Derenzo and Associates, Inc.
Environmental Consultants

EMISSIONS TEST REPORT

Title	Compliance emissions testing report for the natural gas-fueled internal combustion engine operated at the Jordan Development Company, LLC, Milton Bradley North Antrim CPF Facility
Report Date	October 24, 2014
Test Date(s)	September 23, 2014

Facility Information	
Name	Milton Bradley North Antrim CPF Facility
Street Address	NE, NW, NE Section 11 T30N, R9W
City, County	Torch Lake Township, Antrim
Phone	(231) 935-4220

Facility Permit Information	
State Registration No.: P0211	Permit No.: 26-11

Testing Contractor	
Company	Derenzo and Associates, Inc.
Mailing Address	39395 Schoolcraft Road Livonia, MI 48150
Phone	(734) 464-3880
Project No.	1407001

COMPLIANCE EMISSIONS TESTING REPORT
FOR THE
NATURAL GAS-FUELED INTERNAL COMBUSTION ENGINE
OPERATED AT THE
JORDAN DEVELOPMENT COMPANY, LLC,
MILTON BRADLEY NORTH ANTRIM CPF FACILITY,
TORCH LAKE TOWNSHIP, MICHIGAN

1.0 SOURCE INFORMATION

Jordan Development Company, LLC (Jordan Development) owns and operates one (1) Caterpillar (CAT®), Model No. G3516B ULB, natural gas-fired, internal combustion (IC) engine at its Milton Bradley North Antrim CPF facility, located in Torch Lake Township, Antrim County, Michigan. Pursuant to the requirements of Title 40 of the Code of Federal Regulations (40 CFR) Part 60 Subpart JJJJ *Standards of Performance for Stationary Spark Ignition Internal Combustion Engines*; (40 CFR Part 60 Subpart JJJJ), §60.4243(a)(2)(ii), Jordan Development is required to perform testing on specific regulated air pollutant emissions exhausted from the combustion of natural gas used as fuel to power its IC engine-compressors every 8760 hours or three years, whichever comes first.

The compliance demonstration consisted of triplicate; one-hour test runs for the determination of nitrogen oxides (NOx), carbon monoxide (CO), and volatile organic compounds (VOC) emission rates. Instrument analyzers were used for real time analysis of NOx, CO, and VOC.

The compliance testing for the CAT® Model No. G3516B ULB, natural gas-fired, IC engine was performed on September 23, 2014, by Derenzo and Associates, Inc., an environmental consulting and testing company from Livonia, Michigan. Mr. Daniel Wilson and Mr. Jason Logan of Derenzo and Associates performed the testing with the assistance of Mr. Eric Vincke of Gosling Czubak Engineering Sciences and Mr. Rich Sheteron with the Natural Gas Compression Company. Ms. Rebbecca Radulski of the MDEQ and Mr. Jeremy Howe of the MDEQ-AQD, Cadillac District Office observed the testing.

The exhaust gas sampling and analysis was performed using procedures specified in the Test Protocol dated July 21, 2014.

Questions regarding this emission test report should be directed to:

Mr. Troy E. Molby, P.E.
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Project Engineer
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Traverse City, Michigan 49686
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Mr. Daniel Wilson
Environmental Consultant
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Report Certification

This test report was prepared by Derenzo, Associates, Inc. based on field sampling data collected by Derenzo and Associates, Inc. Facility process data were collected and provided by Jordan Development employees or representatives. This test report has been reviewed by Jordan Development representatives and approved for submittal to the MDEQ-AQD.

I certify that the testing was conducted in accordance approved methods unless otherwise specified in this report. I believe the information provided in this report and its attachments are true, accurate, and complete.

Report Prepared By:

Daniel Wilson
Environmental Consultant
Derenzo and Associates, Inc.

Reviewed By:

Andy Rusnak, QSTI
Sr. Environmental Engineer
Derenzo and Associates, Inc.

This test report has been reviewed by Jordan Development representatives and approved for submittal to the Michigan Department of Environmental Quality. I certify that the facility operating conditions were in compliance with permit requirements and were at the maximum routine operating conditions for the facility. Based on information and belief formed after reasonable inquiry, I believe that the testing was performed in accordance with the approved test plan and the statements and information in this report are true, accurate and complete.

