MONTROSE
AIR QUALITY SERVICES

US Steel No. 1 Baghouse Emissions Test Summary 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-478627.01
February 6, 2019

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EXECUTIVE SUMMARY

Montrose Air Quality Services (MAQS) was retained by United States Steel Corporation (U. S. Steel) to evaluate particulate matter (PM) emission rates from the No. 2 BOP, No. 1 Baghouse (No.1 Baghouse) located at No. 1 Quality Drive in Ecorse, Michigan. The emissions testing program was conducted on December 11-12, 2018. The purpose of this report is to document the results of the test program.

The testing was performed to demonstrate compliance with to permit No. 199600132d. The applicable permit particulate emissions limit for the No.1 Baghouse is 0.005 grains/dscf and 0.038 lb/1,000 lbs dry exhaust gas.

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
No. 1 Baghouse	PM	0.005 gr/dscf	0.001 gr/dscf – Train A
			0.0008 gr/dscf – Train B
		0.038 lb/1,000 lbs exhaust gas, dry	0.002 lb/1,000 lb exhaust gas, dry – Train A
			0.002 lb/1,000 lb exhaust gas, dry – Train B

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APPENDIX

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) No. 1 Baghouse (No.1 Baghouse) located at No. 1 Quality Drive in Ecorse, Michigan. The emissions testing program was conducted on December 11-12, 2018.

The testing was performed as a compliance demonstration for permit No. 199600132d and for the Iron and Steel MACT 40 CFR Part 63 requirements. The applicable permit particulate emissions limit for the No.1 Baghouse is 0.005 grains/dscf and the MACT standard limit is 0.01 gr/dscf.

Due to the size of the No.1 Baghouse and the lack of substantial operation U.S. Steel has requested and has previously been granted a testing variance by Mr. Edward Wojcieshowski of the Region 5 EPA. The variance included a reduction of the required MACT Standard sample volume of 60 dry standard cubic feet (dscf) to a total of 45 combined dscf and the overall testing strategy to obtain the particulate samples for this Baghouse.

The testing was conducted with two meter consoles, sampling out of two separate test ports simultaneously in each compartment. Each test run sampled 4 of the 12 of the baghouse compartments at a single point. For example, test No. 1 sampled compartments 1-4. Test No. 2 sampled compartments No. 5-8 and test #3 compartments 9-12. Each of the compartments (12) have two test ports installed on the north side of the baghouse directly over each set of baghouse bags. All of the sampling was conducted out of theses ports (2 total) at a single sampling point approximately 8 feet in the baghouse directly above a row of baghouse bags with two sampling consoles simultaneously.

The testing for the No.1 baghouse was performed in the following fashion. The test started as scrap was charged to the vessel then stopped and restarted when the hot metal is charged or transferred to the vessel and stopped again and restarted at the beginning of the tapping (draining the steel from the furnace) of the furnace and stopped at the end of a tap. Each of the 12 baghouse compartments were tested during a minimum of these three operations (scrap charge, hot metal charge and tapping).

The data from each of the sample trains (2) were combined to yield one complete test run with a combined sample volume of at least 45 dscf. For reporting purposes, each of the test runs were also calculated separately and together to determine the actual concentration and emission rate.

The No.1 baghouse is a positive pressure baghouse that has a low velocity pressure reading in each compartment (0.0002 inches of water). It was necessary to perform a complete velocity traverse on the inlet duct leading to the baghouse. This was done to calculate the flow rate into and subsequently out of each compartment of the baghouse. MAQS performed a complete velocity traverse at the inlet duct prior to each of the three (3) tests.

The opacity was determined utilizing US EPA Method 9 and consisted of reading three complete steel production cycles at the No. 2 BOP roof monitor. The steel production cycle starts when scrap is charged to the vessel and ends three (3) minutes after slag has been removed from the furnace.

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 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 December 11-12, 2018 at the US Steel facility in Ecorse, Michigan. The test program included evaluation of particulate matter (PM) and opacity from the No. 2 Basic Oxygen Plant (BOP), No. 1 Baghouse (No.1 Baghouse).

1.b Purpose of Testing

The testing was performed to demonstrate compliance with permit No. 199600132d. Table 1 summarizes the limitations included in this permit.

