

AD-A249 094

AL-TR-1991-0151



ARMSTRONG

**COMPLIANCE WITH CALIFORNIA RULE 480,
CHROME PLATING FACILITY, BUILDING 243G,
MCLELLAN AIR FORCE BASE, CALIFORNIA**

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LABORATORY

**DTIC
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APR 23 1992**

December 1991

Final Technical Report for Period 24-31 July 1991

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92-10398



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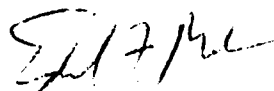
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REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.				
1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE December 1991	3. REPORT TYPE AND DATES COVERED Final 24-31 July 1991		
4. TITLE AND SUBTITLE Compliance with California Rule 480, Chrome Plating Facility, Bldg 243G, McClellan Air Force Base, California		5. FUNDING NUMBERS		
6. AUTHOR(S) Paul T. Scott				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Armstrong Laboratory Occupational and Environmental Health Directorate Brooks Air Force Base, TX 78235-5000		8. PERFORMING ORGANIZATION REPORT NUMBER AL-TR-1991-0151		
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSORING/MONITORING AGENCY REPORT NUMBER		
11. SUPPLEMENTARY NOTES				
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.		12b. DISTRIBUTION CODE		
13. ABSTRACT (Maximum 200 words) California Rule 480, adopted in Aug 89, specifies emissions standards for hexavalent chromium based on annual hexavalent chromium emissions and requires facilities to conduct compliance testing every 2 years. Compliance testing by personnel from the Armstrong Laboratory was conducted on the chrome plating facility, Bldg 243G at McClellan AFB. Two of the 3 scrubbers were tested using CARB Method 425 for total and hexavalent chrome. Results indicate the facility produces less than 2 lb (0.9 kg) per year of hexavalent chromium and is in compliance with rule 480 with an emission of equal to or less than .0034 mg/amp-h. Recommendations are made as to required biennial compliance testing.				
14. SUBJECT TERMS Hexavalent chromium; Rule 480; Air quality; McClellan AFB; CARB method 425; Compliance testing			15. NUMBER OF PAGES 124	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UL	

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**COMPLIANCE WITH CALIFORNIA RULE 480, CHROME PLATING FACILITY,
BLDG 243G, McCLELLAN AIR FORCE BASE, CALIFORNIA**

INTRODUCTION

Background

On 24-31 Jul 91, source emission testing for total and hexavalent chromium emissions was conducted on the scrubber exhaust system of the chrome plating facility located in Bldg 243G, McClellan AFB, CA. Two representative stacks were tested. Testing was performed by the Air Quality Function of Armstrong Laboratory. This survey was requested by the Director, Environmental Management, Sacramento Air Logistic Command (SM-ALC/EM) to demonstrate compliance with California's Rule 480. Personnel involved with on-site testing are listed in Appendix A.

Site Description

Three vertical packed bed scrubbers are installed in the exhaust system of the chrome plating facility in Bldg 243G. The scrubbers provide emission control for chromium particulates which are exhausted from 9 chrome plating tanks in the form of chromic acid mist. The scrubbers are positioned in a line with scrubber No. 1 (Fig. 1) being the most distant from Bldg 243G.

The scrubbers used in this system are manufactured by Viron International. Each scrubber is made up of the scrubber housing, containing the packing material and mist eliminator packing, and two 62-in. (155-cm) vertical exhaust stacks each housing a 30,000-cubic feet per minute (cfm) inline centrifugal fan. Figure 2 provides a diagrammatic view of the typical scrubber. The packing material, which is continually wetted by recirculating water, captures the mist particulates in the exhaust gas as the gas stream flows in a circuitous path through the bed. The mist eliminator packing is a series of static baffles placed across the mist-laden gas stream which acts as an impingement-type separator to capture liquid droplets entrained in the existing gas.

Applicable Standards and Guidelines

Rule 480, adopted in 1988, requires chrome plating facilities to have source emission testing every 2 years to demonstrate compliance with various provisions of the rule. The rule aims to control hexavalent chromium emissions, a heavy metal pollutant with a TLV-TWA of 0.05 mg/m³ and a confirmed human carcinogen. The rule categorizes hard plating shops as small, medium or large. These categories would have to achieve an emission reduction of 95, 95 to 99, or 99 to 99.8 percent respectively or emit hexavalent chromium at a rate less than 0.15, 0.03, or 0.006 mg per amp-h. Rule 480 can be found in Appendix B.

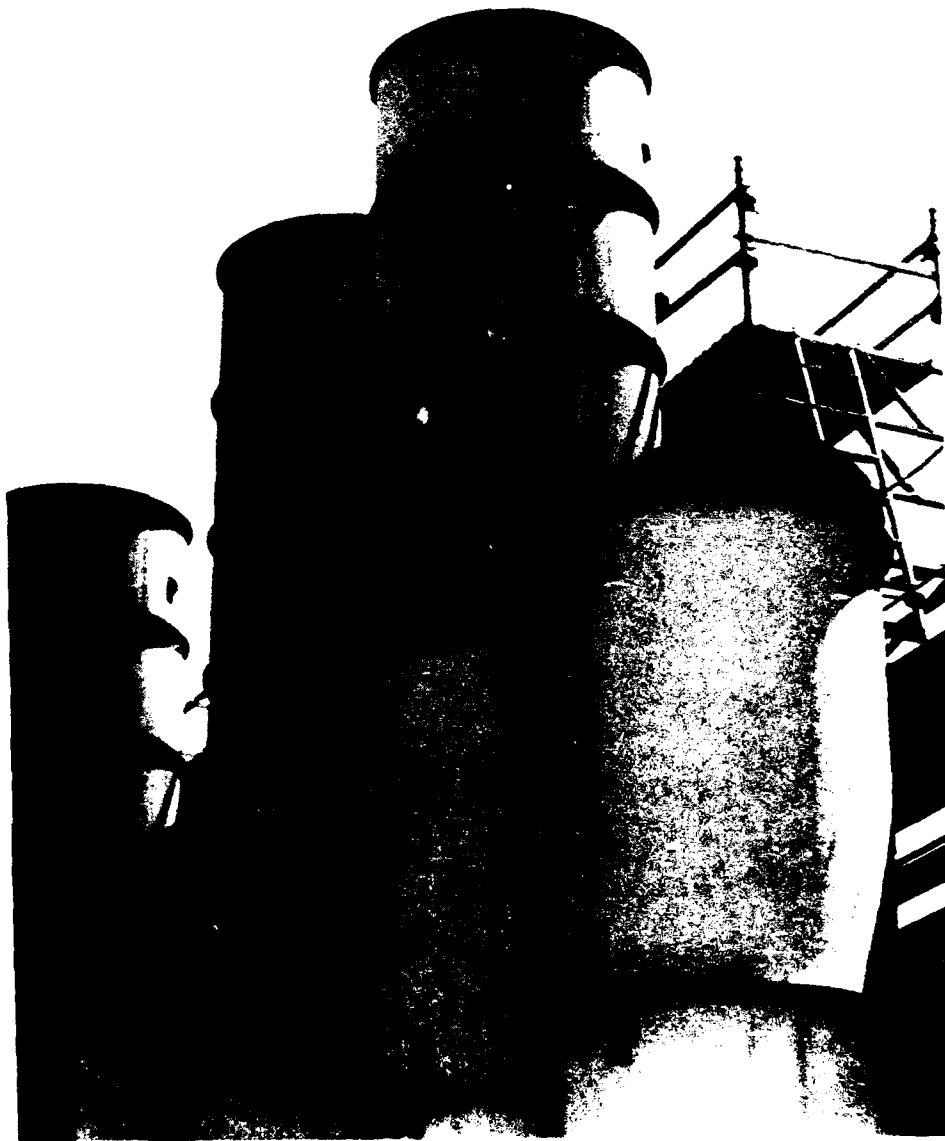


Figure 1. View of stacks with stack No. 1 in foreground.

METHODS AND MATERIALS

Sampling and analysis methodology used during this project are found in California Air Resources Board (CARB) Test Method 425 as amended in September 1990, "Determination of Total Chromium and Hexavalent Chromium Emissions from Stationary Sources" (Appendix C). Options chosen in Method 425 include using new precleaned and tested glassware for each test run. Also, because low values of hexavalent chromium were expected, each sample run was 240 min and impingers were not combined, but split and analyzed per the method. Hexavalent chromium is analyzed via the phenylcarbazide method and total chromium is analyzed via atomic absorption.

Emission testing is accomplished on 2 representative stacks of different scrubbers. These stacks have been denoted as stack 1 (scrubber 1) and stack 2 (scrubber 2). These procedures were coordinated with the Sacramento County Air Pollution Control District.

Extensions have been added to each stack tested to ensure that the minimum requirements for sampling locations with regards to CARB Method 1 are met. The extensions allowed placement of the sampling ports two duct diameters downstream from the exhaust fan and one-half duct diameter upstream from the stack exit. The inside stack diameter at the sampling port location for each stack is 62 in. (155 cm). Based on the duct diameter, port location and type of sampling required (particulate), a total of 24 traverse points were determined for source emission evaluation, (1, 4). The total time for each sampling run was 240 min with sampling time for each traverse point at 10 min.

Samples are collected using the sampling train of CARB Method 425. The train consisted of a button-hook glass probe nozzle, heated probe with glass liner, impingers, a Teflon filter in a glass filter holder and pumping and metering device. Flue gas velocity pressure is measured at the nozzle tip using a Type-S pitot tube connected to a Dwyer 10-in. inclined-vertical manometer. Type K thermocouples were used to measure flue gas as well as sampling train temperatures. Calibration data are presented in Appendix H (2).

Many of the emission calculations are done using "Source Testing Calculation and Check Programs for Hewlett-Packard 41 Calculators" developed by the Environmental Protection Agency's Office of Air Quality Planning and Standards, Research Triangle Park NC (3).

RESULTS AND DISCUSSION

Field Results

Scrubbers were tested during maximum output plating operations. Metal plates were used as material being plated to maintain a maximum output. Individual tanks current was set appropriate for actual plating work. The number of plating tanks in operation during testing ranged from 7 to 9. Average total plating current was around 18,000 amp-h (Appendix D).

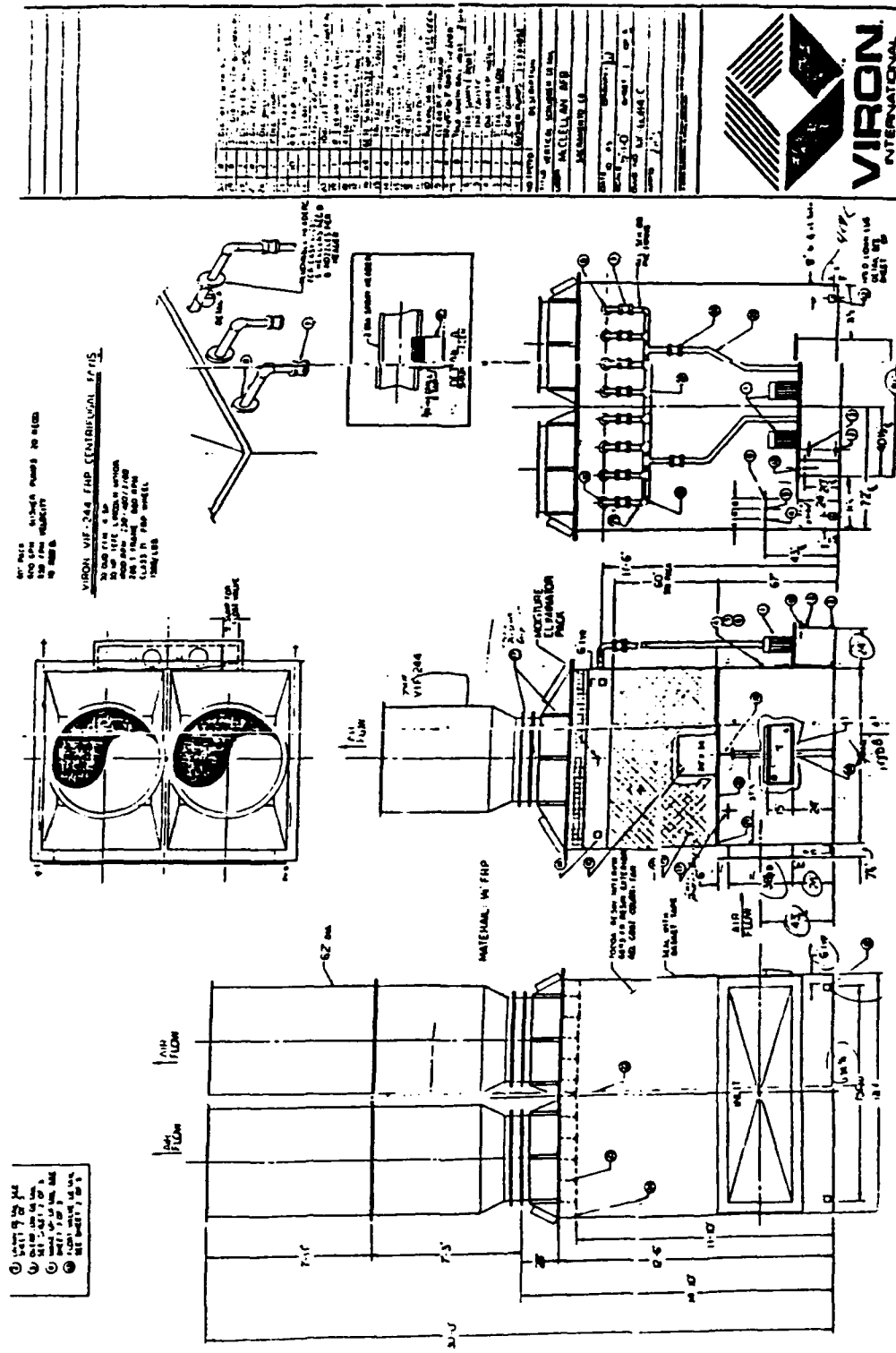


Figure 2. Diagrammatic view of typical scrubber.

Emission testing started with stack 2 on 24 Jul 91. Preliminary velocity, cyclonicity, and leak checks were all nominal; however, port locations were 26.5 in. (66.25 cm) upstream instead of the 31 in. (77.5 cm) as required by EPA and CARB Method 1. Emission testing on stack 2 concluded with run 3 on 26 Jul 91. Emission testing continued with stack 1 on 29 Jul 91. Port locations were similarly placed on stack 1 as on stack 2. Because of inadequate scaffolding, a man lift had to be brought in to support equipment and personnel. The man lift proved inadequate, and it was determined that safety requirements were not being adequately met. At the conclusion of run 1 on stack 1, port locations were changed to accommodate personnel safety. This change also brought port locations within the 2 duct and one-half duct diameter criteria of EPA (1) and CARB Method 1 (4). However, a check of cyclonicity showed the flow to be unacceptable. Straightening vanes were dropped in the stack to correct the flow. The cyclonicity was measured as 12.5°. This measurement is acceptable to EPA methods, but not acceptable according to California methods. Testing (runs 2 and 3) continued at the new ports of stack 1. Isokinetics were good for all runs. The district chose to see the data before making a decision as to its acceptability. Field data and calculations are in Appendix E for stack 1 and Appendix F for stack 2.

