PREVENTATIVE MAINTENANCE and MALFUNCTION ABATEMENT PLAN

Upper Michigan Energy Resources

A.J. Mihm Generating Station
Pelkie, Michigan

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Table of Contents

1.0 INTRODUCTION 3

2.0 SOURCE DESCRIPTIONS 3

2.1 Wärtsilä 18V50SG Engines 3

2.2 Caterpillar G3512 EPA Emergency Standby Generator 3

3.0 AIR EMISSIONS CONTROL DEVICES AND DESCRIPTION 4

3.1 Wärtsilä 18V50SG Engines 4

3.2 Caterpillar G3512 EPA Emergency Standby Generator 5

4.0 EQUIPMENT OPERATING VARIABLES, RANGES, & FREQUENCY 6

5.0 ENGINE EMISSIONS LIMITS 7

5.1 Wärtsilä Engine Emission Limits 7

5.2 Caterpillar G3512 EPA Emergency Standby Generator 8

6.0 PREVENTATIVE MAINTENANCE SCHEDULE (ITEMS INSPECTED AND FREQUENCY) 9

6.1 Wärtsilä 18V50SG Engines Preventative Maintenance Schedule 9

6.2 SCR and Oxidation System Preventative Maintenance Schedule 10

6.3 Caterpillar G3512 EPA Emergency Standby Generator Preventative Maintenance Schedule 10

7.0 CORRECTIVE ACTIONS 12

8.0 MAJOR PARTS REPLACEMENTS LIST 12

9.0 RESPONSIBLE PERSONNEL 12

10.0 RETENTION OF RECORDS 13

11.0 UPDATES TO PREVENTATIVE MAINTENANCE / MALFUNCTION ABATEMENT PLAN 13

LIST OF TABLES

Table No.	Title	Page
1	Equipment Operating Variables, Ranges, & Frequency	6
2	Wärtsilä Units Emission Limits	7
3	Caterpillar G3512 EPA Emergency Standby Generator	8
4	Wärtsilä 18V50SG Engines Preventative Maintenance Schedule	9
5	SCR and Oxidation System Preventative Maintenance Schedule	10
6	Caterpillar G3512 EPA Emergency Standby Generator Preventative Maintenance Schedule	10
7	Major Parts Replacement List	12

LIST OF FIGURES

Figure No.	Title	Page
1	Example of an SCR system with oxidation catalyst	4

1.0 INTRODUCTION

The A.J Mihm Generating Station, located in Pelkie, Michigan, consists of three Wärtsilä natural gas-fired reciprocating internal combustion engine (RICE) generator sets and auxiliary equipment, including a 1,000kW emergency generator as well as a natural gas conditioning heater.

The information contained in this Malfunction Abatement Plan (MAP) describes the air emission sources and air pollution control equipment malfunction related operation at A.J. Mihm Generating Station. This plan is prepared in accordance with Michigan Department of Environmental Quality, Part 9 Rule 336.1911.

The plan outlines steps taken to prevent, detect, and correct malfunctions or equipment failures which may cause any applicable emission limitation to be exceeded.

2.0 SOURCE DESCRIPTIONS

2.1 *Wärtsilä 18V50SG Engines*

The generator sets consist of three (3) Wärtsilä 50 SG natural gas-fired, 4-stroke, spark ignition, lean burn reciprocating internal combustion engines (RICE) coupled with a minimum 18,817 kW electric generator.

The engine generating sets are powered by heavy-duty medium-speed four-stroke engines. The generating sets consist of a RICE coupled directly to a generator. In these engines, natural gas is mixed with air before the inlet valves. During the intake period, gas is also fed into a small pre-chamber where the gas mixture is rich compared to the gas in the cylinder. At the end of the compression phase the gas-air mixture in the pre-chamber is ignited by a spark plug. The flames from the nozzle of the pre-chamber ignite the gas-air mixture in the whole cylinder. To maintain a correct air-fuel ratio, the engine is equipped with an exhaust gas wastegate. It keeps the air pressure in the receiver at an optimal level to match the best power output with the emission requirements. After the working phase the cylinder is emptied of exhaust and the process starts again.

The engines fire pipeline quality natural gas, and are equipped with state-of-the-art air quality control systems including selective catalytic reduction (SCR) for nitrogen oxides (NOx) control, and oxidation catalyst systems for carbon monoxide (CO), volatile organic compound (VOC), and organic hazardous air pollutant (HAP) control.

