

# 2020 Audit of Operations and Maintenance Millersville LFGE Facility

Anne Arundel County Department of Public Works  
Bureau of Waste Management Services  
Millersville Landfill and Resource Recovery Facility  
389 Burns Crossing Road  
Severn, Maryland 21144

**SCS ENGINEERS**

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# 1 INTRODUCTION

SCS Engineers has prepared this report to present the results of the 2020 annual audit of the operations and maintenance (O&M) at the Millersville Landfill Gas-to-Energy (LFGE) facility, conducted on October 14, 2020. A follow-up conference call was held on October 21, 2020.

The Millersville LFGE facility is owned by the Anne Arundel County Department of Public Works (County) and is operated by the Northeast Maryland Waste Disposal Authority (Authority). The Authority currently contracts O&M to Aria Energy (Aria). The LFGE facility consists of a gas treatment process and two (2) Caterpillar model G3520C generator sets fueled by landfill gas (LFG) with a total combined nameplate capacity of 3.2 MW. The generator sets each consist of a spark-ignition reciprocating internal combustion engine attached to an electricity-generating unit. The LFGE facility is supplied with LFG from the adjacent Millersville Landfill and Resource Recovery Facility (MLFRRF).

Prior to conducting the audit, SCS developed an audit plan to determine the scope of the audit (see **Appendix A**). The audit plan was provided to the County on October 5, 2020. The 2020 audit included an interview with Aria staff to review the O&M manual modules, discuss changes to maintenance practices from the previous year, and to discuss recent generator set maintenance. Prior to the audit, SCS reviewed maintenance performed since the last audit and selected the major (in-frame) overhauls to discuss with Aria during the audit. The audit also involved a tour of the interior and exterior of the plant building. The 2020 audit also included a review of cylinder detonation frequency and high inlet/coolant temperatures of the generator sets, an inspection of the sound walls, and an evaluation of external noise and visible emissions. The checklist and the field notes from the audit are included in **Appendix B**.

## 2 BACKGROUND

SCS staff present for the on-site audit consisted of Jacob Shepherd of SCS Engineers. Aria staff present on-site included Edgar Felan. During the conference call, participants included those present during the on-site audit as well as Robert McConnell from SCS Energy and Phil Maida from Aria.

### 2.1 PROCEDURE

The audit was conducted according to the objectives of the 2020 audit plan and checklist. SCS first observed the outside of the plant for visible emissions. SCS then met with Aria and discussed current plant operation and general status of the plant. After this discussion, SCS entered the plant, signed the entrance log, and participated in a health check screening. SCS then reviewed the plant O&M modules and discussed plant operations, maintenance, and if any current challenges existed. Additional details about the interview are included in Section 3.1. After the interview, SCS reviewed recent generator set maintenance items and inspected the engine room while the generator sets were in operation. Then, SCS conducted an external inspection to include the building exterior, outdoor equipment, and storage tanks. Lastly, SCS conducted an evaluation of environmental noise from the plant. Photographs of the plant taken during the audit are included in **Appendix C**.

### 2.2 FACILITY EQUIPMENT

The generating equipment of the facility consists of two Caterpillar G3520C LFG-fired generator sets. The engines solely combust landfill gas, which is generated by the Millersville Landfill. Electricity generated by the engines is transferred through two Enercon Electric switchgear modules (one for each generator set) and a utility transformer to increase the voltage before feeding into the power grid. The generator sets are equipped with engine jacket water cooling systems to control engine temperature. Liquid from the cooling systems is directed to two Smithco Americool horizontally mounted radiators located on towers just outside of the building. Additionally, the facility is equipped with intake and exhaust ventilation fans to control engine room temperature during operation.

LFG is directed from the adjacent landfill blower station through a gas treatment system to the generator sets. The treatment system includes a condensate knockout to remove moisture and particulates, and a radiator to decrease the temperature of the LFG. Methane concentration, heat content, and oxygen concentration of the gas are continuously monitored by a Siemens Ultramat 23 Gas Analyzer and gas flow rate is continuously monitored by a flow meter.

## **3 OPERATIONS AND MAINTENANCE AUDIT**

### **3.1 OPERATOR INTERVIEW**

#### **3.1.1 General**

The generator sets appeared to be operating normally and without any apparent issues during the audit. Routine maintenance is generally conducted according to the plant O&M manual.

