

**AIR EMISSION TEST REPORT**

Title Compliance Test Report for the Verification of Carbon Monoxide Emissions from an Electric Arc Furnace  
Report Date August 29, 2017  
Test Dates August 10, 2017

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**SEP 14 2017**

**AIR QUALITY DIVISION**

<b>Facility Information</b>	
Name	Ervin Industries, Amasteel Division
Street Address	915 Tabor St.
City, County	Adrian, Lenawee

<b>Facility Permit Information</b>	
SRN: B1754	ROP No. : MI-ROP-B1754-2013

<b>Testing Contractor</b>	
Company	Derenzo Environmental Services
Mailing Address	39395 Schoolcraft Road Livonia, MI 48150
Phone	(734) 464-3880
Project No.	1705010



COMPLIANCE TEST REPORT  
FOR THE  
VERIFICATION OF CARBON MONOXIDE EMISSIONS FROM AN  
ELECTRIC ARC FURNACE

ERVIN INDUSTRIES, AMASTEEL DIVISION  
ADRIAN, LENA WEE COUNTY, MICHIGAN

**1.0 INTRODUCTION**

Ervin Amasteel, a division of Ervin Industries, Inc., State Registration Number (SRN) B1754 retained Derenzo Environmental Services (DES) to conduct a testing program for the determination of carbon monoxide (CO) emissions from the exhaust of the Electric Arc Furnace (EAF) at the Ervin Amasteel Tabor Street facility located in Adrian, Michigan.

The testing was performed pursuant to the provisions in Michigan Department of Environmental Quality, Air Quality Division (MDEQ-AQD) Renewable Operating Permit (ROP) No. MI-ROP-B1754-2013. Section No. 5 for flexible emission group FG-0009 of the ROP requires Ervin Amasteel to verify carbon monoxide (CO) emission rates for the EAF annually.

DES representatives Jason Logan and Clay Gaffey performed the field sampling and measurements on August 10, 2017.

The exhaust gas sampling and analysis was performed in accordance with the approved Test Plan dated June 12, 2017.

Questions regarding this emission test report should be directed to:

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**Report Certification**

This test report was prepared by Derenzo Environmental Services based on field sampling data collected by DES. Facility process data were collected and provided by Ervin Amasteel employees or representatives. This test report has been reviewed by Ervin Amasteel representatives and approved for submittal to the MDEQ-AQD. A signed ROP certification form (EQP 5736) is attached at the head of the report.

I certify that the testing was conducted in accordance with the specified test methods and submitted test plan unless otherwise specified in this report. I believe the information provided in this report and its attachments are true, accurate, and complete.

Report Prepared By:



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Clay Gaffey  
Environmental Consultant  
Derenzo Environmental Services

Reviewed By:



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Jason Logan  
Project Manager  
Derenzo Environmental Services

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## **2.0 SOURCE DESCRIPTION**

### **2.1 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. The scrap charges are weighed prior to charging into the furnace to assure charge consistency. Large electrodes are arced within the scrap bringing it to a molten state. The melt rate (scrap to molten metal) is controlled by regulation of amperage and voltage inputs to the EAF. When in a molten state, approximately one percent (%) 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, or "heats," during the evening (off peak) hours.

### **2.2 Rated Capacities and Air Emission Controls**

Each heat uses approximately 80,000 pounds (lbs) of scrap material, or 30 tons per hour (T<sub>PH</sub>), and is melted to a temperature of approximately 3,100°F prior to being poured into the ladle.

The furnace vessel itself is lined with a consumable refractory material, earthen in nature.

Emissions from melting the scrap metal are collected from various points using a system of hoods that are connected to an inline dirty air fan. The initial ducting is water-cooled; the temperature in downstream dry ducts is tempered by combining the furnace fume with collected air from furnace charging, tapping, and casting operations. The combined air stream is directed to a positive-pressure fabric-filter baghouse prior to discharge to the atmosphere.

### **2.3 Air Pollutant Emission Limits**

The stationary source has been issued Renewable Operating Permit No. MI-ROP-B1754-2013. Conditions for flexible emission group FG-0009 specify CO emission limits of 3.0 lbs per ton of melted steel, 90 lbs per hour (3 hour average), and 322.5 tons per year.

**3.0 SUMMARY OF TEST RESULTS AND OPERATING CONDITIONS**

ROP No. MI-ROP-B1754-2013 requires Ervin Amasteel to perform annual testing to verify the CO emission rate from the EAF (FG-0009). The EAF exhaust gas flow and CO concentration measurements were performed in the horizontal duct prior to (or upstream) of the baghouse fan.

