

FINAL REPORT



CLEVELAND CLIFFS

DEARBORN, MICHIGAN

SOURCE TESTING REPORT: LRF1 AND LRF2

RWDI #2402567

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SUBMITTED TO

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EXECUTIVE SUMMARY

RWDI USA LLC (RWDI) was 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, Facility SRN A8640, and to satisfy performance testing requirements in the Iron and Steel NESHAP, 40 CFR 63, Subpart FFFFF.

The test program consisted of testing for particulate matter (PM) (filterable only), particulate matter less than 10 microns (PM₁₀) and particulate matter less than 2.5 microns (PM_{2.5}) (filterable and condensable) and lead (Pb) from the Ladle Refining Furnace (LRF) 1 and LRF 2 Baghouses. In addition, visible emission observations were conducted on the LRF1 and LRF2 baghouse stacks concurrent with the PM and lead testing.

Executive Table i: Average Test Results – LRF1 & LRF2

Source	Parameter	Concentration	
		Average Emission Rate	Emission Limit
LRF1 Baghouse	PM	0.10 lb/hr	6.33 lb/hr
		0.00013 gr/dscf	0.005 gr/dscf (ROP) 0.01 (FFFFF Limit)
	PM ₁₀ and PM _{2.5}	0.59 lb/hr	6.65 lb/hr
	Lead	0.00025 lb/hr	0.022 lb/hr
	Opacity	0%, 6-minute average	5%, 6-minute average
LRF2 Baghouse	PM	0.046 lb/hr	3.72 lb/hr
		0.00010 gr/dscf	0.005 gr/dscf (ROP) 0.01 (FFFFF Limit)
	PM ₁₀ and PM _{2.5}	1.49 lb/hr	3.91 lb/hr
	Lead	0.000062 lb/hr	0.013 lb/hr
LRF1 Building and Roof Monitor	Opacity	0%, 3-minute average	20%, 3-minute average (FFFFF Limit)
		0%, 3-minute average	No Visible Emissions (ROP)
LRF2 Building and Roof Monitor	Opacity	0%, 3-minute average	20%, 3-minute average (FFFFF Limit)
		0%, 3-minute average	No Visible Emissions (ROP)



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1 INTRODUCTION

RWDI USA LLC (RWDI) was 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, Facility SRN A8640, and to satisfy performance testing requirements in the Iron and Steel NESHAP, 40 CFR 63, Subpart FFFFF.

The test program consisted of testing for particulate matter (PM) (filterable only), particulate matter less than 10 microns (PM₁₀) and particulate matter less than 2.5 microns (PM_{2.5}) (filterable and condensable) and lead (Pb) from the Ladle Refining Furnace (LRF) 1 and LRF 2 Baghouses. In addition, visible emission observations were conducted on the LRF1 and LRF2 baghouse stacks concurrent with the PM and lead testing.

1.1 Location and Dates of Testing

The test program was completed between the dates of August 5th and August 9th, 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, Facility SRN A8640 and to satisfy performance testing requirements in the Iron and Steel NESHAP, 40 CFR 63, Subpart FFFFF.

1.3 Description of Source

CCDW is a steel-producing facility. The LRFs receive molten steel from the basic oxygen furnace (BOF). The steel is reheated by electricity and, if necessary, alloys are added to achieve the required alloy composition. Emissions from the LRFs are controlled by their own individual pulse-jet baghouses equipped with a bag leak detection system that continuously monitors the particulate matter loading in the exhaust to ensure proper operation. The bag leak detection system monitors the particulate matter loading in the exhaust on a continuous basis. The baghouses are typically operated at an overall differential pressure of 2-10" W.C. for each baghouse. Typical differential pressures for each individual compartment for each baghouse range from 1-8" W.C.



1.4 Personnel Involved in Testing

Table 1.4.1: Testing Personnel

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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**.

2.2 Applicable Permit Number

MI-ROP-A8640-2016a, Facility SRN A8640, Iron and Steel NESHAP, 40 CFR 63, Subpart FFFFF

3 SOURCE DESCRIPTION

3.1 Description of Process and Emission Control Equipment

Both LRF 1 and LRF 2 dust collectors are continuous automatic, suction type, pulse-jet baghouses. LRF1 consists of five (5) chambers in parallel and is manufactured by Flakt. One (1) main induced draft (ID) fan provides suction for moving the fume and dust laden gases through the fume control system. The fan is of the radial tip design and designed to handle 175,000 actual cubic feet per minute (acfm).

LRF 2 consists of six (6) chambers in parallel and is manufactured by Flakt. One (1) main induced draft (ID) fan provides suction for moving the fume and dust laden gases through the fume control system. The fan is of the radial tip design and designed to handle 100,000 actual cubic feet per minute (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 is produced at the LRFs during each heat.

3.4 Normal Rated Capacity of Process

Approximately 250 tons steel per batch. Production rate is heavily dependent on upstream and downstream operations.



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 LRF production cycle
- Type and amount of alloys added per heat
- Baghouse pressure drop and bag leak detection readings
- Baghouse PM Monitor (bag leak detector) readings

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 USEPA 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 USEPA 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 USEPA Method 3, "Gas Analysis for the Determination of Dry Molecular Weight". RWDI collected integrated sample bags over the duration of each test period for both LRFs using the orsat pump from the sampling consoles. The bag samples were analyzed on-site using a Fyrite for CO₂ and O₂ measurements. The analysis confirmed that oxygen and carbon dioxide levels on both LRFs were at ambient conditions.

