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Executive Summary

Decorative Panels International, Inc. retained Bureau Veritas North America, Inc. to test air emissions from the No. 1 and No. 3 Biofilter sources at their hardboard manufacturing facility in Alpena, Michigan. The No. 1 Biofilter controls emissions from the No. 1 Board Press and cooler (EUPRESS2S). The No. 3 Biofilter controls emissions from the No. 3 Board Press and cooler (EU3-PRESS-AREA). The sources are grouped in the permit within the FGPRESSES and FGMACTDDDD flexible groups.

The objective of the testing was to evaluate compliance of the No. 1 and No. 3 Biofilter sources with emission limits and requirements in:

- United States Environmental Protection Agency (USEPA) Preventative Maintenance, and Malfunction Abatement Plans,
- Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (ROP) MI-ROP-B1476-2015a, effective December 21, 2015, for the FGMACTDDDD sources, and
- National Emission Standards for Hazardous Air Pollutants: Plywood and Composite Wood Products, 40 CFR 63, Subpart DDDD.

Bureau Veritas measured formaldehyde, methanol, and total hydrocarbons (THC) at the inlet and outlet of the No. 1 and No. 3 Biofilter control devices.

Three 60-minute compliance test runs were performed under normal operating conditions following USEPA Methods 1, 2, 3, 25A, 205, and 320.

Detailed results are presented in Tables 1 and 2 after the Tables Tab of this report. The following table summarizes the results of the testing conducted on March 14 and 15, 2019.

No. 1 Biofilter Formaldehyde, Methanol, and THC Results

Parameter	Unit	Run 1	Run 2	Run 3	Average
Formaldehyde inlet concentration	ppmvw	29.1	26.7	28.8	28.2
Formaldehyde inlet emission rate	lb/hr	6.8	6.1	6.8	6.5
Formaldehyde outlet concentration	ppmvw	4.7	7.1	8.1	6.6
Formaldehyde outlet emission rate	lb/hr	1.6	2.4	2.8	2.3
Formaldehyde removal efficiency	%	**76**	**60**	**59**	**65**
Methanol inlet concentration	ppmvw	44.6	41.8	47.6	44.7
Methanol inlet emission rate	lb/hr	11.2	10.1	11.9	11.1
Methanol outlet concentration	ppmvw	23.6	17.4	17.6	19.6
Methanol outlet concentration	lb/hr	8.8	6.4	6.5	7.2
Methanol removal efficiency	%	**22**	**36**	**46**	**35**
THC inlet concentration as carbon	ppmvw	301.4	263.3	304.8	289.8
THC inlet emission rate as carbon	lb/hr	28.2	23.9	28.6	26.9
THC outlet concentration as carbon	ppmvw	65.3	68.3	75.4	69.7
THC outlet emission rate as carbon	lb/hr	9.1	9.4	10.4	9.6
THC removal efficiency as carbon	%	**68**	**60**	**64**	**64**

Note: The average biofilter bed temperature during the three test runs was 80 °F.

No. 3 Biofilter Formaldehyde, Methanol, and THC Results

Parameter	Unit	Run 1	Run 2	Run 3	Average
Formaldehyde inlet concentration	ppmvw	20.7	19.9	20.1	20.2
Formaldehyde inlet emission rate	lb/hr	3.9	3.8	3.8	3.9
Formaldehyde outlet concentration	ppmvw	0.55	0.54	0.57	0.6
Formaldehyde outlet emission rate	lb/hr	0.13	0.12	0.13	0.13
Formaldehyde removal efficiency	%	**97**	**97**	**97**	**97**
Methanol inlet concentration	ppmvw	32.9	30.9	32.1	32.0
Methanol inlet emission rate	lb/hr	6.7	6.3	6.5	6.5
Methanol outlet concentration	ppmvw	0.9	1.2	1.3	1.1
Methanol outlet concentration	lb/hr	0.2	0.3	0.3	0.3
Methanol removal efficiency	%	**96**	**96**	**95**	**96**
THC inlet concentration as carbon	ppmvw	231.7	179.4	262.0	224.4
THC inlet emission rate as carbon	lb/hr	17.6	13.8	19.8	17.1
THC outlet concentration as carbon	ppmvw	28.4	24.1	25.1	25.9
THC outlet emission rate as carbon	lb/hr	2.7	2.1	2.3	2.4
THC removal efficiency as carbon	%	**85**	**84**	**89**	**86**

Note: The average biofilter bed temperature during the three test runs was 82 °F.

