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AMENDMENT NO. 4

TO THE

PROCEDURES

FOR

AIR NAVIGATION SERVICES

AIRCRAFT OPERATIONS

VOLUME I

FLIGHT PROCEDURES

FIFTH EDITION — 2006

INTERNATIONAL CIVIL AVIATION ORGANIZATION

Checklist of Amendments
to the PANS-OPS (Doc 8168), Volume I, Fifth Edition

	Date of applicability
Amendment No. 1 (Approved by the Council on 30 November 2006)	15 March 2007
Amendment No. 2 (Approved by the Council on 6 June 2007)	22 November 2007
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Amendment No. 4 (Approved by the President of the Council of ICAO on behalf of the Council on 23 July 2010) Replacement pages (ix), (xxiii), I-1-1-2, II-1-4-1-1 to II-1-4-5, II-4-1-3, II-5-1-1, II-6-1-1 to II-6-1-3, II-6-2-1, II-6-3-1	18 November 2010

Transmittal note

Amendment No. 4

to the

Procedures for Air Navigation Services

AIRCRAFT OPERATIONS
(Doc 8168)

Volume I
Flight Procedures

1. Insert the following new and replacement pages in the PANS-OPS, Volume I (Fifth Edition) to incorporate Amendment No. 4 which becomes applicable on 18 November 2010.

a) Page (ix) — Table of Contents

b) Page (xxiii) — Foreword

c) Page I-1-1-2 — Part I, Section 1, Chapter 1

d) Pages II-1-4-1 to II-1-4-5 — Part II, Section 1, Chapter 4

e) Page II-4-1-3 — Part II, Section 4, Chapter 1

f) Page II-5-1-1 — Part II, Section 5, Chapter 1

g) Pages II-6-1-1 to II-6-1-3 — Part II, Section 6, Chapter 1

h) Page II-6-2-1 — Part II, Section 6, Chapter 2

i) Page II-6-3-1 — Part II, Section 6, Chapter 3

2. Delete pages II-6-4-1 to II-6-4-4 inclusive.

3. Record the entry of this amendment on page (ii).

Page

Page

Amendment	*Source(s)*	*Subject(s)*	*Approved* *Applicable*
		d) introduction of a new definition for a continuous descent final approach (CDFA) and a description of methods of controlling the vertical flight path on non-precision approaches to include CDFA.	
4	Second and third working group of the whole meetings of the Instrument Flight Procedures Panel (IFPP/WG/WHL/2 and 3)	a) Introduction of the definition of GBAS landing system (GLS); b) new provisions pertaining to RNAV holding requirements consequential to existing PANS-OPS, Volume II, design criteria that seek alignment with the PBN concept; and c) new provisions concerning the use of satellite-based augmentation system (SBAS) approach procedures with vertical guidance (APV)/barometric vertical navigation (baro-VNAV) that are consequential to existing PANS-OPS, Volume II, design criteria.	23 July 2010 18 November 2010

Chapter 1

DEFINITIONS

When the following terms are used in this document, they have the following meanings:

Aerodrome elevation. The elevation of the highest point of the landing area.

Airborne collision avoidance system (ACAS). An aircraft system based on secondary surveillance radar (SSR) transponder signals which operates independently of ground-based equipment to provide advice to the pilot on potential conflicting aircraft that are equipped with SSR transponders.

Altitude. The vertical distance of a level, a point or an object considered as a point, measured from mean sea level (MSL).

Area minimum altitude (AMA). The minimum altitude to be used under instrument meteorological conditions (IMC), that provides a minimum obstacle clearance within a specified area, normally formed by parallels and meridians.

Area navigation (RNAV). A method of navigation which permits aircraft operation on any desired flight path within the coverage of the station-referenced navigation aids or within the limits of the capability of self-contained aids, or a combination of these.

Balked landing. A landing manoeuvre that is unexpectedly discontinued at any point below the OCA/H.

Base turn. A turn executed by the aircraft during the initial approach between the end of the outbound track and the beginning of the intermediate or final approach track. The tracks are not reciprocal.

Note.— Base turns may be designated as being made either in level flight or while descending, according to the circumstances of each individual procedure.

Circling approach. An extension of an instrument approach procedure which provides for visual circling of the aerodrome prior to landing.

Continuous descent final approach (CDFA). A technique, consistent with stabilized approach procedures, for flying the final approach segment of a non-precision instrument approach procedure as a continuous descent, without level-off, from an altitude/height at or above the final approach fix altitude/height to a point approximately 15 m (50 ft) above the landing runway threshold or the point where the flare manoeuvre should begin for the type of aircraft flown.

Controlled airspace. An airspace of defined dimensions within which air traffic control service is provided in accordance with the airspace classification.

Note.— Controlled airspace is a generic term which covers ATS airspace Classes A, B, C, D and E as described in Annex 11, 2.6.

