BTEC Inc.

No. 2 BOP No. 2 Baghouse Particulate Matter Emissions Test Report

Prepared for:

United States Steel Corporation

Ecorse, Michigan

United States Steel Corporation
Great Lakes Works
No. 1 Quality Drive
Ecorse, Michigan 48229

Project No. 14-4624.00
March 5, 2015

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, Great Lakes Works (U. S. Steel) to evaluate Particulate Matter (PM) from the No. 2 Basic Oxygen Process (BOP) No. 2 Baghouse at the U. S. Steel facility located at No. 1 Quality Drive in Ecorse, Michigan. The testing is being performed as a compliance demonstration for permit No. 199600132d. The particulate testing program was conducted on January 22-23, 2015.

The No. 2 Baghouse controls emissions from the BOP hot metal transfer, desulfurization and skimming operations. The testing consisted of triplicate test runs of varying duration. The results of the emission test program are summarized by Table I.

Table I

Executive Summary Table PM Emission Rate Summary

Source	Emission Rate	Permit Limit
No. 2 BOP No. 2 Baghouse	0.44 lb/hr	4.65 lb/hr
	0.0003 gr/dscf	0.0029 gr/dscf

gr/dscf: Grains (particulate) per dry standard cubic foot

BTEC Inc.

1. Introduction

BT Environmental Consulting, Inc. (BTEC) was retained by United States Steel Corporation (U. S. Steel) to provide compliance air testing for Particulate Matter from the No. 2 BOP No. 2 Baghouse (No. 2 Baghouse) exhaust. The No. 2 Baghouse is located at the US Steel facility in Ecorse, Michigan. The testing is being performed as a compliance demonstration for permit No. 199600132d. The particulate testing program was conducted on January 22-23, 2015. The purpose of this report is to document the results of the test program.

AQD has published a guidance document entitled "Format for Submittal of Source Emission Test Plans and Reports" (December 2013). This document is provided as Appendix A. The following is a summary of the emissions test plan in the format suggested by the AQD test plan format guide.

1.a Identification, Location, and Dates of Test

Sampling and analysis for the emission test program was conducted on January 22-23, 2015 at the U. S. Steel facility in Ecorse, Michigan. The test program included evaluation of PM emissions from the No. 2 Baghouse exhaust stack.

1.b Purpose of Testing

Permit No. ROP 199600132d, issued by State of Michigan Division of Environmental Quality, governs this process.

The allowable particulate emission rate by permit is:
0.0029 grains per dry standard cubic foot of exhaust air
4.65 pounds per hour

1.c Source Description

The source tested is the No. 2 Baghouse exhaust stack. The No. 2 Baghouse controls emissions from the BOP hot metal transfer, desulfurization and skimming operations.

1.d Test Program Contact

The contacts for the source are:

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

Mr. Brad Wargnier
U. S. Steel Environmental
United States Steel Corporation
Great Lakes Works
No. 1 Quality Drive
Ecorse, Michigan 48229
(313) 749-2744

1.e Testing Personnel

Names and affiliations for personnel who were present during the testing program are summarized by Table 1.

Table 1
Testing Personnel Summary

Name and Title	Affiliation	Telephone
Mr. Brad Wargnier Environmental Department	U.S. Steel No. 1 Quality Drive Ecorse, Michigan 48229	(313) 749-2744
Mr. Todd Wessel Senior Project Manager	BTEC 4949 Fernlee Avenue Royal Oak, MI 48073	(248) 548-8072
Mr. Paul Molenda Environmental Technician	BTEC 4949 Fernlee Avenue Royal Oak, MI 48073	(248) 548-8072

2. Summary of Results

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

2.a Operating Data

Operating data monitored includes the amount of hot metal transferred, desulfurization time, approximate skim time, heat number and baghouse pressure drop.

2.b Applicable Permit

The applicable permit for this emissions test program is ROP No. 199600132d.

2.c Results

The overall results of the emission test program are summarized by Table 2 (see Section 5.a). Detailed results for each run can be found in table 3.

2.d Emission Regulation Comparison

The results summarized by table 2 (section 5.a) shows that the PM emissions are well below the limits summarized by section 1.b.

3. Source Description

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

3.a Process Description

The No. 2 BOP Shop receives and processes molten iron (hot metal) produced at the plant's blast furnaces on Zug Island and prepares it for the conversion to steel at the No. 2 BOP Shop in vessels 25 and 26.

