International Civil Aviation Organization

Sixth Meeting of the Asia/Pacific Aerodrome Design and Operations Task Force (AP-ADO/TF/6)

Langkawi, Malaysia, 18 - 21 February 2025

Agenda Item 5: Asia/Pacific Regional Guidance on:

- **Risk Assessment for Lights with the Hazardous Effects**

PROVISION OF GUIDANCE MATERIAL FOR ASSESSING THE RISK ASSOCIATED WITH THE NON-AERONAUTICAL GROUND LIGHTS WITHIN THE AERODROME AND ADDRESSING THE SAME APPROPRIATELY

(Presented by India)

SUMMARY

The paper refers to the study on developing the guidance materials for assessing these non-aeronautical ground lights and discusses the aspects of different glare and the probable sources of the glare surrounding the airport. Also, guidance on risk assessment for lights with hazardous effects and measures which need to be taken to address the same will be discussed in detail. The relevant content which could help the airports in understanding the glare concepts and additional guidance on risk assessment is detailed out for review by the experts.

1. INTRODUCTION

1.1 Despite technological advancement, the safe operations of the aircraft rely on pilots ability to process the visual field at different instances with respect to the aircraft position. Any visual field unfolded if it is against expectation or interference could lead to erroneous decisions further contributing to an incident or accident. Pilots can encounter non-aeronautical lighting which could be hazardous and create an uncomfortable state and sometimes with greater exposure time can lead to severe discomfort impacting the specific phase of the operations.

1.2 In earlier days, when there were no mechanisms to direct the aeronautical ground light emissions in specific direction with the required coverage requirements, the lights which are nearby produced glare causing discomfort to the pilots. However, with the changes in the optical design and use of prisms, reflectors etc., the glare aspects have been almost reduced considering the brightness is maintained as per ambient conditions. However, along with the growth of the airports, the areas surrounding the airports have also attracted economic interests resulting in high rise structures, commercial buildings, roads and railways facilitating passenger needs. With these structures coming up, extraneous lighting has become a common phenomenon, in some cases, this can also be hazardous, which, if not attended could create disturbances to the visual field of the pilot. Some States have regulations on monitoring and mitigating these non-aeronautical ground lights.

2. DISCUSSION

2.1 Regulatory reference and standards from ICAO

From Annex 14:

5.3.1 General

Lights which may endanger the safety of aircraft

5.3.1.1 A non-aeronautical ground light near an aerodrome which might endanger the safety of aircraft shall be extinguished, screened or otherwise modified so as to eliminate the source of danger.

From ADM Part 4:

1.2.29 Visual acuity and sensitivity to glare vary from pilot to pilot and are partly determined by age, fatigue and adaptation to prevailing light levels. Moreover, a given pilot's abilities, reactions and responses will vary from day to day. Also, the visual guidance system must be able to accommodate variations in pilot proficiency.

Aircraft taxiing

14.2.2 The pilot mainly relies on apron floodlighting when taxiing on the apron. Uniform illuminance of the pavement within the aircraft stand and elimination of glare are major requirements. On taxiways adjacent to aircraft stands, a lower illuminance is desirable in order to provide a gradual transition to the higher illuminance on the aircraft stands.

2.2 Reference from other regulatory bodies:

2.2.1 CAP 738 Chapter 3: The safeguarding process (UK: Civil Aviation Authority)

Lighting

3.17 Lighting elements of developments have the potential to distract or confuse pilots, particularly in the immediate vicinity of an aerodrome.

3.18 Aerodrome operators, LPAs and developers should pay attention to the intensity and alignment of road lighting, which is a matter of concern over much more than the areas close to the ends of a runway. The intensity of lighting can cause confusion to pilots by creating glare when viewed from the air; a road lighting scheme may give an illusion similar to an approach or runway lighting pattern which may confuse pilots who use such visual cues when landing at night or in low visibility conditions.

3.19 Where floodlighting is proposed, the aerodrome operator should request that the lighting scheme provides full cut-off with no light spill above the horizontal.

3.20 Article 224 of the Air Navigation Order 2016 (as amended) is explicit regarding lights liable to endanger aircraft, including the directions to be taken to extinguish any such light deemed as endangering aircraft.

