ADVISORY CIRCULAR

AC	**:**	**91-011**
DATE	**:**	**18/05/12**
REVISION	**:**	**ORIGINAL**
ISSUED BY	**:**	**SRVSOP**

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

1. PURPOSE

This advisory circular (AC) establishes the requirements of aircraft and operators approval for required navigation performance approach (RNP APCH) operations down to minima designated as localizer performance (LP) and localizer performance with vertical guidance (LPV), 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 AC will apply only to operators that request to operate in regions where the its use is authorised.

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 and 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)**.- The label to denote minima lines associated with APV-I or APV-II performance on 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 view**.- For the purpose of this AC, the primary field of view 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) **Full scale deflection (FSD)**.- The term used to describe the maximum deviation from center of either a course deviation indicator (CDI) or a vertical deviation indicator (VDI), such as a glide slope indicator, and that applies to both linear and angular scaling.

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, so that provides path deviation relative to a selected path. The equipment provides the navigation function required of a stand-alone navigation system. This equipment also provides integrity in absence of the SBAS signal by

using FDE. Furthermore, this class of equipment requires a database, display outputs and pilot controls.

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 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 fictitious threshold point (FTP) that is used to define the alignment of the final approach segment. In approaches aligned with the runway centre line, the FPAP is located at or beyond the opposite threshold of the runway. The delta length offset from the opposite threshold of the runway defines its location.

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 over which the final approach segment path passes at a relative height specified by the reference datum height. It is defined by the WGS-84 latitude, longitude and ellipsoid height. The FTP replaces the LTP when the final approach course is not aligned with the runway extended centre line or when the threshold is displaced from the actual runway threshold. For non-aligned approaches the FTP lies on the intersection of the perpendicular from the FAS to the runway threshold. The FTP elevation is the same as the actual runway threshold elevation.

ee) ***Landing threshold point (LTP)***.- The LTP is a point over which the glide path passes at a relative height specified by the reference datum height. It is defined by the WGS-84 latitude, longitude and ellipsoid height. The LTP is normally located at the intersection of the runway centre line and 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)***.- A satellite-based augmentation system which provides navigation services in the European Region that meet Annex 10 requirements.

hh) **ILS look alike**.- Is defined as the ability of a non-ILS based navigation receiver function to provide operational characteristics and interface functionality to the rest of the aircraft equivalent to that provided by an ILS based receiver function. The output should be in DDM/micro amps, with a 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 form of ABAS 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 which provides navigation services in the Asia/Pacific Region that meet Annex 10 requirements.

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

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 orbiting 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 level of assurance against loss or alteration of data.

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)	AC	Advisory circular
b)	CAA	Civil aviation administration
c)	ABAS	Aircraft-based augmentation system
d)	AFM	Aircraft flight manual
e)	AIP	Aeronautical information publication
f)	AP	Autopilot
g)	APCH	Approach
h)	APV	Approach procedures with vertical guidance
i)	AR	Authorisation required
j)	AIRAC	Aeronautical information regulation and control

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

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

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

5. INTRODUCTION

5.1 This AC addresses approach applications based on GNSS augmented by SBAS which are classified as RNP APCH in accordance with the performance-based navigation (PBN) concept and give access to minima designated as LP and LPV.

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 give access to a different range of minima, depending on the performance of the navigation systems and the assessment of the responsible airspace authority. The provisions given in this navigation specification are consistent with these different sets of LPV minima, down to 200 ft.

5.4 For existing stand-alone and multi-sensor RNP systems using GNSS augmented by SBAS, compliance with the European (EASA AMC 20-28) and United States (FAA AC 20-138(), AC 20-130A or TSO C115b) guidance material assures automatic compliance with this AC, obviating the need for further assessment or AFM documentation. An operational approval to this AC allows an operator to conduct RNP APCH operations globally.

