PERFORMANCE EVALUATION FOR THE EXISTING CHROME PLATING AND EMISSION CONTROL SYSTEM

Contract Number: N62474-87-D-7073

Submitted to:

Mare Island Naval Shipyard
Public Works Department
Code 460
Vallejo, California 94592-5100

30 September 1988

By:

Risk Science Associates/Kaman Tempo
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Notes to the RSA Chrome Scrubber Test Report of August 1988

This test is perfectly corrupt. It is only useful as a set of data to be used in conjunction with other data to calculate the actual amount of chromic acid discharged by the Mare Island Plating shop during normal operations.

The most glaring instances of cheating are as follows:

1. In Table 1 is it shown that the two hard chrome plating baths were operated at currents of 2000 and 2400 Amperes providing an average chromium discharge of .041 mg/ampere-hour. The RSA Report states that Mare Island personnel stated this was the maximum possible tank amperage. This statement is a lie. The Mare Island Plating Shop Process Instructions for flash, build up, decorative and hard chrome plating specify an amperage rate for chrome plating to be 2.5 Amperes per square inch. The test pieces used during the RSA Tests were 18.7 and 16.0 Square feet. This translates into a total of 34.7 square feet which is also 4997 square inches. Accordingly with test pieces of this size the tanks should have been operated at a total of 12,492 Amperes instead of a total of 4400 Amperes. This cheating was designed to reduce the chromic acid emitted by a factor of 12,492 divided by 4400 = 2.83. If the results of the RSA test of 0.041 mg/amp-hr is multiplied by this factor the result is 0.1160 mg/ampere hour. The April 5, 1988 BAAQMD supervised tests resulted in an average discharge rate of 0.1440 mg/ampere-hour. These compare very well. I can only surmise that the reason these corrected results do not match exactly is that cheating by this method is probably a little bit more effective in actual practice than this purely mathematical analysis provides and that even though there was also some cheating in the April 5, 1988 test, the results of that test are far more accurate than the results of the RSA Test.
2. The decorative chrome plating bath was operated at 600 amperes with a test piece having an area of 7.68 square feet. According to the MINS Plating Shop Plating Shop Process Instruction the mandatory current density for chrome plating is 2.5 Amperes per square inch. This test piece should have had a current of 2764 Amperes instead of a mere 600. The correction factor is 4.6. Using the correction factor on the RSA data of 0.368 mg/ampere-hour provides 1.69 mg/ampere-hour. The April 6, 1988 BAAQMD supervised tests provided a result of 0.9328 mg/ampere-hour. The April 6 results are also artificially low due to cheating. The decorative chrome plating bath was only operated at 1,000 Amperes in that test. Assuming the same test plate size for both tests, the correction factor for the April 6, 1988 test results is 2.76. Adjusting the April 6, results using this correction factor results in a result of 2.57 mg/ampere-hour. The discrepancy between the two corrected results is probably explained by another form of cheating that cannot be proven. This is reduction of the concentration of the chromic acid in the bath itself for the RSA test. Taking the ratio of the two adjusted results provides a factor of 0.657. The bath concentration of chrome plating bath is 250 grams/gallon of chromic acid. The bath concentration of the tested decorative chrome bath was probably lowered to be about 0.657 x 250 = 147 grams/gallon. A concentration of 147 grams per gallon would have the appearance of a solution with

250 grams per gallon. This form of cheating could only have been detected by taking a sample of the bath and this was not done. But it explains perfectly the discrepancy between the two properly adjusted emission values from the two separate tests.

3. The anodizing bath was operated at a current value where it had no emissions and did not contribute to the test. The MINS Plating Shop Process Manual stipulates that for Anodizing 40V must be applied to the test piece. This was not done because calculations that are not shown here demonstrate that if 40 Volts had been applied to the specified test piece a current of about 800 Amperes would have been resulted and the anodizing bath would have made a significant contribution to the chromic acid emitted from the scrubber during the tests. Instead of using and controlling Voltage as required, MINS cheated and measured and controlled Amperes, which were set at a ridiculously low value designed to produce zero emissions. Note that in the April 6, 1988 tests the anodizing bath was set at about 10 Amperes and in the RSA Tests it was set at about 5.0 Amperes. Clearly there was massive cheating with this test.

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Executive Summary

This report presents test data, results, conclusions and recommendations from the engineering evaluation of the two wet scrubbers located on the exhaust stacks of the existing chrome plating facility in Building 225 at Mare Island Naval Shipyard (MINS). These scrubbers constitute the emission control systems of the chrome plating facility and serve to remove chromium from the exhaust gases before venting to the atmosphere. The purpose is to reduce atmospheric chromium emissions to an acceptable level. Although the chromium emission of interest to human health, the environment, and the Bay Area Air Quality Management District (BAAQMD) regulation is chromium in the hexavalent state (Cr^{+6}), values reported in this engineering evaluation of scrubber performance and efficiency represent total chromium emissions (trivalent as well as hexavalent chromium). It was assumed that all chromium detected was in the hexavalent form, thus giving a slight overestimation to the Cr^{+6} emission rates and therefore lending a light element of conservatism to this analysis.

A source test of the wet scrubber controlling emissions from the hard chrome plating tanks was conducted on August 10, 1988. It was found that the average emission rate of total chromium was

0.0004 lbs/hr and the average emission rate per total amperage was 0.041 mg/amp-hr.

On August 17, 1988, a source test was conducted of the wet scrubber for the decorative chrome plating bath/chromic acid anodizing bath. The average emission rate of chromium was 0.0001 lbs/hr while the average emission rate per total amperage was 0.368 mg/amp-hr.

The Bay Area Air Quality Management District (BAAQMD) requires that by 1990, emissions of hexavalent chromium from hard chrome plating shall not exceed 0.15 mg/amp-hr for facilities with total annual emissions of less than 2 lbs Cr^{+6}/year. Thus, MINS will be in compliance with this regulation if the total chrome plating facility emissions of chromium are less than 2 lbs/year.

Based on the results of the stack tests, it was determined that, in order to be in compliance, the maximum time that MINS should operate the chrome plating facility is 4000 hours/year or 250 days/year at 16 hours/day, assuming an equal amount of operating time between the hard chrome plating baths and the acid anodizing/decorative chromium operation.

This report concludes by recommending the conditions required for compliance, and recommends specific operating parameters including amperes, bath temperature, exhaust flow rate from the scrubber, scrubber water flow rate, scrubber water blow down rate, visual inspection requirements, and record keeping requirements.

The final recommendation of this report is that the height of the chrome plating facility's stack must be increased to at least 1.5 times the height of the adjacent building in order to meet good engineering practice (GEP).

ENGINEERING EVALUATION

MARE ISLAND NAVAL SHIPYARD CHROME PLATING FACILITY

I. Background

On January 23, 1986, the California Air Resources Board (CARB) identified hexavalent chromium as a toxic air contaminant. In order to reduce the exposure of the public to emissions of hexavalent chromium, the CARB developed an Air Toxic Control Measure (ATCM) under procedures mandated by AB1807. This legislation required that local districts adopt regulations no less stringent than those adopted by the CARB. Under Section 39666 of the Health and Safety Code, the Bay Area Air Quality Management District (BAAQMD) was required to adopt a rule by August 18, 1988. The BAAQMD rule was adopted in August and pertinent sections of this regulation will become effective in 1989 and 1990.

Hexavalent chromium is emitted as chromic acid during the chrome plating operations. Hexavalent chromium is converted to metallic chromium as electrical current is applied to a work piece in a bath of chromic acid. During the plating operation, hydrogen and oxygen bubbles are produced. These gas bubbles create a

chromic acid mist as they break the surface of the bath. The mist is emitted to the air and is collected by a ventilation system. The ventilation system then removes the chromium emissions from the plating area via vents to the atmosphere. Prior to atmospheric emission, hexavalent chromium is removed by appropriate air pollution control equipment.

The Mare Island Naval Shipyard (MINS), Vallejo, California, chrome plating facility is located within the Central Industrial Area of the shipyard (see Figure 1). This facility serves MINS by providing chrome plating to naval ships' parts and equipment. The ability to re-plate these parts on-site obviates the need to buy new parts or equipment and saves considerable time and expense that would be incurred from sending parts off-site for plating. The interests of National Security would suggest that the Navy maintain in-house chrome plating capability.

The MINS chrome plating facility is equipped with two low-pressure drop packed-bed wet scrubbers. These scrubbers control emissions from both plating operations and acid anodizing operations.

The allowable emissions rates in the BAAQMD regulation reflect the application of currently available technology to

reduce and control hexavalent chromium emissions. The CARB has based emission rates on test data collected in the Southern California Air Quality Management District and the San Diego Air Pollution Control District areas. Based on this data, small facilities, defined as those that emit less than two pounds hexavalent chromium per year, will be able to achieve compliance by using de-misters or low-pressure drop packed bed wet scrubbers.

In a packed-bed wet scrubber, the packing captures the chromic acid mist particles as the mist passes through the bed. The packing is wetted by recirculating water from a holding tank. The water passes down through the bed with the counter-current fume and liquid flow causing an intermixing of the two. Mixing is aided by the circuitous flow path the vapor must take due to the random orientation of the packing material. The fume becomes absorbed within liquid droplets. The droplets fall through the packing material and are collected in the bottom of the scrubber vessel. Fresh make-up water is added to the system continuously as contaminated liquid is withdrawn. Finely divided mist passing up through the bed is drawn through a fixed pad mist elimination section where agglomeration of the mist into droplets is accomplished. These droplets then fall down into and through the packed bed. The scrubber water is then returned to a holding tank where it is recirculated through the scrubber system. A flow of ~6 gal/min is withdrawn and sent to the wastewater treatment facility while ~6 gal/min freshwater is added as replacement.

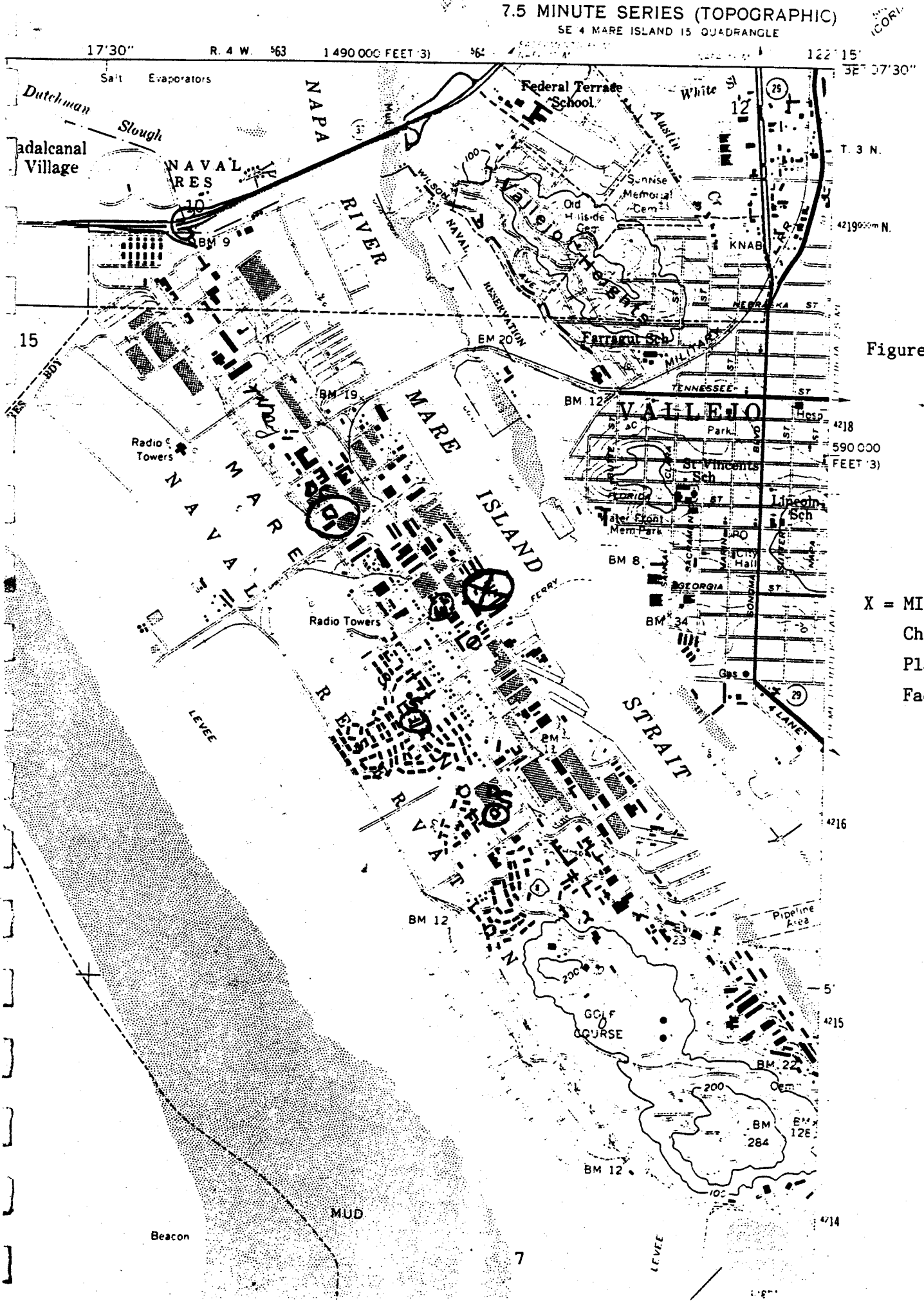

Figure 1

X = MINS Chrome Plating Facility

II. Engineering Evaluation of Scrubber for Hard Chrome Plating Operation

As a result of the previously described regulation for chrome plating operations in the San Francisco Bay Area, a source test was conducted at MINS on August 10, 1988. Source testing was conducted according to BAAQMD procedures and guidelines by Thermo Analytical, Inc., of Richmond, California. The full test results and protocol are described in Appendix A. Both the inlet and outlet of the scrubber controlling emissions from the hard chrome plating tanks JFC and JQP were tested during simultaneous use of these two plating baths.

The tests were conducted during the continuous plating of 18.7 sq. ft. of working surface area in bath JFC and 16.0 sq. ft. of working surface area in bath JQP. The two baths share a common final ventilation duct to the scrubber and thus share a common exhaust stack. The results of these source tests are shown in Table 1. As discussed previously, all quantities of chromium indicated represent total chromium detected and thus assume that all chromium present is present as the hexavalent form.

