Air Emission Test
for
Dynamometer Engine Test Cells

FCA US LLC
Chrysler Technology Center
800 Chrysler Drive
Auburn Hills, MI

FCA
FIAT CHRYSLER AUTOMOBILES

Prepared for:
FCA US LLC
Auburn Hills, Michigan

Bureau Veritas Project No. 11016-000146.00

October 28, 2016

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RENEWABLE OPERATING PERMIT REPORT CERTIFICATION

Authorized by 1994 P.A. 451, as amended. Failure to provide this information may result in civil and/or criminal penalties.

Reports submitted pursuant to R 336.1213 (Rule 213), subrules (3)(c) and/or (4)(c), of Michigan's Renewable Operating Permit (ROP) program must be certified by a responsible official. Additional information regarding the reports and documentation listed below must be kept on file for at least 5 years, as specified in Rule 213(3)(b)(ii), and be made available to the Department of Environmental Quality, Air Quality Division upon request.

Source Name FCA US LLC - Chrysler Technology Center County Oakland

Source Address 800 Chrysler Drive City Auburn Hills

AQD Source ID (SRN) N1436 ROP No. MI-ROP-N1436-2013 ROP Section No. 2

Please check the appropriate box(es):

☐ **Annual Compliance Certification (Pursuant to Rule 213(4)(c))**

Reporting period (provide inclusive dates): From _____ To _____

☐ 1. During the entire reporting period, this source was in compliance with **ALL** terms and conditions contained in the ROP, each term and condition of which is identified and included by this reference. The method(s) used to determine compliance is/are the method(s) specified in the ROP.

☐ 2. During the entire reporting period this source was in compliance with all terms and conditions contained in the ROP, each term and condition of which is identified and included by this reference, **EXCEPT** for the deviations identified on the enclosed deviation report(s). The method used to determine compliance for each term and condition is the method specified in the ROP, unless otherwise indicated and described on the enclosed deviation report(s).

☐ **Semi-Annual (or More Frequent) Report Certification (Pursuant to Rule 213(3)(c))**

Reporting period (provide inclusive dates): From _____ To _____

☐ 1. During the entire reporting period, **ALL** monitoring and associated recordkeeping requirements in the ROP were met and no deviations from these requirements or any other terms or conditions occurred.

☐ 2. During the entire reporting period, all monitoring and associated recordkeeping requirements in the ROP were met and no deviations from these requirements or any other terms or conditions occurred, **EXCEPT** for the deviations identified on the enclosed deviation report(s).

☒ **Other Report Certification**

Reporting period (provide inclusive dates): From NA To NA

Additional monitoring reports or other applicable documents required by the ROP are attached as described:

Test Report evaluating air emissions from FG-UNCNTRLDCELLS-S2/FG-CNTRLDCELLS-S2.
This form shall certify that the testing was conducted in accordance with the
approved test plan and that the facility was operating in compliance with permit
conditions.

I certify that, based on information and belief formed after reasonable inquiry, the statements and information in this report and the supporting enclosures are true, accurate and complete

Mark Cerny	Director Powertrain	248-944-2555
Name of Responsible Official (print or type)	Title	Phone Number

Mark A. Cerny 10-31-16

Signature of Responsible Official Date

* Photocopy this form as needed.

Executive Summary

FCA US LLC retained Bureau Veritas North America, Inc. to test air emissions from engine dynamometer test cells at FCA US LLC's Chrysler Technology Center (CTC) in Auburn Hills, Michigan.

The purpose of the testing was to evaluate (1) volatile organic compound (VOC), carbon monoxide (CO), and nitrogen oxide (NO_x) concentrations and emission rates from engine dynamometer test cells, and (2) compliance with the facility's Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (ROP) MI-ROP-N1436-2013, dated March 21, 2013.

The following three sources in Dynamometer Wings B (FG-UNCNTRLDCELLS-S2), and C and D (FG-CNTRLDCELLS-S2) were tested:

- Wing B, Cell B17 (Stack ID Tag 1520) - Engine emissions from these test cells are exhausted directly to the atmosphere.
- Wing C, Oxidizer 4.01 (Stack ID Tag 1532) - Engine emissions from these test cells are controlled with thermal oxidizers.
- Wing D, Oxidizer 4.01 (Stack ID Tag 1559) - Engine emissions from these test cells are controlled with thermal oxidizers.

The testing was conducted August 31 through September 2, 2016, and followed United States Environmental Protection Agency (USEPA) Reference Methods 1 through 4, 7E, 10, 25A, and 205 guidelines as described in the Intent-to-Test Plan submitted to MDEQ on June 30, 2016. The MDEQ Intent-to-Test Plan acceptance letter is included as Appendix F.

Three 60-minute tests were performed at each source to measure the VOC, CO, and NO_x mass emission rates in pounds per hour (lb/hr). Testing for Wing B, B17 consisted of one 60-minute run being conducted at each of the following load conditions: low [800 revolutions per minute (RPM)], mid (1000 RPM), and high (2000 RPM). Testing for Wing C, 4.01 was conducted while preforming powertrain durability testing using both gasoline and diesel fueled engines. FCA US LLC recorded fuel use during testing, which was used to calculate the emissions in pounds of pollutant per gallon of fuel combusted (lb/gal).

Detailed results of the testing are presented in Tables 1 through 3 after the Tables Tab of this report. The results of the testing are summarized in the following table.

Dynamometer Engine Test Cell Results

Source	Parameter	Result			Average
		Run 1	Run 2	Run 3	
		lb/gal			
Wing B, Cell B17 (FG-UNCNTRLDCELLS-S2)	VOC	0.0085	0.022	0.059	0.030
	CO	0.031	0.012	0.045	0.030
	NO_x	0.0036	Not detected	Not detected	0.0012
Wing C, Oxidizer 4.01 (FG-CNTRLDCELLS-S2)	VOC	Not detected	Not detected	0.000013	0.0000044
	CO	0.011	0.019	0.020	0.017
	NO_x	0.094	0.057	0.059	0.070
Wing D, Oxidizer 4.01 (FG-CNTRLDCELLS-S2)	VOC	Not detected	Not detected	Not detected	Not detected
	CO	0.022	0.033	0.033	0.029
	NO_x	0.052	0.062	0.060	0.058

lb/gal: pound of VOCs, NO_x, or CO per gallon of fuel combusted

Note: a value of zero was used in calculations if a parameter was not detected.

1.0 Introduction

1.1 Summary of Test Program

FCA US LLC retained Bureau Veritas North America, Inc. to test air emissions at FCA US LLC's Chrysler Technology Center (CTC) in Auburn Hills, Michigan. CTC is primarily used as a research and development center for automobile, light-duty truck, and vehicle component manufacturing. Operations and equipment at the technology center include dynamometer test cells used for engine and engine component testing; manufacturing and assembly of pilot processes; and various laboratory activities.

The purpose of the testing was to evaluate (1) volatile organic compound (VOC), carbon monoxide (CO), and nitrogen oxide (NO_x) concentrations and emission rates from engine dynamometer test cells, and (2) compliance with the facility's Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (ROP) MI-ROP-N1436-2013, dated March 21, 2013.

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- Wing B, Cell B17 (Stack ID Tag 1520) - Engine emissions from these test cells are exhausted directly to the atmosphere.
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- Wing D, Oxidizer 4.01 (Stack ID Tag 1559) - Engine emissions from these test cells are controlled with thermal oxidizers.

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Table 1-1 summarizes the sources, parameters, and test dates.

Table 1-1
Sources Tested, Parameters, and Test Dates

Source Identification	Test Run	Test Parameter	Test Date
Wing B, Cell B17 (FG-UNCNTRLDCELLS-S2)	1 through 3	VOC, CO, NO_x	Sept. 1 and 2, 2016
Wing C, Oxidizer 4.01 (FG-CNTRLDCELLS-S2)	1 through 3	VOC, CO, NO_x	Aug. 31, 2016
Wing D, Oxidizer 4.01 (FG-CNTRLDCELLS-S2)	1 through 3	VOC, CO, NO_x	Aug. 31 and Sept. 1, 2016

1.2 Key Personnel

Contact information is listed in Table 1-2. Messrs. Brian Young, Senior Project Manager, Li Wu, and Trevor Zalewski, all with Bureau Veritas, conducted the emissions testing program. Mr. Stuart Weiss, Environmental Specialist with FCA US LLC, provided process coordination and arranged for facility operating parameters to be recorded. Messrs. Tom Gasloli and Samuel Liveson with MDEQ, witnessed the testing.

2.0 Source and Sampling Locations

2.1 Process Description

CTC is contiguous with FCA US LLC's headquarters located at 800 Chrysler Drive in Auburn Hills, Michigan. CTC is primarily a research and development center for automobile, light-duty truck, and vehicle component manufacturing. CTC tests engines and engine components in dynamometer engine test cells. These engine test cells are distributed over five test wings: A, B, C, D, and E. Air emissions from these test cells are regulated by the ROP. Within the ROP, the test wings are grouped into the emission units described in Table 2-1.

Table 2-1
Emission Units

Emission Unit	Component
FG-UNCNTRLDCELLS-S2	30 engine dynamometer test cells (performance test cells) located in Wings B, C, and E. Performance test cells do not have emission control equipment.
FG-CNTRLDCELLS-S2	50 engine dynamometer test cells located in Wing C, Wing D, and Wing E (durability, transmission, and catalyst test cells). Emissions from these test cells are controlled with thermal oxidizers.

2.2 Control Equipment

The exhausts from the dynamometers in Wing B, and some dynamometers in Wing C, are uncontrolled and emitted to the atmosphere. Engine test cells in Wing D, and some in Wing C, that are primarily involved in durability, transmission, and catalyst tests, are controlled with thermal oxidizers. The thermal oxidizers are designed to remove greater than 95% of pollutants.

2.3 Process Data

The following process and control equipment data was recorded by FCA US LLC personnel during the testing:

- Thermal oxidizer combustion temperature (°F).
- Volume of gasoline used (gal/hr).
- Size and type of engine being tested.
- Engine running condition.

Process and control equipment data recorded during testing are included in Appendix E. Table 2-2 summarizes the gasoline consumption rate of each unit recorded during testing.

Table 2-2
Gasoline Usage Recorded During Wing B, C, D Testing

Parameter	Units	Run 1	Run 2	Run 3
Wing B, Cell B17 Gasoline Rate	gal/hr	2.41	0.78	0.43
Wing C, Oxidizer 4.01 Gasoline/Diesel Rate	gal/hr	49.61	75.87	61.05
Wing D, Oxidizer 4.01 Gasoline Rate	gal/hr	79.56	76.12	78.49

2.4 Flue Gas Sampling Locations

Descriptions of the sampling locations are presented in the following sections. Figure 2-1 is a photograph of stacks representative of the Wings B, C, and D sampling locations. The stacks for Wings B and C are identical in shape and size.

