REPÚBLICA DE MOÇAMBIQUE

AUTORIDADE REGULADORA DE AVIAÇAO CIVIL DE MOÇAMBIQUE

Technical circular

CT 139-011

SUBJECT: **PROCEDURE FOR INSPECTING PRIMARY AND SECONDARY POWER SUPPLY AND POWER OUTAGE.**

Date: 08 de Agosto de 2025

1. AUTHORITY

This technical circular is issued under the authority of the Chairman of Board of Directors of the Mozambique Civil Aviation Authority in pursuance of powers vested in him under Article 19 of Law number 05/2016 of 14 June and Article 12 of Resolution 19/2011 of 30 November.

2. PURPOSE:

This Technical circular (CT) provides information on procedures for inspection of primary (Transformer) and Secondary power supply and outage to ensure an essential back-up power capability to Aerodrome electrical systems that support important airport services in case of failure of the main power supply. This Circular provides basic guidance for lines of responsibility for the day-to-day provision of primary and secondary power for the Aerodrome.

3. APPLICABILITY

This Technical Circular applies to all International Airports and those Airdromes which operations demand power supply for safety.

4. REFERENCES:

4.1 ICAO Annex 14 – Volume I, 9th edition, July 2022

4.2 ICAO doc 9157 – Part 5 (Electrical Systems)

4.3 MOZCAR 139 – 3rd Edition

4.4 Manual of Aerodromes Standards, 4th edition, December 2016

5. REQUIREMENTS FOR INSPECTION OF PRIMARY POWER SUPPLY (TRANSFORMER)

The regulation MOZCAR 139.13.2 (1) requires that all aerodromes operators shall have appropriate primary power supply for safe air operations and aerodrome installations.

5.1 For efficient performance of primary power supply, the operator is required to:

a) Carry out inspection during and after the normal hours of aerodrome operation, and fill the checklist for such inspections;

b) To record the result of inspections and for taking follow-up action to correct deficiencies;

c) To carry out routine maintenance and emergency maintenance according to maintance program;

d) To have Personnel responsible for the inspection and maintenance of the transformer, connections, protection system, and the telephone numbers for contacting those persons during and after working hours.

e) Employees who work on aerodrome electrical systems are required, as per the nature of their work, to have a personal protection equipment (PPE) against shock hazards.

5.2 Procedures for inspection of primary power supplies (transformer)

To ensure continuity and safety of services it is important to have procedures for inspection of primary power supply.

5.2.1 Visual and acoustic examination

Visual and acoustic inspections for performance evaluation shall include, but not limited to, inspection appraisal of:

a) Sound to assess electrical equipment conditions and identify potential issues like loose connections, arcing or component degradation. Acoustic technique may be:

i) Acoustic Emission Testing (AET)

ii) Acoustic electrical Testing

iii) Sound as an indicator;

b) Correctness of external connections;

c) Good work performance;

d) Cleanliness;

e) Safety hazards; and

f) Specific requirements for individual items (silica gel, bullchoice).

5.2.2 Electrical tests (Transformer)

Inspections for all electrical equipment shall be performed through electrical tests for performance evaluation, as follow:

a) Cables directly buried in earth, before and after the trench is backfilled;

b) Underground circuit - Each series circuit shall be tested for continuity by ohmmeter or equivalent method;

c) The resistance of the circuit to ground shall be checked with a suitable test set to make sure it is free of grounds;

d) Conduct insulation resistance tests on all circuits - circuits within a duct, manhole or transformer housing, so as to establish a prior condition;

e) Each newly installed series circuit should be subjected to high-voltage test to determine complete freedom from ground faults;

f) Each circuit, including connected transformers, shall be tested as follows or other equivalent technique:

i. At the vault, disconnect both leads from the regulator output terminals. Support both leads so that air gaps of several inches exist between bare conductors and ground. Make sure that the cable sheath is clean and dry for a distance of at least 30 cm from the end of the cable. Also make sure that exposed insulation at each end of the cable is clean and dry.

ii. Test each circuit immediately after installation according to the "First test for new circuits" values in Table 15-1. Test any circuit installed for sixty days or more, even if it has not been operated, according to the "Succeeding tests and old circuits" values.

iii. Connect both conductors, and apply the test voltage indicated below for a period of 5 minutes between conductors and ground.

iv. When additions are made to old circuits, test only the new sections according to the "First test on new circuits" values. Test the complete circuit at the reduced voltages to ensure reliable operation.

v. The maximum acceptable leakage current, in microamperes, shall not exceed the values calculated in paragraph 5.2.2 (i).

