BTEC Inc.

# D Blast Furnace Baghouse Particulate 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. 049AS-278010
May 18, 2018

BT Environmental Consulting, Inc.
4949 Fernlee Avenue
Royal Oak Michigan 48073
(248) 548-8072

## EXECUTIVE SUMMARY

BT Environmental Consulting, Inc. a Montrose Environmental Company (BTEC) was retained by United States Steel Corporation (U. S. Steel) to provide compliance air testing for Particulate Matter (PM) rates and opacity from the D4 Blast Furnace Baghouse exhaust. The D4 Blast Furnace Baghouse is located at the U. S. Steel facility on Zug Island in River Rouge, Michigan. The testing is being performed as a compliance demonstration for permit No. 199600132d. The particulate testing program was conducted on April 3, 2018.

Testing consisted of triplicate test runs measuring 87, 93, and 204 minutes in length. The emissions test program is required by MDEQ Air Quality Division Renewable Operating Permit No. 199600132d. The results of the emission test program are summarized by Table I.

**Table I**

**Executive Summary Table PM Emission Rate Summary**

| Source | Emission Rate | Emission Factor |
|---|---|---|
| D4 Blast Furnace Baghouse | 0.002 gr/dscf | 0.019 lb PM/ton iron |
| | 4.52 lb/hr | |
| | 7.56 lb/cycle | |

## 1. Introduction

BT Environmental Consulting, Inc. a Montrose Environmental Company (BTEC) was retained by United States Steel Corporation (U. S. Steel) to provide compliance air testing for Particulate Matter (PM) from the D4 Blast Furnace Baghouse exhaust. The D4 Blast Furnace Baghouse is located at the U. S. Steel facility on Zug Island in River Rouge, Michigan. The testing is being performed as a compliance demonstration for permit No. 199600132d. The particulate testing program was conducted on April 3, 2018. 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). 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 April 3, 2018 at the U. S. Steel facility on Zug Island in River Rouge, Michigan. The test program included evaluation of PM emissions from the D4 Blast Furnace Baghouse exhaust stack.

### 1.b Pnrpose of Testing

Michigan Renewable Operating Permit No. 199600132d includes (in Tables E-01.14 and F-01.05) the emission limitations listed in Table 1. As per Permit 199600132d Table F-01.05, Section B (page 90), U. S. Steel is required to develop a particulate emission factor for the blast furnace control device. Testing for the emission factor shall encompass at least one full cycle of production operations (i.e., cast to cast) per run. In addition, the production rates shall be measured.

In addition, the D4 Blast Furnace is affected by the National Emission Standard for Hazardous Air Pollutants for Integrated Iron and Steel Manufacturing Facilities codified at Title 40, Part 63, Subpart FFFFF of the Code of Federal Regulations (40 CFR 63, Subpart FFFFF).

**Table 1**
**Renewable Operating Permit No. 199600132d Emission Limitations**

| Pollutant | Emission Limitation | Emission Limitation Units |
|---|---|---|
| PM | 0.0052 | gr/dscf (Permit) |
| PM | 0.01 | gr/dscf (NESHAP) |
| Opacity | 10% (6 minute average) Baghouse Stack | % |
| Opacity | 20% (6 minute average) Casthouse Roof Monitor | % |

### 1.c Source Description

The source tested is the D4 Blast Furnace Baghouse exhaust stack.

### 1.d Test Program Contact

The contacts for the source are:

Mr. Todd Wessel
Client Project Manager
BT Environmental Consulting, Inc. a
Montrose Air Quality Company
4949 Fernlee Avenue
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) 749-2744

### 1.e Testing Personnel

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. Nathan Ganhs<br>Environmental Department | U. S. Steel<br>No. 1 Quality Drive<br>Ecorse, Michigan 48229 | (313) 749-3857 |
| Mr. Todd Wessel<br>Senior Project Manager | BTEC<br>4949 Fernlee Avenue<br>Royal Oak, MI 48073 | (616) 885-4013 |
| Mr. Paul Molenda<br>Environmental Technician | BTEC<br>4949 Fernlee Avenue<br>Royal Oak, MI 48073 | (248) 548-8072 |
| Mr. Mark Dziadoaz<br>Technical Programs Unit<br>Field Operations Section<br>Air Quality Division | Department of<br>Environmental Quality Air<br>Quality Division<br>3058 W. Grand Blvd.,<br>Suite 2-300<br>Detroit Michigan 48202-<br>6058 | 586-753-3745 |

## 2. Summary of Resnlts

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

### 2.a Operating Data

Relevant operating data is available in Appendix E.

### 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 3 (see Section 5.a). Detailed results for each run can be found in Table 4.

