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# Emergency Generator Engine Emissions Test Report

N/5813

*Prepared for:*

**The United States Geological Survey**

Ann Arbor, Michigan

Engine Location: The United States Geological Survey  
Great Lakes Science Center  
1451 Green Road  
Ann Arbor, Michigan

Project No. 13-4389.00  
June 18, 2013

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**EXECUTIVE SUMMARY**

BT Environmental Consulting, Inc. (BTEC) was retained by The United States Geological Survey (USGS) to evaluate emission rates from a new emergency generator set located outside the USGS Great Lakes Science Center building at 1451 Green Road in Ann Arbor, Michigan. The generator set is a Gaseous Fuel Generator Set Model GTA28 CC Engine Series manufactured by Cummins. The emissions test program was conducted on May 9, 2013.

Testing consisted of triplicate 60-minute test runs. The generator set is owned and operated by USGS. Because the engine qualifies for exemption from permitting pursuant to R 336.1285(g) and R 336.1212(4)(d), it is not included in a permit. The emissions testing is required by the Standards of Performance for Stationary Spark Ignition Internal Combustion Engines codified at Title 40, Part 60, Subpart JJJJ of the Code of Federal Regulations (40 CFR 60, Subpart JJJJ). Emission limitations included in Subpart JJJJ that are applicable to this generator set are summarized in Table E-I in addition to test program summary results.

**Table E-I  
U.S. Geological Survey  
Great Lakes Science Center Emergency Generator  
Compliance Test Program Results Summary**

Source	Pollutant	Test Result (ppmv @15%/O <sub>2</sub> )	Emission Limitation (ppmv @15%/O <sub>2</sub> )
GTA28 CC Generator Set	NO <sub>x</sub>	48	160
	CO	101	540
	VOC	0	86

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## **1. Introduction**

BT Environmental Consulting, Inc. (BTEC) was retained by The United States Geological Survey (USGS) to evaluate emission rates from a new emergency generator set located outside the USGS Great Lakes Science Center building at 1451 Green Road in Ann Arbor, Michigan. The generator set is a Gaseous Fuel Generator Set Model GTA28 CC Engine Series manufactured by Cummins.

The Air Quality Division (AQD) of Michigan's Department of Natural Resources and Environment has published a guidance document entitled "Format for Submittal of Source Emission Test Plans and Reports" (February 2008, see Appendix A). The following is a summary of the emissions test program and results in the format outlined by the AQD document.

### **1.a Identification, Location, and Dates of Test**

Field-sampling for this emission test program was conducted on May 9, 2013 at 1451 Green Road in Ann Arbor, Michigan. The purpose of this report is to document the results of the emissions determined during the compliance test program.

### **1.b Purpose of Testing**

The generator set is owned and operated by USGS. Because the engine qualifies for exemption from permitting pursuant to R 336.1285(g), it is not included in a permit. The emissions testing is required by the Standards of Performance for Stationary Spark Ignition Internal Combustion Engines codified at Title 40, Part 60, Subpart JJJJ of the Code of Federal Regulations (40 CFR 60, Subpart JJJJ). Emission limitations included in Subpart JJJJ that are applicable to this generator set are summarized by Table 2 (see Section 2.d).

The purpose of the testing was to quantify emission levels of oxides of nitrogen (NO<sub>x</sub>), CO, and VOC (as propane). In addition, the concentrations of oxygen (O<sub>2</sub>), methane (CH<sub>4</sub>), formaldehyde (HCOH), and moisture in the engine exhaust were measured during the emissions test program.

### **1.c Test Program Contact**

The contact for the test program is:

Mr. Scott McIlhargey  
Facility Operations Specialist  
The United States Geological Survey  
Great Lakes Science Center  
1451 Green Road  
Ann Arbor, Michigan 48105  
(734) 214-7248



### 1.d Test Personnel

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

**Table 1**  
**Test Personnel**

<b>Name and Title</b>	<b>Affiliation</b>	<b>Telephone</b>
Mr. Steve Polloni Power Generation Field Technician	Cummins Bridgeway, LLC 21810 Clessie Court New Hudson, Michigan 48165	(313) 215-3746
Mr. Thaddeus Gibson Maintenance Specialist	United States Geological Survey Great Lakes Science Center 1451 Green Road Ann Arbor, Michigan 48105	(734) 660-9741
Mr. Tom Gasloli Technical Programs Unit	MDEQ Technical Programs Unit Air Quality Division	(517) 335-4861
Mr. Randal J. Tysar Sr. Environmental Engineer	BTEC 4949 Fernlee Avenue Royal Oak, MI 48073	(248) 548-8070
Mr. Todd Wessel Sr. Project Manager	BTEC 4949 Fernlee Avenue Royal Oak, MI 48073	(616) 885-4013

