

**Derenzo and Associates, Inc.**

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**EMISSION TEST REPORT**

Report Title EMISSION TEST REPORT FOR THE VERIFICATION OF  
THERMAL OXIDIZER VOC CAPTURE AND  
DESTRUCTION EFFICIENCY

Report Date June 3, 2015

Test Dates May 20, 2015

<b>Facility Information</b>	
Name	Pioneer Metal Finishing Stephens Rd Facility
Street Address	13251 Stephens Rd
City, County	Warren, Macomb
Phone	(586)-759-3559

<b>Facility Permit Information</b>
State Registration No.: N6388 Permit to Install Nos.: 169-07 and 151-05

<b>Testing Contractor</b>	
Company	Derenzo and Associates, Inc.
Mailing Address	39395 Schoolcraft Road Livonia, Michigan 48150
Phone	(734) 464-3880
Project No.	1501005

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### EMISSION TEST REPORT FOR THE VERIFICATION OF THERMAL OXIDIZER VOC CAPTURE AND DESTRUCTION EFFICIENCY

PIONEER METAL FINISHING – STEPHENS RD FACILITY  
WARREN, MICHIGAN

#### **1.0 INTRODUCTION**

Pioneer Metal Finishing (PMF) operates a metal parts coating facility located at 13251 Stephens Rd., Warren, Macomb County, Michigan (State Registration No. N6388). Coating is transferred to metal parts using dip and spray application and dried or cured in coating ovens. The coating lines are equipped with a process air collection system that exhausts solvent vapor to a regenerative thermal oxidizer (RTO) for volatile organic compound (VOC) emissions reduction.

The coating processes are permitted under the General Permit to Install for Coating Lines Emitting Less Than 10 Tons Per Year (Permit No. 169-07). The conditions of the General Permit allow for the operation of either a thermal or catalytic oxidizer as needed to satisfy the emission limits specified in the general permit; 10 tons per year (TpY) VOC per coating line and less than 30 TpY VOC for all coating lines. In addition, all operations at the facility are subject to the conditions of Permit to Install 151-05 that establishes hazardous air pollutant (HAP) emission limits that are less than the major source threshold (i.e., synthetic minor or Title V opt-out permit).

PMF commenced operation of the RTO on March 4, 2015. Emissions were previously controlled using a catalytic oxidizer that has since been decommissioned. The Michigan Department of Environmental Quality Air Quality Division (MDEQ-AQD) requested that PMF verify the VOC capture and destruction efficiency associated with the RTO emissions control system following startup of the unit.

VOC capture and destruction efficiency testing was performed on May 20, 2015 by Derenzo and Associates, Inc. representatives Robert Harvey, Tyler Wilson, and Kalan Briggs. The project was coordinated by Mr. Eric Rosenberg, Warren Campus Manager – Pioneer Metal Finishing. Mr. Thomas Maza and Ms. Joyce Zhu of the MDEQ-AQD were on-site to observe portions of the compliance testing.

The exhaust gas sampling and analysis was performed using procedures specified in the Test Plan dated April 1, 2015 that was submitted to the MDEQ-AQD for review and approval.

Appendix A provides a copy of the MDEQ-AQD test plan approval letter.

2.0 SUMMARY OF RESULTS

The RTO inlet and exhaust gas streams were monitored simultaneously during three (3) one-hour test periods to determine the VOC mass flowrate entering and exiting the Dürr rotary RTO for VOC destruction efficiency (DE) determination. The calculated VOC DE for the RTO averaged 95.6% by weight. During the test periods, the oxidizer operated at a minimum chamber temperature of 1,535°F and an average chamber temperature of 1,544°F.

The VOC destruction efficiency test results (three-test average) are summarized in Table 2.1. Results for each one hour test period are presented in Section 5 of this report.

VOC capture efficiency for each coating process connected to the emission control system was evaluated using the smoke tube test method; observation of the airflow direction of visual smoke at enclosure openings. The results of the capture efficiency evaluation are presented in Table 2.2 All enclosures connected to the VOC collection system exhibited inward flow as indicated by the observation of air current smoke.

The VOC collection system operated at an average:

- Fan speed of 39.2 Hz (as displayed on the RTO control panel)
- Inlet vacuum of -3.6 inches of water column (as displayed on the RTO control panel)
- Capture gas flowrate of 32,879 scfm (as measured using USEPA Method 2)

For coating operations controlled by an add-on emission control device, the conditions of the general Permit to Install for coating lines (PTI No. 169-07) require PMF to maintain a minimum RTO combustion chamber temperature of 1,400°F (three-hour average) and an overall minimum VOC reduction of 76% by weight. The results of the May 20, 2015 test event demonstrate compliance with the permit requirements.

