FINAL REPORT

FCA US LLC

STERLING HEIGHTS, MICHIGAN

STERLING HEIGHTS ASSEMBLY PLANT (SHAP): SOURCE TESTING REPORT EU-ENG-PSHOP-NC-701HP GENERATOR EMERGENCY ENGINE EU-ENG-PSHOP-NC-201 HP

RWDI #2201099

OCTOBER 6, 2022

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 North Paint Shop emergency generator (EU-ENG-PSHOP-NC-701HP). The test program was conducted to fulfill the requirements of the Michigan Department of Environment, Great Lakes and Energy (EGLE) permit MI-ROP-B7248-2020a ("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 (NOx), carbon monoxide (CO), and volatile organic compounds (VOCs, defined as non-methane hydrocarbons) on the emergency generator. The 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). The exhaust air flow rate was determined on the emergency generator at the exhaust test ports. Testing was conducted on August 11, 2022.

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

Summary of EU-ENG-PSHOP-NC-701HP Emission Data:

Parameter	Symbol	Units	Average	Corrected to 15% O_2	Limits
Nitrogen Oxides	NO_x	ppmvd	178.7	51.1	160
Carbon Monoxide	CO	ppmvd	582.7	166.5	540
VOCs (as propane)	VOC	ppmvd	7.0	2.0	86
Oxygen	O_2	$\%_{dry}$	0.0	-	-
Nitrogen Oxides	NO_x	g/HP-hr	0.86	-	2.0
Carbon Monoxide	CO	g/HP-hr	1.70	-	4.0
VOCs (as propane)	VOC	g/HP-hr	0.03	-	1.0

Summary of EU-ENG-PSHOP-NC-701HP Exhaust Data and Power Ratings:

Parameter	Units	Average
Stack Gas Temperature	°F	1068.5
Velocity	ft/sec	139.5
Actual Flowrate	Cfm	1647.2
Dry Reference Flowrate	dscfm	448.5
Average Horsepower	HP	606 (96% 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 engine associated with the emergency generator installed at the North Paint Shop (NPS) (EU-ENG-PSHOP-NC-701HP). The test program was conducted to fulfill the requirements of the Michigan Department of Environment, Great Lakes and Energy (EGLE) permit MI-ROP-B7248-2020a ("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 (NOx), carbon monoxide (CO), and volatile organic compounds (VOCs, defined as non-methane hydrocarbons) on the emergency generator. These emissions were calculated while the emergency generator was operating within 10% of 100% peak load (or highest achievable load) (each at ~100% load) combusting natural gas. Exhaust air flow rate was determined on the emergency generator during testing.

Testing was conducted on August 11, 2022. 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 (O_2);
- Volatile Organic Compounds (VOCs); and
- Moisture (%).

1.1 Testing Personnel

The following table presents personnel that were involved with the testing program.

Table 1.1.1: Summary of Testing Personnel

Name	Title & Affiliation	Address	Contact Number
Mr. Adekunle Sanni	Environmental Specialist FCA US LLC Sterling Heights Assembly Plant	38111 Van Dyke Ave Sterling Heights, MI 48312	586-208-4483
Mr. Tom Caltrider	Corporate Environmental Programs EHS FCA US LLC	38111 Van Dyke Avenue Sterling Heights, MI 48312	248.882.7169
Mr. Brad Bergeron	Senior Project Manager RWDI USA LLC	2239 Star Court Rochester Hills, MI 48309	519.817.9888
Mr. Mason Sakshaug	Senior Scientist – Supervisor RWDI USA LLC	2239 Star Court Rochester Hills, MI 48309	989.323.0355
Mr. Mike Nummer	Senior Field Technician RWDI USA LLC	2239 Star Court Rochester Hills, MI 48309	586-863-8237

2 SOURCE DESCRIPTION

2.1 Facility Description

The following sources and source group, as identified in the ROP, are included in the program:

Flexible Group FG-NSPS JJJJ EMERGENCY > 500 HP:

