FINAL REPORT

GENERAL MOTORS

SAGINAW, MICHIGAN

SAGINAW METALS CASTING OPERATIONS (SMCO): PRECISION SAND CORE ROOM TESTING REPORT

RWDI #2205601

November 21, 2022

SUBMITTED TO

Jeff Hummel
General Motors
Senior Environmental Project Engineer
Sustainable Workplaces
Jeffrey.Hummel@gm.com

Alexandra Thibeault
General Motors
Senior Environmental Leader
alexandra.thibeault@gm.com

General Motors
SMCO Plant
1629 North Washington Avenue
Saginaw, Michigan 48601

SUBMITTED BY

Brad Bergeron, A.Sc.T., d.E.T.
Senior Project Manager | Principal
Brad.Bergeron@rwdi.com | ext. 2428

Mason Sakshaug, QSTI
Senior Scientist
Mason.Sakshaug@rwdi.com | ext. 3703

RWDI USA LLC
Consulting Engineers & Scientists
2239 Star Court
Rochester Hills, Michigan 48309

T: 248.841.8442
F: 519.823.1316

EXECUTIVE SUMMARY

RWDI USA LLC (RWDI) has been retained by General Motors (GM) to complete the emission sampling program at the Saginaw Metal Casting Operations (SMCO) located at 1629 North Washington Avenue, Saginaw, Michigan. The testing evaluated volatile organic compound (VOC) and particulate matter (PM) concentrations from EU-PSANDCOREROOM. The test program was completed on October 11th, 2022.

Executive Table i: Summary of Results – VOCs and PM – EU-PSANDCOREROOM

Parameter	Emission Rates				ROP Limits
	Test 1	Test 2	Test 3	Average	
VOC (as propane) (lb/hr)	7.98	7.93	7.77	7.89	8.10 lb/hr
Total Particulate (lb/hr)	0.18	0.20	0.18	0.19	0.56 lb/hr (PM) 0.56 lb/hr (PM_{10}) 0.56 lb/hr ($PM_{2.5}$)

TABLE OF CONTENTS

LIST OF TABLES

(Found Within the Report Text)

LIST OF TABLES

(Found After the Report Text)

LIST OF GRAPHS

LIST OF FIGURES

LIST OF APPENDICES

1 INTRODUCTION

RWDI USA LLC (RWDI) has been retained by General Motors (GM) to complete the emission sampling program at the Saginaw Metal Casting Operations (SMCO) located at 1629 North Washington Avenue, Saginaw, Michigan. The testing evaluated volatile organic compound (VOC) and particulate matter (PM) concentrations from EU-PSANDCOREROOM. The test program was completed on October 11th, 2022.

1.1 Location and Dates of Testing

The test program was completed on October 11th, 2022 at the GM SMCO facility.

1.2 Purpose of Testing

The compliance testing was conducted to verify VOC and PM ($PM/PM_{10}/PM_{2.5}$) emissions from EU-PSANDCOREROOM (cold box core machines) for Permit MI-ROP-B1991-2021b.

1.3 Description of Source

The Precision Sand (PSand) operations include all of the processes below, however, the emission testing focused on the core making.

Sand handling and mixing – sand from the prepared sand silo is pneumatically transported to the six core machine sand hoppers. The individual sand hoppers feed the sand mixers where polyurethane resin is mixed with the sand.

Core making – six cold box core machines. Dimethylisopropylamine (DMIPA) is used to cure the mixed sand in the core making machines.

Core box tooling maintenance – includes the use of a core release chemical, metal cleaner, a high pressure water wash, and core box washing station.

Cylinder liner cleaning and heating – cleaning by shot blast; induction heating used to preheat cylinder liners prior to contact with molten aluminum, vented in-plant.

Final mold assembly – physical assembly of the parts of the final mold/core package. The assembly process includes reusable chill plates. Emissions are negligible and vented in-plant.

