

**Regulatory Information**

*Permit No.* Michigan Department of Environment, Great Lakes, and Energy Air Quality  
Division (EGLE) Operating Permit NO. MI-ROP-B1476-2015a  
*Regulatory Citation* 40 CFR 63, Subpart DDDD

**Source Information**

<i>Source Name</i>	<i>Source ID</i>	<i>Target Parameters</i>
RCO	---	DE of THC, HCHO, CH <sub>3</sub> OH

**Contact Information**

<i>Test Location</i>	<i>Test Company</i>
<p>Decorative Panels International 416 Ford Ave Alpena, MI</p> <p>Facility Contact: Timothy Rombach Senior Environmental Engineer timothy.rombach@decpanels.com (989) 356-8568</p> <p>EGLE Contacts: Jeremy Howe Supervisor, Technical Programs Unit Howej1@michigan.gov (231) 878-6687</p> <p>Daniel J. Droste Technical Programs Unit drosted3@michigan.gov (989) 225-6052</p> <p>Rebecca Radulski Environmental Engineer radulskir@michigan.gov (989) 217-0051</p>	<p>Derek Wong Apex Companies, LLC 46555 Humboldt Drive Suite 103 Novi, Michigan 48377 derek.wong@apexcos.com (248) 875-7581</p> <p>Alliance Technical Group, LLC 20 Parkway View Drive Pittsburgh, PA 15205</p> <p>Project Manager Kenji Kinoshita kenji.kinoshita@alliancetg.com (412) 668-4040</p> <p>Field Team Leader Samuel Hines samuel.hines@alliancetg.com (412) 892-1342</p> <p>QA/QC Manager Kathleen Shonk katie.shonk@alliancetg.com (812) 452-4785</p> <p>Report Coordinator Lauren Carney lauren.carney@alliancetg.com (856) 372-2093</p>

Alliance Technical Group, LLC (Alliance) has completed the source testing as described in this report. Results apply only to the source(s) tested and operating condition(s) for the specific test date(s) and time(s) identified within this report. All results are intended to be considered in their entirety, and Alliance is not responsible for use of less than the complete test report without written consent. This report shall not be reproduced in full or in part without written approval from the customer.

To the best of my knowledge and abilities, all information, facts and test data are correct. Data presented in this report has been checked for completeness and is accurate, error-free and legible. Onsite testing was conducted in accordance with approved internal Standard Operating Procedures. Any deviations or problems are detailed in the relevant sections in the test report.

This report is only considered valid once an authorized representative of Alliance has signed in the space provided below; any other version is considered draft. This document was prepared in portable document format (.pdf) and contains pages as identified in the bottom footer of this document.



**Kenji Kinoshita**  
**Project Manager**  
**Alliance Technical Group, LLC**

2/16/24

Date

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## 1.0 Introduction

Alliance Technical Group, LLC (Alliance) was retained by Apex Companies, on behalf of Decorative Panels International, Inc. (DPI) to conduct compliance testing at the Alpena, Michigan, facility. Portions of the facility are subject to provisions of the Michigan Department of Environment, Great Lakes, and Energy Air Quality Division (EGLE) Operating Permit NO. MI-ROP-B1476-2015a and National Emission Standards for Hazardous Air Pollutants (NESHAP) 40 CFR 63, Subpart DDDD. Testing included determining the destruction efficiency of total hydrocarbons (THC), formaldehyde (HCHO) and methanol (CH<sub>3</sub>OH) from the inlet and outlet of the Regenerative Catalytic Oxidizer (RCO) that controls emissions from the No. 3 Press Line Predryer (EU3PREDRYER) and Bake Oven (EU3BAKEOVEN) units.

## 1.1 Facility and Control Unit Descriptions

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, 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 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.

## 1.2 Project Team

Personnel involved in this project are identified in the following table.

**Table 1-1: Project Team**

<b>Facility Personnel</b>	Timothy Rombach – DPI
<b>Apex Consultant</b>	Derek Wong
<b>Regulatory Personnel</b>	Rebecca Radulski Daniel Droste
<b>Alliance Personnel</b>	Samuel Hines

## 1.3 Site Specific Test Plan & Notification

Testing was conducted in accordance with the Intent-to-Test Plan submitted to EGLE on November 3, 2023.

## 1.4 Test Program Notes

During Run 3, the press was shut down; however, the ovens were maintained full and at temperature. The concentrations of the emissions did not decrease during the shutdown; therefore, the test run was continued.

## 2.0 Summary of Results

Alliance conducted compliance testing at the DPI facility located in Alpena, Michigan. Testing included determining the destruction efficiency of total hydrocarbons (THC), formaldehyde (HCHO), and methanol (CH<sub>3</sub>OH) from the inlet and outlet of the RCO.

Table 2-1 provides a summary of the emission testing results. Table 2-2 provides a summary of the process operating and control system data collected during testing. Any difference between the summary results listed in the following tables and the detailed results contained in appendices is due to rounding for presentation.

As stated in the Intent-to-Test Plan, 40 CFR Part 63, Subpart DDDD—National Emission Standards for Hazardous Air Pollutants: Plywood and Composite Wood Products, provides various options for demonstrating compliance: production-based compliance, compliance options for add-on control systems, and emissions averaging compliance option. DPI intended to demonstrate compliance by §63.2240 (b) – Compliance options for add-on control systems. Compliance options for §63.2240 (b) are summarized below:

1. Reduce emission of total HAPs, measured as total hydrocarbons (THC) (as carbon) by 90% (methane may be subtracted from the THC as carbon measurements);
2. Limit emissions of total HAP, measured as THC (as carbon) to 20 ppmvd (methane may be subtracted from the THC-as-carbon measurements);
3. Reduce methanol emissions by 90%;
4. Limit methanol emissions to less than or equal to 1 ppmvd if uncontrolled methanol emissions entering the control device are greater than or equal to 10 ppmvd;
5. Reduce formaldehyde emissions by 90%; or
6. Limit formaldehyde emission to less than or equal to 1 ppmvd if uncontrolled emissions entering the control device are greater than or equal to 10 ppmvd.

