

EMISSIONS TEST REPORT

for

OXIDES OF NITROGEN (NOX) AND CARBON MONOXIDE (CO) EMISSIONS

TURBINE 1

DTE-Gas, Willow Compressor Station
Ypsilanti, Michigan

December 27, 2018

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AP421-TEST-20181227



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EXECUTIVE SUMMARY

DTE Energy’s Environmental Management and Resources (EM&R) Field Services Group performed emissions testing at the DTE-Gas, Willow Compressor Station, located in Ypsilanti, Michigan. The fieldwork, performed on December 27, 2018 was conducted to satisfy requirements of the Michigan Department of Environmental Quality (MDEQ) Permit to Install (PTI) 44-16A. Emissions tests were performed on the Solar Compressor Turbine 1. Testing was performed for Oxides of Nitrogen (NOx) and Carbon Monoxide (CO) while operating the Turbine at the highest achievable operating load.

The results of the emissions testing are highlighted below:

**NO_x Emissions Test Results
Willow Compressor Station
Solar Compressor Turbine (Turbine 1)
December 27, 2018**

Turbine Load (HP)	NO_x Concentration (ppm @ 15% O₂)	CO Concentration (ppm)
5,647	10.3	1.3
Permit Limit	15⁽¹⁾	25

⁽¹⁾ Average Oxides of Nitrogen Emissions Concentration (ppm) corrected to 15% O₂



1.0 INTRODUCTION

DTE Energy's Environmental Management and Resources (EM&R) Field Services Group performed emissions testing at the DTE-Gas, Willow Compressor Station, located in Ypsilanti, Michigan. The fieldwork, performed on December 27, 2018, was conducted to satisfy requirements of the Michigan Department of Environmental Quality (MDEQ) Permit to Install (PTI) 44-16A. Emissions tests were performed on the Solar Compressor Turbine 1. Testing was performed for Oxides of Nitrogen (NO_x) and Carbon Monoxide (CO) while operating the Turbine at the highest achievable operating load.

Testing was performed pursuant to Title 40, *Code of Federal Regulations*, Part 60, Appendix A (40 CFR §60 App. A), Methods 3A, 7E & 10. The fieldwork was performed in accordance with EPA Reference Methods and EM&R's Intent to Test¹, Test Plan Submittal. The following DTE personnel participated in the testing program: Mark Grigereit, Principal Engineer and Mark Westerberg, Senior Environmental Specialist. Mr. Grigereit was the project leader. Mr. Tom Gasloli (MDEQ) approved the test plan.

2.0 SOURCE DESCRIPTION

The Willow Compressor Station located at 3020 East Michigan Avenue, Ypsilanti, Michigan, employs the use of one Solar natural gas-fired 7,700 Horse Power combustion turbine (Turbine 1) with a low NO_x combustor for NO_x control. The turbine generates line pressure assisting with the transmission of natural gas through the pipeline transmission system in SE Michigan. Testing for CO and NO_x emissions was performed while the turbine operated in the LoNO_x mode at 94% gas producer speeds.

The turbine exhausts directly to the atmosphere through a rectangular exhaust duct. Sampling was performed in the round horizontal section of the ductwork located inside the building.

A schematic representation of the turbine exhaust and sampling location is presented in Figure 1.

¹ MDEQ, Test Plan, Submitted October 18, 2018. (Attached-Appendix A)

² MDEQ, Approval Letter, Received October 25, 2018. (Attached-Appendix A)



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 7E	Oxides of Nitrogen	Chemiluminescent Instrumental Analyzer Method
USEPA Method 10	Carbon Monoxide	NDIR Instrumental Analyzer Method

3.1 OXYGEN (USEPA METHOD 3A)

3.1.1 Sampling Method

Oxygen (O₂) emissions were evaluated using USEPA Method 3A, "Gas Analysis for Carbon Dioxide, Oxygen, Excess Air, and Dry Molecular Weight (Instrumental Analyzer Method)". The analyzer utilizes a paramagnetic sensor. Testing was performed simultaneously with the gaseous emissions testing.

The EPA Method 3A sampling system (Figure 2) consisted of the following:

- (1) Single-point sampling probe (traversed across the duct per procedures in Method 7E)
- (2) Heated Teflon™ sampling line
- (3) Gas conditioner with particulate filter
- (4) Flexible unheated Teflon™ sampling line
- (5) Servomax 1400 O₂/CO₂ gas analyzer
- (6) Appropriate USEPA Protocol 1 calibration gases
- (7) Data Acquisition System

3.1.2 Sampling Train Calibration

The O₂ 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. 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.

