Report

Emissions Testing
Diesel RICE
Test Date: October 25, 2013

Eaton Corporation
13100 E. Michigan Avenue
Galesburg, Michigan

NTH Project No. 73-130570-01
October 31, 2013

NTH Consultants, Ltd.
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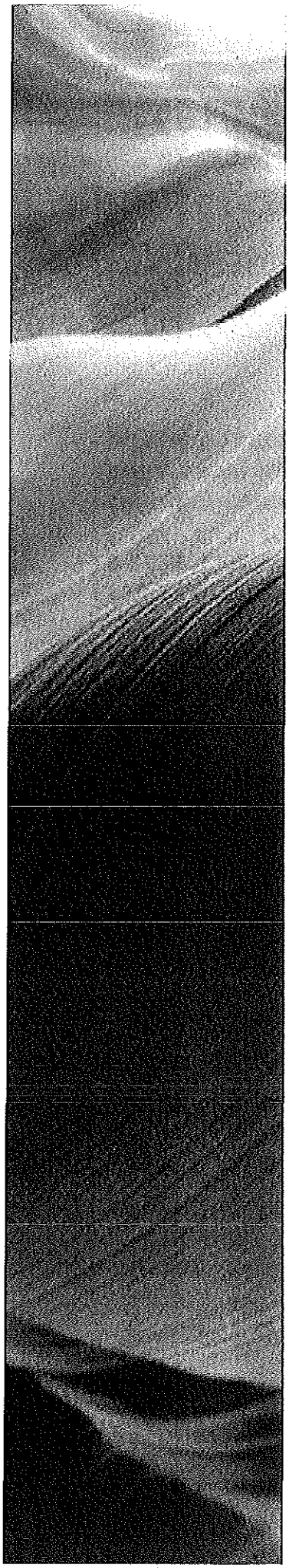

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1.0 INTRODUCTION

NTH Consultants, Ltd. (NTH) was retained by Eaton Corporation (Eaton) to conduct initial performance testing for carbon monoxide (CO) on a single diesel-fired compression ignition (CI) reciprocating internal combustion engine (RICE). The diesel-fired RICE is located at the Eaton facility in Galesburg, Michigan.

1.1 Purpose of Test

The testing was performed to demonstrate compliance with the emission standards for CO pursuant to the requirements contained in Subpart ZZZZ to 40 CFR Part 63 (RICE MACT). Specifically, the diesel-fired RICE, an existing non-emergency stationary CI engine with a rating of 500 horsepower (hp), is required to reduce CO emissions by 70 percent or more, or meet a CO limit of 49 parts per million by volume, dry (ppmvd) corrected to 15 percent oxygen (O_2).

1.2 Test Date

The testing was performed on October 25, 2013.

1.3 Project Contact Information

Location	Address	Contact
Test Facility	Eaton Corporation 13100 E. Michigan Avenue Galesburg, Michigan 49053	Mr. Mike Galloway (269) 342-3455 MichaelAGalloway@Eaton.com
Test Company Representative	NTH Consultants, Ltd. 1430 Monroe Avenue NW, Suite 180 Grand Rapids, Michigan 49505	Mr. Graziano Gozzi, QSTI (616) 451-6262 ggozzi@nthconsultants.com

This test program was performed by Messrs. Kyle Daneff and Tyler Hanna under the supervision of Mr. Graziano Gozzi of NTH. Mr. Mike Galloway of Eaton coordinated the test event.

1.4 Summary of Results

Triplicate 60-minute test runs were performed for CO at the exhaust location of the diesel engine, prior to and after the oxidation catalyst. CO concentrations were measured in ppmvd. The concentrations were then corrected to 15 percent O_2. Testing was performed at normal maximum engine capacity of approximately 350 hp. Although the maximum nameplate capacity is 500 hp, the maximum achievable load is approximately 350 hp based on actual engine run data. Thus, this emissions test event was conducted within plus or minus 10 percent of 350 hp, as required by Subpart ZZZZ to 40 CFR Part 63.

The comprehensive CO field data compiled during the test runs is located in Appendix D. Results and calculations are contained in Appendix B. A summary of the CO test results is shown in Table 1-1 below. Detailed results are presented in Table 1 at the end of this report.

