FINAL REPORT

FORD MOTOR COMPANY

DEARBORN, MICHIGAN

RESEARCH INNOVATION CENTER (RIC) DYNAMOMETERS: NOx, CO and VOC TESTING PROGRAM

RWDI #2205678

November 2, 2022

SUBMITTED TO

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EXECUTIVE SUMMARY

RWDI USA LLC (RWDI) was retained by Ford Motor Company (Ford) to complete the emission sampling program at the Research Innovation Center (RIC) Dynamometer located at 2101 W. Village Road, Dearborn, Michigan. RIC operates as a research facility with dynamometer rooms for the development and experimentation of new engine designs. The purpose of the emissions test was to conduct a compliance emissions test program for the development of emission factors from the 10 uncontrolled dynamometer test rooms. The exhaust from dynamometers located in Rooms 1 to 6 are noted as "South" exhaust and dynamometers located in Rooms 7 to 10 are noted as "North" exhaust.

This emissions testing program included the evaluation of oxides of nitrogen (NO_X), carbon monoxide (CO), and volatile organic compounds (VOC) (as Total Hydrocarbons (THC) and as Non-Methane Organic Compounds (NMOC)) at the outlet of the 6-test room bank of dynamometers ("South" exhaust) and the 4-test rooms bank of dynamometers ("North" exhaust). The testing program also provides emissions factors for use in emissions calculations. The test program was completed on September 7th, 2022.

Executive Table i: Emission Factor Data Summary "South" Exhaust – Rooms 1 to 6 & "North" Exhaust - Rooms 7 to 10

Parameter	Source	Units	Test 1 (Average)	Test 2 (Average)	Test 3 (Average)	Overall Average
NOx Emission Factor	South	lb/gal	0.19	0.25	0.22	0.22
	North		0.00	0.06	0.28	0.12
	Average		**0.095**	**0.16**	**0.25**	**0.17**
	South	lb/MMBTU	1.67	2.21	1.95	1.94
	North		0.00	0.53	2.53	1.02
	Average		**0.84**	**1.37**	**2.24**	**1.48**
CO Emission Factor	South	lb/gal	0.24	0.00	0.19	0.14
	North		0.05	0.05	0.25	0.12
	Average		**0.15**	**0.03**	**0.22**	**0.13**
	South	lb/MMBTU	2.15	0.00	1.66	1.27
	North		0.43	0.45	2.27	1.05
	Average		**1.29**	**0.23**	**1.97**	**1.16**
VOC (NMOC) (Emission Factor)	South	lb/gal	0.08	0.02	0.09	0.06
	North		0.02	0.02	0.09	0.04
	Average		**0.05**	**0.02**	**0.09**	**0.05**
	South	lb/MMBTU	0.71	0.18	0.79	0.56
	North		0.14	0.18	0.85	0.39
	Average		**0.43**	**0.18**	**0.82**	**0.48**

Executive Table ii: Summary of NOx Results

Parameter	South Exhaust Rooms 1 to 6 (average)	North Exhaust Rooms 7 to 10 (average)
Concentration (ppmvd)	6.76	3.83
Outlet Emission Rate (lb/hr)	0.27	0.17
Outlet Emission Factor (lb/gal)	0.22	0.12
Outlet Emission Factor (lb/MMBTU)	1.94	1.02

Executive Table iii: Summary of CO Results

Parameter	South Exhaust Rooms 1 to 6 (average)	North Exhaust Rooms 7 to 10 (average)
Concentration (ppmvd)	10.58	6.85
Outlet Emission Rate (lb/hr)	0.26	0.18
Outlet Emission Factor (lb/gal)	0.14	0.12
Outlet Emission Factor (lb/MMBTU)	1.27	1.05

Executive Table iv: Summary of NMOC Results

Parameter	South Exhaust Room 1 to 6 (average)	North Exhaust Rooms 7 to 10 (average)
Concentration (ppmvd)	2.71	1.64
Outlet Emission Rate (lb/hr)	0.10	0.07
Outlet Emission Factor (lb/gal)	0.06	0.04
Outlet Emission Factor (lb/MMBTU)	0.56	0.39

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1 INTRODUCTION

RWDI USA LLC (RWDI) was retained by Ford Motor Company (Ford) to complete the emission sampling program at the Research Innovation Center (RIC) Dynamometer located at 2101 W. Village Road, Dearborn, Michigan. RIC operates as a research facility with dynamometers for the development and experimentation of new engine designs. The purpose of the emissions test was to conduct a compliance emissions test program for the development of emission factors from the 10 uncontrolled dynamometer test rooms. The exhaust from dynamometers located in Rooms 1 to 6 are noted as "South" exhaust and dynamometers located in Rooms 7 to 10 are noted as "North" exhaust.

This emissions testing program included the evaluation of oxides of nitrogen (NO_X), carbon monoxide (CO), and volatile organic compounds (VOC) (as Total Hydrocarbons (THC) and as Non-Methane Organic Compounds (NMOC)) at the outlet of the 6-test room bank of dynamometers ("South" exhaust) and the 4-test rooms bank of dynamometers ("North" exhaust). The testing program also provides emissions factors for use in emissions calculations.

1.1 Location and Dates of Testing

The test program was completed on September 7th, 2022 at the Ford RIC facility.

1.2 Purpose of Testing

The emissions test program is required by Michigan Department of Environment, Great Lakes, and Energy (EGLE) permit number MI-ROP-B6230-2022.

1.3 Description of Source

Ford's Research Innovation Center (RIC) is located in Dearborn, Michigan.

RIC Dynamometer tests engines for experimental data and future development for use by Ford. Testing is performed in any of approximately 10 Dynamometer Test Rooms located in the Research Innovation Center Dynamometer wing. The dynamometers are un-controlled.

1.4 Personnel Involved in Testing

Table 1.4.1: Testing Personnel

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2 SUMMARY OF RESULTS

2.1 Operating Data

Operational data collected during the testing includes the number of engines operating, amount of fuel consumed, type of fuel, BTU value for overall fuel usage, and whether or not after treatment (catalytic converter) was installed on engine during testing of each dynamometer room during each test. This information can be found in **Appendix A**.

2.2 Applicable Permit Number

MI-ROP-B6230-2022.

