ADVISORY CIRCULAR

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DATE : 09/09/13
REVISION : 1
ISSUED BY : SRVSOP

SUBJECT: AIRCRAFT AND OPERATOR APPROVAL FOR RNP 1 OPERATIONS

1. PURPOSE

This advisory circular (AC) establishes criteria on aircraft and operators approval for RNP 1 operations.

An operator may use alternate means of compliance, provided those means are acceptable to the Civil Aviation Administration (CAA).

The future tense of the verb or the term “shall” apply to operators who choose to meet the criteria set forth in this AC.

Note.- *When this CA was originally published, it included the prefix “Basic” because an Advance RNP 1 specification was planned. Advanced RNP 1 evolved into the Advanced RNP (A-RNP), so it is no longer necessary to include the prefix “Basic” in the RNP 1. Existing approvals granted under Basic-RNP 1 remain valid.*

2. RELEVANT SECTIONS OF THE LATIN AMERICAN AERONAUTICAL REGULATIONS (LAR) OR EQUIVALENT

LAR 91: Sections 91.1015 and 91.1640 or equivalents

LAR 121: Section 121.995 (b) or equivalent

LAR 135: Section 135.565 (c) or equivalent

3. RELATED DOCUMENTS

Annex 6	Operation of aircraft
	Part I – International commercial air transport – Aeroplanes
	Part II – International general aviation - Aeroplanes
Annex 10	Aeronautical communications
	Volume I: Radio navigation aids
Annex 15	Aeronautical information services
ICAO Doc 9613	Performance based navigation (PBN) manual
ICAO Doc 4444	Procedures for air navigation services – Air traffic management (PANS-ATM)
ICAO Doc 8168	Procedures for air navigation services - Aircraft operations
	Volume I: Flight procedures
	Volume II: Construction of visual and instrument flight procedures
FAA AC 90-105 Appendix 2	Qualification criteria for RNP 1 (terminal) operations

4. DEFINITIONS AND ABBREVIATIONS

4.1 Definitions

a) **Aircraft-based augmentation system (ABAS).-** A system which augments and/or integrates the information obtained from the other GNSS elements with information available on board the aircraft. The most common form of ABAS is the receiver autonomous integrity monitoring (RAIM).

b) **Area navigation (RNAV)**.- A navigation method that allows aircraft to operate on any desired flight path within the coverage of ground or space-based navigation aids, or within the limits of the capability of self-contained aids, or a combination of both methods.

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

c) **Flight technical error (FTE)**.- The FTE is the accuracy with which an aircraft is controlled as measured by the indicated aircraft position with respect to the indicated command or desired position. It does not include procedural blunder errors.

d) **Global navigation satellite system (GNSS)**.- A generic term used by the International Civil Aviation Organization (ICAO) to define any global position, speed, and time determination system that includes one or more main satellite constellations, such as GPS and the global navigation satellite system (GLONASS), aircraft receivers and several integrity monitoring systems, including aircraft-based augmentation systems (ABAS), satellite-based augmentation systems (SBAS), such as the wide area augmentation systems (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.

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

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

Required Navigation Performance (RNP) Specification.- A navigation specification based on area navigation that includes the requirement for on-board performance monitoring and alerting, designated by the prefix RNP; *e.g.,* RNP 4, RNP APCH, RNP AR APCH.

Area Navigation (RNAV) Specification.- A navigation specification based on area navigation that does not include the requirement for on-board performance monitoring and alerting, designated by the prefix RNAV; *e.g*., RNAV 5, RNAV 2, RNAV 1.

Note 1.- *The Manual on Performance-based Navigation (PBN) (Doc 9613), Volume II, contains detailed guidelines on navigation specifications.*

Note 2.- *The term RNP, formerly defined as "a statement of the navigation performance necessary for operation within a defined airspace", has been deleted from the Annexes to the Convention on International Civil Aviation because the RNP concept has been replaced by the PBN concept. In said Annexes, the term RNP is now only used within the context of the navigation specifications that require on-board performance control and alerting; e.g., RNP 4 refers to the aircraft and the operational requirements, including a lateral performance of 4 nautical miles (NM), with the requirement for on-board performance control and alerting as described in the PBN Manual of the International Civil Aviation Organization (ICAO) (Doc 9613).*

g) **Navigation system error (NSE).-** The difference between the true position and the estimated position.

h) **Path definition error (PDE).-** The difference between the defined path and the desired path at a given place and time.

i) **Performance-based navigation (PBN)**.- Area navigation based on performance requirements for aircraft operating along an ATS route, on an instrument approach procedure, or in a designated airspace.

Note.- *Performance requirements are expressed in navigation specifications (RNAV and RNP specifications) in terms of accuracy, integrity, continuity, availability, and functionality needed for the proposed operation in the context of a particular airspace concept.*

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

k) **RNP operations**.- Aircraft operations that use an RNP system for RNP applications.

l) **RNP system**.- An area navigation system that supports on-board performance monitoring and alerting.

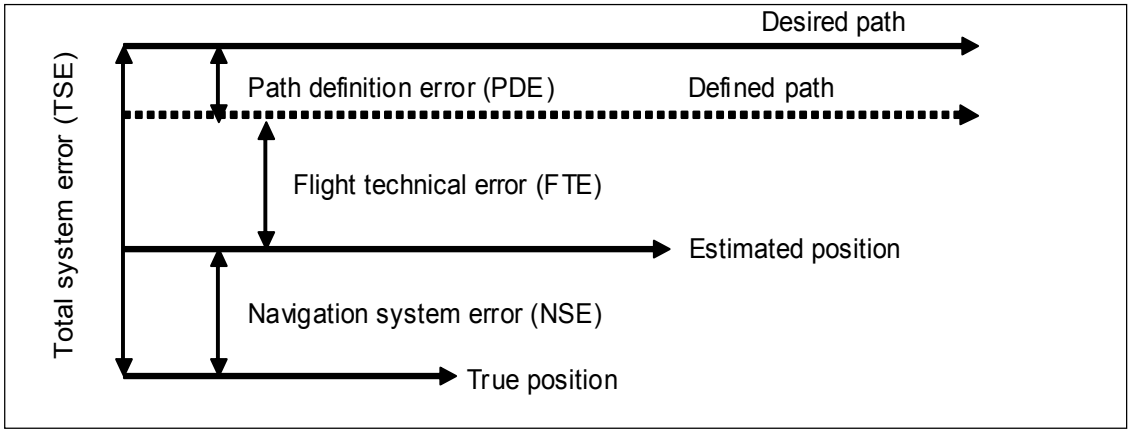
m) **Standard instrument arrival (STAR)**.- A designated instrument flight rule (IFR) arrival route linking a significant point, normally on an air traffic service (ATS) route, with a point from which a published instrument approach procedure can be commenced.

n) **Standard instrument departure (SID)**.- A designated instrument flight rule (IFR) departure route linking the aerodrome or a specified runway of the aerodrome with a specified significant point, normally on a designated ATS route, at which the en-route phase of a flight commences.

o) **Total system error (TSE).-** The difference between the true position and the desired position. This error is equal to the vector sum of the path definition error (PDE), flight technical error (FTE), and navigation system error (NSE).

Note.- *On occasions, the FTE is known as path steering error (PSE), and the NSE as position estimation error (PEE).*

Total system error (TSE)



p) **Waypoint (WPT).** A specified geographical location used to define an area navigation route or the flight path of an aircraft employing area navigation. Waypoints area identified as either:

Fly-by waypoint.- A waypoint which requires turn anticipation to allow tangential interception of the next segment of a route or procedure.

Fly over waypoint.- A waypoint at which a turn is initiated in order to join the next segment of a route or procedure.

4.2 Abbreviations

a)	AAC	Civil Aviation Administration/Civil Aviation Authority
b)	ABAS	Aircraft-based augmentation system
c)	AC	Advisory circular (FAA)
d)	AFM	Aircraft flight manual
e)	A-RNP	Advanced RNP
f)	AIP	Aeronautical information publication
g)	AIRAC	Aeronautical information regulation and control
h)	ANSP	Air navigation service providers
i)	AP	Automatic pilot
j)	APV	Approach procedure with vertical guidance
k)	APV/baro-VNAV	Approach procedure with vertical guidance/Barometric vertical navigation
l)	ARP	Aerodrome reference point
m)	ATC	Air traffic control
n)	ATM	Air traffic management
o)	ATS	Air traffic service
p)	baro-VNAV	Barometric vertical navigation
q)	CA	Advisory circular (SRVSOP)
r)	CA	Course to an altitude
s)	CDI	Course deviation indicator
t)	CDU	Control and display unit
u)	CF	Course to a fix
v)	Doc	Document
w)	DCPC	Direct controller-pilot communication
x)	DF	Direct to a fix
y)	DME	Distance-measuring equipment
z)	DV	Flight dispatcher (SRVSOP)
aa)	EASA	European Aviation Safety Agency
bb)	EHSI	Electronic horizontal situation indicator
cc)	FAA	Federal Aviation Administration (United States)
dd)	FAF	Final approach fix
ee)	FAP	Final approach point
ff)	FD	Flight director
gg)	FM	Fix to a manual termination
hh)	Fly-by WPT	Fly-by way-point
ii)	Flyover WPT	Flyover way-point

