FINAL REPORT

FCA US LLC

WARREN, MICHIGAN

WARREN TRUCK ASSEMBLY PLANT (WTAP) EAST PAINT SHOP: COMPLIANCE TEST

RWDI #2003780

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SUBMITTED TO

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EXECUTIVE SUMMARY

RWDI USA LLC (RWDI) was retained by FCA US LLC (FCA) to complete the emission sampling program at their Warren Truck Assembly Plant (WTAP) located 21500 Mound Road in Warren, Michigan. WTAP operates an automobile assembly plant that includes the West Paint Shop which produces the Jeep Wagoneer and an East Paint Shop which produces the Classic Ram 1500 series truck. Testing was executed as required by Permit to Install (PTI) 13-19B (copy of PTI is provided in **Appendix A**). This testing report covers the required testing for validation of the East Paint shop sources including destruction efficiency (DE) and oxides of nitrogen (NO_x) emission rate for the regenerative thermal oxidizer (SVRTOEAST) (East RTO) serving the E-Coat Tank and curing oven (EUECOATEAST), and the desorption air stream coming from two (2) Zeolite concentrators. The test program was complete on September 27, 2021. The original testing program considered the following:

- Destruction efficiency (DE) for the regenerative thermal oxidizer (SVRTOEAST) serving the E-Coat Tank and curing oven (EUECOATEAST), and the desorption portion from the two (2) Zeolite Concentrators (SVBTHCONCEAST) from the spraybooth portion of EU-COLOR-ONE.
- Removal efficiency for two (2) Zeolite Concentrators servicing the spraybooth from EU-COLOR-ONE.
- Measurements will be completed on the SVRTOEAST exhaust (outlet) and SVBTHCONCEAST clean air exhaust for PM/PM10/PM2.5 and oxides of nitrogen (NOx).

As discussed with Mr. Mark Dziadosz, due to production limitations and the state of start-up operations on the two (2) zeolite concentrators, this program was altered to include the following testing, while the remaining portions of the testing program will be completed on a separate date to be discussed with EGLE.

- Destruction efficiency (DE) for the regenerative thermal oxidizer (SVRTOEAST) serving the E-Coat Tank and curing oven (EUECOATEAST) per condition EUECOATEAST V.3, and the desorption portion from the two (2) Zeolite Concentrators (SVBTHCONCEAST) from the spraybooth portion of EU-COLOR-ONE, per condition FGTOPCOATEAST V.6.
- Measurements for oxides of nitrogen (NOx) on the SVRTOEAST exhaust (outlet) per condition FGRTOEAST V.2.

In addition, although not included in the original test plan, capture efficiency testing for the E-Coat Dip Tank and E-Coat Oven as required under EUECOATEAST V.2. The inclusion and scheduling of the testing was discussed between FCA and EGLE and testing was completed on October 4th and October 5th, 2021.

Ms. Regina Angellotti witnessed the testing on October 4, 2021. Upon review of the ventilation system, it was determined that the system was not operating under representative conditions. The operating conditions were corrected and the system was re-checked on October 5, 2021 while operating under representative conditions. There was no vehicle production in the EUECOATEAST system between October 4-5, 2021, although air flow conditions were representative of normal operation on October 5, 2021.

Executive Table I: SVRTOEAST Average - Destruction Efficiency (RTO)

Parameter	Concentration & Emission Rate			
	Test 1	Test 2	Test 3	Average
Inlet NMOC (as propane)	122.07 ppmv 35.20 lb/hr	160.47 ppmv 45.92 lb/hr	203.17 ppmv 58.30 lb/hr	161.9 ppmv 46.47 lb/hr
Outlet NMOC (as propane)	3.15 ppmv 1.06 lb/hr	4.00 ppmv 1.31 lb/hr	5.12 ppmv 1.68 lb/hr	4.09 ppmv 1.35 lb/hr
Destruction Efficiency (NMOC)	97.0 %	97.1 %	97.1 %	97.1 %

Note: Destruction Efficiency (%) calculated using emission rate

Destruction Efficiency was calculated by dividing the calculated mass emission rate (in lbs/hr) of the outlet in non-methane organic compounds (NMOC) (Total Hydrocarbon (THC) minus Methane) by the inlet emission rate (in lb/hr) for NMOC.

