

EMISSIONS TEST REPORT

for

**40 CFR Part 63, Subpart YYYY
FORMALDEHYDE (CH₂O)**

**EUTURBINE1, EUTURBINE2, EUTURBINE3
MI-ROP-B7221-2020**

**DTE Gas Company – Milford Compressor Station
Milford, Michigan**

July 27-28, 2022

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EXECUTIVE SUMMARY

DTE Energy's Environmental Management and Safety (EM&S) Ecology, Monitoring, and Remediation performed emissions testing at the DTE Gas Company – Milford Compressor Station, located in Milford, Michigan. The fieldwork, performed July 27-28, 2022, was conducted to satisfy requirements of the Michigan Department of Environment, Great Lakes, and Energy (EGLE) Michigan Renewable Operating Permit MI-ROP-B7221-2020 and 40 CFR Part 63 Subpart YYY. Emissions tests were performed on Solar Turbines 2100 (EUTURBINE1), 2200 (EUTURBINE2), and 3100 (EUTURBINE3) for formaldehyde (CH₂O).

The results of the emissions testing are highlighted below:

**Emissions Test Results
Milford Compressor Station
EUTURBINE1-3
July 27-28, 2022**

Emission Unit	O₂ (%)	CH₂O (ppbv @ 15% O₂)
EUTURBINE1	15.2	14.6
EUTURBINE2	15.2	9.2
EUTURBINE3	15.2	11.6
Permit Limit		91



1.0 INTRODUCTION

DTE Energy's Environmental Management and Safety (EM&S) Ecology, Monitoring, and Remediation performed emissions testing at the DTE Gas Company – Milford Compressor Station, located in Milford, Michigan. The fieldwork, performed July 27-28, 2022, was conducted to satisfy requirements of the Michigan Department of Environment, Great Lakes, and Energy (EGLE) Michigan Renewable Operating Permit MI-ROP-B7221-2020 and 40 CFR Part 63 Subpart YYY. Emissions tests were performed on Solar Turbines 2100 (EUTURBINE1), 2200 (EUTURBINE2), and 3100 (EUTURBINE3) for formaldehyde (CH₂O).

The following DTE personnel participated in the testing program: Thomas Snyder, Senior Environmental Specialist, and Mark Grigereit, Principal Engineer.

2.0 SOURCE DESCRIPTION

The DTE Gas Company – Milford Compressor Station operates three (3) identical Model Taurus 70 turbines, manufactured by Solar Turbines, at the facility. The purpose of the turbines is to generate the compression needed to distribute natural gas through the pipeline delivery system. The turbines are all simple cycle design, natural gas fired turbines nominally rated at 10,504 horsepower (ISO).

While MI-ROP-B7221-2020 allows for the installation of a total of five (5) gas compression turbines, only the three addressed in this report have been installed to date.

Figure 1 presents a schematic of the sampling location for each turbine. The exhaust on each turbine is identical.

3.0 SAMPLING AND ANALYTICAL PROCEDURES

DTE Energy obtained emissions measurements in accordance with procedures specified in the USEPA *Standards of Performance for New Stationary Sources*. The sampling and analytical methods used in the testing program are indicated in the table below:

Sampling Method	Parameter	Analysis
USEPA Method 3A	Oxygen	Instrumental Analyzer Method
USEPA Method 320	Formaldehyde	Instrumental Analyzer Method

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3.1 OXYGEN (USEPA METHOD 3A)

3.1.1 *Sampling Method*

Exhaust Oxygen (O₂) content was measured using USEPA Method 3A, "Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)". The O₂ analyzer utilizes a paramagnetic sensor.

Samples were measured on a dry basis (i.e. sample was conditioned prior to introduction into the diluent analyzers).

3.1.2 *Sampling Train*

The EPA Methods 3A sampling system consisted of the following components:

- (1) Heated Teflon™ sampling line, drawing sample from FTIR exhaust.
- (2) Universal® gas conditioner with particulate filter.
- (3) Flexible unheated Teflon™ sampling line.
- (4) Instrumental gas analyzer bank.
- (5) Data Acquisition System.

Refer to Figure 2 for a schematic of the sampling train.

3.1.3 *Sampling Train Calibration*

The O₂ analyzer was calibrated according to procedures outlined in USEPA Methods 3A and 7E. Zero, span, and mid-range calibration gases were introduced directly into the analyzer to determine the instruments linearity. Then a zero and mid-range span gas was introduced through the entire sampling system to determine sampling system bias. System calibrations were performed prior to, and at the conclusion of, each test period.