Troy E. Molby, P.E.
Project Engineer
Jordan Development Company, L.L.C.

2.0 SUMMARY AND DISCUSSION OF TEST RESULTS

2.1 Purpose and Objectives of the Tests

40 CFR Part 60 Subpart JJJJ specifies that owners and operators of stationary SI IC engines with a maximum engine power rating greater than or equal to 500 bhp that commence construction after June 12, 2006 are required to demonstrate compliance with emission limits specified in the rule, every 8,760 hrs. The stationary SI IC engines were manufactured after July 1, 2010, therefore, must comply with emission standards of 2.0 g/bhp-hr for CO, 1.0 g/bhp-hr for NOx, and 0.7 g/bhp-hr for VOC. Owners and operators may alternatively choose to demonstrate compliance with equivalent emission standards of 270 parts per million by volume on a dry basis (ppmvd) CO corrected to 15 percent (%) oxygen (O_2), 82 ppmvd NOx at 15% O_2, and 60 ppmvd VOC at 15% O_2.

In addition to the requirements of Subpart JJJJ, Permit To Install No. 26-11 specifies annual engine emission limits of 31.0 tons per year (TpY) for CO and 8.0 TpY for NOx.

2.2 Operating Conditions during Compliance Tests

The engine was operated at the highest achievable load condition, which is limited by the associated well fields. Testing was conducted using the following materials and material throughputs:

- 410 bhp engine load; and
- 1.4 MMBtu/hr heat input.

Natural Gas Compression Company representatives supplied engine horsepower values. The CAT® Model No. G3516B ULB IC engine was reported to be operating at 410 bhp (30% of full load) during the test event.

Engine operating data is provided in Appendix A.

2.3 Summary of Air Pollutant Sampling Results

The IC engine performance tests were performed on September 23, 2014. CO, NOx, and VOC concentrations were measured in the IC engine exhaust stack. Pollutant mass emission rates were calculated based on the measured pollutant concentrations and measured exhaust gas flowrates.

Table No. 2.1 presents emissions test results compared to the applicable 40 CFR §60 Subpart JJJJ emission limits.

Table No. 2.2 presents a summary of the calculated annual emissions based on measured emission test results compared to PTI No. 26-11 emission limits

Table No. 2.1 Summary of IC engine test results compared to Subpart JJJJ emission limits

Pollutant	Test Result	Limit
CO	0.0140 g/bhp-hr	2.0 g/bhp-hr
NOx	0.835 g/bhp-hr	1.0 g/bhp-hr
VOC	0.034 g/bhp-hr	0.7 g/bhp-hr

Table No. 2.2 Summary of calculated annual emissions compared to PTI emission limits

Pollutant	Test Result	Limit
CO	0.06 TpY	31.0 TpY
NOx	3.30 TpY	8.0 TpY

Notes for Tables Nos. 2.1 and 2.2:

1. Average for three (3) one-hour test periods.

3.0 SOURCE DESCRIPTION

3.1 General Process Description

Jordan Development uses natural gas as fuel to power one (1) reciprocating, IC engine-compressor, which compresses low-pressure gas to higher pressures and sends gas to a pipeline. The facility is located in the NE, NW, NE of Section 11 T30N, R9W, Torch Lake Township, Antrim County, Michigan. One (1) CAT®, Model No. G3516B ULB, natural gas-fired, IC engine is operated at the facility.

3.2 Rated Capacities, Type and Quantity of Raw Materials Used

At 100% load, the CAT® Model No. G3516B ULB IC engine has a maximum power rating of 1,380 brake horsepower (bhp) and a maximum fuel (heat input) requirement of 7,301 British thermal units per horsepower-hour (Btu/hp-hr), or, 10.08 million Btu per hour (MMBtu/hr).

Based on the standard maximum heating value of 1,020 Btu per standard cubic foot (Btu/scf) for natural gas, the CAT® Model No. G3516B ULB IC engine will use a maximum of approximately 165 standard cubic feet of natural gas per minute (scfm), or 237,176 standard cubic feet per day (scf/day).

