AIR EMISSION TEST REPORT
FOR THE
VERIFICATION OF AIR POLLUTANT EMISSIONS FROM
A LANDFILL GAS FUELED ENCLOSED FLARE

WASTE MANAGEMENT, INC.
PINE TREE ACRES LANDFILL

1.0 INTRODUCTION

Waste Management, Inc. (WM) owns and operates the Pine Tree Acres (PTA) municipal solid waste landfill located in Lenox Township, Macomb County.

The conditions of Permit MI-ROP-N5984-2019 that was issued July 30, 2019 specify that within 180 days of permit issuance or five years from the last test date, whichever is later, the permittee shall verify:

- Visible emissions from EU-FLARE3 and EU-FLARE5.
- The NMOC reduction efficiency or ppmv from EU-FLARE4 and EU-FLARE6.
- Visible emissions (per a USEPA Method 9 certified visible emissions observation shall be conducted for a minimum of 15 minutes to determine the actual opacity from that emission point), NOx, SO_2, and CO emission rates from EU-FLARE4 and EU-FLARE6, by testing at owner's expense, in accordance with Department requirements.
- PM and PM10 emission rates from EU-FLARE4 and EU-FLARE6.
- Visible emissions (per a USEPA Method 9 certified visible emissions observation shall be conducted for a minimum of 15 minutes to determine the actual opacity from that emission point), NOx, PM, PM-10, VOC, SO_2, and CO emission rates from each engine in FG-ICENGINES.
- Formaldehyde emission rates from each engine in FG-ICENGINES.

The compliance testing was performed by Impact Compliance & Testing, Inc. (ICT). ICT representatives Tyler Wilson, Blake Beddow, Clay Gaffey, and Andrew Eisenberg performed the field sampling and measurements May 14, 2020 and June 18, 2020.

All of the testing conditions specified in MI-ROP-N5984-2019 and listed above were satisfied during the compliance test event January 14, 2020; January 20-24, 2020; and January 27, 2020, except for the testing conditions specified for EU-FLARE6. Compliance testing was performed for EU-FLARE6 May 14, 2020 and June 18, 2020, following maintenance and repair.

The exhaust gas sampling and analysis was performed using procedures specified in the Stack Test Protocol, dated December 20, 2019, that was reviewed and approved by the State of Michigan Department of Environment, Great Lakes, and Energy-Air Quality Division (EGLE-AQD) in the January 7, 2020 Test Plan Approval Letters. EGLE-AQD representatives Mr. Matthew Karl, Ms. Gina Angellotti, and Mr. Robert Joseph observed portions of the testing project.

Questions regarding this emission test report should be directed to:

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Report Certification

This test report was prepared by ICT based on field sampling data collected by ICT. Facility process data were collected and provided WM-PTA employees or representatives. This test report has been reviewed by WM-PTA representatives and approved for submittal to the EGLE-AQD.

I certify that the testing was conducted in accordance with the specified test methods and submitted test plan unless otherwise specified in this report. I believe the information provided in this report and its attachments are true, accurate, and complete.

Report Prepared By:

Tyler J. Wilson
Senior Project Manager
Impact Compliance & Testing, Inc.

A Renewable Operating Permit Report Certification form signed by the source responsible official accompanies this report.

2.0 SUMMARY OF TEST RESULTS AND OPERATING CONDITIONS

2.1 Purpose and Objective of the Tests

The conditions of MI-ROP-N5984-2019 require WM-PTA to test EU-FLARE6 for VE (USEPA Method 9), carbon monoxide (CO), nitrogen oxides (NOx), NMOC, sulfur dioxide (SO_2), and particulate matter (PM/PM10) emission rates.

2.2 Operating Conditions During the Compliance Tests

The enclosed flare (flare) testing was performed while the flare was operated at normal routine operating conditions. WM-PTA representatives monitored and recorded the combustion zone temperature (ºF), fuel use (scfm), and fuel methane content (%) at 15-minute intervals for each test period.

Table 2.1 presents a summary of the average flare operating conditions during the test periods.

Appendix 2 provides operating records provided by WM-PTA representatives for the test periods.

Table 2.1 Average EU-FLARE6 operating conditions during the test periods

Flare Parameter	5/14/2020	6/18/2020
Combustion zone temperature (ºF)	1,505	1,601
Flare LFG use (scfm)	3,756	2,620
LFG methane content (%)	50.2	49.0
LFG LHV (Btu/scf)	457	446
Exhaust temperature (ºF)	1,498	1,550

2.3 Summary of Air Pollutant Sampling Results

The gas exhausted from the LFG flare was sampled for three (3) one-hour test periods during the compliance testing performed May 14, 2020 and for three (3) one-hour test periods during compliance retesting performed June 18, 2020.

The test event on May 14, 2020 did not include particulate matter (PM/PM10) and the results from that date indicate an exceedance of the CO emission limit. All pollutants were tested on June 18, 2020 following corrective actions performed on the flare inlet piping (presented in Section 6 of this report). The results from the June 18, 2020 demonstrated compliance with all permitted emission limits.

