

COMPLIANCE TEST REPORT

for

CARBON MONOXIDE (CO) EMISSIONS TESTING

WHITE-SUPERIOR COMPRESSOR ENGINE

**ALPENA COMPRESSOR STATION
Harrison, Michigan**

October 7, 2021

Prepared By
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CONTENTS

<u>Section</u>	<u>Page</u>
EXECUTIVE SUMMARY	III
1.0 INTRODUCTION	1
2.0 SOURCE DESCRIPTION	1
3.1.1 Sampling Method.....	2
3.1.2 O ₂ and CO Sampling Train.....	2
3.1.3 Sampling Duration & Frequency	2
3.1.4 Quality Control and Assurance (O ₂ and CO).....	3
3.1.5 Data Reduction.....	3
4.0 OPERATING PARAMETERS	3
5.0 DISCUSSION OF RESULTS	3
6.0 CERTIFICATION STATEMENT	4

RESULTS TABLE

Results Table:Gaseous Emission Testing Results – White-Superior Compressor Engine

FIGURES

- 1 Compressor Engine Stack Drawing & Exhaust Sampling Point Location
- 2 USEPA Method 3A/10 Sampling Train

APPENDICES

- A EGLE Test Plan
- B Field and Analyzer Data
- C Calibration Data
- D Example Calculations
- E Process Operational Data



EXECUTIVE SUMMARY

DTE Energy's Environmental Management and Safety (EMS) Ecology, Monitoring, and Remediation Group performed emissions testing at Alpena Compressor Station, located in Harrison, Michigan. The fieldwork, performed on October 7, 2021 was conducted to satisfy requirements of the Michigan Renewable Operating Permit No. MI-ROP-N5935-2019 and 40 CFR Part 63 Subpart ZZZZ. Emissions tests were performed on the White-Superior Compressor Engine for carbon monoxide (CO).

The results of the emissions testing are summarized below:

Emissions Testing Summary – Compressor Engine (EUWHITESUPERIOR) Alpena Compressor Station Harrison, MI

October 7, 2021	Carbon Monoxide ⁽¹⁾ (ppm _{dry})
White-Superior Compressor Engine	3.1
Subpart ZZZZ Permit Limit	<47

⁽¹⁾ ppm, corrected to 15% O_{2,dry}

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1.0 INTRODUCTION

DTE Energy's Environmental Management and Safety (EMS) Ecology, Monitoring, and Remediation Group performed emissions testing at Alpena Compressor Station, located in Harrison, Michigan. The fieldwork, performed on October 7, 2021 was conducted to satisfy requirements of the Michigan Renewable Operating Permit No. MI-ROP-N5935-2019 and 40 CFR Part 63 Subpart ZZZZ. Emissions tests were performed on the White-Superior Compressor Engine for carbon monoxide (CO).

Testing was performed pursuant to Title 40, *Code of Federal Regulations*, Part 60, Appendix A (40 CFR §60 App. A), Methods 1-3A, and 10.

The fieldwork was performed in accordance with EPA Reference Methods and EMS's Intent to Test¹ which was approved by the Michigan Department of Environment, Great Lakes, and Energy (EGLE)². The following DTE personnel participated in the testing program: Mr. Mark Grigereit, Principal Engineer and Mr. Fred Meinecke, Sr. Engineering Technician. Mr. Grigereit was the project leader.

Mr. Darin Cummings, DTE Gas, provided on-site support of the testing. Ms. Lindsey Wells, EGLE, reviewed the test plan and Mr. Nathanael Gentle, EGLE, observed the testing.

2.0 SOURCE DESCRIPTION

The Alpena Compressor Station, located at 8512 East Arnold Lake Road, Harrison, MI is a natural gas compressor station. The facility operates one White-Superior, 4-cycle, lean burn, natural gas-fired 2,000 Horse-Power reciprocating engine. The engine generates line pressure assisting in the transmission of natural gas throughout the pipeline transmission system in Michigan.

The emissions from the engine are exhausted through a catalyst bed and to the atmosphere through an individual exhaust stack. The composition of the emissions from the engine 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 each day.

Schematic representations of the engine's exhaust and sampling locations are presented in Figure 1.

¹ EGLE, Test Plan, Submitted August 12, 2021. (Attached-Appendix A)

² EGLE, Acceptance Letter, September 13, 2021. (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 10	Carbon Monoxide	NDIR

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

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 O₂ analyzer utilizes a paramagnetic sensor.

3.1.2 O₂ and CO Sampling Train

The EPA Methods 3A and 10 sampling system (Figure 1) 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 O₂/CO₂ 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 one 15-minute sample at the exhaust of the catalyst. Testing was conducted at three points across the diameter of the duct. Sampling was performed simultaneously for O₂ and CO. Data was recorded at 10-second intervals.



