REPORT

FCA US LLC

AUBURN HILLS, MICHIGAN

TECHNOLOGY CENTER:
2019 SOURCE TESTING PROGRAM
PTI 155-18 FG-CONTRLDCELLS - C-WING & D-WING THERMAL OXIDIZERS

RWDI #1903165

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SUBMITTED TO

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EXECUTIVE SUMMARY

RWDI AIR Inc. (RWDI) was retained by FCA US LLC (FCA) to complete air emission testing on one of the thermal oxidizers in the C-Wing (91-THO-4.01) and one of the thermal oxidizers in the D-Wing (92-THO-4.01). The source testing was completed on October 2nd and the 3rd 2019.

CTC was issued a Permit to Install (PTI 155-18) to complete source testing as required under the Flexible Group (FG-CNTRLDCELLS). Under FG-CNTRLDCELLS there are two scenarios noted:

- **Scenario A** – effective emission limits until the Notification specified in SC VII.2 is submitted to AQD; and
- **Scenario B** – effective after the Notification specified in SC VII.2 has been submitted to AQD.

CTC is working towards completing the necessary actions enable operations under Scenario B via submittal of the Notification specified in SC VII.2. Since these actions are not yet complete, this report reflects testing and results under Scenario A conditions.

Testing was successfully completed while all process equipment was operating under representative operating conditions.

The testing program successfully met all requirements. A summary of the results can be found in the "**Tables**" section of this report.

TABLE OF CONTENTS

LIST OF TABLES

(Found Within the Report)

LIST OF TABLES

(Found After the Report Text)

LIST OF APPENDICES

1 INTRODUCTION

RWDI AIR Inc. (RWDI) was retained by FCA US LLC to complete air emission testing on one of the thermal oxidizers in the C-Wing (91-THO-4.01) and one of the thermal oxidizers in D-Wing (92-THO-4.01). Source testing was completed on October 2nd and the 3rd 2019.

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- **Scenario B –** effective after the Notification specified in SC VII.2 has been submitted to AQD.

CTC is working towards completing the necessary actions to enable operations under Scenario B via submittal of the Notification specified in SC VII.2. Since these actions are not yet complete, this report reflects testing and results under Scenario A conditions.

Testing was successfully completed while all process equipment was operating under representative operating conditions.

Testing of emissions was conducted by Mr. Derek Ottens, Mr. Alec Smith, Ms. Danette Hohmeier, Mr. Brad Bergeron, and Mr. Kirk Easto of RWDI. Mr. Stuart Weiss and Mr. Thomas Caltrider were on-site to monitor the process operation and witness the testing on behalf of FCA US LLC. Testing was witnessed by Mr. Mark Dziadosz and Mr. Iranna Konanahalli from Michigan Environment, Great Lakes and Energy (EGLE), AQD/Warren District Office.

A copy of the Source Testing Plan and Approval letter is provided in **Appendix A**.

2 PROCESS DESCRIPTION

CTC is primarily used as a research and development center for automobiles and light-duty trucks. Operations and equipment at CTC under the current PTI include dynamometer test cells used for engines, vehicle drive trains, and engine component testing. Test cells are in operation in five (5) wings of the Powertrain division (A-Wing, B-Wing, C-Wing, D-Wing and E-Wing). As noted in the PTI, up to forty-six (46) engine dynamometer test cells house a total of eighty (80) dynamometer test stands within the C-Wing, D-Wing, and E-Wing. The durability and transmission test cells in C-Wing, D-Wing and E-Wing are managed in flexible group FG-CNTRLDCELLS and are controlled using a total of eleven (11) Thermal Oxidizers. As noted in the PTI, within flexible group FG-CNTRLDCELLS up to forty-six (46) engine dynamometer test cells house a total of eighty (80) dynamometer test stands within the C-Wing, D-Wing, and E-Wing. Other test cells in C-Wing and E-Wing are part of flexible group FG-UNCNTRLDCELLS.

