International Civil Aviation Organization

The Seventh Meeting of the Asia/Pacific Aerodrome Design and Operations Task Force (AP-ADO/TF/7)

(Bangkok, Thailand, 17 to 20 February 2026)

Agenda Item 5: Asia and Pacific Regional Guidance

INTERRELATIONSHIP BETWEEN ICAO ANNEX 10 VOLUME I, ICAO ANNEX 14 VOLUME I AND AERODROME DESIGN MANUAL (DOC 9157) PART 6 FOR VISUAL AND NON-VISUAL AIDS INSTALLATION ON RUNWAY AND TAXIWAY STRIPS AND RESA

(Presented by NEPAL (LEAD), FIJI, INDIA, NEW ZEALAND, AUSTRALIA)

SUMMARY

This paper presents proposal on Asia/Pacific regional guidance on installing visual and non-visual navigational aids on runway and taxiway strips and RESA. It reviews ICAO Annex 10, Annex 14, Annex 3, and Doc 9157 provisions, highlighting gaps in frangibility and siting requirements. A regional SWG is developing harmonized guidance and comparing State practices to reduce runway excursion risks.

1. INTRODUCTION

1.1 This paper is based on the WP/12 presented in the Sixth Meeting of the Asia/Pacific Aerodrome Design and Operations Task Force (AP-ADO/TF/6) held in Langkawi, Malaysia which was adopted under Task List 6/4 to develop a regional guidance material for interrelationship between ICAO Annex 10, Volume I; ICAO Annex 14, Volume I; and Aerodrome Design Manual (Doc 9157) Part 6 for visual and non-visual aids installation on runway and taxiway strips and RESA.

1.2 Visual and non-visual aids (e.g., approach lighting supports, meteorological equipment, radio navigational aids) are required for safe take-off and landing of aircraft. These navigational aids are often located near runways and taxiways and if inappropriately installed may present a significant hazard to aircraft in the event of aircraft undershooting, overshooting or veering-off from runway during landing, take-off or ground maneuvering of aircraft.

1.3 All such equipment and their supports shall be frangible and mounted as low as possible. However, due to various unknown reasons, several equipment and installations at some airports are found on the runway strip or RESA which may potentially cause significant damage to aircraft including sever injuries to passengers in the event of runway excursion and if such installations are mounted without meeting frangibility requirements.

1.4 A SWG including the experts from Nepal, Australia, India, Fiji and New Zealand is working to develop this guidance material. A couple of online meetings in coordination with ICAO Secretariate were held to discuss the relevant ICAO documents and manuals for the development of this guidance material. New Zealand shared their practices regarding the installation of navigational aids.

1.5 The online meeting of the SWG also discussed to study about the provisions of the frangibility and siting of the meteorological equipment in the operational area as mentioned in the ICAO Annex 3.

2. DISCUSSION

Provision for Frangibility and Siting of Objects in Operational Areas

2.1 The ICAO Annex 14, Volume I Aerodrome Design and Operations presents the SARPs for frangibility requirements in Chapter 3 paragraph 3.4.6 and 3.4.7. Similarly, the SARPs for siting of the equipment and installation are provided in the Chapter 9 paragraph 9.9.

2.2 The ICAO Annex 10, Volume I Radio Navigational Aids presents the specification regarding the radio navigational aids, however there are no specifications regarding the frangibility requirements to be complied while siting of the radio navigational aid in the operational areas in this Annex.

2.3 The ICAO Annex 3 Meteorological Service for International Air Navigation also does not contain any specification regarding the frangibility of meteorological equipment to be sited in the operational area.

2.4 A Table has been developed by the SWG regarding the provisions relevant to this guidance material as mentioned in Annex 14, Volume I; Annex 10, Volume I; Annex 3; and Aerodrome Design Manual (Doc 9157) in **Attachment A** to this WP.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information contained in this paper;

b) encourage States to share their national regulation/ guidance/ best practices regarding frangibility and siting of navigational aids in the operational areas; and

c) discuss any relevant matters as appropriate.

