FINAL REPORT

FCA US LLC

AUBURN HILLS, MICHIGAN

TECHNOLOGY CENTER:
2022 SOURCE TESTING PROGRAM
PTI 155-18 FG-CONTRLDCELLS - C-WING THERMAL OXIDIZER

RWDI #2201122

May 20, 2022

SUBMITTED TO

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EXECUTIVE SUMMARY

RWDI USA LLC (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). Source testing was completed on March 22nd and 23rd, 2022.

CTC operates under a Permit to Install (PTI 155-18) and a Renewable Operating Permit (ROP) MI-ROP-N1436-2018. Source testing was required to be completed for all applicable parameters once implementation of FG-CNTRLDCELLS Condition I, Emission Limit (s) Scenario B (outlined below) was completed. Source testing as required under the Flexible Group (FG-CNTRLDCELLS) included Carbon Monoxide (CO), Oxides of Nitrogen (NO_x), Volatile Organic Compounds (VOC as propane), Particulate Matter (tested as Total PM assumed equivaled to $PM/PM_{10}/PM_{2.5}$), as well as oxygen (O_2), carbon dioxide (CO_2), temperature and moisture. 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 provided notice to State of Michigan Environment, Great Lakes and Energy (EGLE) that all actions to enable operations under Scenario B were complete and a submittal of the Notification specified in SC VII.2 was completed. Since these actions are completed, this report reflects testing and results under Scenario B conditions.

The testing program successfully met all requirements. A summary of the results can be found below.

Sampling Result Summary

Source	Parameter	Emission Rate (lb/hr)	Scenario B Emission Limits
C-Wing	TPM/CPM	0.051	15.91 tons per year (PM10) 15.91 tons per year (PM2.5)
	CO	0.75	1 lb/hr
	NOx	5.42	10.45 lb/hr
	VOC	0.27	0.64 lb/hr

All measured levels were within the allowable limits outlined in the PTI for Scenario B.

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1 INTRODUCTION

RWDI USA LLC (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). Source testing was completed on March 22nd and 23rd, 2022.

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

Testing of emissions was conducted by Mr. Mason Sakshaug, Mr Ben Durham, Mr Juan Vargas, Mr. Brad Bergeron, and Mr. Steve Smith 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 Ms. Regina Angellotti and Mr. Adam Bognar from 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 were located on C-Wing (91-THO-4.01) stack. The stack has an inside diameter of 23 inches. The exhaust had a set of sampling ports, 90 degrees apart. The sampling ports were 6 inches in diameter and were 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 Sampling for Volatile Organic Compounds, Nitrogen Oxides, Carbon Monoxide, Oxygen and Carbon Dioxide

Emissions testing was performed at the outlet of the C-Wing 91-THO-4.01 exhaust stack from the FG-CNTRLDCELLS. Pollutant concentrations were determined utilizing RWDI's continuous emissions monitoring (CEM) system which consists of the FTIR and oxygen analyzer (measuring on wet basis).

Stack gas concentrations for NOx, CO, VOCs, H_2O, CO_2 and O_2 were measured using EPA Reference Methods 320 and 3A.

CO measurements were taken continuously following the USEPA Method 320 on the outlet (using a FTIR or equivalent).

NOx measurements were taken continuously following USEPA Method 320 on the outlet (using a FTIR or equivalent).

CO_2 measurements were taken continuously following USEPA Method 320 on the outlet (using a FTIR or equivalent).

Testing for VOCs (expressed on a propane equivalent basis) was accomplished following USEPA Method 320 by utilizing a FTIR or equivalent.

Oxygen measurements were taken continuously following USEPA Method 3A on the outlet (using a wet oxygen analyzer or equivalent). Stratification checks using O_2 as the surrogate for all pollutants, were completed on the exhaust of the oxidizer at three points (16.7%, 50% and 83.3% of inner diameter) on a line passing through the centroidal area, as per the alternative approach in EPA Method 7E Section 8.1.2.

Regular performance checks on the CEM were carried out by zero and span calibration checks on the oxygen analyzer and necessary QA procedures on the FTIR using USEPA Protocol calibration gases. These checks were used to verify the ongoing precision of the FTIR with time by introducing pollutant-free (zero) air followed by known calibration gas (span) into the FTIR. The response of the monitor to pollutant-free air and the corresponding sensitivity to the span gases were reviewed frequently as an ongoing indication of analyzer performance.

