

**SOURCE TEST REPORT  
2019 PARTICULATE MATTER TESTING  
UNITED STATES STEEL CORPORATION  
GREAT LAKES WORKS  
ELECTROSTATIC PRECIPITATOR  
ECORSE, MICHIGAN**

Prepared For:  
**United States Steel Corporation**  
No. 1 Quality Drive  
Ecorse, MI 48229

For Submittal To:  
**Michigan Department of Environment, Great Lakes, and Energy**

Prepared By:  
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**EXECUTIVE SUMMARY**

Montrose Air Quality Services, LLC (MAQS) was retained by United States Steel Corporation (U. S. Steel) to evaluate particulate matter (PM) emission rates from the No. 2 Basic Oxygen Plant (BOP) Electrostatic Precipitator (ESP) located at No. 1 Quality Drive in Ecorse, Michigan. The emissions testing program was conducted on May 14, 2019. The purpose of this report is to document the results of the test program.

The ESP source is located at the U. S. Steel facility in Ecorse, Michigan. The testing was performed as a compliance demonstration for 40 CFR part 63 Subpart FFFFF 63.7790(a). The applicable limit is 0.02 gr/dscf.

The results of the emission test program are summarized by Table I.

**Table I**  
**Executive Summary Table PM Emission Rate Summary**

<b>Source</b>	<b>Pollutant</b>	<b>Limit</b>	<b>Results</b>
ESP	PM	0.02 gr/dscf	0.003 gr/dscf
			11.334 lb/hr

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## 1. Introduction

Montrose Air Quality Services, LLC (MAQS) was retained by United States Steel Corporation (U. S. Steel) to evaluate particulate matter (PM) emission rates from the No. 2 Basic Oxygen Plant (BOP) Electrostatic Precipitator (ESP) located at No. 1 Quality Drive in Ecorse, Michigan. The emissions testing program was conducted on May 14, 2019. The purpose of this report is to document the results of the test program.

The testing was performed as a compliance demonstration for 40 CFR part 63 Subpart FFFFF 63.7790(a). The applicable limit is 0.02 gr/dscf.

The emissions testing for the No.2 BOP ESP exhaust stack consisted of three tests, 87, 92 and 84 minutes. Each of the test runs encompassed all phases of the steel making process. Run 1 was conducted during 3 complete cycles, while Runs 2 and 3 were conducted during 2 cycles.

The opacity was determined utilizing US EPA Method 9 at the No. 2 BOP roof monitor.

AQD has published a guidance document entitled “Format for Submittal of Source Emission Test Plans and Reports” (March 2018). The following is a summary of the emissions test program and results in the format suggested by the aforementioned document.

### 1.a Identification, Location, and Dates of Test

Sampling and analysis for the emission test program was conducted on May 14, 2019 at the U. S. Steel facility in Ecorse, Michigan. The test program included evaluation of particulate matter (PM) and opacity from the Electrostatic Precipitator (ESP) located at the No. 2 Basic Oxygen Plant (BOP).

### 1.b Purpose of Testing

The testing was performed as a compliance demonstration for 40 CFR part 63 Subpart FFFFF 63.7790(a). Table 1 summarizes the limitations associate with this regulation.

**Table 1**  
**AQD Permit No. 199600132d Emission Limitations Summary**

Source	Pollutant	Limit
ESP	PM	0.02 gr/dscf

### **1.c Source Description**

Great Lakes Works of the United States Steel Corporation is a fully integrated steel manufacturer producing steel coils and flat rolled sheets. The #2 Basic Oxygen Plant (#2 BOP) is where the liquid iron is processed with other materials to produce liquid steel.

The #2 BOP has two top-blown, steel conversion vessels. The liquid iron is mixed with steel scrap in the vessels and oxygen is blown on the top of the mixture. During the conversion process, carbon and other impurities are removed, resulting in liquid steel that is further processed at the Great Lakes Works facility.

During the process when oxygen is blown on the top of the mixture, a hood is over the vessel to capture the BOP primary emissions. These emissions are captured and ducted to an electrostatic precipitator (ESP).