The results met Compliance Options 3 and 5 – reduction of methanol and formaldehyde emissions by 90% as shown below in Table 2-1. Only one of the permit limits needs to be met to demonstrate compliance.



Table 2-1: Summary of Results

Run Number	Run 1	Run 2	Run 3	Average
Date	1/9/24	1/9/24	1/9/24	--
<b>Total Hydrocarbons Data (as propane)</b>				
.....Inlet Concentration, ppmvd	121.6	124.3	117.7	121.2
Outlet Concentration, ppmvd	61.4	59.8	63.0	61.4
Inlet Emission Rate, lb/hr	25.8	26.2	25.0	25.7
Outlet Emission Rate, lb/hr	13.4	13.0	13.8	13.4
Reduction Efficiency, %	48.1	50.5	44.9	47.8
<b>Non-Methane Hydrocarbons Data (as carbon)</b>				
Inlet Concentration, ppmvd	197.8	199.0	194.2	197.0
Outlet Concentration, ppmvd	54.1	41.5	67.0	54.2
Inlet Emission Rate, lb/hr	11.4	11.4	11.2	11.3
Outlet Emission Rate, lb/hr	3.2	2.4	4.0	3.2
Reduction Efficiency, %	71.8	78.5	64.5	71.6
<b>Reduction Efficiency Limit, %</b>	--	--	--	<b>≥ 90</b>
<b>Formaldehyde Data</b>				
Inlet Concentration, ppmvd	5.98	6.86	7.22	6.69
Outlet Concentration, ppmvd	0.30	0.31	0.25	0.29
Inlet Emission Rate, lb/hr	0.89	1.0	1.1	0.99
Outlet Emission Rate, lb/hr	0.044	0.046	0.037	0.042
Reduction Efficiency, %	95.0	95.5	96.6	95.7
<b>Reduction Efficiency Limit, %</b>	--	--	--	<b>≥ 90</b>
<b>Methanol Data</b>				
Inlet Concentration, ppmvd	7.37	8.23	6.68	7.43
Outlet Concentration, ppmvd	0.14	0.16	0.16	0.15
Inlet Emission Rate, lb/hr	1.2	1.3	1.1	1.2
Outlet Emission Rate, lb/hr	0.023	0.026	0.025	0.024
Reduction Efficiency, %	98.1	98.0	97.7	97.9
<b>Reduction Efficiency Limit, %</b>	--	--	--	<b>≥ 90</b>

Note: Only one of the permit limits needs to be met to demonstrate compliance.

**Table 2-2: Process Operating / Control System Data**

Run Number	Run 1	Run 2	Run 3	Average
Date	1/9/24	1/9/24	1/9/24	--
Number of Press Cycles	14	13	8	12
Production Rate, ft <sup>2</sup> /hr	6,440	5,980	3,680	5,367
RCO Temperature, °F	823	820	820	823
RCO Prefilter Pressure, inch H <sub>2</sub> O	1.61	1.54	1.56	1.57

The board thickness produced during testing was one-quarter inch. In each press cycle, 20 boards with dimensions of 4 feet by 8 feet are produced.



### 3.0 Testing Methodology

The emission testing program was conducted in accordance with the test methods listed in Table 3-1. Method descriptions are provided below while quality assurance/quality control data is provided in Appendix C.

**Table 3-1: Source Testing Methodology**

Parameter	U.S. EPA Reference Test Methods	Notes/Remarks
Volumetric Flow Rate	1 and 2	Full Velocity Traverses
Oxygen/Carbon Dioxide	3A	Instrumental Analysis
Non-Methane Hydrocarbons	25A and 18	Instrumental Analysis
Formaldehyde, Methanol, and Moisture	320	FTIR – Continuous Sampling
Gas Dilution System Certification	205	---

#### 3.1 U.S. EPA Reference Test Methods 1 and 2 – Sampling/Traverse Points and Volumetric Flow Rate

The sampling location and number of traverse (sampling) points were selected in accordance with U.S. EPA Reference Test Method 1. To determine the minimum number of traverse points, the upstream and downstream distances were equated into equivalent diameters and compared to Figure 1-1 in U.S. EPA Reference Test Method 1.

Full velocity traverses were conducted in accordance with U.S. EPA Reference Test Method 2 to determine the average stack gas velocity pressure, static pressure, and temperature. The velocity and static pressure measurement system consisted of a pitot tube and inclined manometer. The stack gas temperature was measured with a K-type thermocouple and pyrometer.

Stack gas velocity pressure and temperature readings were recorded during each test run. The data collected was utilized to calculate the volumetric flow rate in accordance with U.S. EPA Reference Test Method 2.

As agreed with EGLE on January 4, 2023, because the inlet sampling location did not meet Method 1, the inlet flowrate was assumed equal to the outlet flowrate minus 900 cfm. The 900 cfm is based on the combustion air fan rating for the RCO (810 cfm, see combustion fan specifications in Appendix E) and the average measured flowrate of natural gas combusted in the RCO (19 cfm).

#### 3.2 U.S. EPA Reference Test Method 3A – Oxygen/Carbon Dioxide

The oxygen (O<sub>2</sub>) and carbon dioxide (CO<sub>2</sub>) testing were conducted in accordance with U.S. EPA Reference Test Method 3A. Data was collected online and reported in one-minute averages. The sampling system consisted of a stainless-steel probe, Teflon sample line(s), gas conditioning system and the identified gas analyzer. The gas conditioning system was a non-contact condenser used to remove moisture from the stack gas. If an unheated Teflon sample line was used, then a portable non-contact condenser was placed in the system directly after the probe. Otherwise, a heated Teflon sample line was used. The quality control measures are described in Section 3.6.



