AIR EMISSION TEST REPORT
FOR THE
VERIFICATION OF AIR POLLUTANT EMISSIONS
FROM
AN ELECTRIC ARC FURNACE BAGHOUSE
CONTROL SYSTEM

IMPACT
COMPLIANCE & TESTING

Report Certification

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FROM
AN ELECTRIC ARC FURNACE BAGHOUSE CONTROL SYSTEM

Ervin Industries – Amasteel Division
Adrian, Michigan

The material and data in this document were prepared under the supervision and direction of the undersigned.

Impact Compliance and Testing, Inc.

Andrew Eisenberg
Environmental Consultant

This test report has been reviewed by Ervin Amasteel representatives and is approved for submittal to EGLE-AQD. A signed form (EQP-5736) accompanies this document at the beginning of the report.

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1.0 Introduction

Ervin Industries – Amasteel Division (Ervin Amasteel) retained Impact Compliance & Testing, Inc. (ICT) to measure carbon monoxide (CO) emissions from the exhaust of an electric arc furnace (EAF) processes operated at the Adrian, Michigan facility.

The facility is regulated by Michigan Department of Environmental, Great Lakes, and Energy – Air Quality Division (EGLE-AQD) Renewable Operating Permit (ROP) MI-ROP-B1754-2018 and National Emission Standards for Hazardous Air Pollutants (NESHAP) for Area Sources: Electric Arc Furnaces (40 CFR Part 63 Subpart YYYYY). Scrap metal refining processes are collectively referred to as FG-0009 in MI-ROP-B1754-2018.

Testing was conducted September 6-7, 2022, by ICT personnel Blake Beddow and Andrew Eisenberg. Assistance and process coordination was provided by Richard Payne, Plant Engineer, Ervin Amasteel.

The exhaust gas sampling and analysis was performed using procedures specified in the approved Test Protocol prepared by ICT dated June 24, 2022. Mr. Andrew Riley of EGLE-AQD was on site to observe portions of the test program.

2.0 Summary of Test Results and Operating Conditions

2.1 Purpose and Objective of the Tests

Conditions of the NESHAP for Area Sources: Electric Arc Furnaces (40 CFR Part 63 Subpart YYYYY) require Ervin Amasteel to test initial compliance after any modifications. Subpart YYYYY also states that previous emissions tests may be used to demonstrate compliance provided that the test was conducted within 5 years of the compliance date. MI-ROP-B1754-2018 require annual CO monitoring in lieu of operating a continuous emissions monitoring system (CEMS).

2.2 Operating Conditions During the Compliance Tests

The process operated normally during the triplicate heat-length (80 to 90 minute) CO test periods. The facility processed between 19.2 and 24.8 tons of scrap steel per hour (ton/hr) during the CO test periods. CO test runs were ended once the facility process performed a tap out where steel production was paused, and the melt cycle (heat) was completed.

Process data and production rates are provided in Appendix 1.

2.3 Summary of Air Pollutant Sampling Results

The gases exhausted from the EAF were sampled for three heat lengths (batch cycles) for determination of carbon monoxide (CO) emission rates and factors.

Table 2.1 presents a summary of the measured exhaust gas flowrate, and CO emission rates compared to the emission limits in the ROP and NESHAP.

The data presented in Table 2.1 is the average of the three test periods. Data for individual test periods is presented at the end of this report in Table 6.1.

Table 2.1 Summary of measured exhaust gas flowrate and CO emission rates

Parameter	Electric Arc Furnace Three-Test Average Result	Permitted Limit
Exhaust Flowrate (dscfm)	220,774	-
Scrap Melted (tons)	40.6	-
Melt Cycle Duration (minutes)	112	-
CO Emission Factor (lb/ton)	0.8	3.0
CO Emission Rate (lb/hr)	17	90
CO Emission Rate (TpY)	76.2	322.5

3.0 Source and Sampling Location Description

3.1 General Process Description

Ervin Amasteel manufactures cast steel abrasives using a 30-megawatt (MW) electric arc furnace and heat-treating furnaces. Steel scrap is charged into the furnace and the furnace roof is then closed. Large electrodes are arced within the scrap bringing it to a molten state, which meets quality standards of the facility. When in a molten state, approximately 1% by weight of carbon, manganese, and silicon and a fraction of a percent of aluminum are added as alloys. The molten metal is then poured into a ladle and the melt process is repeated. The facility performs the melt cycles, called "heats", during the evening (off peak) hours.