Based on these results, PMF will calculate its VOC/HAP emissions using an overall control efficiency of 95.6% by weight for the processes that were included in this test event provided the air collection system is properly operating and the RTO combustion chamber is maintained at a minimum temperature of 1,535°F.

Table 2.1 Summary of VOC destruction efficiency test results

Control System	RTO Setpoint Temp. (°F)	Avg. RTO Chamber Temp. (°F)	Min. RTO Chamber Temp. (°F)	Avg. Destruction Efficiency (%wt)
Measured	1,550	1,544	1,535	95.6%
Permit Limit				>76.0%

Table 2.2 Summary of capture efficiency test results for each coating line

Emission Unit ID	Description	Smoke Tube Verified Inward Flow (Y/N)
EU-01	Hi-Temp Chain-on-Edge (COE#1)	Not Operating
EU-02	Large Dip Drain Line	Y
EU-04	Large Spray Booth	Y
EU-05	Batch Oven	Y
EU-06	Two Small Spray Booths*	Y
EU-07	Chain-on-Edge #2 (COE#2)	Y
EU-08	Chain-on-Edge #3 (COE#3)	Y

\* Only one spray booth is installed and operating

### 3.0 SOURCE DESCRIPTION

#### 3.1 Coating Line Processes

PMF operates dip and spray coating processes. Solvent laden air is collected from the coating section (dip booth or spray booth) and curing oven(s) associated with each coating line and directed to the RTO emissions control system.

#### 3.2 Type of Raw Materials Used

The coatings applied by the processes are either for corrosion resistance, adhesion, or surface priming. The high performance coatings are primarily solvent based, though some waterborne formulations are used. These coatings are received from the manufacturer and diluted (reduced) with organic solvents or water prior to their application.

#### 3.3 Emission Control System Description

The Durr model RL50 RTO emission control system consists of a variable frequency drive (VFD) fan, rotary energy recovery chamber, and a high-temperature combustion chamber containing natural gas-fired burners. The unit has a nominal design capacity of 50,000 standard cubic feet per minute (scfm).

Fan speed is controlled (by the VFD controller) to maintain an appropriate vacuum within the process air collection system and direct the collected air to the RTO unit. The solvent laden air enters the RTO unit through the inlet manifold into the base of the rotary energy recovery chambers where it is preheated as it travels through the heat exchange media. The temperature of the preheated air is increased in the combustion chamber to complete the oxidation of hydrocarbons in the process air stream. The heated air flows through the outlet energy recovery

chambers and is cooled (which raises the temperature of the heat exchange media) prior to being discharged to the ambient air through the vertical exhaust stack.

The energy recovery chambers are constantly rotating so that the heated heat exchange media (which was used to cool the exiting gas stream) becomes the preheating heat exchange media that is used to preheat the incoming solvent laden air.

### **3.4 Process Operating Conditions During the Compliance Testing**

Table 2.2 identifies the processes that are connected to the emission control device and were operated during the compliance test.

With the exception of the COE#3, all coating processes operated normally during the RTO test periods and applied solvent-based coating at typical application rates. COE#3 was not scheduled for production on the day of testing and was setup to spray a mixture of coating and solvent during the test periods (no parts were loaded on the line).

Appendix B provides a copy of the PMF production sheets for each coating process in operation during the RTO performance testing.

Destruction efficiency for the RTO emission control system was tested while the RTO combustion chamber setpoint was set at 1,550°F. The combustion chamber temperature is monitored continuously and recorded electronically. In addition, the temperature was periodically recorded manually throughout each test based on the digital display on the RTO control panel. The RTO system fan operated near maximum capacity during all test periods; between 38.7 and 39.3 Hertz (Hz) as indicated by the VFD output display. The measured vacuum in the inlet duct was 3.6 inches of water column.

Appendix C provides RTO temperature and operating records for the three (3) one-hour test periods.

Appendix D provides coating line enclosure drawings.

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

A description of the sampling and analytical procedures is provided in the Test Plan dated April 1, 2015, which was approved by the MDEQ-AQD Technical Programs Unit. This section provides a summary of those procedures.

