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# EMISSIONS TEST REPORT

for

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

**EU006-EU009 (UNITS 501-504)**
**MI-ROP-B7221-2015**

**DTE Gas Company – Milford Compressor Station**
**Milford, Michigan**

**April 29 - 30, 2020**

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## 1.0 INTRODUCTION

DTE Energy Corporate Services, LLC (DECS), a DTE Energy Company (DTE) performed emissions testing at the Milford Compressor Station, located in Milford, Michigan. The fieldwork, performed April 29-30, 2020 was conducted to satisfy requirements of the Michigan Renewable Operating Permit No. MI-ROP-B7221-2015. Emissions tests were performed on EU006 – EU009 (Units 501-504) 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 and the DECS Intent to Test[1], which was approved by the Michigan Department of Environment, Great Lakes, and Energy (EGLE) on April 10, 2020. The following DECS personnel participated in the testing program: Mr. Mark Grigereit, Principal Engineer, Mr. Thomas Snyder, Environmental Specialist, and Mr. Fred Meinecke, Sr. Environmental Technician. Mr. Grigereit was the project leader. Mr. John Leonard, Environmental Engineer, DECS, provided the process coordination for the testing program. Mr. Chris Conley, Manager, DTE Gas, provided operational over-site of the units. Mr. Mark Dziadosz, Mr. Shamim Ahmmod, and Ms. Regina Angellotti, EGLE-Air Quality Division, reviewed the Test Plan and observed portions of the testing.

## 2.0 SOURCE DESCRIPTION

The DTE-Gas Milford Compressor Station located at 3515 Childs Lake Road, Milford, Michigan, employs the use of four (4) Natural gas-fired DeLaval Model HVA-12 4000-Horse Power reciprocating engines designated EU006-EU009. The engines generate line pressure assisting the pipeline transmission of natural gas throughout the pipeline transmission system in SE Michigan.

See Figure 1 for a diagram of the unit sampling locations and stack dimensions. Sampling was conducted on the horizontal exhaust duct prior to the silencer.

[1] EGLE Test Plan, Submitted October 31, 2019. (Attached-Appendix A)

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## 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, Methane, Ethane, $CO_2$, Moisture Content | FTIR |
| 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, CARBON DIOXIDE (ASTM METHOD D6348)

### 3.2.1 Sampling Method

Oxides of Nitrogen, Carbon Monoxide, Methane, Ethane, and Carbon Dioxide 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.

The ASTM D6348 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) MKS MultiGas 2030 FTIR spectrometer
(5) Appropriate calibration gases
(6) Data Acquisition System

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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.

A stratification check for NOx, CO, and Oxygen was conducted on the exhaust of Unit 501 on April 28, 2020. It was discussed with EGLE personnel on site and decided that this stratification check would be applied to subsequent units (502-504) as well. The stratification check results showed single point testing met method 7E criteria based on the diluent. Results from the stratification check are in Appendix C.

### 3.2.2 Sampling Train Calibration

The FTIR was calibrated per procedures outlined in ASTM Method D6348. Direct measurements of nitrogen, oxides of nitrogen ($NO_x$), carbon monoxide (CO), propane ($C_3H_8$), and ethylene ($C_2H_4$) 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.

$NO_x$, CO, and $C_3H_8$ gas standards were passed through the sampling system at each test location to determine the response time and confirm recovery.

$NO_x$, CO, and $C_3H_8$ spiking was performed to verify the ability of the sampling system to quantitatively deliver a sample containing $NO_x$, CO, and $C_3H_8$ from the base of the probe to the FTIR. Analyte spiking assures the ability of the FTIR to quantify $NO_x$, CO, and $C_3H_8$ in the presence of effluent gas.

As part of the spiking procedure, samples from each engine were measured to determine $NO_x$, CO, and $C_3H_8$ concentrations to be used in the spike recovery calculations. The determined sulfur hexafluoride ($SF_6$) 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 $NO_x$, CO, and $C_3H_8$. The following equation illustrates the percent recovery calculation.

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

$$CS = DF * Spike_{dir} + Unspike (1 - DF)$$ (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 $SF_6$ 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 $NO_x$, CO, and $C_3H_8$ spike recoveries were within the ASTM D6348 allowance of ±30%.

