FINAL REPORT

CLEVELAND CLIFFS

DEARBORN, MICHIGAN

QUARTER 3 SOURCE TESTING REPORT: BASIC OXYGEN FURNACE (EUBOF) & BASIC OXYGEN FURNACE SHOP OPERATIONS (FGBOFSHOP)

RWDI #2402105

August 16, 2024

SUBMITTED TO

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EXECUTIVE SUMMARY

RWDI USA LLC (RWDI) was retained by Cleveland-Cliffs Dearborn Works (CCDW) to complete the Quarter 3 (Q3) 2024 emission sampling program at their facility located at 4001 Miller Road, Dearborn, Michigan. The purpose of the emissions test program was to verify emissions required by Michigan Department of Environment, Great Lakes, and Energy (EGLE) Renewable Operating Permit MI-ROP-A8640-2016a, and to comply with the testing requirements specified within the First Material Modification to the consent decree, Civil Action No. 15-cv-11804, DJ # 90-5-2-1-10702.

The test program consisted of testing for filterable particulate matter, lead (Pb), and manganese (Mn) from the BOF Electrostatic Precipitator (ESP), and Pb and Mn from the Secondary Emission Control (SEC) Baghouse (SVBOFBH). Pb and Mn testing was performed simultaneously on the ESP and the SEC Baghouse. In addition, visible emission observations were conducted on the BOF Roof Monitor concurrent with a portion of the Pb and Mn testing at the request of EGLE.

Executive Table i: Test Results

Source	Parameter	Concentration	
		Average Emission Rate	Emission Limit
BOF ESP	PM Filterable only	0.0027 gr/dscf	0.0152 gr/dscf
		10.2 lb/hr	62.6 lb/hr
	Lead	0.011 lb/hr	--
	Manganese	0.018 lb/hr	--
BOF SEC Baghouse	Lead	0.0055 lb/hr	--
	Manganese	0.0065 lb/hr	0.07 lb/hr
BOF ESP & SEC Baghouse Combined	Lead	0.017 lb/hr	0.067 lb/hr
	Manganese	0.025 lb/hr	0.10 lb/hr
BOF Roof Monitor	Visible Emissions	3%, 3-Minute Average(1)	15% 3-minute Average (FGBOFSHOP)
			20% 3-minute Average (EUBOF)

(1) Reported as maximum 3-minute average observed for entire test

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1 INTRODUCTION

RWDI USA LLC (RWDI) was retained by Cleveland-Cliffs Dearborn Works (CCDW) to complete the Quarter 3 (Q3) 2024 emission sampling program at their facility located at 4001 Miller Road, Dearborn, Michigan. The test program consisted of testing for filterable particulate matter (FPM), lead (Pb), and manganese (Mn) from the ESP and Pb and Mn from the SEC Baghouse. Pb and Mn testing was performed simultaneously on the ESP and the SEC Baghouse. Filterable Particulate Emissions (FPM) was measured from the ESP. In addition, visible emission observations were conducted on the BOF Roof Monitor concurrent with a portion of the Pb and Mn testing at the request of EGLE.

1.1 Location and Dates of Testing

The test program was completed between July 11th and 12th, 2024.

1.2 Purpose of Testing

The purpose of the emissions test program was to verify emissions required by Michigan Department of Environment, Great Lakes, and Energy (EGLE) Renewable Operating Permit MI-ROP-A8640-2016a and to comply with the testing requirements specified within the First Material Modification to the consent decree, Civil Action No. 15-cv-11804, DJ # 90-5-2-1-10702.

1.3 Description of Source

CCDW is a steel-producing facility. Scrap metal is charged into the basic oxygen furnace (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 and refining the iron into steel by reducing the carbon content. The heat from the steelmaking process comes from the reaction of oxygen with the dissolved carbon in the molten iron.