TABLE 1

Source Test August 10, 1988

(lbs/hr)

	Inlet	Outlet	% Removal (efficiency)
Run 1	0.0125	0.0005	96.0
Run 2	0.0079	0.0004	94.9
Run 3	0.0075	0.0003	96.0
Average	0.0093	0.0004	95.7

These tests were conducted while baths JQP and JFC were being operated at 2,000 amps and 2,400 amps, respectively. According to MINS chrome plating facility personnel, these parameters are the maximum rates the baths would be expected to be operated at under normal conditions (the "normal maximum rate"). Dividing the average emission rate of 0.0004 lbs/hr by the total amperage yields:

$$\frac{0.0004 \text{ lbs/hr}}{4{,}400 \text{ amps}} \times 454{,}000 \text{ mg/lb} = 0.041 \text{ mg/amp-hr}$$

Other parameters measured during the source test were as follows:

1) Bath temperature JQP 118-139° F
   JFC 132-148° F

2) Exhaust flow from scrubber = 18,211 DSCF/Min

3) Scrubber water circulation rate = 100 gpm *

4) Scrubber water dissolved chromium = 2 ppm

5) Scrubber water blow down rate = 6 gal/min

* Scrubber water circulation rate was not measured, but was taken from the pump performance curve using the pump discharge pressure which was monitored during the test.

III. Engineering Evaluation of Scrubber for Decorative Chrome Plating and Chromic Acid Anodizing Operations

The decorative chrome plating bath and the chromic acid anodizing bath are both serviced by a single scrubber. The results of a source test conducted August 17, 1988, are shown in Table 2:

TABLE 2

Source Test August 17, 1988

(lbs/hr)

	Inlet	Outlet	% Removal (efficiency)
Run 1	0.002	0.0001	95.0
Run 2	0.0009	0.0001	88.9
Run 3	0.0021	0.0001	95.2
Average	0.0017	0.0001	93.0

These tests were conducted while the decorative chrome bath was operating at 600 amps and the acid anodizing bath was operating at 5 amps (after an initial 1-second interval with 150 amps). Dividing the average emission rate of 0.0001 lbs/hr by the total amperage yields:

$$\frac{0.0001 \text{ lbs/hr} \times 454{,}000 \text{ mg/lb.}}{600 \text{ amps} \times \frac{4 \times 3'}{60'\text{hr}} + 5 \text{ amps} \times \frac{40'}{60'\text{hr}}} = 0.368 \text{ mg/amp-hr} \ *$$

Other parameters measured during the source test were as follows:

1) Bath temperature: Decorative Chrome Bath 114-119° F

Acid Anodizing Bath 88-90° F

2) Exhaust flow from scrubber 10,577 DSCF/min

3) Scrubber water circulation rate 100 gpm #

4) Scrubber water dissolved chromium 0.15 ppm

5) Scubber water blow down rate 6 gpm

* Note that the BAAQMD limit is .15 mg/amp-hr for annual facility emissions at less than 2 lbs/yr.

Scrubber water circulation rate was not measured, but was taken from the pump performance curve using the pump discharge pressure which was monitored during the test.

Each 1-hour test run consisted of four 3-minute decorative chrome cycles in the decorative chrome bath. Chrome was applied to a work piece with a surface area of 7.68 sq.ft. During the same one hour test period, a 40 minute acid anodizing operation was conducted on a work piece with a surface area of 1.24 sq.ft. According to MINS chrome plating facility personnel, these will be the maximum rates the baths will be operated at under normal conditions (the "normal maximum rate").

IV. BAAQMD Regulations for Chrome Plating Facilities

Section 310 of Rule 8, Regulation 11, Hazardous Pollutants, Hexavalent Chromium, requires that emissions of hexavalent chromium from hard chrome plating operations shall not exceed 0.15 mg of hexavalent chromium per ampere-hour of electrical current applied. In addition, if total chrome plating facility wide emissions from hard chrome plating operations are more than two pounds per year, but less than 10 pounds per year, the limit is 0.03 mg of hexavalent chromium per ampere-hour of applied electricity. If total chrome plating facility wide emissions are more than 10 pounds per year, the limit is 0.006 mg per ampere-hour. These limits are shown in Table 3:

TABLE 3

BAAQMD Limits

(mg/amp-hr)

Total Annual Facility Emissions	Limit
Less than 2 lbs/year	0.15
Between 2 and 10 lbs/year	0.03
More than 10 lbs/year	0.006

Compliance must be demonstrated within 60 days of the effective date of the regulation, January 1, 1990.

As calculated earlier, the MINS hard chrome plating operation is emitting, on average, 0.041 mg/amp-hr. The acid anodizing/decorative chroming operation is emitting 0.368 mg/amp-hr. Therefore, as shown in Table 3 above, MINS will not be in compliance with the new regulations, if MINS continues to operate the anodizing/decorative chroming operation without modification to the emission control system. The modified emission control system will have to be shown, by source test, that it now meets all requirements. If MINS completely rebuilds the facility, or moves the facility, it will be considered a new source and will then have to meet the chrome plating standards and would have to show *de minimus* risk.

Referring back to the emission rates for the hard chrome plating process shown in Table 1, the average outlet emission rate for hexavalent chromium was 0.0004 pounds per hour. To calculate total chrome plating facility wide emissions, the emission rate from the hard chrome plating process must be added to the emission rate in pounds per hour from the acid anodizing/decorative chroming process. With emission control system modifications, and new tests showing compliance, the recommended maximum time that MINS can operate the chrome plating facility is calculated as follows:

N x average emission rate + M x average emission rate = 2 lbs

N = Number of hours operating hard chrome plating baths at 4400 amps total

M = Number of hours operating acid anodizing/decorative chroming operation at 5 amps/600 amps respectively

For example, if N = M, both systems would be operated at maximum for an equal number of hours.

N = M = 4,000 hours of operation per year, or 250 days at 16 hours per day

Note however that the anodizing/decorative chroming operation currently does not meet BAAQMD requirements.

Actual limits, which will be established in any operating permit for MINS by the BAAQMD, will limit the total amp-hours the equipment can be run in a one-year period. That is, if only one-half the maximum current is applied that was applied during the source test, the baths could theoretically be operated twice as long.

V. Comparison of BAAQMD and RSA/KT Test Results

Table 4 compares the results of previous stack testing conducted by the BAAQMD with the present results from the Risk Science Associates/Kaman Tempo (RSA/KT) test.

TABLE 4

Comparison of BAAQMD and RSA/KT Tests

(lbs/hr)

		Inlet	Outlet	Mg/Amp-Hr
Anodizing/Decor.				
11/12/87	BAAQMD	0.00337	0.00313	n/a
4/06/88	BAAQMD	n/a	0.00213	0.9328
8/17/88	RSA/KT	0.0017	0.0001	0.368
Hard Chrome Plating				
11/12/87	BAAQMD	0.00161	0.00134	n/a
4/05/88	BAAQMD	n/a	0.00263	0.144
8/10/88	RSA/KT	0.0093	0.0004	0.041

n/a = not available

The BAAQMD calculated scrubber efficiencies, 7% for the decorative plating/anodizing operation and 17% for the hard chrome plating operation, were probable due in part to poor scrubber maintenance. Subsequent to the BAAQMD tests, both scrubbers were given major cleaning and overhauls. Additionally, the test was run at extreme amperage loads, far beyond normal maximum aperage loads.

VI. Recommended Operating Conditions

Recommended chrome plating operating conditions would include, in addition to the limitations on hours of operation discussed in Part IV of this report, the following conditions (these likely will be part of the permit conditions issued by the BAAQMD):

1) Total current applied to the following sources should not exceed the amps shown:

Hard chrome plating baths
JQP and JFC combined = 4400 amps

Decorative Chrome plating Bath
and Chromic Acid Anodizing Bath combined = 605 amps
(with modified packed-bed wet scrubber)

2) The bath temperature should not exceed the level maintained during the compliance test:

139° F for bath JQP

148° F for bath JFC

119° F for decorative chrome bath

90° F for acid anodizing bath

3) Exhaust flow from the scrubbers should not exceed 18,211 DSCF/min from baths JQP and JFC, and 10,577 DSCF/min from the decorative/acid anodizing baths.

4) No plating should occur unless at least 100 gal/min of scrubber water is maintained through each scrubber.

5) Scrubber water should not contain more than 2 ppm of dissolved chromium. A minimum of 8,640 gals/day of blow down water should be removed from the system. This is equivalent to 6 gal/min of blow down water while chrome plating operations are in progress.

6) Ventilation and control equipment should be visually inspected at least once every six months for signs of corrosion and leakage. All ventilation and control equipment should be kept in good working order.

7) Records should be kept to demonstrate compliance with limitations on hours of operation and maximum current levels allowed. Records should be kept to show compliance with the inspections recommended by item #6 above.

VII. Stack Height

Pursuant to Section 330 of Regulation 11, Rule 8, exhausted emissions from hard chrome plating and acid anodizing operations must be emitted through a stack no less than 10 meters above ground. Although the MINS chrome plating facility stacks do appear to meet this 10 meter rule, they do not meet good engineering practice (GEP). GEP requires that the stack be at least 1.5 times the height of the adjacent building. The MINS stacks are both below the height of the adjacent building. Thus, emissions from the stack may be venting directly into open windows of the adjacent building and severe building downwash may result in immediate vicinity fumigation under certain meteorological conditions. Therefore, it is recommended that the stack height be increased to at least 1.5 times the height of the adjacent building(s).

APPENDIX A

REPORT ON CHROME PLATING FACILITY AT
MARE ISLAND NAVAL SHIPYARD

RISK SCIENCE ASSOCIATES
300 TAMAL PLAZA
SUITE 150
CORTE MADERA, CALIFORNIA

ATTENTION: DR. ALVIN GREENBURG

Reference: TMA/Norcal C.N. 6076.2

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TABLES

APPENDICES

TMA
Thermo Analytical Inc.

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

(415) 235-2633

September 15, 1988

Dr. Alvin Greenberg
Risk Science Associates
300 Tamal Plaza
Suite 150
Corte Madera, CA 94925

Reference: TMA/Norcal C.N. 6076.2

Subject: Sampling and analysis of a hard chrome plating and decorative chrome plating facility.

Location: Mare Island Naval Shipyard, Plating Shop, Building 225, Vallejo, California, 93592.

Test Dates: Hard chrome plating scrubber - August 10, 1988
Decorative plating scrubber - August 17, 1988

Sampling Personnel: Michelle Pappe, Craig Thiry, Doug Condrotte, Jim Stone and Juan Rios of TMA/Norcal.

Parameters Measured:

	Total Chromium	Hexavalent Chromium
Chrome Concentration	mg/m^3	mg/m^3
Chrome Emission Rate	gram/hr	gram/hr
Chrome Plating Emission Factor	mg/amp-hr	mg/amp-hr

Voltage level to each plating bath (V).
Amperage through plating bath (I).
Temperature of each bath (°F)
Work piece surface area (ft^2)
Scrubber flow rate (SDCFM)
Scrubber chromium content (ug/mL)

2-Risk Science Associates September 15, 1988

Sampling and Analysis Protocols: Bay Area Air Quality Management District's (BAAQMD) Manual of Procedures, ST-35 (not yet a validated procedure at the time of testing).

California Air Resources Board (CARB) Stationary Source Test Methods, Vol. III, Method 425.

Sampling Procedures: Two sampling teams simultaneously tested the inlet and the outlet of the water scrubber during 3 one-hour tests. The samples were collected isokinetically on teflon filters using glass-lined probes with glass nozzles. The teflon filters were analyzed for hexavalent chromium and total chromium according to CARB 425.

The voltage, amperage and temperature to each bath, as well as the work-piece surface area, were recorded at intervals during the test. Scrubber water was sampled before and after each test to determine the chromium content.

Comments: During the sampling, one work-piece was continuously plated in each bath. The work-piece surface area given in the results tables is, therefore, not an average of many work-pieces.

During run 1 of the August 10 inlet test, the glass probe broke on the last point of the test. Tim Underwood, who was the BAAQMD Representative, on-site, said that the data obtained for test 1 could be used as corroborating data for tests 2 and 3.

The impinger waters were analyzed for chromium but in all cases the results were less than the 0.02 ug/mL detection limit.

According to the BAAQMD, all the chromium caught in the stack of a plating operation scrubber is hexavalent chromium. Therefore, when the BAAQMD tested the scrubbers at the Mare Island chrome plating operation, they analyzed for total chromium and not hexavalent chromium.

When TMA/Norcal tested the chrome plating operation at Mare Island, the BAAQMD procedure for filter analysis of chromium had not yet been validated. Therefore, the filters were sent to TMA/ARLI in Monrovia, California, for analysis according to CARB 425 which specifies that the filters be analyzed for total chromium and hexavalent chromium.

The chromium in the probe washes, which the BAAQMD counts along with the chromium on the filters, were analyzed by the lab at TMA/Norcal by EPA methods. All probe washes for the outlet tests were non-detectable; therefore, only the chromium on the filters was used to calculate the results for both outlet stacks.

3-Risk Science Associates

September 15, 1988

Thank you for this opportunity to be of service. If you have any questions, please don't hesitate to call me.

Sincerely yours,

Juan J. Rios
Technical Director
Air Source Testing

Enclosure: Report
JJR/sc

TABLE I SUMMARY OF RESULTS

Location: Mare Island Naval Shipyard, Chrome Plating Facility
Unit: Water Scrubber Outlet, Baths JFC and JQP
Date of Test: August 10, 1988

TOTAL CHROMIUM - SCRUBBER OUTLET

Test No.	1	2	3
Time	1109-1209	1400-1500	1540-1640
Flow Rate, SDCFM	18,071	18,366	18,197
Volume Sampled, SDCF	28.1	28.4	28.0
Stack Temperature, °F	68	71	71
Stack Moisture	0.8	0.8	0.7
Total Amps	4400	4400	4400
*Chromium Concentration, mg/m^3	$7.3x10^{-3}$	$5.2x10^{-3}$	$4.4x10^{-3}$
*Chromium Emissions, grams/hr	0.22	0.16	0.14
*Chromium Emissions, lbs/hr	0.0005	0.0004	0.0003
*Chromium Emissions, grains/SDCF	$3.2x10^{-6}$	$2.3x10^{-6}$	$1.9x10^{-6}$
*Chromium Plating Emissions Factor, mg/amps/hr	0.05	0.04	0.03
Percent Isokinetics	97	96	96
Scrubber Water Chromium Content, ug/ml	1.1	1.9	2.0
Work Piece Surface Area, ft^2-JFC	18.67	18.67	18.67
Work Piece Surface Area, ft^2-JQP	16.0	16.0	16.0
Bath Temperature, °F-JFC	140	147	148
Bath Temperature, °F-JQP	124	134	139
Bath Amps, I-JFC	2400	2400	2400
Bath Amps, I-JQD	2000	2000	2000

*Chromium results based on total chromium on filters. Probe washes were non-detectable.

