EMISSIONS TEST REPORT

for

FORMALDEHYDE (CH_2O) AND CARBON MONOXIDE (CO) EMISSIONS

SRN: N7421
EUTURBINE1

40CFR Part 63, Subpart YYYY and MI-ROP-N7421-2022

DTE Gas Company – Willow Compressor Station
Ypsilanti, Michigan

May 9, 2023

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CONTENTS

DTE

RESULTS TABLE

FIGURES

APPENDICES

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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 – Willow Compressor Station, located in Ypsilanti, Michigan. The fieldwork, performed May 9, 2023, was conducted to satisfy requirements of the Michigan Department of Environment, Great Lakes, and Energy (EGLE) Michigan Renewable Operating Permit MI-ROP-N7421-2022 and 40 CFR Part 63 Subpart YYYY. Emissions tests were performed on Solar Turbine (EUTURBINE1) for formaldehyde (CH_2O) and carbon monoxide (CO).

The results of the emissions testing are highlighted below:

Emissions Test Results
Willow Compressor Station
EUTURBINE1
May 9, 2023

Emission Unit	O2 (%)	CH2O (ppbvd @ 15% O2)	CO (ppmvd @ 15% O2)
EUTURBINE1	15.4	8.5	1.1
Permit Limit		***91***	***25***

1.0 INTRODUCTION

DTE Energy's Environmental Management and Safety (EM&S) Ecology, Monitoring, and Remediation performed emissions testing at the DTE Gas Company – Willow Compressor Station, located in Ypsilanti, Michigan. The fieldwork, performed May 9, 2023, was conducted to satisfy requirements of the Michigan Department of Environment, Great Lakes, and Energy (EGLE) Michigan Renewable Operating Permit MI-ROP-N7421-2022 and 40 CFR Part 63 Subpart YYYY. Emissions tests were performed on Solar Turbine (EUTURBINE1) for formaldehyde (CH_2O) and carbon monoxide (CO).

The fieldwork was performed in accordance with EPA Reference Methods and two DTE Energy Intent to Test[1] documents, which were approved in a letter by Ms. Lindsey Wells from the Michigan Department of Environment, Great Lakes & Energy (EGLE), dated April 13, 2023[2]. The following DTE Energy personnel participated in the testing program: Mr. Thomas Snyder, Senior Environmental Specialist, Mr. Mark Grigereit, Principal Engineer, and Mr. Fred Meinecke, Senior Environmental Specialist. Mr. Snyder was the project leader. Mr. Brad Piontek, operator, and repair technician at the station, provided process coordination for the testing program. Mr. Andrew Riley from the Michigan Department of Environment, Great Lakes & Energy witnessed portions of the testing.

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 (EUTURBINE1) 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 CH_2O and CO emissions was performed while the turbine operated in the $LoNO_x$ mode at an average of 98.8% gas producer speed.

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.

Figure 1 presents a schematic of the sampling location for the turbine.

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:

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[1] EGLE, Test Plans, Submitted February 23, and February 24, 2023. (Attached-Appendix A)

[2] EGLE, Approval Letter, dated April 13, 2023. (Attached-Appendix A)

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Sampling Method	Parameter	Analysis
USEPA Method 3A	Oxygen	Paramagnetic Analyzer
USEPA Method 10	Carbon Monoxide	NDIR Analyzer
USEPA Method 320	Formaldehyde	Fourier Transform Infrared (FTIR)

3.1 OXYGEN (USEPA METHOD 3A)

3.1.1 Sampling Method

Exhaust Oxygen (O_2) content was measured using USEPA Method 3A, "Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)". The O_2 analyzer utilizes a paramagnetic sensor. Triplicate 60-minute tests were performed on the turbine exhaust. Testing was performed simultaneously with the gaseous emissions testing.

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) Single-point sampling probe
(2) Heated Teflon™ sampling line
(3) MAK® gas conditioner with particulate filter
(4) Flexible unheated Teflon™ sampling line.
(5) Servomex 1400 O_2/CO_2 gas analyzer
(6) Appropriate USEPA Protocol 1 calibration gases
(7) Data Acquisition System.

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

3.1.3 Sampling Train Calibration

The O_2 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

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system bias. System calibrations were performed prior to, and at the conclusion of, each test period.

