-7	1458-1941	Cr^{+6}
4/25	SM	7 Series	_____	Cr^{+6}
4/26	13B, PS	MM13B-8	0903-1330	Cr^{+6}
4/26	SM	8 Series	_____	Cr^{+6}
4/26	13B, PS	MM13B-9	1423-1752	Cr^{+6}
4/26	SM	9 Series	_____	Cr^{+6}

13B = Modified Method 13B
PS = Plating Solution
SM = Screening Methods

3.2 HEXAVALENT CHROMIUM EMISSION RESULTS

Flue gas conditions were determined simultaneously with the collection of the Cr^{+6} samples upstream from the scrubber inlet. The samples were collected isokinetically using a Method 13B sample train that had been modified by removing the glass fiber filter and placing 100 mℓ of 0.1 N NaOH in each of the first two impingers. The impinger solutions were recovered into tared polyethylene sample bottles and the total volume of the recovered impinger solution was determined gravimetrically. An aliquot of the recovered solution was analyzed for Cr^{+6}. The following subsections present the flue gas data for each MM13B and the analytical results from the MM13B and the screening method for each operating condition.

3.2.1 Condition 1

Condition 1 data represent the uncontrolled emissions from the chromium plating tank. This condition was achieved by depleting the foam blanket, which the plant normally uses in its daily operation, from the plating tank.

3.2.1.1 Modified Method 13B--

A summary of the flue gas conditions at the sampling location while operating under Condition 1 is presented in Table 3-2. The volumetric flow rates were consistent and averaged 66.8848 dry standard cubic meters per minute (dscmm), (2362 dry standard cubic feet per minute (dscfm)). The flue gas temperature averaged 21°C (70°F) and the moisture content averaged 1.4 percent. The flue gas was essentially ambient air and was assigned a dry molecular weight of 29.0 lb/lb mole. The isokinetic sampling rates were within the allowable limitations for these three sample runs.

A summary of the MM13B sample volumes, analytical results and emission rates for Condition 1 are presented in Table 3-3. Prior to sampling, it was decided that the first MM13B should be run at 8 min/point for a total sample time of 192 minutes. This sample time would ensure collection of a detectable concentration of Cr^{+6}. Following the analysis of the sample,

TABLE 3-2. SUMMARY OF FLUE GAS CONDITIONS

Run No.	Date	Volumetric Flowrate dscm/min	Volumetric Flowrate dscf/min	Temperature °C	Temperature °F	% Moisture	% Isokinetic
Condition 1							
MM13B-1	4/18/88	66.69	2355	23	73	1.6	100.3
MM13B-2	4/19/88	67.59	2387	20	68	1.3	99.1
MM13B-3	4/19/88	66.40	2345	21	70	1.4	103.1
Condition 2							
MM13B-4	4/20/88	66.80	2359	20	68	1.0	101.7
MM13B-5	4/20/88	67.34	2378	18	65	1.0	102.6
MM13B-6	4/21/88	66.40	2345	21	70	1.2	101.7
Condition 3							
MM13B-7	4/25/88	66.12	2335	22	72	1.2	99.3
MM13B-8	4/26/88	64.31	2271	24	75	1.6	98.8
MM13B-9	4/26/88	63.54	2244	24	75	1.5	98.5

TABLE 3-3. SUMMARY OF SAMPLE VOLUMES, ANALYTICAL RESULTS AND EMISSION RATES FOR CONDITION 1

Run No.	Volume Metered dscm	Volume Metered dscf	Total Mass Cr+6, mg	Concentration mg/dscm	Concentration gr/dscf	Emission Rates kg/hr	Emission Rates lb/hr
MM13B-1	3.517	124.199	3.016	0.858	0.0004	0.004	0.008
MM13B-2	2.202	77.759	2.027	0.921	0.0004	0.004	0.008
MM13B-3	2.250	79.461	2.236	0.994	0.0004	0.004	0.008

Screening Methods	Screening Volume	Stack DSCFM	Screening Mg/M^3	13B Mg/M^3	% of 13B
1-A-1	7.9833	2313	.5100	.846	60.3
1-A-2	7.7707	2313	.5626	.846	66.5
1-A-3	7.5394	2313	.5902	.846	69.8
1-A-4	7.8214	2313	.5942	.846	70.2
1-B-1	7.9833	2313	.5874	.846	69.4
1-B-2	7.7707	2313	.5381	.846	63.6
1-B-3	7.5394	2313	.7012	.846	82.9
1-B-4	7.8214	2313	.6732	.846	79.6
2-A-1	7.9493	2307	.1915	.923	20.7
2-A-2	7.7376	2307	.5787	.923	62.7
2-A-3	7.5073	2307	.6129	.923	66.4
2-A-4	7.7881	2307	.7260	.923	78.7
2-B-1	8.027	2307	.7357	.923	79.7
2-B-2	7.781	2307	.5568	.923	60.3
2-B-3	7.546	2307	.8185	.923	88.7
2-B-1	7.861	2307	.8112	.923	87.9
3-A-1	7.9794	2302	.6559	.993	66.1
3-A-2	7.7669	2302	.5793	.993	58.3
3-A-3	7.5357	2302	.8285	.993	83.4
3-A-4	7.8176	2302	.8104	.993	81.6
3-B-1	7.9794	2302	.2465	.993	24.8
3-B-2	7.7669	2302	.5101	.993	51.4
3-B-3	7.5357	2302	.7760	.993	78.1
3-B-4	7.8176	2302	.7323	.993	73.7

it was determined that the sample time per point could be reduced to 5 minutes for a total sample time of 120 minutes.

The uncontrolled emissions for each MM13B were very consistent and averaged 0.924 milligrams per dry standard cubic meter (mg/dscm), or .000404 grains per dry standard cubic feet (gr/dscf)).

3.2.1.2 Screening Method--

A summary of the sample volumes, analytical results and emission rates for the Screening Methods conducted under Condition 1 is presented in Table 3-3. In an effort to determine if any Cr^{+6} is lost in the sample recovery of the Screening Method (i.e., adhere to side of tubing that is not rinsed), it was decided to rinse the tygon tubing that connected the probe to the pump into a separate sample bottle for analysis. The results from the analysis proved that the tubing contained a significant concentration of Cr^{+6}. Therefore, all subsequent sample recoveries of the Screening Method trains included rinsing the tygon tubing into the same sample bottle as the probe.

Screening method runs consisted of fixed flow rate single point sampling. While the data generated during this test were fairly encouraging, later tests showed that single point sampling was not the best approach for developing an alternate sampling method for chromium. The results presented show the percent of sample collected when compared to the MM13B train. The screening method was about 70% successful for this particular test.

3.2.2 <u>Condition 2</u>

Condition 2 data represent emissions generated with the use of a foam blanket in the chromium plating tank. This condition was achieved by adding tablets to the plating tank to generate the foam blanket.

3.2.2.1 Modified Method 13B--

A summary of the flue gas conditioned at the sampling location while operating under Condition 2 is presented in Table 3-2. The volumetric flow

rates were consistent and averaged 67 dscmm (2361 dscfm). The flue gas temperature averaged 20°C (68°F) and the moisture content averaged 1.1 percent. The flue gas was essentially ambient air and was assigned a dry molecular weight of 29.0 lb/lb mole. The isokinetic sampling rates were within the allowable limitations for these sample runs.

A summary of the MM13B sample volumes, analytical results and emission rates for Condition 2 are presented in Table 3-4. Prior to sampling, it was decided that run MM13B-4 should be made at 8 min/point for a total sample time of 192 minutes. This sample time would ensure collection of a detectable concentration of Cr^{+6}. Following the analysis of the sample, it was determined that the sample time per point for MM13B-5 could be reduced to 5 minutes for a total sample time of 120 minutes.

The sampling and sample recovery techniques were modified for MM13B-6. The sampling time was increased to 10 min/point for a total sample time of 240 minutes. The increase in sample time was made at the request of the Industrial Studies Branch. Their reasoning was that with the low concentrations of Cr^{+6} that were reported in MM13B-4 and 5, a larger sample volume should produce more accurate results. The modification of the sample recovery technique consisted of recovering the nozzle and probe rinse in one sample bottle and recovering the impinger catch into a second sample bottle. Each sample was analyzed separately, then the analytical results were combined to determine the total mass of Cr^{+6} collected. This method was devised in an attempt to reduce the total volume of the recovered solutions, concentrate Cr^{+6} concentrations and increase the accuracy of the analytical results. This technique was carried out through the remainder of the MM13B runs.

3.2.2.2 Screening Method--

A summary of the sample volumes, analytical results and emission rates for the Screening Methods conducted under Condition 2 is presented in Table 3-4.

TABLE 3-4. SUMMARY OF SAMPLE VOLUMES, ANALYTICAL RESULTS, AND EMISSION RATES FOR CONDITION 2

Run No.	Volume Metered dscm	Volume Metered dscf	Total Mass Cr^{+6}, mg	Concentration mg/dscm	Concentration gr/dscf	Emission Rates kg/hr	Emission Rates lb/hr
MM13B-4	3.573	126.150	0.012	0.0034	1.43×10^{-6}	1.31×10^{-5}	2.89×10^{-5}
MM13B-5	2.273	80.256	0.012	0.0053	2.30×10^{-6}	2.13×10^{-5}	4.69×10^{-5}
MM13B-6	8.204	289.681	0.031	0.0038	1.65×10^{-6}	1.51×10^{-5}	3.32×10^{-5}
	Screening Vol	Stack DSCFM		Screen Mg/M^3	MM 13B Mg/M^3	% of MM 13B	
4-A-1	7.9548	2316					
4-A-2	7.7429	2316		All below detection limit of Analytical Method			
4-A-3	7.5124	2316					
4-A-4	7.7934	2316					
4-B-1	7.9548	2316		.00306	.00339	90.4	
4-B-2	7.7429	2316		.00369	.00339	109.0	
4-B-3	7.5124	2316		.00564	.00339	166.5	
4-B-4	7.7934	2316		.00589	.00339	173.8	
5-1-U	7.9221	2309		.002377	.006805	34.9	
5-2-U	7.7110	2309		.003816	.006805	56.07	
5-3-U	7.4815	2309		.002517	.006805	37.0	
5-4-U	7.7614	2309		.001972	.006805	28.98	
6-1-U	8.0013	2299		.002094	.003811	55.0	
5-2-U	7.7882	2299		.003290	.003811	86.3	
6-3-U	7.5564	2299		.002608	.003811	68.4	
6-4-U	7.8390	2299		.002766	.003811	72.6	
6-1-P	8.0013	2299		.001153	.003811	30.3	
6-2-P	7.7882	2299		.002231	.003811	58.5	
6-3-P	7.5564	2299		.002792	.003811	73.3	
6-4-P	7.8390	2299		.002447	.003811	64.2	

U = previously used tubing

P = polyethylene tubing

3.2.3 Condition 3

Condition 3 data represent emissions generated from the plating tank while using a foam blanket combined with a wetting agent to control the emissions. The wetting agent is added to reduce the surface tension of the plating bath. The condition was achieved by adding tablets to the bath to generate the blanket and granules to reduce the surface tension.

3.2.3.1 Modified Method 13B--

A summary of the flue gas conditions at the sampling location while operating under Condition 3 is presented in Table 3-2. The volumetric flow rates were consistent and averaged 65 dscmm (2283 dscfm). The flue gas temperature averaged 23°C (74°F) and the moisture content averaged 1.4 percent. The flue gas was essentially ambient air and was assigned a dry molecular weight of 29.0 lb/lb mole. The isokinetic sampling rates were within the allowable limitations for these three sample runs.

A summary of the MM13B sample volumes, analytical results and emission rates for Condition 3 are presented in Table 3-5. Sampling times for MM13B runs 7, 8 and 9 were run at 10 min/point, for a total test time of 240 minutes for each run. Sample recovery was performed as discussed in Section 3.2.2.1.

3.2.3.2 Screening Method--

A summary of sample volumes, analytical results and emission rates for the Screening Methods conducted under Condition 3 are also presented in Table 3-5.

3.3 PLATING TANK SOLUTIONS

During each MM13B run, grab samples of the plating bath were collected and composited. The samples were analyzed for Cr^{+6} concentration to verify the plating solution concentration. The results from the plating solution analyses are presented in Table 3-6.

TABLE 3-5. SUMMARY OF SAMPLE VOLUMES, ANALYTICAL RESULTS, AND EMISSION RATES FOR CONDITION 3

Run No.	Volume Metered dscm	Volume Metered dscf	Total Mass Cr^{+6}, mg	Concentration mg/dscm	Concentration gr/dscf	Emission Rates kg/hr	Emission Rates lb/hr
MM13B-7	7.966	281.298	0.014	0.0018	7.80×10^{-7}	1.56×10^{-5}	7.08×10^{-6}
MM13B-8	7.689	271.500	0.009	0.0012	5.11×10^{-7}	4.52×10^{-6}	9.96×10^{-6}
MM13B-9	5.705	201.429	0.019	0.0033	1.45×10^{-6}	1.27×10^{-5}	2.97×10^{-5}

Screening Method	Screening Vol	Stack DSCFM	Screen Mg/M^3	MM 13B Mg/M^3	% of MM 13B
7-1	8.067	2289	.0004786	.0019147	25.0
7-2	7.852	2289	.0010734	.0019147	56.1
7-3	7.619	2289	.0010066	.0019147	52.6
7-4	7.904	2289	.0008184	.0019147	42.7
8-1	8.1016	2245	.0009448	.0011877	79.5
8-2	7.8858	2245	.0011957	.0011877	100.7
8-3	7.6511	2245	.0012877	.0011877	108.4
8-4	7.9373	2245	.0012547	.0011877	105.6
9-1	8.1016	2200	.0023298	.0034491	67.5
9-2	7.8858	2200	.0017118	.0034491	49.6
9-3	7.6511	2200	.0019119	.0034491	55.4
9-4	7.9373	2200	.0027473	.0034491	79.7

TABLE 3-6. SUMMARY OF PLATING SOLUTION ANALYTICAL RESULTS

Run No.	Cr^{+6} Concentration, μg/mℓ
Condition 1	
MM13B-1	139,010
MM13B-2	141,988
MM13B-3	143,276
Condition 2	
MM13B-4	129,956
MM13B-5	133,640
MM13B-6	134,882
Condition 3	
MM13B-7	1,485,704*
MM13B-8	141,804
MM13B-9	148,818

* It is suspected by the authors that an error in dilution was made (by a factor of 10). This suspicion cannot be proven because the samples have since been disposed of.

SECTION 4.0
SAMPLING LOCATIONS AND TEST METHODS

4.1 PLATING EMISSIONS

4.1.1 Location of Measurement Site

EPA Reference Method 1, "Sample and Velocity Traverses for Stationary Sources", was used to select a representative measurement site. The measurement site at the scrubber inlet was located in a 22.625-in. (nominal) inside diameter circular horizontal duct. Two, 3-in. ID holes were cut in the duct at 90 degrees from each other, resulting in a horizontal and vertical traverse. Upon measurement of the stack diameter, it was discovered that the inside diameters through the two ports were not equal. A visual inspection revealed that there was a deposit of particulate matter on the bottom of the duct. The inside diameter of the horizontal port was 22-5/8 in., and of the vertical port 20-1/2 in.. Because of this unusual condition, the location of the transverse points was discussed with the EPA Task Manager. It was, subsequently, decided to locate the points using the two different diameters. The stack diameter of 22-5/8 in. was used to determine the number of sample transverse points since using the larger diameter would have resulted in the least stack diameters from any disturbance. Using this diameter, the measurement site was 235 in. (10.4 stack diameter) downstream from the nearest flow disturbance (duct reduction) and 14-1/8 in. (0.62 stack diameters) upstream from any flow disturbance (sampling port for EPA's use). According to EPA Method 1 criteria, this site required 24 sample traverse points, 12 along each diameter. The first point on each traverse was moved to the required 0.5 in. from the wall of the duct. The last point on the horizontal traverse was moved to 0.5 in. from the wall of the duct, while on the vertical traverse the last point was moved to 1 in. from the bottom. The reason for this deviation from the reference method was to prevent loose particulate matter lying on the bottom of the duct from being entrained. The EPA Task Manager was consulted and approved this change. Table 4-1 shows the traverse points used.

TABLE 4-1. SAMPLE TRAVERSE POINT LOCATIONS

Traverse Point No.	Port Location	
	Vertical Traverse	Horizontal Traverse
1	0.5[a]	0.5[a]
2	1.37	1.52
3	2.42	2.67
4	3.63	4.00
5	5.13	5.65
6	7.30	8.05
7	13.20	14.57
8	15.38	16.97
9	16.87	18.62
10	18.08	19.96
11	19.13	21.10
12	19.50[b]	22.13[a]

[a] Relocated to the minimum distance from the inside stack wall.
[b] Relocated to 1 inch from residual matter in bottom of duct.

In order to compute the net cross-sectional areas of the duct at the measurement site it was necessary to correct for the area of the duct that was blocked. The area was calculated by first determining the total area of the circle. Then the area of blockage was determined by subtracting the area of the triangle ABC from the "pie" shaped area of the circle bounded by the radii AB and BC. The area of the blockage was then subtracted from the total area of the circle. The area of the duct that is unobstructed is 402.038 in.^{2} less 19.083 in.^{2}which equals 382.955 in.^{2} or 2.659 ft^2. The duct is represented in Figure 4.1.

Prior to sampling, verification of the absence of cyclonic flow at each sample traverse point was assessed based on procedures described in EPA Reference Method 1. In this method the face openings of the Type-S pitot tube are aligned perpendicular to the duct cross-sectional plane, designated "0-degree reference." Null (zero) pitot readings obtained at 0-degree reference indicate an acceptable flow condition at a given point. If the point reading were not zero at 0-degree reference, the pitot was rotated until a null reading was obtained. The value of the rotation angle (yaw) was recorded for each point and averaged across the duct. Method 1 criteria stipulate that average angular rotations greater than 20 degrees indicate cyclonic (nonaxial) flow conditions in the duct. The average of the angular rotations was 3.9 degrees, which indicated acceptable flow patterns and enabled the extraction of representative samples form this source. The cyclonic flow data are contained in Appendix B.

4.1.2 Test Methods

Prior to sampling, velocity and static pressures, moisture content, and temperature were measured to define sampling rates and nozzle sizes as described in the EPA Reference Methods 1,2 and 4. The stack gas molecular weight was not determined by procedures outlined in 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.

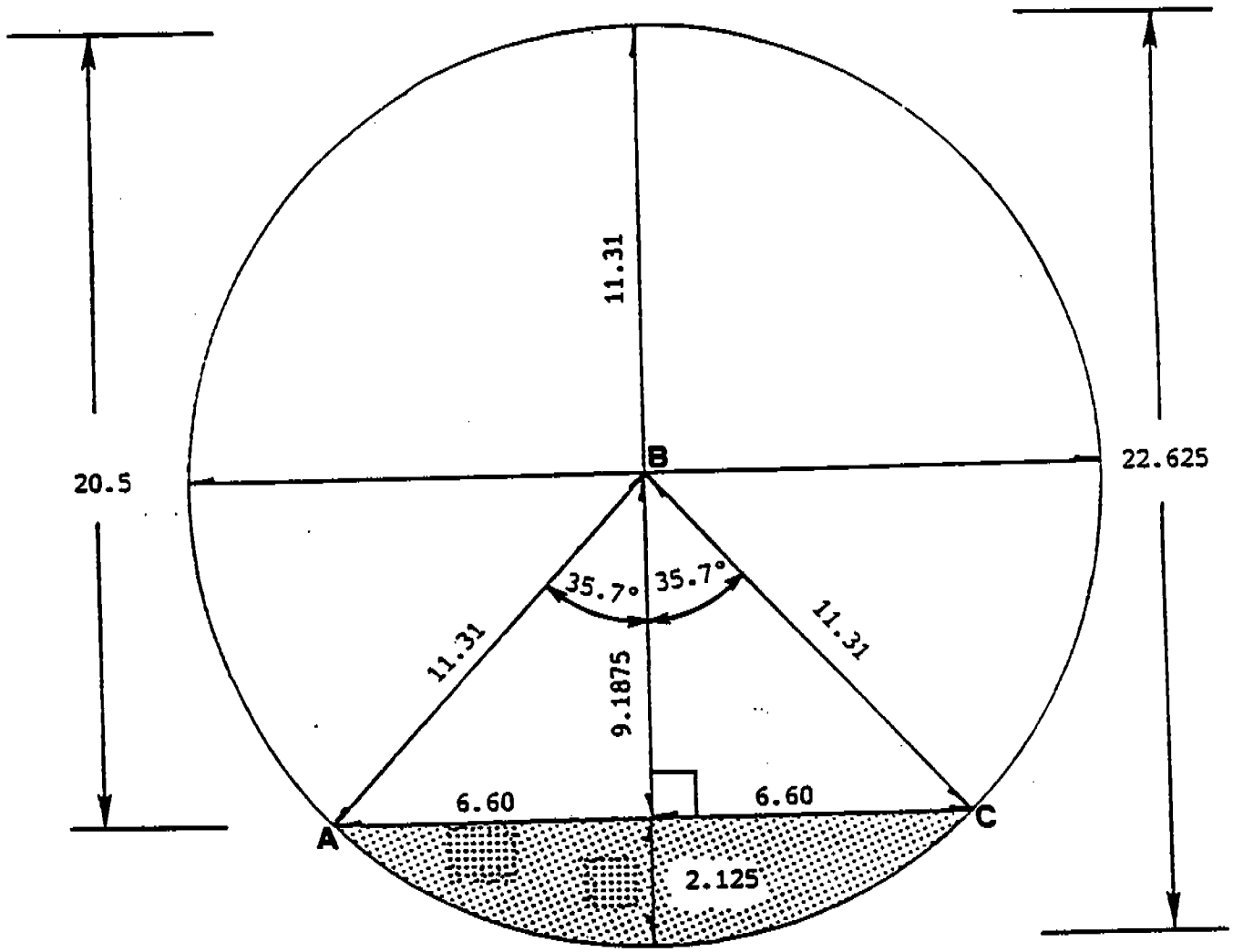


Figure 4.1. Cross-sectional view of duct at measurement site.

An EPA modified method MM13B sample train was used to collect the Cr^{+6} samples. The sample train was modified by placing 0.1 normal sodium hydroxide in the impingers in place of water and removing the filter(s) in the impinger section. The sample train consisted of a 316 stainless steel button-hook design nozzle, an unheated Pyrex glass-lined probe, and a series of four impingers. The first, third and fourth impingers were Greenburg-Smith design, modified by replacing the tip with a 1/2-in. inside diameter glass tube extending to 1/2-in. from the bottom of the flask. The second impinger was a Greenburg-Smith impinger with the standard tip. In the first and second impingers, 100mℓ of 0.1N NaOH was placed. The third impinger was empty, and approximately 200 grams of silica gel was placed in the fourth impinger. Due to extended sampling times on Runs MM13B-7, MM13B-8, and MM13B-9 an additional silica-gel filled impinger was added to the sampling train. 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 last impinger were monitored with thermocouples.

