*International Civil Aviation Organization*

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*Langkawi, Malaysia, 18 - 21 February 2025*

**Agenda Item 4: Planning, Design and Construction of Aerodromes**

# REVIEW ON OPTIONS OF STANDARDIZING THE APPROACH LIGHTING CIRCUIT DESIGN AGAINST THE SWITCH OVER TIME REQUIREMENTS TO ENSURE THE OPERATIONAL REQUIREMENTS ARE MET WITH RESPECT TO PRECISION APPROACH CAT II/III OPERATIONS

(Presented by India)

**SUMMARY**

This paper presents the study on the existing approach interleaving circuit design against the switch over-time requirements in different categories of operations. The switch-over time requirements of one second and 15 seconds will be discussed against the recommended circuit layout with reference to Aerodrome Design Manual (ADM), Part 5 requirements.

The paper proposes options for review of the switching-over time requirements of the approach lighting system during such scenarios where the operations are needed to operate in the precision approach CAT II/III without any ambiguity.

## 1. INTRODUCTION

1.1 **Switch-over time:** The time required for the actual intensity of a light measured in a given direction to fall from 50 per cent and recover to 50 per cent during a power supply changeover, when the light is being operated at intensities of 25 per cent or above.

Annex 14, Volume I, Table 8-1 provides the required guidance on the switch-over time requirements in different categories of operations in different conditions. For example, the switch-over time requirement for runway end lighting in precision approach category I is 15 seconds and for precision approach Category II and III the switch-over time of runway end lighting is one second.

| | | |
|---|---|---|
| Precision approach category I | Approach lighting system | 15 seconds |
| | Runway edge[d] | 15 seconds |
| | Visual approach slope indicators[a, d] | 15 seconds |
| | Runway threshold[d] | 15 seconds |
| | Runway end | 15 seconds |
| | Essential taxiway[a] | 15 seconds |
| | Obstacle[a] | 15 seconds |
| Precision approach category II/III | Inner 300 m of the approach lighting system | 1 second |
| | Other parts of the approach lighting system | 15 seconds |
| | Obstacle[a] | 15 seconds |
| | Runway edge | 15 seconds |
| | Runway threshold | 1 second |
| | Runway end | 1 second |
| | Runway centre line | 1 second |
| | Runway touchdown zone | 1 second |
| | All stop bars | 1 second |
| | Essential taxiway | 15 seconds |

Fig 1. Extract from table 8-1 from ICAO Annex 14 (SARPS)

1.2 As per ICAO Annex 14 SARPS - 8.2 System design, the clause 8.2.1 states that for runways meant for use in runway visual range conditions less than 550 m, in relation to the requirements of Table 8-1, the power supply, lighting and control of the lighting system shall be designed that the equipment failure will not leave the pilot with inadequate visual guidance or misleading information.

## 2. DISCUSSION

**Interleaving circuit design**

2.1 The interleaving of the system is done to protect the pattern of the system in case of one circuit failure of a specific circuit. For example, in the runway and the approach lighting system, interleaving design includes two circuits. Each circuit in an interleaved system should extend throughout the whole of the service (e.g. runway length) and be so arranged that a balanced symmetrical lighting pattern remains in the event of failure of one or more of the circuits.

2.2 From the above referred switch-over time requirement Table 8-1, the approach lighting system switch-over time requirements for precision approach category I is 15 seconds which are usually attained through diesel generator.

2.3 While, for the precision approach category II/III for the inner 300 m of the approach lighting system is one second which is usually achieved through uninterruptible power supply (UPS) units. For the other part of the approach lighting which is basically from 300-900 m shall be provided with switch over time requirement of 15 seconds.

2.4 The concern over here is ADM Part 5 has provided the required fixture layout and circuit interleaving option for the both the approach lighting (for sake of understanding we call this as main approach lighting system) and side row barrette approach lighting system for the precision approach category II/III. The inner 300 m here refers to all the lighting which includes side row barrette approach lighting/ side row barrettes and the part of the main approach lighting system from distance 0-300 m which includes 300 m cross bar. In general, the main approach lighting is connected with two circuits and side row barrette approach lighting in two circuits as part of interleaving provision as shown in Fig 2 & Fig 3.

