Reciprocating Internal Combustion Engines (RICE MACT)
40 CFR 63 Subpart ZZZZ
Environmental Operations Plant

Renewable Operating Permit MI-ROP-A4033

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The Dow Chemical Company
Michigan Operations
Midland, Michigan

Reciprocating Internal Combustion Engines (RICE MACT) Report

Environmental Operations Plant Diversion Diesel pump engines A & B (D-200A/B)

I certify that I have personally examined and am familiar with the information submitted herein, and based on my inquiries of those individuals immediately responsible for obtaining the information; I believe the submitted information is true, accurate, and complete.

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1.1 Summary of Test Program

The Dow Chemical Company (Dow) in Midland, Michigan, is a large complex with manufacturing and utility plants. Dow's Michigan Operations (MiOps) is a major source of Hazardous Air Pollutants (HAPS).

To demonstrate compliance with the RICE MACT, 40CFR63, Subpart ZZZZ, Dow's internal stack testing team conducted compliance sampling on two 1050 horsepower non-emergency diesel engines. The engines are operated to divert influent wastewater and storm water away from the on-site wastewater treatment plant (WWTP) to wastewater storage tanks for a variety of reasons. The testing was conducted to demonstrate compliance with emissions and operating limits found in 63.6600(d), Table 2c of the RICE MACT, 40CFR63, Subpart ZZZZ.

The following table summarizes the pertinent data for this compliance test:

Responsible Groups	• The Dow Chemical Company • Michigan Department of Environmental Quality (MDEQ) • Environmental Protection Agency (EPA)
Applicable Regulations	• ROP-MI-A4033 • 40 CFR 63 Subpart ZZZZ (RICE MACT)
Industry / Plant	• Environmental Operations Plant (EVO)
Plant Location	• The Dow Chemical Company Midland, Michigan, 48667
Unit Initial Start-up	• Engines installed prior to December 19, 2002
Air Pollution Control Equipment	• Engines are equipped with a single stage catalytic reduction and closed crankcase ventilation system
Emission Points	• Diversion Diesel pump engines A & B (D-200A/B)
Pollutants/Diluent Measured	• Carbon Monoxide (CO) • Oxygen (O_2)
Test Dates	• March 29, 2016 Engine A • March 30, 2016 Engine B

1.2 Key Personnel

The key personnel who coordinated the test program were:

- Shane Bennett and Kurt Detrich shared responsiblities to support as a Process Focal Point. The Process Focal Point is responsible for coordinating the plant operation during the test and ensuring the unit is operating at the agreed upon conditions in the test plan. They also serve as the key contact for collecting any process data required and providing all technical support related to process operation.

- Kayla Peacock provided support as the Environmental Focal Point for this unit. The Environmental Focal Point is responsible for ensuring that all regulatory requirements and citations are reviewed and considered for the testing. All agency communication is completed through this role. Contact information is 989-638-1482.

- Chuck Glenn served as the Test Plan Coordinator and was responsible for the overall leadership of the sampling program. The sample plan coordinator develops the overall testing plan, determines the correct sample methods and completes the final report.

- Spencer Hurley served as the back-up for test plan coordination. He also will serve as the technical review role of the test data.

- Mike Abel served as a technical review role of the test data.

- Treston Devers served as the Project Manager. The Project Manager is responsible to review all field data and activities.

- Danny Bennett served as the local Sample Team Leader. The Sample Team Leader confirms all sample techniques and field activities are completed as written in the sample plan.

