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, Torch Lake Township, Michigan.
Report Date	November 12, 2013
Test Date(s)	September 26, 2013

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.	1305017

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**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**

Report Date: November 12, 2013

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 26, 2013, by Derenzo and Associates, Inc., an environmental consulting and testing company from Livonia, Michigan. Mr. Daniel Wilson and Mr. Michael Brack of Derenzo and Associates performed the testing with the assistance of Mr. Tim Rombach 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 9, 2013.

Questions regarding this emission test report should be directed to:

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(734) 464-3880

2.0 PLANT AND SAMPLING LOCATION DESCRIPTION

2.1 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.

2.2 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) of operation.

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).

The engine was operated at the highest achievable load condition, which is limited by the associated well fields. It is anticipated that over time, full load operation may be possible. Testing was conducted using the following materials and material throughputs:

Parameter	CAT® Model No. G3516B ULB IC engine
Fuel	natural gas
Heat Input	Approximately 1.4 MMBtu/hr
Engine Load	510 bhp
Engine Exhaust Flow Rate	1,380 scfm
Engine Exhaust Flow Rate	1,218 dscfm
Engine Exhaust Temperature	702 °F

Mr. Sheteron supplied engine horsepower values for use in calculating emission rates. The CAT® Model No. G3516B ULB IC engine was reported to be operating at 510 bhp (37% of full load@RPM) during the test event.

Required readings were recorded during the emissions testing event and are included in Appendix A.

2.3 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).

2.4 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 duct diameters) downstream and 240 inches (20 duct diameters) upstream from any flow disturbance.

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

NOx, CO, and VOC results are calculated from the pre-test and post-test flowrate averages for each 60-minute sampling period. Measured concentrations are drift and bias corrected as per current USEPA reference methods and MDEQ-AQD requirements (i.e., drift and bias of VOC concentrations).

Figure 1 presents the performance test sampling and measurement locations.

3.0 SUMMARY AND DISCUSSION OF TEST RESULTS

3.1 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, where the stationary SI IC engines are manufactured on or after July 1, 2010 are required to demonstrate compliance with the air 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. These emission standards are required to be maintained over the entire operating life of each affected SI IC engine.

Permit To Install No. 26-11 specifies annual engine emission limits of 31 tons per year (TpY) for CO and 8 TpY for NOx.

3.2 Variations from Normal Sampling Procedures or Operating Conditions

The compliance tests for all pollutants were performed in accordance with the Test Protocol dated July 9, 2013 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.

3.3 Operating Conditions during Compliance Tests

The natural gas-fueled IC engine was operated at normal load conditions during the compliance testing (see Section 2.2), which is within 10% of full operating conditions, based upon the current compression requirements.

3.4 Air Pollutant Sampling Results

The IC engine performance tests were performed on September 26, 2013. 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.

The following tables present emissions test results and applicable limits, found in 40 CFR §60 Subpart JJJJ, for the IC Engine operated at the facility.

CAT Model No. G3516B ULB IC Engine Test Results

Pollutant	Test Result	Limit
CO	0.0048 g/bhp-hr	2.0 g/bhp-hr
NOx	0.866 g/bhp-hr	1.0 g/bhp-hr
VOC	0.030 g/bhp-hr	0.7 g/bhp-hr

g/bhp-hr = grams per brake horse power- hour

The measured and calculated results were determined based upon current operating conditions at the Milton Bradley North facility. The volumetric flow rates were measured at an average of 1,218 dscfm and 1,380 scfm.

The NOx concentrations for the CAT Model No. G3516B ULB IC engine were measured at 111.4 parts per million by volume (ppmv), emission rates calculated at 0.97 lb/hr, and emission factors calculated at 0.866 g/bhp-hr.

The CO concentrations for the CAT Model No. G3516B ULB IC engine were measured at 1.01 ppmv, emission rates calculated at 0.0054 lb/hr, and emission factors calculated at 0.0048 g/bhp-hr.

The VOC results for the CAT Model No. G3516B ULB IC engine were measured at 3.6 ppmv VOC as propane, 0.034 lb/hr VOC as propane, and 0.030 g/bhp-hr VOC.

The diluents gases were measured at 7.73% O_2 and 7.93% CO_2 for the CAT Model No. G3516B ULB IC engine.

Table 1 presents measured gas conditions and calculated pollutant emission rates and emission factors for the tested IC engine.

Appendix B provides computer calculated and field data sheets for the IC engine tests.

Appendix C provides raw instrumental analyzer response data for each test period.

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.

Appendix D presents sample procedures and diagrams for the USEPA sampling methods.

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

In order to determine air pollutant emission rates on a mass basis (e.g., pound per hour), IC engine exhaust stack gas velocities, and volumetric flow rates were determined using USEPA Method 2 prior to and subsequent to conducting each 60-minute test. The pre-test and post-test values were averaged and used for calculating the emission rates for each analyte. An S-type pitot tube connected to a red-oil manometer was used to determine velocity pressure and verify the absence of cyclonic flow. Gas temperature was measured using a K-type thermocouple mounted to the Pitot tube. The Pitot tube and connective tubing were leak-checked to verify the integrity of the measurement system. The Pitot tube was positioned at all of the velocity traverse points 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).

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 single beam single wavelength infrared (SBSW) gas analyzer. The O_2 content of the exhaust was monitored using a gas analyzer that utilizes a paramagnetic sensor.

During each one-hour 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 analyzer; therefore, measurement of O_2 and CO_2 concentrations correspond to standard dry gas conditions. The instrument was calibrated using appropriate calibration gases to determine accuracy and system bias (described in Section 5.4 of this document).