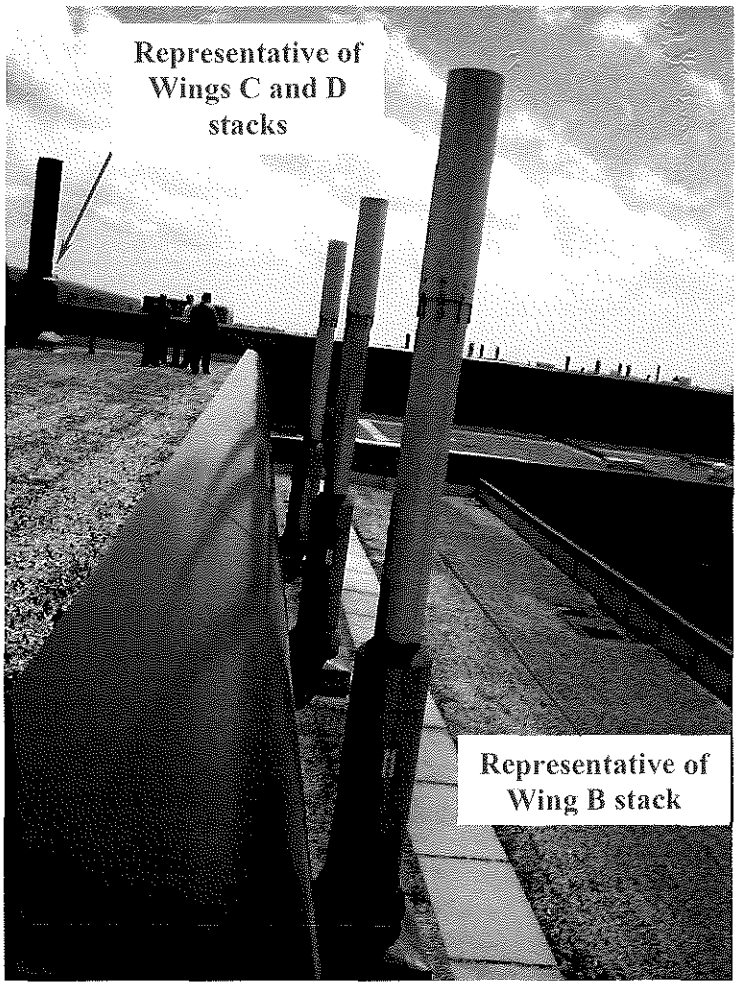


Figure 2-1. Representative Photograph of Exhaust Stacks

2.4.1 Wing B, B17 Sampling Location

One 3-inch diameter sampling port and one half-inch diameter sampling port oriented at 90° to one another are located in a straight section of the 12-inch-internal-diameter exhaust of Wing B, B17. The ports are located:

- Approximately 10 feet (~10 duct diameters) from the nearest upstream disturbance.
- Approximately 10 feet (~10 duct diameters) from the nearest downstream disturbance.

The ports are accessible from a roof. Figure 1 in the Appendix depicts the Wing B, B17 sampling ports and traverse point locations.

2.4.2 Wing C, 4.01 and Wing D, 4.01 Sampling Locations

Two 4-inch diameter sampling ports oriented at 90° to one another are located in a straight section of the 24.5-inch-internal-diameter exhaust of Wings C, 4.01 and Wing D, 4.01. The sampling ports extend 9.25 inches outward from the stack interior wall. The ports are located:

- Approximately 10 feet (~5 duct diameters) from the nearest upstream disturbance.
- Approximately 10 feet (~5 duct diameters) from the nearest downstream disturbance.

The ports are accessible from a roof. Figure 2 in the Appendix depicts the Wing C, 4.01 and Wing D, 4.01 sampling ports and traverse point locations.

2.5 Process Sampling Locations

Process sampling was not required during this test program. A process sample is a sample that is analyzed for operational parameters, such as calorific value of a fuel (e.g., natural gas, coal), organic compound content (e.g., paint coatings), or composition (e.g., polymers).

3.0 Summary and Discussion of Results

3.1 Objectives and Test Matrix

The objective of the testing is to evaluate (1) VOC, CO, and NO_x concentrations and emission rates from engine dynamometer test cells, and (2) compliance with the facility's MDEQ ROP MI-ROP-N1436-2013, dated March 21, 2013.

Table 3-1 summarizes the sampling and analytical test matrix.

Table 3-1
Test Matrix

Sampling Locations	Fuel Type	Sample/Type of Pollutant	USEPA Sampling Method	No. of Test Runs and Duration	Analytical Method	Analytical Laboratory
Wing B, Cell B17	Gasoline	VOC, CO, and NO_x	1, 2, 3, 4, 7E, 10, 25A, and 205	One 60-minute at 800 RPM One 60-minute at 1000 RPM One 60-minute at 2000 RPM	Field measurement, Pitot tube, gravimetric, chemiluminescence and infrared gas analyzers, flame ionization detector	Bureau Veritas
Wing C, Oxidizer 4.01	Gasoline and diesel	VOC, CO, and NO_x	1, 2, 3, 4, 7E, 10, 25A, and 205	Three 60-minute runs	Field measurement, Pitot tube, gravimetric, chemiluminescence and infrared gas analyzers, flame ionization detector	Bureau Veritas
Wing D, Oxidizer 4.01	Gasoline	VOC, CO, and NO_x	1, 2, 3, 4, 7E, 10, 25A, and 205	Three 60-minute runs	Field measurement, Pitot tube, gravimetric, chemiluminescence and infrared gas analyzers, flame ionization detector	Bureau Veritas

3.2 Field Test Changes and Issues

Field test changes were not required to complete the emissions testing. Communication between FCA US LLC, Bureau Veritas, and MDEQ allowed the testing to be performed in accordance with established requirements. It should be noted that air emission data collected on August 30, 2016 (Test Runs 1 through 3), from Wing D, 4.01 Test Cell was voided due to an error with the FCA US LLC data acquisition system. Testing was resumed on the Wing D, 4.01 Test Cell on August 31, 2016, when the issue was corrected.

3.3 Summary of Results

The results are summarized in Table 3-2. Detailed results of the testing are presented in Tables 1 through 3 after the Tables Tab of this report. Graphs of concentrations measured during testing are provided after the Graphs Tab in the Appendix. Sample calculations are presented in Appendix B.

Table 3-2
Dynamometer Engine Test Cell Results

Source	Parameter	Result			Average
		Run 1	Run 2	Run 3	
		lb/gal			
Wing B, Cell B17 (FG-UNCNTRLDCELLS-S2)	VOC	0.0085	0.022	0.059	0.030
	CO	0.031	0.012	0.045	0.030
	NO_x	0.0036	Not detected	Not detected	0.0012
Wing C, Oxidizer 4.01 (FG-CNTRLDCELLS-S2)	VOC	Not detected	Not detected	0.000013	0.0000044
	CO	0.011	0.019	0.020	0.017
	NO_x	0.094	0.057	0.059	0.070
Wing D, Oxidizer 4.01 (FG-CNTRLDCELLS-S2)	VOC	Not detected	Not detected	Not detected	Not detected
	CO	0.022	0.033	0.033	0.029
	NO_x	0.052	0.062	0.060	0.058

lb/gal: pound of VOCs, NO_x, or CO per gallon of fuel combusted
Note: a value of zero was used in calculations if a parameter was not detected.

4.0 Sampling and Analytical Procedures

4.1 Test Methods

Bureau Veritas measured emissions in accordance with the USEPA Methods listed in Table 4-1. Descriptions of the sampling methods and analysis procedures are presented in the following sections.

Table 4-1
Sampling Methods

Parameter	Source			USEPA Reference	
	Wing B B17 (uncontrolled)	Wing C 4.01 (controlled)	Wing D 4.01 (controlled)	Method	Title
Sampling ports and traverse points	•	•	•	1	Sample and Velocity Traverses for Stationary Sources
Velocity and flowrate	•	•	•	2	Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)
Molecular weight	•	•	•	3	Gas Analysis for the Determination of Dry Molecular Weight
Moisture content	•	•	•	4	Determination of Moisture Content in Stack Gases (Approximation Method)
Nitrogen oxides (NO_x)	•	•	•	7E	Determination of Nitrogen Oxides Emissions from Stationary Sources(instrument analyzer procedure)
Carbon monoxide (CO)	•	•	•	10	Determination of Carbon Monoxide Emissions from Stationary Sources (instrument analyzer procedure)
Volatile organic compounds (VOC)	•	•	•	25A	Determination of Total Gaseous Organic Concentration using a Flame Ionization Analyzer
Gas dilution calibration	•	•	•	205	Verification of Gas Dilution Systems for Field Instrument Calibrations

4.1.1 Volumetric Flowrate (USEPA Methods 1 and 2)

USEPA Method 1, "Sample and Velocity Traverses for Stationary Sources," from the Code of Federal Regulations, Title 40, Part 60 (40 CFR 60), Appendix A, was used to evaluate the sampling location and the number of traverse points for the measurement of velocity profiles. Figures 1 and 2 (see Figures Tab) depict the sampling locations and traverse points.

Method 2, "Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)," was used to measure flue gas velocity and calculate volumetric flowrate. An S-type Pitot tube and thermocouple assembly connected to a digital manometer and thermometer was used. Because the dimensions of Bureau Veritas' Pitot tubes meet the requirements outlined in Method 2, Section 10.0, a baseline Pitot tube coefficient of 0.84 (dimensionless) was assigned.

The digital manometer and thermometer are calibrated using calibration standards, which are traceable to National Institute of Standards (NIST). The Pitot tube inspection and calibration sheets will be included in the final test report.

Cyclonic Flow Check. Bureau Veritas evaluated whether cyclonic flow was present at the sampling locations.

Cyclonic flow is defined as a flow condition with an average null angle greater than 20°. The direction of flow can be determined by aligning the Pitot tube to obtain zero (null) velocity head readings—the direction would be parallel to the Pitot tube face openings or perpendicular to the null position. By measuring the angle of the Pitot tube face openings in relation to the stack wall when a null angle is obtained, the direction of flow is measured. If the absolute average of the flow direction angles is greater than 20°, the flue gas flow is considered to be cyclonic at that sampling location and an alternative location should be used.

The measured traverse point flue gas velocity null angle was 0° at each sampling location. The measurements indicate the absence of cyclonic flow at the sampling locations.

Field data sheets are included in Appendix C. Computer-generated field data sheets are included in Appendix D.

4.1.2 Molecular Weight (USEPA Method 3)

Molecular weight was evaluated using Method 3, "Gas Analysis for the Determination of Dry Molecular Weight." Flue gas was extracted through a probe positioned near the centroid of the duct or stack and directed into a Fyrite® gas analyzer. The concentrations of carbon dioxide (CO_2) and oxygen (O_2) were measured by chemical absorption with the Fyrite® gas analyzer to within ±0.5%. The average CO_2 and O_2 results of the samples were used to calculate molecular weight.

4.1.3 Moisture Content (USEPA Method 4)

The moisture content at the exhaust to atmosphere locations was measured using USEPA Method 4, "Determination of Moisture Content in Stack Gases." Bureau Veritas' modular USEPA Method 4 stack sampling system consists of:

- A stainless steel probe.
- Tygon® umbilical line connecting the probe to the impingers.
- A set of four Greenburg-Smith (GS) impingers with the configuration shown in Table 4-2 situated in a chilled ice bath.
- A sampling line.
- An Environmental Supply® control case equipped with a pump, dry-gas meter, and calibrated orifice.

Table 4-2
USEPA Method 4 Impinger Configuration

Impinger	Type	Contents	Amount
1	Modified	Water	~100 milliliters
2	Greenburg Smith	Water	~100 milliliters
3	Modified	Empty	0 milliliters
4	Modified	Silica desiccant	~300 grams

Before initiating a test run, the sampling train was leak-checked by capping the probe tip and applying a vacuum of approximately 15 inches of mercury to the sampling train. The dry-gas meter was then monitored for approximately 1 minute to verify that the sample train leak rate is less than 0.02 cubic feet per minute (cfm). The sample probe was inserted into the sampling port near the centroid of the stack in preparation of sampling. Flue gas was extracted at a constant rate from the stack, with moisture removed from the sample stream by the chilled impingers.

