COMPLIANCE TEST REPORT

for

OXIDES OF NITROGEN (NO_X), CARBON MONOXIDE (CO), AND VOLATILE ORGANIC COMPOUNDS (VOC) EMISSIONS

UNITS 1-3

KALKASKA COMPRESSOR STATION
Kalkaska, Michigan

October 16-17, 2018

Prepared By
Environmental Management & Resources
Environmental Field Services Group
DTE Corporate Services, LLC
7940 Livernois H-136
Detroit, MI 48210

DTE Energy

DTE Energy

EXECUTIVE SUMMARY

DTE Energy's Environmental Management and Resources (EM&R), Field Services Group, performed emissions testing at Kalkaska Compressor Station, located in Kalkaska, Michigan. The fieldwork, performed on October 16-17, 2018 was conducted to satisfy requirements of Michigan Renewable Operating Permit No. N3341-2016A. Emissions tests were performed on Units 1-3 for oxides of nitrogen (NO_x), carbon monoxide (CO), volatile organic compounds (VOC).

The results of the emissions testing are highlighted below:

Emissions Testing Summary – Units 1-3
Kalkaska Compressor Station
Kalkaska, MI
October 16-17, 2018

	Oxides of Nitrogen (lb/hr[1])	Carbon Monoxide (lb/hr[1])	Volatile Organic Compounds (lb/hr[1])
Unit 1	12.9	5.2	0.9
Unit 2	22.0	4.5	0.8
Unit 3	13.4	4.6	0.9
Permit Limit	64.2	7.7	6.0

(1) Pounds per hour

DTE Energy

1.0 INTRODUCTION

DTE Energy's Environmental Management and Resources (EM&R), Field Services Group, performed emissions testing at Kalkaska Compressor Station, located in Kalkaska, Michigan. The fieldwork, performed on October 16-17, 2018 was conducted to satisfy requirements of Michigan Renewable Operating Permit No. N3341-2016A. Emissions tests were performed on Units 1-3 for oxides of nitrogen (NO_x), carbon monoxide (CO), volatile organic compounds (VOC).

Testing was performed pursuant to Title 40, *Code of Federal Regulations*, Part 60, Appendix A (40 CFR §60 App. A), Method 3A and ASTM D6348.

The fieldwork was performed in accordance with EPA Reference Methods and EM&R's Intent to Test[1], Test Plan Submittal. The following EM&R Field Services personnel participated in the testing program: Mr. Mark Grigereit, Principal Engineer, Mr. Thomas Snyder, Environmental Specialist and Mr. Fred Meinecke, Sr. Environmental Technician. Mr. Grigereit was the project leader. Ms. Karla Shawhan-Bonnee, Manager, Kalkaska Compressor Station, provided process coordination for the testing program. Mr. Jeremy Howe with the Air Quality Division of the Michigan Department of Environmental Quality (MDEQ) witnessed the testing and approved the Test Plan[2].

2.0 SOURCE DESCRIPTION

The Kalkaska Compressor Station located at 1250 MichCon Lane, Kalkaska, Michigan, employs the use of three Cooper GMVH 2,700 Horse Power two-stroke, lean burn natural gas-fired reciprocating engines (Engines 1-3). The engines generate line pressure assisting the transmission of natural gas into and out of the gas storage field as well as to and from the pipeline transmission system.

The emissions from the engines are exhausted directly to the atmosphere through individual exhaust stacks. The composition of the emissions from the engines depend both upon the speed of the engine and the torque delivered to the compressor. Ambient atmospheric conditions, as it affects the density of air, may limit the speed and torque at which the engines can effectively operate.

---

[1] MDEQ, Test Plan, Submitted August 6, 2018. (Attached-Appendix A)

[2] MDEQ, Approval Letter, Received September 28, 2018. (Attached-Appendix A)

During the emissions testing each engine was operated within 10% of its highest achievable load.

Schematic representations of each engine's exhaust and sampling locations are presented in Figure 1.

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	Carbon Dioxide	FTIR
ASTM D6348	NO_x, CO, VOC, Moisture Content	FTIR

3.1 CARBON DIOXIDE (USEPA METHOD 3A)

3.1.1 Sampling Method

Carbon Dioxide (CO2) emissions were evaluated using USEPA Method 3A, "Gas Analysis for Oxygen, Carbon Dioxide, Excess Air, and Dry Molecular Weight (Instrumental Analyzer Method)". The Carbon Dioxide sampling was performed simultaneously with the Method ASTM D6348 sampling.

