FINAL REPORT

FCA US LLC

DETROIT, MICHIGAN

JEFFERSON NORTH ASSEMBLY PLANT (JNAP)
EU-TOPCOAT1, EU-TOPCOAT2, AND EU-TOPCOAT3
THERMAL OXIDIZERS

RWDI #1902467

December 19, 2019

SUBMITTED TO

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EXECUTIVE SUMMARY

RWDI AIR Inc. (RWDI) was retained by Fiat Chrysler Automobiles (FCA) US LLC to complete destruction efficiency (DE) testing for volatile organic compounds (VOCs) on the three (3) thermal oxidizers (TOs) controlling the emissions from the EU-TOPCOAT1, EU-TOPCOAT2, and EU-TOPCOAT3 booths as emitted by zeolite concentrators at the Jefferson North Assembly Plant (JNAP) located in Detroit, Michigan. As outlined in Title V Renewable Operating Permit (ROP) MI ROP-N2155-2017 the testing was required to validate the destruction efficiency (DE) for the thermal oxidizers (TOs) serving the TOPCOAT lines (EU-TOPCOAT1, EU-TOPCOAT2, EU-TOPCOAT3) under Flexible Group Condition FG-Facility.

Testing was completed on EU-TOPCOAT1, EU-TOPCOAT2 and EU-TOPCOAT3 between October 22rd and October 23th, 2019 while all process equipment was operating under representative operating conditions. The Michigan Department of Environment, Great Lakes, and Energy (EGLE) agreed with JNAP's request to complete a temperature ladder study of each TO during this DE testing. The oxidizer combustion chamber temperatures were eventually set to 1270°F and a destruction efficiency of >97% for all sources was achieved. In addition, the retention time of each of the oxidizers were calculated. Based on the calculation, all oxidizers were able to achieve a retention time of >0.5 seconds.

For the DE testing, the sampling train for VOC consisted of a flame ionization analyzer as described in USEPA Method 25A. VOC concentrations were continuously collected via heated sample lines from both the inlet and outlet of the TOs simultaneously.

Three 1-hour tests were completed on each of the TO that services the identified booth emissions for EU-TOPCOAT1, EU-TOPCOAT2 and EU-TOPCOAT3 to determine the average DE. Thermal oxidizer inlet and outlet emissions were sampled concurrently during each test run. Stack gas velocity and moisture tests were also taken during each of the three 1-hour DE tests at the outlet only (as noted in the Source Testing Plan -Jefferson North Assembly Plant: Intent-to-Test Plan (ITT) dated July 23, 2019).

Results of the sampling program are outlined in the following table. Results of individual tests are presented in the **Appendices**.

Summary of Results –EU-TOPCOAT1

Parameter	Combustion Chamber 1270°F		
	Test 1	Test 2	Test 3
Date	**2019-10-22**	**2019-10-22**	**2019-10-22**
Start Time	**09:00**	**10:12**	**11:21**
End Time	**10:00**	**11:12**	**12:21**
Average TO Combustion Temperature (°F)	1269	1269	1271
Average Booth Vehicle Population	18	17	13
Inlet THC (ppmv) (as Propane)	630	510	682
Outlet THC (ppmv) (as Propane)	15.7	14.6	16.2
Outlet NMHC (ppmv) (as Propane)	14.6	12.6	14.1
Inlet THC as Mass lb/hr (propane)	48.8	38.7	52.9
Outlet THC as Mass (lb/hr) (propane)	1.2	1.1	1.3
Outlet NMHC as Mass (lb/hr) (propane)	1.1	0.9	1.1
THC Destruction Efficiency (%) (based on lb/hr)	97.5%	97.1%	97.6%
NMHC Destruction Efficiency (%) (based on lb/hr)	97.7%	97.5%	97.9%
Residence Time (sec)	0.69	0.73	0.71

Notes: [1] Destruction Efficiency is calculated based on Total Hydrocarbon concentration
ppmv- parts per million by volume
THC – Total Hydrocarbon
NMOC – Non-Methane Organic Carbon