A total of 25 samples were collected (i.e., 12 samples per stack and 1 sodium hydroxide (NaOH) blank). Each run represented 4 samples: a precheck wash of the probe with 0.1 N NaOH, a probe wash, impinger 1, and impinger 2. Filters were placed in impinger 1. All samples were received at our office and in good condition on 5 Aug 91. The samples were subsequently submitted for analysis to the Armstrong Laboratory, Occupational and Environmental Health Directorate, Analytical Services Division.

Analysis Results

The analyses were completed on 13 Aug 91. A summary of the laboratory results is found in Table 1. The laboratory report is in Appendix G. All hexavalent chromium samples were below the detection limit of 0.02 µg/ml. This detection limit was achieved with a 1.0-cm cell using the phenylcarbazide method. Total chromium was twice detected in the first impinger and also in the probe wash of run 3 of stack 1. Since hexavalent chromium was below detection limits, its detection limit is used as the worst case to determine a collected mass of hexavalent chromium. Algorithms used to determine the worst case hexavalent chromium are listed at the bottom of Table 1. Mass values range from 5.12 µg to 5.9 µg. These values are incorporated in Table 2 to obtain stack emission rates. Average emission rates for stack 1 and 2 are .0034 and .0029 mg/amp-h, respectively.

Finally the stack emission rates are multiplied by the total number of stacks to determine the chrome plating facilities "worst case" hexavalent chromium emissions (Table 3). Using either stack 1 or stack 2 data gives facility emission rates of .0204 and .0174 mg/amp-h, respectively. This is less than the category 1 standard of .15 mg/amp-h and also less than the category 2 standard of .03 mg/amp-h. With the facilities "worst case" annual emissions of .353 lb/year (0.1589 kg/yr) (Table 3), this data places

TABLE 1. SUMMARY OF LABORATORY RESULTS

Date	Stack #	Run/Sample #	Sample Results ($\mu\text{g}/\text{ml}$) ¹		Sample Volume (ml)	Cr+6 Mass ²
			CR+6	Total CR		(μg)
24 Jul	2	1/probe	<.02	<.050	108	2.16
		1/impl	<.02	.081	120	2.40
		1/imp2	<.02	<.050	108	.96
						Total 5.52
25 Jul	2	2/probe	<.02	<.050	100	2.00
		2/impl	<.02	<.050	117.5	2.35
		2/imp2	<.02	<.050	106	.81
						Total 5.16
26 Jul	2	3/probe	<.02	<.050	109	2.18
		3/impl	<.02	<.050	120	2.40
		3/imp2	<.02	<.050	108	.96
						Total 5.54
29 Jul	1	1/probe	<.02	<.050	140	2.80
		1/impl	<.02	<.050	123	2.46
		1/imp2	<.02	<.050	106	.64
						Total 5.90
30 Jul	1	2/probe	<.02	<.050	130	2.60
		2/impl	<.02	<.050	133	2.66
		2/imp2	<.02	<.050	103	.24
						Total 5.50
31 Jul	1	3/probe	<.02	.052	112	2.24
		3/impl	<.02	.070	122	2.44
		3/imp2	<.02	<.050	104	.44
						Total 5.12

¹ < indicates none detected and the appropriate detection limit

² The Cr⁺⁶ mass of the probe and impinger 1 is computed as the measured Cr⁺⁶ concentration multiplied by the sample volume. If the measured Cr⁺⁶ concentration is below detection limits, then the Cr⁺⁶ mass of the probe and impinger 1 is computed as the detection limit multiplied by the respective sample volume to represent a worst case.

When Impinger 2 is below detection limits, its Cr⁺⁶ mass is computed as the ratio of collected moisture of impinger 1 and impinger 2 multiplied by the computed mass of impinger 1 [i.e., (volume sample of impinger 2 - 100 ml)/(sample volume of impinger 1 - 100 ml) x impinger 1 Cr⁺⁶ mass]. This volume also represents a worst case.

TABLE 2. SUMMARY OF EMISSION DATA

DATE	Stack #	Run #	Avg Rate of Current	Std Meter Volume	Stack Flow Rate	Cr+6 Mass ¹	Emission Rate ²	
			I (amp-h/h)	V _m (Std ft ³)	R _s (Std ft ³ /min)	M (μg)	E _r (mg/amp-h)	E _{re} (lb/h)
24 Jul	2	1	18,212.5	115.377	18,251	5.52	.0029	1.155E-4
25 Jul	2	2	18,131.5	121.498	19,479	5.16	.0027	1.094E-4
26 Jul	2	3	17,765.0	127.380	17,765	5.54	.0029	1.154E-4
Avg							.0029	1.134E-4
29 Jul	1	1	18,560.0	108.215	17,255	5.90	.0030	1.245E-4
30 Jul	1	2	18,725.0	123.236	19,658	5.50	.0028	1.160E-4
31 Jul	1	3	11,524.0	118.632	19,050	5.12	.0043	1.088E-4
Avg							.0034	1.166E-4

¹ Cr⁺⁶ Mass is taken from Table 1 and represents a worst case using the detection limit

² $E_r = .06(M \times R_s) / (V_m \times I)$ The sampling time of 4 h and the μg to mg conversion are part of the constant

$E_{re} = 1.3216E-7(M \times R_s) / V_m$ The sampling time of 4 h and the μg to lb conversion are part of the constant

TABLE 3. FACILITY Cr+6 EMISSIONS

Stack #	Facility Emission Rate ¹		Annual Avg Current ²	Annual Facility ³	Rule 480 Category
	(mg/amp-h)	(lb/h)	(kamp-h/yr)	Emissions (lb/yr)	(Applicability/Standard)
2	.0174	6.750E-4	7845.0	0.301	para 302.1/0.03 mg/amp-h
1	.0204	6.948E-4	7845.0	0.353	para 302.1/0.15 mg/amp-h

¹ The facility emission rate is determined by multiplying E_r or E_{re} by the number of stacks (i.e., 6).

² The annual average current is determined from data in Appendix D.

³ The Annual Facility Cr⁺⁶ emissions are determined from multiplying the Facility Emission Rate (FER)(mg/amp-h) by the annual average current (AAC)(kamp-h/yr) (i.e., (FER)(1,000 x AAC)/4.54E+5).

the chrome plating facility in category 1 of Rule 480 (para 302.1) (i.e., annual emissions are less than 2.0 lb of hexavalent chromium). Consequently, the chrome plating facility is in compliance with category 1 of Rule 480.

CONCLUSIONS

The Chrome Plating Facility, Bldg 243G at McClellan AFB produces less than 2 lb/year (0.9 kg/year) of hexavalent chromium emissions and is placed in category 1 of California Rule 480 for compliance purposes. The facility's emission rate of .0204 mg/amp-h is less than the .15 mg/amp-h standard of category 1 and is, therefore, in compliance with Rule 480.

RECOMMENDATIONS

Rule 480 requires testing the chromium packed bed scrubber stacks for hexavalent chromium emissions every 2 years. Though the chrome plating facility is in compliance with Rule 480, certain items require attention either on a regular basis or before future compliance surveys. These requirements include the following:

1. Ensure operators and supervisors are aware of compliance issues and the full impact of noncompliance.
2. Continue to document operating data as accurately as possible.
3. Negotiate with the district to choose a single representative stack for future source emission surveys.
4. Ensure adequate scaffolding extending out (normal to the stack) 6.0 ft (182.9 cm) and 10.0 ft (304.8 cm) either side (tangentially) of the chosen representative stack.
5. Install (weld) a permanent straightening vane (a tic-tac-toe configuration) which is at least 6.0 ft (182.9 cm) deep and located above the fan.
6. Install and locate sampling ports 90° apart in the same horizontal plane, at least 10.5 ft (320.0 cm) downstream of the top of the straightening vane and 31.0 in. (78.7 cm) or more upstream of the stack top.

REFERENCES

1. Code of Federal Regulations, Title 40, Protection of Environment, Part 60, Standards of Performance for New Stationary Sources, July 1, 1987.
2. Quality Assurance Handbook for Air Pollution Measurement Systems - Volume III, Stationary Source Specific Methods, U.S. Environmental Protection Agency, EPA-600/4-77-027-b, Research Triangle Park, North Carolina, December 1984.
3. Source Test Calculation and Check Programs for Hewlett-Packard 41 Calculators. U.S. Environmental Protection Agency, EPA-304/1-85-018, Research Triangle Park, North Carolina, May 1987.
4. Stationary Source Test Methods - Volume I and III, California Air Resources Board, Sacramento, California.

APPENDIX A
Personnel Information

PERSONNEL INFORMATION

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Mr Dan Durfee, SH-ALC/EMR
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APPENDIX B
California Rule 480

RULE 480 CHROME PLATING AND CHROMIC ACID ANODIZING

(Adopted 8-22-89)

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August 22, 1989

480-1

100 GENERAL

101 **PURPOSE:** To limit the emission of hexavalent chromium to the atmosphere from chrome plating and chromic acid anodizing operations.

200 **DEFINITIONS:** For the purposes of this rule the following definitions shall apply:

201 **AMPERE-HOURS:** The integral of electrical current (amperes) applied to a plating tank over a period of time (hours).

202 **ANTI-MIST ADDITIVE:** A chemical which reduces the emission rate from the tank when added to and maintained in the plating tank.

203 **CHROME:** Metallic chrome.

204 **CHROME PLATING:** Hard or decorative chrome plating.

205 **CHROMIC ACID:** An aqueous solution of chromium trioxide (CrO_3) or a commercial solution containing chromium trioxide, chromic acid (H_2CrO_4), dichromic acid ($\text{H}_2\text{Cr}_2\text{O}_7$) or trichromic acid ($\text{H}_2\text{Cr}_3\text{O}_{10}$).

206 **CHROMIC ACID ANODIZING:** The electrolytic process by which a metal surface is converted to an oxide surface coating by the action of a solution containing chromic acid.

207 **CHROMIUM:** Hexavalent chromium, which refers to the valence state of +6 for the chromium in the aqueous solution.

208 **CONTROL EQUIPMENT:** Any device which reduces chromium air contaminant emissions from an emissions collection system and which has been approved by the Air Pollution Control Officer.

209 **DECORATIVE CHROME PLATING:** The process by which chromium is electrodeposited from a solution containing compounds of chromium onto an object resulting in a chrome layer 1 micron (0.04 mil) thick or less.

210 **EMISSION FACTOR:** The mass of chromium emitted during a test conducted in the emissions collection system in accordance with ARB Test Method 425, divided by the ampere-hours consumed by the tanks in the tested emissions collection system, expressed as the mass of chromium emitted per ampere-hour of electrical current consumed.

211 **EMISSIONS COLLECTION SYSTEM:** A device or apparatus used to gather chromium emissions from the surface of a chrome plating or chromic acid anodizing tank or tanks.

- 212 **FACILITY-WIDE EMISSIONS FROM HARD CHROME PLATING OR CHROMIC ACID ANODIZING:** The total uncontrolled chromium emissions from all hard chrome plating or chromic acid anodizing at the stationary source over a calendar year. Emissions shall be calculated as the sum of emissions from the emissions collection system(s) at the stationary source. The emissions from each emission collection system shall be calculated by multiplying the emission factor for that emissions collection system by the sum of the ampere-hours consumed during that year for all of the tanks served by the emissions collection system.
- 213 **HARD CHROME PLATING:** The process by which chromium is electrodeposited from a solution containing compounds of chromium onto an object resulting in a chrome layer thicker than 1 micron (0.04 mil).
- 214 **PLATING TANK:** Any container used to hold a chromium or chromic acid solution for the purpose of chrome plating or chromic acid anodizing.
- 215 **SOURCE:** Any operation that produces and/or emits air pollutants.
- 216 **UNCONTROLLED CHROMIUM EMISSIONS:** The chromium emissions from the emissions collection systems at the stationary source calculated as if no control equipment is in use. For the purpose of determining compliance with this rule, the uncontrolled chromium emissions shall be calculated using an emission factor based on tests conducted in accordance with ARB Test Method 425 or 14 mg/ampere-hour, whichever is less.

300 STANDARDS

- 301 **DECORATIVE CHROME PLATING -** A person shall not operate a decorative chrome plating tank unless one of the following control measures is used in a manner which has been demonstrated to and approved by the Air Pollution Control Officer (APCO) as reducing chromium emissions by 95 percent or more relative to the uncontrolled chromium emissions.
- 301.1 An anti-mist additive is continuously maintained in the plating tank, or;
- 301.2 Control equipment is installed and used, or;
- 301.3 An equivalent method approved by the Air Pollution Control Officer is installed and used.
- 302 **HARD CHROME PLATING OR CHROMIC ACID ANODIZING:**
- 302.1 A person shall not operate a hard chrome plating tank or chromic acid anodizing tank unless the tank has an emissions collection system that meets one of the following requirements:
- a. The chromium emissions from the emissions collection systems serving the plating tank are reduced by at least 95 percent from the uncontrolled chromium emissions, or;
- b. The chromium emissions from the emissions collection systems serving the plating tank are reduced to less than 0.15 milligrams(mg) of chromium per ampere-hour of electrical charge applied to the plating tank.

- 302.2 A person shall not operate a hard chrome plating tank or chromic acid anodizing tank at a stationary source where the facility-wide chromium emissions from hard chrome plating or chromic acid anodizing are greater than 2 pounds per year, but less than 10 pounds per year, unless the tank has an emissions collection system that meets one of the following requirements:
- a. The chromium emissions from the emissions collection systems serving the plating tank are reduced by at least 99 percent from the uncontrolled chromium emissions, or;
 - b. The chromium emissions from the emissions collection systems serving the plating tank are reduced to less than 0.03 mg of chromium per ampere-hour of electrical charge applied to the plating tank.
- 302.3 A person shall not operate a hard chrome plating tank or chromic acid anodizing tank at a stationary source where the facility-wide chromium emissions from hard chrome plating or chromic acid anodizing are greater than or equal to 10 pounds per year, unless the tank has an emissions collection system that meets one of the following requirements:
- a. The chromium emissions from the emissions collection systems serving the plating tank are reduced by at least 99.8 percent from the uncontrolled chromium emissions, or;
 - b. The chromium emissions from the emissions collection systems serving the plating tank are reduced to less than 0.006 mg of chromium per ampere-hour electrical charge applied to the plating tank.
- 302.4 Compliance shall be verified by source testing every 24 months.

400 ADMINISTRATIVE REQUIREMENTS

- 401 RECORDKEEPING REQUIREMENTS: A person subject to the provisions of Section 300 of this rule shall meet the following applicable requirements:
- 401.1 A weekly record of anti-mist additive concentrations or any other measurements recommended by the manufacturer's specification and the Air Pollution Control Officer shall be maintained. Recordkeeping shall begin on the date of final compliance.
 - 401.2 A weekly record of current integrated over time (ampere-hours) for all plating tanks used at a chrome plating or chromic acid anodizing stationary source shall be maintained. Recordkeeping shall begin on August 22, 1989.
 - 401.3 All records including all pertinent information relative to the operation of the plating tanks, all source testing, and all information relative to the emissions collection system and the control equipment shall be maintained for two years and shall be made available to the Air Pollution Control Officer upon request.

402 COMPLIANCE SCHEDULES

- 402.1 A person subject to the provisions of Section 301 shall be in final compliance with the requirements of Section 301, and shall submit to the Air Pollution Control Officer an application for a Permit to Operate, no later than March 1, 1990.