3.1.4 *Sampling Duration & Frequency*

Oxygen (O₂) sampling was performed during all CH₂O sampling. Concentration averages were logged at 10-second intervals.

3.1.5 *Quality Control and Assurance*

All sampling and analytical equipment was calibrated according to the guidelines referenced in Methods 3A and 7E. Calibration gases were EPA Protocol 1 gases. Calibration gas concentrations were within the acceptable ranges specified in Method 7E.

Field calibration data sheets and gas certification sheets are in Appendix C.

3.1.6 Data Reduction

The O₂ (%) readings were logged at 10-second intervals and recorded in 1-minute increments. CH₂O emissions are reported in parts per billion, dry, corrected to 15% O₂ (ppb @ 15% O₂) for comparison to the emission limit.

Raw CEM data is presented in Appendix B.

3.2 FORMALDEHYDE (CH₂O) (USEPA METHOD 320)

3.2.1 Sampling Method

Formaldehyde (CH₂O) emissions were evaluated using USEPA Method 320, "Measurement of Vapor Phase Organic Emissions by Extractive Fourier Transform Infrared (FTIR)". Triplicate 60-minute test runs were performed.

The Method 320 sampling system (Figure 2) consisted of the following:

- (1) Single-point sampling probe
- (2) Flexible heated PTFE sampling line
- (3) Air Dimensions Heated Head Diaphragm Pump
- (4) MAX Analytical MAX-IR with Starboost™ FTIR spectrometer
- (5) Appropriate calibration gases
- (6) Data Acquisition System

The FTIR was equipped with a temperature controlled, 10 meter, high throughput, multipass gas cell maintained at 191°C. Gas flows and sampling system pressures were monitored using a rotometer and pressure transducer. All data was collected at 1 cm⁻¹ resolution.

3.2.2 Sampling Train Calibration

The FTIR was calibrated per procedures outlined in Method 320. Direct measurements of formaldehyde (CH₂O) gas standards were made at the test location to confirm concentrations.

A calibration transfer standard (CTS) was analyzed before and after testing at each location. The concentration determined for all CTS runs were within ±5% of the certified value of the standard. Ethylene was passed through the entire system to determine the sampling system response time and to ensure that the entire sampling system was leak-free.

Nitrogen was purged through the sampling system at each test location to confirm the system was free of contaminants.



Formaldehyde (CH₂O) gas standards were passed through the sampling system at each test location to determine the response time and confirm recovery.

Formaldehyde (CH₂O) spiking was performed to verify the ability of the sampling system to quantitatively deliver a sample containing CH₂O from the base of the probe to the FTIR. Analyte spiking assures the ability of the FTIR to quantify CH₂O in the presence of effluent gas.

As part of the spiking procedure, samples from each engine were measured to determine CH₂O concentrations to be used in the spike recovery calculations. The determined nitrous oxide (N₂O) concentration in the spiked and unspiked samples was used to calculate the dilution factor of the spike and thus used to calculate the concentration of the spiked CH₂O. The following equation illustrates the percent recovery calculation.

$$DF = \frac{N_2O(\text{spike})}{N_2O(\text{direct})} \quad (\text{Sec. 9.2.3 (3) Method 320})$$

$$CS = DF * \text{Spike}_{\text{air}} + \text{Unspike} (1 - DF) \quad (\text{Sec. 9.2.3 (4) Method 320})$$

- DF = Dilution factor of the spike gas
- N₂O_(direct) = N₂O concentration measured directly in undiluted spike gas
- N₂O_(spike) = Diluted N₂O concentration measured in a spiked sample
- Spike_{air} = Concentration of the analyte in the spike standard measured by the FTIR directly
- CS = Expected concentration of the spiked samples
- Unspike = Native concentration of analytes in unspiked samples

All analyte spikes were introduced using an instrument grade stainless steel rotometer. The spike target dilution ratio was 1:10 or less. All CH₂O spike recoveries were within the EPA Method 320 allowance of ±30%.

3.2.3 Quality Control and Assurance

The method validation procedure in Method 320 Section 13 was completed prior to collection of test data, validation data and statistical treatment/analysis included in the report, and emissions data corrected for %R, if applicable. The validation source was a combustion gas turbine fired with natural gas equipped with like-kind emission controls as the unit to be tested. Each validation spiked sample was preceded and followed by an unspiked sample.

