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GENERATORS FOR  
DISTRIBUTION**

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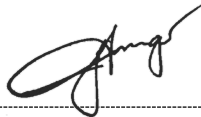
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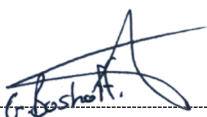
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## **1. Introduction**

This Task manual was compiled from the analysis that was done on critical tasks performed during Diesel Generator Maintenance. It is critical to ensure that identified risks and hazards associated to this task are effectively addressed or remedied to prevent/avoid damage to equipment or injury to all staff. Figure 1 shows an example of a typical standby generator.



**Figure 1: Example of Diesel Generator**

## **2. Supporting clauses**

### **2.1 Scope**

#### **2.1.1 Purpose**

This document sets out the requirements, instructions and / or procedures when performing maintenance on Diesel Generators.

#### **2.1.2 Applicability**

This document shall apply to Distribution Division only and to contractors employed by Distribution to perform Diesel Generator maintenance.

### **2.2 Normative/informative references**

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

#### **2.2.1 Normative**

- [1] ISO 9001 Quality Management Systems.
- [2] Occupational Health and Safety Act.
- [3] 240-44175132: Eskom Personal Protective Equipment (PPE);
- [4] 240-62196227: Life-saving rules

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[5] 240-171000445\_1: Standby generator routine maintenance check sheet

### 2.2.2 Informative

[6] SANS 1186-1: Symbolic safety signs – Part 1: Standard signs and general requirements

[7] 32-644: Eskom documentation management standard.

[8] 0.00/10335 sheet 1-4: Eskom wiring termination standard

## 2.3 Definitions

### 2.3.1 General

None

### 2.3.2 Disclosure classification

**Controlled disclosure:** controlled disclosure to external parties (either enforced by law, or discretionary).

## 2.4 Abbreviations

Abbreviation	Description
<b>A</b>	Amp
<b>AC</b>	Alternative current
<b>CM</b>	Condition Monitoring
<b>DC</b>	Direct Current
<b>DG</b>	Diesel Generator
<b>OEM</b>	Original Equipment Manufacturer
<b>PE</b>	Power Electronics
<b>PM</b>	Preventative Maintenance
<b>PPE</b>	Personal Protective Equipment
<b>Ref.</b>	Reference
<b>RMS</b>	Root Mean Square
<b>V</b>	Volt

## 2.5 Roles and responsibilities

- a) The designated person or his/her delegate shall ensure that this task manual is implemented and adhered to.
- b) The authorized/responsible person is responsible for the safe execution of all work and activities as set out in this task manual.
- c) Only people authorized for activities in this task manual shall perform these duties.

## 2.6 Safety precautions

Whenever work is being carried out on standby generator, the following precautions shall be adhered to:

- a) The prescribed protective clothing, as indicated in 240-44175132, Eskom Personal Protective Equipment (PPE) shall be worn when working on DGs.

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- b) Before taking voltage measurements, ensure that the correct voltage range is selected on the multimeter.
- c) Measurements and maintenance tasks shall only be taken under conditions that do not compromise personnel safety and plant operation. The latest revisions of the relevant drawings must be used to confirm all connections and testing points.
- d) Inside any Diesel Generator there is an electrical shock risk. Familiarisation of all live electrical termination points is essential and contact with these areas shall always be avoided. Direct supervision is advised where possible to mitigate this risk.
- e) During the cleaning proses excessive dust pose a risk. To mitigate dust masks must be worn, direct supervision to monitor lack of oxygen and take regular breaks to allow dust to settle.
- f) During the cleaning proses when making use of an electrical blower loose flying objects pose a risk. To mitigate safety goggles must be worn.

## **2.7 Task Risk Assessment**

- a) It is the responsibility of each person to ensure that the correct plant is worked on/isolated according to Plant Safety regulation, a permit has been issued or an authorisation has been obtained. All staff has signed the workers register, a proper job brief has been done and that the days Hazard Identification and Risk Assessment (HIRA) were done. Ensure that the correct plant or equipment has been identified and ensure that the tests or inspections are performed on the correct equipment.
- b) Carry out a task risk assessment in accordance with the relevant prescribed document and ensure that all relevant documentation is completed and signed.
- c) Ensure that all the members of the team take part when the risk assessment is carried out and signed by all team members.
- d) Check the test equipment to be in good state and fit for purpose before using them.
- e) Only calibrated meters and test equipment shall be used and ensure that the certificates are valid.
- f) Ensure that the 240-62196227: Life-saving rules are adhered to when performing all tasks in this document.