### **1.d Test Program Contact**

The contact for the source and test report is:

Mr. Todd Wessel  
Client Project Manager  
Montrose Air Quality Services  
4949 Fernlee Avenue  
Royal Oak, Michigan 48073  
Phone (616) 885-4013

Mr. Nathan Ganhs  
U. S. Steel Environmental  
United States Steel Corporation  
No. 1 Quality Drive  
Ecorse, Michigan 48192  
Phone (313) 749 3857

### 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**

<b>Name and Title</b>	<b>Affiliation</b>	<b>Telephone</b>
Mr. Todd Wessel Client Project Manager	MAQS 4949 Fernlee Avenue Royal Oak, MI 48073	(616) 885-4013
Mr. Shane Rabideau Field Technician	MAQS 4949 Fernlee Avenue Royal Oak, MI 48073	(810) 656-3986
Mr. Jacob Young Field Technician	MAQS 4949 Fernlee Avenue Royal Oak, MI 48073	(517) 455-8754
Mr. Mark Dziadosz Air Quality Division	EGLE 27700 Donald Court Warren, MI 48092	(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

Operating data recorded includes COM (opacity), oxygen blow rate, length of time oxygen was blown, tons of steel tapped, and the number of ESP fields in operation. Operating data is included in Appendix E.

### 2.b Applicable Permit

The testing was performed as a compliance demonstration for 40 CFR part 63 Subpart FFFF 63.7790(a).

### 2.c Results

The overall results of the emission test program are summarized by Table 3 (see Section 5.a). Detailed results for each source can be found in table 4.

### 2.d Emission Regulation Comparison

The results summarized by table 3 (section 5.a) shows that the PM emissions are below the limits summarized by table 1 (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 Raw and Finished Materials**

Approximately 430,000 lbs of molten iron is mixed with 120,000 lbs. of scrap steel.

#### **3.c Process Capacity**

The furnaces are rated for 250 tons of steel.

#### **3.d Process Instrumentation**

The process stack data will consist of documentation from the BOP control room. This includes amount of steel tapped and the timing of the start and stop of the oxygen blow (blow duration and flow rate, lance on lance off, etc.).

### **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**

To evaluate PM mass emission rates, MAQS utilized the following reference test methods codified at Title 40, Part 60, Appendix A of the Code of Federal Regulations:

- Method 1 - *“Sample and Velocity Traverses for Stationary Sources”*
- Method 2 - *“Determination of Stack Gas Velocity and Volumetric Flowrate”*
- Method 3 - *“Gas Analysis for the Determination of Dry Molecular Weight”  
(Fyrite Analysis)*
- Method 4 - *“Determination of Moisture Content in Stack Gases”*
- Method 5 - *“Determination of Particulate Emissions from Stationary Sources”*
- Method 9 - *“Visual Determination of the Opacity of Emissions from Stationary Sources”*



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. 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 were within the limits specified by Section 10.1 of USEPA Method 2, 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 connected to a Tedlar bag and a set of Fyrite<sup>®</sup> combustion gas analyzers. Gas was collected in the bag at each traverse point during the PM sampling run to obtain an integrated sample. The sample was then analyzed for Oxygen and Carbon Dioxide content using a set of Fyrite<sup>®</sup> combustion gas analyzers. Moisture content was determined from the condensate collected in the Method 5 sampling train according to Method 4.

40 CFR 60, Appendix A, Method 5, "*Determination of Particulate Emissions from Stationary Sources*" was used to measure PM concentrations and calculate PM emission rates (see Figure 2 for a schematic of the sampling train). 87, 92 and 84 minute test runs were conducted on the ESP Stack. With the permission of the Mark Dziadosz from the Michigan Department of Environment, Great Lakes, and Energy, the testing was concluded at the end of the steel making cycle, rather than the full 96 minutes.

All of the testing on the ESP encompassed all phases of the steel making process and sampled a minimum of sixty (60) dry standard cubic feet of gas. Each of the test runs captured emissions from scrap charge, hot metal transfer, desulfurization (blowing), slag skimming, and tapping.

MAQS's Nutech<sup>®</sup> Model 2010 modular isokinetic stack sampling system consisted of (1) a stainless-steel nozzle, (2) a heated glass probe, (3) a heated filter box, (4) a set of four Greensburg-Smith (GS) impingers with the first modified and second standard GS impingers each containing 100 milliliters (ml) of deionized water, a third dry modified GS impinger and a fourth modified GS impinger containing approximately 300 grams of silica gel desiccant, (5) a length of sample line, and (6) a Nutech<sup>®</sup> control case equipped with a pump, dry gas meter, and calibrated orifice.

