BTEC Inc.

Cleaner Scrubber Emissions Test Report

Prepared for:

US Steel Corporation – Great Lakes Works

Ecorse, Michigan

US Steel Corporation – Great Lakes Works
No. 1 Quality Drive
Ecorse, Michigan 48229

Project No. 049AS-267241
May 2, 2018

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

EXECUTIVE SUMMARY

BT Environmental Consulting, Inc. (BTEC) was retained by United States Steel Corporation (US Steel) to conduct an evaluation of particulate matter (PM) on the Pre-Cleaner Scrubber exhaust. This emissions testing program included evaluation of particulate matter (PM). The permit specifies an emission limit of 0.26 pounds per hour for filterable PM. Testing took place on April 5, 2018.

Testing of the Pre-cleaner exhaust consisted of triplicate 60-Minute test runs. The emissions test program was required by MDEQ Air Quality Division Michigan Permit To Install 219-06B and 98-15. The results of the emission test program are summarized by Table I.

Table I
Overall Emission Summary
Test Date: April 5, 2018

Emission Unit	Pollutant	Permit Limit	Test Result
SVCOGALVSCRBR (Pre-Cleaner)	Particulate Matter (filterable)	0.26 lbs/hr	0.027 lbs/hr

1. Introduction

BT Environmental Consulting, Inc. (BTEC) was retained by United States Steel Corporation (US Steel) to conduct an evaluation of particulate matter (PM) on the Pre-Cleaner exhaust. This emissions testing program included evaluation of particulate matter (PM). The permit specifies an emission limit of 0.26 pounds per hour for filterable PM. Testing took place on April 5, 2018.

AQD has published a guidance document entitled "Format for Submittal of Source Emission Test Plans and Reports" (December 2013). The following is a summary of the emissions test program and results in the format suggested by the aforementioned document. All testing was performed in accordance with BTEC test plan 049AS-267241.

1.a Identification, Location, and Dates of Test

Sampling and analysis for the emission test program was conducted on April 5, 2018 at the US Steel facility located in Ecorse, Michigan.

1.b Purpose of Testing

AQD issued Permit To Install 219-06B and 98-15 requires testing. This test was conducted to satisfy that requirement. The permit limits are summarized by Table 1.

Table 1
Emission Limitations
United States Steel Corporation
Permit To Install 219-06B and 98-15 Emission Limitations

Emission Unit	Pollutant	Permit Limit
Pre-Cleaner	Particulate Matter (filterable)	0.26 lbs/hr

1.c Source Description

BTEC sampled the Hot Dip Galvanizing Line (HDGL) Pre-Cleaner outlet stack. The following is a description of the process.

Coils of steel are loaded into the entry end of the process and are uncoiled and straightened. Each leading edge of the next coil is welded to the preceding coil in order to allow the process to run continuously while production is occurring. In the Pre-Cleaner section of the HDGL process, the straightened coils are cleaned within caustic solution tanks, which are heated by a hot water and heat exchanger system. Emissions of dilute caustic generated in the cleaning process tanks are controlled by a mist eliminator and a scrubber before being exhausted to the outer atmosphere through the Pre-Cleaner stack.

After cleaning and rinsing, the coil is dried with hot air. After drying, the coil enters the Annealing Furnace. The coil is heated according to required specifications within the Annealing Furnace and then proceeds to the zinc pot where the steel is given a zinc coating (i.e. galvanized). Excess zinc is removed immediately upon exit of the molten zinc pot, and the zinc-coated steel strip is allowed to dry as it travels in a vertical direction. After air cooling, the strip is quenched in water, dried, inspected, and packaged for customer delivery.

1.d Test Program Contacts

The contacts for the source and test report are:

Mr. Todd Wessel
Senior Project Manager
BT Environmental Consulting, Inc.
4949 Fernlee Ave
Royal Oak, Michigan 48073
Phone (616) 885-4013

Mr. Nathan Ganhs
U. S. Steel Environmental
United States Steel Corporation
Great Lakes Works
No. 1 Quality Drive
Ecorse, Michigan 48229
(313) 749-3857

Names and affiliations for personnel who were present during the testing program are summarized by Table 2.

