FINAL REPORT

FORD MOTOR COMPANY

FLAT ROCK, MICHIGAN

FLAT ROCK ASSEMBLY PLANT (FRAP):
VOC DE TEST REPORT

RWDI #2403202

October 9, 2024

SUBMITTED TO

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EXECUTIVE SUMMARY

RWDI USA LLC (RWDI) has been retained by Ford Motor Company (Ford) to complete the emission sampling program at the Flat Rock Assembly Plant (FRAP) located at 1 International Drive, Flat Rock, Michigan. FRAP operates an automobile assembly plant that produces the Ford Mustang. The purpose of the emissions test program was to evaluate volatile organic compounds (VOC) destruction efficiency (DE) on three (3) regenerative catalytic oxidizers (RCOs) and a single thermal oxidizer (RTO) for compliance purposes. In addition, the weighted average of the three (3) outlets of the RCO (RCO A, B, and C) are required to be less than 5.0 ppmv.

The testing consisted of concurrent measurements at the RCO Inlet, RCO Outlets (A, B & C), RTO Inlet and RTO Outlet. The test program commenced on August 21, 2024 and was stopped due to a parts shortage at the facility after Test 1. The program re-commenced on September 3-4, 2024 and included three (3) additional tests. As requested by Mr. John Lamb of the State of Michigan Department of Environment, Great Lakes and Energy (EGLE) District Office, all four (4) tests are used in the compliance testing program.

Executive Table i: Table of Results

	RCO Destruction Efficiency	RTO Destruction Efficiency	RCO VOC Concentration (weighted average)	RCO Operating Temperature (ºF)	RTO Operating Temperature (ºF)	Production Rate (Veh./test)
Test 1 (August 21, 2024)	94.2%	95.3%	3.0 ppmv	RCO A 1096 ºF RCO B 1328 ºF RCO C 1048 ºF	1457 ºF	31 EN1 29 EN2 **60 Total**
Test 2 (September 3, 2024)	94.3%	90.0%	3.0 ppmv	RCO A 1096 ºF RCO B 1328 ºF RCO C 1057 ºF	1457 ºF	29 EN1 28 EN2 **57 Total**
Test 3 (September 4, 2024)	91.3%	92.0%	4.4 ppmv	RCO A 1094 ºF RCO B 1324 ºF RCO C 1049 ºF	1457 ºF	32 EN1 25 EN2 **57 Total**
Test 4 (September 4, 2024)	91.4%	90.0%	4.6 ppmv	RCO A 1097 ºF RCO B 1330 ºF RCO C 1048 ºF	1458 ºF	24 EN1 22 EN2 **46 Total**
Average	**92.8%**	**91.8%**	**3.8 ppmv**	**RCO A 1096 ºF** **RCO B 1328 ºF** **RCO C 1051 ºF**	**1457 ºF**	29 EN1 26 EN2 **55 Total**

TABLE OF CONTENTS

LIST OF TABLES (WITHIN REPORT)

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1 INTRODUCTION

RWDI USA LLC (RWDI) has been retained by Ford Motor Company (Ford) to complete the emission sampling program at the Flat Rock Assembly Plant (FRAP) located at 1 International Drive, Flat Rock, Michigan. FRAP operates an automobile assembly plant that produces the Ford Mustang. The testing evaluated volatile organic compound (VOC) concentrations and emission rates concurrently from the outlets of three (3) regenerative catalytic oxidizers (RCO), inlet to the RCOs and inlet and outlet of the regenerative thermal oxidizer (RTO). The overall results determined the outlet concentrations from each of the RCO outlets, destruction efficiency of the RTOs and the overall destruction efficiency of the entire RCO system.

1.1 Location and Dates of Testing

The test program was completed on August 21st, 2024, and September 3rd - 4th, 2024 at the Ford FRAP 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-N0929-2018A. A Both documents are provided in **Appendix F**.

1.3 Description of Source

Vehicle body panels are stamped and assembled on site from sheet metal components. The bodies are cleaned, treated, and prepared for painting in the pre-treatment system. Drawing compounds, mill oils, and dirt are removed from the vehicle bodies utilizing both high pressure spray and immersion cleaning/rinsing techniques. Vehicle bodies are then dip coated in electro deposition corrosion primer paint for protection. The electro primer (e-coat) is heat cured to the vehicle body in a high-temperature bake oven. After completing the e-coat operation, vehicle bodies are conveyed to the sealer area for application of various sealants to body seams and joints. Vehicle bodies are then conveyed to an oven to cure the sealers.

After the sealer oven, the vehicles are routed to one of the two identical 3-wet paint systems. In the booth, the vehicles are painted with primer, a color basecoat, and a protective clearcoat layer using automatic bells on robot spray applicators. The vehicles are then passed through an oven to cure the 3-wet applications. The 3-wet booths allow for paint application of one layer after the other without the intermediate drying stage.

The vehicle paint process includes the electrodeposition (ECoat), primer (guidecoat) , basecoat and clearcoat (topcoat) and vehicle sealing operations. The majority of the process emissions associated with these coating activities are oxidized at elevated temperatures by the RCO and RTO emission control equipment.