Table 1: Insulation-resistance test values for field circuits

	First test on new circuits	**Succeeding tests and old circuits**
Approach lighting (5 kV circuits)	9 000 volts	5 000 volts
Touchdown zone and centreline lighting (5 kV circuits)	9 000 volts	5 000 volts
HI runway edge light circuits, (5 kV circuits)	9 000 volts	5 000 volts
MI runway and taxiway (5 kV circuits)	6 000 volts	3 000 volts
600 volt circuits	1 800 volts	600 volts

g) The tests from Table 1 shall be performed with a suitable high-voltage tester which has a steady; filtered DC output voltage. The high-voltage tester should contain an accurate voltmeter and microammeter for reading the voltage applied to the circuit and the insulation leakage current.

h) The tests shall be supervised carefully by qualified personnel to ascertain that excessive voltages are not applied.

i) During the last minute of the high-voltage tests the insulation leakage current in microamperes for each complete circuit shall be measured and should not exceed the value calculated for each circuit as follows:

i. Allow 2 microamperes for each series transformer;

ii. Allow 1 microampere for each 100 m of cable (this value includes allowances for the normal number of connectors and splices.); and

iii. Add the values obtained to determine the total allowable microampere leakage for each complete circuit.

j) If the leakage current exceeds the value calculated as outlined above, the circuit should be sectionalized and the tests repeated for each section. Defective components must be located and repaired, or replaced until the entire circuit passes the test.

k) Make sure that the voltage test specified in paragraph 5.4.e)(v) is actually applied to the circuit at the time the leakage current is measured. The voltage shall be adjusted so the voltmeter reads the desired value before the leakage current is read. If any difficulty is encountered in obtaining the desired voltage, either the circuit being tested or the test set is defective and shall be corrected before the test is continued.

l) On new circuits, an insulation resistance measurement shall be made immediately after the circuit has passed the high-voltage tests with the test set used by aerodrome maintenance. This measurement reading then can be used during maintenance as a comparison with future readings to determine circuit conditions. Ambient temperature and weather conditions shall be recorded at the time of testing.

5.3 Procedures for inspection of constant current regulator (CCR)

Visual Inspections for CCR performance evaluation shall check, but not limited to:

a) porcelain bushings have not been cracked;
b) connections are correct;
c) switches and relays operate freely and are not tied or blocked;
d) fuses (if required) are correct;
e) oil level of oil-filled regulators is correct;
f) All covers are cleaned and tightly replaced after each inspection and tests are completed,
g) Manufacturer Information sticker visibly stuck.

5.3.1 Electrical tests of regulators (CCR)

With load disconnected, energize the regulator once, and watch the open-circuit protector to see that it de-energizes the regulator within 2 or 3 seconds:

a) Connect the load circuit after it has been checked for opens and ground, as required and inspected to see that all transformers are properly lamped.

b) Obtain a voltmeter and an ammeter with an error of not more than ±1 per cent of full scale and simultaneously measure input voltage and output current (connect the ammeter to the terminals of an isolating transformer inserted into the output circuit of the regulator) for each intensity setting tap.

c) Use a recording voltmeter or take readings during both day and night at sufficient intervals to obtain an average supply voltage.

d) If the regulator has input voltage taps, select the tap which most nearly corresponds to average supply voltage. The output current for each intensity setting tap should be within ±2 per cent of the nameplate values after any necessary supply voltage correction is made.

e) Regulators which have automatic supply voltage correction in lieu of input taps do not change the output current as the supply voltage varies:

i) If the output current on full intensity deviates from the nameplate value by more than 2 per cent (and if the regulator is not overloaded), the internal adjustment should be checked, as described on the regulator instruction plate. Since the adjustment may be delicate, it is recommended that a deviation of ±5 per cent be allowed on lower settings before attempting to re-adjust the regulator.

ii) Furthermore, a check should be made to see whether the adjustment had been changed purposely for an unusual local flight operational requirement.

