

EMISSIONS TEST REPORT

for

OXIDES OF NITROGEN (NO_x), CARBON MONOXIDE (CO), AND NON-METHANE NON-ETHANE ORGANIC COMPOUNDS (NMEOC)

EUENGINE1-2

COMPRESSOR ENGINES Units 7 & 8

DTE GAS

**BELLE RIVER MILLS COMPRESSOR STATION
China, Michigan**

March 23-25, 2021

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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 Belle River Mills Compressor Station (SRN: B6478), located in China, Michigan. The fieldwork was performed on March 23-25, 2021, to satisfy requirements of the Michigan Department of Environment, Great Lakes, and Energy (EGLE) Renewable Operating Permit (ROP) No. B6478-2016, 40CFR Part 60 Subpart JJJJ, and 40CFR Part 63 Subpart ZZZZ. Emissions tests were performed on EUENGINEER1-2 for oxides of nitrogen (NO_x), carbon monoxide (CO), and non-methane non-ethane organic compounds (NMEOC).

The results of the emissions testing are highlighted below:

**Emissions Testing Summary – EUENGINEER1-2
Belle River Mills Compressor Station
China, MI
March 23-25, 2021**

| | Oxides of Nitrogen (g/hp-hr) | Carbon Monoxide Destruction Eff. (Out/In, %) | Volatile Organic Compounds (g/hp-hr) |
|---------------------|---------------------------------|--|--|
| EUENGINEER1 | 0.83 | 96.0% | ND |
| EUENGINEER2 | 1.08 | 96.0% | 0.1 |
| Permit Limit | 1.3 | 93% | 1.0 |



1.0 INTRODUCTION

DTE Energy's Environmental Management and Safety (EM&S) Ecology, Monitoring, and Remediation performed emissions testing at the DTE Gas Belle River Mills Compressor Station (SRN: B6478), located in China, Michigan. The fieldwork was performed on March 23-25, 2021, to satisfy requirements of the Michigan Department of Environment, Great Lakes, and Energy (EGLE) Renewable Operating Permit (ROP) No. B6478-2016, 40CFR Part 60 Subpart JJJJ, and 40CFR Part 63 Subpart ZZZZ. Emissions tests were performed on EUENGINE1-2 (Units 7 and 8) for oxides of nitrogen (NO_x), carbon monoxide (CO), and non-methane non-ethane organic compounds (NMEOC).

Testing was performed pursuant to Title 40, *Code of Federal Regulations*, Part 60, Appendix A (40 CFR §60 App. A), Method 19, 25A, and ASTM D6348.

The fieldwork was performed in accordance with EPA Reference Methods, ASTM Methods and EM&S's Intent to Test¹, which was approved by the Michigan Department of Environment, Great Lakes, and Energy (EGLE)². The following EM&S personnel participated in the testing program: Mr. Jason Logan, Environmental Specialist, Mr. Mark Grigereit, Principal Engineer, Mr. Thomas Snyder, Senior Environmental Specialist, and Mr. Fred Meinecke, Senior Environmental Technician. Mr. Logan was the project leader.

Ms. Susan King, DTE Gas, provided on-site support of the testing. Mr. Mark Dziadosz, EGLE-Technical Programs Unit, and Mr. Joe Forth, EGLE-District Office, observed portions of the testing.

2.0 SOURCE DESCRIPTION

The Belle River Mills Compressor Station located at 5440 Puttygut Road, China, Michigan, employs the use of two natural gas-fired Waukesha 1,480 HP 4-cycle reciprocating engines denoted as EUENGINE1-2 in Michigan EGLE Renewable Operating Permit No. MI-ROP-B6478-2016. The engines generate line pressure assisting the refrigeration plant operation.

Belle River Mills Compressor Station is a major source for HAPs. The Waukesha engines are equipped with simple oxidation catalysts to reduce HAP constituents as required by the RICE MACT. Each engine has an independent exhaust stack and catalyst systems. The compressor engines were operated at greater than 90% of the maximum load during the testing.

