Derenzo Environmental Services
Consulting and Testing

EMISSION TEST REPORT

Report Title:	TOTAL AND HEXAVALENT CHROMIUM EMISSIONS FROM CHROME BLENDING PROCESSES
Report Date:	August 23, 2018
Test Date(s):	June 28-29, 2018

Facility Information	
Name:	Haviland Enterprises, Inc.
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City, County:	Grand Rapids, Kent
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Facility Permit Information			
State Registration No.:	N0878	Permit to Install No.:	71-17C

Testing Contractor	
Company:	Derenzo Environmental Services
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Project No.:	1805014

EMISSION TEST REPORT
FOR
TOTAL AND HEXAVALENT CHROMIUM EMISSIONS
FROM
CHROME BLENDING PROCESSES

HAVILAND ENTERPRISES, INC.
GRAND RAPIDS, MICHIGAN

1.0 INTRODUCTION

Derenzo Environmental Services (DES) was contracted by Haviland Enterprises, Inc. (Haviland) for the determination of total and hexavalent chromium emissions from the exhaust of a wet scrubber system controlling emissions from chrome blending processes at its Grand Rapids, Michigan facility.

The testing was performed in accordance with USEPA Method 306 for the measurement of total and hexavalent chromium emissions. Haviland is currently operating under PTI No. 71-17C that was approved and issued by the Michigan Department of Environmental Quality, Air Quality Division (MDEQ-AQD) on May 8, 2018.

The emission testing was performed June 28-29, 2018 by Derenzo Environmental Services personnel Tyler Wilson, Blake Beddow, Brad Thome, Kevin Anderson, and Clay Gaffey. The project was coordinated by Ms. Brittany Albin, Haviland Environmental Engineer. The testing was witnessed by Michigan Department of Environmental Quality, Air Quality Division (MDEQ-AQD) personnel Mr. Tom Gasloli and Ms. Kaitlyn DeVries.

The chromium emissions evaluation and exhaust gas sampling and analysis was performed using procedures specified in the Test Plan dated May 22, 2018 that was submitted to the MDEQ-AQD for review and approval.

Questions regarding this report should be directed to:

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Report Certification

This test report was prepared by DES based on field sampling data collected by DES. Haviland representatives or employees provided facility process data and have approved this test report for submittal to the MDEQ-AQD.

I certify that the testing was conducted in accordance with the specified test methods and submitted test plan unless otherwise specified in this report. I believe the information provided in this report and its attachments are true, accurate, and complete.

Report Prepared By:

Tyler J. Wilson
Livonia Office Supervisor
Derenzo Environmental Services

Reviewed By:

Andy Rusnak, QSTI
Technical Manager
Derenzo Environmental Services

I certify that the facility and emission units were operated at maximum routine operating conditions for the test event. Based on information and belief formed after reasonable inquiry, the statements and information in this report are true, accurate and complete.

Responsible Official Certification:

Brittany Albin
Environmental Engineer
Haviland Enterprises, Inc.

2.0 TEST RESULTS SUMMARY

Emission testing was performed for the chrome scrubber inlet and exhaust (exhaust stack SV-2) for the wet scrubber system. A summary of the average total and hexavalent chromium inlet and exhaust emission rates for the chrome scrubber are presented in Table 2.1 below. Measured inlet and exhaust gas flowrate, sample train data, and chromium concentrations and emission rates for each 64 and 120-minute test period are presented at the end of this report in Tables 6.1-6.4.

Emission calculations are presented in Appendix A.

Process data recorded by Haviland representatives during the test periods is provided in Appendix F.