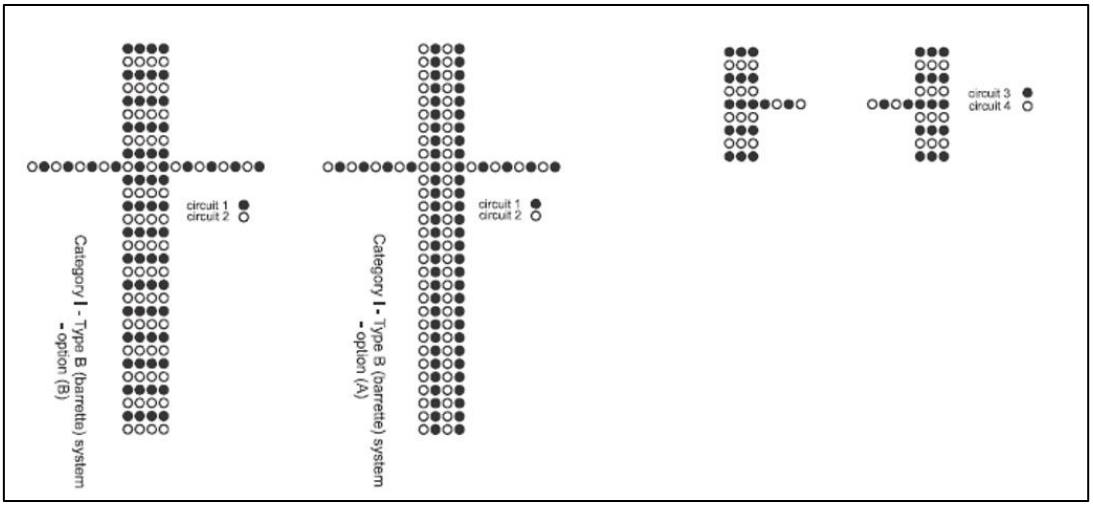


*Fig 2. Typical Barrette Approach Lighting System – CAT I*

*Fig 3. Side Row Barrette Approach Lighting System (CAT II/III)*

2.5 While the main approach lighting system is also the part from 0-300 m and this circuit is also connected to 300- 900 m, the same switch-over time can only be maintained be it one second or 15 seconds. Hence, practically meeting the requirement of one second for 0-300 m and 15 secs from 300-900 m differently for the main approach lighting system is not possible. This is because the circuit stretches from the first barrette to the 900 m section with interleaving as shown in Fig 4.

2.6 For ease of explanation, barretter approach lighting system is taken as an example, while the same would be applicable for distance coded approach lighting system also.

