EMISSIONS PERFORMANCE TEST PROGRAM

Performed For
Michigan South Central Power Agency

Performed At
Coldwater Peaking Plant
Coldwater, Michigan

Permit 80-14, SRN: P0521
Engine Group (FGGEN1-3)
Emission Units: EUGEN1, EUGEN2, and EUGEN3

Test Dates
June 27, 28 and 29, 2018

Report No.
TRC Environmental Corporation Report 300128A

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EMISSIONS PERFORMANCE TEST PROGRAM

1.0 INTRODUCTION

TRC Environmental Corporation (TRC) performed an emissions compliance test program on the Engine Group (FGGEN1-3) at the Coldwater Peaking Plant of Michigan South Central Power Agency (MSCPA) in Coldwater, Michigan on June 27, 28 and 29, 2018. The tests were authorized by and performed for MSCPA.

The purpose of this test program was to determine nitrogen oxides (NO_X), carbon monoxide (CO) and volatile organic compound (VOC) emission rates during normal operating conditions. The results of the test program was used to verify compliance with the emissions performance test requirements presented in 40CFR60 Subpart JJJJ "Standards of performance for Stationary Spark Ignition Combustion Engines" and the facility air quality permit. The test program was conducted according to the TRC Test Protocol 300128A, dated May 17, 2018.

1.1 Project Contact Information

Participants		
Test Facility	Coldwater Peaking Plant 250 North Filmore Road Coldwater, Michigan 49036	Dave Luce Generation Power Plant Lead (989) 429-9595 (phone) dluce@coldwater.org
Test Coordinator	Michigan South Central Power Agency 168 Division Street Coldwater, Michigan 49036	Robert Russell Director of Finance (517) 279-6965 (phone) russellr@mscpa.net
Air Emissions Testing Body (AETB)	TRC Environmental Corporation 7521 Brush Hill Road Burr Ridge, Illinois 60527	Greg Rock Field Team Leader 312-533-2042 (phone) 312-533-2070 (fax) grock@trcsolutions.com Jeffery Daniels Senior Project Manager 630-880-4754 jdaniels@trcsolutions.com

The tests were conducted by William Manny and Greg Rock of TRC. Documentation of the on-site ASTM D7036-04 Qualified Individual(s) (QI) can be located in the appendix to this report.

The following regulatory personnel observed the testing on June 28, 2018:

Mr. David Patterson
State of Michigan
Department of Environmental Quality
Environmental Quality Analyst
Air Quality Division

Mr. Matt Deskins
Kalamazoo District Office
Michigan Department of Environmental Quality
Air Quality Division

1.2 Facility Description

The Coldwater Peaking Plant operates three engines with associated generators for electrical generation during peak (grid) demand periods. The engine group is designated as FGGEN1-3. The individual emission unit IDs for the engines are EUGEN1, EUGEN2, and EUGEN3. The total nominal capacity is approximately 13.0 MWe.

Each engine is a 6,023 horsepower (hp) natural gas-fueled engine with a 4,348 kilowatts (kWe) generator, manufactured in 2014. Emissions are controlled with selective catalytic reduction (SCR) and catalytic oxidation (CatOx).

The facility complies with the provisions of the federal Standards of Performance for New Stationary Sources (NSPS) as specified in 40 CFR Part 60, Subparts A and JJJJ, as they apply to each engine of FGGEN1-3.

2.0 SUMMARY OF RESULTS

The results of this test program are summarized in the table below. Detailed individual run results are presented in Section 6.0.

