FINAL REPORT

GERDAU MACSTEEL, INC.

MONROE, MICHIGAN

MONROE MILL:
STACK TEST REPORT – LADLE PREHEATER

RWDI #2300259.03

March 7, 2023

SUBMITTED TO

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EXECUTIVE SUMMARY

RWDI USA LLC (RWDI) was retained by Gerdau MacSteel, Inc (Gerdau) to complete the emission sampling program at the Gerdau Monroe Mill located at 3000 East Front Street, Monroe, Michigan. The testing evaluated PM, $PM_{2.5}$, PM_{10}, NO_X, SO_2, and CO limits for EULADLEPREHEAT2. The test program was completed the week of January 10th, 2023.

Executive Table i: Average Emission Rates and PTI Limits for EULADLEPREHEAT2

Parameter	Concentration (lb/MMBtu)	
	Test Average	Permit Limit
NO_X	0.0079	0.08
SO_2	<0.0002	0.0006
CO	0.0006	0.084
PM	0.0049	0.0076
PM_{10}	0.0040	0.0076
$PM_{2.5}$	0.0034	0.0076

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3.2 Control Equipment Description

DVLMFBAGHOUSE and a low NOx burner.

3.3 Process Sampling Locations

Table 3.3.1: Summary of Exhaust Parameters

Source	Diameter (in.)	Approximate Duct Diameters from Flow Disturbance	Number of Ports	Points per Traverse	Total Points per Test
EULADLEPREHEAT2	27	4 downstream and 2 upstream	2	12	24

4 SAMPLING METHODOLOGY

4.1 Description of Sampling Train and Field Procedures

The emission test program utilized the following test methods codified at Title 40, Part 60, Appendix A of the Code of Federal Regulations (40 CFR 60, Appendix A):

- **Method 1** – Sample and Velocity Traverses for Stationary Sources
- **Method 2** – Determination of Stack Gas Velocity and Volumetric Flowrate
- **Method 3A** – Determination of Molecular Weight of Dry Stack Gases
- **Method 4** – Determination of Moisture Content in Stack Gases
- **Method 201A** – Determination of PM/PM2.5/PM10 from Stationary Sources
- **Method 202** – Determination of Condensable Particulate Matter from Stationary Sources
- **Method 205** – Verification of Gas Dilution Systems for Field Instrument Calibrations
- **Method 6C** – Determination of Sulfur Dioxide from Stationary Sources
- **Method 7E** – Determination of Nitrogen Oxides from Stationary Sources
- **Method 10** – Determination of Carbon Monoxide from Stationary Sources

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

Traverse points and determination of upstream and downstream distances from flow disturbance were determined using U.S. EPA Method 1.

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

The dry molecular weight of the stack gas was determined following calculations outlined in U.S. EPA Method 3A, using a analyzers.

Stack moisture content was determined through direct condensation and according to U.S. EPA Method 4, "Determination of Moisture Content of Stack Gases". Method 4 was conducted through the 201A/202 train.

4.1.2 Sampling for PM/PM_{10}/$PM_{2.5}$/CPM (USEPA Method 201A/202)

Three (3) 240-minute tests were performed on EULABLEPREHEAT2 duct. RWDI's USEPA Method 201A/202 sampling train consists of (1) a stainless steel nozzle, (2) a stainless steel PM_{10} cyclone head, (3) a stainless steel $PM_{2.5}$ cyclone head, (4) an in stack filter housing, (5) a borosilicate glass probe or liner, (6) a vertical condenser, (7) an empty pot-bellied impinger, (8) an empty modified Greenburg-Smith (GS) impinger, (9) Teflon filter, (10) a second modified GS impinger with 100 ml of water and a third impinger containing silica gel, (11) a sample line and meter box. USEPA Method 201A collects the filterable fractions of PM/PM_{10}/$PM_{2.5}$ and USEPA Method 202 collects the condensable fraction of PM_{10} and $PM_{2.5}$.

A sampling train leak check was conducted before and after each test. After completion of each test, the filter was recovered, the nozzle, PM_{10}, and $PM_{2.5}$ head were recovered into clean sample jars following USEPA Method 201A. The impinger train was purged with nitrogen for one hour at a flowrate of 14 liters per minute. After the purge, all the glassware was recovered per USEPA Method 202.