5.4. Tests of monitoring system

After the tests listed above have been completed and the lighting is functioning as designed, the monitoring systems should be tested by simulating such failures as open-circuits, short-circuits, grounds, failure of lights, loss of power in both the lighting circuits and the control circuits, and observing the performance of the monitor. Inability to detect failures shall be rectified before the overall system is accepted.

6. REQUIREMENTS FOR INSPECTION OF SECONDARY POWER SUPPLY AND OUTAGE:

The regulation MOZCAR 139.13.3 requires that all aerodromes operators shall have appropriate secondary power supply for safe air operations and aerodrome installations.

6.1 For efficient performance of secondary power supply, the operator is required to:

a) Follow procedures for the inspection and maintenance of aerodrome electrical systems as specified in 6.2, including arrangements for secondary power supplies and, if applicable, the particulars of any other method (solar power, mobile lighting) for dealing with partial or total system failure.

b) Ensure continuity of and safety of services it is important to have procedures for inspection of secondary power and electrical outage. It shall be part of the aerodromes self-inspection program.

c) An aerodrome serving an international traffic shall have two levels of power supply back- up.

d) The first level shall consist of standby generators capable of supplying all the important airport areas.

e) The second level of the back-up (which will be put into operation in case the first back-up facility fails) consists of a number of standby generators positioned strategically and dedicated mainly for:

i) Runaway Lighting

To ensure constant source of power for airfield lighting, the Airport maintains a secondary power source to main power for Runways/Taxiways/NAVAIDS. At least two independent circuits should be maintained and supplied by a secondary power supply.

ii) Air Traffic Control Communication Equipment.

iii) Passenger Terminals.

6.2 Procedures for inspection and maintanace of secondary power supplies

1) Ensure that there are adequate procedures and qualified personal to conduct inspections.

2) Ensure that there are procedures for inspection of facilities (generators etc).

3) Ensure that both first and second level back – ups operate automatically in case of power supply disruption to the dedicated areas.

4) The inspection procedure must ensure that the connection of secondary power supply to air navigation services and facilities is automatically connected to the secondary power supply upon failure of the primary power source.

5) Ensure that the following aerodrome facilities are provided with secondary power supply with the capacity of supplying power in case of the failure of the primary power supply:

(a) The signaling lamp and the minimum lighting necessary to enable air traffic services personnel to carry out their duties;
(b) All obstacle lights which, in the opinion of the Authority are essential to ensure the safe operation of aircraft;
(c) Approach, runway and taxiway lighting;
(d) Meteorological equipment;
(e) Essential security lighting, if provided;
(f) Essential equipment and facilities for the aerodrome emergency services;
(g) Floodlighting on a designated isolated aircraft packing position if provided; and
(h) Illumination of apron areas over which passengers are expected to walk.

6) Ensure that the maximum switch-over time between failure of the primary and the secondary source of power for the services required in 6.2.5) meets the specification indicated in Table 2, below.
7) Ensure that there are adequate facilities, and equipment for rapid dissemination of information.

8) Ensure that inspection schedules correspond with the Maintenance schedules for all standby generators as per the Manufacturer's Manual and shall ensure that the machines are maintained accordingly.

9) Ensure that details of the inspection procedures to be followed during routine matters and unusual

circumstances such as construction and emergencies that may arise.

10) Ensure that the procedure contains details of facilities, equipment and personnel performing the inspection tasks at the aerodrome.