Parameter	Units	EUGEN1	EUGEN2	EUGEN3	Emission Limit
NO_x	ppmvd	16.7	11.7	16.2	---
	lb/MMBtu	0.0354	0.0252	0.0339	0.0368
CO	ppmvd	1.9	1.8	1.7	---
	g/hp-hr	0.007	0.007	0.007	0.04
	ppmvd at 15% O_2	1.1	1.0	0.9	270
VOC	lb/MMBtu	0.042	0.053	0.032	0.056

The table below summarizes the test methods used, as well as the number and duration of each at each test location:

Unit ID	Parameter Measured	Test Method	No. of Runs	Run Duration
EUGN1, EUGEN2, EUGEN3	Volumetric Flow rate	USEPA 1-4	3	~30 min
	NOx	USEPA 7E	3	60 min
	CO	USEPA 10	3	60 min
	VOC	USEPA 25A	3	60 min

3.0 DISCUSSION OF RESULTS

On June 28, 2018 the measured values for NO_X emissions from EUGEN2 appeared to exceed the permitted limit. The emissions data from this period for EUGEN2 has been included in the appendix of this report, starting on page 82 (see Aborted Emissions Data section of appendix).

After MSCPA personnel investigated engine conditions and performed troubleshooting, they decided it was best to have their Engine Service Company and Engine Emissions Company work with the TRC emissions testing team to investigate the issue.

On June 29, 2018 the Engine Service Company came and verified that the observed catalyst inlet EUGEN2 NO_X ppm levels were low enough, at 90% efficiency, to easily meet the associated catalyst outlet NO_X limit. Upon further investigation, the Engine Emissions Company determined (by remote connection) that the EUGEN2 pump curve and urea injection rate needed to be optimized. The Engine Emissions Company made the urea injection pump react slower, and lowered the dose amount. The observed urea dose went from levels ranging 1.3 to 2 gph (sporadically going up and down), to a steady injection dose of 0.8 gph. After the EUGEN2 Emission Cabinet PLC programming was adjusted to optimize the urea injection parameters, the measured NO_X ppm levels dropped substantially.

The effect of optimizing the urea injection dose is expected to have eliminated a measurement bias for the TRC NO_X analyzer. TRC was initially using a NO_X analyzer equipped with a stainless steel converter, and an ammonia scrubber attachment. NO_X analyzers equipped with stainless steel converters can have biased NO_X measurements

when free ammonia is in the gas sample, due to the high operating temperature for the converter (630 deg. C). When using the stainless steel converter, gases like ammonia can break down resulting in false readings. In addition to the urea injection adjustments, TRC arranged to switch to a NO_X analyzer with a lower temperature Molybdenum (also known as moly) converter for NO_X measurements.

No other problems were encountered with the testing equipment during the test program. Source operation appeared normal during the entire test program. No other changes or problems were encountered that required modification of any procedures presented in the test plan. No adverse test or environmental conditions were encountered during the conduct of this test program.

The following source operating data parameters were recorded by facility personnel:

Parameter	**Unit of Measure**
Fuel Gas Flow	Standard Cubic Feet per Hour (SCFH)
Urea Flow	Gallon per Hour (GPH)
Pressure Before Catalyst	Millibar (mbar)
Temperature Before Catalyst	Degree Celsius (°C)
Pressure After Catalyst	mbar
Temperature After Catalyst	°C
Engine Load	Kilowatt (kW)
Stack Temperature	°C

The source engine operating data sheets are appended.

4.0 SAMPLING AND ANALYSIS PROCEDURES

All testing, sampling, analytical, and calibration procedures used for this test program were performed in accordance with the methods presented in the following sections. Where applicable, the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III, Stationary Source Specific Methods, USEPA 600/R-94/038c, September 1994 was used to supplement procedures.

4.1 Determination of Sample Point Locations by USEPA Method 1

This method is applicable to gas streams flowing in ducts, stacks, and flues and is designed to aid in the representative measurement of pollutant emissions and/or total volumetric flow rates from stationary sources. In order to qualify as an acceptable sample location, it must be located at a position at least two stack or duct equivalent diameters downstream and a half equivalent diameter upstream from any flow disturbance.

The cross-section of the measurement site was divided into a number of equal areas, and the traverse points were then located in the center of these areas. The minimum number of points were determined from either Figure 1-1 (particulate) or Figure 1-2 (non-particulate) of USEPA Method 1.