4.1.3 Sampling for O_2 and CO_2, SO_2, NO_x, and CO (USEPA Method 3A, 6C, 7E, and 10)

O_2, CO_2, SO_2, NO_x, and CO concentrations were determined utilizing RWDI's continuous emissions monitoring (CEM) system. Prior to testing, a 3-point analyzer calibration error check were conducted using USEPA protocol gases. The calibration error check were performed by introducing zero, mid and high-level calibration gases directly into the analyzer. The calibration error check were performed to confirm that the analyzer response is 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 was introduced at the probe tip to measure if the analyzers response will be within ±5% of the introduced calibration gas concentrations. At the conclusion of each test run a system-bias check was performed to evaluate the percent drift from pre and post-test system bias checks. The system bias checks was used to confirm that the analyzer did not drift greater than ±3% throughout a test run.

Zero and upscale calibration checks was 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 into the sampling system at the probe outlet so that the calibration gases were analyzed in the same manner as the flue gas samples.

A gas sample was continuously extracted from the stack and delivered to a series of gas analyzers, which measure the pollutant or diluent concentrations in the gas. The analyzers were calibrated on-site using EPA Protocol No. 1 certified calibration mixtures. The probe tip was equipped with a sintered stainless-steel filter for particulate removal. The end of the probe was connected to a heated Teflon sample line, which delivers the sample gases from the stack to the CEM system. The heated sample line was designed to maintain the gas temperature above 250°F in order to prevent condensation of stack gas moisture within the line.

Before entering the analyzers, the gas sample was pass directly into a refrigerated condenser, which cools the gas to approximately 35°F to remove the stack gas moisture. After passing through the condenser, the dry gas entered a Teflon-head diaphragm pump and a flow control panel, which delivers the gas in series to the O_2, CO_2, SO_2, NO_x, and CO analyzers. Each of these analyzers measured the respective gas concentrations on a dry volumetric basis.

An Environics was used for calibration. USEPA Method 205 was followed on site.

4.1.4 Gas Dilution (Method 205)

Calibration gas was mixed using an Environics 4040 Gas Dilution System. The mass flow controllers are factory calibrated using a primary flow standard traceable to the United States National Institute of Standards and Technology (NIST). Each flow controller utilizes an 11-point calibration table with linear interpolation, to increase accuracy and reduce flow controller nonlinearity. The calibration is done yearly, and the records are included. A multi-point EPA Method 205 check was executed in the field prior to testing to ensure accurate gas-mixtures.

5.4 Calibration Sheets

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

5.5 Sample Calculations

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

5.6 Field Data Sheets

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

5.7 Laboratory Data

Laboratory data 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
EULADLEPREHEAT2	3	Velocity, Temperature and Flow Rate	U.S. EPA [1] Methods 1-4
	4	PM / PM_{10} / $PM_{2.5}$	U.S. EPA [1] Method 201A/202
	4	Oxygen, Carbon Dioxide	U.S. EPA [1] Method 3A
	3	CO	U.S. EPA [1] Method 10
	3	NO_x	U.S. EPA [1] Method 7E
	3	SO_2	U.S. EPA [1] Method 6C

Notes:

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

Table 2A: Sampling Summary and Sample Log (PM/PM10/PM2.5)

Source and Test #	Sampling Date	Start Time	End Time	Filter ID / Trap ID
EULADLEPREHEAT2 - Velocity / Total Particulate / PM10 / PM2.5				
Blank	11-Jan-23	-	-	47-94
Test #1	11-Jan-23	10:12 AM	12:12 PM	47-96
Test #2*	11-Jan-23	12:35 PM	2:31 PM	47-84
Test #3	11-Jan-23	2:50 PM	4:55 PM	47-91
Test #4	11-Jan-23	5:11 PM	7:11 PM	47-81

Note: * Test 2 was deemed invalid as Final Impinger temperature exceeded 68°F

Table 2B: Sampling Summary and Sample Log (O_2, CO_2, NO_x, CO, SO_2)

Source and Test #	Sampling Date	Start Time	End Time
EULADLEPREHEAT2 - O_2, CO_2, NO_x, CO, SO_2			
Test #1	11-Jan-23	10:24 AM	11:23 AM
Test #2	11-Jan-23	11:36 AM	12:35 PM
Test #3	11-Jan-23	12:57 PM	1:56 PM
Test #4*	11-Jan-23	2:23 PM	4:59 PM
Test #5*	11-Jan-23	5:11 PM	7:11 PM