The results of the emissions testing established the following:

- Based on the March 15, 2019 testing, the No. 1 Biofilter source did not meet the requirements for compliance with the FGMACTDDDD standard.
- Based on the March 14, 2019 testing, the No. 3 Biofilter source met the requirements for compliance with the FGMACTDDDD standard.

1.0 Introduction

1.1 Summary of Test Program

Decorative Panels International, Inc. retained Bureau Veritas North America, Inc. to test air emissions from the No. 1 and No. 3 Biofilter sources at their hardboard manufacturing facility in Alpena, Michigan. The No. 1 Biofilter controls emissions from the No. 1 Board Press and cooler (EUPRESS2S). The No. 3 Biofilter controls emissions from the No. 3 Board Press and cooler (EU3-PRESS-AREA). The sources are grouped in the permit within the FGPRESSES and FGMACTDDDD flexible groups.

The objective of the testing was to evaluate compliance of the No. 1 and No.3 Biofilter sources with emission limits and requirements in:

- United States Environmental Protection Agency (USEPA) Preventative Maintenance, and Malfunction Abatement Plans,
- Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (ROP) MI-ROP-B1476-2015a, effective December 21, 2015, for the FGMACTDDDD sources, and
- National Emission Standards for Hazardous Air Pollutants: Plywood and Composite Wood Products, 40 CFR 63, Subpart DDDD.

Three 60-minute compliance test runs were performed under normal operating conditions following USEPA Methods 1, 2, 3, 25A, 205, and 320.

Bureau Veritas measured formaldehyde, methanol, and total hydrocarbons (THC) at the inlet and outlet of the No. 1 Biofilter control devices on March 14 and 15, 2019.

1.2 Key Personnel

The key personnel involved in this test program are listed in Table 1-1. Mr. David Kawasaki, Staff Consultant with Bureau Veritas, led the emission testing. Mr. Scott Ickes, Senior Manager for Compliance with Decorative Panels International, Inc., provided process coordination and recorded operating parameters. Mr. Jeremy Howe and Ms. Rebecca Radulski, with MDEQ, witnessed the testing.

Table 1-1
Key Personnel

Facility Contact	Emission Testing Project Manager
Scott Ickes Senior Manager, Compliance **Decorative Panels International, Inc.** 416 Ford Avenue Alpena, Michigan 49707 Telephone: 989.356.8568 scott.ickes@decpanels.com	David Kawasaki, QSTI Staff Consultant **Bureau Veritas North America, Inc.** 22345 Roethel Drive Novi, Michigan 48375 Telephone: 248.344.3081 Facsimile: 248.344.2656 david.kawasaki@us.bureauveritas.com
MDEQ Regulatory Agency	
Jeremy Howe Environmental Quality Analyst **Michigan Department of Environmental Quality** Air Quality Division **Cadillac District Office** 120 West Chapin Street Cadillac, Michigan 49601-2158 Telephone: 231.876.4416 Facsimile: 231.775.1511 howej1@michigan.gov	Rebecca Radulski Environmental Engineer **Michigan Department of Environmental Quality** Air Quality Division Gaylord Field Office 2100 West M-32 Gaylord, Michigan 49735-9282 Telephone: 989.705.3404 Facsimile: 989.731.6181 radulskir@michigan.gov

2.0 Source and Sampling Locations

2.1 Process Description

Decorative Panels International, Inc. produces a variety of hardboard products including wall paneling, pegboard, and marker board. Hardwood chips, such as aspen, ash, maple, and beech chips, are purchased and stored in an outdoor raw material storage area and reclaimed into silos. The wood chips are cooked and softened in one of four digesters using steam injection and ground into wood pulp fibers.

The pulp fibers are conveyed to a forming machine, which forms a mat of un-pressed hardboard. The mats are processed through a Coe® dryer and cut using a trimmer and panel brush. The mats are conveyed to one of two hardboard lines, Line 1 or 3. Line 2 was historically operated but has since been decommissioned.

