



Semiannual RICE MACT Compliance Emissions Test Report

**Upper Michigan Resources Corporation
A.J. Mihm Generating Station
Permit No. 34-17
EURICE1, EURICE2, EURICE3 Outlet Ducts
Pelkie, Michigan
October 3, 2019**

**Report Submittal Date
November 12, 2019**

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Mostardi Platt

Project No. M193702

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1.0 EXECUTIVE SUMMARY

MOSTARDI PLATT conducted a formaldehyde emissions test program for Upper Michigan Energy Resources Corporation (UMERC) on October 3, 2019 at A. J. Mihm Generating Station on the Reciprocating Internal Combustion Engine (EURICE) 1, EURICE2, and EURICE3 Outlet Ducts in Pelkie, Michigan. The purpose of the test program was to meet compliance demonstration requirements for emission rates in accordance with Permit to Install 34-17 and the RICE MACT 40 CFR Part 63 Subpart ZZZZ. This report summarizes the results of the test program and test methods used.

The test locations, test dates, and test parameters are summarized below.

TEST INFORMATION		
Test Locations	Test Date	Test Parameters
EURICE1	October 3, 2019	Formaldehyde (CH ₂ O), Moisture (H ₂ O), and Oxygen (O ₂)
EURICE2		
EURICE3		

A.J. Mihm Generating Station electric generation facility includes three (3) Wärtsilä W18V50SG natural gas-fired, four stroke, lean burn, spark ignition reciprocating internal combustion engines (RICE) coupled to 19,260 kW electric generators, a 1,000 kW natural gas-fired emergency generator, and one natural gas-fired natural gas conditioning heater. The RICE electric generating unit engines utilize pipeline quality natural gas and are equipped with selective catalytic reduction (SCR) for nitrogen oxides (NO_x) control and oxidation catalyst systems for carbon monoxide (CO), volatile organic compound (VOC), and organic hazardous air pollutant (HAP) control. Each 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.

TEST RESULTS			
Test Location	Test Parameter	Emission Limit	Actual Test Result
EURICE1	CH ₂ O	14 ppmvd @ 15% O ₂	0.57 ppmvd @ 15% O ₂
EURICE2			0.28 ppmvd @ 15% O ₂
EURICE3			0.70 ppmvd @ 15% O ₂

Operating Data as provided by the plant is included in Appendix A.

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

TEST PERSONNEL INFORMATION		
Location	Address	Contact
Test Coordinator	WEC Energy Group, Inc 231 W. Michigan Street Milwaukee, Wisconsin 53203	Mr. Justin Kowalski Senior Environmental Consultant 414-221-2265 justin.kowalski@wecenergygroup.com
Test Facility	Upper Michigan Energy Resources Corporation A.J. Mihm Generating Station 16017 Sarya Road Pelkie, Michigan 49958	
Testing Company Representative	Mostardi Platt 888 Industrial Drive Elmhurst, Illinois 60126	Mr. Stuart Sands Project Manager (630) 993-2100 (phone) ssands@mp-mail.com

The test crew consisted Messrs. N. Colangelo, J. Carlson, M. Lipinski, E. Ehlers, and S. Sands of Mostardi Platt.

2.0 TEST METHODOLOGY

Emission testing was conducted following the methods specified in 40CFR60, Appendix A and 40CFR63, Appendix A. Schematics of the test section diagrams and sampling trains used are included in Appendix B and C, respectively. Calculation nomenclature and example calculations are included in Appendix D. Reference method test data can be found in Appendix E.

The following methodology was used during the test program:

Method 3A Oxygen (O₂) Determination

Oxygen (O₂) concentrations were measured to determine emission concentrations in ppmvd corrected to 15% O₂ in accordance with Method 3A. Servomex analyzers were used to determine flue gas oxygen. All of the equipment used was calibrated in accordance with the specifications of the Method. Calibration data are presented in Appendix F and copies of gas cylinder certifications are included in Appendix G.

Method 320 Formaldehyde (CH₂O) and Moisture (H₂O) Determination

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 in Appendix E.

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	0.01 μ 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 F 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 contaminants, 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 other 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	98.6	Airgas	CC323311	Primary +/-2%
Acetaldehyde/Methanol/SF6	201.1/212.1/5.099	Airgas	CC718237	Certified Standard-Spec +/- 2%, Certified Standard-Spec +/- 5% (SF6)
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 (SF₆). The determined SF₆ 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.

