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AIR EMISSION TEST REPORT

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

Report Date: June 6, 2017

Test Dates: April 18-20, 2017

Facility Information	
Name	LexaMar Corporation
Street Address	100 LexaMar Drive
City, County	Boyne City, Charlevoix
SRN	N2812

Facility Permit Information	
Operating Permit No.:	MI-ROP-N2812-2015
Emission Units:	EU-BCPL, EU-URSAMINOR

Testing Contractor	
Company	Derenzo Environmental Services
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Project No.	1702027

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

LEXAMAR CORPORATION
BOYNE CITY, MICHIGAN

1.0 INTRODUCTION

LexaMar Corporation (LexaMar) has received State of Michigan Renewable Operating (RO) Permit No. MI-ROP-N2812-2015 for the operation of spray coating and dip coating processes at its facility located in Boyne City, Charlevoix County, Michigan (State Registration No. N2812).

Volatile organic compound (VOC) emissions from the spray and dip coating processes are collected and exhausted to an emission control system consisting of two regenerative thermal oxidizers (RTO) connected in parallel.

Conditions within the RO Permit require LexaMar to verify VOC:

- Destruction efficiency associated with the RTO emissions control system at three different operating scenarios; and
- Overall control efficiency associated with the Ursa Minor Dip Coat Line (EU-URSAMINOR) and Body Color Paint Line (EU-BCPL).

The VOC destruction and capture efficiency testing was performed April 18-20, 2017 by Derenzo Environmental Services (DES) representatives Tyler Wilson, Blake Beddow, and Tom Andrews. The project was coordinated by Mr. Daniel Anderson, LexaMar Senior Industrial Engineer. Mr. Jeremy Howe and Mr. William Rogers of the MDEQ-AQD were on-site to observe portions of the compliance testing.

The control efficiency evaluation and exhaust gas sampling and analysis was performed using procedures specified in the Test Plan dated March 16, 2017 that was submitted to the Michigan Department of Environmental Quality Air Quality Division (MDEQ-AQD) for review and approval.

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

2.0 SOURCE DESCRIPTION

2.1 Coating Line Processes

LexaMar operates spray and dip coating processes that support automobile part manufacturing operations. The primary processes consist of the Ursa Minor Dip Coat Line and the Body Color Paint Line (BCPL).

The Ursa Minor Dip Coat Line consists of cleaning tanks, two (2) dip coating tanks (prime and top coat) and two (2) curing ovens (prime and top coat ovens). Parts to be coated are loaded onto a rack conveyor, pre-cleaned in a series of dip-cleaning tanks (ultrasonic tanks operated with no emissions), and transported through the prime dip coating booth and prime curing oven. The process is repeated for the top coat. Each dip coating booth operates as a permanent total enclosure (PTE) such that all VOC that flashes off within the booth is exhausted to the RTO emissions control system. The curing oven exhausts contain a minimal amount of VOC and are released directly to the ambient air (no emissions control).

The BCPL consists of five (5) spray booths, five (5) flash-off areas, a curing oven, and an exhaust air recirculation system for the spray booths. Parts to be coated are loaded onto a rack conveyor and transported through the coating line. Paints and coatings are applied by conventional hand spray applicators, electrostatic rotary atomizers, and robotic spray guns. The interior of the BCPL operates as a PTE such that all VOC applied by the process is exhausted to the RTO emission control system.

2.2 Type of Raw Materials Used

The Ursa Minor Dip Coat Line uses a primer and topcoat system. The primer is reduced with diacetone alcohol and glycol ether PM. The topcoat is reduced with n-butyl alcohol.

The BCPL applies an adhesion promoter, base (color) coat, and clear coat. The adhesion promoter is sprayed, as received, without reduction. The base (color) coat and clear coat is reduced with n-butyl acetate prior to application to achieve a desired viscosity.

2.3 Emission Control System Description

Solvent laden process air from the Ursa Minor Dip Coat Line coating booths and the BCPL is combined and directed to the RTO emission control system. The RTO emission control system consists of two RTO units connected in parallel to the process air collection system. Each RTO unit is equipped with an isolation damper and a dedicated variable frequency drive (VFD) blower.