The EPA Method 3A sampling system consisted of the following:

(1) Single-point sampling probe (located in the centroid of the exhaust stack)
(2) Flexible heated PTFE sampling line
(3) Air Dimensions Heated Head Diaphragm Pump
(4) MKS MultiGas 2030 FTIR spectrometer
(5) Appropriate calibration gases
(6) Data Acquisition System

RECEIVED
NOV 21 2018
AIR QUALITY DIVISION

3.1.2 Sampling Train Calibration

The CO2 analyzer was calibrated per procedures outlined in USEPA Methods 3A and 7E. Zero, span, and mid-range calibration gases were introduced directly into the analyzer to verify the instruments linearity. A zero and mid-range span gas was then introduced through the entire sampling system to determine sampling system bias at the completion of each test.

3.1.3 Quality Control and Assurance

All sampling and analytical equipment was calibrated per the guidelines referenced in Methods 3A and 7E. Calibration gases were EPA Protocol 1 gases and the concentrations were within the acceptable ranges (40-60% mid-range and span) specified in Method 7E. Calibration gas certification sheets are in Appendix C.

3.1.4 Data Reduction

Carbon Dioxide was derived from the coaddition of 64 scans, with a new data point generated approximately every one minute. The CO_2 emissions were recorded in parts per million (ppm) dry volume basis and were recorded in percent (%) dry volume basis.

3.2 MOISTURE DETERMINATION (ASTM D6348)

3.2.1 Sampling Method

Moisture content in the exhaust was evaluated using ASTM D6348, "Measurement of Vapor Phase Organic Emissions by Extractive Fourier Transform Infrared (FTIR)".

3.3 OXIDES of NITROGEN, CARBON MONOXIDE, NON-METHANE NON-ETHANE ORGANIC COMPOUNDS, CARBON DIOXIDE (ASTM D6348)

3.3.1 Sampling Method

Oxides of Nitrogen, Carbon Monoxide, Volatile Organic Compounds, and Carbon Dioxide emissions were evaluated using ASTM D6348, "Measurement of Vapor Phase Organic Emissions by Extractive Fourier Transform Infrared (FTIR)". Single point sampling was performed. Triplicate 60-minute test runs were performed.

Testing was modified from the submitted Test Plan. Following discussions with Mr. Howe. DTE performed VOC emissions utilizing ASTM D6348 rather than USEPA Method 25A. FID results are included in Appendix G, Method 25A Analyzer Data.

The EPA Method ASTM D6348 sampling system (Figure 2) consisted of the following:

(7) Single-point sampling probe (located in the centroid of the exhaust stack)
(8) Flexible heated PTFE sampling line
(9) Air Dimensions Heated Head Diaphragm Pump
(10) MKS MultiGas 2030 FTIR spectrometer
(11) Appropriate calibration gases
(12) Data Acquisition System

The FTIR was equipped with a temperature controlled, 5.11 meter 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 0.5 cm^{-1} resolution.

3.3.2 Sampling Train Calibration

The FTIR was calibrated per procedures outlined in ASTM D6348. Direct measurements of nitrogen, oxides of nitrogen (NO_x), carbon monoxide (CO), propane (C_3H_8), and ethylene (C_2H_4) 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.

NO_x, CO, and C_3H_8 gas standards were passed through the sampling system at each test location to determine the response time and confirm recovery.

NO_x, CO, and C_3H_8 spiking was performed to verify the ability of the sampling system to quantitatively deliver a sample containing NO_x, CO, and C_3H_8 from the base of the probe to the FTIR. Analyte spiking assures the ability of the FTIR to quantify NO_x, CO, and C_3H_8 in the presence of effluent gas.

As part of the spiking procedure, samples from each engine were measured to determine NO_x, CO, and C_3H_8 concentrations to be used in the spike recovery calculations. The determined sulfur hexafluoride (SF_6) 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 NO_x, CO, and C_3H_8. The following equation illustrates the percent recovery calculation.

$$DF = \frac{SF_{6(spike)}}{SF_{6(direct)}}$$ (Sec. 9.2.3 (3) ASTM D6348)

$$CS = DF * Spike_{dir} + Unspike\ (1 - DF)$$ (Sec. 9.2.3 (4) ASTM D6348)

DF = Dilution factor of the spike gas
$SF_{6(direct)}$ = SF6 concentration measured directly in undiluted spike gas
$SF_{6(spike)}$ = Diluted SF_6 concentration measured in a spiked sample
$Spike_{dir}$ = 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 NO_x, CO, and C_3H_8 spike recoveries were within the EPA Method ASTM D6348 allowance of ±30%.