Table 2.3 presents the average measured air pollutant emission rates for EU-FLARE6 (average of the three test periods) and applicable emission limits.

Test results for each one-hour sampling period and comparison to the permitted emission rates are presented in Section 6.0 of this report.

Table 2.3 Average measured air pollutant emission rates for EU-FLARE6 (three-test average)

Pollutant	5/14/2020	6/18/2020	Permit Limit
NOx (lb/MMBtu)	0.05	0.04	0.06
CO (lb/MMBtu)	1.37	0.05	0.2
NMOC (ppmvd)[1]	6.18	0.33	20
SO_2 (lb/hr)	7.92	4.24	16.1
PM/PM10 (lb/hr)	-	2.26	2.9
VE-Method 9 (%)	0	0	20

Notes:
1. NMOC limit is 20 ppmvd corrected to 15% oxygen.

3.0 SOURCE AND SAMPLING LOCATION DESCRIPTION

3.1 General Process Description

WM-PTA operates an active landfill gas (LFG) collection and control system. Most of the collected gas is treated and used as fuel in electricity generation processes (RICE) operated by WM-PTA and Aria Energy, Sumpter Energy Associates-Pine Tree Acres (SEA-PTA).

Excess collected gas (that exceeds the capacity of the renewable energy facilities or during generating plant downtime) is controlled by Waste Management in two open flares (EU-FLARE3 and EU-FLARE5) and two enclosed flares (EU-FLARE4 and EU-FLARE6).

3.2 Rated Capacities and Air Emission Controls

The following equipment description is from Permit MI-ROP-N5984-2019.

EU-FLARE6	A 6,000 CFM enclosed flare with a sulfur removal system for reducing sulfur content of landfill gas prior to combustion. An enclosed flare is an enclosed combustor or firebox which maintains a relatively constant limited peak temperature generally using a limited supply of combustion air.

3.3 Sampling Locations

The EU-FLARE6 exhaust gas is released to the atmosphere through a dedicated vertical exhaust stack. The vertical exhaust stack has an inner diameter of 156 inches. The vertical exhaust stack is equipped with four (4) sample ports, each opposed 90° from the previous, that provide a sampling location 78.0 inches (0.5 duct diameters) upstream and 648 inches (4.2 duct diameters) downstream from any flow disturbance and satisfies the USEPA Method 1 criteria for a representative sample location.

Individual traverse points were determined in accordance with USEPA Method 1.

Appendix 1 provides a diagram of the emission test sampling location.

4.0 SAMPLING AND ANALYTICAL PROCEDURES

A Stack Test Protocol for the air emission testing was reviewed and approved by EGLE-AQD. This section provides a summary of the sampling and analytical procedures that were used during the testing periods.

4.1 Summary of Sampling Methods

USEPA Method 1	Exhaust gas velocity measurement locations were determined based on the physical stack arrangement and requirements in USEPA Method 1.
USEPA Method 2	Exhaust gas velocity pressure was determined using a Type-S Pitot tube connected to a red oil incline manometer; temperature was measured using a K-type thermocouple connected to the Pitot tube.
USEPA Method 3A	Exhaust gas O_2 and CO_2 content was determined using zirconia ion/paramagnetic and infrared instrumental analyzers, respectively.
USEPA Method 4	Exhaust gas moisture was determined based on the water weight gain in chilled impingers.
USEPA Method 5/202	Exhaust gas filterable and condensable particulate matter was determined using an isokinetic sampling train.
USEPA Method 6C	Exhaust gas SO_2 concentration was determined using a pulsed ultraviolet fluorescence instrumental analyzer.
USEPA Method 7E	Exhaust gas NO_x concentration was determined using a chemiluminescence instrumental analyzer.
USEPA Method 9	Exhaust gas plume observations were made by a certified observer of visible emissions.
USEPA Method 10	Exhaust gas CO concentration was measured using an NDIR instrumental analyzer.
USEPA Method 25A / ALT-097	Exhaust gas VOC (as NMHC) concentration was determined using a flame ionization analyzer equipped with a GC column.

4.2 Exhaust Gas Velocity Determination (USEPA Method 2)

For testing performed May 14, 2020, exhaust stack gas velocities and volumetric flow rates were determined using USEPA Method 2 during instrumental analyzer sampling periods. An S-type Pitot tube connected to a red-oil manometer was used to determine velocity pressure at each traverse point across the stack cross section. Gas temperature was measured using a K-type thermocouple mounted to the Pitot tube. The Pitot tube and connective tubing were periodically leak-checked to verify the integrity of the measurement system.