Notes: * O_2 and CO_2 only for PM testing correlation

Table 3: Sampling Summary - Flow Characteristics
EULADLEPREHEAT2

Stack Gas Parameter		Test No. 1 PM/PM$_{10}$/PM$_{2.5}$	Test No. 2 [2] PM/PM$_{10}$/PM$_{2.5}$	Test No. 3 PM/PM$_{10}$/PM$_{2.5}$	Test No. 4 PM/PM$_{10}$/PM$_{2.5}$	TOTAL AVERAGE [3]
Testing Date		11-Jan-23	11-Jan-23	11-Jan-23	11-Jan-23	-
Stack Temperature	°F	316	320	329	329	322
Moisture	%	11.2%	11.9%	11.7%	11.5%	11.5%
Velocity	ft/s	47.35	46.47	48.63	48.71	47.51
Referenced Flow Rate[3]	CFM	6,770	6,560	6,798	6,835	6,722
Sampling Isokinetic Rate	%	115	117	114	114	115

Notes:

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

[2] Test was deemed invalid due to Final Impinger temperature exceeding 68° F

[3] Average was based on Test 1, 3 and 4 due to Test 2 being invalid

Table 4: Summary of PM / PM_{10} / $PM_{2.5}$ Emission Data

Test	Size	Emission Rate (lb/hr)	Natural gas usage (ft3/hr)	Natural Gas Usage (MMBTU/hr)	Emission Rate (lb/MMBTU)
1	2.5	0.113	31,703	33.19	0.0034
1	10	0.128	31,703	33.19	0.0039
1	Total	0.145	31,703	33.19	0.0044
2*	2.5	0.093	33,100	34.66	0.0027
2*	10	0.117	33,100	34.66	0.0034
2*	Total	0.136	33,100	34.66	0.0039
3	2.5	0.140	33,857	35.45	0.0039
3	10	0.161	33,857	35.45	0.0045
3	Total	0.182	33,857	35.45	0.0051
4	2.5	0.109	34,563	36.19	0.0030
4	10	0.126	34,563	36.19	0.0035
4	Total	0.183	34,563	36.19	0.0051

Averages*	
PM Fraction	**Emission Rate (lb/MMBTU**
2.5	0.0034
10	0.0040
Total	0.0049

Notes: Due to the Final Impinger temperature exceeding 68°F, Test 2 was considered invalid and was not included in the averages.

Ladle Preheater Testing Summary

RWDI Project #2300259.03

Table 5a: Summary of NOx Emissions - Ladle Pre-Heater

Ladle Preheater				Concentrations		Emission Rate		Process Data	
				O_2	NO_x	NO_x	NO_x	Natural Gas Usage	Natural gas Usage
Test ID	Date	Start	End	%	ppm	lb/hr	lbs/mmBTU	MMBTU/hr	ft^3/hr
1	2023-01-11	10:24	11:24	21.4	5.2	0.25	0.0077	32.70	31,230
2	2023-01-11	11:36	12:36	20.4	5.9	0.28	0.0082	34.18	32,650
3	2023-01-11	12:57	13:57	20.3	5.7	0.28	0.0080	34.75	33,190
		Average		20.7	5.6	0.27	0.0079	33.88	32,357

Table 5b: Summary of CO Emissions - Ladle Pre-Heater

Ladle Preheater				Concentrations		Emission Rate		Process Data	
				O_2	CO	CO	CO	Natural Gas Usage	Natural gas Usage
Test ID	Date	Start	End	%	ppm	lb/hr	lbs/mmBTU	MMBTU/hr	ft^3/hr
1	2023-01-11	10:24	11:24	21.7	0.75	0.022	0.0007	32.70	31,230
2	2023-01-11	11:36	12:36	20.3	0.64	0.018	0.0005	34.18	32,650
3	2023-01-11	12:57	13:57	19.9	0.83	0.025	0.0007	34.75	33,190
		Average		20.7	0.74	0.022	0.0006	33.88	32,357

Table 5c: Summary of SO_2 Emissions - Ladle Pre-Heater

Ladle Preheater				Concentrations		Emission Rate		Process Data	
				O_2	SO_2	SO_2	SO_2	Natural Gas Usage	Natural gas Usage
Test ID	Date	Start	End	%	ppm	lb/hr	lbs/mmBTU	MMBTU/hr	ft^3/hr
1	2023-01-11	10:24	11:24	21.4	<0.1	<0.007	<0.0002	32.70	31,230
2	2023-01-11	11:36	12:36	20.8	<0.1	<0.007	<0.0002	34.18	32,650
3	2023-01-11	12:57	13:57	19.8	<0.1	<0.007	<0.0002	34.75	33,190
		Average		20.7	<0.1	<0.007	<0.0002	33.88	32,357

MMBTU = 1047 BTU/sft3 natural gas x ft3 of natural gas x 1 MMBTU/1,000,000 BTU

lb/MMBTU = NOx ppm x 0.0000001194 x 8710 x (20.9/20.9-Actual O2)