Each RTO unit consists of a single horizontal bed packed with ceramic heat exchange media. During normal operation, natural gas is injected into the inlet air stream, which is used as a supplemental fuel to preheat the heat exchanger bed. VOCs are oxidized as they travel through

the bed. Following VOC oxidation, the heated air flows through the second half of the bed and is cooled to less than 300°F (which raises the temperature of the heat exchange media). At preset intervals, the direction of flow through the unit is reversed and the portion of the bed that had been used to cool the air is used to preheat the incoming solvent laden air. The bed center temperature is continuously monitored and recorded.

The exhaust from each unit is combined and directed to a common 36.75-inch diameter vertical exhaust stack.

2.4 Process Operating Conditions During the Compliance Testing

During the RTO destruction efficiency test periods, the Ursa Minor Dip Coat Line processed between 711 and 2,028 parts per hour and the BCPL coated between 618 and 883 parts per hour.

The Ursa Minor Dip Coat Line processed between 1,112 and 1,239 parts per hour during the capture efficiency test periods.

Conditions during the destruction and capture efficiency tests were representative of normal operating conditions.

Destruction efficiency for the RTO emission control system was tested while:

1. RTO A operated at maximum capacity and RTO B was isolated from the coating process exhaust;
2. RTO B operated at maximum capacity and RTO A was isolated from the coating process exhaust; and
3. Both RTO A and B were operated simultaneously at approximately 50% capacity each.

During the RTO destruction efficiency test periods, a minimum 3-hour RTO combustion chamber temperature of 1,747°F was established according to 40 CFR 63.4567(a).

Table 2.1 presents a summary of the process operating conditions during the RTO destruction efficiency and Ursa Minor Dip Coat Line capture efficiency test periods.

Appendix B provides coating line production data, pressure drop measurements, material composition data sheets, and RTO temperature records.

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Table 2.1 Summary of process operating conditions during the VOC destruction and capture efficiency test periods

Date	Time	Ursa Minor (parts/hr)	BCPL (parts/hr)	RTO A Operation*	RTO B Operation*
<u>RTO Destruction Effic.</u>					
4/18/17	7:31-8:31	1,703	618	100%	Idle
4/18/17	9:16-10:16	1,037	670	100%	Idle
4/18/17	11:02-12:02	1,907	692	100%	Idle
4/18/17	12:50-13:50	1,280	638	Idle	100%
4/20/17	6:15-7:15	711	883	Idle	100%
4/20/17	8:15-9:15	1,367	759	Idle	100%
4/20/17	10:11-11:11	2,028	783	50%	50%
4/20/17	12:05-13:05	1,265	652	50%	50%
4/20/17	14:17-15:58 [†]	1,014	810	50%	50%
<u>Ursa Minor Capture Effic.</u>					
4/19/17	11:27-12:27	1,239	--	--	--
4/19/17	12:56-13:56	1,183	--	--	--
4/19/17	14:24-15:24	1,112	--	--	--

Table Notes

* Set point at 1525°F to control natural gas injection.

† Destruction efficiency Test No. 3 for RTO A/B was paused from 14:40-15:19 to load more parts.

3.0 SUMMARY OF RESULTS

3.1 Results for RTO VOC Destruction Efficiency

VOC destruction efficiency was determined for three operating scenarios: RTO A at 100% capacity (with RTO B in idle mode); RTO B at 100% capacity (with RTO A in idle mode); and RTO A and B operating simultaneously at approximately 50% capacity. The RTO inlet and exhaust gas streams were monitored simultaneously to calculate the VOC mass flowrate entering and exiting the emission control system for VOC destruction efficiency determination.

Based on the measured VOC mass flowrates the three-hour average VOC destruction efficiency for each RTO operating scenario exceeded 95% by weight as required by conditions of the RO Permit. The combustion chamber temperature setpoint for each unit was 1525°F. The actual combustion chamber temperature was recorded throughout each test period and the three-hour average combustion chamber was calculated for each operating scenario.