### 3.3 U.S. EPA Reference Test Methods 25A and 18 – Non-Methane Hydrocarbons

The non-methane hydrocarbons (NMHC) testing was conducted in accordance with U.S. EPA Reference Test Methods 25A and 18. The sampling system consisted of a stainless-steel probe, heated Teflon sample line(s) and the identified gas analyzer. Total hydrocarbon data was collected online and reported in one-minute averages. The quality control measures are described in Section 3.7.

The methane concentration was determined by integrated Tedlar bag sampling and offsite lab analysis using U.S. EPA Reference Test Method 18. The average methane concentration was subtracted from the average total hydrocarbon concentration to provide a non-methane VOC concentration.

### 3.4 U.S. EPA Reference Test Method 320 – Formaldehyde, Methanol, and Moisture

The concentrations of formaldehyde ( $H_2CO$ ) and methanol ( $CH_3OH$ ), and moisture content were determined in accordance with U.S. EPA Reference Test Method 320. Each source gas stream was extracted at a constant rate through a heated probe, heated filter, and heated sample line and analyzed with a CAI 600 FTIR operated by a portable computer. The computer has FTIR spectra of calibration gases stored on the hard drive. These single component calibration spectra are used to analyze the measured sample spectra. The gas components to be measured were selected from the spectra library and incorporated into the analytical method. The signal amplitude, linearity, and signal to noise ratio were measured and recorded to document analyzer performance. A leak check was performed on the sample cell. The instrument path length was verified using ethylene as the Calibration Transfer Standard. Dynamic spiking was performed using a certified standard of the target compound or appropriate surrogate in nitrogen with sulfur hexafluoride blended as a tracer to calculate the dilution factor. All test spectra, interferograms, and analytical method information are recorded and stored with the calculated analytical results. The quality control measures are described in Section 3.8.

### 3.5 U.S. EPA Reference Test Method 205 – Gas Dilution System Certification

A calibration gas dilution system field check was conducted in accordance with U.S. EPA Reference Method 205. Multiple dilution rates and total gas flow rates were utilized to force the dilution system to perform two dilutions on each mass flow controller. The diluted calibration gases were sent directly to the analyzer, and the analyzer response recorded on an electronic field data sheet. The analyzer response agreed within 2% of the actual diluted gas concentration. A second Protocol 1 calibration gas, with a cylinder concentration within 10% of one of the gas divider settings described above, was introduced directly to the analyzer, and the analyzer response recorded in an electronic field data sheet. The cylinder concentration and the analyzer response agreed within 2%. These steps were repeated three times. Method 205 data are included in Appendix D.

### 3.6 Quality Assurance/Quality Control – U.S. EPA Reference Test Method 3A

#### *EPA Protocol 1 Calibration Gases*

Cylinder calibration gases used met EPA Protocol 1 ( $\pm 2\%$ ) standards. Calibration gas certificates are included in Appendix D.

#### *Direct Calibration & Calibration Error Test*

Low-Level gas was introduced directly to the analyzer. After adjusting the analyzer to the Low-Level gas concentration and once the analyzer reading was stable, the analyzer value was recorded. This process was repeated for the High-Level gas. For the Calibration Error Test, Low-, Mid-, and High-Level calibration gases were



sequentially introduced directly to the analyzer. All values were within 2.0% of the Calibration Span or 0.5% absolute difference.

#### *System Bias and Response Time*

High- or Mid-Level gas (whichever was closer to the stack gas concentration) was introduced at the probe and the time required for the analyzer reading to reach 95% or 0.5% (whichever was less restrictive) of the gas concentration was recorded. The analyzer reading was observed until it reached a stable value, and this value was recorded. Next, Low-Level gas was introduced at the probe and the time required for the analyzer reading to decrease to a value within 5.0% or 0.5% (whichever was less restrictive) was recorded. If the Low-Level gas was zero gas, the response was 0.5% or 5.0% of the upscale gas concentration (whichever was less restrictive). The analyzer reading was observed until it reached a stable value, and this value was recorded. The measurement system response time and initial system bias were determined from these data. The System Bias was within 5.0% of the Calibration Span or 0.5% absolute difference.

#### *Post Test System Bias Checks*

High- or Mid-Level gas (whichever was closer to the stack gas concentration) was introduced at the probe. After the analyzer response was stable, the value was recorded. Next, Low-Level gas was introduced at the probe, and the analyzer value recorded once it reached a stable response. The System Bias was within 5.0% of the Calibration Span or 0.5% absolute difference or the data was invalidated, and the Calibration Error Test and System Bias were repeated.

#### *Post Test Drift Checks*

Drift between pre- and post-run System Bias was within 3% of the Calibration Span or 0.5% absolute difference. If the drift exceeded 3% or 0.5%, the Calibration Error Test and System Bias were repeated.

#### *Stratification Check*

To determine the number of sampling points, a gas stratification check was conducted prior to initiating testing. The pollutant concentrations were measured at three points (16.7, 50.0 and 83.3% of the measurement line). Each traverse point was sampled for a minimum of twice the system response time.

If the diluent concentration at each traverse point did not differ more than 5% or 0.3% (whichever was less restrictive) of the average pollutant concentration, then single point sampling was conducted during the test runs. If the pollutant concentration did not meet these specifications but differed less than 10% or 0.5% from the average concentration, then three point sampling was conducted (stacks less than 7.8 feet in diameter - 16.7, 50.0 and 83.3% of the measurement line; stacks greater than 7.8 feet in diameter - 0.4, 1.0, and 2.0 meters from the stack wall). If the pollutant concentration differed by more than 10% or 0.5% from the average concentration, then sampling was conducted at a minimum of twelve traverse points. Stratification check data can be found in Appendix D.

