BOARD OF LIGHT AND POWER

CITY OF MARQUETTE
2200 WRIGHT STREET
MARQUETTE, MI 49855-1398

THOMAS R. CARPENTER
EXECUTIVE DIRECTOR

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May 16, 2019

Michigan Department of Environment, Great Lakes, and Energy
Attn: Ms. Karen Kajiya-Mills
Air Quality Division
525 West Allegan St., 2nd Floor South
Lansing, MI 48933

Re: Emission Testing of One Dual Fuel-fired Wartsila 18V50DF Engine,
EU-ENGINE01, Marquette Board of Light & Power Marquette Energy Center (MEC)
Permit: 204-15, SRN: P0668

Dear Ms. Karen Kajiya-Mills:

The report detailing stack testing at the Marquette Energy Center (MEC), which was conducted March 19, 2019, is attached. Testing was performed on EU-ENGINE01 while firing natural gas and demonstrates compliance with the conditions in both Permit to Install (PTI) 204-15 (which was in effect during the test) and PTI 204-15A (which was issued shortly after testing). A summary of the results are as follows:

Pollutant[1]	Emission Rate	Emission Limit
NO_X	1.3 ppmvd @ 15% O_2	82 ppmvd @ 15% O_2
	0.7 lb/hr	3.33 lb/hr
	0.14 g/HP-hr	1.0 g/HP-hr
CO	0.7 ppmvd @ 15% O_2	270 ppm @ 15% O_2
	0.2 lb/hr	5.0 lb/hr
	0.005 g/hp-hr	2.0 g/hp-hr
VOCs (as C_3H_8)	3.3 ppmvd @ 15% O_2	60 ppmvd @ 15% O_2
	1.7 lb/hr	16.5 lb/hr (PTI 204-15A only)
	0.034 g/HP-hr	0.7 g/HP-hr
Formaldehyde	0.21 lb/hr	0.648 lb/hr (PTI 204-15A only)

* The PTI and NSPS allow compliance with either the ppm or g/HP-hr limits.

Unfortunately, testing while firing on ultra-low sulfur diesel fuel (LFO), was not completed as proposed in the stack test protocol. As Mr. Tom Gasloli may recall, the first test run was completed (and is included in the report); however, shortly after completing the test run, the reagent (urea) demand to keep post reactor NOx emissions below the upper limit could not be met while firing on LFO mode at 100% load. Operators attempted to return urea flow to normal conditions; however, were unable to correct the condition and therefore testing on LFO was discontinued.

The MEC staff did some troubleshooting and immediately noted that urea flow at the current test condition was approximately 99.84 gallons per hour (gph). During full load while firing on LFO, urea injection of approximately 117-121 gph is required. The MEC staff adjusted valves associated with urea flow to ensure they were operational and also stopped urea flow to ensure that the flow indicator was working. It appeared that valves were working properly when adjusted by hand, though the MEC staff was unable to understand why the system would not inject urea at the required rate.

The next day, Electrical and Instrumentation Technicians continued troubleshooting to determine the lack of urea flow on the LFO side of the dosing system. Efforts were concentrated to the LFO side of the reagent injection due to the fact that the Natural Gas (NG) side of the dosing system had performed flawlessly during the prior days testing. Based on past experiences, the urea injection lance/nozzle was removed to inspect for hardened build-up which would potentially restrict flow. The lance/nozzle was found to have no evidence of build-up or blockage. The inline filter for the dosing system was then inspected and was found to be slightly plugged. The inline filter was cleaned and then reinstalled. EU-ENGINE01 was then started and ran up to full load while firing on NG. Combustion was switched over to LFO and at the time of troubleshooting, urea flow increased slightly from 99.84 to 106 gph. Urea flow valve was 100% open and post reactor NOx measurements could not be controlled at full load. EU-ENGINE01 was then switched back to NG mode.

The MEC staff inspected the reagent/urea supply pumps to determine if adequate flow was being provided. EU-ENGINE03 was brought online at full load to determine if urea agent flow demand and supply could be maintained for controlling post reactor NOx. The system was found to adequately supply the required flow to control post reactor NOx on EU-ENGINE03 so further investigating continued.

The MEC staff continued to troubleshoot and replaced a proportional valve with a new spare. At this time EU-ENGINE01 was started and brought up to full load. Combustion was switched over to LFO to determine if urea flow injection had increased. Flow could not be maintained at the required amount to control post reactor NOx so EU-ENGIN01 was shut back down.

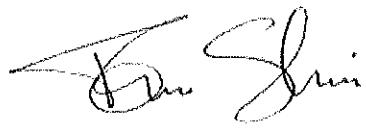
All piping and components were checked with no definite answer to why the full load reagent flow (117-121 gph) could not be obtained on EU-ENGINE01 while firing on LFO. The MEC, after exhausting all efforts to troubleshoot, submitted a warranty claim to Wartsila to help resolve the issue of inadequate reagent flow while operating in LFO mode at full load.

Working with Wartsila, several items within the system were checked, eventually a Wartsila Automation Engineer with access to the rights to programming was sent onsite to increase settings associated with urea/reagent pump and SCR PLC software. While onsite, the Automation Engineer determined that the urea valve electronic controller setting was low and was eventually adjusted up. After the adjustment EU-ENGINE01 was tested again at full load while firing on LFO. Urea injection was determined to be able to reach 117-119 gph, the required amount of flow to maintain emissions below the upper limit for post reactor NOx. This adjustment corrected the urea flow issue we encountered during emission testing and testing will

be rescheduled for later this year when the remainder of testing will be performed on the other two units (EU-ENGINE02 & EU-ENGINE03).

Using alternate test methods, the MEC was able to complete additional VOC testing when firing on natural gas; those results will be transmitted under separate cover. If you have any questions, please contact me at 906.225.8670.

Sincerely,



Thomas J. Skewis
Environmental Technician

cc: *J. Hendrickson/MBLP*
J. Schultz/MBLP
L. Woolley/FTCH
T. Gasloli/EGLE
E. Lancaster/EGLE
S. Bruestle/EGLE

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[i] CO	carbon monoxide
C_3H_8	propane
g/HP-hr	grams per horsepower-hour
lb/hr	pound(s) per hour
NO_X	oxides of nitrogen
NSPS	New Source Performance Standards
O2	oxygen
ppm	parts per million
ppmvd	parts per million by volume, dry
VOC	volatile organic compound

DEQ

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
AIR QUALITY DIVISION

RECEIVED
MAY 17 2019
AIR QUALITY DIV.

