FINAL REPORT

CLEVELAND CLIFFS

DEARBORN, MICHIGAN

SOURCE TESTING REPORT: SVBOFBH MACT 2024

RWDI #2402097

June 14, 2024

SUBMITTED TO

David Pate
Senior Environmental Engineer
David.Pate@Clevelandcliffs.com

Cleveland-Cliffs
Dearborn Works
4001 Miller Rd
Dearborn, Michigan 48120

Jeremy Howe
Michigan Department of Environment, Great Lakes and Energy
Air Quality Division Technical Programs Unit (TPU)
Constitution Hall 2nd Floor, South
525 West Allegan Street
Lansing, Michigan 48909-7760

SUBMITTED BY

Brad Bergeron, A.Sc.T., d.E.T.
Senior Project Manager | Principal
Brad.Bergeron@rwdi.com

Steve Smith, QSTI
Project Manager
Steve.Smith@rwdi.com

Benjamin Durham
Senior Field Technician
Ben.Durham@rwdi.com

RWDI USA LLC
Consulting Engineers & Scientists
2239 Star Court
Rochester Hills, Michigan 48309
T: 248.841.8442
F: 519.823.1316

EXECUTIVE SUMMARY

RWDI USA LLC (RWDI) has been retained by Cleveland-Cliffs Dearborn Works (CCDW) to complete the 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 as well as to conduct performance testing in accordance with the NESHAP for Integrated Iron and Steel Manufacturing Facilities, 40 CFR Part 63, Subpart FFFFF. The NESHAP test program consisted of testing for Particulate Matter (PM) from the SVBOFBH (Secondary Emission Control (SEC)) Baghouse while conducting overlapping visual emission observations (VE) on the BOF Roof Monitor for a portion of the testing. RWDI conducted testing during all operating scenarios of the SEC Baghouse. Testing consisted of three (3) PM tests of 190-240-minutes (based on production cycle) in duration. a 388 minutes of VE observations were conducted covering seven steel production cycles that overlapped with the PM testing.

The testing program was conducted on May 7th and 8th, 2024.

Executive Table i: Test Results -

Location	Parameter	Emission Rate				
		Test 1	Test 2	Test 3	Average Results	Permit Limit
SVBOFBH	Particulate Matter	0.7 lb./hr.	1.4 lb./hr.	2.1 lb./hr.	1.4 lb./hr.	15.6 lb/hr
		0.0002 gr./dscf.	0.0004 gr./dscf.	0.0004 gr./dscf.	0.0004 gr./dscf	0.003 gr./dscf 0.01 gr/dscf[1]
EUBOF Roof Monitor (3-minute Block)	Visible Emissions	2.9%	4.6%	1.7%	4.6%[(2)]	15% opacity, 3-minute average 20% opacity, 3-minute average[1]
EUBOF Roof Monitor (3-minute Rolling)	Visible Emissions	3.3%	8.3%	1.7%	8.3%[(2)]	

[1] NESHAP 40 CFR 63.7790(a) PM Limit, NESHAP and ROP EUBOF I.2 Opacity Limit

[2] Reported as highest 3-minute average observed

TABLE OF CONTENTS

LIST OF TABLES

(Found Within the Report)

LIST OF TABLES

(Found After the Report)

FIGURES

(Found After the Report)

LIST OF APPENDICES

(Found Within the Report)

1 INTRODUCTION

RWDI USA LLC (RWDI) has been retained by Cleveland-Cliffs Dearborn Works (CCDW) to complete the 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 as well as to conduct performance testing in accordance with the NESHAP for Integrated Iron and Steel Manufacturing Facilities, 40 CFR Part 63, Subpart FFFFF. The NESHAP test program consisted of testing for Particulate Matter (PM) from the SVBOFBH (Secondary Emission Control (SEC)) Baghouse while conducting overlapping visual emission observations (VE) on the BOF Roof Monitor for a portion of the testing. RWDI conducted testing during all operating scenarios of the SEC Baghouse. Testing consisted of three (3) PM tests of 190-240-minutes (based on production cycle) in duration and 388 minutes of VE observations covering seven steel production cycles that overlapped with the PM sampling.

The testing program was conducted on May 7th and 8th, 2024.

