Source Test Report for 2023 Compliance Testing

C-Blast Furnace (EUCFURNACE) Stoves

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

Prepared For:

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For Submission To:

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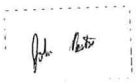
A8640-Tst-20230523

MONTROSE
AIR QUALITY SERVICES

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:** June 24, 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 Stoves (EUCFURNACE Stove) at the CCDW facility located in Dearborn, Michigan. Testing was performed on May 23 and May 25, 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 Stove
- Verify the emissions of nitrogen oxides (NO_x) as NO_2 from EUCFURNACE Stove
- Verify the emissions of carbon monoxide (CO) from EUCFURNACE Stove
- Verify the emissions of lead (Pb), manganese (Mn), and mercury (Hg) from the EUCFURNACE Stove
- 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)
5/23/2023-5/25/2023	EUCFURNACE Stove	Velocity/Volumetric Flow Rate	EPA 1 & 2	3	120
5/23/2023-5/25/2023	EUCFURNACE Stove	O_2, CO_2	EPA 3A	3	120
5/23/2023-5/25/2023	EUCFURNACE Stove	Moisture	EPA 4	3	120
5/23/2023-5/25/2023	EUCFURNACE Stove	Moisture	EPA 4	3	120
5/23/2023-5/25/2023	EUCFURNACE Stove	TPM (PM) (PM_{10} and $PM_{2.5}$)	EPA 5/202	3	120
5/23/2023-5/25/2023	EUCFURNACE Stove	NO_x	EPA 7E	3	120
5/23/2023-5/25/2023	EUCFURNACE Stove	CO	EPA 10	3	120

Test Date(s)	Unit ID/ Source Name	Activity/Parameters	Test Methods	No. of Runs	Duration (Minutes)
5/23/2023-5/25/2023	EUCFURNACE Stove	Pb, Mn, and Hg	EPA 29	3	120

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 Stove

May 23 through May 25, 2023

Parameter/Units	Average Results	Emission Limits
Filterable Particulate Matter (FPM)		
lb/hr	4.53	6.98
Particulate Matter less than 10 microns (PM_{10})*		
lb/hr	10.90	19.72
Particulate Matter less than 2.5 microns ($PM_{2.5}$)*		
lb/hr	10.90	19.72
Manganese		
lb/hr	0.0026	0.012
Lead		
lb/hr	0.0004	0.011
Mercury		
lb/hr	<0.0001	0.003
Nitrogen Oxides (NO_x)		
lb/hr	8.3	106.3
Carbon Monoxide (CO)		
lb/hr	133	1,765

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
Andrew Riley	EGLE	Observer

Name	Affiliation	Role/Responsibility
Katherine Koster	EGLE	Observer

2.0 Plant and Sampling Location Descriptions

2.1 Process Description, Operation, and Control Equipment

The blast furnace stoves provide "hot blast" 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 is fired in the stove burners and is used to heat checker brick within the stoves. This can also be performed with a supplemental amount of natural gas (NG). 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 with no air passing through the stoves.

When the stove reaches the desired temperature, the stove is either bottled until needed or 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. The EUCFURNACE Stoves were operating normally and firing only BFG during this testing event.

2.2 Flue Gas Sampling Location

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

Table 2-1
Sampling Location

Sampling Location	Stack Inside Diameter (in.)	Distance from Nearest Disturbance		Number of Traverse Points
		Downstream EPA "B" (in./dia.)	Upstream EPA "A" (in./dia.)	
EUCFURNACE Stove Exhaust Stack	120.0	1,440.0 / 12.0	1080.0 / 9.0	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 325.6 ton/hr. BFG feed rate averaged 3345 mcf/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
- Time and duration of the operational cycle for each stove
- Amount of natural gas and blast furnace gas (BFG) fired per run

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 (Staußcheibe) 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.

