



South Coast Air Quality Management District

21865 Copley Drive, Diamond Bar, CA 91765-4178
(909) 396-2000 • www.aqmd.gov

SOURCE TEST REPORT

16-334

CONDUCTED AT

Aerocraft Heat Treating Co., Inc.
15701 Minnesota Ave.
Paramount, CA 90723

HEXAVALENT CHROMIUM EMISSIONS FROM VARIOUS LOCATIONS

TESTED: November 17, 2016

ISSUED: December 9, 2016

REPORTED BY: William Welch
Air Quality Engineer II

REVIEWED BY:

A handwritten signature in black ink, appearing to read "Michael Garibay". The signature is written over a horizontal line.

Michael Garibay
Supervising Air Quality Engineer

SOURCE TEST ENGINEERING BRANCH

SCIENCE & TECHNOLOGY ADVANCEMENT DIVISION

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Test No. 16-334

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Date: 11/17/16

SUMMARY

- a. Firm Aerocraft Heat Treating Co., Inc.
- b. Test Location 15701 Minnesota Ave.,
Paramount, CA 90723
- c. Unit Tested Various Metal Treatment Processes
- d. Test Requested by Matt Miyasato (DEO), (909) 396-3249,
Science & Technology Advancement
- e. Reason for Test Request..... High ambient air monitor readings of Cr⁺⁶
- f. Date of Test November 17, 2016
- g. Source Test Performed by..... Mike Garibay, Wayne Stredwick
Eric Padilla, Bill Welch
- h. Test Arrangements Made
Through..... Carlos Ruiz
Aerocraft Heat Treating (562) 412-2434
- i. Company I.D. No..... 23752
- j. Permit No..... Various

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RESULTS

Table 1. Summary of Test Conditions

Operating Conditions:

| | |
|-------------------------------|-------------------------------------------------------------------|
| Building #2 Water Quench Tank | Water recirculating through cooling tower; no quenching events |
| Heat Treat Furnace #3 | With Inconel pieces at 2100 °F |
| Building #2 Oil Quench Tank | Oil recirculating through heat exchanger; one quenching event |

Table 2. Summary of Hexavalent Chromium Emission Concentrations

| Emissions Source | Cr⁺⁶ Concentration (ng/m³)* |
|----------------------------------------------------------|------------------------------------------------------------------|
| Fugitive Emissions from Bldg. #2 Water Quench Tank | 638 |
| Fugitive Emissions from Heat Treat Furnace #3 | 376 |
| Fugitive Emissions from Bldg. #2 Oil Quench Tank | 130 |
| Three Run Average | 381 |

* The concentrations are reported in the same units as the recent ambient air monitoring which was 15 ng/m³ - average 11/5/16 through 11/17/16 from Monitor 4219585 located immediately west of the facility heat treating and quenching area.

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Table 3. Process Materials Containing Hexavalent Chromium

| Process Material | Cr⁺⁶ Concentration (ppm) |
|-------------------------------------------------------------------|----------------------------------------------------|
| Solution Sample from Bldg. #2 Water Quench Tank | 46 |
| Solution Sample from Bldg. #2 Oil Quench Bath Cooling Tower | 0.005 |
| Metal Dust from Intermediate Product Storage | 190 |
| Scale Scraping from Treated Titanium Part | 0.018 |

EXECUTIVE SUMMARY

Source testing was conducted at Aircraft Heat Treating Company, Inc. in Paramount, CA to identify the specific causes of elevated ambient hexavalent chromium levels measured recently near the facility. The emissions above processes within the facility were measured for hexavalent chromium concentration. The processes were classified into three types: water quench baths, oil quench baths, and furnaces. The emissions testing included one of each of the three classifications of processes that were closest in proximity to the ambient monitor with elevated readings. The results were obtained for purposes of identifying potential sources of the elevated ambient readings and to rank them for their relative potential impacts. Liquid samples were also taken from both the water and quench baths, as well solid samples from the loose oxidized surface material from the heat treated products and product racks.

The average ambient concentration of hexavalent chromium adjacent to the facility was 15 ng/m^3 for the period preceding and including the test date. The average measured source concentrations from the processes at the facility was 381 ng/m^3 . These elevated source concentrations, at 25 times the ambient just outside the facility, are considered as positive identification that the facility is contributing to the nearby elevated ambient concentrations. Of the three types of processes tested, the water quench area was most positively identified as a contributor with a measured emissions concentration of 638 ng/m^3 . Of the solid and liquid samples taken, the accumulated dust from the intermediate product storage area was most positively identified with a 190 ppm hexavalent chromium content. The other two process types, the furnace and the oil quench, were also positively identified with elevated hexavalent chromium emissions over ambient at 376 ng/m^3 and 130 ng/m^3 respectively.

Two primary sources of the hexavalent chromium emissions were identified. The first source is from droplets of water from the water quench bath becoming airborne in the water quench cooling towers and the return discharge into the tank. The second source is the dust from oxidized part surfaces, prevalent in the quenching area, becoming airborne when disturbed by forced air cooling and other activities. Either of these primary sources is thought to be produced by heat treating chromium containing products such as stainless steel parts and parts racks, and partial conversion of the solid chromium on the surface of the products under high temperatures encountered during heat treating. It is also thought that the oil quench and furnace samples may have been influenced by emissions from the two primary sources mentioned, but could still be contributors to the emissions.