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Executive Table i: Average Emission Rates and PTI Limits for EULADLEPREHEAT2

Parameter	Concentration (lb/MMBtu)	
	Test Average	Permit Limit
NO_X	0.0079	0.08
SO_2	<0.0002	0.0006
CO	0.0006	0.084
PM	0.0049	0.0076
PM_{10}	0.0040	0.0076
$PM_{2.5}$	0.0034	0.0076

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1 INTRODUCTION

RWDI USA LLC (RWDI) was retained by Gerdau MacSteel, Inc. (Gerdau) to complete an emission sampling program on the ladle preheater source (EULADLEPREHEAT2) at their facility located at 3000 East Front Street, Monroe, Michigan. The test program was conducted to fulfill the requirements of the Michigan Department of Environment, Great Lakes, and Energy (EGLE) MI-ROP-B7061-2016 and PTI 75-18. The pollutants tested include PM, $PM_{2.5}$, PM_{10}, NO_x, CO, and SO_2.

1.1 Location and Dates of Testing

The test program was completed at the Gerdau Monroe Mill the week of January 10th, 2023. Testing was completed on January 11, 2023.

1.2 Purpose of Testing

The purpose of this test program was conducted per PTI 75-18 and MI-ROP-B7061-2016.

1.3 Description of Source

Gerdau Monroe Mill is a producer of Special Bar Quality (SBQ) steel. The EULADLEPREHEAT2 is a 30 MMBtu/hr natural gas-fired ladle preheater that is associated with the Melt Shop Building

1.4 Applicable Permit Number

MI-ROP-B7061-2016 and PTI 75-18.

1.5 Personnel Involved in Testing

Table 1.5: Testing Personnel

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2 SOURCE DESCRIPTION

2.1 Description of Source

Gerdau Monroe Mill is a producer of Special Bar Quality (SBQ) steel. The EULADLEPREHEAT2 is a 30 MMBtu/hr. natural gas-fired ladle preheater that is associated with the Melt Shop Building.

2.2 Type and Quantity of Raw and Finished Material

Natural gas.

2.3 Operating Parameters Used to Regulate Process

Operators regulate the process and control production rates.

2.4 Rated Capacity of Process

30 MMBTU/hr. natural gas-fired ladle preheater.

3 SAMPLING LOCATIONS

3.1 Process Description

The EULADLEPREHEAT2 is a 30 MMBtu/hr natural gas-fired ladle preheater.

3.2 Control Equipment Description

DVLMFBAGHOUSE and a low NOx burner.

3.3 Process Sampling Locations

Table 3.3.1: Summary of Exhaust Parameters

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

Traverse points and determination of upstream and downstream distances from flow disturbance were determined using U.S. EPA Method 1.

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

The dry molecular weight of the stack gas was determined following calculations outlined in U.S. EPA Method 3A, using a analyzers.

Stack moisture content was determined through direct condensation and according to U.S. EPA Method 4, "Determination of Moisture Content of Stack Gases". Method 4 was conducted through the 201A/202 train.

4.1.2 Sampling for PM/PM_{10}/$PM_{2.5}$/CPM (USEPA Method 201A/202)

Three (3) 240-minute tests were performed on EULABLEPREHEAT2 duct. RWDI's USEPA Method 201A/202 sampling train consists of (1) a stainless steel nozzle, (2) a stainless steel PM_{10} cyclone head, (3) a stainless steel $PM_{2.5}$ cyclone head, (4) an in stack filter housing, (5) a borosilicate glass probe or liner, (6) a vertical condenser, (7) an empty pot-bellied impinger, (8) an empty modified Greenburg-Smith (GS) impinger, (9) Teflon filter, (10) a second modified GS impinger with 100 ml of water and a third impinger containing silica gel, (11) a sample line and meter box. USEPA Method 201A collects the filterable fractions of PM/PM_{10}/$PM_{2.5}$ and USEPA Method 202 collects the condensable fraction of PM_{10} and $PM_{2.5}$.

A sampling train leak check was conducted before and after each test. After completion of each test, the filter was recovered, the nozzle, PM_{10}, and $PM_{2.5}$ head were recovered into clean sample jars following USEPA Method 201A. The impinger train was purged with nitrogen for one hour at a flowrate of 14 liters per minute. After the purge, all the glassware was recovered per USEPA Method 202.

