



# No. 5 Pickle Line Hydrogen Chloride Emission Test Report

*Prepared for:*

**United States Steel Corporation**

Ecorse, Michigan

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**AIR QUALITY DIV.**

United States Steel Corporation  
Great Lakes Works  
No. 1 Quality Drive  
Ecorse, Michigan 48829

Project No. 15-4725.00  
October 2, 2015

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MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY  
AIR QUALITY DIVISION

**RENEWABLE OPERATING PERMIT  
REPORT CERTIFICATION**

Authorized by 1994 P.A. 451, as amended. Failure to provide this information may result in civil and/or criminal penalties.

Reports submitted pursuant to R 336.1213 (Rule 213), subrules (3)(c) and/or (4)(c), of Michigan's Renewable Operating (RO) Permit program must be certified by a responsible official. Additional information regarding the reports and documentation listed below must be kept on file for at least 5 years, as described in General Condition No. 22 in the RO Permit and be made available to the Department of Environmental Quality, Air Quality Division upon request.

Source Name United States Steel Corporation Great Lakes Works County Wayne

Source Address #1 Quality Drive City Ecorse

AQD Source ID (SRN) A7809 RO Permit No. 199600132d RO Permit Section No. 1 & 5

Please check the appropriate box(es):

Annual Compliance Certification (General Condition No. 28 and No. 29 of the RO Permit)

Reporting period (provide inclusive dates): From \_\_\_\_\_ To \_\_\_\_\_

- 1. During the entire reporting period, this source was in compliance with ALL terms and conditions contained in the RO Permit, each term and condition of which is identified and included by this reference. The method(s) used to determine compliance is/are the method(s) specified in the RO Permit.
- 2. During the entire reporting period this source was in compliance with all terms and conditions contained in the RO Permit, each term and condition of which is identified and included by this reference, EXCEPT for the deviations identified on the enclosed deviation report(s). The method used to determine compliance for each term and condition is the method specified in the RO Permit, unless otherwise indicated and described on the enclosed deviation report(s).

Semi-Annual (or More Frequent) Report Certification (General Condition No. 23 of the RO Permit)

Reporting period (provide inclusive dates): From \_\_\_\_\_ To \_\_\_\_\_

- 1. During the entire reporting period, ALL monitoring and associated recordkeeping requirements in the RO Permit were met and no deviations from these requirements or any other terms or conditions occurred.
- 2. During the entire reporting period, all monitoring and associated recordkeeping requirements in the RO Permit were met and no deviations from these requirements or any other terms or conditions occurred, EXCEPT for the deviations identified on the enclosed deviation report(s).

Other Report Certification

Reporting period (provide inclusive dates): From Aug. 11, 2015 To Aug. 11, 2015

Additional monitoring reports or other applicable documents required by the RO Permit are attached as described:

Submittal of Pickle Line Stack Test Conducted February 27, 2013 per ROP

Table E-01.08, III.B.3.1

I certify that, based on information and belief formed after reasonable inquiry, the statements and information in this report and the supporting enclosures are true, accurate and complete.

James R. Gray General Manager 313-749-2210  
Name of Responsible Official (print or type) Title Phone Number

[Signature] Date 9 Oct 15

Executive Summary

BT Environmental Consulting, Inc. (BTEC) was retained by United States Steel Corporation Great Lakes Works (U. S. Steel) to conduct an evaluation of the hydrogen chloride (HCl) concentrations and emissions from the No. 5 Pickle Line Scrubber. The scrubber is located at the U. S. Steel facility in Ecorse, Michigan. The evaluation consisted of triplicate 60-minute test runs at the scrubber exhaust sampling location.

The results of the Hydrogen Chloride test program are summarized by the following table.

**Executive Summary Table E-1****Test Program Results Summary****No. 5 Pickle Line Scrubber Exhaust****August 11, 2015**

<b>Scrubber Make up water Flow Rate (gal/min)</b>	<b>Emission Rate Lbs/hr</b>	<b>Concentration PPM, dry</b>	<b>Permit Limit Lbs/hr</b>	<b>Permit Limit PPM</b>
<b>55</b>	<b>1.36</b>	<b>19.6</b>	<b>1.64</b>	<b>18</b>



## **1.0 Introduction**

BT Environmental Consulting, Inc. (BTEC) was retained by United States Steel Corporation Great Lakes Works (U. S. Steel) to conduct an evaluation of the hydrogen chloride (HCl) concentrations and emissions from the No. 5 Pickle Line Scrubber. The scrubber is located at the U. S. Steel facility in Ecorse, Michigan. The evaluation consisted of triplicate 60-minute test runs at the scrubber exhaust sampling location. US EPA Methods 1, 2, 3, 4 and 26A were utilized to perform the study.