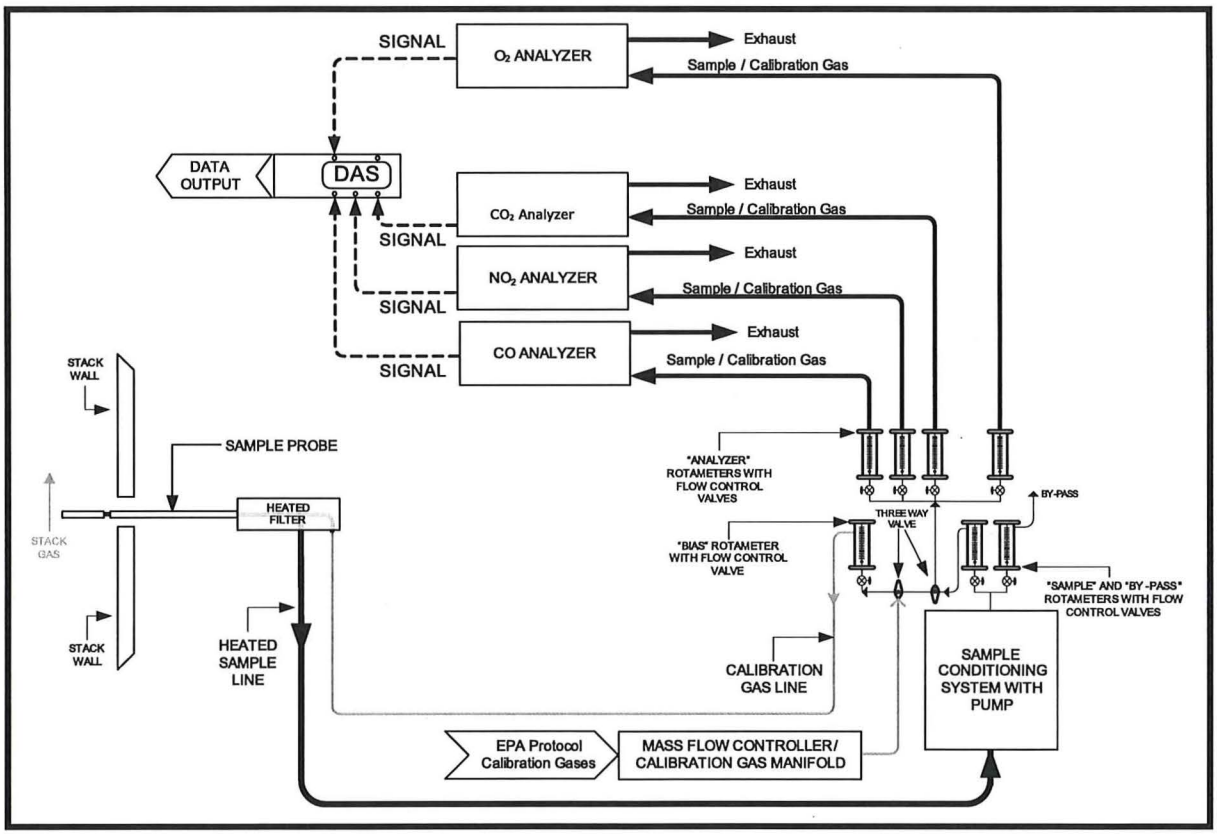
The typical sampling system is detailed in Figure 3-1.

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 Method 7E and Method 10. The typical sampling system is detailed in Figure 3-1.

Figure 3-1
EPA Method 3A, 7E, and/or 10 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.