Core room fugitive emissions – general core handling

1.4 Personnel Involved in Testing

Table 1.4: Testing Personnel

Jeff Hummel Senior Environmental Project Engineer jeffrey.hummel@gm.com	**General Motors**	(517) 719-9053
Alexandra Thibeault Senior Environmental Leader Alexandra.Thibeault@gm.com	**General Motors SMCO** 1629 North Washington Avenue Saginaw, MI 48601	(810) 577-9003
Brad Bergeron Senior Project Manager Brad.Bergeron@rwdi.com	**RWDI USA LLC** 2239 Star Court Rochester Hills, MI 48309	(248) 234-3885
Mason Sakshaug Senior Scientist Mason.Sakshaug@rwdi.com		(989) 323-0355
Mike Nummer Field Technician Michael.Nummer@rwdi.com		(586) 863-8237
Austyn Kingsley Field Technician Austyn.Kingsley@rwdi.com		(586) 863-3553

2 SUMMARY OF RESULTS

2.1 Operating Data

GM personnel ensured that the process was operating under normal operating conditions during the testing. As requested in the EGLE Approval letter for the Test Plan, the following items were recorded.

- Production Rate
- Scrubber pH
- Scrubber pressure drop
- Scrubber liquid flow rate

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

2.2 Applicable Permit Number

SRN B1991, operates under Permit MI-ROP-B1991-2021b.

3 SOURCE DESCRIPTION

3.1 Description of Process and Emission Control Equipment

Core making – The six cold box core machines are ventilated at 25,000 scfm to a cyclone and a packed tower acid scrubber.

3.2 Process Flow Sheet or Diagram (if applicable)

A process flow diagram can be provided on request.

3.3 Type and Quantity of Raw and Finished Materials

See Section 1.3.

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

Production rate, scrubber system PH, scrubber pressure-drop, and scrubber liquid flow rate were all monitored. Process data can be found in **Appendix A**.

4 SAMPLING AND ANALYTICAL PROCEDURES

4.1 Description of Sampling Train and Field 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 3 –** Determination of Molecular Weight of Dry Stack Gases (fyrite)
- **Method 4 –** Determination of Moisture Content in Stack Gases
- **Method 5 –** Determination of Particulate Matter Emissions from Stationary Sources
- **Method 25A –** Determination of Total Gaseous Nonmethane Organic Emissions

4.1.1 Stack Velocity, Temperature, and Volumetric Flow Rate Determination

The exhaust velocities and flow rates were determined following the US EPA Method 2, "Determination of Stack Gas Velocity and Flow Rate (Type S Pitot Tube)". Velocity measurements were taken with a pre-calibrated S-Type pitot tube and incline manometer. Volumetric flow rates were determined following the equal area method as outlined in US EPA Method 1. Temperature measurements were made simultaneously with the velocity measurements and were conducted using a chromel-alumel type "k" thermocouple in conjunction with a digital temperature indicator. A cyclonic flow check was conducted prior to testing.

The dry molecular weights of the stack gas were determined following calculations outlined in US EPA Method 3, "Determination of Molecular Weight of Dry Stack Gas" by fyrite. Stack moisture content was determined using USEPA Method 4. Flow rate determination, temperature and moisture were collected at the outlet.

4.1.2 Sampling for Volatile Organic Compounds

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

Three (3) 60-minute tests were conducted. 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.

In order to subtract methane from THC, the methane was converted from methane as methane to methane as propane and then subtracted from the THC number. The methane response factor (RF) was 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 provides methane as propane and was then subtracted from the THC concentration.

4.2 Particulate Matter and Condensable Particulate Matter

Particulate matter sampling following procedures outlined in U.S. EPA Modified Method 5. Since the source was under 85°F, USEPA Method 202 was not conducted.

A stack sample was withdrawn isokinetically from the source, particulate emissions were collected in the probe and on a heated filter. As stated in Method 202, the impinger portion would only be recovered and included as PM if the filtration temperature exceeds 85°F. Since the filtration temperature did not exceed 85°F, the impingers were only used for moisture determination.

4.3 Description of Recovery and Analytical Procedures

PM samples were recovered and analyzed per USPEA Method 5.

4.4 Sampling Port Description

The source was 35.25" in diameter and met USEPA Method 1 upstream and downstream requirements.

5 TEST RESULTS AND DISCUSSION

5.1 Detailed Results

Table 5.1: Summary of Results – VOCs and PM - PSANDCOREROOM

Parameter	Emission Rates				ROP Limits
	Test 1	Test 2	Test 3	Average	
VOC (as propane) (lb/hr)	7.98	7.93	7.77	7.89	8.10 lb/hr
Total Particulate (lb/hr)	0.18	0.20	0.18	0.19	0.56 lb/hr (PM) 0.56 lb/hr (PM_{10}) 0.56 lb/hr ($PM_{2.5}$)

5.1.1 Discussion of Results

The VOC results were 7.89 lb/hr and the PM results were 0.19 lb/hr. The results were lower than the limit of 0.56 lb/hr for PM and 8.10 lb/hr for VOC. Results for VOCs are provided in **Appendix B**. Results for PM are provided in **Appendix C**.