1.4 Personnel Involved in Testing

Table 1.4.1: Testing Personnel

Personnel	Company	Contact Number
Susan Hicks Environmental Engineer Shicks3@ford.com	**Ford Motor Company**	(313) 594-3185
Jaime Hayward Environmental Engineer jhayward3@ford.com	**Ford Motor Company**	(313) 805-9166
Jonathan Lamb EGLE Detroit District Office lambj@michigan.gov	**EGLE – Detroit District Office** **Air Quality Division**	(313) 348-2527
Amanda Battershell **EGLE TPU** Battershell1@michigan.gov	**EGLE – Technical Programs Unit** **Air Quality Division**	(517) 388-4706
Brad Bergeron Technical Director Brad.Bergeron@rwdi.com	**RWDI USA LLC** 24445 Forterra Drive Warren, MI 48089	(248) 234-3885
Steve Smith Project Manager Steve.Smith@rwdi.com		(734) 751-9701
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Michael Nummer Senior Field Technician Michael.Nummer@rwdi.com		(248) 841-8442
Ben Durham Senior Field Technician Ben.Durham@rwdi.com		
Hunter Griggs Field Technician Hunter.Griggs@rwdi.com		
Cade Smith Field Technician Cade.Smith@rwdi.com		
Kate Strang Field Technician Kate.Strang@rwdi.com		
Roy Zimmer Field Technician Roy.Zimmer@rwdi.com		
Shane Rabideau Field Technician Shane.Rabideau@rwdi.com		
Dave Trahan Senior Field Technician Dave.Trahan@rwdi.com		

2 SUMMARY OF RESULTS

2.1 Operating Data

Operational data collected during the testing includes the number of vehicles produced during each test. Process data is provided in **Appendix A**.

2.2 Applicable Permit Number

MI-ROP-N0929-2018A

3 SOURCE DESCRIPTION

3.1 Description of Process and Emission Control Equipment

FRAP operates three (3) RCOs and one RTO for emission control. See 1.3 for further description of the process.

3.2 Process Flow Sheet or Diagram

Each RCO and RTO controls VOC emissions from the painting process. This diagram can be found in **Figure Section**.

3.3 Type and Quantity of Raw and Finished Materials

The units associated with this process are EGECOAT, EGGUIDECOAT/EGTOPCOAT, and EGCOAT. These include body sealing agents, top/basecoat color paints, protective coatings, and electro deposition primer.

3.4 Normal Rated Capacity of Process

The plant was operating at normal production during the testing.

3.5 Process Instrumentation Monitored During the Test

The RCO and RTO temperature were monitored during the test. For the testing, the RCOs and RTO temperature average temperatures were as follows:

- RCO A – 1,096ºF, Setpoint 1,095ºF
- RCO B – 1,328ºF, Setpoint 1,320ºF
- RCO C – 1,051ºF, Setpoint 1,050ºF
- RTO – 1,457ºF, Setpoint 1,460ºF

4 SAMPLING AND ANALYTICAL PROCEDURES

4.1 Description of Sampling Train and Field Procedures

4.1.1 Sampling for Volatile Organic Compounds - USEPA Method 25A

VOC testing was performed simultaneously on the RCO inlet, each RCO outlet, RTO inlet and RTO outlet. A schematic of the sampling system is provided in **Figure Section**.

The measurements were taken continuously following the USEPA Method 25A on the inlet and outlet (using a non-methane/methane analyzer). As outlined in Method 25A, the measurement location was taken at the centroid of each source.

The compliance test consisted of a four (4) tests of at least 60-minutes from each unit at the preferred temperature. 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 checks were 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 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 the gas analyzer, 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 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 is designed to maintain the gas temperature above 250°F in order to prevent condensation of stack gas moisture within the line.

Each analyzer was able to monitor Total Hydrocarbon (as propane) and Methane concurrently for each test on each of RCO Inlet, RCO A Outlet, RCO B Outlet, RCO C Outlet, RTO Inlet and RTO Outlet. The response factor for Methane to Propane (for each system) was determined via obtaining the concurrent response to methane calibration standard as both methane and THC (as Propane). This response factor was applied to each for the methane results to determine the total methane on the outlets of sources as Propane. During each run for each source, the Total Hydrocarbon (as Propane) and the Methane (corrected to as Propane) was determined, and the methane response (as Propane) was subtracted from the Total Hydrocarbon (as Propane) value. This resulted in obtaining the Total Non-Methane Organic Compound (NMOC) values from each for the sources.

4.2 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.

4.3 Sampling Port Description

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

5 TEST RESULTS AND DISCUSSION

5.1 Detailed Results

Detailed results are provided in **Appendices B** and **C**.

Table 5.1.1: Table of Results

	RCO Destruction Efficiency	RTO Destruction Efficiency	RCO VOC Concentration (weighted average)	RCO Operating Temperature (ºF)	RTO Operating Temperature (ºF)	Production Rate (Veh./test)
Test 1 (August 21, 2024)	94.2%	95.3%	3.0 ppmv	RCO A 1096 ºF RCO B 1328 ºF RCO C 1048 ºF	1457 ºF	31 EN1 29 EN2 **60 Total**
Test 2 (September 3, 2024)	94.3%	90.0%	3.0 ppmv	RCO A 1096 ºF RCO B 1328 ºF RCO C 1057 ºF	1457 ºF	29 EN1 28 EN2 **57 Total**
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Average	**92.8%**	**91.8%**	**3.8 ppmv**	**RCO A 1096 ºF** **RCO B 1328 ºF** **RCO C 1051 ºF**	**1457 ºF**	29 EN1 26 EN2 **55 Total**

5.2 Discussion of Results

Each of the RCO outlets were determined to have less than 5.0 ppmv as the in-stack concentration. The weighted average of RCO outlets was determined to be an average of 3.8 ppmv. The following equation was used to determine weighted average for Test 3 on September 4, 2024, as an example:

Weighted Average of RCO Outlets: = (RCO A ppmv x (RCO A flow rate/RCO Total flow rate) + (RCO B ppmv x (RCO B flow rate / RCO Total flow rate) + (RCO C ppmv x (RCO C flow rate / RCO Total flow rate)

