Background Report Reference

AP-42 Section Number: 12.20

Background Chapter: 4

Reference Number: 43

Title: Source Test Report of a Monsanto Enviro-Chem Demonstration Unit Serving a Hard Chrome Plating Tank at Electronic Chrome and Grinding Co., Inc. 9218-32 Dice Road, Santa Fe Springs, CA 90670

PES

January 1989

Source Test Report of a Monsanto Enviro-Chem Demonstration Unit
Serving a Hard Chrome Plating Tank at
Electronic Chrome and Grinding Co. Inc.
9128-32 Dice Road, Santa Fe Springs, CA 90670

Conducted for the
Metal Finishing Association of Southern California
5000 Van Nuys Blvd.
Sherman Oaks, CA 91403

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1/23/89

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Electronic Chrome and Grinding Co. Inc.
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INTRODUCTION

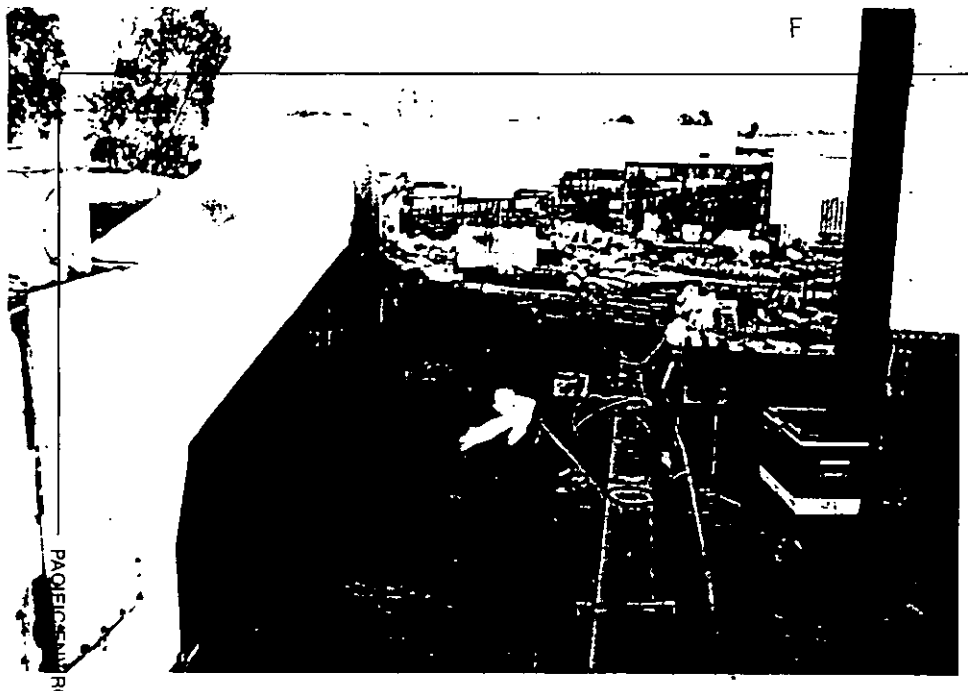
Pacific Environmental Services, Inc. (PES) was contracted by the Metal Finishing Association of Southern California (MFASC), to perform a screening test on the control efficiency of a Monsanto demonstration unit used to collect hexavalent chromium emissions from a hard chrome plating operation. Set up and velocity determination were conducted on January 5, and the main source testing was done on January 9, 1989.

In order to evaluate the effectiveness of the Monsanto unit, it was necessary to have a hard chrome plating tank or set of tanks that were outfitted with an emission collection system. Electronic Chrome and Grinding Co. Inc. in Santa Fe Springs, CA, was the site chosen for the testing. Mike Reed, Vice President and General Manager of Electronic Chrome, arranged for the hookup of the demonstration unit and the tank operation during source testing.

A slip stream was taken from the main emission collection system exhaust to supply the Monsanto unit. The location of the connection was approximately three feet below the roof as shown in Figure 1. The inside diameter of the inlet of the slip stream from the main exhaust was 4.5 inches. The slip stream then increased to 6 inches I.D. to serve the Monsanto unit. The stack outlet on the Monsanto Unit was 5.5" I.D..

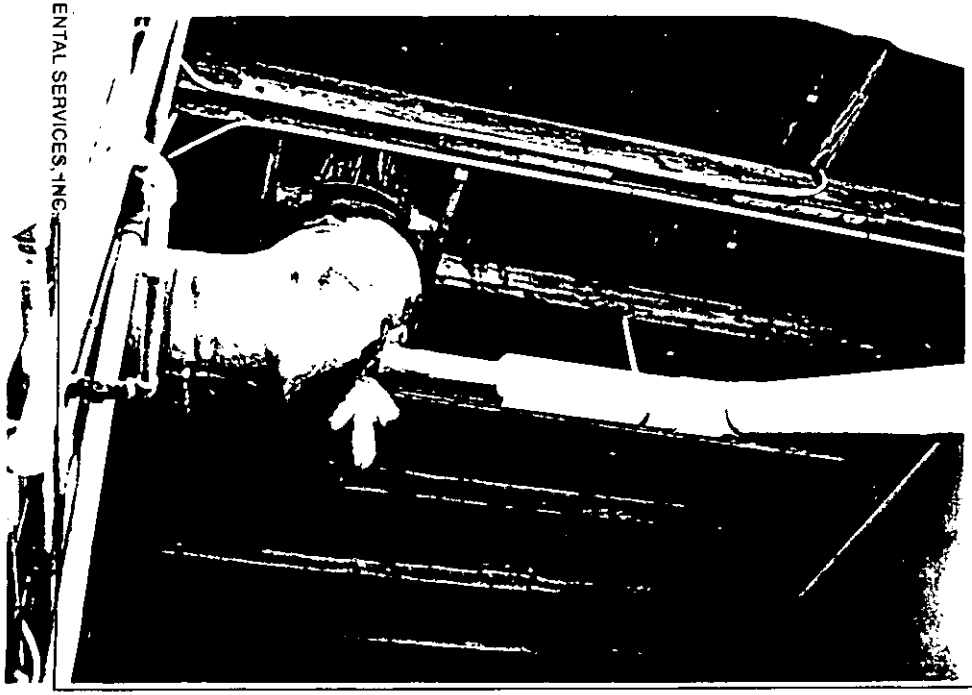
Three locations were chosen for sampling. The first sample, M-I-19, was taken from the main exhaust after the slip stream extraction point. This was done in order to test the Isokinetics of the slip stream system. The second sample, M-I-6, was taken from the slip stream on the inlet to the Monsanto unit. This sample was used to determine the quantity of emissions in the gas stream before entering the Monsanto unit. The third sample, M-S-1, was taken from the stack outlet of the Monsanto unit to determine the emission rate and reduction efficiency of the Monsanto unit. All sample points are shown in Figures 1 and 2.

