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AIR EMISSION TEST REPORT FOR THE VERIFICATION OF AIR POLLUTANT EMISSIONS FROM FNC HEAT TREATING FURNACES

Prepared for:

Woodworth, Inc.
SRN P0547

ICT Project No.: 2200117
November 21, 2022

COMPLIANCE & TESTING

P0547-test_20021017

Report Certification

AIR EMISSION TEST REPORT
FOR THE
VERIFICATION OF AIR POLLUTANT EMISSIONS
FROM
FNC HEAT TREATING FURNACES

Woodworth, Inc.
Homer, Michigan

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

Impact Compliance & Testing, Inc.

Andy Rusnak, QSTI
Technical Manager

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1.0 Introduction

Woodworth, Inc. (Woodworth) (Facility SRN: P0547) owns and operates ferritic nitrocarburizing (FNC) heat treating furnaces at its facility in Homer, Calhoun County, Michigan. The FNC heat treating furnaces are identified as EUHEATTREAT1 through EUHEATTREAT15 (collectively, as flexible group FGHEATTREAT) in Permit to Install (PTI) No. 64-15D.

Air emission compliance testing was performed to satisfy the following requirements contained in PTI No. 64-15D:

> *Before November 30, 2022, the permittee shall verify NOx emission rates from FNC cycles from representative units of FGHEATTREAT by testing at the owner's expense, in accordance with Department requirements. Test results shall be based upon an average of the results of three test runs on representative units with one run per unit during the FNC step of the cycle, unless otherwise specified by the AQD.*; and
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> *Before November 30, 2022, the permittee shall verify ammonia emission rates from FNC cycles from representative units of FGHEATTREAT by testing at the owner's expense, in accordance with Department requirements. Test results shall be based upon an average of the results of three test runs on representative units with one run per unit during the FNC step of the cycle, unless otherwise specified by the AQD.*

The compliance testing was performed by Impact Compliance & Testing, Inc., (ICT), a Michigan-based environmental consulting and testing company. ICT representatives Clay Gaffey, Max Fierro and Andrew Rusnak performed the field sampling and measurements October 17 – 20, 2022.

The exhaust gas sampling and analysis was performed using procedures specified in the Test Plan that was reviewed and approved by the Michigan Department of Environment, Great Lakes and Energy (EGLE). EGLE representatives Ms. Lindsey Wells and Ms. Amanda Cross observed portions of the testing project.

Questions regarding this emission test report should be directed to:

Andy Rusnak, QSTI
Technical Manager
Impact Compliance & Testing, Inc.
4180 Keller Rd. Ste. B
Holt, MI 48824
Ph: (517) 481-3283
andy.rusnak@impactcandt.com

E.J. Stumph
General Manager
Woodworth Inc.
29753 M60
Homer, MI 49245
517-929-6100
estumph@woodworthinc.com

Table 3.2 presents the average measured NO_x and NH_3 emission rates for the furnaces (average of the three test periods).

Test results for each sampling period and comparison to the permitted emission rates are presented in Section 6.0 of this report.

3.0 Source and Sampling Location Description

3.1 General Process Description

WWI has been permitted to install and operate fifteen (15) heat treat furnaces that are identified as emission units EUHEATTREAT1 through EUHEATTREAT15 (collectively FGHEATTREAT). The furnaces are used to heat treat brake rotors.

The brake rotors treated at the WWI Homer facility are subjected to two separate treatment steps:

1. Stress relief heat treatment that is performed on the brake rotor after casting, and
2. Ferritic nitrocarburizing (FNC) treatment performed on the brake rotor after machining.

The metal heat treating process is a batch-type process and has a specific cycle; in general racks of parts are loaded into the furnace, the furnace is heated, the burner ramps down to idle mode to maintain the desired furnace temperature for several hours, the furnace is cooled, and the parts are unloaded.

FNC treatment results in greater rotor performance, enhanced durability, corrosion performance, and wear resistance. In gaseous FNC treatment, the atmosphere within the furnace is purged of ambient air (oxygen) and replaced with a controlled mixture of nitrogen, ammonia, and methane (natural gas). In the high temperature furnace, the ammonia is cracked into nitrogen and hydrogen. Nitrogen and carbon diffuse into the surface of the ferrous material at controlled temperatures to result in the desired properties.

3.2 Rated Capacities and Air Emission Controls

The heat treat furnace has a capacity of approximately six (6) MMBtu/hr.

The entire FNC cycle has a duration of approximately 24 hours. Approximately 6.5 hours of the cycle time uses the FNC process gas (FNC gas phase), which includes ammonia. During the FNC gas phase portion of the cycle, residual methane and hydrogen are ignited and burned off via the oven exhaust burn-off tower. At the end of the cycle, the FNC atmosphere is purged with nitrogen.