The VOC destruction efficiency test results are summarized in Table 3.1.

3.2 Results for Ursa Minor Dip Coat Line VOC Capture Efficiency

VOC capture efficiency for the Ursa Minor Dip Coat Line was determined by simultaneously measuring the VOC mass flowrate in the prime coat oven exhaust to atmosphere, the top coat oven exhaust to atmosphere, and captured gas stream to the RTO emissions control system.

For the Ursa Minor Dip Coat Line, conditions requested by MDEQ-AQD specify a minimum VOC capture efficiency of 90% by weight.

Based on the measured VOC mass flowrates, 95.0% of the VOC exhausted from the Ursa Minor Dip Coat Line is captured and directed to the RTO emissions control system; 5.0% of the VOC is released to atmosphere through the uncontrolled oven exhausts.

The VOC capture efficiency test results are summarized in Table 3.2.

3.3 BCPL Permanent Total Enclosure Verification

A BCPL permanent total enclosure verification (PeTE) was performed prior to the test event by LexaMar personnel, and was approved by MDEQ-AQD before testing began. The measurements made by LexaMar personnel verified that the BCPL PeTE meets USEPA Method 204 criteria.

Table 3.1 Summary of RTO VOC destruction efficiency test results and recorded operating temperature

Control System Operating Scenario	Avg. RTO A Bed Temp ¹ (°F)	Avg. RTO B Bed Temp ¹ (°F)	VOC Destruction Efficiency ¹ (% wt)
RTO A 100%	1,747	NA	98.4%
RTO B 100%	NA	1,832	95.9%
RTO A/B 50%	1,800	1,714	95.9%
Permit Limit			>95.0%

1. Three-hour average for the specified operating scenario.

Table 3.2 Summary of VOC capture efficiency test results for the Ursa Minor Dip Coat Line

Parameter	Test No.1 Results (% wt)	Test No.2 Results (% wt)	Test No.3 Results (% wt)	Average (% wt)	Permit Limit
VOC Captured	95.5%	95.1%	94.3%	95.0%	>90%

4.0 SAMPLING AND ANALYTICAL PROCEDURES

A description of the sampling and analytical procedures is provided in the Test Plan dated March 16, 2017, which was approved by the MDEQ-AQD. This section provides a summary of those procedures.

4.1 Summary of Test Procedures

Derenzo Environmental Services performed the specified pollutant measurements in accordance with the following USEPA reference test methods:

- | | |
|------------|---|
| Method 1 | Velocity and sampling locations based on physical stack 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 3A | RTO exhaust gas O ₂ and CO ₂ content determined using instrumental analyzers. |
| Method 3 | O ₂ and CO ₂ content determined by Fyrite® combustion gas analyzers (for some sampling locations). |
| Method 4 | RTO exhaust gas moisture determined based on the water weight gain in chilled impingers. All other sampling locations determined by wet bulb/dry bulb temperature measurements. |
| Method 25A | Total hydrocarbon concentration using a flame ionization analyzer (FIA) compared to a propane standard. |
| Method 204 | Physical measurements to verify permanent total enclosure design criteria. |

4.2 Sampling Locations

4.2.1 RTO VOC Destruction Efficiency Sampling Locations

The sampling location for the combined coating line exhaust (RTO inlet) is in the 43-inch diameter duct on the roof of the LexaMar facility, prior to the Y connection that connects the two RTO units to the main duct. The sampling location is approximately 18 feet downstream of the nearest flow disturbance (connection to BCPL oven exhaust) and 93 inches upstream from the nearest flow disturbance (duct elbow).

The sampling location for the RTO exhaust is in the 36.75-inch vertical exhaust stack. The sampling location is approximately 19 feet downstream of the nearest flow disturbance (where RTO A and B breach the stack) and 18 feet upstream from the stack atmospheric discharge.