- 402.2 A person subject to the provisions of Section 302, except a person subject to the provisions of Subsection 302.2 shall meet the following compliance schedule:
- Submit to the Air Pollution Control Officer an application for a Permit to Operate the plating tank no later than March 1, 1990, and;
 - Submit to the Air Pollution Control Officer an application for Authority to Construct the equipment necessary to comply with the requirements of Subsection 302.1, if needed no later than September 1, 1990, and;
 - Achieve final compliance with the requirements of Subsection 302.1 no later than March 1, 1991.
- 402.3 A person subject to the provisions of Subsection 302.2 shall meet the following compliance schedule:
- Submit to the Air Pollution Control Officer an application for a Permit to Operate the plating tank no later than March 1, 1990, and;
 - Submit to the Air Pollution Control Officer an application for Authority to Construct the equipment necessary to comply with the requirements of Subsection 302.2, if needed, no later than March 1, 1991, and;
 - Achieve final compliance with the requirements of Subsection 302.2 no later than September 1, 1991.
- 402.4 A person subject to the provisions of Subsection 302.3 shall, in addition, meet the following compliance schedule:
- Submit to the Air Pollution Control Officer an application for a Permit to Operate the plating tank no later than March 1, 1990, and;
 - Submit to the Air Pollution Control Officer an application for Authority to Construct the equipment necessary to comply with the requirements of Subsection 302.3, if needed, no later than March 1, 1991, and;
 - Achieve final compliance with the requirements of Subsection 302.3, no later than September 1, 1993.

500 TEST METHODS

Compliance with the chromium emissions requirement in Section 302 of this rule shall be determined by ARB Test Method 425.

APPENDIX C

California Air Resources Board Sampling Method 425

State of California
Air Resources Board

Method 425

Determination of Total Chromium and Hexavalent Chromium
Emissions from Stationary Sources

Adopted: January 22, 1987

Amended: September 12, 1990

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

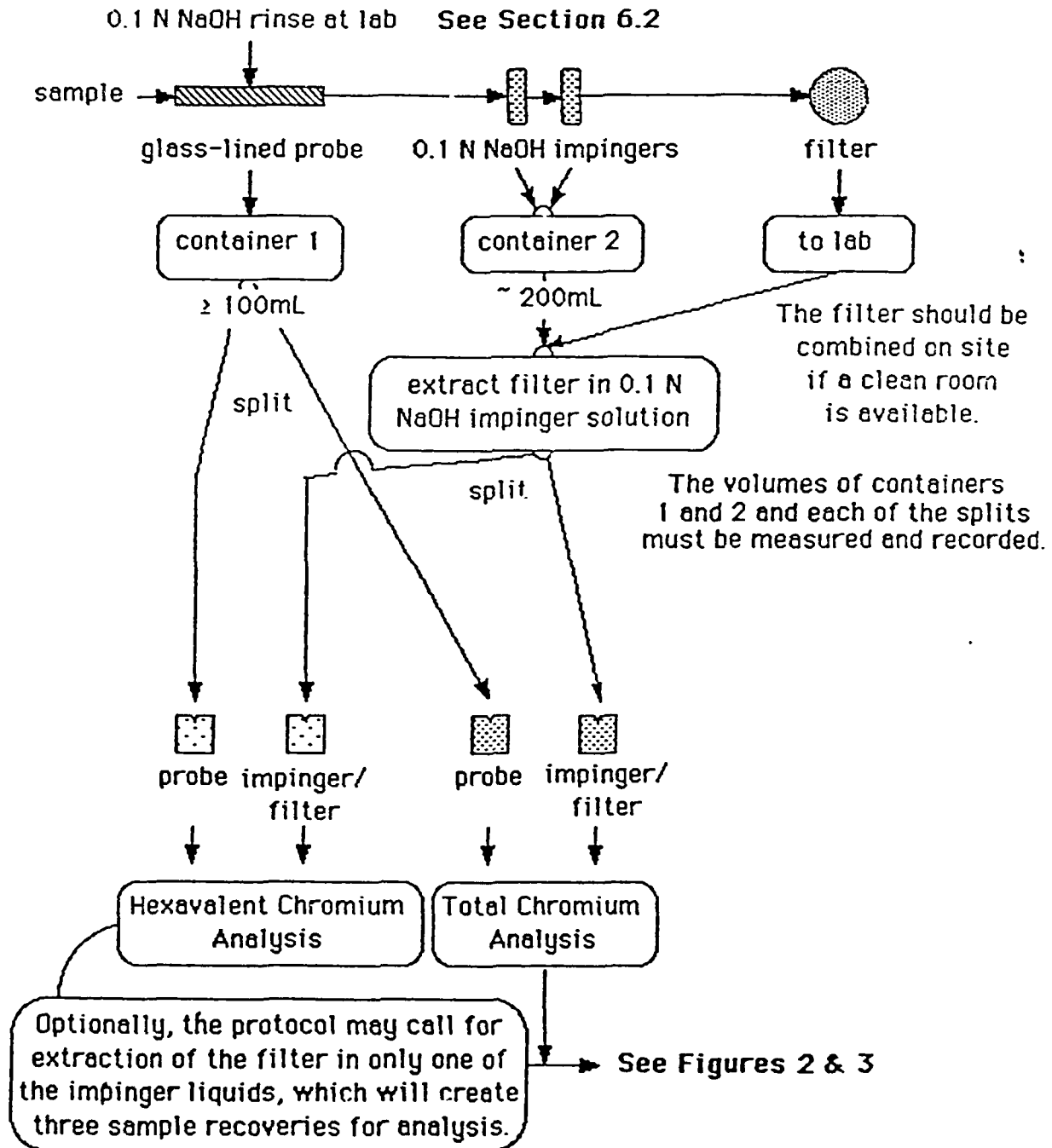
For the total chromium analysis the collected samples must be prepared in order to convert organic forms of chromium to inorganic forms, to minimize organic interferences, and to convert the sample to a suitable solution for analysis. Samples are then subjected to an acid digestion procedure. Following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

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Janes Loop ARB

optionally, the protocol may call for extraction of the filter in only one of the impinger liquids, which will create three sample recoveries for analysis

See Figure 1
and Sections
6.4 and 6.5

typically:
two separate analyses



transfer ~ 35 mL
to a 100mL beaker

adjust the pH to 1 ± 0.2 with 6N sulfuric acid and
add 1.0 mL of diphenylcarbazide solution

bring to volume in a 50 mL volumetric flask

dilute to volume with water
- let color develop 10 minutes

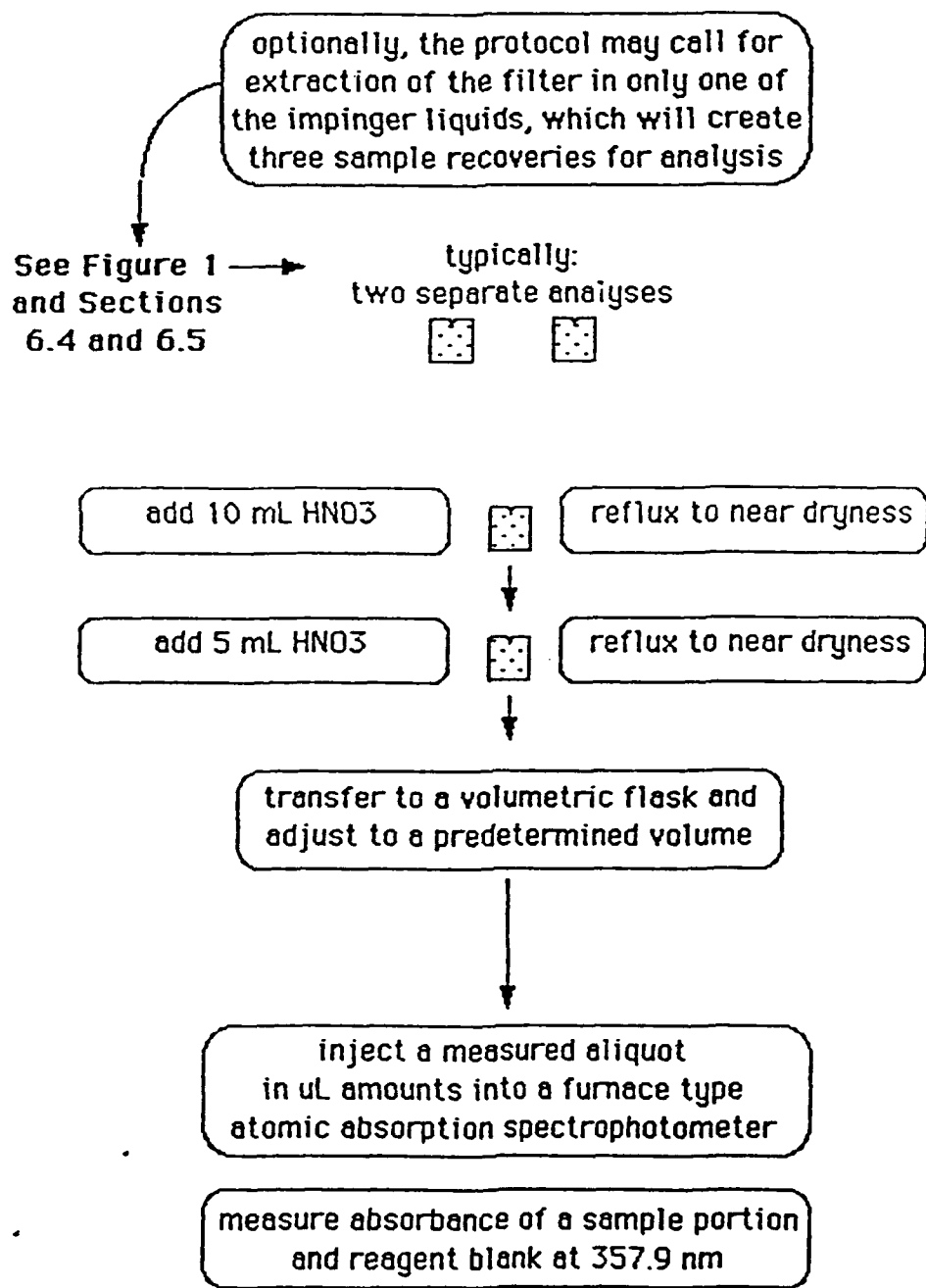
filter to remove suspended solids after
pre-wetting medium retention filter paper with
a few mL each of first reagent blank and then sample

measure absorbance of a sample portion
and reagent blank at 540 nm

if reading exceeds calibration,
dilute with reagent blank or
remeasure using less of remaining sample

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 diphenylcarbazine 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.

Hexavalent Chromium Determination by Ion Chromatography

For hexavalent chromium concentrations which are within the detection range of ion chromatography, this analytical method may be used instead of the colorimetry method specified in these pages. This option applies only to the analysis of hexavalent chromium. The remainder of the test method shall be performed as specified.

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. This option applies only to the analysis of total chromium. The remainder of the test method shall be performed as specified.

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. 1 100 mL beakers

3. 3. 1. 2 Filtration Apparatus

Vacuum unit constructed of glass, to accommodate sintered glass funnels. Medium porosity filter paper is optional. Wherever filtering is specified, centrifuging may also be performed at the analyst's option.

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 Philips Beakers

Borosilicate, 125mL, with digestion covers.

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 permanganate that is required. From the change in absorbance, calculate the amount of potassium permanganate that is needed to neutralize 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 ($\text{K}_2\text{Cr}_2\text{O}_7$, 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 HNO₃ 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.

5. 2. 1 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.

If the specified glass probes are in short supply, the cleaning protocol required above could double the number of days necessary to complete a series of tests. Two options exist which reduce mid-course delays in a sampling effort:

5. 2. 1. 1 Another cleaning procedure may be used if it is tested and documented as achieving the objective of no detectable chromium in the last probe cleaning rinse. Testing and documentation shall include: a pre-test visit to the intended site, collection of samples from an intended test point with the highest expected concentration of chromium, trials of other cleaning procedures, and documentation of those which pass the analytical tests and are used instead of the cleaning procedures in Section 5.2.1 above.
5. 2. 1. 2 The risk of mid-course cleaning delays may be reduced by the use of a sufficient number of probes which have been pre-cleaned and contamination checked by the procedures of Sections 5.2.1 or 5.2.1.1. Extra probes should be included to allow for breakage.

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. (Measure the volume.) The probe rinse is transported to a clean room or 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. (Measure the volumes.)

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 is not 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. (Measure the volume.) 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. (Measure the volumes.)

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. (Measure the volumes.) 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. (Measure the volumes.)

6. 3 REAGENT BLANK PREPARATION

Hexavalent Chromium Reagent Blank

For each preparation, transfer 35 mL of solution to a 100mL beaker, adjust the pH to 1.0 ± 0.2 with 6N sulfuric acid, add 1.0 mL of diphenylcarbazide solution, dilute to volume with water in a 50 mL volumetric flask, 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 100mL beaker, adjust the pH to 1.0 ± 0.2 with 6N sulfuric acid, add 1.0 mL of diphenylcarbazide solution, dilute to volume with water in a 50 mL volumetric flask, 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. This will prime the filter so that it won't absorb color complex.

Transfer a portion of the filtered 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:

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

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 μL 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 HNO₃ 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_p , 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_p 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:

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

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:

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

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 D
Facility Data

Amp-hrs

Run 1 Stack 2 24 July 91

TIME & TANKS →	183	184	185	186	187	188	190	TOTALS ✓
1030-1200 (Run 1A)	3040	2510	2810	3050	3000	3050	910	--- 18,370 amp-hrs
1300-1530 (Run 1B)	3080	2560	2800	3010	3100	3100	405	--- 18,055 amp-hrs

avg amp-hrs during run - > --- 18,212.5 amp-hrs
rate during test

Volume meter std...
ACFM ----

Run 2 Stack 2 25 July 91

TIME & TANKS →	183	184	185	186	187	188	190	TOTALS ✓
0730-1000 Run 2A	3060	2340	2157	3100	3000	3000	806	--- 17,563 amp-hrs
1000-1230 Run 2B	3160	2420	3040	3230	3000	3220	630	--- 18,700 amp-hrs

avg amp-hrs during run - 18,131.5 amp-hrs

Volume meter

Run 3 Stack 2 26 July 91

TIME TANKS	183	184	185	186	187	188	190	TOTALS
0715-0930 Run 3B	3040	2400	3030	3060	3000	3020	60	17,610 amp-hrs
0930-1200 Run 3A	3120	2440	3110	3090	3000	3160	-	17,920 amp-hrs

avg amp-hrs during run 17,765 amp-hrs

Stack 1

Run 1 29 July 91

TIME	THICK	183	184	185	186	187	188	190	Total
Run 1A	0700-0730	3100	2270	3060	3140	3000	3080	970	18620
Run 1B	0930-1200	3200	2330	2990	3180	3000	3190	940	<u>18830</u>
									avg 18725

Run 2 30 July 91

Run 2A	1100-1330	3170	2820	3060	3320	2510	3340	820	17070
Run 2B	1330-1600	3160	2450	3130	3420	2590	2480	820	<u>18050</u>
							189.2 in at 1440		18560

Run 3 31 July 91

Run 3B	0700-0900	2090	1700	1700	2130	1700	dead	550	9870
Run 3A	0930-1200	3100	2310	1207	3280	2500	dead	780	<u>13177</u>
									11524