1.4 Personnel Involved in Testing

Table 1.4: Testing Personnel

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Katherine Koster	**EGLE**	Kosterk1@michian.gov

2 SUMMARY OF RESULTS

2.1 Operating Data

CCDW personnel monitored the process during the course of the testing. All process data can be found in **Appendix A**. During the testing, production averaged 308.1 TPH of liquid steel. The ESP operated at 30 equivalent fields during the testing. Casing 2 and compartments 3A and 4B were out of service. This 30-field operating scenario is defined as the ESP operating standard and was established by the initial testing in May 2023 required by the consent decree modification.

2.2 Applicable Permit Number

MI-ROP-A8640-2016a

3 SOURCE DESCRIPTION

3.1 Description of Process and Emission Control Equipment

Primary emissions from oxygen blowing are controlled by an ESP (SVBOFESP). The emissions enter the ESP where the particulate is electrically charged. The charged particles then flow over positively charged collector plates, where the particles are collected. Vibration to both the discharge electrodes and the collection plates dislodge the particulate matter. The exhaust gas is then discharged from the ESP outlet.

The BOF also utilizes a secondary emission control (SEC) baghouse (SVBOFBH). The SEC baghouse controls particulate emissions during the hot metal charging, tapping, and reloading operations during the steel making process.

3.2 Process Flow Sheet or Diagram (if applicable)

Process flow diagram can be provided upon request.

3.3 Type and Quantity of Raw and Finished Materials

Approximately 250 tons of molten steel and 30 tons of slag is produced at the BOF during each heat. A typical heat will process approximately 200 tons of liquid iron and 60-80 tons of scrap. Lime is added as a flux and various alloys are added based on the final specifications of the steel being produced.

3.4 Normal Rated Capacity of Process

Approximately 250 tons steel per batch.

3.5 Process Instrumentation Monitored During the Test

The process data recorded during the testing can be found in **Appendix A**. The following parameters were recorded:

- Steel Production Rate, TPH
- Start and stop time of each steel production cycle and oxygen blow
- Average oxygen blow rate per heat
- Start and stop time of charging, tapping, and reloading per heat
- Number and identification of the ESP casings, compartments, and fields in operation per heat
- Average ESP inlet draft during oxygen blowing measured per heat
- Average primary louver position of the blowing vessel per heat
- ESP COMS 1-hour and 6-minute block average data per run
- Baghouse pressure drop and bag leak detection readings per heat
- Identification of baghouse compartments in operation per heat
- Manganese and lead concentration in hot metal per heat
- Analysis of a dust sample for Pb and Mn from the ESP hopper per test run

4 SAMPLING AND ANALYTICAL PROCEDURES

4.1 Description of Sampling Train and Field Procedures

4.1.1 Stack Velocity, Temperature, and Volumetric Flow Rate Determination USEPA Method 1-4

The exhaust velocities and flow rates were determined following the US EPA Method 2, "Determination of Stack Gas Velocity and Flow Rate (Type S Pitot Tube)". Velocity measurements were taken with a pre-calibrated S-Type pitot tube. Volumetric flow rates were determined following the equal area method as outlined in US EPA Method 1. Temperature measurements were made simultaneously with the velocity measurements and were conducted using a chromel-alumel type "k" thermocouple in conjunction with a digital temperature indicator.

The dry molecular weight of the stack gas was determined following calculations outlined in U.S. EPA Method 3A, "Gas Analysis for the Determination of Dry Molecular Weight (Instrumental) for the ESP and U.S. EPA Method 3 for the SEC (Fyrite). RWDI collected integrated sample bags over the duration of each test period for the SEC Baghouse using the orsat pump from the sampling consoles. The bag samples were analyzed on-site using a Fyrite for CO_2 and O_2 measurements. The analysis confirmed that oxygen and carbon dioxide levels on the SEC Baghouse were at ambient conditions.

For the ESP, the CO_2 and O_2 analyzers were operated according to USEPA Method 3A. Prior to testing, a 3-point analyzer calibration error check was conducted using USEPA protocol gases. The calibration error check was performed by introducing zero, mid and high-level calibration gases directly into the analyzer. The calibration error check was performed to confirm that the analyzer response was within ±2% of the certified calibration gas introduced. Prior to each test run, a system-bias test was performed where known concentrations of calibration gases were introduced at the probe tip to measure if the analyzers response was within ±5% of the introduced calibration gas concentrations. At the conclusion of each run, a system-bias check was performed to evaluate the percent drift from pre and post-test system bias checks. The system bias checks were used to confirm that the analyzer did not drift greater than ±3% throughout a test run.

