International Civil Aviation Organization

Eighth Meeting of the Aerodromes Operations and Planning Sub-Group (AOP/SG/8)

Bangkok, Thailand, 15 to 19 July 2024

Agenda Item 4: Certification and Operations of Aerodromes

STRATEGIES FOR HAZARDOUS LIGHTS IN EVOLVING AIRPORT ENVIRONMENTS

(Presented by the Republic of Korea and Co-sponsored by Australia)

SUMMARY

This paper highlights the need for strategies to assess and manage hazardous lights in evolving airport environments to enhance aviation safety and sustainability. As airports transform into multifunctional complexes, addressing the safety risks posed by new lighting technologies becomes crucial. Comprehensive strategies can reduce the risks associated with high-intensity LED lights, digital displays, and renewable energy structures, ensuring safe flight operations. These efforts align with the DGCA59's theme "Shaping the future of Air transport: Sustainable, Resilient, and Inclusive".

1. INTRODUCTION

1.1 As airports evolve into multifunctional complexes incorporating logistics hubs, resorts, cultural tourism centers, and global trade and production bases, there is an increasing need to address the safety risks posed by new lighting technologies. High-intensity LED lights, digital displays, and renewable energy structures such as solar panels are becoming more prevalent around aerodromes, presenting new challenges for aviation safety. These changes necessitate the development of comprehensive strategies for the risk assessment and management of hazardous lights (e.g. non-aeronautical ground lights and glare from solar panels).

1.2 In alignment with the theme "Shaping the future of Air transport: Sustainable, Resilient, and Inclusive" it is crucial to ensure that the implementation of new lighting technologies does not compromise safety. Addressing these risks is vital for sustainable airport operations and aligns with the goal of reaching a global consensus on performance improvement initiatives that can effectively mitigate the environmental challenges and rapid technological evolution in aviation.

1.3 According to Annex 14 Standard 5.3.1.1, lights that may endanger the safety of aircraft must be extinguished, screened, or otherwise modified to eliminate the source of danger. Similarly, Annex 14 Recommendation 5.3.1.3 emphasizes that lights which may cause confusion should be modified to eliminate such risks. These standards highlight the importance of managing lighting hazards to ensure safe flight operations. Additionally, the rapid evolution in aviation technologies, such as the development of advanced aircraft systems and automation, necessitates updated strategies to manage these lighting hazards.

2. DISCUSSION

Flight Safety Hazard: The "Glare" Phenomenon

2.1 The presence of high-intensity direct, indirect, or reflected light can cause a phenomenon known as "glare." This can significantly impact flight safety by reducing a pilot's ability to recognize objects or by causing discomfort. The potential sources of glare include high-intensity LED lights, digital displays, and renewable energy structures such as solar panels, which are increasingly common in and around aerodromes. As airports continue to evolve into multifunctional complexes, managing these lighting hazards becomes increasingly critical to ensure both safety and sustainability, especially in light of new aviation technologies that demand more precise and clear visibility conditions.

Assessment Criteria for Sustainability and Safety

2.2 In the context of the theme "Shaping the future of Air transport: Sustainable, Resilient, and Inclusive" and addressing the safety risks posed by hazardous lights to flight safety in evolving airport environments, the Republic of Korea (ROK) has developed a comprehensive risk assessment methodology that utilizes three key criteria:

- **Disability Glare**: This criterion assesses the intensity of glare that can impair a pilot's vision, using a quantitative value of luminance (cd/m²). Disability glare is a phenomenon where light scattering inside the eye causes the image on the retina to be lost, significantly affecting visual performance.

- **Object Recognition**: This criterion evaluates the ability to distinguish an object from its background. It is assessed by the degree of change in object recognition according to the disability glare index.

- **Identification Interference**: This criterion expresses the degree to which glare interferes with identifying the target object under reduced object recognition conditions. It considers the luminance of the object and background, as well as the angle formed by the line connecting the light source and the eye.

Methodology Implementation

2.3 The risk assessment results will be categorized into three levels: Intolerable, Tolerable, and Acceptable, based on the safety risk matrix in line with the Safety Management Manual (Doc 9859). This categorization allows for a structured approach to managing and mitigating risks associated with hazardous lights, ensuring that performance improvement initiatives are in line with sustainability goals.

Validation and Expert Committee

2.4 To ensure the reliability and accuracy of the risk assessment methodology, a committee of at least 10 experts will be established. These experts will validate the results of the risk assessments, ensuring that they are consistent with the latest technological advancements and operational practices. This committee will include representatives from various relevant fields, including aviation safety, lighting technology, and human factors.