#### **3.1.2 Facility-Wide Practices**

The plant O&M manual is categorized into modules with each covering a specific set of equipment or components of the facility. Maintenance items in each module are organized by the recommended frequency that each item is performed. SCS developed a checklist based on the O&M manual modules to check that maintenance is performed according to the manual and Caterpillar recommendations and to track changes in O&M practices from year to year. As mentioned in previous audit reports, current maintenance practices vary slightly with the Caterpillar recommended maintenance schedules. Based on SCS's observations, the generator sets appear to be in normal working condition and the plant appears to be in overall good condition. The plant completes daily logs and monthly reports to monitor plant operation and equipment. Logs and records reviewed during the audit indicate that the daily and monthly maintenance listed in the plant O&M manual is being conducted regularly and generally according to the schedule in the O&M manual.

Plant O&M practices were generally unchanged as compared to the practices indicated during the 2019 audit. No changes were observed with O&M practices for the gas system, the coolant water system, the lube/waste oil system, the exhaust systems, the compressed air system, the building ventilation, the electrical building support system, or the building related equipment.

#### **3.1.3 Caterpillar Generator Set Practices**

During previous audits, the engine maintenance practices of the plant were compared with the maintenance schedules in the Caterpillar O&M manual and the plant O&M manual. Although the current generator set maintenance schedules vary slightly with the Caterpillar O&M manual, the variations do not appear to damage or reduce performance life of the generator sets. Current generator set O&M practices remain unchanged as compared with practices observed during the 2019 audit.

#### **3.1.4 Generator Inlet and Coolant Temperatures**

Prior to the audit, the County indicated that unit #1 had been experiencing high inlet temperatures and unit #2 had been experiencing high coolant temperatures. SCS discussed both of these situations with Aria to identify actions completed to address the situations and to verify that the situations were resolved.

To fix the high inlet temperatures at unit #1, Aria indicated that they replaced both the jacket water system pump and the aftercooler pump. Following these replacements, the inlet temperatures were reduced to normal operating levels. To address the high coolant temperatures on unit #2, Aria evaluated the cylinders and determined that likely there was a small leak in one of the cylinders. Therefore, they replaced the heads on multiple cylinders in the engine leading up to the major (in-frame) overhaul, which was completed in August 2020 (unit #2) and September 2020 (unit #1).

Following this maintenance and the overhaul, the coolant temperatures were reduced to normal operating levels.

At the time of the audit, Aria indicated that both of these situations had been resolved.

### **3.1.5 Cylinder Detonation Events**

In 2019, the plant had experienced an elevated rate of cylinder detonation events, and as a result, Aria had performed multiple cylinder replacements or cleanings. During the 2019 audit, SCS discussed these events with Aria and reviewed plant maintenance records. Aria indicated that the cylinder detonation events decreased after the aftercoolers were replaced and cylinder combustion cleaning (CCO) was performed on both generators. In the 2019 audit report, SCS recommended that Aria evaluate the engines for siloxane build-up, to help forecast and potentially reduce major maintenance intervals, and verify the quality of spark plugs and other consumables used in the engines.

One common reason for cylinder detonations is the build-up inside of the cylinders of compounds (consisting mainly of siloxanes) precipitated out of the LFG during combustion. The concentrations of siloxanes in landfill gas varies between sites and can increase or decrease during the life of a landfill. Siloxanes may also build-up and cause clogging in other components, such as inlet piping or aftercoolers. During the overhauls performed in 2020, Aria photographed the inside of the cylinders. Based on SCS's review of the pictures and records of these events, the amount of siloxane build-up appeared to be typical of landfill gas engines during overhauls.

SCS discussed the current frequency of cylinder detonations, and Aria indicated that cylinder detonations were not a current issue. SCS notes that the frequency of cylinder detonation events is typically low following overhauls and major maintenance events. Therefore, SCS anticipates that cylinder detonation events will be infrequent unless an issue is present. To identify issues resulting in cylinder detonations, SCS will continue to evaluate the maintenance records and frequency of these events.

### **3.1.6 Electrical Substation Equipment**

In 2017, the electrical substation equipment at the plant had malfunctioned, and as a result, plant equipment was unable to provide information to the electrical company, Baltimore Gas & Electric (BGE). Upon review of the equipment, an independent contractor concluded that an arcing event in the substation equipment had occurred, likely due to the build-up of dust and debris in the equipment enclosure. The plant O&M manual contains scheduled preventative maintenance for the electrical substation in Module 11, which includes an annual inspection and cleaning of the equipment. Therefore, SCS discussed the maintenance of the electrical substation equipment with Aria during the audit.