Table 2: Stipulated automatic switchover time

Runway Type	Lighting Aids Requiring Power	Maximum switch Over time
Non-instrument	Visual approach slope indicators a Runway edge b Runway threshold b Runway end b	15 seconds 15 seconds 15 seconds 15 seconds
Non-precision approach	Approach lighting system Visual approach slope indicators a,d Runway edge d Runway threshold d Runway end Obstacle a	15 seconds 15 seconds 15 seconds 15 seconds 15 seconds 15 seconds 15 seconds
Precision approach category I	Approach lighting system Visual approach slope indicators a,d Runway edge d Runway threshold d Runway end Essential taxiways a Obstacle a.	15 seconds 15 seconds 15 seconds 15 seconds 15 seconds 15 seconds 15 seconds

Precision approach category II	Inner 300m of the approach lighting system Other parts of the approach lighting system Obstacle a Runway edge Runway threshold Runway end Runway centre line Runway touchdown zone All stop bars Essential taxiway	1 second 15 seconds 15 seconds 15 seconds 1 second 1 second 1 second 1 second 1 second 15 seconds
Runway meant for take-off in runway visual	Runway edge Runway end Runway centre line	15 seconds c 1 second 1 second

Runway Type	**Lighting Aids Requiring Power**	**Maximum switch Over time**
range conditions less than a value of 800 m	All stop bars Essential taxiway a Obstacle a	1 second 15 seconds 15 seconds

Note:

a. Supplied with secondary power when their operation is essential to the safety of flight operation.

c. One second where no runway centre line lights are provided.

d. One second where approaches are over hazardous or precipitous terrain.

6.3 Lighting Interference due to outages

1) Ensure that outage does not hinder continuity of visual guidance to users. The allowable percentage of inoperable lights must be in such a way that does not alter the basic pattern of the lighting system.

2) Ensure that, an unservicable light shall not be adjacent to another unserviceable light. For the purposes of this advisory circular, lights shall be considered adjacent if located either laterally or

longitudinally in a lighting system.

3) For purposes of this CT, the operating limits for lighting systems before a system is considered inoperable are as follows:

Runway Edge Lights

85% Operable for Visual, Non precision or CAT I Runways.

95% Operable for CAT II Runways (if applicable).

Runway End/Threshold Lights

75% Operable (No more than two lights inoperable at any runway end).

Taxiway Edge Lights

85% Operable.

4) Ensure that the above operating limits can be maintained.

5) If the operating limits cannot be maintained, the aerodrome operator shall determine whether the outage may not provide an accurate reference to aerodrome users, and initiate a NOTAM.

6) Information concerning the outage shall also be disseminated locally.

7) If the inspection reveals that an entire lighting system is inoperable or out of service, an aerodrome condition report shall be issued in accordance with procedure given Manual of Aerodromes Standards.

8) Ensure that there is a reporting system in place to assure prompt correction of conditions.

7. PERSONNEL AND INSTRUCTIONS

1. Ensure that qualified personnel are assigned for every inspection task.

2. Specify the role and function/title/telephone number of personnel responsible for carrying out inspections.

3. The procedure shall identify the inspection and the personnel and when and how the inspection is to be carried out during and outside normal working hours.

4. Describe procedures, checklists, forms used for each inspection. Detailed inspection checklist should be commensurate with the competence, training and skills required for the task to be performed.

8. INSPECTION SCHEDULE

1. Ensure that the procedure for inspection clearly defines:
- What is to be inspected?
- How and when it is to be inspected (Daily, Weekly, Monthly, Bi- annually or Yearly,etc)

2. Ensure that adequate arrangements are made for special additional inspections to conduct:
i) Following Metrological condition
ii) Following a major accident
iii) Following Electrical and Civil Maintenance work

3. The procedure shall be documented in sufficient details in the Aerodrome Manual specifying who, what, how and when a particular inspection regarding secondary power supply is to be carried out

9. SPECIFIC INSPECTION PROCEDURES FOR GENERATORS INSTALLED BEFORE 1990

9.1 General

Engine-generator sets, especially those installed before 1990, may provide limited power in the event of a power outage. They consist of an engine, a generator, control panels, and possibly a fuel storage tank. The engine drives the generator to create electrical power.

Emergency and standby generators are the stationary units hard wired into the electrical distribution system to ensure continuity of the aerodrome air navigation services through a transfer switch. The Automatic Transfer Switches (ATS) are the most common type of transfer switches used for these applications. An ATS can provide a signal for the generator to start and transfer the load from the main supply to the generator.