Figure 1: Sample Locations.

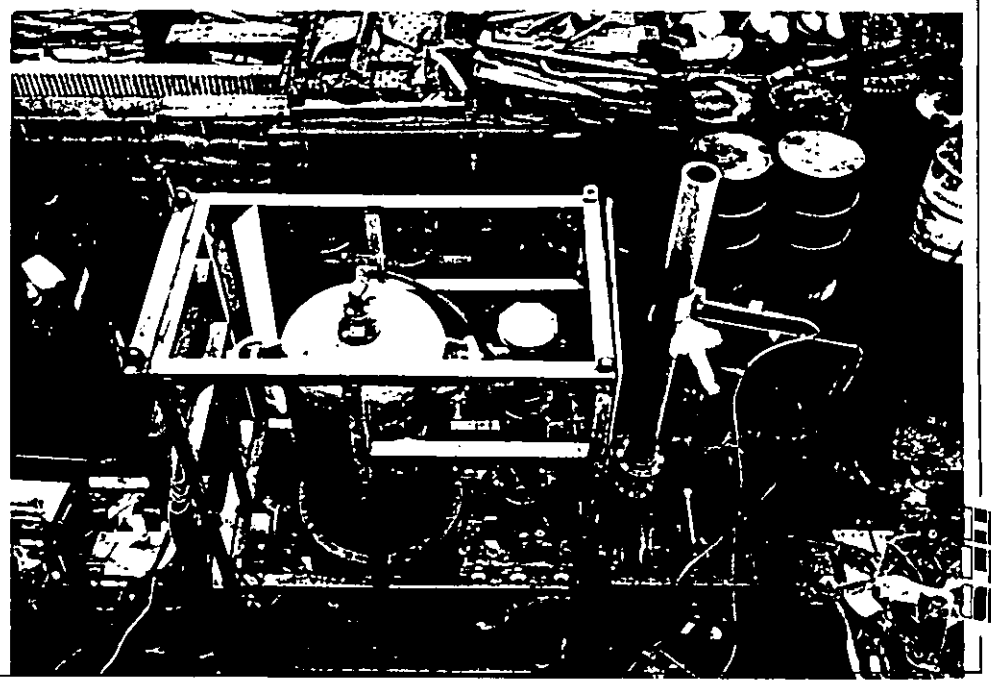


Location of sample M-I-19. On the roof.

Location of sample M-I-6. Ground level.