- EU-ENG-PSHOP-NC-701HP
- Triennial testing of NOx, CO and VOC for non-certified Emergency Engines

SHAP operates an automobile assembly plant that produces Light Duty Trucks for FCA US LLC under Flexible Group ID: FG-NSPS JJJJ EMERGENCY > 500 HP. The emergency generator has a twin exhaust stack configuration where the emissions are distributed to two (2) stacks. The emergency generator is equipped with an oxidation catalyst that controls engine exhaust before venting into the atmosphere. For the purposes of the test protocol, EU-ENG-PSHOP-NC-701HP was required to be tested for CO, NOx, and VOCs to determine compliance with the air permit, Michigan Air Toxics Rule R 336.1225 and NSPS Subpart JJJJ regulations.

3 SAMPLING LOCATION

3.1 Sample Location Description

The sampling locations for the emergency generator are located outside. The outlet sampling locations for both emergency generator stacks meet the USEPA Method 1 criteria. The following table summarizes the sampling locations. Exhaust was analyzed for CO, O_2, NOx, VOCs, flows and moisture. Samples were extracted from sampling ports in each of the twin exhaust stacks for the generator.

The emergency generator has a twin exhaust stack configuration (see **Figure 3.1**). In order to evaluate the emissions from each of the exhaust stacks, for each 60-minute test run, 50% of the sample period were measured from the 1st twin stack and the remaining 50% of the sampling period was measured from the 2nd twin stack. Velocity measurements were taken from each of the twin exhausts.

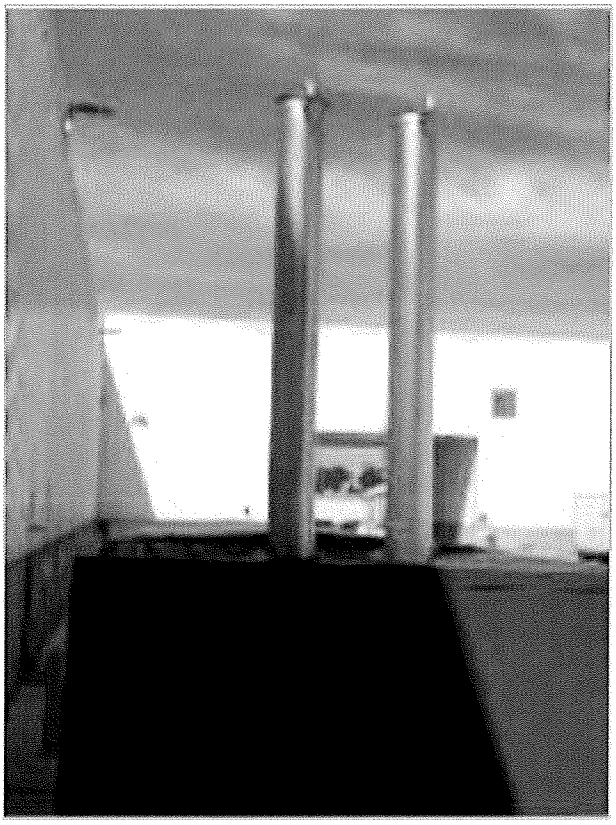


Figure 3.1: Example of Outlet Configurations

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.

4.2 Continuous Emissions Monitoring for O_2, CO, NOx, and VOCs

Testing for O_2, CO, NO_x, and VOCs was accomplished using continuous emission monitors (CEM) and the FTIR. The exhaust gas sample was sampled by drawing a sample stream of flue gases through a stainless-steel probe attached to a heated filter and a heated sample line that is attached to the Automated Sampling Console (ASC-10ST). The ASC-10ST sampling console delivers a continuous sample to the MKS MultiGas 2030 FTIR for analysis.