For testing performed June 18, 2020, exhaust stack gas velocities and volumetric flow rates were determined using USEPA Method 2 during the isokinetic and instrumental analyzer sampling periods. An S-type Pitot tube connected to a red-oil manometer was used to determine velocity pressure at each traverse point across the stack cross section. Gas temperature was measured using a K-type thermocouple mounted to the Pitot tube. The Pitot tube and connective tubing were periodically leak-checked to verify the integrity of the measurement system.

The absence of significant cyclonic flow for each exhaust configuration was verified using an S-type Pitot tube and oil manometer (once prior to each test date: 5/13/2020 and 6/17/2020).

Appendix 3 provides field data sheets from the test event.

4.3 Exhaust Gas Molecular Weight Determination (USEPA Method 3A)

CO_2 and O_2 content in the exhaust gas stream was measured continuously throughout each test period in accordance with USEPA Method 3A. The CO_2 content of the exhaust was monitored using a Servomex 1440D single beam single wavelength (SBSW) infrared gas analyzer. The O_2 content of the exhaust was monitored using a Servomex 1440D gas analyzer that uses a paramagnetic sensor.

During each sampling period, a continuous sample of the exhaust gas stream was extracted from the stack using a stainless-steel probe connected to a Teflon® heated sample line. The sampled gas was conditioned by removing moisture prior to being introduced to the analyzers; therefore, measurement of O_2 and CO_2 concentrations correspond to standard dry gas conditions. Instrument response data were recorded using an ESC Model 8816 data acquisition system that monitored the analog output of the instrumental analyzers continuously and logged data as one-minute averages.

Prior to, and at the conclusion of each test, the instruments were calibrated using upscale calibration and zero gas to determine analyzer calibration error and system bias (described in Section 5.0 of this document). Sampling times were recorded on field data sheets.

Appendix 4 provides O_2 and CO_2 calculation sheets. Raw instrument response data are provided in Appendix 5.

4.4 Exhaust Gas Moisture Content (USEPA Method 4)

For testing performed May 14, 2020, moisture content of the exhaust gas stream was determined in accordance with USEPA Method 4 using a chilled impinger sampling train. The moisture sampling was performed concurrently with the instrumental analyzer sampling. During each sampling period, a gas sample was extracted at a constant rate from the source where moisture was removed from the sampled gas stream using a knockout impinger and impingers that were submersed in an ice bath. At the conclusion of each sampling period, the moisture gain in the impingers was determined gravimetrically by weighing each impinger to determine net weight gain.

For testing performed June 18, 2020, moisture content of the exhaust gas stream was determined in accordance with USEPA Method 4 as a component of the particulate matter sampling train. The moisture sampling was performed concurrently with the instrumental analyzer sampling. During each sampling period, a gas sample was extracted at an isokinetic rate from the source where moisture was removed from the sampled gas stream using a knockout impinger and impingers that were submersed in an ice bath. At the conclusion of each sampling period, the moisture gain in the impingers was determined gravimetrically by weighing each impinger to determine net weight gain.

Appendix 3 provides exhaust gas moisture gain field data sheets.

4.5 Measurement of Particulate Matter Emissions (USEPA Method 5/202)

The conditions of ROP No. MI-ROP-N5984-2019 specify PM/PM10 emission limits for EU-FLARE6. The testing was performed on June 18, 2020, using a combined filterable and condensable particulate matter (PM) sampling train. The filterable and condensable fractions were added to calculate total PM10 emissions (i.e., all filterable and condensable PM emissions were assumed to be in the PM10 size range).

4.5.1 Filterable Particulate Matter Sample Train (USEPA Method 5)

Filterable PM was determined using USEPA Method 5. Exhaust gas was withdrawn from the exhaust stack at an isokinetic sampling rate using an appropriately-sized inconel alloy sample nozzle and heated probe. The collected exhaust gas was passed through a pre-tared glass fiber filter that was housed in a heated filter box. The back half of the filter housing was connected to the condensable PM impinger train.

4.5.2 Condensable Particulate Matter Sample Train (USEPA Method 202)

Condensable PM (CPM) concentrations were measured in accordance with USEPA Method 202. Following the Method 5 filter assembly, the sample gas travelled through the impinger train which consisted of a condenser, a knock-out impinger, a standard Greenberg-Smith (G-S) impinger (dry), a Teflon-coated CPM filter (with exhaust thermocouple), a modified G-S impinger containing 100 milliliters of deionized water, and a modified G-S impinger containing a known amount of indicating silica gel.

The CPM components of the Method 202 sampling train (dry knockout impinger and dry GS impinger) were placed in a tempered water bath and a pump was used to circulate water

through the condenser. The temperature of the bath was maintained such that the CPM filter outlet temperature remained between 65 and 85°F. Crushed ice was placed around the last two impingers to chill the gas to below 68°F.

4.5.3 Sample Recovery and Analysis (USEPA Method 5/202)

At the conclusion of each one-hour test period, the sample train was leak-checked and disassembled. The sample nozzle, probe liner, and filter holder were brushed and rinsed with acetone. The recovered particulate filter and acetone rinses were stored in sealed containers and transferred to Enthalpy Analytical, Inc. (Durham, North Carolina) for gravimetric measurements.