On the hardboard lines, the mats enter a predryer, a press, cooler, and tempering area. The predryer ensures the mat has the desired moisture content before the mat enters presses that heat and form hardboard. The hardboard is coated with linseed or Oxi-Cure® oil in the tempering area. The oil tempers the board thereby increasing its strength and "paintability." Once the board has been tempered, it is superheated to cure the binding resins in the bake ovens (No. 3 Press line only). The hardboard is humidified to approximate atmospheric conditions to limit warping. The boards are inspected, graded, cut, and packed for shipping.

The No. 1 Biofilter controls emissions from the No. 1 Board Press and cooler. The No. 3 Biofilter controls emissions from the No. 3 Board Press and cooler.

2.2 Process Operating Parameters

The process was operated under normal operating conditions during testing. The facility was manufacturing ¼-inch thick board at the No. 1 and No. 3 Board Presses during testing.

Tables 2-1 and 2-2 summarize the number of press cycles completed during the test periods, as well as, the biofilter pressure drops.

Refer to Appendix E for process data recorded during testing.

Table 2-1
Summary of EUPRESS2S Production Data

Time Duration	Corresponding Test Run	Press Cycles Completed	Biofilter Bed Pressure Drop (inch H_2O)
8:25 to 9:25	1	17	2.5
9:45 to 10:45	2	19	2.5
10:56 to 11:56	3	21	2.5
Average		**19**	**2.5**

Table 2-2
Summary of EU3-PRESS-AREA Production Data

Time Duration	Corresponding Test Run	Press Cycles Completed	Biofilter Bed Pressure Drop (inch H_2O)
11:20 to 12:20	1	19	2.0
13:10 to 14:10	2	19	2.0
14:25 to 15:28	3	17	2.2
Average		**18**	**2.1**

2.3 Control Equipment Description

2.3.1 No. 1 Biofilter

Gaseous emissions from the No. 1 Board Press are controlled by a DynaWave Engineering water scrubber and the No. 1 Biofilter. Emissions from the No. 1 Board Press are captured by a permanent total enclosure that surrounds the press area. The air from the enclosure continuously exhausts through a duct that exits the roof of the building and flows towards the pollution control equipment. The captured air (flue gas) enters the top of the scrubber and flows downwards in the vessel. Inside the vessel, water (containing sodium hydroxide to maintain a neutral pH) is sprayed into the air to remove particulates and humidify the air before the air enters the biofilter. The water is sprayed onto a series of chevrons to increase the air-to-water contact surface area.

As the flue gas mixes with the water, particulates and other pollutants are removed. The water drains to the bottom of the vessel and a portion is recirculated into the system with the remaining portion discharged to the onsite water treatment system. The flue gas exits the top of the scrubber and flows into the No. 1 Biofilter.

The No. 1 Biofilter, manufactured by Monsanto Enviro-Chem., consists of six compartments. The air from the scrubber can be heated by a heat exchanger before being directed into the six-biobed compartments. The compartments contain water sprayers to maintain a moist environment, and layers of Douglas-fir bark from the western United States. The Douglas-fir bark provides an environment where biologically active microbes can oxidize and remove the contaminants.

After passing through the bark, the flue gas is drawn into fans that discharge the gas through the stack, SVS2COOLR-STK28.

The biofilter bed temperatures are continuously monitored by multiple thermocouples in each chamber. These temperatures are reduced to 15-minute averages and recorded by the facility.

The No. 1 Biofilter average bed temperatures during testing are presented in Table 2-3. Refer to Appendix E for facility operating data.

Table 2-3
No. 1 Biofilter Bed Average Temperature During Testing

Test Run	Minimum 15-minute Temperature (°F)	Maximum 15-minute Temperature (°F)	Average Temperature (°F)
1	74	83	80
2	74	83	80
3	74	83	81
Average	**74**	**83**	**80**

2.3.2 No. 3 Biofilter

Gaseous emissions from the No. 3 Board Press are controlled by a humidifier and Envirogen manufactured biofilter (No. 3 Biofilter). Emissions from the No. 3 Board Press enters the top of the scrubber and flows downwards in the vessel, where water treated with sodium hydroxide to maintain a neutral pH is sprayed to humidify the inlet air to the biofilter.

As the gas mixes with the water, particulates and other pollutants are removed. The water drains to the bottom of the vessel and a portion is recirculated into the system with the remaining portion discharged to the onsite water treatment system. The flue gas exits the top of the scrubber and flows into the No. 3 Biofilter.