3.1.4 Sampling Duration & Frequency

Oxygen (O_2) sampling was performed during all CH_2O and CO 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 O_2 (%) readings were logged at 10-second intervals and averaged in 1-minute increments. CH_2O emissions are reported in parts per billion, dry, corrected to 15% O_2 (ppb @ 15% O_2) for comparison to the emission limit. CO emissions are reported in parts per million, dry, corrected to 15% O_2 (ppm @ 15% O_2) for comparison to the emission limit

Raw CEM data is presented in Appendix B.

3.2 CARBON MONOXIDE (USEPA METHOD 10)

3.2.1 Sampling Method

Exhaust Carbon Monoxide (CO) content was measured using USEPA Method 10, "Determination of Carbon Monoxide Emissions from Stationary Sources". The CO analyzer utilizes an NDIR detector. Triplicate 60-minute tests were performed on the turbine exhaust.

The EPA Method 10 sampling system (Figure 3) consisted of the following:

(1) Single-point sampling probe
(2) Heated Teflon™ sampling line
(3) MAK® gas conditioner with particulate filter
(4) Flexible unheated Teflon™ sampling line
(5) TECO 48i NDIR CO gas analyzer
(6) Appropriate USEPA Protocol 1 calibration gases
(7) Data Acquisition System.

3.2.2 *Sampling Train Calibration*

The CO sampling train was calibrated per procedures outlined in USEPA Method 10. 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.

3.2.3 *Quality Control and Assurance*

All sampling and analytical equipment was calibrated per the guidelines referenced in Method 10. Calibration gases were EPA Protocol 1 gases, and the concentrations were within the acceptable ranges (40-60% mid-range and span). Calibration gas certification sheets are in Appendix C.

3.2.4 *Data Reduction*

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

The CO emissions data collected during the testing was calculated as ppm by volume, dry, corrected to 15% Oxygen (ppmvd@15%O_2).

3.3 FORMALDEHYDE (CH_2O) (USEPA METHOD 320)

3.3.1 *Sampling Method*

Formaldehyde (CH_2O) 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) ThermoFisher™ MAX-iR with Starboost™ FTIR spectrometer
(5) ThermoFisher™ Thermal Oxidizer Module
(6) Appropriate calibration gases
(7) 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.

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3.3.2 Sampling Train Calibration

The FTIR was calibrated per procedures outlined in Method 320. Direct measurements of formaldehyde (CH_2O) 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 (CH_2O) gas standards were passed through the sampling system at each test location to determine the response time and confirm recovery.

Formaldehyde (CH_2O) spiking with Thermal Oxidizer Module in bypass mode was performed to verify the ability of the sampling system to quantitatively deliver a sample containing CH_2O from the base of the probe to the FTIR. Analyte spiking assures the ability of the FTIR to quantify CH_2O in the presence of effluent gas.

Formaldehyde (CH_2O) spiking with Thermal Oxidizer Module activated was performed to verify target analyte removal, and to demonstrate the efficiency of the Thermal Oxidizer Module.

As part of the spiking procedure, samples from each engine were measured to determine CH_2O concentrations to be used in the spike recovery calculations. The determined nitrous oxide (N_2O) 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 CH_2O. The following equation illustrates the percent recovery calculation.

$$DF = \frac{N2O(spike)}{N2O(direct)} \qquad \text{(Sec. 9.2.3 (3) Method 320)}$$

$$CS = DF * Spike_{dir} + Unspike\ (1 - DF) \qquad \text{(Sec. 9.2.3 (4) Method 320)}$$

DF = Dilution factor of the spike gas
$N_2O_{(direct)}$ = N_2O concentration measured directly in undiluted spike gas
$N_2O_{(spike)}$ = Diluted N_2O 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 CH_2O 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 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 E.

Previous testing at the stack location has demonstrated the source is unstratified. There have been no modifications to the exhaust ducts, or operational changes to the turbines.

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 CH_2O emissions were recorded in parts per billion (ppb) wet volume basis. Moisture content (%) was also recorded. The O_2 emissions were recorded in percent (%) dry volume basis.

The O_2 (%) and CH_2O (ppbvd) readings were logged at 10-second intervals and recorded in 1-minute increments. CH_2O emissions are reported in parts per billion dry, corrected to 15% O_2 (ppbvd @ 15% O_2) for comparison to the emission limit.

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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 gas flow, inlet air temperature, compressor discharge pressure, and compressor discharge temperature.

Operational data can be found in Appendix E.

5.0 RESULTS

Testing was performed while the turbine was operated in LoNOx mode while operating within 10% of 100% load. The results of the Formaldehyde (CH_2O) and Carbon Monoxide (CO) emissions testing conducted on EUTURBINE1 are presented in Results Table No. 1.