Monitoring was conducted 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 MAX Analytical ASC-10ST sampling console. Lengths of unheated sample line were kept to a minimum and insulated. The ASC-10ST sampling console delivers a continuous sample to the MKS MultiGas 2030 FTIR and oxygen analyzer for analysis. The heated filter and line were maintained at approximately 191°C (375°F) and the MKS MultiGas 2030 FTIR and ASC-10ST gas components were kept at 191°C (375°F). The end of the probe was connected to a heated Teflon sample line, which delivered the sample gases from the stack to the FTIR system. The heated sample line is designed to maintain the gas temperature at approximately 375°F in order to prevent condensation of stack gas moisture within the line and condition air to the same temperature as the FTIR.

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.

For oxygen measurement only, prior to testing, a 3-point analyzer calibration error check was conducted using USEPA protocol gases. The calibration error check were 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 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 will be 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. The analyzer was used to measure the respective gas concentrations on a wet volumetric basis which will be converted to a dry volumetric number.

The probe tip was equipped with a heated 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 FTIR/4710 Oxygen analyzer system. The heated sample line was designed to maintain the gas temperature at approximately 375°F in order to prevent condensation of stack gas moisture within the line.

The following table provides confirmation of the speciated VOCs that are included in the FTIR spectrum.

Method	Formula	Compounds
Gasoline	THC (CH4) dry= 1.1*c10+2*c11+2.4*c12+1.9*c13+3*c15+5*c18+6*c19)/((1-c9/100)) THC (C3) – same as above, divided by 3	C10- Methane C11- Ethane C12- Acetylene C13- Ethylene C14- Propylene C15- Propane C16- 1,3, butadiene C17- isobutylene C18- isopentane C19- Cyclohexane

3.2.3 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. A nitrogen purge was completed for each test as per Method 202.

Upon completion of the test, the sampling train was recovered, as in the procedures detailed in the reference method, and the samples analyzed by RWDI internal laboratory for the Method 5 portion and by Enthalpy Analytical, LLC Laboratory for the Method 202 analysis.

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.

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.

Refer to Section 3.2.2 for further details on FTIR QA/QC measures.

4 RESULTS

Detailed information for each test run can be found in the **Appendix B** for the continuous emission monitoring (CEMs) data and **Appendix C** for the Particulate data.

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

4.1 Modifications

During Test 3, the front half Method 5 filter split, and the sample was deem unrecoverable and considered invalid. An additional Test (Test 4) was completed to replace the Test 3 data. RWDI contacted Ms. Regina Angellotti to discuss the issue at the time of occurrence and it was agreed that the sample was deemed unrecoverable. In addition, RWDI completed addition CEM monitoring for O_2 and CO_2 in order to have real-time data with respect to these parameters during the 4th particulate test.

For Test 3 and 4, it was agreed on site with Ms. Regina Angellotti that given the amount of particulate that was being recovered from Test 1 and Test 2, test durations for Tests 3 and 4 were reduced to 60 minutes instead of the 120 minutes originally proposed. As discussed above, Test 3 was discarded and not analyzed.

4.2 Discussion of Results

Sampling was completed on March 22nd and March 23rd, 2022.

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.

The results have been summarized below in **Table 4.1.1**.

Table 4.1.1: Sampling Result Summary

Source	Parameter	Emission Rate (lb/hr)	Scenario B Emission Limits
C-Wing	TPM/CPM	0.051	15.91 tons per year (PM10) 15.91 tons per year (PM2.5)
	CO	0.75	1 lb/hr
	NOx	5.42	10.45 lb/hr
	VOC	0.27	0.64 lb/hr

All measured levels were within the allowable limits outlined in the PTI for Scenario B.

4.3 Process Data

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

- Cells in operation
- Engine type used
- Type of testing performed in each cell
- Type and amount of fuel used
- Oxidizer combustion zone temperature

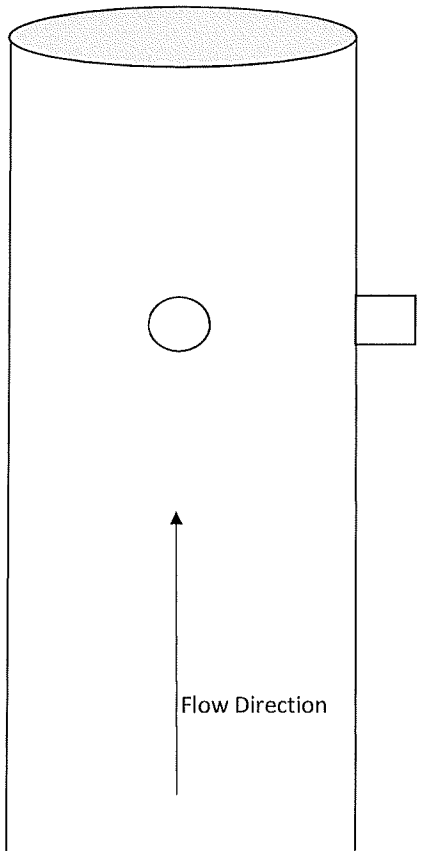
Production data is provided in **Appendix H**.