2.2.2 Annex VII to UK Regulations (EU) 2018/1139: Essential requirements for aerodromes > 3. AERODROME SURROUNDINGS

3.2. Hazards related to human activities and land use, such as, but not limited to, items on the following list, shall be monitored. The risk caused by them shall be assessed and mitigated as appropriate:

(a) any development or change in land use in the aerodrome area;

(b) the possibility of obstacle-induced turbulence;

(c) the use of hazardous, confusing and misleading lights;

(d) the dazzling caused by large and highly reflective surfaces;

(e) the creation of areas that might encourage wildlife activity in the surroundings of the aerodrome movement area; or

(f) sources of non-visible radiation or the presence of moving or fixed objects which may interfere with, or adversely affect, the performance of aeronautical communications, navigation and surveillance systems.

2.3 Based on the above guidance from regulations the guidance material which needs to be compiled shall:

- Assess the lights which endanger the safety of the aircraft.
- Consider the factors of pilot's age, fatigue and prevailing light levels in assessing the same.
- Take consideration of the design aspects of road lighting, especially this can be confused with approach lighting when installed near the approach areas during landing when designed wrongly.
- Take consideration of the design aspects of the Apron flood lighting with minimum glare possible.
- Dazzling caused by reflective surfaces, impacting the operations within and near the aerodrome.

2.4 The referred non-aeronautical ground light needs to be assessed, extinguished, and obscured as appropriate. The terms associated with the above factors are glare, flash blindness and after image effects etc. The below paragraphs explain these concepts in different phases in which these can turn into hazard for regular operations.

2.5 Several incidents and accidents are associated with visual disturbances, which when the eyes are adapted to low-light levels, exposure to bright light can result in temporary visual impairment due to glare, flash blindness, and afterimages, further limiting the pilot's response time. These accidents are recorded to have occurred in the majority in landing and departure phases and also during taxiing. Sometimes ground personnel and air traffic controllers can also be impacted due to this glare. Flash blindness and after image effects are the usual outcomes after affected by a glare and this could be probable cause of distraction to the pilot's visual field of the pilot impairing safety of the operations. The regulations also have laid enough stress on glare provisions and mitigation measures to ensure the glare is limited eventually improving the visual field processing by the pilot.

2.6 Glare is usually defined as a temporary sensation produced by luminance within the visual field that is significantly greater than that to which the eyes can readily respond to and is not associated with biological damage. It is a vision impairment produced by intense light, and it can occur

either directly or by reflection. It occurs whenever there is a high contrast between a light source and the object(s) a person is trying to focus on. *(Source: Glare as a Mechanism of the Motion of an Aircraft Through the MIRCE functionability Field).*

2.7 The common Sources of Glare:

- Staring directly into the source of sun/light.
- Reflected Glare produced due to reflection.
- Disability glare blocks vision or significant reduction in visual capabilities.
- Discomfort Glare is a sensation that humans are unable to tolerate and instinctively look away.
- In a few cases, the condition of the wind shield of the aircraft could also produce glare.

2.8 Although several other sources of glare such as intense sunlight, solar panels at nearby locations and within the airports etc., are contributing factors, the paper focusses on the non-aeronautical ground lights during the night times. Pilots normally in the night conditions adapt to the low light levels and when suddenly exposed to the bright light levels can result in temporary visual impairment, flash blindness and after images. This would be a critical concern for the pilots.

2.9 The probable non-aeronautical ground lights (direct or reflected source) near and within the aerodrome are the following:

2.9.1 Flashing/high intensity/strobe lights from nearby high-rise structures, stadiums, function halls and commercial buildings where bright lights are used which could produce glare.
2.9.2 Improper design and orientation of apron flood lighting created glare during manoeuvre of the aircraft.
2.9.3 Glare produced due to solar power panels installed near the aerodrome.
2.9.4 The possibility of mistakenly identifying a non – aeronautical ground light as an aeronautical ground light.
2.9.5 Lights form emergency vehicles within the Airport.
2.9.6 Perimeter lighting usually will be encountered by pilots during landing and take-off.

2.10 The above phenomenon is a common and obvious reason for causing distraction to the pilot thereby impacting the operations.

Source: landing at JFK airport (you tube)

3. ASSESSMENT OF NON-AERONAUTICAL GROUND LIGHT:

3.1 Based on the above discussion, the non-aeronautical ground lights can be producing glare or a distraction (produced due to a bright source of light) or perceiving of the non- aeronautical ground lighting system with aeronautical ground lighting system etc. Hence, the above aspects would be discussed and addressed going forward.