Table 1-1. Average Diesel Engine CO Test Results

Inlet CO Concentration (ppmvd at 15% O_2)	Outlet CO Concentration (ppmvd at 15% O_2)	CO Reduction (%)	Subpart ZZZZ Requirement
14.04	2.24	83.9%	Outlet CO Concentration of 49 ppmdv at 15% O_2 or CO Reduction of 70%

ppmvd at 15% O_2: parts per million by volume, dry, corrected to 15% O_2

2.0 PROCESS DESCRIPTION

Eaton is a power management company that provides electrical, hydraulic, and mechanical power solutions globally. The Eaton facility located in Galesburg, Michigan owns and operates a 500 horsepower (hp) diesel-fired RICE that is used for transmission testing. Eaton has recently installed an oxidation catalyst in the engine exhaust stack for the purpose of complying with the RICE MACT. The emission testing was conducted at the inlet and outlet of the oxidation catalyst.

3.0 REFERENCE METHODS AND PROCEDURES

The following U.S. EPA Reference Test Methods were performed for the emissions testing:

- **Method 3A:** Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)

- **Method 10:** Determination of Carbon Monoxide Emissions from Stationary Sources

3.1 Exhaust Gas Composition

The exhaust gas composition was determined using U.S. EPA Reference Method 3A. The oxygen concentrations were used to determine exhaust gas composition and to correct emissions to 15 percent oxygen.

3.2 Carbon Monoxide

The CO concentrations were measured using a non-dispersive infrared analyzers (NDIR) following the guidelines of U.S. EPA Reference Method 10. The analyzers were calibrated at a minimum of three points: zero gas, mid-level gas (40-60 percent of calibration span), and high-level gas (90 – 100 percent of span) for the testing.

The setup of the trailer and stack is shown in Figure 1.

3.3 Data Acquisition System

Information and data from each analog instrument signal output was collected with a STRATA® data acquisition system (DAS). Calibration error, drift and bias corrections were calculated automatically. All gathered data was linked to spreadsheets that support dynamic data exchange (i.e. Microsoft™ Excel) for quick data reduction and report generation.

4.0 QUALITY ASSURANCE

Each promulgated U.S. EPA reference method described above is accompanied by a statement indicating that to obtain reliable results, persons using these methods should have a thorough knowledge of the techniques associated with each. To that end, NTH attempts to minimize any factors in the field that could increase error by implementing a quality assurance program into every testing activity segment.

U.S. EPA Protocol No. 1 gas standards were used to calibrate the CO and O_2 analyzers during the test program. These gases are certified according to the *U.S. EPA Traceability Protocol for Assay & Certification of Gaseous Calibration Standards; Procedure G-1; September, 1997*, and are certified to have a total relative uncertainty of ±1 percent.

The DAS software in use during the testing is programmed to the specifications described in the applicable U.S. EPA Method in use during the test, and operates based on each pre-programmed analyzer span value.

5.0 DISCUSSION OF RESULTS

Operations at the diesel engine appeared normal with no apparent problems. Test results are tabulated and can be found in Table 1 at the end of this section. Process data was collected by Eaton and can be found in Appendix C. QA/QC information in contained in Appendix E.

TABLES

Table 1

Eaton Corporation

Diesel RICE

Summary of CO Concentrations and Reduction Efficiency

October 25, 2013

Run No.	1	2	3	Average
Run Time	0954-1054	1157-1257	1320-1420	
Process Conditions Horsepower:	352	354	351	
Fixed Gases **Prior to the Oxidation Catalyst (Inlet):** Oxygen, % by volume, dry:	9.99	9.74	10.09	9.94
After the Oxidation Catalyst (Outlet): Oxygen, % by volume, dry:	8.93	9.07	9.46	9.15
Run No.	1	2	3	Average
Prior to the Oxidation Catalyst (Inlet): CO Concentration, ppmvd corrected to 15% O_2:	13.84	15.65	12.62	14.04
After the Oxidation Catalyst (Outlet): CO Concentration, ppmvd corrected to 15% O_2:	1.82	2.47	2.45	2.24
CO Reduction Efficiency Percent CO Reduced, %:	86.9%	84.3%	80.6%	83.9%

ppmvd corrected to 15% O_2: parts per million by volume, dry, corrected to 15% oxygen