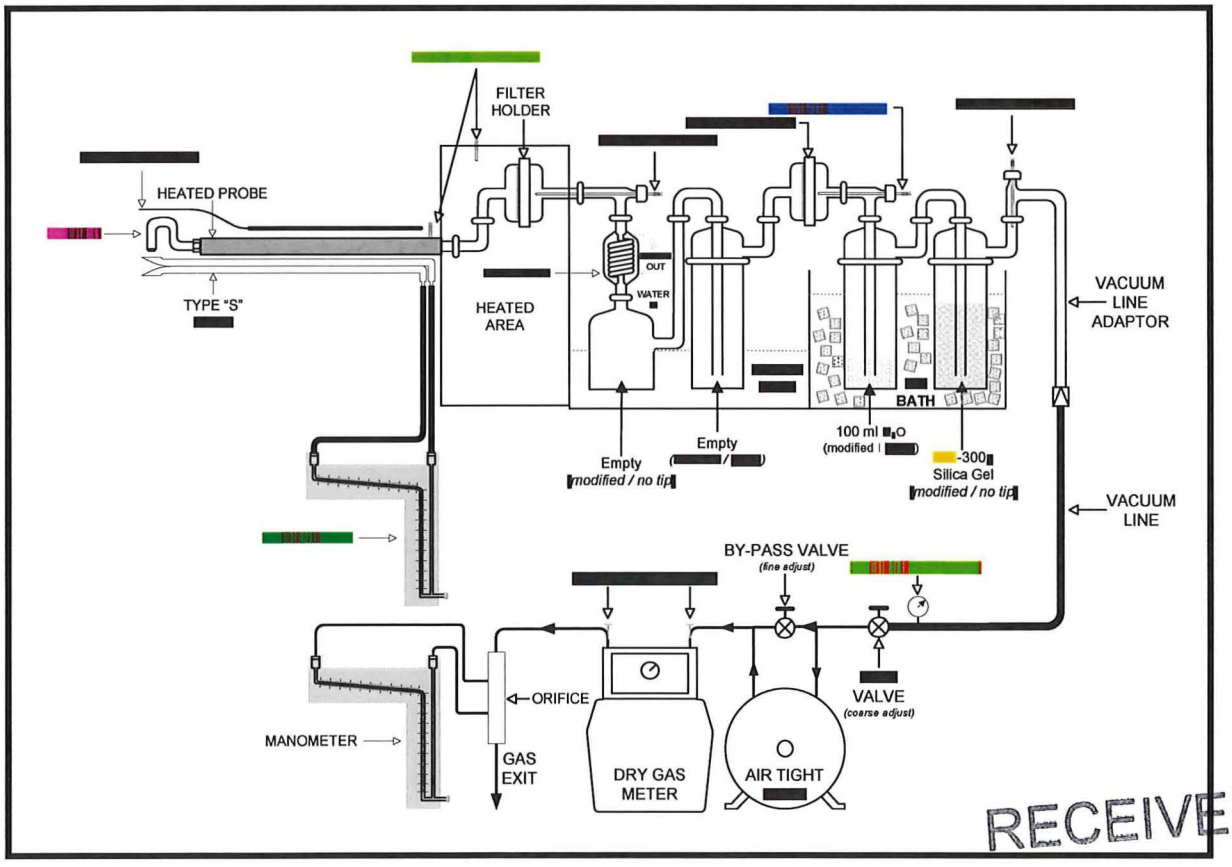
The typical sampling system is detailed in Figure 3-2.

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, and 10 Sampling Train).

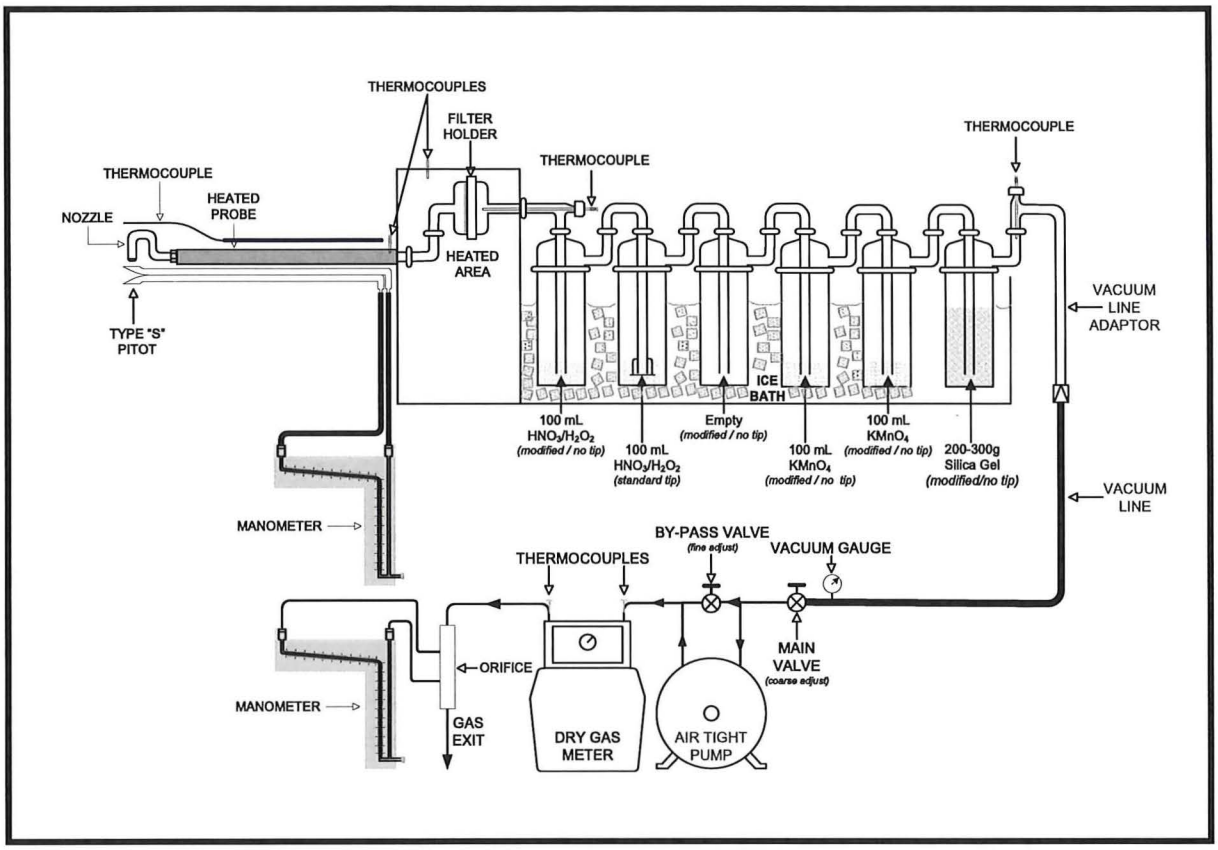
3.1.8 EPA Method 29, Determination of Metals Emissions from Stationary Sources

