



# Technical Guidance Material for Maintenance of Runway and Taxiway-Lighting Systems

## Advisory Circular

Subject: TECHNICAL GUIDANCE MATERIAL FOR MAINTENANCE OF RUNWAY AND TAXIWAY LIGHTING SYSTEMS.

Date: 25 FEBRUARY 2019

### APPLICABILITY

This document applies to all aerodrome operators supporting night and reduced/low visibility aircraft operations, air navigation service providers, and electrical contractors as per CAR (Civil Aviation Regulation) 139.2.22 23(2).

### PURPOSE

The purpose of this document is to provide guidance to common procedures used at aerodromes, when planning for and conducting routine inspections and preventative maintenance on airfield lighting systems.

### REFERENCES AND REQUIREMENTS

1. South African Civil Aviation Regulations Part 139.
2. Annex 14 Volume I.
3. ICAO Doc 9137 AN/898 Part 9.

### 1. BACKGROUND

1.1. Operating an aerodrome at night and reduced/low visibility conditions requires installation, operation, inspection and maintenance of runway and taxiway lighting systems. A comprehensive preventative maintenance and inspection program for determining the functionality of lighting systems will enhance flight

safety and proper acquisition of these visual aid cues for pilots by not permitting any distortion or confusion, due to lighting system failures.

- 1.2. By conducting preventative maintenance activities in accordance with a well-developed and comprehensive plan, you should be able to meet the safety needs of the aviation industry, conform to regulatory obligations, and ensure the continued viability and operational safety of the aerodrome facility.

## 2. GENERAL

- 2.1. The basic purpose of aeronautical visual aid systems is to aid in the safe operation of aircraft, therefore the highest standards of maintenance are required. Once a system has been installed, its usefulness is dependent on its serviceability, which in turn is dependent on the effectiveness of the maintenance work carried out by the aerodrome operator.

2.1.1. Different types of Visual Aids for navigation used at aerodromes are as follows:

- a. Runway edge lights, centre line lights, touch-down zone lights, threshold lights, stop bar lights, runway end lights etc.
- b. Taxiway edge lights, centre line lights, taxi stop bar lights etc.
- c. High intensity approach lights, low intensity approach lights, strobe lights, precision Approach Path Indicator (PAPI) etc.
- d. Aerodrome beacon, wind direction indicators, obstruction lights etc.
- e. Markings and signs etc.

- 2.2. The operator can successfully manage malfunctions or unserviceability of lighting systems by developing an inspection and preventative maintenance plan to deal with system failures and deficiencies.

- 2.3. While planning an aerodrome's maintenance program, the inclusion of the following general guidelines, equipment manufacturers' recommendations, and other pertinent safety and health information should be considered.

2.3.1. A preventative maintenance program should include procedures to deal with:

- a. personnel qualification and training;
- b. availability of spare parts;
- c. readily available as-built drawings;
- d. light system component maintenance schedule;
- e. light system component maintenance procedures;
- f. signs; and
- g. markings.

### 3. PERFORMANCE LEVEL OBJECTIVES FOR VISUAL AIDS

The Performance level objectives for visual aids should be as given below. This performance level should be maintained through scheduled, unscheduled and preventive maintenance.

No.	Light category	Minimum acceptable light output (% of specified value)	Minimum acceptable % of serviceable light	Consecutive lights, more than numbers given below, should not remain unserviceable	
1.	Runway edge lights	50%	a. For Cat-I operation, at or above prescribed visibility	95 %	2
			b. When Runway Visual Range is less than 550m	95 %	
2.	Runway centre line lights	50%	a. For Cat-I operation, at or above prescribed visibility	85 %	2
			b. When Runway Visual Range is less than 550m	95 %	
3.	Runway end lights	50%	a. For Cat-I operation, at or above prescribed visibility	85 %	2
			b. When Runway Visual Range is less than 550m	95 %	
4.	Taxiway Stop-bar lights	50%	Not more than two lights should be Unserviceable		2
	Runway Threshold lights	50%	85 %		–
	Touch Down Zone lights	50%	90 %		–
	Approach lights	50%	Beyond 450 m	85 %	–

Note: With respect to barrettes, crossbars and runway edge lights, lights are considered to be adjacent if located consecutively; and

- laterally: in the same barrette or crossbar; or
- longitudinally: in the same row of edge lights or barrettes.