4.2 Volumetric Flow Rate Determination by USEPA Method 2

This method is applicable for the determination of the average velocity and the volumetric flow rate of a gas stream.

The gas velocity head (ΔP) and temperature were measured at traverse points defined by USEPA Method 1. The velocity head was measured with a Type S (Stausscheibe or reverse type) pitot tube and oil-filled manometer; and the gas temperature was measured with a Type K thermocouple. The average gas velocity in the flue was calculated based on: the gas density (as determined by USEPA Methods 3 and 4); the flue gas pressure; the average of the square roots of the velocity heads at each traverse point, and the average flue gas temperature.

4.3 Determination of the Concentration of Gaseous Pollutants Using a Multi-Pollutant Sampling System

Concentrations of the pollutants in the following sub-sections were determined using one sampling system. The number of points at which sample was collected was determined in accordance with Table 2 to Subpart JJJJ of Part 60 "Requirements for Performance Tests".

A straight-extractive sampling system was used. A data logger continuously recorded pollutant concentrations and generated one-minute averages of those concentrations. All calibrations and system checks were conducted using USEPA Protocol 1 gases. Three-point linearity checks were performed prior to sampling, and in the event of a failing

system bias or drift test (and subsequent corrective action). System bias and drift checks were performed using the low-level gas and either the mid- or high-level gas prior to and following each test run.

The Low Concentration Analyzers (those that routinely operate with a calibration span of less than 20 ppm) used by TRC are ambient-level analyzers. Per Section 3.12 of Method 7E, a Manufacturer's Stability Test is not required for ambient-level analyzers. Analyzer interference tests were conducted in accordance with the regulations in effect at the time that TRC placed an analyzer model in service.

4.3.1 CO_2 Determination by USEPA Method 3A
This method is applicable for the determination of CO_2 concentrations in controlled and uncontrolled emissions from stationary sources only when specified within the regulations. The CO_2 analyzer was equipped with a non-dispersive infrared (IR) detector.

4.3.2 O_2 Determination by USEPA Method 3A
This method is applicable for the determination of O_2 concentrations in controlled and uncontrolled emissions from stationary sources only when specified within the regulations. The O_2 analyzer was equipped with a paramagnetic-based detector.

4.3.3 NO_x Determination by USEPA Method 7E
This method is applicable for the determination of NO_x concentrations in controlled and uncontrolled emissions from stationary sources only when specified within the regulations. The NO_x analyzer utilized a photomultiplier tube to measure the linear and proportional luminescence caused by the reaction of nitric oxide and ozone.

4.3.4 CO Determination by USEPA Method 10
This method is applicable for the determination of CO concentrations in controlled and uncontrolled emissions from stationary sources only when specified within the regulations. The non-dispersive infrared analyzer (NDIR) CO analyzer was equipped with an internal gas correlation filter wheel, which eliminates potential detector interference. As such, use of an interference removal trap was not required.

4.4 Moisture Determination by USEPA Method 4
This method is applicable for the determination of the moisture content of stack gas.

A gas sample was extracted at a constant rate from the source. Moisture was removed from the sample stream by a series of pre-weighed impingers immersed in an ice bath. A minimum of 21 dry standard cubic feet of flue gas was collected during each sample run.

4.5 VOC Determination by USEPA Method 25A (Using GC/FID Instrumentation)

This method is applicable for the determination of non-methane organic (NMOC) compound concentration, which will be considered equivalent to volatile organic compound (VOC) concentration.

A gas sample was extracted from the source through a heated sample line and glass fiber filter to a non-methane flame ionization analyzer which uses gas chromatography (GC/FID) to separate the methane from the remaining gaseous organic compounds. The total non-methane mixture is quantified as propane.