### 2.d Emission Regulatiou Comparisou

The results summarized by table 2 (section 5.a) shows that the PM emissions are 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 blast furnace is a tall shaft-type furnace with a vertical stack superimposed over a crucible-like hearth. Iron-bearing materials (iron ore, pellets, mill scale, steel making slag, scrap, etc.), coke and flux (limestone calcite), are charged into the top of the shaft. A blast of heated air and also, in most instances, a gaseous, liquid or powdered fuel are introduced through openings at the bottom of the shaft just above the hearth crucible. The heated air burns the injected fuel and most of the coke charged in from the top to produce the heat required by the process and to provide reducing gas that removes oxygen from the ore. The reduced iron melts and runs down to the bottom of the hearth. The flux combines with the impurities in the ore to produce a slag that also melts and accumulates on top of the liquid iron in the hearth. From time to time, the iron and slag are drained from the furnace through a tap hole

### 3.b Raw and Finished Materials

Iron ore, pellets, mill scale, steel making slag, scrap, etc., coke and flux (limestone calcite).

### 3.c Process Capacity

The FGBLASTFURNACES-A, B&D are limited to 3,718,000 tons of iron produced per 12-month rolling time period at the end of each calendar month (R336.1205(3)).

### 3.d Process Instrumentation

Process instrumentation measured during the test program includes iron ore charge, scrap charge, natural gas flow, and the pressure drop across the baghouse.

## 4. Sampliug and Analytical Procedures

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

## 4.a Sampling Traiu 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"*

Stack gas velocity traverses were conducted in accordance with the procedures outlined in Methods 1 and 2. Figure 2 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 1 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 tarred glass fiber filter (3) steel sample probe, (4) a set of four Greenburg-Smith (GS) impingers with the first and third modified and second standard GS impingers each containing 100 ml of deionized water, and a fourth 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 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 transported the filters and acetone fractions to BTEC's laboratory in Royal Oak, Michigan for gravimetric analysis.

40 CFR 60, Appendix A, Method 9, *"Visual Determination of the Opacity of Emissions from Stationary Sources"* was used to measure opacity. Triplicate test runs of varying durations were conducted during casting operations. Individual opacity run data can be found in Appendix F.

### 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 D4 Blast Furnace Baghouse exhaust stack are illustrated by Figure 2.

## 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 3.

**Table 3**
**Test Program PM Emission Rate Summary**

| Source | Emission Rate | Emission Factor |
|---|---|---|
| D4 Blast Furnace Baghouse | 0.002 gr/dscf | 0.019 lbs PM/ton iron |
| | 4.52 lb/hr | |
| | 7.56 lb/cycle | |

Detailed data for each test run can be found in Table 4.

### 5.b Discussion of Results

Emission limitations for Permit No. 199900014 are summarized by section 1b. The results of the emissions test program are summarized by Table 3 (see section 5.a). Detailed results for each run are summarized by Table 4.

### 5.c Sampling Procedure Variations

None

### 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. Opacity data sheets are presented in Appendix F.

### 5.j Laboratory Data

Laboratory results 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 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:_____