¹ EGLE, Test Plan, Submitted November 6, 2020. (Attached-Appendix A)

² EGLE, Acceptance Letter, December 1, 2020. (Attached-Appendix A)



A schematic representation of the engine exhaust and sampling location is 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 |
|-------------------|---|----------------------------|
| ASTM Method D6348 | NO _x , CO _{out} , Methane, Ethane, Moisture Content | FTIR |
| USEPA Method 3A | O _{2in} , O _{2out} | Paramagnetic |
| USEPA Method 10 | CO _{in} | NDIR |
| USEPA Method 19 | Pollutant Emission Rate | Fuel usage and BTU content |
| USEPA Method 25A | Total VOC | FID |

3.1 MOISTURE (ASTM METHOD D6348)

3.1.1 Sampling Method

Moisture content in the exhaust was evaluated using ASTM Method D6348, "Measurement of Vapor Phase Organic Emissions by Extractive Fourier Transform Infrared (FTIR)".

3.2 OXIDES of NITROGEN, CARBON MONOXIDE, METHANE, ETHANE (ASTM METHOD D6348)

3.2.1 Sampling Method

Oxides of Nitrogen, Carbon Monoxide (outlet), Methane, and Ethane emissions were evaluated using ASTM Method D6348, "Measurement of Vapor Phase Organic Emissions by Extractive Fourier Transform Infrared (FTIR)". Triplicate 60-minute test runs were performed simultaneously with the FID and catalyst inlet sampling.

The ASTM D6348 sampling system (Figure 2) consisted of the following:

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- (1) Single-point sampling probe
- (2) Flexible heated PTFE sampling line
- (3) Air Dimensions Heated Head Diaphragm Pump
- (4) MKS MultiGas 2030 FTIR spectrometer
- (5) Appropriate calibration gases
- (6) Data Acquisition System

The FTIR was equipped with a temperature controlled, 5.11 meter 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 0.5 cm⁻¹ resolution.

3.2.2 Sampling Train Calibration

The FTIR was calibrated per procedures outlined in ASTM Method D6348. Direct measurements of nitrogen, nitric oxide (NO), carbon monoxide (CO), propane (C₃H₈), and ethylene (C₂H₄) 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.

NO, CO, and C₃H₈ gas standards were passed through the sampling system at each test location to determine the response time and confirm recovery.

NO, CO, and C₃H₈ spiking was performed to verify the ability of the sampling system to quantitatively deliver a sample containing NO, CO, and C₃H₈ from the base of the probe to the FTIR. Analyte spiking assures the ability of the FTIR to quantify NO, CO, and C₃H₈ in the presence of effluent gas. Propane gas is also used as a surrogate to measure ethane and methane.

As part of the spiking procedure, samples from each engine were measured to determine NO, CO, and C₃H₈ concentrations to be used in the spike recovery calculations. The determined sulfur hexafluoride (SF₆) concentration in the spiked and unspiked samples was used to calculate the dilution factor of the spike and thus

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used to calculate the concentration of the spiked NO, CO, and C₃H₈. The following equation illustrates the percent recovery calculation.

$$DF = \frac{SF_{6(spike)}}{SF_{6(direct)}} \quad (\text{Sec. 9.2.3 (3) ASTM Method D6348})$$

$$CS = DF * Spike_{dir} + Unspike(1 - DF) \quad (\text{Sec. 9.2.3 (4) ASTM Method D6348})$$

DF = Dilution factor of the spike gas

SF_{6(direct)} = SF₆ concentration measured directly in undiluted spike gas

SF_{6(spike)} = Diluted SF₆ 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 NO, CO, and C₃H₈ spike recoveries were within the ASTM D6348 allowance of ±30%.

3.2.3 Quality Control and Assurance

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 D.

3.2.4 Data Reduction

Each spectrum was derived from the coaddition of 64 scans, with a new data point generated approximately every one minute. The NO_x, CO, Methane, and Ethane emissions were recorded in parts per million (ppm) dry volume basis. O₂ emissions were recorded in percent (%) dry volume basis. The moisture content was recorded in percent (%). The FTIR data was validated by Prism Analytical Technologies, Inc. The validation reports are in Appendix D.



