COMMENT RESPONSE DOCUMENT (CRD) TO NOTICE OF PROPOSED AMENDMENT (NPA) 2008-14

for amending the Executive Director Decision No. 2003/12/RM of 5 November 2003 on acceptable means of compliance for airworthiness of products, parts and appliances (« AMC-20 »)

"Airworthiness and Operational Approval for on board equipment related to Required Navigation Performance/Area Navigation (RNP/RNAV) Approach Operations"

Explanatory Note

I. General

1. The purpose of the Notice of Proposed Amendment (NPA) 2008-14, dated 26 May 2008, was to propose an amendment to Decision 2003/12/RM of the Executive Director of the European Aviation Safety Agency of 5 November 2003 on acceptable means of compliance for airworthiness of products, parts and appliances (<<AMC-20>>). It proposed the introduction of two new AMC-20 related to the Airworthiness and Operational Approval for on board equipment related to Required Navigation Performance/Area Navigation (RNP/RNAV) Approach.

II. Consultation

2. The draft Executive Director Decision amending Decision N° 2003/12/RM was published on the web site (http://www.easa.europa.eu) on 28 May 2008.

   By the closing date of 28 August 2008, the European Aviation Safety Agency ("the Agency") had received 342 comments from 26 National Aviation Authorities, professional organisations and private companies.

III. Publication of the CRD

3. All comments received have been acknowledged and incorporated into this Comment Response Document (CRD) with the responses of the Agency.

4. In responding to comments, a standard terminology has been applied to attest the Agency's acceptance of the comment. This terminology is as follows:

   - **Accepted** – The comment is agreed by the Agency and any proposed amendment is wholly transferred to the revised text.
   - **Partially Accepted** – Either the comment is only agreed in part by the Agency, or the comment is agreed by the Agency but any proposed amendment is partially transferred to the revised text.
   - **Noted** – The comment is acknowledged by the Agency but no change to the existing text is considered necessary.
   - **Not Accepted** - The comment or proposed amendment is not shared by the Agency

   The resulting text highlights the changes as compared to the current rule.

5. The Executive Director Decision will be issued at least two months after the publication of this CRD to allow for any possible reactions of stakeholders regarding possible misunderstandings of the comments received and answers provided.

6. Such reactions should be received by the Agency not later than 10 September 2009 and should be submitted using the Comment-Response Tool at http://hub.easa.europa.eu/crt.

IV. CRD table of comments, responses and resulting text

(General Comments)	-

comment	*34* comment by: *AEA* We are pleased that the RNP Approach Procedure AMC material is now available and specifically that the Barometric VNAV criteria (we have been waiting for so long) is now incorporated. RNP AR is at this time seen as not much relevant for our operation, but that could change. We therefore also analysed this part of the NPA. The usability of the AMC 20-26 has been improved utilising the Appendices for the more in depth material. This makes the document better readable and useable. As to the consistency between the AMC 20-26 and 20-27: the accuracy criteria is not balanced between the two documents. It is not understood, why for the RNP approach the accuracy system requirements are extensively indicated (Lateral and Vertical) while this is not the case for the RNP AR, while these are meant for more critical operations. This is specifically true for the Vertical Navigation which are used for both type of approaches and where the criticality of the RNP AR is more demanding.
response	*Noted* The AMCs are different, in that for AMC 20-26 the values are optimised for the procedure or aircraft, while for AMC 20-27 they are generalised fixed values. Thus the RNP AR criteria need to be defined in a different manner between the two AMCs.

comment	*35* comment by: *AEA* IFPP Maintenance and Implementation WG is redrafting the APV Baro-VNAV criteria totally, in order to harmonise with the final approach vertical obstacle clearance methodology of the RNP AR (VEB budget method) and the missed approach design criteria. For both, the FTE value plays an important role. To prevent a Chicken & Egg situation as to the assumptions made, it is proposed to harmonise the FTE values. It is suggested that a meeting take place between the key players of the IFPP M&I WG and the authors of the AMC's.
response	*Noted* The comment is noted. It is the Agency's intent to publish these AMCs with the developed text. Any amendments to this will be co-ordinated with all interested parties.

comment	*58* comment by: *CAA CZ* The CAA-CZ supports the NPA 2008-14 and welcomes the development of acceptable means of compliance concerning the airworthiness approval and operational criteria for RNP Authorization Required operations and RNP Approach operations including APV BARO-VNAV operations.
response	*Noted* Thank you for your support.

comment	*135* comment by: *British Airways* *British Airways full supports the EASA Notice of Proposed Amendment (NPA) 2008-14 detailing the acceptable means of compliance for AMC 20-26 and AMC 20-27.* *These long awaited documents not only give guidance on the requirements for an operator seeking operational approval, but also clearly defines the system requirements for the Original Equipment Manufacturers (OEMs).* *British Airways agrees with the agencies assessment that Option 1, to do nothing is not a viable option. Option 2 with its positive impacts on improved safety, improved situation awareness and improved efficiency is the preferred option. With the worlds focus on environmental issues any operational procedures that helps to reduce the impact of aviation on local environments and to reduce airborne emissions is wholly supported.* *Our operations are global and therefore it is imperative that any European rule facilitates global harmonization and we are pleased to see that this is the case with both AMCs..* *Whilst the application of RNP AR in the terminal area and approach operation provides the opportunity to utilize the modern aircraft capability and performance to improve safety, efficiency and capacity, RNP AR should only be used where it can clearly be demonstrated that there is a good business benefit or safety improvement and that it should only be considered where conventional approaches or RNP APCH will not achieve the desired objectives.* *British Airways believes where AR procedures are introduced there will inevitably be a transition period when the mix of capabilities of aircraft and systems will create difficulties for the ANSPs. Current conventional approaches along with RNAV APCH must therefore still be available during this transition period so as not to disadvantage operators who continue to use legacy aircraft/equipment.* *British Airways has a mix of aircraft and FMS equipment, some of which is termed legacy. Whilst we are able to meet the requirements in AMC 20-27 and are indeed approved on several fleets for RNAV GNSS approaches, the requirements of AMC 20-26 AR operations will be more challenging.* *We are currently studying AR operations both for lower minima and its use in aircraft separation. British Airways cautions that in the current economic climate for aviation the cost and/or technical difficulties may make the business case for upgrading/ retrofitting of legacy aircraft/equipment not viable.*
response	*Noted* It is anticipated that both RNP APCH and RNP AR APCH operations will be implemented when a number of key factors have been addressed satisfactorily; specifically, the value and benefits to the operators will be part of the business rationale for implementing the procedures and perhaps even for retrofit/upgrades. Additionally, prior to implementation of these operations, practical solutions will be in place to effectively manage mixed operations between those that are RNP capable and those who are not.

comment	*161* comment by: *UK CAA* **Comment:** Correct Appendix numbering and referencing, eg: Appendix 4 - pages 2,3 and 4 have Appendix 3 in the header; Appendix 5 - page 2 has Appendix 3 in the header.

response | *Accepted*

Header reference corrected.

comment | *162* comment by: *UK CAA*

Comment:
UK CAA supports NPA Option 2 (Rulemaking to provide AMC for airworthiness and operational approval of on-board equipment required for RNP-RNAV).

response | *Noted*

Thank you for your support.

comment | *206* comment by: *Transport Canada Civil Aviation Standards Branch*

As a general comment, Transport Canada Civil Aviation (TCCA) supports the purposes of AMC 20-26 and 20-27. AMC 20-26 is a comparable method we have applied in granting operational approval to one of our air carrier.

response | *Noted*

Thank you for your support.

comment | *209* comment by: *Honeywell Aerospace*

EASA NPA 2008-14

AMC 20-26 Page/Section	Comments for EASA
page 14, 3.2.4	Please check reference to N8000.326 - title does not match (matches .287)
page 18, 5.1.2 (b)	Recommend eliminating the following statement - "with automatic updating from suitable radio based navigation equipment." Not all IR systems have radio updating.
page 20, 6.1	First paragraph - please clarify wording - "emanating to a fix...". Should this be "emanating from a fix...".

page 20, 6.1.1 Note 2	Please provide further clarification as to the meaning and intent of this Note.
page 24, 7.1 item 4	Add ETA as an allowable alternative to Time to Active waypoint.
page 25, 7.1 item 8	Please add electronic map display as an allowable alternative.
page 26, 7.1 item 21 v)	Note 3: Recommend deleting note 3 as it is not applicable to RNP AR procedures.
page 26, 7.1 item 21 v)	Please add additional note (note 5) to accommodate RNAV holding capability, because RNP holding patterns are not widely implemented today in current systems.
page 27, 7.1, item 24	Vertical direct to capability is not appropriate for this AMC and should be deleted. It is not required by any other RNAV/RNP documents.
page 27,7.1 item 26	Add clarification that these altitudes and/or speeds can also be manually entered.
page 28,7.1, item 31	Change the word "accuracy" to "performance" in both places
page 29, 7.2	In first paragraph prior to table, need "<" sign prior to 0.3
page 29, 7.2 item 1-(3)	Is the intent to limit the maximum bank angle to 8 degrees when below 400 ft? The wording does not make that clear.
page 29, 7.2 item 1-(4)	Add text allowing other means or mitigations depending on aircraft, tracking performance, procedures, etc.

page 29, 7.2, item 2-(1)	Add statement at end to say "a single autopilot is acceptable provided dual flight directors or single CDI are available."
page 29, 7.2 item 2-(2)	Please confirm/clarify the meaning of this is that lateral is hazardous and vertical is major.
page 29, 7.2 item 2-(4)	Please clarify, this could be interpreted to mean that loss of GNSS requires a go-around. If another nav mode provides the required nav performance, then it seems a go-around should not be required. Also, change words "navigation accuracy" to "navigation performance" or "RNP".
page 30, 7.2 item 3-(2)	Please confirm/clarify the meaning of this is that lateral is hazardous and vertical is major.
page 31, 8.3 b)	Clarify last sentence of note, in particular the words "minus the 95% of FTE" - does this mean "minus the 95% probability FTE"?
page 32, 8.5	Replace "navigation accuracy" with "RNP"
page 32, 8.7	The detailed list of incompatibilities a) - g) seems to be unnecessary, since the opening paragraph says intermixing of different equipment is not permitted.
page 32, 8.7	Add note to allow for case where different equipment on the airplane is allowed as long as it in not part of the AR operations (eg. 3rd independent FMS for over water redundancy)
page 35, 10.5 b	Change "erouneous operation of equipment" to "eroneous pilot use of equipment" to clarify not an equipment problem.
page 46, appen 3, 3.a	Add note stating that the equipment is not required to inhibit flight plan modification

page 48, appen 3, 3.i.2	Table 1 - Recommend EASA and FAA harmonize requirements for speeds on RF legs
page 51, appen 4, 1 p1	FTE and PSE terminology is inconsistent
page 53, appen 4, 5.a.2	Example does not seem to apply. There are no real AR requirements to be met here for speed, ETA, or RTA error.
AMC 20-27 Page/Section	Comments for EASA
page 66, sec 1, p2	Please clarify meaning with respect to "straight segment"
page 67, sec 2, last paragraph	Please clarify first sentence of last paragraph "Use of BARO-VNAV....." The meaning is not clear.
page 73, sec 7.1 item 3	In the Note, the reference to 10.1.2 does not seem valid.

response

Partially accepted

AMC 20-26

page 14, 3.2.4 Accepted: text deleted.

page 18, 5.1.2 (b) Accepted: text deleted.

page 20, 6.1 Accepted: text amended.

page 20, 6.1.1 Note 2 Not Accepted: The note makes a finding of compliance to

the requirement for those aircraft/systems whose GNSS performance has been previously demonstration to specific airworthiness criteria and with the that demonstrated performance contained in the aircraft documentation.

page 24, 7.1 item 4 Accepted: text amended.

page 25, 7.1 item 8 Accepted: text amended.

page 26, 7.1 item 21 v) Accepted: text amended.

page 26, 7.1 item 21 v) Not Accepted: RNAV holding may be accommodated for non RNP AR but not for RNP AR.

page 27, 7.1, item 24 Accepted: text amended.

page 27,7.1 item 26 Not Accepted: The requirement is to use the procedure unaltered, thus ensuring all safe operating margins are in place. Manual entry of a procedure is not intended for RNP AR.

page 28,7.1, item 31 Not Accepted: Accuracy is intended to be a specific performance parameter in the AMC, and is used in the manner throughout the AMC.

page 29, 7.2 Accepted: text amended.

page 29, 7.2 item 1-(3) Noted: The current statement is the required capability, not a specification of the limit. The implication is that some systems may have lower limits and therefore may not be eligible.

page 29, 7.2 item 1-(4) Partial Accepted: Other means or mitigations depending on aircraft performance for operations applicable to of RNP 0.3 and above operations have been added.

page 29, 7.2, item 2-(1) Partial Accepted: Text amended to clarify intent.

page 29, 7.2 item 2-(2) Noted: The criteria has been amended to clarify the requirement that for operations that are classified as demanding and hence require compliance with table 7.2 the failure conditions are classified as *Hazardous*.

page 29, 7.2 item 2-(4) Noted: This reflects the situation where the missed approach may allow for other than GNSS but the resulting performance is not sufficient for the approach.

page 30, 7.2 item 3-(2) Noted: The criteria has been amended to clarify the requirement that for operations that are classified as demanding and hence require compliance with table 7.2 the failure conditions are classified as *Hazardous*.

page 31, 8.3 b) Noted: This applies to the FTE (95%) that will be achieved or managed with the system/installation.

page 32, 8.5 Accepted: text amended.

page 32, 8.7 Partial Accepted: The text will be revised to state "…intermixing of RNAV equipment will only be permitted when specific factors have been

addressed satisfactorily. As a minimum….”

page 32, 8.7 Not Accepted: This AMC is addressing RNP AR approach and does not establish equipment criteria for other types of operations.

page 35, 10.5 b Not Accepted: This is already addressed through the pilot input part of the criteria.

page 46, appen 3, 3.a Not Accepted: This is about operational considerations. Equipment requirements are elsewhere e.g. paragraphs 7.1 and 7.2. There are no equipment requirements on this type of inhibit.

page 48, appen 3, 3.i.2 Not Accepted: This will not be changed at this time since the AC and AMC are aligned to their associated procedure design criteria i.e. FAA with TERPS and EASA with PANS-OPS.

page 51, appen 4, 1 p1 Accepted: Text amended.

page 53, appen 4, 5.a.2 Not Accepted: It is recognised that some aircraft have such capabilities. The use which is not disallowed may need to be accounted for in such assessment.

AMC 20-27

page 66, sec 1, p2 Accepted: The text amended to Replace "... with straight segment" by "...with straight final approach segment".

page 67, sec 2, last paragraph Accepted: The text as been amended to aid clarity.

page 73, sec 7.1 item 3 Accepted: Text amended.

comment *214* comment by: *Cessna Aircraft Company*

There is no mention of any requirement to "display" ANP/RNP/EPU. Does this imply that this is left to the MOPS/MASPS requirement, or not required?

response *Accepted*

Text amended to include (e.g. EPU, EPE, ACTUAL or equivalent) in item 15.

comment *215* comment by: *Cessna Aircraft Company*

If EASA requires ANP/RNP/EPU display, is it to be displayed on the PFD or acceptable to be displayed on the CDU/MCDU?

response *Noted*

The requirement for the display of ANP/EPU in the Pilots primary field off view is not a requirement as it is assumed that the automatic monitoring should alert the pilot to any deviations and the data could then be accesses via a CDU/MCDU.

comment *222* comment by: *Luftfahrt-Bundesamt*

The LBA has no comments on NPA 2008-14.

response | *Noted*

Thank you for your support.

comment | *225* comment by: *AIRBUS*

General comment:
Whereas the preamble states that the AMC introduces provisions for RNP AR applications at Take Off, there are a number of places in the AMC where considerations for Take Off are missing :

- The Scope does not delineate RNP AR Take Off from RNAV-1 Take Off as per AMC 20-16
- There is no indication on the applicability or non-applicability to Take Off of the performance criteria (Accuracy, Integrity,...) developed in §6, e.g. baro-VNAV
- ...

response | *Accepted*

The text has been amended as required to make reference to Departures, not take-off.

comment | *226* comment by: *AIRBUS*

General comment:
The applicability of the AMC 20-26 criteria to the initial and intermediate Approach segments should be clarified. Compliance with the AMC 20-27 or 20-16 should be acceptable for the part of the approach not designed nor protected with RNP AR criteria, e.g. baro-VNAV as per AMC 20-27 above the FAF.
Justification:
Would suppress overlap with AMC 20-27 or AMC 20-16, and enhance the visibility on the RNP AR unique requirements.

response | *Not accepted*

Reference to AMC 20-27 within the AMC is introduced to aid the reader understanding of varying RNP concepts.

comment | *316* comment by: *FAA*

NPA COMMENT FORM

This Comment Form is to be used by an Office of Other Interest (OOI) when providing comments on an EASA NPA. If the OOI has more than one comment, please duplicate this Comment Form and place any additional comment(s) on a separate form(s).
This Comment Form should be sent to the Office of Primary Responsibility (OPR) by the due date established by the OPR.

1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):
NPA 2-008-14, AMC 20-26, General

2. Comment (Please state your comment clearly and in plain language):
The AC states the scope can include RNP AR departures, but does not contain any further mention of departure procedures or specific requirements such as engage-height. Recommend coordinating that criteria with the FAA and including in a subsequent edition of the AMC.

3. Justification (Please provide support for your comment):

4. Proposed Alternative Text (If any):

5. Person Providing Comment (Include routing symbol): FAA AIR-130

response

Noted

The documents contain provision for departure however it does not address all aspects. Coordination will be undertaken with the FAA as and when the material is developed.

comment

327 comment by: *FAA*

EUROPEAN AVIATION SAFETY AGENCY (EASA) NOTICE OF PROPOSED AMMENDMENT (NPA) NO 20008-14.
Airworthiness and Operation Approval for on board equipment related to Required Navigation Performance/Area Navigation (RNP/RNAV) Approach Operations.

The subject notice of proposed amendments (NPA) include acceptable means of compliance (AMC) as noted below:
AMC 20-26: Airworthiness Approval and Operational Criteria for RNP Authorization Required (RNP/AR) Operations
AMC 20-27: Airworthiness Approval and Operational Criteira for RNP APPROACH (RNP/APCH) Operations Including APV BARO-VNAV Operations

The following comments are offered from a review of the documents:

A. AMC 20-26.

- 1. Section 4.5, FLIGHT EVALUATION. This section recommends that flight evaluation be used prior to publication for procedure validation and obstacle validation, but states that flight evaluation can be accomplished through ground evaluation (e.g. simulator assessment) and actual flight. Sub-paragraph b) states that a flyability assessment is not required prior to publication since it is individually assessed by the operator. These paragraphs seem to require flight evaluation but then leave open the possibility of not doing a flight evaluation by substituting other means of flyability assessment and obstacle validation. **Recommendation: Flight evaluation (flight validation) should always be required prior to the publication of a procedure, and should include, as a minimum, the assessment of flyability, obstacle verification, and a coarse check of the path by a means of independent measurement.** Paragraph 4.5b, recommend a flyability check be required to ensure procedure can be flown by an aircraft capable of flying the intended RNP IFP path in normal operations.

- 2. Section 4, FLIGHT VALIDATION. This section also states that a truth system is typically not required in flight evaluation. The term "truth system" carries the implication that it should be a very accurate, independent, sophisticated means of determining and recording the actual flight path such as systems used in flight test research for developing instrument procedure design criteria. While such systems are necessary for some work, the use of a hand-held GPS unit, together with a laptop computer to record path data, can serve as a very adequate tool in flight evaluation (validation). The equipment is small, inexpensive, requires no connection to aircraft systems, can be operated with short training and orientation and provides a means of characterizing the path flown for path integrity along with data that can be archived for later reference. **Recommendation: A flight validation should be required prior to publication of any procedure for path verification check, obstacle validation, flyability check, and to provide a permanent record. Equipment is available at modest cost that requires no connection to aircraft systems and can be operated with minimal training. System requirements state a 10^{-7} probability of an aircraft exiting the obstacle area per approach, therefore verification of the path integrity would seem essential to support the requirement.**
- 3. Section 6.1.2, Vertical. The equation for the vertical system error represents a slightly less conservative budget than the US and ICAO RNP/AR criteria, which includes, under the radical: a value for the automated terminal information system (ATIS) (20 ft); and a calculation for the contribution of the vertical angle error. This is noted as a difference and does not impact criteria since it will be slightly more conservative than would result from application of that calculated from Sec 6.1.2. **Recommendation: None. Difference noted.**
- 4. Section 6.2, Integrity. This section imposes a requirement of 10^{-7} probability, per approach, of exiting the obstacle protection volume specified in the PBN manual RNP/AR criteria. This requirement includes the possibility of latent conditions and system failures. When compared to ILS containment of the same probability based only on normal operation, this seems extremely demanding and difficult to demonstrate, even though additional means, such as pilot monitoring and intervention. **Recommendation: Some guidance on how this can be demonstrated and documented would be helpful, including what reliance is placed on aircraft certification and what documentation is to be required.**
- 5. Section 7.2, Table 2, states requirements for reversion to another means of navigation for missed approach following loss of GNSS for RNP<0.3 for approach and RNP<1.0 for missed approach. This, when taken in the context of other requirements that inertial is not suitable (even for a limited time with drift allowed), seems to require availability of other service, presumable DME/DME. Can inertial be allowed for specific time/distance with appropriate drift accounted for? Is this the intent? **Recommendation: State a requirement for IRU performance to be acceptable for a short time/distance to allow area construction and obstacle evaluation to accommodate the reversion.**
- 6. Section 10.5 seems to support the need for flight evaluation of all procedures prior to publication. **Recommendation: Include requirement for flight evaluation, including recording and retaining track data. Reference comment 2 above.**
- 7. Appendix 2, Section 4, 4.1 a) refers to an "authorized" instructor.

Recommendation: Include a statement of the qualifications for and authorized instructor for this purpose.

B. AMC 20-27.

- 1. Appendix 1, Glossary. **Recommendation: Add definition for reference datum height (RDH) as the calculated height of the vertical path above threshold. (Distinguished from TCH by error components and including PDE.)**

response

Partially accepted

1. Not Accepted: This paragraph provides the assumptions on which the AMC has been based.

2. Not Accepted: The purpose of this paragraph is to provide the assumptions. The Agency has no oversight pertaining to procedure design and verification.

3. Noted: The equation is identical to that contained in AC90-101, Appendix 2, Paragraph 2.c.

4. Noted: The criteria are derived from AC90-101. Additional guidance and criteria related to this are provided in Paragraph 6.1.2 and Appendix 4.

5. Partially Accepted: The criteria are the same as that contained in AC90-101. Appendix 5 contains specific criteria for system failures and use of GNSS that must be assessed. No specific limitations are placed on non-GNSS navigation as this will vary by implementation and must be assessed accordingly.

6. Not Accepted: Para 10.5 is applicable to operators for the reporting of events that are flying a procedure that has been approved. As such, the criteria are aimed at ensuring that any conditions or anomalies that affect the operations, procedures or authorisations are identified and resolved satisfactorily.

7. Accepted: Text amended to refer to examiners as define by JAA-FCL.

AMC 20-27

8. Accepted: The text has been amended to clarify the definition of BARO-VNAV, without reference to RDH.

comment

341 comment by: *AOPA-Sweden*

AOPA Sweden will not comment on technical details, rather on the general direction of the NPA.

Impact on general aviation not mentioned in NPA.
The impact on the general aviation(GA) fleet and the associated costs are not at all mentioned in the NPA. This NPA can therefore not be the basis for a desicion without an in deep analysis of the impact on the general aviation fleet and operation. AOPA-Sweden proposes a new NPA with the consequences to GA also taken into consideration. The scope excluding GA in this NPA is not acceptable to the GA community, nor desirable.

	However for general aviation IFR flights in the RNAV airspace the NPA will have gross impacts, especially on the requirements of on board equipment. If aircraft are not correctly equipped, they may be excluded from certain airspace, may have to fly longer routings. The proposed requirements may actually cause a negative impact for many airspace users both in terms of economy and environment. With the increasing amount of airspace that requires RNAV, additional costs for RNAV avionic to the General aviation fleet would grossly increase cost and therefore make the RNAV operation in Europe more expensive than in other parts of the world. Therefore, a harmonization with the FAA RNAV requirements would benefit both European aircraft owners and operators, as well as the European industry.
response	*Not accepted* It is the Agency's opinion that the majority of the General Aviation fleet that would benefit from this AMC already have suitable equipment installed or the required equipment could be installed without significant cost. Every effort has been made to harmonise with the international community as much as possible. The introduction of RNAV within European Airspace falls within the purview of ECAC navigation strategy.

comment	*343* comment by: *European Cockpit Association* The requirements regarding flight crew procedures are generally acceptable and should be implemented by the operators.
response	*Noted* Thank you for your support.

comment	*344* comment by: *European Cockpit Association* BARO-VNAV should not be considered as an end state. Further development of full APV I-II approaches should be foreseen.
response	*Noted* These AMC will form part of series of AMC material applicable to Performance Based Navigation. RNAV Approaches using SBAS will be addressed by AMC 20-28, see NPA 2009-04.

comment	*345* comment by: *European Cockpit Association* It is not sufficiently clear that the RNP -AR is designed to be used only on those occasions where the standard RNP approach cannot be implemented. AMC 20-26 is dealing with "Authorisation Required (RNP AR) Operations" but gives the impression that this type of operation would be applicable on a wide scale. It is felt that AMC 20-27 establishes the fundamental basis - for RNP APPROACH (RNP APCH) Operations including APV BARO-VNAV. RNP AR special operations should only be employed where absolutely necessary, for example, because of terrain constraints. ECA does not support an unnecessary proliferation of "reduced obstacle areas".
response	*Noted*

The use of -AR will be on a case by case basis by the ANSP. This AMC is in response to requests from manufactures and operators and does not imply a proliferation of unnecessary requirements.

resulting text: See Appendix B

TITLE PAGE p. 1

comment *207* comment by: *skyguide*

This document is a major step to enable and harmonize RNAV approach introduction

response *Noted*

Thank you for your support.

A. Explanatory Note - I. General p. 3

comment *1* comment by: *KLM*

●1 General

We are pleased that the RNP Approach Procedure AMC material is now available and specifically that the Barometric VNAV criteria (we have been waiting for so long) is now incorporated.
RNP AR is at this time seen as not much relevant for our operation, but that could change. We therefore also analysed this part of the NPA.
The usability of the AMC 20-26 has been improved utilising the Appendices for the more in depth material. This makes the document better readable and useable.
As to the consistency between the AMC 20-26 and 20-27: the accuracy criteria is not balanced between the two documents. It is not understood, why for the RNP approach the accuracy system requirements are extensively indicated (Lateral and Vertical) while this is not the case for the RNP AR, while these are meant for more critical operations. This is specifically true for the Vertical Navigation which are used for both type of approaches and where the criticality of the RNP AR is more demanding.
Finally as a general remark: IFPP Maintenance and Implementation WG is redrafting the APV Baro-VNAV criteria totally, in order to harmonise with the final approach vertical obstacle clearance methodology of the RNP AR (VEB budget method) and the missed approach design criteria. For both, the FTE value plays an important role. To prevent a Chicken & Egg situation as to the assumptions made, it is proposed to harmonise the FTE values. It is suggested that a meeting take place between the key players of the IFPP M&I WG and the authors of the AMC's.

response *Noted*

The AMCs are different in that for AMC 20-26 the values are optimised for the procedure or aircraft, while for AMC 20-27 they are generalised fixed values. Thus the RNP AR criteria need to be defined in a different manner between the two AMCs.

It is the Agency's intent to publish these AMCs with the developed text. Any amendments to this will be co-ordinated with all interested parties.

A. Explanatory Note - V. Coordination with existing EASA rulemaking tasks p. 4-5

comment *188* comment by: *EUROCOPTER*

Reference to JAR-OPS 3 indicates this NPA intends to adress both fixed-wing aircraft and helicopter operations. However, the core document is essentially focusing on fixed-wing aircraft operations and does not adress explicitely specific helicopter issues.

response *Noted*

It is acknowledged that further guidance will be required for rotorcraft. In developing the AMC the Agency did not wish to specifically exclude rotorcraft operations; however, the criteria for rotorcraft will be addressed in subsequent amendments as necessary.

comment *295* comment by: *Walter Gessky*

The NPA does not address all JAA Guidance Material (Leaflets) available on the subject. Grandfathering of installations based on JAA Leaflets is only mentioned on page 67, AMC 20-27, item 2.

response *Noted*

The only guidance material that has relevance to these AMCs is stated. No other JAA guidance material (leaflets) has an effect on AMC 20-26 or 20-27.

A. Explanatory Note - VI. Regulatory Impact Assessment p. 5-7

comment *293* comment by: *Walter Gessky*

Page 5, RIA. 10. Last bullet:
Reference to paragraph 6.13 seems to be wrong.

response *Accepted*

The correct paragraph reference is 6.1.3.

comment *296* comment by: *Walter Gessky*

Page 6, RIA. 13. Impacts:
The RIA does not address the impact of the more stringent requirements proposed in (6.13?), 7.1 and 7.2 against those defined in FAA AC 90-101 and ICAO doc. 9613 to the European manufacturer and operator.

response *Noted*

The initial impression is that AMC 20-26 impose a more stringent requirement on the European manufactures and operators. However, it should be noted that there is a difference in the regulatory framework in which the FAA and the Agency operates. These differences require that the FAA AC 90-101 and AMC

20-26 are not directly harmonised and with the EU system a greater showing off compliance is required by the manufacture and less by the operators. Thus the overall financial impact for European aviation is of the same order of magnitude as that of US aviation.

comment *342* comment by: *AOPA-Sweden*

1. The two options: (I. General 11. Options)

The two options mentioned are not the only two options that should be considered. AOPA-Sweden stresses that yet another option, is to harmonize the European standards with the ones of the FAA. The different standards both when it comes to technical specifications and operational approvals, will cause additional costs that has should be evaluated if needed.

Different operational procedures also pose increased potential for flight safety related problems. The need to have an operational approval should be harmonized with the FAA in order to reduce administration and extra cost related to RNAV.

Within th general aviation sector in the US, 10-thousands of aircraft flies to almost 10 000 airports capable of RNAV approaches already today. In order for the European market, not to get disadvantages compared to the American; the EASA shuold thouroghly evaluate a complete harmonization of the RNAV/GNSS procedures. With such a harmonization, both the US and European markets would benefit from equal competition.

With the proposed non-FAA conform NPA, the European customers, especially on the General aviation side, will not be able to use their RNAV-equipment as it could have been if it was installed in an aircraft in the US.

Therefore the NPA proposed rulemaking should take into account:
1. RNAV equipment that is presently allowed by FAA for RNP5, 1 or 0,3 by the FAA, should also be approved by the EASA. For instance a GPS legally capable of RNAV approach in the US shall also be allowed according European rulemakers.
2.

Operational approvals:
The need for an operational approval should be considered to be removed for general aviation operators and pilots. An approved installation and an RNAV qualified pilot shall be enough. A qualified pilot is a pilot with the proper theoretical and practical training according. No additional paperwork or approvals should be necessary for GA operations. However AOPA-Sweden stresses that the pilots of course must be current on their equipment as well as procedures. The extra administration associated with an operational approval should be removed to improve efficiency in the European aviation sector.

Equipment certified for RNAV Approaches by FAA
AOPA-Sweden further stresses that all equipment that are approved for RNAV approaches by FAA, shall be approved for the same operations by EASA. Of course there are different requirements for the different type of RNAV approaches, but the future use of existing avionic in the GA fleet must be secured.

The risk with the proposed rulemaking is that many GA aircraft will have to buy

	RNAV equipment to a value that might be higher than for the aircraft itself. This is of course not acceptable - therefore a harmonization with the US requirements and also present European must be evaluated.
response	*Not accepted* With respect to the first point there is a difference in the regulatory framework in which the FAA and the Agency operates. These differences require that the FAA AC 90-101 and AMC 20-26 are not directly harmonised and with the EU system a greater showing off compliance is required by the manufacture and less by the operators. Thus the overall financial impact for European aviation is of the same order of magnitude as that of US aviation. Regarding the comment about harmonisation of RNAV/GNSS procedures and the ability of general aviation to benefit from these, this is directly addressed by AMC 20-27 which will provide guidance requirement for a Non-Precision Approach using equipment that is currently installed in General Aviation aircraft. The comment to remove operational approval for general aviation is not accepted. Pilots should have the required training to ensure they are familiar with the operation specific procedures associated with RNAV approaches, including the correct handling of navigation databases. Regarding the cost of the equipment to be installed on aircraft, it should be noted that the carriage of the specified equipment is not mandatory and is dependent upon the airspace and airports to which the operator wishes to operate. As previously mentioned, the majority of the navigation (GNSS) equipment installed within General Aviation aircraft will fulfil the equipage requirements of AMC 20-27.

comment	*346* comment by: *European Cockpit Association* Harmonisation on a global level is of utmost importance, especially regarding procedures to be used by flight crew that operate worldwide. So just stating that the AMC is not fully harmonised is not acceptable. If there is agreement on the European arena that some of the regulations have to be developed to more rigidity to ensure the safety of the challenging RNP AR operations, then EASA should take the necessary steps to convince the owners of the earlier material (ICAO and FAA) that consequential amendments of the older regulations are necessary. Only a coordinated development meets the need of the global aviation community for consistency and harmonised procedures.
response	*Noted* It should be noted that there is a difference in the regulatory framework in which the FAA and the Agency operates. These differences require that the FAA AC 90-101 and AMC 20-26 are not directly harmonised and with the EU system a greater showing off compliance is required by the manufacture and less by the operators. Thus the overall financial impact for European aviation is of the same order of magnitude as that of US aviation.