THERMO ANALYTICAL

Client : RISK SCIENCE — Date Tested : 08/10/88

Test No. : 3 OUTLET — Time : 1540

GAS FLOW DATA

Sample Points 1234

Barometric Pressure 29.78 — Sample Nozzle Area .000299 ft^2

Duct Pressure 29.77 ''Hg — Condensate 4 ml.

Avg. Gas Meter Pressure 0 in.Hg — Vol. of Gas Samples 28.84 CF

Avg Gas Meter Temp 82.5 F — Avg Duct Temp 71 F

Wgt. Collected 0 Gms. — Duration of Test 60 Min.

Avg. Velocity at Sampling Pts 27.5 ft/sec.

Calculations

Condensed Water Vapor:

vw = 0.00267 * 4 * (460 + 70)/29.92 = .19 SCF

Corrected Meter Volume:

Vo = 28.84 * 29.77 / 29.92 * 530 / 542.5 = 28.03 SDCF

Percent Water Vapor:

% H2O = .19 / 28.22 * 100 = .7 %

Particulate Concentration (Grain Loading):

Go = (0 Gms. * 15.43)/ 28.03 SDCF = 0 Grs/SDCF

Particulate Emission Rate:

(0 Grs/SDCF * 18197 SDCFM * 60)/7000 = 0 Lbs/Hr.

THERMO ANALYTICAL

Client : RISK SCIENCE Date Tested :08/10/88

Test No. :3 OUTLET Time :1540

Gas Flow Rate Data

Point	h	T.	Vel.Ft/Sec
1	.25	71	28.2
2	.11	71	18.7
3	.1	71	17.8
4	.29	71	30.4
5	.28	71	29.9
6	.06	71	13.8
7	.09	71	16.9
8	.17	71	23.3
9	.26	71	28.8
10	.17	71	23.3
11	.07	71	14.9
12	.29	71	30.4
13	.42	71	36.6
14	.21	71	25.9
15	.28	71	29.9
16	.31	71	31.4
17	.42	71	36.6
18	.39	71	35.2
19	.45	71	37.9
20	.5	71	39.9

Vs = Cp [h *(T + 460)]^.5 [1/M.W. * Ps]^.5 * 85.49

Conc. of CO2 = 0 % Conc. of O2 = 20.98 %

Conc. of H20 = .7 %

Avg. Gas Velocity; Vs, Avg. 27.5 Ft/Sec

Pitot Tube Correction Factor, Cp .84

Duct Gas Molecular Weight, M.W. 28.88

Duct Pressure, Ps. 29.77 ''Hg Barometric Pressure 29.79 ''Hg

Duct Size Rectangle 35 ''X 46 '' Static Pressure -.09 ''H20

Duct Area 11.18 Sq. Ft Avg. Gas Temp. 71

Gas Flow Rate 27.5 Ft/Sec * 11.18 Sq. Ft * 60 = 18447 CFM

18447 CFM* 530 / 531 * 29.77 /29.92*(1.00- .7 /100%H20)= 18197 SDCFM

M.W. Factor = .0341 Standard Cond. Temp. 70

THERMO ANALYTICAL

Client : RISK SCIENCE Date Tested : 08/17/88

Test No. : 1 INLET Time : 1040

GAS FLOW DATA

Sample Points 123456789

Barometric Pressure 29.78 Sample Nozzle Area .00075 ft^2

Duct Pressure 29.54 ''Hg Condensate 10 ml.

Avg. Gas Meter Pressure 0 in.Hg Vol. of Gas Samples 33.53 CF

Avg Gas Meter Temp 72 F Avg Duct Temp 60 F

Wgt. Collected 0 Gms. Duration of Test 60 Min.

Avg. Velocity at Sampling Pts 12 ft/sec.

Calculations

Condensed Water Vapor:

vw = 0.00267 * 10 * (460 + 70)/29.92 = .47 SCF

Corrected Meter Volume:

Vo = 33.53 * 29.54 / 29.92 * 530 / 532 = 32.98 SDCF

Percent Water Vapor:

% H2O = .47 / 33.45 * 100 = 1.4 %

Particulate Concentration (Grain Loading):

Go = (0 Gms. * 15.43)/ 32.98 SDCF = 0 Grs/SDCF

Particulate Emission Rate:

(0 Grs/SDCF * 12228 SDCFM * 60)/7000 = 0 Lbs/Hr.

Percentage of Isokinetic Sampling Attained: %I = 103 %

THERMO ANALYTICAL

Client : RISK SCIENCE Date Tested :08/17/88

Test No. :1 INLET Time :1040

Gas Flow Rate Data

Point	h	T.	Vel.Ft/Sec
1	.15	60	21.7
2	.1	60	17.8
3	.1	60	17.8
4	.08	60	15.9
5	.04	60	11.2
6	.07	60	14.9
7	.06	60	13.8
8	.02	60	7.9
9	.005	60	4
10	.06	60	13.8
11	.07	60	14.9
12	.05	60	12.6
13	.04	60	11.2
14	.03	60	9.7
15	.07	60	14.9
16	.01	60	5.6
17	.005	60	4
18	.005	60	4

$$Vs = Cp\,[h * (T + 460)]^{.5}\,[1/M.W. * Ps]^{.5} * 85.49$$

Conc. of CO2 = 0 % Conc. of O2 = 20.98 %

Conc. of H20 = 1.4 %

Avg. Gas Velocity; Vs, Avg. 12 Ft/Sec

Pitot Tube Correction Factor, Cp .84

Duct Gas Molecular Weight, M.W. 28.8

Duct Pressure, Ps. 29.54 ''Hg Barometric Pressure 29.78 ''Hg

Duct Size Rectangle 85 ''X 29 '' Static Pressure -3.2 ''H20

Duct Area 17.12 Sq. Ft Avg. Gas Temp. 60

Gas Flow Rate 12 Ft/Sec * 17.12 Sq. Ft * 60 = 12326 CFM

12326 CFM* 530 / 520 * 29.54 /29.92*(1.00- 1.4 /100%H20)- 12229 SDCFM

M.W. Factor = .0342 Standard Cond. Temp. 70

THERMO ANALYTICAL

Client : RISK SCIENCE — Date Tested : 08/17/88

Test No. : 2 INLET — Time : 1240

GAS FLOW DATA

Sample Points 123456789

Barometric Pressure 29.78 — Sample Nozzle Area .00075 ft^2

Duct Pressure 29.54 ''Hg — Condensate 7.5 ml.

Avg. Gas Meter Pressure 0 in.Hg — Vol. of Gas Samples 33.37 CF

Avg Gas Meter Temp 80 F — Avg Duct Temp 76 F

Wgt. Collected 0 Gms. — Duration of Test 60 Min.

Avg. Velocity at Sampling Pts 12.6 ft/sec.

Calculations

Condensed Water Vapor:

vw = 0.00267 * 7.5 * (460 + 70)/29.92 = .35 SCF

Corrected Meter Volume:

Vo = 33.37 * 29.54 / 29.92 * 530 / 540 = 32.34 SDCF

Percent Water Vapor:

% H2O = .35 / 32.69 * 100 = 1.1 %

Particulate Concentration (Grain Loading):

Go = (0 Gms. * 15.43)/ 32.34 SDCF = 0 Grs/SDCF

Particulate Emission Rate:

(0 Grs/SDCF * 12481 SDCFM * 60)/7000 = 0 Lbs/Hr.

Percentage of Isokinetic Sampling Attained: %I = 99 %

THERMO ANALYTICAL

Client : RISK SCIENCE Date Tested :08/17/88

Test No. :2 INLET Time :1240

Gas Flow Rate Data

Point	h	T.	Vel.Ft/Sec
1	.1	68	17.9
2	.14	68	21.2
3	.13	68	20.4
4	.13	69	20.4
5	.08	69	16
6	.05	70	12.7
7	.08	70	16
8	.01	71	5.7
9	.005	72	4
10	.05	71	12.7
11	.07	71	15
12	.05	72	12.7
13	.05	72	12.7
14	.02	83	8.1
15	.07	89	15.3
16	.02	98	8.2
17	.005	100	4.1
18	.005	100	4.1

$$Vs = Cp\ [h * (T + 460)]^{.5}\ [1/M.W. * Ps]^{.5} * 85.49$$

Conc. of CO2 = 0 % Conc. of O2 = 20.98 %

Conc. of H20 = 1.1 %

Avg. Gas Velocity; Vs, Avg. 12.6 Ft/Sec

Pitot Tube Correction Factor, Cp .84

Duct Gas Molecular Weight, M.W. 28.84

Duct Pressure, Ps. 29.54 ''Hg Barometric Pressure 29.78 ''Hg

Duct Size Rectangle 85 ''X 29 '' Static Pressure -3.2 ''H20

Duct Area 17.12 Sq. Ft Avg. Gas Temp. 76

Gas Flow Rate 12.6 Ft/Sec * 17.12 Sq. Ft * 60 = 12942 CFM

12942 CFM* 530 / 536 * 29.54 /29.92*(1.00- 1.1 /100%H20)- 12181 SDCFM

M.W. Factor = .0342 Standard Cond. Temp. 70

THERMO ANALYTICAL

Client : RISK SCIENCE Date Tested :08/17/88

Test No. :3 INLET Time :1425

Gas Flow Rate Data

Point	h	T.	Vel.Ft/Sec
1	.09	81	17.2
2	.12	81	19.8
3	.19	81	25
4	.06	81	14
5	.04	81	11.5
6	.07	81	15.2
7	.06	81	14
8	.02	81	8.1
9	.005	81	4.1
10	.05	81	12.8
11	.07	81	15.2
12	.04	81	11.5
13	.03	81	9.9
14	.02	81	8.1
15	.04	81	11.5
16	.04	81	11.5
17	.01	81	5.7
18	.005	81	4.1

Vs = Cp [h *(T + 460)]^.5 [1/M.W. * Ps]^.5 * 85.49

Conc. of CO2 = 0 % Conc. of O2 = 20.98 %

Conc. of H2O = 1.6 %

Avg. Gas Velocity; Vs, Avg. 12.2 Ft/Sec

Pitot Tube Correction Factor, Cp .84

Duct Gas Molecular Weight, M.W. 28.78

Duct Pressure, Ps. 29.54 ''Hg Barometric Pressure 29.78 ''Hg

Duct Size Rectangle 85 ''X 29 '' Static Pressure -3.2 ''H2O

Duct Area 17.12 Sq. Ft Avg. Gas Temp. 81

Gas Flow Rate 12.2 Ft/Sec * 17.12 Sq. Ft * 60 = 12531 CFM

12531 CFM* 530 / 541 * 29.54 /29.92*(1.00- 1.6 /100%H2O)- 11925 SDCFM

M.W. Factor = .0343 Standard Cond. Temp. 70

Client : RISK SCIENCE Date Tested : 08/17/88

Test No. : 1 OUTLET Time : 1040

GAS FLOW DATA

Sample Points 1234

Barometric Pressure 29.78 Sample Nozzle Area .000541 ft^2

Duct Pressure 29.77 ''Hg Condensate 10 ml.

Avg. Gas Meter Pressure 0 in.Hg Vol. of Gas Samples 33.9 CF

Avg Gas Meter Temp 88.8 F Avg Duct Temp 69 F

Wgt. Collected 0 Gms. Duration of Test 60 Min.

Avg. Velocity at Sampling Pts 16.1 ft/sec.

Calculations

Condensed Water Vapor:

vw = 0.00267 * 10 * (460 + 70)/29.92 = .47 SCF

Corrected Meter Volume:

Vo = 33.9 * 29.77 / 29.92 * 530 / 548.8 = 32.57 SDCF

Percent Water Vapor:

% H2O = .47 / 33.05 * 100 = 1.4 %

Particulate Concentration (Grain Loading):

Go = (0 Gms. * 15.43)/ 32.57 SDCF = 0 Grs/SDCF

Particulate Emission Rate:

(0 Grs/SDCF * 10611 SDCFM * 60)/7000 = 0 Lbs/Hr.

Percentage of Isokinetic Sampling Attained: %I = 105 %

THERMO ANALYTICAL

Client : RISK SCIENCE Date Tested :08/17/88

Test No. :1 OUTLET Time :1040

Gas Flow Rate Data

Point	h	T.	Vel.Ft/Sec
1	.15	69	21.8
2	.12	69	19.5
3	.09	69	16.9
4	.09	69	16.9
5	.05	69	12.6
6	.04	69	11.3
7	.06	69	13.8
8	.14	69	21.1
9	.15	69	21.8
10	.06	69	13.8
11	.03	69	9.8
12	.04	69	11.3
13	.05	69	12.6
14	.05	69	12.6
15	.05	69	12.6
16	.06	69	13.8
17	.1	69	17.8
18	.11	69	18.7
19	.12	69	19.5
20	.17	69	23.3

Vs = Cp [h *(T + 460)]^.5 [1/M.W. * Ps]^.5 * 85.49

Conc. of CO2 = 0 % Conc. of O2 = 20.98 %

Conc. of H2O = 1.4 %

Avg. Gas Velocity; Vs, Avg. 16.1 Ft/Sec

Pitot Tube Correction Factor, Cp .84

Duct Gas Molecular Weight, M.W. 28.8

Duct Pressure, Ps. 29.77 ''Hg Barometric Pressure 29.78 ''Hg

Duct Size Rectangle 35 ''X 46 '' Static Pressure -.08 ''H2O

Duct Area 11.18 Sq. Ft Avg. Gas Temp. 69

Gas Flow Rate 16.1 Ft/Sec * 11.18 Sq. Ft * 60 = 10799 CFM

10799 CFM* 530 / 529 * 29.77 /29.92*(1.00- 1.4 /100%H2O)- 10611 SDCFM

M.W. Factor = .0341 Standard Cond. Temp. 70

THERMO ANALYTICAL

THERMO ANALYTICAL

Client : RISK SCIENCE — Date Tested : 08/17/88

Test No. : 2 OUTLET — Time : 1240

GAS FLOW DATA

Sample Points 1234

Barometric Pressure 29.78 — Sample Nozzle Area .000541 ft^2

Duct Pressure 29.77 ''Hg — Condensate 10.5 ml.

Avg. Gas Meter Pressure 0 in.Hg — Vol. of Gas Samples 37.595 CF

Avg Gas Meter Temp 100 F — Avg Duct Temp 69 F

Wgt. Collected 0 Gms. — Duration of Test 60 Min.

Avg. Velocity at Sampling Pts 17.1 ft/sec.

