BTEC Inc.

Desulf Baghouse Emissions Test Report

Prepared for:

AK Steel Corporation – Dearborn Works

Dearborn, Michigan

AK Steel Corporation – Dearborn Works
4001 Miller Road
Dearborn, Michigan 48120

Project No. 049AS-340614
May 23, 2018

BT Environmental Consulting, Inc.
4949 Fernlee Avenue
Royal Oak, Michigan 48073
(248) 548-8070

BTEC Inc.

EXECUTIVE SUMMARY

BT Environmental Consulting, Inc. (BTEC) was retained by AK Steel Corporation – Dearborn Works (AK Steel) to conduct an evaluation of particulate matter (PM) from the Desulfurization (Desulf) Baghouse Stack and Visual Emissions (VE) from the BOF building roof monitor. The emissions test program was conducted on April 10^{th}-11^{th}, 2018.

Testing of the Desulf baghouse consisted of triplicate test runs for PM. Concurrent VE observations were conducted on the BOF building roof monitor for a portion of each PM test run. Each visible emission observation consisted of a minimum of 2 desulfurization heats and 1 complete steel production cycle. The emissions test program was required by MDEQ Air Quality Division Renewable Operating Permit (ROP) MI-ROP-A8640-2016a, Facility SRN A8640. The results of the emission test program are summarized by Table I.

Table I
Overall Emission Summary
Test Date: April 10^{th}-11^{th}, 2018

Emission Unit	Pollutant	Permit Limit	Test Result
Desulfurization Baghouse Stack	PM	0.01 gr/dscf	0.001 gr/dscf
		7.7 lb/hr	0.8 lb/hr
BOF Roof Monitor	VE	20%(1)	2%

(1) Calculated as highest 3-minute block average observed. 20% limit applies to EUBOFDESULF BOF Shop Building emissions.

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1. Introduction

BT Environmental Consulting, Inc. (BTEC) was retained by AK Steel Corporation – Dearborn Works (AK Steel) to conduct an evaluation of particulate matter (PM) from the Desulfurization (Desulf) Baghouse Stack and Visual Emissions (VE) from the BOF building roof monitor. The emissions test program was conducted on April 10^{th}-11^{th}, 2018.

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. All testing was performed in accordance with BTEC test plan 049AS-340614 (attached as Appendix G).

1.a Identification, Location, and Dates of Test

Sampling and analysis for the emission test program was conducted on April 10^{th}-11^{th}, 2018 at the AK Steel facility located in Dearborn, Michigan.

1.b Purpose of Testing

The purpose of the testing was to satisfy specific requirements in the facilities Title V permit (ROP MI-ROP-A8640-2016a), specifically condition EUBOFDESULF V. Testing was also conducted to satisfy criteria presented in the NESHAP for Integrated Iron and Steel Facilities, 40 CFR 63 Subpart FFFFF, specifically section 63.7821(c).

Table 1
Emission Limitations
AK Steel Corporation – Dearborn Works
MI-ROP-A8640-2016a Emission Limitations

Emission Unit	Pollutant	Permit Limit
Desulfurization Baghouse Stack	PM	0.01 gr/dscf
		7.7 lb/hr
BOF Roof Monitor	VE	20%$_{(1)}$

(1) Calculated as highest 3-minute block average observed. 20% limit applies to EUBOFDESULF BOF Shop Building emissions.

1.c Source Description

At the Desulfurization Station, a movable hood and lances are moved into position over the iron ladle. Once in position, the lances are lowered into the hot metal (molten iron) where they inject desulfurizing reagents (magnesium and lime) with a nitrogen carrier into the hot metal. This process converts the sulfur in the hot metal to sulfides. The sulfides rise to the surface of the hot metal and become bound in the slag. The fume and dust emissions produced during the desulfurization operation are captured in the hood and sent to a baghouse. Once the desulfurization is complete, the lances are raised. The ladle is then tilted and the slag is skimmed from the surface of the molten iron using a hydraulic powered skimming arm, with a refractory paddle. The slag skimmed from the surface of the hot metal drops into a slag pot located below the Desulfurization Station. Emissions from slag skimming are also captured by the movable hood and sent to the same baghouse. The baghouse is equipped with a bag leak detection system that continuously monitors the particulate matter loading in the exhaust to ensure proper operation.