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INTRODUCTION

On November 17, 2016, Engineers from the South Coast Air Quality Management District (SCAQMD) Source Test Engineering (STE) branch conducted source testing at Aircraft Heat Treating Co., Inc. in Paramount, CA. The purpose of the testing was to identify the specific causes of elevated ambient hexavalent chromium levels measured very near to the Aircraft facility. The heat treating subjects chromium containing materials to elevated temperatures, which has the potential to convert small but significant portions of the chromium to the hexavalent state. Other processes were identified that may cause the converted chromium to become airborne. These included heat treating furnaces, oil quench baths, water quench baths, cooling towers for the quench baths, and a forced air cooling process.

For testing, the several potential sources of hexavalent chromium in the heat treating process were classified into four types that have the potential to create emissions:

1. Dust from the surfaces of the heat treated products containing chromium which were prevalent in the facility becoming airborne from forced air cooling, wind, or any activities that disturb the dust.
2. Water quench bath disturbances including, the direct contact quench water cooling tower, and agitation from the cooling tower return discharge to the cooling bath.
3. Oil quenching, which was observed to create visible combustion of the oil and smoke.
4. Heat treating furnaces.

Three (3) locations were identified for single run emissions information testing to address Categories 2 - 4 as stated above. The three source testing samples were single tests for purposes of identifying potential causes for the elevated emissions and to rank them for their relative potential impacts. The locations chosen were the exhaust vent of heat treat Furnace #3, fugitive emissions above the water quench tank and below the cooling tower in Building 2, and the fugitive emissions above oil quench tank in Building 2. These locations were chosen in part due to their proximity to SCAQMD ambient monitoring stations that were indicating elevated levels of hexavalent chromium.

Additional samples were taken from the oil quench bath solutions, the water quench bath solutions, metal scrapings from a titanium heat treated part, and metal dust from an intermediate part storage area. The dust from the intermediate part storage area was of particular importance since there was a large amount of this dust accumulated in this area, and it was also representative of dust that was observed at several locations in the heat treating processing and quenching areas.

The facility had grinding and a plasma cutter located across the street from the heat treating buildings, but these processes were not tested since they were not nearest to the ambient monitor

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with elevated readings, and the facility claimed that they had not used the plasma cutter since June 2016.

Sources whose emissions are measured as greater than that of the downwind monitor are considered to be potential contributors to the hexavalent chromium measured by the monitor, with those exhibiting the greater concentrations more positively identified as contributors.

The Discussion/Test Critique section of this report includes conclusions that can be drawn from the results.

EQUIPMENT AND PROCESS DESCRIPTION

Aerocraft Heat Treating operates 18 custom built, batch type, gas fired, air atmosphere furnaces with temperature ranges from 450 °F to 2250 °F, and working zones as large as 18 ft. x 20 ft. x 7 ft. The company provides commercial heat treating for steel, titanium, and other high temperature materials. The treated parts are placed on racks constructed of high chromium stainless steel which are used to convey the parts into and out of the furnaces and are placed into the furnaces along with the parts while they are heat treated and also during the subsequent quenching. Treated parts can be water or oil quenched, and fan or air-cooled. The facility operates three (3) water quench tanks, two (2) oil quench tanks, and one (1) forced air cooling station. The quench water is cooled in direct contact cooling towers, while the quench oil is cooled by heat exchangers with indirect cooling from fresh water cooling towers. The overall heat treating process is shown in Figure 1.

The chromium in the parts that are stainless steel, and the parts racks constructed from stainless steel have the potential to convert a small but significant portion of the chromium to the hexavalent state, when subjected to elevated temperatures. The surface of the parts and racks after heat treating take on a scaly, rust like appearance indicative of oxidation and chemical change that takes place on the surface of the metal. Hexavalent chromium present in the oxidized chromium can then be dissolved in the water for water quenched parts due to the high solubility in water. Additionally the oxidized metal physically flakes off the parts and racks as they are air cooled and moved about the facility.

Most often when the winds are from the prevailing southwest direction, the emissions from the three heat treating buildings are likely to be funneled through the space between the buildings and directed towards the SCAQMD Monitor 4219585 located on a sidewalk utility pole on Minnesota Avenue. This is one of the two monitors in the area recently with the highest hexavalent chromium readings. The layout of the buildings and placement of the monitor along with the sampling locations are shown in Figure 2.

In addition to heat treating the facility also conducts grinding on the heat treated products and also operates a plasma cutter. Both the grinding and plasma cutting are located in separate buildings across Minnesota Street from the heat treating.

SAMPLING AND ANALYTICAL PROCEDURES

Three locations were identified for one run at each location for emissions information testing. The three source testing samples were obtained for purposes of identifying potential causes for the elevated emissions and to rank them for their relative potential impacts. Three sources of emissions were selected as those determined to present the greatest potential for causing elevated ambient hexavalent chromium near the facilities. The samples were taken from the air above but very near to the sources as to represent emissions that are transported by air currents that are diluted and move towards the direction of the ambient monitors. Ambient air concentrations were used to determine the average molecular weight of the exhaust gas. For the water quench bath and the oil quench bath, the samples were acquired from a single point located approximately 1 ft. above the surface of the solutions. The sampling locations for the quench baths are shown in Figures 3 and 4. For the furnace exhaust, the sample was drawn from a point approximately six inches from the discharge of a furnace exhaust vent to represent the emissions from the furnace as they are being discharged are directed into that air currents that move towards the ambient monitor.

Solution samples were acquired from the water quench tank and oil quench tank within Building #2. An additional sample of metal dust from the intermediate storage area and the was also taken. These samples were analyzed for hexavalent chromium content. A photograph of the metal dust that was sampled in the intermediate storage area is shown in Figure 4.