After completion of the final leak test for each test run, the filters were recovered, and the nozzle, probe, and the front half of the filter holder assemblies of the Method 5 train were brushed and triple rinsed with acetone and collected in a pre-cleaned sample container. MAQS labeled the containers with the test number, test location, and test date, and marked the level of liquid on the outside of each container. MAQS personnel transported all samples to MAQS's laboratory in Royal Oak, Michigan for analysis.

Method 9 Opacity Readings were conducted by Paul Krystyniak of Veolia Water.

#### **4.b Recovery and Analytical Procedures**

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

#### 4.c Sampling Ports

The number of traverse points was determined in accordance with U.S. EPA Method 1 “Sample and Velocity traverses for stationary sources”. The ESP stack is 210 inches in diameter. A total of twenty (24) measurement points were selected for sampling the exhaust stack. Four (4) sample ports were utilized for the testing, which resulted in the use of five (6) traverse points for each port.

#### 4.d Traverse Points

A total of twenty (24) measurement points were selected for sampling the exhaust stack. Four (4) sample ports were utilized for the testing, which resulted in the use of six (6) traverse points for each port.

### 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	Pollutant	Limit	Results
ESP	PM	0.02 gr/dscf	0.003 gr/dscf
			11.3 lb/hr

Detailed data for each test run can be found in Table 4. Opacity data is presented in Appendix F.

#### 5.b Discussion of Results

Emission limitations are summarized by Table 1 (see section 1.b) and Table 3 (see section 5.a). The results of the emissions test program are summarized by Table 3 (see section 5.a).

#### 5.c Sampling Procedure Variations

No variations occurred other than those listed above.

#### 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 for this test program are provided in Appendix D.

**Limitations**

The information and opinions rendered in this report are exclusively for use by United States Steel Corporation. Montrose will not distribute or publish this report without US Steel's consent except as required by law or court order. Montrose 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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Senior Project Manager

# Tables

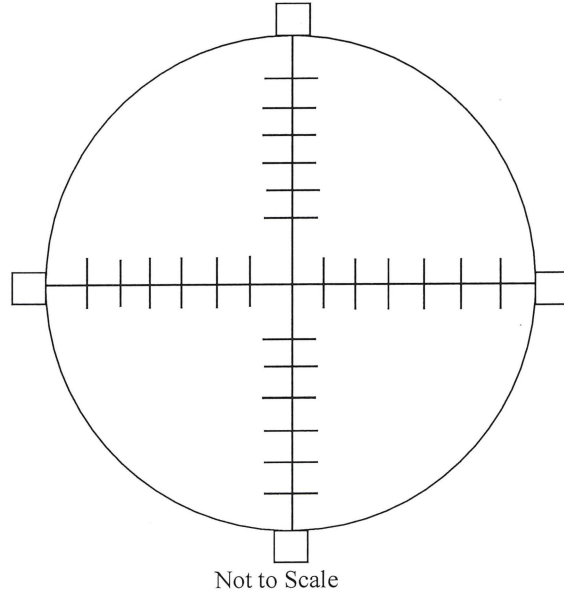
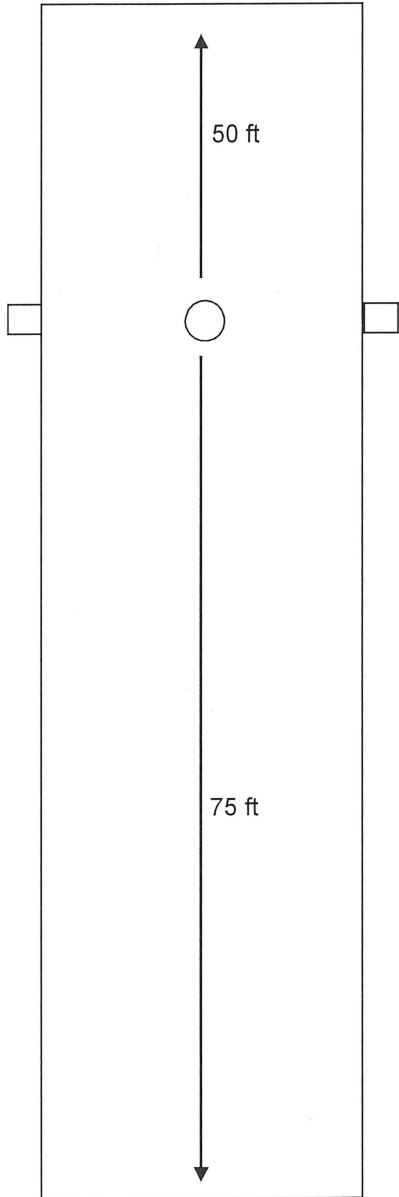
**Table 4  
Particulate Matter Emission Rates**