Each point was sampled isokinetically. The sampling time varied from run to run due to the changing of conditions of the chrome plating tanks. On Run MM13B-1 each point was sampled for 8 minutes with readings recorded every 4 minutes for a total sample time of 192 minutes. The analytical results showed that the Cr^{+6} concentration was high enough to reduce the sample time to 5 min/point for runs MM13B-2 and MMB-3. The addition of the fume suppressant before run MM13B-4 dictated changing sampling time to 8 min/point with a total sampling time of 192 minutes. On run MM13B-5 the sample time was 5 min/point or 120 min/run. It was decided that in order to increase the accuracy of the analytical method a much higher sample volume was required. To accomplish this the sample time per point was changed to 10 minutes for a total sample time of 240 minutes. In addition to increasing the sample time a larger nozzle was used, requiring a higher sampling rate in order to maintain isokinetic sampling conditions. The

sample volume was approximately 300 ft^3. On Run MM13B-9, the sample time was again adjusted due to dissipation of the fume suppressant. The horizontal traverse was held at 10 min/point but the vertical traverse was adjusted to 5 min/point with a total sample time for the run of 180 minutes. The EPA Task Manager was consulted on all of the changes in the sampling time and concurred.

The impingers were weighed before and after each test to determine the moisture content of the flue gas stream. The contents of the impingers were placed in a tared 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. On Runs MM13B-7, MM13B-8 and MM13B-9 the probe and nozzle rinse were separated from the impinger catch in an effort to concentrate the Cr^{+6} in a smaller sample volume. The liquid level was marked on each sample bottle and each bottle was marked indicating the run number and bottle contents. Appropriate blank solutions were collected.

The polyethylene containers were all tared before their use and weighed after the collection of the sample. The volume of each solution was determined by multiplying the specific gravity of the solution times the net weight of the solution. Each sample, including blanks, was analyzed for Cr^{+6} concentration using analytical methodology recently developed by the EPA.

4.2 EMISSION SAMPLE ANALYSIS

The MM13B samples, the Screening Method samples and the plating tank solution composite samples were analyzed for Cr^{+6} concentration. The analyses were conducted on site in a temporary laboratory. Immediately following the sample recovery, the samples were submitted to the analyst and the analyses and the calculations were performed the same day. Initially, calculations of the analytical results were performed on a calculator and

subsequently checked using the Hewlett Packard 41CVX computer that was set up in the on-site computer center. The results of this check method are presented in Appendix C.

The analytical method entitled "Draft Method - Determination of Hexavalent Chromium in Dry Particulate Emissions from Stationary Sources" was used as a "guideline" in conducting the analyses. This method is currently under development by the EPA and is presented in Appendix D.

There were several variations between the Draft Method and the Analytical Method that was performed in the field. They are described as follows.

1. The collected samples were not digested in an alkaline solution. Aliquots of the recovered impinger solutions were pipetted directly from the sample bottle and prepared as in paragraph 5.7.1 of the Draft Method.

2. The pH of the sample aliquot was monitored with a pH meter while adjusting the pH of the aliquot to 2 ± .05.

3. The spectrophotometer was calibrated with standards containing 1 mℓ, 2 mℓ, 5 mℓ, 10 mℓ, 15 mℓ and 20 mℓ of the 5 µg/mℓ working standard. The spectrophotometer calibration factor, K_c, was calculated as follows:

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

4. The calibration factor was determined using a computer program that was developed by the EPA Task Manager for the HP41CVX.

SECTION 5.0
QUALITY ASSURANCE

5.1 INTRODUCTION

The goal of the quality assurance activities for this project is to ensure, to the highest degree possible, the accuracy of data collected. The procedures contained in the "Quality Assurance Handbook for Air Pollution Measurement Systems," Volume III, "Stationary Source Specific Methods," EPA-600/4-77-027B served as the basis for performance of all testing and related work activities that were undertaken in this testing program. In addition to the quality assurance measure guidelines presented above, specific quality assurance activities were conducted for several of the individual testing activities, as performed; these are presented in the paragraphs that follow.

5.2 FIELD QUALITY ASSURANCE PROCEDURES

In order to assure a high level of quality control of the sampling for the comparison of data from these two methods, a field quality assurance program was followed for the test program. Methods used to obtain the required level of quality assurance are itemized below.

5.2.1 Sample Blanks

5.2.1.1 Reagent Blanks--

The 0.1N NaOH absorbing solution was transported to the field in its "as-purchased" container. When in the field, the 0.1N NaOH was transferred to a polyethylene wash bottle. From the wash bottle, the NaOH solution was used for sample train preparation and recovery. A blank sample was collected from the solution in the wash bottle. This sample was given to the on-site laboratory personnel with the emission samples, and analyzed in the same manner. Results of the blank analyses are presented in Table 5-1.

TABLE 5-1. SUMMARY OF ANALYTICAL RESULTS FOR QA/QC SAMPLES AND BLANKS

Sample No.	Date (1988)	Type of Sample			Total µg Cr^{+6}
		Duplicate	Spike	Standard	
1A1	4/18	X			114.6
.25 µg/mℓ	"			X	25.4
MM13B-1	"	X			3036.4
.25 µg/mℓ	4/19			X	25.6
.75 µg/mℓ	"			X	75.2
1-B-4	"		X		157.1
MM13B-1	"	X			2989.5
1-B-3	"	X			146.1
.25 µg/mℓ	"			X	25.5
1-B-4	"	X			142.9
3-B-3	"	X			163.3
.10 µg/mℓ	"			X	10.3
.25 µg/mℓ	"			X	25.6
.50 µg/mℓ	"			X	50.6
MM13B-1 PS	4/20	X			139,010
MM13B-2 PS	"	X			141,988
MM13B-3 PS	"	X			143,276
.05 µg/mℓ	"			X	4.8
.25 µg/mℓ	"			X	25.0
MM13B-4	4/21	X			11.9
MM13B-5	"	X			14.7
.25 µg/mℓ	"			X	25.3
.50 µg/mℓ	"			X	51.3
2-A-1	"	X			38.7
MM13B-4	"		X		12.7
MM13B-3	"	X			2222.5
MM13B-4	"		X		12.7

(continued)

TABLE 5-1. (continued)

Sample No.	Date (1988)	Type of Sample: Duplicate	Spike	Standard	Total µg Cr^{+6}
.05 µg/mℓ	"			X	4.9
.10 µg/mℓ	"			X	10.3
.25 µg/mℓ	"			X	25.6
3-B-1	4/25	X			53.0
2-A-4	"	X			154.2
MM13B-6	"	X			28.1
.05 µg/mℓ	"			X	49.5
.25 µg/mℓ	"			X	24.6
MM13B-7 (imp)	4/26	X			9.8
MM13B-8 (imp)	"	X			7.3
MM13B-8 (imp)	"	X			6.2
MM13B-8 (noz)	"	X			1.9
.25 µg/mℓ	"			X	25.4
.50 µg/mℓ	"			X	50.3
MM13B-8 (imp)	"	X			7.3
.50 µg/mℓ	"			X	50.5
.50 µg/mℓ	"			X	50.2
Blanks	4/18				0
	4/19				0
	4/20				0.19
	4/21				0
	4/25				.32
	4/26				.19

5.2.1.2 H_2O Blanks—

Distilled water blanks were obtained from the wash bottles and analyzed in the same manner as the emission samples.

5.2.2 Matrix Effects Check

A Cr^{+6} stock standard solution was made up in the laboratory. This stock solution was used to make up samples of known concentrations. Random samples were prepared and analyzed to verify the absence of any matrix effects.

5.2.3 Duplicate Samples

One sample for every 10 samples analyzed was a duplicate, e.g., if 24 samples were analyzed, 3 duplicate samples would be analyzed. The results of the duplicated samples are presented in Table 5-1.

5.2.4 Standards

Daily, throughout the analysis of the samples, standards were set up as a spot check of the spectrophotometer calibration. The results of these checks are presented in Table 5-1.

5.2.5 Chain of Custody

In an effort to maintain the integrity of all samples taken at the test facility, a chain of custody procedure was followed. A copy of the "Chain-of-Custody" data sheets is included in Appendix E. These sheets include the sample identification, date of sample recovery, name of person who performs the recovery, place of recovery as well as the name of the responsible person from the analytical group who is taking custody of the samples. Once the samples were placed in custody of the analytical group, that group provided for safe storage and maintenance of records sufficient to maintain sample integrity.

5.2.6 Sample Transfer

All MM13B samples collected during testing remained in the custody of PEER Consultants, P.C. All Screening Methods samples were returned to the EPA after analysis samples were secured in the laboratory while in the field.

5.3 SAMPLING TRAIN COMPONENTS

The equipment to be used in this test program, including nozzles, pitot tubes, dry gas meters, orifices, and thermocouples were uniquely identified and were calibrated in accordance with calibration procedures specified in the applicable EPA Reference Method prior to and at the completion of the testing program. The calibration sheets are presented in Appendix F.

5.4 VERIFICATION OF CALCULATIONS

5.4.1 Emission Calculations

Dry gas volumes, percent moisture of the stack gas and gas flow data were calculated using a particulate emission calculation sheet. Cr^{+6} emission rates were calculated on an emission rate calculation sheet. The data was calculated using a calculator. The results were checked and verified by the contractor task manager.

5.4.2 Chromium Concentration Calculations

All absorbance data for blanks, standards, samples and QA/QC samples were documented in a notebook. The percent absorbance was calculated from the percent transmittance and subsequent calculations were carried out as described in the Draft Method for Hexavalent Chromium Emissions.

APPENDIX A

Process Monitoring Data

TOTAL CURRENT IN AMPERE-HOURS FOR TEST RUN NOS. 1 THROUGH 9

Test Run No.	Plating cells	Ampere-hours
1	Activation cell	158
	Main cells	8,542
	Total	8,700
2	Activation cell	106
	Main cells	5,080
	Total	5,186
3	Activation cell	100
	Main cells	5,519
	Total	5,619
4	Activation cell	150
	Main cells	8,204
	Total	8,354
5	Activation cell	99
	Main cells	5,250
	Total	5,349
6	Activation cell	207
	Main cells	11,732
	Total	11,939
7	Activation cell	198
	Main cells	11,127
	Total	11,325
8	Activation cell	198
	Main cells	11,497
	Total	11,695
9	Activation cell	149
	Main cells	8,383
	Total	8,532

AMPERE-HOUR CALCULATIONS
ACTIVATION CELL OF TANK NO. 1
TEST RUN NOS. 1 THROUGH 9

Test Run No.	Production rate in racks/h[a]	Test time, hours	No. of racks processed[b]	Ampere-hours/rack[c]	Ampere-hours
1	112.5	3.20	360	0.44	158
2	112.5	2.15	242	0.44	106
3	112.5	2.02	227	0.44	100
4	112.5	3.03	340	0.44	150
5	112.5	2.00	225	0.44	99
6	112.5	4.18	470	0.44	207
7	112.5	4.00	450	0.44	198
8	112.5	4.00	450	0.44	198
9	112.5	3.00	338	0.44	149

[a]A rack is removed from the plating tank every 32 seconds.
[b]No. of racks processed = (production rate, racks/h)x(test time, hours).
[c]Activation cycle is 15 s in duration at current ranging from 0 to 200 amperes, which yields an effective current of 105 amperes.
(105 amperes/rack)(15 s)(1 min/60s)(1 h/60 min) = 0.44 ampere-hours/rack.

AMPERE-HOUR CALCULATIONS
TEST RUN NO. 1
MAIN PLATING CELLS OF TANK NO. 1

Time 24-hour clock	Time interval, min	Current	Ampere-hours
14:08			
14:15	7	2,700	315
14:25	10	2,700	450
14:35	10	2,700	450
14:45	10	2,200	367
15:00	15	3,000	750
15:15	15	2,900	725
15:30	15	3,100	775
15:44	14	3,000	700
Subtotal	96		4,532
16:02			
16:15	13	2,600	563
16:30	15	2,600	650
16:45	15	2,200	550
17:00	15	1,800	450
17:15	15	2,800	700
17:30	15	3,000	750
17:38	8	2,600	347
Subtotal	96		4,010
TOTAL	192		8,542

AMPERE-HOUR CALCULATIONS
TEST RUN NO. 2
MAIN PLATING CELLS OF TANK NO. 1

Time 24-hour clock	Time interval, min	Current	Ampere-hours
07:58			
08:10	12	2,800	560
08:20	10	2,600	433
08:30	10	2,700	450
08:35	5	700	58
08:40	5	500	42
08:45	5	3,000	250
Subtotal	47		1,793
08:49			
09:00	11	2,500	458
09:10	10	800	133
09:11	1	800	13
Subtotal	22		604
09:26			
09:30	4	2,900	193
09:40	10	3,000	500
09:50	10	2,200	367
10:00	10	2,000	333
10:10	10	3,000	500
10:20	10	3,000	500
10:26	6	2,900	290
Subtotal	60		2,683
TOTAL	129		5,080

AMPERE-HOUR CALCULATIONS
TEST RUN NO. 4
MAIN PLATING CELLS OF TANK NO. 1

Time 24-hour clock	Time interval, min	Current	Ampere-hours
09:32			
09:40	8	2,500	333
09:50	10	3,000	500
10:00	10	2,600	433
10:10	10	2,700	450
10:20	10	3,000	500
10:30	10	3,000	500
10:40	10	2,400	400
10:50	10	2,600	433
11:08	8	3,100	413
Subtotal	86		3,962
11:35			
11:40	5	3,000	250
11:50	10	2,600	433
12:00	10	2,700	450
12:10	10	2,600	433
12:20	10	2,800	467
12:30	10	2,700	450
12:40	10	2,000	333
12:50	10	3,000	500
13:00	10	2,800	467
13:10	10	2,500	417
13:11	1	2,500	42
Subtotal	96		4,242
TOTAL	182		8,204

AMPERE-HOUR CALCULATIONS
TEST RUN NO. 3
MAIN PLATING CELLS OF TANK NO. 1

Time 24-hour clock	Time interval, min	Current	Ampere-hours
11:57			
12:05	8	2,300	307
12:20	15	3,000	750
12:30	10	2,800	467
12:40	10	3,000	500
12:50	10	2,500	417
12:57	7	3,000	350
Subtotal	60		2,791
14:05			
14:15	10	2,100	350
14:21	6	2,100	210
Subtotal	16		560
14:23			
14:29	6	2,600	260
14:39	10	2,875	479
14:49	10	2,875	479
14:50	10	3,000	500
15:08	9	3,000	450
Subtotal	45		2,168
TOTAL	121		5,519

AMPERE-HOUR CALCULATIONS
TEST RUN NO. 6
MAIN PLATING CELLS OF TANK NO. 1

Time 24-hour clock	Time interval, min	Current	Ampere-hours
10:10			
10:20	10	3,000	500
10:30	10	2,900	483
10:40	10	3,000	500
10:50	10	3,100	517
11:00	10	2,900	483
11:10	10	2,900	483
11:20	10	2,600	433
11:30	10	2,900	483
11:32	2	2,900	967
Subtotal	82		4,849
11:36			
11:40	4	2,200	147
11:50	10	3,000	500
12:00	10	2,900	483
12:10	10	2,900	483
12:15	15	2,600	650
Subtotal	49		2,263
13:13			
13:20	7	2,700	315
13:30	10	2,200	367
13:40	10	2,500	417
13:50	10	2,200	367
14:00	10	2,900	483
14:10	10	2,900	483
14:20	10	3,000	500
14:30	10	2,000	333
14:40	10	2,100	350
14:50	10	1,200	200
15:00	10	2,100	350
15:13	13	2,100	455
Subtotal	120		4,620
TOTAL	251		11,732

AMPERE-HOUR CALCULATIONS
TEST RUN NO. 5
MAIN PLATING CELLS OF TANK NO. 1

Time 24-hour clock	Time interval, min	Current	Ampere-hours
14:15			
14:25	10	2,400	400
14:35	10	2,300	383
14:45	10	2,200	367
14:55	10	2,300	383
15:05	10	2,500	417
15:15	10	2,700	450
Subtotal	60		2,400
15:29			
15:35	6	3,000	300
15:45	10	2,100	350
15:55	10	3,000	500
16:05	10	2,900	483
16:15	10	3,100	517
16:29	14	3,000	700
Subtotal	60		2,850
TOTAL	120		5,250

AMPERE-HOUR CALCULATIONS
TEST RUN NO. 8
MAIN PLATING CELLS OF TANK NO. 1

Time 24-hour clock	Time interval, min	Current	Ampere-hours
09:03			
09:15	12	3,100	620
09:25	10	2,800	467
09:35	10	2,900	483
09:45	10	1,400	233
09:55	10	3,100	517
10:05	10	3,000	500
10:15	10	2,800	467
10:30	15	2,800	700
10:40	10	3,100	517
10:50	10	2,500	417
11:00	10	3,200	533
11:03	3	3,200	160
Subtotal	120		5,614
11:30			
11:40	10	2,600	433
11:50	10	2,300	383
12:00	10	3,200	533
12:10	10	3,000	500
12:20	10	3,100	517
12:30	10	2,900	483
12:40	10	2,900	483
12:50	10	2,800	467
13:00	10	3,100	517
13:10	10	3,000	500
13:20	10	3,300	550
13:30	10	3,100	517
Subtotal	120		5,883
TOTAL	240		11,497

AMPERE-HOUR CALCULATIONS
TEST RUN NO. 7
MAIN PLATING CELLS OF TANK NO. 1

Time 24-hour clock	Time interval, min	Current	Ampere-hours
14:58			
15:05	7	3,100	362
15:15	10	2,400	400
15:25	10	3,100	517
15:35	10	2,900	483
15:45	10	1,600	267
15:55	10	3,200	533
16:05	10	2,700	450
16:15	10	2,900	483
16:25	10	2,700	450
16:35	10	3,100	517
16:45	10	3,100	517
16:55	10	2,500	417
16:58	3	2,500	125
Subtotal	120		5,521
17:41			
17:45	4	3,000	200
17:55	10	3,100	517
18:05	10	2,600	433
18:15	10	2,600	433
18:25	10	3,200	533
18:35	10	1,900	317
18:45	10	2,900	483
18:55	10	3,000	500
19:05	10	3,100	517
19:15	10	2,300	383
19:35	10	3,100	517
19:41	6	2,900	290
Subtotal	120		5,606
TOTAL	240		11,127

SOURCE SAMPLING PROCESS DATA SHEET

Place: Automatic Die Casting Specialists, Inc.
St. Clair Shores, Michigan

Test run No. 1
Test start time: 14:08
Test stop time: 17:38

Date: April 18, 1988
Test condition: Uncontrolled

Time, 24-h clock	Temp., °F	Operating voltage, volts	Operating current, amperes	Fume suppressant makeup and maintenance additions	Notes
14:15	118	5.2	2,700		Started testing: 14:08
14:25	118	5.2	2,700		
14:35	118	5.2	2,700		
14:45	118	5.2	2,200		
15:00	118	5.2	3,000		
15:15	118	5.2	2,900		
15:30	118	5.2	3,100		
15:45	118	5.2	3,000		
					Stopped testing: 15:44 port change
16:00	118	5.2	3,000		
16:15	118	5.2	2,600		Started testing: 16:02
16:30	118	5.2	2,600		
16:45	118	5.2	2,200		
17:00	118	5.2	1,800		
17:15	118	5.2	2,800		
17:30	118	5.2	3,000		
17:40	118	5.2	2,600		
					Stopped testing: 17:38 Surface tension of composite sample = 66 dynes/cm

AMPERE-HOUR CALCULATIONS
TEST RUN NO. 9
MAIN PLATING CELLS OF TANK NO. 1

Time 24-hour clock	Time interval, min	Current	Ampere-hours
14:23			
14:30	7	3,200	373
14:40	10	3,200	533
14:50	10	2,900	483
15:00	10	2,900	483
15:10	10	2,800	467
15:20	10	3,000	500
15:30	10	2,400	400
15:40	10	3,000	500
15:50	10	3,000	500
16:00	10	2,900	483
16:10	10	2,200	367
16:20	10	2,900	483
16:23	3	2,900	145
Subtotal	120		5,717
16:52			
17:00	8	2,800	373
17:10	10	3,000	500
17:20	10	2,900	483
17:30	10	2,800	467
17:40	10	2,200	367
17:50	10	2,800	467
17:52	2	2,800	9
Subtotal	60		2,666
TOTAL	180		8,383

SOURCE SAMPLING PROCESS DATA SHEET

Place: Automatic Die Casting Specialists, Inc.
St. Clair Shores, Michigan

Test run No. 9
Test start time: 14:23
Test stop time: 17:52

Date: April 26, 1988
Test condition: Combination fume suppressant

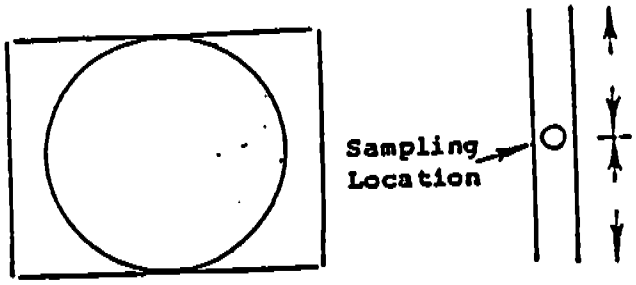
Time, 24-h clock	Temp., °F	Operating voltage, volts	Operating current, amperes	Fume suppressant makeup and maintenance additions	Notes
14:20	121	5.2	2,700	Maintenance addition: 30 tablets or 147 grams at 14:30	Started testing: 14:23 Surface tension at 14:20 = 38 dynes/cm
14:30	121	5.2	3,200		
14:40	121	5.2	3,200		
14:50	121	5.0	2,900		
15:00	121	5.2	2,900		
15:10	121	5.2	2,800		
15:20	121	5.2	3,000		
15:30	121	5.2	2,400	Maintenance addition: 15 tablets or 73.5 grams at 15:30	
15:40	121	5.0	3,000		
15:50	120	5.0	3,000		
16:00	120	5.2	2,900		
16:10	120	5.0	2,200		
16:20	120	5.0	2,900		Stopped testing: 16:23 port change
16:30	120	5.0	2,800		
16:40	119	5.0	2,700		
16:50	119	5.0	2,600		Started testing: 16:52
17:00	119	5.2	2,800		
17:10	118	5.2	3,000		
17:20	118	5.2	2,900		
17:30	118	5.2	2,800		
17:40	118	5.2	2,200		
17:50	118	5.0	2,800		Stopped testing: 17:52 Surface tension of composite sample = 38 dynes/cm

APPENDIX B

Field Data Sheets
Flow Rate and Emission Calculation Sheets

PRELIMINARY VELOCITY TRAVERSE

Plant: AUTOMATIC DIE Job No. _____
Date: 4-18-85
Location: SCRUBBER INLET
Stack I.D.: 22 5/8 - 20 1/2
Barometric Pressure, in. Hg: 29.14
Stack Gauge Pressure, in. H_2O: -1.7
Operators: J. BLAN, A. WASSMAN
Pitot Tube I.D. Number: S-3
Temperature Readout I.D.: T-2
Pitot Tube Leak Check: O.K
Run Number _____ Time 10:53