B. Draft Decision - AMC 20-26 p. 9

comment	*163* comment by: *UK CAA* **Paragraph:** AMC 20-26, Title and Preamble **Pages:** 9 and 11 **Comment:** The AMC title reflects airworthiness approval, but only operational criteria. Indeed, the Preamble highlights that the AMC provides a basis for, but by itself does not constitute an operational approval. This reflects the need for the operator to apply to their competent authority. This was certainly the arrangement with JAR-OPS, but with the extension of the competencies of EASA and the introduction of EU-OPS and eventually IR-OPS, does the Agency not have greater responsibilities? There is a sense from reading the document that EASA has the competency, but that the competent authority has still to develop the operational approval requirements. It is accepted that the ultimate approval should be granted at the local authority level, but that should not diminish the EASA role and responsibility for the approval criteria. Therefore it is recommended that it be made clear that AMC 20-26 contains the Operational Approval Criteria. **Justification:** It would be clearer to National Authorities and operators that EASA has published Operational Approval Criteria consistent with their competencies and not just guidance. Note: EASA is already developing material for the approval of Electronic Flight Bags (EFB) see draft AMC 20-25, the title of which is Airworthiness and Operational Approval for Electronic Flight Bags (EFBs). **Proposed Text:** Change the title of the AMC to: Airworthiness and Operational Approval Criteria for RNP Authorisation Required (RNP AR) Operations. Amend preamble and introduction to para 10 accordingly.
response	*Not accepted* The AMC title is correct and reflects the split of responsibilities for the issuing of approvals, in that the Agency will issue the Airworthiness approval and the Operational approval will be issued by the Competent Authority. The Competent Authority will apply the criteria defined within the AMC.

comment	*210* comment by: *skyguide* The AMC 20-26 describes RNP AR operations, abbreviated with "RNP AR". The ICAO PBN manual uses the abbreviation "RNP AR APCH" ICAO informed skyguide that *'The navspec is called RNP AR APCH. This would be the correct term. RNP AR would be incomplete. Furthermore there is a potential that we develop also a navspec for RNP AR departures'.* Therefore, skyguide suggests to adopt the existing ICAO terminology and replace the term "RNP AR" with "RNP AR APCH" in the NPA.
response	*Not accepted* While the initial emphasis is on approach, it is intended that the guidance and criteria will extend beyond approach in future revisions.

comment	*220* comment by: *Thales Avionics* What is the intent of the reference to Article 5 of EC Regulation 552/2004? There is no such equivalent reference in AMC 20-27 and it seems this Article has no impact on the remaining AMC 20-26 text.
response	*Accepted* There should also be a reference to Regulation (EC) 552/2004 within AMC 20-27. Regulation 552/2004 relates to the interoperability of the European Air Traffic Management network and in particular Article 5 is regarding the issue of a declaration of conformity. A declaration of conformity could be issued by a suitable authorised organisation with respect to the performance of a signal in space and hence permit this declaration to be used to fulfil requirements such as accuracy and availability of the signal.

comment	*221* comment by: *Thales Avionics* Second para. We don't understand the text " RNP Authorisation Required (AR) operations that range from nominal (i.e. where general aircraft qualification is matched to standard AR procedure design)". There is no definition in PBN Manual of "nominal" or "standard" RNP AR procedures. Does the parenthesis means that "general aircraft qualification" automatically meets the RNP AR "nominal" procedures?
response	*Noted* The basic aircraft qualification criteria and associated operational guidance are harmonised with the basic criteria (i.e. standard criteria) for RNP values and procedure design contained in the RNP AR APCH procedure design criteria.

resulting text	See Appendix B

B. Draft Decision - AMC 20-26: 1. Preamble p. 11-12

comment	*2* comment by: *KLM* Relevant Text: "with the additions of provisions for Take-off operations". **Comment**: Take-off Operations are not part of the AMC. **Proposal**: Is that correct?
response	*Partially accepted* Text amended to clarify the intent.

comment	*36* comment by: *AEA* Relevant Text: "*with the additions of provisions for Take-off operations*". **Comment**: Take-off Operations are not part of the AMC.

	Proposal: Clarification: Is that correct?
response	*Partially accepted* Text amended to clarify the intent.

comment	*190* comment by: *EUROCOPTER* It could be worth to mention here that aircraft population expected to take benefits of RNP-AR includes both fixed-wing and rotary-wing aircraft.
response	*Noted* The requirements of the AMC are equally applicable to rotorcraft; however, the specific criteria for rotorcraft will be addressed in subsequent amendments as necessary.

comment	*208* comment by: *Transport Canada Civil Aviation Standards Branch* Regarding AMC 20-26, 1.1 Purpose. - Transport Canada recommends a sentence be added to state that this AMC also provides guidance for operational criteria for RNP AR operations.
response	*Not accepted* The intent of the existing text means the same as proposed.

comment	*227* comment by: *AIRBUS* The preamble reads: "This AMC is harmonised with the criteria developed in AC 90-101,with addition of provisions for Take Off operations, and only addresses limited aspects of the "private/specials" of RNP AR based on AC 120-29A Appendix 5". This AMC is built on the criteria developed in AC 90-101, with inclusion of more stringent criteria (see appendix 6) and with addition of provisions for Take Off operations. EASA required demonstrations for aircraft containment upon non-Normal conditions are significantly more stringent than in FAA AC 90-101. Private/specials RNP AR operations are not developed in this AMC.
response	*Partially accepted* Text amended to clarify the intent of the paragraph.

comment	*306* comment by: *FAA* 1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*): NPA 2-008-14, AMC 20-26, page 11, section 1, 5th para 2. Comment (Please state your comment clearly and in plain language): Recommend deleting reference to AC 120-29A, Appendix 5.

	3. **Justification (Please provide support for your comment):** The FAA does not typically use AC 120-29A in the approval of non-public (special) approach procedures. 4. Proposed Alternative Text (If any): 5. Person Providing Comment (Include routing symbol): FAA AIR-130
response	*Partially accepted* Text amended to clarify the intent of the paragraph.

comment	*329* comment by: *ECOGAS* ECOGAS welcomes this proposed AMC for RNP/RNAV Approach operations, and advocates their finalisation and adoption without further delay. Although in general our view of the proposals is supportive, specific comments have been made in our response where EASA-specific differences have been introduced without apparent quantifiable safety-based reasoning.
response	*Noted* Thank you for your support.

resulting text	See Appendix B

B. Draft Decision - AMC 20-26: 2. Scope p. 12-13

comment	*228* comment by: *AIRBUS* The second paragraph reads: "[...] The assurance of consistency with and conformance to the target level of safety (TLS) objectives for RNP AR operations results from the specific compliance criteria of this AMC, a flight operational safety assessment **when required**, and the associated standard RNP AR procedure design." The wording "when required" should be deleted because a FOSA should be produced in any case. Justification: A preliminary FOSA should be produced in any case at least to record the basis of the decision to not conduct a full FOSA.
response	*Accepted* Text amended.

comment	*229* comment by: *AIRBUS* The three bullets should be written as shown: • Procedure requiring to fly a published arc (also referred to as a RF leg) **after the FAF**

- RNP AR approach using a line of minima less than RNP 0.3
- RNP AR (with reduced lateral obstacle evaluation area) Departure or missed approach that requires RNP less than 1.0.

Justification:
1 - Procedures with RF before the FAF should remain outside RNP AR scope.
2 - Avoid redundant writing of "missed approach requiring RNP less than 1.0" in the 2° and 3° bullets
3 - Add provisions for Departure

response *Partially accepted*

Text amended to clarify the requirement.

comment *230* comment by: *AIRBUS*

The paragraph 2 reads:
"This AMC recognises that current criteria for demonstrated aircraft performance may be insufficient to enable RNP AR operations where the performance required is less than 0.3 NM."
A more accurate wording should be:
"This AMC recognises that current criteria **from DO-236 / ED-75()** for demonstrated aircraft performance may be insufficient to enable RNP AR operations where the performance required is less than 0.3
NM."
Justification:
The wording "Current criteria" could be understood as the criteria of this AMC.

response *Not accepted*

The documents referred are the published guidance material.

comment *240* comment by: *AIRBUS*

The paragraph reads:
"[...] The third aspect is that there will be specific
situations where even full compliance to the AMC will be insufficient to conduct procedures that reflect aircraft specific performance or that are deemed very complex or extremely demanding and whose characteristics are not fully accounted for by this AMC or procedure design criteria e.g. mountainous terrain, [...]"
This sentence is confusing, propose to reword :
"The third aspect is that full compliance to the AMC may be insufficient to conduct Private/specials RNP AR operations designed with non public criteria accounting for aircraft specific performance or whose characteristics are not fully accounted for by this AMC."
Justification:
Compliance with this AMC should be sufficient for conducting any RNP AR operations, e.g. in mountainous terrain, ... when procedures are designed with public procedure design criteria, e.g. FAA Order 8260.52.

response *Accepted*

Text amended.

comment *243* comment by: *DGAC France*

1 AFFECTED PARAGRAPH: AMC 20-26 Paragraph "2 SCOPE"
The two last sentences of the 3rd paragraph before the following items:

- Ability to fly a published..
- Reduced lateral obstacle...
- When conducting a RNP AR approach ...

•2. PROPOSED TEXT/ COMMENT:
Rewrite the second key aspects of the AMC as follows:

~~The second is that there are three elements of the procedure design criteria that will only be used on the occasions where there is a specific operational need or benefit. As a result, operators can be authorised for all or any subset of these types of procedures:~~
The second is that among all the possible RNP AR APCH procedures, 3 procedures are considered complex and should be used when there is a specific operational need or benefit.
The 3 "complex RNP AR APCH operations" are:

- Ability to fly a published...
- Reduced lateral obstacle...
- When conducting a RNP AR approach ...

3. JUSTIFICATION:
The way RNP AR is introduced in the "scope" paragraph is misleading. Indeed we could think that RNP AR scope is the 3 procedures described in the 3 bullets (RF leg, missed approach with RNP < 1, approach with RNP < 0.3) whereas those 3 bullets addresses only the "complex RNP AR Operations", all this being the "second key aspect of the AMC".

As the AMC proposal introduces the term of "complex RNP AR operations" within chapter 7.2, it is recommended to reuse it here from the earlier paragraphs of the AMC, such as in our proposal.

As a additional form comment, the "three key aspects of the AMC" would deserve some kind of numbering / bullets / aligned paragraphs to visually identify them when reading quickly the AMC.
This is important as there is a sentence starting with "these aspects" between the description of the second key aspect and the third one, and it could be confusing.

response *Partially accepted*

The current text defines the requirements, the text has been amended to clarify the use of RF.

comment *246* comment by: *DGAC France*

1. AFFECTED PARAGRAPH: AMC 20-26 Paragraph "2 SCOPE"
Paragraph "this AMC also contains criteria reflecting the Agency's opinion..."

•2. PROPOSED TEXT/ COMMENT:

This paragraph is of enough importance to be highlighted so the reader pays attention to it, because it means that the EASA doc could not be in conformity with ICAO standards

response *Accepted*

Text amended.

comment *297* comment by: *Walter Gessky*

1) Page 13, AMC 20-26, 2. Sixth bullet:
Since the select criteria in the AMC are different to the ICAO PBN Navigation specification for RNP AR APCH it is recommended that proper guidance to inform ICAO about any deviations is provided by EASA to the MS.
2) Page 13, AMC 20-26, 2. eight bullet:
With regard to required additional aircraft or system changes or operational limitations due to differences in requirements from the ICAO PBN Manual and FAA AC 90-101; EASA has to verify that all required information are provided by the manufacturer.

response *Noted*

This comment is not relevant to AMC 20-26. However, the differences between the AMC 20-26 and other criteria are contained in Appendix 6. The Agency's compliance assessment will address the AMC requirements and criteria.

comment *307* comment by: *FAA*

1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):
NPA 2-008-14, AMC 20-26, page 12, section 2, 3rd para

2. Comment (Please state your comment clearly and in plain language):
Consider making RF a minimum requirement (rather than an option).

3. Justification (Please provide support for your comment):
The FAA has not received any applications for operational approval for aircraft without RF capability, and is considering amending the FAA criteria to require RF legs.

4. Proposed Alternative Text (If any):

5. Person Providing Comment (Include routing symbol): FAA AIR-130

1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):
NPA 2-008-14, AMC 20-26, page 13, section 2, 6th para

2. Comment (Please state your comment clearly and in plain language):
The AMC identifies instances where differences between the EASA criteria and FAA/ICAO criteria have been determined by the Agency to be appropriate. Recommend providing guidance on how to address compatibility that has been established under ICAO or FAA criteria: is it EASA's intent to require re-certification, limit ops approval until the differences are addressed, or accept FAA approvals for US carriers operating in Europe?

3. Justification (Please provide support for your comment):

4. Proposed Alternative Text (If any):

5. Person Providing Comment (Include routing symbol): FAA AIR-130

response

Noted

a. The RF criterion is an option and as such is consistent with the option contained in AC90-101. The Agency is aware of application for approval for aircraft that do not require RF and will maintain the optimal use of RF.

b. It is the Agency's intent not to require the re-certification of third country operators in accordance with EASA requirements, but to follow a lighter authorisation process that will be mainly based on existing ICAO standards. This will be described in more detail in the forthcoming Notice of Proposed Amendment (NPA) with respect to the Agency's oversight of Third Country Operators (PART-TCO). Until such time as the NPA has been adopted, it is the responsibility of the individual member states to assess the suitability of third country operators.

comment

347 comment by: *European Cockpit Association*

This implies that operator authorisation may be granted for at least 4 categories of procedures. Procedures may contain none of the bulleted restricting types or may contain any combination of the three types . This is an undesirable complication.

It is essential that pilots can be sure whether they are authorised to fly an approach and a multiplicity of categories makes this more difficult to determine.

If the operator is authorised for all types of RNP AR approaches there is no problem but otherwise the pilot will have to determine presumably from the approach plate in difficult conditions if that particular approach is authorised. This is undesirable.

response

Noted

This material reflects the view that in the initial stages of implementation, the capabilities of the aircraft will vary, as will the RNP procedures implemented. It is expected that RNP AR APCH procedures will only change from the nominal procedure design guidance when there is a specific need or requirement. As such, there will be instances where aircraft lacking the listed capabilities will still be able to achieve some level of operational benefits, where desired by the operators. Until such time that all features and capabilities are included, this will result in limitations that will be placed on such aircraft and their operators.

resulting text

See Appendix B

B. Draft Decision - AMC 20-26: 3. Reference Documents p. 13-15

comment	*3* comment by: *KLM* Section: 3.2.1. **Page**: 14 Relevant Text: ICAO Documentation **Comment**: PBN design manual is not mentioned **Proposal**: Should be added here as reference is made in the AMC
response	*Not accepted* The Paragraph refers to DOC 9613 Performance Based Navigation Manual. The Doc 9613 RNP Manual will be replaced with the PBN manual and will keep the same ICAO document number.

comment	*37* comment by: *AEA* Ref: 3.2.1. ICAO **Comment**: Draft ICAO Doc 9905, RNP AR Procedure Design Manual is not mentioned **Proposal**: ICAO PBN design manual should be added here as reference is made in the AMC
response	*Accepted* Text amended to include reference to manual Doc 9905.

comment	*75* comment by: *Boeing* AMC 20-26 Page: 14 Paragraph 3.2.4, FAA **Editorial Comment:** Boeing suggests that N8000.326 be deleted from the list of FAA documents since it has expired and is no longer in effect. **JUSTIFICATION:** The reference document is no longer active as regulatory guidance.
response	*Accepted* Reference to N8000.326 will be deleted from the text.

comment	*164* comment by: *UK CAA* **Paragraph:** 3.2.4 of AMC 20-26 **Page:** 14 **Comment:** Ref to AC25-11 should be 25-11A (Electronic Flight Deck Display). **Justification:** To reflect new published version.
response	*Partially accepted*

Parentheses added to the text to show that all issues are acceptable.

comment

223 comment by: *Thales Avionics*

Page 15 - Section 3.2.5 Technical Standard Orders

Add: ETSO-C151 () / TSO-C151 () Terrain Awareness and Warning System (TAWS)

Justification: Appendix 3 §2.a (like PBN Manual) mentions Class A TAWS. Class A TAWS are only defined in ETSO-C151.

response

Accepted

Text amended.

comment

308 comment by: *FAA*

1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):
NPA 2-008-14, AMC 20-26, page 14, section 3.2.4

2. Comment (Please state your comment clearly and in plain language):
Recommend adding AC 20-153 and removing N8000.326

3. Justification (Please provide support for your comment):
The AC provides relevant material for database LOAs, and the Notice has expired.

4. Proposed Alternative Text (If any):

5. Person Providing Comment (Include routing symbol): FAA AIR-130

response

Accepted

Text amended.

resulting text

See Appendix B

B. Draft Decision - AMC 20-26: 4. Assumptions p. 15-18

comment

4 comment by: *KLM*

Section: 4.3 (8)
Page: 16
Relevant Text: Temperature effects are accounted for during design.
Comment: Only for Low temperature is catered for. IFPP discusses the need for information of the effect of high temperature. This may result is limitation of the use of the approach, but is not part of the design criteria as is the case for low

	temperature (Increased MOC) **Proposal**: Add: "**low** temperature".
response	*Accepted* The term low temperature added.

comment	*7* comment by: *KLM* Page 17 4.6 Publication b) All routes are based upon WGS 84 coordinates. Should read: All procedures will be based upon WGS 84 coordinates. The original data defining the procedure should be available to the operators in a manner suitable to enable the operator to verify their navigation data. This has to be deleted as unnecessary. e) The navigation data for the procedure(s) to be loaded into the flight management system is compared with the published procedure. When not specified how this has to be done, it should be deleted.
response	*Partially accepted* Para b) the term procedures used in lieu of routes. Para e) the requirement for database to be from an approved supplier has been added and text amended to clarify the assumption.

comment	*28* comment by: *AEA* Relevant Text: 4.6 PUBLICATION *b) All routes are based upon WGS 84 coordinates* **Comment**: Should read: All procedures will be based upon WGS 84 coordinates **Proposal**: Should read: All procedures will be based upon WGS 84 coordinates
response	*Accepted* Text amended.

comment	*29* comment by: *AEA* **Ref**: 4.6 Publication C) Relevant Text: *The original data defining the procedure should be available to the operators in a manner suitable to enable the operator to verify their navigation data*. **Comment**: This is unnecessary **Proposal**: This has to be deleted as unnecessary
response	*Not accepted*

For RNP AR operations, the operator is held responsible for the currency and correctness of the RNP AR procedures contained in the navigation database. The operator or their designees are required to validate the database procedures to ensure no errors and that any differences e.g. renamed and relocated fixes, are accounted for.

comment *30* comment by: *AEA*

Ref:4.6 PUBLICATION
Relevant Text: *e) The navigation data for the procedure(s) to be loaded into the flight management system is compared with the published procedure.*
Proposal: When not specified how this has to be done, it should be deleted

response *Not accepted*

For RNP AR operations, the operator is held responsible for the currency and correctness of the RNP AR procedures contained in the navigation database. The operator or their designees are required to validate the database procedures to ensure no errors and that any differences e.g. renamed and relocated fixes, are accounted for. The requirement for database to be from an approved supplier added and text amended to clarify the assumption.

comment *38* comment by: *AEA*

Ref:4.3 Obstacle Clearance and route spacing (8)
Relevant Text: *Temperature effects are accounted for during design.*
Comment: Only for Low temperature is catered for. IFPP discusses the need for information of the effect of high temperature. This may result is limitation of the use of the approach, but is not part of the design criteria as is the case for low temperature (Increased MOC)
Proposal: Add: "**low** temperature".

response *Accepted*

Text amended.

comment *76* comment by: *Boeing*

AMC 20-26
Page: 17
Paragraph 4.3, Obstacle Clearance and Route Spacing

Significant Change Request: Boeing suggests that the following change be made:

Add new paragraph 4.3.(11) to read as follows:

"(11) Of the RNP AR instrument procedures used by an operator, at least one has the attributes that depart from the standard applications of procedures described in the ICAO RNP AR Procedure Design Manual. The attributes that are assumed include RNP 0.1 on the final approach and RNP 0.3 on the missed approach, including RF legs on the approach and missed approach, and continuous high terrain in close proximity to the obstacle clearance surfaces throughout the procedure."

JUSTIFICATION: This is apparently the reason for the level of criteria in the AMC. The AMC does not provide any other information to understand why its qualification criteria are more stringent than necessary for the standard procedure design criteria of the RNP AR Procedure Design Manual. Without it, it will be difficult to understand and manage aircraft application and usage when all other regulatory approvals are considered -- e.g., FAA, JCAB, CAAC, etc.

response *Partially accepted*

The intent of the commenter's text is accepted, the text has been added with amendments.

comment *77* comment by: *Boeing*

AMC 20-26
Page: 17
Paragraph 4.6.e

Clarification Request: The proposed statement is too general and could be open as to the method of validation. Therefore, Boeing suggests clarifying the statement as follows:

4.6 e) The navigation data for the procedure(s) to be loaded into the flight management system is compared with the published procedure. ***Frequency of comparison should be at initial introduction and when the procedure is altered. Method of validation could be by navigation database code verification, simulation, etc.***

JUSTIFICATION: If EASA's intention is for this requirement to be general in nature, without specifying the method of NDB/publication validation, then no change is needed. However, a clarifying statement to that effect (such as the one we have suggested) may prevent later interpretation, resulting in unnecessary burdens on the RNP operator.

response *Partially accepted*

Text amended to clarify the intent of the assumption.

comment *165* comment by: *UK CAA*

Paragraph:
AMC 20-26; Para 4.1, Note 2
Page: 16
Comment:
The scope of note 3 to section 4.1 Is unclear:
'...a flight check aircraft is expected to be used to evaluate signal in space performance...'

UK CAA's view, as well as that contained in the Eurocontrol document Guidance Material for Flight Inspection of RNAV Procedures*, is that the assessment of the GNSS Signal in Space by flight inspection is inappropriate. The coverage and performance of DME as well as interference and flyability assessment is a reasonable task for flight checking.

	* http://www.ecacnav.com/downloads/Flight_Inspection_of_RNAV_Procedures_Released_Issue_Edition_3.pdf
response	*Accepted* Text amended.

comment	*195* comment by: *Embraer - Indústria Brasileira de Aeronáutica - S.A.* *4.3 OBSTACLE CLEARANCE AND ROUTE SPACING* *All RNP AR procedures:* *(4) Require that barometric vertical navigation capability be used;* **Comment**: It seems that this requirement is a too restrictive. Other VNAV guidance could be used (e.g. SBAS/GBAS). This requirement is in disagreement with item 6.2.1(b) that allows other LNAV/VNAV implementations. As stated in the AC 20-138A the WAAS receiver can convert the VNAV barometric altitudes into height above the WGS-84 ellipsoid, and therefore be able to comply with the accuracy requirements.
response	*Noted* This assumption reflects the existing applications and the PBN manual, where Baro-VNAV with the vertical error budget is the basis for the procedures and operations. In future amendments, guidance will be provided for those aircraft using SBAS and whose vertical TSE and flight path tracking performance are compliant with that required by the RNP AR procedure design.

comment	*224* comment by: *Thales Avionics* Page 17 - Section 4.5 b) Replace: "The flight evaluation prior to publication should confirm track lengths, bank angles, descent gradients, runway alignment and compatibility with predictive terrain hazard warning functions (e.g. Terrain Awareness and Warning Systems)." By: "The flight evaluation prior to publication should confirm track lengths, bank angles, descent gradients, runway alignment and compatibility with **ETSO-C151 () compliant** predictive terrain hazard warning functions (e.g. Terrain Awareness and Warning Systems)." Justification: if the flight evaluation prior to publication is made with a non-standard TAWS, there is a risk that in operations, aircraft flying with approved standard TAWS encounter alerts. As there is no ICAO standardisation for predictive terrain hazard warning functions / TAWS, the only standard that can be referenced is ETSO-C151 / TSO-C151.
response	*Accepted* Text amended.

comment	*231* comment by: *AIRBUS* Paragraph 4.1: The use of DME/DME for RNP AR operations is stated usable as a

"reversionary" capability. It should be further clarified whether "reversionary" includes continuation of an approach, or if the use of DME/DME is only allowed as a contingency procedure for aircraft extraction in case of GPS loss.
Justification:
There is today no standard allowing to demonstrate RNP integrity (ref ICAO "on board performance monitoring & alerting") with DME/DME.

response *Accepted*

Text amended to clarify the term.

comment *232* comment by: *AIRBUS*

Paragraph 4.3:
Sub-paragraph (7) reads:
"(7) If the procedure allows a reversion in aircraft use of navigation infrastructure, e.g. GNSS to DME/DME, the obstacle clearance assessment is based on an RNP that allows either infrastructure;"
It is proposed to add the following clarification:
"(7) If the **contingency** procedure allows a reversion in aircraft use of navigation infrastructure, e.g. GNSS to DME/DME, the obstacle clearance assessment is based on an RNP that allows either infrastructure;"
Justification:
Will clarify that DME/DME cannot support RNP AR operations.

response *Accepted*

Text amended.

comment *247* comment by: *DGAC France*

1 AFFECTED PARAGRAPH: AMC 20-26 Paragraph 4.5 b)

2. PROPOSED TEXT/ COMMENT:

Modify as follows:

... The flight evaluation prior to publication should confirm track lengths, bank angles, descent gradients, runway alignment and compatibility with predictive terrain hazard warning functions (e.g. a class A Terrain Awareness and Warning Systems is required for all RNP AR approach procedures). A truth system is typically not required. ...

3. JUSTIFICATION:
As it is written in appendix 3, §2 (a) , rather than just the compatibility with a Terrain Awareness and Warning System, it should be made clear that it is a TAWS class A which is required.

response *Not accepted*

This section has to do with flight evaluation in the validation of a procedure, not the operational requirement for all aircraft. As such, the suggested change is not appropriate. The intent of the current material is to ensure that when conducting an RNP AR procedure, the procedure design does not lead to nuisance TAWS alerts. The potential causes for the alerts include fixed turn manoeuvres close to obstacles or terrain. This check for nuisance alerts should be extended to all potential TAWS alerts that may be issued when conducting a

RNP AR procedure.

comment

248 comment by: *DGAC France*

1. AFFECTED PARAGRAPH: AMC 20-26 Paragraphs 4.7 and 4.9

2. PROPOSED COMMENT:

Within the AMC dealing with airworthiness or operation, it is a bit surprising to find requirements applicable to ATS or controllers. This is not the place and it cannot add binding requirement here.

Those 2 paragraphs shall be removed from this AMC.

response

Not accepted

These are the assumptions that have been made in support of RNP AR operations.

comment

298 comment by: *Walter Gessky*

Page 18, 4.7 controller training:
This is out of the scope of an EASA AMC. Controller training requirements has to be introduced by EUROCONTROL. Are adequate EC regulations available?

response

Noted

These are the assumptions that have been made in support of RNP AR operations and no controller training requirements are specified within this AMC.

comment

309 comment by: *FAA*

1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):
NPA 2-008-14, AMC 20-26, page 16, section 4.3, para (4)

2. Comment (Please state your comment clearly and in plain language):
Remove requirement for barometric VNAV from numerous locations in the guidance material.

3. Justification (Please provide support for your comment):
The FAA and ICAO criteria is based on barometric VNAV, but does not require it. Alternative sources of vertical guidance (in particular SBAS) are being investigated and may be authorized provided they satisfy the required performance.

4. Proposed Alternative Text (If any):
Are based on the use of barometric vertical navigation capability;

5. Person Providing Comment (Include routing symbol): FAA AIR-130
1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):
NPA 2-008-14, AMC 20-26, page 17, section 4.3 (10), 4.6 (d), and elsewhere (e.g., 6.1.1).

2. Comment (Please state your comment clearly and in plain language):
Recommend adopting common text to refer to the numerical value associated with the RNP leg. ICAO PBN adopted "accuracy value" (as opposed to RNP value or navigation accuracy as used in these paragraphs).

3. Justification (Please provide support for your comment):
Consistency with ICAO.

4. Proposed Alternative Text (If any):
If deemed appropriate, the term "RNP Accuracy Value" could be added to the Glossary in Appendix 1 at page 37.

5. Person Providing Comment (Include routing symbol): FAA AIR-130

response *Partially accepted*

At this time, the AMC is consistent with AC90-101 and the ICAO PBN manual in specifying Baro-VNAV. It is recognised that efforts are underway to establish guidance and criteria for the use of SBAS for vertical guidance. However, it is lacking maturity, it is therefore premature to make a change is this area. It is also outside the scope of the TOR for his AMC. This AMC will be amended in the future when SBAS vertical criteria and supporting assumptions are available.

The term "accuracy value" will be used throughout the document.

comment *348* comment by: *European Cockpit Association*

4.6 PUBLICATION

ADD the following sentence:
The AIP also clearly indicates the specifics that led to the need for an RNP "AR" approach, e.g. RF Turn or RNP < 1,0 for Missed Approach.

response *Not accepted*

The AIP will clearly identify RNP essential information needed to understand the procedure e.g. RF leg, RNP 0.3 for missed approach, etc.

resulting text: See Appendix B

B. Draft Decision - AMC 20-26: 5. System Description - 5.1 Lateral Navigation (LNAV) p. 18

comment *78* comment by: *Boeing*

AMC 20-26
Page: 18
Paragraph 5.1.2.(b)

Clarification Request: The current paragraph (b) states:

"(b) Inertial Navigation System (INS) or Inertial Reference System (IRS), with

automatic updating from suitable radio based navigation equipment."

However, Boeing suggests it should be revised to state:

"(b) Inertial Navigation System (INS) or Inertial Reference System (IRS)" [last part of sentence deleted]

JUSTIFICATION: Most inertial systems are not radio updated; the FMC or RNAV computer is.

response *Accepted*

Text amended.

comment *192* comment by: *EUROCOPTER*

Does that mean INS is always required, even for non-complex RNP-AR operations? Seems contradictory with 7.1 where INS is not explicitely mentioned. Civil helicopters are not fitted with INS and such a requirement would preclude them to take benefit of RNP-AR operations.

response *Noted*

INS is a typical part of an aeroplane equipage that may be included among the navigations sources for RNP AR operations. Paragraph 7.1 lists functional capabilities and performance. The applicant will be required to demonstrate compliance to these requirements.

comment *233* comment by: *AIRBUS*

Paragraph 5.1:
The sub-paragraph 5.1.2 reads:
"The RNAV system may be able to use all positioning sensor inputs simultaneously where the sensor(s) supporting the best accuracy will be used in determining the system accuracy."
This sentence should be deleted.
Justification:
This sentence is in contradiction with another sentence in the AMC stating that primary basis for positioning in RNP AR operations is GNSS.

response *Accepted*

Text amended.

resulting text: See Appendix B

B. Draft Decision - AMC 20-26: 5. System Description - 5.2 Vertical Navigation p. 18-19

comment *5* comment by: *KLM*

Section: 5.2.1 Note 1
Page: 19

Relevant Text: A/P or F/D coupling
Comment: This information is relevant for the APV Baro VNAV criteria as well (see there). There may be a need for FTE criteria for APV Baro VNAV based on A/P OR F/D coupling, when the most conservative FTE of 200 or 300 ft is applied for Baro VNAV.
Proposal: None

response *Noted*

While there may be common elements, there are differences with APV Baro-VNAV that are not relevant for RNP AR APCH. It is not intended to address APV Baro-VNAV within this AMC. APV Baro-VNAV is addressed in AMC 20-27.

comment *6* comment by: *KLM*

Section: 5.2.1 Notes 3 till 7
Page: 19
Relevant Text: This information is not related to the final approach (I hope).
Comment: Is this relevant/appropriate information for the this AMC?
Proposal: Check whether this information is relevant

response *Noted*

This information is intended to ensure that there is a clear understanding of the issues associated with VNAV systems that should be considered. The AMC addresses approach and missed approach, not just final approach.

comment *39* comment by: *AEA*

Ref: 5.2.1 - Note 1
Relevant Text: *A/P or F/D coupling*
Comment: This information is relevant for the APV Baro VNAV criteria as well (see there). There may be a need for FTE criteria for APV Baro VNAV based on A/P OR F/D coupling, when the most conservative FTE of 200 or 300 ft is applied for Baro VNAV.
Proposal: refer to the relevant APV Baro VNAV chapter.

response *Noted*

While there may be common elements, there are differences with APV Baro-VNAV that are not relevant for RNP AR APCH. It is not intended to address APV Baro-VNAV within this AMC. APV Baro-VNAV is addressed in AMC 20-27.

comment *40* comment by: *AEA*

Relevant Text: 5.2.1 Notes 3 to 7
Comment: This information is not related to the final approach. Is this relevant/appropriate information for the this AMC?
Proposal: Check whether this information is relevant

response *Noted*

This information is intended to ensure that there is a clear understanding of the issues associated with VNAV systems that should be considered. The AMC addresses approach and missed approach, not just final approach.

comment	*234* comment by: *AIRBUS* Paragraph 5.2: Sub-paragrph 5.2.1 reads: "Note 3: The specification of vertical angles on multiple path fixes in descent may lead to possible vertical path discontinuities. This type of procedure should be assessed [...]" It is proposed to delete this note 3. Justification: Vertical flight path discontinuities should not be acceptable for RNP AR operations. See also Airbus 2nd general comment.
response	*Not accepted* This information is intended to ensure that there is a clear understanding of the issues associated with VNAV systems that should be considered. The AMC addresses approach and missed approach, not just final approach.

comment	*250* comment by: *DGAC France* 1b AFFECTED PARAGRAPH: AMC 20-26 Paragraph 5.2.2 2. PROPOSED TEXT/ COMMENT: Add in the title that "temperature compensation system" is a recommended function (as it is well specified in the AMC 20-27 para 7.4) 3. JUSTIFICATION:
response	*Not accepted* Temperature compensation may be incorporated but currently is not recommended function due to a lack of guidance and standards for its use and application.

resulting text	See Appendix B

B. Draft Decision - AMC 20-26: 6. Airworthiness Certification Objectives p. 19

comment	*166* comment by: *UK CAA* **Paragraph:** AMC 20-26 Section 6 **Pages:** 19-22 **Comment:** AMC 20-26 would benefit from clearer identification of acceptable equipment standards (similar to that defined in AMC 20-27) in terms of (E)TSO qualification. **Justification:** Not useful as a guidance in its current presentation. **Proposed Text:** The definitions used in AMC 20-27 are a better example.
response	*Noted*

AMC 20-26 reflects aircraft and systems that are typically subject to a type design and airworthiness approval versus AMC 20-27 which reflects equipment that receives ETSO qualification prior to installation. Standards that are acceptable are identified where possible.

comment *310* comment by: *FAA*

1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):
NPA 2-008-14, AMC 20-26, page 19, section 5.2.1, note 2 and 4

2. Comment (Please state your comment clearly and in plain language):
Delete these notes.

3. Justification (Please provide support for your comment):
Systems that preclude the use of a vertical angle on a flight leg will not comply with this AMC, and should not be accommodated. Similarly, manual entry should not be allowed on an RNP AR procedure.