The $CO_2$ 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, prior to sampling, and again at the completion of each test run.

### 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 minute. The $NO_x$, CO, Methane, and Ethane emissions were recorded in parts per million (ppm) dry volume basis. The $CO_2$ emissions were recorded in percent (%) dry volume basis. The moisture content

was recorded in percent (%). The $CO_2$ emissions were corrected for bias according to USEPA Method 7E.

## 3.3 TOTAL HYDROCARBON COMPOUNDS (USEPA METHOD 25A)

### 3.3.1 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) Single-point sampling probe (placed in the center of the stack)
(2) Heated PTFE sampling line
(3) JUM 109A® Total Hydrocarbon gas analyzer
(4) Appropriate USEPA Protocol 1 calibration gasses
(5) Data Acquisition System

### 3.3.2 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 0-5,000 ppm range. Calibration drift checks were performed at the completion of each run.

### 3.3.3 Quality Control and Assurance

The THC sampling equipment was calibrated with propane ($C_3H_8$) 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 80-100% of span). Calibration gas certification sheets are 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 THC emissions were recorded in parts per million (ppm) as propane ($C_3H_8$). The THC emissions were corrected for bias according to USEPA Method 7E. The 1-minute readings collected are in Appendix B.

The NMEOC emissions were reported in grams per Brake Horsepower Hour (g/BHp-Hr) as required by the Method. The 1-minute readings collected are in Appendix B. Emissions calculations, based on equations located in USEPA Methods 25A and 19 are in Appendix E.

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## 4.0 OPERATING PARAMETERS

The test program included the collection of engine torque (Hp), engine speed (RPM), inlet manifold air temperature (°F), fuel upper heating value (BTU), and fuel flow (100 scfh).

A gas chromatograph sample and report of the natural gas used was collected once during each day of testing . The results of the fuel analysis can be found in Appendix E.

Operational data is in Appendix E.

## 5.0 DISCUSSION OF RESULTS

Table Nos. 1 and 2 present the gaseous emissions testing results from EU006-EU009 (Units 501-504) while operating at greater than 90% of full load conditions. The NOx, CO and NMEOC emissions are presented in parts per million (ppm) dry, pounds per hour (lb/hr), and grams per brake horsepower hour (gr/Bhp-H). Additional test data presented for each test includes the unit load in brake-horsepower (BHp), Unit load in percentage (%), Heat Input (Mbtu/hr), exhaust $CO_2$ in percent (%), and exhaust gas moisture content in percent (%).

The results from the testing indicate that EU006-EU009 (Units 501-504) comply with Michigan Renewable Operating Permit No. MI-ROP-B7221-2015.

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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

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# Results Table No. 1
## Engine Emissions Testing Results
## DTE Gas - Milford Compressor Station
## EU006-EU007 (Engines 501 & 502)
## April 30th, 2020

**EU006 (Engine 501)**

| Test ID | Time | Date | Percent Load | Brake-Hp | Heat Input (Mbtu/Hr) | CO2 (% dry[1]) | CO Emissions (dry) | | | NOx Emissions (dry) | | | NMEOC Emissions (dry) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | (ppm) | (lbs/hr) | (gram/BHP-Hr) | (ppm) | (lbs/hr) | (gram/BHP-Hr) | (ppm[1]) | (lbs/hr) | (gram/BHP-Hr) |
| Run - 1 | 12:51-13:51 | 30-Apr-20 | 98.9% | 3,560 | 30.1 | 5.3 | 283.0 | 12.02 | 1.5 | 1,057.7 | 73.80 | 9.4 | ND | ND | ND |
| Run - 2 | 14:06-15:06 | | 99.4% | 3,577 | 30.1 | 5.3 | 286.5 | 12.08 | 1.5 | 1,122.3 | 77.78 | 9.9 | ND | ND | ND |
| Run - 3 | 15:16-16:16 | | 100.6% | 3,622 | 30.2 | 5.4 | 287.5 | 12.07 | 1.5 | 1,157.2 | 79.79 | 10.0 | ND | ND | ND |
| | | *Average:* | *99.6%* | *3,586* | *30.1* | *5.3* | *285.7* | *12.06* | *1.50* | *1,112.4* | *77.12* | *9.77* | *ND* | *ND* | *ND* |