RENEWABLE OPERATING PERMIT REPORT CERTIFICATION

Authorized by 1994 P.A. 451, as amended. Failure to provide this information may result in civil and/or criminal penalties.

Reports submitted pursuant to R 336.1213 (Rule 213), subrules (3)(c) and/or (4)(c), of Michigan's Renewable Operating (RO) Permit program must be certified by a responsible official. Additional information regarding the reports and documentation listed below must be kept on file for at least 5 years, as described in General Condition No. 22 in the RO Permit and be made available to the Department of Environmental Quality, Air Quality Division upon request.

Source Name: Marquette Board of Light and Power — County: Marquette

Source Address: 2200 Wright Street — City: Marquette

AQD Source ID (SRN): P0668 — RO Permit No.: PTI-204-15A — RO Permit Section No.: NA

Please check the appropriate box(es):

☐ **Annual Compliance Certification (General Condition No. 28 and No. 29 of the RO Permit)**

Reporting period (provide inclusive dates): From _____ To _____

☐ 1. During the entire reporting period, this source was in compliance with **ALL** terms and conditions contained in the RO Permit, each term and condition of which is identified and included by this reference. The method(s) used to determine compliance is/are the method(s) specified in the RO Permit.

☐ 2. During the entire reporting period this source was in compliance with all terms and conditions contained in the RO Permit, each term and condition of which is identified and included by this reference, **EXCEPT** for the deviations identified on the enclosed deviation report(s). The method used to determine compliance for each term and condition is the method specified in the RO Permit, unless otherwise indicated and described on the enclosed deviation report(s).

☐ **Semi-Annual (or More Frequent) Report Certification (General Condition No. 23 of the RO Permit)**

Reporting period (provide inclusive dates): From _____ To _____

☐ 1. During the entire reporting period, **ALL** monitoring and associated recordkeeping requirements in the RO Permit were met and no deviations from these requirements or any other terms or conditions occurred.

☐ 2. During the entire reporting period, all monitoring and associated recordkeeping requirements in the RO Permit were met and no deviations from these requirements or any other terms or conditions occurred, **EXCEPT** for the deviations identified on the enclosed deviation report(s).

☒ **Other Report Certification**

Reporting period (provide inclusive dates): From _____ To _____

Additional monitoring reports or other applicable documents required by the RO Permit are attached as described:

Emission Testing of One Dual Fuel-Fired Wartsila 18V50DF Engine (EU-ENGINE01)

I certify that, based on information and belief formed after reasonable inquiry, the statements and information in this report and the supporting enclosures are true, accurate and complete, and that any observed, documented or known instances of noncompliance have been reported as deviations, including situations where a different or no monitoring method is specified by the RO Permit.

Thomas R. Carpenter	Executive Director	906.228.0327
Name of Responsible Official (print or type)	Title	Phone Number

Thomas R. Carpenter — 5-15-19

Signature of Responsible Official — Date

* Photocopy this form as needed.

EQP 5736 (8/99)

mostardi platt

Compliance Emissions Test Report

Performed for: Marquette Board of Light and Power
At The: Marquette Energy Center
EU-ENGINE01 Outlet Duct
Marquette, Michigan
March 19, 2019

Report Submittal Date
May 15, 2019

Project No. M191206

Corporate Headquarters
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Elmhurst, Illinois 60126
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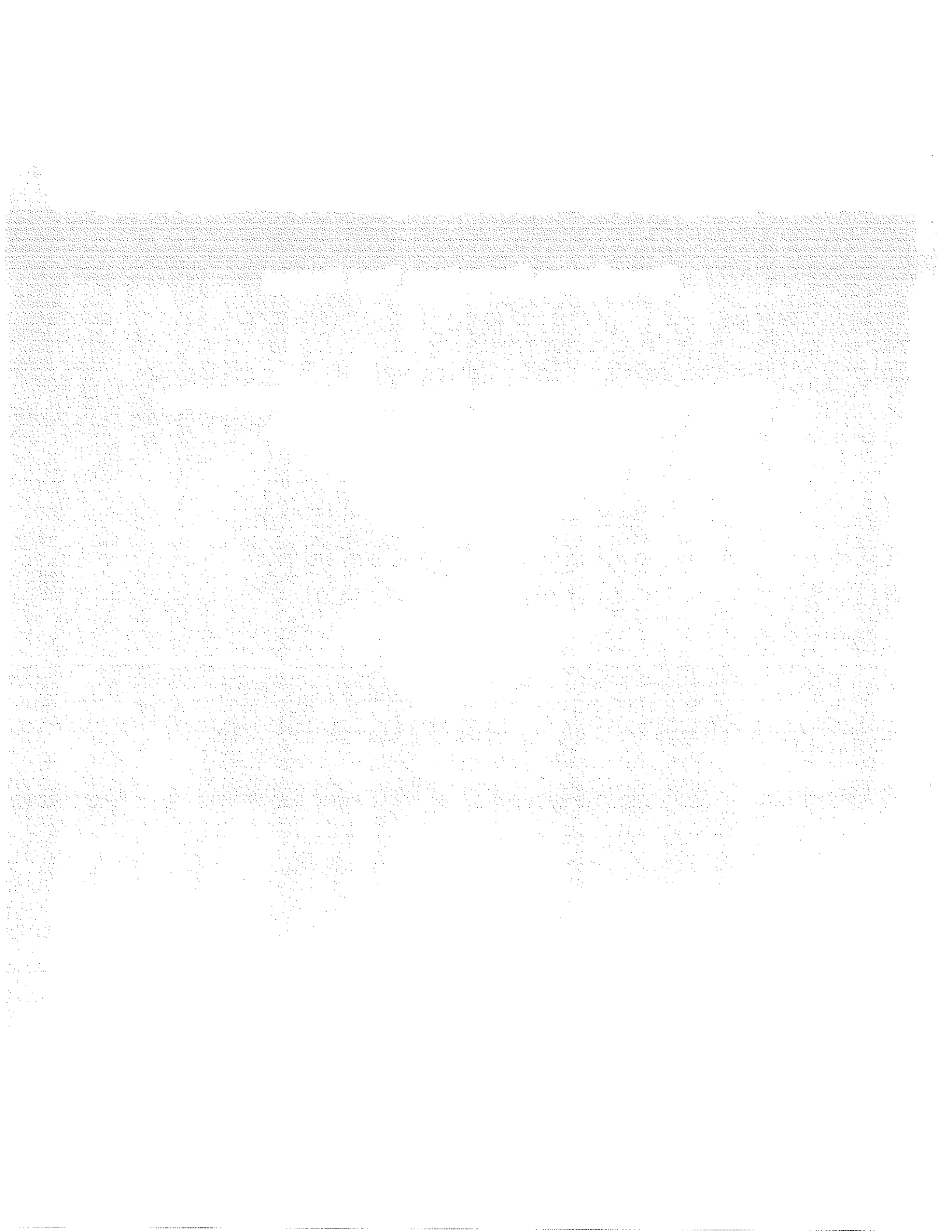

