Background Report Reference

AP-42 Section Number: 12.20

Background Chapter: 4

Reference Number: 70

Title: Final Report: Bethlehem Steel Corporation Chrome Line Scrubber

BCM

January 1992

AP-42 Section 12.20
Reference
Report Sect. 4
Reference 70

Bethlehem Steel Corporation

SPARROWS POINT PLANT
SPARROWS POINT, MD 21219

January 27, 1992

Mr. George P. Ferreri
Air Management Administration
Maryland Department of the Environment
2500 Broening Highway
Baltimore, Maryland 21224

Ref: #8 TFSCT Line Scrubber Stack Testing

Dear George:

Pursuant to the December 27, 1991 "Plan For Compliance", please find attached the test report on Hexavalent Chromium emissions from the #8 Line Scrubber Stack. As you peruse the report, please note that the average loading (.0032 #/hr.) was considerably less than our previous test in July (.133 #/hr.). In fact, this recent test was below the emission estimate for the #8 Line submitted with the application to construct our new #4 Galvanize Line (.0048 #/hr.). Please note that the operating parameters noted in the report may vary from time to time as operating conditions on the line vary. The results were achieved through the introduction of spent sulfuric acid pickle liquor to the scrubber to more efficiently remove the chromium.

As you know the system was a temporary setup to allow the use of the pickle liquor in the scrubber. Based on the test results and in keeping with the spirit and letter of the Plan for Compliance, we will begin working on the plan and schedule to be submitted to you in July for the installation of a permanent spent pickle liquor addition system necessary to maintain compliance with Maryland's screening levels for hexavalent. 30 days after completion of the pickle liquor system, we will submit to you an Operation & Maintenance Plan for the #8 Line.

Should there be any questions on the report or our plan of action, please do not hesitate to call me.

Sincerely,

Erroll B. Hay
Superintendent, Environmental
Health, Control & Safety

JTM:kam
Enclosure

AP-42 Section 12.20
Reference
Report Sect. 4
Reference 70

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Superintendent, Environmental
Health, Control & Safety

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Enclosure

FINAL REPORT

BETHLEHEM STEEL CORPORATION
CHROME LINE SCRUBBER

JANUARY 1992

BCM PROJECT NO. 00-5118-23

PREPARED BY

KENNETH R. GLASSER
PROJECT MANAGER

REVIEWED BY

PAUL D. ROSENSTOCK, Ph.D.
VICE PRESIDENT

0046L

BCM
Engineers, Planners, Scientists and Laboratory Services
One Plymouth Meeting • Plymouth Meeting, PA 19462 • Phone: (215) 825-3800

TABLE OF CONTENTS

APPENDICES

1.0 INTRODUCTION

Bethlehem Steel Corporation operates a chrome steel line at its facility in Sparrows Point, Maryland. The continuous process electroplater typically operates at a line speed of 1,200 to 1,550 feet per minute, and at a plater solution temperature of approximately 100 to 125°F. Chromic acid concentration of the plater solution is approximately 150 to 160 g/l. Chemical treatment concentration is maintained at 25 g/l (see Appendix A). The air emissions from this chrome line are controlled by a scrubbing system.

BCM Engineers Inc. (BCM) was retained to re-determine the compliance status of the outlet stack with respect to the Maryland Department of the Environment emission regulation for hexavalent chromium. Testing was conducted during the period, December 12 through December 13, 1991. The testing program adhered to protocols already established for the previous compliance test at the chrome line scrubber that was conducted by BCM on July 10 and 11, 1991. Details of the protocol can be found in BCM's report, "Chrome Line Scrubber Compliance Evaluation," August 1991.

Three tests were performed at the outlet stack in accordance with the Draft Environmental Protection Agency (EPA) Test Method for Electroplaters (see Appendix B, BCM Intent to Test Protocol dated June 27, 1991). The actual emission rates determined from the three tests are shown in Table 1. Gas flow rate and temperature results are shown in Table II.

Table I
Cr^{+6} Concentration
(Ref.: Draft EPA Method for Electroplaters)

Run No.	mg/m^3 (std)	gr/ft^3 (std)	Approx. Mass Emission Rate (kg/hr)	(lb/hr)
1	0.27.6E-3	1.21E-5	0.681E-3	1.50E-3
2	43.0E-3	1.88E-5	1.10E-3	2.43E-3
3	103.0E-3	4.50E-5	2.61E-3	5.74E-3

Table II
Stack Flow, Temperature

Run No.	Velocity (ft/min)	Flow Rate (acfm)	Temperature (°F)
1	2,010	14,200	104
2	2,090	14,800	103
3	2,060	14,600	103

Since total plant-wide emissions will be modeled by the Maryland Department of the Environment to access ground level concentrations of Cr^{+6}, no attainment criteria are available for this individual source.

The above results were obtained over a period of two sampling days, December 12 and 13, 1992. Run Nos. 1 and 2 were conducted during the first day of sampling. Run No. 3 was conducted during the second day of sampling.

2.0 SCOPE AND OBJECTIVES

The scope of the project was first outlined in BCM's proposal No. 18-8206-00 dated June 6, 1991. The objective of the sampling program was to determine the following parameters:

- Gas flow - acfm
- Stack Temperature - °F
- Cr^{+6} emission - mg/m^3 std, kg/hr

3.0 PROCEDURES

3.1 FIELD WORK

Field testing was conducted on December 12 and 13, 1991. The sampling team consisted of the following BCM personnel:

Karl Brenton, Technician III
Nick Charno, Technician IV

Emission testing was conducted according to procedures outlined in the Draft EPA Method for Electroplaters.

Severe cyclonic flow conditions were encountered in the stack during preliminary pitot tube traverses on the first day of sampling. As a result, velocity pressures in the stack were determined at the angle of cyclonic flow at each point of the traverse. The velocity pressures and angles of cyclonic flow thus obtained, were used in calculating the sampling duration at each traverse point within the stack, as well as determining time-weighted averages for stack and dry gas meter temperatures. The mass emission rates were multiplied by the average cosine of the cyclonic flow angles to obtain the corrected mass emission rates. These procedures for calculating and reporting emissions when cyclonic flow exists are referenced in The Method for Sampling Cyclonic Flow prepared by the Texas Air Control Board, Austin, Texas. This method was confirmed and approved for these tests by Mr. Jim Gouvas, EPA, Region 3; Mr. Frank Clay, EMTIC, Field Testing Section, EPA; and the Maryland Department of the Environment.

3.2 SAMPLING METHODS

3.2.1 Test Station and Traverse Location

The internal diameter of the scrubber outlet stack was 36 inches. Two test ports were located in the same cross sectional plan, 90 degrees apart. The nearest downstream flow disturbance was located five duct diameters from the testing ports. The nearest upstream flow disturbance was the stack outlet and it was located 10 duct diameters from the testing ports. A total of 24 traverse points (12 per port) were utilized for the testing program.

