EMISSIONS TEST REPORT

for

CARBON MONOXIDE (CO) DESTRUCTION EFFICIENCY
40 CFR Part 63 Subpart ZZZZ

EUENGINE1 and EURICE1-3

DTE-Gas Willow Compressor Station
Ypsilanti, Michigan

March 29-April 4, 2023

Prepared By
Environmental Management & Safety
Ecology, Monitoring, and Remediation Group
DTE Corporate Services, LLC
7940 Livernois Ave, G4-S
Detroit, MI 48210

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EXECUTIVE SUMMARY

DTE Energy's Environmental Management and Safety (EM&S), Ecology, Monitoring, and Remediation Group performed emissions testing at the DTE-Gas Willow Compressor Station, located in Ypsilanti, Michigan. The fieldwork performed March 29-April 4, 2023, was conducted to satisfy requirements of the Michigan Renewable Operating Permit MI-ROP-N7421-2022 and 40 CFR Part 63 Subpart ZZZZ. Emission tests were performed on Engine 1100 (EUENGINE1) and Engines 2100-2300 (EURICE1-3) for carbon monoxide (CO). Carbon monoxide (CO-DE) destruction efficiency testing was performed on each engine.

A summary of results of the emissions testing are highlighted below:

CO DE Emissions Test Results
Willow Run Compressor Station – EUENGINE1 & EURICE1-3
Ypsilanti, Michigan
March 29-April 4, 2023

EURICE1-3	Load (BHp)	BHp (%)	Carbon Monoxide (gram/B-Hp)	Carbon Monoxide (DE)
EUENGINE1	4,580	96.7	0.02	98.7%
EURICE1	2,325	93.0	0.01	99.6%
EURICE2	2,330	93.2	0.01	99.5%
EURICE3	4,670	93.4	0.01	99.3%
Permit Limit			**2.0**	**>93%**

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1.0 INTRODUCTION

DTE Energy's Environmental Management and Safety (EM&S), Ecology, Monitoring, and Remediation Group, performed emissions testing at the DTE-Gas Willow Compressor Station, located in Ypsilanti, Michigan. The fieldwork performed March 29-April 4, 2023, was conducted to satisfy requirements of the Michigan Renewable Operating Permit MI-ROP-N7421-2022 and 40 CFR Part 63 Subpart ZZZZ. Emission tests were performed on EUENGINE1 and EURICE1-3 for carbon monoxide (CO). Carbon monoxide (CO-DE) destruction efficiency testing was performed on each engine.

Testing was performed pursuant to Title 40, *Code of Federal Regulations*, Part 60, Appendix A (40 CFR §60 App. A), Methods 3A and 10.

The fieldwork was performed in accordance with EPA Reference Methods and EMR's Intent to Test[1], Test Plan Submittal. The following EM&S Field Services personnel participated in the testing program: Mr. Mark Westerberg, Senior Environmental Specialist and Mr. Mark Grigereit, Principal Engineer, and Mr. Fred Meinecke, Environmental Specialist. Mr. Westerberg was the project leader. Mr. Andrew Riley with the Air Quality Division of the Michigan Department of Environment, Great Lakes, and Energy (EGLE) approved the Test Plan[2] and witnessed portions or the testing

2.0 SOURCE DESCRIPTION

The Willow Compressor Station located at 3020 East Michigan Avenue, Ypsilanti, Michigan, employs the use of four natural gas fired reciprocating internal combustion engines, denoted as EUENGINE1 and EURICE1-3 in ROP-N7421-2022. EUENGINE1 is nominally rated at 4,735 HP EURICE1-2 are nominally rated at 2,500 HP. EURICE3 is nominally rated at 5,000 HP. The engines generate line pressure assisting the transmission of natural gas throughout the pipeline transmission system in SE Michigan.

