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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– Dearborn CEP, LLC, located in Dearborn, Michigan. The fieldwork, performed between August 24-27, 2020, was conducted to satisfy requirements of the Michigan Department of Environment, Great Lakes, and Energy (EGLE) Permit to Install (PTI) 144-17. Emissions tests were performed on two Solar Titan 130 20501S model natural gas-fired CTG with HRSG (EUCTGHRSG1) and (EUCTGHRSG2) for oxides of nitrogen, carbon monoxide, and fine particulate matter ($PM_{2.5}$). Each unit was tested with and without duct burners operating.

The following DTE personnel participated in the testing program: Mark Grigereit, Principal Engineer, Thomas Snyder and Jason Logan, Environmental Specialists, and Fred Meinecke, Senior Environmental Technician. Ms. Regina Angellotti, with EGLE reviewed the test plan and was on site to observe individual portions of the test program.

2.0 SOURCE DESCRIPTION

DTE Dearborn CEP, LLC is located at 1641 Carroll Shelby Way East, Dearborn, Michigan. The facility is within the Ford R&E Center. The DTE Dearborn facility is a central energy plant with a combined heat and power (CHP) plant and hot/chilled water plant at the Ford R&E Center. The CHP Plant consists of two combustion turbine generators (CTG), each within associated heat recovery steam generator (HRSG) with ancillary duct burners (DB) to produce electricity and steam. The primary purpose of the DBs is to provide additional steam generation during winter months or periods of high steam demand. The steam generated by the plant provides Ford with support to the Research and Engineering operations. Dispatch of the electrical generation is controlled by DTE. All electricity generated by the facility is supplied to the local utility grid. Other parts of the DTE Dearborn facility are the Thermal Energy Storage (TES) tank, chillers, back-up generator, and gas compressors.

Figure 1 presents a schematic of the sampling location for each turbine (Units are similarly designed).

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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
USEPA Methods 1 & 2	Sampling Location & Exhaust Volumetric Flowrates	S-type Pitot Tube and Manometer
USEPA Method 3A	Oxygen/Carbon Dioxide	Instrumental Analyzer Method
USEPA Method 4	Exhaust Moisture Content	Gravimetric
USEPA Method 5	$PM_{2.5}$	Isokinetic Sampling Train
USEPA Method 202	Condensable Particulate Matter	Isokinetic Sampling Train
USEPA Method 7E	Oxides of Nitrogen	Instrumental Analyzer Method
USEPA Method 10	Carbon Monoxide	Instrumental Analyzer Method

As proposed in the Test Plan, USEPA Method 5, a method for measuring ***all*** particulate, was used as a surrogate for actual Fine Particulate measurements. This is common practice the for testing of natural gas fired, combustion turbines, because particulate greater than 10 microns should not occur in the exhaust gas stream.

3.1 OXYGEN, OXIDES OF NITROGEN, AND CARBON MONOXIDE (USEPA METHODS 3A, 7E, and 10)

3.1.1 Sampling Method

Exhaust Oxygen (O_2) and carbon dioxide (CO_2) content was evaluated using USEPA Method 3A, "Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)". The analyzers utilize paramagnetic sensors.

Oxides of Nitrogen (NO_x) emissions were evaluated using USEPA Method 7E, "Determination of Oxides of Nitrogen Emissions from Stationary Sources". The NO_X analyzer utilizes a chemiluminescent detector.

Carbon Monoxide (CO) emissions were evaluated using USEPA Method 10, "Determination of Carbon Monoxide Emissions from Stationary Sources (Instrumental Analyzer Procedure)". The CO analyzer utilizes a non-dispersive infrared (NDIR) detector.

All gas samples were measured on a dry basis (i.e. sample was conditioned prior to introduction into the pollutant analyzers).