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1.0 EXECUTIVE SUMMARY

MOSTARDI PLATT conducted a compliance emissions test program for Marquette Board of Light and Power (MBLP) on March 19, 2019 at the Marquette Energy Center (MEC) on the Reciprocating Internal Combustion Engine 1 (EU-ENGINE01) Outlet Duct in Marquette, Michigan. The purpose of the test program was to meet the compliance demonstration requirements for emission rate in accordance with Permit to Install 204-15, 40 CFR Part 60 Subpart JJJJ, and 40 CFR Part 60 Subpart IIII. This report summarizes the results of the test program and test methods used. Note that Method 18 and Method 320 volatile organic compound (VOC) data was collected for informational purposes, those results are presented in Appendix J. Fuel oil sampling was only completed for one run before the unit encountered SCR problems and fuel oil testing was suspended. Retesting for fuel oil will be scheduled at a later date.

The test location, test date, and test parameters are summarized below.

Test Location	Test Date	Test Parameters
EU-ENGINE01 Outlet Duct	March 19, 2019	Nitrogen Oxides (NO_x), Carbon Monoxide (CO), Carbon Dioxide (CO_2), Oxygen (O_2), VOC, Filterable Particulate Matter (FPM), Volumetric Flow, and Moisture

MBLP has installed a dual-fuel Wärtsilä 18V50DFm four stroke, lean burn 17 MW (nominal) engine (173 mmBtu/hr when firing natural gas as primary fuel, 154 mmBtu/hr when firing emergency backup fuel oil), compression ignition reciprocating internal combustion engine used for electrical generation. The RICE electric generating unit utilizes pipeline quality natural gas and is equipped with selective catalytic reduction (SCR) for nitrogen oxides (NOx) control and an oxidation catalyst system for carbon monoxide (CO), volatile organic compound (VOC), and organic hazardous air pollutant (HAP) control. The RICE electric generating unit exhausts into an individual stack.

Selected results of the test program are summarized below. A complete summary of emission test results follows the narrative portion of this report.

Source	Fuel	Parameter	Emission Limit	Test Results
EU-ENGINE01 Outlet Duct 3/19/19	Natural Gas	Nitrogen Oxides (NO_x)	3.3 lb/hr	0.7 lb/hr
			1.0 grams/HP-hr	0.014 grams/HP-hr
			82 ppmvd@15% O_2	1.3 ppmvd@15% O_2
		Carbon Monoxide (CO)	5.0 lb/hr	0.2 lb/hr
			2.0 grams/HP-hr	0.005 grams/HP-hr
			270 ppmvd@15% O_2	0.7 ppmvd@15% O_2
		Volatile Organic Compounds (VOC)	16.5 lb/hr	1.7 lb/hr
			0.7 grams/HP-hr	0.034 grams/HP-hr
			60 ppmvd@15% O_2	3.3 ppmvd@15% O_2
		Formaldehyde	0.648 lb/hr	0.21 lb/hr
	Light Fuel Oil	NO_x	21.0 lb/hr	5.8 lb/hr*
			2.58 g/HP-hr	0.116 g/HP-hr*
		CO	N/A	0.2 lb/hr*
		VOC	N/A	0.0 lb/hr*
		Filterable Particulate Matter (FPM)	0.15 g/kW-hr	0.021 g/kW-hr*

* Testing on the light fuel oil was suspended because of an SCR system malfunction in which MEC was not able to operate the engine at rated capacity for the duration of the test. As a result, only one test run was completed with the understanding that testing will be rescheduled for a later date.

The identifications of the individuals associated with the test program are summarized below.

TEST PERSONNEL INFORMATION		
Location	**Address**	**Contact**
Test Coordinator	Marquette Board of Light and Power Marquette Energy Center 2200 Wright Street Marquette, MI 48955	Mr. Thomas J. Skewis Environmental Technician (906) 225-8670 (office) tskewis@mblp.org
Test Facility		
Testing Company Representative	Mostardi Platt 888 Industrial Drive Elmhurst, Illinois 60126	Mr. John Nestor Project Manager (630) 993-2100 (phone) rsollars@mp-mail.com

The test crew consisted of Messrs. J. Howe, P. Lyons, and J. Nestor. Mr. Tom Gasloli with the Michigan Department of Environmental Quality observed the test program.

2.0 TEST METHODOLOGY

Emission testing was conducted following the methods specified in Code of Federal Regulations, Title 40, Part 60, Appendix A (40CFR60), 40CFR51, and 40CFR63. Schematics of the test section diagrams and sampling trains used are included in Appendix A and B, respectively. Calculation examples and nomenclature are included in Appendix C. Copies of analyzer print-outs and field data sheets for each test run are included in Appendices D and E, respectively.

The following methodologies were used during the test program:

Method 1 Traverse Point Determination

Test measurement points were selected in accordance with Method 1. The characteristics of the measurement location are summarized below.

TEST POINT INFORMATION						
Location	Diameter (Feet)	Area (Square Feet)	Upstream Distance (Inches)	Downstream Distance (Inches)	Test Parameter	Number of Sampling Points
EU-ENGINE01 Outlet Duct	5.25	21.65	>0.5	>2.0	Volumetric Flow	16
					NO_x/CO/VOC/O_2/CO_2	12 (strat), 3

A null point pitot traverse check was performed utilizing a Type S pitot tube to verify the absence of cyclonic flow per USEPA Method 1, Section 11.4. The null point at the test location averaged 15.1 degrees which meets the requirements. The results of this traverse can be found in Appendix D.

Method 2 Volumetric Flowrate Determination

Gas velocity was measured following Method 2, for purposes of calculating stack gas volumetric flow rate. An S-type pitot tube, differential pressure gauge, Thermal couple and temperature readout were used to determine gas velocity at each sample point. All of the equipment used was calibrated in accordance with the specifications of the Method. Calibration data are presented in Appendix F.

