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/

The file name refers to the reference number, the AP42 chapter and section. The file name "ref02_c01s02.pdf" would mean the reference is from AP42 chapter 1 section 2. The reference may be from a previous version of the section and no longer cited. The primary source should always be checked.

Background Report Reference

AP-42 Section Number: 12.20

Background Chapter: 4

Reference Number: 51

Title: California Air Resources Board Test of Price Pfister, Inc.

April 1987

ELECTROPLATING

REF. 4-51.

State of California
AIR RESOURCES BOARD

PRICE PFISTER, INC., CHROMIUM PLATING TANK #1
TOTAL AND HEXAVALENT CHROMIUM EMISSIONS

Engineering Evaluation Branch
Test Report

C-86-106

Report Date: April 3, 1987

APPROVED:

David F. Todd Project Engr.,
Testing Section

Peter K. Onishi Manager,
Testing Section

Vern C. Kimitsuki Chief,
Engineering Evaluation Branch

PRICE PFISTER, INC., CHROMIUM PLATING TANK #1
TOTAL AND HEXAVALENT CHROMIUM EMISSIONS

This report presents an estimate of emissions from Price Pfister, Inc., Chromium Plating Tank #1. These emission estimates are based on tests performed by the Air Resources Board (ARB) staff using a draft ARB test method. The results have been reviewed by the staff and are believed to be accurate within the limits of the method. However, data are usually affected by the test method and process variables which are sometimes not apparent during the tests. The data should not, therefore, be necessarily considered typical of a specific source or industry until the effects of such variables are known and taken into account.

ACKNOWLEDGEMENTS

The project engineer was David Todd and the field engineer was Cindy Castronovo of ARB. Instrument technicians were Jack LaBrue and Bud Thoma of ARB. The chemist was Ed Jeung of the California Department of Health, Air and Industrial Hygiene Laboratory (AIHL). Assistance was provided by Rudy Garanchon of Price Pfister, Inc. Additional assistance was provided by Frances Cameron of the ARB Toxic Branch. Chemical analyses were performed by AIHL.

State of California
AIR RESOURCES BOARD

PRICE PFISTER, INC., CHROMIUM PLATING TANK #1
TOTAL AND HEXAVALENT CHROMIUM EMISSIONS

Engineering Evaluation Branch
Test Report

C-86-106

C86-106
Price Pfister

FIELD DATA

10

Run No. ~~I~~ PT-1U

Meter ΔH 1.92

Location Inlet

VERY IMPORTANT - FILL IN ALL BLANKS

Date 11/18/86

Read and record at the start of each test point.

Operator DTodd

Leak Test = Before 15" of / After 18" of

Sample Box No.

Pitot Tube Lk Chk

1100-1500 Meter Box No. JP483396

Pitot Tube Factor .813

Ambient Temp °F 65

Bar. Press."Hg 28.60

Assumed Moisture % 1.3

Heater Box Setting, °F —

Probe Tip Dia., In. 3/8 .375

Probe Length 6' S/N 3

Probe Heater Setting —

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O ΔP	Orifice ΔH in H_2O Desired	Orifice ΔH in H_2O Actual	~~Dry Gas Temp. °F~~ Inlet	~~Dry Gas Temp. °F~~ Outlet	Pump Vacuum In. Hg Gauge	Impinger Temp °F	Stack Press In. Hg	Stack Temp °F
1	000	245.20	.77	>10	5.5	60		14	50	-3.5	80
2	20	267.2	.76	>10	4.5			~~17~~ 14	55		80
3	40	289.1	.75	>10	4.4			14	55		80
4	60	311.00	.59	>10	4.4			14	50		80
5	80	333	.70	>10	4.4			14	55		80
6	100	354.0	.75	>10	4.0			17	50		80
1	120	374.98	.34	7.2	4.2			17	55		85
2	140	396.2	.38	8.1	4.2			17	55		85
3	160	417	.39	8.2	4.2			17	55		85
4	180	438.9	.79	>10	4.1			17	55		85
5	200	460.2	.97	>10	4.1			17	60		85
6	220	481	.98	>10	4.1			17	60		85
End	240	502.60									
	(240)	(257.4)	(.81)		(4.34)						(82)

H_2O = 89.5 ml Cr VI - 132.4 ug

Dia: 17½"

C86-106
Price Pfister

FIELD DATA

Run No. PT-24

Location Inlet

Date 11/18/86

Operator D Todd

Sample Box No.

Meter Box No. JP483396

Meter ΔH 1.92

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point.

Leak Test = Before 18" ok / After

Pitot Tube Factor .813 S/N 3

Ambient Temp °F 75°

Bar. Press."Hg 28.96

Assumed Moisture % 1.3

Heater Box Setting, °F —

Probe Tip Dia., In. 1/4"

Probe Length 5' glass-lined.

Probe Heater Setting —

C810

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O ΔP	Orifice ΔH in H_2O Desired	Orifice ΔH in H_2O Actual	Dry Gas Temp. °F Inlet	Dry Gas Temp. °F Outlet	Pump Vacuum In. Hg Gauge	Impinger Temp °F	Stack Press In. Hg	Stack Temp F
1 start	000	503.025	.69	2.9	4.3	60		16	40	-3.5	70
2 35	035	540.6	.75	3.2	4.2			17	45		80
3 70	070	577.6	.76	3.2	4.0			17	40		75
4 105	105	614	.156	3.4	4.0			18	~~40~~ 45		~~80~~
5 140	140	650	.69	2.9	3.9			18	45		80
6 175	175	686.6	.71	3.4	3.9			18	40		80
End	210.1	722.70	~~Tube Packed~~	out Silica	Gel 3	Lk Chk	ok	—18" @ 15"			
1 0	~~210~~ 000	722.96	.27	1.2	4.3			17	45		70
2 35	27	760.6	.35	1.5	4.3			17	50		85
3 70	70	798.4	.36	1.5	4.3			17	50		85
4 105	105	836	.80	3.4	4.3			17	50		85
5 140	140	673.6	.91	3.9	4.3			17	50		85
6 175	179	916.	.94	4.0	4.3			17	50		85
End 210	210	949.63									
Meter Total = (722.70 - 503.025) + (949.63 - 722.96) =											
	420	446.345	.793		4.175						80

H_2O = 141.3 ml (vol = 169.4 ug)

Dia = 17½"

C86-106
Price Pfister Truesdail run 10:30-1:30

FIELD DATA

Run No. PT-3U

Location Inlet

Date 11/20/86

Operator D Todd

Sample Box No.

Meter Box No. JP 483396

Meter ΔH 1.92

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point.

Leak Test = Before: 18" ok; After: 16" ok

Pitot Tube Factor 0.813 S/N 3

Ambient Temp °F 75

Bar. Press."Hg 28.97

Assumed Moisture % 1.3

Heater Box Setting, °F —

Probe Tip Dia., In. 1/4"

Probe Length 5' glass lines.

Probe Heater Setting —

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O Δ P	Orifice ΔH in H_2O Desired	Orifice ΔH in H_2O Actual	Dry Gas Temp. °F Inlet	Dry Gas Temp. °F Outlet	Pump Vacuum In. Hg Gauge	Impinger Temp °F	Stack Press In. Hg	Stack Temp °F
W6 + 00	000	950.03	.98	4.2	4.1	60		17	45	-3.5	75
5 035	035	995.3	.96	4.1	3.6			17	45		75
N6 20	070	020.15	.74	3.2	3.7			17	45		75
5 105	105	054.9	.70	3.0	3.7			17	45		75
4 140	140	089.6	.59	2.5	3.7			17	45		80
3 175	175	124	.76	3.3	3.7			17	50		85
E2 210	210	158.9	.79	3.4	3.6			18	55		85
1	245	193	.63	2.7	3.6			18	55		85
	280	227.89									
			Trude out	Silica Gel.	Lk ✓	18" ok	+				
N4 0	0	228.12	.74	3.2	4.0			16	50		85
3 36	35	264	.36	1.5	3.9			17	55		90
2 70	70	300.1	.52	2.2	3.9			18	55		85
1 105	105	336	.18	.68	3.9			18	50		80
End 140	140	372.47									
	420	422.21	.80		3.78						80

H_2O = 123.7 ml Cr^{VI} = 293.6 ug

Dia = 17½"

C86-106
Price Pfister

FIELD DATA

Run No. ~~1~~ 1 PT-1D Meter ΔH 1.67

Location Price-Pfister

Date 11/18/86

Operator Castronovo

Sample Box No. _____

Meter Box No. JP497710

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point.

Leak Test = Before: OK 17" / After: OK 20"

Pitot Tube Factor .821

Ambient Temp °F 65

Bar. Press."Hg 28.60

Assumed Moisture % 1.5

Heater Box Setting, °F ——

Probe Tip Dia., In. 3/8 (.375)

Probe Length 6 ft. glass lined #17

Probe Heater Setting ——

Point	Clock Time (1:30 -	Dry Gas Meter, CF	Pitot in. H_2O ΔP	Orifice ΔH in H_2O Desired	Orifice ΔH in H_2O Actual	Dry Gas Temp. °F Inlet	Dry Gas Temp. °F Outlet	Pump Vacuum In. Hg Gauge	Impinger Temp °F	Stack Press In. H_2O	Stack Temp °F
~~1L~~	~~0~~	~~778.93~~	~~0.44~~								
1L	0	778.93	0.39	6.9	4.3			17	43	0.22	65
2L	19.9	802.3	0.49	8.8	4.3			17	45		63
3L	40.0	826.4	0.51	8.8	4.3			17			65
4L	58.5	848.4	0.51	8.8	4.3			17	42		67
1M	80	874.74	0.14	2.5	~~0.44~~ 4.3			16	50		70
2M	100	898.3	0.43	7.8	4.3			16	50		70
3M	120	922.2	0.42	7.4	4.2			16	50		65
4M	140	946.2	0.45	8.0	4.2			16	50		65
1R	160	969.81	0.41	7.2	4.2			16	45		65
2R	180	993.0	0.38	6.9	4.2			16	45		65
3R	200	016.8	0.42	7.4	4.2			16	50		65
4R	220	040.9	0.45	8.0	4.2			16	50		65
	240	064.3									
	240	285.37	0.64		4.25						65

H_2O = 87.4 ml Cr^{VI} = 46.9 ug

Dia = 20.75" x 15.5"

C86-106
Price Pfister

FIELD DATA

Run No. PT-2D

Location Price-Pfister

Date 11/19/86

Operator Castronovo

Sample Box No. _____

Meter Box No. JP497710

Meter ΔH 1.67

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point.

Leak Test = Before DK 20" / After DK 18"

Pitot Tube Factor .821

Ambient Temp °F 75

Bar. Press."Hg 28.96

Assumed Moisture % 1.5

Heater Box Setting, °F —

Probe Tip Dia., In. 3/8 .375"

Probe Length 6 ft.

Probe Heater Setting —

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O ΔP	Orifice ΔH in H_2O Desired	Orifice ΔH in H_2O Actual	Dry Gas Temp. °F Inlet	Dry Gas Temp. °F Outlet	Pump Vacuum In. Hg Gauge	Impinger Temp °F	Stack Press In. Hg	Stack Temp. °F
1L	0	66.01	0.15	2.7	3.7	60		17	35		65
2L	35	105.8	0.48	8.6	3.7			17	40		65
3L	70	144.6	0.47	8.3	3.6			17	40		65
4L	105	183.3	0.52	9.2	3.6			17	40		70
								~~17~~			
1M	140	222.5	0.53	9.4	3.5			17	45		70
2M	175	260.3	0.53	9.4	3.5			17	40		70
3M	210	298.8	0.39	7.0	3.5			17	45		70
4M	245	337.2	0.47	8.3	3.5			17	50		75
180	280	375.00									
			Tubed Silica Gels		16" LKV	before & after					
1R	000	375.32	0.40	7.1	4.0			17	50		75
2R	35	414.7	0.38	6.9	4.0			17	50		75
3R	70	455.2	0.39	7.0	4.0			17	45		70
4R	105	495.8	0.40	7.1	4.0			17	45		70
End	140	536.46									
	420	470.13	.65		3.72						70

H_2O = 162.2 ml Cr VI = 70.4 ug

Dia = 20.75" × 15.5"

C86-106
Price Pfister

FIELD DATA

Run No. PT-3D

Location Price-Pfister

Date 11/20/86

Operator Castronovo

Sample Box No. _____

Meter Box No. JP497710

Meter ΔH 1.67

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point.