#### 4. PERSONNEL

4.1. Electricians to be entrusted with the task of maintenance of lighting aids should have the following qualifications / qualities:

- 4.1.1. Be experienced with high voltage series circuits and lighting;
- 4.1.2. Be experienced with high voltage series circuits and lighting;
- 4.1.3. Be fully acquainted with the work to be done;
- 4.1.4. Be present or available on call during the operating hours of the airport to correct any deficiencies that might develop;
- 4.1.5. Be provided with appropriate training to maintain their competence and to keep them abreast of new developments.

#### 5. SPARE PARTS

5.1. An adequate stock of spare parts should be available. The required level of stock will depend on the following criteria:

- 5.1.1. Rate of consumption of the items;
- 5.1.2. Time required to get the resupply of the items;
- 5.1.3. Shelf life of the items.

#### 6. AS-BUILT DRAWING

6.1. A set of as-built drawings should be kept readily available in the Maintenance unit. The as-built drawings should be kept in the following manner:

- 6.1.1. Drawings should be kept in the Maintenance unit and in the concerned Engineer's office;
- 6.1.2. Drawings must be kept up to date and any changes at site should be reflected immediately on these drawings;
- 6.1.3. The completeness and the accuracy of all circuit diagrams, drawings and descriptions shall be checked at least annually.

## 7. PREVENTIVE MAINTENANCE OF VISUAL AIDS FOR NAVIGATION

7.1. A system of preventive maintenance of visual aids should be employed to ensure lighting and marking system reliability. Procedures of preventive maintenance should be as follows:

- 7.1.1. Light bulbs should be considered unserviceable and be replaced when their brightness falls below 50% of normal value.
- 7.1.2. The specifications from the Manufacturers regarding the normal life time of all the items of visual aids, should be made available with the maintenance personnel, and light bulbs should be replaced after 90% of the manufacturer's prescribed life time has elapsed.
- 7.1.3. In case when manufacturer's specification is not available, light bulbs should be replaced after 90% of the average life time of the bulbs has elapsed.
- 7.1.4. Light fittings, fasteners and their supporting structures which may be damaged by rust should be painted annually.
- 7.1.5. Cable lives of all concerned sections of visual aids should be verified and cables should be replaced whenever there is any threat to the system to be hampered for damage of cables due to aging.
- 7.1.6. Functions of all other items should be closely monitored and should be replaced whenever there is any threat to the system to be hampered due to aging of those items.

## 8. BASIC COMPONENTS OF MAINTENANCE

8.1. Maintenance includes measures to keep or restore the operational function as well as measures to check and to evaluate the present function of an element. The basic components of maintenance are:

- 8.1.1. Inspection/ Monitoring;
- 8.1.2. (The unserviceable lights can be identified more easily during night inspections, and of course, possible failures can be noticed by the operator at the Control desk if appropriate electric monitoring system is there.);
- 8.1.3. Servicing and overhaul; and
- 8.1.4. Repair.

## 9. INSPECTION AND MAINTENANCE TEAM

9.1. Where applicable, a team for the inspection and maintenance of visual aids should be formed with at least the following members:

- 9.1.1. Electrical Maintenance representative;
- 9.1.2. Surface Maintenance representative;
- 9.1.3. Aerodrome Rescue and Fire Fighting Services (AR&FFS) representative;
- 9.1.4. Safety Officer.