Summary of Results –EU-TOPCOAT2

Parameter	Combustion Chamber 1270°F		
	Test 1	Test 2	Test 3
Date	**2019-10-22**	**2019-10-22**	**2019-10-22**
Start Time	**14:05**	**15:15**	**16:23**
End Time	**15:05**	**16:15**	**17:23**
Average TO Combustion Temperature (°F)	1270	1270	1270
Average Booth Vehicle Population	17	14	18
Inlet THC (ppmv) (as Propane)	575	484	516
Outlet THC (ppmv) (as Propane)	13.3	11.2	11.5
Outlet NMHC (ppmv) (as Propane)	12.0	10.4	9.6
Inlet THC as Mass lb/hr (propane)	37.1	31.1	34.5
Outlet THC as Mass (lb/hr) (propane)	0.86	0.72	0.77
Outlet NMHC as Mass (lb/hr) (propane)	0.78	0.67	0.65
THC Destruction Efficiency (%) (based on lb/hr)	97.7%	97.7%	97.8%
NMHC Destruction Efficiency (%) (based on lb/hr)	97.9%	97.8%	98.1%
Residence Time (sec)	0.85	0.85	0.82

Notes: [1] Destruction Efficiency is calculated based on Total Hydrocarbon concentration
ppmv- parts per million by volume
THC – Total Hydrocarbon
NMOC – Non-Methane Organic Carbon

Summary of Results –EU-TOPCOAT3

Parameter	Combustion Chamber 1270°F		
	Test 1	Test 2	Test 3
Date	**2019-10-23**	**2019-10-23**	**2019-10-23**
Start Time	**08:37**	**09:44**	**10:54**
End Time	**09:37**	**10:44**	**11:54**
Average TO Combustion Temperature (°F)	1273	1273	1273
Average Booth Vehicle Population	19	17	21
Inlet THC (ppmv) (as Propane)	376	312	384
Outlet THC (ppmv) (as Propane)	8.9	8.3	9.1
Outlet NMHC (ppmv) (as Propane)	7.3	6.8	7.5
Inlet THC as Mass lb/hr (propane)	29.1	25.8	29.8
Outlet THC as Mass (lb/hr) (propane)	0.68	0.68	0.70
Outlet NMHC as Mass (lb/hr) (propane)	0.57	0.57	0.59
THC Destruction Efficiency (%) (based on lb/hr)	97.6%	97.4%	97.6%
NMHC Destruction Efficiency (%) (based on lb/hr)	98.1%	97.8%	98.0%
Residence Time (sec)	0.68	0.66	0.70

Notes: [1] Destruction Efficiency is calculated based on Total Hydrocarbon concentration
ppmv- parts per million by volume
THC – Total Hydrocarbon
NMOC – Non-Methane Organic Carbon

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1 INTRODUCTION

RWDI AIR Inc. (RWDI) was retained by Fiat Chrysler Automobiles (FCA) US LLC to complete destruction efficiency (DE) testing for volatile organic compounds (VOCs) on the three (3) thermal oxidizers (TOs) controlling the emissions from the EU-TOPCOAT1, EU-TOPCOAT2, and EU-TOPCOAT3 booth emissions as emitted through zeolite concentrators at the Jefferson North Assembly Plant (JNAP) located in Detroit, Michigan. As outlined in Title V Renewable Operating Permit (ROP) MI ROP-N2155-2017, the testing was required to validate the destruction efficiency (DE) for the thermal oxidizers (TOs) serving the Topcoat lines (EU-TOPCOAT1, EU-TOPCOAT2 and EU-TOPCOAT3) under Flexible Group Condition FG-Facility.

Testing was completed on EU-TOPCOAT1, EU-TOPCOAT2 and EU-TOPCOAT3 between October 22rd and October 23th, 2019 while all process equipment was operating under representative operating conditions. The Michigan Department of Environment, Great Lakes, and Energy (EGLE) agreed with JNAP's request to complete a temperature ladder study of each TO during this DE testing. The oxidizer combustion chamber temperatures were eventually set to 1270°F and a destruction efficiency of >97% for all sources was achieved. In addition, the retention time of each of the oxidizers were calculated. Based on the calculation, all oxidizers were able to achieve a retention time of >0.5 seconds.

Testing of emissions were conducted by Mr. Derek Ottens, Mr. Alec Smith, Mr. Kirk Easto and Mr. Brad Bergeron of RWDI. Mr. Steve Szura from FCA-JNAP and Mr. Thomas Caltrider (FCA) were on-site to monitor the process operation and witness the testing on behalf of FCA US LLC. Testing was witness by Ms. Regina Angelloti and Bob Byrnes from Michigan Environment, Great Lakes and Energy (EGLE) on October 22rd, 2019.

