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Hot Strip Mill NOx 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-384372
August 28, 2018

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

EXECUTIVE SUMMARY

BT Environmental Consulting, Inc. (BTEC) was retained by AK Steel Corporation – Dearborn Works (AK Steel) to evaluate NOx emissions on the Hot Strip Mill No. 1 Reheat Furnace. The furnace exhausts through two stacks, a north stack and a south stack. Both stacks were tested simultaneously as part of the test program.

Testing of the No. 1 Reheat Furnace exhaust stacks consisted of triplicate 60-minute test runs for NOx. Additionally, one moisture test and three stack gas velocity tests were conducted. The results of the emission test program are summarized by Table I.

Table I
NO_x Emissions Summary
Hot Strip Mill No. 1 Reheat Furnace
July 25, 2018

Location	Average Emission Rate	Emission Limit
Hot Strip Mill No. 1 Reheat Furnace	0.05 lb/MMBtu	0.11 lb/MMBtu

1. Introduction

BT Environmental Consulting, Inc. (BTEC) was retained by AK Steel Corporation – Dearborn Works (AK Steel) to evaluate emissions on the Hot Strip Mill No. 1 Reheat Furnace. The furnace exhausts through two stacks, a north stack and a south stack. Both stacks were tested simultaneously as part of the test program.

The purpose of the project was to evaluate Oxides of Nitrogen (NOx) emissions. 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" (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-384372.

1.a Identification, Location, and Dates of Test

Sampling and analysis for the emission test program was conducted on July 25, 2018 at the AK Steel facility located in Dearborn, Michigan. The test program included evaluation of NOx emissions from the Hot Strip Mill No. 1 Reheat Furnace. The furnace exhausts through two stacks, a north stack and a south stack. Both stacks were tested simultaneously as part of the test program.

1.b Purpose of Testing

AQD issued Permit number MI-ROP-A8640 2016a to AK Steel. The permit condition requires verification of NOx emissions rates from a representative reheat furnace from FGHSMFURNACES once every ROP permit term. The permit limits are summarized by Table 1.

Table 1
MI-ROP-A8640 2016a Emission Limitations

Pollutant	Emission Limit
NO_x	0.11 lb/MMBtu

1.c Source Description

The sampling program included the Hot Strip Mill No. 1 Reheat Furnace North and South exhaust stacks. The following is a description of the process.

The reheat furnaces are part of AK Steel's hot strip mill (HSM) where slabs of steel are rolled into coils called hot bands. The slabs of steel are charged into one of AK Steel's three walking beam reheat furnaces and heated to a temperature hot enough to soften the steel so it can be reduced in thickness and formed into a coil. The reheat furnaces are fired with natural gas. The slabs move through the furnace by the action of the walking beams. After passing through the furnace, the slabs are reduced in thickness, first by roughing stands and then by finishing stands, before they are coiled at the coiler.

1.d Test Program Contacts

The contacts for the source and test report are:

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Mr. David Pate
Senior Environmental Engineer
AK Steel Dearborn Works
4001 Miller Road
Dearborn, Michigan 48120
(313) 323-1261

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

Names and affiliations for personnel who were present during the testing program are summarized by Table 2.

Table 2
Hot Strip Mill Reheat Furnace
Test Personnel
July 25, 2018

Name and Title	Affiliation	Telephone
Mr. David Pate Environmental Engineer	AK Steel Corporation Dearborn Works 4001 Miller Road Dearborn, Michigan 48120	(313) 323-1261
Mr. Paul Diven Field Project Manager	BTEC 4949 Fernlee Royal Oak, MI 48073	(248) 548-8070
Mr. Steven Smith Field Project Manager	BTEC 4949 Fernlee Royal Oak, MI 48073	(248) 548-8070
Mr. Mike Nummer Environmental Technician	BTEC 4949 Fernlee Royal Oak, MI 48073	(248) 548-8070
Ms. Regina Hines MDEQ	MDEQ Air Quality Division	(313) 418-0895
Ms. Katherine Koster MDEQ	MDEQ Air Quality Division	(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

Process data is available in Appendix E.

2.b Applicable Permit

The applicable permit for this emissions test program is Permit Number MI-ROP-A8640 2016a

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 are summarized by Table 4 and Table 5.

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 Process Flow Diagram

A process flow diagram is available upon request.

