CIVIL AVIATION AUTHORITY OF FIJI

GUIDANCE MATERIAL

Aerodrome Electrical System – Circuitry

SD – AES(C)

Published by:

Civil Aviation Authority of Fiji
Private Mail Bag, NAP 0354
Nadi International Airport
Fiji

www.caaf.org.fj

PREFACE

This Guidance Material provides CAAF's guidance for assessing circuitry used in Aeronautical Ground Lighting (AGL) systems, including the application of interleaving and selective switching to maintain serviceability and reduce the operational impact of single failures. The guidance is based on ICAO provisions and is intended to support consistent design, installation, and maintenance practices.

The material is primarily written for aerodrome operators, electrical contractors, and CAAF inspectors. Where lighting technologies evolve (including increased use of LED-based fixtures and control systems), aspects of this guidance may be reviewed and updated.

Future editions will be strengthened through operational experience and feedback. Readers are invited to provide comments and suggestions to support continuous improvement.

Chief Executive
Civil Aviation Authority of Fiji

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS

No.	Date applicable	Date entered	Entered by
1	06/01/2026	06/01/2026	SOSC-GS
2			
3			

CORRIGENDA

No.	Date of issue	Date entered	Entered by

Table of Contents

ABBREVIATIONS

Abbreviations

AC	Alternating current
AGL (height)	Above ground level
AGL (lighting)	Aerodrome ground lighting
CCR	Constant current regulator
DMM	Digital multimeter
DSP	Digital signal processor
EMC	Electromagnetic compatibility
EMI	Electromagnetic interference
EPR	Ethylene-propylene rubber panel
ILS	Instrument Landing System
MDT	Mean downtime
MR	Multifaceted reflector
MTBF	Mean time between failures
PAPI	Precision approach path indicator
PUR	Polyurethane
PVC	Polyvinyl chloride
RETIL	Rapid exit taxiway indicator lights
RMS	Root-mean-square
VA	Volt-ampere
VOM	Volt-ohm-milliammeter/Volt-ohmmeter
XLP	Cross-linked polyethylene

REFERENCES

- International Civil Aviation Organization (ICAO) ;Aerodrome Design Manual (Doc 9157), Part 5 — Electrical Systems
- International Electrotechnical Commission (IEC); IEC 61822 — Electrical installations for aeronautical ground lighting at aerodromes
- Other; Directive 2011/65/EU — Restriction of the use of certain hazardous substances (RoHS)

1. Introduction

This Guidance Material describes good practice for the design and assessment of AGL circuitry, with emphasis on interleaving and selective switching. It supports aerodrome operational resilience by reducing the likelihood that a single failure will leave pilots with inadequate or misleading visual guidance.

This guidance applies to aerodrome lighting systems where interleaving is required or adopted, particularly for operations in low visibility conditions, and to taxiway routing where selective switching is used for route guidance.

2. Interleaving of Aerodrome Lighting Circuits

2.1.1 ICAO Annex 14, Volume I (8.2) requires that, for runways intended for use when runway visual range is less than 550 m, the power supply and control arrangements be designed so that the failure of one circuit does not leave the pilot with inadequate visual guidance or misleading information. In practice, this is achieved by interleaving lighting systems using at least two circuits. Examples of circuit interleaving to improve integrity are shown in Figure 1-1 to Figure 1-5.

2.1.2 Each circuit in an interleaved system should extend across the full length/extent of the facility (e.g., runway length) and be arranged so that a balanced, symmetrical pattern remains if one circuit fails.

2.1.3 Good practice:

- Label and identify cables, transformers, and terminations clearly for each circuit.
- Avoid grouping adjacent fittings on the same circuit where this would create misleading gaps if one circuit fails.
- Document the interleaving pattern on as-built drawings and in the maintenance manual..

3. Arrangements in the Electrical Vault

3.1.1 Interleaving should be considered from the electrical vault outward. Where practicable, interleaved circuits should be fed from separate buses and supplied by separate CCRs so that a single equipment failure does not disable all circuits in a system. Figure 1-1, shows the circuits and associated regulators are fed from separate buses, such that each circuit is supplied from a separate CCR.

