FINAL REPORT

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FCA US LLC

TRENTON, MICHIGAN

TRENTON ENGINE COMPLEX: DYNAMOMETER #2

RWDI #1701781

July 17, 2017

SUBMITTED TO

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EXECUTIVE SUMMARY

RWDI AIR Inc. (RWDI) was retained by Fiat Chrysler Automobiles US LLC (FCA) to complete an air sampling program on their #2 Dynamometer (EU-DYNO2) at their Trenton Engine Complex (TEC) located at 2300 Van Horn Road, Trenton, Michigan. Within the #2 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 Environmental Quality (MDEQ) on March 20th, 2017 and a correspondence document was issued by the MDEQ on April 5th, 2017. The ITTP and MDEQ correspondence document can be found in **Appendix A** of this report.

Testing consisted of one 60-minute test run, one 44 minute run and one 45-minute test run. The normal running cycle of the Dynamometer is approximately 43.6minutes, during the testing, in discussion with Mr. Thomas Maza and Mr. Todd Zynda of the (MDEQ), it was agreed to complete Tests 2 and 3 for the test cycle (approximately 45-minute) due to the testing cycle durations. The sampling was conducted on May 24th, 2017.

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

Table 1: Dynamometer 2 Nitrogen Oxides Results

Test #	NOx (ppm)	NOx (lb/test)	Fuel Per Test (gal)	lb of NOx/gal Fuel
T1	7.78	0.71	3.2	0.223
T2	11.7	0.82	3.4	0.244
T3	9.89	0.80	3.2	0.251
Average	**9.80**	**0.78**	**3.2**	**0.240**

Table 2: Dynamometer 2 Carbon Monoxide Results

Test #	CO (ppm)	CO (lb/test)	Fuel Per Test (gal)	lb of CO/gal fuel
T1	167.2	9.31	3.2	2.92
T2	205.1	8.78	3.4	2.60
T3	200.1	9.84	3.2	3.10
Average	**190.8**	**9.31**	**3.2**	**2.87**

1 INTRODUCTION

RWDI AIR Inc. (RWDI) was retained by Fiat Chrysler Automobiles US LLC (FCA) to complete an air sampling program on their #2 Dynamometer (EU-DYNO2) at their Trenton Engine Complex (TEC) located at 2300 Van Horn Road, Trenton, Michigan. Within the #2 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.

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Testing consisted of one 60-minute test run, one 44 minute run and one 45-minute test run. The normal running cycle of the Dynamometer is approximately 43.6minutes, during the testing, in discussion with Mr. Thomas Maza and Mr. Todd Zynda of the (MDEQ), it was agreed to complete Tests 2 and 3 for the test cycle (approximately 45-minute) due to the testing cycle durations. The sampling was conducted on May 24th, 2017.

Mr. Thomas Maza and Mr. Todd Zynda from the MDEQ were on-site to witness the testing. Mr Rohitkumar Patel and Ms. Amy Berendt from FCA were on-site to ensure the process was operating at normal standard conditions.

Table 3: Source, Parameter and Test Date

Source	Parameter	Test Date
Dynamometer 2	Carbon Monoxide, Oxides of Nitrogen, Oxygen, Carbon Dioxide, Velocity, Temperature and Flow Rate	May 24, 2017

2 SOURCE DESCRIPTION

2.1 Facility Description

TEC operates an engine manufacturing plant that produces six-cylinder engines for Chrysler, Dodge and Jeep vehicles. TEC operates five dynamometer test cells (EU-DYNO1, EU-DYNO2, EU-DYNO3, EU-DYNO4 and EU-DYNO5) to complete engine performance testing on six-cylinder engines using unleaded gasoline. The dynamometer test cells fall under FG-DYNOS Flexibility Group Condition. There are no controls associated with these dynamometer test cells

Table 4: Emission Unit Description

Units	Capacity
FG-DYNOS	Five (5) dynamometer engine test cells for engines burning unleaded gasoline. No controls are in place for the dynamometer test cells

3 SAMPLE LOCATION

Testing was completed on EU-DYNO2, the stack has an inside diameter of 32.75 inches. The exhaust stack has two sampling ports, 90 degrees apart and 3 inches in diameter. The sampling ports are located more than 5 duct diameters downstream and more than 2 duct diameters upstream of any flow disturbances.

A stratification test was performed and the flue gas was determined to be uniform or un-stratified.

4 SAMPLING METHODOLOGY

4.1 Testing Methodology

The following table summarizes the test methodologies that were followed during this program.