**EU007 (Engine 502)**

| Test | Time | Date | Percent Load | Brake-Hp | Heat Input (Mbtu/Hr) | CO2 (% dry[1]) | CO Emissions (dry) | | | NOx Emissions (dry) | | | NMEOC Emissions (dry) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | (ppm) | (lbs/hr) | (gram/BHP-Hr) | (ppm) | (lbs/hr) | (gram/BHP-Hr) | (ppm[1]) | (lbs/hr) | (gram/BHP-Hr) |
| Run - 1 | 8:02-9:02 | 30-Apr-20 | 99.0% | 3,563 | 27.7 | 4.7 | 194.6 | 8.48 | 1.1 | 633.4 | 45.34 | 5.8 | ND | ND | ND |
| Run - 2 | 10:04-11:04 | | 88.3% | 3,179 | 24.8 | 4.5 | 183.8 | 7.51 | 1.1 | 493.3 | 33.11 | 4.7 | ND | ND | ND |
| Run - 3 | 11:35-12:35 | | 94.6% | 3,407 | 26.6 | 4.7 | 194.1 | 8.13 | 1.1 | 658.0 | 45.28 | 6.0 | ND | ND | ND |
| | | *Average:* | *94.0%* | *3,383* | *26.4* | *4.6* | *190.8* | *8.04* | *1.10* | *594.9* | *41.24* | *5.50* | *ND* | *ND* | *ND* |

**Notes:**

1 - Corrected for Analyzer Drift per EPA Methdod 7E

CO Permit Limt: 1.75 gram/BHP-Hr

NOx Permit Limt: 11.5 gram/BHP-Hr

ND - Non Detect

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# Results Table No. 2
## Engine Emissions Testing Results
### DTE Gas - Milford Compressor Station
### EU008-EU009 (Engines 503 & 504)
### April 29, 2020

**EU008 (Engine 503)**

| Test | Time | Date | Percent Load | Brake-Hp | Heat Input (Mbtu/Hr) | CO2 (% dry[1]) | CO Emissions (dry) | | | NOx Emissions (dry) | | | NMEOC Emissions (dry) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | (ppm) | (lbs/hr) | (gram/BHP-Hr) | (ppm) | (lbs/hr) | (gram/BHP-Hr) | (ppm[1]) | (lbs/hr) | (gram/BHP-Hr) |
| Run - 1 | 12:35-13:35 | 29-Apr-20 | 94.3% | 3,395 | 24.7 | 4.6 | 207.1 | 8.28 | 1.1 | 143.9 | 9.45 | 1.3 | ND | ND | ND |
| Run - 2 | 13:56-14:56 | | 94.7% | 3,409 | 24.7 | 4.6 | 207.8 | 8.23 | 1.1 | 146.6 | 9.53 | 1.3 | ND | ND | ND |
| Run - 3 | 15:11-16:11 | | 94.5% | 3,401 | 24.7 | 4.6 | 207.0 | 8.24 | 1.1 | 151.2 | 9.89 | 1.3 | ND | ND | ND |
| | | *Average:* | *94.5%* | *3,402* | *24.7* | *4.6* | *207.3* | *8.25* | *1.10* | *147.2* | *9.62* | *1.30* | *ND* | *ND* | *ND* |