Table 2.1 Summary of measured total and hexavalent chromium emission rates

Sampling Location	Measured Total Chromium Emissions (lb/hr)	Measured Hexavalent Chromium Emissions (lb/hr)
Scrubber Inlet (Powder Blender)	7.64×10^{-4}	5.84×10^{-4}
Scrubber Exhaust (Powder Blender)	1.44×10^{-5}	6.07×10^{-6}
Scrubber Inlet (Liquid Blender)	2.69×10^{-3}	2.24×10^{-3}
Scrubber Exhaust (Liquid Blender)	7.64×10^{-6}	4.75×10^{-6}

3.0 PROCESS DESCRIPTION

Haviland operates chrome blending processes, including liquid and powder blending, as well as a chrome wastewater treatment area. Three (3) of the chrome tanks are dedicated to liquid blending. It is assumed chrome in the liquid blending tanks remains in solution once the dry chrome is dissolved. Wastewater from this process is sent to the wastewater treatment area where chrome settles out of solution and is dewatered.

Haviland also operates a MacDermid powder blender. In the powder blender dry materials containing chromium are processed and subsequently packaged. The blender has three (3) process exhausts, which are connected to a wet scrubber. Two (2) of these connections draw air off the mixing drum and the other off the drop leg.

Both the powder blending and liquid blending operations are permitted under one emission unit (EUCHROMEBLEND), but Haviland tested liquid blending separately from powder blending. Day one of testing consisted of three (3) runs on the inlet /outlet of the newly installed chrome wet scrubber with only powder blending operating. Day two consisted of three (3) runs on the inlet/outlet of the newly installed chrome wet scrubber with only liquid blending operating. Sampling results provide scrubber efficiencies for the individual blending operations.

4.0 TESTING AND ANALYSIS

The emission testing was conducted using appropriate USEPA stationary source test methods as presented in the test protocol submitted to the MDEQ-AQD. This section provides a summary of the test methods and procedures performed during the test event.

Pollutant mass emission rate calculations require an accurate determination of exhaust gas flowrate (USEPA Methods 1 and 2). Exhaust gas flowrate measurements require (1) measurement of the velocity head and temperature at various, predetermined locations within the gas stream (USEPA Method 2), (2) measurement of the molecular weight of the exhaust gas (USEPA Method 3), and (3) measurement of the moisture content of the exhaust gas (USEPA Method 4). Field measurement data sheets are presented in Appendix B.

4.1 Sample and Velocity Traverse

USEPA Method 1, *Sample and Velocity Traverses for Stationary Sources*, was used to determine the number of traverse points required for testing the source. Based on flow disturbance data, the sampling port locations meet the minimum criteria for a "representative measurement" of the gas velocity. Appendix D provides a schematic of the traverse and sampling locations.

4.2 Stack Gas Velocity and Volumetric Flowrate

USEPA Method 2, *Determination of Stack Gas Velocity and Volumetric Flowrate*, was used to determine the average gas velocity. Average velocity pressure measurements of the exhaust gas were made using a Stausscheibe (Type S) Pitot tube connected to an oil manometer capable of reading pressures from 0.0 to 10 inches water column. Concurrent temperature measurements of the exhaust gas were made with a type-K thermocouple attached to the Pitot tube. Cyclonic flow determinations were conducted on the exhaust stack and the angle was determined to be less than 20° on average.

4.3 Determination of Molecular Weight

The gas collected by the emission control system is primarily in-plant air. Carbon dioxide (CO_2) and oxygen (O_2) samples were collected and analyzed using a Fyrite® combustion gas analyzer. Samples were taken for the determination of CO_2 and O_2 during the total and hexavalent chromium test events. The average O_2 and CO_2 concentrations measured during testing were 20.9% and 0% respectively.

4.4 Determination of Moisture Content

USEPA Method 4, *Determination of Moisture Content in Stack Gases,* was used to determine the moisture content of the exhaust for each test period. Exhaust gas moisture was collected in chilled impingers (as part of the USEPA Method 306 sample train) and determined gravimetrically.

4.5 Chromium Emissions Testing

USEPA Method 306 "Determination of Chromium Emissions from Decorative and Hard Chromium Electroplating and Anodizing Operations" was used to measure total and hexavalent chromium concentrations and emission rates for the chrome scrubber inlet and exhaust.

Appendix E provides a sampling train diagram for Method 306.