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



4.1.2 PM, PM₁₀, and PM_{2.5} USEPA Method 5/202

Filterable particulate matter was collected isokinetically by USEPA Method 5, and the condensable particulate matter was sampled by USEPA Method 202. The sample gas was drawn isokinetically from the source and drawn through a sampling train consisting of a stainless-steel nozzle, glass-lined probe, a glass fiber filter, pot belly impinger, empty impinger, CPM filter, water knockout impinger, and silica gel impinger. Before and after each test a leak-check was completed to ensure a leak-free system. Upon completion of each test, the nozzle, probe, front half of the filter holder, and filter was recovered in accordance with USEPA Method 5. All sampling apparatus between the glass fiber filter and CPM filter was recovered in accordance with USEPA Method 202. The USEPA Method 5 acetone and filter was analyzed gravimetrically at RWDI's lab in Rochester Hills, Michigan. The USEPA Method 202 segment of the sample was hand-delivered to ALS in Burlington, Ontario for analysis. PM₁₀ and PM_{2.5} was calculated as the sum of the filterable and condensable particulate.

4.1.3 Lead USEPA Method 12

A sample of stack gas was drawn from the stack isokinetically to measure lead. The sampling train consisted of a Teflon-coated nozzle, a glass-lined probe, quartz filter, and a series of impingers containing 0.1N HNO₃. Particulate metals were collected in the nozzle, probe, and filter. After each test, the probe and nozzle were cleaned with nitric rinse and the filter was recovered. The samples were sent to the Enthalpy laboratory in Durham, NC 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 USEPA 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. A minimum of 60 minutes and 1 heat were observed on the roof monitors and the baghouse stacks per test run.



4.1.5 Method Deviations and Comments

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

1. *The LRFs are a batch process with a production rate that is almost completely dependent on upstream and downstream operations. Due to this, run times and production rates per run can be highly variable. Each test was a minimum of 60 minutes in duration and was extended as needed to correspond with the end of the batch. The traverse was repeated until the run is completed.*

Comment: Production rate was highly variable on both LRF's due to the reasoning described above. Due to this, the filters for the Lead portion of the testing on each LRF were weighed to assist with evaluating the impact of production rate on emission rates. In each case, the weights of the filters were less than the method detection limit. No correlation was apparent between production rate and PM/Lead results for either LRF. A correlation was apparent between PM₁₀/PM_{2.5} results and production rate on LRF2 due to organic condensable matter. In this case, results were less than the emission limit for each test run. A comparison of emission rates against production rates is provided in **Appendix A**.

2. *The testing was conducted to satisfy both the 5-year NESHAP performance test requirements and the 3-year testing requirement for PM, PM₁₀, PM_{2.5}, Pb, and opacity from the baghouse stacks. The NESHAP performance test requirement requires that the roof monitor opacity observations overlap with the PM testing. Cleveland-Cliffs is proposing that the baghouse stack visible emission observations be conducted during the lead testing.*

Comment: Method 9 readings on the baghouse stacks were conducted during the lead testing as specified in the above comment.

3. *Downtime at the LRFs is difficult to quantify due to the nature of the process. In the event that a problem at the caster caused a delay, heats were held at the LRF, stirred, and periodically heated to keep the steel at the proper temperature. Cleveland-Cliffs paused the testing in the event that stirring and heating did not occur for 10 minutes and resumed the testing once stirring or heating resumed. Testing was not paused during any periods of alloy addition.*

Comment: No problems with the caster occurred during the testing. There were cases where stirring and heating were stopped while a heat was at the LRF. In these cases, testing was paused as specified in the above comment.

4.2 Description of Recovery and Analytical Procedures

The recovery followed USEPA Method 5, 202, and 12.

4.3 Sampling Port Description

LRF1 is a circular stack with an inner diameter of 106". 2 ports were used for testing.

LRF2 is a circular stack with an inner diameter of 72". 2 ports were used for testing.

5 NESHAP REQUIREMENTS

Table 5.1 lists the NESHAP requirements for this test.

Table 5.1 NESHAP Requirements

NESHAP Reference	ROP Reference	NESHAP / ROP Language	Comments
40 CFR 63.7821	EULADLEREFINE1 V.1 EULADLEREFINE2 V.1	Conduct performance tests for particulate matter emissions and opacity at least once every 5 years (or ROP Renewal Cycle)	Previous performance test was conducted on August 16-20, 2021. This test was completed on August 9, 2024 which is within 5 years of the completion of the previous test.
40 CFR 63.7822(b)(1)	N/A	Determine the concentration of the particulate matter according to the listed test methods in 40 CFR 63.7822(b)(1)(i-v)	The particulate matter concentration was determined in accordance with the required test methods.
40 CFR 63.7822(b)(2)	N/A	Collect a minimum of 60 dry cubic feet of gas during each particulate matter test run. Three valid test runs are needed to comprise a performance test.	A minimum of 60 dry standard cubic feet of gas was collected during each particulate matter test run.
40 CFR 63.7822(h)	EULADLEREFINE1 V.2 EULADLEREFINE2 V.2	Sampling during the performance test will occur only when the operations being controlled are in operation.	Sampling only took place when a heat was in the LRF and the hood was down. Testing was paused between heats.
40 CFR 63.7823(b)	N/A	Performance tests for visible emissions shall be conducted such that opacity observations overlap with the performance tests for particulate.	All opacity observations on the LRF building and roof monitors overlapped with the performance tests for particulate.