Executive Table II: SVRTOEAST - Average Emission Data - NOx Testing

Parameter	Concentration & Emission Rate (ppmv & lb/hr)			
	Test 1	Test 2	Test 3	Average
East RTO Outlet	8.06 ppmv 2.83 lb/hr	7.46 ppmv 2.56 lb/hr	7.48 ppmv 2.56 lb/hr	7.7 ppmv 2.65 lb/hr

Executive Table III: E-Coat System Capture Efficiency

Parameter	Capture Efficiency			
	October 4, 2021*		October 5, 2021	
	Smoke Direction	Flow (acfm)	Smoke Direction	Flow (acfm)
E-Coat Dip Tank Entrance	Outward	4,517 (outward)	Inward	-2,639 (inward)
E-Coat Dip Tank Exit	Inward	N/A	Inward	-2,593 (inward)
E-Coat Oven Entrance	Inward	N/A	Inward	N/A
E-Coat Oven Exit	Inward	N/A	Inward	N/A

Note: Inward – means flow direction was into the control device (RTO)
Outward – means flow direction was away from the control device (RTO)
**After testing on 10/4/2021, it was determined the system had been started up improperly and was not operating under representative conditions at the time of testing. There was no vehicle production on October 4, 2021.* The testing was repeated under representative air flow conditions on October 5, 2021, which confirmed inward flow.

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1 INTRODUCTION

RWDI USA Inc. (RWDI) was retained by FCA US LLC (FCA) to complete the emission sampling program at their Warren Truck Assembly Plant (WTAP) located at 21500 Mound Road in Warren, Michigan. WTAP operates an automobile assembly plant that includes the West Paint Shop which produces the Jeep Wagoneer and an East Paint Shop which produces the Classic Ram 1500 series trucks. The air testing focuses on the East Paint Shop regenerative thermal oxidizer (SVRTOEAST) (RTO) and as outlined under Emission Unit EUECOATEAST and Flexible Group FCTOPCOATEAST

Under Permit to Install (PTI) 13-19B (copy of PTI is provided as **Appendix A**) this testing covers the required testing for the East Paint Shop sources only and includes:

- Destruction efficiency (DE) for the regenerative thermal oxidizer (SVRTOEAST) serving the E-Coat Tank and curing oven (EUECOATEAST) per conditions EUECOATEAST V.3 and FGTOPCOATEAST V.6.
- Measurements were completed on the SVRTOEAST exhaust (outlet) for oxides of nitrogen (NO_x) per condition FGRTOEAST V.2.

The testing satisfies the following conditions under EUECOATEAST and FGTOPCOATEAST for EU-COLOR-ONE:

- Measurements of NOx emissions from the exhaust of the SVRTOEAST.
- Test to determine the destruction efficiency of the SVRTOEAST. These efficiency determinations are consistent with the U.S. EPA "Protocol for Determining the Daily Volatile Organic Compound Emission Rate of Automobile and Light-Duty Truck Primer-Surfacer and Topcoat Operations", September 2008, EPA 453/R-08-002 and the NESHAP Surface Coating of Automobiles and Light-Duty Trucks (40 CFR 63 Subpart IIII).

In addition, although not included in the original test plan, capture efficiency testing for the E-Coat Dip Tank and E-Coat Oven as required under EUECOATEAST V.2. The inclusion and scheduling of the testing was discussed between FCA and EGLE and testing was completed on October 4th and October 5th, 2021.

Ms. Regina Angellotti witnessed the testing on October 4, 2021. Upon review of the ventilation system, it was determined that the system was not operating under representative conditions. The operating conditions were corrected and the system was re-checked on October 5, 2021 while operating under representative conditions. There was no vehicle production in the EUECOATEAST system between October 4-5, 2021, although air flow conditions were representative of normal operation on October 5, 2021.