Total Chrome Plating Shop Hrs
documented for 91

<u>Month</u>	<u>Hrs of Operations</u>	<u>Total Current (kamp-hrs)</u>
Mar	825.5	587.7
Apr	663.0	388.0
May	499.0	238.7
Jun	912.0	644.6
Jul	226.0	157.9
Aug	529.0	320.1
Sep	624.0	448.7
Oct	758.0	453.0
Nov	601.0	464.8
Dec	800.0	667.1
Totals	6,537.5	4,370.5

Converting these totals for 12 months vs 10 months we have:

7,845.0	5,244.6
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APPENDIX E
Scrubber 1 Field Data

XROM "MASSFLO"

RUN NUMBER
ONE, STACK 1 RUN
VOL MTR STD 2
123.236 RUN
STACK DSCFM ?
19.658 RUN
FRONT 1/2 MG ?
0.00590 RUN
BACK 1/2 MG ?
0 RUN

F GR/DSCF = 7.3882E-7
F MG/MMH = 1.6907E-3
F LB/HR = 1.2449E-4
F KG/HR = 5.6468E-5

XROM "MASSFLO"

RUN NUMBER
TWO, STACK ONE RUN
VOL MTR STD ?
100.215 RUN
STACK DSCFM ?
17.255 RUN
FRONT 1/2 MG ?
.00550 RUN
BACK 1/2 MG ?
0 RUN

F GR/DSCF = 7.8433E-7
F MG/MMH = 1.7948E-3
F LB/HR = 1.1600E-4
F KG/HR = 5.2619E-5

XROM "MASSFLO"

RUN NUMBER
THREE, STACK ONE RUN
VOL MTR STD ?
110.632 RUN
STACK DSCFM ?
19.050 RUN
FRONT 1/2 MG ?
.00512 RUN
BACK 1/2 MG ?
0 RUN

F GR/DSCF = 6.6603E-7
F MG/MMH = 1.5241E-3
F LB/HR = 1.0875E-4
F KG/HR = 4.9330E-5

XROM "METH 5"
RUN NUMBER
ONE, STACK 1

METER BOX Y? RUN
1.0127 RUN
DELTA H? .9300 RUN
BAR PRESS ? 29.8800 RUN
METER VOL ? 125.4900 RUN
MTR TEMP F? 85.0000 RUN
% OTHER GAS
REMOVED BEFORE
DRY GAS METER ? RUN
STATIC HOH IN ? -0.0900 RUN
STACK TEMP. 73.0000 RUN
ML. WATER ? 56.0000 RUN
SAT % = 2.7

IMP. % HOH = 2.1

% HOH=2.1

% CO2? 0.0000 RUN
% OXYGEN? 21.0000 RUN
% CO ? 0.0000 RUN
MOL WT OTHER? RUN

MWD =28.84
MW WET=28.61
SORT PSTS ? 6.5701 RUN
TIME MIN ? 240.0000 RUN
NOZZLE DIA ? .3100 RUN
STK DIA INCH ? 62.0000 RUN

* VOL MTR STD = 123.276
STK PRES ABS = 29.87
VOL HOH GAS = 2.64
% MOISTURE = 2.09
MOL DRY GAS = 0.979
% NITROGEN = 79.00
MOL WT DRY = 28.84
MOL WT WET = 29.61
VELOCITY FPS = 16.14
STACK AREA = 20.97
STACK ACFM = 20.300.
* STACK DSCFM = 19.550.
% ISOINETIC = 104.54

XROM "METH 5"
RUN NUMBER
THREE, STACK 1

METER BOX Y? RUN
1.0127 RUN
DELTA H? .8800 RUN
BAR PRESS ? 29.8300 RUN
METER VOL ? 119.2420 RUN
MTR TEMP F? 77.0000 RUN
% OTHER GAS
REMOVED BEFORE
DRY GAS METER ? RUN
STATIC HOH IN ? -0.0600 RUN
STACK TEMP. 69.0000 RUN
ML. WATER ? 46.5000 RUN
SAT % = 2.4

IMP. % HOH = 1.8

% HOH=1.8

% CO2? 0.0000 RUN
% OXYGEN? 21.0000 RUN
% CO ? 0.0000 RUN
MOL WT OTHER? RUN

MWD =28.84
MW WET=28.64
SORT PSTS ? 6.3093 RUN
TIME MIN ? 240.0000 RUN
NOZZLE DIA ? .3110 RUN
STK DIA INCH ? 62.0000 RUN

* VOL MTR STD = 118.632
STK PRES ABS = 29.87
VOL HOH GAS = 2.19
% MOISTURE = 1.81
MOL DRY GAS = 0.982
% NITROGEN = 79.00
MOL WT DRY = 28.84
MOL WT WET = 29.54
VELOCITY FPS = 15.50
STACK AREA = 20.97
STACK ACFM = 19.500.
* STACK DSCFM = 19.050.
% ISOINETIC = 103.19

XROM "METH 5"
RUN NUMBER
TWO, STACK 1

METER BOX Y? RUN
1.0127 RUN
DELTA H? .5300 RUN
BAR PRESS ? 29.9300 RUN
METER VOL ? 115.3300 RUN
MTR TEMP F? 109.0000 RUN
% OTHER GAS
REMOVED BEFORE
DRY GAS METER ? RUN
STATIC HOH IN ? -0.0500 RUN
STACK TEMP. 77.0000 RUN
ML. WATER ? 57.6000 RUN
SAT % = 3.1

IMP. % HOH = 2.4

% HOH=2.4

% CO2? 0.0000 RUN
% OXYGEN? 21.0000 RUN
% CO ? 0.0000 RUN
MOL WT OTHER? RUN

MWD =28.84
MW WET=28.58
SORT PSTS ? 5.8319 RUN
TIME MIN ? 240.0000 RUN
NOZZLE DIA ? .3110 RUN
STK DIA INCH ? 62.0000 RUN

* VOL MTR STD = 100.215
STK PRES ABS = 29.87
VOL HOH GAS = 2.71
% MOISTURE = 2.44
MOL DRY GAS = 0.976
% NITROGEN = 79.00
MOL WT DRY = 28.84
MOL WT WET = 29.50
VELOCITY FPS = 14.75
STACK AREA = 20.97
STACK ACFM = 18.246.
* STACK DSCFM = 17.255.
% ISOINETIC = 107.91

OEHL FORM 18
MAY 78

PARTICULATE SAMPLING DATA SHEET											
SCHEMATIC OF STACK CROSS SECTION				EQUATIONS							
RUN NUMBER 2 DATE 30 July 91 PLANT Midway BASE McClellan AFB SAMPLE BOX NUMBER 3 METER BOX NUMBER 3 Qw/Qm Co				AMBIENT TEMP STATION PRESS 29.830 HEATER BOX TEMP 248.5 PROBE HEATER SETTING 248.5 PROBE LENGTH 62 NOZZLE AREA 0.311 Cp 0.84 DRY GAS REACTION 2.8.84							
Schematic of stack cross section showing a rectangular duct with a central sampling probe.				$H = \left[\frac{5130 \cdot P_d \cdot C_p \cdot A}{C_o} \right]^2 \cdot \frac{T_m}{T_s} \cdot V_p$ post pilot check - post firing check at 8' H₂ - 600 $P_s = 0.06$ $QHE = 1.0195 \quad Y_i = 1.0117$							
TRAVERSE POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H ₂ O)	STACK TEMP (°F)	STACK TEMP (°F)	VELOCITY HEAD (Vp)	ORIFICE PRESS. (in)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP IN (°F)	GAS METER TEMP OUT (°F)	SAMPLE BOX TEMP (°F)	IMPINGER OUTLET TEMP (°F)
1	10	2.1	86	80	0.045	0.51	63.302	113	111	230	62
2	10	2.6	80	80	0.060	0.64	68.6450	114	111	232	60
3	20	2.5	78	79	0.055	0.64	69.115	115	112	232	63
4	30	2.5	79	79	0.055	0.64	69.5720	115	112	232	64
5	40	2.4	79	79	0.052	0.60	70.320	116	113	231	62
6	50	2.5	77	77	0.055	0.64	70.4791	117	114	231	64
7	60	2.2	80	80	0.045	0.52	70.9365	117	114	231	64
8	70	2.3	83	83	0.050	0.58	71.3575	117	114	230	61
9	80	2.4	83	83	0.055	0.63	71.7955	117	115	230	56
10	90	2.5	83	83	0.060	0.64	72.2410	117	115	230	55
11	100	2.5	83	83	0.060	0.64	72.7216	118	115	230	56
12	110	2.5	84	84	0.060	0.64	73.1958	119	115	225	58
13	120	2.5	84	84	0.060	0.64	73.6701	119	115	225	58
T _{avg} = 77 V _{avg} = 5.8319 ΔH = 0.58 T _{in} = 109 T _{out} = 115.339											

PARTICULATE SAMPLING DATA SHEET											
SCHEMATIC OF STACK CROSS SECTION				EQUATIONS							
RUN NUMBER	3 Stack #1			$H = \left[\frac{5130 \cdot P_d \cdot C_p \cdot A}{C_o} \right]^2 \cdot \frac{T_m \cdot V_p}{T_s}$							
DATE	31 July 91			$\Delta H = 2.0195 \quad Y = 1.0127$							
PLANT	Bldg 2436			$P_s = -0.06$							
BASE	McClellan			$\Delta H = 2.0195 \quad Y = 1.0127$							
SAMPLE BOX NUMBER	Mf66			$P_s = -0.06$							
METER BOX NUMBER	3			$\Delta H = 2.0195 \quad Y = 1.0127$							
Qw/Qm				$\Delta H = 2.0195 \quad Y = 1.0127$							
Co				$\Delta H = 2.0195 \quad Y = 1.0127$							
				$P_s = -0.06$							
TRAVERSE POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H ₂ O)	STACK TEMP (°F)	STACK TEMP (°R)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (H)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP IN (°F)	GAS METER TEMP OUT (°F)	SAMPLE BOX TEMP (°F)	IMPINGER OUTLET TEMP (°F)
1	0 0711	3.1	67		0.095	0.095	736.964	64	63	239	47
2	10	3.0	67		0.085	0.085	743.360	70	65	240	50
3	20	2.9	67		0.075	0.075	747.546	73	66	239	51
4	30	2.9	67		0.075	0.075	752.568	74	67	238	52
5	40	2.8	67		0.068	0.068	757.500	74	68	236	52
6	50	2.9	67		0.075	0.075	762.255	75	69	237	52
7	60	2.8	67		0.058	0.058	767.213	76	70	237	53
8	70	2.9	68		0.070	0.077	771.665	76	71	238	50
9	80	3.0	68		0.080	0.088	776.450	77	72	238	51
10	90	3.1	68		0.090	0.099	781.573	78	73	236	51
11	100	2.9	68		0.075	0.083	786.385	79	73	236	53
12	110	3.0	68		0.085	0.094	792.045	78	73	234	53
130	stop						797.302				

PARTICULATE SAMPLING DATA SHEET													
SCHEMATIC OF STACK CROSS SECTION				EQUATIONS				AMBIENT TEMP					
RUN NUMBER 3 DATE 31 July 91 PLANT Bldg 2436 BASE McClellan AFB SAMPLE BOX NUMBER Natch METER BOX NUMBER 3 Qw/Qm Co				SCHEMATIC OF STACK CROSS SECTION 31 JULY 91 Bldg 2436 McClellan AFB Natch 3 Qw/Qm Co				$H = \left[\frac{5130 \cdot P_b \cdot C_p \cdot A}{C_o} \right]^2 \cdot \frac{T_m \cdot V_p}{T_s}$ $H = 2.0195 \quad Y_i = 1.0127$ $p_s = -0.06$				STATION PRESS 29.830 HEATER BOX TEMP 148.1 PROBE HEATER SETTING 148.1 PROBE LENGTH 62 NOZZLE AREA 0.311 Cp 0.84 DRY GAS FRACTION 0.84	
TRAVERSE POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H ₂ O)	STACK TEMP (°F)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (in)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP (°F)	OUT (°F)	SAMPLE BOX TEMP (°F)	IMPINGING OUTLET TEMP (°F)			
1	0.076	1.5	70	0.020	0.22	797.303	76	74	237	62			
2	0.076	1.1	69	0.032	0.35	800.020	77	74	235	55			
3	20	1.9	69	0.032	0.35	803.248	79	75	236	54			
4	30	2.0	69	0.035	0.39	806.578	81	76	232	55			
5	40	2.0	69	0.035	0.34	810.078	81	77	238	56			
6	50	2.5	69	0.058	0.64	813.590	83	79	234	55			
7	60	3.0	69	0.080	0.84	817.950	85	81	235	53			
8	70	3.2	70	0.100	1.12	823.030	87	82	237	53			
9	80	4.0	71	0.130	1.45	828.770	89	83	238	53			
10	90	4.0	73	0.132	1.47	835.202	91	84	234	54			
11	100	4.9	73	0.158	1.71	841.740	92	86	236	55			
12	110	5.0	74	0.170	1.90	848.853	94	87	233	55			
13	120	5.0	74	0.170	1.90	856.212	94	87	233	55			
$T_s = 69$ $VPS = 6.3043$ $W = 119.242$ $W = 2.88$				$T_m = 77$ $T_s = 77$									

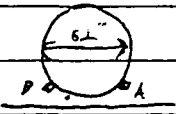
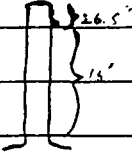
PRELIMINARY SURVEY DATA SHEET NO. 1
(Stack Geometry)

BASE McClellan AFB		PLANT Bldg 243 G	
DATE 29 July 91		SAMPLING TEAM AL	
SOURCE TYPE AND MAKE Chrome Plated Bob Scrubber			
SOURCE NUMBER Stack #1 Run 1 only		INSIDE STACK DIAMETER 62 in Inches	
RELATED CAPACITY in amp-hrs		TYPE FUEL	
DISTANCE FROM OUTSIDE OF NIPPLE TO INSIDE DIAMETER 1.5 in Inches			
NUMBER OF TRAVERSES 2		NUMBER OF POINTS/TRAVERSE 12	
LOCATION OF SAMPLING POINTS ALONG TRAVERSE			
POINT	PERCENT OF DIAMETER	DISTANCE FROM INSIDE WALL (Inches)	TOTAL DISTANCE FROM OUTSIDE OF NIPPLE TO SAMPLING POINT (Inches)
1 A, B			2.8
2 A, B			5.7
3 A, B			8.8
4 A, B			12.5
5 A, B			17.0
6 A, B			23.6
7 A, B			41.4
8 A, B			48.0
9 A, B			52.5
10 A, B			56.2
11 A, B			59.3
12 A, B			62.2

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PRELIMINARY SURVEY DATA SHEET NO. 2
(Velocity and Temperature Traverse)

BASE McClellan AFB		DATE 29 July 91	
BOILER NUMBER Gr Pack 20 Scrubber - Stack one (Top port holes)			
INSIDE STACK DIAMETER 62 in		Inches	
STATION PRESSURE 29.880		In Hg	
STACK STATIC PRESSURE -.09		In H2O	
SAMPLING TEAM AL			

TRAVERSE POINT NUMBER	VELOCITY HEAD, V_p IN H2O	cyclonic angle $\sqrt{V_p} \alpha$	STACK TEMPERATURE (°F)
A 1	/	4	62
2		6	↓
3		5	
4		2	
5		2	
6		0	
7		0	
8		6	
9		5	
10		8	
11		8	
12		11	
Nozzle pre chosen from prior test data ≈ 0.310		avg cyclonicity = 4.75%	
 			
