

No. 2 Basic Oxygen Process Electrostatic Precipitator Particulate Emissions Test Report

Prepared for:

United States Steel Corporation

Ecorse, Michigan

Great Lakes Works
No.1 Quality Drive
Ecorse, Michigan 48229

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AIR QUALITY DIVISION

MAQS Project No. 049AS-551131
March 25, 2019

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EXECUTIVE SUMMARY

Montrose Air Quality Services, LLC (MAQS) was retained by United States Steel Corporation (U.S. Steel) to evaluate filterable 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 February 19-20, 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 permit No. 199600132d. The applicable permit limit is 0.057 pounds per 1,000 pounds dry gas and 0.02 grains per dry standard cubic feet (gr/dscf).

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

Table I
Executive Summary Table PM Emission Rate Summary

Source	Pollutant	Limit	Results
ESP	PM	0.057 lb/1000 lb (dry) 0.02 gr/dscf	0.005 lb/1000 lb (dry)
			0.0029 gr/dscf
			12.218 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 filterable 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 February 19-20, 2019. The purpose of this report is to document the results of the test program.

The testing was performed as a compliance demonstration for permit No. 199600132d. The applicable permit limit is 0.057 pound per 1,000 pounds dry gas and 0.02 grains per dry standard cubic feet (gr/dscf).

The emissions testing of the No.2 BOP ESP exhaust stack consisted of two 84-minute and one 90-minute tests. The first two test runs consisted of 4 complete blows combined, and the third run consisted of 4 complete blows and a partial, interrupted blow.

The opacity was determined utilizing US EPA Method 9 and consisted of reading four complete blows 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 February 19-20, 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 permit No. 199600132d. Table 1 summarizes the limitations included in this permit.

Table 1
AQD Permit No. 199600132d Emission Limitations Summary

Source	Pollutant	Limit
ESP	PM	0.057 lb/1000 lb (dry) 0.02 gr/dscf

1.c Source Description

The U.S. Steel Great Lakes Works 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 contacts for the source and test report are:

Mr. Todd Wessel
Senior 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

Name and Title	Affiliation	Telephone
Mr. Mason Sakshaug Field Project Manager	MAQS 4949 Fernlee Avenue Royal Oak, MI 48073	(989) 323-0355
Mr. Mike Nummer Field Technician	MAQS 4949 Fernlee Avenue Royal Oak, MI 48073	(248) 548-8070
Ben Durham Field Technician	MAQS 4949 Fernlee Avenue Royal Oak, MI 48073	(248) 548-8070
Ms. Gina Angellotti MDEQ	MDEQ 27700 Donald Ct. Warren, MI 48092	(313) 418-0895

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

Michigan Renewable Operating Permit Number 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 source can be found in Table 4.

2.d Emission Regulation Comparison

The results summarized by Table 3 (section 5.a) show 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 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 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). A single 90-minute test run and duplicate 84-minute test runs were conducted on the ESP Stack.

MAQS's Nutech[®] 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 Teflon line connecting the filter to the first impinger (5) 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, (6) a length of sample line, and (7) a Nutech[®] 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 the MAQS laboratory in Royal Oak, Michigan for analysis.

Method 9 for emissions opacity was done by Paul Bush of Veolia Water. The emissions were monitored for opacity during one test run for four separate and complete blows. Results for opacity monitoring 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

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 (20) 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 (5) traverse points for each port. In the event that the blowing operation was not complete after 20 minutes MAQS re-sampled points 5, 4, and 3 as necessary to complete an entire blow.

4.d Traverse Points

A total of twenty (20) 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 (5) 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	0.057 lb/1000 lb (dry) 0.02 gr/dscf	0.005 lb/1000 lb (dry)
			0.0029 gr/dscf
			12.218 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 for Permit No. 199600132d 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

As noted in the testing protocol, MAQS proposed testing four (4) complete blows. In the event the blow is still going after 15 minutes MAQS will continue testing that port until the blow is complete. Therefor the actual test may exceed 60 minutes. This happened during the first test (8 points, 4 ports) resulting in a 84 minute test and the second test (8 points, 4 ports) resulting in a 84 minute test. During the third test in the second port, the initial blow was interrupted after 5 minutes of testing. When the blow was interrupted, testing was paused until another blow started. At the start of the new blow, MAQS re-started at point 1 in the same port and completed the testing of the full blow. This resulted in a 90-minute test for test three.

5.d Process or Control Device Upsets

In test 3 during the second port, the test was paused due to a stoppage in the process.

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.