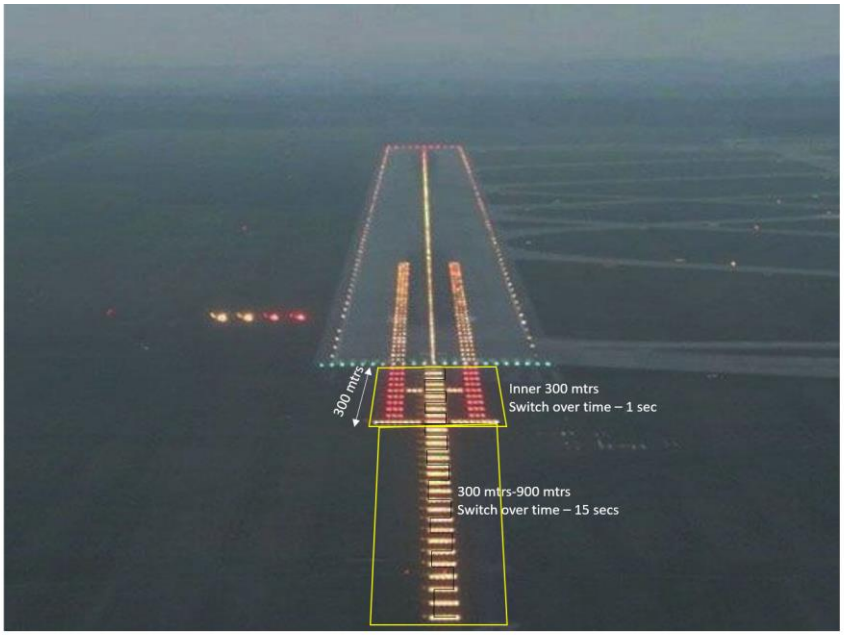


*Fig 4. Switch over time requirements as per table 8-1*

While in order to meet the complaince exactly as per Table 8-1, the below circuit deisgn to be adopted.

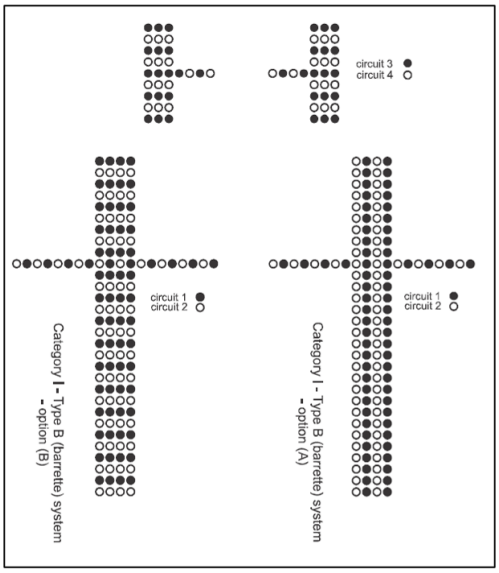


*Fig 5. Barrette approach lighting system options*

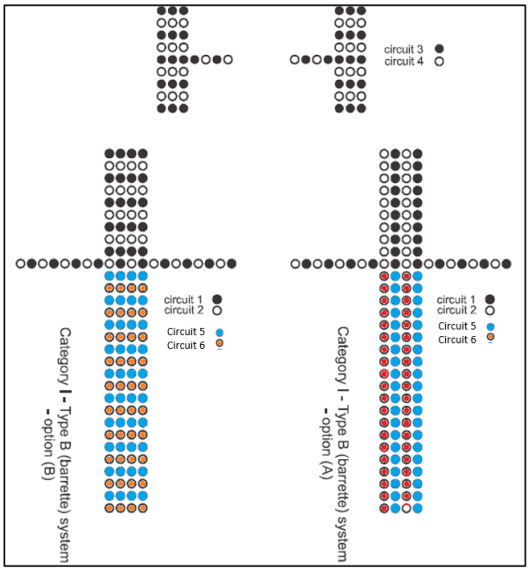


*Fig 6: Proposed interleaving circuit to meet the present Table 8-1 requirements.*

2.7 Based on the above discussion, the following options are provided to ensure that the required switch-over times are reviewed for better clarity on design considerations and execution. However, with this proposal, we have some few concerns such as a no standardized design, specific AGL system circuits are never divided into two portions which is quite unconventional, in case of circuit faults the intensities could be different effecting the overall perception of the approach lighting system.

## 3. DISCUSSION ON POSSIBLE OPTIONS:

### 3.1 Option 1:

3.1.1 Provision of the "other parts of the approach lighting system" also with switch-over time of one second for precision approach CAT II/III approach lighting system.