Calculations

Condensed Water Vapor:

vw = 0.00267 * 10.5 * (460 + 70)/29.92 = .5 SCF

Corrected Meter Volume:

Vo = 37.595 * 29.77 / 29.92 * 530 / 560 = 35.4 SDCF

Percent Water Vapor:

% H2O = .5 / 35.9 * 100 = 1.4 %

Particulate Concentration (Grain Loading):

Go = (0 Gms. * 15.43)/ 35.4 SDCF = 0 Grs/SDCF

Particulate Emission Rate:

(0 Grs/SDCF * 11270 SDCFM * 60)/7000 = 0 Lbs/Hr.

Percentage of Isokinetic Sampling Attained: %I = 108 %

THERMO ANALYTICAL

Client : RISK SCIENCE Date Tested :08/17/88

Test No. :2 OUTLET Time :1240

Gas Flow Rate Data

Point	h	T.	Vel.Ft/Sec
1	.11	69.3	18.7
2	.11	69.3	18.7
3	.12	69.3	19.5
4	.18	69.3	23.9
5	.16	69.3	22.6
6	.08	69.3	16
7	.06	69.3	13.8
8	.06	69.3	13.8
9	.05	69.3	12.6
10	.04	69.3	11.3
11	.05	69.3	12.6
12	.16	69.3	22.6
13	.14	69.3	21.1
14	.05	69.3	12.6
15	.05	69.3	12.6
16	.05	69.3	12.6
17	.1	69.3	17.8
18	.1	69.3	17.8
19	.12	69.3	19.5
20	.15	69.3	21.9

$$Vs = Cp\,[h * (T + 460)]^{.5}\,[1/M.W. * Ps]^{.5} * 85.49$$

Conc. of CO2 = 0 % Conc. of O2 = 20.98 %

Conc. of H20 = 1.4 %

Avg. Gas Velocity; Vs, Avg. 17.1 Ft/Sec

Pitot Tube Correction Factor, Cp .84

Duct Gas Molecular Weight, M.W. 28.81

Duct Pressure, Ps. 29.77 ''Hg Barometric Pressure 29.78 ''Hg

Duct Size Rectangle 35 ''X 46 '' Static Pressure -.09 ''H20

Duct Area 11.18 Sq. Ft Avg. Gas Temp. 69

Gas Flow Rate 17.1 Ft/Sec * 11.18 Sq. Ft * 60 = 11470 CFM

11470 CFM* 530 / 529 * 29.77 /29.92*(1.00- 1.4 /100%H20)- 11270 SDCFM

M.W. Factor = .0341 Standard Cond. Temp. 70

THERMO ANALYTICAL

Client : RISK SCIENCE Date Tested : 08/17/88

Test No. : 3 OUTLET Time : 1425

GAS FLOW DATA

Sample Points 1234

Barometric Pressure 29.78 Sample Nozzle Area .000541 ft^2

Duct Pressure 29.77 ''Hg Condensate 14 ml.

Avg. Gas Meter Pressure 0 in.Hg Vol. of Gas Samples 32.77 CF

Avg Gas Meter Temp 97.6 F Avg Duct Temp 74 F

Wgt. Collected 0 Gms. Duration of Test 60 Min.

Avg. Velocity at Sampling Pts 15.2 ft/sec.

Calculations

Condensed Water Vapor:

vw = 0.00267 * 14 * (460 + 70)/29.92 = .66 SCF

Corrected Meter Volume:

Vo = 32.77 * 29.77 / 29.92 * 530 / 557.6 = 30.99 SDCF

Percent Water Vapor:

% H2O = .66 / 31.65 * 100 = 2.1 %

Particulate Concentration (Grain Loading):

Go = (0 Gms. * 15.43)/ 30.99 SDCF = 0 Grs/SDCF

Particulate Emission Rate:

(0 Grs/SDCF * 9851 SDCFM * 60)/7000 = 0 Lbs/Hr.

[illegible] Isokinetic Sampling Attained: %I = 108 %

THERMO ANALYTICAL

Client : RISK SCIENCE Date Tested :08/17/88

Test No. :3 OUTLET Time :1425

Gas Flow Rate Data

Point	h	T.	Vel.Ft/Sec
1	.07	74.4	15
2	.09	74.4	17
3	.08	74.4	16.1
4	.11	74.4	18.8
5	.11	74.4	18.8
6	.04	74.4	11.4
7	.03	74.4	9.8
8	.04	74.4	11.4
9	.03	74.4	9.8
10	.02	74.4	8
11	.05	74.4	12.7
12	.15	74.4	22
13	.16	74.4	22.7
14	.06	74.4	13.9
15	.05	74.4	12.7
16	.04	74.4	11.4
17	.08	74.4	16.1
18	.08	74.4	16.1
19	.1	74.4	18
20	.16	74.4	22.7

$$Vs = Cp\,[h * (T + 460)]^{.5}\,[1/M.W. * Ps]^{.5} * 85.49$$

Conc. of CO2 = 0 % Conc. of O2 = 20.98 %

Conc. of H2O = 2.1 %

Avg. Gas Velocity; Vs, Avg. 15.2 Ft/Sec

Pitot Tube Correction Factor, Cp .84

Duct Gas Molecular Weight, M.W. 28.73

Duct Pressure, Ps. 29.77 ''Hg Barometric Pressure 29.78 ''Hg

Duct Size Rectangle 35 ''X 46 '' Static Pressure -.09 ''H2O

Duct Area 11.18 Sq. Ft Avg. Gas Temp. 74

Gas Flow Rate 15.2 Ft/Sec * 11.18 Sq. Ft * 60 = 10196 CFM

10196 CFM* 530 / 534 * 29.77 /29.92*(1.00- 2.1 /100%H2O)- 9851 SDCFM

M.W. Factor = .0341 Standard Cond. Temp. 70

TABLE II SUMMARY OF RESULTS

Location: Mare Island Naval Shipyard, Chrome Plating Facility
Unit: Water Scrubber Inlet, Baths JFC and JQP
Date of Test: August 10, 1988

TOTAL CHROMIUM - SCRUBBER INLET

Test No.	1	2	3
Time	1109-1209	1400-1500	1540-1640
Flow Rate, SDCFM	19,513	20,791	19,159
Volume Sampled, SDCF	35.4	33.0	33.8
Stack Temperature, °F	65	64	65
Stack Moisture	1.7	1.8	2.0
*Chromium Concentration, mg/m^3	0.17	0.10	0.10
*Chromium Emissions, grams/hr	5.7	3.6	3.4
*Chromium Emissions, lbs/hr	0.0125	0.0079	0.0075
*Chromium Emissions, grains/SDCF	7.5×10^{-5}	4.4×10^{-5}	4.6×10^{-5}
Percent Isokinetics	119	103	102

*Chromium results based on total chromium on filters and probe washes.

TABLE III SUMMARY OF RESULTS

Location: Mare Island Naval Shipyard, Chrome Plating Facility
Unit: Water Scrubber Outlet, Baths Decorative and Anodizing
Date of Test: August 17, 1988

TOTAL CHROMIUM - SCRUBBER OUTLET

Test No.	1	2	3
Time	1043-1143	1240-1340	1425-1525
Flow Rate, SDCFM	10,611	11,270	9,851
Volume Sampled, SDCF	32.6	35.4	31.0
Stack Temperature, °F	69	69	74
Stack Moisture	1.4	1.4	2.1
Total Amps	750	750	750
*Chromium Concentration, mg/m^3	$2.9x10^{-3}$	$2.7x10^{-3}$	$3.0x10^{-3}$
*Chromium Emissions, grams/hr	0.05	0.05	0.05
*Chromium Emissions, lbs/hr	0.0001	0.0001	0.0001
*Chromium Emissions, grains/SDCF	$1.3x10^{-6}$	$1.2x10^{-6}$	$1.3x10^{-6}$
*Chromium Plating Emissions Factor, mg/amps/hr	0.08	0.08	0.08
Percent Isokinetics	105	108	108
Scrubber Water Chromium Content, ug/ml	0.10	0.12	0.15
Work Piece Surface Area, ft^2-Decorative	7.68	7.68	7.68
Work Piece Surface Area, ft^2-Anodizer	1.24	1.24	1.24
Bath Temperature, °F-Decorative	119	115	115
Bath Temperature, °F-Anodizer	90	89	88
Bath Amps, I-Decorative	600	600	600
Bath Amps, I-Anodizer	5	5	5

*Chromium results based on total chromium on filters. Probe washes were non-detectable.

TABLE IV SUMMARY OF RESULTS

Location: Mare Island Naval Shipyard, Chrome Plating Facility
Unit: Water Scrubber Inlet, Decorative and Anodizing
Date of Test: August 17, 1988

TOTAL CHROMIUM - SCRUBBER INLET

Test No.	1	2	3
Time	1043-1143	1240-1340	1425-1525
Flow Rate, SDCFM	12,228	12,481	11,925
Volume Sampled, SDCF	33.0	32.3	30.3
Stack Temperature, °F	60	76	81
Stack Moisture	1.4	1.1	1.6
Chromium Concentration, mg/m^3	4.5×10^{-2}	1.9×10^{-2}	4.7×10^{-2}
Chromium Emissions, grams/hr	0.93	0.41	0.95
Chromium Emissions, lbs/hr	0.0020	0.0009	0.0021
Chromium Emissions, grains/SDCF	2.0×10^{-5}	0.8×10^{-5}	2.0×10^{-5}
Percent Isokinetics	103	99	97

*Chromium results based on total chromium on filters and probe washes.

TABLE V SUMMARY OF RESULTS

Location: Mare Island Naval Shipyard, Chrome Plating Facility
Unit: Water Scrubber Outlet, Baths JFC and JQP
Date of Test: August 10, 1988

HEXAVALENT CHROMIUM - SCRUBBER OUTLET

Test No.	1	2	3
Time	1109-1209	1400-1500	1540-1640
Flow Rate, SDCFM	18,071	18,366	18,197
Volume Sampled, SDCF	28.1	28.4	28.0
Stack Temperature, °F	68	71	71
Stack Moisture	0.8	0.8	0.7
Total Amps	4400	4400	4400
*Chromium Concentration, mg/m^3	$<1.3x10^{-3}$	$<1.2x10^{-3}$	$<1.3x10^{-3}$
*Chromium Emissions, grams/hr	<0.04	<0.04	<0.04
*Chromium Emissions, lbs/hr	<0.0001	<0.0001	<0.0001
*Chromium Emissions, grains/SDCF	$<5.5x10^{-5}$	$<5.4x10^{-6}$	$<5.5x10^{-5}$
*Chromium Plating Emissions Factor, mg/amps/hr	$<9.1x10^{-3}$	$<9.1x10^{-3}$	$<9.1x10^{-3}$
Percent Isokinetics	97	96	96
Scrubber Water Chromium Content, ug/ml	1.1	1.9	2.0
Work Piece Surface Area, ft^2-JFC	18.67	18.67	18.67
Work Piece Surface Area, ft^2-JQP	16.0	16.0	16.0
Bath Temperature, °F-JFC	140	147	148
Bath Temperature, °F-JQP	124	134	139
Bath Amps, I-JFC	2400	2400	2400
Bath Amps, I-JQD	2000	2000	2000

*Chromium data based on hexavalent chromium results on filters analyzed by CARB 425. Probe washes were non-detectable for chromium.

TABLE VI SUMMARY OF RESULTS

Location: Mare Island Naval Shipyard, Chrome Plating Facility
Unit: Water Scrubber Inlet, Baths JFC and JQP
Date of Test: August 10, 1988

HEXAVALENT CHROMIUM - SCRUBBER INLET

Test No.	1	2	3
Time	1109-1209	1400-1500	1540-1640
Flow Rate, SDCFM	19,513	20,791	19,159
Volume Sampled, SDCF	35.4	33.0	33.8
Stack Temperature, °F	65	64	65
Stack Moisture	1.7	1.8	2.0
*Chromium Concentration, mg/m^3	0.15	0.09	0.10
*Chromium Emissions, grams/hr	5.1	3.1	3.1
*Chromium Emissions, lbs/hr	0.0112	0.0068	0.0068
*Chromium Emissions, grains/SDCF	6.7×10^{-5}	3.8×10^{-5}	4.2×10^{-5}
Percent Isokinetics	119	103	102

*Chromium data based on hexavalent chromium results on filters analyzed by CARB 425 and total chromium in the probe wash.

TABLE VII SUMMARY OF RESULTS

Location: Mare Island Naval Shipyard, Chrome Plating Facility
Unit: Water Scrubber Outlet, Baths Decorative and Anodizing
Date of Test: August 17, 1988

HEXAVALENT CHROMIUM - SCRUBBER OUTLET

Test No.	1	2	3
Time	1043-1143	1240-1340	1425-1525
Flow Rate, SDCFM	10,611	11,270	9,851
Volume Sampled, SDCF	32.6	35.4	31.0
Stack Temperature, °F	69	69	74
Stack Moisture	1.4	1.4	2.1
Total Amps	750	750	750
*Chromium Concentration, mg/m^3	$<1.1x10^{-3}$	$<1.0x10^{-3}$	$<1.1x10^{-3}$
*Chromium Emissions, grams/hr	<0.02	<0.02	<0.02
*Chromium Emissions, lbs/hr	$<4.4x10^{-5}$	$<4.4x10^{-5}$	$<4.4x10^{-5}$
*Chromium Emissions, grains/SDCF	$<4.7x10^{-7}$	$<4.5x10^{-7}$	$<5.0x10^{-7}$
*Chromium Plating Emissions Factor, mg/amps/hr	<0.03	<0.03	<0.03
Percent Isokinetics	105	108	108
Scrubber Water Chromium Content, ug/ml	0.10	0.12	0.15
Work Piece Surface Area, ft^2 - Decorative	7.68	7.68	7.68
Work Piece Surface Area, ft^2 - Anodizer	1.24	1.24	1.24
Bath Temperature, °F-Decorative	119	115	115
Bath Temperature, °F-Anodizer	90	89	88
Bath Amps, I-Decorative	600	600	600
Bath Amps, I-Anodizer	5	5	5

*Chromium data based on hexavalent chromium results on filters analyzed by CARB 425. Probe washes were non-detectable for chromium.

