Report of...

Compliance Emission Sampling

Performed for the...

City of Wyandotte
Municipal Services
Wyandotte, Michigan

On...

Diesel Engines #1, #2 & #3

October 29 & November 3-4, 2015

256.13

By...

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Performed for:

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I. INTRODUCTION

Network Environmental, Inc. was retained by the City of Wyandotte, Department of Municipal Services, to perform an emission study on their Diesel Engines #1, #2 & #3 (permitted as EU-WMSENGINE1, EU-WMSENGINE2 AND EU-WMSENGINE3). The purpose of the study was to document compliance with MDEQ Air Quality Division ROP No. MI-ROP-B2132-2010. MI-ROP-B2132-2010 has established the following emission limits for these engines under flexible group, FGWMSENGINES:

- Carbon Monoxide (CO) reduction (destruction efficiency) of 70% **Or** a formaldehyde emission limit of 580 parts per billion (v/v), Dry @ 15% O_2
- Oxides of Nitrogen (NO_x) emission limit of 35.9 Tons/Year (per 12 month rolling time period). The tested emission rate is used to develop an emission factor.

The CO reduction was determined by monitoring the CO concentrations at the inlet and outlet of each engine's catalytic oxidation emission control system. The NO_x emissions were only required to be determined on one (1) engine. NO_x was monitored on the Engine #2 exhaust only. In conjunction with the NO_x sampling, the exhaust gas parameters (air flow rate, temperature, moisture & density) were also determined, in order to calculate the NO_x mass emission rate (Lbs/Hr) for Engine #2.

The testing was designed to meet the requirements of MI-ROP-B2132-2010 and 40CFR Part 63 Subparts A & ZZZZ. The following reference test methods were employed to conduct the sampling:

- CO – U.S. EPA Method 10
- NO_x – U.S. EPA Method 7E
- O_2 & CO_2 – U.S. EPA Method 3A
- Exhaust Gas Parameters (air flow rate, temperature, moisture & density) – U.S. EPA Reference Methods 1 through 4.

The sampling was performed over the period of October 29 through November 4, 2015 by Stephan K. Byrd, Richard D. Eerdmans and David D. Engelhardt of Network Environmental, Inc.. Assisting with the study were Ms. Kimberly Kemper of Wyandotte Municipal Services, Mr. Nick Hansen of Barr Engineering and the operating staff of the facility. Mr. Mark Dziadosz and Mr. Thomas Maza of the Michigan Department of Environmental Quality (MDEQ) - Air Quality Division were present to observe portions of the sampling and source operation.

II. PRESENTATION OF RESULTS

II.1 TABLE 1
CO DESTRUCTION EFFICIENCY RESULTS
DIESEL ENGINES
CITY OF WYANDOTTE
WYANDOTTE, MICHIGAN

Source	Sample	Date	Time	CO Concentration PPM [1]		CO % Destruction Efficiency
				Inlet	Outlet	
Diesel Engine #1 (EU-WMSENGINE1)	1	10/29/15	10:06-11:06	60.70	2.37	96.09
	2	10/29/15	11:18-12:18	62.07	2.35	96.23
	3	10/29/15	12:28-13:28	62.85	2.35	96.26
		Average		**61.88**	**2.36**	**96.19**
Diesel Engine #2 (EU-WMSENGINE2)	1	11/03/15	10:04-11:04	39.86	2.05	94.86
	2	11/03/15	11:22-12:22	38.99	2.19	94.38
	3	11/03/15	12:39-13:39	37.87	2.11	94.44
		Average		**38.90**	**2.11**	**94.56**
Diesel Engine #3 (EU-WMSENGINE3)	1	11/04/15	09:07-10:07	50.70	3.04	94.01
	2	11/04/15	10:17-11:17	54.27	3.21	94.08
	3	11/04/15	11:28-12:28	54.43	3.12	94.26
		Average		**53.13**	**3.12**	**94.12**

(1) PPM = Parts Per Million (v/v) On A Dry Basis Corrected To 15% O_2
(2) The engines were operated at 1800 kW (99% of capacity) during all of the testing.
(3) MI-ROP-B2132-2010 has established an emission limit of 70% CO reduction (destruction efficiency) for these engines.