Appendix 1 provides diagrams of the emission test sampling location.

The gases exhausted from the EAF were sampled for three (3) test periods on August 10, 2017. The average test period duration was 96 minutes and encompassed one full heat that charged approximately 41 tons of steel scrap.

Table 3.1 presents a summary of the average measured CO emission rate and operating conditions for the EAF (average of the three test periods).

The average measured CO emission rates are below the limits specified in MI-ROP-B1754-2013.

Appendix 2 provides operating records provided by Ervin Amasteel representatives for the test periods.

Test results for each one hour sampling period are presented in Table 6.1 at the end of this report.

Table 3.1 Average pollutant emissions and operating conditions during the test periods

Parameter	EAF	Permit Limit
Test Duration (hours)	1.6	-
Tons Scrap Melted (tons)	40.6	-
Exhaust Flowrate (dscfm)	179,673	-
CO Concentration (ppmvd)	19.6	-
CO Emission Rate (lb/hr)	16.16	90
CO Emission Factor (lb/ton)	0.66	3.00

#### **4.0 SAMPLING AND ANALYTICAL PROCEDURES**

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

##### **4.1 Summary of Sampling Methods**

USEPA Method 1	Exhaust gas velocity measurement locations were determined based on the physical stack arrangement and requirements in USEPA Method 1
USEPA Method 2	Exhaust gas velocity pressure was determined 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 <sub>2</sub> and CO <sub>2</sub> content was determined using zirconia ion/paramagnetic and infrared instrumental analyzers, respectively.
USEPA Method 4	Wet bulb/dry bulb technique
USEPA Method 10	Exhaust gas CO concentration was measured using an NDIR instrumental analyzer

##### **4.2 Sampling Locations (USEPA Method 1)**

The EAF exhaust gas flow and CO concentration measurements were performed in the horizontal duct prior to (or upstream) of the baghouse fan. The location of the sample ports meets the USEPA Method 1 criteria for a representative sample location. The inner diameter of the duct is 113.5 inches. The duct is equipped with two (2) 4.75 inch sample ports, opposed 90°, that provided a sampling location 1,200 inches (10.57 duct diameters) downstream and 216 inches (1.90 duct diameters) upstream from any flow disturbance.

Velocity pressure traverse locations for the sampling points were determined in accordance with USEPA Method 1.

##### **4.3 Exhaust Gas Velocity Determination (USEPA Method 2)**

The EAF exhaust gas velocities and volumetric flow rates were determined using USEPA Method 2 prior to and after each test period. An S-type Pitot tube connected to a red-oil manometer was used to determine velocity pressure at each traverse point across the stack cross section. Gas temperature was measured using a K-type thermocouple mounted to the Pitot tube.

The Pitot tube and connective tubing were leak-checked periodically to verify the integrity of the measurement system.

The absence of significant cyclonic flow for the exhaust configuration was verified using an S-type Pitot tube and oil manometer. The Pitot tube was positioned at each velocity traverse point 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).

Appendix 3 provides exhaust gas flowrate calculations and field data sheets.

#### **4.4 Exhaust Gas Molecular Weight Determination (USEPA Method 3A and 4)**

CO<sub>2</sub> and O<sub>2</sub> content in the EAF exhaust gas stream was measured continuously throughout each test period in accordance with USEPA Method 3A. The CO<sub>2</sub> content of the exhaust was monitored using a Servomex 4900 single beam single wavelength (SBSW) infrared gas analyzer. The O<sub>2</sub> content of the exhaust was monitored using a Servomex 4900 gas analyzer that uses a paramagnetic sensor.

During each sampling period, a continuous sample of the EAF exhaust gas stream was extracted from the stack using a stainless-steel probe connected to a Teflon<sup>®</sup> heated sample line. The sampled gas was conditioned by removing moisture prior to being introduced to the analyzers; therefore, measurement of O<sub>2</sub> and CO<sub>2</sub> concentrations correspond to standard dry gas conditions. Instrument response data were recorded using an ESC Model 8816 data acquisition system that monitored the analog output of the instrumental analyzers continuously and logged data as one-minute averages.

Prior to, and at the conclusion of each test, the instruments were calibrated using upscale calibration and zero gas to determine analyzer calibration error and system bias (described in Section 5.0 of this document). Sampling times were recorded on field data sheets.