3 SOURCE DESCRIPTION

3.1 Description of Process and Emission Control Equipment

RIC tests engines for vehicles manufactured by Ford. Testing is performed in any of 10 Dynamometer Test Rooms located in RIC facility. There are no controls equipment associated with the exhaust from the 10 Dynamometer Test Rooms.

3.2 Process Flow Sheet or Diagram

Each of the "South" and "North" exhausts consisted of one (1) sampling location. The figures can be found in the **Figure Section**.

3.3 Type and Quantity of Raw and Finished Materials

Test rooms are fueled by a combination of gasoline and diesel.

3.4 Normal Rated Capacity of Process

The facility has 10 test rooms. During each test, each room was monitored and included applicable process data. Ford worked with the engineering teams to have some of the test rooms operating during the testing, as these are experimental research engines, the rooms do not operate consistently due to the nature of the research being performed. Ford personnel recorded usage data and engine parameters per the attached example process data collection form included in the Source Testing Plan.

Process data is provided in **Appendix A**.

3.5 Process Instrumentation Monitored During the Test

Test rooms operate on an as needed basis. The engines used included a mixture of gasoline and diesel fuel. The rooms recorded the usage and a total for each fuel for each run.

4 SAMPLING AND ANALYTICAL PROCEDURES

The emission test program utilized the following test methods codified at Title 40, Part 60, Appendix A of the Code of Federal Regulations (40 CFR 60, Appendix A):

- **Method 1** – Sample and Velocity Traverses for Stationary Sources
- **Method 2** – Determination of Stack Gas Velocity and Volumetric Flowrate
- **Method 3A** – Determination of Molecular Weight of Dry Stack Gases (instrumental)
- **Method 4** – Determination of Moisture Content in Stack Gases
- **Method 7E** – Determination of Oxides of Nitrogen from Stationary Sources
- **Method 10** – Determination of Carbon Monoxide from Stationary Sources
- **Method 25A** – Determination of Total Gaseous Organic Concentrations using a Flame Ionization Analyzer

4.1 Stack Velocity, Temperature, and Volumetric Flow Rate

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 or digital 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 3A, "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". A schematic of the Method 1 to 4 sampling train is provided in **Figure Section**. Three (3) moisture tests were completed on each of the noted sources below:

- **"South" Exhaust** – Rooms 1 to 6
- **"North" Exhaust** – Rooms 7 to 10

4.2 Sampling for Carbon Monoxide (CO), Oxides of Nitrogen (NOx), Oxygen (O_2) and Carbon Dioxide (CO_2)

Three (3) 60-minute tests were performed on the outlet of "South" exhaust and "North" exhaust. CO and NOx concentrations were determined utilizing RWDI's continuous emissions monitoring (CEM) system following US EPA Method 7E and 10. O_2 and CO_2 were measured at each location continuously as per Method 3A. 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 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 was 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 was used to confirm that the analyzer did not drift greater than ±3% throughout a test run.

Zero and upscale calibration checks were conducted both before and after each test run in order to quantify measurement system calibration drift and sampling system bias. Upscale is either the mid- or high-range gas, whichever most closely approximates the flue gas level. During these checks, the calibration gases were introduced into the sampling system at the probe outlet so that the calibration gases were analyzed in the same manner as the flue gas samples.

A gas sample was continuously extracted from the stack and delivered to a series of gas analyzers, which measure the pollutant or diluent concentrations in the gas. The analyzers were calibrated on-site using EPA Protocol No. 1 certified calibration mixtures. The probe tips were equipped with a sintered stainless-steel 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 CEM system. The heated sample line was designed to maintain the gas temperature above 250°F in order to prevent condensation of stack gas moisture within the line.

Before entering the analyzers, the gas sample was pass directly into a refrigerated condenser, which cools the gas to approximately 35°F to remove the stack gas moisture. After passing through the condenser, the dry gas entered a Teflon-head diaphragm pump and a flow control panel, which delivered the gas in series to the NOx, O_2, CO_2 and CO analyzers. Each of these analyzers measured the respective gas concentrations on a dry volumetric basis.

A stratification check was taken for each location prior to testing using O_2. **Figure Section** contains an illustration of the USEPA Method 3A, 7E and 10 sampling train.

4.3 Volatile Organic Compounds

VOC and CH_4 concentrations were recorded at the outlet of each of the "South" and "North" exhausts for each test. The measurements were taken continuously following USEPA Method 25A on each outlet (using a non-methane/methane analyzer).

Each test consisted of three (3) 60-minute tests. Regular performance checks on the CEMS were carried out by zero and span calibration checks using USEPA Protocol calibration gases. These checks verified the ongoing precision of the monitor with time by introducing pollutant-free (zero) air followed by known calibration gas (span) into the monitor. The response of the monitor to pollutant-free air and the corresponding sensitivity to the span gases was reviewed frequently as an ongoing indication of analyzer performance.

Prior to testing, a 4-point analyzer calibration error check was conducted using USEPA protocol gases. The calibration error check was performed by introducing zero, low, mid, and high-level calibration gases up the heated line to the probe tip. The calibration error check was performed to confirm that the analyzer response is within ±5% of the certified calibration gas introduced. 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 check was used to confirm that the analyzer did not drift greater than ±3% throughout a test run.

Zero and mid gas calibration checks were conducted both before and after each test run to quantify measurement system calibration drift and sampling system bias. During these checks, the calibration gases were introduced into the sampling system at the probe tip so that the calibration gases were analyzed in the same manner as the flue gas samples.

A gas sample was continuously extracted from the stack and delivered to the gas analyzer, which measures the pollutant or diluent concentrations in the gas. The probe tip was equipped with a sintered stainless-steel filter for particulate removal or heated filter system. The end of the probe was connected to a heated Teflon sample line, which delivered the sample gases from the stack to the CEM system. The heated sample line was designed to maintain the gas temperature above 250°F in order to prevent condensation of stack gas moisture within the line.

To subtract methane from THC, the methane must be converted from methane as methane to methane as propane and then subtracted from the THC number. The methane response factor (RF) is used in the conversion and was determined each test by introducing a known methane concentration to the analyzer and dividing the methane channel response by the THC channel response. Dividing methane by the RF gives methane as propane and was then subtracted from the THC concentration.

