RELATIVE ACCURACY TEST AUDIT
C-FURNACE STOVE STACK CEMS
AK STEEL CORPORATION
DEARBORN WORKS
DEARBORN, MICHIGAN

RECEIVED
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AIR QUALITY DIV.

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1. INTRODUCTION

Environmental Quality Management, Inc. (EQM) was retained by AK Steel Corporation Dearborn Works (AK Steel) facility in Dearborn, Michigan to conduct a Relative Accuracy Test Audit (RATA) on the plant's sulfur dioxide (SO_2) and flow continuous emission monitoring system (CEMS) serving the C-Furnace Stove Stack exhaust. The test program was conducted on April 26, 2017.

The purpose of the testing was to comply with the Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (RO) No. MI-ROP-A8640-2016a as well as to meet the quality assurance requirements for CEMS systems specified in 40 CFR Part 60, Appendix B.

The plant monitors associated with the stove stack CEMS are:

Sulfur Dioxide Analyzer	Flow Analyzer
Manufacturer: TECO	Manufacturer: CEMFLOW
Model: 43iHL	Serial No.: 091707-001-1013
Serial No.: 0721923352	

Reference method sampling was conducted to evaluate the operation of the CEMs according to Performance Specification 2 (SO_2) and 6 (flow) procedures.* The specification tests evaluate the CEM daily operation and calibration system.

Sampling was conducted according to EPA Methods 1, 2, 3A, 4, and 6C for sampling point location, stack gas flow and composition (CO_2 and O_2 percent), moisture, and SO_2, respectively.

Mr. David Pate of AK Steel coordinated process operations and field sampling efforts. Messrs. Chris Janzen, Nick Pharo, Gary Drexler, Eric Zang, and Ben Fern of EQM conducted the air sampling efforts. Ms. Katherine Koster of the Michigan Department of Environmental Quality (MDEQ) witnessed process operations and sampling efforts.

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* 40 CFR Appendix B, Performance Test Specification 2 and 6.

2. SUMMARY OF TEST RESULTS

The exhaust of the C-Furnace Stove Stack was sampled on April 26, 2017 to evaluate the facility's CEM system. Eleven 21-minute sampling runs were conducted. Table 2-1 presents the plant CEM readings and corresponding reference method results. All of the test periods used in the relative accuracy (RA) determination are shown.

The RA of the SO_2 CEM shall be no greater than 20 percent of the mean value of the reference method (RM) test data in terms of the units of the emission standard (lb/hr) or 10 percent when the applicable emission standard is used. The RA was 11.7 percent, or 4.5 percent when the applicable standard is used, in terms of pounds of SO_2/hour.

The RA of the SO_2 CEM based on concentrations was required to be no greater than 20 percent of the mean value of the reference method test data on a part-per-million (ppm) basis or 10% when the applicable emission standard is used in the denominator of the relative accuracy equation. The facility CEM was measured on a dry basis, and the EQM instrument was measured on a dry basis. The RA was 8.0 percent, or 3.0 percent when the applicable standard is used, in terms of ppm SO_2.

The RA of the flow CEM was required to be no greater than 20 percent of the mean value of the reference method test data. The RA was 6.5 percent, in terms of exhaust gas flow.

Calculations are presented in Appendix A.

