BTEC Inc.

C Blast Furnace Casthouse Baghouse Particulate Matter Emissions Test Report

Prepared for:

AK Steel Dearborn Works

Dearborn, Michigan

AK Steel Dearborn Works
4001 Miller Rd.
Dearborn, Michigan 48120

Project No. 14-4630.00
December 29, 2014

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 to evaluate air pollutant emission rates from the C Blast Furnace Baghouse at the AK Steel facility located in Dearborn, Michigan. The test project consisted of evaluating exhaust gas flowrates and filterable particulate matter (PM) emission rates. Testing for this project was conducted on December 9th and 10th, 2014. The purpose of the test was to reestablish operating parameters for the C Blast Furnace Casthouse Baghouse in accordance with 40CFR 63.7823 and 63.7824.

The test program consisted of five tests of varying duration. Sampling was performed utilizing United States Environmental Protection Agency (USEPA) reference test methods. The average results of the emissions test program are summarized by Table 1.

Table 1
Overall Emission Summary

Source	PM Emission Limit (PTI 182-05C) gr/dscf	PM Emission Limit (MACT) gr/dscf	PM Emission Rate gr/dscf
C Furnace Baghouse Exhaust	0.003	0.01	0.00009

In addition, Method 9 observations were conducted for 30 6-minute block averages at both the east and north casthouse roof monitors and the results are summarized in Table 1A.

Table 1 A
Roof Monitor Opacity Summary

Source	Opacity Limit	Highest 6 Minute Block Average Opacity
C BF East Roof Monitor	20%, 6 minute block average	3%
C BF North Roof Monitor	20%, 6 minute block average	4%

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1.0 Introduction

BT Environmental Consulting, Inc. (BTEC) was retained by AK Steel to evaluate air pollutant emission rates from the C Furnace Baghouse at the AK Steel facility located in Dearborn, Michigan. The test project consisted of evaluating exhaust gas flowrates and filterable particulate matter (PM) emission rates. Testing for this project was conducted on December 9th and 10th, 2014. The purpose of the test was to reestablish operating parameters for the C Blast Furnace Casthouse Baghouse in accordance with 40CFR 63.7823 and 63.7824.

The following BTEC professionals participated in conducting this study: Ken Lievense and Matthew Young, Project Managers; and Paul Molenda and Steve Smith, Environmental Technicians.

The purpose of the project was to evaluate the exhaust gas flow rates and PM concentrations and calculate the resultant emission rates from the C Blast Furnace Baghouse exhaust stack. The emissions data will be utilized for compliance purposes. Mr. Jim Earl with the Environmental Affairs Department provided the on-site coordination for this project along with Dave Pate and Jeff McCutcheon with Civil & Environmental Consultants Inc. Process data and operating parameters were monitored and recorded by Steve Felton of ENCOSS. Method 9 observations of the roof monitors were conducted by Robert Bingham and Jason Logan of Derenzo & Associates.

Jon Lamb and Nathan Hude of the MDEQ Air Quality Division were on site December 9 to oversee the testing.

2.0 Process Description

Molten iron (hot metal) is produced in the blast furnace by heating iron ore pellets and other iron-bearing materials, coke, limestone, slag, or other fluxing material. Burden materials consisting of iron ore pellets, flux material (slag, limestone, or dolomite), and a carbon source (usually coke) are delivered to and charged into the top of the furnace. Additional carbon is supplied to the furnace by injecting natural gas and pulverized coal into the hot blast section of the furnace. Preheated combustion (hot blast) air is pushed vertically through the burden material in the furnace from tuyeres located at the bottom of the furnace. The components of the burden chemically react with the hot blast air to reduce the iron oxides into elemental iron and melt. The blast furnace produces molten iron, blast furnace gas, and slag.

Periodically, the molten iron and slag are cast from the furnace into a trough and iron runners in the floor of the casthouse. The slag is separated from the molten iron in the trough prior to entering refractory-lined bottle cars. The slag is then diverted to slag pots. The molten iron is transported in bottle cars to the BOF for use in the steelmaking process.