TABLE VIII SUMMARY OF RESULTS

Location: Mare Island Naval Shipyard, Chrome Plating Facility
Unit: Water Scrubber Inlet, Decorative and Anodizing
Date of Test: August 17, 1988

HEXAVALENT CHROMIUM - SCRUBBER INLET

Test No.	1	2	3
Time	1043-1143	1240-1340	1425-1525
Flow Rate, SDCFM	12,228	12,481	11,925
Volume Sampled, SDCF	33.0	32.3	30.3
Stack Temperature, °F	60	76	81
Stack Moisture	1.4	1.1	1.6
*Chromium Concentration, mg/m^3	0.03	0.01	0.03
*Chromium Emissions, grams/hr	0.54	0.20	0.58
*Chromium Emissions, lbs/hr	0.0012	0.0004	0.0013
*Chromium Emissions, grains/SDCF	1.1×10^{-5}	4.2×10^{-6}	1.2×10^{-5}
Percent Isokinetics	103	99	97

*Chromium data based on hexavalent chromium results on filters analyzed by CARB 425 and total chromium in the probe wash.

APPENDIX I

GAS FLOW DATA

THERMO ANALYTICAL

Client : RISK SCIENCE Date Tested : 08/10/88

Test No. : 1 INLET Time : 1100

GAS FLOW DATA

Sample Points 123456789

Barometric Pressure 29.78 Sample Nozzle Area .000426 ft^2

Duct Pressure 29.52 ''Hg Condensate 13 ml.

Avg. Gas Meter Pressure 0 in.Hg Vol. of Gas Samples 36.11 CF

Avg Gas Meter Temp 73 F Avg Duct Temp 65 F

Wgt. Collected 0 Gms. Duration of Test 60 Min.

Avg. Velocity at Sampling Pts 19.4 ~~19.9~~ ft/sec.

Calculations

Condensed Water Vapor:

vw = 0.00267 * 13 * (460 + 70)/29.92 = .61 SCF

Corrected Meter Volume:

Vo = 36.11 * 29.52 / 29.92 * 530 / 533 = 35.43 SDCF

Percent Water Vapor:

% H2O = .61 / 36.04 * 100 = 1.7 %

Particulate Concentration (Grain Loading):

Go = (0 Gms. * 15.43)/ 35.43 SDCF = 0 Grs/SDCF

Particulate Emission Rate:

(0 Grs/SDCF * 20012 SDCFM * 60)/7000 = 0 Lbs/Hr.

Percentage of Isokinetic Sampling Attained: %I = 119 %

THERMO ANALYTICAL

Client : RISK SCIENCE Date Tested :08/10/88

Test No. :1 INLET Time :1100

Gas Flow Rate Data

Point	h	T.	Vel.Ft/Sec	Point	h	T.	Vel..Ft/Sec
1	.35	65	33.4	25	.2	65	25.2
2	.35	65	33.4	26	.12	65	19.6
3	.35	65	33.4	27	.2	65	25.2
4	.35	65	33.4	28	.25	65	28.2
5	.4	65	35.7	29	.2	65	25.2
6	.35	65	33.4	30	.18	65	24
7	.15	65	21.9	31	.12	65	19.6
8	.05	65	12.6	32	.08	65	16
9	.01	65	5.6	33	.03	65	9.8
10	.01	65	5.6	34	.03	65	9.8
11	.03	65	9.8	35	0	65	0
12	.02	65	8	36	.01	65	5.6
13	.05	65	12.6				
14	.05	65	12.6				
15	.01	65	5.6				
16	0	65	0				
17	0	65	0				
18	0	65	0				
18	.3	65	30.9				
19	.46	65	38.3				
20	.5	65	39.9				
21	.4	65	35.7				
23	.4	65	35.7				
24	.32	65	31.9				

Vs = Cp [h *(T + 460)]^.5 [1/M.W. * Ps]^.5 * 85.49

Conc. of CO2 = 0 % Conc. of O2 = 20.98 %

Conc. of H20 = 1.7 %

Avg. Gas Velocity; Vs, Avg. 19.9 Ft/Sec

Pitot Tube Correction Factor, Cp .84

Duct Gas Molecular Weight, M.W. 28.77

Duct Pressure, Ps. 29.52 ''Hg Barometric Pressure 29.78 ''Hg

Duct Size Rectangle 85 ''X 29 '' Static Pressure -3.6 ''H20

Duct Area 17.12 Sq. Ft Avg. Gas Temp. 65

cyclonic flow adj 19.4

Gas Flow Rate ~~19.9~~ Ft/Sec * 17.12 Sq. Ft * 60 = ~~20441~~ 19929 CFM

20441 CFM* 530 / 525 * 29.52 /29.92*(1.00- 1.7 /100%H20)- ~~20042~~ 19512 SDCFM

M.W. Factor = .0343 Standard Cond. Temp. 70

THERMO ANALYTICAL

Client : RISK SCIENCE Date Tested : 08/10/88

Test No. : 2 INLET Time : 1400

GAS FLOW DATA

Sample Points 123456789

Barometric Pressure 29.78 Sample Nozzle Area .000426 ft^2

Duct Pressure 29.52 ''Hg Condensate 12.5 ml.

Avg. Gas Meter Pressure 0 in.Hg Vol. of Gas Samples 34.1 CF

Avg Gas Meter Temp 80 F Avg Duct Temp 64 F

Wgt. Collected 0 Gms. Duration of Test 60 Min.

Avg. Velocity at Sampling Pts 21.5 ft/sec.

Calculations

Condensed Water Vapor:

vw = 0.00267 * 12.5 * (460 + 70)/29.92 = .59 SCF

Corrected Meter Volume:

Vo = 34.1 * 29.52 / 29.92 * 530 / 540 = 33.02 SDCF

Percent Water Vapor:

% H2O = .59 / 33.61 * 100 = 1.8 %

Particulate Concentration (Grain Loading):

Go = (0 Gms. * 15.43)/ 33.02 SDCF = 0 Grs/SDCF

Particulate Emission Rate:

(0 Grs/SDCF * 21630 SDCFM * 60)/7000 = 0 Lbs/Hr.

Percentage of Isokinetic Sampling Attained: %I = 103 %

THERMO ANALYTICAL

Client : RISK SCIENCE Date Tested :08/10/88

Test No. :2 INLET Time :1400

Gas Flow Rate Data

Point	h	T.	Vel.Ft/Sec
1	.4	64.5	35.7
2	.35	64.5	33.4
3	.18	64.5	23.9
4	.05	64.5	12.6
5	.05	64.5	12.6
6	.03	64.5	9.8
7	.01	64.5	5.6
8	.03	64.5	9.8
9	.03	64.5	9.8
10	.5	64.5	39.9
11	.47	64.5	38.7
12	.4	64.5	35.7
13	.3	64.5	30.9
14	.25	64.5	28.2
15	.12	64.5	19.6
16	.08	64.5	16
17	.06	64.5	13.8
18	.04	64.5	11.3

Vs = Cp [h *(T + 460)]^.5 [1/M.W. * Ps]^.5 * 85.49

Conc. of CO2 = 0 % Conc. of O2 = 20.98 %

Conc. of H20 = 1.8 %

Avg. Gas Velocity; Vs, Avg. 21.5 Ft/Sec

Pitot Tube Correction Factor, Cp .84

Duct Gas Molecular Weight, M.W. 28.76

Duct Pressure, Ps. 29.52 ''Hg Barometric Pressure 29.78 ''Hg

Duct Size Rectangle 85 ''X 29 '' Static Pressure -3.6 ''H20

Duct Area 17.12 Sq. Ft Avg. Gas Temp. 64

Gas Flow Rate 21.5 Ft/Sec * 17.12 Sq. Ft * 60 = ~~22084~~ 21150 CFM adjusted for cyclonic slip

22084 CFM* 530 / 524 * 29.52 /29.92*(1.00- 1.8 /100%H20)- ~~21530~~ 20791 SDCFM

M.W. Factor = .0343 Standard Cond. Temp. 70

THERMO ANALYTICAL

Client : RISK SCIENCE Date Tested : 08/10/88

Test No. : 3 INLET Time : 1540

GAS FLOW DATA

Sample Points 123456789

Barometric Pressure 29.78 Sample Nozzle Area .000426 ft^2

Duct Pressure 29.52 ''Hg Condensate 14.5 ml.

Avg. Gas Meter Pressure 0 in.Hg Vol. of Gas Samples 33.83 CF

Avg Gas Meter Temp 77 F Avg Duct Temp 65 F

Wgt. Collected 0 Gms. Duration of Test 60 Min.

Avg. Velocity at Sampling Pts 21.6 ft/sec.

Calculations

Condensed Water Vapor:

vw = 0.00267 * 14.5 * (460 + 70)/29.92 = .69 SCF

Corrected Meter Volume:

Vo = 33.83 * 29.52 / 29.92 * 530 / 537 = 32.94 SDCF

Percent Water Vapor:

% H2O = .69 / 33.63 * 100 = 2 %

Particulate Concentration (Grain Loading):

Go = (0 Gms. * 15.43)/ 32.94 SDCF = 0 Grs/SDCF

Particulate Emission Rate:

(0 Grs/SDCF * 21648 SDCFM * 60)/7000 = 0 Lbs/Hr.

Percentage of Isokinetic Sampling Attained: %I = 102 %

THERMO ANALYTICAL

Client : RISK SCIENCE Date Tested :08/10/88

Test No. :3 INLET Time :1540

Gas Flow Rate Data

Point	h	T.	Vel.Ft/Sec
1	.35	65	33.4
2	.37	65	34.4
3	.18	65	24
4	.04	65	11.3
5	.02	65	8
6	.05	65	12.6
7	.03	65	9.8
8	.03	65	9.8
9	.01	65	5.6
10	.47	65	38.7
11	.47	65	38.7
12	.43	65	37
13	.35	65	33.4
14	.23	65	27.1
15	.13	65	20.4
16	.08	65	16
17	.08	65	16
18	.05	65	12.6

Vs = Cp [h *(T + 460)]^.5 [1/M.W. * Ps]^.5 * 85.49

Conc. of CO2 = 0 % Conc. of O2 = 20.98 %

Conc. of H20 = 2 %

Avg. Gas Velocity; Vs, Avg. 21.6 Ft/Sec

Pitot Tube Correction Factor, Cp .84

Duct Gas Molecular Weight, M.W. 28.73

Duct Pressure, Ps. 29.52 ''Hg Barometric Pressure 29.78 ''Hg

Duct Size Rectangle 85 ''X 29 '' Static Pressure -3.6 ''H20

Duct Area 17.12 Sq. Ft Avg. Gas Temp. 65

Gas Flow Rate 21.6 Ft/Sec * 17.12 Sq. Ft * 60 = ~~22187~~ 19636 CFM

22187 CFM* 530 / 525 * 29.52 /29.92*(1.00- 2 /100%H20)= ~~21649~~ 19159 SDCFM

M.W. Factor = .0343 Standard Cond. Temp. 70

THERMO ANALYTICAL

Client : RISK SCIENCE Date Tested : 08/10/88

Test No. : A 1 outlet Time : 1100

GAS FLOW DATA

Sample Points 1234

Barometric Pressure 29.78 Sample Nozzle Area .000299 ft^2

Duct Pressure 29.77 ''Hg Condensate 5 ml.

Avg. Gas Meter Pressure 0 in.Hg Vol. of Gas Samples 28.13 CF

Avg Gas Meter Temp 67.4 F Avg Duct Temp 68 F

Wgt. Collected 0 Gms. Duration of Test 60 Min.

Avg. Velocity at Sampling Pts 27.2 ft/sec.

Calculations

Condensed Water Vapor:

vw = 0.00267 * 5 * (460 + 70)/29.92 = .24 SCF

Corrected Meter Volume:

Vo = 28.13 * 29.77 / 29.92 * 530 / 527.4 = 28.13 SDCF

Percent Water Vapor:

% H2O = .24 / 28.36 * 100 = .8 %

Particulate Concentration (Grain Loading):

Go = (0 Gms. * 15.43)/ 28.13 SDCF = 0 Grs/SDCF

Particulate Emission Rate:

(0 Grs/SDCF * 18071 SDCFM * 60)/7000 = 0 Lbs/Hr.

Percentage of Isokinetic Sampling Attained: %I = 97 %

THERMO ANALYTICAL

Client : RISK SCIENCE Date Tested :09/10/99

Test No. : 4 outlet Time :1100

Gas Flow Rate Data

Point	h	T.	Vel.Ft/Sec
1	.28	68	29.8
2	.08	68	15.9
3	.11	68	18.7
4	.19	68	24.5
5	.16	68	22.5
6	.06	68	13.8
7	.05	68	12.6
8	.25	68	28.1
9	.27	68	29.2
10	.27	68	29.2
11	.15	68	21.8
12	.25	68	28.1
13	.32	68	31.8
14	.28	68	29.8
15	.2	68	25.2
16	.4	68	35.6
17	.48	68	39
18	.46	68	38.2
19	.4	68	35.6
20	.39	68	35.2

Vs = Cp [h *(T + 460)]^.5 [1/M.W. * Ps]^.5 * 85.49

Conc. of CO2 = 0 % Conc. of O2 = 20.98 %

Conc. of H20 = .8 %

Avg. Gas Velocity; Vs, Avg. 27.2 Ft/Sec

Pitot Tube Correction Factor, Cp .84

Duct Gas Molecular Weight, M.W. 28.87

Duct Pressure, Ps. 29.77 ''Hg Barometric Pressure 29.79 ''Hg

Duct Size Rectangle 35 ''X 46 '' Static Pressure -.1 ''H20

Duct Area 11.18 Sq. Ft Avg. Gas Temp. 68

Gas Flow Rate 27.2 Ft/Sec * 11.18 Sq. Ft * 60 = 18245 CFM

18245 CFM* 530 / 528 * 29.77 /29.92*(1.00- .8 /100%H20)= 18071 SDCFM

M.W. Factor = .0341 Standard Cond. Temp. 70

THERMO ANALYTICAL

Client : RISK SCIENCE

Date Tested : 08/10/88

Test No. : 2 OUTLET

Time : 1400

GAS FLOW DATA

Sample Points 1234

Barometric Pressure 29.78

Sample Nozzle Area .000299 ft^2

Duct Pressure 29.77 ''Hg

Condensate 5 ml.

Avg. Gas Meter Pressure 0 in.Hg

Vol. of Gas Samples 29.04 CF

Avg Gas Meter Temp 79 F

Avg Duct Temp 71 F

Wgt. Collected 0 Gms.

Duration of Test 60 Min.

Avg. Velocity at Sampling Pts 27.8 ft/sec.

Calculations

Condensed Water Vapor:

vw = 0.00267 * 5 * (460 + 70)/29.92 = .24 SCF

Corrected Meter Volume:

Vo = 29.04 * 29.77 / 29.92 * 530 / 539 = 28.41 SDCF

Percent Water Vapor:

% H2O = .24 / 28.65 * 100 = .8 %

Particulate Concentration (Grain Loading):

Go = (0 Gms. * 15.43)/ 28.41 SDCF = 0 Grs/SDCF

Particulate Emission Rate:

(0 Grs/SDCF * 18366 SDCFM * 60)/7000 = 0 Lbs/Hr.