Table 1
AQD Permit No. 199600132d Emission Limitations Summary

Source	Pollutant	Limit
No. 1 Baghouse	PM	0.005 gr/dscf – Permit
		0.038 lb/1,000 lb exhaust gas, dry – Permit
		0.01 gr/dscf - MACT

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 No. #2 BOP No. 1 Baghouse is the emissions control device for the scrap charging, hot metal charging and tapping (draining the steel from the furnace) operations of the steel-making process. Charging consists of loading scrap metal into the BOP vessel and then pouring hot metal into it. Exhaust hoods are located over the vessels to capture the emissions generated by this process. Ductwork transfers the captured emissions to the baghouse.

The No.1 Baghouse is a twelve (12) compartment, shaker type, positive pressure baghouse, which measures 168 feet by 48 feet. During the testing event, baghouse compartment number 12 was isolated to represent the baghouse operating while maintenance or inspection is conducted on the isolated chamber.

1.d Test Program Contact

The contact for the source and test plan is:

Mr. Todd Wessel
Senior Project Manager
Montrose Air Quality Services, LLC
4949 Fernlee Ave
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. Nathan Ganhs Environmental Department	US Steel No. 1 Quality Drive Ecorse, Michigan 48229	(313) 749 3857
Mr. Todd Wessel Senior Project Manager	MAQS 4949 Fernlee Ave Royal Oak, Michigan 48073	(616) 885-4013
Mr. Dave Trahan Environmental Technician	MAQS 4949 Fernlee Ave Royal Oak, Michigan 48073	(248) 548-8070
Mr. Ben Durham Environmental Technician	MAQS 4949 Fernlee Ave Royal Oak, Michigan 48073	(248) 548-8070
Mr. Shane Rabideau Environmental Technician	MAQS 4949 Fernlee Ave Royal Oak, Michigan 48073	(248) 548-8070

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, fan amps, hot metal tons, and scrap charge. The operating data is included in Appendix F.

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 Tables 4-6.

2.d Emission Regulation Comparison

The results summarized by table 3 (section 5.a) shows that the PM emissions are well 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. Normal operations yield between 242 to 246 tons of finished steel per heat.

3.d Process Instrumentation

The process stack data consists of documentation from the BOP control room and can be found in Appendix F. This includes amount of scrap and iron charged and the timing of each process step.

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 from the baghouse, 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 17/5D - *"Determination of Particulate Emissions from Stationary Sources"*

Stack gas velocity traverses were conducted in accordance with the procedures outlined in Methods 1 and 2. Figures 1 and 2 present the test port and traverse/sampling point locations used at each site. 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.

Due to the majority of positive pressure Baghouses having low velocity pressure readings in each compartment, it is necessary to perform a complete velocity traverse on the inlet duct leading to the Baghouse. This was done to calculate the flow rate into and subsequently out of each compartment of the Baghouse. A complete velocity traverse was performed at the inlet duct prior to each day of testing. Subsequent to the velocity traverse MAQS calculated the average gas velocity at the measurement site (Baghouse compartment) utilizing equation 5D-1 of the 40 CFR Part 60, App. A, Method 5D.

Sixteen traverse points were determined as locations to measure the inlet volumetric flow in accordance with the provisions of the Method. Two (2) sample ports were utilized for the study, resulting in the use of eight (8) traverse points for each port

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 5D/17 sampling trains according to Method 4.

40 CFR 60, Appendix A, Method 5D/17, *"Determination of Particulate Emissions from Stationary Sources"* was used to measure PM concentrations and calculate PM emission rates (see Figure 4 for a schematic of the sampling train). Duplicate approximately 60-minute test runs were conducted with duplicate side-by-side trains on Baghouse No. 1.

MAQS's Nutech® Model 2010 modular isokinetic stack sampling system consisted of (1) a stainless-steel nozzle, (2) an in stack stainless-steel filter housing, (3) a steel probe, (4) a set of four Greenburg-Smith (GS) impingers with the first modified and second standard GS impingers each containing 100 ml of deionized water, and with a third dry modified GS impinger 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.

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 5D/17 train were brushed and triple rinsed with acetone. The nozzle and front half of the Method 5D/17 filter housing was brushed and triple rinsed with acetone. The acetone rinses were 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.

The acetone rinses were transferred to clean pre-weighed beakers. The acetone was evaporated at room-temperature. The beakers and filters were then placed in desiccators for 24 hours and weighed to a constant weight.

4.b Recovery and Analytical Procedures

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

4.c Sampling Ports

The No. 1 Baghouse was sampled as described in the introduction.

4.d Traverse Points

The No. 1 Baghouse was sampled as described in the introduction.