EUTURBINE1 demonstrated compliance with the 40 CFR Part 63, Subpart YYYY formaldehyde (CH_2O) emission limit of 91 ppb @ 15% O_2 and with the MI-ROP-N7421-2022 Carbon Monoxide (CO) emission limit of 25 ppm @ 15% O_2.

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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

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TABLE NO. 1
FORMALDEHYDE and CARBON MONOXIDE EMISSIONS TEST RESULTS
DTE Gas -Willow Compressor Station
EUTURBINE1 (Unit 1200)
May 9, 2023

Test	Test Time	Unit Load (%)[2]	O_2 Concentration (%, dry)[1]	CH_2O Concentration (ppbvd)	CH_2O Concentration (ppbvd @ 15% O_2)	CO Concentration (ppbvd)	CO Concentration (ppbvd @ 15% O_2)
1	8:31-9:31	92%	15.4	7.1	7.6	1.0	1.1
2	9:44-10:44	91%	15.4	9.0	9.7	1.0	1.0
3	11:00-12:00	90%	15.4	7.8	8.3	1.0	1.1
	Average:	***91%***	***15.4***	***8.0***	***8.5***	***1.0***	***1.1***
				Permit Limit:	*91*		*25*

orrected for analyzer drift as per USEPA Method 7E

calculated as actual average horse power divided by 7,700 (nominal rated horsepower)

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FIGURES

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Figure 1 – Sampling Location
EUTURBINE1
Willow Run Compressor Station
May 9, 2023