3.1.2 A spare CCR (or spare regulating module, as applicable) should be available and capable of being brought into service within a minimum time, supported by switching arrangements and documented procedures.

3.1.3 The buses are provided with automatic tiebreakers for use in case of failure.

3.1.4 As a further means of assuring availability in case of failure, an arrangement is made to enable switching to a spare regulator, as shown in Figure 1-2. This method may be used where the regulator consists of the regulating component and input/output transformers. In the case of regulators that consist of only the regulating component, a rack-mounted or plug-in design is used, and availability is achieved by use of a spare regulator that can be readily installed in place of the failed regulator.

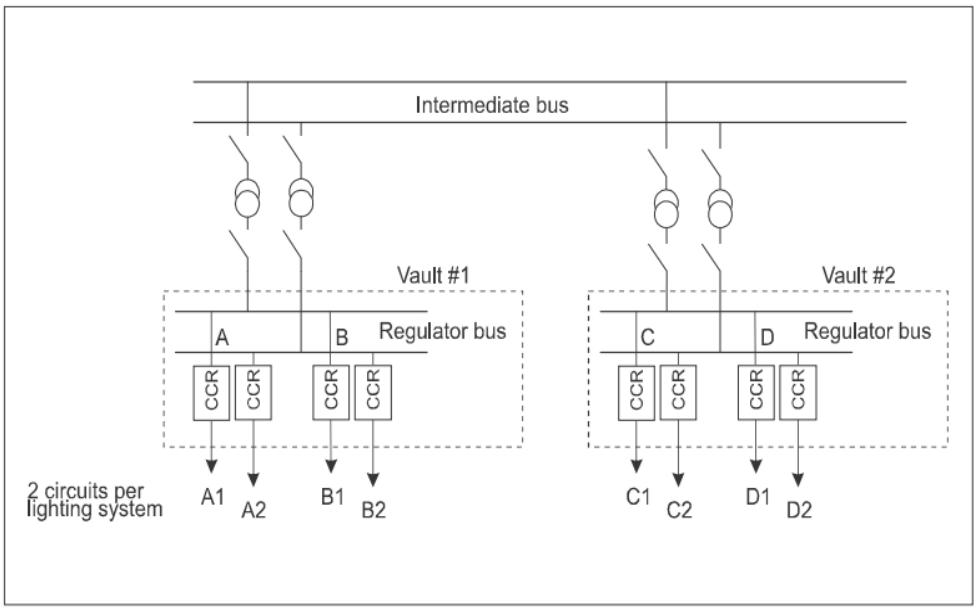

Figure 1-1. Provision of interleaved circuits

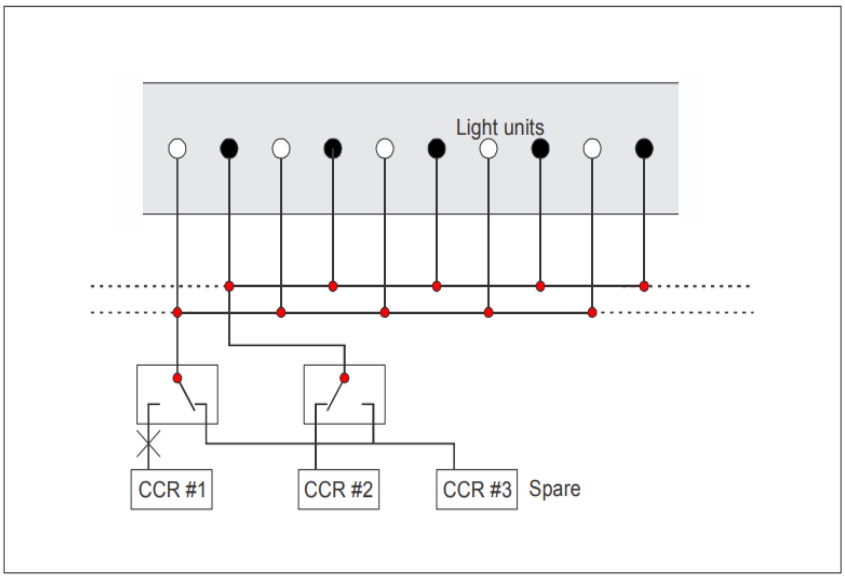

Figure 1-2. Use of a spare regulator

4. Provision of Interleaving

Interleaving should be provided for lighting facilities identified in ICAO Annex 14, Volume I (including Table 8-1) where required for the intended operations. The selected interleaving method should maintain an acceptable pattern and spacing when one circuit fails.

4.1 Approach Lighting System

4.1.1 Approach lighting systems (including Category I and supplementary Category II/III lighting where provided) should be interleaved so that loss of one circuit does not remove critical centreline or barrette guidance.The interleaving of approach lighting Type A (distance-coded centreline) and Type B (barrette centreline) is illustrated in Figure 1-3.

4.1.2 Threshold lights may be supplied as part of runway edge lighting and/or approach lighting arrangements. Where separate threshold components exist, ensure the interleaving maintains an intelligible green threshold/wing-bar pattern.

