

FINAL REPORT



FCA US LLC

STERLING HEIGHTS, MICHIGAN

STERLING HEIGHTS ASSEMBLY PLANT (SHAP): SOURCE TESTING REPORT

RWDI #2104170

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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 Sterling Heights Assembly Plant (SHAP) located at 38111 Van Dyke Road, Sterling Heights, Michigan (SRN: B7248). SHAP operates an automobile assembly plant that produces Ram trucks and includes a North Paint Shop (NPS) and a South Paint Shop (SPS). This Source Testing Program outlines the performance testing required for the engines associated with two emergency generators installed at the SPS. The test program was conducted to fulfill the requirements of the Michigan Department of Environment, Great Lakes and Energy (EGLE) permit MI-ROP-B7248-2020 ("ROP") and 40 CFR (Code of Federal Regulations) Part 60, NSPS (New Source Performance Standards) Subpart JJJJ. The test included measurements of total oxides of nitrogen (NO_x), carbon monoxide (CO), and volatile organic compounds (VOCs, defined as non-methane hydrocarbons) on both engines. These emissions were calculated while the engines were operated within 10% of 100% peak load (or highest achievable load) combusting natural gas (~100% of Full Load for each Engine). And lastly, exhaust air flow rate was determined on all engines at the exhaust test ports. Testing was conducted on August 5, 2021 and August 17, 2021.

The following table represents a summary of the stack testing results.

Summary of EU-ENG-GEN1-SOUTH Emission Data:

Parameter	Symbol	Units	Average	Corrected to 15% O ₂	Limits
Nitrogen Oxides	NO _x	ppmvd	229.7	65.6	160
Carbon Monoxide	CO	ppmvd	407.3	116.3	540
VOCs (as propane)	VOC	ppmvd	113.3	32.3	86
Oxygen	O ₂	% _{dry}	-0.02	-	-
Nitrogen Oxides	NO _x	g/HP-hr	0.91	-	2.0
Carbon Monoxide	CO	g/HP-hr	1.05	-	4.0
VOCs (as propane)	VOC	g/HP-hr	0.46	-	1.0



Summary of EU-ENG-GEN1-SOUTH Exhaust Data and Power Ratings:

Parameter	Units	Average
Stack Gas Temperature	°F	1063.9
Velocity	ft/sec	89.1
Actual Flowrate	Cfm	1639.5
Dry Reference Flowrate	Dscfm	446.7
Average Horsepower	HP	699 (100% of full load)

Summary of EU-ENG-GEN2-SOUTH Emission Data:

Parameter	Symbol	Units	Average	Corrected to 15% O ₂	Limits
Nitrogen Oxides	NO _x	ppmvd	76.2	21.9	160
Carbon Monoxide	CO	ppmvd	360.7	103.6	540
VOCs (as propane)	VOC	ppmvd	5.0	1.4	86
Oxygen	O ₂	% _{dry}	0.11	-	-
Nitrogen Oxides	NO _x	g/HP-hr	0.25	-	2.0
Carbon Monoxide	CO	g/HP-hr	0.74	-	4.0
VOCs (as propane)	VOC	g/HP-hr	0.02	-	1.0

Summary of EU-ENG-GEN2-SOUTH Exhaust Flow and Power Rating Data:

Parameter	Units	Average
Stack Gas Temperature	°F	1070.8
Velocity	ft/sec	69.6
Actual Flowrate	Cfm	1281.6
Dry Reference Flowrate	Dscfm	384.2
Average Horsepower	HP	668 (95% of full load)