Table 2
Test Personnel

Name and Title	Affiliation	Telephone
Mr. Paul Diven Project Manager	BTEC 4949 Fernlee Avenue Royal Oak, MI 48073	(248) 548-8070
Mr. Paul Molenda Environmental Technician	BTEC 4949 Fernlee Avenue Royal Oak, MI 48073	(248) 548-8070
Mr. Jake Zott Environmental Technician	BTEC 4949 Fernlee Avenue Royal Oak, MI 48073	(248) 548-8070
Mr. David Trahan Environmental Technician	BTEC 4949 Fernlee Avenue Royal Oak, MI 48073	(248) 548-8070
Ms. Regina Hines MDEQ	MDEQ Air Quality Division	(313) 418-0895
Mr. Mark Dziadosz MDEQ	MDEQ Detroit District Office	(586) 753-3745

2. Summary of Results

Sections 2.a through 2.d summarize the results of the emissions compliance test program.

2.a Operating Data

CGL process rate, water flow rate across scrubber, and pressure drop across the scrubber were recorded during each run and can be found in Appendix E.

2.b Applicable Permit

AQD issued PTI's 219-06B and 98-15 to Facility SRN A7809, U. S. Steel.

2.c Results

See Table 1 in Section 1.b.

3. Source Description

Sections 3.a through 3.e provide a detailed description of the process.

3.a Process Description

See section 1.c.

3.b Process Flow Diagram

A process flow diagram is available on request.

3.c Raw and Finished Materials

The raw material used for coating the strip is zinc. A water scrubber and a mesh pad mist eliminator are used to control pre-cleaner emissions.

3.d Process Capacity

Galvanized steel: Max of 850,000 tons per year on 12 month rolling basis.

3.e Process Instrumentation

The amount of galvanized steel produced and the flow rate of water through the scrubber.

4. Sampling and Analytical Procedures

Sections 4.a through 4.d provide a summary of the sampling and analytical procedures used.

4.a Sampling Train and Field Procedures

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 Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources"(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 schematic of the sampling location). S-type pitot tubes with thermocouple assemblies, calibrated in accordance with Method 2, were 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.

A cyclonic flow check was performed at the sampling location. The existence of cyclonic flow is determined by measuring the flow angle at each sample point. The flow angle is the angle between the direction of flow and the axis of the stack. If the average of the absolute values of the flow angle is greater than 20 degrees, cyclonic flow exists. The null angle was determined to be less than 20 degrees at each sampling point.

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 using Method 4. Exhaust gas was extracted as part of the PM sampling trains and passed through the impinger configuration (see Figure 2). Exhaust gas moisture content was then determined gravimetrically.

4.b *Filterable Particulate Matter (USEPA Method 5)*

40 CFR 60, Appendix A, Method 5, "Determination of Particulate Emissions from Stationary Sources" was used to measure PM concentrations and calculate appropriate emission rates (see Figure 2 for a schematic of the sampling train).

BTEC's Nutech® Model 2010 modular isokinetic stack sampling system consisted of (1) a stainless steel nozzle, (2) a glass probe, (3) a set of four Greenburg-Smith (GS) impingers with the first two with 100 ml of H2O (ii) an empty impinger, (iii) and an impinger filled with approximately 300 grams of silica gel, (4) a length of sample line, and (5) a Nutech® control case equipped with a pump, dry gas meter, and calibrated orifice.

Upon completion of the final leak test for each test run, the filter was recovered, and the nozzle, probe, and the front half of the filter holder assembly were brushed and triple rinsed with 100 ml of acetone which was collected in a pre-cleaned sample container.

BTEC labeled each container with the test number, test location, and test date, and marked the level of liquid on the outside of the container. In addition, blank samples of the acetone and filter were collected. BTEC personnel carried all samples to BTEC's laboratory (for filter and acetone gravimetric analysis) in Royal Oak, Michigan.

4.c Recovery and Analytical Procedures

Filterable particulate matter samples were processed at BTEC's laboratory in Royal Oak, Michigan.