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

<table>
<tr><th>Source</th><th>Pollutant</th><th>Limit</th><th>Results</th></tr>
<tr><td rowspan="4">No. 1 Baghouse</td><td rowspan="4">PM</td><td rowspan="2">0.005 gr/dscf</td><td>0.001 gr/dscf – Train A</td></tr>
<tr><td>0.0008 gr/dscf – Train B</td></tr>
<tr><td rowspan="2">0.038 lb/1,000 lbs exhaust gas, dry</td><td>0.002 lb/1,000 lb exhaust gas, dry – Train A</td></tr>
<tr><td>0.002 lb/1,000 lb exhaust gas, dry – Train B</td></tr>
</table>

Detailed data for each test run can be found in Tables 4-6. Opacity data is presented in Appendix E.

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

Please see introduction for variations in sampling procedures used on the No. 1 Baghouse.

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.

Tables

Table 4
Baghouse 1
Train A and Train B Combined Emission Rate
Test Date: December 11-12, 2018

	Train A			Train B			
	1	2	3	1	2	3	**Average**
Particulate Concentration (gr/dscf)	0.0005	0.0006	0.0019	0.0005	0.0005	0.0014	0.0009
Chamber Flowrate (dscfm)	248,745	266,549	255,495	248,745	266,549	255,495	256,930
Emission Rate Train A + Train B (lb/hr)				2.133	2.514	7.229	3.959

Table 5
Particulate Matter Emission Rates

Company	**USS**			
Source Designation	**Baghouse 1A**			
Test Date	**12/11/2018**	**12/12/2018**	**12/12/2018**	
Meter/Nozzle Information	P-1	P-2	P-3	Average
Meter Temperature Tm (F)	66.7	52.4	53.9	57.7
Meter Pressure - Pm (in. Hg)	29.7	29.7	29.7	29.7
Measured Sample Volume (Vm)	62.3	53.7	49.1	55.0
Sample Volume (Vm-Std ft3)	61.5	54.6	49.7	55.3
Sample Volume (Vm-Std m3)	1.74	1.55	1.41	1.57
Condensate Volume (Vw-std)	0.660	0.472	0.283	0.472
Gas Density (Ps(std) lbs/ft3) (wet)	0.0742	0.0743	0.0744	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)	4.61	4.09	3.72	4.14
Total weight of sampled gas (m g lbs) (dry)	4.58	4.07	3.71	4.12
Nozzle Size - An (sq. ft.)	0.012851	0.012851	0.012851	0.012851
Isokinetic Variation - I	98.4	98.3	98.3	98.4
Stack Data				
Average Stack Temperature - Ts (F)	78.0	87.5	88.3	84.6
Molecular Weight Stack Gas- dry (Md)	28.8	28.8	28.8	28.8
Molecular Weight Stack Gas-wet (Ms)	28.7	28.7	28.8	28.7
Stack Gas Specific Gravity (Gs)	0.992	0.993	0.994	0.993
Percent Moisture (Bws)	1.06	0.86	0.57	0.83
Water Vapor Volume (fraction)	0.0106	0.0086	0.0057	0.0083
Pressure - Ps ("Hg)	29.4	29.4	29.4	29.4
Average Stack Velocity -Vs (ft/sec)	1.4	1.5	1.4	1.4
Area of Stack (ft2)	567.3	567.3	567.3	567.3
Exhaust Gas Flowrate				
Flowrate ft^3(Actual)	504,051	518,257	502,924	508,411
Flowrate ft^3 (Standard Wet)	502,643	536,315	515,111	518,023
Flowrate ft^3 (Standard Dry)	497,491	533,097	510,990	513,859
Flowrate ft3 (actual, baghouse)	520,955	565,623	544,099	
Flowrate m^3 (standard dry)	14,087	15,096	14,470	14,551
Total Particulate Weights (mg)				
Nozzle/Probe/Filter	1.8	2.0	6.0	3.3
Total Particulate Concentration				
lb/1000 lb (wet)	0.001	0.001	0.004	0.002
lb/1000 lb (dry)	0.001	0.001	0.004	0.002
mg/dscm (dry)	1.0	1.3	4.3	2.2
gr/dscf	0.0005	0.0006	0.0019	0.0010
Total Particulate Emission Rate				
lb/ hr	0.963	1.292	4.079	2.112

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Table 6
Particulate Matter Emission Rates