Leak Test = Before OK 25" / After OK 18"

Pitot Tube Factor .821

Ambient Temp °F 75

Bar. Press. "Hg 28.97

Assumed Moisture % 1.5

Heater Box Setting, °F —

Probe Tip Dia., In. 3/8 .375"

Probe Length 6 ft SN 17

Probe Heater Setting —

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O ΔP	Orifice ΔH in H_2O Desired	Orifice ΔH in H_2O Actual	Dry Gas Temp. °F Inlet	Dry Gas Temp. °F Outlet	Pump Vacuum In. Hg Gauge	Impinger Temp °F	Stack Press In. Hg	Stack Temp °F
1L	0	537.73	0.44	7.8	3.3			18	35		65
2L	35	574.0	0.45	7.9	3.2			18	35		70
3L	70	609.9	0.51	9.0	3.1			18	40		80
4L	105	644.9	0.48	8.4	3.0			18	40		80
								~~18~~	~~45~~		~~80~~
1M	140	679.9	0.50	8.8	3.0			18	45		80
2M	175	714.8	0.44	7.8	3.0			18	45		80
1R	210	741.5	0.43	7.6	3.0			18	45		80
2R	245	784	.37	6.5	2.9			18	45		80
3R	280	818.9	0.38	6.7	3.0			18	40		80
4R	315	853.8	0.46	8.1	3.0			18	45		80
	350	888.6									
			Failed initial leak check - troubleshoot ⇒ leak check OK @ 18"								
			Change silica gel								
			Passed leak check @ 20"								
3M	0	891.6	0.33	5.8	4.3			17	45		75
4M	35	932.4	0.45	7.9	4.2			17	45		75
end	70	973.2									
	420	432.47	.66		3.25						80

H_2O = 133.4 ml Cr^{VI} = 66.2

Dia 20.75" x 15.5"

STATE OF CALIFORNIA — DEPARTMENT OF WATER RESOURCES — COMPUTATION SHEET

Project: Price Pfister

Feature: Total Chrome + Chrome VI

Item: Catches

Sheet ___ Date ___ Designed ___ Checked ___

	Total		Hex		Total		Hex		Total		Hex	
1. Run #	1U	1D	1U	1D	2U	2D	2U	2D	3U	3D	3U	3D
2. Corrected Sample Vol., DSCF	252.67	280.06	252.67	280.06	443.41	466.50	443.41	466.50	419.16	428.77	419.16	428.77
3. Catches, ug												
a. Before Filter	147.7	10.2	125.4	4.6	77.3	25.9	130.4	11.2	104.8	11.2	252.4	6.4
b. Filter	40.5	77.2	7.0	42.3	37.5	132.4	39.0	59.2	74.2	123.2	41.2	59.8
c. After Filter	1.0	6.5	<1	<1	0.7	2.4	<1	<1	0.4	10.7	<1	<1
d. Total	189.2	94.0	132.4	46.9	115.5	160.7	169.4	70.4	179.4	145.1	293.6	66.2
4. Emissions, 10^{-2} ug/DSCF												
a. Before Filter	58.46	3.64	49.63	1.64	17.43	5.55	29.41	2.40	25.00	2.61	60.22	1.49
b. Filter	16.03	27.60	2.77	15.10	8.46	28.38	8.80	12.69	17.70	28.73	9.83	13.95
c. After Filter	0.40	2.32	<.40	<.36	0.16	0.51	<.23	<.21	0.10	2.50	<0.24	<.23
d. Total	74.88	33.56	52.40	16.75	26.05	34.45	38.20	15.09	42.80	33.84	70.04	15.44
5. Stack Flow Rate, DSCFM	4202	4561	4202	4561	4153	4635	4153	4635	4194	4670	4194	4670
6. Emission Rate, 10^{-3} lb/hr	.42	.20	.29	.10	.14	.21	.21	.09	.23	.21	.39	.10
7. Scrubber Data												
a. Sample location	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
b. Efficiency	52		66		-50		57		9		74	
c. Chrome Conc mg/ml	.26		19		21		16		23		21	

DWR 132 (REV. 12-64)

C86-106 PRICE-PFISTER, INC. (CHROME PLATING)

13500 PAXTON, PACOIMA WEEK OF 11-17-86

DATE	RUN NO.	FILTER NO.	PROBE NO.	PROBE CP.	NOZZLE NO.	NOZZLE DIAM.	DESICCATOR WEIGHTS, GMS. TOTAL / TARE	NET	IMP. COND. ML.	TOTAL H2O ML.
	UPSTREAM H2O TRAIN	—	—	—	—	—		8.0	1.0	9.0
	DOWNSTREAM H2O TRAIN	—	—	—	—	—		7.0	1.0	8.0
	PT-1U	27	3	*	3/8-1		1816.5 / 1769.0	47.5	42.0	89.5
	PT-2U	24	3	*	1/4-3		1821.6 / 1781.0	40.6		
	—	—	—		2ND SILICAGEL		1812.7 / 1770.0	42.7	58.0	141.3
	PT-3U	22	3		1/4-3		1820.5 / 1776.5	44.0		
					2ND SILICA GEL		1806.0 / 1778.3	27.7	52.0	123.7
	PT-1U BLANK	26	24	—	—	—	— / —	—	—	—
	PT-1D	28	17	0.821	3/8-2		1835.0 / 1782.6	52.4	35 **	87.4 **
	PT-2D	25	17	0.821	3/8-2		1839.0 / 1791.6	47.4		
	—				2ND SILICA GEL		1805.0 / 1773.2	31.8	83.0	162.2
	PT-3D	20	17	0.821	3/8-2		1818.0 / 1797.0	21.0		
					2ND SILICA GEL		1803.4 / 1781.0	22.4	90.0	133.4
	PT-1D BLANK	21	—	—	—	—	— / —	—	—	—

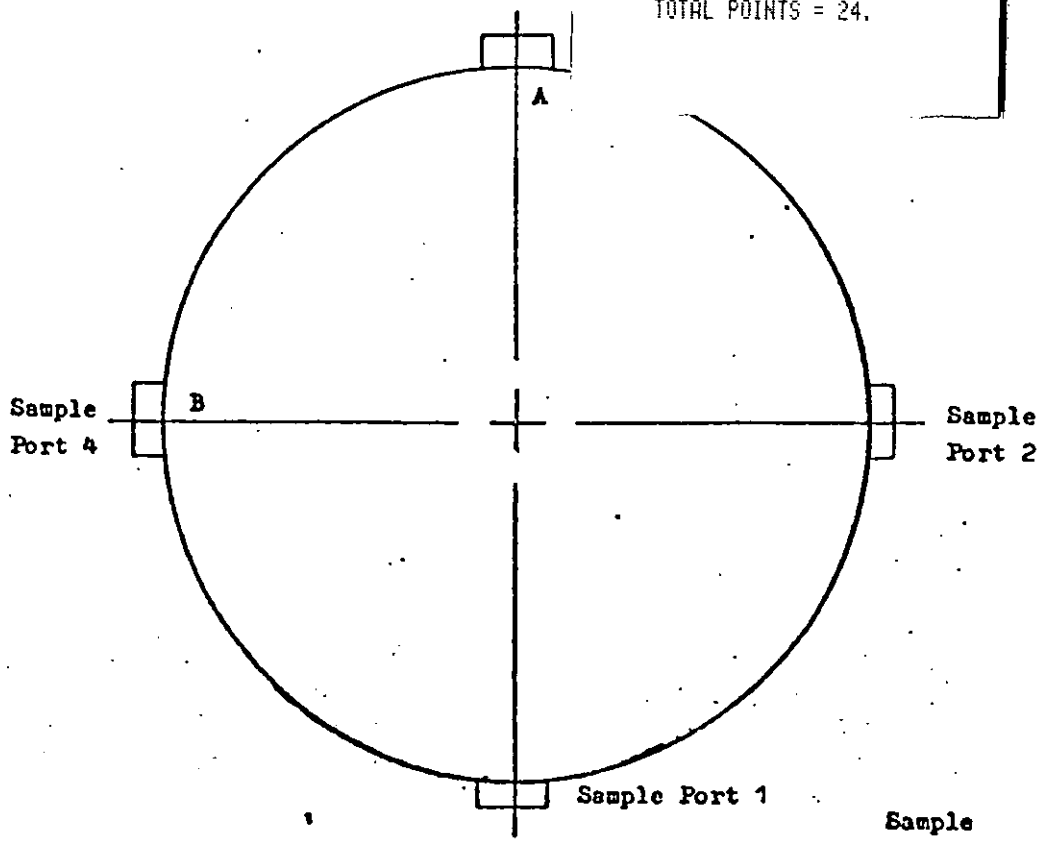
* PROBE #3 PITOT NOT CALIBRATED

** TOTAL H2O IN IMPINGERS MEASURED 135 ML. AT END OF TEST

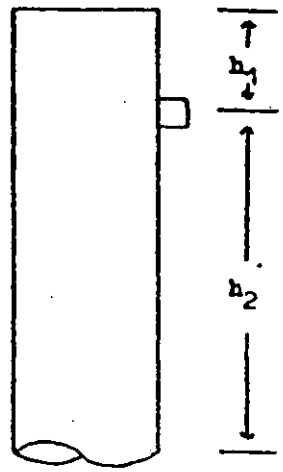
```
XROM "NOP"

DOWNSTREAM DIA?
          2.3429     RUN
UPSTREAM DIA?
          1.0588     RUN
STK DIA INCHES?
         17.5000     RUN

TOTAL POINTS = 24.
```

Fig

Rou



Sample Port Elevation



Notes: 20" – 2½" Nipple

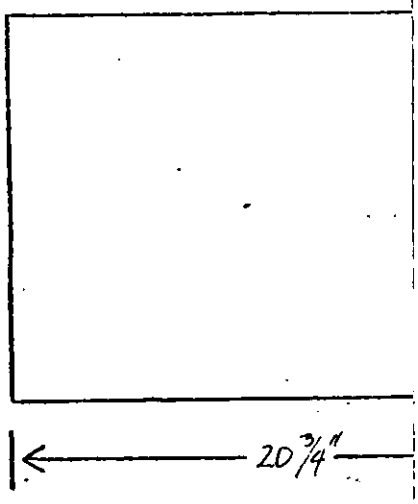
1. Stack diameter 17½".

2. Sampling port in 1½ feet upstream (h_1) of any disturbance and 41" feet downstream (h_2) of any disturbance.

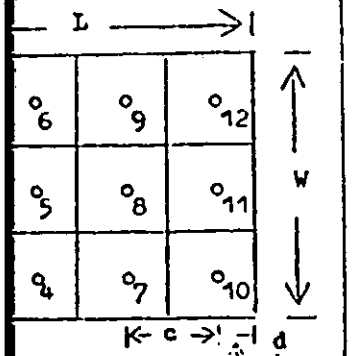
3. Sampling port is not 8 diameters downstream and 2 diameters upstream. The following was done to compensate for this: _____

```
XROM "EDIA"
LONG INCH?
        20.75    RUN
SHORT INCH?
        15.5     RUN

EQUIV DIA FT = 1.5

EQUIV DIA INCHES = 17.7


XROM "NOP"

DOWNSTREAM DIA?
        2.6600   RUN
UPSTREAM DIA?
        .6600    RUN
STK DIA INCHES?
        17.7400  RUN

TOTAL POINTS = 24.
```

Cross section



Example



showing rectangular
ross section divided
equal areas, with a
e point at centroid
area.