## 2. Summary of Results

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

### 2.a Operating Data

The generator set was run prior to testing to ensure proper internal temperature could be reached for the onboard non-selective catalytic reduction (NSCR) system and to adjust the fuel/air mix ratio for optimal emissions control system performance. As specified by 40 CFR 60.4244(a), emissions testing was conducted with the engine operating within 10 percent of 100 percent peak load. The power generation rate during the emissions test program was approximately 407 kW.

### 2.b Applicable Permit

The engine qualifies for exemption from permitting pursuant to R 336.1285(g) and is not included in a permit. The emissions testing is required by the Standards of Performance for Stationary Spark Ignition Internal Combustion Engines codified at Title 40, Part 60, Subpart JJJJ of the Code of Federal Regulations (40 CFR 60, Subpart JJJJ).

### 2.c Results

The overall results of the emissions compliance test program are summarized by Table 3 (see Section 5.a).

### 2.d Emission Regulation Comparison

Emission limitations for the Great Lakes Science Center emergency generator set are summarized by Table 2.

**Table 2**  
**Emission Limitations for Emergency Generators Greater Than 130 hp**

Pollutant	Emission Limitation (ppmv@15% O <sub>2</sub> )	Emission Limitation (g/bhp-hr)
NOx	160	2.0
CO	540	4.0
VOC	86	1.0

Note: Emission Limitations are expressed in two separate units. Either set of emission limitations can be used to demonstrate compliance with 40 CFR 60, Subpart JJJJ. Emissions were determined in terms of concentration (ppmv@15% O<sub>2</sub>).

As summarized by Table 3 (Section 5.a), the emissions test result for each pollutant was less than the corresponding emission limitation.



### **3. Source Description**

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

#### **3.a Process Description**

The Cummins NPower GF-series commercial generator set is a fully integrated power generation system for stationary standby or prime power applications.

#### **3.b Raw and Finished Materials**

The only raw material supplied to the generator set is natural gas.

#### **3.c Process Capacity**

The generator is rated for a maximum natural gas usage rate of 5,890 cfh at 450 kW generation.

#### **3.d Process Instrumentation**

The engine is equipped with controls to adjust the fuel-air ratio of the engine intake manifold.



#### 4. Sampling and Analytical Procedures

Sections 4.a through 4.d provide a summary of the sampling and analytical procedures used to verify emissions from the emergency generator.

##### 4.a Sampling Train and Field Procedures

Sampling and analysis procedures followed the methodologies of the following emission test methods codified at Title 40, Part 60, Appendix A of the Code of Federal Regulations (40 CFR 60, Appendix A) and 40 CFR 63, Appendix A:

- Method 3A - *“Determination of Oxygen and Carbon Dioxide Concentrations in emissions from Stationary Sources”*
- Method 320 - *“Measurement of Vapor Phase Organic and Inorganic Emissions by Extractive Fourier Transform Infrared Spectroscopy”*

The O<sub>2</sub> content was measured using a M&C Products PMA 100-L O<sub>2</sub> gas analyzer (or equivalent) and the CO<sub>2</sub> content was measured using a CAI 600 Series CO<sub>2</sub> gas analyzer (or equivalent). A sample of the gas stream was drawn through an insulated stainless-steel probe with an in-line glass fiber filter to remove any particulate, a heated Teflon<sup>®</sup> sample line, and through an electronic sample conditioner to remove the moisture from the sample before it entered the analyzers. Data was recorded at 4-second intervals on a PC equipped with data acquisition software.

Exhaust gas CO, NO, NO<sub>2</sub>, CH<sub>2</sub>O formaldehyde, CH<sub>4</sub>, C<sub>2</sub>H<sub>6</sub> (ethane), C<sub>2</sub>H<sub>4</sub> (ethylene), C<sub>3</sub>H<sub>8</sub> (propane) and total aliphatic hydrocarbons (as hexane) concentrations were measured by Fourier Transform Infrared (FTIR) spectroscopy. Emissions from the engine were continually purged through the sampling system and FTIR. The sample gas was extracted from the engine exhaust using a heated stainless steel probe, maintained at 191°C. A heated filter box (191°C) connected the probe to the filter assembly to a heated transfer line. A 0.1µ glass filter will used for particulate matter removal. A heated diaphragm pump was used to pull the sample from the engine. The sampling rate was 8 to 10 liters per minute.