The No. 5 Pickle Line Scrubber was tested for a compliance demonstration required by Permit No. 199600132d. BTEC personnel Mr. Todd Wessel and Mr. Paul Molenda performed the testing on August 11, 2015. Mr. Brad Wargnier of U. S. Steel assisted in the study by coordinating the testing and documenting the scrubber operating parameters.

The purpose of this document is to summarize the sampling and analytical methodologies utilized and the results of the emissions test program. Section 2.0 provides a description of the process tested. Sections 3.0 and 4.0 summarize the sampling and analytical methods utilized as well as the results of the emissions test program. Overall results for the emissions test program are summarized by Table 1.

## **2.0 Process Description**

The pickling process uses a mineral acid (hydrochloric acid) to remove metal oxides formed when steel is hot rolled and cooled in the presence of oxygen. It is necessary to remove these oxides to provide a smooth clean surface for use as hot roll steel and/or to perform subsequent cold forming operations.

The No. 5 Pickle Line at U. S. Steel consists of four pickle tubs in series. The fresh acid solution is introduced in the 3<sup>rd</sup> pickle tank. The acid solution then cascades from the 3<sup>rd</sup> tank to the 1<sup>st</sup> tank in a direction counter to the direction of the metal strip. By this countercurrent arrangement, the cleanest strip near the process exit is treated by the freshest acid, ensuring that the steel strip is as free of oxide scale as possible.

The No. 5 Pickle Line Scrubber captures and removes acid mist and vapors from the process line. All pickle line tubs are completely covered with capture hoods to evacuate the acid mist and fumes. Ductwork carries the fumes to the packed bed scrubber rated at 16,950 ACFM. The fumes are moved through the scrubber by an I.D. fan.

The water flow monitor calibration was last completed on Nov. 17, 2014.

No non-routine maintenance has been performed on the scrubber within the last three months.

### 3.0 Sampling and Analytical Methodologies

Sampling and analytical methodologies for the emissions test program can be separated into two categories as follows:

- (1) Measurement of exhaust gas velocity, molecular weight, and moisture content; and,
- (2) Sampling and analysis of exhaust gases for HCl concentrations and emissions.

Sections 3.1 and 3.2 summarize the methodologies used to evaluate exhaust gas parameters for each of the aforementioned categories. Section 3.3 summarizes miscellaneous information related to the emissions test program.

#### 3.1 Exhaust Gas Velocity, Molecular Weight, and Moisture Content

Measurement of exhaust gas velocity, molecular weight, and moisture content were conducted using the following reference test methods codified at Title 40, Part 60, Appendix A of the Code of Federal Regulations (40 CFR 60, Appendix A):

- Method 1 - *“Location of the Sampling Site and Sampling Points”*
- Method 2 - *“Determination of Stack Gas Velocity and Volumetric Flowrate”*
- Method 3 - *“Determination of Molecular Weight of Dry Stack Gas (Fyrite)”*
- Method 4 - *“Determination of Moisture Content in Stack Gases”*

Stack gas velocity traverses were conducted in accordance with the procedures outlined in Method 1 and Method 2 (see Figure 1 for a traverse point diagram). An S-type pitot tube with a thermocouple assembly, calibrated in accordance with Method 2, Section 4.1.1, was used to measure exhaust gas velocity pressures (using a manometer) and temperatures during testing. The S-type pitot tube dimensions were within specified limits, therefore, a baseline pitot tube coefficient of 0.84 (dimensionless) was assigned.

Molecular weight was determined according to USEPA Method 3, “Gas Analysis for the Determination of Dry Molecular Weight.” The equipment used for this evaluation consisted of a one-way squeeze bulb with connecting tubing and a set of Fyrite<sup>®</sup> combustion gas analyzers. Carbon dioxide and oxygen content were analyzed using the Fyrite<sup>®</sup> procedure.

Exhaust gas moisture content was evaluated utilizing USEPA Method 4, “Determination of Moisture Content in Stack Gases.” Exhaust gas was extracted as part of the Method 26A sampling trains (see Figure 2 for a schematic of the sampling train). Exhaust gas was extracted and passed through (i) two impingers, each with 100 ml of 0.1N H<sub>2</sub>SO<sub>4</sub>, (ii) a third impinger that was empty and (iii) a fourth impinger filled with silica gel. Exhaust gas moisture content was then determined gravimetrically.