As part of the data validation procedure, reference spectra are manually fit to that of the sample spectra and a concentration is determined. The reference

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spectra are scaled to match the peak amplitude of the sample, thus providing a scale factor. The scale factor multiplied by the reference spectra concentration is used to determine the concentration value for the sample spectra. Sample pressure and temperature corrections are then applied to compute the final sample concentration. The manually calculated results are then compared with the software-generated results. The data is then validated if the two concentrations are within $\pm 5\%$ agreement. If there is a difference greater than $\pm 5\%$, the spectra are reviewed for possible spectral interferences or any other possible causes that might lead to inaccurately quantified data. MAX Analytical Technologies, Inc. validated the FTIR data. The data validation reports are in Appendix E.

3.2.4 Data Reduction

Each spectrum was derived from the coaddition of 55 scans, with a new data point generated approximately every minute. The CH₂O emissions were recorded in parts per million (ppb) wet volume basis. The O₂ emissions were recorded in percent (%) dry volume basis.

The O₂ (%) and CH₂O (ppbvd) readings were logged at 10-second intervals and recorded in 1-minute increments. CH₂O emissions are reported in parts per billion dry, corrected to 15% O₂ (ppb @ 15% O₂) for comparison to the emission limit.



4.0 OPERATING PARAMETERS

The test program included the collection of turbine operating data during each test run. Parameters recorded included % Load (reported as horsepower), gross dry BTU, fuel feed rate, compressor exhaust pressure, and compressor exhaust temperature.

Operational data can be found in Appendix D.

5.0 RESULTS

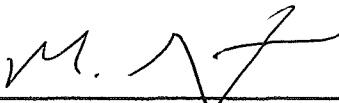
The results of the formaldehyde (CH₂O) emissions testing conducted on EUTURBINE1-3 are presented in Results Table Nos. 1-3.

EUTURBINE1-3 demonstrated compliance with permitted CH₂O emission rates. Testing was performed while the turbines were operated in LoNOx mode at full load.




6.0 CERTIFICATION STATEMENT


"I certify that I believe the information provided in this document is true, accurate, and complete. Results of testing are based on the good faith application of sound professional judgment, using techniques, factors, or standards approved by the Local, State, or Federal Governing body, or generally accepted in the trade."



Mark Grigereit, QSTI

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RESULTS TABLES

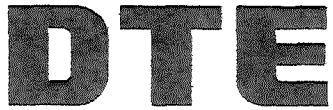


TABLE NO. 1
FORMALDEHYDE EMISSIONS TEST RESULTS
DTE Gas - Milford Compressor Station
EUTURBINE1
July 27, 2022

Test	Test Time	Unit Load (%)²	O₂ Concentration (% dry)¹	CH₂O Concentration (ppbvd)	CH₂O Concentration (ppmbd @ 15% O₂)
1-1	15:07-16:07	92%	15.2	21.6	22.5
1-2	16:22-17:22	92%	15.2	4.3	4.5
1-3	17:36-18:36	91%	15.2	16.2	<u>16.9</u>
				Ave:	14.6
				Permit Limit :	91

¹corrected for analyzer drift as per USEPA Method 7E

²calculated as actual average horse power divided by 10,504 (nominal rated horsepower)

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TABLE NO. 2
FORMALDEHYDE EMISSIONS TEST RESULTS
DTE Gas - Milford Compressor Station
EUTURBINE2
July 27, 2022

Test	Test Time	Unit Load (%)²	O₂ Concentration (% dry)¹	CH₂O Concentration (ppbvd)	CH₂O Concentration (ppbvd @ 15% O₂)
1-1	9:19-10:19	94%	15.2	6.4	6.7
1-2	10:37-11:37	93%	15.2	9.7	10.0
1-3	11:56-12:56	92%	15.2	10.8	<u>11.1</u>
				Ave:	9.2
				Permit Limit :	91

¹corrected for analyzer drift as per USEPA Method 7E

²calculated as actual average horse power divided by 10,504 (nominal rated horsepower)



TABLE NO. 3
FORMALDEHYDE EMISSIONS TEST RESULTS
DTE Gas - Milford Compressor Station
EUTURBINE3
July 28, 2022

Test	Test Time	Unit Load (%)²	O₂ Concentration (% dry)¹	CH₂O Concentration (ppbv)	CH₂O Concentration (ppbv @ 15% O₂)
1-1	8:36-9:36	90%	15.2	7.5	7.8
1-2	9:50-10:50	91%	15.2	14.0	14.5
1-3	11:16-12:16	91%	15.3	11.8	<u>12.3</u>
				Ave:	11.6
				Permit Limit :	91

