DETERMINATION OF CAPTURE EFFICIENCY VERIFICATION AND OXIDIZER DESTRUCTION EFFICIENCY

UNIVERSAL COATING, INC.
FLINT, MICHIGAN

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H & H MONITORING, INC.

DETERMINATION OF CAPTURE EFFICIENCY VERIFICATION AND OXIDIZER DESTRUCTION EFFICIENCY

PREPARED FOR:

UNIVERSAL COATING, INC.
5204 ENERGY DRIVE
FLINT, MICHIGAN 48505

SUBMITTED:

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HHMI PROJECT NO. 2104-001

PREPARED BY:

H & H MONITORING, INC.
17022 BETHEL CHURCH ROAD
MANCHESTER, MICHIGAN 48158
(734) 428-9659

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EXECUTIVE SUMMARY

H & H Monitoring, Inc. (HHMI) was retained by Universal Coating, Inc. (UCI) to perform an emissions evaluation of the volatile organic compound (VOC) emissions control systems at their Flint, Michigan facility. The purpose of this testing is to provide emissions and equipment performance data to demonstrate compliance with Renewable Operating Permit (ROP) No. MI-ROP-N7256-2017b, Permit to Install (PTI) No. 184-20, and 40 CFR Part 63, Subparts MMMM and PPPP as referenced by the permits.

The testing was performed in accordance with the procedures stipulated in USEPA Reference Methods. HHMI professionals conducted the field services on November 2 and 3, 2021. Representatives of UCI coordinated the testing with plant operations. NTH Consultants assisted with the testing program. Michigan Department of Environment, Great Lakes and Energy (EGLE) observed the onsite testing.

SUMMARY OF RESULTS

RTO DESTRUCTION EFFICIENCY AND COATING LINES PTE VERIFICATION		VALUE
NMVOC Destruction Efficiency		
VOC Entering the RTO (lbs/hr)		129.6
NMVOC Exiting the RTO (lbs/hr)		2.37
NMVOC Destruction Efficiency (% by weight)		**98.2%**
Facial Velocity of all natural draft openings (NDOs) (Using RTO Inlet Air Flow)		
Total Captured Exhaust Gas Flow (RTO Inlet acfm)		29,438
Area of all Coating Lines NDOs (sqr ft)		138.98
Average Air Velocity Through All NDOs		**211.82**
Spindle Line 1 PTE VERIFICATION	**Measured Value**	**Meets Criteria**
NDO area to enclosure area ratio (NEAR) ≤ 0.05	0.02	Yes
Average NDO Velocity ≥ 200 ft/min	250.24	Yes
Air Flow Direction through NDOs	Inward	Yes
All exhaust gases from enclosure directed to control device	Yes	Yes
Assume 100% Capture Efficiency		**Yes**
Spindle Line 2 PTE VERIFICATION	**Measured Value**	**Meets Criteria**
NDO area to enclosure area ratio (NEAR)	0.02	Yes
Average NDO Velocity	324.87	Yes
Air Flow Direction through NDOs	Inward	Yes
All exhaust gases from enclosure directed to control device	Yes	Yes
Assume 100% Capture Efficiency		**Yes**
Spindle Line 3 PTE VERIFICATION	**Measured Value**	**Meets Criteria**
NDO area to enclosure area ratio (NEAR)	0.03	Yes
Average NDO Velocity	267.14	Yes
Air Flow Direction through NDOs	Inward	Yes
All exhaust gases from enclosure directed to control device	Yes	Yes
Assume 100% Capture Efficiency		**Yes**

Spindle Line 4 PTE VERIFICATION	Measured Value	Meets Criteria
NDO area to enclosure area ratio (NEAR)	0.01	Yes
Average NDO Velocity	378.51	Yes
Air Flow Direction through NDOs	Inward	Yes
All exhaust gases from enclosure directed to control device	Yes	Yes
Assume 100% Capture Efficiency		**Yes**
Spindle Line 5 PTE VERIFICATION	**Measured Value**	**Meets Criteria**
NDO area to enclosure area ratio (NEAR)	0.01	Yes
Average NDO Velocity	277.01	Yes
Air Flow Direction through NDOs	Inward	Yes
All exhaust gases from enclosure directed to control device	Yes	Yes
Assume 100% Capture Efficiency		**Yes**
Spindle Line 6 PTE VERIFICATION	**Measured Value**	**Meets Criteria**
NDO area to enclosure area ratio (NEAR)	0.01	Yes
Average NDO Velocity	295.80	Yes
Air Flow Direction through NDOs	Inward	Yes
All exhaust gases from enclosure directed to control device	Yes	Yes
Assume 100% Capture Efficiency		**Yes**
Spindle Line 7 PTE VERIFICATION	**Measured Value**	**Meets Criteria**
NDO area to enclosure area ratio (NEAR)	0.01	Yes
Average NDO Velocity	295.21	Yes
Air Flow Direction through NDOs	Inward	Yes
All exhaust gases from enclosure directed to control device	Yes	Yes
Assume 100% Capture Efficiency		**Yes**