II.2 TABLE 2
OXIDES OF NITROGEN (NO_x) EMISSION RESULTS
DIESEL ENGINE #2
CITY OF WYANDOTTE
WYANDOTTE, MICHIGAN

Source	Sample	Date	Time	Air Flow Rate DSCFM [1]	NO_x Concentration PPM [2]	NO_x Emission Rate Lbs/Hr [3]
Diesel Engine#2 (EU-WMSENGINE2)	1	11/03/15	10:04-11:04	3,723	967.7	25.64
	2	11/03/15	11:22-12:22	3,714	956.3	25.28
	3	11/03/15	12:39-13:39	3,708	953.9	25.17
	Average			**3,715**	**959.3**	**25.36**

(1) DSCFM = Dry Standard Cubic Feet Per Minute (Standard Temperature & Pressure = 68 °F & 29.92 In. Hg).
(2) PPM = Parts Per Million (v/v) On A Dry Basis
(3) Lbs/Hr = Pounds of NO_x Per Hour

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III. DISCUSSION OF RESULTS

The results of the emission sampling are summarized in Tables 1 & 2 (Sections II.1 & II.2). The results are presented as follows:

III.1 Carbon Monoxide (CO) Destruction Efficiency Results (Table 1)

Table 1 summarizes the CO DE results for the diesel engine catalytic oxidation systems as follows:

- Source
- Sample
- Date
- Time
- Inlet & Outlet CO Concentrations (PPM) – Parts Per Million (v/v) On A Dry Basis Corrected To 15% O_2
- CO Percent Destruction Efficiency (DE)

III.2 NO_x Emissions – The Diesel Engine #2 NO_x emissions are summarized in Table 2 as follows:

- Source
- Sample
- Date
- Time
- Air Flow Rate (DSCFM) – Dry Standard Cubic Feet Per Minute (Standard Temperature and Pressure = 68 °F and 29.92 Inches Hg)
- NO_x Concentration (PPM) – Parts Per Million (v/v) On A Dry Basis
- NO_x Mass Emission Rates (Lbs/Hr) – Pounds of NO_x Per Hour

IV. SOURCE DESCRIPTION

The engines tested are 1,825 kW standby compression ignition diesel fuel fired engine generators, each equipped with a catalytic oxidation emission control system. Testing was performed at 1800 kW (99% of load capacity) for all the engines. Process operating data collected during the sampling can be found in Appendix F.

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V. SAMPLING AND ANALYTICAL PROTOCOL

Pictures of the sampling locations can be found in Appendix E.

The sampling methods used for the reference method determinations were as follows:

V.1 Carbon Monoxide – The CO sampling was conducted in accordance with U.S. EPA Reference Method 10. A Thermo Environmental Model 48C gas analyzer was used to monitor the catalyst inlets. A Thermo Environmental Model 48 gas analyzer was used to monitor the catalyst outlets. Heated Teflon sample lines were used to transport the inlet and outlet gases to a gas conditioner to remove moisture and reduce the temperature. From the gas conditioner stack gases were passed to the analyzers. The analyzers produce instantaneous readouts of the CO concentrations (PPM).

The analyzers were calibrated by direct injection prior to the testing. Span gases of 169.2 PPM (inlets) and 25.10 PPM (outlets) were used to establish the initial instrument calibrations. Calibration gases of 49.66 PPM & 92.97 PPM for the inlets and 9.23 PPM & 15.30 PPM for the outlets were used to determine the calibration error of the analyzers. The sampling systems (from the back of the stack probes to the analyzers) were injected using the 9.23 PPM or 92.97 PPM gases to determine the system bias. After each sample, a system zero and system injection of 9.23 PPM or 92.97 PPM were performed to establish system drift and system bias during the test period. All calibration gases were EPA Protocol 1 Certified.

The analyzers were calibrated to the output of the data acquisition system (DAS) used to collect the data from the engines. A diagram of the CO sampling train is shown in Figure 1.

V.2 Oxides of Nitrogen (Engine #2 Outlet only) – The NO_x sampling was conducted in accordance with U.S. EPA Reference Method 7E. A Thermo Environmental Model 42H gas analyzer was used to monitor the Engine #2 outlet. A heated Teflon sample line was used to transport the exhaust gases to a gas conditioner to remove moisture and reduce the temperature. From the gas conditioner stack gases were passed to the analyzer. The analyzer produces instantaneous readouts of the NO_x concentrations (PPM).

The analyzer was calibrated by direct injection prior to the testing. A span gas of 2,020 PPM was used to establish the initial instrument calibration. Calibration gases of 486.9 PPM and 980.0 PPM were used to determine the calibration error of the analyzer. A direct injection of 51.97 PPM nitrogen dioxide (NO_2) was performed to show the conversion efficiency of the monitor. The conversion efficiency data can be found in

Appendix B. The sampling system (from the back of the stack probe to the analyzer) was injected using the 980.0 PPM gas to determine the system bias. After each sample, a system zero and system injection of 980.0 PPM were performed to establish system drift and system bias during the test period. All calibration gases were EPA Protocol 1 Certified.