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, Mn, and Hg.

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

Figure 3-3
EPA Methods 29 Sampling Train



3.1.9 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).

3.2 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

During the recovery of the run two USEPA method 29 train, 2.67 mL of the 100 mL was spilled while recovering the glass u-bend of the 3rd empty impinger. All liquid sample from the impinger was recovered. To account for any bias that could occur from the recovery of the of the u-bend, a 2.67% correction factor was applied to the analysis associated with this impinger for all metals. It was determined that even with the conservative correction, the results were well below the applicable emission limits.

On Run 3 of the CO testing, a single reading exceeded the calibration span of the CO instrument (13:33, 1218.7 ppm, instrument range of 998.3). In accordance with USEPA method 7E, the run average did not exceed the calibration span. As this was only a single reading that exceeded the instrument range by less than 25%, it is not believed that this had any effect on data quality.

4.2 Presentation of Results

The average results are compared to the permit limits in Table 1-2. The results of individual compliance test runs performed are presented in Tables 4-1 through 4-3. 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.

Concentration values in Tables 4-1 denoted with a '<' were measured to be below the minimum detection limit (MDL) of the applicable analytical method. Mass emission rates denoted with a '<' in Tables 4-1 were calculated utilizing the applicable MDL concentration value instead of the "as measured" concentration value.

Table 4-1
EUCFURNACE STOVES Metals Results

Run Number	1	2	3	Average
Date	5/23/2023	5/25/2023	5/25/2023	--
Sampling & Flue Gas Parameters				
volumetric flow rate, dscfm	135,578	147,198	142,852	141,876
Lead (Pb)				
mg/dscm	0.0008	0.0009	0.0006	0.0008
lb/hr	0.000380	0.000423	0.000290	0.000365
Manganese (Mn)				
mg/dscm	0.0033	0.0097	0.0033	0.0054
lb/hr	0.00146	0.00468	0.00153	0.00256
Mercury (Hg)				
mg/dscm	<0.0002	<0.0001	<0.0002	<0.0002
lb/hr	<0.000108	<0.000058	<0.000074	<0.000080

† The "<" symbol indicates that compound was below the Minimum Detection Limit (MDL) of the analytical method. See Section 4.2 for details.

