

MALFUNCTION ABATEMENT / PREVENTATIVE MAINTENANCE PLAN

North American Natural Resources, Inc. – Autumn Hills Generating Station
Ottawa County, Michigan

This Preventative Maintenance and Malfunction Abatement Plan (PM/MAP) has been prepared in accordance with R 336.1911 set forth by the Michigan Department of Environment, Great Lakes, and Energy's Air Quality Division (EGLE-AQD). This PM/MAP is applicable to three (3) reciprocating internal combustion engines, permitted under the current Renewable Operating Permit (ROP) for SRN N6006 and includes the following:

- Identification of the personnel responsible for overseeing the inspection, maintenance, and repair of equipment;
- A description of equipment that shall be inspected along with the frequency of the inspections or repairs;
- Identification of the major replacement parts that shall be on-site for quick replacement;
- An identification of the equipment operating variables that shall be monitored to detect malfunction or failure, the normal operating range of these variables, and a description of the method of monitoring; and

The corrective procedures or operational changes that shall be taken in the event of a malfunction or failure to achieve compliance with the applicable emission limits.

The purpose of the PM/MAP is to establish appropriate process monitoring, malfunction response and preventative maintenance procedures for the existing three (3) landfill gas (LFG) fueled engines operated at the Autumn Hills Generating Facility. A copy of the most recent PM/MAP is maintained in the site files.

1. Responsible Personnel

The personnel responsible for overseeing the inspection, maintenance, and repair of the Plant and related facilities are:

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2. Facility and General Process Information

NANR has been permitted to install and operate one (1) Caterpillar (CAT®) G3516LE reciprocating internal combustion (IC) engine and two (2) Caterpillar (CAT®) G3520C reciprocating internal combustion (IC) engines that are fueled with LFG and connected to electricity generators (IC engine/generator). The emission units are identified in the permit as EUENGINE1, EUENGINE2R, and EUENGINE4.

The LFG generated at the Autumn Hills Recycling & Disposal Facility (Autumn Hills RDF) is collected using a system of wells, gas headers and blowers, which have been installed and are operated by the landfill owner. The LFG is dewatered, filtered, and compressed (treated) by the landfill owner before being supplied as fuel to the IC engine/generator sets. The electricity generated is distributed to the local grid.

3. IC Engine / Generator Malfunction Abatement

The CAT® G3520C and G3516LE engines are designed to fire low-pressure, lean fuel mixtures (e.g., LFG). The engines are equipped with an air-to-fuel ratio controller that monitors engine performance parameters and automatically adjusts the air-to-fuel ratio and ignition timing to maintain efficient fuel combustion. This is performed through software provided by Caterpillar.

The engine/generator sets are not equipped with add-on emission control devices. Therefore, the units maintain compliance with applicable air pollutant emission limits through the proper operation of the engine and efficient fuel combustion, which:

- Reduces the formation of carbon monoxide (CO) and nitrogen oxide (NO_x) emissions.
- Destroys methane and nonmethane organic compounds (NMOC) in the LFG fuel (nonmethane hydrocarbons may be classified as volatile organic compounds and/or hazardous air pollutants).

Malfunction Abatement for the CAT® G3520C and G3516LE IC engines consist of monitoring critical engine parameters to ensure proper operation. The engines are equipped with numerous sensors that monitor critical operation parameters. An engine control module (ECM) processes the data and adjusts operating variables (ignition timing, air/fuel ratio, engine speed), activate alarms to warn of an out-of-range variable or shuts down the engine.

In the event of a malfunction or emission limit exceedance occurs at engine generator sets, the following corrective procedures will be performed:

- The operator will immediately shut down the treatment and gas mover system within an hour, to prevent atmospheric venting of gas through the system,

- The operator will review the current system parameters,
- Startup procedures and/or maintenance will then be undertaken to resume operation of the flare,
- A list of corrective procedures for the engines will be continuously updated and kept on record in the case of similar malfunctions. Operational procedures and maintenance plans will be reviewed and updated as necessary, and
- If necessary, a deviation report will be submitted in accordance with the current permit.