5.5 This AC addresses only the requirement for the navigation aspect along a final approach straight segment and the straight continuation 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 – Aircraft and operators approval for RNP APCH operations down to LNAV and LNAV/VNAV minima. Curved approaches are addressed in SRVSOP CA 91-009 – Aircraft and operators approval for RNP AR APCH operations.

5.7 These criteria apply only to approaches conducted down to LP and LPV minima, and do not address approaches down to LNAV and LNAV/VNAV minima (CA 91-008) or RNP approaches with authorisation required (RNP AR APCH) (CA 91-009).

5.8 LP procedures are approaches only with lateral 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 desired final approach path, airport infrastructure deficiencies, or the inability of SBAS to provide the desired availability of vertical guidance (i.e., an airport located on the fringe of the SBAS service area). When this occurs, the State may provide an LP approach procedure based on lateral performance of SBAS. The LP approach procedure is a non-precision approach (NPA) procedure with angular lateral guidance equivalent to a localizer approach. As a NPA, an LP approach procedure provides lateral navigation guidance to a minimum descent altitude (MDA); however, the SBAS integration provides no 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 which is defined laterally by the Flight path alignment point (FPAP) and the Landing threshold point/Fictitious threshold point (LTP/FTP), and defined vertically by the Threshold crossing 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 initial and intermediate segments of an RNP APCH approach, or through vectoring (*e.g.,* interception of the extended final approach segment).

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

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

5.13 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.

5.14 This CA has been harmonised as much 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 GNSS augmented by SBAS is the primary navigation system to support RNP APCH operations down to LP or LPV minima.

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 upon GNSS or conventional navigation aids (*e.g.*, VOR, DME, NDB).

d) The acceptability of the risk of loss of RNP APCH capability for multiple aircraft due to satellite failure and/or SBAS system failure, loss of the onboard performance monitoring and alert function, or radio frequency interference must be considered by the responsible airspace authority.

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, 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. Charting must follow the standards of Annex 4 – *Aeronautical charts* for the designation of an RNAV procedure where the vertical flight path is geometrically specified by a final approach segment (FAS) data block.

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

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

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

d) The navigation data published in the AIP for the procedures and supporting navigation aids must meet the requirements of Annex 4 – *Aeronautical charts* and Annex 15 – *Aeronautical information services* (as appropriate). The charts will provide sufficient information to support navigation database checking by the crew (including waypoints names, track, distance for 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 specific on-board navigation database element defines the LP and LPV FAS and it is mentioned as *"FAS data block"*. This FAS data block contains the lateral and vertical parameters, which define the approach to be flown. Each FAS data block ends with a cyclic redundancy check (CRC), which wraps around the approach data.

6.4 Communication and ATS surveillance

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

b) Adequate obstacle clearance is achieved through aircraft performance and operating procedures.

c) Where reliance is placed on the use of radar to assist contingency procedures, it will demonstrated that its performance is adequate for that purpose and the requirement for radar service will be identified in the AIP.

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

e) The particular hazards of a terminal and approach area and the impact of contingency

procedures following a multiple loss of aircraft LP and LPV approach capability shall be assessed.

6.5 **Navigation aid infrastructure monitoring**

a) The navigation aid infrastructure shall be monitored and, where appropriate, maintained by the service provider. Timely warnings of outages (NOTAM) shall be issued.

b) Status information shall be provided in accordance with Annex 11 – *Air traffic service* for navigation facilities or services that may be used to support of the operation.

6.6 **ATS system monitoring**

If an observation or analysis indicates that a loss of obstacle clearance has occurred, the reason for the apparent deviation from track or altitude 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 qualification 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 uses the FAA advisory circular AC 20-138A (or subsequent version) as the basis for airworthiness approval of a RNP system based on GNSS augmented by SBAS.

