ADVISORY CIRCULAR

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ISSUED BY : SRVSOP

SUBJECT: APPROVAL OF AIRCRAFT AND OPERATORS FOR RNP APCH OPERATIONS DOWN TO LP AND LPV MINIMA USING SBAS-AUGMENTED GNSS

1. PURPOSE

This advisory circular (CA) establishes the requirements for aircraft and operators approval to conduct approach operations with required navigation performance (RNP APCH) down to localizer performance (LP) and localizer performance with vertical guidance (LPV) minima, using the global navigation satellite system (GNSS) augmented by the satellite-based augmentation system (SBAS). Although use of SBAS for RNP APCH operations down to LP and LPV minima is not foreseen in the SAM Region, this advisory circular would apply for the approval of aircraft and operators that could operate on locations where the use of SBAS is foreseen.

An operator may use alternative means of compliance, provided such methods are acceptable to the civil aviation administration (CAA).

The use of the future tense of the verb or the term “must” applies to the operator that chooses to meet the criteria established in this AC.

2. SECTIONS RELATED TO THE LATIN AMERICAN AERONAUTICAL REGULATIONS (LARs) OR EQUIVALENT

LAR 91: Sections 91.1015 y 91.1640 or equivalent

LAR 121: Section 121.995 (b) or equivalent

LAR 135: Section 135.565 (c) or equivalent

3. RELATED DOCUMENTS

Annex 6	Operation of aircraft
Annex 10	Aeronautical telecommunications
	Volume I: Radio navigation aids
Doc 9613	Performance-based navigation (PBN) manual
Doc 8168	Aircraft operations
	Volume I: Flight procedures
	Volume II: Construction of visual and instrument flight procedures
EASA AMC 20-28	Airworthiness approval and operational criteria for RNAV GNSS approach operation to LPV minima using SBAS
FAA AC 20-138B	Airworthiness approval of positioning and navigation systems

4. DEFINITIONS AND ABBREVIATIONS

4.1 Definitions

a) **Localizer performance with vertical guidance (LPV)**.- Label denoting minima associated to performance for APV-1 or APV-II in approach charts. Each label indicates that lateral performance is equivalent to lateral performance of the ILS localizer.

***Note**.- The terms APV-I and APV-II refer to two levels of GNSS approach and landing operations with vertical guidance and must not be used in minimum lines in the charts. The term LPV is used for this purpose, which is compatible with SBAS avionics annunciations (see Annex 10, Volume I, Note 9 to Table 3.7.2.4-1 – Signal-in-space performance requirements).*

b) **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**.- Decision altitude (DA) is referenced to mean sea level and decision height (DH) is referenced to the threshold elevation.*

c) **Obstacle clearance altitude (OCA) or obstacle clearance height (OCH) LPV**.- The lowest altitude or the lowest height above the elevation of the relevant runway threshold or the aerodrome elevation as applicable, used in establishing compliance with appropriate obstacle clearance criteria.

***Note**.- Obstacle clearance altitude is referenced to mean sea level and obstacle clearance height is referenced to the threshold elevation, if the threshold is more than 2 m (7 ft) below aerodrome elevation. Obstacle clearance height in circling approaches is referenced to aerodrome elevation.*

d) **Glide path angle (GPA)**.- Represents the angle between the approach path (glide path) and the horizontal plane defined in accordance with WGS-84 at the landing threshold point/fictitious threshold point (LTP/FTP). The GPA is stored in the final approach segment (FAS) data block.

e) **Final approach segment (FAS) data block**.- The set of parameters for identifying a single precision approach or approach procedure with vertical guidance (APV) and defining its associated approach path.

f) **Primary field of vision**.- For the purpose of this AC, the primary field of vision is located within 15 degrees of the primary line of sight of the pilot.

g) **Continuity**.- The capacity of the overall system (which includes all the elements required to maintain aircraft position within a defined airspace) to provide service free of unscheduled interruptions during the intended operation.

h) **Maximum deflection (FSD)**.- Term used for describing maximum deflection from the centre of a course deviation indicator (CDI) or a vertical deviation indicator (VDI), such as a glide slope indicator, and which applies to both the linear and angular scale.

i) **Fault detection and exclusion (FDE)**.- A function of some airborne GNSS receivers for detecting erroneous satellite signals and excluding them from the position calculation. It requires the availability of at least one more satellite (6 satellites) in addition to the number of satellites needed for receiver autonomous integrity monitoring (RAIM). This function allows navigation to return to its normal performance without service interruption.

j) **Availability**.- The capacity of the navigation system to provide useable service within the specified area of coverage.

k) **Class A TSO-129() / ETSO-C129() GPS equipment**.- Equipment that includes GNSS sensor and navigation capability. It includes RAIM as defined in TSO/ETSO-C129().

l) **Class B and C TSO-129() / ETSO-C129() GPS equipment**.- GNSS sensor that provides GNSS data (position, integrity, etc.) to an integrated navigation system (*e.g.*, FMS).

m) **Class GAMMA TSO-C146**.- This functional class corresponds to equipment consisting of a GNSS/SBAS position sensor and a navigation function that provides path deviation with respect to the selected path. The equipment provides the required navigation function to an autonomous navigation system. This equipment also provides integrity in absence of the SBAS signal by using FDE. Furthermore, this class of equipment requires a database, a departure data display, and controls for the pilot.

n) **Class BETA TSO-C145( ) / ETSO-C145 ( )**.- Equipment consisting of a GNSS/SBAS sensor that determines position (with integrity) and provides position and integrity to an integrated navigation system (*e.g.*, FMS, multi-sensor navigation system). This equipment also provides integrity in the absence of the SBAS signal by using FDE.

o) **Operational class 1 TSO-C146( ) / ETSO-C146( ) or TSO-145( ) / ETSO-C145( )**.- This operational class supports oceanic and domestic en-route, terminal, LNAV, and departure operations.

p) **Operational class 2 TSO-C146( ) / ETSO-C146( ) or TSO-145( ) / ETSO-C145( )**.- This operational class supports oceanic and domestic en-route, terminal, LNAV, LNAV/VNAV, and departure operations.

q) **Operational class 3 TSO-C146( ) / ETSO-C146( ) or TSO-145( ) / ETSO-C145( )**.- This operational class supports oceanic and domestic en-route, terminal, LNAV, LNAV/VNAV, LPV, and departure operations.

r) **Navigation specifications**.- Set of aircraft and flight crew requirements needed to support performance-based navigation operations within a defined airspace. There are two classes of navigation specifications:

Required navigation performance (RNP) specification.- Area navigation (RNAV) specification that includes on-board performance control and alert requirement, designated by the prefix RNP; *e.g.*, RNP 4, RNP APCH, RNP AR APCH.

Area navigation (RNAV) specification.- Area navigation specification that does not include the on-board performance control and alert requirement, designated by the prefix RNAV; *e.g.*, RNAV 5, RNAV 2, RNAV 1.

***Note**.- The Performance-based navigation (PBN) manual (Doc 9613), Volume II, contains detailed guidelines on navigation specifications.*

s) **Integrity.-** Capacity of the navigation system to provide alerts when the system must not be used for navigation.

t) **Performance-based navigation (PBN)**.- Area navigation based on performance requirements applicable to aircraft conducting operations on an ATS route, instrument approach procedure, or a designated airspace.

