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AIR EMISSION TEST REPORT
FOR THE
VERIFICATION OF AIR POLLUTANT EMISSIONS
FROM A
NATURAL GAS FUELED TURBINE

Prepared for:

DCP Antrim Gas, LLC
SRN: N2940

ICT Project No.: 2200098
June 23, 2022

IMPACT COMPLIANCE & TESTING

Report Certification

AIR EMISSION TEST REPORT
FOR THE
VERIFICATION OF AIR POLLUTANT EMISSIONS
FROM A
NATURAL GAS FUELED TURBINE

DCP Antrim Gas, LLC
Johannesburg, MI

The material and data in this document were prepared under the supervision and direction of the undersigned.

Impact Compliance & Testing, Inc.

Tyler J. Wilson
Senior Project Manager

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1.0 Introduction

DCP Operating Company, LP (DCP) owns and operates a natural gas fired turbine at its South Chester Antrim CO_2 Removal Facility located in Johannesburg, Otsego County, Michigan.

The State of Michigan Department of Environment, Great Lakes, and Energy – Air Quality Division (EGLE-AQD) has issued to DCP Permit to Install (PTI) No. 162-18 for operation of the natural gas fired turbine identified in the PTI as emission unit EUTUR03 (also called Turbine No. 3). Turbine No. 3 was tested during this test event.

DCP also operates emission units under Renewable Operating Permit (ROP) No. MI-ROP-N2940-2015 (expired July 6, 2020; renewal pending). Testing was not performed for any emission units relative to the ROP during this test event.

Air emission compliance testing was performed pursuant to conditions of PTI No. 162-18 and the New Source Performance Standards for Stationary Combustion Turbines (the NSPS; 40 CFR 60.4400 of 40 CFR Part 60 Subparts A and KKKK).

The compliance testing presented in this report was performed by Impact Compliance & Testing, Inc. (ICT), a Michigan-based environmental consulting and testing company. ICT representatives Tyler Wilson and Chiren Moore performed the field sampling and measurements May 25, 2022.

The turbine emission performance tests consisted of triplicate, one-hour sampling periods for carbon monoxide (CO) and nitrogen oxides (NOx). Exhaust gas velocity, moisture, oxygen (O_2) content, and carbon dioxide (CO_2) content were determined for each test period to calculate pollutant mass emission rates.

The exhaust gas sampling and analysis was performed using procedures specified in the Stack Test Protocol dated March 18, 2022, that was reviewed and approved by EGLE-AQD. Ms. Lindsey Wells, Ms. Sharon LeBlanc, and Mr. Daniel Droste of EGLE-AQD observed portions of the compliance testing.

Questions regarding this air emission test report should be directed to:

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2.0 Summary of Test Results and Operating Conditions

2.1 Purpose and Objective of the Tests

Conditions of PTI No. 162-18 and the New Source Performance Standards for Stationary Combustion Turbines (the NSPS; 40 CFR 60.4400 of 40 CFR Part 60 Subparts A and KKKK) require DCP to test EUTUR03 for CO and NOx emissions. EUTUR03 (Turbine No. 3) was tested during this compliance test event.

2.2 Operating Conditions During the Compliance Tests

Testing was performed while EUTUR03 operated at the highest achievable operating load. DCP representatives provided turbine output (% load) in 15-minute increments for each test period.

Additional turbine operating parameters were also recorded by DCP representatives in 15-minute increments for each test period.

Appendix 2 provides operating records provided by DCP representatives for the test periods.

Tables 2.1 and 6.1 present a summary of the average turbine operating conditions during the test periods.

2.3 Summary of Air Pollutant Sampling Results

The gases exhausted from the sampled natural gas fueled turbine (EUTUR03; Turbine No. 3) were sampled for three (3) one-hour test periods during the compliance testing performed May 25, 2022.

Table 2.2 presents the average measured CO and NO_X concentrations and emission rates for EUTUR03 (average of the three test periods).