Zero and upscale calibration checks were conducted both before and after each test run in order to quantify measurement system calibration drift and sampling system bias. Upscale is either the mid- or high-range gas, whichever most closely approximates the flue gas level. During these checks, the calibration gases were introduced through the entire sampling system to ensure that system was working properly. The analyzers were calibrated on-site using EPA Protocol No. 1 certified calibration mixtures.

Stack moisture content was determined through direct condensation from the PM or metals sampling trains according to U.S. EPA Method 4, "Determination of Moisture Content of Stack Gases".

4.1.2 Particulate Matter USEPA Method 5

For USEPA Method 5, the particulate matter was withdrawn isokinetically from the source and collected on a quartz filter maintained at a temperature of 120 ±14 °C (248 ±25 °F). The PM mass, which includes any material

that condenses at or above the filtration temperature, was determined gravimetrically after the removal of uncombined water. The sampling train consisted of the following: nozzle (Teflon), probe liner (quartz) with heating system, glass fiber filter, and five impingers in series. Particulate and metals were collected in the nozzle, probe, and filter. The gaseous metal emissions were collected in the impinger train with the first impinger being empty, the next two impingers containing acidified hydrogen peroxide, an empty fourth impinger, and a final impinger containing silica gel, and the metering system. At the end of each test a leak check was performed. The recovery process followed USEPA Method 5 and 29, and all samples were sent to the laboratory for analysis.

Samples were sent to the laboratory for analysis for USEPA Method 5 and 29. A schematic of the sampling train is included in **Figure Section** (**Figure 3**).

4.1.3 Metals (Lead and Manganese) USEPA Method 29

A sample of stack gas was drawn from the stack isokinetically to measure metals. The sampling train consisted of a Teflon-coated nozzle, a glass-lined probe, quartz filter, and five impingers in series. Particulate metals were collected in the nozzle, probe, and filter. The gaseous emissions were collected in the impinger train with the first impinger being empty, the next two impingers containing acidified hydrogen peroxide, an empty fourth impinger, and a final impinger containing silica gel. The recovery process followed USEPA Method 29, and all samples were sent to the laboratory for analysis. A schematic of the sampling train is included in the **Figure Section** (**Figure 3**).

4.1.4 Visible Emissions

Visible Emissions were determined in accordance with U.S. EPA Reference Method 9, "Visual Determination of the Opacity of Emissions from Stationary Sources." For the visible emission observations, readings were observed every 15 seconds over a continuous period of time. A certified observer stood at a distance that provided a clear view of the emissions with the sun oriented in the 140-degree sector at their back. Observations were taken every 15 seconds. VE readings at the BOF Roof Monitor covered a minimum of 180 minutes and 3 steel production cycles and overlapped with the sampling on the ESP and SEC Baghouse.

4.1.5 Method Deviations and Comments

The following modifications applied during the testing. These modifications were accepted in the Source Testing Plan.

1. No port changes took place during oxygen blowing on the ESP. When it was time for a port change, the probe was left at the same port and the points were re-traversed until the oxygen blow was completed. The probe was then moved to the next port and testing was resumed at the first point.
2. In cases where the end of the sampling run did not correspond with the end of a heat, the points were traversed in reverse order until the heat was completed.

4.2 Description of Recovery and Analytical Procedures

The recovery followed USEPA Method 5 and 29.

4.3 Sampling Port Description

EUBOF ESP (SVBOFESP) is a circular stack with an inner diameter of 204". 4 ports are used for testing.

FGBOFSHOP (SVBOFBH) is a circular stack with an inner diameter of 222". 4 ports are used for testing.