***Note**.- In navigation specifications, performance requirements are expressed in terms of the precision, integrity, continuity, availability, and functionality required for the intended operation within the context of a particular airspace concept.*

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

***Note**.- Area navigation includes performance-based navigation as well as other RNAV operations that do not meet the definition of performance-based navigation.*

v) **Vertical navigation**.- A method of navigation which permits aircraft operation on a vertical flight profile using altimetry sources, external flight path references, or a combination of both.

w) **Barometric vertical navigation (baro-VNAV)**.- A navigation system that displays to the pilot the calculated vertical guidance referenced to a specified vertical path angle (VPA), nominally 3º. The vertical guidance calculated by computer is based on the barometric altitude and is specified as a VPA from the reference datum height (RDH).

x) **Operation with basic GNSS**.- Operation based on a GNSS that includes an aircraft-based augmentation system (ABAS). An ABAS system is typically a GNSS receiver that complies with E/TSO-C129a, E/TSO-C145 () or E/TSO-C146() fault detection (FD) requirements.

y) **RNP operations**.- Aircraft operations using an RNP system for RNP applications.

z) **Precision**.- The degree of tolerance (difference) between the desired position, measured or estimated, and the actual position. Navigation performance precision is normally expressed as a

statistical measure of the system error, and is specified as predictable, repeatable, and relative.

aa) **Approach procedure with vertical guidance (APV)**.- Instrument approach procedure using lateral and vertical guidance, but which does not meet the requirements specified for precision approach and landing operations.

bb) **Flight path alignment point (FPAP)**.- The FPAP is a point on the same lateral plane as the landing threshold point (LTP) or the fictitious threshold point (FTP) that is used to determine the alignment of the final approach segment. In approaches aligned with the runway centre line, the FPAP is located at the stop end of the runway or beyond. Its location is defined by the length displacement delta with respect from the opposite runway threshold.

cc) **Way-point (WPT)**.- A specified geographical location used to define an area navigation route or the flight path of an aircraft employing area navigation. Way-points are identified as either:

Fly-by way-point.- A way-point which requires turn anticipation to allow tangential interception of the next segment of a route or procedure, or
Flyover way-point.- A way-point at which a turn is initiated in order to join the next segment of a route or procedure.

dd) ***Fictitious threshold point (FTP).***- The FTP is a point crossed over by the final approach segment path at a relative height specified according to the reference datum height (RDH). The FTP replaces the LTP when the final approach course is not aligned with the extended runway end or when the threshold is displaced. For non-aligned approaches, the FTP is located in the intersection of the perpendicular from the final approach segment (FAS) to the runway threshold. FTP elevation is the same as the real elevation of the runway threshold.

ee) ***Landing threshold point (LTP).***- The LTP is a point over which the glide path passes at a relative height specified according to the reference datum height. The LTP is normally located in the intersection between the runway centre line and the threshold.

ff) **Initial approach fix (IAF)**.- A fix that marks the beginning of the initial segment and the end of the arrival segment, as applicable. In RNAV applications, this fix normally is defined by a “fly-by way-point”.

gg) ***European Geostationary Navigation Overlay Service (EGNOS).***- Satellite-based augmentation system that provides navigation systems that meet the requirements of Annex 10 in the European Region.

hh) **ILS look alike**.- Is defined as the capacity of a non-ILS navigation receiver to provide operational and functional interface with the rest of the aircraft equivalent to an ILS-based receiver. The output should be in DDM/micro amperes, with sensitivity equivalent to an ILS receiver.

ii) **Aircraft-based augmentation system (ABAS)**.- A system that augments and/or integrates the information obtained from the other GNSS elements with information available on board the aircraft.

Note.- *The most common ABAS mode is receiver autonomous integrity monitoring (RAIM).*

jj) **Satellite-based augmentation system (SBAS)**.- A wide coverage augmentation system in which the user receives augmentation information from a satellite-based transmitter.

Note*.- SBAS performance standards are contained in Annex 10, Volume I, Chapter 3.*

kk) **Multi-functional transport satellite-based augmentation system (MSAS)**.- A satellite-based augmentation system that provides navigation services that meet the requirements of Annex 10 in the Asia/Pacific Region.

ll) **Wide area augmentation system (WAAS)**.- A satellite-based augmentation system that provides navigation services that meet the requirements of Annex 10 in the United States of America.

mm) **Flight management system (FMS)**.- An integrated system consisting of an on-board sensor, a receiver and a computer with navigation and aircraft performance databases, capable of

providing performance values and RNAV guidance to a display and automatic flight control system.

nn) **Global positioning system (GPS)**.- The United States global navigation satellite system (GNSS) is a satellite-based radio navigation system that uses precise distance measurements to determine position, speed, and time anywhere in the world. The GPS consists of three elements: the spatial, control and user elements. The spatial element is nominally made up by at least 24 satellites in 6 orbit planes. The control element consists of 5 monitoring stations, 3 ground antennae, and one main control station. The user element consists of antennae and receivers that provide the user precise information on position, speed and time.

oo) **Global navigation satellite system (GNSS)**.- Generic term used by ICAO to define any global system for determining position, speed, and time, which comprises one or more main satellite constellations, such as GPS and the GLObal navigation satellite system (GLONASS), airborne receivers, and various integrity monitoring systems, including aircraft-based augmentation systems (ABAS), satellite-based augmentation systems (SBAS), such as the wide area augmentation system (WAAS) and ground-based augmentation systems (GBAS), such as the local area augmentation system (LAAS).

Distance information will be provided, at least in the immediate future, by GPS and GLONASS.

pp) **RNP system**.- An area navigation system that supports on-board performance control and alert.

qq) **Threshold (THR)**.- The beginning of that portion of the runway usable for landing.

rr) **RNP** value.- The RNP value designates the lateral performance requirement associated to a procedure. Examples of RNP values are: RNP 0.3 and RNP 0.15.

ss) **Cyclic redundancy check (CRC)**.- A mathematical algorithm applied to the digital expression of data that provides a certain level of quality assurance against data loss or changes.

tt) **Receiver autonomous integrity monitoring (RAIM)**.- A technique used within a GPS receiver/processor to determine navigation signal integrity, using only GPS signals or GPS signals enhanced with barometric altitude data. This determination is achieved by checking the consistency of redundant pseudo-range measurements. At least one additional available satellite is required with respect to the number of satellites needed for obtaining the navigation solution.

4.2 Abbreviations

a)	CAA	Civil aviation administration
b)	ABAS	Aircraft-based augmentation system
c)	AFM	Aircraft flight manual
d)	AIP	Aeronautical information publication
e)	AP	Autopilot
f)	APCH	Approach
g)	APV	Approach procedures with vertical guidance
h)	AR	Authorisation required
i)	AIRAC	Aeronautical information regulation and control
j)	AC	Advisory circular (FAA)
k)	AFM	Aircraft flight manual
l)	AMC	Acceptable means of compliance
m)	ANSP	Air navigation service provider

n)	ATC	Air traffic control
o)	ATS	Air traffic service
p)	baro-VNAV	Barometric vertical navigation
q)	CA	Advisory circular (SRVSOP)
r)	CDI	Course deviation indicator
s)	CRC	Cyclic redundancy check
t)	DA/H	Decision altitude/height
u)	DME	Distance measuring equipment
v)	FD	Fight dispatcher
w)	EASA	European Aviation Safety Agency
x)	EGNOS	European geostationary navigation overlay service
y)	EHSI	Enhanced horizontal situation indicator
z)	ETSO	European technical standard order
aa)	EUROCAE	European organisation for civil aviation equipment
bb)	FAA	United States Federal Aviation Administration
cc)	FAF	Final approach fix
dd)	FAP	Final approach point
ee)	FAS	Final approach segment
ff)	FD	Fault detection
gg)	FD	Flight director
hh)	FDE	Fault detection and exclusion
ii)	FG	Flight guidance
jj)	FPAP	Flight path alignment point
kk)	FSD	Full scale deflection
ll)	FMS	Flight management system
mm)	FPAP	Flight path alignment point
nn)	ft	Foot (feet)
oo)	FTE	Flight technical error
pp)	FTP	Fictitious threshold point
qq)	GBAS	Ground-based augmentation system
rr)	GNSS	Global navigation satellite system
ss)	GLONAS	Global navigation satellite system
tt)	GPA	Glide path angle
uu)	GPS	Global positioning system
vv)	HAT	Height above the touchdown zone
ww)	HSI	Horizontal situation indicator
xx)	IAF	Initial approach fix

yy)	IF	Intermediate fix
zz)	ILS	Instrument landing system
aaa)	IMC	Instrument meteorological conditions
bbb)	IPC	Illustrated part catalogues
ccc)	IR	Implementing rule (EASA)
ddd)	ILS look alike	ILS look alike
eee)	LAAS	Local area augmentation system
fff)	LAR	Latin American Aeronautical Regulations
ggg)	LNAV	Lateral navigation
hhh)	LOA	Letter of authorisation/letter of acceptance
iii)	LOC	Localizer
jjj)	LOI	Loss of integrity
kkk)	LP	Localizer performance
lll)	LPV	Localizer performance with vertical guidance
mmm)	LTP	Landing threshold point
nnn)	MCM	Maintenance control manual
ooo)	MEL	Minimum equipment list
ppp)	MSAS	Multifunction satellite augmentation system
qqq)	NDB	Non-directional radio beacon
rrr)	NM	Nautical miles
sss)	NPA	Non-precision approach
ttt)	NSE	Navigation system error
uuu)	NOTAM	Notice to airmen
vvv)	ICAO	International Civil Aviation Organization
www)	OCA/H	Obstacle clearance altitude/height
xxx)	OM	Operations manual
yyy)	OpSpecs	Operations specifications
zzz)	OCS	Obstacle clearance surface
aaaa)	PANS-OPS	Procedures for air navigation services – Aircraft operations
bbbb)	PBN	Performance-based navigation
cccc)	PDE	Path definition error
dddd)	POH	Pilot operating handbook
eeee)	RAIM	Receiver autonomous integrity monitoring
ffff)	RNAV	Area navigation
gggg)	$RNAV_{(GNSS)}$	RNP APCH approaches based on GNSS (GPS)
hhhh)	RNP	Required navigation performance
iiii)	RNP APCH	Required navigation performance approach