3.1 Engine Oil / Engine Coolant Temperature

Engine oil and engine coolant conditions do not directly influence air pollutant emissions. However, maintaining proper engine oil/coolant temperature and pressure is critical to the operation of the engine and preventing early or catastrophic mechanical failure.

The engines are equipped with sensors to monitor the engine oil temperature and oil pressure before and after the oil filter. Notification alarms are activated based on out-of-range conditions (e.g., high oil temperature, low or high oil pressure). An automatic shutdown will occur if the variable exceeds a critical setpoint.

Engine coolant temperature is monitored to assure proper circulation of coolant and cooling of the engine block. Notification alarms are activated based on out-of-range conditions (high or low coolant temperature). An automatic shutdown will occur if the coolant temperature exceeds its critical setpoint temperature.

Abnormal engine operations or shutdowns are logged by the ECM. The cause of the problem is investigated and corrected by the operators and the engine is restarted.

3.2 Air / Fuel Ratio Control

Maintaining proper air/fuel ratio results in efficient fuel combustion and limits the formation of CO and NOX. The engine is equipped with an inlet gas quality monitor that continuously monitors the inlet LFG fuel for methane (fuel value) and oxygen content. The Engine Control Module (ECM) software monitors the fuel gas conditions, engine load and engine speed and automatically adjusts the air/fuel mix valve (raptor valve position) to achieve the desired air/fuel mix setting. This programming is set by the manufacturer.

If the monitored LFG oxygen level increases, or the methane content decreases, beyond preset values the engine automatically shuts down if the desired air/fuel mix ratio cannot be obtained. This prevents excess emissions.

Abnormal fuel conditions and/or engine shutdown is logged by the ECM. The cause of the excess oxygen or decreased methane is investigated (this is typically caused from

landfill wellfield maintenance or adjustments) and corrected by the operators and the engines are restarted.

3.3 Daily Inspections

NANR personnel keep Daily Logs recording the status of operations for each of the generating units. Any shutdowns, probable cause of the shutdown, and the down time period are recorded, and the records maintained at the Plant. The operator performs daily visual inspections of the engines and logs the following information in a daily log:

- Coolant system level;
- Engine air cleaner service indicator;
- Engine oil level;
- Fuel system fuel filter differential pressure; and
- Generator load.

3.4 Engine Operating Parameter Ranges

The following table presents operating ranges (or maximum values) for parameters that have been determined to be critical for proper engine operation.

Engine Parameter	Minimum	Maximum
Engine Coolant Pressure (psi)	38	60
Engine Coolant Temperature (°F)	---	248
Engine Oil Pressure (psi)	> 0	---
Engine Oil Temperature (°F)	---	219
Combustion Air Temperature (°F)	---	167
Gas (Fuel) Pressure (psi)	---	19.6

3.5 On-Call Dial-Out System

The facility is not staffed around the clock. Therefore, the ECM is connected to a dial-out system that notifies the on-call operator of any engine shutdowns and certain faults and warnings during evening/weekend/holiday hours when the facility is not staffed.

At any time, if one of the generating units shuts down, the plant operator is paged immediately, this operator is on call twenty-four (24) hours a day, seven (7) days a week and returns to the plant to investigate the nature of the shutdown. A rotation system is in place with operators from near-by locations covering for each other. Whenever a shutdown occurs, the flare immediately picks up the extra gas. As such, the flare is a backup to the engine plant.

Corrective actions/procedures in the event of a malfunction of Treatment System: (i) evaluate problem; (ii) correct problem with replacement part needed; (iii) if cannot be repaired in timely manner, turn flare on.