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

Table 2.1 Average turbine operating conditions during the test periods

Turbine Parameter	EUTUR03 (Turbine No. 3)
Turbine output (kW)	2,360
Turbine natural gas use (lb/hr)	2,519
Ambient temperature (°F)	69
Fuel heating value (Btu)	895

Table 2.2 Average measured CO and NOx concentrations and emission rates (three-test average)

	NOx			CO	
Emission Unit	(ppmvd @ 15% O_2)	(lb/hr)	(tpy)	(lb/hr)	(tpy)
EUTUR03	6.15	0.83	1.56	0.04	0.08
Limits	***42***	***5.35***	***38.7***	***6.47***	***43.4***

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3.0 Source and Sampling Location Description

3.1 General Process Description

DCP is permitted to operate a natural gas fueled turbine at its South Chester Antrim CO_2 Removal Facility. The unit is fueled exclusively with natural gas.

3.2 Rated Capacities and Air Emission Controls

The natural gas fueled turbine has an output capacity of 4.0 megawatts (MW).

The emission unit does not have add-on emission control equipment. The air-to-fuel ratio is controlled to maintain efficient fuel combustion, which minimized air pollutant emissions.

3.3 Sampling Locations

The turbine exhaust gas is released to the atmosphere through a vertical exhaust stack with a vertical release point.

The exhaust stack sampling ports are located in the vertical exhaust stack, with an inner diameter of 45.25 inches. The stack is equipped with two (2) sample ports, opposed 90°, that provide a sampling location 56.0" (1.24 duct diameters) upstream and >180" (>3.98 duct diameters) downstream from any flow disturbance.

All sample port locations satisfy 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 locations with actual stack dimension measurements.

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 4	Exhaust gas moisture was determined based on the water weight gain in chilled impingers.
USEPA Method 3A	Exhaust gas O_2 and CO_2 content was determined using paramagnetic and infrared instrumental analyzers, respectively.
USEPA Method 7E	Exhaust gas NOx concentration was determined using a chemiluminescence instrumental analyzer.
USEPA Method 10	Exhaust gas CO concentration was measured using an infrared instrumental analyzer.

4.2 Exhaust Gas Velocity Determination (USEPA Method 2)

The turbine exhaust stack gas velocities and volumetric flow rates were determined using USEPA Method 2 once during each test period. 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 leak-checked periodically throughout the test periods to verify the integrity of the measurement system.

The absence of significant cyclonic flow at the sampling location was verified using an S-type Pitot tube and oil manometer. The Pitot tube was positioned at each velocity traverse point with the planes of the face openings of the Pitot tube perpendicular to the stack cross-sectional plane. The Pitot tube was then rotated to determine the null angle (rotational angle as measured from the perpendicular, or reference, position at which the differential pressure is equal to zero).

Appendix 3 provides exhaust gas flowrate calculations and field data sheets.

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

CO_2 and O_2 content in the turbine 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 4900 infrared gas analyzer. The O_2 content of the exhaust was monitored using a Servomex 4900 gas analyzer that uses a paramagnetic sensor.

During each sampling period, a continuous sample of the turbine 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)

Moisture content of the turbine exhaust gas was determined in accordance with USEPA Method 4 using a chilled impinger sampling train. Exhaust gas moisture content measurements were performed concurrently with the instrumental analyzer sampling periods. 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.

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

NO_X and CO pollutant concentrations in the turbine exhaust gas stream were determined using a Thermo Environmental Instruments, Inc. (TEI) Model 42i High Level chemiluminescence NO_X analyzer and a California Analytical Instruments (CAI) Fuji ZRF non-dispersive infrared CO analyzer.

Throughout each test period, a continuous sample of the turbine exhaust gas was extracted from the stack using the Teflon® heated sample line and gas conditioning system and delivered to the instrumental analyzer. Instrument response for the 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 instrument was 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.

5.0 QA/QC Activities

5.1 Flow Measurement Equipment

Prior to arriving onsite (or onsite prior to beginning compliance testing), the instruments used during the source test to measure exhaust gas properties and velocity (pyrometer, Pitot tube, and scale) were calibrated to specifications in the sampling methods.

5.2 NO_x Converter Efficiency Test

The NO_2 – NO conversion efficiency of the Model 42i analyzer was verified prior to the testing program. 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 instrumental analyzer will be deemed acceptable if the measured NOx concentration is at least 90% of the expected value (within 10%).

The NO_2 – NO conversion efficiency test satisfied the USEPA Method 7E criteria (measured NO_x concentration was 100.1% of the expected value).

5.3 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 prior to use of gas divider. The field evaluation yielded no errors greater than 2% of the triplicate measured average and no errors greater than 2% from the expected values.

