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Environmental Services

May 8, 2014

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AIR QUALITY DIV.

Ms. Mary Douglas
Michigan Department of Environmental Quality- Air Quality Division
Kalamazoo District Office
7953 Adobe Road
Kalamazoo, MI 49009-5026

Re: Compliance Test Report
White Pigeon Compressor Station (SRN: N5573), White Pigeon, MI

Dear Ms. Douglas:

The enclosed report summarizes the results of testing conducted on March 11-16 and April 2, 2014 at Consumers Energy Company's (CEC) White Pigeon Compressor Station. Performance tests were conducted on four (4) 4-stroke lean burn (4SLB) natural gas-fired, reciprocating internal combustion engines (RICE) and one (1) 4SLB natural gas-fired emergency RICE, identified as EUENGINE1, EUENGINE2, EUENGINE3, EUENGINE4 (i.e., production engines) and EUEMERGGEN. The purpose of the testing was to evaluate compliance with both (a) the National Emission Standards for Hazardous Air Pollutants (NESHAP) for RICE, 40 CFR Part 63, Subpart ZZZZ, and (b) Standards of Performance for Stationary Spark Ignition (SI) Internal Combustion Engines (ICE), 40 CFR Part 60, Subpart JJJJ.

Summary of 40 CFR 63 Subpart ZZZZ RICE
Carbon Monoxide Reduction, Catalyst Pressure Drop &
Catalyst Inlet Temperature Results

Source	CO Reduction Efficiency (%) [ZZZZ Limit = ≥93%]	Catalyst Pressure Drop (Inches Water Gauge)	Catalyst Inlet Temperature (°F)
EUENGINE1	95.4	3.7	756.4
EUENGINE2	99.8	3.2	775.7
EUENGINE3	98.4	3.0	770.7
EUENGINE4	95.0	3.0	774.5

Based on the dry CO concentrations measured at the oxidation catalyst inlet and outlet corrected to 15% O_2, the above results indicate the oxidation catalysts are operating at a CO reduction efficiency greater than the 93 percentage requirement in 40 CFR Part 63, Subpart ZZZZ.

In addition, NO_x, CO and VOC emission rates were verified for the natural gas-fired RICE pursuant to MI-ROP-N5573-2013, FGENGINES, Conditions I.1, I.2, and IX.2 and EUEMERGGEN, Conditions I.1 and IX.1.

Summary of 40 CFR 60 Subpart JJJJ
NO_x, CO and VOC Emission Rates

Source	NO_x Emission Rate (g/HP-hr) [ROP Limit = 0.5; JJJJ Limit = 2.0]	CO Emission Rate (g/HP-hr) [ROP Limit = 0.2[1]; JJJJ Limit = 4.0]	VOC Emission Rate, Measured as NMOC[2] (g/HP-hr) [JJJJ Limit = 1.0]
EUENGINE1	0.44	0.081	0.009
EUENGINE2	0.44	0.004	0.132
EUENGINE3	0.38	0.033	0.133
EUENGINE4	0.46	0.094	0.120
EUEMERGGEN	0.41	2.256[1]	0.127

[1] ROP Limit does not apply to EUEMERGGEN

[2] The VOC emission rate has been calculated as the measured non-methane organic concentration (NMOC), expressed as proprane

The NOx, CO and VOC engine emission rates shown above all fall within the permit requirements, , as well as the applicable emission limits within 40 CFR Part 60, Subpart JJJJ in cases where the permit does not contain an explicitly emission limit (i.e., VOCs).

Initial testing began on March 11, 2014; however the NO_x emission rate was higher than expected on EUENGINE3 and EUENGINE4 and the percent reduction of CO across the catalyst was lower than expected on EUENGINE2 and EUENGINE4. While all initial test data indicated compliance with the 40 CFR Part 60, Subpart JJJJ emission limits, the initial NO_x emission rates for the aforementioned engines were slightly above the ROP emission limit of 0.5 g/HP-hr, while the observed CO reduction efficiencies were slightly lower than the 93% minimum required in 40 CFR Part 63, Subpart ZZZZ. As further discussed below, testing was halted on March 12, 2014 to permit troubleshooting engine emission performance.

It should be noted that during the initial testing, VOC sampling and analysis was conducted for EUENGINE3 and EUENGINE4 (while samples were obtained for EUENGINE2, they were not analyzed as the test was aborted after only two test runs). EUENGINE4 was one of the two engines found to have a deficient CO removal efficiency during the initial tests. Consumers Energy notes that the average total non-methane, non-ethane organic concentration (TNMNEOC) for EUENGINE4 was only 1.86 ppmdv at 15% O_2. The 93% CO reduction efficiency in 40 CFR Part 63, Subpart ZZZZ is one of two alternatives, with the other consisting of meeting a formaldehyde emission limit of 14 ppmvd at 15% O_2.