Table 5.1 NESHAP Requirements (Continued)

NESHAP Reference	ROP Reference	NESHAP / ROP Language	Comments
40 CFR 63.7823(d)(1)(ii)	N/A	Record observations to the nearest 5 percent at 15-second intervals for at least three steel production cycles rather than using the procedure specified in section 2.4 of Method 9.	A minimum of one complete steel production cycle was observed during each PM test run for a total of three steel production cycles per LRF.
40 CFR 63.7823(d)(1)(iii)	N/A	Determine the 3-minute block average opacity from the average of 12 consecutive observations recorded at 15-second intervals.	Opacity was calculated using the 3-minute block averages in accordance with this requirement.
40 CFR 63.7840(d)	EULADLEREFINE1 V.2 EULADLEREFINE2 V.2	Submit a notification of intent to perform any performance testing under 40 CFR Part 62, Subpart FFFFF at least 60 calendar days before testing is to begin.	The notification was submitted on June 6, 2024, 60 days prior to the start of the testing.

6 TEST RESULTS AND DISCUSSION

6.1 Detailed Results

Table 6.1.1: Average Test Results – LRF1 & LRF2

Source	Parameter	Concentration	
		Average Emission Rate	Emission Limit
LRF1 Baghouse	PM	0.10 lb/hr	6.33 lb/hr
		0.00013 gr/dscf	0.005 gr/dscf (ROP) 0.01 (FFFFF Limit)
	PM ₁₀ and PM _{2.5}	0.59 lb/hr	6.65 lb/hr
	Lead	0.00025 lb/hr	0.022 lb/hr
	Opacity	0%, 6-minute average	5%, 6-minute average
LRF2 Baghouse	PM	0.046 lb/hr	3.72 lb/hr
		0.00010 gr/dscf	0.0050 gr/dscf (ROP) 0.01 (FFFFF Limit)
	PM ₁₀ and PM _{2.5}	1.49 lb/hr	3.91 lb/hr
	Lead	0.000062 lb/hr	0.013 lb/hr
	Opacity	0%, 6-minute average	5%, 6-minute average
LRF1 Building and Roof Monitor	Opacity	0%, 3-minute average	20%, 3-minute average (FFFFF Limit)
		0%, 3-minute average	No Visible Emissions (ROP)
LRF2 Building and Roof Monitor	Opacity	0%, 3-minute average	20%, 3-minute average (FFFFF Limit)
		0%, 3-minute average	No Visible Emissions (ROP)



6.1.1 Discussion of Results

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

- LRF1 – **Appendix B**
- LRF2 – **Appendix C**

6.2 Process Upset Conditions During Testing

There were no process upsets during testing.

6.3 Maintenance Performed in Last Three Months

Daily checks are made of the baghouse compartment differential pressures, overall differential pressures, and compressed air pressure. Weekly checks are performed on the dust hoppers to verify that dust is being properly collected. A monthly inspection of the baghouse cleaning system is performed to ensure that the baghouse is cleaning properly. A quarterly internal check is performed on the baghouse interior to check for bag leaks or damage to the baghouse interior. Vibration analysis is also performed on the baghouse ID fan at a minimum of once per quarter. Re-bagging of the compartments is performed on an as-needed basis. The LRF1 Baghouse with the exception of compartment 3 was completely re-bagged during an outage in mid-June.

6.4 Audit Samples

This test did not require any audit samples.

6.5 Calibration Sheets

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

6.6 Field Data Sheets

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



6.7 Laboratory Data

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

6.8 Visible Emission Observations

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

6.9 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
LRF1 Baghouse	3	Velocity, Temperature and Flow Rate	U.S. EPA ^[1] Methods 1-4
	3	Oxygen, Carbon Dioxide	U.S. EPA ^[1] Method 3
	3	Metals (Lead)	U.S. EPA ^[1] Method 12
	3	Particulate Matter	U.S. EPA ^[1] Method 5-202
	3	Filterable Particulate Matter	U.S. EPA ^[1] Method 5
	3	Visible Emissions	U.S. EPA ^[1] Method 9
LRF2 Baghouse	3	Velocity, Temperature and Flow Rate	U.S. EPA ^[1] Methods 1-4
	3	Oxygen, Carbon Dioxide	U.S. EPA ^[1] Method 3
	3	Metals (Lead)	U.S. EPA ^[1] Method 12
	3	Particulate Matter	U.S. EPA ^[1] Method 5-202
	3	Filterable Particulate Matter	U.S. EPA ^[1] Method 5
	3	Visible Emissions	U.S. EPA ^[1] Method 9

Notes:

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

Table 2A: Sampling Summary and Sample Log - LRF1

Source and Test #	Sampling Date	Start Time	End Time	Filter
LRF1 - Particulate Matter				
Blank	5-Aug-24	-	-	QZ 255
Test #1	5-Aug-24	9:46 AM	11:45 AM	QZ 273
Test #2	5-Aug-24	2:41 PM	5:44 PM	QZ 271
Test #3	6-Aug-24	7:44 AM	10:10 AM	QZ 270
LRF1 - Metals (Lead)				
Blank	7-Aug-24	-	-	QZ 268
Test #1	7-Aug-24	9:34 AM	10:41 AM	QZ 269
Test #2	7-Aug-24	11:34 AM	1:30 PM	QZ 278
Test #3	7-Aug-24	3:34 PM	5:12 PM	QZ 277

Table 2B: Sampling Summary and Sample Log - LRF2

Source and Test #	Sampling Date	Start Time	End Time	Filter
LRF2 - Particulate Matter				
Blank	5-Aug-24	-	-	QZ 255
Test #1	7-Aug-24	8:12 AM	12:01 PM	QZ 272
Test #2	7-Aug-24	1:00 PM	3:06 PM	QZ 284
Test #3	8-Aug-24	7:36 AM	11:26 AM	QZ 276
LRF2 - Metals (Lead)				
Blank	7-Aug-24	-	-	QZ 268
Test #1	8-Aug-24	12:26 PM	3:03 PM	QZ 274
Test #2	9-Aug-24	7:56 AM	9:21 AM	QZ 262
Test #3	9-Aug-24	10:35 AM	12:15 PM	QZ 263