2.2 *Caterpillar G3512 EPA Emergency Standby Generator*

The facility is also equipped with one (1) Caterpillar G3512 natural gas-fired, spark ignition, lean- burn, 4-stroke, RICE based emergency generator. This engine is equipped with an air/fuel ratio control and will be subject to the Standards of Performance for Stationary Spark Ignition Internal Combustion Engines under 40 CFR 60, Subpart JJJJ. The emergency generator is certified by the manufacturer to comply with the emission standards of 40 CFR 60, Subpart JJJJ.

3.0 AIR EMISSIONS CONTROL DEVICES AND DESCRIPTION

3.1 *Wärtsilä 18V50SG Engines*

The three (3) natural gas-fired reciprocating internal combustion engines are equipped with state-of-the-art air quality control systems including selective catalytic reduction (SCR) for nitrogen oxides (NOx) control, oxidation catalyst systems for carbon monoxide (CO), volatile organic compound (VOC), and organic hazardous air pollutant (HAP) controls.

The SCR system is used for control of NOx. In the SCR process, nitrogen oxides are reduced to nitrogen and water vapor, with the help of urea, the reducing agent.

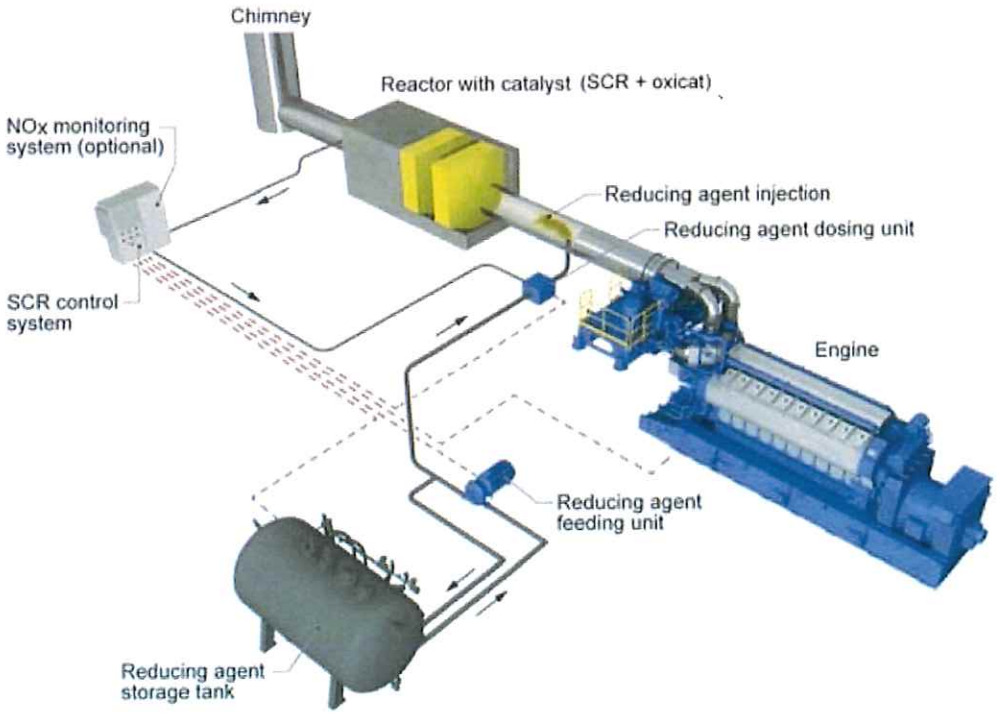
The SCR system includes an automated process control that automatically adjusts the amount of urea injected into the flue gas stream.

The feeding unit pumps urea from the storage tank to the reagent dosing unit. The dosing unit controls the amount of urea fed into the exhaust gas stream.

To reduce CO, VOC, and HAP emissions, an oxidation catalyst is fitted into the same housing as the SCR.

The catalytic oxidation method is used for controlling CO emissions. The abatement method uses catalytically active metals to accelerate the oxidation reactions between the combustible components and the residual oxygen present in the exhaust gases. Other agents or reactants are not needed.