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

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

- DF = Dilution factor of the spike gas
- SF_{6(dir)} = SF₆ concentration measured directly in undiluted spike gas
- SF_{6(spik)} = Diluted SF₆ 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)
Formaldehyde	0.2	-
Moisture	-	0.1

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

3.0 TEST RESULT SUMMARIES

Upper Michigan Energy Resources Corporation A. J. Mihm Generating Station EURICE Unit 1 Outlet Duct												
Test No.	Date	Start Time	End Time	H ₂ O%	O ₂ % Correction	O ₂ % dry	Formaldehyde, ppmvw	Formaldehyde, ppmvd	Formaldehyde, ppmvd @ 15% O ₂	Formaldehyde lb/mmBtu	Heat Input mmBtu/hr	Formaldehyde, lb/hr
1	10/03/19	08:51	09:53	10.11	15.0	11.5	0.76	0.84	0.53	0.0013	164.98	0.21
2	10/03/19	10:09	11:11	10.14	15.0	11.5	0.72	0.80	0.50	0.0012	165.50	0.20
3	10/03/19	11:24	12:26	10.09	15.0	11.6	0.97	1.08	0.68	0.0016	166.88	0.27
Average				10.11	15.0	11.5	0.81	0.91	0.57	0.0014	165.78	0.23

Upper Michigan Energy Resources Corporation A. J. Mihm Generating Station EURICE Unit 2 Outlet Duct												
Test No.	Date	Start Time	End Time	H ₂ O%	O ₂ % Correction	O ₂ % dry	Formaldehyde, ppmvw	Formaldehyde, ppmvd	Formaldehyde, ppmvd @ 15% O ₂	Formaldehyde lb/mmBtu	Heat Input mmBtu/hr	Formaldehyde, lb/hr
1	10/03/19	09:55	10:56	10.31	15.0	11.6	0.49	0.55	0.35	0.0008	165.13	0.14
2	10/03/19	11:29	12:31	10.26	15.0	11.6	0.52	0.58	0.37	0.0009	167.38	0.15
3	10/03/19	13:08	14:10	10.25	15.0	11.7	0.16	0.18	0.11	0.0003	168.08	0.05
Average				10.27	15.0	11.6	0.39	0.43	0.28	0.0007	166.86	0.11

Upper Michigan Energy Resources Corporation A. J. Mihm Generating Station EURICE Unit 3 Outlet Duct												
Test No.	Date	Start Time	End Time	H ₂ O%	O ₂ % Correction	O ₂ % dry	Formaldehyde, ppmvw	Formaldehyde, ppmvd	Formaldehyde, ppmvd @ 15% O ₂	Formaldehyde lb/mmBtu	Heat Input mmBtu/hr	Formaldehyde, lb/hr
1	10/03/19	13:55	14:56	10.02	15.0	11.6	0.98	1.09	0.69	0.0017	165.98	0.28
2	10/03/19	15:12	16:13	10.02	15.0	11.6	1.02	1.13	0.72	0.0017	166.10	0.29
3	10/03/19	16:28	17:30	9.96	15.0	11.6	1.00	1.11	0.71	0.0017	166.00	0.28
Average				10.00	15.0	11.6	1.00	1.11	0.70	0.0017	166.03	0.28

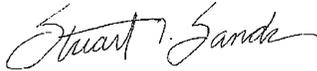
4.0 CERTIFICATION

MOSTARDI PLATT is pleased to have been of service to Upper Michigan Energy Resources Corporation. 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



