

## Introduction

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**1.0 Introduction**

Alliance Technical Group, LLC (Alliance) was retained by Keebler Corporation (Keebler) to conduct compliance testing at the Grand Rapids, MI facility. The facility operates under provisions of the Michigan Department of Environment, Great Lakes and Energy Air Quality Division (EGLE) Permit to Install No. 206-08J. Testing was conducted to determine the emission rates of 2-,3-pentanedione, glycerin, triacetin and 2-ethyl pyrazine from Zones 1, 2, 3, 4, 5, 6 and 7 of the Oven Line 2 Process.

**1.1 Facility Description**

The Keebler Facility owns and operates Zones 1, 2, 3, 4, 5, 6 and 7 of the Oven Line 2 Process. This is a 9.6 MMBtu/hr natural gas fired oven used in the baking process.

**1.2 Project Team**

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

**Table 1-1: Project Team**

<b>Facility Personnel</b>	Danielle Poma
<b>Regulatory Personnel</b>	Lindsey Wells
<b>Alliance Personnel</b>	Trent Johnson Paul Priester Chris Warneke Nolan Wright

**1.3 Site Specific Test Plan & Notification**

Testing was conducted in accordance with the Site-Specific Test Plan (SSTP) submitted to Michigan EGLE.

## Summary of Results

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## 2.0 Summary of Results

Alliance conducted compliance testing at the Keebler facility in Grand Rapids, MI on February 28, 2023 and March 1, 2023. Testing consisted of determining the emission rates of 2-,3-pentanedione, glycerin, triacetin and 2-ethyl pyrazine from Zones 1, 2, 3, 4, 5, 6 and 7 of the Oven Line 2 Process.

Tables 2-1 through 2-7 provide a summary of the emission testing results. This table also 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.

**Table 2-1: Summary of Results – Zone 1**

Run Number	Run 1	Run 2	Run 3	Average
Date	2/28/23	2/28/23	2/28/23	--
<b>2,3-Pentanedione Data</b>				
Concentration, ppmvd	< 0.018	< 0.020	< 0.024	< 0.021
Emission Rate, lb/hr	< 1.1E-04	< 1.2E-04	< 1.5E-04	< 1.3E-04
<b>Glycerin Data</b>				
Concentration, ppmvd	< 0.11	< 0.12	< 0.14	< 0.12
Emission Rate, lb/hr	< 5.9E-04	< 6.5E-04	< 7.8E-04	< 6.7E-04
<b>Triacetin Data</b>				
Concentration, ppmvd	< 0.037	< 0.041	< 0.048	< 0.042
Emission Rate, lb/hr	< 4.9E-04	< 5.4E-04	< 6.5E-04	< 5.6E-04
<b>2-Ethylpyrazine Data</b>				
Concentration, ppmvd	< 0.019	< 0.021	< 0.025	< 0.022
Emission Rate, lb/hr	< 1.3E-04	< 1.4E-04	< 1.6E-04	< 1.4E-04

**Table 2-2: Summary of Results – Zone 2**

Run Number	Run 1	Run 2	Run 3	Average
Date	2/28/23	2/28/23	2/28/23	--
<b>2,3-Pentanedione Data</b>				
Concentration, ppmvd	0.053	0.040	0.035	0.043
Emission Rate, lb/hr	5.3E-04	4.1E-04	3.4E-04	4.2E-04
<b>Glycerin Data</b>				
Concentration, ppmvd	< 0.14	< 0.12	< 0.12	< 0.13
Emission Rate, lb/hr	< 1.3E-03	< 1.1E-03	< 1.1E-03	< 1.2E-03
<b>Triacetin Data</b>				
Concentration, ppmvd	< 0.046	< 0.040	< 0.040	< 0.042
Emission Rate, lb/hr	< 9.8E-04	< 8.7E-04	< 8.5E-04	< 9.0E-04
<b>2-Ethylpyrazine Data</b>				
Concentration, ppmvd	0.031	0.025	0.022	0.026
Emission Rate, lb/hr	3.4E-04	2.7E-04	2.3E-04	2.8E-04