## **2.8 Personal Protective – and Maintenance equipment**

- a) It should be noted that the Divisional –, regional – and site-specific safety regulations with regards to PPE shall always be adhered to.
- b) All personal protective equipment shall comply with 240-44175132: Eskom Personal Protective Equipment (PPE);

## **3. General**

- a) The Diesel Generator shall be set to the local control or manual position before the routine first line inspection is done.
- b) The maintenance is done as per manufacturer's procedure that is part of the user manual supplied with the Diesel Generator.
- c) The maintenance tasks flow diagram is indicated in Figure 2.

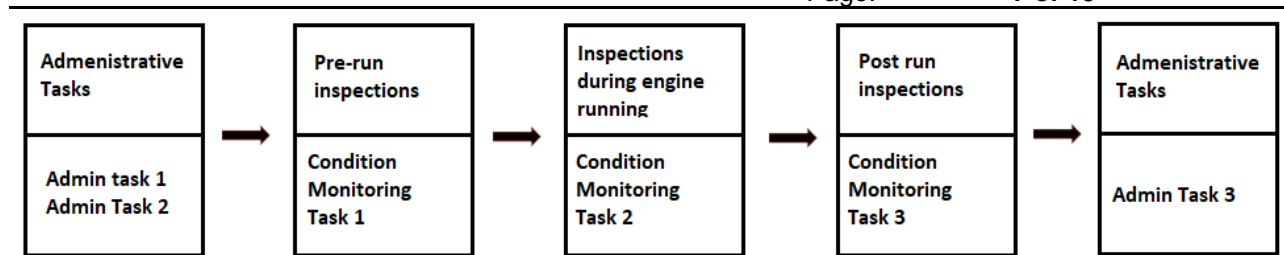


Figure 2: Maintenance tasks flow diagram

## 4. Administrative Tasks

### 4.1 Admin Task 1: Documentation

- A complete set of the latest revised drawings and user manuals for each type of Diesel Generator that will be maintained shall be available when performing preventative maintenance.
- The latest revisions of the relevant drawings must be used to confirm all connections and testing points.
- If wire changes are done on any part of the plant, or any part of the plant are not according to the drawings the drawings shall be marked-up.

### 4.2 Admin Task 2: Completing the check sheets

- All applicable sections of the check sheet must be completed.
- The check sheet is in a chronological order and must be completed from top to bottom.
- On completion of any check sheet, it shall be signed off.

### 4.3 Admin Task 3: Update asset management database

- The technician shall ensure that upon completion of the maintenance, the asset management database is updated if any condition on the plant has changed.
- This is also necessary to keep record of the maintenance types and maintenance dates.

## 5. Generic Condition Monitoring Tasks

### 5.1 GCM Task 1: DC Voltage measurement

#### 5.1.1 Tools and Equipment

Calibrated Multimeter as indicated in Figure 3.



Figure 3: Multimeter

### 5.1.2 Activities

- a) Before taking voltage measurements, ensure that the correct voltage range is selected on the multimeter.

**Note:** Performing a cell voltage measurement whilst the multimeter is setup for measuring currents will cause a short circuit and can lead to the flow of hundreds of amperes which may lead to equipment damage and personal injury.

- b) For DC voltage measurements, ensure that the multimeter is selected to the DC setting.
- c) For AC voltage measurements, ensure that the multimeter is selected to the AC setting.

## 5.2 GCM Task 2: Current measurement

### 5.2.1 Tools and Equipment

- a) Calibrated Multimeter (if the clamp meter does not have an integrated display to read the measurement directly – as the example indicated in Figure 4.
- b) Clamp meter



Figure 4: Clamp meter used with the multimeter.

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### 5.2.2 Activities

- a) Determine if the current to be measured is AC or DC.
- b) Select a clamp accessory for your multimeter that is designed to measure that specific current or one that can measure both AC and DC.

**Note:** Look at the accessory clamp's specifications and determine whether the clamp outputs a current level or a voltage level.

- c) Determine the circuit's anticipated maximum current by checking the nameplate of a component or the breaker rating. Plug-in clamp accessories are available in a variety of pre-set ranges. Determine if the range of your multimeter or clamp accessory is high enough to measure it. If not, select an instrument equipped for higher ranges.

**Note:** If a meter includes fused current terminals, verify that its fuses are good.

- d) To measure AC/DC current with a voltage output clamp, turn the dial of the multimeter to mVac for AC current, or to mVdc for DC current.
- e) Plug the black test lead into the COM jack.
- f) For plug-in clamp accessories that produce a voltage output, plug the red test lead into the V jack. These clamps are usually designed to deliver 1 mV, 10 mV or 100 mV to the DMM for every 1 A of measured current – check the conversion factors for your specific instrument.
- g) Open the jaws by pressing the tool's trigger.
- h) Enclose a single conductor inside the jaws. Make certain the jaws are completely closed before taking readings.
- i) View the reading in the display.
- j) For DC measurements, ensure that the multimeter is selected to the DC setting.
- k) For AC measurements, ensure that the multimeter is selected to the AC setting or mV AC setting.