Dead reckoning (DR) navigation. The estimating or determining of position by advancing an earlier known position by the application of direction, time and speed data.

Decision altitude (DA) or decision height (DH). A specified altitude or height in the precision approach or approach with vertical guidance at which a missed approach must be initiated if the required visual reference to continue the approach has not been established.

Note 1.— Decision altitude (DA) is referenced to mean sea level and decision height (DH) is referenced to the threshold elevation.

Note 2.— The required visual reference means that section of the visual aids or of the approach area which should have been in view for sufficient time for the pilot to have made an assessment of the aircraft position and rate of change of position, in relation to the desired flight path. In Category III operations with a decision height the required visual reference is that specified for the particular procedure and operation.

Note 3.— For convenience where both expressions are used they may be written in the form "decision altitude/height" and abbreviated "DA/H".

Dependent parallel approaches. Simultaneous approaches to parallel or near-parallel instrument runways where radar separation minima between aircraft on adjacent extended runway centre lines are prescribed.

Descent fix. A fix established in a precision approach at the FAP to eliminate certain obstacles before the FAP, which would otherwise have to be considered for obstacle clearance purposes.

Direct visual segment (Direct-VS). The portion of flight that connects the PinS to the landing location; this can be either direct to the landing location or via a descent point (DP) where a limited track change may occur.

DME distance. The line of sight distance (slant range) from the source of a DME signal to the receiving antenna.

Elevation. The vertical distance of a point or a level, on or affixed to the surface of the earth, measured from mean sea level.

Final approach and take-off area (FATO). A defined area over which the final phase of the approach manoeuvre to hover or landing is completed and from which the take-off manoeuvre is commenced. Where the FATO is to be used by performance Class 1 helicopters, the defined area includes the rejected take-off area available.

Final approach segment (FAS). That segment of an instrument approach procedure in which alignment and descent for landing are accomplished.

Flight level (FL). A surface of constant atmospheric pressure which is related to a specific pressure datum, 1 013.2 hectopascals (hPa), and is separated from other such surfaces by specific pressure intervals.

Note 1.— A pressure type altimeter calibrated in accordance with the Standard Atmosphere:

a) when set to a QNH altimeter setting, will indicate altitude;

b) when set to a QFE altimeter setting, will indicate height above the QFE reference datum; and

c) when set to a pressure of 1 013.2 hPa, may be used to indicate flight levels.

Note 2.— The terms "height" and "altitude", used in Note 1 above, indicate altimetric rather than geometric heights and altitudes.

GBAS landing system (GLS). A system for approach and landing operations utilizing GNSS, augmented by a ground-based augmentation system (GBAS), as the primary navigational reference.

Heading. The direction in which the longitudinal axis of an aircraft is pointed, usually expressed in degrees from North (true, magnetic, compass or grid).

Chapter 4

GENERAL INFORMATION FOR SATELLITE-BASED AUGMENTATION SYSTEM (SBAS)

4.1 GENERAL

4.1.1 *Introduction*. An SBAS augments core satellite constellations by providing ranging, integrity and correction information via geostationary satellites. The system comprises a network of ground reference stations that observe satellite signals and master stations that process observed data and generate SBAS messages for uplink to the geostationary satellites, which broadcast the SBAS messages to the users.

4.1.2 By providing extra ranging signals via geostationary satellites and enhanced integrity information for each navigation satellite, SBAS delivers higher availability of service than the core satellite constellations.

4.1.3 *SBAS coverage and service areas.* It is important to distinguish between SBAS coverage areas and service areas. An SBAS coverage area is defined by GEO satellite signal footprints. Service areas for a particular SBAS are established by a State within an SBAS coverage area. The State is responsible for designating the types of operations that can be supported within a specified service area. Different SBAS service areas may overlap. When this occurs and when an FAS data block is available, it identifies which SBAS service provider(s) may be used for approach operations using GNSS APV I and II performance levels. Receiver standards dictate that such approaches cannot be flown using data from more than one SBAS service provider, but de-selection is possible for these approaches. When an FAS data block is not available, the minimum avionics requirements permit the use of any SBAS service provider and permit the mixing of information from more than one SBAS service provider for en-route, terminal and LNAV approach procedures.

4.1.3.1 *SBAS coverage area.* SBAS avionics should function within the coverage area of any SBAS. States or regions should coordinate through ICAO to ensure that SBAS provides seamless global coverage and that aircraft do not suffer operational restrictions. If a State does not approve the use of some or all SBAS signals for en-route, terminal and SBAS LNAV approach operations, pilots would have to de-select GNSS altogether, since receiver standards do not permit de-selection of a particular SBAS for these operations. It is not expected that APV I or II operations are available within the coverage area other than in specifically designated service areas.

4.1.3.2 *SBAS service area.* Near the edge of the SBAS service area, several outages of vertical guidance a day at a specific location could occur. Although these outages are of short duration, they could totally overburden the NOTAM system. As a result, the State may elect to define different SBAS service areas for different levels of SBAS service. SBAS en-route service requirements are much less stringent than those of the SBAS vertically guided approach service.