Improper or poorly maintained generator sets, especially old ones, are more prone to failure and are more likely to fail to provide power to the aerodrome facilitates to ensure safe operation of aircraft. The most common engine failures can be attributed to the starting, cooling, lubrication or fuel delivery systems. Failure of the electric generator is often attributed to excessive moisture in the generator windings. These types of failures can be minimized or prevented, by implementing regularly scheduled, comprehensive, generator maintenance and testing programs.

9.2 Inspection Overview

The components of a good maintenance program consists of: competent visual inspection of the generator, surrounding area and fluid levels; changing the lubrication, coolant and fuel on a regular basis; and testing the starting system, including the batteries. The routine maintenance of such old generators will ensure working at optimum performance levels.

Extreme temperatures, the presence of deleterious water, or excessive exposure to debris, such as dust or sand, may require more frequent inspections for long serving generators.

Keeping a maintenance log is also important. A record of all maintenance, inspections, fluid levels, and test results will enable more accurate planning of future maintenance.

9.3 Procedures for inspection

The procedure for inspection for preventive maintenance is divided into three programmes as shown below:

Daily Procedures	**Repairs (as necessary)**	**Pass/fail**
Visual inspection and condition monitoring of unit – leaks, wear, damage, loose connections/components, vibrations, noise and corrosion.	Correct	
Check engine oils level	Adjust	
Check engine coolant levels	Adjust	
Check fuel delivery system – Leaks, pressure.	Tighten connections	
Check air inlets/outlets for debris	Clean	
Check battery and its charger – verify operation.	Adjust	
Test run the generator for 5 minutes to verify operating parameters (i.e. Frequency, voltage, power factor).	Correct	

Return engine to standby setup for operation.	When required	

Monthly Procedures	Repairs (as necessary)	Pass/Fail
Check engine coolant thermal protection.	Correct	
Check gearbox oil level (if equipped).	Adjust	
Check battery electrolyte level and specific gravity (where appropriate).	Adjust	
Check battery posts, cables, and charger – connections, corrosion, proper operation.	Correct	
Check wiring – connections, corrosion and damage.	Correct	
Check engine drive belts, fan coupling device – tension, wear, weather cracking and damage.	Correct	
Automatic start and transfer to a load bank (or site load). Exercise for at least 30 minutes at a min. Capacity of 30% of the nameplate rating. Check for leaks, connections, components, abnormal operating conditions.	Correct	

Annual Procedures	Repairs (as necessary)	Pass/Fail
Engine oil and filters	Change and replace	
Gearbox Oil (if applicable)	Change	

Drive belts, fan coupling device for tension, wear, weather cracking, damage	Replace	
Clean and re-cap spark plugs	Replace	
Engine air filters	Replace	
Automatic start and transfer to a load bank (or site load). Exercise it for at least 1 hour at 100% of the nameplate capacity. Check for leaks, connections, components, abnormal operating conditions.	Correct	

The above inspection procedures shall be implemented while taking into account the manufacturer's or service provider's recommendations in regard to the servicing and maintaining a particular generator set.

10. CALIBRATION OF ELECTRICAL TEST AND MEASUREMENT EQUIPMENT

This section refers to several types of electrical test equipment used for maintenance of lighted navigational aid equipment and the need for calibration to ensure measurement accuracy and safe operations.
All measurement equipment shall be calibrated, as per MOZCAR 139.13.105 (9), annually by a certified calibration lab for the ranges to be measured, and all accessories checked to ensure accuracy and safety.

Operating and calibration instructions for the equipment listed below are contained in the manufacturer's manual supplied with the equipment.

10.1 The following is the list of most common test equipment in airports, but not limited:

1. Volt-ohm-milliammeter (VOM).
2. Digital multimeter (DMM).
3. Insulation resistance tester (megohmmeter).
4. Insulation-resistance test.
5. Underground cable/fault locator.

6. High-resistance fault locator.
7. Clamp-on ammeter.
8. Cable route tracer.
9. Impulse generator/proof tester.
10. Acoustic detector.
11. Directional detector.
12. Ground resistance tester.
13. Inclinometer.

10.2. **Calibration**

a) All test equipment shall have a valid calibration/verification certificate.
b) The equipment user shall define an acceptance criteria.
c) All calibration certificates shall be assessed to verify the state of equipment.
d) The equipment holder shall share the results with the regulator.

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