3.1.3 Data Reduction

Data collected during the emissions testing was recorded at 10-second intervals and averaged in 1-minute increments. The O₂ emissions were recorded in percent (%). The 1-minute readings collected during the testing can be found in Appendix B.

3.2 OXIDES OF NITROGEN AND CARBON MONOXIDE (USEPA METHODS 7E & 10)

3.2.1 Sampling Method

Oxides of nitrogen (NO_x) emissions were evaluated using USEPA Method 7E, "Determination of Oxides of Nitrogen Emissions from Stationary Sources". The NO_x analyzer utilizes a Chemiluminescent detector. Triplicate 60-minute tests were performed on the engine exhaust. Carbon monoxide (CO) emissions were evaluated using USEPA Method 10, "Determination of Carbon Monoxide Emissions from Stationary Sources". The CO analyzer utilizes an NDIR detector. Triplicate 21-minute tests were performed on the turbine exhaust.

The EPA Method 7E & 10 sampling system (Figure 2) consisted of the following:

- (1) Stainless-steel sample probe (traversed across the duct per procedures in Method 7E)
- (2) Heated Teflon™ sampling line
- (3) Gas conditioner with particulate filter
- (4) Flexible unheated Teflon™ sampling line
- (5) TECO 42i Chemiluminescent NO/NO_x gas analyzer,
TECO 48i NDIR CO gas analyzer
- (6) Appropriate USEPA Protocol 1 calibration gases
- (7) Data Acquisition System.

3.2.2 Sampling Train Calibration

The sampling train was calibrated per procedures outlined in USEPA Method 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.

3.2.3 Quality Control and Assurance

All sampling and analytical equipment was calibrated per the guidelines referenced in Methods 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.

DTE performed a NO_x converter efficiency test by directly challenging the NO_x analyzer with a nitrogen dioxide (NO₂) calibration gas of 15.6 ppm. Results from the converter efficiency test demonstrated that the analyzer met the requirements of Method 7E (Eq-1). Equation-1 shows the converter efficiency test performed.

$$\text{Eq. 1} \quad \text{Eff}_{NO_2} = \frac{C_{Dir}}{C_v} = \frac{14.05}{15.6} = 90.0\%$$

3.2.4 Data Reduction

Data collected during the emissions testing was recorded at 10-second intervals and averaged in 1-minute increments. The NO_x and CO emissions were recorded in parts per million (ppm). The 1-minute readings collected can be found in Appendix B.

Emissions calculations are based on calculations located in USEPA Methods 7E and 19 and can be found in Appendix D. The NO_x emissions data collected during the testing was calculated as parts per million, dry, corrected to 15% O₂.

The emissions data collected can be found in Appendix B.

4.0 OPERATING PARAMETERS

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

Operational data and results of the fuel analysis can be found in Appendix E.

5.0 RESULTS

The results of the NO_x emission testing conducted on Turbine 1 are presented in Table No 1. The NO_x emissions are presented in parts per million (ppm) and parts per million at 15% oxygen (ppm @ 15% O₂) and process data presented in unit load (%).

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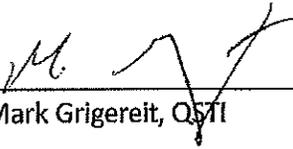


Testing of Turbine 1 demonstrated compliance with MDEQ PTI emission rates. Testing was performed while the turbine was operated in LoNO_x mode at 94% gas producer speed/ and 5,647 HP. (maximum achievable load on the day of testing).



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."



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RESULTS TABLE

**Oxides of Nitrogen and Carbon Monoxide
Testing Results
Solar Compressor Turbine 1
DTE Energy, Willow Compressor Station
Ypsilanti, Michigan**

Parameter	Run 1	Run 2	Run 3	Average
Sampling Date	12/27/18	12/27/18	12/27/18	
Sampling Start Time	9:57-10:18	10:30-10:51	11:00-11:21	
Average Outlet O ₂ Content (% dry)	15.6	15.6	15.6	15.6
Average Outlet O ₂ Content (% dry, corrected) ¹	15.7	15.7	15.7	15.7
Average Outlet NO _x Concentration (ppmv, dry)	8.7	8.7	8.8	8.7
Average Outlet NO _x Concentration (ppmv, dry, corrected) ¹	9.1	9.1	9.2	9.1
Average Outlet NO _x Concentration @ 15% O ₂ (ppmv, dry, corrected)	10.3	10.4	10.4	10.3
Average Outlet CO Concentration (ppmv, dry)	1.2	1.2	1.2	1.2
Average Outlet CO Concentration (ppmv, dry, corrected) ¹	1.2	1.2	1.3	1.3

