BTEC Inc.

No. 5 Pickle Line Hydrogen Chloride Emission Test Report

Prepared for:

United States Steel Corporation

Ecorse, Michigan

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

Project No. 17-4956.01
April 6, 2017

BT Environmental Consulting, Inc.
4949 Fernlee Avenue
Royal Oak, Michigan 48073
(248) 548-8070

BTEC Inc.

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 inlet and exhaust stacks. The scrubber is located at the U. S. Steel facility in Ecorse, Michigan. The evaluation consisted of a single 75-minute test run, and duplicate 60-minute test runs at each 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
February 14, 2017

Unit	Emission Rates		Permit Limit	
	HCl (lb/hr)	HCl (PPMV, dry)	HCl (lb/hr)	HCl (PPMV, dry)
Pickle Line - Inlet	27.14	465.68		
Pickle Line - Outlet	0.89	15.20	1.64	18

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 Feb. 14, 2017 To Feb. 14, 2017

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

Submittal of Pickle Line Stack Test Conducted February 14, 2017 per CO 22-2016 9.A.3.

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.

Ronald Kostyo	General Manager	313-749-2210
Name of Responsible Official (print or type)	Title	Phone Number
Ronald Kostyo		4/13/17
Signature of Responsible Official		Date

* Photocopy this form as needed.

BTEC Inc.

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 inlet and exhaust stacks. The scrubber is located at the U. S. Steel facility in Ecorse, Michigan. The evaluation consisted of a single 75-minute test run, and duplicate 60-minute test runs at each 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, Mr. Shane Rabideau, Mr. David Trahan, and Mr. Jake Zott performed the testing on February 14, 2017. Mr. Nathan Ganhs 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. Detailed results for each source are presented in Tables 2-3.

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 3rd pickle tank. The acid solution then cascades from the 3rd tank to the 1st 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 January 24, 2017.

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.

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. Flowrates were not performed on the inlet stack.

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® combustion gas analyzers. Carbon dioxide and oxygen content were analyzed using the Fyrite® 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_2SO_4, (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_2SO_4), (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. The sampling at the inlet stack was performed non-isokinetically and flowrates were not measured.

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_2O), and the rinses added to the H_2SO_4 sample containers. The back-half of the filter holder was rinsed and added to the H_2SO_4 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. Maxxam Analytics' laboratories located in Mississauga, Ontario, Canada performed the analysis. All appropriate QA/QC measures were strictly adhered to. Results of the laboratory tests are included in Appendix C.

4.0 Test Results

Table 1
Test Program Results Summary
No. 5 Pickle Line Scrubber
February 14, 2017

Unit	Emission Rates		Permit Limit	
	HCl (lb/hr)	HCl (PPMV, dry)	HCl (lb/hr)	HCl (PPMV, dry)
Pickle Line - Inlet	27.14	465.68		
Pickle Line - Outlet	0.89	15.20	1.64	18

Overall results of the emissions test program are summarized by Table 1. Detailed results for each source are presented in Tables 2-3. 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. Process data is presented in Appendix E.

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.

This report was prepared by:_____
Todd Wessel
Senior Project Manager

This report was reviewed by:_____
Brandon Chase
Senior Environmental Engineer

Table 2
Pickle Line Inlet HCl Emission Rates

Company	**US Steel**			
Source Designation	**Pickle Inlet**			
Test Date	**2/14/2017**	**2/14/2017**	**2/14/2017**	
Meter/Nozzle Information	**P-1**	**P-2**	**P-3**	**Average**
Meter Temperature Tm (F)	73.4	77.0	76.8	75.7
Meter Pressure - Pm (in. Hg)	29.3	29.3	29.3	29.3
Measured Sample Volume (Vm)	54.1	43.4	44.1	47.2
Sample Volume (Vm-Std ft3)	52.8	42.0	42.8	45.9
Sample Volume (Vm-Std m3)	1.50	1.19	1.21	1.30
Condensate Volume (Vw-std)	9.902	7.921	8.298	8.707
Gas Density (Ps(std) lbs/ft3) (wet)	0.0701	0.0701	0.0700	0.0701
Gas Density (Ps(std) lbs/ft3) (dry)	0.0745	0.0745	0.0745	0.0745
Total weight of sampled gas (m g lbs) (wet)	4.40	3.50	3.57	3.82
Total weight of sampled gas (m g lbs) (dry)	3.94	3.13	3.19	3.42
Stack Data				
Molecular Weight Stack Gas- dry (Md)	28.8	28.8	28.8	28.8
Molecular Weight Stack Gas-wet (Ms)	27.1	27.1	27.1	27.1
Stack Gas Specific Gravity (Gs)	0.937	0.936	0.935	0.936
Percent Moisture (Bws)	15.78	15.85	16.25	15.96
Water Vapor Volume (fraction)	0.1578	0.1585	0.1625	0.1596
Pressure - Ps ("Hg)	29.2	29.2	29.2	29.2
Area of Stack (ft2)	5.6	5.6	5.6	5.6
Exhaust Gas Flowrate				
	Inlet flows not performed. Flows are assumed equal to the exhaust.			
Flowrate ft^3(Actual)	12,497	12,668	12,793	12,653
Flowrate ft^3 (Standard Wet)	11,358	11,505	11,619	11,494
Flowrate ft^3 (Standard Dry)	10,243	10,340	10,279	10,287
Flowrate m^3 (standard dry)	290	293	291	291
Total HCl Weight (ug)				
Total	930,000.00	920,000.00	870,000.00	906,666.67
Total HCl Concentration				
lb/1000 lb (wet)	0.466	0.579	0.537	0.527
lb/1000 lb (dry)	0.521	0.647	0.602	0.590
mg/dscm (dry)	621.7	772.8	718.2	704.2
PPM (dry)	411.10	511.02	474.93	465.68
Total HCl Emission Rate				
lb/ hr	23.85	29.93	27.65	27.14