AVERAGE		4.75%	

PRELIMINARY SURVEY DATA SHEET NO. 1 (Stack Geometry)			
BASE McClellan AFB		PLANT Bldg 243 G	
DATE 30 July 91		SAMPLING TEAM AL	
SOURCE TYPE AND MAKE chrome Packed Bed Scrubber			
SOURCE NUMBER Stack #1 Runs 2 & 3 only		INSIDE STACK DIAMETER 62 Inches	
RELATED CAPACITY in amp-hrs		TYPE FUEL	
DISTANCE FROM OUTSIDE OF NIPPLE TO INSIDE DIAMETER 1.69 in Inches			
NUMBER OF TRAVERSES 2		NUMBER OF POINTS/TRAVERSE 12	
LOCATION OF SAMPLING POINTS ALONG TRAVERSE			
POINT	PERCENT OF DIAMETER	DISTANCE FROM INSIDE WALL (Inches)	TOTAL DISTANCE FROM OUTSIDE OF NIPPLE TO SAMPLING POINT (Inches)
1 A, B			3.0
2 A, B			5.8
3 A, B			9.0
4 A, B			12.7
5 A, B			17.2
6 A, B			23.7
7 A, B			41.6
8 A, B			48.2
9 A, B			52.7
10 A, B			56.4
11 A, B			59.5
12 A, B			62.4

OEHL FORM 15
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PRELIMINARY SURVEY DATA SHEET NO. 2
(Velocity and Temperature Traverse)

BASE McClellan AFB

DATE 30 July 81

BOILER NUMBER Chrome Packed Bed Scrubber 1

INSIDE STACK DIAMETER 62 in Inches

STATION PRESSURE 29.830 In Hg

STACK STATIC PRESSURE -.06 In H2O

SAMPLING TEAM AL/OEBE

TRAVERSE POINT NUMBER	VELOCITY HEAD, V_p IN H2O	$\sqrt{V_p}$	STACK TEMPERATURE (°F)
1		24	82
2	Nozzle pressure at .31" based on previous data	18	
3		14	
4		11	
5		6	
6		0	
7		0	
8		7	
9		13	
10		17	
11		19	
12		22	
		avg 12.5°	
Port location changed for safety reasons and better comply with Method 1 (EPA and OSHA)			
249"			
13 ft			
Straightening vane installed because cyclonicity > 20° on first attempt			
AVERAGE			

AIR POLLUTION PARTICULATE ANALYTICAL DATA					
BASE <i>McClellan AFB</i>		DATE <i>29 Jul 91</i>		RUN NUMBER <i>1 Stack 1</i>	
BUILDING NUMBER <i>Bldg 243 G</i>			SOURCE NUMBER		
I. PARTICULATES					
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)		
FILTER NUMBER					
ACETONE WASHINGS (Probe, Front Half Filter)					
BACK HALF (If needed)					
		Total Weight of Particulates Collected		gm	
II. WATER					
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)		
IMPINGER 1 (H2O) <i>0.1 N NaOH</i>	<i>123</i>	<i>100</i>	<i>23.0</i>		
IMPINGER 2 (H2O) <i>0.1 N NaOH</i>	<i>106</i>	<i>100</i>	<i>6.0</i>		
IMPINGER 3 (Dry)					
IMPINGER 4 (Silica Gel)	<i>227</i>	<i>200</i>	<i>27.0</i>		
		Total Weight of Water Collected		<i>56.0 gm</i>	
III. GASES (Dry)					
ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO ₂	<i>probe pre-wash = 100 ml</i>				
VOL % O ₂	<i>probe post wash = 140 ml</i>				
VOL % CO					
VOL % N ₂					
Vol % N ₂ = (100% - % CO ₂ - % O ₂ - % CO)					

OEHL FORM 20
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AIR POLLUTION PARTICULATE ANALYTICAL DATA					
BASE <i>McClure AER</i>		DATE <i>31 July</i>		RUN NUMBER <i>3 stack</i>	
BUILDING NUMBER <i>314 243 6</i>			SOURCE NUMBER		
I. PARTICULATES					
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)		
FILTER NUMBER					
ACETONE WASHINGS (Probe, Front Half Filter)					
BACK HALF (if needed)					
Total Weight of Particulates Collected			gm		
II. WATER					
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)		
IMPINGER 1 (H2O) <i>0.1 N NaOH</i>	<i>122 ml</i>	<i>100 ml</i>	<i>22 ml</i>		
IMPINGER 2 (H2O) <i>0.1 N NaOH</i>	<i>104 ml</i>	<i>100 ml</i>	<i>4 ml</i>		
IMPINGER 3 (Dry)					
IMPINGER 4 (Silica Gel)	<i>220.5</i>	<i>200</i>	<i>20.5</i>		
Total Weight of Water Collected			<i>46.5 gm</i>		
III. GASES (Dry)					
ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO ₂	<i>probe pre-wash = 100 ml</i>				
VOL % O ₂	<i>probe post-wash = 12 ml</i>				
VOL % CO					
VOL % N ₂					
Vol % N ₂ = (100% - % CO ₂ - % O ₂ - % CO)					

OEHL FORM 20
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AIR POLLUTION PARTICULATE ANALYTICAL DATA					
BASE <i>McClellan AFB</i>		DATE <i>30 Jul 91</i>		RUN NUMBER <i>2 stack 1</i>	
BUILDING NUMBER <i>Bldg 243 G</i>			SOURCE NUMBER		
I. PARTICULATES					
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)		
FILTER NUMBER					
ACETONE WASHINGS (Probe, Front Half Filter)					
BACK HALF (if needed)					
	Total Weight of Particulates Collected		gm		
II. WATER					
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)		
IMPINGER 1 (H2O) <i>0.1 N NaOH</i>	<i>133</i>	<i>100</i>	<i>33 ml</i>		
IMPINGER 2 (H2O) <i>0.1 N NaOH</i>	<i>103</i>	<i>100</i>	<i>03 ml</i>		
IMPINGER 3 (Dry)					
IMPINGER 4 (Silica Gel)	<i>221.6</i>	<i>200</i>	<i>21.6</i>		
	Total Weight of Water Collected		<i>57.6 gm</i>		
III. GASES (Dry)					
ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO ₂	<i>probe pre-wash = 100ml</i>				
VOL % O ₂	<i>probe post-wash = 130ml</i>				
VOL % CO					
VOL % N ₂					
Vol % N ₂ = (100% - % CO ₂ - % O ₂ - % CO)					

OEHL FORM 20
MAY 78

APPENDIX F
Scrubber 2 Field Data

XRCM METH 5
 RUN NUMBER
 ONE, STACK 2
 METER BOX Y? RUN
 1.0127 RUN
 DELTA H? .8300 RUN
 BAR PRESS ? 29.8700 RUN
 METER VOL ? 118.2020 RUN
 MTR TEMP F? 88.0000 RUN
 % OTHER GAS
 REMOVED BEFORE
 DRY GAS METER ? RUN
 STATIC HOH IN ?
 -1.600 RUN
 STACK TEMP. 101.0000 RUN
 ML. WATER ? 51.3000 RUN
 SAT % = 6.7

IMP. % HOH = 2.0

% HOH=2.0

% CO2? 0.0000 RUN
 % OXYGEN? 21.0000 RUN
 % CO ? 0.0000 RUN
 MOL WT OTHER? RUN

MWD =29.84
 MW WET=29.62
 SORT PSTS ? 6.4195 RUN
 TIME MIN ? 240.0000 RUN
 NOZZLE DIA ? .3100 RUN
 STK DIA INCH ? 62.0000 RUN

* VOL MTR STD = 119.777
 STK PRES ABS = 29.86
 VOL HOH GAS = 2.41
 % MOISTURE = 2.85
 MOL DRY GAS = 0.990
 % NITROGEN = 79.00
 MOL WT DRY = 28.34
 MOL WT WET = 29.62
 VELOCITY FPS = 15.77
 STACK AREA = 20.97
 STACK ACFM = 19.879.
 * STACK DSCFM = 19.251.
 % ISOINETIC = 105.40

XRCM METH 5
 RUN NUMBER
 TWO, STACK 2
 METER BOX Y? RUN
 1.0127 RUN
 DELTA H? .9000 RUN
 BAR PRESS ? 29.8000 RUN
 METER VOL ? 122.9230 RUN
 MTR TEMP F? 88.0000 RUN
 % OTHER GAS
 REMOVED BEFORE
 DRY GAS METER ? RUN
 STATIC HOH IN ?
 -1.600 RUN
 STACK TEMP. 70.0000 RUN
 ML. WATER ? 46.3000 RUN
 SAT % = 2.5

IMP. % HOH = 1.8

% HOH=1.8

% CO2? 0.0000 RUN
 % OXYGEN? 21.0000 RUN
 % CO ? 0.0000 RUN
 MOL WT OTHER? RUN

MWD =29.94
 MW WET=29.65
 SORT PSTS ? 6.4643 RUN
 TIME MIN ? 240.0000 RUN
 NOZZLE DIA ? .3000 RUN
 STK DIA INCH ? 62.0000 RUN

* VOL MTR STD = 121.496
 STK PRES ABS = 29.79
 VOL HOH GAS = 2.19
 % MOISTURE = 1.76
 MOL DRY GAS = 0.990
 % NITROGEN = 79.00
 MOL WT DRY = 28.34
 MOL WT WET = 29.65
 VELOCITY FPS = 15.09
 STACK AREA = 20.97
 STACK ACFM = 19.951.
 * STACK DSCFM = 19.479.
 % ISOINETIC = 104.44

XRCM METH 5
 RUN NUMBER
 THREE, STACK 2
 METER BOX Y? RUN
 1.0127 RUN
 DELTA H? .9900 RUN
 BAR PRESS ? 29.9050 RUN
 METER VOL ? 129.0620 RUN
 MTR TEMP F? 81.0000 RUN
 % OTHER GAS
 REMOVED BEFORE
 DRY GAS METER ? RUN
 STATIC HOH IN ?
 -1.600 RUN
 STACK TEMP. 70.0000 RUN
 ML. WATER ? 46.2000 RUN
 SAT % = 2.5

IMP. % HOH = 1.7

% HOH=1.7

% CO2? 0.0000 RUN
 % OXYGEN? 21.0000 RUN
 % CO ? 0.0000 RUN
 MOL WT OTHER? RUN

MWD =29.94
 MW WET=29.66
 SORT PSTS ? 6.5517 RUN
 TIME MIN ? 240.0000 RUN
 NOZZLE DIA ? .3100 RUN
 STK DIA INCH ? 62.0000 RUN

* VOL MTR STD = 127.709
 STK PRES ABS = 29.79
 VOL HOH GAS = 3.17
 % MOISTURE = 1.46
 MOL DRY GAS = 0.990
 % NITROGEN = 79.00
 MOL WT DRY = 28.34
 MOL WT WET = 31.46
 VELOCITY FPS = 16.05
 STACK AREA = 20.97
 STACK ACFM = 20.194.
 * STACK DSCFM = 19.287.
 % ISOINETIC = 107.71

Copy available to DDC does not
 include fully detailed reproduction

XROM "MASSFLO"

RUN NUMBER
ONE, STACK TWO RUN

VOL MTR STD ?

115.377 RUN
STACK DSCFM ?
18.251 RUN
FRONT 1/2 MG ?
.00552 RUN
BACK 1/2 MG ?
0 RUN

F GR/DSCF = 7.3832E-7
F MG/MMH = 1.6895E-3
F LB/HR = 1.1550E-4
F KG/HR = 5.2391E-5

XROM "MASSFLO"

RUN NUMBER
TWO, STACK TWO RUN

VOL MTR STD ?
121.498 RUN
STACK DSCFM ?
19.479 RUN
FRONT 1/2 MG ?
.00516 RUN
BACK 1/2 MG ?
0 RUN

F GR/DSCF = 6.5540E-7
F MG/MMH = 1.4998E-3
F LB/HR = 1.0943E-4
F KG/HR = 4.9636E-5

XROM "MASSFLO"

RUN NUMBER
THREE, STACK TWO RUN

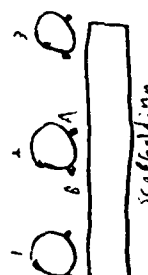
VOL MTR STD ?
127.38 RUN
STACK DSCFM ?
20.057 RUN
FRONT 1/2 MG ?
.00554 RUN
BACK 1/2 MG ?
0 RUN

F GR/DSCF = 6.7117E-7
F MG/MMH = 1.5359E-3
F LB/HR = 1.1539E-4
F KG/HR = 5.2339E-5

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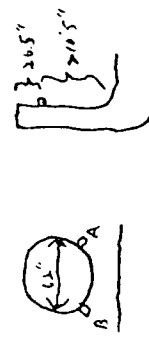
PARTICULATE SAMPLING DATA SHEET											
SCHEMATIC OF STACK CROSS SECTION				EQUATIONS				AMBIENT TEMP			
RUN NUMBER	1			STACK #	2			page 2 of 2			
DATE	24 July 91			$H = \left[\frac{5130 \cdot F \cdot C_p \cdot A}{C_o} \right]^2 \cdot \frac{T_m \cdot V_p}{T_s}$				STATION PRESS			
PLANT	Bldg 2436							29.870 in Hg			
BASE	McClellan			post p. tot check - good post train check at 14.2 in Hg - good				HEATER BOX TEMP			
SAMPLE BOX NUMBER	Nute 6							248.1 15			
METER BOX NUMBER	3							PROBE HEATER SETTING			
Qw/Qm								248.5 15			
Cu								PROBE LENGTH			
								NOZZLE AREA (in ²)			
								0.310 in ²			
								Cp			
								0.84			
								DRY GAS FRACTION (dry flw)			
								28.84			
TRAVERSE POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H ₂ O)	STACK TEMP (°F)	STACK TEMP (°F)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (in)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP (°F)	OUT (°F)	SAMPLE BOX TEMP (°F)	IMPINGER OUTLET TEMP (°F)
1	0	1.7	104		0.04	0.42	188.250	93	91	243	65
2	10	1.6	106		0.045	0.47	192.058	88	89	243	58
3	20	1.8	106		0.05	0.52	195.150	90	90	243	57
4	30	1.8	107		0.045	0.47	199.825	93	92	244	55
5	40	1.6	106		0.045	0.47	203.745	94	94	250	57
6	50	1.5	107		0.035	0.37	207.778	95	95	255	57
7	60	1.5	107		0.035	0.37	211.250	95	95	253	58
8	70	1.6	108		0.040	0.42	214.782	96	97	257	59
9	80	2.1	104		0.075	0.79	218.510	96	97	265	54
10	90	2.5	109		0.10	1.05	223.645	95	94	258	54
11	100	2.7	110		0.125	1.21	229.675	97	95	259	56
12	110	3.0	110		0.145	1.52	235.341	97	96	264	57
	120						242.045				
				T _s = 104	V _{AST} = 6.495		T _m = 88				
						Total = 4361 = 119.201					
						ΔH = 0.83					