The impingers were transported to the recovery area where they were weighed. The exhaust gas contained significant amounts of moisture. Therefore, prior to recovery, the CPM portion of the sample train underwent the nitrogen purge step of Method 202. The glassware (between the particulate filter and CPM filter) was rinsed with DI water, acetone, and hexane in accordance with the Method 202 sample recovery procedures. The CPM filter and recovered rinses were clearly and uniquely labeled and transferred to Enthalpy Analytical, Inc. for analysis.

Diluent gas content (Method 3A O_2 and CO_2) measurements were performed with each of the PM/PM10 isokinetic sampling periods.

Appendix 4 provides PM/PM10 calculation sheets. The PM/PM10 laboratory report is provided in Appendix 7.

4.6 Sulfur Dioxide Concentration Measurements (USEPA Method 6C)

Exhaust gas SO_2 concentration measurements were performed using a Thermo Environmental Instruments, Inc. (TEI) Model 43i that uses pulsed ultraviolet fluorescence technology in accordance with USEPA Method 6C for the measurement of SO_2 concentration.

Appendix 4 provides SO_2 calculation sheets. Raw instrument response data are provided in Appendix 5.

4.7 NO_x and CO Concentration Measurements (USEPA Methods 7E and 10)

NO_x and CO pollutant concentrations in the exhaust gas stream was determined using a Thermo Environmental Instruments, Inc. (TEI) Model 42c High Level chemiluminescence NO_x analyzer and a TEI Model 48i infrared CO analyzer.

Throughout each test period, a continuous sample of exhaust gas was extracted from the stack using the Teflon® heated sample line and gas conditioning system and delivered to the instrumental analyzers. Instrument response for each analyzer was recorded on an ESC Model 8816 data acquisition system that logged data as one-minute averages. Prior to, and at the conclusion of each test, the instruments were calibrated using upscale calibration and zero gas to determine analyzer calibration error and system bias.

Appendix 4 provides CO and NO_x calculation sheets. Raw instrument response data are provided in Appendix 5.

4.8 Visible Emissions Observations (USEPA Method 9)

USEPA Method 9 procedures were used to evaluate the opacity of the exhaust gas during the emission sampling periods.

In accordance with USEPA Method 9, the qualified observer stood at a distance sufficient to provide a clear view of the emissions with the sun oriented in the 140° sector to his back. Opacity observations were made at the point of greatest opacity in the portion of the plume where condensed water vapor was not present. Observations were made at 15-second intervals for at least 15-minutes for EUFLARE-6. All visual opacity determinations were performed by a qualified observer in accordance with USEPA Method 9, Section 3.

Opacity test data and the observer certificate are presented in Appendix 8.

4.9 Measurement of Volatile Organic Compounds (USEPA Method 25A/ALT-097)

The VOC emission rate was determined by measuring the nonmethane hydrocarbon (NMHC) concentration in the EU-FLARE6 exhaust gas. NMHC pollutant concentration was determined using TEI Model 55i Methane / Nonmethane hydrocarbon analyzer. The TEI 55i analyzer contains an internal gas chromatograph column that separates methane from non-methane components. The concentration of NMHC in the sampled gas stream, after separation from methane, is determined relative to a propane standard using a flame ionization detector in accordance with USEPA Method 25A.

The USEPA Office of Air Quality Planning and Standards (OAQPS) has issued several alternate test methods approving the use of the TEI 55-series analyzer as an effective instrument for measuring NMOC from gas-fueled reciprocating internal combustion engines (RICE) in that it uses USEPA Method 25A and 18 (ALT-066, ALT-078 and ALT-096).

Samples of the exhaust gas were delivered directly to the instrumental analyzer using the Teflon® heated sample line to prevent condensation. The sample to the NHMC analyzer was not conditioned to remove moisture. Therefore, VOC measurements correspond to standard conditions with no moisture correction (wet basis).

Prior to, and at the conclusion of each test, the instrument was calibrated using mid-range calibration (propane) and zero gas to determine analyzer calibration error and system bias (described in Section 5.0 of this document).

Appendix 4 provides VOC calculation sheets. Raw instrument response data for the NMHC analyzer is provided in Appendix 5.

4.10 Fuel Gas Measurement for H_2S (Draeger Tubes)

The EGLE-AQD Test Protocol Approval Letter required the following additional process data to be recorded during the test program:

- *One fuel gas sample per test day, collected during active testing using a Draeger tube, for H2S determination.*

ICT and/or WM-PTA satisfied the additional process data request by performing one Draeger tube measurement per test day (photos included in Appendix 7).

Appendix 7 provides photos of the two (2) Draeger® tubes.