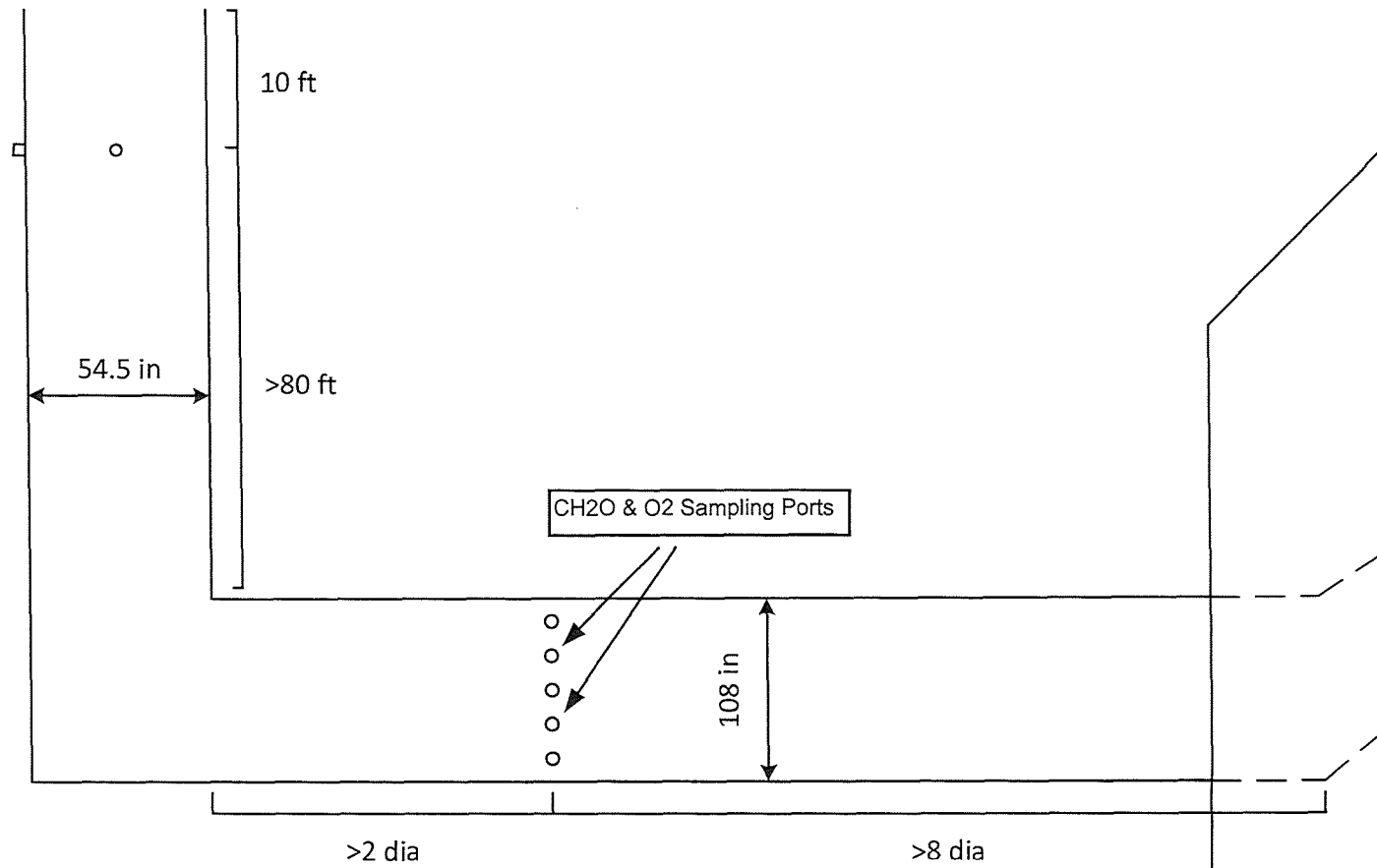
¹corrected for analyzer drift as per USEPA Method 7E

²calculated as actual average horse power divided by 10,504 (nominal rated horsepower)

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FIGURES

Figure 1. Sampling Location
Milford Compressor Station
EUTURBINE1-3



**Figure 2. Method 320/3A
Milford Compressor Station
EUTURBINE1-3**