Hexavalent Chromium Emission Sampling

Testing was conducted based on California Air Resources Board Method 425 applied to the non-stack open air above the quench baths and furnace, with the procedures of the method specific to stack sampling omitted. Three samples were taken at single non-isokinetic sample points for informational purposes. Each sampling train consisted of a sampling line, which was used to draw the stack sample from the source. The sample was then drawn through two impingers each filled with an aqueous solution of 0.1N NaHCO₃ (per section 21.2), an empty impinger, a 2" filter, and an impinger bubbler filled with tared silica gel. Each sampling train was connected to a leak free vacuum pump, a dry gas meter, and a calibrated orifice. The impingers were contained in an ice bath to condense water vapor and other condensable matter present in the sample stream (see Figure 5).

The samples were extracted using the sampling trains. The pH of the solution in the first impinger was measured after the test, but prior to recovery, at pH 9. The impinger solutions were recovered within 24 hours and the SCAQMD laboratory analyzed the hexavalent chromium in the samples by CARB SOP MLD039. Hexavalent chromium deposited in the filter, sample line and impingers were extracted and analyzed by an Ion Chromatograph equipped with a post-

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column reactor (IC/PCR) and a visible wavelength detector. Moisture content was determined gravimetrically and volumetrically.

Hexavalent Chromium Content of Process Materials

The metal dust sample was extracted in a sodium bicarbonate solution. Aliquots from this solution and the solution samples from the oil and water quench tanks were taken. Samples were analyzed according to SCAQMD Method #0046, *Standard Operating Procedure for the Analysis of Hexavalent Chromium in Ambient Air by Ion Chromatography*.

DISCUSSION/TEST CRITIQUE

For purposes of interpreting the test results, the typical ambient Los Angeles Basin average for hexavalent chromium measured during the most recent SCAQMD Multiple Air Toxics Exposure Study (MATES) IV study is less than 0.1 ng/m^3 . While all of the results are substantially higher than the background, it should be noted that it takes a significant volume of air at source concentrations substantially higher than the background to be able to affect the ambient air levels and is a function of distance away from the facility due to air dilution. The intent of this test was to identify sources that are at least several times higher than the background levels to identify the major contributors and to provide a focus for potential remediation. The average ambient concentration adjacent to the facility was 15 ng/m^3 for the period including and preceding the test date, as compared to the measured source concentrations from the facility which was 381 ng/m^3 as the average of the three tanks tested. These elevated source concentrations at 25 times the ambient, are considered as positive identification that the facility is contributing to the nearby elevated ambient concentrations. Additionally, it is possible that multiple sources in the facility of all three types tested, are all contributing to the nearby elevated ambient concentrations.

The CARB Method 425 sampling method isokinetic requirements could not be met due to the samples being taken in the open space above the tanks/furnace vent and not in a stack of their control devices since there were no control devices present. This resulted in an over isokinetic condition of over 110% as allowed in the method. General isokinetic theory dictates that an over-isokinetic condition results in dilution of the emissions particles and a resulting low bias in the measured emissions. Although a low bias may have occurred, the results are considered to be suitable for purposes of their intended use, since the emissions are certain to be present at concentrations at or above that which was measured during the testing.

Of the three types of sources tested for emissions, the water quench area was most positively identified as a contributor with a measured emissions concentration of 638 ng/m^3 . From the solid and liquid samples taken, the accumulated dust from the intermediate product storage area was most positively identified with a 190 ppm hexavalent chromium content. For purposes of discussion, it would take only 0.13 mg of the dust that was sampled to be able to cause a 15 ng/m^3 reading from the ambient monitor which typically samples 1.7 m^3 in 24 hours. Since these ambient samplers typically collect a few milligrams of total suspended particulate matter over a 24 hour period, they could easily be collecting 0.13 mg of dust from the facility. SCAQMD inspectors, Victor Yip and Jeff Lloyd observed that a substantial quantity of this metal dust could be observed suspended in the air during the forced air quenching events that occurred on the test date. Other means of causing this dust to become airborne include wind, forklift traffic, or even sweeping the dust.

Based on the highest ambient air and process source samples, it is thought that the highest contributors to elevated ambient readings near the facility are from the facility dust and water quench tanks/cooling towers. As according to representatives from the facility in a December 1,

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2016 meeting with SCAQMD, Aerocraft is in the process of removing the facility dust and replacing the water quench tank solutions in order to reduce emissions of hexavalent chromium.

The emissions were also high from the heat treat Furnace #3 at 376 mg/m^3 , but the elevated concentration could have resulted from the water quench bath whose cooling tower fan discharges towards the furnace. The sample from the oil quench at 130 ng/m^3 bath yielded a significant Cr^{+6} concentration, but it may actually be reflective of ambient dust in the immediate area. Aerocraft has indicated it will conduct further testing to investigate the emissions from the furnaces and oil quench baths after the dust and water remediation steps have been taken.

The facility uses a small sweeper/vacuum vehicle for mitigating dust from the various processes. It was observed at the facility that after sweeping, a high pressure air hose was used to clean the inner cowling and mechanical parts of the vehicle. This resulted in the generation of a large cloud of dust that vented near the oil quench tank. Based on the laboratory analysis of the metal dust from the intermediate storage area ("XYZ Rack"), it is reasonable to assume that the dust from the sweeper may also contain significant amounts of Cr^{+6} .