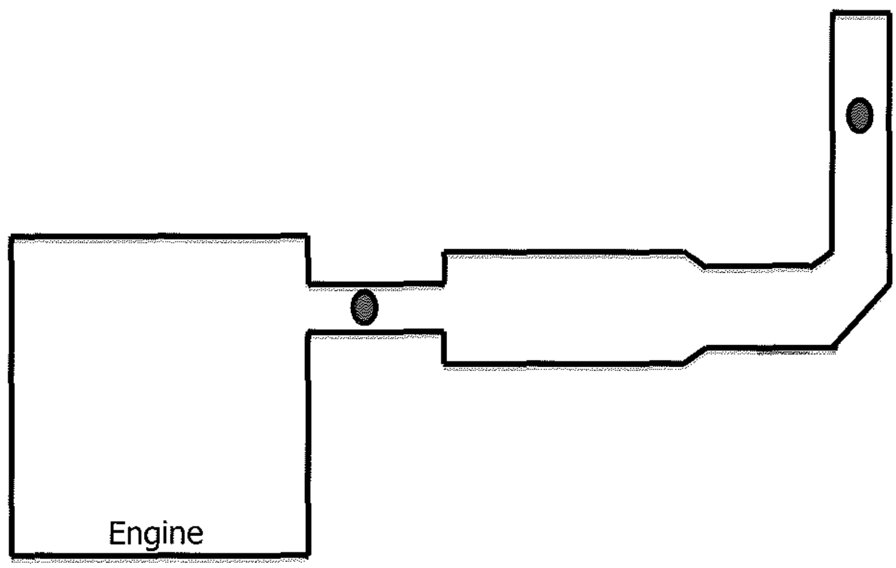
2.1 Facility Description

Dow owns and operates two diesel powered engines subject to the RICE MACT. These engines are located at the Environmental Operations Plant (EVO) at Dow's Michigan Operations facility (MiOps). The engines were all installed and operated before December 19, 2002; therefore, these engines are considered "*existing*" affected sources according to the RICE MACT. These engines are operated in non-emergency situations to manage waste water and storm water at the MiOps site.

These units are direct injection compression ignition 12 cylinder engines with a horsepower rating of > 500 HP and direct burn low sulfur diesel. The engines are equipped with a single stage catalytic reduction and a closed crankcase ventilation system.

2.2 Flue Gas Sampling Locations

Sampling was conducted on the engines after the single stage catalytic reduction. The flue gas sample location met the minimum guidelines for carbon monoxide (CO) and oxygen (O_2) sampling.



3.1 Objectives and Test Matrix

Dow conducted compliance testing of two diesel Model KTA-2300-P engines that were installed in 1986 and that meet the definition of a CI RICE. These engines are non-emergency compression ignition engines each with a horsepower of 1050 HP. The testing was conducted to demonstrate compliance with emissions and operating limits found in 63.6600(d), Table 2c of the RICE MACT, 40CFR63, Subpart ZZZZ. The specific objectives of this test were to:

- Demonstrate concentration of CO emissions in the exhaust <23 ppmvd corrected to 15% O_2 or;
- Demonstrate CO emissions are reduced by 70% or more;
- Establishing the differential pressure across the catalyst that will be used to demonstrate ongoing compliance;
- Maintain catalyst inlet temperature such that 450°F ≤ catalyst inlet temperature ≤ 1350°F as required by the rule.

3.2 Facility Operations

The plant must operate the engines equipped with a closed crankcase ventilation system as follows:

- Minimize idle time at startup to <30 minutes (Table 2c)
- Install oxidation catalyst:
  - Maintain your catalyst so that the pressure drop across the catalyst does not change by more than 2 inches of water from the pressure drop across the catalyst that was measured during the initial performance test; AND
  - Exhaust maintained such that 450°F ≤ catalyst inlet temperature ≤ 1350°F (Table 2b)

3.3 Comments

- Mark Dziadosz of the Michigan Department of Environmental Quality observed Engine A testing on Tuesday, March 29.
- Kathy Brewer of the Michigan Department of Environmental Quality observed Engine B testing on Wednesday, March 30.
- On Diesel Engine A, two levels of calibration gas were completed since emissions were unknown. All gases met required limits.
- There were inlet sample equipment issues. However, since the outlet emission levels were far below the required limit, the removal efficiency was not completed or calculated. All test data was included in the report but not used for reporting purposes.

3.4 Process Operating Rates

The operation of each engine is not directly related to any production rate since this is not a process that actually produces a product. During this testing the facility operated the engines at normal operating rates, as follows:

- at a load (as determined by engine RPM and pump discharge pressure) representative of normal operating conditions as required by 40 CFR 63.7(e); AND
- Exhaust maintained such that 450°F ≤ catalyst inlet temperature ≤ 1350°F.

There are field mounted instruments for each of the two engines that were used to measure engine RPM (RPM), inlet temp of catalyst (°F) and catalyst differential pressure (DeltaP). A field mounted pump discharge pressure instrument is located on the discharge line common to both pumps.

