



Duel Fuel Generator Engine Emissions Testing Summary Report

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AIR QUALITY DIV.

Prepared for:
Bay City Electric Light & Power

Bay City Electric Light & Power
900 South Water Street
Bay City, Michigan 48708

Project No. 16-4844.00
June 21, 2016

BT Environmental Consulting, Inc.
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EXECUTIVE SUMMARY

AIR QUALITY DIV.

BT Environmental Consulting, Inc. (BTEC) was retained by Bay City Electric Light & Power (BCELP) to measure carbon monoxide (CO) and oxygen (O₂) concentrations at the inlet and outlet of catalytic converters on four dual fuel engines and to measure nitrogen oxides (NO_x) concentrations at the catalytic converter outlet on the same four engines. Two of the engines are located at the BCELP facility at 900 South Water Street in Bay City, Michigan and two of the engines are located at the BCELP facility at the corner of Henry and Fisher Streets in Bay City, Michigan. The Water Street facility operates under Michigan Department of Environmental Quality (MDEQ) Permit No. 587-96A. The facility located at the corner of Henry and Fisher Streets operates under MDEQ Permit No. 823-91B.

The generators are owned and operated by BCELP. The emissions testing is required by the National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines codified at Title 40, Part 63, Subpart ZZZZ of the Code of Federal Regulations (40 CFR 63, Subpart ZZZZ). This standard requires a CO control efficiency across the catalyst bed of at least 70% at 15% O₂. In addition, Permit No. 587-96A limits outlet NO_x emissions to 2.21 lbs/MMBtu when firing dual fuel and Permit No. 823-91B limits outlet NO_x emissions to 2.03 lbs/MMBtu when firing dual fuel.

The emissions test program was conducted on May 24, 25, and 26, 2016. The results of the emission test program are summarized by Tables E-1 through E-4.

**Table E-1
EUENGINE1 – 900 South Water Street
Overall Emission Summary
Test Date: May 24, 2016**

Inlet Concentration		Outlet Concentration			CO Destruction Efficiency (%)	NO _x Emission Rate (lbs/MMBtu)
CO (ppmvd)	O ₂ (%)	CO (ppmvd)	NO _x (ppmvd)	O ₂ (%)		
398.8	11.35	49.5	758.2	11.31	88	1.72

**Table E-2
EUENGINE2 – 900 South Water Street
Overall Emission Summary
Test Date: May 24, 2016**

Inlet Concentration		Outlet Concentration			CO Destruction Efficiency (%)	NO _x Emission Rate (lbs/MMBtu)
CO (ppmvd)	O ₂ (%)	CO (ppmvd)	NO _x (ppmvd)	O ₂ (%)		
435.6	12.07	64.9	628.93	12.05	85	1.55

Table E-3
EU00001 – Henry Street
Overall Emission Summary
Test Date: May 25, 2016

Inlet Concentration		Outlet Concentration			CO Destruction Efficiency (%)	NOx Emission Rate (lbs/MMBtu)
CO (ppmvd)	O ₂ (%)	CO (ppmvd)	NOx (ppmvd)	O ₂ (%)		
295.3	11.17	39.2	614.0	11.13	87	1.37

Table E-4
EU00002 – Henry Street
Test Date: May 26, 2016

Inlet Concentration		Outlet Concentration			CO Destruction Efficiency (%)	NOx Emission Rate (lbs/MMBtu)
CO (ppmvd)	O ₂ (%)	CO (ppmvd)	NOx (ppmvd)	O ₂ (%)		
356.8	11.19	50.4	617.9	11.21	86	1.39

1. Introduction

BT Environmental Consulting, Inc. (BTEC) was retained by Bay City Electric Light & Power (BCELP) to measure carbon monoxide (CO) and oxygen (O₂) concentrations at the inlet and outlet of catalytic converters on four dual fuel engines and to measure nitrogen oxides (NO_x) concentrations at the catalytic converter outlet on the same four engines. Two of the engines are located at the BCELP facility at 900 South Water Street in Bay City, Michigan and two of the engines are located at the BCELP facility at the corner of Henry and Fisher Streets in Bay City, Michigan. The Water Street facility operates under Michigan Department of Environmental Quality (MDEQ) Permit No. 587-96A. The facility located at the corner of Henry and Fisher Streets operates under MDEQ Permit No. 823-91B.