_____ Project Manager

Stuart T. Sands



_____ Quality Assurance

Scott W. Banach

APPENDICES

Appendix A – Plant Operating Data

**A.J. Mihm Generating Station
RICE MACT Emissions Testing
Summary of Operating Data
10/3/2019**

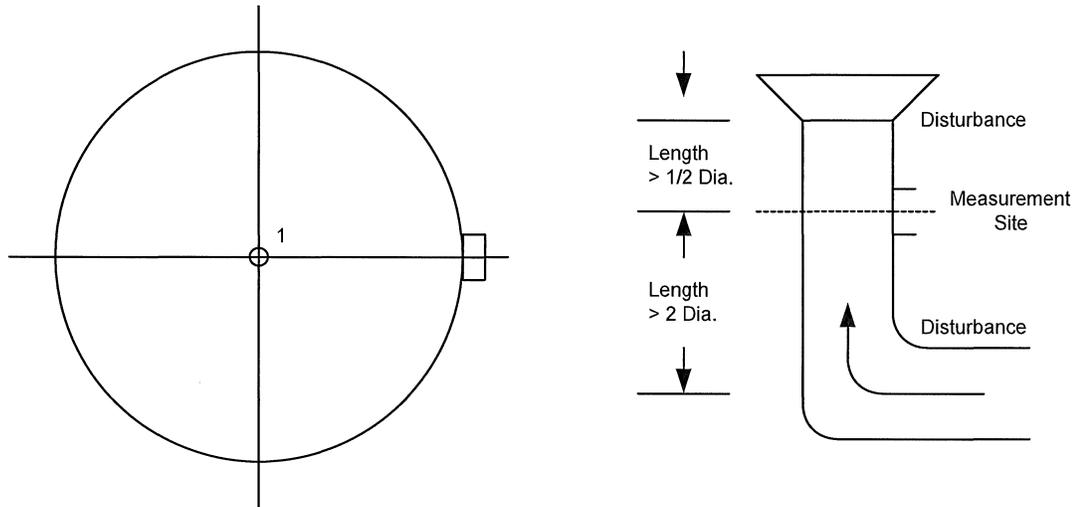
EURICE1				
10/3/2019				
Method 3A and 320				
Start Time	851	1009	1124	
End Time	953	1111	1226	
	Run 1	Run 2	Run 3	Average
Engine (kW)	18,939	18,927	18,938	18,935
Engine natural gas use (pound/hour)	6,599	6,620	6,675	6,631
SCR/Oxidation catalyst inlet temperature) (deg F)	734	733	728	732
Pressure drop across the oxidation catalyst (PSI)	0.12	0.11	0.11	0.11

EURICE2				
10/3/2019				
Method 3A and 320				
Start Time	955	1129	1308	
End Time	1056	1231	1410	
	Run 1	Run 2	Run 3	Average
Engine (kW)	18,870	18,875	18,880	18,875
Engine natural gas use (pound/hour)	6,605	6,695	6,723	6,674
SCR/Oxidation catalyst inlet temperature) (deg F)	725	720	717	721
Pressure drop across the oxidation catalyst (PSI)	0.12	0.12	0.12	0.12

EURICE3				
10/3/2019				
Method 3A and 320				
Start Time	1355	1512	1628	
End Time	1456	1613	1730	
	Run 1	Run 2	Run 3	Average
Engine (kW)	18,865	18,869	18,876	18,870
Engine natural gas use (pound/hour)	6,639	6,644	6,640	6,641
SCR/Oxidation catalyst inlet temperature) (deg F)	719	719	719	719
Pressure drop across the oxidation catalyst (PSI)	0.13	0.14	0.14	0.14

Appendix B - Test Section Diagrams

GASEOUS TRAVERSE FOR ROUND DUCTS



Job: Upper Michigan Energy Resources Corporation
A.J. Mihm Generating Station

Date: October 3, 2019

Test Location: EURICE1, EURICE2, EURICE3 Outlet Ducts (identical)

Duct Diameter: 5.29 Feet

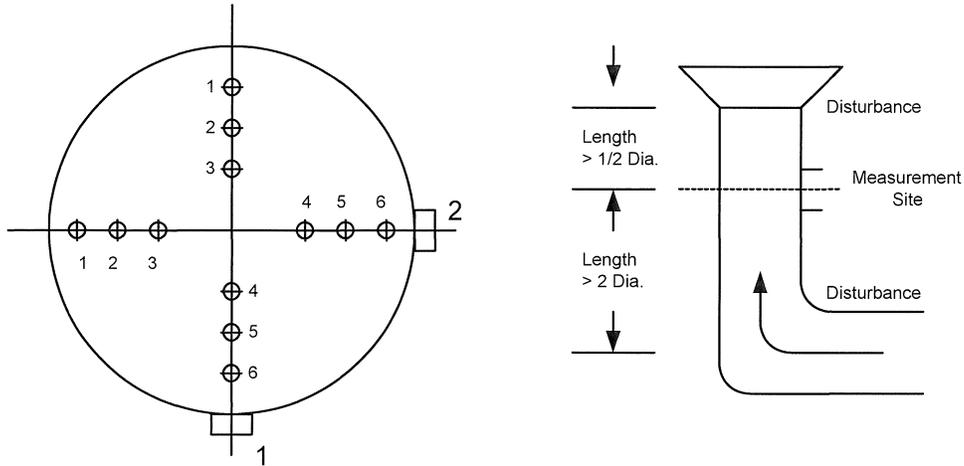
Duct Area: 21.979 Square Feet

No. Points Across Diameter: 1

No. of Ports: 1

Port Length: 8.0 Inches

GASEOUS TRAVERSE FOR ROUND DUCTS (Stratification Test)