5 TEST RESULTS AND DISCUSSION

5.1 Detailed Results

Table 5.1: Test Results

Source	Parameter	Concentration	
		Average Emission Rate	Emission Limit
BOF ESP	PM Filterable only	0.0027 gr/dscf	0.0152 gr/dscf
		10.2 lb./hr.	62.6 lb./hr.
	Lead	0.011 lb./hr.	--
	Manganese	0.018 lb./hr.	--
BOF SEC Baghouse	Lead	0.0055 lb./hr.	--
	Manganese	0.0065 lb./hr.	0.07 lb./hr.
BOF ESP & SEC Baghouse Combined	Lead	0.017 lb./hr.	0.067 lb./hr.
	Manganese	0.025 lb./hr.	0.10 lb./hr.
BOF Roof Monitor	Visible Emissions	3%, Highest 3-Minute Average Observed	15% 3-minute Average (FGBOFSHOP)
			20% 3-minute Average (EUBOF)

5.1.1 Discussion of Results

Detailed results for the program are provided in the following Appendices:

- SVBOFESP (ESP) – **Appendix B**
- SVBOFBH (Secondary Baghouse) – **Appendix C**

5.2 Process Upset Conditions During Testing

There were no process upsets during testing.

5.3 Maintenance Performed in Last Three Months

Only routine maintenance has been performed within the last three months on the SEC Baghouse. For the ESP, in addition to routine maintenance, an annual inspection and associated repairs was conducted from February 27 – May 6 on the internals of the ESP.

5.4 Audit Samples

This test did not require any audit samples.

5.5 Calibration Sheets

Calibration sheets can be found in **Appendix D**.

5.6 Field Data Sheets

Field data sheets can be found in **Appendix E**.

5.7 Laboratory Data

Laboratory data can be found in **Appendix F**.

5.8 Visible Emission Observations

Visible emission observations data can be found in **Appendix G**.

5.9 Sample Calculations

Sample calculations can be found in **Appendix H**.

TABLES

Table 1: Summary of Sampling Parameters and Methodology

Source Location	No. of Tests per Stack	Sampling Parameter	Sampling Method
ESP (SVBOFESP)	3	Velocity, Temperature and Flow Rate	U.S. EPA [1] Methods 1, 2, and 4
	3	Filterable PM/Lead / Manganese	U.S. EPA [1] Method 5/29
	3	Oxygen / Carbon Dioxide	U.S. EPA [1] Method 3
Secondary Baghouse (SVBOFBH)	3	Velocity, Temperature and Flow Rate	U.S. EPA [1] Methods 1, 2 and 4
	3	Lead / Manganese	U.S. EPA [1] Method 29
	3	Oxygen / Carbon Dioxide	U.S. EPA [1] Method 3

Notes:

[1] U.S. EPA - United States Environmental Protection Agency

Table 2A: Sampling Summary and Sample Log (SVBOFESP)

Source and Test #	Sampling Date	Start Time	End Time	Filter ID / Trap ID
SVBOFESP - Velocity / Lead / Manganese				
Blank	12-Jul-24	-	-	M29-Blank
Test #1	11-Jul-24	9:58 AM	1:19 PM	QZ 234
Test #2	11-Jul-24	2:35 PM	4:37 PM	QZ 235
Test #3	12-Jul-24	9:05 AM	10:55 AM	QZ 233

Table 2B: Sampling Summary and Sample Log (SVBOFBH)

Source and Test #	Sampling Date	Start Time	End Time	Filter ID / Trap ID
SVBOFBH - Velocity / Lead / Manganese				
Blank	12-Jul-24	-	-	M29-Blank
Test #1	11-Jul-24	9:58 AM	1:19 PM	-
Test #2	11-Jul-24	2:35 PM	4:37 PM	-
Test #3	11-Jul-24	9:05 AM	10:55 AM	-

Table 3A: Sampling Summary - Flow Characteristics - SVBOFESP

Stack Gas Parameter		Test No. 1 Filterable PM/Lead/Manganese	Test No. 2 Filterable PM/Lead/Manganese	Test No. 3 Filterable PM/Lead/Manganese	Average
Testing Date		11-Jul-24	11-Jul-24	12-Jul-24	
Stack Temperature	°F	254	278	245	259
Moisture	%	15.5%	17.5%	15.5%	16.2%
Velocity	ft/s	50.8	55.8	49.7	52.1
Referenced Flow Rate	CFM	422,403	438,440	420,569	427,137
Oxygen	%	19.0	19.0	19.0	19.0
Carbon Dioxide	%	3.0	3.0	3.0	3.0
Sampling Isokinetic Rate	%	102.4	104.2	101.7	102.8