The generators are owned and operated by BCELP. The emissions testing is required by the National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines codified at Title 40, Part 63, Subpart ZZZZ of the Code of Federal Regulations (40 CFR 63, Subpart ZZZZ). This standard requires a CO control efficiency across the catalyst bed of at least 70% at 15% O₂. In addition, Permit No. 587-96A limits outlet NO_x emissions to 2.21 lbs/MMBtu when firing dual fuel and Permit No. 823-91B limits outlet NO_x emissions to 2.03 lbs/MMBtu when firing dual fuel.

The emissions test program was conducted on May 24, 25, and 26, 2016. The purpose of this report is to document the results of the test program.

AQD has published a guidance document entitled "Format for Submittal of Source Emission Test Plans and Reports" (December 2013). The following is a summary of the emissions test program and results in the format suggested by the aforementioned document.

1.a Identification, Location, and Dates of Test

Two of the engines (EUENGINE1 and EUENGINE 2) are located at the BCELP facility at 900 South Water Street in Bay City, Michigan and two of the engines (EU00001 and EU00002) are located at the BCELP facility at the corner of Henry and Fisher Streets in Bay City, Michigan. The Water Street facility operates under Michigan Department of Environmental Quality (MDEQ) Permit No. 587-96A. The facility located at the corner of Henry and Fisher Streets operates under MDEQ Permit No. 823-91B.

On May 24, 2016, EUENGINE2 was tested followed by testing of EUENGINE1. EU00001 was tested on May 25, 2016 and EU00002 was tested on May 26, 2016. It should be noted that, in the test program field notes and data sheets, EUENGINE1 is designated Engine 1, EUENGINE2 is designated Engine 2, EU00001 is designated Engine 3, and EU00002 is designated Engine 4.

1.b Purpose of Testing

The generators are owned and operated by BCEL P. The emissions testing is required by the National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines codified at Title 40, Part 63, Subpart ZZZZ of the Code of Federal Regulations (40 CFR 63, Subpart ZZZZ). This standard requires a CO control efficiency across the catalyst bed of at least 70% at 15% O₂. In addition, Permit No. 587-96A limits outlet NO_x emissions to 2.21 lbs/MMBtu when firing dual fuel and Permit No. 823-91B limits outlet NO_x emissions to 2.03 lbs/MMBtu when firing dual fuel.

1.c Source Description

EUENGINE1 (permit No. 587-96A) is a dual fuel engine that fires approximately 95% natural gas and 5% diesel fuel. The engine generates 5,757 kilowatts and 8,000 horsepower. EUENGINE2 (permit No. 587-96A) is a dual fuel engine that fires approximately 95% natural gas and 5% diesel fuel. The engine generates 6,955 kilowatts and 9,630 horsepower. E00001 and EU0002 (Permit No. 823-91B) are dual fuel engines that fire approximately 95% natural gas and 5% diesel fuel. These engines generate 7,750 kilowatts each.

1.d Test Program Contacts

The contacts for the source and test report are:

Mr. Lee Techlin
Generation and Maintenance Supervisor
Bay City Electric Light & Power
900 South Water Street
Bay City, Michigan 48708
(989) 894-8223

Mr. Chris Occhipinti
Project Engineer
NTH Consultants, Ltd.
1430 Monroe NW
Grand Rapids, Michigan 49505
(517) 702-2952

Names and affiliations for personnel who were present during the testing program are summarized by Table 1.

**Table 1
Test Personnel**

Name and Title	Affiliation	Telephone
Mr. Lee Techlin Generation and Maintenance Supervisor Bay City Electric Light & Power	Bay City Electric Light & Power 800 South Water Street Bay City, Michigan 48708	(989) 894-8223
Mr. Chris Occhipinti Project Engineer	NTH Consultants, Ltd. 608 S. Washington Ave. Lansing, Michigan 48823	(517) 702-2952
Mr. Todd Wessel Senior Project Manager	BTEC 4949 Fernlee Avenue Royal Oak, MI 48073	(616) 885-4013
Mr. Mike Nummer Environmental Technician	BTEC 4949 Fernlee Avenue Royal Oak, MI 48073	(248) 548-8070
Mr. Mark Dziadosz Environmental Quality Analyst	MDEQ Air Quality Division	(586) 753-3745

2. Summary of Results

Sections 2.a through 2.c summarize the results of the emissions compliance test program.