At the conclusion of the test run, a post-test leak check was conducted and the impinger train was carefully disassembled. The weight of liquid or silica gel in each impinger was measured with a scale capable of measuring ±0.5 gram. The weight of water collected within the impingers and volume of flue gas sampled was used to calculate the percent moisture content. One moisture content sample was collected during each test run. Figure 4-1 depicts the USEPA Method 4 sampling train.

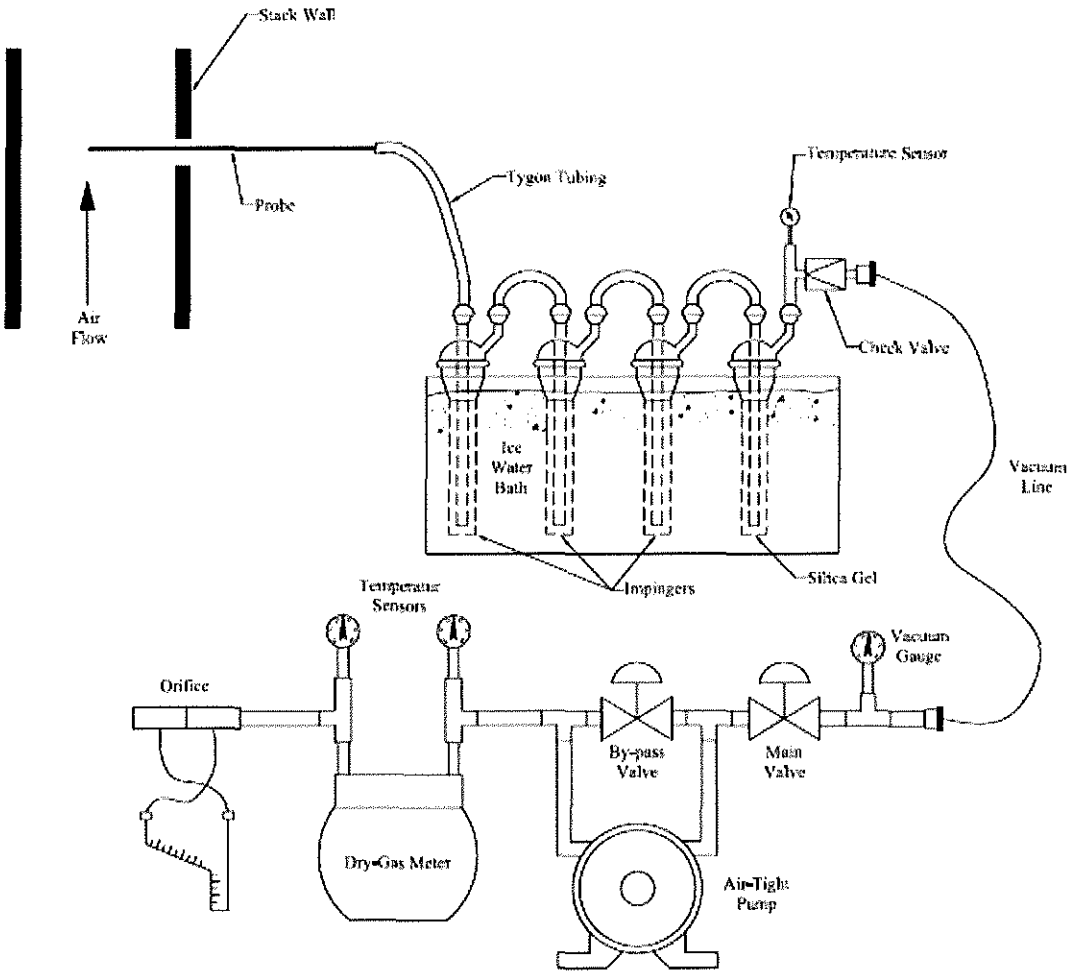


Figure 4-1. USEPA Method 4 Sampling Train

4.1.4 Nitrogen Oxides and Carbon Monoxide (USEPA Methods 7E and 10)

USEPA Method 7E, "Determination of Nitrogen Oxides Emissions from Stationary Sources (Instrumental Analyzer Method)" was used to measure NO_x concentrations. Carbon monoxide concentrations were measured using USEPA Method 10, "Determination of Carbon Monoxide Emissions from Stationary Sources." The sampling trains for USEPA Methods 7E and 10 are similar and the flue gas was extracted from the stack through:

- A stainless-steel probe.
- Heated Teflon® sample line to prevent condensation.

- A chilled Teflon condenser with peristaltic pump to remove moisture from the sampled gas stream prior to entering the analyzer.

- Chemiluminescence (NO_x) and infrared (CO) gas analyzers.

Figure 4-2 depicts the USEPA Methods 7E and 10 sampling train.

Data was recorded at 1-second intervals on a computer equipped with data acquisition software. Recorded NO, and CO concentrations were averaged over the duration of each 60-minute test run.

Before testing, a three-point stratification test was conducted by measuring the NO_x or CO gas concentration at a location positioned at 17, 50, and 83% of the stack diameter for at least twice the analyzer response time. The NO_x or CO concentrations measured were uniform in the stack cross section and less than ±5% or 0.5 part per million (ppm) of the mean concentration for all traverse points so the gas stream was considered to be unstratified and a single sampling point, located near the centroid of the duct was used for sampling.

A 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 evaluate the analyzer response is within ±2% of the calibration gas span. Prior to each test run, a system-bias test was performed in which known concentrations of calibration gases were introduced at the probe tip to measure if the analyzers response is within ±5% of the calibration span.

An NO/NO_2 conversion check was performed prior to the first test day by introducing an approximate 50 ppm NO_2 calibration gas into the NO_x analyzer. The analyzer's NO_x concentration response was greater than 90% of the introduced NO_2 calibration gas concentration, so the analyzer's NO/NO_2 conversion met the converter efficiency requirement of Section 13.5 of USEPA Method 7E.

At the conclusion of the each test run, an additional system-bias check was performed to evaluate the drift from pre- and post-test system-bias checks. The system-bias checks evaluated if the analyzer drift is within the allowable criterion of ±3% from pre-test to post-test system bias checks. The analyzer drift data was used to correct the measured flue gas concentration.

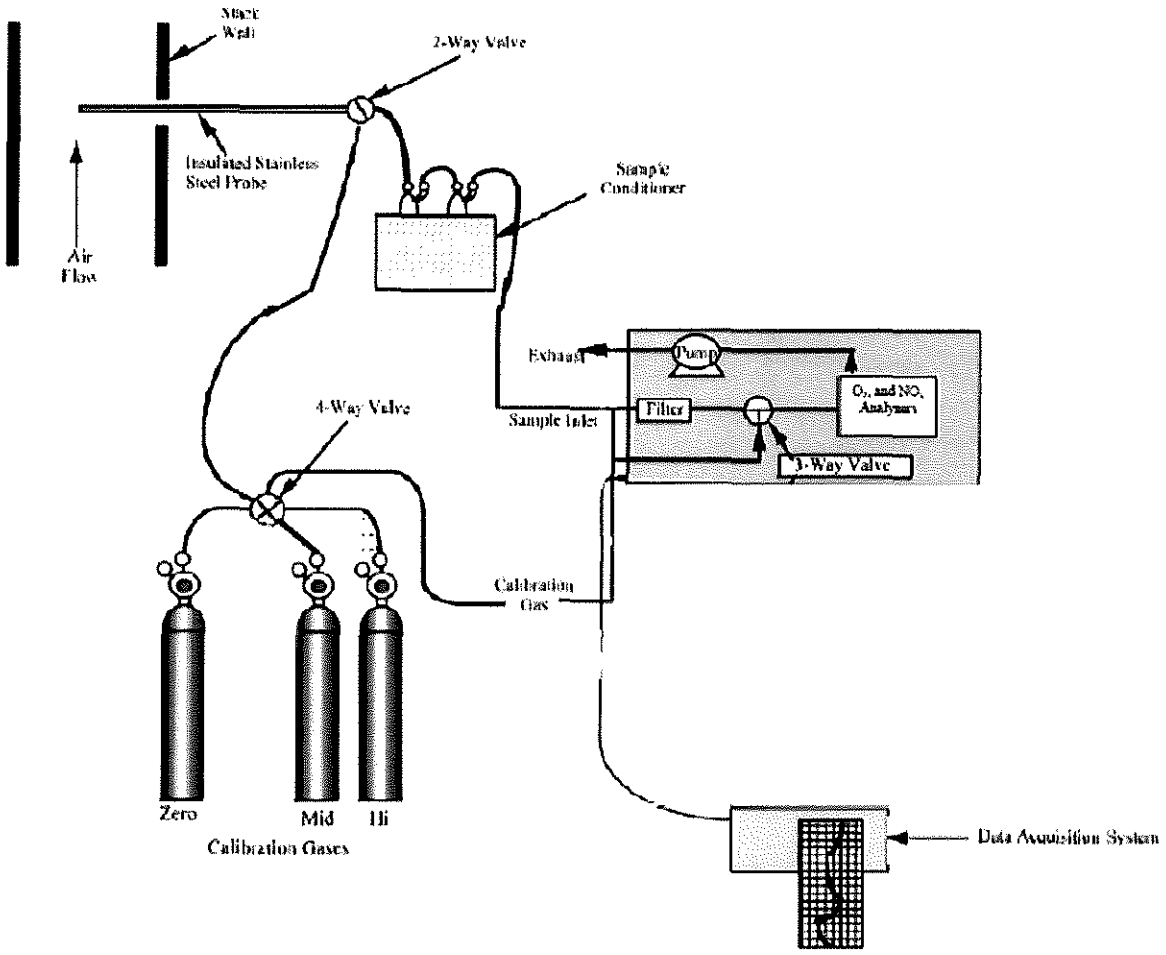


Figure 4-2. USEPA Methods 7E and 10 Sampling Train

4.1.5 Volatile Organic Compounds (USEPA Method 25A)

VOC concentrations were measured following USEPA Method 25A, "Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer." Samples were collected through a stainless steel probe and heated sample line that was inserted into the analyzer's sample port. Bureau Veritas used a J.U.M. 109A, 3-300A, or J.U.M. VE7 flame ionization detector-based hydrocarbon analyzer.

A flame ionization detector (FID) measures an average hydrocarbon concentration in parts per million by volume (ppmv) of VOC relative to the calibration gas propane. The FID is fueled by 100% hydrogen, which generates a flame with a negligible number of ions. Flue gas is introduced into the FID and enters the flame chamber. The combustion of flue gas generates electrically charged ions. The analyzer applies a polarizing voltage between two electrodes

around the flame, producing an electrostatic field. Negatively charged ions (anions) migrate to a collector electrode, while positive charged ions (cations) migrate to a high-voltage electrode. The current between the electrodes is directly proportional to the hydrocarbon concentration in the sample. The flame chamber is depicted in Figure 4-3.

Using the voltage analog signal, measured by the FID, the concentration of VOCs is recorded by a data acquisition system (DAS). The average concentration of VOCs is reported as the calibration gas (i.e., propane) in equivalent units.

Before testing, the FID analyzers were calibrated by introducing a zero-calibration range gas (<1% of span value) and high-calibration range gas (80-90% span value) to the tip of the sampling probe. The span value was set to 1.5 to 2.5 times the expected concentration (e.g., 0-100 ppmv). Next, a low-calibration range gas (25-35% of span value) and mid-calibration range gas (45-55% of span value) were introduced. The analyzers were considered to be calibrated when the analyzer response was ±5% of the calibration gas value.