Weighted Average of RCO Outlets: = (6.0 ppmv x (124,792 scfm/ 386,716 scfm) + (3.1 ppmv x (118,800 scfm / 386,716 scfm) + (3.1ppmv x (143,124 scfm/ 386,716scfm)

Weighted Average of RCO Outlets: = 4.4 ppmv

The entire system destruction efficiency was determined to be 92.8% which consisted of the following calculations example for Test 1 on August 21st, 2024:

System Destruction Efficiency = 1 – (RCO A (lb/hr) + RCO B (lb/hr) + RCO C (lb/hr)) / (RCO Inlet (lb/hr) + RTO Inlet (lb/hr))

System Destruction Efficiency = 1 – (4.0 lb/hr + 2.2 lb/hr + 2.2 lb/hr) / (125.4 lb/hr + 20.4 lb/hr)

System Destruction Efficiency = 94.2%

The RTO destruction efficiency was determined to be 91.8% which consisted of the following calculations example for Test 2 (September 3rd, 2024):

RTO Destruction Efficiency = 1 – (RTO outlet lb/hr) / (RTO Inlet lb/hr)

RTO Destruction Efficiency = 1 – (1.8 lb/hr) / (17.9 lb/hr)

RTO Destruction Efficiency = 90.0%

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. The original program commenced on August 21st, 2024. After Test 1, the Plant provided notification that production could no longer occur due to critical parts shortage. This issues was discussed with EGLE on-site during the original testing. The testing resumed September 3rd and 4th, 2024 with an additional three (3) tests completed. As discussed with Jonathan Lamb (EGLE – Detroit District Office) all four (4) tests (August 21st, 2024 single test and three (3) from September 3rd and 4th, 2024) and included in the report.

5.5 Maintenance Performed in Last Three Months

There was no maintenance performed outside of normal operations.

5.6 Re-Test

This was not a retest.

5.7 Audit Samples

This test did not require any audit samples.

5.8 Process Data

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

5.9 Continuous Emission Data

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

5.10 Flows and Moisture

Flow rate determination spreadsheets can be found in **Appendix C**.

5.11 Calibration Data

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

5.12 Example Calculations

Example calculation sheets can be found in **Appendix E**.

5.13 Source Testing Plan

Copy of Source Testing Plan and EGLE approval letter can be found in **Appendix F**.

5.14 Laboratory Data

There was no laboratory data from this testing program.

TABLES

Table 1: Summary of Results
Ford FRAP VOC DE

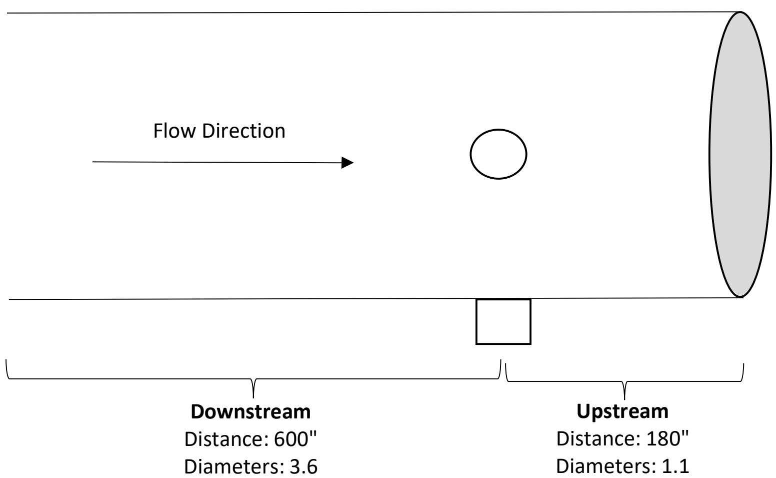
	Test 1	Test 2	Test 3	Test 4	Average
Date	21-Aug	3-Sep	4-Sep	4-Sep	--
Time	13:00-13:59	12:40-14:25	7:20-8:19	9:20-10:19	--
RCO Inlet Flowrate (scfm)	344,197	367,366	362,951	373,448	361,991
RCO A Outlet Flowrate (scfm)	131,030	119,975	124,792	117,675	123,368
RCO B Outlet Flowrate (scfm)	113,860	115,267	118,800	116,847	116,194
RCO C Outlet Flowrate (scfm)	160,262	132,914	143,124	128,813	141,278
RTO Inlet Flowrate (scfm)	25,183	24,784	24,101	24,241	24,577
RTO Outlet Flowrate (scfm)	26,903	27,000	27,209	27,469	27,145
RCO Inlet propane ppm	62.9	45.3	42.9	51.0	50.5
RCO Inlet methane ppm	22.2	1.94	2.91	2.66	7.43
RCO Inlet Response Factor	2.35	2.46	2.40	2.36	2.39
RCO Inlet Propane-methane ppm	53.4	44.5	41.7	49.9	47.4
RCO Inlet propane lb/hr	125.8	111.8	103.5	127.4	117.1
RCO A Outlet propane ppm	50.7	65.6	68.7	72.0	64.3
RCO A Outlet methane ppm	105.5	130.9	133.3	138.7	127.1
RCO A Outlet Response Factor	2.28	2.10	2.16	2.22	2.19
RCO A Outlet Propane-methane ppm	4.5	3.1	7.1	9.4	6.0
RCO A Outlet propane lb/hr	4.0	2.5	6.0	7.6	5.0
RCO B Outlet propane ppm	12.1	10.4	10.9	11.5	11.2
RCO B Outlet methane ppm	21.0	17.8	18.6	18.9	19.1
RCO B Outlet Response Factor	2.28	2.40	2.39	2.32	2.35
RCO B Outlet Propane-methane ppm	2.9	3.0	3.1	3.3	3.1
RCO B Outlet propane lb/hr	2.2	2.4	2.6	2.6	2.5
RCO C Outlet propane ppm	31.2	30.8	32.9	33.4	32.1
RCO C Outlet methane ppm	63.2	67.5	73.0	74.3	69.5
RCO C Outlet Response Factor	2.16	2.42	2.46	2.32	2.34
RCO C Outlet Propane-methane ppm	1.9	3.0	3.1	1.3	2.3
RCO C Outlet propane lb/hr	2.2	2.4	2.5	2.3	2.4
RTO Inlet propane ppm	120.8	107.9	142.3	109.3	120.1
RTO Inlet methane ppm	6.3	6.1	7.1	7.0	6.6
RTO Inlet Response Factor	2.34	2.57	2.28	2.28	2.37
RTO Inlet Propane-methane ppm	118.1	104.9	139.2	106.3	117.1
RTO Inlet propane lb/hr	20.4	17.9	23.0	17.7	19.7
RTO Outlet propane ppm	5.2	9.7	9.9	9.4	8.5
RTO Outlet methane ppm	0.00	0.0	0.0	0.0	0.0
RTO Outlet Response Factor	2.28	2.71	2.55	2.50	2.51
RTO Outlet Propane-methane ppm	5.2	9.7	9.9	9.4	8.5
RTO Outlet propane lb/hr	1.0	1.8	1.8	1.8	1.6
RCO DE	94.2%	94.3%	91.3%	91.4%	92.8%
RTO DE	95.3%	90.0%	92.0%	90.0%	91.8%
Flow Weighted Average RCO Outlets propane ppm	3.0	3.0	4.4	4.6	3.8