A schematic of the USEPA Method 25A is provided in **Figures Section**.

Results were reported as THC and as Non-Methane Organic Compounds (NMOC).

4.4 Gas Dilution System

Calibration gas was mixed using an Environics 4040 Gas Dilution System. The mass flow controllers are factory calibrated using a primary flow standard traceable to the United States National Institute of Standards and Technology (NIST). Each flow controller utilizes an 11-point calibration table with linear interpolation, to increase accuracy and reduce flow controller nonlinearity. The calibration is done yearly, and the records are included in the Source Testing Report. A multi-point EPA Method 205 check was executed in the field prior to testing to ensure accurate gas-mixtures.

The gas dilution system consisting of calibrated orifices or mass flow controllers 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 were evaluated for accuracy in the field in accordance with US EPA Method 205 "*Verification of Gas Dilution Systems for Field Instrument Calibrations*". The gas divider dilutions were measured to evaluate that the responses are within ±2% of predicted values. In addition, a certified mid-level calibration gas within ±10% of one of the tested dilution gases was introduced into an analyzer to ensure the response of the gas calibration is within ±2% of gas divider dilution concentration

4.5 Description of Recovery and Analytical Procedures

There were no samples to recover during this test program. All testing used real time data from the analyzers.

4.6 Sampling Port Description

All sampling ports meet USEPA Method 1 locations and can be found in the **Figure Section**.

5 TEST RESULTS AND DISCUSSION

5.1 Detailed Results

Table 5.1.1: Emission Factor Data Summary "South" Exhaust – Rooms 1 to 6 & "North" Exhaust - Rooms 7 to 10

Parameter	Source	Units	Test 1 (Average)	Test 2 (Average)	Test 3 (Average)	Overall Average
NOx Emission Factor	South	lb/gal	0.19	0.25	0.22	0.22
	North		0.00	0.06	0.28	0.12
	Average		**0.095**	**0.16**	**0.25**	**0.17**
	South	lb/MMBTU	1.67	2.21	1.95	1.94
	North		0.00	0.53	2.53	1.02
	Average		**0.84**	**1.37**	**2.24**	**1.48**
CO Emission Factor	South	lb/gal	0.24	0.00	0.19	0.14
	North		0.05	0.05	0.25	0.12
	Average		**0.15**	**0.03**	**0.22**	**0.13**
	South	lb/MMBTU	2.15	0.00	1.66	1.27
	North		0.43	0.45	2.27	1.05
	Average		**1.29**	**0.23**	**1.97**	**1.16**
VOC (NMOC) (Emission Factor)	South	lb/gal	0.08	0.02	0.09	0.06
	North		0.02	0.02	0.09	0.04
	Average		**0.05**	**0.02**	**0.09**	**0.05**
	South	lb/MMBTU	0.71	0.18	0.79	0.56
	North		0.14	0.18	0.85	0.39
	Average		**0.43**	**0.18**	**0.82**	**0.48**

Table 5.1.2: Summary of NOx Results

Parameter	South Exhaust Rooms 1 to 6 (average)	North Exhaust Rooms 7 to 10 (average)
Concentration (ppmvd)	6.76	3.83
Outlet Emission Rate (lb/hr)	0.27	0.17
Outlet Emission Factor (lb/gal)	0.22	0.12
Outlet Emission Factor (lb/MMBTU)	1.94	1.02

Table 5.1.3: Summary of CO Results

Parameter	South Exhaust Rooms 1 to 6 (average)	North Exhaust Rooms 7 to 10 (average)
Concentration (ppmvd)	10.58	6.85
Outlet Emission Rate (lb/hr)	0.26	0.18
Outlet Emission Factor (lb/gal)	0.14	0.12
Outlet Emission Factor (lb/MMBTU)	1.27	1.05

Table 5.1.4: Summary of NMOC Results

Parameter	South Exhaust Room 1 to 6 (average)	North Exhaust Rooms 7 to 10 (average)
Concentration (ppmvd)	2.71	1.64
Outlet Emission Rate (lb/hr)	0.10	0.07
Outlet Emission Factor (lb/gal)	0.06	0.04
Outlet Emission Factor (lb/MMBTU)	0.56	0.39

5.2 Discussion of Results

The detailed results can be found in the following Graphs and Appendices:

- **Graphs 1 to 3 –** Summary of NOx, CO and VOC (THC , Methane and NMOC) Results for Rooms 1 to 6
- **Graphs 4 to 6 –** Summary of NOx, CO and VOC (THC , Methane and NMOC) Results for Rooms 7 to 10
- **Appendix B –** Summary of CO, NOx, VOC, O_2 and CO_2 Results
- **Appendix F –** Raw and Corrected Data for CEMS Results

5.3 Variations in Testing Procedures

There were no sampling variations.

5.4 Process Upset Conditions During Testing

There were normal process breaks during production.

5.5 Maintenance Performed in Last Three Months

There has been no maintenance in the last three months.

5.6 Re-Test

This was not a retest.

5.7 Audit Samples

This test did not require any audit samples.

5.8 Flows and Moisture

Flow and moisture determination data can be found in **Appendix C**.

5.9 Calibration Data

Calibration data can be found in **Appendix D**.

5.10 Process Data

Process data can be found in **Appendix A**.

5.11 Example Calculations

Example calculations can be found in **Appendix E**.

5.12 Laboratory Data

There was no laboratory data from this testing program.