WTAP recorded the production rate of vehicles processed during each Destruction Efficiency test from the RTO. WTAP recorded the RTO combustion chamber temperature during each of the Destruction Efficiency test. This data can be found in **Appendix H.**

The results of the sampling program are outlined in the **Tables** section of the report. Results of individual tests are presented in **Appendix C**. The test program was complete the week of September 27, 2021.

2 SOURCE DESCRIPTION

2.1 Plant and Sources Overview

This section gives a detailed description of each process that is controlled by the East RTO.

2.1.1 EUECOATEAST

The electrodeposition (E-Coat) coating process consists of a series of dip tanks, rinses, a curing oven, and a cooling tunnel. Emissions from the E-coat tanks and the E-coat curing oven are controlled by the East RTO (SVRTOEAST).

2.1.2 SVRTOEAST

EU-COLOR-ONE coating booth (basecoat and clearcoat) emissions are exhausted through a bank of particulate filters and the east RTO.

2.2 Sampling Locations Overview

The sampling locations for the RTO are located outside. This following table summarizes the sampling locations.

Table 2.2.1: Summary of the Stack Characteristics– SVRTOEAST

Source	Parameter	Diameter	Approximate Duct Diameters from Flow Disturbance	Number of Ports	Points per Traverse	Total Points per Test	Stack Temperature
SVRTOEAST Inlet	THC	75.5"	~2 downstream and ~2 upstream	2	Centroid of Stack for THC 8 Flow	1 THC 16 Flow	~274°F
SVRTOEAST Outlet	THC/NMOC, NOx	70"	~8 downstream and ~2 upstream	2	Centroid of Stack for THC 8 Flow	1 THC 16 Flow 1 NOx	~315°F

Further notes and photos of the system are provided in **Appendix A**.

3 TESTING METHODOLOGIES

3.1 Description of Testing Methodologies

The following section provides brief descriptions of the sampling methods and discusses any modifications to the reference test methods that were completed with the testing.

3.1.1 Summary of Specific Methodologies

3.1.1.1 Stack Velocity, Temperature, and Volumetric Flow Rate Determination

The exhaust velocities and flow rates were determined following the US EPA Method 2, "Determination of Stack Gas Velocity and Flow Rate (Type S Pitot Tube)". Velocity measurements were taken with a pre-calibrated S-Type pitot tube and incline manometer. Volumetric flow rates were determined following the equal area method as outlined in US EPA Method 1. Temperature measurements were made simultaneously with the velocity measurements and were conducted using a chromel-alumel type "k" thermocouple in conjunction with a digital temperature indicator.

The dry molecular weight of the stack gas was determined following calculations outlined in US EPA Method 3/3A, "Determination of Molecular Weight of Dry Stack Gas". O_2 and CO_2 measurements were taken via analyzer at the outlet, and fyrite at the inlet. Stack moisture content was determined through direct condensation and according to US EPA Method 4, "Determination of Moisture Content of Stack Gas". Moistures were collected at a single point during each test. One (1) moisture was collected at each the inlet and outlet for each DE test for 30 minutes to collect a minimum of 21 dscf of stack gas.

3.1.1.2 Sampling for Total Hydrocarbons (Destruction Efficiency)

NMOC Destruction Efficiency testing was performed simultaneously on the inlet and outlet of the East RTO. The following section lists notes clarifying the inlet and outlet locations of the RTO:

- The inlet of the East RTO consists of one (1) duct and was used for the inlet location for velocity, temperature, moisture, and NMOC.
- The outlet of the East RTO consists of one (1) duct (exhaust stack) and was used for the outlet location for velocity, temperature, moisture, NMOC, and NOx.

The measurements were taken continuously following the USEPA Method 25A on the combined inlet and outlet (using a non-methane/methane analyzer). As outlined in Method 25A, the measurement location was taken at the centroid of each source.