3.c Raw and Finished Materials

Steel slabs are fed into the Reheat Furnaces. The furnaces are fired by natural gas.

3.d Process Capacity

At full capacity, each reheat furnace burns between 400-500 MMBtu/hr of natural gas and typically processes between 200-250 TPH of steel slabs. During the testing, production averaged 275 TPH of steel slabs and 469 MMBtu/hr of natural gas usage.

3.e Process Instrumentation

There is no air pollution control equipment for this source. Combustion emissions are exhausted directly through the furnace exhaust stacks.

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

The emissions test program utilized the following test methods codified at Title 40, Part 60, Appendix A (40 CFR 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 3A - *"Determination of Molecular Weight of Dry Stack Gas" (Analyzer)*
- Method 4 - *"Determination of Moisture Content in Stack Gasses"*
- Method 7E - *"Determination of Nitrogen Oxides Emissions from Stationary Sources"*
- Method 19 - *"Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates"*

USEPA Methods 1-4

Stack gas velocity traverses were conducted in accordance with the procedures outlined in Method 1 and Method 2. S-type pitot tubes with thermocouple assemblies, calibrated in accordance with Method 2, Section 4.1.1, were used to measure exhaust gas velocity pressures (using a manometer) and temperatures during testing. The S-type pitot tube dimensions outlined in Sections 2-6 through 2-8 are within specified limits, therefore, a baseline pitot tube coefficient of 0.84 (dimensionless) is assigned. A diagram of the sample points is provided in Figures 2-3.

Cyclonic flow checks were 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 angles is greater than 20 degrees, cyclonic flow exists. Cyclonic flow was confirmed to not exist at the Hot Strip Mill sampling location.

The Molecular Weight of the gas stream was evaluated according to procedures outlined in Title 40, Part 60, Appendix A, Method 3A. The O_2/CO_2 content of the gas stream was measured using two Servomex 4100 O_2/CO_2 analyzers.

Exhaust gas was extracted as part of the Method 4 sampling train. Exhaust gas moisture content was then determined by method 4.

One flow traverse was conducted per NOx run and one moisture measurement was conducted on each reheat furnace stack for the test program. Flow measurements were only used to calculate the weighted average of the calculated individual stack NOx lb/mmBtu results. The weighted average results for the entire furnace is reported in Table 3.

USEPA Methods 7E/19

Exhaust NO_x content was measured using a TECO 42i HL and a Telodyne T200H NO_x gas analyzer. NO_x emissions were calculated in units of lb/MMBtu using USEPA Method 19 calculations. Sample calculations can be found in Appendix C.

4.b Recovery and Analytical Procedures

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

4.c Sampling Ports

Diagrams of the stacks showing sampling ports in relation to upstream and downstream disturbances are included as Figure 2 and Figure 3.

4.d Traverse Points

Diagrams of the stacks indicating traverse point locations and stack dimensions are included as Figure 2 and Figure 3.

5. Test Results and Discussion

Sections 5.a through 5.k provide a summary of the test results.

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 Tables 4-5.

Table 3
NO_x Emissions Summary
Hot Strip Mill No. 1 Reheat Furnace

Location	Average Emission Rate	Emission Limit
Hot Strip Mill No. 1 Reheat Furnace	0.05 lb/MMBtu	0.11 lb/MMBtu

5.b Discussion of Results

Test results were in compliance with the emission limitations.

5.c Sampling Procedure Variations

There were no sampling variations other than those documented in the test plan and approved by the MDEQ that were used during the emission compliance test program.

5.d Process or Control Device Upsets

Run 1 was interrupted for 15 minutes. Sampling was paused and resumed at the end of the interruption. Each run was disrupted for approximately five minutes in order to change ports.

5.e Control Device Maintenance

The unit being tested does not have a control device.

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

No laboratory data for this test program.