TABLES

Tabel 1: South Exhaust Rooms 1 to 6 NOX, CO and VOC EMISSIONS TABLE

Source: Ford RIC South
RWDI Project #2205678

Parameter	1	2	3	Average
Date	7-Sep-22	7-Sep-22	7-Sep-22	--
Start Time:	8:15	10:00	12:10	--
Stop Time:	9:14	10:59	13:09	--
Duration (mins):	60	60	60	--
Stack Data				
Flow Rate (dscfm):	5,541	5,464	5,525	5,510
Flow Rate (dm^3/s):	2.62	2.58	2.61	2.60
Moisture:	0.017	0.024	0.016	0.019
Fuel Data				
Gallons Used:	1.730	0.280	1.870	1.293
Heat Content (Btu/hr):	194345.44	31349.86	210158.73	145284.68
CO Emission Data				
CO Concentration (ppm_d):	17.30	-0.01	14.44	10.58
CO Concentration (mg/m^3_d):	20.14	-0.01	16.81	12.31
CO Concentration (lb/hr_d):	0.42	0.00	0.35	0.26
CO Emission Rate (lb/mmbtu):	2.15	-0.01	1.66	1.27
CO Emission Rate (lb/gal):	0.24	0.00	0.19	0.14
NO_x Emission Data				
NO_x Concentration (ppm_d):	8.17	1.77	10.34	6.76
NO_x Concentration (mg/m^3):	15.61	3.38	19.77	12.92
NO_x Concentration (lb/hr):	0.32	0.07	0.41	0.27
NO_x Emission Rate (lb/mmbtu)	1.67	2.21	1.95	1.94
NO_x Emission Rate (lb/gal)	0.19	0.25	0.22	0.22
THC Emission Data				
THC Concentration (as propane) (ppm_w):	4.49	1.06	5.21	3.59
THC Concentration (as propane) (ppm_d):	4.56	1.09	5.30	3.65
THC Concentration (as propane) (mg/m^3_d):	8.37	1.99	9.71	6.69
THC Concentration (as propane) (lb/hr_d):	0.17	0.04	0.20	0.14
Methane Emission Data				
Methane Correction Factor	2.49	2.45	2.42	2.45
Methane Concentration (as methane) (ppm_w):	2.31	2.23	2.24	2.26
Methane Concentration (as methane) (ppm_d):	2.35	2.29	2.27	2.30
Methane Concentration (as propane) (ppm_w):	0.93	0.91	0.92	0.92
Methane Concentration (as propane) (ppm_d):	0.94	0.93	0.94	0.94
Methane Concentration (as propane) (mg/m^3):	1.73	1.71	1.72	1.72
Methane Concentration (as propane) (lb/hr):	0.04	0.04	0.04	0.04
NMOC Emission Data				
NMOC Concentration (as propane) (ppm_v):	3.62	0.15	4.36	2.71
NMOC Concentration (as propane) (lbs/hr):	0.14	0.01	0.17	0.10
NMOC Emission Rate (as propane) (lbs/mmbtu):	0.71	0.18	0.79	0.56
NMOC Emission Rate (as propane) (lbs/gal):	0.08	0.02	0.09	0.06

Note: "d" indicated based on dry conditions

Table 2: North Exhaust Rooms 7 to 10 NOx, CO and VOC EMISSIONS TABLE

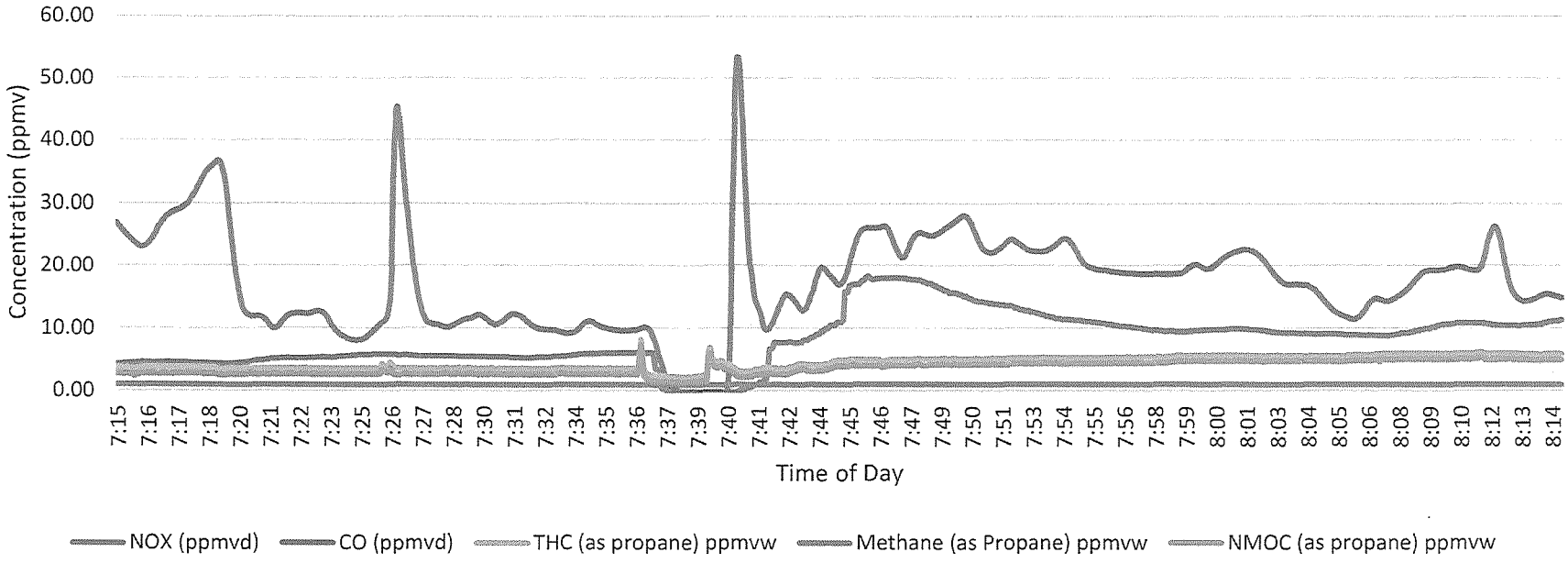
Source: Ford RIC North
RWDI Project #2205678