W = width

Equivalent diameter, D_e

$$D_e = 4\left(\frac{\text{area}}{\text{perimeter}}\right) = 4\left(\frac{321.63}{72.50}\right) = 17.75$$

L = 20.75

W = 15.5

a = 5.17 (5 1/8)

b = 2.58 (2 5/8)

c = 5.19 (5 1/8)

d = 2.59 (2 5/8)

a = distance between traverse points as measured along the width, W

b = distance of traverse point from wall as measured along the width, W

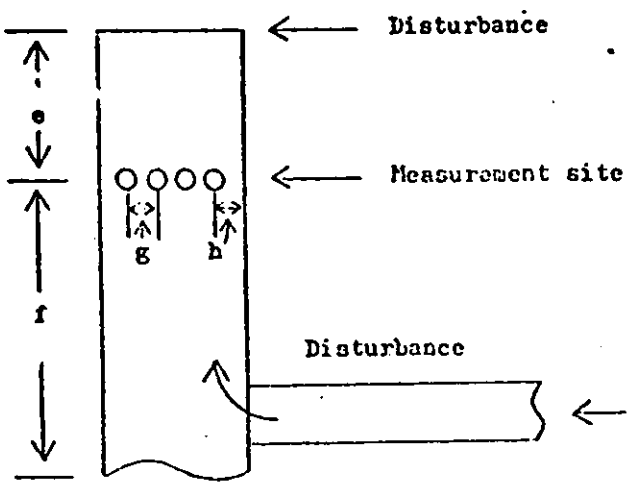
c = distance between traverse points as measured along the length, L

d = distance of traverse point from wall as measured along the length, L

Number of traverse points 12

① 2 5/8
② 7 3/4
③ 12 7/8
④ 18

Elevation



e = 2 D_e

f = 8 D_e

g = a if measurement site is located along the width

= c if measurement site is located along the length

h = b if measurement site is located along the width

= d if measurement site is located along the length

e = 1'

f = 4'

g = _____

h = _____

File No. C86-106

State of California

17½ x A + 2.5 =

AIR RESOURCES BOARD

Stationary Source Control Division
Engineering Evaluation Branch

2½" Nipple
17½" Dia

VELOCITY TRAVERSE DATA

	Traverse Point Number	Velocity Head in. H_2O (ΔP)	Distance from inside wall (in.)	Stack Temperature (T_s), °F	Static ~~Velocity~~ Head in. H_2O	$\sqrt{\Delta P}$	Stack Temperature (T_s), °F
N	1	.41	~~3.27~~ = 3¼	75		.64	
	2	.79	5.073 = 5⅛	80		.89	
	3	.79	7.663 = 7⅝	80		.89	
	4	.63	14.835 = 14⅞	80	-3.5	.79	
	5	.70	17.428 = 17⅜	80		.84	
	6	.78	19.23 19¼	80		.88	
W	1	.32	3¼	50		.57	
	2	.33	5⅛	80		.57	
	3	.39	7⅝	80		~~.57~~ .62	
	4	.74	14⅞	80	-3.5	.86 ~~.35~~ .62	
	5	.90	17⅜	80		.95	
	6	.89	19¼	80		.94	
	Average			80°F	-3.5	.7867	

Plant Price Pfister

Pitot Tube Factor 0.802

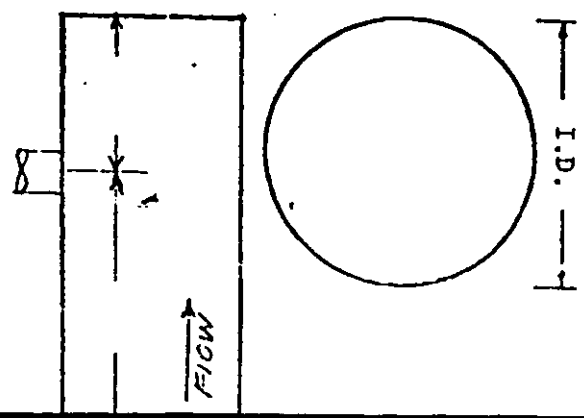
Sampling Site Inlet

Remarks

Barometric Pressure, in. Hg 28.60

Static Pressure in Stack (P_g) in. Hg -3.5

Operators D Todd Date 11/18/86



File No. 86-106

A - 19
State of California

AIR RESOURCES BOARD

Stationary Source Division
Engineering Evaluation Branch

MOTOR VEHICLE TRANSIT DIV.

	Point Number	Diameter (in.)	Distance from Inside Wall (in.)	Stack Temperature (Ts), °F	Static ~~Velocity~~ Head in. H_2O	$\sqrt{\Delta P}$	Stack Temperature (T_s), °F
Left	1	0.32	2 5/8	55		0.57	
	2	0.47	7 3/4	57		0.69	
	3	0.49	12 7/8	55	0.23	0.70	
	4	0.50	18	54	~~0.23~~	0.71	
Middle	1	0.45	2 5/8	55		0.67	
	2	0.45	7 3/4	55		0.67	
	3	0.39	12 7/8	55	0.23	0.62	
	4	0.47	18	55		0.69	
Right	1	0.34	2 5/8	55		0.58	
	2	0.37	7 3/4	55	0.22	0.61	
	3	0.41	12 7/8	55	~~0.24~~	0.64	
	4	0.53	18	55		0.73	
				55	0.22	0.66	

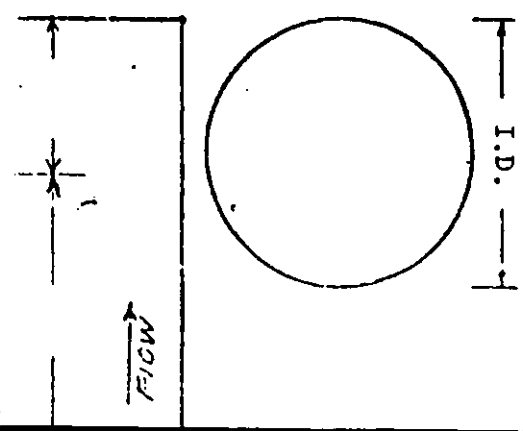
Pitot Tube Factor .802

Price-Pfister

Scrubber outlet

rectangular stack extension

28.6



Castronovo 11-18-86

State of California File No. 86-106

AIR RESOURCES BOARD

Division of Implementation & Enforcement
Engineering Evaluation Unit

WATER VAPOR CALCULATIONS

Standard Conditions ~~60~~ 68 °F and 29.92 in. Hg

Ambient Conditions 60 °F and 28.6 in. Hg

Pre Leak check ✓
Post Leak check ✓

Time	Gas Volume Through Meter (Vm), Ft³	Impinger Temp. (Ti), °F	Meter Temp. (Tm), °F	Orifice Pressure (Δh), in. H_2O	Volume of Water Collected in Impinger (V_{1c}), ml
0912	749.745	41	60	5.9	Final 201
0917	756.45	41	↓	5.85	Initial 200
0922	763.4	42		5.8	8 g silica gel
0927	770.45	42		5.7	
0932	777.665	42		5.7	
					Net (V_{1c}) 9 ml

(20.3) 27.92

A. Gas Volume Metered (V_{mstd})

$$P_{ma} = P_{bar} + (\Delta H/13.6) = (28.6) + \frac{(1.67)}{13.6} = 28.72 \text{ in. Hg}$$

$$V_{mstd} = \frac{528\ °R}{29.92 \text{ in. Hg}} \cdot \frac{V_m P_{ma}}{T_m} = (\cancel{17.38}\ 17.64)\ \frac{(27.92)(28.72)}{(520)} = 27.20 \text{ SDCF}$$

B. Volume of Water Collected (V_{wstd})

$$V_{wstd} = (\cancel{0.0464}\ 0.04707\ \frac{Ft^3}{ml})\ (V_{1c}) = (\cancel{0.0464}\ 0.04707)\ (9\ ml) = 0.42 \text{ SCF}$$

C. Moisture Content in Stack Gas (Bw) in Percent

$$Bw = \frac{B}{A + B} \times 100 = \frac{(0.42)}{(27.20 + 0.42)} \times 100 = 1.52$$

D. If calculated moisture content (C) is greater than at saturation temperature (e.g. 212°F or below) use the table for moisture content.

% OF H_2O AT SATURATION

TEMP. °F	% H_2O	TEMP. °F	% H_2O	TEMP. °F	% H_2O
50	1.2	130	15.1	180	51.1
60	1.7	140	19.7	185	57.0
70	2.5	150	25.3	190	63.6
80	3.5	155	28.7	195	70.8
90	4.8	160	32.3	200	78.6
100	6.5	165	36.4	205	87.0
110	8.7	170	40.8	210	96.2
120	11.5	175	45.7	212	100.0

State of California File No. 86-106

AIR RESOURCES BOARD

Division of Implementation & Enforcement
Engineering Evaluation Unit

WATER VAPOR CALCULATIONS

Standard Conditions ~~60~~ 68 °F and 29.92 in. Hg

Ambient Conditions 70 °F and 28.60 in. Hg

Lk V pre 15" of post 17" of

ΔH = 1.92 Inlet

Time	Gas Volume Through Meter (Vm), Ft³	Impinger Temp. (Ti), °F	Meter Temp. (Tm), °F	Orifice Pressure (Δh), in. H_2O	Volume of Water Collected in Impinger (V_{1c}), ml
000	217.28		60		Final 201
6.0 ~~5.4~~	224.5	50		5.5	Initial 200
11.0	230.7	50		5.5	1
22.8	244.81	50		5.5	
	27.53	50		5.5	Net (V_{1c}) 8ml

A. Gas Volume Metered (V_{mstd})

$$P_{ma} = P_{bar} + (\Delta H/13.6) = (28.60) + \frac{(1.92)}{13.6} = 29.74 \text{ in. Hg}$$

$$V_{mstd} = \frac{528\ °R}{29.92 \text{ in. Hg}} \cdot \frac{V_m\ P_{ma}}{T_m} = (17.64)\ \frac{(27.53)(29.74)}{(520)} = 27.77 \text{ SDCF}$$

B. Volume of Water Collected (V_{wstd})

$$V_{wstd} = (0.04707\ \frac{Ft^3}{ml})\ (V_{1c}) = (0.04707)\ (8) = 0.37656 \text{ SCF}$$

C. Moisture Content in Stack Gas (Bw) in Percent

$$Bw = \frac{B}{A + B} \times 100 = \frac{(.37656)}{(27.77 + .37656)} \times 100 = 1.3$$

D. If calculated moisture content (C) is greater than at saturation temperature (e.g. 212°F or below) use the table for moisture content.