jj)	FMS	Flight management system
kk)	FTE	Flight technical error
ll)	GBAS	Ground-based augmentation system
mm)	GNSS	Global navigation satellite system
nn)	GLONASS	Global navigation satellite system
oo)	GPS	Global positioning system
pp)	GS	Ground speed
qq)	HAL	Horizontal alerting limit
rr)	HSI	Horizontal situation indicator
ss)	IF	Initial fix
tt)	IFP	Instrument flight procedures
uu)	IFR	Instrument flight rules
vv)	IMC	Instrument meteorological conditions
ww)	LAAS	Local area augmentation system
xx)	LAR	Latin American Aeronautical Regulations
yy)	LNAV	Lateral navigation
zz)	LOA	Letter of authorisation/letter of acceptance
aaa)	MCDU	Multifunction control and display unit
bbb)	MEL	Minimum equipment list
ccc)	MIO	Operations inspector manual (SRVSOP)
ddd)	NM	Nautical mile
eee)	MP	Monitoring pilot
fff)	NAVAID	Navigation aid
ggg)	NOTAM	Notice to airmen
hhh)	NPA	Non-precision approach
iii)	NSE	Navigation system error
jjj)	LNAV	Lateral navigation
kkk)	OACI	International Civil Aviation Organization
lll)	OM	Operations manual
mmm)	OEM	Original equipment manufacturer
nnn)	OpSpecs	Operations specifications
ooo)	PA	Precision approach
ppp)	PANS-ATM	Procedures for Air Navigation Services - Air traffic management
qqq)	PANS-OPS	Procedures for Air Navigation Services - Aircraft operations
rrr)	PBN	Performance-based navigation
sss)	PDE	Path definition error
ttt)	PEE	Position estimation error

uuu)	PF	Pilot flying
vvv)	PNF	Pilot not flying
www)	POH	Pilot operating handbook
xxx)	P-RNAV	Precision area navigation
yyy)	PSE	Path steering error
zzz)	RAIM	Receiver autonomous integrity monitoring
aaaa)	RF	Constant radius arc to a fix / Radius to a fix
bbbb)	RNAV	Area navigation
cccc)	RNP	Required navigation performance
dddd)	RNP APCH	Required navigation performance approach
eeee)	RNP AR APCH	Required navigation performance authorisation required approach
ffff)	RTCA	Radio Technical Commission for Aviation
gggg)	SBAS	Satellite-based augmentation system
hhhh)	SID	Standard instrument departure
iiii)	SRVSOP	Regional Safety Oversight Cooperation System
jjjj)	STAR	Standard instrument arrival
kkkk)	STC	Supplemental type certificate
llll)	TF	Track to a fix
mmmm)	TO/FROM	To/from
nnnn)	TSE	Total system error
oooo)	TSO	Technical standard order
pppp)	VA	Heading to an altitude
qqqq)	VI	Heading to an intercept
rrrr)	VM	Heading to a manual termination
ssss)	VMC	Visual meteorological conditions
tttt)	VNAV	Vertical navigation
uuuu)	WAAS	Wide area augmentation system
vvvv)	WGS	World geodetic system
wwww)	WPT	Waypoint

5. INTRODUCTION

5.1 The RNP 1 navigation specification provides a means to develop routes for connectivity between the en-route structure and terminal airspace with no or limited air traffic service (ATS) surveillance.

5.2 The RNP 1 is used to support RNP operations on standard instrument departures (SIDs), standard instrument arrivals (STARs) and approaches (initial and intermediate approach segments) up to the final approach fix (FAF)/final approach point (FAP).

5.3 This AC does not address all the requirements that may be specified for particular operation. These requirements are established in other documents, such as the aeronautical

information publication (AIP) and ICAO Doc 7030 – Regional Supplementary Procedures.

5.4 While operational approval primarily relates to the navigation requirements of the airspace, the operators and pilots must consider all operational documents relating to the airspace, which are required by the CAA, before conducting flights into RNP 1 airspace.

5.5 RNP 1 can be associated with RF (radius to fix) path terminator and with baro-VNAV (barometric vertical navigation).

5.6 When *constant radius arc to a fix (RF) legs* are incorporated into RNP 1 procedures, the Appendix 4 of this AC – Radius to fix (RF) path terminator, provides criteria for the approval of this capability.

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

- ✓ ICAO Doc 9613, Volume II, Part C, Chapter 3 – Implementing RNP 1.

5.8 To the extent possible, this CA has been harmonised with the following guidance material:

- ✓ FAA AC 90-105 Appendix 2 - Qualification criteria for RNP 1 (terminal) operations

Note. - *Despite harmonisation efforts, operators shall take note of the differences between this CA and the aforementioned document when applying for an approval from the corresponding Administration.*

6. GENERAL CONSIDERATIONS

6.1 General information

a) **Performance-based navigation concept.-** The performance-based navigation (PBN) concept represents a change from sensor-based navigation to PBN. The PBN concept specifies the performance requirements of the aircraft RNP system in terms of precision, integrity, availability, continuity, and functionality required for operations in a given airspace. Performance requirements are identified in the navigation specifications (*e.g.*, the requirements of this AC), which also identify options in terms of navigation sensors, navigation equipment, operating procedures, and training needs to meet performance requirements.

b) RNP procedures and routes require the use of RNP systems with onboard performance monitoring and alerting. A critical component of RNP is the ability that must have the aircraft navigation system in combination with the pilot to monitor its achieved navigation performance, and to identify for the pilot whether the operational requirement is or is not met during an operation.

Note.- *Compliance with the performance control and alerting requirements does not imply automatic monitoring of the flight technical error (FTE). The on-board performance monitoring and alerting function should consist at least of a navigation system error (NSE) monitoring and alerting algorithm and a lateral navigation display that allow the flight crew to monitor the FTE. To the extent operational procedures are used to control the FTE, the flight crew procedures, equipment characteristics and the facilities are assessed for 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 and crew procedures.*

c) **Operations with RNP systems**.- RNP operations:

1) do not require the pilot to monitor the ground-based navigation aids (NAVAIDs) used for position updating, unless required by the aircraft flight manual (AFM);

2) base obstacle clearance assessments on the associated required system performance;

3) Rely on conventional compliance with descent profiles and altitude requirements;

Note.- *Pilots operating aircraft with an approved barometric vertical navigation (baro-VNAV) system can continue using said system while operating on routes SIDs, and STARs. Operators must ensure compliance with all altitude limitations as published in the procedure in reference to the pressure altimeter.*

4) all routes and procedures must be based on the world geodetic system (WGS) 84 coordinates; and

5) the navigation data published for the routes, procedures and supporting NAVAIDs must meet the requirements of Annex 15 to the Convention on International Civil Aviation.

6.2 Navigation aid infrastructure

a) The RNP 1 specification is based upon GNSS.

b) While RNP systems based on DME/DME are capable of providing RNP 1 accuracy, the use of this navigation specification has been foreseen mainly for environments where DME infrastructure cannot support DME/DME area navigation with the required performance.

c) The increased complexity in the DME infrastructure requirements and assessment make RNP 1 operations based on DME/DME impractical and unprofitable for a general application.

d) Route design should take into account the navigation performance that can be achieved with the available navigation aid (NAVAID) infrastructure. Although the requirements of RNAV 1 and RNAV 2 navigation systems are identical, NAVAID infrastructure can affect the required performance.

e) Air navigation service providers (ANSPs) shall ensure that the operators of GNSS equipped aircraft have a means available to predict fault detection using an aircraft-based augmentation system (ABAS) [*e.g.*, receiver autonomous integrity monitoring (RAIM)].

f) When applicable, the ANSPs shall also ensure that the operators of aircraft equipped with a satellite-based augmentation system (SBAS) have a means to predict fault detection.

g) The prediction services may be provided by the ANSP, airborne equipment manufacturers or other entities.

h) Prediction services can be available for receivers that meet only the minimum performance of a technical standard order (TSO) or be specific to the receiver design. The prediction service shall use status information on GNSS satellites and must use a horizontal alert limit (HAL) appropriate for the operation (1 NM within 30 NM from the aerodrome and 2 NM otherwise).

i) Outages shall be identified in the event of a predicted, continuous loss of ABAS fault detection of more than 5 minutes for any part of the RNP 1 operation.

j) ANSPs must undertake an assessment of the NAVAIDS infrastructure. It must be demonstrated that the assessment is sufficient for the proposed operations, including reversionary modes.

6.3 Communications and ATS surveillance

a) The RNP 1 navigation specification is intended in environments where ATS surveillance is limited or not available.

b) RNP 1 SIDs and STARs are primary intended to be conducted in direct controller-pilot communication (DCPC) environments.

6.4 Obstacle clearance, route spacing and horizontal separation

a) Doc 8168 (PANS OPS), Volume II, provides detailed guidance on obstacle clearance. The general criteria in Parts I and III apply, and assume normal operations.

b) En-route spacing for RNP 1 depends on route configuration, air traffic density, and intervention capacity. Horizontal separation minima are published in Doc 4444 – Procedures for air navigation services – Air traffic management (PANS-ATM), Chapter 5.

6.5 Publications

a) SIDs, STARs and RNP 1 procedures must be based on normal descent profiles and must identify minimum altitude requirements of the segments.

b) The navigation information published in the AIP for the procedures and supporting NAVAIDs must meet the requirements of Annex 15 - Aeronautical information services.

c) All procedures must be based upon the coordinates of the world geodetic system - 84 (WGS-84).

d) The AIP should clearly indicate whether the navigation application is RNP 1.

e) The available navigation infrastructure shall be clearly designated in all the appropriate charts (*e.g.*, GNSS).

f) The required navigation standard (*e.g.*, RNP 1) for all RNP 1 procedures shall be clearly designated in all the appropriate charts.

6.6 Additional considerations

a) For procedure design and infrastructure evaluation, the normal FTE of 0.5 NM defined in the operating procedures is assumed to be a 95 per cent value.

b) The default alerting functionality of a TSO-C129a sensor (stand-alone or integrated) switches between terminal alerting (± 1 NM) and en-route alerting (± 2 NM) at 30 miles from the airport reference point (ARP).