Tables

Table 4
Particulate Matter Emission Rates

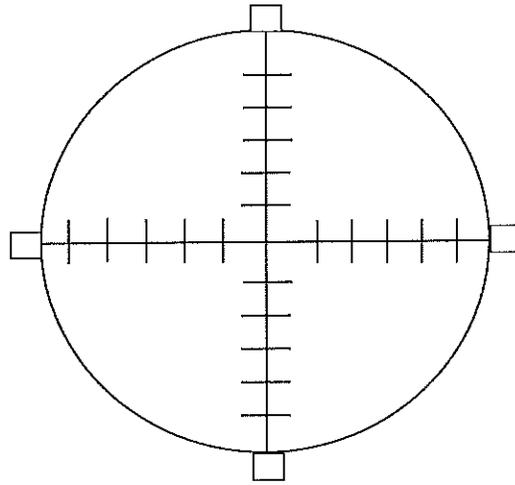
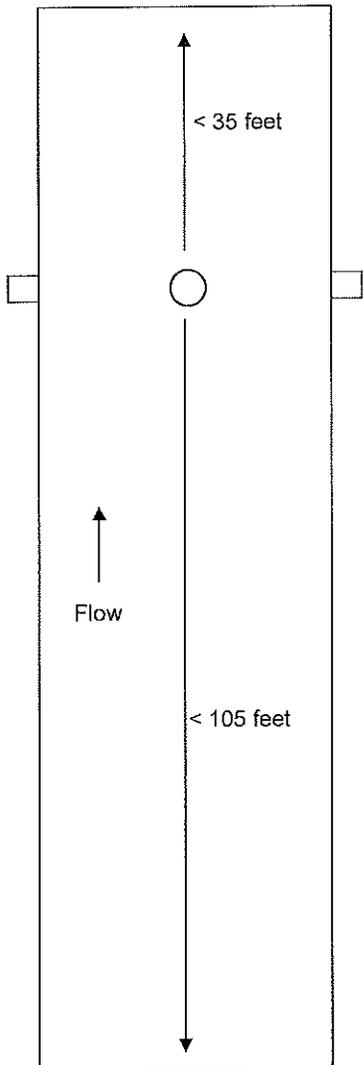
Company Source Designation Test Date	US Steel ESP			Average
	2/19/2019	2/19/2019	2/20/2019	
Meter/Nozzle Information	P-1	P-2	P-3	
Meter Temperature Tm (F)	67.0	74.1	72.6	71.2
Meter Pressure - Pm (in. Hg)	30.2	30.2	29.8	30.1
Measured Sample Volume (Vm)	73.8	72.5	82.0	76.1
Sample Volume (Vm-Std ft3)	74.3	72.0	80.5	75.6
Sample Volume (Vm-Std m3)	2.10	2.04	2.28	2.14
Condensate Volume (Vw-std)	15.404	13.815	16.734	15.317
Gas Density (Ps(std) lbs/ft3) (wet)	0.0725	0.0728	0.0725	0.0726
Gas Density (Ps(std) lbs/ft3) (dry)	0.0778	0.0778	0.0778	0.0778
Total weight of sampled gas (m g lbs) (wet)	6.50	6.24	7.05	6.60
Total weight of sampled gas (m g lbs) (dry)	5.78	5.60	6.27	5.88
Nozzle Size - An (sq. ft.)	0.000428	0.000428	0.000428	0.000428
Isokinetic Variation - I	103.2	99.6	102.1	101.6
Stack Data				
Average Stack Temperature - Ts (F)	194.4	200.8	202.1	199.1
Molecular Weight Stack Gas- dry (Md)	30.1	30.1	30.1	30.1
Molecular Weight Stack Gas-wet (Ms)	28.0	28.2	28.0	28.1
Stack Gas Specific Gravity (Gs)	0.968	0.973	0.968	0.970
Percent Moisture (Bws)	17.17	16.11	17.21	16.83
Water Vapor Volume (fraction)	0.1717	0.1611	0.1721	0.1683
Pressure - Ps ("Hg)	30.0	30.0	29.6	29.8
Average Stack Velocity -Vs (ft/sec)	49.9	50.0	52.3	50.7
Area of Stack (ft2)	240.4	240.4	240.4	240.4
Exhaust Gas Flowrate				
Flowrate ft ³ (Actual)	719,835	720,612	755,093	731,847
Flowrate ft ³ (Standard Wet)	582,050	576,495	594,996	584,513
Flowrate ft ³ (Standard Dry)	482,097	483,639	492,621	486,119
Flowrate m ³ (standard dry)	13,652	13,695	13,950	13,765
Total Particulate Weights (mg)				
Nozzle/Probe/Filter	11.9	13.2	18.0	14.4
Total Particulate Concentration				
lb/1000 lb (wet)	0.004	0.005	0.006	0.005
lb/1000 lb (dry)	0.005	0.005	0.006	0.005
mg/dscm (dry)	5.7	6.5	7.9	6.7
gr/dscf	0.0025	0.0028	0.0035	0.0029
Total Particulate Emission Rate				
lb/ hr	10.253	11.780	14.622	12.218