5 CONCLUSIONS

Testing was successfully completed on March 22nd and 23rd, 2022. All parameters were tested in accordance with referenced methodologies.

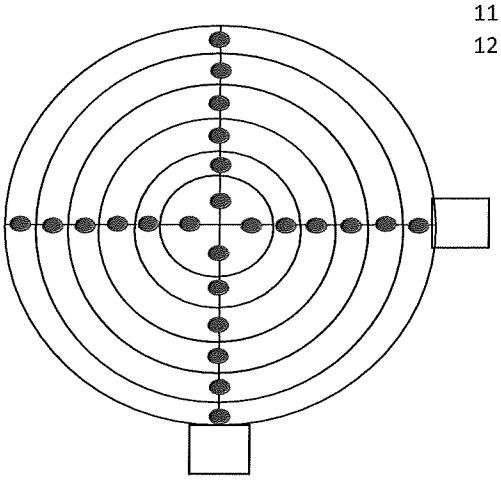
FIGURES

Figure No. 1: Stack Schematic



Diameter: 23

Sampling Points (in.)	
1	0.50
2	1.54
3	2.71
4	4.07
5	5.75
6	8.19
7	14.81
8	17.25
9	18.93
10	20.29
11	21.46
12	22.50



Not to scale

C-4.01
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RWDI USA LLC
2239 Star Court
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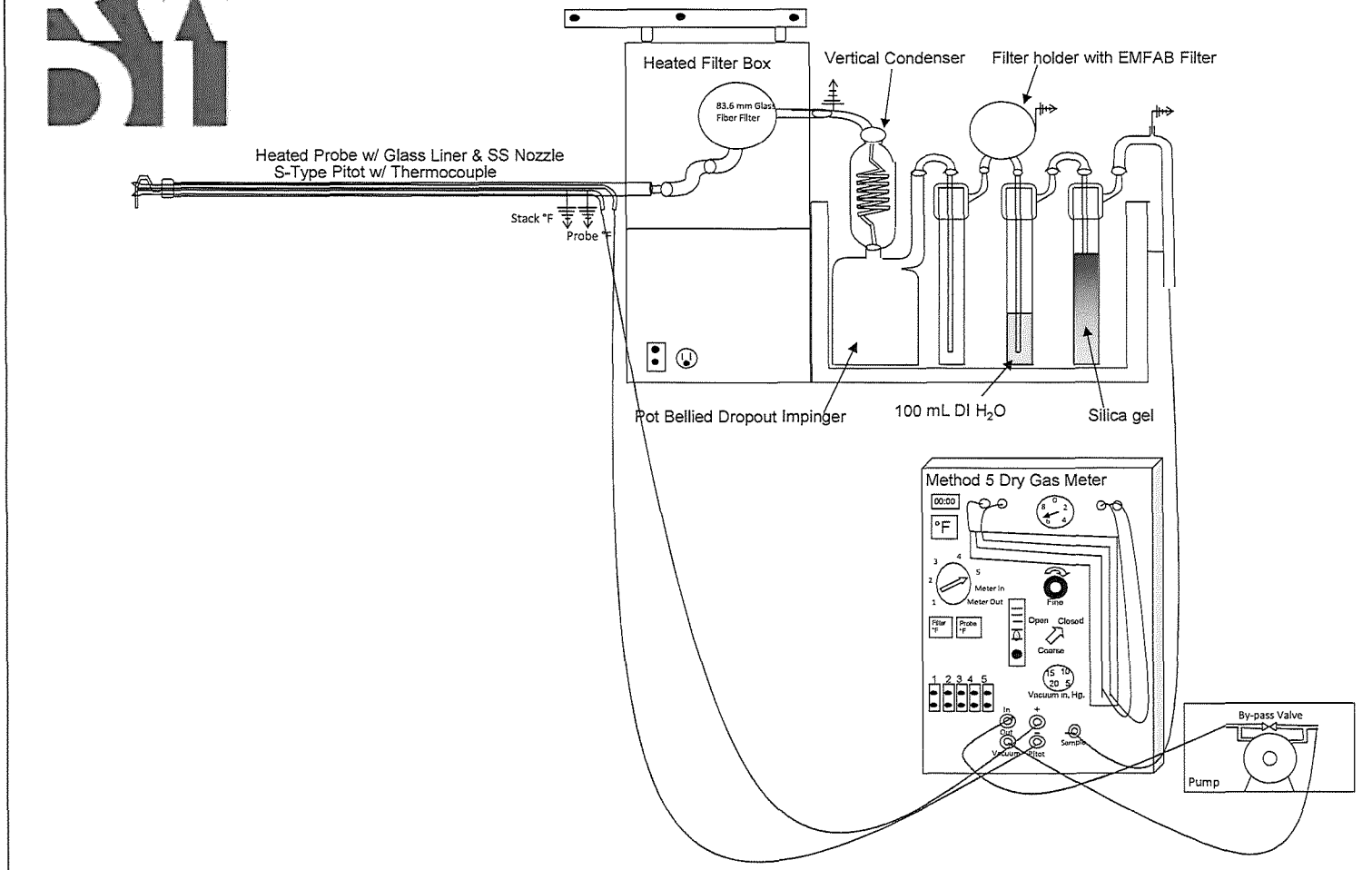