The test consisted of three 60-minute tests on the RTO at the preferred temperature as predetermined from WTAP personnel. Regular performance checks on the CEMS were carried out by zero and span calibration checks using USEPA Protocol calibration gases. These checks verified the ongoing precision of the monitor with time by introducing pollutant-free (zero) air followed by known calibration gas (span) into the monitor.

The response of the monitor to pollutant-free air and the corresponding sensitivity to the span gases was reviewed frequently as an ongoing indication of analyzer performance.

Prior to testing, a 4-point analyzer calibration error check was conducted using USEPA protocol gases. The calibration error check was performed by introducing zero, low, mid and high-level calibration gases through the heated sampling line. The calibration error check is performed to confirm that the analyzer response is within ±5% of the certified calibration gas introduced.

Prior to each test run, a system-bias test was performed where known concentrations of calibration gases were introduced at the probe tip to measure if the analyzers response were within ±5% of the introduced calibration gas concentrations. At the conclusion of each test run a system-bias check were performed to evaluate the percent drift from pre- and post-test system bias checks. The system bias checks were used to confirm that the analyzer did not drift greater than ±3% throughout a test run.

Zero and upscale calibration checks were conducted both before and after each test run to quantify measurement system calibration drift and sampling system bias. Upscale is the mid-range gas. During these checks, the calibration gases were introduced into the sampling system at the probe outlet so that the calibration gases were analyzed in the same manner as the flue gas samples.

A gas sample was continuously extracted from the stack and delivered to a series of gas analyzers, which measure the pollutant or diluent concentrations in the gas. The analyzers were calibrated on-site using EPA Protocol No. 1 certified calibration mixtures. The probe tip was equipped with a sintered stainless-steel filter for particulate removal. The end of the probe was connected to a heated Teflon sample line, which delivered the sample gases from the stack to the CEM system. The heated sample line was designed to maintain the gas temperature above 250°F to prevent condensation of stack gas moisture within the line.

3.1.1.3 Sampling for Nitrogen Oxides, Oxygen and Carbon Dioxide

Oxides of Nitrogen (NOx), oxygen and carbon dioxide concentrations were determined utilizing RWDI's continuous emissions monitoring (CEM) system at the East RTO outlet. Prior to testing, a 3-point analyzer calibration error check were conducted using USEPA protocol gases. The calibration error check was performed by introducing zero, mid and high-level calibration gases directly into the analyzer. The calibration error check was performed to confirm that the analyzer response is within ±2% of the calibration span of the analyzer for the low, mid, and high-level calibration gases. Prior to each test run, a system-bias test was performed where known concentrations of calibration gases were introduced at the probe tip to measure if the analyzer's response was within ±5% of the calibration span of the analyzer for the low and mid-level calibration gases. At the conclusion of each test run a system-bias check as performed to evaluate the percent drift from pre and post-test system bias checks. The system bias checks were used to confirm that the analyzer did not drift greater than ±3% throughout a test run.

Zero and upscale calibration checks were conducted both before and after each test run to quantify measurement system calibration drift and sampling system bias. Upscale was the mid-level calibration gas based on the stack characteristics. During these checks, the calibration gases were introduced into the sampling system at the probe outlet so that the calibration gases were analyzed in the same manner as the flue gas samples.

A gas sample was continuously extracted from the stack and delivered to a Teledyne T200H for NO_x and O_2 and a Teledyne T300M for CO_2. The analyzers were calibrated on-site using EPA Protocol No. 1 certified calibration mixtures. The probe tip was equipped with a sintered stainless-steel filter for particulate removal. The end of the probe was connected to a heated Teflon sample line, which will deliver the sample gases from the stack to the CEM system. The heated sample line was designed to maintain the gas temperature above 250°F to prevent condensation of stack gas moisture within the line.

Before entering the analyzers, the gas sample will pass directly into a refrigerated condenser, which cools the gas to approximately 35°F to remove the stack gas moisture. After passing through the condenser, the dry gas will enter a Teflon-head diaphragm pump and a flow control panel, which will deliver the gas in series to the O_2, CO_2, and NO_x analyzers (as applicable). Each of these analyzers will measure the respective gas concentrations on a dry volumetric basis.