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

8.2 Equipment qualification and aircraft installation

a) **GNSS SBAS Stand-alone navigation system**

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

b) **Integrated navigation system incorporating a GNSS SBAS sensor**

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

1) the performance requirements of E/TSO-C146a (or subsequent version) that apply to the functional Class gamma, operational Class 3 or Delta 4 is demonstrated; and

2) the GNSS SBAS sensor is approved in accordance with E/TSO C145a Class beta, operational Class 3.

c) **Approach system incorporating Class delta GNSS SBAS equipment**

The equipment must be approved in accordance with E/TSO-C146a (or subsequent version). This provision ensures that the equipment at least complies with RTCA DO-229C (or subsequent version). The equipment must be Class delta 4.

8.3 Aircraft requirements

8.3.1 System performance, monitoring and alerting

a) **Precision**.- Along the final approach segment and in the straight continuation of the final approach in the missed approach, the lateral and vertical total system error is dependent on the navigation system error (NSE), path definition error (PDE) and flight technical error (FTE).

1) NSE.- the accuracy itself (the error bound with 95% probability) changes due to different satellite geometries. The assessment based on measurements within a sliding time window is not suitable for GNSS. Therefore, GNSS accuracy is specified as a probability for each and every sample. NSE requirements are fulfilled without any demonstration if the equipment computes three dimensional position using a linearized, weighted least square solution in accordance with RTCA DO 229C (or subsequent version) Appendix J. 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 subsequent versions) meets the precision requirements of Annex 10 to the Convention on International Civil Aviation.

2) FTE.- FTE performance is considered acceptable if the lateral and vertical display full scale deflection is compliant with the non-numeric lateral cross-track and vertical deviation requirements of RTCA DO 229C (or subsequent version), and if the flight crew maintains the aircraft within 1/3 of the FSD for the lateral deviation, and within ½ of the FSD for the vertical deviation.

3) PDE.- PDE is considered negligible based upon the process of path specification to data specification and associated quality assurance that is included in the FAS data block generation process which is a standardized process. The responsibilities for FAS data block generation lies with the air navigation service provider (ANSP).

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

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

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

c) **Continuity**.- It shall be demonstrated 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 improbable.

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

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

***Note 2**.- Probability terms are defined in EASA AMC 25.1309 and FAA AC 23.1309-1(), AC 27-1B or AC 29-2C.*

d) **On-board performance monitoring and alerting**.- During operations on the final approach segment of an RNP APCH operation down to LP and LPV minima, the on-board performance

monitoring and alerting function is fulfilled through:

1) NSE monitoring and alerting (see the section related to the signal-in-space).

2) FTE monitoring and alerting.- LPV approach guidance must be displayed on a lateral and vertical deviation display (HSI, EHSI, CDI/VDI), including a failure indicator. The deviation display must have a suitable FSD based on the required track keeping accuracy. The lateral and vertical FSD 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 to determine if the data is valid. If the FAS data block does not pass the CRC test, the equipment will not allow activation of the LP or LPV approach operation.

e) **Signal-in-space**

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

2) After sequencing the FAP and during operations on 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 the signal-in-space errors 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 errors 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 the missed approach if it is based on conventional means (VOR, DME, NDB) or on dead reckoning navigation. The requirements for the straight continuation of the final approach, in the missed approach, are in accordance with RTCA DO 229C (or subsequent versions).*

***Note 2**.- Compliance with the performance monitoring and alerting requirement does not imply an automatic monitor of flight technical error. The on-board monitoring and alerting function should consist at least of a navigation system error (NSE) monitoring and alerting algorithm and a lateral and vertical deviation display enabling the crew to monitor the flight technical error (FTE). To the extent operational procedures are used to monitor FTE, the crew procedure, the equipment characteristics and installation are evaluated for their effectiveness and equivalence as described in the functional requirements and operating procedures. The path definition error (PDE) is considered negligible 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 and LPV minima. Therefore, such criteria are limited to the LP and LPV final approach segment and to the interception of the extended final approach segment.