Paul Diven
Field Project Manager

This report was reviewed by:_____

Brandon Chase
QA/QC Manager

**Table 4**
**D4 Blast Furnace Particulate Matter Emission Rates**

| Company | US Steel | | | |
|---|---|---|---|---|
| Source Designation | D Blast furnace Baghouse | | | |
| Test Date | 4/3/2018 | 4/3/2018 | 4/3/2018 | |
| **Meter/Nozzle Information** | P-1 | P-2 | P-3 | Average |
| Meter Temperature Tm (F) | 62.9 | 72.6 | 75.2 | 70.2 |
| Meter Pressure - Pm (in. Hg) | 29.6 | 29.4 | 29.3 | 29.5 |
| Measured Sample Volume (Vm) | 73.2 | 83.1 | 174.6 | 110.3 |
| Sample Volume (Vm-Std ft3) | 74.8 | 82.8 | 172.4 | 110.0 |
| Sample Volume (Vm-Std m3) | 2.12 | 2.34 | 4.88 | 3.11 |
| Condensate Volume (Vw-std) | 0.613 | 0.613 | 1.650 | 0.959 |
| Gas Density (Ps(std) lbs/ft3) (wet) | 0.0743 | 0.0743 | 0.0743 | 0.0743 |
| Gas Density (Ps(std) lbs/ft3) (dry) | 0.0745 | 0.0745 | 0.0745 | 0.0745 |
| Total weight of sampled gas (m g lbs) (wet) | 5.60 | 6.20 | 12.92 | 8.24 |
| Total weight of sampled gas (m g lbs) (dry) | 5.57 | 6.17 | 12.85 | 8.20 |
| Nozzle Size - An (sq. ft.) | 0.000299 | 0.000299 | 0.000299 | 0.000299 |
| Isokinetic Variation - I | 98.9 | 97.9 | 99.0 | 98.6 |
| **Stack Data** | | | | |
| Average Stack Temperature - Ts (F) | 96.2 | 98.3 | 105.4 | 100.0 |
| Molecular Weight Stack Gas- dry (Md) | 28.8 | 28.8 | 28.8 | 28.8 |
| Molecular Weight Stack Gas-wet (Ms) | 28.7 | 28.8 | 28.7 | 28.7 |
| Stack Gas Specific Gravity (Gs) | 0.993 | 0.993 | 0.992 | 0.993 |
| Percent Moisture (Bws) | 0.81 | 0.73 | 0.95 | 0.83 |
| Water Vapor Volume (fraction) | 0.0081 | 0.0073 | 0.0095 | 0.0083 |
| Pressure - Ps ("Hg) | 29.4 | 29.2 | 29.1 | 29.2 |
| Average Stack Velocity -Vs (ft/sec) | 52.4 | 55.4 | 52.9 | 53.6 |
| Area of Stack (ft2) | 90.7 | 90.7 | 90.7 | 90.7 |
| **Exhaust Gas Flowrate** | | | | |
| Flowrate $ft^3$(Actual) | 285,264 | 301,745 | 287,827 | 291,612 |
| Flowrate $ft^3$ (Standard Wet) | 266,259 | 278,380 | 261,769 | 268,803 |
| Flowrate $ft^3$ (Standard Dry) | 264,094 | 276,334 | 259,286 | 266,572 |
| Flowrate $m^3$ (standard dry) | 7,478 | 7,825 | 7,342 | 7,549 |
| **Total Particulate Weights (mg)** | | | | |
| Nozzle/Probe/Filter | 13.2 | 8.9 | 17.1 | 13.1 |
| **Total Particulate Concentration** | | | | |
| lb/1000 lb (wet) | 0.005 | 0.003 | 0.003 | 0.004 |
| lb/1000 lb (dry) | 0.005 | 0.003 | 0.003 | 0.004 |
| mg/dscm (dry) | 6.2 | 3.8 | 3.5 | 4.5 |
| gr/dscf | 0.0027 | 0.0017 | 0.0015 | 0.0020 |
| **Total Particulate Emission Rate** | | | | |
| lb/ hr | 6.19 | 3.94 | 3.42 | 4.52 |
| Number of Cycles | 1 | 1 | 2 | |
| Cycle length (min) | 95 | 109 | 233 | |
| Cycle length (hr) | 1.58 | 1.82 | 3.88 | 2.43 |
| Total Iron Cast (tons) | 408 | 440 | 739 | 529 |
| lbs / cycle * | 9.80 | 7.17 | 6.63 | 7.56 |
| Emission Factor (lb PM/ton Iron) | 0.024 | 0.016 | 0.018 | 0.019 |

* lb / cycle average is weighted for number of cycles per run

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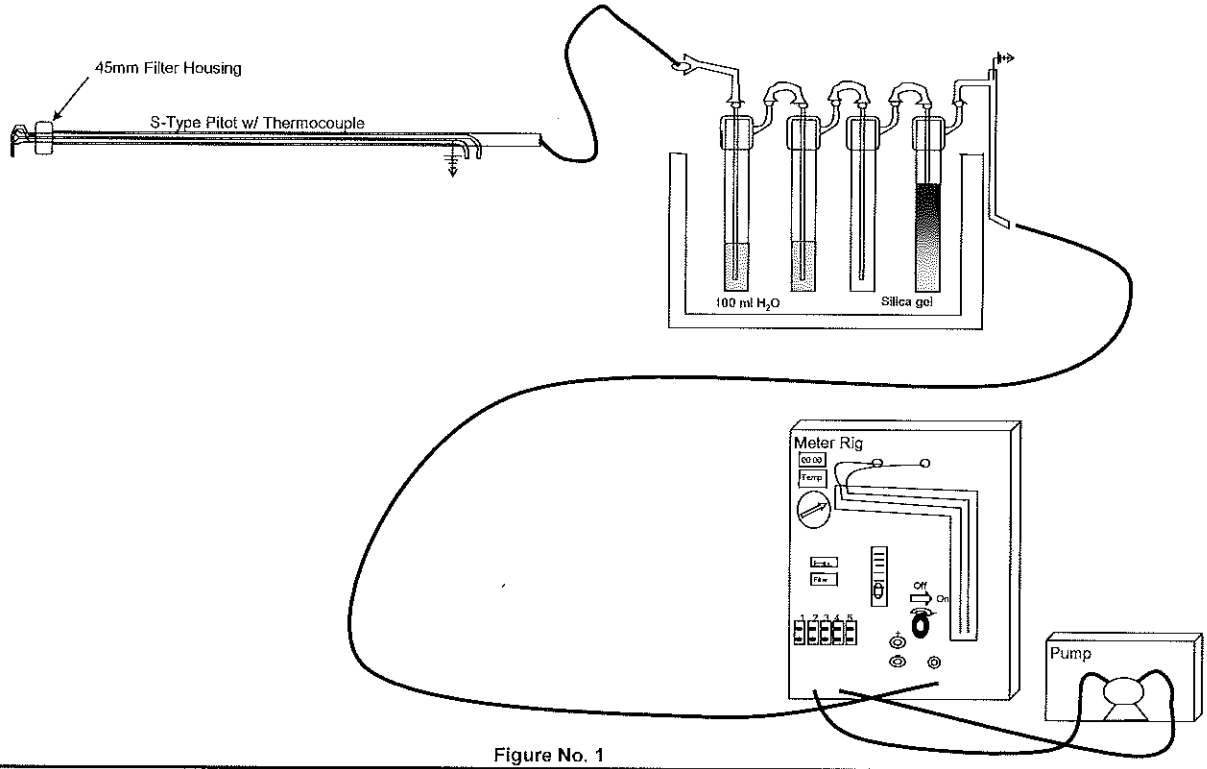