The Roll Coater and two Tumble Spray coaters are fully enclosed, are exhausted to the RTO and have no NDOs. PTE verification was not performed, and 100% capture efficiency is assumed.

Consistent with PTE verification conducted on January 31, 2017, at the source, and based upon a telephone conversation between Mr. Bob Byrnes of EGLE and Ms. Julie Taylor of UCI on November 12, 2021, EGLE is not requiring for UCI, the minimum distance of four equivalent opening diameters from the VOC emitting point to an NDO.

1.0 INTRODUCTION

HHMI conducted a volatile organic compounds (VOC) capture verification and destruction efficiency study on the VOC Control System for the coating processes at the UCI facility located in Flint, Michigan. In accordance with ROP No. MI-ROP-N7256-2017b, PTI No. 184-20, and 40 CFR Part 63, Subparts MMMM and PPPP, UCI is required to demonstrate, by testing, that the VOC control system is following requirements for capture and destruction efficiency. The abatement system includes permanent total enclosures (PTEs), fume hoods, ductwork, and fans, which direct the VOC emissions from the coating processes to VOC Abatement System, a regenerative thermal oxidizer (RTO).

Verification of the permanent total enclosures (PTE) was conducted to confirm assumption of 100% VOC capture efficiency at the permanent total enclosures (PTEs) and VOC testing for destruction efficiency (DE) at the regenerative thermal oxidizer (RTO). Emission units that are controlled by the RTO include Spindle Lines 1 through 7 (EU-CE1 through EU-CE7), a Roll Coat line (EU-RC) and Tumble Spray Lines 3 and 4 (EU-TS3 and EU-TS4). Note, however, the Roll Coat line and Tumble Spray Lines 3 and 4 are completely enclosed; PTE verification was not conducted for these lines. Additionally, Tumble Spray Lines 3 and 4 were not operating during destruction efficiency testing. The test protocol submitted to EGLE on August 19, 2021, included discussion that *"in the event staffing is not available, as a priority, UCI will run the new lines first and then as staffing allows, will run as many of the remaining lines as possible."*

Messrs. Brad Wallace, James Ralston and Daniel Hassett performed the field services for the study on November 2 and 3, 2021. Additionally, UCI and NTH representatives recorded coating material usage and oxidizer data during the testing.

This report presents the results obtained as well as describes the techniques used in the performance of this testing study. A description of the coating processes and the abatement system are presented in Section 2.0. A discussion of sampling and analytical procedures used during the test program is provided in Section 3.0. A discussion of the project results is presented in Section 4.0. A summary of the quality assurance procedures used in the performance of this study is presented in Section 5.0. Tables 1 and 2 provide detailed summaries of the emissions testing data. Figures 1 through 5 present information regarding duct dimensions, traverse point locations, and sampling trains. Appendix A presents example calculations for Test Run 1. Appendix B includes quality assurance information. Appendix C presents calculation data spreadsheets and copies of original field data sheets. Appendix D contains copies of analyzer concentration field data. Appendix E contains the process operating data recorded during the testing. Appendix F presents the Test Plan for the test series.

Below is a listing of the personnel involved with this testing project:

UCI

Name	Function	Phone No.
Ms. Julie Taylor	Director of Quality-Risk Manager	(810) 785-7555

HHMI

Name	Function	Phone No.
Mr. Daniel L. Hassett	Project Director	(734) 428-9659
Mr. Brad Wallace	Site Leader	(734) 428-9659
Mr. James Ralston	Technician	(734) 428-9659

NTH

Name	Function	Phone No.
Ms. Rhiana Dornbos, P.E.	Senior Project Engineer	(406) 599-9177
Ms. Mary Mello	Project Professional	(248) 990-1035
Ms. Abbie Welch	Staff Engineer	(616) 450-6436