4.2.2 Ursa Minor Dip Coat Line VOC Capture Efficiency Sampling Locations

The sample and velocity pressure measurement location for the top coat oven exhaust gas is in the 14-inch diameter exhaust duct for the top coat oven blower. This location is 5.1 duct diameters from the nearest upstream flow disturbance (exhaust fan) and at least 2.3 duct diameters from the nearest downstream flow disturbance (measurement to the underside of the ceiling).

The sample and velocity pressure measurement location for the prime coat oven exhaust gas is in the 12-inch diameter exhaust duct for the prime coat oven blower. This location is 6.7 duct diameters from the nearest upstream flow disturbance (exhaust fan) and at least 2.6 duct diameters from the nearest downstream flow disturbance (measurement to the underside of ceiling).

The sample and velocity pressure measurement location for the combined coating booth exhaust to the RTO is in the 17 7/8-inch diameter horizontal duct above the coating line. This location is 17.3 duct diameters from the nearest upstream flow disturbance (lateral duct adjoining the two coating booth exhausts) and 7.3 duct diameters from the nearest downstream flow disturbance (90-degree elbow prior to the booster fan).

Appendix C 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 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.

4.4 Gas Molecular Weight Determinations

Carbon dioxide (CO₂) and oxygen (O₂) content for the RTO exhaust gas stream was determined using instrumental analyzers in accordance with USEPA Method 3A. A Non-Dispersive Infrared (NDIR) gas analyzer was used to measure the CO₂ content; a gas analyzer equipped with a zirconia ion sensor was used to measure the O₂ content. Throughout each test period, a sample of the RTO exhaust gas was delivered to the instrumental analyzers using an extractive

gas sampling system and heated Teflon® sample line. The sampled gas stream was dried using a refrigerant-based condenser prior to analysis. Instrument response for each analyzer was recorded on an ESC Model 8816 data logging system that monitored the analog output of the instrumental analyzers continuously and logged data as one-minute averages.

CO₂ and O₂ content for other gas streams was measured using Fyrite® gas analyzers containing scrubbing solutions to selectively remove CO₂ and O₂ from the gas sample. Samples were withdrawn from the air stream during the test periods 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 (CO₂ or O₂) was determined by the solution volume change as indicated by the calibrated scale on the Fyrite® scrubber chamber.

Upon recommendation and approval from MDEQ-AQD representative Mr. Jeremy Howe, CO₂ and O₂ measurements were performed initially by DES with Fyrite® gas analyzers but were not performed throughout the test periods since the gas streams (other than the RTO exhaust) are essentially building air collected by the emission control system.

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 all other gas streams 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 each process measurement location. 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.

The THC concentration measurements were performed using Thermo Environmental Instruments, Inc. (TEI) Model 51 Total Hydrocarbon Analyzers, TEI Model 51c Total Hydrocarbon Analyzers, or a California Analytical Instruments, Inc. (CAI) Model 600 HFID Total Hydrocarbon Analyzer.

Throughout each test period, a sample of the gas from each measurement location was delivered to a dedicated flame ionization analyzer (FIA) 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 300°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 of each day, 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 a mid-range calibration gas and zero gas. A STEC Model SGD-710C 10-step gas divider or a STEC Model SGD-SC-5L five-step gas divider was used to obtain intermediate calibration gas concentrations as needed.

Due to the large swing in measured concentrations for the RTO exhaust gas (THC peaks that occur during the RTO valve switch and change in airflow direction) the scale for the FIA instrument used for the RTO exhaust gas was set to 1,000 ppm. The calibration error test was performed based on a 0-100 ppmv span and an additional calibration error test injection was performed at the end of a test period whenever a 1-minute average data point was logged over 100 ppmv span, to verify accuracy of the instrument at the peak 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 C provides diagrams and a description of the USEPA Method 25A sample trains.

4.7 Quality Assurance Procedures

Appendix D 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, scale, barometer, and pyrometer calibrations.

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.

4.7.1 Gas Divider Certifications (USEPA Method 205)

A STEC Model SGD-710C 10-step gas divider and a STEC Model SGD-SC-5L five-step gas divider were used to obtain appropriate calibration span gases. The STEC gas dividers were 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 STEC gas dividers deliver calibration gas values ranging from 0% to 100% 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 dividers. The field evaluation yielded no errors greater than 2% of the triplicate measured average and no errors greater than 2% from the expected values.

