

FINAL REPORT



FCA US LLC

TRENTON, MICHIGAN

TRENTON ENGINE COMPLEX: DYNAMOMETER #4

RWDI #2201100

June 23, 2022

SUBMITTED TO

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EXECUTIVE SUMMARY

RWDI USA LLC (RWDI) was retained by FCA US LLC (FCA) to complete an air sampling program on their #4 Dynamometer (EU-DYNO4) at their Trenton Engine Complex (TEC) located at 2300 Van Horn Road, Trenton, Michigan. Within the #4 Dynamometer test cell, engine performance testing on six-cylinder engines using unleaded gasoline is completed. The test program was conducted to evaluate the Carbon Monoxide (CO) and Nitrogen Oxides (NOx) concentrations and emission rates as well as several other parameters as discussed below.

In addition, Oxygen, Carbon Dioxide, stack gas velocity and flow rate were measured in order to determine stack gas composition and emission rates. The Intent-To-Test Plan (ITTP) was submitted to the Michigan Department of Environment, Great Lakes, and Energy (EGLE) on March 10th, 2022, and a correspondence document was issued by EGLE on April 4th, 2022. The ITTP and EGLE correspondence document can be found in **Appendix A** of this report.

Testing consisted of four (4) 45-minute test runs as approved prior to testing with Ms. Regina Angellotti from EGLE. The normal running cycle of the Dynamometer is approximately 45 minutes. Fuel is used in the test cycle for approximately 38 minutes of the 45-minute cycle. The sampling was conducted on April 27th, 2022.

Results of the sampling program are outlined in the tables below. Results of individual tests are presented in the Appendices.

Table 6.1: Dynamometer 4 Nitrogen Oxides Results

Test #	NOx (ppmvd)	NOx (lb/hr)	Fuel Per Test (gal/hr)	lb of NOx/gal Fuel
T1	10.9	0.97	3.85[1]	0.25
T2	13.5	1.24	3.82	0.33
T3	12.1	1.07	3.84	0.28
T4	12.2	1.07	3.89	0.28
Average	12.2	1.09	3.85	0.28

Note: [1] Fuel usage was not available for run 1 (T1), so an average usage rate from Runs 2 to 4 was used as an estimation.

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1 INTRODUCTION

RWDI USA LLC (RWDI) was retained by FCA US LLC (FCA) to complete an air sampling program on their #4 Dynamometer (EU-DYNO4) at their Trenton Engine Complex (TEC) located at 2300 Van Horn Road, Trenton, Michigan. Within the #4 Dynamometer test cell, engine performance testing on six-cylinder engines using unleaded gasoline is completed. The test program was conducted to evaluate the Carbon Monoxide (CO) and Nitrogen Oxides (NOx) concentrations and emission rates as well as several other parameters as discussed below.

In addition, Oxygen, Carbon Dioxide, stack gas velocity and flow rate were measured in order to determine stack gas composition and emission rates. The source testing plan was submitted to the Michigan Department of Environment, Great Lakes, and Energy (EGLE) on March 10th, 2022, and a correspondence document was issued by EGLE on April 4th, 2022. The source testing plan and EGLE correspondence document can be found in **Appendix A** of this report.

Testing consisted of four (4) 45-minute test runs as approved prior to testing with Ms. Regina Angellotti from EGLE. The normal running cycle of the Dynamometer is approximately 45 minutes. Fuel is used in the test cycle for approximately 38 minutes of the 45-minute cycle. The sampling was conducted on April 27th, 2022.

Ms. Regina Angellotti and Mr. Sam Liveson from EGLE were on-site to witness the testing. Mr Thomas Caltrider and Mr. Michael Spacil from FCA were on-site to ensure the process was operating at normal standard conditions.

Table 1.1: Source, Parameter and Test Date

Source	Parameter	Test Date
Dynamometer 4	Carbon Monoxide, Oxides of Nitrogen, Oxygen, Carbon Dioxide, Velocity, Temperature and Flow Rate	April 27, 2022



4.2 Description of Testing Methodology

The following section provides brief descriptions of the sampling methods.

4.3 Stack Velocity, Temperature, and Volumetric Flow Rate Determination

The exhaust velocity and flow rate were determined following the USEPA 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 incline manometer. Volumetric flow rates were determined following the equal area method as outlined in USEPA 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 digital temperature indicator.