Job: Upper Michigan Energy Resources Corporation
A.J. Mihm Generating Station

Date: October 3, 2019

Test Location: EURICE1, EURICE2, EURICE3 Outlet Ducts (identical)

Duct Diameter: 5.29 Feet

Duct Area: 21.979 Square Feet

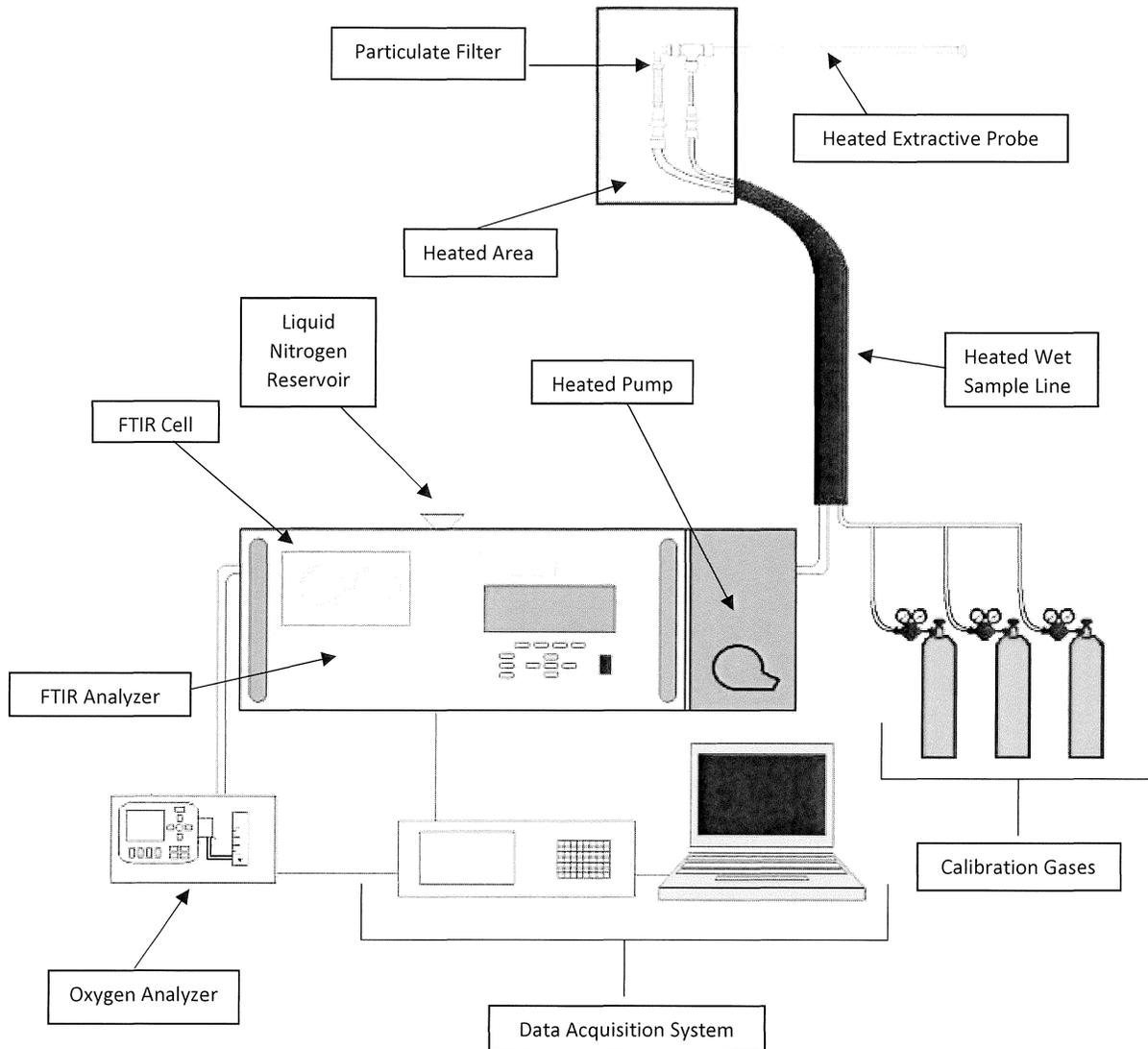
No. Points Across Diameter: 6

No. of Ports: 2

Port Length: 8.0 Inches

Appendix C - Sample Train Diagram

USEPA Methods 3A and 320 – Sample Train Diagram



Appendix D - Calculation Nomenclature and Formulas