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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: Per. Barry A

Paul Diven
Project Manager

This report was reviewed by: Brandon Chase

Brandon Chase
QA/QC Manager

Table 4
Hot Strip Mill North NOx Emission Rates
AK Steel
Dearborn
BTEC Project No. 049as-384372
Sampling Dates: 7/25/2018

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	7/25/2018	7/25/2018	7/25/2018	
Test Run Time	11:00-12:20	12:51-13:56	14:25-15:30	
Outlet Flowrate (dscfm)	54,387	68,410	54,237	**59,011**
Oxygen Concentration (%)	7.98	7.92	8.29	**8.06**
Oxygen Concentration (%, drift corrected as per USEPA 7E)	8.07	8.06	8.45	**8.20**
Carbon Dioxide Concentration (%)	7.26	7.27	7.02	**7.18**
Carbon Dioxide Concentration (%, drift corrected as per USEPA 7E)	7.30	7.23	6.99	**7.17**
Outlet Oxides of Nitrogen Concentration (ppmv)	32.91	28.33	28.28	**29.84**
Outlet NOx Concentration (ppmv, corrected as per USEPA 7E)	33.32	28.68	28.63	**30.21**
NOx Emission Rate (lb/hr)	**12.78**	**13.84**	**10.95**	**12.52**
NOx Emission Rate (lb/hr) (corrected as per USEPA 7E)	**12.94**	**14.01**	**11.09**	**12.68**
NOx Emission Rate (lb/MMBtu) (corrected as per USEPA 7E)	**0.056**	**0.049**	**0.050**	**0.052**
Outlet NOx Concentration (ppmv, corrected to 15% O_2)	**15.32**	**13.18**	13.57	**14.02**

O_2 Correction			
Co	0.05	0.01	0.00
Cma	10.06	10.06	10.06
Cm	9.94	9.88	9.87

CO_2 Correction			
Co	0.23	0.29	0.29
Cma	10.07	10.07	10.07
Cm	9.94	10.02	9.99

NOx Correction			
Co	0.11	0.06	0.10
Cma	50.5	50.5	50.5
Cm	49.83	49.85	49.81

dscfm = dry standard cubic feet per minute
ppmv = parts per million on a volume-to-volume basis
lb/hr = pounds per hour
Fd = 8,710 dscf/MMBtu

Equations
lb/hr = ppmv * MW/24.14 * 1/35.31 * 1/453,600 * ***dcfm*** * 60
$Conc_{@15\%O2}$ = Conc * (20.9 -15)/(20.9 - $\%O_2$)
lb/MMBtu = ppm * 1.194E-7 * Fd * 20.9 / (20.9- O2)

Rev. 2.0
5/8/2012 BC

Table 5
Hot Strip Mill South NOx Emission Rates
AK Steel
Dearborn
BTEC Project No. 049as-384372
Sampling Dates: 7/25/2018

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	7/25/2018	7/25/2018	7/25/2018	
Test Run Time	11:00-12:20	12:51-13:56	14:25-15:30	
Outlet Flowrate (dscfm)	71,241	75,469	73,173	**73,294**
Oxygen Concentration (%)	6.29	6.44	6.88	**6.54**
Oxygen Concentration (%, drift corrected as per USEPA 7E)	6.31	6.52	6.94	**6.59**
Carbon Dioxide Concentration (%)	8.38	8.25	8.04	**8.22**
Carbon Dioxide Concentration (%, drift corrected as per USEPA 7E)	8.42	8.11	7.95	**8.16**
Outlet Oxides of Nitrogen Concentration (ppmv)	38.57	31.51	30.68	**33.59**
Outlet NOx Concentration (ppmv, corrected as per USEPA 7E)	39.86	32.42	31.92	**34.73**
NOx Emission Rate (lb/hr)	**19.62**	**16.98**	**16.03**	**17.54**
NOx Emission Rate (lb/hr) (corrected as per USEPA 7E)	**20.27**	**17.47**	**16.68**	**18.14**
NOx Emission Rate (lb/MMBtu) (corrected as per USEPA 7E)	**0.059**	**0.049**	**0.050**	**0.053**
Outlet NOx Concentration (ppmv, corrected to 15% O_2)	**16.12**	**13.30**	**13.49**	**14.30**

O_2 Correction			
Co	0.17	0.12	0.11
Cma	10.06	10.06	10.06
Cm	9.93	9.88	9.92

CO_2 Correction			
Co	0.21	0.29	0.28
Cma	10.07	10.07	10.07
Cm	9.98	10.17	10.12

NOx Correction			
Co	0.50	0.61	0.42
Cma	50.5	50.5	50.5
Cm	48.74	48.74	48.30

dscfm = dry standard cubic feet per minute
ppmv = parts per million on a volume-to-volume basis
lb/hr = pounds per hour
Fd = 8,710 dscf/MMBtu