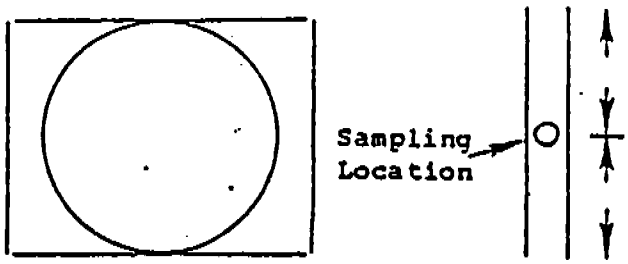
Schematic of Traverse Point Layout

Traverse Point Number	Velocity Head (Δp_s) in. H_2O	Stack Temp. (T_s), °F	Cyclonic Flow Check ° from Null
H-1	0.06	79	
2	0.06	79	
3	0.08	79	
4	.07	78	
5	.10	78	
6	.10	78	
7	.09	78	
8	.10	78	
9	.08	78	
10	.07	78	
11	.05	77	
12	04	77	
Average			

Traverse Point Number	Velocity Head (Δp_s) in. H_2O	Stack Temp. (T_s), °F	Cyclonic Flow Check ° from Null
V 1 1/2	.05	76	
2	05	76	
3	06	76	
4	.07	76	
5	.08	76	
6	.11	76	
7	.10	76	
8	.13	76	
9	.19	76	
10	.12	77	
Average			

PRELIMINARY VELOCITY TRAVERSE

Plant: Atlantic Die Cast...
Date: 4-25-88
Location: 3 crusher inlet
Stack I.D.:
Barometric Pressure, in. Hg:
Stack Gauge Pressure, in. H_2O: -1.7
Operators:
Pitot Tube I.D. Number:
Temperature Readout I.D.:
Pitot Tube Leak Check:



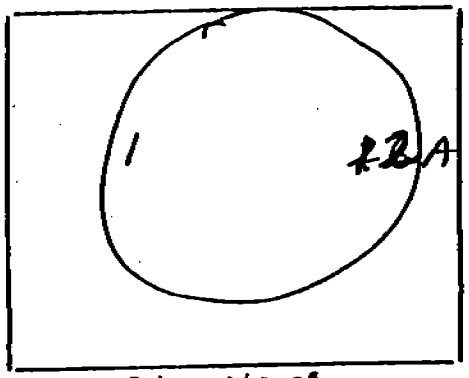
Schematic of Traverse Point Layout

Traverse Point Number	Velocity Head (Δp_s) in. H_2O	Stack Temp. (T_s), °F	Cyclonic Flow Check ° from Null
1			cc 4
2			c 0
3			cc 1
4			c 3
5			c 8
6			c 2
7			0
8			c 11
9			c 6
10			cc 5
11			cc 3
12			cc 5
			-19
			+11
Average			

Traverse Point Number	Velocity Head (Δp_s) in. H_2O	Stack Temp. (T_s), °F	Cyclonic Flow Check ° from Null
1		≈	c 5
2		≈	c 5
3		≈	c 5
4		≈	c 5
5			0
6			0
7			0
8			0
9		≈	cc 10
10		≈	cc 5
11		≈	cc 5
12		≈	c 5
Average			

FIELD DATA

Plant Automatic Oil
Date 4-18-85 Job No.
Sampling Location SCRUBBER INLET
Sample Type MM13B
Run Number MM13B-1
Operator J. BLAU / A. WAISMAN
Ambient Temperature 80
Barometric Pressure 29.14
Static Pressure (P_s) -1.7
Filter Number(s)
Pretest Leak Rate = .001 cfm @ 11 in. Hg
Pretest Pitot Leak Check O.K
Pretest Orsat Leak Check
Read and Record all Data Every ___ Minutes



Schematic of Traverse Point Layout

Probe Length and Type 3' GLASS
Pitot Tube I.D. No. ___ Cp .84
Nozzle I.D. ___ Avg. .366
Assumed Moisture, % 2
Temp. Readout S/N T-2
Meter Box Number ~~T-2~~ MB1
Meter $\Delta H_@$ 1.78
C Factor .03
Meter Gamma .998
Heater Box Setting ___
Reference Δp .93
Post Test Leak Rate = .003 cfm @ 8 in. Hg
Post Test Pitot Leak Check O.K
Post Test Orsat Leak Check

Page 1 of 2

Temp. Sensor ID No.

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	Probe Temp °F
	0	14:08	914.715										
A 1	4		917.763	0.100	.82	.82	71	70	70	1		50	
	8		919.247	.093	.79	.79	72	76	70	1		46	
A 2	12		921.715	.056	1.0	1.0	72	80	72	1		45	
	16		924.210	.059	1.1	1.1	71	84	73	1		47	
A-3	20		926.715	.075	1.4	1.4	71	90	75	1		49	
	24		929.903	.075	1.4	1.4	70	94	76	1		49	
A-4	28		932.675	.081	1.5	1.5	71	98	80	1		50	
	32		935.635	.083	1.6	1.6	72	100	80	1		50	
A-5	36		938.638	.086	1.6	1.6	72	106	82	1		51	
	40		941.711	.087	1.7	1.7	73	106	86	1		52	
A-6	44		944.710	.086	1.6	1.6	73	108	86	1		53	
	48		947.793	.079	1.5	1.5	73	108	86	1		54	
A-7	52		950.805	.075	1.4	1.4	73	110	90	1		54	
	56		953.398	.068	1.3	1.3	73	110	91	1		54	
A-8	60		955.995	.059	1.1	1.1	73	110	91	1		54	
	64		958.783	.061	1.2	1.2	73	110	91	1		54	
A-9	68		961.993	.113	2.2	2.2	73	113	91	1		54	
	72		965.431	.113	2.2	2.3	74	114	91	2		54	
A-10	76		969.762	.220	4.2	4.2	74	120	91	5		54	
	80			.200	3.9	3.9	74						

PACIFIC ENVIRONMENTAL SERVICES, INC.

ant Name: Automatic Die Casting Test Date: 4-18-88

n Number: MM13B-1 Operator: J. Blay, A Weisman

ge 2 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	Probe Temp °F
	80	15:28	974.501										
-11	84		977.905	0.092	1.8	1.8	74	120	98	2		57	
	88		980.553	0.070	1.3	1.3	73	120	98	2		56	
-12	92		983.891	.068	1.3	1.3	74	120	98	2		56	
	96	15:44	986.199	.070	1.3	1.3	74	118	100	2		55	
			LEAK CHECK 8" VAC .001										
		16:02	986.372	AFTER LEAK CHECKS									
-1	100		988.732	.043	.83	.83	74	102	100	1		57	
	104		990.876	.042	.81	.81	73	108	100	1		51	
-2	108		993.113	.047	.91	.91	74	110	100	1		52	
	112		995.466	.048	.94	.94	73	114	102	1		53	
-3	116		997.910	.053	1.0	1.0	74	114	102	1		55	
	120		1.000.378	.053	1.0	1.0	74	116	102	1		56	
-4	124		002.950	.057	1.1	1.1	74	116	102	1		56	
	128		005.643	.060	1.2	1.2	73	118	104	1		58	
-5	132		008.249	.063	1.1	1.1	73	118	104	1		59	
	136		010.026	.067	1.3	1.3	73	118	103	1		58	
-6	140		013.891	.069	1.4	1.4	73	118	103	1		56	
	144		017.511	.073	1.4	1.4	73	119	104	1		55	
-7	148		020.61	.097	1.9	1.9	73	119	104	1		54	
	152		023.305	.097	1.9	1.9	73	118	104	1		54	
-8	156		026.631	.089	1.75	1.75	73	119	105	1		54	
	160		029.635	.091	1.8	1.8	73	118	106	1		55	
-9	164		032.595	.077	1.5	1.5	72	118	104	1		54	
	168		035.681	.081	1.5	1.5	71	118	104	1		53	
-10	172		038.605	.083	1.6	1.6	73	118	104	1		54	
	176		041.841	.090	1.8	1.8	73	118	104	1		54	
-11	180		044.796	.081	1.6	1.6	72	118	103	1		54	
	184		047.861	.086	1.7	1.7	71	118	104	1		54	
-12	188		050.074	.039	.77	.77	72	117	104	1		55	
	192		052.259	.042	.82	.82	72	114	103	1		55	

T_{SAM} = 73°F

SAMPLE RECOVERY DATA

Plant: Automatic Die Casting Run No.: MM13B-1

Date: 4/18/88 Sample Box No.: BAC-1 Job No.: _____

Sample Location: Scrubber inlet

Sample Type: MM13-B Filter No.: _____

Sample Recovery Person: HJO - JRD

Comments: _____

FRONT HALF

Acetone Container No.: _____ Liquid Level Marked: _____ Sealed: _____

Filter Container No.: _____ _____ _____ Sealed: _____

Description of Filter: _____

Samples stored and locked: _____

BACK HALF/MOISTURE

.1N NaOH

Container No: MM13B-1 _____ _____

Liquid Level Marked: _____ Sealed: _____

IMP. NO.	CONTENTS	INITIAL VOL (ml)	WEIGHT (grams) INITIAL	FINAL	NET
1			567.0	574.1	7.1
2			568.6	573.5	4.9
3			448.2	451.3	3.1
4			688.4	715.1	26.7
5					
6					
TOTAL					41.8

Description of Impinger Catch: _____

EMISSION TEST CALCULATIONS

PLANT Automatic Die Casting SOURCE/RUN MM13B-1 DATE 5/4/88

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)

$$V_{m_{std}} = 17.64\ V_{m_c} Y \left(\frac{P_{bar} + \Delta H / 13.6}{T_m}\right) = 17.64\ (137.171)\ (\cancel{1.78}\ \cancel{.988}\ .988)\ \frac{(29.14) + (1.48)/13}{(563)}$$

$V_{m_{std}}$ = ~~124.199~~ 124.199 dscf

3. Volume Water Vapor Collected, Standard Conditions

Impingers = $V_{wc} = 0.04707\ (V_f - V_i) = 0.04707\ (15.1) = .71$ scf

Silica Gel = $V_{wsg} = 0.04715\ (W_f - W_i) = 0.04715\ (26.7) = 1.26$ scf

$V_{w_{std}} = V_{wc} + V_{wsg} = 1.97$ scf

4. Percent Moisture, By Volume

$$B_{w_s} = \frac{V_{w_{std}}}{V_{w_{std}} + V_{m_{std}}} = \frac{(1.97)}{(1.97) + (124.199)} = 1.56\%$$

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 =

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

%EA = _____

$M_s = M_d\ (1 - B_{ws}) + 18.0\ (B_{ws}) = (29.0)(1 - .0156) + 18.0\ (.0156) = 28.83$ lb/lb-mole

6. Stack Gas Velocity, Average

$$V_{s_{avg}} = 85.49 C_p \left(\sqrt{\Delta P}\right)_{avg} \sqrt{\frac{T_s}{P_s M_s}} = 85.49 \left(\cancel{.85}\ .84\right)(.272)\sqrt{\frac{(533)}{(29.02)(28.83)}}$$

$V_{s_{avg}}$ = ~~15.78~~ 15.59 ft/s

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

$$Q_a(\text{circular}) = \left(\frac{60 \times V_s\ (\text{Stack Area}^*)}{144}\right) = 60 \times V_s \left(\frac{A_o\ (in^2)}{144}\right)$$

$$= 60 \times \underline{15.59} \left(\frac{\cancel{383.2}\ 383.5}{144}\right)$$

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

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

Q_a = ~~2489.20~~ 2491.2 acfm

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

$$Q_{std} = 17.64\, Q_a (1-B_{ws}) \left(\frac{P_s}{T_s}\right) = 17.64 \left(\cancel{2489.20}\ 2491.2\right)(1-.0156)\left(\frac{29.02}{533}\right)$$

Q_{std} = ~~2353.43~~ 2355.3 dscfm

9. Isokinetic Variation

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

$$= 0.0944 \frac{(533)\left(\cancel{124.199}\ 124.199\right)}{(29.02)\left(\cancel{15.78}\ 15.59\right)\left(\cancel{.1056}\ 7.29 \times 10^{-4}\right)(192)(1-.0156)}$$

= ~~99.04~~ 100.25 %

* Stack area ~~determined~~ calculated to be 383.2 in² as demonstrated in Figure ----

EMISSION RATE CALCULATIONS

Plant Automatic Die Casting Run No. MM13B-1 Date 5/9/88

Parameter measured Cr^{+6}

Sample volume $V_{m\ std}$ 124.199 dscf
Sample concentration (C_s) 4.88 mg/ℓ
Blank concentration (C_b) 0 mg/ℓ
Solution volume (V_{sol}) .618 ℓ
Volumetric flow rate Q_{std} ~~2353.43~~ 2355.3 ft^3/min

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

$$\frac{4.88}{\ell}\ \text{mg} - \frac{0}{\ell}\ \text{mg}\ (.618\ \ell) = 3.016\ \text{mg}$$

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

$$\frac{(3.016\ \text{mg})\ \dfrac{0.0154\ \text{gr}}{\text{mg}}}{124.199\ \text{dscf}} = .0004\ \text{gr/dscf}$$

3. Emission rate (lb/hr):

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

$$\frac{(.0004\ \text{gr})}{\text{dscf}}\ \frac{1.43\times10^{-4}\ \text{lb}}{\text{gr}}\ \frac{(\overset{2355.3}{\cancel{2353.43}}\ \text{ft}^3)}{\text{min}}\ \frac{60\ \text{min}}{\text{hr}} = \overset{.008}{\cancel{.0076}}\ \text{lb/hr}$$

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

$$\frac{(\overset{.008}{\cancel{.0076}}\ \text{lb})}{\text{hr}}\ \frac{0.4539\ \text{kg}}{\text{lb}} = \overset{.004\ .0037}{\cancel{.0034}}\ \text{kg/hr}$$

FIELD DATA

Plant Automatic Die Casting
Date 4-19-88 Job No.
Sampling Location SCRUBBER INLET
Sample Type MM13B
Run Number MM13B-2
Operator J. Olay, A. Upisman
Ambient Temperature 69
Barometric Pressure 29.29
Static Pressure (P_s) -1.7
Filter Number(s)
Pretest Leak Rate = .001 cfm @ 15 in. Hg
Pretest Pitot Leak Check O.K
Pretest Orsat Leak Check
Read and Record all Data Every 5 Minutes

Schematic of Traverse Point Layout

Probe Length and Type 3' Glass
Pitot Tube I.D. No. 5-3 Cp .79
Nozzle I.D. | | Avg. .366
Assumed Moisture, % 1.5
Temp. Readout S/N T-2
Meter Box Number MB-1
Meter $\Delta H_@$ 1.78
C Factor 1.02
Meter Gamma .998
Heater Box Setting
Reference Δp .095
Post Test Leak Rate = .002 cfm @ 7 in. Hg
Post Test Pitot Leak Check O.K
Post Test Orsat Leak Check

Page 1 of

Temp. Sensor ID No. 3B

Traverse Point Number	Sampling Time, (min)	Clock Time (24-hour clock)	Gas Meter Reading (V_m) ft³	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	Probe Temp °F
	0	7:58	053.599									48	
H-1	5		057.751	.030	.56	.56	71	78	78	1		48	
H-2	9:~~11~~		57.693	.038	.70	.70	~~70~~	88	80	1			
			Flow	STOPPED			70						
		8:17	58.986					90	86				
H-2	10		58.026					90	88	1		50	
H-3	15		61.150	.055	1.0	1.0	70	95	86	1		47	
H-4			64.435	.063	1.2	1.2	70	102	88	2		48	
H-5			67.850	.071	1.3	1.3	70	106	90	2		49	
H-6			71.300	.064	1.3	1.3	70	108	90	4		50	
H-7		8:45	074.984	.080	1.6	1.6	69	111	92	4		51	
H-8			78.563	.084	1.7	1.7	69	107	92	4		49	
H-9			082.611	.083	1.6	1.6	69	107	95	4		50	
H-10			086.553	.092	1.8	1.8	69	110	96	1		51	
H-11			089.452	.042	.83	.83	69	112	96	2		50	
H12		9:11	093.025	.080	1.5	1.5	69	110	96				
				VAC 10" LEAK .002									
			093.248	AFTER LEAK CHECK AND ART CHAG									

STOP PROCESS DOWN 8:45 RESTART 8:49

Plant Name: Automatic Die Casting Test Date: 4-19

Run Number: MM 13 B - 2 Operator: J. Blay, A. Kaisman

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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	Probe Temp °F
	60	9:26	093.248										
V-1	65		096.463	.055	1.1	1.1	67	92	91	1	~~52~~	52	
V-2	70		99.751	.065	1.3	1.3	67	92	91	2	~~50~~	50	
V-3	75		103.601	.071	1.4	1.4	66	92	90	2	~~49~~	49	
V-4	80		106.915	.077	1.4	1.4	67	94	90	2	~~51~~	51	
V-5	85		110.631	.081	1.6	1.6	68	98	90	2	~~52~~	52	
V-6	90		114.411	.084	1.6	1.6	68	101	90	3		52	
V-7	95		118.603	.110	2.2	2.2	67	104	90	5		52	
V-8	100		122.742	.104	2.0	2.0	67	106	90	4		53	
V-9	105		126.715	09.7	1.9	1.9	68	109	91	4		54	
V-10	110		131.282	.141	2.8	2.8	67	110	91	6		54	
V-11	115		135.135	.095	1.9	1.9	67	111	94	4		55	
V-12	120	10:26	137.363	.025	.49	.49	67	111	94	4		55	
			V_m=83.541	$\sqrt{\Delta P_{ave}}$=.273		ΔH_{ave}=1.45	$T_{s_{ave}}$=68°F	AVE=102°F	AVE=90°F				

SAMPLE RECOVERY DATA

Plant: AUTOMATIC DIE CASTING Run No.: MM13B-2

Date: 4-19-88 Sample Box No.: _____ Job No.: _____

Sample Location: SCRUBBER INLET

Sample Type: MM 13B Filter No.: _____

Sample Recovery Person: JRB - JRD

Comments: _____

FRONT HALF

Acetone Container No.: _____ Liquid Level Marked: _____ Sealed: _____

Filter Container No.: _____ _____ _____ Sealed: _____

Description of Filter: _____

Samples stored and locked: _____

BACK HALF/MOISTURE

Container No: MM 13B-2 _____ _____

Liquid Level Marked: ✓ Sealed: _____

IMP. NO.	CONTENTS	INITIAL VOL (ml)	WEIGHT (grams) INITIAL	FINAL	NET
1			567.0	570.0	3.0
2			569.2	570.9	1.7
3			449.8	450.6	0.8
4			647.3	663.2	15.9
5					
6					
TOTAL					21.4

Description of Impinger Catch: FIRST IMPINGER YELLOW

PES

EMISSION TEST CALCULATIONS

PLANT Automatic Die Casting SOURCE/RUN HM13B-2 DATE 5/6/88

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)

$$V_{m_{std}} = 17.64\ V_{m_c} Y \left(\frac{P_{bar} + \Delta H / 13.6}{T_m}\right) = 17.64\ (83.541)(.998)\frac{(29.29)+(1.45)/13.6}{(556)}$$

$V_{m_{std}}$ = 77.759 dscf

3. Volume Water Vapor Collected, Standard Conditions

Impingers = $V_{wc} = 0.04707\ (V_f - V_i) = 0.04707\ (5.5) = .2589$ scf

Silica Gel = $V_{wsg} = 0.04715\ (W_f - W_i) = 0.04715\ (15.9) = .7497$ scf

$V_{w_{std}} = V_{wc} + V_{wsg}$ = 1.009 scf

4. Percent Moisture, By Volume

$$B_{ws} = \frac{V_{w_{std}}}{V_{w_{std}} + V_{m_{std}}} = \frac{(1.009)}{(1.009)+(77.759)} = .0128\ (1.3\%)$$

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 = _____

$M_s = M_d\ (1-B_{ws}) + 18.0\ (B_{ws}) = (29)(1-.013) + 18.0\ (.013) = 28.86$ lb/lb-mole

6. Stack Gas Velocity, Average

$$V_{s_{avg}} = 85.49 C_p \left(\sqrt{\Delta P}\right)_{avg} \sqrt{\frac{T_s}{P_s M_s}} = 85.49\ (.84)(.273)\sqrt{\frac{(528)}{(29.17)(28.86)}}$$

$V_{s_{avg}}$ = 15.53 ft/s

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

$$Qa\,(\text{circular}) = \left(\frac{60 \times V_s\ (A_o(in))}{144}\right) = 60 \times V_s\ (\qquad)$$

$$= 60 \times 15.53\ \left(\frac{383.5}{144}\right)$$

"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 = 2481.6 acfm

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

$$Q_{std} = 17.64\, Q_a (1-B_{ws}) \left(\frac{P_s}{T_s}\right) = 17.64\ (2481.6)\ (1-.013)\ \left(\frac{29.17}{528}\right)$$

Q_{std} = 2387.0 dscfm

9. Isokinetic Variation

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

$$= 0.0944\ \frac{(528)\ (77.759)}{(29.17)\ (15.53)\ (7.29\times10^{-4})\ (120)\ (1-.013)}$$

= 99.09 %

EMISSION RATE CALCULATIONS

Plant Automatic Die Castin Run No. MH13B-2 Date 5/9/88

Parameter measured Cr^{+6}

Sample volume $V_{m\ std}$ 77.759 dscf
Sample concentration (C_s) 3.067 mg/ℓ
Blank concentration (C_b) 0 mg/ℓ
Solution volume (V_{sol}) .6661 ℓ
Volumetric flow rate Q_{std} ~~2384.K~~ 2387.0 ft^3/min

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

$$\frac{3.067}{\ell}\ \text{mg} - \frac{0}{\ell}\ \text{mg}\ (.6661\ \ell) = 2.027\ \text{mg}$$

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

$$\frac{(2.027\ \text{mg})\ \frac{0.0154\ \text{gr}}{\text{mg}}}{77.759\ \text{dscf}} = .0004\ \text{gr/dscf}$$

3. Emission rate (lb/hr):

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

$$\frac{(.0004\ \text{gr})}{\text{dscf}}\ \frac{1.43\times10^{-4}\ \text{lb}}{\text{gr}}\ \frac{(\overset{2387.0}{\cancel{2384.K}}\ \text{ft}^3)}{\text{min}}\ \frac{60\ \text{min}}{\text{hr}} = \overset{.0082}{\cancel{.0082}}\ \text{lb/hr}$$

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

$$\frac{(.0082}{\text{hr}}\ \text{lb})\ \frac{0.4539\ \text{kg}}{\text{lb}} = .0037\ \text{kg/hr}$$

FIELD DATA

Plant AUTOMATIC DIE CASTING
Date 4-17 Job No.
Sampling Location SCRUBBER INLET
Sample Type MM13B
Run Number MM13B-3
Operator J BLAU A. MEISMER
Ambient Temperature 71
Barometric Pressure 29.29
Static Pressure (P_s) -1.7
Filter Number(s)
Pretest Leak Rate = .001 cfm @ 10 in. Hg
Pretest Pitot Leak Check O.K
Pretest Orsat Leak Check
Read and Record all Data Every 5 Minutes

Schematic of Traverse Point Layout

Probe Length and Type 3' GLASS
Pitot Tube I.D. No. S-3 Cp .84
Nozzle I.D. | | | Avg. .365
Assumed Moisture, % 1.5
Temp. Readout S/N T-2
Meter Box Number MB-1
Meter $\Delta H_@$ 1.78
C Factor 1.03
Meter Gamma .998
Heater Box Setting —
Reference Δp .95
Post Test Leak Rate = .006 cfm @ 5 in. Hg
Post Test Pitot Leak Check O.K
Post Test Orsat Leak Check

Page ____ of ____ Temp. Sensor ID No.