1.d Test Program Contacts

The contacts for the source and test report are:

Mr. David Pate
Senior Environmental Engineer
AK Steel Corporation – Dearborn Works
4001 Miller Rd.
Dearborn, Michigan
(313) 323-1261

Mr. Barry Boulianne
Senior Project Manager
BT Environmental Consulting, Inc.
4949 Fernlee Avenue
Royal Oak, Michigan 48073
(313) 449-2361

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. Steve Smith Project Manager	BTEC 4949 Fernlee Avenue Royal Oak, MI 48073	(248) 548-8070
Mr. Dave Trahan Environmental Technician	BTEC 4949 Fernlee Avenue Royal Oak, MI 48073	(248) 548-8070
Mr. Mike Nummer Environmental Technician	BTEC 4949 Fernlee Avenue Royal Oak, MI 48073	(248) 548-8070
Mr. Robert Bingham Visible Emissions Observer	Smoke Reader, LLC 7608 Tulane St. Taylor, MI 48180	(586) 942-8548
Mr. Mark Dziadosz MDEQ	MDEQ Air Quality Division	(586) 753-3745
Ms. Katherine Koster MDEQ	MDEQ Detroit District Office	(313) 456-4678

2. Summary of Results

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

2.a Operating Data

BOF Desulfurization Baghouse
Temperature 100 -200°F
Moisture Content ~1%
Compartment Differential Pressure 2-5" W.C.
Overall Differential Pressure 4-7" W.C.
Flow Rate ~90-100,000 ACFM

2.b Applicable Permit

AQD issued ROP MI-ROP-A8640-2016a, Facility SRN A8640 to AK Steel.

2.c Results

See Table 1 in Section 1.b.

3. Sonrce Description

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

3.a Process Description

The operation of the desulfurization and slag skimming process is a batch process that takes between approximately 15-25 minutes to complete. The process consists of a desulfurization step where magnesium and lime are injected into the molten iron to create a slag. Sulfur in the iron is converted to sulfides which bind to the slag. After desulfurization, the lances are removed from the bath and the iron ladle is tilted. A hydraulic powered skimming arm with a refractory paddle is used to skim the slag into a slag pot. Both of these operations are controlled by a baghouse. At the end of the initial desulfurization step, a sample is taken and analyzed for sulfur content. If the sample analysis results are within specification, the heat is shipped off after the slag skimming is complete. If the sample analysis results are not in specification, the heat is re-shot for a short period of time and then re-skimmed.

3.b Process Flow Diagram

A process flow diagram is available on request.

3.c Raw and Finished Materials

Approximately 200 – 220 tons of molten iron is processed at the Desulfurization station per heat. The amount of magnesium and lime injected depends on the sulfur content of the heat prior to desulfurization and the desired sulfur content of the heat after desulfurization is completed. Typical amounts injected are 150 – 300 pounds of magnesium and 400 – 800 pounds of lime per heat. The iron is further processed into steel at the BOF vessels. The skimmed slag is watered at the Desulf slag watering station and then further processed by the slag contractor.

3.d Process Capacity

Typical production for the desulfurization operation is 250-350 tons per clock hour. During the test, production for the desulfurization station ranged between 558 and 625 tons per testing hour and 236 – 395 tons per clock hour.

3.e Process Instrumentation

Differential pressure gauges and a bag leak detection device are used to verify proper operation of the baghouse.

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 were 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 Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources"(Fyrite)*
- Method 4 - *"Determination of Moisture Content in Stack Gases"*

Stack gas velocity traverses were conducted in accordance with the procedures outlined in Method 1 and Method 2 (see Figure 2 for a schematic of the sampling location). S-type pitot tubes with thermocouple assemblies, calibrated in accordance with Method 2, were used to measure exhaust gas velocity pressures (using a manometer) and temperatures during testing. The S-type pitot tube dimensions were within specified limits, therefore, a baseline pitot tube coefficient of 0.84 (dimensionless) was assigned.

A cyclonic flow check was performed at the sampling location. The existence of cyclonic flow is determined by measuring the flow angle at each sample point. The flow angle is the angle between the direction of flow and the axis of the stack. If the average of the absolute values of the flow angle is greater than 20 degrees, cyclonic flow exists. The null angle was determined to be less than 20 degrees at each sampling point.