EGLE

Name	Function	Phone No.
Mr. Mark Dziadosz	Environmental Quality Analyst	(586) 753-3745
Mr. Robert Byrnes	Environmental Engineer Spl	(517) 275-0439

2.0 PROCESS DESCRIPTION

UCI's Flint, Michigan facility provides parts coating services. For Spindle Lines 1 through 7, various individual parts are loaded onto an automatic spindle conveyance system. The conveyor moves the parts through differing stages of the finishing process depending on the type of finish to be applied to each type of part. Automatic spray booths, flash zones and bake ovens are utilized to complete the coating process. The Roll Coat line is a fully enclosed process using rollers to apply coating to flat surfaces of metal parts and then conveyed to a drying oven. The Tumble Spray Lines 3 and 4 are fully enclosed spray drums used to apply coating to parts.

Emissions from Spindle Lines 1 through 7 are contained and captured using a permanent total enclosure designed to meet the criteria detailed in USEPA Method 204 and equipped with exhaust ductwork that transfers the coating fumes to a regenerative thermal oxidizer (RTO). The Roll Coat line and Tumble Spray Lines 3 and 4 are fully enclosed and emissions are routed to the RTO. The oxidizer is a 12-chamber RTO equipped with a sequential rotary desorb system for chamber regeneration. The oxidizer operates with a design capacity of 30,000 cubic feet per minute, chamber retention time of 0.5 seconds and was operating at an average temperature of 1,570 degrees F for each of the three separate test runs. RTO data can be found in Appendix E.

3.0 SAMPLING AND ANALYTICAL PROCEDURES

Permanent total enclosure (PTE) verification for Spindle Lines 1 through 7 was performed. Total VOC was measured concurrently in the inlet and outlet ductwork of the Regenerative Thermal Oxidizer (RTO) to determine destruction efficiency. Methane was measured at the outlet of the RTO for determination of non-methane VOC.

Procedures employed for this study were conducted in accordance with the following applicable USEPA reference methodologies:

- Methods 1 and 2 to determine exhaust gas volumetric flow rates.
- Method 3 to determine exhaust gas molecular weights.
- Method 4 to determine exhaust gas moisture content.
- Method 25A to determine VOC emissions in the exhaust gases during destruction efficiency testing.

Descriptions of the procedures and methodologies performed to complete this testing project are presented individually in the following sub-sections.

3.1 VOC CONTROL SYSTEM DESTRUCTION EFFICIENCY

Destruction efficiency (DE) is expressed as the ratio of the difference between the measured inlet and outlet mass VOC emission rates divided by the mass VOC emission rate measured at the inlet. Methane was subtracted from the outlet total VOC result to obtain the non-methane VOC (NMVOC). The inlet to the RTO is at basic ambient conditions with no combustion processes, therefore no methane could be present in the ductwork upstream of the RTO, so no methane measurements were made in the emissions at the RTO inlet.

The RTO DE determination of NMVOC emissions was conducted in accordance with USEPA Reference Methods. Three 60-minute test runs were conducted on the RTO inlet and outlet locations. Corresponding exhaust gas volumetric flow rate and moisture content determinations were made that correlate with each test run.

HHMI utilized total hydrocarbon analyzers (JUM VE-7 and JUM 109A) to obtain NMVOC measurements. Based on these measurements, the NMVOC destruction efficiency of the RTO was calculated.

3.2 PTE ENCLOSURE VERIFICATION

UCI constructed Spindle Lines 1 through 7 with PTEs that were measured to verify the criteria stipulated in Method 204 to assume 100% capture. HHMI documented the following information for each PTE as required by Method 204:

- Total area of the NDO
- Total area of the PTE (floor, walls, and ceiling)

- NDO area to enclosure area ratio (NEAR)
- NDO air flow velocities

HHMI monitored the NDOs to confirm inward airflow. UCI provided NDO data for each Spindle Line to confirm greater than 200 feet per minute NDO air velocity for three 60-minute periods.

Method 204, criteria 5.1, also includes a statement that any NDO shall be at least four equivalent opening diameters from each VOC emitting point unless otherwise specified by the Administrator. Consistent with PTE verification conducted on January 31, 2017, at the source, and based upon a telephone conversation between Mr. Bob Byrnes of EGLE and Ms. Julie Taylor of UCI on November 12, 2021, EGLE is not requiring for UCI the minimum distance of four equivalent opening diameters from the VOC emitting point to an NDO.