4. Proposed Alternative Text (If any):

5. Person Providing Comment (Include routing symbol): FAA AIR-130

response *Not accepted*

The notes are provided to aid in understanding of the issues that must be considered in determining aircraft capability and in authorising operations and reflect the systems that have been approved to date for RNP AR APCH. Armed with such information it may still be possible to develop and implement a procedure (with minor revision) that is RNP AR that allows more aircraft types to participate.

B. Draft Decision - AMC 20-26: 6. Airworthiness Certification Objectives - 6.1 Accuracy - 6.1.1. Lateral p. 20

comment *237* comment by: *AIRBUS*

The note 2 reads:
"[...] However, such a Flight Manual statement, by itself, does not constitute an airworthiness approval for RNAV AR operations and compliance with all other criteria of this AMC will need to be shown."
The word "RNAV" should be replaced by the word "RNP".
Justification:
Typo error.

response *Accepted*

Text amended.

comment *238* comment by: *AIRBUS*

The note 3 reads:
"[...] Manufacturers should consider the effects of sensor failure or errors on

lateral position during the conduct of an approach, and the potential approach and missed approach RNP, in implementing system architecture, sensor switching, and redundancy."
This sentence should be modified as shown:
"Manufacturers should consider the effects of sensor failure or errors on lateral position during the conduct of **RNP AR operations**, and the potential **departure**, approach and missed approach RNP, in implementing system architecture, sensor switching, and redundancy."
Justification:
Provision for departure must be added.

response *Accepted*

Text amended.

comment *331* comment by: *ECOGAS*

Note 2 seems convoluted and unnecessary. Suggest deletion or clarification.

response *Not accepted*

The current statement makes a finding of compliance to the requirement for those aircraft/systems whose GNSS performance is part of a demonstration to specific airworthiness criteria and with the demonstrated performance contained in the aircraft documentation.

resulting text: See Appendix B

B. Draft Decision - AMC 20-26: 6. Airworthiness Certification Objectives - 6.1 Accuracy - 6.1.2. Vertical p. 20-21

comment *8* comment by: *KLM*

Section: 6.1.2 Formula
Page: 20
Relevant Text: Formula
Comment: The contents of the formula should be explained more precise, or should be deleted. The order of the elements in the text does not follow the elements in the formula and the FTE of 75 ft is not mentioned.
Question: is the 75 ft FTE based of A/P or F/D coupling? If so, this is then a basic assumption, even for RNP0.3, where it is now indicated that A/P or F/D is not a requirement. If that is the case, should the same values (200 and 300 ft) be applied as for the APV Baro-VNAV?
Proposal: Explain more precise the formula or delete but describe the principle only.
Check the need for A/P or F/D coupling in relation to the assumed 75 ft FTE.
Verify whether under all circumstances the FTE of 75 ft can be applied.

response *Noted*

The performance formula is essential to ensure that aircraft systems performance meets the assumptions included in the RNP AR procedure design.

comment *9* comment by: *KLM*

Section: 6.1.2.
Page: 21
Relevant Text: Note 2
Comment: The PBN RNP AR design manual does take these errors into account. It is not understood why it is indicated that this is not the case.
Proposal: Delete, or change the PBN RNP AR approach design manual criteria if it is seen as irrelevant (which I agree)

response *Not accepted*

The note provides an explanation of how the procedure design criteria are accounted for through the design and airworthiness assessment, since they cannot be included in a general formulaic analysis.

comment *41* comment by: *AEA*

Relevant Text: Formula
Comment: The contents of the formula should be explained more precise, or should be deleted. The order of the elements in the text does not follow the elements in the formula and the FTE of 75 ft is not mentioned.
Question: is the 75 ft FTE based of A/P or F/D coupling? If so, this is then a basic assumption, even for RNP0.3, where it is now indicated that A/P or F/D is not a requirement. If that is the case, should the same values (200 and 300 ft) be applied as for the APV Baro-VNAV?
Proposal: Explain more precise the formula or delete but describe the principle only.
Check the need for A/P or F/D coupling in relation to the assumed 75 ft FTE.
Verify whether under all circumstances the FTE of 75 ft can be applied.

response *Noted*

The performance formula is essential to ensure that aircraft systems performance meets the assumptions included in the RNP AR procedure design.

comment *42* comment by: *AEA*

Relevant Text: 6.2.1. Note 2
Comment: The PBN RNP AR design manual does take these errors into account. It is not understood why it is indicated that this is not the case.
Proposal: Delete, or change the PBN RNP AR approach design manual criteria if it is seen as irrelevant

response *Not accepted*

The note provides an explanation of how the procedure design criteria are accounted for through the design and airworthiness assessment, since they cannot be included in a general formulaic analysis.

comment *167* comment by: *UK CAA*

Paragraph:
AMC 20-26 Para 6.1.2
Page: 20
Comment: The definition of the allowable vertical system error introduces a

root-sum-square of the component errors. These individual errors are not defined or referenced thereby making clear (reader) comprehension difficult. Constituent elements of the altimetry system error are similarly ill defined.
Justification:
Not useful as guidance in its current presentation.
Proposed Text:
Define the individual terms used to define the vertical system error and altitude system error. The definitions used in AMC 20-27 are a better example**.**

response

Not accepted

AMC 20-26 establishes the formula so that operations may benefit from the best aircraft vertical performance possible, for which the individual parameters are defined. AMC 20-27 defines a specific set of requirement since optimal performance benefits are not the objective for Baro-VNAV.

comment

168 comment by: *UK CAA*

Paragraph:
AMC 20-26, para 6.1.2
Page: 21
Comment:
Note 1 concerning the explanation of the relationship between this material and current guidance for VNAV, is confusing. There is clearly a hierarchy of performance standards for VNAV, but the text does not explicitly convey this.
Justification:
Lacking in clarity.
Proposed Text:
Intent of paragraph is understood, but suggest re-wording.

response

Accepted

The text has been amended as proposed by comment 241.

comment

239 comment by: *AIRBUS*

The paragraph reads:
"During operations on instrument approach procedures notified exclusively for RNP aircraft, the vertical system error includes altimetry error (assuming the temperature and lapse rates of the International Standard Atmosphere), the effect of along track error, system computation error, data resolution error, and flight technical error. The 99.7% of system error in the vertical direction must be less than the following (in feet):"
It is proposed to modify the last sentence of this paragraph as shown:
"**During the stabilized constant final descent part of the approach where the VEB criteria apply,** the 99.7% of system error in the vertical direction must be less than the following (in feet):"
Justification:
The requirement on the Vertical accuracy should only be applicable to the stabilized constant final descent part of the approach.

response

Partially accepted

The commenter's intent is accepted, the text amend accordingly.

comment

241 comment by: *AIRBUS*

Note 1 reads:
"Current guidance for VNAV such as AC20129, and AC9097 has less stringent performance requirements. However, systems meeting this guidance material have been demonstrated and approved for the vertical path performance specified herein or similar guidance e.g. AC12029A. For aircraft and systems not yet approved, a supplemental analysis, assessment and regulatory approval (i.e. airworthiness) will be necessary in meeting the requirements herein."
This note could be shortened as shown:
"Current guidance for VNAV such as AC20129, and AC9097 has less stringent performance requirements. A supplemental analysis, assessment and regulatory approval (i.e. airworthiness) will be necessary in meeting the requirements herein."

response *Accepted*

Text amended.

comment *242* comment by: *AIRBUS*

Note 2 reads:
"For the vertical system error above, waypoint resolution error (WPR) is not included and is not considered since data and database processes associated with DO200A and DO201A are required. In addition ATIS, automatic terminal information service temperature error is not included and is assumed to be negligible from operational procedure."
The note should be shortened as shown:
"ATIS, automatic terminal information service temperature error is not included and is assumed to be negligible from operational procedure."
Justification:
The Way Point Resolution error is included in the vertical system error.

response *Accepted*

The parameter has been amended to Vertical Angle Error.

comment *251* comment by: *DGAC France*

1. AFFECTED PARAGRAPH: AMC 20-26 Paragraph 6.1.2

2. PROPOSED COMMENT:

In order to clarify the paragraph 6.1.2, more explicit references to the various errors shall be introduced to address the following questions:

a) The VNAV accuracy chapter addresses only the Altimetry System Error. It would help to know what the Total System Error target for the VNAV accuracy depending on the runway altitude is. ASE is rather an assumption taking into account CS25.1325 than a requirement.

It is recommended to replace the chapter by a wording similar to the one of AMC 20-27 chapter 6.3.2, with the appropriate PANS OPS criteria regarding obstacle clearance if they are different for RNP AR.

b) How the 75ft maximum vertical excursion target is met? Is it TSE or FTE?

c) It is recommended to add the TSE acronym in the note 1 of §6.1.1

response

Not accepted

AMC 20-26 establishes the formula so that operations may benefit from the best aircraft vertical performance possible, for which the individual parameters are defined. AMC 20-27 defines a specific set of requirement since optimal performance benefits are not the objective for Baro-VNAV.

comment

253 comment by: *DGAC France*

1. AFFECTED PARAGRAPH:
AMC 20-26 Paragraph 6.1.2 Note 1

2. PROPOSED COMMENT:
The note seems not consistent. If the performance of the current systems which are in compliance with the referred standards 'AC 20-129, AC 90-97), does not meet the proposed AMC 20-26 requirements, then those current systems should be analysed because it could impact the overall operational procedures. Otherwise it means that it is useless to define more stringent requirement.

response

Partially accepted

The note indicates that current regulatory guidance is not sufficient for determining the best aircraft performance possible or as needed for RNP AR. The note has been amended as a result of additional comments to clarify the meaning.

comment

311 comment by: *FAA*

1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):
NPA 2-008-14, AMC 20-26, page 21, section 6.1.2, note 1

2. Comment (Please state your comment clearly and in plain language):
The second sentence states that "systems... have been demonstrated and approved" - clarify that additional substantiation was required for this approval.

3. Justification (Please provide support for your comment):
Clarification - as written it could imply that *all* systems that complied with 20-129 and 90-97 would qualify.

4. Proposed Alternative Text (If any):
However, systems meeting this guidance material may be approved for RNP AR operations without new certification where the applicant has data from the original certification and can demonstrate that the system satisfies the tighter accuracy stated in the AMC.

5. Person Providing Comment (Include routing symbol): FAA AIR-130

1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your*

comment):
NPA 2-008-14, AMC 20-26, page 21, section 6.1.2, note 2

2. Comment (Please state your comment clearly and in plain language):
ATIS is considered in the design criteria (it is not assumed to be negligible).

3. Justification (Please provide support for your comment):

4. Proposed Alternative Text (If any):
In addition, ATIS... is considered in the design criteria but is not an error component attributed to the aircraft.

5. Person Providing Comment (Include routing symbol): FAA AIR-130

1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):
NPA 2-008-14, AMC 20-26, page 21, section 6.1.3 (and App 5)

2. Comment (Please state your comment clearly and in plain language):
The FAA does not require a FOSA for any public RNP AR procedures. The procedure design criteria, aircraft criteria and operational criteria were developed so that safety can be assured generically, rather than evaluating individual aircraft on individual approach procedures. The workload associated with conducting a procedure-specific FOSA for each aircraft is not justified. Recommend limiting the application of a procedure-specific FOSA to approach procedures where there are deviations from the procedure design criteria.

3. Justification (Please provide support for your comment):

4. Proposed Alternative Text (If any):

5. Person Providing Comment (Include routing symbol): FAA AIR-130

1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):
Page 21 of 99, Paragraph 6.1.2., Note 2
2. Comment (Please state your comment clearly and in plain language):
Current text states waypoint resolution error (WPR) is not included, based on reliance with DO-200A and DO-201A.

3. Justification (Please provide support for your comment):
Waypoint resolution error should be included as an error, since reliance on a qualitative process may not catch certain quantitative errors. *(Currently in PBN Vol II, pg C-6-8, and AC 90-101).*

4. Proposed Alternative Text (If any):
"**Waypoint Resolution Error.** The navigation database must provide sufficient data resolution to ensure the navigation system achieves the required accuracy. Waypoint resolution error must be less than or equal to 60 feet, including both the data storage resolution and the RNAV system computational resolution used internally for construction of flight plan waypoints. The navigation database must contain vertical angles (flight path angles) stored to a resolution of hundredths of a degree, with computational

resolution such that the system-defined path is within 5 ft of the published path."

5. Person Providing Comment (Include routing symbol): FAA AIR-130

response *Partially accepted*

6.1.2 Note 1: Partially Accepted - The note has been amended as a result of additional comments to clarify the meaning.

6.1.2 Note 2: Partially Accepted - Text Amended to introduce reference to ATRIS being part of the procedure design.

6.1.3: Not Accepted - The FOSA requirement reflects one difference in the regulatory processes. While FAA does not require it unless there are notable deviations in the procedure design criteria, leaving it to the operator to address, this is not possible within Europe. This requirement reflects a baseline assumption that more complex or stringent applications are being implemented through procedure design.

6.1.2 Note 2: Not Accepted. The parameter has been amended to vertical angle error, as the Way Point Resolution error is included in the vertical system error.

resulting text: See Appendix B

B. Draft Decision - AMC 20-26: 6. Airworthiness Certification Objectives - 6.1 Accuracy - 6.1.3. RNP System Performance p. 21-22

comment *10* comment by: *KLM*

Section: 6.2.1
Page: 22
Relevant Text: Note 1
Comment: Note is related to b) only? The word "this" refers to 10E07?
Proposal: Alinea should be brought in line with b).

response *Accepted*

Text amended.

comment *79* comment by: *Boeing*

AMC 20-26
Page: 21
Paragraph 6.1.3. RNP System Performance

Significant Change Request: Boeing suggests that the phrase in the first paragraph that currently states:

" ... e.g., obstacle rich environment or high density air traffic environment."
be changed to the following:

" ... e.g., ***low RNPs for obstacle clearance or separation, flyability of instrument procedures, and*** *an obstacle rich environment or high density air traffic environment.*

JUSTIFICATION: Obstacle rich environments and high density air traffic environments that exist today do not have this type of requirement. This requirement appears to be addressing concerns about operational risk because of smaller airspace margins for clearance and separation, coupled with operating environments where assuring performance compliance is more critical. The implications are that RNP APCH procedures in high density air traffic environments should also be subject to this.

response *Partially accepted*

Text amended, the use of flyabilty is not included as an example, as it always has to assured.

comment *80* comment by: *Boeing*

AMC 20-26
Page: 21
Paragraph 6.1.3. RNP System Performance

Editorial Comments: Boeing suggests that the following changes be made:

1. Incorporate the specific requirements (1xRNP, 2xRNP, and 75 feet) into the lateral and vertical performance sections. The rest of the material is background and information that should be changed to explanatory notes.

2. Discontinue use of the term "containment" in this section.

JUSTIFICATION:

1. The only real difference with the existing lateral and vertical performance requirements appears to be that the additional conditions for assessment or evaluation have been added, e.g., probable, remote and extremely failures and one engine inoperative, which can be incorporated in the lateral and vertical performance requirements.

2. There appear to be different uses of the term "containment" in the document.

response *Partially accepted*

1. Not Accepted: The text is considered acceptable.

2. Partially Accepted: The word is correct in the context of this paragraph; however, the document will be amended to ensure a consistent use of the term.

comment *81* comment by: *Boeing*

AMC 20-26
Page: 21
Paragraph 6.1.3.a RNP System Performance

Clarification Request: Boeing suggests that paragraph (a) be changed as follows:

*"a) The lateral excursions observed as a result of Probable failures should be documented against an objective of containment within 1xRNP **(95%).** Vertical excursions should remain within 75 feet **(99.7%)**."*

.

JUSTIFICATION: The conditional containment values should have an associated conditional probability for compliance determination.

response *Partially accepted*

The requirement for a percentile is not considered appropriate for these conditions. These conditions are limit performance conditions. The text has been amended to clarify the requirement.

comment *82* comment by: *Boeing*

AMC 20-26
Page: 22
Paragraph 6.1.3.b RNP System Performance

Clarification Request: Boeing suggests that paragraph (b) be changed as follows:

*"b) The lateral excursions observed as a result of One Engine Inoperative (OEI) should be documented against an objective of containment within 1xRNP **(95%)**."*

.

JUSTIFICATION: The conditional containment value should have an associated conditional probability for compliance determination.

response *Not accepted*

The requirement for a percentile is not considered appropriate for this condition, as it is a limit performance condition.

comment *83* comment by: *Boeing*

AMC 20-26
Page: 22
Paragraph 6.1.3.c. RNP System Performance

Clarification Request: Boeing suggests that paragraph (c) be changed as follows:

*"c) The lateral excursions observed as a result of Remote failures should be documented against an objective of containment within 2xRNP **(99%)**."*

JUSTIFICATION: The conditional containment value should have an associated conditional probability for compliance determination. This value should be consistent with the overall safety objective of extremely remote loss of containment at 2xRNP.

response *Not accepted*

The requirement for a percentile is not considered appropriate for this

condition as it is a limit performance conditions.

comment

200 comment by: *Embraer - Indústria Brasileira de Aeronáutica - S.A.*

6.1.3. RNP System Performance

Comment : The requirements set forth in this paragraph are confusing and may lead to very different interpretations. For instance it could be considered from the rest of the AMC that a single RNP system would be able to fly RNP AR 0.3nm procedures. But it would not be possible to meet this requirement, since even if the RNAV system failure falls into a remote category, meeting the safety assessment requirements of other paragraphs, it would not be able to cope with the containment requirement of (c).
Our interpretation of this section is that, considering that most RNP AR will have different lines of minima associated with different levels of RNP, the pilot should be aware of which minima can be achieved with a failure or if he will have to divert to the missed approach. Also these requirements should be applicable only for procedures with RNP less than 0.3 or containing missed approaches with RNP less than 1.
Nevertheless, we believe that the safety objectives of this paragraph are already been taken into consideration by other requirements like the loss and misleading of navigational data and TAWS installation.
As a final comment, please change the Note 1 of item (d) indicating that "Extremely Remote failures are failures with a probability between 10^{-7} and 10^{-9}." for consonance with AMC 25.1309.

response

Partially accepted

Comments are noted and note 1 to Para d) amended.

resulting text

See Appendix B

B. Draft Decision - AMC 20-26: 6. Airworthiness Certification Objectives - 6.2 Integrity p. 22

comment

312 comment by: *FAA*

1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):
NPA 2-008-14, AMC 20-26, page 22, section 6.1.3 (b)

2. Comment (Please state your comment clearly and in plain language):
Clarify that the OEI in this case is the effect of failure of an engine during the approach, not the RNP capability of the aircraft with OEI (in the case of engine failure en route, and then initiating an approach).

3. Justification (Please provide support for your comment):

4. Proposed Alternative Text (If any):

	5. Person Providing Comment (Include routing symbol): FAA AIR-130
response	*Not accepted* The criterion establishes the conditions and levels of performance that must be assessed for RNP AR operations. In the case of one engine inoperative, specific operational flight phase conditions will not be imposed.

B. Draft Decision - AMC 20-26: 6. Airworthiness Certification Objectives - 6.2 Integrity - 6.2.1. System p. 22-23

comment	*43* comment by: *AEA* Relevant Text: 6.2.1. System - Note 1 **Comment**: Note is related to b) only? The word "this" refers to 10E07? **Proposal**: should be brought in line with b).
response	*Accepted* Text amended.

comment	*193* comment by: *EUROCOPTER* In Note 1, consideration of aircraft wingspan is only applicable to fixed-wing aircraft. For rotorcraft, rotor diameter should be considered.
response	*Partially accepted* Reference to aircraft wing span has been deleted from the note.

comment	*244* comment by: *AIRBUS* Sub-paragraph b) reads: "b) Other systems (e.g. GNSS/SBAS RNAV equipped or other) or alternate means of compliance. For other systems or alternate means of compliance, the probability of the aircraft exiting the lateral and vertical extent of the obstacle clearance volume (defined in ICAO PBN RNP AR Procedure Design Manual) must not exceed 10E-7 per approach, including the approach and missed approach." This paragraph should be modified as shown: "b) Other systems (e.g. GNSS/SBAS RNAV equipped or other) or alternate means ofcompliance. For other systems or alternate means of compliance, the probability of the aircraft exiting the lateral and vertical extent of the obstacle clearance volume (defined in ICAO PBN RNP AR Procedure Design Manual) must not exceed 10E-7 per approach, for the departure, approach and missed approach as appropriate." Justification: Provision for departure should be added.
response	*Accepted* Text amended.

comment	*245* comment by: *AIRBUS*

Note 1 reads:
"[...] The requirement applies to a single approach, considering the exposure time of the operation and the Navaid geometry and navigation performance available for each published approach."
The impact of the Navaid geometry (DME/DME?) on the integrity should be clarified.

response *Not accepted*

This requirement is consistent with AC 90-101 and PBN.

resulting text: See Appendix B

B. Draft Decision - AMC 20-26: 6. Airworthiness Certification Objectives - 6.2 Integrity - 6.2.2. Display p. 23

comment *196* comment by: *Embraer - Indústria Brasileira de Aeronáutica - S.A.*

Comment: The requirement differs from AC 90-101 (more restrictive) requiring Hazardous fail condition for RNP 0.3. The AC 90-101 asks for Hazardous fail condition for RNP bellow 0.3. This difference is not included in annex 6. We believe that there is a possible mistake on requirement text.

response *Accepted*

Text amended.

comment *313* comment by: *FAA*

1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):
NPA 2-008-14, AMC 20-26, page 22, section 6.1.3 (c), Note 1 (i)

2. Comment (Please state your comment clearly and in plain language):
GNSS outage is considered separately and should not be referenced here (see 7.2, 2, 4)

3. Justification (Please provide support for your comment):

4. Proposed Alternative Text (If any):

5. Person Providing Comment (Include routing symbol): FAA AIR-130

response *Not accepted*

This section contains the key requirements associated with system performance and FOSA. While paragraph 7.2 addresses other specific functionality aspects of GNSS loss, this paragraph defines the specific conditions associated with GNSS and safety assessment are described.

resulting text	See Appendix B

B. Draft Decision - AMC 20-26: 7. Functional Criteria p. 24

comment	*252* comment by: *AIRBUS*

Items 1 & 12 read:
"For RNP < 0.3 NM, one acceptable means of compliance is an appropriately scaled Nonnumeric deviation display (i.e., lateral deviation indicator and vertical deviation indicator) located in the pilot's primary field of view. A fixed scale CDI is acceptable as long as the CDI demonstrates appropriate scaling and sensitivity for the intended navigation accuracy and operation. With a scalable CDI, the scale should derive from the selection of RNP, and not require the separate selection of a CDI scale. Where a CDI is relied upon, alerting and annunciation limits must also match the scaling values. If the equipment uses default navigation accuracy to describe the operational mode (e.g. en route, terminal area and approach), then displaying the operational mode is an acceptable means from which the flight crew may derive the CDI scale sensitivity.

An alternative for lateral deviation is a navigation map display, readily visible to the flight crew, with appropriate map scales, integral navigation map display deviation information, and giving equivalent functionality to the lateral deviation display, except that scaling may be set manually by the pilot. The use of numeric display and map display depends on the flight crew workload, the display characteristics, flight crew procedures and training."

"Display of Deviation. The navigation system must provide a numeric display of the vertical deviation with a resolution of 10 feet or less, and the lateral deviation with a resolution of 0.01 NM or less."

The wording "For RNP < 0.3NM ..." should be repalced by the wording "For RNP 0.3NM ..." at the beginning of the 2nd paragraph of item 1.

The item 12 should be deleted and combined with 3rd paragraph of item 1:
"An alternative for lateral deviation is a navigation map display, readily visible to the flight crew, with appropriate map scales, integral navigation map display deviation information, and giving equivalent functionality to the lateral deviation display, except that scaling may be set manually by the pilot. **The navigation system should provide a numeric display of the lateral deviation with a resolution of 0.01 NM or less.** The use of numeric display and map display depends on the flight crew workload, the display characteristics, flight crew procedures and training."
Justification:
Consistency with EASA positions expressed during aircraft certification concerning the requirement for a LAT DEV at RNP 0.3 or RNP<0.3. A numeric display of the vertical deviation should not be required in addition to vertical deviation indicator.

response	*Partially accepted*

The text has been amended to clarify the required functionality and options and incorporates the commenter's intent.

comment *314* comment by: *FAA*

1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):
NPA 2-008-14, AMC 20-26, page 23, section 6.3, note 1

2. Comment (Please state your comment clearly and in plain language):
The note states that dual systems are 'likely', yet 7.2, states that there must be a second system. A procedure-specific FOSA should not be required.

3. Justification (Please provide support for your comment):

4. Proposed Alternative Text (If any):
Change to "Where continued operation is required for a procedure with stringent RNP on both the approach and missed approach, dual systems will be needed (see 7.2)."

5. Person Providing Comment (Include routing symbol): FAA AIR-130

response *Accepted*

Text amended.

resulting text: See Appendix B

B. Draft Decision - AMC 20-26: 7. Functional Criteria - 7.1 Minimum Required Functions for RNP AR Operations p. 24-28

comment *11* comment by: *KLM*

Section: 7.1
Page: 26
Relevant Text: item 21
Comment: :A geodetic line between two fixes is the description of TF. However it is not indicated as such. This item should start with i).
Add the ARINC 424 PT's directly behind the textual description for clarity.
I note that the CA leg type is not mentioned. Is that on purpose (I agree as the CA leg does not match with RNP (AR) as the initial drift is not corrected) whereby the original intended ground track is not followed.
Proposal: See above

response *Accepted*

Text amended.

comment *44* comment by: *AEA*

Relevant Text: Item 21 - Mainatining Track and leg Transitions
Comment: :A geodetic line between two fixes is the description of TF. However it is not indicated as such. This item should start with i).

Add the ARINC 424 PT's directly behind the textual description for clarity.
The CA leg type is not mentioned. Is that on purpose (agreed- as the CA leg does not match with RNP (AR) as the initial drift is not corrected) whereby the original intended ground track is not followed.
Proposal:
Start Item with i)
Add the ARINC 424 PT's directly behind the textual description for clarity.

response *Accepted*

Text amended.

comment *84* comment by: *Boeing*

AMC 20-26
Page: 24
Paragraph 7.1, Minimum Required Functions for RNP AR Operations;
Table 1, Item 1

Editorial Suggestion: Boeing suggests that the following wording be added to Item 1:

"In lieu of appropriately scaled lateral and vertical deviation indicators in the pilot's primary optimum field of view, a numeric display of deviation may be acceptable depending on the flight crew workload and the numeric display characteristics. A numeric display will require additional initial and recurrent flight crew training "

JUSTIFICATION: This provision currently exists in FAA's Advisory Circular (AC) 90-101, " Approval Guidance for RNP Procedures with SAAAR." Based on actual experience with Boeing 737 airplanes during tens of thousands of low RNP operations since 1996, this has proven to be usable and effective. Not to include this provision would exclude thousands of airplanes that cannot be practically modified to include graphic deviation displays from the improved safety of RNP AR operations.

response *Partially accepted*

The text has been amended to clarify the required functionality and options and incorporates the commenter's intent.

comment *85* comment by: *Boeing*

AMC 20-26
Page:24 (RS)
Paragraph 7.1, Minimum Required Functions for RNP AR Operations;
Table 1, Item 5

Clarification Request: Boeing suggests that the following change be made to Item 5:

"Display of To/From the active fix. The navigation system must provide a To/From display in the pilot's primary field of view. ***Systems with electronic map display in the pilot's primary field of view having designation of the active waypoint are sufficient."***
.

JUSTIFICATION: To/From is applicable to CDI-type displays. Electronic Map displays do not need an explicit To/From indication.

response *Accepted*

Text amended.

comment *86* comment by: *Boeing*

AMC 20-26
Page:25 (RS)
Paragraph 7.1, Minimum Required Functions for RNP AR Operations;
Table 1, Item 8

Clarification Request: Boeing suggests that the following change be made to Item 8:

"Slaved Course Selector. The navigation system must provide a course selector automatically slaved to the RNAV computed path. ***Systems with electronic map display in the pilot's primary field of view having a depiction of the active route are sufficient****."*

JUSTIFICATION: Course Selector is applicable to CDI-type displays. Electronic Map displays do not need an explicit Course Selector.

response *Partially accepted*

An acceptable alternative is an integral navigation map display. This acceptable alternative has been introduced.

comment *87* comment by: *Boeing*

AMC 20-26
Page: 25
Paragraph 7.1, Minimum Required Functions for RNP AR Operations;
Table 1, Item 12

Significant Change Request: Boeing suggests that the following change be made to Item 12:

"Display of Deviation. The navigation system must provide a numeric display of the vertical deviation with a resolution of 10 feet or less, and the lateral deviation with a resolution of 0.01 NM or less. ***Numeric displays in 0.1 NM increments may be acceptable with appropriate operational mitigations****."*

.

JUSTIFICATION: This change should be made to permit older FMCs to use the numeric displays in 0.1 NM increments. This can be done completely safely, provided that appropriate operational mitigations are in place. The FAA currently is allowing such displays for operational use.

response *Not accepted*

This item has been deleted as a result of other comments.

comment *88* comment by: *Boeing*

AMC 20-26
Page: 25
Paragraph 7.1, Minimum Required Functions for RNP AR Operations;
Table 1, Item 14

Significant Change Request: Boeing suggests that Item 14 be deleted in its entirety.

JUSTIFICATION: In performance-based operations, the navigation system monitors its actual navigation performance and alerts the crew if the performance does not meet the requirement (RNP). There is no operational need to monitor the sensors; that is done automatically by the flight management and alerting system.

response *Partially accepted*

The requirement for primary field of view is considered not to be required. However, the flight crew should be able to ascertain those navigation sensors are in use, if required. Text has been amended accordingly.

comment *89* comment by: *Boeing*

AMC 20-26
Page: 26
Paragraph 7.1, Minimum Required Functions for RNP AR Operations;
Table 1, Item 21

Clarification Request: Boeing suggests that the following note be added to Item 21*:*

"Note 5: It is recognized that RNP holding is not included among the functional capabilities of many RNP capable systems. In this case, the system should provide the capability for an RNAV racetrack type holding pattern whose dimensions will reflect actual meteorological conditions and size limits described in ED-75B/DO-236B."