Figure No. 1

| Site: | Sampling Date: | |
|---|---|---|
| USEPA Method 17<br>US Steel<br>Ecorse, Michigan | April 3, 2018 | BT Environmental Consulting, Inc.<br>4949 Fernlee Avenue<br>Royal Oak, Michigan |

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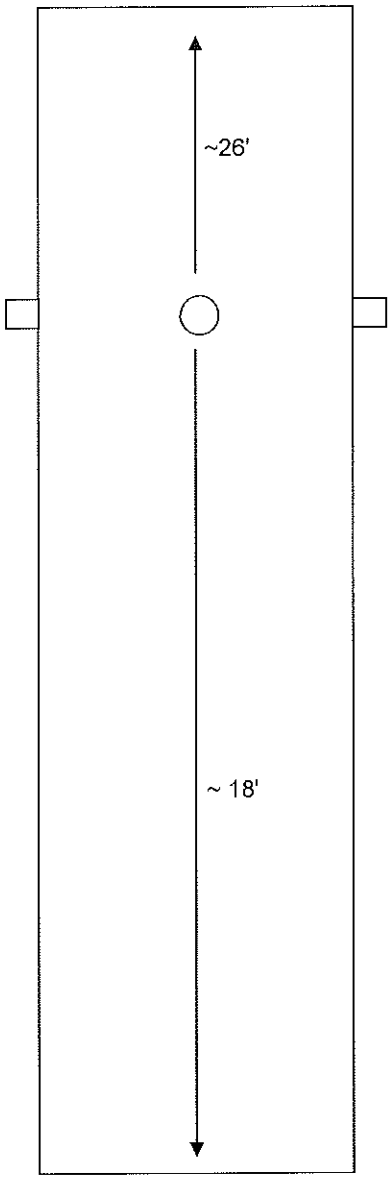
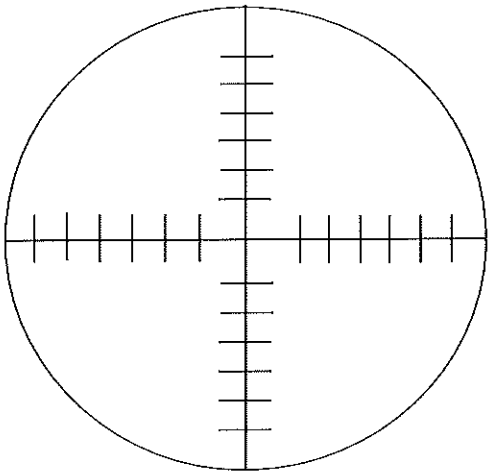
diameter = 129"



Not to Scale

| Points | Distance " |
|---|---|
| 1 | 2.7 |
| 2 | 8.6 |
| 3 | 15.2 |
| 4 | 22.8 |
| 5 | 32.3 |
| 6 | 45.9 |
| 7 | 83.1 |
| 8 | 96.8 |
| 9 | 106.2 |
| 10 | 113.8 |
| 11 | 120.4 |
| 12 | 126.3 |

**Figure No. 2**

| | | |
|---|---|---|
| **Site:**<br>**D-Blast Furnace**<br>**US Steel**<br>**Ecorse, Michigan** | **Sampling Dates:**<br>**4/3/2018** | **BT Environmental Consulting, Inc.**<br>**4949 Fernlee Avenue**<br>**Royal Oak, Michigan 48073** |