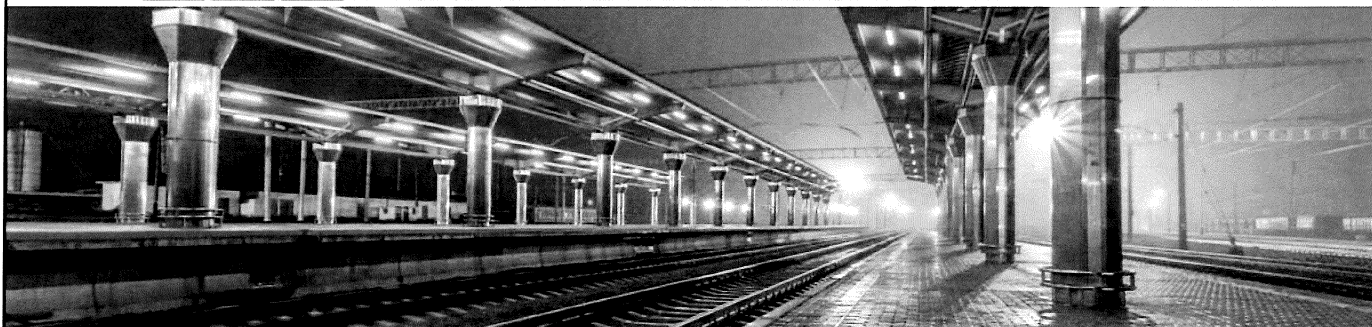


APEX COMPANIES, LLC



## Air Emissions Test Report for Biofilters, Scrubbers and Regenerative Catalytic Oxidizer



PREPARED FOR:  
Decorative Panels International  
416 Ford Street  
Alpena, Michigan 49707

State Registration No. B1476

Project No. 11019-000034.00  
October 15, 2019

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## Executive Summary

Decorative Panels International retained Apex Companies, LLC to conduct air emissions testing at the Decorative Panels International facility in Alpena, Michigan. The purpose of the air emission testing was to evaluate compliance with certain emission limits in (1) Michigan Department of Environment, Great Lakes, and Energy Renewable Operating Permit MI-ROP-B1476-2015a, effective April 6, 2016, and (2) National Emission Standards for Hazardous Air Pollutants: Plywood and Composite Wood Products, 40 CFR 63, Subpart DDDD. The emission units tested were:

- No. 1 Biofilter
- No. 3 Biofilter
- Ducon Dual Scrubbers 1 and 2
- Regenerative Catalytic Oxidizer

The testing followed United States Environmental Protection Agency Reference Methods 1 through 5, 25A, 205, and 320.

Detailed results are presented in Tables 1 through 7 after the Tables Tab of this report. The following tables summarize the results of the testing conducted August 20 through 22, 2019.

### No. 1 Biofilter Hazardous Air Pollutants Emissions Results

Parameter	Unit	Average Result Test Runs 1 to 3	Average Result Test Runs 4 to 6 (Increased Temperature)	Permit Limit
Formaldehyde inlet concentration	ppmv, wet	29.87	31.03	--
Formaldehyde inlet emission rate	lb/hr	7.4	7.4	--
Formaldehyde outlet concentration	ppmv, wet	1.07	1.60	1 <sup>†</sup>
Formaldehyde outlet emission rate	lb/hr	0.31	0.51	--
Formaldehyde removal efficiency	%	96	93	≥90 <sup>†</sup>
Methanol inlet concentration	ppmv, wet	47.85	48.01	--
Methanol inlet emission rate	lb/hr	12.7	12.2	--
Methanol outlet concentration	ppmv, wet	18.54	15.76	1 <sup>†</sup>
Methanol outlet emission rate	lb/hr	5.8	5.3	--
Methanol removal efficiency	%	54	56	≥90 <sup>†</sup>
THC inlet concentration	ppmv, wet	135.2	119.6	--
THC inlet emission rate	lb/hr	49	42	--
THC outlet concentration	ppmv, wet	19.0	18.2	20 <sup>†</sup>
THC outlet emission rate	lb/hr	8.2	8.5	--
THC removal efficiency	%	83	85	≥90 <sup>†</sup>

THC: total hydrocarbons

ppmv, wet: part per million by volume, wet basis

lb/hr: pound per hour

<sup>†</sup>Only one of the six permit limits need to be met in order to demonstrate compliance.

## Particulate Matter Emissions Results

Source	Unit	Average Result	Permit Limit
No. 1 Biofilter	lb/hr	3.0	29.3
	lb/1,000 lb exhaust gas, dry	0.015	0.10
Ducon Dual Scrubbers	lb/1,000 lb exhaust gas, dry	0.014	0.10
No. 3 Biofilter	lb/hr	12.3	29.3
	lb/1,000 lb exhaust gas, dry	0.083	0.10
Regenerative Catalytic Oxidizer	lb/1,000 lb exhaust gas, dry	0.011	0.10

lb/hr: pound per hour

lb/1,000 lb exhaust gas, dry: pound per 1,000 pounds of exhaust gasses on a dry gas basis

# 1.0 Introduction

## 1.1 Summary of Test Program

Decorative Panels International (DPI) retained Apex Companies, LLC (Apex) to conduct air emissions testing at the DPI facility in Alpena, Michigan. The purpose of the air emission testing was to evaluate compliance with certain emission limits in (1) Michigan Department of Environment, Great Lakes, and Energy (EGLE) Renewable Operating Permit (ROP) MI-ROP-B1476-2015a, effective April 6, 2016, and (2) National Emission Standards for Hazardous Air Pollutants (NESHAP): Plywood and Composite Wood Products, 40 CFR 63, Subpart DDDD.

The testing followed United States Environmental Protection Agency (USEPA) Reference Methods 1 through 5, 25A, 205, and 320.

Table 1-1 lists the emission sources tested, parameters, and test dates.

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

Source	Test Parameter	Test Date(s)
No. 1 Biofilter	Formaldehyde Methanol Total hydrocarbons (THCs) Particulate matter (PM)	August 20, 2019
Ducon Dual Scrubbers (Ducons 1 and 2)	PM	August 21, 2019
No. 3 Biofilter	PM	August 22, 2019
Regenerative Catalytic Oxidizer (RCO)	PM	August 22, 2019

## 1.2 Key Personnel

The key personnel involved in this test program are listed in Table 1-2. Mr. David Kawasaki, Staff Consultant with Apex, led the emission testing program. Mr. Scott Ickes, Senior Manager, Compliance, with DPI, provided process coordination and recorded operating parameters. Ms. Rebecca Radulski and Mr. David Patterson, with EGLE, witnessed the testing and verified production parameters were recorded.



**Table 1-2**  
**Key Contact Information**

Client	Apex
<p>Scott Ickes Senior Manager, Compliance <b>Decorative Panels International</b> 416 Ford Avenue Alpena, Michigan 49707 Phone: 989.356.8568 scott.ickes@decpanels.com</p>	<p>David Kawasaki, QSTI Staff Consultant <b>Apex Companies, LLC</b> 22345 Roethel Drive Novi, Michigan 48375 Phone: 248.590.5134 david.kawasaki@apexc.com</p>
EGLE	
<p>Karen Kajiya-Mills Technical Programs Unit Supervisor <b>EGLE Air Quality Division</b> <b>Technical Programs Unit</b> Constitution Hall, 2<sup>nd</sup> Floor, South 525 West Allegan Street Lansing, Michigan 48909 Phone: 517.256.0880 kajiya-millsk@michigan.gov</p>	<p>Rebecca Radulski Environmental Engineer <b>EGLE Air Quality Division</b> <b>Gaylord Field Office</b> 2100 West M-32 Gaylord, Michigan 49735 Phone: 989.705.3404 radulskir@michigan.gov</p>
<p>David Patterson Environmental Quality Analyst <b>EGLE Air Quality Division</b> <b>Technical Programs Unit</b> Constitution Hall, 2<sup>nd</sup> Floor, South 525 West Allegan Street Lansing, Michigan 48909 Phone: 517.284.6782 pattersond2@michigan.gov</p>	

## 2.0 Source and Sampling Locations

### 2.1 Process Description

Decorative Panels International 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.