Prior to testing, a preliminary velocity traverse, dry-bulb/wet-bulb moisture determination, and Fyrite® analysis for the chrome scrubber exhaust was conducted to determine the appropriate nozzle size for isokinetic sampling. After the preliminary traverse, exhaust gas velocity pressures and temperatures were continuously monitored during the chromium emissions sampling.

DES used a Nutech Model 2010 modular isokinetic stack sampling system to measure chromium emissions in accordance with the above-referenced sampling method. Triplicate 64-minute test runs were conducted simultaneously for the scrubber inlet and exhaust for the powder blending process and an average sample volume of 19.5 dry standard cubic feet (dscf) for the inlet and 25.6 dscf for the exhaust were obtained. Triplicate 120-minute test runs were conducted simultaneously for the scrubber inlet and exhaust for the liquid blending process and an average sample volume of 31.2 dscf for the inlet and 49.5 dscf for the exhaust were obtained.

The Method 306, chromium sampling train consisted of (1) a borosilicate-glass nozzle, (2) a non-heated glass probe liner, (3) a set of four Greenberg-Smith (GS) impingers with the first modified and second standard GS impingers each containing 100 milliliters (ml) of 0.1 Normal Sodium hydroxide (0.1 N NaOH), a third dry modified GS impinger, and a fourth modified GS impinger containing a known weight of silica gel desiccant. The impinger train was connected to the dry gas meter sampling console using a length of umbilical sample line.

The sample train was assembled and leak checked. Upon successful completion of the leak check, the initial dry gas meter reading was recorded. The duct temperature, dry gas meter temperature and duct velocity pressure were measured and recorded on the data sheet. The isokinetic-sampling rate in terms of pressure drop across the calibrated orifice was calculated and recorded on the data sheet. The pump and timer were turned on, and the sample rate was adjusted to correspond to the calculated isokinetic rate.

Once the sample rate was set, the following data were recorded:

- Dry gas meter inlet and outlet temperatures
- Sample vacuum
- Stack temperature
- Last impinger temperature

- Velocity pressure
- Orifice differential pressure
- Sample volume (dry gas meter readings)

At the end of the sample time for the first point, the probe was moved to the next point, and the measurements, calculations and recording of data was repeated. Upon completion of sampling from a port, the pump was turned off and the dry gas meter reading recorded. The probe assembly was then placed into the next sampling port and the previously described sampling procedure was repeated for the second, third, and fourth sampling ports.

When the sample run was completed, the final, dry gas meter reading was recorded and the probe was removed from the port. A post-test leak check was performed on the sampling train at a vacuum at least as great as that of the highest sample vacuum measured during the sample run. The final leak rate was recorded on the data sheet. The sample train was sealed from contamination and disassembled for recovery.

The interior of the nozzle, probe liner, and all glassware up to the fourth impinger were rinsed with 0.1 N NaOH. The 0.1 N NaOH rinses were collected in a pre-cleaned sample container. Prior to rinsing the impingers, gravimetric analyses (post-test weights) were obtained for the determination of moisture content of the stack gases and then the contents of the impingers (0.1 N NaOH and collected moisture) were collected in the sample container. Each container was uniquely labeled with the test number, location, and date. The sample container caps were sealed with tape and the level of liquid was marked on the outside of the container. Samples were shipped to Element One, Inc. laboratory (Element One) in Wilmington, North Carolina. The samples were analyzed using a Perkin-Elmer NEXLON 350X ICP-MS in accordance with USEPA Method 306, at Element One's laboratory.

The laboratory analytical report is provided in Appendix G.

5.0 QUALITY ASSURANCE/QUALITY CONTROL

USEPA Quality Assurance/Quality Control (QA/QC) procedures were followed during the emissions testing program. The following information is a general overview of the QA/QC requirements of the test program. Please refer to the individual USEPA test methods in 40 CFR Part 60, Appendix A, for detailed information regarding these procedures.

5.1 Exhaust Gas Properties and Flowrate

In accordance with the USEPA Methods 1-4, the following QA/QC activities were performed:

- Prior to arriving onsite, the instruments used during the source testing to measure the exhaust gas properties, such as the barometer, pyrometer, and Pitot tube are calibrated and documented to specifications outlined in the sampling methods. Calibration and inspection sheets are presented in Appendix C.