The heated transfer line, held at 191°C, connected the probe/filter assembly to the FTIR. The FTIR was be equipped with a temperature-controlled, 5.11 meter multipass gas cell maintained at 191°C.

FTIR data was collected using an MKS MultiGas 2030 FTIR spectrometer. All data was collected at 0.5cm<sup>-1</sup> resolution. Each sample spectrum was derived from the co-addition of 60 scans, with a new data point generated every one minute.

FTIR sampling and analysis was conducted by Prism Analytical Technologies, Inc. (PATI) of Mount Pleasant, Michigan. A copy of PATI's test summary report is included as

Appendix B. Figure 1 presents a diagram of the O<sub>2</sub>/CO<sub>2</sub> monitoring system and Figure 2 presents a diagram of the FTIR monitoring system.

#### **4.b Recovery and Analytical Procedures**

Recovery and analytical procedures were described in Section 4.a.

#### **4.c Sampling Ports**

All sampling took place at the engine exhaust duct.

#### **4.d Traverse Points**

The generator set came pre-installed with one exhaust duct that is 8 inches in diameter.

## 5. Test Results and Discussion

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

### 5.a Results Tabulation

The results of the emissions test program are summarized by Table 3.

**Table 3**  
**U.S. Geological Survey**  
**Great Lakes Science Center Emergency Generator**  
**Compliance Test Program Results Summary**

Source	Pollutant	Test Result (ppmv @15%/O <sub>2</sub> )	Emission Limitation (ppmv @15%/O <sub>2</sub> )
GTA28 CC Generator Set	NOx	48	160
	CO	101	540
	VOC	0	86

### 5.b Discussion of Results

Emission limitations are summarized by Table 2 (see Section 1.b). The results of the emissions test program are summarized by Table 3 (see Section 5.a).

Emission results for each pollutant were averaged using all points from the entire 60 minute run. Detailed emissions test results are summarized by Table 4.

### 5.c Sampling Procedure Variations

No sampling procedure variations occurred during testing.

### 5.d Process or Control Device Upsets

No upset conditions occurred during testing.

### 5.e Control Device Maintenance

No control device maintenance was performed during the testing.

### 5.f Audit Sample Analyses

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



### **5.g Calibration Sheets**

Relevant equipment calibration documents are provided as Appendix C.

### **5.h Sample Calculations**

Sample calculations are provided in Appendix D.

### **5.i Field Data Sheets**

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

### **5.j Laboratory Data**

All analysis was done live through the use of online Analyzers and as such there is no laboratory data. Raw analyzer data is provided in Appendix E.

# TABLES

**Table 4**  
**U.S. Geological Survey**  
**Great Lakes Science Center Emergency Generator**  
**Detailed Average Emission Test Results Summary**

FTIR Reported Results

Run	Duct	CO (ppmv dry)	NOx (ppmv dry)	VOCs (ppmv dry)
Run 1	Engine	348.2	149.4	1.1
Run 2	Engine	347.5	178.8	1.1
Run 3	Engine	334.0	161.7	1.1

O<sub>2</sub> Analyzer Drift Correction

Run	Duct	Uncorrected O <sub>2</sub>	C <sub>ma</sub>	Init Zero	Final Zero	Init Span	Final Span	C <sub>m</sub>	C <sub>o</sub>	*C <sub>gas</sub>
Run 1	Engine	0.75	10.1	0.17	0.19	10.09	10.04	10.06	0.18	0.58
Run 2	Engine	1.09	10.1	0.19	0.18	10.04	10.02	10.03	0.19	0.92
Run 3	Engine	1.14	10.1	0.18	0.19	10.02	10.02	10.02	0.19	0.98

\*Drift-corrected O<sub>2</sub> values are negative; for 15% O<sub>2</sub> correction calculations a value of zero is used for the O<sub>2</sub> value.

