Background Report Reference

AP-42 Section Number: 12.20

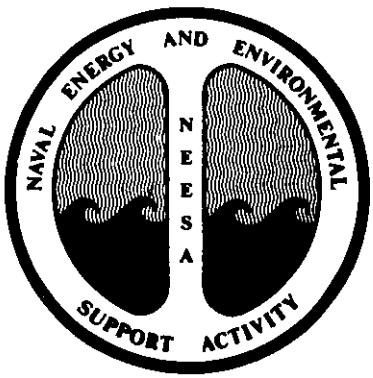
Background Chapter: 4

Reference Number: 37

Title: Chromium Emissions from Chromic Plating and Chromic Acid Anodizing Operations at Bldg. 5, Naval Aviation Depot, Naval Air Station, Alameda, CA

March 1990

ELECTROPLATING
REF. 4-37



NAVAL ENERGY AND ENVIRONMENTAL

SUPPORT ACTIVITY

Port Hueneme, California 93043-5014

DEPARTMENT OF THE NAVY
NAVAL ENERGY AND ENVIRONMENTAL SUPPORT ACTIVITY
PORT HUENEME, CALIFORNIA 93043-5014

IN REPLY REFER TO:

4730
Ser 111C1/ 621
3 May 1990

U.S. Environmental Protection Agency
MD-13
Attn: Andy Smith
Research Triangle Park
North Carolina 27711

CHROMIUM EMISSION TEST RESULTS FROM CHROMIC ACID ANODIZING OPERATIONS

As discussed in phone conversation between Drek Newton and Andy Smith of 12 April 1990, we are forwarding recent hexavalent chromium emission test results from two Navy chromic acid anodizing facilities. Enclosures (1) and (2) are results of chromium compliance emission test performed on chrome plating and chromic acid anodizing operations at Naval Aviation Depot, Alameda, California.

Do not use the hard chrome plating tests results in enclosure (1) to develop emission factors. The chrome plating ventilation systems are in poor condition. Building 5 plating shop is scheduled for closure this year.

Our contact is Drek Newton at (805) 982-3903.

Barry R. Hickenbottom
BARRY R. HICKENBOTTOM
Director, Air/Facilities Division
By direction of
the Commanding Officer

Encl:
(1) NEESA 2-157A, Chromium Emissions from Chrome Plating and Chromic Acid Anodizing Operations at Building 5, Naval Aviation Depot, Naval Air Station, Alameda, California, March 1990
Encl:
(2) NEESA 2-158A, Chromium Emissions from Chromic Acid Anodizing Operations at Building 167, Naval Aviation Depot, Naval Air Station, Alameda, California, March 1990

Copy to: (w/o enclosures)
Commander, Western Division, Naval Facilities Engineering Command, P.O. Box 727
San Bruno, CA 94066, Code 1824

NEESA 2-157A MARCH 1990

CHROMIUM EMISSIONS FROM CHROME PLATING AND CHROMIC ACID ANODIZING OPERATIONS AT BUILDING 5, NAVAL AVIATION DEPOT NAVAL AIR STATION, ALAMEDA, CALIFORNIA

By:

Drek A. Newton
James C. Reichle, P.E.

Naval Energy And Environmental Support Activity
Port Hueneme, California 93043-5014

AUTOVON 551-3903 or Commercial (805) 982-3903

EXECUTIVE SUMMARY

The Naval Energy and Environmental Support Activity (NEESA) performed chromium emission tests on the ventilation exhaust from chrome plating and chromic acid anodizing operations at Building 5, Naval Aviation Depot, Alameda, California. We performed the tests during 23-26 February 1990. The Bay Area Air Quality Management District (BAAQMD) required the tests to demonstrate compliance with hexavalent chromium emission limits. BAAQMD requires hexavalent chromium emissions from Building 5 be less than 0.15 milligrams per ampere-hour. BAAQMD also require stack exit velocities to exceed 10 meters per second.

Building 5 contains one chromic acid anodize and four hard chrome plating tanks ventilated through three scrubbers. Tanks 14 and 15 (plate) are ventilated through scrubber 242. Tanks 10 and 11 (plate) are ventilated through scrubber 241. Tank 1 (anodize) is ventilated through scrubber 239.

Results show the chromium emission rates from all chrome plating and chromic acid anodizing tanks comply with BAAQMD requirements when both floating polyballs and Fumetrol 101 anti-mist additive are used to minimize emissions from the plating or anodizing bath. Average stack exit velocity from all three ventilation lines exceeds 10 meters per second.

TEST NO.	MEASURED EMISSION RATE (mg/amp-hr)	PROCESS CONDITIONS AIR AGITATION	FLOATING POLYBALLS	ANTI-MIST ADDITIVE
5-242-1-OUT 5-242-2-OUT 5-242-3-OUT	0.080 0.062 0.059[a]			
242 AVERAGE	0.071	YES	YES	YES
5-241-1-OUT 5-241-2-OUT 5-241-3-OUT	0.096 0.101 0.086			
241 AVERAGE	0.094	YES	YES	YES
5-239-1-OUT 5-239-2-OUT	0.036 0.037			
239 AVERAGE	0.037	YES	YES	YES

[a]Not used to calculate average emission rate. Refer to discussion.

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TABLE OF CONTENTS

FIGURES

TABLES

APPENDICES

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1.0 INTRODUCTION

The Naval Energy and Environmental Support Activity (NEESA) performed (and contracted) source emission tests to measure hexavalent airborne chromium emissions from three chrome plating and/or chromic acid anodizing shops at Naval Aviation Depot (NAD), Alameda, California, during 20-28 February, 1990. This report describes results of emission tests on chrome plating and chromic acid anodizing operations at Building 5.

2.0 BACKGROUND

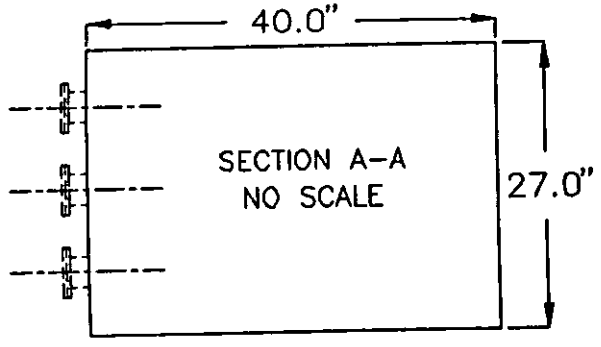
The Bay Area Air Quality Management District (BAAQMD) recently approved Regulation 11 (Rule 8) limiting hexavalent chromium emissions from chrome plating and chromic acid anodizing operations. Appendix F, pages F-1 to F-4, contains a copy of Rule 8. NAD Alameda funded NEESA to perform chromium compliance emission tests at Buildings 167, 5, and 360.

The BAAQMD rule expresses chromium emission limits in milligrams per ampere-hour of electrical current used during plating or anodizing. The rule specifies three limit values, depending on the total quantity of chromium emissions from the facility. Building 167 must comply with the 0.03 mg/amp-hr limit. Buildings 5 and 360, scheduled for closure when the new plating shop (Building 32) is operational, must comply with the 0.15 mg/amp-hr limit.

NAD Alameda originally planned to complete these test during the Summer of 1989. The test dates were delayed when we informed them of the need to install new stacks on the exhaust lines at Buildings 5 and 360. The October 1989 earthquake forced public works to delay manufacture of the stack extensions in order to repair quake damage.

TRAVERSE POINT	TRAVERSE POINT LOCATION (DISTANCES FROM WALL) DUCT SIZE (IN.) 27 X 40*
1,9,17	2.5
2,10,18	7.5
3,11,19	12.5
4,12,20	17.5
5,13,21	22.5
6,14,22	27.5
7,15,23	32.5
8,16,24	37.5

*3 PORTS ON 27 INCH SIDE



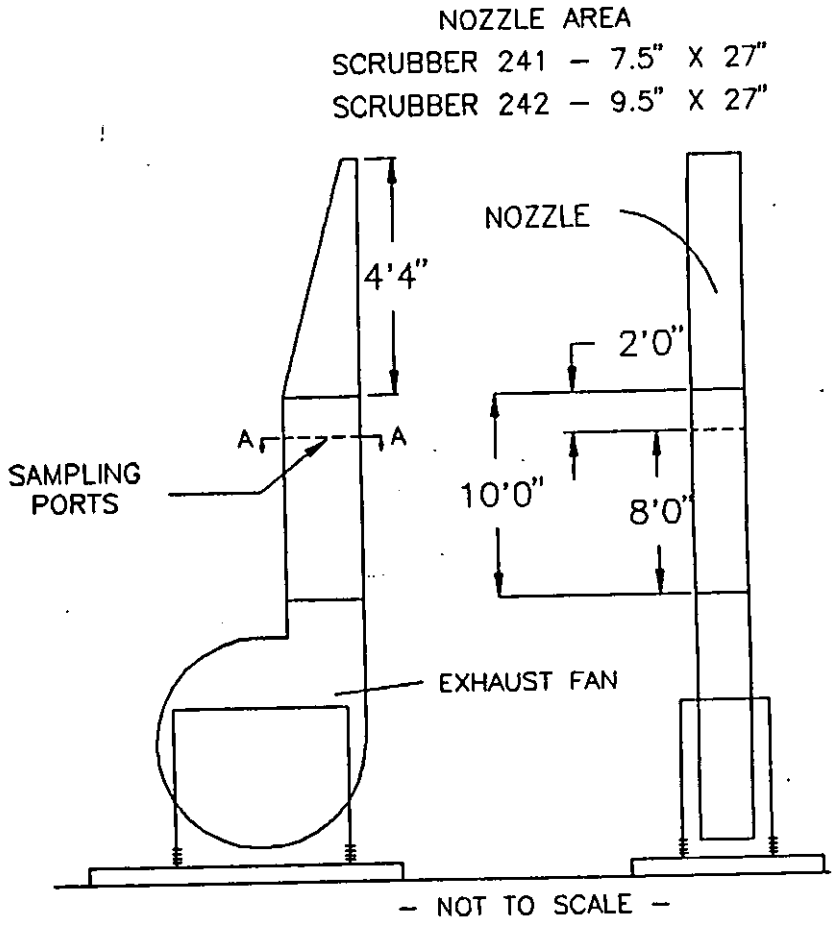


FIGURE 1

OUTLET SAMPLING SITE - SCRUBBERS 241 & 242

3.0 SOURCE EMISSION TEST PROCEDURE

We used recently revised California Air Resources Board (CARB) Method 425 to determine chromium emissions. Appendix F, pages F-5 to F-22, contains a copy of this method. As recommended by BAAQMD and based on our past plating shop test experience, we assumed all chromium emissions are hexavalent. Our contracted laboratory analyzed all samples for total chromium according to CARB Method 425.

The CARB 425 sampling train is basically an EPA Method 5 train except for the following exceptions. Sodium hydroxide solution (0.1 Normal) is placed in the first and second impingers instead of water. A teflon coated filter (not heated) is placed between the third and fourth impingers. The transition between the probe and the first impinger is either glass cyclone and filter by-passes or flexible teflon tubing.

We chose sample volumes (and corresponding sampling times) for each run based on the BAAQMD emission limit for the source and the quantitative analysis limit for CARB 425 analytical methods.

Appendix E lists our Hewlett Packard 41-CX program "Nomokin" used instead of a nomograph to determine isokinetic sampling parameters during testing.

Building 5 contains one chromic acid anodize and four hard chrome plating tanks ventilated through three scrubbers. Tank 1 (anodize) is ventilated through scrubber 239. Tanks 10 and 11 (plate) are ventilated through scrubber 241. Tanks 14 and 15 (plate) are ventilated through scrubber 242.

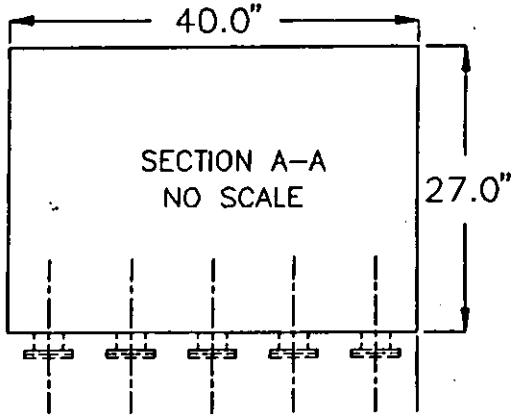
We verified amp-meter calibrations by measuring amperes through several bus bars with a DC clamp-on amp meter. All tanks checked at Building 5 show that the amp-meters are accurately calibrated and measure actual plating and anodizing current.

During all emission tests chromic acid tanks contained floating plastic balls and Fumetrol 101 anti-mist suppressant to reduce chromium emissions.

Figures 1 and 2 show the three test sites and traverse point locations.

TRAVERSE POINT	TRAVERSE POINT LOCATION (DISTANCES FROM WALL) DUCT SIZE (IN.) 40 X 27*
1,6,11,16,21	2.7
2,7,12,17,22	8.1
3,8,13,18,23	13.5
4,9,14,19,24	18.9
5,10,15,20,25	24.3

*5 PORTS ON 40 INCH SIDE



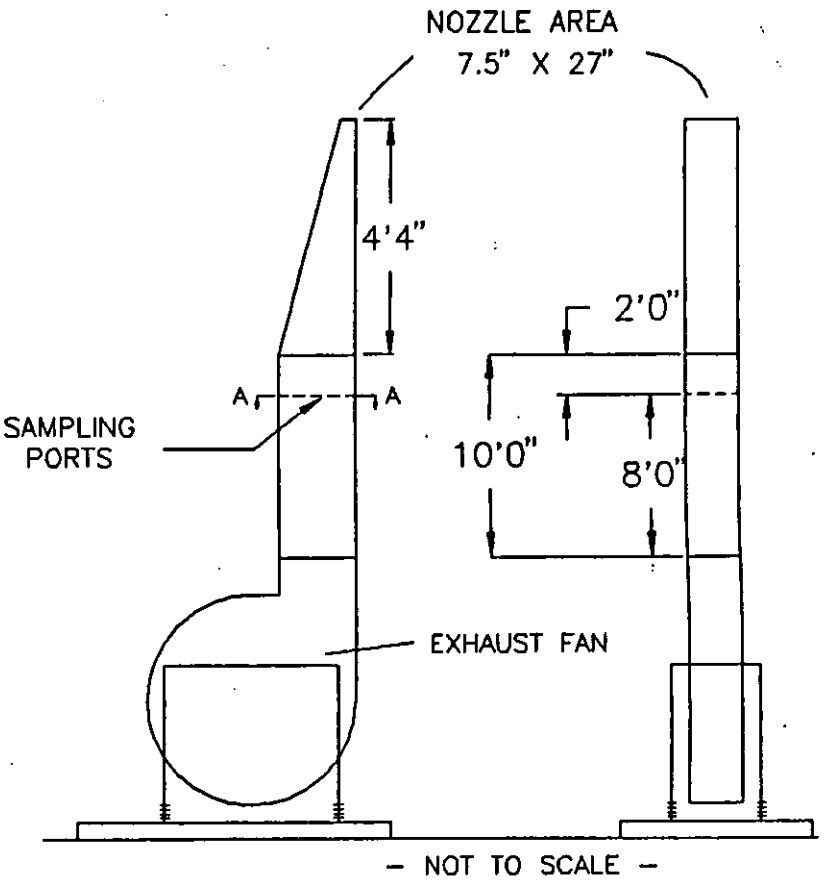


FIGURE 2

OUTLET SAMPLING SITE – SCRUBBER 239

4.0 CHAIN OF CUSTODY

Control Box/Probe: Reichle, Perez, Egami
Sample Recovery: Newton, Reichle
Amp-hour Tank Data: Newton
Sample Transport: Newton

Sample Analysis: TMA/Norcal
2030 Wright Avenue
Richmond, CA 94804-0040
(415) 235-0438
Attn: Nahid Mahani
or Susan Smith

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5.0 RESULTS

Table 1 summarizes chromium emission results from each test. Table 2 shows average outlet emission rates results and process conditions during each test. Table 3 summarizes other relevant test data.

TABLE 1: EMISSION TEST RESULTS
HARD CHROME PLATING AND CHROMIC ACID ANODIZING OPERATIONS
BUILDING 5, NAD ALAMEDA

TEST NO.	CHROMIUM SAMPLE WEIGHT (mg)	CHROMIUM EMISSION CONC. (mg/SCF)	CHROMIUM EMISSION RATE (mg/hr)	AVERAGE AMPERES (Amp)	CHROMIUM EMISSION FACTOR (mg/Amp-hr)	STACK EXIT VELOCITY (m/s)
5-242-1-OUT	0.0448	1.006E-03	191.801	2393.0	0.080	9.1
5-242-2-OUT	0.0484	6.248E-04	148.160	2401.0	0.062	11.3
5-242-3-OUT	0.0678	4.770E-04	142.590	2404.0	0.059[a]	14.2
5-241-1-OUT	0.0931	1.059E-03	397.858	4165.0	0.096	22.6
5-241-2-OUT	0.0999	1.000E-03	432.399	4272.0	0.101	26.0
5-241-3-OUT	0.0877	8.321E-04	379.351	4433.0	0.086	27.5
5-239-1-OUT	0.0072	4.605E-05	15.383	422.0	0.036	20.1
5-239-2-OUT	0.0103	6.076E-05	21.002	562.0	0.037	20.8

[a]Not used to calculate average emission rate. Refer to discussion.

TABLE 2: RESULTS AND PROCESS CONDITIONS
HARD CHROME PLATING AND CHROMIC ACID ANODIZING OPERATIONS
BUILDING 5, NAD ALAMEDA

SCRUBBER NO.	AVERAGE EMISSION RATE (mg/amp-hr)	AVERAGE STACK EXIT VELOCITY (m/s)	PROCESS CONDITIONS AIR AGITATION	FLOATING POLYBALLS	ANTI-MIST ADDITIVE
242 (PLATE)	0.071	11.5	YES	YES	YES
241 (PLATE)	0.094	25.4	YES	YES	YES
239 (ANODIZE)	0.037	20.4	YES	YES	YES

Appendix A, pages A-1 to A-4, contains chromium analysis results of all samples. Appendix A, page A-5, shows recent analysis results of chromic acid content in the plating and anodizing baths. Appendix B contains all ampere hour calculation sheets and field tank load data sheets. Appendix C contains our field emission test data sheets. Appendix D summarizes the test results and contains sample calculations. Appendix E lists our HP-41C calculator program "Nomokin" used instead of a nomograph to determine isokinetic sampling parameters during testing. Appendix G contains equipment calibration sheets. Appendix H contains resumes of NEESA test personnel.

TABLE 3: EMISSION TEST DATA

HARD CHROME PLATING AND CHROMIC ACID ANODIZING OPERATIONS
BUILDING 5, NAD ALAMEDA

TEST NO.	NOZZLE DIA. (in.)	SAMPLE RATE (CFM)	SAMPLE TIME (min.)	AIR SAMPLE VOLUME (SCF)	% H2O (%)	STACK FLOW RATE (DSCFM)	ISOKIN (%)
5-242-1-OUT	0.396	0.49	120	44.55	2.1	3179.17	102.1
5-242-2-OUT	0.396	0.36	168	77.41	2.1	3951.96	101.9
5-242-3-OUT	0.481	0.64	120	142.23	1.8	4982.09	140.9
5-241-1-OUT	0.399	0.75	120	87.92	1.9	6261.36	100.7
5-241-2-OUT	0.400	0.73	120	99.90	1.9	7205.80	99.0
5-241-3-OUT	0.401	0.83	120	105.45	1.8	7598.71	98.6
5-239-1-OUT	0.396	0.66	250	156.44	2.0	5567.65	98.2
5-239-2-OUT	0.399	0.63	250	169.03	1.7	5761.37	101.0

6.0 DISCUSSION

6.1 General

The Bay Area Air Quality Management District (BAAQMD) requires hexavalent chromium emissions from Building 5 be less than 0.15 milligrams per ampere-hour. Results show building 5 complies when both floating polyballs and Fumetrol 101 anti-mist additive are used to minimize emissions from the chrome plating and chromic acid anodizing baths.

All stack flow rates may be 9% high. The quartz nozzles we received from the vendor are wider than typical steel nozzles which reduces the distance between the pitot tube and the nozzle. Our post test pitot tube calibration with the quartz nozzle in place shows the pitot coefficient is 0.75 instead of 0.82. A 9% decrease in the pitot coefficient reduces the actual stack flow rates by 9% and increases the isokinetic percentages by 9%. The average stack exit velocities probably range from 10.5 to 23.1 instead of 11.5 to 25.4. The outlet isokinetic percentages actually range from 107% to 111% instead of 98% to 102%.

The pitot tube coefficient error does not change the results. Building 5 chromium emissions are one to two-thirds of the 0.15 mg/Amp-hr emission limit. The error actually makes the outlet emission rates more conservative because the emission concentrations were multiplied by a higher stack flow rate value.

6.2 Scrubber 242

The isokinetic percentage of run 3 was about 150% due to an error measuring the nozzle diameter. The emission rate from run 3 was not used to calculate the average emission rate. Although the test may be considered void, the results are still shown in Table 1 because they are consistent with the first two runs. Increasing the 0.059 mg/Amp-hr emission rate by 150% to approximate the effect of the high sampling rate increases it to 0.089 mg/Amp-hr.

The stack flow rate at the scrubber 242 outlet sampling site is very low, averaging 540 feet per minute. Low flow rates reduce S-type pitot tube velocity measurement accuracy. We performed a velocity traverse at the scrubber inlet where the velocity is higher. The scrubber inlet velocity traverse shows the scrubber inlet flow rate is 3300 SCFM.

6.3 Scrubber 239

We performed two semi-simultaneous 250 minute test runs at the outlet test site to compensate for both low expected emission concentrations and difficulty maintaining electrical power to the rectifier. The first 50 minutes of run 1 was performed on 24FEB90 but was stopped because only 75 Amps could be maintained on the rectifier. The rectifier was repaired on 25FEB90. We completed runs 1 and 2 on 26FEB90. We performed an additional sampling train leak check on sampling train 1 before resuming the test.

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APPENDIX A

SAMPLE ANALYSIS RESULTS
LABORATORY ANALYSIS REPORTS

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SAMPLE ANALYSIS RESULTS

SAMPLE IDENTIFICATION	ANALYSIS VOLUME (l)	LAB CHROMIUM ANALYSIS (ug/l)	CHROMIUM WEIGHT (mg)	
5-242-1-OUT-PROBE	0.0660	390	0.0257	
5-242-1-OUT-IMP1	0.1257	130	0.0163	
5-242-1-OUT-IMP2	0.1239	22	0.0027	
			0.0448	TOTAL
5-242-2-OUT-PROBE	0.0683	310	0.0212	
5-242-2-OUT-IMP	0.2720	100	0.0272	
			0.0484	TOTAL
5-242-3-OUT-PROBE	0.0370	600	0.0222	
5-242-3-OUT-IMP1	0.1458	310	0.0452	
5-242-3-OUT-IMP2	0.1169	4	0.0005	
			0.0678	TOTAL
5-241-1-OUT-PROBE	0.0854	270	0.0230	
5-241-1-OUT-IMP1	0.1171	560	0.0656	
5-241-1-OUT-IMP2	0.1320	34	0.0045	
			0.0931	TOTAL
5-241-2-OUT-PROBE	0.0877	260	0.0228	
5-241-2-OUT-IMP1	0.1500	480	0.0720	
5-241-2-OUT-IMP2	0.1081	47	0.0051	
			0.0999	TOTAL
5-241-3-OUT-PROBE	0.0435	510	0.0222	
5-241-3-OUT-IMP	0.2428	270	0.0656	
			0.0877	TOTAL
5-239-1-OUT-PROBE	0.0923	43	0.0040	
5-239-1-OUT-IMP1	0.1623	18	0.0029	
5-239-1-OUT-IMP2	0.1569	< 2	< 0.0003	
			0.0072	TOTAL
5-239-2-OUT-PROBE	0.1045	48	0.0050	
5-239-2-OUT-IMP1	0.1434	35	0.0050	
5-239-2-OUT-IMP2	0.1170	< 2	< 0.0002	
			0.0103	TOTAL

SAMPLE RECOVERY WEIGHTS/VOLUMES

SAMPLE IDENTIFICATION	TARE (gm)	FINAL (gm)	NET (gm or ml)	FILTER NO.
5-242-1-OUT-PROBE	55.61	121.59	65.98	
5-242-1-OUT-IMP1	55.90	181.56	125.66	
5-242-1-OUT-IMP2	55.69	179.62	123.93	006
5-242-2-OUT-PROBE	55.91	124.22	68.31	
5-242-2-OUT-IMP	55.05	327.00	271.95	008
5-242-3-OUT-PROBE	56.02	93.01	36.99	
5-242-3-OUT-IMP1	55.88	201.63	145.75	
5-242-3-OUT-IMP2	55.23	172.12	116.89	010
5-241-1-OUT-PROBE	55.60	140.95	85.35	
5-241-1-OUT-IMP1	55.58	172.68	117.10	
5-241-1-OUT-IMP2	55.03	186.98	131.95	005
5-241-2-OUT-PROBE	55.12	142.86	87.74	
5-241-2-OUT-IMP1	55.51	205.55	150.04	
5-241-2-OUT-IMP2	55.62	163.71	108.09	007
5-241-3-OUT-PROBE	55.18	98.68	43.50	
5-241-3-OUT-IMP	55.04	297.82	242.78	009
5-239-1-OUT-PROBE	55.94	148.23	92.29	
5-239-1-OUT-IMP1	55.55	217.87	162.32	
5-239-1-OUT-IMP2	55.07	211.93	156.86	011
5-239-2-OUT-PROBE	55.74	160.28	104.54	
5-239-2-OUT-IMP1	55.35	198.72	143.37	
5-239-2-OUT-IMP2	55.98	172.94	116.96	012

TMA
Thermo Analytical Inc.

TMA/Norcal
2030 Wright Avenue
P.O. Box 4040
Richmond, CA 94804-0040

(415) 235-2633 Fax No. (415) 235-0438

March 13, 1990

NEESA - 111C
Port Hueneme, CA 93043-5014

Attention: Drek Newton

TMA/Norcal I.D.: 6993-1

NEESA Reference: Chrome Plating Emissions NAD Alameda

Dear Drek:

Enclosed are the results of 33 water samples received on February 28, 1990, for analysis of Chromium.

The samples were analyzed by CARB Method 425 using Heated Graphite Furnace Atomic Absorption for the low level samples and Atomic Absorption Flame for the high level samples.

TMA/Norcal sample numbers 6993-1-(2,-3,-4,-5,-6,-8,-9,-10,-12,-13,-17,-23,-27, -28,-29,-30,-31,-32, and -33) were analyzed by Graphite Furnace and TMA/Norcal sample numbers 6993-1-(1,-7,-11,-14,-15,-16,-18,-19,-20,-21,-22,-24,-25, and -26) were analyzed by Atomic Absorption Flame. The detection limit for Graphite Furnace is 0.002 mg/l and the detection limit for Atomic Absorption Flame is 0.01 mg/l. Hand written results were faxed on March 12, 1990.

The results are shown in Table 1 on the following page. If you have any questions please call.