Aria indicated that they performed maintenance of the electrical substation equipment in 2019, and had intended to conduct 2020 maintenance in early 2020. However, the maintenance has been delayed due to the current COVID-19 health situation. Aria indicated during the audit that the annual maintenance was planned for November 2020. However, SCS understands that this work was postponed and is scheduled to be completed by December 16, per the Authority.

SCS will continue to review the annual substation maintenance listed in the plant O&M manual during the regular audits.

### **3.1.7 Plant De-Rate Controls**

Based on the availability and quality of the landfill gas sent to the plant by the County, Aria indicated that the County and Aria had agreed on de-rate programming. The programming is set to de-rate the engines based on either the BTU content of the LFG (based on the methane content of the LFG and heat content of methane) or the pressure in the LFG supply piping from the landfill. The programming will de-rate the engines to maintain a pressure setpoint in the supply piping or if the BTU drops below a specified level. Aria indicated that in only one instance since the programming was initiated did the engines de-rate based on BTU content of the LFG.

SCS observed the de-rate programming and verified that the programming was maintaining the pressure setpoints within the landfill gas supply piping.

### **3.1.8 Cooling Tower Maintenance**

During the 2019 audit, SCS identified a noise from the compressor cooling tower and noted this to Aria. Aria indicated that they were in the process of scheduling maintenance to address the noise. Therefore, during the 2020 audit, SCS discussed maintenance of the motor assembly to verify if the maintenance had been performed. Aria indicated that a replacement motor was ordered following the 2019 audit and subsequently replaced in December 2019. Based on SCS's observations of the cooling tower, no visible or audible issues were noted, which suggests the issue was resolved.

## **3.2 RECENT GENERATOR SET MAINTENANCE**

As with prior audits, SCS received the list of maintenance performed on the generator sets since the 2019 audit and selected significant maintenance items to review with Aria during the audit. Because the 2020 audit followed the major overhauls of both generator sets, the audit focused on the major overhauls and related maintenance items.

### **3.2.1 Review of Recent Maintenance Records**

SCS reviewed the procedures that Aria used during the major overhauls. The procedures used appear to be consistent with accepted industry standard practices. The records of the major overhaul events conducted in August 2020 (unit #2) and September 2020 (unit#1) include adequate detail to document procedures during both events. Following the overhauls, both generator sets appeared to be operating correctly on the day of the audit.

In general, the facility conducts maintenance on the generator sets in accordance with the Caterpillar maintenance manual and the facility's O&M manual, with slight variation. Depending on gas quality and flow rate, routine maintenance items, including overhauls, may need to be performed more frequently.

### **3.2.2 Engine Room Inspection**

The engines appeared to be operating normally during the audit. SCS did not observe any indications that any recent maintenance was performed poorly. No unsafe conditions or potential hazards were observed in the engine room. The plant was clean and well organized during the site visit, indicating good housekeeping practices. The site appears to have a good stock of spare parts and items for preventative maintenance. Spare parts are supplied by Aria and are kept on-site or are shipped to the site prior to performing planned maintenance.

SCS noted during the audit that a fernco connector on the air inlet piping appeared to be loose. During the conference call held after the in-person audit, SCS communicated this observation to Aria and recommended checking the connection. Following this conference call, Aria inspected and secured the fernco.

### **3.3 FACILITY INSPECTION**

#### **3.3.1 Operations Room**

The facility is staffed for 8 hours per day on weekdays and includes a call-out system for plant alarms or shutdowns. The operations room appears well organized and clean. Safety equipment is organized and accessible. The floor space was clear of debris and equipment. Potential hazards are marked with visible and conspicuous signs. Waste and flammables are stowed away in designated safe locations. There were no adverse safety conditions noted during the inspection.

Engine control and monitoring equipment, including two SCADA panels, one for each engine, are installed at the plant. Upon review of these systems, SCS observed that equipment appears to be in good working order and display all necessary parameters for operation. There are various controls to stop operation of equipment in the case of an emergency. The methane analyzer is regularly calibrated and appeared to be in good condition during the audit. The gas compressor and gas supply piping to the engines appeared to be in good condition during the audit.

#### **3.3.2 Building Exterior**

The facility is secure and is locked when the building is unstaffed. The door, fence, and barbed wire all appear to be in good shape and free of rust or significant damage. The liquid storage area did not have any apparent damage. Each storage tank is placed within a concrete containment and surrounded by a gravel area. The containments and gravel area are free of chemicals and there was no evidence of recent spills.