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1 INTRODUCTION

RWDI USA LLC (RWDI) was retained by FCA US LLC (FCA) to complete the emission sampling program at their Sterling Heights Assembly Plant (SHAP) located at 38111 Van Dyke Road, Sterling Heights, Michigan (SRN: B7248). SHAP operates an automobile assembly plant that produces Ram trucks and includes a North Paint Shop (NPS) and a South Paint Shop (SPS). This Source Testing Program outlines the performance testing required for the engines associated with two emergency generators installed at the SPS. The test program was conducted to fulfill the requirements of the Michigan Department of Environment, Great Lakes and Energy (EGLE) permit MI-ROP-B7248-2020 ("ROP") and 40 CFR (Code of Federal Regulations) Part 60, NSPS (New Source Performance Standards) Subpart JJJJ. The test included measurements of total oxides of nitrogen (NO_x), carbon monoxide (CO), and volatile organic compounds (VOCs, defined as non-methane hydrocarbons) on both engines. A copy of the PTI is provided in **Appendix A**. The test program included measurements of total oxides of nitrogen (NO_x), carbon monoxide (CO), and volatile organic compounds (VOCs, defined as non-methane hydrocarbons) on both engines (EU-ENG-GEN1-SOUTH and EU-ENG-GEN2-SOUTH). These emissions were calculated while the engines were operated within 10% of 100% peak load (or highest achievable load) (each at ~100% load) combusting natural gas. Exhaust air flow rate was determined on both engines during each of the tests.

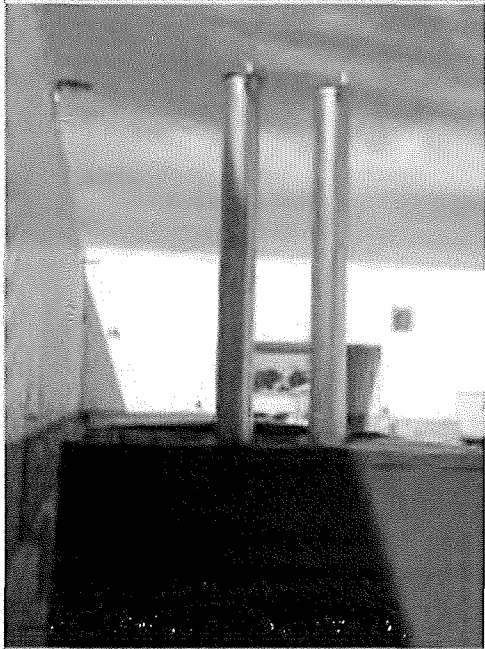
Testing was conducted on August 5, 2021 and August 17, 2021. Results from the sampling program are presented in the **Tables Section** of the report, with more detailed sampling results provided in the **Appendices**. Copies of the approval letter and related correspondence are provided in **Appendix A**.

This stack testing study consisted of the following parameters:

- Velocity, flow rate and temperature;
- Nitrogen oxides (NO_x);
- Carbon Monoxide (CO);
- Oxygen (O₂);
- Volatile Organic Compounds (VOCs); and
- Moisture (%).



Figure 1: Example of one of the EU-ENG-GEN-SOUTH Outlet Configurations



The sampling point selection and stratification test was performed in accordance with EPA Reference Method 7E section 8.1.2. (applicable to instrumental analyzer methods).

4 SAMPLING METHODOLOGY

The following section provides an overview of the sampling methodologies used in this program.

4.1 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 inclined 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, "Determination of Molecular Weight of Dry Stack Gas". Stack moisture content was determined using an extractive Fourier Transform Infrared (FTIR) spectroscopy and according to US EPA Method 320, "Measurement of Vapor Phase Organic and Inorganic Emissions by Extractive Fourier Transform Infrared (FTIR Spectroscopy)". Moisture was collected at a single point during each test.



4.3 Quality Assurance/Quality Control Activities

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.

Quality control procedures specific to the CEM monitoring equipment included linearity checks to determine the instrument performance and reproducibility checks prior to its use in the field. Regular performance checks on the analyser were also carried out during the testing program by performing hourly zero checks and span calibration checks using primary gas standards. Sample system bias checks were also done. These checks were used to verify the ongoing accuracy of the monitor and sampling system over time. Pollutant-free nitrogen was introduced to perform the zero checks, followed by a known calibration (span) gas into the monitor. The response of the monitor to pollutant-free air and the corresponding sensitivity to the span gas were recorded regularly during the tests.