## 5.3 GCM Task 3: Oscilloscope measurement

### 5.3.1 Tools and Equipment

Calibrated oscilloscope: also referred to as a Scope meter (see example in Figure 5).



Figure 5: Oscilloscope

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### **5.3.2 Special Tools**

Not applicable.

### **5.3.3 Activities**

- a) Determine if the voltage or current to be measured is AC or DC.
- b) Select a voltage probe or current clamp that is designed to measure that specific voltage/current or one that can measure both AC and DC.
- c) The selection of the number of channels to be used at one time, the vertical and horizontal scale deflection and all associated auxiliary information to be displayed must be carefully chosen during measurement.

**Note:** Some scope meters have fully isolated channels. Some older scope meters may have common earth probes and need to be used together with isolating amplifiers. Consult the manufacturer's manual for safe and accurate operation.

## **5.4 GCM Task 4: Cleaning the Diesel Generator cubicle and components.**

### **5.4.1 Tools and Equipment**

- a) Blower
- b) Paint brush
- c) Cotton cloth

### **5.4.2 Activities**

- a) By using a blower remove all dust and debris from the DG cubicle.
- b) Dust that is sticky can be removed with dry cloth or paint brush.

## **6. Maintenance Tasks for Diesel Generators**

### **6.1 CM Task 1: Maintenance Tasks before Diesel Generator Start-up**

#### **6.1.1 Documentation, Tools and Equipment**

- a) Relevant check sheets (240-171000445\_1 as per Annex A), setting sheet, manual and drawings.
- b) Multi meter
- c) Amp probe / Clamp meter
- d) Technicians' toolbox

#### **6.1.2 Activities**

The following inspections shall be done to the DG before the test run is conducted.

- a) All installations require a fire extinguisher near the DG in case of a fire.
- b) Inspect the fire-resistant fuel shut-off valve with weight to be in good order.
- c) Fuel tank cap must be intact.
- d) Inspect fuel lines for leaks.
- e) Record fuel level of day tank and bulk tank.
- f) Check engine for oil leaks.
- g) Check for oil level and top up if required.

- h) Check for coolant level and top up if required.
- i) Check engine for coolant leaks.
- j) Check the operation of water jacket heaters.
- k) Check air cleaner differential pressure switch.
- l) Check battery voltage, electrolyte levels and loose connections.
- m) Check "V" belt tension & damage.
- n) Check engine for excessive dirt or debris. Clean it as required.
- o) Check control panel and alarms.
- p) Record running hours.

## **6.2 CM Task 2: Maintenance Tasks while Diesel Generator is running.**

### **6.2.1 Documentation, Tools and Equipment**

- a) Relevant check sheets (240-171000445\_1 as per Annex A), setting sheet, manual and drawings.
- b) Technicians' toolbox
- c) Multi meter
- d) Amp probe / Clamp meter

### **6.2.2 Special Tools**

- a) Laptop (optional depending on type of DG Controller)
- b) Scope meter

### **6.2.3 Activities**

The following inspections shall be done while the generator is running to observe any abnormal behaviour.

- a) Start the generator and see that it successfully starts within the three attempts allowed.
- b) Check for leakages of fuel, oil and coolant under the designed pressure.
- c) Generator load transferred automatically or manually.
- d) Check oil pressure & coolant temperature.
- e) Check for any alarms.
- f) Check for voltage and current reading in all 3 phases.
- g) Connect the PC to the Generator controller and customise any settings if the generator's functionalities and performance is correct.
- h) Test that all alarms to control are operational.

## **6.3 CM Task 3: Maintenance Tasks after Diesel Generator is switched off.**

### **6.3.1 Documentation, Tools and Equipment**

- a) Relevant check sheets (240-171000445\_1 as per Annex A), setting sheet, manual and drawings.

### **6.3.2 Activities**

The following inspections are done after the test run is finished.

- a) Do final inspection to see no visual signs of abnormalities or defects is visible.
- b) Select the generator controller to the Auto or Remote position to ensure it will automatically start when required.
- c) Record the running hours after test was conducted.

## **6.4 CM Task 4: Preventative maintenance**

The Preventative maintenance shall be conducted by the OEM or Eskom appointed contractor. This level of maintenance is customised to the specific OEM manuals.

### **6.4.1 Documentation, Tools and Equipment**

- a) Relevant check sheets, setting sheet, manual and drawings.
- b) Multi meter
- c) Amp probe / Clamp meter
- d) Technicians' toolbox

### **6.4.2 Special Tools**

- a) Laptop (optional depending on type of DG Controller)
- b) Scope meter
- e) Specialised tools required for in depth inspection and analysis.