**Table 2-3: Summary of Results – Zone 3**

Run Number	Run 1	Run 2	Run 3	Average
Date	3/1/23	3/1/23	3/1/23	--
<b>2,3-Pentanedione Data</b>				
Concentration, ppmvd	0.11	0.11	0.11	0.11
Emission Rate, lb/hr	9.0E-04	9.3E-04	9.6E-04	9.3E-04
<b>Glycerin Data</b>				
Concentration, ppmvd	< 0.13	< 0.13	< 0.13	< 0.13
Emission Rate, lb/hr	< 9.7E-04	< 9.5E-04	< 1.0E-03	< 9.8E-04
<b>Triacetin Data</b>				
Concentration, ppmvd	< 0.039	< 0.039	< 0.040	< 0.039
Emission Rate, lb/hr	< 7.1E-04	< 6.9E-04	< 7.3E-04	< 7.1E-04
<b>2-Ethylpyrazine Data</b>				
Concentration, ppmvd	0.041	0.051	0.053	0.048
Emission Rate, lb/hr	3.7E-04	4.5E-04	4.9E-04	4.4E-04

**Table 2-4: Summary of Results – Zone 4**

Run Number	Run 1	Run 2	Run 3	Average
Date	3/1/23	3/1/23	3/1/23	--
<b>2,3-Pentanedione Data</b>				
Concentration, ppmvd	0.050	0.055	0.059	0.055
Emission Rate, lb/hr	5.2E-04	5.7E-04	6.4E-04	5.8E-04
<b>Glycerin Data</b>				
Concentration, ppmvd	< 0.12	< 0.12	< 0.12	< 0.12
Emission Rate, lb/hr	< 1.1E-03	< 1.2E-03	< 1.2E-03	< 1.2E-03
<b>Triacetin Data</b>				
Concentration, ppmvd	< 0.039	< 0.040	< 0.040	< 0.040
Emission Rate, lb/hr	< 8.9E-04	< 9.0E-04	< 9.4E-04	< 9.1E-04
<b>2-Ethylpyrazine Data</b>				
Concentration, ppmvd	0.023	0.025	0.026	0.025
Emission Rate, lb/hr	2.6E-04	2.8E-04	3.1E-04	2.8E-04

**Table 2-5: Summary of Results – Zone 5**

Run Number	Run 1	Run 2	Run 3	Average
Date	3/1/23	3/1/23	3/1/23	--
<b>2,3-Pentanedione Data</b>				
Concentration, ppmvd	0.14	0.18	0.16	0.16
Emission Rate, lb/hr	1.4E-03	1.7E-03	1.5E-03	1.5E-03
<b>Glycerin Data</b>				
Concentration, ppmvd	< 0.13	< 0.13	< 0.13	< 0.13
Emission Rate, lb/hr	< 1.2E-03	< 1.1E-03	< 1.2E-03	< 1.1E-03
<b>Triacetin Data</b>				
Concentration, ppmvd	< 0.039	< 0.038	< 0.039	< 0.038
Emission Rate, lb/hr	< 8.1E-04	< 7.8E-04	< 8.3E-04	< 8.0E-04
<b>2-Ethylpyrazine Data</b>				
Concentration, ppmvd	0.058	0.067	0.063	0.062
Emission Rate, lb/hr	5.9E-04	6.9E-04	6.6E-04	6.5E-04

**Table 2-6: Summary of Results – Zone 6**

Run Number	Run 1	Run 2	Run 3	Average
Date	2/28/23	2/28/23	2/28/23	--
<b>2,3-Pentanedione Data</b>				
Concentration, ppmvd	0.22	0.22	0.21	0.22
Emission Rate, lb/hr	2.0E-03	2.1E-03	2.0E-03	2.0E-03
<b>Glycerin Data</b>				
Concentration, ppmvd	< 0.086	< 0.083	< 0.083	< 0.084
Emission Rate, lb/hr	< 7.2E-04	< 7.3E-04	< 7.2E-04	< 7.2E-04
<b>Triacetin Data</b>				
Concentration, ppmvd	< 0.042	< 0.041	< 0.040	< 0.041
Emission Rate, lb/hr	< 8.3E-04	< 8.4E-04	< 8.3E-04	< 8.4E-04
<b>2-Ethylpyrazine Data</b>				
Concentration, ppmvd	0.19	0.20	0.18	0.19
Emission Rate, lb/hr	1.9E-03	2.0E-03	1.9E-03	1.9E-03