4.1.4 *SBAS operational considerations.* Key to providing accurate and high integrity approach capability with SBAS is the correcting for the signal delay caused by the ionosphere. This requires a relatively dense network of reference stations to measure ionospheric characteristics and provide information to the SBAS Master Station.

4.1.5 *SBAS avionics certification*. SBAS avionics certification requirements have been developed (RTCA DO-229D) and are based on Annex 10. At a minimum, the SBAS airborne sensors shall be able to operate within the coverage volume of any SBAS.

4.2 SBAS STANDARD CONDITIONS

4.2.1 *Departure.* All classes of SBAS avionics may be used to fly existing GNSS RNAV departure procedures. Display scaling and mode transitions are equivalent to Basic GNSS. SBAS meets or exceeds Basic GNSS accuracy, integrity, availability and continuity requirements for Basic GNSS departure.

4.2.1.1 *Departure procedure.* The entire departure procedure shall be selected from the on-board data base. Pilot entry of the departure procedure is not authorized. When integrity requirements cannot be met to support the SBAS departure operation, the SBAS receiver will annunciate the procedure is not available.

4.2.1.2 *Straight departure.* From the DER to the turn initiation point of the first waypoint in the departure procedure, the SBAS receiver provides a nominal full-scale deflection (FSD) of 0.3 NM. Larger FSDs may be acceptable with augmentations, such as an autopilot, that can control the flight technical error.

4.2.1.3 *Terminal operation mode reversion.* At the turn initiation point for the first waypoint in the departure procedure, the SBAS receiver will revert to the terminal operation mode until the last waypoint of the departure procedure is sequenced. In the terminal mode, the nominal FSD is 1 NM and the horizontal alert limit is 1 NM. After the last waypoint in the departure procedure is sequenced, the SBAS receiver will provide en-route display scaling and integrity.

4.2.2 *Arrival.* Performance requirements for SBAS in the arrival phase are the same as for Basic GNSS. Refer to Section 3, Chapter 1.

4.2.3 Approach

4.2.3.1 *SBAS sensor approach performance.* SBAS avionics standards provide for three levels of approach performance:

a) LPV;

b) LNAV/VNAV; and

c) LNAV.

Note 1.— LNAV may be an automatic reversionary mode upon the loss of LPV.

Note 2.— LPV performance is only provided by Class 3 and 4 receivers in accordance with RTCA DO-229D, Minimum Operational Performance Standards for Global Positioning System/Wide Area Augmentation System Airborne Equipment.

4.2.3.2 *SBAS accuracy and integrity.* SBAS avionics accurately calculates position, and ensures integrity in the calculated position for a given approach operation type.

4.2.3.3 *Integrity.* The necessary level of integrity for each of these approach types is established by specific horizontal and vertical alert limits called HAL and VAL. These limits are analogous to the monitoring limits for ILS. These alert limits form the region of maximum error that shall be satisfied to meet the integrity requirements for a given approach type.

4.2.3.4 SBAS avionics ensures integrity in the calculated position for a given approach type, by continuously calculating the horizontal and vertical protection level estimates (HPL and VPL) and comparing the calculated values with HAL and VAL respectively. When either HPL or VPL exceeds the specific alert limits, HAL or VAL, for a specific type of approach operation, the pilot is alerted to suspend the current operation. The pilot only receives the alert and is not required to monitor VPL or HPL.

4.2.4 Missed approach

4.2.4.1 *General.* SBAS provides guidance in the missed approach segment. Activation of missed approach guidance generally occurs during a high pilot workload period. SBAS avionics standards, described in RTCA DO-229D, have significantly improved the pilot/avionics interface for activating missed approach guidance, when compared to basic GNSS avionics standards. SBAS avionics minimum operating performance requirements specify much more standardization in the pilot/avionics interface than was present in the specifications for basic GNSS avionics. Because of this standardization, and other SBAS avionics missed approach requirements, pilots will be able to more efficiently and easily initiate the sequencing to the missed approach segment.

4.2.4.2 *Missed approach sequencing*

4.2.4.2.1 The pilot physically initiates the missed approach by beginning the pull-up. Initiation in the following discussion refers to when the pilot takes action(s) required to sequence guidance and transition display and integrity modes of the avionics for the missed approach segment. For missed approaches, SBAS avionics perform at least three functions based on when the missed approach is sequenced. These functions are:

a) transition the guidance to the missed approach guidance for the selected approach procedure after the MAPt is sequenced;

b) transition the lateral FSD to either 0.3 NM or 1.0 NM depending on the initial leg type and leg alignment in the missed approach procedure; and

c) transition the integrity mode (HAL) to either NPA or terminal depending on the initial leg type and alignment in the missed approach procedure.

