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AIR EMISSION TEST REPORT
FOR THE
VERIFICATION OF VOLATILE ORGANIC COMPOUND CAPTURE AND DESTRUCTION EFFICIENCY

Prepared for:

Pioneer Metal Finishing – Stephens Road
SRN N6388

Test Date: September 15, 2022

ICT Project No.: 2100181
September 30, 2022

IMPACT
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Report Certification

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VERIFICATION OF VOLATILE ORGANIC COMPOUND
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Pioneer Metal Finishing – Stephens Road
Warren, MI

Report Certification

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

Impact Compliance & Testing, Inc.

Tyler J. Wilson
Senior Project Manager

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1.0 Introduction

Pioneer Metal Finishing (PMF) operates several metal parts coating lines that apply solvent based coatings at its Stephens Road facility located in Warren, Macomb County, Michigan. Solvent vapors are collected from these coating lines and directed to a regenerative thermal oxidizer (RTO) for the reduction of volatile organic compound (VOC) emissions.

The State of Michigan Department of Environment, Great Lakes, and Energy – Air Quality Division (EGLE-AQD) has issued to PMF Permit to Install (PTI) No. 151-05B for operation of FGRTO at the Stephens Road facility, which consists of:

- *Six (6) emissions units for coating of metal parts. The purge and cleanup solvents are included. The particulate emissions are controlled by dry filters. The VOC emissions are controlled via Non-Fugitive Enclosure (NFE) associated with each emission unit and a common regenerative thermal oxidizer (RTO).*

Air emission compliance testing was performed pursuant to conditions specified in PTI No. 151-05B for FGRTO.

The compliance testing presented in this report was performed by Impact Compliance & Testing, Inc. (ICT), a Michigan-based environmental consulting and testing company. ICT representatives Tyler Wilson, Blake Beddow, and Andrew Eisenberg performed the field sampling and measurements September 15, 2022.

Compliance testing was performed for FGRTO (FGRTO consists of six (6) emissions units for coating of metal parts). The compliance tests consisted of triplicate, one-hour sampling periods for the FGRTO RTO, for VOC (as total hydrocarbons, THC) destruction efficiency (DE), and VOC emissions. RTO Inlet and exhaust gas velocity, moisture, oxygen (O_2) content, and carbon dioxide (CO_2) content were determined for each test period to calculate VOC mass emission rates. VOC capture efficiency (CE) measurements were also performed for the coating booths during each one-hour VOC DE test period.

The exhaust gas sampling and analysis was performed using procedures specified in the Stack Test Protocol dated November 26, 2021, that was reviewed and approved by EGLE-AQD. Ms. Kaitlyn Leffert and Mr. Andrew Riley of EGLE-AQD observed portions of the compliance testing.

Questions regarding this air emission test report should be directed to:

Tyler J. Wilson
Senior Project Manager
Impact Compliance & Testing, Inc.
37660 Hills Tech Drive
Farmington Hills, MI 48331
(734) 357-8046
Tyler.Wilson@impactCandT.com

Mr. Justin Engel
EHS Coordinator
Pioneer Metal Finishing
24600 Industrial Highway
Warren, MI 48089
(586) 480-1704
JEngel@pioneermetal.com

2.0 Summary of Test Results and Operating Conditions

2.1 Purpose and Objective of the Tests

Conditions of PTI No. 151-05B require Pioneer Metal Finishing to test FGRTO for VOC DE, VOC emissions, and to verify VOC CE of each coating booth. The RTO associated with FGRTO was tested during this compliance test event.

2.2 Operating Conditions During the Compliance Tests

The testing was performed while the FGRTO processes were operated at routine, maximum achievable operating conditions. PMF representatives provided process data in 1-minute and/or 15-minute increments for each test period.

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

Process data is presented in Tables 2.1 and 6.1.

2.3 Summary of Air Pollutant Sampling Results

The FGRTO RTO inlet and exhaust gas streams were each sampled for three (3) one-hour test periods to determine VOC DE and VOC emissions during the compliance testing performed September 15, 2022.

In addition, differential pressure was measured between each non-fugitive enclosure (NFE) and the adjacent area through each natural draft opening (NDO), using a differential pressure monitoring instrument and smoke tubes, to determine capture efficiency (CE) for the FGRTO coating processes.

Table 2.2 presents the average measured VOC DE and VOC emission rates for FGRTO (average of the three test periods).

Test results for each one-hour sampling period and comparison to the permitted limits are presented in Section 6.0 of this report.