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:

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

This equation is limited to use for stack temperatures between 50°F and 200°F. The stack temperatures during each flowrate were within this range.

Appendix 4 provides O<sub>2</sub> and CO<sub>2</sub> calculation sheets. Raw instrument response data are provided in Appendix 5.

#### **4.5 CO Concentration Measurements (USEPA Method 10)**

CO pollutant concentrations in the EAF exhaust gas streams were determined using a Fuji ZRF infrared CO analyzer.

Throughout each test period, a continuous sample of the EAF exhaust gas was extracted from the stack using the Teflon<sup>®</sup> heated sample line and gas conditioning system and delivered to the instrumental analyzers. Instrument response for each analyzer was recorded on an ESC Model 8816 data acquisition system that logged data as one-minute averages. Prior to, and at the conclusion of each test, the instruments were calibrated using upscale calibration and zero gas to determine analyzer calibration error and system bias.

Appendix 4 provides CO calculation sheets. Raw instrument response data are provided in Appendix 5.

### **5.0 QA/QC ACTIVITIES**

#### **5.1 Gas Divider Certification (USEPA Method 205)**

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.



## **5.2 Instrumental Analyzer Interference Check**

The instrumental analyzers used to measure CO, O<sub>2</sub> and CO<sub>2</sub> have had an interference response test performed 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 measured interferent gases. No major analytical components of the analyzers have been replaced since performing the original interference tests.

## **5.3 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<sub>2</sub> and O<sub>2</sub> 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<sup>®</sup> 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<sub>2</sub>, O<sub>2</sub>, and CO in nitrogen and zeroed using hydrocarbon free nitrogen. A STEC Model SGD-710C ten-step gas divider was used to obtain intermediate calibration gas concentrations as needed. Prior to the test periods, a secondary mid-range calibration gas was introduced into the system for CO in order to show linearity of the divider.

## **6.0 RESULTS**

### **6.1 EAF Exhaust Test Results and Allowable Emission Limits**

Operating data and air pollutant emission measurement results for each one hour test period are presented in Table 6.1. The average measured CO emissions were:

- 16.16 lb/hr; and
- 0.66 lb/ton.

Continuous operation (i.e. 8,760 hours per year) at the average measured CO mass emission rate would result in maximum annual emissions of less than 75 tons CO per year. Actual annual emissions are calculated by Ervin Amasteel using the measured process emission factor (0.66 lb/ton) and records of steel scrap throughput. These data are maintained at the facility and are available upon request.

The measured CO pollutant emission rates for the EAF are less than the allowable limits specified in MDEQ ROP No. MI-ROP-B1754-2013:

- 90 lb/hr;
- 3.0 lb/ton; and
- 322.5 ton/year.

## **6.2 Variations from Normal Sampling Procedures or Operating Conditions**

The testing for all pollutants was performed in accordance with USEPA methods and the approved test protocol dated June 12, 2017. The facility was operated normally during the test periods. In addition to the required measurements, Mr. Richard Payne, Plant Engineer for Ervin, performed opacity measurements to verify there were no visible emissions present during the testing program. The field measurement sheet is included with the operating data in Appendix 2.

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Table 6.1 Measured exhaust gas conditions and CO air pollutant emissions for the EAF exhaust at Ervin Amasteel

Test No.	1	2	3	Three Test Average
Test Date	8/10/17	8/10/17	8/10/17	
Test Period (24-hr clock)	19:09-20:30	21:08-22:27	22:43-00:03	
Heat Melt Weight (tons)	40.5	40.7	40.5	40.6
Melt Cycle Time (hours)	1.4	1.8	1.6	1.6
Heat Melt Rate (tons/hour)	30.0	22.2	25.1	25.7
<b>Exhaust Gas Composition</b>				
CO <sub>2</sub> content (%)	0.25	0.23	0.23	0.24
O <sub>2</sub> (%)	21.14	21.27	21.27	21.23
Moisture (%)	1.5	1.4	1.6	1.5
<b>Exhaust Gas Flowrate</b>				
Dry basis (dscfm)	140,450	207,084	191,484	179,673
<b>Carbon Monoxide Emissions</b>				
CO conc. (ppmvd)*	8.6	20.0	30.1	19.6
CO emissions (lb/hr)	5.25	18.09	25.14	16.16
CO permit limit (lb/hr)				90.0
CO emission factor (lb/ton)	0.17	0.82	1.00	0.66
CO permit limit (lb/ton)				3.00

\*Corrected for calibration bias