Company	**US Steel**			
Source Designation	**Baghouse 1B**			
Test Date	**12/11/2018**	**12/12/2018**	**12/12/2018**	
Meter/Nozzle Information	P-1	P-2	P-3	Average
Meter Temperature Tm (F)	60.2	51.6	56.8	56.2
Meter Pressure - Pm (in. Hg)	29.7	29.7	29.7	29.7
Measured Sample Volume (Vm)	61.9	54.4	50.0	55.4
Sample Volume (Vm-Std ft3)	61.4	54.9	49.9	55.4
Sample Volume (Vm-Std m3)	1.74	1.56	1.41	1.57
Condensate Volume (Vw-std)	0.613	0.189	0.519	0.440
Gas Density (Ps(std) lbs/ft3) (wet)	0.0743	0.0744	0.0742	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)	4.61	4.10	3.74	4.15
Total weight of sampled gas (m g lbs) (dry)	4.58	4.09	3.72	4.13
Nozzle Size - An (sq. ft.)	0.012851	0.012851	0.012851	0.012851
Isokinetic Variation - I	98.2	98.6	99.1	98.6
Stack Data				
Average Stack Temperature - Ts (F)	78.0	87.5	88.3	84.6
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	28.8
Stack Gas Specific Gravity (Gs)	0.992	0.994	0.992	0.993
Percent Moisture (Bws)	0.99	0.34	1.03	0.79
Water Vapor Volume (fraction)	0.0099	0.0034	0.0103	0.0079
Pressure - Ps ("Hg)	29.4	29.4	29.4	29.4
Average Stack Velocity -Vs (ft/sec)	1.4	1.5	1.4	1.4
Area of Stack (ft2)	567.3	567.3	567.3	567.3
Exhaust Gas Flowrate				
Flowrate ft^3(Actual)	504,051	518,257	502,924	508,411
Flowrate ft^3 (Standard Wet)	502,643	536,315	515,111	518,023
Flowrate ft^3 (Standard Dry)	497,491	533,097	510,990	513,859
Flowrate ft3 (actual, baghouse)	520,955	565,431	544,099	
Flowrate m^3 (standard dry)	14,087	15,096	14,470	14,551
Total Particulate Weights (mg)				
Nozzle/Probe/Filter	2.0	1.8	4.6	2.8
Total Particulate Concentration				
lb/1000 lb (wet)	0.001	0.001	0.003	0.002
lb/1000 lb (dry)	0.001	0.001	0.003	0.002
mg/dscm (dry)	1.1	1.2	3.3	1.9
gr/dscf	0.0005	0.0005	0.0014	0.0008
Total Particulate Emission Rate				
lb/ hr	1.072	1.156	3.118	1.782

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Figures

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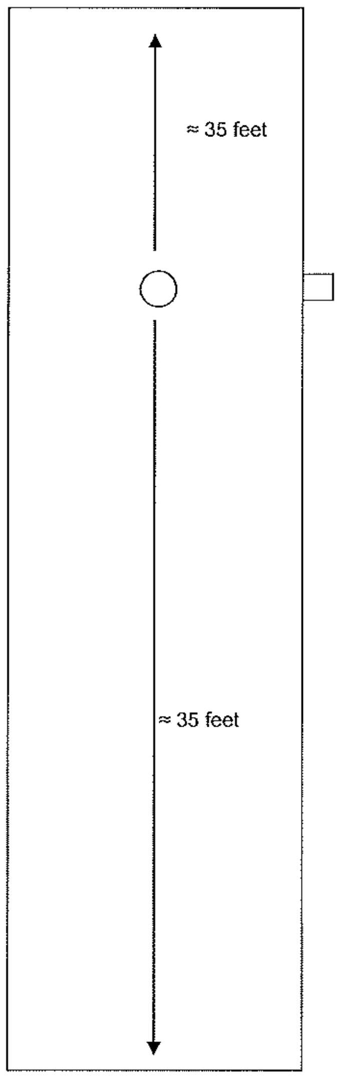
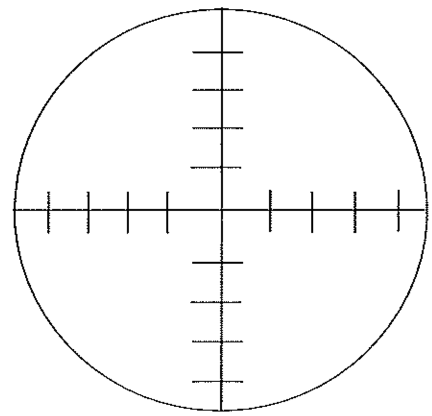
diameter = 140 inches