jjjj)	RNP AR APCH	Required navigation performance approach with authorization required
kkkk)	RTCA	Radio Technical Commission for Aeronautics
llll)	SAM	South American Region
mmmm)	SBAS	Satellite-based augmentation system
nnnn)	SRVSOP	Regional Safety Oversight Cooperation System
oooo)	TCH	Threshold clearance height
pppp)	THR	Threshold
qqqq)	TSE	Total system error
rrrr)	TSO	Technical standard order
ssss)	VDI	Vertical deviation indicator
tttt)	VMC	Visual meteorological conditions
uuuu)	VNAV	Vertical navigation
vvvv)	VTF	Vector to final
wwww)	VOR	VHF omnidirectional radio range
xxxx)	VPA	Vertical path angle
yyyy)	WAAS	Wide area augmentation system
zzzz)	WGS	World geodetic system
aaaaa)	WPT	Waypoint

5. INTRODUCTION

5.1 This AC deals with SBAS-augmented GNSS-based approach applications classified as RNP APCH in accordance with the performance-based navigation (PBN) concept and that provide access down to LP and LPV minima.

5.2 RNP APCH procedures include existing $RNAV_{(GNSS)}$ approach procedures conducted down to LP or LPV minima.

5.3 RNP APCH down to LPV minima may provide access to a different range of minima, depending on navigation system performance and on the assessment of the appropriate airspace authority. The provisions contained in this AC are consistent with these different groups of LPV minima, up to 200 ft.

5.4 For autonomous and multi-sensor RNP systems that use SBAS-augmented GNSS, compliance with the European (EASA AMC 20-28) and US FAA [AC 20-138(), AC 20-130A or TSO C115b] guidance material ensures automatic compliance with this AC, turning unnecessary a further assessment or AFM documentation. An operational approval of this criterion enables the operator to conduct RNP APCH operations down to LP or LPV minima worldwide.

5.5 This AC only deals with the navigation requirement along a straight final approach segment and the direct extension of the final approach in the missed approach.

5.6 The navigation requirements for the initial and intermediate segments and for the other missed approach segments are addressed in SRVSOP CA 91-008 – Approval of aircraft and operators for RNP APCH operations down to LNAV and LNAV/VNAV minima. Curved approaches are addressed in SRVSOP CA 91-009 – Approval of aircraft and operators for RNP AR APCH operations.

5.7 These criteria apply only to approaches down to LP and LPV minima, and do not apply to

approaches down to LNAV and LNAV/VNAV minima (CA 91-008) or RNP approaches with required authorisation (RNP AR APCH) (CA 91-009).

5.8 LP procedures are approaches only with vertical guidance, similar to instrument landing system (ILS) procedures with localizer (LOC) that use SBAS for a more precise vertical guidance. These procedures are designed for places where the terrain and obstacles do not allow LPV minima, and have a smaller obstacle clearance surface (OCS) compared to other procedures, which in many cases allows for minima that are lower than those for procedures with lateral navigation (LNAV) alone.

***Note**.- At some airports, it may not be possible to meet the requirement to publish an approach procedure with LPV vertical guidance. This may be due to: obstacles and terrain along the intended final approach path, airport structure deficiencies, or inability of SBAS to provide the desired vertical guidance availability (*e.g., *an airport located on the SBAS service area strip). When this occurs, the State may provide an LP approach procedure based on SBAS lateral performance. The LP approach procedure is a non-precision approach (NPA) procedure with angular lateral guidance equivalent to an approach with localizer. Being a NPA, the LP approach procedure provides lateral navigation guidance down to a minimum descent altitude (MDA); however, SBAS integration does not provide vertical guidance for LP approaches. Except for the guidance material directly related to SBAS vertical guidance, the guidance material in this CA applies to both LP and LPV approach operations.*

5.9 The final approach segment (FAS) of RNP APCH operations down to LP and LPV minima is especially characterised by a geometrically defined FAS. The FAS is the approach path defined laterally by the flight path alignment point (EFAP) and the landing threshold/fictitious threshold point (LTP/FTP), and vertically by the threshold clearance height (TCH) and the glide path angle (GPA).

5.10 The FAS may be intercepted by an approach transition (*e.g.,* RNAV 1) or by an initial or intermediate segment of an RNP APCH approach, or by radar vectoring (*e.g.,* interception of the extended final approach segment).

5.11 Aircraft equipped with SBAS avionics of operational class 2, 3, or 4 may use SBAS vertical guidance in lieu of barometric vertical guidance when conducting a baro-VNAV procedure developed in accordance with the APV/baro-VNAV criteria of Doc 8168, Volume II, provided the procedure is located within an area designated for SBAS service with vertical guidance.

5.12 The published temperature restrictions for barometric VNAV procedures do not apply for SBAS approach operations.

5.13 Although RNP APCH operations down to LP or LPV minima using SBAS-augmented GNSS are not envisaged for the near future in the South American (SAM) Region due to lack of navigation aid infrastructure, this condition does not prevent operator in this region to request and obtain from their CAA the respective authorisation for conducting these procedures where published.

5.14 The material described in this CA has been developed based on the following document:

- ✓ Attachment to ICAO State letter SP 65/4-10/53 – Part B – RNP APCH operations down to LP and LPV minima.

5.15 This CA has been harmonised inasmuch as possible with the following guidance documents:

- ✓ EASA AMC 20-28 - Airworthiness approval and operational criteria for RNAV GNSS approach operation to LPV minima using SBAS; y
- ✓ FAA AC 20-138B - Airworthiness approval of positioning and navigation systems.

***Note**.- Despite harmonisation efforts, operators shall take note of the differences between this CA and the aforementioned documents when requesting an authorisation from the corresponding administrations.*

6. GENERAL CONSIDERATIONS

6.1 Radio aid infrastructure

a) The SBAS-augmented GNSS is a primary navigation system for supporting RNP APCH operations down to LP or LPV.

b) The navigation system must comply with Annex 10, Volume I to the Convention on International Civil Aviation.

c) The missed approach segment may be based on conventional navigation aids (*e.g.*, VOR, DME, NDB).

d) The airspace authority must analyse the acceptability of the risk of losing RNP APCH capability in several aircraft due to satellite and/or SBAS system failure, failure of the on-board performance control and alert function, or radio frequency interference.

6.2 Obstacle clearance

a) The PANS-OPS (ICAO Doc 8168, Volume II) provides detailed obstacle clearance guidance; the general criteria contained in Parts I and III of said document apply, together with the approach criteria of Doc 8168, Volume II, Part III, Section 1, Chapter 5 and Section 3, Chapter 5 concerning SBAS.

b) Missed approach procedures may be supported by RNAV or conventional segments (*e.g.*, based on NDB, VOR, DME).

6.3 Publication

a) The AIP should clearly indicate that the navigation application is RNP APCH. Charts should follow the standards of Annex 4 – *Aeronautical charts* for the designation of an RNAV procedure where the vertical flight path is geometrically specified by the final approach segment (FAS) data block.

b) The charting designation will continue to be compatible with the current convention [$RNAV_{(GNSS)}$] and will be promulgated as an LP or LPV OCA (H).

***Note**.- LP, LPV, LNAV, and LNAV/VNAV minima may be indicated in the same chart entitled $RNAV_{(GNSS)}$.*

c) If the missed approach segment is based on conventional means, the air navigation facilities needed to conduct the approach shall be identified in the relevant publications.

d) The navigation data published in the AIP for procedures and for support navigation aids must meet the requirements of Annex 4 – *Aeronautical charts* and of Annex 15 – *Aeronautical information services* (as applicable). Charts will provide sufficient information to support navigation database checking by the crew (including the name of waypoints, path, distance of each segment, and vertical path angle).

e) All procedures must be based on WGS-84 coordinates.

f) The LP and LPV FAS will be promulgated using the FAS data block process. This FAS data block contains the lateral and vertical parameters that define the approach to be executed. Each FAS data block ends with a cyclic redundancy check (CRC) that processes approach data.