The reader of this report may be aware that similar testing was conducted at the nearby Anaplex Corporation the day before this test was conducted. The Anaplex results are reported under a separate cover, SCAQMD Source Test #16-333. When interpreting the significance of the results, the differences in concentrations between the facilities (Aerocraft being much lower than of Anaplex) is misleading and requires further clarification. The sources at Anaplex are relatively small plating and chemical tanks emitting at high concentrations, whereas Aerocraft is a larger facility with larger quench baths and a large dust laden metals processing area that emits at lower concentrations but over a wider emissions surface area. For example, the dichromate seal tank tested at Anaplex was a 658 gallon tank as compared to the Aerocraft quench baths at 37,000 gallons. For this reason, the differences between the two facilities in concentrations measured at the sources, does not reflect the relative differences in total emissions from the two facilities. The total emissions from the two facilities is likely to be more similar than is indicated by the dissimilar concentrations measured at the sources within the facilities. The similarities in total facility emissions is more properly reflected in the similarities in the ambient monitoring readings taken next to both facilities.

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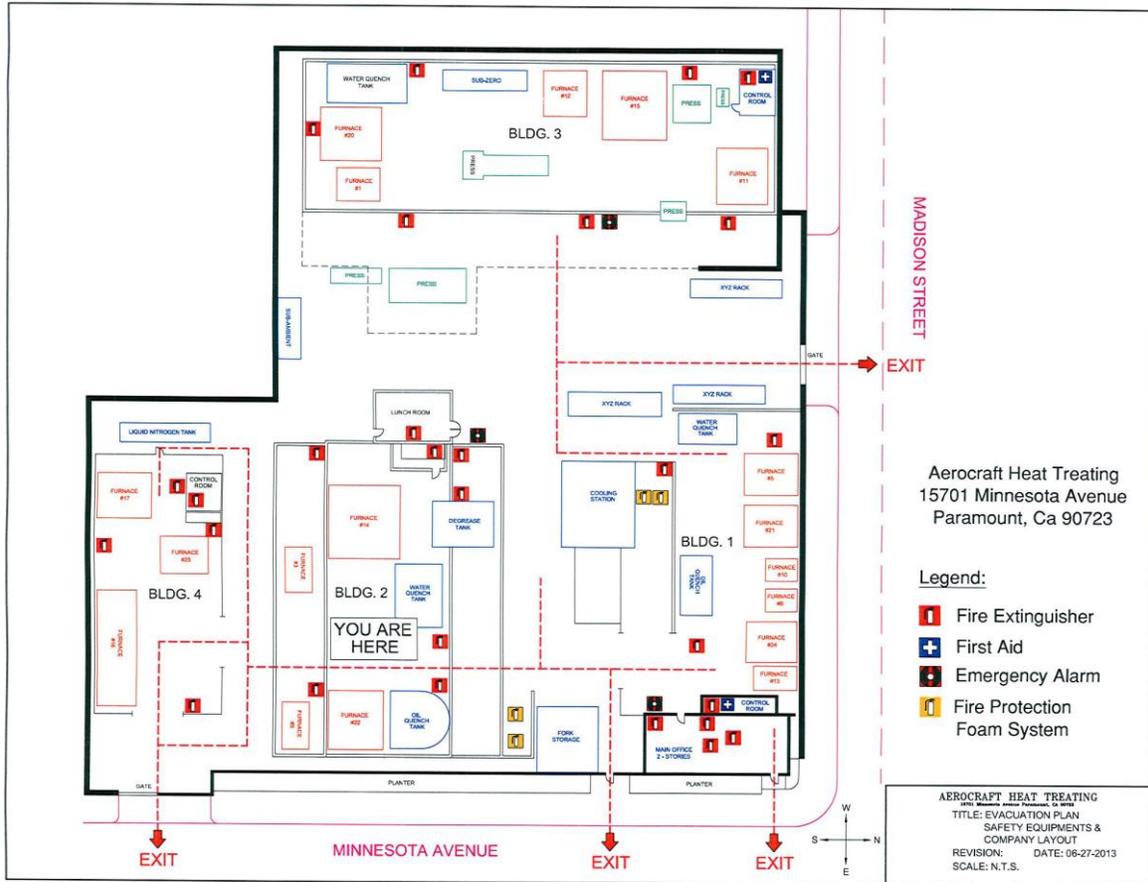