#### *Data Collection*

A Data Acquisition System with battery backup was used to record the instrument response in 1-minute averages. The data was continuously stored as a \*.CSV file in Excel format on the hard drive of a computer. At the completion of testing, the data was also saved to the Alliance server. All data was reviewed by the Field Team Leader before leaving the facility. Once arriving at Alliance's office, all written and electronic data was relinquished to the report coordinator and then a final review was performed by the Project Manager.



### 3.7 Quality Assurance/Quality Control – U.S. EPA Reference Test Method 25A

#### *EPA Protocol 1 Calibration Gases*

Cylinder calibration gases used met EPA Protocol 1 ( $\pm 2\%$ ) standards. Calibration gas certificates are included in Appendix D.

#### *Calibration Error Test and Response Time*

Within two hours prior to testing, zero gas was introduced through the sampling system to the analyzer. After adjusting the analyzer to the Zero gas concentration and once the analyzer reading was stable, the analyzer value was recorded. This process was repeated for the High-Level gas, and the time required for the analyzer reading to reach 95% of the gas concentration was recorded to determine the response time. Next, Low- and Mid-Level gases were introduced through the sampling system to the analyzer, and the response was recorded when it was stable. All values were less than  $\pm 5\%$  of the calibration gas concentrations.

#### *Post Test Drift Checks*

Mid-Level gas was introduced through the sampling system. After the analyzer response was stable, the value was recorded. Next, Zero gas was introduced through the sampling system, and the analyzer value recorded once it reached a stable response. The Analyzer Drift was less than  $\pm 3\%$  of the span value.

#### *Data Collection*

A Data Acquisition System with battery backup was used to record the instrument response in one minute averages. The data was continuously stored as a \*.CSV file in Excel format on the hard drive of a computer. At the completion of testing, the data was also saved to the Alliance server. All data was reviewed by the Field Team Leader before leaving the facility. Once arriving at Alliance's office, all written and electronic data was relinquished to the report coordinator and then a final review was performed by the Project Manager.

### 3.8 Quality Assurance/Quality Control – U.S. EPA Reference Test Method 320

EPA Protocol 1 Calibration Gases – Cylinder calibration gases used met EPA Protocol 1 ( $\pm 2\%$ ) standards. Calibration gas certificates are included in the Appendix D.

After providing ample time for the FTIR to reach the desired temperature and to stabilize, zero gas (nitrogen) was introduced directly to the instrument sample port. While flowing nitrogen, the signal amplitude was recorded, a background spectra was taken, a linearity check was performed and recorded, the peak-to-peak noise and the root mean square in the spectral region of interest was measured, and a screenshot was recorded.

Following the zero gas checks, room air was pulled through the sample chamber and the line width and resolution was verified to be at  $1879\text{ cm}^{-1}$ , the peak position was entered and the FWHH was recorded (screenshot). Following these checks, another background spectra was recorded, and the calibration transfer standard (CTS) was introduced directly to the instrument sample port. The CTS instrument recovery was recorded, and the instrument mechanical response time was measured.

Next, stack gas was introduced to the FTIR through the sampling system and several scans were taken until a stable reading was achieved. The native concentration of the target spiking analyte  $\text{H}_2\text{CO}$  and  $\text{CH}_3\text{OH}$  was recorded. Spike gas was introduced to the sampling system at a constant flow rate  $\leq 10\%$  of the total sample flow rate and a corresponding dilution ratio was calculated along with a system response time. Matrix spike recovery spectra were recorded and were within the  $\pm 30\%$  of the calculated value of the spike concentration that the method requires.

The matrix spike recovery was conducted once at the beginning of the testing and the CTS recovery procedures were repeated following each test run. The corresponding values were recorded.



Location: Apex Companies - Alpena, MI

Source: Regenerative Catalytic Oxidizer (RCO) Inlet/Outlet

Project No.: AST-2024-0071

Run No. /Method Run 1 / Method 3A

**O<sub>2</sub> - Outlet Concentration (C<sub>O<sub>2</sub></sub>), % dry**

$$C_{O_2} = (C_{obs} - C_0) \times \left( \frac{C_{MA}}{C_M - C_0} \right)$$

where,

$C_{obs}$	<u>20.2</u>	= average analyzer value during test, % dry
$C_0$	<u>0.0</u>	= average of pretest & posttest zero responses, % dry
$C_{MA}$	<u>10.0</u>	= actual concentration of calibration gas, % dry
$C_M$	<u>10.1</u>	= average of pretest & posttest calibration responses, % dry
$C_{O_2}$	<u>20.0</u>	= O <sub>2</sub> Concentration, % dry





Location: Apex Companies - Alpena, MI

Source: Regenerative Catalytic Oxidizer (RCO) Inlet/Outlet

Project No.: AST-2024-0071

Run No. /Method: Run 1 / Method 3A

CO<sub>2</sub> - Outlet Concentration (C<sub>CO<sub>2</sub></sub>), % dry

$$C_{CO_2} = (C_{obs} - C_0) \times \left( \frac{C_{MA}}{C_M - C_0} \right)$$

where,

<u>C<sub>obs</sub></u>	<u>0.5</u>	= average analyzer value during test, % dry
<u>C<sub>o</sub></u>	<u>0.0</u>	= average of pretest & posttest zero responses, % dry
<u>C<sub>MA</sub></u>	<u>5.0</u>	= actual concentration of calibration gas, % dry
<u>C<sub>M</sub></u>	<u>5.1</u>	= average of pretest & posttest calibration responses, % dry
<u>C<sub>CO<sub>2</sub></sub></u>	<u>0.52</u>	= CO <sub>2</sub> Concentration, % dry