3.2 Rated Capacities and Air Emission Controls

The facility processes and melts a little under 30 tons of scrap steel per hour, or approximately 40 tons per melt cycle (heat). The scrap steel is melted to approximately 3,100 degrees Fahrenheit (°F) prior to being poured into the ladle.

Emissions from melting the scrap metal are directed, prior to discharge to the atmosphere, to a positive-pressure fabric filter baghouse. The emissions are directed to the baghouse via an inline dirty air fan to a water-cooled duct system that terminates into dry ducting. Dry ducting tempers the furnace fume with fugitive emissions captured from furnace charging, tapping, and casting operations.

Appendix 2 presents sampling locations

3.3 Sampling Locations

Inlet gas velocity was measured at the baghouse inlet duct which has an inner diameter of 113.5 inches.

Exhaust gas CO concentration and CO2/O2 content was measured inside the inlet duct downstream of where stack velocity is measured, which is at ground level. Due to the variable nature of the EAF exhaust CO concentration and the ground level sampling location not meeting USEPA Method 1 criteria the exhaust gas cannot be classified as not stratified using the guidelines (i.e., the results indicate stratification pursuant to the Method 7E guidelines due the time-dependent variability of the CO concentration). Therefore, the maximum number of sampling points, determined in accordance with USEPA Method 1, were sampled throughout each test period (i.e., twelve points were sampled).

Sampling location diagrams are provided in Appendix 2.

4.0 Sampling and Analytical Procedures

A test protocol for the air emission testing was reviewed and approved by the EGLE-AQD. This section provides a summary of the sampling and analytical procedures that were used during the testing periods.

4.1 Summary of Sampling Methods

USEPA Method 1	Velocity and sampling locations were selected based on physical stack measurements in accordance with USEPA Method 1.
USEPA Method 2	Exhaust gas velocity pressure and temperature using a Type-S Pitot tube connected to a red oil incline manometer; temperature was measured using a K-type thermocouple connected to the pitot tube.
USEPA Method 3A	Exhaust gas O_2 and CO_2 content determined using paramagnetic and infrared instrumental analyzers, respectively.
USEPA Method 4	Exhaust gas moisture content was determined using the wet bulb/dry bulb technique.
USEPA Method 10	Exhaust gas CO concentration measured using an infrared instrumental analyzer.

Appendix 3 provides sample train drawings and detailed sampling procedures

4.2 Sampling Location and Exhaust Gas Velocity Determination (USEPA Methods 1 and 2)

A single inlet duct contributes to the total air volume introduced into the baghouse. The gas velocity and volumetric flowrate for the inlet duct were measured using USEPA Methods 1 and 2.

Velocity measurement points were determined in accordance with the procedures specified in USEPA Method 1. The Pitot tube was positioned at each of the velocity traverse points with the planes of the face openings of the Pitot tube perpendicular to the stack cross-sectional plane. The Pitot tube was then rotated to determine the null angle (rotational angle as measured from the perpendicular, or reference, position at which the differential pressure is equal to zero). Velocity pressure measurements were performed at each traverse point using an S-type Pitot tube and red-oil manometer. Temperature measurements at each traverse point were conducted using a K-type thermocouple and a calibrated digital thermometer.

Volumetric flowrate measurements were performed at the beginning of each heat-length CO test run with the flowrate measurement used to calculate CO mass emissions.

Appendix 2 provides drawings for the inlet duct sampling locations. Flowrate calculations and field data sheets are presented in Appendix 4.

4.3 Exhaust Gas Molecular Weight Determination (USEPA Method 3A)

Carbon dioxide (CO_2) and oxygen (O_2) concentrations were measured concurrently with the CO test runs and the PM test runs using an instrumental analyzer in accordance with Method 3A. A Servomex 1440D single beam single wavelength infrared (SBSW) Gas Analyzer was used to measure the CO_2 content in the exhaust gas. A Servomex 1440D Gas Analyzer equipped with a paramagnetic sensor was used to measure the O_2 content in the exhaust gas.