Data released by:

Susan Smith
Inorganics Department
Supervisor

Prepared by:

Nahid Mahani
I.H. Laboratory
Director/Program Manager

SS/NM/td

NEESA - IIIC
Page 2
March 26, 1990

REVISED REPORT

TABLE 1

TMA/Norcal I.D.	Client I.D.	Chromium (mg/l)
6993-1-1	167-1-IN - IMP	0.14
6993-1-2	167-1-OUT - IMP	<0.002
6993-1-3	167-2-OUT - IMP 1	0.002
6993-1-4	167-2-OUT - IMP 2	<0.002
6993-1-5	167-3-OUT - IMP 1	0.005
6993-1-6	167-3-OUT - IMP 2	<0.002
6993-1-7	167-1-IN - PROBE	1.7
6993-1-8	167-1-OUT - PROBE	0.040
6993-1-9	167-2-OUT - PROBE	0.012
6993-1-10	167-3-OUT - PROBE	0.023
6993-1-11	5-241-1-OUT - IMP 1	0.56
6993-1-12	5-241-1-OUT - IMP 2	0.034
6993-1-13	5-241-2-OUT - IMP 2	0.047
6993-1-14	5-241-3-OUT - IMP	0.27
6993-1-15	5-241-1-OUT - PROBE	0.27
6993-1-16	5-241-2-OUT - PROBE	0.26
6993-1-17	5-241-3-OUT - PROBE	0.51
6993-1-18	5-242-1-OUT - IMP 1	0.13
6993-1-19	5-242-1-OUT - IMP 2	0.022
6993-1-20	5-241-2-OUT - IMP 1	0.48
6993-1-21	5-242-2-OUT - IMP 2	0.10
6993-1-22	5-242-3-OUT - IMP 1	0.31
6993-1-23	5-242-3-OUT - IMP 2	0.004
6993-1-24	5-242-1-OUT - PROBE	0.39
6993-1-25	5-242-2-OUT - PROBE	0.31
6993-1-26	5-242-3-OUT - PROBE	0.60
6993-1-27	5-239-1-OUT - IMP 1	0.018
6993-1-28	5-239-1-OUT - IMP 2	<0.002
6993-1-29	5-239-2-OUT - IMP 1	0.035
6993-1-30	5-239-2-OUT - IMP 2	<0.002
6993-1-31	5-239-1-OUT - PROBE	0.043
6993-1-32	5-239-2-OUT - PROBE	0.048
6993-1-33	NaOH BLANK	<0.002

REPORT NAVAVNDEPOT ALAMEDA

MATERIALS LABORATORY TEST REPORT
NAVAVNDEPOT 4730/12 (REV. 4-87)

NAVAL AVIATION DEPOT
ALAMEDA, CALIFORNIA 94501

FROM: Chemical Engineering & High Polymer Materials Lab, Code 0542, Bldg 7
Product Support Directorate, NAS Alameda, CA 94501

REPORT NUMBER: 290-108
DATE TESTED: 03/01/90

TO: Plating and Abrasive Shop, Code 93213 (ATTN: S. Wong), Bldg 5

DATE SAMPLED: 01/31/90
DATE RECEIVED: 01/31/90

MATERIAL TESTED: Fourth Tuesday Electroplating Process Tank Samples

RESULTS:

TANK NO	MATERIAL	LAB ANALYSIS		LIMITS		LABORATORY COMMENTS
		CrO3	SULFATE	CrO3	SULFATE	
10	Cr PLATE	39.7	0.56	37-45	.45-.55	SOLUTION OK
11	Cr PLATE	39.8	0.58	37-45	.45-.55	ADD 180 LBS CHROMIC ACID
14	Cr PLATE	49.0	0.76	37-45	.45-.55	ABNORMAL DO NOT USE
15	Cr PLATE	39.0	0.60	37-45	.45-.55	ADD 100 LBS CHROMIC ACID / No log Book
		Cr6 CHPD	pH	Cr6 CHPD	pH	
1	AL ANODIZE	11.6	1.6	6.7-13.4	0.5-1.0	ADD 200 LBS CHROMIC ACID
7	NO CONVERSION			16-24	4.2-5.0	TANK NOT IN SERVICE
6	AL CONVERSION	1.4	1.9	0.5-1.0	1.5-2.0	
33	ALODINE 2627	10.4		6-19		
54	CD CONVERSION	1.34	1.7	4 (1-3)	1.0-1.7	
		NI	H3BO3/HCL	pH	NICKEL	H3BO3/HCL	pH	
19	NI ACETATE	0.19		6.0	.22-.44		5.5-6.5	ADD 6 LBS NICKEL ACETATE
25	NI STRIKE	23.1	13.8		7-9	12.3		KEEP AT WORKING LEVEL WITH WATER ADDITIONS
26	NI PLATE	12.7	3.4	4.7	14-16	> 4	4.0-4.4	ADD BORIC ACID & 24 GALS SNR-24 NICKEL CONCENTRATE
27	NI PLATE	15.4	3.6	4.5	14-16	> 4	4.0-4.4	ADD BORIC ACID
34	HNO3 DIP				45-55			TANK NOT IN SERVICE
50	HNO3 PASS		( )		21% (DICHROMATE = 2.7)			TANK NOT IN SERVICE
55	HNO3		2.8		2-3%			
16	H2SO4 ANODIZE		10.6		9.2			
28	H2SO4 ETCH		32.2		32%			
37	H2SO4-HF ETCH		33.3		33%			
39	ALODINE 629		28.9		16-32			
57	HCL		6.3		4-6%			
		GRAVITY	ACID ACCEPT:	GRAVITY	ACID ACCEPTANCE			
40	DEGREASER	1.33	0.18	1.2 MINIMUM	0.10 MINIMUM			

ADDITIONAL COMMENTS:
DO NOT SAMPLE TOO FULL(HALF OF SAMPLE BOTTLE IS OK). AND PLEASE RINSE BOTTLES AFTER SAMPLING. except tanks 40 Degrees

TESTED BY: (Signature) [signature] DATE: 03/02/90 Ron E. Kong

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APPENDIX B

AMPERE-HOUR CALCULATION SHEETS
FIELD TANK LOAD DATA

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AMPERE-HOUR CALCULATION SHEET
BUILDING 5, SCRUBBER 242 (TANKS 14 & 15)
HARD CHROME PLATING

2/23/90 TIME	DEL-T MIN.	RECTIFIER amperes #14 + #15	AVG AMPS	AMP-HRS	242-1-OUT AMP-HRS	242-2-OUT AMP-HRS	242-3-OUT AMP-HRS
1310		2400					
1315	5		2390	199			
1335	20	2380	2390	797	797		
1355	20		2392	797	797		
1405	10		2392	399			
1445	40		2392	1594	1594		
1455	10	2403	2392	399			
1500	5		2401	200			
1515	15	2398	2401	600	600		
1540	25		2393	997	997		
1545	5	2387	2393	199			
1606	21		2394	838			
1615	9	2400	2394	359			
1617	2		2400	80			
1705	48	2400	2400	1920			
1710	5		2400	200			
1806	56		2400	2240		2240	
1817	11		2400	440			
1830	13	2400	2400	520		520	
1913	43		2401	1721		1721	
1920	7		2401	280			
1945	25	2402	2401	1000		1000	
2016	31		2403	1242		1242	
2130	74	2404	2403	2964			
2210	40		2404	1603			
2245	35	2404	2404	1402			1402
2250	5		2404	200			200
2300	10		2404	401			
2340	40		2404	1603			1603
2345	5		2404	200			
0025	40		2404	1603			1603
2/24 0050	25	2404	2404	1002			
TOTAL AMP-HRS DURING TEST					4785	6723	4808
TEST SAMPLING TIME (MIN.)					120	168	120
AVERAGE AMPS DURING TEST					2393	2401	2404

AMPERE-HOUR CALCULATION SHEET
BUILDING 5, SCRUBBER 241 (TANKS 10 & 11)
HARD CHROME PLATING

2/23/90 TIME	DEL-T MIN.	RECTIFIER amperes #10 + #11	AVG AMPS	AMP-HRS	241-1-OUT AMP-HRS	241-2-OUT AMP-HRS	241-3-OUT AMP-HRS
1130							
1145	15	4146	4094	1024	1024		
1210	25		4153	1730	1730		
1220	10		4153	692			
1230	10	4160	4153	692	692		
1300	30	4174	4167	2084	2084		
1307	7		4200	490			
1347	40		4200	2800	2800		
1455	68	4225	4200	4759			
1458	3		4225	211			
1515	17	4225	4225	1197		1197	
1538	23		4235	1623		1623	
1545	7	4245	4235	494			
1615	30	4254	4250	2125		2125	
1625	10		4310	718		718	
1630	5		4310	359			
1705	35	4366	4310	2514		2514	
1710	5		4386	365		365	
1815	65		4386	4751			
1830	15	4405	4386	1096			1096
1855	25		4425	1844			1844
1905	10		4425	738			
1945	40	4445	4425	2950			2950
1950	5		4463	372			
2030	40		4463	2975			2975
2130	60	4481	4463	4463			
TOTAL AMP-HRS DURING TEST					8329	8543	8865
TEST SAMPLING TIME (MIN.)					120	120	120
AVERAGE AMPS DURING TEST					4165	4272	4433

AMPERE-HOUR CALCULATION SHEET
BUILDING 5, SCRUBBER 239 (TANK 1)
CHROMIC ACID ANODIZING

2/24/90 TIME	DEL-T MIN.	RECTIFIER amperes #1	AVG AMPS	AMP-HRS	239-1-OUT AMP-HRS	239-2-OUT AMP-HRS
1300		90				
1304	4		83	6		
1315	11	75	83	15	15	
1345	30	75	75	38	38	
1345	0	0	0	0	0	
1354	9	0	0	0	0	
TEST STOPPED DUE TO RECTIFIER PROBLEMS...CONTINUED 2/26/90						
2/26/90						
717	0	350				
719	2	325	338	11	11	11
721	2	400	363	12	12	12
723	2	350	375	13	13	13
727	4	350	350	23	23	23
729	2	400	375	13	13	13
737	8	400	400	53	53	53
742	5	350	375	31	31	31
745	3	250	300	15	15	15
755	10	250	250	42	42	42
800	5	225	238	20	20	20
805	5	225	225	19	19	19
807	2		218	7	7	7
810	3	210	218	11		
817	7		205	24		
820	3	200	205	10	10	10
837	17	200	200	57	57	57
TEST STOPPED TO RELOAD TANKS						
912	0	350				
913	1		375	6		
914	1	400	375	6	6	6
916	2	400	400	13	13	13
917	1	450	425	7	7	7
920	3	450	450	23	23	23
925	5	475	463	39	39	39
930	5	475	475	40	40	40
934	4	550	513	34	34	34
936	2	550	550	18	18	18
943	7		638	74	74	74
948	5		638	53		
955	7	725	638	74	74	74
1000	5	700	713	59	59	59
1028	28		700	327	327	327
1030	2	700	700	23		
TEST STOPPED TO RELOAD TANKS						

AMPERE-HOUR CALCULATION SHEET
BUILDING 5, SCRUBBER 239 (TANK 1)
CHROMIC ACID ANODIZING
(CONTINUED)

2/26/90 TIME	DEL-T MIN.	RECTIFIER amperes #1	AVG AMPS	AMP-HRS	239-1-OUT AMP-HRS	239-2-OUT AMP-HRS
1107		450				
1108	1		538	9		
1110	2	625	538	18	18	18
1112	2	600	613	20	20	20
1118	6		613	61	61	61
1124	6		613	61		
1130	6	625	613	61	61	61
1135	5	650	638	53	53	53
1137	2	700	675	23	23	23
1140	3	675	688	34	34	34
1150	10	700	688	115	115	115
1214	24	700	700	280	280	280
TEST STOPPED TO RELOAD TANKS						
1254		450				
1255	1		500	8		
1256	1	550	500	8		8
1258	2	600	575	19		19
1300	2	700	650	22		22
1302	2	700	700	23		23
1304	2	750	725	24		24
1306	2	725	738	25		25
1316	10	750	738	123		123
1326	10	800	775	129		129
1339	13	850	825	179		179
1345	6		850	85		85
1350	5	850	850	71		
TOTAL AMP-HRS DURING TEST					1758	2343
TEST SAMPLING TIME (MIN.)					250	250
AVERAGE AMPS DURING TEST					422	562

TANK LOAD DATA SHEET

DATE: 2/23/90
BASE: ALAMEDA
BUILDING NO: 5

TANK NO: 14 & 15
RUN NO: 5-242-1
5-242-2
5-242-3

RECTIFIER	WORKPIECE DESCRIPTION
#14	2X2' SHEET STEEL
CAL 12/21/89	1/2 GAL FUMATROL
	AIR AGITATION ON PLASTIC BALLS
#15 RECINK	2X1.5' SHEET STEEL
CAL 12/21/89	1/2 GAL FUMATROL
S/N ST5900	AIR AGITATION ON PLASTIC BALLS
	TEMP 128°F

	RECTIFIER			
TIME (INIT)	#14	#15		
1:10pm	11V 1100A	9V 1400A		
135pm	1100A	1380A		
255pm	1100 A	1403A		
315pm	1100 A	1398A		
345pm	1100A	1387A		
415pm	1100 A	1400A		
505pm	1100 A	1400A		
630pm	1100 A	1400 A		
745pm	1100 A	1402 A		
930pm	1100 A	1404A		
1045pm	1100 A	1404A		
0050am	1100A	1404A		
1/27/90	AMP METER & CALIBRATION CHECK			
AMP METER	350A	NOT IN USE ASSUMED OK SINCE 3 OTHER TANKS ARE OK		
DC CLAMP-ON @ BUSBAR	420A AMP METER READING IS CONSERVATIVE			

TANK LOAD DATA SHEET

DATE: 2/23/90
BASE: ALAMEDA
BUILDING NO: 5

TANK NO: 10 & 11
RUN NO: 5-241-1
5-241-2
5-241-3

RECTIFIER	WORKPIECE DESCRIPTION
11-RECINC	18 FT² SHEET SURFACE AREA
~~HOLFORD~~	SHEET STEEL (TANK 11)
NO SER NO	3X3' 1.5 GAL FUMATROL
	AIR AGITATION ON TEMP 130
10-RECINC	SHEET SURFACE AREA
CAL 4-1489	2X2 SHEET STEEL
USN207581	PLASTIC BALLS AIR AGITATION ON
	1 GAL FUMATROL 101 TEMP 130

TANK VENTILATION IS PRETTY GOOD

	RECTIFIER			
TIME (INIT)	#10	#11		
1120 pm	7V 1072 A	13.1V 2970 A		
1145 am	1076 A	3070 A		
1230 pm	1080 A	3080 A		
0100 pm	1084 A	3090 A		
255 pm	1085 A	3140 A		
315 pm	1085 A	3140 A		
345 pm	1085 A	3160 A		
415 pm	1084 A	3170 A		
505 pm	1086 A	3280 A		
630 pm	1055 A	3320 A		
745 pm	1085 A	3360 A		
930 pm	1081 A	3400 A		
2/27/90 AMP-METER CALIBRATION CHECK				
AMP METER	702	NOT IN USE ASSUMED OK		
DC CHAMPION @ BUSBAR	700 CALIBRATION IS ACCURATE	SINCE CAL ~~CHECK~~ ON OTHER TANKS IS OK		

TANK LOAD DATA SHEET

DATE: 2/24/90
BASE: ALAMEDA
BUILDING NO: 5

TANK NO: 1
RUN NO: 5-230-1 *

RECTIFIER	WORKPIECE DESCRIPTION
TANK #1	CHROMIC ACID ANODIZING - 4 X 16'
CAL 12/21/89	3 GAL'S FUMATAC 101
RECINC	PLASTIC BALLS
R/N 575505	AIR AGITATION ON
	- 4 BOMB RACKS
	ELECTRICAL PROBS - USUALLY ANODIZE UP
	TO 12 BOMB RACKS BUT CIRCUITS
	KEEP BREAKING.

	RECTIFIER			
TIME (INIT)	#1			
100 rpm	40V 90A			
115 rpm	75A			
150	0V 0A	SHUT [redacted]	OFF @ 145 rpm	
	TRANSFORMER/RECTIFIER NOT			
	WORKING. REPAIRED LATE			
	SATURDAY 2/24/90			
	TEST RESUMED WITH HIGHER			
	LOADS 2/26/90			

(CONT) LOGGED BY DOUG DELONG

TANK LOAD DATA SHEET CR03 ANODIZE

DATE: 2/26/90
BASE: ALAMEDA
BUILDING NO: 5

TANK NO: 1
RUN NO: 3-239-1R2

RECTIFIER	WORKPIECE DESCRIPTION
TANK #1	8 BOB RACKS
	700 sq ft 3 GASES FUMATROL ADDED
	AIR AGITATION ON
	POLY BALLS IN TEMP 100°F

	RECTIFIER			
TIME (INIT)	TANK #1			
0717	7V 350A			
0719	9V 325A		RAMPING	
0721	10V 400A		UP TO	
0723	12V 350A		40V	
0725	13.5V 350A		& BOMB	
0727	15V 350A		RACKS	
0729	17V 400A			
0731	20V 400A		FUMATROL	FOAMING
0733	25V 400A		ARCING	PART HANGERS
0735	30V 400A			
0737	35V 400A			
0739	40V 350A			
0742	40V 250A			
0745	40V 250A			

TANK LOAD DATA SHEET (CONTINUED)

DATE: 6/26/90
TANK NO: 1
RUN NO: 5-239-1
5-239-2

	RECTIFIER			
TIME (INIT)	#1			
0750	40V 250A			
0755	40V-250A			
0800	40V 225A			
0805	40V 225A			
0810	40V 210A			
0820	40V-200			
0825	40V-200	PARTS	A BIT WELL DONE	
0830	40V 200A			
0835	40V 200A			
0838	40V 200A			
6		POWER OFF TO RELOAD		
0912	10V 350A	TANKS		
0914	15V 400A	3 - 4'X8' 1/16" THICK SHEET		
0916	18V 400A		ALUMINUM	
0917	19V 450A		FEW MISC SMALL PARTS	
0920	21V 450A	RAMPING UP TO		
0925	24V 475A		40V	
0930	25V 475A			
0934	26V 550A			
0936	29V 550A			

TANK LOAD DATA SHEET (CONTINUED)

DATE: 2/26/90
TANK NO: 1
RUN NO: 5-239-1
5-239-2

	RECTIFIER			
TIME (INIT)	#1			
0855am	40 V 725 A			
1000	35.5V 700 A			
1010	38 V - 700 A			
1015	38V - 700A	PARTS LOOK GREAT		
1025	35V - 700A			
1030	38V - 700A	POWER OFF TO RELOAD TANKS		
		3 4'X8' ALUMINUM SHEETS		
1107	20V 450A			
1110	37V 625A			
1112	40V 600A			
1130	39V 625A			
1135	39V 650A			
1137	40V 700A			
1140	41V 675A			
1150	41V 700A			
1202pm	40V 700 A			
1215pm	40V 700A	POWER OFF TO RELOAD		
		RUN #1	COMPLETE	

TANK LOAD DATA SHEET (CONTINUED)

DATE: 2/26/90
TANK NO: 1
RUN NO: 5-239-1
5-239-2

	RECTIFIER			
TIME (INIT)	#1			
1254pm	20V 450A	4 ⇒ 4'X8' SHEETS OF AL		
1256pm	25V 550A			
12:58	30V 600A	> RAMP UP VOLTS		
@1:00pm	34V 700A			
1:02	36V 700A			
1:04	37V 750A			
1:06	39V 725A			
1:16	39V 750A			
1:26	39V-800A			
139	39V 850A			
150	39V 850A			
AMP-METER CALIBRATION CHECK				
1/27/90 AMP-METER	600A			
DC CLAMP ON @ BUS BAR 1	350A			
DC CLAMP ON @ BUSBAR 2	250A			
TOTAL BUSBAR 1 & 2	600A			
	CALIBRATION IS ACCURATE			

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APPENDIX C

FIELD SAMPLING DATA

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PRELIM

TRAVERSE DATA SHEET

(REV 8/86)

5-242-1-OUT

PLANT BLDG 5		Length from upstream disturbance	ft
LOCATION ALAMEDA		Diameter from upstream disturbance 2	dia
DATE 2/23/90		Length from downstream disturbance	ft
OPERATOR M.P.		Diameters from downstream disturbance 0.5	dia
RUN # 5-242-1-OUT	CIRCULAR, DIA. in	Required number of traverse points 24	ea
	RECTANGULAR, LxW 40 x 27 in	Number of traverse points used 24	ea

POINT # n	STACK PRESSURE (in H_2O) ΔPvel	Pstatic	$\sqrt{\Delta P}$	LOCATION (in) L	W	POINT # n	STACK PRESSURE (in H_2O) ΔPvel	Pstatic	$\sqrt{\Delta P}$	LOCATION (in) L	W
1	.06					26					
2	.04					27					
3	.03					28					
4	.03					29					
5	.03					30					
6	.02					31					
7	.03					32					
8	.03					33					
9	.06					34					
10	.07					35					
11	.05					36					
12	.03					37					
13	.02	-.034				38					
14	.01					39					
15	.01					40					
16	.02					41					
17	.06					42					
18	.06					43					
19	.05					44					
20	.04					45					
21	.03					46					
22	.02					47					
23	.01					48					
24	.01					49					
25						50					

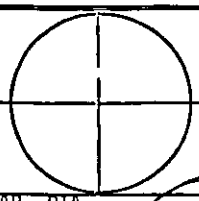
$$\Delta P_{ave} = \left[\frac{\Sigma\sqrt{\Delta P}}{n}\right]^2 = 0.032$$

TRAVERSE DATA SHEET

(REV 8/86)

SCRUBBER INLET TRAVERSE

PLANT Bldg 5
LOCATION Alameda
DATE 23 Feb 90
OPERATOR JR
RUN # inlet trav 242



CIRCULAR, DIA. 24 in
RECTANGULAR, LxW ____ in

Length from upstream disturbance ____ ft
Diameter from upstream disturbance ____ dia
Length from downstream disturbance ____ ft
Diameters from downstream disturbance ____ dia
Required number of traverse points ____ ea
Number of traverse points used ____ ea

POINT # n	STACK PRESSURE (in H_2O) ΔPvel	Pstatic	$\sqrt{\Delta P}$	LOCATION (in) L	W	POINT # n	STACK PRESSURE (in H_2O) ΔPvel	Pstatic	$\sqrt{\Delta P}$	LOCATION (in) L	W
1	0.11					26					
2	0.12					27					
3	0.11					28					
4	0.10					29					
5	0.095					30					
6	0.09					31					
7	0.10					32					
8	0.11					33					
9	0.13					34					
10	0.14					35					
11	0.14					36					
12	0.14					37					
13	0.05					38					
14	0.05					39					
15	0.06					40					
16	0.05					41					
17	0.05					42					
18	0.08					43					
19	0.11					44					
20	0.14					45					
21	0.15					46					
22	0.15					47					
23	0.15					48					
24	0.15					49					
25						50					

$$\Delta P_{ave} = \left[\frac{\Sigma\sqrt{\Delta P}}{n}\right]^2 = 0.1164$$

IMPINGER BOX SET UP FOR CHROMIUM EMISSION TEST-
AND NOZZLE CALIBRATION SHEET

DATE: 2/23/90

LINE NO: 242 TANKS 14 & 15

BASE: NAO ALAMEDA

RUN NO: S-242-1-OUT

BUILDING NO: 5

CIRCLE 1: INLET (OUTLET)

PREP BY: DM

[✓] 1. Wash all glassware with ~~detergent~~, ~~acetone~~, ~~deionized water~~, and rinse with 0.1N NaOH solution.
[✓] 2. Add 100ml 0.1N NaOH solution in the first two impingers (standard Greenburg-Smith impingers). Record initial weights.
[✓] 3. The third impinger (modified Greenburg-Smith) is dry. Record initial weight.
[✓] 4. The fourth impinger (modified Greenburg-Smith) contains about 1 liter of indicating type silica gel. Record initial weight.
[✓] 5. Place teflon coated filter into filter holder and install between the third and fourth impingers. Record filter number. Do not weigh.
[✓] 6. Assemble impinger bottles and glass elbows (180s) so that air flows from a smaller to larger holes (if applicable).
[✓] 7. Calibrate nozzle by measuring four IDs with a micrometer.

Impinger No.	Contents	Tare	Initial	Final	Condensate
4-1	1. 100ml 0.1N NaOH	481.13	582.03	593.10	11.07
4-2	2. 100ml 0.1N NaOH	471.67	571.92	~~572.82~~ ~~573.82~~	0.90
4-3	3. Empty	457.50	——	~~457.82~~	0.32
4-4	4. 1 l silica gel	466.94	~~766.27~~	774.58	8.31
				Net Weight Gain	20.60

Filter No: 006

Silica gel condition after test: 10% SPENT

Nozzle No: ~~3/8~~ QUARTZ Calibrated by: DM/~~DM~~

					Average
ID Before Test:	0.390 ~~0.378~~	0.405 ~~0.379~~	0.392 ~~0.380~~	0.397 ~~0.379~~	0.396 ~~0.380~~
ID After Test:	0.390	0.405	0.393	0.395	0.396

(SJS rev11/88, #02510)

stack mount = 24.
Stack Area 1076.75

PLANT BLDG 5	BAROMETRIC PRESSURE, in Hg 30.220		METER BOX # #12	PROBE # (PITOT #) 3-1	NOZZLE # 1/2 inch
LOCATION ALAMEDA	AMBIENT TEMPERATURE, °F 67		METER ΔH@ 1.751	PITOT COEF 0.82	IDEAL NOZZLE DIA, in. 0.321
DATE Feb-23-90	AVE STATIC PRESSURE, in H_2O +.034		METER γ 0.998	PROBE LENGTH, in. 36	ACTUAL NOZZLE DIA, in. 0.[illegible]0-396
OPERATOR mp	AVE VEL HEAD, in H_2O 0.032		SAMPLE BOX # 4	PROBE LINER MATERIAL GLASS	LEAK CHECK @ PITOT'S 6000 @ 5 inHg
RUN # #1 S-242-1-OUT	ASSUMED MOISTURE, % 1%	SCHEMATIC OF STACK CROSS SECTION (SHOW TRAVERSE PTS)	HEATER BOX SETTING N/A	PROBE HEATER SETTING N/A	LEAK RATE CFM@ in Hg .005 CFM@ 15 in Hg

TRAVERSE POINT #	SAMPLING TIME	GAS METER READING	ORIFICE PRESSURE (CALC) (A)	VELOCITY HEAD (MEAS) (A)	STACK TEMPERATURE (B)	GAS SAMPLE TEMPERATURE AT DRY GAS METER		IMPINGER TEMPERATURE	SAMPLE BOX TEMPERATURE	SAMPLE VACUUM	O_2	CO_2	CO	NOX
1:15						Inlet	Outlet							
	min	$(Vm)\ ft^3$	(ΔH) in H_2O	(ΔP) in H_2O	(Ts) °F	(Tm in) °F	(Tm out) °F	°F	°F	in Hg	%	%	ppm	ppm
1	0	355.759	1.72 [illegible]	.03 [illegible]	68	78	75	50		4				
2	5	359.6	0.98	.04	67	72	71	47		3				
3	10	362.7	0.73	.03	68	72	72	50		2				
4	15	364.3	0.49	.02	68	74	72	52		1				
5	20	366.5	0.24	.01	69	74	72	54		1				
6	25	368.3	0.24	.01	68	75	72	56		1				
7	30	369.5	0.24	.01	69	75	73	57		1				
8	35 [illegible]	370.6	0.25	.01	67	75	73	57		1				
9	40	372.3	1.22	.05	67	74	72	57		3				
10	45	375.4	0.98	.04	66	74	73	50		3				
11	50	377.9	0.49	.02	66	75	72	51		2				
12	55	380.1	0.25	.01	67	76	73	54		1				
13	60	381.6	0.25	.01	67	75	73	57		1				
TOTAL														
AVERAGE														

1:35 CHANGE PORT

(SJS rev11/88, #0251Q)

.395

PLANT	BAROMETRIC PRESSURE, in Hg		METER BOX #	PROBE # (PITOT #)	NOZZLE #
LOCATION	AMBIENT TEMPERATURE, °F		METER ΔH@	PITOT COEF	IDEAL NOZZLE DIA, in.
DATE	AVE STATIC PRESSURE, in H_2O		METER γ	PROBE LENGTH, in.	ACTUAL NOZZLE DIA, in.
OPERATOR	AVE VEL HEAD, in H_2O		SAMPLE BOX #	PROBE LINER MATERIAL	LEAK CHECK @ PITOT'S
RUN # S-242-1-OUT	ASSUMED MOISTURE, %	SCHEMATIC OF STACK CROSS SECTION (SHOW TRAVERSE PTS)	HEATER BOX SETTING	PROBE HEATER SETTING	LEAK RATE CFM@ in Hg

TRAVERSE POINT #	SAMPLING TIME	GAS METER READING	ORIFICE PRESSURE (CALC)	VELOCITY HEAD (MEAS)	STACK TEMPERATURE	GAS SAMPLE TEMPERATURE AT DRY GAS METER		IMPINGER TEMPERATURE	SAMPLE BOX TEMPERATURE	SAMPLE VACUUM	O_2	CO_2	CO	NOX
						Inlet	Outlet							
	min	(Vm) ft^3	(ΔH) in H_2O	(ΔP) in H_2O	(Ts) °F	(Tm in) °F	(Tm out) °F	°F	°F	in Hg	%	%	ppm	ppm
14	65	383.2	0.25	.01	67	75	73	57		1				
15	70	384.5	0.12	.005	67	75	73	58		1				
16	75	385.7	0.12	.005	67	76	74	58		1				
17	80	386.6	0.98	.04	67	76	74	58		2				
18	85	389.2	0.73	.03	67	74	74	48		2				
19	90	392.1	0.49	.02	67	76	74	50		1				
20	95	394.3	0.25	.01	67	77	74	52		1				
21	100	395.6	0.25	.01	66	76	74	54		1				
22	105	397.0	0.25	.01	67	77	74	53		1				
23	110	398.6	0.12	.005	67	77	74	53		1				
24	115	399.4	0.12	.005	67	77	74	55		1				
	120	400.523												
		* Final Leak check Pitot tubes (Good @ 5 in H_2O												
TOTAL		Nozzle = 1.006 CFM @ 10 in Hg												
AVERAGE														

PASS!