### 3.2 Hydrogen Chloride Concentrations

Measurement of HCl concentrations was conducted using the following reference test methods codified at 40 CFR 60, Appendix A:

- Method 26A - *“Determination of Hydrogen Halide and Halogen Emissions from Stationary Sources (isokinetic method)”*

The Method 26A sampling train consists of: (1) a heated borosilicate or quartz probe liner; (2) a heated borosilicate or quartz glass filter holder containing a pre-weighed 110-mm diameter washed teflon filter with Teflon filter support; (3) a set of two Greensburg-Smith (GS) impingers each of which contained 100 ml of 0.1 Normal Sulfuric Acid (0.1 N H<sub>2</sub>SO<sub>4</sub>), (4) a modified GS impinger that was empty as a knock out impinger, (5) a modified GS impinger containing a known weight of silica gel desiccant; (6) a length of sample line, and (7) a Nutech control case equipped with a pump, dry gas meter, and calibrated orifice. Figure 2 provides an illustration of the Method 26A sample train.

After completion of the final leak test for each test run, the impinger train was carefully disassembled. The liquid volume of each impinger was measured gravimetrically and any volume increase was noted on field sheets. The impinger catch solution was then transferred to pre-cleaned sample containers. The impingers were then triple rinsed with deionized water (DI H<sub>2</sub>O), and the rinses added to the H<sub>2</sub>SO<sub>4</sub> sample containers. The back-half of the filter holder was rinsed and added to the H<sub>2</sub>SO<sub>4</sub> sample container. The containers were labeled with the test number, test location, test date, and the level of liquid was marked on the outside of each container. Immediately after recovery, the sample containers were placed in a sealed cooler for storage.

The samples were submitted to the contract laboratory. Chain of Custody (COC) forms for the field samples were completed on-site. Bureau Veritas Laboratories located in Novi, Michigan performed the analysis. All appropriate QA/QC measures were strictly adhered to. Results of the laboratory tests are included in Appendix C.

### 3.3 Miscellaneous Information

Due to the nature of the emissions test program, it is important to note any issues that occurred during the emissions test program:

- The scrubber flow rate and pressure drop was monitored at fifteen-minute intervals throughout each of the test runs. This monitoring indicated that the makeup flow rate in gallons per minute was 55, recirculation flow rate was approximately 552, and pressure drop was 6.2 inches of water.



#### 4.0 Test Results

Overall results of the emissions test program are summarized by Table 1. Field and computer-generated data sheets are provided in Appendix A. Equipment calibration information and U. S. Steel process documentation is presented in Appendix B and laboratory analytical reports are provided as Appendix C. Example calculations for equations used to determine emission rates and scrubber removal efficiencies are presented in Appendix D.

#### Limitations

The information and opinions rendered in this report are exclusively for use by United States Steel Corporation. BTEC will not distribute or publish this report without United States Steel Corporation's consent except as required by law or court order. BTEC accepts responsibility for the competent performance of its duties in executing the assignment and preparing reports in accordance with the normal standards of the profession, but disclaims any responsibility for consequential damages.

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Todd Wessel  
Senior Project Manager

This report was reviewed by: Brandon Chase  
Brandon Chase  
Staff Environmental Engineer