Parameter	1	2	3	Average
Date:	7-Sep-22	7-Sep-22	7-Sep-22	--
Start Time:	8:15	10:00	12:10	--
Stop Time:	9:14	10:59	13:09	--
Duration (mins):	60	60	60	--
Stack Data				
Flow Rate (dscfm):	6,285	6,105	6,143	6,178
Flow Rate (dm^3/s):	2.97	2.88	2.90	2.92
Moisture:	0.028	0.017	0.024	0.023
Fuel Data				
Gallons Used:	2.27	3.51	1.01	2.26
Heat Content (Btu/hr):	259726.90	407093.79	113183.68	260001.46
CO Emission Data				
CO Concentration (ppm_d):	4.04	6.90	9.61	6.85
CO Concentration (mg/m^3_d):	4.70	8.03	11.19	7.97
CO Concentration (lb/hr_d):	0.11	0.18	0.26	0.18
CO Emission Rate (lb/mmbtu):	0.43	0.45	2.27	1.05
CO Emission Rate (lb/gal):	0.05	0.05	0.25	0.12
NO_x Emission Data				
NO_x Concentration (ppm_d):	0.02	4.97	6.50	3.83
NO_x Concentration (mg/m^3):	0.04	9.50	12.43	7.32
NO_x Concentration (lb/hr):	0.00	0.22	0.29	0.17
NO_x Emission Rate (lb/mmbtu):	0.00	0.53	2.53	1.02
NO_x Emission Rate (lb/gal):	0.00	0.06	0.28	0.12
THC Emission Data				
THC Concentration (as propane) (ppm_w):	1.57	2.59	3.06	2.41
THC Concentration (as propane) (ppm_d):	1.62	2.63	3.14	2.46
THC Concentration (as propane) (mg/m^3_d):	2.97	4.82	5.75	4.51
THC Concentration (as propane) (lb/hr_d):	0.07	0.11	0.13	0.10
Methane Emission Data				
Methane Correction Factor:	2.51	2.52	2.53	2.5
Methane Concentration (as methane) (ppm_w):	1.89	2.08	2.13	2.0
Methane Concentration (as methane) (ppm_d):	1.94	2.11	2.19	2.1
Methane Concentration (as propane) (ppm_w):	0.75	0.82	0.84	0.8
Methane Concentration (as propane) (ppm_d):	0.77	0.84	0.86	0.8
Methane Concentration (as propane) (mg/m^3):	1.42	1.54	1.58	1.5
Methane Concentration (as propane) (lb/hr):	0.03	0.04	0.04	0.0
NMOC Emisson Data				
NMOC Concentration (as propane) (ppm_v):	0.84	1.79	2.27	1.64
NMOC Concentration (as propane) (lbs/hr):	0.04	0.08	0.10	0.07
NMOC Emission Rate (as propane) (lbs/mmbtu):	0.14	0.18	0.85	0.39
NMOC Emission Rate (as propane) (lbs/gal):	0.02	0.02	0.09	0.04

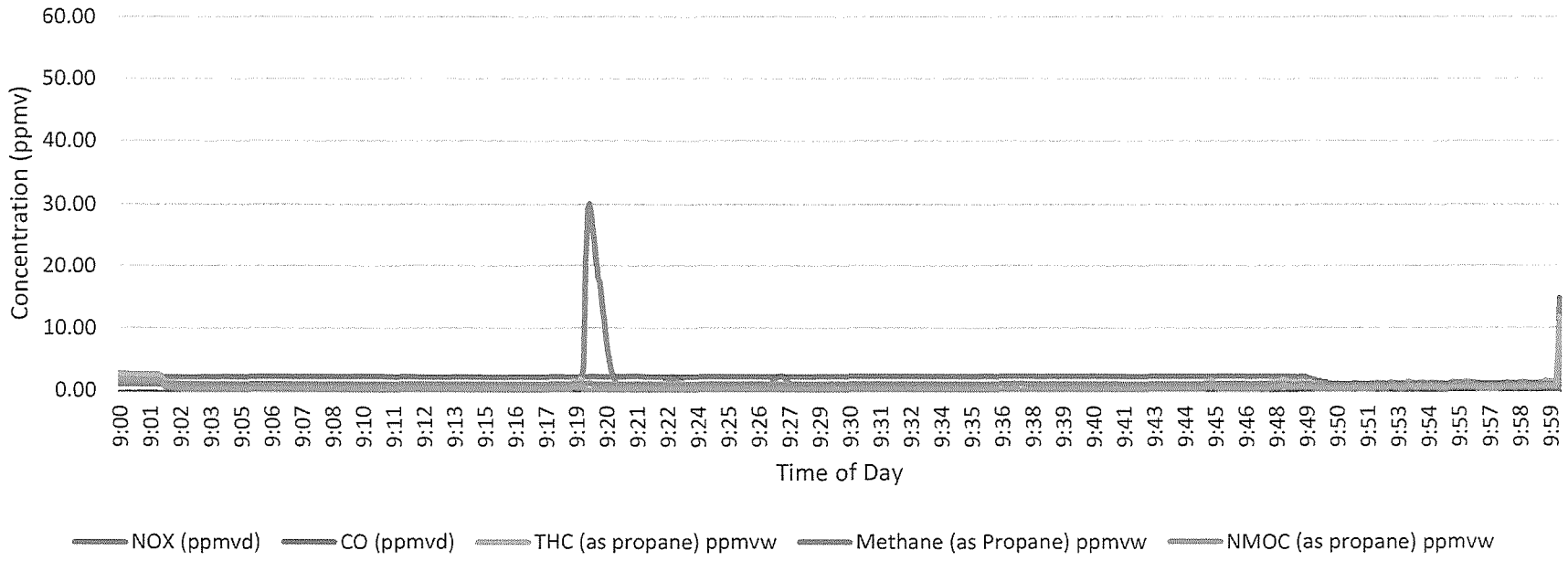
Note: "d" indicated based on dry conditions