Table 2.1 Average process operating conditions during the test periods

Emission Unit	RTO Retention Time (sec)	Coating Usage (gal)	RTO Combustion Chamber Temp. (°F)	RTO Fan Variable Frequency Drive (Hz)
FGRTO	15	31.5	1,584	30.1

Table 2.2 Average measured VOC DE and VOC emission rates (three-test average)

Emission Unit	VOC DE (%)	VOC Emissions (lb/hr)	VOC Emissions (tpy)
FGRTO	93	3.88	4.03*
Permit Limit	***95***	**-**	***9.3***

Note: VOC emissions (tpy) were calculated using estimated, worst-case-scenario facility operating hours (40 hours per week; 52 weeks per year).

3.0 Source and Sampling Location Description

3.1 General Process Description

PMF is permitted to operate FGRTO at its Stephens Road facility. FGRTO consists of six (6) emissions units for coating of metal parts. The purge and cleanup solvents are included. The particulate emissions are controlled by dry filters. The VOC emissions are controlled via NFE associated with each emission unit and a common RTO.

3.2 Rated Capacities and Air Emission Controls

All of the spray booths, except the small dip drain line (EU-03) currently exhaust to the RTO. The RTO is a Durr Model No. RL50 with a flow capacity of 50,000 standard cubic feet per minute (scfm) and a design VOC (as THC) DE of 95% by weight. Prior to this compliance test event, the RTO was required to maintain a minimum combustion zone temperature of 1,535°F (from the most recent acceptable stack test; May 20, 2015). Following this compliance test event, the RTO is required to maintain a minimum combustion zone temperature of 1,584°F. The RTO maintains a nominal resistance time of approximately 0.5 seconds. Exhaust gas from the RTO is discharged through a vertical exhaust stack.

3.3 Sampling Locations

The sample ports for the RTO inlet stack for FGRTO are located in a horizontal section of the duct, with an inner diameter of 52.0 inches. The RTO inlet stack is equipped with two (2) sample ports, opposed 90°, that provide a sampling location at least 0.5 duct diameters upstream and at least 2.0 duct diameters downstream from any flow disturbance.

The sample ports for the RTO exhaust stack for FGRTO are located in a vertical section of the duct, with an inner diameter of 64.25 inches. The RTO exhaust stack is equipped with two (2) sample ports, opposed 90°, that provide a sampling location at least 0.5 duct diameters upstream and at least 2.0 duct diameters downstream from any flow disturbance.

All sample port locations satisfy the USEPA Method 1 criteria for a representative sample location. Individual traverse points were determined in accordance with USEPA Method 1.

Appendix 1 provides diagrams of the emission test sampling locations with actual stack dimension measurements.

4.0 Sampling and Analytical Procedures

A Stack Test Protocol for the air emission testing was reviewed and approved by 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	RTO inlet and exhaust gas velocity measurement locations were determined based on the physical stack arrangement and requirements in USEPA Method 1.
USEPA Method 2	RTO inlet and 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. RTO inlet gas dry molecular weight was determined as specified in Section 8.6 of Method 2.
USEPA Method 4	RTO inlet gas moisture content was determined using wet bulb / dry bulb temperature measurements. RTO exhaust gas moisture content was determined based on the water weight gain in chilled impingers.
USEPA Method 3A	RTO exhaust gas O_2 and CO_2 content was determined using paramagnetic and infrared instrumental analyzers, respectively.
USEPA Method 25A	RTO inlet and exhaust gas VOC (as THC) concentration was determined using flame ionization analyzers (FIA) compared to a propane standard.

4.2 RTO Inlet and Exhaust Gas Velocity Determination (USEPA Method 2)

The RTO inlet and exhaust stack gas velocities and volumetric flow rates were determined using USEPA Method 2 once during 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 throughout the test periods to verify the integrity of the measurement system.

The absence of significant cyclonic flow at each sampling location 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 gas flowrate calculations and field data sheets.

4.3 RTO Inlet Gas Molecular Weight Determination (USEPA Method 2)

The RTO inlet gas consists of gas that has been exhausted from the Stephens Road facility (i.e., prior to the RTO combustion source). This gas is expected to have ambient air concentrations of O_2 and CO_2. CO_2 and O_2 content for the RTO inlet was determined using a dry molecular weight of 29.00 per Section 8.6 in USEPA Method 2.

4.4 RTO Exhaust Gas Molecular Weight Determination (USEPA Method 3A)

CO_2 and O_2 content in the RTO exhaust gas stream were measured continuously throughout each test period in accordance with USEPA Method 3A. The CO_2 content of the exhaust was monitored using a Servomex 1440D infrared gas analyzer. The O_2 content of the exhaust was monitored using a Servomex 1440D gas analyzer that uses a paramagnetic sensor.