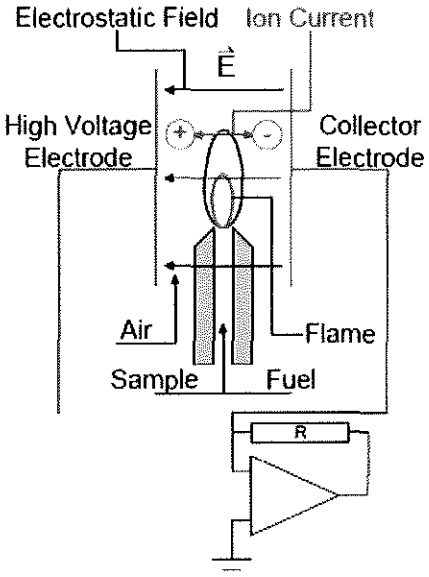


Figure 4-3. FID Flame Chamber

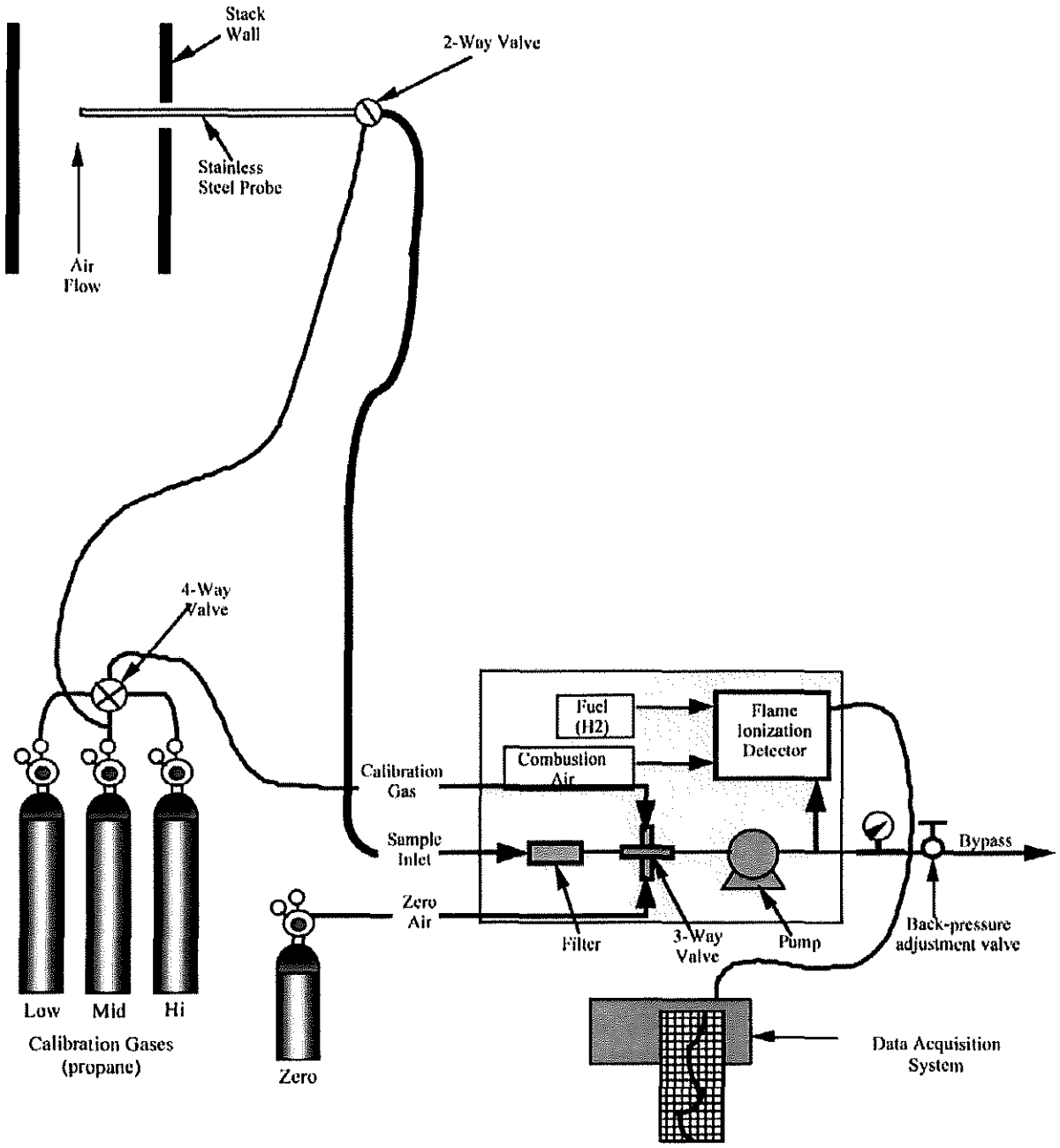
At the conclusion of a test run a calibration drift test was performed by introducing the zero- and mid- or low-calibration gas to the tip of the sampling probe. The test run data were considered valid if the calibration drift test demonstrated that the analyzers were responding within ±3% from pre-test to post-test calibrations. Refer to Figure 4-4 for a drawing the USEPA Method 25A sampling train. See Appendix A for calibration data.

4.1.6 Gas Dilution (USEPA Method 205)

A gas dilution system was used to introduce known values of calibration gases into the analyzers. The gas dilution system consists of calibrated orifices or mass flow controls and dilutes a high-level calibration gas to within ±2% of predicted values. The gas divider is capable of diluting gases at set increments and was evaluated for accuracy in the field in accordance with USEPA Method 205, "Verification of Gas Dilution Systems for Field Instrument Calibrations."

Before testing, the gas divider dilutions were measured to evaluate that they were within ±2% of predicted values. Three sets of three dilutions of the high-level calibration gas were performed. In addition, a certified mid-level calibration gas was introduced into an analyzer; this calibration gas concentration was within ± 10% of a gas divider dilution concentration.

Figure 4-4. USEPA Method 25A Sampling Train



4.2 Procedures for Obtaining Process Data

Process data were recorded by FCA US LLC personnel. Refer to Sections 2.1 and 2.2 for discussions of process and control device data and Appendix E for the operating parameters recorded during testing.

4.3 Sampling Identification and Custody

Chain of Custody procedures are not applicable to this test program. The emissions test methods used during this test program provide onsite results and do not require laboratory analysis.

5.0 QA/QC Activities

Equipment used in this emissions test program passed quality assurance/quality control (QA/QC) procedures. Refer to Appendix A for equipment calibration and inspection sheets. Field data sheets are presented in Appendix C. Computer-generated Data Sheets are presented within Appendix D.

5.1 Pretest QA/QC Activities

Before testing, the sampling equipment was cleaned, inspected, and calibrated according to procedures outlined in the applicable USEPA sampling methods and USEPA's "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III, Stationary Source Specific Methods."

5.2 QA/QC Audits

The results of select sampling and equipment QA/QC audits and the acceptable tolerance are presented in the following sections. Calibration and inspection sheets for analyzers, dry-gas meters (DGMs), thermocouples, and Pitot tubes are presented in Appendix A.

5.2.1 Instrument Analyzer QA/QC Audits

The instrument analyzer sampling trains described in Section 4.1 were audited for measurement accuracy and data reliability. The analyzers passed the applicable calibration criteria. Table 5-1 summarizes the gas cylinders used during this test program. Calibration gas selection, bias, and drift checks are included in Appendix A.

Table 5-1
Calibration Gas Cylinder Information

Parameter	Gas Vendor	Cylinder Serial Number	Cylinder Value	Expiration Date
Air	Airgas	5383490Y	-	February 10, 2024
Hydrogen	Airgas	CC20386	99.999%	NA
Propane	Airgas	CC443378	308.0 ppm	January 8, 2022
Nitrogen	Airgas	CC173587	-	March 18, 2024
CO	Airgas	XC032359B	4408 ppm	October 30, 2022
NO_X	Airgas	XC033685B	491.7 ppm	December 2, 2021
NO_2	Airgas	CC500773	50.18 ppm	November 11, 2017

5.2.2 Thermocouple QA/QC Audits

Temperature measurements using thermocouples and digital pyrometers were compared to reference temperatures (i.e., ice water bath, boiling water) to evaluate accuracy of the equipment. The thermocouples and pyrometers measured temperatures within ±1.5% (i.e., the USEPA acceptance criterion) of the reference temperatures. Thermocouple and pyrometer calibration results are presented in the Appendix A.

5.3 QA/QC Checks for Data Reduction and Validation

Mr. Brian Young validated the computer spreadsheets onsite. The computer spreadsheets were used to evaluate the accuracy of field calculations. The field data sheets were reviewed to evaluate whether data has been recorded and inputted appropriately. The computer data sheets were checked against the raw field data sheets for accuracy during review of the draft report. Sample calculations were performed to verify computer spreadsheet computations.

5.4 QA/QC Problems

Equipment audits and QA/QC procedures demonstrate sample collection accuracy for the test runs.

Limitations

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Table 1
Wing B, B17 VOC, CO, and NO_x Emission Results
FCA US LLC Chrysler Technology Center
Auburn Hills, Michigan

Bureau Veritas Project No. 11016-000146.00

Sampling Dates: September 1, 2016 and September 2, 2016

Parameter	Units	Run 1	Run 2	Run 3	
Date		Sep 1, 2016	Sep 1, 2016	Sep 2, 2016	Average
Start Time	hr:min	12:55	14:15	8:00	
Duration	min	60	60	60	60
Engine speed	RPM	2,000	1,000	800	
Fuel Consumption	gal/hr	2.41	0.78	0.43	
Volumetric Flowrate	dscf/min	2,237	2,262	2,200	2,233
NO_x Concentration (C_{avg})	ppmvd	0.94	0.28	-0.04	0.39
Corrected NO_x Concentration (C_{gas})†	**ppmvd**	**0.55**	**-0.28**	**-0.20**	**0.02**
NO_x Mass Emission Rate	**lb/hr**	**0.0088**	**0**	**0**	**0.0029**
NO_x Mass Emission Rate	**lb/gal**	**0.0036**	**0**	**0**	**0.0012**
CO Concentration (C_{avg})	ppmvd	8.2	0.7	2.8	3.9
Corrected CO Concentration (C_{gas})†	**ppmvd**	**7.7**	**0.93**	**2.0**	**3.6**
CO Mass Emission Rate	**lb/hr**	**0.076**	**0.0092**	**0.020**	**0.035**
CO Mass Emission Rate	**lb/gal**	**0.031**	**0.012**	**0.045**	**0.030**
VOC Concentration (C_{avg})	ppmvd	1.6	1.4	1.9	1.6
Corrected VOC Concentration (C_{gas})†	**ppmvd**	**1.3**	**1.1**	**1.7**	**1.4**
VOC Mass Emission Rate	**lb/hr**	**0.021**	**0.017**	**0.025**	**0.021**
VOC Mass Emission Rate	**lb/gal**	**0.0085**	**0.022**	**0.059**	**0.030**

† corrected for analyzer drift

lb/hr: pound per hour

dscf/min: dry standard cubic foot per minute

ppmvd: part per million by dry volume

lb/gal: pound of gas per gallon of fuel

RPM: revolution per minute

Note: subsequent calculations assume zero

Table 2
Wing C, 4.01 VOC, CO, and NO_x Emission Results
FCA US LLC Chrysler Technology Center
Auburn Hills, Michigan