3.2.2 Gas Flow and Temperature Determinations

The gas flow rate and temperature profiles were measured by conducting a simultaneous velocity and temperature traverse. Gas velocity heads were measured with an "S"-Type pitot tube, which was connnected to an inclined manometer. A Chromel-Alumel thermocouple connected to a potentiometer was used to determine the gas temperature.

3.2.3 Gas Molecular Weight

According to the Draft EPA Method for Electroplaters, a gas molecular weight determination by EPA Method 3 was not required. The value of 28.95 was used for the dry molecular weight of air.

3.2.4 Gas Moisture Content

Actual testing for stack gas moisture content was not required for the above-referenced method. For agency purposes, the relative humidity (as quoted by the local weather bureau) was reported.

3.2.5 Non-Isokinetic Sampling

The sampling procedures and sampling equipment used were those outlined in the Draft EPA Method for Electroplaters. An all-glass probe and nozzle were used for sampling. The size of the nozzle required to maintain a sampling rate of 0.75 cfm was calculated from the results of a previously completed velocity and temperature traverse. A nozzle of the calculated size was attached to the end of the probe, which was inserted into the stack. An "S"-type pitot tube and Chomel-Alumel thermocouple were clamped to the probe and were used to monitor the velocity head and temperature at the traverse points during the sampling period. Sampled gas passed through the nozzle and the probe to the impinger train. Each of the first two impingers contained 125 ml of 0.1 N NaOH, as required by the method; the third impinger was filled with silica gel. From the impinger train, the gas was conducted through an umbilical cord to the control console (an Andersen Universal Stack Sampler), which contained the following pieces of equipment (listed in the order in which sampled gas pass through them): a main valve, a bypass valve for flow adjustment, an airtight vacuum pump, a dry gas meter, and a calibrated orifice. The orifice was equipped with pressure taps which were connected across the inclined manometer used to ensure that sampling conditions were maintained.

The sampling train was checked for leaks before and after each sample run. The inlet of the nozzle was plugged and the pump vacuum was held at the highest vacuum attained during that period of testing. In all cases, the leakage rate was minimal and did not exceed the maximum allowable leakage of 0.02 cubic feet per minute (cfm).

Upon completion of the test, the probe and nozzle were washed internally with 0.1 N NaOH solution. The washings obtained were added to the solutions contained in the first impinger and the solutions from both impingers were combined to form one sample. Combined samples from each test run were placed in separate bottles. Into a fourth sample bottle, a portion of unused 0.1 N NaOH impinger solution was placed; this fourth sample bottle constituted the blank. All test samples, as well as the blank of 0.1 N NaOH solution, were submitted to Air Quality Services, Inc. for analysis.

3.3 ANALYTICAL METHODS

All samples generated during the testing program were analyzed by Air Quality Services, Inc., located in Pittsburgh, Pennsylvania.

At the laboratory, aliquots of the final impinger solutions were transferred to volumetric flasks and combined with diphenylcarbazide solution. The absorbance of the colored derivative thus obtained from each sample was determined spectrophotometrically at a wavelength of 540 mμ (milli-microns). A plot of standard Cr^{+6} concentrations versus absorbance at 540 mμ was used to determine Cr^{+6} concentrations in the samples. An outline of the diphenyl-carbazide/spectrophotometric method for hexavalent chromium appeared in Appendix C of BCM's earlier report, "Chrome Line Scrubber Compliance Evaluation", dated August 1991. The following pages include laboratory results, field data acquired for each test run, and final results corrected for cyclonic flow.

3.4 EQUIPMENT CALIBRATION

In accordance with accepted procedures published by the EPA, all gas velocity measuring equipment, gas volume metering equipment, and temperature measuring equipment had been calibrated within 60 days of the test program.

APPENDIX A

CHROME LINE OPERATING DATA

Test No. 2

No. 8 Chrome Line Operating Data

Date/Time	Plater Amps	Plater Amps	Plater Solution Temp. °F	Chemical Treatment Sol. Temp. °F	Line Speed (FPM)	Chromic Acid Concentration g/l
12/12/91	2E 3750	6E 0				
1345 Hrs.	3E 3600	7E 3000	1- 115	121	1500	Plater - 149
	4E 3400	East Anode 3400	2- 125			CT - 25
	5E 3250					
	2W 3200					
	3W 3300	6W 0				
	4W 2900	7W 2700				
	5W 3000	West Anode 2900				
1519	2E 3750	6E 0	1- 117	115	1200	Plater - 149
	3E 3600	7E 3200	2- 119			CT - 25
	4E 3500	East Anode 3600				
	5E 3250					
	2W 3200					
	3W 3700	6W 0				
	4W 2800	7W 3000				
	5W 3100	West Anode 3600				
1705	2E 4000	6E 0	1- 108	120	1200	Plater - 149
	3E 3600	7E 3750	2- 114			CT - 25
	4E 4000	East Anode 4000				
	5E 4000					
	2W 3750					
	3W 3600	6W 0				
	4W 3300	7W 3300				
	5W 3400	West Anode 3500				

Scrubber Water Flows - Packing - 150 gpm
Pig Tail Sprays - See attachment
SPL Flw - See attachment

Observer - J. Dolan

Test No. 3

No. 8 Chrome Line Operating Data

Date/Time	Plater Amps	Plater Amps	Plater Solution Temp. °F	Chemical Treatment Sol. Temp. °F	Line Speed (FPM)	Chromic Acid Concentration g/l
12/12/91	2E 4000	6E 0				
0840 Hrs.	3E 3400	7E 3250	1- 99	119	1550	Plater - 157
	4E 3900	East Anode 4000	2- 102			CT - 24
	5E 3750					
	2W 3900					
	3W 3600	6W 0				
	4W 3300	7W 3400				
	5W 3200	West Anode 3600				
1000 Hrs.	2E 4000	6E 0	1- 120	116	1550	Plater - 157
	3E 3600	7E 3600	2- 100			CT - 24
	4E 3750	East Anode 4000				
	5E 3750					
	2W 3700					
	3W 2500	6W 0				
	4W 3200	7W 3200				
	5W 3200	West Anode 3500				
1124 Hrs.	2E 4000	6E 0	1- 98	120	1550	Plater - 157
	3E 3600	7E 1600	2- 102			CT - 24
	4E 3700	East Anode 3900				
	5E 2000					
	2W 3600					
	3W 3300	6W 0				
	4W 2900	7W 1300				
	5W 1500	West Anode 3400				

Scrubber Water Flows - Packing - 150 gpm
Pig Tail Sprays - See attachment
SP2 Flow - See attachment