4.d Sampliug Ports

A diagram of the stack showing sampling ports in relation to upstream and downstream disturbances are included as Figure 1.

4.e Traverse Points

A diagram of the stack indicating traverse point locations and stack dimensions are included as Figure 1.

5. Test Results aud Discussion

Sections 5.a through 5.k provide a summary of the test results.

5.a Results Tabulation

The overall results of the emissions test program are summarized by Table 3. Detailed results for the emissions test program are summarized by Table 4.

Table 3
Overall Emission Summary
Test Date: April 5, 2018

Emission Unit	Pollutant	Permit Limit	Test Result
SVCOGALVSCRBR (Pre-Cleaner)	Particulate Matter (filterable)	0.26 lbs/hr	0.027 lbs/hr

5.b Discussion of Results

The test results for filterable PM were below the permit limit.

5.c Sampling Procedure Variations

There were no sampling variations used during the emission compliance test program.

5.d Process or Control Device Upsets

Run 1 was thrown out due to excess water in the scrubber system, causing an excess of water through the sampling system. Due to the test taking place a short time after the CGL was shut down and subsequently started up, the dampers for the alkali tanks drifted off their set points. This caused excess moisture through to the scrubber due to the lack of adequate draft. Once the dampers were adjusted, the test was completed without any

further issues. BTEC re-preformed all preliminary checks before re-starting the test protocol.

5.e Control Device Maintenance

No maintenance was performed on the scrubber.

5.f Re-Test

The emissions test program was not a re-test.

5.g Audit Sample Analyses

No audit samples were collected as part of the test program.

5.h Calibration Sheets

Relevant equipment calibration documents are provided in Appendix B.

5.i Sample Calculations

Sample calculations are provided in Appendix C.

5.j Field Data Sheets

Field documents relevant to the emissions test program are presented in Appendix A.

5.k Laboratory Data

Laboratory analytical results for this test program are presented in Appendix D.

MEASUREMENT UNCERTAINTY STATEMENT

Both qualitative and quantitative factors contribute to field measurement uncertainty and should be taken into consideration when interpreting the results contained within this report. Whenever possible, Montrose Air Quality Services, LLC, (MAQS) personnel reduce the impact of these uncertainty factors through the use of approved and validated test methods. In addition, MAQS personnel perform routine instrument and equipment calibrations and ensure that the calibration standards, instruments, and equipment used during test events meet, at a minimum, test method specifications as well as the specifications of our Quality Manual and ASTM D 7036-04. The limitations of the various methods, instruments, equipment, and materials utilized during this test have been reasonably considered, but the ultimate impact of the cumulative uncertainty of this project is not fully identified within the results of this report.

Limitations

All testing performed was done in conformance to the ASTM D7036-04 standard. The information and opinions rendered in this report are exclusively for use by U.S. Steel. BTEC will not distribute or publish this report without U.S. Steel'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:_____