7. AIRWORTHINESS AND OPERATIONAL APPROVAL

7.1 For a commercial air transport operator to be granted a RNP 1 approval, it must comply with two types of approvals:

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

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

7.2 For general aviation operators, the State of registry will determine whether or not the aircraft meets the applicable RNP 1 requirements and will issue the operational approval (*e.g.*, letter of authorisation – LOA).

7.3 Before filing the application, operators shall review all aircraft qualification requirements. Compliance with airworthiness requirements or equipment installation alone does not constitute operational approval.

8. AIRWORTHINESS APPROVAL

8.1 System and aircraft requirements

8.1.1 Description of the RNP navigation system

a) **Lateral navigation (LNAV)**

1) In LNAV, the RNP equipment allows the aircraft to fly in accordance with the appropriate route instructions along a path defined by waypoints (WPTs) contained in an on-board navigation database.

Note. - *LNAV is normally a mode of flight guidance systems, in which the RNP equipment provides path steering commands to the flight guidance system, which controls the FTE through the manual pilot control on a path deviation display or through the coupling of the flight director (FD) or automatic pilot (AP).*

2) For purposes of this AC, RNP 1 operations are based on the use of RNP equipment that automatically determines the position of the aircraft on the horizontal plane, using data input from the GNSS.

b) **Vertical navigation (VNAV)**

1) In VNAV, the system allows the aircraft to fly level and descent point to point in a vertical linear profile path that is kept in an on board navigation database. The vertical profile will be based upon altitude constraints or VPAs, where appropriate, associated with the lateral navigation (LNAV) path waypoints (WPT).

Note. - *Normally, VNAV is a flight guidance systems mode, where the RNAV/RNP equipment containing the VNAV capability provides path steering commands to the flight guidance system, which controls the flight technical error (FTE) by means of the pilot manual control in the vertical deviation display or through flight director (FD) or autopilot (AP) coupling.*

8.1.2 **System performance, control, and alerting**

a) **Accuracy. -** During operations in RNP 1 designated airspace or routes, total lateral system error must not exceed ± 1 NM during at least 95% of total flight time. Likewise, along-track error must not exceed ± 1 NM during at least 95% of total flight time. In order to meet the accuracy requirement, 95% of the flight technical error (FTE) must not exceed 0.5 NM.

Note. - *The use of a deviation indicator with a full-scale deflection of 1 NM constitutes an acceptable means of compliance. The use of a flight director (FD) or an automatic pilot (AP) also represents an acceptable means of compliance (roll stabilization systems do not meet the requirements).*

b) **Integrity. -** Malfunction of the aircraft navigation equipment is classified as a major failure condition according to airworthiness regulations (*e.g.*, 10^{-5} per hour).

c) **Continuity. -** Loss of function is classified as a minor failure if the operator can revert to a different navigation system and proceed to an appropriate aerodrome.

d) **Performance monitoring and alerting. -** The RNP system or the RNP system in combination with the pilot will provide an alert if the accuracy requirement is not met, or if the probability that the lateral total system error (TSE) exceeds 2 NM is greater than 10^{-5} per hour.

e) **Signal-in-space.-** If GNSS is used, the aircraft navigation equipment will provide an alert if the probability of signal-in-space errors causing a lateral position error greater than 2 NM exceeds 10^{-7} per hour (Annex 10, Volume I, Table 3.7.2.4.1).

8.1.3 **Aircraft eligibility requirements for RNP 1 operations in terminal area**

The following systems installed in the aircraft meet the requirements defined in this AC. This equipment requires evaluation by the manufacturer and operator against all the functional and performance requirement established in this AC.

a) Aircraft with E/TSO-C129a Class A1 system or E/TSO-C146 () system installed for IFR use in accordance with FAA AC 20-138 or AC 20-138A;

b) Aircraft with E/TSO-C129/C129a sensor (Class B or C) installed in a flight management system (FMS) that meets the criteria of TSO-C115b and installed for IFR use in accordance with AC 20-130A;

c) Aircraft with E/TSO-C145 () sensor installed in an FMS that meets TSO-C115b requirements and installed for IFR use in accordance with FAA AC 20-130A or AC 20-138A; and

d) Aircraft with certified RNP capability, or approved based on equivalent standards.

8.1.4 **System eligibility requirements for RNP 1 operations**

a) **Stand-alone systems.-** Stand-alone E/TSO-C129 Class A1 or A2 systems (without deviation from AC 91-008 functional requirements) or E/TSO-C146 Class 1, 2 or 3 systems (without deviation of functional requirements establish in this AC) meet aircraft qualification requirements for RNP 1 operations. GNSS systems must be approved in accordance with AC 20-138A.

b) **Multi-sensor systems.**- Multi-sensor systems using E/TSO-C129 Class B o C sensors or E/TSO-C145 Class 1, 2 and 3 sensors, meet aircraft qualification requirements for RNP 1 operations, provided that the installations comply with the criteria of this AC. RNP systems must be installed in accordance with AC 20-138A and the associated FMS must comply with E/TSO-C115b and AC 20-130A.

8.2 **Qualification documentation**

a) **Aircraft qualification documentation**

1) Aircraft or avionics manufacturers must produce aircraft qualification documentation showing compliance with the applicable criteria, as appropriate. For aircraft not approved for flying RNP 1 procedures, aircraft and avionics manufacturers must develop aircraft qualification documentation showing compliance with this AC, provided the equipment is properly installed and operated. The necessary documentation shall also define the

appropriate maintenance procedures. This documentation is not required for aircraft that have an AFM or AFM supplement that explicitly states that the RNP system is approved for operations with values of RNP 1 or lower, and that the equipment meets the reliability and performance requirements of the following documents: AC 20-138A, AC 20-130A, E/TSO-C115b and AC 20-129, as applicable.

2) Operators will submit this documentation, together with the formal application, in Phase 2 of the approval process.

b) **Acceptance of documentation by the CAA**

1) *For new aircraft/equipment (capability shown in production)*.- The new aircraft/equipment qualification documentation may be approved as part of an aircraft certification project, and will be reflected in the AFM and related documents.

2) *For aircraft/equipment in use*.- Previous approvals to conduct RNAV 1 procedures using the GNSS (GPS), according to AC 91-003 or AC 90-100/AC 90-100A, do not require an additional assessment, provided it is shown that the RNAV equipment meets the on-board performance monitoring and alerting requirements. For installations/equipment that are not eligible for conducting RNP 1 procedures, the operator shall send the RNP 1 and aircraft qualification documentation to the corresponding bodies of the CAA (*e.g.*, Aircraft certification division or Airworthiness inspection division, or equivalents).

3) The corresponding bodies of the CAA, as appropriate, will accept the data package for RNP 1 operations. This acceptance will be documented in a letter to the operator.

8.3 **Aircraft and systems eligibility for RNP 1 operations in terminal area**

8.3.1 **Aircraft that have a statement of compliance with respect to the criteria of this AC.-** Aircraft that have a statement of compliance with respect to the criteria set forth in this AC or equivalent document (*e.g.*, FAA AC 90-105 Appendix 2) in the AFM, AFM supplement, pilot operating handbook (POH) or avionics operating manual, meet the performance and functional requirements of this AC.

8.3.2 **Aircraft with a statement by the manufacturer**.- Aircraft that have a statement by the manufacturer documenting compliance with the criteria set forth in this AC or equivalent meet the performance and functional requirements of this document. This statement must include the airworthiness basis for compliance. The aircraft or equipment manufacturer will determine compliance with sensor requirements, while the operator will determine, through inspection, compliance with the functional requirements of this document.

8.3.3 For modified aircraft, the original equipment manufacturer (OEM) or the holder of the aircraft installation approval, *e.g.,* the holder of a supplemental type certificate (STC), will demonstrate compliance to the CAA, and the approval can be submitted in the documentation of the manufacturer (*e.g.*, service letters).

8.3.4 Stand-alone GNSS systems must be approved according to E/TSO-C129a Class A1 or E/TSO-C146 and operational Class 1, 2 or 3 (with no deviation from the functional requirements described in this AC), and installed for IFR use in accordance with AC 20-138A.

8.3.5 Aircraft with E/TSO-C129a sensor(s) Class B or C or E/TSO-C145 sensor(s) and FMS that meet E/TSO-C115b requirements and are installed for IFR use according to FAA AC 20-130A.

8.3.6 Aircraft/equipment approved under SRVSOP AC 91-003 or equivalent (*e.g.,* FAA AC 90-100A) for the use of GNSS, are approved under this AC for RNP 1 operations.

8.3.7 RNP aircraft with P-RNAV approval based on GNSS capability meet the functional requirements of this AC for RNP 1 operations, such as SIDs y STARs. The GNSS system approved according to E/TSO-C129 and satisfying the step-detection and health word checking contained in E/TSO-C129A, meets P-RNAV performance requirements.

Note.- *RNP 1 operations are based on GNSS positioning. Positioning data from other navigation sensors can be integrated into GNSS data provided they do not cause position errors that exceed the total system error (TSE) budget. Otherwise,*

means to deselect or cancel the other types of navigation sensors must be provided.

8.4 **Functional requirements**

Appendix 1 contains the functional requirements that meet the criteria of this document.