4.7.2 Instrumental Analyzer Interference Check

The instrumental analyzers used to measure O₂ and CO₂ 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.

4.7.3 Instrument Calibration and System Bias Checks

Accuracy of the instrumental analyzers used to measure THC, O₂, and CO₂ concentration was verified prior to and at the conclusion of each test period using the calibration procedures in Methods 25A, 3A and 7E.

At the beginning of each day of the RTO destruction efficiency-testing program, initial three-point instrument calibrations were performed for the CO₂ and O₂ 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 a tee connection, which is installed between the sample probe and the particulate filter, through a poppet check valve. After each one-hour test period, mid-range and zero gases were re-introduced in series at the tee connection in the sampling system to check against the method's performance specifications for calibration drift and zero drift error.

The instruments were calibrated with USEPA Protocol 1 certified concentrations of CO₂ and O₂ 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 and a STEC Model SGD-SC-5L five-step gas divider were used to obtain intermediate calibration gas concentrations as needed.

4.7.4 Determination of Exhaust Gas Stratification

A stratification test was performed for the RTO exhaust stack. 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 each exhaust stack indicate that the measured pollutant concentrations did not vary by more than 5% of the mean across the stack diameter. Therefore, each exhaust stack gas was considered to be unstratified and the compliance test sampling was performed at a single sampling location within the RTO exhaust stack.

4.7.5 Meter Box Calibrations

The Nutech Model 2010 dry gas metering console, which was used for exhaust gas moisture content sampling, 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 Nutech metering console was calibrated using a NIST traceable Omega[®] Model CL 23A temperature calibrator.

4.7.6 Sampling System Response Time Determination

The response time of each sampling system was determined each day 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.

Results of the response time determinations were recorded on field data sheets. For each test period, test data were collected once the sample probe was in position for at least twice the maximum system response time.

4.7.7 Exhaust Gas Flow Measurement

Prior to arriving onsite, the instruments used during the source test to measure exhaust gas properties and velocity (barometer, pyrometer, and Pitot tube) were calibrated to specifications outlined in the sampling methods.

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.

5.0 TEST RESULTS AND DISCUSSION

5.1 RTO VOC Destruction Efficiency

5.1.1 Summary of Test Procedures and Calculations

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. Testing was performed for three (3) operating scenarios: RTO A at 100% capacity (with RTO B in idle mode), RTO B at 100% capacity (with RTO A in idle mode), and RTO A and B operating simultaneously at approximately 50% capacity. Three (3) one-hour sampling periods were performed at each operating scenario.

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:

$$M_{\text{VOC}} = Q [C_{\text{VOC}}] (MW_{\text{C}_3}) (60 \text{ min/hr}) / V_M / 1\text{E}+06$$

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:

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

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

5.1.2 RTO VOC Destruction Efficiency Test Results

Tables 5.1 through 5.3 present measured gas conditions and results for each destruction efficiency test period.

The RTO A destruction efficiency tests were performed on April 18, 2017. Recorded data (flowrate and instrument response) and calculations for each test period are presented in Appendix E as test periods 1, 2, and 3 for RTO A. The calculated VOC destruction efficiency for RTO A averaged 98.4%.

The RTO B destruction efficiency tests were performed on April 18 and 20, 2017. Recorded data (flowrate and instrument response) and calculations for each test period are presented in Appendix E as test periods 1, 2, and 3 for RTO B. The calculated VOC destruction efficiency for RTO B averaged 95.9%.

The RTO A/B destruction efficiency tests were performed on April 20, 2017. Recorded data (flowrate and instrument response) and calculations for each test period are presented in Appendix E as test periods 1, 2, and 3 for RTO A/B. The calculated VOC destruction efficiency for the combined operation of RTO A/B averaged 95.9%.