2 PROCESS DESCRIPTION

JNAP is located at 2101 Conner Road in Detroit, Michigan. JNAP operates an automobile assembly plant that produces Jeep Grand Cherokee and Dodge Durango models for FCA US LLC in regard to this DE testing under ROP-N2155-2017 EU-TOPCOAT1, EU-TOPCOAT2 and EU-TOPCOAT3, the testing requirements are found under Flexible Group: FG-Facility. Paint is applied to vehicles automatically and manually in booths. Vehicles proceed through a curing oven. This line consists of three basecoat robot zones, basecoat electrostatic bells, basecoat automatic conventional zone, heated flash zone, two clearcoat robot zones, clearcoat electrostatic bells zone and a cure oven. Emissions from each of the three (3) lines (EU-TOPCOAT1, EU-TOPCOAT2, and EU-TOPCOAT3) basecoat bell zone, basecoat automatic conventional zone, heated flash, and clearcoat bell zones are ducted to a filter house, followed by a zeolite concentrator and a thermal oxidizer dedicated to abating booth emissions (three (3) total booth TOs). Vehicles painted in each booth are cured in a dedicated oven discharging to a dedicated thermal oxidizer (three (3) total oven oxidizers TOs).

This test report addresses the three booth thermal oxidizers abating emissions from the concentrators.

A general overview of the Topcoat process is provided below.

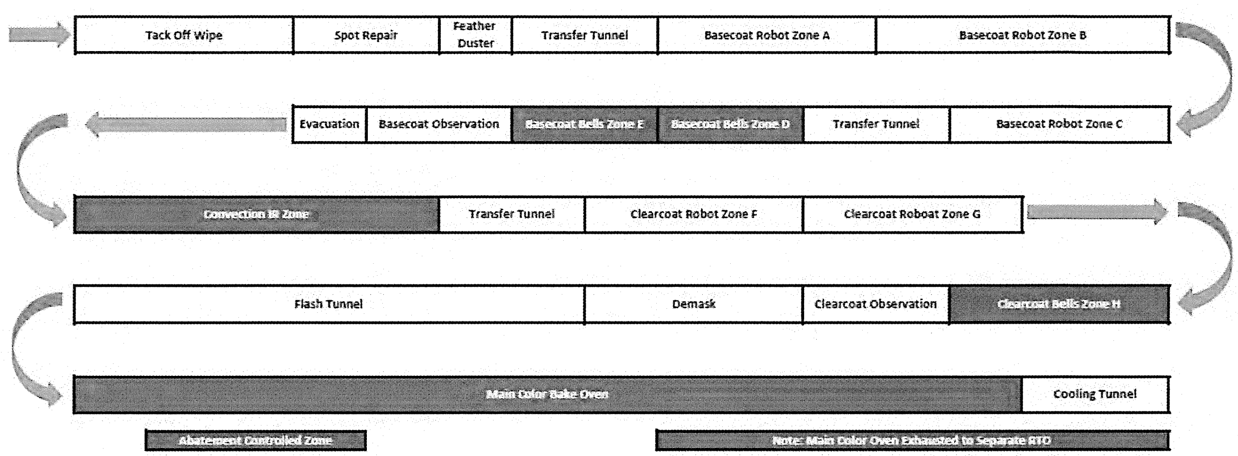

Figure 2.1-1: Process Overview

3 SAMPLING LOCATIONS

3.1 Sample Location

The sampling locations were located inside the building on the inlet and outlet of the TOs.

Table 3.1: Stack Parameters

Source	Parameter	Diameter	Approximate Duct Diameters from Flow Disturbance	Number of Ports	Stack Temperature (°F)
EU-TOPCOAT 1 Inlet	THC	29.5"	~8 up and ~2 down	2	-
EU-TOPCOAT 1 Outlet	THC	33"	~3 up and ~2 down	2	662
EU-TOPCOAT2 Inlet	THC	29.5"	~8 up and ~2 down	2	-
EU-TOPCOAT2 Outlet	THC	33"	~3 up and ~2 down	2	551
EU-TOPCOAT3 Inlet	THC	20" x 32"	~5 up and ~15 down	4	-
EU-TOPCOAT3 Outlet	THC	33	~5 up and ~5 down	2	639

4 SAMPLING METHODOLOGY

4.1 Test Methods

4.1.1 Stack Velocity, Temperature, and Volumetric Flow Rate

The exhaust velocities and flow rates were determined following U.S. EPA Method 2, "Determination of Stack Gas Velocity and Volumetric 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 U.S. EPA Method 2. Temperature measurements were made simultaneously with the velocity measurements and were conducted using a chromel-alumel type "k" thermocouple in conjunction with a calibrated digital temperature indicator.

The dry molecular weight of the stack gas was determined following calculations outlined in U.S. EPA Method 3, "Gas Analysis for the Determination of Dry Molecular Weight". A portable ECOM combustion analyzer was used to measure the temperature and gas composition of the stack for the determination of the dry molecular weight. Stack moisture content was determined through direct condensation and according to U.S. EPA Method 4, "Determination of Moisture Content of Stack Gases".

