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EMISSION TEST REPORT

Title	Landfill Gas Fired Reciprocating Engine CO Emissions for the RICE NESHAP
Report Date	August 12, 2014
Test Date(s)	July 23, 2014

Facility Information	
Name	Wayne Energy Recovery Inc. – Partnership Facility
Street Address	49350 I-94 Service Drive
City, County	Belleville, Wayne

Facility Permit Information	
State Registration No: M4782	Permit No. : MI-ROP-M4782-2010a

Testing Contractor	
Company	Derenzo and Associates, Inc.
Mailing Address	39395 Schoolcraft Road Livonia, MI 48150
Phone	(734) 464-3880
Project No.	1402001

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MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
AIR QUALITY DIVISION

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 Permit (ROP) 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 specified in Rule 213(3)(b)(ii), and be made available to the Department of Environmental Quality, Air Quality Division upon request.

Source Name EQ-The Environmental Quality Company-Wayne Energy County Wayne

Source Address 49350 N. I-94 Service Drive City Belleville

AQD Source ID (SRN) M4782 ROP No. MI-ROP-M4782-2010a ROP Section No. _____

Please check the appropriate box(es):

☐ **Annual Compliance Certification (Pursuant to Rule 213(4)(c))**

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 ROP, 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 ROP.

☐ 2. During the entire reporting period this source was in compliance with all terms and conditions contained in the ROP, 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 ROP, unless otherwise indicated and described on the enclosed deviation report(s).

☐ **Semi-Annual (or More Frequent) Report Certification (Pursuant to Rule 213(3)(c))**

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

☐ 1. During the entire reporting period, **ALL** monitoring and associated recordkeeping requirements in the ROP 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 ROP 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 ROP are attached as described:

Certification for Air Emissions compliance testing on two (2) separate 4SRB SI RICE emission units as specifed in 40 CFR Part 63 Subpart ZZZZ. Testing commenced on July 23, 2014.

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

Kerry Durnen	Director of Operations	(734) 699-6265
Name of Responsible Official (print or type)	Title	Phone Number
Kerry Durnen		8/15/14
Signature of Responsible Official		Date

* Photocopy this form as needed.

EQP 5736 (Rev 11-04)

EMISSION TEST REPORT

LANDFILL GAS FIRED RECIPROCATING ENGINE
CO EMISSIONS FOR THE
RICE NESHAP

1.0 INTRODUCTION

Wayne Energy Recovery Inc., Partnership (Wayne Energy) owns and operates two (2) 500 hp Caterpillar G-398 naturally-aspirated spark ignition (SI) reciprocating internal combustion engines (RICE) at its facility located in Belleville, Wayne County, Michigan. Each SI RICE is subject to the emission standards and testing requirements in Title 40 of the Code of Federal Regulations (40 CFR) Part 63 Subpart ZZZZ *National Emissions Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines* (40 CFR Part 63 Subpart ZZZZ) as an existing non-emergency, non-black start stationary RICE with a power output $100 \leq HP \leq 500$ horsepower, which combusts landfill gas and is located at a major source of hazardous air pollutant (HAP) emissions.

Pursuant to 40 CFR Part 63 Subpart ZZZZ (Table 2c), an owner/operator of an existing SI RICE with a power output $100 \leq HP \leq 500$ horsepower, which combusts landfill gas at a major source of HAP emissions must limit carbon monoxide (CO) emissions to an outlet concentration of 177 ppmvd at 15% oxygen.

1.1 Purpose and Objectives of Testing

Derenzo and Associates, Inc. (Derenzo and Associates) was contracted to perform the SI RICE CO emissions testing specified in 40 CFR Part 63 Subpart ZZZZ. The CO compliance emission measurements consisted of three (3), one-hour test runs during which the engine exhaust gas, at the outlet of the catalyst emission control system, was measured for CO and O_2 concentrations using instrumental analyzers.

The compliance testing was performed by Derenzo and Associates representatives Daniel Wilson and Jason Logan on July 23, 2014. The exhaust gas sampling and analysis was performed using procedures specified in the test protocol dated February 5, 2014 and clarifications provided in the approval letter issued by the Michigan Department of Environmental Quality-Air Quality Division (MDEQ-AQD).