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

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[1] EGLE, Test Plan, Submitted March 8, 2023. (Attached-Appendix A)

[2] EGLE, Approval Letter, Received March 17, 2023. (Attached-Appendix A)

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

A schematic representation of the engine exhaust and sampling locations are presented in Figures 1 and 2.

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 10	Carbon Monoxide (CO)	NDIR

3.1 OXYGEN (USEPA METHOD 3A)

3.1.1 Sampling Method

Oxygen (O_2) 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 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) Servomax 1400 O_2/CO_2 gas analyzer
(6) Appropriate USEPA Protocol 1 calibration gases
(7) Data Acquisition System

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3.1.2 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 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 according to 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

Data collected during the emissions testing was recorded at 10-second intervals and averaged in 1-minute increments. The O_2 emissions were recorded in percent (%). The 1-minute readings collected during the testing can be found in Appendix B.

3.2 CARBON MONOXIDE (USEPA METHOD 10)

3.2.1 Sampling Method

Carbon monoxide (CO) emissions at the catalyst inlet and exhaust on EUENGINE1 and EURICE1-3 were evaluated 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 each EURICE exhaust.

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

(1) Stainless-steel sample 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 trains were 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.

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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

Data collected during the emissions testing was recorded 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.

Emissions calculations are based on calculations located in USEPA Method 10, and 19 and can be found in Appendix E. The CO emissions data collected during the testing was calculated as grams per brake horsepower-hour (g/BHp-Hr).

4.0 OPERATING PARAMETERS

For each test period, operators took screenshots of the process collection software. Once at the beginning and once at the end of a test period. Process data includes fuel flow (100scf/hr), catalyst pre and post temperature (°F), pressure drop across the catalyst ("H_2O), Brake-HP, and torque.

Operational data is in Appendix D.

5.0 DISCUSSION OF RESULTS

The Results of the CO testing for EUENGINE1 and EURICE 1-3 are presented in Tables 1-4. The CO emissions are presented in parts per million (ppm) and grams per brake horsepower-hour (g/Bhp-Hr). Process data presented includes the Unit load in percent (%), as 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 EUENGINE1 and EURICE1-3 meet the emissions limits established in Michigan Renewable Operating Permit MI-ROP-N7421-2022 and 40 CFR Part 63 Subpart ZZZZ.

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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."

Mr. Mark Grigerelt, QSTI

This report prepared by:

Mr. Mark Grigerelt, QSTI
Principal Engineer, Ecology, Monitoring, and Remediation Group
Environmental Management and Safety
DTE Energy Corporate Services, LLC

This report reviewed by:

Mr. Mark Westerberg, QSTI
Senior Env. Specialist, Ecology, Monitoring, and Remediation Group
Environmental Management and Safety
DTE Energy Corporate Services, LLC

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RESULTS TABLES

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TABLE NO. 1
CO EMISSIONS TEST RESULTS
DTE Gas - Willow Run Compressor Station
EUEngine1 (Engine 1100)
March 29, 2023

Test	Test Time	Unit Load (% of rated HP)[2]	Engine Speed (RPM)	Engine Torque (Brake-hp)	Fuel Flow (100 SCFH)	Heat Input (MMBtu/hr)	O_2 Inlet (%, dry)[1]	O_2 Outlet (%, dry)[1]	CO Inlet (ppmvd @ 15% O_2)	CO Outlet (ppmvd @ 15% O_2)	CO Destruction
1	8:56-9:56	96.4%	990	4,564	285.1	30.6	11.8	11.9	255.7	2.4	99.1%
2	9:12-10:12	97.9%	990	4,635	286.0	30.7	11.8	12.0	263.4	3.9	98.5%
3	10:30-11:30	95.9%	991	4,542	281.3	30.2	11.8	12.0	265.0	3.6	98.6%
	Three Test Average:	*96.7%*	*990*	*4,580*	*284.1*	*30.5*	11.8	11.9	261.4	3.3	98.7%
								Permit Limit :			***>93%***