Emissions generated within the casthouse from the molten iron and slag that are cast from the C Furnace are captured by collection hoods and are routed to a baghouse that is used to control particulate emissions from the process.

2.1 TYPE AND QUANTITY OF RAW AND FINISHED MATERIALS USED IN THE PROCESS

Iron-bearing materials may include iron ore pellets, scrap, and other iron-bearing materials. Coke is added to provide the main chemical reagents (carbon and carbon monoxide) for iron ore reduction. BOF slag, limestone and/or dolomite, is added as a fluxing material to remove impurities and produces a slag that rises to the top of the iron trough. Quantities depend on the charging rate to the furnace to make the desired iron quality and produce approximately 250-300 tons per hour of molten iron.

2.2 DESCRIPTION OF ANY OPERATIONS THAT COULD PRODUCE VARIABLE EMISSIONS

Emissions will vary over the duration of the cast. Initially, one of the two tapholes is drilled, and a cast begins, first casting iron, and then iron and slag toward the end of the cast. At the conclusion of the cast, the taphole is plugged. Sometimes both tapholes will have to cast iron simultaneously in order to extract the iron from the blast furnace, which requires both sides (north and east) of the C Furnace casthouse to be operating and controlled at the same time.

2.3 BASIC OPERATING PARAMETERS USED TO REGULATE THE PROCESS

Operations evaluate and monitor feed streams of raw materials (iron ore pellets, pulverized coal, coke, natural gas, etc.) and furnace conditions (various temperatures, pressures, burden) to track furnace performance when it is operating. In addition, hot and cold blast air volumes and other parameters are monitored continuously during furnace operation.

3.0 Sampling and Analytical Methodologies

Sampling and analytical methodologies for the emissions test program can be separated into two categories as follows:

(1) Measurement of exhaust gas velocity, molecular weight, and moisture content; and,
(2) Measurement of filterable particulate matter using Method 5.

Descriptions of sampling and analytical methodologies by category are summarized by Sections 3.1 through 3.2, respectively.

Sampling took place only during casting, i.e, from drilling through plugging. An integral number of casts were sampled in each test run and were at least one hour in duration per 40 CFR 63.7822(e).

3.1 Exhaust Gas Velocity, Molecular Weight, and Moisture Content

Measurement of exhaust gas velocity, molecular weight, and moisture content were conducted using the following reference test methods codified at 40 CFR 60, Appendix A:

Method 1 - *"Location of the Sampling Site and Sampling Points"*
Method 2 - *"Determination of Stack Gas Velocity and Volumetric Flow rate"*
Method 3 - *"Determination of Molecular Weight of Dry Stack Gas" (Fyrite)*
Method 4 - *"Determination of Moisture Content in Stack Gases"*

Stack gas velocity traverses were conducted in accordance with the procedures outlined in Methods 1 and 2 (see Figure 1 for exhaust stack traverse point diagram). An S-type pitot tube with a thermocouple assembly, calibrated in accordance with Method 2, Section 4.1.1, was 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.

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 (see figure 2 for a schematic of the sampling train) and passed through (i) two impingers, each with 100 ml of a mixture of ethylene glycol and water (approved by Tom Maza of the MDEQ), (ii) an empty impinger, and (iii) an impinger filled with silica gel. Exhaust gas moisture content is then determined gravimetrically.

3.2 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). Five test runs were conducted on the C Furnace Baghouse exhaust under normal operating conditions.

BTEC's Nutech® Model 2010 modular isokinetic stack sampling system consisted of (1) a stainless steel nozzle, (2) a glass probe, (3) a set of four Greenburg-Smith (GS) impingers with the first two with 100 ml of H_2O (ii) an empty impinger, (iii) and an impinger filled with approximately 300 grams of silica gel, (4) a length of sample line, and (5) 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 100 ml of acetone which was collected in a pre-cleaned sample container.