The heated line was maintained at approximately 375°F and the MKS MultiGas 2030 FTIR and MAX Analytical ASC-10ST gas components were at 375°F. The end of the probe was connected to a heated Teflon sample line, which delivers the sample gases from the stack to the FTIR system. The heated sample line is designed to maintain the gas temperature above 250°F in order to prevent condensation of stack gas moisture within the line. The sample was then routed through a manifold system and introduced to the individual CEM's for measurement. As recommended by EGLE, the sample line was heated to 375°F.

The ASC-10ST was used to deliver calibration gases (Calibration Transfer Standard (CTS), QA Spike and Nitrogen) to the FTIR in direct (to analyzer) and system (to probe) modes.

A laptop computer was utilized for operating the MKS MultiGas 2030 FTIR and MAX Analytical ASC-10ST sampling console and logging the multi-gas FTIR data. Data was logged as one minute averages for the actual test period (FTIR PRN files and Spectra). All concentration data were determined using the MKS 2030 MultiGas FTIR software. A typical MKS 2030 FTIR and ASC-10 ST configuration is depicted in **Figure 4.2.1**.

For oxygen measurement, an EPA Method 3A compliant Brand Gaus Model 4710 wet O_2 analyzer was used. Prior to testing, sample system bias checks and instrument linearity checks (calibration error) were completed in compliance with EPA Method 3A. In addition, the analysers were calibrated (zeroed and span checked) at the completion of each run. A data logger system programmed to collect and record data at 1- second intervals was used to compute and record one-minute average concentrations. The average was drift corrected using pre and post drift checks and changed from wet to dry using stack moisture content.

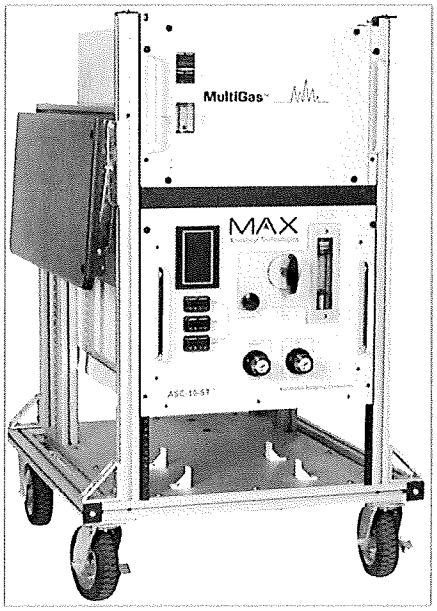


Figure 4.2.1: Typical MKS MultiGas 2030 FTIR and ASC-10ST measurement system

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 conducted 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 ±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 SF_6 as a tracer) and CO/NOx (mixed with SF_6 as a tracer) were used as the spiked recovery gas for VOC and CO/NOx 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.

5 RESULTS

The flow and emissions data for this study are presented in the '**Tables**' section of this report. Detailed information regarding each test run can be found in the corresponding appendix. Field notes are presented in **Appendix D**. All calibration information for the equipment used for the program is included in **Appendix E**. Detailed example calculations for each measured pollutant is provided in **Appendix G**.

Table 5.1: Summary of Process Data

Process Data Parameter	Units	EU-ENG-PSHOP-NC-701HP		
		Run 1	Run 2	Run 3
Time of Testing	--	09:30 to 10:37	10:56 to 11:59	12:53 to 13:58
Engine Output	kW	432	432	432
Engine Output	BHP	605.7	605.7	605.7
Engine Speed	RPM	1,728	1,728	1,728

Table 5.2: Summary of EU-ENG-PSHOP-NC-701HP Emission Data:

Parameter	Symbol	Units	Average	Corrected to 15% O_2	Limits
Nitrogen Oxides	NO_x	ppmvd	178.7	51.1	160
Carbon Monoxide	CO	ppmvd	582.7	166.5	540
VOCs (as propane)	VOC	ppmvd	7.0	2.0	86
Oxygen	O_2	$\%_{dry}$	0.0	-	-
Nitrogen Oxides	NO_x	g/HP-hr	0.86	-	2.0
Carbon Monoxide	CO	g/HP-hr	1.70	-	4.0
VOCs (as propane)	VOC	g/HP-hr	0.03	-	1.0