During each sampling period, a continuous sample of the RTO exhaust gas stream was extracted from the stack using a stainless-steel probe connected to a Teflon® heated sample line. The sampled gas was conditioned by removing moisture prior to being introduced to the analyzers; therefore, measurement of O_2 and CO_2 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.

Appendix 4 provides O_2 and CO_2 calculation sheets. Raw instrument response data are provided in Appendix 5.

4.5 RTO Inlet and Exhaust Gas Moisture Content (USEPA Method 4)

Moisture content of the RTO inlet gas was determined using the USEPA Method 4 approximation technique consisting of wet bulb / dry bulb temperature measurements using a type-K thermocouple and calibrated digital pyrometer in conjunction with a psychometric chart.

Moisture content of the RTO exhaust gas was determined in accordance with USEPA Method 4 using a chilled impinger sampling train. Exhaust gas moisture content measurements were performed concurrently with the instrumental analyzer sampling periods. At the conclusion of each sampling period the moisture gain in the impingers was determined gravimetrically by weighing each impinger to determine net weight gain.

4.6 RTO Inlet and Exhaust Gas VOC Measurements (USEPA Method 25A)

VOC concentrations were determined by measuring the THC concentrations in the RTO Inlet and Exhaust gases. THC pollutant concentration was determined using Thermo Environmental Instruments, Inc. (TEI) 51 flame ionization analyzers (FIA). The concentration of THC in the sampled gas streams is determined relative to a propane standard using flame ionization detectors in accordance with USEPA Method 25A.

Samples of the RTO inlet and exhaust gases were delivered directly to the instrumental analyzers using the Teflon® heated sample lines to prevent condensation. The samples to the THC analyzers were not conditioned to remove moisture. Therefore, VOC measurements correspond to standard conditions with no moisture correction (wet basis).

Prior to, and at the conclusion of each test, the instruments were calibrated using mid-range calibration (propane) and zero gas to determine analyzer drift (described in Section 5.0 of this document).

Measured VOC concentrations in the RTO inlet gas and RTO exhaust gas flowrates were used to calculate VOC mass emission rates (tons per year, tpy) for comparison to the VOC emission rate permit limit.

In addition, measured VOC concentrations in the RTO inlet and exhaust gases, and RTO inlet and exhaust gas flowrates, were used to calculate VOC DE for comparison to the VOC DE permit limit.

Appendix 4 provides VOC calculation sheets. Raw instrument response data for the THC analyzers is provided in Appendix 5.

5.0 QA/QC Activities

5.1 Flow Measurement Equipment

Prior to arriving onsite (or onsite prior to beginning compliance testing), the instruments used during the source test to measure exhaust gas properties and velocity (pyrometer, Pitot tube, and scale) were calibrated to specifications in the sampling methods.

5.2 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.

5.3 Instrumental Analyzer Interference Check

The instrumental analyzers used to measure 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 measured interferent gases. No major analytical components of the analyzers have been replaced since performing the original interference tests.

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_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.

At the beginning of each test day, appropriate high-range, mid-range, and low-range span gases followed by a zero gas were introduced to the THC analyzers, in series at tee connections, which are installed between the sample probes and the particulate filters, through poppet check valves. After each one-hour test period, mid-range and zero gases were re-introduced in series at the tee connections in the sampling systems to check against the method's performance specifications for analyzer drift.

The instruments were calibrated with USEPA Protocol 1 certified concentrations of CO_2 and O_2 in nitrogen and zeroed using hydrocarbon free nitrogen. The THC (VOC) instruments were calibrated with USEPA Protocol 1 certified concentrations of propane in air and zeroed using

hydrocarbon-free air. A STEC Model SGD-710C ten-step gas divider was used to obtain intermediate calibration gas concentrations as needed.

5.5 Determination of RTO Inlet/Exhaust Gas Stratification

A stratification test was performed for the RTO inlet and exhaust stacks. The stainless-steel sample probe was positioned at sample points correlating to 16.7, 50.0 (centroid), and 83.3% of the stack diameter. Pollutant concentration data were recorded at each sample point for a minimum of twice the maximum system response time.

The recorded concentration data for the RTO inlet and exhaust stacks indicated that the measured air pollutant concentrations did not vary by more than 5% of the mean across the stack diameter. Therefore, the RTO inlet and exhaust gas streams were considered to be unstratified and the compliance test sampling was performed at a single sampling location within each RTO stack.

5.6 System Response Time

The response time of the sampling system was determined prior to the compliance test program by introducing upscale gas and zero gas, in series, into the sampling system using a tee connection at the base of the sample probe. The elapsed time for the analyzer to display a reading of 95% of the expected concentration was determined using a stopwatch.