3.3 OXYGEN AND CARBON MONOXIDE CONCENTRATIONS (USEPA METHODS 3A AND 10)

3.3.1 Sampling Method

Oxygen inlet and outlet (O_{2in} and O_{2out}) emissions were evaluated using USEPA Method 3A, "Determination of Oxygen and Carbon Dioxide Concentrations in Emissions From Stationary Sources (Instrumental Analyzer Procedure)". Carbon Monoxide inlet (CO_{in}) emissions were evaluated using USEPA Method 10, "Determination of Carbon Monoxide Emissions from Stationary Sources (Instrumental Analyzer Procedure)". O_{2in} and CO_{in} were measured using one sampling system (below). O_{2out} was measured by routing the dry exhaust gas from the FTIR outlet to the O_{2out} instrument.

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

- (1) Stainless-steel sampling probe
- (2) Heated Teflon™ sampling line
- (3) Gas conditioner with particulate filter
- (4) Flexible unheated Teflon™ sampling line
- (5) Servomex 1400 O_2/CO_2 gas analyzer
- (6) Thermo 48i CO gas analyzer
- (7) Appropriate USEPA Protocol 1 calibration gases
- (8) Data Acquisition System

3.3.2 Sampling Train Calibration

The O_2 and CO analyzers were calibrated according to procedures outlined in USEPA Methods 3A (O_2), 7E, and 10 (CO). Zero, span, and mid-range calibration gases were introduced directly into the analyzers to verify the instruments linearity. Upscale and downscale gases were then introduced through each respective sampling system to determine sampling system bias and instrument drift at the completion of each test.

3.3.3 Quality Control and Assurance

All sampling and analytical equipment was calibrated according to the guidelines referenced in Methods 3A, 7E, and 10. 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.

3.3.4 Data Reduction

Data collected during the emissions testing was recorded at 10-second intervals and averaged in 1-minute increments. The O₂ and CO concentrations were recorded in percent (%) and parts per million by volume, dry (ppmvd), respectively. The 1-minute readings collected during the testing can be found in Appendix B.

CO inlet and outlet concentrations were reduced to ppmvd at 15% oxygen to determine the destruction efficiency of the catalyst. Outlet oxygen concentrations were used in conjunction with Method 19 equations to determine emission factors for NO_x and VOCs.

3.4 TOTAL HYDROCARBON COMPOUNDS (USEPA METHOD 25A)

3.4.1 Sampling Method

Total hydrocarbon compound (THC) emissions were evaluated using USEPA Method 25A, "Determination of Total Hydrocarbon Emissions from Stationary Sources (Instrumental Analyzer Method)". The THC analyzer utilizes a flame ionization detector (FID). The FID measures total hydrocarbon compounds (including Methane). Triplicate 60-minute tests were performed on the engine exhaust.

The Method 25A sampling system (Figure 3) consisted of the following:

- (1) Stainless steel sampling probe
- (2) Heated PTFE sampling line
- (3) JUM 109A[®] Total Hydrocarbon gas analyzer
- (4) Appropriate USEPA Protocol 1 calibration gasses
- (5) Data Acquisition System

3.4.2 Sampling Train Calibration

In accordance with USEPA Method 25A, a 4-point (zero, low, mid, and high) calibration check was performed on the THC analyzer. The analyzer was calibrated with propane in the 0-1,000 ppm range. Calibration drift checks were performed at the completion of each run.

3.4.3 Quality Control and Assurance

The THC sampling equipment was calibrated with propane (C₃H₈) per the guidelines referenced in Methods 25A. Calibration gases were EPA Protocol 1 gases and the concentrations were within the acceptable ranges (25-35% low range, 45-55% mid-range and 80-90% of span). Calibration gas certification sheets are in Appendix C.



3.4.4 Data Reduction

Data collected during the emissions testing was recorded at 10-second intervals and averaged in 1-minute increments. THC emissions were recorded in parts per million by volume, wet basis (ppmv) as propane (C_3H_8). For conversion to VOC concentrations, methane and ethane concentrations collected from the FTIR were converted to a propane standard. THC, ethane, and methane were corrected to dry readings (at a propane standard) using moisture data from the FTIR. Ethane and methane were subtracted from THC to calculate VOC concentrations, as defined in 40 CFR Part 60 Subpart JJJJ. Dry VOC concentrations were converted to grams per brake horsepower-hour (g/bhp-hr) using Method 19 equations for comparison to the permitted emission limits.

