Source Test Report for 2023 Compliance Testing

C-Blast Furnace (EUCFURNACE) Baghouse

Cleveland-Cliffs Inc., Dearborn Works (CCDW)
Dearborn, Michigan

Prepared For:

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Review and Certification

All work, calculations, and other activities and tasks performed and presented in this document were carried out by me or under my direction and supervision. I hereby certify that, to the best of my knowledge, Montrose operated in conformance with the requirements of the Montrose Quality Management System and ASTM D7036-04 during this test project.

Signature:

Date: July 25, 2023

Name: John Nestor

Title: District Manager

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1.0 Introduction

1.1 Summary of Test Program

Cleveland-Cliffs Inc., Dearborn Works (CCDW) (Facility ID: A8640) contracted Montrose Air Quality Services, LLC (Montrose) to perform a compliance test program on the "C" Blast Furnace Baghouse (EUCFURNACE Baghouse) at the CCDW facility located in Dearborn, Michigan. Testing was performed on May 25 and May 26, 2023, for the purpose of satisfying the emission testing requirements pursuant to Michigan Department of Environment, Great Lakes, and Energy (EGLE) Renewable Operation Permit No. MI-ROP-A8640-2016a.

The specific objectives were to:

- Verify the emissions of FPM (PM), PM_{10}, and $PM_{2.5}$ from the EUCFURNACE Baghouse
- Verify the emissions of nitrogen oxides (NO_x) as NO_2 from EUCFURNACE Baghouse
- Verify the emissions of carbon monoxide (CO) from EUCFURNACE Baghouse
- Verify the emissions of lead (Pb), and manganese (Mn) from the EUCFURNACE Baghouse
- Verify the emissions of Volatile Organic Compounds (VOC) from the EUCFURNACE Baghouse
- Verify the percent opacity of visible emissions (VE) from the EUFURNACE Baghouse and EUFURNACE Roof Monitor
- Conduct the test program with a focus on safety

Montrose performed the tests to measure the emission parameters listed in Table 1-1.

Table 1-1
Summary of Test Program

Test Date(s)	Unit ID/ Source Name	Activity/Parameters	Test Methods	No. of Runs	Duration (Minutes)
5/25/2023-5/26/2023	EUCFURNACE Baghouse	Velocity/Volumetric Flow Rate	EPA 1 & 2	3	100-188
5/25/2023-5/26/2023	EUCFURNACE Baghouse	O_2, CO_2	EPA 3A	3	100-188
5/25/2023-5/26/2023	EUCFURNACE Baghouse	Moisture	EPA 4	3	100-188
5/25/2023-5/26/2023	EUCFURNACE Baghouse	Moisture	EPA 4	3	100-188
5/25/2023-5/26/2023	EUCFURNACE Baghouse	TPM (PM) (PM_{10} and $PM_{2.5}$)	EPA 5/202	3	100-188

Test Date(s)	Unit ID/ Source Name	Activity/Parameters	Test Methods	No. of Runs	Duration (Minutes)
5/25/2023-5/26/2023	EUCFURNACE Baghouse	NO_x	EPA 7E	3	100-188
5/25/2023-5/26/2023	EUCFURNACE Baghouse	Visible Emissions	EPA 9	3	60
5/25/2023-5/26/2023	EUCFURNACE Baghouse	CO	EPA 10	3	100-188
5/25/2023-5/26/2023	EUCFURNACE Baghouse	NM-VOC	EPA 25A	3	100-188
5/25/2023-5/26/2023	EUCFURNACE Baghouse	Pb and Mn	EPA 29	3	100-188

To simplify this report, a list of Units and Abbreviations is included in Appendix D.1. Throughout this report, chemical nomenclature, acronyms, and reporting units are not defined. Please refer to the list for specific details.

This report presents the test results and supporting data, descriptions of the testing procedures, descriptions of the facility and sampling locations, and a summary of the quality assurance procedures used by Montrose. The average emission test results are summarized and compared to their respective permit limits in Table 1-2. Detailed results for individual test runs can be found in Section 4.0. All supporting data can be found in the appendices.

All filterable and condensable emissions are to be considered as $PM_{2.5}$ and PM_{10} for this compliance determination. Detailed results for individual test runs can be found in Section 4.0. All supporting data can be found in the appendices.

The testing was conducted by the Montrose personnel listed in Table 1-3. The tests were conducted according to the test plan (protocol) dated April 6, 2023 that was submitted to the EGLE.

Table 1-2
Summary of Compliance Results – EUCFURNACE Baghouse

May 25 and May 26, 2023

Parameter/Units	Average Results	Emission Limits
Filterable Particulate Matter (FPM)		
lb/hr	1.35	13.87
gr/dscf	0.0004	0.003
gr/dscf (MACT Limit)	0.0004	0.01
Particulate Matter less than 10 microns (PM_{10})*		
lb/hr	2.48	18.24
Particulate Matter less than 2.5 microns ($PM_{2.5}$)*		
lb/hr	2.48	18.24
Baghouse Visible Emissions		
% Opacity	0	10%, 6-minute average
Casthouse Visible Emissions		
% Opacity	0	20%, 6-minute average
Manganese		
lb/hr	0.0035	0.042
Lead		
lb/hr	0.0007	0.0077
NM-VOC		
lb/hr	4.94	9.92
Nitrogen Oxides (NO_x)		
lb/hr	0.56	5.46
Carbon Monoxide (CO)		
lb/hr	40.31	56.25

1.2 Key Personnel

A list of project participants is included below:

Facility Information

Source Location:	Cleveland-Cliffs Inc., Dearborn Works (CCDW) 4001 Miller Road Dearborn, MI 48120
Project Contact:	David Pate
Role:	Senior Environmental Engineer
Company:	CCDW
Telephone:	313-323-1261
Email:	David.pate@clevelandcliffs.com

Agency Information

Regulatory Agency:	EGLE
Agency Contact:	Jeremy Howe
Email:	Howej1@michigan.gov

Testing Company Information

Testing Firm:	Montrose Air Quality Services, LLC
Contact:	John Nestor
Title:	District Manager
Telephone:	248-765-5032
Email:	jonestor@montrose-env.com

Test personnel and observers are summarized in Table 1-3.