Sound walls are secured onto parts of the fencing and are placed around the plant on all sides not adjacent to the landfill. Aria indicated that sound walls are replaced if needed. The sound walls were in good condition during the audit. The ventilation and cooling systems, including the outdoor radiator cooling towers, appeared to be operating correctly during the audit. Sound walls and radiator towers are included in the daily checks documented in daily logs.

#### **3.3.3 External Environmental Inspection**

Following the inspection of the engine room, SCS performed an exterior inspection for environmental nuisances including visible emissions from the generator stacks, any malodors produced by the plant, and an evaluation of the environmental noise caused by the plant.

No visible emissions occurred and no malodors were present during the audit. SCS did not observe any indication of any recent visible emission events (such as discoloration on the building). Based on the noise evaluation performed at various distances away from the plant, the plant is not producing sound levels above ambient environmental levels beyond the landfill property boundary.

## **4 AUDIT SUMMARY**

Based on our observations during the audit, the plant appears to be operating normally and according to accepted industry standards. Recent generator set maintenance items reviewed by SCS appear to have been conducted according to Caterpillar and industry standards.

### **4.1 GENERATOR SET CONDITION**

Overall, the generator sets appear to be in good condition. O&M practices vary slightly from the Caterpillar maintenance recommendations and the plant O&M manual. However, these variations do not seem to negatively affect the generator sets or plant electrical production. Recent generator set maintenance items reviewed by SCS including the major in-frame overhauls appear to have been conducted according to Caterpillar and industry standards. The plant maintains good records of these maintenance items.

As of the date of the audit, the high inlet temperatures at unit #1 and high coolant temperatures at unit #2 were resolved. The generator sets were not experiencing a high frequency of cylinder detonation events. On the date of the audit, the generator sets were not experiencing any on-going issues.

### **4.2 ELECTRICAL SUBSTATION**

Aria indicated that the 2020 annual electrical substation had been postponed due to challenges resulting from the COVID-19 health situation. Per the Authority, this maintenance is planned for completion in December 2020. SCS recommends that Aria perform this maintenance as soon as possible and that the annual maintenance schedule for this equipment continue.

### **4.3 ENVIRONMENTAL EVALUATION**

SCS did not observe any environmental nuisances during the audit, including visible emissions, odors, or environmental noise. SCS recommends that Aria continue regular visible emission observations to verify compliance with opacity and visible emission limitations in the plant Title V air permit.

### **4.4 OVERALL PLANT CONDITION**

During the audit, the plant was clean and appeared to be in good condition. No safety issues were apparent during the audit. Based on the interview with operator staff and review of daily and monthly maintenance logs, Aria conducts maintenance for the building and operations equipment according to the schedule in the plant O&M manual. The building exterior, sound walls, and fencing are in good condition and free of significant damage.



Appendix A  
Audit Plan

October 5, 2020  
File No. 02211047.15

Mr. Mark Morris  
Environmental Monitoring Manager  
Waste Management Services  
Anne Arundel County Department of Public Works  
Millersville Landfill and Resource Recovery Facility  
389 Burns Crossing Road  
Severn, Maryland 21144

via electronic mail

Subject: 2020 Operations and Maintenance Audit Plan  
Millersville LFGE Facility

Dear Mark:

SCS Engineers (SCS) has prepared this letter summarizing the 2020 Operations and Maintenance (O&M) Audit plan for the Millersville Landfill Gas-to-Energy Plant (plant). The onsite portion of the audit will be performed on Wednesday, October 14, 2020 at 10:00 a.m. Prior to this date, SCS will request records of recent maintenance, including the overhauls performed on both units. SCS will review records of the overhauls and any other maintenance items identified for consideration during the audit, and then schedule a conference call with Aria to discuss the maintenance items. During the onsite portion of the audit, SCS expects that both generator sets will be in operation and plant operations staff will be available to provide any requested documentation and answer questions about O&M practices. Unless directed otherwise, SCS understands that the County will coordinate with the plant operations staff on availability and provide relevant details about the audit to operations staff.