3.1.2 O_2, NO_X and CO Sampling Train

The EPA Methods 3A, 7E, and 10 sampling system (Figure 2) consisted of the following components:

(1) Stainless steel sampling probe
(2) Heated Teflon™ sampling line
(3) MAK® gas conditioner with particulate filter
(4) Flexible unheated Teflon™ sampling line
(5) Instrumental gas analyzer bank
(6) Appropriate USEPA Protocol 1 Calibration Gases
(7) Data Acquisition System

3.1.3 Sampling Train Calibration

The O_2, NO_X, and CO instruments were calibrated according to procedures outlined in USEPA Methods 3A, 7E, and 10. Zero, span, and mid-range calibration gases were introduced directly into each analyzer to determine the instruments linearity. A zero and mid-range span gas was then introduced through the entire sampling system to determine sampling system bias for each analyzer. Additional system calibrations were performed at the completion of each test.

3.1.4 Sampling Duration & Frequency

NO_X and CO emissions testing consisted of triplicate 20-minute samples. Stratification testing was performed during previous emissions testing. No modifications where made to the ductwork and stacks and the static pressure checks verified that the null angle was at 90. EGLE agreed that the previous stratification checks were sufficient. The exhausts were not stratified on either source for each condition. Data was recorded at 10-second intervals.

3.1.5 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.

Calibration gas concentrations were within the acceptable ranges specified in Method 7E.

Prior to testing, DTE performed converter efficiency testing by directly challenging the NO_x analyzer with a nitrogen dioxide (NO_2) calibration gas of 15.42 ppm. Results from the converter efficiency test demonstrated that the analyzer met the requirements of Method 7E[Eq. 1] (Greater than 90%).

Eq. 1 $$Eff_{NO2} = \frac{13.88}{15.42} = 90\%$$

Field calibration data sheets and gas certification sheets are in Appendix C.

3.1.6 Data Reduction

The O2 (%), CO_2 (%), NO_X (ppmvd), and CO (ppmvd) readings were recorded at 10-second intervals and averaged to 1-minute increments. NO_X and CO emissions were reported in parts per million corrected to 15% O_2 (ppm @ 15% O_2), pounds per million British thermal units (lb/MMBtu), and pounds per hour (lb/hr) for comparison to the permitted emission limits. Emission were calculated using USEPA Method 19.

Raw CEM data is presented in Appendix B.

3.2 FINE PARTICULATE MATTER (USEPA METHODS 5/202)

3.2.1 Sampling Method

A combined USEPA Method 5/Method 202 isokinetic sampling train was used to measure the filterable (front-half) and condensable (back-half) particulate emissions. The permit limit specifies $PM_{2.5}$ determination however because of the nature of the source being tested, Method 5 along with Method 202 was performed instead of the Method 201A/202 combination. The results from Method 5 and Method 202 were combined and assumed to be $PM_{2.5}$. This practice is not uncommon for combustion sources that are fired with natural gas.

Field data sheets for the Method 5/Method 202 sampling can be found in Appendix F.

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3.2.2 Particulate Matter Sampling Train

The combined Method 5/202 isokinetic sampling train consisted of the following components:

(1) Stainless-steel button-hook nozzle
(2) Heated stainless quartz-lined probe
(3) Heated 3" glass filter holder with a quartz filter (maintained at a temperature of 248 ± 25 °F)
(4) Method 23-type condenser
(5) Condensate dropout impinger (dry) without the bubbler tube
(6) Modified Greenburg-Smith impinger (dry) with no taper as a backup impinger
(7) 3" glass filter holder with a PTFE filter (maintained at a temperature between 65 and 85 °F)
(8) Modified Greenburg-Smith impinger containing 100 millimeters (ml) of distilled de-ionized (DDI) water
(9) Modified Greenburg-Smith impinger containing approximately 300 grams of silica gel desiccant.
(10) Length of sample line
(11) Environmental Supply® control case equipped with a pump, dry gas meter, and calibrated orifice.

Refer to Figure 3 for a schematic of the isokinetic sampling train.

3.2.3 Sampling Train Calibration

All sampling and analytical equipment was calibrated according to the guidelines referenced in Method 5 and Method 202, as appropriate.

Equipment calibration data can be found in Appendix C.

3.2.4 Sampling Duration & Frequency

Triplicate, 120-minute test runs were conducted on the exhaust of each unit while the duct burner was on and off.