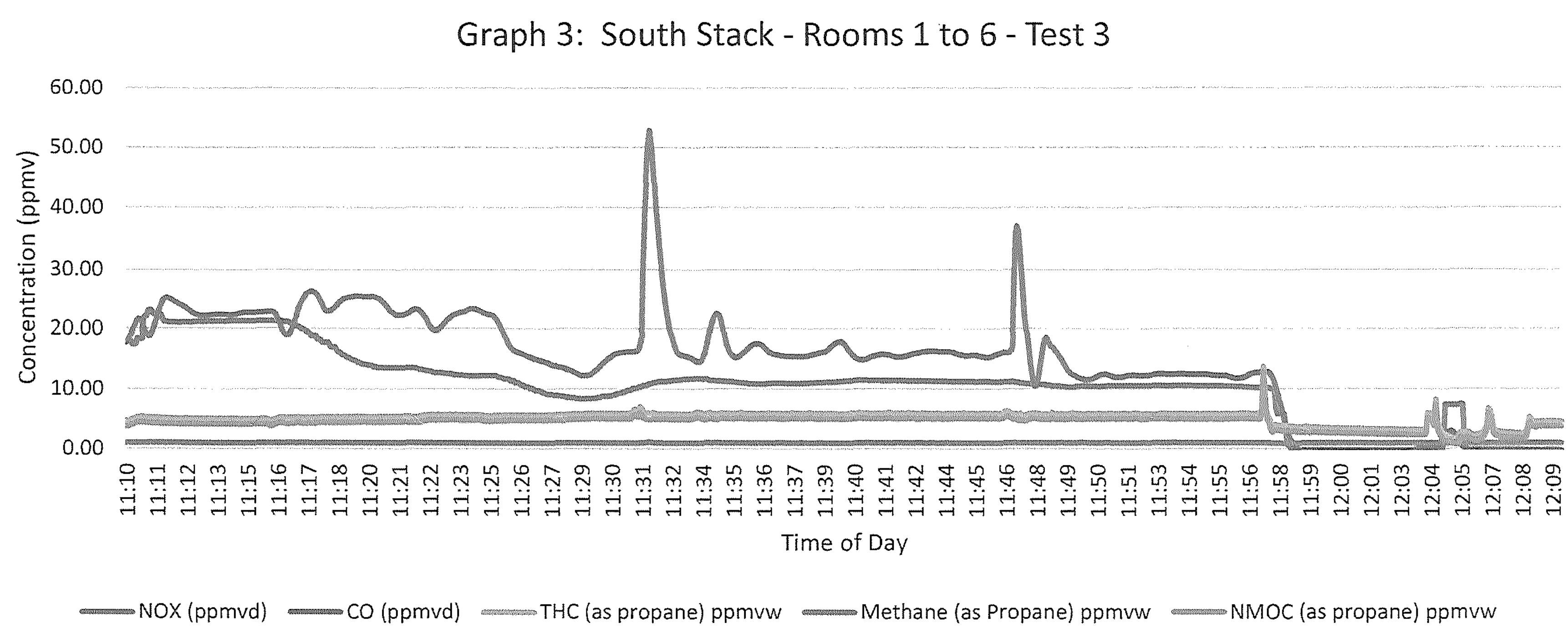
GRAPHS

Graph 1: South Stack - Rooms 1 to 6 - Test 1

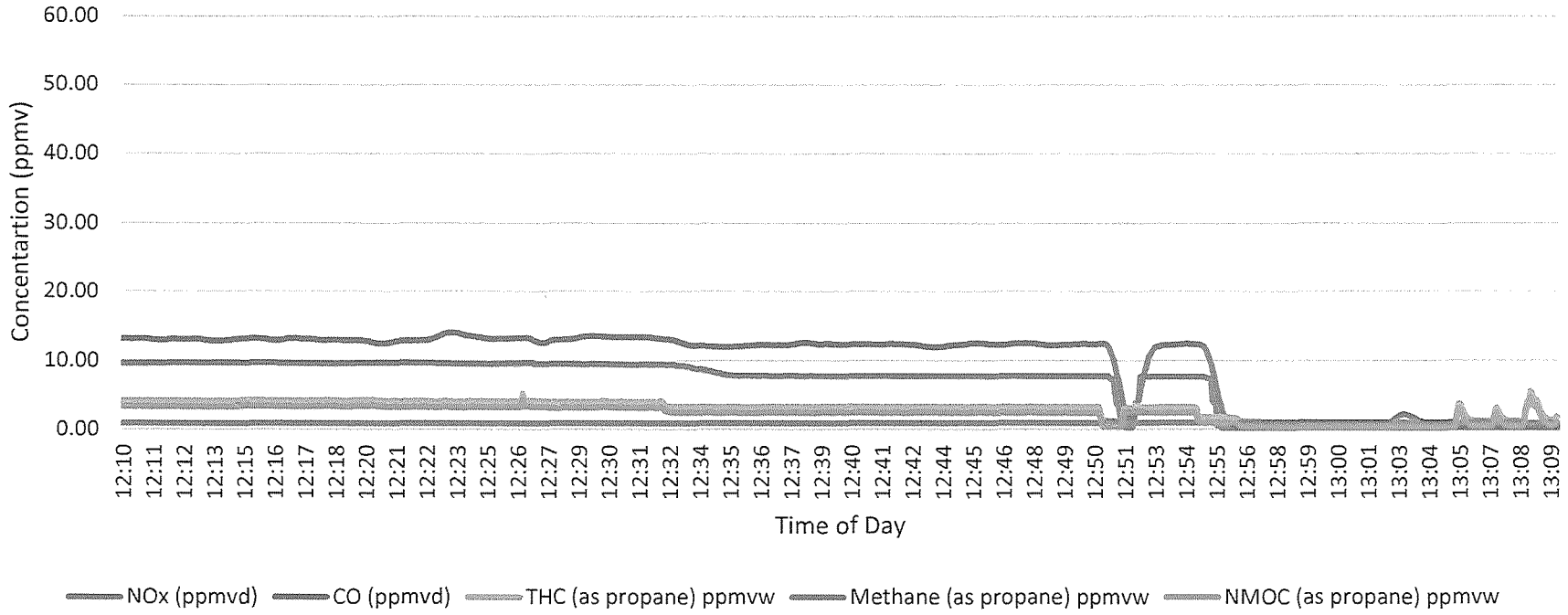


Graph 2: South Stack - Rooms 1 to 6 - Test 2





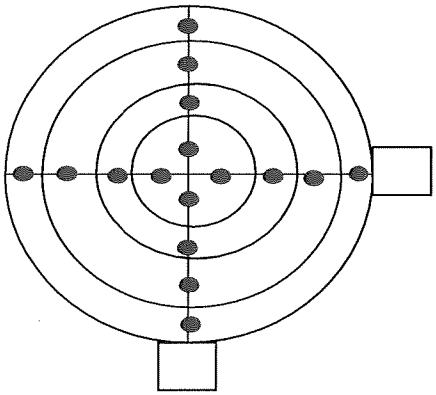
Graph 6: North Stack - Rooms 7 to 10 - Test 3