Operating parameters were measured and recorded by DPI personnel during testing. Table 2-1 summarizes the operating conditions during hazardous air pollutant (HAP) compliance testing of the No. 1 Biofilter source. Additional operating parameter data are included in Appendix F.

**Table 2-1  
Summary of EUPRESS2S Operating Data**

Test Run	Number of Press Cycles
1	15
2	15
3	20
<b>Average</b>	<b>17</b>
4	15
5	17
6	19
<b>Average</b>	<b>17</b>

### 2.2 Control Equipment Description

#### 2.2.1 EUPRESS2S – 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 Stack SVS2COOLR-STK28.

Biofilter bed temperature and pressure drop were measured and recorded by DPI personnel during testing. Table 2-2 summarizes the operating conditions during testing of the No. 1 Biofilter. Detailed operating parameter data are included in Appendix F.

**Table 2-2  
Summary of No. 1 Biofilter Operating Data**

Test Run	Bed Temperature (°F)	Bed Pressure Drop (inch H <sub>2</sub> O)
1	79	0.3
2	80	0.3
3	82	0.2
<b>Average</b>	<b>80</b>	<b>0.2</b>
4	90	0.2
5	96	0.3
6	95	0.2
<b>Average</b>	<b>94</b>	<b>0.2</b>

### 2.2.2 Ducon Dual Scrubbers

The Ducon Dual Scrubbers control emissions from the EUTRIMMER/PBRUSH unit. The emissions from the trimming and painting process are drawn into one of the Ducon Scrubbers. As the gas mixes with the water, particulates and other pollutants are removed. The flue gas exits the top of the scrubber through the SVDUCONSCR-B-STK87 or SVDUCONSCR-B-STK88 stack.

Water flowrate and pressure drop across the scrubbers were measured and recorded by DPI personnel during testing. Table 2-3 summarizes the operating conditions during testing of the Ducons. Detailed operating parameter data are included in Appendix F.

**Table 2-3  
Summary of Ducons Operating Data**

Test Run	Water flow (gpm)	Pressure Drop across Ducon 1 (in H <sub>2</sub> O)	Pressure Drop across Ducon 2 (in H <sub>2</sub> O)
1	12	8	8
2	12	8	8
3	12	8	8
<b>Average</b>	<b>12</b>	<b>8</b>	<b>8</b>

2.2.3 EU3PRESS-AREA – 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 Stack SV#3PRESS-STK68.

Biofilter bed temperature was measured and recorded by DPI personnel during testing. Table 2-4 summarizes the operating conditions during testing of the No. 3 Biofilter. Detailed operating parameter data are included in Appendix F.

**Table 2-4  
Summary of No. 3 Biofilter Operating Data**

Test Run	Bed Temperature (°F)
1	86
2	86
3	84
<b>Average</b>	<b>85</b>

2.2.4 Regenerative Catalytic Oxidizer

The RCO controls emissions from the EU3PREDRYER and EU3BAKEOVEN units. Emissions entering the RCO pass through a pre-filter that removes particulate matter. The flue gas is directed through an inlet damper to one of two chambers, heated by a burner, and directed through a catalyst bed. The burner increases the temperature of the flue gas to sustain the catalytic reaction. The catalyst is comprised of layers of treated ceramic saddles and rings, where pollutants are oxidized to carbon dioxide and water.

After passing through the catalyst in one chamber, the flue gas is directed through the second chamber, flowing in the opposite direction. This opposing flow allows transfer of heat to the catalyst bed in the second chamber. After exiting the second chamber, the flue gas is discharged through the RCO exhaust stack, SV#3LNRCO-STK93. In a repeated process, after a set cycle time (i.e., 90 seconds), chamber valves open and close, and direct the flue gas through the second chamber catalyst first, before directing it through the first chamber, and through the exhaust stack.

RCO catalyst temperature was measured and recorded by DPI personnel during testing. Table 2-5 summarizes the operating conditions during testing of the RCO. Detailed operating parameter data are included in Appendix F.

**Table 2-5  
Summary of RCO Operating Data**

Test Run	Catalyst Temperature (°F)
1	825
2	825
3	825
<b>Average</b>	<b>825</b>

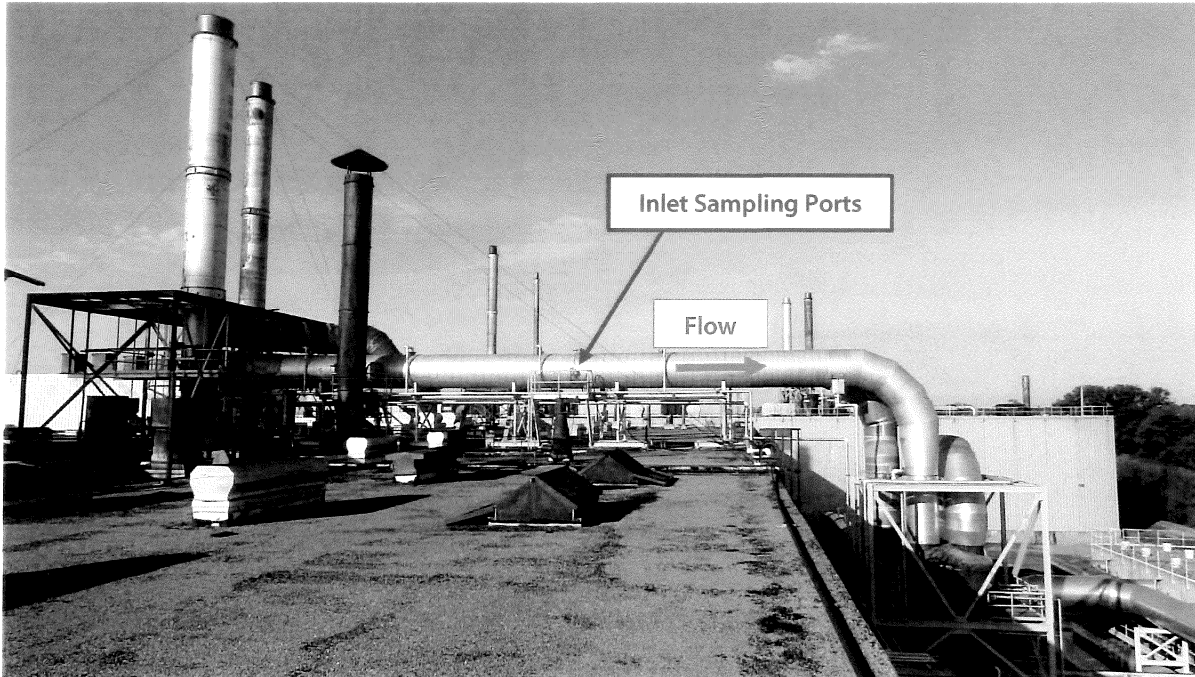
## 2.3 Flue Gas Sampling Locations

### 2.3.1 No. 1 Biofilter Inlet Sampling Location

Two sampling ports oriented at 90° to one another are located in a straight section of a 59.75 inch-internal-diameter duct. The sampling ports are located:

- Approximately 480 inches (8.0 duct diameters) from the nearest downstream disturbance.
- Approximately 528 inches (8.8 duct diameters) from the nearest upstream disturbance.

The sampling ports are accessible via platform. A photograph of the No. 1 Biofilter inlet sampling location is presented in Figure 2-1. Figure 1 in the Appendix depicts the No. 1 Biofilter inlet sampling ports and traverse point locations.