The No. 3 Biofilter consists of four compartments. The air exiting the humidifier can be further humidified and heated by adding steam into the ductwork upstream of the biobed compartments. The compartments contain water sprayers to maintain a moist environment, and layers of Douglas-fir bark from the western United States. The Douglas-fir bark provides an environment where biologically active microbes can oxidize and remove contaminants.

After passing through the bark, the flue gas is drawn into fans that discharge the gas through the stack, SV#3PRESS-STK68.

The biofilter bed temperatures are continuously monitored by multiple thermocouples in each chamber. These temperatures are reduced to 15-minute averages and recorded by the facility.

The No. 3 Biofilter average bed temperatures during testing are presented in Table 2-4. Refer to Appendix E for facility operating data.

Table 2-4
No. 3 Biofilter Bed Average Temperature During Testing

Test Run	Minimum 15-minute Temperature (°F)	Maximum 15-minute Temperature (°F)	Average Temperature (°F)
1	79	87	83
2	80	86	82
3	80	85	82
Average	**80**	**86**	**82**

2.4 Flue Gas Sampling Locations

Figures 2-1 and 2-2 provide photographs that show the sampling ports for the No. 1 Biofilter sampling locations. Figure 2-3 provides a photograph that shows the sampling ports for the No. 3 Biofilter sampling locations. Appendix Figures 1 through 4 present the No. 1 and No. 3 Biofilter inlet and outlet sampling ports and traverse point locations.