Method 3A Oxygen (O_2)/Carbon Dioxide (CO_2) Determination

Flue gas O_2 was determined in accordance with Method 3A. An ECOM analyzer was used to determine stack gas oxygen content connected to the outlet of the FTIR analyzer.

Flue gas carbon dioxide concentrations and emission rates were determined in accordance with Method 3A. An MKS MultiGas 2030 FTIR spectrometer was used to determine the CO_2 concentrations, in the manner specified in the Method. Nitrogen Content was determined from the difference of CO_2 and O_2.

Stack gas was delivered to the analyzer via a Teflon® sampling line, heated to a minimum temperature of 375°F. The entire system was calibrated in accordance with the Method, using certified calibration gases introduced at the probe, before and after each test run.

All of the equipment used was calibrated in accordance with the specifications of the Method and calibration data are included in Appendix F. Copies of the gas cylinder certifications are included in Appendix H.

Method 7E Nitrogen Oxide (NO_X) Determination

Flue gas NO_x concentrations and emission rates were determined in accordance with Method 7E. An MKS MultiGas 2030 FTIR spectrometer was used to determine nitrogen oxide concentrations, in the manner specified in the Method.

Stack gas was delivered to the analyzer via a Teflon® sampling line, heated to a minimum temperature of 375°F. The entire system was calibrated in accordance with the Method, using certified calibration gases introduced at the probe, before and after each test run.

A list of calibration gases used and the results of all calibration and other required quality assurance checks can be found in Appendix F. Copies of calibration gas certifications can be found in Appendix H.

Method 10 Carbon Monoxide (CO) Determination

Flue gas CO concentrations and emission rates were determined in accordance with Method 10. An MKS MultiGas 2030 FTIR spectrometer was used to determine carbon monoxide concentrations, in the manner specified in the Method.

Stack gas was delivered to the analyzer via a Teflon® sampling line, heated to a minimum temperature of 375°F. The entire system was calibrated in accordance with the Method, using certified calibration gases introduced at the probe, before and after each test run.

A list of calibration gases used and the results of all calibration and other required quality assurance checks can be found in Appendix F. Copies of calibration gas certifications can be found in Appendix H.

Method 25A Volatile Organic Compound (VOC) Determination

Total hydrocarbon (THC) concentrations and emission rates were determined in accordance with Method 25A. Stack gas was delivered to the system via a Teflon® sampling line, heated to a minimum temperature of 375°F.

Methane and ethane concentrations were determined in accordance with Method 320 and then subtracted from the THC concentrations in order to comply with non-methane, non-ethane hydrocarbon criteria as specified in the permit. The methane concentration was also corrected for a response factor for the analyzer.

The system was calibrated before and after each test run using certified calibration gases of propane for the THC determination. Calibration data are presented in Appendix F, field sheets are presented in Appendix D, and copies of gas certifications are presented in Appendix H.

Method 320 Fourier Transform Infrared (FTIR) Detector for Methane, Ethane, Formaldehyde, and Moisture Determination

Flue gas methane, ethane, formaldehyde, and moisture concentrations and emission rates were determined in accordance with Method 320. FTIR data was collected using an MKS MultiGas 2030 FTIR spectrometer. The FTIR was equipped with a temperature-controlled, 5.11 meter multi-pass gas cell maintained at 191°C. Gas flows and sampling system pressures were monitored using a rotameter and pressure transducer.

All data was collected at 0.5 cm^{-1} resolution. Each spectrum was derived from the coaddition of 62 scans, with a new data point generated approximately every one minute. Analyzer data for each run is present is Appendix D.

SAMPLING SYSTEM PARAMETERS				
MKS Serial #	**Sampling Line**	**Probe Assembly**	**Particulate Filter Media**	**Operating Temperatures**
019088128	100' 3/8" dia., heated Teflon	Heated 3', 3/8" dia. SS	0.01µ heated borosilicate glass fiber	191°C

QA/QC procedures followed US EPA Method 320. See below for QA/QC procedure details and list of calibration gas standards. All calibration gases were introduced to the analyzer and the sampling system using an instrument grade stainless steel rotameter. All QA/QC procedures were within the acceptance criteria allowance of the applicable EPA methodology. See Appendix G for FTIR QA/QC Data.

FTIR QA/QC PROCEDURES						
QA/QC Specification	**Purpose**	**Calibration Gas Analyte**	**Delivery**	**Frequency**	**Acceptance Criteria**	**Result**
M320: Zero	Verify that the FTIR is free of contaminants & zero the FTIR	Nitrogen (zero)	Direct to FTIR	pre/post test	< MDL or Noise	**Pass**
M320:Calibration Transfer Standard (CTS) Direct	Verify FTIR stability, confirm optical path length	Ethylene	Direct to FTIR	pretest	+/- 5% cert. value	**Pass**
M320: Analyte Direct	Verify FTIR calibration	Acetaldehyde, Methanol, SF6	Direct to FTIR	pretest	+/- 5% cert. value	**Pass**
M320: CTS Response	Verify system stability, recovery, response time	Ethylene	Sampling System	Daily, pre/post test	+/- 5% of Direct Measurement	**Pass**
M320: Zero Response	Verify system is free of system bias	Nitrogen (zero)	Sampling System	pretest	Bias correct data	**Pass**
M320: Analyte Spike	Verify system ability to deliver and quantify analyte of interest in the presence of effluent gases	Acetaldehyde, Methanol, SF6	Dynamic Addition to Sampling System, 1:10 effluent	Throughout testing – daily	+/- 30% theoretical recovery	**Pass**

Note: The determined concentrations from direct analyses were used in all system/spike recovery calculations.

CALIBRATION GAS STANDARDS				
Components	**Concentration (ppm)**	**Vendor**	**Cylinder #**	**Standard Type**
Ethylene	101.0	Airgas	CC260594	Primary +/- 1%
Methane	906.6	Airgas	CC123928	+/- 1% NIST Traceable
Acetaldehyde/ Methanol/SF6	194.4/195.3/ 4.820	Airgas	CC475635	Certified Standard-Spec +/- 5%
Nitrogen	Zero Gas	Airgas	N/A	UHP Grade

Analyte Spiking

Acetaldehyde and methanol spiking was performed prior to testing to verify the ability of the sampling system to quantitatively deliver a sample containing Acetaldehyde and methanol from the base of the probe to the FTIR. Analyte spiking assures the ability of the FTIR sampling system to recover volatile organics in the presence of effluent gas.