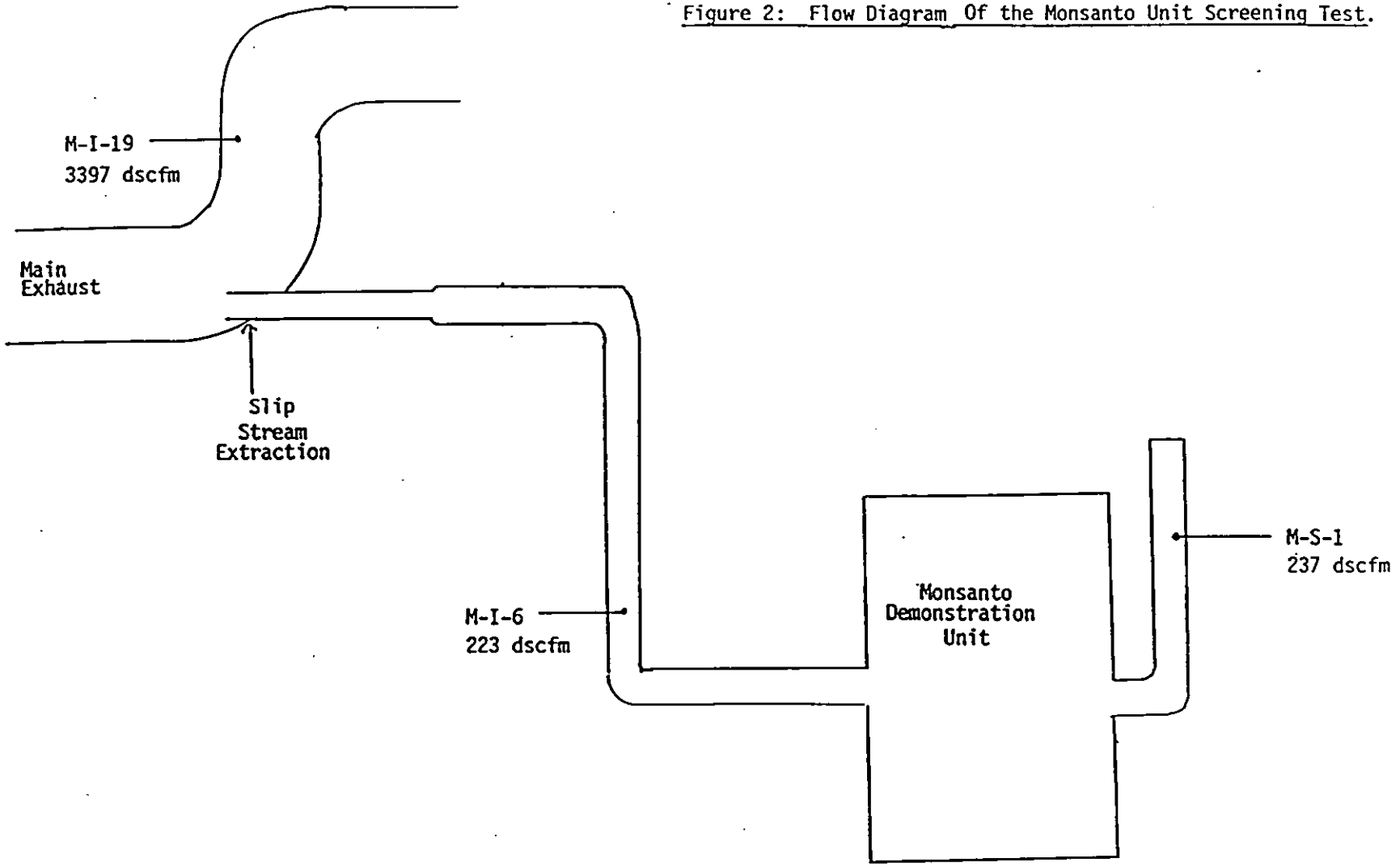


Slip stream extraction from main duct.



Location of Sample M-S-1. Ground level.

Figure 2: Flow Diagram Of the Monsanto Unit Screening Test.



EQUIPMENT AND PROCESS DESCRIPTION

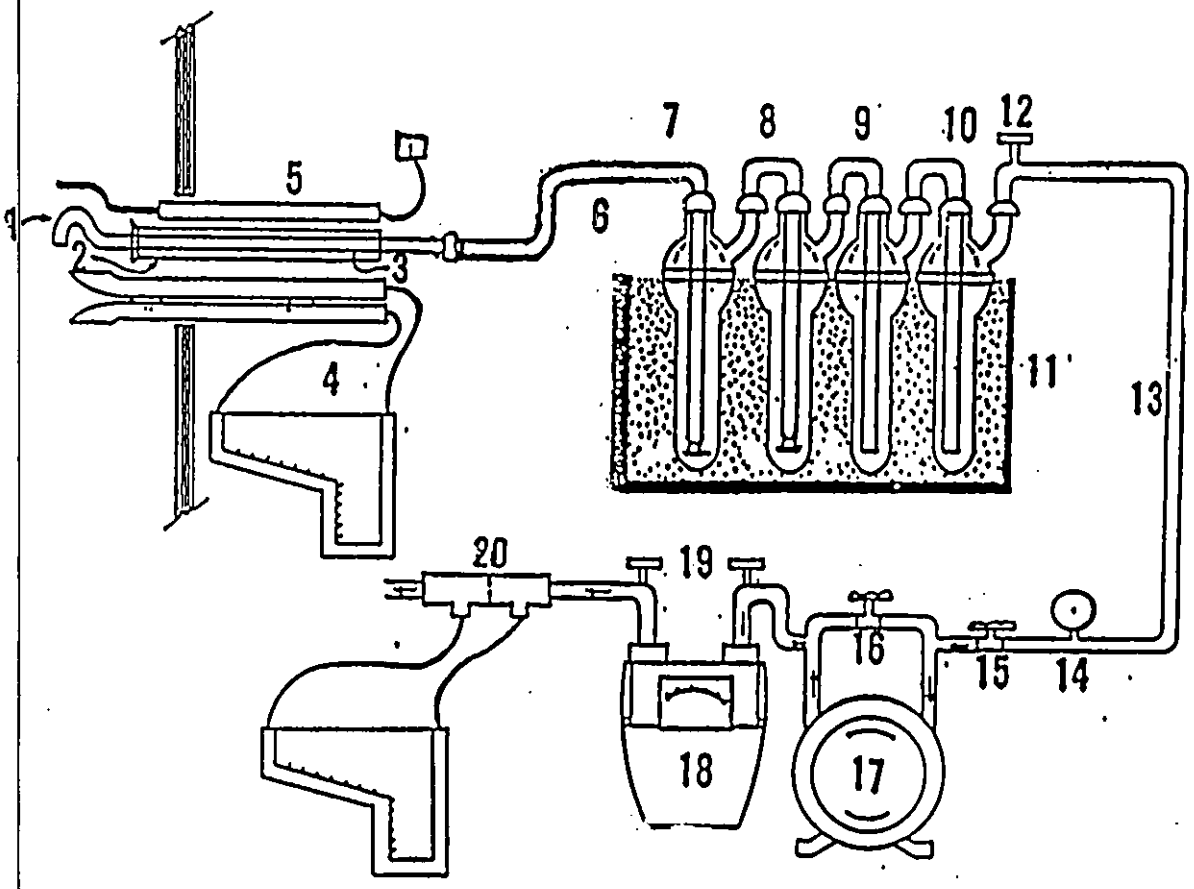
Electronic Chrome and Grinding Co. Inc., 1928-32 Dice Road, Santa Fe Springs, CA 90670, is engaged in the business of hard chrome plating for a wide range of industries, including the aircraft, oil, and hydraulics industries. Tank numbers 1 and 2 were served by the emission collection system. The dimensions of tank 1 were 30" x 66" x 13'. Tank 1 had a 3 1/2" freeboard and 90% of the tank was covered by polyballs. Tank 1 was operated during the majority of the test. The temperature of tank 1 was maintained at 124 F, voltage maintained at 5-6 volts, and the amperage ranged from 2500-4000 amps. The dimensions of tank 2 were 4' x 8' x 6'. Tank 2 had a 3" freeboard and was not covered by polyballs during the testing. Tank 2 was used for only 1/2 hour during the period.