Three test runs of 1 hour each were completed for the test. The average of the DeltaP readings collected during each test run was used to establish the DeltaP operating parameter limit to be used for demonstrating on-going compliance with the rule. Measurements of RPM and pump discharge pressure are an indication that the engines are operating normally. The inlet temperatures for the catalyst show the exhaust temperature is being maintained within the required range specified by the rule.

CO and O_2 measurements were collected during the three, one-hour test runs and the average of these results for each test run was used to show that CO emissions in the exhaust are less than 23 ppmv on a dry basis as required by the rule; OR a 70% reduction in CO emissions will be demonstrated by using the catalyst inlet and outlet CO concentrations to calculate the reduction (see Catalyst Reduction Efficiency in Calculations Section 5.0 for details).

TABLE 3.1: Test Summary

Engine	SAMPLE TYPE	TEST METHOD	*ACTUAL EMISSION RATE	ALLOWABLE EMISSION RATE
Diesel Engine A	CO Emissions (ppmv@15%O2)	EPA Method 10	10.7 ppmv@15%O2	23 ppmv@15%O2
Diesel Engine B	CO Emissions (ppmv@15%O2)	EPA Method 10	8.3 ppmv@15%O2	23 ppmv@15%O2

* Average over three one-hour runs.

TABLE 3.2: Test Run Data

PARAMETER	RUN 1	RUN 2	RUN 3	AVERAGE
Diesel Engine A				
Sample Date	03/29/16	03/29/16	03/29/16	n/a
Sample Times (start/end)	1115/1215	1300/1400	1430/1530	n/a
Outlet CO (ppmv)	13.5	12.5	12.3	12.8
Outlet O2 (%)	13.9	13.9	13.9	13.9
Outlet CO (ppmv@15%O2)	**11.3**	**10.6**	**10.3**	**10.7**
Diesel Engine B				
Sample Date	03/30/16	03/30/16	03/30/16	n/a
Sample Times (start/end)	1015/1115	1225/1325	1350/1450	n/a
Outlet CO (ppmv)	14.0	15.4	15.0	14.8
Outlet O2 (%)	10.5	10.4	10.4	10.4
Outlet CO (ppmv@15%O2)	**7.9**	**8.6**	**8.4**	**8.3**

TABLE 3.3: PROCESS DATA

PARAMETER	RUN 1	RUN 2	RUN 3	AVERAGE
Diesel Engine A				
Sample Date	03/29/16	03/29/16	03/29/16	n/a
Sample Times (start/end)	1115/1215	1300/1400	1430/1530	n/a
Engine RPM (RPM)	1798	1797	1796	1797
Pump Discharge Pressure (psig)	37.6	37.6	37.6	37.6
Amount Diesel Used (Gal)	25.1	18.3	22.1	21.9
HapGuard Temp (°F)	612	613	609	611
HapGuard Δp (inches water)	1.71	1.57	1.53	1.60
Diesel Engine B				
Sample Date	03/30/16	03/30/16	03/30/16	n/a
Sample Times (start/end)	1015/1115	1225/1325	1350/1450	n/a
Engine RPM (RPM)	1780	1812	1835	1809
Pump Discharge Pressure (psig)	44.4	45.8	47.0	45.7
Amount Diesel Used (Gal)	34.2	37.9	37.5	36.5
HapGuard Temp (°F)	779	789	795	788
HapGuard Δp (inches water)	0.88	0.82	0.89	0.86

4.1 Test Methods

All sampling and analytical procedures are EPA published methods or methods referenced by 63.6610 of the RICE MACT, 40CFR63, Subpart ZZZZ. This compliance test utilized the following methods:

EPA Method 3A for O_2 Concentration
EPA Method 10 for CO Concentration

4.2 Procedures

The above methods were completed using mobile continuous emission monitors. Gas was withdrawn from the stack and transported to monitors located at ground level. A stainless-steel probe was inserted into the stack and used to collect sample gas. A Teflon sample line heated to 250°F transported sample gas from the probe to the analyzers. The analyzers were kept at a constant temperature inside the mobile laboratory.

Sample gas was collected continuously from the sample points for a period of 60 minutes per run. At the mobile laboratory, the stack gas was routed to a condenser and then transported to the analyzers for analysis. All vent streams were analyzed "dry". Therefore, no moisture determination is necessary.

EPA Method 3A (Determination of Oxygen and Carbon Dioxide Concentrations, Instrumental Analyzer Procedure)

EPA Method 3A (Instrumental Method) was used to determine the diluent during each run on the outlet.