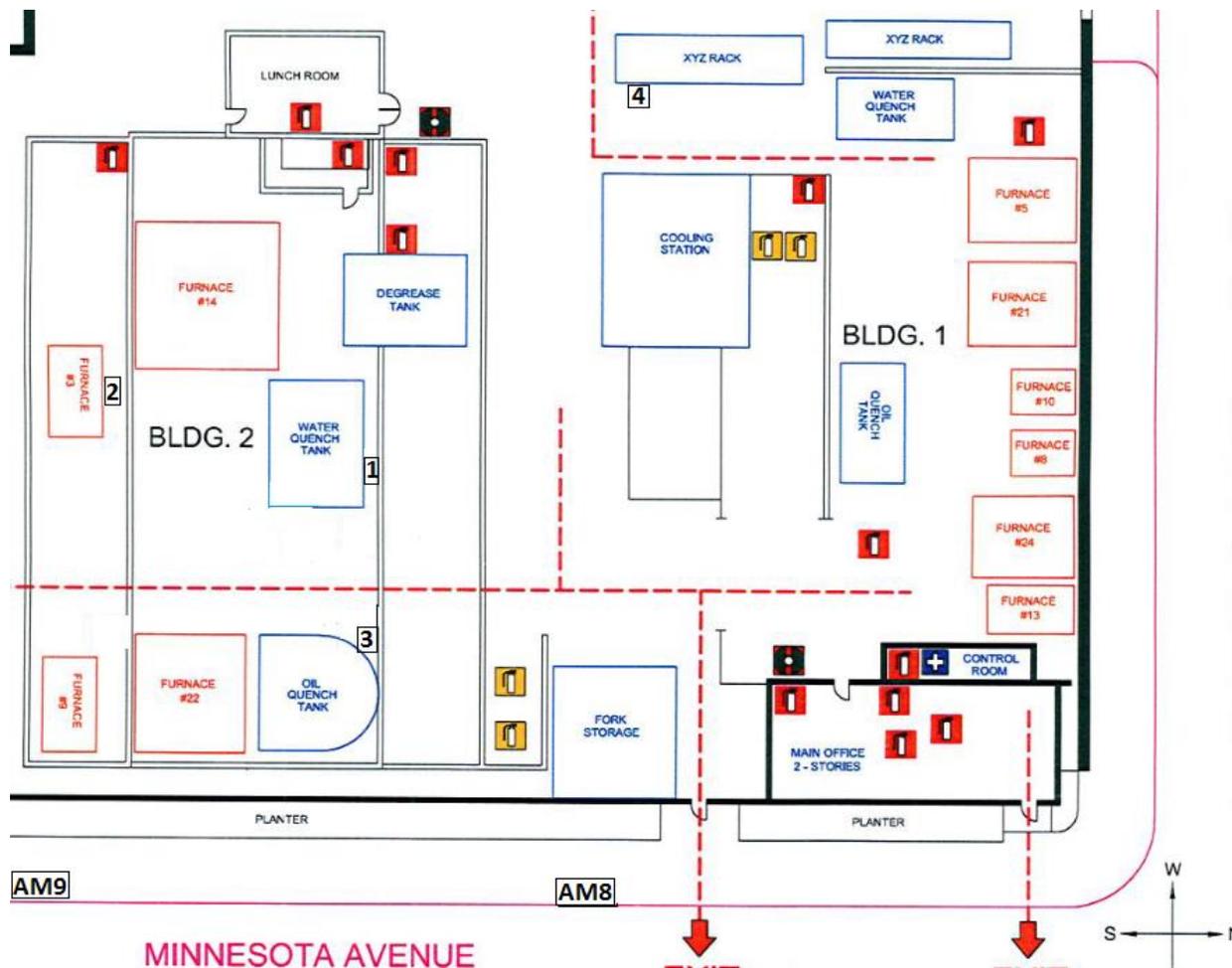
Figure 1: Overall Facility Layout

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- 1 – Bldg. 2 Water Quench Tank
- 2 – Furnace #3
- 3 – Bldg. 2 Oil Quench Tank
- 4 – Intermediate Storage Area
- AM8 – Air Monitoring Station
- AM9 – Air Monitoring Station

Figure 2: Source Sampling and Air Monitoring Locations



Figure 3: Bldg. 2 Water Quench Tank



Figure 4: Bldg. 2 Oil Quench Tank

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Figure 5: Intermediate Storage Area (“XYZ Rack”) Metal Dust

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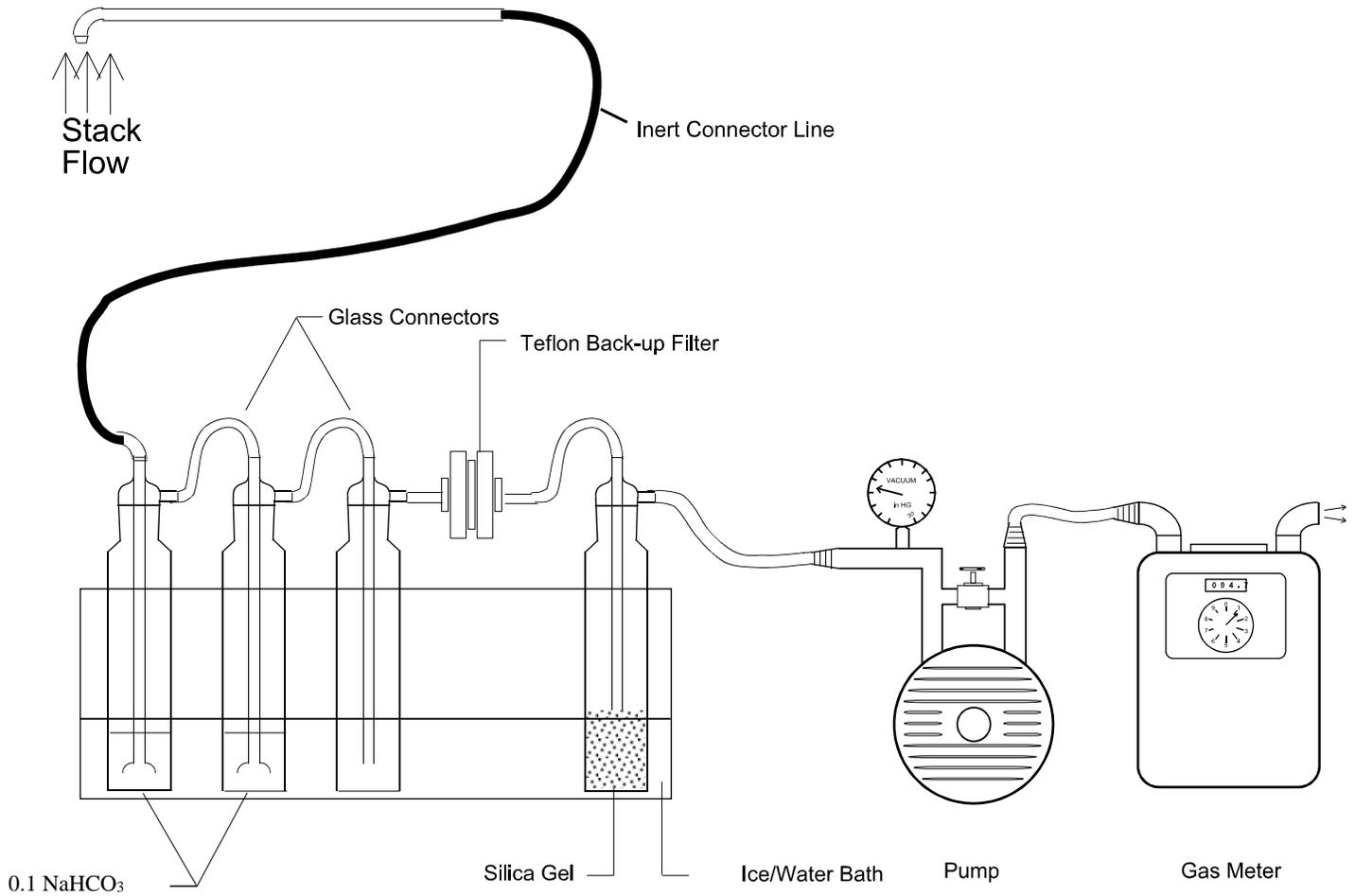