2.a Operating Data

Process data monitored during the emissions test program is included in Appendix A.

2.b Applicable Permit

Two of the engines (EUENGINE1 and EUENGINE 2) are located at the BCELP facility at 900 South Water Street in Bay City, Michigan and two of the engines (EU00001 and EU00002) are located at the BCELP facility at the corner of Henry and Fisher Streets in Bay City, Michigan. The Water Street facility operates under Michigan Department of Environmental Quality (MDEQ) Permit No. 587-96A. The facility located at the corner of Henry and Fisher Streets operates under MDEQ Permit No. 823-91B.

2.c Results

The overall results of the emission test program are summarized by Tables 2 through 5 (see Section 5.a).

3. Source Description

Sections 3.a through 3.e provide a detailed description of the process.

3.a Process Description

EUENGINE1 (permit No. 587-96A) is a dual fuel engine that fires approximately 95% natural gas and 5% diesel fuel. The engine generates 5,757 kilowatts and 8,000 horsepower. EUENGINE2 (permit No. 587-96A) is a dual fuel engine that fires approximately 95% natural gas and 5% diesel fuel. The engine generates 6,955 kilowatts and 9,630 horsepower. E00001 and EU0002 (Permit No. 823-91B) are dual fuel engines that fire approximately 95% natural gas and 5% diesel fuel. These engines generate 7,750 kilowatts each.

3.b Process Flow Diagram

Due to the simplicity of the engines, a process flow diagram is not necessary.

3.c Raw and Finished Materials

The raw materials used by the process are natural gas and diesel fuel.

3.d Process Capacity

The process capacities are listed in Section 3.a.

3.e Process Instrumentation

Process data is included in Appendix A.

4. Sampling and Analytical Procedures

Sections 4.a through 4.d provide a summary of the sampling and analytical procedures used.

4.a Sampling Train and Field Procedures

CO concentration was measured using two Teledyne Model 300EM CO gas analyzers (or equivalent), and the O₂ content was measured using two M&C Products PMA 100-L O₂ gas analyzers (or equivalent). The NO_x concentration was measured using a Thermal Environmental Model 42i gas analyzer. A sample of the gas stream was drawn through a stainless-steel probe with an in-line glass fiber filter to remove any particulate, a heated Teflon[®] sample line, and through an electronic sample conditioner to remove the moisture from the sample before it enters the analyzers. Data was recorded at 10-second intervals on a PC equipped with data acquisition software.

The configuration of the sampling system allowed for the injection of calibration gases directly to the analyzers or through the sampling system. For analyzer calibrations, calibration gases were mixed to desired concentrations using an EnviroNics Series 4040 Computerized Gas Dilution System. The Series 4040 consisting of a single chassis with four mass flow controllers. The mass flow controllers are factory-calibrated using a primary flow standard traceable to the United States' National Institute of Standards and Technology (NIST). Each flow controller utilizes an 11 point calibration table with linear interpolation, to increase accuracy and reduce flow controller nonlinearity. All monitors in use were calibrated with U.S. EPA Protocol No. 1 calibration gases and operated to ensure that zero drift, calibration gas drift, and calibration error met the specified method requirements. Copies of the Protocol gas certificates can be found in Appendix B.

The sample gas was extracted at three points through a stainless steel probe positioned at 17%, 50% and 83% of the stack diameter. Triplicate 60-minute test runs were conducted on each engine. A schematic of the sampling train is provided as Figure 1.

Sampling and analysis procedures utilized the following test methods codified at Title 40, Part 60, Appendix A of the Code of Federal Regulations (40 CFR 60, Appendix A):

- Method 3A, "*Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources*", was used to measure the O₂ and CO₂ concentration of the exhaust gas.
- Method 7E, "*Determination of Nitrogen Oxides Emissions from Stationary Sources*", was used to measure the NO_x concentration of the exhaust gas.
- Method 10, "*Determination of Carbon Monoxide Emissions from Stationary Sources*", was used to measure the CO concentration of the exhaust gas.
- Method 19, "*Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates*", was used to determine NO_x emission rates in terms of lbs/MMBtu.