3.2.5 Sample Recovery

After completion of the final leak test for each test run, the Method 5 filter was recovered, and the probe, nozzle and the front half of the filter holder assembly were brushed and rinsed with acetone. The acetone rinses were collected in a pre-cleaned sample container. The container was labeled with the test number, test location, test

date, and the level of liquid marked on the outside of the container. Immediately after recovery, the sample containers were placed in a cooler for storage.

The Method 202 impinger train was carefully disassembled. The liquid volume of each impinger was measured (by weight) and recorded on the field data sheet. The silica gel was re-weighed, and any increase was recorded on the field data sheets. Moisture from the condensate dropout impinger was added to the second impinger. The Method 202 impinger train was purged with ultra-high purity compressed nitrogen at 14 liters per minute for 60 minutes. During the purge the condenser recirculation pump was operated and the first two impingers were heated/cooled to maintain the gas temperature exiting the CPM filter between 65 and 85 °F.

After completion of the purge, contents from the dropout impinger and the impinger prior to the CPM filter were collected into a pre-cleaned sample container. The condenser, impingers and front-half of the CPM filter holder were rinsed with DDI water and the rinses added to the sample container. The sample components were then rinsed with acetone followed by two rinses with hexane. The acetone and hexane rinses were collected into a pre-cleaned sample container. The CPM filter was recovered and placed into a labeled container. All containers were labeled with the test number, test location, test date, and the level of liquid marked on the outside of the container. Immediately after recovery, the sample containers were placed in a cooler for storage.

3.2.6 Quality Control and Assurance

The condensate dropout impinger and backup impinger were placed in an insulated box with water and maintained so that the gas stream temperature at the exit of the condensable filter holder was between 65 and 85 °F. The water and silica gel impingers were placed in an ice water bath to maintain the exit gas temperature from the silica gel impinger below 68°F.

All Method 5 glassware was rinsed with acetone prior to use in the field. All Method 202 glassware was pre-cleaned prior to testing with soap and water, and rinsed using tap water, distilled de-ionized (DDI) water, acetone, and finally, hexane. After cleaning, the glassware was baked at 300 °C for 6 hours.

Collected blanks consisted of a field recovery blank, acetone rinse blank, a DDI water rinse blank, and a hexane rinse blank taken directly from the bottles used during recovery of the samples. A proof blank was not required as the glassware was baked prior to use in the field.

At the laboratory, the Method 5 PM acetone rinses were transferred to clean pre-weighed beakers and evaporated to dryness at ambient temperature and pressure.

The beakers and filters were then desiccated for 24 hours and weighed to a constant weight. The data sheets containing the initial and final weights on the filters and beakers can be found in Appendix G.

Analysis of the Method 202 samples and blanks were conducted by Maxxam Analytics of Mississauga, Ontario. All analysis followed the procedures listed in Method 202. A complete laboratory report can be found in Appendix G.

3.2.7 Data Reduction

Particulate matter concentrations ($PM_{2.5}$) was reduced to lb/hr for comparison to the permitted emission limit. Filterable and condensable PM results were combined and assumed to be $PM_{2.5}$.

4.0 OPERATING PARAMETERS

The test program included the collection of turbine operating data during each test run. Parameters recorded included mass fuel flow rate (lb/hr), heat input (MMBtu/hr), electrical generation (kW), compressor discharge pressure (PSIG), turbine exhaust temperature (F) and steam flow from HRSG (KPPH).

Operational data and results of the fuel analysis can be found in Appendix E.

5.0 RESULTS

The results of the Oxides of nitrogen, carbon monoxide, and particulate matter emission testing conducted on EUCTGHRSG1-2 are presented in Table Nos. 1-4. $PM_{2.5}$ emissions are presented in lb/hr (combined filterable and condensable particulate). The results of the NOx and CO emissions testing are presented in parts per million at 15% oxygen (ppm @ 15% O_2), pounds per million BTU (lb/MMBTU), and lb/hr. EUCTGHRSG1 demonstrated compliance with permitted emission rates.

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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."

