AECOM



# 40 CFR 63, Subpart ZZZZ
# Reciprocating Internal Combustion Engines (RICE MACT)
# WWTP Diversion Diesel Pumps
# Engine A (D-200A)
# Engine B (D-200B)

Project number: 60724067

March 7, 2024

The Dow Chemical Company
Michigan Operations
Midland, MI

Delivering a better world

## Quality information

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## Revision History

| Revision | Revision date | Details | Authorized | Name | Position |
|---|---|---|---|---|---|
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# 1. Introduction

## 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).

AECOM was contracted to conduct an emissions compliance test of two 1,050 horsepower (hp) non-emergency diesel engines (designated as Engine A and Engine B) to demonstrate compliance with the RICE MACT regulations in 40CFR63, Subpart ZZZZ. 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:

**Table 1-1. General Summary Information**

| | |
|---|---|
| Responsible Groups | • The Dow Chemical Company<br>• Michigan Department of Energy, Great Lakes, and Environment. (EGLE)<br>• U. S. Environmental Protection Agency (US EPA) |
| Applicable Regulations | • ROP-MI-A4033-2024<br>• 40 CFR 63, Subpart ZZZZ (RICE MACT) |
| Industry / Plant | • Environmental Operations Plant (EVO) |
| Plant Location | • The Dow Chemical Company Midland, MI 48667 |
| Unit Installation Date | • Engine A 6/2/2021<br>• Engine B 3/17/2022 |
| Unit Initial Compliance Date | • Engine A 11/18/2021<br>• Engine B 8/03/2022 |
| Air Pollution Control Equipment | • All engines are equiped with dual single stage catalytic reduction and closed crankcase filtration emissions control systems |
| Emission Points | • P200 Diesel Engine A<br>• P200 Diesel Engine B |
| Pollutants/Diluent Measured | • Carbon Monoxide (CO)<br>• Oxygen ($O_2$) |
| Test Dates | • Feb 20, 2024 (Engine A)<br>• Feb 21, 2024 (Engine B) |

## 1.2 Key Personnel

Names and affiliations of personnel, including their roles in the test program, are summarized in the following table.

**Table 1-2. Test Program Personnel Summary**

| Role | Role Description | Name | Affiliation |
|---|---|---|---|
| Process Focal Point | • Coordinate plant operation during the test.<br>• Ensure the unit is operating at the agreed upon conditions in the test plan.<br>• Collect any process data required.<br>• Provide all technical support related to process operation. | Morgan Raup | Dow Chemical |
| Environmental Focal Point | • Ensure all regulatory requirements and citations are reviewed and considered for the testing. | Becky Meyerholt | Dow Chemical |
| Technical Reviewer | • Completes technical review of the test data. | Wayne Washburn | AECOM |
| Field Team Leader | • Ensures field sampling meets the quality assurance objectives of the plan. | Peter Becker | AECOM |
| Sample Project Leader | • Ensures data generated meets the quality assurance objectives of the plan. | James Edmister | AECOM |

# 2. Plant and Sampling Location Description

## 2.1 Facility Description

Dow operates a chemical manufacturing facility in Midland, Michigan. Environmental Operations (EVO) operates two 1,050 hp diesel engines used to divert influent wastewater and stormwater 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 2b of the RICE MACT, 40CFR63, Subpart ZZZZ.

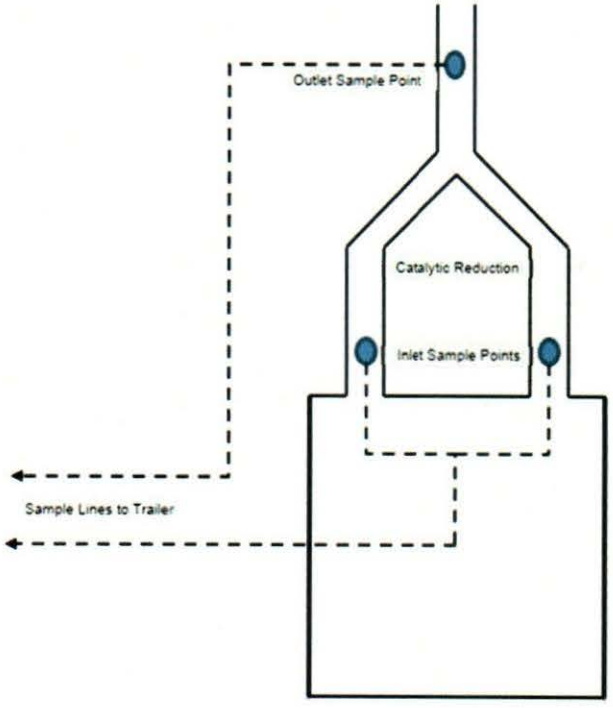
## 2.2 Control Equipment

CO emissions are controlled by catalytic oxidation.