5.4 Instrumental Analyzer Interference Check

The instrumental analyzers used to measure CO, NO_X, O_2, and CO_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.

5.5 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 CO, NO_x, 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.

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

5.6 Determination of Exhaust Gas Stratification

A stratification test was performed for the turbine exhaust stack during Test No. 1, with regards to requirements specified in 40 CFR, Part 60, Subpart KKKK, Section 60.4400. The stainless-steel sample probe was positioned at sixteen (16) sample points inside the turbine exhaust stack (eight (8) points per sample port). Pollutant concentration data were recorded at each sample point for a minimum of twice the maximum system response time.

Following the stratification test, the analyzer sampling probe was moved to a single point within the turbine exhaust stack (middle of stack), for the duration of the test periods.

5.7 System Response Time

The response time of the sampling system was determined prior to the compliance test program 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.

Sampling periods did not commence until the sampling probe had been in place for at least twice the greatest system response time.

5.8 Meter Box Calibrations

The dry gas meter sampling console used for moisture testing was calibrated prior to and after the testing program. 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 metering console was calibrated using a NIST traceable Omega® Model CL 23A temperature calibrator.

Appendix E presents test equipment quality assurance data (NO_2 – NO conversion efficiency test data, instrument calibration and system bias check records, calibration gas certifications, interference test results, meter box calibration records, and field equipment calibration records).

6.0 Results

6.1 Test Results and Allowable Emission Limits

Turbine operating data, and CO and NOx concentrations and emission measurement results for each one-hour test period are presented in Table 6.1.

EUTUR03 has the following allowable CO and NOx concentration limits and emission limits:

Emission Unit ID	NOx Limits	CO Limits
EUTUR03	42 ppm[A] or 150 ppm[B], corrected to 15% O_2 on a dry gas basis	165 ppm[B], corrected to 15% O_2 on a dry gas basis
EUTUR03	5.35 pph[A]	6.47 pph[A]
EUTUR03	38.7 tpy	43.4 tpy

Notes:
A. Limit is for temperatures above 0°F
B. Limit is for temperatures below 0°F

The measured air pollutant concentrations and emission rates for EUTUR03 are less than the allowable limits specified in PTI No. 162-18 and the New Source Performance Standards for Stationary Combustion Turbines (the NSPS; 40 CFR 60.4400 of 40 CFR Part 60 Subparts A and KKKK).

6.2 Variations from Normal Sampling Procedures or Operating Conditions

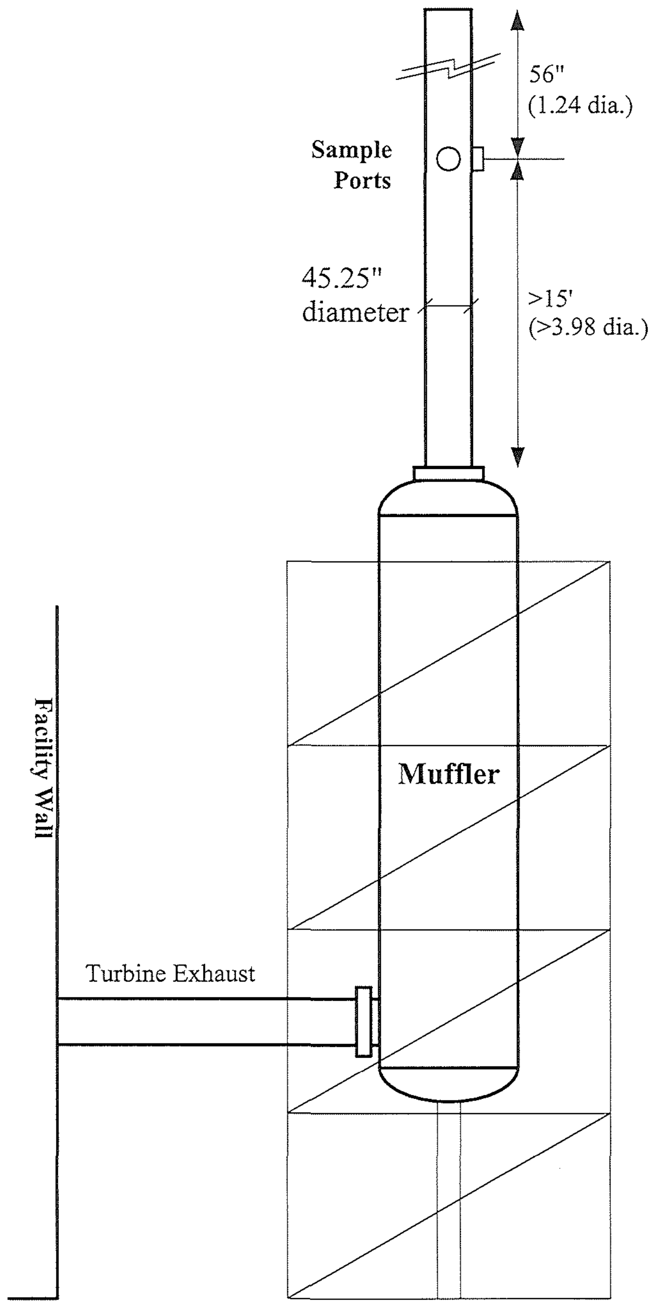
The testing for all pollutants was performed in accordance with USEPA methods and the approved Stack Test Protocol. No variations from normal operating conditions occurred during the turbine test periods.