4.1.2 Continuous Emissions Monitoring for VOCs

Testing for VOCs was accomplished simultaneously at the inlet and outlet using continuous emission monitors (CEM). VOC testing followed USEPA Method 25A "Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer" In order to compare inlet and outlet concentrations, the outlet concentrations of total VOCs were converted to parts per million (ppmv) as propane. The exhaust gas sample was withdrawn from a single point at the center of the duct/stack using a stainless-steel probe. The sample proceeded through a heated filter where particulate matter was removed. The sample was then transferred via a heated Teflon® line and introduced to the analyzer (hot/wet) for measurement.

For the THC measurements a J.U.M. Engineering Model 3-300A, it uses a heated oven and hydrogen flame ionization detector (FID) to combust and detect hydrocarbons. For the NMHC measurements a J.U.M. Engineering Model 109A was used. The 109A uses two hydrogen flame ionization detectors (FID) fed by two sample capillaries. One of the two sample capillaries is connected in series to a temperature controlled catalyst module. This catalyst oxidizes all hydrocarbons except Methane carbon. Both detectors are connected to two individual electrometer amplifiers. From these two FID signals, total organic gaseous carbon from the detector without the catalyst and methane carbon from the detector with the catalyst, the non-methane hydrocarbon signals is generated via differential calculation Thus resulting in the three continuous simultaneous signals shown on individual front panel displays.

Prior to testing, instrument linearity checks and calibration error checks were conducted. USEPA protocol gases were used for all span values. The FIDs were calibrated using zero (>1% of span value) and high (80-90% of span value) sent though the system to the sample tip and returned to the analyzers. Low Span gas (25 to 35% of span value) and mid (45 to 55% of span value) were then introduced. In addition, the analyzers were checked (zeroed and span checked) at the completion of each test using the Zero and Mid span gases. The test runs were considered valid provided the response was within ±3% from the instrument span value.

Data acquisition was provided using a data logger system programmed to collect and record data at one second intervals. Average one-minute concentrations were calculated from the one second measurements.

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 representative operating conditions.

4.2 Quality Assurance/ Quality Control Measures

Applicable quality assurance measures were implemented during the sampling program to ensure the integrity of the results. These measures included detailed documentation of field data and equipment calibrations for all measured parameters.

All samplers were bench tested and calibrated in RWDI's office prior to field deployment. For each sample collected with a Method 5 sampling train, both pre- and post- leak checks were conducted by plugging the inlet and drawing a vacuum of equal to or greater than the vacuum recorded during the test. Dry gas meter reading leakage rates greater than 4 percent of the average sampling rate or 0.00057 m^3/min (0.02 cfm), whichever is less, were considered unacceptable. Similar leak check procedures for pitot tube and pressure lines were also conducted. Daily temperature sensor audits were completed by noting the ambient temperature, as measured by a reference thermometer, and comparing these values to those obtained from the stack sensor. Leak checks for each test were documented on the field data sheets presented in the applicable appendices for each sample parameter.

Quality checks for the CEMS (VOCs) are provided in the methodology section.

5 RESULTS

5.1 Results

The emission results for this study are presented in **Appendix C** of this report. Tables 5.1a to 5.1c outline the summary of the testing results and process data collected during the testing periods respectively EU-TOPCOAT1, EU-TOPCOAT2 and EU-TOPCOAT3.

Table 5.1a: Summary of Results –EU-TOPCOAT1

Parameter	Combustion Chamber 1270°F		
	Test 1	Test 2	Test 3
Date	**2019-10-22**	**2019-10-22**	**2019-10-22**
Start Time	**09:00**	**10:12**	**11:21**
End Time	**10:00**	**11:12**	**12:21**
Average TO Combustion Temperature (°F)	1269	1269	1271
Average Booth Vehicle Population	18	17	13
Inlet THC (ppmv) (as Propane)	630	510	682
Outlet THC (ppmv) (as Propane)	15.7	14.6	16.2
Outlet NMHC (ppmv) (as Propane)	14.6	12.6	14.1
Inlet THC as Mass lb/hr (propane)	48.8	38.7	52.9
Outlet THC as Mass (lb/hr) (propane)	1.2	1.1	1.3
Outlet NMHC as Mass (lb/hr) (propane)	1.1	0.9	1.1
THC Destruction Efficiency (%) (based on lb/hr)	97.5%	97.1%	97.7%
NMHC Destruction Efficiency (%) (based on lb/hr)	97.7%	97.5%	97.9%
Residence Time (sec)	0.69	0.73	0.71