Sampling periods did not commence until the sampling probe had been in place for at least twice the greatest system response time.

5.7 Meter Box Calibrations

The dry gas meter sampling console used for moisture testing was calibrated prior to and after the testing program. This calibration uses 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 metering console was calibrated using a NIST traceable Omega® Model CL 23A temperature calibrator.

Appendix 6 presents test equipment quality assurance data (instrument calibration and system bias check records, calibration gas certifications, interference test results, meter box calibration records, and field equipment calibration records).

6.0 Results

6.1 Test Results and Allowable Limits

Process operating data and air pollutant measurement results for each one-hour test period are presented in Table 6.1.

FGRTO has the following allowable emission limits specified in PTI No. 151-05B:

- 9.3 tpy and 95% DE for VOC.

The measured VOC emission rate (tpy) for FGRTO is less than the allowable limit specified in PTI No. 151-05B.

The measured VOC DE (%) for FGRTO does not achieve the minimum allowable limit specified in PTI No. 151-05B.

The measured VOC CE for all FGRTO coating booths was considered satisfactory, with regards to smoke tube testing of each NDO for each NFE.

The measured VOC CE for all FGRTO coating booths was considered satisfactory (except for the chain on edge (COE) process (EU-12) oven (all three (3) tests), the large dip drain (EU-02) booth port (all three (3) tests) and oven (one (1) test), which do not meet the PTI No. 151-05B specified criteria of -0.007 inches of water), with regards to the differential pressure monitoring instrument of each NDO for each NFE.

Appendix 7 provides VOC CE field data sheets.

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 Stack Test Protocol. The FGRTO processes were operated at routine, maximum achievable operating conditions and no variations from normal operating conditions occurred during the test periods.

Table 6.1 Measured exhaust gas conditions, VOC DE, and VOC emission rates for FGRTO

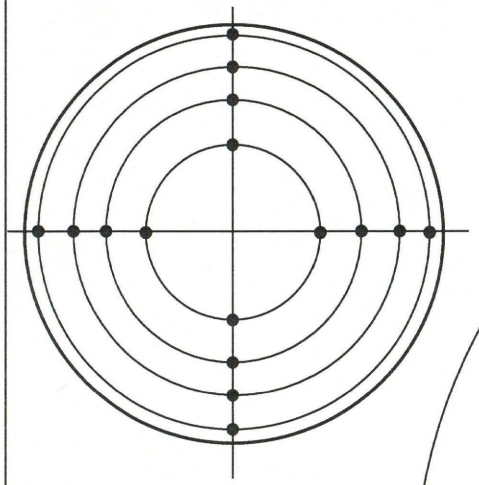
Test No.	1	2	3	
Test date	9/15/2022	9/15/2022	9/15/2022	Three Test
Test period (24-hr clock)	1053-1153	1243-1343	1406-1506	Average
RTO retention time (sec)	15	15	15	15
Coating usage (gal)	29.63	36.50	28.38	31.50
RTO chamber temperature (°F)	1,585	1,584	1,584	1,584
RTO fan variable freq. drive (Hz)	31.2	29.1	29.8	30.1
RTO Inlet Gas Composition				
CO_2 content (% vol)	0.00	0.00	0.00	0.00
O_2 content (% vol)	20.9	20.9	20.9	20.9
Moisture (% vol)	1.5	1.4	1.3	1.4
RTO Inlet gas temperature (°F)	84.6	89.5	92.4	88.8
RTO Inlet gas flowrate (dscfm)	24,601	24,624	24,231	24,485
RTO Inlet gas flowrate (scfm)	24,980	24,973	24,540	24,831
RTO Exhaust Gas Composition				
CO_2 content (% vol)	0.39	0.38	0.40	0.39
O_2 content (% vol)	20.8	20.8	20.8	20.8
Moisture (% vol)	1.5	2.2	1.9	1.9
RTO Exhaust gas temperature (°F)	168	169	172	170
RTO Exhaust gas flowrate (dscfm)	35,213	29,445	28,290	30,983
RTO Exhaust gas flowrate (scfm)	35,747	30,093	28,834	31,558
Volatile Organic Compounds				
Inlet VOC (ppmv)	330	331	346	336
Inlet VOC (lb/hr)	56.7	56.7	58.4	57.3
Exhaust VOC (ppmv)	16.2	19.2	18.5	18.0
Exhaust VOC (lb/hr)	3.99	3.97	3.67	3.88
Exhaust VOC (tpy)*	4.15	4.13	3.82	4.03
VOC permit limit (tpy)	-	-	-	*9.3*
VOC DE (%)	93	93	94	93
VOC DE permit limit (%)	-	-	-	*95*

Note: VOC emissions (tpy) were calculated using estimated, worst-case-scenario facility operating hours (40 hours per week; 52 weeks per year).