<b>Company</b>	<b>USS</b>			
<b>Source Designation</b>	<b>ESP</b>			
<b>Test Date</b>	<b>5/14/2019</b>	<b>5/14/2019</b>	<b>5/14/2019</b>	
<b>Meter/Nozzle Information</b>				
	P-1	P-2	P-3	Average
Meter Temperature Tm (F)	70.8	84.9	83.4	79.7
Meter Pressure - Pm (in. Hg)	29.5	29.6	29.6	29.6
Measured Sample Volume (Vm)	76.7	98.4	85.6	86.9
Sample Volume (Vm-Std ft3)	74.1	92.8	80.8	82.6
Sample Volume (Vm-Std m3)	2.10	2.63	2.29	2.34
Condensate Volume (Vw-std)	9.421	9.553	8.652	9.208
Gas Density (Ps(std) lbs/ft3) (wet)	0.0720	0.0729	0.0718	0.0722
Gas Density (Ps(std) lbs/ft3) (dry)	0.0753	0.0756	0.0745	0.0751
Total weight of sampled gas (m g lbs) (wet)	6.01	7.46	6.43	6.63
Total weight of sampled gas (m g lbs) (dry)	5.58	7.01	6.02	6.20
Nozzle Size - An (sq. ft.)	0.000478	0.000478	0.000478	0.000478
Isokinetic Variation - I	97.7	96.5	96.8	97.0
<b>Stack Data</b>				
Average Stack Temperature - Ts (F)	238.0	230.0	233.0	233.7
Molecular Weight Stack Gas- dry (Md)	29.1	29.2	28.8	29.1
Molecular Weight Stack Gas-wet (Ms)	27.9	28.2	27.8	27.9
Stack Gas Specific Gravity (Gs)	0.962	0.973	0.960	0.965
Percent Moisture (Bws)	11.28	9.33	9.67	10.10
Water Vapor Volume (fraction)	0.1128	0.0933	0.0967	0.1010
Pressure - Ps ("Hg)	29.3	29.3	29.3	29.3
Average Stack Velocity - Vs (ft/sec)	46.2	53.6	51.4	50.4
Area of Stack (ft2)	240.5	240.5	240.5	240.5
<b>Exhaust Gas Flowrate</b>				
Flowrate ft <sup>3</sup> (Actual)	667,262	773,911	742,141	727,771
Flowrate ft <sup>3</sup> (Standard Wet)	494,512	580,198	553,899	542,870
Flowrate ft <sup>3</sup> (Standard Dry)	438,719	526,050	500,337	488,369
Flowrate m <sup>3</sup> (standard dry)	12,423	14,896	14,168	13,829
<b>Total Particulate Weights (mg)</b>				
Nozzle/Probe/Filter	15.0	16.4	12.0	14.5
<b>Total Particulate Concentration</b>				
lb/1000 lb (wet)	0.005	0.005	0.004	0.005
lb/1000 lb (dry)	0.006	0.005	0.004	0.005
mg/dscm (dry)	7.2	6.2	5.2	6.2
gr/dscf	0.0031	0.0027	0.0023	0.0027
<b>Total Particulate Emission Rate</b>				
lb/ hr	11.795	12.343	9.864	11.334

Rev. 14.0  
3-20-15 BC

# Figures

diameter = 210"