**RCO DE =1 -(RCOA + RCOB + RCOC))/(RCOIn + RTOIn)

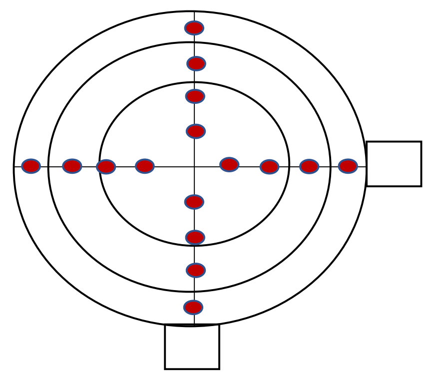
FIGURES

Figure No. 1: RCO Inlet Traverse Points

Diameter (in.): 168



Sampling Points (in.)	
1	5.4
2	17.6
3	32.6
4	54.3
5	113.7
6	135.4
7	150.4
8	162.6



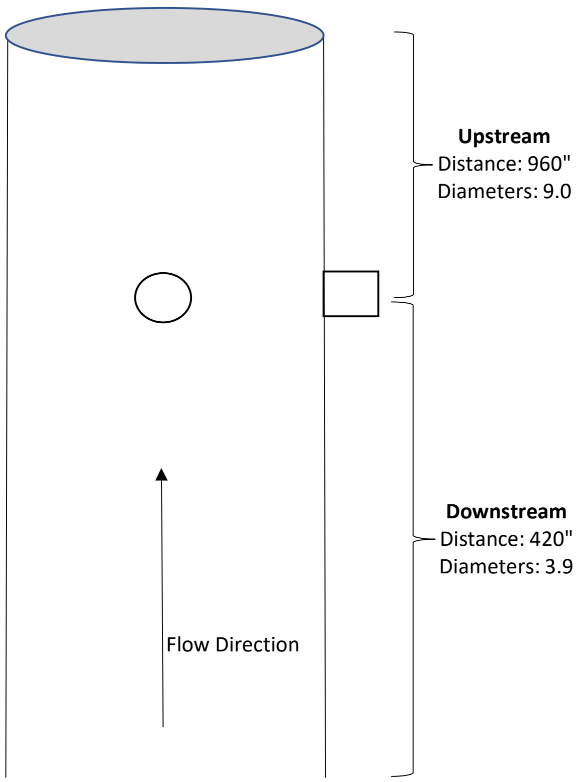
Not to Scale

RCO Inlet
Ford Motor Company
Flat Rock Assembly Plant
Flat Rock, Michigan

Date:
8/21/2024, 9/3-4/2024

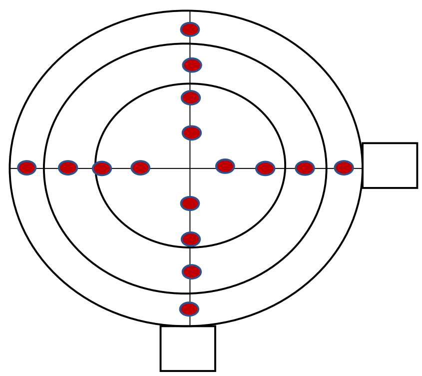
RWDI USA LLC
24445 Forterra Drive
Warren, MI 48089

