EMISSIONS TEST REPORT

for

CARBON MONOXIDE (CO) EMISSIONS

EUENGINE4, EUENGINE5, & EUENGINE6

DTE Washington 10 Compressor Station (N3391)
Washington Township, Michigan

May 5-7 and June 10, 2020

Prepared By
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EXECUTIVE SUMMARY

DTE Energy's Environmental Management and Resources (EM&R), Field Services Group, performed emissions testing at the DTE Washington 10 Compressor Station, located in Washington Township, Michigan. The fieldwork, performed on May 5-7 and June 10, 2020 was conducted to satisfy requirements of the Michigan Renewable Operating Permit No. N3391-2017a. Emission testing was performed on EUENGINE4-6 (Engines 4-6) for carbon monoxide (CO) emission rates and destruction efficiencies.

The results of the emissions testing are highlighted below:

Emissions Testing Summary
Washington 10 Compressor Station
EUENGINE4-6
May 5-7 and June 10, 2020

Parameter	EUENGINE4	EUENGINE5	EUENGINE6	Permit Limit
Average Pre-Catalyst Carbon Monoxide Concentration (CO grams/BHp-hr)[1]	1.66	1.51	1.43	2.50
Average Carbon Monoxide Destruction Efficiency (%)	97.9	98.2	99.4	93.0

[1] BHp-hr – Brake horsepower per hour

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1.0 INTRODUCTION

DTE Energy's Environmental Management and Resources (EM&R), Field Services Group, performed emissions testing at the DTE Washington 10 Compressor Station, located in Washington Township, Michigan. The fieldwork, performed on May 5-7 and June 10, 2020, was conducted to satisfy requirements of the Michigan Air Renewable Operating Permit No. N3391-2017a. Emission testing was performed on EUENGINE4-6 (Engines 4-6) for carbon monoxide (CO) emission rates and destruction efficiencies.

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 EM&R's Intent to Test[1], Test Plan Submittal. The following EM&R personnel participated in the testing program: Mark Grigereit, Principal Engineer, Mr. Thom Snyder, Environmental Specialist, Mr. Jason Logan, Environmental Specialist, Mr. Mark Westerberg, Sr. Environmental Specialist and Mr. Fred Meinecke, Senior Environmental Technician. Mr. Grigereit was the project leader. Mr. Mark Dziadosz with the Air Quality Division of the Michigan Department of Environment, Great Lakes and Energy (EGLE) approved the Test Plan[2] and witnessed portions of the testing.

2.0 SOURCE DESCRIPTION

The Washington 10 Compressor Station located at 12700 E. 30 Mile Road, Washington Township, Michigan, employs the use of three natural gas-fired 4,735 Horse Power reciprocating engines (EUENGINES4-6). 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 in SE Michigan.

The emissions from Engines 4, 5, & 6 are exhausted through a catalyst bed and 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 on a daily basis.

During the emissions testing, Engines 4 & 5 were operated within 10% of each engines' rated horsepower. Engine 6 was initially tested on May 5. The unit operated at 89.4% of the rated load. The unit was retested on June 10 while operating within 10% of rated horsepower.

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[1] EGLE, Test Plan, Submitted February 20, 2020. (Attached-Appendix A)

[2] EGLE, Approval Letter, Received April 9, 2020. (Attached-Appendix A)

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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	Oxygen	Instrumental Analyzer Method
USEPA Method 10	Carbon Monoxide	NDIR

3.1 OXYGEN AND CARBON MONOXIDE (USEPA METHODS 3A AND 10)

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 O_2 analyzer utilizes a paramagnetic sensor.

Carbon monoxide (CO) emissions were evaluated using USEPA Method 10, "Determination of Carbon Monoxide Emissions from Stationary Sources". The CO analyzer utilizes a NDIR detector.

3.1.2 O_2 and CO Sampling Train

The EPA Methods 3A and 10 sampling system (Figure 2) consisted of the following components:

(1) Stainless steel sampling probe.
(2) Heated PTFE sampling line.
(3) Sampling gas conditioner with particulate filter.
(4) Flexible unheated PTFE sampling line.
(5) Servomex 1400 O_2/CO_2 gas analyzer and TECO 48i NDIR CO gas analyzer.