The analyzer was calibrated to the output of the data acquisition system (DAS) used to collect the data from the outlet. A diagram of the NO_x sampling train is shown in Figure 1.

V.3 Oxygen (Outlets only) – The O_2 sampling was conducted in accordance with U.S. EPA Reference Method 3A. A Servomex Model 1400M portable stack gas analyzer was used to monitor the outlets. A heated Teflon sample line was used to transport the exhaust gases to a gas conditioner to remove moisture and reduce the temperature. From the gas conditioner stack gases were passed to the analyzer. The analyzer produces instantaneous readouts of the O_2 concentrations (%).

The analyzer was calibrated by direct injection prior to the testing. A span gas of 20.96% was used to establish the initial instrument calibration. Calibration gases of 11.99% and 5.942% were used to determine the calibration error of the analyzer. The sampling system (from the back of the stack probe to the analyzer) was injected using the 11.99% gas to determine the system bias. After each sample, a system zero and system injection of 11.99% were performed to establish system drift and system bias during the test period. All calibration gases were EPA Protocol 1 Certified.

The analyzer was calibrated to the output of the data acquisition system (DAS) used to collect the data from the outlets. A diagram of the O_2 sampling train is shown in Figure 1.

V.4 Oxygen (Inlets only) – Inlet O_2 concentration is assumed equal to outlet concentrations based upon previous test results.

V.5 Carbon Dioxide (Engine #2 Outlet only) – The CO_2 sampling was conducted in accordance with U.S. EPA Reference Method 3A. A Servomex Model 1400M portable stack gas analyzer was used to monitor the Engine #2 outlet. A heated Teflon sample line was used to transport the exhaust gases to a gas conditioner to remove moisture and reduce the temperature. From the gas conditioner stack gases were passed to the analyzer. The analyzer produces instantaneous readouts of the CO_2 concentrations (%).
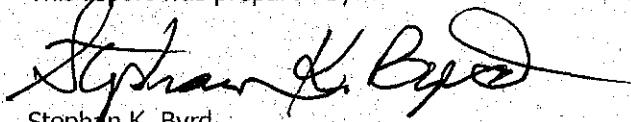
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The analyzer was calibrated by direct injection prior to the testing. A span gas of 20.42% was used to establish the initial instrument calibration. Calibration gases of 12.01% and 6.028% were used to determine the calibration error of the analyzer. The sampling system (from the back of the stack probe to the analyzer) was injected using the 6.028% gas to determine the system bias. After each sample, a system zero and system injection of 6.028% were performed to establish system drift and system bias during the test period. All calibration gases were EPA Protocol 1 Certified.

The analyzer was calibrated to the output of the data acquisition system (DAS) used to collect the data from the outlet. A diagram of the CO_2 sampling train is shown in Figure 1.
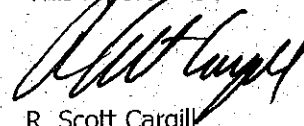
V.6 Moisture (Engine #2 Outlet only) – The moisture was determined in accordance with U.S. EPA Method 4. The samples were withdrawn from the stack and passed through a condensing coil with drop out before being passed through pre-weighed silica gel. The water collected was measured to the nearest 1 ml and the silica gel was re-weighed to the nearest 0.5 g. The moisture collected along with the sample volume was used to determine the percent moisture in the Engine #2 outlet. Each sample had a minimum sample volume of twenty-one (21) standard cubic feet. A diagram of the moisture sampling train is shown in Figure 2.

V.7 Air Flows (Engine #2 Outlet only) – The air flow rates were determined in conjunction with the other sampling by employing U.S. EPA Reference Methods 1 and 2. The sampling for the source was conducted on the 14 inch I.D. exhaust stack. A total of 12 traverse points (6 per sampling port) were used for the air flow determinations. The sample point dimensions are shown in Appendix E. Velocity pressures were determined using an S-Type pitot tube. Temperatures were measured using a Type K thermocouple. Oxygen and carbon dioxide content was determined in conjunction with the CO/NO_x sampling. A diagram of the air flow sampling train is shown in Figure 3.