If the installed navigation system is also able to fly the initial, intermediate, and missed approach segments of the 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) **Navigation display and required functions**

1) Approach guidance must be displayed 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 primary flight instrument for approach;

(b) the display must be visible to the pilot and be located in his primary field of view (±15 degrees from the normal line of sight of the pilot) when looking forward along the flight path; and

(c) the deviation display must have a suitable FSD based on the required track keeping accuracy;

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

***Note 1**.- Where the minimum crew is two pilots, it should be possible for the pilot not flying to verify the desired path and the aircraft position relative to the path*.

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

2) **The following system functions are required as a minimum**:

(a) The capability to display the GNSS approach mode (*e.g.*, LP, LPV, LNAV/VNAV, LNAV) in the primary field of view. This annunciation indicates to the flight crew the active approach mode in order to correlate it with the corresponding line of minima on the approach chart. It can also detect the level of degradation of the service (*e.g.,* downgrade from LPV to LNAV). The airborne system should automatically provide the highest level of service available for the annunciation of the GNSS approach mode when the approach is selected.

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

(c) The navigation database must contain all the necessary data/information to fly the published approach procedure (final approach segment). Although data may be stored or transmitted in different ways, the data must be organised in data blocks for calculating CRC. This format provides integrity protection for the data it contains. Consequently, each final approach segment is defined by a specific "FAS data block" that contains the necessary lateral and vertical parameters depicting the approach to be flown. Once the FAS data block has been decoded, the equipment will apply the CRC to the data block to determine if the data is 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 capacity to select from the data base into the installed system the whole approach procedure to be flown (SBAS channel number and/or approach name).

(e) The indication of the loss of navigation (*e.g.*, system failure) in the pilot´s primary field of view by means of a navigation warning flag or equivalent indicator on the lateral and/or vertical navigation display.

(f) The indication of the loss of integrity (LOI) function in the pilot´s normal field of view (*e.g.*, by means of an appropriately located annunciator).

(g) The capability to immediately provide track deviation indications relative to the extended final approach segment, in order to facilitate interception of said segment from a radar vector [*e.g.,* vector to final (VTF) function].

***Note**.- These requirements are limited to the final approach segment, the straight continuation of the final approach in the missed approach, and to the interception of the extended final approach segment. If the installed system is also able to fly the initial, intermediate and missed approach segments of the approach it must be approved 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 the operational and qualification documentation of the updated aircraft.

8.6 Airworthiness compliance

8.6.1 General

a) This section describes a means of airworthiness compliance for new or modified installations (Paragraph 8.6.2), as well as for existing installations (Paragraph 8.6.3). It also describes specific points that must be considered during these approval processes (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 installations

a) In order to demonstrate compliance with this AC, the following specific items must be considered:

1) The applicant will present to the CAA a compliance statement which shows 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 together with evidence resulting from the activities defined in the following paragraphs.

2) Compliance with airworthiness requirements for the intended function and safety must be demonstrated by equipment qualification, system safety analysis, confirmation of the appropriate software design assurance level, performance analysis, and a combination of ground and flight tests. To support the approval application, design information will be presented showing that the objectives and criteria of this section have been satisfied.

8.6.3 Existing installations

The applicant will present to the CAA a compliance statement which shows how the criteria of this AC have been satisfied for the existing installations. Compliance may be established by inspection of the installed system to confirm the availability of required features and functionalities. The performance and integrity criteria of Sections 8.3 and 8.4 may be confirmed by reference to the aircraft flight manual or other applicable approvals and through supporting certification data. In the absence of such evidence, supplementary analysis 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 only means of selection;

(b) a clear annunciation of the selected approach system on or near the display;

(c) display of guidance information appropriate to the selected approach system; and

(d) delivery of guidance information to a flight director/autopilot, appropriate to the selected approach system.

b) Annunciation for flight director, autopilot, and selected approach system shall be consistent, and compatible with the original cockpit design philosophy.

c) Equipment failure scenarios involving conventional navigation/approach systems and the installed systems shall be evaluated to demonstrate that:

1) adequate alternative means of navigation are available following failure of the installed system; and

2) reversionary switching arrangements, *e.g.,* selection of ILS system 2 or LPV system 2 on HSI # 1 in case of dual equipment, do not lead to misleading or unsafe display

configurations.

The evaluation shall consider also the probability of failures within the switching arrangements.

d) The coupling arrangements between the installed systems and the flight director/autopilot shall be evaluated to show compatibility and to demonstrate that operating modes, including installed system failure modes, are clearly and unambiguously indicated to the flight crew.

e) The use of the installed system and the manner of presentation of lateral and vertical guidance information to the flight crew shall be evaluated to show that the risk of flight crew error has been minimised. The flight crew must be aware, at all times of the system in use for the approach.

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 flight crew memory for any system operating procedure or task.

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

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

4) Placing particular emphasis on the number of steps and minimising the time required to accomplish flight plan modifications to accommodate ATC clearances, holding pattern procedures, runway and instrument approach changes, missed approaches, and diversions to alternate destinations.

5) Minimising the number of nuisance alerts so the flight crew will recognise and react appropriately when required.

8.6.5 FTE performance assessment for LP and LPV approach operations

a) The ILS look alike presentation is detailed in RTCA DO-229C (or subsequent version), in particular the lateral and vertical FSD requirements. The deflection may be fully angular, with no limitations, or angular but bounded at a certain value (*e.g.*, bounded at ±1 NM in lateral and ±150 in vertical).

1) For installations where the autopilot has not been modified and the equipment provides ILS look alike deviations, the applicant shall conduct several approaches while flying raw data, flight director and coupled to the autopilot, as applicable. The objective of this test is to ensure that installed equipment interface is compatible with the aircraft rather than verifying approach performance.

2) For installations where the autopilot has been modified, where the autopilot lateral/vertical control channel performance has not been assessed or where non-standard deviations are provided (not ILS look alike), then the 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 excessive reference to other cockpit displays.

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

(a) Lateral guidance from 1000 feet height above touchdown (HAT) to DA(H) shall be stable without large deviations (*e.g.*, within ±50 microamps deviation) from the indicated path.

(b) Vertical guidance from 700 feet HAT to DA(H) shall be stable without large deviations (*e.g.*, within ±75 microamps deviation) from the indicated path.

***Note**.-Compatibility with ILS display systems can be achieved by converting the lateral and vertical deviations to microamperes, based upon a FSD at 150 microamperes.*

8.6.6 Intermixing of equipment

Simultaneous use of airborne systems with different flight crew interfaces can be very confusing and lead to problems when they have conflicting methods of operation and conflicting display formats. For approach operations, simultaneous use of equipment that is not identical or compatible is not permitted.

8.6.7 Aircraft flight manual/Pilot operating handbook

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

1) A statement which identifies the equipment and aircraft build or modification standard certificated for RNAV GNSS approach operations down to LP and LPV minima using SBAS. This may include a very brief description of the installed system, including the airborne equipment software version, the display equipment, and a statement that the system is suitable for LP and LPV approach operations. A brief introduction to the LP and LPV approach concept may also be included.

2) Appropriate amendments or supplements to cover LP and 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 are available in other operating or training 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 or 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 application for RNP APCH operational approval down to LP or LPV minima*;

2) *Airworthiness documents related to aircraft eligibility.*- 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 GNSS equipment augmented by SBAS 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 demonstrate 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, upgrade or recurrent training for the flight crew and flight dispatchers.

Note.- *It is not required to establish a separate training programme 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 within a training programme.*

(b) Non-commercial operators (*e.g.,* LAR 91 operators) must be familiar with, and

demonstrate that they will operate their aircraft in accordance with the procedures, practices and training aspects of Paragraph 9.3.

5) *Operations manual and checklists*

(a) Commercial operators (*e.g.,* LAR 121 and 135 operators) must review the operations manual (OM) and 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 application in Phase 2 of the approval process.