Table 3A: Sampling Summary – Flow Characteristics – LRF1 PM (M5-202)

Company	Cleveland Cliffs			
Source	LRF 1			
Date	5-Aug-24	5-Aug-24	6-Aug-24	
Test Number	Test 1	Test 2	Test 3	Average
Start Time	9:45	14:41	7:44	-
End Time	11:45	17:44	10:10	-
Stack Information				
Flow Rate (ft ³ /min) (Actual)	107,368	96,738	97,724	100,610
Flow (ft ³ /min) (Standard Wet)	92,215	86,673	86,774	88,554
Flow (ft ³ /min) (Standard Dry)	90,090	84,383	85,444	86,639
Flow (m ³ /min) (Standard Dry)	2,551	2,389	2,420	2,453
Percent Moisture (%)	2.3	2.6	1.5	2.2
Pressure Ps ("Hg)	29.99	29.99	29.98	29.98
Average Stack Temperature (T _s) (°F)	156.1	130.6	135.8	140.8
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)	28.59	28.55	28.67	28.61
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)	29.2	26.3	26.6	27.4
Cross Section Area of Stack (ft ²)	61.3	61.3	61.3	61.3
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
Meter Info				
Isokinetic Variation I (%)	103.7	104.2	102.7	103.5
Meter Pressure Pm ("Hg)	30.3	30.3	30.2	30.3
Meter Temperature Tm (°F)	89.5	89.7	76.5	85.3
Measured Sample Volume Vm (ft ³)	94.70	73.03	128.54	98.76
Sample Volume (Vm St ft ³)	100.16	77.13	139.01	105.43
Sample Volume (Vm St m ³)	2.84	2.18	3.94	2.99
Total Weight of Sampled Gas (lbs) wet	7.58	5.85	10.46	7.96
Total Weight of Sampled Gas (lbs) dry	7.47	5.75	10.36	7.86
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)	2.36	2.09	2.16	2.21
Nozzle Size (in ²)	0.00075	0.00075	0.00075	0.00
Impinger Gain (g)	21.4	15.1	16.2	17.6
Silica Gel Gain (g)	28.7	29.3	29.7	29.2
Total Gas Sampled (vm st ft ³ + condensate volume)	102.52	79.23	141.17	107.64
Particulate Results (PM10 and PM2.5)				
Nozzle/Probe/Filter Weight (mg)	0.5	0.6	1.8	1.0
Organic Condensable Particulate (mg)	3.5	2.3	3.1	3.0
Inorganic Condensable Particulate (mg)	4.0	2.9	3.4	3.4
Condensable Blank Correction (mg)	2.0	2.0	2.0	2.0
Total Particulate (mg)	6.00	3.80	6.30	5.37
Total Particulate Emission Rate (lb/hr)	0.72	0.55	0.51	0.59
				Permit Limit
				6.65
				--
Filterable Particulate Results (PM)				
Nozzle/Probe/Filter Weight (mg)	0.5	0.6	1.8	1.0
Filterable Particulate Emission Rate (lb/hr)	0.06	0.09	0.15	0.10
Filterable Particulate Concentration (gr/dscf)	0.00008	0.00012	0.00020	0.00013
				Permit Limit
				6.33
				0.01 (FFFFF Limit)

Table 3B: Sampling Summary – Flow Characteristics – LRF2 PM (M5-202)

Company	Cleveland Cliffs			
Source	LRF2			
Date	7-Aug-24	7-Aug-24	8-Aug-24	
Test Number	Test 1	Test 2	Test 3	Average
Start Time	8:12	13:00	7:36	-
End Time	12:01	15:06	11:26	-

Stack Information				
Flow Rate (ft ³ /min) (Actual)	62,217	65,806	64,838	64,287
Flow (ft ³ /min) (Standard Wet)	54,295	55,990	57,216	55,834
Flow (ft ³ /min) (Standard Dry)	53,400	55,274	56,252	54,975
Flow (m ³ /min) (Standard Dry)	1,512	1,565	1,593	1,557

Percent Moisture (%)	1.6	1.3	1.7	1.5
Pressure Ps ("Hg)	29.27	29.27	29.88	29.47
Average Stack Temperature (T _s) (°F)	131.9	147.1	137.6	138.9
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 _w) (g/mole)	28.66	28.70	28.66	28.67
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)	36.7	38.8	38.2	37.9
Cross Section Area of Stack (ft ²)	28.3	28.3	28.3	28.3
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

Meter Info				
Isokinetic Variation I (%)	102.6	101.5	103.8	102.7
Meter Pressure Pm ("Hg)	29.5	29.5	30.2	29.7
Meter Temperature Tm (°F)	70.4	72.0	68.1	70.1
Measured Sample Volume Vm (ft ³)	130.16	115.10	95.71	113.66
Sample Volume (Vm St ft ³)	122.86	108.37	92.68	107.97
Sample Volume (Vm St m ³)	3.48	3.07	2.62	3.06
Total Weight of Sampled Gas (lbs) wet	9.25	8.14	6.98	8.13
Total Weight of Sampled Gas (lbs) dry	9.16	8.08	6.91	8.05
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)	2.06	1.41	1.59	1.68
Nozzle Size (in ²)	0.00049	0.00049	0.00049	0.00
Impinger Gain (g)	10.8	5.9	8.6	8.4
Silica Gel Gain (g)	32.9	23.9	25.1	27.3
Total Gas Sampled (vm st ft ³ + condensate volume)	124.92	109.77	94.27	109.65