[1] corrected for analyzer drift as per USEPA Method 7E

[2] calculated as actual average horse power divided by 4,735(nominal rated horsepower)

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TABLE NO. 2
CO EMISSIONS TEST RESULTS
DTE Gas - Willow Run Compressor Station
EURICE1 (Engine 2300)
March 30, 2023

Test	Test Time	Unit Load (% of rated HP)[2]	Engine Speed (RPM)	Engine Torque (Brake-hp)	Fuel Flow (100 SCFH)	Heat Input (MMBtu/hr)	O_2 Inlet (%, dry)[1]	O_2 Outlet (%, dry)[1]	CO Inlet (ppmvd @ 15% O_2)	CO Outlet (ppmvd @ 15% O_2)	CO Destruction
1	9:25-10:25	92%	1000	2,307	145.5	15.6	11.5	11.2	151.1	0.7	99.6%
2	10:36-11:36	93%	1000	2,317	147.0	15.8	11.6	11.3	158.7	0.6	99.6%
3	11:48-12:48	94%	1001	2,350	148.5	16.0	11.5	11.3	152.7	0.7	99.6%
	Three Test Average:	93%	*1001*	*2,325*	*147.0*	*15.8*	11.5	11.3	154.1	0.7	99.6%
								Permit Limit :			***>93%***

[1] corrected for analyzer drift as per USEPA Method 7E

[2] calculated as actual average horse power divided by 2,500 (nominal rated horsepower)

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TABLE NO. 3
CO EMISSIONS TEST RESULTS
DTE Gas - Willow Run Compressor Station
EURICE2 (Engine 2200)
April 4, 2023

Test	Test Time	Unit Load (% of rated HP)[2]	Engine Speed (RPM)	Engine Torque (Brake-hp)	Fuel Flow (100 SCFH)	Heat Input (MMBtu/hr)	O_2 Inlet (%, dry)[1]	O_2 Outlet (%, dry)[1]	CO Inlet (ppmvd @ 15% O_2)	CO Outlet (ppmvd @ 15% O_2)	CO Destruction
1	07:22-08:22	90%	999	2,262	160.0	17.1	11.3	11.3	144.8	0.7	99.5%
2	8:35-9:35	94%	993	2,349	164.9	17.6	11.3	11.3	141.9	0.8	99.5%
3	9:53-10:53	95%	992	2,379	167.1	17.9	11.3	11.2	143.3	0.8	99.5%
	Three Test Average:	*93%*	*995*	*2,330*	*164.0*	*17.5*	11.3	11.3	143.3	*0.7*	*99.5%*
								Permit Limit :			***>93%***

[1] corrected for analyzer drift as per USEPA Method 7E

[2] calculated as actual average horse power divided by 2,500 (nominal rated horsepower)

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TABLE NO. 4
CO EMISSIONS TEST RESULTS
DTE Gas - Willow Run Compressor Station
EURICE3 (Engine 2100)
April 3, 2023

Test	Test Time	Unit Load (% of rated HP)[2]	Engine Speed (RPM)	Engine Torque (Brake-hp)	Fuel Flow (100 SCFH)	Heat Input (MMBtu/hr)	O_2 Inlet (%, dry)[1]	O_2 Outlet (%, dry)[1]	CO Inlet (ppmvd @ 15% O_2)	CO Outlet (ppmvd @ 15% O_2)	CO Destruction
1	07:55-08:55	91%	999	4,571	315.7	33.8	11.1	11.1	147.4	1.0	99.3%
2	9:12-10:12	93%	999	4,647	320.5	34.3	11.2	11.1	149.5	1.0	99.3%
3	10:29-11:29	96%	999	4,793	329.6	35.2	11.2	11.1	150.7	1.1	99.2%
	Three Test Average:	93%	999	4,670	321.9	34.4	11.1	11.1	149.2	1.0	99.3%
								Permit Limit :			*>93%*

[1] corrected for analyzer drift as per USEPA Method 7E

[2] calculated as actual average horse power divided by 5,000(nominal rated horsepower)