One minute readings are in Appendix B.

4.0 OPERATING PARAMETERS

The test program included the collection of process data including load (%), engine speed (RPM), manifold pressure (psi), manifold temperature ($^{\circ}F$), suction pressure (psig), discharge pressure (%), exhaust temperature ($^{\circ}F$), fuel upper heating value (BTU), fuel flow (scfm), and more.

Operational data is in Appendix F.

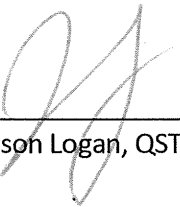
5.0 DISCUSSION OF RESULTS

Table Nos. 1 & 2 presents the emission testing results from EUENGINE1 and EUENGINE2 while operating at greater than 90% of full load conditions. NO_x and VOC emissions in grams per brake horsepower hour (g/bHP-Hr) and CO destruction efficiency of the catalyst (% out/in ppmvd at 15% O₂) are presented. EUENGINE1-2 demonstrated compliance with NO_x, CO, and VOC emission limits as stated in Michigan Renewable Operating Permit No. MI-ROP-B6478-2016, 40 CFR Part 60 Subpart JJJJ, 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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RESULTS TABLES



TABLE NO. 1
EMISSIONS TEST RESULTS
DTE Gas - Belle River Mills Compressor Station
EUENGINEER1
March 25, 2021

| Test | Test Time | Unit | O _{2in} | O _{2out} | NOx | NOx | CO _{in} | CO _{out} | CO | Methane | Ethane | THC | VOC | VOC |
|------|-----------------------|------------|-----------------------|-----------------------|----------------------|----------------------|----------------------|----------------------|-------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| | | Load | <u>Content</u> | <u>Content</u> | <u>Concentration</u> | <u>Concentration</u> | <u>Concentration</u> | <u>Concentration</u> | <u>Destruction Eff.</u> | <u>Concentration</u> | <u>Concentration</u> | <u>Concentration</u> | <u>Concentration</u> | <u>Emission Rate</u> |
| | | (%) | (%, dry) ¹ | (%, dry) ¹ | (ppmvd) | (g/bhp-hr) | (g/bhp-hr) | (g/bhp-hr) | (%) | (ppmvd) ² | (ppmvd) ² | (ppmvd) ² | (ppmvd) ² | (g/bhp-hr) |
| 1 | 8:41-9:41 | 95% | 10.3 | 10.6 | 107.3 | 0.82 | 12.0 | 0.5 | 96% | 712.3 | 70.5 | 736.8 | -46.0 | ND |
| 2 | 10:35-11:35 | 93% | 10.3 | 10.6 | 108.4 | 0.86 | 13.7 | 0.5 | 97% | 710.9 | 70.3 | 756.0 | -25.2 | ND |
| 3 | 12:02-13:02 | <u>94%</u> | <u>10.4</u> | <u>10.7</u> | <u>98.7</u> | <u>0.79</u> | <u>13.1</u> | <u>0.5</u> | <u>96%</u> | <u>724.7</u> | <u>72.3</u> | <u>770.6</u> | <u>-26.3</u> | <u>ND</u> |
| | Average: | 94% | 10.3 | 10.6 | 104.8 | 0.83 | 12.9 | 0.5 | 96% | 716.0 | 71.0 | 754.5 | -32.5 | ND |
| | Permit Limit : | | | | | 1.3 | | | 93% | | | | | 1.0 |

¹At a propane standard



TABLE NO. 2
EMISSIONS TEST RESULTS
DTE Gas - Belle River Mills Compressor Station
EUENGINEER2
March 23, 2021