4.2.4.2.2 With SBAS avionics, missed approaches may be initiated under four different conditions. The conditions are:

a) the pilot initiates the missed approach sequence prior to arriving at the landing threshold point/fictitious threshold point (LTP/FTP);

b) the pilot initiates the missed approach sequence after the LTP/FTP but prior to the departure end of runway (DER);

c) the pilot does not initiate missed approach sequencing prior to reaching the DER. In this case, the avionics will automatically initiate the missed approach; and

d) the pilot cancels the approach mode prior to the LTP/FTP.

4.2.4.3 *Missed approach FSD.* The value of missed approach FSD can vary based on two different situations:

a) When the first leg in the missed approach procedure is a Track to Fix (TF) leg aligned within 3^{o} of the final approach course, FSD switches to 0.3 NM and the integrity switches to NPA mode. These remain in this state until the turn initiation point for the first waypoint in the missed approach procedure. At this point FSD switches to 1.0 NM and the integrity to terminal mode. The turn initiation point is associated with fly-by waypoints. Where the sequencing to the next segment begins is termed the turn initiation point. This point is not fixed. It is determined by the avionics based on several factors including:

1) current tracking error;

2) ground speed;

3) wind conditions; and

4) track change between segments.

b) When the first leg is not a TF leg aligned within 3° of the final approach course, at missed approach initiation FSD switches to 1.0 NM and the integrity to terminal mode.

4.3 AVIONICS FUNCTIONALITY

4.3.1 *SBAS avionics equipment classification and capabilities*. There are four separate SBAS avionics equipment classes. The different equipment classes provide for different performance capabilities. The minimum performance capability exists with Class I equipment. This equipment supports en-route, terminal and LNAV approach operations. Class II SBAS equipment supports Class I capabilities and LNAV/VNAV approach operations. Class III and IV equipment support Class II SBAS equipment capabilities plus LPV approach operations.

Note.— The terms APV-I and APV-II refer to two performance levels of GNSS approach and landing operations with vertical guidance, and these terms are not intended to be used for charting of the minima lines. For such use the term LPV is applied to align with SBAS avionics annunciation requirements (see Annex 10, Volume I, Note 9 to Table 3.7.2.4-1 "Signal-in-space performance requirements").

4.3.2 *Final approach segment (FAS) data block.* The APV database for SBAS includes a FAS Data Block. The FAS Data Block information is protected with high integrity using a cyclic redundancy check (CRC).

4.3.3 SBAS avionics annunciation requirements

4.3.3.1 The avionics are required to annunciate the most accurate level of service supported by the combination of the SBAS signal, the receiver, and the selected approach, using the naming conventions on the minima lines of the selected approach procedure. This annunciation is the function of:

a) avionics capability associated with the SBAS equipment capability;

b) SBAS signal-in-space performance accomplished through the comparison of VPL and HPL with the procedure-required VAL and HAL; and

c) published procedure availability that is identified in the database.

4.3.3.2 Based on the three factors in 4.3.3.1:

a) if an approach is published with an LPV minima line and the receiver is only certified for LNAV/VNAV, the equipment would indicate "LPV not available — use LNAV/VNAV minima," even though the SBAS signal would support LPV;

b) if an approach is published without an LPV minima line, even if the receiver is certified for LPV and the SBAS signal in space supports the LPV, the receiver will notify the pilot either "LNAV/VNAV available" or "LNAV available"; and

c) if the SBAS signal does not support published minima lines which the receiver is certified to fly, the receiver will notify the pilot with a message such as “LPV not available — use LNAV/VNAV minima” or “LPV not available — use LNAV minima”.

4.3.4 *Lateral approach display requirements for LPV minima.* SBAS avionics support flying the complete RNAV procedure and also can operate in a Vector to Final (VTF) mode. Lateral display scaling requirements are different for the different operating modes. The full-scale deflection (FSD) is defined with information contained in the FAS Data Block. Lateral scaling is equivalent to ILS lateral display scaling. Nominally, full-scale course width at threshold is +/–105 m.

4.3.4.1 Inbound, once past the landing threshold, the FSD optionally may remain constant at the threshold FSD (nominally 105 m) until the missed approach is activated or the aircraft has passed the departure end of runway (DER).

4.3.4.2 *Flying the complete procedure.* This angular display is maintained from threshold until the FAF or where FSD = 0.3 NM, whichever occurs first. At the FAF, FSD increases linearly until FSD = 1.0 NM, 2 NM beyond the FAF.

4.3.4.3 *Vector to final (VTF) operations.* When operating in the VTF mode, the angular display is the same as described above, except that the angular splay continues until FSD = 1.0 NM regardless of the length of the FAS. Beyond this point FSD remains constant at 1.0 NM.

4.3.5 *Vertical approach display requirements for LPV minima.* The FSD is +/–glide path angle/4. The vertical guidance originates from the glide path intercept point (GPIP). The GPIP is located at the intersection of the glide path and the horizontal plane formed by the FPAP and LTP/FTP. Near the threshold, once the full-scale angular displacement equals 15 m, the FSD is linearized at +/–15 m from that point to the GPIP. Vertical guidance is “flagged” once the aircraft passes the GPIP or a missed approach is initiated.

4.3.5.1 When the full-scale angular displacement equals 150 m, the FSD is linearized to +/–150 m at that point and at greater distances from threshold. Vertical guidance is “flagged” when the aircraft is outside a +/–35° wedge about the final approach course originating at the GNSS azimuth reference point.

4.3.6 *Approach display requirements when flying SBAS LNAV/VNAV and LNAV minima*. The displays can be angular as described in 4.3.4 or linear. When lateral linear display scaling is used, it is consistent with display requirements for Basic GNSS. Vertical scaling is described in 4.3.5 except that the minimum FSD may optionally be +/– 45 m (150 ft) for LNAV/VNAV procedures. For cases where a FAS data block is not provided but SBAS is providing vertical guidance (SBAS LNAV/VNAV) and angular guidance is being used, the lateral full-scale angular display is fixed constant at 2° regardless of runway length.

1.3.2 Aircraft equipped with APV/baro-VNAV systems that have been approved by the State of the Operator for the appropriate level of lateral navigation (LNAV)/VNAV operations may use these systems to carry out APV/baro-VNAV approaches provided that:

a) the navigation system has a certificated performance equal to or less than 0.6 km (0.3 NM), with 95 per cent probability. This includes:

   1) GNSS navigation systems certified for approach operations;

   2) multi-sensor systems using inertial reference units in combination with certified DME/DME or GNSS; and

   3) RNP systems approved for RNP 0.3 values or less;

b) the APV/baro-VNAV equipment is serviceable;

c) the aircraft and aircraft systems are appropriately certified for the intended APV/baro-VNAV approach operations;

d) the aircraft is equipped with an integrated LNAV/VNAV system with an accurate source of barometric altitude; and

e) the VNAV altitudes and all relevant procedural and navigational information are retrieved from a navigation database whose integrity is supported by appropriate quality assurance measures.

Note 1.— SBAS Class III and IV avionics certified using TSO C-145/146 or its equivalent are approved to fly APV/barometric VNAV procedures.

Note 2.— Guidance on the approval process, aircraft requirements and aircraft system requirements for APV/baro-VNAV operations can be found in the Performance-based Navigation (PBN) Manual, Volume II, Attachment *(Doc 9613) and TSO C-145/146.*

1.3.3 Where LNAV/baro-VNAV procedures are promulgated, the approach area has been assessed for obstacles penetrating the Annex 14 inner approach, inner transitional and balked landing surfaces. If obstacles penetrate these surfaces, a restriction is placed on the minimum value of OCA/H permitted.

1.4 OPERATIONAL CONSTRAINTS

1.4.1 Pilots are responsible for any necessary cold temperature corrections to all published minimum altitudes/heights. This includes:

a) the altitudes/heights for the initial and intermediate segment(s);

b) the DA/H; and

c) subsequent missed approach altitudes/heights.

Note.— The final approach path vertical path angle (VPA) is safeguarded against the effects of low temperature by the design of the procedure.

1.4.2 Temperatures below the promulgated minimum

Baro-VNAV procedures are not permitted when the aerodrome temperature is below the promulgated minimum aerodrome temperature for the procedure, unless the flight management system (FMS) is equipped with approved cold temperature compensation for the final approach. In this case, the minimum temperature can be disregarded provided it is within the minimum certificated temperature limits for the equipment. Below this temperature, and for aircraft that do not have FMSs equipped with approved cold temperature compensation for the final approach, an LNAV procedure may still be used provided that:

a) a conventional RNAV non-precision procedure and APV/LNAV OCA/H are promulgated for the approach; and

b) the appropriate cold temperature altimeter correction is applied to all minimum promulgated altitudes/heights by the pilot.

1.4.3 Vertical path angle (VPA) deviation table

1.4.3.1 A VPA deviation table provides an aerodrome temperature with an associated true vertical path angle. This table is intended to advise flight crews that, although the non-temperature-compensated aircraft's avionics system may be indicating the promulgated final approach vertical path angle, the actual vertical path angle is different from the information presented to them by the aircraft avionics system. This table is not intended to have the pilot adjust the VPA flown to achieve the actual promulgated vertical path angle, nor is it meant to affect those avionics systems that have a capacity to properly apply temperature compensation to a baro-derived final approach VPA. Non-compensated baro-VNAV guidance should not be flown when the aerodrome temperature is below the lowest promulgated temperature. To show the difference in the minimum temperature application, examples of these tables for aerodrome elevations at mean sea level and at 6 000 feet are provided in Tables II-4-1-1 and II-4-1-2.