##### **4.1 Summary of VOC Destruction Efficiency Test Procedures**

Derenzo and Associates, Inc. performed the specified pollutant measurements in accordance with the following USEPA reference test methods:

- |            |   |
|------------|---|
| Method 1   | Velocity and sampling locations based on physical measurements in accordance with USEPA Method 1.   |
| Method 2   | Gas flowrate determined using a type S Pitot tube in accordance with USEPA Method 2.  |
| Method 3   | RTO inlet gas O <sub>2</sub> and CO <sub>2</sub> content determined by Fyrite® combustion gas analyzers.  |
| Method 4   | RTO exhaust gas moisture determined based on the water weight gain in chilled impingers. RTO inlet gas moisture determined by wet bulb/dry bulb temperature measurements. |
| Method 25A | Total hydrocarbon concentration using a flame ionization analyzer (FIA) compared to a propane standard.   |

RTO VOC destruction efficiency was determined based on the simultaneous sampling of the RTO inlet and exhaust gas streams during three (3) one-hour sampling periods. THC concentration in the RTO inlet and exhaust gas streams was measured by individual Thermo Environment Instruments (TEI) Model 51 flame ionization detectors (FID) according to USEPA Method 25A as described in Section 4.6 of this document.

Gas properties for the RTO inlet were determined pursuant to USEPA Methods 3 and 4 using Fyrite® gas scrubbers to determine carbon dioxide and oxygen (CO<sub>2</sub>/O<sub>2</sub>) content and moisture by the wet bulb/dry bulb method. Gas properties for the RTO exhaust were determined pursuant to USEPA Methods 3 and 4 using Fyrite® gas scrubbers to determine CO<sub>2</sub>/O<sub>2</sub> content and moisture by the chilled impinger method.

Air velocity measurements for each sampling location were performed near the beginning and end of each one-hour test period using a type-S Pitot tube in accordance to USEPA Method 2.

#### **4.2 RTO Sampling Locations**

The sampling location for the combined coating line exhaust (RTO inlet) is in the 52-inch diameter duct at the exterior wall of the PMF facility. The sampling location is approximately 14 feet downstream of the nearest flow disturbance (45° elbow near the building wall) and 10.6 feet upstream from the nearest flow disturbance (45° elbow near RTO).

The sampling location for the RTO exhaust is in the cylindrical 64.25-inch vertical exhaust stack. The sampling location is approximately 12 feet downstream of the nearest flow disturbance (elbow at the stack base) and 7.5 feet upstream from the stack atmospheric discharge.

Appendix E provides diagrams of the performance test sampling locations.

#### **4.3 Process Air Flowrate Measurements**

Velocity traverse locations for the sampling points were determined in accordance with USEPA Method 1 based on the stack diameter and measured distance to upstream and downstream flow disturbances.

Exhaust gas velocity pressure and temperature were measured at each sampling location in accordance with USEPA Method 2. An S-type Pitot tube connected to a red-oil manometer was used to determine velocity pressure and a K-type thermocouple mounted to the Pitot tube was used for temperature measurements. The Pitot tube and connective tubing were periodically leak-checked to verify the integrity of the measurement system.

The absence of cyclonic flow for each sampling location was verified using the gas velocity measurement train (S-type Pitot tube connected to an 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). The measured null angle for each traverse location was recorded on a data sheet. Cyclonic flow at each sampling location is minimal.

#### **4.4 Gas Molecular Weight Determinations**

Carbon dioxide (CO<sub>2</sub>) and oxygen (O<sub>2</sub>) content for the RTO inlet and RTO exhaust gas streams were measured using Fyrite® gas analyzers containing scrubbing solutions to selectively remove CO<sub>2</sub> and O<sub>2</sub> from the gas sample. Samples were withdrawn from the air stream near the beginning of each test period using a sample probe and hand-held aspirator and introduced to the Fyrite® solutions through the scrubbing tube inlet valve. The sampled gas was passed through the appropriate scrubbing solution several times and the gas concentration (CO<sub>2</sub> or O<sub>2</sub>) was determined by the solution volume change as indicated by the calibrated scale on the Fyrite® scrubber chamber.

#### **4.5 Gas Stream Moisture Determinations**

Moisture content for the RTO exhaust gas was determined using the USEPA Method 4 chilled impinger method. Moisture content for RTO inlet gas stream was determined based on wet bulb-dry bulb temperature measurements using a type-K thermocouple and calibrated digital pyrometer (USEPA Method 4 approximation technique using a psychometric chart).

#### **4.6 Hydrocarbon Concentration Measurements**

USEPA Method 25A, *Determination of Total Gaseous Organic Concentration Using A Flame Ionization Detector*, was used to determine the total hydrocarbon (THC) concentration, relative to a propane standard, for the RTO inlet and exhaust measurement locations. The measured THC concentration was used with the measured volumetric air flowrate to calculate a THC mass flow rate (pounds per hour as propane) for each test period.