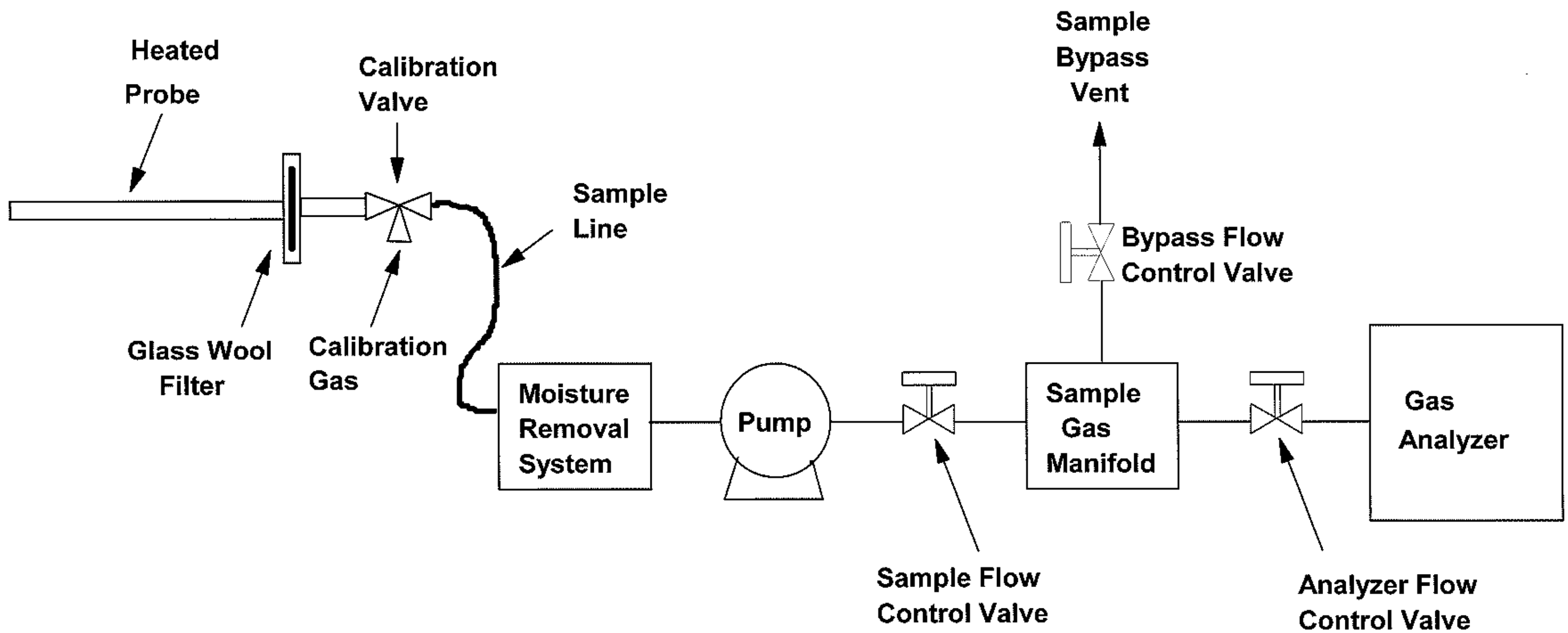
An analyzer measured O_2 content on the basis of the strong paramagnetic properties of O_2 relative to other compounds present in combustion gases. In the presence of a magnetic field, O_2 molecules become temporary magnets. The analyzer determines the sample gas O_2 concentration by detecting the displacement torque of the sample test body in the presence of a magnetic field.

EPA Method 10 (Determination of Carbon Monoxide)

EPA Method 10 was used to determine carbon monoxide concentrations during each run on the outlet.

An analyzer measured CO based on its absorption of infrared radiation. The infrared unit uses a single beam, single wavelength technique, with wavelength selection being achieved by a carefully specified narrow band optical filter making it highly selective for CO measurement in the presence of other infrared-absorbing gases.

FIGURE 4.1: SAMPLING TRAIN USED FOR CO & O_2 (M10 & M3A) –NOTE- No Particulate filter will be used.