The three-hour average VOC destruction efficiency is greater than the minimum destruction efficiency required by the RO Permit (95% by weight).

5.2 Ursa Minor Coating Line VOC Capture Efficiency

5.2.1 Summary of Test Procedures and Calculations

VOC emissions from the Ursa Minor Dip Coat Line coating booths are captured within individual permanent enclosures and exhausted to the RTO emissions control system. The prime and topcoat curing oven exhausts are vented directly to atmosphere via individual vertical exhaust stacks.

THC concentration (based on a propane reference) in the captured gas stream and individual uncontrolled curing oven exhausts were monitored simultaneously throughout three (3) one-hour

test periods to determine the VOC mass flowrate directed to the control device and exhausted to atmosphere. Air flowrate measurements were performed once for each one-hour test period. Gas molecular weight measurements (fixed gases and moisture determinations) were performed for each one-hour test period.

The controlled (captured) and uncontrolled VOC mass flowrates were determined simultaneously at the three (3) sampling locations using the equation presented in Section 5.1.1 of this document. The percentage of VOC captured (and directed to the RTO emissions control device) was determined using the following equation:

$$\text{Captured VOC Emissions (\%)} = \frac{\text{VOC in captured stream (lb/hr)}}{\text{VOC in captured stream (lb/hr)} + \Sigma \text{VOC in uncaptured stream (lb/hr)}}$$

5.2.2 Ursa Minor Dip Coat Line VOC Capture Efficiency Test Results

Table 5.4 presents measured gas conditions and results for each capture efficiency test period.

The Ursa Minor Dip Coat Line capture efficiency tests were performed on April 19, 2017. Recorded data (flowrate and instrument response) and calculations for each test period are presented in Appendix F. The permanent total enclosures for each coating booth operated normally such that all VOC emissions within the booths was captured by the process air collection system.

The amount of VOC captured by the process air collection system, compared to the overall Ursa Minor Dip Coat Line VOC emission rate (captured VOC plus uncollected VOC) ranged between 94.3 and 95.5% and averaged 95.0%.

The calculated VOC capture efficiency for all individual one-hour test periods is greater than the minimum capture efficiency as agreed upon with MDEQ-AQD (90% by weight).

5.2.3 Capture Efficiency Data Quality Objective (DQO) Criteria

The capture efficiency test procedures used for the Ursa Minor Dip Coat Line are consistent with those in §63.4565(d) *Gas-to-gas protocol using a temporary total enclosure or a building enclosure*, except that §63.4565 requires that:

Each test run must be at least 3 hours duration or the length of a production run, whichever is longer, up to 8 hours. For the purposes of this test, a production run means the time required for a single part to go from the beginning to the end of the production, which includes surface preparation activities and drying and curing time.

The capture efficiency results for this test event (and previous test events) are based on one-hour sampling periods and are subject to the criteria of the Data Quality Objective (DQO) or the

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Lower Confidence Limit (LCL) approach in accordance with §63.4565(e) *Alternative capture efficiency protocol*.

The three-test data set for EU-URSAMINOR capture efficiency (95.5, 95.1 and 94.3%) satisfies the DQO criteria in that the calculated DQO Indicator (P value) is less than 5%.

5.3 Process Operating Conditions During the Compliance Test Periods

The emission testing was performed while the RTO emissions control system and associated processes operated at normal production rates.

Process and control device operation data collected by LexaMar representatives is provided in Appendix B.

5.4 Variations from Normal Sampling Procedures or Operating Conditions

The testing was performed in accordance with the Test Plan dated March 16, 2017. 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.

VOC destruction efficiency testing was paused after the first test period for RTO B due to an RTO shutdown on April 18, 2017. The test crew moved testing equipment inside of the facility to perform VOC capture efficiency testing while the RTO was under repair. Following VOC capture efficiency testing and repair of the RTO, the testing crew moved testing equipment back outside of the facility, and continued VOC destruction efficiency testing on April 20, 2017.

During the third VOC destruction efficiency test period for RTO A/B, the test was paused from 14:40-15:19 during a switch to a different part configuration (LexaMar inserts several blank racks to separate different parts). Following the switch, the test was resumed until one hour of sampling data were obtained.