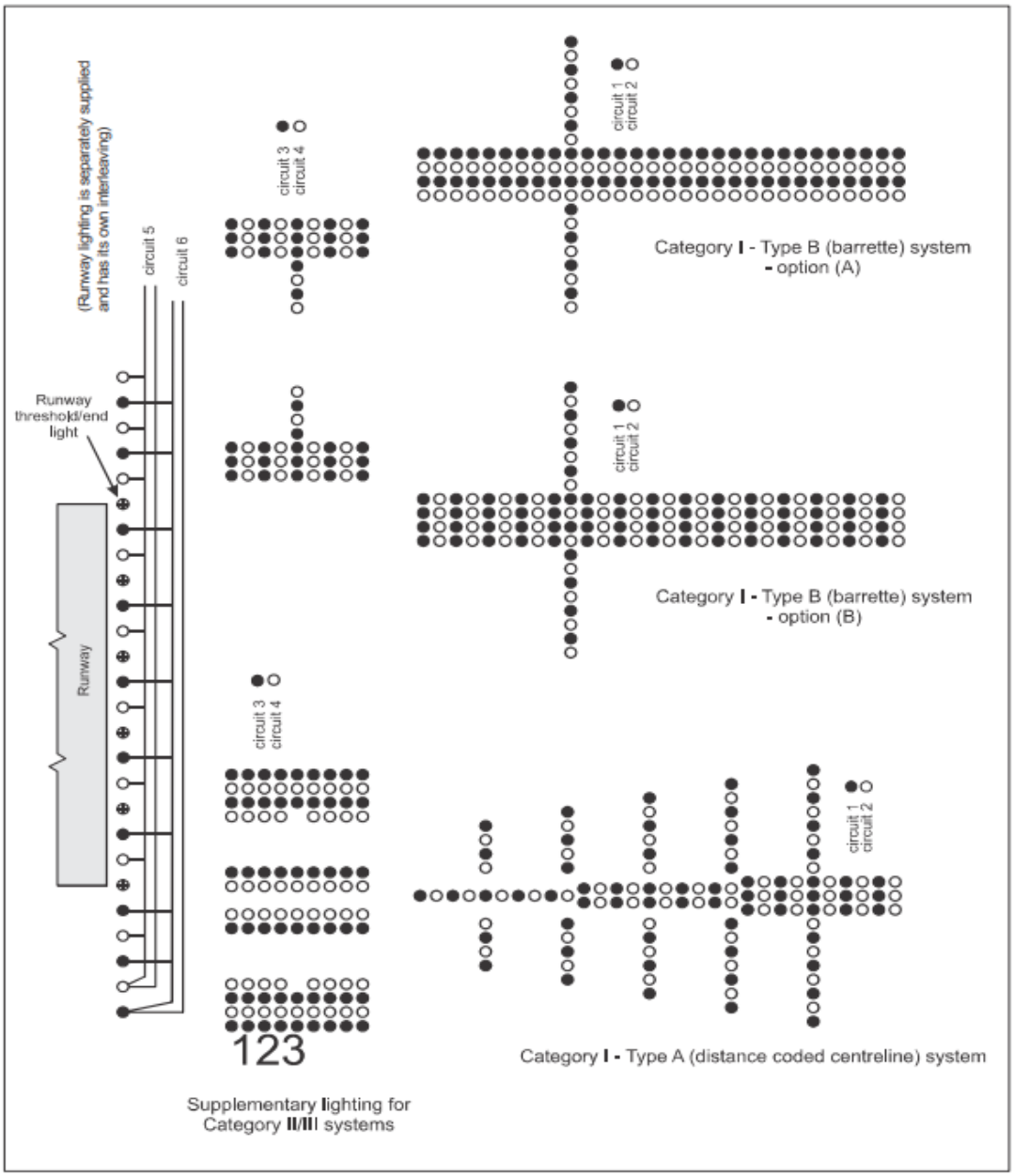

Figure 1-3. Precision approach lighting system interleaving

4.1.3 The threshold lights for the runway are runway end/threshold lights with red and green signals (facing opposite) at each light station. In Figure 1-3, six runway threshold lights are shown for a Category I installation. A Category II/III installation would have additional runway end/threshold lights (please refer to Figure 5-22 in Annex 14, Volume I). The runway end/threshold lights are usually interleaved as part of the runway edge lighting system. Interleaving for the approach lighting system involves the unidirectional green threshold lights and the wing bar lights.

4.2 Runway Centreline and Touchdown Zone Lighting Systems

4.2.1 Runway centreline lights are colour-coded (variable white to 900m from threshold, alternating white/red from 900m or mid-point of runway to 300m from runway end, after which only red is shown to the pilot) as specified by ICAO Annex 14. Where interleaving is used, select a method that either preserves the colour coding or maintains acceptable spacing, as determined by the aerodrome operator/competent authority. Figure 1-5 (b) illustrates the interleaving for the first white only portion of the system. Similar interleaving would be used for the final all-red portion.

4.2.2 Figure 1-4 illustrates various means to provide interleaving for the coded white/red portion of the system, and the selection is prescribed by the local authority. Where it is necessary to preserve the colour coding, Figure1-4 (a) should be used. However, this interleaving would increase the spacing in failed segments to three times the normal value. Figure 11-4 (d) illustrates an interleaving arrangement where lights are installed with 7.5 m spacing and couplets of the same colour are installed. Figure 1-4 (b) does not preserve the coding (with circuit failure, the lights are either all red or all white) but does maintain an acceptable spacing for provision of a pattern of lights for centreline guidance (the spacing is doubled with circuit failure).

4.2.3 For touchdown zone lights, interleaving should maintain a consistent longitudinal spacing between barrettes after the loss of one circuit (Figure 1-5)