5-242-1-OOT

```
                RUN
METHOD 5 NOMO

ENTER DATA
THEN PUSH R/S

TEST NO=?

          5.    RUN
RUN NO.=?
      242.001   RUN
FILTER NO=?
        006.    RUN

DELTA-H@AT = ?
       1.751    RUN
METER GAMMA = ?
        .998    RUN
STACK AREA
IN. SQ. = ?
   1,076.750    RUN
STACK STATIC
P IN H2O=?
        .340    RUN
PBAR IN HG=?
       30.220   RUN
% H2O=?
       1.000    RUN
STACK GAS WET
MOL WT, MS,
LB/LB MOL=?
      29.000    RUN
AVG STACK
TEMP DEG F=?
      70.000    RUN
AVG DELTA-P
IN. H2O=?
        .032    RUN
AMBIENT
TEMP F=?
      65.000    RUN
PITOT TUBE
CSUBP=?
        .828    RUN

AVG STACK
VELOCITY FPM=
     584.174

FOR 0.75 CFM
IDEAL NOZZLE
DIA INCHES= 0.490

ACTUAL NOZZLE
DIA INCHES=?
        .396    RUN

SAMPLE CFM = 0.490

MINIMUM RUN
TIME, MIN. = 61.176
```

```
*******
POINT NO. 1.
          .07 STO 01
        68.00 STO 02
        78.00 STO 03
              RUN
DELTA H=
IN. H2O....
         1.72
*******
POINT NO. 2.
          .04 STO 01
        67.00 STO 02
        72.00 STO 03
              RUN
DELTA H=
IN. H2O....
         0.98
*******
POINT NO. 3.
          .03 STO 01
        68.00 STO 02
              RUN
DELTA H=
IN. H2O....
         0.73
*******
POINT NO. 4.
          .02 STO 01
        74.00 STO 03
              RUN
DELTA H=
IN. H2O....
         0.49
*******
POINT NO. 5.
          .01 STO 01
        69.00 STO 02
              RUN
DELTA H=
IN. H2O....
         0.24
*******
POINT NO. 6.
        68.00 STO 02
        75.00 STO 03
              RUN
DELTA H=
IN. H2O....
         0.24
*******
POINT NO. 7.
        69.00 STO 02
              RUN
DELTA H=
IN. H2O....
         0.24
*******
POINT NO. 8.
        67.00 STO 02
              RUN
DELTA H=
IN. H2O....
         0.25
```

```
        74.00 STO 03
              RUN
DELTA H=
IN. H2O....
         1.22
*******
POINT NO. 10.
          .04 STO 01
        66.00 STO 02
              RUN
DELTA H=
IN. H2O....
         0.98
*******
POINT NO. 11.
          .02 STO 01
        75.00 STO 03
              RUN
DELTA H=
IN. H2O....
         0.49
*******
POINT NO. 12.
          .01 STO 01
        67.00 STO 02
        76.00 STO 03
              RUN
DELTA H=
IN. H2O....
         0.25
*******
POINT NO. 13.
       500.00   RUN
LAST MTR VOL ?
       381.60   RUN
TIME ?
        60.00   RUN

PRESENT ISOKIN=100.07

CONTINUE RUN ...

******
POINT NO. 13.
        75.00 STO 03
              RUN
DELTA H=
IN. H2O....
         0.25
*******
POINT NO. 14.
              RUN
DELTA H=
IN. H2O....
         0.25
*******
POINT NO. 15.
          .005 STO 01
              RUN
DELTA H=
IN. H2O....
         0.12
```

```
DELTA H=
IN. H2O....
         0.12
*******
POINT NO. 17.
          .04 STO 01
              RUN
DELTA H=
IN. H2O....
         0.98
*******
POINT NO. 18.
          .03 STO 01
        74.00 STO 03
              RUN
DELTA H=
IN. H2O....
         0.73
*******
POINT NO. 19.
          .02 STO 01
        76.00 STO 03
              RUN
DELTA H=
IN. H2O....
         0.49
*******
POINT NO. 20.
          .01 STO 01
        77.00 STO 03
              RUN
DELTA H=
IN. H2O....
         0.25
*******
POINT NO. 21.
        66.00 STO 02
        76.00 STO 03
              RUN
DELTA H=
IN. H2O....
         0.25
*******
POINT NO. 22.
        67.00 STO 02
        77.00 STO 03
              RUN
DELTA H=
IN. H2O....
         0.25
*******
POINT NO. 23.
          .005 STO 01
              RUN
DELTA H=
IN. H2O....
         0.12
*******
POINT NO. 24.
              RUN
DELTA H=
IN. H2O....
         0.12
```

```
         0.00   RUN
======

ISOKIN
AVG VALUES
KV=3.006
TMETER F=75.208
DELTA-H=0.491
DELTA P=0.017
FINAL METER
VOLUME FT3=?
       480.523  RUN
INITIAL=355.759
SAMPLE TIME
MIN. =?
       120.000  RUN
PSTACK ABS
IN HG=30.245
TSTACK F=67.208

======

SOURCE TYPE?
0=OTHER
1=BOILER
         0.000  RUN
% CO2 =?
         0.000  RUN
% O2 =?
        20.900  RUN
H2O GAIN KNOWN?
1=YES 0=NO
         1.000  RUN
AWAITING
RECOVERY DATA.

HIT R/S
TO CONTINUE...

              RUN
H2O GAIN=?
        20.600  RUN
NET METER
VOL. FT3=
        44.674

CORRECTED
SAMPLE VOL.
VMSTD  SCF=
        44.549

MOLE FRACT. DRY
GAS, (1-BWS) =
         0.979

% H2O =
         2.1

STACK GAS WET
MOL. WT, MS,
LB/LB MOL=
        28.685
```

```
FPM =
       429.289

STACK DRY GAS
FLOW QS  SCFM=
     3,179.174

ACFM =
     3,209.976

**********

ISOKINETIC %I =102.1

**********
```

5-242-1-OOT

IMPINGER BOX SET UP FOR CHROMIUM EMISSION TEST
AND NOZZLE CALIBRATION SHEET

DATE: 2/23/90 LINE NO: 242

BASE: ALAMEDA RUN NO: ~~24~~ 5-242-2-OUT

BUILDING NO: 5 CIRCLE 1: INLET (OUTLET)

PREP BY: DM

[✓] 1. Wash all glassware with ~~detergent~~, ~~acetone, deionized~~ water, and rinse with 0.1N NaOH solution.
[✓] 2. Add 100ml 0.1N NaOH solution in the first two impingers (standard Greenburg-Smith impingers). Record initial weights.
[✓] 3. The third impinger (modified Greenburg-Smith) is dry. Record initial weight.
[✓] 4. The fourth impinger (modified Greenburg-Smith) contains about 1 liter of indicating type silica gel. Record initial weight.
[✓] 5. Place teflon coated filter into filter holder and install between the third and fourth impingers. Record filter number. Do not weigh.
[✓] 6. Assemble impinger bottles and glass elbows (180s) so that air flows from a smaller to larger holes (if applicable).
[✓] 7. Calibrate nozzle by measuring four IDs with a micrometer.

Impinger No.	Contents	Tare	Initial	Final	Condensate
2-1	1. 100ml 0.1N NaOH	445.26	546.61	564.33	17.72
2-2	2. 100ml 0.1N NaOH	461.59	561.69	564.34	2.65
2-3	3. Empty	448.44	—	448.56	0.16
2-4	4. 1 l silica gel	506.16	854.79	869.13	14.34
				Net Weight Gain	34.87

Filter No: 008

Silica gel condition after test: 10% SPEN

Nozzle No: 3/8" ~~Quartz~~ Calibrated by: N.P

					Average
ID Before Test:	0.390	0.405	0.393	0.395	0.396
ID After Test:	0.405	0.390	0.395	0.390	0.395

(SJS rev11/88, #0251Q)

PLANT: BLDG 5	BAROMETRIC PRESSURE, in Hg: 30.245		METER BOX #: #12	PROBE # (PITOT #): 3-1	NOZZLE #: 3/8" QUARTZ
LOCATION: ALAMEDA	AMBIENT TEMPERATURE, °F: 60		METER ΔH@: 1.751	PITOT COEF: 0.82	IDEAL NOZZLE DIA, in.: 0.576
DATE: 2-23-90	AVE STATIC PRESSURE, in H_2O: 0.34		METER γ: 0.998	PROBE LENGTH, in.: 36	ACTUAL NOZZLE DIA, in.: 0.396
OPERATOR: M.P.	AVE VEL HEAD, in H_2O: .017		SAMPLE BOX #: 2	PROBE LINER MATERIAL: GLASS	LEAK CHECK @ PITOT'S: #2 OK @ 2"H2O #4 OK @ 4"Hg
RUN #: 5-242-2 OR #2	ASSUMED MOISTURE, %: 1%	SCHEMATIC OF STACK CROSS SECTION (SHOW TRAVERSE PTS)	HEATER BOX SETTING: N/A	PROBE HEATER SETTING: N/A	LEAK RATE CFM@ in Hg: 0.008 @ 10"Hg

TRAVERSE POINT #	SAMPLING TIME min	GAS METER READING (Vm) ft^3	ORIFICE PRESSURE (CALC) (ΔH) in H_2O	VELOCITY HEAD (MEAS) (ΔP) in H_2O	STACK TEMPERATURE (Ts) °F	GAS SAMPLE TEMPERATURE AT DRY GAS METER: Inlet (Tm in) °F	GAS SAMPLE TEMPERATURE AT DRY GAS METER: Outlet (Tm out) °F	IMPINGER TEMPERATURE °F	SAMPLE BOX TEMPERATURE °F	SAMPLE VACUUM in Hg	O_2 %	CO_2 %	CO ppm	NOX ppm
5:10 PM														
1	0	400.863	1.70	.07	67	68	68	52		4				
2	7	406.393	0.98	.04	65	70	67	44		3				
3	14	410.568	0.49	.02	66	72	67	45		2				
4	21	412.501	0.25	.01	65	74	68	44		2				
5	28	414.600	0.12	.005	65	70	67	46		1				
6	35	416.289	0.12	.005	65	71	67	47		1				
7	42	417.600	0.12	.005	65	68	66	48		1				
STOP 8	49	418.821	0.12	.005	65	68	66	47		1				
GOOD START 9	56	420.500	1.70	.07	65	66	65	39		4				
10	63	425.5	1.47	.06	65	72	70	39		4				
11	70	431.702	0.98	.04	65	73	70	39		3				
12	77	434.406	0.74	.03	65	74	66	43		2				
13	84	437.792	0.24	.01	65	72	66	45		1				
TOTAL														
AVERAGE														

(SJS rev11/88, #02510)

PLANT	BAROMETRIC PRESSURE, in Hg		METER BOX #	PROBE # (PITOT #)	NOZZLE #
LOCATION	AMBIENT TEMPERATURE, °F		METER ΔH@	PITOT COEF	IDEAL NOZZLE DIA, in.
DATE	AVE STATIC PRESSURE, in H_2O		METER γ	PROBE LENGTH, in.	ACTUAL NOZZLE DIA, in.
OPERATOR	AVE VEL HEAD, in H_2O		SAMPLE BOX #	PROBE LINER MATERIAL	LEAK CHECK @ PITOT'S
RUN # 5-242-2-OUT	ASSUMED MOISTURE, %	SCHEMATIC OF STACK CROSS SECTION (SHOW TRAVERSE PTS)	HEATER BOX SETTING	PROBE HEATER SETTING	LEAK RATE CFM@ in Hg

TRAVERSE POINT #	SAMPLING TIME min	GAS METER READING (Vm) ft^3	ORIFICE PRESSURE (CALC) (ΔH) in H_2O	VELOCITY HEAD (MEAS) (ΔP) in H_2O	STACK TEMPERATURE (Ts) °F	GAS SAMPLE TEMPERATURE AT DRY GAS METER Inlet (Tm in) °F	GAS SAMPLE TEMPERATURE AT DRY GAS METER Outlet (Tm out) °F	IMPINGER TEMPERATURE °F	SAMPLE BOX TEMPERATURE °F	SAMPLE VACUUM in Hg	O_2 %	CO_2 %	CO ppm	NOX ppm
14	91	440.168	0.24	.01	65	69	66	47		2				
15	98	441.766	0.49	.02	64	68	65	48		2				
CHANGE PORT 7:13 16	105	444.808	0.49	.02	64	68	66	47		2				
7:20 START 17	112	447.572	1.22	.05	64	67	65	47		4				
18	119	452.406	1.22	.05	65	69	64	42		4				
19	126	456.309	0.98	.04	64	72	64	42		2				
20	133	460.640	0.73	.03	64	71	64	44		2				
21	140	464.021	0.73	.03	64	71	65	44		2				
22	147	466.493	0.98	.04	64	71	64	45		3				
23	154	470.400	0.74	.03	64	77	64	44		2				
24	161	473.600	0.73	.03	64	70	64	43		2				
STOP 8:16	168	477.961												
TOTAL		Final Leak Check	(pitots = GOOD @ Since 1420) Nozzle + (.007 CFM@ 10 in Hg)											
AVERAGE							PASS!							

5-242-2-OUT

```
                                RUN
METHOD 5 NOMO

ENTER DATA
THEN PUSH R/S

TEST NO=?
                    5.      RUN
RUN NO.=?
                242.002     RUN
FILTER NO=?
                  888.      RUN

DELTA-H*AT = ?
                1.751       RUN
METER GAMMA = ?
                 .998       RUN
STACK AREA
IN. SQ. = ?
            1,076.750       RUN
STACK STATIC
P IN H2O=?
                 .340       RUN
PBAR IN HG=?
               30.220       RUN
% H2O=?
                1.000       RUN
STACK GAS WET
MOL WT, MS,
LB/LB MOL=?
               29.000       RUN
AVG STACK
TEMP DEG F=?
               67.000       RUN
AVG DELTA-P
IN. H2O=?
                 .017       RUN
AMBIENT
TEMP F=?
               68.000       RUN
PITOT TUBE
CSUBP=?
                 .828       RUN

AVG STACK
VELOCITY FPM=
                          424.580
FOR 0.75 CFM
IDEAL NOZZLE
DIA INCHES= 0.576

ACTUAL NOZZLE
DIA INCHES=?
                 .396       RUN

SAMPLE CFM = 0.355

MINIMUM RUN
TIME, MIN. = 84.500

INITIAL METER
VOLUME FT3 =?
              400.863       RUN
*******
POINT NO. 1.
                 .07 STO 01
               67.00 STO 02
               68.00 STO 03
                             RUN
DELTA H=
IN. H2O....
                1.70
*******
POINT NO. 2.
                 .04 STO 01
               65.00 STO 02
               70.00 STO 03
                             RUN
DELTA H=
IN. H2O....
                0.98
*******
POINT NO. 3.
                 .02 STO 01
               66.00 STO 02
               72.00 STO 03
                             RUN
DELTA H=
IN. H2O....
                0.49
*******
POINT NO. 4.
                 .01 STO 01
               65.00 STO 02
               74.00 STO 03
                             RUN
DELTA H=
IN. H2O....
                0.25
*******
POINT NO. 5.
                .005 STO 01
               70.00 STO 03
                             RUN
DELTA H=
IN. H2O....
                0.12
*******
POINT NO. 6.
               71.00 STO 03
                             RUN
DELTA H=
IN. H2O....
                0.12
*******
POINT NO. 7.
               68.00 STO 03
                             RUN
DELTA H=
IN. H2O....
                0.12
*******
DELTA H=
IN. H2O....
                0.12
*******
POINT NO. 9.
                 .07 STO 01
               66.00 STO 03
                             RUN
DELTA H=
IN. H2O....
                1.70
*******
POINT NO. 10.
                 .06 STO 01
               72.00 STO 03
                             RUN
DELTA H=
IN. H2O....
                1.47
*******
POINT NO. 11.
                 .04 STO 01
               73.00 STO 03
                             RUN
DELTA H=
IN. H2O....
                0.98
*******
POINT NO. 12.
                 .03 STO 01
               74.00 STO 03
                             RUN
DELTA H=
IN. H2O....
                0.74
*******
POINT NO. 13.
              500.00    RUN
LAST MTR VOL ?
              434.406   RUN
TIME ?
               77.00    RUN

PRESENT ISOKIN=100.26

CONTINUE RUN ..

******
POINT NO. 13.
                 .01 STO 01
               72.00 STO 03
                             RUN
DELTA H=
IN. H2O....
                0.24
*******
POINT NO. 14.
               69.00 STO 03
                             RUN
DELTA H=
IN. H2O....
                0.24
POINT NO. 15.
                 .02 STO 01
               64.00 STO 02
               68.00 STO 03
                             RUN
DELTA H=
IN. H2O....
                0.49
*******
POINT NO. 16.
                             RUN
DELTA H=
IN. H2O....
                0.49
*******
POINT NO. 17.
                 .05 STO 01
               67.00 STO 03
                             RUN
DELTA H=
IN. H2O....
                1.22
*******
POINT NO. 18.
               65.00 STO 02
               69.00 STO 03
                             RUN
DELTA H=
IN. H2O....
                1.22
*******
POINT NO. 19.
                 .04 STO 01
               64.00 STO 02
               72.00 STO 03
                             RUN
DELTA H=
IN. H2O....
                0.98
*******
POINT NO. 20.
                 .03 STO 01
               71.00 STO 03
                             RUN
DELTA H=
IN. H2O....
                0.73
*******
POINT NO. 21.
                             RUN
DELTA H=
IN. H2O....
                0.73
*******
POINT NO. 22.
                 .04 STO 01
                             RUN
DELTA H=
IN. H2O....
                0.98
*******
POINT NO. 23.
                 .03 STO 01
               77.00 STO 03
                             RUN
DELTA H=
IN. H2O....
                0.74
*******
POINT NO. 24.
               70.00 STO 03
                             RUN
DELTA H=
IN. H2O....
                0.73
*******
POINT NO. 25.
                0.00    RUN
======

ISOKIN
AVG VALUES
KV=3.717
TMETER F=70.458
DELTA-H=0.732
DELTA P=0.826
FINAL METER
VOLUME FT3=?
              477.961   RUN
INITIAL=400.863
SAMPLE TIME
MIN. =?
              168.000   RUN
PSTACK ABS
IN HG=30.245
TSTACK F=64.750

======

SOURCE TYPE?
0=OTHER
1=BOILER
                0.000   RUN
% CO2 =?
                0.000   RUN
% O2 =?
               20.900   RUN
H2O GAIN KNOWN?
1=YES 0=NO
                1.000   RUN
AWAITING
RECOVERY DATA.

HIT R/S
TO CONTINUE...

                        RUN
H2O GAIN=?
               34.870   RUN
WET METER
VOL. FT3=
                        76.944
CORRECTED
SAMPLE VOL.
VMSTD  SCF=
                        77.414
MOLE FRACT. DRY
GAS, (1-BWS) =
                         0.979
% H2O =
                         2.1
STACK GAS WET
MOL. WT, MS,
LB/LB MOL=
                        28.611
AVG VELOCITY
FPM =
                       530.857
STACK DRY GAS
FLOW QS  SCFM=
                     3,951.961
ACFM =
                     3,969.450


**********

ISOKINETIC %I =101.9

*********
```

5-242-2-OUT

IMPINGER BOX SET UP FOR CHROMIUM EMISSION TEST
AND NOZZLE CALIBRATION SHEET

DATE: 2/23/90 LINE NO: 242

BASE: ALAMEDA RUN NO: S-242-3-OUT

BUILDING NO: 5 CIRCLE 1: INLET OUTLET

PREP BY: DM

[✓] 1. Wash all glassware with detergent, acetone, deionized water, and rinse with 0.1N NaOH solution.
[✓] 2. Add 100ml 0.1N NaOH solution in the first two impingers (standard Greenburg-Smith impingers). Record initial weights.
[✓] 3. The third impinger (modified Greenburg-Smith) is dry. Record initial weight.
[✓] 4. The fourth impinger (modified Greenburg-Smith) contains about 1 liter of indicating type silica gel. Record initial weight.
[✓] 5. Place teflon coated filter into filter holder and install between the third and fourth impingers. Record filter number. Do not weigh.
[✓] 6. Assemble impinger bottles and glass elbows (180s) so that air flows from a smaller to larger holes (if applicable).
[✓] 7. Calibrate nozzle by measuring four IDs with a micrometer.

Impinger No.	Contents	Tare	Initial	Final	Condensate
4-1	1. 100ml 0.1N NaOH	482.13	584.06	603.36	19.3
4-2	2. 100ml 0.1N NaOH	475.11	575.83	571.70	-4.13
4-3	3. Empty	460.57	—	462.52	1.95
4-4	4. 1 l silica gel	~~775~~	774.58	813.66	39.08
				Net Weight Gain	56.20

Filter No: 010

Silica gel condition after test: 95% SPENT

Nozzle No: _____ Calibrated by: DM

					Average
ID Before Test:	0.580	0.582	0.582	0.578	0.581
ID After Test:	0.480	0.482	0.481	0.478	0.480

USING CIRCLE

(SJS rev11/88, #02510)

Stack Area

PLANT: BLDG 5	BAROMETRIC PRESSURE, in Hg: 30.22		METER BOX #:	PROBE # (PITOT #): 3-1	NOZZLE #:
LOCATION: ALAMEDA	AMBIENT TEMPERATURE, °F: ~~65~~ 60		METER ΔH@: 1.751	PITOT COEF: 0.82	IDEAL NOZZLE DIA, in.:
DATE: 2/23/90	AVE STATIC PRESSURE, in H_2O: 0.34		METER γ: 0.998	PROBE LENGTH, in.: 36	ACTUAL NOZZLE DIA, in.: 0.481
OPERATOR: M.P.	AVE VEL HEAD, in H_2O: 0.026		SAMPLE BOX #: 4	PROBE LINER MATERIAL: GLASS	LEAK CHECK @ PITOT'S: Good
RUN #: S-242-3-OUT	ASSUMED MOISTURE, %: 2%	SCHEMATIC OF STACK CROSS SECTION (SHOW TRAVERSE PTS)	HEATER BOX SETTING:	PROBE HEATER SETTING:	LEAK RATE CFM@ in Hg: Good .004 cfm

TRAVERSE POINT #	SAMPLING TIME	GAS METER READING	ORIFICE PRESSURE (CALC)	VELOCITY HEAD (MEAS)	STACK TEMPERATURE	GAS SAMPLE TEMPERATURE AT DRY GAS METER		IMPINGER TEMPERATURE	SAMPLE BOX TEMPERATURE	SAMPLE VACUUM	O_2	CO_2	CO	NOX
						Inlet	Outlet							
10:10 am	min	(Vm) ft^3	(ΔH) in H_2O	(ΔP) in H_2O	(Ts) °F	(Tm in) °F	(Tm out) °F	°F	°F	in Hg	%	%	ppm	ppm
1	0	478.300	3.65 ACT 6.1	.07	66	57	57	46		14				
2	5	484.806	3.09 6.1	.06	63	62	57	40		14				
3	10	491.108	2.58 6.1	.05	63	64	57	53		14				
4	15	497.900	2.09 4.5	.04	63	69	59	53		13				
5	20	504.7	1.56 3.4	.03	63	69	59	53		6				
6	25	509.4	1.56 3.4	.03	63	69	60	53		6				
7	30	514.000	1.04 2.3	.02	63	70	60	50		6				
CHANGE PORTS 1040 8	35	518.500	1.05 2.3	.02	63	71	60	50		6				
1100 9	40	523.535	4.67 6.1	.09	63	66	61	53		15				
10	45	530.57	4.12 6.1	.08	63	62	60	44		16				
11	50	537.15	2.59 6.1	.05	63	65	60	55		16				
12	55	543.72	2.59 5.6	.05	63	66	60	60		16				
13	60	550.34	1.56 3.4	.03	63	68	61	62		14.5				
TOTAL			ACTUAL ΔH			DIFFERENCE DUE TO ERROR IN MEASURING NOZZLE DIAMETER								
AVERAGE			AVERAGE ΔH											

(SJS rev11/88, #0251Q)

PLANT	BAROMETRIC PRESSURE, in Hg		METER BOX #	PROBE # (PITOT #)	NOZZLE #
LOCATION	AMBIENT TEMPERATURE, °F		METER ΔH@	PITOT COEF	IDEAL NOZZLE DIA, in.
DATE	AVE STATIC PRESSURE, in H_2O		METER γ	PROBE LENGTH, in.	ACTUAL NOZZLE DIA, in.
OPERATOR	AVE VEL HEAD, in H_2O		SAMPLE BOX #	PROBE LINER MATERIAL	LEAK CHECK @ PITOT'S
RUN # S-242-3-OUT	ASSUMED MOISTURE, %	SCHEMATIC OF STACK CROSS SECTION (SHOW TRAVERSE PTS)	HEATER BOX SETTING	PROBE HEATER SETTING	LEAK RATE CFM@ in Hg

TRAVERSE POINT #	SAMPLING TIME min	GAS METER READING (Vm) ft^3	ORIFICE PRESSURE (CALC) (ΔH) in H_2O	VELOCITY HEAD (MEAS) (ΔP) in H_2O	STACK TEMPERATURE (Ts) °F	GAS SAMPLE TEMPERATURE AT DRY GAS METER Inlet (Tm in) °F	GAS SAMPLE TEMPERATURE AT DRY GAS METER Outlet (Tm out) °F	IMPINGER TEMPERATURE °F	SAMPLE BOX TEMPERATURE °F	SAMPLE VACUUM in Hg	O_2 %	CO_2 %	CO ppm	NOX ppm
14	65	556.85	1.57 ACTUAL 3.4	.03	63	70	61	54		14.5				
15	70	563.33	1.05 2.27	.02	63	71	61	51		5				
CHANGE PORTS 1140 16	75	567.92	2.60 5.65	.05	63	68	61	49		13				
1145 START 17	80	573.700	3.12 6.1	.06	64	68	62	49		15				
18	85	580.456	2.61 5.7	.05	63	69	61	49		14				
19	90	588.000	2.08 4.5	.04	63	67	60	51		10				
20	95	593.409	2.07 4.5	.04	63	66	61	50		10				
21	100	598.051	1.57 3.4	.03	63	70	61	49		7				
22	105	603.2	2.09 4.5	.04	63	69	60	48		9				
23	110	610.000	1.57 3.4	.03	63	70	61	48		7				
STOP 24	115	613.700	1.57 3.4	.03	64	71	61	41		7				
00252m	120	619.123												
TOTAL	* FINAL LEAK CK =		Pitot tubes = Good @ 7 in H2O → PASS! Nozzles = .003 CFM @ 20 in Hg											
AVERAGE														

5-242-3-OUT

```
                    RUN
METHOD 5 HOMO

ENTER DATA
THEN PUSH R/S

TEST NO=?
                5.      RUN
RUN NO.=?
           242.003      RUN
FILTER NO=?
              010.      RUN

DELTA-H@AT = ?
            1.751       RUN
METER GAMMA = ?
            9.000       CLX
             .998       RUN
STACK AREA
IN. SQ. = ?
        1,076.750       RUN
STACK STATIC
P IN H2O=?
             .340       RUN
PBAR IN HG=?
           30.220       RUN
% H2O=?
            2.000       RUN
STACK GAS WET
MOL WT, MS,
LB/LB MOL=?
           29.000       RUN
AVG STACK
TEMP DEG F=?
           64.000       RUN
AVG DELTA-P
IN. H2O=?
             .026       RUN
AMBIENT
TEMP F=?
           60.000       RUN
PITOT TUBE
CSUBP=?
             .820       RUN

AVG STACK
VELOCITY FPM=
                  523.578
FOR 0.75 CFM
IDEAL NOZZLE
DIA INCHES= 0.519

ACTUAL NOZZLE
DIA INCHES=?
             .481       RUN

SAMPLE CFM = 0.643

MINIMUM RUN
TIME, MIN. = 46.651
```

```
INITIAL METER
VOLUME FT3 =?
           478.300      RUN
*******
POINT NO. 1.
                .07 STO 01
              66.00 STO 02
              57.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                3.55
*******
POINT NO. 2.
                .06 STO 01
              63.00 STO 02
              62.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                3.09
*******
POINT NO. 3.
                .05 STO 01
              64.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                2.58
*******
POINT NO. 4.
                .04 STO 01
              69.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                2.09
*******
POINT NO. 5.
                .03 STO 01
                    RUN
DELTA H=
IN. H2O....
                1.56
*******
POINT NO. 6.
                    RUN
DELTA H=
IN. H2O....
                1.56
*******
POINT NO. 7.
                .02 STO 01
              70.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                1.04
*******
POINT NO. 8.
              71.00 STO 03
                    RUN
DELTA H=
IN. H2O....
```

```
POINT NO. 9.
                .09 STO 01
              66.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                4.67
*******
POINT NO. 10.
                .08 STO 01
              62.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                4.12
*******
POINT NO. 11.
                .05 STO 01
              65.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                2.59
*******
POINT NO. 12.
              66.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                2.59
*******
POINT NO. 13.
                .03 STO 01
              68.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                1.56
*******
POINT NO. 14.
              70.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                1.57
*******
POINT NO. 15.
                .02 STO 01
              71.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                1.05
*******
POINT NO. 16.
                .05 STO 01
              68.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                2.60
```

```
POINT NO. 17.
                .06 STO 01
              64.00 STO 02
                    RUN
DELTA H=
IN. H2O....
                3.12
*******
POINT NO. 18.
                .05 STO 01
              63.00 STO 02
              69.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                2.61
*******
POINT NO. 19.
                .04 STO 01
              63.00 STO 02
              67.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                2.08
*******
POINT NO. 20.
              66.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                2.07
*******
POINT NO. 21.
                .03 STO 01
              70.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                1.57
*******
POINT NO. 22.
                .04 STO 01
              69.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                2.09
*******
POINT NO. 23.
                .03 STO 01
              70.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                1.57
```

```
*******
POINT NO. 24.
              64.00 STO 02
              71.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                1.57
*******
POINT NO. 25.
                0.00    RUN
======

ISOKIN
AVG VALUES
KV=4.663
TMETER F=67.375
DELTA-H=2.247
DELTA P=0.042
FINAL METER
VOLUME FT3=?
           619.123      RUN
INITIAL=478.300
SAMPLE TIME
MIN. =?
           120.000      RUN
PSTACK ABS
IN HG=30.245
TSTACK F=63.208

======

SOURCE TYPE?
0=OTHER
1=BOILER
                0.000   RUN
% CO2 =?
                0.000   RUN
% O2 =?
               20.900   RUN
H2O GAIN KNOWN?
1=YES 0=NO
                1.000   RUN
AWAITING
RECOVERY DATA.
```

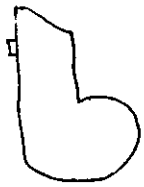
```
HIT R/S
TO CONTINUE...

                    RUN
H2O GAIN=?
             56.200     RUN
NET METER
VOL. FT3=
                  140.541
CORRECTED
SAMPLE VOL.
VMSTD  SCF=
                  142.228
MOLE FRACT. DRY
GAS, (1-BWS) =
                    0.982
% H2O =
                      1.8
STACK GAS WET
MOL. WT, MS,
LB/LB MOL=
                   28.638
AVG VELOCITY
FPM =
                  665.564
STACK DRY GAS
FLOW QS  SCFM=
                4,982.890
ACFM =
                4,976.712


**********

ISOKINETIC %I =140.9

*********
```



PRELIM

TRAVERSE DATA SHEET

(REV 8/86)

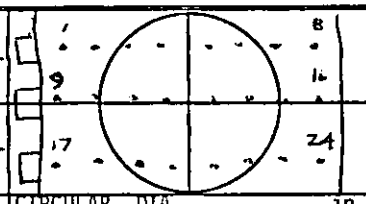
PLANT

LOCATION BLDG 5 ALAMEDA

DATE 23 FEB 90

OPERATOR DENE EGAMI

RUN # 5-241-1-OUT



CIRCULAR, DIA. in

RECTANGULAR, LxW 26.5 X 39.5 in

Length from upstream disturbance ft

Diameter from upstream disturbance ~2.5 dia

Length from downstream disturbance ~ ft

Diameters from downstream disturbance ~0.5 dia

Required number of traverse points ea

Number of traverse points used 24 ea

POINT # n	STACK PRESSURE (in H_2O) ΔPvel	Pstatic	$\sqrt{\Delta P}$	LOCATION (in) L	W	POINT # n	STACK PRESSURE (in H_2O) ΔPvel	Pstatic	$\sqrt{\Delta P}$	LOCATION (in) L	W
1	0.18	~~1.2~~				26					
2	0.16					27					
3	0.12					28					
4	0.08					29					
5	0.06					30					
6	0.05					31					
7	0.055					32					
8	0.055					33					
9	0.15					34					
10	0.12					35					
11	0.08					36					
12	0.05	1.2				37					
13	0.035					38					
14	0.035					39					
15	0.04					40					
16	0.055					41					
17	0.10					42					
18	0.085					43					
19	0.06					44					
20	0.055					45					
21	0.05					46					
22	0.05					47					
23	0.055					48					
24	0.055					49					
25						50					

$$\Delta P_{ave} = \left[\frac{\Sigma\sqrt{\Delta P}}{n}\right]^2 = 0.077$$

C-15

Hd Chrome Plate

IMPINGER BOX SET UP FOR CHROMIUM EMISSION TEST
AND NOZZLE CALIBRATION SHEET

DATE: 2/23/90 LINE NO: 241 TANKS 10 & 11

BASE: NAD ALAMEDA RUN NO: S-241-1

BUILDING NO: S CIRCLE 1: INLET (OUTLET)

PREP BY: DJL

[✓] 1. Wash all glassware with ~~detergent~~, ~~acetone~~, ~~deionized water~~, and rinse with 0.1N NaOH solution.
[✓] 2. Add 100ml 0.1N NaOH solution in the first two impingers (standard Greenburg-Smith impingers). Record initial weights.
[✓] 3. The third impinger (modified Greenburg-Smith) is dry. Record initial weight.
[✓] 4. The fourth impinger (modified Greenburg-Smith) contains about 1 liter of indicating type silica gel. Record initial weight.
[✓] 5. Place teflon coated filter into filter holder and install between the third and fourth impingers. Record filter number. Do not weigh.
[✓] 6. Assemble impinger bottles and glass elbows (180s) so that air flows from a smaller to larger holes (if applicable).
[✓] 7. Calibrate nozzle by measuring four IDs with a micrometer.