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	ICAO Annex 14, Volume I	
SN	**Description**	**Reference**
	Objects in the Runway Strip	
1.	*Note.— See 9.9 for information regarding siting of equipment and installations on runway strips.* *3.4.6 Recommendation.— An object situated on a runway strip which may endanger aeroplanes should be regarded as an obstacle and should, as far as practicable, be removed.* *Note 1.— Consideration will have to be given to the location and design of drains on a runway strip to prevent damage to an aeroplane accidentally running off a runway. Suitably designed drain covers may be required. For further guidance, see the Aerodrome Design Manual (Doc 9157), Part 1.* *Note 2.— Where open-air or covered storm water conveyances are installed, consideration will have to be given to ensure that their structure does not extend above the surrounding ground so as not to be considered an obstacle. See also Note 1 to 3.4.16.* *Note 3.— Particular attention needs to be given to the design and maintenance of an open-air storm water conveyance in order to prevent wildlife attraction, notably birds. If needed, it can be covered by a net. Procedures on wildlife management are specified in the PANS-Aerodromes (Doc 9981). Further guidance can be found in the Airport Services Manual (Doc 9137), Part 3.*	Chapter 3
2.	3.4.7 No fixed object, other than visual aids required for air navigation or those required for aircraft safety purposes and which must be sited on the runway strip, and satisfying the relevant frangibility requirement in Chapter 5, shall be permitted on any part of a runway strip of a precision approach runway delineated by the lower edges of the inner transitional surfaces. No mobile object shall be permitted on this part of the runway strip during the use of the runway for landing or take-off.	Chapter 3
	3.5 Runway end safety areas	
3.	*Objects on runway end safety areas* *Note.— See 9.9 for information regarding siting of equipment and installations on runway end safety areas.* *3.5.7 Recommendation.— An object situated on a runway end safety area which may endanger aeroplanes should be regarded as an obstacle and should, as far as practicable, be removed.*	Chapter 3
	9.9 Siting of equipment and installations on operational areas	
4.	9.9.1 Unless its function requires it to be there for air navigation or for aircraft safety purposes, no equipment or installation shall be: a) on a runway strip, a runway end safety area, a taxiway strip or within the distances specified in Table 3-1, column 11, if it would endanger an aircraft; or b) on a clearway if it would endanger an aircraft in the air.	Chapter 9

5.	9.9.2 Any equipment or installation required for air navigation or for aircraft safety purposes which must be located: a) on that portion of a runway strip within: 1) 75 m of the runway centre line where the code number is 3 or 4; or 2) 45 m of the runway centre line where the code number is 1 or 2; or b) on a runway end safety area, a taxiway strip or within the distances specified in Table 3-1; or c) on a clearway and which would endanger an aircraft in the air; shall be frangible and mounted as low as possible.	Chapter 9
6.	*9.9.3 Recommendation.— Any equipment or installation required for air navigation or for aircraft safety purposes which must be located on the non-graded portion of a runway strip should be regarded as an obstacle and should be frangible and mounted as low as possible.* *Note.— Guidance on the siting of navigation aids is contained in the Aerodrome Design Manual (Doc 9157), Part 6.*	Chapter 9
7.	9.9.4 Unless its function requires it to be there for air navigation or for aircraft safety purposes, no equipment or installation shall be located within 240 m from the end of the strip and within: a) 60 m of the extended centre line where the code number is 3 or 4; or b) 45 m of the extended centre line where the code number is 1 or 2; of a precision approach runway category I, II or III.	Chapter 9
8.	9.9.5 Any equipment or installation required for air navigation or for aircraft safety purposes which must be located on or near a strip of a precision approach runway category I, II or III and which: a) is situated within 240 m from the end of the strip and within: 1) 60 m of the extended runway centre line where the code number is 3 or 4; or 2) 45 m of the extended runway centre line where the code number is 1 or 2; or b) penetrates the inner approach surface, the inner transitional surface or the balked landing surface; shall be frangible and mounted as low as possible.	Chapter 9
9.	*9.9.6 Recommendation.— Any equipment or installation required for air navigation or for aircraft safety purposes which is an obstacle of operational significance in accordance with 4.2.4, 4.2.11, 4.2.20 or 4.2.27 should be frangible and mounted as low as possible.*	Chapter 9
	Attachment A	
10.	*11.3 Clearance of obstacles*	Attachment A