Bureau Veritas Project No. 11016-000146.00

Sampling Dates: August 31, 2016 and September 1, 2016

Parameter	Units	Run 1	Run 2	Run 3	
Date		Aug 31, 2016	Aug 31, 2016	Sep 1, 2016	Average
Start Time	hr:min	13:25	14:47	8:20	
Duration	min	60	60	60	60
Fuel Consumption	gal/hr	49.61	75.87	61.05	
Volumetric Flowrate	dscf/min	3,757	4,006	3,875	3,879
Residence Time	sec	1.4	1.3	1.3	1.3
NO_x Concentration (C_{avg})	ppmvd	171	149	128	149
Corrected NO_x Concentration (C_{gas})†	**ppmvd**	**173**	**152**	**131**	**152**
NO_x Mass Emission Rate	**lb/hr**	**4.6**	**4.4**	**3.6**	**4.2**
NO_x Mass Emission Rate	**lb/gal**	**0.094**	**0.057**	**0.059**	**0.070**
CO Concentration (C_{avg})	ppmvd	38	88	79	68
Corrected CO Concentration (C_{gas})†	**ppmvd**	**33**	**82**	**72**	**62**
CO Mass Emission Rate	**lb/hr**	**0.54**	**1.44**	**1.22**	**1.07**
CO Mass Emission Rate	**lb/gal**	**0.011**	**0.019**	**0.020**	**0.017**
VOC Concentration (C_{avg})	ppmvd	0.14	0.11	0.28	0.18
Corrected VOC Concentration (C_{gas})†	**ppmvd**	**-0.065**	**-0.038**	**0.030**	**-0.024**
VOC Mass Emission Rate	**lb/hr**	**0**	**0**	**0.00080**	**0.00027**
VOC Mass Emission Rate	**lb/gal**	**0**	**0**	**0.000013**	**0.0000044**

† corrected for analyzer drift

lb/hr: pound per hour

dscf/min: dry standard cubic foot per minute

ppmvd: part per million by dry volume

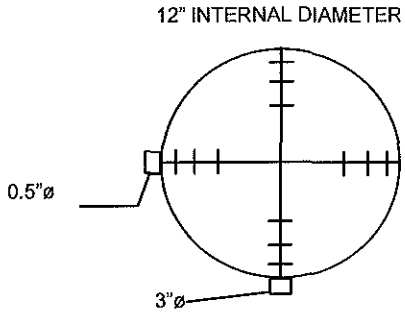
lb/gal: pound of gas per gallon of fuel

Note: subsequent calculations assume zero

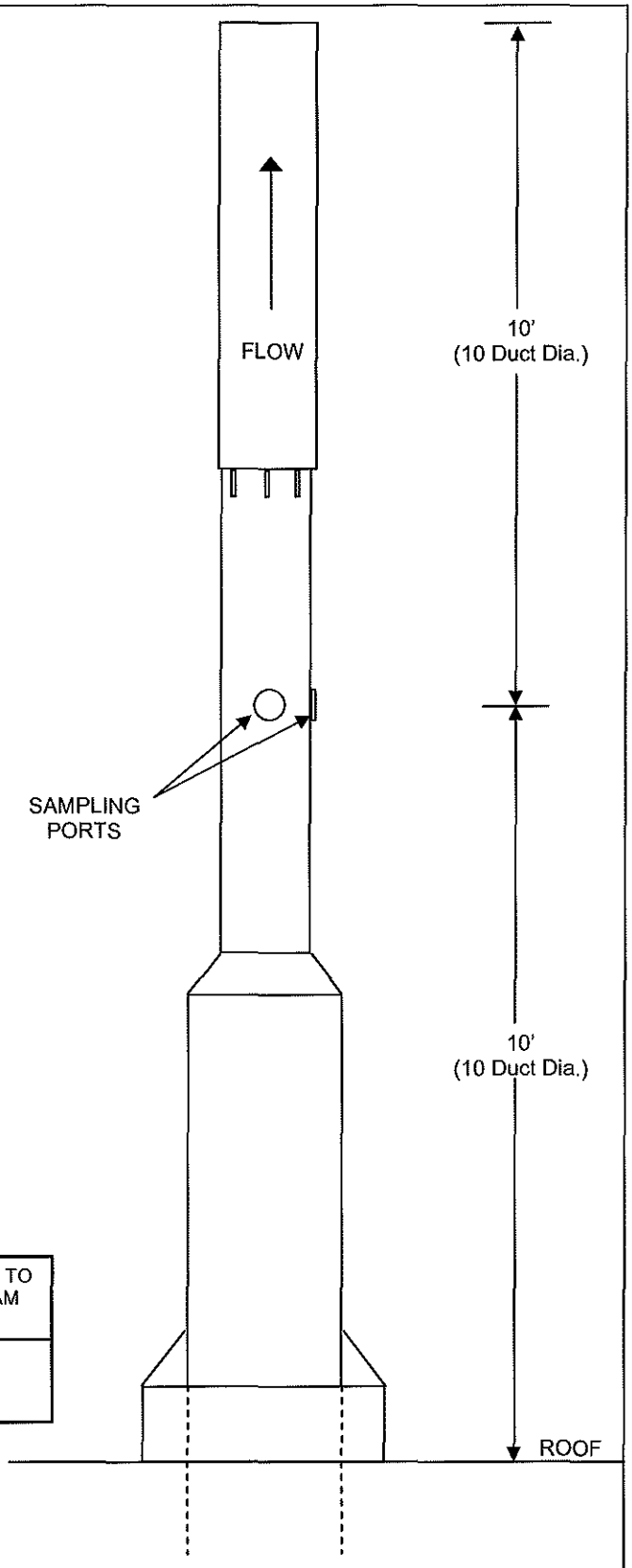
Table 3
Wing D, 4.01 VOC, CO, and NO_x Emission Results
FCA US LLC Chrysler Technology Center
Auburn Hills, Michigan
Bureau Veritas Project No. 11016-000146.00
Sampling Date: August 31, 2016

Parameter	Units	Run 4	Run 5	Run 6	
Date		Aug 31, 2016	Aug 31, 2016	Aug 31, 2016	Average
Start Time	hr:min	7:55	9:10	10:31	
Duration	min	60	60	60	60
Fuel Consumption	gal/hr	79.56	76.12	78.49	
Volumetric Flowrate	dscf/min	3,796	4,460	4,708	4,322
Residence Time	sec	1.3	1.1	1.1	1.2
NO_x Concentration (C_{avg})	ppmvd	144	140	140	141
Corrected NO_x Concentration (C_{gas})†	**ppmvd**	**151**	**148**	**140**	**146**
NO_x Mass Emission Rate	**lb/hr**	**4.1**	**4.7**	**4.7**	**4.5**
NO_x Mass Emission Rate	**lb/gal**	**0.052**	**0.062**	**0.060**	**0.058**
CO Concentration (C_{avg})	ppmvd	108	132	124	122
Corrected CO Concentration (C_{gas})†	**ppmvd**	**107**	**131**	**124**	**121**
CO Mass Emission Rate	**lb/hr**	**1.8**	**2.5**	**2.6**	**2.3**
CO Mass Emission Rate	**lb/gal**	**0.022**	**0.033**	**0.033**	**0.029**
VOC Concentration (C_{avg})	ppmvd	0.16	0.069	0.12	0.11
Corrected VOC Concentration (C_{gas})†	**ppmvd**	**-0.043**	**-0.083**	**-0.14**	**-0.088**
VOC Mass Emission Rate	**lb/hr**	**0**	**0**	**0**	**0**
VOC Mass Emission Rate	**lb/gal**	**0**	**0**	**0**	**0**

† corrected for analyzer drift
lb/hr: pound per hour
dscf/min: dry standard cubic foot per minute
ppmvd: part per million by dry volume
lb/gal: pound of gas per gallon of fuel
Note 1: Test Runs 1 through 3, conducted August 30, 2016, were voided due to an error with the Fiat Chrysler Automobiles data acquisition system.
Note 2: subsequent calculations assume zero



TRAVERSE POINT	DISTANCE FROM STACK WALL (INCHES)
6	0.53
5	1.75
4	3.55
3	8.45
2	10.25
1	11.47



	DISTANCE FROM PORTS TO NEAREST UPSTREAM BEND/ DISTURBANCE	DISTANCE FROM PORTS TO NEAREST DOWNSTREAM BEND/DISTURBANCE
WING B TEST CELL OUTLET	10 FEET (10 DIAMETERS)	10 FEET (10 DIAMETERS)

Figure 1
Wing B, B17 Test Cell Outlet
Sampling Ports and Traverse Point Locations

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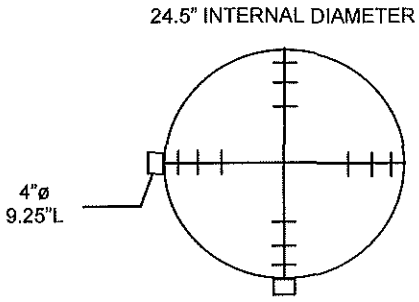
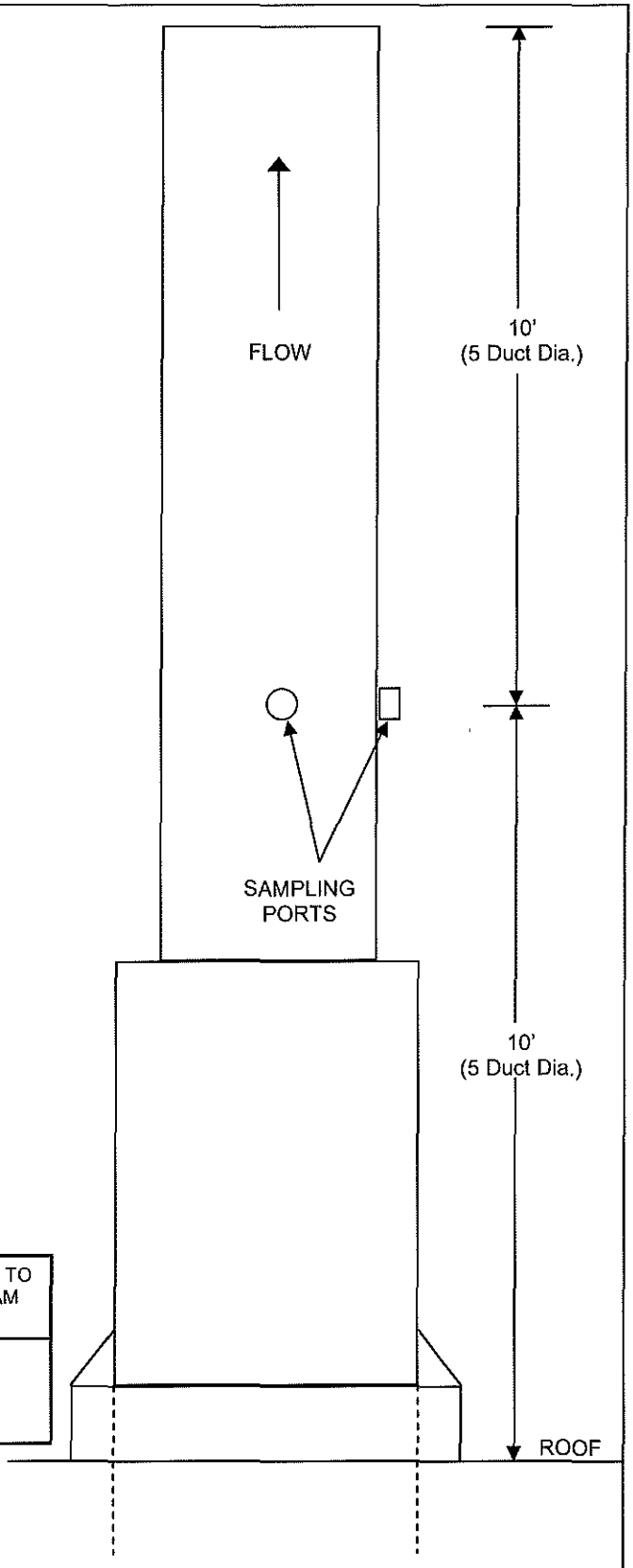
FCA US LLC
Chrysler Technology Center
Auburn Hills, Michigan