4. Preventative Maintenance

EUENGINE1, EUENGINE2R, and EUENGINE4 are maintained per the guidelines in the Caterpillar Operation and Maintenance Manual. The actual maintenance schedule is dependent on actual fuel gas conditions and observations of engine performance. Specific operating variables with operating ranges, which are monitored to detect malfunctions or required maintenance, are outlined in Section 4.4.

Proper maintenance of the fuel train ensures good fuel mixing and combustion, which limits CO and NO_x formation. The monitoring and regular replacement of worn engine parts (such as cylinder seals) reduces particulate matter (PM₁₀/PM_{2.5}) emissions (primarily engine oil).

4.1 Parts Inventory

NANR maintains a stock of long-lead time or hard to obtain replacement parts for the electric generating units and for the gas compressor at the Autumn Hills Generating Facility. The part list is balanced against the requirement given NANR's long-term engine maintenance program following practices in the industry.

Michigan Caterpillar also stocks a list of parts as required by the various landfill gas to energy power producers in the state of Michigan. Additionally, NANR works in concert at the operator level to network with other likely situated companies to exchange parts when required.

The following parts are kept on-site for the Treatment System: Site glass gauges for the water separator and oil separator; spare gauges for coalescing filters; 12 coalescing filters; spare compressor belt, spare vanes for compressor and 200 gallons of oil for compressor.

Details of materials managed on-site are provided in Appendix B.

4.2 Oil Sampling Program

When engine oil is changed per the preventative maintenance schedule (typically monthly), a sample of the oil is sent for analysis of several properties. The oil analysis results are used to determine fuel condition, the level of engine wear or parts that may need attention (inspection or replacement). Depending upon the results, the maintenance schedule may be adjusted from the manufacturer's guidelines.

5. Recordkeeping

The following information will be maintained to verify proper operation and maintenance of the engines and that proper procedures were implemented in response to malfunction requirements:

1. Daily records of the equipment monitoring parameters that are presented in this document (Section 4.3 Daily Inspections).
2. Equipment maintenance records for those systems that affect the operation of the engine.
3. Engine faults, alarms and shutdowns are recorded and logged by the ECM.
4. Records of process malfunctions or equipment failures if such events are different from those covered in this Plan. Particularly if it is suspected that emission limits may have been exceeded or LFG was vented to the atmosphere from the Sumpter Energy facility.

6. Plan Revisions

If the plan fails to address or inadequately addresses an event that meets the characteristics of a malfunction at the time the plan is initially developed, the owner or operator shall revise the plan within 45 days after such an event occurs and submit the revised plan for approval to the AQD District Supervisor. Should the AQD determine the PM/MAP to be inadequate, the AQD District Supervisor may request modification of the plan to address those inadequacies.

This PM/MAP will be:

1. Amended or modified if equipment or processes are added that are not covered under the Plan; or
2. Revised within 45 days of an event if the procedures described in this document do not adequately address any malfunction event that occurs at the facility.

Plan revisions will be documented using the revision history log (Appendix A) and submitted to the AQD District Supervisor as required by the Permit.

Appendix A
Plan Revision History

Revisions of the PM/MAP are performed when there is a substantial change in operations or equipment. The following revisions have been made to the Plan.

Initial Date of Issuance: October 17, 2022

Date	Actions / Reasons for Revision
10/17/2022	Initial Draft of MAP/PMP
11/04/2022	Revisions to contact information and site-specific operations as requested by EGLE.

Appendix B
Materials Inventory

Materials Inventory Table

Parts needed for quick repair or that have long lead times for the engines are kept on-site. The table below lists such parts and their respective on-site quantity, which can vary throughout the year. Additional materials not outlined in the table are ordered, as necessary.

Material Name	Quantity
New engine oil	400 Gal.
Spark Plugs	60
Boost sensor	
Oil temp sensor	
Oil filters	
Air filters	
Det sensors	
Rocker Box	
Rocker arms	
Cylinder pack with piston and rod bearing	