Not to Scale

Points	Distance "
6	9.2
5	30.7
4	62.2
3	147.8
2	179.3
1	200.8

**Figure 1**

Site:  
US Steel Corporation  
Ecorse, Michigan  
ESP

Sampling Dates:  
May 14, 2019

**Montrose Air Quality Services,  
LLC**  
4949 Fernlee Avenue  
Royal Oak, Michigan 48073



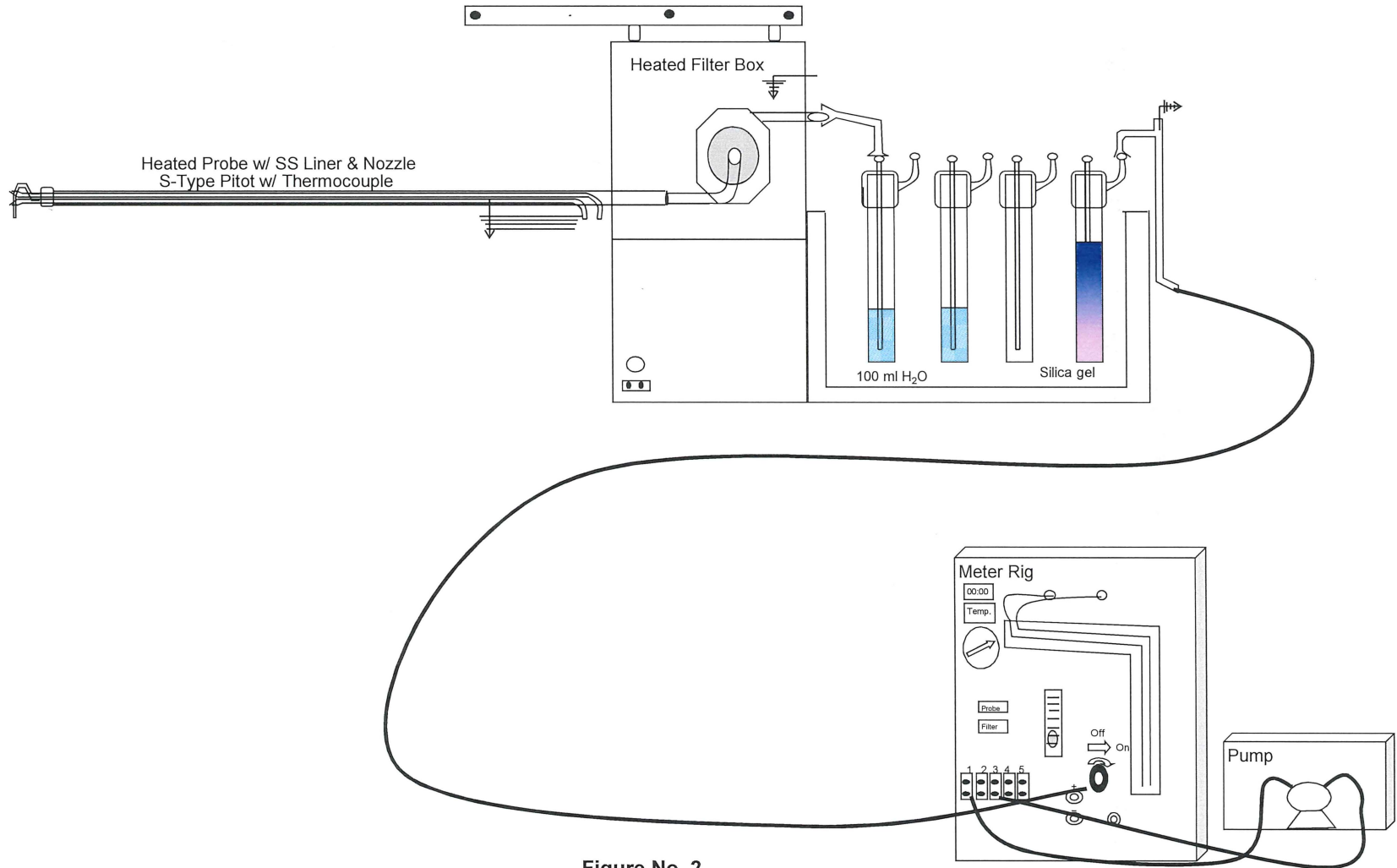


Figure No. 2

Site:  
USEPA Method 5  
US Steel Corporation  
Ecorse, Michigan

Sampling Date:  
May 14, 2019

Montrose Air Quality Services, LLC  
4949 Fernlee Avenue  
Royal Oak, Michigan 48073

**Appendix A**  
**Field and Computer Generated Raw Data and Field Notes**