5.2 Variations in Testing Procedures

The testing followed the test plan included in **Appendix D** along with EGLE approval correspondence.

5.3 Process Upset Conditions During Testing

There were normal process breaks during production.

5.4 Maintenance Performed in Last Three Months

Regular routine preventative maintenance was performed within the last three months.

5.5 Re-Test

This was not a retest.

5.6 Audit Samples

This test did not require any audit samples.

5.7 Calibration Sheets

Calibration sheets can be found in **Appendix E**.

5.8 Sample Calculations

Sample calculations can be found in **Appendix F**.

5.9 Field Data Sheets

Field data sheets can be found in **Appendix B** (for VOCs) and **Appendix C** (for PM).

5.10 Laboratory Data

Laboratory data can be found in **Appendix G**.

TABLES

Table 1

THC EMISSIONS TABLE

Source: Sand Core
RWDI Project #2205601

Parameter	1	2	3	Average
Date	11-Oct-22	11-Oct-22	11-Oct-22	--
Start Time:	8:02	9:25	10:44	--
Stop Time:	9:04	10:27	11:47	--
Duration (mins):	60	60	60	--
Outlet Flow Rate (dscfm):	20,933	21,443	21,261	21,212
Outlet Flow Rate (dm^3/s):	9.88	10.12	10.03	10.01
Moisture:	0.009	0.016	0.015	0.013
Outlet THC Concentration (as propane) (ppm_w):	58.7	55.6	54.4	56.26
Outlet THC Concentration (as propane) (ppm_d):	59.25	56.55	55.26	57.02
Outlet THC Concentration (as propane) (mg/m^3_d):	108.59	103.65	101.28	104.51
Outlet THC Concentration (as propane) (lb/hr_d):	8.51	8.32	8.06	8.30
Outlet Methane Correction Factor	2.47	2.47	2.47	2.47
Outlet Methane Concentration (as methane) (ppm_w):	9.01	6.37	4.87	6.75
Outlet Methane Concentration (as methane) (ppm_d):	9.10	6.47	4.95	6.84
Outlet Methane Concentration (as propane) (ppm_w):	3.64	2.58	1.97	2.73
Outlet Methane Concentration (as propane) (ppm_d):	3.68	2.62	2.00	2.77
Outlet Methane Concentration (as propane) (mg/m^3):	6.74	4.80	3.67	5.07
Outlet Methane Concentration (as Carbon) (mg/m^3):	5.51	3.93	3.00	4.14
Outlet Methane Concentration (as propane) (lb/hr):	0.53	0.39	0.29	0.40
Outlet NMOC Concentration (as propane) (ppmv):	55.57	53.93	53.25	54.25
Outlet NMOC Concentration (as propane) (lbs/hr):	7.98	7.93	7.77	7.89