- During isokinetic sampling, the exposed space of the sample port opening, between the probe and the port wall, was covered in order to minimize influence of ambient conditions on velocity pressure readings.

- Prior to the sampling event, the velocity measurement assembly (Pitot tube, flexible line, and inclined manometer) was leak checked through both the positive and negative side of the Pitot at a velocity pressure equal to or greater than 3 inches water column.

- Prior to the sampling event, the absence of cyclonic flow was verified at the sampling location to ensure the validity of the measured data.

5.2 Isokinetic sampling

The QA/QC guidelines practiced during the total and hexavalent chromium testing include:

- Prior to their use in the field, the sampling nozzle, glass liner, the first three impingers, and all connecting glassware were cleaned in accordance with the guidelines outlined in USEPA Method 306 Section 5 (1)(b).

- A three-point calibration measurement was performed on the glass nozzle used in the performance of the isokinetic testing. This field calibration sheet is presented in Appendix C.

- The Nutech Model 2010 sampling console was calibrated prior to and after the testing program. This calibration uses the critical orifice calibration technique presented in USEPA Method 5. Meter calibration sheets are presented in Appendix C.

- The digital pyrometer in the Nutech metering console was calibrated using a NIST traceable Omega® Model CL 23A temperature calibrator.

- Prior to each test run, the sampling train was assembled and leak-checked at the sampling site by plugging the inlet to the probe and pulling a vacuum of approximately 5 in. Hg. At the conclusion of each test run, the sampling train was leak-checked by drawing a vacuum equal to or greater than the highest vacuum measured during the test run.

- Following each test run, the pH of the contents of the first impinger in the sample train was checked and verified to be greater than 8.5.

- Blank samples of the 0.1 N NaOH used in the compliance testing were obtained and submitted to the laboratory for subsequent analysis in the same manner as each of the chromium test samples.

- Element One performed the required internal blank and recovery procedures presented in the USEPA Method 306. A duplicate analysis of one of the test samples was performed and the

Method QA/QC requirements were within acceptable limits. A report generated by Element One can be found in Appendix G.

6.0 MEASUREMENT RESULTS

6.1 Total and Hexavalent Chromium Emission Rates

The average measured chromium emission rates for the chrome scrubber were as follows:

- 7.64×10^{-4} lb/hr total chromium and 5.84×10^{-4} lb/hr hexavalent chromium for the scrubber inlet during the power blending process. The average measured exhaust gas flowrate for the chrome scrubber inlet during the powder blending process was 701 dry standard cubic feet per minute (dscfm).

- 1.44×10^{-5} lb/hr total chromium and 6.07×10^{-6} lb/hr hexavalent chromium for the scrubber exhaust during the power blending process. The average measured exhaust gas flowrate for the chrome scrubber exhaust during the powder blending process was 1,574 dscfm.

- 2.69×10^{-3} lb/hr total chromium and 2.24×10^{-3} lb/hr hexavalent chromium for the scrubber inlet during the liquid blending process. The average measured exhaust gas flowrate for the chrome scrubber inlet during the liquid blending process was 584 dscfm.

- 7.64×10^{-6} lb/hr total chromium and 4.75×10^{-6} lb/hr hexavalent chromium for the scrubber exhaust during the liquid blending process. The average measured exhaust gas flowrate for the chrome scrubber exhaust during the liquid blending process was 1,613 dscfm.

Tables 6.1-6.4 present the emission concentrations, sample volumes, and measured exhaust gas properties for the total and hexavalent chromium test runs conducted on the chrome scrubber inlet and exhaust.

6.2 Monitoring Parameters

Material throughput and water circulation through the chrome scrubber system were recorded during the test periods. Appendix F provides monitoring data recorded during each 64 and 120-minute sampling period.

6.3 Variations from Normal Sampling Procedures or Operating Conditions

The chrome blending processes and the chrome scrubber operated normally and no variations from the normal operating conditions occurred during the testing program.