## 10. PREVENTIVE MAINTENANCE CHECKS ON AGL (Aeronautical Ground Lighting)

10.1. Maintenance for all types of approach, runway and taxiway lights should include checking and, if necessary, taking the indicated corrective action, as follows:

### 10.1.1. **Daily**

- a. System for burnt-out lamps; replacing burnt-out lamps.
- b. System for gross misalignment (if applicable); Adjusting.
- c. Control equipment for proper operation on each brightness step (if applicable); Correcting or repairing malfunctions.
- d. Glass for breakage; replacing broken parts.

### 10.1.2. **Annually**

- a. Fasteners of each light unit; Tightening.
- b. Lights for corrosion; Painting or Replacing rusted parts.
- c. Reflector of each light unit (if applicable); Cleaning or Replacing.
- d. Glass of each light; Cleaning or Replacing.
- e. Lamps of the whole system; Replacing of the unserviceable lamps or entire system.
- f. Elevation setting (if applicable); Adjusting.
- g. Horizontal alignment; Adjusting.
- h. Plug connexions for cleanness and faultless contact; Cleaning or Replacing of dirty parts.
- i. Light fittings and their supporting structure (if existing) for adequacy of fastening and for corrosion and rust; tightening fasteners; Painting or Spraying general condition of the whole system, and recording result.

10.1.3. **Unscheduled**

- a. Elevation setting and the horizontal alignment (if applicable) of the light unit after severe storm; Adjusting
- b. Light units for obstruction by grass. etc. (not applicable for Inset lights); removing any obstacles found.

**11. PRECISION APPROACH PATH INDICATOR MAINTENANCE SHOULD INCLUDE CHECKING AND, IF NECESSARY, TAKING THE INDICATED CORRECTIVE ACTION AS FOLLOWS:**

11.1. **Twice Monthly**

- a. Elevation setting (vertical angle) of the light units; Adjusting
- b. Spreader glasses, filters and lamps for cleanness; Cleaning

11.2. **Annually**

- a. System from the air, and recording results; Adjusting and Replacing lamps
- b. Supporting structure and the foundation of each unit; Repairing

**12. RUNWAY THRESHOLD AND RUNWAY END LIGHT MAINTENANCE SHOULD INCLUDE CHECKING AND, IF NECESSARY, TAKING THE INDICATED CORRECTIVE ACTION AS FOLLOWS:**

12.1. **Twice Weekly**

- a. Fasteners of the lights; Tightening
- b. Glass of each light for wear and tear; Replacing.

**13. INSET LIGHTS (RUNWAY CENTER LINE LIGHTS, TOUCHDOWN ZONE LIGHTS, TAXIWAY CENTER LINE LIGHTS, STOP BAR LIGHTS) MAINTENANCE SHOULD INCLUDE CHECKING AND, IF NECESSARY, TAKING THE INDICATED CORRECTIVE ACTION AS FOLLOWS:**

13.1. **Daily**

- a. Lenses for cleanness; Cleaning

13.2. **Twice Weekly (not applicable to taxiway and stop bar lights)**

- a. Light output of lights within 900 m from each threshold including measuring and recording the results; Cleaning of the lenses
- b. Top parts of lights within 900 m from each threshold; Replacing

13.3. **Quarterly (not applicable to taxiway and stop bar lights)**

- a. Light output of all lights within the system including measuring and recording the results; Cleaning of the lenses
- b. Top parts of the lights; Replacing

13.4. **Semi-annually (not applicable to taxiway and stop bar lights)**

- a. Lights for cleanness inside and out; Cleaning
- b. Lights for moisture; Drying
- c. Electrical connections of the lights; tightening; Spraying with contact agent
- d. Alignment of lights; Adjusting

13.5. **Annually**

- a. Prisms and filters; Cleaning or Replacing
- b. Sealing compound; Resealing

13.6. **Unscheduled**

- a. Top parts of the lights two to four weeks after replacement; Tightening.