**EU009 (Engine 504)**

| Test | Time | Date | Percent Load | Brake-Hp | Heat Input (Mbtu/Hr) | CO2 (% dry[1]) | CO Emissions (dry) | | | NOx Emissions (dry) | | | NMEOC Emissions (dry) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | (ppm) | (lbs/hr) | (gram/BHP-Hr) | (ppm) | (lbs/hr) | (gram/BHP-Hr) | (ppm[1]) | (lbs/hr) | (gram/BHP-Hr) |
| Run - 1 | 8:33-9:33 | 29-Apr-20 | 95.2% | 3,427 | 26.1 | 5.0 | 170.1 | 6.55 | 0.87 | 536.3 | 33.94 | 4.5 | ND | ND | ND |
| Run - 2 | 9:56-10:56 | | 94.9% | 3,415 | 26.0 | 5.0 | 168.6 | 6.47 | 0.86 | 533.6 | 33.65 | 4.5 | ND | ND | ND |
| Run - 3 | 11:07-12:07 | | 94.9% | 3,415 | 26.1 | 5.1 | 169.3 | 6.47 | 0.86 | 538.3 | 33.79 | 4.5 | ND | ND | ND |
| | | *Average:* | *95.0%* | *3,419* | *26.1* | *5.0* | *169.3* | *6.50* | *0.86* | *536.1* | *33.79* | *4.50* | *ND* | *ND* | *ND* |

**Notes:**

1 - Corrected for Analyzer Drift per EPA Methdod 7E

CO Permit Limt: 1.75 gram/BHP-Hr

NOx Permit Limt: 11.5 gram/BHP-Hr

ND - Non Detect

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# FIGURES

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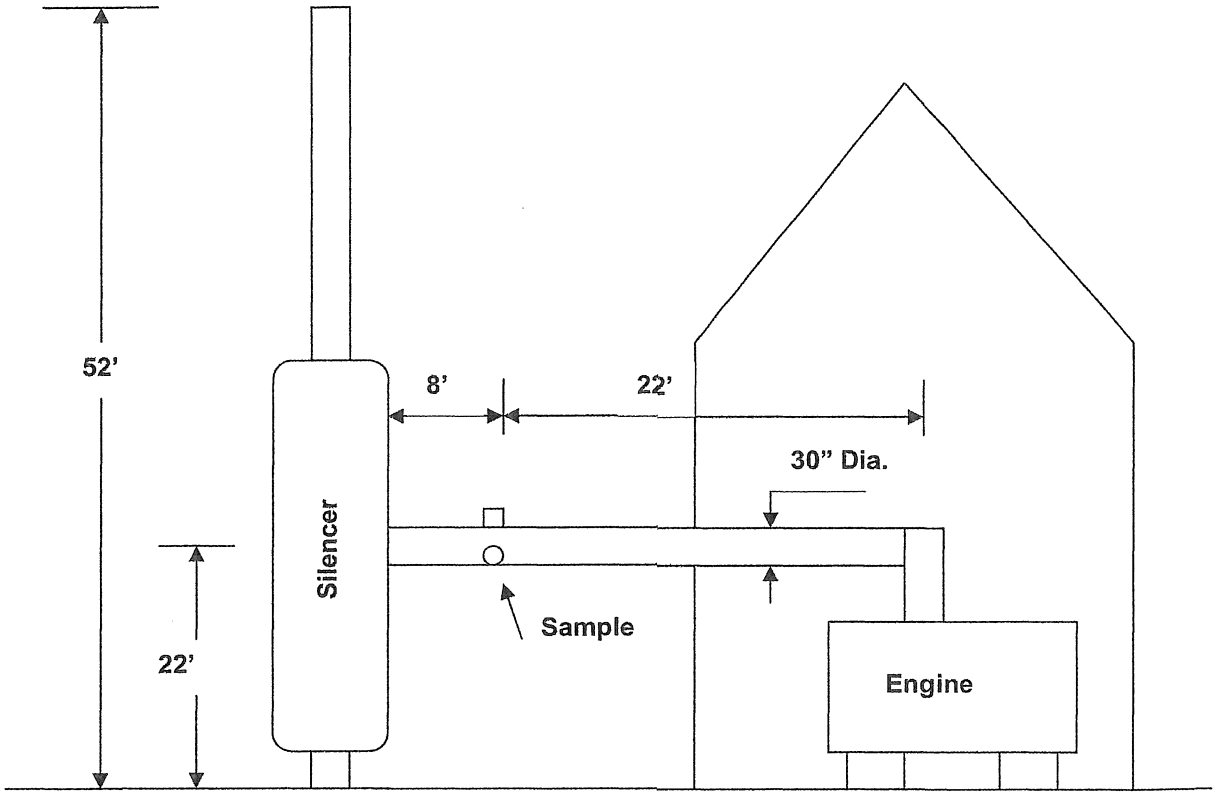
# Figure 1 – Sampling Location
# Milford Compressor Station
# Engines 501-504
# April 29-30, 2020