6.4 Air traffic service communication and surveillance (ATS)

a) The RNP APCH operation down to LP or LPV minima using SBAS-augmented GNSS does not include specific requirements for ATS communication or surveillance.

b) An adequate obstacle clearance is obtained through aircraft performance and operating procedures.

c) When contingency procedures depend on the use of radar, its performance must be shown to be adequate for such end. The radar service requirement will be identified in the AIP.

d) Appropriate radio phraseology will be promulgated for RNP APCH operations.

e) The specific terminal area and approach hazards and the effect of contingency procedures following a multiple loss of RNP APCH capability shall be assessed.

6.5 Navigation aid infrastructure oversight

a) The service provider shall oversee and maintain, if appropriate, the navigation aid infrastructure;

furthermore, it shall issue timely warnings of service outages (NOTAMs).

b) Information shall be provided in accordance with Annex 11 – *Air traffic service* with respect to the status of navigation facilities that may be used in support of the operation.

6.6 **ATS system oversight**

If an observation or analysis indicates that a loss of obstacle clearance has occurred, the reason for the apparent track or altitude deviation must be determined and measures must be adopted to prevent recurrence.

7. AIRWORTHINESS AND OPERATIONAL APPROVAL

7.1 For a commercial air transport operator to obtain RNP APCH approval down to LP or LPV minima, it shall comply with two types of approval:

a) the airworthiness approval by the State of registry; and

b) the operational approval by the State of the operator.

7.2 For general aviation operators, the State of registry will determine if the aircraft meets the applicable RNP APCH requirements and will issue the operating authorisation (*e.g.,* a letter of authorisation – LOA).

7.3 Before submitting their request, operators shall review all aircraft rating requirements. Compliance with airworthiness requirements of equipment installation by themselves does not constitute operational approval.

8. AIRWORTHINESS APPROVAL

8.1 General

a) The following airworthiness criteria are applicable to the installation of RNP systems required for RNP APCH operations down to LP or LPV minima:

1) This CA builds on FAA advisory circular AC 20-138A (or later version) for airworthiness approval of a GNSS-based RNP system augmented by SBAS.

2) This CA will be used to show compliance with applicable airworthiness codes and functional criteria.

8.2 On-board equipment and installation rating

a) **SBAS GNSS autonomous navigation system**

The SBAS GNSS autonomous system must be approved in accordance with E/TSO-C146a (or later version). The application of this provision ensures that the equipment at least complies with RTCA DO-229C (or later version). The equipment must be Class Gamma, Operational class 3.

b) **Integrated navigation system with SBAS GNSS sensor**

For an integrated navigation system (*e.g.*, FMS) that includes an SBAS GNSS, E/TSO C115b and AC 20-130A provide an acceptable means of compliance for the approval of this navigation system when it meets the following guidelines:

1) Compliance with the performance requirements of E/TSO-C146a (or later version) applicable to functional Class gamma, Operational class 3 or Delta 4; and

2) Approval of the SBAS GNSS sensor in accordance with E/TSO C145a Class beta, Operational class 3.

c) **Approach system with SBAS GNSS Class Delta equipment**

The equipment must be approved in accordance with la E/TSO-C146a (or later version). This provision ensures that the equipment at least complies with RTCA DO-229C (or later version).

The equipment must be Class delta 4.

8.3 Aircraft requirements

8.3.1 **Performance, control, and alert requirements**

a) **Precision**.- During the final approach segment and in the direct extension of the final approach in the missed approach, total system lateral and vertical error depends on the navigation system error (NSE), the path definition error (PDE) and the flight technical error (FTE).

1) NSE.- Precision (error estimated with 95% probability) varies due to different satellite geometries. The assessment based on measurements within a variable time window is not appropriate for GNSS. Therefore, GNSS precision is specified as a probability for each NSE sample. Requirements are met without any demonstration if the equipment calculates 3D position using a squared weighted linear solution in accordance with Appendix J to RTCA DO 229C (or later version). The NSE must be within the precision requirements of Annex 10, Volume 1, paragraph 3.7.2.4 (signal-in-space performance requirements). The equipment that complies with E/TSO-C145a/C146a (or later versions) meets the precision requirements of Annex 10 to the Convention on International Civil Aviation.

2) FTE.- FTE performance is considered acceptable if the maximum deflection (FSD) of the lateral and vertical display is compatible with non-numerical lateral and vertical deviation requirements of RTCA DO 229C (or later version), and if the flight crew maintains the aircraft within 1/3 of the FSD for lateral deviation, and within ½ of the FSD for vertical deviation.

3) PDE.- PDE is considered insignificant based on the path specification process and the quality assurance included in the FAS data block generation process. The air navigation service provider (ANSP) is responsible for generating the FAS data block.

***Note**.- FTE performance is considered acceptable is the flight guidance system approach mode is used during approach.*

b) **Integrity**.- The simultaneous display of lateral guidance, vertical guidance and erroneous distance data during an RNP APCH operation down to LP or LPV minima is considered a hazardous failure condition (extremely remote).

***Note**.- When the APC approach capability is added to an aircraft that has ILS capability, the integrity of the existing ILS display(s) or course deviation indicator(s) used for the LPV approach operation is considered acceptable.*

c) **Continuity**.- It will be shown that:

1) The probability of loss of navigation information is remote.

2) The probability of not recovering from the loss of all communication and navigation functions is extremely remote.

The loss of the LP or LPV approach capability is considered as a minor failure condition if the operator can revert to a different navigation system and fly to a suitable airport. For the LP or LPV approach operation, at least one system is required.

***Note 1**.- The operator must develop contingency procedures in the event of loss of the approach capability during approach.*

***Note 2**.- The term probability is defined in EASA AMC 25.1309 and FAA AC 23.1309-1(), AC 27-1B or AC 29-2C.*

d) **On-board performance control and alert**.- During operations in the final approach segment of an RNP APCH operation down to LP and LPV minima, the on-board performance control and alert function is fulfilled through:

1) NSE control and alert (see the section related to the signal-in-space).

2) FTE control and alert.- LPV approach guidance must be shown in lateral and vertical deviation displays (HSI, EHSI, CDI/VDI), including a failure indicator. The deviation display must have a suitable FSD based on maintenance of the required track precision. Lateral and vertical FSDs are angular and associated to the lateral and vertical definition of the final approach segment contained in the FAS data block.

3) Navigation database.- Once the FAS data block has been decoded, the equipment will apply the CRC to the data block in order to determine whether the information is valid. If the FAS data block does not pass the CRC test, the equipment will not permit the activation of the LP or LPV approach operation.

e) **Signal-in-space**

1) Within 2 NM of the FAP, the aircraft navigation equipment will provide an alert within 10 seconds of the signal-in-space error causing a lateral position error is greater than 0.3 NM with a probability of 10^{-7} per hour (Annex 10, Volume I, Table 3.7.2.4-1).

2) After FAP sequencing and during operations in the final approach segment of an RNP APCH operation down to LP or LPV minima:

(a) The aircraft navigation equipment will provide an alert within 6 seconds if signal-in-space the error causing a lateral position error is greater than 40 m, with a probability of $1\text{-}2.10^{-7}$ in any approach (Annex 10, Volume I, Table 3.7.2.4-1); and

(b) The aircraft navigation equipment will provide an alert within 6 seconds if the signal-in-space error causing a vertical position error is greater than 50 m (or 35 m for LPV minima down to 200 ft), with a probability of $1\text{-}2.10^{-7}$ in any approach (Annex 10, Volume I, Table 3.7.2.4-1)

***Note 1**.- There are no RNP APCH requirements for missed approach if such missed approach is based on conventional means (VOR, DME, NDB) or dead reckoning navigation. The requirements for direct extension of the final approach in the missed approach are in accordance with RTCA DO 229C (or later versions).*

***Note 2**.- Compliance with the performance control and alert requirement does not imply automatic monitoring of a flight technical error. The on-board control and alert function should at least consist of a navigation system error (NSE) control and alert algorithm and a lateral and vertical deviation display that allows the crew to monitor flight technical error (FTE). To the extent operational procedures are used to monitor FTE, the crew procedure, the equipment and facility characteristics are assessed for efficacy and equivalence as described in the functional requirements and operating procedures. The path definition error (PDE) is considered insignificant due to the quality assurance process (paragraph 9.4) and flight crew procedures (paragraph 9.2).*

8.4 Functional requirements

Functional criteria provided in this section are only applicable to RNP APCH operations down to LP or LPV minima. Therefore, such criteria are limited to the LP or LPV final approach segment and to the interception of the extended final approach segment.

If the navigation system installed is also capable of performing the initial, intermediate, and missed approach segments of approach, it must be approved in accordance with the corresponding requirements (*e.g.*, CA 91-008 of the SRVSOP – RNP APCH down to LNAV and LNAV/VNAV minima).

a) **Required navigation and functional displays**

1) Approach guidance must be shown on a lateral and vertical deviation display (HSI, EHSI, CDI/VDI), including a failure indicator, and must meet the following requirements:

(a) This display must be used as a primary flight instrument for approach;

(b) The display must be visible and be located in the main field of vision of the pilot (±15 degrees from the normal line of vision of the pilot) when looking forward along the flight path;

(c) The deviation display must have a suitable FSD based on maintaining the required track precision;

Lateral and vertical FSDs are angular and associated to lateral and vertical definitions of the final approach segment contained in the FAS data block.

***Note 1**.- When the minimum crew is two pilots, it should be possible for the pilot who is not in command to check the intended path and aircraft position with respect to the path.*

***Note 2**.- For more details about the lateral and vertical deviation display scales, see the non-numeric lateral and vertical deviation requirements of DO 229C (or later version).*

2) **At least the following system functions are required**:

(a) The capability of displaying the GNSS approach mode (*e.g.*, LP, LPV, LNAV/VNAV, LNAV) in the main field of vision. This announcement indicates to the flight crew the active approach mode in order to correlate it with the respective line of minima of the approach chart. It can also detect the level of degradation of the service (*e.g.,* degradation from LPV to LNAV). The on-board system should automatically provide the highest service level available for announcing the GNSS approach mode when the approach is selected.

(b) The capability of continuously showing the distance to the landing threshold point/fictitious threshold point (LTP/FTP).

(c) The navigation database must contain all the necessary information/data for flying the published approach procedure (final approach segment). Although data may be stored or transmitted in different forms, they must be organised in data blocks for calculating CRC. This format provides integrity protection for the data it stores. Consequently, each final approach segment is defined by an "FAS data block" that contains the lateral and vertical parameters needed to display the intended approach to be used. Once the FAS data block has been decoded, the equipment will apply the CRC to said block in order to determine whether the data are valid. If the FAS data block does not pass the CRC test, the equipment will not allow the activation of the approach operation.

(d) The capability of loading the whole approach procedure to be performed into the RNAV system from the database (by the number of SBAS channel and/or name of the approach).

(e) Navigation loss indication (*e.g.*, system failure) in the main field of vision of the pilot through a flag or equivalent indicator in the lateral and/or vertical navigation display.

(f) Loss of integrity (LOI) indication in the main field of vision of the pilot (*e.g.*, through a suitably located indicator).

(g) The capability of immediately providing track deviation indications in relation to the extended final approach segment, to facilitate interception of said segment from a radar vector [*e.g.,* in a vector-to-final (VTF) mode].

***Note**.- These requirements are limited to the final approach segment, to the direct extension of the final approach segment in the missed approach, and to the interception of the extended final approach segment. If the installed system is also capable of performing the initial, intermediate and missed approach segments of the approach, it must be tested in accordance with the corresponding requirement (*e.g.*, RNP APCH or RNAV 1 criteria).*

8.5 Aircraft modification

a) If any system required for RNP APCH operations is modified (*e.g.,* change in software or hardware), the aircraft modification must be approved.

b) The operator must obtain a new operational approval supported on updated operational and rating documentation of the aircraft.

8.6 Airworthiness compliance

8.6.1 General

a) This section describes a means of airworthiness compliance for new or modified facilities (paragraph 8.6.2), as well as for existing facilities (paragraph 8.6.3). It also describes specific items to be taken into account during the approval process (paragraphs 8.6.4 and 8.6.5).

b) In order to determine whether the aircraft is equipped with a navigation system that meets the requirements of an LP or LPV approach, relevant documentation showing airworthiness compliance must be available.

8.6.2 New or modified facilities

a) Upon showing compliance with this CA, the following specific items must be considered:

1) The applicant will present to the CAA a statement of compliance showing how the criteria of this CA have been met. The statement must be based on a plan agreed with the CAA in the initial stage of the approval process. The plan must identify the certification information to be submitted, which will include, as necessary, a description of the system and the evidence resulting from the activities defined in the following paragraphs.

2) Compliance with airworthiness requirements for the intended function and safety must be shown through the equipment rating, the system safety analysis, confirmation of the appropriate level of safety of the programme design, a performance analysis, and a combination of ground and flight tests. In order to support the approval request, design information will be presented showing that the objectives and criteria of this section have been met.

8.6.3 Existing facilities

The applicant will present to the CAA a statement of compliance showing how the criteria of this CA have been met for existing facilities. Compliance may be established through an inspection of the installed system to confirm availability of the required characteristics and functions. The integrity and performance criteria of Sections 8.3 and 8.4 may be confirmed in reference to the aircraft flight manual or other applicable approvals and through supporting certification data. In the absence of such evidence, supplementary analyses and/or tests may be required.

8.6.4 Specific installation criteria

a) The following items must be taken into consideration during the airworthiness approval process:

1) Where conventional navigation/approach systems other than the systems installed provide display and/or guidance to the flight director/autopilot, the following means shall be provided:

(a) A system source selector as the single means of selection;

(b) A clear indication of the selected approach system on or close to the display;

(c) Guidance information display suitable for the selected approach system; and

(d) Delivery of guidance information to a flight director/autopilot, suitable for the selected approach system.

b) The indication to the flight director, autopilot, and selected approach system shall be compatible with the original cockpit design philosophy.

c) Equipment failure scenarios involving conventional navigation/approach systems and installed systems shall be assessed to show that:

1) Alternate means of navigation are available that are suitable in case of failure of the installed system; and

2) Reversal switching arrangements, *e.g.,* selection of the ILS 2 or LPV 2 system in the HSI # 1 in case of dual equipment, will not lead to erroneous or unsafe display configurations.

The assessment shall also take into account the probability of failures in switching devices.

d) Coupling arrangements between installed systems and the flight director/autopilot shall be assessed to show compatibility and that operating modes, including the failure mode system, have been clearly and unambiguously indicated to the flight crew.

e) The utilisation of the installed system and the mode of display of lateral and vertical guidance information to the flight crew shall be assessed to show that the flight crew error risk has been minimised. The flight crew must be aware at all times of the approach system being used.

f) The controls, displays, operating characteristics, and the flight crew interface with the

installed system shall be assessed with respect to flight crew workload, especially in the approach environment. Essential design considerations include the following:

1) Minimising dependence on the memory of the flight crew for any system operating procedure or task.

2) Developing a clear unambiguous display of system modes/sub-modes and navigation data, with emphasis on the improved situational awareness requirements for any automatic mode change.

3) Using the sensitive context help and error messages (*e.g.*, invalid entries or invalid data entry messages shall provide a simple means of determining how to enter valid data).

4) Putting special emphasis on the number of steps and minimising the time required to make modifications to the flight plan in order to accommodate ATC clearances, holding pattern procedures, runway or approach changes, missed approaches, and deviations to alternate destinations.

5) Minimising the number of "distraction" alerts so that the crew may recognise and properly react when so required.

8.6.5 FTE performance assessment for LP or LPV approach operations

a) The ILS look alike display is described in RTCADO-229C (or later version), especially the lateral and vertical FSD requirements. Deflection may be fully angular, with no limitations, or angular but limited to a given value (*e.g.*, limited to ±1 NM lateral and ±150 m vertical).

1) For installations where the autopilot has not been modified and the equipment provides ILS-alike deviations, the applicant shall conduct several manual flight approaches with the flight director or autopilot connected, as required. The objective of this test is to make sure that the interface of the installed equipment is compatible with the aircraft rather than checking approach performance.

2) For installations where the autopilot has been modified, and where the performance of the lateral/vertical control channel of the autopilot has not been assessed or when non-standard deviations are provided (not ILS look alike), approach performance must meet the established LAR requirement or equivalent.

3) For manual control of the approach flight path, the appropriate flight display(s) shall provide sufficient information to maintain the approach path and achieve alignment with the runway without major reference to other cockpit displays.

4) The LPV approach tracking performance shall be kept stable as follows:

(a) Lateral guidance from 1000 feet of height above touchdown (HAT) to DA(H) shall remain stable without major deviation (*e.g.*, within a deviation of ±50 microamperes) of the indicated path.

(b) Vertical guidance from 700 feet HAT to DA(H) shall remain stable without major deviation (*e.g.*, within a deviation of ±75 microamperes) of the indicated path.

***Note**.-Compatibility with ILS display systems may be attained by converting lateral and vertical deviations to microamperes, based on an FSD of 150 microamperes.*

8.6.6 Equipment mix

Simultaneous use of airborne systems with different flight crew interfaces may be confusing and lead to problems in case of conflicting operating practices and display formats. For approach operations, simultaneous use of equipment that is not identical or compatible is not allowed.

8.6.7 Aircraft flight manual/Pilot operating manual

a) For a new or modified aircraft, the aircraft flight manual (AFM) or the pilot operating manual (POH), as applicable, shall provide at least the following information:

1) A statement identifying the standard aircraft construction or modification certificate for GNSS RNAV approach operations down to LP or LPV minima using SBAS. This may include a brief description of the installed system, including the on-board equipment software version, the display equipment, and a statement that the system is suitable for LP or LPV approach operations. A brief introduction to the LP or LPV approach concept may also be included.

2) Appropriate amendments or supplements to cover LP or LPV approach operations in the following sections:

   (a) Limitations – including the use of lateral and vertical deviations, FD and AP; validity of navigation databases, navigation information check by the flight crew.

   (b) Normal procedures.

   (c) Abnormal procedures – including actions in response to the loss of integrity/loss of navigation, or in response to degradation of the GNSS approach mode (*e.g.,* degradation of LPV to LNAV).

***Note**.- In addition to this information, it is assumed that a detailed description of the installed system and the associated operating instructions and procedures is available in other operating or instruction manuals.*

8.7 Continued airworthiness

a) The operators of aircraft approved for RNP APCH operations down to LP or LPV minima must ensure the continuity of the technical capability of such aircraft to meet the technical requirements established in this CA.

b) Each operator applying for an RNP APCH operational approval down to LP or LPV minima shall submit to the CAA of the State of registry a maintenance and inspection programme that includes all those maintenance requirements necessary to ensure that navigation systems continue to meet the RNP APCH approval criteria down to LP or LPV minima.

c) The following maintenance documents must be reviewed, as appropriate, in order to include RNP APCH aspects down to LP or LPV minima:

   1) Maintenance control manual (MCM);

   2) Illustrated part catalogue (IPC); and

   3) Maintenance programme.

d) The maintenance programme approved for the affected aircraft must include the maintenance practices indicated in the corresponding maintenance manuals of the manufacturer of the aircraft and its components, and must consider:

   1) That the equipment involved in the RNP APCH operation down to LP or LPV minima must remain in accordance with the instructions of the component manufacturer;

   2) That any modification or change in the navigation system that in any way affects the initial RNP APCH approval down to LP or LPV minima must be communicated and reviewed by the CAA for purposes of acceptance of approval of such changes prior to their implementation; and

   3) Any repair not included in the approved/accepted maintenance documentation and that might affect navigation performance integrity must be communicated to the CAA for purposes of acceptance or approval.

e) RNP maintenance documentation must include the training programme for maintenance personnel, which must contemplate, *inter alia*:

   1) PBN concept;

   2) Application of RNP APCH down to LP or LPV minima;

   3) Equipment involved in an RNP APCH operation down to LP or LPV minima; and

4) Use of the MEL.

9. OPERATIONAL APPROVAL

The airworthiness approval alone does not authorise an operator to conduct RNP APCH operations. In addition to the airworthiness approval, the operator must obtain an operational approval to confirm the suitability of normal and contingency procedures with respect to the specific equipment installation.

9.1 Operational approval requirements

In order to obtain RNP APCH approval down to LP or LPV minima, the applicant or operator will complete the following steps taking into account the criteria established in this paragraph and in the paragraphs following this section:

a) *Airworthiness approval*.- Aircraft shall have the corresponding airworthiness approvals as established in paragraph 8 of this CA.

b) *Application*.- The operator will present to the CAA the following documentation:

1) *The request for RNP APCH operational approval down to LP or LPV minima*;

2) *Airworthiness documents related to aircraft admissibility.*- The operator will submit relevant documentation acceptable to the CAA showing that the aircraft has RNP navigation systems that meet RNP APCH requirements down to LP or LPV minima, as described in paragraph 8 of this CA. The operator will present those parts of the AFM or AFM supplement that include the statement of airworthiness.

3) *Description of aircraft equipment*.- The operator will provide a configuration list describing the relevant components and the equipment to be used in RNP APCH operations down to LP or LPV minima. The list shall include each manufacturer, model, and version of the SBAS-augmented GNSS equipment and FMS software installed.

4) *Training programme for the flight crew and flight dispatchers (DV)*

(a) Commercial operators (*e.g.*, LAR 121 and 135) will submit to the CAA the training curriculum for RNP APCH operations down to LP or LPV minima and other suitable material (*e.g*., computer-based training) to show that the operational procedures and practices and the training aspects described in paragraph 9.3 concerning RNP APCH operations down to LP or LPV minima have been included in the initial, promotion, or recurrent training for the flight crew and flight dispatchers.

Note.- *A separate training programme is not required if training on RNP APCH down to LP or LPV minima identified in paragraph 9.3 has already been included in the operator's training programme. However, it should be possible to identify which aspects of RNP APCH operations down to LP or LPV minima are covered in the training programme.*

(b) Non-commercial operators (*e.g.,* LAR 91 operators) must be familiar with, and show that they will be operating using, the operational procedures and practices and training aspects of paragraph 9.3.

5) *Operations manual and checklists*

(a) Commercial operators (*e.g.,* LAR 121 and 135 operators) must check the operations manual (OM) and the checklists so as to include information and guidance on the operating procedures described in paragraph 9.2 of this CA. The appropriate manuals must contain operating instructions on the navigation equipment and contingency procedures. Manuals and checklists must be submitted for review as attachments to the formal request in Phase 2 of the approval process.

(b) Non-commercial operators (*e.g.,* LAR 91 operators) must provide operating

instructions on the navigation equipment and contingency procedures. This information must be available for crews in the OM or in the pilot operating manual (POH). These manufacturer's manuals and instructions for the operation of the aircraft navigation equipment, as appropriate, must be submitted to the CAA as attachments to the formal request for their review.

6) *Minimum equipment list (MEL)*.- The operator will submit for approval of the CAA any revision to the MEL needed for RNP APCH operations down to LP or LPV minima. If an RNP APCH operational approval down to LP or LPV minima is granted based on a specific operational procedure, operators must modify the MEL and specify the dispatch conditions required.

7) *Maintenance*.- Together with the formal request, operators or owners will submit the maintenance requirements as established in paragraphs 8.6 and 8.7 of this CA.

8) *Training programme for maintenance personnel*.- Operators will send the training curriculum corresponding to maintenance personnel in accordance with paragraph 8.7 e) of this CA.

9) Performance history (if applicable).- The request will include the operating background of the operator. The applicant will include events or incidents related to RNP navigation errors (*e.g.,* those reported in the navigation error investigation forms of each CAA) and the methods used by the operator to address such events or incidents through new or revised training programmes, procedures, aircraft maintenance or modifications.

10) *Navigation data validation programme*.- The operator will present the details of the navigation data validation programme as described in Appendix 1 to this CA.

c) *Training*.- Once the amendments to the manuals, programmes, and documents sent have been accepted or approved, and before starting RNP APCH operations down to LP or LPV minima, the operator will provide the training required to its personnel.

d) *Validation flight*.- The AAC may deem it advisable to conduct a validation flight before granting the RNP APCH authorisation down to LP or LPV minima. The validation flight will be conducted in accordance with the criteria and procedures established in Chapter 11 – Validation tests, of Volume II, Part II of the SRVSOP Operations inspector manual. In order to determine whether the validation flight may be conducted in commercial operations, the aforementioned Chapter 11 will be consulted.

e) *Issuance of authorisation to conduct RNP APCH operations down to LP or LPV minima*.- Once the operator has successfully completed the operational approval process, the CAA will grant the operator the authorisation to conduct RNP APCH operations down to LP or LPV minima.

1) LAR 121 and/or 135 operators.- For LAR 121 and/or LAR 135 operators, the CAA will issue the corresponding operations specifications (OpSpecs) reflecting the RNP APCH authorisation down to LP or LPV minima.

2) LAR 91 operators.- For LAR 91 operators, the CAA will issue a letter of authorisation (LOA).

9.2 Operating procedures

a) **Pre-flight planning**

1) Operators and pilots foreseeing to conduct an RNP APCH operation down to LP or LPV minima must present the relevant flight plan suffixes. On-board navigation data must be current and include the appropriate procedures.

***Note**.- It is expected that the navigation databases will be current throughout the duration of the flight. If the AIRAC cycle must change during the flight, the operators and pilots should establish procedures to ensure the precision of navigation data, including the availability of the navigation facilities used for defining the routes and flight procedures.*

2) In addition to the normal pre-flight checks, the following must be included:

(a) The pilot must make sure that approach procedures that may be used for the intended flight (including alternate aerodromes) have been selected from a valid navigation database (current AIRAC cycle), have been verified through the appropriate processes, and are not forbidden by company instructions or NOTAMs;

(b) Subject to CAA regulations, the pilot shall ensure during the pre-flight phase that there are sufficient means available for navigating and landing at the point of destination or at the alternate aerodrome in case of loss of the on-board LP or LPV capability;

(c) Operators and flight crews must take into account all NOTAMs (including SBAS NOTAMs) or information text of the operator that could harm aircraft system operation or the availability or suitability of the procedures at the landing airport or any other alternate airport.

(d) If the missed approach procedure is based on conventional means (*e.g.,* VOR, NDB), the appropriate on-board equipment required for this procedure must be installed on the aircraft and in operating conditions. Ground-based navigation aids must also be serviceable. If the missed approach procedure is based on RNAV (conventional missed approach or dead reckoning not available), the appropriate on-board equipment required to fly this procedure must be installed on the aircraft and in operating conditions.

3) The availability of the navigation aid infrastructure required for the intended routes, including any non-RNAV contingency, must be confirmed for the period of intended operation using all available information. Since Annex 10, Volume I requires GNSS integrity, the availability of this system must also be determined as applicable.

b) **Availability of augmented GNSS**

1) Service levels required for RNP APCH operations down to LP or LPV minima may be verified either by NOTAM (when available) or by prediction services. The operations authority may provide specific guidance on how to comply with this requirement. Operators must be familiar with the prediction information available for the intended route.

2) LP or LPV service availability prediction shall take into account the latest NOTAMs on the status of the GPS constellation and the SBAS system, and of the avionics model (when available). The service may be provided by the ANSP, the avionics manufacturer, other entities, or through an on-board LP or LPV receiver service prediction capability.

3) In case of foreseen and continuous loss of the appropriate level of fault detection (FD) for more than five minutes for any part of the RNP APCH operation down to LP or LPV minima, flight planning should be reviewed (*e.g.*, delaying the departure or planning a different departure procedure).

4) The service availability prediction software does not guarantee such service. Rather, it is a tool for assessing the foreseen capacity to meet the required navigation performance. Due to unexpected failure of some GNSS or SBAS elements, pilots/ANSPs must be aware that GNSS or SBAS may be completely lost while in the air. This may require reversal to an alternate means of navigation. Consequently, pilots shall assess their ability to navigate (possibly to an alternate destination) in case of SBAS GNSS navigation failure.

5) It is expected that availability prediction services will also be developed for future GNSS systems with a performance equivalent to SBAS.

c) **Before starting the procedure**

1) In addition to the normal procedure, before starting the approach (before the IAF and in a way consistent with crew workload), the flight crew will check if the loaded procedure is the correct one, as compared with the approach charts. This check must include:

(a) waypoint sequence;

(b) the rationality of approach segment tracks and distances, the precision of the approach, and the length of the final approach segment; and

***Note**.- At least, this check could be a simple inspection of a suitable mapping display.*

(c) the vertical path angle.

2) ATC tactical interventions in the terminal area may include radar headings, "direct to" clearances that avoid the initial segments of an approach, interception of an initial or intermediate approach segment or interception of waypoints extracted from the database. Upon complying with ATC instructions, the flight crew shall be aware of RNP navigation system implications:

(a) manual entry of coordinates in the RNAV system by the flight crew to operate within the terminal area is not permitted.

(b) "direct to" clearances may be accepted for the intermediate fix (IF) provided the resulting track change at the IF does not exceed 45 degrees.

***Note**.- "Direct to" clearance to the FAF is not acceptable.*

3) The approach system enables the pilot to intercept the final approach track much before the FAF [vectoring to final (VTF) or equivalent]. This function shall be used to comply with the promulgated ATC authorisation.

d) **During the procedure**

1) *The approach mode will be automatically activated by the RNP system*.- When a direct transition to the approach procedure is performed (*e.g*., when the aircraft receives vectors from ATC to the extended final approach and the crew selects the VTF or equivalent function), the LP or LPV approach mode will also be automatically activated.

2) The system provides lateral and/or vertical guidance for the LP or LPV final approach segment or the extended final approach segment (for a direct transition).

3) The crew must check that the GNSS approach mode indicates LP or LPV (or an equivalent warning) 2 NM before the FAP.

4) The final approach segment should be intercepted at the FAF at the latest, so that the aircraft may get established on the right final approach course before initiating the descent (to ensure terrain and obstacle clearance).

5) The relevant displays must be selected so as to be able to monitor the following information:

(a) aircraft position relative to lateral path;

(b) aircraft position relative to vertical path; and

(c) absence of loss-of-integrity (LOI) alert

6) The flight crew should comply with all altitude and speed restrictions.

7) Before FAF sequencing, the crew must interrupt the approach procedure if there is:

(a) loss of navigation, as indicated by a warning flag (*e.g.,* loss of power, equipment failure,…);

(b) loss of integrity monitoring (LOI), as announced by a local indicator or equivalent; and

(c) a low altitude alert (if applicable).

8) After FAF sequencing, the procedure must be discontinued, unless the pilot has on sight the required visual references to proceed with the approach, if:

(a) loss of navigation is indicated by a warning flag (*e.g.*, lateral flag, vertical flag, or both flags);

***Note**.- The loss of integrity monitoring (LOI) following FAF sequencing results in a loss of the navigation condition (warning flag).*

(a) loss of vertical guidance is flagged (even if lateral guidance is already displayed); and

(b) FTE is excessive and cannot be corrected on a timely basis.

9) Pilots must perform a missed approach if excessive lateral and vertical deviations are found that cannot be corrected on a timely basis, unless the pilot has on sight the visual references required to proceed with the published procedure (*e.g.*, RNAV or conventional).

e) **General operating procedures**

1) Operators and pilots must not request an RNP APCH operation down to LP or LPV minima unless they meet the criteria listed in the relevant CAA documents. If an aircraft pilot who does not meet the criteria is cleared by the ATC to conduct such operation, the pilot must communicate to the ATC that the clearance cannot be accepted and must request other instructions.

2) The pilot must follow the instructions or procedures identified by the manufacturer as necessary to meet the performance requirements of this section.

3) If the missed approach procedure is based on conventional means (*e.g.*, NDB, VOR, DME), the corresponding navigation equipment must be installed and in operating condition.

4) Pilots are encouraged to use the flight director and/or autopilot (AP) in lateral navigation mode, if available.

f) **Contingency procedures**

1) The operator shall develop contingency procedures to safely respond to a loss of RNP APCH capability during approach.

2) The pilot must advise ATC of any loss of RNP APCH capability, together with the proposed course of action. If the requirements of a RNP APCH procedure down to LP or LPV minima cannot be met, pilots must advise ATS as soon as possible. Loss of the capability of conducting RNP APCH operations down to LP or LPV minima includes any failure or event that results in the aircraft not being able to meet the RNP APCH requirements of the procedure. The operator shall develop contingency procedures to safely respond to a loss of RNP APCH capability during approach.

3) In the event of communication failure, the flight crew must proceed with the RNP APCH procedure in accordance with the published procedures in cases of loss of communication.