Particulate Results (PM10 and PM2.5)				
Nozzle/Probe/Filter Weight (mg)	1.0	0.6	0.5	0.7
Organic Condensable Particulate (mg)	25.7	2.7	29.7	19.4
Inorganic Condensable Particulate (mg)	3.1	4.5	2.6	3.4
Condensable Blank Correction (mg)	2.0	2.0	2.0	2.0
Total Particulate (mg)	27.8	5.8	30.8	21.5
Total Particulate Emission Rate (lb/hr)	1.60	0.39	2.48	1.49
				Permit Limit
				3.91

Filterable Particulate Results (PM)					Permit Limit	
Nozzle/Probe/Filter Weight (mg)	1.0	0.6	0.5	0.7		
Filterable Particulate Emission Rate (lb/hr)	0.057	0.040	0.040	0.046	3.72	--
Filterable Particulate Concentration (gr/dscf)	0.00012	0.00008	0.00008	0.00010	0.0050	0.01 (FFFFF Limit)

Table 4A: Sampling Summary - Flow Characteristics - LRF1 Metals (M12 Lead)

Company

Cleveland Cliffs

Source

LRF 1

Date

7-Aug-24

7-Aug-24

7-Aug-24

Test Number	Test 1	Test 2	Test 3	Average
Start Time	9:34	11:34	15:34	-
End Time	10:41	13:30	17:12	-

Stack Information

Flow Rate (ft ³ /min) (Actual)	92,342	93,397	95,352	93,697
Flow (ft ³ /min) (Standard Wet)	83,272	84,857	85,124	84,418
Flow (ft ³ /min) (Standard Dry)	81,921	83,672	84,010	83,201
Flow (m ³ /min) (Standard Dry)	2,320	2,369	2,379	2,356

Percent Moisture (%)	1.6	1.4	1.3	1.4
Pressure Ps ("Hg)	29.98	29.97	29.97	29.97
Average Stack Temperature (T _s) (°F)	126.6	122.0	132.4	127.0
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)	28.66	28.69	28.70	28.68
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)	25.1	25.4	25.9	25.5
Cross Section Area of Stack (ft ²)	61.3	61.3	61.3	61.3
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

Meter Info

Isokinetic Variation I (%)	102.2	103.0	102.7	102.6
Meter Pressure Pm ("Hg)	30.2	30.2	30.2	30.2
Meter Temperature Tm (°F)	79.0	80.1	76.1	78.4
Measured Sample Volume Vm (ft ³)	56.86	88.04	80.17	75.02
Sample Volume (Vm St ft ³)	61.18	94.53	86.72	80.81
Sample Volume (Vm St m ³)	1.73	2.68	2.46	2.29
Total Weight of Sampled Gas (lbs) wet	4.61	7.11	6.52	6.08
Total Weight of Sampled Gas (lbs) dry	4.56	7.05	6.46	6.02
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)	1.01	1.34	1.15	1.17
Nozzle Size (in ²)	0.00075	0.00075	0.00075	0.00
Impinger Gain (g)	10.2	11.4	6.7	9.4
Silica Gel Gain (g)	11.2	17.0	17.7	15.3
Total Gas Sampled (vm st ft ³ + condensate volume)	62.19	95.87	87.88	81.98

Filterable Particulate Results as Requested by EGLE On-Site

Filter Weight (mg)	<0.5	<0.5	<0.5	<0.5
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Lead Results

Sample Weight (ug)	3.01	0.937	0.724	1.557
Lead Concentration (mg/dscm (dry))	0.00174	0.00035	0.00029	0.00079
Lead Concentration (gr/dscf)	7.59E-07	1.53E-07	1.29E-07	3.47E-07
Lead Emission Rate (lb/hr)	0.00054	0.00011	0.00009	0.00025
				Limit
				0.022

Table 4B: Sampling Summary – Flow Characteristics – LRF2 Metals (M12 Lead)

Company	Cleveland Cliffs			
Source	LRF2			
Date	8-Aug-24	8-Aug-24	9-Aug-24	
Test Number	Test 1	Test 2	Test 3	Average
Start Time	12:26	7:56	10:35	-
End Time	15:03	9:21	12:15	-

Stack Information				
Flow Rate (ft ³ /min) (Actual)	66,660	61,713	63,217	63,863
Flow (ft ³ /min) (Standard Wet)	58,149	53,506	54,575	55,410
Flow (ft ³ /min) (Standard Dry)	56,866	52,568	53,690	54,374
Flow (m ³ /min) (Standard Dry)	1,610	1,489	1,520	1,540

Percent Moisture (%)	2.2	1.8	1.6	1.9
Pressure Ps ("Hg)	29.88	29.88	29.88	29.88
Average Stack Temperature (T _s) (°F)	144.6	148.3	150.9	147.9
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)	28.60	28.65	28.66	28.64
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)	39.3	36.4	37.3	37.6
Cross Section Area of Stack (ft ²)	28.3	28.3	28.3	28.3
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