Figure 2-1. No. 1 Biofilter Inlet Sampling Location

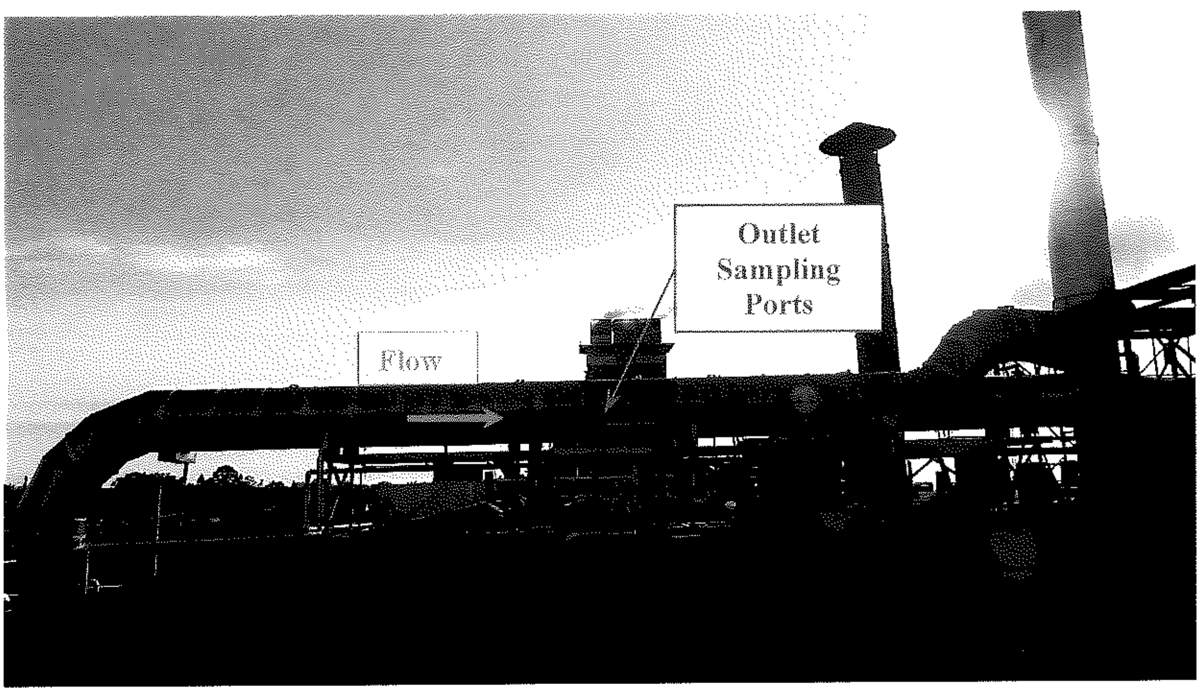

Figure 2-2. No. 1 Biofilter Outlet Sampling Location

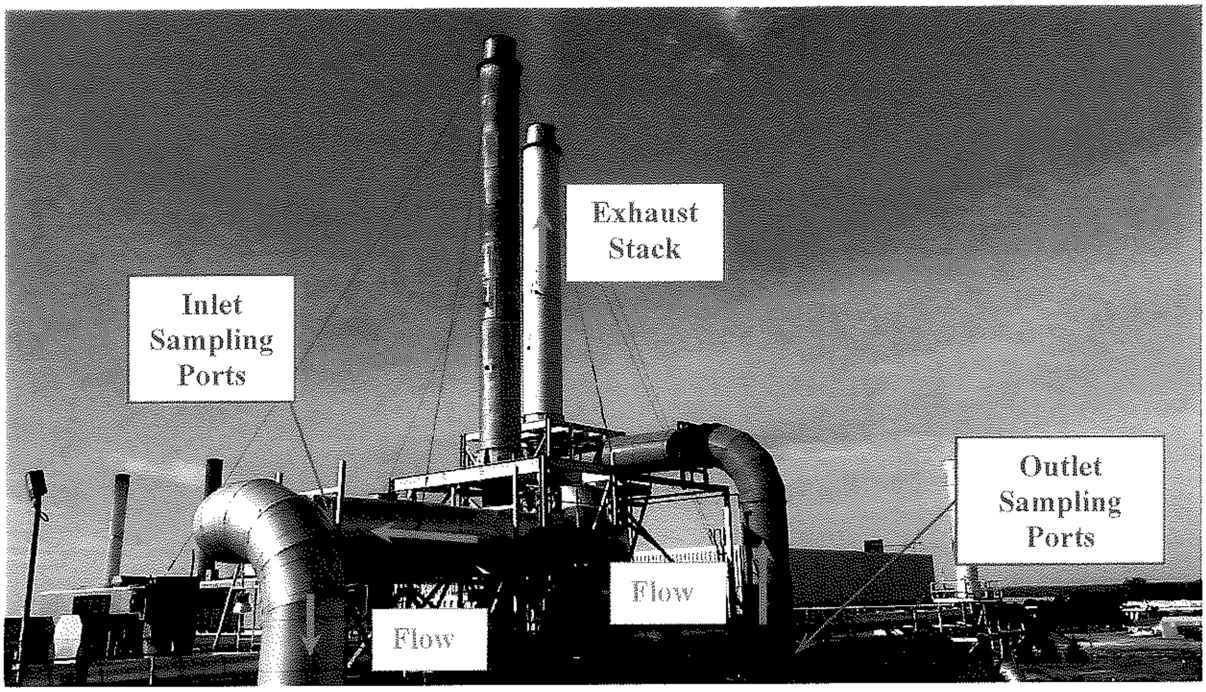

Figure 2-3. No. 3 Biofilter Inlet and Outlet Sampling Locations

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 was to satisfy testing requirements and evaluate compliance of the No. 1 and No. 3 Biofilter sources with emission limits and requirements in:

- USEPA Preventative Maintenance, and Malfunction Abatement Plans,
- MDEQ ROP MI-ROP-B1476-2015a for the FGMACTDDDD sources, and
- National Emission Standards for Hazardous Air Pollutants: Plywood and Composite Wood Products, 40 CFR 63, Subpart DDDD.

Compliance with the FGMACTDDDD total HAP permit limits, based on the use of an add-on control device, can be demonstrated by any one of the following criteria:

1. 90% reduction of total HAP mass emission rate, measured as THC, as carbon.
2. Total HAP concentration less than 20 part per million by volume, dry (ppmvd), measured as THC (as carbon).
3. Total HAP reduction so that methanol mass emission rate is reduced by 90%.
4. Total HAP reduction so that methanol concentration is less than 1 ppmvd, if the uncontrolled methanol concentration entering the control device is greater than 10 ppmvd.
5. Total HAP reduction so that formaldehyde mass emission rate is reduced by 90%.
6. Total HAP reduction so that formaldehyde concentration is less than 1 ppmvd, if the uncontrolled formaldehyde entering the control device is greater than 10 ppmvd.

Bureau Veritas measured formaldehyde, methanol, and THC at the inlet and outlet stacks of the No.1 and No. 3 Biofilters. Table 3-1 summarizes the sampling and analytical test matrix.