9.3 Training programme

The flight crew training programme shall be developed in such a way as to provide sufficient training in a simulator, a training device, or an aircraft on-line training device, on the use of the aircraft approach system so as to ensure that pilots will not receive guidance only on tasks. The following syllabus shall be considered as a minimum amendment to the training programme in support of operations:

a) RNP approach concept, containing LP or LPV minima:

1) Approach operations theory;

2) Approach charts;

3) Use of the approach system, including:

- Selection of the LP or LPV approach procedure;

- ILS “look alike” principle;

4) use of the lateral navigation mode(s) and the associated lateral control techniques;

5) use of the vertical navigation mode(s) and the associated vertical control techniques;

6) radio telephony (R/T) phraseology for LP or LPV approach operations;

7) implications for LP or LPV approach operations of malfunction of systems not related to the approach system (*e.g.*, hydraulic or engine failure); and

b) RNP approach operation with LP or LPV minima:

1) Definition of LP or LPV approach operations and their direct relationship with $RNAV_{(GNSS)}$ procedures;

2) Regulatory requirements for LP or LPV operations;

3) Navigation equipment required for LP or LPV approach operations LPV:

- GNSS concepts and characteristics;
- Augmented GNSS characteristics; and
- MEL.

4) Procedure characteristics:

- Mapping description;
- Aircraft display description; and
- Minima.

5) Retrieval of the LP or LPV approach procedure from the database (*e.g.*, using its name or SBAS channel number);

6) Change of the arrival and alternate airports.

7) Execution of the procedure:

- Use of AP, automatic accelerator, and flight director;
- Behaviour of the flight guidance (FG) mode;
- Management of lateral and vertical path;
- Compliance with speed and/or altitude restrictions;
- Interception of an initial or intermediate approach segment following an ATC notification;
- Interception of an extended final approach segment;
- Consideration of GNSS approach mode indication (LP, LPV, LNAV/VNAV, LNAV,…); and
- Use of another airborne equipment to support track monitoring and avoid weather conditions and obstacles.

8) ATC procedures;

9) Normal procedures; and

10) Contingency procedures.

9.4 Navigation database

a) The operator shall not use a navigation database for approach operations unless the navigation database supplier has a Type 2 letter of acceptance (LOA) or equivalent.

b) EASA issues a Type 2 LOA in accordance with EASA document OPINION Nr. 01/2005 – *Acceptance of navigation database suppliers* dated 14 January 2005. In turn, the FAA issues a Type 2 LOA in accordance with AC 20-153, while Transport Canada issues a letter of acknowledgment of an aeronautical data process that uses the same support as the aforementioned documents.

c) Document EUROCAE/RTCA ED-76/DO-200A – *Standards for processing aeronautical data* contains guidance concerning the process to be followed by a supplier. The LOA demonstrates compliance with this standard.

***Note**.- The navigation database of LP or LPV procedures is characterised by a FAS data block protected by a CRC. The FAS data block contains the lateral and vertical parameters that define the approach to be performed. These parameters have been calculated, validated, and promulgated by an ANSP. Furthermore, each FAS data block ends with a CRC that processes the approach data. Consequently, integrity is assured when the on-board equipment using the data successfully passes a CRC in the data block.*

d) The operator must continue monitoring both the process and the navigation data in accordance with the quality system required by the applicable operating regulations.

e) The operator will implement procedures to ensure the distribution and timely insertion of updated and unaltered electronic navigation data to all aircraft needing it.

10. OPERATOR OVERSIGHT

a) A regulatory authority may consider the reports of any navigation error to determine corrective measures. Navigation errors attributed to a specific part of the navigation equipment and that repeat themselves may result in the cancellation of the approval for the use of such equipment..

b) Information that indicates the possibility of repeated errors may call for a modification of the operator's training programme. Information that attributes multiple errors to a particular pilot crew indicates the need for recovery training or a licence revision.

APPENDIX 1

NAVIGATION DATA VALIDATION PROGRAMME

1. INTRODUCTION

The procedure stored in the navigation database defines aircraft lateral and vertical guidance. The navigation database is updated every 28 days. Navigation data used in each update are critical for the integrity of each RNP APCH approach down to LP or LPV minima. Taking into account the reduced obstacle clearance associated to these approaches, the validation of navigation data requires special consideration. This appendix provides guidance on operator procedures for validating navigation data associated with RNP APCH approaches down to LP or LPV minima.

2. DATA PROCESSING

a) The operator will identify in its procedures the person responsible for updating navigation data.

b) The operator must document a process for accepting, verifying, and loading navigation data into the aircraft.

c) The operator must subject its documented data process to a configuration control.

3. INITIAL VALIDATION OF DATA

The operator must validate each RNP APCH procedure down to LP or LPV minima before flying the procedure under instrument meteorological conditions (IMC) to ensure compatibility with its aircraft and to make sure that the resulting paths correspond to the published procedure. As a minimum, the operator must:

a) Compare the procedure navigation data to be loaded in the FMS with a published procedure.

b) Validate the navigation data loaded for the procedure either using a flight simulator or the aircraft under visual meteorological conditions (VMC). The procedure outlined in a chart display must be compared with the published procedure. The complete procedure must be flown to make sure that the path can be used, that there are no apparent lateral or vertical path disconnects, and that it is consistent with the published procedure.

c) Once the procedure is validated, a copy of the validated navigation data must be retained and kept for comparison with subsequent data updates.

4. DATA UPDATES

Once the operator obtains a navigation data update and before using such data on the aircraft, the operator must compare the update with the validated procedure. This comparison must identify and resolve any navigation data discrepancy. In case of significant changes (any change that affects the path or the approach performance) to any part of the procedure and if such changes are verified based on the initial data, the operator must validate the amended procedure in accordance with the initial validation of the data.

5. NAVIGATION DATA SUPPLIERS

Navigation data suppliers must have a letter of acceptance (LOA) for processing such data (*e.g.,* FAA AC 20-153 or the document on the issuance of letters of acceptance to navigation data suppliers by the European Aviation Safety Agency – EASA (EASA IR 21 Subpart G) or equivalent document). An LOA recognises the data of a supplier as data where the quality, integrity, and quality management practices are consistent with the criteria contained in document DO-200A/ED-76. An operator's database supplier must have a Type 2 LOA, and its respective suppliers must have a Type 1 or 2 LOA. The CAA may accept an LOA issued to navigation data suppliers or issue its own

LOA.

6. AIRCRAFT MODIFICATIONS (DATABASE UPDATE)

If an aircraft system required for RNP APCH operations down to LP or LPV minima is modified (*e.g.,* change of software), the operator is responsible for validating the RNP APCH procedures down to LP or LPV minima with the navigation database and the modified system. This can be done without a direct assessment if the manufacturer verifies that the modification does not affect the navigation database or path calculation. In the absence of such verification by the manufacturer, the operator must conduct an initial validation of the navigation data with the modified system.

APPENDIX 2

PROCESS OF APPROVAL OF RNP APCH DOWN TO LP OR LPV MINIMA

a) The process of approval of RNP APCH operations down to LP or LPV minima covers two types of approval: the airworthiness and the operational approval. Although both have different requirements, they must be considered under a single process.

b) This process is an orderly method used by CAAs to ensure that applicants meet the established requirements.

c) The approval process consists of the following phases:

1) Phase one: Pre-application

2) Phase two: Formal application

3) Phase three: Documentation analysis

4) Phase four: Inspection and demonstration

5) Phase five: Approval

d) In *Phase one - Pre-application*, the CAA holds a meeting with the applicant or operator (pre-application meeting) in which it is informed of all the requirements it must meet during the approval process.

e) In *Phase two – Formal application*, the applicant or operator submits a formal request, accompanied by all the relevant documentation, as established in paragraph 9.1 of this CA.

f) In *Phase three – Documentation analysis,* the CAA assesses the documentation and the navigation system to determine their admissibility and what approval method is to be applied with respect to the aircraft. As a result of this analysis and assessment, the CAA may accept or reject the formal application together with the documentation.

g) In *Phase four – Inspection and demonstration*, the operator will provide training to its personnel and conduct the validation flights, if so required.

h) In *Phase five - Approval*, the CAA issues the RNP APCH approval down to LP or LPV minima once the operator has met the approval and operational requirements. For operators under LAR 121 and 135, the CAA will issue OpSpecs, and for operators under LAR 91, it will issue an LOA.

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