¹corrected for analyzer drift as per USEPA Method 7E

O₂ : oxygen

NO_x : oxides of nitrogen

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FIGURES



Figure 1 – Sampling Location
Willow Run Compressor Station – EUTURBINE1
December 27, 2018

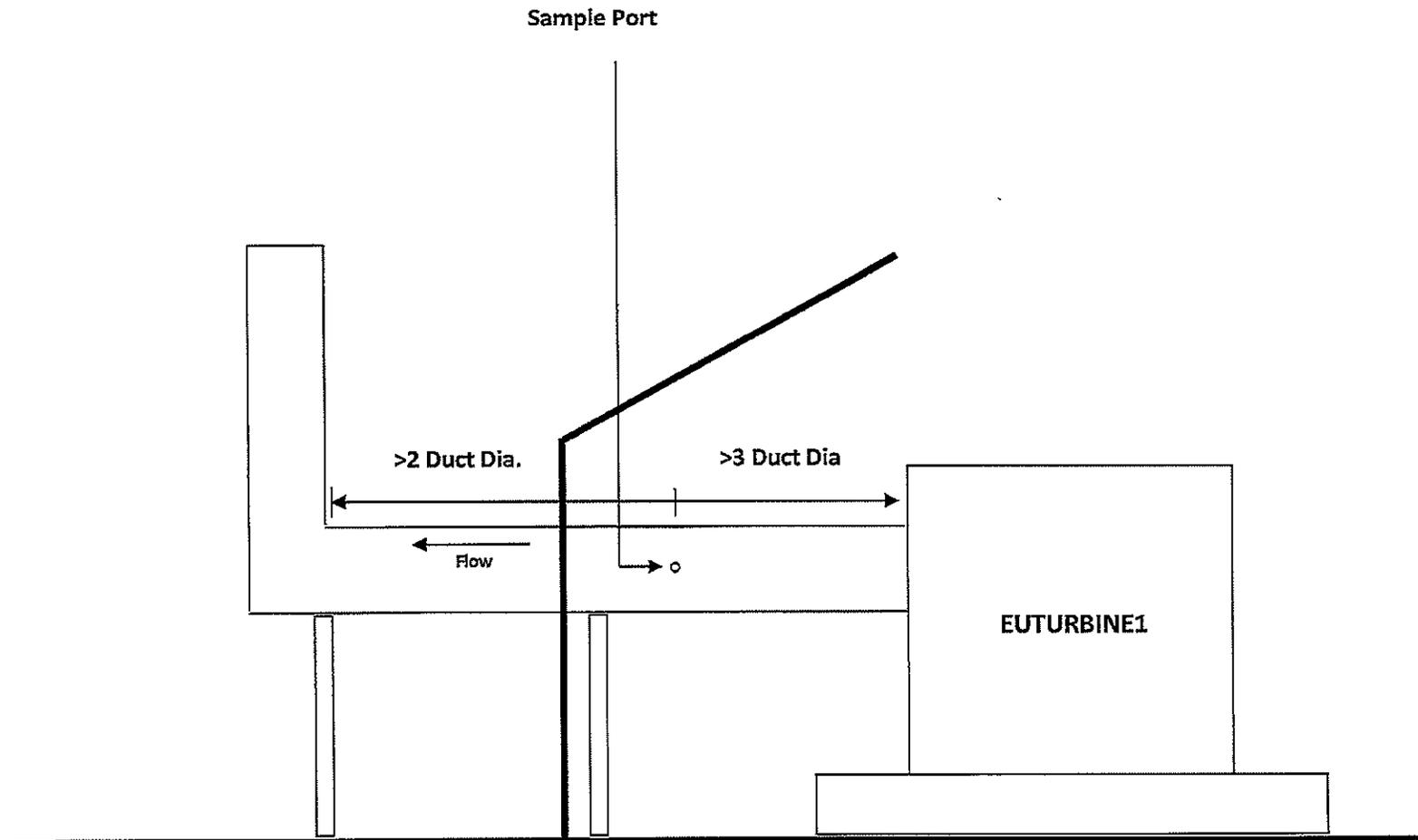




Figure 2 – EPA Methods 3A, 7E & 10
Willow Run Compressor Station – EUTURBINE1
December 27, 2018