Equations
lb/hr = ppmv * MW/24.14 * 1/35.31 * 1/453,600 * ***dcfm*** * 60
$Conc_{@15\%O2}$ = Conc * (20.9 -15)/(20.9 - $\%O_2$)
lb/MMBtu = ppm * 1.194E-7 * Fd * 20.9 / (20.9- O2)

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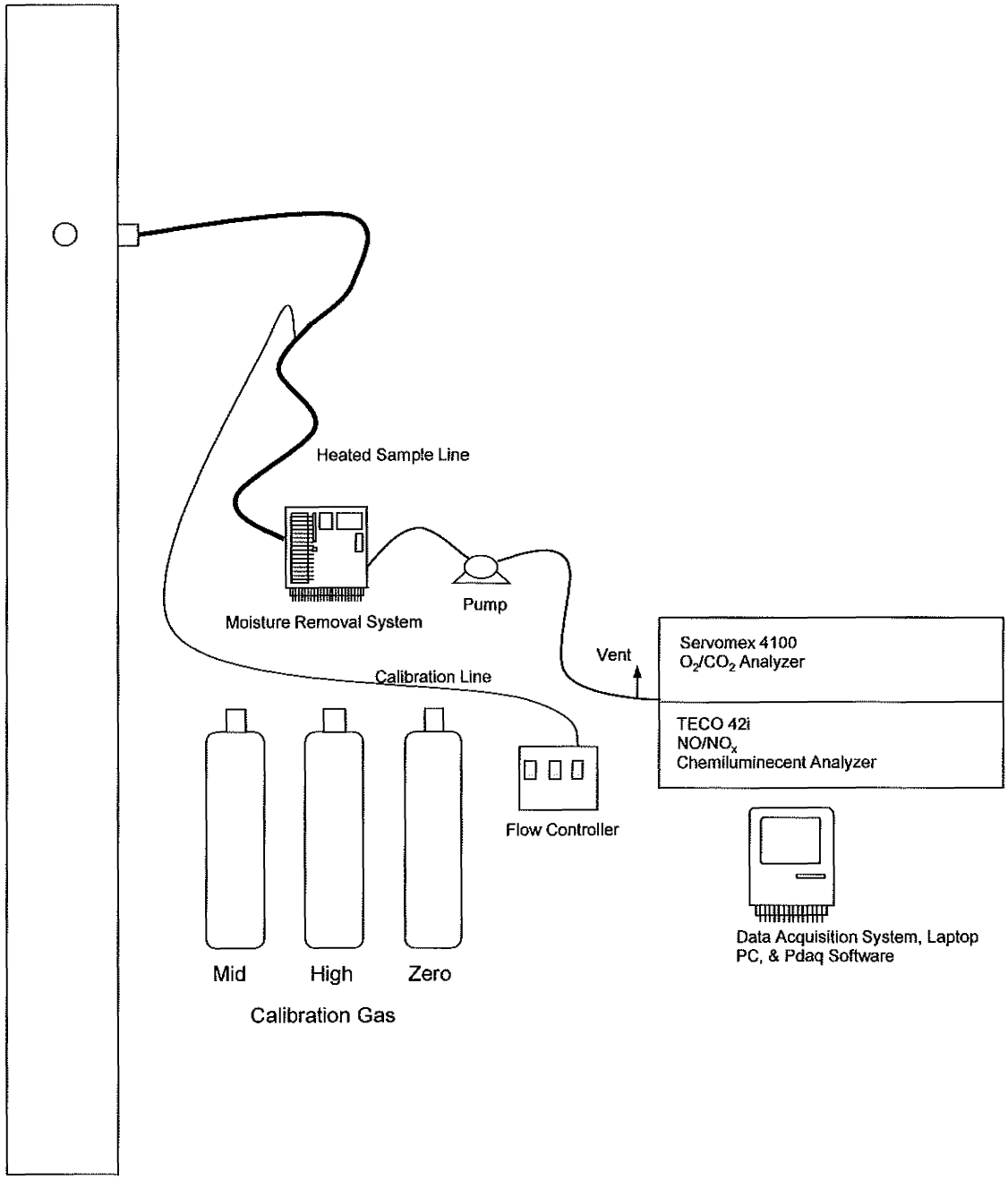

Figure No. 1

Site: **USEPA Method 3A, 7E** **AK Steel** **Dearborn, Michigan**	**Sampling Date:** **July 23, 2018**	**BT Environmental Consulting Inc.** **4949 Fernlee Avenue** **Royal Oak, MI 48073**

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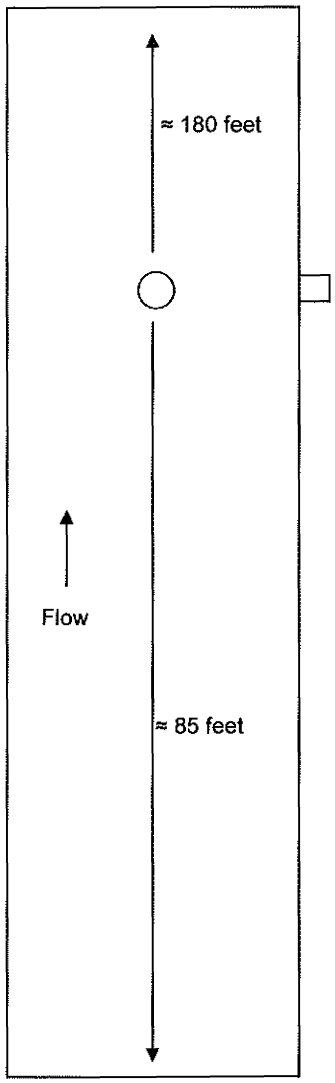
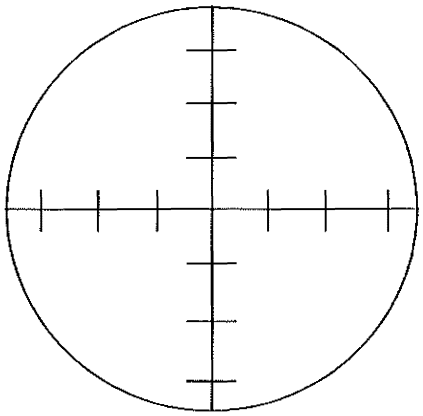
diameter = 168 inches





Not to Scale

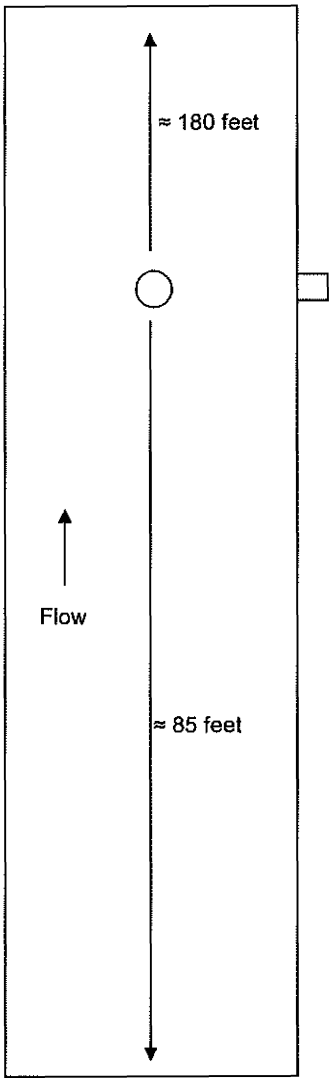
Points	Distance "
1	7.4
2	24.5
3	49.7
4	118.3
5	143.5
6	160.6

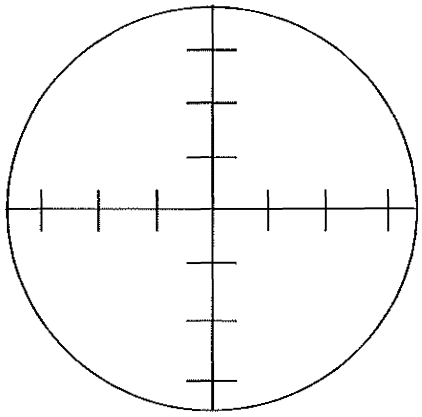
Figure No. 2

Site: **Hot Strip Mill North Stack** **AK Steel** **Dearborn, Michigan**	**Sampling Date:** **July 25, 2018**
BT Environmental Consulting, Inc. **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**	

BTEC Inc.

diameter = 168 inches





Not to Scale

Points	Distance "
1	7.4
2	24.5
3	49.7
4	118.3
5	143.5
6	160.6

Figure No. 3

Site: **Hot Strip Mill South Stack** **AK Steel** **Dearborn, Michigan**	**Sampling Date:** **July 25, 2018**

BT Environmental Consulting, Inc.
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