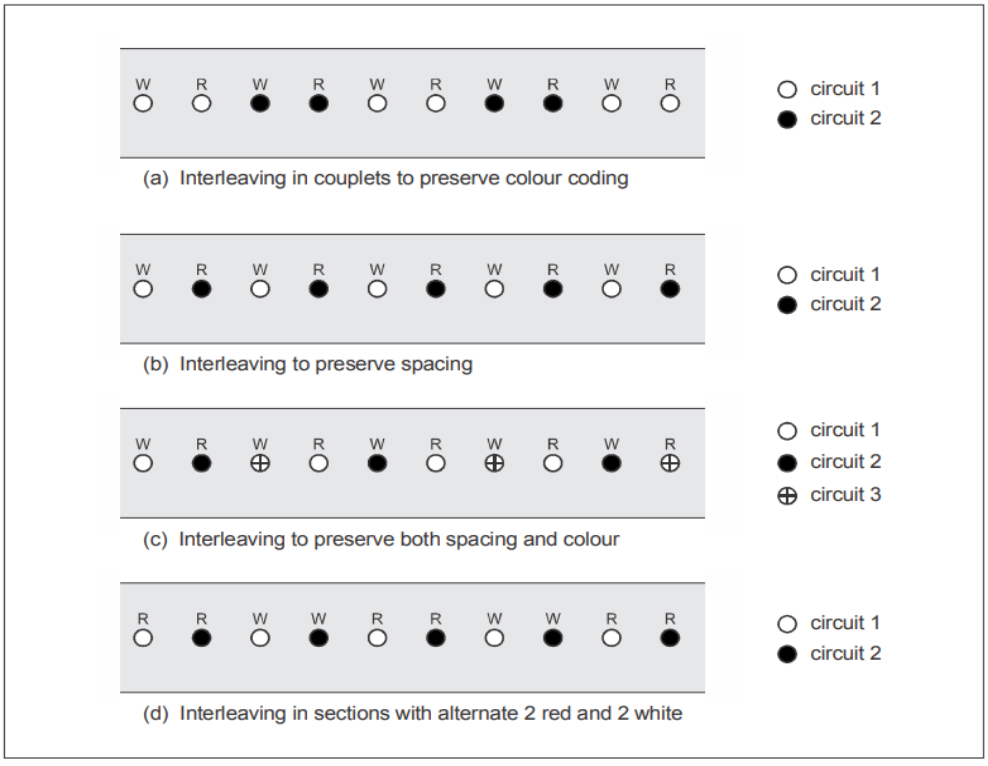

Figure 1-4. Interleaving of colour-coded lights

4.3 Taxiway Centreline Lighting

4.3.1 Taxiway centreline lighting may be interleaved on taxiways considered essential for low visibility operations. For other taxiways, a single circuit may be acceptable where operationally justified.

4.3.2 Where taxiway centreline lighting is colour coded green/yellow (to indicate the distance of the aircraft exit from a runway in relation to the ILS critical area), the interleaving method should consider both spacing and the need to preserve colour coding (Figure 1-4). More robust methods may require additional circuits or closer spacing.

4.3.3 As in the case of runway centreline lighting, Figure 1-4 (a) preserves colour coding but leaves failed segments that are three times the normal light spacing. Figure 1-4 (b) causes an increased spacing which is twice the norm but also does not preserve the coding such that the exiting pilot would see either a line of green or yellow lights. The method of Figure 1-4 (c) preserves minimal spacing but is more costly. The method of Figure 1-4 (d) is an alternative which preserves the colour coding and leaves a normal spacing if the lights are installed at half the normal spacing (e.g., at 7.5 m instead of 15 m).

4.4 Stop Bars

4.4.1 Stop bars should be controlled independently of each other and independently of taxiway centreline lights. Circuits should be interleaved so that all lights of a stop bar do not fail simultaneously.

4.4.2 Where stop bars are paired with lead-on centreline lighting, ensure that: (a) lead-on lights provide positive confirmation to proceed when the stop bar is extinguished; and (b) centreline lights beyond the stop bar are appropriately extinguished when the stop bar is illuminated (and vice versa), in accordance with the aerodrome's SMGCS procedures.

4.4.3 The green lead-on lighting provides a confirmation of voice instruction for the aircraft to proceed once the stop bar is turned off. When the stop bar is illuminated, the taxiway centreline lights installed beyond the stop bar are extinguished for a distance of at least 90 m, and vice versa. Control and monitoring of the lead-on lights can be accomplished through means of addressable switches, whilst the power supply and possible interleaving is that of the taxiway centreline lighting. Should the supply to the lead-on lights be other than a dedicated circuit, it is necessary to ensure that the circuits to which these lights are connected will be active when the lead-on lighting is required.

4.4.4 Further information regarding stop bars is provided in the Aerodrome Design Manual (Doc 9157), Part 4.

5. Possible Provision of Interleaving

The following facilities are not normally interleaved but may be interleaved where required by operational need or as directed by the aerodrome operator/competent authority.

