International Civil Aviation Organization

A42-WP/445[1]
TE/179
29/7/25

WORKING PAPER

ASSEMBLY — 42ND SESSION

TECHNICAL COMMISSION

Agenda Item 24: Aviation Safety and Air Navigation Priority Initiatives

ASSESSMENT OF VISIBILITY, ACCORDING TO PROCEDURES, OF APPROACH LIGHTING SYSTEM AT DECISION HEIGHT FOR DIFFERENT ILS APPROACH CATEGORIES AND GEOMETRIES

(Presented by Argentina and supported by Belize, Bolivia (Plurinational State of), Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Jamaica, Mexico, Nicaragua, Peru and Uruguay)

EXECUTIVE SUMMARY

This paper attempts to assess what portion of the approach lighting system is actually visible to the pilot on reaching decision height, considering variables such as glide path, aircraft attitude and instrument landing system (ILS) category, in order to determine whether there is excess lighting infrastructure that goes unused and advance a system optimization proposal to: enhance approach lighting system efficiency and design; ensure that installed infrastructure effectively contributes to pilots' decision-making; and optimize signage for adverse weather conditions.

Action: The Assembly is invited to:
a) note this working paper;
b) request that ICAO, through its Aerodrome Design and Operation Panel (ADOP) and other related expert groups, develop harmonized criteria and applicability conditions for the proposal presented herein, including technical guidelines on dimensions and resulting geometrical features; and
c) consider these guidelines in the development of future regulations for aerodrome design and operation and aircraft operation, recognizing that the pilot's view of the approach lighting system differs.

Strategic Goals:	This working paper relates to *Every Flight is Safe and Secure* and *The Economic Development of Air Transport Assures the Delivery of Economic Prosperity and Societal Well-Being for All.*
Financial implications:	No direct financial implications are expected to result for ICAO from this working paper. *For airports*: • Potential reduction in the costs of installing and maintaining approach lighting systems. • Energy consumption and operational resource savings. Possible positive impact on airport charges, resulting in lower costs for airlines and users.
References:	Annex 14 — *Aerodromes*, Volume I, *Aerodrome Design and Operations* FAA – Order JO 6850.2C EASA – (EU) Regulation Nbr. 139/2014.

[1] Spanish version provided by Argentina.

1. INTRODUCTION

1.1 The need to optimize the use of airport infrastructure has become increasingly urgent in view of the physical limitations of many aerodromes and the economic, operational and environmental challenges faced by the sector. In this context, a critical review of traditional ways of dealing with approach lighting systems is especially relevant.

1.2 In instrument approach operations, the purpose of approach lighting systems is to provide reliable visual references to the pilot when reaching decision height (DH). These references are decisive in confirming the safe continuation of landing.

1.3 Lighting infrastructure facilities are typically designed to meet requirements set by international bodies, such as ICAO, the Federal Aviation Administration (FAA) and the European Union Aviation Safety Agency (EASA). There is room to question, however, whether all such infrastructure is visually effective when pilots must make their critical decision.

1.4 This working paper intends to ascertain the real need of lighting infrastructure facilities from a technical and geometrical approach, considering the glide slope (GS), the aircraft attitude and the field of view available from the cockpit. The purpose is to determine which part of the lighting system is within the pilot's actual visual range at the time of reaching decision height, depending on the ILS category of the approach.

2. ANALYSIS

2.1 A conceptual review of the design and application of the approach lighting system is proposed that takes into consideration, from a theoretical point of view and according to operational procedures, what is actually visible to the pilot when reaching decision height, depending on the operational and geometrical parameters of the approach.

2.2 In particular, this paper aims to:

a) estimate the effective visual distance in each ILS category (CAT I, II, III);

b) identify significant differences between the length of the lighting facilities and the length that is actually useful in operational terms;

c) assess the impact of these differences on safety; and

d) propose technical criteria for the optimization, where appropriate, of the design and length of these systems.

2.3 In this context, following a geometrical and operational approach it is possible to assess the actual visibility of the approach lighting system at the moment that the aircraft reaches decision height and transitions from instrument flight to visual flight as per published procedures. The analysis considers different glide slope configurations, aircraft attitudes and ILS categories.

2.4 The results show a direct correlation between the angle of descent and the effective visual range:

2.4.1 In ILS CAT I (DH = 60 m), the observed visible distance (pilot's eye to aiming point) ranges from approximately 730 m to 1,160 m, depending on GS and pitch angle. In this scenario, assuming D = 450 m, the pilot would see between 286 m and 709 m of the approach lighting system when transitioning from instrument flight to visual flight.

2.4.2 In ILS CAT II/CAT IIIa (DH = 30 m), the observed visible distance (pilot's eye to aiming point) ranges from approximately 570 m to 350 m, depending on GS and pitch angle. In this scenario, assuming D = 450 m, the pilot would see at most 120 m of the approach lighting system when transitioning from instrument flight to visual flight.

2.4.3 In ILS CAT IIIb (DH = 15 m), the available visual distance is even more restricted, ranging from 160 m to 270 m. In this scenario, assuming D = 450 m, the pilot would not see the approach lighting system at all when transitioning from instrument flight to visual flight.

3. CONCLUSIONS

3.1 It is therefore confirmed that higher GS and aircraft attitude negatively affect horizontal visual distance. This effect means that part of the approach lighting system lies outside the effective field of vision at decision height.

3.2 From a technical viewpoint, this presents an opportunity to review and optimize the design and/or length of approach lighting systems for all three instrument operation categories, giving special attention to categories II and III in which segments of the lighting system could be identified that add no direct operational value and are irrelevant in terms of safety.

3.3 The foregoing is applicable, for CAT II and CAT III operations, to the installation of runway centreline lights, reinforcement of runway edge and centreline lights, and installation of runway touchdown zone lights to ensure a continuous visual reference during the visual stages of these landings.

3.4 Lastly, consideration should be given to the adoption of criteria based on actual visibility when assessing future lighting system installation, modification or upgrade projects and inclusion of this variable in cost-benefit and operational safety analyses.

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