Pre and post test leak checks were done on the flow system by pressurizing and plugging the positive and negative side of the pitot separately. 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.

The FTIR test method follows the US EPA Method 320 test procedures. The primary control check for the FTIR (EPA Method 320) is a Calibration Transfer Standard (CTS) check which was performed before and after each test run.

Initial background spectrum using dry nitrogen gas was obtained per Section 8.5 of EPA Method 320. A CTS was performed pre-test using procedures outlined in Section 8.6.1 of EPA Method 320. A post-test CTS per source was also performed. CTS result averages were measured to be within $\pm 5\%$ of the calibration gas standard.

In addition, a known calibration spike was introduced into the FTIR once per day for the source to confirm the FTIR is working properly and verify the ability to quantify the target analytes in the presence of the stack gas. Three replicate data sets of QA spike were measured during the testing period.

A known calibration spike gas was introduced prior to the first run to measure FTIR analyzer response as part of the quality assurance (QA) spiking procedure. The FTIR analyzer response needed to be between 70% and 130% of the expected value and as such determined to be acceptable (Section 8.6.2 of EPA Method 320 requires the average QA spiked percent recovery to be between 70% and 130%). Results of this procedure are provided in the final test report.

Propane (mixed with SF₆ as a tracer) and CO/NO_x (mixed with SF₆ as a tracer) were used as the spiked recovery gas for VOC and CO/NO_x testing. Also, ethylene was used as the CTS gas.

Finally, the off-site QA/QC included a data review and a data comparison using MKS "Method Analyzer" software. Method validation was conducted for each test run by pulling a random spectrum sample and results have been included in the appendices.



7 CONCLUSIONS

Testing was successfully completed on August 5th and 17th of 2021. All sources were tested in accordance with referenced methodologies following the EGLE approved test protocol.

TABLES



TABLE 1: EU-ENG-GEN1-SOUTH Emission Results

FCA US,LLC- Sterling Heights Assembly Plant (SHAP)

Facility:	SHAP
City:	Sterling Heights, MI
Source:	EU-ENG-GEN1-SOUTH
Date:	8/17/2021

	Symbol	Units	Test #1			Test #2			Test #3			Average	Corrected to 15% O ₂	Limits
			North Duct	South Duct	Total Emissions	North Duct	South Duct	Total Emissions	North Duct	South Duct	Total Emissions			
Nitrogen Oxides Concentration	NO _x	ppmvd	140.9	291.9	-	140.3	209.7	-	193.8	401.4	-	229.7	65.6	160 ^a
Carbon Monoxide Concentration	CO	ppmvd	656.3	227.1	-	651.7	197.4	-	490.2	221.2	-	407.3	116.3	540 ^a
VOCs (as propane) Concentration	VOC	ppmvd	147.9	100.4	-	144.6	76.7	-	126.2	83.9	-	113.3	32.3	86 ^a
Oxygen Concentration	O ₂	% _{dry}	-0.18	-0.1	-	-0.2	-0.1	-	0.5	-0.1	-	-0.02	-	-
Nitrogen Oxides Concentration	NO _x	g/HP-hr	0.30	0.66	0.96	0.30	0.47	0.77	0.43	0.58	1.01	0.91	-	2.0 ^b
Carbon Monoxide Concentration	CO	g/HP-hr	0.86	0.31	1.17	0.85	0.27	1.12	0.67	0.19	0.86	1.05	-	4.0 ^b
VOCs (as propane) Concentration	VOC	g/HP-hr	0.30	0.22	0.52	0.30	0.16	0.46	0.27	0.12	0.39	0.46	-	1.0 ^b

a = ppm corrected to 15%O₂

b = g/HP-hr

TABLE 2: EU-ENG-GEN2-SOUTH Emission Results

FCA US,LLC- Sterling Heights Assembly Plant (SHAP)