BTEC labeled each container with the test number, test location, and test date, then marked the level of liquid on the outside of the container. Blank samples of the filter and acetone were collected. BTEC personnel transported all samples to BTEC's laboratory in Royal Oak, Michigan, for analysis.

4.0 Test Results

The results of the emissions test program are summarized by Table 1.

Table 1
Overall Emission Summary

Source	PM Emission Limit (PTI 182-05C) gr/dscf	PM Emission Limit (MACT) gr/dscf	PM Emission Rate gr/dscf
C Furnace Baghouse Exhaust	0.003	0.01	0.00009

Field and computer generated data for each test run are available in Appendix A, as well as all other applicable field data. Equipment calibration information is presented in Appendix B. Example calculations for equations used to determine emission rates are presented in Appendix C. Laboratory analysis is available in Appendix D. Process data is available in Appendix E.

Table 1 A
Roof Monitor Opacity Summary

Source	Opacity Limit	Highest 6 Minute Block Average Opacity
C BF East Roof Monitor	20%, 6 minute block average	3%
C BF North Roof Monitor	20%, 6 minute block average	4%

The Method 9 observation forms along with the observers training certificates are in Appendix F

Limitations

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: Brandon Chase
Brandon Chase
Staff Environmental Engineer

This report was reviewed by: Brandon Chase
pp Matthew Young
Project Manager

Table 2
C Blast Furnace Baghouse Particulate Matter Emission Rates

Company	**AK Steel**					
Source Designation	**C Furnace BH**					
Test Date	**12/9/2014**	**12/9/2014**	**12/9/2014**	**12/10/2014**	**12/10/2014**	
Meter/Nozzle Information	P-1	P-2	P-3	P-4	P-5	Average
Meter Temperature Tm (F)	69.7	79.7	81.6	78.6	85.1	78.9
Meter Pressure - Pm (in. Hg)	29.5	29.5	29.6	29.6	29.6	29.6
Measured Sample Volume (Vm)	77.4	117.3	164.3	97.2	115.6	114.3
Sample Volume (Vm-Std ft3)	75.8	112.7	158.0	94.1	110.6	110.3
Sample Volume (Vm-Std m3)	2.15	3.19	4.48	2.67	3.13	3.12
Condensate Volume (Vw-std)	1.169	1.499	1.146	0.453	0.481	0.950
Gas Density (Ps(std) lbs/ft3) (wet)	0.0741	0.0742	0.0743	0.0744	0.0744	0.0743
Gas Density (Ps(std) lbs/ft3) (dry)	0.0745	0.0745	0.0745	0.0745	0.0745	0.0745
Total weight of sampled gas (m g lbs) (wet)	5.71	8.47	11.83	7.04	8.27	8.26
Total weight of sampled gas (m g lbs) (dry)	5.65	8.40	11.78	7.01	8.24	8.22
Nozzle Size - An (sq. ft.)	0.000175	0.000167	0.000250	0.000163	0.000167	0.000184
Isokinetic Variation - I	100.7	100.4	99.1	100.1	99.8	100.0
Stack Data						
Average Stack Temperature - Ts (F)	101.2	102.5	103.5	96.0	93.7	99.4
Molecular Weight Stack Gas- dry (Md)	28.8	28.8	28.8	28.8	28.8	28.8
Molecular Weight Stack Gas-wet (Ms)	28.7	28.7	28.8	28.8	28.8	28.7
Stack Gas Specific Gravity (Gs)	0.990	0.991	0.993	0.994	0.994	0.992
Percent Moisture (Bws)	1.52	1.31	0.72	0.48	0.43	0.89
Water Vapor Volume (fraction)	0.0152	0.0131	0.0072	0.0048	0.0043	0.0089
Pressure - Ps ("Hg)	29.3	29.3	29.3	29.5	29.5	29.4
Average Stack Velocity -Vs (ft/sec)	65.9	66.3	64.9	60.6	59.7	63.5
Area of Stack (ft2)	125.9	125.9	125.9	125.9	125.9	125.9
Exhaust Gas Flowrate						
Flowrate ft^3(Actual)	498,093	501,333	490,323	458,327	451,073	479,830
Flowrate ft^3 (Standard Wet)	459,236	461,101	450,160	428,959	423,949	444,681
Flowrate ft^3 (Standard Dry)	452,261	455,049	446,920	426,906	422,113	440,650
Flowrate m^3 (standard dry)	12,807	12,886	12,655	12,089	11,953	12,478
Total Particulate Weights (mg)						
Nozzle/Probe/Filter	0.9	0.2	0.4	1.1	0.0	0.5
Total Particulate Concentration						
lb/1000 lb (wet)	0.00035	0.00005	0.00007	0.00034	0.00000	0.00016
lb/1000 lb (dry)	0.00035	0.00005	0.00007	0.00035	0.00000	0.00016
mg/dscm (dry)	0.4	0.1	0.1	0.4	0.0	0.2
gr/dscf	0.00018	0.00003	0.00004	0.00018	0.00000	0.00009
Total Particulate Emission Rate						
lb/ hr	0.71	0.11	0.15	0.66	0.00	0.33