	11.3.4 Where an ILS localizer is installed within the light plane boundaries, it is recognized that the localizer, or screen if used, must extend above the light plane. In such cases the height of these structures should be held to a minimum and they should be located as far from the threshold as possible. In general the rule regarding permissible heights is 15 cm for each 30 m the structure is located from the threshold. As an example, if the localizer is located 300 m from the threshold, the screen will be permitted to extend above the plane of the approach lighting system by 10 × 15 = 150 cm maximum, but preferably should be kept as low as possible consistent with proper operation of the ILS.	
11.	*11.3.5 In locating an MLS azimuth antenna the guidance contained in Annex 10, Volume I, Attachment G, should be followed. This material, which also provides guidance on collocating an MLS azimuth antenna with an ILS localizer antenna, suggests that the MLS azimuth antenna may be sited within the light plane boundaries where it is not possible or practical to locate it beyond the outer end of the approach lighting for the opposite direction of approach. If the MLS azimuth antenna is located on the extended centre line of the runway, it should be as far as possible from the closest light position to the MLS azimuth antenna in the direction of the runway end. Furthermore, the MLS azimuth antenna phase centre should be at least 0.3 m above the light centre of the light position closest to the MLS azimuth antenna in the direction of the runway end. (This could be relaxed to 0.15 m if the site is otherwise free of significant multipath problems.) Compliance with this requirement, which is intended to ensure that the MLS signal quality is not affected by the approach lighting system, could result in the partial obstruction of the lighting system by the MLS azimuth antenna. To ensure that the resulting obstruction does not degrade visual guidance beyond an acceptable level, the MLS azimuth antenna should not be located closer to the runway end than 300 m and the preferred location is 25 m beyond the 300 m crossbar (this would place the antenna 5 m behind the light position 330 m from the runway end). Where an MLS azimuth antenna is so located, a central part of the 300 m crossbar of the approach lighting system would alone be partially obstructed. Nevertheless, it is important to ensure that the unobstructed lights of the crossbar remain serviceable all the time.*	

	Annex 10, Volume I	
SN	**Description**	**Reference**
1.	CHAPTER 3. SPECIFICATIONS FOR RADIO NAVIGATION AIDS Note.— Specifications concerning the siting and construction of equipment and installations on operational areas aimed at reducing the hazard to aircraft to a minimum are contained in Annex 14, Chapter 8.	Chapter 3
2.	3.11.5.2.6.1 Normally, the approach azimuth ground equipment antenna shall be located on the extension of the runway centre line beyond the stop end and shall be adjusted so that the vertical plane containing the zero degree course line will contain the MLS approach reference datum. Siting of the antenna shall be consistent with safe obstacle clearance SARPs in Annex 14.	
3.	3.11.5.3.6.1 The approach elevation ground equipment antenna shall be located beside the runway. Siting of the antennas shall be consistent with obstacle clearance Standards and Recommended Practices in Annex 14.	
4.	Attachment C 2.1.9.9 Typical examples of critical and sensitive areas. Figures C-3 and C-4 (including associated Tables C-1, C-2A and C-2B) show examples of critical and sensitive areas for the different categories of operations and for different classes of vehicle/aircraft heights and several localizer and glide path antenna types. The calculation of these examples has been done with a simulation model using an exact method of resolution of ILS propagation equations applied to a 3D model of corresponding aircraft. The dimensions are based on assumptions of flat terrain, 3.0° glide path, allocations of 60 per cent of applicable tolerances for static multipath and 80 per cent for dynamic multipath, an approaching aircraft at 105 knots, i.e. with a 2.1 rad/s low-pass filter and an omnidirectional receiving antenna pattern. The examples consider typical orientations of reflecting surfaces of taxiing, holding and manoeuvring aircraft/large ground vehicles. The tail heights for the ground vehicles/small aircraft, medium, large and very large aircraft categories correspond to Annex 14 aerodrome reference code letters A, B/C, D/E and F, respectively, as detailed within FAA Advisory Circular 150/5300-13. In case of uncertainty about which category an aircraft belongs to for the purposes of critical and sensitive areas assessment, the tail height is the determining feature.	
	2.4 Guidance for the siting, elevation, adjustment and coverage of glide path equipment 2.4.1 Lateral placement. The lateral placement of the glide path antenna system with respect to the runway centre line is normally not less than 120 m (400 ft). In deciding the lateral placement of the glide path antenna, account should be taken of the appropriate provisions of Annex 14 with regard to obstacle clearance surfaces and objects on strips for runways.	
	7.12 Airport siting considerations 7.12.1 The installation of a GBAS ground subsystem involves special considerations in choosing prospective sites for the reference receiver antennas and	

	the VDB antenna(s). In planning antenna siting, Annex 14 obstacle limitation requirements must be met.	
	4. Siting considerations 4.1 MLS/ILS collocation 4.1.1.2.5 After determining the acceptable range of elevation antenna locations based on the above criteria, the minimum elevation antenna offset is determined by the obstacle limitation requirements in Annex 14, Chapter 4.	
	4.1.1.3.3 After determining the acceptable range of elevation antenna locations based on the above criteria, this location may have to be bounded further to satisfy obstacle limitation requirements in Annex 14, particularly taxiway-to obstacle separation criteria.	
	4.1.2.2 Azimuth antenna sited ahead of localizer antenna 4.1.2.2.1 The azimuth antenna is to be symmetrically sited on the localizer course line at least 30 m (100 ft) ahead of the localizer antenna array. The limit for the maximum distance (variable "X" in Figure G-21) is determined by the requirement to satisfy the obstacle limitation requirements set forth in Annex 14 for both the azimuth antenna structure and azimuth monitor. This is the preferred location for the azimuth antenna. However, factors such as the presence of a localizer near field monitor may require the location of the azimuth antenna to be modified. The azimuth antenna cannot be sited such that it blocks line-of-sight between the localizer antenna and the localizer field monitor. Due to line-of-sight blockage of the ILS ground check point by the azimuth station, the ILS ground check points may have to be reassessed.	
	4.2.4 If the location of an MLS azimuth antenna on extended runway centre line 60 m (200 ft) beyond the far end of the approach lighting system is not possible or practical, it may be sited within the light plane boundaries given the following criteria: a) in the horizontal plane, the antenna is to be sited on extended runway centre line not closer than 300 m to the runway stop end and as far as possible from the nearest light position toward runway stop end. (This places the back of the azimuth equipment against a light position.) b) the siting of the azimuth station is to be such that the shadowing of the lights of the approach lighting system is minimized, particularly within decision height boundaries. The azimuth station should not shadow any light(s) other than that located in a centre part of a cross bar or a centre line barrette (see Annex 14, Volume I, Attachment A, section 11.3 for further guidance).	
Note	There is no reference regarding the Frangibility and Aerodrome Design Manual Part 6 in this annex.	