Observer - J. Dolan

Table 1. Operating Data - December 12-13, 1991
No.8 TFS Line Chromium Scrubber Tests
Sparrows Point

Date	Time	Flows	
		SPL ml/min	Water gal/min
12 Dec 91	0730	3,300	-
12 Dec 91	0735	1,800	-
12 Dec 91	0748	590	5.7
12 Dec 91	0811	430	5.7
12 Dec 91	0900	1,700	5.7
12 Dec 91	0915	830	5.9
12 Dec 91	0932	820	5.9
12 Dec 91	0950	660	5.9
12 Dec 91	1030	660	6.0
12 Dec 91	1100	660	6.0
12 Dec 91	1130	620	6.0
12 Dec 91	1154	580	6.0
12 Dec 91	1308	1,700	5.5
12 Dec 91	1322	1,700	-
12 Dec 91	1330	Switch to town water.	
12 Dec 91	1332	3,300	5.0
12 Dec 91	1344	3,000	5.0
12 Dec 91	1359	3,800	5.1
12 Dec 91	1406	3,300	-
12 Dec 91	1417	1,300	-
12 Dec 91	1429	1,100	5.1
12 Dec 91	1440	No.8 TFS line down for oil change.	
12 Dec 91	1515	No.8 TFS line restarts.	

Table 1. Operating Data - December 12-13, 1991
No.8 TFS Line Chromium Scrubber Tests
Sparrows Point

Date	Time	Flows	
		SPL ml/min	Water gal/min
12 Dec 91	1541	1,000	7.5
12 Dec 91	1602	2,000	6.3
12 Dec 91	1608	630	6.4
12 Dec 91	1637	490	6.3
12 Dec 91	1658	3,300	6.4
12 Dec 91	1704	2,700	6.4
13 Dec 91	0716	0	6.5
13 Dec 91	0720	12,000	-
13 Dec 91	0721	9,000	-
13 Dec 91	0743	2,100	4.6
13 Dec 91	0749	2,200	4.9
13 Dec 91	0759	910	4.9
13 Dec 91	0814	3,900	4.6
13 Dec 91	0827	3,100	4.6
13 Dec 91	0832	3,200	4.6
13 Dec 91	0840	2,900	4.6
13 Dec 91	0848	1,300	4.5
13 Dec 91	0858	-	4.7
13 Dec 91	0911	1,300	4.7
13 Dec 91	0931	1,200	4.7
13 Dec 91	0946	1,300	4.7
13 Dec 91	1000	1,200	4.7
13 Dec 91	1012	3,300	4.7
13 Dec 91	1019	2,900	4.6

Table 1. Operating Data - December 12-13, 1991
No.8 TFS Line Chromium Scrubber Tests
Sparrows Point

Date	Time	Flows	
		SPL ml/min	Water gal/min
13 Dec 91	1038	2,800	4.6
13 Dec 91	1044	2,800	4.6
13 Dec 91	1102	3,200	4.3
13 Dec 91	1117	2,400	4.4
13 Dec 91	1129	4,300	4.4

APPENDIX B

SAMPLING DATA SHEETS

Betz • Converse • Murdoch • Inc. BCM

VELOCITY DETERMINATIONS

Client: Bethlehem Steel

Sample Port Location:

Location: Chrome Line Scrubber Outlet

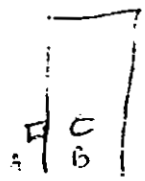
Date: 8-2-91

Stack Pressure: +.38

Barometric Pressure:

Pitot Factor: .84

Engineer: KB/ME



Pitot/Temperature Readings

Point No.	Distance (Inches)	Port B		Port C		Port A		Port C		Port	
		ΔP	T	ΔP	T	ΔP	T	ΔP	T	ΔP	T
1		.49	105	-55		.26	107	-40			
2		.50	105	-50		.35	107	-60			
3		.47	106	-45		.25	107	-30			
4		.46	106	-40		.23	105	-30			
5		.40	106	-15		.22	105	-30			
6		.30	106	-15		.20	105	-25			
7		.31	106	+25		.21	106	0			
8		.34	106	+8		.29	106	0			
9		.58	106	+5		.40	107	+20			
10		.68	106	+10		.54	107	+10			
11	.77	.78	106	+10		.67	106	+10			
12	.75	.46	106	+10		.66	104	+10			
TOTAL											
AVG.											

Betz • Converse • Murdoch • Inc. BCM

VELOCITY DETERMINATIONS

Client: Bethlehem Steel

Sample Port Location:

Location: [illegible]

Date: [illegible]

Stack Pressure: +.35

Barometric Pressure:

Pitot Factor: .84

Engineer: KDINC

Pitot/Temperature Readings

Point No.	Distance (Inches)	Port B		Port A		Port B		Port A		Port	
		ΔP	T	ΔP	T	ΔP	T	ΔP	T	ΔP	T
1		.53	105	.25	103	.34	106	.29	105		
2		.47	[illegible]	[illegible]	104	.47	106	.31	98		
3		.45	105	.25	103	.46	105	.36	104		
4		.35	[illegible]	[illegible]	101	.35	106	.38	104		
5		.35	104	.21	103	.35	105	.34	104		
6		.28	105	.22	104	.28	104	.30	104		
7		.38	105	.27	103	.39	103	.28	104		
8		.46	104	.37	103	.48	102	.45	103		
9		.63	105	.44	102	.66	102	.46	104		
10		.75	104	.61	103	.78	102	.70	104		
11		.76	103	.72	101	.75	102	.74	103		
12		.77	103	.70	103	.77	102	.71	104		
		Run 1					Run 2				
TOTAL											
AVG.											

Betz • Converse • Murdoch • Inc. BCM

VELOCITY DETERMINATIONS

Client: Bethlehem Steel Sample Port Location:

Location: Chrome lime Scrubber Outlet

Date: 12-13-91

Stack Pressure: +.33

Barometric Pressure: _____

Pitot Factor: .84

Engineer: KB/NC

Pitot/Temperature Readings

Point No.	Distance (Inches)	Port B		Port A		Port__		Port__		Port__	
		ΔP	T	ΔP	T	ΔP	T	ΔP	T	ΔP	T
1		.52	105	.33	105						
2		.48	105	.33	106						
3		.44	106	.30	104						
4		.38	104	.30	104						
5		.35	105	.28	105						
6		.30	104	.27	105						
7		.38	105	.32	105						
8		.57	103	.37	105						
9		.68	105	.42	105						
10		.76	105	.71	105						
11		.73	104	.69	105						
12		.75	105	.72	105						
			Run 3								
TOTAL											
AVG.											