Figure No. 2: RCO Outlets (A, B, C) Traverse Points



Diameter (in.): 107

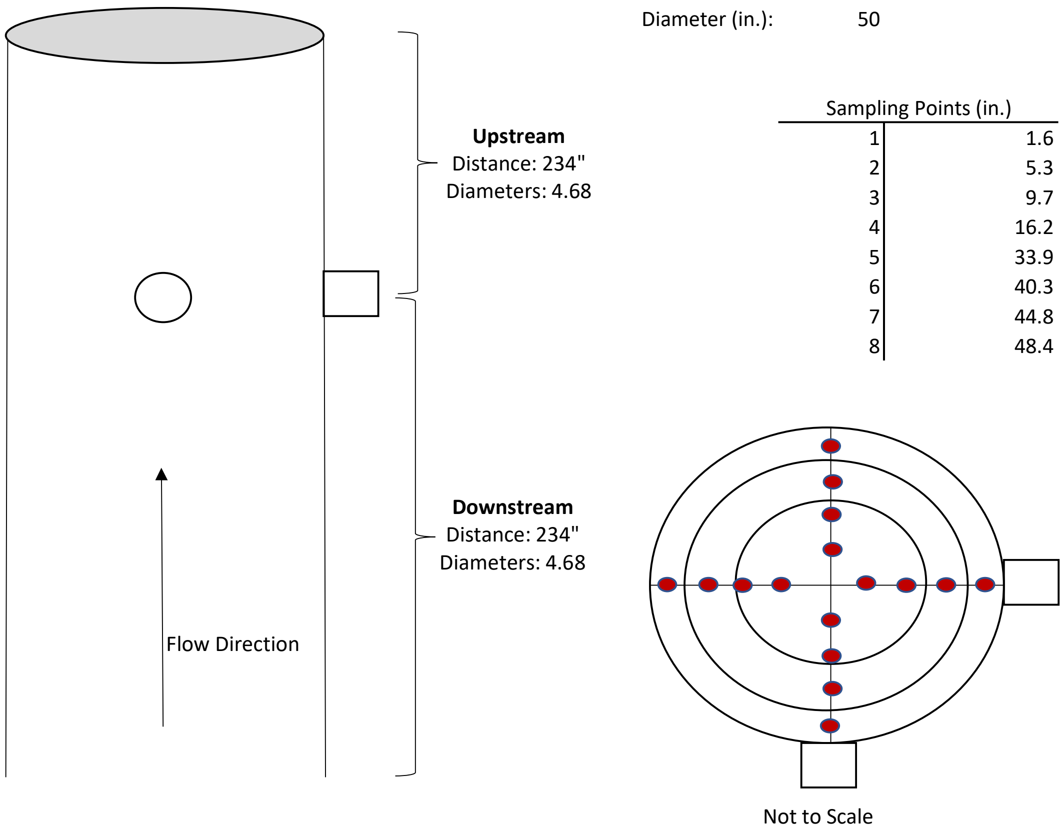
Sampling Points (in.)	
1	3.4
2	11.2
3	20.8
4	34.6
5	72.4
6	86.2
7	95.8
8	103.6



Not to Scale

RCO Outlet A,B,C	**Date:**	**RWDI USA LLC**
Ford Motor Company	8/21/2024, 9/3-4/2024	24445 Forterra Drive
Flat Rock Assembly Plant		warren, MI 48089
Flat Rock, Michigan		