**Table 2-7: Summary of Results – Zone 7**

Run Number	Run 1	Run 2	Run 3	Average
Date	2/28/23	2/28/23	2/28/23	--
<b>2,3-Pentanedione Data</b>				
Concentration, ppmvd	0.23	0.18	0.17	0.19
Emission Rate, lb/hr	2.7E-03	2.4E-03	2.4E-03	2.5E-03
<b>Glycerin Data</b>				
Concentration, ppmvd	< 0.086	< 0.10	< 0.10	< 0.095
Emission Rate, lb/hr	< 9.5E-04	< 1.2E-03	< 1.3E-03	< 1.2E-03
<b>Triacetin Data</b>				
Concentration, ppmvd	< 0.038	< 0.044	< 0.045	< 0.042
Emission Rate, lb/hr	< 1.0E-03	< 1.3E-03	< 1.4E-03	< 1.2E-03
<b>2-Ethylpyrazine Data</b>				
Concentration, ppmvd	0.10	0.11	0.10	0.10
Emission Rate, lb/hr	1.2E-03	1.6E-03	1.5E-03	1.4E-03

**Table 2-8: Summary of Results – Summary of Zones 1-7**

Run Number	Zone 1 Average	Zone 2 Average	Zone 3 Average	Zone 4 Average	Zone 5 Average	Zone 6 Average	Zone 7 Average	Total
Date	2/28/23	2/28/23	3/1/23	3/1/23	3/1/23	2/28/23	2/28/23	--
<b>2,3-Pentanedione Data</b>								
Concentration, ppmvd	< 0.021	0.043	0.11	0.055	0.16	0.22	0.19	
Emission Rate, lb/hr	< 1.3E-04	4.2E-04	9.3E-04	5.8E-04	1.5E-03	2.0E-03	2.5E-03	8.1E-03
<b>Glycerin Data</b>								
Concentration, ppmvd	< 0.12	< 0.13	< 0.13	< 0.12	< 0.13	< 0.084	< 0.095	
Emission Rate, lb/hr	< 6.7E-04	< 1.2E-03	< 9.8E-04	< 1.2E-03	< 1.1E-03	< 7.2E-04	< 1.2E-03	< 7.1E-03
<b>Triacetin Data</b>								
Concentration, ppmvd	< 0.042	< 0.042	< 0.039	< 0.040	< 0.038	< 0.041	< 0.042	
Emission Rate, lb/hr	< 5.6E-04	< 9.0E-04	< 7.1E-04	< 9.1E-04	< 8.0E-04	< 8.4E-04	< 1.2E-03	< 5.9E-03
<b>2-Ethylpyrazine Data</b>								
Concentration, ppmvd	< 0.022	0.026	0.048	0.025	0.062	0.19	0.10	
Emission Rate, lb/hr	< 1.4E-04	2.8E-04	4.4E-04	2.8E-04	6.5E-04	1.9E-03	1.4E-03	5.1E-03

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# Testing Methodology

### 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 D.

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

Parameter	U.S. EPA Reference Test Methods	Notes/Remarks
Volumetric Flow Rate	1 & 2	Full Velocity Traverses
Oxygen/Carbon Dioxide	3A	Instrumental Analysis
Moisture Content	4 / ALT-008	Gravimetric Analysis
Speciated & Total Volatile Organic Compounds	18	Constant Rate Sampling

#### 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 1-2 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.

#### 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 was 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 3.5.

#### 3.3 U.S. EPA Reference Method 4 / ALT-008 – Moisture Content

The stack gas moisture content (BWS) was determined in accordance with U.S. EPA Reference Test Method 4. The gas conditioning train consisted of a series of chilled impingers. Prior to testing, each impinger was filled with a known quantity of water or silica gel. Each impinger was analyzed gravimetrically before and after each test run on the same balance to determine the amount of moisture condensed.

#### 3.4 U.S. EPA Reference Test Method 18 – Speciated & Total Volatile Organic Compounds

The VOC testing was conducted in accordance with U.S. EPA Reference Test Method 18. The gas was withdrawn at a constant rate through a stainless probe, Teflon tubing, chilled midget impinger (moisture knockout), sorbent tubes, rotometer, critical orifice, and pump.