**Location:** Apex Companies - Alpena, MI  
**Source:** Regenerative Catalytic Oxidizer (RCO) Inlet/Outlet  
**Project No.:** AST-2024-0071  
**Run No./Method:** Run 1 / Method 25A

**THC - Outlet Concentration (as C3H8) (C<sub>THC</sub>), ppmvd**

$$C_{THC} = \frac{C_{THCw}}{1 - BWS}$$

where,

$C_{THCw} = \frac{59.5}{1} =$  THC - Outlet Concentration (as C3H8), ppmvw  
 $BWS = \frac{0.031}{1} =$  moisture fraction, unitless  
 $C_{THC} = \frac{61.4}{1} =$  ppmvd

**THC - Outlet Emission Rate (as C3H8) (ER<sub>THC</sub>), lb/hr**

$$ER_{THC} = \frac{C_{THC} \times MW \times Q_s \times 60 \frac{min}{hr} \times 28.32 \frac{L}{ft^3}}{24.04 \frac{L}{g-mole} \times 1.0E06 \times 454 \frac{g}{lb}}$$

where,

$C_{THC} = \frac{61.4}{1} =$  THC - Outlet Concentration (as C3H8), ppmvd  
 $MW = \frac{44.1}{1} =$  THC molecular weight, g/g-mole  
 $Q_s = \frac{31,831}{1} =$  stack gas volumetric flow rate at standard conditions, dscfm  
 $ER_{THC} = \frac{13.42}{1} =$  lb/hr

**NMHC Concentration (as C3H8) (C<sub>NMHC</sub>), ppmvd**

$$C_{NMHC} = C_{THC} - C_{CH4}$$

where,

$C_{THC} = \frac{61.37}{1} =$  NMHC Concentration (as C3H8), ppmvd  
 $C_{CH4} = \frac{43.33}{1} =$  CH4 Concentration (as C3H8), ppmvd  
 $C_{NMHC} = \frac{18.04}{1} =$  ppmvd

**NMHC Emission Rate (as C3H8) (ER<NMHC>), lb/hr**

$$ER<NMHC> = \frac{C<NMHC> \times MW \times Q_s \times 60 \frac{min}{hr} \times 28.32 \frac{L}{ft^3}}{24.04 \frac{L}{g-mole} \times 1.0E06 \times 454 \frac{g}{lb}}$$

where,

$C<NMHC> = \frac{18.04}{1} =$  NMHC Concentration (as C3H8), ppmvd  
 $MW = \frac{44.1}{1} =$  NMHC molecular weight, g/g-mole  
 $Q_s = \frac{31,831}{1} =$  stack gas volumetric flow rate at standard conditions, dscfm  
 $ER<NMHC> = \frac{3.95}{1} =$  lb/hr

**NMHC - Outlet Concentration (CNMHCc), ppmvd as Carbon**

$$CNMHCc = CNMHC * 3$$

where,

$C<NMHC> = \frac{18.04}{1} =$  NMHC - Outlet Concentration, ppmvd  
 $C<NMHCc> = \frac{54.113}{1} =$  ppmvd

**NMHC Emission Rate (as Carbon) (ER<NMHC>), lb/hr**

$$ER<NMHC> = \frac{C<NMHCc> \times MW \times Q_s \times 60 \frac{min}{hr} \times 28.32 \frac{L}{ft^3}}{24.04 \frac{L}{g-mole} \times 1.0E06 \times 454 \frac{g}{lb}}$$

where,

$C<NMHCc> = \frac{54.11}{1} =$  NMHC Concentration (as Carbon), ppmvd  
 $MW = \frac{12.0107}{1} =$  NMHC molecular weight, g/g-mole  
 $Q_s = \frac{31,831}{1} =$  stack gas volumetric flow rate at standard conditions, dscfm  
 $ER<NMHCc> = \frac{3.22}{1} =$  lb/hr



**Location:** Apex Companies - Alpena, MI  
**Source:** Regenerative Catalytic Oxidizer (RCO) Inlet/Outlet  
**Project No.:** AST-2024-0071  
**Run No. /Method** Run 1 / Method 320  
**Run No.** 1  
**Target** 33

**Formaldehyde - Outlet Concentration (C<CHOH>), ppmvd**

$$C<CHOH> = \frac{C<CHOHw>}{1 - BWS}$$

where,

C<CHOHw> 0.29 = Formaldehyde - Outlet Concentration, ppmvw  
 BWS 0.031 = moisture fraction, unitless  
 C<CHOH> 0.30 = ppmvd

**Formaldehyde - Outlet Emission Rate (ER<CHOH>), lb/hr**

$$ER<CHOH> = \frac{C<CHOH> \times MW \times Qs \times 60 \frac{min}{hr} \times 28.32 \frac{L}{ft^3}}{24.04 \frac{L}{g-mole} \times 1.0E06 \times 454 \frac{g}{lb}}$$

where,

C<CHOH> 0.30 = Formaldehyde - Outlet Concentration, ppmvd  
 MW 30.031 = CHOH molecular weight, g/g-mole  
 Qs 31,831 = stack gas volumetric flow rate at standard conditions, dscfm  
 ER<CHOH> 5.84 = lb/hr



Location Apex / DPI - Alpena, MI  
 Source RCO Outlet  
 Project No. AST-2024-0071  
 Run No. 1  
 Parameter(s) VFR

**Absolute Stack Gas Pressure (Ps), in. Hg**

$$P_s = P_b + \frac{P_g}{1.26}$$

where,

$P_b$   $\frac{29.21}{}$  = barometric pressure, in. Hg  
 $P_g$   $\frac{-0.80}{}$  = static pressure, in. H<sub>2</sub>O  
 $P_s$   $\frac{29.15}{}$  = in. Hg