Table 4-2
EUCFURNACE STOVES TPM Results

Run Number	1	2	3	Average
Date	5/23/2023	5/25/2023	5/25/2023	--
Time	12:25-14:50	8:55-11:10	12:15-14:30	--
Sampling & Flue Gas Parameters				
sample duration, minutes	120	120	120	120
O_2, % volume dry	5.4	4.5	4.9	4.9
CO_2, % volume dry	21.3	21.0	21.7	21.3
flue gas temperature, °F	544.6	513.5	494.9	517.7
moisture content, % volume	12.61	11.38	11.93	12.61
volumetric flow rate, dscfm	118,271	126,987	121,789	122,349
Filterable Particulate Matter (FPM)				
gr/dscf	0.0040	0.0056	0.0034	0.0043
lb/hr	4.013	6.066	3.519	4.533
Condensable Particulate Matter (CPM)				
grains/dscf	0.0054	0.0067	0.0061	0.0061
lb/hr	5.469	7.292	6.336	6.366
Total Particulate Matter (TPM)*				
lb/hr	9.481	13.358	9.854	10.898

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

Table 4-3
EUCFURNACE STOVES NOx and CO Emissions Results

Run Number	1	2	3	Average
Date	5/23/2023	5/25/2023	5/25/2023	--
Time	12:25-14:50	8:55-11:10	12:15-14:30	--
Sampling & Flue Gas Parameters				
volumetric flow rate, dscfm	118,271	126,987	121,789	122,349
Nitrogen Oxides (NO_x)				
ppmvd	10.0	8.9	9.4	9.4
lb/hr, as NO_2	8.5	8.1	8.2	8.3
Carbon Monoxide (CO)				
ppmvd	236.1	251.6	258.1	248.6
lb/hr	121.9	139.5	137.2	132.9

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 Method 3A, 7E, and 10 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.