## **Tables**

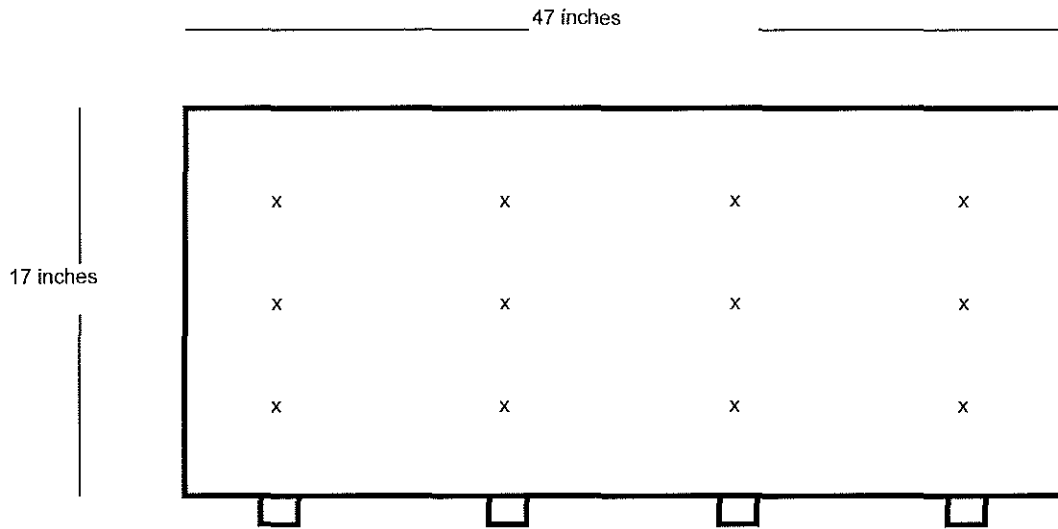


**Table 1**  
**No. 5 Pickle Line Scrubber Exhaust HCl Results Summary**

<b>Company</b>	<b>US Steel</b>			
<b>Source Designation</b>	<b>No. 5 Pickle Line Exhaust</b>			
<b>Test Date</b>	<b>8/11/2015</b>	<b>8/11/2015</b>	<b>8/11/2015</b>	
<b>Meter/Nozzle Information</b>	<b>P-1</b>	<b>P-2</b>	<b>P-3</b>	<b>Average</b>
Meter Temperature Tm (F)	78.6	86.3	89.8	84.9
Meter Pressure - Pm (in. Hg)	29.4	29.4	29.4	29.4
Measured Sample Volume (Vm)	44.0	44.9	46.4	45.1
Sample Volume (Vm-Std ft3)	42.11	42.4	43.6	42.7
Sample Volume (Vm-Std m3)	1.19	1.20	1.23	1.21
Condensate Volume (Vw-std)	6.884	7.921	7.544	7.450
Gas Density (Ps(std) lbs/ft3) (wet)	0.0706	0.0701	0.0704	0.0704
Gas Density (Ps(std) lbs/ft3) (dry)	0.0745	0.0745	0.0745	0.0745
Total weight of sampled gas (m g lbs) (wet)	3.46	3.53	3.60	3.53
Total weight of sampled gas (m g lbs) (dry)	3.14	3.16	3.25	3.18
Nozzle Size - An (sq. ft.)	0.000317	0.000317	0.000317	0.000317
Isokinetic Variation - I	102.1	103.3	102.6	102.7
<b>Stack Data</b>				
Average Stack Temperature - Ts (F)	117.8	118.0	118.0	117.9
Molecular Weight Stack Gas- dry (Md)	28.8	28.8	28.8	28.8
Molecular Weight Stack Gas-wet (Ms)	27.3	27.1	27.2	27.2
Stack Gas Specific Gravity (Gs)	0.943	0.937	0.941	0.940
Percent Moisture (Bws)	14.05	15.73	14.75	14.84
Water Vapor Volume (fraction)	0.1405	0.1573	0.1475	0.1484
Pressure - Ps ("Hg)	29.3	29.3	29.3	29.3
Average Stack Velocity - Vs (ft/sec)	47.1	47.8	48.9	47.9
Area of Stack (ft2)	5.5	5.5	5.5	5.5
<b>Exhaust Gas Flowrate</b>				
Flowrate ft <sup>3</sup> (Actual)	15,667	15,917	16,285	15,956
Flowrate ft <sup>3</sup> (Standard Wet)	14,008	14,226	14,555	14,263
Flowrate ft <sup>3</sup> (Standard Dry)	12,040	11,988	12,408	12,145
Flowrate m <sup>3</sup> (standard dry)	341	339	351	344
<b>Total HCl Weight (ug)</b>				
Total HCl	29,000	37,000	42,000	36,000
<b>Total HCl Concentration</b>				
lb/1000 lb (wet)	0.018	0.023	0.026	0.022
lb/1000 lb (dry)	0.020	0.026	0.028	0.025
mg/dscm (dry)	24.3	30.8	34.0	29.7
PPM (dry)	16.1	20.4	22.5	19.6
<b>Total HCl Emission Rate</b>				
lb/ hr	1.10	1.39	1.59	1.36