During the FNC gas phase portion of the cycle (approximately 6.5 hours), residual methane and hydrogen are ignited and burned off via the oven exhaust burn-off tower. The burn-off tower consists of vertical sections of insulated pipe. The furnace exhaust is introduced at the base of the tower through piping that disperses the gas within the tower. Natural gas fueled burners at the base of the tower ignite the gas mixture, which burns as it travels through the tower. Ambient air is allowed into the flame section by gaps between the insulated sections.

The purpose of the burn-off tower is to combust hydrogen and methane exiting the furnace before it is discharged to the ambient air. However, it also has the potential to convert residual ammonia in the furnace exhaust to NO_x.

4.0 Sampling and Analytical Procedures

A test protocol for the air emission testing was reviewed and approved by the EGLE. This section provides a summary of the sampling and analytical procedures that were used during the Woodworth 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 2F	Exhaust gas velocity pressure was determined using a spherical 3D 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 was determined using a zirconium oxide and FTIR analyzer, respectively.
ASTM D6348	Exhaust gas NO_x, NH_3 and moisture concentration was measured using a Fourier transform infrared spectroscopy (FTIR) analyzer.

4.2 Exhaust Gas Velocity Determination (USEPA Method 2F)

The furnace exhaust stack gas velocities and volumetric flow rates were determined using USEPA Method 2F during each test. Four (4) traverses were conducted during each batch. Each traverse was performed during a separate phase of the FNC gas phase period (i.e., distinct time period that has different inlet gas flowrates). A traverse was performed during the burn-start, FNC1, FNC2 and FNC3 phases of the FNC gas phase. An spherical 3D Pitot tube connected to a red-oil manometer was used to determine velocity pressure, yaw angle and pitch angle 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 prior to use to verify the integrity of the measurement system.

The absence of significant cyclonic flow for the exhaust configuration was verified using the spherical 3D Pitot tube and oil manometer. At each velocity traverse point the Pitot tube was rotated to zero out the yaw angle manometer. After the yaw angle manometer was zeroed, the yaw angle was measured with a digital inclinometer that was attached to the pitot tube. The velocity pressure and pitch angle pressure differential were also recorded when the yaw angle manometer was zeroed.

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

5.0 QA/QC Activities

5.1 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_2 and O_2 analyzers by injecting calibration gas directly into the inlet sample port for each instrument. 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 instrumental analyzer inlet) and determining the instrument response against the initial instrument calibration readings.

The instruments were calibrated with USEPA Protocol 1 certified concentrations of CO_2, and O_2 in nitrogen and zeroed using hydrocarbon free nitrogen.

5.2 FTIR QA/QC Activities

At the beginning of each day a calibration transfer standard (CTS, ethylene gas), analyte of interest (nitrogen oxide and ammonia) and nitrogen calibration gas were directly injected into the FTIR to evaluate the unit response.

Prior to and after each test run the CTS was analyzed. The ethylene was passed through the entire system (system purge) to verify the sampling system response and to ensure that the sampling system remained leak-free at the stack location. Nitrogen was also passed through the sampling system to ensure the system is free of contaminants.

Analyte spiking, of each emission unit, on ambient air and during the run on exhaust gas (spike data during the run was removed from the overall test run averages), with nitrogen oxide was performed to verify the ability of the sampling system to quantitatively deliver a sample containing the compound of interest from the base of the probe to the FTIR and assured the ability of the FTIR to quantify that compound in the presence of effluent gas. Analyte spiking, of each emission unit, prior to, during and after sampling, with ammonia was also performed. The spike target dilution ratio was 1:10 (1 part cal gas; 9 parts stack gas).

As part of the data validation procedure, reference spectra were manually fit to that of the sample spectra (two spectra from each test period) and a concentration was determined. Concentration data was manually validated using the MKS MG2000 method analyzer software. The software used multi-point calibration curves to quantify each spectrum. The software-calculated results were then compared with the measured concentrations to ensure the quality of the data.