Molecular weight was determined according to USEPA Method 3, "Gas Analysis for the Determination of Dry Molecular Weight." The equipment used for this evaluation consisted of a one-way squeeze bulb with connecting tubing and a set of Fyrite® combustion gas analyzers. Carbon dioxide and oxygen content were analyzed using the Fyrite® procedure.

Exhaust gas moisture content was evaluated using Method 4. Exhaust gas was extracted as part of the PM sampling train and passed through the impinger configuration (see Figure 1). Exhaust gas moisture content was then determined gravimetrically.

4.b *Filterable Particulate Matter (USEPA Method 5)*

40 CFR 60, Appendix A, Method 5, "Determination of Particulate Emissions from Stationary Sources" was used to measure PM concentrations and calculate appropriate emission rates (see Figure 2 for a schematic of the sampling train).

BTEC's Nutech® Model 2010 modular isokinetic stack sampling system consisted of (1) a stainless steel nozzle, (2) a glass probe, (3) a heated borosilicate or quartz glass filter holder containing a pre-weighed 90-mm diameter glass fiber filter with Teflon filter support, (4) a set of four Greenburg-Smith (GS) impingers with the first two with 100 ml of H2O (ii) an empty impinger, (iii) and an impinger filled with approximately 300 grams of silica gel, (5) a length of sample line, and (6) a Nutech® control case equipped with a pump, dry gas meter, and calibrated orifice.

Upon completion of the final leak test for each test run, the filter was recovered, and the nozzle, probe, and the front half of the filter holder assembly were brushed and triple rinsed with acetone which was 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 carried all samples to BTEC's laboratory (for filter and acetone gravimetric analysis) in Royal Oak, Michigan.

4.c Recovery and Analytical Procedures

The samples were all taken to BTEC's laboratory in Royal Oak, Michigan where they were processed in accordance with USEPA Method 5 analytical procedures.

4.d Sampling Ports

A diagram of the stack showing sampling ports in relation to upstream and downstream disturbances is included as Figure 2.

4.e Traverse Points

A diagram of the stack indicating traverse point locations and stack dimensions is included as Figure 2.

5. Test Results and Discussion

Sections 5.a through 5.k provide a summary of the test results. All results were in compliance with the applicable permit and NESHAP limitations.

5.a Results Tabulation

The overall results of the emissions test program are summarized by Table 3. Detailed results for the emissions test program are summarized by Table 5.

Table 3
Overall Emission Summary
Test Date: April 10th-11th, 2018

Emission Unit	Pollutant	Permit Limit	Test Result
Desulfurization Baghouse Stack	PM	0.01 gr/dscf	0.001 gr/dscf
		7.7 lb/hr	0.8 lb/hr
BOF Roof Monitor	VE	20%(1)	2%

(1) Calculated as highest 3-minute block average observed. 20% limit applies to EUBOFDESULF BOF Shop Building emissions.

5.b Discussion of Results

All results were in compliance with the applicable permit and NESHAP limitations.

5.c Sampling Procedure Variations

Part of the normal testing procedure involves moving the testing apparatus to different ports to obtain sample from various traverse points. It was noted in the test protocol that the short duration of the desulfurization cycle and the layout of the sampling location could lead to a situation where large portions of the heat would be missed if ports were changed on a strict time schedule. To minimize this, AK Steel proposed that port changes only be conducted during periods between desulfurization cycles when the testing is paused. In addition, AK steel proposed that to reach the time and cubic feet requirements of the permit and NESHAP rule, the run would be extended for an extra heat by repeating sampling in one of the ports. MDEQ expressed agreement with the proposal as long as, over the course of the testing, each port would be sampled roughly the same number of times. For this test, each sample run required that one of the ports be repeated. A different port was repeated for each run to where each test port was sampled exactly 4 times total over the course of the 3 test runs. Correspondence concerning the method deviations is attached as Appendix H.

5.d Process or Control Device Upsets

There were no process upsets during this test.