4.1.3 Sampling for O_2 and CO_2, SO_2, NO_x, and CO (USEPA Method 3A, 6C, 7E, and 10)

O_2, CO_2, SO_2, NO_x, and CO concentrations were determined utilizing RWDI's continuous emissions monitoring (CEM) system. Prior to testing, a 3-point analyzer calibration error check were conducted using USEPA protocol gases. The calibration error check were performed by introducing zero, mid and high-level calibration gases directly into the analyzer. The calibration error check were performed to confirm that the analyzer response is 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 was introduced at the probe tip to measure if the analyzers response will be within ±5% of the introduced calibration gas concentrations. At the conclusion of each test run a system-bias check was performed to evaluate the percent drift from pre and post-test system bias checks. The system bias checks was used to confirm that the analyzer did not drift greater than ±3% throughout a test run.

Zero and upscale calibration checks was 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 into the sampling system at the probe outlet so that the calibration gases were analyzed in the same manner as the flue gas samples.

A gas sample was continuously extracted from the stack and delivered to a series of gas analyzers, which measure the pollutant or diluent concentrations in the gas. The analyzers were calibrated on-site using EPA Protocol No. 1 certified calibration mixtures. The probe tip was equipped with a sintered stainless-steel filter for particulate removal. The end of the probe was connected to a heated Teflon sample line, which delivers the sample gases from the stack to the CEM system. The heated sample line was designed to maintain the gas temperature above 250°F in order to prevent condensation of stack gas moisture within the line.

Before entering the analyzers, the gas sample was pass directly into a refrigerated condenser, which cools the gas to approximately 35°F to remove the stack gas moisture. After passing through the condenser, the dry gas entered a Teflon-head diaphragm pump and a flow control panel, which delivers the gas in series to the O_2, CO_2, SO_2, NO_x, and CO analyzers. Each of these analyzers measured the respective gas concentrations on a dry volumetric basis.

An Environics was used for calibration. USEPA Method 205 was followed on site.

4.1.4 Gas Dilution (Method 205)

Calibration gas was mixed using an Environics 4040 Gas Dilution System. The mass flow controllers are factory calibrated using a primary flow standard traceable to the United States National Institute of Standards and Technology (NIST). Each flow controller utilizes an 11-point calibration table with linear interpolation, to increase accuracy and reduce flow controller nonlinearity. The calibration is done yearly, and the records are included. A multi-point EPA Method 205 check was executed in the field prior to testing to ensure accurate gas-mixtures.

The gas dilution system consisting of calibrated orifices or mass flow controllers and dilutes a high-level calibration gas to within ±2% of predicted values. The gas divider is capable of diluting gases at set increments and was evaluated for accuracy in the field in accordance with US EPA Method 205 "*Verification of Gas Dilution Systems for Field Instrument Calibrations*". Before testing, the gas divider dilutions were measured to evaluate that the responses are within ±2% of predicted values. In addition, a certified mid-level calibration gas within ±10% of one of the tested dilution gases were introduced into an analyzer to ensure the response of the gas calibration is within ±2% of gas divider dilution concentration.

4.2 Description of Recovery and Analytical Procedures

The particulate matter samples were all recovered in accordance with US EPA Methods 201A and 202.

5 TEST RESULTS AND DISCUSSION

5.1 Detailed Results

Table 5.1.1: Average Emission Data – EULADLEPREHEAT2 and PTI Limits

Parameter	Test 1	Test 2	Test 3	Test 4	Average	PTI Limits
NO_X (lb/MMBtu)	0.0077	0.0082	0.0080	---	0.0079	0.08
SO_2 (lb/MMBtu)	<0.0002	<0.0002	<0.0002	---	<0.0002	0.0006
CO (lb/MMBtu)	0.0007	0.0005	0.007	---	0.0006	0.084
PM (lb/MMBtu)	0.0044	0.0039 [1]	0.0051	0.0051	0.0049 [2]	0.0076
PM_{10} (lb/MMBtu)	0.0039	0.0034 [1]	0.0045	0.0035	0.0040 [2]	0.0076
$PM_{2.5}$ (lb/MMBtu)	0.0034	0.0027 [1]	0.0039	0.0030	0.0034 [2]	0.0076

Note: [1] Test was deemed invalid as Final Impinger temperature exceeded 68°F.
[2] Average is based on Test 1, 3, and 4 as Test 2 as deemed invalid.

5.2 Discussion of Results

The detailed results can be found in **Appendices B, C, and D**.

5.3 Variations in Testing Procedures

$PM/PM_{10}/PM_{2.5}$ Test 2 was deemed invalid due to Final Impinger temperature exceeding 68°F. Test 4 was completed to replace Test 2. Test 2 was not used in the average results.