Percentage of Isokinetic Sampling Attained: %I = 96 %

THERMO ANALYTICAL

Client : RISK SCIENCE Date Tested :08/10/88

Test No. :2 OUTLET Time :1400

Gas Flow Rate Data

Point	h	T.	Vel.Ft/Sec
1	.29	71	30.4
2	.09	71	16.9
3	.1	71	17.9
4	.18	71	23.9
5	.15	71	21.9
6	.05	71	12.6
7	.26	71	28.8
8	.28	71	29.9
9	.08	71	16
10	.15	71	21.9
11	.21	71	25.9
12	.3	71	30.9
13	.28	71	29.9
14	.2	71	25.2
15	.42	71	36.6
16	.47	71	38.7
17	.47	71	38.7
18	.48	71	39.1
19	.39	71	35.3
20	.39	71	35.3

Vs = Cp [h *(T + 460)]^.5 [1/M.W. * Ps]^.5 * 85.49

Conc. of CO2 = 0 % Conc. of O2 = 20.98 %

Conc. of H2O = .8 %

Avg. Gas Velocity; Vs, Avg. 27.8 Ft/Sec

Pitot Tube Correction Factor, Cp .84

Duct Gas Molecular Weight, M.W. 28.87

Duct Pressure, Ps. 29.77 ''Hg Barometric Pressure 29.79 ''Hg

Duct Size Rectangle 35 ''X 46 '' Static Pressure -.1 ''H2O

Duct Area 11.18 Sq. Ft Avg. Gas Temp. 71

Gas Flow Rate 27.8 Ft/Sec * 11.18 Sq. Ft * 60 = 18648 CFM

18648 CFM* 530 / 531 * 29.77 /29.92*(1.00- .8 /100%H2O)= 18566 SDCFM

M.W. Factor = .0341 Standard Cond. Temp. 70

APPENDIX II

TMA/NORCAL FIELD DATA SHEETS

TMA/NORCAL INC.

Air Pollution Analysis

Source Test Field Data Sheet

DATE: 8/10/88
PLANT: Mare Island
SAMPLE TYPE: Chromium
DUCT LOCATION: outlet
DUCT DIAM: 35"x46"
FITTING SIZE: 3"
WALL THICKNESS: —
DUCT STATIC PRESS: -.1

Test Number #1

.019	ORIFICE
#1	FILTER NO.
.000299	NOZZLE DIAM./AREA
6mm C	NOZZLE TYPE/NUMBER
	GAS COLLECTOR
766758	METER NO.
29.78	BAROMETRIC PRESS.
M1	MAGNEHELIC
.84 Stype	TRAVERSE PITOT TUB
Sure	MONITORING PITOT T
200.2	INITIAL IMP. VOL.
4 + 5	CONDENSATE
209	FINAL IMP. VOL.

PITOT TRAVERSE					PITOT MONITOR			SAMPLING								REMARKS
		Time: 1100														
Point	In from wall	ΔH "H_2O	Duct Temp °F	Vel FPS	Δh "H_2O	Duct Temp °F	Vel FPS	Time	Point	Meter Rate CFM	Meter Temp Inlet	Meter Temp Outlet	Vol. Ft^3	Orif. Sett.	Pump Vac.	Leak check OK
1	4.37"	.28	66	29.8				11:09	beginning	.523	64	64	368.96	.8	13"	
2	13.1	.08	69	14.8				11:12		.26	65	64	370	.203	21"	
3	21.88	.11	68	18.9				11:15		.39	66	64	371.8	.22	16"	
4	30.6	.19	68	24.5				11:18		.143	67	65	372.8	.353	3"	
1	30.6	.16	68	22.5				11 21		.393	68	65	374.3	.466	5"	
2	21.88	.06	68	13.8				1124		.243	68	65	375.1	.175	2"	
3	13.11	.09	67	12.5				1127		.22	68	65	375.9	.15	2"	
4	4.37	.25	68	28.1				1130		.49	68	65	386.6	.73	6"	
1	4.37	.27	68	29.2				1133		.5	68	65	377.8	.79	6"	
2	13.11	.11	68	18.6				36		.32	68	65	380.1	.322	4"	
3	21.88	.15	68	21.8				39		.385	68	65	381.2	.439	4"	
4	30.6	.28	69	29.1				42		.49	70	65	382.1	.73	5"	
1	30.6	.32	68	31.8				45		.56	71	65	383.2	.93	6"	
2	21.88	.28	68	29.1				48		.526	72	65	385.1	.82	6"	
3	13.11	.20	67	23.2				51		.45	74	65	386.5	.59	5"	
4	4.37	.90	68	35.7				54		.63	73	65	388	1.2	6"	
1	4.37	.48	68	34.1				57		.69	73	65	390.1	1.4	6"	
2	13.11	.46	68	38.2				1200		.68	75	65	391.5	1.35	6"	
3	21.88	.46	68	35.7				1203		.63	80	65	393.5	1.18	6"	
4	30.6	.39	68	35.3				1206		.62	80	65	395.7	1.16	5"	
								1209	end				397.09			
													2813 Cubic Set			Leak Check OK

Gas Sampling Time: 1206 — Slow 4
Start: _____ Stop: _____

Team Members: Juan / Jim

TMA/NORCAL INC.

Air Pollution Analysis

Source Test Field Data Sheet

Test Number 2

DATE: 8/10/88
PLANT: Mare Island

SAMPLE TYPE: Cr^{+6}

DUCT LOCATION: outlet
DUCT DIAM: 35x46
FITTING SIZE: ≈ 3.1
WALL THICKNESS: —
DUCT STATIC PRESS: -.1

.019	ORIFICE
#	FILTER NO.
.000299	NOZZLE DIAM./AREA
6mm C	NOZZLE TYPE/NUMBE
	GAS COLLECTOR
1766788	METER NO.
29.78	BAROMETRIC PRESS.
M2	MAGNEHELIC
.84 type S	TRAVERSE PITOT TU
—	MONITORING PITOT
200	INITIAL IMP. VOL.
5	CONDENSATE
205	FINAL IMP. VOL.

PITOT TRAVERSE					PITOT MONITOR			SAMPLING								REMARKS
		Time: start									slo 4					
Point	In from wall	Δ H "H_2O	Duct Temp °F	Vel FPS	Δ h "H_2O	Duct Temp °F	Vel FPS	Time	Point	Meter Rate CFM	Meter Temp Inlet	Meter Temp Outlet	Vol. Ft^3	Orif. Sett.	Pump Vac.	Leak Check
1		.29	70	30.4				2:00		.54	71	71	402.64	.55	10"	
2		.09	70	16.4				2:03		.30	75	75	404	.26	3"	
3		.10	70	17.8				2:06		.32	75	79	405.7	.29	3"	
4		.18	70	24.1				9		.42	95	77	406.4	.52	3"	
1		.15	70	22.6				12		.38	77	78	407.5	.44	4"	
2		.09	70	13.6				15		.23	77	79	408.6	.15	3"	
3		.26	70	28.8				18		.51	75	79	409.2	.77	3"	
4		.28	71	29.9				21		.53	80	80	410.8	.83	4"	
1		.08	71	16.0				24		.29	79	80	412.4	.24	4"	
2		.15	71	21.9				27		.39	78	80	413.2	.45	3"	
3		.21	70	25.9				30		.46	78	80	414.3	.62	3"	
4		.30	70	30.8				33		.55	78	80	415	.89	5"	
1		.28	70	29.8				36		.54	79	80	417.2	.83	4"	
2		.20	70	25.7				39		.45	81	80	418.7	.60	3"	
3		.42	71	36.6				42		.46	81	80	420.1	1.25	5"	
4		.47	72	38.7				45		.69	81	81	422.1	1.40	6"	
1		.47	72	38.7				48		.69	81	80	423.9	1.40	6"	
2		.48	72	39.1				51		.71	87	82	426.5	1.44	6"	
3		.39	72	35.5				54		.64	87	82	428.2	1.17	6"	
4		.39	72	35.5				57		.64	86	82	430.0	1.17	6"	
								3:00					431.68			
													29.04	cubic feet		
																Leak Check

Gas Sampling Time: _____
Start: _____ Stop: _____

Team Members: Juan / Jim

DATE: 8/10/88
PLANT: Mare Island
SAMPLE TYPE: Cr+6
DUCT LOCATION: Outlet
DUCT DIAM: 35x46
FITTING SIZE: ~
WALL THICKNESS: ~
DUCT STATIC PRESS: -.09

TMA/NORCAL INC.

Air Pollution Analysis

Source Test Field Data Sheet

Test Number 3

.1019	ORIFICE
.	FILTER NO.
.000299	NOZZLE DIAM./AREA FT
6mm C	NOZZLE TYPE/NUMBER
—	GAS COLLECTOR
1766788	METER NO.
29.78	BAROMETRIC PRESS.
MD	MAGNEHELIC
.84 tapes	TRAVERSE PITOT TUBE
—	MONITORING PITOT TU
200ml	INITIAL IMP. VOL.
4	CONDENSATE
204	FINAL IMP. VOL.

PITOT TRAVERSE					PITOT MONITOR			SAMPLING								REMARKS
		Time: 6						4		4						
Point	In from wall	ΔH "H_2O	Duct Temp °F	Vel FPS	Δh "H_2O	Duct Temp °F	Vel FPS	Time	Point	Meter Rate CFM	Meter Temp Inlet	Meter Temp Outlet	Vol. Ft³ 432.78	Orif. Sett.	Pump Vac.	leak Check-OK
1		.28	71	28.2				3:40	beg	.50	78	80	432.78	.74	3"	
2		.11	71	16.7				3:43		.33	77	82	434.5	.53	2"	
3		.10	70	17.6				3:46		.320	77	83	435	.30	2"	
4		.29	71	30.4				3:49		.54	77	83	436.3	.86	2"	
1		.28	71	29.9				3:52		.54	79	83	437.7	.833	2"	
2		.06	71	13.8				3:55		.25	80	83	439.4	.18	1"	
3		.09	71	16.9				3:58		.30	78	82	439.7	.27	2"	
4		.17	71	23.2				4:01		.42	78	82	440.7	.50	2"	
1		.26	71	28.8				4:04		.52	78	82	441.9	.77	3"	
2		.17	71	23.3				4:07		.42	81	83	443.5	.51	3"	
3		.07	71	14.9				4:10		.27	81	83	445.10	.2	3"	
4		.29	71	30.4				4:13		.55	81	83	445.8	.86	3"	
1		.42	72	36.6				16		.66	81	84	447.2	1.25	3"	
2		.21	71	25.8				19		.47	86	87	449.3	.63	3"	
3		.28	70	29.8				22		.54	87	85	450.5	.84	3"	
4		.31	70	31.4				25		.57	86	84	452.2	.931	3"	
1		.42	70	36.6				28		.66	85	85	453.8	1.26	3"	
2		.39	70	35.2				31		.64	88	85	455.9	1.18	3"	
3		.45	70	37.8				34		.69	88	85	457.7	1.36	3"	
4		.50	70	39.9				37		.72	88	85	459.2	1.51	4"	
								40	Stop				461.59	ending value		
													28.84 cubic Sft			

Gas Sampling Time: _____
Start: _____ Stop: _____

Team Members: Juan, Jim

7mm E

TMA/NORCAL INC.

Air Pollution Analysis

Source Test Field Data Sheet

DATE: 8-10-88
PLANT: Mare Is.
SAMPLE TYPE: Cr
DUCT LOCATION: inlet
DUCT DIAM: square 35" x 29"
FITTING SIZE:
WALL THICKNESS:
DUCT STATIC PRESS: -3.6

Test Number 1

1st point is all way in port

upper port

24.00 | 24 | .61 | 1.44 | .80 | 1:40 | 3.5 min

	ORIFICE
(not 304	FILTER NO. 000436
7mm	NOZZLE DIAM./AREA FT
E	NOZZLE TYPE/NUMBER
	GAS COLLECTOR
	METER NO.
29.78	BAROMETRIC PRESS.
	MAGNEHELIC
3	TRAVERSE PITOT TUBE
3	MONITORING PITOT TUB
200	INITIAL IMP. VOL.
10 + 3	CONDENSATE
203	FINAL IMP. VOL.

PITOT TRAVERSE					PITOT MONITOR			11:08:54 SAMPLING								REMARKS
		Time:				66	1	✓		x2	x	x	x	3	x	
Point	In from wall	ΔH "H_2O	Duct Temp °F	Vel FPS	Δh "H_2O	Duct Temp °F	Vel FPS	Time	Point	Meter Rate CFM	Meter Temp Inlet	Meter Temp Outlet	meter Vol. Ft^3	Orif. Sett.	Pump Vac.	
1		.20			.35	66	33.63	~~5:33~~	1:10	83	63	63	248.80	2.09	9	
2		—			.35		~~34~~	~~6:66~~	3:20	~~84~~	75	64				
3		—			.35	73	33.76	~~9:99~~	5:00	84				2.69		
4		—			35		33.88	~~12:32~~	6:40		65	64		2.11		
5		—			.40		36.20	~~14:65~~	8:00	91	~~74~~			3.41		
6		.04		21:40	.35	70	33.76	~~16:44~~		85	87	64		2.12		
7		.01		23.10	.15	70	22.10	~~23:31~~		~~84~~	~~85~~ 10	65		0.92		
8		.01	down	24:20	.05		12.76			~~79~~	87	65		0.30		
9		.01	0	25 40	.01	63	5.66				63	65	263.85	0.01		
10		.01	0	2720	.1	64					83	65	264.24	0.06		
11		.05		2945	.3		9.8			24	76	65	264.75	0.18		
12		.15		3205	.2	63	8.0			20	75	65	265.28	0.12	9	
13		.25	65	3352	.05	62	12.66			32	75	65	265.71	0.30		
14		.35	*	3532	.05	61	12.66			32	73	65	266.24	0.20	8	
15		.40	62	3720	.01	62	5.66			14	74	65	266.68	0.06		
16		.38											266.83			
17		.35	67													
18		.25			11:38:54											

Gas Sampling Time:
Start: _____ Stop: _____

* 40° clock

Team Members: _____

TMA/NORCAL INC.