**14. PREVENTIVE MAINTENANCE CHECKS ON OTHER AIRPORT LIGHTS**

14.1. Other airport lights include, for example, airport beacons, obstacle lights and wind direction indicators. These normally need less maintenance than approach, runway or taxiway lighting systems. Their maintenance should include checking and, if necessary, taking the indicated corrective action as follows:

14.1.1. **Daily**

- a. Lamps; Replacing if necessary Control equipment for proper operation (not applicable in the case of obstacle lights); Correcting or Repairing
- b. Fabric of the wind cone; Repairing or Replacing



14.1.2. **Semi Annually (only for airport beacon)**

- a. Power supply (brushes and slip-rings); Leaning or replacing
- b. Electrical connections; Tightening
- c. Rotating parts; Fastening.

14.1.3. **Annually**

- a. Optical system of the airport beacon glasses and the gaskets of obstacle lights; Cleaning or Replacing
- b. Function of the flashing relays and of the day light switches of the obstacle lights; cleaning, Repairing or Replacing
- c. Power supply and the lighting of the wind direction indicator; Repairing or Replacing
- d. Electrical connections; Tightening; Spraying with contact
- e. Fasteners of obstacle lights
- f. Structure and the fasteners of the wind direction indicator; Tightening or Repairing the structure lights for corrosion; painting
- g. Colour of the fabric cone of the wind direction indicator; replacing.
- h. Location of obstacle lights for easy access for maintenance; Arranging of change of location if required and possible.

14.1.4. **Unscheduled**

- a. Wind direction indicator after severe storms; repairing.

## 15. DOCKING GUIDANCE SYSTEM

15.1. Principal requirements to be checked and maintenance action to be taken, if necessary, include:

15.1.1. **Daily**

- a. System for over-all operation; repairing
- b. Lamps; replacing burnt-out lamps

15.1.2. **Semi-annually**

- a. Alignment of the system; adjusting.

### 15.1.3. **Annually**

- a. Electrical connections (if provided) for corrosion, wear and tear; cleaning, tightening and replacing
- b. Function of relays (if provided); cleaning or replacing
- c. Structure of the system and the function of all mechanical parts; repairing
- d. System for cleanness and moisture; cleaning and drying

## 16. PREVENTIVE MAINTENANCE INSPECTION CHECK PROCEDURES

Because in-pavement lights are installed in the aircraft traffic area and are run over by aircraft, they tend to be higher maintenance items that need frequent attention to support specified performance. Additionally, their location below ground level makes them prone to water infiltration; this also needs frequent attention.

## 17. DAILY INSPECTIONS

- 17.1. A runway inspection should be conducted daily. The operator should check for:
- a. Burned-out lamps;
  - b. Dimly burning lamps; and
  - c. Record their location.

## 18. WEEKLY INSPECTIONS

18.1. A field electrician should inspect and service any lights reported as defective in the daily inspections. The preferred service method is to replace the in-pavement light unit with a spare and take the defective unit back to the shop for repair. The lighting circuit should be deactivated, locked-out and tagged-out before any maintenance is tried on the lights.

18.2. The following defects may be the cause of the lighting malfunction:

### 18.2.1. **No light**

- a. Fixture should be removed and replaced with a refurbished unit; and
- b. Brought to the maintenance shop for re-lamping and refurbishing.

### 18.2.2. **Electrical failure**

- a. A series circuit problem exists, if the replacement lamp also fails; or

- b. A series circuit problem exists, if a string of lights fails.

### 18.2.3. Dim light

- a. Exposed optical surface of the in-pavement light gets dirty from exposure to aircraft traffic and weather
- b. Can also be a sign of a weak lamp; and
- c. May be cause for fixture replacement.

### 18.2.4. Light aiming

- a. Shallow-base in-pavement light fixtures are often twisted out of alignment by aircraft landing or turning; and
- b. Check any dimly burning lights to see if they are merely misaligned.