Notes:

[1] Referenced flow rate expressed as dry at 101.3 kPa, 68 °F, and Actual Oxygen

Table 3B: Sampling Summary - Flow Characteristics - SVBOFBH

Stack Gas Parameter		Test No. 1 Lead/Manganese	Test No. 1 Lead/Manganese	Test No. 3 Lead/Manganese	Average
Testing Date		11-Jul-24	11-Jul-24	12-Jul-24	
Stack Temperature	°F	119	124	108	117
Moisture	%	1.9%	2.0%	2.4%	2.1%
Velocity	ft/s	36.0	35.2	33.1	34.8
Referenced Flow Rate	CFM	506,797	490,342	488,436	495,192
Oxygen	%	21.0	21.0	21.0	21.0
Carbon Dioxide	%	0.0	0.0	0.0	0.0
Sampling Isokinetic Rate	%	99.6	101.7	101.0	100.8

Notes:

[1] Referenced flow rate expressed as dry at 101.3 kPa, 68 °F, and Actual Oxygen

Table 4A: Total Particulate Matter and Metals – Averaged Results - SVBOFESP

SVBOFESP	Test 1		Test 2		Test 3		Average		Emission Limit			
	Concentration	Emission Rate	Concentration	Emission Rate	Concentration	Emission Rate						
Particulate	(gr/dscf)	lb/hr	(gr/dscf)	lb/hr	(gr/dscf)	lb/hr	(gr/dscf)	(lbs/hr)	(gr/dscf)	PM lb/hr	PM_{10} lb/hr	$PM_{2.5}$ lb/hr
PM (Filterable only)	0.0023	8.5	0.0044	16.5	0.0015	5.6	0.0027	10.2	0.0152	62.6	--	--
Metals	(gr/dscf)	lb/hr	(gr/dscf)	lb/hr	(gr/dscf)	lb/hr	(gr/dscf)	(lb/hr)	lb/hr			
Total Lead (Pb)	1.87E-06	0.0068	4.07E-06	0.015	3.12E-06	0.011	3.02E-06	0.011	--			
Total Manganese (Mn)	4.60E-06	0.017	5.57E-06	0.021	4.75E-06	0.017	4.97E-06	0.018	--			

Table 4B: Metals – Averaged Results (SVBOFBH)

SVBOFBH	Test 1		Test 2		Test 3		Average		Emission Limit
	Concentration	Emission Rate	Concentration	Emission Rate	Concentration	Emission Rate			
Metals	(gr/dscf)	(lb/hr)	(gr/dscf)	(lb/hr)	(gr/dscf)	(lb/hr)	(gr/dscf)	(lb/hr)	lb/hr
Total Lead (Pb)	1.41E-06	0.0061	1.45E-06	0.0061	1.05E-06	0.0044	1.30E-06	0.0055	--
Total Manganese (Mn)	1.75E-06	0.0076	1.86E-06	0.0078	9.89E-07	0.0042	1.53E-06	0.0065	0.07

Table 4C: Metals – Averaged Results (SVBOFESP + SVBOFBH)