| Test | Test Time | Unit Load (%) | O _{2in} Content (%) ¹ | O _{2out} Content (%) ¹ | NO _x Concentration (ppmvd) | NO _x Concentration (g/bhp-hr) | CO _{in} Concentration (g/bhp-hr) | CO _{out} Concentration (g/bhp-hr) | CO Destruction Eff. (%) | Methane Concentration (ppmvd) ² | Ethane Concentration (ppmvd) ² | THC Concentration (ppmvd) ² | VOC Concentration (ppmvd) ² | VOC Emission Rate (g/bhp-hr) |
|----------------|-------------|---------------|---|--|---------------------------------------|--|---|--|-------------------------|--|---|--|--|------------------------------|
| 1 | 10:25-11:25 | 96% | 10.3 | 10.6 | 128.9 | 1.01 | 10.7 | 0.5 | 96% | 661.3 | 64.9 | 678.4 | -47.8 | ND |
| 2 | 13:55-14:55 | 99% | 10.4 | 10.7 | 141.4 | 1.10 | 7.5 | 0.3 | 96% | 644.7 | 62.0 | 755.1 | 48.5 | 0.1 |
| 3 | 15:16-16:16 | 99% | 10.4 | 10.7 | 146.1 | 1.13 | 7.8 | 0.3 | 96% | 636.6 | 60.9 | 772.3 | 74.9 | 0.2 |
| Average: | | 98% | 10.4 | 10.7 | 138.8 | 1.08 | 8.7 | 0.3 | 96% | 647.5 | 62.6 | 735.3 | 25.2 | 0.1 |
| Permit Limit : | | | | | | 1.3 | | | 93% | | | | | 1.0 |

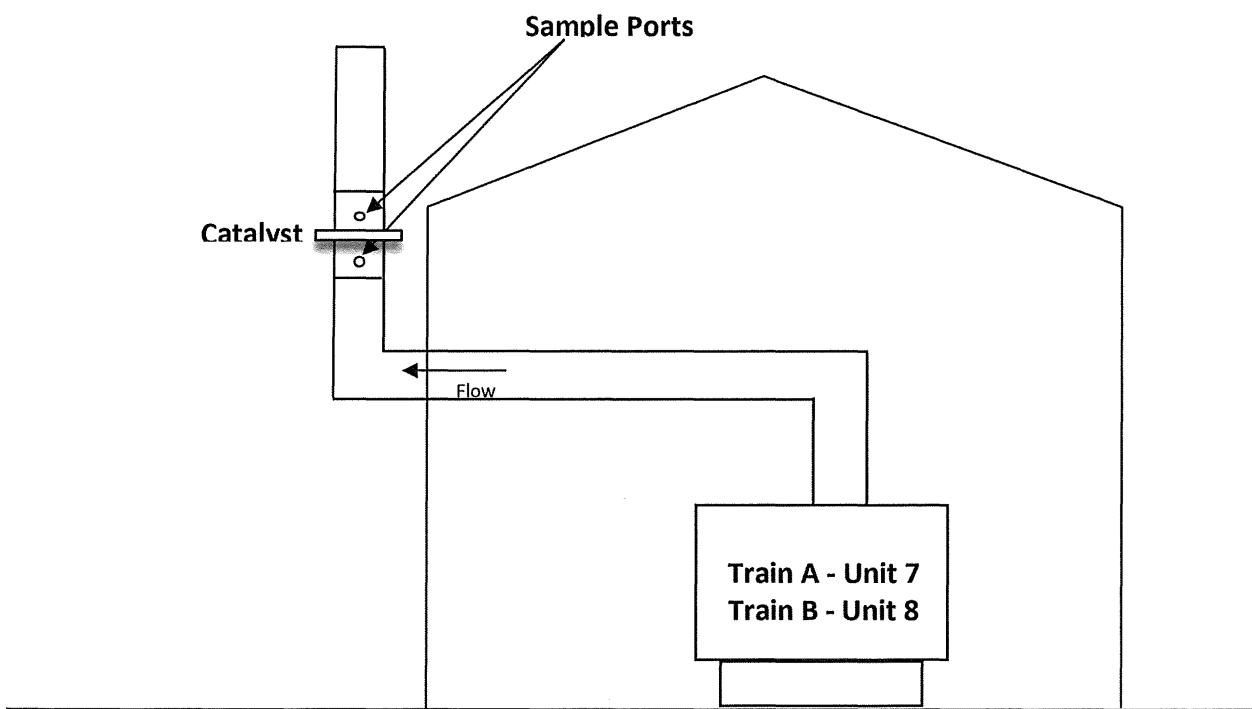
¹At a propane standard

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FIGURES

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**Figure 1 – Sampling Location
Refrigeration Plant (Unit 7 & 8)
Belle River Mills Compressor Station**