3 SAMPLING LOCATIONS AND METHODS

3.1 Sampling Location

The outlet sampling locations for the Thermal Oxidizer on C-Wing (91-THO-4.01) and D-Wing (92-THO-4.01) stacks are identical. Each stack has an inside diameter of 22 inches. Each exhaust had a set of sampling ports, 90 degrees apart. The sampling ports were 6 inches in diameter and are located approximately 8 duct diameters downstream and more than 2 duct diameters upstream of any flow disturbances.

3.2 Test Methods

3.2.1 Velocity, Temperature and Volumetric Flow Rate Determination

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". Stack moisture content was determined through direct condensation and according to U.S. EPA Method 4, "Determination of Moisture Content of Stack Gases".

3.2.2 Determination of Total Particulate Matter (US EPA Method 5 and 202)

Sampling for total particulate matter was performed in accordance with U.S. EPA Method 5, "Determination of Particulate Matter Emissions from Stationary Sources" and USEPA Method 202 "Dry Impinger Method for Determining Condensable Particulate Emissions from a Stationary Source". Sampling was conducted using a calibrated Environmental Supply C-5000 Source Sampling System. The sampling probe including: nozzle, probe liner, probe sheath, and pitot, were constructed out of Inconel metal due to the high temperatures of the exhaust source. Triplicate sampling runs were conducted.

Sampling was conducted isokinetically using the required number of traverse points across the stack diameter. The sample was drawn through an Inconel nozzle, Inconel lined sample probe and quartz fibre filter, all maintained at 250 °F ± 25 °F, to capture total particulate matter. The sample was then introduced into the impinger train where it passed through two empty impingers, a secondary filter which was maintained at a temperature between 68 °F and 85 °F. Lastly, the gas stream was drawn through one water impinger and one impinger containing silica gel. A total of 12 points (six (6) per traverse) were used.

Upon completion of the test, the sampling train was recovered, as in the procedures detailed in the reference method, and the samples were packaged for transport to ALS in Burlington, Ontario for analysis.

A summary of the Sampling Parameters and Methodology may be found in **Table 1 (Table Section)**.

3.3 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, equipment calibrations for all measured parameters, completion of Chain of Custody forms when submitting laboratory samples, and submission of field blank samples to the laboratories. **Table 2 (Table Section)** presents a sample log and summarizes the sampling times, sample ID's, and filter ID's.

All samplers were bench tested and calibrated in RWDI's Guelph 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.

4 RESULTS

The average emission results for this study are presented in the **Table 3** found in the '**Tables**' section of this report. Detailed information for each test run can be found in the **Appendix B**.

All sampling field notes are provided in **Appendix C**. All laboratory results are included in **Appendix D**. All calibration information for the equipment used for this study is included in **Appendix E**. Process Data is provided in **Appendix F**. Sample calculations are provided in **Appendix G**.

4.1 Discussion of Results

Sampling was completed on October 2nd and 3rd, 2019 and no issues occurred during the sampling process. A summary of the results can be found in the tables section of this report and the more detailed calculations can be found in **Appendix B**. Contact was maintained between the site contact 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.

Total particulate matter (TPM) was measured (U.S. EPA Method 5/202) instead of PM_{10} and $PM_{2.5}$ separately via U.S. EPA 201A/202 due to limitations of the sampling equipment from the high stack gas temperature. This was communicated to EGLE prior to commencing with the testing. The TPM value was used in the calculations and applied equally to the PM_{10} and $PM_{2.5}$ portions of particulate. This is a conservative approach that was discussed with EGLE prior to commencing with the program. The results have been summarized below in **Table 4.1.1**.

Table 4.1.1: Sampling Result Summary

Source	Parameter	Concentration (gr/dscf)	Emission Rate (lbs/hr)	Fuel Usage (gal/ test)	Emission Factor (lbs/gal of Fuel)
C-Wing	TPM/CPM	0.0046	0.145	70.2	0.0041
D-Wing	TPM/CPM	0.0029	0.088	112.1	0.0016

The average emission rate for C-Wing Oxidizer 91-THO-4.01 was determined to be 0.145 lbs/hr which resulted in an emission factor of 0.0041 lb/gal based on the fuel usage per test (average 70.2 gallons). The average emission rate for D-Wing Oxidizer 92-THO-4.01 was determined to be 0.088 lbs/hr which resulted in an emission factor of 0.0016 lb/gal based on the fuel usage per test (average 112.1 gallons).