*Fig 7. Option 1: Provision of one second switch over time for entire approach lighting system*

3.1.2 As in general, the airport usually operates in CAT I and CAT II/III conditions. With this option, even in CAT I conditions the switch-over time would be one second. Even in CAT II/III operations, the entire approach lighting system would be with one second switch over time, which is better in terms of safety of the operations.

| | | |
|---|---|---|
| Non-precision approach | Approach lighting system | 15 seconds |
| | Visual approach slope indicators[a, d] | 15 seconds |
| | Runway edge[d] | 15 seconds |
| | Runway threshold[d] | 15 seconds |
| | Runway end | 15 seconds |
| | Obstacle[a] | 15 seconds |
| Precision approach category I | Approach lighting system | 15 seconds |
| | Runway edge[d] | 15 seconds |
| | Visual approach slope indicators[a, d] | 15 seconds |
| | Runway threshold[d] | 15 seconds |
| | Runway end | 15 seconds |
| | Essential taxiway[a] | 15 seconds |
| | Obstacle[a] | 15 seconds |
| Precision approach category II/III | Inner 300 m of the approach lighting system | 1 second |
| | Other parts of the approach lighting system | ~~15 seconds~~ 1 second |
| | Obstacle[a] | 15 seconds |
| | Runway edge | 15 seconds |
| | Runway threshold | 1 second |
| | Runway end | 1 second |
| | Runway centre line | 1 second |
| | Runway touchdown zone | 1 second |
| | All stop bars | 1 second |
| | Essential taxiway | 15 seconds |
| Runway meant for take-off in runway visual range conditions less than a value of 800 m | Runway edge | 15 seconds[c] |
| | Runway end | 1 second |

*Fig 8. Proposed changes of revising the switch over time to one second for the other part of the approach lighting system also.*

3.2 **Option 2: Additional circuit - 2 nos. for the central part of the approach lighting system within 0-300 m to comply with the existing regulations (refer Fig 9).**

3.2.1 In this option, to meet the existing regulatory standards, the main approach lighting system shall be in 4 circuits. In the 0-300 m section shall be with two circuits and from 300-900 m to be in two circuits. In addition to this the side row barrette lighting shall be in two circuits. Hence 6 circuits shall be required to meet this compliance.


*Fig 9. Required circuit design with inner 300 m switch-over time one second, side row barrette lighting (**2 circuits**) & inner main approach lighting system (**2 circuits**) and approach lighting system after 300 m (**2 circuits**) as per present standards referring to Table 8-1.*

3.2.2 Although in this section, we are saving on the UPS capacity enhancement cost (with LED fixtures, the UPS enhancement required would be further less), due to exclusion of 300 - 900 m of approach lighting system for the other parts of approach lighting system form (300 - 900 m), the additional CCR's requirement and additional two circuits to be considered. Refer the below table for additional information. Also, the requirement of airfield lighting control and monitoring system would be additional which is not economic.

3.2.3 Also technically, one risk with this option is that, during earth faults, chances exist that the intensity variation of the inner portion of approach lighting system and outer part of approach lighting system could be different creating an intensity difference which impacts the balance and integrity of elements. The balance and integrity of elements is very much required as part of ADM Part 4 – Visual aids requirements.

| **Reference** | **Option 1 (for each direction) VS** | **Option 2** |
|---|---|---|
| | | |
| **Equipment** | Requires additional UPS capacity of 10 KW- 2 no. per landing direction | Requires 2 CCRs per direction in addition |
| **Cost of additional equipment** | Appx. 25,000.00 USD [UPS additional capacity] | 30,000 USD [2 nos. of additional CCR's] |
| **Feeder cable cost** | Nil | 28000 USD (considering 2 km feeder cable length) for each direction |
| **ALCMS inclusion cost** | No additional cost required | 12,000 USD |
| **TOTAL Capital cost** | 25000 USD | 70,000.00 USD |
| | | Note: In case of new project, for Option 3, less rating of CCR's can be considered for the inner 300mtrs of approach centreline lighting |
| **Maintenance** | No additional maintenance | 2 New Circuit maintenance<br>Additional CCR and associated ALCMS hardware/ software Maintenance |

## 4. ACTION BY THE MEETING

4.1 The meeting is invited to:

a) note the information contained in this paper; and

b) discuss and review the two options by the group and based on the same, agreed proposal to be submitted for further review.

—END—