Two (2) identical sample trains, one labeled as spiked and one as unspiked, were used at each sampling location. The first sorbent tube in the spiked train was spiked with a known mass of VOC prior to testing. The midjet impinger and both tubes in the unspiked train were unspiked. The sampling system was pretest leak checked using the rotometer to verify the absence of flow. Three (3) spiked sample train were collected concurrently with the all three (3) of the un-spiked sample trains during each run to meet the method QA/QC requirements as U.S. EPA Reference test Method 18 Section 8.4.3. No posttest leak check is permitted for Method 18 adsorbent tubes. The sampling meter was also pre and post calibrated using a Dry-Cal flow meter.

Following the completion of each test run, the contents of the first and second impingers were measured and placed in a sample vial labelled as container 1. The first and second midjet impingers and the connecting glassware were rinsed with DI water, and these rinses were added to the vial with zero headspace. Immediately following the recovery, container 1 was placed on ice. The contents of container 1 were analyzed for VOC. The two-section silica gel tube will be capped and labeled as tube 1 and placed on ice for shipment to the laboratory. The contents of the two-section silica gel tube were analyzed separately for breakthrough determination. The spiked sample train was recovered with the procedures described above. All the samples were kept on ice, sealed, zero-head spaced, labeled and shipped to the identified laboratory for analysis. Upon receiving the samples, the analytical lab analyzed them using gas chromatography / flame ionization detector (GC/FID) following the analytical procedures outlined in U.S. EPA Reference Test Method 18. The quality control measures are described in Section 3.6.

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

Cylinder calibration gases used met EPA Protocol 1 (+/- 2%) standards. Copies of all calibration gas certificates can be found in the Quality Assurance/Quality Control Appendix.

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 percent of the Calibration Span or 0.5% absolute difference.

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 percent 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 percent 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 percent 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 percent of the Calibration Span or 0.5% absolute difference.

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 percent of the Calibration Span or 0.5% absolute difference or the data was invalidated and the Calibration Error Test and System Bias were repeated.

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

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 percent 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 percent 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 percent or 0.5% from the average concentration, then three (3) point sampling was conducted (stacks less than 7.8 feet in diameter - 16.7, 50.0 and 83.3 percent 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 percent or 0.5% from the average concentration, then sampling was conducted at a minimum of twelve (12) traverse points. Copies of stratification check data can be found in the Quality Assurance/Quality Control Appendix.

A Data Acquisition System with battery backup was used to record the instrument response in one (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.

### **3.6 Quality Assurance/Quality Control – U.S. EPA Reference Test Method 18**

A leak check before each sampling run was performed. The probe inlet was plugged, and a sample pump was turned on to pull a vacuum of at least 10-inch Hg or the highest vacuum experienced during the sampling run. A leakage rate in excess of 2 percent of the average sampling is acceptable. After the completion of the leak check, the probe inlet plug was released carefully before turning off the sample pump.

Initial dry gas meter reading and barometric pressure were recorded before starting each sampling run. The sampling began with the tip of the nozzle/probe assembly positioned close to the centroid of exhaust stack. Once the sample pump is started the sample flow was adjusted to a constant flow rate approximately 400 cc/min. The midjet impinger train was kept cold to maintain the temperature of the gases leaving the last impinger at 68°F or less. After the completion of the sampling run a posttest leak check was not performed.

VOC spike recovery was checked using the procedures outlined in U.S. EPA Method 18 Section 8.4.3. During all three of the sampling runs, two identical trains were setup and collected, with one of the trains spiked with a known concentration of VOC. The known concentration was targeted between 40 to 60 percent of the mass expected to be collected in the native/unspiked sample train. The spiked samples were transported to the laboratory with all the other unspiked/native samples and analyzed following the procedures outlined in U.S. EPA Method 18 Section 11.0. The impinger contents and absorbents from the two trains were analyzed utilizing identical analytical procedures and instrumentation. The fraction of spiked VOC recovered was determined by combining the amount recovered in the impinger and in the absorbent tube, using equations in U.S. EPA Method 18 Section 12.9. Recovery values for all the spiked samples were between the method allowable criteria of 70 to 130 percent as stated in U.S. EPA Method 18 Section 8.4.3.