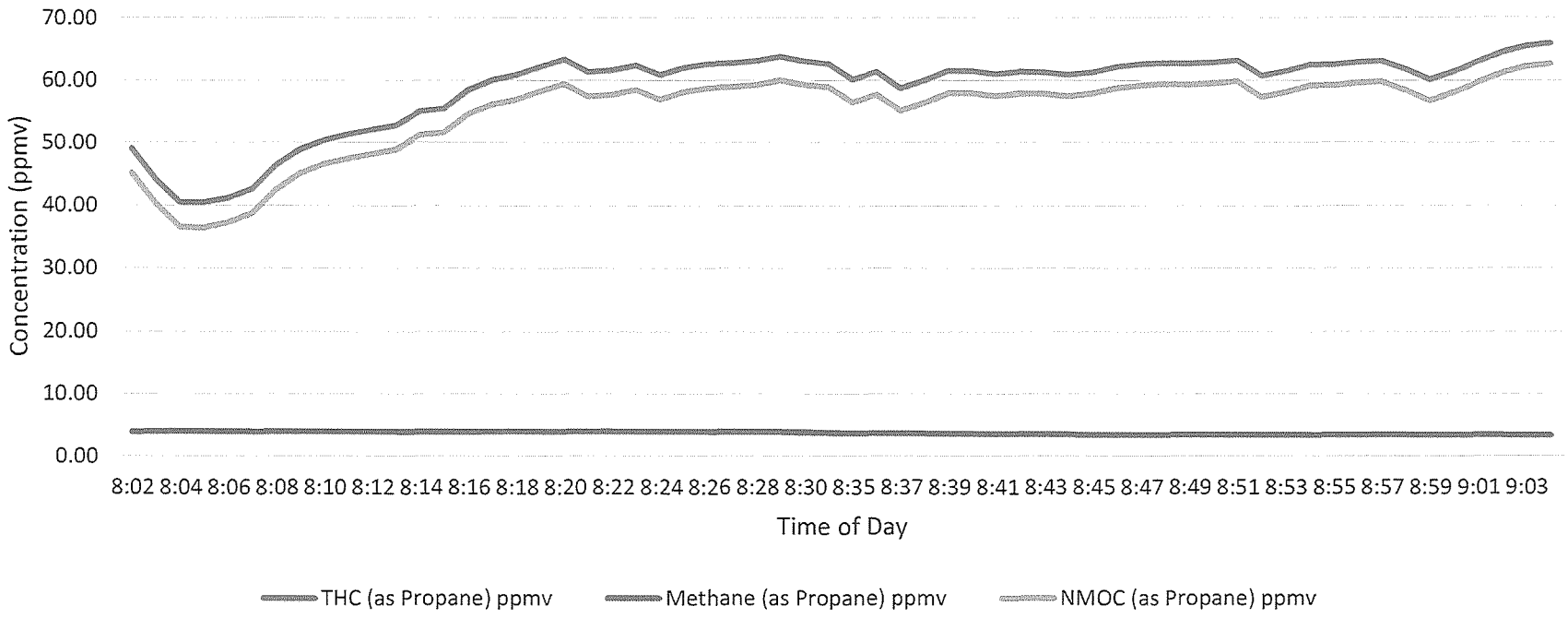
Note: "d" indicated based on dry conditions