Air Pollution Analysis

Source Test Field Data Sheet

Test Number 1

DATE: 8-10-88
PLANT: Mare Is.
SAMPLE TYPE: Cr
DUCT LOCATION: inlet
DUCT DIAM: 85 x 29
FITTING SIZE:
WALL THICKNESS:
DUCT STATIC PRESS: -3.1
lower port

	ORIFICE
3	FILTER NO. 1000426
7mm	NOZZLE DIAM./AREA FT^2
E	NOZZLE TYPE/NUMBER
	GAS COLLECTOR
	METER NO.
27.78	BAROMETRIC PRESS.
	MAGNEHELIC
5	TRAVERSE PITOT TUBE
5	MONITORING PITOT TUBE
see previous	INITIAL IMP. VOL.
	CONDENSATE
	FINAL IMP. VOL.

PITOT TRAVERSE					PITOT MONITOR			SAMPLING 4								REMARKS
Point	In from wall	Time: ΔH "H_2O"	Time: Duct Temp °F	Time: Vel FPS	X Δh "H_2O"	6 Duct Temp °F	1 Vel FPS	Time	Point	2 Meter Rate CFM	Meter Temp Inlet	Meter Temp Outlet	Vol. Ft^3	3 Orif. Sett.	Pump Vac.	
1		.01			.30	65	31.11	0		.78	71	65	~~266.83~~	1.81	6	
2		—			.46	67	38.52	1:40		.96	77	66	269.13	2.77	6	
3		—			.50	67	40.24	3 20		1.01	80	66	269.64	3.04	7	
4		—			.40	68	35	5:00		.92	89	66	271.31	2.68	11	
5		.04			.40	64	36.36	6 40		.90	90	66	273.28	2.40	11	
6		.09			.32	67	32.19	8:20		.82	91	62	274.41	1.91	10	
7		.17			.20	67	25.45	10:00		.65	92	66	275.81	1.23	7	
8		.22			.12	64	19.65	11 40		.50	91	62	277.00	0.74	7	
9		.28			.20	64	25.38	13 20		.65	90	61	277.95	1.23	7	
10		.28			.25	65	28.40	14:00		.72	86	66	278.75	1.53		
11		.20			.20	64	25.40	15:40		.64	88	68	279.54	1.22	10	
12		.25			.18	63	24.10	17:20		.61	88	68	280.62	1.10		
13		.35			.12	64	19.65	19:00		.50	84	68	281.79	0.73	10	
14		.40			.08	62	16.02	20:40		.41	86	66	282.68	0.45	10	
15		.35			.03	61	9.80	22:20		.25	84	65	283.33	0.18		
16		.48		45° →	.03	61	9.20	24:00		.23	80	67	283.84	0.18		
17		.20		60°	0	61	-	25:40		-	79	68	284.38	-	10	
18		.37			.01	58	5.65	27:20			76	68	284.38	0.06		
								29:00					284.9			

Gas Sampling Time: _____
Start: _____ Stop: _____

Team Members: _____

TMA/NORCAL INC. 7 mm 'B'

Air Pollution Analysis

Source Test Field Data Sheet

DATE: 8-10-88
PLANT: Mare Is
SAMPLE TYPE: Cr
DUCT LOCATION:
DUCT DIAM: 85 x 29
FITTING SIZE:
WALL THICKNESS:
DUCT STATIC PRESS: -3.6 inlet

Test Number 2

21.89
.55
.91

	ORIFICE
4	FILTER NO. 10004
7 mm	NOZZLE DIAM./AREA F
7 mm 'B'	NOZZLE TYPE/NUMBER
	GAS COLLECTOR
	METER NO.
29.78	BAROMETRIC PRESS.
	MAGNEHELIC
5	TRAVERSE PITOT TUBE
5	MONITORING PITOT TU
200	INITIAL IMP. VOL.
+4 +9	SCONDENSATE
204	FINAL IMP. VOL.

start

PITOT TRAVERSE					PITOT MONITOR			2 pm SAMPLING								REMARKS
Point	In from wall	Time: ΔH "H_2O"	Duct Temp °F	Vel FPS	X Δh "H_2O"	R6 Duct Temp °F	1 Vel FPS	Time	Point	2 Meter Rate CFM	R4 Meter Temp Inlet	R4 Meter Temp Outlet	Gas meter Vol. Ft^3	3 Orif. Sett.	Pump Vac.	
1					.40	60	35.75	0	1	90	70	70	258.01	2.44	12	
2					35	70	33.76	3:20	2	84	75	70	290.61	2.11	12	
3					.18	67	24.19	6:40	3	61	90	70	293.57	1.10	14	
4					.05	64	12.69	10:00	4	32	90	72	295.85	0.31	14	
5					.05	65	12.70	13:20	5	32	90	73	297.16	0.30	15	
6	45°	clock		*	.03	63	9.82	16:40	6	25	85	72	298.13	0.18	12	
7	37°	clock		*	.01	62	5.66	20:00	7	14	80	75	299.26	0.06	15	
8	60°	clock			.03	62	9.81	23:20	8	25	80	75	299.65	0.18	14	
9				*	.07	63	9.82	26:40	9	25	79	75	300.16	0.18	14	
								30:00					301.18			
1					.50	63	40.09	0	1	1.02	79	75	301.18	3.08	13	
2					.47	68	39.05	3:20	2	0.99	85	75	304.11	2.88	13	
3					.40	68	36.03	6:40	3	0.93	98	76	307.68	2.48	11	
4					.30	67	31.17	10:00	4	0.81	100	78	310.82	1.87	9	
5					.25	67	28.45	13:20	5	0.73	99	78	313.51	1.56	8	
6					.12	65	19.67	16:40	6	0.51	96	78	316.18	0.75	9	
7	46°	clock		*	.08	62	16.02	20:00	7	0.41	93	78	317.82	0.50	11	
8	40°	clock			.06	62	13.87	23:20	8	0.36	88	78	319.17	0.37	10	
9	31°	clock			.04	62	11.32	26:40	9	0.29	83	78	321.14	0.25		
								30:00					322.11			
				cyclone adjusted			20.59									

lower / upper

Gas Sampling Time:
Start: Stop:

Team Members:

TMA/NORCAL INC. leak check

Air Pollution Analysis .02 ft³/1 min

DATE: 8-10-88
PLANT: Mare Is.
SAMPLE TYPE: Cr
DUCT LOCATION:
DUCT DIAM: 29 x 85
FITTING SIZE:
WALL THICKNESS:
DUCT STATIC PRESS: -2.6

Source Test Field Data Sheet

Test Number 3

	ORIFICE
	FILTER NO. .0004
7 mm	NOZZLE DIAM./AREA
B	NOZZLE TYPE/NUMBER
	GAS COLLECTOR
	METER NO.
29.78	BAROMETRIC PRESS.
	MAGNEHELIC
5	TRAVERSE PITOT TUB
5	MONITORING PITOT T
200	INITIAL IMP. VOL.
+6 +65	CONDENSATE
206	FINAL IMP. VOL.

PITOT TRAVERSE					PITOT MONITOR			3:40 pm SAMPLING								REMARKS
Point	In from wall	Time: ΔH "H_2O"	Duct Temp °F	Vel FPS	X Δh "H_2O"	K6 Duct Temp °F	1 Vel FPS	Time	Point	2 Meter Rate CFM	K4 Meter Temp Inlet	K4 Meter Temp Outlet	SAS meter Vol. Ft^3	3 Orif. Sett.	X Pump Vac.	
					.35	64	37.57	0	1	0.95	71	71	325.01	2.13	11	
					.37	70	34.71	3:20	2	0.87	77	71	327.71	2.27	11	
					.18	69	24.19	6:40	3	0.61	86	71	330.14	1.10	13	
					.04	65	11.72	10:00	4	0.29	90	70	332.66	0.24	15	
upper	*	75°	clock		.02	66	8.04	13:20	5	0.20	85	71	333.84	0.12	15	
	*	60°			.05	65	12.70	16:40	6	0.32	80	70	334.71	0.30	14	
	*	60°	clock		.03	63	9.82	20:00	7	0.25	76	70	335.97	0.18	14	
	*	60°			.03	63	9.82	23:20	8	0.25	77	70	336.63	0.18	14	
	*	60°			.01	63	5.67	26:40	9	0.14	70	75	337.57	0.06	15	
						63		30:00			70	75	338.17			
					.47	63	39.94	0	1	0.98	71	70	338.17	2.85	12	
					.47	62	39.05	3:20	2	0.98	80	70	341.12	2.86	12	
					.43	64	37.35	6:40	3	0.95	94	70	344.29	2.65	12	
					.25	68	32.70	10:00	4	0.86	98	70	347.59	2.16	13	
					.23	64	27.21	13:20	5	0.70	98	70	350.51	1.43	14	
lower	*	45°			.13	64	20.46	16:40	6	0.57	98	71	353.01	0.81	14	
	*	60°			.08	63	16.03	20:00	7	0.41	93	71	354.75	0.49	15	
	*	89°			.08	62	16.02	23:20	8	0.41	88	71	356.44	0.49	15	
					.05	62	12.66	26:40	9	0.32	84	71	357.83	0.30	15	
								30:00					358.84			
				cyclone adjusted slow			19.12		4:45	55						

Gas Sampling Time:
Start: Stop:

Team Members:

DATE: 17 Aug 88
PLANT: Mayer Island

SAMPLE TYPE: Cr^{+6}/Cr
DUCT LOCATION: OUTLET STACK 2 Oxidative

DUCT DIAM: 46"x 35"
FITTING SIZE: ~
WALL THICKNESS: ~
DUCT STATIC PRESS: ~.08

THERMO-ANALYTICAL NORCAL CO.
AIR POLLUTION ANALYSIS

Source Test Field Data Sheet

Test Number 1

Y2: .9951

	THIMBLE NO.
.500 S-1	NOZZLE DIAM Area
8mm Y	NOZZLE TYPE
Wet	GAS COLLECTOR
39421 F0	METER NO.
29.78	BAROMETRIC PRESS.
M3	DRAFT GAGE
	TRAVERSE PITOT TUBE
.64 Staps	MONITORING PITOT TUBE
Imp #9	CONDENSATE

PITOT TRAVERSE					PITOT MONITOR 6			SAMPLING 4								REMARKS
Point	In from Cent.	Time: Δh "H2O	Duct Temp °F	Vel FPS	Δh "H2O	Duct Temp °F	Vel FPS	Time	Point	Meter Rate CFM	Meter Temp °F	Meter Press "Hg	Vol Ft³	Orif. Sett.	Pump Vac.	Leak check OK
					.15	66	20.3	10:43	1	.71	88		29.845	1.8	10"	29.845 initial reading
					.12	67	14.1	10:46	2	.66	85/82		32.5	1.6	12"	
					.09	68	17.3	10:49	3	.57	85/82		35.0	1.2	15"	
					.09	68	17.3	10:52	4	.57	86/82		36.3	1.2	15"	
					.05	66	12.9	10:55	1	.43	86/82		38.8	.65	20"	
					.04	66	11.5	10:58	2	.38	86/86		39.9	.52	20"	
					.06	66	14.1	11:01	3	.47	86/86		41.0	.78	20"	
					.14	66	21.5	11:04	4	.72	84/84		42.3	1.6	16"	
					.15	66	22.3	11:07	1	.75	90/90		44.1	2.0	18"	
					.06	66	14.1	11:10	2	.47	92/92		46.9	.79	20"	
					.03	73	10.0	11:13	3	.33	92/92		45.3	.59	20"	
					.04	73	11.6	11:16	4	.39	92/92		49.3	.52	20"	
					.05	72	12.9	11:19	1	.43	91/92		51.4	.65	20"	
					.05	71	12.9	11:22	2	.43	90/92		51.9	.65	20"	
					.05	71	12.9	11:25	3	.43	90/92		53.2	.65	20"	
					.06	72	14.2	11:28	4	.47	90/93		54.1	.78	20"	
					.10	73	16.3	11:31	1	.61	92/90		56.2	1.2	17"	
					.11	71	19.2	11:34	2	.64	92/90		57.7	1.44	17"	
					.12	71	20.10	11:37	3	.67	94/92		59.3	1.6	17"	
					.17	72	23.8	11:40	4	.80	95/95		61.4	2.2		
								10:43					63.74			63.745 Final reading
																Leak check ok 30"

Gas sampling time: 1 hour
Start: -

Team members: _____

$Y_d = .995$

DATE: Mon 5/17/88
PLANT: Mare Island
SAMPLE TYPE: Cr^{6+} / Cr
DUCT LOCATION: Outlet

DUCT DIAM: 46x35"
FITTING SIZE: ~
WALL THICKNESS: ~
DUCT STATIC PRESS: -.09

THERMO-ANALYTICAL NORCAL CO.
AIR POLLUTION ANALYSIS

Source Test Field Data Sheet

Test Number
2

	THIMBLE NO.
5mm	NOZZLE DIAM
0.0541	NOZZLE ~~TYPE~~ area
	GAS COLLECTOR
5942146	METER NO.
29.78	BAROMETRIC PRESS.
1.13	DRAFT GAGE
	TRAVERSE PITOT TUBE
Standard .84	MONITORING PITOT TUBE
2 ml this	CONDENSATE

PITOT TRAVERSE					PITOT MONITOR			SAMPLING								REMARKS
Point	In from Cent.	Time: Δh "H2O	Duct Temp °F	Vel FPS	Δh "H2O	Duct Temp °F	Vel FPS	Time	Point	Meter Rate CFM	Meter Temp °F	Meter Press "Hg	Vol Ft³	Orif. Sett.	Pump Vac.	leak check OK 30" Vac
					.11	72	19.2	12:40	1	.64	93/90		~~89.685~~	1.43	15"	65.68 Volume
					.11	73	19.2	12:43	2	.64	92/95		65.0	1.43	15"	
					.12	73	20.0	46	3	.67	100/98		70.4	1.6	15"	
					.18	74	24.6	49	4	.83	102/98		72.5	2.4	20	
					.16	~~89~~	23.1	52	1	.79	99/103		74.5	2.1	10	
					.08	69	16.2	55	2	.58	103/100		77.0	1.37	15	
					.08	74	12.9	58	3	.439	102/100		79.01	.66	12"	
					.06	74	14.2	1:01	4	.48	101/101		80.24	.79	10"	
					.05	75	12.0	1:04	1	.44	101/99		82.3	.66	12"	
					.04	73	11.6	07	2	.39	101/99		83.5	.53	12"	
					.05	75	13.0	10	3	.44	102/100		84.2	.66	12"	
					.16	70	23.1	13	4	.79	102/100		85.9	2.1	10"	
					.14	69	21.6	16	1	.74	105/101		87.5	1.9	10"	
					.05	69	12.9	19	2	.42	106/101		91.2	.70	10"	
					.05	70	12.9	22	3	.44	106/101		93.6	.70	12"	
					.05	75	13.0	25	4	.44	105/101		93.7	.66	12"	
					.10	73	18.3	28	1	.62	104/101		97.1	1.32	12"	
					.10	73	18.3	1:31	2	.62	102/101		97.5	1.33	12"	
					.13	70	20.0	1:34	3	.68	102/101		98.0	1.66	12"	
					.15	70	22.5	1:37	4	.76			101.0	2.0		
													103.38			103.38

Gas sampling time: 1-hr.