Mark Grigereit, QSTI

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FOR

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Environmental Management and Resources
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RESULTS TABLES

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TABLE NO. 1
EMISSIONS TEST RESULTS
DTE Dearborn CEP, LLC
EUCTGHRSG1 (Duct Burners Off)
August 26, 2020

Date	Test Time	Unit Load (%)	Stack Temperature (°F)	Stack Moisture (%)	Stack Velocity (ft/min)	Exhaust Gas Flowrates (ACFM)	(SCFM)	(DSCFM)	Oxides of Nitrogen (ppm)[1]	(lb/hr)	Carbon Monoxide (ppm)[1]	$PM_{2.5}$ Emissions (lb/hr)
26-Aug	7:01-9:03	84%	320	7.1	4,436	121,964	82,543	76,720	4.7	2.30	1.0	0.28
26-Aug	9:27-11:30	84%	320	7.1	4,450	122,360	82,801	76,947	4.7	2.31	1.0	0.43
26-Aug	11:46-13:49	84%	319	7.5	4,350	119,602	81,103	75,030	4.6	2.28	0.9	0.19
								Ave:	**4.7**	**2.30**	**1.0**	***0.30***
								Permit Limit:	**12**	**8.84**	***15***	***1.06***

[1] parts per million$_{(dry)}$ @ corrected to 15% O_2

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TABLE NO. 2
EMISSIONS TEST RESULTS
DTE Dearborn CEP, LLC
EUCTGHRSG1 (Duct Burners On)
August 27, 2020

Date	Test Time	Unit Load (%)	Stack Temperature (°F)	Stack Moisture (%)	Stack Velocity (ft/min)	Exhaust Gas Flowrates (ACFM)	(SCFM)	(DSCFM)	Oxides of Nitrogen (ppm)[1]	(lb/hr)	(lb/MMBtu)	Carbon Monoxide (lb/MMBtu)	$PM_{2.5}$ Emissions (lb/hr)
27-Aug	6:50-8:51	88%	288	12.9	4,310	118,508	83,246	72,548	12.2	12.20	0.04	0.01	0.30
27-Aug	9:13-11:15	88%	287	13.1	4,328	118,987	83,642	72,685	12.4	12.40	0.05	0.01	0.42
27-Aug	11:44-13:46	87%	286	13.1	4,204	115,590	81,367	70,732	13.3	13.30	0.05	0.01	0.30
								Ave:	**12.6**	**12.63**	**0.05**	**0.01**	***0.34***
								Permit Limit:	**25**	**19.04**	***0.12***	***0.13***	***2.0***

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TABLE NO. 3
EMISSIONS TEST RESULTS
DTE Dearborn CEP, LLC
EUCTGHRSG2 (Duct Burners Off)
August 24, 2020

Date	Test Time	Unit Load (%)	Stack Temperature (°F)	Stack Moisture (%)	Stack Velocity (ft/min)	Exhaust Gas Flowrates (ACFM)	(SCFM)	(DSCFM)	Oxides of Nitrogen (ppm)[1]	(lb/hr)	Carbon Monoxide (ppm)[1]	$PM_{2.5}$ Emissions (lb/hr)
24-Aug	7:23-9:24	88%	317	7.5	4,396	120,860	82,235	76,097	6.6	3.40	1.3	0.63
24-Aug	9:47-11:49	86%	315	8.0	4,299	118,195	80,569	74,100	7.0	3.57	1.3	0.64
24-Aug	12:13-14:15	85%	314	7.9	4,171	114,686	78,299	72,109	7.1	3.56	1.2	0.67
								Ave:	**6.9**	**3.51**	**1.3**	***0.65***
								Permit Limit:	**12**	**8.84**	***15***	***1.06***

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TABLE NO. 4
EMISSIONS TEST RESULTS
DTE Dearborn CEP, LLC
EUCTGHRSG2 (Duct Burners On)
August 25, 2020