Meter Info				
Isokinetic Variation I (%)	103.3	100.3	103.9	102.5
Meter Pressure Pm ("Hg)	30.1	30.1	30.1	30.1
Meter Temperature Tm (°F)	72.4	77.0	74.0	74.5
Measured Sample Volume Vm (ft ³)	59.61	78.87	80.15	72.88
Sample Volume (Vm St ft ³)	57.24	75.03	76.65	69.64
Sample Volume (Vm St m ³)	1.62	2.12	2.17	1.97
Total Weight of Sampled Gas (lbs) wet	4.33	5.65	5.77	5.25
Total Weight of Sampled Gas (lbs) dry	4.27	5.59	5.71	5.19
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)	1.29	1.34	1.26	1.30
Nozzle Size (in ²)	0.00049	0.00049	0.00049	0.00
Impinger Gain (g)	15.7	15.3	12.4	14.5
Silica Gel Gain (g)	11.7	13.1	14.4	13.1
Total Gas Sampled (vm st ft ³ + condensate volume)	58.53	76.37	77.92	70.94

Filterable Particulate Results - as Requested by EGLE On-Site				
Filter Weight (mg)	<0.5	<0.5	<0.5	<0.5

Lead Results				
Sample Weight (ug)	0.399	0.841	0.583	0.608
Lead Concentration (mg/dscm (dry))	0.00025	0.00040	0.00027	0.00030
Lead Concentration (gr/dscf)	1.08E-07	1.73E-07	1.17E-07	1.33E-07
Lead Emission Rate (lb/hr)	0.000053	0.000078	0.000054	0.000062