TRC utilized a Thermo Environmental Model 55C Non-Methane Analyzer. The use of a non-methane/non-ethane flame ionization analyzer has been broadly approved for measurements from stationary spark ignition combustion engines. The following approved alternate procedures have been approved by USEPA and are posted on the Emissions Measurement Center Website:

- Methane cutter analyzer (such as J.U.M. Engineering HFID Model 109A)(see reference in Table 2 of Subpart JJJJ)
- ALT-066 (approves use of TECO 55C GC/FID type hydrocarbon analyzer for methane measurement in lieu of Method 18)
- ALT-078 (approves use of TECO 55C GC/FID type hydrocarbon analyzer for NMOC measurement, with data quality considered equivalent to methane cutter analyzers)
- ALT-096 (approval of newer model TECO 55I GC/FID analyzer for same, states that use of the GC/FID instrument is broadly accepted for Subpart JJJJ, and specifies that Method 25A procedures are to be used for NMOC analyzer sampling and QA/QC)
- ALT-106 (approves use of VIG Industries GC/FID analyzers for same application, as well as additional procedures for non-methane/non-ethane measurements using the same equipment).

TRC utilized USPEA Approved Alternate procedures ALT-066 and ALT-078 for this test program. The specified NMOC analyzers used a direct interface measurement with a heated sampling line from the sampling point to the gas chromatographic injection valve. The sampling components remained heated (>220 °F) at all times. The appropriate test procedure, calibration, and standardization requirements in sections 8, 9, and 10 of Method 25A were followed for linearity, calibration error, and calibration drift.

The report has the calibration results for the methane and non-methane channels/signals to demonstrate proper separation of methane from the NMOC hydrocarbons. A methane/propane calibration gas standard was also used to demonstrate proper separation at the start of each test day. NMOC values are quantified as propane.

5.0 QUALITY ASSURANCE PROCEDURES

TRC integrates our Quality Management System (QMS) into every aspect of our testing service. We follow the procedures specified in current published versions of the test Method(s) referenced in this report. Any modifications or deviations are specifically identified in the body of the report. We routinely participate in independent, third party audits of our activities, and maintain:

- Accreditation from the Louisiana Environmental Laboratory Accreditation Program (LELAP);
- Accreditation from the Stack Testing Accreditation Council (STAC) and the American Association for Laboratory Accreditation (A2LA) that our operations conform with the requirements of ASTM D 7036 as an Air Emission Testing Body (AETB).

These accreditations demonstrate that our systems for training, equipment maintenance and calibration, document control and project management will fully ensure that project objectives are achieved in a timely and efficient manner with a strict commitment to quality.

All calibrations are performed in accordance with the test Method(s) identified in this report. If a Method allows for more than one calibration approach, or if approved alternatives are available, the calibration documentation in the appendices specifies which approach was used. All measurement devices are calibrated or verified at set intervals against standards traceable to the National Institute of Standards and Technology (NIST). NIST traceability information is available upon request.

ASTM D7036-04 specifies that: *"AETBs shall have and shall apply procedures for estimating the uncertainty of measurement. Conformance with this section may be demonstrated by the use of approved test protocols for all tests. When such protocols are used, reference shall be made to published literature, when available, where estimates of uncertainty for test methods may be found."* TRC conforms with this section by using approved test protocols for all tests.

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Gaseous Test Results Summary – Engine 1

Instrumental Reference Method
Calibration Corrected Test Data

Project Number:	300128	Start Date:	6/28/18
Customer:	MSCPA	End Date:	6/28/18
Unit Identification:	EUGEN1	Facility:	Coldwater Peaking Plant
Sample Location:	Stack	Recorded by:	G. Rock
RM Probe Type:	Extractive (Dry)	Fc Factor:	-
Load Level/Condition:	High (Normal)	Fd Factor:	8710

Reference Method Results, As Measured Moisture Basis

Run #	Date	Start Time	End Time	NOX ppmvd	CO ppmvd	CO2 % v/v dry	O2 % v/v dry
1	6/28/18	8:05	9:04	16.9	1.8	5.5	10.6
2	6/28/18	9:40	10:39	16.8	1.8	5.6	10.6
3	6/28/18	11:20	12:19	16.6	1.9	5.6	10.6
Average				**16.7**	**1.9**	**5.6**	**10.6**