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**Figure 2 – ASTM D6348
Refrigeration Plant – (Units 7 & 8)
Belle River Mills Compressor Station**

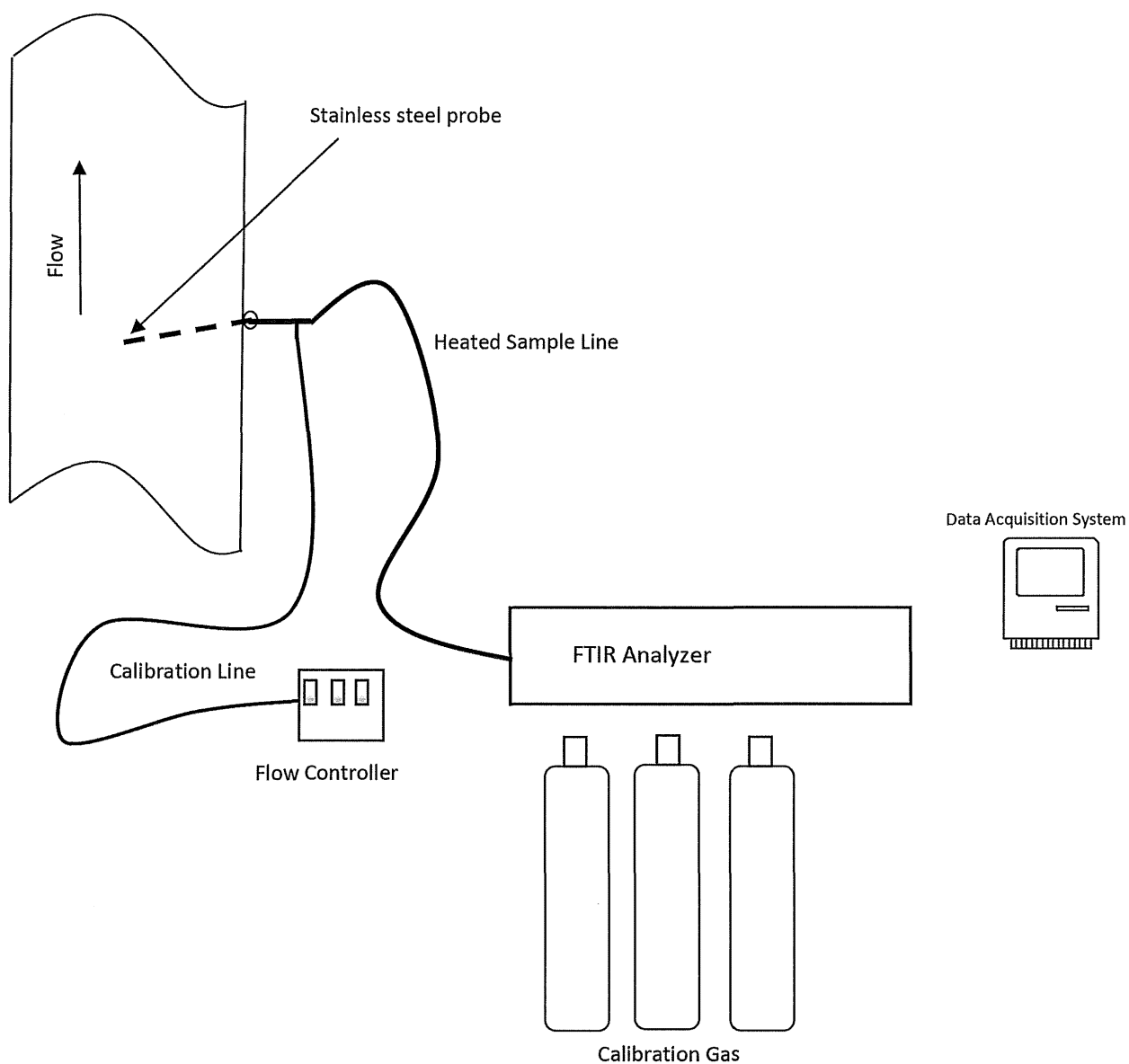