The dry molecular weight of the stack gas was determined following calculations as per Equation 3-1 outlined in USEPA Method 3, "Determination of Molecular Weight of Dry Stack Gas". Carbon dioxide and stack moisture content were determined using an extractive Fourier Transform Infrared (FTIR) spectroscopy according to USEPA 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.

4.4 Sampling for Nitrogen Oxides, Carbon Monoxide, Oxygen, and Carbon Dioxide

Emissions testing was performed at the outlet of EU-DYNO4 exhaust stack from the FG-DYNOS group. 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 NO_x, CO, CO₂, H₂O and O₂ 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).

CO₂ measurements were taken continuously following the USEPA Method 320 on the outlet (using a FTIR).

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

Oxygen measurements were taken continuously following USEPA Method 3A on the outlet (using a wet oxygen analyzer). Stratification checks, using O₂ as the surrogate for all pollutants, were completed on the engine exhaust 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.

The compliance test consisted of four (4) 45-minute tests from the exhaust of EU-DYNO4 exhaust stack from the FG-DYNOS group during Performance Testing. Regular performance checks on the CEM were carried out by zero and span calibration checks on the oxygen analyzer and necessary quality assurance (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

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5 PROCESS DATA

FCA representatives provided production information during testing of EU-DYNO4, including test cycle information and fuel usage (kg/test). Detailed information of the type, amount, and conditions of the engines being run during the testing is located in **Appendix G**.

6 RESULTS

The average emission results for this study are presented in the tables below. Detailed information regarding each test run can be found in **Appendix B** and **C**.

Table 6.1: Dynamometer 4 Nitrogen Oxides Results

Test #	NOx (ppm)	NOx (lb/hr)	Fuel Per Test (gal/hr)	lb of NOx/gal Fuel
T1	10.9	0.97	3.85[1]	0.25
T2	13.5	1.24	3.82	0.33
T3	12.1	1.07	3.84	0.28
T4	12.2	1.07	3.89	0.28
Average	12.2	1.09	3.85	0.28

Table 6.2: Dynamometer 4 Carbon Monoxide Results

Test #	CO (ppm)	CO (lb/test)	Fuel Per Test (gal)	lb of CO/gal fuel
T1	122.7	6.65	3.85[1]	1.73
T2	156.1	8.75	3.82	2.29
T3	152.4	8.19	3.84	2.13
T4	155.0	8.29	3.89	2.13
Average	146.6	7.97	3.85	2.07

7 CONCLUSIONS

Testing was successfully completed on April 27th, 2022. All parameters were tested in accordance with USEPA referenced methodologies.

TABLES



TABLE 1: EU-DYNO4 Emission Results

FCA US, LLC- Trenton Engine Complex

Facility: FCA Trenton
City: Trenton, MI
Source: DYNO 4
Date: 4/27/2022

Parameter	Symbol	Units	Test #1	Test #2	Test #3	Test #4	Average	Limits
Nitrogen Oxides Concentration	NO _x	ppmvd	10.9	13.5	12.1	12.2	12.2	-
Carbon Monoxide Concentration	CO	ppmvd	122.7	156.1	152.4	155.0	146.6	-
Oxygen Concentration	O ₂	% _{dry}	20.8	20.9	20.9	21.0	20.9	-
Nitrogen Oxides Concentration	NO _x	lbs/hr	0.97	1.24	1.07	1.07	1.09	-
Carbon Monoxide Concentration	CO	lbs/hr	6.65	8.76	8.19	8.29	7.97	-
Nitrogen Oxides Concentration	NO _x	lb NO _x /gal	0.25	0.33	0.28	0.28	0.28	0.30
Carbon Monoxide Concentration	CO	lb CO/gal	1.73	2.29	2.13	2.13	2.07	3.12

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TABLE 2: EU-DYNO4 Flow Measurements

FCA US,LLC- Trenton Engine Complex

Facility: FCA Trenton
City: Trenton, MI
Source: DYNO 4
Date: 4/27/2022

Parameter	Units	Run 1	Run 2	Run 3	Run 4	Average
Stack Gas Temperature	°F	52	53	60	57	55
Velocity	ft/sec	34.7	36.0	35.0	34.6	35.2
Actual Flowrate	cfm	12,186	12,636	12,285	12,159	12,369
Dry Reference Flowrate	dscfm	12,431	12,863	12,327	12,271	12,540
Fuel use	gal/hr	3.85*	3.82	3.84	3.89	3.85

*Fuel usage is not available for run 1 and an average fuel usage rate from the runs 2-4 was used in the emission calculation.