5.0 QA/QC ACTIVITIES

5.1 NO_x Converter Efficiency Test

The NO_2 – NO conversion efficiency of the Model 42c analyzer was verified onsite prior to the testing program (once prior to each test date: 5/13/2020 and 6/17/2020). A USEPA Protocol 1 certified concentration of NO_2 was injected directly into the analyzer, following the initial three-point calibration, to verify the analyzer's conversion efficiency. The analyzer's NO_2 – NO converter uses a catalyst at high temperatures to convert the NO_2 to NO for measurement. The conversion efficiency of the analyzer is deemed acceptable if the measured NO_x concentration is greater than or equal to 90% of the expected value.

The NO_2 – NO conversion efficiency tests satisfied the USEPA Method 7E criteria (measured NO_x concentrations were 99.3% and 98.4% of the expected value, i.e., greater than 90% of the expected value as required by Method 7E).

5.2 Methane/NMHC Separation Verification

A demonstration of the TEI Model 55i methane / non-methane organic compound separation efficiency was performed onsite (once prior to each test date: 5/13/2020 and 6/17/2020). The analyzer was challenged with a Certified Standard Spec blend gas containing 1,004 ppmv methane and 10.94 ppmv non-methane compounds (specifically propane) for the demonstration. The TEI Model 55i instrumental analyzer was calibrated using certified cylinders of 2,538 ppmv methane and 15.03 ppmv propane. The blend gas was then injected into the analyzer and the measured methane and non-methane concentrations were recorded using a data logger. The measured methane concentration stabilized at 1,005 ppmv and the measured NMOC concentration stabilized at 11.0 ppmv 5/13/2020. The measured methane concentration stabilized at 1,005 ppmv and the measured NMOC concentration stabilized at 11.0 ppmv 6/17/2020. The demonstrations indicate that the non-methane components (propane) did not elute with the methane (i.e., the internal column is highly efficient in separating methane and non-methane compounds).

5.3 Particulate Matter Recovery and Analysis

All recovered particulate matter samples were stored and shipped in certified trace clean amber glass sample bottles with Teflon® lined caps. The liquid level on each bottle was marked with a permanent marker prior to pick-up and the caps were secured closed with tape. Samples of the reagents used in the test event (200 milliliters each of deionized high-purity water, acetone and hexane) were submitted with the samples for analysis to verify that the reagents used to recover the samples have low particulate matter residues.

The glassware used in the condensable PM impinger trains was washed and rinsed prior to use in accordance with the procedures of USEPA Method 202. The glassware was not baked prior to use; therefore, ICT used the field train proof blank option provided in USEPA Method 202. Analysis of the collected field train proof blank rinses (sample train rinse performed prior to use) indicated a total of 1.8 milligrams (mg) of recovered PM from the sample train. In addition, a field train recovery proof blank was performed following the second sampling period. Analysis of the field train recovery proof blank resulted in 4.1 mg of recovered PM from the sample train. The reported condensable PM test results were blank-corrected according to the method (USEPA Method 202 allows a blank correction of up to 2 mg).

5.4 Laboratory QA/QC Procedures

The particulate matter analyses were conducted by a qualified third-party laboratory according to the appropriate QA/QC procedures specified in the USEPA Methods 5 and 202 and are included in the final report provided by Enthalpy Analytical.

5.5 Sampling System Response Time Determination

The response time of the sampling system was determined prior to the compliance test program (each test day) by introducing upscale gas and zero gas, in series, into the sampling system using a tee connection at the base of the sample probe. The elapsed time for the analyzer to display a reading of 95% of the expected concentration was determined using a stopwatch.

Results of the response time determinations were recorded on field data sheets. For each test period, test data were collected once the sample probe was in position for at least twice the maximum system response time.

5.6 Gas Divider Certification (USEPA Method 205)

A STEC Model SGD-710C 10-step gas divider was used to obtain appropriate calibration span gases. The ten-step STEC gas divider was NIST certified (within the last 12 months) with a primary flow standard in accordance with Method 205. When cut with an appropriate zero gas, the ten-step STEC gas divider delivered calibration gas values ranging from 0% to 100% (in 10% step increments) of the USEPA Protocol 1 calibration gas that was introduced into the system. The field evaluation procedures presented in Section 3.2 of Method 205 were followed onsite, prior to use of gas divider (once prior to each test event: 5/13/2020 and 6/17/2020). The field evaluations yielded no errors greater than 2% of the triplicate measured average and no errors greater than 2% from the expected values.

5.7 Instrumental Analyzer Interference Check

The instrumental analyzers used to measure NO_x, CO, SO_2, CO_2, and O_2 have had an interference response test preformed prior to their use in the field, pursuant to the interference response test procedures specified in USEPA Method 7E. The appropriate interference test gases (i.e., gases that would be encountered in the exhaust gas stream) were introduced into each analyzer, separately and as a mixture with the analyte that each analyzer is designed to measure. All of analyzers exhibited a composite deviation of less than 2.5% of the span for all measured interferent gases. No major analytical components of the analyzers have been replaced since performing the original interference tests.