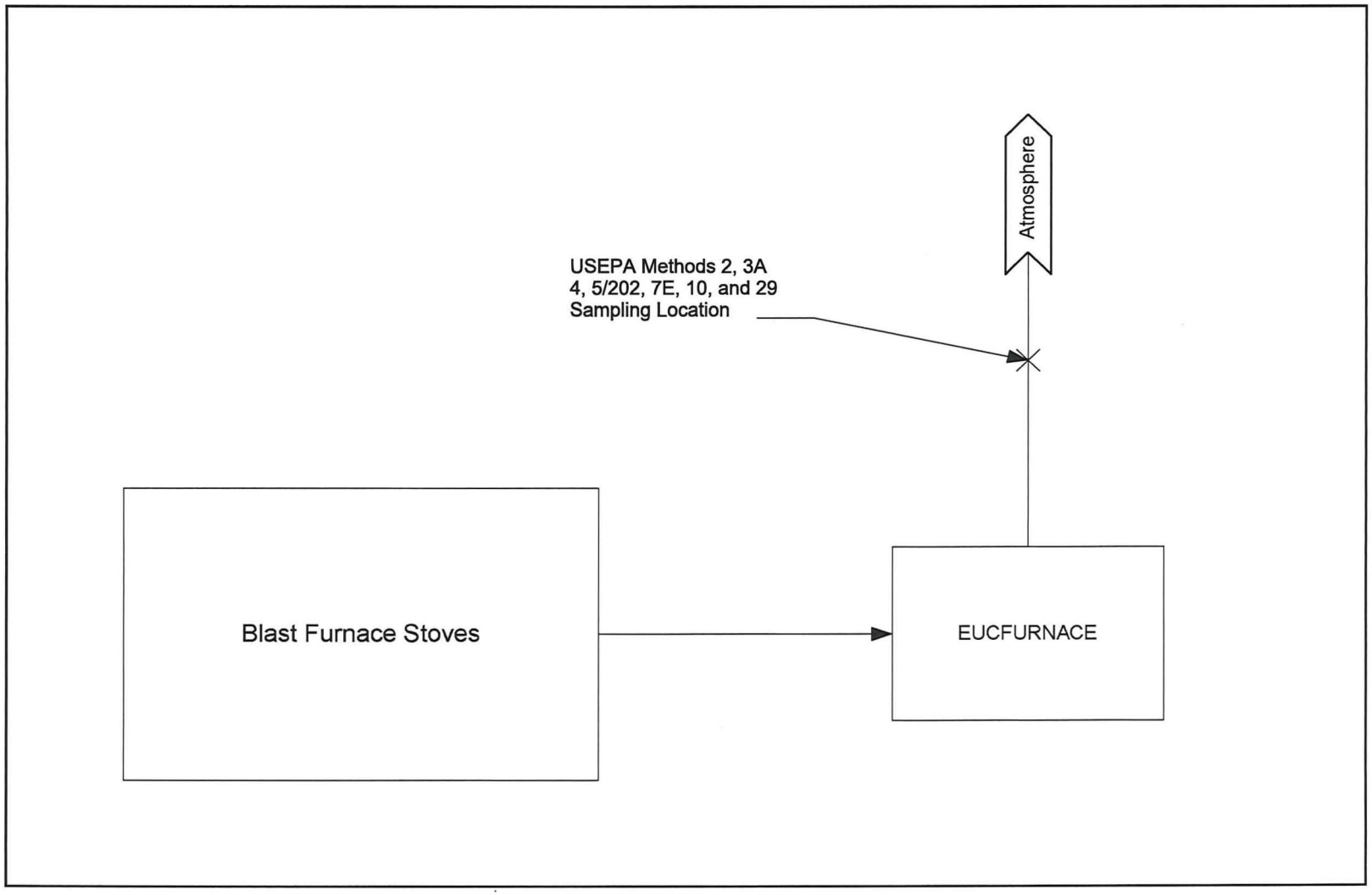
5.3 Quality Statement

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).