Emission Rate Calculation Summary

Run #	NOX lb/MMBtu	CO lb/MMBtu	NOX lb/hr	CO lb/hr	Flow DSCFM
1	0.0357	0.0023	1.42	0.091	11,722
2	0.0355	0.0024	1.39	0.093	11,535
3	0.0350	0.0025	1.36	0.096	11,423
Average	**0.0354**	**0.0024**	**1.39**	**0.093**	**11,560**

Results Corrected to a Reference O_2 Concentration		Emission Rate Test Calculation Summary g/HP-hr Determined Using lb/hr and horsepower-hour			
Run #	CO ppmvd corrected to 15% Oxygen	BHP HP-hr	CO g/HP-hr	-	-
1	1.0	5804	0.0071	-	-
2	1.1		0.0073	-	-
3	1.1		0.0075	-	-
Average	**1.1**		**0.0073**	-	-

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METHOD 25A TEST RESULTS SUMMARY

Project Number:	300128	Test Date(s):	06/28/18
Customer:	MSCPA	Facility:	Coldwater Peaking Plant
Unit Identification:	EUGEN1	Recorded by:	G. Rock

Location	Stack			
Test Run No.	1	2	3	Average
Test Date	6/28/2018	6/28/2018	6/28/2018	
Test Time - Start	8:05	9:40	11:20	
Test Time - End	9:04	10:39	12:19	
Fractional Gas Moisture Content (B_{ws})	0.116	0.118	0.117	**0.117**
NMHC (ppmvw as Propane)	18.04	18.59	18.55	**18.39**
NMHC (ppmvd as Propane)	20.41	21.08	21.01	**20.83**
O_2 (% dry)	10.6	10.6	10.6	**10.6**
F_d	8710	8710	8710	**8710**
NMHC - F_d Basis (lb/MMBtu)	0.041	0.043	0.042	**0.042**

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Gaseous Test Results Summary – Engine 2

Instrumental Reference Method
Calibration Corrected Test Data

Project Number:	300128	Start Date:	6/29/18
Customer:	MSCPA	End Date:	6/29/18
Unit Identification:	EUGEN2	Facility:	Coldwater Peaking Plant
Sample Location:	Stack	Recorded by:	G. Rock
RM Probe Type:	Extractive (Dry)	Fc Factor:	-
Load Level/Condition:	High (Normal)	Fd Factor:	8710

Reference Method Results, As Measured Moisture Basis

Run #	Date	Start Time	End Time	NOX ppmvd	CO ppmvd	CO2 % v/v dry	O2 % v/v dry
1	6/29/18	8:50	9:49	11.7	1.7	5.4	10.8
2	6/29/18	10:30	11:29	11.7	1.8	5.4	10.8
3	6/29/18	12:15	13:14	11.7	1.8	5.4	10.8
Average				**11.7**	**1.8**	**5.4**	**10.8**

Emission Rate Calculation Summary

Run #	NOX lb/MMBtu	CO lb/MMBtu	NOX lb/hr	CO lb/hr	Flow DSCFM
1	0.0253	0.0022	0.98	0.087	11,653
2	0.0253	0.0024	0.99	0.092	11,760
3	0.0252	0.0024	0.98	0.092	11,688
Average	**0.0252**	**0.0023**	**0.98**	**0.090**	**11,700**

Results Corrected to a Reference O_2 Concentration		Emission Rate Test Calculation Summary g/HP-hr Determined Using lb/hr and horsepower-hour			
Run #	CO ppmvd corrected to 15% Oxygen	BHP HP-hr	CO g/HP-hr	-	-
1	1.0	5835	0.0068	-	-
2	1.0		0.0072	-	-
3	1.1		0.0071	-	-
Average	**1.0**		**0.0070**	-	-

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METHOD 25A TEST RESULTS SUMMARY