5.8 Instrument Calibration and System Bias Checks

At the beginning of each day of the testing program, initial three-point instrument calibrations were performed for the NO_x, CO, SO_2, CO_2, and O_2 analyzers by injecting calibration gas directly into the inlet sample port for each instrument. System bias checks were performed prior to and at the conclusion of each sampling period by introducing the upscale calibration gas and zero gas into the sampling system (at the base of the stainless steel sampling probe prior to the particulate filter and Teflon® heated sample line) and determining the instrument response against the initial instrument calibration readings. At the beginning of each test day, appropriate high-range, mid-range, and low-range span gases followed by a zero gas were introduced to the NMHC analyzer, in series at a tee connection, which is installed between the sample probe and the particulate filter, through a poppet check valve. After each one-hour test period, mid-range and zero gases were re-introduced in series at the tee connection in the sampling system to check against the method's performance specifications for calibration drift and zero drift error.

The instruments were calibrated with USEPA Protocol 1 certified concentrations of CO_2, O_2, NO_x, CO, and SO_2 in nitrogen and zeroed using hydrocarbon free nitrogen. The NMHC (VOC) instrument was calibrated with USEPA Protocol 1 certified concentrations of propane in air and zeroed using hydrocarbon-free air. A STEC Model SGD-710C ten-step gas divider was used to obtain intermediate calibration gas concentrations as needed.

5.9 Determination of Exhaust Gas Stratification

Sampling for all pollutants, for both test dates, was performed at twenty-four (24) traverse points throughout each 1-hour test (6 points per sample port; 4 sample ports). The Inconel sample probe was positioned at each sample point for 2.5 minutes during each test. Traverse points were determined with regards to USEPA Method 1 and PM sampling.

5.10 Meter Box Calibrations

The Nutech Model 2010 sampling console, which was used for exhaust gas moisture content and PM10 sampling, was calibrated prior to and after the testing program (before and after each test date). This calibration uses the critical orifice calibration technique presented in USEPA Method 5. The metering console calibration exhibited no data outside the acceptable ranges presented in USEPA Method 5.

The digital pyrometer in the Nutech metering consoles were calibrated using a NIST traceable Omega® Model CL 23A temperature calibrator.

Appendix 6 presents test equipment quality assurance data (NO_2 – NO conversion efficiency test data, methane/NMHC separation study records, instrument calibration and system bias check records, calibration gas and gas divider certifications, interference test results, meter box calibration records, and scale, pyrometer, barometer, Pitot tube, probe, and nozzle calibration records).

6.0 RESULTS

6.1 Test Results and Allowable Emission Limits

EU-FLARE6 operating data and air pollutant emission measurement results for each one-hour test period are presented in Tables 6.1 and 6.2.

The measured air pollutant emission rates for each emission unit are less than the allowable limits specified in MI-ROP-N5984-2019. The allowable limits specified in MI-ROP-N5984-2019 are listed in the following table.

Emission Unit	NMOC	SO_2 (lb/hr)[1]	NOx (lb/MMBtu)	CO (lb/MMBtu)	PM/PM10 (lb/hr)	VE
EU-FLARE6	98% DE, or 20 ppmvd C_6 @ 3% O_2	16.1	0.06	0.2	2.9	20% 6-min avg [Note 2]

Notes:
1. There are two SO_2 limits specified in FG-FLARES. The limit presented is the more stringent.
2. The VE limit for EU-FLARE6 is based on USEPA Method 9 for at least 15 minutes.

6.2 Variations from Normal Sampling Procedures or Operating Conditions

The testing for all pollutants was performed in accordance with USEPA methods and the approved Stack Test Protocol.

Compliance testing for EU-FLARE6 was originally scheduled to be performed during the January 2020 test event. Due to a failing burner, EU-FLARE6 testing was postponed and rescheduled following repair of the failing burner.

Compliance testing for EU-FLARE6 was rescheduled for May 14, 2020. On May 14, 2020, the Inconel alloy probe/nozzle required for PM/PM10 testing was determined to be compromised (failed pre-test leak checks), due to heat damage from previous testing. WM, ICT, and EGLE-AQD agreed that the PM/PM10 testing portion of the test event be postponed until new equipment could be obtained, and that ICT proceed with scheduled compliance testing for all other pollutants.

The CO emissions measured on May 14, 2020 exhibited a high degree of variability throughout the test periods and the calculated CO emission rate exceeded the permitted

lb/hr and lb/MMBtu values. Upon investigation, this was attributed to water in the underground header piping, causing fluctuating pressure and fuel flow to EU-FLARE6

The water in the piping was cleared and a new Inconel alloy probe/nozzle was procured for follow-up testing performed on June 18, 2020 that included all pollutants (the PM/PM10 testing in addition to a retest of all combustion pollutants). The emission test results from the June 18, 2020 event satisfies all conditions specified in Permit MI-ROP-N5984-2019 for EU-FLARE6.