This report was prepared by:

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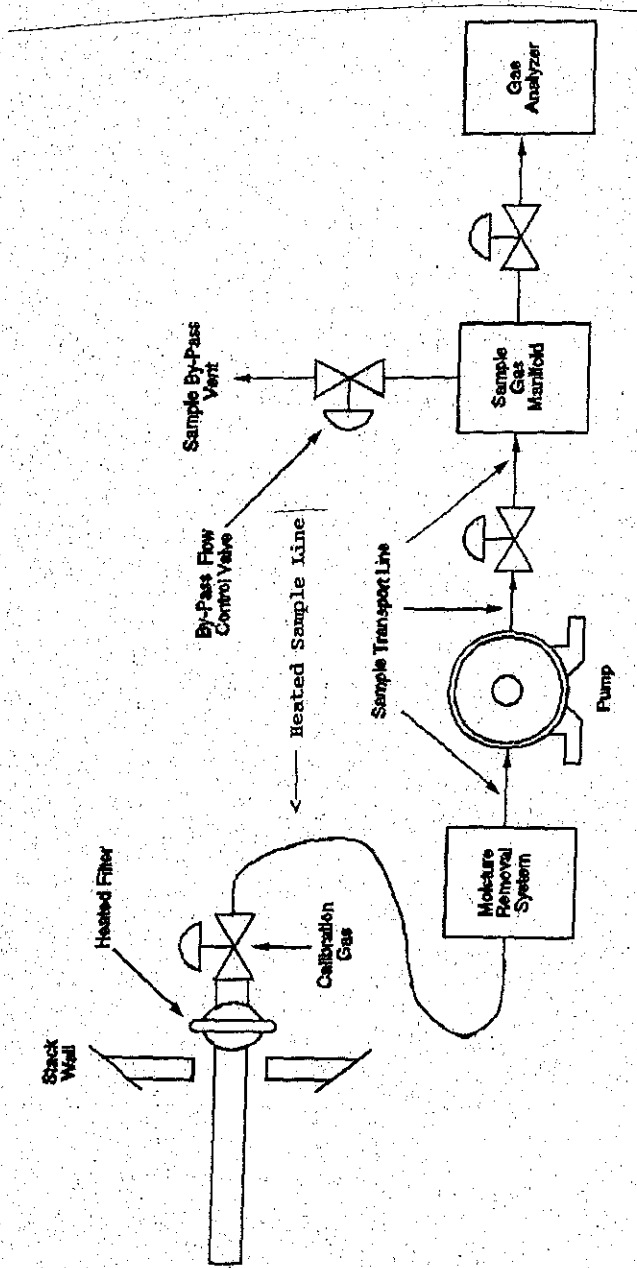
R. Scott Cargill
Vice President
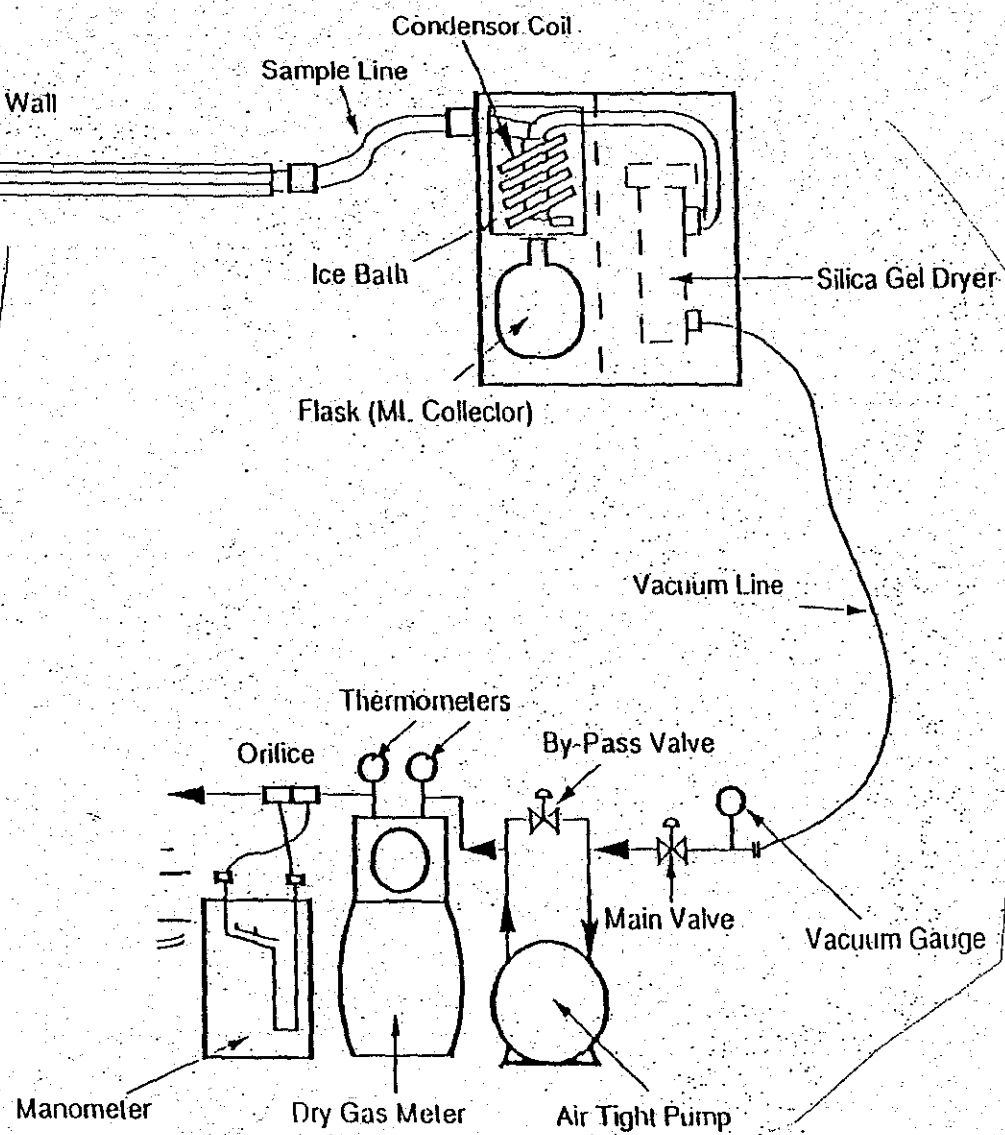
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Figure 1