The flue gas was withdrawn continuously from the inlet duct of the baghouse using a heated Teflon sample line and sample pump. Moisture was removed from the sampled gas stream using a condenser and the conditioned (dried) gas samples were delivered to the instrumental analyzers.

Appendix 4 provides O_2 and CO_2 calculation sheets. Raw instrument data are provided in Appendix 6.

4.4 Moisture Content (USEPA Method 4)

Exhaust gas moisture content for the CO test runs was determined by using the wet bulb/dry bulb technique. The moisture content determination worksheet uses two equations to provide the percentage of moisture in an exhaust gas stream.

The following Equation was used to determine moisture content based on the wet bulb temperature and the dry bulb temperature.

$$\%H_2O = \frac{e'' - \frac{(P_a - e'')*(t_d - t_w)}{2,800 - 1.3*t_w}}{P_a} * 100$$

e"	vapor pressure of water at the wet bulb temperature (in. Hg)
P_a	absolute barometric pressure (in. Hg)
t_d	dry bulb temperature (°F)
t_w	wet bulb temperature (°F)

The vapor pressure (e") of water is required in the equation above, and can be determined using the following equation:

$$e'' = (6.07864 * 10^{-6}) * (t_w)^3 - (1.00431 * 10^{-3})(t_w)^2 + (0.075602) * t_w - 1.69343$$

These equations are limited to stack temperatures between 50°F and 200°F. The stack temperatures during each flowrate were within this range.

Appendix 4 provides moisture catch recovery field data sheets.

4.5 CO Concentration Measurements (USEPA Method 10)

Exhaust gas CO concentrations were determined during each sample period using a Thermo Environmental Inc. Model 48i Non-Dispersive Infrared (NDIR) Gas Analyzer in accordance with USEPA Method 10.

Exhaust gas was withdrawn continuously from the inlet duct of the baghouse using a heated Teflon sample line, conditioned, and delivered to the CO instrumental analyzer. Sampling was conducted at twelve points within the stack cross-section for a minimum of 5 minutes per point to satisfy stratification requirements.

Appendix 4 provides CO calculation sheets. Raw instrument response data are provided in Appendix 6.

5.0 Quality Assurance/Quality Control Activities

Appendix 6 provides sampling equipment quality assurance and calibration data. A summary of these procedures is provided in this section.

5.1 Sampling Location and Flow Measurement Equipment

The representative flowrate locations were determined in accordance with USEPA Method 1 based on the measured distance to upstream and downstream disturbances. The flowrate location was determined to be acceptable based on the absence of significant cyclonic flow, which was measured and recorded on field data sheets. The inlet duct diagram is provided in Appendix 2.

Prior to performing the initial velocity traverse each day, the S-type Pitot tube and manometer lines were leak-checked. These checks were made by blowing into the impact opening of the Pitot tube until 3 or more inches of water were recorded on the manometer, then capping the impact opening and holding it closed for 15 seconds to ensure that it was leak free. The static pressure side of the Pitot tube was leak-checked using the same procedure.

5.2 Dry Gas Meter Calibration

The isokinetic sampling console was calibrated prior to and after the test event using the critical orifice calibration technique presented in USEPA Method 5. The metering console calibration exhibited no data outside the acceptable ranges presented in USEPA Method 5. The digital pyrometer in the gas metering console was calibrated using a NIST traceable Omega® Model CL 23A temperature calibrator.

Appendix 6 presents the dry gas meter calibration sheets.

5.3 Instrumental Analyzer Interference Check

The instrumental analyzers used to measure CO, O_2 and CO_2 have had an interference response test preformed prior to their use in the field, pursuant to the interference response test procedures specified in USEPA Method 7E. The appropriate interference test gases (i.e., gases that would be encountered in the exhaust gas stream) were introduced into each analyzer, separately and as a mixture with the analyte that each analyzer is designed to measure. All of analyzers exhibited a composite deviation of less than 2.5% of the span for all

5.4 Instrument Calibration and System Bias Checks

At the beginning of each day of the testing program, initial three-point instrument calibrations were performed for the CO, CO_2 and O_2 analyzers by injecting calibration gas directly into the inlet sample port for each instrument. System bias checks were performed prior to and at the conclusion of each sampling period by introducing the upscale calibration gas and zero gas into the sampling system (at the base of the stainless-steel sampling probe prior to the particulate filter and Teflon® heated sample line) and determining the instrument response against the initial instrument calibration readings.