Table 3
Pickle Line Exhaust HCl Emission Rates

Company	US Steel			
Source Designation	No. 5 Pickle Line Exhaust			
Test Date	2/14/2017	2/14/2017	2/14/2017	
Meter/Nozzle Information	P-1	P-2	P-3	Average
Meter Temperature Tm (F)	41.5	50.5	54.8	48.9
Meter Pressure - Pm (in. Hg)	29.2	29.4	29.4	29.3
Measured Sample Volume (Vm)	38.64	56.4	58.5	51.2
Sample Volume (Vm-Std ft3)	39.83	56.9	59.0	51.9
Sample Volume (Vm-Std m3)	1.13	1.61	1.67	1.47
Condensate Volume (Vw-std)	4.338	6.412	7.685	6.145
Gas Density (Ps(std) lbs/ft3) (wet)	0.0718	0.0717	0.0713	0.0716
Gas Density (Ps(std) lbs/ft3) (dry)	0.0745	0.0745	0.0745	0.0745
Total weight of sampled gas (m g lbs) (wet)	3.17	4.54	4.75	4.15
Total weight of sampled gas (m g lbs) (dry)	2.97	4.24	4.40	3.87
Nozzle Size - An (sq. ft.)	0.000301	0.000524	0.000524	0.000450
Isokinetic Variation - I	95.5	97.1	101.2	97.9
Stack Data				
Average Stack Temperature - Ts (F)	106.3	106.7	106.7	106.5
Molecular Weight Stack Gas- dry (Md)	28.8	28.8	28.8	28.8
Molecular Weight Stack Gas-wet (Ms)	27.8	27.7	27.6	27.7
Stack Gas Specific Gravity (Gs)	0.959	0.958	0.953	0.956
Percent Moisture (Bws)	9.82	10.13	11.53	10.49
Water Vapor Volume (fraction)	0.0982	0.1013	0.1153	0.1049
Pressure - Ps ("Hg)	29.2	29.2	29.2	29.2
Average Stack Velocity -Vs (ft/sec)	37.5	38.1	38.4	38.0
Area of Stack (ft2)	5.5	5.5	5.5	5.5
Exhaust Gas Flowrate				
Flowrate ft^3(Actual)	12,497	12,668	12,793	12,653
Flowrate ft^3 (Standard Wet)	11,358	11,505	11,619	11,494
Flowrate ft^3 (Standard Dry)	10,243	10,340	10,279	10,287
Flowrate m^3 (standard dry)	290	293	291	291
Total HCl Weight (ug)				
Total	18,000.00	40,000.00	47,000.00	35,000.00
Total HCl Concentration				
lb/1000 lb (wet)	0.013	0.019	0.022	0.018
lb/1000 lb (dry)	0.013	0.021	0.024	0.019
mg/dscm (dry)	16.0	24.8	28.1	23.0
PPM (dry)	10.55	16.42	18.61	15.20
Total HCl Emission Rate				
lb/ hr	0.61	0.97	1.09	0.89

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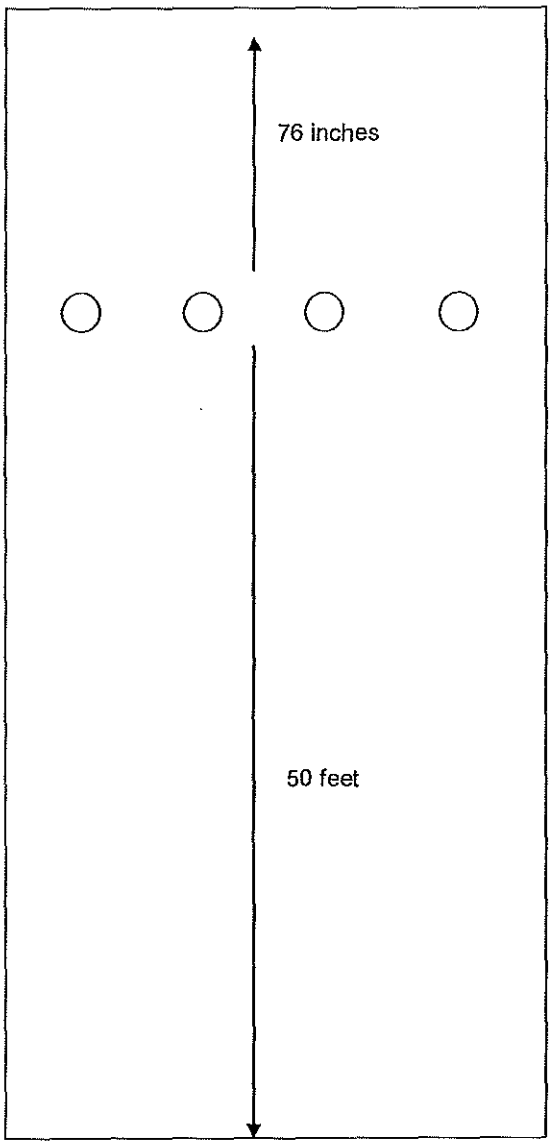