Future Considerations

2.5 As aviation technology and infrastructure continue to evolve, it is essential to continuously update and refine the risk assessment methodologies. Future considerations should include advancements in lighting technology, changes in airport design, and emerging trends in aviation operations. Ongoing research and collaboration with international experts will be necessary to keep the guidelines relevant and effective, contributing to the overall objective of performance improvement driving sustainability.

Conclusion

2.6 The ROK calls upon Member States and industries to engage in collective efforts to address the emerging challenges posed by hazardous lights. The proliferation of high-intensity LED lights, digital displays, and renewable energy structures such as solar panels near aerodromes necessitates robust strategies for assessing and mitigating the associated risks.

2.7 In conclusion, this collaborative effort will not only enhance aviation safety but also support the sustainable growth of the global aviation industry. By proactively addressing these lighting hazards, we can safeguard flight operations, protect passengers and crew, and maintain the integrity of our air navigation systems. The ROK stands ready to work with ICAO and its Member States to achieve these goals and to contribute to the ongoing evolution of global aviation safety standards.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information contained in this paper;

b) advise Member States to share best practices for the assessment and management of hazardous lights to enhance global aviation safety;

c) to collaborate with ICAO, Member States, and Industries to develop Asia-Pacific regional guidance that address the emerging challenges around aerodromes; and

d) discuss any relevant matters as appropriate.

— — — — — — —

APPENDIX : A RISK ASSESSMENT METHODOLOGY - The Republic of Korea

1. The risk assessment should comprehensively review and determine disability glare, object recognition, and identification interference.

2. Disability glare is evaluated as a quantitative value of luminance (cd/m²), which is the phenomenon of light scattering inside the eye and causing the image on the retina to be lost. The following formula can be applied to evaluate it:

$$L_{vl} = K\sum_{i=1}^{n}\left(\frac{E_{glarc}}{\theta_i^2}\right) \quad \left(where, E_{glarc} = \frac{I_{glarc}}{d^2}\cos\theta\right)$$

- L_{vl} *: Disability glare index (cd/㎡)*
- I_{glare} / E_{glare} *: Intensity / Illuminance of the i-th light source*
- *K : Pilot age Constant*
- *d : Distance from the light source*
- θ*: Angle formed by the line connecting the i-th light source and the eye*

3. Object recognition is the ability to distinguish an object from its background at night, evaluated by the degree of change in object recognition according to the disability glare index. The evaluation uses the following formula and background luminance:

$$C = \frac{|L_{objcct} - L_{back}|}{L_{back} + L_{vl}}$$

- *C: Object recognition*
- L_{object} : *Luminance of the aeronautical light*
- L_{back} *: Luminance of background*
- L_{vl} *: Disability glare index (cd/㎡)*

3-1. How to apply background luminance

(1) If there is a direct impact on the flight path of an aircraft or the controller of the control tower, the light intensity of the evaluation target shall be applied as it is.

(2) If paved with Ascon, etc., apply 60% of the light intensity of the evaluation target. However, if there is a measured value, it shall be prioritized.

(3) In the case of unpaved soil or gravel, apply 40% of the light intensity of the evaluation target. However, if a measured value is available, it shall be prioritized.

(4) In the case of grass or similar, apply 30% of the light intensity of the evaluation target. However, if there is a measured value, it shall be prioritized.

(5) For objects that cause reflections, use the measured luminance.

4. Identification interference expresses the degree to which glare interferes with identifying the target object under reduced object recognition conditions. The formula is:

$$D = \frac{L_{vl}}{L_{objcct}} \quad (where, L_{vl} = K\sum_{i=1}^{n}(\frac{E_{glarc}}{\theta_i^n}))$$

- *D : Identification interference*
- L_{object} : *Luminance of the aeronautical light*
- L_{back} *: Luminance of background*
- L_{vl} *: Disability glare index (cd/㎡)*
- θ *: Angle formed by the line connecting the i-th light source and the eye*

5. The relationship with other lights, except aeronautical lights, is not considered. When multiple lights are evaluated, each is reviewed individually, and the results are compiled to estimate the affected range.