Traverse Point Number	Sampling Time, (min)	Clock Time (24-hour clock)	Gas Meter Reading (V_m) ft³ (137.994)	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	Probe Temp °F
	0	11:57	137.994										
H-3	5		141.285	.061	1.15	1.15	71	81	81	1		50	
4	10		144.961	.081	1.5	1.5	70	85	85	1		42	
-3	15		147.921	.049	.94	.94	71	86	86	1		46	
H-2	20		151.205	.061	1.2	1.2	70	86	85	1		47	
H-5	25		154.003	.085	1.6	1.6	70	88	88	1		47	
H-6	30		157.951	.094	1.8	1.8	70	89	89	1		45	
H-7	35		163.110	.106	2.1	2.1	71	100	90	1		47	
H-8	40		166.811	.075	1.45	1.45	71	100	90	1		48	
H-9	45		170.762	.102	2.00	2.00	70	100	90	1		48	
H-10	50		174.665	.082	1.6	1.6	71	100	90	1		48	
H-11	55		177.921	.060	1.2	1.2	70	101	91	1		49	
H-12	60	12:57	180.617	.039	.75	.75	70	100	91	1		49	
				LEAK CHECK PRE & CHARGE									
			180.760	5" VAC.			003						

PACIFIC ENVIRONMENTAL SERVICES, INC.

Plant Name: AUTOMATIC DIE CASTING Test Date: 4-19-88

Run Number: MB13B-3 Operator: J. BLAU, A WAISMAN

Page 2 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	Probe Temp °F
	60	/14:05	180.760	.051									
V-1	65	/	183.820	.057	1.097	.97	69	82	86	1		50	
V-2	70	/	186.875	.059	1.0	1.0	69	86	86	1		52	
V-3	75	/	190.371	.069	1.3	1.3	70	92	86	1		51	
V-4	80	/	194.121	.082	1.6	1.6	69	92	87	1		51	
V-5	85	/	197.824	.080	1.5	1.5	69	96	88	1		50	
V-6	90	/	201.723	.092	1.8	1.8	69	99	90	1		51	
V-7	95	/	205.751	.098	1.9	1.9	70	100	90	1		52	
V-8	100	/	209.873	.104	2.0	2.0	70	98	90	1		52	
V-9	105	/	213.731	.083	1.7	1.7	70	99	90	1		52	
V-10	110	/	217.415	.074	1.4	1.4	67	96	89	1		52	
V-11	115	/	220.621	.061	1.1	1.1	67	94	89	1		52	
V-12	120	/ 15:08	222.899	.031	.60	.60	69	92	88	1		53	
		/											
		/	V_m=84.762	$\sqrt{\Delta P_{avg}}$=.269		ΔH_{avg}=1.42	T_s=70°F	$T_{m_{avg}}$=95°F	88°F				

SAMPLE RECOVERY DATA

Plant: Automatic Die Casting Run No.: MM13-B-3

Date: 4/19/88 Sample Box No.: RAC-1 Job No.: _____

Sample Location: Scrubber inlet

Sample Type: MM13B Filter No.: _____

Sample Recovery Person: HJO

Comments: _____

FRONT HALF

Acetone Container No.: _____ Liquid Level Marked: _____ Sealed: _____

Filter Container No.: _____ _____ _____ Sealed: _____

Description of Filter: _____

Samples stored and locked: _____

BACK HALF/MOISTURE

Container No: MM13D-3 _____ _____

Liquid Level Marked: YES Sealed: _____

IMP. NO.	CONTENTS	INITIAL VOL (ml)	WEIGHT (grams) INITIAL	FINAL	NET
1			542.7	546.9	4.2
2			570.8	572.6	1.8
3			479.1	480.2	1.1
4			730.3	747.0	16.7
5					
6					
TOTAL					23.8

Description of Impinger Catch: Yellow

PES

EMISSION TEST CALCULATIONS

PLANT Automatic Die Casting SOURCE/RUN MH13B-3 DATE 5/6/88

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)

$$V_{m_{std}} = 17.64\ V_{m_c} Y \left(\frac{P_{bar} + \Delta H / 13.6}{T_m}\right) = 17.64\ (84.762)(.998)\frac{(29.29)+(1.42)/1}{(552)}$$

$V_{m_{std}} =$ 79.461 dscf

3. Volume Water Vapor Collected, Standard Conditions

Impingers $= V_{wc} = 0.04707\ (V_f - V_i) = 0.04707\ (7.1) =$ .3342 scf

Silica Gel $= V_{wsg} = 0.04715\ (W_f - W_i) = 0.04715\ (16.7) =$ .7874 scf

$V_{w_{std}} = V_{wc} + V_{wsg} =$ 1.122 scf

4. Percent Moisture, By Volume

$$B_{ws} = \frac{V_{w_{std}}}{V_{w_{std}} + V_{m_{std}}} = \frac{(1.122)}{(1.122)+(79.461)} = 0.0139\ (1.4\%)$$

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 =

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

%EA = _____

$M_s = M_d\ (1-B_{ws}) + 18.0\ (B_{ws}) = (29)(1-.014) + 18.0\ (.014) =$ 28.85 lb/lb-mole

6. Stack Gas Velocity, Average

$$V_{s_{avg}} = 85.49 C_p \left(\sqrt{\Delta P}\right)_{avg} \sqrt{\frac{T_s}{P_s M_s}} = 85.49\ (.84)(.269)\sqrt{\frac{(530)}{(29.17)(28.85}}$$

$V_{s_{avg}}$ = 15.33 ft/s

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

$$Qa(\text{circular}) = \left(\frac{60 \times V_s\ (\quad)}{144}\right) = 60 \times V_s \left(\frac{A_o\ (in^2)}{144}\right)$$

$$= 60 \times 15.33 \left(\frac{383.5}{144}\right)$$

"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 = 2449.6 acfm

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

$$Q_{std} = 17.64\, Q_a (1-B_{ws}) \left(\frac{P_s}{T_s}\right) = 17.64\ (2449.6)\ (1-.014)\ \left(\frac{29.17}{530}\right)$$

Q_{std} = 2344.9 dscfm

9. Isokinetic Variation

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

$$= 0.0944 \frac{(530)\ (79.461)}{(29.17)\ (15.33)\ (7.24 \times 10^{-4})\ (120)\ (1-.014)}$$

= 103.07 %

EMISSION RATE CALCULATIONS

Plant Automatic Die Casting Run No. MM13B-3 Date 5/9/88

Parameter measured Cr^{+6}

Sample volume $V_{m\ std}$ 79.461 dscf
Sample concentration (C_s) 4.015 mg/ℓ
Blank concentration (C_b) 0 mg/ℓ
Solution volume (V_{sol}) .557 ℓ
Volumetric flow rate Q_{std} ~~2342.1~~ 2344.9 ft^3/min

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

$$\frac{4.015}{\ell}\ \text{mg} - \frac{0}{\ell}\ \text{mg}\ (.557\ \ell) = 2.236\ \text{mg}$$

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

$$\frac{(2.236\ \text{mg})\ \frac{0.0154\ \text{gr}}{\text{mg}}}{79.461\ \text{dscf}} = .0004\ \text{gr/dscf}$$

3. Emission rate (lb/hr):

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

$$\frac{(.0004\ \text{gr})}{\text{dscf}}\ \frac{1.43\times10^{-4}\ \text{lb}}{\text{gr}}\ \frac{(\cancel{2342.1}\ 2344.9\ \text{ft}^3)}{\text{min}}\ \frac{60\ \text{min}}{\text{hr}} = \cancel{.0087}\ .0080\ \text{lb/hr}$$

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

$$\frac{(\cancel{.0087}\ .0080\ \text{lb})}{\text{hr}}\ \frac{0.4539\ \text{kg}}{\text{lb}} = \cancel{.0040}\ .0037\ \text{kg/hr}$$

FIELD DATA

Plant: Automatic Die Casting
Date: 4-20-88 Job No.:
Sampling Location: Scrubber Inlet
Sample Type: MM13B
Run Number: MM13B-4
Operator: J. Blau A. Weisman
Ambient Temperature: 72
Barometric Pressure: 29.31
Static Pressure (P_s): -1.7
Filter Number(s):
Pretest Leak Rate = .003 cfm @ 11 in. Hg
Pretest Pitot Leak Check: 0.K
Pretest Orsat Leak Check:
Read and Record all Data Every 4 Minutes
Port Change 8

Schematic of Traverse Point Layout

Probe Length and Type: 3' Glass
Pitot Tube I.D. No.: S-1 Cp: .84
Nozzle I.D.: | | | Avg. .366
Assumed Moisture, %: 1.5
Temp. Readout S/N: T-1
Meter Box Number: MB-1
Meter $\Delta H_@$: 1.78
C Factor:
Meter Gamma: .998
Heater Box Setting:
Reference Δp: .95
Post Test Leak Rate = .004 cfm @ 4 in. Hg
Post Test Pitot Leak Check: 0.K
Post Test Orsat Leak Check:

Page 1 of 2

Temp. Sensor ID No.

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	Probe Temp °F
	0	9:32	223.770										
H-1	4		225.850	.026	.49	.49	70	80	80	1		55	
	8		227.231	.026	.49	.49	70	86	84	1		49	
H-2	12		229.176	.036	.69	.69	69	88	90	1		41	
	16		231.395	.040	.77	.77	67	90	90	1		41	
H-3	20		233.785	.053	1.02	1.02	67	92	90	1		41	
	24		236.363	.057	1.1	1.1	66	96	90	1		42	
H-4	28		239.301	.077	1.5	1.5	69	96	90	1		42	
	32		242.313	.081	1.6	1.6	69	98	90	1		43	
H-5	36		245.221	.086	1.7	1.7	69	100	90	1		45	
	40		248.515	.086	1.7	1.7	70	101	90	1		44	
H-6	44		251.692	.088	1.7	1.7	70	102	90	1		46	
	48		254.763	.086	1.7	1.7	70	104	90	1		45	
H-7	52		257.906	.088	1.7	1.7	69	104	91	1		47	
	56		261.053	.093	1.8	1.8	68	104	91	1		47	
H-8	60	10:32	264.405	.099	1.9	1.9	69	104	91	1		47	
	64		267.530	.095	1.9	1.9	68	104	92	1		47	
H-9	68		270.891	.101	2.0	2.0	68	102	92	1		47	
	72		274.153	.104	2.0	2.0	68	104	91	1		47	
H-10	76		276.910	.065	1.3	1.3	68	104	92	1		48	
	80			.063	1.2	1.2	68	102	91	1		49	

PACIFIC ENVIRONMENTAL SERVICES, INC.

Plant Name: AUTOMATIC DIE CASTING Test Date: 4-20-88

Run Number: MM13 B-4 Operator: J. BLAU

Page 2 of 2

Traverse Point Number	Sampling Time, (min) / Clock (24-hour clock)	Gas Meter Reading (V_m) ft³	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	Probe Temp °F
	80 / 10:52	279.546										
H-11	84 /	282.013	.055	1.1	1.1	66	102	90	1		46	
	88 /	284.562	.057	1.1	1.1	66	98	90	1		46	
H-12	92 /	286.711	.040	.77	.77	68	96	90	1		46	
	96 / 11:08	288.891	.042	.81	.81	69	96	90	1		46	
	PORT CHANGE	LEAK	CHECK	5"	VAC	=	001					
	96 / 11:35	289.041										
V-1	100 /	291.710	.063	1.2	1.2	71	85	88	1		58	
	8 104 /	294.251	.058	1.1	1.1	70	90	90	1		50	
V-2	12 108 /	296.781	.055	1.1	1.1	71	96	91	1		46	
	16 112 /	299.113	.053	1.0	1.0	71	98	92	1		46	
V-3	20 116 /	301.865	.061	1.2	1.2	70	99	92	1		46	
	24 120 /	304.666	.059	1.2	1.2	68	99	92	1		48	
V-4	28 124 /	307.983	.068	1.3	1.3	68	99	92	1		48	
	32 128 /	310.020	.069	1.3	1.3	68	99	92	1		48	
V-5	36 132 /	313.038	.074	1.5	1.5	67	99	92	1		48	
	40 136 /	316.009	.077	1.5	1.5	67	98	91	1		49	
V-6	44 140 /	319.185	.087	1.7	1.7	66	99	91	1		48	
	48 144 /	322.315	.093	1.8	1.8	66	98	90	1		49	
V-7	52 148 /	325.549	.107	1.9	1.9	67	99	91	1		49	
	56 152 /	328.945	.108	2.1	2.1	66	99	90	1		49	
V-8	60 156 /	332.354	.110	2.14	2.14	67	100	90	1		50	
	4 160 /	335.640	.107	2.0	2.0	68	100	90	1		50	
V-9	8 164 /	338.891	.096	1.9	1.9	68	101	90	1		52	
	12 168 /	342.061	.097	1.9	1.9	68	104	90	1		53	
V-10	16 172 /	345.106	.085	1.7	1.7	69	104	91	1		53	
	20 176 /	348.183	.081	1.6	1.6	68	104	91	1		54	
V-11	24 180 /	351.201	.081	1.6	1.6	67	102	91	1		54	
	28 184 /	354.241	.083	1.6	1.6	66	100	91	1		53	
V-12	32 188 /	357.013	.073	1.4	1.4	66	100	92	1		54	
	36 192 / 13:11	359.874	.071	1.4	1.4	69	98	91	1		54	
	/	V_m=135.954	$\sqrt{\Delta P}$= .269		ΔH=1.44	T_s=68°F	T_m=98°F	T_m=90°F				

SAMPLE RECOVERY DATA

Plant: Atlantic Die Casting Run No.: MM-13B-4

Date: 4-19- Sample Box No.: RAC-1 Job No.: _____

Sample Location: _____

Sample Type: _____ Filter No.: _____

Sample Recovery Person: _____

Comments: _____

FRONT HALF

Acetone Container No.: _____ Liquid Level Marked: _____ Sealed: _____

Filter Container No.: _____ _____ _____ Sealed: _____

Description of Filter: _____

Samples stored and locked: _____

BACK HALF/MOISTURE

Container No: _____ _____ _____

Liquid Level Marked: _____ Sealed: _____

IMP. NO.	CONTENTS	INITIAL VOL (ml)	WEIGHT (grams) INITIAL	FINAL	NET
1		100ml	541.9	540.4	-1.5
2		100ml	573.5	575.0	1.5
3		MT	481.1	482.3	1.2
4		silcal	747.0	772.8	25.8
5					
6					
TOTAL					27.0

Description of Impinger Catch: _____

PES

EMISSION TEST CALCULATIONS

PLANT Automatic Die Casting SOURCE/RUN MH13B-4 DATE 5/6/88

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)

$$V_{m_{std}} = 17.64\ V_{m_c} Y \left(\frac{P_{bar} + \Delta H / 13.6}{T_m}\right) = 17.64\ (134.954)(.998)\ \frac{(29.31)+(1.44)/}{(554)}$$

$V_{m_{std}} =$ 126.150 dscf

3. Volume Water Vapor Collected, Standard Conditions

Impingers = $V_{wc} = 0.04707\ (V_f - V_i) = 0.04707\ (1.2) =$ .0565 scf

Silica Gel = $V_{wsg} = 0.04715\ (W_f - W_i) = 0.04715\ (25.8) =$ 1.2165 scf

$V_{w_{std}} = V_{wc} + V_{wsg} =$ 1.273 scf

4. Percent Moisture, By Volume

$$B_{w_s} = \frac{V_{w_{std}}}{V_{w_{std}} + V_{m_{std}}} = \frac{(1.273)}{(1.273)+(126.150)} = .0100\ (1.0\%)$$

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 = _____

$M_s = M_d\ (1-B_{ws}) + 18.0\ (B_{ws}) = (29.0)(1-.010) + 18.0\ (.010) =$ 28.89 lb/lb-mole

6. Stack Gas Velocity, Average

$$V_{s_{avg}} = 85.49 C_p \left(\sqrt{\Delta P}\right)_{avg} \sqrt{\frac{T_s}{P_s M_s}} = 85.49\ (.84)(.269)\sqrt{\frac{(528)}{(29.19)(28.89)}}$$

$V_{s_{avg}}$ = 15.29 ft/s

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

$$Q_a(\text{circular}) = \left(\frac{60 \times V_s\ (\quad)}{144}\right) = 60 \times V_s \left(\frac{A_o\,(in^2)}{144}\right)$$

$$= 60 \times 15.29 \left(\frac{\cancel{383.04e}\ 383.5}{144}\right)$$

"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 = ~~2439.63~~ 2443.2 acfm

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

$$Q_{std} = 17.64\, Q_a (1-B_{ws}) \left(\frac{P_s}{T_s}\right) = 17.64\ (\cancel{2439.63}\ 2443.2)\ (1-.010)\left(\frac{29.19}{528}\right)$$

Q_{std} = ~~2355.27e~~ 2358.9 dscfm

9. Isokinetic Variation

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

$$= 0.0944 \frac{(528)\ (126.150)}{(29.19)\ (15.29)\ (7.29 \times 10^{-4})\ (192)\ (1-.010)}$$

= 101.67 %

EMISSION RATE CALCULATIONS

Plant Automatic Die Casting Run No. MH13B-4 Date 5/9/88

Parameter measured Cr^{+6}

Sample volume $V_{m\ std}$ 126.150 dscf
Sample concentration (C_s) .024 mg/ℓ
Blank concentration (C_b) .002 mg/ℓ
Solution volume (V_{sol}) .531 ℓ
Volumetric flow rate Q_{std} ~~2355.32~~ 2358.9 ft^3/min

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

$$\frac{.024}{\ell}\ \text{mg} - \frac{.002}{\ell}\ \text{mg}\ (.531\ \ell) = .012\ \text{mg}$$

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

$$\frac{(.012\ \text{mg})\ \dfrac{0.0154\ \text{gr}}{\text{mg}}}{126.150\ \text{dscf}} = 1.43\times10^{-6}\ \text{gr/dscf}$$

3. Emission rate (lb/hr):

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

$$\frac{(1.43\times10^{-6}\ \text{gr})}{\text{dscf}}\ \frac{1.43\times10^{-4}\ \text{lb}}{\text{gr}}\ \frac{(\cancel{2355.32}\ 2358.9\ \text{ft}^3)}{\text{min}}\ \frac{60\ \text{min}}{\text{hr}} = \cancel{2.88\times10^{-5}}\ 2.89\times10^{-5}\ \text{lb/hr}$$

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

$$\frac{(\cancel{2.88\times10^{-5}}\ 2.89\times10^{-5}\ \text{lb})}{\text{hr}}\ \frac{0.4539\ \text{kg}}{\text{lb}} = 1.31\times10^{-5}\ \text{kg/hr}$$

FIELD DATA

Plant: Automatic Die Casting
Date: 4-20-88 Job No.:
Sampling Location: Scrubber Inlet
Sample Type: MM 13 B
Run Number: MM 13 B-5
Operator: J. Blau, A. Wasman
Ambient Temperature: 73
Barometric Pressure: 29.19
Static Pressure (P_s): -1.7
Filter Number(s): —
Pretest Leak Rate = .001 cfm @ 8 in. Hg
Pretest Pitot Leak Check: O.K.
Pretest Orsat Leak Check:
Read and Record all Data Every ___ Minutes

Schematic of Traverse Point Layout

Probe Length and Type: 3' Glass
Pitot Tube I.D. No.: S-1 Cp: .84
Nozzle I.D.: | | | Avg.: .361
Assumed Moisture, %: 1.5
Temp. Readout S/N: T-2
Meter Box Number: MB-1
Meter $\Delta H_@$: 1.78
C Factor: 1.03
Meter Gamma: .998
Heater Box Setting: —
Reference Δp: .95
Post Test Leak Rate = .003 cfm @ 7 in. Hg
Post Test Pitot Leak Check: O.K.
Post Test Orsat Leak Check:

Page 1 of 2

Temp. Sensor ID No.

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	Probe Temp °F
	0	14:15	360.040										
H 1	5		363.36	.057	1.1	1.1	65	88	88	2		57	
2	10		366.220	.047	.91	.91	66	96	90	1		47	
3	15		369.865	.074	1.4	1.4	65	93	90	3		49	
4	20		373.624	.086	1.7	1.7	65	96	90	3		50	
5	25		377.541	.090	1.8	1.8	65	97	91	4		51	
6	30		381.480	.092	1.8	1.8	65	98	90	4		50	
7	35		385.256	.081	1.6	1.6	65	98	90	4		50	
8	40		389.115	.086	1.7	1.7	65	98	90	4		50	
9	45		392.963	.081	1.6	1.6	65	98	90	4		50	
10	50		396.365	.059	1.2	1.2	64	98	90	2		50	
11	55		399.100	.042	.82	.82	65	97	90	1		49	
12	60	15:15	401.955	.043	.84	.84	65	96	90	1		49	
	Post Check		Leak Check			8" HAC			.003				
			401.982	Orifice Leak Check									

PACIFIC ENVIRONMENTAL SERVICES, INC.