(6) USEPA Protocol 1 calibration gases.
(7) Data Acquisition System.

3.1.3 Sampling Duration & Frequency

The emissions testing of the engine consisted of triplicate 60-minute samples at the inlet and exhaust of the catalyst. Testing was conducted at three points across the diameter of the duct during each run. Sampling was performed simultaneously for O_2 and CO. Data was recorded at 10-second intervals.

3.1.4 Quality Control and Assurance (O_2 and CO)

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 located in Appendix C.

3.1.5 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 Methods 7E, 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

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 located in Appendix D.

5.0 DISCUSSION OF RESULTS

During the emissions testing, Engines 4 & 5 were operated within 10% of each engines' rated horsepower. Engine 6 was tested on May 5. The unit operated at 89.4% of the rated load. The unit was retested on June 10 while operating within 10% of rated horsepower. The May 5 testing demonstrated compliance with emission rates and control efficiency and has been included in the report.

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Unit 6 – May 5 test data in located in Appendix F.

The results of the CO emission testing on Engines 4-6 are presented in Tables No 1-3. The CO emissions are presented in grams per brake horsepower hour (g/Bhp-Hr), prior to and after the catalyst, and the destruction efficiency in percent (%). Process data presented includes the Unit load in percent (%), Engine Speed in revolutions per minute (RPM), Engine Torque in brake horsepower (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 4-6 are in compliance with permit requirements for CO of 2.5 g/BHp-Hr and 93% destruction efficiency.

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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 TABLES

Carbon Monoxide (CO) Emissions Testing Results
EUENGINE4
DTE Energy, Washington 10 Compressor Station
Washington Township, Michigan

Parameter	Run 1	Run 2	Run 3	Average
Sampling Date	05/06/20	05/06/20	05/06/20	
Sampling Start Time	7:02-8:02	8:11-9:11	9:26-10:26	
Gross Dry BTU	1064	1064	1064	1064
Load (%)	97.4	97.3	97.7	97.5
Speed (RPM)	990.8	991.1	991.0	991.0
Brake-HP	4,570	4,567	4,585	4574
Brake-HP (%)	97%	96%	97%	97%
Fuel Flow (100 scf/hr)	308.5	308.4	307.8	308.2
Heat Input Rate (MMBtu/Hr)	32.82	32.81	32.75	32.79
Average Inlet O_2 Content (%, dry)	11.2	11.5	11.5	11.4
Average Intlet O_2 Content (%, dry, corrected)[1]	11.2	11.5	11.5	11.4
Average Inlet CO Concentration (ppmv, dry)	359.6	376.4	364.6	366.9
Average Inlet CO Concentration (ppmv, dry, corrected)[1]	358.7	376.9	369.7	368.4
Average Inlet CO Concentration (lb/MMBtu)	0.487	0.531	0.518	0.512
Average Inlet CO Emission Rate (lb/hr, dry)	16.00	17.41	16.96	16.79
CO Emission Rate (gram/BHP-Hr, dry)	**1.59**	**1.73**	**1.68**	**1.66**
Average Outlet O_2 Content (%, dry)	11.2	11.5	11.4	11.4
Average Outlet O_2 Content (%, dry, corrected)[1]	11.2	11.5	11.4	11.4
Average Outlet CO Concentration (ppmv, dry)	7.1	7.3	9.0	7.8
Average Outlet CO Concentration (ppmv, dry, corrected)[1]	6.9	7.1	8.8	7.6
Average Outlet CO Concentration (lb/MMBtu)	0.009	0.010	0.012	0.011
Average Outlet CO Emission Rate (lb/hr, dry)	0.31	0.33	0.40	0.3
CO Emission Rate (gram/BHP-Hr, dry)	**0.03**	**0.03**	**0.04**	**0.03**
CO Destruction Efficiency	**98.1%**	**98.1%**	**97.6%**	**97.9%**

[1]corrected for analyzer drift as per USEPA Method 6C

O_2 : oxygen

CO : carbon monoxide

ppmv : parts per million on a volume-to-volume basis

lb/hr : pounds per hour

Carbon Monoxide (CO) Emissions Testing Results
EUENGINE5
DTE Energy, Washington 10 Compressor Station
Washington Township, Michigan