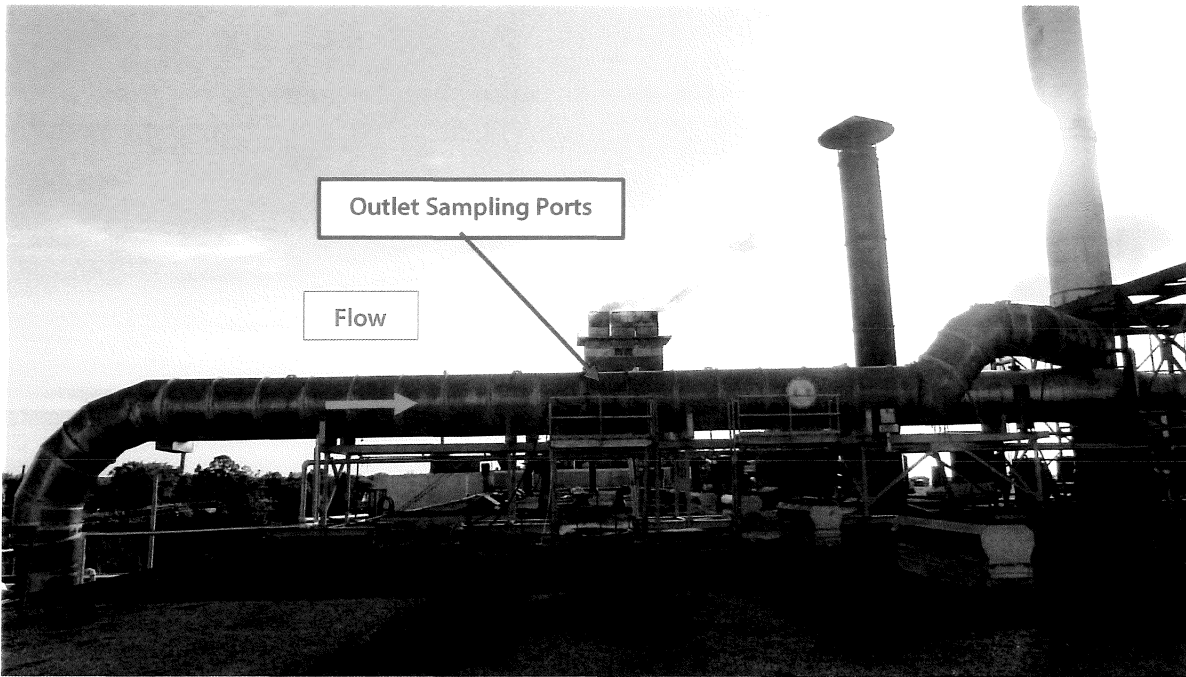
**Figure 2-1. No. 1 Biofilter Inlet Sampling Location**

### 2.3.2 No. 1 Biofilter Outlet Sampling Location

Two sampling ports oriented at 90° to one another are located in a straight section of a 59.25 inch-internal-diameter duct. The sampling ports are located:

- Approximately 200 inches (3.37 duct diameters) from the nearest downstream disturbance.
- Approximately 450 inches (7.59 duct diameters) from the nearest upstream disturbance.

The sampling ports are accessible via platform. A photograph of the No. 1 Biofilter outlet sampling location is presented in Figure 2-2. Figure 2 in the Appendix depicts the No. 1 Biofilter outlet sampling ports and traverse point locations.



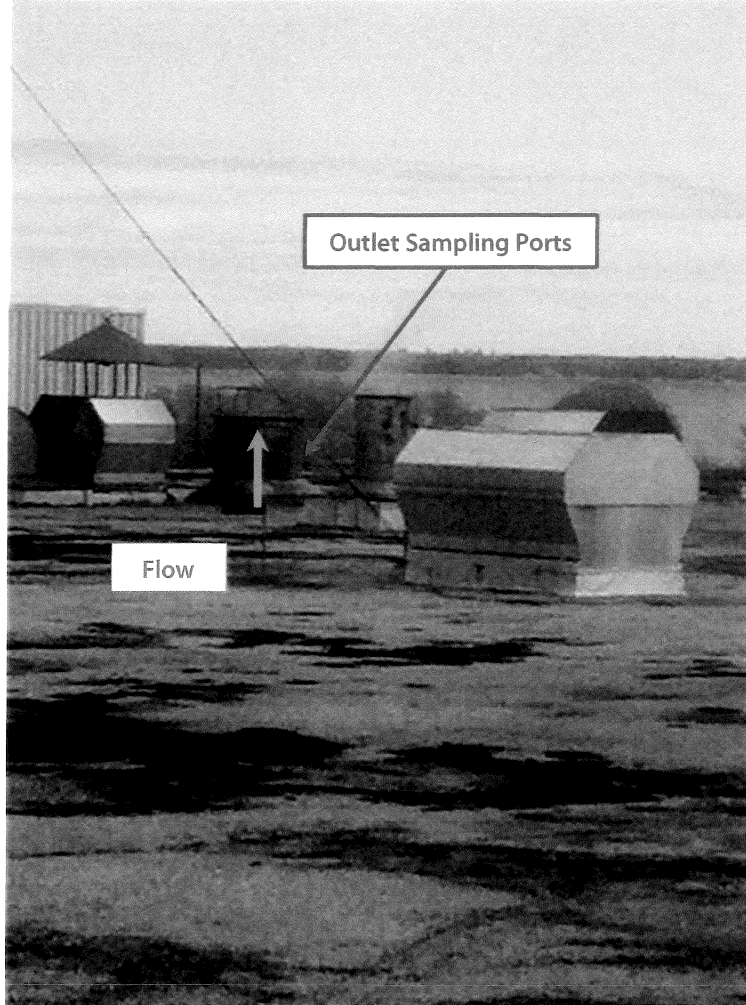
**Figure 2-2. No. 1 Biofilter Outlet Sampling Location**

### 2.3.3 Ducon 1 Sampling Location

Two sampling ports oriented at 90° to one another are located in a straight section of a 62 inch-internal-diameter duct. The sampling ports are located:

- Approximately 32 inches (0.5 duct diameters) from the nearest downstream disturbance.
- Approximately 126 inches (2.0 duct diameters) from the nearest upstream disturbance.

The sampling ports are accessible from the roof of the building. A photograph of the Ducon 1 outlet sampling location is presented in Figure 2-3. Figure 3 in the Appendix depicts the Ducon 1 outlet sampling ports and traverse point locations.



**Figure 2-3. Ducon 1 Outlet Sampling Location**

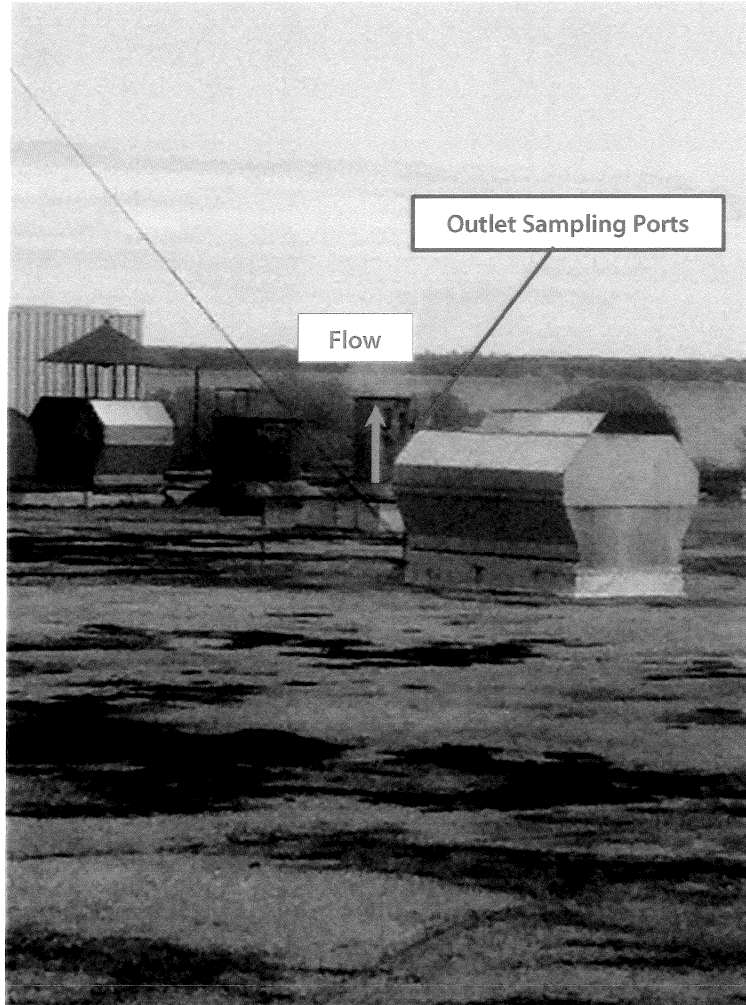
#### 2.3.4 Ducon 2 Sampling Location

Two sampling ports oriented at 90° to one another are located in a straight section of a 40 inch-internal-diameter duct. The sampling ports are located:

- Approximately 21 inches (0.5 duct diameters) from the nearest downstream disturbance.
- Approximately 240 inches (6.0 duct diameters) from the nearest upstream disturbance.