8.5 **Continued airworthiness**

a) The operators of aircraft approved to perform RNP 1 operations, must ensure the continuity of the technical capacity of them, in order to meet technical requirements established in this AC.

b) Each operator who applies for RNP 1 operational approval shall submit to the CAA of State of registry, a maintenance and inspection program that includes all those requirements of maintenance necessary to ensure that navigation systems continue fulfilling the RNP 1 approval criteria.

c) The following maintenance documents must be revised, as appropriate, to incorporate RNP 1 aspects:

1) Maintenance control manual (MCM);

2) Illustrated parts catalogs (IPC); and

3) Maintenance program.

d) The approved maintenance program for the affected aircrafts should include maintenance practices listed in maintenance manuals of the aircraft manufacturer and its components, and must consider:

1) that equipment involved in the RNP 1 operation should be maintained according to directions given by manufacturer's components;

2) that any amendment or change of navigation system affecting in any way RNP 1 initial approval, must be forwarded and reviewed by the CAA for its acceptance or approval of such changes prior to its implementation; and

3) that any repair that is not included in the approved/accepted maintenance documentation, and that could affect the integrity of navigation performance, should be forwarded to the CAA for acceptance or approval thereof.

e) Within the RNP 1 maintenance documentation must be presented the training program of maintenance personnel, which inter alia, should include:

1) PBN concept;

2) RNP 1 application;

3) equipment involved in an RNP 1 operation; and

4) MEL use.

9. OPERATIONAL APPROVAL

Airworthiness approval alone does not authorise an applicant or operator to conduct RNP 1 operations. In addition to the airworthiness approval, the applicant or operator must obtain an operational approval to confirm the suitability of normal and contingency procedures in connection to the installation of a given piece of equipment.

Concerning commercial air transport, the assessment of an application for RNP 1 operational approval is done by the State of the operator, in accordance with standing operating rules [*e.g.*, LAR 121.995 (b) and LAR 135.565 (c)] or equivalents) supported by the criteria described in this AC.

For general aviation, the assessment of an application for RNP 1 operational approval is

carried out by the State of registry, in accordance with standing operating rules (*e.g.*, LAR 91.1015 and LAR 91.1640 or equivalents) supported by the criteria established in this AC.

9.1 Requirements to obtain operational approval

9.1.1 In order to obtain RNP 1 approval, the applicant or operator will take the following steps, taking into account the criteria established in this paragraph and in Paragraphs 10, 11, 12, and 13:

a) *Airworthiness approval*.- Aircraft shall have the corresponding airworthiness approvals, pursuant to Paragraph 8 of this CA.

b) *Application*.- The operator shall submit the following documentation to the CAA:

1) *RNP 1 operational approval application;*

2) *Description of aircraft equipment*.- The operator shall provide a configuration list with details of the relevant components and the equipment to be used for RNP 1 operations. The list shall include each manufacturer, model, and equipment version of GNSS equipment and software of the installed FMS.

3) *Airworthiness documents related to aircraft eligibility*.- The operator shall submit relevant documentation, acceptable to the CAA, showing that the aircraft is equipped with RNP systems that meet the RNP 1 requirements, as described in Paragraph 8 of this AC. For example, the operator will submit the parts of the AFM or AFM supplement that contain the airworthiness statement.

4) *Training programme for flight crews and flight dispatchers (DV)*

(a) Commercial operators (*e.g.*, LAR 121 and LAR 135 operators) will present to the CAA the RNP 1 training curriculums to show that the operational procedures and practices and the training aspects described in Paragraph 11 have been included in the initial, upgrade or recurrent training curriculums for flight crews and DV.

Note.- *It is not necessary to establish a separate training programme if the RNP 1 training identified in Paragraph 11 has already been included in the training programme of the operator. However, it must be possible to identify what aspects of RNP 1 are covered in the training programme.*

(b) Private operators (*e.g.*, LAR 91 operators) shall be familiar with and demonstrate that they will perform their operations based on the practices and procedures described in Paragraph 11.

5) *Operations manual and checklists*

(a) Commercial operators (*e.g.*, LAR 121 and 135 operators) must review the operations manual (OM) and the checklists in order to include information and guidance on the operating procedures detailed in Paragraph 10 of this AC. The appropriate manuals must contain the operating instructions for navigation equipment and contingency procedures. The manuals and checklists must be submitted for review along with the formal application in Phase 2 of the approval process.

(b) Private operators (*e.g.*, LAR 91 operators) must operate their aircraft based on the practices and procedures identified in Paragraph 10 of this CA.

6) *Minimum Equipment List (MEL)*.- The operator will send to the CAA for approval any revision to the MEL that is necessary to conduct RNP 1 operations. If a RNP 1 operational approval is granted based on a specific operational procedure, operators must modify the MEL and specify the required dispatch conditions.

7) *Maintenance*.- The operator will submit for approval a maintenance programme to conduct RNP 1 operations.

8) *Training programme for maintenance personnel*.- Operators will submit the training curriculums that correspond to maintenance personnel in accordance with Paragraph 8.5 e).

9) *Navigation data validation programme*.- The operator will present the details about the navigation data validation programme as described in Appendix 2 to this AC.

c) *Training*.- Once the amendments to manuals, programmes, and documents submitted have been accepted or approved, the operator will provide the required training to its personnel.

d) *Validation flight*.- The CAA may deem it advisable to perform a validation flight before granting the operational approval. Such validation can be performed on commercial flights. The validation flight will be carried out according to Chapter 12, Volume II, Part II of the operations inspector manual (MIO) of the Regional Safety Oversight Cooperation System (SRVSOP).

e) *Issuance of the approval to conduct RNP 1 operations*.- Once the operator has successfully completed the operational approval process, the CAA will grant the operator the authorization to conduct RNP 1 operations.

1) LAR 121 and/or 135 operators.- For LAR 121 and/or LAR 135 operators, the CAA will issue the corresponding operations specifications (OpSpecs) that will reflect the RNP 1 approval.

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

10. OPERATING PROCEDURES

10.1 The operator and the flight crews will become familiar with the following operating and contingency procedures associated with RNP 1 operations.

a) **Pre-flight planning**

1) Operators and pilots intending to conduct RNP 1 SIDs and STARs must fill out the appropriate boxes in the ICAO flight plan.

2) On-board navigation data must be current and include appropriate procedures.

Note.- *It is expected that the navigation database will be up to date during the operation. If the AIRAC cycle expires during the flight, operators and pilots shall establish procedures to ensure the precision of navigation data, including the suitability of navigation facilities used to determine the routes and procedures for the flight. Normally, this is done comparing electronic data with written documents. An acceptable means of compliance is to compare aeronautical charts (new and old) to check navigation reference points before dispatch. If an amended chart is published for the procedure, the database must not be used to conduct the operation.*

3) The availability of the NAVAID infrastructure required for the intended routes, including any non-RNP contingency, must be confirmed for the period of intended operations, using all available information. Since Annex 10 Volume I requires GNSS integrity (RAIM or SBAS signal), it is also necessary to confirm appropriate availability of these signals. For aircraft that navigate with SBAS receivers [all TSO-C145 () / C146 () receivers], operators shall confirm appropriate availability of the GNSS RAIM in areas where the SBAS signal is not available.

4) RAIM (ABAS) availability

(a) RAIM levels required for RNP 1 can be verified either through NOTAMs (where available) or through prediction services. Operators must be familiar with the prediction information available for the intended route.

(b) For systems whose integrity is based on RAIM, RAIM prediction must be done before departure. This capability can be provided by a ground service or through the RAIM prediction capability of the aircraft on-board receiver.

(c) The prediction of RAIM availability must take into account the last NOTAMs of the GPS constellation and the avionics model (if available). The RAIM prediction service can be provided through the ANSPs, the avionics manufacturers, other entities, or through the RAIM prediction capability of the aircraft on-board receiver. RAIM availability can be confirmed using a model-specific RAIM prediction software.

(d) The predictive capability must account for known and predicted outages of GPS satellites or other effects on the navigation system sensors. The prediction programme should not use a mask angle below 5 degrees, since operational experience indicates that satellite signals on low elevations are not reliable. RAIM availability prediction should take into account the latest GPS constellation notices to airmen (NOTAMs) issued by the CAA or by the ANSPs, and use an identical algorithm to that used in the airborne equipment or an algorithm based on assumptions for RAIM prediction that provides a more conservative result.

(e) In the event that a continuous loss of the appropriate failure detection level is forecast for more than five (5) minutes for any portion of the RNP 1 operation, the flight plan shall be revised (*e.g.*, delaying the departure or planning a different departure procedure).

(f) The RAIM availability prediction software does not guarantee the service. This software is rather a tool for assessing the expected capacity to meet the required navigation performance. Due to unplanned failures of some GNSS elements, pilots and ANSPs must understand that both RAIM and GNSS navigation can be lost while the aircraft is on flight, which may require reversal to an alternate means of navigation. Therefore, pilots must assess their navigation capabilities (potentially to an alternate aerodrome) in case of failure of GNSS navigation. If system integrity needs to be verified, the RAIM prediction programme shall meet the criteria of FAA AC 20-138, Paragraph 12.

(g) For aircraft navigating with SBAS receivers (all E/TSO-C145/C146), operators must take into account the latest GPS constellation and SBAS NOTAMs. Operators must also check appropriate GPS RAIM availability in areas where SBAS signal is unavailable.

b) **General operating procedures**

1) The pilot shall comply with any instruction or procedure identified by the manufacturer, as necessary, to meet the performance requirements of this section.

Note.- *Pilots must adhere to any AFM limitation or operating procedure required to maintain RNP 1 performance.*

2) Operators and pilots shall not request or file RNP 1 routes, SIDs or STARs, unless they meet all the criteria set forth in this AC. If an aircraft that does not meet these criteria and is cleared by the ATC to conduct a RNP 1 procedure, the pilot will notify the ATC that it cannot accept such clearance and will request alternate instructions;

3) At system initialization, pilots must:

(a) confirm that the navigation database is current;

(b) verify that the aircraft position has been entered correctly;

(c) verify the appropriate entry of the assigned ATC route once they receive the initial clearance, and any subsequent change in route; and

(d) ensure that the sequence of WPTs as depicted in their navigation system matches the route depicted in the appropriate charts and the assigned route.