					Limit
					0.013

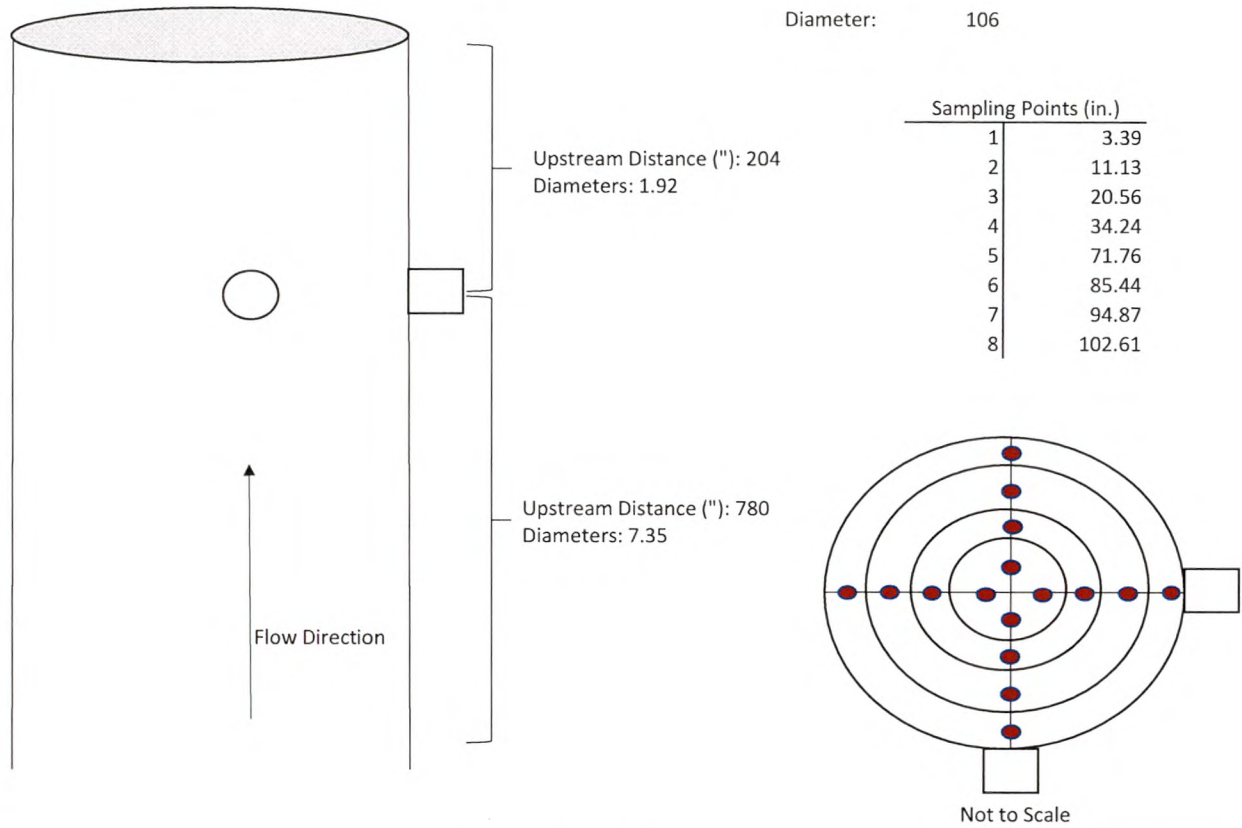
FIGURES

FIGURES





Attachment A-1: LRF 1 Emissions Stack Diagram



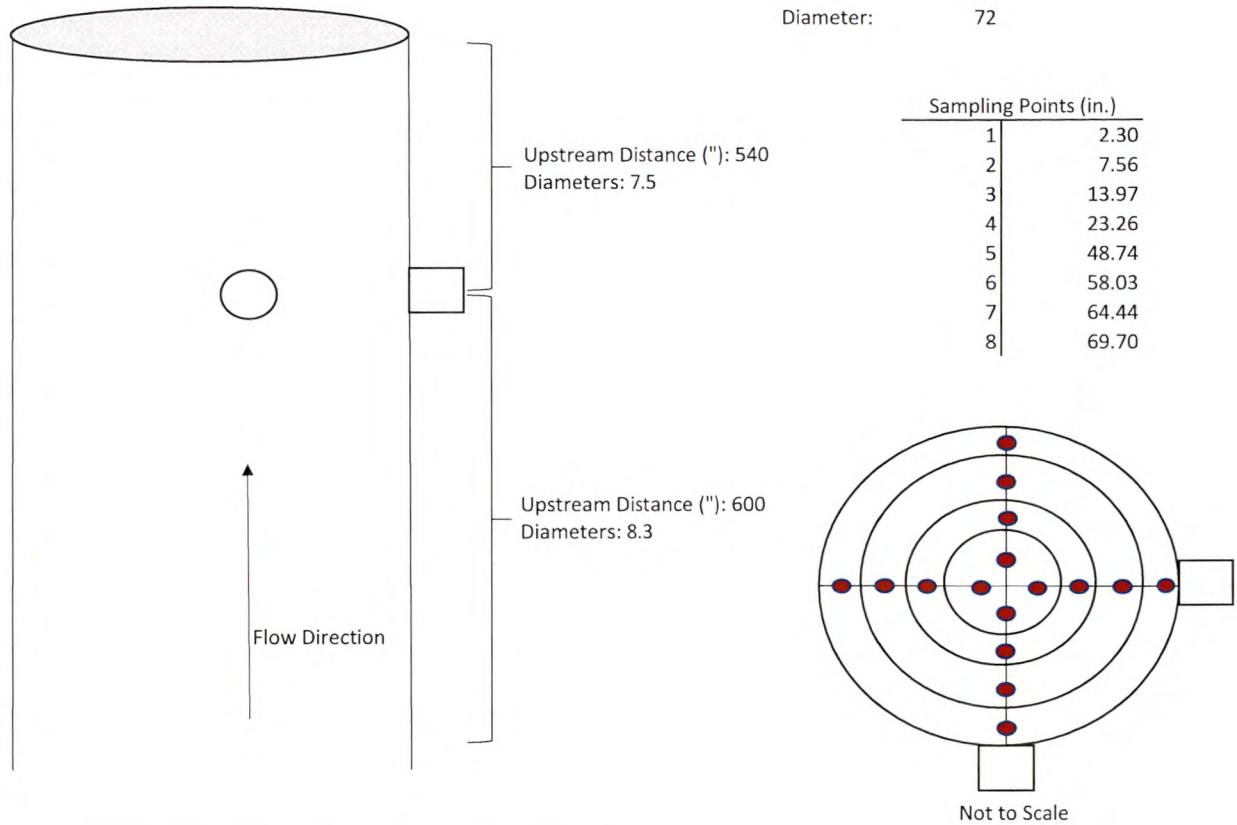
LRF 1
Cleveland Cliffs
Dearborn Works
Dearborn, MI

Date: Aug. 5 to 9, 2024

RWDI USA LLC
2239 Star Court
Rochester Hills, MI 48309



Attachment A-2: LRF 2 Emissions Stack Diagram



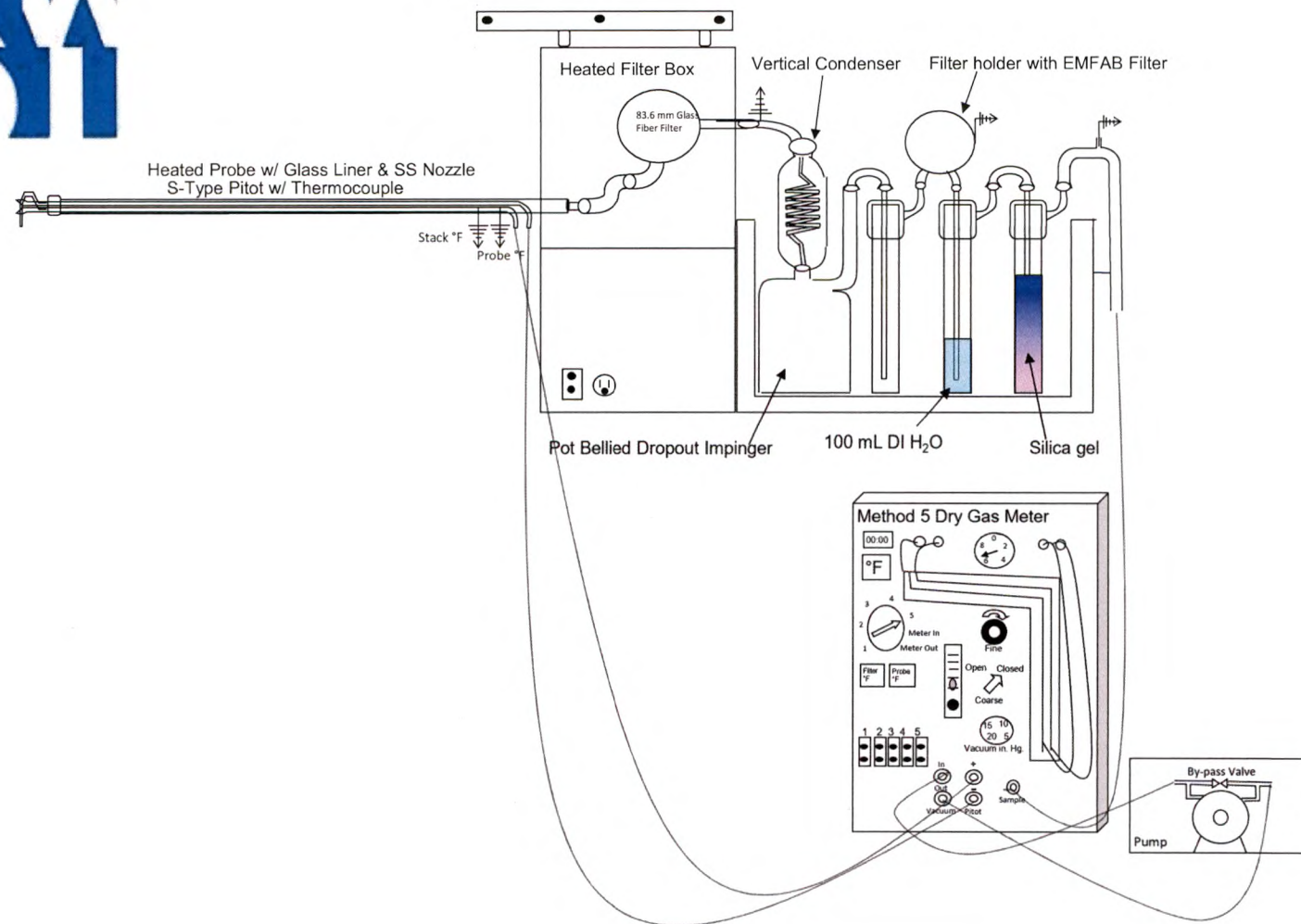
LRF 2
Cleveland Cliffs
Dearborn Works
Dearborn, MI