RT 63%

PLANT Bethlehem Steel

DATE 12-12-91 OPERATOR KB/KC

SAMPLING LOCATION Chrome line exhaust. meter

BCM

METER BOX NUMBER A2 $\Delta H_@$

SAMPLE BOX NUMBER(S)

PROBE NUMBER TYPE

METHOD 6 FIELD DATA SHEET

Run 1

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	IMPINGER TEMPERATURE, °F
					INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F		
B		0928	717.250					
1	4'10"	933	720.5	105	46	41	5	38
2	4'50	9'01	723.4	105	54	41	5	38
3	3'46	12'53	726.3	106	54	44	5	38
4	5'32	18'25	730.1	106	75	46	5	38
5	6'31	24'56	734.2	104	80	48	5	38
6	5'38	30'34	738.3	105	85	51	5	40
7	5'23	35'57	742.1	105	87	53	5	40
8	7'0	42'57	747.3	104	91	55	5	40

CO_2 ____

O_2 ____

CO ____

P_b 30.40

9	5'05	51'02	753.2	105	92	58	5	40
10	5'39	59'41	759.1	104	92	59	5	42
11	9'13	68'54	765.7	103	95	61	5	40
12	9'16	78'10	772.5C	103	97	63	5	40
B	00	10550	712.5C	STOP	TEST	Hang		
1	4'10	82'20	775.2	103	30	63	5	40
2	2'40	85'00	777.4	104	91	63	5	40
3	5'01	90'01	781.5	105	93	62	5	40

CO_2 ____

O_2 ____

CO ____

P_b ____

leak chk = 0 cfm @ 12" Hg

4	4'26	94'27	784.2	101	96	62	5	40
5	4'20	98'47	787.2	103	98	64	5	40
6	4'19	103'06	791.7	104	98	64	5	42
7	4'53	107'59	793.9	103	99	65	5	42
8	5'44	113'43	798.3	103	100	66	5	42
9	6'20	120'03	802.7	103	100	67	5	42
10	7'43	127'46	808.1	103	101	67	5	42
11	8'35	136'21	814.6	101	102	69	5	42
12	8'31	144'52	821.017	103	105	69	5	42

CO_2 ____

O_2 ____

CO ____

P_b ____

RH 64%

PLANT Bethlehem Steel

DATE 12-12-91 OPERATOR KB/NC

SAMPLING LOCATION Chrome Lin. Inside Baffle

BCM

METER BOX NUMBER A2 $\Delta H_@$

SAMPLE BOX NUMBER(S)

PROBE NUMBER TYPE

METHOD 6 FIELD DATA SHEET

Run 2

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	IMPINGER TEMPERATURE, °F
					INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F		
B		1343	821.408					
1	4'17	4'17	821.91	106	53	52	6	40
2	4'52	9'07	825.2	106	73	51	6	40
3	3'46	12'53	831.7	105	80	53	6	40
4	5'32	18'25	831.9	106	85	57	6	40
5	6'31	24'56	839.4	105	91	58	6	42
6	5'38	30'34	843.6	104	92	59	6	42
7	5'23	35'57	847.3	103	94	62	6	42
8	7'0	42'57	852.4	102	96	63	6	42

CO_2 ____ O_2 ____ CO ____ P_b 30.28

9	8'05	51'02	858.6	103	98	64	6	42
10	8'39	59'44	858.927	102	98	65	6	42
1439 11	~~9'13~~	~~68'57~~	858.927	STOP	TEST	Line	Down	
~~12~~	~~9'16~~	~~78'10~~	1522 START TEST					
10	8'39	59'41	864.6	102	70	53	6	42
11	9'13	68'54	871.2	102	80	55	6	42
12	9'16	78'10	878.025	102	88	57	6	42
A	00	1551	878.025	STOP	TEST	Change Port		

CO_2 ____ O_2 ____ CO ____ P_b ____

1	4'10	82'20	881.0	103	83	60	6	44
2	2'40	85'00	883.4	98	74	60	6	44
3	5'01	90'01	887.1	104	84	60	6	44
4	4'26	94'27	890.2	104	90	60	6	44
5	4'20	98'47	892.0	104	92	61	6	45
6	4'19	103'06	896.1	104	93	61	6	45
7	4'53	107'59	899.1	103	94	63	6	45
8	5'44	113'43	903.2	104	95	63	6	45

CO_2 ____ O_2 ____ CO ____ P_b ____

PLANT Bethlehem Steel

DATE 12-12-91 OPERATOR KB/NC

SAMPLING LOCATION Chrome line Scrubber Outlet

BCM

METER BOX NUMBER A2 $\Delta H_@$

SAMPLE BOX NUMBER(S)

PROBE NUMBER TYPE

METHOD 6 FIELD DATA SHEET

Filter #

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	IMPINGER TEMPERATURE, °F
					INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F		
9	6'20	120'03	908.1	107	95	64	6	45
10	7'43	127'46	913.5	104	97	65	6	45
11	8'35	136'21	920.5	103	97	66	6	45
12	5'31	144'52	926.018	104	98	67	6	45

CO_2 _____

O_2 _____

CO _____

P_b _____

Leak CHK = .015 CFM @ 15" Hg

CO_2 _____

O_2 _____

CO _____

P_b _____

CO_2 _____

O_2 _____

CO _____

P_b _____

RH 729

PLANT Bethlehem Steel

DATE 12-13-91 OPERATOR KB/MC

SAMPLING LOCATION Furnace Line Scrubber Outlet

BCM

METER BOX NUMBER A2 $\Delta H_@$

SAMPLE BOX NUMBER(S)

PROBE NUMBER TYPE

METHOD 6 FIELD DATA SHEET

Run 3

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	IMPINGER TEMPERATURE, °F	
					INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F			
B		0840	926.804						
1	4'17	4'17	929.7	105	63	57	6	40	CO_2
2	4'50	9'07	933.2	105	72	57	6	40	O_2
3	3'46	12'53	935.9	106	82	58	6	40	CO
4	5'32	18'25	939.8	104	88	61	6	40	P_b 29.91
5	6'31	24'56	944.2	105	92	62	6	40	
6	5'38	30'34	948.1	105	97	65	6	40	
7	5'23	35'57	951.9	105	99	67	6	40	
8	7'00	42'57	956.4	105	101	69	6	40	
9	8'05	51'02	962.4	105	102	70	6	42	CO_2
10	8'39	59'41	968.4	105	104	72	6	42	O_2
11	9'13	68'54	975.3	104	105	74	6	42	CO
12	9'16	78'10	982.196	105	107	75	6	42	P_b
				STOP TEST CHANGE PORT					
A	~~~	1025	982.458	Leak CHK	—	—	—	—	
1	4'10	82'20	985.5	105	34	61	6	44	
2	2'40	85'00	987.5	106	93	67	6	44	
3	5'01	90'01	991.3	104	96	68	6	44	CO_2
4	4'26	94'27	994.8	104	98	68	6	45	O_2
5	4'20	98'47	997.3	105	99	70	6	45	CO
6	4'19	103'06	1000.5	105	101	70	6	45	P_b
7	4'53	107'59	1004.1	105	102	71	6	45	
8	5'44	113'43	1008.4	105	103	71	6	45	
9	6'20	120'03	1012.8	105	104	72	6	45	
10	7'43	127'46	1018.5	104	105	74	6	45	