Table 2-1. Testing Summary for C-Furnace Stove Stack

April 26, 2017 Plant: AK Steel Dearborn Works, Dearborn, Michigan

Run No.	Time[a]	Reference Method			AK CEM Data		
		SO_2		Flow, Kscfm[d]	SO_2		Flow, Kscfm[d]
		lb/hr[b]	ppm[c]		lb/hr[b]	ppm[c]	
1[e]	0740-0800	44.3	52.3	97.0	66.2	53.2	134.1
2[e]	0816-0836	70.0	51.8	154.6	64.9	50.4	143.2
3	0849-0909	84.1	61.9	154.5	74.3	58.7	147.8
4	0922-0942	75.8	59.2	145.6	67.1	56.0	132.4
5	0958-1018	71.4	56.2	144.4	66.6	52.8	140.0
6	1033-1053	75.5	56.3	152.5	68.7	53.3	142.4
7	1105-1125	77.1	58.0	151.4	70.2	54.5	148.3
8	1137-1157	69.3	56.1	140.5	61.3	52.0	131.1
9	1214-1234	69.1	52.8	149.8	60.2	47.4	141.3
10	1248-1308	73.1	57.8	144.7	68.3	53.1	142.1
11	1318-1338	70.5	55.9	147.0	63.2	51.1	145.5
RA (%)		--	--	--	**4.5**	**3.0**	**6.5**

[a] Times listed are not corrected for Daylight Savings Time, and are therefore 60 minutes behind actual time and process time as a result (i.e., Run #1 began at 8:40 AM and Run #11 ended at 2:38 PM EDT).

[b] Pounds per hour.

[c] Parts per million, dry basis.

[d] Thousand standard cubic feet per minute. The Flow times vary for each run and are included in Appendix A and C.

[e] Runs not used in the Relative Accuracy determinations.

3. SAMPLING LOCATION AND TEST METHODS

Sampling was conducted at the C-Furnace Stove Stack outlet. EPA Method 1 was used to select representative measurement sites for the velocity traverses. The sampling location is shown in Figure 3-1. For O_2, CO_2, and SO_2 measurement, three sampling points were used to collect each reference method sample. Each point was sampled 7 minutes for a total sampling time of 21 minutes. The sampling location was over 960 inches downstream or 8 duct diameters (dd) to the nearest flow disturbance, and over 240 inches upstream or 2 dd to the nearest flow disturbance in the 120-inch-diameter circular stack. The other test methods are described below.

3.1 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. One flow traverse was conducted for each RATA run.

3.2 Oxygen and Carbon Dioxide

Oxygen (O_2) and carborn dioxide (CO_2) concentrations were measured following the procedures of EPA Method 3A, "Gas Analysis for Carbon Dioxide, Oxygen, Excess Air, and Dry Molecular Weight." Stack gas was manifolded from the CEM sampling system to analyzers that continually measured the O_2 and CO_2 levels in the sampling stream. The non-dispersive infrared (NDIR) analyzers are capable of measuring concentrations to within one-tenth of a percent of full scale. The O_2 analyzer was operated on a 0 to 21.95 percent range with calibration gases of 0.0, 11.0, and 21.95 percent. The CO_2 analyzer was operated on a 0 to 33.31 percent range with calibration gases of 0.0, 18.89, and 33.31 percent.

The analyzers received the sample from a manifold system that was fed by a Baldwin gas conditioner. The gas conditioner consists of an airtight Teflon diaphragm pump and a refrigeration unit. The pump has a flow controller and a rotometer to provide a constant flow rate to the analyzers. The refrigeration unit contains two separate stainless steel chambers that are maintained at a temperature of 39°F. A peristaltic pump removes any condensate from the chambers. Figure 3-2 is a schematic of the sampling system.

3.3 Stack Gas Moisture Content

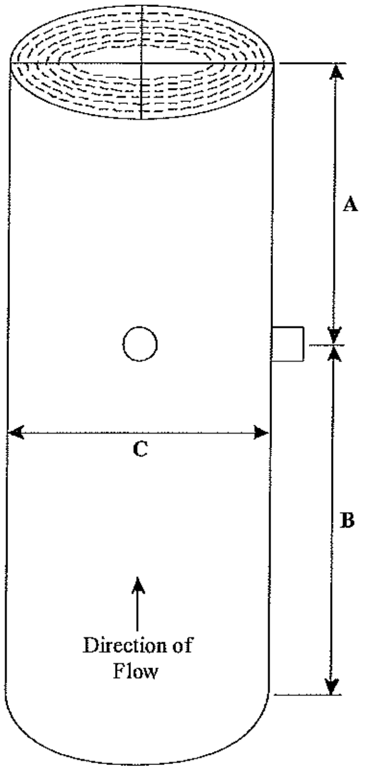
EPA Method 4, "Determination of Moisture Content in Stack Gases," was used to determine stack gas moisture content. The initial and final contents of all impingers were determined gravimetrically. One moisture run was conducted for every two RATA runs.