SCS plans to conduct the following activities during the audit:

1. Conduct an interview with plant operations staff. This will involve a review of the O&M manual module checklist (supplemented with Caterpillar manufacturer recommendations), a comparison of current practices with practices in-place during the previous audit, and a discussion of plant status and any current or on-going challenges. SCS may request records to document that O&M practices and activities conform to the plant O&M manual and acceptable industry practices. This may be performed both onsite and during the planned conference call.
2. Tour the interior and exterior of the plant to include the operations and controls area, the gas compressor room, the generator set room, sound walls, exterior piping, exterior storage tanks, cooling equipment, and building exterior. SCS may photograph areas of interest (inside and outside of the plant) and ask questions or request additional information if necessary. This will occur during the onsite portion of the audit.
3. Review recent generator set maintenance conducted since the previous audit. SCS requests a list of significant maintenance performed since the date of the previous audit (September 25, 2019) prior to performing the audit. From this list, SCS will select multiple maintenance



activities to review and determine if they were performed according to accepted industry practices. The review will involve a discussion with operators, review of applicable documentation, and an inspection of the generator sets and any related equipment on which maintenance was performed. This may be performed both onsite and during the planned conference call.

4. Review O&M activities performed for the switchgear and electrical substation equipment since the previous audit. Review the frequency of detonation events and instances of high inlet/coolant temperatures, and any maintenance or other activities performed to reduce these events. Discuss additional potential actions to further reduce these activities. This may be performed both onsite and during the planned conference call.
5. Inspect the condition of the sound walls and review schedule for maintenance and replacement. Inspect the compressor cooling system, verify that no noises/vibration are present, and review maintenance performed on this equipment since the last audit.
6. Evaluate plant noise at the property boundary and inspect the outside of the plant for the presence of odors or visible emissions from the engines.

A general checklist of planned audit activities is attached. SCS may expand the scope of the audit or request more information depending on operator responses, the records review, or observations recorded during inspections of the plant and plant equipment. Following the audit, we will prepare a report to summarize the procedures and observations of the audit, and present findings and any recommendations to the County.

Should you have any questions, please feel free to contact us by email or via phone at (703) 471-6150.

Sincerely,



Jacob Shepherd, P.E.  
Senior Project Engineer  
SCS Engineers



Robert McConnell  
Operations Manager  
SCS Energy

Attachments



Appendix B  
Field Notes

## ANNE ARUNDEL PLANT AUDIT CHECKLIST

Date: October 14, 2020

Plant Staff: Edgar Felan

Audit Team: Jacob Shepherd

Inspection Item	Completed		Comment/Result
	Yes	No	
Check in and sign in at admin bldg and plant	X		
Interview operator staff	X		
Discuss current / future challenges or issues	X		
Review Module O&M Checklist with staff	X		
Check for changes in practices	X		
Review recent generator set maintenance	X		
Review other generator set maintenance	X		
Inspect the generator sets	X		No issues noted
Review switchgear / substation equipment	X		
Review O&M logs for switchgear / substation	X		
Inspect outside of building	X		No issues noted
Inspect cooling equipment	X		No issues noted
Inspect gas compression equipment and piping	X		No issues noted
Review compressor cooling system maintenance	X		
Note any visible or audible issues	X		None noted
Note any visible emissions/odors/excessive noise	X		None noted
Review O&M records and logs	X		
Obtain project availability percentage	X		Generally >95%; Reduced in Sep due to overhauls
Review current gas quality	X		Methane at 45.2%
Photographs of plant	X		

**2020 Operations and Maintenance Audit**

Millersville LFGE Facility

Millersville LFGE Plant O&M Module Checklist

October 14, 2020

SCS Engineers / SCS Energy

## MODULE 1: GAS SYSTEM

### Daily

<input checked="" type="checkbox"/>	Record readings of all pressure and temperature devices and verify they are within normal range.
<input checked="" type="checkbox"/>	Check site glasses for condensate level in primary & polishing filter vessels.
<input checked="" type="checkbox"/>	Check oil level in compressor.
<input checked="" type="checkbox"/>	Visual/Audible inspection for anything unusual (leaks, squeals, etc.)
<input checked="" type="checkbox"/>	Check gas composition at analyzer, verify auto calibration occurred.
<input checked="" type="checkbox"/>	Check gas control panel and switchgear for any alarm conditions.
<input checked="" type="checkbox"/>	Verify gas flow meter is operating and recording properly.