Table II-4-1-1
VPA deviations at MSL

A/D Temp	Actual VPA
+30°C	3.2°
+15°C	3.0°
0°C	2.8°
–15°C	2.7°
–31°C	2.5°

Table II-4-1-2
VPA deviations at 6 000 ft MSL

A/D Temp	Actual VPA
+22°C	3.2°
+3°C	3.0°
–20°C	2.7°
–30°C	2.6°
–43°C	2.5°

Note.— Values presented in Tables II-4-1-1 and II-4-1-2 are not representative of actual values that may be calculated for a particular aerodrome.

1.4.3.2 Some baro-VNAV systems have the capability to correctly compensate for the temperature effects on the vertical path angle of an instrument approach procedure following an input of the aerodrome (altimeter source) temperature by the pilot. Pilots operating aircraft with this feature active can expect that the angle displayed will be the corrected vertical path angle, thus the VPA deviation table is not applicable.

1.4.4 Altimeter setting

Baro-VNAV procedures shall only be flown with:

a) a current local altimeter setting source available; and

b) the QNH/QFE, as appropriate, set on the aircraft's altimeter.

Chapter 1

GBAS PRECISION APPROACH PROCEDURES

1.1 APPROACH CONDUCT

A precision approach using GBAS is selected by use of a channel number in the airborne equipment. The GBAS precision approach is carried out in a manner very similar to an ILS precision approach by using lateral guidance on the intermediate segment until intercepting the glide path, whereupon vertical guidance is initiated and continued, along with lateral guidance, for landing.

1.2 GBAS APPROACH DISPLAY CRITERIA

1.2.1 GBAS provides precision approach service equivalent to ILS Category I approach service. Minimum required GBAS display functionality is equivalent to ILS. GBAS continuously provides very accurate distance to landing threshold information. System failure display and annunciation are equivalent to ILS.

1.2.2 The GBAS path is defined differently from an ILS path. Data defining the path, including the glide path, lateral sector width, lateral sensitivity and other characteristics of the guidance sector, are transmitted by ground equipment to the airborne system using a high-integrity digital data message. The digital message defines the final approach segment (FAS) path and guidance characteristics. The airborne system geometrically calculates the path and defines the guidance characteristics specified in the transmitted digital data. The airborne system generates guidance with characteristics similar to other precision approach systems such as ILS that transmit electronic beams for the aircraft equipment to track. A complete description of the FAS data block and an example of the format are contained in PANS-OPS, Volume II, Part III, Section 3, Chapter 6, Appendix (to be developed).

1.3 GBAS CHANNEL SELECTION

The detailed information on pilot selection of the GBAS channel can be found in Annex 10, Volume I, Attachment D, 7.7.

1.4 PUBLICATION

The instrument approach chart for a GBAS approach procedure is identified by the title GLS RWY XX. If more than one GBAS approach is published for the same runway, the duplicate procedure title convention (PANS-OPS, Volume II, Part I, Section 4, Chapter 9, 9.5.3) is applied, with the approach having the lowest minima being identified as GLS Z RWY XX.

Chapter 1

GENERAL

1.1 INTRODUCTION

1.1.1 The general criteria in Part I, Section 6, Chapter 1, "Holding Criteria", are applied except as modified or amplified by the material in this chapter.

1.1.2 Holding functionality varies across different RNAV systems. Some simpler RNAV systems provide only a capability to follow a course to a waypoint. Other systems calculate the size of the holding pattern to be flown based on the wind conditions, the TAS or the ICAO holding speed limit, whichever is lower, and the leg time or the leg distance of the hold, and provide steering guidance, based upon near-constant bank angles during the turns. More modern systems follow a defined ground track throughout the procedure. The older aircraft enter the holding pattern by flying over the waypoint while the modern systems fly by the holding waypoint.

1.1.3 The RNAV holding pattern design criteria protect all types of RNAV systems.

1.2 AIRCRAFT EQUIPPED WITH RNAV SYSTEMS WITH HOLDING FUNCTIONALITY (See Figure II-6-1-1)

1.2.1 These systems are approved by the State of the Operator for the appropriate level of RNAV operations and may be used to carry out RNAV holding, provided that before conducting any flight it is ensured that:

a) the aircraft is fitted with serviceable RNAV equipment; and

b) the pilot has a current knowledge of how to operate the equipment to optimize navigation accuracy.

1.2.2 Holding waypoints and supporting data contained in the navigation database are calculated and promulgated by the State authority . Holding waypoints may also be input by the operator or crew for some applications (e.g. RNAV 5) when identified in OPS approval documentation. Any errors introduced from the navigation database or manual entry will affect the actual computed position. The pilot should cross-check the waypoint position using VOR/DME fix information where this is available.

1.3 AIRCRAFT EQUIPPED WITH RNAV SYSTEMS WITHOUT HOLDING FUNCTIONALITY (see Figure II-6-1-2)

1.3.1 For aircraft equipped with RNAV systems without any holding functionality, it is possible to fly a published RNAV holding procedure overhead a waypoint manually.