## Figures

Figure 1  
 US Steel No. 5 Pickle Line Exhaust Stack



x = sampling point

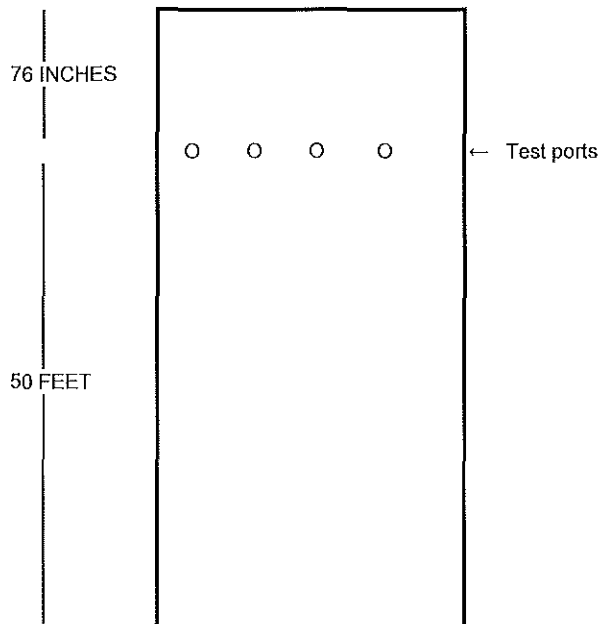
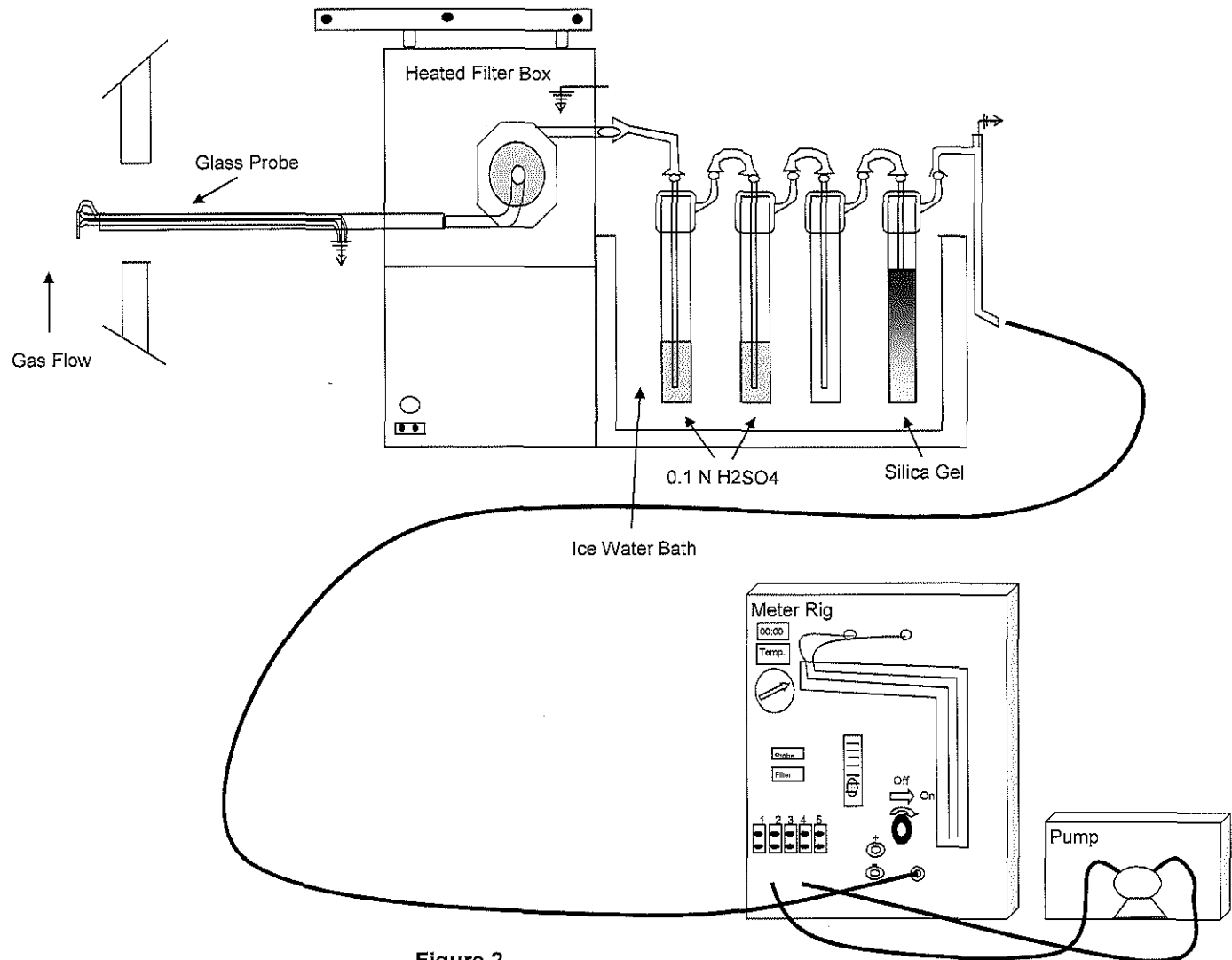


Figure 1

Site: No. 5 Pickle Line Exhaust United States Steel Ecorse, MI	Sampling Date: August 11, 2015	BT Environmental Consulting, Inc. 4949 Fernlee Ave Royal Oak, Michigan
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**Figure 2**

Site:  
USEPA Method 26A Sampling Train  
United States Steel  
Ecorse, MI

Sampling Date:  
August 11, 2015

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