**Moisture Fraction (BWSsat), dimensionless (theoretical at saturated conditions)**

$$BWS_{sat} = \frac{10^{6.37 - \left(\frac{2,827}{T_s + 36}\right)}}{P_s}$$

where,

$T_s$   $\frac{259.6}{}$  = stack temperature, °F  
 $P_s$   $\frac{29.2}{}$  = absolute stack gas pressure, in. Hg  
 $BWS_{sat}$   $\frac{1.000}{}$  = dimensionless

**Molecular Weight (DRY) (Md), lb/lb-mole**

$$M_d = (0.44 \times \% CO_2) + (0.32 \times \% O_2) + (0.28 (100 - \% CO_2 - \% O_2))$$

where,

$CO_2$   $\frac{0.5}{}$  = carbon dioxide concentration, %  
 $O_2$   $\frac{20.0}{}$  = oxygen concentration, %  
 $M_d$   $\frac{28.88}{}$  = lb/lb mol

**Molecular Weight (WET) (Ms), lb/lb-mole**

$$M_s = M_d (1 - BWS) + 18.015 (BWS)$$

where,

$M_d$   $\frac{28.88}{}$  = molecular weight (DRY), lb/lb mol  
 $BWS$   $\frac{0.030}{}$  = moisture fraction, dimensionless  
 $M_s$   $\frac{28.56}{}$  = lb/lb mol

**Average Velocity (Vs), ft/sec**

$$V_s = 85.49 \times C_p \times (\Delta P^{1/2})_{avg} \times \sqrt{\frac{T_s}{P_s \times M_s}}$$

where,

$C_p$   $\frac{0.84}{}$  = pitot tube coefficient  
 $\Delta P^{1/2}$   $\frac{0.917}{}$  = average pre/post test velocity head of stack gas, (in. H<sub>2</sub>O)<sup>1/2</sup>  
 $T_s$   $\frac{719.3}{}$  = average pre/post test absolute stack temperature, °R  
 $P_s$   $\frac{29.15}{}$  = absolute stack gas pressure, in. Hg  
 $M_s$   $\frac{28.56}{}$  = molecular weight of stack gas, lb/lb mol  
 $V_s$   $\frac{61.2}{}$  = ft/sec

**Average Stack Gas Flow at Stack Conditions (Qa), acfm**

$$Q_a = 60 \times V_s \times A_s$$

where,

$V_s$   $\frac{61.2}{}$  = stack gas velocity, ft/sec  
 $A_s$   $\frac{12.50}{}$  = cross-sectional area of stack, ft<sup>2</sup>  
 $Q_a$   $\frac{45,913}{}$  = acfm

**Average Stack Gas Flow at Standard Conditions (Qs), dscfm**

$$Q_{sd} = 17.636 \times Q_a \times (1 - BWS) \times \frac{P_s}{T_s}$$

where,

$Q_a$   $\frac{45,913}{}$  = average stack gas flow at stack conditions, acfm  
 $BWS$   $\frac{0.030}{}$  = moisture fraction, dimensionless  
 $P_s$   $\frac{29.15}{}$  = absolute stack gas pressure, in. Hg  
 $T_s$   $\frac{719.3}{}$  = average pre/post test absolute stack temperature, °R  
 $Q_s$   $\frac{31,831}{}$  = dscfm

Location Apex Companies - Alpena, MI  
 Source Regenerative Catalytic Oxidizer (RCO) Inlet/Outlet  
 Project No. AST-2024-0071