CO Concentration, ppmvd corrected to 15% O_2 = CO ppmvd x [(20.9 - 15)/(20.9 - O_2%)]
Percent CO Reduced, % = (inlet CO corrected to 15% O_2 - outlet CO corrected to 15% O_2)/(inlet CO corrected to 15% O_2)

FIGURES

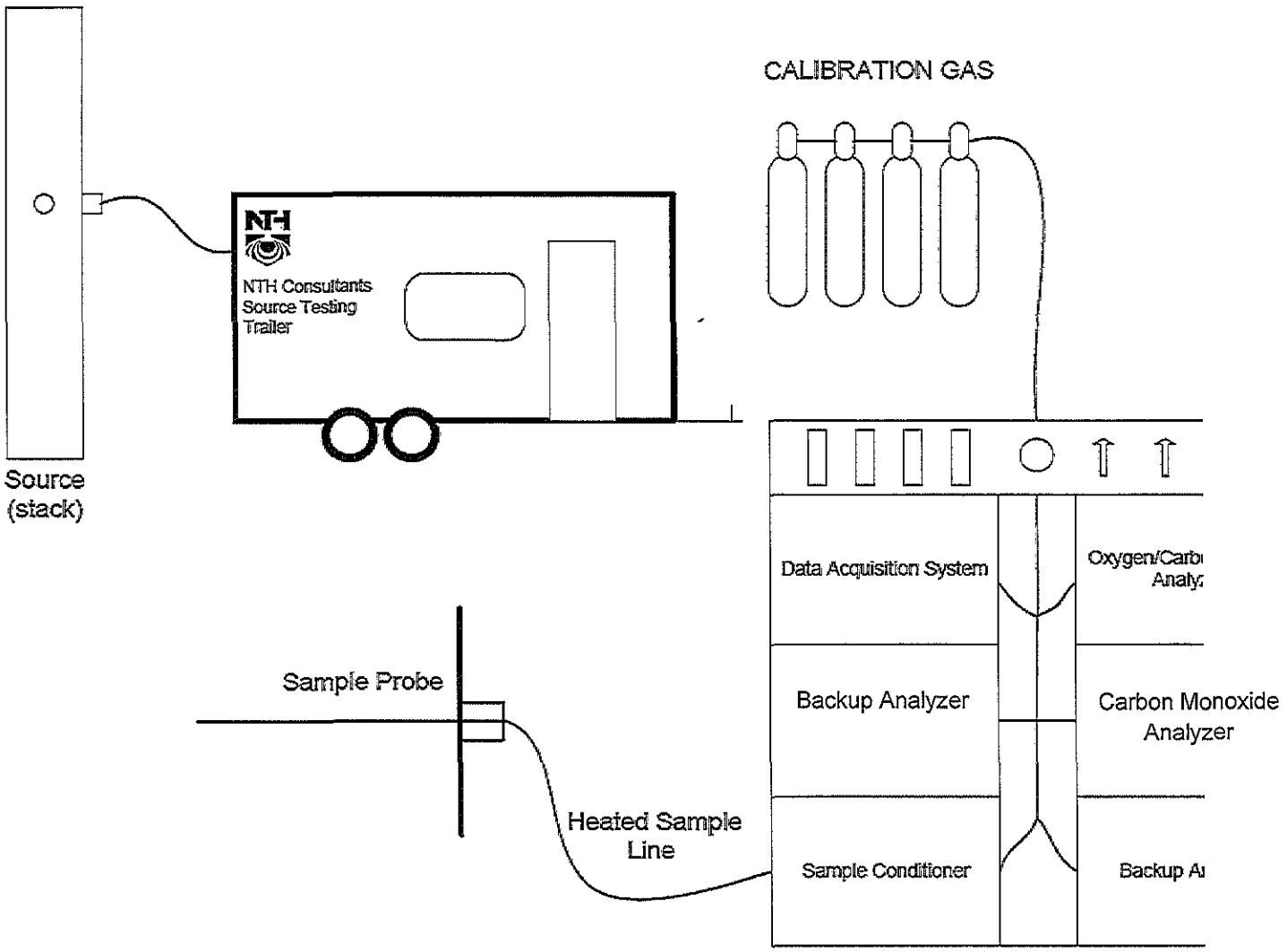

Figure No. 1
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Gas Composition/Carbon Monoxide Anal