4) Pilots must not fly an RNP 1 SID or STAR, unless it can be retrievable from the on-board navigation database by the procedure name, and conforms to the charted procedure. However, the procedure may subsequently be modified through the insertion or deletion of specific WPTs in response to ATC clearances. Manual entry or the creation of new WPTs through manual entry of latitude and longitude or rho/theta values is not permitted. Additionally, pilots must not change any SID or STAR database WPT type from a fly-by to a flyover or *vice versa*.

5) Pilots shall cross-check the cleared flight plan by comparing charts or other applicable

resources with the navigation system text displays and aircraft map displays, if applicable. If required, the exclusion of specific NAVAIDs must be confirmed. A procedure shall not be used if there are any doubts about the validity of the procedure in the navigation database.

Note.- *Pilots may notice a slight difference between the navigation information portrayed on the chart and their primary navigation display. Differences of 3° or less may result from the equipment manufacturer´s application of magnetic variation and are operationally acceptable.*

6) Cross-checking with conventional NAVAIDs is not required as the absence of integrity alert is considered sufficient to meet integrity requirements. However, monitoring of navigation reasonableness is suggested, and any loss of RNP capability shall be reported to the ATC.

7) For RNP 1 routes, pilots must use a lateral deviation indicator, FD or AP in lateral navigation mode (LNAV). Pilots of aircraft with a lateral deviation display must make sure that the lateral deviation scaling is suitable for the navigation accuracy associated with the route/procedure (*e.g.,* full-scale deflection: ± 1 NM for RNP 1).

8) All pilots are expected to maintain route centre lines, as depicted by on-board lateral deviation indicators and/or flight guidance during all RNP 1 operations described in this AC, unless authorized to deviate by ATC or due to emergency conditions. For normal operations, the cross-track error/deviation (the difference between the system computed path and the aircraft position relative to the path, i.e. FTE) should be limited to ± ½ the navigation accuracy associated with the procedure (i.e. 0.5 NM for RNP 1). Brief lateral deviations from this standard (*e.g.*, overshoots or undershoots) during or immediately after a turns, up to a maximum of 1 times the navigation accuracy (i.e. 1 NM for RNP 1) are allowable.

Note.- *Some aircraft do not display or compute a path during turns, but are still expected to satisfy the above standard during intercepts following turns and on straight segments.*

9) If the ATC issues a heading assignment that takes the aircraft off of a route, the pilot should not modify the flight plan in the RNP system until a clearance is received to rejoin the route or the controller confirms a new route clearance. When the aircraft is not on the published RNP 1 route, the specified accuracy requirement does not apply.

10) Manually selecting aircraft bank limiting functions may reduce the aircraft's ability to maintain its desired track and are not recommended. Pilots should recognize that manually selectable aircraft bank-limiting functions might reduce their ability to satisfy ATC path expectations, especially when executing large angle turns. This should not be construed as a requirement to deviate from aeroplane flight manual procedures; pilots should be encouraged to limit the selection of such functions within accepted procedures.

11) Pilots operating aircraft with an approved baro-VNAV system may continue using that system while executing RNP 1 STARs. Operators must ensure compliance with all altitude constraints as published in the procedure by reference to the barometric altimeter.

12) Before starting a RNP 1 procedure, flight crews must:

(a) confirm that the correct procedure has been selected. This process includes confirmation of the WPT sequence, the reasonableness of track angles, distances, and any other parameters that can be modified by the pilot, such as altitude or speed constraints; and

(b) for multi-sensor systems, verify that the correct sensor is being used for position computation.

c) **Aircraft with RNP selection capability**

Pilots of aircraft with the capability of selecting RNP input must select RNP 1 or lower for RNP 1 SIDs, STARs or procedures.

d) **RNP 1 SID specific requirements**

1) Before beginning take-off, the pilot must verify that the aircraft´s RNP 1 system is available, operating correctly, and that the appropriate aerodrome and runway data have been loaded. Before the flight, pilots must verify that the aircraft´s navigation system is operating correctly and that the appropriate runway and departure procedure (including any applicable en-route transition) have been entered and are properly depicted. Pilots assigned to a RNP 1 departure procedure and subsequently receive a change of runway, procedure or transition, must verify that the appropriate changes have been entered and are available for navigation before take-off. A final check of proper runway entry and correct route depiction, shortly before take-off, is recommended.

2) *Altitude for engagement the RNAV equipment*.- The pilot must be able to use the RNP 1 equipment to follow flight guidance for lateral navigation no later than 153 m (500 ft) above aerodrome elevation.

3) Pilots must use an authorised method (lateral deviation indicator/navigation map display/FD/AP) to achieve an appropriate level of performance for RNP 1.

4) *GNSS aircraft.*- When a GNSS is used, the signal must be obtained before the take-off roll commences. For aircraft using E/TSO-C129a equipment, the departure aerodrome must be loaded into the flight plan in order to achieve the appropriate navigation system monitoring and sensitivity. For aircraft using E/TSO-C145 ()/C146 () equipment, if the departure starts at a runway waypoint (WPT), then the departure aerodrome does not need to be in the flight plan to obtain appropriate monitoring and sensitivity. If a RNP 1 SID extends beyond 30 NM from the aerodrome and a lateral deviation indicator is used, its full-scale sensitivity must be selected to a value not greater than 1 NM between 30 NM from the aerodrome and the termination of the RNP 1 SID.

5) For aircraft using a lateral deviation display (i.e. navigation map display), the scale must be set for the RNP 1 SID, and the FD or AP should be used.

e) **RNP 1 STAR specific requirements**

1) Before to the arrival phase, the pilot should verify that the correct terminal route has been loaded. The active flight plan should be checked, by comparing the charts with the map display (if applicable) and the multi-function control display unit (MCDU). This includes confirmation of WPT sequence, the reasonableness of track angles and distances, any altitude or speed constraints, and, wherever possible, which WPTs are fly-by and which are flyover. If required by a route, a check will need to be made to confirm that updating will exclude a particular NAVAID. A route must not be used if doubt exists as to the validity of the route in the navigation database.

Note.- *As a minimum, the arrival checks could be a simple inspection of a suitable map display that achieves the objectives of this paragraph.*

2) The creation of new WPTs by manual entry into the RNP 1 system by the pilot would invalidate route, and is not permitted.

3) Where the contingency procedure requires reversion to a conventional arrival route, necessary preparations must be completed before starting the RNP 1 procedure.

4) Procedure modifications in the terminal area may take the form of radar headings or “direct to” clearances and the pilot must be capable of reacting in a timely fashion. This may include the insertion of tactical WPTs loaded from the database. Manual entry or modifications by the pilot of the loaded route using temporary WPT or fixes not provided in the database in not permitted.

5) Pilots must verify whether the aircraft navigation system is operating properly and the correct arrival procedure and runway are entered and properly depicted.

6) Although a particular method is not mandated, any published altitude and speed constraints must be observed.

7) Aircraft with E/TSO-C129a GNSS RNP systems: If the RNP 1 STAR begins beyond 30 NM from the aerodrome and a lateral deviation indicator is used, then full-scale sensitivity should be manually selected to a value not greater than 1 NM before commencing the STAR. For aircraft using a lateral deviation display (i.e. navigation map display), the scale must be set to the RNP 1 STAR and the FD or AP should be used.

f) **Contingency procedures**

1) The pilot must notify ATC of any loss of RNP capability (integrity alerts or loss of navigation), together with the proposed course of action. If, for any reason, is unable to comply with the requirements of an RNP 1 SID or STAR, pilots must advise ATS as soon as possible. The loss of RNP capability includes any failure or event causing the aircraft to no longer satisfy the RNP 1 requirements of the route.

2) In the event of a communication failure, the pilot should continue with the published lost communications procedure.

11. TRAINING PROGRAMMES

11.1 The training programme for flight crews and flight dispatchers (DV) shall provide sufficient training (*e.g*., using flight training devices, flight simulators and aircraft) on the RNP system to the extent necessary. The training programme will include the following topics:

a) the information of this AC;

b) the meaning and proper use of aircraft equipment/navigation suffixes;

c) the procedures characteristics as determined from chart depiction and textual description;

d) the depiction of WPTs types (fly-by and flyover) and ARINC 424 path terminators provided in Appendix 1 to this AC and any other types used by the operator, as well as associated aircraft flight paths;

e) the required navigation equipment for operations on RNP 1 SIDs and STARs.

f) specific information on the RNP system:

1) levels of automation, mode annunciations, changes, alerts, interactions, reversions, and degradation;

2) functional integration with other aircraft systems;

3) the meaning and appropriateness of route discontinuities as well as related flight crew procedures;

4) pilot procedures consistent with the operation;

5) types of navigation sensors (*e.g*. GNSS) used by the RNP system and associated system prioritization, weighting and logic;

6) turn anticipation, taking into account the effects of speed and altitude;

7) interpretation of electronic displays and symbols; and

8) understanding of the aircraft configuration and operational conditions required to support RNP 1 operations, i.e. appropriate selection of CDI scaling (lateral deviation display scaling);

g) RNP system operating procedures, as applicable, including how to perform the following actions:

1) verify currency and integrity of aircraft navigation data;

2) verify the successful completion of RNP system self-tests;

3) initialize navigation system position;

4) retrieve and fly a RNP 1 SID or STAR with the appropriate transition;

5) adhere to speed and/or altitude constraints associated with an RNP 1 SID or STAR;

6) select the appropriate RNP 1 SID or STAR for the active runway and be familiar with procedures to deal with a runway change;

7) verify WPTs and flight plan programming;

8) fly direct to a WPT;

9) fly a course/track to a WPT;

10) intercept a course/track;

11) following vectors and re-joining a RNP 1 route from a “heading” mode;

12) determine cross-track error/deviation. More specifically, the maximum allowable deviations to support RNP 1 must be understood and respected;

13) resolve route discontinuities (insert and delete/eliminate en-route discontinuities);

14) remove or reselect the navigation sensor input;

15) when required, confirm the exclusion of a specific NAVAID or NAVAID type;

16) change arrival aerodrome and alternate aerodrome;

17) perform parallel offset if that capability is available. Pilots should know how to apply offsets, the functionality of the particular RNP system, and the need to advise the ATC if this functionality is not available; and

18) perform RNP holding pattern functions (*e.g.* insert or delete a holding pattern).

h) Operator-recommended levels of automation for each phase of flight and workload, including methods to minimize cross-track error to maintain route centreline;

i) radiotelephony phraseology used for RNAV/RNP applications; and

j) contingency procedures for RNAV/RNP failures.