There are two hot metal transfer stations one primary and one auxiliary (used in emergencies), two desulfurization/slag skimming stations at the facility. The process steps at the No. 2 BOP Shop stations are as follows:

1. Hot metal in torpedo cars is delivered from the blast furnaces.
2. Hot metal is transferred (poured) from the torpedo car into a charging ladle.
3. The charging ladle is moved into position at the desulfurization station. A lance is lowered in the charging ladle into position.
4. A powdered desulfurization agent is blown through the lance using an inert carrier gas and injected by fluid momentum into the hot metal bath. Desulfurization agent is injected for time periods and in amounts calculated to meet the desired sulfur specification.
5. The charging ladle is tilted to the slag skimming position where the slag is skimmed from the surface of the hot metal.
6. After skimming the charging ladle is removed from the desulfurization/slag skimming station for further processing.

3.b Raw and Finished Materials

Raw Material used includes hot metal and a powdered desulfurization agent.

3.c Process Capacity

EG2BOP-HMT - typical batches consist of 205-240 tons of liquid iron for the desulfurization.

3.d Process Instrumentation

The only process operating parameters relevant to the emissions test program is the baghouse pressure drop. Also note that one on the nine baghouse compartments was isolated for the testing event. This was done to represent the baghouse operating while maintenance or inspection was conducted on the isolated chamber.

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 was 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"*
- Method 4 - *"Determination of Moisture Content in Stack Gases"*
- Method 17 - *"Determination of Particulate Emissions from Stationary Sources (In Stack Filtration)"*

Stack gas velocity traverses were conducted in accordance with the procedures outlined in Methods 1 and 2. Figure 1 presents the test port and traverse/sampling point locations used. A cyclonic flow evaluation was conducted at each sampling location. An S-type pitot tube and thermocouple assembly calibrated in accordance with Method 2, Section 4.1.1 was used to measure exhaust gas velocity pressures and temperatures during testing. Because the pitot tube dimensions outlined in Sections 2.6 through 2.8 were within the specified limits, the baseline pitot tube coefficient of 0.84 (dimensionless) was assigned for this testing.

Molecular weight determinations were conducted according to Method 3. The equipment used for this evaluation consisted of a one-way squeeze bulb with connecting tubing and a set of Fyrite® combustion gas analyzers. Moisture content was determined from the condensate collected in the Method 17 sampling train according to Method 4.

Method 17 was used to measure particulate concentrations and calculate particulate emission rates from the exhaust stack (see Figure 2 for sampling train schematic diagram) BTEC's Nutech® Model 2010 modular isokinetic stack sampling system consisted of (1) a stainless-steel button-hook nozzle, (2) a stainless steel in stack filter holder with a pre weighed glass fiber filter, (3) a steel sample probe with a tygon tubing transfer line, (4) a modified GS impinger containing approximately 300 g of silica gel desiccant, (5) a length of sample line, and (6) a Nutech® control case equipped with a pump, dry gas meter, and calibrated orifice.

A sampling train and pitot tube leak test was conducted before and after each test run. Upon completion of the final leak check for each test run, the filter was recovered, and the nozzle and the front half of the filter holder assembly were brushed and triple rinsed with acetone. The acetone rinses were collected in a pre-cleaned sample containers.

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 transported the filters and acetone fractions to BTEC's laboratory in Royal Oak, Michigan for gravimetric analysis.

4.b Recovery and Analytical Procedures

Recovery and analytical procedures were described in Section 4.a.

4.c Sampling Ports

Sampling ports are located on the stack and meet method 1 criteria.

4.d Traverse Points

Sampling port and traverse point locations for the No. 2 Baghouse exhaust stack are illustrated by Figure 1.

5. Test Results and Discussion

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

5.a Results Tabulation

The results of the emissions test program are summarized by Table 2.

Table 2

Test Program PM Emission Rates Summary

Source	Emission Rate	Permit Limit
No. 2 BOP No. 2 Baghouse	0.44 lb/hr	4.65 lb/hr
	0.0003 gr/dscf	0.0029 gr/dscf

gr/dscf: Grains (particulate) per dry standard cubic foot

Detailed data for each test run can be found in Table 3.

5.b Discussion of Results

Emission limitations for Permit No. 199600132d are summarized by section 1b. The results of the emissions test program are summarized by Table 2 (see section 5.a). Detailed results for each run are summarized by Table 3.

5.c Sampling Procedure Variations

Due to the cold ambient temperatures and lack of substantial moisture in the process a request was made to eliminate the first three impingers in the back half of the sample train.

5.d Process or Control Device Upsets

No upset conditions occurred during testing.

5.e Control Device Maintenance

No maintenance was performed during the test program.

5.f Audit Sample Analyses

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

5.g Calibration Sheets

Relevant equipment calibration documents are provided as Appendix B.

5.h Sample Calculations

Sample calculations are provided in Appendix C.