APPENDIX 1

- Sample Port Diagrams

Velocity sample locations as measured from stack wall



Pt. #	in.
1	1.66
2	5.46
3	10.08
4	16.80
5	35.20
6	41.91
7	46.54
8	50.34

PMF - Stephens Road
RTO Inlet Sample Location

Scale	Sheet
None	1 of 1

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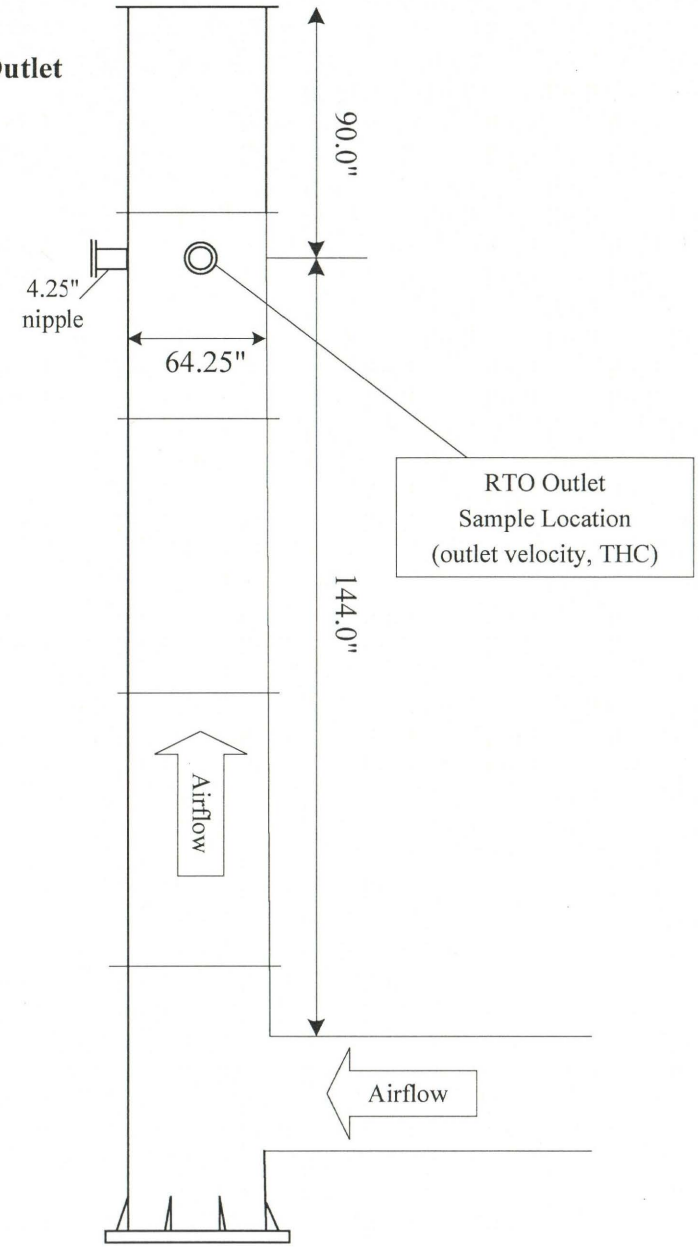
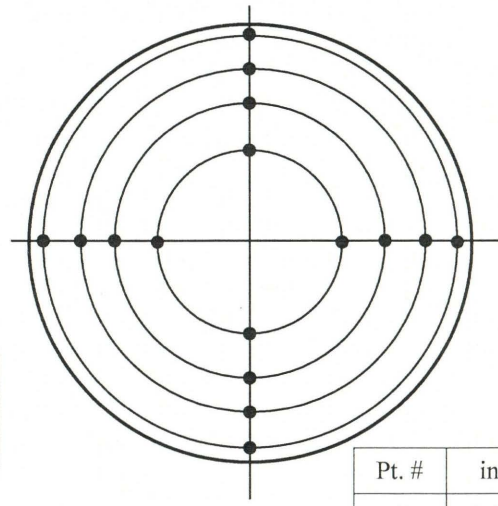
RTO Outlet



Velocity sample locations as measured from stack wall



Pt. #	in.
1	2.06
2	6.75
3	2.47
4	20.75
5	43.50
6	51.79
7	57.50
8	62.19

PMF - Stephens Road
RTO Exhaust Sample Location

Scale	Sheet
None	1 of 1

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