JUSTIFICATION: RNP holding patterns (e.g., size and entry) are not widely implemented in RNP systems today. Until this has changed, RNAV holding capability should be accommodated.

response *Not accepted*

Resulting from other comments, RNP holding and other path designators have been deleted as minimum requirements.

comment *90* comment by: *Boeing*

AMC 20-26
Page: 27
Paragraph 7.1, Minimum Required Functions for RNP AR Operations;
Table 1, Item 23

Clarification Request: Boeing suggests that the following changes be made to Item 23:

"Waypoint Resolution Error. The navigation database must provide sufficient

data resolution to ensure the navigation system achieves the required accuracy. Waypoint resolution error must be less than or equal to 60 feet, including both the data storage resolution and the RNAV system computational resolution used internally for construction of flight plan waypoints. The navigation database must contain vertical angles (flight path angles) stored to a resolution of hundredths of a degree, with ***equivalent*** *computational resolution ~~such that the system defined path is within 5 ft of the published path~~ ."*

JUSTIFICATION: With the given vertical angle resolution, the 5-ft requirement is redundant and imposes a 4.7 NM leg length limit on any leg using a vertical angle.

response *Accepted*

Text Amended.

comment *91* comment by: *Boeing*

AMC 20-26
Page: 27
Paragraph 7.1, Minimum Required Functions for RNP AR Operations;
Table 1, Item 24

Significant Change Request: Boeing suggests that the following change be made to Item 24:

"Capability for a 'Direct-To' Function. The navigation system must have a 'Direct-To' function the flight crew can activate at any time. This function must be available to any fix. The navigation system must also be capable of generating a geodesic path to the designated 'To' fix, without 'S-turning' and without undue delay. ~~For systems with VNAV capability, a linear path should be computed from current position to a vertically constrained fix, consistent with the use of the "Direct-to" capability.~~"

JUSTIFICATION: The suggested deletion removes the vertical "Direct-To" requirement, since it would cause the system to override a vertical angle on the newly selected active fix.

response *Accepted*

Text amended.

comment *93* comment by: *Boeing*

AMC 20-26
Page: 28
Paragraph 7.1, Minimum Required Functions for RNP AR Operations;
Table 1, Item 34

Significant Change Request: Boeing suggests that the second full sentence in Item 34 be changed to read as follows:

"*The resolution to which the data is stored must be sufficient to ~~achieve the required track keeping accuracy.~~* ***ensure that the assumption of no path definition error is satisfied."***

JUSTIFICATION: The current requirement is in conflict with the current TSE and FTE requirements. FTE path tracking and associated errors is tracking performance, not a measure of errors in the path being followed. This also implies operator/manufacturer responsibility for correct, accurate state data.

response *Accepted*

Text amended.

comment *194* comment by: *EUROCOPTER*

Is RNP < 0.3 part of basic RNP-AR or complex RNP-AR? Next section (7.2) tends to indicate that RNP < 0.3 is considered as a complex operation. If this is true, requirements related to RNP < 0.3 should not be in 7.1.

response *Noted*

Table 7.2 is describing the requirements for "demanding procedures" to include those procedures that require an RNP<0.3. However, this does not preclude the use of RNP<0.3 for other procedural requirements were terrain or obstacle clearance is not an issue.

comment *197* comment by: *Embraer - Indústria Brasileira de Aeronáutica - S.A.*

7.1 MINIMUM REQUIRED FUNCTIONS FOR RNP AR OPE

Item 17)

Comment: As written, this statement seems to become DME NAVAID mandate for RNP AR procedures. We believe that is not necessary and it is not the true intend based on item 5.1.2. We suggest modifying the text replacing it by:

"When DME is used as support for RNP AR operations, *automatic tuning of DME navigation aids used for position updating together with the capability to inhibit individual navigation aids from the automatic selection process.*
Note: Further guidance may be found in EUROCAE ED75B/ RTCA DO236B, Section 3.7.3.1."

response *Accepted*

Text amended.

comment *202* comment by: *Embraer - Indústria Brasileira de Aeronáutica - S.A.*

7.1 MINIMUM REQUIRED FUNCTIONS FOR RNP AR OPERATIONS

Comment: We consider that EASA should reconsider the requirement to perform RNP holdings as a minimum function for RNP AR operations. It does not add significantly operational gains but it does add a greater complexity on the systems required to comply with it. Normally holdings won't be included inside the mountainous terrains but at higher altitudes safe from obstacles, for waiting lines to proceed to approach or on the end of the missed approach part. It's not expected to include holdings at FAF in RNP AR procedures.

response *Accepted*

Resulting from other comments, RNP holding and other path designators have been deleted as minimum requirements.

comment

211 comment by: *Transport Canada Civil Aviation Standards Branch*

Regarding AMC 20-26, 7.1, Item 1. - The "alternative" provided of a navigation map display would only be operationally acceptable to Transport Canada Civil Aviation (TCCA) if a separate display with independent scaling was available for weather radar/lightning detection, TAWS, and ACAS display. Using a navigation map display to permit the flight crew to detect a lateral course deviation requires that the minimum range be selected to the maximum resolution depiction of a cross-track error (typically 10 nm). However, when the use of weather radar/lightning detection, TAWS or ACAS is required, the minimum range selection may not be appropriate to that required for safety of flight. Therefore, the requirement to use minimum range can be mitigated by a separate display of weather radar/lightning detection, TAWS, and ACAS with independent scaling would permit use of the navigation display at minimum range for monitoring cross-track navigation performance while independent display and ranging of weather radar/lightning detection, TAWS, and ACAS information.

response

Noted

Thank you for you comments which are greater appreciated and understood. An applicant who wished to use a map display, that is used for multiple functions, as a deviation indicator will have to address how they intend to ensure correct operation for all functions.

comment

212 comment by: *Transport Canada Civil Aviation Standards Branch*

Regarding AMC 20-26 7.1, Item 3. - Transport Canada Civil Aviation (TCCA) 's position for commercial operations requires that the display of distance to the active (To) waypoint must (shall) be in the pilots' primary field of view. Existing approvals for Canadian commercial operators flying RNAV (GNSS) instrument approach procedures, requires display of distance to the active (To) waypoint be in the pilots' primary field of view and that procedures be taken so that this display of distance not be confused with DME distance display. This essential requirement for distance to the active waypoint is required for situational awareness related to conducting an instrument approach procedure in order to anticipate turns, and descents/climbs associated with the approach and missed approach.

response

Noted

This requirement is in accordance with that published in the ICAO PBN. The Agency appreciated TCCA comments, and if implementation experience shows it necessary, the requirement will be amended.

comment

255 comment by: *AIRBUS*

The item 8 should rewritten as shown:
"Slaved Course Selector. An alternative to FMS integral navigation map display or CDI (ref item 1) is a course selector automatically slaved to the RNAV computed path."
Justification:
Modern FMS LNAV do not feature a "Slaved Course Selector".

response | *Partially accepted*

Text amended to allow for the use of an integral navigation map display.

comment | *256* comment by: *AIRBUS*

Item 17 should be rewritten as shown:
"**As per contingency procedure,** an automatic tuning of DME navigation aids used for position updating together with the capability to inhibit ~~individual~~ navigation aids from the automatic selection process."

response | *Partially accepted*

The amended text resulting form other comments meets the intent of this comment.

comment | *258* comment by: *DGAC France*

1b AFFECTED PARAGRAPH:
AMC 20-26 Paragraph 7.1 Item 1

2. PROPOSED COMMENT:

The item 1 is written in three blocks, there is confusion whether the third one starting with " an alternative" is applicable to the second case dealing with "RNP < 0.3nm" or not.
In order to make clear that this last paragraph starting with "an alternative for lateral deviation is a navigation map display" does not apply for RNP < 0.3 NM approaches, and taking into account that all this paragraph 7.1 deals with NOMINAL procedures, whereas paragraph 7.2 deals with COMPLEX procedures, it is highly recommended to move from this table 1 the second block starting with "for RNP <0.3 nm ... scale sensitivity" to table 2 (paragraph 7.2) after creating a DISPLAY section in that table 2.

3. JUSTIFICATION:

Managing such Flight Technical Error is challenging for the pilot.
It is why Navigation Display and numeric display are not adapted for RNP < 0.3 NM operations for the pilot to monitor the FTE.
So we consider that lateral deviation must be displayed on the Primary Flight Display with an appropriate scale to make pilot able to manage and anticipate his FTE.

response | *Accepted*

The text of this item has been restructured and amended for better clarity.

comment | *259* comment by: *DGAC France*

1b AFFECTED PARAGRAPH:
AMC 20-26 Paragraph 7.1 Item 13

2. PROPOSED TEXT/ COMMENT:

Item 3: The Note 2 is a strong requirement and its contents shall be introduced as a requirement just after the second sentence of the item.

response	*Accepted* Text amended.

comment	*260* comment by: *AIRBUS* The Item 21 should be rewritten as shown: "Maintaining Track and Leg Transitions. The aircraft must have the capability to execute leg transitions and maintain tracks consistent with the following paths: A geodesic line between two fixes; i) Track to a Fix (TF) ii) Course to a fix (CF)" Suppress Note 2, Note 3, Note 4. Add Note x : "Use of CF may be acceptable in missed approach only, subject to local approval." Justification: Consistency with FAA Order 8260.52a Requirement for radius to fix (RF) pertains to section 7.2.
response	*Partially accepted* Based on this and other comments the requirements as specified have been reviewed and amended accordingly.

comment	*270* comment by: *AIRBUS* It is proposed to reword Item 22 as shown: "Fly By and Fly Over Fixes. The flyover turn does not provide for repeatable paths, and is not compatible with RNP flight tracks. The fly-over turn may be used for limited RNP AR path changes under TF-TF transitions. When fly by turns are required for specific RNP AR operations, the navigation system must limit the path definition within the theoretical transition area defined in RTCA DO236B under the wind conditions identified in the ICAO PBN RNP AR Procedure Design Manual."
response	*Partially accepted* The commenter's text has been accepted in principle; however it has been amended to refer to fly-by turns in the 2nd sentence and the introduction of DF-TF transitions.

comment	*271* comment by: *AIRBUS* It is proposed to delete Item 24. Justification: Consistency with performance requirements in §6.
response	*Not accepted* This function is required to support ATC instructions.

comment	*274* comment by: *AIRBUS* It is proposed to shorten Item 25 as shown:

"The navigation system must be capable of defining a vertical path by a flight path angle to a fix. Fix altitude constraints must be defined as an "AT" altitude constraint."
Justification:
Consistency with the performance requirement in §6.

response

Not accepted

The use of window constraints may be required for air traffic management purposes.

comment

277 comment by: *AIRBUS*

The word "FA" should be removed from Item 30.
Justification:
Consistency with item 21

response

Accepted

Text amended.

comment

315 comment by: *FAA*

NPA COMMENT FORM

This Comment Form is to be used by an Office of Other Interest (OOI) when providing comments on an EASA NPA. If the OOI has more than one comment, please duplicate this Comment Form and place any additional comment(s) on a separate form(s).
This Comment Form should be sent to the Office of Primary Responsibility (OPR) by the due date established by the OPR.

1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):
Page 24, Paragraph 7.1, Item 1

2. Comment (Please state your comment clearly and in plain language):
Third paragraph of Item 1 display section allows for lateral deviation display on a navigation map. Suggest deleting this paragraph and inserting PBN language from Vol II, pg C-6-9: "Numeric display of deviation....."

3. Justification (Please provide support for your comment):
PBN Manual (Vol II, pg C-6-9), states use of map display is "generally not considered acceptable". Current AMC language would allow for map display, albeit not without extensive analysis, and with a "TBD" outcome.

4. Proposed Alternative Text (If any):
See recommendation above.

5. Person Providing Comment (Include routing symbol): FAA AIR-130

NPA COMMENT FORM

This Comment Form is to be used by an Office of Other Interest (OOI) when

	providing comments on an EASA NPA. If the OOI has more than one comment, please duplicate this Comment Form and place any additional comment(s) on a separate form(s). This Comment Form should be sent to the Office of Primary Responsibility (OPR) by the due date established by the OPR. 1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*): NPA 2-008-14, AMC 20-26, page 27, section 7.1, 23 2. Comment (Please state your comment clearly and in plain language): For your information, the FAA has approved aircraft that do not provide this vertical angle resolution, provided the applicant demonstrates compliance with 6.2.1b). The FAA may update AC 90-101 to reflect this potential approval path. 3. Justification (Please provide support for your comment): 4. Proposed Alternative Text (If any): 5. Person Providing Comment (Include routing symbol): FAA AIR-130 NPA COMMENT FORM This Comment Form is to be used by an Office of Other Interest (OOI) when providing comments on an EASA NPA. If the OOI has more than one comment, please duplicate this Comment Form and place any additional comment(s) on a separate form(s). This Comment Form should be sent to the Office of Primary Responsibility (OPR) by the due date established by the OPR. 1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*): Page 28, Paragraph 7.1, Item 34, 2. Comment (Please state your comment clearly and in plain language): Suggest inserting a "hard" requirement for display of the navigation database currency. 3. Justification (Please provide support for your comment): Current text contains no guidance and conflicts with ICAO PBN Manual and FAA guidance materials. 4. Proposed Alternative Text (If any): Recommend this section also state, "The aircraft must provide a means to display the validity period for the onboard navigation database to the flight crew."
response	*Partially accepted* 7.1, Item 1: Partially Accepted: As a result of other comments this item has been reviewed and restructured to aid clarity. The use of a navigation map display is limited in its application and is dependent on the RNP value for which

approval is sort.

7.1, Item 23: Noted: Thank you for the information.

7.1, Item 34: Partially Accepted: This requirement in contained in 7.1, Item 20 which has been amended to state "The system must provide ….".

comment *332* comment by: *ECOGAS*

Para 7.1 Item 21 Note 3 - suggest deletion, this is not relevant to the topic of RNP Approach operations

response *Accepted*

Text deleted.

comment *333* comment by: *ECOGAS*

Para 7.1 Item 24: The proposed requirement for VNAV-equipped aircraft to compute and execute vertical 'direct to' functionality is unnecessary and believed to be a unique-to-EASA requirement. We would like to see this requirement clarified or deleted.

response *Not accepted*

This function is required to support ATC instructions.

comment *334* comment by: *ECOGAS*

Para 7.1 Item 26: Clarification is required as to whether manual entry of altitudes / speeds is permitted.

response *Noted*

This does not prohibit manual entries. However, it does not encourage them either and any manual entries must not be saved in the published navigation database.

comment *349* comment by: *European Cockpit Association*

MINIMUM REQUIRED FUNCTIONS FOR RNP AR OPERATIONS, Displays

No protection against altimeter setting error.

response *Noted*

Altimetry setting is a key issue in the operations, procedures and training for RNP AR as described in Appendix 3.

comment *350* comment by: *European Cockpit Association*

MINIMUM REQUIRED FUNCTIONS FOR RNP AR OPERATIONS, Performance, Monitoring and Alerting

[...]Signals radiated by GNSS augmentation systems managed by certified navigation service providers ~~may~~ s**hould** be taken into account.

"MAY" appears too weak to implement the basic principle of "use all available means" into RNP AR operations.

response

Not accepted

Currently, RNP AR has not been extended to address GNSS augmentation systems. This will be addressed in a future amendment.

comment

351 comment by: *European Cockpit Association*

MINIMUM REQUIRED FUNCTIONS FOR RNP AR OPERATIONS, Performance, Monitoring and Alerting

Item 18, Note 1, second sentence
In lieu of using radio navigation aid designated operational coverage (DOC), the navigation system should provide checks which preclude use of duplicate frequency navaids within range, overthehorizon navaids, and use of navaids with poor geometry.
Comment: The heritage concept of DOC should not be completely neglected. It is suggested to substitute "In addition to ..." for "In lieu of ..." Further, this sentence, also in its original form, appears to constitute a requirement, and may therefore not be appropriate to be part of a "Note". It is suggested to move the amended sentence from the note to the end of the body text of Item 18:
"Capability for the RNAV system to perform automatic selection (or deselection) of navigation sources, a reasonableness check, an integrity check, and a manual override or deselect. In addition to using radio navigation aid designated operational coverage (DOC), the navigation system should provide checks which preclude use of duplicate frequency navaids within range, overthehorizon navaids, and use of navaids with poor geometry.
Note 1: The reasonableness and integrity checks are intended to prevent navigation aids being used for navigation update in areas where the data can lead to radio position fixing errors due to cochannel interference, multipath, stations in test, changes in station location and direct signal screening."

response

Not accepted

DOC is not a requirement for RNP AR and is current a capability that is unsupported by aeronautical information contained in navigation databases.

comment

352 comment by: *European Cockpit Association*

MINIMUM REQUIRED FUNCTIONS FOR RNP AR OPERATIONS, Path Definition and Flight Planning

A rigid and inflexible application of speed assignments at waypoints does not reflect variations to support various aircraft characteristics and/or adapted energy management. While for altitudes the "window concept" is supported by current FMS design, similar techniques do not exist for speeds in current FMS (no possibility to introduce max / min or "window" speeds).It is therefore suggested to split the Item into two separate requirements:
"Altitudes associated with published terminal procedures must be extracted from the navigation database."
"Speeds associated with published terminal procedures should be extracted from the navigation database and may be subject to alteration by pilot input."

response	*Not accepted* The current requirement is for data extraction and does not address what may occur operationally that could affect the RNAV flight plan.

resulting text	See Appendix B

B. Draft Decision - AMC 20-26: 7. Functional Criteria - 7.2 Additional Required Functions Supporting Complex RNP AR Operations p. 29-30

comment	*94* comment by: *Boeing* AMC 20-26 Page: 29 (BR, DN) Paragraph 7.2, Additional Required Functions Supporting Complex RNP AR Operations; Table 2, Item 1(4) **Significant Change Request:** Boeing suggests that the following change be made to Item 1(4): *"(4) Upon initiating a go around or missed approach (through activation of TOGA or other means), the flight guidance mode should remain in LNAV to enable continuous track guidance during an RF leg.* ***Other means and/or mitigations may be acceptable, depending on the aircraft, demonstrated path tracking performance, procedures, and associated FOSA."*** **JUSTIFICATION:** This change will make the requirement consistent with the criteria for approach less than RNP 0.3 and missed approach less than RNP 1.0. Requiring only automatic LNAV engagement will exclude thousands of airplanes from the improved safety of RNP AR operations.
response	*Partially accepted* The proposed text has been accepted in principle, but the application of the migration has been restricted to those miss-approach/go-round procedures that require an RNP 0.3 or greater.

comment	*95* comment by: *Boeing* AMC 20-26 Page: 29 Paragraph 7.2, Additional Required Functions Supporting Complex RNP AR Operations; Table 2, Item 2 (1) **Significant Change Request:** Boeing suggests that the following change be made to the last sentence of Item 2(1): *" ... Typically, the aircraft must have at least the following equipment: dual GNSS sensors, dual flight management systems, dual air data systems, dual autopilots, and a single inertial reference unit (IRU).* ***A single autopilot is***

acceptable provided dual flight directors are available and the approach permits use of the flight directors to either continue the approach or execute a missed approach."

JUSTIFICATION: Requiring dual autopilots is not necessary for most approaches and may cause unnecessary diversions. Dual flight directors are necessary and should be added to the requirement.

response *Partially accepted*

The text has been accepted with an amendment to require the flight directors to be independent.

comment *177* comment by: *ERA*

7.2 item 1, (2): "The aircraft must have an electronic map display of the selected procedure."
We understand that this means that an appropriately scaled non-numeric deviation display is not satisfactory, although this is adequate under 7.1 item 1 for non-RF leg type operation. A CDI should be considered adequate because the use of a CDI will enable the pilot to monitor flight technical error very closely throughout the turn by observing needle centred. It should be borne in mind that the requirement in 7.2. item 1 will be applicable also for RNP AR that does *not* utilise RNP below 0.3 in approach and/or below 1.0 in missed approach; it can be envisaged that autopilot-coupling (automation level four) will not be required for the entire approach and/or missed approach for RNP=0.3/1.0, and for hand flying with FD in LNAV (automation level 2), the CDI provides excellent guidance. (Our finding is that executing a turn as an RF leg with CDI enhances track keeping and situational awareness greatly.)

7.2 item 1, (4) states that "Upon initiating a go-around or missed approach (through activation of TOGA or other means), the flight guidance mode should remain in LNAV...."; 7.2 item 2, (3) and item 3, (3) state that "Upon initiating a go-around or missed approach (through activation of TOGA or other means), the flight guidance mode should remain in LNAV ... Other means and/or mitigation may be acceptable...". The use of "should" in all three instances, and the sentence "Other means...." in the two latter imply that TOGA-to-LNAV is not a 'hard' requirement. However, in the comparison table, app. 6, the text states "AMC is more stringent by removing the alternative for when aircraft lacks continuous LNAV guidance". Clarification would be appreciated.

response *Partially accepted*

A CDI will enable the deviations to be monitored; however, for a complex procedure it will not provide sufficient situational awareness, thus an electronic map display of the selected procedure is required.

For the requirement for TOGA-LNAV to remain engaged, the application of the migration has been restricted to those miss-approach/go-round procedures that require an RNP 0.3 or greater.

comment *198* comment by: *EUROCOPTER*

For RNP-AR approaches less than RNP-0.3, no credit is given to the use of SBAS in replacement of basic GNSS (GPS only). In particular, the requirement for IRU is penalising for civil helicopters which, for economic reasons, are not

equiped with IRUs. RNP-AR approaches less than 0.3 should be opened to helicopters using only SBAS and DME-DME.

Moreover, if IRU is required here to cope with the case of GNSS loss, it seems not consitent with Appendix 5, section 7b, where IRU seems to be required only for RF legs and RNP<1 missed approaches.

response *Not accepted*

SBAS is not addressed in this version of the AMC and will be the subject of future amendments when mature criteria are developed. There is no requirement to carry an IRU; it is noted as a typical installation. The reference in Appendix 5 is an example and other means may be required as part of the FOSA.

comment *201* comment by: *Embraer - Indústria Brasileira de Aeronáutica - S.A.*

7.2 ADDITIONAL REQUIRED FUNCTIONS SUPPORTING COMPLEX RNP AR OPERATIONS

Comment : Change the requirement on item 1. (3) - "The navigation system, the flight director system and autopilot must be capable of commanding a bank angle up to 25 degrees at or above 400 feet AGL and up to 8 degrees below 400 feet AGL." to "The navigation system, the flight director system and autopilot must be capable of commanding a bank angle up to 25 degrees or more at or above 400 feet AGL and up to 8 degrees or more below 400 feet AGL."

Reason: The requirement is not clear and may lead to interpretation that the maximum bank angle limit should be 25 degrees above 400 ft and 8 degrees below 400 ft. We believe that the objective of this requirement is not to limit the maximum bank angle that the aircraft and systems can achieve, but to make sure it can at least make the turns at the specified bank angles. Also AC 90-101 requires bank angles up to 30 degrees above 400 ft and this paragraph is not listed in appendix 6 as a different requirement.

response *Partially accepted*

The requirement has been qualified by adding the statement (These values are consistent with those published in the ICAO Doc 9905). This requirement does not preclude navigation system have a greater performance.

comment *254* comment by: *AIRBUS*

The following new item (x) should be added in item 2:
"For RNP < 0.3 NM, one acceptable means of compliance is an appropriately scaled Nonnumeric deviation display (i.e., lateral deviation indicator and vertical deviation indicator) located in the pilot's primary field of view. A fixed scale CDI is acceptable as long as the CDI demonstrates appropriate scaling and sensitivity for the intended navigation accuracy and operation. With a scalable CDI, the scale should derive from the selection of RNP, and not require the separate selection of a CDI scale. Where a CDI is relied upon, alerting and annunciation limits must also match the scaling values. If the equipment uses default navigation accuracy to describe the operational mode (e.g. en route, terminal area and approach), then displaying the operational

	mode is an acceptable means from which the flight crew may derive the CDI scale sensitivity. Justification: Consistency with EASA positions expressed during aircraft certification concerning the requirement for a LAT DEV at RNP 0.3 or RNP<0.3.
response	*Partially accepted* The display of the track deviation has been reviewed and restructured in Table 7.1 item 1.

comment	*261* comment by: *DGAC France* 1b AFFECTED PARAGRAPH: AMC 20-26 Paragraph 7.2 table Item 2 2. PROPOSED TEXT/ COMMENT: (4) Loss of GNSS: Does "other mean of navigation" includes radio navigation aids such as DME/DME. If yes, can you confirm that current system can reselect automatically radio navigation systems, once they have been deselected before initiating the RNP AR approach
response	*Noted* The use DME/DME is allowed providing the performance requirements for the operation can be met. Given the navigation hierarchy that is present in modern navigation system, the Agency has no reason to suspect that these criteria can not be met. However, specific system implementations may be a factor considered in the operational evaluations and FOSA.

comment	*269* comment by: *AIRBUS* The following item should be added: "Maintaining Track and Leg Transitions. In addition to the legs transition required in 7.1 (21) the aircraft must have the capability to execute leg transitions and maintain radius to a fix (RF) legs. Note : It should be noted that a radius to fix (RF) leg is considered a procedure design tool that is available to solve a specific operational requirement or problem. As such it may be considered a highly desired option for select RNP AR operations. In some instances, the RF will be applied in the final or missed approach, requiring additional consideration in a FOSA. Systems lacking such capability should have sufficient means to ensure that operators are aware of this limitation and that it precludes the conduct of RNP AR procedures containing an RF leg." Justification: Requirement for radius to fix (RF) pertains to section 7.2.
response	*Partially accepted* The proposed note has been incorporated into the text to aid the understanding of the use of an RF leg. Table 7.2 are additional functions, thus reference to Table 7.1 is considered not to be appropriate.

comment	*280* comment by: *AIRBUS* The word "COMPLEX" should be removed from the title of the paragraph. Justification: The word "COMPLEX" is defined nowhere in the AMC.
response	*Accepted* The word complex has been deleted from the text.

comment	*287* comment by: *AIRBUS* It is proposed to modify Item 1 (3) as shown: "(3) The navigation system, the flight director system and autopilot must be capable of commanding a bank angle up to 25 degrees. Aircraft with bank angle limit lower than 25° may get operational approval for RNP AR operations provided their limited performance have been accounted for in the procedure design criteria (e.g. § 1.12 of FAA Order 8260.52)" Justification: Consistency with procedure design criteria
response	*Not accepted* The text has however been qualified to define that the values specified are consistent with those published in the ICAO Doc 9905.

comment	*288* comment by: *AIRBUS* It is proposed to modify the last sentence of Item 2 (3) as shown: "For RNP not less than 0.3, other means or mitigations may be acceptable depending on the aircraft, demonstrated path tracking performance, procedures and associated FOSA." Justification: Consistency with EASA positions expressed during aircraft certification
response	*Accepted* The proposed text has been accepted in principle, but the application of the migration has been restricted to those miss-approach/go-round procedures that require an RNP 0.3 or greater.

comment	*335* comment by: *ECOGAS* Para 7.2 Item 2(1): Wording needs amending to allow operation of procedures by aircraft with single autopilot/dual flight directors
response	*Accepted* Text amended.

comment	*336* comment by: *ECOGAS* Para 7.2 Item 2(1): Request further consideration of whether a single IRU is a requirement for these procedures. Should this be optional, and therefore not specified in this paragraph?
response	*Noted*

The specific systems configurations are subject to the assessment of continuity as well as a safety assessment to determine when it can be authorised; the items quoted are typical installations.

comment *337* comment by: *ECOGAS*

Para 7.2 Item 2(4): Suggest deletion of the following words: "After initiating a go-around or missed approach", or maybe the entire paragraph. Go-around may not be required if the aircraft's systems can cope with GNSS failure without compromising performance, as seems to be required elsewhere in the document.

response *Not accepted*

RNP AR Approaches are predicated on the use of GNSS, thus a loss of GNSS will necessitate abandoning the approach and reverting to other RNAV or conventional procedures.

resulting text: See appendix B

B. Draft Decision - AMC 20-26: 8. Airworthiness compliance p. 30-33

comment *12* comment by: *KLM*

Section: 8.4
Page: 32
Relevant Text: Note 1 and 2
Comment: The assumed drift rate of 8NM/½hr is bothering us. More support/information should be given in this document. Note 1 should give this information to prevent the Operator burden.
Note 2 is only a statement, but does not give any usable information as to the effect of INS/IRS.
Proposal: Add more useful information.

response *Not accepted*

The current criteria grant alleviation if an operator chooses to assume 8 NM/hr. If credit is sought for better performance, then substantiation is required.

comment *45* comment by: *AEA*

Relevant Text: 8.4 Use of Inertial Reference Systems (IRS)- Note 1 and 2
Comment: The assumed drift rate of 8NM/½hr is bothering us. More support/information should be given in this document. Note 1 should give this information to prevent the Operator burden.
Note 2 is only a statement, but does not give any usable information as to the effect of INS/IRS.
Proposal: Add more useful information.

response *Not accepted*

The current criteria grant alleviation if an operator chooses to assume 8 NM/hr. If credit is sought for better performance, then substantiation is required.

comment 59 comment by: *CAA CZ*

According to our opinion the text of the article 8.1.1 in Chapter 8 of the AMC 20-26 describing the airworthiness compliance in case of new or modified installations is too general. The CAA-CZ recommends to include a specific list of prerequisites necessary for the system intended to be used for RNP AR operations to comply from the airworthiness point of view, in a relevant order when appropriate.
From the final wording of the text of this article it should be, according to our opinion, more obvious that several means of compliance might require, in the individual steps of the approval process, separate approval processes before they can be actually used as such. This concerns the means of compliance, the consequence of which are, for example, modifications and changes to the basic documentation.

response *Not accepted*

The criteria for new/modified aircraft are described in much detail in the AMC. The additional information that is provided in these paragraphs is intended to aid the applicant in their compliance assessments.

comment 96 comment by: *Boeing*

AMC 20-26
Page: 30
Paragraph 8. Airworthiness Compliance

Significant Change Request: Boeing suggests that the following paragraph be added as new paragraph 8.1.2:

"8.1.2 Existing Installations (derived from TGL10).
The applicant will need to submit, to the responsible authority, a compliance statement which shows how the criteria of this AMC have been satisfied for existing installations. Compliance may be established by inspection of the installed system to confirm the availability of required features and functionality. The performance and integrity criteria of Section 6 may be confirmed by reference to statements in the Aircraft Flight Manual or to other applicable approvals and supporting certification data. In the absence of such evidence, supplementary analyses and/or tests may be required. Paragraph 9 addresses Aircraft Flight Manual changes that might be necessary."

JUSTIFICATION: The proposed AMC does not acknowledge existing systems and aircraft that have obtained other regulatory approvals and, as such, is not consistent with prior European regulatory guidance -- e.g., AMC20-4, TGL 10, or AMC20-27.

response *Accepted*

New paragraph added.

comment 169 comment by: *UK CAA*

Paragraph:

AMC 20-26, para 8
Page: 30
Comment:
Within the airworthiness compliance there is no provision for dealing with "Existing Installations". See equivalent provisions in AMC 20-27 para 8.3
Justification:
There are many aircraft in service, which have an RNP AR capability, yet were delivered before the emergence of these criteria. Consequently, they do not support all of the enhanced features discussed in the document. Nevertheless, they still qualify for RNP AR, albeit under conditions determined as acceptable through the FOSA process, e.g., with acceptable flight crew mitigation and/or limitations of approval to applications in air traffic, radar monitored environments.
Proposed Text:
Suggest that text be developed to address existing installations and in particular, the credit that may be attained for aircraft designs where the enhanced features supporting RNP AR e.g., Lateral Deviation, TOGA to LNAV, may not be available.

response *Accepted*

Paragraph 8.1.2 added.

comment *199* comment by: *Embraer - Indústria Brasileira de Aeronáutica - S.A.*

8.1.1 New or Modified Installations

b) Aircraft Qualification
(2)

Comment: We believe that the possibility of the use of other final approach system (e.g. MLS and GLS) should be considered also. The text could be revised replacing it by:

b) Aircraft Qualification
(2) Use of the RNAV systems and the manner of presentation of lateral and vertical guidance information on the flight deck must be evaluated to show that the risk of flight crew error has been minimised. In particular, during the transition to the final approach, the display of ILS or other approved landing system information simultaneously with RNAV information to a flight crew member will need careful consideration.

response *Accepted*

Text amended.

comment *203* comment by: *EUROCOPTER*

The first paragraph refers to fixed-wing operations only. Helicopters equipped in accordance with JAR-OPS 3 should also be considered.

response *Not accepted*

The requirements of the AMC are equally applicable to rotorcraft, however, the specific criteria for rotorcraft will be addressed in subsequent amendments as necessary.

comment *216* comment by: *Cessna Aircraft Company*

The following comment applies to the first paragraph in 8.7 INTERMIXING OF EQUIPMENT:
"Installation of area navigation systems with different crew interfaces can be very confusing and can lead to problems when they have conflicting methods of operation and conflicting display formats. There can be problems even when intermixing different versions of the same equipment. **For approach operations, intermixing of RNAV equipment is not permitted.** As a minimum, consideration must be given to the following potential incompatibilities particularly where the flight deck architecture includes cross coupling capabilities (e.g. GNSS2 switched to drive the number 1 displays)."

More clarification is needed here. The intent of this subparagraph is neither clear nor concise. The highlighted sentence above is very emphatic in stating a requirement, then, the next sentence seems to contradict the requirement. Did this next sentence (As a minimum...) move the reader towards the external interfaces rather than focus on the dissimilar pilot operation (data input) of a panel mount RNAV versus a airline type RNAV/FMS HI, RCI or UNS? One could read that intermixing RNAV equipment is permitted as long as the "potential incompatibilities" are found acceptable. Beware of a possible conflict with TGL-10 para 8.5.

response *Partially accepted*

The amended text meets the intent of this comment.

comment *249* comment by: *DGAC France*

1. AFFECTED PARAGRAPH: AMC 20-26 Paragraph 5.1.2 and paragraph 8.5

2. PROPOSED TEXT/ COMMENT:

a. Chapter 5.1.2 mentions that DME sensor could be used without any order of priority or combination.
It could be misleading with chapter 8.5 which introduces DME/DME use for reversionary solution when authorized.
b. Furthermore, since for complex RNP AR approach (RNP < 0.3) DME/DME will not reach precision requirement, chapter 8.5 note 1 should be replaced by the following requirement:

For RNP AR < 0.3, it is required to "de-select" the radio navigation mean (DME) in order to be sure that GNSS will be the primary mean to determine aircraft position.

response *Not accepted*

The current criteria establish the requirement to assess the performance capability and to determine the required actions necessary for use of DME/DME. This allows for either crew procedures or system design to manage sensor use and selection. The AMC does not intend to be prescriptive in this area.

comment *262* comment by: *DGAC France*

1. AFFECTED PARAGRAPH: AMC 20-26 Paragraph 8.6

2. PROPOSED COMMENT:

Reword the paragraph

3. JUSTIFICATION:

The wording of this paragraph is "misleading" and seems not consistent with par 5.1.2.
Is the VOR updating info allowed to be used as it is written in the para 8.6 (the RNAV system may not used VOR updating) or is it forbidden as it is suggested in the para 5.1.2?
We don't understand why and how the execution of a "missed approach" could meet the requirements.

response *Noted*

The current requirement is clear that VOR may not be used for updating. However, experience to-date is that for some procedures the missed approach is predicated on navigation aids other than GNSS. If it is VOR, then it needs to be accounted for, as noted.

comment *263* comment by: *DGAC France*

1. AFFECTED PARAGRAPH:
AMC 20-26 Paragraph 8.7.f)

2. PROPOSED COMMENT:

The last sentence stating that the agency will not approve a system with inconstancy in the display is an obvious statement that is more of a general nature (in the spirit of Part 21 or EASA internal procedures.) To write here this sentence is confusing and may lead the reader to believe other "deviations" to the AMC are still acceptable. There is therefore no value to add here that last sentence and it shall be suppressed.

response *Accepted*

Last sentence deleted.

comment *300* comment by: *Walter Gessky*

Page 30, 8.1.1, a) editorial error, replace "leaflet" in line 2 by "AMC".

response *Accepted*

Text amended.

comment *317* comment by: *FAA*

NPA COMMENT FORM

This Comment Form is to be used by an Office of Other Interest (OOI) when providing comments on an EASA NPA. If the OOI has more than one comment, please duplicate this Comment Form and place any additional comment(s) on a separate form(s).

This Comment Form should be sent to the Office of Primary Responsibility (OPR) by the due date established by the OPR.

1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):
NPA 2-008-14, AMC 20-26, page 31, section 8.1.1b(2)

2. Comment (Please state your comment clearly and in plain language):
Delete the reference to ILS.

3. Justification (Please provide support for your comment):
Material appears to be out of scope (not relevant to RNP AR operations).

4. Proposed Alternative Text (If any):

5. Person Providing Comment (Include routing symbol): FAA AIR-130

NPA COMMENT FORM

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1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):
Page 31, Paragraph 8.2.

2. Comment (Please state your comment clearly and in plain language):
Suggest inserting a "hard" requirement aimed at data suppliers.

3. Justification (Please provide support for your comment):
Current text only mentions database "should" be shown to comply with ED-76/DO-200A or equivalent approved procedures.

4. Proposed Alternative Text (If any):
Recommend requirement state, "Data suppliers must have a Letter of Acceptance (LOA) for processing navigation data. An LOA recognizes the data supplier as one whose data quality, integrity and quality management practices are consistent with the criteria of DO-200A/ED-76. The operator's supplier (e.g., FMS company) must have a Type 2 LOA, and their respective suppliers must have a Type 1 or 2 LOA." This requirement is consistent with FAA guidance materials.