1.1 Location and Dates of Testing

The test program was completed over May 7th and 8th, 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 as well as to conduct performance testing in accordance with the NESHAP for Integrated Iron and Steel Manufacturing Facilities, 40 CFR Part 63, Subpart FFFFF.

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

David Pate Senior Environmental Engineer	**Cleveland-Cliffs Dearborn Works**	(313) 323-1261 David.Pate@Clevelandcliffs.com
Brad Bergeron Technical Director	**RWDI USA LLC** 2239 Star Court Rochester Hills, MI 48309	(248) 234-3885 Brad.Bergeron@rwdi.com
Steve Smith Project Manager		(734) 751-9701 Steve.Smith@rwdi.com
Mike Nummer Senior Field Technician		Michael.Nummer@rwdi.com
Roy Zimmer Field Technician		Roy.Zimmer@rwdi.com
Cade Smith Field Technician		Cade.Smith@rwdi.com
Jeffrey Peitzsch	**Montrose Air Quality Services**	jbpeitzsch@montrose-env.com

2 SUMMARY OF RESULTS

2.1 Operating Data

CCDW personnel monitored the process during the testing. All process data can be found in **Appendix A**. During the testing, production averaged 278.6 TPH of liquid steel.

2.2 Applicable Permit Number

MI-ROP-A8640-2016a and NESHAP for Integrated Iron and Steel Manufacturing Facilities, 40 CFR Part 63, Subpart FFFFF.

3 SOURCE DESCRIPTION

3.1 Description of Process and Emission Control Equipment

The BOF utilizes an ESP and a secondary emission baghouse to control emissions. The ESP consists of 5 casings in parallel. Casings 1 through 4 consist of 10 fields. Casing 5 consists of 6 fields that are functionally equivalent to 10 fields in the other casings. This equates to 50 equivalent ESP fields. The baghouse is a 14-compartment reverse-air style baghouse with a capacity of 1,000,000 ACFM.

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
- Average oxygen blow rate per heat
- Start/stop times of charging, tapping, reladling per heat
- Baghouse pressure drop and bag leak detector reading per heat
- Number of baghouse fans in operation, damper positions, fan speed, and plenum pressure for each operation scenario

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. The volumetric flow rate was determined following the equal area method as outlined in US EPA Method 1. Temperature measurements were made simultaneously with the velocity measurement and was 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 and USEPA Method 3 (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.

Stack moisture content was determined through direct condensation from the PM 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 (borosilicate glass) with heating system, quartz filter, modified GS impinger with 100 ml of water, standard GS impinger with 100 ml of water, empty modified GS impinger, silica gel impinger, and the metering system. At the end of each test a leak check was performed. The filter and probe/nozzle acetone rinses were analyzed at the RWDI in-house laboratory.

A schematic of the sampling train is included in **Figure Section** (**Figure 3**).

4.1.3 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. 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 PM sampling. To satisfy MACT requirements, opacity percentages are reported based on 3-minute block averages.

4.1.4 Method Deviations

The following modifications were provided and accepted in the Source Testing Plan.

1. Testing was performed for an integral number of production cycles. When all sample points had been sampled but the heat was still in progress, sampling on the final test port was repeated (and if necessary, moved to the previous test port) until the production cycle was completed.

4.1.5 NESHAP Testing Considerations

1. Testing was only conducted during the steel production cycle. A steel production cycle is defined as beginning when scrap is charged and ending 3 minutes after slag is emptied from the vessel into a slag pot.

2. Each test run consisted of an integral number of steel production cycles.

3. Visible emissions observations on the BOF Roof Monitor were conducted such that the opacity observations overlapped with the particulate testing. Observations were conducted for more than the minimum of 180 minutes required by the NESHAP rule.

4. A minimum of 60 dscf of gas was collected during each particulate matter test run. Gas volume sampled ranged from 92 to 117 dscf.

5. Instead of procedures in section 2.4 of Method 9 in 40 CFR 60, Appendix A, observations from the BOF Roof Monitor were recorded to the nearest 5% at 15-second intervals for seven steel production cycles.

6. Cleveland-Cliffs used this performance test to change the operating limits for the baghouse capture system. This was done in accordance with the Title V Air Permit MI-ROP-A8640-2016a, FGBOF Shop V.5 as well as the Integrated Iron and Steel NESHAP, 40 CFR 63.7824(c).