Figure 6: CARB Method 425

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CALCULATIONS

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APPENDICES

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
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APPENDIX A

Field Data

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APPENDIX B

District Laboratory Data

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SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
21865 Copley Dr., Diamond Bar, CA 91765-4182

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MONITORING & ANALYSIS
REPORT OF LABORATORY ANALYSIS

| | |
|------------------------------------------------------------------------------------------------------|--------------------------------------------|
| TO Mike Garibay, Supervising AQ Engineer Source Test Engineering | LABORATORY NO <u>1632007</u> |
| | SOURCE TEST NO <u>16-334</u> |
| SAMPLE(S) DESCRIBED AS 3 Hex Chrome trains | DATE RECEIVED <u>11/18/2016</u> |
| | PROJECT/ RULE <u>Paramount</u> |
| SAMPLING LOCATION Aerocraft Heat Treating 15701 Minnesota Avenue Paramount, CA 90723 | REQUESTED BY <u>Wayne Stredwick</u> |
| | DATE ANALYZED <u>11/18/2016</u> |

ANALYTICAL WORK PERFORMED, METHOD OF ANALYSIS AND RESULTS

Moisture and Hexavalent Chrome by CARB 425 (Sodium Bicarbonate solution)

| | TRAIN 18 | TRAIN 15 | Train 10 |
|----------------------|-----------------------|-------------------|-----------------------|
| Moisture gain, g | 3.2 | 0.8 | -5.4 |
| Silica gel% expended | 70 | 75 | 70 |
| Filter gain, mg | <1 | <1 | <1 |
| Recovery notes | No Probe Tube only | Probe and Tube | No Probe Tube only |

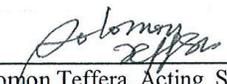
Cr⁺⁶ total µg 0.50 0.35 0.19

Cr⁺⁶ blank ND

NOTE (1) Additional significant figures provided for calculation purposes.

REF STR-113-66

Date Approved: 11/28/2016

Approved By: 

Solomon Teffera, Acting Senior Manager
Laboratory Services
(909) 396-2391

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MONITORING AND ANALYSIS
REPORT OF LABORATORY ANALYSIS

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TO: Mike Garibay
Supervising AQ Engineer
Science & Technology Advancement

LABORATORY NO. 1632007-13, 14, & 16

REFERENCE NO. Cr(VI)2-1: 123-125

SAMPLES DESCRIBED AS:

One quench tank sample, one
cooling tower sample, and one
metal dust sample collected from
Aerocraft Heat Treating

SUBMITTED ON: 11-18-2016

REQUESTED BY: Wayne Stredwick

SAMPLE SOURCE:

Aerocraft Heat Treating
15701 Minnesota Ave.
Paramount, CA 90723

ANALYTICAL WORK PERFORMED, METHOD OF ANALYSIS AND RESULTS

Analytical Method

Analysis of Hexavalent Chromium of a Solid and Liquid Sample by Ion Chromatography

The dust sample was extracted in a sodium bicarbonate solution. An aliquot from each liquid sample was taken. The analysis for hexavalent chromium (Cr^{6+}) for all three samples was performed in accordance with SCAQMD Method #0046, (*Standard Operating Procedure for the Analysis of Hexavalent Chromium in Ambient Air by Ion Chromatography*).

Results:

See page 2.