The information presented in this report follows the MDEQ-AQD *Format for Submittal of Source Emission Test Plans and Reports, December 2013.*

Appendix A provides a copy of the MDEQ-AQD test plan approval letter.

1.2 Project Contacts and Report Certification

Questions regarding this emission test report should be directed to:

Mr. Daniel Wilson
Environmental Consultant
Derenzo and Associates, Inc.
39395 Schoolcraft Rd.
Livonia, MI 48150
(734) 464-3880

Ms. Melinda Keillor
EHS Manager
EQ-The Environmental Quality Company
49350 I-94 Service Drive
Belleville, Michigan 48111
(734) 699-6287

This test report was prepared by Derenzo, Associates based on the emission measurements and field sampling data collected by Derenzo and Associates. Facility process and operating data were collected and provided by representatives of Wayne Energy.

A Notification of Compliance Status (NOCS) report, certified by the emission source owner/operator accompanies this test report.

Report Prepared By:

Daniel Wilson
Environmental Consultant

Reviewed By:

Robert L. Harvey, P.E.
General Manager

2.0 SUMMARY OF TEST RESULTS

The exhaust gas from each landfill gas-fueled SI RICEs is routed to an oxidation catalyst for the control of CO in the exhaust gas. The exhaust gas downstream of the emission control catalyst was sampled for three (3) one-hour test periods during the compliance testing performed July 23, 2014. Instrumental analyzers were used to measure concentrations of CO and O_2 in the engine exhaust gas at the catalyst outlet. Table 1 below presents a summary of the compliance test results.

The testing was performed while each SI RICE was operated at full operating load. Table 2 below presents a summary of the emission unit operating conditions during the test periods.

The test results indicate compliance with the 40 CFR Part 63 Subpart ZZZZ emission standard of 177 ppmvd at 15% O_2 for an existing landfill gas fueled SI RICE $100 \leq HP \leq 500$ located at a major source of HAP emissions.

Table 1. Summary of SI-RICE compliance test results, measured at catalyst outlet

Emission Unit ID	CO Concentration (ppmvd)	Oxygen Content (% vol)	CO Concentration (ppmvd @15% O_2)
Engine 2	361	1.97	113
Engine 5	<0.1	0.91	<0.1
Emission Standard	N/A	N/A	117

Table 2. Summary of emission unit operating conditions

Emission Unit ID	Operating Hours[†]	Generator Output (kW)	Catalyst Inlet (°F)
Engine 2	74,090	257	954
Engine 5	7,610	229	933

[†] Engine run hour meter reading at the beginning of Test 1.

3.0 SOURCE DESCRIPTION

3.1 Emission Unit Location and Description

The Wayne Energy facility is located at 49350 I-94 Service Drive, Belleville,Wayne County, Michigan.

Each Caterpiller G-398 SI RICE is fueled with landfill gas and is connected to an electricity generator. Wayne Energy provided the following identification information for the tested engines:

- Engine 2, CAT® Model No. G-398, Serial No. 73B 673 is rated at 500 HP
- Engine 5, CAT® Model No. G-398, Serial No. 73B 1990 is rated at 500 HP

3.2 Rated Capacities, Type and Quantity of Raw Materials Used

Each CAT® G-398 SI RICEs has a maximum rated output of 500 hp and is fueled with landfill gas recovered from the adjacent landfill. Each engine is connected to a separate generator that has the capacity to produce approximately 350 kilowatts (kW) of electricity.

Facility operators recorded the generator output (kW), landfill gas methane content (% volume), and catalyst inlet temperature at 15-minute intervals throughout each test period.

Appendix B provides operating records provided by Wayne Energy representatives.

3.3 Emission Control System Description

Exhaust gases from each SI RICE are directed through a dedicated catalyst emission control system prior to release to ambient air. CO and other hydrocarbons in the SI RICE exhaust gas stream are oxidized by the catalyst using excess oxygen that is present in the SI RICE exhaust gas stream. The SI RICE exhaust gas provides the heat necessary to initiate the catalytic reaction (an additional heat source is not used to preheat the inlet gas).