Throughout each test period, a sample of the gas from each measurement location was delivered to a dedicated Thermo Environmental Instruments, Inc. (TEI) Model 51 Total Hydrocarbon Analyzer using an extractive gas sampling system and heated Teflon® sample line equipped with a heating element and temperature controller to maintain the temperature of the sample line at approximately 250°F. The sampled gas streams were not dried prior to being introduced to the FIA instruments; therefore, THC concentration measurements correspond to standard conditions with no moisture correction. Instrument response for each analyzer was recorded on an ESC Model 8816 data logging system that monitors the analog output of the instrumental analyzers continuously and logs data as one-minute averages.

Prior to the first test period, appropriate high-range, mid-range and low-range span gases (USEPA protocol 1 certified calibration gases of propane in air) followed by a zero gas (hydrocarbon free air) were introduced into each sampling system to verify instrument response and sampling system integrity. The calibration gas was delivered to the sampling system through a spring-loaded check valve and a stainless steel “Tee” installed at the base of the sample probe. At the conclusion of each test period, instrument calibration was verified against mid-range and low-range calibration gases and zero gas. A STEC Model SGD-710C 10-step gas divider was used to obtain intermediate calibration gas concentrations as needed.

The scale for the FIA instrument used for the RTO exhaust gas was set to 100 ppm. The calibration error test was performed based on a 0-100 ppmv span and an additional calibration error test injection was performed at 11.96 ppmv to verify accuracy of the instrument at the lower end of the measurement range.

The average instrument reading for each test period was adjusted for calibration bias based on the pre-test and post-test calibration error test results.

Appendix E provides diagrams and a description of the USEPA Method 25A sample trains.



#### **4.7 VOC Capture Efficiency Determination**

Ventilation or air current smoke tubes were used to observe the direction of air flow for the air collection systems associated with the chain-on-edge spray booths and ovens (COE#2 and COE#3), large dip-drain room and curing oven, hand spray booths, and batch oven.

The smoke tube was placed in front of each natural draft opening, an adequate amount of smoke was generated manually using the squeeze bulb, and the direction of air flow was noted (into or out of the natural draft opening). All natural draft openings for each process were tested and recorded on a data sheet.

Appendix D provides coating line enclosure drawings and field data sheets that were used to identify natural draft openings and record the direction of airflow.

#### **4.8 Quality Assurance Procedures**

Accuracy of the instrumental analyzers used to measure THC concentration was verified prior to and at the conclusion of each test period using the calibration procedures in Method 25A.

The Pitot tubes used for velocity pressure measurements were inspected for mechanical integrity and physical design prior to the field measurements. The gas velocity measurement train (Pitot tube, connecting tubing and incline manometer) was leak-checked prior to the field measurements and periodically throughout the testing period.

The Nutech® Model 2010 sampling console and dry gas meter, which was used to extract a metered amount of exhaust gas from the RTO exhaust stack was calibrated prior to and after the test event. The calibration procedure uses the critical orifice calibration technique presented in USEPA Method 5. The digital pyrometer in the Nutech metering console was calibrated using a NIST traceable Omega® Model CL 23A temperature calibrator.

Appendix F provides quality assurance and calibration records for the sampling equipment used during the test periods, including gas divider and instrumental analyzer calibration records, calibration gas certificates, Pitot tube inspection sheets and meter box calibrations.

## 5.0 TEST RESULTS AND DISCUSSION

### 5.1 RTO VOC Destruction Efficiency

The THC concentration in the RTO inlet and exhaust gas streams was monitored simultaneously to determine the VOC mass flowrate entering and exiting the emission control system. Three (3) one-hour sampling periods were performed.

Air flowrate measurements were performed near the beginning and end of each one-hour test period. Gas molecular weight measurements (fixed gases and moisture determinations) were performed for each one-hour test period.

The VOC mass flowrate into and out of the RTO emission control system was calculated using the following equation:

$$M_{VOC} = Q [C_{VOC}] (MW_{C_3}) (60 \text{ min/hr}) / V_M / 1E+06$$

Where:  $M_{VOC}$  = Mass flowrate VOC (lb/hr)  
 $Q$  = Volumetric flowrate (scfm)  
 $C_{VOC}$  = THC concentration (ppmv  $C_3$ )  
 $MW_{C_3}$  = Molecular weight of propane (44 lb/lb-mol)  
 $V_M$  = Molar volume of ideal gas at standard condition (385 scf/lb-mol)