Table 1-3
Test Personnel and Observers

Name	Affiliation	Role/Responsibility
John Nestor	Montrose	Project Manager, QI
Roy Zimmer	Montrose	Field Technician
Clayton DeRonne	Montrose	Field Technician
Shane Rabideau	Montrose	Field Technician
Jeffery Peitzsch	Montrose	Field Technician
David Pate	CCDW	Observer/Client Liaison/Test Coordinator

2.0 Plant and Sampling Location Descriptions

2.1 Process Description, Operation, and Control Equipment

The Molten iron is produced in the blast furnaces 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 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 basic oxygen furnace (BOF) for use in the steelmaking process.

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

2.2 Flue Gas Sampling Location

Information regarding the sampling location is presented in Table 2-1.

Table 2-1
Sampling Location

		Distance from Nearest Disturbance		
Sampling Location	**Stack Inside Diameter (in.)**	**Downstream EPA "B" (in./dia.)**	**Upstream EPA "A" (in./dia.)**	**Number of Traverse Points**
EUCFURNACE Baghouse	152.0	1,200.0 / 8.1	840.0/ 5.7	Isokinetic: 12 (3/port) Gaseous: 3

The sampling location was verified in the field to conform to EPA Method 1. Acceptable cyclonic flow conditions were determined from historical testing using EPA Method 1, Section 11.4. See Appendix A.1 for more information.

2.3 Operating Conditions and Process Data

The compliance testing was performed while the EUCFURNACE was operating at normal capacity. Iron production during the test averaged 342.8 ton/hr.

Plant personnel were responsible for establishing the test conditions and collecting all applicable unit-operating data. The Facility process data that was provided is presented in Appendix B. Data collected includes the following parameters:

- Cast start and end times
- Start and stop time of each cast and each test run;
- Tons of iron and tons of slag tapped per hour and per cast
- Baghouse pressure drop- overall and per compartment every 10 minutes
- Bag leak detector readings – overall and per compartment every 10 minutes
- Casthouse damper positions and inlet pressure every 10 minutes

3.0 Sampling and Analytical Procedures

3.1 Test Methods

The test methods for this test program have been presented in Table 1-1. Additional information regarding specific applications or modifications to standard procedures is presented below.

3.1.1 EPA Method 1, Sample and Velocity Traverses for Stationary Sources

EPA Method 1 is used to assure that representative measurements of volumetric flow rate are obtained by dividing the cross-section of the stack or duct into equal areas, and then locating a traverse point within each of the equal areas. Acceptable sample locations must be located at least two stack or duct equivalent diameters downstream from a flow disturbance and one-half equivalent diameter upstream from a flow disturbance.

3.1.2 EPA Method 2, Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)

EPA Method 2 is used to measure the gas velocity using an S-type pitot tube connected to a pressure measurement device, and to measure the gas temperature using a calibrated thermocouple connected to a thermocouple indicator. Typically, Type S (Stauβcheibe) pitot tubes conforming to the geometric specifications in the test method are used, along with an inclined manometer. The measurements are made at traverse points specified by EPA Method 1.

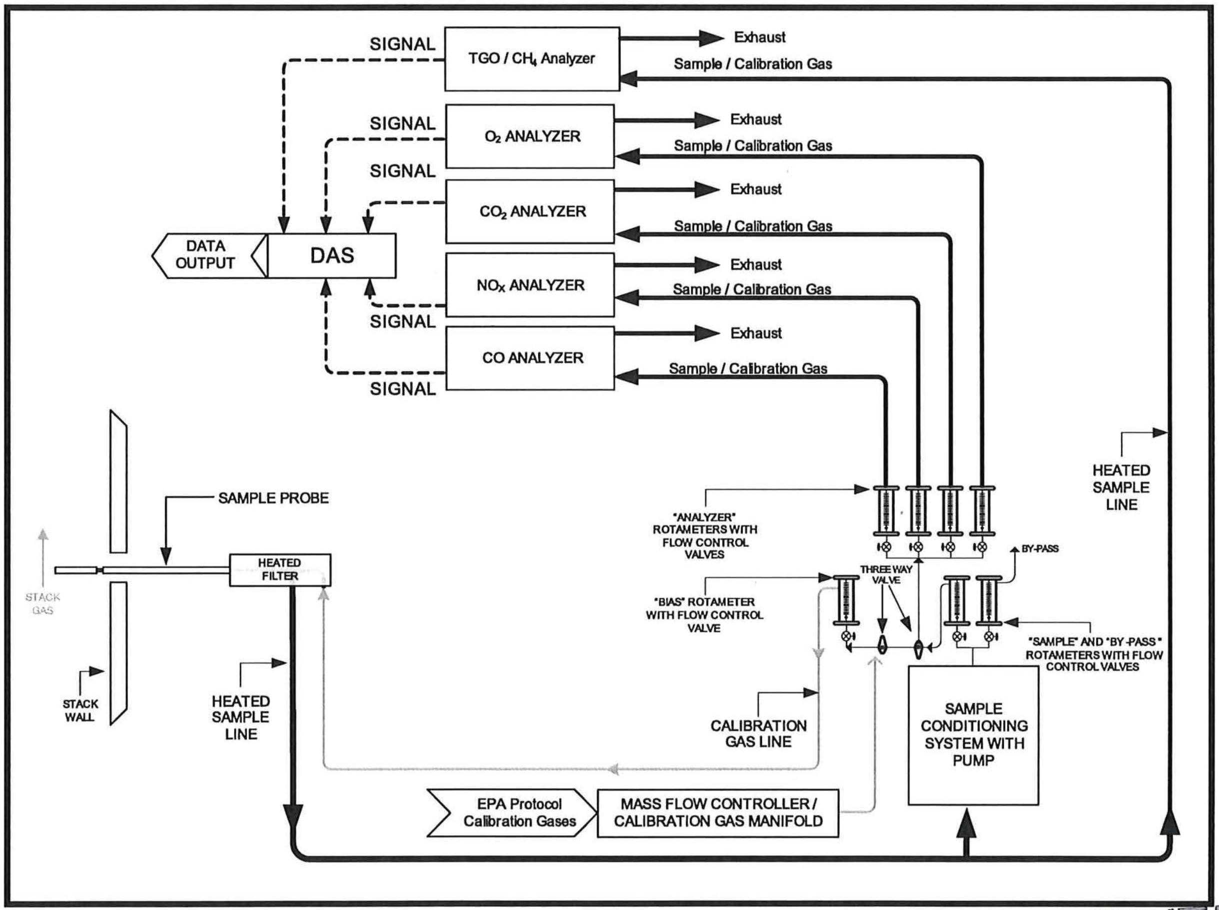
The typical sampling system is detailed in Figure 3-1.