% OF H_2O AT SATURATION

TEMP. °F	% H_2O	TEMP. °F	% H_2O	TEMP. °F	% H_2O
50	1.2	130	15.1	180	51.1
60	1.7	140	19.7	185	57.0
70	2.5	150	25.3	190	63.6
80	3.5	155	28.7	195	70.8
90	4.8	160	32.3	200	78.6
100	6.5	165	36.4	205	87.0
110	8.7	170	40.8	210	96.2
120	11.5	175	45.7	212	100.0

C86-106 PRICE-PFISTER, INC. (CHROME PLATING)

13500 PAXTON, PACOIMA WEEK OF 11-17-86

DATE	RUN NO.	FILTER NO.	PROBE NO.	PROBE Cp.	NOZZLE NO.	NOZZLE DIAM.	DESICCATOR WEIGHTS, GMS. TOTAL / TARE	NET	IMP. COND. ML.	TOTAL H2O ML.
	UPSTREAM H2O TRAIN	—	—	—	—	—		8.0	1.0	9.0
	DOWNSTREAM H2O TRAIN	—	—	—	—	—		7.0	1.0	8.0
	PT-1U	27	3	*	3/8-1	.376	1816.5 / 1769.0	47.5	42.0	89.5
	PT-2U	24	3	*	1/4-3	.253	1821.6 / 1781.0	40.6		
	—	—	—	2ND SILICAGEL			1812.7 / 1770.0	42.7	58.0	141.3
	PT-3U	22	3		1/4-3	.253	1820.5 / 1776.5	44.0		
				2ND SILICA GEL			1806.0 / 1778.3	27.7	52.0	123.7
	PT-1U BLANK	26	24	—	—	—	— / —	—	—	—
	PT-1D	28	17	0.821	3/8-2	.377	1835.0 / 1782.6	52.4	**	**
	PT-2D	25	17	0.821	3/8-2	.377	1839.0 / 1791.6	47.4		
				2ND SILICA GEL			1805.0 / 1773.2	31.8	83.0	162.2
	PT-3D	20	17	0.821	3/8-2	.377	1818.0 / 1797.0	21.0		
				2ND SILICA GEL			1803.4 / 1781.0	22.4	90.0	133.4
	PT-1D BLANK	21	—	—	—	—	— / —	—	—	—

* PROBE #3 PITOT NOT CALIBRATED

** TOTAL H2O IN IMPINGERS MEASURED 135 ML. AT END OF TEST

CALIFORNIA AIR RESOURCES BOARD TEST OF CHROMAL PLATING COMPANY
Report No. C-86-125
April 3, 1987

UNACCEPTABLE

The inside cover of this report says that the data in the report are an estimate of chromium emissions from this source. In addition, sampling is for an inlet location only, and only 12 points were sampled. The correct number of points for this location is 24, if the sampling is to conform with Reference Method 1. In sampling for chromium, it is necessary to use the specified number of points since past sampling has shown that the distribution of the pollutant is not uniform across the duct. Since this test was merely to obtain an estimate of the emissions, this is the probable reason for using too few points.

CALIFORNIA AIR RESOURCES BOARD TEST OF PRICE PFISTER, INC.
Report No. C-86-106
April 3, 1987

UNACCEPTABLE

The inside cover of this report says that the data in the report are an estimate of chromium emissions from this source. Since data are an estimate, this may account for the insufficient number of sampling points used during the test. It is necessary to use the appropriate number of sampling points - which is 24 - when sampling for chromium since the distribution of chromic acid mist is not uniform within the duct. The presence of chromic acid droplets at the inlet also makes it necessary to sample the proper number of points if accurate data are to be obtained.

CHROMIUM EMISSIONS TESTS FOR TANK 193 AND TANK 195 AT DOUGLAS AIRCRAFT COMPANY (DAC)
March 5, 1987

As per instructions from Andy Smith, this test report was not reviewed since the test report is for an anodizing operation.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

April 20, 1989

MEMORANDUM

SUBJECT: Acceptability of Test Reports

FROM: Frank R. Clay FRC
Field Testing Section, EMB, TSD (MD-14)

TO: Andrew Smith
Industrial Studies Branch, ESD (MD-13)

Attached are three test reports that have been reviewed for acceptability. None was acceptable and the reasons are given below.

Attachment

cc: Dallas Safreit

4/20/89
I got these from F. Clay today.
I don't recall my asking Frank not
to review Douglas Aircraft,
And apparently he didn't
review Standard Nickel Chromium
[illegible]. He had it before but rejected
it because of no field data sheets.
This was to be reviewed again with the field data
sheets.

Price Pfister, Inc., Chromium Plating Tank #1
Total and Hexavalent Chromium Emissions

SUMMARY

The Air Resources Board (ARB) has identified hexavalent chromium as a toxic air contaminant. Because of this, sampling was requested by the ARB Toxic Pollutants Branch to determine chromium emissions from a "decorative" chromium plater. Samples were collected at Price Pfister, Inc. on November 18 through 20, 1986, by the staff of the Engineering Evaluation Branch (EEB) of the ARB. The samples were analyzed by the Department of Health Services (DOHS) Air and Industrial Hygiene Laboratory (AIHL) for total chromium and hexavalent chromium.

Chromium is applied by electroplating from a plating solution in which it is present as hexavalent chromium, an anion in a high oxidation state. Electroplating is accomplished by applying a high amperage, low voltage (5800-6800 amps, 6.5 volts) direct current (dc) power through the plating solution. The material to be plated is hung from the negative, or cathode, bus bars of the plating tank. Anodes are hung from the positive bus bars. Chromium plating is only 8-20% efficient. A major reason for the inefficiency is the disassociation of water molecules in the plating solution by the electrical current. This results in the release of hydrogen gas at the cathode and oxygen at the anode. A portion of the plating solution is entrained with these released gases, which are vented for safety reasons. At Price Pfister, these gases are passed through a scrubber and then vented to the atmosphere. The scrubber is used to recover some of the vented plating

solution and return it to the plating tank. According to the operator, 99% of the total chromium returned to the plating tank should be hexavalent chromium or product quality could deteriorate.

Sampling and analysis for hexavalent and total chromium samples was conducted in accordance with the ARB's Draft Test Method 425 (Determination of Total Chromium and Hexavalent Chromium Emissions from Stationary Sources). The results of the sampling, analysis, and other data are shown in the Summary Table. Emissions from the plating tank (before the scrubber) ranged between 0.14×10^{-3} lb/hr and 0.42×10^{-3} lb/hr for total chromium and 0.21×10^{-3} and 0.39×10^{-3} lb/hr for hexavalent chromium. Emissions after the scrubber ranged between 0.20×10^{-3} lb/hr and 0.21×10^{-3} lb/hr for total chromium and 0.09×10^{-3} lb/hr and 0.10×10^{-3} lb/hr for hexavalent chromium. Scrubber efficiency for preventing the release of chromium ranged between 9 and 52 percent for total chromium and 57 to 74 percent for hexavalent chromium.

Summary Table

Test Data For
Price Pfister, Inc.

1. Run Number	1		2		3	
2. Chromium Emissions	Total[a/]	Hex.[b/]	Total	Hex.	Total	Hex.
a. Before Scrubber, 10^{-3} lb/hr	0.42	0.29	0.14	0.21	0.23	0.39
b. After Scrubber, 10^{-3} lb/hr	0.20	0.10	0.21	0.09	0.21	0.10
c. Scrubber Efficiency, percent	52	66	NC[c/]	57	9	74
3. Chromium in Scrubber Water						
a. Total, mg/ml[d/]	26		21		23	
b. Hexavalent, mg/ml[d/]	19		16		21	
4. Plating Tank Data						
a. Tank Temperature, degrees F	100		100		100	
b. Tank Surface Area, sq. ft.	48		48		48	
c. Electroplating Amps	6000		6000		6000	
d. Chromic Acid Conc., oz/gal	30		30		30	

a/ Total - Total chromium including hexavalent chromium

b/ Hex. - Hexavalent chromium

c/ NC - Not Calculated

d/ 99% of the total chromium in the scrubber water should be hexavalent chromium according to the operator.

Price Pfister, Inc., Chromium Plating Tank #1
Total and Hexavalent Chromium Emissions

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APPENDICES

A. ARB Draft Test Method 425

B. Data and Calculations

C. AIHL Analytical Results

I. INTRODUCTION

The Air Resources Board (ARB) has identified hexavalent chromium as a toxic air contaminant. Subsequently, the Toxic Pollutants Branch of the ARB requested the Engineering Evaluation Branch (EEB) of the ARB to conduct an emissions test to evaluate hexavalent chromium emissions from a "decorative" chromium plating operation. Price Pfister, Inc., in Pacoima was selected for testing and testing was conducted on November 18 through 20, 1986. The samples were analyzed for total and hexavalent chromium by the Air and Industrial Hygiene Laboratory (AIHL) of the Department of Health Services. The objectives of this test were to:

1. Determine total and hexavalent chromium emissions from a "decorative" chromium plater.
2. Determine the efficiency of the wet scrubber used by Price Pfister for controlling chromium emissions.
3. Determine if it is necessary to stabilize the sample filters immediately after sampling as part of the test method development.

At different times during the ARB evaluation test, parallel samples were collected by the South Coast Air Quality Management District (AQMD) and Truesdail Laboratories. Truesdail Laboratories is a contract laboratory commissioned for the Metal Finishing Association of Southern California Inc. Matt Dunn of Dames and Moore, Santa Barbara, observed the evaluation test for the Metal Finishing Association.

II. Conclusions

Emissions of total chromium (including hexavalent chromium) at Price Pfister ranged from 0.14×10^{-3} lb/hr to 0.42×10^{-3} lb/hr before the scrubber and 0.20×10^{-3} lb/hr to 0.21×10^{-3} lb/hr after the scrubber. Emissions of hexavalent chromium at Price Pfister ranged from 0.21×10^{-3}

lb/hr to 0.39×10^{-3} lb/hr before the scrubber and 0.09×10^{-3} lb/hr to 0.10×10^{-3} lb/hr after the scrubber. Scrubber efficiency ranged from 9 to 52 percent in removing total chromium and 57 to 74 percent in removing hexavalent chromium from the exhaust.

The number of samples was too limited to determine if treating the sample filters on site had any effect on the hexavalent chromium analytical results.

III. PROCESS DESCRIPTION

Price Pfister is classified as a "decorative" chromium plater. In "decorative" chromium plating, chromium is applied in a thin layer (0.00001-0.000002 inches) to produce a bright and decorative, as well as corrosion and abrasion resistant, surface. In "hard" chromium plating, the other classification, chromium is applied to steel surfaces in thicknesses of 0.0001-0.010 inches to build up worn parts and provide abrasion resistant surfaces such as those seen on hydraulic rams and cylinders.

The chromium is deposited onto the surface of the base material by electroplating. Electroplating operations, including cleaning, rinsing, plating, and post plating treatments, can be manual or with any degree of automation that is desired. Price Pfister's operation is basically automatic due to the consistency of the parts that are plated.

The parts to be plated can either be suspended by wires or racks before being submerged into a tank containing plating solution. At Price Pfister, the parts are suspended by racks. The chromium is deposited onto the material surface from a solution in which it is present as hexavalent chromium, an anion in a high oxidation state. Along with chromium acid, the aqueous solution usually contains a small and carefully controlled amount of catalyst

ion, such as sulfate. The necessary direct current (dc) power for electroplating is supplied by rectifiers and applied to the plating tank by bus bars. Anodes are hung from positive bus bars and the item to be plated is hung from the negative or cathode bus bars. Tank voltage and current are monitored with voltmeters and ammeters.

Chromium plating is one of the most difficult electroplating operations; temperature, current density, and bulk composition are kept within a relatively narrow range. With respect to electric current, chromium plating is only 8-20% efficient. Much of the electric current is used converting water in the plating solution into hydrogen and oxygen gases. This results in the off gassing of hydrogen at the cathode and oxygen at the anode. The release of these gases from the plating tank causes a spray that carries some of the plating solution with the gases. For safety reasons the spray must be vented. For economic reasons, the spray is usually vented through a scrubber to recover some of the plating solution. Part of the scrubber water is then used as makeup to replace some of the lost plating solution. According to the operator, 99% of the total chromium in the scrubber water should be hexavalent chromium or product quality could deteriorate.

During the three days of emissions sampling, Price Pfister tried to maintain consistant plating conditions. Table 1 shows the operating parameters and conditions during the 3 days of testing.