### Monthly

<input checked="" type="checkbox"/>	Span gas analyzer.
<input checked="" type="checkbox"/>	Check/adjust belt tension on compressors. [Conducted daily]
<input checked="" type="checkbox"/>	Check/adjust belt tension and wet screws on gas cooler. [Conducted daily]
<input checked="" type="checkbox"/>	Grease fan bearings on gas cooler.
<input checked="" type="checkbox"/>	Blow-off dust and dirt from all electric motors, fans, and shrouds.

### Semi-Annual

<input checked="" type="checkbox"/>	Grease electric motor bearings for gas cooler and compressor
<input type="checkbox"/>	N/A Test vibration switch on gas cooler.
<input checked="" type="checkbox"/>	Check belts for wear and cracking.
<input checked="" type="checkbox"/>	Change inlet condensate filter on gas analyzer.
<input checked="" type="checkbox"/>	Change compressor oil.

### Annual

<input checked="" type="checkbox"/>	Clean cooling fins on gas cooler.
<input type="checkbox"/>	Perform complete inspection of gas cooler (e.g.: fan blades, pivot points, actuators, nuts, bolts, pulley sheaves, bearings, etc.)
<input checked="" type="checkbox"/>	Change filters in primary and polishing filter vessels.
<input checked="" type="checkbox"/>	Inspect and clean VFDs.

### Bi-Annual

<input checked="" type="checkbox"/>	Rebuild condensate diaphragm pumps
-------------------------------------	------------------------------------

## MODULE 2: ENGINE GENERATOR SETS

### Daily (Plant Practices & Caterpillar Maintenance)

<input checked="" type="checkbox"/>	Record readings of all pressure and temperature devices and verify they are within normal range.
<input checked="" type="checkbox"/>	Visual/Audible inspection for anything unusual (leaks, squeals, etc.)
<input checked="" type="checkbox"/>	Check oil level, record oil consumption from make-up oil tank.
<input checked="" type="checkbox"/>	Measure/record crankcase blowby.
<input checked="" type="checkbox"/>	Check compressor bypass.
<input checked="" type="checkbox"/>	Measure/record cylinder pressure.
<input checked="" type="checkbox"/>	Check engine mounts.
<input checked="" type="checkbox"/>	Check engine protective devices.
<input checked="" type="checkbox"/>	Inspect starting motor.

### Daily - Maintenance Manual

<input checked="" type="checkbox"/>	Check air starting motor lubricator oil level.
<input checked="" type="checkbox"/>	Drain air tank moisture and sediment.
<input type="checkbox"/>	Measure/record bearing temperature.
<input checked="" type="checkbox"/>	Check cooling system coolant level.
<input checked="" type="checkbox"/>	Inspect engine air cleaner service indicator.
<input checked="" type="checkbox"/>	Check engine oil level.
<input checked="" type="checkbox"/>	Check fuel system fuel filter differential pressure.
<input checked="" type="checkbox"/>	Check fumes disposal filter differential pressure.
<input checked="" type="checkbox"/>	Check generator load.
<input checked="" type="checkbox"/>	Check power factor.
<input checked="" type="checkbox"/>	Check voltage and frequency.
<input checked="" type="checkbox"/>	Walk-around inspection.

### Quarterly

<input checked="" type="checkbox"/>	Obtain cooling system coolant sample (level 2).
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### Biannually

<input checked="" type="checkbox"/>	Top-End Overhaul (CCO at 8,000 hrs; T.E. at 16,000)
-------------------------------------	---

### As-Needed

<input checked="" type="checkbox"/>	Replace engine air cleaner element.
<input checked="" type="checkbox"/>	Check fuel metering valve.
<input checked="" type="checkbox"/>	Dry generator.
<input checked="" type="checkbox"/>	Test generator set.
<input checked="" type="checkbox"/>	Test insulation.
<input checked="" type="checkbox"/>	Measure/record stator winding temperature.
<input checked="" type="checkbox"/>	Check throttle control valve.
<input checked="" type="checkbox"/>	Measure/record valve stem projection.

## MODULE 2: ENGINE GENERATOR SETS

### MILLERSVILLE PRACTICES / CATERPILLAR-SPECIFIED MAINTENANCE

#### Every 500 Hours

X	Measure/record cylinder pressure [conducted with 1000 hour]
X	Measure/record valve stem projections [conducted with 1000 hour]
X	Replace ignition system spark plugs [conducted with 1000 hour]

#### Every 1100 Hours (1000 hours by Cat)

X	Drain aftercooler condensation
X	Inspect alternator [conducted with 2000 hour]
N/A	Inspect/adjust/replace belts.
X	Measure crankcase pressure. (daily)
X	Inspect crankshaft vibration damper.
X	Clean engine crankcase breather.
X	Change engine oil. (and as-needed)
X	Change engine oil filter.
X	Adjust engine valve lash and bridge.
X	Inspect/replace hoses and clamps.
X	Check/adjust ignition system timing.
X	Inspect inlet air system.
X	Clean radiator. (performed annually)
X	Inspect water pump.