5.e Control Device Maintenance

Daily checks are made of the baghouse compartment and overall differential pressure. Weekly checks are performed on the dust hoppers to verify that dust is being collected. A monthly inspection of the baghouse cleaning system is performed to ensure that the baghouse is cleaning properly. A quarterly internal check is performed on the baghouse interior to check for bag leaks or damage to the baghouse interior. Vibration analysis is also performed on the baghouse ID fan at a minimum of once per quarter. Re-bagging of the compartments is performed on an as-needed basis. In 2017, three of the six compartments were re-bagged. In 2018 prior to the testing, a fourth compartment was re-bagged.

5.f Re-Test

The emissions test program was not a re-test.

5.g Audit Sample Analyses

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

5.h Calibration Sheets

Relevant equipment calibration documents are provided in Appendix B.

5.i Sample Calculations

Sample calculations are provided in Appendix C.

5.j Field Data Sheets

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

5.k Laboratory Data

Laboratory analytical results for this test program are presented in Appendix D.

6. NESHAP and ROP Testing Requirements

Table 4 summarizes the NESHAP and ROP conditions as they relate to testing and notification requirements.

Table 4
NESHAP and ROP Testing Requirements

NESHAP Reference	ROP Reference	NESHAP/ROP Language	Comments
40 CFR 63.7821	EUBOFDESULF V.1	Conduct performance tests for particulate matter emissions and opacity at least once every 5 years.	Previous performance test was conducted on April 8-11, 2013. The test commenced with 5 years of the completion of the previous test.
40 CFR 63.7822(b)(1)	N/A	Determine the concentration of particulate matter according to the the listed test methods in 40 CFR 63.7822(b)(1)(i-v)	The particulate matter concentration was determined in accordance with the required test methods.
40 CFR 63.7822(b)(2)	N/A	Collect a minimum of 60 dry standard cubic feet of gas during each particulate matter test run. Three valid test runs are needed to comprise a performance test.	Between 79.5 and 82.8 dry standard cubic feet of gas were collected during each particulate matter test run.
40 CFR 63.7822(h)	EUBOFDESULF V.2	Sampling during the performance test will occur only when the operations being controlled are in operation.	Sampling only occurred when desulfurization or slag skimming was taking place. Testing was paused between heats.
40 CFR 63.7823(b)	EUBOFDESULF V.3	Performance tests for visible emissions shall be conducted such that opacity observations overlap with the performance tests for particulate.	All opacity observations overlapped with the performance tests for particulate.

Table 4 (continued)
NESHAP and ROP Testing Requirements

NESHAP Reference	ROP Reference	NESHAP/ROP Language	Comments
40 CFR 63.7823(d)(1)(ii)	EUBOFDESULF V.4(a)	Record observations to the nearest 5 percent at 15-second intervals for at least three steel production cycles rather than using the procedure specified in Section 2.4 of Method 9.	One complete steel production cycle was observed during each PM test run for a total of three steel production cycles.
40 CFR 63.7823(d)(1)(iii)	EUBOFDESULF V.4(b)	Determine the 3-minute block average opacity from the average of 12 consecutive observations recorded at 15-second intervals.	Opacity was calculated using the 3-minute block averages in accordance with this requirement.
40 CFR 63.7840(d)	EUBOFDESULF VII.4	Submit a notification of intent to perform any performance testing under 40 CFR Part 63, Subpart FFFFF at least 60 calendar days before testing is to begin.	The notification was submitted on February 2, 2018, 67 days prior to the start of the testing.

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 AK Steel. BTEC will not distribute or publish this report without AK Steel'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: ____________________
Steve Smith
Field Project Manager