6.4 Deviations from the Test Protocol

Sampling port locations were changed from those originally proposed in pages 13-14 in the Test Protocol. Port locations were discussed June 19, 2018. Final port location drawings are attached.

During powder blending operations (testing on June 28, 2018), the following deviations occurred in regards to the submitted Test Protocol:

- All valves were open on the duct going to the scrubber (different from what was stated in pages 22-23 of the Test Protocol). Approval was received from MDEQ-AQD on June 19, 2018 prior to the test event.

- The powder blending operator left the mixer running in the blender during packaging. This is an adjustment to the proposed process operating procedure specified in page 22 of the Test Protocol.

During liquid blending operations (testing on June 29, 2018), the following deviations occurred in regards to the submitted Test Protocol:

- All valves were open on the duct going to the scrubber (different from what was stated in pages 22-23 of the Test Protocol). Approval was received from MDEQ-AQD on June 19, 2018 prior to the test event.

- The liquid blending operator continued to mix blend while the quality control (QC) sample was being analyzed. This is an adjustment to the proposed process operating procedure specified in page 23 of the Test Protocol.

- Approximately 2,310 pounds (lbs) of chromium trioxide flake was processed from a flake to a powder on June 28, 2018, during powder blending process emissions testing. All of this material was going to be dumped into the liquid blending process during one of those emissions test periods to represent a worst-case scenario (assuming powdered chrome generates more dust than it being in flake form). Approximately 1,757 lbs of powdered chromium was dumped instead.

Table 6.1 Scrubber Inlet Chromium Concentrations and Emission Rates (Powder Blending)

Test No. Test Date Test Period (24-hr clock)	1 6/28/18 08:27-09:39	2 6/28/18 10:24-11:36	3 6/28/18 12:22-13:32	 Test Avg.
Exhaust gas flowrate (scfm)	660	747	763	723
Exhaust gas flowrate (dscfm)	642	727	734	701
Moisture (% vol)	2.69	2.66	3.76	3.04
Sample Train Data (Method 306)				
Sample volume (dscf)	18.1	19.8	20.7	19.5
Sample volume (dscm)	0.51	0.56	0.59	0.55
Total Chrome in sampling train (µg)	119	173	190	161
Hexavalent Chrome in sampling train (µg)	91.6	134	143	123
Calculated Total Chromium Emissions				
Total Chromium content (gr/dscf)	1.02×10^{-4}	1.35×10^{-4}	1.42×10^{-4}	1.26×10^{-4}
Total Chromium emission rate (lb/hr)	5.60×10^{-4}	8.40×10^{-4}	8.91×10^{-4}	7.64×10^{-4}
Calculated Hexavalent Chromium Emissions				
Hexavalent Chromium content (gr/dscf)	7.83×10^{-5}	1.04×10^{-4}	1.07×10^{-4}	9.64×10^{-5}
Hexavalent Chromium emission rate (lb/hr)	4.31×10^{-4}	6.51×10^{-4}	6.71×10^{-4}	5.84×10^{-4}

Table 6.2 Scrubber Exhaust Chromium Concentrations and Emission Rates (Powder Blending)

Test No. Test Date Test Period (24-hr clock)	1 6/28/18 08:27-09:39	2 6/28/18 10:24-11:36	3 6/28/18 12:22-13:32	Test Avg.
Exhaust gas flowrate (scfm)	1,561	1,646	1,681	1,629
Exhaust gas flowrate (dscfm)	1,516	1,584	1,621	1,574
Moisture (% vol)	2.84	3.77	3.55	3.39
Sample Train Data (Method 306)				
Sample volume (dscf)	24.4	25.9	26.6	25.6
Sample volume (dscm)	0.69	0.73	0.75	0.73
Total Chrome in sampling train (μg)	1.90	1.24	2.19	1.78
Hexavalent Chrome in sampling train (μg)	0.49	0.63	1.13	0.75
Calculated Total Chromium Emissions				
Total Chromium content (gr/dscf)	1.20×10^{-6}	7.40×10^{-7}	1.27×10^{-6}	1.07×10^{-6}
Total Chromium emission rate (lb/hr)	1.56×10^{-5}	1.00×10^{-5}	1.77×10^{-5}	1.44×10^{-5}
Calculated Hexavalent Chromium Emissions				
Hexavalent Chromium content (gr/dscf)	3.09×10^{-7}	3.74×10^{-7}	6.56×10^{-7}	4.46×10^{-7}
Hexavalent Chromium emission rate (lb/hr)	4.01×10^{-6}	5.08×10^{-6}	9.11×10^{-6}	6.07×10^{-6}
Permitted Hexavalent Chromium Emissions				
Hexavalent Chromium emission rate (lb/hr)				**2.74×10^{-4}**