3.1.3 EPA Method 3A, Gas Analysis for the Determination of Dry Molecular Weight

EPA Method 3A is an instrumental test method for measuring O2 and CO2 in stack gas. The effluent gas is continuously or intermittently sampled and conveyed to analyzers that measure the concentration of O2 and CO2. The performance requirements of the method must be met to validate data. These gases were measured for the purpose of determining molecular weight during this test event.

This method was paired with EPA Methods 7E, 10 and 25A. The typical sampling system is detailed in Figure 3-1.

Figure 3-1
EPA Method 3A, 7E, 10, 25a Sampling Train



3.1.4 EPA Method 4, Determination of Moisture Content in Stack Gas

EPA Method 4 is either a manual, non-isokinetic method or a method conducted in conjunction with other test methods that is used to measure the moisture content of gas streams. Gas is sampled at a specified rate through a probe and impinger train. Moisture is removed using a series of pre-weighed impingers containing methodology-specific liquids and silica gel immersed in an ice water bath. The impingers are weighed after each run to determine the percent moisture.

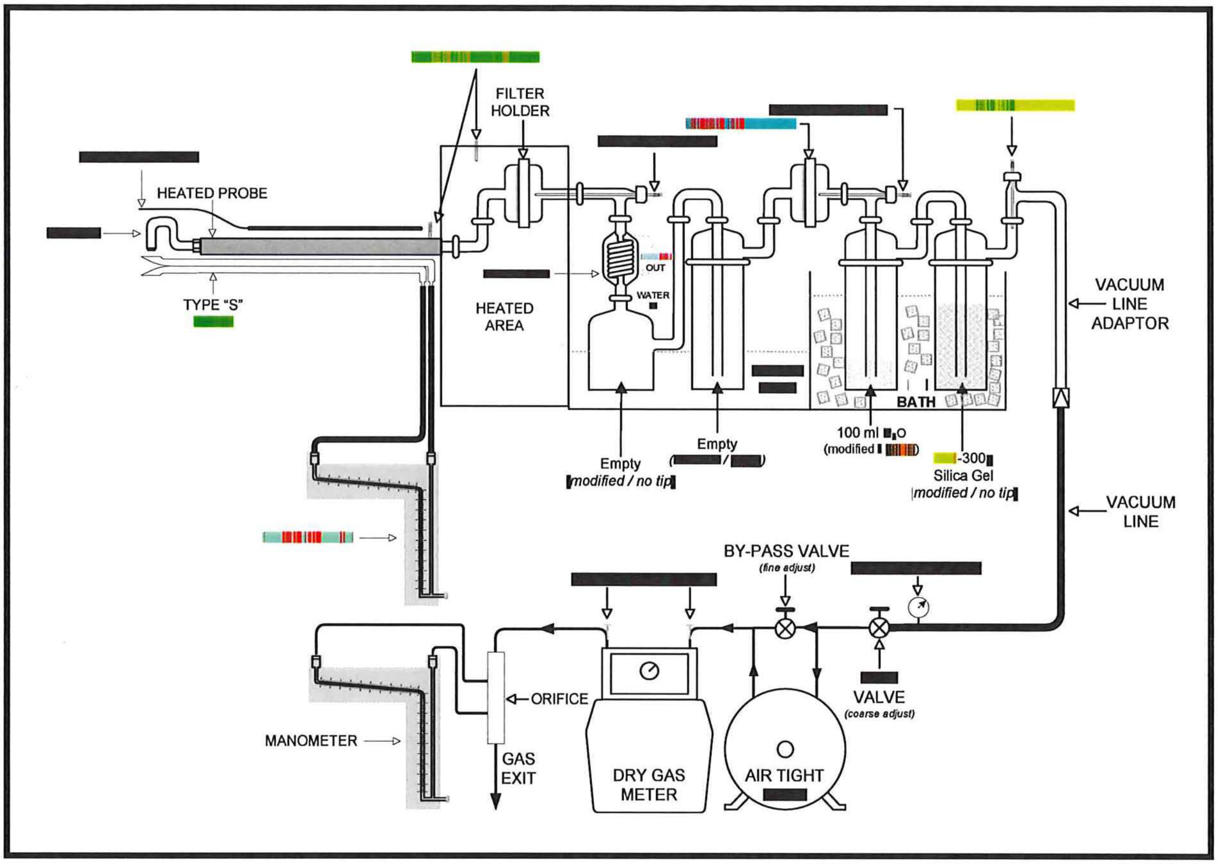
The typical sampling system is detailed in Figure 3-2.