The temperature of the SI RICE exhaust gas at the catalyst inlet is monitored continuously.

4.0 SAMPLING AND ANALYTICAL PROCEDURES

This section provides a summary of the exhaust gas sampling and analytical procedures that were used during the test event.

4.1 Testing Location and Sampling System

A continuous sample of the RICE exhaust gas was obtained from the sampling ports installed just downstream of the emission control catalyst. During each one-hour pollutant sampling period, a continuous sample of the RICE exhaust gas stream was extracted from the stack using a stainless steel probe connected to a Teflon® heated sample line. The sampled gas was conditioned by removing moisture prior to being introduced to the instrumental analyzers.

Appendix C provides a diagram of the sampling location.

4.2 Exhaust Gas Oxygen and CO Concentration (USEPA Methods 3A and 10)

The O_2 content and CO concentration in the RICE exhaust gas stream was measured continuously throughout each one-hour test period in accordance with USEPA Methods 3A and 10. A Servomex 4900 oxygen analyzer with a paramagnetic sensor was used to measure the O_2 content; CO concentration was measured using a Fuji Model ZRF non-dispersive infrared (NDIR) analyzer. Sampling times were recorded on field data sheets.

Instrument response for each analyzer was recorded on an ESC Model 8816 data logging system that monitored the analog output of the instrumental analyzers continuously and logged data as one-minute averages. Prior to, and at the conclusion of each test, instrument calibration was verified using appropriate calibration gases to determine accuracy and system bias (described in Section 4.3 of this document).

Appendix D provides field data sheets and calculations.

Appendix E provides raw (one-minute average) instrumental analyzer response data for each test period.

4.3 Quality Assurance Procedures

4.3.1 Instrument Calibration and System Bias Checks

At the beginning of each day, initial three-point instrument calibrations were performed by injecting calibration gas directly into the inlet sample port for each instrument. System bias checks were performed prior to and at the conclusion of each sampling period by introducing the appropriate upscale calibration gas and zero gas into the sampling system (at the base of the stainless steel sampling probe prior to the particulate filter and Teflon® heated sample line) and verifying the instrument response against the initial instrument calibration readings.

The instrument analyzers were calibrated with USEPA Protocol 1 certified O_2 and CO concentrations in nitrogen and zeroed using nitrogen. A STEC ten-step gas divider was used (as needed) to obtain intermediate calibration gas concentrations.

4.3.2 Sampling System Response Time Determination

The response time of the sampling system was determined prior to the compliance test program by introducing upscale gas and zero gas, in series, into the sampling system using a tee connection at the base of the sample probe. The elapsed time for the analyzer to display a reading of 95% of the expected concentration was determined using a stopwatch.

The Fuji Model ZRF NDIR analyzer exhibited the longest system response time at 75 seconds. Results of the response time determinations were recorded on field data sheets. For each test period, test data were collected once the sample probe was in position for at least twice the maximum system response time.

4.3.3 Gas Divider Certification (USEPA Method 205)

The STEC 10-step gas divider was used in the field to obtain appropriate calibration span gases. The 10-step gas divider was NIST-certified on July 3, 2014 with a primary flow standard in accordance with Method 205. When cut with an appropriate zero gas, the ten-step gas divider delivers calibration gas values at 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, and 90%, of the USEPA Protocol 1 calibration gas that is introduced into the system. The field evaluation procedures presented in Section 3.2 of Method 205 were followed prior to use of the 10-step gas divider. The field evaluation yielded no errors greater than 2% of the triplicate measured average and no errors greater than 2% from the expected values.

4.3.4 Instrumental Analyzer Interference Check

The instrumental analyzers used to measure CO and O_2 concentrations have had an interference response test performed prior to their use in the field (July 26, 2006 and June 6, 2013, respectively), pursuant to the interference response test procedures specified in USEPA Method

7E. The appropriate interference test gases (i.e., gases that would be encountered in the exhaust gas stream) were introduced into each analyzer, separately and as a mixture with the analyte that each analyzer is designed to measure. All of analyzers exhibited a composite deviation of less than 3.0% of the span for all measured interferent gases. No major analytical components of the analyzers have been replaced since performing the original interference tests.