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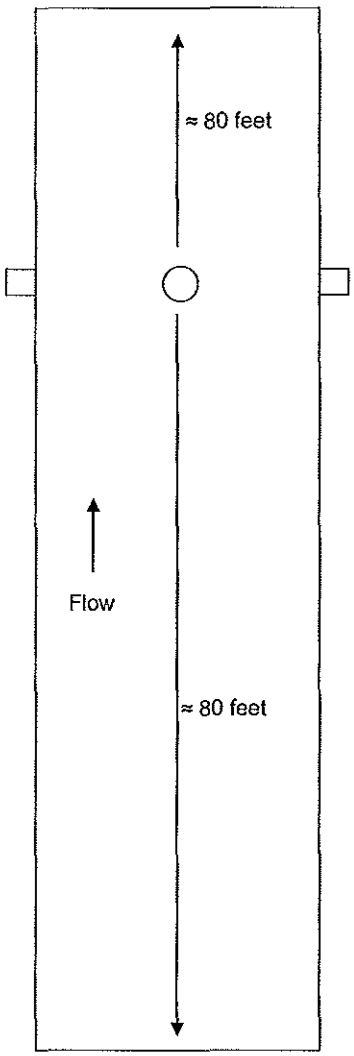
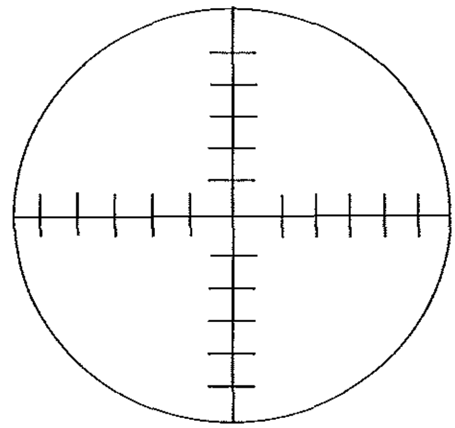
diameter = 152 inches





Not to Scale

Points	Distance "
1	4.0
2	12.5
3	22.2
4	34.4
5	52.0
6	100.0
7	117.6
8	129.8
9	139.5
10	148.0