Figure No. 3: RTO Inlet Traverse Points



Diameter (in.): 50

Sampling Points (in.)	
1	1.6
2	5.3
3	9.7
4	16.2
5	33.9
6	40.3
7	44.8
8	48.4

RTO Inlet
Ford Motor Company
Flat Rock Assembly Plant
Flat Rock, Michigan

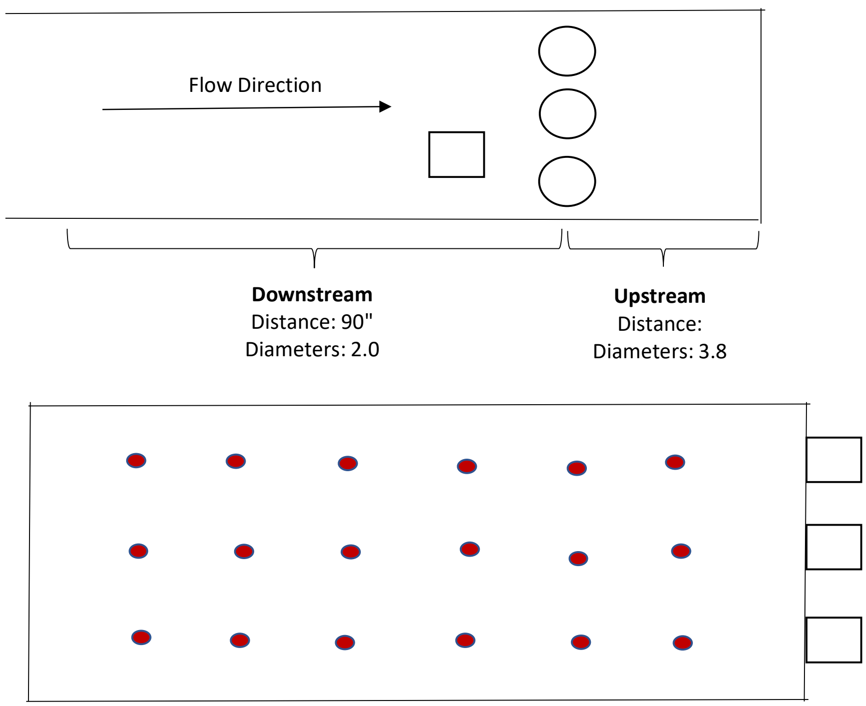
Date:
8/21/2024, 9/3-4/2024

RWDI USA LLC
24445 Forterra Drive
Warren, MI 48089

Figure No. 4: RTO Outlet Traverse Points

Diameter (in.): 46 x42

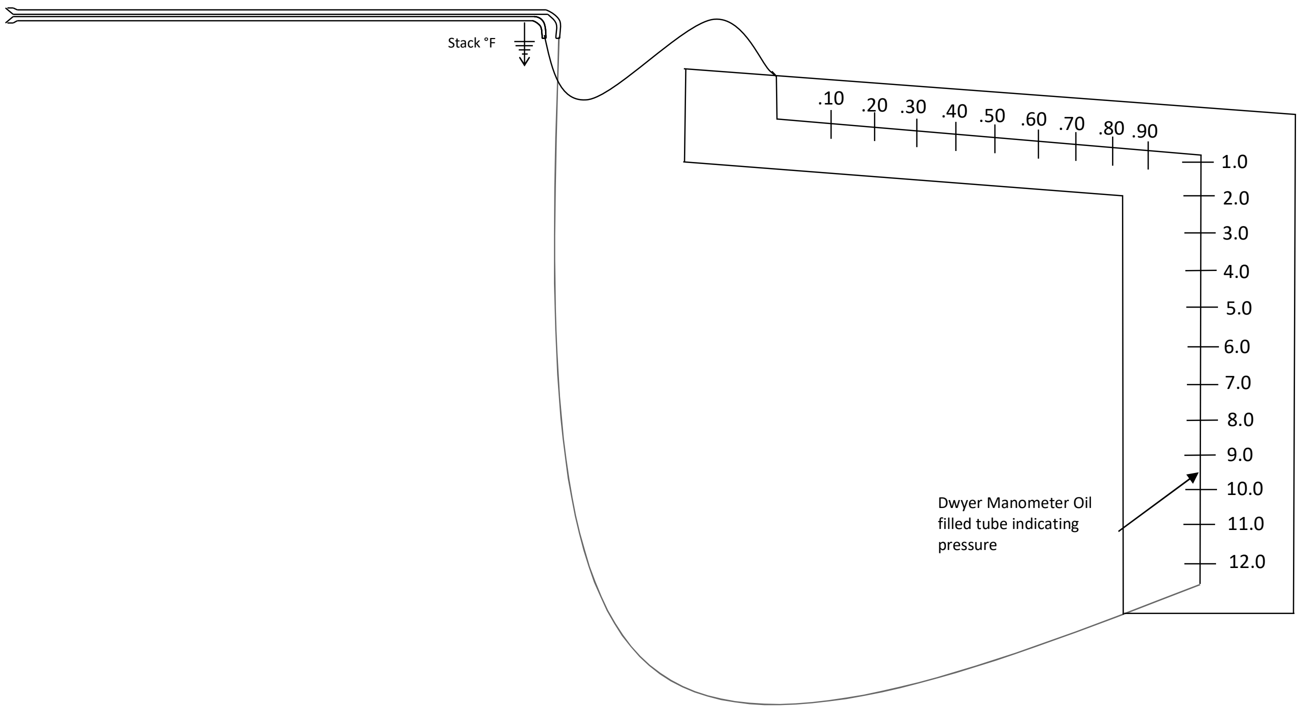
Sampling Points (in.)	
1	3.8
2	11.5
3	19.2
4	26.8
5	34.5
6	42.2



Not to Scale

RTO Outlet	**Date:**	**RWDI USA LLC**
Ford Motor Company	8/21/2024, 9/3-4/2024	24445 Forterra Drive
Flat Rock Assembly Plant		Warren, MI 48089
Flat Rock, Michigan		