#### Every 2200 Hours (2000 hours by Cat)

X	Lubricate bearing (ball).
X	Clean/inspect engine speed/timing sensor.
X	Inspect generator.
X	Inspect generator set vibration.
X	Check stator lead.

## MODULE 2: ENGINE GENERATOR SETS

### MILLERSVILLE PRACTICES / CATERPILLAR-SPECIFIED MAINTENANCE

#### Every 8000 Hours

- Check rotating rectifier. (every 2200 hours)
- Inspect turbocharger.
- Test varistor
- Replace water temperature regulator. (and as-needed)
- Testing winding. (and as-needed)

#### Between 10,000 and 20,000 Hours

- Top end overhaul.

#### Every 24,000 Service Hours/3 Years

- Change cooling system coolant (NGEC). [as-needed]

#### Between 30,000 and 60,000 Hours

- In-frame overhaul (last performed 2016 at 40k hours; currently at 61k hours).

#### Between 50,000 and 100,000 Hours

- Inspect bearings. (16,000 hours)
- Major overhaul.

### MODULE 3: COOLING WATER SYSTEMS

#### Daily

- |   |  |
|---|--|
| X | Record readings of all pressure and temperature devices and verify they are within normal range. |
| X | Check site glasses for proper level  |
| X | Visual/Audible inspection for anything unusual (leaks, squeals, etc.)                            |

#### Monthly

- |     |   |
|-----|---|
| N/A | Check/Adjust belt tension and set screws on radiator. |
| X   | Grease fan bearings on radiator.                      |
| X   | Check fan blades for damage and proper movement.      |
| X   | Test coolant for condition/stabilizer                 |

#### Semi-Annual

- |     |  |
|-----|--|
| X   | Grease electric motor bearings for radiator.           |
| X   | Test vibration switch on radiator.                     |
| N/A | Check belts for wear and cracking. (replace as needed) |

#### Annual

- |   |  |
|---|--|
| X | Clean cooling fins on radiator bundles.  |
|   | Perform complete inspection of radiator (e.g.: fan blades, pivot points, actuators, nuts, bolts, pulley sheaves, bearings, etc.) [Third-party] |
| X |  |

## MODULE 4: LUBE & WASTE OIL SYSTEMS

### Daily

- |   |  |
|---|--|
| X | Record readings of all pressure and temperature devices and verify they are within normal range. |
| X | Visual inspection for any leaks.   |
| X | Check site glasses for level in storage tanks and make-up oil tanks.                             |
| X | Check/pump rain water from containment area. Record any pumping activity in log book.            |
| X | Inspect all piping for oil leaks.  |

### Monthly

- |   |   |
|---|---|
| X | Inspect storage tanks for any exterior rusting. |
| X | Change oil and filters. [elect for testing]     |

## MODULE 5: EXHAUST, CRANKCASE VENT, & COMBUSTION AIR SYSTEMS

### Daily

- Record readings of all pressure and temperature devices and verify they are within normal range.
- Check site glass on accumulator tank and drain if necessary.
- Visual/Audible inspection for anything unusual (leaks, squeals, etc.)

### Monthly

- Check/change combustion air filter material.
- Check/change crankcase vent filter.

### Annually

- Change engine crankcase vent filter.

## MODULE 6: COMPRESSED AIR SYSTEMS

### Daily

- Record readings of all pressure and temperature devices and verify they are within normal range.
- Check fluid level.
- Visual/Audible inspection for anything unusual (leaks, squeals, etc.)

### Monthly

- Clean aftercooler fins. [weekly]
- Blow-off dust and dirt from all electric motors, fans, & shrouds.

### Bi-Monthly

- Take oil sample.
- Change oil filter.

### Semi-Annual

- Grease motor bearings
- Clean/replace air filters (monthly in modules)

### Annual

- Change compressor oil.
- Replace air/fluid separator elements.

## MODULE 7: BUILDING VENTILATION

### Daily

- Record readings of methane detection panel and verify they are within normal range.
- Visual/Audible inspection for anything unusual (leaks, squeals, etc.)