Date Approved: 11/29/16

Approved By: 
Solomon Teffera, Acting Sr. Manager
Laboratory Services

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REPORT OF LABORATORY ANALYSIS
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Aerocraft Heat Treating
15701 Minnesota Ave., Paramount CA 90723

| LAB ID | SAMPLE DATE | SAMPLE DESCRIPTION | Cr(VI) | UNITS |
|------------|-------------|---------------------------------|--------|-------|
| 1632007-13 | 11/18/2016 | Quench Water Tank | 46 | ppm |
| 1632007-14 | 11/18/2016 | Cooling Tower Water | 5.0 | ppb |
| 1632007-16 | 11/18/2016 | Metal Dust from Product Storage | 190 | ppm |

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TO: Mike Garibay
Supervising AQ Engineer
Science & Technology Advancement

LABORATORY NO. 1632007-15

REFERENCE NO. Cr(VI)2-1: 127

SAMPLES DESCRIBED AS:

Source Test 16-334 solid (flakes)
titanium sample from Aircraft
Heat Treating

SUBMITTED ON: 11-18-2016

REQUESTED BY: Wayne Stredwick

SAMPLE SOURCE:

Aircraft Heat Treating
15701 Minnesota Ave.
Paramount, CA 90723

ANALYTICAL WORK PERFORMED, METHOD OF ANALYSIS AND RESULTS

Analytical Method

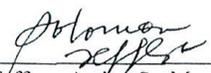
Analysis of Hexavalent Chromium of a Solid Sample by Ion Chromatography

The solid (flakes) sample was pulverized with a mortar and pestle and extracted in a sodium bicarbonate solution. The analysis for hexavalent chromium (Cr^{6+}) was performed in accordance with SCAQMD Method #0046, (*Standard Operating Procedure for the Analysis of Hexavalent Chromium in Ambient Air by Ion Chromatography*).

Results:

See page 2.

Date Approved: 12/1/16

Approved By: 
Solomon Teffera, Acting Sr. Manager
Laboratory Services

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Aerocraft Heat Treating
15701 Minnesota Ave., Paramount CA 90723

| LAB ID | SAMPLE DATE | SAMPLE DESCRIPTION | Cr(VI) ppb |
|------------|-------------|------------------------------------------|---------------|
| 1632007-15 | 11/18/2016 | Source test 16-334 solid titanium sample | 18 |

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APPENDIX C

Calibration Data

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Date(s): 11/17/16

| SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT DRY GAS METER CALIBRATION WORKSHEET | | | | | | | | | | | | | | |
|------------------------------------------------------------------------------------|--------------|-------------|--------|---------|-----------------------------|--------------------------|-------------|--------------|-----|------------------|-----|--------------|--------------|--|
| PERFORMED BY: T. Nguyen | | | | | | | | | | | | | | |
| Page 1 | | | | | | | | | | | | | | |
| DATE: | | 11-15-2016 | | | AMBIENT AIR | | 75 ° F | | | DRY GAS METER ID | | NO711 | | |
| PBAR: | | 29.43 In.Hg | | | STANDARD DRY GAS METER ID#: | | 7812470 | | | DRY GAS METER ID | | : | | |
| TRIAL CFM | TOTAL cubiCF | TEMP | H2O IN | H2O OUT | H2O | METER READ1 (in cubic F) | METER READ2 | TOTAL cubiCF | HRS | MIN | SEC | TIME Decimal | UC FL RT CFM | |
| 1 | 1/4 | 15.0 | 74 | 1.2 | 1.25 | 185.0 | 200.0 | 15.0 | 47 | 11.05 | | 47.18 | 0.3179 | |
| 2 | 1/4 | 13.1 | 74 | 1.2 | 1.25 | 200.1 | 213.2 | 13.1 | 41 | 25.60 | | 41.43 | 0.3162 | |
| 3 | 1/4 | 31.8 | 74 | 1.2 | 1.25 | 213.4 | 245.2 | 31.8 | 1 | 30.55 | | 100.51 | 0.3164 | |
| 1 | 1/2 | 30.2 | 74 | 2.8 | 2.8 | 272.5 | 302.7 | 30.2 | 56 | 4.80 | | 56.08 | 0.5385 | |
| 2 | 1/2 | 20.1 | 74 | 2.8 | 2.8 | 302.8 | 322.9 | 20.1 | 37 | 14.61 | | 37.24 | 0.5387 | |
| 3 | 1/2 | 21.9 | 74 | 2.8 | 2.8 | 323.1 | 345.0 | 21.9 | 40 | 38.34 | | 40.64 | 0.5389 | |
| 1 | 3/4 | 32.4 | 74 | 5.6 | 5.6 | 353.1 | 385.5 | 32.4 | 40 | 17.70 | | 40.30 | 0.8041 | |
| 2 | 3/4 | 16.3 | 74 | 5.6 | 5.6 | 400.9 | 417.2 | 16.3 | 21 | 55.77 | | 21.93 | 0.7433 | |
| 3 | 3/4 | 22.0 | 74 | 5.6 | 5.6 | 417.4 | 439.4 | 22.0 | 29 | 36.34 | | 29.61 | 0.7431 | |
| 1 | 1 | 19.6 | 74 | 9.5 | 9.5 | 463.2 | 482.8 | 19.6 | 18 | 51.76 | | 18.86 | 1.0391 | |
| 2 | 1 | 21.7 | 74 | 9.5 | 9.5 | 483.0 | 504.7 | 21.7 | 20 | 52.99 | | 20.88 | 1.0391 | |
| 3 | 1 | 18.4 | 74 | 9.5 | 9.5 | 505.3 | 523.7 | 18.4 | 17 | 44.30 | | 17.74 | 1.0373 | |

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
21865 Copley Drive, Diamond Bar, California 91765

Test No. 16-334

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Date(s): 11/17/16

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
21865 Copley Drive, Diamond Bar, California 91765

Test No. 16-334

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Date(s): 11/17/16

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SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
DRY GAS METER CALIBRATION WORKSHEET