Run Number		Run 1	Run 2	Run 3	Average
Date		1/9/24	1/9/24	1/9/24	--
Start Time		17:35	18:51	20:07	--
Stop Time		18:34	19:50	21:06	--
<b>Input Data - Inlet</b>					
Moisture Fraction, dimensionless	BWSI	0.041	0.043	0.040	0.042
Volumetric Flow Rate (M1-4), dscfm	QsI	30,931	30,612	30,864	30,802
<b>Input Data - Outlet</b>					
Moisture Fraction, dimensionless	BWS	0.031	0.032	0.029	0.031
Volumetric Flow Rate (M1-4), dscfm	Qs	31,831	31,512	31,764	31,702
<b>Calculated Data - Inlet</b>					
O <sub>2</sub> i Concentration, % dry	C <sub>O<sub>2</sub>i</sub>	20.1	20.0	20.1	20.1
CO <sub>2</sub> i Concentration, % dry	C <sub>CO<sub>2</sub>i</sub>	0.52	0.44	0.38	0.45
THCi (as C <sub>3</sub> H <sub>8</sub> ) Concentration, ppmvd	C <sub>THCi</sub>	121.6	124.3	117.7	121.2
THCi (as C <sub>3</sub> H <sub>8</sub> ) Concentration, ppmvw	C <sub>THCi<sub>w</sub></sub>	116.6	119.0	113.0	116.2
THCi (as C <sub>3</sub> H <sub>8</sub> ) Emission Rate, lb/hr	ER <sub>THCi</sub>	25.8	26.2	25.0	25.7
CH <sub>4</sub> Concentration, ppmvd	C <sub>CH<sub>4</sub></sub>	167.0	174.0	159.0	166.7
CH <sub>4</sub> Emission Rate, lb/hr	ER <sub>CH<sub>4</sub></sub>	12.9	13.3	12.3	12.8
ppmvd Subtraction Value		55.7	58.0	53.0	--
lb/hr Subtraction Value		12.9	13.3	12.3	--
NMHCi (as C <sub>3</sub> H <sub>8</sub> ) Concentration, ppmvd	C<NMHCi>	65.9	66.3	64.7	65.7
NMHCi (as C <sub>3</sub> H <sub>8</sub> ) Emission Rate, lb/hr	ER<NMHCi>	14.0	14.0	13.7	13.9
NMHCi (as Carbon) Concentration, ppmvd	C<NMHCi <sub>c</sub> >	197.8	199.0	194.2	197.0
NMHCi (as Carbon) Emission Rate, lb/hr	ER<NMHCi <sub>c</sub> >	11.4	11.4	11.2	11.3
<b>Calculated Data - Outlet</b>					
O <sub>2</sub> Concentration, % dry	C <sub>O<sub>2</sub></sub>	20.0	20.1	20.2	20.1
CO <sub>2</sub> Concentration, % dry	C <sub>CO<sub>2</sub></sub>	0.52	0.45	0.40	0.46
THC (as C <sub>3</sub> H <sub>8</sub> ) Concentration, ppmvd	C <sub>THC</sub>	61.4	59.8	63.0	61.4
THC (as C <sub>3</sub> H <sub>8</sub> ) Concentration, ppmvw	C <sub>THC<sub>w</sub></sub>	59.5	57.9	61.2	59.5
THC (as C <sub>3</sub> H <sub>8</sub> ) Emission Rate, lb/hr	ER <sub>THC</sub>	13.4	13.0	13.8	13.4
CH <sub>4</sub> Concentration, ppmvd	C <sub>CH<sub>4</sub></sub>	130.0	138.0	122.0	130.0
CH <sub>4</sub> Emission Rate, lb/hr	ER <sub>CH<sub>4</sub></sub>	10.3	10.9	9.7	10.3
ppmvd Subtraction Value		43.3	46.0	40.7	--
lb/hr Subtraction Value		10.3	10.9	9.7	--
NMHC (as C <sub>3</sub> H <sub>8</sub> ) Concentration, ppmvd	C <sub>NMHC</sub>	18.0	13.8	22.3	18.1
NMHC (as C <sub>3</sub> H <sub>8</sub> ) Emission Rate, lb/hr	ER <sub>NMHC</sub>	3.9	3.0	4.9	3.9
NMHC (as Carbon) Concentration, ppmvd	C <sub>NMHC<sub>c</sub></sub>	54.1	41.5	67.0	54.2
NMHC (as Carbon) Emission Rate, lb/hr	ER <sub>NMHC<sub>c</sub></sub>	3.2	2.4	4.0	3.2
<b>FTIR Calculated Data</b>					
Formaldehyde - Outlet Concentration, ppmvd	C<CHOH>	0.30	0.31	0.25	0.29
Formaldehyde - Outlet Concentration, ppmvw	C<CHOH <sub>w</sub> >	0.29	0.30	0.24	0.28
Formaldehyde - Outlet Emission Rate, lb/hr	ER<CHOH>	0.044	0.046	0.037	0.042
Methanol - Outlet Concentration, ppmvd	C<CH <sub>3</sub> OH>	0.14	0.16	0.16	0.15
Methanol - Outlet Concentration, ppmvw	C<CH <sub>3</sub> OH <sub>w</sub> >	0.14	0.16	0.15	0.15
Methanol - Outlet Emission Rate, lb/hr	ER<CH <sub>3</sub> OH>	0.023	0.026	0.025	0.024
Methanol - Inlet Concentration, ppmvd	C<CH <sub>3</sub> OH>	7.37	8.23	6.68	7.43
Methanol - Inlet Concentration, ppmvw	C<CH <sub>3</sub> OH <sub>w</sub> >	7.14	7.97	6.49	7.20
Methanol - Inlet Emission Rate, lb/hr	ER<CH <sub>3</sub> OH>	1.17	1.29	1.06	1.18
Formaldehyde - Inlet Concentration, ppmvd	C<CHOH>	5.98	6.86	7.22	6.69
Formaldehyde - Inlet Concentration, ppmvw	C<CHOH <sub>w</sub> >	5.79	6.64	7.01	6.48
Formaldehyde - Inlet Emission Rate, lb/hr	ER<CHOH>	0.89	1.01	1.07	0.99
<b>Reduction Efficiency Data</b>					
THCi (as C <sub>3</sub> H <sub>8</sub> ) Emission Rate, lb/hr	ER<THCi (as C <sub>3</sub> H <sub>8</sub> )>	25.8	26.2	25.0	25.7
THC (as C <sub>3</sub> H <sub>8</sub> ) Emission Rate, lb/hr	ER<THC (as C <sub>3</sub> H <sub>8</sub> )>	13.4	13.0	13.8	13.4
THC (as C <sub>3</sub> H <sub>8</sub> ) Reduction Efficiency, %	RE<THC (as C <sub>3</sub> H <sub>8</sub> )>	48.1	50.5	44.9	47.8
NMHCi (as Carbon) Concentration, lb/hr	ER<NMHCi (as C <sub>3</sub> H <sub>8</sub> )>	11.4	11.4	11.2	11.3
NMHC (as Carbon) Concentration, lb/hr	ER<NMHC (as C <sub>3</sub> H <sub>8</sub> )>	3.2	2.4	4.0	3.2
NMHC (as Carbon) Reduction Efficiency, %	RE<NMHC (as C <sub>3</sub> H <sub>8</sub> )>	71.8	78.5	64.5	71.6
Formaldehyde - Inlet Emission Rate, lb/hr	ER<CHOH>	0.89	1.0	1.1	0.99
Formaldehyde - Outlet Emission Rate, lb/hr	ER<CHOH>	0.044	0.046	0.037	0.042
CHOH Reduction Efficiency, %	RE<CHOH>	95.0	95.5	96.6	95.7
Methanol - Inlet Emission Rate, lb/hr	ER<CH <sub>3</sub> OH>	1.2	1.3	1.1	1.2
Methanol - Outlet Emission Rate, lb/hr	ER<CH <sub>3</sub> OH>	0.023	0.026	0.025	0.024
CH <sub>3</sub> OH Reduction Efficiency, %	RE<CH <sub>3</sub> OH>	98.1	98.0	97.7	97.9