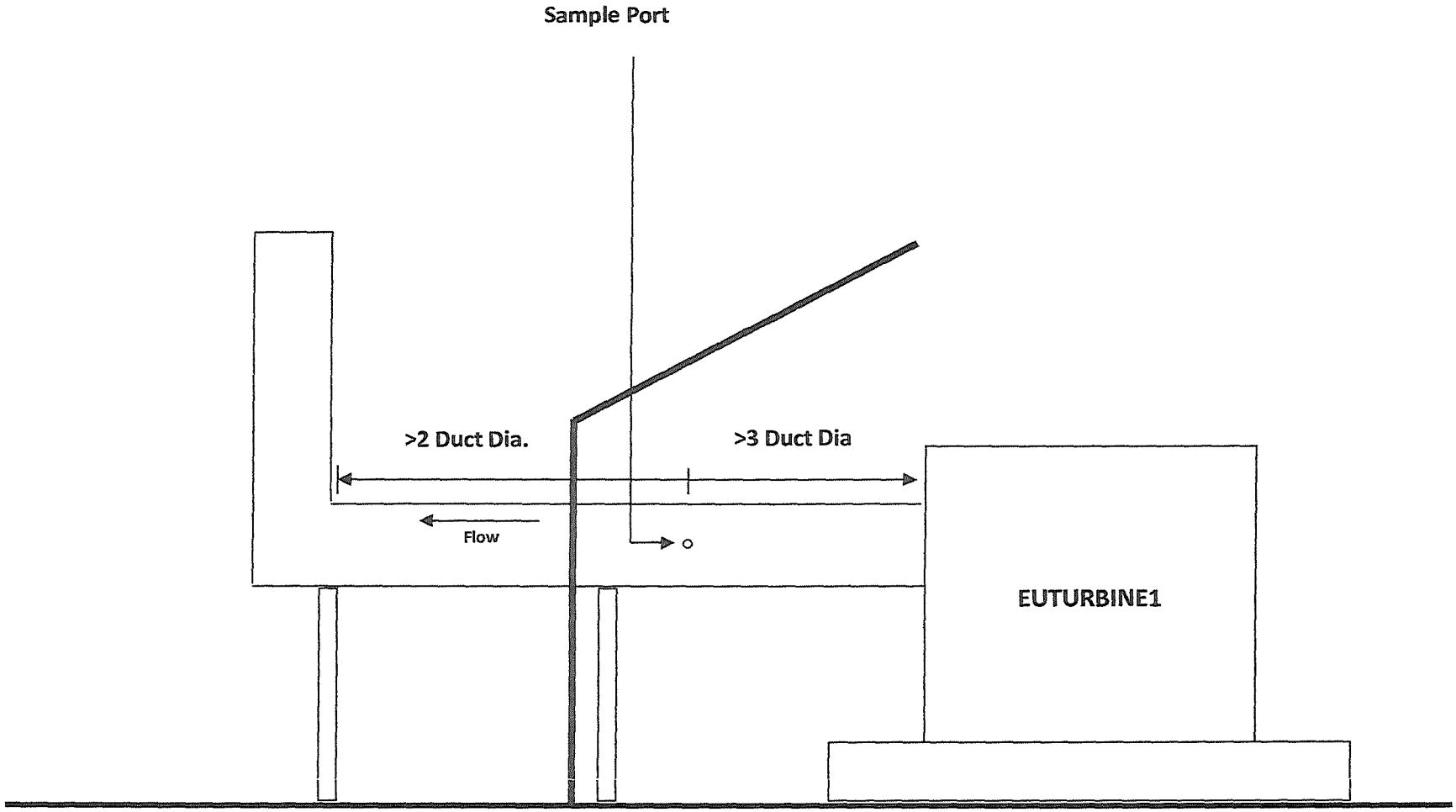

Figure 2. Method 320
Willow Compressor Station
EUTURBINE1
May 9, 2023

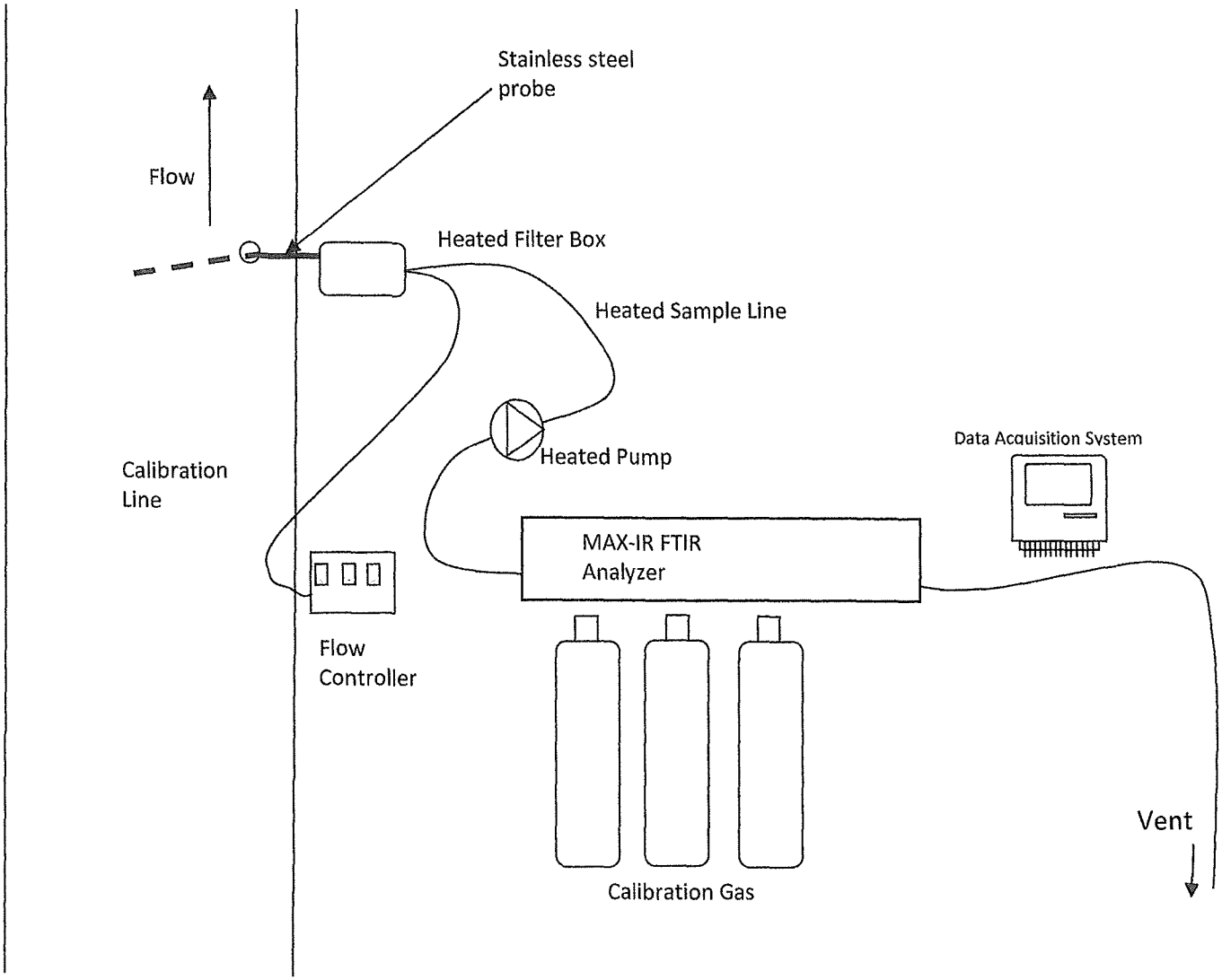

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