This report was reviewed by: ____________________
Brandon Chase
QA/QC Manager

Table 5
Desulfurization Baghouse Particulate Matter Emission Rates

Company	**AK Steel**			
Source Designation	**Desulf**			
Test Date	**4/10/2018**	**4/10/2018**	**4/11/2018**	
Meter/Nozzle Information	Run 1	Run 2	Run 3	Average
Meter Temperature Tm (F)	68.8	72.2	72.3	71.1
Meter Pressure - Pm (in. Hg)	29.9	29.9	29.7	29.8
Measured Sample Volume (Vm)	81.2	78.9	79.1	79.7
Sample Volume (Vm-Std ft3)	82.8	79.9	79.5	80.7
Sample Volume (Vm-Std m3)	2.34	2.26	2.25	2.29
Condensate Volume (Vw-std)	0.472	0.566	0.519	0.519
Gas Density (Ps(std) lbs/ft3) (wet)	0.0744	0.0743	0.0743	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)	6.19	5.98	5.95	6.04
Total weight of sampled gas (m g lbs) (dry)	6.17	5.95	5.93	6.02
Nozzle Size - An (sq. ft.)	0.000309	0.000309	0.000309	0.000309
Isokinetic Variation - I	98.9	99.2	98.7	98.9
Stack Data				
Average Stack Temperature - Ts (F)	172.6	158.6	177.0	169.4
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	0.993	0.993	0.993
Percent Moisture (Bws)	0.57	0.70	0.65	0.64
Water Vapor Volume (fraction)	0.0057	0.0070	0.0065	0.0064
Pressure - Ps ("Hg)	29.6	29.6	29.4	29.6
Average Stack Velocity -Vs (ft/sec)	68.8	62.8	65.0	65.5
Area of Stack (ft2)	23.8	23.8	23.8	23.8
Exhaust Gas Flowrate				
Flowrate ft^3(Actual)	98,293	89,757	92,939	93,663
Flowrate ft^3 (Standard Wet)	81,173	75,822	75,788	77,594
Flowrate ft^3 (Standard Dry)	80,714	75,289	75,296	77,100
Flowrate m^3 (standard dry)	2,286	2,132	2,132	2,183
Total Particulate Weights (mg)				
Nozzle/Probe/Filter	7.5	10.6	1.8	6.6
Total Particulate Concentration				
lb/1000 lb (wet)	0.003	0.004	0.001	0.002
lb/1000 lb (dry)	0.003	0.004	0.001	0.002
mg/dscm (dry)	3.2	4.7	0.8	2.9
gr/dscf	0.0014	0.0020	0.0003	0.0013
Total Particulate Emission Rate				
lb/ hr	1.0	1.3	0.2	0.8

Rev. 14.0
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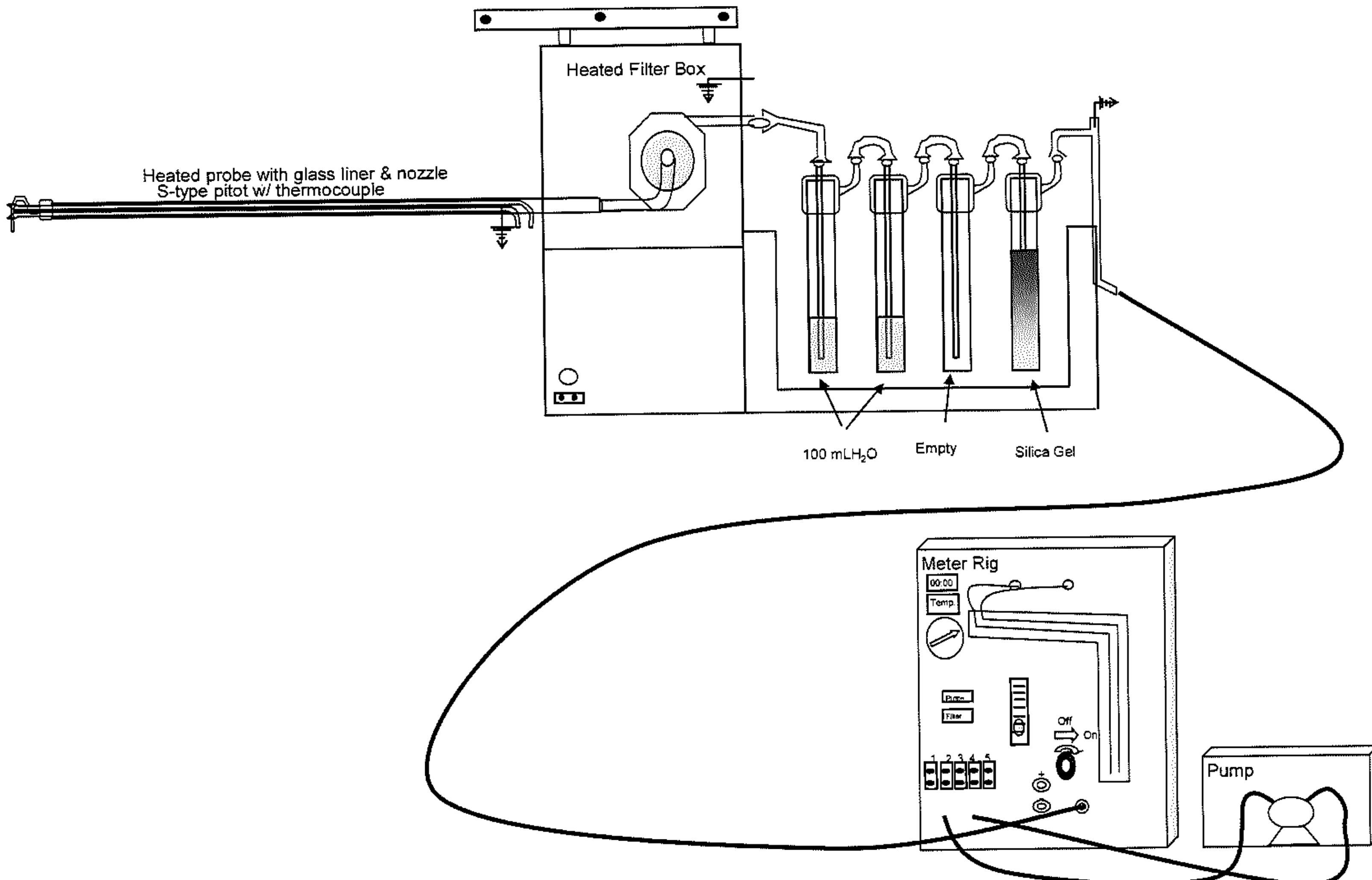