3.2 The significant feature of glare is its "Variability" factor. Glare is not constant and can vary based on human factors such as age, eye-pigment which has an impact on individuals tolerance to glare, specific eye conditions etc., , the point of observation, height, angle of observation, exposure time to glare, wind screen conditions, colour of the light and its ambient conditions, phase of the aircraft (such as landing, take -off, short final approach etc.,) etc. Based on above factors although the glare may be calculated, but, considering its variability in nature the tolerance factor is influenced by several other aspects which are specific in nature for an individual and the circumstances.

4. ACTION BY THE MEETING

4.1 The meeting is invited to:

a) note the information contained in this paper; and

b) Include the below content "23 Non - Aeronautical ground lights" in ATTACHMENT A. GUIDANCE MATERIAL SUPPLEMENTARY TO ANNEX 14, VOLUME I, as appropriate based on the review and recommendations proposed in this paper.

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5.3 Lights

5.3.1 General

Lights which may endanger the safety of aircraft.

5.3.1.1 A non-aeronautical ground light near an aerodrome which might endanger the safety of aircraft shall be extinguished, screened, or otherwise modified so as to eliminate the source of danger. Refer ATTACHMENT A - Section 23 for guidance on the same.

23 Non – Aeronautical ground lights

23.1 The non-aeronautical ground lighting refers to the source of the light which is not part of the Aeronautical ground lighting system and causing discomfort due to glare, flash blindness, misleading or confusing patterns to the pilot during landing, take off and manoeuvring. Such sources of light generally include road lighting inside the airside as well as city road lights, hoardings, high rise structure lighting, Strobe lighting and apron flood lighting.

23.2 Road lighting installed in the approach phases could be disrupting the visual field of pilot during the course of the approach. In some cases, road lighting may cause misleading patterns which could be perceived as approach lighting or other runway lighting systems. These lights shall be positioned to not

focus aiming towards the aircraft causing glare or the flash blindness. Flash-blindness is a visual effect that would be perceived by the eye even after the source is removed. Figure A-10 refers to the possible recommended position and aiming angles of the lights of the airside perimeter and the outside road lighting, especially in the approach zone, which shall suffice the required illumination levels on the roads and at the same time ensure the lights are also not disturbing the visual field. If the same is not feasible, the lighting aiming angles shall be tilted so to ensure that the glare caused due to the aiming angle is minimized to the possible extent. Special care to be taken to keep the upward light ratio as minimum possible to ensure the lighting is not spilled over above the horizontal. This also applies to the apron flood lighting design to ensure minimum light spillage over above the horizontal which further may contribute to the glare and other factors.

Note: Upward Light Ratio (ULR) is the proportion of light from a system (direct and reflected) that is emitted above the horizontal axis