	Aerodrome Design Manual (Doc 9157), Part 6 (Frangibility)	
SN	**Description**	**Reference**
1.	**Chapter 2** **SITING CONSIDERATIONS** **2.1 SITING OF EQUIPMENT** 2.1.1 Guidance or specifications on the siting of navigational aids are contained in Annex 10 — Aeronautical Communications, Volume I — Radio Navigation Aids, and Annex 14 — Aerodromes, Volume I — Aerodrome Design and Operations, and Volume II — Heliports, and their related manuals. These should be taken into account when siting navigational aids. In general, equipment and security fencing should be sited as far away from the runway and taxiway centre lines as practicable.	
2.	ILS localizer 2.1.7 The preferred location for the localizer antenna array is on the extended runway centre line beyond the far end of the runway. This location permits the radiated on-course signal to overlie the runway centre line. The following factors govern site selection: a) coverage requirement; b) type of localizer array; c) obstacles or vertical reflecting surfaces within the desired localizer coverage volume; d) obstacle clearance and missed approach criteria; e) location of monitoring antenna; and f) technical siting considerations. ILS glide path antenna system	
3.	2.1.8 The lateral displacement of the ILS glide path antenna system should not be less than 120 m with respect to the runway centre line. The longitudinal location should be selected to place the ILS reference datum as close as possible to the recommended nominal value of 15 m above the threshold. In general, the following factors govern site selection: a) desired operating limits with respect to approach speeds and rates of descent of aeroplanes; b) the position of obstacles in the final approach area, the aerodrome sector and the missed approach areas, and the resulting obstacle clearance limits; c) runway length available; d) location of monitoring antenna; and e) technical siting considerations. Note.— For further guidance on siting discussed in 2.1.7 and 2.1.8, please refer to Annex 10, Volume I, Chapter 3 and Attachment C.	
4.	MLS approach azimuth equipment 2.1.9 The preferred location for the approach azimuth equipment antenna (analogous to the ILS localizer) is on the extended centre line beyond the stop end of the runway and on the extended centre line before the threshold for the back	

	azimuth equipment antenna, if provided. The following factors govern site selection: a) need for collocation with existing ILS localizer antenna array; b) obstacle clearance and missed approach criteria; c) multipath considerations; d) possible interference problem when the MLS has to be located in the approach lighting area; e) location of monitoring antenna; and f) technical siting considerations.	
5.	**MLS approach elevation equipment** 2.1.10 The approach elevation equipment antenna (analogous to the ILS glide path) should be located offset of the runway. The location is selected so that the asymptote of the minimum glide path crosses the threshold at the MLS approach reference datum. The following factors govern site selection: a) need for collocation with existing ILS glide path antenna; b) obstacle clearance and missed approach criteria; c) multipath considerations; d) location of monitoring antenna; and e) technical siting considerations. 2.1.11 In the case of ILS/MLS collocation, the MLS approach elevation equipment antenna should be positioned forward of the ILS glide path and outboard (further away from the runway centre line) or inboard (nearer to the runway centre line) of the ILS antenna.	
6.	2.2.6 Due to its heavy mass, the transmitter housing for ILS installations cannot be made frangible. Therefore, when planning for the installation of an ILS, the location of the transmitter housing for the localizer as well as for the glide path should be carefully considered. In no instance should the transmitter housing for the ILS localizer be located within the runway end safety area (or the extension thereof within a distance of 300 m from the runway end). Where practicable, the transmitter housing for the ILS glide path should be located outside the runway strip. In any event, the lateral displacement of the transmitter housing for the ILS glide path should not be less than 120 m with respect to the runway centre line.	
7.	2.2.7 MLS installations, including both the currently designed azimuth antenna and the elevation antenna are heavy equipment and cannot be made frangible. Therefore, these installations should be positioned so as to present the least hazard to aircraft. The MLS azimuth antenna should be located as far away as practicable from the runway end and, in any event, not closer than 300 m. Where practicable, the MLS elevation antenna should be located outside the runway strip.	
8.	2.2.8 Existing structures located within a distance of 300 m from the runway end not meeting the frangibility requirement, such as an existing non-frangible ILS localizer antenna array, should be replaced by a frangible structure or relocated beyond a distance of 300 m from the runway end. Similarly, structures located within the graded portion of the runway strip not meeting the frangibility	