Figure 1- Example of an SCR system with oxidation catalyst



3.2 *Caterpillar G3512 EPA Emergency Standby Generator*

The emergency generator is equipped with an Air/Fuel Ratio Control system. The fuel system includes a fuel metering valve, engine control module (ECM), inlet manifold pressure sensor, NOx sensor, load signal, and an inlet manifold temperature sensor.

The fuel metering valve controls the flow of fuel to the engine. The ECM determines the requirement for the mixture of air and fuel. The ECM sends a signal to the fuel metering valve. The fuel metering valve controls the volume of the gas flow to the engine.

The fuel flows through the fuel metering valve into the air inlet elbow. The mixture of air and fuel flows through the turbocharger compressor. The mixture enters the aftercooler through a throttle which is electronically controlled. The air/fuel mixture is cooled in the aftercooler. The mixture then enters the inlet manifold. The ECM sends an electronic throttle signal to the electronic actuator. The throttle is controlled by the actuator.

4.0 EQUIPMENT OPERATING VARIABLES, RANGES, & FREQUENCY

Table 1 – Equipment Operating Variables, Ranges, & Frequency

Description of Observation	Method of Observation	Normal Operating Range	Frequency of Observation	Comments
SCR Inlet Temperature	Engine control system	600-780 F	Continuously. Inlet temperature is continuously monitored by thermocouples. If a temperature exceeds 895F the engine automatically shuts down.	Range determined during stack testing conducted at full load
Urea Injection Rate	Engine control system	4-10 gallons/hour	Continuous. Urea injection rate is continuously monitored. Metering equipment is used to measure urea and water to achieve proper injection rate.	Range determined during stack testing conducted at full load
SCR Pressure Drop	Engine control system	0.20-0.65 psi	Continuous. Pressure drop across the SCR is continuously monitored.	Range determined during stack testing conducted at full load
Oxidation Catalyst Pressure Drop	Engine control system	0.05-0.35 psi	Continuous. Pressure drop across the oxidation catalyst is continuously monitored.	Range determined during stack testing conducted at full load

5.0 ENGINE EMISSIONS LIMITS

5.1 *Wärtsilä Engine Emission Limits*

Table 2 - Wärtsilä Engine Emission Limits

Pollutant	Limit	Time Period / Operating Scenario	Underlying Applicable Requirements
NOx	3.0 pph	Hourly, excluding periods of startup and shutdown	R 336.1205(1)(a) & (3), 40 CFR 52.21(c) & (d)
NOx	1.0 g/HP-hr or 82 ppmvd at 15% O_2	Hourly, excluding periods of startup and shutdown	40 CFR 60.4233(e), Table 1 to 40 CFR Part 60 Subpart JJJJ
CO	5.5 pph	Hourly, excluding periods of startup and shutdown	R 336.1205(1)(a) & (3), 40 CFR 52.21(d)
CO	2.0 g/HP-hr or 270 ppmvd at 15% O_2	Hourly, excluding periods of startup and shutdown	40 CFR 60.4233(e), Table 1 to 40 CFR Part 60 Subpart JJJJ
VOC	5.5 pph	Hourly, excluding periods of startup and shutdown	R 336.1205(1)(a) & (3), R 336.1702(a)
VOC	0.7 g/HP-hr or 60 ppmvd at 15% O_2	Hourly, excluding periods of startup and shutdown	40 CFR 60.4233(e), Table 1 to 40 CFR Part 60 Subpart JJJJ
Formaldehyde or CO as a surrogate for HAPs	≤14 ppmvd at 15% O2 or CO reduction limit of ≥93% reduction	Hourly, excluding periods of startup and shutdown	40 CFR 63.6600(b) Table 2a

5.2 *Caterpillar G3512 EPA Emergency Standby Generator*

Table 3 - Caterpillar G3512 EPA Emergency Standby Generator

Pollutant	Limit	Time Period / Operating Scenario	Underlying Applicable Requirements
NOx	2.0 g/HP-hr OR 160 ppmvd	Hourly	40 CFR 52.21(c) & (d) 40 CFR 60.4233(e) Table 1 to 40 CFR Part 60, Subpart JJJJ
CO	4.0 g/HP-hr OR 540 ppmvd	Hourly	40 CFR 60.4233(e) Table 1 to 40 CFR Part 60, Subpart JJJJ
VOC	1.0 g/HP-hr OR 86 ppmvd	Hourly	R 336.1702(b), 40 CFR 60.4233(e) Table 1 to 40 CFR Part 60, Subpart JJJJ

ppmvd = parts per million by volume at 15 percent oxygen and on a dry gas basis

6.0 PREVENTATIVE MAINTENANCE SCHEDULE (ITEMS INSPECTED AND FREQUENCY)

Maintenance information involving the sources noted in this Preventative Maintenance and Malfunction Abatement Plan will be stored in the maintenance management system, Maximo. UMERC will utilize internal resources, as well contracted vendors to conduct maintenance, repairs, and calibration, as necessary.