The instruments were calibrated with USEPA Protocol 1 certified concentrations of CO_2, O_2, and CO in nitrogen and zeroed using nitrogen. A STEC Model SGD-710C ten-step gas divider was used to obtain intermediate calibration gas concentrations as needed.

5.5 Gas Divider Certification

A STEC Model SGD-710C 10-step gas divider was used to obtain appropriate calibration span gases. The ten-step STEC gas divider was NIST certified (within the last 12 months) with a primary flow standard in accordance with Method 205. When cut with an appropriate zero gas, the ten-step STEC gas divider delivered calibration gas values ranging from 0% to 100% (in 10% step increments) of the USEPA Protocol 1 calibration gas that was introduced into the system. The field evaluation procedures presented in Section 3.2 of Method 205 were followed prior to use of gas divider. The field evaluation yielded no errors greater than 2% of the triplicate measured average and no errors greater than 2% from the expected values.

6.0 Results

6.1 Test Results and Allowable Emission Limits

The CO mass emission rate was calculated based on the measured CO concentration in the baghouse inlet duct and the inlet duct volumetric flowrate. The CO emission rate per ton of steel tapped (lb/ton) was calculated based on the weight of scrap that was tapped during a period of time and the elapsed time for each included heat.

The average CO concentration for each test period was between 11.8 and 28.2 ppmvd, with concentration spikes up to around 100 ppm.

Test results in Table 7.1 indicate that Ervin Amasteel is operating within the following CO emission limits in MI-ROP-B1754-2018:

- 90 lb CO/hr on a three-hour average,
- 3.0 lb CO/ton of melted steel, and
- 322.5 tons CO/year.

6.2 Variations from Normal Sampling Procedures or Operating Conditions

The testing was performed as described in the approved test protocol and specified USEPA test methods. During the test event the processes were operated normally, at or near normal maximum achievable capacity.

Table 6.1 Measured CO emissions from FG-0009 exhaust

Test No.	1	2	3	Three
Test Date:	9/6/2022	9/6/2022	9/6-9/7/2022	Test
Test Period:	19:27-20:55	21:35-22:56	23:25-00:46	Average
Exhaust Gas Properties				
Exhaust gas flow (dscfm)	213,350	224,677	224,296	220,774
Moisture (% H2O)	1.74	1.74	1.74	1.74
CO2 (%)	0.30	0.25	0.30	0.28
O2 (%)	21.2	21.1	21.1	21.2
Tons scrap tapped per hour (Tph)	19.2	22.1	24.8	22.1
Carbon Monoxide Emissions				
Concentration (ppmvd)	15.9	11.1	27.1	18.0
Emission Rate (lb/hr)	14.8	10.8	26.6	17.4
CO Permit Limit (lb/hr)	-	-	-	*90.0*
Emission Rate (ton/yr)	64.8	47.5	116	76.2
CO Permit Limit (ton/yr)	-	-	-	*322.5*
Emission Factor (lb CO/ton steel)	0.53	0.57	1.20	0.77
Emission Factor Limit	-	-	-	*3.0*