	requirement, such as an existing non-frangible ILS glide path antenna, should be replaced by a frangible structure, if practicable, and relocated within the non-graded portion of the runway strip. In this context, it should be noted that, generally, the lateral displacement of the ILS glide path antenna system should not be less than 120 m with respect to the runway centre line (2.1.8 refers).	
9.	2.2.9 Due to its heavy mass, the housing for GBAS processing and transmitter units cannot be made frangible. Therefore, when planning for the installation of a GBAS ground subsystem, the location of the housing for the GBAS processing and transmitter units will need to be carefully considered.	
10.	**ILS/MLS/GBAS structures** 5.2.21 No full-scale testing has been undertaken so far to establish design criteria and testing procedures for frangibility of ILS/MLS/GBAS structures. Due to their location in the overrun/undershoot area, the ILS localizer and the MLS azimuth antenna constitute a greater hazard to aircraft operations than the ILS glide path antenna, the MLS elevation antenna, and the GBAS VDB and reference receiver antennas when located on the runway strip at a certain distance from the centre line (normally 120 m). The requirement for full-scale, high-speed testing using a rigid impactor was developed for lightweight tower structures with a minimal top mass but is impracticable to apply to different types of structures or to towers with a heavier top mass. Accordingly, an alternative to full-scale testing for evaluation of frangibility of such structures is required.	
11.	5.2.22 Notwithstanding the above, the design criteria associated with a 3 000-kg aeroplane should be retained for the ILS localizer and GBAS VDB and reference receiver antennas. As indicated in 4.9.31, current designs prove that light-weight structures for such installations can be applied. The possibility of using modular designs, thereby limiting the total mass, should also be considered. The validation of energy assumptions and development of values for mass limitation require special study.	
12.	5.2.23 It is not envisaged that full-scale tests of ILS/MLS/GBAS installations and their supports will take place in the future. Therefore, until computer models are further developed, verification procedures and acceptance criteria for such installations cannot be specified. As a result, it is recommended that in cases where frangible design of equipment is impracticable or jeopardizes the operational performance to stipulated requirements, the equipment should be relocated or otherwise positioned so as not to present a hazard to aircraft. Generally, where relocation is impracticable, installations should be made as lightweight as possible. In particular, consideration should be given to the possibility of arranging components in order to limit the number and/or mass of obstacles on those areas that must be maintained free of all but frangible equipment and installations required for air navigation.	

	ICAO Annex 3	
SN	**Description**	**Reference**
	APPENDIX 3. TECHNICAL SPECIFICATIONS RELATED TO METEOROLOGICAL OBSERVATIONS AND REPORTS (See Chapter 4 of this Annex.) *1.1 GENERAL PROVISIONS RELATED TO METEOROLOGICAL OBSERVATIONS Recommendation.— The meteorological instruments used at an aerodrome should be situated in such a way as to supply data which are representative of the area for which the measurements are required.* Note.— Specifications concerning the siting of equipment and installations on operational areas, aimed at reducing the hazard to aircraft to a minimum, are contained in Annex 14, Volume I, Chapter 9.	
Note	There is no reference to frangibility and Aerodrome Design Manual part 6 in this annex	

New Zealand Best Practices

9.10.2 Any equipment or installation required for air navigation or for aircraft safety purposes which must be located:

a) on that portion of a runway strip within:
1) 75 m of the runway centre line where the code number is 3 or 4; or
2) 45 m of the runway centre line where the code number is 1 or 2; or
b) on a runway end safety area, a taxiway strip or within the distances specified in Table 3-1; or
c) on a clearway and which would endanger an aircraft in the air;
shall be frangible and mounted as low as possible.

At NZWN, due to the geographical constraints of the airfield, the housing of the equipment required for the operation of the instrument landing system, has been sited below the level of the runway strip. In the instance of the glidepath antennae, this has been contained in an unground bunker (picture attached) and similarly for the localiser aerials where it is contained beneath the aerial array also (picture attached).

In addition, as commented upon during the online meeting, I have attached an extra photo of an instance where during an aircraft excursion from the runway, it came into contact with a hut used to contain equipment for the operation of a localizer which was not frangible.

Non frangible LLZ hut

NZWN – Heavy Sea Swell

WLZ – LLZ (Localizer) bunker

WLG - Glidepath Bunker

ZQN - EMAS