The Monsanto Enviro-Chem demonstration unit consisted of a fan module and a mist eliminator module (Brinks Fiberbed Mist Eliminator). The demonstration unit is approximately 10' x 4' x 10' and weighed 3500 pounds. It was fully instrumented for controlling and monitoring the gas flow rate and could handle up to 450 ACFM. The unit was constructed of ATLAC 382 resin. The fiber bed mist eliminator utilized collection mechanisms of impaction, interception, and brownian movement to collect even the smallest mist and solid particles. The unit is shown in Figure 1.

TESTING METHODOLOGY

The samples at each location were extracted using CARB method 425 as developed for the demonstration project except that no filter was used. The source sampling trains for M-I-19 and M-I-6 consisted of a stainless steel nozzle, a teflon lined stainless steel probe, two impingers each with 100 ml of 0.1N sodium hydroxide, an empty impinger, an impinger filled with silica gel, a vacuum pump, a dry gas meter, and a calibrated orifice connected to an inclined manometer. The train for M-S-1 was configured the same way except a glass probe was used instead of a teflon lined stainless steel probe.

Sampling for the three locations was done simultaneously for a period of six hours. Velocity and temperature of the emission streams were measured and recorded every 15 minutes during the test. The meter temperature along with the volume of the gas through the meter also was measured every 15 minutes during the test. The voltage and amperage of the chrome tanks were measured and recorded every 30 minutes. All information was recorded on field data sheets (Appendix).



1. Glass or stainless steel sampling nozzle
2. Stainless steel probe sheath
3. Stainless steel, glass, or Teflon-lined probe
4. Type S pitot tube and manometer for ΔP readings
5. Stack temperature sensor
6. 15 ft. teflon probe line with ball and socket connectors
7. Greenburg-Smith impinger with 100 ml. of .1 N NaOH solution
8. Greenburg-Smith impinger with 100 ml. of .1 N NaOH solution
9. Modified Greenburg-Smith impinger - dry
10. Modified Greenburg-Smith impinger filled with 200 grams of silica gel
11. Impinger case filled with ice
12. Impinger exit gas temperature sensor
13. Umbilical line to meter box
14. Vacuum gauge
15. Coarse adjustment valve
16. By-pass valve to adjust ΔH
17. Leak free vacuum pump
18. Dry gas meter
19. Dry gas meter inlet and outlet temperature sensors
20. Orifice meter with manometer for ΔH readings

FIGURE 3
Diagram Of Sampling Train

Laboratory analyses were conducted by Thermo Analytical Laboratory in Monrovia, CA. Volume, total chrome concentration, and hexavalent chrome concentration were determined for the three samples. Analyses for total chrome used atomic absorption spectrophotometry and analyses for hexavalent chrome used diphenylcarbazide colorimetric techniques.

RESULTS OF TESTING

Calculations were made from the field data sheets to determine sample volume, percent moisture, molecular weight, velocities, flow rates, and isokinetic testing for the gas at each sample location. Results are shown in table 1 and on the emission test calculation sheets (Appendix).

The sample collection was intended to be isokinetic on all 3 test ports. However results showed 103, 86, and 84%. The inlet and outlet of the Monsanto Unit were below the EPA acceptable range of isokinetic testing (90-110%). Since both were on the low side, results were probably still representative of expected concentrations.

Flow rates in the large 19.5" duct and the extraction duct were intended to provide near equal velocities. From the measured flow rates, the two velocities were calculated as follows.

19.5" duct	3397 dscfm	27.3 fps
4.5" duct	223 dscfm	33.7 fps – 18.9 fps

6"

The extracted gas stream showed 0.00497 mg/scf of Cr T while the main gas stream showed 0.00402 mg/scf (a relatively small difference). Cr 6 showed greater differences which could not be explained.

The inlet loading to the Monsanto Unit was 0.2682 mg/amp-hour. The outlet was < 0.0045 mg/amp-hour. To express the efficiency in mg/amp-hour, the total gas flow needed to be calculated and the chromium emissions had to be considered for the two inlet stacks. The adjusted results are shown on the bottom of the table using results of chrome concentrations in M-I-6 and M-S-1

For hexavalent chrome concentrations the method used by the laboratory could only determine the concentration to a minimum detectable level of 0.05 mg/l. This in turn means that the control efficiency of the Monsanto unit for hexavalent chrome was greater than the calculated value of 98.1% (expressed as mg/amp-hour), but the exact efficiency was unknown. Therefore additional tests should collect larger sample volumes or modify analytical procedures to allow accurate measurement at lower concentrations.

Table 1: Control Efficiency of the Monsanto Demonstration Unit.

SAMPLE RUN NUMBER	SAMPLE VOLUME (ml)	Conc. Cr T (mg/l)	Conc. Cr 6 (mg/l)	Cr T (mg)	Cr 6 (mg)	SAMPLE METER VOL (dscf)	EMISSIONS Cr T (mg/scf)	EMISSIONS Cr 6 (mg/scf)	FLOW RATE (dscfm)	ACTUAL EMISSIONS Cr T (mg/hour)	ACTUAL EMISSIONS Cr 6 (mg/hour)	CONTROL EFFICIENCY Cr T %	CONTROL EFFICIENCY Cr 6 %
M-I-19	532	1.51	0.9	0.8033	0.4788	199.999	0.00402	0.00239	3397	818.67	487.95		
M-I-6	498	2.65	1.9	1.3197	0.9462	265.731	0.00497	0.00356	223	66.45	47.64		
M-S-1	425	0.046	<0.05	0.0196	<0.0213	327.900	0.00006	<0.00006	237	0.85	<0.92	98.7	>98.1