Plant Name: Automatic Die Casting Test Date: 4-20

Run Number: MM13B-5 Operator: J. BLAU

Page 2 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	Probe Temp °F
	60	/ 15:29	402.982										
V-1	65	/	405.365	.050	9.8	9.8	71	86	86	1		49	
2	70	/	408.425	.053	1.01	1.01	70	86	84	1		48	
3	75	/	411.840	.067	1.3	1.3	71	98	90	2		50	
4	80	/	415.391	.072	1.4	1.4	70	104	90	3		52	
5	85	/	419.113	.080	1.6	1.6	70	107	91	3		52	
6	90	/	422.965	.088	1.7	1.7	71	110	94	3		52	
7	95	/	427.235	.109	2.1	2.1	71	112	96	5		52	
8	100	/	431.517	.112	2.2	2.2	71	112	96	5		53	
9	105	/	435.765	.103	2.0	2.0	71	112	92	5		52	
10	110	/	439.529	.095	1.7	1.7	68	110	95	4		52	
11	115	/	443.461	.083	1.6	1.6	67	106	96	4		53	
12	120	/ 16:29	446.683	.061	1.1	1.1	66	104	92	4		53	
		/											
		/											
		/	V_m=86.516	$\sqrt{\Delta P}$=.271		ΔH=1.46	T_s=65°F	IN T_m=100°F	OUT T_m=91				

8-29

PES

SAMPLE RECOVERY DATA

Plant: Automatic Die Casting Run No.: MM13B-5

Date: _____ Sample Box No.: RAC-1 Job No.: _____

Sample Location: Scrubber Inlet

Sample Type: MM13B Filter No.: _____

Sample Recovery Person: HO - JRB

Comments: _____

FRONT HALF

Acetone Container No.: _____ Liquid Level Marked: _____ Sealed: _____

Filter Container No.: _____ _____ _____ Sealed: _____

Description of Filter: _____

Samples stored and locked: _____

BACK HALF/MOISTURE

Container No: _____ _____ _____

Liquid Level Marked: _____ Sealed: _____

IMP. NO.	CONTENTS	INITIAL VOL (ml)	WEIGHT (grams) INITIAL	FINAL	NET
1			569.1	569.7	0.6
2			571.1	572.0	0.9
3			449.9	450.9	1.0
4			663.2	677.7	14.5
5					
6					
TOTAL					17.0

Description of Impinger Catch: _____

PES

EMISSION TEST CALCULATIONS

PLANT Automatic DieCasting SOURCE/RUN MM13B-5 DATE 5/6/88

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)

$$V_{m_{std}} = 17.64\ V_{m_c} Y \left(\frac{P_{bar} + \Delta H / 13.6}{T_m}\right) = 17.64\ (86.516)(.998)\frac{(29.19)+(1.46)/1}{(556)}$$

$V_{m_{std}}$ = 80.256 dscf

3. Volume Water Vapor Collected, Standard Conditions

Impingers = $V_{wc} = 0.04707\ (V_f - V_i) = 0.04707\ (2.5) =$ ~~0.118~~ .1177 scf

Silica Gel = $V_{wsg} = 0.04715\ (W_f - W_i) = 0.04715\ (14.5) =$ .6837 scf

$V_{w_{std}} = V_{wc} + V_{wsg} =$ 0.8014 scf

4. Percent Moisture, By Volume

$$B_{w_s} = \frac{V_{w_{std}}}{V_{w_{std}} + V_{m_{std}}} = \frac{(.8014)}{(.8014)+(80.256)} = .0099\ (.99\%)$$

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 = _____

$M_s = M_d\ (1-B_{ws}) + 18.0\ (B_{ws}) = (29.0)(1-.0099) + 18.0\ (.0099) =$ 28.89 lb/lb-mole

6. Stack Gas Velocity, Average

$$V_{s_{avg}} = 85.49 C_p \left(\sqrt{\Delta P}\right)_{avg} \sqrt{\frac{T_s}{P_s M_s}} = 85.49\ (.84)(.271)\sqrt{\frac{(525)}{(29.07)(28.89)}}$$

$V_{s_{avg}}$ = 15.39 ft/s

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

$$Q_a(\text{circular}) = \left(\frac{60 \times V_s\ (\quad)}{144}\right) = 60 \times V_s \left(\frac{A_o\ (in^2)}{144}\right)$$

$$= 60 \times 15.39 \left(\frac{383.5}{\cancel{383.04e}}\right)$$

"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 = 2459.2 ~~2455.73e~~ acfm

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

$$Q_{std} = 17.64\, Q_a (1-B_{ws}) \left(\frac{P_s}{T_s}\right) = 17.64\ (2459.2)\ (1-.0099)\left(\frac{29.07}{525}\right)$$

Q_{std} = 2378.2 ~~2374.66~~ dscfm

9. Isokinetic Variation

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

$$= 0.0944 \frac{(525)(80.256)}{(29.07)(15.39)(7.29 \times 10^{-4})(120)(1-.0099)}$$

= 102.64 %

EMISSION RATE CALCULATIONS

Plant Automatic Die Casting Run No. MM13-5 Date 5/9/88

Parameter measured Cr^{+6}

Sample volume $V_{m\ std}$ 80.256 dscf
Sample concentration (C_s) .021 mg/ℓ
Blank concentration (C_b) .002 mg/ℓ
Solution volume (V_{sol}) .624 ℓ
Volumetric flow rate Q_{std} ~~2374.4~~ 2378.2 ft^3/min

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

$$\frac{.021}{\ell}\ \text{mg} - \frac{.002}{\ell}\ \text{mg}\ (.624\ \ell) = .012\ \text{mg}$$

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

$$\frac{(.012\ \text{mg})\ \frac{0.0154\ \text{gr}}{\text{mg}}}{90.256\ \text{dscf}} = 2.30\times10^{-6}\ \text{gr/dscf}$$

3. Emission rate (lb/hr):

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

$$\frac{(2.30\times10^{-6}\ \text{gr})}{\text{dscf}}\ \frac{1.43\times10^{-4}\ \text{lb}}{\text{gr}}\ \frac{(\cancel{2374.4}\ 2378.2\ \text{ft}^3)}{\text{min}}\ \frac{60\ \text{min}}{\text{hr}} = 4.69\times10^{-5}\ \text{lb/hr}$$

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

$$\frac{(4.69\times10^{-5}\ \text{lb})}{\text{hr}}\ \frac{0.4539\ \text{kg}}{\text{lb}} = 2.13\times10^{-5}\ \text{kg/hr}$$

FIELD DATA

Plant Automatic Die Casting
Date 4-27-88 Job No.
Sampling Location Scrubber Inlet
Sample Type MM13B
Run Number MM13 B-6
Operator J. Olau, A. Weisman
Ambient Temperature 72
Barometric Pressure 29.35/29.37
Static Pressure (P_s) -1.7
Filter Number(s)
Pretest Leak Rate = .001 cfm @ 15 in. Hg
Pretest Pitot Leak Check O.K.
Pretest Orsat Leak Check
Read and Record all Data Every 5 Minutes
Portchamber 10 Min.

Schematic of Traverse Point Layout

Probe Length and Type 3' Glass
Pitot Tube I.D. No. S-1 Cp .84
Nozzle I.D. .496 | .498 | .498 | Avg. .497
Assumed Moisture, %
Temp. Readout S/N T-2
Meter Box Number MB-1
Meter $\Delta H_@$ 1.90
C Factor 1.9
Meter Gamma .998
Heater Box Setting —
Reference Δp .021
Post Test Leak Rate = .002 cfm @ 9 in. Hg
Post Test Pitot Leak Check
Post Test Orsat Leak Check

Page 1 of Temp. Sensor ID No.

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	Probe Temp °F
	0	10:10	447.546				70	76	76	1		58	
H-1	5		452.11	.038	2.6	2.6	70	82	70	1		48	
	10		456.11	.040	2.75	2.75	70	88	76	1		51	
H-2	15		461.97	.052	3.6	3.6	70	96	80	1		53	
	20		467.49	.054	3.8	3.8	70	100	81	1		54	
H-3	25		474.04	.073	5.1	5.1	70	106	84	1		55	
	30		479.71	.073	5.2	5.2	70	110	88	1		55	
H-4	35		487.82	.079	5.6	5.6	71	112	91	2		56	
	40		494.23	.075	5.4	5.4	71	114	91	2		56	
H-5	45		501.27	.083	6.0	6.0	70	117	92	2		57	
	50		508.34	.085	6.1	6.1	71	117	94	2		57	
H-6	55		515.51	.085	6.1	6.1	71	116	96	2		58	
	60	11:10	522.64	.088	6.3	6.3	71	118	98	2		59	
H-7	65		529.7	.089	6.4	6.4	71	118	100	2		58	
	70		536.91	.086	6.2	6.2	72	116	99	2		59	
H-8	75		543.93	.081	5.9	5.9	71	116	99	2		59	
	80		550.11	.078	5.6	5.6	70	106	96	2		59	
H-9	85		557.57	.071	5.0	5.0	68	102	96	1		54	
	90		563.90	.066	4.8	4.8	67	106	96	1		55	
H-10	95		569.93	.062	4.5	4.5	68	110	96	1		53	
				.057	4.1	4.1	69	112	96				

PACIFIC ENVIRONMENTAL SERVICES, INC.

Plant Name: AUTOMATIC DIE CASTING Test Date: 4-21-88

Run Number: MM13B-6 Operator: J. ALAN

Page 2 of

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	Probe Temp °F
	100	111:55	575.88										
H-11	105	/	581.93	.035	4.0	4.0	69	110	98	1		53	
	110	/	586.24	.049	3.5	3.5	70	111	96	1		53	
H-12	115	/	592.51	.048	3.4	3.4	70	110	94	1		53	
	120	112:15	597.536	.044	3.2	3.2	70	110	96	1		53	
	PORT CHANGE			LEAK CHECK	4" VAC		.002						
		113:13	597.698										
V1	125	/ ~~113~~	602.68	.045	3.1	3.1	72	84	84	1		61	
	130	/	607.76	.046	3.2	3.2	73	94	89	1		49	
V2	135	/	613.25	.053	3.7	3.7	72	101	90	1		48	
	140	/	619.91	.056	4.0	4.0	71	104	90	1		52	
V3	145	/	625.13	.063	4.5	4.5	71	106	90	1		51	
	150	/	631.13	.060	4.3	4.3	71	105	92	1		52	
V4	155	/	637.79	.072	5.1	5.1	71	107	93	1		51	
	160	/	644.65	.074	5.3	5.3	70	108	92	1		52	
V-5	165	/	651.58	.082	5.9	5.9	71	109	93	1		52	
	170	/	659.60	.084	6.0	6.0	71	110	94	1		52	
V-6	175	/	665.76	.092	6.6	6.6	71	111	94	1		53	
	180	/	673.10	.094	6.8	6.8	70	112	95	1		52	
V-7	185	/	680.33	.099	7.1	7.1	71	111	96	2		52	
	190	/	686.39	.092	6.6	6.6	71	111	95	2		52	
V-8	195	/	694.64	.095	6.8	6.8	69	111	96	2		53	
	200	/	700.74	.093	6.7	6.7	70	111	96	2		53	
V-9	205	/	709.26	.107	7.7	7.7	71	112	96	2		52	
~~V-9~~	210	/	716.670	.104	7.5	7.5	71	111	96	3		53	
V-10	215	/	723.71	.088	6.3	6.3	72	111	96	3		53	
	220	/	730.75	.084	6.0	6.0	72	111	95	3		53	
V-11	225	/	737.05	.065	4.7	4.7	71	110	95	2		55	
	230	/	743.40	.069	4.9	4.9	71	109	95	2		54	
V-12	235	/	750.34	.081	5.8	5.8	69	110	94	2		53	
	240	115:13	757.420	.086	6.2	6.2	71	110	95	3			
		/	V_m=309.712	$\sqrt{\Delta P}$=0.268		ΔH=5.2	T_s=70°F	$T_{m_{in}}$=107°F	$T_{m_{out}}$=92°F				

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SAMPLE RECOVERY DATA

Plant: Auto Matic Die Castings Run No.: MM 13B-6

Date: 4-20-88 Sample Box No.: _____ Job No.: _____

Sample Location: Scrubber Inlet

Sample Type: MM 13B Filter No.: _____

Sample Recovery Person: J. Blau

Comments: 4 hr. Test 309.

FRONT HALF

Acetone Container No.: _____ Liquid Level Marked: _____ Sealed: _____

Filter Container No.: _____ _____ _____ Sealed: _____

Description of Filter: _____

Samples stored and locked: _____

BACK HALF/MOISTURE

Container No: MM13B-6 _____ _____

Liquid Level Marked: YES Sealed: YES

IMP. NO.	CONTENTS	INITIAL VOL (ml)	WEIGHT (grams) INITIAL	FINAL	NET
1			544.6	542.9	-1.7
2			575.3	588.6	13.3
3	MT		460.7	486.5	5.8
4	Silcagel		694.5	749.3	54.8
5					
6					
TOTAL					72.2

Description of Impinger Catch: CLEAR

PES

EMISSION TEST CALCULATIONS

PLANT Automatic Die Casting SOURCE/RUN MM13B-6 DATE 5/9/88

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)

$$V_{m_{std}} = 17.64\ V_{m_c} Y \left(\frac{P_{bar} + \Delta H / 13.6}{T_m}\right) = 17.64\ (309.712)(0.998)\frac{(29.37) + (5.2)/13.6}{(560)}$$

$V_{m_{std}} =$ 289.681 dscf

3. Volume Water Vapor Collected, Standard Conditions

Impingers = $V_{wc} = 0.04707\ (V_f - V_i) = 0.04707\ (17.4) =$ 0.819 scf

Silica Gel = $V_{wsg} = 0.04715\ (W_f - W_i) = 0.04715\ (548) =$ 2.584 scf

$V_{w_{std}} = V_{wc} + V_{wsg} =$ 3.403 scf

4. Percent Moisture, By Volume

$$B_{ws} = \frac{V_{w_{std}}}{V_{w_{std}} + V_{m_{std}}} = \frac{(3.403)}{(3.403) + (289.681)} = 0.0116\ (1.2\%)$$

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 =

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

%EA = _____

$M_s = M_d\ (1 - B_{ws}) + 18.0\ (B_{ws}) = (29.0)(1 - .012) + 18.0\ (.012) =$ 28.87 lb/lb-mole

PES

6. Stack Gas Velocity, Average

$$V_{s_{avg}} = 85.49 C_p \left(\sqrt{\Delta P}\right)_{avg} \sqrt{\frac{T_s}{P_s M_s}} = 85.49\ (.84)\ (.268) \sqrt{\frac{(530)}{(29.25)(28.87)}}$$

$V_{s_{avg}}$ = 15.25 ft/s

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

$$Qa\,(circular) = \left(\frac{60 \times V_s\ (\quad)}{144}\right) = 60 \times V_s \left(\frac{A_o\,(in^2)}{144}\right)$$

$$= 60 \times 15.25 \left(\frac{383.5}{144}\right)$$

"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 = 2436.8 acfm

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

$$Q_{std} = 17.64\, Q_a (1-B_{ws}) \left(\frac{P_s}{T_s}\right) = 17.64\ (2436.8)\ (1-.0116)\ \left(\frac{29.25}{530}\right)$$

Q_{std} = 2344.8 dscfm

9. Isokinetic Variation

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

$$= 0.0944 \frac{(530)\ (289.681)}{(29.25)\ (15.25)\ (13.47 \times 10^{-4})\ (240)\ (1-.0116)}$$

= 101.7 %

EMISSION RATE CALCULATIONS

Plant Automatic Die Casting Run No. MM13B-6 Date 5/9/88

Parameter measured Cr^{+6}

Sample volume $V_{m\ std}$ 289.681 dscf
Sample concentration (C_s) .031 (N/D) mg/ℓ .057 (imp.)
Blank concentration (C_b) 0 mg/ℓ
Solution volume (V_{sol}) .150 (N/D) ℓ .464 ℓ (imp.)
Volumetric flow rate Q_{std} ~~2344.5~~ 2344.8 ft^3/min

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

$\frac{.031}{\ell}$ mg − $\frac{0}{\ell}$ mg (.150 ℓ) = .0047 mg

$\frac{.057}{\ell}$ mg − $\frac{0}{\ell}$ mg (.464 ℓ) = .026 mg

Total mg = .031

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

$\frac{(.031\ mg)\ \frac{0.0154\ gr}{mg}}{289.681\ dscf} = 1.65 \times 10^{-6}$ gr/dscf

3. Emission rate (lb/hr):

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

$\frac{(1.65 \times 10^{-6}\ gr)}{dscf}\ \frac{1.43 \times 10^{-4}\ lb}{gr}\ \frac{(\cancel{2344.5}\ 2344.8\ ft^3)}{min}\ \frac{60\ min}{hr} = \cancel{3.31 \times 10^{-5}}\ 3.32 \times 10^{-5}$ lb/hr

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

$\frac{(\cancel{3.31 \times 10^{-5}}\ 3.32 \times 10^{-5}\ lb)}{hr}\ \frac{0.4539\ kg}{lb} = \cancel{1.50 \times 10^{-5}}\ 1.51 \times 10^{-5}$ kg/hr

FIELD DATA

Plant AUTOMATIC DIE CASTING
Date 4-25-88 Job No.
Sampling Location SCRUBBER INLET
Sample Type MM13D
Run Number MM13B-7
Operator S. BLAU, A. WEISBERG
Ambient Temperature 71
Barometric Pressure 29.52
Static Pressure (P_s) -1.7
Filter Number(s)
Pretest Leak Rate = .001 cfm @ 12 in. Hg
Pretest Pitot Leak Check O.K
Pretest Orsat Leak Check
Read and Record all Data Every 5 Minutes
PORT CHANGE 10

Schematic of Traverse Point Layout

Probe Length and Type 3' Pyrex Glass
Pitot Tube I.D. No. S-1 Cp .84
Nozzle I.D. | | | Avg. .497
Assumed Moisture, % 1
Temp. Readout S/N S-2
Meter Box Number MB-1
Meter $\Delta H_@$ 1.90
C Factor 1.18
Meter Gamma .998
Heater Box Setting —
Reference Δp .025
Post Test Leak Rate = .004 cfm @ 13 in. Hg
Post Test Pitot Leak Check O.K
Post Test Orsat Leak Check —

Page ____ of ____ Temp. Sensor ID No.

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	Probe Temp °F
	0	14:58	757.772										
H-1	5		761.38	.024	1.65	1.65	70	90	80	1		47	
	10		765.35	.027	1.88	1.88	70	90	84	1		44	
H-2	15		771.23	.056	3.75	3.75	70	99	88	4		45	
	20		777.22	.060	4.3	4.3	71	107	90	6		46	
H-3	25		784.18	.080	5.7	5.7	72	112	92	9		48	
	30		791.24	.084	6.0	6.0	73	116	94	10/00		49	
H-4	35		798.50	.097	7.0	7.0	73	121	96	11		51	
	40		805.89	.101	7.34	7.3	72	127	98	12		50	
H-5	45		813.28	.098	7.2	7.2	73	132	100	11		51	
	50		820.73	.103	7.5	7.5	74	136	102	12		52	
H-6	55		827.98	.095	7.0	7.0	74	135	105	10		53	
	60		835.32	.096	7.1	7.1	74	135	106	10		53	
H-7	65		842.24	.078	5.8	5.8	74	135	108	9		54	
	70		849.10	.078	5.7	5.7	74	135	108	8		54	
H-8	75		855.62	.076	5.6	5.6	73	133	108	7		55	
	80		862.21	.073	5.4	5.4	74	133	109	7		54	
H-9	85		868.01	.057	4.2	4.2	74	128	110	5		55	
	90		874.23	.061	4.5	4.5	74	126	108	5		55	
H-10	95		880.21	.061	4.4	4.4	74	123	108	6		55	
	100			.062	4.5	4.5	73	121	107	8		54	

PACIFIC ENVIRONMENTAL SERVICES, INC.

Plant Name: AUTOMATIC DIE CASTING

Run Number: MM13A-1

Page 2 of 2

Test Date: 4-25-84

Operator: J. BLAU, A. WEISMAN

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	Probe Temp °F
	100	1638	888.31										
H-11	105		891.96	.054	3.9	3.9	73	120	106	5		55	
~~H-11~~	110		897.75	.057	4.1	4.1	74	119	105	4		55	
H-12	115		903.53	.055	3.9	3.9	74	119	105	5		51	
	120	16:58	909.022	.051	3.7	3.7	74	119	104	4		50	
			LEAK CHECK	13" VAC			0.01 cfm						
			909.768	AFTER LEAK CHECK									
V-1	125	17:41	914.97	.048	3.4	3.4	70	114	98	4		58	
	130		920.13	.046	3.3	3.3	71	106	101	4		47	
V-2	135		925.78	.054	3.9	3.9	71	114	102	4		50	
	140		931.43	.052	3.8	3.8	69	118	103	4		48	
V-3	145		937.28	.059	4.3	4.3	72	119	104	5		47	
	150		943.26	.061	4.5	4.5	71	121	105	5		53	
V-4	155		949.39	.064	4.7	4.7	72	122	104	6		53	
	160		955.81	.066	4.8	4.8	72	122	105	6		54	
V-5	165		962.05	.071	5.1	5.1	71	124	106	6		55	
	170		968.49	.075	5.5	5.5	72	124	108	8		55	
V-6	175		975.30	.084	6.2	6.2	72	126	108	8		56	
	180		982.23	.086	6.3	6.3	72	126	106	9		57	
V-7	185		989.69	.103	7.6	7.6	72	127	107	11		59	
~~V-8~~	190		996.10	.101	7.4	7.4	72	132	107	12		61	
V-8	195		1004.73	.108	8.0	8.0	71	133	108	13		63	
	200		12.31	.106	7.9	7.9	72	135	118	13		63	
V-9	205		19.43	.089	6.6	6.6	72	136	110	10		63	
	210		26.63	.091	6.7	6.7	72	135	110	10		64	
V-10	215		34.80	.081	5.9	5.9	73	134	110	8		65	
	220		40.26	.083	6.1	6.1	73	132	110	8		66	
V-11	225		47.08	.085	6.3	6.3	73	131	110	8		66	
	230		54.11	.083	6.1	6.1	73	130	110	8		67	
V-12	235		59.71	.056	4.1	4.1	74	130	118	4		67	
V-12	240	19:41	1065.164	.049	3.6	3.6	74	127	110	4		68	
			V_m=306.646	$\sqrt{\Delta P}$=.267		ΔH:5.3	T_s=72	T_m=123	T_m=104				

SAMPLE RECOVERY DATA

Plant: AUTOMATIC DIE CASTING Run No.: MM 13B-7

Date: 4/25/88 Sample Box No.: RAC-1 Job No.: _____

Sample Location: Scrubber Inlet

Sample Type: MM13B Filter No.: _____

Sample Recovery Person: A. WEISMAN

Comments: _____

FRONT HALF

Acetone Container No.: _____ Liquid Level Marked: _____ Sealed: _____

Filter Container No.: _____ _____ _____ Sealed: _____

Description of Filter: _____

Samples stored and locked: _____

BACK HALF/MOISTURE

Container No: MM 13B-7 PROBE+NOZZLE RINSE MM 13B-7 IMPINGER CATCH _____

Liquid Level Marked: YES Sealed: _____

IMP. NO.	CONTENTS	INITIAL VOL (ml)	WEIGHT (grams) INITIAL	FINAL	NET
1	100 ml NaOH		568.8	560.8	-8.0
2	100 ml NaOH		569.7	561.1	-8.6
3	EMPTY		449.2	453.3	4.1
4	SILICA GEL		646.0	671.5	25.5
5	SILICA GEL		686.2	747.9	61.7
6					
TOTAL					74.7

Description of Impinger Catch: _____

PES

EMISSION TEST CALCULATIONS

PLANT Automatic Die Casting SOURCE/RUN MH13B-7 DATE 5/9/88

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)

$$V_{m_{std}} = 17.64\ V_{m_c} Y \left(\frac{P_{bar} + \Delta H / 13.6}{T_m}\right) = 17.64\ (306.646)\ (\cancel{.04}\ .998)\ \frac{(29.52) + (5.3)/}{(574)}$$

$V_{m_{std}}$ = 281.298 dscf

3. Volume Water Vapor Collected, Standard Conditions

Impingers = $V_{wc} = 0.04707\ (V_f - V_i) = 0.04707\ (\cancel{13.8}\ -12.5) = \cancel{.6119}\ -.5884$ scf

Silica Gel = $V_{wsg} = 0.04715\ (W_f - W_i) = 0.04715\ (\cancel{61.9}\ 87.2) = \cancel{2.9092}\ 4.1115$ scf

$V_{w_{std}} = V_{wc} + V_{ws_g} = \cancel{3.5216}\ 3.523$ scf

4. Percent Moisture, By Volume

$$B_{w_s} = \frac{V_{w_{std}}}{V_{w_{std}} + V_{m_{std}}} = \frac{(\cancel{3.5216}\ 3.523)}{(\cancel{3.5216}\ 3.523) + (281.298)} = .0124\ (1.2\%)$$

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 = _____

$M_s = M_d\ (1 - B_{ws}) + 18.0\ (B_{ws}) = (29.0)(1 - .0124) + 18.0\ (.0124) = 28.86$ lb/lb-mole