3.3 Emission Control System Description

The engines incorporate state of the art technology in order to fire lean fuel mixtures and produce low combustion by-product emissions. Emissions from the combustion of natural gas are controlled by catalyst and subsequently released into the ambient air through a stack connected to the IC engine exhaust manifold and noise control system (noise muffler).

3.4 Sampling Locations (USEPA Method 1)

The exhaust stack sampling ports for the CAT Model No. G3516B ULB IC engine tested satisfied the USEPA Method 1 criteria for a representative sample location. The inner diameter of the engine exhaust stack is 12 inches. The two (2) sample ports, opposed 90°, provide a stack sampling location approximately 36 inches (3.0 duct diameters) downstream and 240 inches (20.0 duct diameters) upstream from any flow disturbance.

Velocity pressure traverse locations for the sampling points were determined in accordance with USEPA Method 1.

Figure 1 presents the performance test sampling and measurement locations.

4.0 SAMPLING AND ANALYTICAL PROCEDURES

A test protocol for the compliance testing was prepared by Derenzo and Associates and reviewed by the MDEQ-AQD. This section provides a summary of the sampling and analytical procedures that were used during the test and presented in the test plan.

4.1 Exhaust Gas Velocity and Flowrate Determination (USEPA Method 2)

The IC engine exhaust stack gas velocity and volumetric flow rate was determined using USEPA Method 2 prior to and after each test. An S-type Pitot tube connected to a red-oil manometer was used to determine velocity pressure at each traverse point across the stack cross section. Gas temperature was measured using a K-type thermocouple mounted to the Pitot tube. The Pitot tube and connective tubing were periodically leak-checked to verify the integrity of the measurement system.

The absence of significant cyclonic flow for the exhaust configuration was verified using an S-type Pitot tube and oil manometer. The Pitot tube was positioned at each velocity traverse point with the planes of the face openings of the Pitot tube perpendicular to the stack cross-sectional plane. The Pitot tube was then rotated to determine the null angle (rotational angle as measured from the perpendicular, or reference, position at which the differential pressure is equal to zero).

Appendix B provides computer calculated and field data sheets for the flowrate measurements.

4.2 Exhaust Gas Molecular Weight Determination (USEPA Method 3A)

CO_2 and O_2 content in the IC engine exhaust gas stream was measured continuously throughout each one-hour test period in accordance with USEPA Method 3A. The CO_2 content of the exhaust was monitored using a Servomex 4900 single beam single wavelength infrared (SBSW) gas analyzer. The O_2 content of the exhaust was monitored using a Servomex 4900 gas analyzer that utilizes a paramagnetic sensor.

During each sampling period, a continuous sample of the IC engine 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 analyzers; therefore, measurement of O_2 and CO_2 concentrations correspond to standard dry gas conditions. Instrument response data were recorded using an ESC Model 8816 data acquisition 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, the instruments were calibrated using upscale calibration and zero gas to determine analyzer calibration error and system bias (described in Section 5.0 of this document). Sampling times were recorded on field data sheets.

Appendix C provides pollutant emission rate calculations. Appendix D provides raw instrumental analyzer response data for each test period.

4.3 Exhaust Gas Moisture Content Determinations (Method 4)

Moisture content of each RICE exhaust gas was determined in accordance with USEPA Method 4 using a chilled impinger sampling train. The moisture sampling was performed concurrently with the instrumental analyzer sampling. During each sampling period a gas sample was extracted at a constant rate from the source where moisture was removed from the sampled gas stream using impingers that were submersed in an ice bath. At the conclusion of each sampling period, the moisture gain in the impingers was determined gravimetrically by weighing each impinger to determine net weight gain.

4.4 NOx and CO Concentration Measurements (USEPA Method 7E and 10)

NO_x and CO pollutant concentrations in each engine exhaust gas stream was determined using a Thermo Environmental Instruments, Inc. (TEI) Model 42c High Level chemiluminescence NO_X analyzer and a Fuji ZRF infrared CO analyzer.