The THC destruction efficiency of the RTO emission control system was determined for each test period using the following equation:

$$DE = [1 - (M_{VOC \text{ in}} / M_{VOC \text{ out}})] * 100\%$$

Where:  $DE$  = VOC destruction efficiency (%wt)  
 $M_{VOC \text{ in}}$  = VOC mass flowrate into the RTO (lb/hr)  
 $M_{VOC \text{ out}}$  = VOC mass flowrate exhausted from the RTO (lb/hr)

A TEI Model 55i Methane / Nonmethane hydrocarbon analyzer was also used to sample and analyze the RTO exhaust gas for the determination of methane content. The measured exhaust gas methane concentration was negligible (generally less than 1 ppm). Therefore, the methane subtraction procedures specified in the test plan were not used and the VOC destruction efficiency calculations were based on measured THC mass flow into and out of the RTO system.

Recorded data (flowrate and instrument response) and calculations for each test period are presented in Appendix G. The calculated VOC destruction efficiency ranged between 95.5 and 95.6% and averaged 95.6%. The lowest recorded RTO operating temperature during any of the one-hour test periods was 1,535°F and the average chamber temperature was 1,544°F.

For coating operations controlled by an add-on emission control device, the conditions of the general Permit to Install for coating lines (PTI No. 169-07) require PMF to maintain a minimum RTO combustion chamber temperature of 1,400°F (three-hour average) and an overall minimum VOC reduction of 76% by weight. The results of the May 20, 2015 test event demonstrate compliance with the permit requirements.

Based on these results, PMF will calculate its VOC/HAP emissions using an overall control efficiency of 95.6% by weight for the processes that were included in this test event provided the air collection system is properly operating and the RTO combustion chamber is maintained at a minimum temperature of 1,535°F.

Table 5.1 presents measured gas conditions and VOC destruction efficiency results for each RTO test periods.

## **5.2 VOC Capture Efficiency**

The results of the capture efficiency evaluation are presented in Table 2.2. All enclosures that are connected to the VOC collection system exhibited inward flow as indicated by the observation of air current smoke.

For the COE#3 oven, two of the natural draft openings (NDO) initially exhibited turbulence due to impingement drying air being blown onto the conveyor chain near the NDO (i.e., air is drawn into the oven through the openings but the flow is turbulent at the opening interface). PMF maintenance staff installed metal plates to cover the impingement air slots at these openings to reduce the turbulent effect so that each NDO exhibited a more stable inward flow as indicated the air current smoke.

The data sheets in Appendix D identify the two openings at which the metal covers were installed.

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

The testing was performed in accordance with the Test Plan dated April 1, 2015 and the MDEQ-AQD test plan approval letter. During the testing program the coating lines were operated at normal operating conditions, at or near maximum capacity and satisfied the parameters specified in the MDEQ-AQD test plan approval letter with the exception noted below.

COE#3 was not scheduled for production on the day of testing and was setup to spray a mixture of coating and solvent during the test periods (no parts were loaded on the line).

Table 5.1 Measured gas conditions and VOC destruction efficiency test results for the RTO emission control system

Test No.	Test 1	Test 2	Test 3	Avg
Date	5/20/15	5/20/15	5/20/15	
Test Times	13:46-14:46	15:13-16:13	16:36-17:36	
<b>RTO Operating Temperatures</b>				
RTO Temperature Setpoint (°F)	1,550	1,550	1,550	1,550
Lowest Recorded Temperature (°F)	1,538	1,535	1,536	1,536
Average Recorded Temperature (°F)	1,545	1,544	1,544	1,544
<b>Collection System Parameters</b>				
Fan Speed (Hz)	38.9	39.5	39.1	39.2
Inlet Duct Vacuum (in. wc)	-3.6	-3.5	-3.6	-3.6
<b>RTO Inlet Gas Stream</b>				
Temperature (°F)	86	93	93	91
Flowrate (scfm)	33,352	32,918	32,366	32,879
Average THC Conc. (ppmv C <sub>3</sub> )	468	325	382	392
Calculated VOC Mass Flow (lb/hr)	107	73.5	84.9	88.5
<b>RTO Exhaust Gas Stream</b>				
Temperature (°F)	193	201	205	200
Flowrate (scfm)	39,600	39,578	39,197	39,458
Average THC Conc. (ppmv C <sub>3</sub> )	17.6	11.8	13.9	14.4
Calculated VOC Mass Flow (lb/hr)	4.78	3.20	3.74	3.91
<b>Calculated Destruction Efficiency</b>				
1 - [VOC <sub>out</sub> / VOC <sub>in</sub> ] x 100%	95.5%	95.6%	95.6%	95.6%