RH 72%

PLANT Bethlehem Steel

DATE 12-13-[illegible] OPERATOR KD/ve

SAMPLING LOCATION Chrome Fume Scrubber Outlet

BCM

METER BOX NUMBER _____ $\Delta H_@$ _____

SAMPLE BOX NUMBER(S) _____

PROBE NUMBER _____ TYPE _____

METHOD 6 FIELD DATA SHEET

Run 3

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	IMPINGER TEMPERATURE, °F
					INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F		
11	8'35	136'21	1024.8	104	105	74	6	45
12	8'31	144'52	1030.978	105	107	75	6	45
			Leak Chk = .005	CFM @ 15" Hg				

CO_2 _____

O_2 _____

CO _____

P_b _____

CO_2 _____

O_2 _____

CO _____

P_b _____

CO_2 _____

O_2 _____

CO _____

P_b _____

APPENDIX C

LABORATORY ANALYSIS AND DATA REDUCTION

AIR QUALITY SERVICES, INC.

4527 Clairton Boulevard
Pittsburgh, PA 15236
(412) 881-5630

TABLE I
ANALYSIS OF SCRUBBER OUTLET SAMPLES FOR HEXAVALENT CHROMIUM
BCM ENGINEERS
ONE PLYMOUTH MEETING MALL
PLYMOUTH MEETING PENNSYLVANIA 19462
PURCHASE ORDER #22604 BETHLEHEM STEEL CHROME LINE
SAMPLES RECEIVED: DECEMBER 23, 1991

BCM SAMPLE NUMBER	AQS LABORATORY NUMBER	SAMPLE VOLUME MILLILITERS	HEXAVALENT CHROMIUM TOTAL MICROGRAMS
RUN #1	60500	400	81.5 µg
RUN #2	60501	538	127.9
RUN #3	60502	487	296.3
BLANK	60503	500	0.0

THE SAMPLES WERE ANALYZED BY THE DIPHENYLCARBIZIDE METHOD.
THE DATA HAS BEEN CORRECTED FOR THE BLANK.

HEX CHROME - DRAFT EPA TEST METHOD FOR ELECTROPLATERS
For Non-Isokinetic Sampling With Corrections For Cyclonic Flow
(Requires 24 Point Traverse & Minimum Sample Vol Of 100 ft3)

RUN NUMBER: one
PLANT NAME/LOCATION: Bethlehem Steel, Sparrows Point, MD
SAMPLING LOCATION: Chrome Line Scrubber Outlet
ANALYTICAL METHOD: EPA Draft Method For Electroplaters
STACK RADIUS (INCHES)= 18 **STACK PRESS (INCHES H2O)=** 0.38

AMBIENT CONDITIONS

Pbar (Hg")	BEGIN =	30.40	STOP =	30.40	AVERAGE=	30.40
% R H	BEGIN =	68.00	STOP =	68.00	AVERAGE=	68.00

METER BOX CALIBRATION FACTOR = 1.0000 **DELTA H =** 1.85

ACT GAS METER READ'G (Vm) ft3			CLOCK TIME(MIN)		
START	STOP	TOTAL	START	STOP	ELAPSED
717.280	821.017	103.737	0.00	144.87	144.87

ACTUAL SAMPLING RATE AT TEST CONDITIONS (ft3/min) = 0.72

PRELIMINARY PITOT AND CYCLONIC FLOW DETERMINATIONS

	TRAVERSE LOCATION	PORT A			PORT B		
			ABS MISALIGNMT	COSINE		ABS MISALIGNMT	COSINE
PT	(% DIAM)	DELTA P	ANGLE	OF ANGLE	DELTA P	ANGLE	OF ANGLE
1	2.10	0.28	40	0.7660	0.53	55	0.5736
2	6.70	0.25	60	0.5000	0.49	50	0.6428
3	11.80	0.28	20	0.9397	0.45	45	0.7071
4	17.70	0.28	30	0.8660	0.38	40	0.7660
5	25.00	0.21	30	0.8660	0.35	15	0.9659
6	35.60	0.22	25	0.9063	0.28	15	0.9659
7	64.40	0.27	0	1.0000	0.38	25	0.9063
8	75.00	0.37	0	1.0000	0.46	8	0.9903
9	82.30	0.44	20	0.9397	0.63	5	0.9962
10	88.20	0.61	10	0.9848	0.75	10	0.9848
11	93.30	0.72	10	0.9848	0.76	10	0.9848
12	97.90	0.70	10	0.9848	0.77	10	0.9848

AVG DELTA P = 0.45 **AVG COS=** 0.8836

AVERAGE ABSOLUTE MISALIGNMENT = 22.63

RUN NUMBER one
TRAVERSE TIMES REQUIRED FOR PROPORTIONAL SAMPLING
(Included are corrections for cyclonic flow. Requires 24 Point Traverse & Minimum Sample Vol Of 100 ft3)

		PORT A	PORT B
PT	TRAVERSE LOCATION (% DIAM)	REQ'D SAMPLING TIME (MIN)	REQ'D SAMPLING TIME (MIN)
1	2.10	4.22	4.35
2	6.70	2.60	4.68
3	11.80	5.17	3.89
4	17.70	4.77	4.91
5	25.00	4.13	5.95
6	35.60	4.42	5.32
7	64.40	5.41	5.81
8	75.00	6.33	6.99
9	82.30	6.49	8.23
10	88.20	8.00	8.88
11	93.30	8.70	8.93
12	97.90	8.57	8.99

TOTAL REQUIRED SAMPLING TIME = 145.75 **Min**
EXPECTED SAMPLE VOL @ 0.75 ft3/min = 109.31 **Cubic Feet**

STACK & DRY GAS METER TEMPERATURE DATA

		PORT A			PORT B		
			DRY GAS METER TEMP (F)			DRY GAS METER TEMP (F)	
PT	TRAVERSE LOCATION (% DIAM)	ACTUAL STACK TEMP(F)	INLET	OUTLET	ACTUAL STACK TEMP(F)	INLET	OUTLET
1	2.10	105	46	41	103	80	63
2	6.70	105	59	41	104	91	63
3	11.80	106	74	44	103	93	62
4	17.70	106	78	46	101	96	62
5	25.00	104	80	48	103	98	64
6	35.60	105	85	51	104	98	64
7	64.40	105	87	53	103	99	65
8	75.00	104	90	55	103	100	66
9	82.30	105	92	58	102	100	67
10	88.20	104	92	59	103	101	67
11	93.30	103	95	61	101	102	69
12	97.90	103	97	63	103	105	69