3.3.3 Quality Control and Assurance

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 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 ± 5% agreement. If there is a difference greater than ± 5%, the spectra are reviewed for possible spectral interferences or any other possible causes that might lead to inaccurately quantified data. PRISM Analytical Technologies, Inc. validated the FTIR data. The data validation reports are in Appendix D.

3.3.4 Data Reduction

Each spectrum was derived from the coaddition of 64 scans, with a new data point generated approximately every one minute. The NO_x, CO, and VOC emissions were recorded in parts per million (ppm) dry volume basis. The CO2 emissions were recorded in percent (%) dry volume basis. The moisture content was recorded in percent (%).

4.0 OPERATING PARAMETERS

The test program included the collection of engine torque (Hp), engine speed (RPM), inlet and exhaust manifold air temperature (°F) and pressure (psi), fuel upper heating value (BTU), and fuel flow (100 scfh).

Operational data is in Appendix F.

5.0 DISCUSSION OF RESULTS

The Results of the NO_x, CO and NMOC testing for Engines 1-3 are presented in Tables 1-3. The NO_x, CO and NMOC emissions are presented in parts per million (ppm) and pounds per hour (lbs/hr). Process data presented includes the Unit load in percent (%), Engine Torque in brake horsepower-hour (Brake-Hp), and Heat Input in Million British Thermal Unit per hour (MMBtu/hr) for each test.

The results of the testing indicate that Engines 1-3 meet the emission limits listed in Michigan Renewable Operating Permit No. N3341-2016A.

DTE Energy

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."

Thomas Snyder, QSTI

This report prepared by:

Mr. Thomas Snyder, QSTI
Environmental Specialist, Environmental Field Services
Environmental Management and Resources
DTE Energy Corporate Services, LLC

This report reviewed by:

Mr. Mark R. Grigereit, QSTI
Principal Engineer, Environmental Field Services
Environmental Management and Resources
DTE Energy Corporate Services, LLC

DTE Energy

TABLE NO. 1
EMISSION TESTING RESULTS - CO, NOx, and NMOC
Engine 1 - Kalkaska Compressor Station
October 16, 2018

Test	Time	Load (%)	Brake-HP	Heat Input (MMBtu/Hr)	CO_2 [1] (%)	CO Emissions (lbs/hr)	NOx Emissions (lbs/hr)	NMOC Emissions (lbs/hr)
Run - 1	8:00-9:00	92.0	2,579	18.1	3.4	5.1	11.9	0.9
Run - 2	9:08-10:08	98.3	2,675	19.2	3.4	5.3	13.4	0.9
Run - 3	10:22-11:22	92.3	2,513	18.1	3.4	5.1	13.5	0.9
	Avg:	*94.2*	*2,589*	*18.5*	*3.4*	*5.2*	*12.9*	*0.9*

(1) Corrected for analyzer drift per USEPA method 7E

Permit Limits (lbs/hr):

CO: 7.7

NOx: 64.2

NMOC: 6.0

DTE Energy

TABLE NO. 2
EMISSION TESTING RESULTS - CO, NOx, and NMOC
Engine 2 - Kalkaska Compressor Station
October 16, 2018

Test	Time	Load (%)	Brake-HP	Heat Input (MMBtu/Hr)	CO_2 [1] (%)	CO Emissions (lbs/hr)	NOx Emissions (lbs/hr)	NMOC Emissions (lbs/hr)
Run - 1	11:52-12:52	96.7	2,620	18.8	3.5	4.5	21.0	0.8
Run - 2	13:28-14:28	97.0	2,631	18.9	3.5	4.4	22.3	0.8
Run - 3	14:35-15:35	98.3	2,664	19.1	3.6	4.5	22.7	0.8
	Avg:	***97.3***	***2,638***	***18.9***	***3.5***	***4.5***	***22.0***	***0.8***

(1) Corrected for analyzer drift per USEPA method 7E

Permit Limits (lbs/hr):

CO: 7.7

NOx: 64.2

NMOC: 6.0

DTE Energy

TABLE NO. 3
EMISSION TESTING RESULTS - CO, NOx, and NMOC
Engine 3 - Kalkaska Compressor Station
October 17, 2018