For Method 19 calculations, the dry-basis F-factor proposed for the testing is equal to a fuel that would 95% of the natural gas F-factor and 5% of the oil F-factor. This F-factor would be $(8,710 \times 0.95) + (9,190 \times 0.05) = 8,734$ dscf/MMBtu.

4.b Recovery and Analytical Procedures

This test program did not include laboratory samples, consequently, sample recovery and analysis is not applicable to this test program.

4.c Sampling Ports

For each engine, exhaust gas was extracted from the single exhaust pipe at the catalyst inlet and outlet sampling locations with the probe tip located at three sampling points in the duct.

4.d Traverse Points

For each engine, exhaust gas was extracted from the single exhaust pipe at the catalyst inlet and outlet sampling locations with the probe tip located at three sampling points in the duct.

5. Test Results and Discussion

Sections 5.a through 5.k provide a summary of the test results.

5.a Results Tabulation

The overall results of the emissions test program are summarized by Tables 2 through 5.

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Table 2
EUENGINE1 – 900 South Water Street
Overall Emission Summary
Test Date: May 24, 2016

Inlet Concentration		Outlet Concentration			CO Destruction Efficiency (%)	NOx Emission Rate (lbs/MMBtu)
CO (ppmvd)	O ₂ (%)	CO (ppmvd)	NOx (ppmvd)	O ₂ (%)		
398.8	11.35	49.5	758.2	11.31	88	1.72

Table 3
EUENGINE2 – 900 South Water Street
Overall Emission Summary
Test Date: May 24, 2016

Inlet Concentration		Outlet Concentration			CO Destruction Efficiency (%)	NOx Emission Rate (lbs/MMBtu)
CO (ppmvd)	O ₂ (%)	CO (ppmvd)	NOx (ppmvd)	O ₂ (%)		
435.6	12.07	64.9	628.93	12.05	85	1.55

Table 4
EU00001 – Henry Street
Overall Emission Summary
Test Date: May 25, 2016

Inlet Concentration		Outlet Concentration			CO Destruction Efficiency (%)	NOx Emission Rate (lbs/MMBtu)
CO (ppmvd)	O ₂ (%)	CO (ppmvd)	NOx (ppmvd)	O ₂ (%)		
295.3	11.17	39.2	614.0	11.13	87	1.37

Table 5
EU00002 – Henry Street
Test Date: May 26, 2016

Inlet Concentration		Outlet Concentration			CO Destruction Efficiency (%)	NOx Emission Rate (lbs/MMBtu)
CO (ppmvd)	O ₂ (%)	CO (ppmvd)	NOx (ppmvd)	O ₂ (%)		
356.8	11.19	50.4	617.9	11.21	86	1.39

5.b Discussion of Results

The generators are owned and operated by BCELP. The emissions testing is required by the National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines codified at Title 40, Part 63, Subpart ZZZZ of the Code of Federal Regulations (40 CFR 63, Subpart ZZZZ). This standard requires a CO control efficiency across the catalyst bed of at least 70% at 15% O₂. In addition, Permit No. 587-96A limits outlet NOx emissions to 2.21 lbs/MMBtu when firing dual fuel and Permit No. 823-91B limits outlet NOx emissions to 2.03 lbs/MMBtu when firing dual fuel.

As summarized by Tables 2 through 5, each engine meets its corresponding emission limitations.

5.c Sampling Procedure Variations

No sampling variations occurred during the testing.

5.d Process or Control Device Upsets

No upset conditions occurred during testing.

5.e Control Device Maintenance

There was no control equipment maintenance performed immediately before the emissions test program.



5.f Re-Test

The emissions test program was not a re-test.

5.g Audit Sample Analyses

No audit samples were collected as part of the test program.

5.h Calibration Sheets

Relevant equipment calibration documents are provided in Appendix B.

5.i Sample Calculations

Sample calculations are provided in Appendix C.

5.j Field Data Sheets

Field documents relevant to the emissions test program are presented in Appendix D.