FIGURES

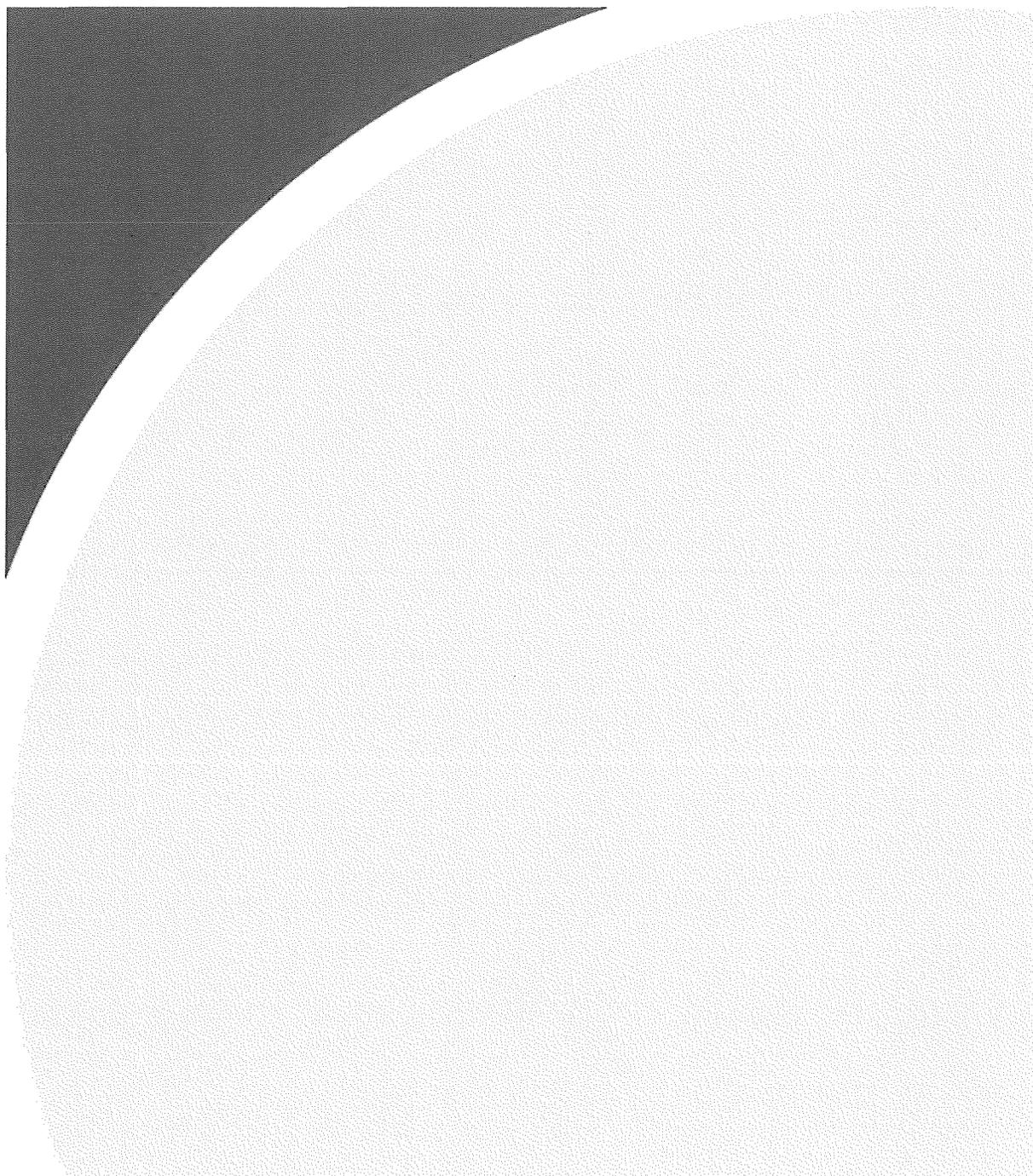
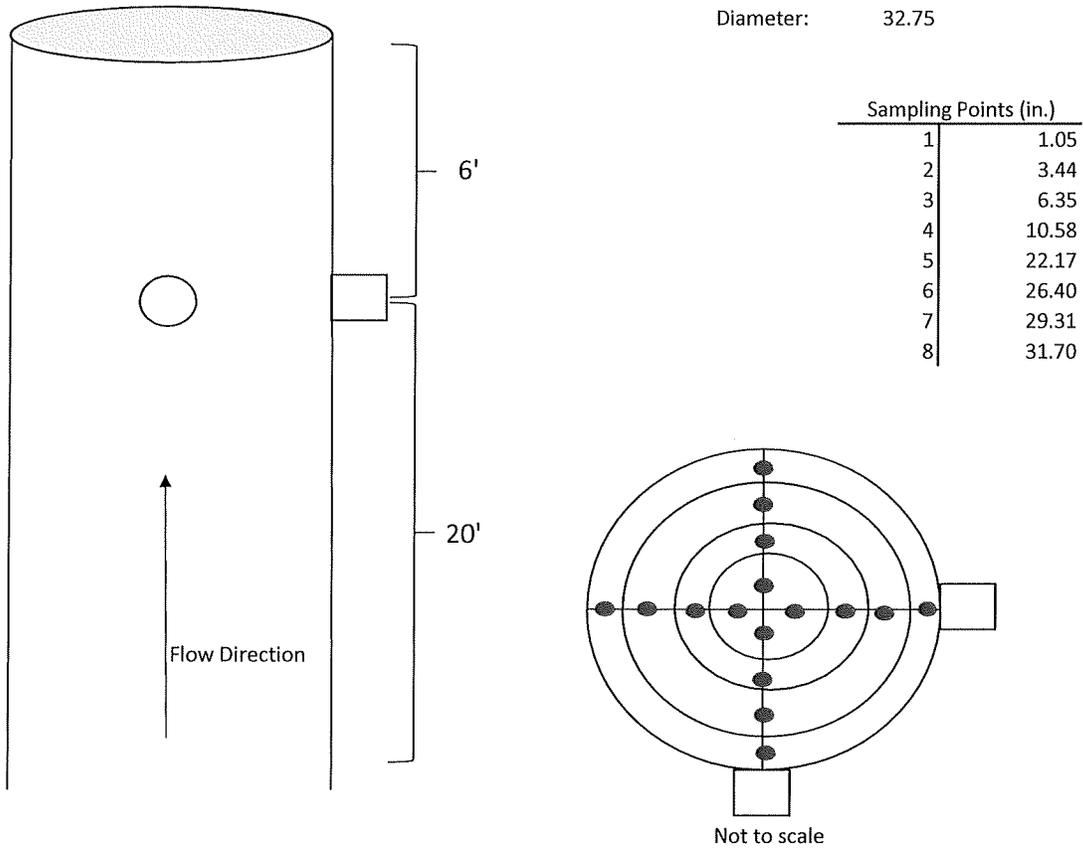