As part of the spiking procedure, samples were measured to determine native acetaldehyde and methanol concentrations to be used in the spike recovery calculations. The analyte spiking gases contained a low concentration of sulfur hexafluoride (SF_6). The determined SF_6 concentration in the spiked sample was used to calculate the dilution factor of the spike and thus used to calculate the concentration of the spiked Acetaldehyde and methanol. The spike target dilution ratio was 1:10 or less.

The following equation illustrates the percent recovery calculation.

$$DF = \frac{SF6(spk)}{SF6(direct)} \qquad \text{(Sec. 9.2.3 (3) USEPA Method 320)}$$

$$CS = DF * Spike(dir) + Unspike(1 - DF) \qquad \text{(Sec. 9.2.3 (4) USEPA Method 320)}$$

DF = Dilution factor of the spike gas
$SF_{6(dir)}$ = SF_6 concentration measured directly in undiluted spike gas
$SF_{6(spk)}$ = Diluted SF_6 concentration measured in a spiked sample
$Spike_{dir}$ = Concentration of the analyte in the spike standard measure by the FTIR directly
CS = Expected concentration of the spiked samples
Unspike = Native concentration of analytes in unspiked samples

Post Collection Data Validation

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 ± 20% agreement. If there is a difference greater than ± 20% the spectra are reviewed for possible spectra interferences or any other possible causes leading to incorrectly quantified data.

Detection Limit

The detection limit of each analyte was calculated following Annex A2 of ASTM D6348-12 procedure using spectra that contained similar amounts of moisture and carbon dioxide.

Analyte	Detection Limit (ppmv wet)	Detection Limit (%v)
Methane	**1.0**	-
Ethane	**0.5**	-
Moisture	-	**0.1**

QA/QC data are found in Appendix G. Copies of gas cylinder certifications are found in Appendix H. All concentration data were recorded on a wet, volume basis. The sample and data collection followed the procedures outlined in Method 320.

Method 5 Filterable Particulate Matter Determination

Flue gas filterable particulate matter concentrations and emission rates are determined in accordance with Method 5. The probe and filter housing are maintained at a temperature of 248°F +/- 25°F. An Environmental Supply Company, Inc. sampling train is used to sample stack gas at an isokinetic rate. Four impingers were utilized. The impingers were weighed prior to and after each test run in order to determine moisture content of the stack gas. The total sample time was 60 minutes, with twelve sample points being utilized. A minimum of 30 dry standard cubic feet was sampled for the run.

Particulate matter in the sample probe was recovered utilizing acetone; a minimum of six passes of the probe brush through the entire probe was performed, followed by a visual inspection of the acetone exiting the probe. The acetone solution exiting the probe was clear, therefor the wash was considered complete. The nozzle was then removed from the probe and cleaned in a similar manner, utilizing an appropriately sized nozzle brush. The filter housing was washed a minimum of three times with acetone and inspected for cleanliness, and the filter placed in its corresponding petri dish. The acetone wash and the filter were labeled and marked, then analyzed off site by Mostardi Platt personnel in accordance with the method.

All of the equipment used is calibrated in accordance with the specifications of the Method. Calibration data is presented in the Appendix of the final report.

3.0 TEST RESULT SUMMARY

Marquette Board of Power and Light
Marquette Energy Center
EUENGINE01
Gaseous Summary
Full Load - Natural Gas Firing

Test No.	Date	Start Time	End Time	NO_x ppmvd	CO ppmvd	CO_2 % (dry)	O_2 % (dry)	Formaldehyde, ppmvd	Moisture, %	Flowrate, DSCFM	Flowrate, SCFM	THC ppm as C_3H_8 (wet)	CH_4 ppm as CH_4 (wet)	CH_4 ppm as C_3H_8 (wet)*	C_2H_6 (wet)	C_2H_6 ppm as C_3H_8 (wet)	VOC ppm as C_3H_8 (wet)
1	03/19/19	09:45	10:44	3.0	1.5	5.3	11.3	0.9	9.4	46,439	51,257	394.8	1,038.2	359.9	43.8	29.2	5.7
2	03/19/19	11:28	12:27	1.8	1.0	5.3	11.4	1.0	9.4	46,949	51,820	395.2	1,036.7	359.4	44.9	29.9	6.9
3	03/19/19	13:25	14:24	1.6	1.0	5.3	11.4	1.0	9.4	47,582	52,519	390.7	1,037.6	359.7	43.8	29.2	1.8
Average				2.1	1.2	5.3	11.4	1.0	9.4	46,990	51,865	393.9	1,037.5	359.7	44.2	29.4	4.8

Emission Rate Summary

Test No.	Date	Start Time	End Time	Fd Factor, dscf/MMBtu	CO ppmvd @ 15% O_2	NO_x ppmvd @ 15% O_2	NMNE VOC ppmvd @ 15% O_2	Formaldehyde, lb/hr	NO_x lb/hr	CO lb/hr	NMNE VOC lb/hr	Horsepower	NO_x g/hp-hr	CO g/hp-hr	NMNE VOC g/hp-hr
1	03/19/19	09:45	10:44	8,710.0	0.9	1.8	3.9	0.19	1.0	0.3	2.0	22,742.8	0.020	0.006	0.040
2	03/19/19	11:28	12:27	8,710.0	0.6	1.1	4.7	0.22	0.6	0.2	2.4	22,792.9	0.012	0.004	0.049
3	03/19/19	13:25	14:24	8,710.0	0.6	1.0	1.2	0.22	0.6	0.2	0.7	22,761.3	0.011	0.004	0.013
Average				8,710.0	0.7	1.3	3.3	0.21	0.7	0.2	1.7	22,765.7	0.014	0.005	0.034

* Methane is corrected for a response factor of 1.04 for the California Analytical FID Analyzer

Marquette Board of Power and Light
Marquette Energy Center
EUENGINE01
Gaseous Summary
Full Load - Light Fuel Oil Firing