6.1 *Wärtsilä 18V50SG Engines Preventative Maintenance Schedule*

Table 4 - Wärtsilä 18V50SG Engines Preventative Maintenance Schedule

Inspection Item	Maintenance Type	Frequency
Cylinder Head With Valves		
Yoke, valve rotators & valve clearances	Check	Approximately every 2,000 operating hours
One cylinder head	Check	Approximately every 20,000 operating hours
Valve rotators of one cylinder head	Check	Approximately every 20,000 operating hours
Main starting valve	Overhaul / Maintain	Approximately every 20,000 operating hours
Valve rotators	Overhaul / Maintain	Approximately every 30,000 operating hours
All cylinder heads	Overhaul / Maintain	Approximately every 30,000 operating hours
Turbocharging, Charge Air Cooling and Waste Gate		
Charge air cooler	Clean/adjust/lubricate/calibrate	Approximately every 4,000 operating hours
Bypass/Wastegate valve and actuator	Check	Approximately every 4,000 operating hours
Bypass/Wastegate valve and actuator	Overhaul / Maintain	Approximately every 15,000 operating hours
Air filter cartridge	Clean/adjust/lubricate/calibrate	Approximately every 10,000 operating hours
Turbocharger	Clean/adjust/lubricate/calibrate	Approximately every 20,000 operating hours
Turbocharger bearings	Replace	Approximately every 20,000 operating hours
Turbocharger parts	Check	Approximately every 20,000 operating hours
Turbocharger gas-inlet/outlet casings	Check	Approximately every 40,000 operating hours
Ignition System		
Spark plugs	Replace	Approximately every 3,000 operating hours
Ignition coil	Clean/adjust/lubricate/calibrate	Approximately every 3,000 operating hours
Ignition coil	Replace	Approximately every 30,000 operating hours
Prechamber valve	Clean/adjust/lubricate/calibrate	Approximately every 15,000 operating hours
Prechamber tips	Replace	Approximately every 15,000 operating hours
Prechamber assemblies	Replace	Approximately every 30,000 operating hours
Fuel System		
Gas system leak test	Check	Approximately every 2,000 operating hours
Gas filter cartridges	Replace	Approximately every 4,000 operating hours

Main gas admission valves	Replace	Approximately every 20,000 operating hours
Gas system	Overhaul / Maintain	Approximately every 26,000 operating hours
Automation and Engine Controls		
Safety System and Automatic stop device	Check	Approximately every 10,000 operating hours
Measuring electronics	Replace	Approximately every 45,000 operating hours

6.2 SCR and Oxidation System Preventative Maintenance Schedule

Table 5 - SCR and Oxidation System Preventative Maintenance Schedule

Equipment	Job	Frequency
Pump unit	Inspect reducing agent pump stator condition	Monthly
NOx sensors and process control analyzers	Calibrate measurement cell of NOxBOx analyzer	Monthly
NOx sensors and process control analyzers	Maintain NOxBOx analyzer	Every three months
Reactor	Inspect differential pressure transmitter	Every six months
NOx sensors and process control analyzers	If necessary, replace the NOx sensors	Annually or every 4,000 hours
Reactor	Clean and inspect the catalyst	Annually
Pump unit	Maintain reducing agent filter	Approximately every 6,000 hours
Dosing unit	Maintain compressed air filter	Approximately every 6,000 hours
Pump unit	Change the reducing agent pump gear box oil	Approximately every 16,000 hours
Pump unit	Overhaul the reducing agent pump stator	Approximately every 16,000 hours
Reducing agent injection	Maintain the atomizing lance	Approximately every 16,000 hours
Pump unit	Overhaul the reducing agent pump	Approximately every 32,000 hours