While Consumers Energy did not directly test the formaldehyde concentration from EUENGINE4, the average TNMNEOC value (of which formaldehyde is a subset) was less than 15% of the Subpart ZZZZ formaldehyde emission limit. As initial testing on EUENGINE2

showed a CO removal efficiency which was only slightly lower than that achieved by EUENGINE4, and both engines were using the same pipeline natural gas fuel supply, we believe that the TNMNEOC for this engine was also less than 14 ppmdv at 15% O_2. Thus, we believe that there is credible evidence that we passed all the requirements for Subpart ZZZZ for all of the engines during the initial testing event, based on the alternative compliance method.

It was decided that there were issues with the engines that needed to be addressed before continuing the test event, which was halted on March 12, 2014. In reviewing the Caterpillar manual, and comparing set points to what was programmed in the ADEM 3 engine control panels, it was discovered that the natural gas heating value (LHV) programmed into each engine's control panel was not representative of actual fuel gas conditions at the time of testing. The LHV is used to calculate a fuel correction factor used in the ADEM 3. The site obtained the actual LHV from the on-site gas chromatograph and entered that into the engine control panels. Once the LHV adjustment was made, the NO_x emission rates were in compliance. The Caterpillar manual does provide information on the LHV and adjustment of the gas correction factor, but the review of this set point value is not part of the Caterpillar recommended maintenance checklist. Consequently, it was not part of the Consumers Energy normal maintenance checklist and we would not have discovered this issue except for looking for solutions to this stack test event. Currently, the natural gas heating value data is not sent to the Supervisory Control and Data Acquisition (SCADA) system, so it has to be reviewed manually. The site is looking into how this process can be improved so that the heating value in the engine control panels is regularly updated based on the onsite natural gas analyses.

Once the LHV adjustments were made and catalyst maintenance activities were conducted, testing on the production engines was restarted on March 14, 2014 and was completed on March 16, 2014. Operation of the production engines between the initial and final tests was minimized as much as possible, with the engines primarily being operated to assist with troubleshooting activities. Testing of the emergency engine could not be completed in mid-March due to the inability to achieve a testing load of 90-110% of rated capacity by shifting available internal loads to the emergency engine. Thus, testing for the emergency engine was delayed until a portable load bank could be brought onsite to allow for testing to be conducted at greater than 90% load. The emergency engine was tested on April 2, 2014.

After reviewing the PM/MAP, the Plant 3 Maintenance Procedures Manual, and oxidation catalyst vendor operation and maintenance recommendations, we conclude that all required monitoring is being conducted for the oxidation catalysts. The vendor recommends removing, inspecting and cleaning (as needed) when a change in temperature rise across the catalyst drops to one-half the initial value or the pressure drop across the catalyst changes by ±2 inches of water column. The facility monitors these values and there was no indication of an issue with either of these conditions. In addition, the vendor recommends regenerating (washing) the catalyst "when emission limits cannot be met and cleaning has not adequately improved the performance". Again, there was no indication that catalyst regeneration was necessary, as the monitored parameters were within the specified operating ranges. The site is reviewing the catalyst preventative maintenance procedures and will update them to include scheduled preventative maintenance on a more frequent interval.

Based on a comprehensive review of preventative maintenance activities conducted consistent with the Preventative Maintenance/Malfunction Abatement Plan (PM/MAP), post-test troubleshooting activities, and observations during the testing event, it was determined that the emission performance issues with the engines were not attributable to a failure to conduct routine maintenance on the engines consistent with the PM/MAP. Rather, the emissions performance appeared to be attributable to two main factors, identified as: (a) the fuel correction factor in the Advanced Digital Engine Management (ADEM) 3 Control System, and (b) the catalyst maintenance practices.

Please contact me at (517) 788-2201 if there are any questions on this submittal.

Sincerely,

Amy Kapuga

Amy D. Kapuga, P.E.
Environmental Services Department

Enc

cc: Karen Kajiya-Mills, MDEQ-Lansing
Director, Air and Radiation Division, US EPA – Region V
Tim Wolf, White Pigeon
Paul Jergens, Northville Compressor Station (cover letter only)
Ocie Gregory, Royal Oak (cover letter only)
White Pigeon Emission Test File