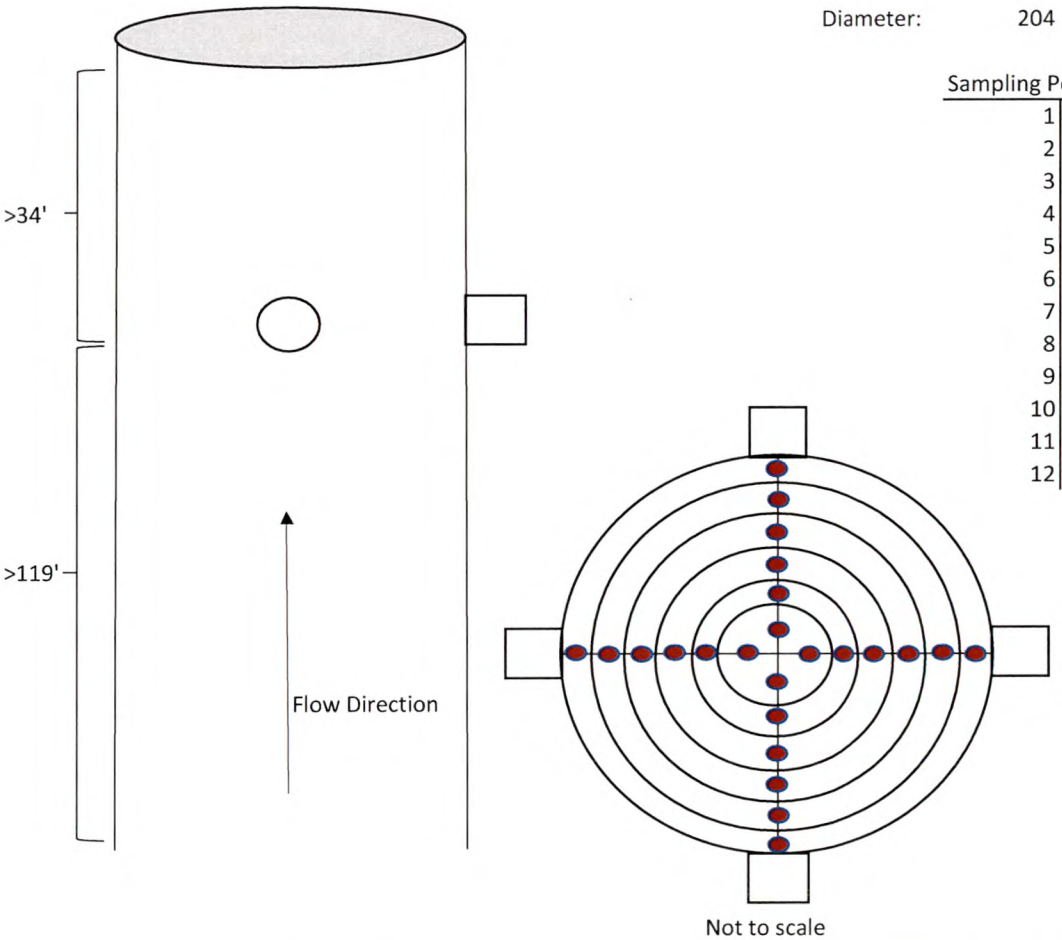
SVBOFESP + SVBOFBH	Test 1		Test 2		Test 3		Average		Emission Limit
	Concentration	Emission Rate	Concentration	Emission Rate	Concentration	Emission Rate			
Metals	(gr/dscf)	(lb/hr)	(gr/dscf)	(lb/hr)	(gr/dscf)	(lb/hr)	(gr/dscf)	(lb/hr)	lb/hr
Total Lead (Pb)	3.27E-06	0.0129	5.52E-06	0.0215	4.17E-06	0.016	4.32E-06	0.017	0.067
Total Manganese (Mn)	6.35E-06	0.024	7.43E-06	0.029	5.74E-06	0.021	6.51E-06	0.025	0.10

Table 5: Opacity- Averaged Results - SVBOFESP

SVBOFESP	Opacity						Average Opacity	Maximum 3-Min Opacity	Average 3-Min Opacity Limit
	Average	Max 3-Min Reading	Average	Max 3-Min Reading	Average	Max 3-Min Reading			
	Test 1		Test 2		Test 3				
Parameter	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Opacity	0	2	0	0	0	3	0	3	20