FIGURES

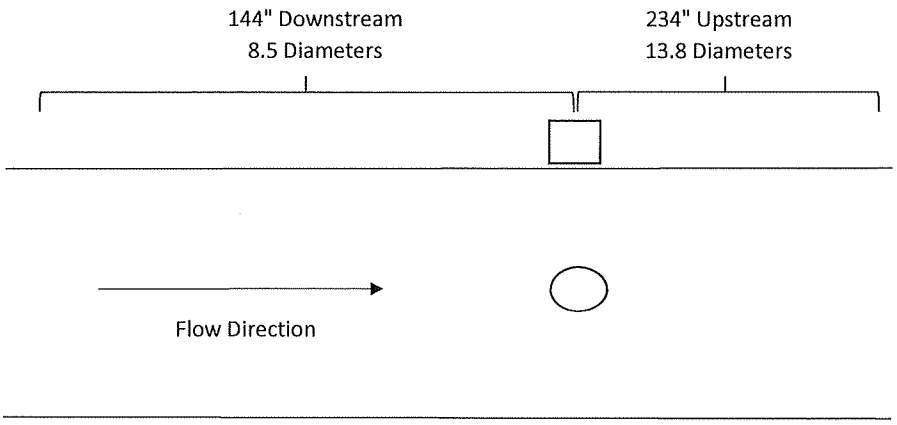
Figure No. 2: North Stack Traverse Points

Diameter: 17



Not to Scale

Sampling Points (in.)	
1	0.54
2	1.79
3	3.30
4	5.49
5	11.51
6	13.70
7	15.22
8	16.46

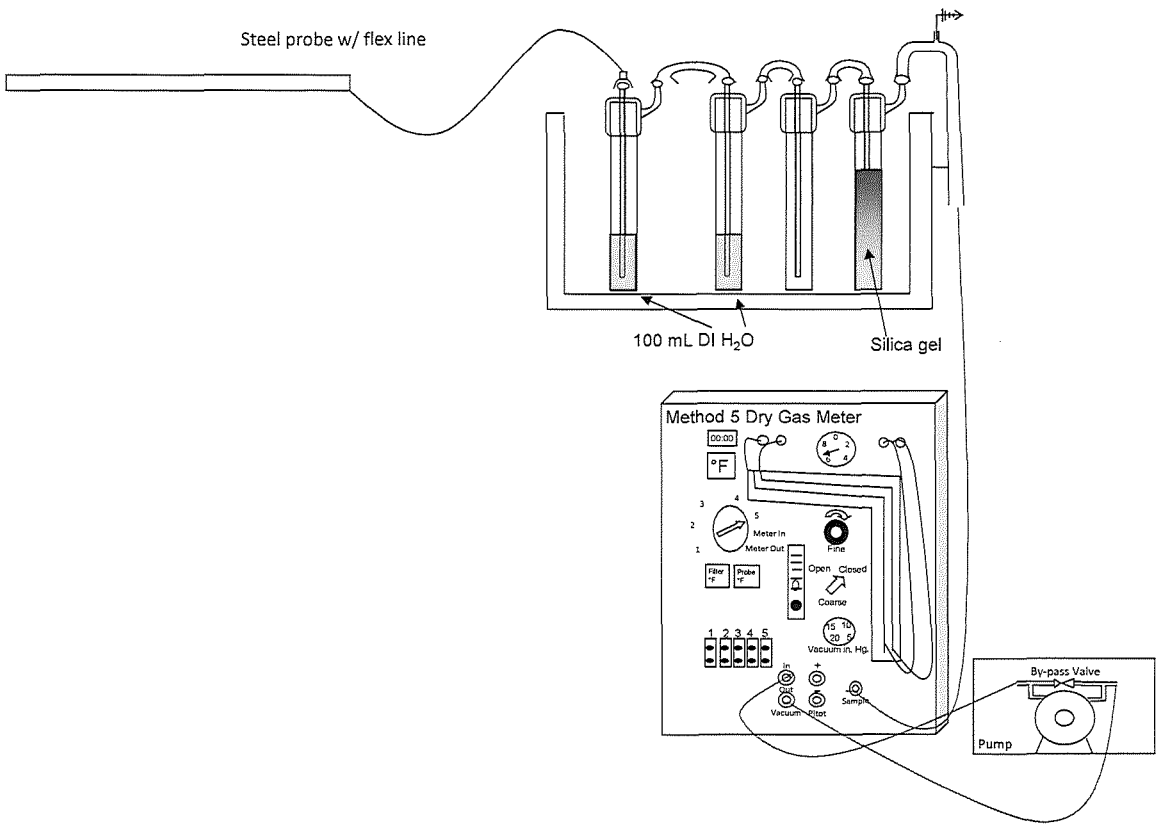


Dynamometer - North
Ford Motor Company
Research & Innovation Center
Dearborn, Michigan