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FIGURES

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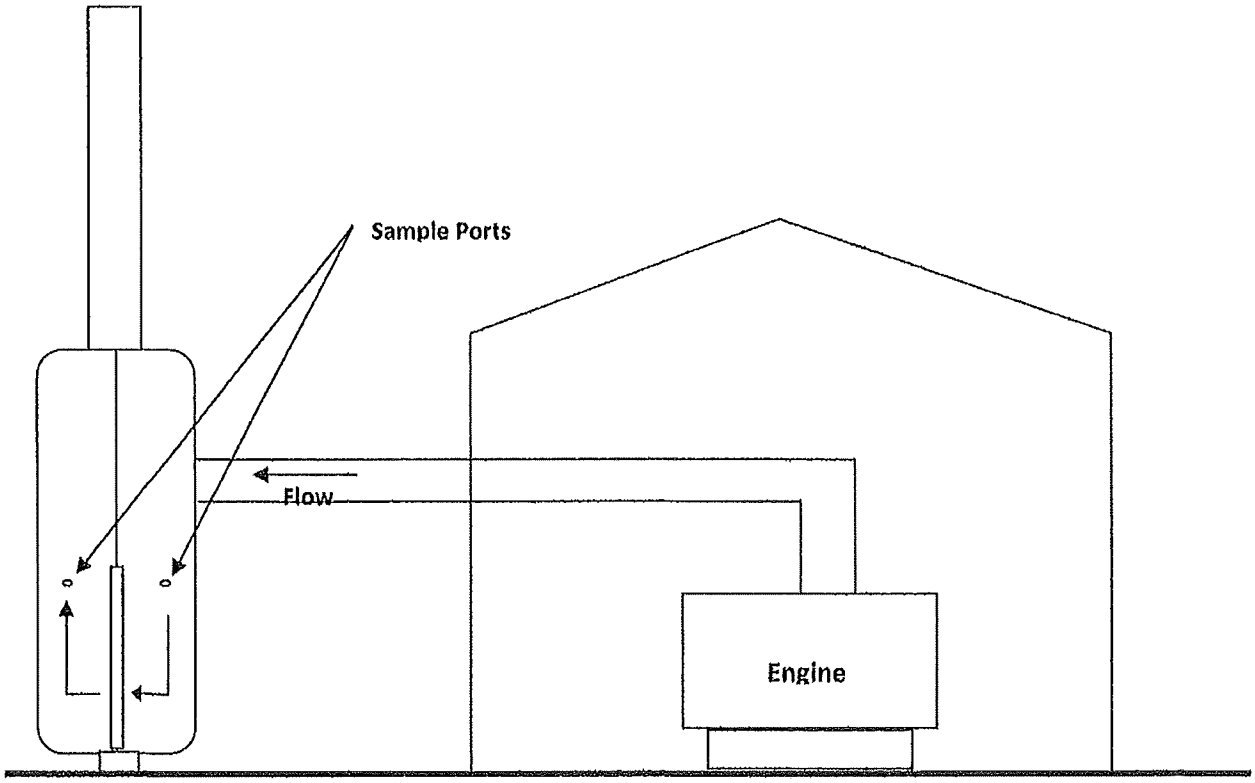
Figure 1 – Sampling Locations
EUENGINE1
Willow Compressor Station
March 29-April 4, 2023



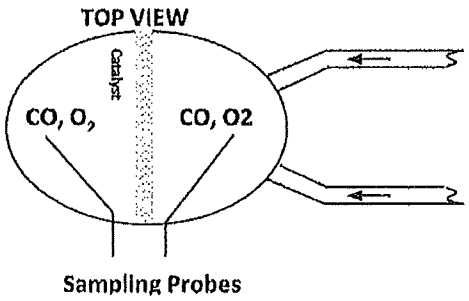


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Figure 2 – Sampling Locations
EURICE1-3
Willow Compressor Station
March 29-April 4, 2023