5.1 Visual Approach Slope Indicator Systems (e.g. PAPI)

5.1.1 Where operated in conjunction with ILS, visual approach slope indicator systems should be provided with two circuits per runway end.

5.1.2 Normally, the PAPI is installed on the left side of the runway. When the visual approach slope indicator system is a full PAPI or T-VASI and installed on both sides of the runway, supply each side from a separate circuit so that a complete pattern remains if one circuit fails.

5.1.3 Where installed on one side only (PAPI and AT-VASI), distribute lamps within each unit across two circuits where practicable. If a failure of a complete light unit results in a misleading indication, the system should be de-energized.

5.2 Runway holding position signs

5.2.1 Where interleaving is provided, runway-holding position signs should be installed such that separate circuits are used for the signs on each side of the taxiway.

5.3 Rapid exit taxiway indicator lights (RETIL)

5.3.1 The RETIL system is composed of a pattern of in-pavement fixtures used to indicate the approach to a runway exit. RETIL systems are typically not interleaved due to small quantity of fixtures, each necessary for the distance coding. They should be supplied from a dedicated circuit and CCR. Because a single light failure can compromise the coding, there should be means to detect failure and de-energize the system to prevent misleading indications.

5.3.2 The functionality of the RETIL system is dependent upon the number of lights in consecutive barrettes, and the failure of one light within a barrette results in a malfunction of the system. Therefore, it is recommended that the system be provided with a means to automatically turn off the entire system should there be a loss of a single light unit.

5.4 Runway Guard Lights

5.4.1 Runway guard lights should be supplied from circuitry separate from the associated runway/taxiway circuits due to differing brightness requirements and operational need when runway/taxiway lighting is not illuminated. Where interleaving is applied, ensure the flashing characteristic and alternating pattern are preserved.

5.4.2 Where interleaving is provided, the RGL configuration a (elevated) is interleaved such that one circuit is used for each side of the hold positions.

5.4.3 Where interleaving is provided, the RGL configuration b (in-pavement) is interleaved with the connection made in couples of lights such that the alternate flashing characteristic is maintained. For example, as, c1, c1, c2, c2, c1, c1, c2, c2.

5.5 Taxiway/runway lead-in lights.

5.5.1 Green taxiway/runway lead-in lights need not be interleaved, as the function of this lighting is to confirm the voice instruction to proceed. However, if interleaved, they may be provided with two circuits, as for a runway centreline of single colour, as shown in Figure 1-5 (b).

5.5.2 Where the taxiway lead-in lights are provided with colour coding, additional circuits may be required to preserve the colour coding with a loss of a circuit.