Paul Diven
Project Manager

This report was reviewed by:_____

Brandon Chase
QA/QC Manager

Table 4
Pre-Cleaner Scrubber Particulate Matter Emission Rates

Company	**US Steel**			
Source Designation	**TSP Scrubber**			
Test Date	**4/5/2018**	**4/5/2018**	**4/5/2018**	
Meter/Nozzle Information	Run 2	Run 3	Run 4	Average
Meter Temperature Tm (F)	66.0	70.9	73.9	70.3
Meter Pressure - Pm (in. Hg)	29.8	29.8	29.7	29.7
Measured Sample Volume (Vm)	51.4	54.2	53.8	53.1
Sample Volume (Vm-Std ft3)	50.8	53.0	52.3	52.0
Sample Volume (Vm-Std m3)	1.44	1.50	1.48	1.47
Condensate Volume (Vw-std)	10.892	11.740	12.118	11.583
Gas Density (Ps(std) lbs/ft3) (wet)	0.0696	0.0695	0.0693	0.0694
Gas Density (Ps(std) lbs/ft3) (dry)	0.0745	0.0745	0.0745	0.0745
Total weight of sampled gas (m g lbs) (wet)	4.29	4.50	4.46	4.42
Total weight of sampled gas (m g lbs) (dry)	3.78	3.95	3.89	3.88
Nozzle Size - An (sq. ft.)	0.000234	0.000234	0.000234	0.000234
Isokinetic Variation - I	96.2	100.0	100.5	98.9
Stack Data				
Average Stack Temperature - Ts (F)	135.8	135.6	138.9	136.8
Molecular Weight Stack Gas- dry (Md)	28.8	28.8	28.8	28.8
Molecular Weight Stack Gas-wet (Ms)	26.9	26.9	26.8	26.9
Stack Gas Specific Gravity (Gs)	0.930	0.928	0.925	0.928
Percent Moisture (Bws)	17.67	18.13	18.82	18.21
Water Vapor Volume (fraction)	0.1767	0.1813	0.1882	0.1821
Pressure - Ps ("Hg)	29.6	29.6	29.5	29.6
Average Stack Velocity -Vs (ft/sec)	86.9	87.8	87.5	87.4
Area of Stack (ft2)	2.9	2.9	2.9	2.9
Exhaust Gas Flowrate				
Flowrate ft^3(Actual)	15,035	15,191	15,134	15,120
Flowrate ft^3 (Standard Wet)	13,175	13,315	13,169	13,220
Flowrate ft^3 (Standard Dry)	10,847	10,902	10,690	10,813
Flowrate m^3 (standard dry)	307	309	303	306
Total Particulate Weights (mg)				
Nozzle/Probe/Filter	0.5	2.0	0.5	1.0
Total Particulate Concentration				
lb/1000 lb (wet)	0.0003	0.0010	0.0002	0.0005
lb/1000 lb (dry)	0.0003	0.0011	0.0003	0.0006
mg/dscm (dry)	0.3	1.3	0.3	0.7
gr/dscf	0.0002	0.0006	0.0001	0.0003
Total Particulate Emission Rate				
lb/ hr	0.014	0.055	0.014	0.027

Note: Runs 2 and 4 front half particulate gain was below detection limit of 0.5mg and has been reported as the detection limit.

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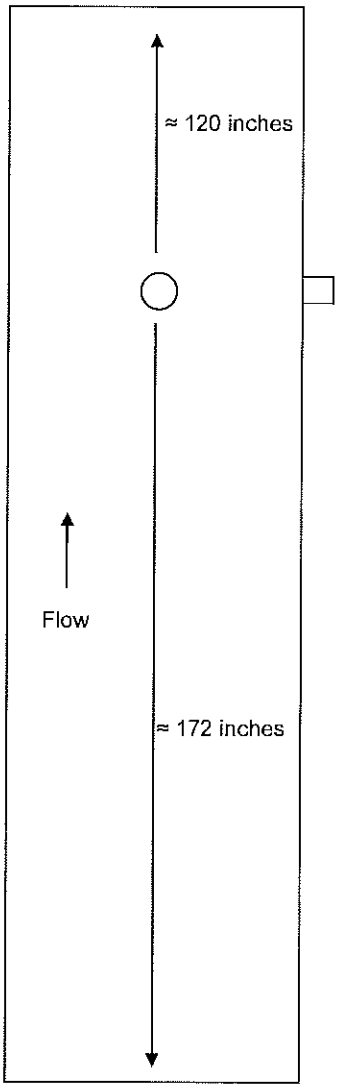
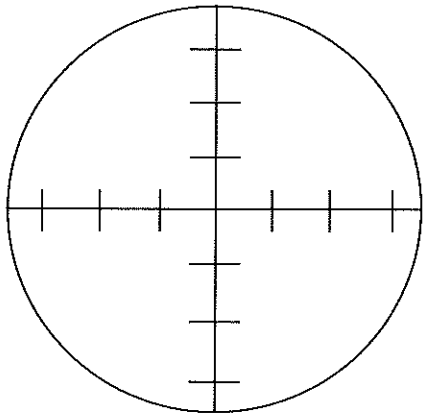
diameter = 23 inches





Not to Scale

Points	Distance "
1	1.0
2	3.4
3	6.8
4	16.2
5	19.6
6	22.0

Figure No. 1

Site: **CGL Scrubber** **US Steel** **Ecorse, Michigan**	**Sampling Date:** **April 5, 2018**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**