SAMPLE RUN NUMBER	ADJUSTED TOTAL FLOW RATE (dscfm)	TOTAL EMISSIONS Cr T (mg/hour)	TOTAL EMISSIONS Cr 6 (mg/hour)	AVERAGE AMP-HOURS	EMISSIONS Cr T (mg/amp-hour)	EMISSIONS Cr 6 (mg/amp-hour)	CONTROL EFFICIENCY Cr T %	CONTROL EFFICIENCY Cr 6 %
M-I-19	3620	873.144	519.108	2883	0.3029	0.1801		
M-I-6	3620	1079.484	773.232	2883	0.3744	0.2682		
M-S-1	3634	13.082	<13.082	2883	0.0045	<0.0045	98.8	>98.3

Appendixes

Electronic Chrome + Grinding

1-9-89

Location - INLET 19.5 Ø

BAROMETER 29.49

CONTROL CONSOLE #4 BUTECH

ΔH@ 1.92

METER GAMMA 1.003

STATIC PRESSURE -2.1

NOZZLE DIAMETER 0.275

METER LEAK RATE 0.008 @ 18"

POST TEST LEAK RATE .001 @ 6" Hg

STACK ID 19.5

POINT	TIME ELAPSED	TIME CLOCK	ΔP	ΔH	STACK TEMP	METER TEMP	VAC in	IMP. TEMP	Meter
5	0	1150	0.285	1.2	67	80/83	5	50	577.690
5	15	1210	0.285	1.2	67	76/74	5	50	584.9
5	30	1225	0.285	1.2	67	78/75	5	53	592.4
5	45	1240	0.285	1.2	67	80/76	5	56	601.4
5	60	1255	0.285	1.2	69	79/76	5	54	609.6
5	75	1310	0.285	1.2	69	78/74	5	54	621.6
5	90	1325	0.285	1.2	69	77/74	5	55	629.5
5	105	1340	0.285	1.2	70	81/76	5	57	637.6
5	120	1355	0.285	1.2	70	82/77	5	58	645.6
5	135	1410	0.285	1.2	69	81/78	5	59	653.6
5	150	1425	0.285	1.2	69	77/75	5	54	662.4
5	165	1440	0.285	1.2	70	78/75	5	52	671.2
5	180	1455	0.285	1.2	71	78/74	5	53	679.8
5	195	1510	0.285	1.2	71	76/73	5	53	689.0
5	210	1525	0.285	1.2	70	74/71	5	54	697.8
5	225	1540	0.285	1.2	70	73/70	5	55	705.8
5	240	1555	0.285	1.2	71	73/69	5	55	714.4
5	255	1610	0.285	1.2	70	75/70	5	53	723.6
5	270	1625	0.285	1.2	69	75/70	5	54	731.3
5	285	1640	0.285	1.2	68	73/69	5	53	740.0
5	300	1655	0.285	1.2	67	72/68	5	54	748.5
5	315	1710	0.285	1.2	68	69/66	5	52	756.3
5	330	1725	0.285	1.2	67	68/65	5	52	764.9
5	345	1740	0.285	1.2	67	66/63	5	48	773.0
5	360	1755	0.285	1.2					781.832
				1.2	$\bar{T}$ = 68.79	$\bar{T}_m$ = 74.167			

PACIFIC ENVIRONMENTAL SERVICES, INC.

Electronic Chrome + Grinding
1-9-89
Location WEST 6" Ø
Barometer 29.49
Control Consol 6IX
ΔH@ 1.753

Meter Gamma 2.993
Static Pressure -1.8
Nozzle ID 0.371
Pretest Leak rate 0.005 @ 25
Post-test Leak rate 0.002 @ 5" Hg
Stack I.D. 6"

Point	Time Elapsed	Time Clock	ΔP	ΔH	Stack Temp	Meter Temp	Vac In.	Imp. Temp	METER 597.690
4	0	1155	~~0.099~~ ~~0.837~~	0.98	67	85/82	2	50	960.712
4	15	1210	0.099	0.98	67	78	2	50	969.2
4	30	1225	0.099	0.98	67	79	2	50	977.3
4	45	1240	0.099	0.98	67	80	2	56	987.2
4	60	1255	0.099	0.98	69	80	2	54	995.6
4	75	1310	0.099	0.98	69	79	0	54	008.9
4	90	1325	0.099	0.98	69	78	1	55	16.1
4	105	1340	0.099	0.98	70	80	1	57	24.6
4	120	1355	0.099	0.98	70	80	1	58	33.3
4	135	1410	0.099	~~0.98~~ 2.0	69	80	1	59	43.1
4	150	1425	0.099	2.0	68	77	3	54	51.8
4	165	1440	0.099	2.2	69	76	3.1	52	62.2
4	180	1455	0.099	2.2	70	76	3.1	53	79.9
4	195	1510	0.099	2.2	70	75	3.1	52	94.5
4	210	1525	0.099	2.2	69	73	3.1	53	108.8
4	225	1540	0.099	2.2	69	72	3.1	54	120.2
4	240	1555	0.099	2.2	69	71	3.1	54	133.4
4	255	1610	0.099	2.2	69	73	3.1	53	147.1
4	270	1625	0.099	2.2	68	73	3.1	53	160.5
4	285	1640	0.099	2.2	~~68~~ 67	71	3.1	53	173.8
4	300	1655	0.099	1.95	66	70	3.2	53	184.6
4	315	1710	0.099	1.95	65	68	3.2	50	198.3
4	330	1725	0.099	1.95	65	67	3.2	52	210.7
4	345	1740	0.099	1.95	65	65	3.2	48	225.0
4	360	1755	0.099	~~1.95~~	65		3.2		235.823

$\bar{T}_s$ = 528.04 T_m = 535.48

Electronic Chrome + Grinding
1-9-89
location Stack 55" Ø
Barometer
Control Console 104
ΔH @ 1.78

Meter Gamma 0.993
Static Pressure ↑0.02
Nozzle Ø 0.373
Pretest leak rate 0.009 @ 15" Hg
Post-test leak rate 0.002 @ 9 11 Hg
Stack I.D. 55
C Factor = 0.096