Figure 1

Site: **USEPA Method 5** **AK Steel** **Dearborn, Michigan**	**Sampling Date:** **April 10-11, 2018**	**BT Environmental Consulting, Inc.** **4949 Fernlee** **Royal Oak, Michigan**

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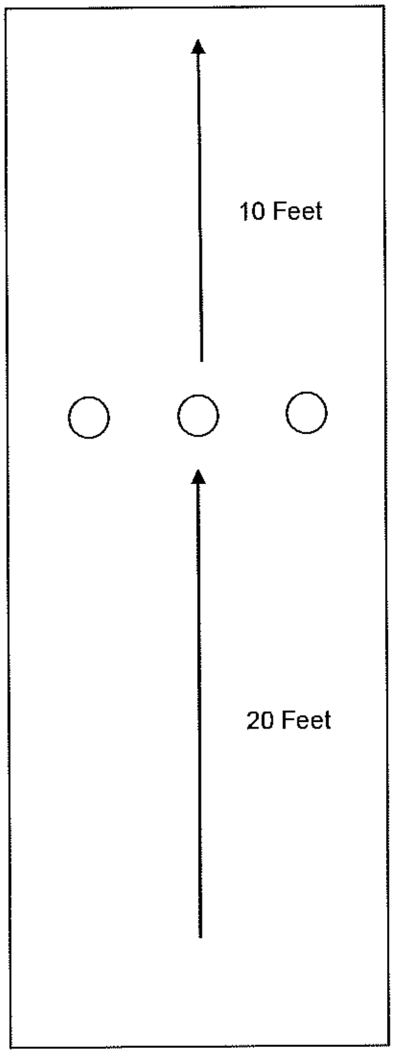
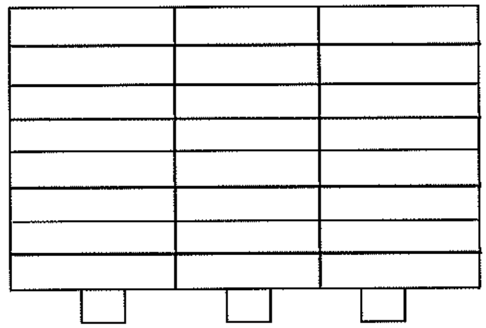
Stack Dimensions: 47W" X 73D"





Not to Scale

Points	Distance "
1	4.6
2	13.7
3	22.8
4	31.9
5	41.1
6	50.2
7	59.3
8	68.4

Figure No. 2

Site: **Desulf BH** **AK Steel** **Dearborn, Michigan**	**Sampling** **April 10-11, 2018**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan**