SOURCE TESTING REPORT
COMPLIANCE TESTING
BOF ESP OUTLET
AK STEEL DEARBORN WORKS
DEARBORN, MICHIGAN

Prepared for:

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November 2018

1. INTRODUCTION

Environmental Quality Management, Inc. (EQM) was retained by AK Steel Dearborn Works to plan and conduct a compliance air sampling program at the BOF Electrostatic Precipitator (ESP) stack exhaust. The compliance program was conducted to evaluate emissions of filterable particulate matter (PM) from the BOF ESP stack and visible emissions (VE) from the BOF Roof Monitor. Three sampling runs, each run a minimum of 2 heats in duration, were conducted for PM. Visible emissions were conducted for a minimum of one complete heat concurrent with each PM run. EPA-approved sampling methods and laboratory analysis procedures were used to meet the objectives of the sampling program. An outline of the test program is presented in Table 1-1. Project participants and responsibilities are presented in Table 1-2.

Table 1-1. Sampling Requirements for AK Steel Dearborn, Michigan

Test Point No.	Test Point Name	Parameter Tested	Test Method
1	BOF ESP Exhaust	Flow Moisture PM O_2/CO_2	EPA Method 2 EPA Method 4 EPA Method 5 EPA Method 3A
2	BOF Roof Monitor	Opacity	EPA Method 9

Table 1-2. Project Participants

Name/Company	Responsibility
David Pate/AK Steel	Coordinate process operation and sampling activities Site/Process preparation Process information
Regina Hines/DEQ	Agency Review of Process and Sampling Procedures
Dan Scheffel/EQM Doug Allen/EQM Ben Fern/EQM Gary Drexler/EQM Nick Pharo/EQM Chris Janzen/EQM Robert Bingham/Smoke Reader LLC	Project Manager Field sampling crew Field sampling crew Field sampling crew Field sampling crew Field sampling crew VE observations

2. SUMMARY OF TEST RESULTS

The emission measurement program was performed from October 10-11, 2018. Table 2-1 presents the average results and limit comparison. Table 2-2 presents the summary of stack gas conditions. Table 2-3 presents the filterable particulate concentrations and mass emission rates.

Appendix A summarizes emission and example calculations, Appendix B presents field data, Appendix C presents laboratory results, Appendix D presents calibration data, Appendix E presents process data, Appendix F presents visible emissions data, Appendix G presents the test protocol and regulatory letter regarding the test effort, and Appendix H presents any additional correspondence between AK Steel and the Michigan Department of Environmental Quality (MDEQ) concerning this test.

Table 2-1. Average Results and Limit Comparison

Source	Pollutant	Permit Limit	Test Result
BOF ESP	PM	0.02 gr/dscf[a,b]	0.0039 gr/dscf
		0.0152 gr/dscf[b]	
		62.6 lb/hr[b]	17.6 lb/hr
BOF Roof Monitor	VE	20%[a,b]	5.0%[c]
		15%[d]	

[a]Limits as provided in 40 CFR 63 Subpart FFFFF Limit.
[b]Limit in MI-ROP-A8640-2016a.
[c]Calculated as highest 3-minute block average observed.
[d]Limit in MI-ROP-A8640-2016a,FGBOFSHOP I.2.

Table 2-2. Stack Gas Conditions BOF ESP Exhaust Stack

October 10-11, 2018 AK Steel, Dearborn Works

Run No.	Date/Time	Stack Gas Velocity, fps[a]	Volumetric Flow Rate acfm[b]	Volumetric Flow Rate dscfm[c]	Stack Temperature, °F	Moisture Content, % H_2O	CO_2, %	O_2, %
1	10/10/2018 0922-1156	58.2	792,711	534,715	215	13.6	2.6	19.4
2	10/10/2018 1227-1428	55.2	751,443	513,871	212	12.8	2.1	19.7
3	10/11/2018 0932-1134	57.0	776,619	516,848	216	14.1	2.8	19.1
Average		**56.8**	**773,591**	**521,811**	**214**	**13.5**	**2.5**	**19.4**

[a]Feet per second.
[b]Actual cubic feet per minute.
[c]Dry standard cubic feet per minute.

Table 2-3. Filterable Particulate Emissions BOF ESP Exhaust Stack

October 10-11, 2018 AK Steel – Dearborn Works

Run No.	Date/Time	Filterable Particulate Matter Concentration, gr/dscf[a]	Filterable Particulate Matter Mass Rate, lb/hr[b]
1	10/10/2018 0922-1156	4.59E-03	21.03
2	10/10/2018 1227-1428	3.78E-03	16.64
3	10/11/2018 0932-1134	3.43E-03	15.21
Average		**3.93E-03**	**17.62**

[a]Grains per dry standard cubic foot.
[b]Pounds per hour.

3. SAMPLING AND ANALYTICAL PROCEDURES

The sampling and analytical procedures used in this test program conform to EPA Reference Methods 1 through 4, 5, and 9, as published in the Federal Register.

3.1 Location of Measurement Sites

EPA Method 1, "Sample Velocity Traverses for Stationary Sources," was used to select representative measurement sites. The sampling location was at the exhaust of the BOF ESP. A schematic of the test location is shown in Figure 4-1 in Section 4.

3.2 Stack Gas Volumetric Flow Rate

EPA Method 2, "Determination of Stack Gas Velocity and Volumetric Flow Rates," was used to determine stack gas volumetric flow rates. Type "S" pitot tubes meeting the EPA specifications and an inclined manometer were used to measure velocity pressures. A calibrated Type "K" thermocouple attached directly to the pitot tube was used to measure stack gas temperature. The stack gas velocity was calculated from the average square root of the stack gas velocity pressure, average stack gas temperature, stack gas molecular weight, and absolute static pressure. The volumetric flow rate is the product of velocity and stack cross-sectional area.

3.3 Stack Gas Dry Molecular Weight

The ESP sampling location was sampled continuously for CO_2 and O_2 using a Servomex paramagnetic analyzer; gaseous pollutants were measured according to EPA Reference Method 3A, "Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)." Figure 3-1 is a schematic of the sampling system.

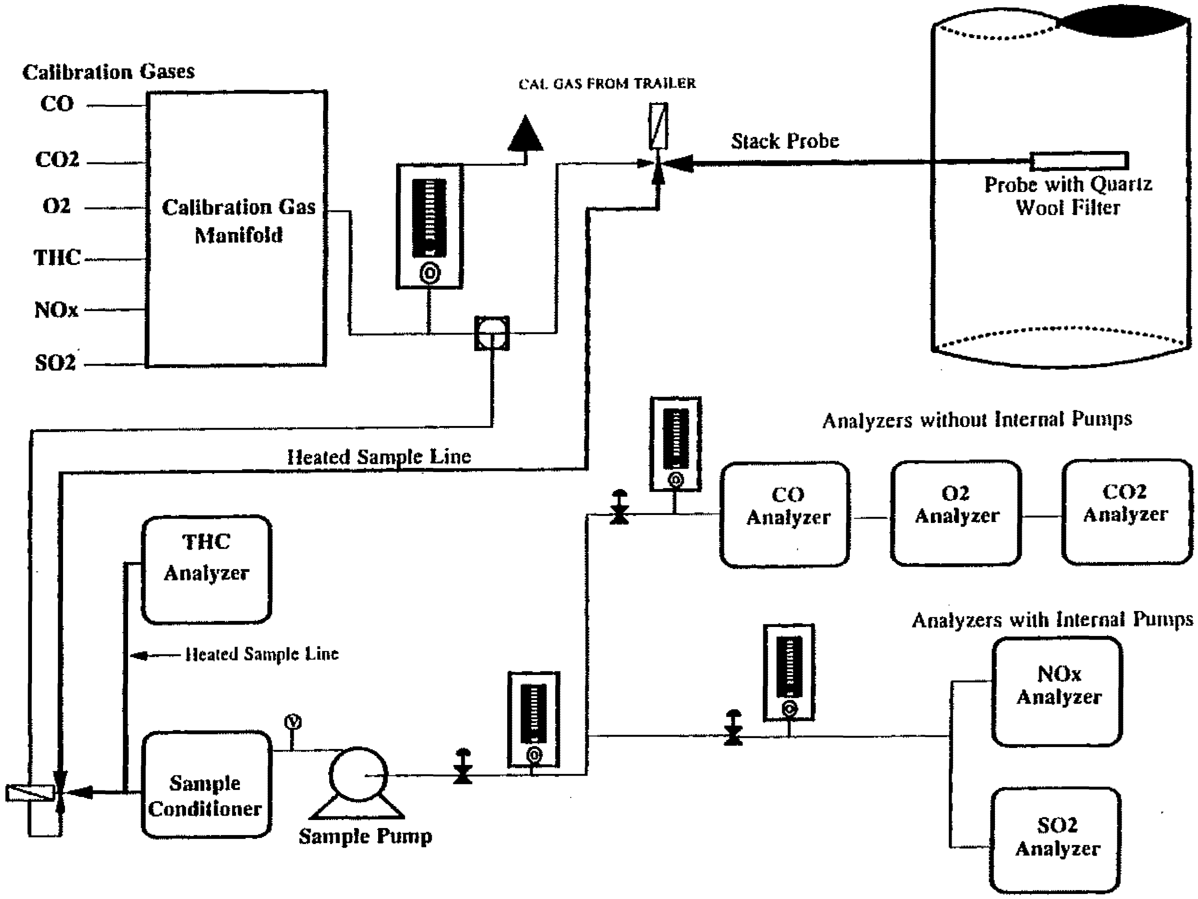


Figure 3-1. CEM Sample Flow and Calibration System
Note: This study used the CO_2 and O_2 analyzers.

3.4 Stack Gas Moisture Content

EPA Reference Method 4, "Determination of Moisture Content in Stack Gases," was used to determine stack gas moisture content. This method was conducted as part of each particulate measurement run. The initial and final contents of all impingers were determined gravimetrically.

3.5 Filterable Particulate

EPA Method 5 was used to measure the concentration and mass emission rate of filterable particulate matter. Three sampling runs, each run a minimum of 2 heats in duration, were collected at the ESP stack outlet location. Figure 3-2 presents schematics of the sampling train for Method 5.

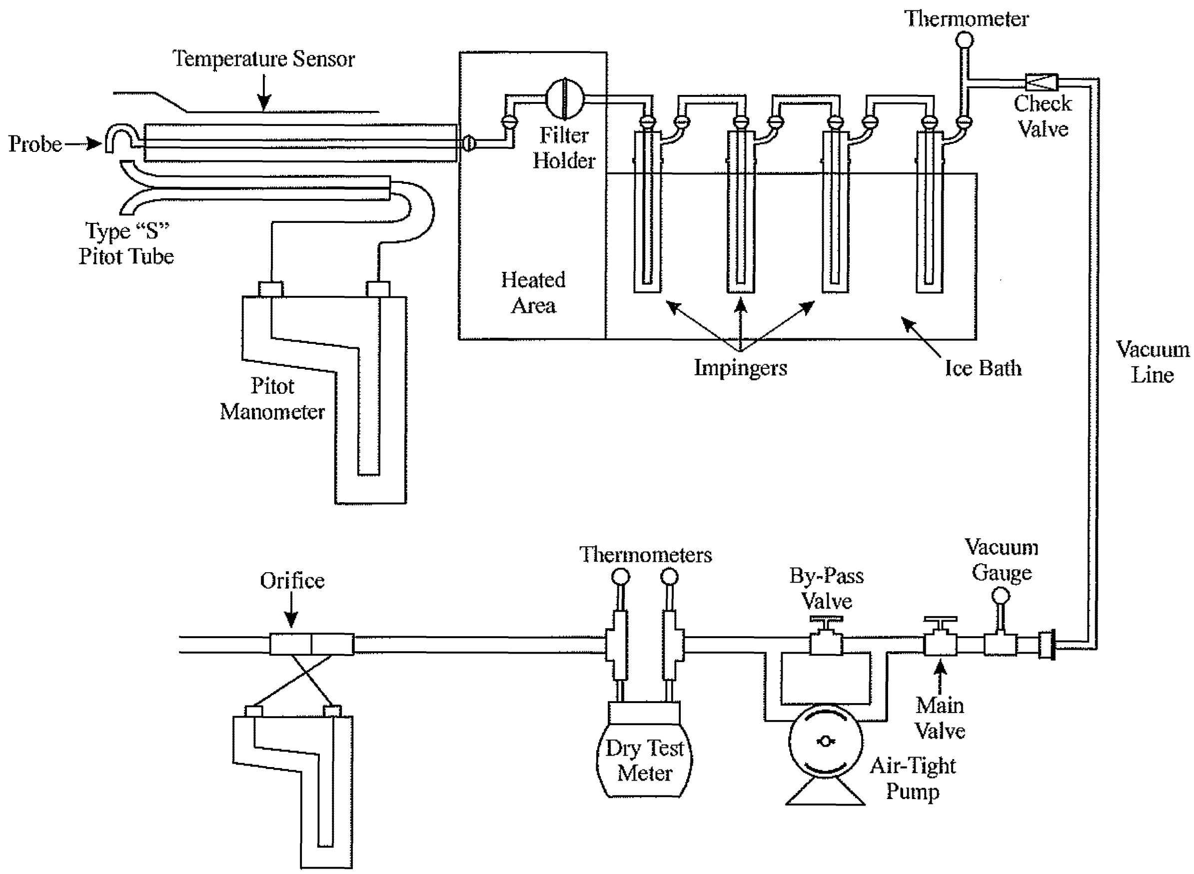


Figure 3-2. Method 5 Sampling Train

3.6 Opacity

EPA Method 9, "Visual Determination of the Opacity of Emissions from Stationary Sources," was used to measure visible emissions from the BOF Roof Monitor. During each particulate measurement run, plume opacity was recorded every 15 seconds. Opacity is reported as the highest 3-minute block average from the average of 12 consecutive observations recorded at 15-second intervals. This reporting methodology is required by the Title V permit and the Iron and Steel MACT.

3.7 Test Comments and Method Deviations

The following method deviations were proposed in the test protocol. Comments concerning each request are provided as follows:

1. AK Steel operates 2 BOF Vessels that exhaust to a common ESP. Although oxygen blowing can only take place on one vessel at a time, oxygen blowing could be occurring on a vessel while charging, tapping, slag blowing, and slag dumping are performed on the other vessel. Consequently, some overlap into a heat on the other vessel is likely when the end of the production cycle is reached on a vessel. In this case, AK Steel is proposing that the run will be ended at the end of the production cycle regardless of what is taking place on the other vessel.

   Comment: All runs commenced when scrap was charged to a vessel and ended 3 minutes after the completion of slag-off. Overlap from concurrent heats was factored into the production calculations.

2. AK Steel is proposing that no port changes take place during oxygen blowing. When it is time for a port change, the probe will be left at the same point until the oxygen blow is completed. Once the blow is completed, the probe will be moved to another port and placed at the point that corresponds to where it would be if the port change was performed solely based on time. This could lead to some points not being sampled. MDEQ has requested this modification in the past so that sampling could take place during the maximum particulate load on the ESP.

   Comment: MDEQ accepted this method deviation in the Test Plan Review Letter dated September 10, 2018, and this deviation was performed as stated during the test.

3. It is anticipated that the end of a sampling run may not correspond with the end of a heat. In order to satisfy the requirement of sampling integral heats, AK Steel is proposing that the traverse be restarted at the first port and continued in order until the heat is completed.

   Comment: MDEQ accepted this method deviation in the Test Plan Review Letter dated September 10, 2018, and this deviation was performed as stated during the test.

4. Visible emissions at the complete BOF Roof Monitor will be observed during the testing in accordance with the methodology discussed in this test plan. If the applicable opacity limit is exceeded, AK Steel will evaluate the validity of the ESP performance test with the MDEQ by determining if operations at the vessel were the source of the emissions. Documentation of any such investigation conducted will be included in the final report submittal.

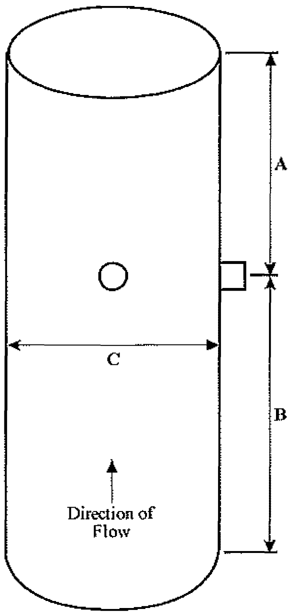
   Comment: The BOF Roof Monitor Opacity Limit was not exceeded during the test program.

4. PROCESS DESCRIPTION/SAMPLING LOCATIONS

Scrap steel is charged into the BOF vessel and then molten iron is charged into the vessel on top of the scrap. Fluxing agents are also added during the steelmaking process. Oxygen is blown into the molten iron/scrap mixture causing the scrap to melt. Iron is refined into steel by reducing the carbon content (which results in CO emissions). The heat for the steelmaking process comes from the reaction of oxygen with the dissolved carbon in the molten iron.

Particulate emissions consisting of iron oxides and various other metal oxides are also produced. In order to remove the large amounts of particulate, the flue gas is controlled by a 32-field electrostatic precipitator (ESP). The ESP is considered the primary control device in the steel making process at AK Dearborn's BOF shop. The dust-laden gases enter the ESP and the dust particles are electrically energized (negative charge) prior to entering the ESP. The charged particles then migrate over the positively charged collector plates where the particulate matter is collected. Rappers are used to vibrate both the discharge electrodes and the collection plates to dislodge the accumulated dust. The clean gases pass through the ID fans and are discharged out of the stack passing through the COM light pathway.

In addition to the ESP, a secondary emission control baghouse (BOF baghouse) is in operation at the facility. This BOF baghouse collects and controls particulate emissions during the hot metal charging and tapping operations that occur at the BOF vessels during the steel making heats. This baghouse also controls emissions generated by the iron reladling operations. A diagram of the sampling location is shown in Figure 4-1.



Location	Upstream A	Downstream B	Inside Diameter C
ESP Exhaust Stack	>240 inches	>480 inches	204 inches
4 total ports, 6 sample points per port, 24 sample points			
Sample Point 1	4.3 inches from inside of port		
Sample Point 2	13.7 inches from inside of port		
Sample Point 3	24.1 inches from inside of port		
Sample Point 4	36.1 inches from inside of port		
Sample Point 5	51.0 inches from inside of port		
Sample Point 6	72.6 inches from inside of port		

Figure 4-1. Sampling Location

5. NESHAP AND ROP TESTING REQUIREMENTS

Table 5-1 summarizes the NESHAP and ROP conditions as they relate to testing and notification requirements.

Table 5-1. NESHAP and ROP Testing Requirements

NESHAP Reference	ROP Reference	NESHAP/ROP Language	Comments
40 CFR 63.7821	EUBOF V.1 and V.2	Conduct performance tests for particulate matter emissions and opacity at least twice during the ROP renewal period.	This was the first test conducted within the current ROP Renewal Period (commenced April 22, 2016).
40 CFR 63.7822(b)(1)	N/A	Determine the concentration of particulate matter according to 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 dscf of gas during each particulate matter test run. Three valid test runs are needed to comprise a performance test.	Between 95.9 and 103.7 dscf of gas were collected during each particulate matter test run.
40 CFR 63.7822(g)(1) and 40 CFR 63.7823(d)(5)	EUBOF V.1 and V.6	Sample only during the steel production cycle. Conduct sampling under conditions that are representative of normal operation. Record the start and stop time of each steel production cycle and each abnormal operation.	Sampling only occurred during the steel production cycle. The start and stop time of each steel production cycle and each abnormal operation was recorded as required.

Table 5-1. NESHAP and ROP Testing Requirements (continued)

NESHAP Reference	ROP Reference	NESHAP/ROP Language	Comments
40 CFR 63.7822(g)(2)	EUBOF V.1	Sample for an integral number of steel production cycles. The steel production cycle begins when the scrap is charged to the furnace and ends 3 minutes after the slag is emptied from the vessel into the slag pot.	Sampling was conducted for an integral number of cycles subject to the limitation discussed in Test Comment 1. The cycle as described was documented and followed.
40 CFR 63.7823(d)(1)(ii)	EUBOF V.4	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)	EUBOF V.4	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 63.7823(d)(4)	EUBOF V.5	Opacity observations from the roof monitors must cover at least 3 steel production cycles. The steel production cycle begins when the scrap is charged to the furnace and ends 3 minutes after the slag is emptied from the vessel into the slag pot.	An observation was conducted on one complete steel production cycle per run for a total of three steel production cycles.

Table 5-1. NESHAP and ROP Testing Requirements (continued)

NESHAP Reference	ROP Reference	NESHAP/ROP Language	Comments
40 CFR 63.7823(b)	EUBOF V.2	Performance tests shall be conducted such that the opacity observations overlap with the performance test for particulate.	All opacity observations overlapped with the performance test for particulate.
40 CFR 63.7840(d)	EUBOF 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 August 8, 2018, 63 days prior to the start of the testing.

6. QUALITY ASSURANCE AND QUALITY CONTROL

The field sampling quality assurance for this project included the use of calibrated source sampling equipment, reference test methods, and traceability protocols for recording and calculating data. The analytical quality assurance includes use of validated analytical procedures, calibration of equipment, and analysis of control samples and blanks. The calibration and quality control procedures used for this test program are described in the following subsection.

6.1 Calibration Procedures and Frequency

All manual stack gas sampling equipment is calibrated before the start of the test program in accordance with the procedures outlined in the *Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III*, EPA-600/4-72-027B. Table 6-1 is a summary of the stack gas sampling equipment calibrations that are performed in preparation for this project. The meter boxes are re-calibrated after the test.

Table 6-2 lists the additional calibration checks that are performed on the sampling equipment on site, just prior to the testing, to ensure that equipment was not damaged during transport. Table 6-3 details the field checks conducted on the continuous emission monitoring systems before and during the test program.

Table 6-1. Field Equipment Calibration Summary[a]

Equipment	Calibrated Against	Allowable Error
Method 5 meter box	Reference test meter	Y ±0.02 Y ΔH@ ±0.20 ΔH@ post-test Y ±0.05 Y
Pitot tube	Geometric specifications	See EPA Method 2
Thermocouple	ASTM-3F thermometer	±1.5%
Impinger (or condenser thermometer)	ASTM-3F	±2°F
Dry gas meter thermometer	ASTM-3F	±5°F
Probe nozzles	Caliper	±0.004 in.
Barometer	NBS traceable barometer	±0.1 in. Hg

[a]As recommended in the *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume III. Stationary Source-Specific Methods*. EPA-600/4-77-027b, August 1977.

Table 6-2. Field Checks of Sampling Equipment

Equipment	Checked Against	Allowable Difference
Pitot tube	Inspection	No visible damage
Thermocouples	ASTM 2F or 3F	±1.5%
Probe nozzles	Caliper	±0.004 in.

Table 6-3. Field Checks of O_2 and CO_2 Analyzers

Calibration	Instrument Check	Acceptable Limit
Initial Calibration	O_2 and CO_2 Calibration Error, % Span	±2%
	Sampling System Bias	±5% of Span
Daily Calibration	O_2 and CO_2 Calibration Error, % Span	±2%
	O_2 and CO_2 Drift, % Span	±3% of Span