Appendix F presents test equipment quality assurance data (instrument calibration and system bias check records, calibration gas and gas divider certifications, interference test results).

5.0 DISCUSSION OF TEST RESULTS

5.1 Results Summary and Comparison to Emission Standard

Emission testing was performed for each landfill-gas fueled CAT® G-398 SI RICE to measure exhaust gas CO concentration and O_2 content downstream of the installed oxidation catalyst. Pursuant to 40 CFR Part 63 Subpart ZZZZ, an owner/operator of an existing landfill gas fueled SI RICE with a power output $100 \leq hp \leq 500$ at a major source of HAP emissions must limit CO emissions to an outlet concentration of no more than 177 ppmvd at 15% oxygen.

The emission test results for Engine 2 are presented in Table 3. The measured exhaust gas CO concentration at the Engine 2 catalyst outlet 257 ppmvd. Based on the measured oxygen content of 1.97% by volume (dry basis), the corrected CO concentration is 113 ppmvd at 15% oxygen.

The emission test results for Engine 5 are presented in Table 4. The measured exhaust gas CO concentration at the Engine 5 catalyst outlet was approximately zero (0) ppmvd and contained less than 1% oxygen.

The difference in the measured CO outlet concentration is based on the catalyst service life (i.e., Engine 2 catalyst had been in service longer than the Engine 5 catalyst).

5.2 Operating Conditions During the Compliance Tests

The emission testing was performed while each SI RICE generator output (kW), operated between 228 kW and 260 kW. The landfill gas used as fuel in the SI RICE contained between 54 and 56% methane by volume. The engine exhaust gas temperature at the catalyst was greater than 900°F and recorded at 15 minute intervals.

Generator output (kW), landfill gas methane content (% volume), and catalyst inlet temperature were recorded by Wayne Energy operators at 15-minute intervals throughout each test period and are presented in Appendix B.

5.3 Variations from Normal Sampling Procedures or Operating Conditions

The testing was performed according to the procedures specified in the test protocol dated February 5, 2014 and clarifications provided in the approval letter issued by the MDEQ-AQD.

A copy of the USEPA test plan approval letter is provided in Appendix A.

Table 3. Measured exhaust gas CO concentrations and O_2 content for Engine No. 2 for each one-hour test period

Test Number	1	2	3	Three
Test Date	07/23/14	07/23/14	07/23/14	Test
Test Period (24-hr)	1313-1413	1428-1528	1543-1643	Average
Genset Operating Parameters				
Generator Output (kW)	258	257	258	257
Fuel methane content (%)	54.9	54.9	54.8	54.9
Exhaust Oxygen Content				
O_2 content (% vol)	1.97	1.99	1.96	1.97
Carbon Monoxide Concentrations				
CO concentration (ppmvd)	368	358	358	361
CO concentration (ppmvd@15% O_2)	115	112	111	113
RICE NESHAP CO Limit (ppmvd CO at 15% O_2)				*177*

Table 4. Measured exhaust gas CO concentrations and O_2 content for Engine No. 5 for each one-hour test period

Test Number	1	2	3	Three
Test Date	07/23/14	07/23/14	07/23/14	Test
Test Period (24-hr)	847-947	1002-1102	1116-1216	Average
Genset Operating Parameters				
Generator Output (kW)	230	230	229	229
Fuel methane content (%)	55.1	54.7	55.0	54.9
Exhaust Oxygen Content				
O_2 content (% vol)	0.91	0.90	0.90	0.91
Carbon Monoxide Concentrations				
CO concentration (ppmvd)	< 0.1	< 0.1	< 0.1	< 0.1
CO concentration (ppmvd@15% O_2)	< 0.1	< 0.1	< 0.1	< 0.1
RICE NESHAP CO Limit (ppmvd CO at 15% O_2)				*177*

Notes
40 CFR Part 63 Subpart ZZZZ emission standard is 177 ppmvd at 15% O_2.