Project Number:	300128	Test Date(s):	06/29/18
Customer:	MSCPA	Facility:	Coldwater Peaking Plant
Unit Identification:	EUGEN2	Recorded by:	G. Rock

Location	Stack			
Test Run No.	1	2	3	**Average**
Test Date	6/29/2018	6/29/2018	6/29/2018	
Test Time - Start	8:50	10:30	12:15	
Test Time - End	9:49	11:29	13:14	
THC (ppmvw as Propane)	22.63	22.54	22.57	**22.58**
Fractional Gas Moisture Content (B_{ws})	0.117	0.117	0.117	**0.117**
NMHC (ppmvw as Propane)	22.63	22.54	22.57	**22.58**
NMHC (ppmvd as Propane)	25.63	25.53	25.56	**25.57**
O_2 (% dry)	10.8	10.8	10.8	**10.8**
F_d	8710	8710	8710	**8710**
NMHC - F_d Basis (lb/MMBtu)	0.053	0.053	0.053	**0.053**

Gaseous Test Results Summary – Engine 3

Instrumental Reference Method
Calibration Corrected Test Data

Project Number:	300128	Start Date:	6/27/18
Customer:	MSCPA	End Date:	6/27/18
Unit Identification:	EUGEN3	Facility:	Coldwater Peaking Plant
Sample Location:	Stack	Recorded by:	G. Rock
RM Probe Type:	Extractive (Dry)	Fc Factor:	-
Load Level/Condition:	High (Normal)	Fd Factor:	8710

Reference Method Results, As Measured Moisture Basis

Run #	Date	Start Time	End Time	NOX ppmvd	CO ppmvd	CO2 % v/v dry	O2 % v/v dry
1	6/27/18	13:24	14:23	16.3	1.6	5.6	10.5
2	6/27/18	15:02	16:01	16.1	1.7	5.6	10.5
3	6/27/18	16:46	17:45	16.2	1.7	5.6	10.5
Average				**16.2**	**1.7**	**5.6**	**10.5**

Emission Rate Calculation Summary

Run #	NOX lb/MMBtu	CO lb/MMBtu	NOX lb/hr	CO lb/hr	Flow DSCFM
1	0.0340	0.0021	1.35	0.082	11,541
2	0.0336	0.0021	1.32	0.084	11,484
3	0.0339	0.0021	1.34	0.083	11,544
Average	**0.0339**	**0.0021**	**1.34**	**0.083**	**11,523**

Results Corrected to a Reference O_2 Concentration		Emission Rate Test Calculation Summary g/HP-hr Determined Using lb/hr and horsepower-hour			
Run #	CO ppmvd corrected to 15% Oxygen	BHP HP-hr	CO g/HP-hr	-	-
1	0.9	5786	0.0065	-	-
2	0.9		0.0066	-	-
3	0.9		0.0065	-	-
Average	**0.9**		**0.0065**	-	-

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METHOD 25A TEST RESULTS SUMMARY

Project Number:	300128	Test Date(s):	06/27/18
Customer:	MSCPA	Facility:	Coldwater Peaking Plant
Unit Identification:	EUGEN3	Recorded by:	G. Rock

Location	Stack			
Test Run No.	1	2	3	**Average**
Test Date	6/27/2018	6/27/2018	6/27/2018	
Test Time - Start	13:24	15:02	16:45	
Test Time - End	14:23	16:01	17:44	
THC (ppmvw as Propane)	14.21	13.78	13.64	**13.88**
Fractional Gas Moisture Content (B_{ws})	0.118	0.120	0.123	**0.120**
NMHC (ppmvw as Propane)	14.21	13.78	13.64	**13.88**
NMHC (ppmvd as Propane)	16.11	15.66	15.55	**15.77**
O_2 (% dry)	10.5	10.5	10.5	**10.5**
F_d	8710	8710	8710	**8710**
NMHC - F_d Basis (lb/MMBtu)	0.032	0.031	0.031	**0.032**