Table 6.1 Measured exhaust gas conditions and air pollutant emission rates for Flare No. 6 (EU-FLARE6)

Test No.	1	2	3	Three
Test date	5/14/2020	5/14/2020	5/14/2020	Test
Test period (24-hr clock)	10:55-12:40	13:25-15:00	15:35-17:04	Average
Fuel flowrate (scfm)	3,787	3,748	3,732	3,756
Combustion Zone Temp. (ºF)	1,505	1,504	1,507	1,505
LFG methane content (%)	50.1	50.3	50.3	50.2
LFG heat content (Btu/scf)	456	458	458	457
Exhaust Gas Composition				
CO_2 content (% vol)	7.03	6.99	6.85	6.96
O_2 content (% vol)	13.9	13.9	14.0	13.9
Moisture (% vol)	6.30	8.65	8.39	7.78
Exhaust gas temperature (ºF)	1,504	1,504	1,487	1,498
Exhaust gas flowrate (dscfm)	73,287	71,543	65,656	70,162
Exhaust gas flowrate (scfm)	78,214	78,318	71,665	76,066
Nitrogen Oxides				
NO_X conc. (ppmvd)	11.0	10.8	10.1	10.6
NO_X emissions (lb/hr)	5.79	5.54	4.74	5.36
NO_X emissions (lb/MMBtu)	0.06	0.05	0.05	0.05
Permitted emissions (lb/MMBtu)	-	-	-	*0.06*
Carbon Monoxide				
CO conc. (ppmvd)	463	455	461	460
CO emissions (lb/hr)	148	142	132	141
Permitted emissions (lb/hr)	-	-	-	*16.30*
CO emissions (lb/MMBtu)	1.43	1.38	1.29	1.37
Permitted emissions (lb/MMBtu)	-	-	-	*0.2*
Non-Methane Organic Compounds				
NMOC conc. (ppmv)[1]	4.29	4.01	5.02	4.44
NMOC conc. (ppmvd as C_6)[2]	5.83	5.57	7.13	6.18
Permitted conc. (ppmvd)[2]	-	-	-	*20*

Table 6.2 Measured exhaust gas conditions and air pollutant emission rates for Flare No. 6 (EU-FLARE6) [Continued]

Test No.	1	2	3	Three
Test date	5/14/2020	5/14/2020	5/14/2020	Test
Test period (24-hr clock)	11:44-12:54	14:33-15:40	16:25-17:32	Average
<u>Sulfur Dioxide</u>				
SO_2 conc. (ppmv)	10.7	11.2	12.1	11.3
SO_2 emissions (lb/hr)	7.82	7.97	7.96	7.92
Permitted emissions (lb/hr)	-	-	-	*16.1*
<u>Visible Emissions</u>				
Highest 6-minute average (%)	0.0	0.0	0.0	0.0
Permitted emissions (%)	-	-	-	*20%*

1. Measured as nonmethane hydrocarbons as propane.
2. Parts per million by volume (ppmvd) as hexane (C_6) @ 3% oxygen.

Table 6.3 Measured exhaust gas conditions and air pollutant emission rates for Flare No. 6 (EU-FLARE6)

Test No.	1	2	3	Three
Test date	6/18/2020	6/18/2020	6/18/2020	Test
Test period (24-hr clock)	8:35-10:30	11:26-13:07	13:50-15:28	Average
Fuel flowrate (scfm)	2,674	2,615	2,570	2,620
Combustion Zone Temp. (ºF)	1,602	1,600	1,600	1,601
LFG methane content (%)	49.5	48.7	48.7	49.0
LFG heat content (Btu/scf)	450	443	443	446
Exhaust Gas Composition				
CO_2 content (% vol)	6.25	5.98	6.05	6.10
O_2 content (% vol)	14.7	15.1	14.9	14.9
Moisture (% vol)	8.97	8.50	8.44	8.64
Exhaust gas temperature (ºF)	1,552	1,548	1,550	1,550
Exhaust gas flowrate (dscfm)	39,246	38,037	37,570	38,284
Exhaust gas flowrate (scfm)	43,115	41,572	41,033	41,907
Nitrogen Oxides				
NO_X conc. (ppmvd)	9.86	9.45	9.08	9.46
NO_X emissions (lb/hr)	2.78	2.58	2.45	2.60
NO_X emissions (lb/MMBtu)	0.04	0.04	0.04	0.04
Permitted emissions (lb/MMBtu)	-	-	-	*0.06*
Carbon Monoxide				
CO conc. (ppmvd)	22.2	10.9	27.6	20.2
CO emissions (lb/hr)	3.81	1.80	4.53	3.38
Permitted emissions (lb/hr)	-	-	-	*16.30*
CO emissions (lb/MMBtu)	0.05	0.03	0.07	0.05
Permitted emissions (lb/MMBtu)	-	-	-	*0.2*
Non-Methane Organic Compounds				
NMOC conc. (ppmv)[1]	0.18	0.20	0.23	0.20
NMOC conc. (ppmvd as C_6)[2]	0.28	0.33	0.37	0.33
Permitted conc. (ppmvd)[2]	-	-	-	*20*