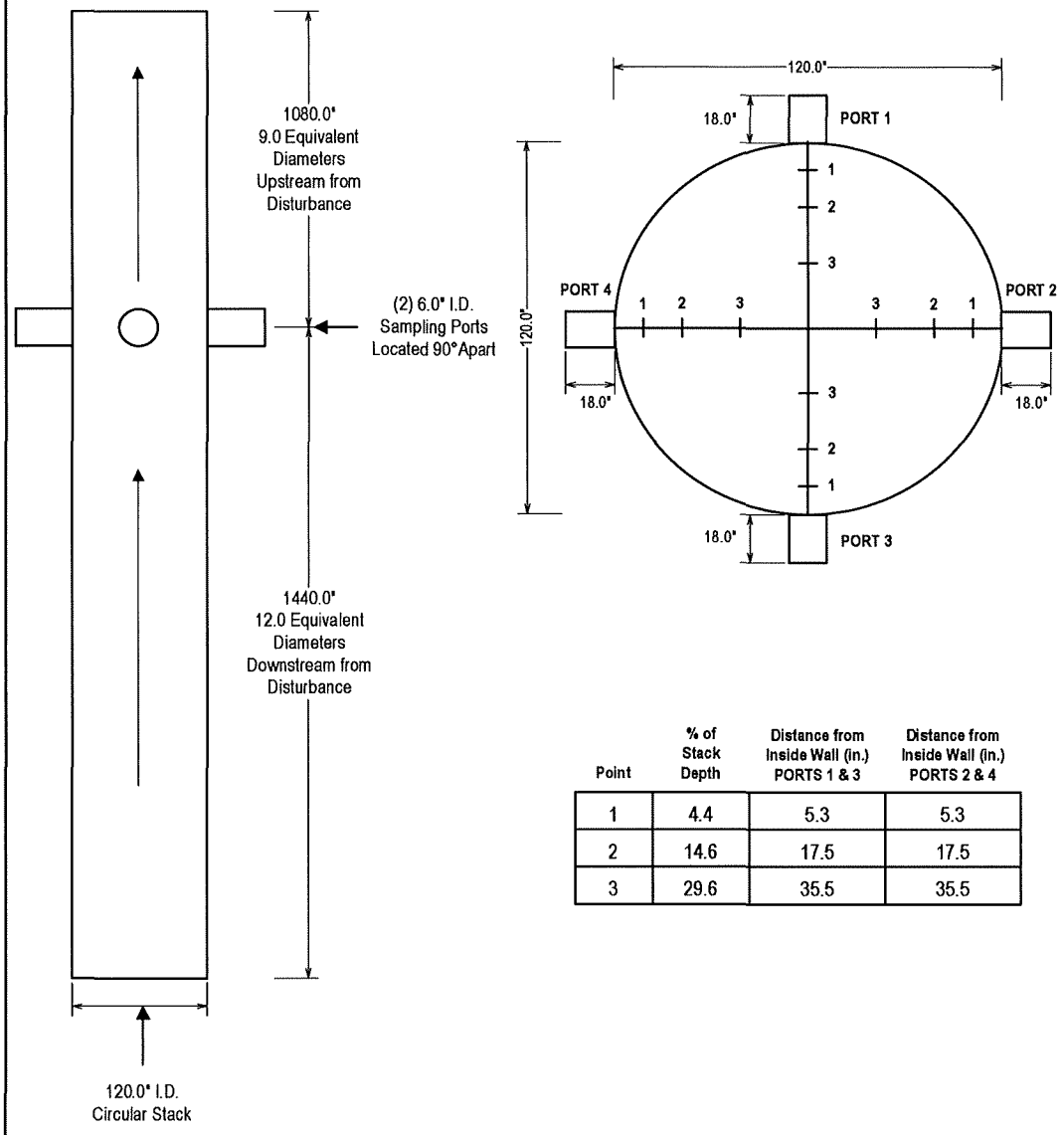
Appendix A
Field Data and Calculations

Appendix A.1
Sampling Locations

EUCFURNACE STOVE SAMPLING LOCATION SCHEMATIC

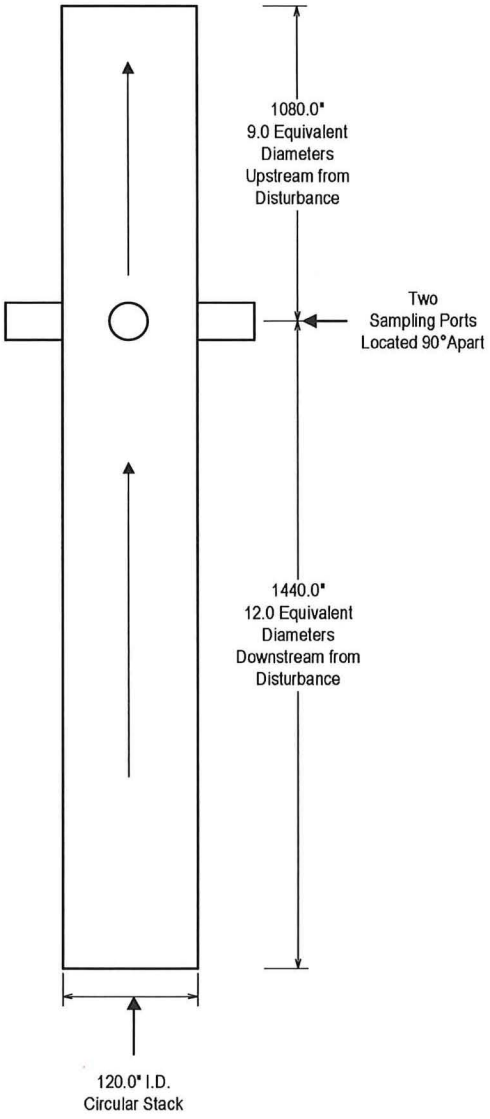


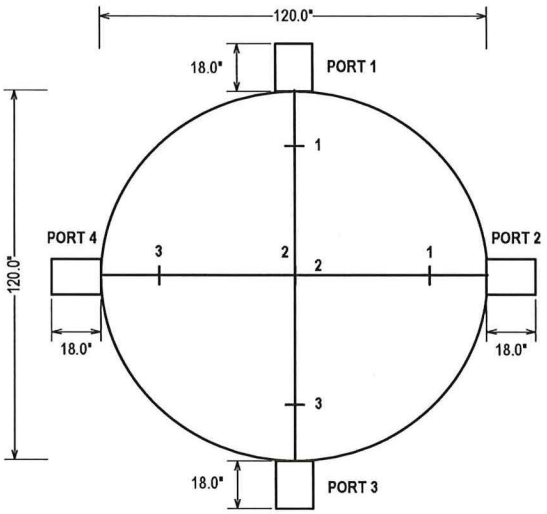
EUCFURNACE STOVE EXHAUST FLOW TRAVERSE POINT LOCATION DRAWING



Point	% of Stack Depth	Distance from Inside Wall (in.) PORTS 1 & 3	Distance from Inside Wall (in.) PORTS 2 & 4
1	4.4	5.3	5.3
2	14.6	17.5	17.5
3	29.6	35.5	35.5

EUCFURNACE STOVE 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	20.0	20.0
2	50.0	60.0	60.0
3	83.3	100.0	100.0