Project No. 11016-000146.00

Last Revision:
October 28, 2016



TRAVERSE POINT	DISTANCE FROM STACK WALL (INCHES)
8	0.78
7	1.59
6	4.75
5	7.91
4	16.59
3	19.75
2	21.93
1	23.72



	DISTANCE FROM PORTS TO NEAREST UPSTREAM BEND/ DISTURBANCE	DISTANCE FROM PORTS TO NEAREST DOWNSTREAM BEND/DISTURBANCE
WINGS C AND D TEST CELL OUTLETS	10 FEET (5 DIAMETERS)	10 FEET (5 DIAMETERS)

Figure 2
Wing C, 4.01 and Wing D, 4.01
Outlet Sampling Ports and
Traverse Point Locations

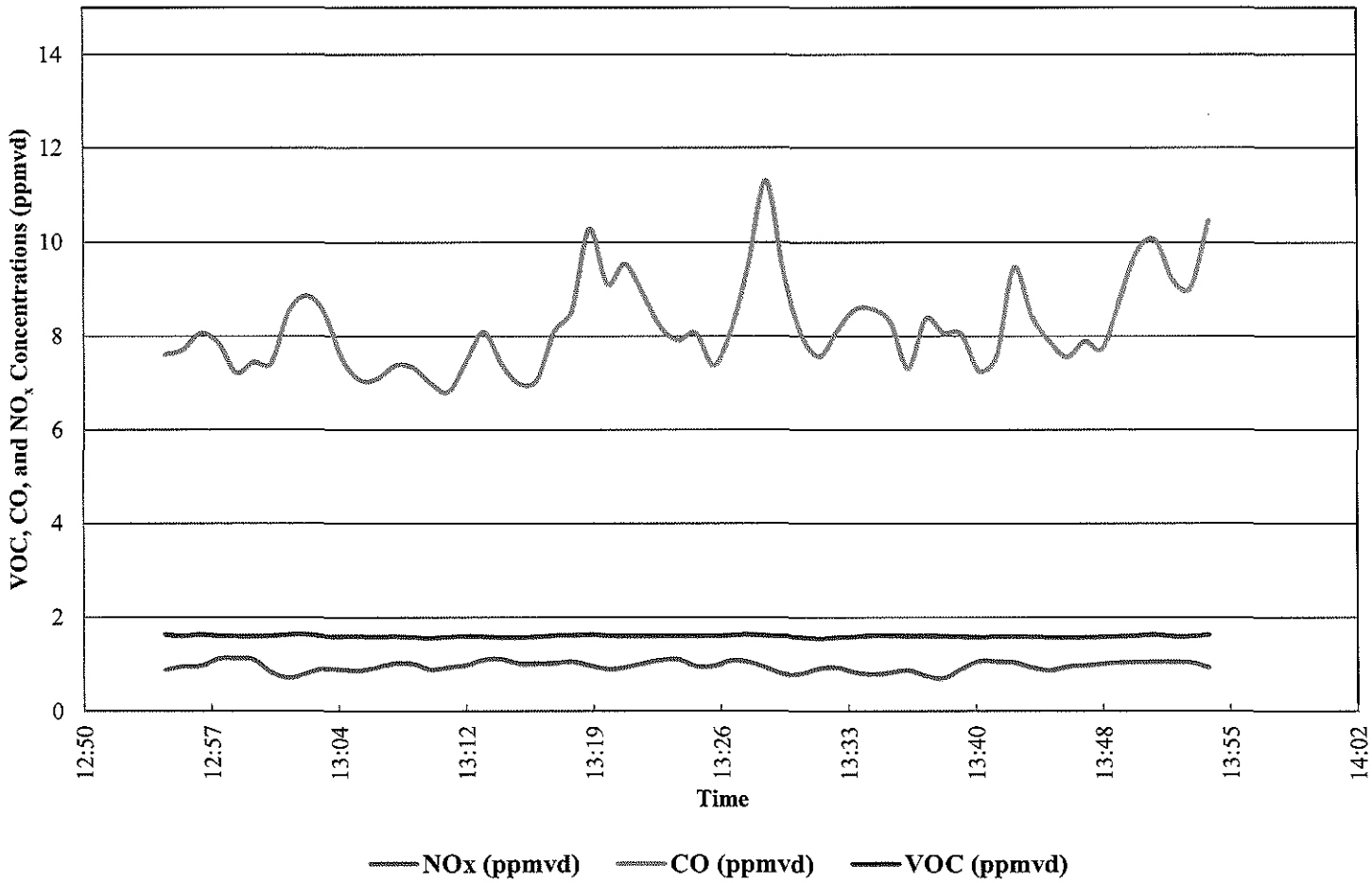
BUREAU VERITAS

FCA US LLC
Chrysler Technology Center
Auburn Hills, Michigan

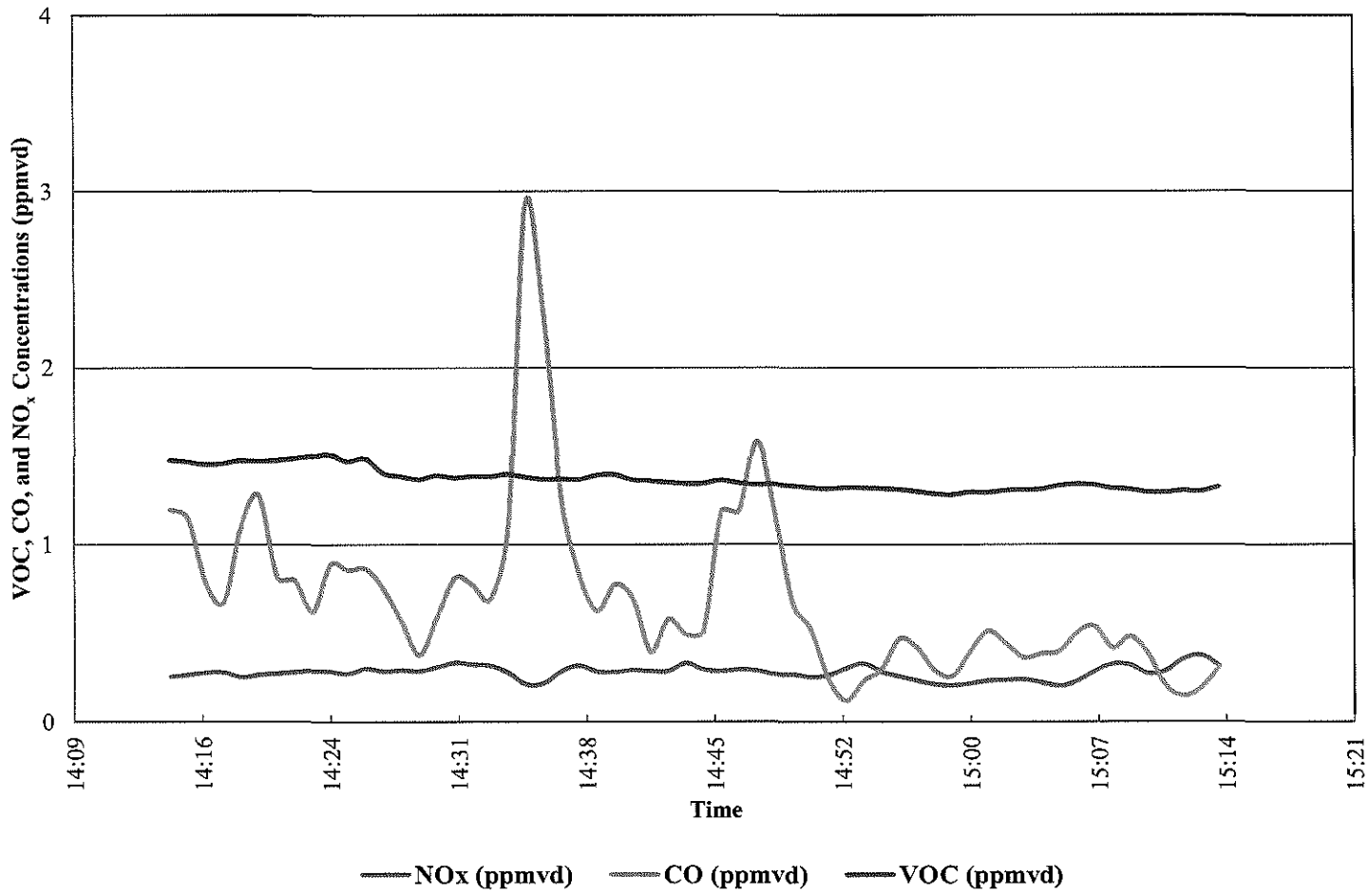
Project No. 11016-000146.00

Last Revision:
October 28, 2016

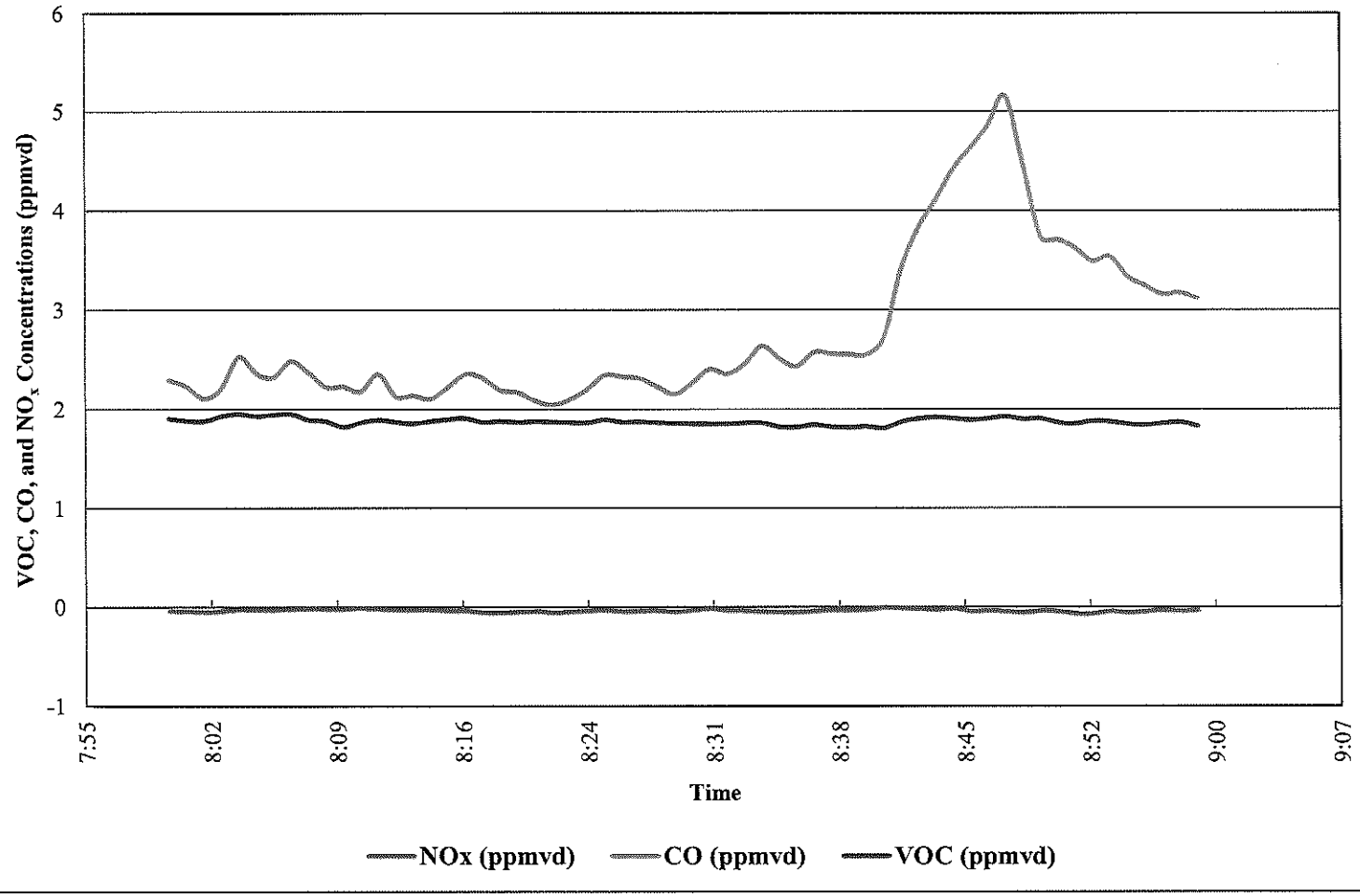
Wing B, B17 VOC, CO, and NOx Concentrations - Run 1
FCA US LLC Chrysler Technology Center
Auburn Hills, Michigan
Bureau Veritas Project No. 11016-000146.00
Sampling Date: September 1, 2016