4.2 Description of Recovery and Analytical Procedures

The recovery followed USEPA Method 5. Results were analyzed gravimetrically at the RWDI in-house laboratory.

4.3 Sampling Port Description

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 – Particulate Matter and Visual Emissions

Location	Parameter	Emission Rate				
		Test 1	Test 2	Test 3	Average Results	Permit Limit
SVBOFBH	Particulate Matter	0.7 lb./hr.	1.4 lb./hr.	2.1 lb./hr.	1.4 lb./hr.	15.6 lb/hr
		0.0002 gr./dscf.	0.0004 gr./dscf.	0.0004 gr./dscf.	0.0004 gr./dscf	0.003 gr./dscf 0.01 gr/dscf[1]
EUBOF Roof Monitor (3-minute Block)	Visible Emissions	2.9%	4.6%	1.7%	4.6%[(2)]	15% opacity, 3-minute average 20% opacity, 3-minute average[1]
EUBOF Roof Monitor (3-minute Rolling)	Visible Emissions	3.3%	8.3%	1.7%	8.3%[(2)]	

[1] NESHAP 40 CFR 63.7790(a) PM Limit, NESHAP and ROP EUBOF I.2 Opacity Limit

[2] Reported as highest 3-minute block average observed

5.1.1 Discussion of Results

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

- SVBOFBH (Secondary Baghouse) Particulate Matter Results – **Appendix B**
- EUBOF Roof Visual Emissions Results – **Appendix C**

5.2 Process Upset Conditions During Testing

There were no process upsets during the testing.

5.3 Maintenance Performed in Last Three Months

Only routine maintenance has been performed within the last three months on the SEC Baghouse.

5.4 Audit Samples

This test did not require any audit samples.

5.5 Visible Emission Observations

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

5.6 Field Data Sheets

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

5.7 Laboratory Data

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

5.8 Calibration Data

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

5.9 Sample Calculations

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

TABLES

Table 1: Summary of Sampling Parameters and Methodology

Source Location	No. of Tests per Stack	Sampling Parameter	Sampling Method
Secondary Baghouse (SVBOFBH)	3	Velocity & Temeprature	U.S. EPA [1] Methods 1 & 2
		Oxygen & Carbon Dioxide	U.S. EPA [1] Method 3
		Moisture	U.S. EPA [1] Method 4
		Particulate Matter	U.S. EPA [1] Method 5
		Visual Emissions	U.S. EPA [1] Method 9

Notes:

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

Table 2: Sampling Summary and Sample Log (SVBOFBH)

Source and Test #	Sampling Date	Start Time	End Time	Filter ID / Trap ID
SVBOFBH - Particulate Matter				
Blank	7-May-24	-	-	QZ56
Test #1	7-May-24	8:09 AM	2:23 PM	QZ129
Test #2	8-May-24	7:43 AM	12:48 PM	QZ132
Test #3	8-May-24	1:23 PM	5:04 PM	QZ136

Table 3: Sampling Summary - Flow Characteristics - SVBOFBH

Stack Gas Parameter		Test No. 1 Filterable PM	Test No. 2 Filterable PM	Test No. 3 Filterable PM	Average
Testing Date		7-May-24	8-May-24	7-May-24	
Stack Temperature	°F	106	104	111	107
Moisture	%	1.1%	1.4%	1.0%	1.2%
Velocity	ft/s	28.0	30.4	28.8	29.1
Referenced Flow Rate	CFM	451,700	489,742	464,928	468,790
Oxygen	%	21.0	21.0	21.0	21.0
Carbon Dioxide	%	0.0	0.0	0.0	0.0
Sampling Isokinetic Rate	%	99.1	99.4	98.6	99.0

Notes:

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

Table 4: Total Particulate Matter Results - SVBFBH

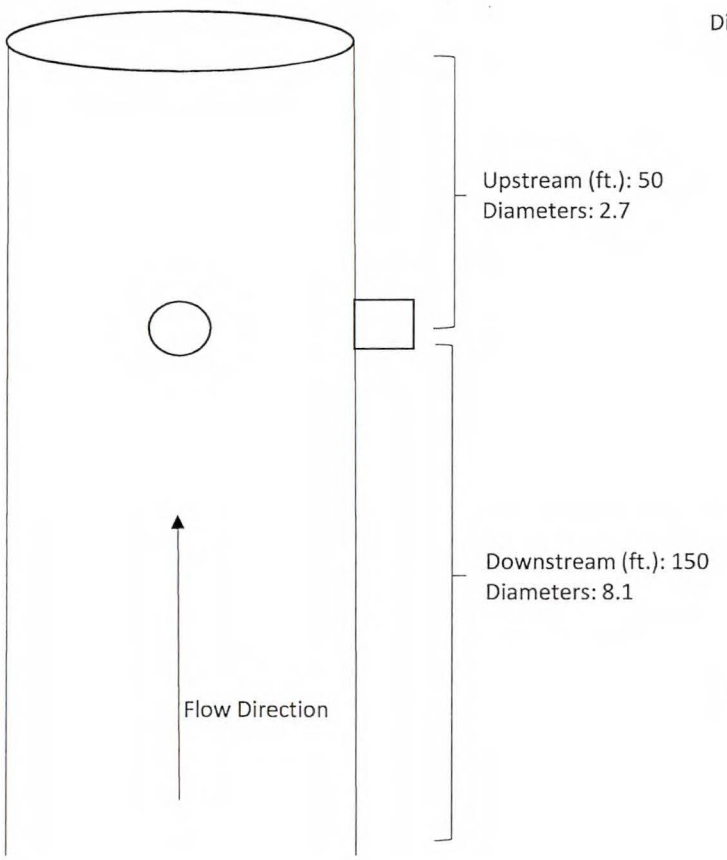
Company		Cleveland Cliffs		
Source		SEC		
Date	7-May-24	8-May-24	8-May-24	
Test Number	**Test 1**	**Test 2**	**Test 3**	**Average**
Start Time	8:09	7:43	13:23	-
End Time	14:23	12:48	17:04	-
Stack Information				
Flow Rate (ft^3/min) (Actual)	451,700	489,742	464,928	468,790
Flow (ft^3/min) (Standard Wet)	420,905	444,885	417,151	427,647
Flow (ft^3/min) (Standard Dry)	416,393	438,560	412,951	422,635
Flow (m^3/min) (Standard Dry)	11,791	12,419	11,694	11,968
Percent Moisture (%)	1.1	1.4	1.0	1.2
Pressure Ps ("Hg)	29.87	29.05	29.05	29.32
Average Stack Temperature (T_s) ($^\circ$F)	105.8	104.3	111.3	107.1
Molecular Weight of Stack Gas dry (M_d) (g/mole)	28.84	28.84	28.84	28.84
Molecular Weight of Stack Gas wet (M_s) (g/mole)	28.72	28.69	28.69	28.70
Stack Gas Specific Gravity (G_s) (kg/L)	1.0	1.0	1.0	1.0
Water Vapor Volume Fraction (%)	0.0	0.0	0.0	0.0
Average Stack Velocity (V_s) (ft/sec)	28.0	30.4	28.8	29.1
Cross Section Area of Stack (ft^2)	268.8	268.8	268.8	268.8
Percent Carbon Dioxide (%)	0.0	0.0	0.0	0.0
Percent Oxygen (%)	21.0	21.0	21.0	21.0
Percent Carbon Monoxide (%)	0.0	0.0	0.0	0.0
Percent Excess Air at Test Location (%)	-	-	-	-
Meter Info				
Isokinetic Variation I (%)	99.1	99.4	98.6	99.0
Meter Pressure Pm ("Hg)	29.9	29.1	29.1	29.4
Meter Temperature Tm ($^\circ$F)	65.8	74.6	82.8	74.4
Measured Sample Volume Vm (ft^3)	119.95	114.73	100.48	111.72
Sample Volume (Vm St ft^3)	115.74	105.92	91.35	104.34
Sample Volume (Vm St m^3)	3.28	3.00	2.59	2.95
Total Weight of Sampled Gas (lbs) wet	8.69	7.97	6.85	7.83
Total Weight of Sampled Gas (lbs) dry	8.63	7.90	6.81	7.78
Gas Density Ps wet ("Hg)	0.07	0.07	0.07	0.07
Gas Density Ps dry ("Hg)	0.07	0.07	0.07	0.07
Condensate Volume (ft^3)	1.25	1.53	0.93	1.24
Nozzle Size (in^2)	0.00031	0.00031	0.00031	0.00
Impinger Gain (g)	5.3	7.4	3.1	5.3
Silica Gel Gain (g)	21.3	25.0	16.6	21.0
Total Gas Sampled (vm st ft^3 + condensate volume)	117.00	107.45	92.27	105.57
Particulate Results				
Nozzle/Probe/Filter Weight (mg)	1.5	2.5	3.5	2.5
Total Particulate (mg)	1.5	2.5	3.5	2.5
Total Particulate Emission Rate (lb/hr)	0.72	1.37	2.10	1.40
Total Particulate Concentration lb/1000 lb (wet)	0.0004	0.0007	0.0011	0.0007
Total Particulate Concentration lb/1000 lb (dry)	0.0004	0.0007	0.0011	0.0007
Total Particulate Concentration mg/dscm (dry)	0.46	0.83	1.35	0.88
Total Particulate Concentration (gr/dscf)	0.00020	0.00036	0.00059	0.00039