PERFORMED BY: T. Nguyen

DATE: 11-15-2016

DRY GAS METER ID : N0711

| TRIAL CFM | TOTAL cubicf | H2O PRESSURE | | | H2O | METER (in cubic F) | | | HRS | MIN | SEC | TIME Decimal | UC FL RT CFM |
|-----------|--------------|--------------|-----|------|-----|---------------------|-------|--------|------|-----|-------|--------------|--------------|
| | | IN | OUT | TEMP | | READ1 | READ2 | CubicF | | | | | |
| 1 | 1/4 | 15.1 | 74 | 1.0 | 0.3 | 0.7 | 591.1 | 606.2 | 15.1 | 47 | 40.33 | 47.67 | 0.3167 |
| 2 | 1/4 | 13.1 | 74 | 1.0 | 0.3 | 0.7 | 606.3 | 619.4 | 13.1 | 41 | 30.55 | 41.51 | 0.3156 |
| 3 | 1/4 | 31.8 | 74 | 1.0 | 0.3 | 0.7 | 619.6 | 651.4 | 31.8 | 1 | 40 | 51.96 | 100.87 |
| 1 | 1/2 | 30.0 | 74 | 2.7 | 1.0 | 1.8 | 678.5 | 708.5 | 30.0 | 56 | 39.60 | 56.66 | 0.5295 |
| 2 | 1/2 | 20.0 | 74 | 2.7 | 1.0 | 1.8 | 708.6 | 728.6 | 20.0 | 37 | 41.43 | 37.69 | 0.5306 |
| 3 | 1/2 | 21.6 | 74 | 2.7 | 1.0 | 1.8 | 728.7 | 750.3 | 21.6 | 40 | 0.29 | 40.00 | 0.5399 |
| 1 | 3/4 | 32.2 | 74 | 5.4 | 2.1 | 3.8 | 758.4 | 790.6 | 32.2 | 40 | 36.79 | 40.61 | 0.7928 |
| 2 | 3/4 | 16.6 | 74 | 5.4 | 2.1 | 3.8 | 805.7 | 822.3 | 16.6 | 22 | 26.55 | 22.44 | 0.7397 |
| 3 | 3/4 | 21.8 | 74 | 5.4 | 2.1 | 3.8 | 822.4 | 844.2 | 21.8 | 29 | 4.80 | 29.08 | 0.7497 |
| 1 | 1 | 19.7 | 74 | 9.3 | 3.0 | 6.2 | 868.1 | 887.8 | 19.7 | 18 | 44.35 | 18.74 | 1.0513 |
| 2 | 1 | 21.6 | 74 | 9.3 | 3.0 | 6.2 | 888.0 | 909.6 | 21.6 | 20 | 32.25 | 20.54 | 1.0517 |
| 3 | 1 | 18.7 | 74 | 9.3 | 3.0 | 6.2 | 909.8 | 928.5 | 18.7 | 18 | 14.36 | 18.24 | 1.0253 |

DATE: 11-15-2016

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
21865 Copley Drive, Diamond Bar, California 91765

Test No. 16-334

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SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
DRY GAS METER CALIBRATION WORKSHEET

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DATE : 11-15-2016
PERFORMED BY: T.Nguyen

DRY GAS METER COEFFICIENT CALCULATIONS

STANDARD DRY GAS METER ID#: 7812470
With Coefficient of 1.0000

DRY GAS METER ID : N0713

| TRIAL | CFM | U/C FlowRate | TEMP | H2O Corrected FlowRate | U/C FlowRate | TEMP | H2O Corrected FlowRate | COEF | AVE: | OVERALL |
|-------|-----|--------------|------|------------------------|--------------|------|------------------------|--------|--------|---------|
| 1 | 1/4 | 0.3179 | 74 | 1.23 | 0.3054 | 74 | 0.65 | 0.3039 | 1.0051 | 1.0075 |
| 2 | 1/4 | 0.3162 | 74 | 1.23 | 0.3038 | 74 | 0.65 | 0.3028 | 1.0034 | |
| 3 | 1/4 | 0.3164 | 74 | 1.23 | 0.3040 | 74 | 0.65 | 0.3025 | 1.0050 | |
| 1 | 1/2 | 0.5385 | 74 | 2.8 | 0.5194 | 74 | 1.83 | 0.5095 | 1.0195 | 1.0132 |
| 2 | 1/2 | 0.5397 | 74 | 2.8 | 0.5206 | 74 | 1.83 | 0.5106 | 1.0195 | |
| 3 | 1/2 | 0.5389 | 74 | 2.8 | 0.5198 | 74 | 1.83 | 0.5195 | 1.0005 | |
| 1 | 3/4 | 0.8041 | 74 | 5.6 | 0.7809 | 74 | 3.75 | 0.7665 | 1.0188 | 1.0080 |
| 2 | 3/4 | 0.7433 | 74 | 5.6 | 0.7219 | 74 | 3.75 | 0.7151 | 1.0095 | |
| 3 | 3/4 | 0.7431 | 74 | 5.6 | 0.7217 | 74 | 3.75 | 0.7248 | 0.9958 | |
| 1 | 1 | 1.0391 | 74 | 9.5 | 1.0189 | 74 | 6.15 | 1.0224 | 0.9966 | 1.0043 |
| 2 | 1 | 1.0391 | 74 | 9.5 | 1.0189 | 74 | 6.15 | 1.0229 | 0.9961 | |
| 3 | 1 | 1.0373 | 74 | 9.5 | 1.0171 | 74 | 6.15 | 0.9971 | 1.0201 | |

DRY GAS METER ID : N0711
DATE: 11-15-2016

CORRECTION FACTOR: 1.0075