IV. SAMPLING LOCATIONS AND METHODS

Hexavalent and total chromium samples were collected according to Draft ARB Stationary Source Test Method 425 (Determination of Total Chromium and Hexavalent Chromium Emissions from Stationary Sources). A type S pitot tube was used to determine stack gas velocity. Moisture content was determined

Table 1

Operating Data During Emissions Testing
For Price Pfister, Inc., Chromium Plating Tank #1

1.	Tank Number	1
2.	Plating Tank Data	
	a. Tank Temp	100°F
	b. Surface Area,	48 sq. ft.
	c. Dimensions	12 ft x 4 ft 5 feet, deep
3.	Plating Solution Data	
	a. Chromic Acid	30 oz./gallon solution
	b. Sulfuric Acid, total	0.3 oz./gallon solution
	c. Solution Volume	1800 gallons
4.	Power Data	
	a. Voltage	6.5 volts, dc
	b. Current	5800-6800
5.	Rack Data[a/]	
	a. Number	160 racks/hour
	b. Full racks,	0.01 mils in 3 1/2 minutes
	- Tuesday, 11/18/86	78%
	- Wednesday, 11/19/86	78%
	- Thursday, 11/20/86	83%
6.	Depth of Chrome Deposited	0.01 mils in 3 1/2 minutes

a/ During a normal work day at Price Pfister, 160 racks per hour (or 1280 racks per day) passed through tank 1. Not all of the racks that pass through tank 1 have parts. Some are empty and those empty racks are not necessarily evenly distributed throughout the day.

as specified by ARB Method 4 (Determination of Moisture Content in Stack Gases). Dry molecular weight (CO, CO_2, O_2, N_2) was estimated based upon atmospheric concentrations. Figure 1 shows the sampling locations before and after the scrubber.

Draft Method 425 is similar to ARB Test Method 5 but with special requirements. Those special requirements for sampling chromium at Price Pfister included the use of glass-lined stainless steel sampling probes, special teflon coated glass-fiber filters, and specially prepared acetone and distilled water. Hexavalent chromium is very reactive and the purpose of these special requirements was to prevent the loss of hexavalent chromium after it was collected. Also, the acetone and deionized distilled water used for sample recovery were analyzed before and after sampling to document their chromium content and the presence of impurities that would react with the hexavalent chromium. Appendix A contains a copy of Draft Method 425.

For analysis, all samples were split as described in Method 425. One half was analyzed for hexavalent chromium and the other half for total chromium. For the first two sample runs (a sample run includes two sample trains, one before the scrubber and one after the scrubber), the hexavalent half of the filters were placed in an extraction solution (sodium hydroxide and sodium carbonate in water) immediately after they were collected. The hexavalent half of the third run was not placed in the extraction solution until it arrived at AIHL in Berkeley. This was done to determine if the delay affected the hexavalent chromium results.

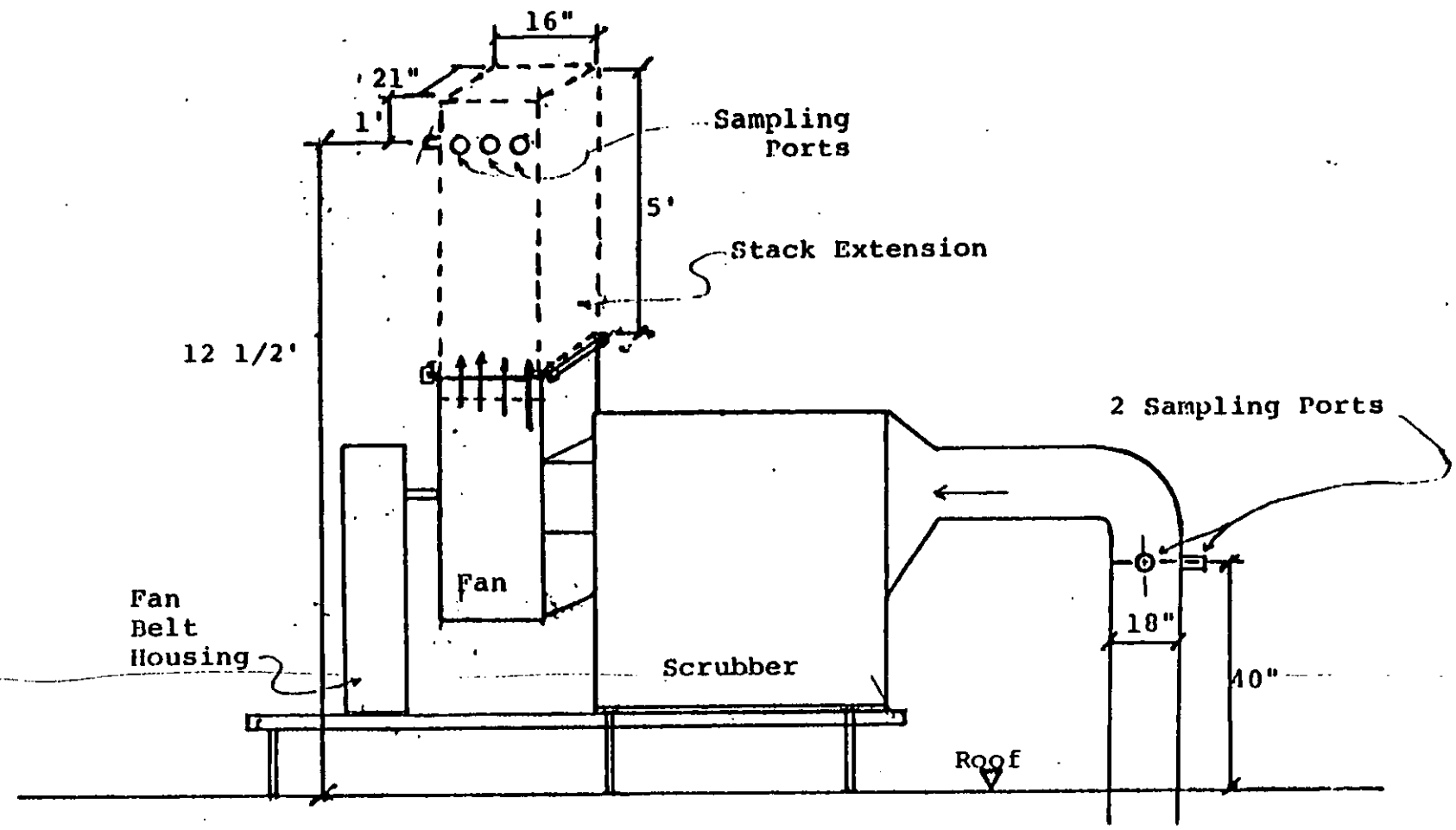
V. TEST RESULTS

The analytical results and other test data are shown in Table 2. The sample analytical results are presented according to the parts of the sampling train that were analyzed separately. In general, the larger particles are

Figure 1

Price Pfister, Inc.

Source Test Port Locations
(before and after scrubber)



DFT C86-106
10/17/86

Table 2

Emissions Data For
Price Pfister, Inc.

1 Run Number	1				2				3			
2 Test Date	11/18/86				11/19/86				11/20/86			
3 Chromium Sample	Total		Hexavalent		Total		Hexavalent		Total		Hexavalent	
4 Sample Location	BS a/	AS a/	BS	AS	BS	AS	BS	AS	BS	AS	BS	AS
5 Concentration, 10^{-2} ug/DSCF												
a. Before Filter Sample	58.45	3.64	49.63	1.64	17.43	5.55	29.40	2.40	25.00	2.61	60.21	1.49
b. Filter Sample	16.03	27.60	2.77	15.11	8.46	28.39	8.80	12.69	17.70	28.73	9.83	13.95
c. After Filter Sample	0.40	2.32	<0.40	<0.36	0.16	0.51	<0.23	<0.22	0.10	2.50	<0.24	<0.23
Total	74.88	33.56	52.40	16.75	26.05	34.45	38.20	15.09	42.80	33.84	70.04	15.44
5 Stack Flow Rate, DSCFM	4202	4561	4202	4561	4153	4635	4153	4635	4194	4670	4194	4670
6 Emission Rate, 10^{-3} lb/hr	0.42	0.2	0.29	0.10	0.14	0.21	0.21	0.09	0.23	0.21	0.39	0.10
7 Scrubber Data												
a. Efficiency, %	52		66		NC b/		57		9		74	
b. Chromium Conc., mg/ml c/	26		19		21		16		23		21	

a/ BS-Before Scrubber (Upstream) AS-After Scrubber (Downstream)

b/ NC - Not Calculated

c/ 99% of the total chromium should be hexavalent chromium according to the operator.

collected in the sampling probe before the sample filter. Finer particles pass through the probe to be collected by the filter. And still finer particles can pass through the filter to be collected in the impingers and sample lines after the filter.

Based upon the test results, overall scrubber collection efficiency for total chromium ranges between 9 and 52 percent and for hexavalent chromium between 57 to 74 percent. The data indicates the scrubber is more efficient in collecting the larger chromium containing particles than the finer chromium containing particles. The data also indicates the use of recirculated scrubber water may be a contributing factor to the scrubber's marginal performance in controlling the finer chromium containing particles. This may be due to the presence of chromium in the water recirculated to the scrubber's sprayers. Samples of the recirculated scrubber water used in the spray contained from 21 to 26 mg of total chromium and 16 to 21 mg of hexavalent chromium per milliliter of scrubber solution. (According to the operator, 99% of the total chromium in the scrubber water should be hexavalent chromium.)

Results of the study to determine if treating the filters on site is effective in reducing hexavalent chromium loss are presented Table 3. Table 3 compares the concentration (ug/dscf) of hexavalent chromium collected on the treated and untreated filters. The filter sample results do not indicate the untreated filters are losing hexavalent chromium relative to the treated filters. But because of the variation in concentrations and the limited number of samples, no specific conclusions can be reached.

Table 3

Comparison of Filter Results For
Hexavalent Chromium

RUN #	1	2	3	Avg
I. Concentration, ug/DSCF				
A. Before Scrubber				
1. Treated Filter[a/]	0.02	0.09		0.06
2. Untreated Filter[a/]			0.10	0.10
B. After Scrubber				
1. Treated Filter	0.15	0.28		0.22
2. Untreated Filter			0.29	0.29

a/ In the field, after sampling, the hexavalent chromium half of the treated filters was treated with the sodium hydroxide and sodium carbonate extract solution. The untreated filters were not treated until later at the laboratory.

VI. QUALITY CONTROL

Hexavalent chromium is very reactive and collected in very low concentrations. The emphasis of the various quality control techniques is to prevent the loss or contamination of hexavalent chromium samples. For that reason all sample containers both in the field and the laboratory were made of glass or teflon and prewashed with specially prepared detergents, acids, and deionized distilled water. Other quality control techniques are discussed below.

A. SAMPLING

When collecting samples the only recommended probes are quartz or glass-lined probes. Any other probe material, including stainless steel, could contaminate the collected sample. Teflon coated glass-fiber filters are the recommended filter media. During laboratory sample recovery and preparation, the uncoated glass-fiber filter can release silicate from the filter material which, when acidified, becomes silicic acid. The silicic acid exists in the recovered sample as a suspended particulate that interfers with the colormetric analysis of the sample. The teflon coating greatly reduces the amount of silicate that is released from the glass fibers.

The deionized, distilled water used for impinger catches and the acetone used to rinse samples from the probes and impingers were provided by AIHL. Both were pre-analyzed for hexavalent chromium and other impurities by AIHL and stored in glass or teflon containers.

B. SAMPLE RECOVERY AND ANALYSIS

The laboratory method for recovering and analyzing the samples for hexavalent and total chromium is similar to that for ARB Method 5 samples. However, AIHL determined that parts of the Method 5 sample recovery and

analysis will cause some of the hexavalent chromium to be lost from the sample because of the reactivity of hexavalent chromium. To prevent this, the following changes were made. All solvents containing samples are reduced in volume at room temperature rather than in an oven at 105°C because the reactivity of hexavalent chromium increases with temperature. Some of the analytical reagants were treated with potassium permanganate to remove the reducing agents that would react with hexavalent chromium during sample recovery and analysis.