Impinger No.	Contents	Tare	Initial	Final	Condensate
3-1	1. 100ml 0.1N NaOH	476.01	575.74	587.80	12.4
3-2	2. 100ml 0.1N NaOH	473.87	574.33	575.72	1.39
3-3	3. Empty	469.72	—	470.12	0.40
3-4	4. 1 l silica gel	462.24	758.77	480.97	22.20
				Net Weight Gain	36.39

Filter No: 005

Silica gel condition after test: 50% SPENT

Nozzle No: 3/8" Quartz Calibrated by: DE/JR

					Average
ID Before Test:	0.400"	Ø.400	Ø.397	Ø.400	Ø.399
ID After Test:	Ø.400	Ø.400	Ø.404	Ø.396	Ø.400

(SJS rev11/88, #02510)

PLANT: Bldg 5	BAROMETRIC PRESSURE, in Hg: 30.22		METER BOX #: #14 (1.13 min)	PROBE # (PITOT #): 3-6	NOZZLE #: 3/8" QUARTZ
LOCATION: Alameda	AMBIENT TEMPERATURE, °F: 55		METER ΔH@: 1.456	PITOT COEF: 0.82	IDEAL NOZZLE DIA, in.: 0.40
DATE: 23 Feb	AVE STATIC PRESSURE, in H_2O: 1.2		METER γ: 0.999	PROBE LENGTH, in.: 3 FEET	ACTUAL NOZZLE DIA, in.: 0.399
OPERATOR: JC	AVE VEL HEAD, in H_2O: 0.072		SAMPLE BOX #: 3	PROBE LINER MATERIAL: GLASS	LEAK CHECK @ PITOT'S: ok @ 7"
RUN #: S-241-1-OUT	ASSUMED MOISTURE, %: 1	SCHEMATIC OF STACK CROSS SECTION (SHOW TRAVERSE PTS)	HEATER BOX SETTING: →	PROBE HEATER SETTING: N/A	LEAK RATE CFM@ in Hg: Pass 0.01 @ 16"

TRAVERSE POINT #	SAMPLING TIME (2nd) min	GAS METER READING (Vm) ft^3	ORIFICE PRESSURE (CALC) (ΔH) in H_2O	VELOCITY HEAD (A) (MEAS) (ΔP) in H_2O	STACK TEMPERATURE (B) (Ts) °F	GAS SAMPLE TEMPERATURE AT DRY GAS METER (C) Inlet (Tm in) °F	Outlet (Tm out) °F	IMPINGER TEMPERATURE °F	SAMPLE BOX TEMPERATURE °F	SAMPLE VACUUM in Hg	O_2 %	CO_2 %	CO ppm	NOX ppm
START TIME 11:30														
1	0	700.406	3.9	0.19	64	58	58	58		11"				
2	5	706.4	3.49	0.17	69	63	63	61		10"				
3	10	712.03	2.27	0.11	69	67	63	60		5.5"				
4	15	716.6	1.35	0.065	68	68	64	56		3"				
5	20	719.85	1.04	0.05	68	68	64	54		3"				
6	25	722.8	0.83	0.04	68	68	64	53		2.5"				
7	30	725.53	0.83	0.04	68	68	65	52		2.5"				
STOP 12:10 8	35	728.21	0.83	0.04	68	69	65	52		2.5"				
RESTART 12:20 9	40	730.9	2.91	0.14	68	~~70~~ 68	~~66~~ 66	~~61~~ 61		7.5"				
10	45	735.9	2.08	0.1	68	70	66	48		7.5"				
11	50	741.0	1.25	0.06	~~69~~	73	67	52		7"				
12	55	—	0.84	0.04	69	76	68	53		7"				
TOTAL														
AVERAGE														

(SJS rev11/88, #0251Q)

.012 @ 13"

PLANT	BAROMETRIC PRESSURE, in Hg		METER BOX #	PROBE # (PITOT #)	NOZZLE #
LOCATION	AMBIENT TEMPERATURE, °F		METER ΔH@	PITOT COEF	IDEAL NOZZLE DIA, in.
DATE	AVE STATIC PRESSURE, in H_2O		METER γ	PROBE LENGTH, in.	ACTUAL NOZZLE DIA, in.
OPERATOR	AVE VEL HEAD, in H_2O		SAMPLE BOX #	PROBE LINER MATERIAL	LEAK CHECK @ PITOT'S
RUN # S-241-1-OUT	ASSUMED MOISTURE, %	SCHEMATIC OF STACK CROSS SECTION (SHOW TRAVERSE PTS)	HEATER BOX SETTING	PROBE HEATER SETTING	LEAK RATE CFM@ in Hg

TRAVERSE POINT #	SAMPLING TIME min	GAS METER READING (Vm) ft^3	ORIFICE PRESSURE (CALC) (ΔH) in H_2O	VELOCITY HEAD (A) (MEAS) (ΔP) in H_2O	STACK TEMPERATURE (B) (Ts) °F	GAS SAMPLE TEMPERATURE AT DRY GAS METER (C) Inlet (Tm in) °F	Outlet (Tm out) °F	IMPINGER TEMPERATURE °F	SAMPLE BOX TEMPERATURE °F	SAMPLE VACUUM in Hg	O_2 %	CO_2 %	CO ppm	NOX ppm
13	60	750.32	0.63	0.03	69	76	69	55		2"				
14	65	752.8	0.63	0.03	69	75	69	53		2"				
15	70	755.14	0.84	0.04	68	72	69	51		2.5"				
STOP 1:00	75	757.82	1.15	0.055	69	72	69	49		3"				
RESTART 1:07														
17	80	760.8	0.97	0.095	69	68	69	65		5"				
18	85	764.9	1.87	0.09	69	69	68	49		5"				
19	90	768.9	1.25	0.06	69	71	68	50		3.5"				
20	95	772.2	1.04	0.05	70	72	69	53		3"				
21	100	775.2	1.05	0.05	69	73	69	53		3"				
22	105	778.22	1.15	0.055	69	73	69	53		3"				
23	110	781.28	1.25	0.06	69	73	70	53		3.5"				
24	115	784.52	1.05	0.05	69	74	71	53		3"				
STOP 1:47	120	787.645												
TOTAL (8pm)														
AVERAGE														

POST TEST LEAK
#2 OK @ 7.5" H_2O
#4 OK @ 9.0" H_2O
PROBE 0.012 @ 13" Hg

```
                    RUN
METHOD 5 MOMO

ENTER DATA
THEN PUSH R/S

TEST NO=?
           5.       RUN
RUN NO.=?
      241.001       RUN
FILTER NO=?
        005.        RUN

DELTA-H*AT = ?
       1.456        RUN
METER GAMMA = ?
       9.000        CLX
        .999        RUN
STACK AREA
IN. SQ. = ?
   1,076.750        RUN
STACK STATIC
P IN H2O=?
       1.200        RUN
PBAR IN HG=?
      30.220        RUN
% H2O=?
       1.000        RUN
STACK GAS WET
MOL WT, MS,
LB/LB MOL=?
      29.000        RUN
AVG STACK
TEMP DEG F=?
      70.000        RUN
AVG DELTA-P
IN. H2O=?
        .072        RUN
AMBIENT
TEMP F=?
      65.000        RUN
PITOT TUBE
CSUBP=?
        .820        RUN

AVG STACK
VELOCITY FPM=
     875.347
FOR 0.75 CFM
IDEAL NOZZLE
DIA INCHES= 0.400

ACTUAL NOZZLE
DIA INCHES=?
        .399        RUN

SAMPLE CFM = 0.748

MINIMUM RUN
TIME, MIN. = 40.131

*******
INITIAL METER
VOLUME FT3 =?
     700.486        RUN
*******
POINT NO. 1.
            .19 STO 01
          64.00 STO 02
          58.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                   3.90
*******
POINT NO. 2.
            .17 STO 01
          69.00 STO 02
          63.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                   3.49
*******
POINT NO. 3.
            .11 STO 01
          67.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                   2.27
*******
POINT NO. 4.
           .065 STO 01
          68.00 STO 02
          68.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                   1.35
*******
POINT NO. 5.
           .05 STO 01
                    RUN
DELTA H=
IN. H2O....
                   1.04
*******
POINT NO. 6.
           .04 STO 01
                    RUN
DELTA H=
IN. H2O....
                   0.83
*******
POINT NO. 7.
                    RUN
DELTA H=
IN. H2O....
                   0.83
*******
                    RUN
DELTA H=
IN. H2O....
                   0.83
*******
POINT NO. 9.
            .14 STO 01
          68.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                   2.91
*******
POINT NO. 10.
            .10 STO 01
          70.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                   2.08
*******
POINT NO. 11.
            .06 STO 01
          69.00 STO 02
          73.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                   1.25
*******
POINT NO. 12.
            .04 STO 01
          76.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                   0.84
*******
POINT NO. 13.
            .03 STO 01
                    RUN
DELTA H=
IN. H2O....
                   0.63
*******
POINT NO. 14.
          75.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                   0.63
*******
POINT NO. 15.
            .04 STO 01
          68.00 STO 02
          72.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                   0.84
POINT NO. 16.
           .055 STO 01
          69.00 STO 02
                    RUN
DELTA H=
IN. H2O....
                   1.15
*******
POINT NO. 17.
          500.00    RUN
LAST MTR VOL ?
          757.82    RUN
TIME ?
           75.00    RUN

PRESENT ISOKIN=104.48

CONTINUE RUN ..

******
POINT NO. 17.
                    RUN
DELTA H=
IN. H2O....
                   1.15
*******
POINT NO. 18.
          -.055 STO 01
         -69.00 STO 02
         -72.00 STO 03
                    RUN
CORRECTING
DELTA H=
IN. H2O....
                  -1.15
*******
POINT NO. 17.
           .095 STO 01
          69.00 STO 02
          68.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                   1.97
*******
POINT NO. 18.
            .09 STO 01
          69.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                   1.87
*******
POINT NO. 19.
            .06 STO 01
          71.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                   1.25
           .05 STO 01
          70.00 STO 02
          72.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                   1.04
*******
POINT NO. 21.
          69.00 STO 02
          73.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                   1.05
*******
POINT NO. 22.
           .055 STO 01
                    RUN
DELTA H=
IN. H2O....
                   1.15
*******
POINT NO. 23.
            .06 STO 01
                    RUN
DELTA H=
IN. H2O....
                   1.25
*******
POINT NO. 24.
            .05 STO 01
          74.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                   1.05
*******
POINT NO. 25.
           0.00     RUN
======

ISOKIN
AVG VALUES
KV=5.917
TMETER F=70.167
DELTA-H=1.479
DELTA P=0.066
FINAL METER
VOLUME FT3=?
        787.645     RUN
INITIAL=700.486
SAMPLE TIME
MIN. =?
         120.000    RUN
PSTACK ABS
IN HG=30.308
TSTACK F=68.500

======

0=OTHER
1=BOILER
           0.000    RUN
% CO2 =?
           0.000    RUN
% O2 =?
          20.900    RUN
H2O GAIN KNOWN?
1=YES 0=NO
           1.000    RUN
AWAITING
RECOVERY DATA.

HIT R/S
TO CONTINUE...

                    RUN
H2O GAIN=?
          36.390    RUN
NET METER
VOL. FT3=
                  87.152
CORRECTED
SAMPLE VOL.
V'STD  SCF=
                  87.917
MOLE FRACT. DRY
GAS, (1-BWS) =
                   0.981
% H2O =
                     1.9
STACK GAS WET
MOL. WT, MS,
LB/LB MOL=
                  28.629
AVG VELOCITY
FPM =
                 843.893
STACK DRY GAS
FLOW QS  SCFM=
               6,261.361
ACFM =
               6,318.152


**********

ISOKINETIC %I =100.7

*********
```

5-241-1-OUT

Hd CHROME PLATE

IMPINGER BOX SET UP FOR CHROMIUM EMISSION TEST
AND NOZZLE CALIBRATION SHEET

DATE: 2/23/90

LINE NO: 241 TANKS 10 & 11

BASE: ALAMEDA

RUN NO: S-241-2-OUT

BUILDING NO: 5

CIRCLE 1: INLET (OUTLET)

PREP BY: DM

[✓] 1. Wash all glassware with ~~detergent~~, ~~acetone~~, ~~deionized water~~, and rinse with 0.1N NaOH solution.
[✓] 2. Add 100ml 0.1N NaOH solution in the first two impingers (standard Greenburg-Smith impingers). Record initial weights.
[✓] 3. The third impinger (modified Greenburg-Smith) is dry. Record initial weight.
[✓] 4. The fourth impinger (modified Greenburg-Smith) contains about 1 liter of indicating type silica gel. Record initial weight.
[✓] 5. Place teflon coated filter into filter holder and install between the third and fourth impingers. Record filter number. Do not weigh.
[✓] 6. Assemble impinger bottles and glass elbows (180s) so that air flows from a smaller to larger holes (if applicable).
[✓] 7. Calibrate nozzle by measuring four IDs with a micrometer.

Impinger No.	Contents	Tare	Initial	Final	Condensate
1-1	1. 100ml 0.1N NaOH	512.05	613.29	629.21	15.92
1-2	2. 100ml 0.1N NaOH	515.52	617.00	619.76	2.76
1-3	3. Empty	503.49	—	504.12	0.63
1-4	4. 1 l silica gel	506.58	878.10	900.23	22.13
				Net Weight Gain	41.44

Filter No: 007

Silica gel condition after test: 30% SPENT

Nozzle No: 3/8" QUARTZ Calibrated by: Reichle

					Average
ID Before Test:	0.400	0.400	0.404	0.396	0.400
ID After Test:	0.400	0.402	0.404	0.396	0.401

(SJS rev11/88, #0251Q)

PLANT: BLDG 5	BAROMETRIC PRESSURE, in Hg: 30.22		METER BOX #: 14	PROBE # (PITOT #): 3-6	NOZZLE #: 3/8" QUARTZ
LOCATION: ALAMEDA	AMBIENT TEMPERATURE, °F		METER ΔH@: 1.49	PITOT COEF: 0.82	IDEAL NOZZLE DIA, in.: 0.107
DATE: 23 Feb 90	AVE STATIC PRESSURE, in H_2O: 1.2		METER γ: 1.000	PROBE LENGTH, in.: 3 foot	ACTUAL NOZZLE DIA, in.: 0.400
OPERATOR: REICHLE	AVE VEL HEAD, in H_2O: ~~0.06~~ 0.066		SAMPLE BOX #: 1814	PROBE LINER MATERIAL: Glass	LEAK CHECK @ PITOT'S: PRE OK @ 6" water
RUN #: 5-241-2-OUT	ASSUMED MOISTURE, %: 1	SCHEMATIC OF STACK CROSS SECTION (SHOW TRAVERSE PTS)	HEATER BOX SETTING: —	PROBE HEATER SETTING: —	LEAK RATE CFM@ in Hg: PRE TEST OK @ 0.011 @ 12" Hg

TRAVERSE POINT #	SAMPLING TIME	GAS METER READING	ORIFICE PRESSURE (CALC)	VELOCITY HEAD (A') (MEAS)	STACK TEMPERATURE (R)	GAS SAMPLE TEMPERATURE AT DRY GAS METER (C) Inlet	(C) Outlet	IMPINGER TEMPERATURE	SAMPLE BOX TEMPERATURE	SAMPLE VACUUM	O_2	CO_2	CO	NOX
	min	(Vm) ft^3	(ΔH) in H_2O	(ΔP) in H_2O	(Ts) °F	(Tm in) °F	(Tm out) °F	°F	°F	in Hg	%	%	ppm	ppm
START 2:58 PM 1	0	787.92	4.32	0.20	~~74~~ 69	71	71	58		11				
2	5	794.0	3.69	0.17	68	73	72	58		10				
3	10	799.81	2.40	~~0.16~~	68	75	72	58		5.5				
4	15	804.52	1.97	0.09	69	78	73	58		5.5				
5	20	808.58	1.31	0.06	~~67~~ 68	~~73~~ 77	73	~~58~~ 57		4.5				
6	25	811.82	1.20	.055	68	76	73	~~56~~ 54		4.0				
7	30	814.95	1.09	.050	68	76	74	51		4.0				
CHANGE PORT 8	35	818.02	1.09	.050	68~~76~~ 70	76	73	50		4.0				
3:38 3:59 9	40	821.11	4.34	0.20	68	73	73	53		11.5				
10	45	827.34	3.26	0.15	69	74	73	46		10				
11	50	833.14	2.19	0.10	68	77	73	52		7.5				
12	55	837.05	1.53	0.07	68	78	74	53		6				
	60													
TOTAL														
AVERAGE														

(SJS rev11/88, #02510)

PLANT Bldg 5	BAROMETRIC PRESSURE, in Hg 30.22		METER BOX # 14	PROBE # (PITOT #)	NOZZLE #
LOCATION Alameda	AMBIENT TEMPERATURE, °F		METER ΔH@ 1.494	PITOT COEF 0.82	IDEAL NOZZLE DIA, in.
DATE 23 Feb 90	AVE STATIC PRESSURE, in H_2O 1.2		METER γ 1.000	PROBE LENGTH, in. 3 foot	ACTUAL NOZZLE DIA, in.
OPERATOR Reichle	AVE VEL HEAD, in H_2O 0.066		SAMPLE BOX # 14	PROBE LINER MATERIAL Glass	LEAK CHECK @ PITOT'S Post OK @ 8.2"
RUN # S-241-2-OUT	ASSUMED MOISTURE, % 1	SCHEMATIC OF STACK CROSS SECTION (SHOW TRAVERSE PTS)	HEATER BOX SETTING —	PROBE HEATER SETTING —	LEAK RATE CFM@ in Hg .014 @ 12" Hg OK POST.

TRAVERSE POINT #	SAMPLING TIME min	GAS METER READING (Vm) ft^3	ORIFICE PRESSURE (CALC) (ΔH) in H_2O	VELOCITY HEAD (A) (MEAS) (ΔP) in H_2O	STACK TEMPERATURE (B) (Ts) °F	GAS SAMPLE TEMPERATURE AT DRY GAS METER (C) Inlet (Tm in) °F	Outlet (Tm out) °F	IMPINGER TEMPERATURE °F	SAMPLE BOX TEMPERATURE °F	SAMPLE VACUUM in Hg	O_2 %	CO_2 %	CO ppm	NOX ppm
13	60	842.13	1.09	~~0.50~~ 0.05	68	77	74	49		4.5				
14	65	845.32	0.87	.04	69	76	73	50		3.5				
~~13~~ 15	70	848.16	1.09	.05	68	76	74	50		4.0				
CHANGE 16 4:29	75	851.37	1.53	.07	68	75	73	48		4.0				
PORTS 17 4:30	80	854.34	3.03	0.14	68	72	72	50		8.0				
18	85	859.62	2.58	0.12	69	73	72	44		8.0				
19	90	864.61	1.74	.08	68	75	72	47		5.0				
20	95	868.61	1.53	.07	68	76	72	49		5.0				
21	100	872.58	1.53	.07	68	76	72	49		5.0				
22	105	876.23	1.74	.08	68	75	71	49		5.0				
23	110	880.15	1.74	.08	70	75	71	48		5.0				
24	115	884.26	1.53	.07	68	76	71	48		5.0				
STOP 5:10	120	887.90												
TOTAL														
AVERAGE														

5-241-2-OUT

```
                    CTO.001
                        RUN
METHOD 5 HOMO

ENTER DATA
THEN PUSH R/S

TEST NO=?
                5.      RUN
RUN NO.=?
            241.002     RUN
FILTER NO=?
              007.      RUN

DELTA-H@AT = ?
            1.494       RUN
METER GAMMA = ?
            1.000       RUN
STACK AREA
IN. SQ. = ?
        1,076.750       RUN
STACK STATIC
P IN H2O=?
            1.200       RUN
PBAR IN HG=?
           30.220       RUN
% H2O=?
            1.000       RUN
STACK GAS WET
MOL WT, MS,
LB/LB MOL=?
           29.000       RUN
AVG STACK
TEMP DEG F=?
           69.000       RUN
AVG DELTA-P
IN. H2O=?
             .066       RUN
AMBIENT
TEMP F=?
           69.000       RUN
PITOT TUBE
CSUBP=?
             .820       RUN

AVG STACK
VELOCITY FPM=
                    837.289
FOR 0.75 CFM
IDEAL NOZZLE
DIA INCHES= 0.487

ACTUAL NOZZLE
DIA INCHES=?
             .460       RUN

SAMPLE CFM = 0.725

MINIMUM RUN
TIME, MIN. = 41.352

VOLUME FT3.=?
           787.920      RUN
*******
POINT NO. 1.
                .20 STO 01
              69.00 STO 02
              71.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                4.32
*******
POINT NO. 2.
                .17 STO 01
              68.00 STO 02
              73.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                3.69
*******
POINT NO. 3.
                .11 STO 01
              75.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                2.48
*******
POINT NO. 4.
                .09 STO 01
              69.00 STO 02
              78.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                1.97
*******
POINT NO. 5.
                .06 STO 01
              68.00 STO 02
              77.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                1.31
*******
POINT NO. 6.
               .055 STO 01
              76.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                1.20
*******
POINT NO. 7.
                .05 STO 01
                    RUN
DELTA H=
IN. H2O....
                1.09
*******
IN. H2O....
                1.09
*******
POINT NO. 9.
                .20 STO 01
              73.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                4.34
*******
POINT NO. 10.
                .15 STO 01
              69.00 STO 02
              74.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                3.26
*******
POINT NO. 11.
                .10 STO 01
              68.00 STO 02
              77.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                2.19
*******
POINT NO. 12.
                .07 STO 01
              78.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                1.53
*******
POINT NO. 13.
                .05 STO 01
              77.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                1.09
*******
POINT NO. 14.
                .04 STO 01
              69.00 STO 02
              76.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                0.87
*******
POINT NO. 15.
             500.00     RUN
LAST MTR VOL ?
             845.32     RUN
TIME ?
              65.00     RUN

PRESENT ISOKIN=101.03

*******
POINT NO. 15.
                .05 STO 01
              68.00 STO 02
                    RUN
DELTA H=
IN. H2O....
                1.09
*******
POINT NO. 16.
                .07 STO 01
              75.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                1.53
*******
POINT NO. 17.
                .14 STO 01
              72.00 STO 03
               3.00   CLX
              68.00 STO 02
                    RUN
DELTA H=
IN. H2O....
                3.03
*******
POINT NO. 18.
                .12 STO 01
              69.00 STO 02
              73.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                2.60
*******
POINT NO. 19.
                .08 STO 01
              68.00 STO 02
              75.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                1.74
*******
POINT NO. 20.
                .07 STO 01
              76.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                1.53
*******
POINT NO. 21.
                    RUN
DELTA H=
IN. H2O....
                1.53
*******
              75.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                1.74
*******
POINT NO. 23.
              78.00 STO 02
                    RUN
DELTA H=
IN. H2O....
                1.74
*******
POINT NO. 24.
                .07 STO 01
              68.00 STO 02
              76.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                1.53
*******
POINT NO. 25.
                0.00    RUN
======

ISOKIN
AVG VALUES
KV=6.887
TMETER F=75.250
DELTA-H=2.018
DELTA P=0.000
FINAL METER
VOLUME FT3=?
           887.980      RUN
INITIAL=787.920
SAMPLE TIME
MIN. =?
           120.000      RUN
PSTACK ABS
IN HG=30.308
TSTACK F=68.292

======

SOURCE TYPE?
0=OTHER
1=BOILER
                0.000   RUN
% CO2 =?
                0.000   RUN
% O2 =?
               20.900   RUN
H2O GAIN KNOWN?
1=YES 0=NO
                1.000   RUN
RECOVERY DATA.

HIT R/S
TO CONTINUE...

                    RUN
H2O GAIN=?
               41.440   RUN
NET METER
VOL. FT3=
                   99.980
CORRECTED
SAMPLE VOL.
VMSTD  SCF=
                   99.980
MOLE FRACT. DRY
GAS, (1-BWS) =
                    0.981
% H2O =
                      1.9
STACK GAS WET
MOL. WT, MS,
LB/LB MOL=
                   28.628
AVG VELOCITY
FPM =
                  970.840
STACK DRY GAS
FLOW QS  SCFM=
                7,285.800
ACFM =
                7,259.390

**********

ISOKINETIC %I =99.0

**********
```

5-241-2-OUT

IMPINGER BOX SET UP FOR CHROMIUM EMISSION TEST
AND NOZZLE CALIBRATION SHEET

DATE: 2/23/90 LINE NO: 241

BASE: ALAMEDA RUN NO: S-241-3-OUT

BUILDING NO: 5 CIRCLE 1: INLET (OUTLET)

PREP BY: DJL

[✓] 1. Wash all glassware with ~~detergent~~, ~~acetone~~, ~~deionized water~~, and rinse with 0.1N NaOH solution.
[✓] 2. Add 100ml 0.1N NaOH solution in the first two impingers (standard Greenburg-Smith impingers). Record initial weights.
[✓] 3. The third impinger (modified Greenburg-Smith) is dry. Record initial weight.
[✓] 4. The fourth impinger (modified Greenburg-Smith) contains about 1 liter of indicating type silica gel. Record initial weight.
[✓] 5. Place teflon coated filter into filter holder and install between the third and fourth impingers. Record filter number. Do not weigh.
[✓] 6. Assemble impinger bottles and glass elbows (180s) so that air flows from a smaller to larger holes (if applicable).
[✓] 7. Calibrate nozzle by measuring four IDs with a micrometer.