6. Stack Gas Velocity, Average

$$V_{s_{avg}} = 85.49 C_p \left(\sqrt{\Delta P}\right)_{avg} \sqrt{\frac{T_s}{P_s M_s}} = 85.49\ (.84)(.267)\sqrt{\frac{(532)}{(29.40)(28.86)}}$$

$V_{s_{avg}}$ = 15.18 ft/s

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

$$Q_a(\text{circular}) = \left(\frac{60 \times V_s\ (\quad)}{144}\right) = 60 \times V_s \left(\frac{A_o(in^2)}{144}\right)$$

$$= 60 \times 15.8 \left(\frac{\cancel{383.94}\ (383)}{144}\right) 5$$

"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 = ~~2423.116~~ 2425.6 acfm

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

$$Q_{std} = 17.64\, Q_a (1-B_{ws}) \left(\frac{P_s}{T_s}\right) = 17.64\ (\cancel{2423.11}\ 2425.6)\ (1-.0124)\left(\frac{29.40}{532}\right)$$

Q_{std} = ~~2332.866~~ 2335.3 dscfm

9. Isokinetic Variation

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

$$= 0.0944 \frac{(532)(281.298)}{(29.40)(15.18)(1347 \times 10^{-4})(240)(1-.0124)}$$

= 99.3 %

EMISSION RATE CALCULATIONS

Plant Automatic Die Casting Run No. MM13B-7 Date 5/9/88

Parameter measured Cr^{+6}

Sample volume $V_{m\ std}$ 281.298 dscf
Sample concentration (C_s) .025(imp), .036(n/p) mg/ℓ
Blank concentration (C_b) .003 mg/ℓ
Solution volume (V_{sol}) 380.8(imp), 176.9(n/p) ℓ
Volumetric flow rate Q_{std} 2335.3 ft^3/min

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

$$\frac{.025}{\ell}\text{ mg} - \frac{.003}{\ell}\text{ mg}\ (\cancel{380.8\ell}\ .381\ \ell) = .0084\text{ mg}$$

$$.036\ mg/\ell - .003\ mg/\ell\ (\cancel{176.9\ell}\ .177\ \ell) = .0058\ mg$$ = Total mg = .014

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

$$\frac{(.014\text{ mg})\ \frac{0.0154\ gr}{mg}}{281.298\text{ dscf}} = 7.80\times10^{-7}\ gr/dscf$$

3. Emission rate (lb/hr):

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

$$\frac{(7.80\times10^{-7}\ gr)}{dscf}\ \frac{1.43\times10^{-4}\ lb}{gr}\ \frac{(\cancel{2332.86\ ft^3}\ 2335.3)}{min}\ \frac{60\ min}{hr} = 1.56\times10^{-5}\ lb/hr$$

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

$$\frac{(1.56\times10^{-5}\ lb)}{hr}\ \frac{0.4539\ kg}{lb} = 7.08\times10^{-6}\ kg/hr$$

FIELD DATA

Plant AUTOMATIC DIE CASTING
Date 4-26-88 Job No.
Sampling Location SCRUBBER INLET
Sample Type MM13B
Run Number MM130-8
Operator J. BLAU, A. BRISMAN
Ambient Temperature 78
Barometric Pressure 29.11
Static Pressure (P_s) -1.7
Filter Number(s)
Pretest Leak Rate =.001 cfm @ 18 in. Hg
Pretest Pitot Leak Check 0.12
Pretest Orsat Leak Check
Read and Record all Data Every 5 Minutes

Schematic of Traverse Point Layout

Probe Length and Type 3' GLASS
Pitot Tube I.D. No. 3-1 Cp .84
Nozzle I.D. Avg. .497 .497
Assumed Moisture, %
Temp. Readout S/N T-2
Meter Box Number MB-1
Meter $\Delta H_@$ 1.90
C Factor 1.19
Meter Gamma .998
Heater Box Setting
Reference Δp .024
Post Test Leak Rate =.001 cfm @ 8 in. Hg
Post Test Pitot Leak Check
Post Test Orsat Leak Check

Page 1 of 2 PORT CHANGE @ 10 Temp. Sensor ID No.

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	Probe Temp °F
	0	9:03	065.461										
H 1	5		69.16	.021	1.4	1.4	75	78	78	1		47	
	10		72.75	.021	1.4	1.4	75	86	83	1		41	
H 2	15		77.49	.041	2.84	2.8	76	94	86	1		43	
	20		82.31	.046	3.2	3.2	76	100	87	1		44	
H-3	25		88.38	.067	4.7	4.7	76	104	90	1		45	
	30		94.61	.073	5.1	5.1	76	106	90	2		45	
H-4	35		101.34	.085	6.0	6.0	76	108	92	2		45	
	40		108.18	.088	6.2	6.2	76	110	94	3		47	
H-5	45		115.48	.096	6.8	6.8	75	111	96	3		48	
	50		122.48	.096	6.8	6.8	75	111	96	3		45	
H-6	55		129.49	.088	6.3	6.3	75	111	96	3		49	
	60		136.31	.089	6.3	6.3	75	111	96	3		49	
H-7	65		142.89	.080	5.7	5.7	75	110	96	3		49	
	70		149.63	.082	5.8	5.8	75	110	96	2		48	
H-8	75		155.98	.075	5.3	5.3	74	110	96	1		47	
	80		162.32	.072	5.2	5.2	75	110	96	1		48	
H 9	85		167.61	.051	3.6	3.6	75	110	96	1		48	
	90		172.91	.049	3.5	3.5	76	110	96	1		48	
H-10	95		178.14	.051	3.6	3.6	76	110	97	1		48	

PACIFIC ENVIRONMENTAL SERVICES, INC

Plant Name: AUTOMATIC DIE CASTING Test Date: 4-26-88

Run Number: MM 13A-8 Operator: J. OLAV

Page 2 of 2

Traverse Point Number	Sampling Time (min) / Clock Time (24-hour clock)	Gas Meter Reading (V_m) ft³	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	Probe Temp °F
	100 /	183.50										
H-11	105 /	189.01	.055	3.7	3.7	75	112	98	1		49	
	110 /	194.50	.054	3.8	3.8	76	112	98	1		50	
H-12	115 /	200.48	.065	4.7	4.7	74	112	100	2		50	
	120 / 11:03	206.357	.061	4.4	4.4	75	112	97	2		50	
206.945	/ 11:30	206.945	CHECK	CHECK	.001	AT	81					
V-1	125 /	212.61	.050	3.5	3.5	74	85	88	1		50	
	130 /	216.75	.047	3.3	3.3	73	96	92	1		48	
V-2	135 /	222.43	.051	3.7	3.7	75	102	91	1		49	
	140 /	227.23	.049	3.5	3.5	74	104	93	1		50	
V-3	145 /	232.81	.058	4.1	4.1	74	105	93	1		49	
	150 /	238.70	.062	4.4	4.4	74	106	93	2		50	
V-4	155 /	244.68	.066	4.7	4.7	74	106	94	2		50	
	160 /	250.61	.064	4.5	4.5	74	106	94	2		51	
V-5	165 /	257.08	.079	5.6	5.6	74	106	94	3		51	
V-6	170 /	263.62	.080	5.7	5.7	74	108	94	3		52	
V-6	175 /	270.71	.092	6.5	6.5	74	108	94	3		53	
	180 / 12:30	277.63	.093	6.6	6.6	74	110	96	3		53	
V-7	185 /	285.00	.105	7.5	7.5	74	110	95	4		53	
	190 /	292.48	.108	7.7	7.7	74	110	96	4		53	
V-8	195 /	299.95	.109	7.8	7.8	74	110	96	4		54	
	200 /	307.59	.112	8.0	8.0	74	110	96	4		53	
V-9	205 /	314.76	.097	6.9	6.9	74	111	96	3		53	
	210 /	322.08	.103	7.3	7.3	74	110	96	3		52	
V-10	215 /	328.48	.074	5.3	5.3	74	110	96	2		51	
	220 /	334.71	.072	5.1	5.1	74	110	97	2		51	
V-11	225 /	341.31	.082	5.8	5.8	75	110	96	2		51	
	230 /	347.96	.079	5.6	5.6	75	111	96	2		53	
V-12	235 /	353.70	.063	4.4	4.4	73	112	96	2		52	
	240 /	359.551	.062	4.4	4.4	73	111	96	2		52	
	/						T_m = 107°F	T_m = 94°F				
	/	V_m = 293.502	$\sqrt{\Delta P}$ = .263		ΔH = 5.0	T_s = 75°F	107					

SAMPLE RECOVERY DATA

Plant: Automatic Diecasting Run No.: MM13B-8

Date: 4/25/88 Sample Box No.: RAC-1 Job No.: _____

Sample Location: Scrubber inlet

Sample Type: MM13B Filter No.: _____

Sample Recovery Person: _____

Comments: _____

FRONT HALF

Acetone Container No.: _____ Liquid Level Marked: _____ Sealed: _____

Filter Container No.: _____ _____ _____ Sealed: _____

Description of Filter: _____

Samples stored and locked: _____

BACK HALF/MOISTURE

Container No: _____ _____ _____

Liquid Level Marked: _____ Sealed: _____

IMP. NO.	CONTENTS	INITIAL VOL (ml)	WEIGHT (grams) INITIAL	FINAL	NET
1	100 ml NaOH		580.2	561.7	-18.5
2	100 ml NaOH		574.8	619.7	44.9
3	empty		445.2	447.7	2.5
4	Sil. Gel		637.7	685.5	47.8
5	Sil. Gel		648.9	666.5	17.6
6					
TOTAL					94.3

Description of Impinger Catch: _____

PES

EMISSION TEST CALCULATIONS

PLANT Automatic Die Casting SOURCE/RUN MM13B-8 DATE 5/9/88

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)

$$V_{m_{std}} = 17.64\ V_{m_c} Y \left(\frac{P_{bar} + \Delta H / 13.6}{T_m}\right) = 17.64\ (293.502)(.998)\frac{(29.11) + (5.0)/1}{(561)}$$

$V_{m_{std}} =$ 271.500 dscf

3. Volume Water Vapor Collected, Standard Conditions

Impingers $= V_{wc} = 0.04707\ (V_f - V_i) = 0.04707\ (\cancel{767.2}\ 38.9) = \cancel{3.612}\ 1.360$ scf

Silica Gel $= V_{wsg} = 0.04715\ (W_f - W_i) = 0.04715\ (\cancel{17.6}\ 65.4) = \cancel{0.830}$ scf

$V_{w_{std}} = V_{wc} + V_{wsg} =$ 4.444 scf 3.084

4. Percent Moisture, By Volume

$$B_{w_s} = \frac{V_{w_{std}}}{V_{w_{std}} + V_{m_{std}}} = \frac{(4.444)}{(4.444) + (271.500)} = .0161\ (1.6\%)$$

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 = _____

$M_s = M_d\ (1 - B_{ws}) + 18.0\ (B_{ws}) = (29.0)(1 - .016) + 18.0\ (.016) =$ 28.82 lb/lb-mole

6. Stack Gas Velocity, Average

$$V_{s_{avg}} = 85.49 C_p \left(\sqrt{\Delta P}\right)_{avg} \sqrt{\frac{T_s}{P_s M_s}} = 85.49\ (.84)(.263)\sqrt{\frac{(535)}{(28.99)(28.82)}}$$

$V_{s_{avg}}$ = 15.11 ft/s

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

$$Q_a\text{(circular)} = \left(\frac{60 \times V_s\ (\quad)}{144}\right) = 60 \times V_s \left(\frac{A_o^{*}\ (in^2)}{144}\right)$$

$$= 60 \times 15.11 \left(\frac{\cancel{383.04}\ 383.5}{144}\right)$$

"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 = ~~2412.07~~ 2414.5 acfm

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

$$Q_{std} = 17.64\, Q_a (1-B_{ws}) \left(\frac{P_s}{T_s}\right) = 17.64\ (\cancel{2412.07}\ 2414.5)\ (1-.016)\left(\frac{28.99}{535}\right)$$

Q_{std} = ~~2268.71~~ 2270.9 dscfm

9. Isokinetic Variation

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

$$= 0.0944 \frac{(535)\ (271.500)}{(28.99)\ (15.11)\ (13.42 \times 10^{-4})\ (240)\ (1-.016)}$$

= 98.77 %

EMISSION RATE CALCULATIONS

Plant Automatic Die Casting Run No. MM13B-8 Date 5/10/88

Parameter measured Cr^{+6}

Sample volume $V_{m\,std}$ 271.500 dscf
Sample concentration (C_s) .019(imp), .016(np) mg/ℓ
Blank concentration (C_b) .002 mg/ℓ
Solution volume (V_{sol}) 403.5(imp), 133.0(np) ℓ
Volumetric flow rate Q_{std} ~~2268.71~~ 2270.9 ft^3/min

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

$$\frac{.019}{\ell}\text{ mg} - \frac{.002}{\ell}\text{ mg}\ (.404\ \ell) = .007\text{ mg}$$

Total mg = .009

.016 mg/ℓ - .002 mg/ℓ (.133) = .002

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

$$\frac{(.009\text{ mg})\ \frac{0.0154\text{ gr}}{\text{mg}}}{271.500\text{ dscf}} = 5.11\times10^{-7}\text{ gr/dscf}$$

3. Emission rate (lb/hr):

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

$$\frac{(5.11\times10^{-7}\text{ gr})}{\text{dscf}}\ \frac{1.43\times10^{-4}\text{ lb}}{\text{gr}}\ \frac{(\cancel{2268.71}\ 2270.9\ \text{ft}^3)}{\text{min}}\ \frac{60\text{ min}}{\text{hr}} = \cancel{9.94\times10^{-6}}\ 9.96\times10^{-6}\text{ lb/hr}$$

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

$$\frac{(\cancel{9.94\times10^{-6}}\ 9.96\times10^{-6}\text{ lb})}{\text{hr}}\ \frac{0.4539\text{ kg}}{\text{lb}} = \cancel{4.51\times10^{-6}}\ 4.52\times10^{-6}\text{ kg/hr}$$

FIELD DATA

Plant Automatic Die Casting
Date 4-30-85 Job No.
Sampling Location Scrubber Inlet
Sample Type MM13-A
Run Number MM13 B-9
Operator J. Olney, A. Wassmer
Ambient Temperature 73
Barometric Pressure ~~29.5~~ = 29.47
Static Pressure (P_g) -1.7
Filter Number(s)
Pretest Leak Rate = .003 cfm @ 14 in. Hg
Pretest Pitot Leak Check O.K
Pretest Orsat Leak Check —
Read and Record all Data Every 5 Minutes
Port Change 10

Schematic of Traverse Point Layout

Probe Length and Type 3' Glass
Pitot Tube I.D. No. S-1 Cp .84
Nozzle I.D. | | | Avg. .497
Assumed Moisture, % 1
Temp. Readout S/N T-2
Meter Box Number MB 1
Meter $\Delta H_@$ 1.9
C Factor 1.19
Meter Gamma .998
Heater Box Setting —
Reference Δp .026
Post Test Leak Rate = .001 cfm @ 15 in. Hg
Post Test Pitot Leak Check O.K
Post Test Orsat Leak Check —

Page 1 of 3

Temp. Sensor ID No.

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	Probe Temp °F
	0 / 2:33	359.738				76	78	80	2		52	
H-1	5 /	363.48	.023	1.6	1.6	75	84	82	2		42	
	10 /	367.75	.028	1.9	1.9	74	92	82	4		46	
H-2	15 /	372.90	.051	3.5	3.5	74	99	84	4		42	
	20 /	378.09	.053	3.7	3.7	75	102	86	6		43	
H-3	25 /	383.87	.066	4.5	4.5	75	106	88	6		46	
	30 /	389.88	.069	4.8	4.8	75	110	92	8		48	
H-4	35 /	396.36	.082	5.8	5.8	76	113	90	9		50	
	40 /	403.15	.086	6.1	6.1	75	116	93	9		54	
H-5	45 /	409.96	.088	6.2	6.2	75	118	94	10		57	
	50 /	416.78	.090	6.4	6.4	76	120	96	10		57	
H-6	55 /	423.83	.086	6.1	6.1	75	120	96	10		57	
	60 /	430.59	.092	6.6	6.6	74	120	95	10		59	
H-7	65 /	437.46	.087	6.2	6.2	74	120	98	8		57	
	70 /	444.11	.082	5.8	5.8	75	121	99	7		53	
H-8	75 /	450.54	.074	5.3	5.3	75	124	100	7		52	
	80 /	457.18	.073	5.2	5.2	75	124	110	6		47	
H-9	85 /	463.00	.065	4.7	4.7	75	122	102	6		48	
	90 /	468.90	.063	4.5	4.5	76	119	111	5		47	
H-10	/	474.49	.053	3.8	3.8	75	116	100	4		48	
			.051	3.6	3.6	75						

PACIFIC ENVIRONMENTAL SERVICES, INC.

Plant Name: AUTOMATIC DIE CASTING Test Date: 4-26-88

Run Number: MM13B-9 Operator: J. BLAU

Page 2 of 3

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	Probe Temp °F
	100 /	479.68										
H-11	105 /	484.62	.043	3.1	3.1	75	112	100	3		47	
	110 /	489.10	.040	2.8	2.8	75	110	100	3		47	
H12	115 /	494.38	.051	3.6	3.6	74	109	100	3		48	
	120 /	499.813	.054	3.8	3.8	74	109	98	5		48	
	/		LEAK	CHECK		14	VAC.	.002	CFM			
	/	500.260	AFTER	LEAK	CHECK							
	/											
	/											
	/	READ 5	MIN.	PORT	CHANGE			5 min	OK			
	/											
	/	VERTICAL	TRAVERSE									
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PACIFIC ENVIRONMENTAL SERVICES, INC.

Plant Name: AUTOMATIC DIE CASTING

Test Date: 4-26-88

Run Number: MM10B-9

Operator: A. WEISMAN

Page 3 of 3

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	Probe Temp °F
		4:52	500.260										
V-1	1125	4:52	505.7	.051	3.5	3.5	76	89	90	5		46	
V-2	1130	/	511.4	.060	4.3	4.3	76	102	97	5		44	
V-3	1135	/	519.1	.053	3.7	3.7	75	104	96	5		45	
V-4	1140	/	522.7	.065	4.6	4.6	75	110	94	6		48	
V-5	1145	/	528.8	.070	4.9	4.9	76	112	94	6		48	
V-6	1150	/	535.2	.078	5.5	5.5	75	112	95	7		49	
V-7	1155	/	545.9	.110	7.9	7.9	75	112	96	14		49	
V-8	1160	/	550.0	.105	7.4	7.4	75	116	96	12		50	
V-9	1165	/	557.0	.085	6.2	6.2	75	120	96	9		51	
V-10	1170	/	563.7	.080	5.7	5.7	74	120	97	8		51	
V-11	1175	/	572.5	.080	5.7	5.7	74	119	97	8		51	
V-12	1180	/	576.184	.060	4.4	4.4	73	118	98	6		51	
		/											
		/	V_m=215.999	$\sqrt{\Delta P}$=.258		ΔH=4.8	T_s=75°F	T_s=111°F	T_s=95°F				

B-54

SAMPLE RECOVERY DATA

Plant: Automatic Diecasting Run No.: MM13B-9

Date: 4/26/88 Sample Box No.: RAC-1 Job No.: _____

Sample Location: Scrubber Inlet

Sample Type: MM13B Filter No.: _____

Sample Recovery Person: _____

Comments: _____

FRONT HALF

Acetone Container No.: _____ Liquid Level Marked: _____ Sealed: _____

Filter Container No.: _____ _____ _____ Sealed: _____

Description of Filter: _____

Samples stored and locked: _____

BACK HALF/MOISTURE

Container No: _____ _____ _____

Liquid Level Marked: _____ Sealed: _____

IMP. NO.	CONTENTS	INITIAL VOL (ml)	WEIGHT (grams) INITIAL	FINAL	NET
1	100 ml 1N NaOH	100 ml	570.0	569.3	-0.7
2	" " "	100 ml	570.9	573.3	2.4
3	empty		450.7	452.8	2.1
4	silica gel		697.3	746.5	49.2
5	silica gel		669.5	680.3	10.8
6					
TOTAL					63.8

Description of Impinger Catch: _____

PES

EMISSION TEST CALCULATIONS

PLANT Automatic Die Casting SOURCE/RUN MM13B-9 DATE 5/9/88

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)

$$V_{m_{std}} = 17.64\ V_{m_c} Y \left(\frac{P_{bar} + \Delta H / 13.6}{T_m}\right) = 17.64\ (215.999)(.998)\frac{(29.47)+(4.8)/}{(563)}$$

$V_{m_{std}} =$ 201.429 dscf

3. Volume Water Vapor Collected, Standard Conditions

Impingers $= V_{wc} = 0.04707\ (V_f - V_i) = 0.04707\ (3.8) =$ 0.179 scf

Silica Gel $= V_{ws_g} = 0.04715\ (W_f - W_i) = 0.04715\ (60.0) =$ ~~2.83~~ 2.829 scf

$V_{w_{std}} = V_{wc} + V_{ws_g} =$ 3.01 scf

4. Percent Moisture, By Volume

$$B_{w_s} = \frac{V_{w_{std}}}{V_{w_{std}} + V_{m_{std}}} = \frac{(3.01)}{(3.01)+(201.429)} = .0147\ (1.5\%)$$

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 = _____

$M_s = M_d\ (1-B_{ws}) + 18.0\ (B_{ws}) = (29.0)(1-.0147) + 18.0\ (.0147) =$ 28.84 lb/lb-mole

6. Stack Gas Velocity, Average

$$V_{s_{avg}} = 85.49 C_p \left(\sqrt{\Delta P}\right)_{avg} \sqrt{\frac{T_s}{P_s M_s}} = 85.49\ (.84)\ (.258) \sqrt{\frac{(535)}{(29.35)(28.84)}}$$

$V_{s_{avg}}$ = 14.73 ft/s

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

$$Qa\,(circular) = \left(\frac{60 \times V_s\ (\quad)}{144}\right) = 60 \times V_s \left(\frac{A_o\,(in^2)}{144}\right)$$

$$= 60 \times 14.73 \left(\frac{\cancel{383.04e}\ 383.5}{144}\right)$$

"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 = ~~2350.84e~~ 2353.7 acfm

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

$$Q_{std} = 17.64\, Q_a (1-B_{ws}) \left(\frac{P_s}{T_s}\right) = 17.64\ (\cancel{2350.84}\ 2353.7)\ (1-.0147)\left(\frac{29.35}{535}\right)$$

Q_{std} = ~~2241.53e~~ 2244.3 dscfm

9. Isokinetic Variation

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

$$= 0.0944 \frac{(535)\ (201.429)}{(29.35)\ (14.73)\ (13.47 \times 10^{-4})\ (180)\ (1-.0147)}$$

= 98.50 %

EMISSION RATE CALCULATIONS

Plant Automatic Die Casting Run No. HMIBB-9 Date 5/10/88

Parameter measured Cr^{+6}

Sample volume $V_{m\ std}$ 201.429 dscf
Sample concentration (C_s) .033(imp), .046(nb) mg/ℓ
Blank concentration (C_b) .002 mg/ℓ
Solution volume (V_{sol}) .342(imp), .154(nb) ℓ
Volumetric flow rate Q_{std} ~~2241.56~~ 2244.3 ft^3/min