Point	Time Elapsed	Time Clock	ΔP	ΔH	Stack Temp	Meter Temp	Vac In.	Imp. Temp	Meter
4	0	1155	~~0.161~~	3.0	67 x	78	8	50	676.708
4	15	1210	0.161	3.0	67 x	78	8	50	691.2
4	30	1225	0.161	3.0	67 x	79	8	50	704.5
4	45	1240	0.161	3.0	67 x	80	8	56	718.2
4	60	1255	0.161	3.0	69 x	80	8	53	732.7
4	75	1310	0.161	3.0	69 x	80	8	54	747.7
4	90	1325	0.161	3.0	69 x	79	7.8	55	760.1
4	105	1340	0.161	3.0	70 x	80	7.8	57	774.7
4	120	1355	0.161	3.0	70 x	80	7.8	56	788.5
4	135	1410	0.161	3.0	69 x	80	7.8	59	802.7
4	150	1425	0.161	3.0	68 x	78	7.8	54	817.3
4	165	1440	0.161	3.0	69 x	76	7.8	52	831.7
4	180	1455	0.161	3.0	70 x	76	7.6	53	846.7
4	195	1510	0.161	3.0	70 x	75	7.6	52	859.8
4	210	1525	0.161	3.0	69 x	73	7.7	53	873.1
4	225	1540	0.161	3.0	69 x	72	7.7	54	886.4
4	240	1555	0.161	3.0	69 x	71	7.7	54	902.5
4	255	1610	0.161	3.0	69 x	73	7.7	53	916.9
4	270	1625	0.161	3.0	68 x	73	7.8	53	931.1
4	285	1640	0.161	3.0	67 x	71	7.8	53	945.2
4	300	1655	0.161	3.0	66 x	70	7.8	53	959.1
4	315	1710	0.161	3.0	65	68	7.8	52	974.6
4	330	1725	0.161	3.0	65	67	7.9	52	986.4
4	345	1740	0.161	3.0	65	65	7.9	48	002.0
4	360	1755	0.161	3.0					013.805
					68.042	75.04			

PES

Electronic Chrome & Grinding

TANK # 2 - NO BALLS

3" FREEBOARD

V.	Amps
1230	512
1300	0
1330	0
1400	0
1430	0
500	0
530	0
600	0

TANK # 1 - ≅ 90% cover

3½" Freeboard

Volts	Amps	Volts		Amps
6	2480			
6	2500	1600	5	3950
6	2490	1630	5	3880
6	2500	1700	5	3830
6	2500	1730	5	3800
6	2500	1800	5	3800
0	0			
0	0			

Plating
Mona-Pumps

Tank	Temperatures
~~#2~~ 1	
1630	124°
1700	124°
1730	124°
1800	125°

PES

SAMPLE RECOVERY DATA

Plant: Electronic Chrome + Grinding

Date: 1-9-89

Sampling Location: Inlet 19.5"

Sample Type: Chrome

Run Number: M-I-19.5

Sample Box Number: _____

Clean-up Man: Parks

Job Number: 3625

Comments: _____

FRONT HALF

Filter Number: _____ _____ _____

Description of Filter: _____

MOISTURE

Impingers			
Final Volume:	186 ml	_____ ml	_____ ml
Initial Volume:	200 ml	_____ ml	_____ ml
Net Volume:	-14 ml	_____ ml	_____ ml
Total H_2O:	_____	_____	_____
Silica Gel			
Final Volume:	279.9 g	_____ g	_____ g
Initial Volume	238.7 g	_____ g	_____ g
Net Volume	+41.2 g	_____ g	27.2 ml g
Total Moisture:	_____	_____	_____

Description of Impinger Catch: _____

PES

SAMPLE RECOVERY DATA

Plant: Electronic Chrome & Grinding

Date: 1-9-89

Sampling Location: Inlet 6"

Sample Type: Chrome

Run Number: M-I6

Sample Box Number: _____

Clean-up Man: Parks

Job Number: 3625

Comments: _____

FRONT HALF

Filter Number: _____ _____ _____

Description of Filter: _____

MOISTURE

Impingers			
Final Volume:	170 ml	_____ ml	_____ ml
Initial Volume:	200 ml	_____ ml	_____ ml
Net Volume:	-30 ml	_____ ml	_____ ml
Total H_2O:	_____	_____	_____
Silica Gel			Total
Final Volume:	292.9 g	_____ g	_____ g
Initial Volume	237.7 g	_____ g	25.2 g
Net Volume	55.2 g	_____ g	_____ g
Total Moisture:	_____	_____	_____

Description of Impinger Catch: _____

PES

SAMPLE RECOVERY DATA

Plant: Electronic Chrome + Grinding

Date: 1-9-1989

Sampling Location: Stack 5.5"

Sample Type: Chrome

Run Number: M-5-1[illegible]

Sample Box Number:

Clean-up Man: Parks

Job Number: 3625

Comments:

FRONT HALF

Filter Number:

Description of Filter:

MOISTURE

Impingers			
Final Volume:	196 ml	ml	ml
Initial Volume:	200 ml	ml	ml
Net Volume:	-4 ml	ml	ml
Total H_2O:			
Silica Gel			
Final Volume:	301.8 g	g	g
Initial Volume	248.5 g	g	Total g
Net Volume	+53.3 g	g	49.3 g
Total Moisture:			

Description of Impinger Catch:

PES

EMISSION TEST CALCULATIONS

Definition of Symbols

A = cross-sectional area of stack, ft^2

A_n = Cross-sectional area of Nozzle, ft^2

B_{ws} = Water vapor in gas stream, proportional by volume

C_p = Pilot tube coefficient

I = Percent of Isokinetic Sampling

M_d = dry molecular weight, lb/lb-mole

M_s = Molecular weight of stack gas, lb/lb-mole

P_{bar} = Barometric Pressure at the sampling site, in Hg

P_s = Stack gas pressure, in. Hg

Q_s = Stack volumetric flow rate, actual condition acfm

$Q_{(std)}$ = stack volumetric flow rate, actual conditions dscfm

T_m = Average dry gas meter temperature, $R = 460^\circ + F^\circ$

T_s = Average stack gas temperature, $^\circ R = 460^\circ + F^\circ$

V_{lc} = Total volume of liquid collected in impingers and silica gel, ml

V_m = Volume of gas sample as measured by dry gas meter, dscf

$V_{m(std)}$ = V_m corrected to standard conditions, dscf

$V_{w(std)}$ = Volume of water vapor in gas sample corrected to standard conditions, scf

V_s = Stack gas velocity, ft/sec

Y = Dry gas meter calibration factor

ΔH = Average pressure differential across the orifice meter, in. H_2O

θ = Total Sampling Time, min.