Date: Aug. 5 to 9, 2024

RWDI USA LLC
2239 Star Court
Rochester Hills, MI 48309



Figure 3: USEPA Method 5/202 Schematic



USEPA Method 5/202

Cleveland Cliffs

Dearborn Works

LRF1 and LRF2

Dearborn, Michigan

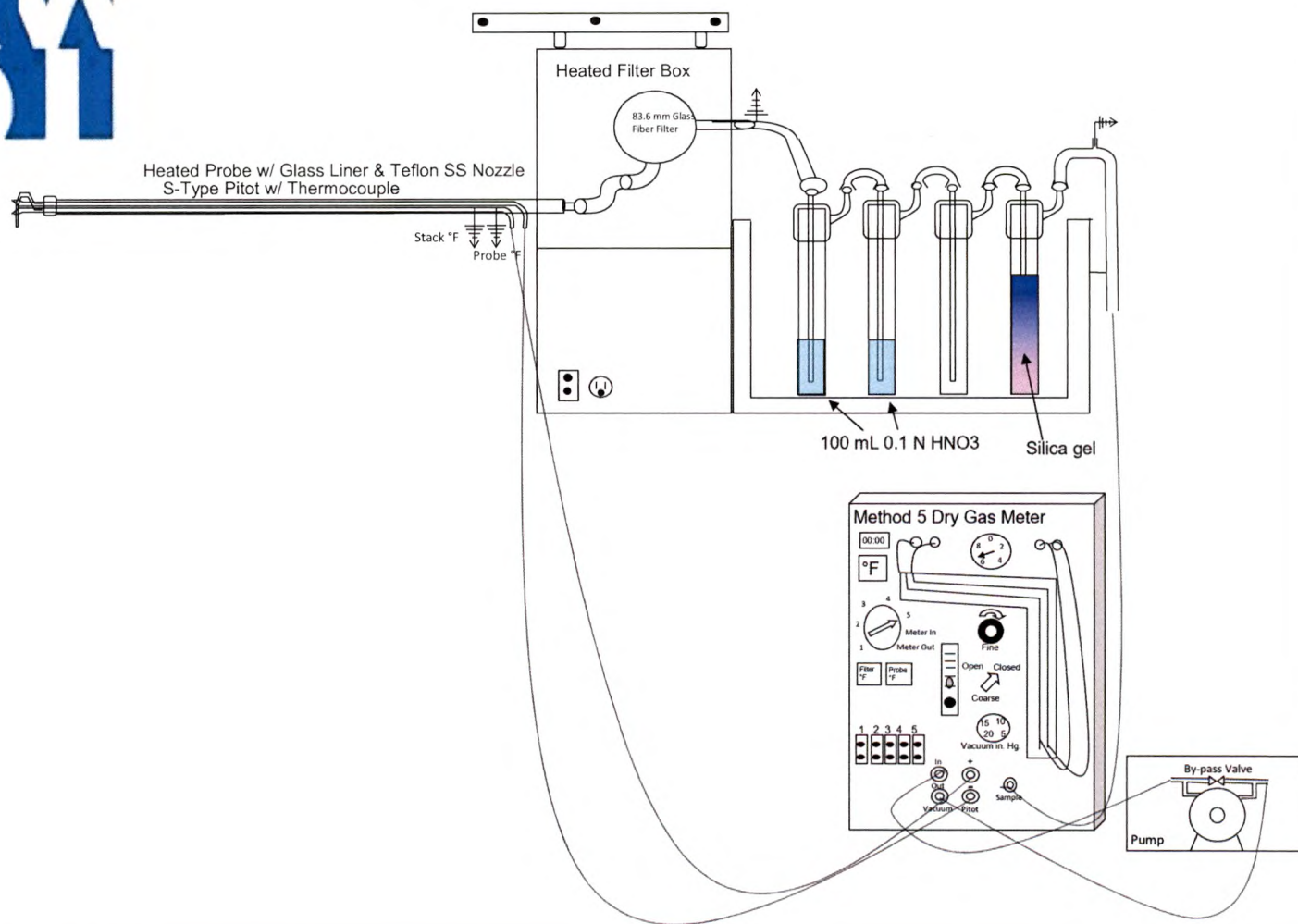
Project No. 2402567

Date: Aug. 5 to 9, 2024





Figure 4: USEPA Method 12 Schematic



USEPA Method 12

Cleveland Cliffs

Dearborn Works

LRF1 and LRF2

Dearborn, Michigan

Project No. 2402567

Date: Aug. 5 to 9, 2024