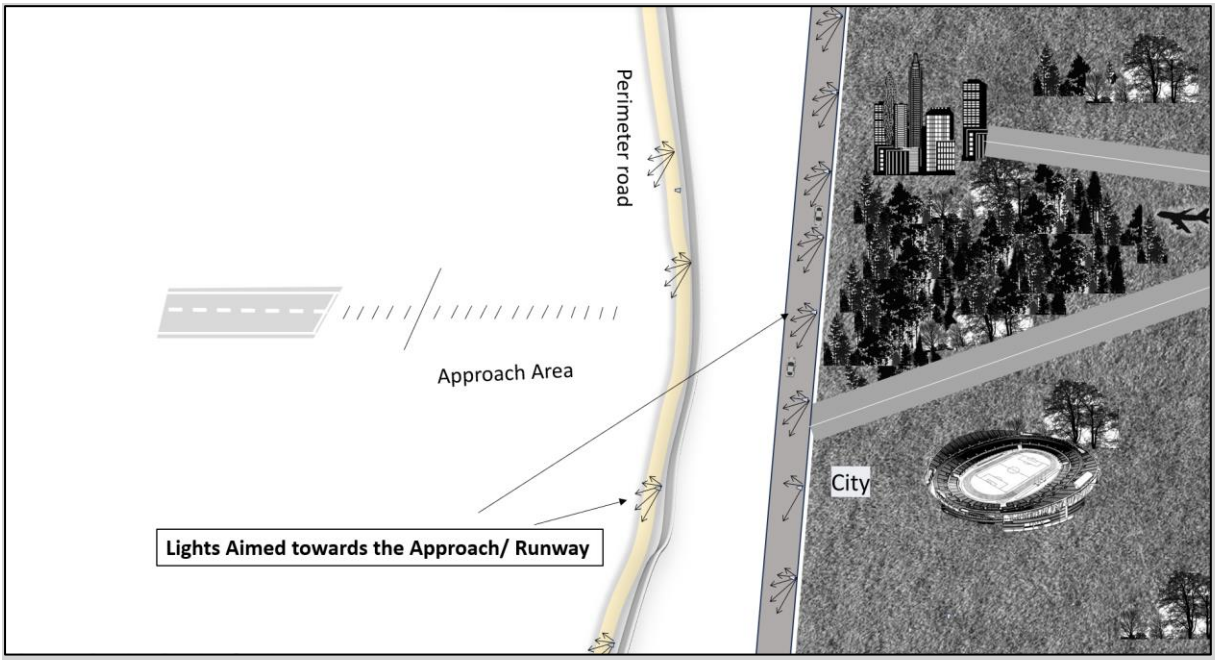

Figure A-10 Aiming angle of the road light fixtures in approach area

23.3 The aiming angle of the perimeter and city road lighting shall be faced away from the landing aircraft. This will eliminate the risk of glare and other sorts of distortion especially during landing. While, when aimed, it is also necessary to take care not to disturb the take-off aircraft also. As per the study, aviation incidents pertaining to visual aids predominantly occurs in the approach zone. Airports shall consider all the factors which disturb the visual field of the pilot.

23.4 The lighting from the high-rise structures and facilities like stadiums, function halls etc., located near or surrounding the airport shall be regulated to ensure flashy lighting, strobe lighting, and lights intercepting the aircraft are avoided. Constructions surrounding the airport shall be guided to reduce the lighting elevation angle to the extent possible. The pattern of the lights shall not resemble the runway lighting over the high-rise structures and other constructions. Airports shall prepare local procedures which will enable them to establish the process of identification of such sources of non-aeronautical ground lights. Obstruction lighting shall be installed to denote the obstacles as guided in Chapter 6 of ICAO Annex 14 Volume I – visual aids for denoting obstacles. Periodic survey to be conducted by airports for any such deviations and to be aligned to the requirement. Pilot inputs to be taken, during coordination meetings or any other forums periodically to understand any such lighting which is affecting the visual field and appropriate action to be carried out.

23.5 Apron flood lighting could be one of the sources of glare if not designed properly. Enough care should be taken to ensure the lights are designed to not cause any discomfort to the manoeuvring or the landing/take-off aircraft. Guidance on aiming the flood lighting is provided in Aerodrome Design Manual (Doc 9157), Part 4 - Chapter 11. During rain, chances are that a thin water film may form intermittently over the pavements, which could produce glare. Also, enough care is to be taken at the design stage to ensure that the flood lighting is not focused on the runway/ taxiway or Apron pavements. The glare effect sometimes on these surfaces obscures the markings. ULR also shall be taken care of during design for ensuring the proper aiming.

23.6 Apart from the above lights, the neon/ LED hoardings and even the sunlight reflecting from solar panels installed nearby can be a hazard to the aircraft especially on final approaches. To mitigate such hazards, State should formulate a procedure wherein the glare analysis should be conducted by a specialist agency before allowing installation of such lights, solar panels or hoardings close to airport especially on approach and take off path of the aircraft. In addition to the assessment of the glare to aircraft landing and taking off, the glare to ATC controllers may also be assessed.

23.7 Risk Assessment methodology

23.7.1 The risk assessment shall primarily determine the degree of hazardousness of the disability glare or misleading patterns leading to confusion. The factor to be determined by the Pilot in flight based on the impact of the glare and the same input shall be shared to ATC/ airport operator for the necessary action. The pilot is the observer and based on the viewing direction, the details are to be specified with the intention of getting the information on both the highest degree of glare and the angle of observation. In some cases, the characteristics of colour and pattern could turn hazardous.

Glare degree / Exposure time	Insignificant	Minor	Moderate	Major	Catastrophic
<15 Sec	Unnoticeable	Unnoticeable	Just admissible	Noticeable	Unbearable
15-30 Sec	Unnoticeable	Unnoticeable	Just admissible	Noticeable	Unbearable
30-60 Sec	Unnoticeable	Noticeable	Noticeable	Unbearable	Unbearable
>60 Sec	Noticeable	Noticeable	Unbearable	Unbearable	Unbearable

23.7.2 The other details which may be recorded could be the age, background illuminance and the aircraft location references, phase of the flight operation to ascertain the degree of glare.

23.7.3 Airport operators may take appropriate action to bring the conditions to an acceptable level and review the same at a definite frequency.

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