O<sub>2</sub> Analyzer Drift Correction

C<sub>gas</sub> = effluent gas concentration,

C = avg. gas concentration indicated by analyzer

C<sub>o</sub> = avg. of initial and final system calibration bias check for the zero gas

C<sub>m</sub> = avg. of initial and final system calibration bias check for the upscale calibration gas

C<sub>ma</sub> = actual concentration of the upscale calibration gas,

$$C_{gas} = (C - C_o) \frac{C_{ma}}{C_m - C_o}$$

Results Corrected to 15% O<sub>2</sub>

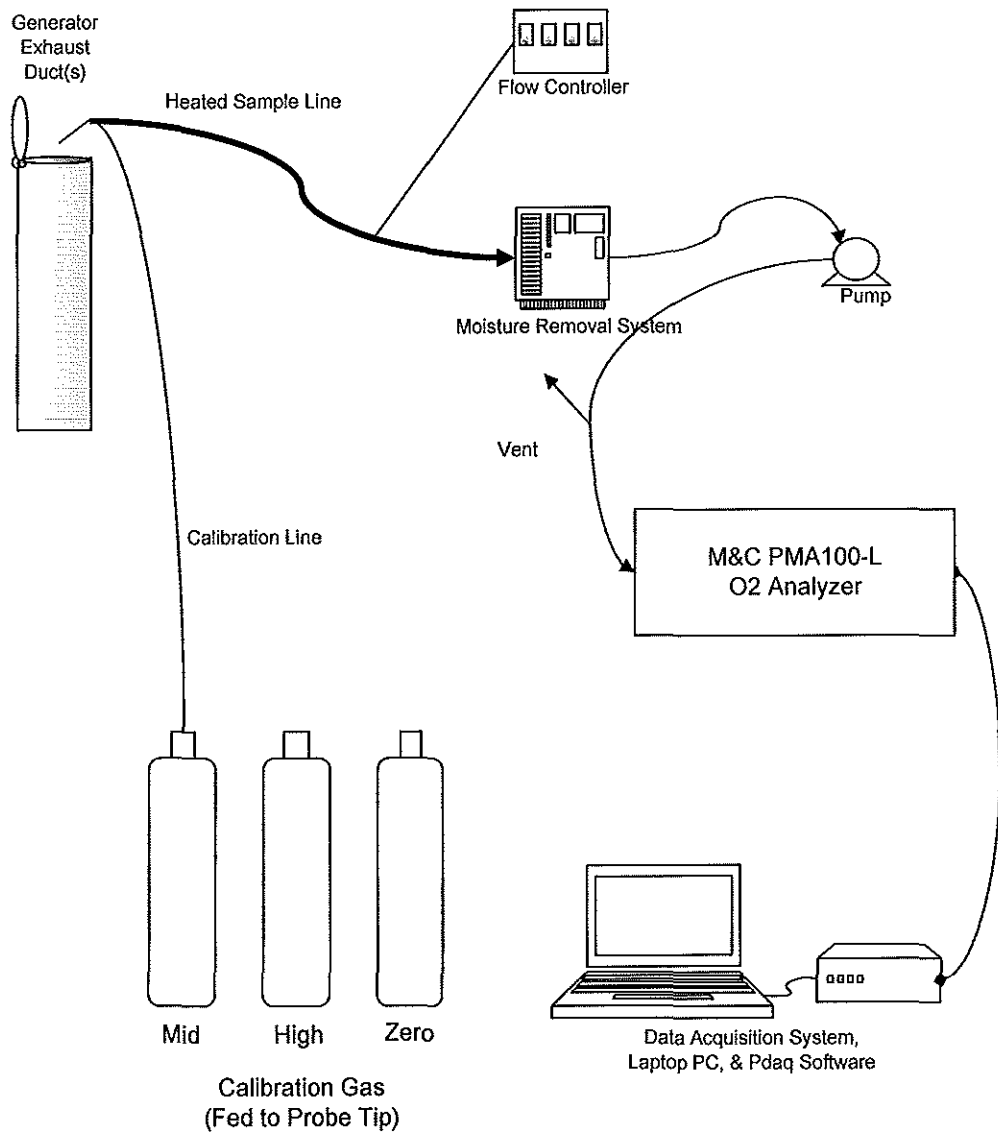
Run	Duct	CO (ppmv dry)	Nox (ppmv dry)	VOCs (non methane) (ppmv dry)
Run 1	East Exhaust	101.1	43.4	0.3
Run 2	East Exhaust	102.6	52.8	0.3
Run 3	East Exhaust	98.9	47.9	0.3
3-Run Averages:		101	48	0