6.3 Caterpillar G3512 EPA Emergency Standby Generator Preventative Maintenance Schedule

Table 6 - Caterpillar G3512 EPA Emergency Standby Generator Preventative Maintenance Schedule

Equipment	Job	Frequency
Electrical connection	Check	Monthly
Engine air cleaner service indicator	Inspect	Monthly
Oil filter differential pressure	Check	Monthly
Fuel filter differential pressure	Check	Monthly

Generator set	Set	Monthly
Coolant sample	Obtain	Approximately every 250 hours or annually
Engine oil sample	Obtain	Approximately every 250 hours or annually
Fumes disposal filter	Drain	Approximately every 250 hours or annually
Fan drive bearings	Lubricate	Approximately every 500 hours or annually
Gas filter condensation	Drain	Approximately every 6 months
Gas pressure regulator condensation	Drain	Approximately every 6 months
Inlet air system	Check	Approximately every 1000 hours
Engine oil and filter	Change or obtain sample	Annually
Cooling System Supplemental Coolant Additive	Test/Add	Annually
Engine Air Cleaner Element (Single Element)	Inspect/Replace	Annually
Fumes Disposal Filter Differential Pressure	Check	Annually
Generator Bearing	Inspect	Annually
Radiator	Clean	Annually
Spark Plugs	Inspect/Adjust/Replace	Annually
Coolant Sample (Level 2)	Obtain	Approximately every 3000 hours
Exhaust Bypass	Inspect	Approximately every 4500 hours
Nitrogen Oxide Sensor	Calibrate/Replace	Approximately every 8000 hours
Coolant	Change	Every 3 years
Coolant Temperature Regulator	Replace	Every 6 years
Generator Bearing	Replace	Every 10 Years
Ignition Transformer Extender	Replace	Every 10 Years
Turbocharger	Inspect	Every 10 Years

7.0 CORRECTIVE ACTIONS

In the event of a malfunction, as per defined by the Michigan Department of Environmental Quality [Rule R336.1113 (a)], or an operational variable that is out of range, responsible personnel or designee(s) will take actions to evaluate and if necessary, initiate action(s) to correct the situation as soon as practicable, in accordance with safe operating practices. If necessary, this includes evaluating if emissions have the potential to or are exceeding permitted limits.

Notice will occur to the Department if a malfunction that results in emission of a hazardous or toxic air pollutant which continues for more than one hour in excess of any applicable standard or limitation. Notice and a written report will be provided if an emissions of any air contaminant continuing for more than two hours in excess of an applicable standard or limitation, as required in Rule 912 [Rule R336.1912].

8.0 MAJOR PARTS REPLACEMENTS LIST

Items noted will be maintained in inventory for replacement during repairs and maintenance on the SCR system, including the Oxidation Catalyst system.

Table 7 – Major Parts Replacement List

Filter housing cartridges 100MY 10"	Filter (pack of 25)
Filter housing gaskets	Air filter
Filter housing top nut gasket	Probe sinter
Fuses	Glass tube fuse 4 Amperes 217 Series, 5 × 20 mm, Fast-acting
Injector gaskets	Glass tube fuse 2 Amperes 217 Series, 5 × 20 mm, Fast-acting
Side service hatch glass fiber ribbon sealing material (50m roll)	Electrochemical cells, Nitric oxide (NO)
Grease ceramic sealing paste (injector inst.)	Peristaltic pumps
NOx Sensors	3-way valves
Filter cartridges	Sample pump LMG4 24V AC
Peristaltic pump replacement tube	Spark plug

9.0 RESPONSIBLE PERSONNEL

The individuals responsible for implementing this plan are the PIC Facility Manager and UMERC Contract Manager. These individuals are responsible for developing procedures that will be utilized to inspect and perform routine maintenance on the equipment included in this plan. These individuals may designate other personnel who will be tasked with implementing the requirements of this plan, including inspections, maintenance, and repair of emission control devices, along with overall management of the emission sources.

10.0 RETENTION OF RECORDS

Appropriate records, as specified in the Air Permit and according to appropriate MDEQ regulations, will be kept on file and retained accordingly.

11.0 UPDATES TO PREVENTATIVE MAINTENANCE / MALFUNCTION ABATEMENT PLAN

Updates to the Preventative Maintenance / Malfunction Abatement Plan will be submitted to the Air Quality Division District Supervisor for written approval.