3.1.5 EPA Method 5, Determination of Particulate Matter from Stationary Sources

EPA Method 5 is a manual, isokinetic method used to measure FPM emissions. The samples are analyzed gravimetrically. This method is performed in conjunction with EPA Methods 1 through 4. The stack gas is sampled through a nozzle, probe, filter, and impinger train. FPM results are reported in emission concentration and emission rate units.

The typical sampling system is detailed in Figure 3-2 (EPA Methods 5 and 202 Sampling Train).

Figure 3-2
EPA Methods 5 and 202 Sampling Train



3.1.6 EPA Method 7E, Determination of Nitrogen Oxides Emissions from Stationary Source (Instrumental Analyzer Procedure)

EPA Method 7E is an instrumental test method used to continuously measure emissions of NO_x as NO_2. Conditioned gas is sent to an analyzer to measure the concentration of NO_x. NO and NO_2 can be measured separately or simultaneously together but, for the purposes of this method, NO_x is the sum of NO and NO_2. The performance requirements of the method must be met to validate the data.

The typical sampling system is detailed in Figure 3-1 (EPA Methods 3A, 7E, and 10 Sampling Train).

3.1.7 EPA Method 10, Determination of Carbon Monoxide Emissions from Stationary Sources (Instrumental Analyzer Procedure)

EPA Method 10 is an instrumental test method used to continuously measure emissions of CO. Conditioned gas is sent to an analyzer to measure the concentration of CO. The performance requirements of the method must be met to validate the data.

The typical sampling system is detailed in Figure 3-1 (EPA Methods 3A, 7E, 10, and 25a Sampling Train).

3.1.8 EPA Method 25A, Determination of Non-Methane Organic Concentration Using a Flame Ionization Analyzer.

EPA Method 25A is an instrumental test method used to continuously measure emissions of total gaseous organics (TGO) in stack gas. A gas sample is extracted from the source through a heated sample line and glass fiber filter to a flame ionization analyzer (FIA). Results are reported as volume concentration equivalents of the calibration gas or as carbon equivalents.

For the purpose of this test, dual FIAs were utilized to measure TGO (as methane) and CH4 (as methane).

The typical sampling system is detailed in Figure 3-1

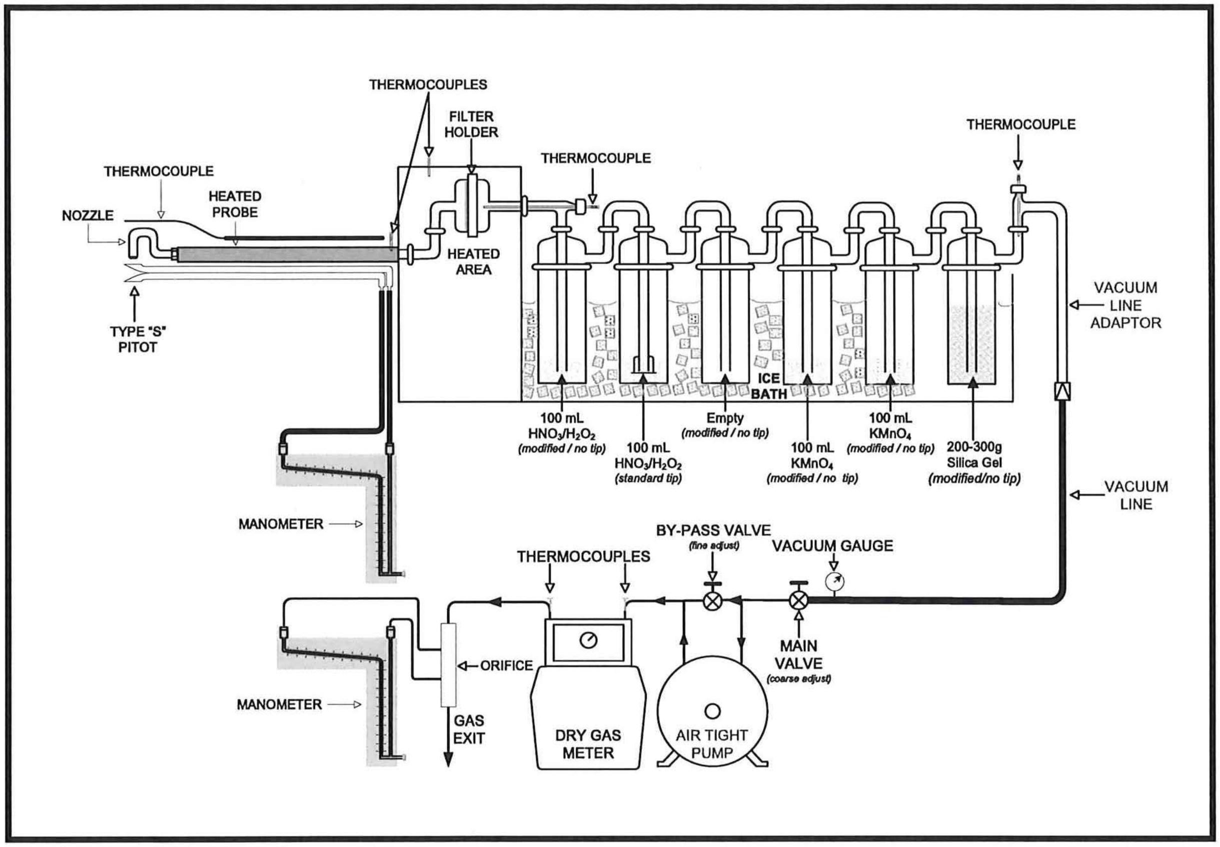
3.1.9 EPA Method 29, Determination of Metals Emissions from Stationary Sources