Test No.	Date	Start Time	End Time	NO_x ppmvd	CO ppmvd	CO_2 % (dry)	O_2 % (dry)	Moisture, %	Flowrate, DSCFM	Flowrate, SCFM	THC ppm as C_3H_8 (wet)	CH_4 ppm as CH_4 (wet)	CH_4 ppm as C_3H_8 (wet)*	C_2H_6 (wet)	C_2H_6 ppm as C_3H_8 (wet)	VOC ppm as C_3H_8 (wet)
1	03/19/19	15:20	16:19	14.6	0.8	6.0	12.5	9.4	55,860	60,490	1.0	2.1	0.7	0.3	0.2	0.1

Emission Rate Summary

Test No.	Date	Start Time	End Time	Fd Factor, dscf/MMBtu	CO ppmvd @ 15% O_2	NO_x ppmvd @ 15% O_2	NMNE VOC ppmvd @ 15% O_2	NO_x lb/hr	CO lb/hr	NMNE VOC lb/hr	Horsepower	NO_x g/hp-hr	CO g/hp-hr	NMNE VOC g/hp-hr
1	03/19/19	15:20	16:19	9,190.0	0.6	10.3	0.1	5.8	0.2	0.0	22,762.3	0.116	0.004	0.001

* Methane is corrected for a response factor of 1.04 for the California Analytical FID Analyzer

Client: Marquette Board of Light and Power
Facility: Marquette Energy Center
Test Location: EU-ENGINE01
Test Method: 5

Source Condition	**Light Fuel Oil**
Date	**3/19/19**
Start Time	**15:20**
End Time	**16:27**
	Run 1
Stack Conditions	
Average Gas Temperature, °F	700.2
Flue Gas Moisture, percent by volume	7.7%
Average Flue Pressure, in. Hg	29.53
Gas Sample Volume, dscf	58.703
Average Gas Velocity, ft/sec	102.137
Gas Volumetric Flow Rate, acfm	134,690
Gas Volumetric Flow Rate, dscfm	55,860
Gas Volumetric Flow Rate, scfm	60,490
Average %CO_2 by volume, dry basis	6.0
Average %O_2 by volume, dry basis	12.5
Isokinetic Variance	102.1
Kilowatts	16,986.0
Standard Fuel Factor Fd, dscf/mmBtu	9,190.0
Filterable Particulate Matter (Method 5)	
grams collected	0.00626
grains/acf	0.0007
grains/dscf	0.0016
lb/hr	0.788
g/kW-hr	0.021

4.0 CERTIFICATION

MOSTARDI PLATT is pleased to have been of service to Marquette Board of Light and Power. If you have any questions regarding this test report, please do not hesitate to contact us at 630-993-2100.

CERTIFICATION

As project manager, I hereby certify that this test report represents a true and accurate summary of emissions test results and the methodologies employed to obtain those results, and the test program was performed in accordance with the methods specified in this test report.