CO, O_2, NO_x & CO_2 Sampling Train

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Condensor Coil

Sample Line

Slack Wall

Ice Bath

Silica Gel Dryer

Flask (Ml. Collector)

Vacuum Line

Thermometers

Orifice

By-Pass Valve

Main Valve

Vacuum Gauge

Manometer

Dry Gas Meter

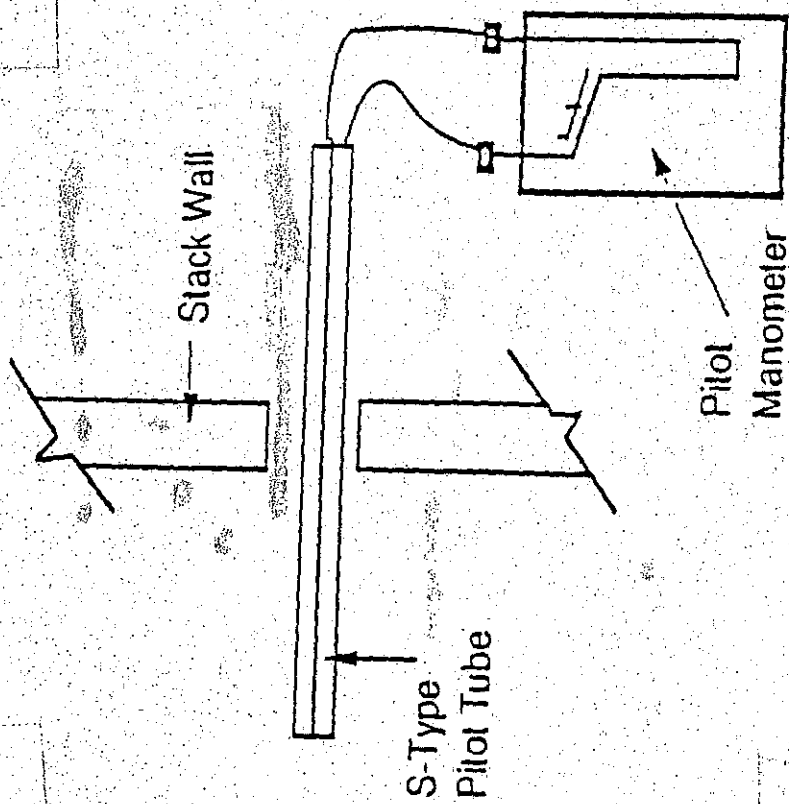Air Tight Pump

Figure 2

Moisture Sampling Train

Stack Wall

S-Type
Pilot Tube

Pilot
Manometer

Figure 3

Air Flow Sampling Train