Table 5.3: Summary of EU-ENG-PSHOP-NC-701HP Exhaust Data and Power Ratings

Parameter	Units	Average
Stack Gas Temperature	°F	1068.5
Velocity	ft/sec	139.5
Actual Flowrate	Cfm	1647.2
Dry Reference Flowrate	dscfm	448.5
Average Horsepower	HP	605.7 (96% of full load)

6 OPERATING CONDITIONS

Operating conditions during the sampling were monitored by FCA Operations and RWDI personnel. During the test, RWDI personnel recorded the load output (either HP or kW), and engine speed (RPM). All process data is provided in **Appendix F**.

Volume of fuel consumed was not available during the stack test and is not included with the process data.

Radio contact was maintained between the process operators and the sampling team throughout the testing. A member of the RWDI sampling team contacted the operator before each test, to ensure that the process was at normal operating conditions.

7 CONCLUSIONS

Testing was successfully completed on August 11th 2022. All sources were evaluated in accordance with referenced methodologies following the EGLE approved test protocol.

TABLES

TABLE 1: EU-ENG-PSHOP-NC-701HP Emission Results

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

Facility:	SHAP
City:	Sterling Heights, MI
Source:	EU-ENG-PSHOP-NC-701HP
Date:	8/11/2022

	Symbol	Units	Test #1			Test #2			Test #3			Average	Corrected to 15% O_2	Limits
			South	North	Total Emissions	South	North	Total Emissions	South	North	Total Emissions			
Nitrogen Oxides Concentration	NO_x	ppmvd	142.3	191.1	-	174.5	185.5	-	170.7	208.2	-	178.7	51.1	160[a]
Carbon Monoxide Concentration	CO	ppmvd	400.6	370.9	-	1166.2	354.0	-	842.4	362.0	-	582.7	166.5	540[a]
VOCs (as propane) Concentration	VOC	ppmvd	5.9	6.3	-	7.6	6.7	-	7.8	7.5	-	7.0	2.0	86[a]
Oxygen Concentration	O_2	$\%_{dry}$	0.0	0.0	-	0.0	0.0	-	0.0	0.0	-	0.0	-	-
Nitrogen Oxides Concentration	NO_x	g/HP-hr	0.34	0.47	0.81	0.42	0.44	0.86	0.41	0.50	0.91	0.86	-	2.0[b]
Carbon Monoxide Concentration	CO	g/HP-hr	0.58	0.55	1.14	1.70	0.52	2.22	1.22	0.53	1.75	1.70	-	4.0[b]
VOCs (as propane) Concentration	VOC	g/HP-hr	0.01	0.01	0.03	0.02	0.02	0.03	0.02	0.02	0.04	0.03	-	1.0[b]

a = ppm corrected to 15%O_2

b = g/HP-hr

Table 2: EU-ENG-PSHOP-NC-701HP Flow Measurements

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

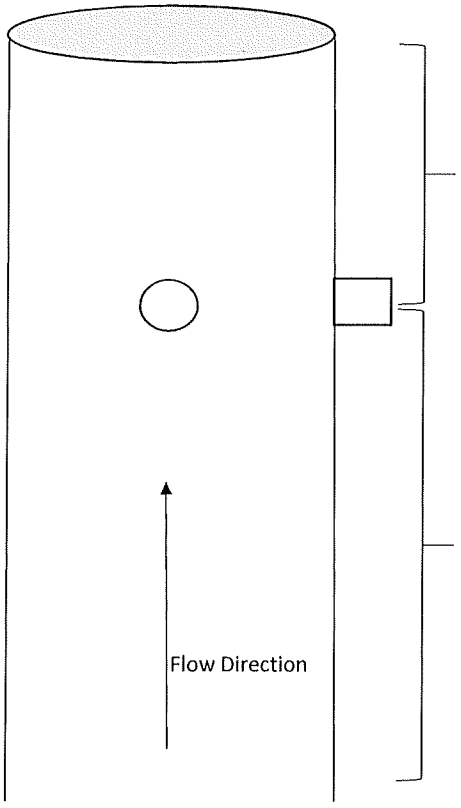
Facility:	SHAP
City:	Sterling Heights, MI
Source:	EU-ENG-PSHOP-NC-701HP
Max Horsepower:	631
Max Kilowatt:	450