Table 3-1
Sampling and Analytical Matrix

Sampling Location	Sample/ Type of Pollutant	Sample Method	Date (2019)	Run	Start Time	End Time	Analytical Method	Analytical Laboratory
Inlet and Outlet of No. 1 Biofilter	Flowrate, molecular weight, moisture content, formaldehyde, methanol, total hydrocarbons	EPA 1, 2, 3, 25A, 205, 320	Mar 15	1	8:25	9:25	Pitot tube, chemical absorption analyzer, flame ionization analyzer, Fourier transform infrared analyzer	Bureau Veritas
				2	9:45	10:45		
				3	10:56	11:56		
Inlet and Outlet of No. 3 Biofilter	Flowrate, molecular weight, moisture content, formaldehyde, methanol, total hydrocarbons	EPA 1, 2, 3, 25A, 205, 320	Mar 14	1	11:20	12:20	Pitot tube, chemical absorption analyzer, flame ionization analyzer, Fourier transform infrared analyzer	Bureau Veritas
				2	13:10	14:10		
				3	14:25	14:44		
					14:47	15:28		

3.2 Field Test Changes and Issues

The testing was performed in accordance with USEPA procedures, during normal operating conditions, as outlined in the Intent-to-Test Plan, which was submitted to MDEQ on January 15, 2019, and approved on February 15, 2019.

No field test changes or issues were encountered during the test program, with the exception that Test Run 3 for the No. 3 Biofilter was paused for three minutes due to a pause in production.

3.3 Summary of Results

A summary of results is presented in Tables 3-2 and 3-3. Detailed results are presented in Tables 1 and 2 in the Tables Tab of this report. Graphs of the measured concentrations are presented in the Graphs Tab of this report. Sample calculations are presented in Appendix B.

Table 3-2
No. 1 Biofilter Formaldehyde, Methanol, and THC Results

Parameter	Unit	Run 1	Run 2	Run 3	Average
Formaldehyde inlet concentration	ppmvw	29.1	26.7	28.8	28.2
Formaldehyde inlet emission rate	lb/hr	6.8	6.1	6.8	6.5
Formaldehyde outlet concentration	ppmvw	4.7	7.1	8.1	6.6
Formaldehyde outlet emission rate	lb/hr	1.6	2.4	2.8	2.3
Formaldehyde removal efficiency	%	**76**	**60**	**59**	**65**
Methanol inlet concentration	ppmvw	44.6	41.8	47.6	44.7
Methanol inlet emission rate	lb/hr	11.2	10.1	11.9	11.1
Methanol outlet concentration	ppmvw	23.6	17.4	17.6	19.6
Methanol outlet concentration	lb/hr	8.8	6.4	6.5	7.2
Methanol removal efficiency	%	**22**	**36**	**46**	**35**
THC inlet concentration as carbon	ppmvw	301.4	263.3	304.8	289.8
THC inlet emission rate as carbon	lb/hr	28.2	23.9	28.6	26.9
THC outlet concentration as carbon	ppmvw	65.3	68.3	75.4	69.7
THC outlet emission rate as carbon	lb/hr	9.1	9.4	10.4	9.6
THC removal efficiency as carbon	%	**68**	**60**	**64**	**64**

Note: The average biofilter bed temperature during the three test runs was 80 °F.

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Table 3-3
No. 3 Biofilter Formaldehyde, Methanol, and THC Results

Parameter	Unit	Run 1	Run 2	Run 3	Average
Formaldehyde inlet concentration	ppmvw	20.7	19.9	20.1	20.2
Formaldehyde inlet emission rate	lb/hr	3.9	3.8	3.8	3.9
Formaldehyde outlet concentration	ppmvw	0.55	0.54	0.57	0.6
Formaldehyde outlet emission rate	lb/hr	0.13	0.12	0.13	0.13
Formaldehyde removal efficiency	%	**97**	**97**	**97**	**97**
Methanol inlet concentration	ppmvw	32.9	30.9	32.1	32.0
Methanol inlet emission rate	lb/hr	6.7	6.3	6.5	6.5
Methanol outlet concentration	ppmvw	0.9	1.2	1.3	1.1
Methanol outlet concentration	lb/hr	0.2	0.3	0.3	0.3
Methanol removal efficiency	%	**96**	**96**	**95**	**96**
THC inlet concentration as carbon	ppmvw	231.7	179.4	262.0	224.4
THC inlet emission rate as carbon	lb/hr	17.6	13.8	19.8	17.1
THC outlet concentration as carbon	ppmvw	28.4	24.1	25.1	25.9
THC outlet emission rate as carbon	lb/hr	2.7	2.1	2.3	2.4
THC removal efficiency as carbon	%	**85**	**84**	**89**	**86**

Note: The average biofilter bed temperature during the three test runs was 82 °F.