Table 2

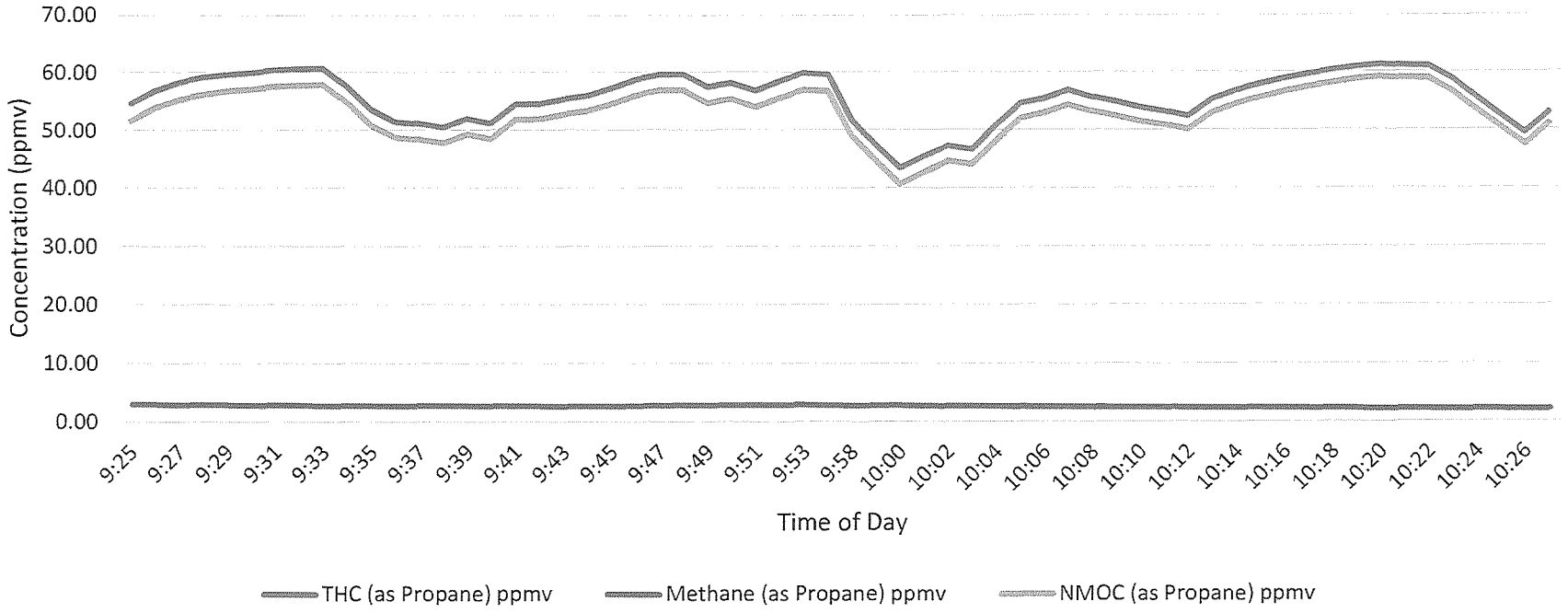
Company	GM SMCO			
Source	EU-PSANDCOREROOM			
Date	11-Oct-22	11-Oct-22	11-Oct-22	
Test Number	Test 1	Test 2	Test 3	Average
Stack Information				
Flow ft3 (Actual)	21,756	22,439	22,236	22,144
Flow ft3 (Standard Wet)	21,117	21,784	21,580	21,494
Flow ft3 (Standard Dry)	20,933	21,443	21,261	21,213
Flow m3 (Standard Dry)	593	607	602	601
Percent Moisture	0.9	1.6	1.5	1.3
Pressure Ps ("Hg)	29.47	29.47	29.47	29.47
Average Stack Temperature Ts (F)	75.8	75.7	75.8	75.8
Molecular Weight of Stack Gas dry (Md)	28.84	28.84	28.84	28.84
Molecular Weight of Stack Gas wet (Ms)	28.75	28.67	28.68	28.70
Stack Gas Specific Gravity (Gs)	1.0	1.0	1.0	1.0
Water Vapor Volume Fraction	0.009	0.016	0.015	0.013
Average Stack Velocity Vs (ft/sec)	53.5	55.2	54.7	54.5
Area of Stack (ft2)	6.8	6.8	6.8	6.8
Percent Carbon Dioxide	0.0	0.0	0.0	0.0
Percent Oxygen	21.0	21.0	21.0	21.0
Percent Carbon Monoxide	0.0	0.0	0.0	0.0
Meter Info				
Isokinetic Variation I	98.8	99.1	99.2	99.0
Meter Pressure Pm ("Hg)	29.7	29.7	29.7	29.7
Meter Temperature Tm (F)	70.6	76.0	78.4	75.0
Measured Sample Volume Vm	55.59	57.71	57.54	56.95
Sample Volume (Vm St ft3)	55.13	56.68	56.25	56.02
Sample Volume (Vm St m3)	1.56	1.61	1.59	1.59
Total Weight of Sampled Gas (m g lbs) wet	4.13	4.27	4.23	4.21
Total Weight of Sampled Gas (m g lbs) dry	4.11	4.23	4.19	4.18
Gas Density Ps wet	0.07	0.07	0.07	0.07
Gas Density Ps dry	0.07	0.07	0.07	0.07
Condensate Volume	0.49	0.90	0.84	0.74
Nozzle Size	0.00030	0.00030	0.00030	0.00030
Impinger Gain	2.5	6.1	6.0	4.9
Silica Gel Gain	7.8	13.0	11.9	10.9
Particulate Results				
Nozzle/Probe/Filter Weight (mg)	3.6	3.9	3.6	3.7
lb/hr	0.18	0.20	0.18	0.19