Figure No. 5: USEPA Method 2 Schematic



USEPA Method 2

Ford Motor Company

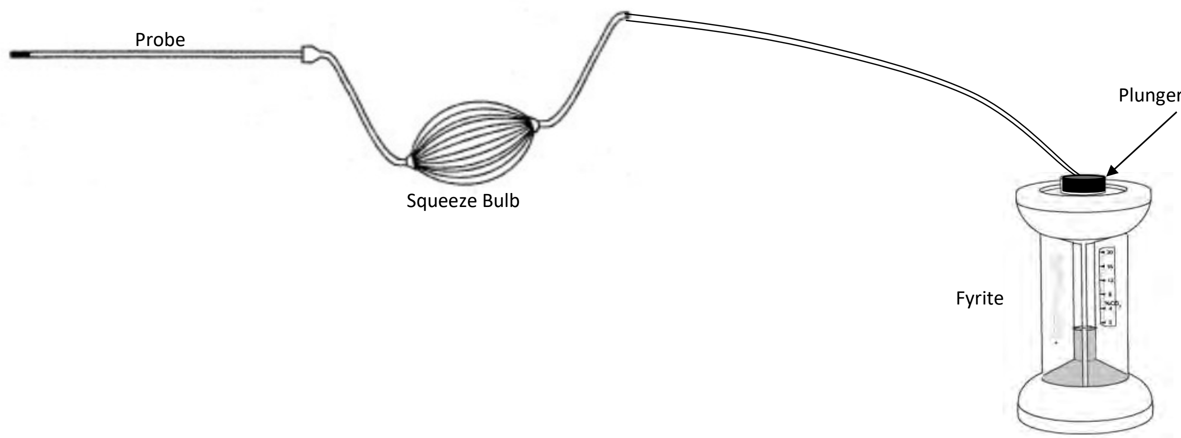
Flat Rock Assembly Plant

Flat Rock, Michigan

Project #2403202

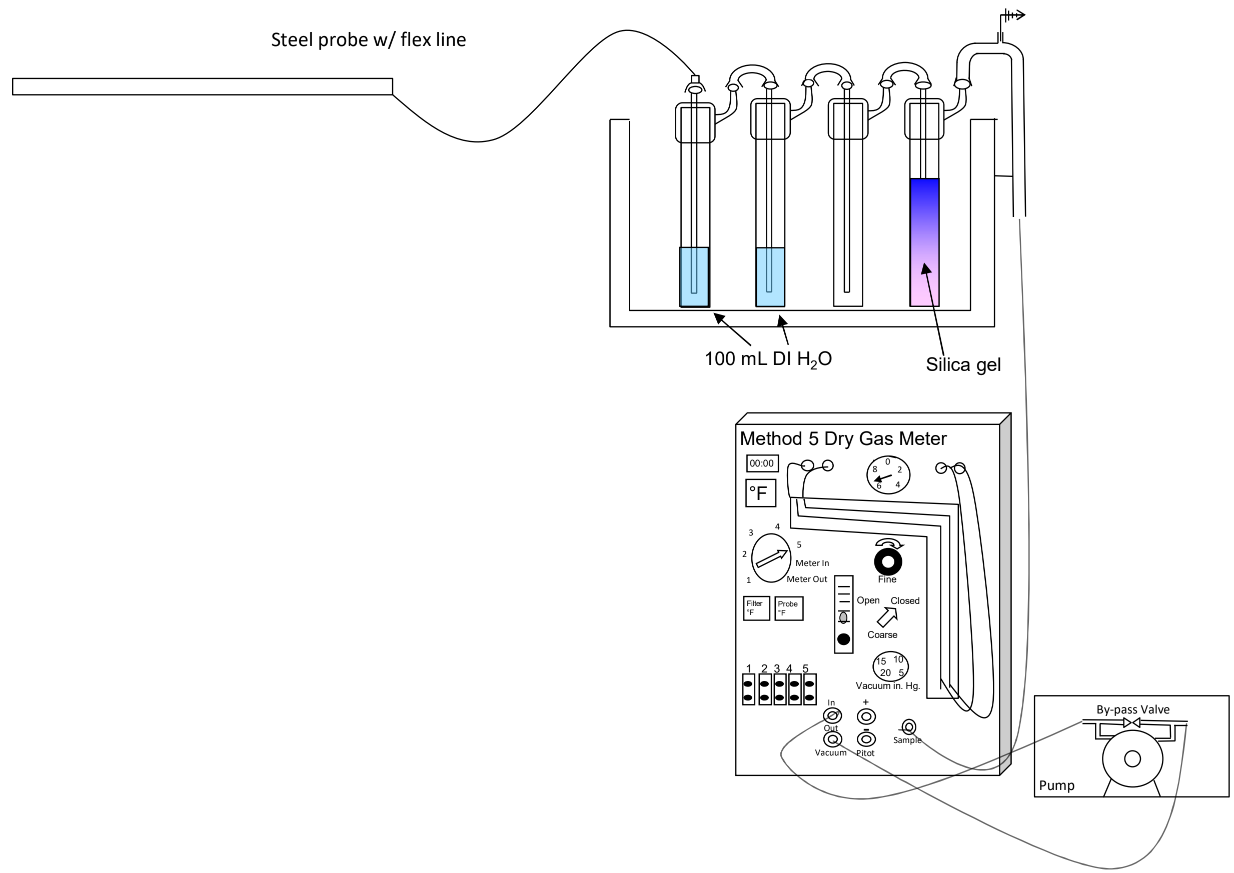
Date: August 21, 2024
September 3-4, 2024

Figure No. 6: USEPA Method 3 Schematic (Fyrite)



USEPA Method 3 **Ford Motor Company** Flat Rock Assembly Plant Flat Rock, Michigan Project# 2403202	**Date: August 21, 2024** **September 3-4, 2024**	