12. NAVIGATION DATABASE

a) The operator must obtain the navigation database from a supplier that complies with RTCA (Radio Technical Commission for Aeronautics) document DO 200A/EUROCAE ED 76 – Standards for processing aeronautical data. Navigation data must be compatible with the foreseen function of the equipment (see Annex 6 Part I). A letter of acceptance (LOA) issued by the appropriate regulatory authority to each of the participants in the data chain demonstrate compliance with this requirement (*e.g.*, FAA LOA issued in accordance with FAA AC 20-153 or EASA LOA issued in accordance with EASA Opinion Nr. 01/2005).

b) The operator must advise the navigation database supplier of discrepancies that invalidate a SID or STAR, and prohibit their use through a notice to flight crews.

c) Operators should consider the need to conduct periodic check of the operational navigation databases in order to meet existing quality control system or safety management system requirements.

Note.- *To minimize the path definition error (PDE), the database should comply with DO 200A or an equivalent operational means must be in place to ensure database integrity for the RNP 1 SIDs or STARs.*

13. OVERSIGHT, INVESTIGATION OF NAVIGATION ERRORS, AND WITHDRAWAL OF RNP 1 APPROVAL

a) The operator will establish a procedure to receive, analyse, and follow up on navigation error reports in order to determine appropriate corrective action.

b) Information indicating a potential for repetitive errors may require the modification of the training programme of the operator.

c) Information attributing multiple errors to a pilot in particular may call for additional training or a license revision for that pilot.

d) Repetitive navigation errors attributed to the equipment or a specific part of the navigation equipment or to operating procedures can be the cause of cancellation of an operational approval (withdrawal of RNP 1 OpSpecs authorisation or withdrawal of the LOA in the case of private operators).

APPENDIX 1

FUNCTIONAL REQUIREMENTS

Paragraph	Functional requirements	Explanation
a)	Navigation data, including a failure indicator, must be displayed on a lateral deviation display [*e.g.,* course deviation indicator (CDI), enhanced horizontal situation indicator (EHIS)] and/or a navigation map display]. These lateral deviation displays must be used as primary flight instruments for the navigation of the aircraft, for manoeuvre anticipation, and for indication of failure / status / integrity.	1) Non-numeric lateral deviation display (e.g. CDI, EHSI), with a to/from indication and a failure annunciation, for use as primary flight instruments for navigation of the aircraft, for manoeuvre anticipation, and for failure / status / integrity indication, with the following six attributes: (a) The capability to continuously display to the pilot flying, on the primary flight instruments for navigation of the aircraft (primary navigation display), the computed path and aircraft position relative to the path. For operations where the required minimum flight crew is two pilots, the means for the pilot not flying to verify the desired path and the aircraft position relative to the path must also be provided; (b) Each display must be visible to the pilot and located in the primary field of view (±15 degrees from the pilot's normal line of sight) when looking forward along the flight path. (c) The lateral deviation display scaling should agree with any implemented alerting and annunciation limits; (d) The lateral deviation display must also have a full-scale deflection suitable for the current phase of flight and must be based on the required track-keeping accuracy. (e) The display scaling may be set: - automatically by default logic; - automatically to a value obtain from a navigation database; or - manually by pilot procedure. The full-scale deflection value must be known or must be available for display to the pilot commensurate with the required track-keeping accuracy. (f) The lateral deviation display must be automatically slaved to the RNP computed path. The course selector of

Paragraph	Functional requirements	Explanation
		the deviation display should be automatically slewed to the RNP computed path, or the pilot must adjust the CDI or HSI selected course to the computed desired track. 2) As an alternate means, a navigation map display can provide equivalent functionality to a lateral deviation display as described in Paragraphs (a) - (f) above, with appropriate map scales and giving equivalent functionality to a lateral deviation display. The map scale should be set manually to a value appropriate for the RNP 1 operation.
b)	The following functions of the RNP 1 systems are required as a minimum:	1) A navigation database containing current navigation data officially issued for civil aviation, which can be updated in accordance with the aeronautical information regulation and control (AIRAC) cycle and from which ATS routes can be retrieved and loaded into the RNP system. The stored resolution of data must be sufficient to achieve negligible path definition error (PDE). The database must be protected against pilot modification of the stored data; 2) The means to display the validity period of the navigation data to the pilot; 3) The means to retrieve and display the data stored in the navigation database relating to individual waypoints and NAVAIDs, to enable the pilot to verify the route to be flown; and 4) The capability to load from the navigation database into the RNP system, the entire segment of the SID or STAR to be flown. ***Note.-*** *Due to variability in systems, this document defines the RNP segment from the first occurrence of a named WPT, track or course up to the last occurrence of a named WPT, track or course. Heading legs prior to the first named WPT or after the last named WPT do not have to be loaded from the navigation database. The entire SID will still be considered an RNP 1 procedure.*
c)	The means to display the following items, either on the primary field of view of the pilots, or on a readily accessible display page [*e.g.*, on a multi-function control display unit (MCDU)]:	1) the active navigation sensor type; 2) the identification of the active (to) waypoint; 3) the ground speed or time to the active (to) waypoint; and 4) the distance and bearing to the active (to)

Paragraph	Functional requirements	Explanation
		waypoint.
d)	The capability to execute a “direct to” function.	
e)	The capability for automatic leg sequencing with the display of sequencing to the pilot.	
f)	The capability to load and execute an RNP 1 SID or STAR from the on-board database, by procedure name, into the RNP system.	
g)	The aircraft must have the capability to automatically execute leg transitions and maintain tracks consistent with the following ARINC 424 path terminators or their equivalent: ➢ Initial fix (IF); ➢ Course to a fix (CF); ➢ Direct to a fix (DF); and ➢ Track to a fix (TF).	***Note 1.-*** *Path terminators are defined in the ARINC 424 specification, and their application is described in more detail in RTCA documents DO-236B and DO-201A and in EUROCAE ED-75B and ED-77* ***Note 2.-*** *Numeric values for courses and tracks must be automatically loaded from the RNP system database.*
h)	The aircraft must have the capability to automatically execute leg transitions consistent with the following ARINC 424 path terminators: ➢ heading to an altitude (VA); ➢ heading to a manual termination (VM); and ➢ heading to an intercept (VI); or must be able to be manually flown on a heading to intercept a course or to go direct to another fix after reaching a procedure-specified altitude.	
i)	The aircraft must have the capability to automatically execute leg transitions consistent with the following ARINC 424 path terminators: ➢ course to an altitude (CA);	

Paragraph	Functional requirements	Explanation
	and ➢ course from a fix to a manual termination (FM); or the RNP system must permit the pilot to readily designate a waypoint and select a desired course to or from a designated waypoint.	
j)	The capability to display an indication of the RNP 1 system failure in the pilot´s primary field of view.	
k)	Database integrity	The navigation database suppliers must comply with RTCA DO-200/EUROCAE document ED 76 - Standards for processing aeronautical data. A Letter of acceptance (LOA) issued by the appropriate regulatory authority to each of the participants in the data chain demonstrates compliance with this requirement. Discrepancies that invalidate a route must be reported to database suppliers and the affected routes must be prohibited through a notice from the operator to its flight crews. Aircraft operators must consider the need to conduct periodic checks of the navigation databases in order to meet existing safety system requirements.

APPENDIX 2

NAVIGATION DATA VALIDATION PROGRAMME

1. INTRODUCTION

The information stored in the navigation database defines the lateral and longitudinal guidance of the aircraft for RNP 1 operations. Navigation database updates are carried out every 28 days. The navigation data used in each update are critical to the integrity of every RNP 1 procedure, SID and STAR. This appendix provides guidance on operator procedures to validate the navigation data associated with the RNP 1 operations.

2. DATA PROCESSING

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

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

c) The operator must place its documented data process under configuration control.

3. INITIAL DATA VALIDATION

3.1 The operator must validate every RNP 1 procedure, SID and STAR before flying under instrument meteorological conditions (IMC) to ensure compatibility with the aircraft and to ensure that the resulting paths are consistent with the published procedures, SIDs and STARs. As a minimum, the operator must:

a) compare the navigation data of RNP 1 procedures, SIDs, and STARs to be loaded into the FMS with valid charts and maps containing the published procedures, SIDs, and STARs.

b) validate the navigation data loaded for RNP 1 procedures, SIDs, and STARs, either on the flight simulator or on the aircraft, under visual meteorological conditions (VMC). RNP 1 procedures, SIDs, and STARs outlined on a map display must be compared to the published procedures, SIDs, and STARs. Complete RNP 1 procedures, SIDs, and STARs must be flown in order to ensure that the paths can be used, that they have no apparent lateral or longitudinal discrepancies, and that they are consistent with the published routes, SIDs, and STARs.

c) Once the RNP 1 procedures, SIDs, and STARs are validated, a copy of the validated navigation data shall be kept and maintained in order to compare them with subsequent data updates.