Facility:	SHAP
City:	Sterling Heights, MI
Source:	EU-ENG-GEN2-SOUTH
Date:	8/5/2021

	Symbol	Units	Test #1			Test #2			Test #3			Average	Corrected to 15% O ₂	Limits
			East Duct	West Duct	Total Emissions	East Duct	West Duct	Total Emissions	East Duct	West Duct	Total Emissions			
Nitrogen Oxides Concentration	NO _x	ppmvd	63.6	81.0	-	59.0	96.0	-	61.5	96.2	-	76.2	21.9	160 ^a
Carbon Monoxide Concentration	CO	ppmvd	276.7	477.4	-	301.6	423.4	-	272.4	412.6	-	360.7	103.6	540 ^a
VOCs (as propane) Concentration	VOC	ppmvd	4.7	5.2	-	4.6	5.1	-	5.1	5.2	-	5.0	1.4	86 ^a
Oxygen Concentration	O ₂	% _{dry}	0.69	-0.3	-	-0.2	0.4	-	0.3	-0.2	-	0.11	-	-
Nitrogen Oxides Concentration	NO _x	g/HP-hr	0.15	0.18	0.33	0.09	0.13	0.22	0.09	0.12	0.21	0.25	-	2.0 ^b
Carbon Monoxide Concentration	CO	g/HP-hr	0.39	0.65	1.04	0.28	0.34	0.62	0.25	0.31	0.57	0.74	-	4.0 ^b
VOCs (as propane) Concentration	VOC	g/HP-hr	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.02	-	1.0 ^b

a = ppm corrected to 15%O₂

b = g/HP-hr

Table 3: EU-ENG-GEN1-SOUTH Flow Measurements

FCA US,LLC- Sterling Heights Assembly Plant (SHAP)

Facility:	SHAP
City:	Sterling Heights, MI
Source:	EU-ENG-GEN1-SOUTH
Max Horsepower:	701
Max Kilowatt:	500

Parameter	Units	Run 1		Run 2		Run 3		Average
		North Duct	South Duct	North Duct	South Duct	North Duct	South Duct	
Stack Gas Temperature	°F	1066.4	1060.3	1068.7	1055.6	1061.6	1070.9	1063.9
Velocity	ft/sec	92.6	96.3	92.8	95.4	95.2	62.1	89.1
Actual Flowrate	cfm	1705.3	1771.9	1708.5	1756.7	1751.5	1142.9	1639.5
Dry Reference Flowrate	dscfm	462.7	483.0	463.4	480.5	480.7	310.1	446.7
Average Horse Power	HP	699		700		700		699.7
Load	%	99.7%		99.8%		99.8%		99.8%

Table 4: EU-ENG-GEN2-SOUTH Flow Measurements

FCA US,LLC- Sterling Heights Assembly Plant (SHAP)

Facility:	SHAP
City:	Sterling Heights, MI
Source:	EU-ENG-GEN2-SOUTH
Max Horsepower:	701
Max Kilowatt:	500

Parameter	Units	Run 1		Run 2		Run 3		Average
		East Duct	West Duct	East Duct	West Duct	East Duct	West Duct	
Stack Gas Temperature	°F	1073.6	1066.0	1074.0	1072.9	1070.9	1067.2	1070.8
Velocity	ft/sec	95.2	91.6	62.7	54.6	62.5	51.2	69.6
Actual Flowrate	cfm	1752.6	1685.7	1153.3	1005.6	1149.8	942.7	1281.6
Dry Reference Flowrate	dscfm	475.2	459.3	312.7	272.8	312.4	256.7	348.2
Average Horse Power	HP	670		667		667		668
Load	%	95.5%		95.2%		95.2%		95.3%