Team members: _____

68.3 1.7

DATE: 8/17/88
PLANT: Mare Island
SAMPLE TYPE: Cr6t
DUCT LOCATION: outlet

DUCT DIAM: 46 & 35
FITTING SIZE: —
WALL THICKNESS: —
DUCT STATIC PRESS: -.09

THERMO-ANALYTICAL NORCAL CO.
AIR POLLUTION ANALYSIS

Source Test Field Data Sheet

Test Number
3

	THIMBLE NO.
[illegible]	NOZZLE DIAM
Emm Y	NOZZLE TYPE
	GAS COLLECTOR
4042146	METER NO.
29.78	BAROMETRIC PRESS.
M3	DRAFT GAGE
	TRAVERSE PITOT TUBE
.84 Standard	MONITORING PITOT TUBE
7 M-R +9	CONDENSATE

PITOT TRAVERSE					PITOT MONITOR			SAMPLING								REMARKS
Point	In from Cent.	Time: Δh "H2O	Duct Temp °F	Vel FPS	Δh "H2O	Duct Temp °F	Vel FPS	Time	Point	Meter Rate CFM	Meter Temp °F	Meter Press "Hg	Vol Ft³	Orif. Sett.	Pump Vac.	leak check 30"-
					.07	71	15.3	2:25	1	.51	95/90		104.72	.92	22"	
					.04	71	17.5	28	2	.58	97/94		106.6	1.18	25"	
					.08	71	16.3	31	3	.55	96/99		107.9	1.1	25"	
					.11	72	19.2	34	4	.65	101/97		110.2	1.45	25"	
					.16	75	19.2	37	1	.65	101/97		111.6	1.45	25"	
					.09	74	11.6	40	2	.39	100/97		114.0	.53	25"	
					.03	73	10.0	43	3	.34	100/97		115.2	.39	25"	
					.04	74	11.6	46	4	.39	99/96		116.5	.53	25"	
					.03	74	10.0	49	1	.34	100/96		117.8	.39	25"	
					.07	77	5.21	52	2	.27	100/96		118.9	.26	25"	
					.05	76	13.0	55	3	.44	100/96		119.7	.65	25"	
					.15	77	22.5	58	4	.75	100/96		120.6	1.65	20"	
					.16	75	23.2	301	1	.78	100/96		123.0	2.10	20"	
					.06	75	14.2	3:04	2	.48	100/96		125.5	.79	25"	
					.05	75	13.0	3:07	3	.44	100/96		127.1	.65	25"	
					.04	76	11.6	3:10	4	.39	99/96		128.5	.52	25"	
					.08	76	16.4	13	1	.55	99/96		129.7	1.05	25"	
					.06	76	16.4	16	2	.55	99/95		131.3	1.05	25"	
					.10	76	18.3	19	3	.61	99/95		133.5	1.3	20"	
					.16	75	23.2	22	4	.78	100/95		135.1	2.1	20	
								2					137.49			

Gas sampling time:
Start:

Team members: _____

start leak ✓ and -lof 12.64 12.6 0.8
end .020 @ 22" 0.14 0.56 0.97
0.06 0.94 2.83

DATE: 8-17-88
PLANT: Mare Is
SAMPLE TYPE: Cr
DUCT LOCATION: Inlet

THERMO-ANALYTICAL NORCAL CO.
AIR POLLUTION ANALYSIS .000750

Source Test Field Data Sheet

sampling DUCT DIAM: 83"; port 9"
FITTING SIZE:
WALL THICKNESS:
X DUCT STATIC PRESS: ∓-3.2, -3.2

Test Number 1

	THIMBLE NO.
9 mm	NOZZLE DIAM
F	NOZZLE TYPE
	GAS COLLECTOR
1008554	METER NO.
17.78	BAROMETRIC PRESS.
	DRAFT GAGE
S	TRAVERSE PITOT TUBE
S	MONITORING PITOT TUBE
10	CONDENSATE

	PITOT TRAVERSE				PITOT MONITOR			1043 SAMPLING								REMARKS
Point	Time In from Cent.	Time: 731 Δh "H2O	Duct Temp °F	Time Vel FPS	X Δh "H2O	Duct Temp °F	(1) Vel FPS	Time	Point	(2) Meter Rate CFH	X Meter Temp °F	Meter Press "Hg	X Vol Ft³	(3) Orif. Sett.	X Pump Vac.	
1	0	.08	60		.05	60		0	1		66		361.71		18	
2	320	.12	59		.10	60	11.57		2	0.80	70		365.41	1.90	15	
3	640	.10	60		.10	60	17.87		3	6.80	70					
4	1000	.04	60		.08	60	15.99		4	0.71	72		371.21	1.52	18	
5	1320	.03	60		.04	60	11.30		5	0.50	72		373.42	0.71	19	
6	1640	.08	59		.07	60	14.93		6	0.67	72		375.21	1.33	18	
7	2000	.07	59		.06	61	13.86		7	0.62	72		377.31	1.14	20	
8	2320	.01	59		.02	62	8.00		8	0.36	73		379.48	0.38	21	
9	2640	.005	60		.005	63	4.00		9	0.17	73		380.89	0.09	23	
	30:00												381.50			
1	0	.05	60		.06	63	13.88		1	0.62	71		381.50	1.13	20	
2	320	.07	59		.07	62	14.78		2	0.67	72		383.12	1.33	20	
3	640	.06	59		.05	62	12.66		3	0.56	71		385.65	0.94	20	
4	1000	.04	59		.04	62	11.32		4	0.50	74		387.03	0.76	20	
5	1320	.02	60		.03	62	9.71		5	0.44	74		387.53	0.57	20	
6	1640	.06	59		.07	62	14.92		6	0.67	74		391.06	1.33	20	
7	2000	.02	60		.01	64	5.67		7	0.25	74		392.94	0.19	20	
8	2320	.005	60		.005	65	4.01		8	0.17	74		394.19	0.09	20	
9	2640	.005	60		.005	65	4.01		9	0.17	73		394.73	0.09	20	
	30:00											X	395.24			
													33.53			

Gas sampling time:

Team members:

start leak v .006 ~ 15
end " " .008 @ 10

DATE: 8-17-88
PLANT: Mare Is.

SAMPLE TYPE: Cr
DUCT LOCATION: Inlet

DUCT DIAM: 83" i port 9"
FITTING SIZE:
WALL THICKNESS:
DUCT STATIC PRESS: -3.2, -3.2

THERMO-ANALYTICAL NORCAL CO.
AIR POLLUTION ANALYSIS

Source Test Field Data Sheet

Test Number 2

All previous test

THIMBLE NO.
NOZZLE DIAM
NOZZLE TYPE
GAS COLLECTOR
METER NO.
BAROMETRIC PRESS.
DRAFT GAGE
TRAVERSE PITOT TUBE
MONITORING PITOT TUBE
CONDENSATE
1.5

PITOT TRAVERSE					PITOT MONITOR			1240 SAMPLING								REMARKS
Point	In from Cent.	Time: Δh "H2O	Duct Temp °F	Vel FPS	Δh "H2O	Duct Temp °F	(1) Vel FPS	Time	Point	(2) Meter Rate CFM	Meter Temp °F	Meter Press "Hg	Vol Ft³	(3) Orif. Sett.	Pump Vac.	
					.10	68	15.01	0	1	0.80	76		397.25	1.89	10	
					.14	65	21.31	320	2	0.95	78		399.42	2.66	10	
					.13	68	20.34	640	3	0.92	79		402.44	2.47	10	
					.3	69	20.35	1000	4	0.72	81		405.31	2.47	10	
					.08	69	16.12	1320	5	0.72	82		408.14	1.52	10	
					.03	70	12.76	1640	6	0.57	80		411.19	0.95	3	
					.06	70	16.14	2000	7	0.72	80		413.89	1.52	8	
					.01	71	5.71	2320	8	0.35	81		415.72	0.19	7	
					.005	72	4.04	2640	9	0.18	82		416.75	0.09	7	
						73		3000					417.30			
					.05	71	12.74	0	1	0.57	81		417.30	0.95	5	
					.07	71	15.11	320	2	0.67	81		419.14	1.33	6	
					.05	72	12.78	640	3	0.57	81		421.34	0.94	5	
					.03	76	9.94	1000	4	0.44	81		423.32	0.56	4	
					.02	83	8.17	1320	5	0.35	81		424.08	0.37	3	
					.07	89	15.36	1640	6	0.66	81		426.17	1.23	5	
					.02	98	8.28	2000	7	0.35	81		428.12	0.56	6	
					.005	100	4.14	2320	8	0.17	81		429.82	0.07	7	
					.005	100	4.14	2640	9	0.17	81		430.20	0.07	7	
								3000					430.63			

Gas sampling time:
Start:

Team members: _____

start out @ 15.
end dust stop @ 10"

see previous test

DATE: 8-17-88
PLANT: Mare Is

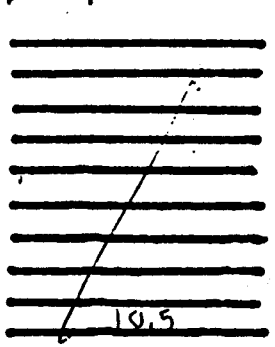
SAMPLE TYPE: Cr
DUCT LOCATION: Inlet

DUCT DIAM: 83", port 5"
FITTING SIZE:
WALL THICKNESS:
DUCT STATIC PRESS: -3.2, -3.2

THERMO-ANALYTICAL NORCAL CO.
AIR POLLUTION ANALYSIS

Source Test Field Data Sheet

Test Number 3



PITOT TRAVERSE					PITOT MONITOR			225 SAMPLING								REMARKS
Point	In from Cent.	Time: Δh "H2O	Duct Temp °F	Vel FPS	X Δh "H2O	X Duct Temp °F	(1) Vel FPS	Time	Point	(2) Meter Rate CFM	X Meter Temp °F	Meter Press "Hg	X Vol Ft³	(3) Orif. Sett.	X Pump Vac.	
					.09	77	17.60	0	1	0.74	82		435 38	1 62	10	
					.12	77	20.32	320	2	0.56	82		436 30	2·16	10	
					.19	79	25.08	640	3	1.11	84		437 77	3 57	18	
					.06	80	14.11	1000	4	0.62	87		441 71	1 13	5	
					.04	80	11 52	1320	5	0.51	87		444.08	0 75	5	
					.01	80	15.24	1640	6	0.67	87		445 94	1.32	6	
					.06	81	14.12	2000	7	0.62	87		448.00	1 13	7	
					.02	82	8.10	2320	8	0.36	88		450. 1~	0 57	5	
					.005	84	4.07	2640	9	0 18	90		451.45	0.04	7	
								3000					451 92			
					.05	82	12.10	0	1	0 57	90		451.94	0.94	5	
					.07	82	15 27	320	2	0.68	90		453.63	1.32	7	
					.04	81	11 53	640	3	0.51	90		455.54	0.75	7	
					.03	81	9.98	1000	4	0 44	90		457 20	0.56	7	
					.02	81	8 15	1320	5	0.32	90		458 21	0 37	8	
					.04	81	11.53	1640	6	0.51	90		460.50	0 75	8	
					.03	82	9.14	2000	7	0 44	90		462 14	0.56	8	
					.01	83	5.77	2320	8	0.25	90		463 74	0 18	9	
					.003	84	1.02	2640	9	0 .9	92		464.78	0.09	9	
								3000					465 14			

Gas sampling time:

Team members: _____

APPENDIX III

FIELD DATA RECORDED BY NORMAN GRIB

Bath #4

#4 (2,000 Amps

Time	Bath	Temp	Volt	Amps
	JUICE (5E 4" Tall) corner of room			
Run 1				
11:11		118°F	7.5	2,000
11:20		118	7.5	2,000
11:30		120	7.5	2,000
11:40		121°F	7.5	2,000
11:50		121°F	7.5	2,000
12:00		123	7.5	2000 SJS
12:10		124	7.5	2000 SJS
12:35		125	7.5	2000
[redacted] 1:35		129	7.5	2000
Run 2 2:00		131	7.5	2,000
2:10		131	7.5	2,000
2:20		132	7.5	2,000
2:30		132	7.5	2,000
2:40		133	7.5	2,000
2:50		134	7.5	2,000
3:00		134	7.5	2,000

Bath #4 (SE corner Jar Rom)

Run 3

Time	Temp	Volt	Amp
3:40pm	136	7.5	2,000
3:50	137	7.5	2,000
4:00	137	7.5	2,000
4:10	137	7.5	2,000
4:20	139	7.5	2,000
4:30	139	7.5	2,000
4:40	139	7.5	2,000

Surface Area (both sides)

Bath #5

Bath + JFC = #5 = 2688 in²

Bath + JQR = #4 = 2304 in²

~~#5 (2,200 in²)~~

Time	Bath 24w #5 JFC (NE corner of room)	Temp	Volt	Amp	
Run 1					
11:00		132°F	9.0	2400	
11:20		134°F	9.0	2400	
11:30		136°F	9.0	2400	
11:40		137	9.0	2400	
11:50		138	9.0	2400	
12:00		139	9.0	2400	
12:10		140	9.0	2400	
Run 2					
12:35		142	8.5	2400	
1:35		144	8.5	2400	
Run 2					
2:00		145	8.5	2400	
2:10		146	8.5	2400	
2:20		146	8.5	2400	
2:30		146	8.5	2400	
2:40		146	8.5	2400	
2:50		147	8.5	2400	
3:00		147	8.5	2400	

"JFC"

Bath #5 (N.E corner of room)

Run 3

Time	Temp	Volt	Amps
3:40	148 °F	8.5	2400
3:50	148	8.5	2400
4:00	148	8.5	2400
4:10	148	8.5	2400
4:20	148	8.5	2400
4:30	148	8.5	2400
4:40	148	8.5	2400

8/17/88

Test

Area of Parts

Decorative Chrome Bath

$14'' \times 39.5'' \times 2 \text{ sides} \div 144 \frac{in^2}{ft^2}$

$= 7.68 \text{ ft}^2$

Anodizer Bath

2 pieces

① 116 in^2

② 62 in^2

$\Sigma = 178 \text{ in}^2 \div 144$

$= 1.24 \text{ ft}^2$