Impinger No.	Contents	Tare	Initial	Final	Condensate
3-1	1. 100ml 0.1N NaOH	478.65	578.30	593.20	14.9
3-2	2. 100ml 0.1N NaOH	476.44	580.82	582.1	1.28
3-3	3. Empty	472.13	——	472.51	0.38
3-4	4. 1 l silica gel	462.31	681.16	706.17	25.01
				Net Weight Gain	41.57

Filter No: 009

Silica gel condition after test: 60-70% spent

Nozzle No: 3/8" QUARTZ Calibrated by: Rocha

					Average
ID Before Test:	0.400	0.402	0.404	0.396	0.401
ID After Test:	0.400	0.395	0.395	0.402	0.398

(SJS rev11/88, #02510)

PLANT: Bldg 5	BAROMETRIC PRESSURE, in Hg: 30.22		METER BOX #: 14	PROBE # (PITOT #): 3-6	NOZZLE #: 3/8" QUARTZ
LOCATION: Alameda	AMBIENT TEMPERATURE, °F: 60		METER ΔH@: 1.494	PITOT COEF: Ø.82	IDEAL NOZZLE DIA, in.: Ø.381
DATE: 23 Feb 90	AVE STATIC PRESSURE, in H_2O: 1.2		METER γ: 1.000	PROBE LENGTH, in.: 3 foot	ACTUAL NOZZLE DIA, in.: Ø.401
OPERATOR: Reichk	AVE VEL HEAD, in H_2O: Ø.ØØ88		SAMPLE BOX #: 14	PROBE LINER MATERIAL: Glass PRE:	LEAK CHECK @ PITOT'S: OK @ 6" w.c.
RUN #: S-241-3-OUT	ASSUMED MOISTURE, %: 1	SCHEMATIC OF STACK CROSS SECTION (SHOW TRAVERSE PTS)	HEATER BOX SETTING: —	PROBE HEATER SETTING: — PRE:	LEAK RATE CFM@ in Hg: OK 0.01 @ 12"

TRAVERSE POINT #	SAMPLING TIME	GAS METER READING	ORIFICE PRESSURE (CALC)	VELOCITY HEAD (MEAS) (A)	STACK TEMPERATURE (B)	GAS SAMPLE TEMPERATURE AT DRY GAS METER (C)		IMPINGER TEMPERATURE	SAMPLE BOX TEMPERATURE	SAMPLE VACUUM	O_2	CO_2	CO	NOX
						Inlet	Outlet							
START 6:15 p.m.	min	(Vm) ft^3	(ΔH) in H_2O	(ΔP) in H_2O	(Ts) °F	(Tm in) °F	(Tm out) °F	°F	°F	in Hg	%	%	ppm	ppm
1	Ø	888.125	4.53	Ø.21	66	62	62	61	—	13				
2	5	894.28	4.10	Ø.19	66	63	62	49		11				
3	10	900.28	3.25	Ø.15	68	67	63	56		9				
4	15	905.63	2.19	Ø.10	66	70	63	56		5				
5	20	910.0	1.53	.Ø7	66	~~68~~ 70	64	54		3				
6	25	913.39	1.31	.Ø6	68	69	64	52		3				
7	30	—	1.31	.Ø6	66	68	64	51		3				
PORT CHANGE 8	35	919.9	1.31	.Ø6	67	68	64	52		3				
9	40	923.45	4.12	Ø.19	65	64	63	49		11.5				
10	45	929.41	3.45	Ø.16	69	65	63	50		10				
11	50	935.19	2.62	Ø.12	65	68	63	56		9				
12	55	940.40	1.53	Ø.Ø7	67	69	63	56		4				
	60													
TOTAL														
AVERAGE														

(SJS rev11/88, #02510)

u0-395 395 u02 398

PLANT	BAROMETRIC PRESSURE, in Hg		METER BOX #	PROBE # (PITOT #)	NOZZLE #
LOCATION	AMBIENT TEMPERATURE, °F		METER ΔH@	PITOT COEF	IDEAL NOZZLE DIA, in.
DATE	AVE STATIC PRESSURE, in H_2O		METER γ	PROBE LENGTH, in.	ACTUAL NOZZLE DIA, in.
OPERATOR	AVE VEL HEAD, in H_2O		SAMPLE BOX #	PROBE LINER MATERIAL	LEAK CHECK @ PITOT'S GOOD @ 5" H_2O #3 #4
RUN # S-241-3-OUT	ASSUMED MOISTURE, %	SCHEMATIC OF STACK CROSS SECTION (SHOW TRAVERSE PTS)	HEATER BOX SETTING	PROBE HEATER SETTING	LEAK RATE CFM@ in Hg POST PK: 0.0075 @ 12"

TRAVERSE POINT #	SAMPLING TIME min	GAS METER READING (Vm) ft^3	ORIFICE PRESSURE (CALC) (ΔH) in H_2O	VELOCITY HEAD (A) (MEAS) (ΔP) in H_2O	STACK TEMPERATURE (B) (Ts) °F	GAS SAMPLE TEMPERATURE AT DRY GAS METER (C) Inlet (Tm in) °F	GAS SAMPLE TEMPERATURE AT DRY GAS METER Outlet (Tm out) °F	IMPINGER TEMPERATURE °F	SAMPLE BOX TEMPERATURE °F	SAMPLE VACUUM in Hg	O_2 %	CO_2 %	CO ppm	NOX ppm
13	60	944.28	1.31	Ø.Ø6	65	68	63	54		4				
14	65	947.7Ø	1.Ø9	Ø.Ø5	65	68	63	53		3				
15	70	950.89	1.31	Ø.Ø6	65	67	63	54		4				
PORT 96 7:45	75	954.27	1.53	Ø.Ø7	65	68	63	54		4				
CHANGE 7 7:50	80	—	3.Ø2	Ø.14	66	63	63	~~53~~ 52		8				
18	85	963.25	2.61	Ø.12	65	65	62	50		7				
19	90	968.2Ø	1.96	Ø.Ø9	66	67	62	51		5				
20	95	972.44	1.53	Ø.Ø7	65	69	63	54		5				
21	100	976.18	1.25	Ø.Ø8	67	70	63	53		4				
22	105	979.59	1.97	Ø.Ø9	65	70	64	52		5				
23	110	983.79	1.98	Ø.Ø9	65	71	64	53		5				
24	115	988.Ø5	1.76	Ø.ØØ	65	72	65	53		5				
8:30	120	992.135												
TOTAL														
AVERAGE														

5-241-3-OUT

```
                                RUN
METHOD 5 NOMO

ENTER DATA
THEN PUSH R/S

TEST NO=?
                          5.    RUN
RUN NO.=?
                       241.003  RUN
FILTER NO=?
                       009.     RUN

DELTA-H*AT = ?
                       1.494    RUN
METER GAMMA = ?
                       1.000    RUN
STACK AREA
IN. SQ. = ?
                    1,076.750   RUN
STACK STATIC
P IN H2O=?
                       1.200    RUN
PBAR IN HG=?
                      30.220    RUN
% H2O=?
                       1.000    RUN
STACK GAS WET
MOL WT, MS,
LB/LB MOL=?
                      29.000    RUN
AVG STACK
TEMP DEG F=?
                      68.000    RUN
AVG DELTA-P
IN. H2O=?
                        .088    RUN
AMBIENT
TEMP F=?
                      60.000    RUN
PITOT TUBE
CSUBP=?
                        .828    RUN

AVG STACK
VELOCITY FPM=
                      965.984
FOR 0.75 CFM
IDEAL NOZZLE
DIA INCHES= 0.382

ACTUAL NOZZLE
DIA INCHES=?
                        .401    RUN

SAMPLE CFM = 0.828

MINIMUM RUN
TIME, MIN. = 36.216
```

```
VOLUME FT3 =?
                     888.125    RUN
*******
POINT NO. 1.
                        .21 STO 01
                      66.00 STO 02
                      62.00 STO 03
                                RUN

DELTA H=
IN. H2O....
                                4.53
*******
POINT NO. 2.
                        .19 STO 01
                      63.00 STO 03
                                RUN

DELTA H=
IN. H2O....
                                4.10
*******
POINT NO. 3.
                        .15 STO 01
                      68.00 STO 02
                      67.00 STO 03
                                RUN

DELTA H=
IN. H2O....
                                3.25
*******
POINT NO. 4.
                        .10 STO 01
                      66.00 STO 02
                      70.00 STO 03
                                RUN

DELTA H=
IN. H2O....
                                2.19
*******
POINT NO. 5.
                        0.07 STO 01
                                RUN

DELTA H=
IN. H2O....
                                1.53
*******
POINT NO. 6.
                        .06 STO 01
                      68.00 STO 02
                      69.00 STO 03
                                RUN

DELTA H=
IN. H2O....
                                1.31
*******
POINT NO. 7.
                      66.00 STO 02
                      68.00 STO 03
                                RUN

DELTA H=
IN. H2O....
                                1.31
*******
```

```
                                RUN

DELTA H=
IN. H2O....
                                1.31
*******
POINT NO. 9.
                        .19 STO 01
                      65.00 STO 02
                      64.00 STO 03
                                RUN

DELTA H=
IN. H2O....
                                4.12
*******
POINT NO. 10.
                        .16 STO 01
                      69.00 STO 02
                      65.00 STO 03
                                RUN

DELTA H=
IN. H2O....
                                3.45
*******
POINT NO. 11.
                        .12 STO 01
                      65.00 STO 02
                      68.00 STO 03
                                RUN

DELTA H=
IN. H2O....
                                2.62
*******
POINT NO. 12.
                        .07 STO 01
                      67.00 STO 02
                      69.00 STO 03
                                RUN

DELTA H=
IN. H2O....
                                1.53
*******
POINT NO. 13.
                     588.00     RUN
LAST MTR VOL ?
                     944.28     RUN
TIME ?
                      60.00     RUN

PRESENT ISOKIN=98.32

CONTINUE RUN ..

******
POINT NO. 13.
                        .06 STO 01
                      65.00 STO 02
                      68.00 STO 03
                                RUN

DELTA H=
IN. H2O....
                                1.31
```

```
POINT NO. 14.
                        .05 STO 01
                                RUN

DELTA H=
IN. H2O....
                                1.09
*******
POINT NO. 15.
                        .06 STO 01
                      67.00 STO 03
                                RUN

DELTA H=
IN. H2O....
                                1.31
*******
POINT NO. 16.
                        .07 STO 01
                      68.00 STO 03
                                RUN

DELTA H=
IN. H2O....
                                1.53
*******
POINT NO. 17.
                        .14 STO 01
                      66.00 STO 02
                      63.00 STO 03
                                RUN

DELTA H=
IN. H2O....
                                3.02
*******
POINT NO. 18.
                        .12 STO 01
                      65.00 STO 02
                      65.00 STO 03
                                RUN
                                RUN

DELTA H=
IN. H2O....
                                2.61
*******
POINT NO. 19.
                        .09 STO 01
                      66.00 STO 02
                      67.00 STO 03
                                RUN

DELTA H=
IN. H2O....
                                1.96
*******
POINT NO. 20.
                        .07 STO 01
                      65.00 STO 02
                      69.00 STO 03
                                RUN

DELTA H=
IN. H2O....
                                1.53
*******
```

```
                      67.00 STO 02
                      70.00 STO 03
                                RUN

DELTA H=
IN. H2O....
                                1.75
*******
POINT NO. 22.
                        .09 STO 01
                      65.00 STO 02
                                RUN

DELTA H=
IN. H2O....
                                1.97
*******
POINT NO. 23.
                      71.00 STO 03
                                RUN

DELTA H=
IN. H2O....
                                1.98
*******
POINT NO. 24.
                        .08 STO 01
                      72.00 STO 03
                                RUN

DELTA H=
IN. H2O....
                                1.76
*******
POINT NO. 25.
                        0.00    RUN
======

ISOKIN
AVG VALUES
KV=7.141
TMETER F=67.542
DELTA-H=2.211
DELTA P=0.097
FINAL METER
VOLUME FT3=?
                     992.135    RUN
INITIAL=888.125
SAMPLE TIME
MIN. =?
                     120.000    RUN
PSTACK ABS
IN HG=30.308
TSTACK F=65.958

======

SOURCE TYPE?
0=OTHER
1=BOILER
                        0.000   RUN
% CO2 =?
                        0.000   RUN
% O2 =?
                       20.900   RUN
```

```
                        1.000   RUN
AWAITING
RECOVERY DATA.

HIT R/S
TO CONTINUE...

                                RUN
H2O GAIN=?
                      41.570    RUN
NET METER
VOL. FT3=
                                104.010
CORRECTED
SAMPLE VOL.
VMSTD  SCF=
                                105.445
MOLE FRACT. DRY
GAS. (1-BWS) =
                                0.982
% H2O =
                                1.8
STACK GAS WET
MOL. WT, MS,
LB/LB MOL=
                                28.638
AVG VELOCITY
FPM =
                            1,018.286
STACK DRY GAS
FLOW QS  SCFM=
                            7,598.712
ACFM =
                            7,614.166


**********

   ISOKINETIC %I =98.6

**********
```

5-241-3-OUT

PRELIM

TRAVERSE DATA SHEET

(REV 8/86)

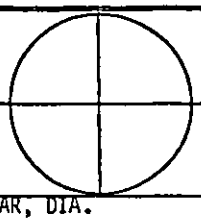
PLANT Alameda

LOCATION Bldg 5

DATE 24 Feb 90

OPERATOR Reichle

RUN # Velocity traus- 239-1-OUT



CIRCULAR, DIA. ____ in

RECTANGULAR, LxW 40 X 27 in

Length from upstream disturbance ____ ft

Diameter from upstream disturbance 2 dia

Length from downstream disturbance ____ ft

Diameters from downstream disturbance 0.5 dia

Required number of traverse points 25 ea

Number of traverse points used 25 ea

POINT # n	STACK PRESSURE (in H_2O) ΔPvel	Pstatic	$\sqrt{\Delta P}$	LOCATION (in) L	W	POINT # n	STACK PRESSURE (in H_2O) ΔPvel	Pstatic	$\sqrt{\Delta P}$	LOCATION (in) L	W
1	Ø.Ø6		Ø.245			26					
2	Ø.Ø6		Ø.245			27					
3	Ø.Ø5		Ø.224			28					
4	Ø.Ø5		Ø.224			29					
5	Ø.Ø5		Ø.224			30					
6	Ø.Ø8		.282			31					
7	Ø.Ø7		.264			32					
8	Ø.Ø6		.245			33					
9	Ø.Ø5		.224			34					
10	Ø.Ø5	+Ø.72	.224			35					
11	Ø.Ø9		.300			36					
12	Ø.Ø7		.264			37					
13	Ø.Ø5		.224			38					
14	Ø.Ø4		.200			39					
15	Ø.Ø6		.245			40					
16	Ø.Ø8		.282			41					
17	Ø.Ø7		.264			42					
18	Ø.Ø4		.200			43					
19	Ø.Ø4		.200			44					
20	Ø.Ø5	+Ø.70	.224			45					
21	Ø.Ø7		.264			46					
22	Ø.Ø6		.245			47					
23	Ø.Ø6		.245			48					
24	Ø.Ø7		.264			49					
25	Ø.Ø7		.264			50					

$$\Delta P_{ave} = \left[\frac{\Sigma\sqrt{\Delta P}}{n}\right]^2 = \text{~~Ø.Ø280~~} \quad Ø.ØØ5926$$

IMPINGER BOX SET UP FOR CHROMIUM EMISSION TEST
AND NOZZLE CALIBRATION SHEET

DATE: 2/24/90 LINE NO: 239

BASE: ALAMEDA RUN NO: 5-239-1-OUT

BUILDING NO: 5 CIRCLE 1: INLET (OUTLET)

PREP BY: DM

[✓] 1. Wash all glassware with ~~detergent, acetone, deionized water~~, and rinse with 0.1N NaOH solution.
[✓] 2. Add 100ml 0.1N NaOH solution in the first two impingers (standard Greenburg-Smith impingers). Record initial weights.
[✓] 3. The third impinger (modified Greenburg-Smith) is dry. Record initial weight.
[✓] 4. The fourth impinger (modified Greenburg-Smith) contains about 1 liter of indicating type silica gel. Record initial weight.
[✓] 5. Place teflon coated filter into filter holder and install between the third and fourth impingers. Record filter number. Do not weigh.
[✓] 6. Assemble impinger bottles and glass elbows (180s) so that air flows from a smaller to larger holes (if applicable).
[✓] 7. Calibrate nozzle by measuring four IDs with a micrometer.

FORGOT TO WEIGH

Impinger No.	Contents	Tare	Initial	Final	Condensate
1-1	1. 100ml 0.1N NaOH	513.22	613.58		
1-2	2. 100ml 0.1N NaOH	516.10	616.81	619.41	2.6
1-3	3. Empty	505.99	—	506.03	0.04
1-4	4. 1 l silica gel	~~?~~	900.23	929.41	29.18
				Net Weight Gain	

2% H_2O ASSUMPTION IS ACCURATE BASED ON RUN #2

Filter No: 011

BEFORE 30% SPENT

Silica gel condition after test: 70% SPENT

Nozzle No: #1RTZ Calibrated by: Reichle

					Average
ID Before Test:	0.390	0.405	0.395	0.395	0.396
ID After Test:	0.390	0.404	0.395	0.396	

(SJS rev11/88, #02510) Astack = 1076.75

PLANT Alameda	BAROMETRIC PRESSURE, in Hg 30.21		METER BOX # 12	PROBE # (PITOT #)	NOZZLE #
LOCATION Bldg 5	AMBIENT TEMPERATURE, °F 61		METER ΔH@ 1.802	PITOT COEF Ø.82	IDEAL NOZZLE DIA, in. Ø.423
DATE 24 Feb 90	AVE STATIC PRESSURE, in H_2O Ø.70		METER γ .996	PROBE LENGTH, in. 3 foot	ACTUAL NOZZLE DIA, in. Ø.396
OPERATOR REICHLE	AVE VEL HEAD, in H_2O Ø.Ø59		SAMPLE BOX # 12	PROBE LINER MATERIAL GLASS PRE	LEAK CHECK @ PITOT'S Ø K @ 5.5"
RUN # 5-239-OUT-1	ASSUMED MOISTURE, % 2	SCHEMATIC OF STACK CROSS SECTION (SHOW TRAVERSE PTS)	HEATER BOX SETTING —	PROBE HEATER SETTING — PREOK	LEAK RATE CFM@ in Hg .009 @ 15" Hg

TRAVERSE POINT #	SAMPLING TIME	GAS METER READING	ORIFICE PRESSURE (CALC)	VELOCITY HEAD (A) (MEAS)	STACK TEMPERATURE (B)	GAS SAMPLE TEMPERATURE AT DRY GAS METER (C)		IMPINGER TEMPERATURE	SAMPLE BOX TEMPERATURE	SAMPLE VACUUM	O_2	CO_2	CO	NOX
						Inlet	Outlet							
	min	(Vm) ft^3	(ΔH) in H_2O	(ΔP) in H_2O	(Ts) °F	(Tm in) °F	(Tm out) °F	°F	°F	in Hg	%	%	ppm	ppm
START 1:04 pm 1	Ø	623.Ø8	1.97	Ø.Ø8	67	71	71	63		8"				
2	10	632.47	1.98	Ø.Ø8	68	75	72	45		10				
3	20	640.40	1.75	Ø.Ø7	68	79	73	55		4.5"				
4	30	647.Ø2	1.75	Ø.Ø7	68	80	75	56		4.5"				
5	40	653.83	2.ØØ	Ø.Ø8	68	80	75	56		5.Ø				
START 1:54 pm 6	50	661.452												
7	60													
8	70													
9	80													
10	90													
11	100													
12	110													
13	120													
TOTAL														
AVERAGE														

(SJS rev11/88, #02510)

PLANT Alameda	BAROMETRIC PRESSURE, in Hg 29.68		METER BOX # 12	PROBE # (PITOT #) 3	NOZZLE # 3/8 QUARTZ
LOCATION Bldg 5	AMBIENT TEMPERATURE, °F 69		METER ΔH@ 1.602	PITOT COEF Ø.82	IDEAL NOZZLE DIA, in. Ø.427
DATE 26 Feb 90	AVE STATIC PRESSURE, in H_2O Ø.70		METER γ .996	PROBE LENGTH, in. 3 foot	ACTUAL NOZZLE DIA, in. Ø.396
OPERATOR Reichle	AVE VEL HEAD, in H_2O Ø.059		SAMPLE BOX # 12	PROBE LINER MATERIAL Glass	LEAK CHECK @ PITOT'S ck - @ 6" H_2O
RUN # 5-239-1-OUT	ASSUMED MOISTURE, % 2	SCHEMATIC OF STACK CROSS SECTION (SHOW TRAVERSE PTS)	HEATER BOX SETTING —	PROBE HEATER SETTING — PREdic Ø.0125@1.3"	LEAK RATE CFM@ in Hg

TRAVERSE POINT #	SAMPLING TIME	GAS METER READING	ORIFICE PRESSURE (CALC) (ΔH) in H_2O	VELOCITY HEAD (MEAS) (ΔP) in H_2O	STACK TEMPERATURE (Ts) °F	GAS SAMPLE TEMPERATURE AT DRY GAS METER Inlet (Tm in) °F	Outlet (Tm out) °F	IMPINGER TEMPERATURE °F	SAMPLE BOX TEMPERATURE °F	SAMPLE VACUUM in Hg	O_2 %	CO_2 %	CO ppm	NOX ppm
START 9:17 AM														
1·6	50	661.556	1.67	Ø.Ø7	61	48	49	48		5"				
7	60	668.36	1.2Ø	Ø.Ø5	61	52	49	36		4"				
8	70	674.Ø65	Ø.97	Ø.Ø4	60	56	50	39		3.5"				
9	80	679.39	1.21	Ø.Ø5	60	57	51	39		4"				
10	90	685.475	2.2Ø	Ø.Ø9	61	61	54	42		6"				
11	100	693.517	1.21	Ø.Ø5	62	56	55	42		4"				
12	110	699.76	Ø.97	Ø.Ø4	62	58	54	40		3.5"				
13	120	705.Ø64	Ø.96	Ø.Ø4	62	56	54	43		3.5"				
14	130	710.335	1.2Ø	Ø.Ø5	63	57	55	38		4.Ø"				
15	140	716.24	1.22	Ø.Ø5	62	62	56	41		4.Ø"				
16	150	722.42	1.46	Ø.Ø6	62	59	56	45		4.5"				
17	160	729.325	Ø.97	Ø.Ø4	64	63	58	42		3.5"				
18	170	734.655	Ø.73	Ø.Ø3	63	65	60	43		3Ø"				
TOTAL														
AVERAGE														

(SJS rev11/88, #02510)

PLANT	BAROMETRIC PRESSURE, in Hg		METER BOX #	PROBE # (PITOT #)	NOZZLE #
LOCATION	AMBIENT TEMPERATURE, °F		METER ΔH@	PITOT COEF	IDEAL NOZZLE DIA, in.
DATE	AVE STATIC PRESSURE, in H_2O		METER γ	PROBE LENGTH, in.	ACTUAL NOZZLE DIA, in.
OPERATOR	AVE VEL HEAD, in H_2O		SAMPLE BOX #	PROBE LINER MATERIAL	LEAK CHECK @ PITOT'S
RUN # S-239-1-OUT	ASSUMED MOISTURE, %	SCHEMATIC OF STACK CROSS SECTION (SHOW TRAVERSE PTS)	HEATER BOX SETTING	PROBE HEATER SETTING	LEAK RATE CFM@ in Hg

TRAVERSE POINT #	SAMPLING TIME	GAS METER READING	ORIFICE PRESSURE (CALC)	VELOCITY HEAD (A) (MEAS)	STACK TEMPERATURE (B)	GAS SAMPLE TEMPERATURE AT DRY GAS METER (C)		IMPINGER TEMPERATURE	SAMPLE BOX TEMPERATURE	SAMPLE VACUUM	O_2	CO_2	CO	NOX
						Inlet	Outlet							
OFF 10:28 ON 11:06	min	(Vm) ft^3	(ΔH) in H_2O	(ΔP) in H_2O	(Ts) °F	(Tm in) °F	(Tm out) °F	°F	°F	in Hg	%	%	ppm	ppm
19	180	739.37	Ø.73	Ø.Ø3	64	65	61	43		3.Ø				
20	190	744.21	Ø.98	Ø.Ø4	63	63	61	44		3.Ø				
OFF 11:18 21	200	749.635	~~1.22~~	Ø.Ø5	64	66	62	41		3 Ø				
ON 11:28 22	210	755.555	Ø.98	Ø.Ø4	64	66	62	42		4.Ø				
23	220	761.01	Ø.98	Ø.Ø4	64	68	64	45		3.5				
24	230	766.5ØØ	1.23	Ø.Ø5	65	69	64	45		4.Ø				
25	240	772 93	1.18	Ø.Ø6	65	70	66	47		5.Ø				
OFF 12:14 PM	250	779.592												
				POST TEST LEAK CHECK										
				Ø.ØØ5 @ 12" H_2O										
				PITOT #2 OK @ 6.5" H_2O										
				PITOT #4 OK @ 6.5" H_2O										
TOTAL														
AVERAGE														

FIRST RUN 24 FEB 90

5-239-1-OUT

```
                                RUN
METHOD 5 NOMO

ENTER DATA
THEN PUSH R/S

TEST NO=?
                5.      RUN
RUN NO.=?
            239.001     RUN
FILTER NO=?
              011.      RUN

DELTA-H*AT = ?
            1.002       RUN
METER GAMMA = ?
            9.000       CLX
             .996       RUN
STACK AREA
IN. SQ. = ?
        1,076.750       RUN
STACK STATIC
P IN H2O=?
             .700       RUN
PBAR IN HG=?
           30.210       RUN
% H2O=?
            2.000       RUN
STACK GAS WET
MOL WT. MS.
LB/LB MOL=?
           29.000       RUN
AVG STACK
TEMP DEG F=?
           68.000       RUN
AVG DELTA-P
IN. H2O=?
             .059       RUN
AMBIENT
TEMP F=?
           61.000       RUN
PITOT TUBE
CSUBP=?
             .820       RUN

AVG STACK
VELOCITY FPM=
          791.506
FOR 0.75 CFM
IDEAL NOZZLE
DIA INCHES= 0.424

ACTUAL NOZZLE
DIA INCHES=?
             .396       RUN

SAMPLE CFM = 0.656

MINIMUM RUN
TIME, MIN. = 45.749
```

C-33

```
******
INITIAL METER
VOLUME FT3 =?
          623.000       RUN
*******
POINT NO. 1.
                .00 STO 01
              67.00 STO 02
              71.00 STO 03
                        RUN
DELTA H=
IN. H2O....
                1.97
*******
POINT NO. 2.
              68.00 STO 02
              75.00 STO 03
                        RUN
DELTA H=
IN. H2O....
                1.98
*******
POINT NO. 3.
                .07 STO 01
              79.00 STO 03
                        RUN
DELTA H=
IN. H2O....
                1.74
*******
POINT NO. 4.
              80.00 STO 03
                        RUN
DELTA H=
IN. H2O....
                1.75
*******
POINT NO. 5.
                .08 STO 01
                        RUN
DELTA H=
IN. H2O....
                2.00
*******
POINT NO. 6.
                0.00    RUN
======

ISOKIN
AVG VALUES
KV=6.330
TMETER F=77.000
DELTA-H=1.886
DELTA P=0.076
FINAL METER
VOLUME FT3=?
          661.452       RUN
INITIAL=623.000
SAMPLE TIME
MIN. =?
             50.000     RUN
PSTACK ABS
IN HG=30.261
TSTACK F=67.000
```

```
******

SOURCE TYPE?
0=OTHER
1=BOILER
                0.000   RUN
% CO2 =?
                0.000   RUN
% O2 =?
               20.900   RUN
H2O GAIN KNOWN?
1=YES 0=NO
                0.000   RUN
WET METER
VOL. FT3=
           38.219

CORRECTED
SAMPLE VOL.
VMSTD  SCF=
           38.005

MOLE FRACT. DRY
GAS, (1-BWS) =
                0.900

% H2O =
                2.0

STACK GAS WET
MOL. WT, MS,
LB/LB MOL=
           28.619

AVG VELOCITY
FPM =
          903.631

STACK DRY GAS
FLOW QS  SCFM=
        6,697.131

ACFM =
        6,756.838


**********

ISOKINETIC %I =99.2

*********
```

5-239-1-OUT CONTINUED 26 FEB 90

```
                                RUN
METHOD 5 NOMO

ENTER DATA
THEN PUSH R/S

TEST NO=?
                5.      RUN
RUN NO.=?
            239.001     RUN
FILTER NO=?
              011.      RUN

DELTA-H*AT = ?
            1.002       RUN
METER GAMMA = ?
             .996       RUN
STACK AREA
IN. SQ. = ?
        1,076.750       RUN
STACK STATIC
P IN H2O=?
             .700       RUN
PBAR IN HG=?
           29.600       RUN
% H2O=?
            2.000       RUN
STACK GAS WET
MOL WT, MS,
LB/LB MOL=?
           29.000       RUN
AVG STACK
TEMP DEG F=?
           68.000       RUN
AVG DELTA-P
IN. H2O=?
             .059       RUN
AMBIENT
TEMP F=?
           48.000       RUN
PITOT TUBE
CSUBP=?
             .820       RUN

AVG STACK
VELOCITY FPM=
          798.529
FOR 0.75 CFM
IDEAL NOZZLE
DIA INCHES= 0.427

ACTUAL NOZZLE
DIA INCHES=?
             .396       RUN

SAMPLE CFM = 0.645

MINIMUM RUN
TIME, MIN. = 46.585
```

```
INITIAL METER
VOLUME FT3 =?
          661.550       RUN
*******
POINT NO. 1.
                .07 STO 01
              61.00 STO 02
              48.00 STO 03
                        RUN
DELTA H=
IN. H2O....
                1.67
*******
POINT NO. 2.
                .05 STO 01
                8.00    CLX
              52.00 STO 03
                        RUN
DELTA H=
IN. H2O....
                1.20
*******
POINT NO. 3.
                .04 STO 01
              60.00 STO 02
              56.00 STO 03
                        RUN
DELTA H=
IN. H2O....
                0.97
*******
POINT NO. 4.
                .05 STO 01
              57.00 STO 03
                        RUN
DELTA H=
IN. H2O....
                1.21
*******
POINT NO. 5.
                .09 STO 01
              61.00 STO 02
              61.00 STO 03
                        RUN
DELTA H=
IN. H2O....
                2.20
*******
POINT NO. 6.
                .05 STO 01
              62.00 STO 02
              56.00 STO 03
                        RUN
DELTA H=
IN. H2O....
                1.21
*******
POINT NO. 7.
                .04 STO 01
              58.00 STO 03
                        RUN
DELTA H=
IN. H2O....
                0.97
```

```
              56.00 STO 03
                        RUN
DELTA H=
IN. H2O....
                0.96
*******
POINT NO. 9.
                .05 STO 01
              63.00 STO 02
              57.00 STO 03
                        RUN
DELTA H=
IN. H2O....
                1.21
*******
POINT NO. 10.
              62.00 STO 02
              62.00 STO 03
                        RUN
DELTA H=
IN. H2O....
                1.22
*******
POINT NO. 11.
                .06 STO 01
              59.00 STO 03
                        RUN
DELTA H=
IN. H2O....
                1.46
*******
POINT NO. 12.
                .04 STO 01
              64.00 STO 02
              63.00 STO 03
                        RUN
DELTA H=
IN. H2O....
                0.97
*******
POINT NO. 13.
                .03 STO 01
              63.00 STO 02
              65.00 STO 03
                        RUN
DELTA H=
IN. H2O....
                0.73
*******
POINT NO. 14.
              64.00 STO 02
                        RUN
DELTA H=
IN. H2O....
                0.73
*******
POINT NO. 15.
                .04 STO 01
              63.00 STO 02
              63.00 STO 03
                        RUN
DELTA H=
IN. H2O....
                0.98
```

```
                .05 STO 01
              64.00 STO 02
              66.00 STO 03
                        RUN
DELTA H=
IN. H2O....
                1.22
*******
POINT NO. 17.
                .04 STO 01
                        RUN
DELTA H=
IN. H2O....
                0.98
*******
POINT NO. 18.
              68.00 STO 03
                        RUN
DELTA H=
IN. H2O....
                0.98
*******
POINT NO. 19.
                .05 STO 01
              65.00 STO 02
              69.00 STO 03
                        RUN
DELTA H=
IN. H2O....
                1.23
*******
POINT NO. 20.
                .06 STO 01
                        RUN
DELTA H=
IN. H2O....
                1.47
*******
POINT NO. 21.
                0.00    RUN
======

ISOKIN
AVG VALUES
KV=4.990
TMETER F=60.000
DELTA-H=1.178
DELTA P=0.048
FINAL METER
VOLUME FT3=?
          779.592       RUN
INITIAL=661.550
SAMPLE TIME
MIN. =?
            200.000     RUN
PSTACK ABS
IN HG=29.731
TSTACK F=62.600
```

```
SOURCE TYPE?
0=OTHER
1=BOILER
                0.000   RUN
% CO2 =?
                0.000   RUN
% O2 =?
               20.900   RUN
H2O GAIN KNOWN?
1=YES 0=NO
                0.000   RUN
WET METER
VOL. FT3=
          117.570

CORRECTED
SAMPLE VOL.
VMSTD  SCF=
          110.437

MOLE FRACT. DRY
GAS, (1-BWS) =
                0.900

% H2O =
                2.0

STACK GAS WET
MOL. WT, MS,
LB/LB MOL=
           28.619

AVG VELOCITY
FPM =
          718.694

STACK DRY GAS
FLOW QS  SCFM=
        5,285.288

ACFM =
        5,373.984


**********

ISOKINETIC %I =97.9

*********
```

5-239-1-OUT CONTINUED

AVG DSCFM =

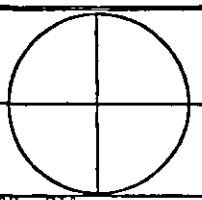
(6697 + 5285 × 4) / 5

(99.2 + 97.9 × 4) / 5

TRAVERSE DATA SHEET

(REV 8/86)

PLANT BLDG 5
LOCATION ALAMEDA
DATE 2/24/90
OPERATOR M.P.
RUN # 5-239-2-OUT



CIRCULAR, DIA. ____ in
RECTANGULAR, LxW 40X27 in

Length from upstream disturbance ____ ft
Diameter from upstream disturbance 2 dia
Length from downstream disturbance ____ ft
Diameters from downstream disturbance 0.5 dia
Required number of traverse points 25 ea
Number of traverse points used 25 ea

POINT # n	STACK PRESSURE (in H_2O) ΔPvel	Pstatic	$\sqrt{\Delta P}$	LOCATION (in) L	W	POINT # n	STACK PRESSURE (in H_2O) ΔPvel	Pstatic	$\sqrt{\Delta P}$	LOCATION (in) L	W
1	.07		.265			26					
2	.07		.265			27					
3	.07		.265			28					
4	.08		.283			29					
5	.08		.283			30					
6	.08		.283			31					
7	.06		.245			32					
8	.05		.224			33					
9	.04		.200			34					
10	.07	+0.70	.265			35					
11	.07		.265			36					
12	.05		.224			37					
13	.03		.173			38					
14	.04		.200			39					
15	.06	+0.71	.245			40					
16	.06		.245			41					
17	.05		.224			42					
18	.04		.200			43					
19	.04		.200			44					
20	.05		.224			45					
21	.05		.224			46					
22	.04		.200			47					
23	.04		.200			48					
24	.03		.173			49					
25	.04		.200			50					

$$\Delta P_{ave} = \left[\frac{\pm\sqrt{\Delta P}}{n}\right]^2 = 0.053_{e-34}$$

IMPINGER BOX SET UP FOR CHROMIUM EMISSION TEST
AND NOZZLE CALIBRATION SHEET

DATE: 2/24/90 LINE NO: 239

BASE: ALAMEDA RUN NO: 5-239-2-OUT

BUILDING NO: 5 CIRCLE 1: INLET (OUTLET)

PREP BY: REICHLE

[✓] 1. Wash all glassware with ~~detergent~~, ~~acetone, deionized water~~, and rinse with 0.1N NaOH solution.
[✓] 2. Add 100ml 0.1N NaOH solution in the first two impingers (standard Greenburg-Smith impingers). Record initial weights.
[✓] 3. The third impinger (modified Greenburg-Smith) is dry. Record initial weight.
[✓] 4. The fourth impinger (modified Greenburg-Smith) contains about 1 liter of indicating type silica gel. Record initial weight.
[✓] 5. Place teflon coated filter into filter holder and install between the third and fourth impingers. Record filter number. Do not weigh.
[✓] 6. Assemble impinger bottles and glass elbows (180s) so that air flows from a smaller to larger holes (if applicable).
[ ] 7. Calibrate nozzle by measuring four IDs with a micrometer.