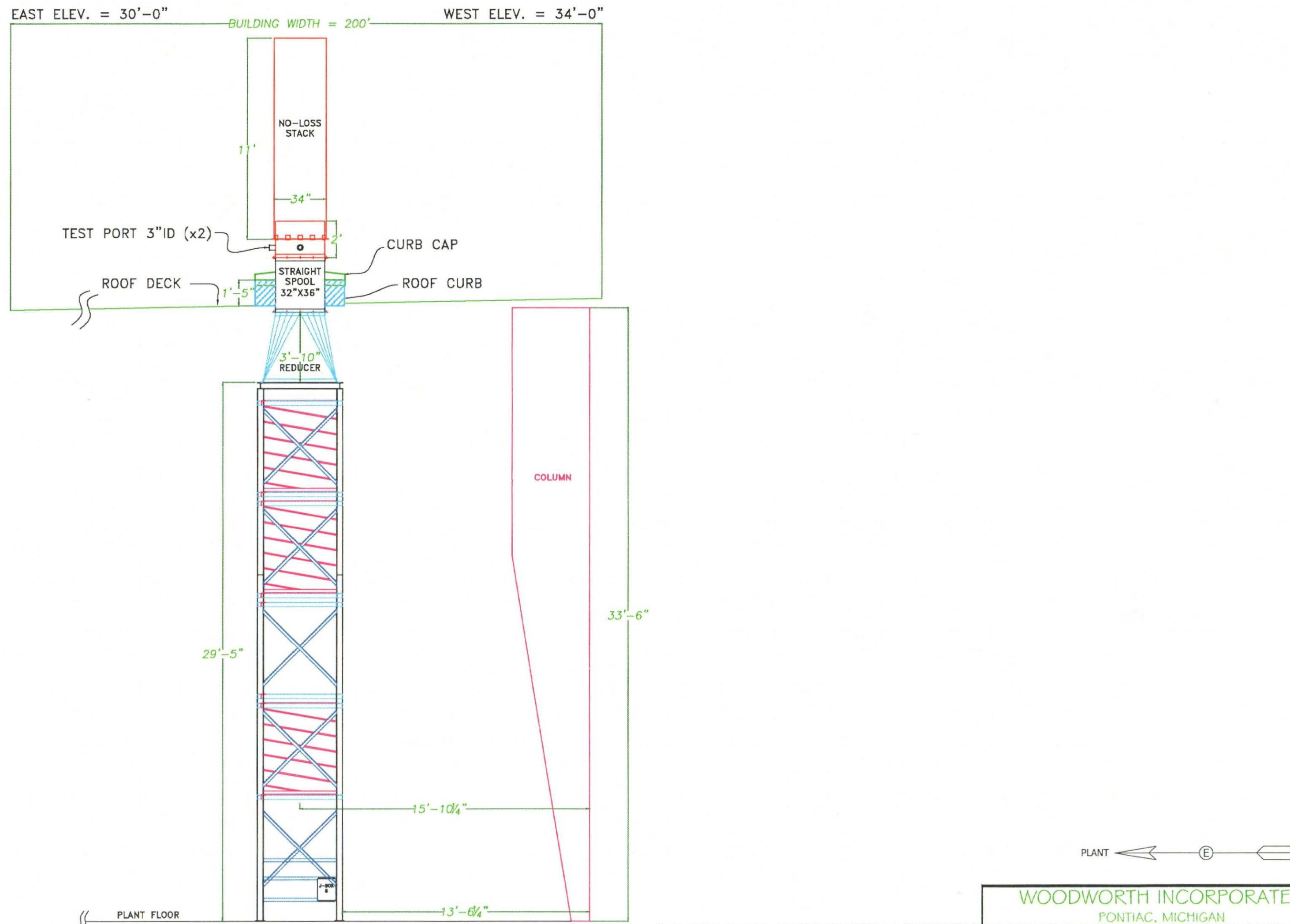
Appendix 7 presents test equipment quality assurance data (instrument calibration and bias check records, calibration gas, Pitot tube calibration records and FTIR QA/QC data).

conditions and no variations from normal operating conditions occurred during the furnace test periods.

For the initial test performed on Furnace No. 6 (10/17/22), Woodworth operated the furnace at lower natural gas and ammonia feed rates. Woodworth believed that this modification in operating conditions would result in lower emissions of NO_x and NH_3. Sampling of this process operating condition resulted in significantly higher NH_3 emissions, compared to the previous emissions testing. Woodworth determined that this was not a feasible operating scenario and reverted back to the normal natural gas and ammonia feed rates. Three tests were performed for this scenario on Furnaces No. 6, 7 and 8 (Furnace 6 was retested on 10/20/22 at the normal gas feed rates). Data and calculations for the first test performed on Furnace No. 6 (10/17/22) are not included in the three-test average, however, are presented in the Appendices.

APPENDIX 1

- Figure 1 – Sample Port Diagram



WOODWORTH INCORPORATED
PONTIAC, MICHIGAN

PROJECT TITLE:
BURN–OFF TOWER (FOR H01–H16)

SCALE THIS:	DRAWN BY:	CHECKED BY:	APP'D BY:
DATE: 10/10/15	SHEET OF SHEETS	DRAWING NO. WWH–BO–01	

DATE	REVISION	NAME
9/26/18	REMOVED DUCT #2	QUEZ