EPA Method 29 is a manual, isokinetic test method to measure a variety of metals using inductively coupled argon plasma emission spectroscopy (ICAP) and cold vapor atomic absorption (CVAA) spectroscopy. This method is performed in conjunction with EPA Methods 1-4. A stack sample is withdrawn isokinetically from the source, filterable emissions are collected in the probe and on a heated filter, and condensable emissions are collected in an aqueous acidic solution of hydrogen peroxide (analyzed for all target analytes) and an optional aqueous acidic solution of potassium permanganate (required only when Hg is a target analyte). The recovered samples are digested, and appropriate fractions are analyzed for the target analytes which may include Hg by CVAAS and for Sb, As, Ba, Be, Cd, Cr, Co, Cu, Pb, Mn, Ni, P, Se, Ag, Tl, and Zn by ICAP or atomic absorption spectroscopy (AAS). Graphite furnace atomic absorption spectroscopy (GFAAS) is used for analysis of Sb, As, Cd, Co, Pb, Se, and Tl if these elements require greater analytical sensitivity than can be obtained using ICAP. AAS may be used for analysis of all target analytes if the resulting in-stack method detection limits meet the goal of the testing program. Similarly, inductively coupled plasma-mass spectroscopy (ICP-MS) may be used for analysis of Sb, As, Ba, Be, Cd, Cr, Co, Cu, Pb, Mn, Ni, Ag, Tl and Zn. The results from analysis of individual fractions of the sample train are summed to obtain the total concentration of each metal per sample train.

The target metals for this compliance emissions testing program are Pb and Mn.

The typical sampling system is detailed in Figure 3-3.

Figure 3-3
EPA Methods 29 Sampling Train



3.1.10 EPA Method 202, Dry Impinger Method for Determining Condensable Particulate Emissions from Stationary Sources

The CPM is collected in dry impingers after filterable PM has been collected on a filter maintained as specified in either Method 5 of Appendix A-3 to 40 CFR 60, Method 17 of Appendix A-6 to 40 CFR 60, or Method 201A of Appendix M to 40 CFR 51. The organic and aqueous fractions of the impingers and an out-of-stack CPM filter are then taken to dryness and weighed. The total of the impinger fractions and the CPM filter represents the CPM. Compared to the version of Method 202 that was promulgated on December 17, 1991, this method eliminates the use of water as the collection media in impingers and includes the addition of a condenser followed by a water dropout impinger immediately after the final in-stack or heated filter. This method also includes the addition of one modified Greenburg Smith impinger (backup impinger) and a CPM filter following the water dropout impinger.

CPM is collected in the water dropout impinger, the modified Greenburg Smith impinger, and the CPM filter of the sampling train as described in this method. The impinger contents are purged with nitrogen immediately after sample collection to remove dissolved SO_2 gases from the impinger. The CPM filter is extracted with water and hexane. The impinger solution is then extracted with hexane. The organic and aqueous fractions are dried and the residues are weighed. The total of the aqueous and organic fractions represents the CPM.

The potential artifacts from SO_2 are reduced using a condenser and water dropout impinger to separate CPM from reactive gases. No water is added to the impingers prior to the start of sampling. To improve the collection efficiency of CPM, an additional filter (the "CPM filter") is placed between the second and third impingers

The typical sampling system is detailed in Figure 3-2 (EPA Methods 5 and 202 Sampling Train).

3.1.11 EPA Method 9, Visual Determination of the Opacity of Emissions

EPA Method 9 is used to observe the visual opacity of emissions (opacity). The observer stands at a distance sufficient to provide a clear view of the emissions with the sun oriented in the 140° sector to their back. The line of vision is perpendicular to the plume direction and does not include more than one plume diameter. Observations are recorded at 15-second intervals and are made to the nearest 5% opacity. The qualified observer is certified according to the requirements of EPA Method 9, section 3.1.

3.2 Process Test Methods

The test plan did not require that process samples be collected during this test program; therefore, no process sample data are presented in this test report.

4.0 Test Discussion and Results

4.1 Field Test Deviations and Exceptions

No field deviations occurred during this test program outside of the items that were presented in the test plan. These items were:

1. As the runs will include an integral number of casts, it is likely that the completion of a full traverse will not correspond with the end of the cast. In this case, sampling will continue with the traverse restarting at point 1. Typical cast durations are from 90 minutes to 3 hours.

2. VOC emissions will be reported as Non-Methane VOC. A methane cutter will be used to determine methane concentrations which will be deducted from the total VOC.

3. For run 2, 2 of the CO readings exceeded the calibration span of the analyzer. For run 3, 3 of the CO readings exceeded the calibration span of the CO analyzer. This represented 1.6% of the readings for run 2 and 4.6% of the readings for run 3. In accordance with USEPA method 7E, the run average did not exceed the calibration span. Due to this small percentage of readings that were above the span, Montrose does not believe that this resulted in any significant impact on the results reported.

4.2 Presentation of Results

The average results are compared to the permit limits in Table 1-2 through 1-5. The results of individual compliance test runs performed are presented in Tables 4-1 through 4-4. Emissions are reported in units consistent with those in the applicable regulations or requirements. Additional information is included in the appendices as presented in the Table of Contents.