## 2.3 Flue Gas Sampling Locations

Sampling was conducted on the typical exhaust trains of Engine A and Engine B prior to and after the individual identical dual (in parallel) single stage catalytic reduction system serving each engine. Flue gas sample locations met the minimum guidelines for carbon monoxide (CO) and oxygen ($O_2$) sampling using instrumental analyzers.

Figure 2-1. Sampling Location Diagram of Engines A and B (Typical)



# 3. Summary and Discussion of Test Results

## 3.1 Objectives and Test Matrix

Under contract with Dow Midland Operations, AECOM, Inc. conducted compliance sampling on the engines located at the Environmental Operations Plant (EVO) at Dow's Michigan Operations (MiOps) facility. These engines are operated in non-emergency situations to manage wastewater and stormwater at the MiOps WWTP. The testing was conducted to demonstrate compliance with emissions and operating limits found in 63.6600(d), Table 2c. The specific objectives of this test were to:

- Verify that the destruction efficiency (DE) for CO is greater than 70%.

## 3.2 Facility Operations

For engines >500 HP, the facility must:

- Minimize idle time at startup to <30 minutes,
- Maintain the catalyst so that the pressure-drop across the catalyst does not change by more than 2 inches of water at 100 percent load ±10 percent from the pressure drop across the catalyst measured during the initial performance test, and
- Maintain the exhaust temperature such that 450°F ≥ catalyst inlet temperature ≤ 1350°F.

## 3.3 Comments / Exceptions

- As allowed by 40 CFR, Part 60, Subpart ZZZZ, this Compliance Test consisted of three, one-hour test runs.

**Table 3-1. Summary of Results**

| SAMPLE TYPE | TEST METHOD | ACTUAL EMISSION REDUCTION | REQUIRED EMISSION REDUCTION |
|---|---|---|---|
| CO Emissions (DE) Engine A | EPA Method 10 | 94.8 % | 70 % |
| CO Emissions (DE) Engine B | EPA Method 10 | 96.2 % | 70 % |

**Table 3-2. Test Run Data**

| P200 Engine A Test Run Data | | | | |
|---|---|---|---|---|
| **PARAMETER** | **RUN 1** | **RUN 2** | **RUN 3** | **AVERAGE** |
| Sample Date | 2/20/2024 | 2/20/2024 | 2/20/2024 | -- |
| Sample Times (start/end) | 10:05-11:05 | 11:22-12:22 | 12:40-13:40 | -- |
| Outlet CO (ppmv @ 15% $O_2$) | 2.30 | 2.00 | 1.91 | 2.07 |
| Inlet CO (ppmv @ 15% $O_2$) | 41.01 | 38.77 | 39.94 | 39.91 |
| **CO (DE %)** | --- | --- | --- | **94.8** |
| **P200 Engine B Test Run Data** | | | | |
| **PARAMETER** | **RUN 1** | **RUN 2** | **RUN 3** | **AVERAGE** |
| Sample Date | 2/21/2024 | 2/21/2024 | 2/21/2024 | -- |
| Sample Times (start/end) | 09:00-10:00 | 10:15-11:15 | 11:35-12:35 | -- |
| Outlet CO (ppmv @ 15% $O_2$) | 1.78 | 1.68 | 1.65 | 1.70 |
| Inlet CO (ppmv @ 15% $O_2$) | 45.88 | 44.94 | 42.61 | 44.48 |
| **CO (DE %)** | --- | --- | --- | **96.2** |

## Table 3-3. Engine A Process Data

| PARAMETER | RUN 1 | RUN 2 | RUN 3 | AVERAGE |
|---|---|---|---|---|
| Sample Date | 2/20/2024 | 2/20/2024 | 2/20/2024 | -- |
| Sample Times (start-end) | 10:05-11:05 | 11:22-12:22 | 12:40-13:40 | -- |
| Engine RPM (RPM) | 1,847 | 1,846 | 1,846 | 1,846 |
| Engine Load (%) | 84 | 85 | 85 | 85 |
| Fuel Consumed (Gallons) | 49 | 44 | 51 | 48 |
| **Catalyst 1** | | | | |
| Catalyst Inlet Temp (Deg F) | 704 | 712 | 716 | 710.7 |
| Differential Pressure (IWC) | 21.09 | 20.97 | 20.91 | 20.99 |
| **Catalyst 2** | | | | |
| Catalyst Inlet Temp (Deg F) | 717 | 724 | 729 | 723.3 |
| Differential Pressure (IWC) | 21.35 | 21.22 | 21.18 | 21.25 |