Impinger No.	Contents	Tare	Initial	Final	Condensate
3-1	1. 100ml 0.1N NaOH	478.6	579.4	602.6	23.2
3-2	2. 100ml 0.1N NaOH	476.8	578.9	580.17	1.27
3-3	3. Empty	470.39	—	470.79	0.40
3-4	4. 1 l silica gel	694.16	—	729.6	35.44
				Net Weight Gain	60.31

Filter No: 012

Silica gel condition after test: 80% Spent

Nozzle No: 3/8 QTZ Calibrated by: M.P.

					Average
ID Before Test:	0.399	0.398	0.399	0.403	0.399
ID After Test:	0.399	0.401	0.402	0.398	0.400 OK

29.000
1076.75

(SJS rev11/88, #02510)

PLANT	BAROMETRIC PRESSURE, in Hg [redacted] 29.68		METER BOX # #12 N04407	PROBE # (PITOT #) 3-1	NOZZLE # 3/8 QUARTZ
LOCATION NARF	AMBIENT TEMPERATURE, °F 65		METER ΔH@ 1.494	PITOT COEF 0.82	IDEAL NOZZLE DIA, in. 0.4316
DATE Feb-26-90	AVE STATIC PRESSURE, in H_2O +0.71		METER γ 1.000	PROBE LENGTH, in. 36	ACTUAL NOZZLE DIA, in. 0.399
OPERATOR MP	AVE VEL HEAD, in H_2O 0.053		SAMPLE BOX # 3	PROBE LINER MATERIAL GLASS	LEAK CHECK @ PITOT'S 6000@5in H20
RUN # S-239-#-001 #1 Thru shut	ASSUMED MOISTURE, % 1%	SCHEMATIC OF STACK CROSS SECTION (SHOW TRAVERSE PTS)	HEATER BOX SETTING N/A	PROBE HEATER SETTING N/A	LEAK RATE CFM@ in Hg .014 CFM@ 19 in Hg

TRAVERSE POINT #	SAMPLING TIME	GAS METER READING	ORIFICE PRESSURE (CALC)	VELOCITY HEAD (MEAS)	STACK TEMPERATURE	GAS SAMPLE TEMPERATURE AT DRY GAS METER		IMPINGER TEMPERATURE	SAMPLE BOX TEMPERATURE	SAMPLE VACUUM	O_2	CO_2	CO	NOX
						Inlet	Outlet							
7:17	min	(Vm) ft^3	(ΔH) in H_2O	(ΔP) in H_2O	(Ts) °F	(Tm in) °F	(Tm out) °F	°F	°F	in Hg	%	%	ppm	ppm
1	0	999.151 [redacted]	1.95	.09	59	68°	67	40		6				
2	10	1006.461	1.92	.09	59	60°	56°	43		6				
3	20	1016.000	1.72	.08	59	64°	57°	46		5				
4	30	1023.200	1.51	.07	59	65	58	46		4				
5	40	1031.356	1.51	.07	59	68	60	47		4				
8:08 8:17 6	50	1038.932	1.49	.07	60	60	60	49		4	PORT RANGE			
7	60	1046.142	1.07	.05	60	64	59	45		3				
8:37 8	70	1052.929	1.07	.05	60	65	59	44		3	TANK LOAD CHANGE			
1:13 9	80	1060.770	1.06	.05	61	61	57	45		4				
2:43 10	90	1067.908	1.29	.06	61	65	59	48		4				
1:48 11	100	1075.216	1.28	.06	61	64	60	49		4	PORT CHANGE			
12	110	1081.219	0.64	.03	61	64	60	47		2				
13	120	1086.572	0.64	.03	62	64	61	47		2				
TOTAL														
AVERAGE														

(SJS rev11/88, #0251Q)

PLANT	BAROMETRIC PRESSURE, in Hg		METER BOX #	PROBE # (PITOT #)	NOZZLE #
LOCATION	AMBIENT TEMPERATURE, °F		METER ΔH@	PITOT COEF	IDEAL NOZZLE DIA, in.
DATE	AVE STATIC PRESSURE, in H_2O		METER γ	PROBE LENGTH, in.	ACTUAL NOZZLE DIA, in.
OPERATOR	AVE VEL HEAD, in H_2O		SAMPLE BOX #	PROBE LINER MATERIAL	LEAK CHECK @ PITOT'S
RUN # S-239-2-OUT	ASSUMED MOISTURE, %	SCHEMATIC OF STACK CROSS SECTION (SHOW TRAVERSE PTS)	HEATER BOX SETTING	PROBE HEATER SETTING	LEAK RATE CFM@ in Hg

TRAVERSE POINT #	SAMPLING TIME min	GAS METER READING (Vm) ft^3	ORIFICE PRESSURE (CALC) (ΔH) in H_2O	VELOCITY HEAD (MEAS) (ΔP) in H_2O	STACK TEMPERATURE (Ts) °F	GAS SAMPLE TEMPERATURE AT DRY GAS METER Inlet (Tm in) °F	GAS SAMPLE TEMPERATURE AT DRY GAS METER Outlet (Tm out) °F	IMPINGER TEMPERATURE °F	SAMPLE BOX TEMPERATURE °F	SAMPLE VACUUM in Hg	O_2 %	CO_2 %	CO ppm	NOX ppm
14	130	1092.000	0.86	.04	62	66	62	47		3				
10:28 15	140	1097.304	0.42	.02	63	61	61	47		2				
11:08 16	150	1101.422	1.27 ~~1.27~~	.06	63	62	62	47		4				
11:24 17	160	1106.900	1.07	.05	63	65	63	48		4				
18	170	1113.209	1.07	.05	64	67	63	51		4				
19	180	1120.216	1.07	.05	64	67	63	51		3.5				
20	190	1126.000	1.50	.07	64	67	63	52		5				
12:14 21	200	1133.452	1.27	.06	64	60	60	47		4				
22	210	1139.711	1.06	.05	65	~~59~~ 63	59	50		4				
23	220	1146.887	1.27	.06	65	64	60	53		4				
24	230	1153.400	1.28	.06	65	68	62	55		4				
25	240	1159.561	1.50	.07	65	68	63	55		5				
Final Leak Check 1145.22	250	1168.000												
TOTAL	* Final Leak Check	Pitot Tubes = GOOD @ 5.5 in H2O Nozzles = .005 CFM @ 10 in Hg												
AVERAGE														

PORT CHANGE

TANK LOAD CHANGE

PORT CHANGE

nozzle

PASS!

```
                                RUN
METHOD 5 NOMO
5-239-2OUT
ENTER DATA
THEN PUSH R/S

TEST NO=?
                5.      RUN
RUN NO.=?
            239.002     RUN
FILTER NO=?
              012.      RUN

DELTA-H@AT = ?
              1.494     RUN
METER GAMMA = ?
              1.000     RUN
STACK AREA
IN. SQ. = ?
          1,076.758     RUN
STACK STATIC
P IN H2O=?
               .710     RUN
PBAR IN HG=?
             29.680     RUN
% H2O=?
              1.000     RUN
STACK GAS WET
MOL WT, MS,
LB/LB MOL=?
             29.000     RUN
AVG STACK
TEMP DEG F=?
             66.000     RUN
AVG DELTA-P
IN. H2O=?
               .053     RUN
AMBIENT
TEMP F=?
             48.000     RUN
PITOT TUBE
CSUBP=?
               .820     RUN

AVG STACK
VELOCITY FPM=
                755.394
FOR 0.75 CFM
IDEAL NOZZLE
DIA INCHES= 0.436

ACTUAL NOZZLE
DIA INCHES=?
               .399     RUN

SAMPLE CFM = 0.628

MINIMUM RUN
TIME, MIN. = 47.753
```

```
INITIAL METER
VOLUME FT3 =?
            999.151     RUN
*******
POINT NO. 1.
                .09 STO 01
              59.00 STO 02
              68.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                1.95
*******
POINT NO. 2.
              60.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                1.92
*******
POINT NO. 3.
                .08 STO 01
              64.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                1.72
*******
POINT NO. 4.
                .07 STO 01
              65.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                1.51
*******
POINT NO. 5.
              68.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                1.51
*******
POINT NO. 6.
              68.00 STO 02
              68.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                1.49
*******
POINT NO. 7.
                .05 STO 01
              64.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                1.07
*******
```

```
                    RUN
DELTA H=
IN. H2O....
                1.07
*******
POINT NO. 9.
              61.00 STO 01
              61.00 STO 03
                .05 STO 01
              61.00 STO 02
                    RUN
DELTA H=
IN. H2O....
                1.06
*******
POINT NO. 10.
                .06 STO 01
              65.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                1.29
*******
POINT NO. 11.
              64.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                1.28
*******
POINT NO. 12.
                .03 STO 01
                    RUN
DELTA H=
IN. H2O....
                0.64
*******
POINT NO. 13.
              62.00 STO 02
                    RUN
DELTA H=
IN. H2O....
                0.64
*******
POINT NO. 14.
                .04 STO 01
              66.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                0.86
*******
POINT NO. 15.
                .02 STO 01
              63.00 STO 02
              61.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                0.42
-------
```

```
                .06 STO 01
              62.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                1.27
*******
POINT NO. 17.
                .05 STO 01
              65.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                1.07
*******
POINT NO. 18.
              64.00 STO 02
              67.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                1.07
*******
POINT NO. 19.
                    RUN
DELTA H=
IN. H2O....
                1.07
*******
POINT NO. 20.
                .07 STO 01
                    RUN
DELTA H=
IN. H2O....
                1.50
*******
POINT NO. 21.
                .06 STO 01
              60.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                1.27
*******
POINT NO. 22.
                .05 STO 01
              65.00 STO 02
              63.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                1.06
*******
POINT NO. 23.
                .06 STO 01
              64.00 STO 03
                    RUN
DELTA H=
IN. H2O....
                1.27
```

```
                .07 STO 01
                    RUN
DELTA H=
IN. H2O....
                1.49
*******
POINT NO. 25.
                .06 STO 01
                    RUN
DELTA H=
IN. H2O....
                1.27
*******
POINT NO. 26.
                0.00    RUN
======

ISOKIN
AVG VALUES
KV=5.417
TMETER F=64.000
DELTA-H=1.231
DELTA P=0.056
FINAL METER
VOLUME FT3=?
          1,168.000     RUN
INITIAL=999.151
SAMPLE TIME
MIN. =?
              250.000   RUN
PSTACK ABS
IN HG=29.732
TSTACK F=61.920

======

SOURCE TYPE?
0=OTHER
1=BOILER
                0.000   RUN
% CO2 =?
                0.000   RUN
% O2 =?
               20.900   RUN
H2O GAIN KNOWN?
1=YES 0=NO
                1.000   RUN
AWAITING
RECOVERY DATA.

HIT R/S
TO CONTINUE...
                    RUN
```

```
H2O GAIN=?
               60.310   RUN
WET METER
VOL, FT3=
                168.849
CORRECTED
SAMPLE VOL.
VMSTD  SCF=
                169.834
MOLE FRACT. DRY
GAS, (1-BWS) =
                  0.983
% H2O =
                  1.7
STACK GAS WET
MOL. WT, MS,
LB/LB MOL=
                 28.657
AVG VELOCITY
FPM =
                779.631
STACK DRY GAS
FLOW QS  SCFM=
              5,761.366
ACFM =
              5,829.635


**********

ISOKINETIC %I =101.0

*********
5-239-2-OUT
```

APPENDIX D

TEST RESULTS
SAMPLE CALCULATIONS

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HARD CHROME PLATING AND CHROMIC ACID ANODIZING OPERATIONS
BUILDING 5, NAD ALAMEDA

TABLE 1: EMISSION TEST RESULTS

TEST NO.	CHROMIUM SAMPLE WEIGHT (mg)	CHROMIUM EMISSION CONC. (mg/SCF)	CHROMIUM EMISSION RATE (mg/hr)	AVERAGE AMPERES (Amp)	CHROMIUM EMISSION FACTOR (mg/Amp-hr)	STACK EXIT VELOCITY (m/s)
5-242-1-OUT	0.0448	1.006E-03	191.801	2393.0	0.080	9.1
5-242-2-OUT	0.0484	6.248E-04	148.160	2401.0	0.062	11.3
5-242-3-OUT	0.0678	4.770E-04	142.590	2404.0	0.059	14.2
5-241-1-OUT	0.0931	1.059E-03	397.858	4165.0	0.096	22.6
5-241-2-OUT	0.0999	1.000E-03	432.399	4272.0	0.101	26.0
5-241-3-OUT	0.0877	8.321E-04	379.351	4433.0	0.086	27.5
5-239-1-OUT	0.0072	4.605E-05	15.383	422.0	0.036	20.1
5-239-2-OUT	0.0103	6.076E-05	21.002	562.0	0.037	20.8

TABLE 2: RESULTS AND PROCESS CONDITIONS

SCRUBBER NO.	AVERAGE EMISSION RATE (mg/amp-hr)	PROCESS CONDITIONS AIR AGITATION	FLOATING POLYBALLS	ANTI-MIST ADDITIVE
242 (PLATE)	0.067	YES	YES	YES
241 (PLATE)	0.094	YES	YES	YES
239 (ANODIZE)	0.037	YES	YES	YES

TABLE 3: EMISSION TEST DATA

TEST NO.	NOZZLE DIA. (in.)	SAMPLE RATE (CFM)	SAMPLE TIME (min.)	AIR SAMPLE VOLUME (SCF)	% H2O (%)	STACK FLOW RATE (DSCFM)	ISOKIN (%)
5-242-1-OUT	0.396	0.49	120	44.55	2.1	3179.17	102.1
5-242-2-OUT	0.396	0.36	168	77.41	2.1	3951.96	101.9
5-242-3-OUT	0.481	0.64	120	142.23	1.8	4982.09	140.9
5-241-1-OUT	0.399	0.75	120	87.92	1.9	6261.36	100.7
5-241-2-OUT	0.400	0.73	120	99.90	1.9	7205.80	99.0
5-241-3-OUT	0.401	0.83	120	105.45	1.8	7598.71	98.6
5-239-1-OUT	0.396	0.66	250	156.44	2.0	5567.65	98.2
5-239-2-OUT	0.399	0.63	250	169.03	1.7	5761.37	101.0

EMISSION RESULTS
SAMPLE CALCULATIONS
TEST 239-1-OUT (TOTAL CHROMIUM)

CHROMIUM WEIGHT = Σ_n [analysis volume (l) * lab analysis (mg/l)]
Where: n = probe, impinger 1, and impinger 2

Example:
Emission Weight = [0.0932 (l) * 0.043 (mg/l)] + [0.1623 (l) * 0.018 (mg/l)]
+ [0.1569 (l) * < 0.002 (mg/l)] = 0.0072 (mg)

EMISSION CONCENTRATION = chromium weight (mg) / air sample volume (SCF)

Example:
Emission Concentration = 0.0072 (mg) / 156.44 (SCF)
= 4.605E-5 (mg/SCF)

EMISSION RATE = emission concentration (mg/SCF) * stack flow rate (SCFM)
* 60 (min/hr) / average amperes (Amp)

Example:
Emission Rate = 4.605E-5 (mg/SCF) * 5567.65 (SCFM)
* 60 (min/hr) / 422.0 (Amp) = 0.036 (mg/Amp-hr)

STACK EXIT VELOCITY = stack flow rate (SCFM) * 0.305 (m/ft) /
[stack exit area (ft^2) * 60 (s/min)]

Example:
Stack Exit Velocity = 5567.65 (SCFM) * 0.305 (m/ft) / [1.406 (ft^2)
* 60 (s/min] = 20.1 (m/s)

Note: Stack Exit Area is 27 x 7.5 inches.

APPENDIX E

"NOMOKIN" SAMPLING PROGRAM
EPA CONSTANTS AND EQUATIONS

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E P A METHOD 5 HP/41CX CALCULATOR PROGRAM

```
01♦LBL "NOMOKIN"
02 CLRG
03 FIX 0
04 "METHOD 5 NOMO"
05 AVIEW
06 ADV
07 "ENTER DATA"
08 AVIEW
09 "THEN PUSH R/S"
10 AVIEW
11 ADV
12 "TEST NO.=?"
13 PROMPT
14 "RUN NO.=?"
15 PROMPT
16 "FILTER NO.=?"
17 PROMPT
18 FIX 3
19 "INITIAL METER"
20 AVIEW
21 "VOLUME FT3=?"
22 PROMPT
23 STO 22
24 "DELTA-H*AT = ?"
25 PROMPT
26 STO 12
27 "METER GAMMA = ?"
28 PROMPT
29 STO 13
30 "STACK AREA"
31 AVIEW
32 "IN. SQ. = ?"
33 PROMPT
34 STO 25
35 "STACK STATIC"
36 AVIEW
37 "P IN H2O=?"
38 PROMPT
39 13.6
40 /
41 "PBAR IN HG=?"
42 PROMPT
43 STO 27
44 +
45 STO 26
46 1
47 "% H2O=?"
48 PROMPT
49 100
50 /
51 -
52 STO 28
53 "STACK GAS WET"
54 AVIEW
55 "MOL WT, MS,"
56 AVIEW
57 "LB/LB MOL=?"
58 PROMPT
59 STO 05
60 "AVG STACK"
61 AVIEW
62 "TEMP DEG F=?"
63 PROMPT
64 460
65 +
66 STO 06
67 "AVG DELTA-P"
68 AVIEW
69 "IN. H2O=?"
70 PROMPT
71 STO 24
72 "AMBIENT"
73 AVIEW
74 "TEMP F=?"
75 PROMPT
76 460
77 +
78 STO 08
79 "PITOT TUBE"
80 AVIEW
81 "CSUBP=?"
82 PROMPT
83 STO 09
84 ADV
85 "AVG STACK"
86 AVIEW
87 "VELOCITY FPM="
88 AVIEW
89 RCL 06
90 RCL 24
91 *
92 RCL 26
93 /
94 RCL 05
95 /
96 SQRT
97 5123.2
98 *
99 *
100 STO 10
101 VIEW X
102 "FOR 0.75 CFM"
103 AVIEW
104 "IDEAL NOZZLE"
105 AVIEW
106 "DIA INCHES= "
107 432
108 RCL 06
109 *
110 RCL 27
111 *
112 PI
113 RCL 28
114 *
115 RCL 10
116 *
117 RCL 08
118 *
119 RCL 26
120 *
121 /
122 SQRT
123 ARCL X
124 AVIEW
125 ADV
126 X↑2
127 "ACTUAL NOZZLE"
128 AVIEW
129 "DIA INCHES=?"
130 PROMPT
131 STO 11
132 X↑2
133 /
134 1/X
135 .75
136 *
137 ADV
138 "SAMPLE CFM = "
139 ARCL X
140 AVIEW
141 1/X
142 30
143 *
144 ADV
145 "MINIMUM RUN"
146 AVIEW
147 "TIME, MIN. = "
148 ARCL X
149 AVIEW
150 ADV
151 "******"
152 AVIEW
153 "--BEGIN RUN--"
154 AVIEW
155 ADV
156 "ENTER DATA AS:"
157 AVIEW
158 ADV
159 "STO A = DELTA-P"
160 AVIEW
161 "STO B = T-STACK"
162 AVIEW
163 "STO C = T-METER"
164 AVIEW
165 ADV
166 "TO CORRECT"
167 AVIEW
168 "ERROR, RE-ENTER"
169 AVIEW
170 "ALL VALUES AS"
171 AVIEW
172 "NEGATIVES"
173 AVIEW
174 ADV
175 "TO CHECK"
176 AVIEW
177 "ISOKIN, HIT"
178 AVIEW
179 "500, R/S"
180 AVIEW
181 ADV
182 "TO END RUN,"
183 AVIEW
184 "HIT 0, R/S"
185 AVIEW
186 ADV
187 "******"
188 AVIEW

189♦LBL 01
190 ADV
191 RCL 07
192 1
193 +
194 FIX 0
195 "POINT NO. "
196 ARCL X
197 AVIEW
198 FIX 2
199 STOP
200 500
201 X=Y?
202 GTO 40
203 RDN
204 0
205 X>Y?
206 GTO 30
207 X<>Y
208 X=0?
209 GTO 02
210 1
211 ST+ 07
212 RCL 02
213 460
214 +
215 ST+ 20
216 STO 16
217 RCL 03
218 ST+ 17
219 460
220 +
221 STO 18
222 RCL 01
223 SQRT
224 ST+ 19
225 RCL 01
226 RCL 16
227 *
228 SQRT
229 ST+ 23

230♦LBL 31
231 "DELTA H="
232 AVIEW
233 "IN. H2O...."
234 AVIEW
235 851
236 RCL 09
237 RCL 28
```

```
238 *
239 X↑2
240 *
241 RCL 12
242 *
243 RCL 26
244 *
245 RCL 27
246 /
247 RCL 18
248 *
249 RCL 16
250 /
251 RCL 11
252 4
253 Y↑X
254 *
255 RCL 01
256 *
257 ST+ 15
258 VIEW X
259 "*******"
260 AVIEW
261 GTO 01

262*LBL 30
263 "CORRECTING"
264 AVIEW
265 1
266 ST- 07
267 RCL 02
268 CHS
269 460
270 +
271 ST- 20
272 STO 16
273 RCL 03
274 CHS
275 ST- 17
276 460
277 +
278 STO 18
279 RCL 01
280 CHS
281 SQRT
282 ST- 19
283 RCL 01
284 CHS
285 RCL 16
286 *
287 SQRT
288 ST- 23
289 GTO 31

290*LBL 40
291 "LAST MTR VOL ?"
292 PROMPT
293 RCL 22
294 -
295 RCL 13
296 *
297 RCL 17
298 RCL 07
299 /
300 460
301 +
302 /
303 "TIME ?"
304 PROMPT
305 /
306 RCL 20
307 *
308 RCL 28
309 /
310 RCL 11
311 X↑2
312 /
313 RCL 23
314 /
315 RCL 09
316 /
317 RCL 05
318 RCL 26
319 *
320 SQRT
321 *
322 3.579
323 *
324 ADV
325 "PRESENT ISOKIN="
326 ARCL X
327 AVIEW
328 ADV
329 "CONTINUE RUN .."
330 AVIEW
331 ADV
332 "******"
333 AVIEW
334 GTO 01

335*LBL 02
336 "======"
337 AVIEW
338 ADV
339 "ISOKIN"
340 AVIEW
341 "AVG VALUES"
342 AVIEW
343 FIX 3
344 RCL 23
345 RCL 07
346 /
347 STO 23
348 "KV="
349 ARCL X
350 AVIEW
351 RCL 17
352 RCL 07
353 /
354 "TMETER F="
355 ARCL X
356 AVIEW
357 460
358 +
359 STO 17
360 RCL 15
361 RCL 07
362 /
363 STO 04
364 "DELTA-H="
365 ARCL X
366 AVIEW
367 RCL 19
368 RCL 07
369 /
370 X↑2
371 STO 19
372 "DELTA P="
373 ARCL X
374 AVIEW
375 "FINAL METER"
376 AVIEW
377 "VOLUME FT3=?"
378 PROMPT
379 STO 21
380 "INITIAL="
381 ARCL 22
382 AVIEW
383 "SAMPLE TIME"
384 AVIEW
385 "MIN. =?"
386 PROMPT
387 STO 14
388 "PSTACK ABS"
389 AVIEW
390 "IN HG="
391 ARCL 26
392 AVIEW
393 RCL 20
394 RCL 07
395 /
396 STO 20
397 460
398 -
399 "TSTACK F="
400 ARCL X
401 AVIEW
402 ADV
403 "======="
404 AVIEW
405 ADV
406 "SOURCE TYPE?"
407 AVIEW
408 "0=OTHER"
409 AVIEW
410 "1=BOILER"
411 PROMPT
412 STO 06
413 "% CO2 =?"
414 PROMPT
415 STO 01
416 "% O2 =?"
417 PROMPT
418 STO 02
419 "H2O GAIN KNOWN?"
420 AVIEW
421 "1=YES 0=NO"
422 PROMPT
423 STO 00
424 X=0?
425 GTO C
426 "AWAITING"
427 AVIEW
428 "RECOVERY DATA."
429 AVIEW
430 ADV
431 "HIT R/S"
432 AVIEW
433 "TO CONTINUE..."
434 AVIEW
435 ADV
436 STOP
437 "H2O GAIN=?"
438 PROMPT
439 STO 29

440*LBL C
441 "NET METER "
442 AVIEW
443 "VOL. FT3="
444 AVIEW
445 RCL 21
446 RCL 22
447 -
448 RCL 13
449 *
450 VIEW X
451 "CORRECTED"
452 AVIEW
453 "SAMPLE VOL."
454 AVIEW
455 "VMSTD  SCF="
456 AVIEW
457 RCL 26
458 RCL 17
459 /
460 17.646
461 *
462 *
463 STO 22
464 VIEW X
465 "MOLE FRACT. DRY"
466 AVIEW
467 "GAS, (1-BWS) ="
468 AVIEW
469 RCL 00
470 X=0?
471 GTO 03
472 RCL 29
473 RCL 22
```

```
474 .0471
475 /
476 RCL 29
477 +
478 /
479 CHS
480 1
481 +
482 STO 28
483 VIEW X

484*LBL 04
485 "% H2O = "
486 AVIEW
487 1
488 -
489 CHS
490 100
491 *
492 FIX 1
493 VIEW X
494 FIX 3
495 GTO 11

496*LBL 03
497 RCL 28
498 VIEW X
499 GTO 04

500*LBL 11
501 "STACK GAS WET"
502 AVIEW
503 "MOL. WT, MS,"
504 AVIEW
505 "LB/LB MOL="
506 AVIEW
507 RCL 01
508 .44
509 *
510 RCL 02
511 .32
512 *
513 +
514 100
515 RCL 01
516 RCL 02
517 +
518 -
519 .28
520 *
521 +
522 RCL 28
523 *
524 1
525 RCL 28
526 -
527 18
528 *
529 +
530 VIEW X
531 "AVG VELOCITY "
532 AVIEW
533 "FPM ="
534 AVIEW
535 RCL 26
536 *
537 1/X
538 SQRT
539 RCL 23
540 *
541 RCL 09
542 *
543 5123.2
544 *
545 STO 10
546 VIEW X
547 "STACK DRY GAS"
548 AVIEW
549 "FLOW @S  SCFM="
550 AVIEW
551 RCL 10
552 .1225
553 *
554 RCL 25
555 *
556 RCL 28
557 *
558 RCL 26
559 *
560 RCL 20
561 /
562 VIEW X
563 "ACFM ="
564 AVIEW
565 RCL 10
566 RCL 25
567 *
568 144
569 /
570 VIEW X
571 RCL 06
572 X=0?
573 GTO 08
574 "EXCESS AIR % ="
575 AVIEW
576 100
577 RCL 02
578 -
579 RCL 01
580 -
581 .264
582 *
583 RCL 02
584 -
585 1/X
586 RCL 02
587 *
588 100
589 *
590 VIEW X
591*LBL 08
592 ADV
593 "**********"
594 ADV
595 AVIEW
596 RCL 22
597 RCL 20
598 *
599 1039
600 *
601 RCL 28
602 /
603 RCL 26
604 /
605 RCL 14
606 /
607 RCL 10
608 /
609 RCL 11
610 X↑2
611 /
612 FIX 1
613 ADV
614 "ISOKINETIC %I ="
615 ARCL X
616 AVIEW
617 ADV
618 "*********"
619 AVIEW
620 .END.
```