1.3.2 The holding waypoint is retrieved from the database or input by the flight crew. The desired inbound course and the end of the outbound shall be published by the State. The pilot should cross-check the waypoint position using VOR/DME fix information where this is available.

1.3.3 The pilot shall fly the holding manually by at least:

a) changing the automatic sequencing of waypoint to manual;

b) designating the holding waypoint as active (Direct to);

c) selecting the desired inbound course (by means of numerical keypad entry, HSI course pointer, or CDI omnidirectional bearing selector (OBS)) to the designated holding waypoint.

1.3.4 This type of holding will be flown manually and RNAV track guidance is provided only on the inbound track.

Note.— The holding waypoint may not be charted as a flyover waypoint, but the pilot and/or aircraft navigation system is expected to treat the waypoint as a flyover waypoint while flying the holding.

1.3.5 The end of the outbound leg of the holding is defined by timing or by a distance from the holding waypoint (WD) provided by the RNAV system.

1.3.5.1 *Outbound leg defined by timing (see Figure II-6-1-2 A).* Outbound timing begins when turn to outbound is completed or abeam the waypoint, whichever occurs later.

1.3.5.2 *Outbound leg defined by an RNAV distance from the waypoint (see Figure II-6-1-2 B).*When the end of the outbound leg is defined by an RNAV distance from the holding waypoint (WD), the outbound leg terminates as soon as the distance is reached.

1.4 Conventional holding patterns may be flown with the assistance of an RNAV system. In this case, the RNAV system has no other function than to provide guidance for the autopilot or flight director. The pilot remains responsible for ensuring that the aircraft complies with the speed, bank angle, timing and distance assumptions contained in Part I, Section 6, Chapter 1, 1.3.

1.5 PILOT RESPONSIBILITIES

1.5.1 When RNAV equipment is used for non-RNAV holding procedures, the pilot shall verify positional accuracy at the holding fix on each passage of the fix.