APPENDIX 1

- PROCESS OPERATING DATA

Ervin Amasteel
September 06-07, 2022
CO Testing Data

EAF Booth

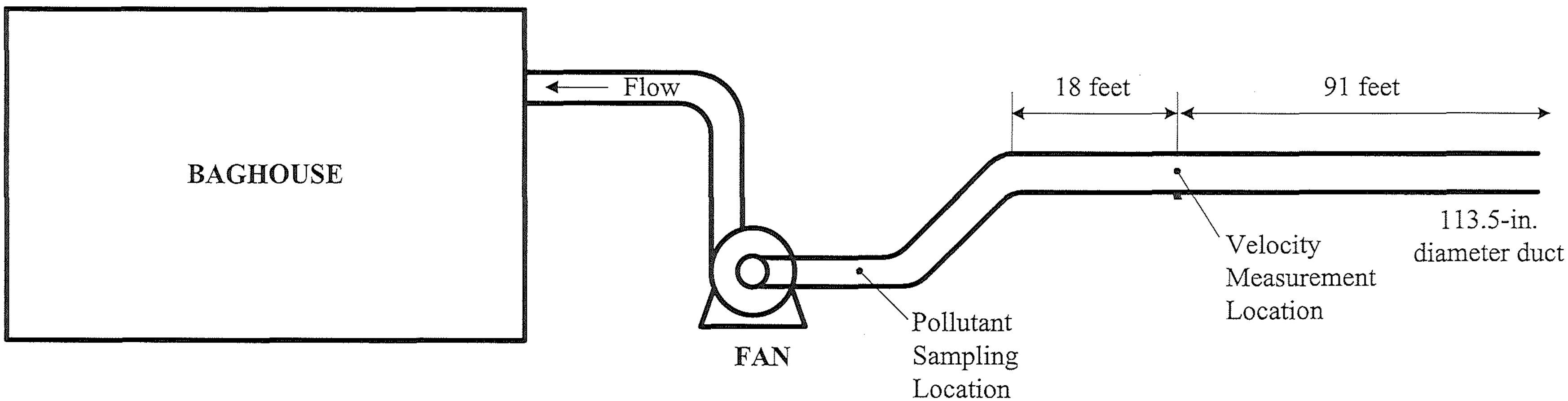
	(9/06/2022)	(9/06/2022)	(9/06-07/2022)
Test#	1	2	3
Heat#	1	2	3
KWH	19,814	20,012	20,216
Charge 1 WT	40,160	39,760	40,300
Charge 2 WT	40,080	40,260	40,000
Alloy Weight	1200	950	850
Final Weight	81440	80970	81150
Start time	19:28	21:35	23:25
Sec. Chg Time	19:48	21:55	23:45
Ending Temp	3154	3226	3201
Static Pres. On EAF	-0.05	-0.05	-0.05
Tap #	16	16	16
Cycle Time	127	110	98
Pour Time	20:53	22:56	0:46
Pwr on Time in Cycle	73	67	67.0

Dust Col. Cntrl Rm

D.C. Static Pres.	-5.9	-5.5	-5.6
Control Dampers %	96.1	95.1	95.8
Temp @ Fan	143	156	155
Fan Amps	155	153	149
Pres. Drp Acrs Bgs	5.5 to 6.0"	6.0 to 6.25"	6.0 to 6.5"

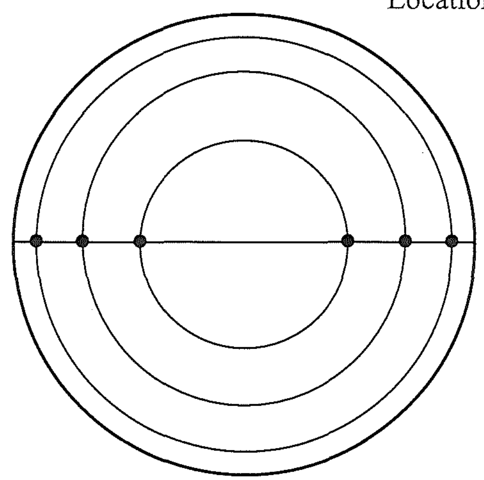
APPENDIX 2

- EXHAUST STACK SAMPLING LOCATIONS

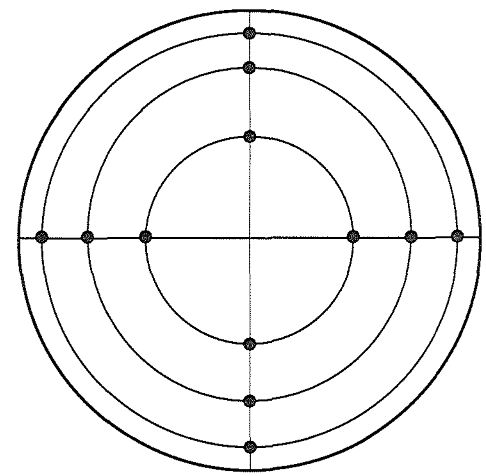


Sample / traverse locations as measured from duct wall (non-particulate testing)

Pt. #	in.
1	5.0
2	16.6
3	33.6
4	79.9
5	96.9
6	108.5



CO Sample Locations



Velocity Traverse Locations

Ervin Amasteel Adrian Facility
EAF Exhaust Sampling Location

Scale 1 of 1	ICT