As discussed with Ms. Regina Angellotti, Testing for SO_2, NO_x and CO was completed as three (3) 1-hour tests. O_2 and CO_2 was also recorded for the 1st three initial 1-hour tests and was continued throughout the remainder of the PM testing periods.

5.4 Calibration Sheets

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

5.5 Sample Calculations

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

5.6 Field Data Sheets

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

5.7 Laboratory Data

Laboratory data 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
EULADLEPREHEAT2	3	Velocity, Temperature and Flow Rate	U.S. EPA [1] Methods 1-4
	4	PM / PM_{10} / $PM_{2.5}$	U.S. EPA [1] Method 201A/202
	4	Oxygen, Carbon Dioxide	U.S. EPA [1] Method 3A
	3	CO	U.S. EPA [1] Method 10
	3	NO_x	U.S. EPA [1] Method 7E
	3	SO_2	U.S. EPA [1] Method 6C

Notes:

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

Table 2A: Sampling Summary and Sample Log (PM/PM10/PM2.5)

Source and Test #	Sampling Date	Start Time	End Time	Filter ID / Trap ID
EULADLEPREHEAT2 - Velocity / Total Particulate / PM10 / PM2.5				
Blank	11-Jan-23	-	-	47-94
Test #1	11-Jan-23	10:12 AM	12:12 PM	47-96
Test #2*	11-Jan-23	12:35 PM	2:31 PM	47-84
Test #3	11-Jan-23	2:50 PM	4:55 PM	47-91
Test #4	11-Jan-23	5:11 PM	7:11 PM	47-81

Note: * Test 2 was deemed invalid as Final Impinger temperature exceeded 68°F

Table 2B: Sampling Summary and Sample Log (O_2, CO_2, NO_x, CO, SO_2)

Source and Test #	Sampling Date	Start Time	End Time
EULADLEPREHEAT2 - O_2, CO_2, NO_x, CO, SO_2			
Test #1	11-Jan-23	10:24 AM	11:23 AM
Test #2	11-Jan-23	11:36 AM	12:35 PM
Test #3	11-Jan-23	12:57 PM	1:56 PM
Test #4*	11-Jan-23	2:23 PM	4:59 PM
Test #5*	11-Jan-23	5:11 PM	7:11 PM

Notes: * O_2 and CO_2 only for PM testing correlation

Table 3: Sampling Summary - Flow Characteristics
EULADLEPREHEAT2

Stack Gas Parameter		Test No. 1	Test No. 2 [2]	Test No. 3	Test No. 4	TOTAL AVERAGE [3]
		$PM/PM_{10}/PM_{2.5}$	$PM/PM_{10}/PM_{2.5}$	$PM/PM_{10}/PM_{2.5}$	$PM/PM_{10}/PM_{2.5}$	
Testing Date		11-Jan-23	11-Jan-23	11-Jan-23	11-Jan-23	-
Stack Temperature	°F	316	320	329	329	322
Moisture	%	11.2%	11.9%	11.7%	11.5%	11.5%
Velocity	ft/s	47.35	46.47	48.63	48.71	47.51
Referenced Flow Rate[3]	CFM	6,770	6,560	6,798	6,835	6,722
Sampling Isokinetic Rate	%	115	117	114	114	115

Notes:

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

[2] Test was deemed invalid due to Final Impinger temperature exceeding 68° F

[3] Average was based on Test 1, 3 and 4 due to Test 2 being invalid

Table 4: Summary of PM / PM_{10} / $PM_{2.5}$ Emission Data

Test	Size	Emission Rate (lb/hr)	Natural gas usage (ft3/hr)	Natural Gas Usage (MMBTU/hr)	Emission Rate (lb/MMBTU)
1	2.5	0.113	31,703	33.19	0.0034
1	10	0.128	31,703	33.19	0.0039
1	Total	0.145	31,703	33.19	0.0044
2*	2.5	0.093	33,100	34.66	0.0027
2*	10	0.117	33,100	34.66	0.0034
2*	Total	0.136	33,100	34.66	0.0039
3	2.5	0.140	33,857	35.45	0.0039
3	10	0.161	33,857	35.45	0.0045
3	Total	0.182	33,857	35.45	0.0051
4	2.5	0.109	34,563	36.19	0.0030
4	10	0.126	34,563	36.19	0.0035
4	Total	0.183	34,563	36.19	0.0051

Averages*	
PM Fraction	**Emission Rate (lb/MMBTU**
2.5	0.0034
10	0.0040
Total	0.0049

Notes: Due to the Final Impinger temperature exceeding 68°F, Test 2 was considered invalid and was not included in the averages.