Table 5: Opacity- Averaged Results - SVBOFBH

SVBOFBH	Opacity - 3-Minute Average			Overall 3-Minute Average (Block Average)	Overall 3-Minute Average (Rolling Average)	NESHAP & ROP EUBOF 1.2 Limit	ROP FGBOFSHOP Limit
	Test 1	Test 2	Test 3				
Parameter	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**
Opacity	2.9	8.3	1.7	4.6	8.3	15	20

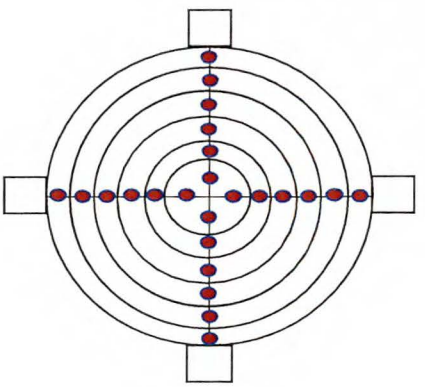
FIGURES

Figure No. 1: 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



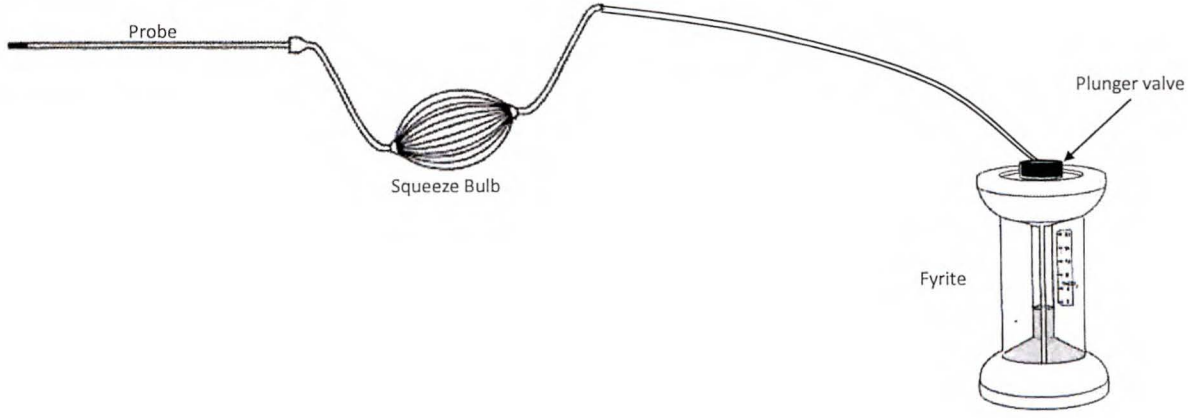
Not to Scale

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

Date:
May 7-8, 2024

RWDI USA LLC
2239 Star Court
Rochester Hills, MI 48309

Figure No. 2: USEPA Method 3 Schematic (Fyrite)