RUN NUMBER one
ACTUAL TRAVERSE TIME & TIME WEIGHTED AVERAGE TEMP

	PORT A			PORT B		
PT	ACTUAL TRAVERSE TIME (MIN)	AVERAGE METER TEMP(F)	ACTUAL STACK TEMP(F)	ACTUAL TRAVERSE TIME (MIN)	AVERAGE METER TEMP(F)	ACTUAL STACK TEMP(F)
1	4.28	43.5	105	4.17	71.5	103
2	4.83	50	105	2.67	77	104
3	3.77	59	106	5.02	77.5	103
4	5.53	62	106	4.43	79	101
5	6.52	64	104	4.33	81	103
6	5.63	68	105	4.32	81	104
7	5.38	70	105	4.88	82	103
8	7.00	72.5	104	5.73	83	103
9	8.08	75	105	6.33	83.5	102
10	8.65	75.5	104	7.72	84	103
11	9.22	78	103	8.58	85.5	101
12	9.27	80	103	8.52	87	103

TIME WEIGHTED AVERAGE

STACK TEMP = 103.56

GAS METER TEMP = 75.02

FINAL RESULTS - CONCENTRATION (Mg/Cubic Meter)

(Based on standard temperature and pressure of 68F and 29.92 Hg")

$$\text{Vm(Std Cubic Meter)} = 17.64 \ (\text{Vm}) \ (\text{meter calib}) \ \frac{(\text{BP} + .07355 \text{ X delta H})}{\text{Tm} + 460} \ 0.02831$$

Vm(Std) = 2.957 Cubic Meters

Tot Mg Cr = 0.0815 (From Laboratory Analysis)

Cs = Concentration Mg/Cubic Meter (Std)

Cs = 0.0276 Mg/Cubic Meter (Std)

HEX CHROME - DRAFT EPA TEST METHOD FOR ELECTROPLATERS

For Non-Isokinetic Sampling With Corrections For Cyclonic Flow

(Requires 24 Point Traverse & Minimum Sample Vol Of 100 ft3)

RUN NUMBER: two
PLANT NAME/LOCATION: Bethlehem Steel, Sparrows Point, MD
SAMPLING LOCATION: Chrome Line Scrubber Outlet
ANALYTICAL METHOD: EPA Draft Method For Electroplaters
STACK RADIUS (INCHES) = 18 **STACK PRESS (INCHES H2O) =** 0.38

AMBIENT CONDITIONS

Pbar (Hg")	BEGIN =	30.28	STOP =	30.28	AVERAGE =	30.28
% R H	BEGIN =	69.00	STOP =	69.00	AVERAGE =	69.00

METER BOX CALIBRATION FACTOR = 1.0000 **DELTA H =** 1.85

ACT GAS METER READ'G (Vm) ft3			CLOCK TIME(MIN)		
START	STOP	TOTAL	START	STOP	ELAPSED
821.408	926.048	104.640	0.00	144.87	144.87

ACTUAL SAMPLING RATE AT TEST CONDITIONS (ft3/min) = 0.72

PRELIMINARY PITOT AND CYCLONIC FLOW DETERMINATIONS

	TRAVERSE LOCATION	PORT A			PORT B		
			ABS MISALIGNMT	COSINE		ABS MISALIGNMT	COSINE
PT	(% DIAM)	DELTA P	ANGLE	OF ANGLE	DELTA P	ANGLE	OF ANGLE
1	2.10	0.29	40	0.7660	0.54	55	0.5736
2	6.70	0.31	60	0.5000	0.47	50	0.6428
3	11.80	0.36	20	0.9397	0.46	45	0.7071
4	17.70	0.38	30	0.8660	0.35	40	0.7660
5	25.00	0.39	30	0.8660	0.35	15	0.9659
6	35.60	0.30	25	0.9063	0.28	15	0.9659
7	64.40	0.28	0	1.0000	0.39	25	0.9063
8	75.00	0.45	0	1.0000	0.46	8	0.9903
9	82.30	0.46	20	0.9397	0.66	5	0.9962
10	88.20	0.70	10	0.9848	0.78	10	0.9848
11	93.30	0.74	10	0.9848	0.75	10	0.9848
12	97.90	0.71	10	0.9848	0.77	10	0.9848

AVG DELTA P = 0.48 **AVG COS =** 0.8836

AVERAGE ABSOLUTE MISALIGNMENT = 22.63

RUN NUMBER two

TRAVERSE TIMES REQUIRED FOR PROPORTIONAL SAMPLING

(Included are corrections for cyclonic flow. Requires 24 Point Traverse & Minimum Sample Vol Of 100 ft3)

		PORT A	PORT B
PT	TRAVERSE LOCATION (% DIAM)	REQ'D SAMPLING TIME (MIN)	REQ'D SAMPLING TIME (MIN)
1	2.10	4.15	4.24
2	6.70	2.80	4.43
3	11.80	5.67	4.27
4	17.70	5.37	4.56
5	25.00	5.44	5.75
6	35.60	4.99	5.14
7	64.40	5.32	5.69
8	75.00	6.75	6.75
9	82.30	6.41	8.14
10	88.20	8.29	8.75
11	93.30	8.52	8.58
12	97.90	8.34	8.69

TOTAL REQUIRED SAMPLING TIME = 147.01 **Min**

EXPECTED SAMPLE VOL @ 0.75 ft3/min = 110.26 **Cubic Feet**

STACK & DRY GAS METER TEMPERATURE DATA

		PORT A			PORT B		
PT	TRAVERSE LOCATION (% DIAM)	ACTUAL STACK TEMP(F)	DRY GAS METER TEMP (F) INLET	OUTLET	ACTUAL STACK TEMP(F)	DRY GAS METER TEMP (F) INLET	OUTLET
1	2.10	103	83	60	106	53	52
2	6.70	98	74	60	106	73	51
3	11.80	104	84	60	105	80	53
4	17.70	104	90	60	106	85	57
5	25.00	104	92	61	105	91	58
6	35.60	104	93	61	104	92	59
7	64.40	103	94	63	103	94	62
8	75.00	104	95	63	102	96	63
9	82.30	104	95	64	103	98	64
10	88.20	104	97	65	102	70	53
11	93.30	103	97	66	102	80	55
12	97.90	104	98	67	102	88	57