Parameter	Run 1	Run 2	Run 3	Average
Sampling Date	05/07/20	05/07/20	05/07/20	
Sampling Start Time	7:10-8:10	8:19-9:19	9:29-10:29	
Gross Dry BTU	1068	1068	1068	1068
Load (%)	95.7	98.1	97.8	97.2
Speed (RPM)	959.7	929.9	928.7	939.4
Brake-HP	4,347	4,320	4,303	4323
Brake-HP (%)	92%	91%	91%	91%
Fuel Flow (100 scf/hr)	294.0	290.7	289.5	291.4
Heat Input Rate (MMBtu/Hr)	31.41	31.05	30.92	31.13
Average Inlet O_2 Content (%, dry)	11.5	11.6	11.5	11.5
Average Intlet O_2 Content (%, dry, corrected)[1]	11.5	11.7	11.6	11.6
Average Inlet CO Concentration (ppmv, dry)	323.0	319.7	317.1	319.9
Average Inlet CO Concentration (ppmv, dry, corrected)[1]	324.6	323.7	324.1	324.1
Average Inlet CO Concentration (lb/MMBtu)	0.458	0.465	0.462	0.462
Average Inlet CO Emission Rate (lb/hr, dry)	14.39	14.44	14.28	14.37
CO Emission Rate (gram/BHP-Hr, dry)	**1.50**	**1.52**	**1.51**	**1.51**
Average Outlet O_2 Content (%, dry)	11.6	11.6	11.5	11.6
Average Outlet O_2 Content (%, dry, corrected)[1]	11.6	11.6	11.6	11.6
Average Outlet CO Concentration (ppmv, dry)	5.2	8.2	5.0	6.1
Average Outlet CO Concentration (ppmv, dry, corrected)[1]	5.0	8.1	4.8	6.0
Average Outlet CO Concentration (lb/MMBtu)	0.007	0.012	0.007	0.009
Average Outlet CO Emission Rate (lb/hr, dry)	0.23	0.36	0.21	0.3
CO Emission Rate (gram/BHP-Hr, dry)	**0.02**	**0.04**	**0.02**	**0.03**
CO Destruction Efficiency	**98.4%**	**97.5%**	**98.5%**	**98.2%**

[1]corrected for analyzer drift as per USEPA Method 6C

O_2 : oxygen

CO : carbon monoxide

ppmv : parts per million on a volume-to-volume basis

lb/hr : pounds per hour

Carbon Monoxide (CO) Emissions Testing Results
EUENGINE6
DTE Energy, Washington 10 Compressor Station
Washington Township, Michigan

Parameter	Run 1	Run 2	Run 3	Average
Sampling Date	06/10/20	06/10/20	06/10/20	
Sampling Start Time	8:32-9:32	9:42-10:42	10:53-11:53	
Gross Dry BTU	1060	1060	1060	1060
Speed (RPM)	966.8	967.0	963.6	965.8
Brake-HP	4,448	4,463	4,448	4453
Brake-HP (%)	94%	94%	94%	94.0%
Fuel Flow (100 scf/hr)	303.7	304.7	303.9	304.1
Heat Input Rate (MMBtu/Hr)	32.19	32.30	32.21	32.23
Average Inlet O_2 Content (%, dry)	10.7	10.6	10.7	10.7
Average Intlet O_2 Content (%, dry, corrected)[1]	11.1	11.1	11.1	11.1
Average Inlet CO Concentration (ppmv, dry)	316.2	316.8	316.6	316.5
Average Inlet CO Concentration (ppmv, dry, corrected)[1]	325.1	324.5	323.8	324.5
Average Inlet CO Concentration (lb/MMBtu)	0.438	0.436	0.436	0.437
Average Inlet CO Emission Rate (lb/hr, dry)	14.09	14.09	14.04	14.07
CO Emission Rate (gram/BHP-Hr, dry)	**1.44**	**1.43**	**1.43**	**1.43**
Average Outlet O_2 Content (%, dry)	11.1	11.1	11.1	11.1
Average Outlet O_2 Content (%, dry, corrected)[1]	11.1	11.0	11.0	11.0
Average Outlet CO Concentration (ppmv, dry)	2.8	1.7	1.8	2.1
Average Outlet CO Concentration (ppmv, dry, corrected)[1]	2.7	1.6	1.7	2.0
Average Outlet CO Concentration (lb/MMBtu)	0.004	0.002	0.002	0.003
Average Outlet CO Emission Rate (lb/hr, dry)	0.12	0.07	0.07	0.1
CO Emission Rate (gram/BHP-Hr, dry)	**0.01**	**0.01**	**0.01**	**0.01**
CO Destruction Efficiency	**99.2%**	**99.5%**	**99.5%**	**99.4%**