Date	Test Time	Unit Load (%)	Stack Temperature (°F)	Stack Moisture (%)	Stack Velocity (ft/min)	Exhaust Gas Flowrates (ACFM)	(SCFM)	(DSCFM)	Oxides of Nitrogen (ppm)[1]	(lb/hr)	(lb/MMBtu)	Carbon Monoxide (lb/MMBtu)	$PM_{2.5}$ Emissions (lb/hr)
25-Aug	7:29-9:31	89%	290	12.6	4,373	120,245	84,573	73,919	11.7	10.92	0.04	0.02	0.66
25-Aug	9:55-11:58	90%	288	13.2	4,346	119,482	84,238	73,128	11.7	11.07	0.04	0.01	0.34
25-Aug	12:19-14:21	88%	288	12.5	4,283	117,759	83,024	72,676	13.3	12.35	0.05	0.01	0.27
								Ave:	**12.2**	**11.45**	**0.04**	**0.01**	***0.42***
								Permit Limit:	**25**	**19.04**	***0.12***	***0.13***	***2.0***

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FIGURES

Figure 1 – Sample Location
DTE Dearborn CEP – EUCTGHRSG1-2
August 24-27, 2020

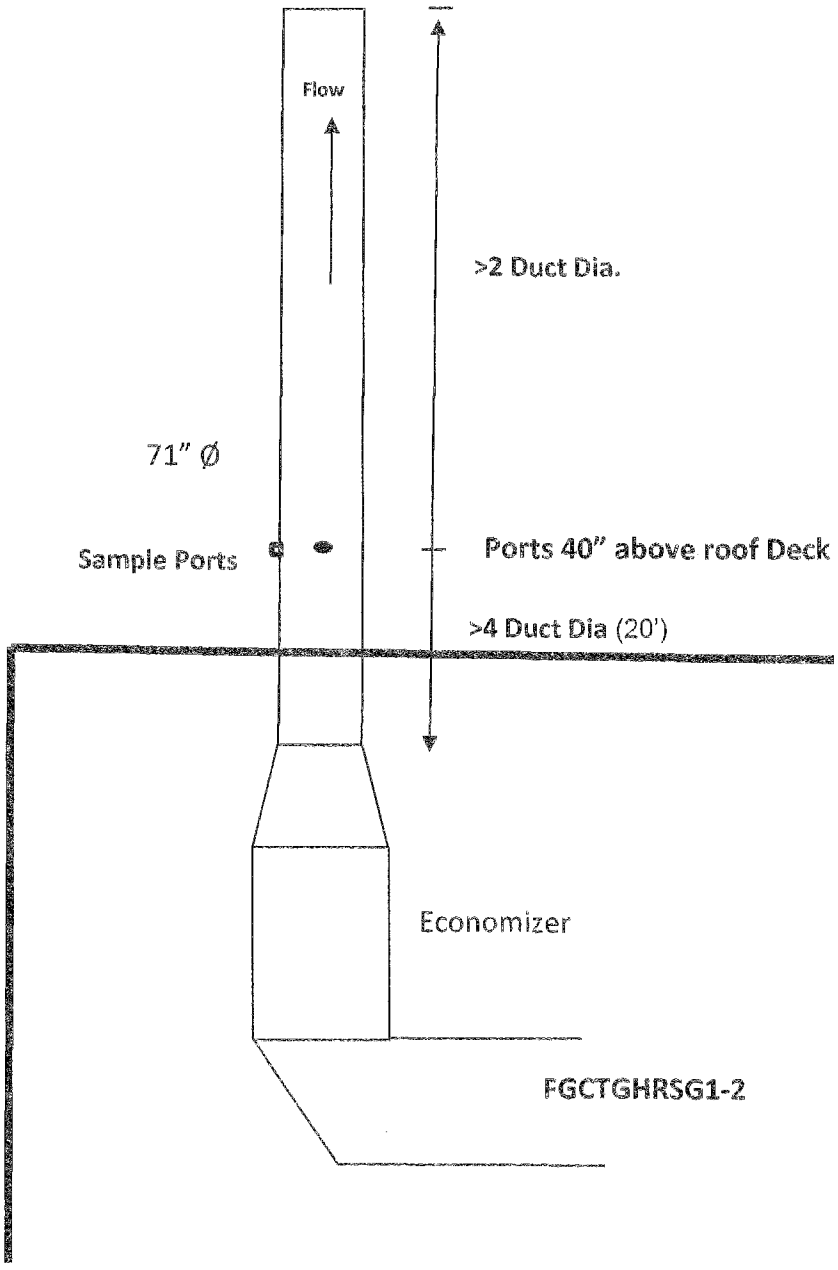

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Figure 2 – EPA Methods 3A, 7E, 10
DTE Dearborn CEP – EUCTGHRSG1-2
August 24-27, 2020