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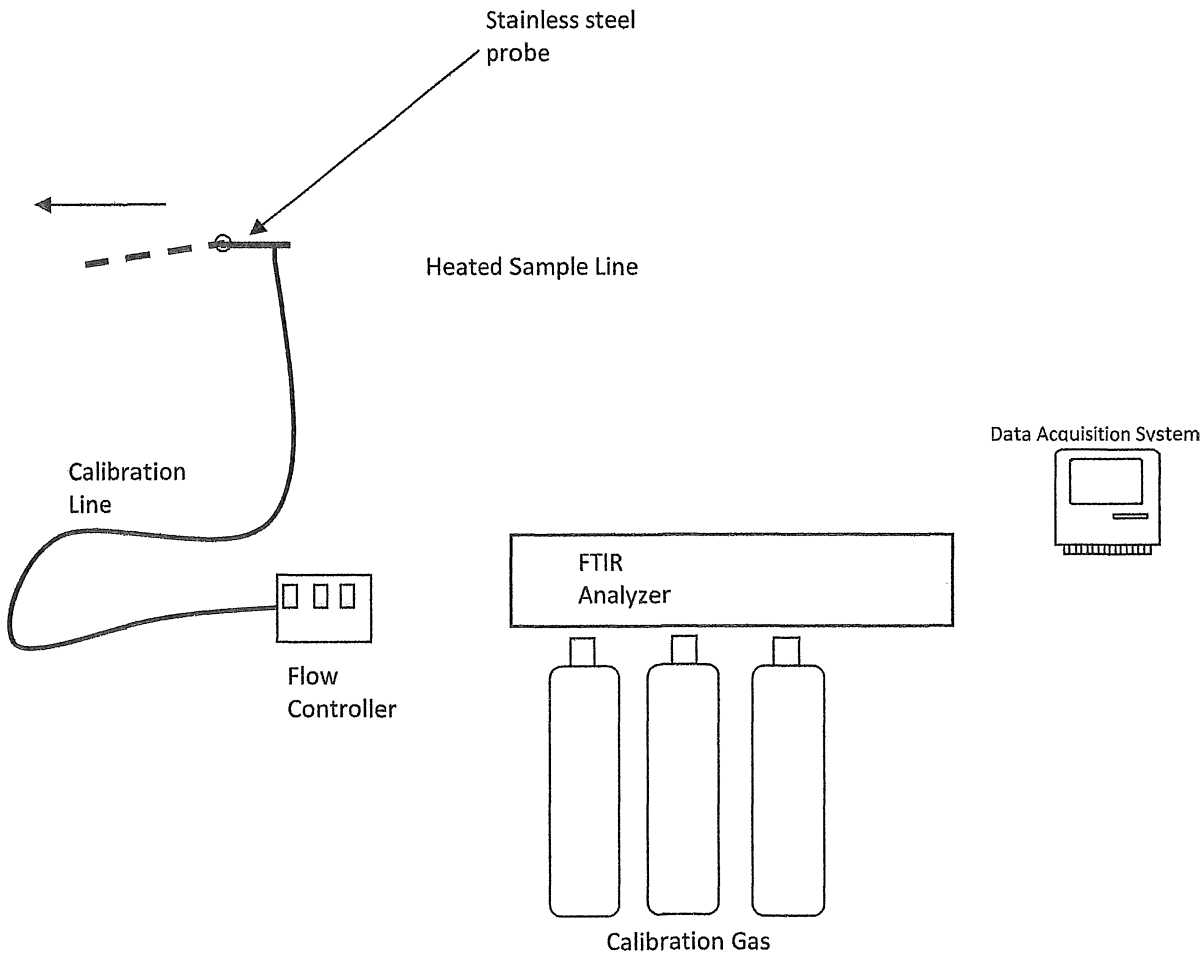
# Figure 2 – ASTM D6348
# Milford Compressor Station
# Engines 501-504
# April 29-30, 2020