Table 4-1
EUCFURNACE Cast House Baghouse Metals Results

Run Number	**1**	**2**	**3**	**Average**
Date	5/25/2023	5/26/2023	5/26/2023	--
Sampling & Flue Gas Parameters				
volumetric flow rate, dscfm	456,849	414,823	396,856	422,842
Lead (Pb)				
mg/dscm	0.0003	0.0002	0.0007	0.0004
lb/hr	0.000570	0.000328	0.001076	0.000658
Manganese (Mn)				
mg/dscm	0.0020	0.0016	0.0030	0.0022
lb/hr	0.00336	0.00256	0.00448	0.0035

Table 4-2
EUCFURNACE Cast House Baghouse TPM Results

Run Number	**1**	**2**	**3**	**Average**
Date	5/25/2023	5/26/2023	5/26/2023	--
Time	18:05-19:59	10:32-12:47	12:53-16:50	--
Sampling & Flue Gas Parameters				
sample duration, minutes	100	108	188	132
O_2, % volume dry	20.80	20.80	20.80	20.80
CO_2, % volume dry	0.00	0.00	0.00	0.00
flue gas temperature, °F	140.0	161.8	130.9	144.2
moisture content, % volume	1.26	1.78	1.45	1.50
volumetric flow rate, dscfm	423,572	373,378	357,356	423,572
Filterable Particulate Matter (FPM)				
gr/dscf	0.0005	0.0004	0.0004	0.0004
lb/hr	1.673	1.128	1.247	1.349
Condensable Particulate Matter (CPM)				
grains/dscf	0.0005	0.0003	0.0002	0.0003
lb/hr	1.706	0.935	0.761	1.134
Total Particulate Matter (TPM)*				
lb/hr	3.379	2.063	2.009	2.484

* Total PM emissions are to be considered as PM_{10} and $PM_{2.5}$ for compliance determination.

Table 4-3
EUCFURNACE Cast House Baghouse NOx, CO, and VOC Emissions Results

Run Number	1	2	3	Average
Date	5/25/2023	5/26/2023	5/26/2023	--
Time	18:05-19:59	10:32-12:47	12:53-16:50	--
Sampling & Flue Gas Parameters				
volumetric flow rate, dscfm	456,849	414,823	396,856	422,842
Nitrogen Oxides (NO_x)				
ppmvd	0.2	0.4	0.2	0.3
lb/hr, as NO_2	0.5	1.3	0.7	0.8
Carbon Monoxide (CO)				
ppmvd	19.2	18.9	27.6	21.9
lb/hr	38.3	34.2	47.8	40.1
Non-Methane Volatile Organic Compounds (NM-VOC)				
ppmvd	3.2	4.2	6.8	4.8
lb/hr	3.7	4.4	6.8	4.9

5.0 Internal QA/QC Activities

5.1 QA/QC Audits

The meter boxes and sampling trains used during sampling performed within the requirements of their respective methods. All post-test leak checks, minimum metered volumes, minimum sample durations, and percent isokinetics met the applicable QA/QC criteria.

EPA Methods 3A, 7E, 10, and 25a calibration audits were all within the measurement system performance specifications for the calibration drift checks, system calibration bias checks, and calibration error checks.

The NO_2 to NO converter efficiency check of the analyzer was conducted per the procedures in EPA Method 7E, Section 16.2.2. The conversion efficiency met the criteria.

EPA Method 5 analytical QA/QC results are included in the laboratory report. The method QA/QC criteria were met, except if noted in Section 5.2. An EPA Method 5 reagent blank was analyzed. The maximum allowable amount that can be subtracted is 0.001% of the weight of the acetone used. The blank did not exceed the maximum residue allowed.

EPA Method 29 analytical QA/QC results are included in the laboratory report. The method QA/QC criteria were met.

EPA Method 202 analytical QA/QC results are included in the laboratory report. The method QA/QC criteria were met. An EPA Method 202 Field Train Recovery Blank (FTRB) was performed for each source category. The maximum allowable amount that can be subtracted is 0.002 g (2.0 mg).

5.2 QA/QC Discussion

All QA/QC criteria were met during this test program.