USEPA Method 3

Cleveland Cliffs

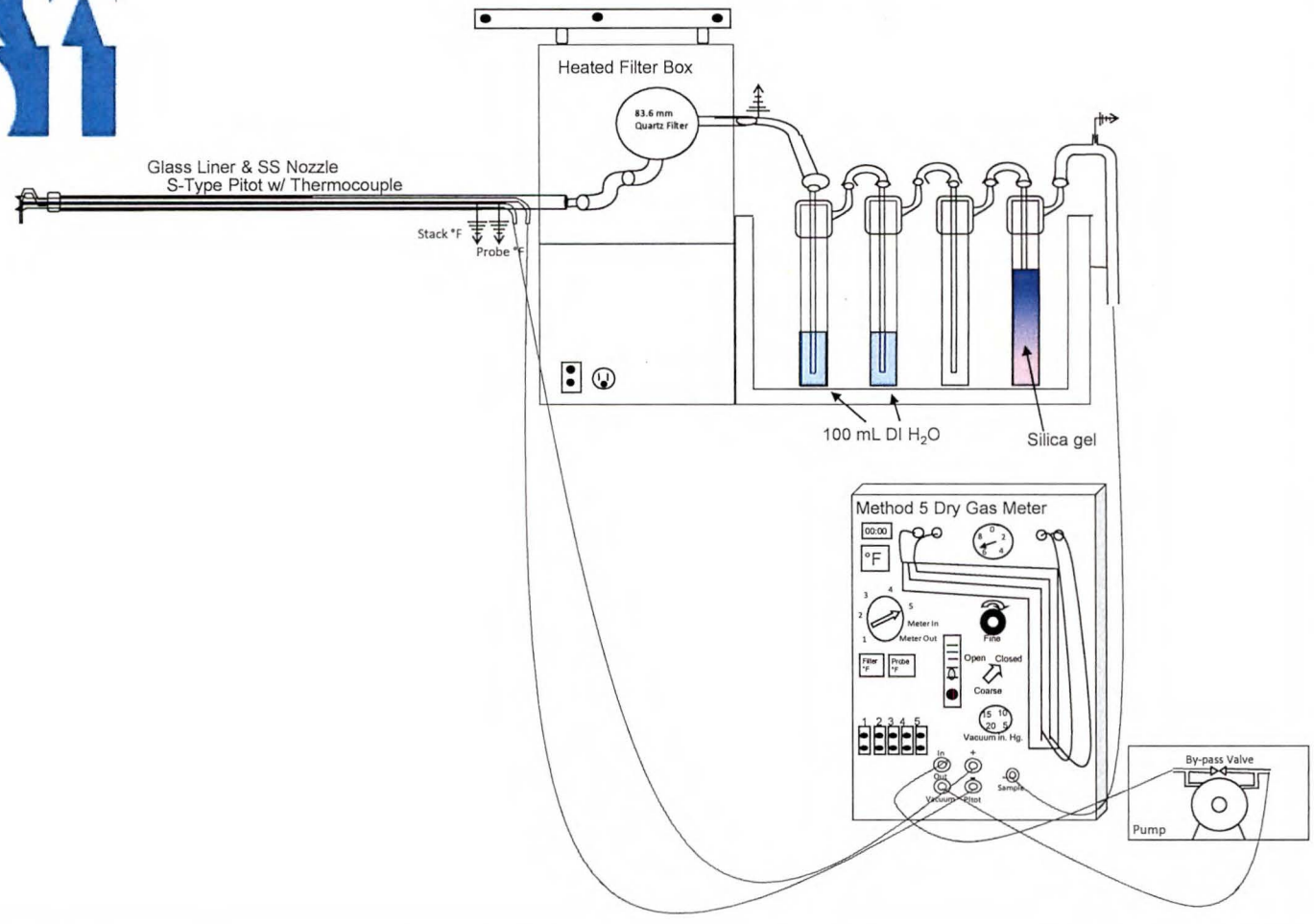
Dearborn Works

Dearborn, MI

Project# 2402097

Date: May 7th-8th, 2024

Figure 3: Schematic of USEPA Method 5



USEPA Method 5

Cleveland Cliffs

Dearborn Works

Dearborn, Michigan

Job No. 2402097

Date: May 7-8th, 2024