Date:
September 7, 2022

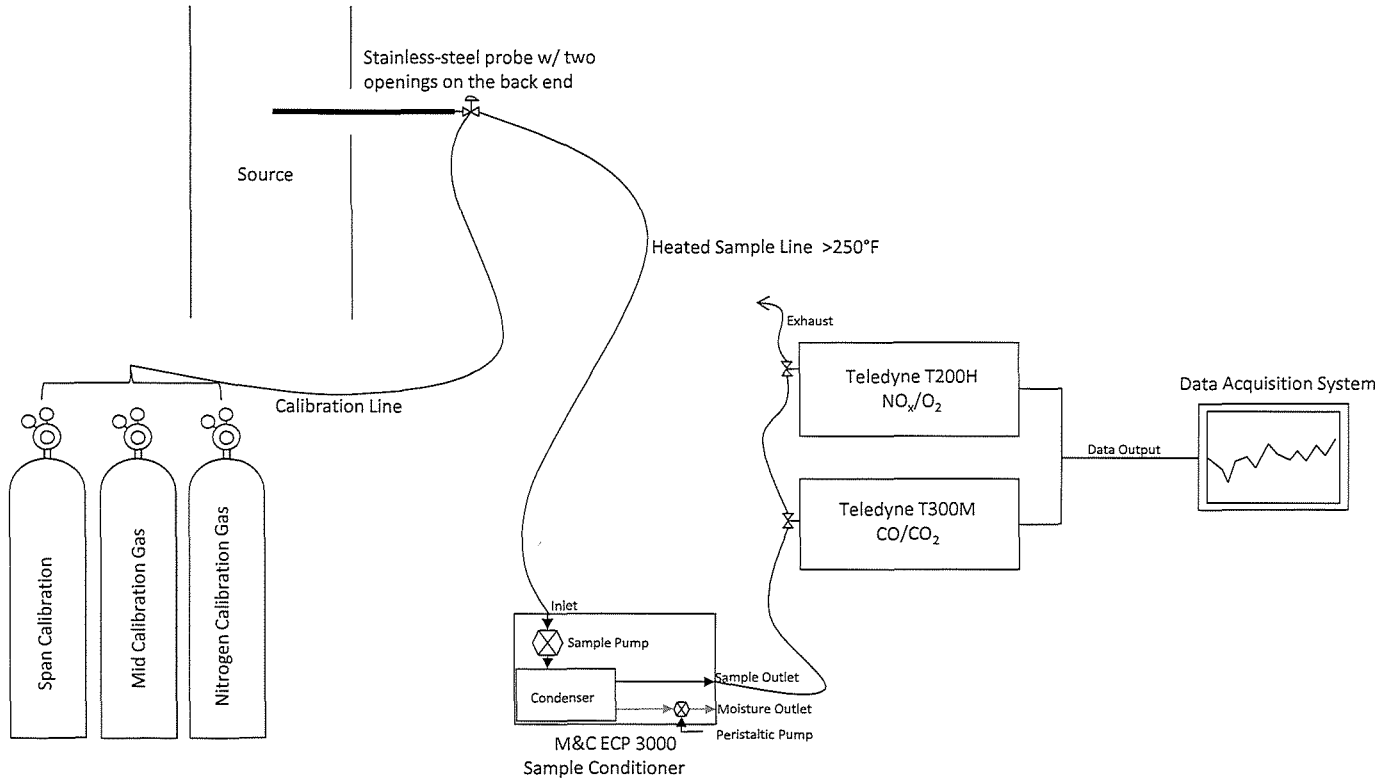
RWDI USA LLC
2239 Star Court
Rochester Hills, MI 48309

Figure No. 4: USEPA Method 4 Schematic



USEPA Method 4 **Ford Motor Company** Research & Innovation Center Dynamometer Cells 1-10 Dearborn, Michigan	Figure No. 4 **Date: September 7, 2022**	

Figure No. 5: USEPA Method 3A,7E,10 Schematic



USEPA Method 3A,7E,10

Ford Motor Company
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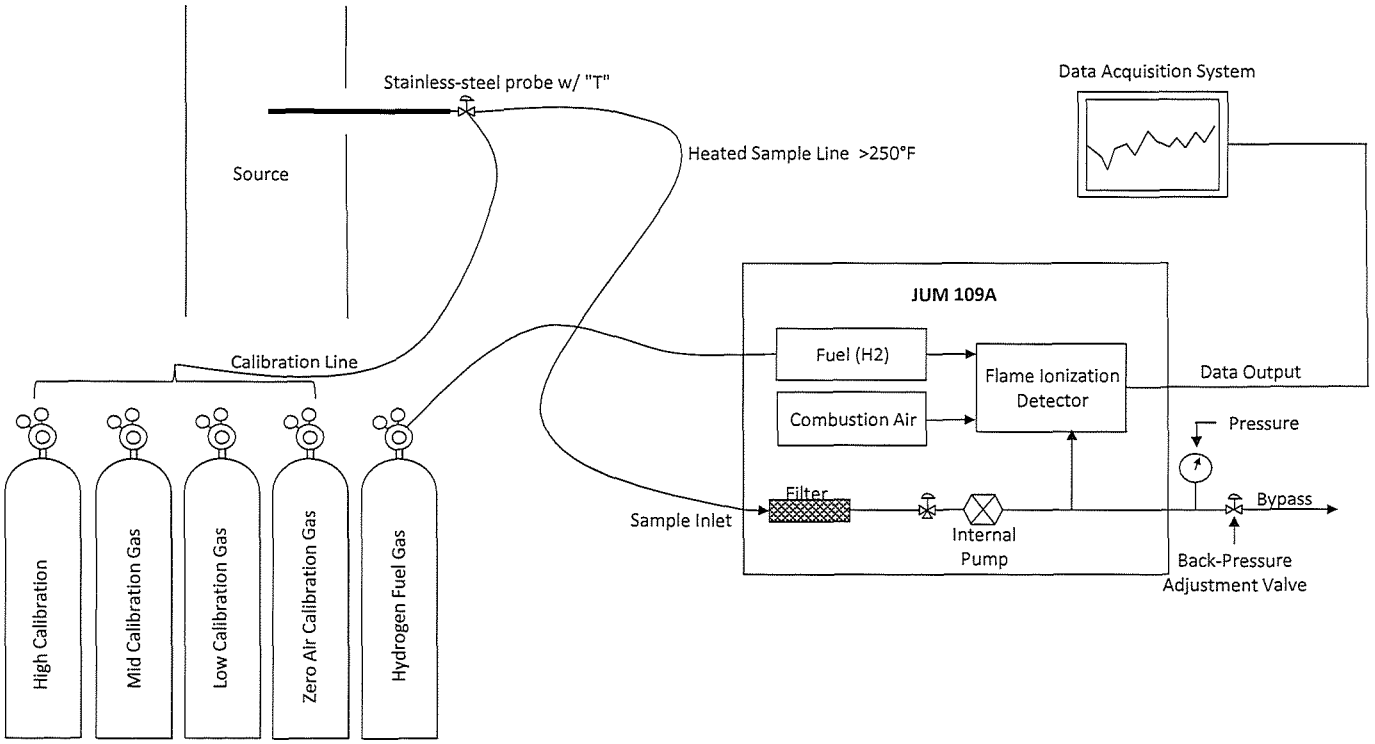
Dynamometer Cells 1-10
Dearborn, Michigan

Figure No. 5

Date: September 7, 2022

Figure No. 6: USEPA Method 25A Schematic



USEPA Method 25A

Ford Motor Company
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Dynamometers 1-10
Dearborn, Michigan

Figure No. 6

Date: September 7, 2022