[1]corrected for analyzer drift as per USEPA Method 6C

O_2 : oxygen

CO : carbon monoxide

ppmv : parts per million on a volume-to-volume basis

lb/hr : pounds per hour

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Engine Operational Data

DTE Gas - Milford Compressor Station

EUENGINE4-6

May 5-7 & June 10, 2020

Unit 4 EUENGINE4	Ignition Timing	Fuel Flow	Fuel Pressure	Air Man PSIA	1st stg Suction Press	1st Stg Suction Temp	1st Stage Discharge Press	2nd Stage Suction Temp	2nd Stage Suction Press	2nd Stage Discharge Press	2nd Stage Discharge Temp	HP	Speed RPM	Engine Torque	Catalyst Inlet Temp (F)	Catalyst Outlet Temp (F)	Catalyst DP " H2O
Run 1	16.5	30853.1	11.3	31.9	721.0	70.5	1053.9	94.1	1050.3	1589.9	181.6	4570.0	990.8	97.4	847.1	622.7	2.1
Run 2	16.5	30837.6	11.2	32.1	720.3	71.0	1054.9	97.0	1051.4	1591.1	184.2	4566.9	991.1	97.3	844.8	620.4	2.1
Run 3	16.5	30782.8	11.1	32.2	719.6	71.7	1055.3	99.1	1051.3	1592.4	186.4	4585.2	991.0	97.7	842.6	619.3	2.1

Unit 5 EUENGINE5	Ignition Timing	Fuel Flow	Fuel Pressure	Air Man PSIA	1st stg Suction Press	1st Stg Suction Temp	1st Stage Discharge Press	2nd Stage Suction Temp	2nd Stage Suction Press	2nd Stage Discharge Press	2nd Stage Discharge Temp	HP	Speed RPM	Engine Torque	Catalyst Inlet Temp (F)	Catalyst Outlet Temp (F)	Catalyst DP " H2O
Run 1	16.3	29404.5	10.8	31.3	620.7	64.4	771.4	81.9	766.3	1589.8	203.6	4346.7	959.7	95.7	828.2	774.2	3.0
Run 2	16.0	29069.3	10.6	31.8	698.3	65.2	849.9	84.8	843.9	1592.4	190.6	4320.0	929.9	98.1	815.0	764.3	2.9
Run 3	16.0	28952.5	10.6	31.7	696.0	66.1	848.9	86.8	842.6	1594.6	193.0	4302.7	928.7	97.8	809.9	756.3	2.9

Unit 6 EUENGINE6	Ignition Timing	Fuel Flow	Fuel Pressure	Air Man PSIA	1st stg Suction Press	1st Stg Suction Temp	1st Stage Discharge Press	2nd Stage Suction Temp	2nd Stage Suction Press	2nd Stage Discharge Press	2nd Stage Discharge Temp	HP	Speed RPM	Engine Torque	Catalyst Inlet Temp (F)	Catalyst Outlet Temp (F)	Catalyst DP " H2O
Run 1	16.3	30373.3	10.9	32.2	806.2	70.3	1296.3	109.6	1294.5	1793.2	207.4	4448.2	966.8	97.1	788.0	736.6	2.3
Run 2	16.4	30466.3	10.9	32.2	808.7	70.6	1304.6	111.6	1302.5	1793.6	208.3	4462.8	967.0	97.4	789.0	737.7	2.3
Run 3	16.3	30386.8	10.9	32.3	825.7	70.9	1328.2	114.7	1325.4	1794.0	207.4	4447.8	963.6	97.4	781.8	732.3	2.3