The sampling ports are accessible from the roof of the building. A photograph of the Ducon 2 outlet sampling location is presented in Figure 2-4. Figure 4 in the Appendix depicts the Ducon 2 outlet sampling ports and traverse point locations.





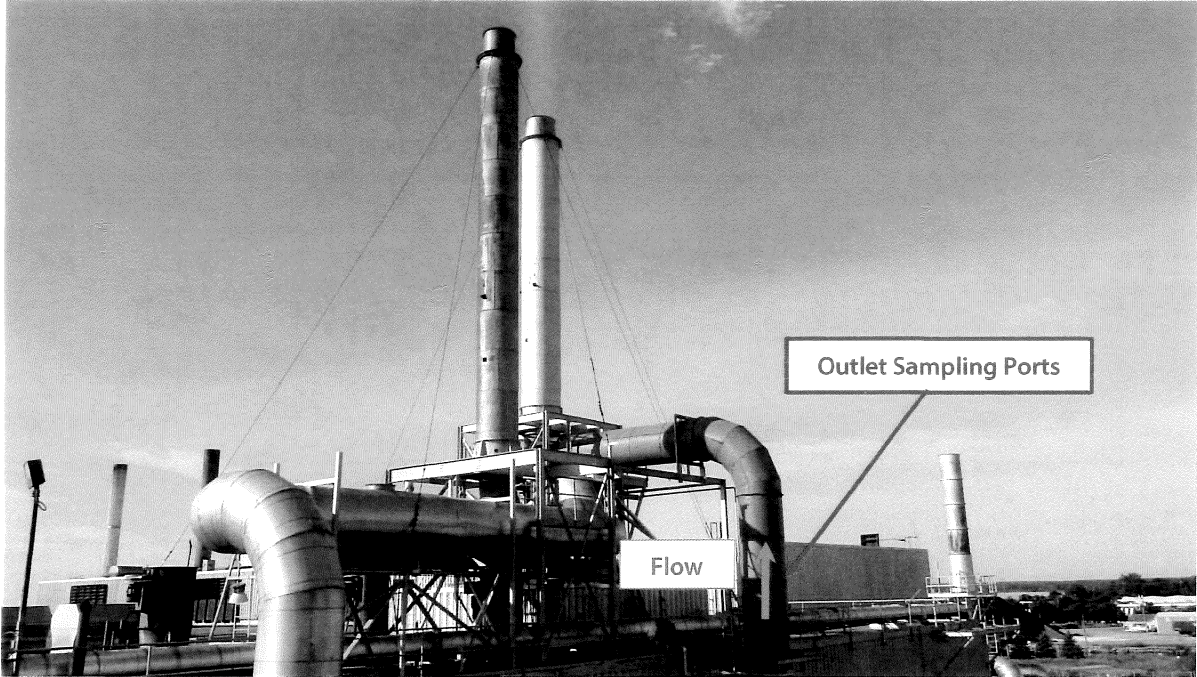
**Figure 2-4. Ducon 2 Outlet Sampling Location**

#### 2.3.5 No. 3 Biofilter Outlet Sampling Location

Two sampling ports oriented at 90° to one another are located in a straight section of a 51.25 inch-internal-diameter duct. The sampling ports are located:

- Approximately 180 inches (3.51 duct diameters) from the nearest downstream disturbance.
- Approximately 300 inches (5.85 duct diameters) from the nearest upstream disturbance.

The sampling ports are accessible from the roof of the building. A photograph of the No. 3 Biofilter outlet sampling location is presented in Figure 2-5. Figure 5 in the Appendix depicts the No. 3 Biofilter outlet sampling ports and traverse point locations.



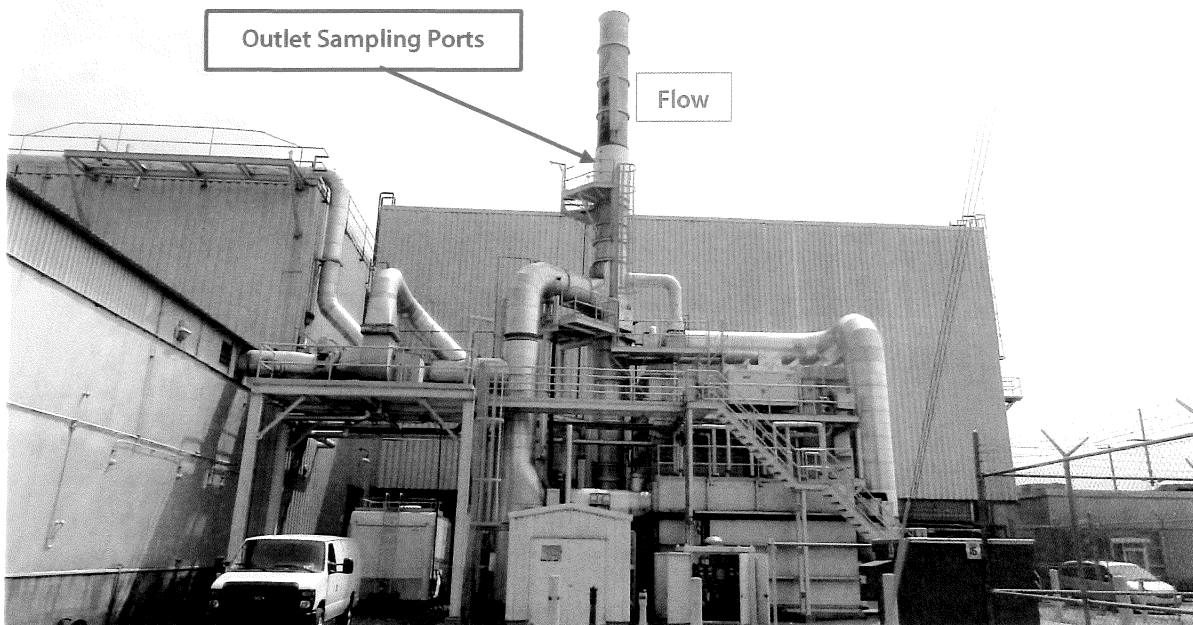
**Figure 2-5. No. 3 Biofilter Outlet Sampling Location**

### 2.3.6 Regenerative Catalyst Oxidizer Sampling Location

Two sampling ports oriented at 90° to one another are located in a straight section of a 47.5 inch-internal-diameter duct. The sampling ports are located:

- Approximately 25 feet (6.3 duct diameters) from the nearest downstream disturbance.
- Approximately 15 feet (3.8 duct diameters) from the nearest upstream disturbance.

The sampling ports are accessible via ladder and platform. A photograph of the RCO outlet sampling location is presented in Figure 2-6. Figure 6 in the Appendix depicts the RCO outlet sampling ports and traverse point locations.



**Figure 2-6. RCO Outlet Sampling Location**

#### 2.4 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 air emission testing was to evaluate compliance with certain emission limits in (1) EGLE ROP MI-ROP-B1476-2015a, effective April 6, 2016, and (2) National Emission Standards for Hazardous Air Pollutants (NESHAP): Plywood and Composite Wood Products, 40 CFR 63, Subpart DDDD.

Table 3-1 summarizes the sampling and analytical matrix.