USEPA Method 5/202

FCA US LLC

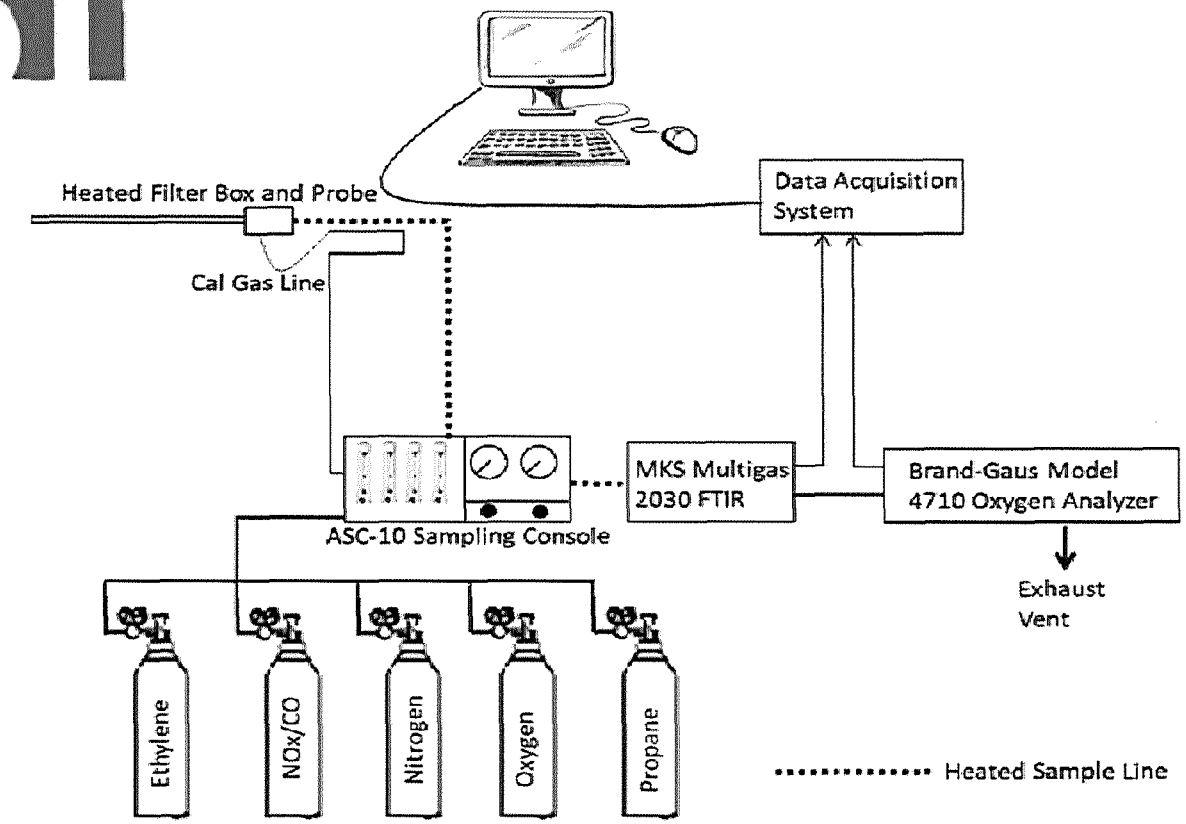
Chrysler Technology Center

RTO Emissions Testing - Auburn Hills, Michigan

Project #2201122

Figure No. 2: USEPA Method 5/202 Schematic

Date: March 22-23, 2022



USEPA Method 320

FCA US LLC

Chrysler Technology Center

RTO Emissions Testing - Auburn Hills, Michigan

Project #2201122

Figure No. 3: USEPA Method 320 Schematic

Date: March 22-23, 2022