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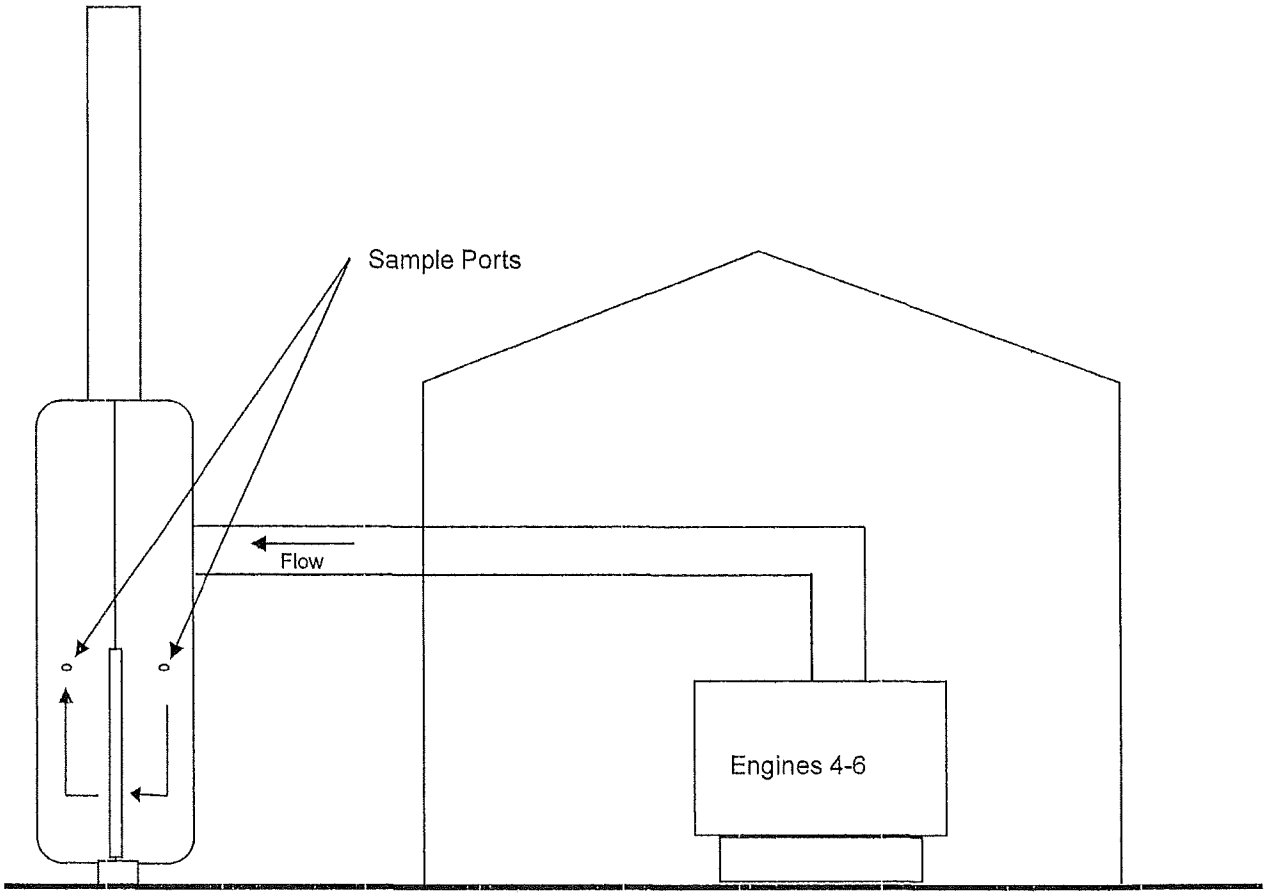
FIGURES

Figure 1 – Sampling Locations
EUENGINE4-6
Washington 10 Compressor Station
May 5-7, 2020