3.4 Sulfur Dioxide

Sulfur dioxide concentrations were sampled for according to the procedures of EPA Method 6C, "Determination of Sulfur Dioxide Emissions from Stationary Sources (Instrumental Analyzer Procedure)." EQM used an ultraviolet SO_2 analyzer. Data was recorded on a Strata data logging system. Each sampling run was 21 minutes in length. Prior to and at the end of each 21-minute test run, the system was calibrated using zero gas and mid gas to determine the drift of the instrument. A complete direct and system calibration was conducted at the beginning of the test program using a zero gas and two sulfur-dioxide-in-nitrogen EPA Protocol One calibration gases. Results are in Appendix B, CEM Data. Figure 3-2 is a schematic of the sampling system.

3.5 Relative Accuracy Test Audit

A relative accuracy test audit (RATA) was conducted in accordance with 40 CFR, Part 60, Appendix B, Specification 2 for Sulfur Dioxide (SO_2) and Specification 6 for rate. The audit equipment was completely separate but parallel to the installed continuous emission equipment. The SO_2 parts per million data was recorded by an electronic data logger on a once per second basis. SO_2 parts per million was averaged and stored as one minute average data points, emulating the CEMS installation. The reference method data was averaged and compared to the corresponding CEMS data. CEMS times and reference method times were checked and coordinated to minimize any time differentials. A single flow traverse was conducted during each RATA run to convert reference method parts per million to pounds per hour.



Location	Upstream A	Downstream B	Inside Diameter C
C Furnace Stoves Exhaust	>240 inches	>960 inches	120 inches

Flow Sampling Points – 12 Total Points (3 per port)		
Traverse Pt 1 – 5 1/4”	Traverse Pt 2 – 17 1/2	Traverse Pt 3 – 35 1/2
CEM Sampling Points – 3 Total Points (1 port)		
Traverse Pt 1 – 15 3/4”	Traverse Pt 2 – 47 1/4	Traverse Pt 3 – 78 3/4