The results of the emissions testing established the following:

- Based on the March 15, 2019 testing, the No. 1 Biofilter source did not meet the requirements for compliance with the FGMACTDDDD standard.

- Based on the March 14, 2019 testing, the No. 3 Biofilter source met the requirements for compliance with the FGMACTDDDD standard.

4.0 Sampling and Analytical Procedures

Bureau Veritas measured emissions following the guidelines and procedures specified in 40 CFR 51, Appendix M, "Recommended Test Methods for State Implementation Plans," 40 CFR 60, Appendix A, "Standards of Performance for New Stationary Sources," 40 CFR 63, Appendix A, "Test Methods Pollutant Measurement Methods from Various Waste Media," and State of Michigan Part 10 Rules, "Intermittent Testing and Sampling." Table 4-1 outlines the test methods for the test parameters, including ancillary measurements required by the USEPA methods (i.e., traverse point selection, velocity, molecular weight, and moisture content).

Table 4-1
Emission Test Parameters

Parameter	Source		USEPA Reference	
	Inlet of Biofilters	Outlet of Biofilters	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
Total hydrocarbons	●	●	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
Formaldehyde, methanol, and moisture content	●	●	320	Measurement of Vapor Phase Organic and Inorganic Emissions by Extractive Fourier Transform Infrared (FTIR) Spectroscopy

4.1 Emission Test Methods

4.1.1 Volumetric Flowrate (USEPA Methods 1 and 2)

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, the number of traverse points for sampling, and the measurement of velocity profiles. Details of the sampling location and number of velocity traverse points are presented in Table 4-2.

Table 4-2
Sampling Location and Number of Traverse Points

Source	Sampling Location	Duct Diameter (inches)	Distance from Ports to Upstream Flow Disturbance (diameters)	Distance from Ports to Downstream Flow Disturbance (diameters)	Number of Ports Used	Traverse Points per Port	Total Traverse Points	Cyclonic Flow Null Angle (°)
No. 1 Biofilter	Inlet	59.75	8.8	8.0	2	12	24	0
No. 1 Biofilter	Outlet	59.25	7.6	3.4	2	12	24	0
No. 3 Biofilter	Inlet	51.00	2.6	1.5	2	12	24	0
No. 3 Biofilter	Outlet	51.25	5.9	3.5	2	12	24	0

Figures 2-1 and 2-2 are photographs depicting the sampling locations at the No. 1 Biofilter source. Figure 2-3 is a photograph depicting the sampling locations at the No. 3 Biofilter source. Appendix Figures 1 through 4 present the No. 1 and No. 3 Biofilter's inlet and outlet sampling ports and traverse point locations.

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. S-type Pitot tubes and thermocouple assemblies, calibrated in accordance with Method 2, Section 10.0, were used during testing. Because the dimensions of the Pitot tubes met the requirements outlined in Method 2, Section 10.1, and were within the specified limits, the baseline Pitot tube coefficient of 0.84 (dimensionless) was assigned. Refer to Appendix A for the Pitot tube inspection sheets.

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 reading—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 walls 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 degrees, the flue gas is considered cyclonic at that sampling location and an alternative location should be found.

The measurements summarized in Table 4-2 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 measured using USEPA Method 3, "Gas Analysis for the Determination of Dry Molecular Weight." Flue gas was extracted from the stack through a probe positioned near the centroid of the duct and directed into a Fyrite® gas analyzer. The concentrations of carbon dioxide (CO_2) were measured by chemical absorption to within ±0.5%. The average CO_2 results of the grab samples were used to calculate molecular weight.

4.1.3 Total Hydrocarbons (USEPA Method 25A)

The THC sampling followed USEPA Method 25A, "Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer" procedures. Samples were collected through a stainless steel probe and heated sample line into the analyzer. Bureau Veritas used J.U.M. manufactured flame ionization detector based hydrocarbon analyzers.

A flame ionization detector (FID) determines the average hydrocarbon concentration in part per million by volume (ppmv) of THC as the calibration gas (i.e., 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 at right.