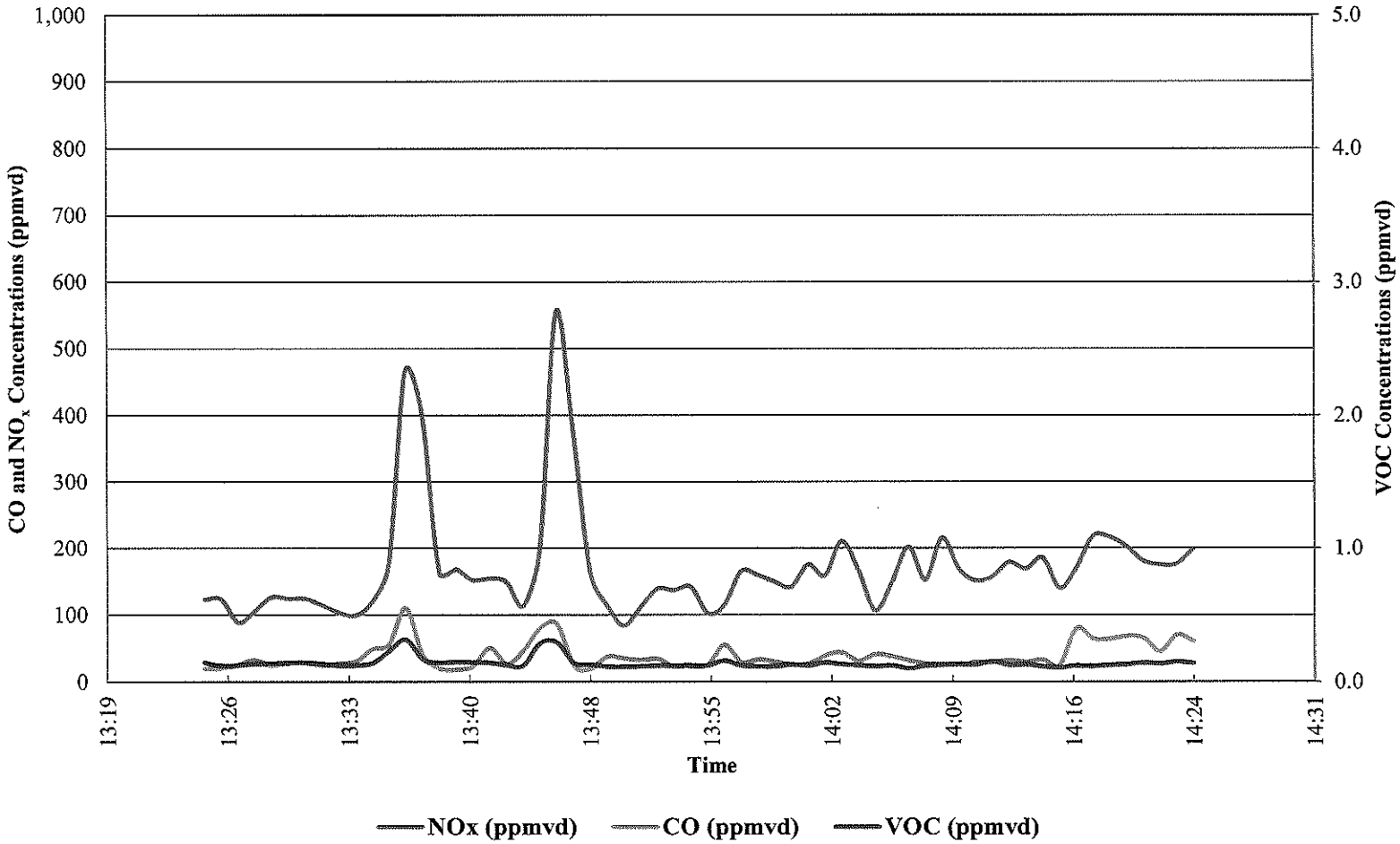
Wing B, B17 VOC, CO, and NOx Concentrations - Run 2
FCA US LLC Chrysler Technology Center
Auburn Hills, Michigan
Bureau Veritas Project No. 11016-000146.00
Sampling Date: September 1, 2016



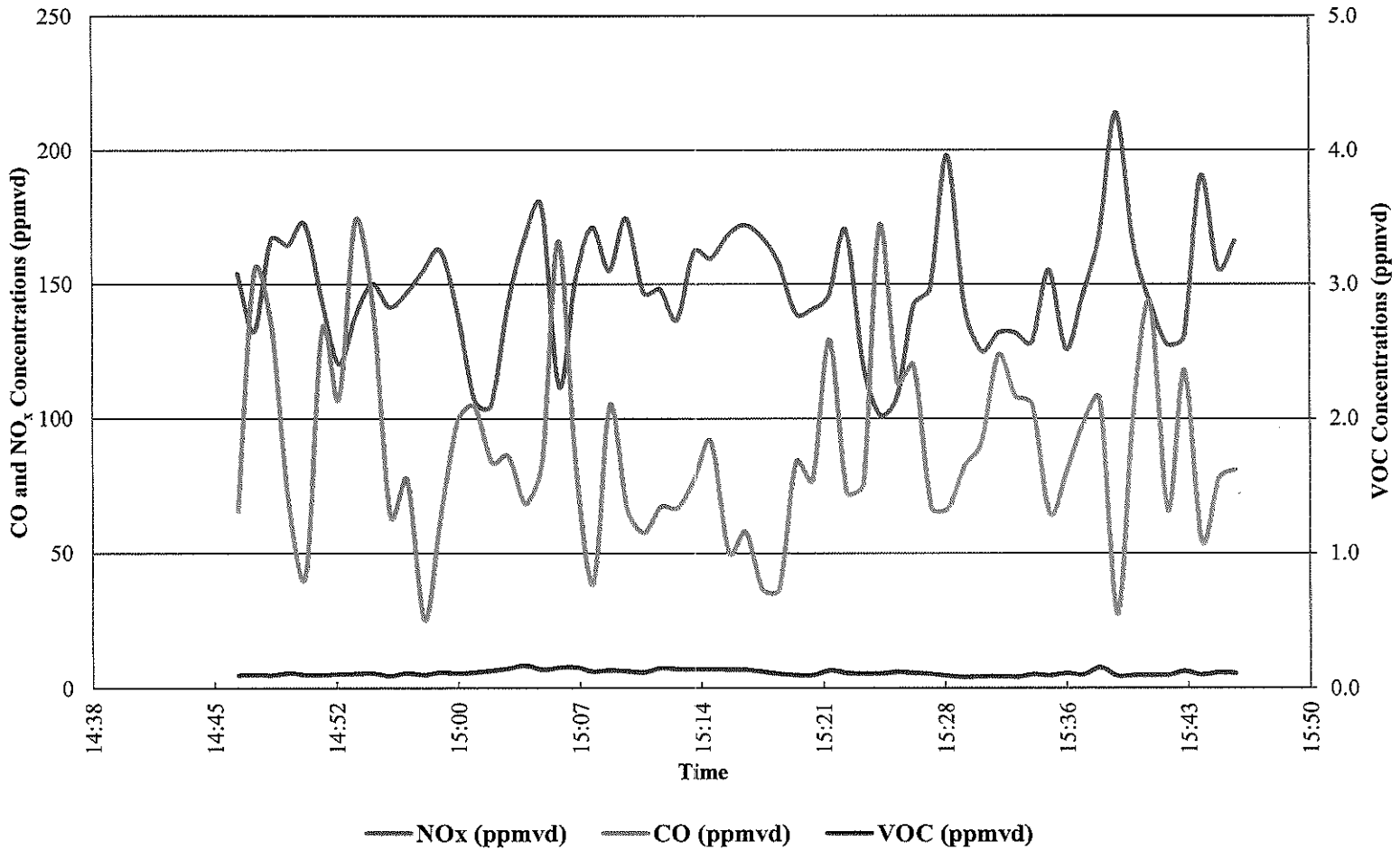
Wing B, B17 VOC, CO, and NOx Concentrations - Run 3
FCA US LLC Chrysler Technology Center
Auburn Hills, Michigan
Bureau Veritas Project No. 11016-000146.00
Sampling Date: September 2, 2016