Figure 3 presents the instrument analyzer train. Appendix D presents detailed gas sampling procedures for the USEPA sampling trains.

4.3 Exhaust Gas Moisture Content Determinations (Method 4)

Moisture content of the IC engine exhaust gas was determined in accordance with USEPA Method 4 using a chilled impinger sampling train, which was performed concurrently with the instrumental analyzer sampling methodologies. A non-heated probe was used for the moisture determinations as the engine exhaust temperature exceeded 700 °F. During each sampling period, a gas sample was extracted at a predetermined 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. Net weight gain and sample volume are used to calculate the exhaust gas moisture content.

Figure 4 presents the moisture sampling train schematic. Appendix D presents detailed gas sampling procedures for the USEPA sampling trains.

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

NOx and CO pollutant concentrations in the exhaust of the IC engine were determined using a chemiluminescence NOx analyzer and NDIR CO analyzer.

Three (3) one-hour sampling periods were performed for the IC engine exhaust testing. Throughout each one-hour 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 a data logging system that monitored the analog output continuously and logged data as one-minute averages. Prior to, and at the conclusion of each test, the instruments were calibrated using appropriate upscale calibration and zero gas to determine analyzer calibration error and system bias. Sampling times were recorded on field data sheets.

Figure 3 presents the instrument analyzer train. Appendix D presents detailed gas sampling procedures for the USEPA sampling trains.

4.5 VOC Concentration Measurements (USEPA Method ALT 096)

The exhaust gas VOC concentrations were measured using a Flame Ionization Detector (FID) instrumental analyzer in accordance with USEPA Alt 096 for direct measurement of VOC (non-methane organic compounds) concentrations. The TECO model 55I methane, non-methane hydrocarbon analyzer has been approved by the USEPA on Subpart JJJJ sources for VOC measurements.

Samples of the exhaust gas were delivered to the instrument analyzer using an extractive gas sampling system that prevents condensation or contamination of the sample. The exhaust gas samples were delivered directly to the instrument analyzer, therefore VOC measurements correspond to standard conditions with no moisture correction (wet basis).

The specified instrument analyzer was calibrated using certified propane concentrations in hydrocarbon-free air.

Based on previous IC engine testing, the VOC measured with the FIA analyzer were expected to be approximately 5 to 35 ppmv for the exhaust, measured as propane. Therefore, the instrument analyzer VOC measurement span was set based on available calibration gases that satisfy minimum and maximum method requirements.

Figure 3 presents the instrument analyzer train. Appendix D presents detailed gas sampling procedures for the USEPA sampling trains.

Appendix B presents the computer calculated and field data from the testing program.

5.0 INTERNAL QA/QC ACTIVITIES

5.1 NOx Converter Efficiency Test

The NO_2 – NO conversion efficiency of the TEI Model 42C instrumental analyzer was verified prior to the performance tests. The instrument analyzer NO_2 – NO converter uses a catalyst at high temperatures to convert the NO_2 to NO for measurement. A USEPA Protocol 1 certified NO_2 calibration gas was used to verify the efficiency of the NO_2 – NO converter.

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 the test day, initial three-point instrument calibrations were performed by injecting calibration gas directly into the inlet sample port for each instrument. System bias checks were preformed prior to and at the conclusion of each sampling period by introducing the appropriate 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 verifying the instrument response against the initial instrument calibration readings. If the drift error is within 3% of the span over the period of the test run, the test run is considered acceptable.

The instruments were calibrated with USEPA Protocol 1 certified concentrations of CO_2, O_2, NOx, CO, Propane, and zeroed using pure nitrogen or hydrocarbon free air.

5.5 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.

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).

Report Prepared By:

Daniel C. Wilson
Environmental Consultant

Report Reviewed By:

Michael J. Brack, QSTI
Field Services Manager

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

Test No.	1	2	3	
Test date	09/26/13	09/26/13	09/26/13	Test
Test period (24-hr clock)	9:50 - 10:50	11:23 - 12:23	12:57 - 13:57	Avg.
Engine Horsepower (Hp)	510	510	510	510
Exhaust gas composition				
CO_2 content (% vol)	7.73	7.71	7.75	7.73
O_2 content (% vol)	7.91	7.96	7.92	7.93
Moisture (% vol)	11.3	11.8	12.1	11.7
Exhaust gas flowrate				
Standard conditions (scfm)	1,343	1,400	1,396	1,380
Dry basis (dscfm)	1,191	1,235	1,228	1,218
Nitrogen oxides emission rates				
NO_X conc. (ppmvd)*	108.3	112.9	113.1	111.4
NO_X emissions (lb/hr NO_2)	0.92	1.00	1.00	0.97
NO_X emissions (g/bhp-hr)	0.82	0.89	0.89	0.866
NO_X permit limit (g/bhp-hr)	*1.00*	*1.00*	*1.00*	*1.00*
Carbon monoxide emission rates				
CO conc. (ppmvd)*	0.44	1.52	1.08	1.01
CO emissions (lb/hr)	0.0023	0.0082	0.0058	0.0054
CO emissions (g/bhp-hr)	0.0020	0.0073	0.0052	0.0048
CO permit limit (g/bhp-hr)	*2.00*	*2.00*	*2.00*	*2.00*
VOC/NMHC emission rates				
VOC conc. (ppmv C_3)*	3.7	3.6	3.5	3.6
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*	*0.70*	*0.70*	*0.70*

* Corrected for calibration bias.