MEMORY REGISTER ASSIGNMENTS FOR NOMOKIN CALCULATOR PROGRAM

STO	ASSIGNED VARIABLE	UNITS	@ LINE NO.	CHANGE	2ND ASSIGNED VARIABLE	UNITS	@ LINE NO.	
00	H2O GAIN KNOWN?	1=YES 0=NO	423					PROGRAM LOGIC GATE
01	$(\Delta P)n$	"WC	195	→	% CO2		414	VELOCITY PRESSURE
02	$(ts)n$	^{o}F	195	→	% O2		417	STACK TEMPERATURE
03	$(tm)n$	^{o}F	195					CONTROL BOX METER TEMPERATURE
04	$\Delta Havg$	"WC	360					PRESSURE DROP ACROSS METER BOX ORIFICE
05	Ms	lb/lb mole	59					WET STACK GAS MOLECULAR WEIGHT
06	ts(avg)	^{o}R	66					AVERAGE STACK TEMPERATURE
07	Σn		207					COUNTER
08	tamb	^{o}R	78					AMBIENT AIR TEMPERATURE
09	Cp		83					PITOT TUBE COEFF.
10	Vs(avg)	fpm	100	→	Vs (actual)	fpm	545	STACK GAS VELOCITY
11	Dn	in.	131					NOZZLE DIAMETER
12	$\Delta H@$	"WC	26					
13	γ		29					DRY GAS METER CORRECTION FACTOR
14	Tt	min.	384					NET TIME OF TEST
15	$\Sigma\Delta H$		253					
16	$(ts)n$	^{o}R	212					
17	$\Sigma(tm)$	^{o}F	214	→	(tm)avg	R	356	
18	$(tm)n$	^{o}R	217					
19	$\Sigma\sqrt{\Delta P}$		220	→	(ΔP)avg		368	
20	$\Sigma(ts)$	^{o}R	211	→	(ts)avg	R	393	
21	VM (final)	ft^3						FINAL METER VOLUME
22	VM (initial)	ft^3	22	→	Vm(std)		463	INITIAL METER VOLUME
23	$\Sigma\sqrt{\Delta P \cdot ts}$		225	→	$\sqrt{\Delta P \cdot ts}$	(AVG.)	344	
24	ΔPavg		24					PRESSURE DROP ACROSS PITOT TUBE
25	As	in^2	34					STACK CROSS-SECTIONAL AREA
26	Ps	"HG	45					ABSOLUTE STACK PRESSURE
27	Pb	"HG	43					BAROMETRIC PRESSURE
28	estimated (1-Bws)		52	→	actual (1-Bws)		482	MOLE FRACTION DRY GAS
29	H2O gain	grams	439					WATER GAIN OF IMPINGERS

-- EPA CONSTANTS --

Symbol	Unit	Description
g	32.1725 ft/sec^2	Acceleration due to gravity
g/lb	453.59237	Conversion factor
K_p	85.39 $\frac{ft}{sec}\left[\frac{(lb/lb\text{-}mole)(in.\ Hg)}{(^oR)(in.\ H_2O)}\right]$ 1/2	Pitot tube constant (METHOD II)
K_1	0.4710 ft^3/ml	Conversion factor (METHOD IV)
K_2	0.04718 ft^3/ml	Conversion factor (METHOD IV)
K_3	17.65 $^oR/in$ Hg	Standardizes temperature and pressure (METHOD IV)
K_1	17.65 $^oR/in$ Hg	Standardizes temperature and pressure (METHOD V)
K_2	0.04710 ft^3/ml	Conversion factor (METHOD V)
K_4	0.09444 $\frac{(min)(in\ Hg)}{(^oR)\ (sec)}$	Constant for standard pressure and temperature (METHOD V)
MW_{air}	28.9641 lb/lb-mole	Molecular weight of air
$MW_{H\ O}$	18.01534 lb/lb-mole	Molecular weight of water
P_{std}	29.92126 "Hg	Absolute standard pressure
P_{air}	0.0752236 lb/ft^3	Density of air at 20°C
P_{H_2O}	0.99824 g/ml	Density of water at 20°C
P_{H_2O}	62.31639 lb/ft^3	Density of water at 20°C
T_{std}	528°R	Standard absolute temperature

-- STANDARD EPA PARTICULATE CALCULATIONS --

1. Volume of dry gas in cubic feet sampled at standard conditions.*

$$V_{m_{std}} = V_m \left(\frac{T_{std}}{t_m + 460} \right) \left[\frac{P_b + \frac{\Delta H}{13.6}}{P_{std}} \right]$$

$$V_{m_{std}} = 17.646\ V_m \left(\frac{P_b + \frac{\Delta H}{13.6}}{t_m + 460} \right) = ft.^3$$

2. Volume of water vapor in cubic feet collected at standard conditions.*

By volume measurement:

$$V_{w_{gas}} = \frac{(V_w)\ \rho_{H_2O}\ R\ T_{std}}{P_{std}\ MW_{H_2O}\ 453.59237}$$

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

By mass measurement:

$$V_{w_{gas}} = \frac{(m_w)\ R\ T_{std}}{P_{std}\ MW_{H_2O}\ 453.59237}$$

$$V_{w_{gas}} = 0.0472\ m_w$$

3. Percent moisture in stack gas

$$\%M = \frac{V_{w_{gas}}}{V_{m_{std}} + V_{w_{gas}}} \times 100$$

4. Mole fraction of dry gas

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

* $528^{\circ}R$, 29.92126 in. Hg

11. Particulate - probe, cyclone, and filter, grains/SCF.

$$C_{an} = \left[\frac{m_f}{V_{m_{std}}}\right]\left[\frac{15.432\ gr}{gram}\right]$$

$$C_{an} = 15.432\ \frac{m_f}{V_{m_{std}}} = gr/SCF$$

12. Particulate total, grains/SCF

$$C_{ao} = 15.432\left[\frac{m_t}{V_{m_{std}}}\right] = gr/SCF$$

13. Particulate - probe, cyclone and filter, gr/CF at stack conditions

$$C_{at} = C_{an}\left[\frac{P_s}{P_{std}}\right]\left[\frac{T_{std}}{(t_s + 460)}\right] M_d$$

$$C_{at} = \frac{17.646\ C_{an}\ P_s\ M_d}{t_s + 460} = gr/CF$$

14. Particulate - total, gr/CF at stack conditions

$$C_{au} = \frac{17.646\ C_{ao}\ P_s\ M_d}{(t_s + 460)} = gr/CF$$

15. Particulate - probe, cyclone and filter, lbs/hr

$$C_{aw} = C_{an}\ Q_s\left(\frac{60\ min.}{1\ hr.}\right)\left(\frac{1\ lb}{7000\ gr}\right)$$

$$C_{aw} = 0.008571\ C_{an}\ Q_s = lbs/hr$$

16. Particulate - total, lbs/hr

$$C_{ax} = 0.008571\ C_{ao}\ Q_s = lbs/hr$$

17. Percent excess air at sampling point

$$\%\ EA = \frac{100\ (O_2)}{26.4 - 1.264\ (O_2) - 0.264\ (CO_2)}$$

NOTE: Assumes CO concentration is approximately zero compared to O_2 and CO_2.

* 528°R, 29.92126 "Hg

5. Average molecular weight of dry stack gas.

$$MW_d = \left[0.44\ (\%CO_2)\right] + \left[0.32\ (\%O_2)\right] + \left[0.28(100 - \%O_2 - \%CO_2)\right] = \text{lb/lb mole}$$

6. Molecular weight of stack gas.

$$MW = MW_d \times M_d + 18\ (1-M_d) = \frac{\text{lb}}{\text{lb-mole}}$$

7. Stack pressure, "Hg Absolute

$$P_s = P_b + \frac{\text{stack pressure } "H_2O}{13.6}$$

8. Stack velocity at stack conditions, fpm

$$V_s = C_p\ 60 \left[\frac{(2G)(\rho H_2O)(P_{std})(MW_{air})(ts + 460)(\Delta P)}{12\ (\rho_{air})(P_s)(MW)(T_{std})}\right]^{\frac{1}{2}}$$

$$V_s = 5123.2\ C_p \left[\frac{(t_s + 460)\ \ (\Delta P_s)}{(P_s)\ (MW)}\right]^{\frac{1}{2}} = \text{fpm}$$

9. Stack gas volume at standard conditions, SCFM*

$$Q_s = \frac{V_s\ A_s\ M_d\ T_{std}\ P_s}{144\ (t_s + 460)\ P_{std}}$$

$$Q_s = \frac{0.1225\ V_s\ A_s\ M_d\ Ps}{t_s + 460} = \text{DSCFM}$$

10. Percent isokinetic

$$\%I = \frac{V_{m_{std}}(t_s + 460)\ P_{std}\ 100}{M_d\ T_{std}\ P_s\ T_t\ V_s\left[\frac{\pi\ (D_n)^2}{4\ (144)}\right]}$$

$$\%I = \frac{1039\ V_{m_{std}}\ (t_s + 460)}{M_d\ P_s\ T_t\ V_s\ D_n^{\ 2}}$$

* $528^{o}R$, 29.92126 "Hg

APPENDIX F

MISCELLANEOUS DOCUMENTS

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REGULATION 11
HAZARDOUS POLLUTANTS
RULE 8
HEXAVALENT CHROMIUM

REGULATION 11
HAZARDOUS POLLUTANTS
RULE 8
HEXAVALENT CHROMIUM

(Adopted July 20, 1988)

11-8-100 GENERAL

11-8-101 Description: The purpose of this Rule is to control emissions of hexavalent chromium to the atmosphere from the following sources: hard chrome plating, decorative chrome plating, and chromic acid anodizing.

11-8-102 Exemption, Trivalent Chromium: The provisions of this Rule do not apply to operations which do not use hexavalent chromium.

11-8-200 DEFINITIONS

11-8-201 Chrome Plating: The process by which chromium is electrodeposited from a solution containing compounds of chromium onto a substrate in order to provide either a decorative surface or a corrosion- and wear-resistant surface.

11-8-202 Chromic Acid Anodizing: The electrolytic process by which a metal surface is converted to an oxide in a solution containing chromic acid.

11-8-203 Decorative Chrome Plating: A chrome plating process resulting in the deposition of a chrome layer 1 micron (0.04 mil) thick or less.

11-8-204 Emission: A gas or liquid stream containing one or more air contaminants. The verb form, emit, means the act of discharging an emission into the atmosphere. Includes fugitive emissions and secondary emissions from wastewater treatment.

11-8-205 Emissions Collection System: A device or apparatus used to gather hexavalent chromium emissions from the surface of a chrome plating or anodizing tank. An emissions collection system typically consists of hoods, ducting, and fan, and may collect emissions from one or more plating tanks.

11-8-206 Hard Chrome Plating: A chrome plating process resulting in the deposition of a chrome layer greater than 1 micron (0.04 mil) thick.

11-8-207 Mist Suppressant: A chemical additive which reduces the emission rate of hexavalent chromium from a plating bath. A mist suppressant may operate by reducing the surface tension of the plating bath, by creating a layer of dense foam over the entire surface of the bath, or by a combination of these effects.

11-8-300 STANDARDS

11-8-301 Decorative Chrome Plating: A person shall not operate a decorative chrome plating tank unless one of the following control techniques is applied:

301.1 A mist suppressant is continuously maintained in the tank in a manner which has been demonstrated to the satisfaction of the APCO to reduce emissions of hexavalent chromium by 95 percent or more relative to emissions when a mist suppressant is not used.

301.2 A layer of plastic balls is continuously maintained in the tank in a manner which has been demonstrated to the satisfaction of the APCO to reduce emissions of hexavalent chromium by 95 percent or more relative to emissions when plastic balls are not used.

301.3 An equivalent method approved by the APCO is applied.

11-8-310 **Hard Chrome Plating and Chromic Acid Anodizing:** A person shall not operate a hard chrome plating tank or chromic acid anodizing tank unless the emissions of hexavalent chromium from the emissions collection system serving the tank have been reduced to less than the following levels:

310.1 Emissions of hexavalent chromium from hard chrome plating and chromic acid anodizing shall not exceed 0.15 milligrams (mg) of hexavalent chromium per ampere-hour of electrical current applied to the tank(s) served by the emissions collection system.

310.2 If total facility-wide emissions of hexavalent chromium from hard chrome plating and chromic acid anodizing are more than 2 pounds per year, but less than 10 pounds per year, the limit is 0.03 milligrams (mg) of hexavalent chromium per ampere-hour of electrical current applied to the tank(s) served by the emissions collection system.

310.3 If total facility-wide emissions of hexavalent chromium from hard chrome plating and chromic acid anodizing are more than 10 pounds per year, the limit is 0.006 milligrams (mg) of hexavalent chromium per ampere-hour of electrical current applied to the tank(s) served by the emissions collection system.

11-8-330 **Minimum Acceptable Stack Design:** A person shall not operate a source subject to Section 11-8-310 unless all exhausted emissions are emitted through a stack no less than 10 meters above grade at a velocity of no less than 10 meters/second.

11-8-400 ADMINISTRATIVE REQUIREMENTS

11-8-401 **Compliance Schedule:** Any person subject to this Rule shall comply with the following increments of progress:

401.1 January 1, 1989: Any person subject to Section 11-8-301 shall submit to the APCO a description of the method used to achieve compliance. The description shall identify, operating parameters such as chemical concentrations, bath temperatures, or any other parameter identified by the APCO, which must be maintained in order to comply with this Rule.

401.2 January 1, 1989: Any person subject to Section 11-8-310 shall submit to the APCO an application for an authority to construct equipment to meet the requirements of Section 11-8-310.1, or demonstrate through an approved source test that the source is already in compliance.

401.3 July 1, 1991: Any person subject to Sections 11-8-310.2 or 11-8-310.3 shall submit to the APCO an application for an authority to construct equipment to meet the requirements of Sections 11-8-310.2 and 11-8-310.3.

401.4 July 1, 1990: Any person subject to Section 11-8-310.2 or 11-8-310.3 shall submit to the APCO a report describing control techniques, including modifications of operating practices, processes or equipment, that that person considered. The report shall include the reasons for non-utilization of any control technique considered. All control techniques identified by the APCO prior to January 1, 1990, shall be considered.

11-8-402 **Effective Dates:**

402.1 Section 11-8-301 is effective January 1, 1989.

402.2 Section 11-8-310.1 is effective January 1, 1990.

402.3 Sections 11-8-310.2 and 310.3 are effective July 1, 1992.

11-8-403 **Demonstration of Compliance:** Compliance with Section 11-8-310 shall be determined by the following procedure: The actual emission factor (expressed in mg/amp-hour) for the equipment in question shall be measured per Section 11-8-602. Allowable annual electricity usage, in amp-hours, shall be calculated based on the

measured factor. The operating permit shall be conditioned to reflect the allowable electricity usage and operating conditions.

11-8-404 **Initial Demonstration of Compliance:** Any person subject to Section 11-8-310 shall, within 60 days of the effective date of the appropriate Section, or within 60 days of startup of the plating operation, whichever is later, perform a source test to determine the hexavalent chromium emission factor and submit the results to the APCO.

11-8-500 MONITORING AND RECORDS

11-8-501 **Usage Records:** Any person subject to this Rule shall keep monthly records of current applied to the plating baths integrated over time, in units of amp-hours.

11-8-502 **Operating Parameter Records:** Any person subject to Section 11-8-401.1 shall maintain records of chemical concentrations, bath temperatures, or any other measurements recommended by manufacturer's specification or the APCO.

11-8-503 **Reporting:** Any person subject to this Rule shall submit records of current consumption to the APCO on an annual basis, and shall maintain such records for at least one year following submittal. Sufficient information shall be provided to allow separate determination of compliance for each emissions collection system.

11-8-600 MANUAL OF PROCEDURES

11-8-601 **Determination of Emissions:** Emissions of hexavalent chromium shall be determined by multiplying the measured amp-hours of usage by the emission factor measured pursuant to Section 11-8-602.

11-8-602 **Determination of Emission Factor:** The hexavalent chromium emission factor (mg/amp-hr) shall be measured as prescribed in the Manual of Procedures, Volume IV, ST-35.

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

1 APPLICABILITY, PRINCIPLE, AND FIGURES

1. 1 APPLICABILITY

This method applies to the determination of hexavalent chromium (Cr(VI)) and total chromium emissions from stationary sources. Applicability has been demonstrated for the metal finishing and glass industries. Its applicability has not been demonstrated for sources with high particulate mass emission rates.

1. 2 PRINCIPLE

Particulate emissions are collected from the source in an alkaline medium by use of CARB Method 5, with modifications noted in this method. The components of the collected sample are each divided into two equal portions with one portion of each component used for total chromium analysis and the other portion used for hexavalent chromium analysis.

1. 2. 1 Hexavalent Chromium Analysis

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

1. 2. 2 Total Chromium Analysis

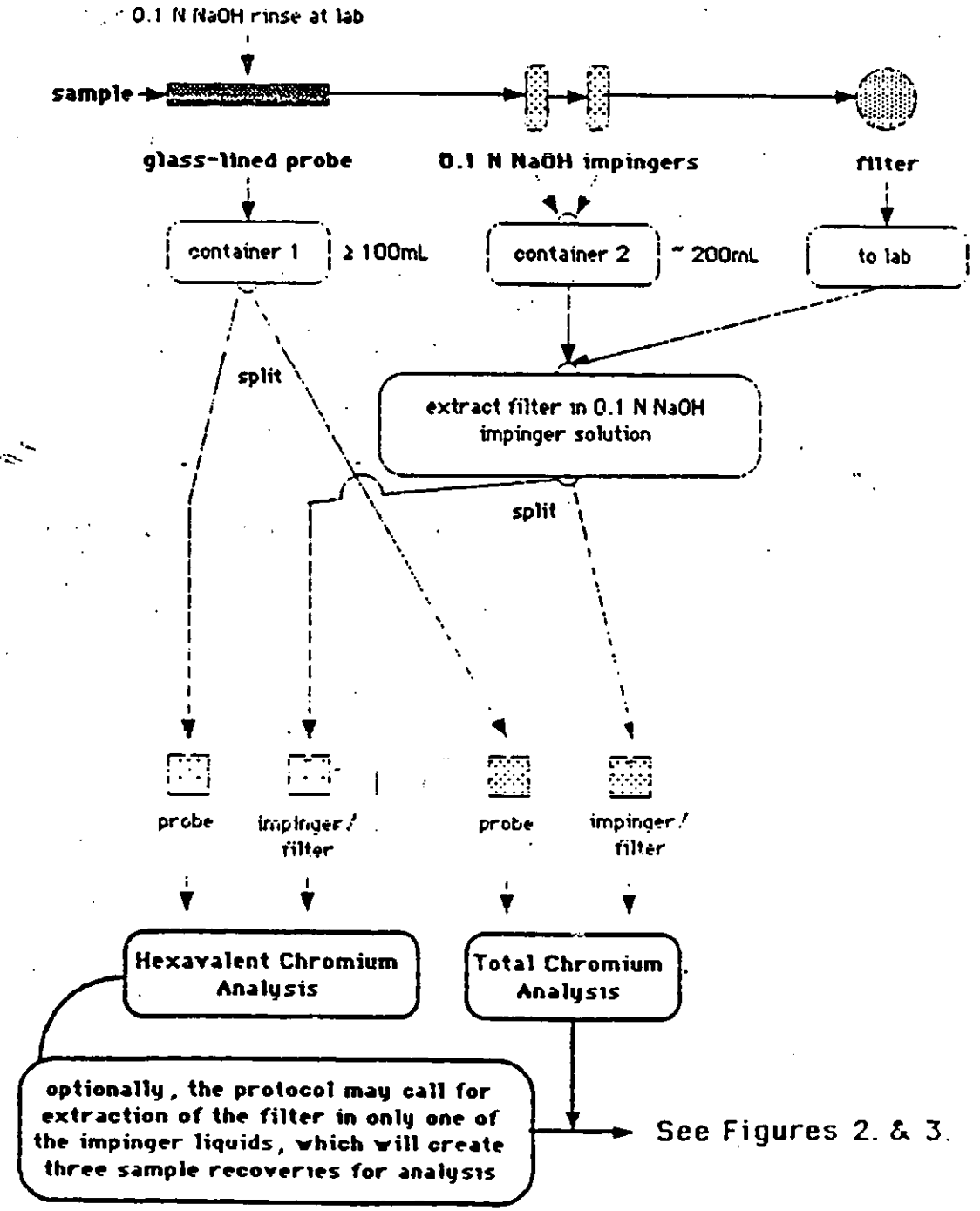
For the total chromium analysis the collected samples must be prepared in order to convert organic forms of chromium to inorganic forms, to minimize organic interferences, and to convert the sample to a suitable solution for analysis. Samples are then subjected to an acid digestion procedure. Following the appropriate dissolution and dilution 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.

1. 3 FIGURES

The following figures summarize features of this method.

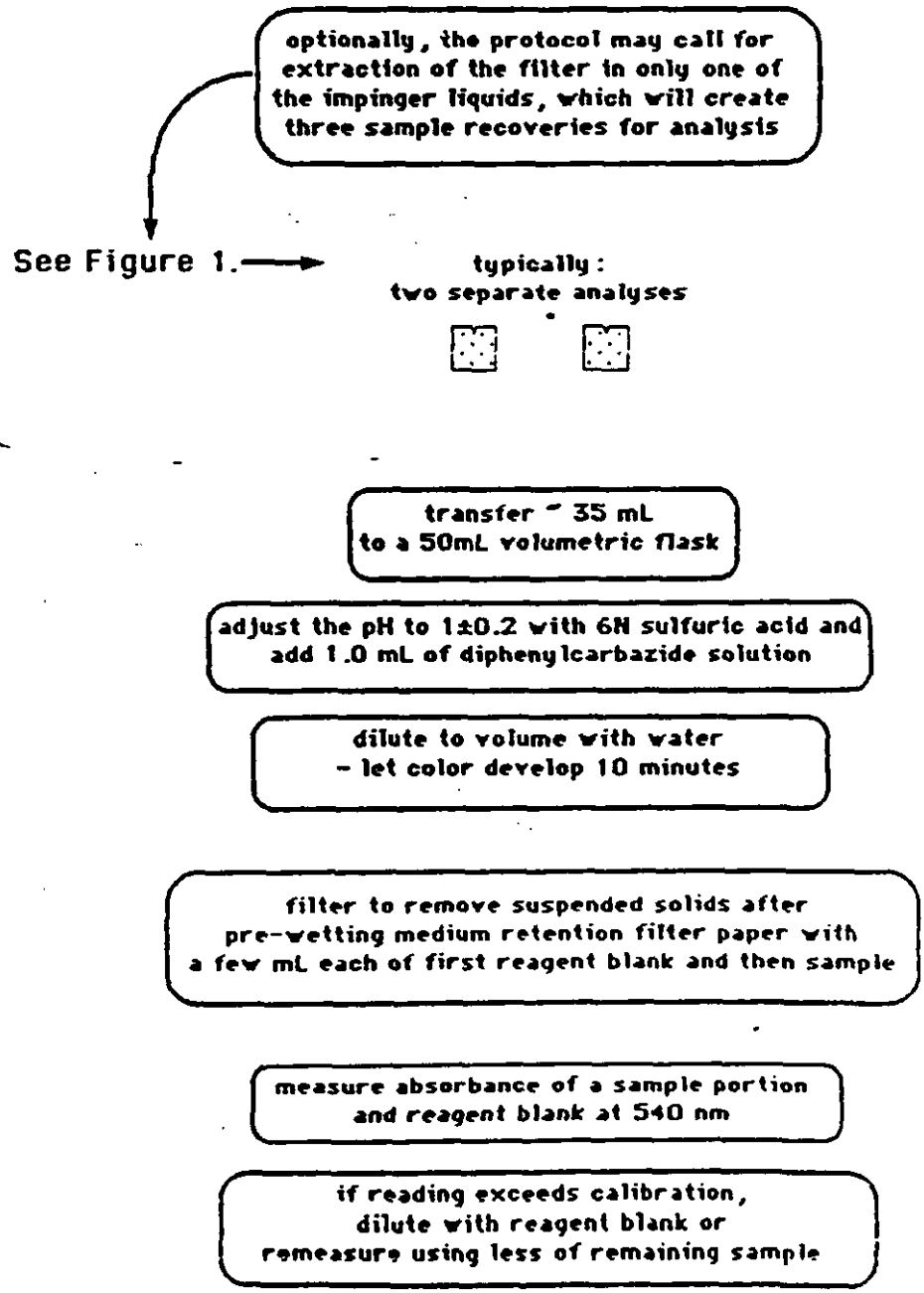
1. 3. 1 Figure 1.

Sample Collection and Recovery for Hexavalent and Total Chromium



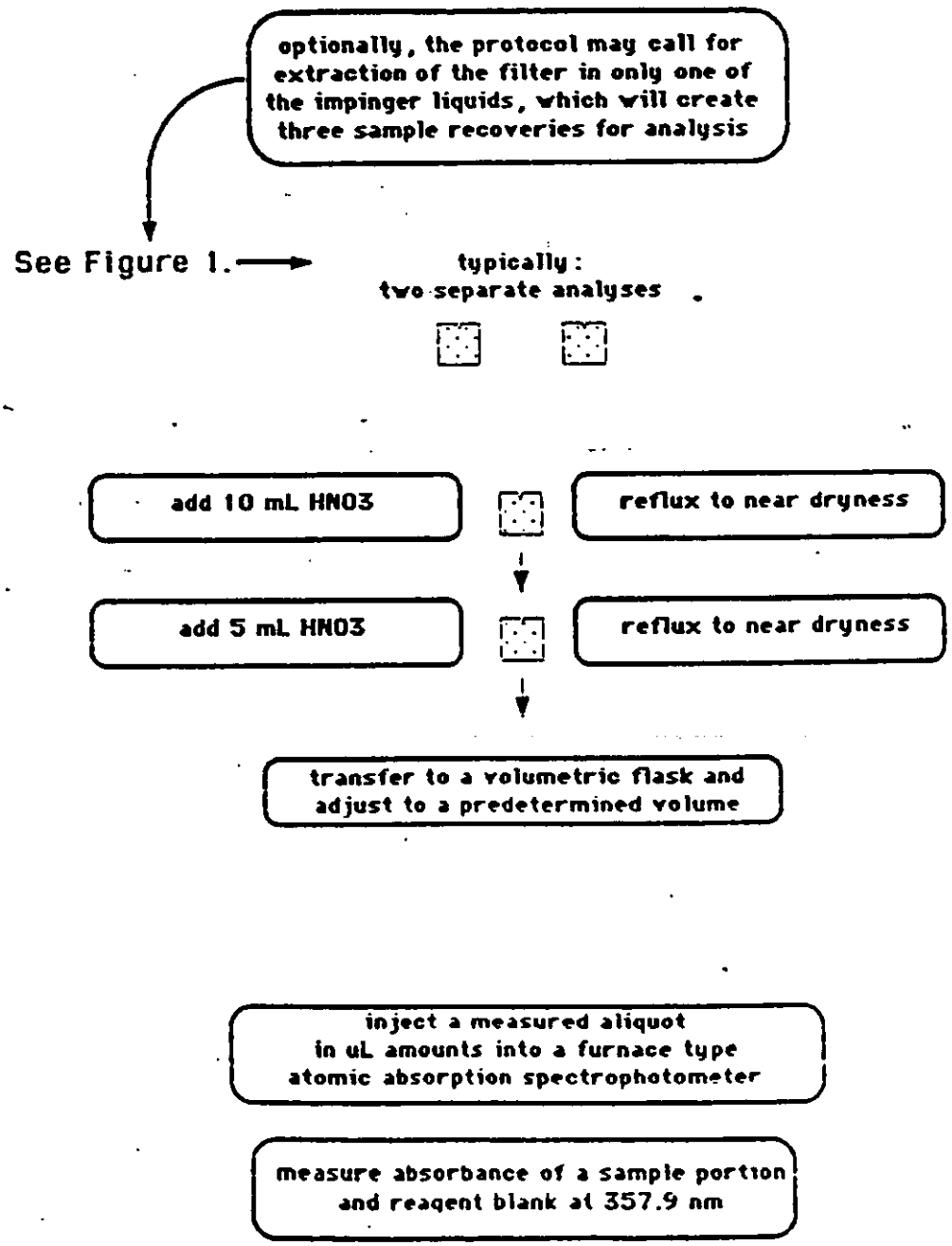
1. 3. 2 Figure 2.

Hexavalent Chromium Analysis



1. 3. 3 Figure 3.

Total Chromium Analysis



2 RANGE, SENSITIVITY, PRECISION, AND INTERFERENCES

2. 1 RANGE

2. 1. 1 Hexavalent Chromium

A straight line response curve was obtained in the range 0.5 ug Cr(VI)/50 mL to 3.0 ug Cr(VI)/50 mL. For a minimum analytical accuracy of 100 ± 10 percent, the lower limit of the range is 2 ug/100mL. The upper limit can be extended by appropriate dilution or by using a smaller cell path length after recalibration for the smaller cell. (Reference 8.3)

2. 2 SENSITIVITY

The minimum sampling volume should be calculated for each test and should be based upon [1] the targeted minimum detectable concentration at the source, [2] the expected minimum detection limit achievable at the laboratory, and [3] the sampling time limitations at the source.

2. 2. 1 Hexavalent Chromium

A minimum detection limit, of 0.2 ug Cr(VI)/50mL using a 5 cm cell, has been observed. (Reference 8.3)

2. 3 PRECISION FOR HEXAVALENT CHROMIUM

The overall precision for sample collection and analysis for Cr(VI) will be determined after data are collected from a test protocol which includes multiple simultaneous sampling techniques.

2. 4 INTERFERENCES

2. 4. 1 Interferences of Hexavalent Chromium

Molybdenum, mercury and vanadium react with diphenylcarbazide 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.

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. This step may be omitted if the sample is known to be free of calcium or no analytical interferences are expected.

2. 5 ALTERNATIVE METHODS

Direct Measurement of Gas Volumes through Pipes and Small Ducts

Air Resources Board Method 2A may be used, where applicable, as an alternative to pitot tube methods specified in Method 5, as referenced herein.

Total Chromium Determination by Flame Atomic Absorption Spectroscopy

For high total chromium concentrations which are within the detection range of flame atomic absorption spectroscopy, this analytical method may be used instead of the furnace type method specified in these pages.

Other Methods

The Executive Officer or authorized representative may approve an alternative test method (including other techniques or conditions) for the determination of hexavalent and/or total chromium emissions from stationary sources. To approve an alternative method, the Executive Officer or authorized representative may require the submission of test data demonstrating that the alternative method is equivalent to Method 425.