FIGURES

Figure 1: Sampling Points and Configuration - **SVBOFESP**



Diameter: 204

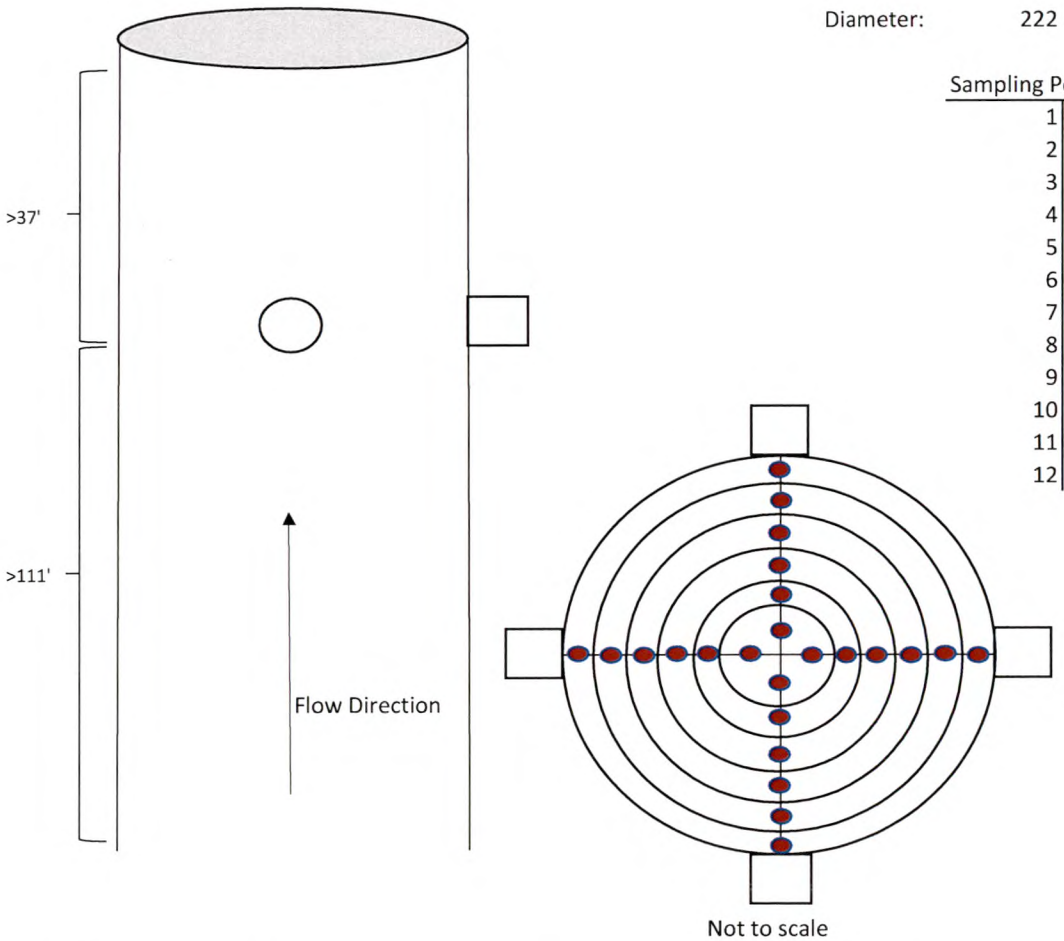
Sampling Points (in.)	
1	4.28
2	13.67
3	24.07
4	36.11
5	51.00
6	72.62
7	131.38
8	153.00
9	167.89
10	179.93
11	190.33
12	199.72

ESP (SVBOFESP)
Cleveland-Cliffs
Dearborn Works
Dearborn, Michigan

Date:
July 11 to 12, 2024

RWDI USA LLC
2239 Star Court
Rochester Hills, MI 48309

Figure 2: Sampling Points and Configuration (SVBOFBH)