Table 6.3 Scrubber Inlet Chromium Concentrations and Emission Rates (Liquid Blending)

Test No. Test Date Test Period (24-hr clock)	1 6/29/18 06:00-08:05	2 6/29/18 09:50-11:53	3 6/29/18 13:20-15:24	Test Avg.
Exhaust gas flowrate (scfm)	655	580	568	601
Exhaust gas flowrate (dscfm)	639	561	551	584
Moisture (% vol)	2.43	3.24	3.00	2.89
Sample Train Data (Method 306)				
Sample volume (dscf)	32.9	30.8	30.0	31.2
Sample volume (dscm)	0.93	0.87	0.85	0.88
Total Chrome in sampling train (µg)	2,198	484	522	1,068
Hexavalent Chrome in sampling train (µg)	1,824	425	414	888
Calculated Total Chromium Emissions				
Total Chromium content (gr/dscf)	1.03×10^{-3}	2.43×10^{-4}	2.68×10^{-4}	5.14×10^{-4}
Total Chromium emission rate (lb/hr)	5.64×10^{-3}	1.17×10^{-3}	1.27×10^{-3}	2.69×10^{-3}
Calculated Hexavalent Chromium Emissions				
Hexavalent Chromium content (gr/dscf)	8.55×10^{-4}	2.13×10^{-4}	2.13×10^{-4}	4.27×10^{-4}
Hexavalent Chromium emission rate (lb/hr)	4.68×10^{-3}	1.03×10^{-3}	1.00×10^{-3}	2.24×10^{-3}

Table 6.4 Scrubber Exhaust Chromium Concentrations and Emission Rates (Liquid Blending)

Test No.	1	2	3	
Test Date	6/29/18	6/29/18	6/29/18	Test
Test Period (24-hr clock)	06:00-08:05	09:50-11:53	13:20-15:24	Avg.
Exhaust gas flowrate (scfm)	1,720	1,661	1,614	1,665
Exhaust gas flowrate (dscfm)	1,673	1,606	1,562	1,613
Moisture (% vol)	2.74	3.33	3.24	3.10
Sample Train Data (Method 306)				
Sample volume (dscf)	50.9	49.1	48.4	49.5
Sample volume (dscm)	1.44	1.39	1.37	1.40
Total Chrome in sampling train (µg)	1.91	1.50	1.90	1.77
Hexavalent Chrome in sampling train (µg)	1.29	1.01	1.00	1.10
Calculated Total Chromium Emissions				
Total Chromium content (gr/dscf)	5.79×10^{-7}	4.71×10^{-7}	6.06×10^{-7}	5.52×10^{-7}
Total Chromium emission rate (lb/hr)	8.31×10^{-6}	6.49×10^{-6}	8.12×10^{-6}	7.64×10^{-6}
Calculated Hexavalent Chromium Emissions				
Hexavalent Chromium content (gr/dscf)	3.91×10^{-7}	3.17×10^{-7}	3.19×10^{-7}	3.43×10^{-7}
Hexavalent Chromium emission rate (lb/hr)	5.61×10^{-6}	4.37×10^{-6}	4.27×10^{-6}	4.75×10^{-6}
Permitted Hexavalent Chromium Emissions				
Hexavalent Chromium emission rate (lb/hr)				**2.74×10^{-4}**