Test	Time	Load (%)	Brake-HP	Heat Input (MMBtu/Hr)	CO_2 [1] (%)	CO Emissions (lbs/hr)	NOx Emissions (lbs/hr)	NMOC Emissions (lbs/hr)
Run - 1	7:47-8:47	93.3	2,538	18.3	3.3	4.6	13.7	1.0
Run - 2	9:00-10:00	93.0	2,524	18.2	3.4	4.5	13.4	0.9
Run - 3	10:11-11:11	93.0	2,527	18.3	3.3	4.6	13.2	0.9
	Avg:	***93.1***	***2,530***	***18.3***	***3.3***	***4.6***	***13.4***	***0.9***

(1) Corrected for analyzer drift per USEPA method 7E

Permit Limits (lbs/hr):

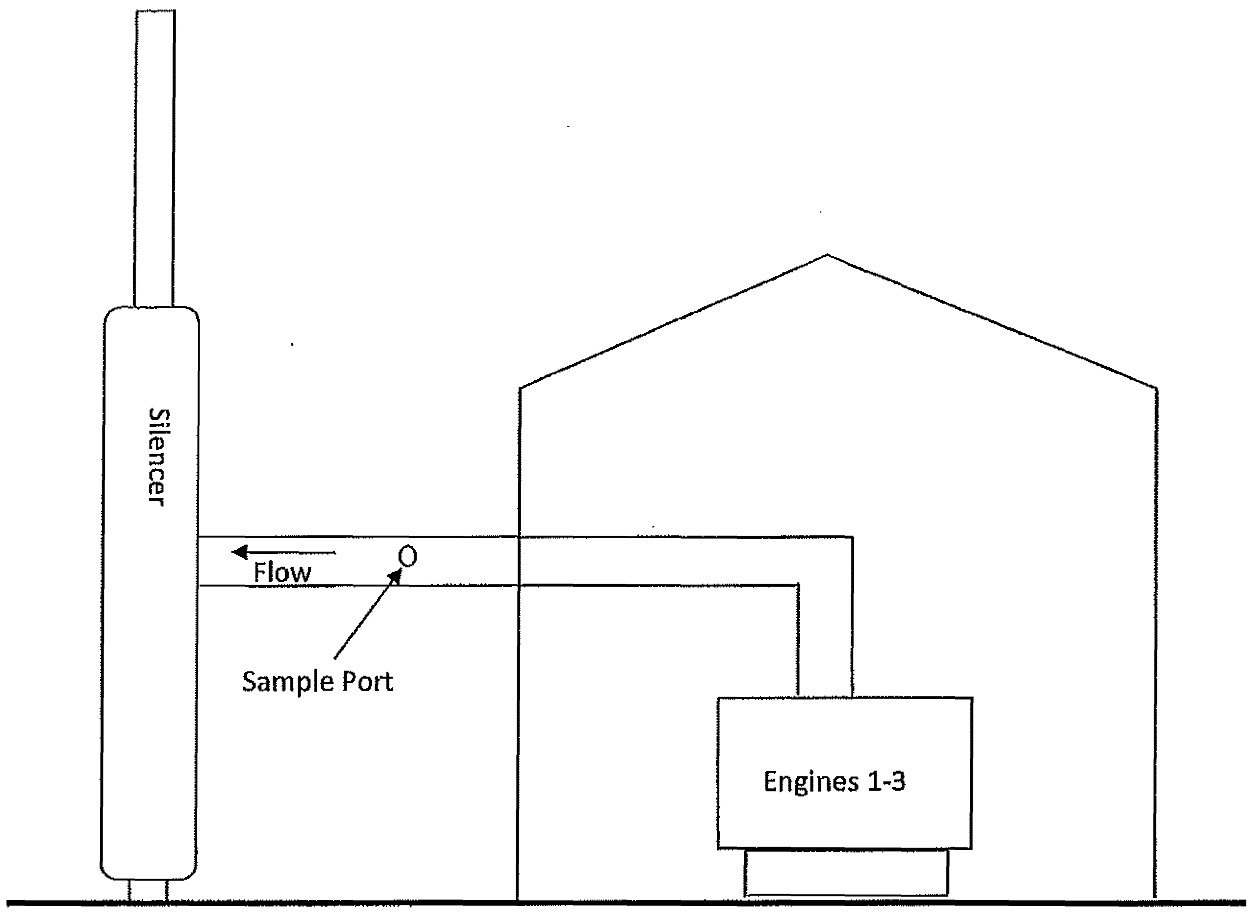
CO: 7.7

NOx: 64.2

NMOC: 6.0

DTE Energy

Figure 1 – Sampling Location
Kalkaska Compressor Station
October 16 & 17, 2018



DTE Energy

Figure 2 – USEPA Method 3A & ASTM D6348
Kalkaska Compressor Station
October 16 & 17, 2018