Ladle Preheater Testing Summary

RWDI Project #2300259.03

Table 5a: Summary of NOx Emissions - Ladle Pre-Heater

Ladle Preheater				Concentrations		Emission Rate		Process Data	
				O_2	NO_x	NO_x	NO_x	Natural Gas Usage	Natural gas Usage
Test ID	Date	Start	End	%	ppm	lb/hr	lbs/mmBTU	MMBTU/hr	ft^3/hr
1	2023-01-11	10:24	11:24	21.4	5.2	0.25	0.0077	32.70	31,230
2	2023-01-11	11:36	12:36	20.4	5.9	0.28	0.0082	34.18	32,650
3	2023-01-11	12:57	13:57	20.3	5.7	0.28	0.0080	34.75	33,190
		Average		20.7	5.6	0.27	0.0079	33.88	32,357

Table 5b: Summary of CO Emissions - Ladle Pre-Heater

Ladle Preheater				Concentrations		Emission Rate		Process Data	
				O_2	CO	CO	CO	Natural Gas Usage	Natural gas Usage
Test ID	Date	Start	End	%	ppm	lb/hr	lbs/mmBTU	MMBTU/hr	ft^3/hr
1	2023-01-11	10:24	11:24	21.7	0.75	0.022	0.0007	32.70	31,230
2	2023-01-11	11:36	12:36	20.3	0.64	0.018	0.0005	34.18	32,650
3	2023-01-11	12:57	13:57	19.9	0.83	0.025	0.0007	34.75	33,190
		Average		20.7	0.74	0.022	0.0006	33.88	32,357

Table 5c: Summary of SO_2 Emissions - Ladle Pre-Heater

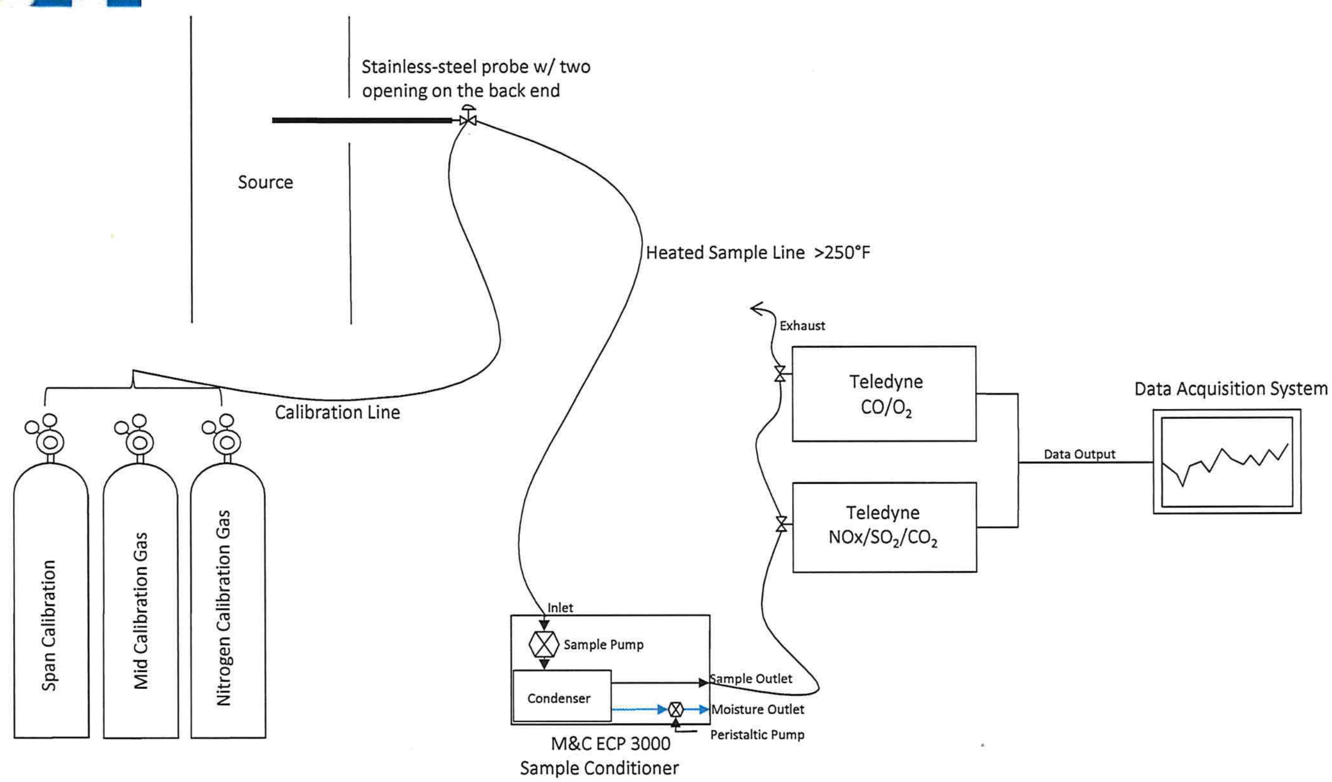
Ladle Preheater				Concentrations		Emission Rate		Process Data	
				O_2	SO_2	SO_2	SO_2	Natural Gas Usage	Natural gas Usage
Test ID	Date	Start	End	%	ppm	lb/hr	lbs/mmBTU	MMBTU/hr	ft^3/hr
1	2023-01-11	10:24	11:24	21.4	<0.1	<0.007	<0.0002	32.70	31,230
2	2023-01-11	11:36	12:36	20.8	<0.1	<0.007	<0.0002	34.18	32,650
3	2023-01-11	12:57	13:57	19.8	<0.1	<0.007	<0.0002	34.75	33,190
		Average		20.7	<0.1	<0.007	<0.0002	33.88	32,357