**Table 3-1  
Sampling and Analytical Matrix**

Sampling Location	Sample/Type of Pollutant	Sample Method	Date (2019)	Run	Start Time	End Time	Analytical Laboratory	
No. 1 Biofilter	Flowrate, molecular weight, moisture content, PM, THC, formaldehyde, methanol	USEPA 1-3, 25A, 205, and 320	Aug. 20	1	08:36	09:36	Not applicable	
				2	09:58	10:58		
				3	11:34	12:44		
				4	14:20	15:20		
				5	17:04	18:04		
				6	18:21	19:21		
	Flowrate, molecular weight, moisture content, particulate matter	USEPA 1-5	Aug. 20	1	08:36	09:44	Bureau Veritas Laboratories	
				2	09:58	11:06		
				3	11:34	12:53		
	Ducon 1	Flowrate, molecular weight, moisture content, particulate matter	USEPA 1-5	Aug. 21	1	07:32	08:35	Bureau Veritas Laboratories
					2	08:50	09:55	
					3	10:19	11:22	
Ducon 2	Flowrate, molecular weight, moisture content, particulate matter	USEPA 1-5	Aug. 21	1	07:30	08:33	Bureau Veritas Laboratories	
				2	08:50	09:55		
				3	10:19	11:22		
No. 3 Biofilter	Flowrate, molecular weight, moisture content, particulate matter	USEPA 1-5	Aug. 22	1	07:58	08:59	Bureau Veritas Laboratories	
				2	09:27	10:29		
				3	10:48	12:00		
RCO	Flowrate, molecular weight, moisture content, particulate matter	USEPA 1-5	Aug. 22	1	07:53	08:54	Bureau Veritas Laboratories	
				2	09:09	10:13		
				3	10:25	11:30		

### 3.2 Field Test Changes and Issues

Communication between DPI, Apex, and EGLE allowed the testing to be completed, as proposed in the July 11, 2019 Intent-to-Test Plan, with the following exceptions:

- Test Run 3 for the No. 1 Biofilter was paused from 11:52 to 12:02 due to a pause in production.
- Testing was not conducted for Boilers #1 and #2. The boilers have individual emissions limits, although air emissions are routed to a shared exhaust stack. On the planned day of testing, both boilers were in operation due to facility needs. Compliance testing for Boilers #1 and #2 will be conducted at a future date, when production power requirements are lower and only one boiler will be operational at a time.

### 3.3 Summary of Results

The results of testing are presented in Tables 3-2 through 3-4. Detailed results are presented in the Appendix Tables 1 through 7 after the Tables Tab of this report. Graphs are presented after the Graphs Tab of this report. Sample calculations are presented in Appendix B.

**Table 3-2  
No. 1 Biofilter Hazardous Air Pollutants  
Emissions Results**

Parameter	Unit	Run 1	Run 2	Run 3	Average Result	Permit Limit
Formaldehyde inlet concentration	ppmv, wet	25.97	28.95	34.69	<b>29.87</b>	--
Formaldehyde inlet emission rate	lb/hr	6.5	7.1	8.6	<b>7.4</b>	--
Formaldehyde outlet concentration	ppmv, wet	0.91	1.01	1.29	<b>1.07</b>	<b>1<sup>†</sup></b>
Formaldehyde outlet emission rate	lb/hr	0.27	0.30	0.37	<b>0.31</b>	--
Formaldehyde removal efficiency	%	96	96	96	<b>96</b>	<b>≥90<sup>†</sup></b>
Methanol inlet concentration	ppmv, wet	46.28	48.40	48.88	<b>47.85</b>	--
Methanol inlet emission rate	lb/hr	12.4	12.7	13.0	<b>12.7</b>	--
Methanol outlet concentration	ppmv, wet	18.15	17.73	19.74	<b>18.54</b>	<b>1<sup>†</sup></b>
Methanol outlet emission rate	lb/hr	5.8	5.6	6.0	<b>5.8</b>	--
Methanol removal efficiency	%	53	56	54	<b>54</b>	<b>≥90<sup>†</sup></b>
THC inlet concentration	ppmv, wet	159.3	129.4	117.1	<b>135.2</b>	--
THC inlet emission rate	lb/hr	59	47	43	<b>49</b>	--
THC outlet concentration	ppmv, wet	18.5	19.8	18.8	<b>19.0</b>	<b>20<sup>†</sup></b>
THC outlet emission rate	lb/hr	8.1	8.6	7.9	<b>8.2</b>	--
THC removal efficiency	%	86	82	82	<b>83</b>	<b>≥90<sup>†</sup></b>

THC: total hydrocarbons

ppmv, wet: part per million by volume, wet basis

lb/hr: pound per hour

† Only one of the six permit limits need to be met in order to demonstrate compliance.

**Table 3-3**  
**No. 1 Biofilter Hazardous Air Pollutants**  
**Emissions Results (Increased Temperature)**

Parameter	Unit	Run 4	Run 5	Run 6	Average Result	Permit Limit
Formaldehyde inlet concentration	ppmv, wet	30.54	31.74	30.80	<b>31.03</b>	--
Formaldehyde inlet emission rate	lb/hr	7.4	7.5	7.3	<b>7.4</b>	--
Formaldehyde outlet concentration	ppmv, wet	1.62	1.59	1.60	<b>1.60</b>	1†
Formaldehyde outlet emission rate	lb/hr	0.52	0.49	0.51	<b>0.51</b>	--
Formaldehyde removal efficiency	%	93	93	93	<b>93</b>	≥90†
Methanol inlet concentration	ppmv, wet	40.02	51.82	52.20	<b>48.01</b>	--
Methanol inlet emission rate	lb/hr	10.3	13.0	13.2	<b>12.2</b>	--
Methanol outlet concentration	ppmv, wet	14.13	13.61	19.53	<b>15.76</b>	1†
Methanol outlet emission rate	lb/hr	4.9	4.5	6.6	<b>5.3</b>	--
Methanol removal efficiency	%	53	65	50	<b>56</b>	≥90†
THC inlet concentration	ppmv, wet	97.6	122.2	139.1	<b>119.6</b>	--
THC inlet emission rate	lb/hr	34	42	48	<b>42</b>	--
THC outlet concentration	ppmv, wet	15.5	15.8	23.3	<b>18.2</b>	20†
THC outlet emission rate	lb/hr	7.4	7.2	10.8	<b>8.5</b>	--
THC removal efficiency	%	79	83	92	<b>85</b>	≥90†

THC: total hydrocarbons

ppmv, wet: part per million by volume, wet basis

lb/hr: pound per hour

†: Only one of the six permit limits need to be met in order to show compliance.

**Table 3-4**  
**Particulate Matter Emissions Results**

Source	Unit	Run 1	Run 2	Run 3	Average Result	Permit Limit
No. 1 Biofilter	lb/hr	5.8	1.9	1.3	<b>3.0</b>	<b>29.3</b>
	lb/1,000 lb exhaust gas, dry	0.028	0.0095	0.0068	<b>0.015</b>	<b>0.10</b>
Ducon 1	lb/1,000 lb exhaust gas, dry	0.0055	0.016	0.0066	<b>0.0093</b>	<b>0.014</b> <b>0.10</b>
Ducon 2	lb/1,000 lb exhaust gas, dry	0.014	0.020	0.020	<b>0.018</b>	
No. 3 Biofilter	lb/hr	1.5	23.5	11.9	<b>12.3</b>	<b>29.3</b>
	lb/1,000 lb exhaust gas, dry	0.010	0.16	0.081	<b>0.083</b>	<b>0.10</b>
Regenerative Catalytic Oxidizer	lb/1,000 lb exhaust gas, dry	0.0043	0.023	0.0050	<b>0.011</b>	<b>0.10</b>

lb/hr: pound per hour

lb/1,000 lb exhaust gas, dry: pound per 1,000 pounds of exhaust gasses on a dry gas basis

## 4.0 Sampling and Analytical Procedures

Apex measured emissions in accordance with USEPA sampling methods. Table 4-1 presents the emissions test parameters and sampling methods.

**Table 4-1  
Emission Testing Methods**

Parameter	Testing Unit	USEPA Reference	
		Method	Title
Sampling ports and traverse points	•	1	Sample and Velocity Traverses for Stationary Sources
Velocity and flowrate	•	2	Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)
Molecular weight	•	3	Gas Analysis for the Determination of Dry Molecular Weight
Moisture content	•	4	Determination of Moisture Content in Stack Gases
Particulate matter	•	5	Determination of Particulate Matter Emissions from Stationary Sources
Total hydrocarbons	•	25A	Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer
Gas dilution	•	205	Verification of Gas Dilution Systems for Field Instrument Calibrations
Formaldehyde, methanol, and moisture content	•	320	Measurements of Vapor Phase Organic and Inorganic Emissions by Extractive Fourier Transform Infrared

### 4.1 Emission Test Methods

#### 4.1.1 Volumetric Flowrate (USEPA Methods 1 and 2)

USEPA Method 1, "Sample and Velocity Traverses for Stationary Sources," was used to evaluate the sampling locations and the number of traverse points for sampling and the measurement of velocity profiles. Figures 1 through 6 in the Appendix depict the source locations and traverse points.