6. The risk assessment is confirmed by dividing object recognition and identification interference according to the following matrix:

< **Object recognition** >

Time(s) / *Object recognition* (%)	15 or more	11 or more ~ less than 15	7 or more ~ less than 11	3 or more ~ less than 7	less than 3
60 or more	Intolerable	Intolerable	Intolerable	Intolerable	Intolerable
50 or more ~ less than 60	Intolerable	Intolerable	Intolerable	Tolerable	Tolerable
40 or more ~ less than 50	Intolerable	Tolerable	Tolerable	Tolerable	Acceptable
30 or more ~ less than 40	Tolerable	Tolerable	Acceptable	Acceptable	Acceptable
less than 30	Tolerable	Acceptable	Acceptable	Acceptable	Acceptable

< **Identification interference** >

Time(s) / *Identification interference*	15 or more	11 or more ~ less than 15	7 or more ~ less than 11	3 or more ~ less than 7	less than 3
2 or more	Intolerable	Intolerable	Intolerable	Intolerable	Intolerable
1.5 or more ~ less than 2	Intolerable	Intolerable	Intolerable	Tolerable	Tolerable
1.0 or more ~ less than 1.5	Intolerable	Tolerable	Tolerable	Tolerable	Acceptable
0.7 or more ~ less than 1.0	Tolerable	Tolerable	Acceptable	Acceptable	Acceptable
less than 0.7	Tolerable	Acceptable	Acceptable	Acceptable	Acceptable

< **Example of safety risk tolerability** - *Doc 9859* >

Safety Risk Description	*Recommended Action*
INTOLERABLE	Take immediate action to mitigate the risk or stop the activity. Perform priority safety risk mitigation to ensure additional or enhanced preventative controls are in place to bring down the safety risk index to tolerable.
TOLERABLE	Can be tolerated based on the safety risk mitigation. It may require management decision to accept the risk.
ACCEPTABLE	Acceptable as is. No further safety risk mitigation required.

APPENDIX : Part 139 (Aerodromes) Manual of Standards - Australia

9.143 Other lighting on the aerodrome

(1) This section applies only to lights that are not otherwise provided as visual aids to aircraft under the other provisions of this MOS.

(2) The following requirements must be complied with:

(a) an aerodrome operator must notify CASA in writing as soon as possible after becoming aware that a person is installing or proposing to install, or is using or is proposing to use, any installation, equipment or laser, outside the aerodrome boundary, that has or may have lighting or lighting intensity greater than that specified in Figure 9.144 (2);

(b) CASA must:

(i) consider whether the notification identifies a risk to the safety of aviation; and

(ii) if necessary, issue directions for action to mitigate the risk.

Note For directions, see regulation 94 of CAR, and regulation 11.245 of CASR.

(3) An aerodrome operator must immediately notify CASA in writing if the operator proposes to install or use any installation, equipment or laser, inside the aerodrome boundary, that has or may have lighting or lighting intensity greater than that specified in Figure 9.144 (2).

(4) An aerodrome operator must not proceed with the installation or use of any installation, equipment or laser mentioned in subsection (3) until CASA has assessed, and approved in writing, the proposed lighting intensity of the installation, equipment or laser.

(5) An aerodrome operator must immediately notify CASA in writing of any proposals to install or use any installation, equipment or laser within the aerodrome boundary which will have any of the following kinds of lighting:

(a) multiple light colours emitting from a single source;

(b) rapid changes in light colour;

(c) flashing lights.

Note Coloured lights, flashing lights or lasers may cause a hazard to aircraft operations irrespective of their intensity.

(6) An aerodrome operator must not proceed with any proposal mentioned in subsection (5) until CASA has assessed, and approved in writing, the lighting intensity proposed for the installation, equipment or laser.

(7) Subsections (3), (5) and (6) do not apply to the following:

(a) visual aids required for aircraft operations;

(b) signalling equipment;

(c) visual aids required for road safety.

(8) An aerodrome operator must immediately notify CASA in writing of any proposals for equipment or lighting installation within the aerodrome boundary which would reflect sunlight, including solar panels, mirrors or reflective building cladding.

(9) An aerodrome operator must not proceed with any proposal mentioned in subsection (8) unless CASA has determined, in writing, that it will not cause a hazard to aircraft operations.

(10) CASA may direct the aerodrome operator, in writing, that an installation, equipment, laser or reflective source within the aerodrome boundary must be modified, shielded, or extinguished to ensure aviation safety.

Note Certain lights might cause confusion, distraction or glare to pilots in the air. Ground lights may cause confusion or distraction by reason of their colour, position, pattern or intensity of light emission above the horizontal plane. Under regulation 94 of the CAR, CASA may issue notices about dangerous lights and it is an offence to fail to comply with any directions in a notice.