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**FIGURES**



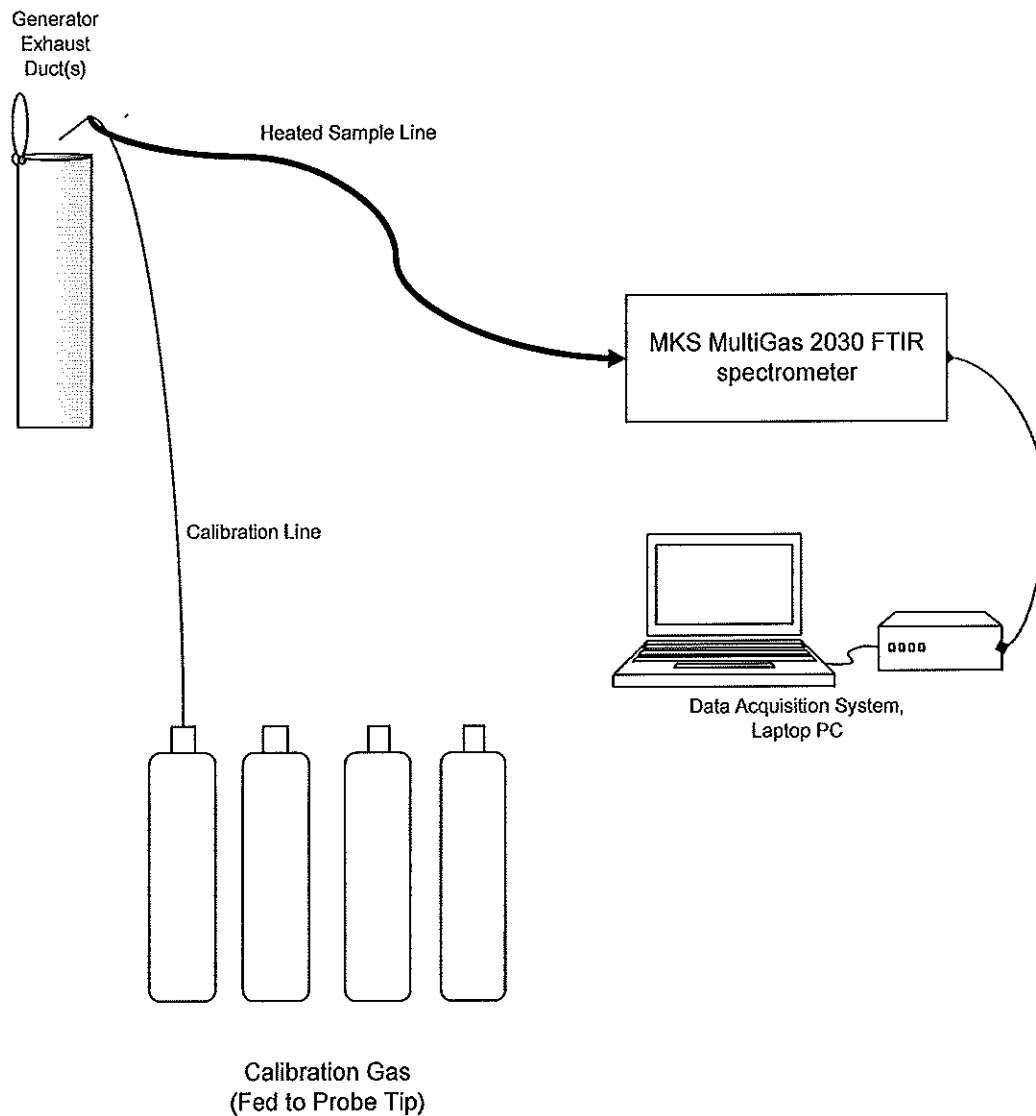
**Figure 1**  
**USEPA Method 3A**

Site:  
Generator Set GTA28 CC  
USGS  
Great Lakes Science Center  
Ann Arbor, MI

Sampling Date:  
May 9, 2013

**BT Environmental Consulting Inc.**  
4949 Fernlee Avenue  
Royal Oak, MI 48073





**Figure 2**  
**USEPA Method 320**

Site:  
Generator Set GTA28 CC  
USGS  
Great Lakes Science Center  
Ann Arbor, MI

Sampling Date:  
May 9, 2013

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