Diameter: 222

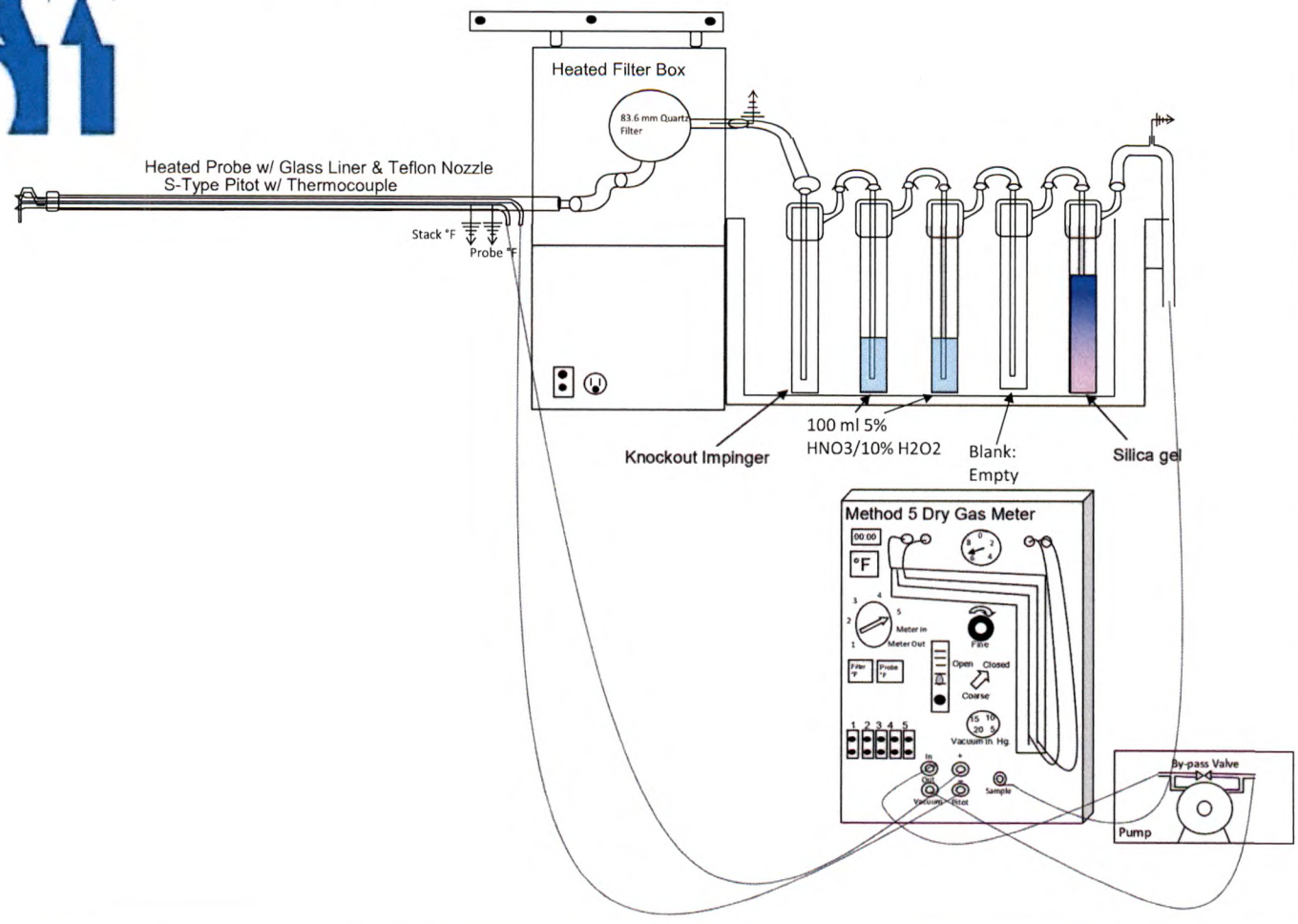
Sampling Points (in.)	
1	4.66
2	14.87
3	26.20
4	39.29
5	55.50
6	79.03
7	142.97
8	166.50
9	182.71
10	195.80
11	207.13
12	217.34

SEC Baghosue (SVBOFBH)
Cleveland-Cliffs
Dearborn Works
Dearborn, Michigan

Date:
July 11 to 12, 2024

RWDI USA LLC
2239 Star Court
Rochester Hills, MI 48309

Figure 3: US EPA Method 5 / 29 Sampling Train



USEPA Method 5/ 29

Cleveland-Cliffs
ESP and SEC Baghouse
Dearborn, Michigan