Figure No. 1

Site:
C Blast Furnace Baghouse Exhaust
AK Steel
Dearborn, Michigan

Sampling Date:
December 9-20, 2014

BT Environmental Consulting, Inc.
4949 Fernlee Avenue
Royal Oak, Michigan 48073

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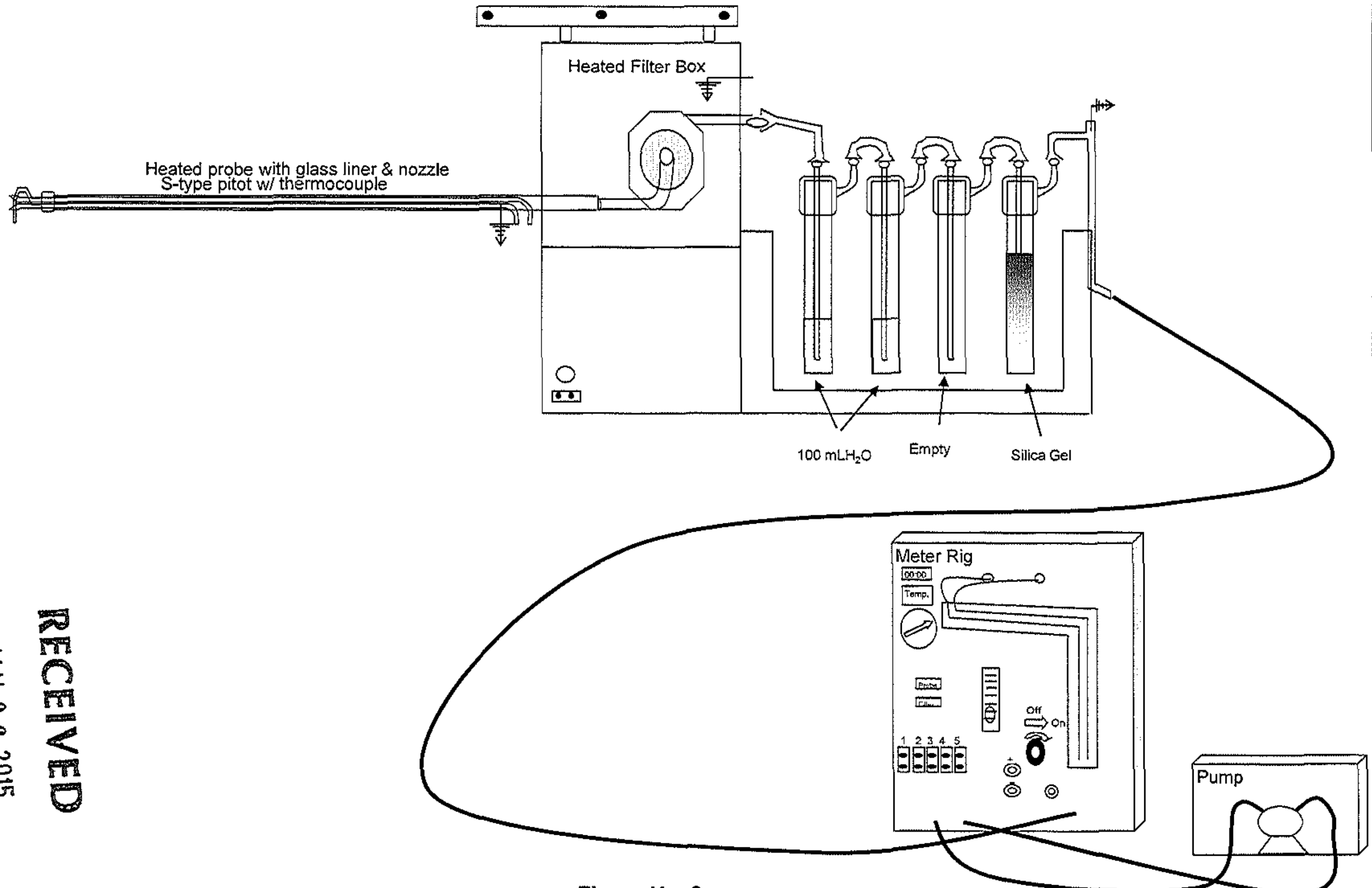

Figure No. 2

Site: **USEPA Method 5** **AK Steel** **Dearborn, Michigan**	**Sampling Date:** **December 9-10, 2014**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**