Figure No. 1: Exhaust Configuration and Sampling Points



Cell 4
FCA, LLC
Trenton Engine Plant
Trenton, Michigan

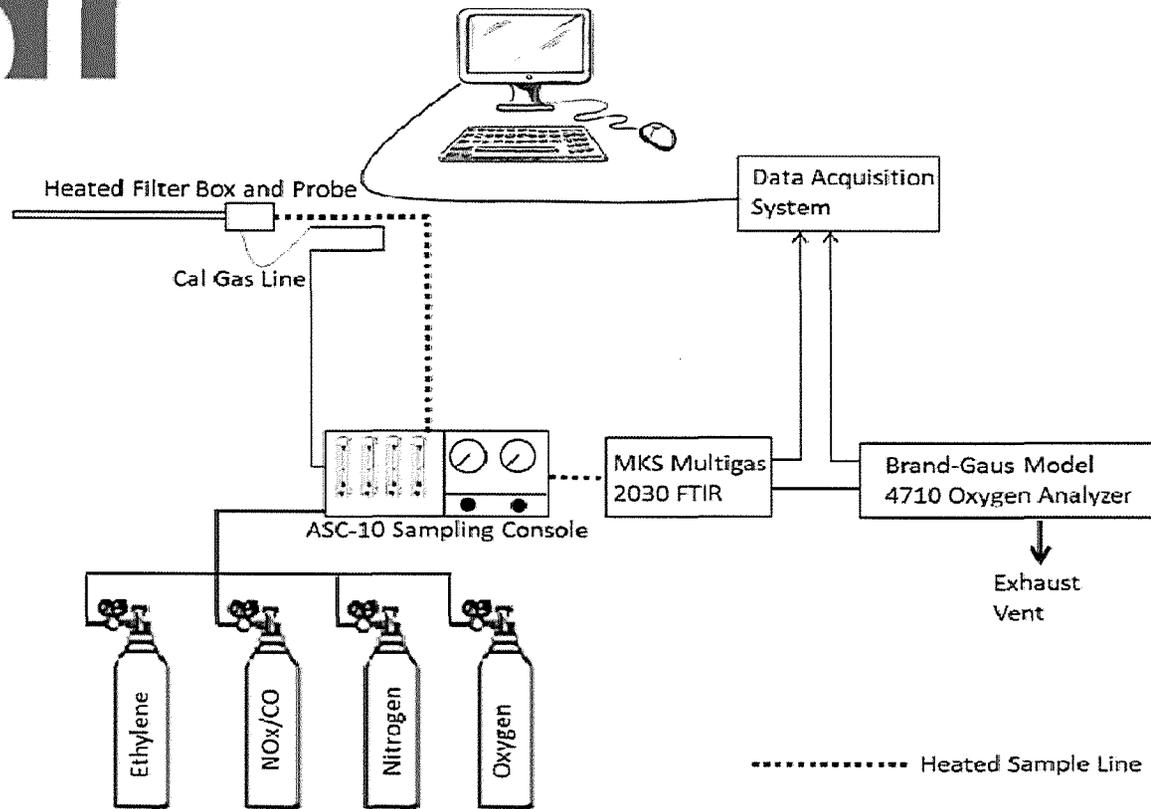
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Figure No. 2 USEPA Method 320 Schematic