4. DATA UPDATING

Upon receiving a navigation data update and before using such data on the aircraft, the operator must compare the update with the validated procedures, SIDs or STARs. This comparison must identify and resolve any discrepancy in the navigation data. If there are significant changes (any change affecting the path or the performance of the procedures, SIDs and STARs) in any part of the procedure, SID, and STAR, and if those changes are verified through the initial data, the operator must validate the amended route in accordance with the initial validation data.

5. NAVEGATION DATA SUPPLIERS

Navigation data suppliers must have a letter of acceptance (LOA) in order to process these data (*e.g.*, FAA AC 20-153 or the document on the conditions for the issuance of letters of acceptance to navigation data suppliers by the European Aviation Safety Agency – EASA (EASA IR

21 Subpart G) or equivalent documents). A LOA recognises the data supplier as one whose data quality, integrity and quality management practices are consistent with the criteria of DO-200A/ED-76. The database supplier of an operator must have a Type 2 LOA and its respective suppliers must have a Type 1 or 2 LOA. The CAA may accept a LOA issued to navigation data suppliers or issue its own LOA.

6. AIRCRAFT MODIFICATIONS (DATABASE UPDATE)

If an aircraft system necessary for RNP 1 operations is modified (*e.g.*, change of software), the operator is responsible for validating the RNP 1 procedures, SIDs, and STARs with the navigation database and the modified system. This can be done without any direct assessment if the manufacturer confirms that the modification has no effect on the navigation database or on path calculation. If there is no such confirmation by the manufacturer, the operator must perform an initial validation of the navigation data with the modified system.

APPENDIX 3

RNP 1 APPROVAL PROCESS

a) The RNP 1 approval process consists of two types of approvals, airworthiness and operational. Although the two have different requirements, they must be considered in one single process.

b) This process is an orderly method used by the CAA to make sure that the applicants meet the established requirements.

c) The approval process is made up by the following phases:

1) Phase one: Pre-application

2) Phase two: Formal application

3) Phase three: Documentation evaluation

4) Phase four: Inspection and demonstration

5) Phase five: Approval

d) In *Phase one - Pre-application*, the CAA calls the applicant or operator to a pre-application meeting. At this meeting, the CAA informs the applicant or operator of all the operational and airworthiness requirements that it must meet during the approval process, including the following:

1) the contents of the formal application;

2) the review and evaluation of the application by the CAA;

3) the limitations (if any) applicable to the approval; and

4) conditions under which the RNP 1 approval could be cancelled.

e) In *Phase two – Formal Application*, the applicant or operator submits the formal application along with all the relevant documentation, as established in Paragraph 9.1.1 b) of this AC.

f) In Phase three – *Documentation evaluation*, the CAA evaluates all the documentation and the navigation system to determine their eligibility and the approval method to be followed in connection with the aircraft. As a result of this analysis and evaluation, the CAA may accept or reject the formal application along with the documentation.

g) In *Phase four – Inspection and demonstration*, the operator will provide training to its personnel and will carry out the validation flight, if required.

h) In *Phase five* - Approval, the CAA issues the RNP 1 approval once the operator has met the airworthiness and operational requirements. For LAR 121 and 135 operators, the CAA will issue the OpSpecs, and for LAR 91 operators, a LOA.

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APPENDIX 4

RADIUS TO FIX (RF) PATH TERMINATOR

1. INTRODUCTION

1.1 Background

This appendix addresses ARINC 424 RF path terminator functionality when used in association with RNP 1 navigation specification. RF legs are an optional capability for use with RNP 1 rather than a minimum requirement. This functionality can be used in the initial and intermediate approach segments, the final phase of the missed approach, SIDs and STARs. The application of this appendix in the final approach or the initial or intermediate phases of the missed approach is prohibited. Such procedure segments wishing to apply RF would have to use the RNP AR specification.

1.2 Purpose

1.2.1 This appendix provides guidance to CAAs implementing instrument flight procedures (IFPs) where RF legs are incorporated into terminal procedures.

1.2.2 For the ANSP, it provides a consistent ICAO recommendation on how to implement RF legs. For the operator, it provides training requirements. This appendix is intended to facilitate operational approval for existing RNP systems that have a demonstrated RF leg capability. An operational approval based upon this standard allows an operator to conduct operations on procedures containing RF legs globally.

1.2.3 This appendix also provides airworthiness and operational criteria for the approval of an RNP system incorporating an RF leg capability. Although the ARINC 424 RF leg functionality in this appendix is identical to that found in the RNP AR specification, the approval requirements when applied in association with RNP 1 are not as constraining as those applied to RNP AR. This is taken into account in the related obstacle protection and route spacing criteria. Doc 9905 provides a continuous lateral protection of 2 × RNP for RNP AR applications, on the basis that the certification and approval process provides assurance that the integrity and continuity of the navigation solution will meet 10^{-7}. The demanding integrity and continuity requirements for RNP AR do not apply to the RF functionality described here as Doc 8168 provides additional buffers in the RF design criteria.

2. IMPLEMENTATION CONSIDERATIONS

2.1 Application of RF legs

2.1.1 The RF leg should be used when there is a requirement for a specific fixed radius curved path in a terminal procedure. The RF leg is defined by the arc centre fix, the arc initial fix, the arc ending fix and the turn direction. The radius is calculated by the navigation computer as the distance from the arc centre fix to the arc ending fix. RNP systems supporting this leg type provide the same ability to conform to the track-keeping accuracy during the turn as in the straight line segments. RF legs are intended to be applied where accurate repeatable and predictable navigation performance is required in a constant radius turn.

2.1.3 RF legs may be used on any segment of a terminal procedure except the FAS, the Initial missed approach phase or the intermediate missed approach phase. The criteria for designing procedures with RF legs are detailed in PANS-OPS (Doc 8168).

Note.- *Although the RF leg is designed to be applied within the extent of terminal procedures, during higher flight level/altitude segments aircraft may become bank angle limited. When designing terminal procedures with curved path segments, consideration should be given to the interface between the terminal procedure (SID or STAR) and the ATS route structure and whether it is more appropriate to implement the curved path segment though use of the FRT. The FRT design feature within an ATS route structure is provided for any such curved path requirements as part of the A-RNP specification.*

2.2 IFP design considerations and assumptions

2.2.1 The radius of turn depends upon the ground speed of the aircraft and the applied bank angle. From an IFP design perspective, the maximum ground speed of the aircraft is determined by the maximum allowable IAS, the turn altitude and the maximum tail wind. IFP design criteria for maximum IAS, turn altitude, bank angle and maximum tailwind are described in detail in PANS-OPS (Doc 8168).

2.2.2 When speed restrictions are required for departures they will be placed on the RF leg exit waypoint or a subsequent waypoint as required. For arrivals, the speed restriction should be applied to the waypoint associated with the beginning of the RF leg (path terminator of preceding leg).

2.2.3 The inbound and outbound legs will be tangential to the RF leg.

2.2.4 The requirements of an RF leg may be continued through to a sequential RF leg when implementing wrap-around instrument procedures, e.g. departures.

2.2.5 The procedure will be subjected to comprehensive validation checks prior to publication in order to assure flyability by the intended aircraft types.

3. GENERAL CONSIDERATIONS FOR USE OF RF LEGS

3.1 Benefits

RF legs provide a predictable and repeatable ground track during a turn and prevent the dispersion of tracks experienced in other types of turn construction due to varying aircraft speeds, turn anticipation, bank, roll rate, etc. Therefore, RF legs can be employed where a specified path must be flown during a turn. Additionally, because an RF leg traverses a specified distance it can be used to maintain aircraft longitudinal spacing between aircraft having the same speed. This is not necessarily true with other turn constructions such as fly-by transitions, because of the varying turn paths aircraft execute.

3.2 Publication considerations

Guidance for charting RF legs is provided in PANS-OPS (Doc 8168). The requirement for RF functionality must be clearly marked on the chart.

3.3 ATC coordination

3.1.1 It is expected that ATC will be familiar with RF leg benefits and their limitations, e.g. speed. ATC shall not allocate a speed that exceeds a constraint associated with the (design) flyability of an RF leg.

3.1.2 Aircraft must be established on the inbound track to the RF leg prior to it being sequenced by the navigation system. ATC must therefore not issue a Direct To clearance to a waypoint beginning an RF leg or a vector to intercept an RF leg.

4. AIRCRAFT REQUIREMENTS

4.1 RNP system-specific information

4.1.1 The navigation system should not permit the pilot to select a procedure that is not supported by the equipment, either manually or automatically (e.g. a procedure is not supported if it incorporates an RF leg and the equipment does not provide RF leg capability).

4.1.2 The navigation system should also prohibit pilot access to procedures requiring RF leg capability if the system can select the procedure, but the aircraft is not otherwise equipped (e.g. the aircraft does not have the required roll steering autopilot or flight director installed).