GRAPHS

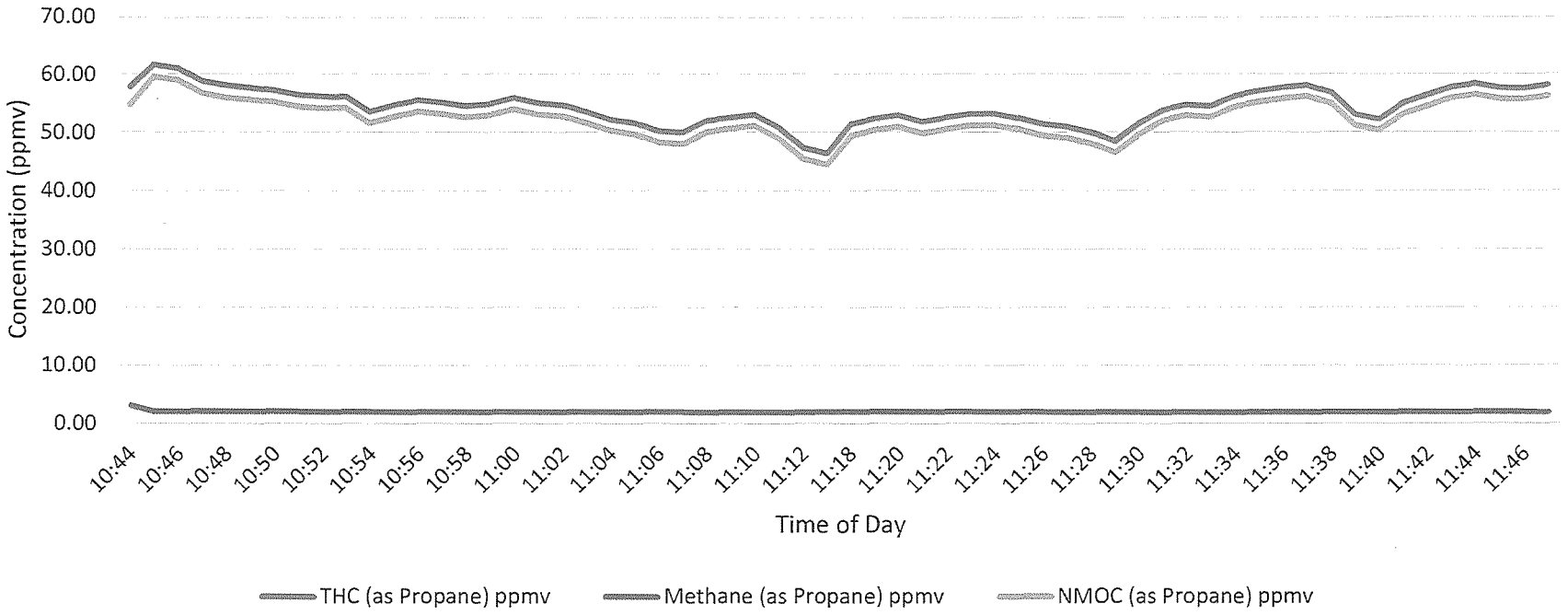
Graph 1: EU-PSANDCOREROOM - VOCs Test 1



Graph 2: EU-PSANDCOREROOM - VOCs Test 2

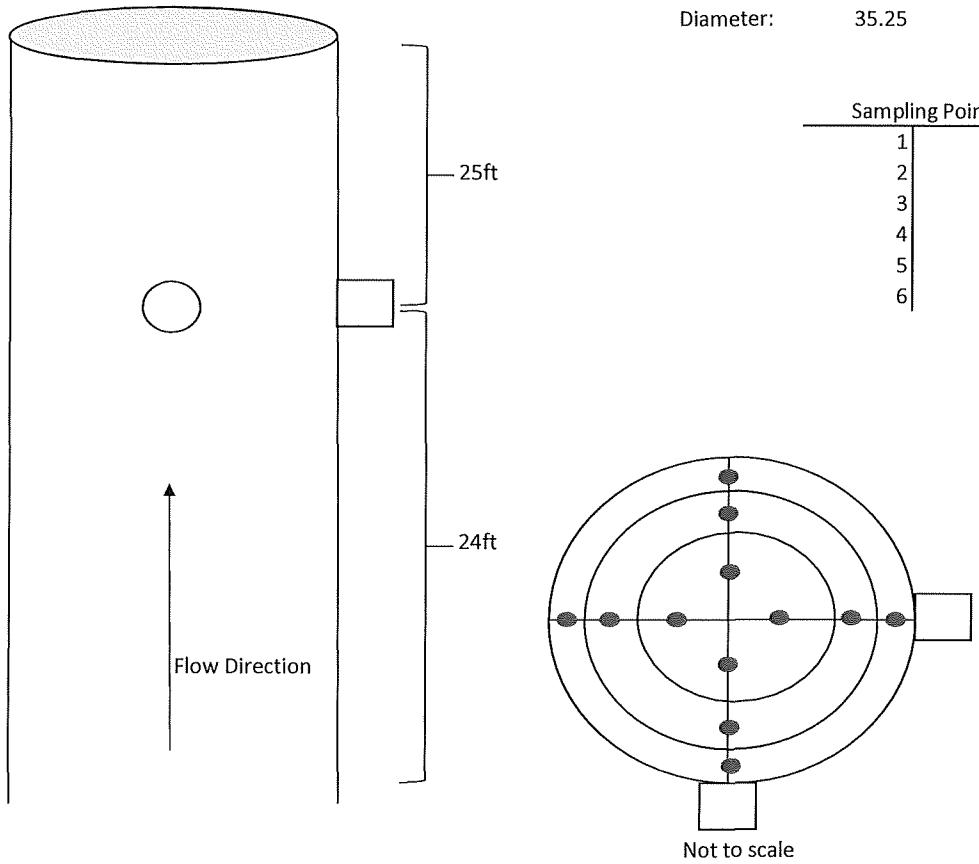


Graph 3: EU-PSANDCOREROOM - VOCs Test 3