NPA COMMENT FORM

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1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):
NPA 2-008-14, AMC 20-26, page 32, section 8.4, note 2

2. Comment (Please state your comment clearly and in plain language):
Modify Note 2.

3. Justification (Please provide support for your comment):
The use of inertial navigation (within the FMS) is considered an acceptable reversionary mode for loss of GNSS on an approach procedure requiring RNP<1 in the missed approach. The procedure design criteria ensures safe operation in this event. This is already in use with the FAA and also agrees in concept with the ICAO PBN Manual.

4. Proposed Alternative Text (If any):
The text should be changed to directly state that reversion to inertial navigation is an acceptable means of compliance for the performance requirements associated with a missed approach requiring an accuracy value less than 1.0 (RNP<1.0 in the missed approach segment).

5. Person Providing Comment (Include routing symbol): FAA AIR-130

NPA COMMENT FORM

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1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):
NPA 2-008-14, AMC 20-26, page 32, section 8.6, Note

2. Comment (Please state your comment clearly and in plain language):
Reversion to VOR would not be acceptable if the missed approach is RNP<1

3. Justification (Please provide support for your comment):
VOR performance is not acceptable in this instance. Consustent with existing FAA guidance material & concepts in the PBN Manual.

4. Proposed Alternative Text (If any):
Add to the end of the note "if the procedure does not require RNP less than 1 on the missed approach."

5. Person Providing Comment (Include routing symbol): FAA

AIR-130

NPA COMMENT FORM

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1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):
NPA 2-008-14, AMC 20-26, page 32, section 8.7

2. Comment (Please state your comment clearly and in plain language):
Delete material concerning intermixing of systems, since intermixing is not required.

3. Justification (Please provide support for your comment):
Text should be consistent with AMC 20-27 - it is sufficient to simply say that intermixing is not allowed for RNP AR operations.

4. Proposed Alternative Text (If any):

5. Person Providing Comment (Include routing symbol): FAA AIR-130

NPA COMMENT FORM

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This Comment Form should be sent to the Office of Primary Responsibility (OPR) by the due date established by the OPR.

1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):
NPA 2-008-14, AMC 20-26, page 33, section 9a

2. Comment (Please state your comment clearly and in plain language):
Due to the historical differences in defining "RNP", the statement must also include reference to the specific attributes/characteristics to which compliance was determined (e.g., reference to AC 90-101, an RNP Capabilities Doc, Airworthiness Capabilities Doc, etc).

3. Justification (Please provide support for your comment):

4. Proposed Alternative Text (If any):

5. Person Providing Comment (Include routing symbol): FAA AIR-130

response | *Partially accepted*

8.1.1.b(2): Not Accepted: The displays of RNAV and ILS deviation information has been highlighted based upon past experience where the potential for misunderstanding resulted from very similar display presentations.

8.2: Not Accepted: The requirement for the database to be supplied from an organisation having an LOA for processing navigation data is detailed in paragraph 10 of the AMC.

8.4: Note 2: Not Accepted: This section identifies the requirements for IRS, if used. Table 7.1, 16 contains a requirement for automatic reversion to an alternate navigation sensor. Together with the performance monitoring and alerting requirements, the intent of the comment is considered satisfied.

8.6 Note: Not Accepted: The current requirement is clear that VOR may not be used for updating. However, experience to-date is that for some procedures the missed approach is predicated on navigation aids other than GNSS. If it is VOR, then it needs to be accounted for.

8.7: Partially Accepted: The text has been amended to clarify the intent. Intermixing of RNAV equipment will only be permitted when specific factors have been addressed satisfactorily.

9a: Noted: The AMC is expected to be applied to systems, aircraft and operators that do not have the historical differences described. In any case, applications will be subject to examination to determine what is being described and if the set of information and compliance documentation is clear and sufficient.

comment *338* comment by: *ECOGAS*

Para 8.7: Business Aircraft which are equipped to perform RNP/RNAV approaches frequently have dissimilar equipment which is not fundamental to their approval for RNP/RNAV operations, but nonetheless is desirable for aircraft safety. For example, it is not unusual to have a 3rd FMS of a different (typically less-complex) type to provide redundancy in normal useage. Such dissimilarities should be specifically permitted.

response *Accepted*

The text has been amended to clarify the intent. Intermixing of RNAV equipment will only be permitted when specific factors have been addressed satisfactorily.

resulting text: See Appendix B

B. Draft Decision - AMC 20-26: 9. Aircraft Flight Manual/ Pilot Operating Handbook p. 33

comment *264* comment by: *DGAC France*

1 AFFECTED PARAGRAPH:
AMC 20-26 Paragraph 9.b)

2. PROPOSED COMMENT:

The note states that the detailed information about the procedure is available in an approved document. What kind of approved document is to be used for this purpose? Is there a wish from the agency that the document that contains such information is "approved"?

Would EASA clarify the point, please?

response *Noted*

The note reflects the fact that other documentation is approved as part of the RNP AR authorisation.

B. Draft Decision - AMC 20-26: 10. Operational Criteria p. 33-36

comment *217* comment by: *Cessna Aircraft Company*

Para 10.6 FLEET APPROVALS
"Normally, operational approvals for RNAV AR Procedures will be fleet specific."

Cessna Question:
Could "fleet" here mean all of a Manufacturers' Models are approved if only one serial number of a specific type is approved?

response *Noted*

In this case, it should be interpreted to be aircraft type/model and is independent of the operator.

comment *265* comment by: *DGAC France*

1. AFFECTED PARAGRAPH:
AMC 20-26 Paragraph 10.4.3 Aircraft Modification

2. PROPOSED TEXT/ COMMENT:

This paragraph is written as a guideline to the applicant willing to modify a navigation system. It does not give an acceptable means of compliance.
For instance, the paragraph talks of validation means. The agency should state what is acceptable.
It should be detailed (simulator session, flight test ...)

What is "initial" data validation? Do we want some non regression testing using the same scenario that was used for initial compliance findings?

In addition, such a following wording may add some clarity and should be used in the beginning of the paragraph:
"Authorization granted by the authority is valid for a specific aircraft and a specific avionics configuration. If there is a major change, initial authorization is no more valid and should be granted once again."

response *Partially accepted*

The requirement for initial data validation has been added to paragraph 10.4.

With this amendment to the text the criteria of the paragraph are now consistent with the proposed change.

comment

266 comment by: *DGAC France*

1 AFFECTED PARAGRAPH:

AMC 20-26 Paragraph 10.7 RNP Monitoring Program

2. PROPOSED TEXT/ COMMENT:

This paragraph speaks of an "interim approval". It is not defined. We can see within the Appendix 2 chapter 2.4 operating procedure, a phase with a temporary limitation and gained experience.
If we are talking about the same concept, a clear reference or more explicit definition shall be introduced to express the "interim approval".

Confirm therefore that the operator must submit the information every 30 days during the 90 days of the temporary limitations as a minimum.

response

Accepted

An initial 90 day interim approval period introduced.

comment

318 comment by: *FAA*

NPA COMMENT FORM

This Comment Form is to be used by an Office of Other Interest (OOI) when providing comments on an EASA NPA. If the OOI has more than one comment, please duplicate this Comment Form and place any additional comment(s) on a separate form(s).
This Comment Form should be sent to the Office of Primary Responsibility (OPR) by the due date established by the OPR.

1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):
NPA 2-008-14, AMC 20-26, page 34-35, section 10.4

2. Comment (Please state your comment clearly and in plain language):
The requirement for initial data validation is missing. The FAA's operational experience is that this is an important requirement and should be included. Recommend the NPA include guidance like that found in FAA AC 90-101.

3. Justification (Please provide support for your comment):
Safety, compatibility with ICAO and FAA. If no initial database validation is conducted, then the safety of the RNP AR operation could be compromised.

4. Proposed Alternative Text (If any):

5. Person Providing Comment (Include routing symbol): FAA AIR-130

response

Accepted

New sub-paragraph 10.4.1 introduced.

resulting text | See Appendix B

B. Draft Decision - AMC 20-26: Appendix 1 - Glossary p. 37-38

comment | *301* comment by: *Walter Gessky*

Page 38, not all acronyms used in the AMC are noted in Appendix 1

response | *Accepted*

The list of acronyms has been amended to include all those used within the document.

resulting text | See Appendix B

B. Draft Decision - AMC 20-26: Appendix 2 - Training and Crew Qualification Issues p. 39-44

comment | *97* comment by: *Boeing*

AMC 20-26
Page: 42 - 43
Appendix 2, Training and Crew Qualification Issues
Paragraph 3 Flight Training Segments

Significant Change Request: Boeing notes that the following items are knowledge items and should be moved to Paragraph 2 (Ground training segments) of Appendix 2:

c, d, e, g, h, i, j, k and r

JUSTIFICATION: Simulator training is for training proper crew skills. Knowledge training belongs in Ground Training.

response | *Partially accepted*

The Agency concurs with the comment with the exception of i) which is considered to be a flight training requirement. The crew must be aware of and capable of selecting the correct aircraft configuration to maintain the correct speeds.

comment | *136* comment by: *AEA*

Ref: 5 Recurrent training of RNP AR Knowledge and procedures (p.44)
Comment:
It is not clearly explained how often flight crews must demonstrate RNP AR maneuvers during recurrent training (whether it is every six months, every 12

months or other period). Further, it is not clearly stated what is ment by the phrase "may be substituted for any required "precicion-like" approach". Which approach can be replaced by which?
Proposal:
change para 5.2:
"*A minimum of two RNP AR approaches must be flown by each pilot for each duty position (Pilot Flying and Pilot Monitoring), with one culminating in a landing and one culminating in a missed approach, and may be substituted for any required "precicion-like" approach.*
Note 1: Equivalent RNP approaches may be credited toward this requirement.
Note 2: The required approaches shall be performed at recurrent training with a maximum interval of XX months."

response *Not accepted*

The frequency of a recurrent training and checking programme is to be agreed and approved by the Competent Authority in accordance with EU-OPS 1.965.

resulting text: See Appendix B

B. Draft Decision - AMC 20-26: Appendix 3 - RNP Operational Considerations p. 45-50

comment *13* comment by: *KLM*

Section: Appendix 3, 2 b)
Page: 45
Relevant Text: Relative to the A/P or F/D coupling
Comment: It is indicated that A/P or F/D must be used for approaches with an RNP , 0.3 or where use is made of the RF leg. However, if this is the case, the vertical FTE has not been differentiated for these two options. For the APV Baro VNAV a large FTE is applicable (200/300 ft or the more conservative value of 150 ft).
Proposal: Check the relation between the vertical FTE and the values used for APV Baro-VNAV

response *Noted*

APV Baro-VNAV differs in performance from that required for RNP AR, and cannot be assumed to be acceptable. For RNP AR, the vertical error budget is described in ICAO Doc 9905.

comment *14* comment by: *KLM*

Section: 3 d)
Page: 46
Relevant Text: d) The use of the word initially
Comment: What does this mean in this context?
Proposal: To be explained

response *Accepted*

This relates to beginning of a procedure. GNNS updating should be available prior to commencing the procedure. The first sentence has been deleted to aid

clarity.

comment *15* comment by: *KLM*

Section: 3 g)
Page: 47
Relevant Text: FTE
Comment: Based on A/P or F/D. And what if not an obligation? (RNP0.3 and no RF leg). What is the assumed FTE then?
Proposal: To be verified whether there is a different FTE in case of non coupling option.

response *Noted*

The performance requirement for the procedure is the stated RNP value, which includes an allowance for the navigation source error and FTE. The FTEwill be affected by the mode of operation, (e.g. manual vs. flight guidance system). However, independent of the mode of operation, the aircraft must remain within the stated RNP value for the approach.

comment *46* comment by: *AEA*

Ref: 2 Operational Considerations - b) autopilot and flight director
Relevant Text: Relative to the A/P or F/D coupling
Comment: It is indicated that A/P or F/D must be used for approaches with an RNP , 0.3 or where use is made of the RF leg. However, if this is the case, the vertical FTE has not been differentiated for these two options. For the APV Baro VNAV a large FTE is applicable (200/300 ft or the more conservative value of 150 ft).
Proposal: Check the relation between the vertical FTE and the values used for APV Baro-VNAV

response *Noted*

APV Baro-VNAV differs in performance from that required for RNP AR, and cannot be assumed to be acceptable. For RNP AR, the vertical error budget is described in ICAO Doc 9905.

comment *47* comment by: *AEA*

Ref: d) GNSS Updating
Relevant Text: The use of the word initially
Comment: What does this mean in this context?
Proposal: clarification

response *Accepted*

This relates to beginning of a procedure. GNNS updating should be available prior to commencing the procedure. The first sentence has been deleted to aid clarity.

comment *48* comment by: *AEA*

Ref: 3. FLIGHT CONSIDERATIONS g) Track Deviation Monitoring.
Relevant Text: FTE

Comment: Based on A/P or F/D. And what if not an obligation? (RNP0.3 and no RF leg). What is the assumed FTE then?
Proposal: To be verified whether there is a different FTE in case of non coupling option.

response *Noted*

The performance requirement for the procedure is the stated RNP value, which includes an allowance for the navigation source error and FTE. The FTE will be affected by the mode of operation, (e.g. manual vs. flight guidance system). However, independent of the mode of operation, the aircraft must remain within the stated RNP value for the approach.

comment *98* comment by: *Boeing*

AMC 20-26
Page: 45 BR
Appendix 3, RNP Operational Considerations
Paragraph 2. b) Autopilot and Flight Director

Significant Change Request: Boeing suggests that the following change be made to the last sentence of Paragraph 2.b):

*" ... When the dispatch of a flight is predicated on flying an RNP AR approach requiring the autopilot at the destination and/or alternate, the **pilot** must determine that the autopilot is installed and operational."*

JUSTIFICATION: The dispatcher has no means to determine if the autopilot is installed or operational; the crew must do that.

response *Accepted*

Text amended however the term flight crew is used instead of pilot as proposed.

comment *99* comment by: *Boeing*

AMC 20-26
Page: 46
Appendix 3, RNP Operational Considerations
Paragraph 3.d) GNSS Updating

Significant Change Request: Boeing suggests that the following change be made to Paragraph 3.d):

*"d) GNSS Updating. Initially all RNP AR instrument approach procedures require GNSS updating of the navigation position solution**. Where installations provide an alert for loss of RNP, the flight crew may predicate the decision to continue or discontinue the procedure on the lack of alert or upon receiving an alert, respectively.***
***Where such an alert is not provided**, the flight crew must verify GNSS updating is available prior to commencing the RNP AR approach. During the approach, if at any time GNSS updating is lost and the navigation system does not have the performance to continue the approach, the flight crew must abandon the RNP AR approach unless the pilot has in sight the visual references required to continue the approach."*

JUSTIFICATION: The requirement in Appendix 3 is not consistent with the performance monitoring and alerting requirement in Table 7.1, Item 15, of the proposed AMC. The impact unnecessarily increases crew workload in the period when it is least desired or needed.

response *Partially accepted*

Text has been amended to be consistent with the requirements of Table 7.1 item 15.

comment *100* comment by: *Boeing*

AMC 20-26
Page: 47
Appendix 3, RNP Operational Considerations
Paragraph 3. g) Track Deviation Monitoring

Clarification Request: Boeing suggests that the following changes be made to the text in the first paragraph of Paragraph 3.g):

*" ... For normal operations, crosstrack error/deviation (the difference between the RNP system computed path and the aircraft position relative to the path) should be limited to ~~1/½~~ the navigation accuracy **(RNP)** associated with the procedure segment. ... "*

JUSTIFICATION: Crew alerting systems for excessive deviation can only be set to one value (RNP) on a specific segment of the approach. It is inappropriate and unnecessary to set a more stringent value than RNP to meet the required level of safety. At the lower RNPs, this requirement will cause unnecessary missed approaches, especially if a correction was already in progress when ½ RNP was reached. This requirement would not be harmonized with the parallel FAA requirements.

Note: This is also inconsistent with Paragraph 6.1.3 of the AMC, which requires evaluation to 1xRNP for lateral excursions.

response *Accepted*

Text amended as proposed and the last sentence has been deleted as this is no longer consistent with this change.

comment *101* comment by: *Boeing*

AMC 20-26
Page: 47
Appendix 3, RNP Operational Considerations
Paragraph 3 g) Track Deviation Monitoring

Significant Change Request: Boeing suggests that the second paragraph in Paragraph 3.g) be changed to read as follows:

*~~"The vertical deviation must be within 75 feet during the final approach segment.~~ Vertical deviation should be monitored above and below the glidepath. The vertical deviation must be within 75 feet **below the path** during the final approach segment. ~~While being above the glidepath provides~~*

~~margin against obstacles on the final approach, it can result in a goaround decision closer to the runway and reduce the margin against obstacles in the missed approach."~~ ***Below 1000 feet above the airport elevation, maintain vertical deviation within 75 feet high or low relative to the path. Deviations above the path provide additional obstacle clearance margin; however, if they exceed 75 feet when the airplane is below 1000 feet above the airport elevation, they can adversely affect stabilized approach criteria."***

JUSTIFICATION: Deviations greater than 75 feet high near the FAF should not require a missed approach; however, stabilized approach criteria must be met.

The wording that appears in the proposed AMC, which is indicated below in bolded type, is not correct, since the airplane would be beginning a missed approach from above the required path:

"While being above the glidepath provides margin against obstacles on the final approach, it can result in a goaround decision closer to the runway and reduce the margin against obstacles in the missed approach."

response *Partially accepted*

The text has been amended to introduce intent of the comment.

comment *102* comment by: *Boeing*

AMC 20-26
Page: 47
Appendix 3, RNP Operational Considerations
Paragraph 3.h) System Crosscheck

Significant Change Request: Boeing suggests that the following note be added to the end of Paragraph 3.h):

"NOTE: This crosscheck may not be necessary if the lateral and vertical guidance systems have been developed and/or evaluated consistent with extremely remote failure conditions and if the normal system performance supports 1xRNP containment."
JUSTIFICATION: This change would be consistent with FAA criteria and the RNP system performance requirements of Paragraph 6.1.3. of the proposed AMC.

HOWEVER: If our suggestion above is not accepted, then Boeing recommends that Paragraph 3.h) be deleted in its entirety. **JUSTIFICATION:** For an RNP AR approved system, this is an unnecessary requirement. What "other available data" is being referred to in the statement? Conventional navigation aids are not as accurate.

response *Accepted*

Note added.

comment *103* comment by: *Boeing*

AMC 20-26

Page: 48
Appendix 3, RNP Operational Considerations
Paragraph 3.i) Procedures with RF Legs

Significant Change Request: Boeing suggests that the following change be made to Paragraph 3.i):

i) Procedures with RF Legs. An RNP procedure may require the ability to execute an RF leg to avoid terrain or obstacles. As not all aircraft have this capability, flight crews should be aware of whether or not they can conduct these procedures. ~~When flying an RF leg, flight crew compliance with the desired path is essential to maintain the intended ground track~~.

JUSTIFICATION: This is a requirement for all instrument approaches and is not a unique requirement just because the crew is flying an RF leg. An RF leg is simply another (improved) method of making a turn.

response *Accepted*

Sentence deleted.

comment *104* comment by: *Boeing*

AMC 20-26
Page: 49
Appendix 3, RNP Operational Considerations
Paragraph 3.m) Non-Standard Climb Gradient

Editorial Comment: Boeing suggests that the entire paragraph be deleted.

JUSTIFICATION: This information in this paragraph applies to all instrument approach operations and need not be mentioned here, implying that it is an RNP AR unique requirement.

response *Accepted*

Paragraph deleted.

comment *105* comment by: *Boeing*

AMC 20-26
Page: 47
Appendix 3, RNP Operational Considerations
Paragraph 3.n)(3) Go-Around or Missed Approach

Clarification Request: Boeing suggests that the following change be made to Paragraph 3.n)(3):

*"(3) Upon loss of GNSS updates, the RNAV guidance may begin to 'coast' on IRU, if installed, and drift, degrading the navigation position solution. Thus, when the RNP AR APCH missed approach operations rely on IRU 'coasting' the inertial guidance will provide **acceptable navigation performance** for a specified amount of time."*

JUSTIFICATION: RNP guidance can continue for a long time, but its accuracy is the real issue.

response	*Accepted* Text amended.

comment	*204* comment by: *EUROCOPTER* Helicopter Category (Cat H) is missing. It should be introduced in this table.
response	*Noted* This will be addressed by future amendment to this AMC.

comment	*267* comment by: *DGAC France* **1 AFFECTED PARAGRAPH:** **AMC 20-26 Appendix 3 Paragraph 3 g) 1) Flight considerations** **2. PROPOSED TEXT/ COMMENT:** Add in the paragraph, that it does not apply for operations with RNP < 0.3 NM. **3. JUSTIFICATION:** As said in previous comments, managing such Flight Technical Error is challenging for the pilot. It is why Navigation Display and numeric display are not adapted for RNP < 0.3 NM operations for the pilot to monitor the FTE. So we consider that lateral deviation must be displayed on the Primary Flight Display with an appropriate scale to make pilot able to manage and anticipate his FTE.
response	*Not accepted* The requirements for the display of cross track error are dependent upon the RNP value and are defined in paragraph 7.1 Table 1.

comment	*319* comment by: *FAA* NPA COMMENT FORM This Comment Form is to be used by an Office of Other Interest (OOI) when providing comments on an EASA NPA. If the OOI has more than one comment, please duplicate this Comment Form and place any additional comment(s) on a separate form(s). This Comment Form should be sent to the Office of Primary Responsibility (OPR) by the due date established by the OPR. 1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*): NPA 2-008-14, AMC 20-26, page 47, section 3h 2. Comment (Please state your comment clearly and in plain language): The only methods that have been identified to fulfil this cross-check

requirement have been the use of TAWS with peaks/obstacle data, and the use of weather radar in ground mapping mode (only on unique procedures with this can provide positional awareness). In the majority of approvals granted by the FAA, the applicant has complied with 6.2.1b and demonstrated design consistent with a malfunction hazard level of Hazardous.

3. Justification (Please provide support for your comment):

4. Proposed Alternative Text (If any):
Recommend including the note from the PBN Manual (or similar language from AC 90-101).

5. Person Providing Comment (Include routing symbol): FAA AIR-130

response *Accepted*

Note added.

comment *353* comment by: *European Cockpit Association*

Appendix 3.3. FLIGHT CONSIDERATIONS

ADD a further "Note" as follows:
"Note 2: During RNP Baro-VNAV operations, the operational crosscheck between altimeter read-out and charted altitude values at FAF or other profile fixes does not protect against altimeter setting errors."

response *Not accepted*

The importance of ensuring correct Altimeter settings is addressed by the specific guidance and requirements in paragraph 3.k of Appendix 3.

resulting text: See Appendix B

B. Draft Decision - AMC 20-26: Appendix 4 - Acceptable Methods for FTE Assessment for RNP p. 51-54

comment *16* comment by: *KLM*

Section: App 4
Page: 51
Relevant Text: Whole
Comment: The chapter is only related to the Lateral FTE. No mention is made of the vertical FTE. This information is relevant (see above and the AMC20-27 comments related to this issue)
Proposal: Add vertical FTE analyses/information and verify the values applied in the PBN RNP AR approach design criteria in relation to the APV Baro-VNAV criteria developments in PANS-OPS.

response *Not accepted*

It is not intended to limit the FOAS to lateral considerations only. However, it is

noted that the examples given are for lateral FTE. It should be noted that in paragraph of the Appendix **PARAMETERS TO BE MEASURED AND PRESENTATION OF RESULTS**, vertical path displacement is listed. Comparing and verifying Baro-VNAV for RNP AR and APV Baro-VNAV is beyond the scope of the AMC.

comment *49* comment by: *AEA*

Comment: The chapter is only related to the Lateral FTE. No mention is made of the vertical FTE. This information is relevant (see above and the AMC20-27 comments related to this issue)
Proposal: Add vertical FTE analyses/information and verify the values applied in the PBN RNP AR approach design criteria in relation to the APV Baro-VNAV criteria developments in PANS-OPS.

response *Not accepted*

It is not intended to limit the FOAS to lateral considerations only. However, it is noted that the examples given are for lateral FTE. It should be noted that in paragraph of the Appendix **PARAMETERS TO BE MEASURED AND PRESENTATION OF RESULTS**, vertical path displacement is listed. Comparing and verifying Baro-VNAV for RNP AR and APV Baro-VNAV is beyond the scope of the AMC.

comment *106* comment by: *Boeing*

AMC 20-26
Page: 53
Appendix 4, Acceptable Methods for FTE Assessment for RNP
Paragraph 4.c)(1) Performance Assessment

Clarification Request: Boeing suggests that the following changes be made to Paragraph 4.c)(1):

*"(1) An acceptable criteria to be used for assessing probable failures and engine failure during the aircraft qualification is to demonstrate that the aircraft trajectory is maintained within a 1xRNP **(95%)** corridor laterally or 75 feet **(99.7%)** vertically. Proper documentation of this demonstration in the Aircraft Flight Manual (AFM), AFM extension, or appropriate aircraft operational support document alleviates the operational evaluations. This performance should consider the operational conditions assumed in the design of the RNP AR procedure e.g. wind, turns, etc."*

JUSTIFICATION: The conditional containment values should have an associated conditional probability for compliance determination.

response *Not accepted*

This requirement may be demonstrated using a deterministic or a statistical percentile approach. Introduction of percentiles will imply that only a statistical approach is acceptable.

B. Draft Decision - AMC 20-26: Appendix 5 - Flight Operation Safety Assessments p. 55-57

comment	*107* comment by: *Boeing* AMC 20-26 Page: 55 Appendix 5, Flight Operation Safety Assessments Paragraph 1 **Clarification Request:** Boeing suggests that the following changes be made to the 3rd full paragraph under Paragraph 1: *"A FOSA should conducted for each RNP AR approach procedure where more stringent aspects of the nominal procedure design criteria are applied (e.g. RNP 0.1 missed approach, **RF legs near terrain or obstacles**, and RNP missed approaches less than 1.0)."* **JUSTIFICATION:** RF legs, by themselves, can improve terrain or obstacle clearance, and are a better way to make RNAV turns; therefore, their use should not always trigger a FOSA.
response	*Not accepted* The wording is consistent with the descriptions used in paragraph 7.2 for demanding operations.

comment	*205* comment by: *EUROCOPTER* Loss of GNSS signals: It seems that IRU is required only for RNP-AR approaches with RF or missed approach less than RNP 1. Does than mean that straight RNP-AR approaches less than 0.3 can be flown without IRU?
response	*Noted* While the criteria cites specific conditions and situations based upon experience, the over arching requirements for compliant performance and continuity must be assessed to determine how and when an IRU may be needed or if it can be used.

comment	*268* comment by: *DGAC France* **1 AFFECTED PARAGRAPH: AMC 20-26 Annexe 5 chapter 1.** A FOSA should conducted for each RNP AR approach procedure where more ..... **2. PROPOSED TEXT/ COMMENT:** Replace existing sentence by the following one: A FOSA should be conducted for each Complex RNP AR approach procedure (e.g. ....) or ... **3. JUSTIFICATION:** 1) "be" as a typo. 2) Complex RNP AR approaches have been introduced in the AMC, chapter 7.2. This adequate terminology shall be used in the text.
response	*Not accepted*

The term complex has been deleted from paragraph 7.2 with requirement being now demanding operations. The wording is therefore considered consistent.

B. Draft Decision - AMC 20-26: Appendix 6 - AMC 20-26/PBN Manual/AC90-101 Comparison p. 58-65

comment *170* comment by: *UK CAA*

Attachment #1

Paragraph:
AMC 20-26, Appendix 6
Page: 58
Comment:
The Appendix is an excellent reference in showing the comparison between the AMC, the ICAO PBN Manual and the FAA AC 90-101. What seems to be missing is a comparison of how the different regulatory systems (EASA and FAA) interpret the relevant material and apply it during the airworthiness and operational approval processes.
Justification:
There is a lot of confusion in Industry regarding the way EASA approaches RNP AR certification and the methods applied by the FAA. In particular, the overlap between airworthiness approval and operational approval.
Proposed Text:
Consider inclusion of a diagram in Appendix 6 depicting how the applicable sections and paragraphs of this AMC and the FAA AC relate to the respective airworthiness and operational approval processes.

Such a diagram is attached for information.

response *Not accepted*

The purpose of the table is to show criteria alignment and differences only. It is not intended to attempt to explain the differences in regulatory criteria and applications, which are considered beyond the scope of this AMC.

comment *289* comment by: *AIRBUS*

A note should be added to highlight the following:
"This comparison uses AMC 20-26 as the basis. It does not include the differences introduced by the AC 90-91 unique requirements not retained in the AMC 20-26."

response *Partially accepted*

Text has been introduced to satisfy the intent of this comment.

comment *320* comment by: *FAA*

NPA COMMENT FORM

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comment(s) on a separate form(s).
This Comment Form should be sent to the Office of Primary Responsibility (OPR) by the due date established by the OPR.

1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):
NPA 2-008-14, AMC 20-26, page 60, 7.1,1 in the table

2. Comment (Please state your comment clearly and in plain language):
App 3, 3g does allow for numeric display instead of non-numeric. Correct inconsistency.

3. Justification (Please provide support for your comment):

4. Proposed Alternative Text (If any):

5. Person Providing Comment (Include routing symbol): FAA AIR-130

NPA COMMENT FORM

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1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):
NPA 2-008-14, AMC 20-26, page 61, 7.1, 21 in table

2. Comment (Please state your comment clearly and in plain language):
Recommend consistency with ICAO. The holding pattern airspace for RNP AR approaches is identical to other approaches, there is no justification for this unique requirement. Fixed radius transitions have nothing to do with RNP AR.

3. Justification (Please provide support for your comment):
There is no harmonized criteria available for RNP holding that justifies the "...more stringent requirements".

4. Proposed Alternative Text (If any):

5. Person Providing Comment (Include routing symbol): FAA AIR-130

NPA COMMENT FORM

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This Comment Form should be sent to the Office of Primary Responsibility (OPR) by the due date established by the OPR.

1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):
NPA 2-008-14, AMC 20-26, page 63, 7.2, 2 & 3 in table

2. Comment (Please state your comment clearly and in plain language):
Section 7.2 does allow for an aircraft that does not automatically stay engaged to LNAV. The section states this as a recommendation ('should') while the table states that it is required. Correct inconsistency - recommend consistency with ICAO PBN and FAA criteria and allow aircraft that do not automatically engage to LNAV guidance at TOGA, as the procedure design criteria provides some assurance that the track alignment upon initiating a go-around will be acceptable under normal operating conditions.

3. Justification (Please provide support for your comment):

4. Proposed Alternative Text (If any):

•5. Person Providing Comment (Include routing symbol): FAA AIR-130

response *Partially accepted*

App 3, 3g: Not Accepted. The guidance is consistent with Table 7.1, item 1 regarding numeric display and the considerations for their use.

7.1, 21: Accepted. Resulting from other comments RNP holding and other path designators have been deleted as minimum requirement.

7.2, 2&3: Partially Accepted. This requirement is intentional, but the application of the migration has been restricted to those miss-approach/go-round procedures that require an RNP 0.3 or greater.

resulting text: See Appendix B

B. Draft Decision - AMC 20-27 p. 66

comment *108* comment by: *Boeing*

AMC 20-27
Page: 66
Beginning of AMC 20-27

Editorial Comment: Boeing suggests that the introductory section of AMC 20-27 be consistent with that of proposed AMC 20-26 to include a brief description of the document and a table of contents.

JUSTIFICATION: Consistency in format of two related guidance documents is preferred, as it makes search and comparison of information easier to accomplish.

response *Noted*

Boeing comment is noted, the object of an AMC is to provide sufficient information and guidance material to permit an applicant to obtain an approval. The differing subjects covered do not necessitate the same form of presentation.

comment *171* comment by: *UK CAA*

Paragraph:
AMC 20-27, Title and Purpose
Page: 66
Comment:
The AMC title reflects airworthiness approval, but only operational criteria. Indeed, the Purpose highlights this again. This reflects the need for the operator to apply to their competent authority.

This was certainly the arrangement with JAR-OPS, but with the extension of the competencies of EASA and the introduction of EU-OPS and eventually IR-OPS, does the Agency not have greater responsibilities? There is a sense from reading the document that EASA has the competency, but that the competent authority has still to develop the operational approval requirements. It is accepted that the ultimate approval should be granted at the local authority level, but that should not diminish the EASA role and responsibility for the approval criteria. Therefore it is recommended that it be made clear that AMC 20-27 contains the Operational Approval Criteria.
Justification:
It would be clearer to National Authorities and operators that EASA has published Operational Approval Criteria consistent with their competencies and not just guidance.
Note: EASA is already developing material for the approval of Electronic Flight Bags (EFB) see draft AMC 20-25, the title of which is Airworthiness and Operational Approval for Electronic Flight Bags (EFBs).
Proposed Text:
Change the title of the AMC to: Airworthiness and Operational Approval Criteria for RNP APPROACH (RNP APCH) Operations Including APV BARO-VNAV Operations.
Amend the Purpose and para 10 accordingly.

response *Not accepted*

The AMC title is correct and reflects the split of responsibilities for the issuing of approvals, in that the Agency will issue the Airworthiness approval and the Operational approval will be issued by the Competent Authority. The Competent Authority will apply the criteria defined within the AMC.

comment *291* comment by: *Thales Avionics*

Minor comment.