### 18.2.5. Water in the Fixture

- a. Examine the lens for standing water or condensation behind the lens;
- b. If water is present, remove and service the fixture.

## 19. MONTHLY INSPECTIONS

- 19.1. Until a regular maintenance schedule is set up, it may be necessary to do the checks below on a monthly or even weekly basis at busy facilities. After some experience has been gained, the interval may be adjusted to meet operational needs.
- 19.2. The frequency of measurement of lights for a precision approach runway should be based on:
  - a. Traffic density;
  - b. Local pollution level;
  - c. Reliability of the installed equipment; and
  - d. Continuous assessment of the results of the in-field measurements, but in any case should not be less than twice a year.

## 20. CLEANING

- 20.1. Due to their position at ground level, in-pavement lights need frequent cleaning to support their specified performance. The frequency with which the lights are cleaned depends on:

- a. Location;
  - b. Weather conditions; and
  - c. Traffic density.
- 20.2. Rubber deposits have been shown to have an extremely detrimental effect on light output. Clean the lights when the light output of the fixture is less than 50 % of the standard [or of the design value when this value is in excess of the standard] A fixture degraded below this is ineffective for high background brightness, low visibility conditions.

## 21. INTENSITY CHECKS AND PHOTOMETRIC TESTING

- 21.1. Test equipment is now available to allow for the rapid and accurate testing of the light output of both in-pavement and elevated runway lighting fixtures. Regular photometric measurements are the only practical way of determining if the lights are emitting the specified amount of light and for determining misalignment errors.
- 21.2. By using regular photometric measurements, maintenance of runway lighting fixtures may be targeted only where needed thereby saving resources and time while allowing the aerodrome to be assured of meeting light output specifications, especially in low-visibility conditions. This aids in providing a consistent lighting pattern to give the pilot with the best possible, non-ambiguous visual cues when landing.
- 21.3. Necessary frequency of photometric measurements will vary from facility to facility and from runway to runway depending on amount of traffic and age of fixtures. After experience has been gained with the measurement equipment, inspection schedules may be decided on or modified.
- 21.4. Due to the susceptibility of runway centerline lights to accumulate rubber deposits on the lens, weekly checks may be necessary. This is especially true for CAT II and CAT III runways where low-visibility operations are conducted. Any in-pavement runway light showing a light output of less than 50% of standard [or 50% of the design value] is ineffective for high background brightness or low visibility conditions and should be targeted for cleaning or maintenance.
- 21.4.1. **Photometric testing should be done:**
- a. Before cleaning or re-lamping, to prove what maintenance is necessary; and
  - b. After cleaning, or other maintenance actions, to track the effectiveness of the maintenance and decide the extent of degradation of the optical assembly.

## 22. BI-MONTHLY CHECKS – BOLT TORQUE




The torque of the bolts attaching the light to its base should be checked. The impact of aircraft wheels can loosen mounting bolts and cause misalignment or fixture damage; this is particularly troublesome in the touchdown zone.

## 23. SEMI-ANNUAL CHECKS – SHALLOW BASE INSTALLATIONS

- 23.1. Check the shallow base installations for the presence of water. Any water should be removed and the base should be sealed to prevent its re-entry.
- 23.2. This check should be conducted more often in winter months since freezing may cause damage to the fixture by shearing the fixture hold-down bolts or rupturing the base. Having a dry light base is the exception rather than the rule. Water in light bases is very common, resulting from the miles of conduit that leak and slowly fill the system with water.
- 23.3. To avoid water freezing in bases, place ETHA-foam (also known as closed cell foam) disks that are 2 inches thick by 8 inches diameter in the bases to displace the water. This prevents ice damage to the base, fixture, and transformer by allowing any remaining water to crush the ETHA-foam disks.

## 24. SUMMARY

Aerodrome operators should have a preventive maintenance program including a plan for inspection to ensure the continued viability and operational safety of the aerodrome facility.

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