MOSTARDI PLATT

John Nestor

_____ Program Manager

John S. Nestor

Scott W. Banach

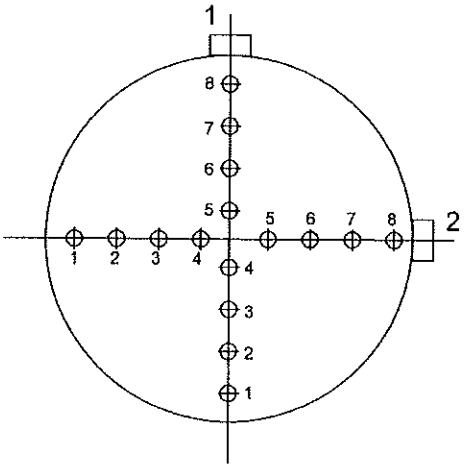
_____ Quality Assurance

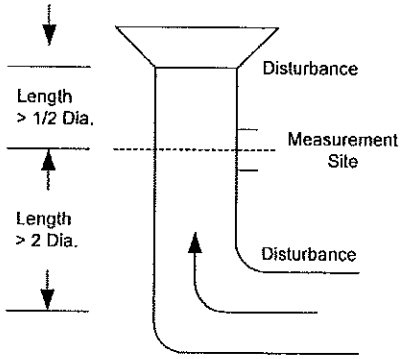
Scott W. Banach

APPENDICES

Appendix A - Test Section Diagrams

VOLUMETRIC FLOW TRAVERSE FOR ROUND DUCTS

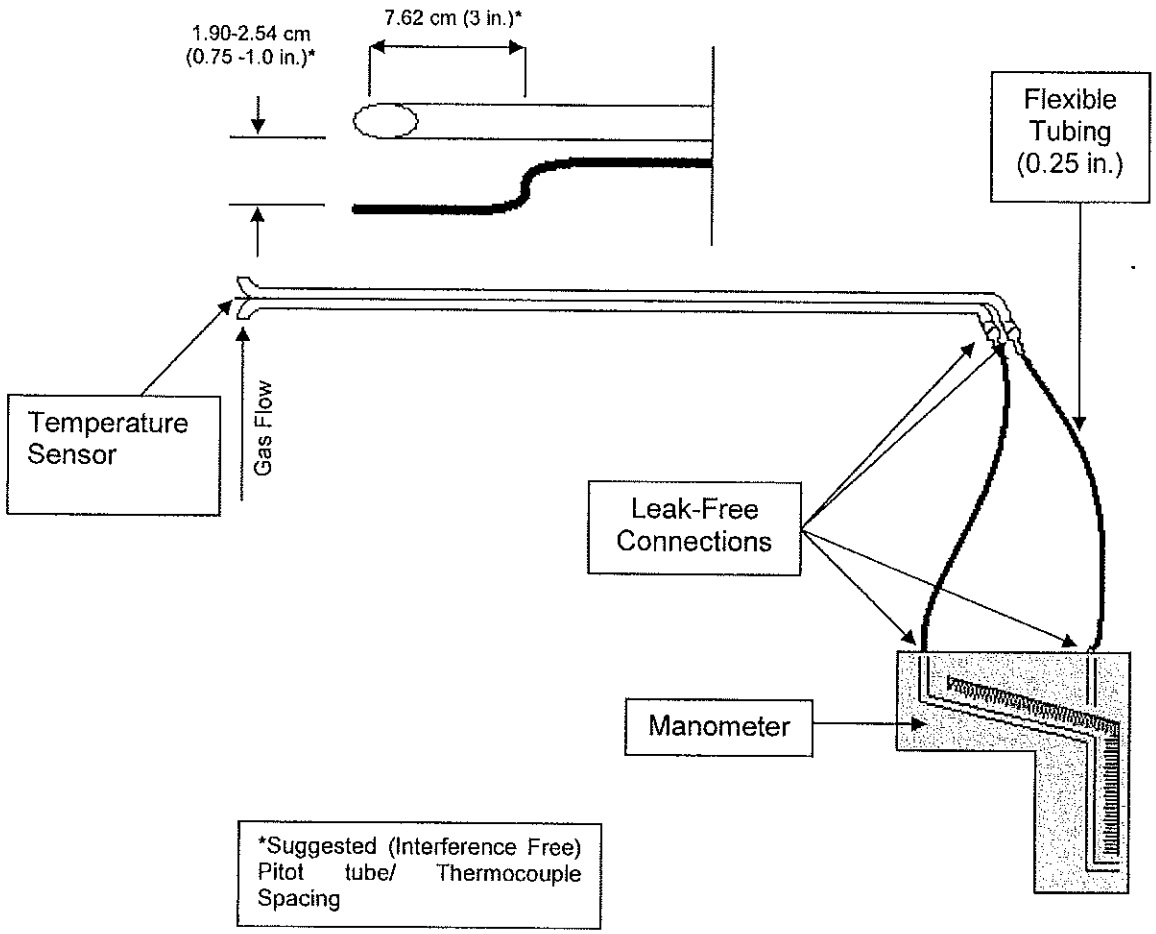




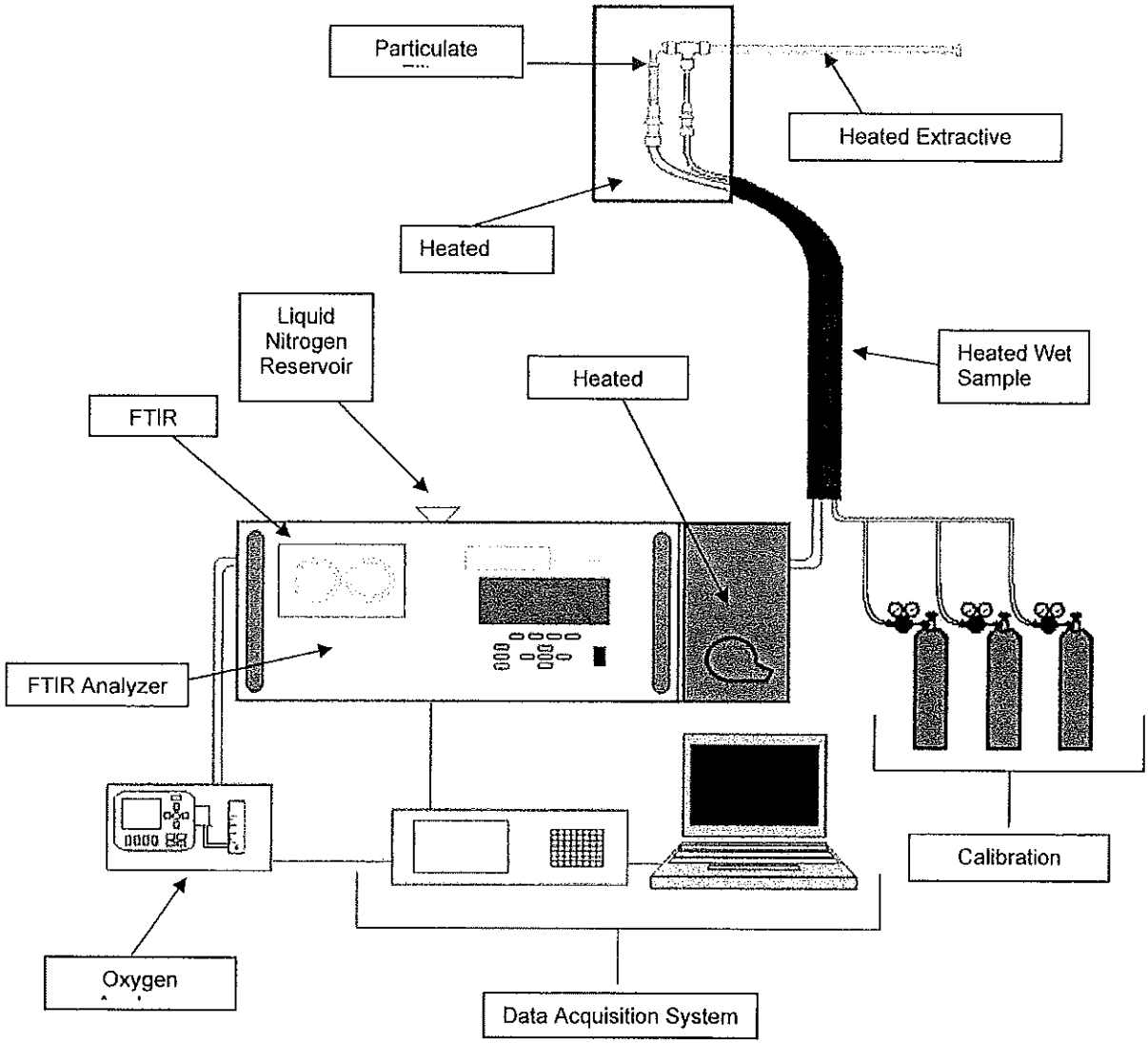
Job:	Marquette Board of Light and Power Marquette Energy Center Marquette, Michigan
Date:	3/19/19
Test Location:	EU-ENGINE01 Outlet Duct
Duct Diameter:	5.29 Feet
Duct Area:	21.979 Square Feet
No. Points Across Diameter:	6
No. of Ports:	2
Port Length:	8.0 Inches