Parameter	Units	Test #1		Test #2		Test #3		Average
		A	B	A	B	A	B	
Stack Gas Temperature	°F	1062.0	1069.0	1067.0	1069.0	1071.0	1073.0	1068.5
Velocity	ft/sec	138.5	143.1	139.1	139.2	138.8	140.2	139.8
Actual Flowrate	cfm	1631.0	1686.0	1639.0	1640.0	1635.0	1652.0	1647.2
Dry Reference Flowrate	dscfm	446.0	458.0	447.0	446.0	445.0	449.0	448.5
Average Horse Power	HP	605.7		605.7		605.7		605.7
Average kiloWatt	kW	432		432		432		432.0
Load	%	95.9%		95.9%		95.9%		95.9%

FIGURES

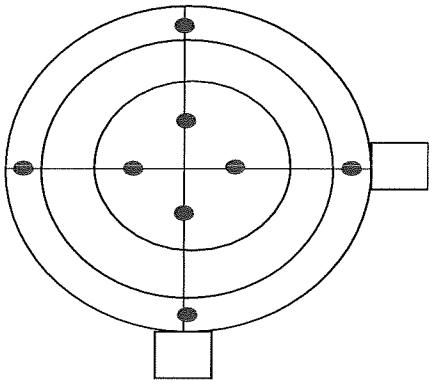
Figure No. # 1 Stack Schematic

Note: Emergency generator has a twin stack (north and south) that are identical. The drawing below is for one (1) of the stacks.



Diameter: 5

Sampling Points (in.)	
1	0.50
2	1.50
3	4.50
4	5.50



Not to scale

EU-ENG-PSHOP-NC-701HP
FCA US LLC
Sterling Heights Assembly Plant
Sterling Heights, MI