The Roll Coat line and Tumble Spray Lines 3 and 4 are completely enclosed with no NDOs and all fumes generated by the lines exhausted to the RTO. Therefore, PTE verification was not conducted on the Roll Coat and Tumble Spray lines.

3.3 SAMPLING LOCATIONS

Spindle Lines 1 through 7, the Roll Coat and Tumble Spray 3 and 4 lines are connected to a manifold system that directs the coating fumes to a main duct (48" ∅) leading to the oxidizer. Test ports are installed on the 48-inch diameter inlet duct to the RTO. The ports are located approximately 53 inches (1.12 duct diameters) downstream from a 90° elbow and approximately 39 inches (0.82 duct diameters) upstream from a 90° elbow.

Test ports are installed on the 30-inch by 52.5-inch rectangular RTO exhaust stack. The ports are located approximately 65 inches (1.02 equivalent duct diameters) downstream from a 90° elbow and approximately 125 inches (3.28 equivalent duct diameters) upstream from the stack exit.

Figures 1 and 2 depict test port locations and duct/stack layout.

3.4 USEPA TEST METHODS AND PROCEDURES

Testing procedures employed during the performance of this study were conducted in accordance with USEPA Methods 1, 2, 3, 4, 25A and 204. A summary of the test procedures is presented below.

Method 1, "*Sample and Velocity Traverses for Stationary Sources,*" was used to determine the number of traverse points for flow rate measurement at each sampling location. The number of upstream and downstream stack/duct diameters from the sampling ports to the nearest flow disturbance was determined. Based on these determinations, the appropriate number of traverse points was chosen for the purpose of determining the volumetric flow rate of the flue gas. The sample port locations and the upstream and downstream stack diameters are depicted in Figures 1 and 2.

Method 2, "*Determination of Stack Gas Velocity and Volumetric Flow Rate (Type-S Pitot Tube)*," was used to measure velocity pressures and temperatures at each traverse point. A calibrated Type-S pitot tube equipped with a thermocouple was positioned at each of the traverse points and the exhaust gas temperature and velocity pressure were measured and recorded. The Type-S Pitot tube was calibrated in accordance with the specifications outlined in Method 2. Measurement readings were made on a manometer capable of measuring to the nearest 0.01 inch of water. Temperature readings were made using a calibrated pyrometer.

The average stack gas velocity is a function of average velocity pressure, absolute stack pressure, average stack temperature, molecular weight of the wet stack gas, and Pitot tube coefficient. Determination of average stack gas velocity was performed in accordance with equations presented in Method 2. Actual exhaust gas flow rate was determined from the average stack gas velocity and stack dimensions. Exhaust gas flow rate data from the stack are presented in Appendix C.

Method 3, (*Gas Analysis for the Determination of Dry Molecular Weight),* was used to determine the molecular weight of the flue gas. Grab samples of the exhaust gas were collected and analyzed for oxygen (O_2) and carbon dioxide (CO_2) concentrations using a Fyrite combustion gas analyzer.

The dry molecular weight of the stack gas was calculated based on the assumption that the primary constituents are oxygen, carbon dioxide, and nitrogen (other compounds present have a negligible relative effect on molecular weight). Having measured the oxygen and carbon dioxide concentrations, the percent stack gas was then equal to the sum of each constituent compound's molecular weight (lb/lb-mole) multiplied by its respective concentration.

Method 4, "*Determination of Moisture Content in Stack Gases*," was used to measure the moisture in the exhaust gases at each of the sampling locations.

For the RTO inlet location, moisture content in the exhaust gases for the abatement system was determined using the wet-bulb/dry-bulb stoichiometric calculation procedure described in Method 4.

RTO exhaust gas moisture content was determined by extracting a measured volume of the exhaust gas, which was pulled through a series of chilled impingers. The impingers were packed in ice to facilitate the condensation of the stack gas moisture. Before each test run the impingers were weighed and those weights recorded. After each test run the same procedure was repeated. The difference of the sums of the pre-test and post-test weights represents the amount of water condensed.

The moisture concentration in the stack gas was calculated based on the volume of gas sampled and the water condensed. The percent moisture by volume in the stack gas, at standard temperature and pressure (68 degrees Fahrenheit and 29.92 inches of mercury), was calculated using the equations stipulated in this test method. A sketch depicting the moisture measurement train is presented in Figure 3.

Method 25A, "*Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer*," was used to measure VOC emissions concentrations each of the sampling locations. Test locations included the main inlet duct leading to the RTO and the RTO exhaust stack. JUM Engineering flame ionization detectors (FID) were used to conduct testing. Continuous samples were withdrawn from the sample locations through a probe, heated sample line, and pump prior to being subjected to the ionization flame.