RUN NUMBER two
ACTUAL TRAVERSE TIME & TIME WEIGHTED AVERAGE TEMP

	PORT A			PORT B		
PT	ACTUAL TRAVERSE TIME (MIN)	AVERAGE METER TEMP(F)	ACTUAL STACK TEMP(F)	ACTUAL TRAVERSE TIME (MIN)	AVERAGE METER TEMP(F)	ACTUAL STACK TEMP(F)
1	4.17	71.5	103	4.28	52.5	106
2	2.67	67	98	4.83	62	106
3	5.02	72	104	3.77	66.5	105
4	4.43	75	104	5.53	71	106
5	4.33	76.5	104	6.52	74.5	105
6	4.32	77	104	5.63	75.5	104
7	4.88	78.5	103	5.38	78	103
8	5.73	79	104	7.00	79.5	102
9	6.33	79.5	104	8.08	81	103
10	7.72	81	104	8.65	61.5	102
11	8.58	81.5	103	9.22	67.5	102
12	8.52	82.5	104	9.27	72.5	102

TIME WEIGHTED AVERAGE

STACK TEMP = 103.48

GAS METER TEMP = 74.12

FINAL RESULTS - CONCENTRATION (Mg/Cubic Meter)

(Based on standard temperature and pressure of 68F and 29.92 Hg")

$$\text{Vm(Std Cubic Meter)} = 17.64 \quad (\text{Vm}) \quad (\text{meter calib}) \quad \frac{(\text{BP} + .07355 \text{ X delta H})}{\text{Tm} + 460} \quad 0.02831$$

Vm(Std) = 2.976 Cubic Meters

Tot Mg Cr= 0.1279 (From Laboratory Analysis)

Cs = Concentration Mg/Cubic Meter (Std)

Cs = 0.0430 Mg/Cubic Meter (Std)

RUN NUMBER two

FINAL RESULTS - APPROXIMATE MASS EMISSION RATE (Kg/Hr)

$$\text{Kg / Hr} = 0.0001597\ R^2 \sqrt{\frac{\text{Delta Pavg } (Ts + 460)}{\text{Pbar} \cdot (28.73)}} \times Cs \times \text{COS(Avg)}$$

Where: R = Stack Radius

Ts = Stack Temperature(F)

Cs = Concentration (Mg/dscm)

COS(Avg) = Average Cyclonic Flow Angle

Kg / Hr = 0.001101

ADDITIONAL FORMULAS USED IN THIS TEST

STACK VELOCITY AND FLOW RATE (CYCLONIC FLOW)

$$\text{Velocity (Vs), Ft/Min} = 85.49 \times 60 \times Cp \times \sqrt{\text{Delta P}} \sqrt{\frac{Ts + 460}{Ps \times Ms}} \times \text{COS(Avg)}$$

Where: Cp = 0.84 (For S Type Pitot Tube)

Ms = 28.95 (Molecular Weight of Stack Gas)

Ps = Stack Pressure Absolute

$$\text{Flow Rate (Qs), ACFM} = \frac{Vs \times As}{144}$$

Where: As = Area of Stack (Square Inches)

HEX CHROME - DRAFT EPA TEST METHOD FOR ELECTROPLATERS

For Non-Isokinetic Sampling With Corrections For Cyclonic Flow

(Requires 24 Point Traverse & Minimum Sample Vol Of 100 ft3)

RUN NUMBER: three
PLANT NAME/LOCATION: Bethlehem Steel, Sparrows Point, MD
SAMPLING LOCATION: Chrome Line Scrubber Outlet
ANALYTICAL METHOD: EPA Draft Method For Electroplaters
STACK RADIUS (INCHES)= 18 **STACK PRESS (INCHES H2O)=** 0.33

AMBIENT CONDITIONS

Pbar (Hg")	BEGIN =	29.91	STOP =	29.91	AVERAGE=	29.91
% R H	BEGIN =	72.00	STOP =	72.00	AVERAGE=	72.00

METER BOX CALIBRATION FACTOR = 1.0000 **DELTA H =** 1.85

ACT GAS METER READ'G (Vm) ft3			CLOCK TIME(MIN)		
START	STOP	TOTAL	START	STOP	ELAPSED
926.804	1030.978	104.174	0.00	144.87	144.87

ACTUAL SAMPLING RATE AT TEST CONDITIONS (ft3/min) = 0.72

PRELIMINARY PITOT AND CYCLONIC FLOW DETERMINATIONS

	TRAVERSE LOCATION		PORT A ABS MISALIGNMT	COSINE		PORT B ABS MISALIGNMT	COSINE
PT	(% DIAM)	DELTA P	ANGLE	OF ANGLE	DELTA P	ANGLE	OF ANGLE
1	2.10	0.23	40	0.7660	0.50	55	0.5736
2	6.70	0.33	60	0.5000	0.48	50	0.6428
3	11.80	0.30	20	0.9397	0.44	45	0.7071
4	17.70	0.30	30	0.8660	0.38	40	0.7660
5	25.00	0.28	30	0.8660	0.35	15	0.9659
6	35.60	0.27	25	0.9063	0.30	15	0.9659
7	64.40	0.32	0	1.0000	0.38	25	0.9063
8	75.00	0.37	0	1.0000	0.57	8	0.9903
9	82.30	0.42	20	0.9397	0.68	5	0.9962
10	88.20	0.71	10	0.9848	0.76	10	0.9848
11	93.30	0.69	10	0.9848	0.73	10	0.9848
12	97.90	0.72	10	0.9848	0.75	10	0.9848

AVG DELTA P = 0.47 **AVG COS=** 0.8836

AVERAGE ABSOLUTE MISALIGNMENT = 22.63

RUN NUMBER three
TRAVERSE TIMES REQUIRED FOR PROPORTIONAL SAMPLING

(Included are corrections for cyclonic flow. Requires 24 Point Traverse & Minimum Sample Vol Of 100 ft3)

PT	TRAVERSE LOCATION (% DIAM)	PORT A REQ'D SAMPLING TIME (MIN)	PORT B REQ'D SAMPLING TIME (MIN)
1	2.10	3.75	4.14
2	6.70	2.94	4.55
3	11.80	5.26	3.96
4	17.70	4.85	4.83
5	25.00	4.68	5.84
6	35.60	4.81	5.41
7	64.40	5.78	5.71
8	75.00	6.22	7.64
9	82.30	6.22	8.39
10	88.20	8.48	8.77
11	93.30	8.36	8.60
12	97.90	8.54	8.72