FIGURES

Figure No. # 1 Schematic of EU-PSANDCOREROOM (SV-Z03-ISO-1)



Diameter: 35.25

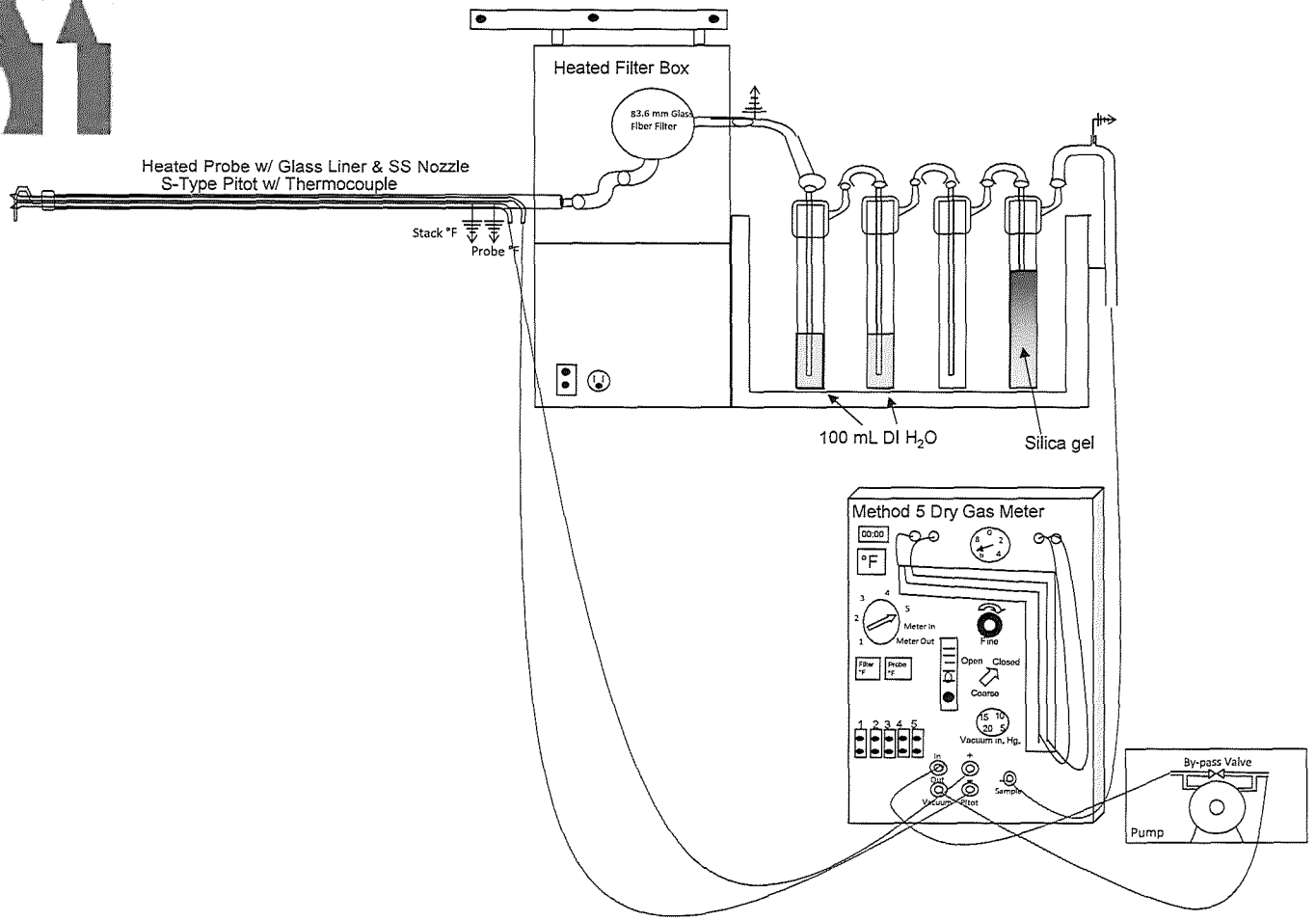
Sampling Points (in.)	
1	1.55
2	5.15
3	10.43
4	24.82
5	30.10
6	33.70