USEPA 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 flowrates. 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 are within the specified limits, the baseline Pitot tube coefficient of 0.84 (dimensionless) was assigned. The digital manometer and thermometer are calibrated using calibration standards that are traceable to National Institute of Standards and Technology (NIST). Pitot tube inspection sheets are included in Appendix A.

**Cyclonic Flow Check.** Apex 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°, the flue gas is considered to be cyclonic at that sampling location and an alternative location should be selected.

The average of the measured traverse point flue gas velocity null angles were less than 20° at the sampling locations. The measurements indicate the absence of cyclonic flow.

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)

USEPA Method 3, "Gas Analysis for the Determination of Dry Molecular Weight," was used to determine the molecular weight of the flue gas. 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<sub>2</sub>) and oxygen (O<sub>2</sub>) were measured by chemical absorption to within ±0.5%. The average CO<sub>2</sub> and O<sub>2</sub> results of the grab samples were used to calculate molecular weight.

#### 4.1.3 Moisture Content (USEPA Method 4)

USEPA Method 4, "Determination of Moisture Content in Stack Gases" was used to determine the moisture content of the flue gas. Prior to testing, the moisture content was estimated using measurements from previous testing, psychrometric charts and/or water saturation vapor pressure tables. These data were used in conjunction with preliminary velocity head pressure and temperature data to calculate flue gas velocity, nozzle size, and to establish the isokinetic sampling rate for the Method 5 sampling. For each sampling run, moisture content of the flue gases was measured using the reference method outlined in Section 2 of USEPA Method 4 in conjunction with the performance of USEPA Method 5.

#### 4.1.4 Filterable Particulate Matter (USEPA Method 5)

USEPA Method 5, "Determination of Particulate Emissions from Stationary Sources," was used to measure the filterable "front-half" particulate matter emissions. The "front half" refers to the filterable particulate mass collected from the nozzle, probe, and filter. Figure 4-1 depicts the USEPA Method 5 sampling train.

Apex's modular isokinetic stack sampling system consists of the following:

- A stainless steel or glass button-hook nozzle.
- A heated (248±25°F) stainless steel or glass-lined probe.
- A desiccated and pre-weighed 83-millimeter-diameter glass fiber filter (manufactured to at least 99.95% efficiency (<0.05 % penetration) for 0.3-micron dioctyl phthalate smoke particles) in a heated (248±25°F) filter box.
- A set of four impingers with the configuration shown in Table 4-2.
- A sampling line.
- An Environmental Supply® control case equipped with a pump, dry-gas meter, and calibrated orifice.



**Table 4-2**  
**USEPA Method 5 Impinger Configuration**

Impinger Order (Upstream to Downstream)	Impinger Type	Impinger Contents	Contents
1	Modified	Water	~100 grams
2	Greenburg Smith	Water	~100 grams
3	Modified	Empty	0 grams
4	Modified	Silica desiccant	~300 grams

Prior to testing, a preliminary velocity traverse was performed and a nozzle size was calculated that would allow isokinetic sampling at an average rate of approximately 0.75 cubic feet per minute (cfm). Apex selected a pre-cleaned nozzle that has an inner diameter that approximated the calculated ideal value. The nozzle was inspected and measured with calipers across three cross-sectional chords to evaluate the inside diameter; rinsed and brushed with acetone; and connected to the sample probe.

The impact and static pressure openings of the Pitot tube were leak-checked at or above a velocity head of 3.0 inches of water for more than 15 seconds. The sampling train was leak-checked by capping the nozzle tip and applying a vacuum of approximately 10 inches of mercury to the sampling train. The dry-gas meter was then monitored (for approximately 1 minute) to measure that the sample train leak rate was less than 0.02 cubic feet per minute (cfm). The probe and filter heaters were turned on, and the sample probe was inserted into the sampling port to begin sampling.

Ice was placed around the impingers, and the probe and filter temperatures were allowed to stabilize at  $248 \pm 25$  °F before each sample run. After the desired operating conditions were coordinated with the facility, testing was initiated.

Stack parameters (e.g., flue velocity, temperature) were monitored to establish the isokinetic sampling rate within  $100 \pm 10$  % for the duration of the test. Data was recorded at each of the traverse points.

At the conclusion of a test run and the post-test leak check, the sampling train was disassembled, and the impingers and filter were transported to the recovery area. The filter was recovered using tweezers and placed in a Petri dish. The Petri dish was immediately labeled and sealed with Teflon tape. The nozzle, probe, and the front half of the filter holder assembly were brushed and, at a minimum, triple-rinsed with acetone to recover particulate matter. The acetone rinses were collected in pre-cleaned sample containers.

At the end of a test run, the mass of liquid collected in each impinger was measured using a scale to within  $\pm 0.5$  grams; these masses were used to calculate the moisture content of the flue gas. The contents of the impinger train were discarded after the mass was measured.

Apex labeled each container with the test number, test location, and test date, and marked the level of liquid on the outside of the container. Immediately after recovery, the sample containers were stored. The sample containers were transported to Bureau Veritas Laboratories in Mississauga, Ontario, Canada for analysis. The laboratory analytical results are included in Appendix E.

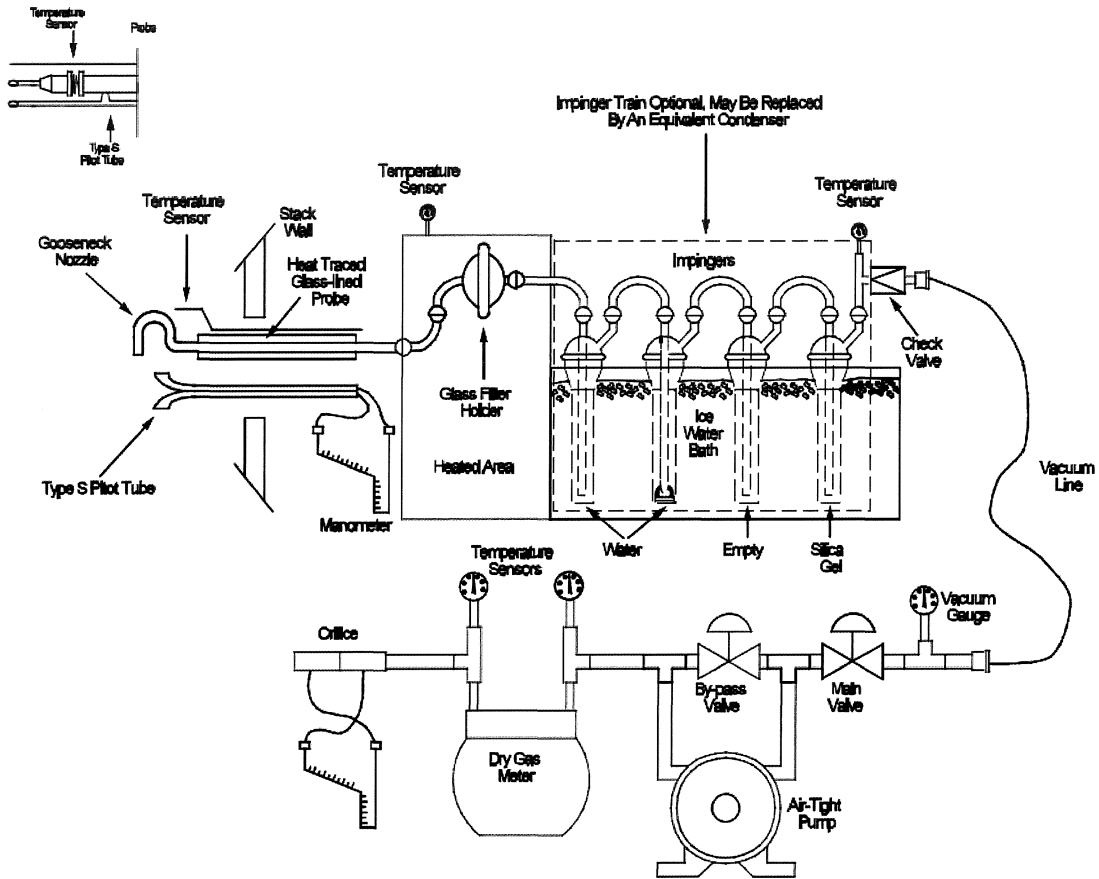


Figure 4-1. USEPA Method 5 Sampling Train

#### 4.1.5 Total Hydrocarbons (USEPA Method 25A)

USEPA Method 25A, "Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer," was used to measure total hydrocarbon concentrations in the flue gas. Samples were collected through a stainless steel probe and heated sample line into an analyzer.