Appendix B - Sample Train Diagrams

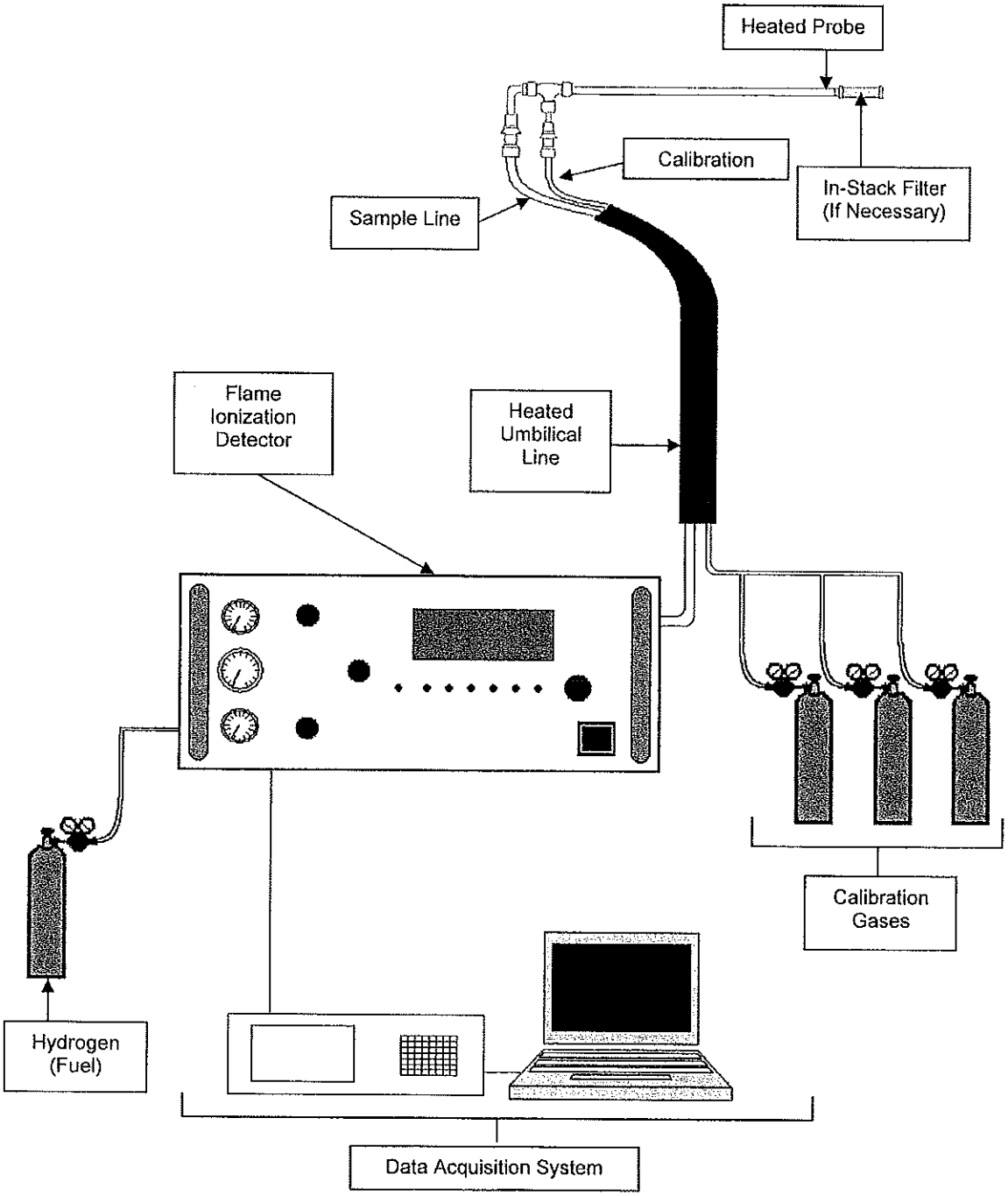
USEPA Method 2 – Type S Pitot Tube Manometer Assembly



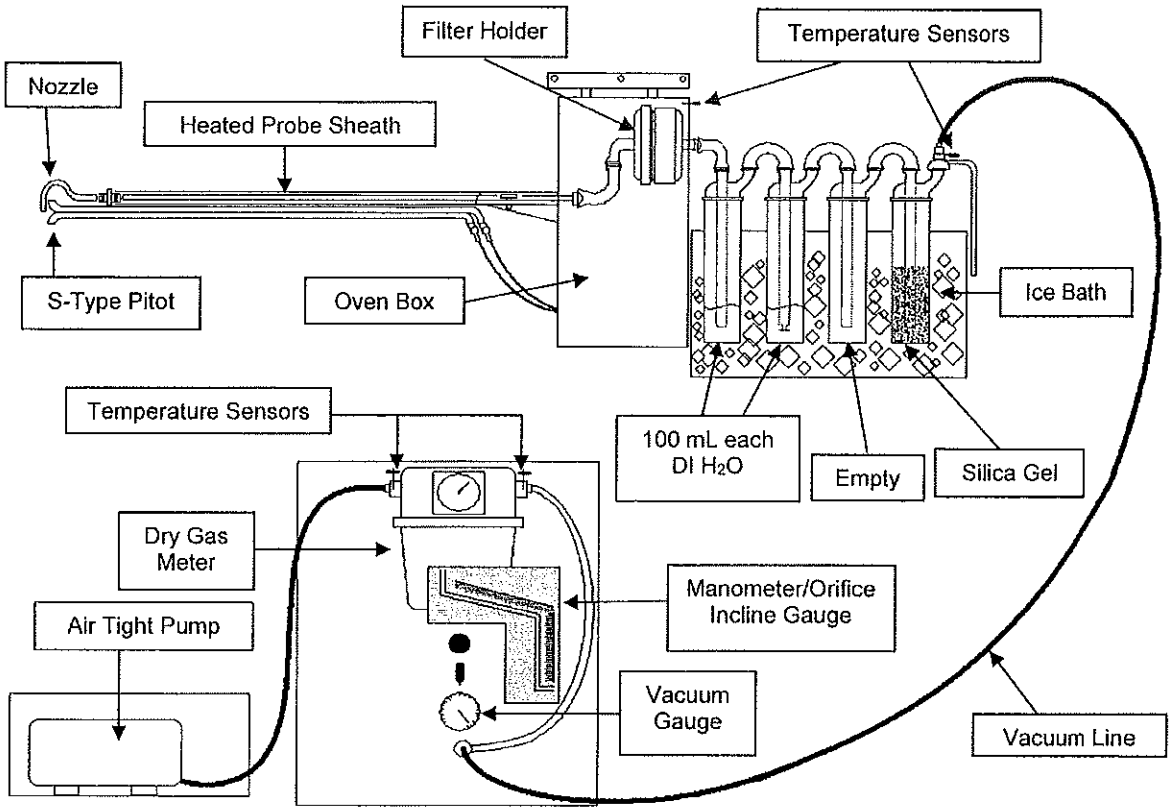
USEPA Methods 3A and 320 – Sample Train Diagram



USEPA Method 25A – Total Gaseous Organic Compound Sample Train



USEPA Method 5 - Particulate Matter Sample Train Diagram



Appendix C - Calculation Nomenclature and Formulas