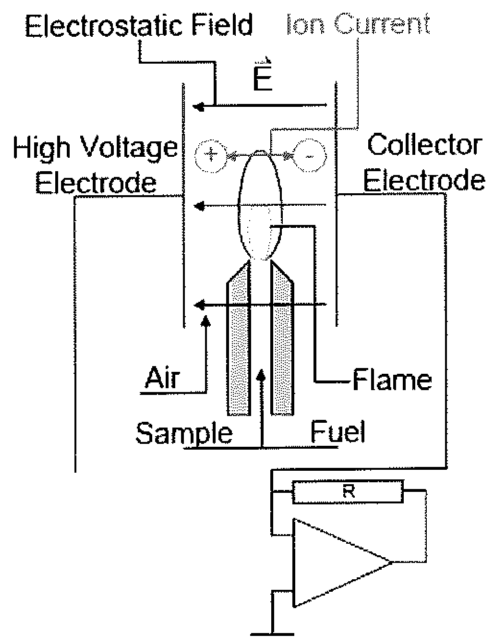

Figure 4-1. FID Flame Chamber

Using the voltage analog signal, measured by the FID, the concentration of total hydrocarbons is recorded by a data acquisition system (DAS). The average concentration of total hydrocarbons 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 values were 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.

At the conclusion of a test run, a calibration drift test was performed by introducing the zero- and mid-calibration gases to the tip of the sampling probe. The test run data were considered valid if the calibration drift test demonstrated the analyzers responded within ±3% of calibration span from pre-test to post-test calibrations.

Figure 4-2 depicts the USEPA Method 25A sampling train.

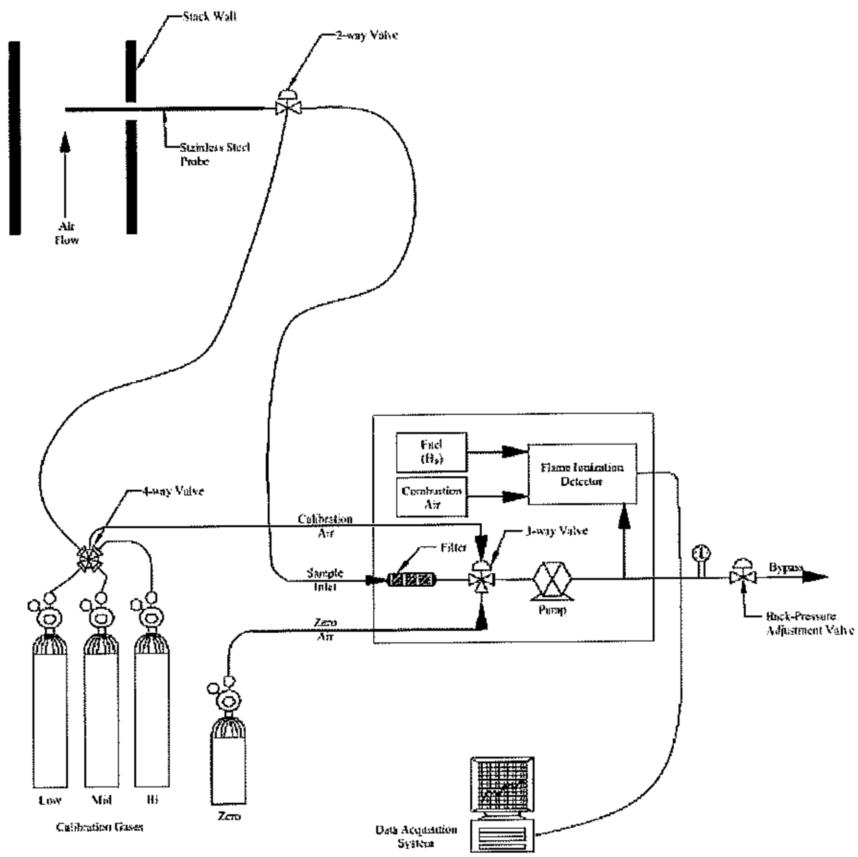

Figure 4-2. USEPA Method 25A Sampling Train

4.1.4 Gas Dilution (USEPA Method 205)

A gas dilution system was used to introduce known values of calibration gases into the THC analyzers. The gas dilution system consisted of calibrated mass flow controllers. The system diluted a high-level calibration gas to within ±2% of predicted values. This gas divider was capable of diluting gases at various increments.