Notes: [1] Destruction Efficiency is calculated based on Total Hydrocarbon concentration
ppmv- parts per million by volume
THC – Total Hydrocarbon
NMOC – Non-Methane Organic Carbon

Table 5.1b: Summary of Results –EU-TOPCOAT2

Parameter	Combustion Chamber 1270°F		
	Test 1	Test 2	Test 3
Date	**2019-10-22**	**2019-10-22**	**2019-10-22**
Start Time	**14:05**	**15:15**	**16:23**
End Time	**15:05**	**16:15**	**17:23**
Average TO Combustion Temperature (°F)	1270	1270	1270
Average Booth Vehicle Population	17	14	18
Inlet THC (ppmv) (as Propane)	575	484	516
Outlet THC (ppmv) (as Propane)	13.3	11.2	11.5
Outlet NMHC (ppmv) (as Propane)	12.0	10.4	9.6
Inlet THC as Mass lb/hr (propane)	37.1	31.1	34.5
Outlet THC as Mass (lb/hr) (propane)	0.86	0.72	0.77
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THC Destruction Efficiency (%) (based on lb/hr)	97.7%	97.7%	97.8%
NMHC Destruction Efficiency (%) (based on lb/hr)	97.9%	97.8%	98.1%
Residence Time (sec)	0.85	0.85	0.82

Notes: [1] Destruction Efficiency is calculated based on Total Hydrocarbon concentration
ppmv- parts per million by volume
THC – Total Hydrocarbon
NMOC – Non-Methane Organic Carbon

Table 5.1c: Summary of Results –EU-TOPCOAT3

Parameter	Combustion Chamber 1270°F		
	Test 1	Test 2	Test 3
Date	**2019-10-23**	**2019-10-23**	**2019-10-23**
Start Time	**08:37**	**09:44**	**10:54**
End Time	**09:37**	**10:44**	**11:54**
Average TO Combustion Temperature (°F)	1273	1273	1273
Average Booth Vehicle Population	19	17	21
Inlet THC (ppmv) (as Propane)	376	312	384
Outlet THC (ppmv) (as Propane)	8.9	8.3	9.1
Outlet NMHC (ppmv) (as Propane)	7.3	6.8	7.5
Inlet THC as Mass lb/hr (propane)	29.1	25.8	29.8
Outlet THC as Mass (lb/hr) (propane)	0.68	0.68	0.70
Outlet NMHC as Mass (lb/hr) (propane)	0.57	0.57	0.59
THC Destruction Efficiency (%) (based on lb/hr)	97.6%	97.4%	97.6%
NMHC Destruction Efficiency (%) (based on lb/hr)	98.1%	97.8%	98.0%
Residence Time (sec)	0.68	0.66	0.70

Notes: [1] Destruction Efficiency is calculated based on Total Hydrocarbon concentration
ppmv- parts per million by volume
THC – Total Hydrocarbon
NMOC – Non-Methane Organic Carbon

Field notes are provided in **Appendix D**. All calibration information for the equipment used for this study is included in **Appendix E**.

JNAP representatives provided production information during each of the testing periods including temperature for the TOs and vehicle counts in the booth during each test. All equipment was operated under representative operating conditions. **Appendix F** includes the production for each testing period.

6 CONCLUSIONS

Based on the results, EU-TOPCOAT1, EU-TOPCOAT2, and EU-TOPCOAT3 are able to operate at an average combustion chamber setpoint temperature of 1270°F and maintain a destruction efficiency equal to 97% and a retention time of >0.5 seconds.

TABLES

Table 2: Flow Rate, Velocity and Temperature Measurements

Test ID	Date	Start	End	TO Combustion Chamber Temperature (°F)	Actual Flow Rate (cfm)	Exit Velocity (ft/s)	Average Stack Temperature (°F)
EU-TOPCOAT1							
1	2019-10-22	9:00	10:00	1269	23,285	65.3	655
2	2019-10-22	10:12	11:12	1269	22,579	63.4	675
3	2019-10-22	11:21	12:21	1271	22,802	63.9	656
				Average	22,889	64.2	662
EU-TOPCOAT2							
1	2019-10-22	14:05	15:05	1270	17,322	48.6	550
2	2019-10-22	15:15	16:15	1270	17,368	48.7	557
3	2019-10-22	16:23	17:23	1270	17,807	50.0	547
				Average	17,499	49.1	551
EU-TOPCOAT3							
1	2019-10-23	8:37	9:37	1273	24035	67.4	674
2	2019-10-23	9:44	10:44	1273	23736	66.6	627
3	2019-10-23	10:54	11:54	1273	22447	63.0	617
				Average	23,406	65.7	639