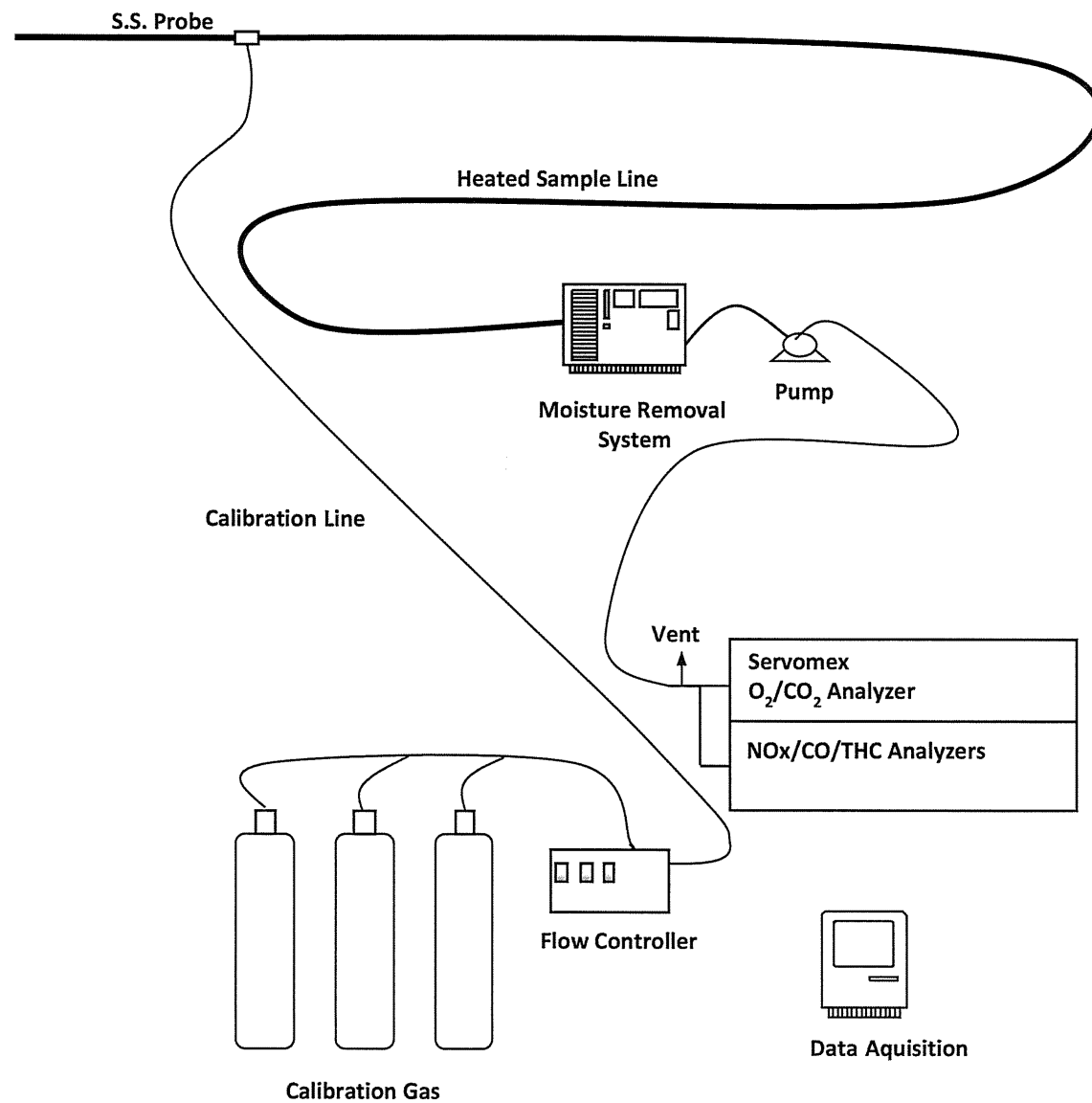


Figure 3 – Emissions Monitors
Refrigeration Plant (Unit 7 & 8)
Belle River Mills Compressor Station





APPENDIX A

EGLE TEST PLAN