5.k Laboratory Data

Raw CEM data is provided electronically in Appendix D.

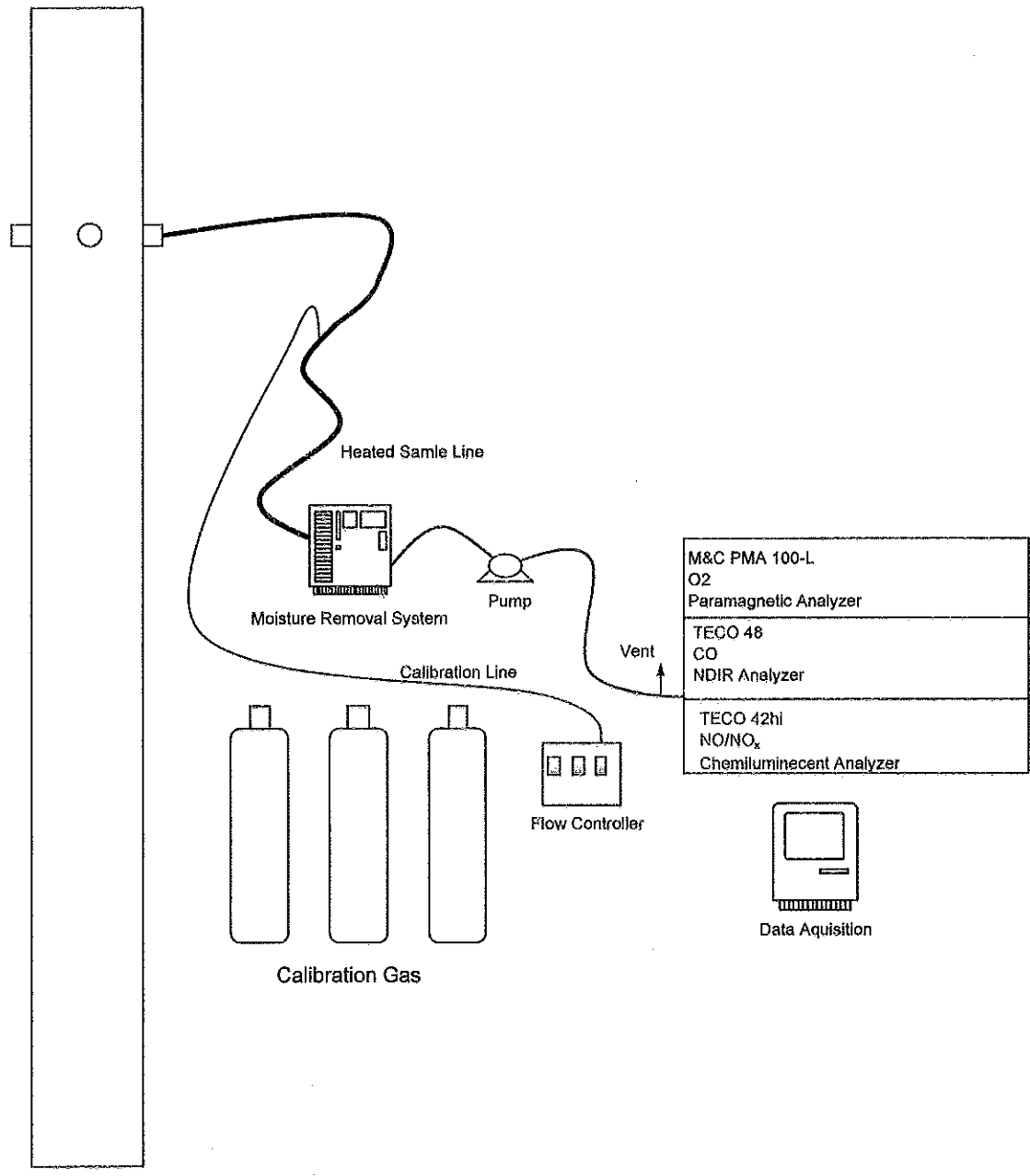


Figure 1

Site:
USEPA Method 3A/7E/10
Bay City Electric Light & Power
Dual Fuel Engines

Sampling Dates:
May 24, 25, and 26, 2016

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