### Weekly

- Check pre-filter pads on vent fans. [monthly]

### Monthly

- Check/adjust belt tension on vent fans.
- Grease fan bearings on vent fans.
- Change pre-filter pads on vent fans.
- Check belts and filters on HVAC unit. (and replace)

### Semi-Annual

- Grease electric motor bearings (if not sealed bearing motor)

### Annual

- Clean HVAC unit cooling fins.
- Change filters on HVAC unit. (Quarterly in modules)

### As-Needed

- Check pre-filter pads on vent fans.

## MODULE 8: ELECTRICAL SUPPORT SYSTEMS

### Daily

- Record readings of all electrical devices and verify they are within normal range.
- Visual/Audible inspection for anything unusual (smoke, burn marks, etc.)

### Weekly

- Check electrolyte level in batteries (48V and 24V systems), except on sealed batteries.
- Check battery connections for corrosion (48V and 24V systems)

### Monthly

- Clean battery chargers with compressed air.
- Clean transformer coils and interior with vacuum and compressed air.
- Inspect all connections for tightness and corrosion. Inspect coils for tracking
- Clean motor control center with vacuum and compressed air.
- Inspect all connections for tightness and corrosion.
- Inspect overloads and motor starters for signs of excess heat or arcing.

## MODULE 9: SWITCHGEAR - BREAKER & CONTROL EQUIPMENT

### Daily

- Record readings of all electrical devices and verify they are within normal range.
- Visual/Audible inspection for anything unusual (smoke, alarm lights, etc.)

### Annual

- Clean switchgear with vacuum and compressed air.
- Inspect all connections for tightness and corrosion.
- Inspect all components and wiring for signs of excess heat and/or deteriorated insulation.
- Manually operate all circuit breakers three times, checking for abnormal operation.

\* De-energize and ground substation before inspections.

## MODULE 10: BUILDING RELATED EQUIPMENT

### Daily

- Record readings of all pressure devices and verify they are within normal range.
- Verify Fire Alarm Panel has power and is in normal operation.
- Verify maintenance equipment requiring charging is plugged-in.

### Monthly

- Inspect building for cracks in walls and concrete
- Inspect roof for cuts, tears, and holes.
- Inspect asphalt paving for cracks.
- Inspect fencing for damage.
- Inspect gravel areas for weeds, etc.
- Have Fire Extinguishers inspected.

### Annual

- Test Fire Alarm Panel, devices and monitoring. (Completed by Fire Hawk annually)

## MODULE 11: ELECTRICAL SUBSTATION EQUIPMENT

### Daily

- Record readings of all electrical devices (volts, amps, & kW) and verify they are within normal ranges.
- Visual/audible inspection for anything unusual (smoke, burns marks, arcing, etc.)
- Inspect/pump transformer container for rain water. Document all pumping activities in log book.

### Monthly

- Inspect gravel areas for weeds, etc.

### Annual (2020 delayed)

- Clean breaker with vacuum and compressed air.
- Inspect all connections for tightness and corrosion.
- Inspect all components and wiring for signs of excess heat and/or deteriorated insulation.
- Manually operate all circuit breakers three times, checking for abnormal operation.
- Inspect primary transformer connections and safety devices, take oil sample for testing.

\* De-energize and ground substation before inspections.

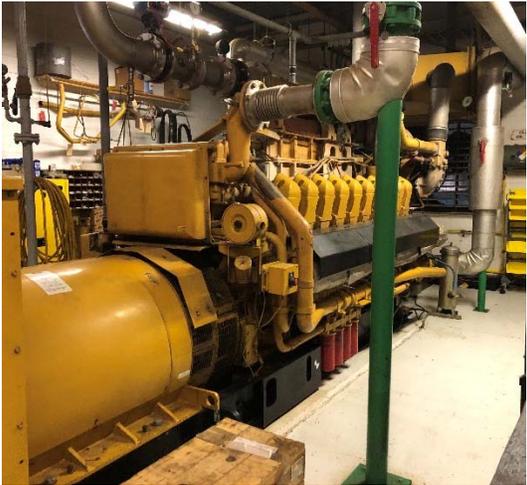


Appendix C  
Photographs

APPENDIX C – PHOTOGRAPHS



Gas Compressor



Generator room



Generator room



Generator Room



Rear sound wall



Side sound wall



Inside plant



Outside storage area



Generator set radiator tower



Gas compressor radiator tower