Figure No. 7: Schematic of USEPA Method 4



USEPA Method 4

Ford Motor Company

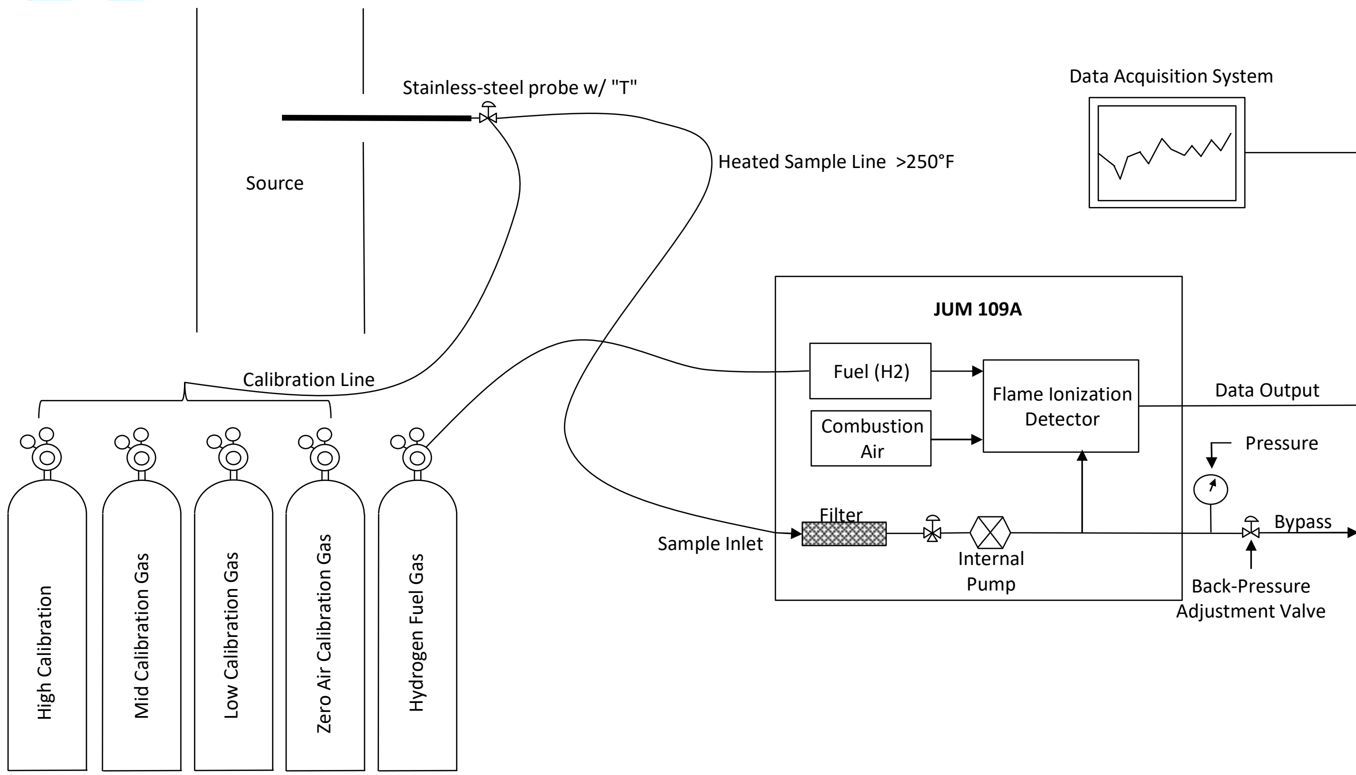
Flat Rock Assembly Plant

Flat Rock, Michigan

Project # 2403202

Date: August 21, 2024
September 3-4, 2024

Figure No. 8: USEPA Method 25A Schematic



USEPA Method 25A

Ford Motor Company

Flat Rock Assembly Plant

Flat Rock, Michigan

Date: August 21, 2024
September 3-4, 2024

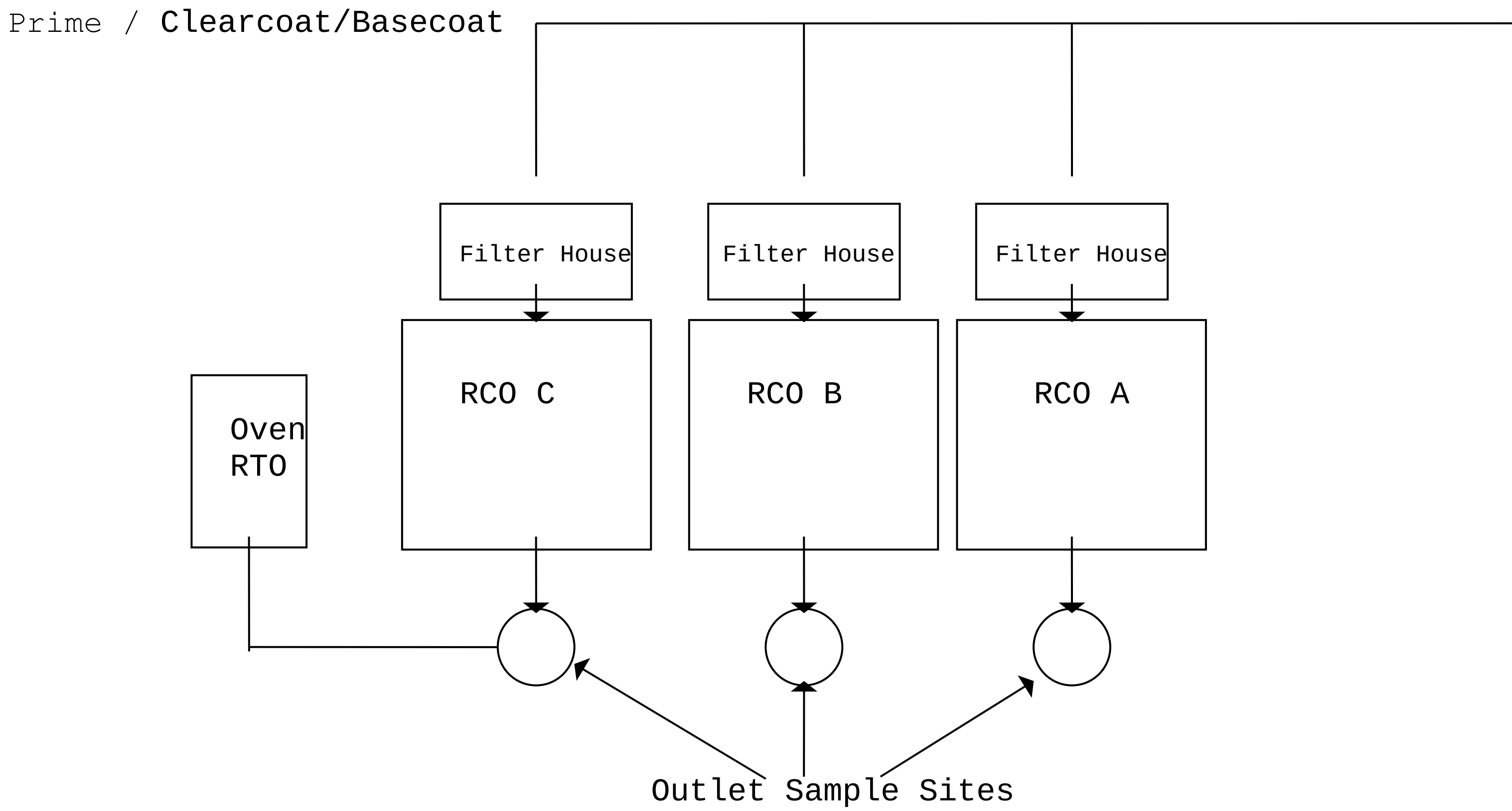


Figure 9
Flat Rock Assembly Plant
Abatement System Layout and Sampling Locations