***1 gallon of distillate fuel with 15 ppm of sulfur or less produces 137,381 Btu.**

## Table 3-4. Engine B Process Data

| PARAMETER | RUN 1 | RUN 2 | RUN 3 | AVERAGE |
|---|---|---|---|---|
| Sample Date | 2/21/2024 | 2/21/2024 | 2/21/2024 | -- |
| Sample Times (start-end) | 09:00-10:00 | 10:15-11:15 | 11:35-12:35 | -- |
| Engine RPM (RPM) | 1,847 | 1,848 | 1,848 | 1,848 |
| Engine Load (%) | 84 | 85 | 85 | 85 |
| Fuel Consumed (Gallons) | 47 | 43 | 49 | 46 |
| **Catalyst 1** | | | | |
| Catalyst Inlet Temp (Deg F) | 715 | 717 | 722 | 718.0 |
| Differential Pressure (IWC) | 18.70 | 18.70 | 18.79 | 18.73 |
| **Catalyst 2** | | | | |
| Catalyst Inlet Temp (Deg F) | 714 | 716 | 721 | 717.0 |
| Differential Pressure (IWC) | 18.92 | 18.91 | 18.99 | 18.94 |

***1 gallon of distillate fuel with 15 ppm of sulfur or less produces 137,381 Btu.**

# 4. Sampling and Analytical Procedures

## 4.1 Test Methods

All sampling and analytical procedures are EPA published methods or methods allowed by 63.6610. This compliance test utilized the following methods:

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

**EPA Method 3A (Flue Gas Composition and Molecular Weight)**
EPA Method 3A (Instrumental Analyzer Method) was utilized to determine the diluent gas concentrations during each run at both the inlet and outlet of the catalysts serving each engine exhaust train.

Each Method 3A analyzer measured $O_2$ concentrations based on 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 (CO Sampling and Analysis)**
EPA Method 10 was utilized to determine carbon monoxide concentrations during each run at both the inlet and outlet of the catalysts serving each engine exhaust train.

Each Method 10 analyzer measured CO based on its absorption of non-dispersive infrared (NDIR) radiation. The NDIR 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. In addition, the Thermo Model 48 platform of analyzers employ gas filter correlation (GFC) techniques to eliminate bias from any other infrared-absorbing compounds besides CO.

## 4.2 Procedures

The above methods are performed using mobile continuous measurement instrumental analyzers. Gases are withdrawn from the gas stream and transported to monitors located at ground level. A stainless-steel probe is inserted into the gas stream and used to collect sample gas. A Teflon sample line heated to ≥250°F transports sample gas from the probe to the analyzers. The analyzers are kept at a constant temperature inside the mobile laboratory.

Sample gas is collected continuously from the gas stream for a period of one hour. A stratification test is performed during the first test run at three traverse points, which are 16.7%, 50.0%, and 83.3% of the measurement line that passes through the centroidal area of the stack or duct cross section. At the mobile laboratory, the stack gas is routed to a gas moisture condenser and then transported to the analyzers for dry-basis analysis.

The Destruction Efficiency (DE) tests are conducted by first measuring the Oxygen and Carbon Monoxide concentrations within the inlet and outlet gas streams of the catalyst system, with the CO concentrations then corrected to 15% excess oxygen prior to calculating DE as follows:

$$DE = (CO_{In} - CO_{Out}) / CO_{In} * 100\%$$

Destruction efficiency is determined for the 3-run average inlet and outlet CO (ppmvd @ 15% $O_2$).

## 4.3 Source Test Equipment

Table 4-1: Instrumental Analyzers

| Instrument | System | Output | Make | Model | Serial # or ID # |
|---|---|---|---|---|---|
| Method 3A ($O_2$) | Inlet $O_2$ | 0-25% | Servomex | 1440 | OXC-1601 |
| Method 10 (CO) | Inlet CO | 0-200 ppm | Thermo | 48i | CO-A1601 |
| Method 3A ($O_2$) | Outlet $O_2$ | 0-25% | Servomex | 1440 | OXC-1602 |
| Method 10 (CO) | Outlet CO | 0-60 ppm | Thermo | 48C | CO-A1604 |

Figure 4-1. Sampling Train Used for CO & O2 (M10 & M3A)