PHỤ LỤC

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PART II — AERODROME OPERATIONAL MANAGEMENT

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***6.19* Part II, Chapter 10 — Obstacle Evaluation and Control**
(Applicable as of 21 November 2030)

6.19.1 This chapter contains provisions pertaining to obstacle limitation surfaces and aeronautical study. It deals with topics on selection of required obstacle limitation surfaces, comprising obstacle free surfaces and obstacle evaluation surfaces, and how these surfaces can be adjusted to match the type of operations provided at an aerodrome. In addition, the chapter provides guidance on how to conduct aeronautical study.

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ACRONYMS AND ABBREVIATIONS

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ADG Aeroplane design group†

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AT-VASIS Abbreviated T visual approach slope indicator system†

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CNS Communications, navigation, and surveillance

OES Obstacle evaluation surface†

OFS Obstacle free surface†

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LNAV Lateral navigation†

MLS Microwave landing system

NPA Non- precision approach procedures

OCA/H Obstacle clearance altitude/height

RNP Required navigation performance†

SBAS Satellite-based augmentation system

SDF Step-down fixes†

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TOD Terrain obstacle datasets†

T-VASIS T visual approach slope indicator system†

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VNAV Vertical navigation†

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†Applicable as of 21 November 2030

Chapter 4

WORK IN PROGRESS (WIP)

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4.3 OPERATIONAL PRACTICE

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4.3.3 A safety risk assessment of all planned works should be completed beforehand in order to ensure the hazard to the safe operation of aircraft have been identified by the aerodrome operator in coordination with interested parties, and appropriate mitigation measures introduced to keep risks to an acceptable level. Risk mitigation actions include, inter alia, the use of visual aids to denote restricted use area.

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4.3.8 The following actions should be taken when establishing the worksite, as well as throughout the duration of works, when necessary:

a) a safety risk assessment should be conducted to determine the need for visual aids to indicate temporary changes to the movement area;

b) unserviceability markers are displayed when any portion of a taxiway, apron, or holding bay is unfit for the movement of aircraft, but it is still possible for aircraft to bypass the area safely;

c) existing markings leading into a worksite should be masked or the route closed;

Editorial Note.— Renumber subsequent paragraphs accordingly.

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Note 1.— Unserviceability relates to areas temporarily not available for operational use.

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Note 5.— Temporary changes to the movement area may include, inter alia, reduction in the runway length, reduction in the maximum allowable wingspan, taxiway closure or any other closure to the movement area. Certain visual aids such as closed runway lighting could be used for a temporary period varying from a few hours to several weeks or longer, depending on the works in progress or other closure reasons.

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Chapter 10

OBSTACLE EVALUATION AND CONTROL

(Applicable as of 21 November 2030)

10.1 GENERAL

10.1.1 The airspace around aerodromes is critical to the safety and regularity of operations. These areas are often congested with aircraft that are performing landing and take-off operations. It is critical that this area be maintained free from obstacles that could adversely impact the safety and accessibility of intended aircraft operations at aerodromes. To meet this purpose, sets of obstacle limitation surfaces (OLS) were established to be introduced at aerodromes to prevent the aerodromes from being unusable due to uncontrolled growth of obstacle around aerodrome.

10.1.2 A new obstacle or the extension of an existing obstacle can adversely affect the safety and regularity of aircraft operations; it may result in increased operating minima, changes in ANSP procedures, reduced capacity or operational restrictions on departures. It is therefore necessary to introduce OLS at and in the vicinity of aerodromes to effectively control the growth of obstacles and the possible turbulences that may be generated by these obstacles.

10.1.3 The existence of construction activities, buildings, structures, facilities, plantations, landfills or activities of any nature that interfere with the OLS may impose limitations on the effective utilization of an aerodrome or a portion of the airspace. It is therefore important for coordination to exist between civil aviation authorities and aerodrome operators in managing the OLS.

10.1.4 The OLS defines the limits to which objects may project into the airspace and imposes restrictions on any public or private property, making them an effective method in controlling land use in the vicinity of aerodromes.

10.1.5 The OLS comprises two sets of surfaces: obstacle free surfaces (OFS) and obstacle evaluation surfaces (OES). The OFS and OES have distinct purposes and are applied based on the type of runway, aeroplane design group (ADG) and the flight procedures available for that runway.

10.1.6 The objectives and operational practices described in this chapter are intended to provide the information needed to apply the surfaces defined in Annex 14 – *Aerodromes,* Volume I – *Aerodrome Design and Operations*.

The Surfaces

10.1.7 The OFS are surfaces that are applied within a defined airspace in the immediate vicinity of the aerodrome. The OFS are established to protect the existing and future operational capacity of the aerodrome by limiting obstacles. The OFS are intended to preserve accessibility of the aerodrome by containing standard operations (straight-in approaches) with a high level of probability. As such, they are to be kept free from obstacles except for existing obstacles and/or terrain which would have been assessed earlier.

10.1.8 The OES are surfaces that are applied in a defined airspace, in addition to the OFS, to be evaluated against obstacles. They are used in determining the acceptability of obstacles in ensuring safety and regularity of operations at the aerodrome. The penetration of the OES by terrain or obstacles are to be evaluated as they may adversely affect the safety or accessibility of the intended aircraft operations.

10.1.9 The dimensions of OFS and OES are determined based on aeroplane design group (ADG) categorization. The ADG utilizes two criteria, which are related to the aeroplane performance characteristics and dimensions. The first criterion is based on the aircraft’s indicated airspeed at threshold and the second criterion on the aeroplane wingspan.

10.1.10 In addition to existing operations, the OFS and OES selected for the aerodrome should safeguard future planned aircraft operations.

Aeronautical study

10.1.11 Objects penetrating the OFS and OES may adversely impact flight operations. The impact of these penetrations to safety and regularity of aircraft operations must be examined through the conduct of an aeronautical study.

10.1.12 An aeronautical study is a process of examining an aeronautical concern by assessing its impact on safety and regularity of aircraft operations and identifying, if need be, possible mitigation measures.

10.1.13 An aeronautical study may also be applied to examine the impact of obstacles at and in the vicinity of new airports or renovated and expanded airports at the master planning stage.

Note.— Further guidance on master planning can be found in the Airport Planning Manual, *Part I –* Master Planning *(Doc 9184).*

10.1.14 In addition to flight operations, the aeronautical study must consider and address other aeronautical concerns such as impact on communication facilities, navigational aids, aerodrome operations and air traffic control line of sight.

10.2 OBJECTIVES

10.2.1 States shall define the roles and responsibilities of stakeholder(s) and delegate them the appropriate authority in the identification of the OFS and required OES, the safeguarding of these surfaces, and the surveillance of the areas within these surfaces.

Note.— Stakeholder(s) include the aerodrome operator, local authority, ANSPs, land use agency, military organization or any agency the State deems appropriate.

10.2.2 States shall establish a process for the identification of OFS and OES required to protect flight operations at an aerodrome.

10.2.3 Through the process, States or the appropriate authority shall:

a) determine the OFS and OES applicable based on ADG category;

b) vary the OFS, when required, to account for changes in the approach angle to account for local conditions and aeroplane characteristics;

c) determine the OES required to protect the operations at the aerodrome;

d) vary the OES based on the operational requirements of the aerodrome;

e) ensure the safeguarding of the OFS and OES; and

f) identify obstacles and terrain data penetrating the OFS and OES.

Note.— The data collected are to be in accordance with terrain and obstacle datasets (TOD) provisions as stipulated in Annex 15 — Aeronautical Information Services *and the* Procedures for Air Navigation Services—Aeronautical Information Management *(PANS-AIM, Doc 10066).*

10.2.4 When instrument approaches are carried out on non-instrument runway(s), States or the appropriate authority shall review the dimensions of the approach and transitional OFS for such runway(s).

10.2.5 States shall establish a process for conducting aeronautical study.

10.2.6 States shall define the party/parties responsible for conducting the aeronautical study.

10.2.7 The process to be established by States shall include the following details:

a) identify stakeholders involved in the aeronautical study process;

b) define situations where an aeronautical study is required;

c) define the data required to produce a complete description of the aerodrome, obstacle and its environment;

d) describe the methodology for the conduct of the impact assessment;

e) identify appropriate mitigation measures to address any impact posed by an obstacle;

f) define the acceptance criteria taking into consideration all studies and assessments submitted prior to approving the proposed obstacle; and

g) define documentation and promulgation procedures of the aeronautical study.

Note.— An aeronautical study may be conducted anytime when, in the opinion of the State or appropriate authority, a proposed obstacle may adversely affect aircraft operations.

10.3 OPERATIONAL PRACTICES

10.3.1 Preventing the growth of obstacles

10.3.1.1 The primary responsibility to ensuring the aerodrome and its environment is and remains free from obstacles should be shared between the State and the aerodrome operator. The responsibilities and interactions among other additional stakeholders such as the aircraft operator, ANSP, local authority, etc. should be established and coordinated by the appropriate authority.

10.3.1.2 States are responsible for establishing a process for the selection of OLS required to protect the airspace against growth of obstacles and for evaluation of existing and potential obstacles and terrain. The process should include guidance on:

a) identifying the OLS needed to support the existing and/or planned operations at the aerodrome;

   Note. — For OLS selection, refer to 10.3.1.5.

b) establishing the mechanisms to protect the surfaces and empower the appropriate authority to deny objects that may impact the safety and regularity of operations; and

c) using OFS and OES for survey of the aerodrome and its surroundings and the collection of obstacle data.

10.3.1.3 The ADG consists of two criteria, indicated air speed at threshold and wingspan. In choosing the applicable ADG, the appropriate authority should consider the critical aeroplane operating at the aerodrome based on these two criteria (see Annex 14, Volume I, Chapter 1, 1.8.1 and 1.8.2).

Aeroplane design group	Indicated airspeed at threshold		Wingspan
I	Less than 169 km/h (91 kt)	and	Up to but not including 24 m
IIA	Less than 169 km/h (91 kt)	and	24 m up to but not including 36 m
IIB	169 km/h (91 kt) up to but not including 224 km/h (121 kt)	and	Up to but not including 36 m
IIC	224 km/h (121 kt) up to but not including 307 km/h (166 kt)	and	Up to but not including 36 m
III	Less than 307 km/h (166 kt)	and	36 m up to but not including 52 m
IV	Less than 307 km/h (166 kt)	and	52 m up to but not including 65 m
V	Less than 307 km/h (166 kt)	and	65 m up to but not including 80 m

10.3.1.4 In aerodromes with more than one runway, the appropriate authority can define different ADG for each runway and in areas where the surfaces overlap, the more stringent surface will apply.

Note.— Guidance on the application of ADG can be found in the Airport Services Manual, *Part 6 –* Control of Obstacles *(Doc 9137).*

10.3.1.5 The OLS to be adopted are dependent on:

a) the type of runway – precision, non-precision and non-instrument;

b) the ADG applicable for the runway; and

c) existing and/or planned flight operations at an aerodrome and the corresponding OES(s) needed to protect the flight procedures. When selecting OES, the appropriate authority can adopt the OES defined in Annex 14, Volume I, Chapter 4, or design OES specific to the procedures conducted at the aerodrome.

10.3.1.6 States may delegate the responsibility for the safeguarding and surveying of areas within these surfaces to other appropriate authority.

10.3.1.7 The protection of these surfaces can be enhanced by incorporating them into the zoning laws. In lieu of zoning laws, authority may also consider having the necessary coordination process with the land use agencies to ensure aviation requirements are factored into land use planning and airport master planning. The aviation requirements are not limited to OLS only but may include other requirements relating to disturbance to communications, navigation, and surveillance (CNS) facilities, glare or glint issues, wildlife management considerations and other potential hazards.

Note.— Further guidance can be found in the Airport Services Manual, *Part 6 –* Control of Obstacles *(Doc 9137).*

10.3.1.8 The surveying of aerodromes and their vicinity is key to ensuring safety of flight operations. The establishment of OFS and OES help in ensuring the obstacle database remains updated. Objects that penetrate these surfaces are to be assessed and their information captured in the database.

10.3.1.9 A process shall be established to share the obstacle data with AIS.

10.3.1.10 The data collected, specifically the geographical coordinates of obstacles in TOD Area 2 and Area 3, should be measured and reported in degrees, minutes, seconds and tenths of seconds. In addition, the top elevation, obstacle type, marking and lighting (if any) of obstacles should be reported.

Note.— The TOD requirements including specifications on data quality can be found in Annex 15 and PANS-AIM, (Doc 10066), Table A1-6.

10.3.2 Adapting OFS and OES to operational needs

Adjusting obstacle free surfaces

10.3.2.1 The OFS are designed based on the nominal approach angle of 3.0°. There are aerodromes where the approach angle can either be lower or higher.

10.3.2.2 The slope of the approach surface is intended to adapt to approach operations that have an approach angle of 3.0° or higher. The slope of the approach surface may be raised if approach procedures with an approach angle of more than 3.0° are implemented. However, the approach angle should not be increased to enable the growth of obstacles.

10.3.2.3 Where the approach angle is less than 3.0° the slope of the approach surface must be lowered to protect the operations.

10.3.2.4 In certain circumstances, due to alignment of visual slope indicator systems with instrument landings aids, the slope of the approach surface must be lowered, too, to align the surface with the requirements of the *Procedures for Air Navigation Services — Aircraft Operations* (Doc 8168).

Adjustments of the Approach OFS

10.3.2.5 The approach OFS has been designed based on the approach angle of 3.0° and runway type. Any changes to these parameters will require changes to the dimensions of the OFS.

10.3.2.6 Changes to the approach angle will affect the slope and length of the approach OFS. As the OFS for instrument runway is designed to reach a height of 150 m (500 ft) or up to the obstacle clearance altitude/height (OCA/H), an increase or decrease in the slope will change the length of the surface.

Note.— Further guidance on changing the slope of OFS is given in the Airport Services Manual, *Part 6* – Control of Obstacles *(Doc 9137).*

10.3.2.7 The slope of the approach OFS is associated with:

a) the visual segment surface (see PANS-OPS (Doc 8168), Volume II, Part I, Section 4, Chapter 5, paragraph 5.4.6.2) which protects the visual phase of an instrument approach procedures; and

b) the obstacle protection surface of a PAPI for both instrument and non-instrument approach procedures.

10.3.2.8 To calculate the slope when there are changes to the approach angle, the following steps should be taken:

a) for runways served with instrument approaches:

i) subtract the standard angular margin from the promulgated approach angle. The standard angular margin equals the difference between the standard approach angle of 3.0° and the standard approach surface's gradient of 3.33 per cent which is approximately 1.91 per cent (3.0° - 3.33 per cent);

Note.— Further guidance on the calculation of slope and their precalculated values is provided in Doc 9137, Part 6.

ii) identify the slope associated with the obstacle protection surface. e.g. The harmonization between a 3.0° ILS and the PAPI will result in the obstacle protection surface of the PAPI to be at 3.22 per cent to align with the signal of the ILS. (see Annex 14, Volume 1, Chapter 5, Figure 5-21 and Table 5-3). The slope of the approach surface shall be reduced accordingly; and

iii) the lower slope between the two calculated in (i) and (ii) will be adopted for the approach OFS;

b) for runways intended for visual approach operations only:

i) when T visual approach slope indicator system (T-VASIS), abbreviated T visual approach slope indicator system (AT-VASIS), PAPI and APAPI are provided, the obstacle protection surface will be used to determine the slope.

10.3.2.9 The length of the approach OFS is calculated to ensure the surface reaches a height of 150 m (500 ft.). e.g. For approach OFS slope of 4.1 per cent, the length is 500 ft/0.041 = 12 195 ft or 3.7 km. For instrument approaches, the length may need to be extended to reach the applicable OCA/H.

10.3.2.10 Where the final approach track is offset and intersects the extended runway centre line, the splay on the side closest to the final approach track should be increased by the offset angle. Where the final approach track is offset but does not intersect the extended runway centre line, the splay closest to the final approach track should be increased by an amount equal to the final approach course offset at 1 400 m from the runway threshold.

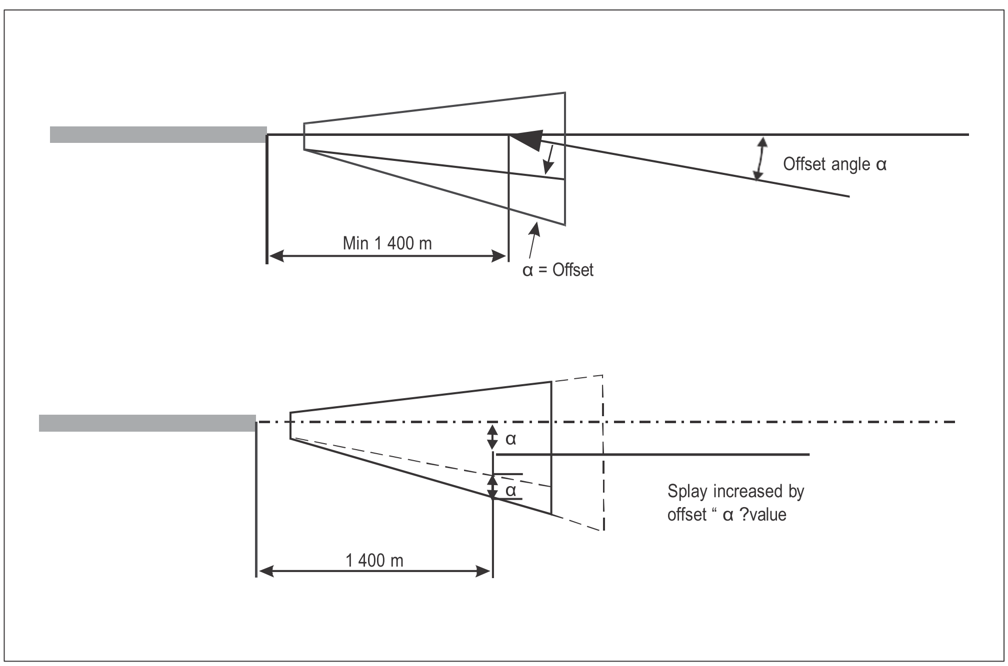

Figure 10-1. Plan view visual segment surface offset final approach with runway centre line crossing

Adjustment of the inner approach OFS

10.3.2.11 The inner approach OFS is part of the approach OFS. The surface will have the same slope as the approach OFS. Any adjustment to the slope of the approach OFS will bring about a corresponding change in the slope of the inner approach OFS. As the length of the inner approach extends to a height of 45 m, any variation to the slope will require adjustment to the length. The length of the inner approach can be calculated using the following formula:

Length of inner approach = 45 m/slope. For example, an aerodrome with inner approach slope of 3.33 per cent, the required length is: 45 m/0.0333=1 350 m.

Runway holding position and penetration of the approach OFS

10.3.2.12 The runway holding position can be established at the runway end or at the location prior to the landing threshold to reduce runway occupancy and increase runway capacity. This position is in accordance with the dimension stated in Table 3-2 of Annex 14 – *Aerodromes*, Volume 1 – *Aerodrome Design and Operations*. In any case, the following surfaces should not be penetrated:

a) inner approach, inner transitional and balked landing surfaces (OFS):

   the inner approach, inner transitional and balked landing surfaces establish airspace for the protection of aeroplanes during balked landings and late go-arounds against fixed and mobile objects and

b) obstacle clearance surface:

   the OCS are introduced in PANS-OPS (Doc 8168) to deal with penetrations of the visual segment surface (VSS). Obstacles shall not require the pilot to destabilize the approach to avoid them. For this purpose, no obstacle shall penetrate an obstacle clearance surface (OCS).

Adjusting obstacle evaluation surfaces

10.3.2.13 The OES selected by the State or the appropriate authority should reflect the type of operations conducted/planned at the aerodrome. In selecting the OES, the appropriate authority should consider both existing and planned operations.

10.3.2.14 The appropriate authority can either:

a) modify the OES to suit the existing and planned operational needs of the aerodrome;

b) design an OES specific to the flight procedures conducted at the aerodrome; or

c) declare an OES as an obstacle free surface.

Adjustment of the take-off climb surface

10.3.2.15 Aircraft during take-off may have different climb performances and therefore would be variably affected by an obstacle. At take-off, not all aircraft lift off the runway from the same point nor do they follow the same climb rates. Hence, an object may be an obstacle for an aircraft with low performances on take-off but not to another aircraft with higher performance.

10.3.2.16 The slope of the take-off climb surface can be reviewed if the local conditions and the operational characteristics of aeroplanes of ADG IIC, III, IV and V operating at the runway support a slope higher than 2 per cent. Such review should be done in consultation with the aircraft operator as any increase to the slope may impact take-off performances and reduces payload.

10.3.2.17 A balanced approach to the selection of the gradient for the take-off climb surface is recommended. Local considerations need to be accounted for, as well as aircraft operator's requirements for efficient operations.

10.3.2.18 For typical aircraft operations with take-off masses not at maximum, the slope of the take-off climb surface may be increased to match the slope of the approach OFS in the opposite runway direction when no significant limitations are to be expected, e.g. for narrow-body aircraft at low elevation aerodromes with longer runways.

10.3.2.19 In contrast, some aerodromes at higher elevations and/or in hot environments may require a slope of the take-off climb surface of less than 2.0 per cent.

Modifying horizontal OES

10.3.2.20 In situations where there are no circling or visual circuits, there is no need to establish the entire extent of horizontal OES. When a circling approach or visual circuit is not allowed on one side of the runway, the extent of horizontal OES may be reduced in order not to limit new constructions in that area.

10.3.2.21 Often, circling minima are not at the minimum due to the terrain and obstacle environment. In such cases, the height of the horizontal OES may be raised to match the obstacle clearance altitude (OCA) of the circling approach, considering the applicable minimum obstacle clearance requirements.

Note 1.— A single or a combination of horizontal OES is to be adopted at aerodromes where there are circling operations.

Note.2.— It must be ensured that the modification of the horizontal OES will not impact the safety of visual procedures and aerodrome circuits, nor significantly affect the regularity of other flight procedures including instrument approach and departures procedures.

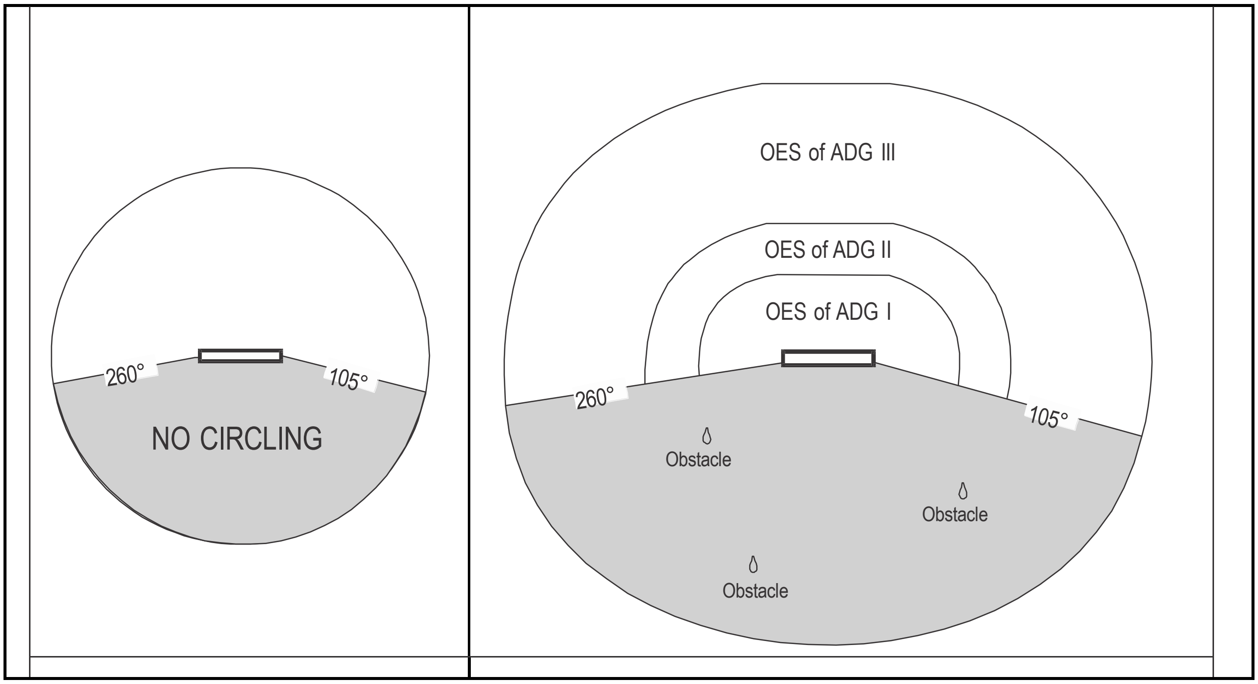

Figure 10-2. Modifying horizontal OES on a non-circling area

Declaring an OES as a surface that is free of obstacles

10.3.2.22 States or the appropriate authority may decide to declare an OES as a surface that should be free of obstacles. This may be done to protect the airspace in the vicinity of the aerodrome by restricting growth of obstacles that may undermine future aerodrome needs and flight operations. By not allowing penetration of the OES, it would simplify the process for approving obstacles, reducing the number of aeronautical studies required and reduce the likelihood of the flight procedures being amended.

10.3.2.23 When declaring an OES as a surface that should be maintained free of obstacles, amendments are necessary to the local zoning laws, aerodrome standards, etc.

Specific obstacle evaluation surfaces

10.3.2.24 In cases where existing and/or planned flight procedures cannot be safeguarded by the OES specified in Annex 14, Volume 1, Chapter 4, specific OES should be established to account for the local flight procedures.

10.3.2.25 Adjustments of the OES or specific OES may be required for, including but not limited to:

a) instrument approach procedures based on NDB or radar;

b) straight-in instrument approach procedures with low approach minima (OCA/H);

c) offset instrument approach procedures, or

d) curved instrument approach procedures (RNP AR).

10.3.2.26 While the Annex 14, Volume I, horizontal surface(s) and surface for straight-in instrument approaches consider most common straight-in instrument approaches, the variety of all possible instrument approaches procedures cannot be addressed.

10.3.2.27 Precision approaches as well as straight-in approaches with significant offsets or curved approaches are not considered for the design of the surface for straight-in instrument approaches. Furthermore, low approach minima may not be fully addressed.

10.3.2.28 For non-precision approaches, approach minima of as low as 120 m (400 ft) may be achieved. With a minimum obstacle clearance (MOC) of 75 m (250 ft) for the final approach, an obstacle as high as OES in the inner section (45 m or 150 ft) would result in approach minima of 120 m (400 ft). An obstacle as high as the OES in the outer section (60 m or 200 ft) would result in approach minima of 135 m (450 ft). An obstacle beyond the limits of the surfaces as high as 100 m (330 ft) would result in approach minima of 175m (580ft). In case the non-precision approach procedure supports step-down fixes (SDF), the approach minima of 175 m (580 ft) may be lowered to 135 m (450 ft) and to 120 m (400 ft).

10.3.2.29 For required navigation performance (RNP) approach procedures with lateral navigation (LNAV)/vertical navigation (VNAV) minima or LPV minima (satellite-based augmentation system (SBAS) approach procedure with vertical guidance (APVI)), approach minima of approximately 85 m to 95 m (280 ft to 310 ft) (depending on the aircraft speed category) or 100 m to 110 m (330 ft to 360 ft) may be achieved, depending on the actual approach procedure design as well as altitude and temperature effects, assuming obstacles as high as the surface for non-precision approaches.

10.3.2.30 Low approach minima are considered by means of the Annex 14, Volume I surface for precision approaches. This surface, however, is based on the basic ILS surfaces and are therefore considered precision approaches (using ILS, microwave landing system (MLS), GBAS, SBAS CAT I) only. For non-precision approach procedures (NPA) and APV with low approach minima (OCA/H), the dimensions of the Annex 14 surface for precision approaches is not sufficient and greater areas need to be considered.

10.3.2.31 The design of specific OES may be aligned with the protection areas specified for the design of instrument flight procedures. The related criteria are contained in PANS-OPS (Doc 8168) and the *Required Navigation Performance Authorization Required (RNP AR) Procedure Design Manual* (Doc 9905).

10.3.2.32 Furthermore, specific OES may be established to account for the local visual flight operations, including specified visual circuit patterns, VFR routes as well as VFR reporting points.

Note.— Guidance material for the protection of visual flight operations is contained in the Airport Services Manual*, Part 6 –* Control of Obstacles *(Doc 9137).*

10.3.3 Evaluating hazardous objects

10.3.3.1 Objects located beyond or below the OFS and OES may still be a concern to the safety and regularity of flight operations. These objects, due to their characteristics and purpose, may pose a hazard to air navigation. Such objects include wind turbines, chimneys, skeleton structures, transmission lines and power stations.

10.3.3.2 The orientation of buildings and their façades are known to cause turbulence, glare and disturbance to CNS equipment. The appropriate authority should work with land planning agencies to manage these hazards for buildings that are in the immediate vicinity of the aerodrome.

10.3.3.3 An aeronautical study should be considered when examining the impact on safety and regularity of flight operations due to these developments.

Note.— Details on the impact and references on possible assessment techniques to evaluate the risks posed by these objects can be found in the Airport Services Manual, *Part 6* – Control of Obstacles *(Doc 9137).*

Appendix to Chapter 10

AERONAUTICAL STUDY PROCESS

1. Aeronautical study

1.1 To investigate an aeronautical concern arising from the introduction of an obstacle, an aeronautical study is used to evaluate the impact of the obstacle on flight operations and identify possible measures that can mitigate these concerns.

1.2 The process of conducting an aeronautical study should include:

a) data gathering;

b) stakeholder engagement and impact assessment;

c) identifying mitigations (if applicable); and

d) acceptance or rejection.

Note.— A flowchart showing the aeronautical study process is included as an Attachment to this Appendix.

2. Data gathering

2.1 Information collected should include but not be limited to:

a) national regulations and procedures (zoning laws, land use policy);

b) use of the aerodrome (day/night, IFR/VFR, public/private use, certified/uncertified);

c) dimensions of approach lighting system;

d) existing and future runway and taxiway characteristics;

e) mix of aircraft operating at the aerodrome;

f) number of regular flights (commercial air transport);

g) procedures specific to the aerodrome;

h) flight procedures (existing and future);

i) contingency procedures;

j) details on existing obstacles and mitigations;

k) existing/planned visual navigation aids/electronic navigation aids/surveillance aids/communication aids etc.; and

l) airspace structure and details of nearby aerodromes.

Note.— For non-flight operations related aeronautical studies, other information may be required.

2.2 Details of the proposed obstacle or terrain should include but are not limited to:

a) location;

b) obstacle evaluation;

c) classification (e.g., building, crane, tree(s), antenna(s), power lines);

d) dimensions as well as height, top elevation including ground elevation;

e) frangibility;

f) permanence (permanent/temporary);

g) presence (fixed/mobile);

h) visibility (e.g., marking and lighting); and

i) material (as it may interfere with electronic signals).

2.3 Aerodrome details (this list is not exhaustive and may include others):

a) ICAO code;

b) CNS facilities;

c) procedures specific to the aerodrome;

d) use of aerodrome (IFR/VFR day/low visibility operations)

e) visual aids;

f) type of aircraft;

g) runway characteristics (number of runways, dimensions, type);

h) airspace;

i) nearby aerodromes; and

j) aerodrome noise zones.

2.4 Affected surfaces:

a) surfaces penetrated; and

b) extent of penetration.

2.5 Flight operations related to instrument flight procedures (this list is not exhaustive and may include others):

a) instrument approach procedures (initial, intermediate, final and missed approaches as well as visual segment and circling);

b) SIDs (standard instrument departure routes and/or omni-directional departures);

c) standard arrival routes (STAR);

d) minimum sector altitudes (MSA) and terminal arrival altitudes (TAA);

e) holding patterns;

f) ATC surveillance minimum altitudes; and

g) en route ATS routes.

2.6 Flight operations (visual flight procedures and visual approaches):

a) visual departures;

b) traffic patterns (standard circuit patterns or other published patterns, incl. patterns for entry and exit to/from circuit patterns); and

c) VFR routes and VFR reporting points.

3. Stakeholder engagement and impact assessment

3.1 The proponent of the aeronautical study can either be an agency of the State, aerodrome operators or by any appropriate authority. In conducting the study, it is critical to have the participation of all relevant stakeholders. The stakeholders should include but are not limited to:

a) the civil aviation authority;

b) proponent of the proposed construction/development;

c) the aerodrome operator;

d) air navigation services providers;

e) flight procedure designers;

f) aircraft operators (commercial aviation and the military); and

g) other appropriate authorities (e.g. land use planner, military etc.).

Note 1. — The level of stakeholders' involvement may vary depending on the needs of the study.

Note 2. — The design of procedures in accordance with PANS-OPS (Doc 8168) criteria assumes normal operations. It is the responsibility of the operator to provide contingency procedures for abnormal and emergency operations. It might be necessary to involve aircraft operators in the aeronautical study process.

3.2 There could be a situation where more than one OES is penetrated. Due to different purposes each OES serves, every surface needs to be evaluated individually to assess its impact.

Note.— Explanations on how impact assessments are conducted can be found in the Airport Services Manual, *Part 6* – Control of Obstacles *(Doc 9137).*

4. Identifying mitigations

Note.— Identifying the mitigating measure and assessing their impact on stakeholders is a key task in the aeronautical study process. Different measures are required to address OFS and OES penetrations. Certain mitigation measures, while acceptable, may not be desirable due to the penalty it imposes on aerodrome operations.

4.1 The mitigation measure identified should consider the OLS that is/are being penetrated.

4.2 Obstacles penetrating the OFS will impose an adverse effect on the safety of flight operations and should be removed. Where removal is not practicable, the penetrations are to be mitigated by means of limiting operations at the aerodrome such as designating the runway for departure only or allowing only visual approaches to the runway, before considering other measures. Other measures include, but are not limited to:

a) displacing the threshold; and/or

b) raising the glide slope and PAPI angle.

4.3 Obstacles penetrating the OES may have an adverse impact to the safety or accessibility of intended aircraft operations. Mitigation measures may include, but are not limited to:

a) adjusting flight procedures (e.g., increased minimum obstacle clearance altitudes, increased minimum climb gradients, change of routing);

b) including the obstacles in the relevant ICAO charts;

c) promulgating safety information to the users of the aerodrome (particularly concerning the change);

d) increasing approach minima (OCA/H);

e) increasing minimum climb gradient for departures (Procedure design gradient (PDG));

f) increasing descent gradients;

g) increasing flight altitude;

h) revising traffic/circuit patterns;

i) revising VFR routes and/or reporting points; and

j) adjusting/including marking and lighting.

4.4 Upon completion of the aeronautical study, it may be necessary to conduct a safety risk assessment to quantify the risk probability and severity and the acceptability of any proposed mitigation measures in reducing the risk to an acceptable level.

Note. — Provisions on safety risk assessment are stipulated in Chapter 3 of this document and on the Safety Management Manual (Doc 9859).

5. Acceptance

5.1 The study may result in one of the following outcomes where the obstacle is:

a) acceptable, because the risk is already mitigated;

b) acceptable, only if the risk is mitigated; or

c) not acceptable, because the risk cannot be mitigated.

5.2 The State or the appropriate authority establishes the approval/acceptance criteria to be used in evaluating the study. The study is to be submitted by the aerodrome operator or an appropriate authority prior to development or installation of the proposed obstacle.

5.3 The State or the appropriate authority should analyse the aeronautical study and verify that:

a) appropriate coordination has been performed between the stakeholders;

b) aeronautical concerns have been properly investigated and assessed, based on current and future flight operations and procedures;

c) proposed mitigation measures adequately address the impact posed by the obstacle; and

d) the subsequent safety risk assessment, when required, has been conducted in accordance with Chapter 3 of this document and meets the acceptability criteria specified in 3.5.1.

Note. — It is preferable to have relevant experts from the State, as required, on the team that conducts the aeronautical study. On completion of the analysis of the aeronautical study, the State or the appropriate authority:

a) gives formal approval or acceptance of the aeronautical study to the aerodrome operator or an appropriate authority. If in the study some impacts to flight operations have been underestimated or have not been identified, coordinate with the aerodrome operator or an appropriate authority to reach an agreement on safety acceptance; or

b) if no agreement can be reached, rejects the proposal for possible resubmission by the aerodrome operator or an appropriate authority; or

c) may choose to impose conditional measures to ensure safety and regularity.

Attachment to Chapter 10
Aeronautical study flowchart