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

$$\frac{.033}{\ell}\ mg - \frac{.002}{\ell}\ mg\ (.342\ \ell) = .012\ mg$$

$$.046\ mg/\ell - .002\ mg/\ell\ (.154\ \ell) = .007$$

Total mg = .019

2. Concentration (gr/dscf): $\frac{(mg)\ \frac{0.0154\ gr}{mg}}{V_{m\,std}} = gr/dscf$

$$\frac{(.019\ mg)\ \frac{0.0154\ gr}{mg}}{201.429\ dscf} = 1.45\times10^{-6}\ gr/dscf$$

3. Emission rate (lb/hr):

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

$$\frac{(1.45\times10^{-6}\ gr)}{dscf}\ \frac{1.43\times10^{-4}\ lb}{gr}\ \frac{(\cancel{2241.82}\ 2244.3\ ft^3)}{min}\ \frac{60\ min}{hr} = 2.79\times10^{-5}\ lb/hr$$

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

$$\frac{(2.79\times10^{-5}\ lb)}{hr}\ \frac{0.4539\ kg}{lb} = 1.27\times10^{-5}\ kg/hr$$

APPENDIX C

Calculation Checks

4-19-88

K_c = 106.5547

	EPA # Total micrograms	PEER # Total micrograms
2 A 1	37.861	38.0
A 2	122.809	122.7
A 3	126.194	126.1
A 4	155.544	155.7
2 A 1 Tygon	5.065	5.1
2 "	4.144	4.09
3 "	4.273	4.2
4 "	4.483	4.4
1 B 3 Duplicate	146.209	146.1
2 B 1	159.609	159.5
2 B 2	114.196	114.1
2 B 3	165.969	166.1
2 B 4	172.895	172.9
1 B 4 Duplicate	142.763	142.9
2 B 1 Tygon	6.127	6.1
2 B 2 Tygon	7.927	7.9
2 B 3 Tygon	7.807	7.9
2 B 4 Tygon	6.035	6.0
MM 13-B 2	2029.511	2026.9

0127S

4-19-88

K_c = 106.5547

	EPA # Total micrograms	PEER # Total micrograms
3 B 1	55.706	55.7
3 B 2	112.285	122.2
3 B 3	165.704	165.0
3 B 4	162.218	162.1
3 B 3 Duplicate	163.373	163.3
.10 µg/m std	.103	.103
.25	.256	.256
.50	.506	.506

4-20-88

K_c = 107.1050 Blank Corr = .186

4-19-88

K_c = 106.5547

	EPA # Total Micrograms	PEER # Total Micrograms
[2]A 1	37.861	38.0
A 2	122.809	122.7
A 3	126.194	126.1
A 4	155.544	155.7
[2]A 1 Tygon	5.065	5.1
2 Tygon	4.144	4.09
3 Tygon	4.273	4.2
4 Tygon	4.483	4.4
1 B 3 Duplicate	146.209	146.1

0127S

K_c = 106.5547

	EPA # Total Micrograms	PEER # Total Micrograms
2B1	159.609	159.5
2B2	114.196	114.1
2B3	165.969	166.1
2B4	172.895	172.9
1B4 Duplicate	142.763	142.9
2B1 Tygon	6.127	6.1
2B2 Tygon	7.927	7.9
2B3 Tygon	7.807	7.9
2B4 Tygon	6.035	6.0
MM 13-B 2	2029.511	2026.9
3A1	148.025	148.2
3A2	127.460	127.4
3A3	176.794	176.8
3A4	179.345	179.4
MM 13B - 3	2235.650	2236.0
3B1	55.706	55.7
3B2	112.285	112.2
3B3	165.704	165.0
3B4	162.218	162.1
3B3 Duplicate	163.373	163.3
.10 µg/mℓ std	.103	.103
.25	.256	.256
.50	.506	.506

4-20-88

Blank Corr = .186

K_c = 107.1050

	EPA # Total Micrograms	PEER # Total Micrograms
Run #1 Process Sol'tn 4/18	134,917.796*	134,920*
2 Process Sol'tn 4/19	135,933.912*	135,962*
3 Process Sol'tn 4/19	138,149.886*	138,118*
Dup #1 Process Sol'tn	139,042.271*	139,010*
#2 Process Sol'tn	142,021.321*	141,988*
#3 Process Sol'tn	143,309.832*	143,276*
4A1	.217	.24
4A2	> blank correction	> blank correction
4A3	.248	.25
4A4	.598	.60
NaOH Blank	.186	.186
MM 13-B - 4	12.316	12.5
4B1	.682	.69
0.05 µg/mℓ std	4.612	4.8
0.25 µg/mℓ std	25.232	25.0

* Reported in micrograms per milliliter (µg/mℓ)

0127S

K_c = 107.1050

	EPA # Total Micrograms	PEER # Total Micrograms
4 B 2	.853	.81
3	1.081	1.2
4	1.227	1.3
5 1 U	1.702	1.6
2 U	2.529	2.5
3 U	1.551	1.6
4 U	1.326	1.3
STD 1.25 µg/100mℓ	.007 µg/mℓ	.006
13 B - 5	12.984	13.1
STD 0.25 µg/100mℓ	.002 µg/mℓ	.002
13 B - 5	16.305	16.2

K_c = 106.8043

	EPA # Total Micrograms	PEER # Total Micrograms
MM 13B - 4 Dup	11.962	11.9
MM 13B - 5 Dup	14.661	14.7
.25 µg/mℓ	25.347	25.3
.50 µg/mℓ	51.284	51.3
610	1.678	1.7
620	2.591	2.6
630	2.008	2.0
2A1 (Dup)	38.661	38.7
MM 13B - 4	275.934 (?)	1.2
MM 13B - 3 Dup	2222.503	2222.5
640	2.193	2.2
MM 13B6 (NOZ/PROBE)	4.673	4.7
MM 13B6 Impinger Catch	26.605	26.6
MM 133 - 4 + 50 µg/mℓ	531.225	531.2
0.5 µg/mℓ .1N NaOH	50.589	50.6
6 1 P	.997	.910
6 2 P	1.878	1.9
6 3 P	2.280	2.3
6 4 P	2.073	2.1
MM 13B-6	.049 µg/mℓ	

4-21-88 K_c 106.8043

MM13B 4 (process solution)	129,961.55 µg/mℓ	129,956
MM13B 5 (process solution)	133,646.188 µg/mℓ	133,640
MM13B 6 (process solution)	134,887.525 µg/mℓ	134,882
.05 µg/mℓ std	4.887	4.9
.1 µg/mℓ std	10.292	10.3
.25 µg/mℓ std	25.669	25.6

SAMPLING SUMMARY SHEET

PLANT AUTOMATIC DIE CASTING

LOCATION SAINT CLAIR SHORES, MICHIGAN

SAMPLED SOURCE DECORATIVE CHROMIUM ELECTROPLATING TANK #27

(NO FUME SUPRESSANT)

Run	Date	N_p	(3) Y_m	(4) ΔH	(5) P Bar.	(6) V_m	(7) T_m	(8) V_m Std.	(9) %	(10) P_{st}	17 P_s	(18) T_s	(19) VP	(20) V_w	21 $V_{w_{gas}}$	22 %M	23 M_d
13B1	19APR88	X2 24	.998	1.48	29.14	137.171	102	125.729		-1.7	29.02	73		41.8	1.97	1.54	.985
13B2	19APR88	24	.998	1.45	29.29	83.248	96	72.517		-1.7	29.17	68		21.4	1.01	1.28	.987
13B3	19APR88	24	.998	1.42	29.29	84.762	92	79.493		-1.7	29.17	70		23.8	1.12	1.39	.986

Run	(24) CO_2	(25) O_2	26 N_2	(27) CO	(28) —	29 MW_d	30 MW	(31) C_p	(32) $\sqrt{\Delta P_s (T_s + 460)}$	(33) T_t	(34) D_n	35 V_s	(36) D_s	(37) Area	38 ACFM	(39) DSCFM	40 XI
13B1	0.7	21.0	78.3			28.95	28.78	.84	6.2808	192	.366	15.6		2.6113	2445	2313	101.25
13B2	0.7	21.0	78.3			28.95	28.81	.84	6.1770	120	.366	15.3		2.6113	2398	2307	100.13
13B3	0.7	21.0	78.3			28.95	28.80	.84	6.1930	120	.366	15.4		2.6113	2404	2302	102.9

$$V_{m\,Std.} = Y_m \frac{17.64 \times V_m \left(P\ Bar. + \frac{\Delta H}{13.6}\right)}{(T_m + 460)}$$

$$V_{w_{gas}} = 0.0471\ V_w$$

$$M_d = ECO_2 \times .44 + (EO_2 \times .32) + (ECO + EN_2) \times .28 + \left(E\text{Other} \times \frac{\text{Mol. wt.}}{100}\right)$$

$$MW_d = M_d \times 18(1 - M_d)$$

$$V_s = 85.49 \times C_p \sqrt{\Delta P_s (T_s + 460)} \left[\frac{1}{P_s \times MW}\right]^{1/2}$$

$$I = \frac{0.09450 \times (T_s + 460) \times V_{m\,Std.}}{V_s \times T_t \times P_s \times M_d \times A_n}$$

$$\%M = \frac{100 \times V_{w_{gas}}}{V_{m\,Std.} + V_{w_{gas}}}$$

$$M_d = \frac{100 - \%M}{100}$$

$$P_s = P\ Bar. \pm \frac{P_{st}}{13.6}$$

N_p = Total No. of Sampling points

Y_m = Meter Box Correction Factor

ΔH = Average Orifice Pressure Drop, Inches H_2O

P Bar. = Barometric Pressure, Inches Hg. Absolute

V_m = Volume of Dry Gas at Meter Conditions, DCF

T_m = Average Meter Temperature, °F.

$V_{m\,Std.}$ = Volume of Dry Gas at STP. DSCF[a]

E = Per Cent other gas removed before Dry Gas Meter

P_{st} = Static Pressure of Stack Gas, Inches H_2O

P_s = Stack Gas Pressure, Inches Hg.

T = Average Stack Temperature, °F

VP = Vapor Pressure of H_2O At Stack Temperature

V_w = Total H_2O Collected in Impingers and Silica Gel

$V_{w_{gas}}$ = Volume of water vapor collected at STP, SCF[b]

%M = Per Cent Moisture by volume

M_d = Mole Fraction of Dry Gas

ECO_2 = Volume % Dry

EO_2 = Volume % Dry

EN_2 = Volume % Dry

ECO = Volume % Dry

MW_d = Molecular Weight of Stack Gas Dry Basis

MW = Molecular Weight of Stack Gas, Wet Basis

$\sqrt{\Delta P (T + 460)}$ is determined by averaging the square root of the product of the velocity head (P) and the absolute stack temperature from each sampling point.

T_t = Net time of test in minutes

D_n = Sampling Nozzle Diameter, Inches

A_n = Area of Nozzle opening, ft^2.

V_s = Stack Gas Velocity at Stack Conditions, Feet per second.

D_s = Diameter of Stack, Inches

Area = Area of duct in ft^2

ACFM = Actual Cubic Feet per minute

DSCFM = Dry Standard Cubic Feet per minute

XI = Per Cent Isokinetic

[a] Dry Standard Cubic Feet @ 68°F, 29.92 in. Hg.

[b] [illegible]

SUMMARY OF EMISSIONS

PLANT AUTOMATIC DIE CASTING LOCATION SAINT CLAIR SHORES, MICHIGAN

SAMPLED SOURCE DECORATIVE CHROMIUM ELECTROPLATING TANK #27 (NO FUME SUPRESSANT)

RUN	DATE	1 V_m Std.	2 DSCFM
13B1	18 APR 88	125.729	2313
13B2	19 APR 88	77.517	2307
13B3	19 APR 88	79.493	2302

FRONT HALF MILLIGRAMS				4	5
PROBE	CYCLONE	FILTER	3 TOTAL	BACK HALF	FRONT + BACK TOTAL
			3.0129		
			2.0269		
			2.2360		

CONCENTRATIONS

RUN	FRONT HALF Gr/DSCF	FRONT HALF Mg/M^3	FRONT HALF Lb/Hr	FRONT HALF Kg/Hr	BACK HALF Gr/DSCF	BACK HALF Mg/M^3	BACK HALF Lb/Hr	BACK HALF Kg/Hr	TOTAL Gr/DSCF	TOTAL Mg/M^3	TOTAL Lb/Hr	TOTAL Kg/Hr
13B1	.00037	.846	.0073	.0033								
13B2	.00040	.923	.0079	.0036								
13B3	.00043	.993	.0086	.0039								
	6	7	8	9	10	17	18	19	20	21	22	23

Remarks:

SAMPLING SUMMARY SHEET

PLANT AUTOMATIC DIE CASTING

LOCATION SAINT CLAIR SHORES, MICHIGAN

SAMPLED SOURCE DECORATIVE CHROMIUM ELECTROPLATING TANK #27 (TEMPORARY FUME SUPRESSANT)

Run	Date	N_p	(3) Y_m	(4) ΔH	(5) P Bar.	(6) V_m	(7) T_m	(8) V_m Std.	(9) %	(10) P_{st}	17 P_s	(18) T_s	(19) VP	(20) V_w	21 $V_{w_{gas}}$	22 %M	23 M_d
13B4	20 APR 88	x2 24	.998	1.44	29.31	135.954	94	127.135		-1.7	29.19	68		27.0	1.27	.99	.990
13B5	20 APR 88	24	.998	1.46	29.19	86.516	95	80.433		-1.7	29.07	68		17.0	0.80	.99	.990
13B6	21 APR 88	x2 24	.998	5.21	29.37	309.712	100	289.803		-1.7	29.25	70		72.2	3.40	1.2	.988

Run	(24) CO_2	(25) O_2	26 N_2	(27) CO	(28) —	29 MW_d	30 MW	(31) C_p	(32) $\sqrt{\Delta P_s (T_s + 460)}$	(33) T_t	(34) D_n	35 V_s	(36) D_s	(37) Area	38 ACFM	(39) DSCFM	40 %I
13B4	0.7	21	78.3			28.95	28.84	.84	6.1849	192	.366	15.3		2.6113	2398	2316	102.2
13B5	0.7	21	78.3			28.95	28.84	.84	6.1781	120	.366	15.3		2.6113	2401	2309	103.8
13B6	0.7	21	78.3			28.95	28.83	.84	6.1652	240	.497	15.3		2.6113	2389	2299	101.9

$$V_{m\,Std.} = T_m \frac{17.64 \times V_m \left(P\ Bar. + \frac{\Delta H}{13.6}\right)}{(T_m + 460)}$$

$$\%M = \frac{100 \times V_{w_{gas}}}{V_{m\,Std.} + V_{w_{gas}}}$$

$$V_{w_{gas}} = 0.0471\ V_w$$

$$M_d = \frac{100 - \%M}{100}$$

$$MW_d = \%CO_2 \times .44 + (\%O_2 \times .32) + (\%CO + \%N_2) \times .28 + \left(\%Other \times \frac{Mol.\ wt.}{100}\right)$$

$$MW = MW_d \times M_d + 18(1 - M_d)$$

$$P_s = P\ Bar. \pm \frac{P_{st}}{13.6}$$

$$V_s = 85.49 \times C_p \sqrt{P_s (T_s + 460)} \left[\frac{1}{P_s \times MW}\right]^{1/2}$$

$$\%I = \frac{0.09450 \times (T_s + 460) \times V_{m\,Std.}}{V_s \times T_t \times P_s \times M_d \times A_n}$$

N_p = Total No. of Sampling points

Y_m = Meter Box Correction Factor

ΔH = Average Orifice Pressure Drop, inches H_2O

P Bar. = Barometric Pressure, Inches Hg. Absolute

V_m = Volume of Dry Gas at Meter Conditions, DCF

T_m = Average Meter Temperature, °F.

$V_{m\,Std.}$ = Volume of Dry Gas at STP. DSCF[a]

% = Per Cent other gas removed before Dry Gas Meter

P_{st} = Static Pressure of Stack Gas, inches H_2O

P_s = Stack Gas Pressure, inches Hg.

T_s = Average Stack Temperature, °F

VP = Vapor Pressure of H_2O At Stack Temperature

V_w = Total H_2O Collected in Impingers and Silica Gel

$V_{w_{gas}}$ = Volume of water vapor collected at STP, SCF[b]

%M = Per Cent Moisture by volume

M_d = Mole Fraction of Dry Gas

$\%CO_2$ = Volume % Dry

$\%O_2$ = Volume % Dry

$\%N_2$ = Volume % Dry

%CO = Volume % Dry

MW_d = Molecular Weight of Stack Gas Dry Basis

MW = Molecular Weight of Stack Gas, Wet Basis

C_p = Pitot Tube Coefficient

$\sqrt{\Delta P (T_s + 460)}$ is determined by averaging the square root of the product of the velocity head (ΔP) and the absolute stack temperature from each sampling point.

T_t = Net time of test in minutes

D_n = Sampling Nozzle Diameter, inches

A_n = Area of Nozzle opening, ft^2.

V_s = Stack Gas Velocity at Stack Conditions, Feet per second.

D_s = Diameter of Stack, inches

Area = Area of duct in ft^2

ACFM = Actual Cubic Feet per minute

DSCFM = Dry Standard Cubic Feet per minute

%I = Per Cent Isokinetic

[a] Dry Standard Cubic Feet @ 68°F, 29.92 in. Hg.

[b] Standard Conditions @ 68°F, 29.92 in. Hg.

SUMMARY OF EMISSIONS

PLANT AUTOMATIC DIE CASTING LOCATION SAINT CLAIR SHORES, MICHIGAN

SAMPLED SOURCE DECORATIVE CHROMIUM ELECTROPLATING TANK #27 (TEMPORARY FUME SUPRESSANT)

RUN	DATE	1 V_m Std.	2 DSCFM	FRONT HALF MILLIGRAMS PROBE	Impingers ~~CYCLONE~~	FILTER	3 TOTAL	4 BACK HAL.	5 FRONT + BACK TOTAL
1384	20APR88	127.135	2316				.012.2		
1385	20APR88	80.433	2309				.015.5		
1386	21APR88	289.803	2299	4.673	26.605		.031278		

CONCENTRATIONS

RUN	FRONT HALF Gr/DSCF	Mg/M³	Lb/Hr	Kg/Hr	BACK HALF Gr/DSCF	Mg/M³	Lb/Hr	Kg/Hr	TOTAL Gr/DSCF	Mg/M³	Lb/Hr	Kg/Hr
1384	.000001	.003389	.000029	.000013								
1385	.000003	.006805	.000059	.000027								
1386	.000002	.003811	.0000328	.000015								
	6	7	8	9	10	17	18	19	20	21	22	23

Remarks:

SAMPLING SUMMARY SHEET

PLANT AUTOMATIC DIE CASTING

LOCATION SAINT CLAIR SHORES, MICHIGAN

SAMPLED SOURCE DECORATIVE CHROMIUM ELECTROPLATING TANK #27 (PERMANENT FUME SUPRESSANT)

Run	Date	N_p	(3) Y_m	(4) ΔH	(5) P Bar.	(6) V_m	(7) T_m	(8) V_m Std.	(9) %	(10) P_{st}	17 P_s	(18) T_s	(19) VP	(20) V_w	21 $V_{w_{gas}}$	22 %M	23 M_d
1387	25APR88	x2 24	.998	5.3	29.50	306.646	113	281.712		-1.7	29.38	72		74.7	3.52	1.13	.988
1388	26APR88	x2 24	.998	5.0	29.46	293.502	100	275.324		-1.7	29.34	75		94.3	4.44	1.60	.984
1389	26APR88	36	.998	4.8	29.46	215.999	163	201.442		-1.7	29.34	75		63.8	3.00	1.50	.985

Run	(24) CO_2	(25) O_2	26 N_2	(27) CO	(28) —	29 MW_d	30 MW	(31) C_p	(32) $\sqrt{\Delta P_s (T_s + 460)}$	(33) T_t	(34) D_n	35 V_s	(36) D_s	(37) Area	38 ACFM	(39) DSCFM	40 %I
1387	0.7	21.0	78.3			28.95	28.82	.84	6.1501	240	.497	15.2		2.6113	2378	2289	99.5
1388	0.7	21.0	78.3			28.95	28.78	.84	6.0882	240	.497	15.1		2.6113	2358	2245	99.1
1389	0.7	21.0	78.3			28.95	28.79	.84	5.9596	180	.497	14.7		2.6113	2307	2200	.987

$$V_{m\,Std.} = V_m \frac{17.64 \times V_m \left(P\ Bar. + \frac{\Delta H}{13.6}\right)}{(T_m + 460)}$$

$$V_{w_{gas}} = 0.0471\ V_w$$

$$MW_d = CO_2 \times .44 + (O_2 \times .32) + (CO + N_2) \times .28 + \left(\%Other \times \frac{Mol.\ wt.}{100}\right)$$

$$MW = MW_d \times M_d + 18(1 - M_d)$$

$$V_s = 85.48 \times C_p \sqrt{\Delta P_s (T_s + 460)} \left[\frac{1}{P_s \times MW}\right]^{1/2}$$

$$\%I = \frac{0.09450 \times (T_s + 460) \times V_{m\,Std.}}{V_s \times T_t \times P_s \times M_d \times A_n}$$

$$\%M = \frac{100 \times V_{w_{gas}}}{V_{m\,Std.} + V_{w_{gas}}}$$

$$M_d = \frac{100 - \%M}{100}$$

$$P_s = P\ Bar. \pm \frac{P_{st}}{13.6}$$

N_p = Total No. of Sampling points

Y_m = Meter Box Correction Factor

ΔH = Average Orfice Pressure Drop, Inches H_2O

P Bar. = Barometric Pressure, Inches Hg. Absolute

V_m = Volume of Dry Gas at Meter Conditions, DCF

T_m = Average Meter Temperature, °F.

$V_{m\,Std.}$ = Volume of Dry Gas at STP, DSCF[a]

% = Per Cent other gas removed before Dry Gas Meter

P_{st} = Static Pressure of Stack Gas, Inches H_2O

P_s = Stack Gas Pressure, Inches Hg.

T_s = Average Stack Temperature, °F

VP = Vapor Pressure of H_2O At Stack Temperature

V_w = Total H_2O Collected in Impingers and Silica Gel

$V_{w_{gas}}$ = Volume of water vapor collected at STP, SCF[b]

%M = Per Cent Moisture by volume

M_d = Mole Fraction of Dry Gas

CO_2 = Volume % Dry

O_2 = Volume % Dry

N_2 = Volume % Dry

CO = Volume % Dry

MW_d = Molecular Weight of Stack Gas Dry Basis

MW = Molecular Weight of Stack Gas, Wet Basis

$\sqrt{\Delta P (T_s + 460)}$ Is determined by averaging the square root of the product of the velocity head (P) and the absolute stack temperature from each sampling point.

T_t = Net time of test in minutes

D_n = Sampling Nozzle Diameter, inches

A_n = Area of Nozzle opening, ft^2.

V_s = Stack Gas Velocity at Stack Conditions, Feet per second.

D_s = Diameter of Stack, inches

Area = Area of duct in ft^2

ACFM = Actual Cubic Feet per minute

DSCFM = Dry Standard Cubic Feet per minute

%I = Per Cent Isokinetic

[a] Dry Standard Cubic Feet @ 68°F, 29.92 in. Hg.