MMBTU = 1047 BTU/sft3 natural gas x ft3 of natural gas x 1 MMBTU/1,000,000 BTU

lb/MMBTU = NOx ppm x 0.0000001194 x 8710 x (20.9/20.9-Actual O2)

FIGURES

Figure No. 1: USEPA Method 3A,6C,7E and 10 Schematic



USEPA Method 3A, 6C, 7E and 10

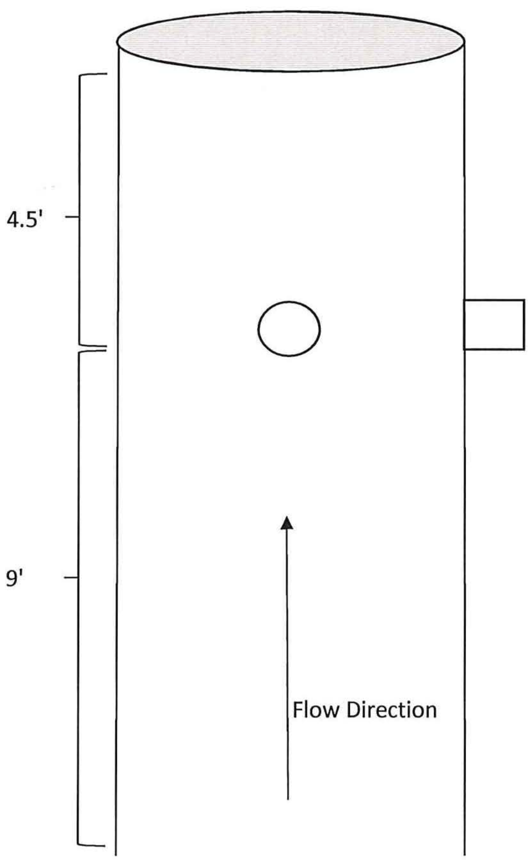
Gerdau

Ladle Preheater

Monroe Mill

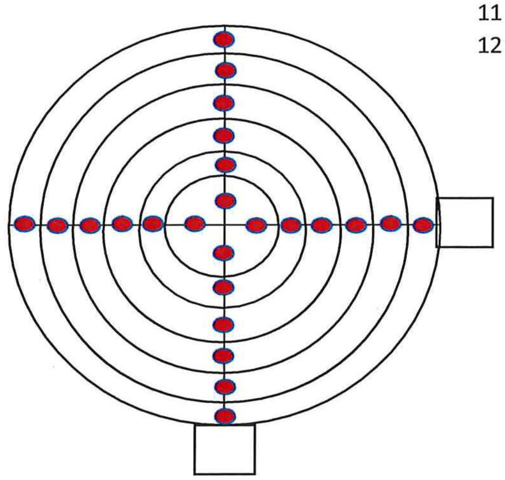
Monroe, Michigan

Figure No. 3



Diameter: 27

Sampling Points (in.)	
1	1.00
2	1.81
3	3.19
4	4.78
5	6.75
6	9.61
7	17.39
8	20.25
9	22.22
10	23.81
11	25.19
12	26.00



Not to scale

Ladle Preheater - Traverese Points
Gerdau
Monroe Mill
Monroe, Michigan

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