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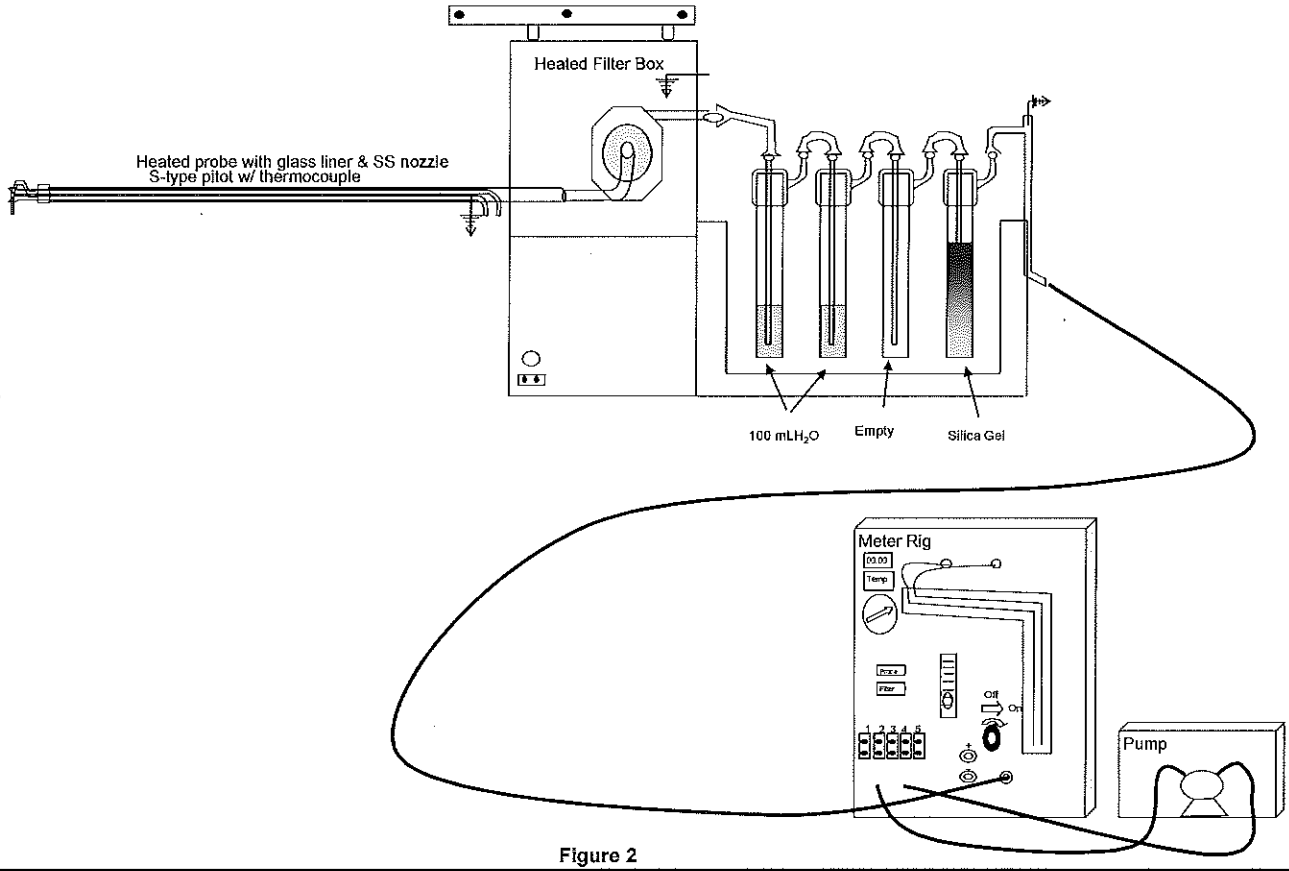

Figure 2

Site:	Sampling Date:	
USEPA Method 5 US Steel Ecorse, Michigan	April 5, 2018	BT Environmental Consulting, Inc. 4949 Fernlee Avenue Royal Oak, Michigan 48073