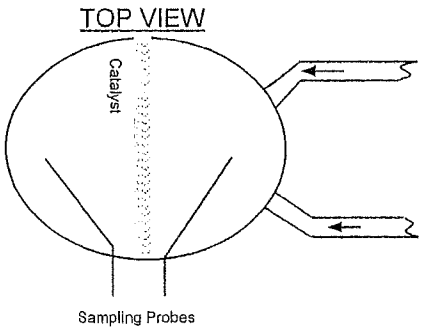


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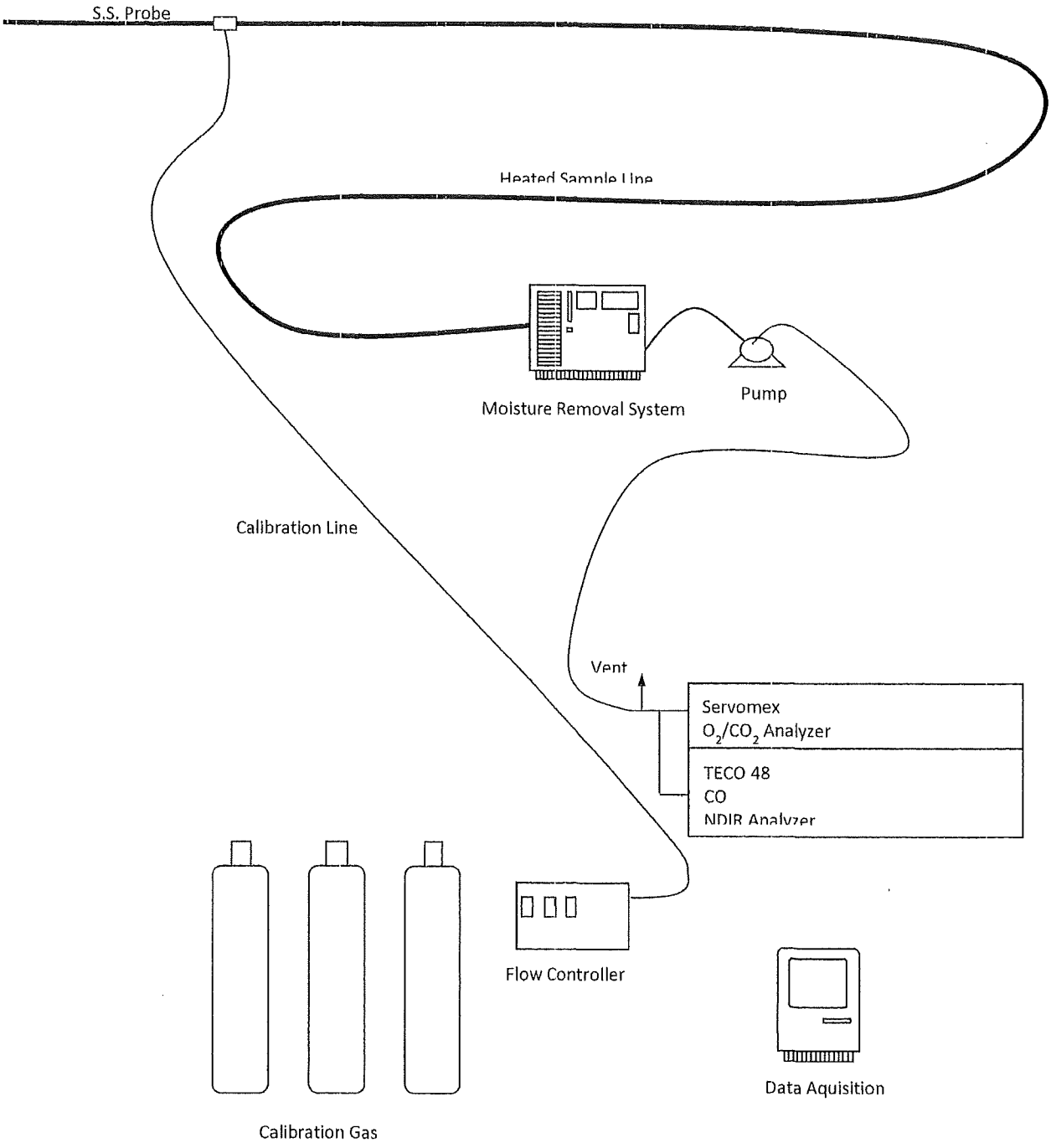
Figure 2 – Method 3A and 10
EUENGINE4-6
Washington 10 Compressor Station
May 5-7, 2020



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APPENDIX A

EGLE TEST PLAN