3 APPARATUS

All surfaces which may come in contact with sample must be glass, Teflon, or other similarly non-metallic (stainless steel may be a source of chromium contamination) inert material. See Section 5.2.

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

Except where otherwise noted in this method, same as CARB Method 5, Section 2.1. Exceptions include a glass nozzle, a glass lined stainless steel probe, 0.1 N NaOH in the first two impingers, a Teflon-coated glass fiber filter, and a silica gel moisture trap after the filter. As shown in Figure 1, sample flow should be through the probe first, then the impingers, and then the filter.

3. 2 SAMPLE RECOVERY

Except where otherwise noted in this method, same as CARB Method 5, Section 2.2. Also, see Section 6. 2 of this method.

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 digestion 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 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

Except where otherwise noted in this method, same as CARB method 5, Section 3.1, except Teflon-coated glass fiber filters are used, and 0.1 N NaOH is used in the first two impingers. See section 4.3.2 below.

4. 2 SAMPLE RECOVERY

Except where otherwise noted in this method, same as CARB Method 5, Section 3.2.

4. 3 REAGENTS FOR HEXAVALENT CHROMIUM

4. 3. 1 Type II Water

Type II water is deionized and 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 Batch of 0.1% NaOH Solution, Analytical Reagent Grade

The same batch of 0.1N NaOH solution should be used for impinger sampling, sample recovery, preparation, extraction, and analysis. Therefore, sampling and analytical personnel should coordinate their plans so that all steps in sampling and analysis use the same batch of solution which will be prepared fresh for each source test. Typically, dissolve 4.0 g NaOH in water in a 1 liter volumetric flask and dilute to the mark. Repeat, as necessary, so that a single batch of

sufficient volume is prepared to serve all of the needs of sampling and analysis. Store the solution in a tightly capped polyethylene bottle.

4. 3. 3 Potassium Dichromate Stock Solution

Dissolve 2.829 g of analytical reagent grade potassium dichromate ($K_2Cr_2O_7$) in water, and dilute to 1 liter (1 mL = 1000 ug Cr(VI)).

4. 3. 4 Potassium Dichromate Standard Solution

Dilute 10.00 mL potassium dichromate stock solution to 100 mL (1 mL = 100 ug Cr(VI) with water.

4. 3. 5 Sulfuric Acid, 6N, Analytical Reagent Grade

Dilute 166 mL sulfuric acid to 1000 mL in water.

4. 3. 6 Diphenylcarbazide Solution, Analytical Reagent Grade

Dissolve 0.5 g of 1,5-diphenylcarbazide in 100 mL acetone. Store in a brown bottle. Discard when the solution becomes discolored.

4. 3. 7 0.1% Potassium Permanganate Solution

Analytical Reagent Grade

4. 3. 8 0.01% Potassium Permanganate Solution

Analytical Reagent Grade

4. 3. 9 Removal of Reducing Agents in the Reagents

The 0.1 N NaOH extraction solution (4.3.2) and the 6N sulfuric acid solution (4.3.5) 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 (4.3.8) to 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 (4.3.7) 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.

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

4.4.2.1 Reagent preparation should use Ultrex or equivalent grade HNO_3.

4.4.2.2 Glassware cleaning should use ACS reagent grade HNO_3.

4.4.3 Hydrogen Peroxide (30%) (Optional), Analytical Reagent Grade

4.4.4 Matrix Modifier

Follow manufacturer's recommendations, when interferences are suspected.

4.4.5 Total 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, or 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 Total Chromium Working Standards

All total chromium preparations injected for analysis shall be prepared to contain 1.0% (v/v) HNO_3. The zero standard shall be 1.0 % (v/v) HNO_3.

5 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

5.1 SAMPLE COLLECTION

Except where otherwise indicated in this method, all samples are collected from the source by use of CARB Method 5. Exceptions include a glass nozzle, a glass lined stainless steel probe, 0.1 N NaOH in the first two impingers, and a Teflon-coated glass fiber filter. As shown in Figure 1, sample flow should be through the probe first, then the impingers, and then the filter.

5.2 SAMPLE HANDLING AND PRESERVATION

All surfaces which may come in contact with sample must be glass, Teflon, or other similarly non-metallic (even stainless steel may

be a source of chromium contamination) inert material and must be prewashed with detergents, soaked in 1:1 HNO_3 for several hours, rinsed with Type II water, and finally rinsed with 0.1 N NaOH batch solution. For awkward objects, such as long glass probes, soaking may be replaced by careful wiping.

Probes are generally the most difficult sampling apparatus to clean. Therefore, before use in sampling, to ensure that sampling equipment is clean and free of chromium contamination, apparatus which may come in contact with sample must be cleaned until a sample of final rinse for each probe has been analyzed as below the detection limit for total chromium. The procedures of Section 6 shall be followed for this contamination check.

6 PROCEDURES FOR SAMPLE RECOVERY, PREPARATION, AND ANALYSIS

6. 1 SILICA GEL WEIGHING

For stack gas moisture determination, weigh the spent silica gel or silica gel plus impinger to the nearest 0.5 g using a balance. This step may be conducted in the field.

6. 2 SAMPLE COLLECTION AND RECOVERY

The sample is collected using probe, impingers, and filter.

6. 2. 1 Probe

The probe is rinsed with 0.1 N NaOH. The total rinse volume should exceed 100 mL and be stored in container 1. The probe rinse is transported to a site with laboratory conditions where it is split with half saved for hexavalent chromium analysis and half saved for total chromium analysis. Each sample split is ~50mL.

6. 2. 2 Impingers and Filter

The sampling and analytical personnel shall discuss the expected sample concentrations and the analytical limits of detection for hexavalent and total chromium. The impinger catch and filter should be handled one of two ways depending on these expectations as directed in Sections 6.2.2.1 and 6.2.2.2 below.

6. 2. 2. 1 Higher Concentrations

If it <u>is not</u> considered important to minimize the dilution of any sample component, then the contents of both impingers (~200mL total) shall be combined and stored in container 2. As soon as possible, the filter is transported in a filter container to a site with laboratory conditions where it should be extracted in all of the impinger solution from container 2. The extraction should include shaking for a minimum of 30 minutes. The alkaline

impinger medium will retard reduction of hexavalent chromium. The extract solution is split with half saved for hexavalent chromium analysis and half saved for total chromium analysis. Each sample split is ~100 mL.

6. 2. 2. 2 Lower Concentrations

If it is considered important to minimize the dilution of any sample component, then the contents of each impinger (~100mL each) may be stored in containers 2 and 3. The filter shall be extracted in only one of the impinger contents, whichever is suspected to have the higher concentration. The extraction shall include shaking for a minimum of 30 minutes. The contents of the first impinger are stored in container 2 and those of the second impinger in container 3. Whichever impinger contents are not used for extraction must be handled as a third sample recovery requiring separate analyses. Both sample recoveries are split as described above. Each sample split is ~50 mL.

6. 3 REAGENT BLANK PREPARATION

Hexavalent Chromium Reagent Blank

For each preparation, transfer 35 mL of solution to a 50mL volumetric flask, adjust the pH to 1.0 ± 0.2 with 6N sulfuric acid, add 1.0 mL of diphenylcarbazide solution, dilute to volume with water, and let color develop for 10 minutes.

Total Chromium Reagent Blank

For total chromium, the reagent blank is simply 1 % HNO_3.

6. 4 SAMPLE PREPARATION

6. 4. 1 Hexavalent Chromium Sample Preparation

For each preparation, transfer 35 mL of solution to a 50mL volumetric flask, adjust the pH to 1.0 ± 0.2 with 6N sulfuric acid, add 1.0 mL of diphenylcarbazide solution, dilute to volume with water, and let color develop for 10 minutes. (This leaves at least 15 mL of sample split for further analyses. The total volume of sample split must be known at this point.)

6. 4. 2 Total Chromium Sample Preparation

In a beaker, add 10ml of concentrated nitric acid to the sample aliquot taken for analysis. Cover the beaker with a digestion cover. Place the beaker on a hot plate and reflux the sample down to near dryness. Add another 5mL nitric acid to complete digestion. Reflux the sample volume down to near dryness.

Wash down the beaker walls and digestion cover 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 final concentration of HNO_3 in the solution should be 1 % (v/v). 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. 5 ANALYSIS

6. 5. 1 Hexavalent Chromium Analysis

The analyst must filter the preparation for clarity at this point. Medium retention filter paper should be used. The filter paper shall be pre-wetted with a few mL of reagent blank and sample preparation before filling the absorption cell. This will prime the filter so that it won't absorb color complex while the absorption cell is filled.

Transfer a and filter a portion of the preparation into a 5 cm absorption cell.

Measure the absorbance at the optimum wavelength of 540 nm.

Subtract the sample blank absorbance reading to obtain a net reading.

If the absorbance reading of a sample preparation exceeds the calibration range, dilute with reagent blank or re-measure using less of the sample preparation. (There should be about 15mL remaining at this point. See Sections 6.2.1, 6.2.2.1, and 6.2.2.2.)

6. 5. 2 Check for Matrix Effects on the Cr(VI) Results

As the analysis for Cr(VI) 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 following method: Obtain two equal volume aliquots of the same sample solution. The aliquots should each contain between 6 and 10 ug of Cr(VI) (less if not possible). Spike one of the aliquots with an aliquot of standard solution that contains between 6 and 10 ug of Cr(VI). Now treat both the spiked and unspiked sample aliquots as described in Section 6.4.1 above. Next, calculate the Cr(VI) 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(VI) 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 this method 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 the method of standard additions procedure.

6. 5. 3 Total Chromium Analysis

The 357.9-nm wavelength line shall be used.

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

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 matrices.

Inject a measured uL aliquot of preparation into the furnace and atomize. If the concentration found exceeds the calibration range, 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.

Subtract a sample blank reading from a sample reading to obtain a net reading.

7 CALIBRATION, QUALITY CONTROL, AND DATA REPORTING

7. 1 GENERAL

Perform all of the calibrations described in CARB Method 5, Section 5, with any modifications appropriate for this method.

7. 2 CALIBRATION AND QUALITY CONTROL FOR HEXAVALENT CHROMIUM

7. 2. 1 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 Institute of Standards and Technology. 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.

7. 2. 2 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(VI) standard solution in the sample cell and a reagent 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 reagent 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 reagent blank occurs.

7. 2. 3 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) if necessary, for the method of standard additions, plot added concentration versus absorbance.

7. 2. 4 Each standard for hexavalent chromium is made up fresh in a separate 50mL volumetric flask starting with 35 mL of the same batch of NaOH solution reserved for its sample set. Then an appropriate amount of hexavalent chromium is added to each calibration standard, starting with none for the zero standard. Then 6N sulfuric acid and diphenylcarbazide solution are added in the same manner as in sample preparation.

7. 3 CALIBRATION AND QUALITY CONTROL FOR TOTAL CHROMIUM

7. 3. 1 Either (1) run a series of chromium standards and reagent blanks 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.

Calibration standards for total chromium should start with 1% v/v HNO_3 with no chromium for the zero standard with appropriate increases in total chromium concentration in the other calibration standards. The calibration standards should be prepared following the steps outlined in sample preparation.

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 a significant change in the signal for the standards 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 (1) by 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 reagent blank and three total chromium standards. A calibration curve should be made for every batch of samples, unless check standards remain within 10% of the last calibration curve.

7. 3. 6 Dilute samples with reagent blank solution 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 matrix-matched sample blank per sample batch to determine if contamination or any memory effects are occurring.

7. 3. 8 Test the system with check standards after approximately every 15 samples.

7. 3. 9 Run one duplicate sample for every 10 samples, providing there is enough sample for duplicate analysis. A duplicate sample is a sample brought through the whole sample preparation.

7. 3.10 Spiked samples or standard reference materials shall be used daily to ensure that correct procedures are being followed and that all equipment is operating properly. This will serve as a check on calibration standards, too.

7. 3.11 Whenever sample matrix problems are suspected, the method of standard additions shall be used for the analysis of all 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 DATA REPORTING

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(VI) in Sample

Calculate and report m_h, the total ug Cr(VI) in the sample. This can be obtained from the calibration curve or from the method of standard additions. Note that m_h is the sum of the masses of hexavalent chromium analyses performed on all sample splits. Also take in account the dilutions when calculating m_h.

Report these calculations based on net readings, but report all sample blank data, too.

7. 4. 2 Total Chromium in the Sample

Calculate and report m_t, 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_t is the sum of the masses of total chromium analyses performed on all sample splits. Also take into account the necessary dilutions when calculating out m_t.

Report these calculations based on net readings, but report all sample blank data, too.

7. 4. 3 Average Dry Gas Meter Temperature and Average Orifice Pressure Drop

Except where otherwise noted in this method, same as Method 5, Section 6.2.

7. 4. 4 Dry Gas Volume, Volume of Water Vapor, Moisture Content

Except where otherwise noted in this method, same as Method 5, Sections 6.3, 6.4, and 6.5, respectively.

7. 4. 5 Cr(VI) Emission Concentration

Calculate and report $[h]_s$ (g/dscm), the Cr(VI) concentration in the stack gas, dry basis, corrected to standard conditions, as follows:

$$[h]_s = (10^{-6}\text{g/ug})(m_h/V_{m(std)})$$

7. 4. 6 Total Chromium Emission Concentration

Calculate and report $[t]_s$ (g/dscm), the total chromium concentration in the stack gas, dry basis, corrected to standard conditions as follows:

$$[t]_s = (10^{-6}\text{g/ug})(m_t/V_{m(std)})$$

7. 4. 7 Isokinetic Variation, Acceptable Results

Except where otherwise noted in this method, same as Method 5, Sections 6.11 and 6.12, respectively.

8 REFERENCES

8. 1 US. Environmental Protection Agency/Office of Solid Waste, Washington, D.C., "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, "SW-846 (1986), Third Edition.

8. 2 Same as in Bibliography of Method 5, Citations 2 to 6 and 7.

8. 3 California Air Resources Board, Inorganic Analysis Section. (1988)

APPENDIX G

EQUIPMENT CALIBRATION SHEETS

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BOX NUMBER: 12
DATE: 11-08-1989 PRE TEST
BAROMETRIC PRESSURE: 30.060
OPERATOR: Miller

LEAKRATE (CFM): 0.000

--------*----*----*----*----*----*----*

Delta-H = 5.00

Vw	Td
0.0	83.0
1.0	85.0
2.0	87.0
3.0	88.0
4.0	89.0
5.0	90.0

Dry Gas Meter Average Temp.... 87.0
Wet Test Meter Average Temp... 74.0

Vd(initial) 707.212
Vd(final) 712.318
Net Dry Gas Meter Vol..... 5.106
Net Wet Test Meter Vol..... 5.000
Run Time (min.sec) 4.12

GAMMA 0.991
DH@ 1.940

--------*----*----*----*----*----*----*

Delta-H = 3.00

Vw	Td
0.0	86.0
1.0	87.0
2.0	88.0
3.0	89.0
4.0	90.0
5.0	90.0

Dry Gas Meter Average Temp.... 88.3
Wet Test Meter Average Temp... 74.0

Vd(initial) 713.332
Vd(final) 718.443
Net Dry Gas Meter Vol..... 5.111
Net Wet Test Meter Vol..... 5.000
Run Time (min.sec) 5.23

GAMMA 0.997
DH@ 1.907

--------*----*----*----*----*----*--G=1

BOX 12 · 11/8/89

Delta-H = 2.00

Vw	Td
0.0	83.0
1.0	84.0
2.0	85.0
3.0	85.0
4.0	86.0
5.0	87.0

Dry Gas Meter Average Temp.... 85.0
Wet Test-Meter Average Temp... 73.0

Vd(initial) 682.809
Vd(final) 687.881
Net Dry Gas Meter Vol..... 5.072
Net Wet Test Meter Vol..... 5.000
Run Time (min.sec) 6.36

GAMMA 1.003
DH@ 1.916

Delta-H = 1.00

Vw	Td
0.0	80.0
1.0	82.0
2.0	83.0
3.0	83.0
4.0	84.0
5.0	85.0

Dry Gas Meter Average Temp.... 82.8
Wet Test Meter Average Temp... 74.0

Vd(initial) 693.982
Vd(final) 699.075
Net Dry Gas Meter Vol..... 5.093
Net Wet Test Meter Vol..... 5.000
Run Time (min.sec) 9.01

GAMMA 0.996
DH@ 1.802

BOX 12 11/8/89

Delta-H = 0.50

Vw	Td
0.0	83.0
1.0	83.0
2.0	84.0
3.0	84.0
4.0	84.0
5.0	85.0

Dry Gas Meter Average Temp.... 83.8
Wet Test-Meter Average Temp... 74.0

Vd(initial) 700.088
Vd(final) 705.184
Net Dry Gas Meter Vol..... 5.096
Net Wet Test Meter Vol..... 5.000
Run Time (min.sec) 12.35

GAMMA 0.998
DH@ 1.751

BOX NUMBER: 14
DATE: 02-15-1990 PRETEST
BAROMETRIC PRESSURE: 30.130
OPERATOR: R.T.M.

LEAKRATE (CFM): 0.000

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Delta-H = 5.00

Vw	Td
0.0	79.0
1.0	78.0
2.0	78.0
3.0	79.0
4.0	79.0
5.0	79.0

Dry Gas Meter Average Temp.... 78.7
Wet Test Meter Average Temp... 60.0

Vd(initial) 139.879
Vd(final) 144.963
Net Dry Gas Meter Vol..... 5.084
Net Wet Test Meter Vol..... 5.000
Run Time (min.sec) 3.59

GAMMA 1.007
DH@ 1.676

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Delta-H = 3.00

Vw	Td
0.0	76.0
1.0	75.0
2.0	76.0
3.0	76.0
4.0	76.0
5.0	77.0

Dry Gas Meter Average Temp.... 76.0
Wet Test Meter Average Temp... 60.0

Vd(initial) 145.986
Vd(final) 151.083
Net Dry Gas Meter Vol..... 5.097
Net Wet Test Meter Vol..... 5.000
Run Time (min.sec) 4.56

GAMMA 1.004
DH@ 1.550

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BOX 14 2/15/90

Delta-H = 2.00

Vw	Td
0.0	75.0
1.0	74.0
2.0	75.0
3.0	75.0
4.0	75.0
5.0	76.0

Dry Gas Meter Average Temp.... 75.0
Wet Test Meter Average Temp... 60.0

Vd(initial) 152.108
Vd(final) 157.209
Net Dry Gas Meter Vol..... 5.101
Net Wet Test Meter Vol..... 5.000
Run Time (min.sec) 6.02

GAMMA 1.004
DH@ 1.549

Delta-H = 1.00

Vw	Td
0.0	73.0
1.0	73.0
2.0	73.0
3.0	73.0
4.0	73.0
5.0	74.0

Dry Gas Meter Average Temp.... 73.2
Wet Test Meter Average Temp... 60.0

Vd(initial) 158.237
Vd(final) 163.350
Net Dry Gas Meter Vol..... 5.113
Net Wet Test Meter Vol..... 5.000
Run Time (min.sec) 8.22

GAMMA 1.000
DH@ 1.494

BOX 14 2/15/90

Delta-H = 0.50

Vw	Td
0.0	72.0
1.0	72.0
2.0	72.0
3.0	72.0
4.0	72.0
5.0	72.0

Dry Gas Meter Average Temp....	72.0
Wet Test-Meter Average Temp...	60.0
Vd(initial)	164.370
Vd(final)	169.485
Net Dry Gas Meter Vol.....	5.115
Net Wet Test Meter Vol.....	5.000
Run Time (min.sec)	11.40
GAMMA	0.999
DH@	1.456

BOX NUMBER: 12
DATE: 03-12-1990 POST TEST
OPERATOR: tommy

DH	GAMMA	DH@
5.00	0.991	1.914
3.00	0.993	1.887
2.00	0.998	1.911
1.00	0.992	1.827
0.50	0.995	1.727

LEAKRATE (CFM) = 0.000

BOX NUMBER: 12 POST TEST
DATE: 03-12-1990
BAROMETRIC PRESSURE: 31.020
OPERATOR: tommy

LEAKRATE (CFM): 0.000

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Delta-H = 5.00

Vw	Td
0.0	79.0
1.0	78.0
2.0	80.0
3.0	81.0
4.0	81.0
5.0	82.0

Dry Gas Meter Average Temp.... 80.2
Wet Test Meter Average Temp... 63.0

Vd(initial) 845.423
Vd(final) 850.573
Net Dry Gas Meter Vol..... 5.150
Net Wet Test Meter Vol..... 5.000
Run Time (min.sec) 4.18

GAMMA 0.991
DH@ 1.914

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Delta-H = 3.00

Vw	Td
0.0	80.0
1.0	80.0
2.0	81.0
3.0	81.0
4.0	82.0
5.0	82.0

Dry Gas Meter Average Temp.... 81.0
Wet Test Meter Average Temp... 63.0

Vd(initial) 851.595
Vd(final) 856.768
Net Dry Gas Meter Vol..... 5.173
Net Wet Test Meter Vol..... 5.000
Run Time (min.sec) 5.31

GAMMA 0.993
DH@ 1.887

BOX 12 3/12/90

Delta-H = 2.00

Vw	Td
0.0	81.0
1.0	80.0
2.0	81.0
3.0	81.0
4.0	82.0
5.0	82.0

Dry Gas Meter Average Temp.... 81.2
Wet Test Meter Average Temp... 63.0

Vd(initial) 857.807
Vd(final) 862.968
Net Dry Gas Meter Vol..... 5.161
Net Wet Test Meter Vol..... 5.000
Run Time (min.sec) 6.48

GAMMA 0.998
DH@ 1.911

Delta-H = 1.00

Vw	Td
0.0	81.0
1.0	80.0
2.0	80.0
3.0	81.0
4.0	81.0
5.0	82.0

Dry Gas Meter Average Temp.... 80.8
Wet Test Meter Average Temp... 64.0

Vd(initial) 864.009
Vd(final) 869.199
Net Dry Gas Meter Vol..... 5.190
Net Wet Test Meter Vol..... 5.000
Run Time (min.sec) 9.23

GAMMA 0.992
DH@ 1.827

BOX 12 3/12/90

Delta-H = 0.50

Vw	Td
0.0	80.0
1.0	80.0
2.0	80.0
3.0	81.0
4.0	81.0
5.0	82.0

Dry Gas Meter Average Temp....	80.7
Wet Test Meter Average Temp...	64.0
Vd(initial)	869.199
Vd(final)	874.378
Net Dry Gas Meter Vol.....	5.179
Net Wet Test Meter Vol.....	5.000
Run Time (min.sec)	12.54
GAMMA	0.995
DH@	1.727

BOX NUMBER: 14
DATE: 03-08-1990 POST TEST
OPERATOR: wdp

DH	GAMMA	DH@
5.00	0.990	1.563
5.00	0.993	1.572
3.00	0.993	1.544
2.00	0.998	1.509
1.00	0.997	1.481
0.50	0.999	1.414

LEAKRATE (CFM) = 0.000

BOX NUMBER: 14
DATE: 03-08-1990 POST TEST
BAROMETRIC PRESSURE: 30.080
OPERATOR: wdp

LEAKRATE (CFM): 0.000

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Delta-H = 5.00

Vw	Td
0.0	78.0
1.0	78.0
2.0	79.0
3.0	80.0
4.0	80.0
5.0	81.0

Dry Gas Meter Average Temp.... 79.3
Wet Test Meter Average Temp... 68.0

Vd(initial) 188.155
Vd(final) 193.251
Net Dry Gas Meter Vol..... 5.096
Net Wet Test Meter Vol..... 5.000
Run Time (min.sec) 3.47

GAMMA 0.990
DH@ 1.563

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Delta-H = 5.00

Vw	Td
0.0	79.0
1.0	78.0
2.0	79.0
3.0	80.0
4.0	81.0
5.0	82.0

Dry Gas Meter Average Temp.... 79.8
Wet Test Meter Average Temp... 68.0

Vd(initial) 193.252
Vd(final) 198.338
Net Dry Gas Meter Vol..... 5.086
Net Wet Test Meter Vol..... 5.000
Run Time (min.sec) 3.48

GAMMA 0.993
DH@ 1.572

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BOX 14 3/8/90

Delta-H = 1.00

Vw	Td
0.0	78.0
1.0	78.0
2.0	79.0
3.0	79.0
4.0	80.0
5.0	80.0

Dry Gas Meter Average Temp.... 79.0
Wet Test Meter Average Temp... 68.5

Vd(initial) 211.578
Vd(final) 216.680
Net Dry Gas Meter Vol..... 5.102
Net Wet Test Meter Vol..... 5.000
Run Time (min.sec) 8.14

GAMMA 0.997
DH@ 1.481

Delta-H = 0.50

Vw	Td
0.0	79.0
1.0	79.0
2.0	79.0
3.0	80.0
4.0	80.0
5.0	80.0

Dry Gas Meter Average Temp.... 79.5
Wet Test Meter Average Temp... 68.5

Vd(initial) 217.702
Vd(final) 222.805
Net Dry Gas Meter Vol..... 5.103
Net Wet Test Meter Vol..... 5.000
Run Time (min.sec) 11.23

GAMMA 0.999
DH@ 1.414

BOX 14 3/8/90

Delta-H = 3.00

Vw	Td
0.0	76.0
1.0	76.0
2.0	77.0
3.0	77.0
4.0	78.0
5.0	78.0

Dry Gas Meter Average Temp.... 77.0
Wet Test Meter Average Temp... 68.0

Vd(initial) 199.354
Vd(final) 204.439
Net Dry Gas Meter Vol..... 5.085
Net Wet Test Meter Vol..... 5.000
Run Time (min.sec) 4.51

GAMMA 0.993
DH@ 1.544

Delta-H = 2.00

Vw	Td
0.0	78.0
1.0	78.0
2.0	79.0
3.0	79.0
4.0	80.0
5.0	80.0

Dry Gas Meter Average Temp.... 79.0
Wet Test Meter Average Temp... 68.0

Vd(initial) 205.466
Vd(final) 210.558
Net Dry Gas Meter Vol..... 5.092
Net Wet Test Meter Vol..... 5.000
Run Time (min.sec) 5.53

GAMMA 0.998
DH@ 1.509

S-TYPE PITOT TUBE CALIBRATION WORKSHEET PRETEST 15FEB90
CALIBRATED BY: JCR

S-TYPE NO.	PITOT SIDE	RUN NO.	VELOCITY PRESSURES NBS-STD (IN H2O)	S-TYPE (IN H2O)	CP(S)	MEAN	DEV.	COMMENTS
3-6	A	1	0.200	0.295	0.823	0.821	0.002	NO NOZZLE
		2	0.300	0.440	0.826		0.005	
		3	0.500	0.745	0.819		-0.002	
		4	0.700	1.050	0.816		-0.005	
3-6	B	1	0.200	0.290	0.830	0.818	0.012	NO NOZZLE
		2	0.300	0.460	0.808		-0.011	
		3	0.500	0.745	0.819		0.001	
		4	0.700	1.050	0.816		-0.002	
3-1	A	1	0.200	0.295	0.823	0.823	.000	NO NOZZLE
		2	0.300	0.420	0.845		0.022	
		3	0.500	0.765	0.808		-0.015	
		4	0.700	1.050	0.816		-0.007	
3-1	B	1	0.200	0.260	0.877	0.835	0.042	NO NOZZLE
		2	0.300	0.450	0.816		-0.018	
		3	0.500	0.765	0.808		-0.026	
		4	0.700	1.000	0.837		0.002	

S-TYPE PITOT TUBE CALIBRATION WORKSHEET POST-TEST 08MAR90
CALIBRATED BY: DAN

S-TYPE NO.	PITOT SIDE	RUN NO.	VELOCITY PRESSURES NBS-STD (IN H2O)	S-TYPE (IN H2O)	CP(S)	MEAN	DEV.	COMMENTS
3-6	A	1	0.177	0.280	0.795	0.792	0.003	NO NOZZLE
		2	0.320	0.506	0.795		0.003	
		3	0.500	0.795	0.793		0.001	
		4	0.810	1.300	0.789		-0.003	
		5	0.960	1.550	0.787		-0.004	
3-6	A	1	0.210	0.379	0.744	0.748	-0.003	3/8" QUARTZ
		2	0.310	0.554	0.748		.000	
		3	0.500	0.890	0.750		0.002	
		4	0.690	1.230	0.749		0.001	
		5	1.000	1.790	0.747		.000	
3-1	A	1	0.200	0.310	0.803	0.801	0.002	NO NOZZLE
		2	0.330	0.510	0.804		0.003	
		3	0.580	0.900	0.803		0.002	
		4	0.820	1.300	0.794		-0.007	
3-1	A	1	0.200	0.355	0.751	0.753	-0.002	3/8" QUARTZ
		2	0.290	0.510	0.754		0.002	
		3	0.490	0.870	0.750		-0.002	
		4	0.710	1.250	0.754		0.001	
		5	0.970	1.720	0.751		-0.002	
		6	1.700	2.980	0.755		0.003	

APPENDIX H

RESUMES OF TEST PERSONNEL

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RESUME

DREK A. NEWTON	Mechanical Engineer
1984	B.S. Mechanical Engineering Cal Poly State University San Luis Obispo, CA
1984-1986	Research and Development Engineer VETCO Offshore, Inc. Ventura, CA
1987-Present	Mechanical Engineer Coal/Air Department Naval Energy and Environmental Support Activity Port Hueneme, CA

RESUME

MANUEL L. PEREZ	SET Engineering Technician
1979-1980	Engineering Technician Aid Frequency Management Division Point Mugu, California
1981-1983	Student Aid Energy Office Navy Energy Support Office Port Hueneme, California
1983-1984	Engineering Aid Coal/Air Department Naval Energy and Environmental Support Activity Port Hueneme, California
1985 to Present	Engineering Technician Coal/Air Department Naval Energy and Environmental Support Activity Port Hueneme, California

RESUME

JAMES C. REICHLE, P.E.	Mechanical Engineer
1982	B.S. Mechanical Engineering University of Portland Portland, OR
1982-1983	Mechanical Engineer FPH Forest Grove, OR
1983-1985	Mechanical Engineer Fläkt Evaporator AB Jönköping, Sweden
1985-Present	Mechanical Engineer Naval Energy and Environmental Support Activity Port Hueneme, CA

RESUME

DENE EGAMI	Engineering Technician
1987-Present	University of the Pacific Stockton, CA
1990-Present	Engineering Technician Naval Energy and Environmental Support Activity Port Hueneme, CA