Table 5: Summary of Test Methodology

Parameter	Proposed Method
Temperature, Flow Rate and Moisture	USEPA[1] Method 1-4
Oxides of Nitrogen (NOx)	USEPA[1] Method 7E (CEM)
Carbon Monoxide	USEPA[1] Method 10 (CEM)

Notes: [1] USEPA = United States Environmental Protection Agency

4.2 Description of Testing Methodology

The following section provides brief descriptions of the sampling methods.

4.2.1 USEPA Method 1-4

The exhaust velocities and flow rates were determined following the United States Environmental Protection Agency (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. Velocity and sampling points for each traverse were determined from USEPA Method 1, "Sample and Velocity Traverses for Stationary Sources". 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 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 USEPA Method 3, "Gas Analysis for the Determination of Dry Molecular Weight". Stack moisture content was determined through direct condensation and according to USEPA Method 4, "Determination of Moisture Content in Stack Gases". Detailed flow and moisture information is located in **Appendix D**.

4.2.2 USEPA Method 10

USEPA Method 10, "Determination of Carbon Monoxide Emissions from Stationary Sources (Instrument Analyzer Procedure)", was used to measure the carbon monoxide concentration of the flue gas. The exhaust gas sample was withdrawn from a single point at the centre of the duct/stack using a stainless steel probe. The sample proceeded through a heated filter where particulate matter was removed. The sample was then transferred via a heated Teflon® line to a sample conditioner. The Teflon line was heated to 120°C (250°F) to prevent any condensation. The sample was then routed through a manifold system and introduced to the individual CEM's for measurement. An ABB Model EL3020 Non-Dispersive Infrared Analzyer (NDIR) was used for CO measurements. A schematic of the sampling system apparatus is located in **Appendix B.**

Prior to testing at the exhaust port sampling location, a 3-point stratification test was conducted at 16.7, 50 and 83.3 percent of the stack diameter for at least twice the response time as outlined in the method. At this location the CO concentration was measured to be uniform in the stack cross section and was less than ±5% of the mean concentration and 0.5ppm of the mean concentration for all three traverse points. The gas stream was considered to be unstratified and a single sampling point, located at the centroid of the stack was used for sampling. Stratification information is included in **Appendix E.**

Prior to testing, a 3-point analyzer calibration error check was conducted using USEPA protocol gases. The calibration error check was 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 was 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 was within ±5% of the introduced calibration gas concentrations. At the conclusion of each test run a system-bias check was performed to evaluate the percent drift from pre and post-test system bias checks. The system bias checks confirmed that the analyzer did not drift greater than ±3% throughout a test run.

Data acquisition was provided using a data logger system programmed to collect and record data at one second intervals. Average one minute concentrations were calculated from the one second measurements.

Appendix C contains detailed data for CO and NOx emissions, including summary of results and 1 minute averages. Calibration error check and system bias check information is located in **Appendix E** with calibration gas Certificates of Accuracy located in **Appendix F.** One analyzer was used and calibrated on two separate scales. A high (986 ppm) and low (260 ppm) range was used. The lower scale was used to correct the data as the overall average CO concentration (ppm) was below the range of the lower scale.

4.2.3 USEPA Method 7E

NOx emissions were measured following USEPA Method 7E, "Determination of Nitrogen Oxides Emissions from Stationary Sources." The NOx concentration was measured using a Teledyne 200EH Chemiluminescence gas analyzer. The exhaust gas sample was withdrawn from a single point at the centre of the duct/stack using a stainless steel probe. The sample proceeded through a heated filter where particulate matter was removed. The sample was then transferred via a heated Teflon® line to a sample conditioner. The Teflon line was heated to 120°C (250°F) to prevent any condensation. The sample was then routed through a manifold system and introduced to the individual CEM's for measurement.

A NO/NO2 conversion check was performed prior to the start of the sampling by introducing NO_2 gas into the NOx analyzer. The analyzers NOx concentration readout was greater than 90% of the introduced calibration gas; therefore, the conversion met the converter efficiency requirement of section 13.5 of USEPA Method 7E. NO/NO_2 conversion data is located in Appendix E.

Calibration error and system-bias checks were performed as described in section 4.2.2.

4.2.4 Special Situations and Modifications

Testing consisted of one 60-minute test run, one 44 minute run and one 45-minute test run. The normal running cycle of the Dynamometer is approximately 43.6minutes, during the testing, in discussion with Mr. Thomas Maza and Mr. Todd Zynda of the (MDEQ), it was agreed to complete Tests 2 and 3 for the test cycle (approximately 45-minute) due to the testing cycle durations.

5 PROCESS DATA

FCA representatives provided production information during testing of EU-DYNO2, 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 H**.

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 C** and **D**.

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7 CONCLUSIONS

Testing was successfully completed on May 24th, 2017. All parameters were tested in accordance with USEPA referenced methodologies.

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