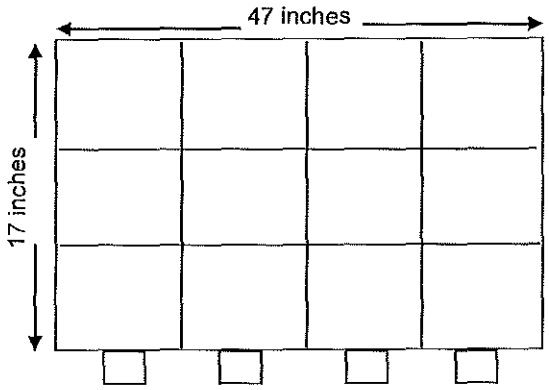

Not to Scale

Points	Distance "
1	2.8
2	8.5
3	14.2

Figure 1

Site: **No. 5 Pickle Line Exhaust** **US Steel** **Ecorse, Michigan**	**Sampling Date:** **February 14, 2017**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avc** **Royal Oak, Michigan**

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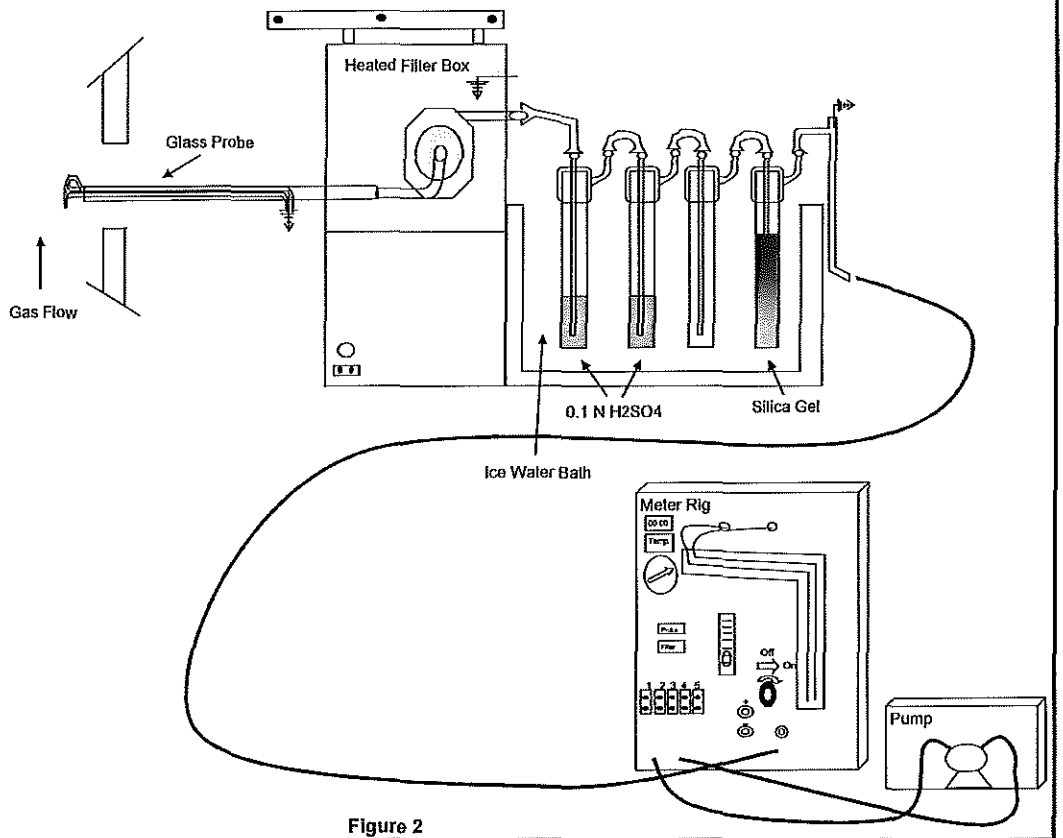

Figure 2

Site:	Sampling Date:	
USEPA Method 26A Sampling Train United States Steel Ecorse, MI	February 14, 2017	BT Environmental Consulting, Inc. 4949 Fernlee Ave Royal Oak, Michigan