Throughout each test period, a continuous sample of the engine exhaust gas was extracted from the stack using the Teflon® heated sample line and gas conditioning system and delivered to the instrumental analyzers. Instrument response for each analyzer was recorded on an ESC Model 8816 data acquisition system that logged data as one-minute averages. Prior to, and at the conclusion of each test, the instruments were calibrated using upscale calibration.and zero gas to determine analyzer calibration error and system bias.

Appendix C provides pollutant emission rate calculations. Appendix D provides raw instrumental analyzer response data for each test period.

4.5 VOC Concentration Measurements (USEPA Method ALT 096)

The VOC emission rate was determined by measuring the nonmethane hydrocarbon (NMHC) concentration in each RICE exhaust gas stream. NMHC pollutant concentration was determined using TEI Model 55i Methane / Nonmethane hydrocarbon analyzer.

Throughout each one-hour test period, a continuous sample of the IC engine exhaust gas was extracted from the stack using the Teflon® heated sample line described in Section 4.3 of this document, and delivered to the instrumental analyzer. The sampled gas was not conditioned prior to being introduced to the analyzer; therefore, the measurement of NMHC concentration corresponds to standard wet gas conditions. Instrument NMHC (VOC) response for the 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, the instrument was calibrated using mid-range calibration and zero gas to determine analyzer calibration error and system bias (described in Section 5.0 of this document).

Appendix C provides pollutant emission rate calculations. Appendix D provides raw instrumental analyzer response data for each test period.

5.0 INTERNAL QA/QC ACTIVITIES

5.1 NOx Converter Efficiency Test

The NO_2 – NO conversion efficiency of the Model 42c analyzer was verified prior to the testing program. A USEPA Protocol 1 certified concentration of NO_2 was injected directly into the analyzer, following the initial three-point calibration, to verify the analyzer's conversion efficiency. The analyzer's NO_2 – NO converter uses a catalyst at high temperatures to convert the NO_2 to NO for measurement. The conversion efficiency of the analyzer is deemed acceptable if the measured NO_2 concentration is within 90% of the expected value.

The NO_2 – NO conversion efficiency test satisfied the USEPA Method 7E criteria (the calculated NO_2 – NO conversion efficiency is greater than or equal to 90%).

5.2 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.

5.3 Instrumental Analyzer Interference Check

The instrumental analyzers used to measure NOx, CO, O_2, and CO_2 have had an interference response test performed prior to their use in the field, 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.

5.4 Instrument Calibration and System Bias Checks

At the beginning of each day of the testing program, initial three-point instrument calibrations were performed for the NO_x, CO, CO_2 and O_2 analyzers 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 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 determining the instrument response against the initial instrument calibration readings.

At the beginning of each test day, appropriate high-range, mid-range, and low-range span gases followed by a zero gas were introduced to the NMHC analyzer, in series at a tee connection, which is installed between the sample probe and the particulate filter, through a poppet check valve. After each one hour test period, mid-range and zero gases were re-introduced in series at the tee connection in the sampling system to check against the method's performance specifications for calibration drift and zero drift error.

The instruments were calibrated with USEPA Protocol 1 certified concentrations of CO_2, O_2, NO_x, and CO in nitrogen and zeroed using hydrocarbon free nitrogen. The NMHC (VOC) instrument was calibrated with USEPA Protocol 1 certified concentrations of propane in air and zeroed using hydrocarbon-free air. A STEC Model SGD-710C ten-step gas divider was used to obtain intermediate calibration gas concentrations as needed.

5.5 Gas Divider Certification (USEPA Method 205)

A STEC Model SGD-710C 10-step gas divider was used to obtain appropriate calibration span gases. The ten-step STEC gas divider was NIST certified (within the last 12 months) with a primary flow standard in accordance with Method 205. When cut with an appropriate zero gas, the ten-step STEC gas divider delivered calibration gas values ranging from 0% to 100% (in 10% step increments) of the USEPA Protocol 1 calibration gas that was introduced into the system. The field evaluation procedures presented in Section 3.2 of Method 205 were followed prior to use of 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.