EU-PSANDCOREROOM (SV-Z03-ISO-1)
General Motors
Saginaw Metal Castings Operation (SMOC)
Saginaw, Michigan

Date:
10-Oct-22

RWDI USA LLC
2239 Star Court
Rochester Hills, MI 48309

Figure No. 2



USEPA Method 5

General Motors

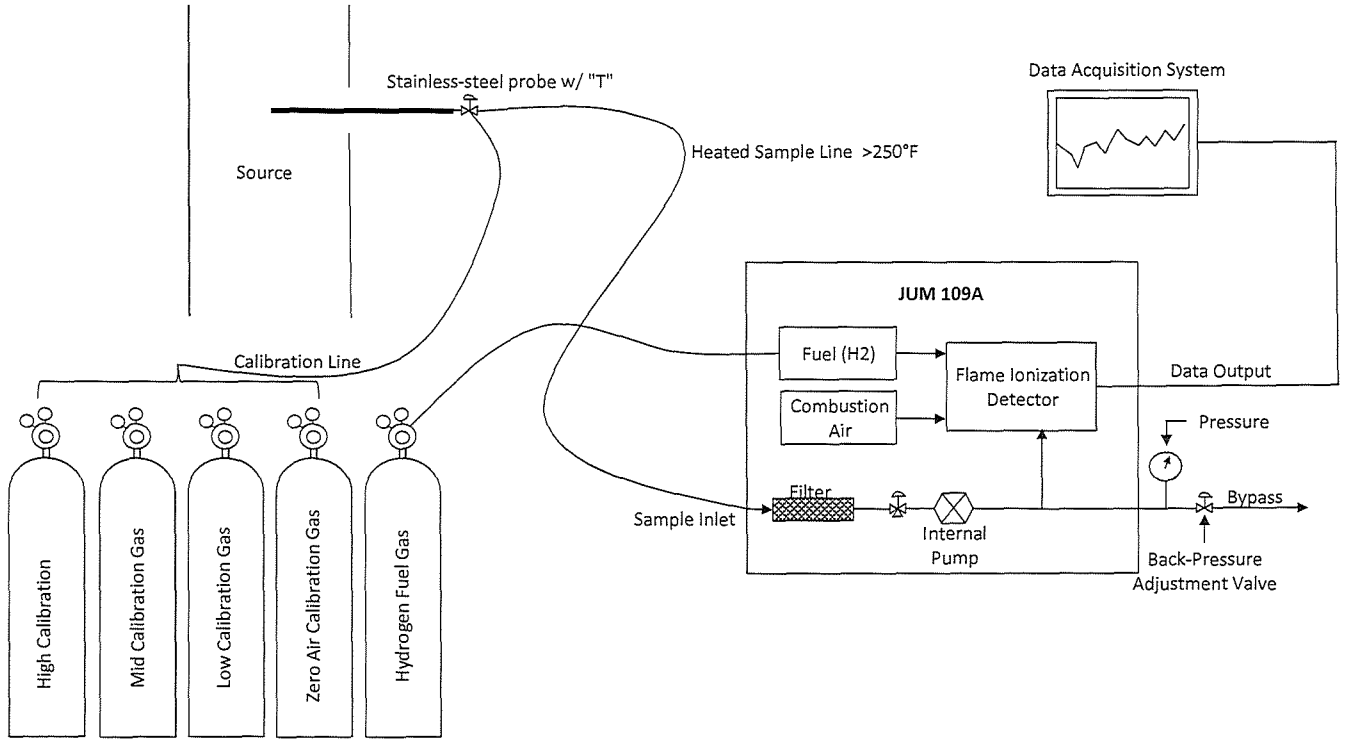
SMCO

EU-PSANDCOREROOM

Saginaw, Michigan

October 11, 2022

Figure No. 3: USEPA Method 25A Schematic



USEPA Method 25A

General Motors

SMCO

EU-PSANDCOREROOM

Saginaw, Michigan

October 11, 2022