PARTICULATE SAMPLING DATA SHEET											
SCHEMATIC OF STACK CROSS SECTION				EQUATIONS				AMBIENT TEMP			
RUN NUMBER 2 DATE 25 July 91 PLANT Bldg 2436 BASE McClellan AFB SAMPLE BOX NUMBER Nutech METER BOX NUMBER 3 Qw/Qm Co				27, 420 0% O ₂				(44 in start) STATION PRESS 29.800 in Hg HEATER BOX TEMP 248 ± 25 OF PROBE HEATER SETTING 248 ± 25 PROBE LENGTH 6 ft NOZZLE AREA (A) 0.309 sq ft Cp DRY GAS FRACTION 0.84 29.84			
$H = \left[\frac{5130 \cdot P_d \cdot C_p \cdot A}{C_o} \right]^2 \cdot \frac{T_m \cdot V_p}{T_s}$ pre pilot check - good pre train check at 15 in Hg - good post pilot check - good post train check at 5 in Hg - good static pressure = 0.16 $\Delta H = 2.095$ $Y = 1.6127$				$OR = OF + 460$							
scrubber stacks 											
TRAVERSE POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H ₂ O)	STACK TEMP (OF)	STACK TEMP (TS) (OF)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (IN)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP IN (OF)	GAS METER TEMP OUT (OF)	SAMPLE BOX TEMP (OF)	IMPIGING OUTLET TEMP (OF)
A 1	0 0755	4.0	63		0.125	1.31	142.316	63	62	265	52
2	10	4.8	64		0.150	1.60	148.570	70	64	258	48
3	20	5.0	65		0.145	1.76	155.326	74	65	255	50
4	30	4.5	65		0.140	1.50	162.455	76	67	255	54
5	40	4.0	65		0.120	1.29	169.160	77	68	255	53
6	50	3.4	65		0.110	1.08	175.365	78	70	254	51
7	60	2.5	65		0.055	0.57	181.090	79	71	253	51
8	70	2.0	67		0.040	0.43	185.450	77	71	254	49
9	80	1.9	69		0.035	0.37	189.185	77	71	254	48
10	90	2.1	69		0.045	0.48	192.625	77	73	254	50
11	100	2.9	74		0.075	0.80	196.412	80	75	251	47
12	110	3.0	71		0.080	0.86	201.560	82	75	253	50
	120 STOP						306.576				

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PARTICULATE SAMPLING DATA SHEET										
SCHEMATIC OF STACK CROSS SECTION				EQUATIONS			AMBIENT TEMP			
RUN NUMBER	2 Stack 2			$H = \left[\frac{5130 \cdot F_d \cdot C_p \cdot A}{C_o} \right]^2 \cdot \frac{T_m \cdot V_p}{T_s}$			STATION PRESS			
DATE	25 Jul 91						29.800 in Hg			
PLANT	Bldg 243 G						HEATER BOX TEMP			
BASE	McClellan AFB						248.5-25			
SAMPLE BOX NUMBER	Nutech						PROBE HEATER SETTING			
METER BOX NUMBER	3						248.5-25			
Qw/Qm							PROBE LENGTH			
Co							6 FT in			
							NOZZLE AREA (A)			
							0.309			
							Cp			
							0.84			
							DRY GAS FRACTION (F _g)			
							0.84			
TRAVERSE POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H ₂ O)	STACK TEMP (°F)	STACK TEMP (°F)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (H)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP IN (°F)	GAS METER TEMP OUT (°F)	IMPINGING OUTLET TEMP (°F)
1	0 10:14	2.5	74	74	0.06	0.64	306.524	79	78	48
2	10	2.3	74	74	0.055	0.59	310.460	83	79	48
3	20	2.3	73	73	0.055	0.59	315.305	85	80	50
4	30	2.3	73	73	0.055	0.60	319.615	87	82	50
5	40	2.2	73	73	0.052	0.56	323.990	89	83	50
6	50	2.8	73	73	0.06	0.65	328.235	90	85	50
7	60	2.2	73	73	0.052	0.57	332.790	92	86	50
8	70	2.2	73	73	0.052	0.57	337.083	92	87	50
9	80	2.8	73	73	0.065	0.71	341.367	93	88	50
10	90	3.1	73	73	0.083	0.91	346.080	94	89	52
11	100	3.8	73	73	0.125	1.27	351.375	95	91	54
12	110	4.9	74	74	0.155	1.70	356.08	93	92	57
	120 stop						365.247			
				$\bar{T} = 70$	$V_{p, \text{avg}} = 6.4649$	$T_{o, \text{avg}} = 122.923$	$\bar{T}_m = 80$			
					$\Delta T = 0.90$					
Vacuum pump slipped working at 100.4 mm (114 hrs). Pump repaired and sampling restarted at 12:14 hrs										

PARTICULATE SAMPLING DATA SHEET															
RUN NUMBER				SCHEMATIC OF STACK CROSS SECTION				EQUATIONS				AMBIENT TEMP			
Three Stack 2				scrubber stacks scaffolding				$OR = OF + 460$ $H = \left[\frac{5130 \cdot Pd \cdot Cp \cdot A}{Co} \right]^2 \cdot \frac{T_m}{T_s} \cdot Vp$ <pre>pre plot check - good</pre> <pre>pre train check if 15.4m - good</pre>				STATION PRESS 65 (start) OF HEATER BOX TEMP 29.805 In Hg PROBE HEATER SETTING 24.8 ± 2.5 OF PROBE LENGTH 24.8 ± 2.5 NOZZLE ADAPTATION 6 ft m Cp 0.213 in sq ft DRY GAS FRACTION 0.84 2.8.84			
DATE 26 July 91															
PLANT Bldg 2436															
BASE McClellan AFB															
SAMPLE BOX NUMBER 3															
METER BOX NUMBER 3				$static pressure = -0.16$ $\Delta H = 2.0195$ $Y = 1.0127$											
Qw/Qm				$30 H_2O$ $0.2 other$											
TRAVERSE POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H ₂ O)	STACK TEMP (OF)	STACK TEMP (TR OF)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (IN)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP IN (OF)	GAS METER TEMP OUT (OF)	SAMPLE BOX TEMP (OF)	IMPINGER OUTLET TEMP (OF)				
1	0 start	1.8	66		0.045	0.50	365.440	65	66	241	56				
2	10	2.1	66		0.06	0.67	369.327	69	66	246	52				
3	20	2.1	67		0.065	0.73	373.772	73	67	244	53				
4	30	2.1	67		0.065	0.73	378.470	75	69	245	54				
5	40	2.1	67		0.065	0.73	383.187	76	69	245	55				
6	50	1.0	67		0.06	0.68	387.900	77	71	243	65				
7	60	0.9	67		0.05	0.57	392.470	79	72	241	66				
8	70	1.0	67		0.06	0.68	396.706	79	73	238	64				
9	80	1.0	67		0.085	0.97	401.260	80	74	238	64				
10	90	1.0	67		0.105	1.19	406.652	81	75	232	66				
11	100	1.1	68		0.146	1.59	412.585	83	76	232	67				
12	110	1.1	68		0.165	1.88	417.370	84	77	232	68				
	120 stop						426.777								

PARTICULATE SAMPLING DATA SHEET											
SCHEMATIC OF STACK CROSS SECTION				EQUATIONS							
 $Q_R = Q_F + 460$ $H = \left[\frac{5130 \cdot F \cdot C \cdot A}{C_o} \right]^2 \cdot \frac{T_m}{T_s} \cdot V_p$ post pitot check - wood post train check at 13 in 115 - wood				AMBIENT TEMP STATION PRESS 29.805 in Hg HEATER BOX TEMP 248 F OF PROBE HEATER SETTING 248 F OF PROBE LENGTH 6 ft NOZZLE AREA (sq in) 0.313 in sq Cp 6.84 DRY GAS FRACTION (wt %) 28.84							
TRaverse POINT NUMBER	SAMPLING TIME (min)	VACUUM PRESSURE (in Hg)	STACK TEMP (OF)		VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (in)	GAS VOLUME (cu ft)	GAS METER TEMP (OF)		SAMPLE BOX TEMP (OF)	IMPINGER OUTLET TEMP (OF)
			(OF)	(TS)				IN	AVG (1m)	OUT	
A 1	0	1.0	70		0.135	1.53	436.780	80		78	64
2	10	1.6	70		0.150	1.71	433.500	85		79	55
3	30	1.0	64		0.135	1.55	444.545	87		80	63
4	30	1.0	70		0.115	1.33	447.450	89		81	63
5	40	1.0	70		0.110	1.15	453.815	90		82	68
6	50	1.0	72		0.110	1.15	459.745	91		84	64
7	60	1.0	73		0.105	0.97	465.510	91		85	67
8	70	1.0	74		0.145	0.52	469.950	93		87	67
9	80	1.0	75		0.143	0.48	474.195	93		89	68
10	90	1.0	75		0.165	0.75	478.170	94		90	66
11	100	1.0	75		0.185	0.98	482.481	96		91	68
12	110	1.0	76		0.165	1.21	488.520	98		92	68
120	stop						494.505				
			T _s = 70		V _{PS} T _s = 6.1577		T _{avg} = 81				
					ΔH = 0.94						

[illegible]

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PRELIMINARY SURVEY DATA SHEET NO. 1
(Stack Geometry)

BASE <i>McClellan</i>		PLANT <i>Bldg 2436</i>	
DATE <i>24 July 91</i>		SAMPLING TEAM <i>AL</i>	
SOURCE TYPE AND MAKE <i>chrome packed Red scrubber</i>			
SOURCE NUMBER <i>scrubber stack #2</i>		INSIDE STACK DIAMETER <i>62</i> Inches	
RELATED CAPACITY <i>in gmp-hrs</i>		TYPE FUEL	
DISTANCE FROM OUTSIDE OF NIPPLE TO INSIDE DIAMETER <i>1.5 in</i> Inches			
NUMBER OF TRAVERSES <i>2</i>		NUMBER OF POINTS/TRAVERSE <i>12</i>	
LOCATION OF SAMPLING POINTS ALONG TRAVERSE			
POINT	PERCENT OF DIAMETER	DISTANCE FROM INSIDE WALL (Inches)	TOTAL DISTANCE FROM OUTSIDE OF NIPPLE TO SAMPLING POINT (Inches)
<i>1 A, B</i>			<i>2.8</i>
<i>2 A, B</i>			<i>5.7</i>
<i>3 A, B</i>			<i>8.8</i>
<i>4 A, B</i>			<i>12.5</i>
<i>5 A, B</i>			<i>17.0</i>
<i>6 A, B</i>			<i>23.6</i>
<i>7 A, B</i>			<i>41.4</i>
<i>8 A, B</i>			<i>48.0</i>
<i>9 A, B</i>			<i>52.5</i>
<i>10 A, B</i>			<i>56.2</i>
<i>11 A, B</i>			<i>59.3</i>
<i>12 A, B</i>			<i>62.2</i>

AIR POLLUTION PARTICULATE ANALYTICAL DATA					
BASE # McCllellan AFB		DATE 26 July 91		RUN NUMBER 3	
BUILDING NUMBER Bldg 2436			SOURCE NUMBER stack # 2		
I. PARTICULATES					
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)		
FILTER NUMBER					
ACETONE WASHINGS (Probe, Front Half Filter)					
BACK HALF (If needed)					
		Total Weight of Particulates Collected		gm	
II. WATER					
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)		
IMPINGER 1 (H2O) 0.1 N NaOH	120 ml	100 ml	20 ml		
IMPINGER 2 (H2O) 0.1 N NaOH	108 ml	100 ml	8 ml		
IMPINGER 3 (Dry)					
IMPINGER 4 (Silica Gel)	218.2	200	18.2		
		Total Weight of Water Collected		46.2 gm	
III. GASES (Dry)					
ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO ₂	probe pre-wash = 110 ml				
VOL % O ₂	probe post-wash = 109 ml				
VOL % CO					
VOL % N ₂					
Vol % N ₂ = (100% - % CO ₂ - % O ₂ - % CO)					

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AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE McClellan AFB	DATE 24 July 81	RUN NUMBER stacks # 1
BUILDING NUMBER	SOURCE NUMBER stacks	

I. PARTICULATES			
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER			
ACETONE WASHINGS (Probe, Front Half Filter)			
BACK HALF (if needed)			
	Total Weight of Particulates Collected		gm

II. WATER			
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 (H2O) 0.1 N NaOH	120.0	100	20.0
IMPINGER 2 (H2O) 0.1 N NaOH	108.0	100	8.0
IMPINGER 3 (Dry)			
IMPINGER 4 (Silica Gel)	223.3	200	23.3
	Total Weight of Water Collected		51.3 gm

III. GASES (Dry)					
ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO ₂	probe prewash = 170 ml		0.1 NaOH		
VOL % O ₂	probe wash = 108 ml		0.1 NaOH		
VOL % CO					
VOL % N ₂					

$$\text{Vol \% N}_2 = (100\% - \% \text{CO}_2 - \% \text{O}_2 - \% \text{CO})$$

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AIR POLLUTION PARTICULATE ANALYTICAL DATA					
BASE <i>M. C. Lellan AFB</i>		DATE <i>25 July 71</i>		RUN NUMBER <i>2 stack 2</i>	
BUILDING NUMBER			SOURCE NUMBER		
I. PARTICULATES					
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)		
FILTER NUMBER					
ACETONE WASHINGS (Probe, Front Half Filter)					
BACK HALF (if needed)					
		Total Weight of Particulates Collected		gm	
II. WATER					
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)		
IMPINGER 1 (H2O) <i>0.1 N NaOH</i>	<i>117.5</i>	<i>100.0</i>	<i>17.5</i>		
IMPINGER 2 (H2O) <i>0.1 N NaOH</i>	<i>106.0</i>	<i>100.0</i>	<i>6.0</i>		
IMPINGER 3 (Dry)					
IMPINGER 4 (Silica Gel)	<i>222.8</i>	<i>200.0</i>	<i>22.8</i>		
		Total Weight of Water Collected		<i>46.3</i> gm	
III. GASES (Dry)					
ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO ₂	<i>Probe Wash Vol (Probe) = 116 ml</i>				
VOL % O ₂	<i>Probe Wash Volume = 100 ml</i>				
VOL % CO					
VOL % N ₂					
$\text{Vol \% N}_2 = (100\% - \% \text{CO}_2 - \% \text{O}_2 - \% \text{CO})$					

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APPENDIX G
Laboratory Results

AIR FORCE
OCCUPATIONAL AND ENVIRONMENTAL HEALTH DIRECTORATE
BROOKS AFB, TEXAS, 78235-5000

REPORT OF ANALYSIS

BASE SAMPLE NO: CN910001 OEHL SAMPLE NO: 91041052
SAMPLE TYPE: NON-POTABLE WATER
SITE IDENTIFIER: DATE RECEIVED: 910806
DATE COLLECTED: 910724 DATE REPORTED: 910813
SAMPLE SUBMITTED BY: SM-ALC/EMC

RESULTS

<u>Test</u>	<u>Results</u>	<u>Units</u>
Chromium	<50	ug/L
Chromium VI	<20.	ug/L

Comments:

< - Signifies none detected and the detection limits.

Analyzed by: Aaron L. Forrest

Aaron L. Forrest, Sgt, USAF
Occupational Analysis Technician

Reviewed by: G. Cornell Long

G. Cornell Long
Chief, Metals Analysis Function

TO:

AL/OEHE
BROOKS AFB TX 78235-5000

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AIR FORCE
OCCUPATIONAL AND ENVIRONMENTAL HEALTH DIRECTORATE
BROOKS AFB, TEXAS, 78235-5000

REPORT OF ANALYSIS

BASE SAMPLE NO: CN910002 OEHL SAMPLE NO: 91041053
SAMPLE TYPE: NON-POTABLE WATER
SITE IDENTIFIER: DATE RECEIVED: 910806
DATE COLLECTED: 910724 DATE REPORTED: 910813
SAMPLE SUBMITTED BY: SM-ALC/EMC

RESULTS

<u>Test</u>	<u>Results</u>	<u>Units</u>
Chromium	<50	ug/L
Chromium VI	<20.	ug/L

Comments:

< - Signifies none detected and the detection limits.