13.6 = Specific gravity of Mercury

PES

Plant: Electronic Chrome + Grinding Co. Inc.
Date: 1-9-1989
Source/Sample Number: Chrome / M-I-19

1. $V_{m(std)} = 17.64\ V_m\ Y\ \left[\frac{P_{bar} + (\Delta H/13.6)}{T_m}\right]$

$V_{m(std)} = 17.64\ (30.44)\ (1.003)\ \frac{(29.49) + (1.2)/13.6}{(537.17)}$

$V_{m(std)} =$ 199.999 dscf

2. Volume Water Vapor Collected, Standard Conditions

$V_{lc} =$ 27.2 condensate from impingers and Silica Gel

$V_{W(std)} = .04707\ V_{lc} =$ 1.28 scf

$V_{W(std)} =$ 1.28 scf

3. Percent Moisture, by volume

$B_{Ws} = \frac{V_{W(std)}}{V_{W\ std} + V_{W\ (std)}} = \frac{(1.28)}{(1.28) + (199.99)} =$ 0.0064

$B_{Ws} =$ 0.0064

4. Molecular Weight, Stack gas

Dry Molecular Wight

$M_d = 0.440\ (\%\ CO_2) + 0.320\ (\%\ O_2) + 0.280\ (\%\ N_2 + \%\ CO)$

$M_d = 0.440\ (\ 0\ ) + 0.320\ (20.9) + 0.280\ (78.1)$

$M_d =$ 28.84 lb/lb-mole

$M_s = M_d + B_{Ws}(18 - M_d) = (28.84) + (.0064)\ (18 - 28.84)$

$M_s =$ 28.771 lb/lb-mole

Plant: Electronic Chrome and Grinding
Date: 1-9-1989
Source/Sample Number: Chrome / M-I-19

5. Stack Gas Velocity Average

$$V_{s(avg)} = 85.49\ C_p\ (\sqrt{\Delta P})_{avg} \sqrt{\frac{T_s}{P_s M_s}}$$

$$V_{s(avg)} = 85.49\ (.99)\ (.419) \sqrt{\frac{(528.79)}{(28.77)\ (29.34)}}$$

$V_{s(avg)}$ = 29.07 - ft/sec.

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

$Q_s = 60\ V_s\ A = 60\ (29.07)\ (267)$

Q_s = 34926 acfm

7. Stack volumetric flow rate, standard conditions (68° F, 29.92 Hg)

$$Q_{(std)} = 17.64\ Q_s\ (1-B_{ws})\ \frac{P_s}{T_s} =$$

$$Q_{(std)} = 17.64\ (34849)\ (.9936)\ \frac{(29.31)}{(528.8)}$$

Q_{std} = 33967 dscfm

8. Isokinetic Variation

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

$$= 0.0945\ \frac{(528.8)\ (199.99)}{(29.31)\ (29.07)\ (.00038)\ (360)\ (1-.064)}$$

%I = 103.32 %

Plant: Electronic Chrome and Grinding Co. Inc.
Date: 1-9-1989
Source/Sample Number: Chrome M-I-6

1. $V_{m(std)} = 17.64\ V_m\ Y \left[\frac{P_{bar} + (\Delta H/13.6)}{T_m}\right]$

$V_{m(std)} = 17.64\ (274.311)(.993)\left[\frac{(29.49) + (1.68)/13.6}{(535.49)}\right]$

$V_{m(std)} =$ 265.731 dscf

2. Volume Water Vapor Collected, Standard Conditions

$V_{lc} =$ 25.2 condensate from impingers and Silica Gel

$V_{W(std)} = .04707\ V_{lc} =$ 1.186 scf

$V_{W(std)} =$ 1.186 scf

3. Percent Moisture, by volume

$B_{Ws} = \frac{V_{W(std)}}{V_{W\ std} + V_{W\ (std)}} = \frac{(1.186)}{(1.186) + (265.731)} =$ 0.0044

$B_{Ws} =$ 0.0044

4. Molecular Weight, Stack gas

Dry Molecular Wight

$M_d = 0.440\ (\%\ CO_2) + 0.320\ (\%\ O_2) + 0.280\ (\%\ N_2 + \%\ CO)$

$M_d = 0.440\ (0) + 0.320\ (20.9) + 0.280\ (79.1)$

$M_d =$ 28.84 lb/lb-mole

$M_s = M_d + B_{Ws}(18 - M_d) = (28.84) + (.0044)(18 - 28.84)$

$M_s =$ 28.792 lb/lb-mole

PES

Plant: Electronic Chrome & Grinding Co. Inc.
Date: 1-9-1999
Source/Sample Number: Chrome M-I-6

5. Stack Gas Velocity Average

$$V_{s(avg)} = 85.49\ C_p\ (\sqrt{\Delta P})_{avg} \sqrt{\frac{T_s}{P_s M_s}}$$

$$V_{s(avg)} = 85.49\ (0.99)(.2904)\sqrt{\frac{(528.04)}{(29.36)(28.792)}}$$

$V_{s(avg)}$ = 19.427 ft/sec.