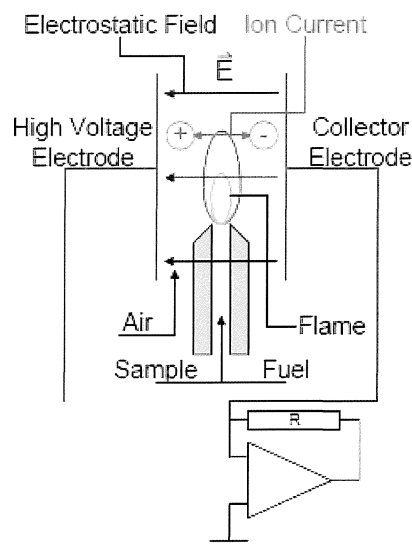
A flame ionization detector (FID) determines the average hydrocarbon concentration in part per million by volume (ppmv) of THC as the calibration gas (i.e., propane). The FID is fueled by 100% hydrogen, which generates a flame with a negligible number of ions. Flue gas is introduced into the FID and 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.

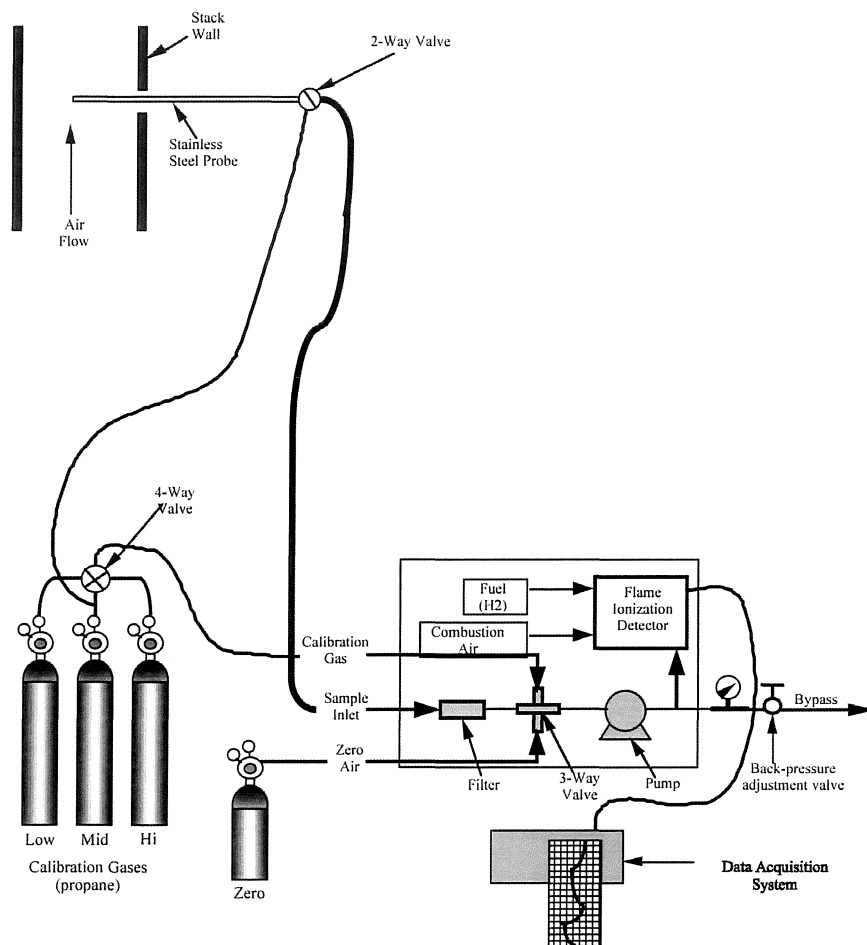
Using the voltage analog signal, measured by the FID, the concentration of THCs was recorded by a data acquisition system (DAS). The average concentration of THCs is reported as the calibration gas (i.e., propane) in equivalent units.

Before testing, the analyzer was calibrated by introducing a zero-calibration range gas (<1% of span value) and high-calibration range gas (80-90% span value) to the tip of the sampling probe. The span value was set to 1.5 to 2.5 times the expected concentration (e.g., 0-100 ppmv). Next, a low-calibration range gas (25-35% of span value) and mid-calibration range gas (45-55% of span value) were introduced. The analyzers are considered to be calibrated when the analyzer response is  $\pm 5\%$  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 gas to the tip of the sampling probe. The test run data was considered valid if the calibration drift test demonstrated the analyzers are responding within 3% of the 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**

4.1.6 Gas Dilution (USEPA Method 205)

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

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

#### 4.1.7 Formaldehyde, Methanol, and Moisture Content (USEPA Method 320)

USEPA Method 320, "Measurements of Vapor Phase Organic and Inorganic Emissions by Extractive Fourier Transform Infrared (FTIR) Spectroscopy," was used to measure formaldehyde, methanol, and moisture content in the flue gas. Gaseous samples were withdrawn from the stack and transferred to an MKS Instruments MultiGas 2030 FTIR spectrometer.

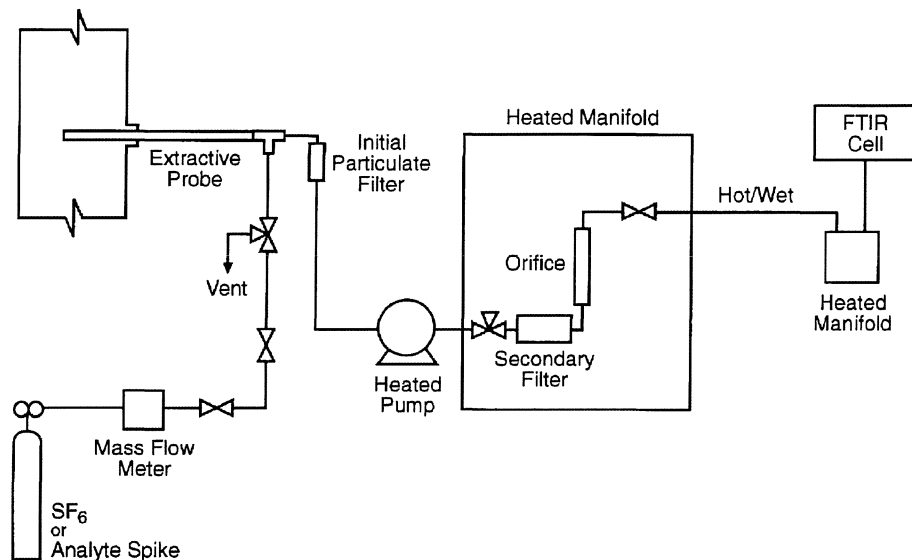
The sample gas was directed through a heated probe, heated filter and heated transfer line connected to the FTIR. The probe, filter, transfer line, and FTIR were maintained at 191°C (375°F) during testing. The formaldehyde, methanol, and moisture concentrations were measured based on their infrared absorbance compared to reference spectra. The FTIR analyzer scanned the sample gas approximately once per second. A data point was generated every half minute as the co-addition of 32 scans.

FTIR quality assurance procedures followed USEPA Method 320. A calibration transfer standard (CTS) was analyzed before and after testing. Acetaldehyde and methanol matrix spiking were performed prior to testing. Section 3.29 of USEPA Method 320 allows the use of a surrogate analyte for the purposes of analyte spiking. Acetaldehyde was chosen as a surrogate to formaldehyde for the following reason:

- Acetaldehyde's physical and chemical properties are similar to those of formaldehyde. Formaldehyde is the C1 aldehyde (CH<sub>2</sub>O); acetaldehyde is the C2 aldehyde (CH<sub>3</sub>CHO).

The analyte spikes were set to a target dilution ratio of 1:10 or less. Valid tests required spike recoveries to be within the Method 320 allowance of 100±30%.

Figure 4-3 depicts the USEPA Method 320 sampling train.



**Figure 4-3. USEPA Method 320 Sampling Train**

#### 4.2 Process Data

DPI recorded process data during testing. EGLE personnel verified the requested operating and process data were recorded. Process data are included in Appendix F.