Analyzed by: Aaron L. Forrest
Aaron L. Forrest, Sgt, USAF
Occupational Analysis Technician

Reviewed by: G. Cornell Long
G. Cornell Long
Chief, Metals Analysis Function

TO:

AL/DESE
BROOKS AFB TX 78235-5000

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AIR FORCE
OCCUPATIONAL AND ENVIRONMENTAL HEALTH DIRECTORATE
BROOKS AFB, TEXAS, 78235-5000

REPORT OF ANALYSIS

BASE SAMPLE NO: CN910003 OEHL SAMPLE NO: 91041054
SAMPLE TYPE: NON-POTABLE WATER
SITE IDENTIFIER: DATE RECEIVED: 910806
DATE COLLECTED: 910724 DATE REPORTED: 910813
SAMPLE SUBMITTED BY: SM-ALC/EMC

RESULTS

<u>Test</u>	<u>Results</u>	<u>Units</u>
Chromium	81	ug/L
Chromium VI	<20.	ug/L

Comments:

< - Signifies none detected and the detection limits.

Analyzed by: Aaron L. Forrest

Aaron L. Forrest, Sgt, USAF
Occupational Analysis Technician

Reviewed by: G. Cornell Long

G. Cornell Long
Chief, Metals Analysis Function

TO:

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REPORT OF ANALYSIS

BASE SAMPLE NO: CN910004 DEHL SAMPLE NO: 91041055
SAMPLE TYPE: NON-POTABLE WATER
SITE IDENTIFIER: DATE RECEIVED: 910806
DATE COLLECTED: 910724 DATE REPORTED: 910813
SAMPLE SUBMITTED BY: SM-ALC/EMC

RESULTS

<u>Test</u>	<u>Results</u>	<u>Units</u>
Chromium	<50	ug/L
Chromium VI	<20.	ug/L

Comments:

< - Signifies none detected and the detection limits.

Analyzed by: Aaron L. Forrest

Aaron L. Forrest, Sgt, USAF
Occupational Analysis Technician

Reviewed by: G. Cornell Long

G. Cornell Long
Chief, Metals Analysis Function

TO:

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REPORT OF ANALYSIS

BASE SAMPLE NO: CN910005 DEHL SAMPLE NO: 91041056
SAMPLE TYPE: NON-POTABLE WATER
SITE IDENTIFIER: DATE RECEIVED: 910806
DATE COLLECTED: 910725 DATE REPORTED: 910813
SAMPLE SUBMITTED BY: SM-ALC/EMC

RESULTS

<u>Test</u>	<u>Results</u>	<u>Units</u>
Chromium	<50	ug/L
Chromium VI	<20.	ug/L

Comments:

< - Signifies none detected and the detection limits.

Analyzed by: Aaron L. Forrest

Aaron L. Forrest, Sgt, USAF
Occupational Analysis Technician

Reviewed by: G. Cornell Long

G. Cornell Long
Chief, Metals Analysis Function

TO:

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REPORT OF ANALYSIS

BASE SAMPLE NO: CN910006 OEHL SAMPLE NO: 91041057
SAMPLE TYPE: NON-POTABLE WATER
SITE IDENTIFIER: DATE RECEIVED: 910806
DATE COLLECTED: 910725 DATE REPORTED: 910813
SAMPLE SUBMITTED BY: SM-ALC/EMC

RESULTS

<u>Test</u>	<u>Results</u>	<u>Units</u>
Chromium	<50	ug/L
Chromium VI	<20.	ug/L

Comments:

< - Signifies none detected and the detection limits.

Analyzed by: Aaron L. Forrest

Aaron L. Forrest, Sgt, USAF
Occupational Analysis Technician

Reviewed by: G. Cornell Long

G. Cornell Long
Chief, Metals Analysis Function

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REPORT OF ANALYSIS

BASE SAMPLE NO: CN910007 OEHL SAMPLE NO: 91041058
SAMPLE TYPE: NON-POTABLE WATER
SITE IDENTIFIER: DATE RECEIVED: 910806
DATE COLLECTED: 910725 DATE REPORTED: 910813

RESULTS

<u>Test</u>	<u>Results</u>	<u>Units</u>
Chromium	<50	ug/L
Chromium VI	<20.	ug/L

Comments:

< - Signifies none detected and the detection limits.

Analyzed by: Aaron L. Forrest

Aaron L. Forrest, Sgt, USAF
Occupational Analysis Technician

Reviewed by: G. Cornell Long

G. Cornell Long
Chief, Metals Analysis Function

TO:

SM-ALC/EMC
MCLELLAN AFB CA 95652-5990

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BROOKS AFB, TEXAS, 78235-5000

REPORT OF ANALYSIS

BASE SAMPLE NO: CN910008 OEHL SAMPLE NO: 91041059
SAMPLE TYPE: NON-POTABLE WATER
SITE IDENTIFIER: DATE RECEIVED: 910806
DATE COLLECTED: 910725 DATE REPORTED: 910813
SAMPLE SUBMITTED BY: SM-ALC/EMC

RESULTS

<u>Test</u>	<u>Results</u>	<u>Units</u>
Chromium	<50	ug/L
Chromium VI	<20.	ug/L

Comments:

< - Signifies none detected and the detection limits.

Analyzed by: Aaron L. Forrest

Aaron L. Forrest, Sgt, USAF
Occupational Analysis Technician

Reviewed by: G. Cornell Long

G. Cornell Long
Chief, Metals Analysis Function

TO:

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BROOKS AFB TX 78235-5000

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BROOKS AFB, TEXAS, 78235-5000

REPORT OF ANALYSIS

BASE SAMPLE NO: CN910009 OEHL SAMPLE NO: 91041060
SAMPLE TYPE: NON-POTABLE WATER
SITE IDENTIFIER: DATE RECEIVED: 910806
DATE COLLECTED: 910726 DATE REPORTED: 910813
SAMPLE SUBMITTED BY: SM-ALC/EMC

RESULTS

<u>Test</u>	<u>Results</u>	<u>Units</u>
Chromium	<50	ug/L
Chromium VI	<20.	ug/L

Comments:

< - Signifies none detected and the detection limits.

Analyzed by: Aaron L. Forrest

Aaron L. Forrest, Sgt, USAF
Occupational Analysis Technician

Reviewed by: G. Cornell Long

G. Cornell Long
Chief, Metals Analysis Function

TO:

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BROOKS AFB TX 78235-5000

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REPORT OF ANALYSIS

BASE SAMPLE NO: CN910010 DEHL SAMPLE NO: 91041061
SAMPLE TYPE: NON-POTABLE WATER
SITE IDENTIFIER: DATE RECEIVED: 910806
DATE COLLECTED: 910726 DATE REPORTED: 910813

RESULTS

<u>Test</u>	<u>Results</u>	<u>Units</u>
Chromium	<50	ug/L
Chromium VI	<20.	ug/L

Comments:

< - Signifies none detected and the detection limits.

Analyzed by:

Aaron L. Forrest

Aaron L. Forrest, Sgt, USAF
Occupational Analysis Technician

Reviewed by:

G. Cornell Long

G. Cornell Long
Chief, Metals Analysis Function

TD:

SM-ALC/EMC
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AIR FORCE
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REPORT OF ANALYSIS

BASE SAMPLE NO: CN910011 OEHL SAMPLE NO: 91041062
SAMPLE TYPE: NON-POTABLE WATER
SITE IDENTIFIER: DATE RECEIVED: 910806
DATE COLLECTED: 910726 DATE REPORTED: 910813
SAMPLE SUBMITTED BY: SM-ALC/EMC

RESULTS

<u>Test</u>	<u>Results</u>	<u>Units</u>
Chromium	<50	ug/L
Chromium VI	<20.	ug/L

Comments:

< - Signifies none detected and the detection limits.

Analyzed by: Aaron L. Forrest

Aaron L. Forrest, Sgt, USAF
Occupational Analysis Technician

Reviewed by: G. Cornell Long

G. Cornell Long
Chief, Metals Analysis Function

TO:

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BROOKS AFB TX 78235-5000

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OCCUPATIONAL AND ENVIRONMENTAL HEALTH DIRECTORATE
BROOKS AFB, TEXAS, 78235-5000

REPORT OF ANALYSIS

BASE SAMPLE NO: CN910012 OEHL SAMPLE NO: 91041063
SAMPLE TYPE: NON-POTABLE WATER
SITE IDENTIFIER: DATE RECEIVED: 910806
DATE COLLECTED: 910726 DATE REPORTED: 910813
SAMPLE SUBMITTED BY: SM-ALC/EMC

RESULTS

<u>Test</u>	<u>Results</u>	<u>Units</u>
Chromium	<50	ug/L
Chromium VI	<20.	ug/L

Comments:

< - Signifies none detected and the detection limits.

Analyzed by:

Aaron L. Forrest

Aaron L. Forrest, Sgt, USAF
Occupational Analysis Technician

Reviewed by:

G. Cornell Long

G. Cornell Long
Chief, Metals Analysis Function

TO:

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BROOKS AFB, TEXAS, 78235-5000

REPORT OF ANALYSIS

BASE SAMPLE NO: CN910013 OEHL SAMPLE NO: 91041064
SAMPLE TYPE: NON-POTABLE WATER
SITE IDENTIFIER: DATE RECEIVED: 910806
DATE COLLECTED: 910729 DATE REPORTED: 910813
SAMPLE SUBMITTED BY: SM-ALC/EMC

RESULTS

<u>Test</u>	<u>Results</u>	<u>Units</u>
Chromium	<50	ug/L
Chromium VI	<20.	ug/L

Comments:

< - Signifies none detected and the detection limits.

Analyzed by: Aaron L. Forrest

Aaron L. Forrest, Sgt, USAF
Occupational Analysis Technician

Reviewed by: G. Cornell Long

G. Cornell Long
Chief, Metals Analysis Function

TO:

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REPORT OF ANALYSIS

BASE SAMPLE NO: CN910014 OEHL SAMPLE NO: 91041065
SAMPLE TYPE: NON-POTABLE WATER
SITE IDENTIFIER: DATE RECEIVED: 910806
DATE COLLECTED: 910729 DATE REPORTED: 910813
SAMPLE SUBMITTED BY: SM-ALC/EMC

RESULTS

<u>Test</u>	<u>Results</u>	<u>Units</u>
Chromium	<50	ug/L
Chromium VI	<20.	ug/L

Comments:

< - Signifies none detected and the detection limits.

Analyzed by: Caren L. Forrest

Aaron L. Forrest, Sgt, USAF
Occupational Analysis Technician

Reviewed by: G. Cornell Long

G. Cornell Long
Chief, Metals Analysis Function

TO:

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BROOKS AFB, TEXAS, 78235-5000

REPORT OF ANALYSIS

BASE SAMPLE NO: CN910015 OEHL SAMPLE NO: 91041066
SAMPLE TYPE: NON-POTABLE WATER
SITE IDENTIFIER: DATE RECEIVED: 910806
DATE COLLECTED: 910729 DATE REPORTED: 910813
SAMPLE SUBMITTED BY: SM-ALC/EMC

RESULTS

<u>Test</u>	<u>Results</u>	<u>Units</u>
Chromium	<50	ug/L
Chromium VI	<20.	ug/L

Comments:

< - Signifies none detected and the detection limits.

Analyzed by: Aaron L. Forrest

Aaron L. Forrest, Sgt, USAF
Occupational Analysis Technician

Reviewed by: G. Cornell Long

G. Cornell Long
Chief, Metals Analysis Function

TO:

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BROOKS AFB TX 78235-5000

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BROOKS AFB, TEXAS, 78235-5000

REPORT OF ANALYSIS

BASE SAMPLE NO: CN910016 OEHL SAMPLE NO: 91041067
SAMPLE TYPE: NON-POTABLE WATER
SITE IDENTIFIER: DATE RECEIVED: 910806
DATE COLLECTED: 910729 DATE REPORTED: 910813
SAMPLE SUBMITTED BY: SM-ALC/EMC

RESULTS

<u>Test</u>	<u>Results</u>	<u>Units</u>
Chromium	<50	ug/L
Chromium VI	<20.	ug/L

Comments:

< - Signifies none detected and the detection limits.

Analyzed by: Aaron L. Forrest

Aaron L. Forrest, Sgt, USAF
Occupational Analysis Technician

Reviewed by: G. Cornell Long

G. Cornell Long
Chief, Metals Analysis Function

TO:

AL/DEBE
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REPORT OF ANALYSIS

BASE SAMPLE NO: CN910017 OEHL SAMPLE NO: 91041068
SAMPLE TYPE: NON-POTABLE WATER
SITE IDENTIFIER: DATE RECEIVED: 910806
DATE COLLECTED: 910730 DATE REPORTED: 910813
SAMPLE SUBMITTED BY: SM-ALC/EMC

RESULTS

<u>Test</u>	<u>Results</u>	<u>Units</u>
Chromium	<50	ug/L
Chromium VI	<20.	ug/L

Comments:

< - Signifies none detected and the detection limits.

Analyzed by: Aaron L. Forrest

Aaron L. Forrest, Sgt, USAF
Occupational Analysis Technician

Reviewed by: G. Cornell Long

G. Cornell Long
Chief, Metals Analysis Function

TO:

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AIR FORCE
OCCUPATIONAL AND ENVIRONMENTAL HEALTH DIRECTORATE
BROOKS AFB, TEXAS, 78235-5000

REPORT OF ANALYSIS

BASE SAMPLE NO: CN910018 OEHL SAMPLE NO: 91041069
SAMPLE TYPE: NON-POTABLE WATER
SITE IDENTIFIER: DATE RECEIVED: 910806
DATE COLLECTED: 910730 DATE REPORTED: 910813
SAMPLE SUBMITTED BY: SM-ALC/EMC

RESULTS

<u>Test</u>	<u>Results</u>	<u>Units</u>
Chromium	<50	ug/L
Chromium VI	<20.	ug/L

Comments:

< - Signifies none detected and the detection limits.

Analyzed by: Aaron L. Forrest

Aaron L. Forrest, Sgt, USAF
Occupational Analysis Technician

Reviewed by: G. Cornell Long

G. Cornell Long
Chief, Metals Analysis Function

TO:

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BROOKS AFB TX 78235-5000

PAGE 1

AIR FORCE
OCCUPATIONAL AND ENVIRONMENTAL HEALTH DIRECTORATE
BROOKS AFB, TEXAS, 78235-5000

REPORT OF ANALYSIS

BASE SAMPLE NO: CN910019 OEHL SAMPLE NO: 91041070
SAMPLE TYPE: NON-POTABLE WATER
SITE IDENTIFIER: DATE RECEIVED: 910806
DATE COLLECTED: 910730 DATE REPORTED: 910813
SAMPLE SUBMITTED BY: SM-ALC/EMC

RESULTS

<u>Test</u>	<u>Results</u>	<u>Units</u>
Chromium	<50	ug/L
Chromium VI	<20.	ug/L

Comments:

< - Signifies none detected and the detection limits.