Not to Scale

Points	Distance "
1	4.5
2	14.7
3	27.2
4	45.2
5	94.8
6	112.8
7	125.3
8	135.5

Figure No. 1

Site:	Sampling Date:	Montrose Air Quality Services, LLC.
US Steel Corporation Ecorse, Michigan No. 1 Baghouse Inlet	December 11-12, 2018	4949 Fernlee Avenue Royal Oak, Michigan 48073

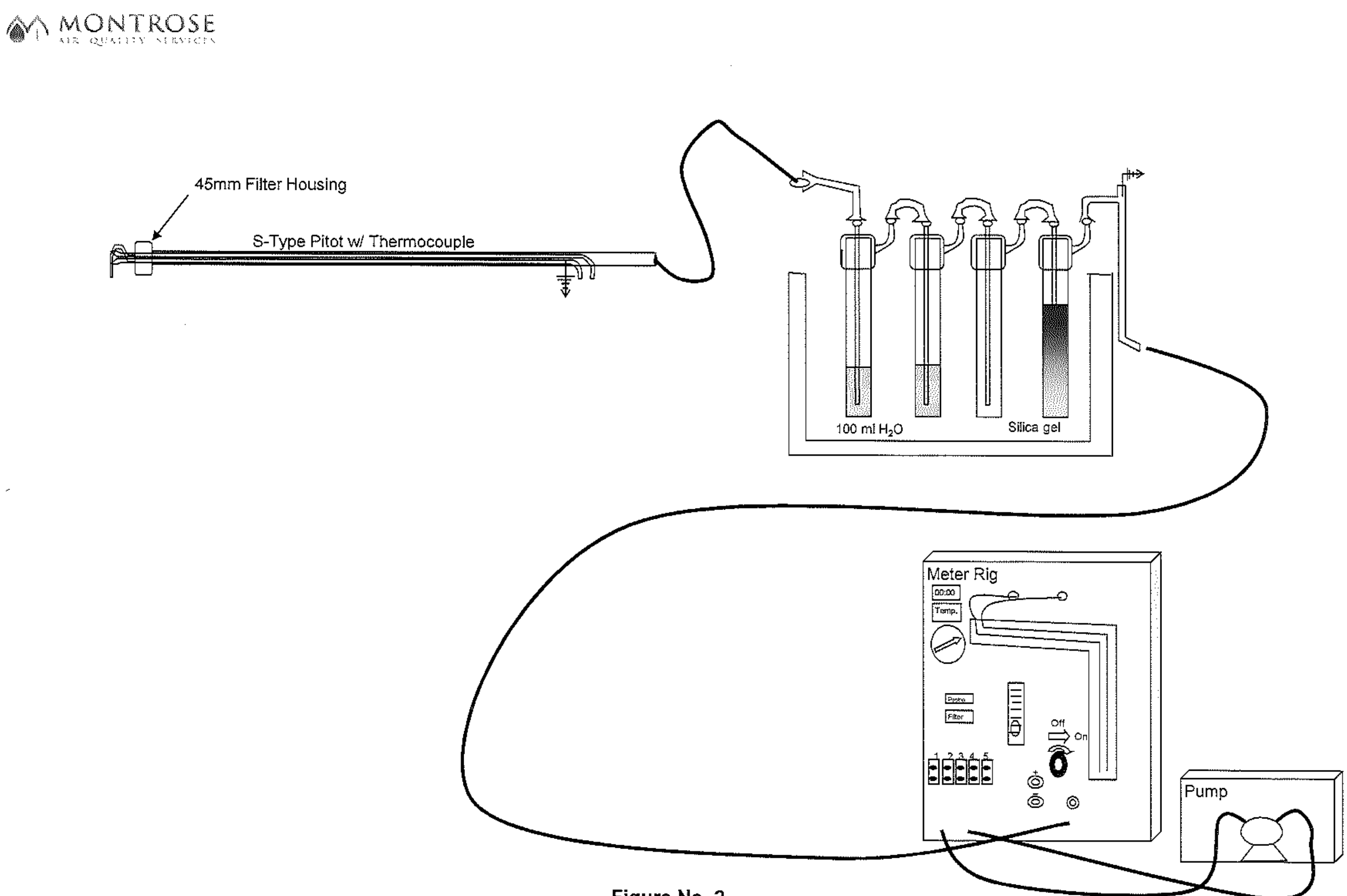


Figure No. 2

Site: **USEPA Method 17/5D** **US Steel Corporation** **Ecorse, Michigan**	**Sampling Date:** **December 11-12, 2018**	**Montrose Air Quality Services, LLC.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**

Appendix A
Field and Computer Generated Raw Data and Field Notes