5.i Field Data Sheets

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

5.j Laboratory Data

Laboratory results are presented in Appendix D.

Table 3
No. 2 BOP No. 2 Baghouse PM Emission Rate Summary

Company	**US Steel**			
Source Designation	**No. 2 Baghouse**			
Test Date	**1/22/2015**	**1/22/2015**	**1/23/2015**	
Meter/Nozzle Information	P-1	P-2	P-3	Average
Meter Temperature Tm (F)	66.4	75.3	68.9	70.2
Meter Pressure - Pm (in. Hg)	29.9	29.9	29.8	29.8
Measured Sample Volume (Vm)	75.9	83.0	75.0	78.0
Sample Volume (Vm-Std ft3)	77.1	82.9	75.6	78.5
Sample Volume (Vm-Std m3)	2.18	2.35	2.14	2.22
Condensate Volume (Vw-std)	0.283	0.330	0.330	0.314
Gas Density (Ps(std) lbs/ft3) (wet)	0.0744	0.0744	0.0744	0.0744
Gas Density (Ps(std) lbs/ft3) (dry)	0.0745	0.0745	0.0745	0.0745
Total weight of sampled gas (m g lbs) (wet)	5.76	6.19	5.65	5.87
Total weight of sampled gas (m g lbs) (dry)	5.75	6.18	5.63	5.85
Nozzle Size - An (sq. ft.)	0.000322	0.000322	0.000322	0.000322
Isokinetic Variation - I	100.5	101.2	100.0	100.6
Stack Data				
Average Stack Temperature - Ts (F)	71.2	70.2	69.9	70.4
Molecular Weight Stack Gas- dry (Md)	28.8	28.8	28.8	28.8
Molecular Weight Stack Gas-wet (Ms)	28.8	28.8	28.8	28.8
Stack Gas Specific Gravity (Gs)	0.994	0.994	0.994	0.994
Percent Moisture (Bws)	0.37	0.40	0.43	0.40
Water Vapor Volume (fraction)	0.0037	0.0040	0.0043	0.0040
Pressure - Ps ("Hg)	29.7	29.7	29.6	29.6
Average Stack Velocity -Vs (ft/sec)	50.6	46.9	49.9	49.1
Area of Stack (ft2)	63.6	63.6	63.6	63.6
Exhaust Gas Flowrate				
Flowrate ft^3(Actual)	192,858	178,771	190,426	187,352
Flowrate ft^3 (Standard Wet)	190,035	176,480	187,400	184,638
Flowrate ft^3 (Standard Dry)	189,340	175,780	186,585	183,902
Flowrate m^3 (standard dry)	5,362	4,978	5,284	5,208
Total Particulate Weights (mg)				
Nozzle/Probe/Filter	1.6	2.1	0.6	1.4
Total Particulate Concentration				
lb/1000 lb (wet)	0.001	0.001	0.000	0.001
lb/1000 lb (dry)	0.001	0.001	0.000	0.001
mg/dscm (dry)	0.7	0.9	0.3	0.6
gr/dscf	0.0003	0.0004	0.0001	0.0003
Total Particulate Emission Rate				
lb/ hr	0.52	0.59	0.20	0.44

Figures

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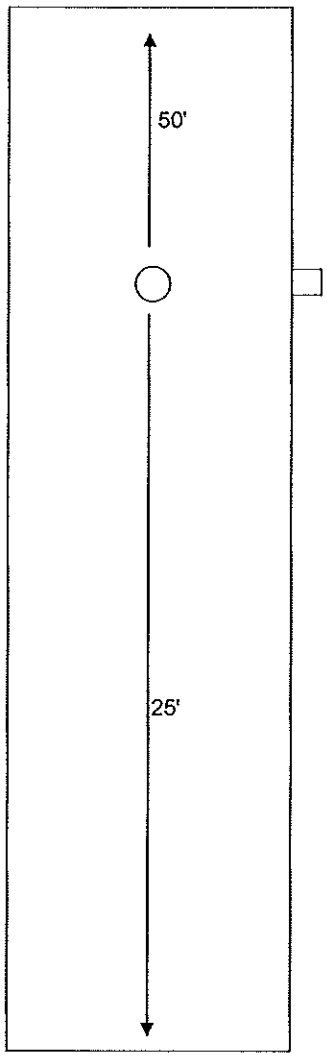
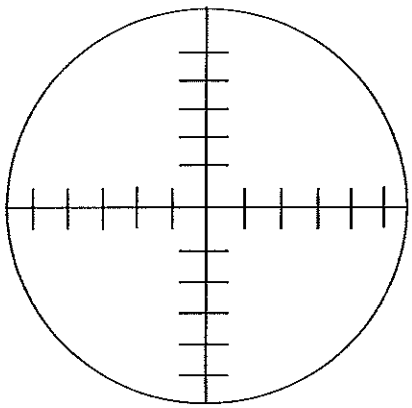
diameter = 108 inches