The emission limits noted in the PTI are 15.91 tons per year (tpy) for each of PM_{10} and $PM_{2.5}$. The tpy emission limits were based on default emission factors noted as 0.0062 lb/gal for fuel for all other fuels (except diesel) and 0.012 lb/gal of fuel for diesel. Default emission factors are listed in PTI 155-18, Section I. Emission Limits, Scenario A.

4.2 Process Data

As noted by EGLE, the following process data was required to be collected during testing:

- Fuel usage during each test; and
- Set-point and average test temperature of the thermal oxidizer combustion chamber during each test.

Fuel usage data during each test is summarized below in **Table 4.2.1**. The temperature data from each of the thermal oxidizer combustion chambers during each test is provided in **Appendix F**.

Table 4.2.1: Fuel Usage Summary

Source	Oxidizer ID	Fuel Usage (Gals)
C-Wing	91-THO-4.01	73.82 Total 56.84 E10 Gasoline 16.98 Diesel
C-Wing	91-THO-4.01	77.02 Total 63.74 E10 Gasoline 13.28 Diesel
C-Wing	91-THO-4.01	59.83 Total 47.38 E10 Gasoline 12.44 Diesel
	Average C-Wing	**70.22 Total**
D-Wing	92-THO-4.01	93.66 Total (E10 Gasoline only)
D-Wing	92-THO-4.01	117.64 Total (E10 Gasoline only)
D-Wing	92-THO-4.01	125.06 Total (E10 Gasoline only)
	Average D-Wing	**112.12 Total**

5 CONCLUSIONS

Testing was successfully completed on October 2nd and 3rd, 2019. All parameters were tested in accordance with referenced methodologies.

TABLES

Table 1: Summary of Sampling Parameters and Methodology

Source Location	No. of Tests per Stack	Sampling Parameter	Sampling Method
C-Wing 91-THO-4.01	3	Stack Parameters	U.S. EPA [1] Methods 1-4
	3	Total Particulate Matter	U.S. EPA [1] Method 5
	3	Condensable Particulate Matter	U.S. EPA [1] Method 202
D-Wing 92-THO-4.01	3	Stack Parameters	U.S. EPA [1] Methods 1-4
	3	Total Particulate Matter	U.S. EPA [1] Method 5
	3	Condensable Particulate Matter	U.S. EPA [1] Method 202

Notes:

[1] U.S. EPA - United States Environmental Protection Agency

Table 3: Sampling Summary

CTC Source Testing

Stack Gas Parameter		C-Wing (91-THO-4.01)				D-Wing (92-THO-4.01)			
		Test #1	Test #2	Test #3	Average	Test #1	Test #2	Test #3	Average
	Testing Date	Oct/02	Oct/02	Oct/02		Oct/03	Oct/03	Oct/03	
Stack Temperature	°F	1390	1399	1391	**1393**	1406	1399	1405	**1403**
	°C	755	759	755	**756**	763	759	763	**762**
Sample Volume	ft³	66.72	97.94	67.41	**77.36**	60.86	65.53	69.07	**65.15**
	m³	1.89	2.77	1.91	**2.19**	1.72	1.85	1.95	**1.84**
Moisture	%	10.0%	10.3%	8.8%	**9.7%**	8.5%	14.8%	14.8%	**12.7%**
Velocity	ft/s	73.04	75.29	72.54	**73.62**	69.66	72.70	78.00	**73.45**
	m/s	22.26	22.95	22.11	**22.44**	21.23	22.16	23.78	**22.39**
Actual Flow Rate	cf/min	14,347	14,789	14,249	**14,462**	13,684	14,280	15,322	**14,429**
Referenced Flow Rate[1]	dscf/min	3,678	3,761	3,701	**3,714**	3,540	3,452	3,690	**3,561**
	m^3/s	1.74	1.77	1.75	**1.75**	1.67	1.63	1.74	**1.68**
Oxygen	%	10.1	10.7	10.2	**10.3**	10.4	10.4	10.5	**10.4**
	%	6.8	6.9	7.1	**6.9**	8.3	8.3	8.0	**8.2**
Sampling Isokinetic Rate	%	100	99	101	-	94	104	103	-
TPM Capture		**Test #1**	**Test #2**	**Test #3**		**Test #4**	**Test #5**	**Test #6**	
Filter Capture	grains	0.046	0.031	0.037	0.038	0.043	0.031	0.037	0.037
Acetone Capture	grains	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Total Filterable Particulate	grains	**0.048**	**0.032**	**0.039**	**0.040**	**0.045**	**0.032**	**0.039**	**0.039**
Extractable Condensable Particulates	grains	0.264	0.148	0.097	0.170	0.120	0.068	0.063	0.084
Non-Extractable Condensable Particulates	grains	0.116	0.231	0.073	0.140	0.054	0.068	0.071	0.064
Total TPM	grains	**0.427**	**0.412**	**0.208**	**0.349**	**0.219**	**0.168**	**0.173**	**0.187**
TPM Concentration		**Test #1**	**Test #2**	**Test #3**		**Test #4**	**Test #5**	**Test #6**	
Total Filterable Particulate	gr/dscf	0.0007	0.0003	0.0006	0.0005	0.0007	0.0005	0.0006	0.0006
Extractable Condensable Particulates		0.0040	0.0015	0.0014	0.0023	0.0020	0.0010	0.0009	0.0013
Non-Extractable Condensable Particulates	gr/dscf	0.0017	0.0024	0.0011	0.0017	0.0009	0.0010	0.0010	0.0010
Total TPM	gr/dscf	**0.0064**	**0.0042**	**0.0031**	**0.0046**	**0.0036**	**0.0026**	**0.0025**	**0.0029**
Production Rate									
Fuel Usage	gal/test	**73.8**	**77.0**	**59.8**	**70.2**	**93.7**	**117.6**	**125.1**	**112.1**
TPM Emission Rate		**Test #1**	**Test #2**	**Test #3**		**Test #4**	**Test #5**	**Test #6**	
Total Filterable Particulate	lb/hr	0.0226	0.0107	0.0182	0.017	0.0223	0.0146	0.0177	0.018
Extractable Condensable Particulates	lb/hr	0.1247	0.0488	0.0458	0.073	0.0600	0.0307	0.0290	0.040
Non-Extractable Condensable Particulates	lb/hr	0.0547	0.0762	0.0341	0.055	0.0269	0.0307	0.0325	0.030
Total TPM	lb/hr	**0.202**	**0.136**	**0.098**	**0.145**	**0.109**	**0.076**	**0.079**	**0.088**
Total Particulate Mass	lb/test	0.40	0.27	0.20	0.290	0.22	0.15	0.16	0.176
PM Emission Rate [2]	lb/gal	**0.0055**	**0.0035**	**0.0033**	**0.0041**	**0.0023**	**0.0013**	**0.0013**	**0.0016**

Notes:

[1] Referenced flow rate expressed as dry at 101.3 kPa, 68 °F, and Actual Oxygen

[2] Emission Rate as lbs TPM per gal of Fuel

Detailed sampling results including individual test results can be found in Appendix B

Table 5: Production Data

Date	Oxidizer	Run			Total Fuel (gal)	Comments
C-Wing 91-THO-4.01						
10/2/2019	91-THO-4.01	Test #1	9:10	11:15	73.82	"Total Fuel" is the total fuel usage during each test.
10/2/2019	91-THO-4.01	Test #2	12:00	14:06	77.0	
10/2/2019	91-THO-4.01	Test #3	14:35	16:43	59.83	
D-Wing 92-THO-4.01						
10/3/2019	92-THO-4.01	Test #4	8:08	10:11	93.66	"Total Fuel" is the total fuel usage during each test.
10/3/2019	92-THO-4.01	Test #5	10:30	12:35	117.64	
10/3/2019	92-THO-4.01	Test #6	12:57	15:00	125.1	