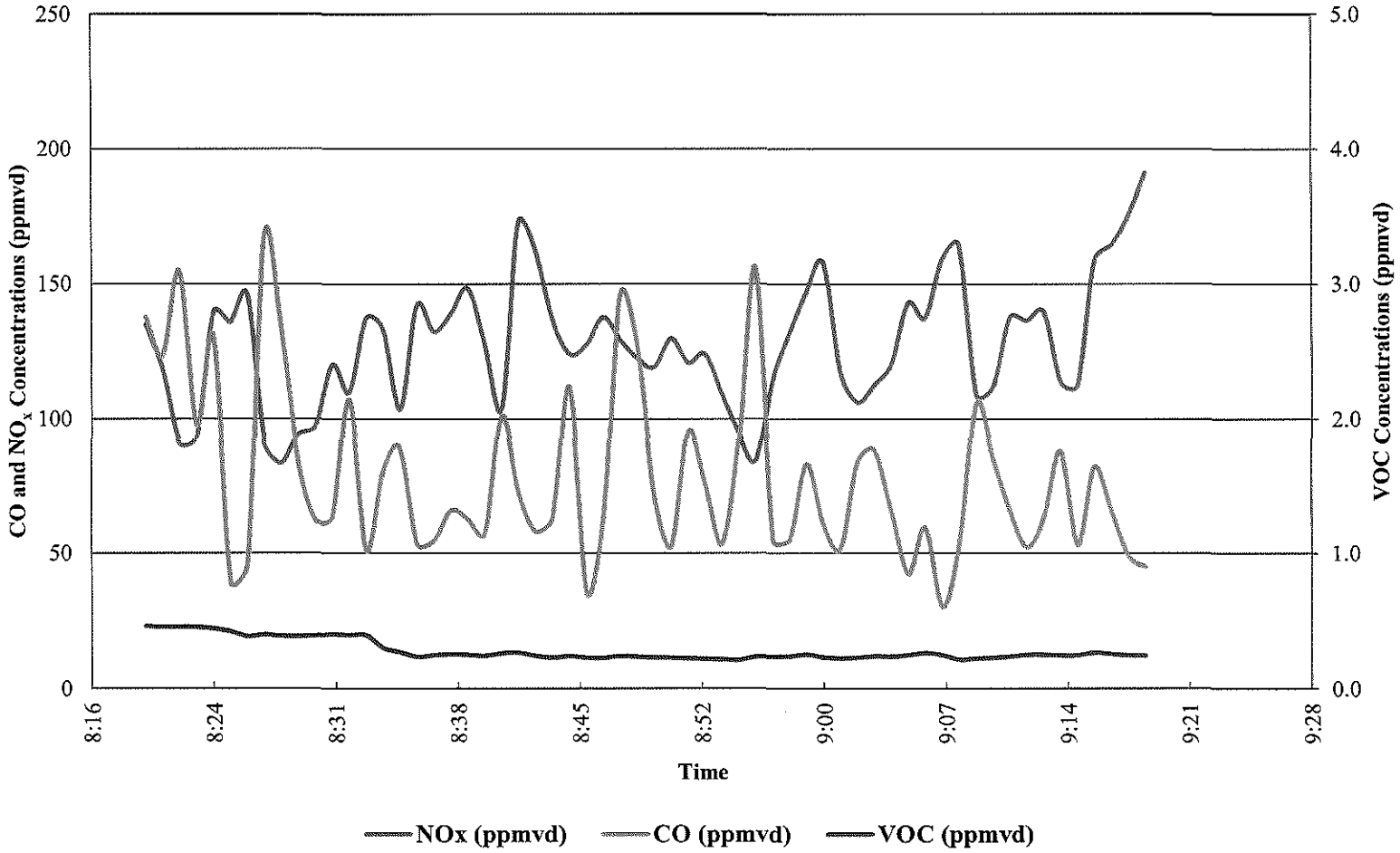
Wing C, 4.01 VOC, CO, and NOx Concentrations - Run 1
FCA US LLC Chrysler Technology Center
Auburn Hills, Michigan
Bureau Veritas Project No. 11016-000146.00
Sampling Date: August 31, 2016



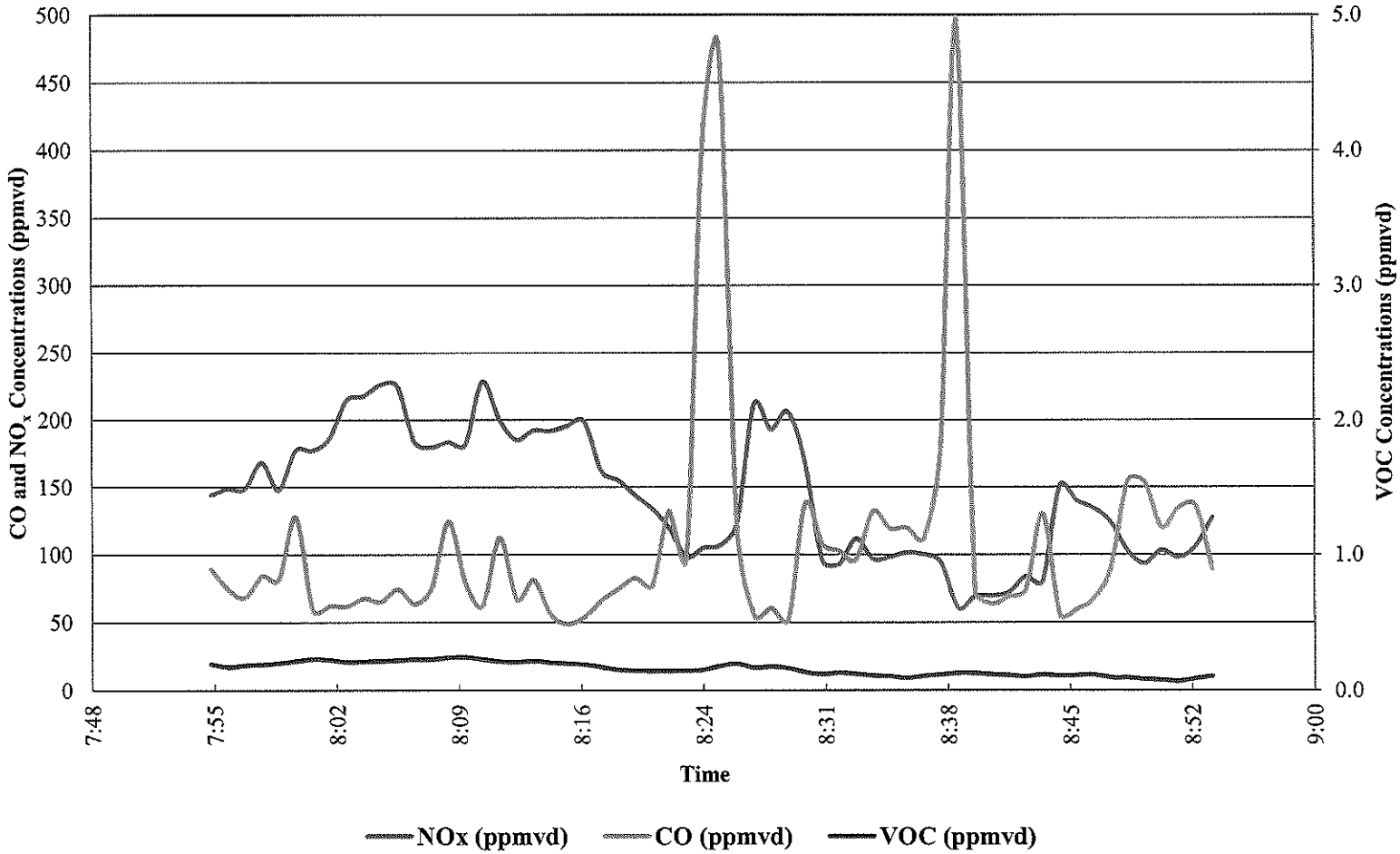
Wing C, 4.01 VOC, CO, and NOx Concentrations - Run 2
FCA US LLC Chrysler Technology Center
Auburn Hills, Michigan
Bureau Veritas Project No. 11016-000146.00
Sampling Date: August 31, 2016



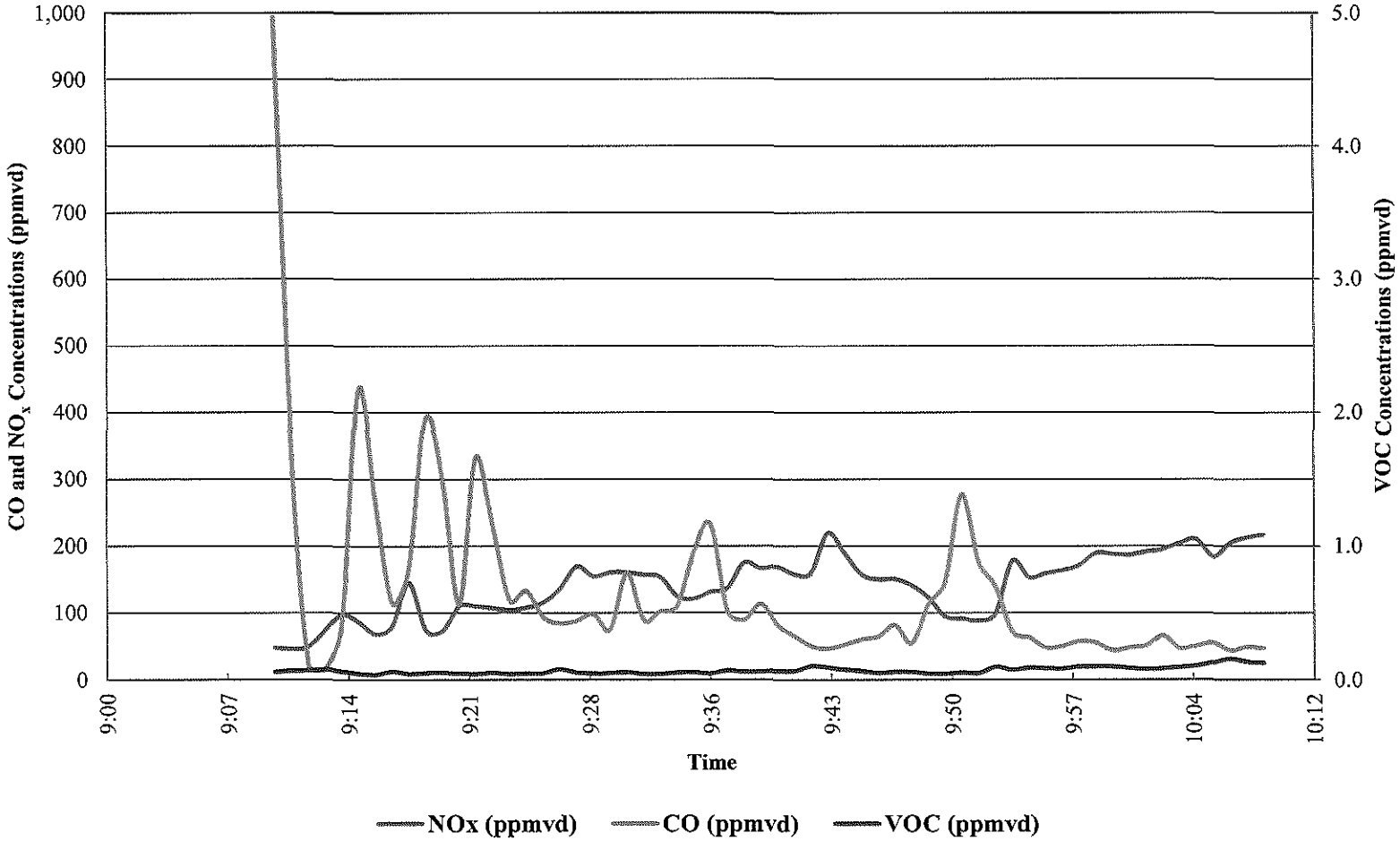
Wing C, 4.01 VOC, CO, and NOx Concentrations - Run 3
FCA US LLC Chrysler Technology Center
Auburn Hills, Michigan
Bureau Veritas Project No. 11016-000146.00
Sampling Date: September 1, 2016



Wing D, 4.01 VOC, CO, and NOx Concentrations - Run 4
FCA US LLC Chrysler Technology Center
Auburn Hills, Michigan
Bureau Veritas Project No. 11016-000146.00
Sampling Date: August 31, 2016



Wing D, 4.01 VOC, CO, and NOx Concentrations - Run 5
FCA US LLC Chrysler Technology Center
Auburn Hills, Michigan
Bureau Veritas Project No. 11016-000146.00
Sampling Date: August 31, 2016



Wing D, 4.01 VOC, CO, and NOx Concentrations - Run 6
FCA US LLC Chrysler Technology Center
Auburn Hills, Michigan
Bureau Veritas Project No. 11016-000146.00
Sampling Date: August 31, 2016