Page 66, second para: "...procedures designed with straight segment**s**".

response *Accepted*

Text amended.

comment *292* comment by: *Thales Avionics*

Page 66
5th para: "For other phases of flight, barometric VNAV provides vertical path information that can be defined by ~~vertical angles or~~ altitudes at fixes in the procedure."
In other phases vertical path is never defined by vertical angles.
Note: this sentence could be removed.

response *Accepted*

Text amended.

resulting text: See Appendix C

B. Draft Decision - AMC 20-27: 1. Purpose p. 66

comment *20* comment by: *KLM*

Section: 1
Page: 66
Relevant Text: Second alinea : "with straight segment"
Comment: Straight segment may be wrongly interpreted as straight-in segment only. However, an off-set final could be applied. Issue is that the RF leg cannot be applied for the final and missed approach segments.
Proposal: "without the application of an RF leg in the final and missed approach phase of flight.

response *Partially accepted*

The text does not define RNP approach procedures. The text has been amended (see comment 209) for clarification.

comment *50* comment by: *AEA*

Relevant Text: RNP APCH procedures are characterised by existing charted RNAV (GNSS) approach procedures designed with straight segment.
Comment: Straight segment may be wrongly interpreted as straight-in segment only. However, an off-set final could be applied. Issue is that the RF leg cannot be applied for the final and missed approach segments.
Proposal: "without the application of an RF leg in the final and missed approach phase of flight.

response *Partially accepted*

The text does not define RNP approach procedures, The text has been amended (see comment 209) for clarification.

comment *61* comment by: *Eurocontrol*

1. para 6
Comment:
missing word - "compliance".
...to demonstrate **compliance** with the operational criteria.

response	*Accepted* Text amended.

comment	*109* comment by: *Boeing* AMC 20-27 Page: 66 Paragraph 1. Purpose **Editorial Comment**: Boeing suggests that the statement of purpose be simplified, following the example of proposed AMC 20-26. The other explanatory material about operations and Baro-VNAV should be moved to Paragraph 2., Background. **JUSTIFICATION:** Consistency in format of two related guidance documents is preferred. Further, the purpose should explain the reason and rationale for the document and place it in context with the subject matter; background materials do not necessarily explain the purpose.
response	*Noted* Boeing comment is noted, the object of an AMC is to provide material to provide sufficient information and guidance to permit an applicant to obtain an approval. The differing subjects covered do not necessitate the same form of presentation.

comment	*110* comment by: *Boeing* AMC 20-27 Page: 66 Paragraph 1. Purpose **Clarification Request:** Boeing suggests that the following change be made to the text of the 2nd paragraph of Paragraph 1: *"RNP APCH procedures are characterised by existing charted RNAV (GNSS) approach procedures designed with straight **final approach** segment."* **JUSTIFICATION:** We recommend this text clarification to demonstrate that procedures incorporate a final segment, but could have curved paths to the final, straight-in segment.
response	*Accepted* Text amended.

comment	*160* comment by: *Garmin International* The last paragraph of section 1 defines what the terms *shall* and *must* mean in the context of this AMC. However, there is no definition about what the term *should* means in the context of this AMC. Suggest adding a definition for the term *should*.
response	*Partially accepted* In common English the term should is used to make recommendations. The

AMC text has been amended to ensure the correct use of should/shall.

comment *172* comment by: *UK CAA*

Paragraph: AMC 20-27
Page: 66
Comment:
Include a Table of Contents as per AMC 20-26
Justification:
It would make for easier navigation in what is a 33 page document.

response *Noted*

The UK CAA comment is noted, the object of an AMC is to provide material to provide sufficient information and guidance to permit an applicant to obtain an approval. The differing subjects covered do not necessitate the same form of presentation.

comment *339* comment by: *ECOGAS*

Suggest clarification or deletion of the paragraph "RNP APCH procedures are characterised by existing charted RNAV (GNSS) approach procedures designed wiith straight segment." The sentence does not seem accurate.

response *Not accepted*

The sentence is accurate, it is in accordance with the ICAO PBN concept as defined in ICAO Doc 9613, RNP APCH are RNAV(GNSS approaches) when the operator is using LNAV or LNAV/VNAV minima.

resulting text: See Appendix C

B. Draft Decision - AMC 20-27: 2. Background p. 66-67

comment *62* comment by: *Eurocontrol*

2. para 2
Comment
(see the relevant AMC). relevant AMC is 20-26. Name it.

response *Accepted*

Text amended.

comment *111* comment by: *Boeing*

AMC 20-27
Page: 67
Paragraph 2. Background

Clarification Request: Boeing suggests that the 4th paragraph of Paragraph 2 (text starting "It is not intended....") with replaced with the following:

"Existing airworthiness approvals granted for lateral navigation per AMC 20-5 or equivalent are not affected by this AMC. No regulatory action is required for such approvals."

.

JUSTIFICATION: The text in the proposed AMC concerning reinvestigation should be clearer with regard to impact to existing approvals and actions taken.

response *Partially accepted*

Reference to this text has been deleted, Para 8.3 has been amended to clarify which previous approvals are acceptable.

comment *290* comment by: *AIRBUS*

Paragraphs 3 and 4 read:
"This AMC supersedes the approach section of AMC 20-5 or equivalent document. It is not intended that aircraft which have received airworthiness approval for the lateral navigation part in compliance with AMC 20-5 or equivalent (JAA TGL 3 or ACJ 20X5)
should be reinvestigated.

This AMC identifies the airworthiness and operational requirements for RNP APCH operations including APV BAROVNAV operation [...]"

These paragraphs should be modified as shown:
"This AMC supersedes the approach section of AMC 20-5 or equivalent document. It is not intended that aircraft which have received airworthiness approval for the lateral navigation part in compliance with AMC 20-5 or equivalent (JAA TGL 3, ACJ 20X5, **AC 20-130A or AC 20-138**) should be reinvestigated.

This AMC identifies the airworthiness and operational requirements for RNP APCH operations including APV BAROVNAV operation. **It is not intended that aircraft which have received airworthiness approval for the vertical navigation part in compliance with AMC 20-26 or equivalent (AC 90-101) should be re-investigated.**"

response *Partially accepted*

Reference to this text has been deleted, Para 8.3 has been amended to clarify which previous approvals are acceptable.

comment *321* comment by: *FAA*

NPA COMMENT FORM

This Comment Form is to be used by an Office of Other Interest (OOI) when providing comments on an EASA NPA. If the OOI has more than one comment, please duplicate this Comment Form and place any additional comment(s) on a separate form(s).
This Comment Form should be sent to the Office of Primary Responsibility (OPR) by the due date established by the OPR.

1. Affected Text (Please *specify clearly the location (e.g., page*

number, paragraph/section number) of the proposed text affected by your comment):
Page 66, Section 1., fourth paragraph.

2. Comment (Please state your comment clearly and in plain language):
This paragraph limits the operational implementation of RNP APCH to aircraft with baro-VNAV. However, an SBAS vertical path capability could be mapped to an RNP APCH & an SBAS implementation in an aircraft could be modified to assure compliance with the performance assumptions inherent in RNP APCH operations such that an aircraft need not have baro-VNAV in order t fly the vertical path designed in an RNP APCH procedure.

3. Justification (Please provide support for your comment):
The guidance material should not constrain application of new or innovative technologies. FAA is drafting new guidance material for inclusion of this capability in the draft AC covering RNP APCH qualification and operation.

4. Proposed Alternative Text (If any):
This AMC addresses RNP APCH operation without vertical guidance (NPA operation) and with vertical guidance based on barometric VNAV (APV BAROVNAV operation). An aircraft may use GNSS augmentations (SBAS and GBAS) to provide vertical path guidance on an RNP APCH provided the performance of the aircraft is consistent with the requirements for an APV BAROVNAV operation and the associated procedure design criteria. Final approaches utilizing SBAS (Localiser Performance with Vertical guidance (LPV) operation) are addressed in separate AMC material.

5. Person Providing Comment (Include routing symbol):
FAA AIR-130

response *Not accepted*

The use of SBAS or GBAS for vertical guidance is outside the scope of this AMC.

resulting text See Appendix C

B. Draft Decision - AMC 20-27: 3. Scope p. 67

comment *183* comment by: *Garmin International*

Section 3 paragraph 2 last sentence says "Unless stated to the contrary in this AMC, systems and procedures previously approved as compliant with earlier area navigation guidance material will need to be re-evaluated to identiry where additional approval effort, if any, is needed."

This sentence seems contradictory to the sentence in section 2 that says: "It is not intended that aircraft which have received airworthiness approval for the lateral navigation part in compliance with AMC 20-5 or equivalent (JAA TGL 3 or ACJ 20X5) should be reinvestigated."

Suggest that the Section 3 paragraph 2 last sentence be adjusted to be

	consistent with the section 2 sentence.
response	*Partially accepted* Reference to this text has been deleted, Para 8.3 has been amended to clarify which previous approvals are acceptable.

resulting text	See Appendix C

B. Draft Decision - AMC 20-27: 4. Reference Documents p. 67-69

comment	*137* comment by: *Garmin International* There are two instances of ETSO-C115() listed in section 4.2.2. One of the instances should be removed.
response	*Accepted* Last reference to ETSO-C115( ) deleted.

comment	*138* comment by: *Garmin International* There are two instances of FAA TSO-C115() in section 4.2.4. One of these should be removed.
response	*Accepted* Last reference to TSO-C115( ) deleted.

comment	*173* comment by: *UK CAA* **Paragraph:** 4.2.3 of AMC 20-27 **Page:** 68 **Comment:** Ref to AC25-11 should be 25-11A as above. **Justification:** Top reflect new published version.
response	*Partially accepted* Text amended to read AC 25-11( ) to permit those installation conforming to previous issue to be acceptable.

comment	*272* comment by: *DGAC France* **1 AFFECTED PARAGRAPH: AMC 20-27 Paragraph "4.2.4 Technical Standard Order "** **2. PROPOSED TEXT/ COMMENT:** TSO C 115() is referenced twice in this chapter. One reference should be suppressed. **3. JUSTIFICATION:**

	Editorial
response	*Accepted* Last reference to TSO-C115( ) deleted.

resulting text	See Appendix C

B. Draft Decision - AMC 20-27: 5. Assumptions p. 70-71

comment	*64* comment by: *Eurocontrol* 5.3 para 4 What are the relevant publications? Can an example be given?
response	*Partially accepted* Relevant publications are for instance the AIP or approach charts. The example of approach charts has been added to the text.

comment	*65* comment by: *Eurocontrol* 5.3 para 5 Comment why the "(as appropriate)"? This implies that I can claim that Annex 15 and 4 are not appropriate. It's a kind of get-out clause. Maybe it should say that the data will meet the requirements in the appropriate sections of the annexes to be more clear.
response	*Partially accepted* The text "as appropriate" has been deleted.

comment	*66* comment by: *Eurocontrol* 5.4 *It is expected that ATC will be familiar with aircraft VNAV capability,* Comment this is not consistent with Eurocontrol operational concept which only requires ATC to be aware of aircraft ability to fly RNAV(GNSS) approach which could be to the LNAV-only minima line. Not whether the aircraft has VNAV capability. As this is not an aircraft issue does it need to be mentioned in this document?
response	*Noted* ATC should be familiar the effect of low temperature on the Baro-VNAV guidance or the guidance impact of a QNH error.

comment	*112* comment by: *Boeing* AMC 20-27

Page: 70
Paragraph 5.1. Navaid Infrastructure

Clarification Request: Boeing suggests that the second paragraph in Paragraph 5.1., concerning APV BARO-VNAV operation, be removed.

JUSTIFICATION: This material has no information or assumption about Navaid infrastructure. The first part is about the aircraft and system, which is about AMC compliance. The second sentence is more appropriate for the section in the AMC on Obstacle Clearance (except that section appears to have the appropriate material included already).

response *Accepted*

Paragraph deleted.

comment *113* comment by: *Boeing*

AMC 20-27
Page: 70
Paragraph 5.2 Obstacle Clearance

Clarification Request: Boeing suggests that the following material be added to Paragraph 5.2:

"All RNP APCH procedures:
(1) are published by an Aeronautical Information Service Provider certified according to article 7 of Regulation 550/2004 8 or
(2) are consistent with the relevant parts of ICAO Doc 8168 PANS OPS;
(3) take account of the functional and performance capabilities of RNP systems and their safety levels as detailed in this AMC;
Note: Particular attention should be given to the constraints implied by the Airworthiness Certification objectives of Paragraph 6.
(4) Support reasonableness checking by the flight crew by including, on the charts, fix data (e.g. range and bearing to navigational aids or waypoint to waypoint);
(5) Terrain and obstacle data in the vicinity of the approach is published in accordance with ICAO Annex 15 to the Convention on International Civil Aviation and Doc 9881, Guidelines for Electronic Terrain, Obstacle and Aerodrome Mapping Information;
(6) If the procedure allows a reversion in aircraft use of navigation infrastructure, e.g. GNSS to DME/DME, the obstacle clearance assessment is based on an RNP that allows either infrastructure;
(7) Barometric altitude compensation for temperature effects is accounted for in the procedure design, and any necessary limitations are specified in the AIP;

(8) Procedures are designated RNAV e.g. RNAV(GNSS) and throughout the AIP and on aeronautical charts."

JUSTIFICATION: To ensure consistent information in related AMCs -- refer to Paragraph 4.3 of proposed AMC 20-26***.***

response *Not accepted*

The proposed text is as per AMC 20-26 for consistency; However, RNP APCH obstacle criteria are well defined in PANS OPS, thus reference to PANS OPS

(ICAO Doc 8168) is deemed sufficient.

comment *273* comment by: *DGAC France*

1. AFFECTED PARAGRAPH:
AMC 20-27 Paragraph 5.4 "Communication, ATS surveillance and ATC coordination"

2. PROPOSED TEXT/ COMMENT:

It is proposed to replace the existing paragraph by the following:

"ATC may use radar vectoring techniques to place aircraft onto final approach axis when the RNAV system supports this function. ~~A state intending to authorise this technique will instruct a certified AIS provider to include such information in the relevant AIP.~~ Air Navigation Service Providers implementing such operation in their airspace should inform airspace users of this operational possibility in the relevant AIP. "

3. JUSTIFICATION:

This paragraph is not adequate to explain how the NSA will regulate the ANSP or the AIS. This paragraph is within to the Assumption section of an AMC dealing with airworthiness approval or operational criteria for some kind of navigation. The intent of the text shall just clarify that airspace users will be informed through the AIP that the ATC may require vectoring to the final approach segment.

response *Accepted*

Text amended.

comment *294* comment by: *Thales Avionics*

Page 71, § 5.4 Last para

Sentence: "ATC may use radar vectoring techniques to place aircraft onto final approach axis when the RNAV system supports this function. "

It is difficult to understand which function is referred. Is it Item 1 in §7.3?

It could be specified.

response *Noted*

This is effectively the function as defined in sec 7.3 Item 1.

comment *322* comment by: *FAA*

NPA COMMENT FORM

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This Comment Form should be sent to the Office of Primary Responsibility (OPR) by the due date established by the OPR.

1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):
NPA 2-008-14, AMC 20-27, page 70, section 7.1, 3rd para

2. Comment (Please state your comment clearly and in plain language):
Radiofrequency interference should also be considered.

3. Justification (Please provide support for your comment):

4. Proposed Alternative Text (If any):

5. Person Providing Comment (Include routing symbol): FAA AIR-130

NPA COMMENT FORM

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1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):
Page 71, Paragraph 5.4, second sentence in the first paragraph.

2. Comment (Please state your comment clearly and in plain language):
This statement is incorrect. Obstacle clearance is achieved through aircraft performance, operating procedures *and* procedure design, not just aircraft performance and operating procedures.

3. Justification (Please provide support for your comment):
Editorial. As written, the information is misleading. The role of employing the proper procedure design criteria cannot be ignored. This is consistent with the "three-legged stool" used in the PBN Seminars & FAA presentations.

4. Proposed Alternative Text (If any):
Recommend changing the sentence to read: "Adequate obstacle clearance is achieved through aircraft performance, operating procedures and procedure design."

5. Person Providing Comment (Include routing symbol):
FAA AIR-130

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1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):
Page 71, Paragraph 5.4, third paragraph.

2. Comment (Please state your comment clearly and in plain language):
This statement is not needed. ATC need not know specifics associated with these operations. Existing ATC procedures for providing altimeter settings and temperatures is accommodated in the criteria. This is an operational responsibility of the pilot/flight crew.

3. Justification (Please provide support for your comment):
The impact on ATC is minimized by implementing RNP APCH operations. It's no different than RNAV(GNSS) operations using the LNAV/VNAV criteria. Existing guidance for ATC concerning updates of altimeter setting & temperature updates is sufficient for these operations. Need to harmonize guidance materials within FAA, EASA & ICAO.

4. Proposed Alternative Text (If any):
Delete this paragraph.

5. Person Providing Comment (Include routing symbol):
FAA AIR-130

NPA COMMENT FORM

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This Comment Form should be sent to the Office of Primary Responsibility (OPR) by the due date established by the OPR.

1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):
Page 71, Paragraph 5.5, last two sentences in the paragraph.

2. Comment (Please state your comment clearly and in plain language):
These statements assume what MET service providers and ATC do today is inadequate and requires new procedures for them. This is not the case. MET information is provided accurately and in a timely manner today by both manually initiated communications between MET providers and flight crews, and ATC provides up-to-date altimeter settings as well. IT is a flight crew responsibility to ensure they have the requisite current MET information before conducting an RNP APCH operation. There is not a new requirement for MET service providers, automated MET systems (e.g., ASOS) or for ATC.

3. Justification (Please provide support for your comment):
The impact on MET providers and ATC is minimized by implementing RNP APCH operations. It's no different than RNAV(GNSS) operations using the

LNAV/VNAV criteria. Existing guidance for MET providers (including automated systems) and ATC concerning updates of altimeter setting and temperature updates is sufficient for these operations. Current FAA RNP AR operations indicate no changes are needed. Need to harmonize FAA< EASA & ICAO guidance materials.

4. Proposed Alternative Text (If any):
Change the paragraph to read, "In support of this, existing MET services assure the accuracy, currency and availability of meteorological data is available to support APV BAROVNAV operations. Also, in order to minimise the potential for misssetting the barometric reference, flight crews must confirm the current, local altimeter setting prior to commencement of the approach through any appropriate and available means, including querying ATC."

5. Person Providing Comment (Include routing symbol):
FAA AIR-130

response *Partially accepted*

Sec 5.1 paragraph 3 (interference): Accepted. Text amended.

Sec 5.4 paragraph 1 (obstacle clearance): Accepted. Text amended.

Sec 5.4 paragraph 3 (Safety and Baro-VNAV): Noted. ATC should be familiar with the effect of low temperature on the Baro-VNAV guidance or the guidance impact of a QNH error.

Sec 5.5 (MET service): Not Accepted. The requested change does not affect the meaning of this paragraph. This is an assumption and does not imply any additional requirements on the MET service.

comment *355* comment by: *Lauri LAINE*

i) PANS-OPS defines obstacle clearance to be based on barometric altitude (with its inherent inaccuracies) when conducting a NPA. This is understandable when we consider the "hinterland NPA operations". But,
ii) Both at Hernesaari (EFHE) and Cityhall (EECL) our IFR approach is from over the open sea (Gulf of Finland). Therefore, Would it be possible to add here a Note:
iii) "Note 1: Local conditions permitting, the local authority may, case by case, approve procedures where the obstacle clearance is based on radar altemeter."

In our AW139 operation, this would enhance the safety of flight as we would get rid of the possibility of mis-set barometric altimeter.
It could also improve our dispatch reliability if we could get somewhat lower MDA. This because we then need not to account for natural unreliability of barometric altitude but take the benefit of our dual RA installation.
(AW139 is yet not able to comply with the requirements set forth in the future AMC 20-26)

response *Not accepted*

AMC 20-27 is not intended to discuss PANS OPS procedure design criteria or to develop alternate criteria. This is the role of ICAO IFPP.

comment *356* comment by: *Lauri LAINE*

	PANS-OPS defined obstacle clearance criteria for NPA is based on "rectangular box": both vertical and lateral clearance requirements are defined. However, "The probability of colliding with an obstacle" does not increase in rectangular proportions! It increases more like somekind of expanding ellipse. This concept has already been adopted for precision approaches. Present day computers can easily calculate "the probability of hitting an obstacle" and base the MDA on that criteria. This would result in kind of an ellipse clearance window in place of today's rectangular. The probability of beeing in any corner of the present "box" is extremely remote!! When we compare the GNNS navigation to NDB navigation, both are classified as "Non-Precision Approaches", but the actual difference in lateral navigation accuracy is huge. Should we be able to benefit on that? (Academic question: If we think the present "obstacle clearance box"; why the probability of hitting an obstacle in the corners (of the box) has to be extremely remote (as compared to lesser requirements in only purely vertical or lateral deviation.)) With helicopters we often operate in confined environment. That is where the most benefit of helicopters is gained! Therefore this "ellipse concept" (of obstacle window) would greatly enhance the operation while "maintaining at least the same lavel of safety" as mandated by the basic requirements. PANS-OPS actually states (Foreword, Chapter 4 "Implemetation") that the local authority may grant exceptions of the document. Could something similar be brought in to the AMC's we are talking about? Local conditions may, and in helicopter operations will, wary from country to country.
response	*Not accepted* AMC 20-27 is not intended to discuss PANS OPS procedure design criteria or to develop alternate criteria. This is the role of ICAO IFPP.

resulting text	See Appendix C

B. Draft Decision - AMC 20-27: 6. RNP APCH Airworthiness Criteria - 6.2 Equipment Qualification p. 72

comment	*139* comment by: *Garmin International* The first paragraph of section 6.2.1 refers to "ETSO-C146a/TSO-C146a Class Gamma". Has there actually been a release of "ETSO-C146a" or is it still "ETSO-C146"? Additionally, the FAA has released "TSO-C146b" and there is equipment approved to this TSO-C146b as well as TSO-C146a. Suggest that the references to ETSOs and TSOs be made generically throughout this guidance, e.g., "TSO-C146()" unless compliance with a particular revision is absolutely required.
response	*Accepted* Text amended.

comment	*140* comment by: *Garmin International*

	The first paragraph of section 6.2.1 refers to "ETSO-C146a/TSO-C146a Class Gamma". The reference to ETSO-C146 and TSO-C146 implies "Class Gamma" so suggest that this text be removed. Similarly, the second paragraph of section 6.2.1 refers to "ETSO-C145()/TSO-C145() class Beta". The reference to ETSO-C145 and TSO-C145 implies "class Beta" so suggest that this text be removed.
response	*Not accepted* ETSO-C146() does not only include Class GAMMA equipment but includes also class DELTA.

comment	*174* comment by: *UK CAA* **Paragraph:** AMC 20-27 Para 6.2.2 a) **Page:** 72 **Comment:** Air Data Systems using Air Data Modules rather than Air Data Computers (more common in more modern aircraft) may be designed to perform to ARINC 738 (Air Data and Inertial Reference System) 'specification'. The altimetry performance standards are similar. **Justification:** Alternative to ARINC 706 **Proposed Text:** Reference ARINC 738 as another acceptable system capability definition. Text for para d) will require amendment as a consequence.
response	*Partially accepted* Reference to ARINC 738 specification added. The addition of this specification does not change the meaning of paragraph d).

resulting text	See Appendix C

B. Draft Decision - AMC 20-27: 6. RNP APCH Airworthiness Criteria - 6.3 Accuracy p. 72-76

comment	*17* comment by: *KLM* Page 75 **6.4 Integrity** During operations on instrument approach procedures, the probability of displaying misleading navigational or positional information to the flight crew during the approach, including the final segment, shall be remote. How should this be ensured when not described. To be deleted.
response	*Not accepted* Terminology used in this paragraph is that used in the airworthiness terminology as defined in the CS requirements. Integrity is defined for example in CS AMC 25.1309.

comment	*21* comment by: *KLM*

Section: 6.3.2. b) VNAV equipment error
Page: 74
Relevant Text: 99.7 percent probability
Comment: There is a mix of use of values based on 3 and 2 SD. It is more logical to apply 2SD throughout where applicable.
Proposal: Use values based on 2SD.

response *Not accepted*

The use of 3SD values is consistent with the guidance that has already been issued (e.g. ICAO, FAA).

comment *22* comment by: *KLM*

Section: 6.3.2 d) FTE
Page: 74
Relevant Text: Values of 150 ft, notes 1 and 2.
Comment: The FTE of 150 ft (3SD) is more restrictive than AC 20-129 and ICAO PBN. IFPP is currently working on modifying the APV Baro-VNAV Chapter in PANS-OPS Vol II.
Therefore, there is an opportunity to bring this document in line with PANS-OPS Vol II and v.v.
200 ft/300 ft is a large value in the error budget which may result in conservative design. Therefore the lower value would be beneficial, but demonstration will be difficult.
Alternatively use can be made of A/P or F/D coupling capability, if this results in a significant benefit (lower OCH>>>Lower RVR).
With these options (200/300 ft alternatively 150 ft) IFPP there is no basis for the PANS-OPS design. Therefore there is a need for a definitive value, but if sufficiently beneficial with the option for the use of A/P coupling if the result is beneficial.
Proposal: There is a need for one single value that can be used by the IFPP and, if beneficial, values of A/P or F/D coupling FTE is required.

response *Noted*

As indicated in the AMC, there is a single value for FTE of 150 ft (3SD). This value permits manual flight if a Vertical Deviation Indicator with a sufficient full scale deflection is installed. This does not prevent the use of an autopilot or flight director which would lead to a lower FTE.

comment *23* comment by: *KLM*

Section: 6.3.2 e)
Page: 75
Relevant Text: text below the table.
Comment: see above. IFPP Maintenance and Integration WG is in the process of modifying the APV Baro-VNAV chapter where the Vertical error Budget comparable with the RNP AR approach procedures will be applied. This description is based on the current method. Aim is to apply the vertical errors from the AMC20-27 to build the VEB. However, a chicken/egg situation must be prevented.
There is a need for one single figure that IFPP can be used (or two options is beneficial).
Proposal: There is a need for one single value that can be used by the IFPP

and, if beneficial values of A/P of F/D coupling FTE is required.
75 ft?

response *Noted*

As indicated in the AMC, there is a single value for FTE of150 ft (3SD). This value permits manual flight if a Vertical Deviation Indicator with a sufficient full scale deflection is installed. This does not prevent the use of Autopilot or flight director which would lead to a lower FTE. The use of a 75 ft FTE value is consider too stringent for APV Baro-VNAV operation.

comment *31* comment by: *AEA*

Ref: 6.4 Integrity
Relevant Text: *During operations on instrument approach procedures, the probability of displaying misleading navigational or positional information to the flight crew during the approach, including the final segment, shall be remote.*
Comment: How should this be ensured when not described.
Proposal: To be deleted

response *Not accepted*

Terminology used in this paragraph is that used in the airworthiness terminology as defined in the CS requirements. Integrity is defined for example in CS AMC 25.1309.

comment *51* comment by: *AEA*

Ref: 6.3.2. b) VNAV equipment error
Relevant Text: 99.7 percent probability
Comment: There is a mix of use of values based on 3 and 2 SD. It is more logical to apply 2SD throughout where applicable.
Proposal: Use values based on 2SD.

response *Not accepted*

The use of 3SD values is consistent with the guidance that has already been issued (e.g. ICAO, FAA).

comment *52* comment by: *AEA*

Ref: 6.3.2 - d) Vertical Flight Technical Error (FTE)
Relevant Text: Values of 150 ft, notes 1 and 2.
Comment: The FTE of 150 ft (3SD) is more restrictive than AC 20-129 and ICAO PBN. IFPP is currently working on modifying the APV Baro-VNAV Chapter in PANS-OPS Vol II.
Therefore, there is an opportunity to bring this document in line with PANS-OPS Vol II and v.v.
200 ft/300 ft is a large value in the error budget which may result in conservative design. Therefore the lower value would be beneficial, but demonstration will be difficult.
Alternatively use can be made of A/P or F/D coupling capability, if this results in a significant benefit (lower OCH>>>Lower RVR).
With these options (200/300 ft alternatively 150 ft) IFPP there is no basis for the PANS-OPS design. Therefore there is a need for a definitive value, but if sufficiently beneficial with the option for the use of A/P coupling if the result is

beneficial.
Proposal: There is a need for one single value that can be used by the IFPP and, if beneficial, values of A/P or F/D coupling FTE is required.

response *Noted*

As indicated in the AMC, there is a single value for FTE of 150 ft (3SD). This value permits manual flight if a Vertical Deviation Indicator with a sufficient full scale deflection is installed. This does not prevent the use of an autopilot or flight director which would lead to a lower FTE.

comment *53* comment by: *AEA*

Ref: 6.3.2 e) Vertical Total System Error (TSE)
Relevant Text: *The vertical TSE values are compatible with the vertical obstacle clearance criteria applied by PANS-OPS where the maximum vertical clearance of 322 ft, which is provided on a 3 degree vertical path, is intended to accommodate a 3σ TSE with an additional buffer for abnormal operations. The manual monitoring of the altimeters to comply with the DA/DH is independent of the BARO-VNAV system and provides additional mitigation*
Comment: see above. IFPP Maintenance and Integration WG is in the process of modifying the APV Baro-VNAV chapter where the Vertical error Budget comparable with the RNP AR approach procedures will be applied. This description is based on the current method. Aim is to apply the vertical errors from the AMC20-27 to build the VEB. However, a chicken/egg situation must be prevented.
There is a need for one single figure that IFPP can be used (or two options is beneficial).
Proposal: There is a need for one single value that can be used by the IFPP and, if beneficial values of A/P of F/D coupling FTE is required. 75 ft?

response *Noted*

As indicated in the AMC, there is a single value for FTE of150 ft (3SD). This value permits manual flight if a Vertical Deviation Indicator with a sufficient full scale deflection is installed. This does not prevent the use of Autopilot or flight director which would lead to a lower FTE. The use of a 75 ft FTE value is consider too stringent for APV Baro-VNAV operation.

comment *69* comment by: *Eurocontrol*

6.3.1 c)
.....does not cause position errors to exceed the Navigation System Error (NSE) budget,
Comment
where is the NSE error budget defined?

response *Accepted*

Text has been amended to refer to Total System Error (TSE).

comment *70* comment by: *Eurocontrol*

6.3.2 a)
However, the error need not be less than ±9 m (±30 ft).
Comment

It is not clear what the requirement is here. It tells us what it is not. Is this correct? What is the ASE requirement?

response *Noted*

ASE is characterised by the ±9 m (±30 ft) per 185 km/hr (100 knots) criteria with a lower limit at ±9 m (±30 ft). It means that for a speed lower than 185 km/hr (100 knots), ±9 m (±30 ft) criteria should be demonstrated and not a lower value.

comment *71* comment by: *Eurocontrol*

6.4 page 76 Note 1
Comment
What is this additional safety assessment unique to RNP? Is it FOSA? We understood that FOSA was only required for RNP AR.

response *Noted*

It is not the intent of this note to address FOSA. FOSA as correctly identified is associated with RNP AR operations. The intent of this note is to recall that a "Remote" safety objective (e.g. CS 25.1309 terminology) is acceptable thanks to the RNAV concept associated to RNP APCH operation (i.e. procedure design criteria, ATC assumption, equipment installed, crew procedure, etc.).

comment *114* comment by: *Boeing*

AMC 20-27
Page: 72
Paragraph 6.3.1 Horizontal

Clarification Request: Boeing suggests that the following changes be made to Paragraph 6.3.1:

1. Use lateral and along track error, consistent with general practice, replace "longitudinal" with "along track."

2. While this section indicates that it is about TSE, the only requirements discussed are for FTE. An added statement such as the following would result in a more complete section:

"The horizontal positioning error component of TSE is assumed to be equal to the 2D navigation accuracy of systems/sensors qualified to AC20-138, 20-138A, and 20-130A"

JUSTIFICATION:
1. Consistency in use of terminology is necessary in order not to change the meaning of RNP and to avoid confusion when applying different AMCs on RNP to the same aircraft and systems.

2. A more specific statement on positioning error is needed when discussing TSE and requirements allocations; otherwise, there is a gap.

response *Partially accepted*

1. Not accepted: The term longitudinal is used correctly within the context of the paragraph and it is not accepted to replace the word as recommended by

the commentator. The ICAO PBN manual (Doc 9613) is also using the term longitudinal.

2. Accepted: The text has been amended to include a note with the commentators change.

comment

115 comment by: *Boeing*

AMC 20-27
Page: 74
Paragraph 6.3.2.b VNAV Equipment Error

Significant Change Request: Boeing suggests that error values for level flight segments be included in paragraph 6.3.2.b.

JUSTIFICATION: RNP APCH does not require use of VNAV, and allows for more traditional vertical step procedures, where the level segment accuracy should also be assured. The current values, if applied to level segments, would be excessive and would impact obstacle clearance assumptions.

response

Not accepted

There is no vertical requirement in this AMC associated to the use of VNAV guidance outside the final approach segment. The vertical guidance requirement is only applicable to the final approach segment.

comment

116 comment by: *Boeing*

AMC 20-27
Page: 74
Paragraph 6.3.2.c Horizontal Coupling Error

Clarification Request: Boeing suggests that the following changes be made to Paragraph 6.3.2.c:

1. Change "function of the horizontal TSE" to "function of the horizontal ***NSE"*** to be consistent with the immediately preceding parenthetical statement "(vertical error component of along track positioning error)"; and

2. Change "longitudinal accuracy" to ***"along track positioning error."***

So that the final text reads as follows:

*"The Horizontal coupling error (vertical error component of along track positioning error) is a function of the horizontal ~~TSE~~ **NSE** (see 6.3.1) and is directly reflected in the along track tolerance offset used in APV BAROVNAV procedure design criteria.*

*This Horizontal Coupling error in this context is assumed to be 96 ft on a 99.7 percent probability basis using a ~~longitudinal accuracy~~ **along track positioning error** of 0.2 NM at 95% and a vertical path of 3°."*

JUSTIFICATION:
1. This section is about HCE and terms should be consistent. Additionally, it becomes confusing when considering TSE does not have path definition error and FTE along track components.

2. We consider it important to stay consistent with terminology instead of switching from positioning error to accuracy when describing the same error.

response *Partially accepted*

1. Accepted - Text amended.

2. Not Accepted - The term longitudinal is used correctly within the context of the paragraph and it is not accepted to replace the word as recommended by the commentator. The ICAO PBN manual (Doc 9613) is also using the term longitudinal.

comment *117* comment by: *Boeing*

AMC 20-27
Page: 74
Paragraph 6.3.2.d Vertical FTE

Clarification Request: Boeing suggests that the FTE for level segments be included in this paragraph.