3.1.1.4 Gas Dilution (Method 205)

Calibration gas was mixed using an Environics 4040 Gas Dilution System. The mass flow controllers are factory calibrated using a primary flow standard traceable to the United States National Institute of Standards and Technology (NIST). Each flow controller utilizes an 11-point calibration table with linear interpolation, to increase accuracy and reduce flow controller nonlinearity. The calibration is done yearly, and the records are included in **Appendix G.** A multi-point EPA Method 205 check was executed in the field prior to testing to ensure accurate gas-mixtures. The gas dilution system consisting of calibrated orifices or mass flow controllers and dilutes a high-level calibration gas to within ±2% of predicted values. The gas divider is capable of diluting gases at set increments and was evaluated for accuracy in the field in accordance with US EPA Method 205 "*Verification of Gas Dilution Systems for Field Instrument Calibrations*". Before testing, the gas divider dilutions were measured to evaluate that the responses are within ±2% of predicted values. In addition, a certified mid-level calibration gas within ±10% of one of the tested dilution gases were introduced into an analyzer to ensure the response of the gas calibration is within ±2% of gas divider dilution concentration. The results of the EPA Method 205 check can also be found in **Appendix G.**

3.1.1.5 Sampling for Capture Efficiency

Sampling of capture efficiency is intrusive to the production as the testing obstructs the flow of vehicles into the E-Coat area. Therefore, for the capture efficiency testing, no vehicles were entering the system, however all ventilation systems and oven are anticipated to operate normally (simulating normal, representative production conditions).

Sampling for capture efficiency included a visualization test (smoke test). Smoke was applied to the entrance and exit of the Dip Tank and Oven. Each location was tested separately under normal ventilation scenario. Provided the visualization testing demonstrates that the smoke (or air flow) is flowing into the Dip Tank/Oven and therefore into the control system (RTO), the capture efficiency is assumed to be 100%.

In addition, although not included in the original test plan, capture efficiency testing for the E-Coat Dip Tank and E-Coat Oven as required under EUECOATEAST V.2. The inclusion and scheduling of the testing was discussed between FCA and EGLE and testing was completed on October 4th and October 5th, 2021.

Ms. Regina Angellotti witnessed the testing on October 4, 2021. Upon review of the ventilation system, it was determined that the system was not operating under representative conditions. The operating conditions were corrected and the system was re-checked on October 5, 2021 while operating under representative conditions. There was no vehicle production in the EUECOATEAST system between October 4-5, 2021, although air flow conditions were representative of normal operation on October 5, 2021.

4 PROCESS DATA

During the emissions testing, plant process data was monitored and collected by WTAP personnel to ensure representative operation of the facility. The following information was collected:

1. Production rate for each process (EUECOATEAST, and FGTOPCOATEAST (EU-COLOR-ONE);
2. SVRTOEAST combustion chamber operating temperature during each test.

Process data is provided in **Appendix H**.

5 RESULTS

All calibration information for the equipment used for this study is included in **Appendix G**. The following tables summarize the testing results, and more detailed tables can be found in **Appendices C, D, and F** for the SVRTORTO Destruction Efficiency results. Detailed data for E-Coat System Capture Efficiency is provided in **Appendices E and F**.

Table 5.1: SVRTOEAST Average - Destruction Efficiency (RTO)

Parameter	Concentration & Emission Rate			
	Test 1	Test 2	Test 3	Average
Inlet NMOC (as propane)	122.07 ppmv 35.20 lb/hr	160.47 ppmv 45.92 lb/hr	203.17 ppmv 58.30 lb/hr	161.9 ppmv 46.47 lb/hr
Outlet NMOC (as propane)	3.15 ppmv 1.06 lb/hr	4.00 ppmv 1.31 lb/hr	5.12 ppmv 1.68 lb/hr	4.09 ppmv 1.35 lb/hr
Destruction Efficiency (NMOC)	97.0 %	97.1 %	97.1 %	97.1 %

Destruction Efficiency was calculated by dividing the calculated mass emission rate (in lbs/hr) of the outlet in non-methane organic compounds (NMOC) (Total Hydrocarbon (THC) minus Methane) by the inlet emission rate (in lb/hr) for NMOC.