Analyzed by: Aaron L. Forrest

Aaron L. Forrest, Sgt, USAF
Occupational Analysis Technician

Reviewed by: G. Cornell Long

G. Cornell Long
Chief, Metals Analysis Function

TO:

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BROOKS AFB TX 78235-5000

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AIR FORCE
OCCUPATIONAL AND ENVIRONMENTAL HEALTH DIRECTORATE
BROOKS AFB, TEXAS, 78235-5000

REPORT OF ANALYSIS

BASE SAMPLE NO: CN910020 OEHL SAMPLE NO: 91041071
SAMPLE TYPE: NON-POTABLE WATER
SITE IDENTIFIER: DATE RECEIVED: 910806
DATE COLLECTED: 910730 DATE REPORTED: 910813
SAMPLE SUBMITTED BY: SM-ALC/EMC

RESULTS

<u>Test</u>	<u>Results</u>	<u>Units</u>
Chromium	<50	ug/L
Chromium VI	<20.	ug/L

Comments:

< - Signifies none detected and the detection limits.

Analyzed by:

Aaron L. Forrest

Aaron L. Forrest, Sgt, USAF
Occupational Analysis Technician

Reviewed by:

G. Cornell Long

G. Cornell Long
Chief, Metals Analysis Function

TO:

AL/OEBE
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AIR FORCE
OCCUPATIONAL AND ENVIRONMENTAL HEALTH DIRECTORATE
BROOKS AFB, TEXAS, 78235-5000

REPORT OF ANALYSIS

BASE SAMPLE NO: CN910021 OEHL SAMPLE NO: 91041072
SAMPLE TYPE: NON-POTABLE WATER
SITE IDENTIFIER: DATE RECEIVED: 910806
DATE COLLECTED: 910731 DATE REPORTED: 910813
SAMPLE SUBMITTED BY: SM-ALC/EMC

RESULTS

<u>Test</u>	<u>Results</u>	<u>Units</u>
Chromium	52	ug/L
Chromium VI	<20.	ug/L

Comments:

< - Signifies none detected and the detection limits.

Analyzed by: Aaron L. Forrest

Aaron L. Forrest, Sgt, USAF
Occupational Analysis Technician

Reviewed by: G. Cornell Long

G. Cornell Long
Chief, Metals Analysis Function

TO:

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BROOKS AFB TX 78235-5000

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AIR FORCE
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BROOKS AFB, TEXAS, 78235-5000

REPORT OF ANALYSIS

BASE SAMPLE NO: CN910022 OEHL SAMPLE NO: 91041073
SAMPLE TYPE: NON-POTABLE WATER
SITE IDENTIFIER: DATE RECEIVED: 910806
DATE COLLECTED: 910731 DATE REPORTED: 910813
SAMPLE SUBMITTED BY: SM-ALC/EMC

RESULTS

<u>Test</u>	<u>Results</u>	<u>Units</u>
Chromium	<50	ug/L
Chromium VI	<20.	ug/L

Comments:

< - Signifies none detected and the detection limits.

Analyzed by: *Aaron L. Forrest*

Aaron L. Forrest, Sgt, USAF
Occupational Analysis Technician

Reviewed by: *G. Cornell Long*

G. Cornell Long
Chief, Metals Analysis Function

TO:

AL/OEHE
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AIR FORCE
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REPORT OF ANALYSIS

BASE SAMPLE NO: CN910023 OEHL SAMPLE NO: 91041074
SAMPLE TYPE: NON-POTABLE WATER
SITE IDENTIFIER: DATE RECEIVED: 910806
DATE COLLECTED: 910724 DATE REPORTED: 910813
SAMPLE SUBMITTED BY: SM-ALC/EMC

RESULTS

<u>Test</u>	<u>Results</u>	<u>Units</u>
Chromium	70	ug/L
Chromium VI	<20.	ug/L

Comments:

< - Signifies none detected and the detection limits.

Analyzed by:

Aaron L. Forrest

Aaron L. Forrest, Sgt, USAF
Occupational Analysis Technician

Reviewed by:

G. Cornell Long

G. Cornell Long
Chief, Metals Analysis Function

TO:

AL/OEHE
BROOKS AFB TX 78235-5000

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AIR FORCE
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BROOKS AFB, TEXAS, 78235-5000

REPORT OF ANALYSIS

BASE SAMPLE NO: CN910024 OEHL SAMPLE NO: 91041075
SAMPLE TYPE: NON-POTABLE WATER
SITE IDENTIFIER: DATE RECEIVED: 910806
DATE COLLECTED: 910731 DATE REPORTED: 910813
SAMPLE SUBMITTED BY: SM-ALC/EMC

RESULTS

<u>Test</u>	<u>Results</u>	<u>Units</u>
Chromium	<50	ug/L
Chromium VI	<20.	ug/L

Comments:

< - Signifies none detected and the detection limits.

Analyzed by:

Aaron L. Forrest

Aaron L. Forrest, Sgt, USAF
Occupational Analysis Technician

Reviewed by:

G. Cornell Long

G. Cornell Long
Chief, Metals Analysis Function

TO:

AL/OEBE
BROOKS AFB TX 78235-5000

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AIR FORCE
OCCUPATIONAL AND ENVIRONMENTAL HEALTH DIRECTORATE
BROOKS AFB, TEXAS, 78235-5000

REPORT OF ANALYSIS

BASE SAMPLE NO: CN910025 OEHL SAMPLE NO: 91041076
SAMPLE TYPE: NON-POTABLE WATER
SITE IDENTIFIER: DATE RECEIVED: 910806
DATE COLLECTED: 910731 DATE REPORTED: 910813
SAMPLE SUBMITTED BY: SM-ALC/EMC

RESULTS

<u>Test</u>	<u>Results</u>	<u>Units</u>
Chromium	<50	ug/L
Chromium VI	<20.	ug/L

Comments:

< - Signifies none detected and the detection limits.

Analyzed by: Aaron L. Forrest

Aaron L. Forrest, Sgt, USAF
Occupational Analysis Technician

Reviewed by: G. Cornell Long

G. Cornell Long
Chief, Metals Analysis Function

TO:

AL/OEBE
BROOKS AFB TX 78235-5000

APPENDIX H
Calibration Data

NOZZLE CALIBRATION DATA FORM

Date 29 July

Calibrated by Scott

Nozzle identification number	Nozzle Diameter ^a			ΔD , ^b mm (in.)	D_{avg} ^c
	D_1 , mm (in.)	D_2 , mm (in.)	D_3 , mm (in.)		
29 July - Run 1 stack 1	0.310	0.310	0.311		0.310
30 July - Run 2 stack 1	0.312	0.312	0.311		0.311
31 July - Run 3 stack 1	0.312	0.311	0.310		0.311

where:

^a $D_{1,2,3}$ = three different nozzles diameters, mm (in.); each diameter must be within (0.025 mm) 0.001 in.

^b ΔD = maximum difference between any two diameters, mm (in.),
 $\Delta D \leq (0.10 \text{ mm}) 0.004 \text{ in.}$

^c D_{avg} = average of D_1 , D_2 , and D_3 .

~~stack 1~~ stack 1

McClellan AFB

Quality Assurance Handbook M5-2.6

NOZZLE CALIBRATION DATA FORM

Date

Calibrated by

Scott

Nozzle identification number	Nozzle Diameter ^a			ΔD ^b mm (in.)	D_{avg} ^c
	D_1 mm (in.)	D_2 mm (in.)	D_3 mm (in.)		
24 July 91 - Run 1 stack #2	0.310	0.311	0.310		0.310
25 July 91 - Run 2 stack #2	0.310	0.308	0.309		0.309
26 July 91 - Run 3 stack #2	0.312	0.312	0.314		0.313

where:

^a $D_{1,2,3}$ = three different nozzles diameters, mm (in.); each diameter must be within (0.025 mm) 0.001 in.

^b ΔD = maximum difference between any two diameters, mm (in.), $\Delta D \leq (0.10 \text{ mm}) 0.004 \text{ in.}$

^c D_{avg} = average of D_1 , D_2 , and D_3 .

stack #2

MCClellan AFB

Bldg 2436

Quality Assurance Handbook MS-2.6

Post

METER BOX CALIBRATION DATA AND CALCULATION FORM

(English units)

Date 6 Nov 91Meter box number 3Barometric pressure, $P_b = 29.313$ in. Hg Calibrated by Vaughn/O'Brien

Orifice manometer setting (ΔH), in. H_2O	Gas volume		Temperature					Time (Θ), min	Y_i	$\Delta H\Theta_i$ in. H_2O
	Wet test meter (V_w), ft ³	Dry gas meter (V_d), ft ³	Wet test meter (t_w), °F	Dry gas meter						
				Inlet (t_{d_i}), °F	Outlet (t_{d_o}), °F	Avg ^a (t_d), °F				
0.5	5	5.015	69 71	70 72	70 70	69 69	70.5	12.88	0.997	1.90
1.0	5	5.013	72 73	72.5 74	77 81	79 72	75.5	9.079	1.001	1.888
1.5	10	10.042	75 74	74.5 87	84.5 87	74 78	76 80.25	15.179	1.003	1.976
2.0	10	10.086	75 75	75 93	88 81	90.5 79.5	85.0	13.163	1.005	1.968
3.0	10	10.103	75 74	74.5 96	93 84	94.5 82.5	88.5	10.789	1.008	1.967
4.0	10	10.122	74 74	74 94	96 86	95 85	90	9.459	1.007	2.007
								Avg	1.004	1.951

ΔH , in. H_2O	$\frac{\Delta H}{13.6}$	$Y_i = \frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6}) (t_w + 460)}$	$\Delta H\theta_i = \frac{0.0317 \Delta H}{P_b (t_d + 460)} \left[\frac{(t_w + 460) \theta}{V_w} \right]^2$
0.5	0.0368	$Y_i = \frac{(5)(29.313)(70.5+460)}{(5.015)(29.313 + \frac{0.5}{13.6})(70+460)}$	$\Delta H\theta_i = \frac{(0.0317)(0.5)}{29.313(70.5+460)} \left[\frac{(70+460)(12.88)}{5} \right]^2$
1.0	0.0737	$Y_i = \frac{(5)(29.313)(75.5+460)}{(5.013)(29.313 + \frac{1.0}{13.6})(72.5+460)}$	$\Delta H\theta_i = \frac{(0.0317)(1.0)}{29.313(75.5+460)} \left[\frac{(72.5+460)(9.079)}{5} \right]^2$
1.5	0.110	$Y_i = \frac{(10)(29.313)(80.25+460)}{(10.042)(29.313 + \frac{1.5}{13.6})(74.5+460)}$	$\Delta H\theta_i = \frac{(0.0317)(1.5)}{29.313(80.25+460)} \left[\frac{(74.5+460)(15.179)}{10} \right]^2$
2.0	0.147	$Y_i = \frac{(10)(29.313)(85+460)}{(10.086)(29.313 + \frac{2.0}{13.6})(75+460)}$	$\Delta H\theta_i = \frac{(0.0317)(2.0)}{29.313(85+460)} \left[\frac{(75+460)(13.163)}{10} \right]^2$
3.0	0.221	$Y_i = \frac{(10)(29.313)(82.5+460)}{(10.103)(29.313 + \frac{3.0}{13.6})(74.5+460)}$	$\Delta H\theta_i = \frac{(0.0317)(3.0)}{29.313(82.5+460)} \left[\frac{(74.5+460)(10.789)}{10} \right]^2$
4.0	0.294	$Y_i = \frac{(10)(29.313)(85+460)}{(10.122)(29.313 + \frac{4.0}{13.6})(74+460)}$	$\Delta H\theta_i = \frac{(0.0317)(4.0)}{29.313(85+460)} \left[\frac{(74+460)(9.459)}{10} \right]^2$

^a If there is only one thermometer on the dry gas meter, record the temperature under t_d .

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METER BOX CALIBRATION DATA AND CALCULATION FORM

(English units)

Pre

Date 20 Sept 90

Meter box number Nutech #3

Barometric pressure, $P_b = 29.23$ in. Hg Calibrated by Vaughn/O'Brien

Orifice manometer setting (ΔH), in. H_2O	Gas volume		Temperature				Time (θ), min	Y_i	$\Delta H@_{i10}$ in. H_2O
	Wet test meter (V_w), ft ³	Dry gas meter (V_d), ft ³	Wet test meter (t_w), °F	Dry gas meter					
				Inlet (t_{di}), °F	Outlet (t_{do}), °F	Avg ^a (t_d), °F			
0.5	5	4.97	81 84 542.5	81 85	80 81	541.75	13.64	1.0034	2.1987
1.0	5	4.95	83 81 542	86 90	81 83	545	9.32	1.0131	2.0311
1.5	10	9.98	80 80 540	91 90	83 84	547	15.16	1.0112	1.9931
2.0	10	9.99	80 79 539.5	91 92	84 85	548	13.11	1.0117	1.9800
3.0	10	9.98	79 79 539.0	93 94	85 85	549.25	10.67	1.0134	1.9592
4.0	10	9.88	79 79 539.0	95 96	85 86	550.5	9.24	1.0234	1.9546
Avg							1.0127	2.0195	

ΔH , in. H_2O	$\frac{\Delta H}{13.6}$	$Y_i = \frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6}) (t_w + 460)}$	$\Delta H@_i = \frac{0.0317 \Delta H}{P_b (t_d + 460)} \left[\frac{(t_w + 460) \theta}{V_w} \right]^2$
0.5	0.0368	$Y_i = \frac{5 (29.23) (541.75)}{4.97 (29.23 + \frac{0.5}{13.6}) 542.5}$	$\Delta H@_i = \frac{0.0317 (0.5)}{29.23 (541.75)} \left[\frac{(542.5) (13.64)}{5} \right]^2$
1.0	0.0737	$Y_i = \frac{5 (29.23) (545)}{4.95 (29.23 + \frac{1.0}{13.6}) 542}$	$\Delta H@_i = \frac{0.0317 (1.0)}{29.23 (545)} \left[\frac{(542) (9.32)}{5} \right]^2$
1.5	0.110	$Y_i = \frac{10 (29.23) (547)}{9.98 (29.23 + \frac{1.5}{13.6}) 540}$	$\Delta H@_i = \frac{0.0317 (1.5)}{29.23 (547)} \left[\frac{(540) (15.16)}{10} \right]^2$
2.0	0.147	$Y_i = \frac{10 (29.23) (548)}{9.99 (29.23 + \frac{2.0}{13.6}) 539.5}$	$\Delta H@_i = \frac{0.0317 (2.0)}{(29.23) (548)} \left[\frac{(539.5) (13.11)}{10} \right]^2$
3.0	0.221	$Y_i = \frac{10 (29.23) (549.25)}{9.98 (29.23 + \frac{3.0}{13.6}) 539}$	$\Delta H@_i = \frac{0.0317 (3.0)}{(29.23) (549.25)} \left[\frac{(539) (10.67)}{10} \right]^2$
4.0	0.294	$Y_i = \frac{10 (29.23) (550.5)}{9.88 (29.23 + \frac{4.0}{13.6}) 539}$	$\Delta H@_i = \frac{0.0317 (4.0)}{(29.23) (550.5)} \left[\frac{(539) (9.24)}{10} \right]^2$

^a If there is only one thermometer on the dry gas meter, record the temperature under t_d .

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