JUSTIFICATION: RNP APCH does not require use of VNAV, and allows for more traditional vertical step procedures, where the level segment accuracy should also be assured.

response *Not accepted*

There is no vertical requirement in this AMC associated to the use of VNAV guidance outside the final approach segment. The vertical guidance requirement is only applicable to the final approach segment.

comment *141* comment by: *Garmin International*

Section 6.3.1 item a) says in part "... (compliant with the full-scale deflection sensitivity requirement of TSO-C129a paragraph (a).3.(viii))". Since TSO-C146() equipment also meets the intent of this guidance through compliance with paragraph RTCA/DO-229 paragraph 2.2.1.4.2.1, it is suggested that this text be modified to "(compliant with the full-scale deflection sensitivity requirement of TSO-C129a paragraph (a).3.(viii)) or RTCA/DO-229() paragraph 2.2.1.4.2.1."

response *Accepted*

Text amended.

comment *142* comment by: *Garmin International*

The equation for ASE (ft) in section 6.3.2 item a) is not clear as to how to interpret its meaning. For example, the equation appears to have a period between "10^{-8}" and "(h + delta h)". Is the period supposed to be the "·" symbol for multiplication?

Additionally, there appears to be a period between "6.5" and "10^{-3}". Is the period supposed to be the "·" symbol for multiplication? If so, should the "·" appear between "-8.8" and "10^{-8}"? Likewise, should the "·" appear between

	"10^{-3}" and "(h + delta h)"?
response	*Partially accepted* ASE formula is deleted from the text for clarity.

comment	*143* comment by: *Garmin International* Section 6.3.2 item b) contains the text "... on a 99.7 percent probability basis should be demonstrated to be less:". Should "less" be "less than" in this sentence?
response	*Accepted* Text amended.

comment	*144* comment by: *Garmin International* Since AMC 20-27 indicates it is focused only on final approach segment baro VNAV, it does not seem to be relevant to include "climb" in the context of the VNAV Equipment Error requirements specified in section 6.3.2 item b) table because the AMC addresses only approaches. Suggest removing "Climb/" from the table's second column heading.
response	*Accepted* Text amended.

comment	*146* comment by: *Garmin International* The 6.3.2, item e), table specifies "150 ft" as the VNAV Equipment Error in the "10000 to 15000 ft" row. "150 ft" is inconsistent with the VNAV equipment error specified in the 6.3.2 item b) table for 10000 ft to 15000 ft. The 6.3.2 item e) table should specify "220 ft" for 10000 ft to 15000 ft to be consistent. Additionally, it may be necessary to adjust the Vertical Total System error for 10000 ft to 15000 ft if the RSS was computed using 150 ft rather than 220 ft.
response	*Partially accepted* 220 ft is replaced by 150 ft. in paragraph 6.3.2 item b) table for 10000 ft to 15000 ft for consistency between the 2 tables. An error of 150ft is required to ensure the provision of a sufficient buffer between the Vertical TSE and the obstacle clearance.

comment	*147* comment by: *Garmin International* Section 6.3.2 item f) uses the abbreviation "FAP" but there is no definition of "FAP" in AMC 20-27. Suggest adding a definition of "FAP" to AMC 20-27.
response	*Accepted* Definition of FAP : Final Approach Point added to APPENDIX 1: GLOSSARY

comment	*148* comment by: *Garmin International*

	In the second paragraph of section 6.4, Garmin does not know of a requirement for TSO-C129() or TSO-C146() equipment to provide an alert "if the probability that the TSE exceeds 0.6 NM (for the final approach segment) or 2NM (for initial, intermediate and missed approach segment) is greater than 10-5". It appears that AMC 20-27 desires to use existing TSO-C129() and TSO-C146() equipment without modification, so how can compliance be shown for this guidance?
response	*Accepted* The text has been amended for clarity and consistency with the ICAO PBN manual (Doc 9613).

comment	*218* comment by: *Cessna Aircraft Company* **For 6.3 Accuracy** **6.3.1 Horizontal** "In order to satisfy the ±0.3 NM TSE accuracy for the final approach segment, FTE (95%) should not exceed ±0.25 NM whatever the operating mode (manual, Flight Director or Autopilot): a) An FTE (95%) of ±0.25NM is assumed for manual mode if a standardised CDI is installed (compliant with the full scale deflection sensitivity requirement of TSOC129a paragraph (a).3.(viii)) Otherwise, it should be demonstrated that an FTE of ±0.25 NM can be maintained under all foreseeable conditions through a dedicated flight test evaluation. b) An FTE (95%) of ±0.25NM is assumed when coupled to a flight director. c) An FTE (95%) of ±0.125 NM is assumed when coupled to an autopilot. Outside of the Final Approach Segment, an FTE of ±0.5 NM may be assumed." **COMMENT- The meaning as written and understood by one commenter, is that EASA has made <u>assumptions</u> in (a)(b)(c) that define the FAS FTE and as long as the applicant agrees with that <u>assumption</u>, there is no need to conduct flight tests to determine FTE. Is that their intention?** **Clarification for one example:** **b) A demonstrated FTE (95%) of ±0.25NM is assumed when coupled to a flight director.**
response	*Accepted* Text amended.

comment	*275* comment by: *DGAC France* **1 <u>AFFECTED PARAGRAPH:</u>** **AMC 20-27 Paragraph 6.3.2.b) VNAV equipment error** **2. <u>PROPOSED TEXT/ COMMENT</u>:** The VNAV equipment error for operation on airport at altitude above 10 000 ft must be 150 ft instead of 220 ft. a) The table should be amended as follow:

	Climb/Descent Along Specified Vertical Profile (angle) (ft)
At or below 5000 ft (MSL)	100
5000 ft to 10000 ft (MSL)	150
10000 ft to 15000 ft (MSL)	~~**220**~~ **150**

b) Add the following note:
Note 2: VNAV equipment error requirement is more stringent compared with AC 20-129 and the ICAO PBN manual where 220 ft (from 10000 ft to 15000 ft MSL) is required.

3. JUSTIFICATION:

The VNAV equipment error is to be reduced from 220 ft to 150 ft (compared with AC 20-129) to satisfy the safety level described in paragraph 6.3.2.f (Vertical Total System error). If 220 ft is used in the RSS computation the safety margin (buffer) for this operation is not sufficiently important and therefore not acceptable.

In order to highlight the differences between AMC 20-27 and AC 20-129 regarding the VNAV equipment error requirement, it is recommended to add a second note clarifying that AMC 20-27 VNAV equipment error budget is more stringent compared with AC 20-129 for operation on airport at altitude above 10000 ft.

response *Accepted*

Text amended.

comment *323* comment by: *FAA*

NPA COMMENT FORM

This Comment Form is to be used by an Office of Other Interest (OOI) when providing comments on an EASA NPA. If the OOI has more than one comment, please duplicate this Comment Form and place any additional comment(s) on a separate form(s).
This Comment Form should be sent to the Office of Primary Responsibility (OPR) by the due date established by the OPR.

1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):

NPA 2-008-14, AMC 20-27, page 73, 6.3.2a

2. Comment (Please state your comment clearly and in plain language):
The altimetry accuracy stated in this paragraph cannot be assumed for any system that complies with the certification requirements. The certification requirement excludes calibration error, which is operationally allowed to be 75' at time of departure (confirmed by the mandatory pilot procedure to check the

altimeter reading against the field elevation before takeoff). The VEB altimetry performance is loosely associated with RVSM-capable aircraft, but no conclusive relationship has been found. The FAA requires any applicant to provide data to support the conclusion that their aircraft provides the requisite performance, and also identifies any continuing airworthiness considerations to maintain that accuracy. For these reasons, the FAA criteria for Baro APV RNP APCH (AC 20-129 and AC 90-97) does not modify the altimetry performance in any way. The altimetry performance is assumed to be worse than the VEB altimetry, and is compensated by reducing the along-track coupling error and flight technical error (as compared to the proposed AMC 20-27).

3. Justification (Please provide support for your comment):

4. Proposed Alternative Text (If any):
Recommend deleting all references to VEB altimetry equation.

5. Person Providing Comment (Include routing symbol):
FAA AIR-130

NPA COMMENT FORM

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This Comment Form should be sent to the Office of Primary Responsibility (OPR) by the due date established by the OPR.

1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):

NPA 2-008-14, AMC 20-27, page 74, 6.3.2c

2. Comment (Please state your comment clearly and in plain language):
The HCE is considerably smaller due to the restriction of using baro APV on GNSS approaches. The GNSS along-track error is conservatively estimated at 100m (95%).

3. Justification (Please provide support for your comment):

4. Proposed Alternative Text (If any):
Recommend updating the text to reflect the actual HCE experienced in GNSS operations.

5. Person Providing Comment (Include routing symbol):
FAA AIR-130

NPA COMMENT FORM

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This Comment Form should be sent to the Office of Primary Responsibility

(OPR) by the due date established by the OPR.

1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):

NPA 2-008-14, AMC 20-27, page 74, 6.3.2d (also 7.2, 1)

2. Comment (Please state your comment clearly and in plain language):
The FAA restricts the FTE to considerably smaller values in AC 90-97, by: a) requiring the use of flight director or autopilot; b) requiring the flight crew to monitor vertical deviation and limit the maximum deviation to 50 ft low (100 ft high). Through these operational restrictions, there is no need to modify the original airworthiness criteria in AC 20-129.

3. Justification (Please provide support for your comment):

4. Proposed Alternative Text (If any):

Delete this FTE guidance. Later text invokes operational use of the FTE limits stated above.

5. Person Providing Comment (Include routing symbol):
FAA AIR-130

NPA COMMENT FORM

This Comment Form is to be used by an Office of Other Interest (OOI) when providing comments on an EASA NPA. If the OOI has more than one comment, please duplicate this Comment Form and place any additional comment(s) on a separate form(s).
This Comment Form should be sent to the Office of Primary Responsibility (OPR) by the due date established by the OPR.

1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):

NPA 2-008-14, AMC 20-27, page 74, 6.3.2e

2. Comment (Please state your comment clearly and in plain language):
The use of a 3-sigma value is not explained, and does not appear to have any relation to a target level of safety. Assuming the performance characterizations are accurate, that would result in 1 in 1000 approaches going below the obstacle clearance surface. If a VEB methodology is adopted, recommend use of a 5.3 to 6-sigma value to be consistent with the TLS.

3. Justification (Please provide support for your comment):

4. Proposed Alternative Text (If any):

5. Person Providing Comment (Include routing symbol):

FAA AIR-130

response *Noted*

6.3.2.a: Partially accepted. ASE formula deleted from the main text for clarity. However, it is retained as a footnote defining the value ASE used in paragraph

6.3.2 e).

Para 6.3.2.c: Not Accepted. A conservative Horizontal Coupling error leads to additional safety margins.

Para 6.3.2.d: Not Accepted. FTE value permits manual flight if a Vertical Deviation Indicator with a sufficient full scale deflection is installed. This does not prevent the use of autopilot or flight director which would lead to a lower FTE.

Para 6.3.2.e: Noted. The text just after the table explains how the Target Level of Safety is demonstrated. This was discussed with ICAO IFPP members. The principle is not different from the horizontal plane (2 SD value + buffer) except that in the vertical plane a 3 SD value is used and added to a vertical buffer.

resulting text: See Appendix C

B. Draft Decision - AMC 20-27: 6. RNP APCH Airworthiness Criteria - 6.5 Continuity of Function p. 76-77

comment *18* comment by: *KLM*

Page 76:

6.5 Continuity of function
It shall be demonstrated that:
(a) The probability of loss of all navigation information is Remote.
(b) The probability of nonrestorable
loss of all navigation and communication functions
is Extremely Improbable.

Which organization or person has to perform this. Unclear and with the system requirements not necessary. Delete as not useful and unclear.

response *Not accepted*

Terminology used in this paragraph is that used in the airworthiness terminology as defined in the CS requirements. It is the responsibility of the (S)TC holder to demonstrate airworthiness requirements.

comment *32* comment by: *AEA*

Relevant Text: *It shall be demonstrated that:*
(a) The probability of loss of all navigation information is Remote.
(b) The probability of nonrestorable loss of all navigation and communication functions is Extremely Improbable.
Comment: Which organization or person has to perform this. Unclear and with the system requirements not necessary.
Proposal: Delete as not useful and unclear

response *Not accepted*

Terminology used in this paragraph is that used in the airworthiness terminology as defined in the CS requirements. It is the responsibility of the (S)TC holder to demonstrate airworthiness requirements.

comment

118 comment by: *Boeing*

AMC 20-27
Page: 76
Paragraph 6.4 Integrity

Significant Change Request: Boeing suggests that the following changes be made:

1. Add ***"Note 7: For aircraft and systems approved for RNP AR operations, per AMC 20-26, the crew alerting based upon RNP is an acceptable alternative."***

2. Remove the requirement for two separate altimeters.

JUSTIFICATION:

1. Systems with RNP alerting should be addressed so as not to imply or impose additional and unnecessary requirements for alerting.

2. The obstacle clearance margins for RNP APCH are such that aircraft can be operated with single system installations, and that dead reckoning operations can be safely performed. Adding more stringent requirements for system installations does not seem appropriate unless conventional operations and mitigations are being eliminated.

response

Partially accepted

1: Accepted. Note 7 added.

2: Not Accepted. The requirement for 2 altimeters to is maintained. This is to ensure the correct crosscheck of the displayed altitude during the approach.

comment

179 comment by: *ERA*

6.4, Note 2: states "An airborne safety objective of Remote is applicable to an instrument approach in particular on the final segment, i.e. from the FAF down to the runway."
Where is this requirement for 10E-5 stated? If ICAO Doc 8168 is the source, could the specific reference be given?

response

Noted

Quantitative and qualitative probabilities are defined in the Certification Specifications.

resulting text

See Appendix C

B. Draft Decision - AMC 20-27: 7. Functional Criteria - 7.1 Required Function p. 77-79

for RNP APCH

comment *119* comment by: *Boeing*

AMC 20-27
Page: 77
Paragraph 7.1, Required Function for RNP APCH
Table Item 1

Significant Change Request: Boeing suggests that the last paragraph on the general aspects of flight director and/or autopilot should be removed or clarified.

JUSTIFICATION: The RNP for RNP APCH procedures is such that the procedures can be flown manually and even with dead reckoning in the event of loss of GNSS.

response *Accepted*

Text deleted.

comment *120* comment by: *Boeing*

AMC 20-27
Page: 77
Paragraph 7.1, Required Function for RNP APCH
Table Item 3

Clarification Request: Boeing suggests that the second full sentence in Item 3 be changed read:

"The resolution to which the data is stored ~~should~~ ***must*** *be sufficient to ~~achieve the required track keeping accuracy~~* ***ensure that the assumption of no path definition error is satisfied."***

.

JUSTIFICATION: The proposed requirement is in conflict with the current TSE and FTE requirements. FTE path tracking and associated errors is tracking performance, not a measure of errors in the path being followed

response *Accepted*

Text amended.

comment *121* comment by: *Boeing*

AMC 20-27
Page: 79
Paragraph 7.1, Required Function for RNP APCH
Table Item 18

Significant Change Request: Boeing suggests that the following be added to Item 18:

"Note: Systems providing RNP alerts that reflect loss of GNSS integrity are considered acceptable."

	JUSTIFICATION: RNP APCH should allow for systems and functions predicated on RNP with appropriate and associated alerts.
response	*Accepted* Text amended.

comment	*149* comment by: *Garmin International* Section 7.1 table item 1 sub-item 3) ends with the text "(See also ETSO/TSO C129a)". It is unclear what purpose this parenthetical reference serves since AMC 20-27 section 6.3.1 already references the TSO-C129 CDI scale paragraph. Additionally, this reference appears to exclude ETSO/TSO-C129 equipment built to the initial revision (i.e., not C129a). This reference also appears to exclude ETSO/TSO-C146() equipment. Suggest that this parenthetical reference be removed or corrected.
response	*Accepted* Reference to ETSO-C129a deleted from text.

comment	*150* comment by: *Garmin International* Section 7.1 table item 1 paragraph beginning with "Enhanced navigation display ...". It is unclear why this guidance is even necessary, particularly the statement "This is particularly true for GNSS stand-alone receiver (see 8.4.2)." Suggest removing the text "This is particularly true for GNSS stand-alone receiver (see 8.4.2)." and otherwise clarifying this paragraph as to the perceived issue that it is seeking to address. The installation of the CDI/(E)HSI location in the primary field of view should provide the to/from indication, failure indicator and lateral deviation indication. Standalone GNSS equipment that meets TSO-C129() and TSO-C146() provide the outputs to drive the CDI/(E)HSI to/from indication, failure indicator and lateral deviation indication, including automatic display scaling/full-scale deflection that is in agreement with alerting and annunciation limits suitable for the current phase of flight. Thus, when these outputs are used in an installation that places the CDI/(E)HSI in the primary field of view, these indications should be sufficient. If the foregoing is accomplished, there is no need for an IFR-approved moving map display. See also Garmin comments on section 8.4.2.
response	*Accepted* Sentence deleted.

comment	*151* comment by: *Garmin International* Section 7.1 table item 10 indicates that the navigation system must provide the ability to display distance to go to any waypoint selected by the flight crew. The text for this item appears to be verbatim from AC 90-101, Appendix 2, paragraph 3.d.(11). However, it is unclear what benefit the flight crew gains by having the ability to display distance to go to any arbitrary waypoint

	selected by the flight crew. Section 7.1, table item 9 indicates display of distance between flight plan waypoints is a requirement. It appears that item 10 is more appropriately limited to any flight plan waypoint rather than to any arbitrary waypoint. Suggest changing the text to "... display distance to go to any flight plan waypoint selected by the flight crew."
response	*Partially accepted* The text has been amended to aid clarity.

comment	*152* comment by: *Garmin International* Section 7.1, table item 16 says "Capability to automatically execute leg transitions consistent with ARINC 424 FA path terminators, or RNAV system must permit the pilot to fly a track ...". FA path terminators are associated with a magnetic course not a track. Consequently, use of the term "track" is inconsistent. Suggest changing "track" to "magnetic course".
response	*Partially accepted* Text amended, the term “track” is replaced by “course”.

comment	*276* comment by: *DGAC France* **1 AFFECTED PARAGRAPH: AMC 20-27 Paragraph 7.1 Required function for RNP APCH Item 3** **2. PROPOSED TEXT/ COMMENT:** Rewrite as follows: ".....*already loaded into the RNAV/GNSS system as permitted by paragraph 10.~~1.2.~~ (See appendix 4 paragraph 1.2) However, the procedure stored....."* **3. JUSTIFICATION:** Editorial The paragraph 10.1.2 reference, which is quoted in Item 3, doesn't exist anymore.
response	*Partially accepted* Text amended to refer to paragraph 10, which defines the operational approval criteria.

comment	*299* comment by: *Thales Avionics* Page 78, §7.1 Item 10 Flight Management systems generally provide distance to go (along path) only to the active (To) waypoint and the Destination (MAPt). Direct distance is provided for other waypoints. Proposed text for Item 10: "Display of distance ~~to go~~. The navigation system must provide the ability to display **the direct** distance ~~to go~~ to any waypoint selected by the flight crew and **distance to go for at least the active (To) waypoint. "** Note: equivalent requirement is found in PBN Manual only for RNP AR APCH. PBN Manual is less demanding for RNP APCH:

"g) The means to display the following items on a readily accessible display page:
(i)The display of distance between flight plan waypoints
(ii)The display of distance to go
(iii)The display of along track distances"

response *Partially accepted*

The text has been amended to aid clarity.

comment *304* comment by: *Thales Avionics*

Minor comment.

Page 78, §7.1 Item 15

Replace: EUROCAE ED75A/RTCA DO236A

by: EUROCAE ED75B/RTCA DO236B

response *Partially accepted*

The text is amended to clarify that either ED 75A/DO236A or ED 75B/DO 236B is acceptable.

comment *324* comment by: *FAA*

NPA COMMENT FORM

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1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):

Page 77, Item 1, last sentence states: "In this case coupling to the flight director and/or automatic pilot from the RNAV system should be indicated with an unambiguous mode."

2. Comment (Please state your comment clearly and in plain language):

What's needed is not an "unambiguous mode". What's needed is an "unambiguous annunciation."

3. Justification (Please provide support for your comment):

Editorial for clarity.

4. Proposed Alternative Text (If any):

Change the sentence to read, "In this case coupling to the flight director and/or automatic pilot from the RNAV system should be indicated with an

unambiguous annunciation."

5. Person Providing Comment (Include routing symbol):
FAA AIR-130

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1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):
Page 77, Item 3, b) states: "from which approach procedures can be retrieved and loaded into the RNAV system."

2. Comment (Please state your comment clearly and in plain language):
This guidance is inadequate and does not reflect the desired requirement to extract the instrument approach procedure in its entirety from the navigation database and prevent piecing the approach procedure together manually. Reference Item 6 on page 78.

3. Justification (Please provide support for your comment):
Editorial for clarity.

4. Proposed Alternative Text (If any):
Change the sentence to read, "from which approach procedures can be retrieved in their entirety and loaded into the RNAV system."

5. Person Providing Comment (Include routing symbol):
FAA AIR-130

response

Partially accepted

Sec 7.1 Item 1: Partially Accepted. The sentence has been deleted as a result of other comments.

Sec 7.1 Item 3b: Accepted. Text amended.

comment

340 comment by: *ECOGAS*

Para 7.1 Item 3: Reference to paragraph 10.1.2 is unclear in its intention - where is paragraph 10.1.2?

response

Accepted

Text amended to refer to paragraph 10, which defines the operational approval criteria.

resulting text

See Appendix C

B. Draft Decision - AMC 20-27: 7. Functional Criteria - 7.2 Additional Required Function for APV BARO-VNAV Operation p. 79-80

comment *24* comment by: *KLM*

Section: 7.2
Page: 79
Relevant Text: Item 1.
+100/-50 ft is mentioned. F/D and/or A/P is not required, but becomes an obligation if the requirement cannot be met.
Comment: It seems that +100/-50 ft becomes the controlling value. Can that play a role in the FTE discussion?

response *Accepted*

Text amended. The +100/-50ft criteria are replaced by +100/-100 ft criteria for consistency purposes. It should be noted that this criteria is not a 3xStandard Deviation criteria.

comment *54* comment by: *AEA*

Ref: 7.2 Additional required function for APV BARO-VNAV operation - Item 1
Relevant Text: +100/-50 ft is mentioned. F/D and/or A/P is not required, but becomes an obligation if the requirement cannot be met.
Comment: It seems that +100/-50 ft becomes the controlling value. Can that play a role in the FTE discussion?

response *Accepted*

Text amended. The +100/-50ft criteria are replaced by +100/-100 ft criteria for consistency purposes. It should be noted that this criteria is not a 3xStandard Deviation criteria.

comment *122* comment by: *Boeing*

AMC 20-27
Page: 80
Paragraph 7.2, Additional required function for APV BAROVNAV operation
Table Item 4

Significant Change Request: Boeing suggests that the altitude display and entry resolutions for below altitude transition levels be revised to be consistent with standard flight instrument displays.

JUSTIFICATION: The proposed requirements have at least two significant issues: One is that one-foot resolution is not usable in analog or digital readouts; the one-foot increment cannot be discriminated and is unreadable in a dynamic operation. The proposed operating margins are predicated on altimeter error, coupling errors, and tracking errors, which also reflect the use of altimetry systems and displays in use today. Lastly, the management and action to one-foot displays has the potential for added workload, e.g., nuisance and distraction to the flight crew.

response *Not accepted*

The resolution requirements are consistent with the ICAO PBN Manual.

comment

153 comment by: *Garmin International*

Section 7.2 table item 1 includes the text "The display must allow the pilot to readily distinguish if the vertical deviation exceeds +100/-50 feet." It is unclear whether this implies that a numeric vertical deviation value must be on a cockpit display (e.g., RNAV CDU), or that the displayed non-numeric vertical deviation must allow the pilot to distinguish if the vertical deviation exceeds +100/-50 feet. Please clarify the intent of this text.

response

Accepted

Text amended to require a non-numeric display.

comment

328 comment by: *FAA*

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1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):

Page 79, Section 7.1, Item 1: "Flight director is not required for this operation..."

2. Comment (Please state your comment clearly and in plain language):

Recommend requiring operational use of flight director or autopilot to reduce FTE. AC 90-97 contains the following guidance on this issue- "Since VDI scaling/sensitivity values vary widely, eligible aircraft must also be equipped with and operationally using either a flight director or autopilot capable of following the vertical path"

3. Justification (Please provide support for your comment):

Consistency between this AMC and AC 90-97 (and draft AC 90-RNP) and also to potentially allow for future operations such as simultaneous RNP approaches that might otherwise not be possible.

4. Proposed Alternative Text (If any):

"Flight Director is required for this operation..." Consideration may be given to providing an exception when operating in visual conditions.

5. Person Providing Comment (Include routing symbol):

Mark Steinbicker, FAA, Performance Based Flight Systems Branch, AFS-470

response	*Not accepted* The requirement is first to define the performance, the FTE in this case. A design fulfilling this objective can be accepted. A VDI with an acceptable full scale deflection is therefore acceptable without mandating FD/AP coupling.

resulting text	See Appendix C

B. Draft Decision - AMC 20-27: 7. Functional Criteria - 7.3 Recommended Function for RNP APCH p. 80

comment	*123* comment by: *Boeing* AMC 20-27 Page: 80 Paragraph 7.3, Recommended Function for RNP APCH Table Item 2 **Clarification Request:** Boeing suggests that the following be added to Item 8: ***"Systems with electronic map display in the pilot's primary field of view having a depiction of the active route are sufficient."*** **JUSTIFICATION:** Course selector is applicable to CDI-type displays. Electronic map displays do not need an explicit Course Selector.
response	*Accepted* Text amended.

resulting text	See Appendix C

B. Draft Decision - AMC 20-27: 7. Functional Criteria - 7.4 Recommended Function for APV BARO-VNAV operation p. 80-81

comment	*154* comment by: *Garmin International* Section 7.4 table item 2 uses the abbreviation "FAP" but there is no definition of "FAP" in AMC 20-27. Suggest adding a definition of "FAP" to AMC 20-27.
response	*Accepted* Definition of FAP: Final Approach Point added to APPENDIX 1: GLOSSARY.

comment	*325* comment by: *FAA* NPA COMMENT FORM

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1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):
NPA 2-008-14, AMC 20-26, page 80, section 7.2, 7

2. Comment (Please state your comment clearly and in plain language):
The FAA does not require use of independent altimeter for cross-check.

3. Justification (Please provide support for your comment):

4. Proposed Alternative Text (If any):

5. Person Providing Comment (Include routing symbol):
FAA AIR-130

NPA COMMENT FORM

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1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):
NPA 2-008-14, AMC 20-27, page 81, section 8

2. Comment (Please state your comment clearly and in plain language):
For aircraft that comply with AC 20-138() or AC 20-130A, with TSO-C129() or TSO-C145/146(), should not warrant any further evaluation or compliance.

3. Justification (Please provide support for your comment):

4. Proposed Alternative Text (If any):
Clarify that any installation (new or old) accomplished in accordance with AC 20-138() or 20-130A with TSO-c129() Class A or 146(), or 115()/129() FMS with -129 Class B/C or 145 sensor is considered compliant without unique review.

5. Person Providing Comment (Include routing symbol): FAA AIR-130

response

Partially accepted

Sec 7.2 Item 7: Noted. The requirement for 2 altimeters is to ensure the correct crosscheck of that displayed altitude during the approach.

Sec 8: Partially accepted. Para 8.3 has been amended to clarify that previous approvals are acceptable.

resulting text	See Appendix C

B. Draft Decision - AMC 20-27: 8. Airworthiness Compliance - 8.4 Specific Installation assessment p. 83

comment	*155* comment by: *Garmin International* Section 8.4.1 uses the abbreviation "FAP" but there is no definition of "FAP" in AMC 20-27. Suggest adding a definition of "FAP" to AMC 20-27.
response	*Accepted* Definition of FAP: Final Approach Point added to APPENDIX 1: GLOSSARY.

comment	*156* comment by: *Garmin International* Section 8.4.2 contains text that says: "Enhanced navigational display is considered, for certain installation (e.g. GNSS stand-alone receiver installation), as an essential function for the crew to verify the approach procedure loaded from the navigational database. For the vast majority of GNSS standalone receiver installations (e.g. ETSO/TSO C 129() class A1 equipment) this display is a key element for the navigation crew monitoring and for the verification of the approach procedure loaded from the navigation database." it is unclear why a GNSS stand-alone receiver installation requires an enhanced navigational display when other installations do not. For example, an FMS Legs page provides the same basic information as a GNSS stand-alone receiver's Active Flight Plan page. So, why is a GNSS stand-alone receiver installation singled out in this text? Is it single-pilot operation v. dual-pilot operation? What are the conditions that lead to this guidance implying that a GNSS stand-alone receiver installation is inferior to other installations? Suggest removing the text "(e.g. GNSS stand-alone receiver installation)" and the text "For the vast majority of GNSS standalone receiver installations (e.g. ETSO/TSO C 129() class A1 equipment) this display is a key element for the navigation crew monitoring and for the verification of the approach procedure loaded from the navigation database." Installations accomplished in accordance with current and previous policy and guidance do not require certification credit for the moving map display. As such, installations past and present that meet the criteria of current and previous policy should not be required to achieve certification credit for the moving map display (i.e., "IFR approved moving map display"). Additionally, suggest clarifying the text in this section to provide objectively verifiable conditions that will lead both an operator and certification authority inspector to the same conclusion as to when an installation requires an enhanced navigational display. See also Garmin comment on Section 7.1 table item 1 paragraph beginning

	with "Enhanced navigation display ...".
response	*Partially accepted* Text amended to clarify the intent of the requirement, i.e. that not only stand-alone equipment is affected by this requirement.

comment	*219* comment by: *Cessna Aircraft Company* **For 8.4.3 Intermixing of equipment** "Simultaneous use of RNAV systems with different crew interfaces can be very confusing and can lead to problems when they have conflicting methods of operation and conflicting display formats. For approach operations, simultaneous use of RNAV equipment which are not identical or compatible is not permitted." **Comment: More clarification is needed here. The intent of this subparagraph is neither clear nor concise. Beware of a possible conflict with TGL-10 para 8.5.**
response	*Not accepted* The Agency considers this paragraph to be clear in its meaning.

resulting text	See Appendix C

B. Draft Decision - AMC 20-27: 9. Aircraft Flight Manual/ Pilot Operating Handbook p. 83-84

comment	*19* comment by: *KLM* Page 84 b) Appropriate amendments or supplements to cover RNP APCH approach operations in the following sections: • Limitations - including use of VNAV, FD and AP; currency of navigation database; crew verification of navigation data; availability of RAIM or equivalent function; restrictions on use of GNSS for conventional Non Precision Approaches. • Normal Procedures • Abnormal Procedures - including actions in response to a Loss of Integrity (e.g. 'RAIM Position Warning', (or equivalent) message or a 'RAIM not available', (or equivalent) message). Note: This limited set assumes that a detailed description of the installed system and related operating instructions and procedures are available in other approved operational or training manuals.

RAIM checks before actual flight may only be useful when period for the whole of the approach procedure plus/minus an amount of time is defined. More useful is the integrity check on board the aircraft with warnings to indicate that insufficient GNSS updating is available and the ANP is not ensured. The actual navigation performance is important and RAIM checks can be deleted.

response *Not accepted*

For systems based only on GNSS, RAIM prediction is necessary and is required. Appendix 4 paragraph 1.2 clearly indicates the time window where RAIM prediction should be checked (ETA +/- 15 min).
For systems not only based on GNSS, requirement for RAIM prediction could be different. In that case manufacturer documentation is the reference (e.g. RAIM prediction required only when there are less than "xx" satellites in the constellation).

comment *33* comment by: *AEA*

Relevant Text:
b) Appropriate amendments or supplements to cover RNP APCH approach operations in the following sections:

- *Limitations - including use of VNAV, FD and AP; currency of navigation database;crew verification of navigation data; availability of RAIM or equivalent function;restrictions on use of GNSS for conventional Non Precision Approaches.*
- *Normal Procedures*
- *Abnormal Procedures - including actions in response to a Loss of Integrity (e.g. 'RAIM Position Warning', (or equivalent) message or a 'RAIM not available', (or equivalent) message).*

Note: This limited set assumes that a detailed description of the installed system and related operating instructions and procedures are available in other approved operational or training manuals.
Comment: RAIM checks before actual flight may only be useful when period for the whole of the approach procedure plus/minus an amount of time is defined. More useful is the integrity check on board the aircraft with warnings to indicate that insufficient GNSS updating is available and the ANP is not ensured.
Proposal: The actual navigation performance is important and RAIM checks can be deleted.

response *Not accepted*

For systems based only on GNSS, RAIM prediction is necessary and is required. Appendix 4 paragraph 1.2 clearly indicates the time window where RAIM prediction should be checked (ETA +/- 15 min).
For systems not only based on GNSS, requirement for RAIM prediction could be different. In that case manufacturer documentation is the reference (e.g. RAIM prediction required only when there are less than "xx" satellites in the constellation).

B. Draft Decision - AMC 20-27: 10. RNP APCH Operational Criteria p. 84-87

comment	*25* comment by: *KLM* Section: 10.3 and Appendix 2 **Page**: 85 and 91 Relevant Text: Aerodrome Competence and Operator verification **Comment**: EU OPS 1.975 covers these requirements and is standard practice. The Operator should have the assurance that the published procedure is based on the design requirements. The amount of APV Baro-VNAV will increase rapidly and should therefore not be treated as special procedures, provided the training and airport selection requirements as published in EU OPS are complied with. **Proposal**: Only refer to the EU OPS rule.
response	*Not accepted* EU OPS is only applicable to commercial air transportation, and aircraft other than those engaged in commercial air transportation can fly RNP APCH. Thus, all operators regardless of the type of operations shall ensure the same level of evaluation is performed to maintain safety.

comment	*73* comment by: *Eurocontrol* 10.2 para 3 a) Comment Flight Crews should take precautions to switch altimeter settings at appropriate times..... Justification vague for a certification document - what are the appropriate times? Give examples.
response	*Noted* Section 10 provides only general operational guidance. Details of crew procedures are provided in Appendix 4. Regarding altimeter setting see Appendix 4 paragraph 1.2.

comment	*175* comment by: *UK CAA* **Paragraph:** AMC 20-27, para 10 and Appendix 4 **Page:** 84 **Comment:** It is not agreed that the AFM or AFM Supplement should detail the Operating Procedures. This is not appropriate. Such procedures should be documented in the Fight Crew Operations Manual (FCOM) or equivalent. **Justification:** The AFM should only contain Limitations and that which is relevant to Normal, Abnormal and Emergency Procedures consistent with current practices. The material detailed in Appendix 4 is purely operational. **Proposed Text:** Amend para 10 to remove reference of placing operating procedures in the AFM.
response	*Accepted* Text amended.

comment 278 comment by: *DGAC France*

1 AFFECTED PARAGRAPH:

AMC 20-27 Paragraph 10, RNP APCH Operational criteria

2. PROPOSED TEXT/ COMMENT:
Modify the paragraph as follows:

"Operations of the RNAV system should be in accordance with the AFM or AFM supplement. ~~The items to be addressed in the AFM or AFM supplement~~ The operational procedures to be addressed by the operator are detailed in appendix 4. The (Master) Minimum Equipment List (MMEL/MEL) should be amended to identify the minimum equipment necessary to satisfy operations using the RNAV system."