6.0 VERIFICATION OF BODY COLOR PAINT LINE TOTAL ENCLOSURE

6.1 Physical Design and Operating Criteria

RO Permit No. MI-ROP-N2812-2015 requires LexaMar to maintain a PeTE for the Body Color Paint Line such that all VOC emitted by the process is captured and directed to the RTO emission control system.

6.2 PeTE Description and Physical Measurements

Parts are loaded onto the Body Color Paint Line conveyor, cleaned in a high-pressure water washing system and conveyed through a flash tunnel for drying. The parts enter the PeTE

portion of the Body Color Paint Line through a 2.0-ft. by 7.6-ft. conveyor window into the adhesion promoter application booth. The parts are conveyed through the adhesion promoter booth, two (2) basecoat application booths, and two (2) clearcoat application booths. Flash-off tunnels are positioned after the adhesion promoter booth and the second basecoat booth. Parts are conveyed through a final cure oven after second clearcoat booth and exit the PeTE through a 3.0-ft. by 8.0-ft. conveyor window at the exit of the cure oven.

The two conveyor windows identified in the preceding text are the only natural draft openings present in the enclosure resulting in a total NDO area of 39.2 square feet. The total enclosure surface area, not including the final cure oven, is approximately 7,294 square feet.

6.3 Verification of PeTE Criteria

6.3.1 NDO to Enclosure Area Ratio

Based on the dimensions of the enclosure areas and the NDOs, the NDO to enclosure area ratio (NEAR) is less than 5%. Other than the two conveyor windows, all points of access into the enclosure are used for intermittent personnel or maintenance access and remain closed during routine operation of the Body Color Paint Line.

$$\text{NEAR: } 39.2 \text{ ft}^2 / 7,294 \text{ ft}^2 * 100 = 0.54\%$$

6.3.2 Differential Pressure

Differential pressure readings were recorded during each test period by LexaMar representatives and are presented in Appendix B.

6.3.3 NDO Spacing Relative to VOC Sources

The closest VOC emitting point relative to the PeTE entrance is the adhesion promoter robotic spray applicator.

The PeTE entrance NDO has dimensions of 2.0-ft. by 7.6-ft., which results in the requirement to maintain a minimum spacing of 12.7 feet between the NDO and the closest VOC emitting point (i.e., four times the opening area divided by the perimeter as specified by the RO Permit).

$$4 [(2 * \text{NDO Area}) / (\text{NDO Perimeter})] = 4 [(2 (2.0 \text{ ft.} \times 7.6 \text{ ft.}) / (2.0 \text{ ft.} + 7.6 \text{ ft.}))] = 12.7 \text{ ft.}$$

The physical location of the robot maintains a minimum spacing of 16-feet between the adhesion promoter spray applicator and the PeTE entrance NDO. This physical robot location satisfies the spacing requirement.

The closest VOC emitting point relative to the PeTE exit NDO is the second clearcoat application booth. The final cure oven is of sufficient length to maintain a spacing of

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significantly greater than four equivalent diameters between the second clearcoat application booth and the PeTE exit NDO.

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Table 5.1 RTO-A measured gas conditions and destruction efficiency test results

	Test 1	Test 2	Test 3	3-Hour Avg
Date	4/18/17	4/18/17	4/18/17	
Test Times	0731-0831	0916-1016	1102-1202	
RTO-A Bed Temperature (°F)	1,760	1,748	1,733	1,747
RTO Inlet				
Temperature (°F)	88	107	104	100
Flowrate (scfm)	20,658	19,214	21,118	20,330
Average THC Conc. (ppmv C ₃)	790	806	911	836
Calculated VOC Mass Flow (lb/hr)	112	106	132	117
RTO Exhaust				
Temperature (°F)	221	221	188	210
Flowrate (scfm)	18,378	18,647	18,270	18,432
Average THC Conc. (ppmv C ₃)	14.9	14.8	15.4	15.0
Calculated VOC Mass Flow (lb/hr)	1.88	1.90	1.94	1.91
Calculated Destruction Efficiency				
$1 - [\text{VOC}_{\text{out}} / \text{VOC}_{\text{in}}] \times 100\%$	98.3%	98.2%	98.5%	98.4%