Figures



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AIR QUALITY SERVICES

diameter = 210 inches



Not to Scale

5 Points, 4 Ports	Distance "
1	5.5
2	17.2
3	30.7
4	47.5
5	71.8

Figure No. 1

Site:
ESP
US Steel
Ecorse, MI

Sampling Date:
February 19-20, 2019

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

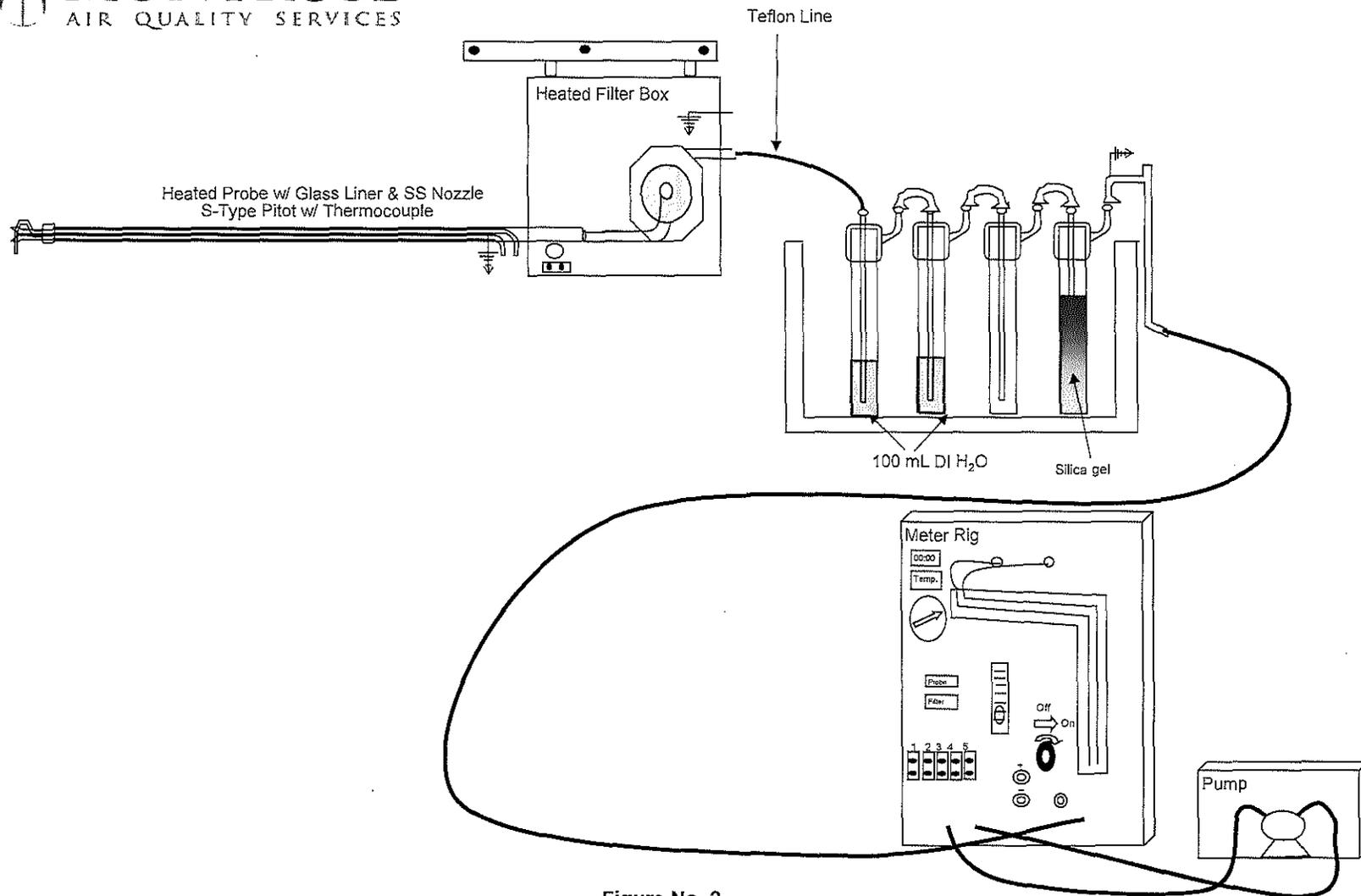


Figure No. 2

Site:
USEPA Method 5 Independent
US Steel
Ecorse, MI

Sampling Date:
February 19-20, 2019

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