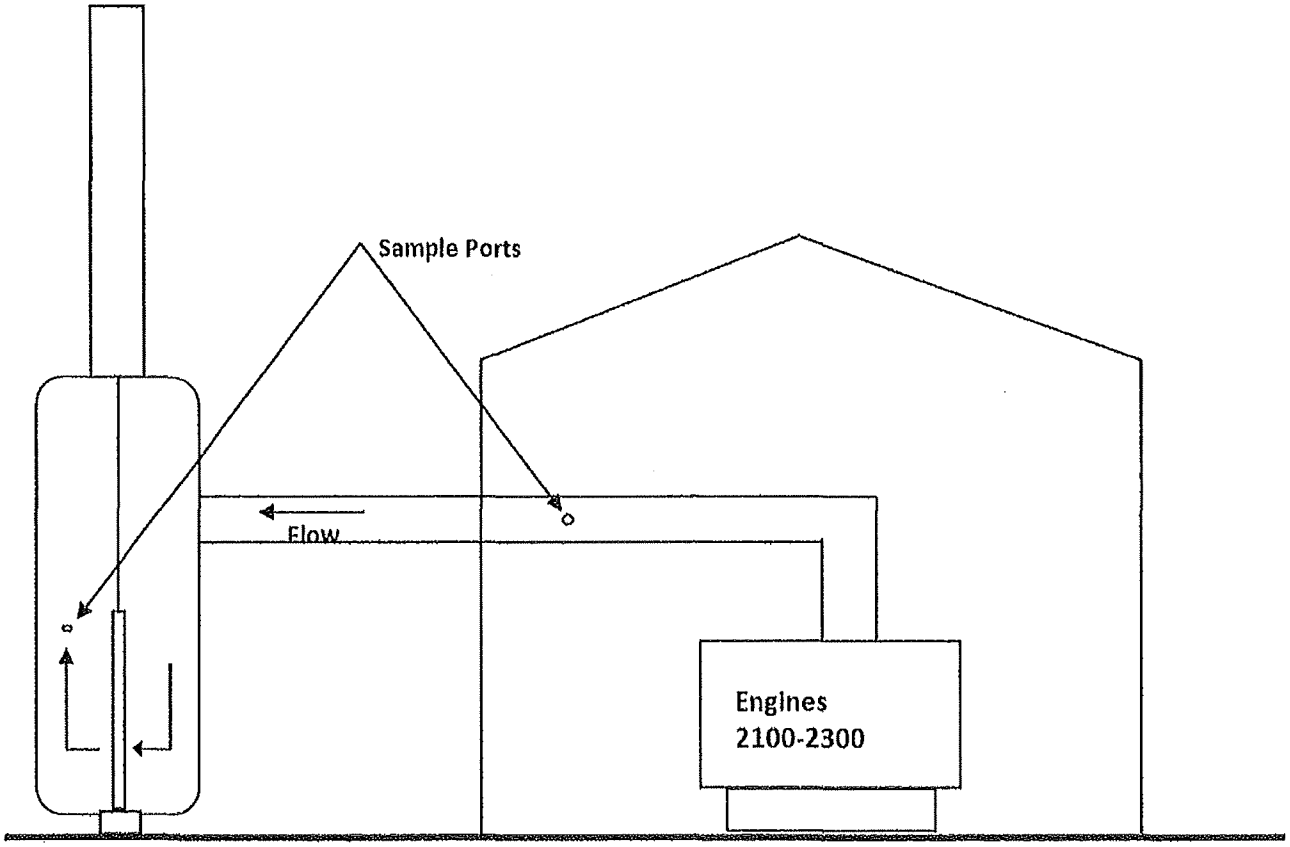

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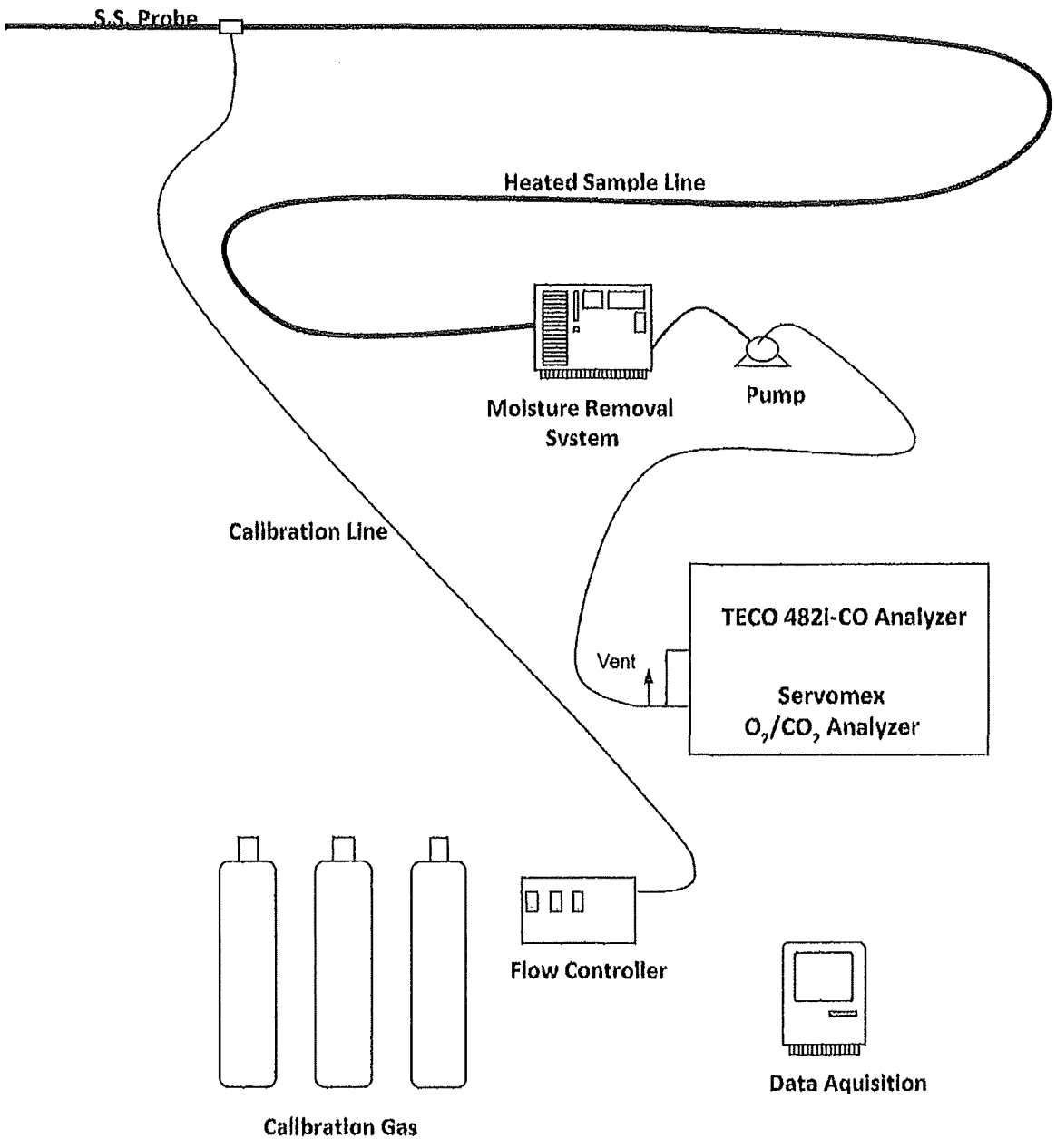
Figure 3 – EPA Methods 3A & 10
EUTURBINE1 & EURICE1-3
Willow Run Compressor Station
March 29-April 4, 2023



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