APPENDIX A

ARB DRAFT TEST METHOD 425

State of California
AIR RESOURCES BOARD

Method 425

Determination of Total Chromium and Hexavalent Chromium Emissions from Stationary Sources

Adopted _____, 1986

METHOD 425: DETERMINATION OF TOTAL CHROMIUM AND HEXAVALENT CHROMIUM EMISSIONS FROM STATIONARY SOURCES

1. APPLICABILITY AND PRINCIPLE

1.1 Applicability.

This method applies to the determination of hexavalent chromium (Cr^{+6}) and total chromium emissions from stationary sources.

1.2 Principle.

Particulate emissions are collected from the source by use of CARB METHOD 5. The collected sample is divided into two equal portions with one portion used for total chromium analysis and the other portion for hexavalent chromium analysis.

1.2.1 For the hexavalent chromium analysis the collected sample portions are extracted in an alkaline solution and analyzed by the diphenylcarbazide colorimetric method.

1.2.2 For the total chromium analysis the collected samples must be prepared in order to convert organic forms of chromium to inorganic forms, to minimize organic interferences, and to convert the sample to a suitable solution for analysis. Samples are then subjected to an acid digestion procedure. Following the appropriate dissolution of the sample, a representative aliquot is placed manually or by means of an automatic sampler into a graphite tube furnace. The sample aliquot is then slowly evaporated to dryness, charred (ashed), and atomized. The absorption of hollow cathode radiation during atomization will be proportional to the chromium concentration.

2. RANGE, SENSITIVITY, PRECISION, AND INTERFERENCES

2.1 Range.

2.1.1. Hexavalent chromium. A straight line response curve was obtained in the range 1 ug Cr^{+6}/100 mL to 20 ug Cr^{+6}/100 mL. For a minimum analytical accuracy of $\pm$ 10 percent, the lower limit of the

range is 2 ug/100mL. The upper limit can be extended by appropriate dilution.

2.2 Sensitivity.

2.2.1. Hexavalent Chromium. A minimum detection limit of 1 ug Cr^{+6}/100 mL has been observed (9.1).

2.3 Precision for hexavalent chromium. The overall precision for sample collection and analysis for Cr^{+6} 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 Interferences.

2.4.1. Interferences of hexavalent chromium. Molybdenum, mercury and vanadium react with diplhenylcarbazide to form a color; however, approximately 20 mg of 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.

2.4.2 Interferences for total chromium.

2.4.2.1. The long residence time and high concentrations of the atomized sample in the optical path of the graphite furnace can result in severe physical and chemical interferences. Furnace parameters must be optimized to minimize these effects. If the analyte is not completely volatilized and removed from the furnace during atomization, memory effects will occur. If this situation is detected, the tube should be cleaned by operating the furnace at higher atomization temperatures.

2.4.2.2. Nitrogen should not be used as the purge gas because of a possible CN band interference.

2.4.2.3. Low concentrations of calcium may cause interferences; at concentrations above 200 mg/L calcium's effect is constant. Calcium nitrate is therefore added to ensure a known constant effect.

2.5 If other techniques or conditions are used in the

analysis of total chromium and/or hexavalent chromium then the tester is required to substantiate the data through an adequate quality assurance program approved by the Executive Officer.

3. APPARATUS

Any other sampling apparatus which, after review by the Executive Officer, is deemed equivalent for the purposes of this test method, may be used.

3.1 Sampling Train. Same as CARB Method 5, Section 2.1. except use a glass lined stainless steel probe.

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

3.3 Analysis. The following apparatus and materials are needed.

3.3.1. Analysis of hexavalent chromium.

3.3.1.1. Philips Beakers. Borosilicate, 125mL, with watchglass covers.

3.3.1.2. Filtration Apparatus. Vacuum unit constructed of glass, to accommodate sintered glass funnels.

3.3.1.3. Volumetric Flasks. 100-mL and other appropriate volumes.

3.3.1.4. Hot Plate.

3.3.1.5. Pipettes. Assorted sizes, as needed.

3.3.1.6. Spectrophotometer. To measure absorbance at 540nm.

3.3.2. Analysis of total chromium.

3.3.2.1 Atomic absorption spectrophotometer: Single or dual channel, single- or double-beam instrument having a grating monochromator, photomultiplier detector, adjustable slits, a wavelength range of 190 to 800 nm and provisions for simultaneous background correction and interfacing with a strip chart recorder.

3.3.2.2. Chromium hollow cathode lamp or electrodeless discharge lamp.

3.3.2.3. Graphite furnace: Any graphite furnace device with the appropriate temperature

and timing controls.

3.3.2.4. Strip chart recorder: A recorder is strongly recommended for furnace work so that there will be a permanent record and so that any problems with the analysis such as drift, incomplete atomization, losses during charring, changes in sensitivity, etc., can easily be recognized.

4. REAGENTS

Unless otherwise indicated, all reagents must 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 CARB method 5, Section 3.1. except Teflon-coated glass fiber filters are used. Any other sampling method which, after review of the Executive Officer, is deemed equivalent for the purposes of this test method, may be used.

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

4.3 Reagents for hexavalent chromium.

4.3.1 Water. Deionized distilled, meeting American Society for Testing and Materials (ASTM) specification for type reagent - ASTM Test Method D 1193-77. The water should be monitored for impurities.

4.3.2. Extraction 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 2.829 g of analytical reagent grade $K_2Cr_2O_7$ in water, and dilute to 1 liter (1 mL = 1000 ug Cr^{+6}).

4.3.4. Potassium Dichromate Standard Solution. Dilute 10.00mL potassium dichromate stock solution to 100 mL (1 mL = 100 ug Hexavalent Chromium) with water.

4.3.5. Sulfuric Acid, 6N. Dilute 166 mL sulfuric acid to 1000 mL in water.

4.3.6. Acetone. Acetone will be of spectroscopic grade.

4.3.6. Acetone. Acetone will be of spectroscopic grade.

4.3.7 Diphenylcarbazide Solution. Dissolve 0.5 mg of 1, 5-diphenycarbazide in 100 mL acetone. Store in a brown bottle. Discard when the solution becomes discolored.

4.3.8 0.1% Potassium Permanganate Solution

4.3.9 0.01% Potassium Permanganate Solution

4.4. Reagents for total chromium

4.4.1. ASTM Type II water (ASTM D1193): refer to section 4.3.1.

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

4.4.3. Hydrogen peroxide (30%) optional.

4.4.4. Calcium nitrate solution: Dissolve 11.8 g of calcium nitrate, $Ca(NO_3)_2.4H_2O$ (analytical reagent grade), in Type II water and dilute to 1 liter. If the instrument manufacturer recommends a different matrix modifier then use that reagent.

4.4.5. Chromium standard stock solution (1000mg/L): Either procure a certified aqueous standard from a supplier (Spex Industries, Alpha Products, or Fisher Scientific) and verify by comparison with a second standard, <u>or</u> dissolve 2.829 g of Potassium Dichromate ($K_2Cr_2O_7$, analytical reagent grade) in Type II water and dilute to 1 liter.

4.4.6. Chromium working standards: These standards should be prepared to contain 1.0% (v/v) HNO_3; 1mL of 30% H_2O_2 and 1mL of the calcium nitrate solution may be added to lessen interferences.

5. SAMPLE COLLECTION, PRESERVATION, AND HANDLING

5.1 Sample collection. All samples are collected from the source by use of CARB Method 5.

5.2 Sample handling and preservation. All sample containers must be prewashed with detergents, acids and Type II water. Glass containers are suitable.

6. PROCEDURES

6.1 SAMPLE PREPARATION

6.1.1. The sample is collected in the probe, impingers and filters. The filter is placed in container number 1. The probe is rinsed with acetone solvent and the rinse is placed in container number 2. Place half the contents of Container Number 2 (the acetone probe rinse) in a 125-mL Philips beaker A. Place the other half of the contents of Container Number 2 in a second 125 mL Philips beaker B. Rinse Container Number 2 with acetone and transfer half the rinse to beaker A and the other half of the rinse to beaker B. Evaporate both beakers to dryness. Place half the contents of the impingers in beaker C and the other half in beaker D. Rinse the impingers and place half of the rinse into beaker C and the other half into beaker D. Evaporate to dryness. Take the filter from Container Number 1 and divide it into quarters. Take the quarters that are diagonal to each other and place them into beaker E. Then place the other two quarters of the filter from Container Number 1 into beaker F. Cut each filter quarter into small pieces. Save beaker A,C and E for hexavalent chromium analysis. Save beaker B,D and F for total chromium analysis.

6.1.2. If the particulate matter is not homogeneously distributed on the filter, one of the following alternative procedures may be followed.

6.1.2.1 The first option is to simultaneously use two method 5 sampling trains. The sample filter from one of the sample trains is to be used for total chromium analysis and the other filter from the other sample train will be used for hexavalent chromium analysis.

6.1.2.2 The second option is to change the extraction procedure. The entire filter is subjected first to the alkaline extraction, followed by filtering and then by acid extraction. Then both extracts are halved and one acid extract portion is combined with one alkaline extract portion for the total chromium analysis. The other alkaline extract

portion is used for hexavalent chromium determination. The extraction and analysis procedures are in Sections 6.3 and 6.4.

6.2 Removal of reducing agents in the reagents. The extraction solution (4.3.2) and the 6N sulfuric acid solution may contain small amounts of reducing agents that can react with the hexavalent chromium. Potassium permanganate is added to these reagents in order to neutralize these reducing agents.
Pipette 3 mL of the extraction solution into cuvettes A and B. Use cuvette A as a sample cell and cuvette B as a reference cell. Zero the instrument at 528 nm with both cuvettes. Wait 10 minutes. Add an adequate amount (uL) of 0.01% potassium permanganate solution to (4.3.9) cuvette A. Enough should be added so that after 10 minutes a slight change in absorbance is observed. This step may have to be repeated a number of times in order to determine the required amount of potassium permangante that is required. From the change in absorbance, calculate the amount of potassium permanganate that is needed to nuetralize the reducing agents found in the reagents. Then pipette the proper volume of higher concentration 0.1% potassium permanganate solution into the reagents. This is done by assuming that the number of milliequivalents of reducing agents in the reagents are equal to the number of milliequivalents of 0.1% potassium permanganate pipetted. This procedure is repeated with the 6N sulfuric acid solution.

6.3 Hexavalent Chromium sample preparation.
Sample digestion and preparation. To beaker (A) add 25 mL of alkaline digestion solution (Section 4.3.2). Shake solution at room temperature for 30 minutes.
Quantitatively transfer the solution to the filtration apparatus with water. Filter the solution through the sintered glass funnel into a 150mL recieving beaker. Transfer the filtrate from the filter flask quantitatively to a 100mL volumetric flask. Fill to a volume of approximately 75mL to 85mL.

Adjust the pH to 1± 0.2 with 6N percent sulfuric acid. Shake carefully to release carbon dioxide. 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 5-cm absorption cell, and measure the absorbance at the optimum wavelength of 540 nm. 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 ug Cr^{+6} standard as determined in

Section 7.2.2, dilute the sample and the reagent blank with equal volumes of water. Repeat this procedure for beakers C and E.

6.3.1 Reagent Blank Preparation. Take a representatative amount of acetone and a blank Method 5 filter and proceed as in Section 6.3.

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

6.3.3 Analysis.

6.3.4 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 each contain between 6 and 10 ug of Cr^{+6} (less if not possible). Spike one of the aliquots with an aliquot of standard solution that contains between 6 and 10 ug of Cr^{+6}. Now treat both the spiked and unspiked sample aliquots as described in Section 6.3. Next, calculate the Cr^{+6} mass Cs, in ug in the aliquot of the unspiked sample solution by using the following equation:

$$Cs = Ca \frac{As}{At-As} \qquad \text{Eq. 1}$$

where:

Ca = Cr^{+6} in the standard solution, ug.

As = Absorbance of the unspiked sample solution.

At = 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 standard 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 standard additions procedure.