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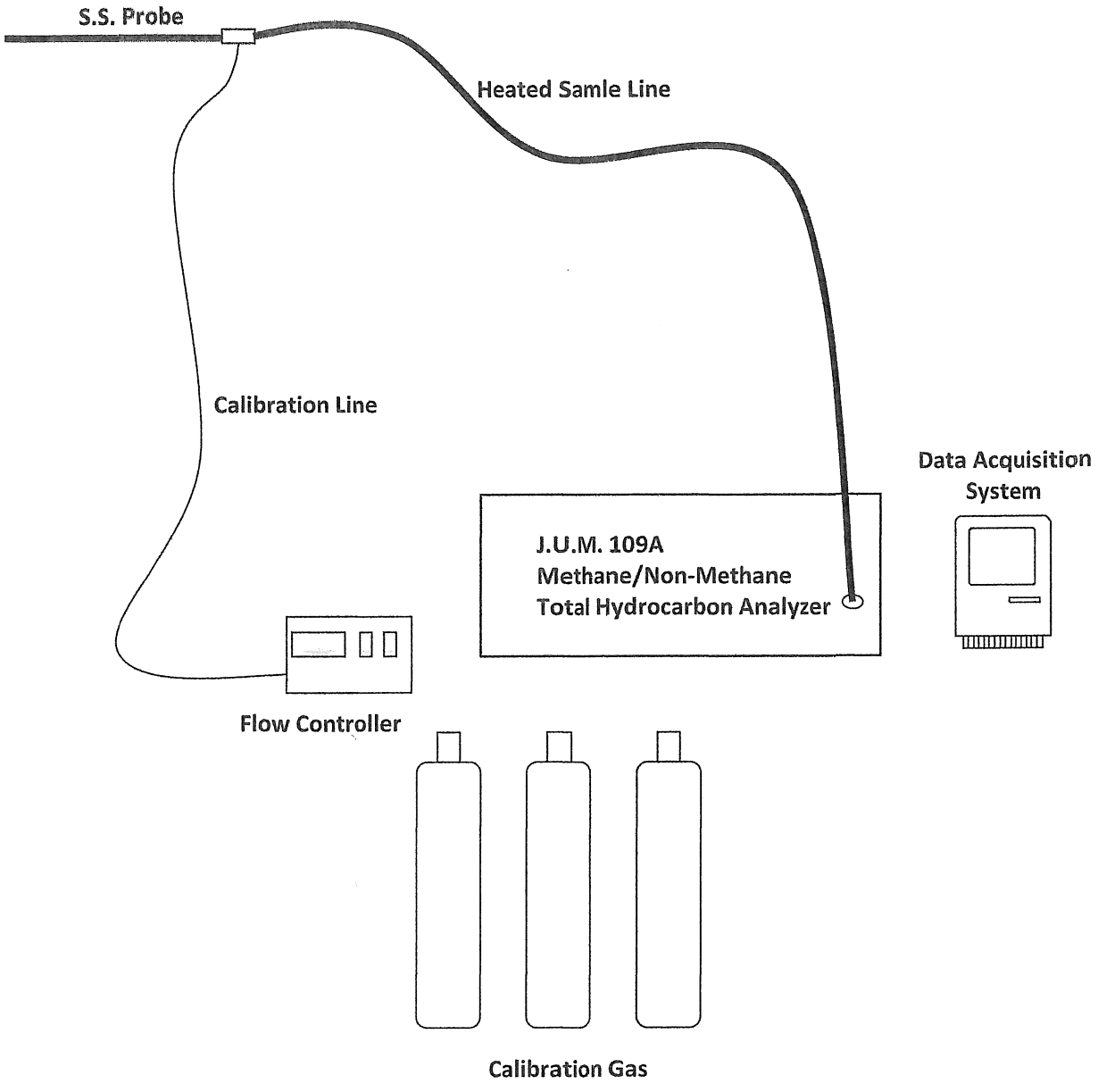
# Figure 3 – USEPA Method 25A
# Milford Compressor Station
# Engines 501-504
# April 29-30, 2020



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# APPENDIX A

# EGLE TEST PLAN and APPROVAL LETTER