### **6.4.3 Activities**

The following is a list of common inspections and tests conducted on generators at different running hours:

#### **6.4.3.1 250hrs**

Inspect, test, adjust and/or replace:

- a) Engine valve lash
- b) Fuel injectors
- c) Magnetic pick-ups
- d) Fanbelts change
- e) Cooling systems coolant sample for analysis
- f) Cooling system coolant and additive change
- g) Fuel sample for analysis
- h) Fuel filter replacement
- i) Engine lubricant sample for analysis
- j) Engine lubricant and filter change
- k) Fan drive bearing
- l) Hoses and clamps
- m) Radiator clean

- n) Starter motor
- o) Turbo charger

**6.4.3.2 500hrs**

Inspect, test, adjust and/or replace

- a) Air shut off
- b) Engine lubricant and filter change
- c) Water pump

**6.4.3.3 1000hrs**

Inspect, test, adjust and/or replace

- a) Crankcase breather clean
- b) Engine protective devices

**6.4.3.4 2000hrs**

Inspect, test, adjust and/or replace

- a) Actuator control linkage
- b) Crankshaft vibration damper
- c) Engine mounts

**6.5 CM Task 5: Condition based engine overhauling****6.5.1 Activities**

The OEM generator condition analysis combined with the latest preventative maintenance results and the total running hours will be considered when deciding to perform either:

- Top-end overhaul of the motor or
- Major overhaul

**7. Authorisation**

This document has been seen and accepted by:

Name and surname	Designation
Mfundu Songo	Senior Manager: Technology and Engineering
Aumkar Sukhoo	Senior Manager: Operations Enablement Maintenance and Operating CoE (Acting)
Thomas Jacobs	Chief Engineer: Standby Power Systems
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**8. Revisions**

Date	Rev	Compiler	Remarks
Oct 2024	1	Welman van Niekerk	Original issue

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## **9. Development team**


The following people were involved in the development and revision of this document:

- Thomas Jacobs
- Frikkie Knoetze
- Welman van Niekerk
- Philip Groenewald
- Ajith Persadh

## **10. Acknowledgements**

Thanks to all who reviewed the document and for providing comments.

**Annex A– Diesel Generator routine maintenance check sheet**

	<b>Standby Generator Routine Maintenance Check Sheet</b>				Reference No.: 240-171000445_1	
Site name				Permit / Workorder No.		
kVA/kW rating				Output Voltage / Current		
Engine Make / Model				Engine Serial No.		
Alternator Make / Model				Alternator Serial No.		
<b>Activities to be done BEFORE Starting the Generator</b>						
<b>Inspections</b>						
Fire extinguisher available?	Y	N	Fire extinguisher inspections up to date?	Y	N	
Fire-resistant shutdown valve in good order?	Y	N	Fuel tank cap intact?	Y	N	
Water jacket heaters in good order?	Y	N	Fuel lines in good order?	Y	N	
Engine oil leaks visible?	Y	N	Fuel leaks visible?	Y	N	
Engine oil level correct?	Y	N	Engine coolant leaks visible?	Y	N	
Air cleaner differential pressure switch operational?	Y	N	Engine coolant level correct?	Y	N	
"V" belt tension correct? No visible damage?	Y	N	Battery voltage correct?	Y	N	
Engine clean (No excessive dirt or debris)?	Y	N	Battery electrolyte levels correct?	Y	N	
Control panel clear of Alarms and Warnings?	Y	N	Battery terminal connections tight?	Y	N	
<b>Measurements</b>						
Running hours		hrs	Battery voltage		V	
Fuel level of day tank		%	Fuel level of bulk tank		%	
<b>Activities to be done AFTER Starting the Generator</b>						
<b>Inspections</b>						
Generator started successfully?	Y	N	Oil pressure correct?	Y	N	
Fuel leaks visible?	Y	N	Coolant temperature correct?	Y	N	
Engine coolant leaks visible?	Y	N	Generator load transfer circuit operational?	Y	N	
Engine oil leaks visible?	Y	N	Control panel clear of Alarms and Warnings?	Y	N	
<b>Measurements</b>						
Oil pressure		kPa	Coolant temperature		°C	
Red phase voltage		V	Red phase current		A	
White phase voltage		V	White phase current		A	
Blue phase voltage		V	Blue phase current		A	
<b>Synchronized units (if applicable)</b>						
Unit successfully synchronised?	N/A	Y	N	Protection alarms present?	Y	N
Synchronise selector switch	ON	OFF				
<b>Mobile units pre-trip checks (if applicable)</b>						
Licence disc up to date and number plate intact?	Y	N	All wheel nuts present and tight?	Y	N	
All lights and reflectors in good order?	Y	N	Towing mechanism in good order?	Y	N	
All tyres (including spare wheel) in good order?	Y	N				
Done by:				Date:		
				Signature:		

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