TOTAL REQUIRED SAMPLING TIME = 146.45 **Min**

EXPECTED SAMPLE VOL @ 0.75 ft3/min = 109.84 **Cubic Feet**

STACK & DRY GAS METER TEMPERATURE DATA

PT	TRAVERSE LOCATION (% DIAM)	PORT A ACTUAL STACK TEMP(F)	PORT A DRY GAS METER TEMP (F) INLET	PORT A DRY GAS METER TEMP (F) OUTLET	PORT B ACTUAL STACK TEMP(F)	PORT B DRY GAS METER TEMP (F) INLET	PORT B DRY GAS METER TEMP (F) OUTLET
1	2.10	105	84	67	105	63	57
2	6.70	106	93	67	105	72	57
3	11.80	104	96	68	106	82	58
4	17.70	104	98	68	104	88	61
5	25.00	105	99	70	105	92	62
6	35.60	105	101	70	105	97	65
7	64.40	105	102	71	105	99	67
8	75.00	105	103	71	103	101	69
9	82.30	105	104	72	105	102	70
10	88.20	104	105	74	105	104	72
11	93.30	104	105	74	104	105	74
12	97.90	105	107	75	105	107	75

RUN NUMBER three

ACTUAL TRAVERSE TIME & TIME WEIGHTED AVERAGE TEMP

	PORT A			PORT B		
PT	ACTUAL TRAVERSE TIME (MIN)	AVERAGE METER TEMP(F)	ACTUAL STACK TEMP(F)	ACTUAL TRAVERSE TIME (MIN)	AVERAGE METER TEMP(F)	ACTUAL STACK TEMP(F)
1	4.17	75.50	105.00	4.28	60.00	105.00
2	2.67	80.00	106.00	4.83	64.50	105.00
3	5.02	82.00	104.00	3.77	70.00	106.00
4	4.43	83.00	104.00	5.53	74.50	104.00
5	4.33	84.50	105.00	6.52	77.00	105.00
6	4.32	85.50	105.00	5.63	81.00	105.00
7	4.88	86.50	105.00	5.38	83.00	105.00
8	5.73	87.00	105.00	7.00	85.00	103.00
9	6.33	88.00	105.00	8.08	86.00	105.00
10	7.72	89.50	104.00	8.65	88.00	105.00
11	8.58	89.50	104.00	9.22	89.50	104.00
12	8.52	91.00	105.00	9.27	91.00	105.00

TIME WEIGHTED AVERAGE

STACK TEMP = 103.10

GAS METER TEMP = 82.34

FINAL RESULTS - CONCENTRATION (Mg/Cubic Meter)

(Based on standard temperature and pressure of 68F and 29.92 Hg")

$$\text{Vm(Std Cubic Meter)} = 17.64 \ (\text{Vm}) \ (\text{meter calib}) \ \frac{(\text{BP} + .07355 \times \text{delta H})}{\text{Tm} + 460} \ 0.02831$$

Vm(Std) = 2.882 Cubic Meters

Tot Mg Cr= 0.2963 (From Laboratory Analysis)

Cs = Concentration Mg/Cubic Meter (Std)

Cs = 0.103 Mg/Cubic Meter (Std)

RUN NUMBER three

FINAL RESULTS - APPROXIMATE MASS EMISSION RATE (Kg/Hr)

$$\text{Kg / Hr} = 0.0001597 \; R^2 \sqrt{\frac{\text{Delta Pavg } (Ts + 460)}{\text{Pbar } (28.73)}} \; X \; Cs \; X \; COS(Avg)$$

Where: R = Stack Radius

Ts = Stack Temperature(F)

Cs = Concentration (Mg/dscm)

COS(Avg) = Average Cyclonic Flow Angle

Kg / Hr = 0.002606

ADDITIONAL FORMULAS USED IN THIS TEST

STACK VELOCITY AND FLOW RATE (CYCLONIC FLOW)

$$\text{Velocity (Vs), Ft/Min} = 85.49 \; X \; 60 \; X \; Cp \; X \; \sqrt{\text{Delta P}} \; \sqrt{\frac{Ts + 460}{Ps \; X \; Ms}} \; X \; COS(Avg)$$

Where: Cp = 0.84 (For S Type Pitot Tube)

Ms = 28.95 (Molecular Weight of Stack Gas)

Ps = Stack Pressure Absolute

$$\text{Flow Rate (Qs), ACFM} = \frac{Vs \; X \; As}{144}$$

Where: As = Area of Stack (Square Inches)

APPENDIX D

EQUIPMENT CALIBRATION

0 DRY GAS METER AND ORIFICE METER

The dry gas meter and orific were calibrated using a wet test meter. Gases were moved through the dry gas meter at orifice ressure differentials (ΔH's) of 0.5, 1.0, and 2.0 inches of ater. With the information obtained, γ, the ratio of accuracy of wet test meter to dry test meter; and $\Delta H_@$, the orifice pressure differential that gives 0.75 cfm of air at 68°F and 29.92 inches of mercury, were calculated. The γ has a tolerance of 1.00 ±0.01 and the $\Delta H_@$ has a tolerance of 1.84 +0.26 -0.24. The γ and $\Delta H_@$ are determined as follows:

$$\gamma = \frac{V_w P_b \ (t_d + 460)}{V_d [P_b + .07353 (\Delta H)] (t_w + 460)}$$

$$\Delta H_@ = \frac{0.0317 \ (\Delta H)}{P_b \ (t_d + 460)} \left(\frac{(T_w + 460) \ \theta}{V_w} \right)^2$$

Where:

ΔH = Orifice pressure differential, in H_2O

P_b = Barometric pressure, in Hg

t_d = Average temperature of dry gas meter, °F

t_w = Average temperature of wet test meter, °F

θ = Duration of test, min.

V_d = Dry gas meter volume, ft^3

V_w = Wet test meter volume, ft^3

Source category: Electroplating
Plant name : Bethlehem Steel Corp.
Process : Hard chromium electroplating

Filename: REF_4-70
Location: Sparrows Point, MD
Test date: December 12-13, 1991

Date: 03/07/96
Ref. No.: 4-70
Process rate basis: production

Source	Type of control	Pollutant	Run No.	Test Method	Samp. time, min	Isokinetic, %	Gas volume, DSCF	Volum. flow rate, DSCFM	Mass, ug	Concen., gr/DSCF	Emission rate, lb/hr	Process rate, A-hr	Emission factor mg/A-hr	Emission factor gr/A-hr	Rat.
		Cr+6	1	EPA 13			104.3		81.50	1.21E-05	0.00000	ERR	ERR	ERR	
		Cr+6	2				105.0		127.90	1.88E-05	0.00000	ERR	ERR	ERR	
		Cr+6	3				101.7		296.30	4.50E-05	0.00000	ERR	ERR	ERR	
											Average		ERR	ERR	NR

Basis for rating: Inadequate documentation
Problems noted:
Other notes: Chromic acid concentration: 160 - 170 g/L
Report does not adequately document test; cannot check results

CANNOT USE