3.1.4 Quality Control and Assurance (O₂ and CO)

All sampling and analytical equipment was calibrated per 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.

3.1.5 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 D. The CO emissions data collected during the testing was calculated as parts per million, corrected to 15% oxygen (ppm @ 15% O₂).

4.0 OPERATING PARAMETERS

The test program included the collection of compressor data collected included engine speed (RPM) and torque (Hp), fuel flow, inlet & exhaust manifold air pressure (psi) and temperature (F), and differential pressure across the catalyst (in. H₂O).

Operational data is in Appendix E.

5.0 DISCUSSION OF RESULTS

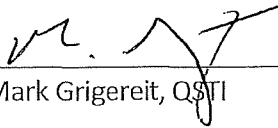
The Results Table presents the emission testing results from Compressor Engine while operating at greater than 90% of full load conditions. The CO emissions are presented in parts per million, corrected to 15% oxygen (ppm @ 15% O₂). Additional test data presented for each test includes the collected operating data.

The results from the testing demonstrate that the Compressor Engine is in compliance with Michigan Renewable Operating Permit No. MI-ROP-N5935-2019 and 40 CFR Part 63 Subpart ZZZZ.

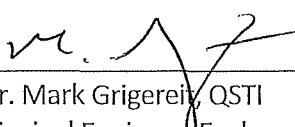


6.0 CERTIFICATION STATEMENT


"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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APPENDIX C

CALIBRATION DATA

Alpena Compressor
Oct. 7, 2021
FM/MG

<u>O₂</u>	12:00 EST	<u>CO</u>
0.0 - 0.0 (0.1) - (0.04)		0.0 - 0.04 - 0.06 - (0.01)
18.00 - 17.97		46.43 - 46.40
10.18 - 10.07 - 10.01 - 10.01		26.17 - 26.68 - 26.35 - 26.10

Run 1	<u>O₂</u>	<u>CO</u>
1206-1221	(0.07)	(0.01)
	10.01	26.00
		7.82
	7.82	6.80

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CO and O₂ Calibration Sheet

Plant: Alpena Compressor Station

Location: Engine 1

Date: 10/8/2020

Test #: Run 1

Operator: MG/FM

Monitor: TECO 48i
Servomex 1400

CO = 46.43

Span value, O₂ = 10.00

CO Calibration gas conc., ppm	Calibration response, ppm					Analyzer cal. error, % of span	Drift, % of span			System bias, % of span			
	Direct injection	System injection**					Test 1			Pretest	PostT 1		
		Pretest	PostT 1										
0.0	0.04	0.0	0.0			0.0			-0.1	-0.1			
46.43	46.40					-0.1							
26.17	26.68	26.10	26.0			1.1	-0.2		-1.2	-1.5			

O ₂ Calibration gas conc., ppm	Calibration response, ppm					Analyzer cal. error, % of span	Drift, % of span			System bias, % of span			
	Direct injection	System injection**					Test 1			Pretest	PostT 1		
		Pretest	PostT 1										
0.0	0.0	0.0	-0.1			-0.3			-0.4	-0.7			
18.1	18.0					-1.3							
10.2	10.1	10.0	10.0			-1.5	0.0		-0.6	-0.6			

Response Time = 30

** Run zero and either mid or high calibration gas, whichever one is closer to actual stack concentration.

Analyzer cal. error, % of span = (dir. inj. cal. response, ppm - cal. gas conc., ppm)X100%/(span value, ppm): Limit = 2%.

Drift, % of span = (sys. inj. final cal. response, ppm - sys. inj. initial cal. response, ppm)X100%/(span value, ppm): Limit = 3%.

System bias, % of span = (relevant sys. inj. cal. resp., ppm - dir. inj. cal. resp., ppm)X100%/(span value, ppm): Limit = 5%.

System response time (95% of response from zero to high cal. gas), sec. = 30

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APPENDIX D

EXAMPLE CALCULATIONS



EXAMPLE CALCULATIONS

Analyzer Drift Correction

$$C = (\bar{C} - C_o) \left(\frac{C_{ma}}{C_m - C_o} \right)$$

- Where:
- C = Effluent gas concentration, dry basis (ppm).
 - \bar{C} = Average gas concentration indicated by gas analyzer, dry basis (ppm).
 - C_o = Average of initial and final system calibration bias check responses for the zero gas (ppm).
 - C_{ma} = Actual concentration of the upscale calibration gas (ppm).
 - C_m = Average of initial and final system calibration bias check responses for the upscale calibration gas (ppm).