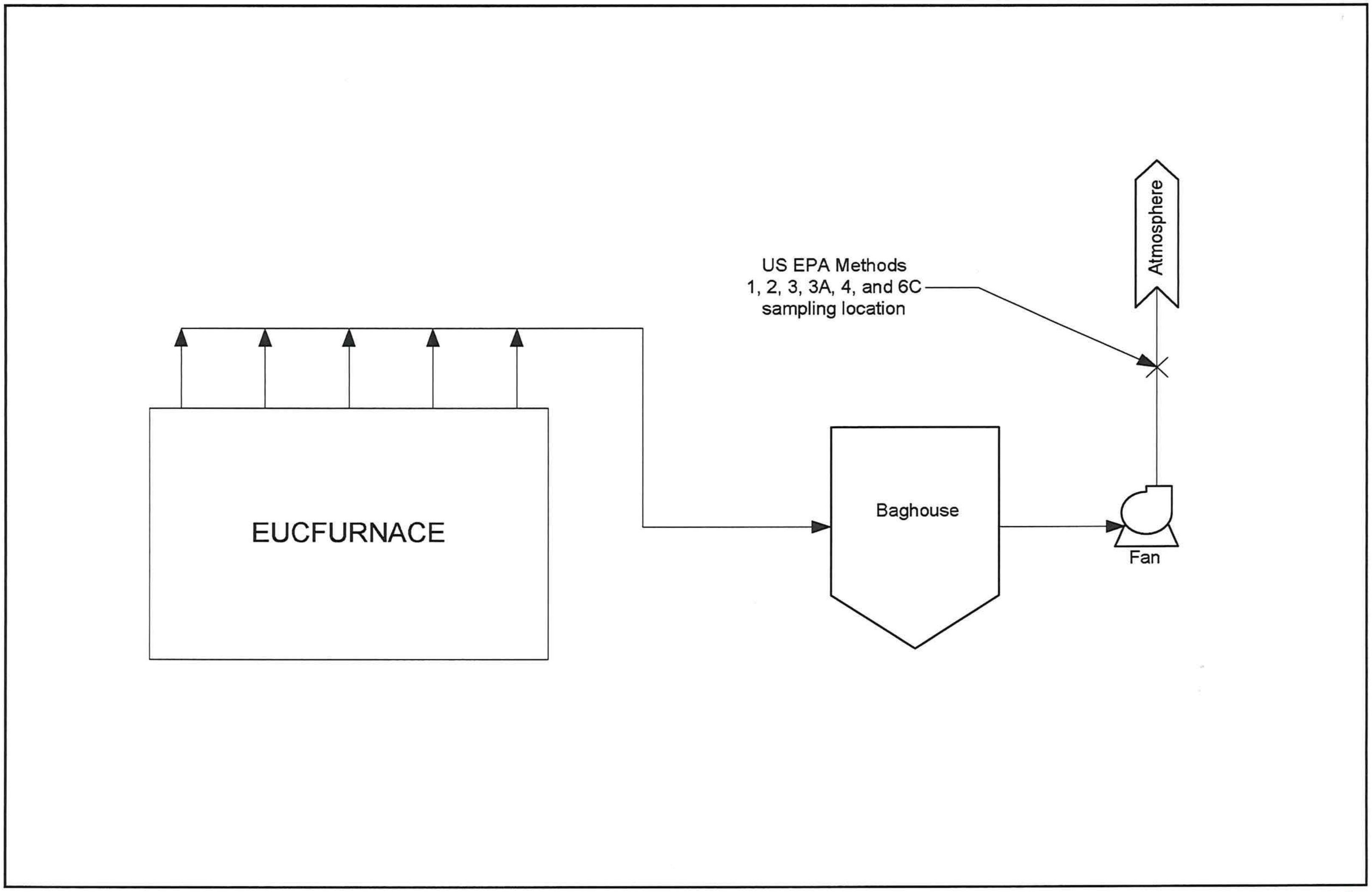
5.3 Quality Statement

Montrose is qualified to conduct this test program and has established a quality management system that led to accreditation with ASTM Standard D7036-04 (Standard Practice for Competence of Air Emission Testing Bodies). Montrose participates in annual functional assessments for conformance with D7036-04 which are conducted by the American Association for Laboratory Accreditation (A2LA). All testing performed by Montrose is supervised on site by at least one Qualified Individual (QI) as defined in D7036-04 Section 8.3.2. Data quality objectives for estimating measurement uncertainty within the documented limits in the test methods are met by using approved test protocols for each project as defined in D7036-04 Sections 7.2.1 and 12.10. Additional quality assurance information is included in the report appendices. The content of this report is modeled after the EPA Emission Measurement Center Guideline Document (GD-043).