Location: Apex Companies - Alpena, MI  
 Source: Regenerative Catalytic Oxidizer (RCO) Inlet/Outlet  
 Project No.: AST-2024-0071  
 Date: 1/9/24

Time Unit Status	O <sub>2</sub> - Inlet % dry Valid	CO <sub>2</sub> - Inlet % dry Valid	THC - Inlet ppmvw Valid	O <sub>2</sub> - Outlet % dry Valid	CO <sub>2</sub> - Outlet % dry Valid	THC - Outlet ppmvw Valid
Uncorrected Run Average (C <sub>obs</sub> )	20.15	0.55	116.57	20.18	0.54	59.45
Cal Gas Concentration (C <sub>MA</sub> )	10.00	5.00	100.00	10.00	5.00	50.00
Pretest System Zero Response	0.00	0.07	0.09	0.00	0.00	0.00
Posttest System Zero Response	0.00	0.00	0.00	0.03	0.03	0.08
Average Zero Response (C <sub>0</sub> )	0.00	0.04	0.05	0.02	0.02	0.04
Pretest System Cal Response	9.99	5.03	102.40	10.09	5.09	50.55
Posttest System Cal Response	10.03	4.90	100.02	10.07	5.02	50.02
Average Cal Response (C <sub>M</sub> )	10.01	4.97	101.21	10.08	5.06	50.29
Corrected Run Average (Corr)	20.13	0.52	NA	20.04	0.52	NA
17:35	20.15	0.55	102.02	20.20	0.53	55.71
17:36	20.15	0.55	104.10	20.18	0.53	56.49
17:37	20.15	0.55	103.58	20.19	0.53	56.77
17:38	20.15	0.55	104.02	20.17	0.54	56.16
17:39	20.15	0.55	103.49	20.17	0.54	56.75
17:40	20.15	0.54	104.36	20.16	0.54	56.38
17:41	20.15	0.54	104.12	20.18	0.53	55.73
17:42	20.16	0.54	103.51	20.18	0.53	54.83
17:43	20.16	0.54	104.38	20.17	0.52	55.44
17:44	20.16	0.54	104.78	20.17	0.53	55.41
17:45	20.16	0.53	105.22	20.18	0.52	55.52
17:46	20.15	0.53	106.25	20.17	0.52	55.21
17:47	20.16	0.53	109.46	20.17	0.52	56.59
17:48	20.17	0.53	115.85	20.19	0.52	59.82
17:49	20.18	0.52	119.79	20.22	0.51	63.05
17:50	20.18	0.52	118.23	20.20	0.51	62.26
17:51	20.15	0.54	119.89	20.14	0.53	63.62
17:52	20.14	0.55	119.90	20.13	0.55	63.97
17:53	20.13	0.55	120.88	20.15	0.54	64.51
17:54	20.13	0.55	121.21	20.12	0.55	64.32
17:55	20.15	0.54	120.21	20.13	0.55	64.41
17:56	20.14	0.54	120.41	20.12	0.55	63.64
17:57	20.15	0.54	120.20	20.14	0.54	63.86
17:58	20.17	0.54	119.09	20.15	0.54	62.68
17:59	20.16	0.54	119.77	20.17	0.54	63.28
18:00	20.15	0.54	121.82	20.17	0.54	63.62
18:01	20.16	0.54	122.36	20.19	0.53	64.22
18:02	20.17	0.54	122.22	20.21	0.53	63.99
18:03	20.16	0.54	122.52	20.21	0.54	64.47
18:04	20.17	0.54	122.81	20.21	0.54	63.81
18:05	20.17	0.54	121.70	20.24	0.52	63.56
18:06	20.17	0.54	123.21	20.22	0.53	63.91
18:07	20.16	0.54	124.05	20.19	0.54	65.06
18:08	20.16	0.54	124.56	20.20	0.54	64.30
18:09	20.16	0.54	124.90	20.22	0.53	64.06
18:10	20.15	0.55	126.60	20.20	0.54	64.65
18:11	20.16	0.55	126.44	20.20	0.54	65.57
18:12	20.16	0.54	127.86	20.20	0.54	65.55
18:13	20.17	0.54	122.99	20.22	0.53	64.10
18:14	20.14	0.56	121.59	20.18	0.55	60.85
18:15	20.13	0.57	119.97	20.17	0.56	60.10
18:16	20.13	0.57	118.27	20.16	0.57	58.71
18:17	20.14	0.56	116.57	20.21	0.55	57.24
18:18	20.14	0.56	116.59	20.19	0.56	56.06
18:19	20.14	0.56	115.98	20.17	0.56	56.60
18:20	20.15	0.56	116.10	20.16	0.57	56.21
18:21	20.15	0.55	114.90	20.21	0.55	55.72
18:22	20.15	0.55	115.61	20.19	0.55	54.94
18:23	20.16	0.55	116.14	20.20	0.55	56.05
18:24	20.15	0.55	116.64	20.20	0.55	55.63
18:25	20.16	0.55	116.04	20.21	0.54	55.35
18:26	20.15	0.55	115.48	20.20	0.55	54.58
18:27	20.16	0.55	114.40	20.19	0.55	55.26
18:28	20.16	0.55	113.61	20.18	0.56	53.19
18:29	20.13	0.57	119.11	20.17	0.56	53.97
18:30	20.07	0.59	120.81	20.17	0.57	55.12
18:31	20.07	0.59	120.37	20.17	0.57	56.87
18:32	20.07	0.59	120.78	20.17	0.57	56.24
18:33	20.07	0.59	118.72	20.19	0.55	56.17
18:34	20.08	0.59	117.75	20.18	0.56	54.98