Note 1.- *One acceptable means to meet these requirements is to screen the aircraft's on-board navigation database and remove any routes or procedures the aircraft is not eligible to execute. For example, if the aircraft is not eligible to complete RF leg segments, then the database screening could remove all procedures containing RF leg segments from the navigation database.*

Note 2.- *Another acceptable means of compliance may be pilot training to identify and prohibit the use of procedures containing RF legs.*

4.2 On-board performance monitoring and alerting

The navigation system must have the capability to execute leg transitions and maintain a track consistent with an RF leg between two fixes. The lateral TSE must be within ±1 × RNP of the path defined by the published procedure for at least 95 per cent of the total flight time for each phase of flight and each autopilot and/or flight director mode requested.

Note 1.- *Industry standards for RF defined paths can be found in RTCA DO-236B/EUROCAE ED-75B (section 3.2.5.4.1 and 3.2.5.4.2).*

Note 2.- *Default values for FTE can be found in RTCA DO-283A. FAA AC 120-29A, 5.19.2.2 and 5.19.3.1, also provides guidance on establishing FTE values.*

4.3 System failure modes/annunciations

4.3.1 The RNP system shall provide a visible alert within the pilot's primary field of view when loss of navigation capability and/or LOI are experienced.

4.3.2 Any failure modes that have the potential to affect the RF leg capability should be identified. Failure modes may include loss of electrical power, loss of signal reception, RNP system failure, including degradation of navigation performance resulting in a loss of RNP containment integrity.

4.3.3 The ability of the aircraft to maintain the required FTE after a full or partial failure of the autopilot and/or flight director should be documented.

Note- *If autopilot malfunction testing was performed for worst case failures, no further validation is required. In this case, the manufacturer is expected to provide a statement of confirmation.*

4.4 Functional requirements

4.4.1 An autopilot or flight director with at least "roll-steering" capability that is driven by the RNP system is required. The autopilot/flight director must operate with suitable accuracy to track the lateral and, as appropriate, vertical paths required by a specific RNP procedure.

4.4.2 An electronic map display depicting the RNP computed path of the selected procedure is required.

4.4.3 The flight management computer, the flight director system, and the autopilot must be capable of commanding and achieving a bank angle up to 25 degrees above 400 ft AGL.

4.4.4 The flight guidance mode should remain in lateral navigation while on an RF leg, when a procedure is abandoned or a missed approach/go-around is initiated (through activation of TOGA or other means) to enable display of deviation and display of positive course guidance during the RF leg. As an alternative means, crew procedures may be used that ensure that the aircraft adheres to the specified flight path throughout the RF leg segment.

4.5 Compliance demonstration

4.5.1 In seeking an airworthiness approval for a navigation system implementing the RF path terminator, the compliance demonstration supporting such an approval should be scoped to the airspace operational concept and the boundaries to which the RF leg is likely to be applied.

4.5.2 Consideration should be given to evaluation of the navigation system on a representative set of procedure designs under all foreseen operating conditions. The evaluation should address maximum assumed crosswind and maximum altitude with the aircraft operating in the range of

expected airspeeds for the manoeuvre and operating gross weights. Procedure design constraints should include sequencing multiple, consecutive RF leg segments of varying turn radii, including consecutive RF leg segments reversing the direction of turn (i.e. reversing from a left-hand RF turn to a right-hand RF turn). Within the demonstration, the applicant should be seeking to confirm the FTE commensurate with the identified RNP navigation accuracy and that the RF turn entry and exit criteria are satisfied. Any limitations identified during the compliance demonstration should be documented. Flight crew procedures should be assessed, including identification of any limitations which surround the use of pilot selectable or automatic bank angle limiting functions and confirmation of those related to go-around or missed approach from an RF leg segment.

5. OPERATIONAL REQUIREMENTS

5.1 Background

This section identifies the operational requirements associated with the use of RF legs as scoped in 1.1 of this appendix. It assumes that the airworthiness approval of the aircraft and systems has been completed. This means that the basis for the RF leg function and the system performance has already been established and approved based upon appropriate levels of analysis, testing and demonstration. As part of this activity, the normal procedures, as well as any limitations for the function, will have been documented, as appropriate, in the aircraft flight and operations manuals.

5.2 Approval process

The approval process will follow the procedures established in Appendix 3 of this AC.

5.3 Aircraft eligibility

5.3.1 Relevant documentation acceptable to the CAA must be available to establish that the aircraft is equipped with an RNP system with a demonstrated RF leg capability. Eligibility may be established in two steps: first, recognizing the qualities and qualifications of the aircraft and equipment; and second, determining the acceptability for operations. The determination of eligibility for existing systems should consider acceptance of manufacturer documentation of compliance, e.g. FAA ACs 90-105, 90-101A, 20-138B, EASA AMC 20-26.

Note.- *RNP systems demonstrated and qualified for RNP AR operations using RF leg functionality are considered qualified with recognition that the RNP operations are expected to be performed consistent with the operators RNP AR approval. No further examination of aircraft capability, operator training, maintenance, operating procedures, databases, etc. is necessary.*

5.3.2 *Eligibility airworthiness documents*. The flight manual or referenced document should contain the following information:

a) A statement indicating that the aircraft meets the requirements for RNP 1 operations with RF legs and has demonstrated the established minimum capabilities for these operations. This documentation should include the phase of flight, mode of flight (e.g. FD on or off, and/or AP on or off, and applicable lateral and vertical modes), minimum demonstrated lateral navigation accuracy, and sensor limitations, if any;

b) Any conditions or constraints on path steering performance (e.g. AP engaged, FD with map display, including lateral and vertical modes, and/or CDI/map scaling requirements) should be identified. Use of manual control with CDI only is not allowed on RF legs; and

c) The criteria used for the demonstration of the system, acceptable normal and non-normal configurations and procedures, the demonstrated configurations and any constraints or limitations necessary for safe operation should be identified.

5.4 Operational approval

5.4.1 The operational approval will follow the steps described in Paragraph 9.1 of this AC.

5.4.2 *Issuance of the approval to conduct RNP 1 operations with RF legs*.- Once the operator has successfully completed the operational approval process, the CAA will grant to the operator the authorization to conduct RNP 1 operations with RF legs.

a) LAR 121 and/or 135 operators.- For LAR 121 and/or LAR 135 operators, the CAA will issue the corresponding operations specifications (OpSpecs) that will reflect the RNP 1 authorization with RF legs.

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

5.4.2 Training documentation.- Commercial operators must have a training programme addressing the operational practices, procedures and training related to RF legs in terminal operations (e.g. initial, upgrade or recurrent training for pilot, dispatchers or maintenance personnel). Private operators should be familiar with the practices and procedures identified in 5.6 - Pilot knowledge and training.

Note.- *It is not required to establish a separate training programme or regime if RNAV and RF leg training is already an integrated element of a training programme. However, it should be possible to identify what aspects of RF leg use are covered within a training programme.*

5.4.4 OMs and checklists.- OMs and checklists for commercial operators must address information/guidance on the SOP detailed in 5.5 - Operating procedures. Private operators should operate using the practices and procedures identified in 5.6 - Pilot knowledge and training. These SOP and practices must clearly define any aircraft limitations associated with RF leg execution (e.g. if the aircraft is not capable of executing RF leg segments, then the instructions to pilots must prohibit an attempt to fly a procedure requiring RF leg capability).

5.5 Operating procedures

5.5.1 The pilot must use either a flight director or autopilot when flying an RF leg. The pilot should comply with any instructions or procedures identified by the manufacturer as necessary to comply with the performance requirements in this appendix.

5.5.2 Procedures with RF legs will be identified on the appropriate chart.

5.5.3 When the dispatch of a flight is predicated on flying an RNP procedure with an RF leg, the dispatcher/pilot must determine that the installed autopilot/flight director is operational.

5.5.4 The pilot is not authorized to fly a published RNP procedure unless it is retrievable by the procedure name from the aircraft navigation database and conforms to the charted procedure. The lateral path must not be modified, with the exception of complying with ATC clearances/instructions.

5.5.5 The aircraft must be established on the procedure prior to beginning the RF leg.

5.5.6 The pilot is expected to maintain the centre line of the desired path on RF legs. For normal operations, cross-track error/deviation (the difference between the displayed path and the displayed aircraft position relative to the displayed path (i.e. FTE) should be limited to half the navigation accuracy associated with the procedure (e.g. 0.5 NM for RNP 1).

5.5.7 Where published, the pilot must not exceed maximum airspeeds associated with the flyability (design) of the RF leg.

5.5.8 If an aircraft system failure results in the loss of capability to follow an RF turn, the pilot should maintain the current bank and roll out on the charted RF exit course. The pilot should advise ATC as soon as possible of the system failure.

5.6 Pilot knowledge and training

5.6.1 The training programme must include:

a) The information in this appendix;

b) The meaning and proper use of RF functionality in RNP systems;

c) Associated procedure characteristics as determined from the chart depiction and textual description;

d) Associated levels of automation, mode annunciations, changes, alerts, interactions, reversions, and degradation;

Note.- *Manually selecting aircraft bank limiting functions may reduce the aircraft's ability to maintain its desired track and are not permitted. The pilots should recognize that manually selectable aircraft bank-limiting functions may reduce their ability to satisfy ATC path expectations, especially when executing large angle turns.*

e) Monitoring track-keeping performance;

f) The effect of wind on aircraft performance during execution of RF legs and the need to remain within the RNP containment area. The training programme should address any operational wind limitations and aircraft configurations essential to safely complete the RF turn;

g) The effect of ground speed on compliance with RF paths and bank angle restrictions impacting the ability to remain on the course centre line;

h) Interpretation of electronic displays and symbols; and

i) Contingency procedures.

5.7 Navigation database

Aircraft operators will be required to manage their navigation data base load either through the packing or through flight crew procedure, where they have aircraft systems capable of supporting the RF functionality, but as an operator they do not have an approval for its use.