Figure 3-1. C-Furnace Stove Stack Sampling Location

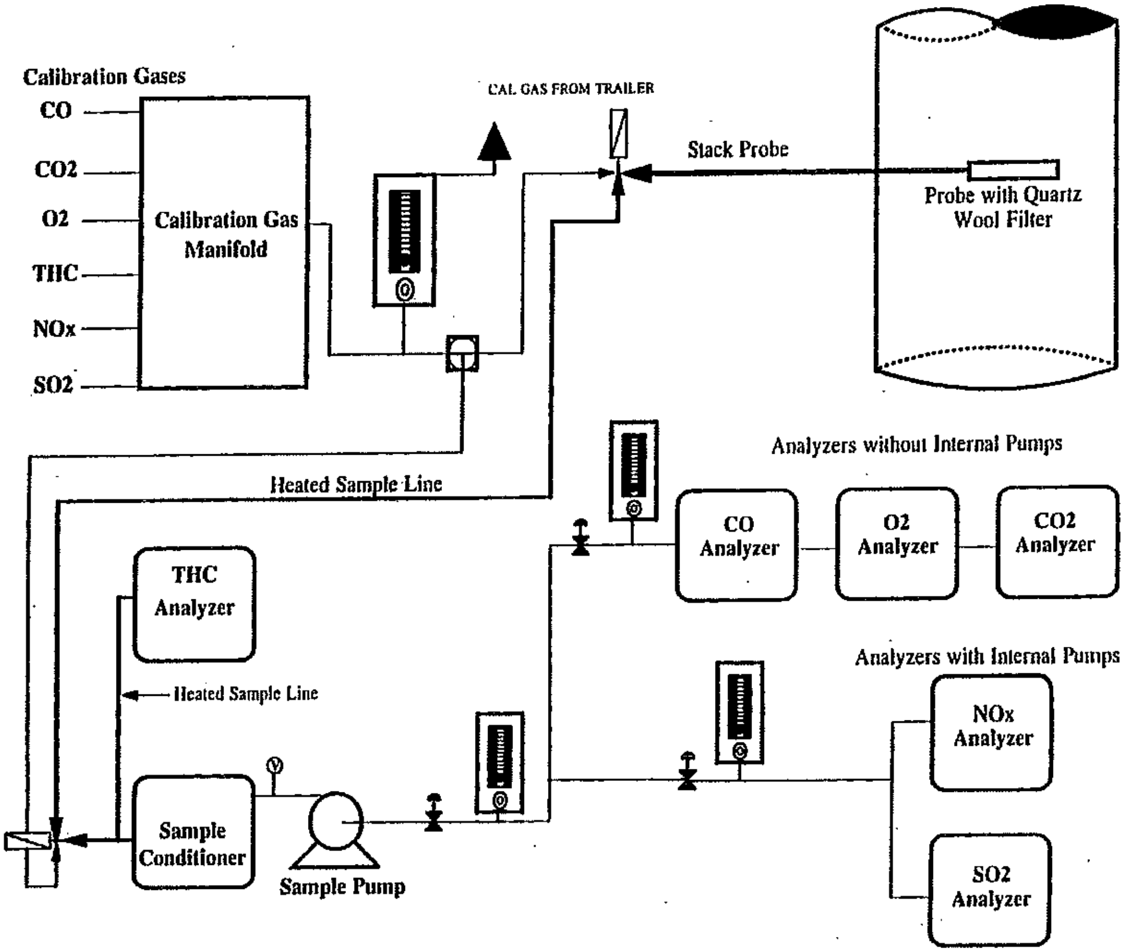


Figure 3-2. CEM Sampling System
(Note: Only the O_2, CO_2, and SO_2 Analyzers were used)

4. QUALITY ASSURANCE/QUALITY CONTROL

The field sampling quality assurance for this project includes the use of calibrated source sampling equipment, reference test methods, sample chain of custody, and traceability protocols for recording and calculating data.

Field quality control checks include the following:

- Pre- and post-test leak checks of sampling trains.
- Recording of all field data on standard data forms that also serve as checklists.
- Adherence to reference test methods as published in the most recent revisions of the Federal Register, 40 CFR 60, Appendix A, EPA Reference Methods 2, 3A, 4, and 6C, July 1, 2008.
- Calibration of dry gas meters and thermocouples, as specified in EPA-600/4-77-027B, "Quality Assurance Handbook for Air Pollution Measurement Systems," Volume III - Stationary Source Specific Methods.
- The CEM system met all performance requirements of EPA Methods 3A and 6C.
- CEM system leak checks and integrity checks, including response time, linearity of each calibration gas standard, drift checks, and correlation coefficients.
- Pre- and post-test calibrations. The SO_2 analyzer was calibrated with two EPA Protocol One sulfur-dioxide-in-nitrogen standards in the analytical range; zero N_2 calibration data is presented in Table 4-1.

4.1 Pretest Preparation and Calibration

Before the instruments were brought to the test site, each analyzer was checked in the laboratory following the analyzer manufacturer-recommended procedures. The check included, at a minimum, examining the analyzer's overall status for any obvious component damage, verifying secure placement of electronic cards, and checking filters, gauges, and rotometers for wear or damage.