Concentration Standardization to 15% Oxygen

$$C_{15\%} = C \left(\frac{5.9}{20.9 - \%O_2} \right)$$

- Where:
- $C_{15\%}$ = Effluent gas concentration, dry basis, corrected to 15% O₂
 - C = Effluent gas concentration, dry basis (ppm).
 - %O₂ = Measured exhaust gas oxygen content (%)
-

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RESULTS TABLE

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White-Superior Compressor Engine
DTE Energy Gas, Alpena Compressor Station
Harrison, MI

Parameter	Run 1
Sampling Date	10/08/20
Sampling Start Time	12:06-12:21
Gross BTU	1040
Torque (%)	86
Speed (RPM)	902
Brake-HP	1852
Brake-HP (%)	92
Fuel Flow (100 scf/hr)	143.4
Heat Input Rate (MMBtu/Hr)	14.91
Catalyst Diff Pressure ("H2O)	-0.6
Catalyst Pre Temp (F)	660
Catalyst Post Temp (F)	919
Average Outlet O ₂ Concentration (% , dry)	7.8
Average Outlet O ₂ Concentration (% , dry, corrected) ¹	8.0
Average Outlet CO Concentration (ppmv, dry)	6.8
Average Outlet CO Concentration (ppmv, dry, corrected) ¹	6.8
Average Outlet CO Concentration (ppmv, dry, @15% O₂)¹	3.1
Average Outlet CO Concentration (lb/MMBtu)	0.007
Average Outlet CO Emission Rate (lb/hr, dry)	0.10
Average Outlet CO Emission Rate (lb/MMscf fuel)	7.29

¹corrected for analyzer drift as per USEPA Method 7E

O₂ : oxygen

CO : carbon monoxide

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FIGURES

Figure 1 – Sampling Location
Compressor Engine
Alpena Compressor Station
October 7, 2021