Table 6.5 Measured exhaust gas conditions and air pollutant emission rates for Flare No. 6 (EU-FLARE6) [Continued]

Test No.	1	2	3	Three
Test date	6/18/2020	6/18/2020	6/18/2020	Test
Test period (24-hr clock)	8:35-10:30	11:26-13:07	13:50-15:28	Average
Particulate Matter				
Sampled volume (dscf)	33.5	32.7	32.8	33.0
Filterable catch (mg)	8.65	10.4	5.66	8.23
Condensable catch (mg)	7.82	4.58	3.87	5.42
Total catch (mg)	16.5	15.0	9.53	13.7
PM10 emissions (lb/hr)	2.72	2.48	1.57	2.26
Permitted emissions (lb/hr)	-	-	-	*2.9*
Sulfur Dioxide				
SO_2 conc. (ppmv)	8.93	12.6	11.8	11.1
SO_2 emissions (lb/hr)	3.50	4.78	4.44	4.24
Permitted emissions (lb/hr)	-	-	-	*16.1*
Visible Emissions				
Highest 6-minute average (%)	0.0	0.0	0.0	0.0
Permitted emissions (%)	-	-	-	*20%*

1. Measured as nonmethane hydrocarbons as propane.
2. Parts per million by volume (ppmvd) as hexane (C_6) @ 3% oxygen.

Table 6.6 Summary of LFG fuel H_2S Measurements (Draeger Tubes)

Test Date	5/14/2020	6/18/2020
H_2S (ppm)	90	100

1. Estimated from observation of Draeger tubes. Photos are provided in Appendix 7.

APPENDIX 1

Sample Port Diagram

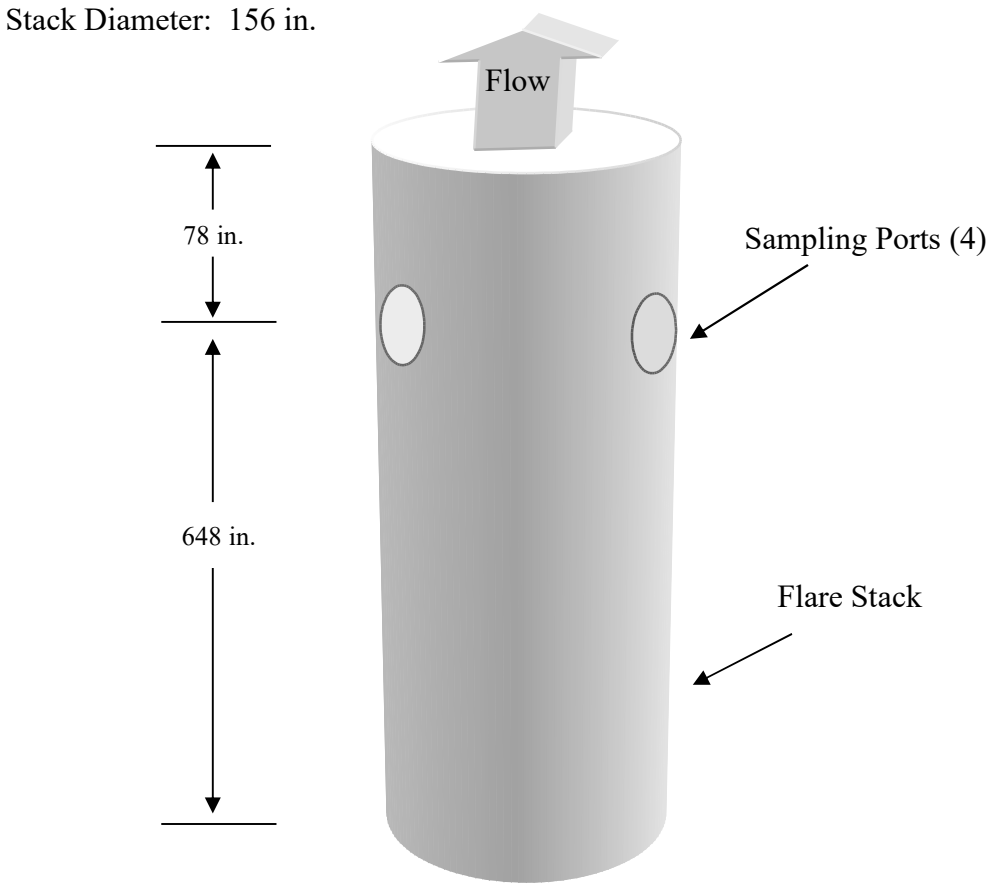

Diagram not to scale

EU-FLARE6 Diagram