## 5.0 Quality Assurance and Quality Control

### 5.1 QA/QC Procedures

Equipment used in this emissions test program passed Quality Assurance (QA) and Quality Control (QC) procedures. Refer to Appendix A for equipment calibrations. Before testing, the sampling equipment was cleaned, inspected, and calibrated according to procedures outlined in the applicable USEPA sampling method and USEPA's "Quality Assurance Handbook for Air Pollution Measurement Systems: Volume III, Stationary Source-Specific Methods."

### 5.2 QA/QC Audits

Onsite QA/QC procedures (i.e., Pitot tube inspections, nozzle size verifications, leak check, calculation of isokinetic sampling rates, calibrations) were performed in accordance with the respective USEPA sampling methods. Equipment inspection and calibration measurements are presented in Appendix A.

Offsite QA audits include dry-gas meter and thermocouple calibrations.

#### 5.2.1 Audit Sample Results QA/QC

QA audit samples were not proposed during this test program. Currently, audit samples for the parameters to be measured are not available from the EPA Stationary Source Audit Program.

#### 5.2.2 Sampling Train QA/QC

The sampling trains described in Section 4.1 were audited for measurement accuracy and data reliability. Table 5-1 summarizes the QA/QC audits conducted on each sampling train.

**Table 5-1  
USEPA Method 5 Sampling Train QA/QC**

Parameter	Run 1	Run 2	Run 3	Method Requirement	Comment
<b>No. 1 Biofilter</b>					
Average velocity pressure head (in H <sub>2</sub> O)	1.06	1.03	0.98	>0.05 in H <sub>2</sub> O	Valid
Sampling train post-test leak check	0 ft <sup>3</sup> for 1 min at 5 in Hg	0 ft <sup>3</sup> for 1 min at 4 in Hg	0 ft <sup>3</sup> for 1 min at 4 in Hg	<0.020 ft <sup>3</sup> for 1 minute at a vacuum ≥ recorded during test	Valid
Sampling vacuum (in Hg)	1	1	1		
<b>Ducon 1</b>					
Average velocity pressure head (in H <sub>2</sub> O)	0.08	0.07	0.08	>0.05 in H <sub>2</sub> O	Valid
Sampling train post-test leak check	0.004 ft <sup>3</sup> for 1 min at 5 in Hg	0 ft <sup>3</sup> for 1 min at 5 in Hg	0.001 ft <sup>3</sup> for 1 min at 3 in Hg	<0.020 ft <sup>3</sup> for 1 minute at a vacuum ≥ recorded during test	Valid
Sampling vacuum (in Hg)	1	1	1		
<b>Ducon 2</b>					
Average velocity pressure head (in H <sub>2</sub> O)	0.42	0.36	0.35	>0.05 in H <sub>2</sub> O	Valid
Sampling train post-test leak check	0 ft <sup>3</sup> for 1 min at 5 in Hg	0 ft <sup>3</sup> for 1 min at 3 in Hg	0 ft <sup>3</sup> for 1 min at 3 in Hg	<0.020 ft <sup>3</sup> for 1 minute at a vacuum ≥ recorded during test	Valid
Sampling vacuum (in Hg)	1	1	1		
<b>No. 3 Biofilter</b>					
Average velocity pressure head (in H <sub>2</sub> O)	0.96	0.98	0.97	>0.05 in H <sub>2</sub> O	Valid
Sampling train post-test leak check	0 ft <sup>3</sup> for 1 min at 6 in Hg	0 ft <sup>3</sup> for 1 min at 3 in Hg	0 ft <sup>3</sup> for 1 min at 4 in Hg	<0.020 ft <sup>3</sup> for 1 minute at a vacuum ≥ recorded during test	Valid
Sampling vacuum (in Hg)	1	1	1		
<b>RCO</b>					
Average velocity pressure head (in H <sub>2</sub> O)	0.79	0.78	0.75	>0.05 in H <sub>2</sub> O	Valid
Sampling train post-test leak check	0 ft <sup>3</sup> for 1 min at 5 in Hg	0 ft <sup>3</sup> for 1 min at 5 in Hg	0 ft <sup>3</sup> for 1 min at 5 in Hg	<0.020 ft <sup>3</sup> for 1 minute at a vacuum ≥ recorded during test	Valid
Sampling vacuum (in Hg)	1	1	1		

### 5.2.3 Instrument Analyzer QA/QC

The instrument analyzer sampling trains described in Section 4.1 were audited for measurement accuracy and data reliability. The analyzers passed the applicable calibration criteria. Table 5-2 summarizes the gas cylinders used during this test program. Analyzer calibration, bias, and drift data are included in Appendix A.

**Table 5-2  
Calibration Gas Cylinder Information**

Parameter	Gas Vendor	Cylinder Serial Number	Cylinder Value	Expiration Date
Air	Airgas	CC139694	--	4/5/2026
Propane	Airgas	CC56826	51.30 ppm	10/12/2023
Propane	Airgas	CC156708	109.6 ppm	12/3/2026
Propane	Airgas	CC18627	1,098 ppm	11/30/2026
Nitrogen	Airgas	1535054Y	99.9995%	2/4/2024
Ethylene	Airgas	ALM 026651	103.4 ppm	1/16/2021
Acetaldehyde, methanol, sulfur hexafluoride	Airgas	CC496690	99.40 ppm 104.0 ppm 10.29 ppm	10/24/2019

5.2.4 Dry-Gas Meter QA/QC

Table 5-3 summarizes the dry-gas meter calibration checks in comparison to the acceptable USEPA tolerance. Complete dry-gas meter calibrations are included in Appendix A.

**Table 5-3  
Dry-Gas Meter Calibration QA/QC**

Dry-Gas Meter	Pre-test DGM Calibration Factor	Post-test DGM Calibration Factor	Difference Between Pre- and Post-test Calibrations	Acceptable Tolerance	Comment
7	1.006 (6/24/2019)	0.996 (9/13/2019)	-0.010	±0.05	Valid
X	1.008 (5/28/2019)	1.003 (9/13/2019)	0.005	±0.05	Valid

5.2.5 Thermocouple QA/QC

Temperature measurements using thermocouples and digital pyrometers were compared to a reference temperature prior to testing to evaluate accuracy of the equipment. The thermocouples and pyrometers measured temperature within ±1.5% of the reference temperatures and were within USEPA acceptance criteria. Thermocouple calibration sheets are included in Appendix A.

5.2.6 Laboratory Blanks QA/QC

QA/QC blanks were analyzed for the parameters of interest. The results are presented in Table 5-4. Blank corrections were not applied to the sample results. Blank and sample laboratory results are included in Appendix E.



**Table 5-4**  
**Laboratory Blanks QA/QC**

Sample Identification	Result (mg)	Comment
Method 5 Filter Blank	1.60	Reporting limit is 0.30 milligrams.
Method 5 Acetone Blank	0.5	Reporting limit is 0.5 milligrams. Sample volume was approximately 37 milliliters.

### 5.3 Data Reduction and Validation

The emissions testing Project Manager and/or the QA/QC Officer validated computer spreadsheets. The computer spreadsheets were used to ensure that field calculations were accurate. Random inspection of the field data sheets were conducted to verify data have been recorded appropriately. At the completion of a test, the raw field data were entered into computer spreadsheets to provide applicable onsite emissions calculations. The computer data were checked against the raw field sheets for accuracy during review of the report.

### 5.4 Sample Identification and Custody

The Apex project manager was responsible for the handling and procurement of the data collected in the field. The project manager ensured the data sheets are accounted for and completed in their entirety. Applicable Chain of Custody procedures followed guidelines outlined within ASTM D4840-99 (Reapproved 2010), "Standard Guide for Sample Chain-of-Custody Procedures." Detailed sampling and recovery procedures are described in Section 4.1. For each sample collected (i.e., impinger), sample identification and custody procedures were completed as follows:

- Containers were sealed to prevent contamination.
- Containers were labeled with test number, location, and test date.
- The level of fluid was marked on the outside of the sample containers to indicate if leakage occurred prior to receipt of the samples by the laboratory.
- Containers were placed in a cooler for storage, if necessary.
- Samples were logged using guidelines outlined in ASTM D4840-99(Reapproved 2010).
- Samples were transported to the laboratory under chain of custody.

Chains of custody and laboratory analytical results are included in Appendix E.

### 5.5 QA/QC Problems

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