(b) Non-commercial operators (*e.g.,* LAR 91 operators) must establish operating instructions on the navigation equipment and contingency procedures. This information must be available for crews in the OM or in the pilot operating handbook (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 application 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 required dispatch conditions.

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

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 AC.

9) Performance history (if applicable).- The application 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 AC.

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 intending to conduct an RNP APCH operation down to LP or LPV minima must file the relevant ATC flight plan suffixes. The on board navigation data must be current and include the appropriate procedures.

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

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

(a) The pilot must ensure that approach procedures which may be used for the intended flight (including alternate aerodromes) are selectable from a valid navigation data base (current AIRAC cycle), have been verified by the appropriate processes, and are not prohibited by a company instructions or NOTAMs;

(b) Subject to CAA regulations, during the pre-flight phase, the pilot shall ensure sufficient means are available to navigate and land at the destination or at an alternate aerodrome in the case of loss of the LP or LPV airborne capability;

(c) Operators and flight crews must take into account of any NOTAM (including SBAS NOTAMs) or operator briefing material that could adversely affect the aircraft system operation, or the availability or suitability of the procedures at the aerodrome of landing or any alternate aerodrome.

(d) If the missed approach procedure is based on conventional means (*e.g.,* VOR, NDB), the appropriate airborne equipment required to fly this procedure must be installed in the aircraft and must be operational. The associated ground-based navigation aids must also be operational. If the missed approach procedure is based on RNAV (no conventional or dead reckoning missed approach), the appropriate airborne equipment required to fly this procedure must be installed in the aircraft and must be operational.

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

b) **Augmented GNSS availability**

1) Service levels required for RNP APCH operations down to LP or LPV minima can be verified either through NOTAMs (when available) or through prediction services. The operating 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 GPS constellation and SBAS system status NOTAMs and avionics model (when available). The service may be provided by the ANSP, avionics manufacturer, other entities, or through an airborne receiver LP or LPV service prediction capability.

3) In the event of a predicted and continuous loss of the appropriate level of fault detection (FD) of more than five minutes for any part of the RNP APCH operation down to LP or LPV minima, the flight planning must be revised (*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 expected capability to meet the required navigation performances. Due to unexpected failure of some GNSS or SBAS elements, pilots/ANSPs must be realize that GNSS or SBAS navigation altogether may be lost while airborne which may require

reversion to an alternate means of navigation. Therefore, pilots shall assess their capability to navigate (potentially to an alternate destination) in case of failure of GNSS plus SBAS navigation.

5) These availability prediction services are expected to be developed also for future GNSS systems with a performances equivalent to SBAS.

c) **Prior to commencing the procedure**

1) In addition to normal procedure, prior to commencing the approach (before the IAF and in compatibility with crew workload), the flight crew must verify the correctness of the loaded procedure comparing it with the appropriate approach charts. This check must include:

(a) the waypoint sequence;

(b) the reasonableness of the tracks and distances of the approach legs, and the accuracy of the inbound course and mileage 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 which by-pass the initial legs of an approach, interception of an initial or intermediate segment of an approach or the insertion of waypoints loaded from the database. In complying with ATC instructions, the flight crew shall be aware of the implications for the navigation system.

(a) the manual entry of coordinates into the navigation 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 45º.

***Note**.- “Direct to” clearance to FAF is not acceptable.*

3) The approach system provides the capability for the pilot to intercept the final approach track well before the FAF [vector to final (VTF) function or equivalent function]. This function shall be used to respect a given ATC clearance.

d) **During the procedure**

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

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

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

4) The final approach segment shall be intercepted no later than the FAP in order for the aircraft to be correctly established on the final approach course before initiating the descent (to ensure terrain and obstacle clearance).

5) The relevant displays must be selected so that the following information can be monitored:

(a) aircraft position relative to the lateral path;

(b) aircraft position relative to the vertical path; and

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

6) The flight crew must respect all published altitude and speed constraints.