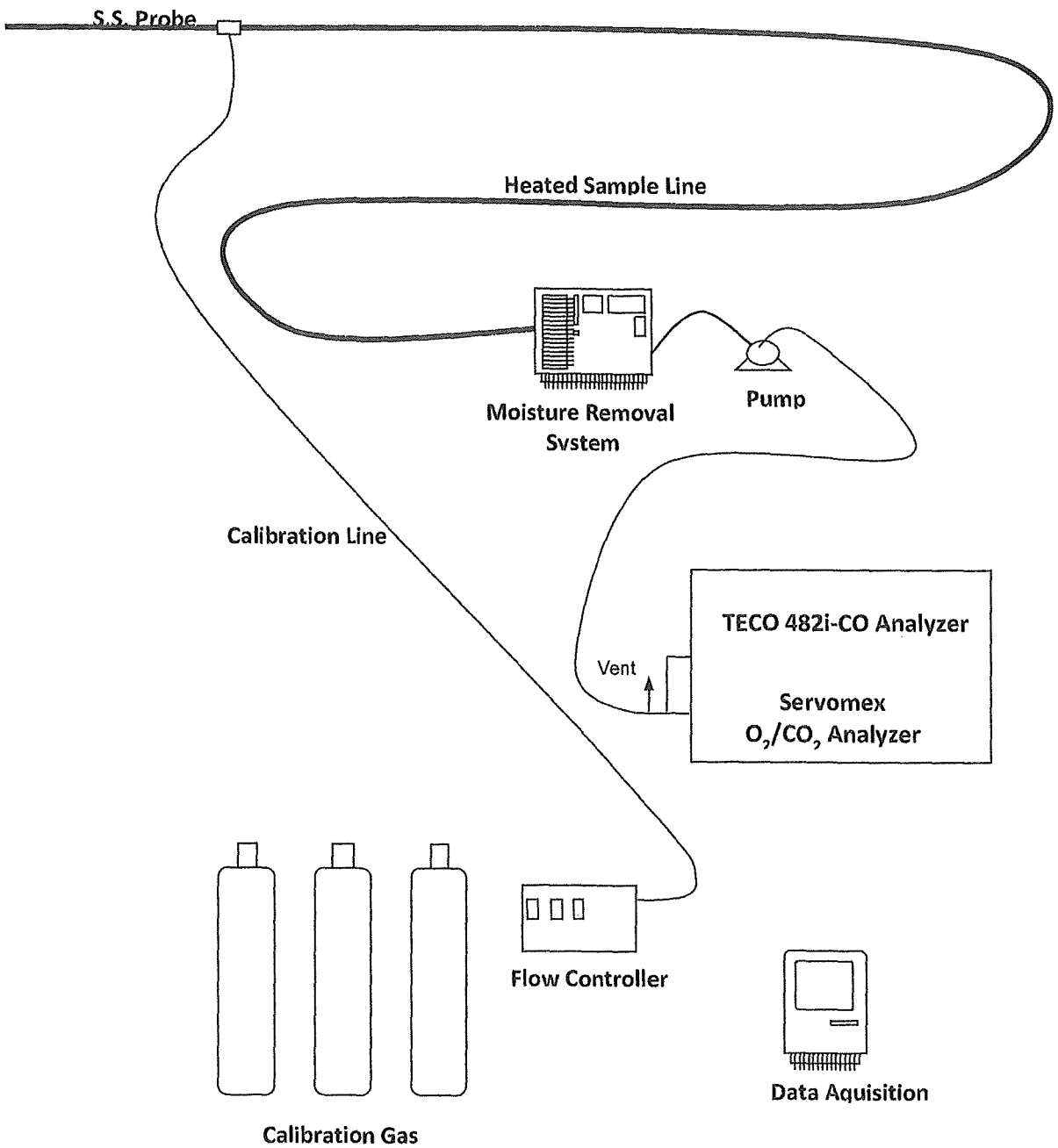
Figure 3 – EPA Methods 3A & 10
EUTURBINE1
Willow Run Compressor Station
May 9, 2023



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