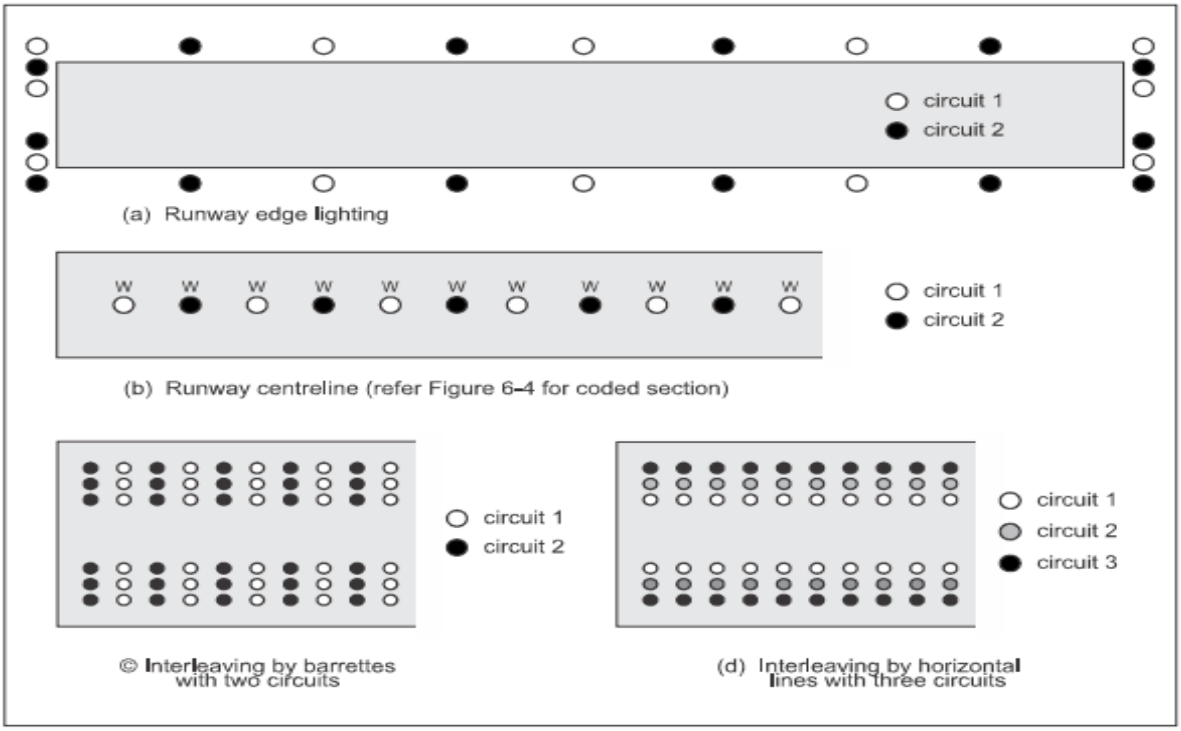

Figure 1-5. Runway edge, centreline, and touchdown zone lighting

6. Selective Switching of Taxiway Circuits

To support route guidance, taxiway centreline lighting should be circuited to permit selective switching of taxiway segments. This may be achieved by:

- a dedicated CCR for each segment; or
- multiple segments fed from a single CCR with relays/field switches (either in the field or at the regulator output) to energize selected segments; and/or
- addressable switching systems integrated with the aerodrome lighting control and monitoring system.

Where selective switching is used for ATS/ATC operations, the control interface should provide clear situational awareness (e.g., a facsimile diagram or touch-screen

route display) and support both manual segment selection and pre-programmed route selection, as applicable:

a) the use of an individual control switch/button for each segment. The control switches should be located on a facsimile diagram on the airport control panel so that ATC staff can visualize the route that has been selected. This may also be accomplished with the use of a touch-sensitive screen, which presents a diagram of the airport routing system.
b) interconnecting the controls so that actuating a single switch on the control panel will cause all segments of a designated route to be lighted; and
c) using a computer programmed to automatically select and light the optimum route after the operator designates the runway exit to be used and the gate destination for the aircraft.

Appendix A. Inspector assessment checklist (prompt)

Use this checklist to support consistent assessment of interleaving and selective switching installations.

A. Documentation and design

- ☐ Current drawings provided (single line diagrams, circuit schedules, vault/bus configuration, interleaving pattern).
- ☐ Interleaving rationale supports intended operations (e.g., LVP/RVR < 550 m where applicable).
- ☐ Method maintains balanced/symmetrical pattern on loss of one circuit.
- ☐ Cable/transformer identification and labelling scheme defined.

B. Electrical vault arrangements

- ☐ Interleaved circuits supplied from separate CCRs and (where practicable) separate buses.
- ☐ Spare CCR/module availability and changeover procedure documented and practicable.
- ☐ Protection and switching arrangements support safe maintenance.

C. Field installation

- ☐ Circuit identification matches drawings at terminations and transformers.
- ☐ Interleaving pattern implemented as designed (spot check sample segments).
- ☐ Stop bar circuits independent and interleaved; lead-on logic consistent with SMGCS.
- ☐ RGL/RETIL supplied as per guidance (separate circuits; flashing pattern preserved; misleading indications mitigated).

D. Testing and commissioning

- ☐ Commissioning tests completed and recorded (continuity, insulation resistance, functional tests, CCR settings).
- ☐ Failure-mode checks performed (simulate circuit loss and confirm acceptable pattern).
- ☐ As-built documentation and maintenance instructions handed over.