7) Prior to sequencing the FAP, the crew must abort the approach procedure if there is:

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

(b) loss of integrity monitoring (LOI), annunciated by a local annunciator or equivalent; and

(c) low altitude alert (if applicable).

8) After sequencing the FAP, the procedure must be discontinued, unless the pilot has in sight the visual references required to continue the approach, if:

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

***Note**.- Loss of integrity monitoring (LOI) after sequencing the FAP leads to a loss of navigation condition (warning flag).*

(b) loss of vertical guidance is indicated (even if lateral guidance is already displayed); and

(c) FTE is excessive and cannot be timely corrected.

9) Pilots must execute a missed approach if excessive lateral and/or vertical deviations are encountered and cannot timely corrected, unless the pilot has in sight the visual references required to continue the approach. The missed approach must be flown in accordance with the published procedure (*e.g*., conventional or RNAV).

e) **General operating procedures**

1) Operators and pilots must not request an RNP APCH operation down to LP or LPV minima unless they satisfy all the criteria indicated in the relevant CAA documents. If a pilot of an aircraft which does not meet the criteria, is cleared by the ATC to conduct such operation, the pilot must advise ATC that the clearance cannot be accepted and must request alternate instructions.

2) The pilot must comply with 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), related navigation equipment must be installed and serviceable.

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

f) **Contingency procedures**

1) The operator shall develop contingency procedures in order to react safely following the loss of RNP APCH capability during the approach.

2) The pilot must notify ATC of any loss of the 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. The loss of RNP APCH capability includes any failure or event causing the aircraft to no longer satisfy the RNP APCH requirements of the procedure.

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 structured to provide sufficient theoretical and practical training, using a simulator, training device, or line training in an aircraft, on the use of the aircraft´s approach system to ensure that pilots are not just task oriented. The following syllabus shall be considered as a minimum amendment to the training programme to support the RNP APCH

operations down to LP and LPV minima:

a) RNP approach concept containing LP or LPV minima:

1) theory of approach operations;

2) approach charting;

3) use of the approach system including:

- selection of the LP or LPV approach procedure;
- ILS “look alike” principle;

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

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

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

7) the implication for LP or LPV approach operations of system malfunctions which are 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 its direct relationship with $RNAV_{(GNSS)}$ procedures;

2) regulatory requirements for LP or LPV approach operations;

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

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

4) procedure characteristics:

- chart depiction;
- aircraft display depiction;
- minima.

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

6) change of the arrival and alternate airports.

7) flying the procedure:

- use of autopilot, auto throttle and flight director;
- flight guidance (FG) mode behaviour;
- lateral and vertical path management;
- adherence to speed and/or altitude constraints;
- fly interception of an initial or intermediate segment of an approach following an ATC notification;
- fly interception of the extended final approach segment (e.g., using the VTF function);
- consideration of the GNSS approach mode indication (LP, LPV, LNAV/VNAV, LNAV,…); and
- the use of other aircraft equipment to support track monitoring and weather and

obstacles avoidance.

8) ATC procedures;

9) abnormal 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 – the a*cceptance 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 basis as the aforementioned documents.

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

***Note**.- The navigation database of the LP and LPV procedures is characterised by the FAS data block protected by a CRC. The FAS data block contains the lateral and vertical parameters, which define the approach to be flown. These parameters have been calculated, validated, and promulgated by the 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 to monitor both the process and the navigation data in accordance with the quality system required by the applicable operational regulations.

e) The operator will implement procedures that ensure timely distribution and insertion of current and unaltered electronic navigation data to all aircraft that require it.

10. OVERSIGHT OF OPERATORS

a) A regulatory authority may consider any navigation error reports in determining corrective measures. Repeated navigation errors occurrences attributed to a specific piece of navigation equipment may result in cancellation of the approval for use of that equipment.

b) Information that indicates the potential for repeated errors may require modification of the operator's training programme. Information that attributes multiple errors to a particular pilot crew may necessitate remedial training or licence review.

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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