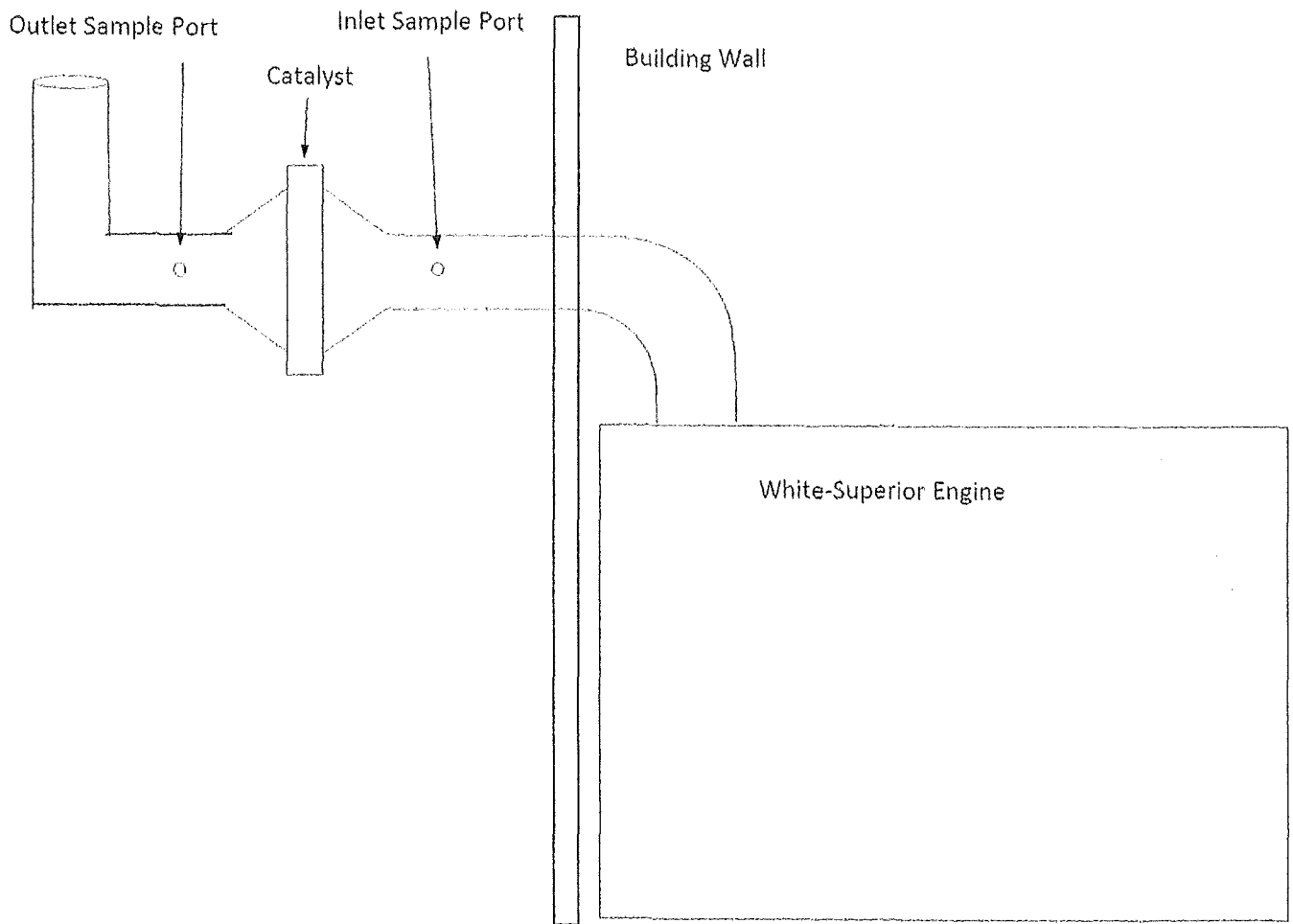
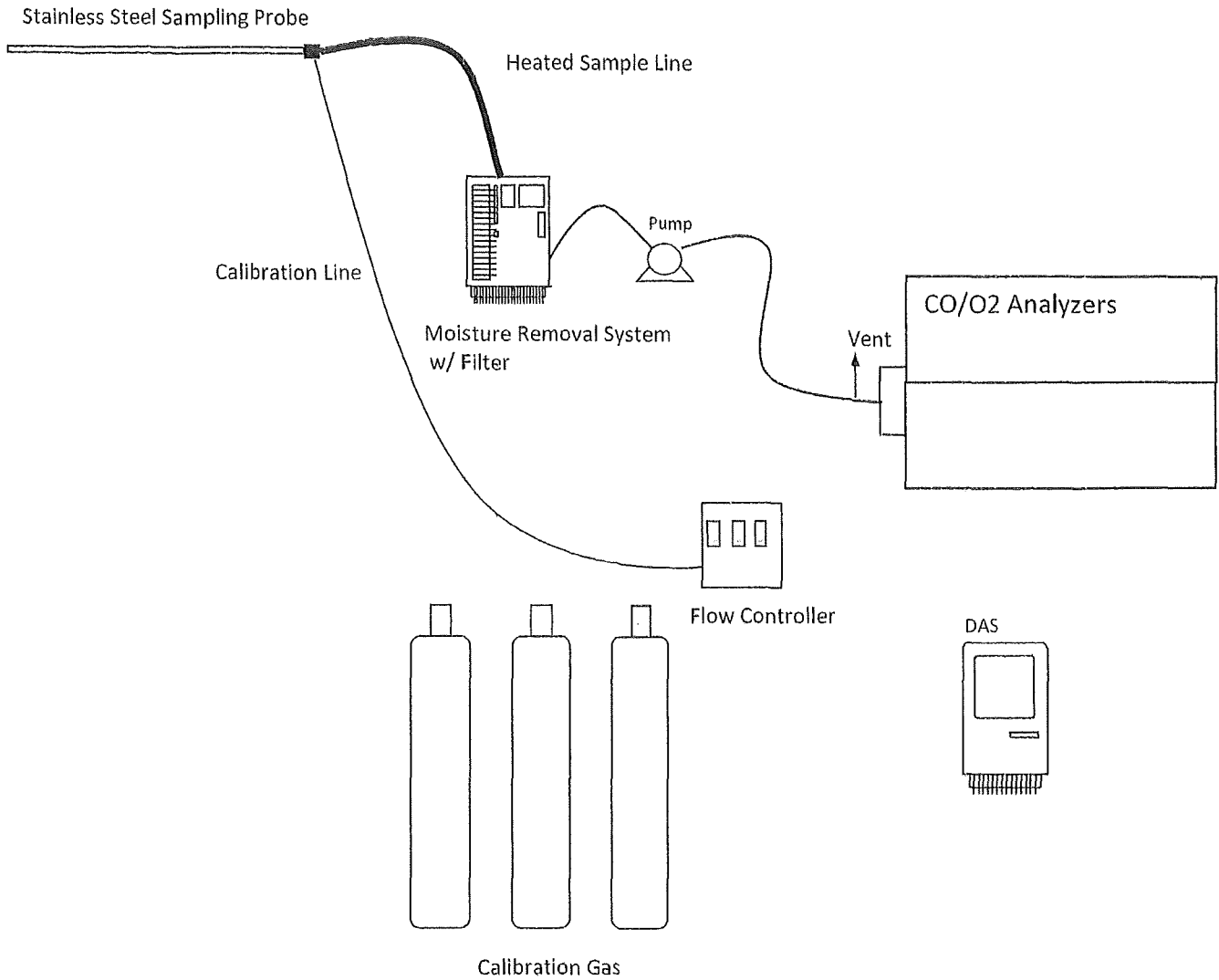


Figure 2 – EPA Methods 3A/10
Alpena Compressor Station
October 7, 2021



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APPENDIX A
EGLE TEST PLAN