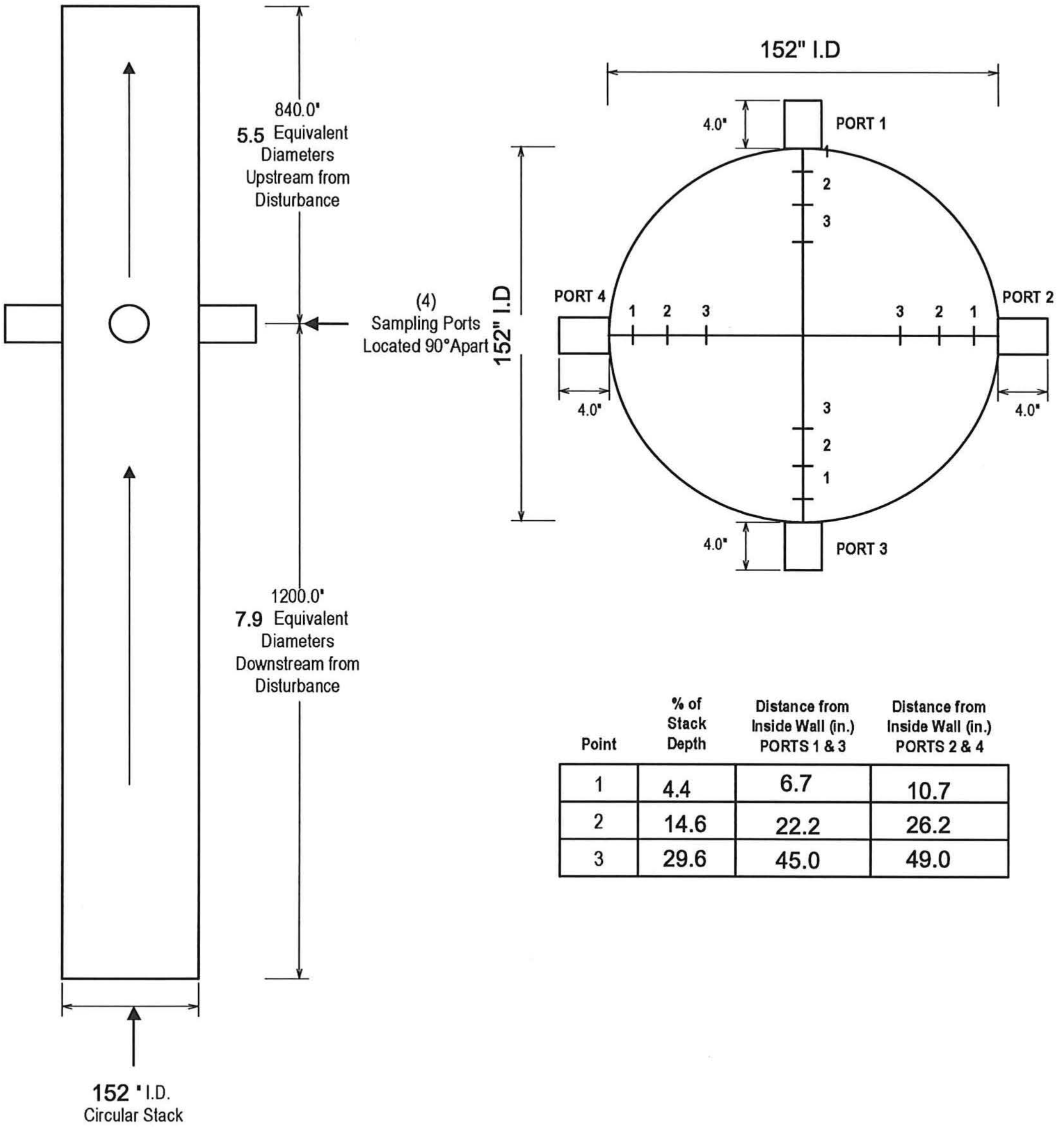
Appendix A
Field Data and Calculations

Appendix A.1
Sampling Locations

EUCFURNACE BAGHOUSE SAMPLING LOCATION SCHEMATIC

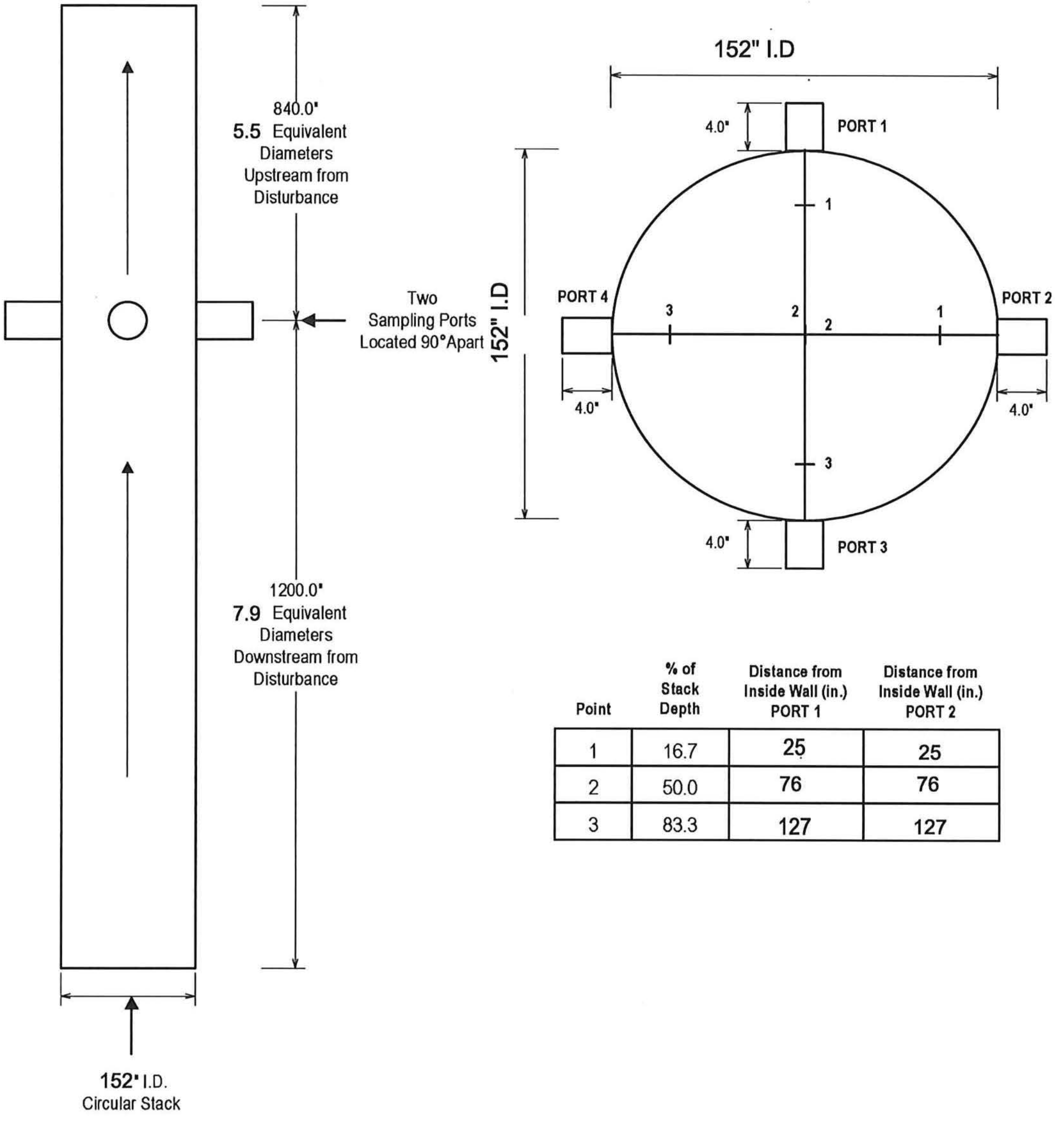


EUCFURNACE BAGHOUSE EXHAUST (FLOW) TRAVERSE POINT LOCATION DRAWING



Point	% of Stack Depth	Distance from Inside Wall (in.) PORTS 1 & 3	Distance from Inside Wall (in.) PORTS 2 & 4
1	4.4	6.7	10.7
2	14.6	22.2	26.2
3	29.6	45.0	49.0

EUCFURNACE BAGHOUSE EXHAUST (CEMS) TRAVERSE POINT LOCATION DRAWING



Point	% of Stack Depth	Distance from Inside Wall (in.) PORT 1	Distance from Inside Wall (in.) PORT 2
1	16.7	25	25
2	50.0	76	76
3	83.3	127	127