Date:
11-Aug-22

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2239 Star Court
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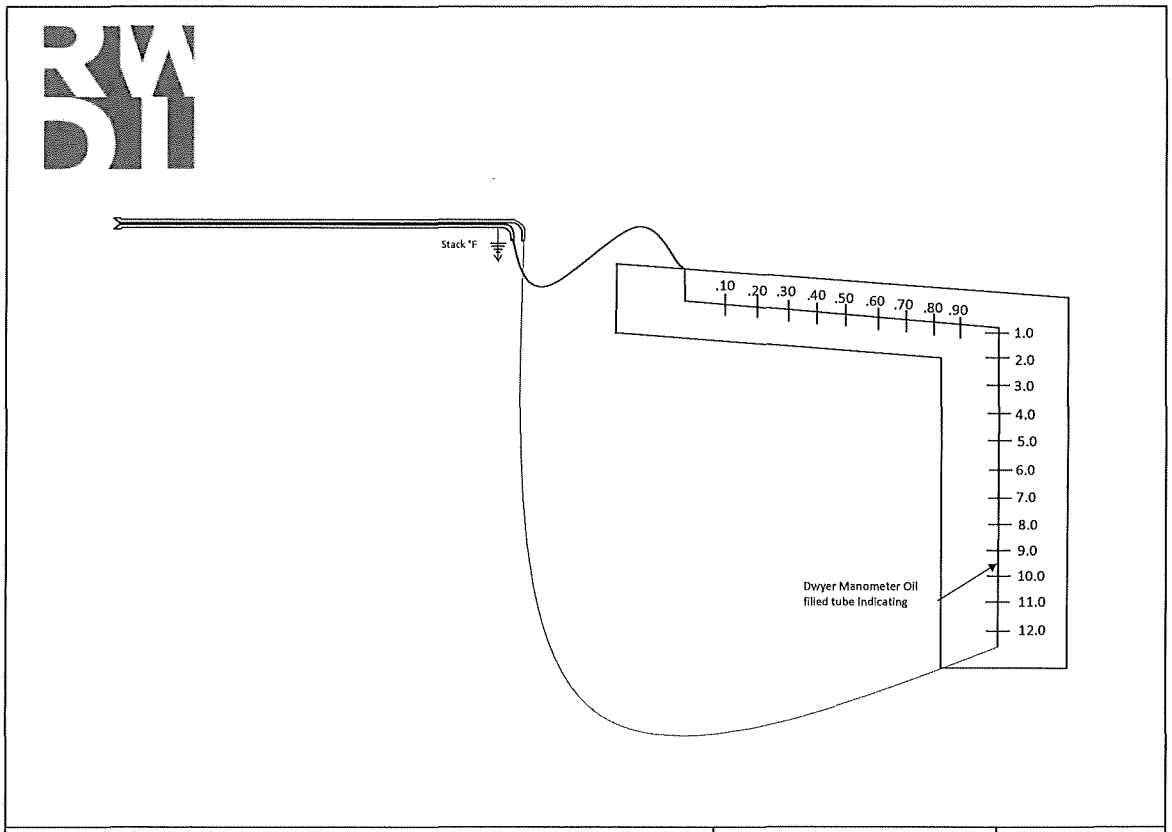
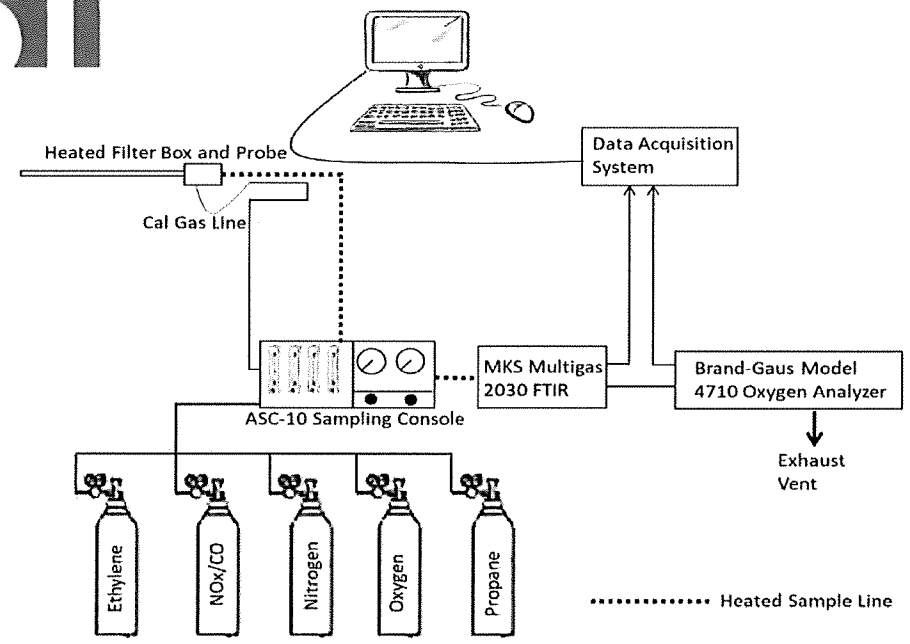


USEPA Method 2
FCA US, LLC
Sterling Heights Assembly Plant
EU-ENG-PSHOP-NC-701HP
Sterling Heights, Michigan
Project #2201099

Figure No. 2

Date: August 11, 2022

Figure No. #3



USEPA Method 320
FCA US LLC
Sterling Heights Assembly Plant
EU-ENG-PSHOP-NC-701HP
Sterling Heights, MI
Project 2201099

Figure 3

Date: August 11, 2022