6.4 Total Chromium Sample Preparation.

6.4.1 Add 10ml of conc. nitric acid to the sample in the beaker(B). Cover the beaker with a watch glass. Place the beaker on a hot plate and reflux the sample down to 2-3mL. Add another 5mL nitric acid to complete digestion. Reflux the sample volume down to 1mL.

6.4.2. Wash down the beaker walls and watch glass with distilled water and filter the sample to remove silicates and other insoluble material that could clog the nebulizer. Filtration should be done only if there is concern that insoluble materials may clog the nebulizer. Adjust the volume to 50 mL or a predetermined value based on the expected metal concentrations. The sample is now ready for analysis. The applicability of a sample preparation technique must be demonstrated by analyzing spiked samples and/or relevant standard reference materials.

6.4.3 The 357.9-nm wavelength line shall be used.

6.4.4 Follow the manufacturer's operating instructions for all other spectrophotometer parameters.

6.4.5 Furnace parameters suggested by the manufacturer should be employed as guidelines. Since temperature-sensing mechanisms and temperature controllers can vary between instruments or with time, the validity of the furnace parameters must be periodically confirmed by systematically altering the furnace parameters while analyzing a standard. In this manner, losses of analyte due to higher than necessary temperature settings or losses in sensitivity due to less than optimum settings can be minimized. Similar verification of furnace parameters may be required for complex sample matices.

6.4.6 Inject a measured uL aliquot of sample into the furnace and atomize. If the concentration found is greater than the highest standard, the sample should be diluted in the same acid matrix and reanalyzed. The use of multiple injections can improve accuracy and help detect furnace pipetting errors.

6.4.7 Repeat procedure (6.4) for beakers D and F.

7. CALIBRATION

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

7.2 Calibration Hexavalent Chromium

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

Alternatively, a scanning procedure may be employed to determine the proper measuring wavelength. If the instrument is a double-beam spectrophotometer, scan the spectrum between 530 and 550 nm using a 50 ug Cr^{+6} standard solution in the sample cell and a blank solution in the reference cell. If a peak does not occur, the spectrophotometer is malfunctioning and should be repaired. When a peak is obtained within the 530 to 550 nm range, the wavelength at which this peak occurs shall be the optimum wavelength for the measurement of absorbance of both the standards and the samples. For a single-beam spectrophotometer, follow the scanning procedure described above, except that the blank and standard solutions shall be scanned separately. The optimum wavelength shall be the wavelength at which the maximum differences in absorbance between the standard and the blank occurs.

7.2.2 Spectrophotometer Calibration. Either (1) run a series of chromium standards and construct a calibration curve by plotting the concentrations of the standards against the absorbances or (2) for the method of standard additions, plot added

concentration versus absorbance. See section 6.3.4 for the use of the method of standard additions.

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

7.3 Calibration of Total Chromium

7.3.1. Either (1) run a series of chromium standards and construct a calibration curve by plotting the concentrations of the standards against the absorbances or (2) for the method of standard additions, plot added concentration versus absorbance. For instruments that read directly in concentration, set the curve corrector to read out the proper concentration.

7.3.2. Run a check standard after approximately every 10 sample injections. Standards are run in part to monitor the life and performance of the graphite tube. Lack of reproducibility or significant change in the signal for the standard indicates that the tube should be replaced.

7.3.3. Duplicates, spiked samples, and check standards should be routinely analyzed.

7.3.4 Calculate metal concentrations by (1) the method of standard additions, or (2) from a calibration curve, or (3) directly from the instrument's concentration readout. All dilution or concentration factors must be taken into account. Concentrations reported for multiphased or wet samples must be appropriately qualified (e.g., 5 ug/g dry weight).

7.3.5. Calibration curves must be composed of a minimum of a blank and three standards. A calibration curve should be made for every hour of continuous sample analysis.

7.3.6. Dilute samples if they are more concentrated than the highest standard or if they fall on the plateau of a calibration curve.

7.3.7 Employ a minimum of one blank per sample batch to determine if contamination or any memory effects are occurring.

The blanks are prepared in the following manner. Obtain a clean unused filter and follow the procedure in Sections 6.4.1 and 6.4.2.

7.3.8. Analyze check standards after approximately every 15 samples.

7.3.9. Run one duplicate sample for every 10 samples. A duplicate sample is a sample brought through the whole sample preparation.

7.3.10 Spiked samples or standard reference materials shall be periodically employed to ensure that correct procedures are being followed and that all equipment is operating properly.

7.3.11 The method of standard additions shall be used for the analysis of all EP extracts, or whenever a new sample matrix is being analyzed.

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

7.3.13 All quality control data should be maintained and available for easy reference or inspection.

7.4 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.

7.4.1 Total Cr^{+6} in Sample. Calculate m_{ch}, the total ug Cr^{+6} in sample. This can be obtained from the calibration curve or from the method of standard additions. Note that m_{ch} is the sum of the masses of hexavalent chromium analyses performed on the contents of beakers B, D and F. Also take in account the dilutions when calculating m_{ch}.

7.4.2 Total Chromium in the Sample. Calculate m_{ct}, the total ug of Chromium in the sample. This can be obtained from the calibration curve or from the method of standard additions. Note that m_{ct} is the sum of the masses of total chromium analyses performed on the contents of beakers A,C and E.

Also take into account the necessary dilutions when calculating out m_{ct}.

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

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

7.4.5 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:

$$c_s = (10^{-6} g/ug)(m_{ch}/V_{m(std)})$$

7.4.6 Total Chromium Emission Concentration. Calculate c_{st} (g/dscm), the total chromium concentration in the stack gas, dry basis, corrected to standard conditions as follows:

$$c_{st} = (10^{-6} g/ug)(m_{ct}/V_{m(std)})$$

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

8. OTHER METHODS.

8.1 Total chromium determination by atomic absorption spectroscopy. This method uses the direct aspiration method.

8.2 Hexavalent chromium by flameless atomic absorption spectroscopy. This method complexes hexavalent chromium with ammonium pyrrolidine dithiocarbamate. This chromium complex is then measured by atomic absorbtion spectrophotometer equipped with a flameless accessory.

9. REFERENCES.

9.1 US. Environmental Protection Agency/Office of Solid Waste, Washington, D.C., "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, "SW-846 (1980), SW-846 Revision A (August 8, 1980), and SW-846 Revision B (July 1981).

9.2 Cox, X.B., R.W., 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.

9.3 Same as in Bibliography of Method 5, Citations 2 to 6 and 7.

9.4 California Air Resources Board, Aerometric Data Division. Method ADD1 006.

APPENDIX B

DATA AND CALCULATIONS

PARTICULATE EMISSIONS TEST SUMMARY AND RESULTS

APE-SSCD-Engr. Eval. Branch

File No. C-86-106

Project Name: Price Pfister

Remarks: 1D

Hex Cr

Total Cr

SUMMARY OF TEST DATA

Metered Sample Volume	285.37 cubic feet
Meter Temperature:	60 deg.F
Nozzle Diameter:	0.375 inches
Pitot Tube C-Factor:	0.821
Sampling Time:	240.00 minutes
Avg. delta H Orifice Pressure:	4.25 inches H2O
Avg. $\sqrt{}$(delta P Pitot Pressure):	0.64 $\sqrt{}$(inches H2O)
H2O in Impingers and Silica Gel:	87.4 milliliters
Particulate Catch:	46.9 x10^-3 milligrams 94.0 x10^-3 mg
Stack Dimensions: L= 20.750 W= 15.500	inches
Stack Area:	2.234 square feet
Stack Temperature:	65 deg.F
Barometric Pressure:	28.600 inches Hg
O2 In Stack:	20.90 percent
CO2 In Stack:	0.00 percent
CO In Stack:	0.00 percent

CALCULATED RESULTS:

Isokinetic Ratio:	74.5 percent
Corrected Sample Volume:	280.06 DSCF(68 deg.F)
Particulate Concentration:	0.00258 x10^-3 grain/DSCF(68 deg.F)
Particulate Emissions:	0.1010 x10^-3 lb/hr .2024 x10^-3 #/hr
Stack Flow:	4561 SCFM(dry,68 deg.F)
Stack Velocity:	35.9 feet/second
H2O Vapor In Stack:	1.4 percent
(H2O In Stack is BELOW Saturation)	
Stack Gas Mole Weight(dry):	28.85
Stack Gas Mole Weight(wet):	28.69

Verified by: _____

PARTICULATE EMISSIONS TEST SUMMARY AND RESULTS

APE-SSCD-Engr. Eval. Branch

File No. C- 86-106

Project Name: Price Pfister

Remarks: 1U

	Hex Cr	Total
SUMMARY OF TEST DATA		
Metered Sample Volume	257.40 cubic feet	
Meter Temperature:	60 deg.F	
Nozzle Diameter:	0.375 inches	
Pitot Tube C-Factor:	0.813	
Sampling Time:	240.00 minutes	
Avg. delta H Orifice Pressure:	4.34 inches H2O	
Avg. √(delta P Pitot Pressure):	0.81 √(inches H2O)	
H2O in Impingers and Silica Gel:	89.5 milliliters	
Particulate Catch:	132.4 milligrams	189.2×10^{-3} mg
Stack Diameter:	17.500 inches	
Stack Area:	1.670 square feet	
Stack Temperature:	82 deg.F	
Barometric Pressure:	28.600 inches Hg	
O2 In Stack:	20.90 percent	
CO2 In Stack:	0.00 percent	
CO In Stack:	0.00 percent	
CALCULATED RESULTS:		
Isokinetic Ratio:	54.6 percent	
Corrected Sample Volume:	252.67 DSCF(68 deg.F)	
Particulate Concentration:	0.00809 grain/DSCF(68 deg.F)	
Particulate Emissions:	0.2912 lb/hr	$.4161 \times 10^{-3}$ lb/hr
Stack Flow:	4202 SCFM(dry,68 deg.F)	
Stack Velocity:	45.8 feet/second	
H2O Vapor In Stack:	1.6 percent	
(H2O In Stack is BELOW Saturation)		
Stack Gas Mole Weight(dry):	28.85	
Stack Gas Mole Weight(wet):	28.67	

Verified by: _____

PARTICULATE EMISSIONS TEST SUMMARY AND RESULTS

APE-SSCD-Engr. Eval. Branch

File No. C- 86-106

Project Name: Price Pfister

Remarks: 2D

Hex Cr

Total Cr

SUMMARY OF TEST DATA

Metered Sample Volume	470.13 cubic feet
Meter Temperature:	60 deg.F
Nozzle Diameter:	0.375 inches
Pitot Tube C-Factor:	0.821
Sampling Time:	420.00 minutes
Avg. delta H Orifice Pressure:	3.72 inches H2O
Avg. √(delta P Pitot Pressure):	0.65 √(inches H2O)
H2O in Impingers and Silica Gel:	162.2 milliliters
Particulate Catch:	70.4 milligrams 160.7×10^{-3} mg
Stack Dimensions: L= 20.750 W= 15.500 inches	
Stack Area:	2.234 square feet
Stack Temperature:	70 deg.F
Barometric Pressure:	28.960 inches Hg
O2 In Stack:	20.90 percent
CO2 In Stack:	0.00 percent
CO In Stack:	0.00 percent

CALCULATED RESULTS:

Isokinetic Ratio:	69.8 percent
Corrected Sample Volume:	466.50 DSCF(68 deg.F)
Particulate Concentration:	0.00233 grain/DSCF(68 deg.F)
Particulate Emissions:	0.0925 lb/hr $.2111 \times 10^{-3}$ lb/hr
Stack Flow:	4635 SCFM(dry,68 deg.F)
Stack Velocity:	36.4 feet/second
H2O Vapor In Stack:	1.6 percent
(H2O In Stack is BELOW Saturation)	
Stack Gas Mole Weight(dry):	28.85
Stack Gas Mole Weight(wet):	28.68

Verified by:

PARTICULATE EMISSIONS TEST SUMMARY AND RESULTS

APB-SSCD-Engr. Eval. Branch

File No. C- 86-106

Project Name: Price Pfister

Remarks: 2U

	Hex Cr	Total Cr
SUMMARY OF TEST DATA		
Metered Sample Volume	446.35 cubic feet	
Meter Temperature:	60 deg.F	
Nozzle Diameter:	0.250 inches	
Pitot Tube C-Factor:	0.813	
Sampling Time:	420.00 minutes	
Avg. delta H Orifice Pressure:	4.18 inches H2O	
Avg. √(delta P Pitot Pressure):	0.79 √(inches H2O)	
H2O in Impingers and Silica Gel:	141.3 milliliters	
Particulate Catch:	169.4 x10^-3 milligrams	115.5 x10^-3 mg
Stack Diameter:	17.500 inches	
Stack Area:	1.670 square feet	
Stack Temperature:	80 deg.F	
Barometric Pressure:	28.900 inches Hg	
O2 In Stack:	20.90 percent	
CO2 In Stack:	0.00 percent	
CO In Stack:	0.00 percent	
CALCULATED RESULTS:		
Isokinetic Ratio:	124.0 percent	
Corrected Sample Volume:	443.41 DSCF(68 deg.F)	
Particulate Concentration:	0.00569 x10^-3 grain/DSCF(68 deg.F)	
Particulate Emissions:	0.2098 x10^-3 lb/hr	.1430 x10^-3 #/hr
Stack Flow:	4153 SCFM(dry,68 deg.F)	
Stack Velocity:	44.4 feet/second	
H2O Vapor In Stack:	1.5 percent	
(H2O In Stack is BLOCK Saturation)		
Stack Gas Mole Weight(dry):	28.65	
Stack Gas Mole Weight(wet):	28.69	

Verified by: _____

PARTICULATE EMISSIONS TEST SUMMARY AND RESULTS

AFB-SSCD-Engr. Eval. Branch

File No. C- 86-106

Project Name: Price Pfister

Remarks: 3D

Hex Cr

total Cr

SUMMARY OF TEST DATA

Metered Sample Volume	432.47 cubic feet
Meter Temperature:	60 deg.F
Nozzle Diameter:	0.375 inches
Pitot Tube C-Factor:	0.821
Sampling Time:	420.00 minutes
Avg. delta H Orifice Pressure:	3.25 inches H2O
Avg. √(delta P Pitot Pressure):	0.66 √(inches H2O)
H2O in Impingers and Silica Gel:	133.4 milliliters
Particulate Catch:	66.2 milligrams $\times 10^{-3}$ 145.1 $\times 10^{-3}$ mg
Stack Dimensions: L= 20.750 W= 15.500	inches
Stack Area:	2.234 square feet
Stack Temperature:	80 deg.F
Barometric Pressure:	26.970 inches Hg
O2 In Stack:	20.90 percent
CO2 In Stack:	0.00 percent
CO In Stack:	0.00 percent

CALCULATED RESULTS:

Isokinetic Ratio:	63.7 percent
Corrected Sample Volume:	426.77 DSCF(68 deg.F)
Particulate Concentration:	0.00238 $\times 10^{-3}$ grain/DSCF(68 deg.F)
Particulate Emissions:	0.0954 $\times 10^{-3}$ lb/hr .2091 $\times 10^{-3}$ #/hr
Stack Flow:	4670 SCFM(dry,68 deg.F)
Stack Velocity:	37.3 feet/second
H2O Vapor In Stack:	1.4 percent
(H2O In Stack is BELOW Saturation)	
Stack Gas Mole Weight(dry):	28.85
Stack Gas Mole Weight(wet):	28.70

Verified by: _____

TICULATE EMISSIONS TEST SUMMARY AND RESULTS

-SSCD-Engr. Eval. Branch

: No. C- 86-106

ject Name: Price Pfister

arks: 3U

Hex Cr

MARY OF TEST DATA		total Cr
ered Sample Volume	422.21 cubic feet	
er Temperature:	60 deg.F	
zle Diameter:	0.250 inches	
ct Tube C-Factor:	0.813	
pling Time:	420.00 minutes	
. delta H Orifice Pressure:	3.78 inches H2O	
. √(delta P Pitot Pressure):	0.80 √(inches H2O)	
in Impingers and Silica Gel:	123.7 milliliters	
ticulate Catch:	293.6 x10-3 milligrams	179.4 x10-3 mg
ck Diameter:	17.500 inches	
ck Area:	1.670 square feet	
ck Temperature:	80 deg.F	
ometric Pressure:	28.970 inches Hg	
In Stack:	20.90 percent	
In Stack:	0.00 percent	
In Stack:	0.00 percent	

CULATED RESULTS:	
Kinetic Ratio:	116.7 percent
rected Sample Volume:	419.16 DSCF(68 deg.F)
ticulate Concentration:	0.01081 x10-3 grain/DSCF(68 deg.F
ticulate Emissions:	0.3866 x10-3 LB/hr .239 x10-3
ck Flow:	4194 SCFM(dry,68 deg.F)
ck Velocity:	44.8 feet/second
Vapor In Stack:	1.4 percent
O In Stack is BELOW Saturation)	
ck Gas Mole Weight(dry):	28.65
ck Gas Mole Weight(wet):	28.70

ified by: _____

APPENDIX C

AIHL ANALYTICAL RESULTS

AIHL/ARB
LABORATORY REPORT

TO: ADD ☐
CD ☐
SSD ☒
OTHER ☐ _____

I.D. No.

ARB STUDY OR CONTROL NUMBER C 8 6 - 1 0 6

PROJECT ENGINEER David Todd

Name of Establishment PRICE - PEISTER

Address 13500 PAXTON
PACOIMA, CA

Date this Report:

Mo.	Day	Yr
12	31	86

Lab. No. For Lab. Use Only	SAMPLE NUMBER	Laboratory Results
616248		Net total Chromium(VI), ug/filter
	1D	42.3 ✓
	1U	7.0 ✓
	2D	59.2 ✓
	2U	39.0 ✓
	3D	59.8 ✓
	3U	41.2 ✓

Signatures of Chemists Involved: Date

▷ PAUL WONG 11/24/86

▷

▷

Signature of Supervising Chemist Date

▷ Mike R. Amuda 11/24/86

AIHL/ARB 3/84 8001-008
State of California - Department of Health Services

LABORATORY REPORT

CD ☐
SSD ☒
OTHER ☐

I.D. No.

STUDY OR CONTROL NUMBER C 8 6 - 1 0 6

TO: DEAN SIMEROTH
PROJECT ENGINEER David Todd

e of Establishment Price Pfister

ess 13500 Raxton, Pacoimce, CA.

Date this Report:

Mo.	Day	Yr

Lab. No. *Lab. Use Only*	SAMPLE NUMBER	Laboratory Results
1624 A		Chromium (VI), µg per (½) sample
		Probe Rinse
	1D	2.3 ✓
	1U	62.7 ✓
	2D	5.6 ✓
	2U	65.2 ✓
	3D	3.2 ✓
	3U	126.2 ✓
		All samples with the exception of "1U" & "2U" had quantitative recoveries (1U → 20% recovery; 2U → 17% recovery)

atures of Chemists Involved: PAUL WONG — Date 12/15/86

Signature of Supervising Chemist: E Jung — Date 12/15/86

AIHL/ARB 3/84 8001-008
State of California - Department of Health Services

AIHL/ARB
LABORATORY REPORT

TO: ADD ☐ CD ☐ SSD ☒ OTHER ☐

I.D. No.

ARB STUDY OR CONTROL NUMBER C 8 6 - 1 0 6

PROJECT ENGINEER David Todd

Name of Establishment Price Pfister

Address 13500 Raxton, Pacoimce, CA.

Date this Report: Mo. Day Yr.

Lab. No. For Lab. Use Only	SAMPLE NUMBER	Laboratory Results
1624 A		Chromium, ug per 1/2 sample
		A.F. and Impinger water
	1D	<1.0
	1U	5.3*
	2D	<1.0
	2U	<1.0
	3D	<1.0
	3U	<1.0

* very cloudy before & after acidification. Reading possibly caused by cloudiness.

Signatures of Chemists Involved: PAUL WONG Date 12/15/86

Signature of Supervising Chemist E. Jeung Date 12/15/86

AIHL/ARB 3/84 8001-008
State of California - Department of Health Services

LABORATORY REPORT

CD ☐
SSD ☒
OTHER ☐ _____

I.D. No.

UDY OR CONTROL NUMBER C 8 6 - 1 0 6

PROJECT ENGINEER David Todd

Establishment Price Pfister

13500 Paxton, Pacoimce. CA,

Date this Report:

Mo.	Day	Yr

ab. No. b: Use Only	SAMPLE NUMBER	Laboratory Results	
624A		Chromium (VI), ug per ½ sample	
		BLANKS	
		acetone	<1.0
		1-AF	<1.0
		BF	<1.0
		2-AF	<1.0
		BF	<1.0
		H_2O	<1.0

atures of Chemists Involved: PAUL WONG

Date 12/15/86

Signature of Supervising Chemist E Jung

Date 12/15/86

AIHL/ARB 3/84 8001-008
State of California - Department of Health Services

AIHL/ARB
LABORATORY REPORT

TO: ADD ☐ CD ☐ SSD ☒ OTHER ☐ _____

I.D. No.

RB STUDY OR CONTROL NUMBER C 8 6 - 1 0 6

PROJECT ENGINEER David Todd

me of Establishment Price Pfister

dress 13,500 Raxton

Pacoimce, CA

Date this Report: Mo. Day Yr

Lab. No. r Lab. Use Only	SAMPLE NUMBER	Laboratory Results
61624 A		Total Chromium, ug per filter
	B1K1	< 1.0
	B1K2	3.8
	1D	77.3
	1U	40.5
	2D	132.4
	2U	37.5
	3D	123.2
	3U	74.2

natures of Chemists Involved: PAUL WONG Date 1/12/87

Signature of Supervising Chemist ▶ E. Jeung Date 1/14/87

AIHL/ARB 3/84 8001-008

LABORATORY REPORT

CD ☐
SSD ☒
OTHER ☐ _____

I.D. No.

RB STUDY OR CONTROL NUMBER C 8 6 - 1 0 6

PROJECT ENGINEER David Todd

ne of Establishment Price Pfister

dress 13,500 Raxton
Pacoimce, CA.

Date this Report:

Mo.	Day	Yr
01	16	87

Lab. No. or Lab. Use Only	SAMPLE NUMBER	Laboratory Results
61624A		Total Chromium, ug per Sample
	1D-PR	10.2
	1U-PR	147.7
	2D-PR	25.9
	2U-PR	77.3
	3D-PR	11.2
	3U-PR	104.8
	1D-AF&IMP	6.5
	1U-AF&IMP	1.0
	2D-AF&IMP	2.4
	2U-AF&IMP	0.7
	3D-AF&IMP	10.7
	3U-AF&IMP	0.4

Signatures of Chemists Involved: Date

▶ PAUL WONG 1/12/87

▶

▶

Signature of Supervising Chemist Date

▶ E Jung 1/14/87

AIHL/ARB 3/84 8001-008
State of California - Department of Health Services

AIHL/ARB
LABORATORY REPORT

TO: ADD ☐ CD ☐ SSD ☒ OTHER ☐

I.D. No.

RB STUDY OR CONTROL NUMBER C 8 6 - 1 0 6

PROJECT ENGINEER David Todd

me of Establishment Price Pfister

Date this Report: Mo. Day Yr.

dress 13,500 Raxton

Pacoimce, CA

Lab. No. r Lab. Use Only	SAMPLE NUMBER	Laboratory Results
01624 A		Scrubber Water - Total Chromium, ug/mL
	1S	25,501
	2S	21,350
	3S	23,220

natures of Chemists Involved: PAUL WONG Date 1/12/87

Signature of Supervising Chemist E Jung Date 1/14/87

AIHL/ARB 3/84 8001-008