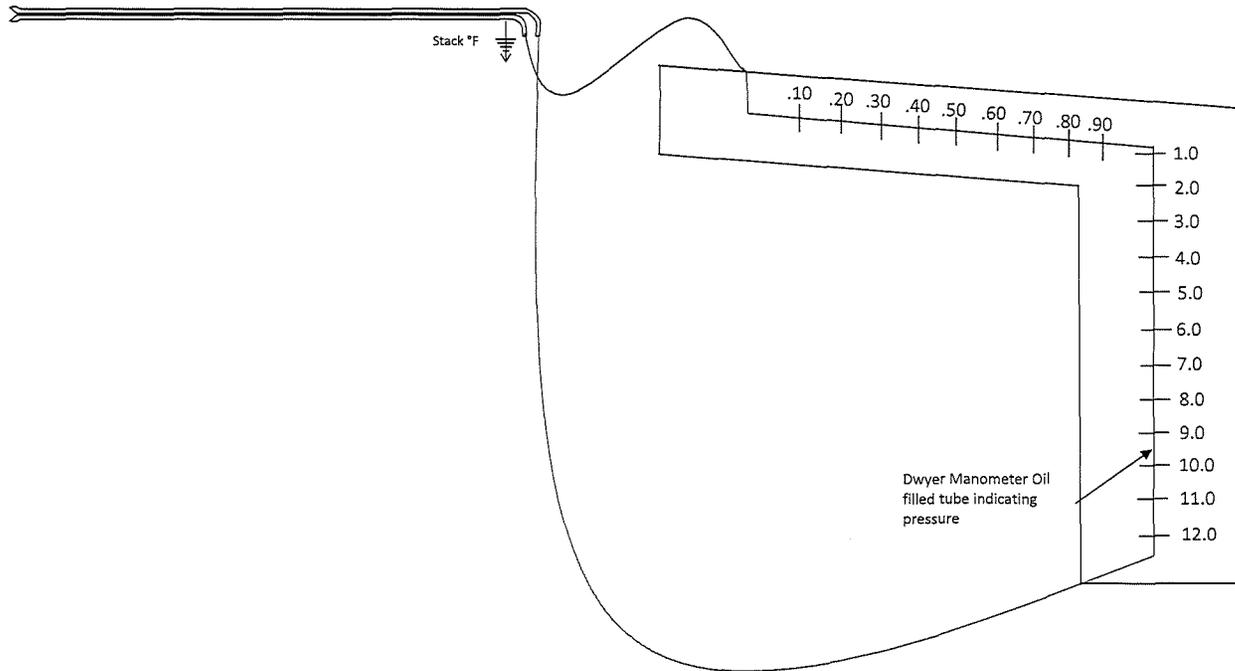
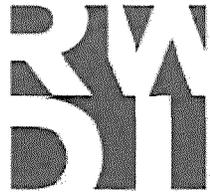
USEPA Method 320

FCA US, LLC
Trenton Engine Plant
Cell 4
Trenton, Michigan

Project #2201100

Date: April 27, 2022





USEPA Method 2 Schematic

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Figure No. 3

Date: April 27, 2022