Each FID directs a portion of the sample through a capillary tube to the FID that ionizes the hydrocarbons to carbon. The detector determines the carbon concentration in terms of parts per million (ppm). The concentration of VOC was then converted to an analog signal (voltage) and recorded on a computerized data acquisition system at 2-second intervals. The data were then averaged over the test period to determine the concentration for VOC reported as equivalent units of the calibration gas (propane). A sketch depicting the JUM VE-7 measurement train is presented in Figure 4.

In addition, HHMI also measured methane in the exhaust stream of the oxidizer. The amount of methane was continuously measured using procedures consistent with USEPA Method 25A. A flame ionization analyzer equipped with a proprietary design Katalyzer® to remove non-methane organic compounds was used to measure methane. The methane results were subtracted from the VOC emissions to obtain NMVOC. To perform this calculation, the methane data must be converted to like terms of the VOC results (propane). This is achieved by developing a methane response factor to propane by introducing methane calibration gas into the VOC detector and recording the response. Calculation of the response factor can be found in Appendix B. Conversion of methane to propane using the response factor is demonstrated in Table 1. A sketch depicting the JUM 109A measurement train is presented in Figure 5.

Method 204, *"Criteria for and Verification of a Permanent or Temporary Total Enclosure,"* was used to verify the acceptability of each enclosure. The dimensions of the PTE were measured to determine the total surface area of the enclosure (floor, walls and ceiling). Then the areas of the natural draft openings followed by the distances from the NDO to the nearest VOC emission point were measured. The data collected were then used to determine if the enclosures met the criteria for a PTE.

The average NDO velocity was also calculated by dividing the actual air flow (acfm) entering the RTO by the collective total area of all NDOs for Spindle Lines 1 through 7.

4.0 DISCUSSION OF RESULTS

The PTEs on Spindle Lines 1 through 7 meet the PTE criteria stipulated in USEPA Method 204. It should be noted that during a telephone conversation with Ms. Julie Taylor on November 12, 2021, Mr. Bob Byrnes of EGLE did not require the minimum distance of four equivalent opening diameters from the VOC emitting point to the NDOs, as allowed by criteria 5.1 of Method 204.

VOC entering the RTO was measured at an average of 129.6 lb/hr while NMVOC exiting the RTO was measured at an average of 2.37 lb/hr, yielding an average DE of 98.2%.

The VOC destruction efficiency and PTE verifications are shown in the Tables portion of this report. Supplemental information for each test run is provided with the field data and calculation information in Appendix C.

5.0 QUALITY ASSURANCE

Quality assurance (QA) objectives required for this study followed applicable criteria detailed by each method used. The following sub-sections detail specific QA limitations and this study's compliance with those limitations.

Where applicable, reference method QA control procedures were followed to demonstrate creditability of the data developed. Quality assurance information for field equipment is provided in Appendix B. The procedures included, but were not limited to, the following:

- Sampling equipment was calibrated according to procedures contained in the "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III," EPA 600/R-94/038c, September 30, 1994.
- The sample trains were configured according to the appropriate test methods.
- Quality control checks of sample trains were performed on-site, including sample train and Pitot tube leak checks.
- VOC FIDs were calibrated in accordance with USEPA Method 25A. Calibration error was within the allowable limit of 5% of calibration gas value. Zero and calibration drift were both within the allowable limit of 3% of analyzer span for all test runs. FID response times (0-95% of span) were within the allowable 30 seconds, as required.

6.0 LIMITATIONS

This report is provided to Universal Coating, Inc. in response to a limited assignment. HHMI will not provide any information contained in, or associated with, this report to any unauthorized party without expressed written consent from Universal Coating, Inc., unless required to do so by law or court order. HHMI accepts responsibility for the performance of the work, specified by the limited assignment, which is consistent with others in the industry, but disclaims any consequential damages arising from the information contained in this report.

This report is intended solely for the use of Universal Coating, Inc. The scope of services performed for this assignment may not be appropriate to comply with the requirements of other similar process operations, facilities, or regulatory agencies. Any use of the information or conclusions presented in this report, for purposes other than the defined assignment, is done so at the sole risk of the user.

This emission testing survey was conducted, and report developed by the following H & H Monitoring, Inc. personnel:

Brad Wallace	James Ralston	Daniel L. Hassett
Site Leader	Technician	President