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Table 5.2 RTO-B measured gas conditions and destruction efficiency test results

	Test 1	Test 2	Test 3	3-Hour Avg
Date	4/18/17	4/20/17	4/20/17	
Test Times	1250-1350	0615-0715	0815-0915	
RTO-B Bed Temperature (°F)	1,814	1,845	1,837	1,832
RTO Inlet				
Temperature (°F)	102	83	82	89
Flowrate (scfm)	19,879	21,883	21,580	21,114
Average THC Conc. (ppmv C ₃)	792	882	576	750
Calculated VOC Mass Flow (lb/hr)	108	133	85	109
RTO Exhaust				
Temperature (°F)	214	195	204	204
Flowrate (scfm)	18,338	18,451	18,081	18,290
Average THC Conc. (ppmv C ₃)	30.2	34.1	37.5	34.0
Calculated VOC Mass Flow (lb/hr)	3.81	4.33	4.66	4.27
Calculated Destruction Efficiency				
$1 - [\text{VOC}_{\text{out}} / \text{VOC}_{\text{in}}] \times 100\%$	96.5%	96.7%	94.5%	95.9%

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Table 5.3 RTO-A/B measured gas conditions and destruction efficiency test results

	Test 1	Test 2	Test 3	3-Hour Avg
Date	4/20/17	4/20/17	4/20/17	
Test Times	1011-1111	1205-1305	1417-1558*	
RTO-A Bed Temperature (°F)	1,822	1,817	1,782	1,800
RTO-B Bed Temperature (°F)	1,735	1,715	1,691	1,714
RTO Inlet				
Temperature (°F)	90	97	98	95
Flowrate (scfm)	21,474	20,788	21,690	21,317
Average THC Conc. (ppmv C ₃)	780	615	583	659
Calculated VOC Mass Flow (lb/hr)	115	87.8	87.0	96.6
RTO Exhaust				
Temperature (°F)	182	190	195	189
Flowrate (scfm)	19,179	20,076	19,774	19,676
Average THC Conc. (ppmv C ₃)	27.9	27.8	31.1	28.9
Calculated VOC Mass Flow (lb/hr)	3.68	3.83	4.22	3.91
Calculated Destruction Efficiency				
1 - [VOCout / VOCin] x 100%	96.8%	95.6%	95.1%	95.9%

* Test No. 3 was paused from 1440-1519 while more parts were loaded

Table 5.4 Ursa Minor Dip Coat Line measured gas conditions and capture efficiency test results

	Test 1	Test 2	Test 3	Avg
Date	4/19/17	4/19/17	4/19/17	
Test Times	1127-1227	1256-1356	1424-1524	
Prime Coat Oven Exhaust				
Temperature (°F)	206	209	211	209
Flowrate (scfm)	1,394	1,367	1,381	1,381
Average THC Conc. (ppmv C ₃)	47.8	53.9	44.6	48.7
Calculated VOC Mass Flow (lb/hr)	0.46	0.51	0.42	0.46
Top Coat Oven Exhaust				
Temperature (°F)	207	206	207	207
Flowrate (scfm)	2,733	2,757	2,741	2,744
Average THC Conc. (ppmv C ₃)	20.4	22.6	19.0	20.7
Calculated VOC Mass Flow (lb/hr)	0.38	0.43	0.36	0.39
Coating Booths to RTO (Captured)				
Temperature (°F)	90	85	88	88
Flowrate (scfm)	4,540	4,197	4,113	4,283
Average THC Conc. (ppmv C ₃)	568	634	454	552
Calculated VOC Mass Flow (lb/hr)	17.7	18.3	12.8	16.3
Calculated Capture Efficiency				
VOC Captured / Total VOC Measured	95.5%	95.1%	94.3%	95.0%