[b]

SUMMARY OF EMISSIONS

PLANT AUTOMATIC DIE CASTING LOCATION SAINT CLAIR SHORES, MICHIGAN

SAMPLED SOURCE DECORATIVE CHROMIUM ELECTROPLATING TANK #27 (PERMANENT FUME SUPRESSANT)

RUN	DATE	(1) V_m Std.	(2) DSCFM
13B7	25APR88	261.712	2289
13B8	26APR88	275.324	2245
13B9	26APR88	201.442	2200

FRONT HALF MILLIGRAMS				(4)	5
PROBE	Impingers ~~CYCLONE~~	Probe & Noz ~~FILTER~~	(3) TOTAL	BACK HALF	FRONT + BACK TOTAL
	9.180	6.094	15.274		
	7.34	1.92	9.240		
	12.716	6.955	~~.019~~ .625		
			.019675		

C-15

CONCENTRATIONS

FRONT HALF					BACK HALF				TOTAL			
RUN	Gr/DSCF	Mg/M^3	Lb/Hr	Kg/Hr	Gr/DSCF	Mg/M^3	Lb/Hr	Kg/Hr	Gr/DSCF	Mg/M^3	Lb/Hr	Kg/Hr
13B7	.0000008	.0019147	.0000164	.0000074								
13B8	.0000005	.0011877	.00001	.0000045								
13B9	.0000015	.0034491	.0000284	.0000129								
	6	7	8	9	10	17	18	19	20	21	22	23

Remarks:

APPENDIX D

Draft Method - Determination of Hexavalent Chromium in Dry Particulate Emissions from Stationary Sources

DRAFT METHOD - DETERMINATION OF HEXAVALENT CHROMIUM IN DRY PARTICULATE EMISSIONS FROM STATIONARY SOURCES

1.0 APPLICABILITY AND PRINCIPLE

1.1 Applicability

This method applies to the determination of hexavalent chromium (Cr^{+6}) in dry particulate emissions only from specified stationary sources whose emissions do not contain acids or organics.

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 for Cr^{+6} by the diphenylcarbazide colorimetric method.

2.0 RANGE, SENSITIVITY, PRECISION, AND INTERFERENCES

2.1 Range

A straight-line response curve can be obtained in the range 5 µg Cr^{+6}/100 mℓ to 100 µg Cr^{+6}/100 mℓ. For a minimum analytical accuracy of ±10 percent, the lower limit of the range is 10 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} in dry particulate emissions was determined 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 deviations were less than 10 percent in all cases.

2.4 Interference

Molybdenum, mercury and vanadium react with diphenylcarbazide to form a color; however, approximately 20 mg of these elements can be present in a sample without creating a problem. Iron produces a yellow color, but this effect is not measured photometrically at 540 nm. No interference was observed at the sources listed in Section 2.3.

3.0 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 constructed of plastic or glass, to accommodate 47-mm diameter, 3.0-μg size Teflon filters (NOTE: Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency).

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.

4.0 REAGENTS

Unless otherwise indicated, all reagents shall conform to the specifications established by the Committee on Analytical Reagents of the American Chemical Society. Where such specifications are not available, use the best available grade.

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 Water--

Deionized distilled, meeting American Society for Testing and Materials (ASTM) specifications for type 2 reagent - ASTM Test Method D 1193-77 (incorporated by reference - see Section 61.18).

4.3.2 Digestion Solution--

Dissolve 20.0 g NaOH and 30.0 g anhydrous Na_2CO_3 in water in a 1-liter volumetric flask, and dilute to the mark. Store the solution in a tightly capped polyethylene bottle. Prepare fresh monthly.

4.3.3 Potassium Dichromate Stock Solution--

Dissolve 141.4 mg of analytical reagent grade $K_2Cr_2O_7$ in water, and dilute to 1 liter (1 mℓ = 50 μg Cr^{+6}).

4.3.4 Potassium Dichromate Standard Solution--

Dilute 10.00 mℓ $K_2Cr_2O_7$ stock solution to 100 mℓ (1 mℓ = 5 μg Cr^{+6}) with water.

4.3.5 Sulfuric Acid, 10 percent (v/v)--

Dilute 10 mℓ H_2SO_4 to 100 mℓ in water.

4.3.6 Acetone--

Same as Method 5, Section 3.2.

4.3.7 Diphenylcarbazide Solution--

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

5.0 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 dry particulate source samples from the sources described in Section 2.3 demonstrated that the Cr^{+6} content of the samples was stable. Nevertheless, all samples should be protected from extreme heat, kept dry and should be analyzed within 1 month of collection.

5.4 Sample Digestion and Preparation

Place the contents of Container Number 2 (the acetone probe rinse) in a 250-mℓ beaker. Evaporate to dryness. Place the contents of Container Number 1 in the same beaker (cut the filter into small pieces). Add 40 mℓ of digestion solution (Section 4.3.2). 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 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 water.

5.5 Reagent Blank Preparation

Take a representative amount of acetone and a blank Method 5 filter and proceed as in Section 5.4.

5.6 Silica Gel Weighing

Weigh the spent silica gel (Container Number 3) or silica gel plum 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 a 50-mℓ or smaller aliquot of the prepared sample to a 100 mℓ volumetric flask and add sufficient water to bring the volume to approximately 80 mℓ. Adjust the pH to 2 ± 0.5 with 10 percent H_2SO_4, add 2.0 mℓ of diphenylcarbazide solution, and dilute to volume with water. Allow the solution to stand about 10 minutes for color development. For each set of samples analyzed, treat an identical aliquot of reagent blank solution in the same way. Transfer a portion of the sample to a 1-cm absorption cell and measure the absorbance a the optimum wavelength (Section 6.2.1). Measure and subtract the reagent blank absorbance reading, if any, to obtain a net reading. If the absorbance of the sample exceeds the absorbance of the 100 µg Cr^{+6} standard as determined in Section 6.2.2, dilute the sample and the reagent blank with equal volumes of water.

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:

Obtain two equal volume aliquots of the same sample solution. The aliquots should contain between 30 and 50 µg of Cr^{+6} (less is acceptable if not possible). Spike one of the aliquots with an aliquot of standard solution that contains between 30 and 50 µg of Cr^{+6}. Now treat both the spiked and unspiked sample aliquots as described in Section 5.7.1.

Next, calculate the Cr^{+6} mass (C_s), in µg in the aliquot of the unspiked sample solution by using the following equation.

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

Where:

C_a = Cr^{+6} in the standard solution, µg.
A_s = Absorbance of the unspiked sample solution.
A_t = Absorbance of the spiked sample solution.

Volume corrections will not be required since the solutions as analyzed have been made to the same final volume. If the results of the method of additions procedure used on the single source sample do not agree to within 10 percent of the value obtained by the routine spectrophotometric analysis, then reanalyze all samples from the source using this method of additions procedure.

6.0 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 are normally 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 shall read correctly within ±5 nm, at all calibration points; otherwise, repair and recalibrate the spectrophotometer. 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 the 50 µg Cr^{+6} standard solution (Section 4.3.4) in the sample cell and a blank solution in the reference cell. If a peak does not occur, the spectrophotometer is malfunctioning. When a peak is obtained within the 530 to 550 nm range, record and use the wavelength at which this peak occurs as 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 scan the blank and standard solutions separately. For this instrument, the optimum wavelength is the wavelength at which the maximum difference in absorbance between the standard and the blank occurs.

6.2.2 Spectrophotometer Calibration--

Alternative calibration procedures are allowed provided acceptable accuracy and precision can be demonstrated. Add 0.0 mℓ, 1 mℓ, 2 mℓ,

5 mℓ, 10 mℓ, 15 mℓ, and 20 mℓ of the working standard solution (1 mℓ = 5 μg Cr^{+6}) to a series of seven 100-ml volumetric flasks. Dilute each to mark with water. 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 K_c as follows:

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

where:

K_c = Calibration factor.
A_1 = Absorbance of the 5 μg Cr^{+6}/100 mℓ standard.
A_2 = Absorbance of the 10 μg Cr^{+6}/100 mℓ standard.
A_3 = Absorbance of the 25 μg Cr^{+6}/100 mℓ standard.
A_4 = Absorbance of the 50 μg Cr^{+6}/100 mℓ standard.
A_5 = Absorbance of the 75 μg Cr^{+6}/100 mℓ standard.
A_6 = Absorbance of the 100 μg Cr^{+6}/100 mℓ standard.

6.2.2.1 Spectrophotometer Calibration Quality Control--Multiply the absorbance value obtained for each standard by the K_c factor (least squares slope) to determine the distance each calibration point lies from the theoretical calibration line. These calculated concentration values shall not differ from the actual concentrations (i.e., 5, 10, 25, 50, 75, and 100 μg Cr^{+6}/100 ℓ) by more than ___ percent (to be determined) for five of the six standards.

7.0 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:

$$m = \frac{100\ K_c\ AF}{v_a}$$

Where:

100 = Volume in mℓ of total sample.

A = Absorbance of sample.

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

v_a = Volume in mℓ of aliquot analyzed.

7.2 Average Dry Gas Meter Temperature and Average Orifice Pressure D

Same as Method 5, Section 6.2.

7.3 Dry Gas Volume, Volume of Water Vapor, Moisture Content

Same as Method 5, Section 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:

$$c_s = 10^{-6} g/\mu g)(m/V_{m(std)})$$

7.5 Isokinetic Variation, Acceptable Results

Same as Method 5, Sections 6.11 and 6.12, respectively.

8.0 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, and 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 in Bibliography of Method 5, Citations 2 to 5 and 7.

APPENDIX E

Chain-of-Custody Data Sheets

SAMPLE CHAIN OF CUSTODY

Plant: Automatic Die Casting Test Number: MM13B-1

Date Sampled: 4-18 Run Number: -1

SAMPLE RECOVERY

Container Code	Description
MM13B-1	NaOH Probe wash & impinger catch

Person Engaged in Sample Recovery

Signature: J R B

Title: Meter Reader

Location at which Recovery was Done: OFFICE

Date and Time of Recovery: 4-18-88

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature:

Title:

Date and Time of Receipt:

Sample Storage:

Laboratory Person Receiving Sample

Signature: Helen Owens

Title: Project site mgr. / analyst

Date and Time of Receipt: 4/18/88 1722

Sample Storage: locked recovery room/lab

ANALYSIS

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

SAMPLE CHAIN OF CUSTODY

Plant: Automatic Die Casting Test Number: MM130-2

Date Sampled: 4-19-88 Run Number: -2

SAMPLE RECOVERY

Container Code	Description
MM130-2	NaOH Wash & Impinger Catch

Person Engaged in Sample Recovery

Signature: J R B

Title: Motor Reader

Location at which Recovery was Done: Office

Date and Time of Recovery: 4-19-88

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature:

Title:

Date and Time of Receipt:

Sample Storage:

Laboratory Person Receiving Sample

Signature: Helen Owens

Title: Analyst

Date and Time of Receipt: 4/19/88 1056

Sample Storage: Locked recovery room/ on-site lab

ANALYSIS

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

SAMPLE CHAIN OF CUSTODY

Plant: Automatic Die Casting Test Number: MM 13B-3

Date Sampled: 4-19-88 Run Number: -3

SAMPLE RECOVERY

Container Code	Description
MM13B-3	NaOH Wash & Impinger Catch

Person Engaged in Sample Recovery

Signature: [illegible]

Title: Meter Reader

Location at which Recovery was Done: Office

Date and Time of Recovery: 4-19-88

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature:

Title:

Date and Time of Receipt:

Sample Storage:

Laboratory Person Receiving Sample

Signature: Helen Owens

Title: Analyst

Date and Time of Receipt: 4/19/88 1538

Sample Storage: locked recovery room / laboratory

ANALYSIS

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

SAMPLE CHAIN OF CUSTODY

Plant: Automatic Die Casting Test Number: MM 13D-4

Date Sampled: 4-20 Run Number: #4

SAMPLE RECOVERY

Container Code	Description
MM13D-4	NaOH

Person Engaged in Sample Recovery

Signature: [illegible]

Title: Meter Reader

Location at which Recovery was Done: Office

Date and Time of Recovery: 4-20-88

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature:

Title:

Date and Time of Receipt:

Sample Storage:

Laboratory Person Receiving Sample

Signature: [illegible] Owens

Title: Physicist/analyst

Date and Time of Receipt: 4/20/88 1:30pm

Sample Storage: locked recovery room

ANALYSIS

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

SAMPLE CHAIN OF CUSTODY

Plant: Automatic Die Casting Test Number: MM13B-5

Date Sampled: 4-20-88 Run Number: #5

SAMPLE RECOVERY

Container Code	Description
MM13B-5	

Person Engaged in Sample Recovery

Signature: JRB

Title: Meter Reader

Location at which Recovery was Done: OFFICE

Date and Time of Recovery: 4-20-88

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature:

Title:

Date and Time of Receipt:

Sample Storage:

Laboratory Person Receiving Sample

Signature: Helen Owens

Title: analyst

Date and Time of Receipt: 4/20/88 5:00pm

Sample Storage: locked storage room

ANALYSIS

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

PES

SAMPLE CHAIN OF CUSTODY

Plant: Automatic Die Casting Test Number: MM13B-6

Date Sampled: 4-21-88 Run Number: #6

SAMPLE RECOVERY

Container Code	Description
MM13B-6	M234
MM13B-7	impinger catch

Person Engaged in Sample Recovery

Signature: [illegible]

Title: Meter Reader

Location at which Recovery was Done: Office

Date and Time of Recovery: 4-21-88

Sample(s) Recipient Upon Recovery if Not Recovery Person

Signature:

Title:

Date and Time of Receipt:

Sample Storage:

Laboratory Person Receiving Sample

Signature: [illegible]

Title: analyst

Date and Time of Receipt: 4/21/88 @3:30pm

Sample Storage: locked recovery room

ANALYSIS

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

SAMPLE CHAIN OF CUSTODY

Plant: Automatic Die Casting Test Number: ~~#7~~ MM13B-7

Date Sampled: 4-25-88 Run Number: #7

SAMPLE RECOVERY

Container Code	Description
MM13B-7	NaOH Prime wash
MM13B-7	NaOH Impinger catch

Person Engaged in Sample Recovery

Signature: ARB

Title: Meter Reader

Location at which Recovery was Done: office

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: Helen Owens

Title: analyst I

Date and Time of Receipt: 4/25/88 ~~at~~ 1:30p

Sample Storage: locked recovery room

ANALYSIS

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

SAMPLE CHAIN OF CUSTODY

Plant: Automatic Die Casting Test Number: MM13B-8

Date Sampled: 4-26-88 Run Number: #8

SAMPLE RECOVERY

Container Code	Description
~~Rot~~ MM13B-8	NaOH Nozzle wash
MM13B-8	NaOH Impinger catch

Person Engaged in Sample Recovery

Signature: [illegible]

Title: Water Rec

Location at which Recovery was Done: Office

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: Helen Owens

Title: analyst

Date and Time of Receipt: 4/26/88, 1:30 pm

Sample Storage: Locked recovery room

ANALYSIS

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

SAMPLE CHAIN OF CUSTODY

Plant: Automatic Die Casting Test Number: #MM13A-9

Date Sampled: 4-26-88 Run Number: #9

SAMPLE RECOVERY

Container Code	Description
MM13A-9	NaOH Nozzle wash
MM13A-9	NaOH impinger catch

Person Engaged in Sample Recovery

Signature: [illegible]

Title: Meter Reader

Location at which Recovery was Done: Off. c-f

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: Helen Owens

Title: analyst

Date and Time of Receipt: 4/26/88 5.30pm

Sample Storage: lab recovery room

ANALYSIS

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

APPENDIX F

Equipment Calibration Data

PITOT TUBE CALIBRATION DATA SHEET

Calibrated By: T MILLER

Date: 8-12-87

Pitot I.D. No.: S-1

Effective Length: 2.5' (30")

Pitot Tube Assembly Level? Yes ✓ No

Pitot Tube Openings Damaged? Yes (explain below) No ✓

α_1 = 1 ° (<10°) α_2 = 2 ° (<10°)

β_1 = 1 ° (<5°) β_2 = 0 ° (<5°)

γ = 1 ° θ = 2 ° A = 0.915 °

z = A sin γ = 0.016 cm (in.) 0.32 cm (<1/8 in.)

w = A sin θ = 0.032 cm (in.) 0.08 cm (<1/32 in.)

P_A = 0.458 cm (in.)

P_B = 0.457 cm (in.)

D_t = 0.380 cm (in.)

Comments:

F-2

Calibration Required? Yes No ✓

TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 1-20-88 Thermocouple number SH-5

Ambient temperature _____ °F Barometric pressure 27.05 in. Hg

Calibrator T. Miller Reference: mercury-in-glass ASTM-3F(34078)

other _____

Reference point number[a]	Source[b] (specify)	Reference thermometer temperature, °F	Thermocouple potentiometer temperature, °F	Temperature difference,[c] %
1	ambient	75	73	2.7
2	ice bath	32	32	0
3	heated oil	428	428	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 1-20-88 Thermocouple number 5H-4

Ambient temperature 75 °C Barometric pressure 29.05 in. Hg

Calibrator T. Miller Reference: mercury-in-glass ASTM 3F (34078)

other

Reference point number[a]	Source[b] (specify)	Reference thermometer temperature, °C	Thermocouple potentiometer temperature, °C	Temperature difference,[c] %
1	ambient	75	73	2.7
2	ice bath	33	33	0
3	heated oil	430	430	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 1-20-88 Thermocouple number 3B

Ambient temperature 75 °C Barometric pressure 29.05 in. Hg

Calibrator T. Miller Reference: mercury-in-glass ASTM 3F (34078)

other

Reference point number[a]	Source[b] (specify)	Reference thermometer temperature, °C	Thermocouple potentiometer temperature, °C	Temperature difference,[c] %
1	ambient	75	74	1.3
2	ice bath	33	33	0
3	heated oil	425	~~224~~ 424	0.2

[a]Every 30°C (50°F) for each reference point.

[b]Type of calibration system used.

[c] $\left[\frac{(\text{ref temp, °C} + 273) - (\text{test thermom temp, °C} + 273)}{\text{ref temp, °C} + 273}\right] 100 \leq 1.5\%.$

Ref. meter Y = .9985

DRY GAS METER AND ORIFICE CALIBRATION

Date: 4-16-88 Box No.: MB-1

Barometric Pressure, P_b = 29.40 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	ΔH@
0.5	5.608	5.901	70	97/102	82/86	552°R	13.98	.987	1.71
1.0	5.437	5.745	70	101/107	87/89	556	9.62	.989	1.71
2.0	5.910	6.228	70	106/112	89/91	560	7.60	.996	1.79
4.0	7.117	7.459	70	109/118	91/93	563	6.45	1.002	1.77
6.0	6.309	6.571	71	115/119	93/94	565	4.67	1.005	1.77
8.0	7.553	7.836	71	116/122	94/96	567	5.08	1.007	1.95
							Average	0.998	1.78

Calculations:

ΔH	$\frac{\Delta H}{13.6}$	Y: $\frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6}) (t_w + 460)}$	ΔH@: $\frac{0.0317 \Delta H}{P_b (t_d + 460)} \left[\frac{(t_w + 460)\ e}{V_w} \right]^2$
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.

ΔH@ = 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 _____ Date 4-28-88 Meter box number MB-1 Plant PEER/EPA CHROME

Barometric pressure, P_b = 29.46 in. Hg Dry gas meter number REF. Pretest Y 0.998

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 $\frac{V_w P_b (t_d + 460)}{V_d \left(P_b + \frac{\Delta H}{13.6}\right) (t_w + 460)}$
1.1	345.412	662.350	76	118	100	109 °F	10.0	5.0	0.997	
	351.146	668.441	76	116	100	569 °R				
1.1	351.146	668.441	76	114	100	108 °F	10.0	5.0	0.996	
	356.554	674.527	76	114	100	568 °R				
1.1	356.554	674.527	76	114	100	107 °F	10.0	5.0	0.996	
	362.025	680.611	76	114	100	567 °R				
									Y = 0.996	

[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.

T. MILLER

PACIFIC ENVIRONMENTAL SERVICES, INC.

POSTTEST DRY GAS METER CALIBRATION DATA FORM

Test numbers _____ Date 4-28-88 Meter box number MB-1 Plant PEER / EPA CHROME

Barometric pressure, P_b = 29.46 in. Hg Dry gas meter number REF. Pretest Y 0.998

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	$Y_i \frac{V_w P_b (t_d + 460)}{V_d \left(P_b + \frac{\Delta H}{13.6}\right)(t_w + 460)}$
4.1	311.750	627.044	74	122	94	111 °F 571 °R	10.0	15.0	1.012	
	322.557	638.343	74	130	97					
4.1	322.557	638.343	74	124	97	114 °F 574 °R	10.0	15.0	1.013	
	333.344	649.647	75	132	100					
4.1	333.344	649.647	75	132	100	117 °F 577 °R	10.0	15.0	1.014	
	344.101	660.952	76	133	101					
									Y = 1.013	

[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

PACIFIC ENVIRONMENTAL SERVICES, INC.

TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 4-14-87 Thermocouple number MB-1 RAC 1065

Ambient temperature 74 °F °C Barometric pressure 29.40 in. Hg

Calibrator FM Reference: mercury-in-glass ASTM 15-167 C

other

Reference point number[a]	Source[b] (specify)	Reference thermometer temperature, °C	Thermocouple potentiometer temperature, °C	Temperature difference,[c] %
METER INLET	AMB. AIR	74°F (23.3°C)	72°F (22.2°C)	0.37
METER OUTLET	AMB. AIR	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] $\left[\frac{(\text{ref temp, °C} + 273) - (\text{test thermom temp, °C} + 273)}{\text{ref temp, °C} + 273}\right] 100 \leq 1.5\%.$

APPENDIX G

Project Participants and Activity Log

PROJECT PARTICIPANTS

Name	Title	Responsibility
Frank Clay	U.S. EPA Task Manager Computer Center Coordinator Test Observationist	Observed test activity and on-site data reduction and calculations
John Brown	U.S. EPA, Technician	Conducted Screening Methods tests
Helen Owens	PEER Consultants, P.C. Project Leader	On-site analysis, coordinated test activity with plant and contractors
Andrew Weisman	PEER Consultants, P.C. Technician	Assisted in site set-up, sampling, sample recovery
Eric Hollins	PEER Consultants, P.C. Technician	Assisted in site set-up, sampling, sample recovery
Jim Blaw	Pacific Environmental Services Subcontractor Project Leader	Conducted emission sampling, sample train set-up and recovery
Robin Barker	MRI NSPS Contractor	Monitored process operation

ACTIVITY LOG

4/17	Test crew travels to Detroit
4/18	Site set-up, conduct MM13B-1 and Screening Methods and analysis
4/19	Conduct MM13B-2 and 3, Screening Methods and Analysis
4/20	Conduct MM13B-4 and 5, Screening Methods and Analysis
4/21	Conduct MM13B-6, Screening Methods and Analysis
4/25	Conduct MM13B-7, Screening Methods and Analysis
4/26	Conduct MM13B-8 and 9, Screening Methods, analysis, disassemble test site
4/27	Travel