Table 5.2: SVRTOEAST - Average Emission Data - NOx Testing

Parameter	Concentration & Emission Rate (ppmv & lb/hr)			
	Test 1	Test 2	Test 3	Average
SVRTOEAST Outlet	8.06 ppmv 2.83 lb/hr	7.46 ppmv 2.56 lb/hr	7.48 ppmv 2.56 lb/hr	7.7 ppmv 2.65 lb/hr

Table 5.3: E-Coat System Capture Efficiency

Parameter	Capture Efficiency			
	October 4, 2021*		October 5, 2021	
	Smoke Direction	Flow (acfm)	Smoke Direction	Flow (acfm)
E-Coat Dip Tank Entrance	Outward	4,517 (outward)	Inward	-2,639 (inward)
E-Coat Dip Tank Exit	Inward	N/A	Inward	-2,593 (inward)
E-Coat Oven Entrance	Inward	N/A	Inward	N/A
E-Coat Oven Exit	Inward	N/A	Inward	N/A

Note: Inward – means flow direction was into the control device (RTO)
Outward – means flow direction was away from the control device (RTO)
**After testing on 10/4/2021, it was determined the system had been started up improperly and was not operating under representative conditions at the time of testing. There was no vehicle production on October 4, 2021.* The testing was repeated under representative air flow conditions on October 5, 2021, which confirmed inward flow.

6 OPERATING CONDITIONS

Operating conditions during the sampling were monitored by FCA personnel. All equipment was operated under normal maximum operating conditions.

Contact was maintained between the operator and the sampling team. A member of the RWDI sampling team contacted the operator before each test, to ensure that the process was at normal maximum operating conditions.

7 CONCLUSIONS

Testing for RTO VOC destruction efficiency and oxides of nitrogen (NOx) emissions rate was completed on September 27th, 2021. Although, not included in the original program, capture efficiency testing for the E-Coat Dip Tank and Oven was completed on October 4th and repeated on October 5th, 2021, for validation of inward flow.

TABLES

Table 1: Summary of Sampling Parameters and Methodology

Source Location	No. of Tests per Stack	Sampling Parameter	Sampling Method
East RTO	3	Volumetric Flow Rate	U.S. EPA [1] Methods 1 & 2
	3	Molecular Weight (O_2, CO_2)	U.S. EPA [1] Method 3 (Inlet) 3A (Outlet)
	3	Moisture	U.S. EPA [1] Method 4
	3	Total Hydrocarbons/Methane	U.S. EPA [1] Method 25A

[1] United States Environmental Protection Agency

Table 2: Sampling Times

Test #	Sampling Date	Start Time	End Time
Test #1	27-Sep-21	10:18 AM	11:17 AM
Test #2	27-Sep-21	11:52 AM	12:51 PM
Test #3	27-Sep-21	2:19 PM	3:18 PM

Table 3a: WTAP East RTO NOx Emission Rate Table

Test	O_2	CO_2	NO_x	NO_x
	%	%	ppm	lbs/hr
1	19.6	0.6	8.06	**2.83**
2	19.6	0.7	7.46	**2.56**
3	19.5	0.7	7.48	**2.56**
Average	19.6	0.7	7.67	**2.65**

Table 3b: WTAP East RTO Destruction Efficiency Table

Test	NMOC Inlet (lb/hr) (as propane)	NMOC Outlet (lb/hr) (as propane)	Destruction Efficiency (as propane) (%)
1	35.2	1.1	**97.0%**
2	45.9	1.3	**97.1%**
3	58.3	1.7	**97.1%**
Average	46.5	1.4	**97.1%**

Notes:
NMOC - Non Methane Organic Compounds