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

$Q_s = 60\ V_s\ A = 60\ (19.427)(.196)$ ← area of 6" diameter duct

Q_s = 228.86 acfm ✓

7. Stack volumetric flow rate, standard conditions (68° F, 29.92 Hg)

$$Q_{(std)} = 17.64\ Q_s\ (1-B_{ws})\ \frac{P_s}{T_s} =$$

$$Q_{(std)} = 17.64\ (228.86)(.8966)\frac{(29.36)}{(528.04)}$$

Q_{std} = 223.48 dscfm ✓

8. Isokinetic Variation

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

$$= 0.0945\ \frac{(528.04)(265.731)}{(29.36)(19.427)(.00075)(360)(1-.0044)}$$

%I = 86.31 % ↑ 87.78

PES

Plant: Electronic Chrome & Grinding Co Inc.
Date: 4-4-1989
Source/Sample Number: Chrome M-5-I

1. $V_{m(std)} = 17.64\ V_m\ Y\ \left[\frac{P_{bar} + (\Delta H/13.6)}{T_m}\right]$

$V_{m(std)} = 17.64\ (337.07)(.993)\left[\frac{(29.49) + (3.0)/13.6}{(535.09)}\right]$

$V_{m(std)} =$ 327.90 dscf

2. Volume Water Vapor Collected, Standard Conditions

$V_{lc} =$ 49.3 condensate from impingers and Silica Gel

$V_{W(std)} = .04707\ V_{lc} =$ 2.32 scf

$V_{W(std)} =$ 2.32 scf

3. Percent Moisture, by volume

$B_{ws} = \frac{V_{W(std)}}{V_{W\ std} + V_{W\ (std)}} = \frac{(2.32)}{(2.32)+(327.9)} =$ 0.007

$B_{ws} =$ 0.007

4. Molecular Weight, Stack gas

Dry Molecular Wight

$M_d = 0.440\ (\%\ CO_2) + 0.320\ (\%\ O_2) + 0.280\ (\%\ N_2 + \%\ CO)$

$M_d = 0.440\ (\ 0\ ) + 0.320\ (20.9) + 0.280\ (79.1)$

$M_d =$ 28.84 lb/lb-mole

$M_s = M_d + B_{ws}(18 - M_d) = (28.84) + (0.007)(18-28.84)$

$M_s =$ 28.769 lb/lb-mole

Plant: Electronic Chrome + Grinding Co. Inc,
Date: 1-9-1989
Source/Sample Number: Chrome M-5-I

5. Stack Gas Velocity Average

$$V_{s(avg)} = 85.49\ C_p\ (\sqrt{\Delta P})_{avg} \sqrt{\frac{T_s}{P_s M_s}}$$

$$V_{s(avg)} = 85.49\ (0.99)(.3665) \sqrt{\frac{(529.04)}{(29.491)(28.764)}}$$

$V_{s(avg)}$ = 24.472 ft/sec.

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

$$Q_s = 60\ V_s\ A = 60\ (24.472)(0.165)$$

Q_s = 242.25 acfm

7. Stack volumetric flow rate, standard conditions (68° F, 29.92 Hg)

$$Q_{(std)} = 17.64\ Q_s\ (1-B_{ws})\ \frac{P_s}{T_s} =$$

$$Q_{(std)} = 17.64\ (242.25)(.993)\frac{(29.491)}{(528.04)}$$

Q_{std} = 236.99 dscfm

8. Isokinetic Variation

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

$$= 0.0945\ \frac{(528.04)(327.9)}{(29.491)(24.472)(.00076)(360)(1-.067)}$$

%I = 83.57 %

Received: 01/10/89 01/24/89 07:56:37

REPORT Pacific Environmental Service
TO 820 So. Myrtle Ave.
Monrovia, Calif. 91016

ATTEN Mr. Dean High

CLIENT PACIFIC ENVI SAMPLES 4
COMPANY Pacific Environmental Service
FACILITY

WORK ID Project: 3625
TAKEN By Pacific Environmen. Staff
TRANS By Pacific Environmen. Staff
TYPE Liquids
P.O. # # 3625
INVOICE under separate cover

PREPARED Thermo Analytical, Inc.
BY 160 Taylor Street
Monrovia, CA 91016

ATTEN
PHONE 818-357-3247

Robert S. Ferguson
CERTIFIED BY

CONTACT RSF

This report is for the sole and exclusive use of the client to whom it is addressed and represents only those samples herein described. Samples not destroyed in testing are retained a maximum of 30 days unless otherwise requested.

Information reported by telephone to Scott Parks on 1/3/89.

SAMPLE IDENTIFICATION

01 Stack M-5-1
02 Inlet M-1-6
03 Inlet 19-M-I-19
04 Blank

TEST CODES and NAMES used on this report

CR HEX	Hexavalent Chromium
CR L	Chromium - Liquids
WC	General Chemical Testing

PACIFIC ENVIRONMENTAL SERVICES, INC.

Received: 01/10/89 Results by Sample

SAMPLE ID Stack M-5-1 SAMPLE # 01 FRACTIONS: A
Date & Time Collected not specified Category

CR_HEX	CR_L	WC
< .05 mg/L	0.046 mg/L	425 mls

SAMPLE ID Inlet M-1-6 SAMPLE # 02 FRACTIONS: A
Date & Time Collected not specified Category

CR_HEX	CR_L	WC
1.9 mg/L	2.65 mg/L	498 mls

SAMPLE ID Inlet 19-M-I-19 SAMPLE # 03 FRACTIONS: A
Date & Time Collected not specified Category

CR_HEX	CR_L	WC
0.9 mg/L	1.51 mg/L	532 mls

SAMPLE ID Blank SAMPLE # 04 FRACTIONS: A
Date & Time Collected not specified Category

CR_HEX	CR_L	WC
< .05 mg/L	0.005 mg/L	375 mls

acific Environmental Service

The volumes of four liquids were measured, and they were analyzed for hexavalent and total chromium content, according to EPA method 425. Please see the enclosed tables for the results.