Table 6.1 Measured exhaust gas conditions, and CO and NOx concentrations and emission rates for Turbine No. 3 (EUTUR03)

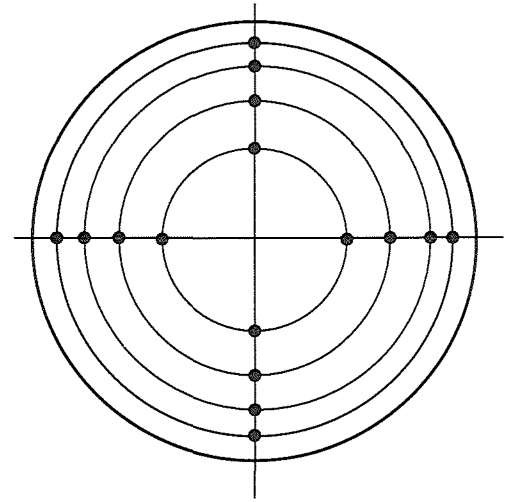
Test No. Test date Test period (24-hr clock)	1 5/25/2022 820-920	2 5/25/2022 937-1037	3 5/25/2022 1057-1157	Three Test Average
Turbine output (kW)	2,388	2,359	2,332	2,360
Turbine natural gas use (lb/hr)	2,408	2,582	2,566	2,519
Ambient temperature (°F)	69	68	70	69
Fuel heating value (Btu)	894	895	895	895
Exhaust Gas Composition				
CO_2 content (% vol)	3.71	3.69	3.70	3.70
O_2 content (% vol)	15.6	15.6	15.6	15.6
Moisture (% vol)	6.1	6.2	5.6	6.0
Exhaust gas flowrate (dscfm)	21,111	20,959	21,000	21,023
Exhaust gas flowrate (scfm)	22,493	22,333	22,247	22,358
Exhaust gas temperature (°F)	939	944	945	943
Nitrogen Oxides				
NO_X conc. (ppmvd)	5.65	5.41	5.41	5.49
NO_X conc. (ppmvd @ 15% O_2)	6.33	6.06	6.07	6.15
Limit (ppmvd @ 15% O_2)	-	-	-	*42*
NO_X emissions (pph)	0.85	0.81	0.82	0.83
Limit (pph)	-	-	-	*5.35*
NO_X emissions (tpy)	1.61	1.53	1.53	1.56
Limit (tpy)	-	-	-	*38.7*
Carbon Monoxide				
CO conc. (ppmvd)	1.29	0.04	0.03	0.45
CO conc. (ppmvd @ 15% O_2)	1.45	0.04	0.04	0.51
CO emissions (pph)	0.12	0.00	0.00	0.04
Limit (pph)	-	-	-	*6.47*
CO emissions (tpy)	0.22	0.01	0.01	0.08
Limit (tpy)	-	-	-	*43.4*

APPENDIX 1

- Turbine Sample Port Diagram



Exhaust Stack
Cross-Section with
Traverse Points



Velocity sample locations as measured from stack wall were determined as part of the testing program

3/26/2020 TJW	**DCP Antrim Gas, LLC** Exhaust Sample Location, Centaur 50 Turbine		
	Scale None	Sheet 1 of 1	IMPACT COMPLIANCE & TESTING