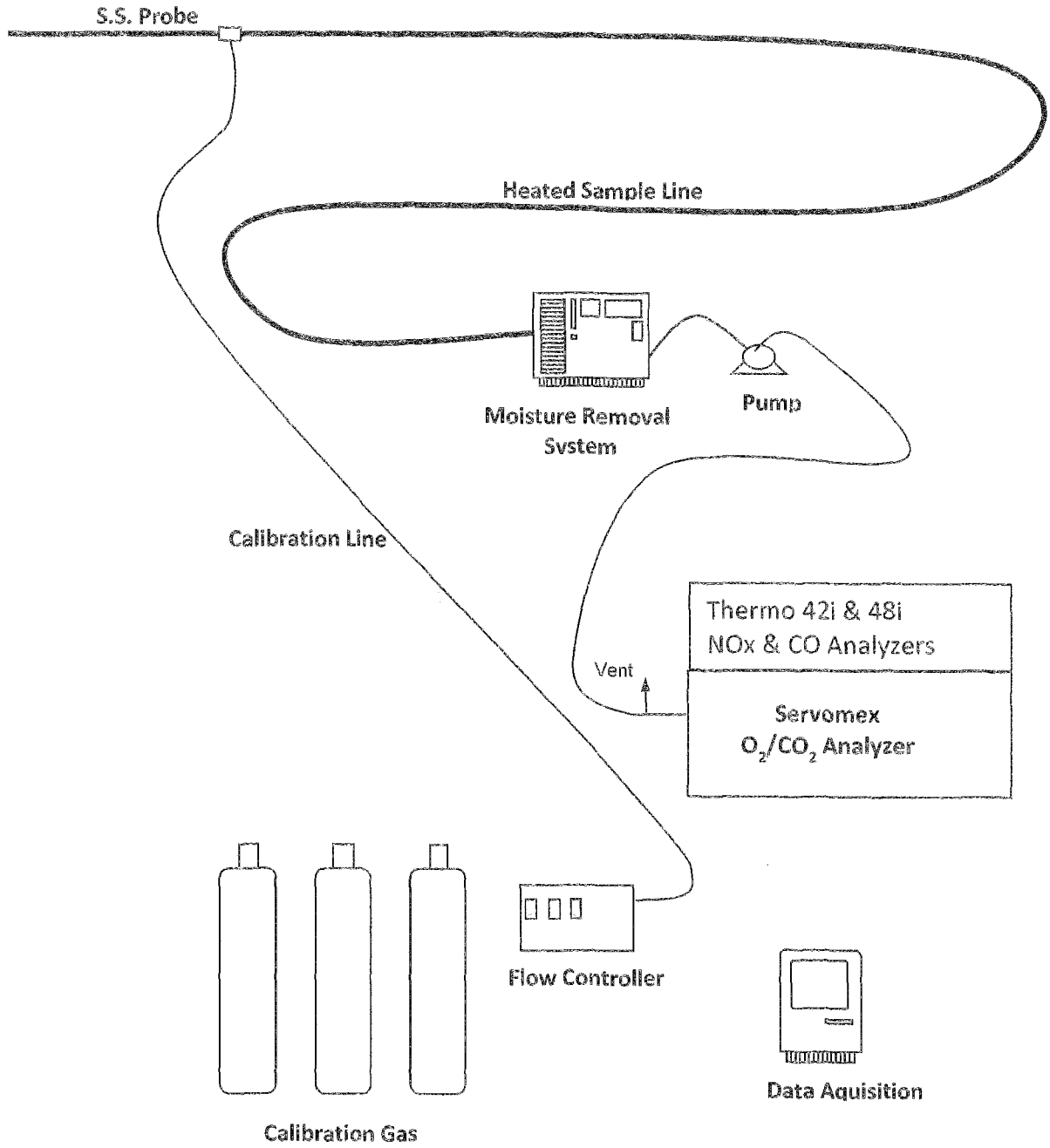

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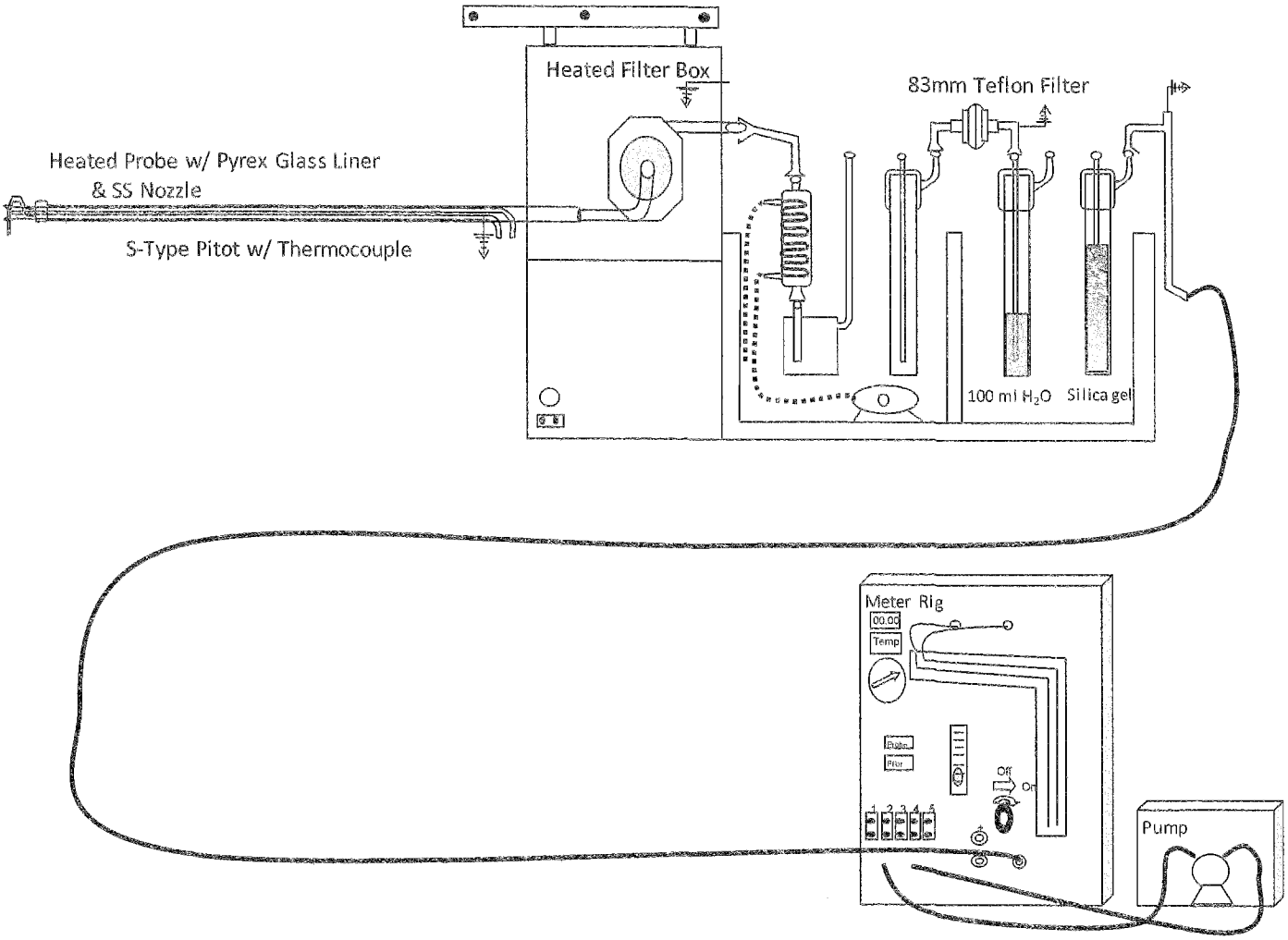
Figure 3 – Methoid 5/202
DTE Dearborn CEP – EUCTGHRSG1-2
August 24-27, 2020



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