Not to Scale

Points	Distance "
1	2.8
2	8.9
3	15.8
4	24.4
5	36.9
6	71.1
7	83.6
8	92.2
9	99.1
10	105.2

Figure No. 1

Site: **No. 2 Baghouse** **US Steel** **Ecorse, Michigan**	**Sampling Date:** **January 22-23, 2015**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**

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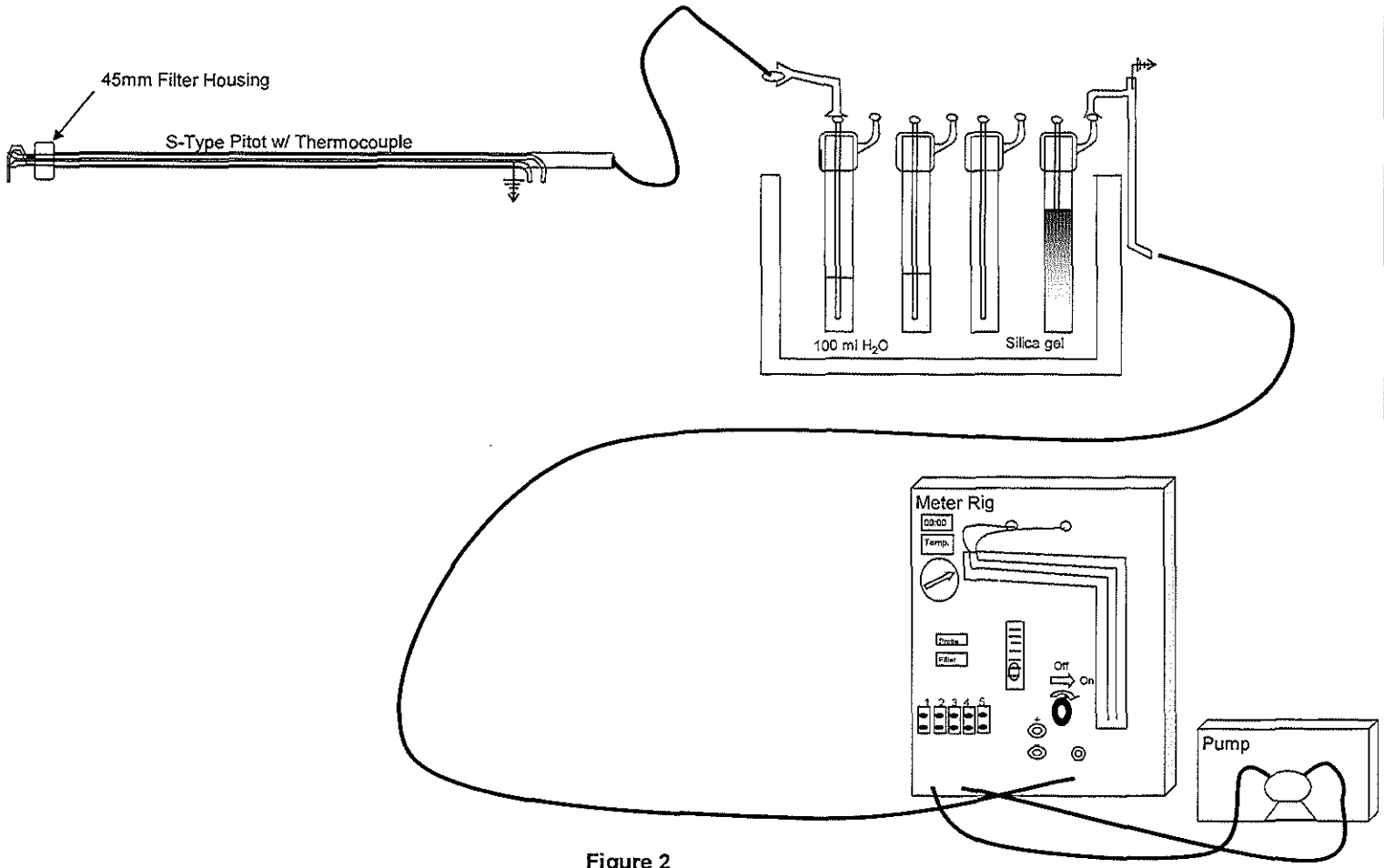

Figure 2

Site: **USEPA Method 17** **United States Steel Corp.** **No. 2 Baghouse** **Ecorse, Michigan**	**Sampling Date:** **January 22-23, 2015**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**