5.6 Determination of Exhaust Gas Stratification

A stratification test for the IC engine exhaust stack was performed during the performance test sampling periods. The stainless steel sample probe was positioned at sample points correlating to 16.7, 50.0 (centroid) and 83.3% of each stack diameter. Pollutant concentration data were recorded at each sample point for a minimum of twice the maximum system response time.

The recorded data for each IC engine exhaust stack gas indicate that the measured CO concentrations did not vary by more than 5% of the mean across either stack diameter. Therefore, the stack gas of the engine was considered to be unstratified and the compliance test sampling was performed at a single sampling location within the engine exhaust stack.

5.7 Meter Box Calibrations

The dry gas meter sampling console used for moisture testing was calibrated prior to and after the testing program. This calibration uses the critical orifice calibration technique presented in

USEPA Method 5. The metering consol calibration exhibited no data outside the acceptable ranges presented in USEPA Method 5.

The digital pyrometer in the metering console was calibrated using a NIST traceable Omega® Model CL 23A temperature calibrator.

Appendix E presents test equipment quality assurance data (NO_2 – NO conversion efficiency test data, instrument calibration and system bias check records, calibration gas certifications, interference test results, meter box calibration records, and pitot tube calibration records).

6.0 RESULTS

6.1 Test Results

Engine operating data and air pollutant emission measurement results for each one hour test period are presented in Table 6.1.

The measured air pollutant concentrations and emission rates for the IC engine are less than the limits specified in 40 CFR Part 60, Subpart JJJJ and PTI No. 26-11:

- 1.0 g/bhp-hr and 8.0 TpY for NO_X;
- 2.0 g/bhp-hr and 31.0 TpY for CO; and
- 0.7 g/bhp-hr for VOC.

6.2 Variations from Normal Sampling Procedures or Operating Conditions

The compliance testing was performed in accordance with the Test Protocol dated July 21, 2014 with the reduced load exception noted above.

Instrument calibrations and sampling period results satisfied the quality assurance verifications required by USEPA Methods 3A, 7E, 10, and ALT 096 (25A). No variations from the normal operating conditions of the IC engines occurred during the testing program.

Report Prepared By:

Daniel C. Wilson
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Report Reviewed By:

Andy Rusnak, QSTI
Senior Environmental Engineer

Table 6.1 Summary of Engine No. 1 Test Results (CAT G3516B ULB)
Jordan Development Milton Bradley North

Test No.	1	2	3	
Test date	09/23/14	09/23/14	09/23/14	Test
Test period (24-hr clock)	10:02-11:02	11:32-12:32	13:00-14:00	Avg.
Engine Horsepower (Hp) w/o After Cooler	409	423	399	410
Exhaust gas composition				
CO_2 content (% vol)	7.82	7.76	7.77	7.78
O_2 content (% vol)	7.99	8.07	8.03	8.03
Moisture (% vol)	12.3	13.1	13.2	12.8
Exhaust gas flowrate				
Standard conditions (scfm)	1,328	1,326	1,316	1,323
Dry basis (dscfm)	1,165	1,153	1,142	1,153
Nitrogen oxides emission rates				
NO_X conc. (ppmvd)*	88.9	91.3	93.6	91.3
NO_X emissions (lb/hr NO_2)	0.74	0.75	0.77	0.75
NO_X emissions (TpY)	3.25	3.30	3.36	3.30
NO_X emissions (g/bhp-hr)	0.82	0.81	0.87	0.835
NO_X permit limit (g/bhp-hr)				***1.00***
Carbon monoxide emission rates				
CO conc. (ppmvd)*	1.68	3.17	2.71	2.52
CO emissions (lb/hr)	0.0085	0.0160	0.0135	0.0127
CO emissions (TpY)	0.04	0.07	0.06	0.06
CO emissions (g/bhp-hr)	0.0095	0.0171	0.0154	0.0140
CO permit limit (g/bhp-hr)				***2.00***
VOC/NMHC emission rates				
VOC conc. (ppmv C_3)*	3.4	3.3	3.3	3.3
VOC emissions (lb/hr)	0.03	0.03	0.03	0.03
VOC emissions (g/bhp-hr)	0.03	0.03	0.03	0.03
VOC permit limit (g/bhp-hr)				***0.70***

* Corrected for calibration bias.