9.144 Lights — requirements for zones

(1) This section does not apply to the lights mentioned in paragraphs 9.143 (7) (a), (b) and (c).

(2) Lights installed at an aerodrome must comply with the zone requirements as shown in Figure 9.144 (2).

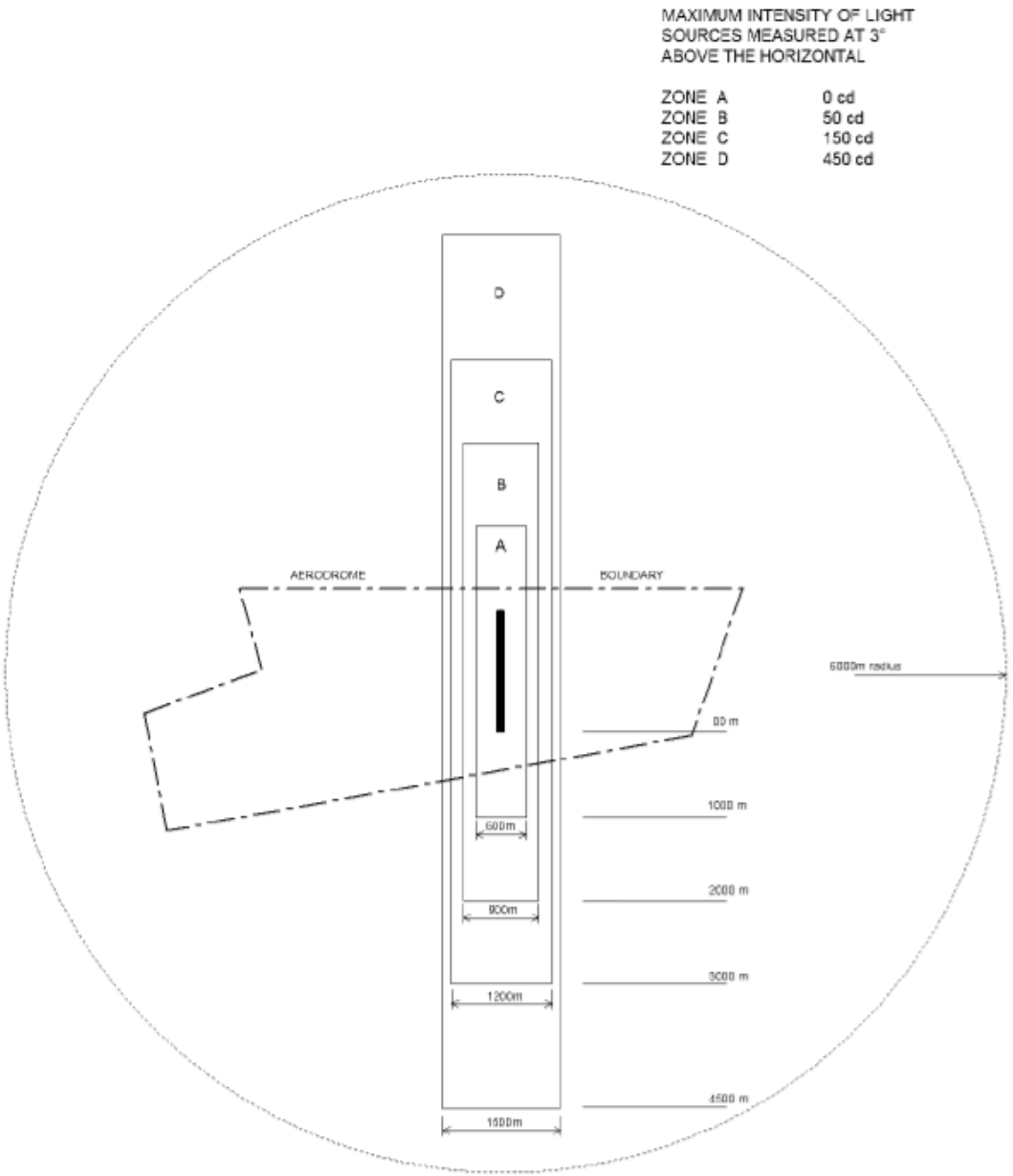

Figure 9.144 (2) Zone requirements for lighting (shows matters)

Note In many cases the polar diagrams published by manufacturers do not show sufficient detail in the sector near the horizontal and further information may need to be requested.

For installations where the light fitting does not meet the zone requirements, a screen may be used to limit light emission to zero above the horizontal.

—END—