Table 4-1. Performance Specifications for Methods 3A and 6C

Parameter	Performance Test	Specification
Oxygen/ Carbon Dioxide	Sampling System Bias	±5% of span for zero and upscale calibration gases
	Zero Drift	±3% of span over test run period
	Upscale Calibration Drift	±3% of span over test run period
	Analyzer Calibration Error	±2% of span for zero, mid-, and high-range calibration gases
Sulfur Dioxide	Sampling System Bias	±5% of span for zero and upscale calibration gases
	Zero Drift	±3% of span over test run period
	Upscale Calibration Drift	±3% of span over test run period
	Analyzer Calibration Error	±2% of span for zero, mid-, and high-range calibration gases

Each analyzer was plumbed to accept calibration gas as it would in field operation. The calibration gases were injected at the same flow rate and pressure at which an effluent sample would enter the analyzer. If the analyzer is flow- and/or pressure-sensitive, then flow- and/or pressure-sensitive devices were used during all analyzer operations. Settings were recorded and maintained to ensure that valid data was obtained. A zero gas and a high-range calibration gas were injected one at a time. Then the analyzer's output was adjusted and recorded on the recording device until both gases could be injected and the proper response obtained without analyzer adjustments. All flow and pressure settings were maintained at appropriate levels throughout the calibration procedures.

4.2 Analyzer Field Setup

4.2.1 Analyzer Calibration Error Test

The analyzers were allowed to warm up a minimum of 1 hour before initiation of any calibration procedures. The length of the warmup period depends on the type of analyzer being used. A zero gas and a high-range calibration gas (100 percent of scale) were introduced into each analyzer, one at a time. The analyzer's output was adjusted as necessary to match the concentration of the calibration gases. This process was repeated until the proper response to both gases was obtained without analyzer adjustment.

Once the analyzer setup procedures were completed, the calibration error (CE) test was performed as follows. Zero, mid-, and high-range calibration gases (as defined in the test method) were introduced into each analyzer and the response recorded. No adjustments were made to the analyzer's output. The analyzer flow rate and/or pressure settings were maintained at their original recorded set-points as required throughout this process.

The analyzer's CE response for each calibration gas was recorded. The difference between the recorded gas concentration displayed by the gas analyzer and the known calibration gas tag value for each cylinder did not exceed the allowable calibration error of ±2% of the instrument span for the O_2, CO_2, and SO_2 instruments. The following equation was used to calculate the CE for each gas:

$$\text{CE} = \frac{\text{Analyzer Response} - \text{Known Gas Value}}{\text{Analyzer Span}} 100\%$$

Individual CE values for all instruments are contained in Appendix B.

4.2.2 Sampling System Bias Check

Once the CE test was successfully completed, the sampling system bias check was initiated. No adjustments were made to the analyzer's output after the CE test was completed. If adjustments were required for any reason, the CE test was repeated prior to the sampling system bias check.

Sampling system bias is the difference between the analyzer response exhibited when a known concentration gas was introduced directly into the analyzer (direct analyzer calibration) and when the same gas was introduced at the outlet of the sampling probe (system calibration). The system bias was determined for both the zero and an upscale calibration gas. The upscale for each analyzer was the calibration gas that most closely approximated the respective effluent gas concentration. The following equation was used to calculate the system bias for both the zero and upscale calibration gases:

$$\text{System Bias} = \frac{\text{System Response} - \text{Analyzer Response}}{\text{Instrument Span}} 100\%$$

Individual bias check results are contained in Appendix B.

5. FACILITY/PROCESS DESCRIPTION

The blast furnace stoves provide "hot blast" air for injection into the blast furnace. Blast furnace gas (BFG) produced by the furnace is cleaned, and then recycled to the blast furnace stoves to be used as fuel. The BFG, along with a small amount of natural gas (NG), is fired in the stove burners and is used to heat checker brick within the stoves. The stoves are cycled between periods of heating up ("on gas") while firing BFG and NG, and periods of supplying hot blast air to the furnace ("on blast"). During firing, the checker brick is being heated up with no air passing through the stoves.

When the stove reaches the desired temperature, the stove is put "on blast," at which time air supplied by the blower passes through the heated checker brick, creating the hot blast air, which is injected into the furnace through the tuyeres. Typically, only one stove is supplying hot blast at any given time; however, sometimes two stoves supply hot blast depending on the circumstances of the process and stove performance.

Process and production data is included in Appendix C along with the AK Steel Stove Stack CEMS reports for each of the RATA test runs. During the RATA, the blast furnace averaged 300.0 tons per hour which is greater than 50% of rated capacity.