1.5.2 Pilots shall ensure that speeds used to fly the RNAV holding procedures comply with Tables I-6-1-1 and I-6-1-2.

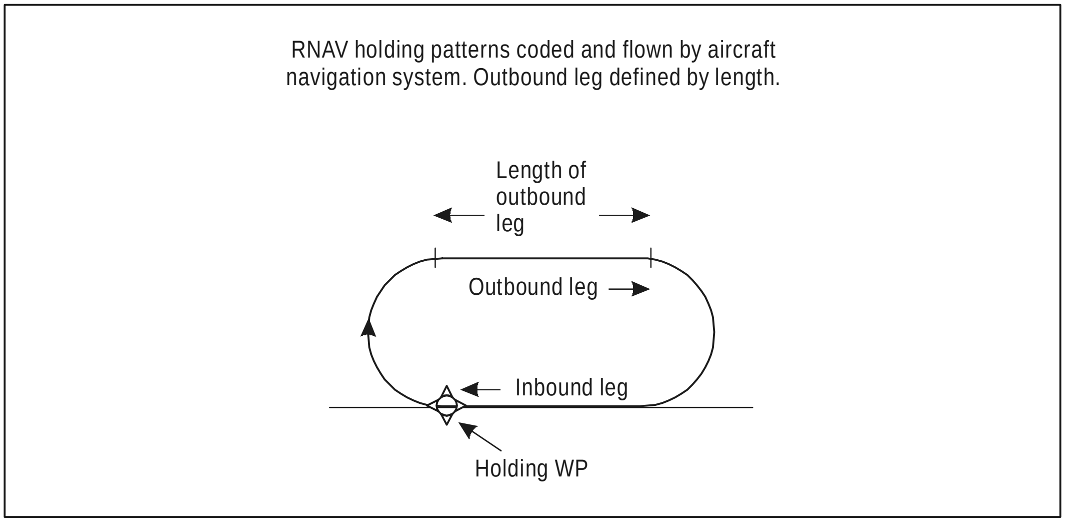

Figure II-6-1-1. RNAV holding for systems with holding functionality

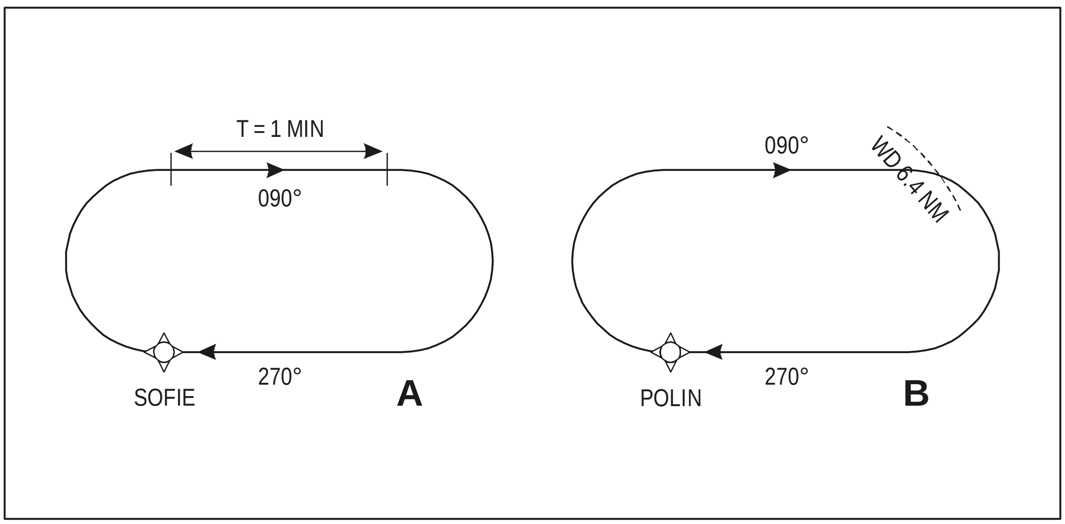

Figure II-6-1-2. RNAV holding for systems without holding functionality

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Chapter 2

HOLDING PATTERNS

2.1 Some RNAV systems can fly non-RNAV holding patterns without strict compliance with the PANS-OPS, Volume II, assumptions. Before these systems are used operationally, they must have demonstrated, to the satisfaction of the appropriate authority, that their commands will contain the aircraft within the basic holding area defined by PANS-OPS, Volume II, for the environmental conditions assumed by those criteria. The pilot shall verify overflight of the stipulated fixes by means of the reference facility.

2.2 RNAV holding may be conducted in specifically designed holding patterns. These holding patterns utilize the criteria and flight procedure assumptions of conventional holding with orientations that are referenced to a track to a waypoint. These holding patterns assume that the aircraft is approved for the RNAV application associated with the holding pattern and is being operated in accordance with that approval (e.g. RNAV 5, RNP 4, RNAV 2, RNAV 1, Basic RNP 1, RNP APCH).

2.3 RNAV area holding is specified by an area holding waypoint and an associated circle. The radius of this circle is always such that the pilot may select any inbound track to the fix and join and follow a standard left or right holding pattern based on the fix and selected track. Alternatively, any other pattern may be flown which will remain within the specified area (see Figure II-6-2-1).

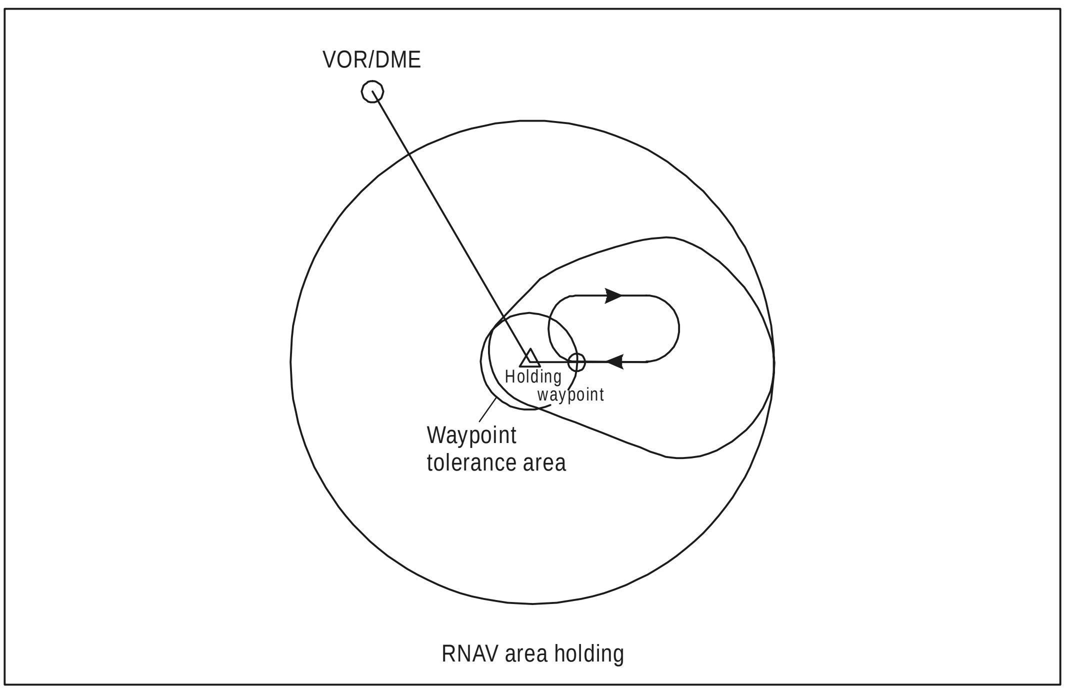

Figure II-6-2-1. RNAV area

Chapter 3

HOLDING ENTRY

Except where it is published that specific entries are required, entries into an RNAV holding pattern are the same as for conventional holding.