Analyzer Calibration Error Calculations

The calibration error test consisted of challenging each reference monitor at three measurement points against known calibration gas values. Calibration error is calculated using the following equation:

$$CE_{RM} = \frac{|Analyzer\ Response - Calibration\ Gas\ Value|}{Span\ of\ Analzyer} \times 100$$

CO-Outlet Run #1 Example

$$CE_{RM} = \frac{|0.0\ ppmv - 0.0\ ppmv|}{29.7\ ppmv} \times 100 = \underline{0.0\ \%}$$

$$CE_{RM} = \frac{|15.2\ ppmv - 15.0\ ppmv|}{29.7\ ppmv} \times 100 = \underline{0.7\ \%}$$

$$CE_{RM} = \frac{|29.7\ ppmv - 29.7\ ppmv|}{29.7\ ppmv} \times 100 = \underline{0.0\ \%}$$

System Calibration Bias Calculations

The system bias calibration test consisted of challenging the reference sample system at two measurement points against the local calibration values. Calibration bias calculations are calculated using the following equation:

$$CB_{RM} = \frac{|System\ Calibration\ Response - Analzyer\ Calibration\ Response|}{Span\ of\ Analzyer} \times 100$$

CO-Outlet Run #1 Example

$$CB_{RM} = \frac{|0.0\ ppmv - 0.0\ ppmv|}{29.7\ ppmv} \times 100 = \underline{0.0\ \%}$$

$$CB_{RM} = \frac{|15.2\ ppmv - 15.2\ ppmv|}{29.7\ ppmv} \times 100 = \underline{0.0\ \%}$$

Calibration Drift Calculations

The calibration drift tests were conducted at the beginning and end of each run. Analyzer maintenance, repair or adjustment could not be completed until the system calibration response was recorded. Calibration drift is calculated using the following equation:

$$CD_{RM} = \frac{|Final\ System\ Cal\ Response - Initial\ System\ Cal\ Response|}{Span\ of\ Analzyer} \times 100$$

CO-Outlet Run #1 Example

$$CD_{RM} = \frac{|0.0\ ppmv - 0.0\ ppmv|}{29.7\ ppmv} \times 100 = \underline{0.0\ \%}$$

$$CD_{RM} = \frac{|15.3\ ppmv - 15.2\ ppmv|}{29.7\ ppmv} \times 100 = \underline{0.3\ \%}$$

System Calibration Drift Correction

The gas concentrations are corrected for the system calibration bias. The concentrations are calculated using the following equations:

$$C_{Gas} = (\overline{C} - C_O)\left(\frac{C_{MA}}{C_M - C_O}\right)$$

where: C_{Gas} = Effluent Concentration, dry ppm or %
$\overline{C}$ = Average Analyzer Concentration, ppm or %
C_O = Average Initial and Final System Calibration Responses for Zero Gas, ppm or %
C_M = Average Initial and Final System Calibration Responses for Upscale Calibration Gas, ppm or %
C_{MA} = Actual Concentration of Upscale Calibration Gas, ppm or %

CO-Outlet Run #1 Example

$$C_{Gas} = (13.7\ ppmv - 0.0\ ppmv)\left(\frac{15.0\ ppmv}{15.3\ ppmv - 0.0\ ppmv}\right) = \underline{13.5\ ppmv}$$

O2-Outlet Run #1 Example

$$C_{Gas} = (14.0\ \% - 0.0\ \%)\left(\frac{12.0\ \%}{12.1\ \% - 0.0\ \%}\right) = \underline{13.9\ \%}$$

CO Correction to 15% O_2

The CO is corrected to 15% O_2 for emission calculations. The following equation as used to calculate the corrected CO value:

If the Corrected Gas Value is a positive number, use the following equation:

$$Gas_{Corr} = Corrected\ Raw\ Gas\ Value\ \times \left(\frac{5.9\%}{20.9\% -\ Corrected\ Raw\ O_2\ Value}\right)$$

If the Corrected Gas Value is a negative number, use the following equation:

$$Gas_{Corr} = Corrected\ Raw\ Gas\ Value\ \div \left(\frac{5.9\%}{20.9\% -\ Corrected\ Raw\ O_2\ Value}\right)$$

CO-Outlet Run #1 Example

$$Gas_{Corr} = 13.5\ ppmv\ \times \left(\frac{5.9\%}{20.9\% - 13.9\%}\right) = \underline{11.3\ ppmv\ @\ 15\%\ O_2}$$