3. JUSTIFICATION:

Appendix 4 should not be considered as an AFM or AFM supplement. Appendix 4 is identifying operational procedures that should be addressed by the operator (e.g in the OPS manual).
Airworthiness limitation and OPS procedures are different by nature and appendix 4 is addressing only Ops procedures.

response *Accepted*

Text amended.

comment 279 comment by: *DGAC France*

1. AFFECTED PARAGRAPH:

AMC 20-27 Paragraph 10.1 Flight operations documentation

2. PROPOSED TEXT/ COMMENT:

Rewrite as follows:

"10.1 Flight Operations Documentation
The relevant parts and sections of the Operations Manual (e.g. Aircraft Operations manual, check lists, training of crew) should be revised to take account of the operating procedures detailed ~~below (Normal Procedures and Abnormal Procedures).~~ in this section 10 and in particular in the appendix 4. The operator should make timely..... (no further change)"

3. JUSTIFICATION:
This paragraph must consider the appendix 4 content. Appendix 4 identifies operational procedures that should be addressed by operators (e.g in the OPS manual).
Appendix 4 identifies operational procedures that should be addressed by the operator (e.g in the OPS manual). In addition Normal and abnormal procedures are described in Appendix 4 and not below as para 10.1 is indicating.

response *Accepted*

Text Amended.

comment *326* comment by: *FAA*

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1. Affected Text (Please *specify clearly the location (e.g., page number, paragraph/section number) of the proposed text affected by your comment*):
Page 85, Section 10.2, b) Cold Temperature, last sentence states, "If the airborne system contains a temperature compensation capability, manufacturer instructions should be followed for use of the BAROVNAV function."

2. Comment (Please state your comment clearly and in plain language):
This guidance is inadequate and potentially misleading upon operational implementation.

3. Justification (Please provide support for your comment):
Editorial for clarity. The use of temperature compensation must be coordinated with the State's ATC authority and implemented IAW guidelines from the ATC authority. Failure to do so could lead to deviation from the desired vertical plane assigned by ATC a loss of aircraft separation. Need to harmonize FAA, EASA & ICAO guidance materials.

4. Proposed Alternative Text (If any):
Change the sentence to read, "If the airborne system contains a temperature compensation capability, manufacturer instructions should be followed for use of the BAROVNAV function, and the operational use of the temperature compensation function must be coordinated with and approved by the State's ATC authorities."

response *Partially accepted*

Text amended - the term "Air Navigation Service Provider" is used in lieu of "State's ATC authorities".

comment *354* comment by: *European Cockpit Association*

10.2 Flight Crew Training

ADD a "Note" as follows:
"Note: During APV Baro-VNAV operations, the operational crosscheck between altimeter read-out and charted altitude values at FAF or other profile fixes does not protect against altimeter setting errors."

response *Accepted*

Text amended.

resulting text	See Appendix C

B. Draft Decision - AMC 20-27: Appendix 1 - Glossary p. 88-90

comment	*157* comment by: *Garmin International* Appendix 1 Glossary "Basic GNSS operation" definition ends with the phrase "with RAIM compliant to TSO C 129a". TSO-C146a equipment also provides ABAS capability in the absence of SBAS integrity messages. Suggest changing the phrase to "with fault detection compliant to TSO-C129a, TSO-C145a or TSO-C146a".
response	*Accepted* Text Amended.

comment	*158* comment by: *Garmin International* Appendix 1 Glossary TSO-C146() Class GAMMA and TSO-C145() class BETA definitions. TSO-C146() implies RTCA/DO-229 Class Gamma equipment. Likewise, TSO-C145() implies RTCA/DO-229 Class Beta equipment. In other words, the "Class GAMMA" and "Class BETA" portions of these terms are redundant. Suggest changing these definitions to begin: TSO-C146(): Equipment consisting ... TSO-C145(): Equipment consisting ...
response	*Not accepted* ETSO-C146() does not only include Class GAMMA equipment but includes also class DELTA. The ETSO-C145( ) description will be kept for clarity.

comment	*159* comment by: *Garmin International* Appendix 1 Glossary TSO-C146() or TSO-C145( ) Operational Class 3 definition. While this equipment does support APV II approaches, such approaches are not classified as precision approaches. Additionally, this class of equipment does not support GLS approaches; GLS approaches are supported by LAAS or GBAS equipment. Suggest changing "LNAV/VNAV, precision approach (APV II and GLS)" to "LNAV/VNAV approach, APV II approach".
response	*Partially accepted* Text amended to delete the reference to precision approach and APV II.

comment	*176* comment by: *UK CAA* **Paragraph:** Appendix 1

Page: 88
Comment:
Appendix 1 is inconsistent in the expansion of acronyms, compare MDA(H) and DA(H).

response *Accepted*

The DA(H) acronym amended to be consistent with MDA(H).

comment *281* comment by: *DGAC France*

1 AFFECTED PARAGRAPH: AMC 20-27 Appendix 1

TSO C 146( ) Class Gamma definition

2. PROPOSED TEXT/ COMMENT:

Modify the definition as follows:
"TSO C 146( ) Class GAMMA: This functional class corresponds to an equipment consisting of both the GNSS/SBAS position sensor and a navigation function, so that the equipment provides path deviations relative to a selected path. The equipment provides the navigation function required of a stand-alone navigation system. This equipment also provides integrity in the absence of ~~WAAS~~ **SBAS** signal through the use of FDE. In addition, this class of equipment requires a data base, display outputs and pilot controls."

3. JUSTIFICATION:

WAAS should be replaced by SBAS in order to reflect all possible Space Based Augmentation Systems (WAAS, EGNOS, MTSAT,...).

response *Accepted*

Text Amended.

comment *282* comment by: *DGAC France*

1 AFFECTED PARAGRAPH: AMC 20-27 Appendix 1

TSO C 146() or TSO C 145 () operational class 3

2. PROPOSED TEXT/ COMMENT:

Replace the existing definition by the following one:

"TSO C 146() or TSO C145 ( ) Operational Class 3: This operational class supports oceanic and domestic enroute, terminal and non precision approach, LNAV/VNAV, ~~precision approach (APV II and GLS)~~ **LPV** and departure operation.

3. JUSTIFICATION:

APV II and GLS should be replaced by the LPV wording.

response *Accepted*

Text amended.

resulting text	See Appendix C

B. Draft Decision - AMC 20-27: Appendix 2 - Operational Characteristics of the Procedure and its Operational Use p. 91

comment *55* comment by: *AEA*

Ref: AMC 20-27 - 10.3 & AMC 20-27: Appendix 2
Relevant Text: Aerodrome Competence and Operator verification
Comment: EU OPS 1.975 covers these requirements and is standard practice. The Operator should have the assurance that the published procedure is based on the design requirements. The amount of APV Baro-VNAV will increase rapidly and should therefore not be treated as special procedures, provided the training and airport selection requirements as published in EU OPS are complied with.
Proposal: Only refer to the EU OPS rule.

response *Not accepted*

Non commercial operators who are not required to comply with EU OPS will use RNP APCH procedure, thus additional guidance is required.

comment *124* comment by: *Boeing*

AMC 20-27
Page: 91
Appendix 2, Operational Characteristics of the Procedure and Its Operational Use

Significant Change Request: Boeing suggests that the following revisions be made:

"The operator should show evidence that consideration has been given to ~~the evaluation of any new or modified~~ ***operations involving*** *RNP APCH procedures* ***when associated with aerodrome competence qualification, as specified in EUOPS 1.975.***
~~RNP APCH procedure should be design using straight segments; the operator should check that the selected procedure fulfils this requirement.~~
~~Particular attention should be paid to procedures:~~
~~• in mountainous environments,~~
~~• within the proximity of well known obstacles,~~

- *~~that may require adequate knowledge for the aerodrome access or aerodrome competence qualification, as specified in EUOPS 1.975 or the applicable operational requirements.~~"*

JUSTIFICATION: With the text as proposed in the AMC, EASA would burden operators with the "evaluation" of potentially hundreds of RNP APCH procedures; however, this is the responsibility of the ANSP in each country. Further, the term "modified" (... any new or modified RNP APCH procedures ...) is not defined and can be interpreted in dozens of ways. The typical RNAV (GNSS) approach is vastly easier to fly than the conventional approach it replaces, and RNAV approaches thus far have an excellent safety record,

primarily due to this fact. In light of this, the new proposed requirements do not appear to be justified.

response

Not accepted

The existing text is considered to be applicable to both commercial and non-commercial operators, as such reference to EU OPS 1.975 is not sufficient.

comment

125 comment by: *Boeing*

AMC 20-27
Page: 91
Appendix 2, Operational Characteristics of the Procedure and Its Operational Use

Significant Change Request: Boeing suggests that the last paragraph of Appendix 2 ("*The operational evaluation of a RNP APCH procedure showing evidence of the above mentioned operational characteristics ...")* be deleted in its entirety.

JUSTIFICATION: This is a requirement that will quickly become impossible to fulfill. As indicated in our other comments to this portion of the AMC, with the text as proposed, EASA would burden operators with the "evaluation" of potentially hundreds of RNP APCH procedures; however, this is the responsibility of the ANSP in each country.

response

Not accepted

The Agency does not consider that this requirement will over burden operators as it is only applicable to those procedures where specific knowledge or competency is required.

comment

283 comment by: *DGAC France*

1 AFFECTED PARAGRAPH: AMC 20-27 Appendix 2

2. PROPOSED TEXT/ COMMENT:
Bullet of the appendix 2 should be rearranged as follow:
.....
Particular attention should be paid to procedures:

- **- ...**
- **- ...**
- **- that may require adequate knowledge for the aerodrome access or aerodrome competence qualification, as specified in EU-OPS 1.975 or other related instructions; ~~the applicable operational requirements~~.**

~~The~~ This competence may be required specifically for this RNAV procedure or the procedure may be published for an aerodrome already listed as requiring an aerodrome competence,
~~The~~ This required competence may be aircraft type related and subject to periodic revalidation,

- **- In the absence of radar coverage,**

- **- ….**

3. JUSTIFICATION:

Editorial: the sentences explaining the "competence" are to be put as sub items of the third bullet. It is recommended to strengthen the link by using "this" instead of "the".

Regarding "the applicable operational requirements", it is recommended to replace by "other related instruction": initially, AMC to OPS was the thought document. EU-OPS does not have AMC.

response *Partially accepted*

The Text has been amended to strengthen the sentence. The term "applicable operational requirements" is maintained as non-commercial operators will also use an RNP APCH and are subject to operational requirements.

resulting text: See Appendix C

B. Draft Decision - AMC 20-27: Appendix 3 - Alternative Navigation Database Integrity Check p. 92-93

comment *284* comment by: *DGAC France*

1 AFFECTED PARAGRAPH: AMC 20-27 Appendix 3 para 2.1

2. PROPOSED TEXT/ COMMENT:
Replace reference "C.1" by "1" as follow:
"…
2.1 The Operator verification process
The operator should, at the very least, verify the information listed in ~~C.~~1, by comparison with the official published data.
…."

3. JUSTIFICATION:

Editorial

response *Accepted*

Text amended.

resulting text: See Appendix C

B. Draft Decision - AMC 20-27: Appendix 4 - AFM Procedures p. 94-97

comment *26* comment by: *KLM*

Section: App 4
Page: 94
Relevant Text: e)
Comment: The requirement that 2 RNAV systems must be available when the missed approach procedure is based on RNAV is limiting. I wonder whether this is understood by the designers at this moment and that most RNAV approaches use RNAV missed approaches. The question is whether e.g. a single FMS system as applied fro many B737,s in relation to the missed approach (probability) is not overly specified.
Comment: The requirement that 2 RNAV systems must be available when the missed approach procedure is based on RNAV is limiting. I wonder whether this is understood by the designers at this moment and that most RNAV approaches use RNAV missed approaches. The question is whether e.g. a single FMS system as applied fro many B737,s in relation to the missed approach (probability) is not overly specified.
Proposal: Reconsider this requirement.

response *Accepted*

The text has been amended without requesting explicitly the carriage of dual RNAV systems.

comment *27* comment by: *KLM*

Section: App 4
Page: 95 through 97
Relevant Text: Related to the RAIM check
Comment: We would not like to put the burden on a whole dispatch organisation to do a prediction when not really necessary.
Proposal: Clear information is needed related to the role of RAIM. The prediction has a low level of integrity. There is a need for a statement that when systems are used with GNSS and IRS there is no need for this. The GNSS check prior the FAF with the obligation to discontinue and to continue after the FAF should be stated as a sufficient solution.

response *Partially accepted*

Text has been amended to clarify that RAIM prediction is only necessary where RAIM algorithm has been implemented in the GNSS system.

comment *56* comment by: *AEA*

Ref: AMC 20-27: Appendix 4- 1.1 Pre-flight Planning
Relevant Text: e) If the missed approach procedures is based on conventional means....
Comment: The requirement that 2 RNAV systems must be available when the missed approach procedure is based on RNAV is limiting. I wonder whether this is understood by the designers at this moment and that most RNAV approaches use RNAV missed approaches. The question is whether e.g. a single FMS system as applied fro many B737,s in relation to the missed approach (probability) is not overly specified.
Comment: The requirement that 2 RNAV systems must be available when the missed approach procedure is based on RNAV is limiting. I wonder whether this is understood by the designers at this moment and that most RNAV approaches use RNAV missed approaches. The question is whether e.g. a single FMS system

	as applied fro many B737,s in relation to the missed approach (probability) is not overly specified. **Proposal**: Reconsider this requirement.
response	*Accepted* The text has been amended without requesting explicitly the carriage of dual RNAV systems.

comment	*57* comment by: *AEA* Relevant Text: Pages 95 to 97 Related to the RAIM check **Comment**: We would not like to put the burden on a whole dispatch organisation to do a prediction when not really necessary. **Proposal**: Clear information is needed related to the role of RAIM. The prediction has a low level of integrity. There is a need for a statement that when systems are used with GNSS and IRS there is no need for this. The GNSS check prior the FAF with the obligation to discontinue and to continue after the FAF should be stated as a sufficient solution.
response	*Partially accepted* Text has been amended to clarify that RAIM prediction is only necessary where RAIM algorithm has been implemented in the GNSS system.

comment	*74* comment by: *Eurocontrol* Appendix 4 1.1f) Note Comment: missing word -"be" For certain systems, prediction is not systematic but is only required in specific cases and shall **be** detailed in the relevant section of the AFM
response	*Accepted* Text amended.

comment	*126* comment by: *Boeing* AMC 20-27 Page: 94 Appendix 4, AFM Procedures Paragraph 1.1.b) Preflight Planning **Significant Change Request:** Boeing suggests that EASA delete the first two paragraphs in paragraph 1.1.b) **JUSTIFICATION:** This is clearly a function of the navigation data base integrity process and an operator responsibility. The proposed requirements would further burden the crew during an already busy preflight process. There could be dozens of approaches that would need to be checked with no crew time available.
response	*Partially accepted* In conjunction with comment 302 the text has been amended to suppress the reference to the verification by the appropriate process.

comment 127 comment by: *Boeing*

AMC 20-27
Page: 95
Appendix 4, AFM Procedures
Paragraph 1.1.f)

Significant Change Request: Boeing suggests that the following change be made to Paragraph 1.1.f):

*"For those **GNSS** systems relying on RAIM, its availability 15 min before Estimated Time of Arrival (ETA) until 15 min after ETA should be verified during the pre flight planning. In the event of a predicted continuous loss of fault detection of more than five (5) minutes, the flight planning should be revised (e.g. delaying the departure or planning a different approach procedure). ..."*

JUSTIFICATION: For multi-sensor systems having performance monitoring and alerting, the requirement for RAIM predictions is unnecessary and not supported by service history. The probability of loss of RNP 0.3 capability is less than the probability of loss of a conventional (VOR/NDB) Navaid. RNP 0.3 availability typically exceeds 99.97%.

response *Accepted*

Text amended.

comment 128 comment by: *Boeing*

AMC 20-27
Page: 95
Appendix 4, AFM Procedures
Paragraph 1.2 c)

Significant Change Request: Boeing suggests that the first full paragraph be deleted from Paragraph 1.2.c), which reads:

"The crew must also check from the published charts, map display or Control Display Unit (CDU), which waypoints are fly-by and which are fly-over."

JUSTIFICATION: In most cases, this proposed requirement is impossible to do and would be unnecessary, for two reasons:

1. The nav system cannot display such information (unless the turn angle is large and the turning maneuver is displayed); and

2. This is a procedure design issue and airplane system compatibility issue, not an operational issue.

response *Accepted*

Text deleted.

comment 129 comment by: *Boeing*

AMC 20-27
Page: 95

Appendix 4, AFM Procedures
Paragraph 1.2.c)

Significant Change Request: Boeing suggests that the following revision be made to the 2nd full paragraph in Paragraph 1.2.c):

"For multisensor systems, the crew must verify during the approach that GNSS sensor is used for position computation. ***This requirement may be satisfied by an approved RNP alerting system that constantly compares the navigation system performance with the RNP.***"

JUSTIFICATION: This is performance-based navigation, not sensor-based navigation. With certified UNABLE RNP alerting systems, it is unnecessary for the crew to check sensor availability; that is done automatically and safely already. This proposed requirement in many cases would also result in the crew going heads-down at a critical flight phase to check the presence of GPS updating.

response *Not accepted*

Crew should check during the approach that GNSS is being used to ensure that for example if a DME/DME reversion has occurred, for which the infrastructure has not been assessed, contingency procedures should then be applied.

comment *130* comment by: *Boeing*

AMC 20-27
Page: 95
Appendix 4, AFM Procedures
Paragraph 1.2.c)

Significant Change Request: Boeing suggests that the following changes be made to the 4th full paragraph in Paragraph 1.2.c)::

"For those systems relying on RAIM and necessitating a check of its availability for RNP APCH, the flight crew should perform a new RAIM availability check if ETA is more than 15 minutes different from the ETA used during the preflight planning. This check is also performed automatically for ETSO/TSOC129a Class A1 receiver, 2 NM before the FAF ***and is not necessary for systems that have approved RNP alerting systems that show when actual navigation system performance fails to satisfy the RNP for the procedure****"*

JUSTIFICATION: We consider this change essential to avoid unnecessary flightcrew workload at a critical phase of flight.

response *Partially accepted*

A note has been added to the text that introduces the intent of this comment.

comment *131* comment by: *Boeing*

AMC 20-27
Page: 95
Appendix 4, AFM Procedures
Paragraph 1.2.c)

Clarification Request: Boeing requests that the following changes be made to the "Note" in Paragraph 1.2.c):

"Note: Direct to clearance to FAF is not acceptable. ***Modifying the procedure to intercept the final approach course prior to the FAF is acceptable for radar vectored arrivals or at other times with ATC approval****."*

JUSTIFICATION: Our suggested addition would allow for a common and safe practice for all types of approaches, provided the crew is complying with an ATC clearance.

response *Accepted*

Text amended.

comment *132* comment by: *Boeing*

AMC 20-27
Page: 97
Appendix 4, AFM Procedures
Paragraph 1.3., During the Procedures

Significant Change Request: Boeing suggests that the following change be made to the paragraph beginning ""Deviations above and below the vertical path ..." in Paragraph 1.3.:

"Vertical deviation should be monitored above and below the glidepath. The vertical deviation must be within 75 feet below the path during the final approach segment. Below 1000 feet above the airport elevation, maintain vertical deviation within 75 feet high or low relative to the path.
Deviations above path provides additional obstacle clearance margin however, if they exceed 75 feet when the airplane is below 1000 feet above the airport elevation, they can adversely affect stabilized approach criteria."

JUSTIFICATION: Our recommended change would make RNP APCH procedures consistent with RNP AR procedures. There is no justification for being more restrictive for below path deviations than AR approaches, given the greater obstacle clearance criteria for these types of approaches relative to AR approaches. Our certified deviation alerting systems do not address differing maximum deviation values (above and below path), so we strongly recommend using the same value (+/- 75 feet).

response *Partially accepted*

The text has been amended to reflect the requirement of +/- 100 ft, but alignment with RNP AR procedure is recommended for operators conducting these two types of approach.

comment *178* comment by: *ERA*

Appendix 4, 1.1 b) second paragraph: "The pilot should check approach procedures ... as extracted by system (e.g. CDU flight plan page) and

presented graphically on the moving map..."
It is our understanding that a map display is not a hard requirement. Therefore, the text should read "and/or presented" or conditional words added, e.g. "when map display is used".

response

Accepted

Text amended to use the term "or".

comment

184 comment by: *Garmin International*

The AFM should include only those Limitations that must be adhered to. Most of the items shown in Appendix 4 are not candidates for the AFM but should be included in an appropriate training syllabus.

response

Accepted

Text amended to clarify that Appendix 4 is applicable to operational procedure and is therefore not applicable to an AFM section.

comment

213 comment by: *Transport Canada Civil Aviation Standards Branch*

Regarding AMC 20-27, Appendix 4, 1.1 e) and 6.5 Continuity of function - Transport Canada Civil Aviation (TCCA) does not support the requirement that "Two systems must be available and serviceable on board the aircraft" for RNAV-based missed approach procedures. This statement appears to go beyond what is written in section 6.5 Continuity of function. To do so would potentially negate existing approvals for Canadian commercial operators flying RNAV (GNSS) instrument approach procedures. The recommendation that operators develop contingency procedures for the loss of RNP APCH capability is strongly supported. These extraction procedures could be based on the use of traditional nav aids.

response

Partially accepted

The text has been amended without requesting explicitly the carriage of dual RNAV systems.

comment

285 comment by: *DGAC France*

1 AFFECTED PARAGRAPH:

AMC 20-27 Appendix 4

2. PROPOSED TEXT/ COMMENT:

Reword the existing text by:
"
APPENDIX 4: ~~AFM PROCEDURES~~ OPERATIONAL PROCEDURES
~~This appendix may be used by (S)TC holder's to amend their AFM, as part of the airworthiness~~
~~approval, to support these type of operations~~
This appendix should be used by the operator to amend the relevant parts and sections of the Operations Manual as described in 10.1, to support these types of operations
....."

3. JUSTIFICATION:

Appendix 4 identifies operational procedures that should be addressed by the operator (e.g in the OPS manual).
The title and the foreword should be amended to clarify that this appendix is addressing the operational aspect and not the airworthiness

response

Accepted

Text amended to clarify that Appendix 4 is applicable to operational procedure and is therefore not applicable to an AFM section.

comment

286 comment by: *DGAC France*

1. AFFECTED PARAGRAPH: AMC 20-27 Appendix 4

2. PROPOSED TEXT/ COMMENT:
The head of page 95, 96 and 97 are referenced as Appendix 3 instead of Appendix 4.

3. JUSTIFICATION:

Editorial

response

Accepted

Text amended.

comment

302 comment by: *Thales Avionics*

Page 94. Appendix 4, § 1.1b).

Proposed modification:
"
b) The pilot must ensure that RNP APCH procedures which may be used for the intended flight (including alternates aerodromes) are selectable from a valid navigation data base (current AIRAC cycle)~~, have been verified by the appropriate process~~ and are not prohibited by a company instruction or NOTAM.".

Justification: Pilots cannot ensure that the procedures have been verified by the appropriate process.

response

Accepted

Text amended.

comment

305 comment by: *Thales Avionics*

Minor comment

Page 94 Appendix 4, §1.1b) Second para.

Replace MCDU by CDU
Justification: to be consistent with the use of CDU in the rest of the text.

response	*Accepted* Text amended.

resulting text	See Appendix C

B. Draft Decision - AMC 20-27: Appendix 5 - Flight Crew Training Syllabus p. 98-99

comment	*133* comment by: *Boeing* AMC 20-27 Page: 98 Appendix 5 Paragraph: 2. Item 6. **Clarification Request:** Boeing suggests that Item 6, which states "Change arrival airport and alternate airport," be deleted. **JUSTIFICATION:** Item 6 is not related or unique to RNP APCH operations and is part of basic crew procedures.
response	*Not accepted* Flight crew should be familiar with this task.

comment	*134* comment by: *Boeing* AMC 20-27 Page: 98 Appendix 5, Flight Crew Training Syllabus Introductory paragraph **Clarification Request:** Boeing suggests that the following changes be made to the introductory paragraph to Appendix 5: *"The flight crew training program should be structured to provide sufficient theoretical and practical training, using a simulator, training device, or line training in an aircraft, in the concept of RNP APCH operations without or with vertical guidance (APV BAROVNAV) and the use of the aircraft's RNAV system in such operations to ensure that pilots are not just task oriented. The following syllabus should be considered as minimum amendment to the training programme to support ~~these~~* ***the following*** *operations.* ***Operators who are already using procedures, including APV BARO VNAV, to fly other types of approaches, may receive appropriate credit for common training and procedural elements.****"* . **JUSTIFICATION:** Our suggested working would avoid expending resources unnecessarily for training on requirements that have already been satisfied or skills/knowledge that crews already have. Flying RNP APCHs for Boeing 7-series airplane types is identical in standard operating procedures as VOR, NDB, LOC, or other types of conventional non-ILS approaches.
response	*Partially accepted*

	Text amended to reflect the comment.
comment	*303* comment by: *Thales Avionics* Page 98, Appendix 5, §2 6. "6. Change arrival airport and alternate airport" Procedure change on the same airport could be added.
response	*Accepted* Text amended.

resulting text	See Appendix C

Appendix A - Attachments

AttachmentToAMC20_26Appendix6.pdf
Attachment #1 to comment #170

Appendix B

AMC 20-26 Airworthiness Approval and Operational Criteria for RNP Authorisation Required (RNP AR) Operations

This AMC provides guidance material for the airworthiness approval and operational criteria of aircraft to conduct RNP Authorisation Required (AR) Operations. It relates to the implementation of area navigation within the context of the Single European Sky[1], in particular in relation to the verification of conformity of the airborne constituents, per Article 5 of EC Regulation 552/2004. Additional guidance material can be found in the ICAO Performance Based Navigation Manual, Document 9613 Volume II Chapter 6, as contained in ICAO State Letter AN 11/45-07/22.

TABLE OF CONTENTS

[1] Regulation (EC) No 549/2004 of the European Parliament and of the Council of 10 March 2004 laying down the framework for the creation of the single European sky (the framework Regulation) (OJ L 96, 31.03.2004, p. 1).

1. PREAMBLE

As a further development of the concept of area navigation within the European Region, RNP should be implemented on instrument approach procedures supporting increased availability, enhanced safety and reduced operating minima over and above that provided from traditional non-precision and conventional RNAV approaches.

This AMC provides guidance material for the airworthiness approval of area navigation systems and their use for RNP Authorisation Required (AR) operations that range from nominal (i.e. where general aircraft qualification is matched to standard AR procedure design) to those more demanding in operational and performance requirements. The assurance of consistency with and conformance to the target level of safety (TLS) objectives for RNP AR operations results from the specific compliance criteria of this AMC and the associated standard RNP AR procedure design.

This AMC is generally consistent with the Single European legislation and with material in the ICAO Performance-Based Navigation Manual, as well as in EUROCONTROL publications dealing with related operational and functional requirements for area navigation. The material contained in this AMC reflects the fundamental change associated with RNP in the roles, responsibilities and requirements for the regulator, manufacturer, operator and procedure designer.

This AMC is based on barometric-vertical navigation (BARO-VNAV) and RNAV multi-sensor navigation systems, as well as the system concepts, guidance and standards in the RTCA DO-236()/EUROCAE ED-75() MASPS. RNP AR builds on the RNP concept that requires the ability of the aircraft navigation system to monitor its achieved navigation performance, and to identify to the pilot whether the operational requirement is or is not being met during an operation.

This AMC addresses general certification considerations including functional requirements, accuracy, integrity, continuity of function and system limitations.

This AMC introduces some provisions for aircraft qualification to RNP AR Departure protected with customised procedure design criteria. These provisions will be completed in a next issue of the AMC, once ICAO have published public procedure design criteria for departures.

This AMC is based on the criteria developed in AC 90-101, with inclusion of more stringent criteria (see Appendix 6) including notably a focus on aircraft performance in Non-Normal conditions.

~~This AMC is harmonised with the criteria developed in AC 90-101, with addition of provisions for Take Off operations, and only addresses limited aspects of the "private/specials" of RNP AR based on AC 120-29A Appendix 5~~

Compliance with this AMC provides a basis for, but by itself does not constitute, an operational approval to conduct RNP operations. It is recognised that the special procedure design criteria contained in the RNP AR procedure design manual, operator needs or operating conditions may necessitate additional operational evaluation.

Aircraft operators should apply to their competent authority for such an approval. Since this AMC has been harmonised with other RNP implementation and operations approval criteria outside of Europe i.e. USA/FAA, it is expected to facilitate interoperability and ease the effort in obtaining operational approval by airline operators.

1.1 PURPOSE

This AMC establishes an acceptable means to obtain airworthiness approval of a RNP system and operational criteria for use in designated European airspace blocks where RNP AR operations have been implemented by the competent aviation authority. An applicant may elect to use an alternative means of compliance. However, that means of compliance must meet the objectives of this AMC and be acceptable to the Agency. Compliance with

this AMC is not mandatory hence the use of the terms *shall* and *must* apply only to an applicant who elects to comply with this AMC in order to obtain airworthiness approval.

1.2 BACKGROUND

The application of RNP AR to terminal area and approach operations provides an opportunity to utilise modern aircraft capability and performance to improve safety, efficiency and capacity. Safety is improved when RNP AR procedures replace visual procedures or non-precision approaches, and efficiency is improved through more repeatable and optimum flight paths. Capacity can be improved by de-conflicting traffic during instrument conditions.

RNP AR includes unique capabilities that require aircraft and aircrew authorisation similar to Category (CAT) II/III ILS operations. All RNP AR procedures have reduced lateral obstacle evaluation areas and vertical obstacle clearance surfaces predicated on the aircraft and aircrew performance requirements of this AMC. In general, RNP AR procedures are expected to be developed to not only address specific operational needs or requirements but also to enable benefits to the broadest segment of the RNP AR aircraft population possible. As a result, there are some aspects of RNP AR approach procedure design that will be used only as necessary.

A critical component of RNP is the ability of the aircraft navigation system to monitor its achieved navigation performance, and to identify to the pilot whether the operational requirement is or is not being met during an operation.

The criteria (both procedure design and certification) may take account of the fact that aircraft with different flight guidance capabilities will be used to fly the procedures. However, the procedure design criteria does reflect specific levels of aircraft performance and capability for the barometric VNAV aspects of the operation. The operator authorisation may be extended where the operational requirements can be met by aircraft but require more stringent performance criteria.

2 SCOPE

This material provides airworthiness approval criteria related to RNAV systems with lateral navigation (LNAV) and barometric vertical navigation (VNAV) capabilities, intended to be used under Instrument Flight Rules, including Instrument Meteorological Conditions, in designated European airspace blocks where RNP Authorisation Required (AR) operations have been implemented per a decision of the competent aviation authorities. It addresses general certification considerations including functional requirements, accuracy, integrity, continuity of function, and system limitations.

The material contained in this AMC is unique and represents the fundamental change associated with RNP in the roles, responsibilities and requirements for the regulator, manufacturer, air operator and procedure designer. The assurance of consistency with and conformance to the target level of safety (TLS) objectives for RNP AR operations results from the specific compliance criteria of this AMC, a flight operational safety assessment ~~when required,~~ and the associated standard RNP AR procedure design

The material and criteria contained herein also provides a means for development and approval of an RNP AR capability consistent with the RNP AR procedures implemented using the ICAO PBN RNP AR Procedure Design Manual. However, it should be recognised that in order to perform RNP AR operations there are three key aspects of this AMC that must be considered. The first is that where an operator/manufacturer satisfies all criteria contained herein, they should be considered operationally ready to conduct RNP AR operations using procedure design and alternatives defined by the ICAO PBN RNP AR Procedure Design Manual. The second is that there are three elements of the procedure design criteria that will only be used on the occasions where there is a specific operational

need or benefit. As a result, operators can be authorised for all or any subset of these types of procedures:

- ~~Ability to fly a published arc (also referred to as a RF leg)~~
- Reduced lateral obstacle evaluation area on the missed approach or departure (also referred to as a ~~missed approach~~ procedure requiring RNP less than 1.0) or
- When conducting a RNP AR approach using a line of minima less than RNP 0.3 and/or a missed approach or departure that requires RNP less than 1.0. and
- Ability to fly a published arc (also referred to as a RF leg)

These aspects of instrument procedures are reflected in the guidance and criteria of the ICAO PBN RNP AR procedure design manual. Therefore, an operator/manufacturer with aircraft lacking some or all of these capabilities, should recognise that this will result in operational limitations i.e. the more complex or demanding operations using these procedure criteria may not be performed. The third aspect is that there will be specific situations where even full compliance to the AMC ~~will~~ may be insufficient to conduct procedures that ~~reflect~~ are tailored to aircraft specific performance ~~or that are deemed very complex or extremely demanding and whose characteristics are not fully accounted for by this AMC or procedure design criteria e.g. mountainous terrain, maximised climb or descent gradients, winds, momentary loss of navigation signals, extraction, etc for the instrument procedure~~.

This AMC recognises that ~~current~~ published criteria for demonstrated aircraft performance may be insufficient to enable RNP AR operations where the performance required is less than 0.3 NM. Consequently, this AMC provides the criteria necessary to support airworthiness approval to these lower accuracy values and criteria including guidance for the assessment of:

- Training and Crew Qualification (see APPENDIX 2)
- RNP Operational Considerations (see APPENDIX 3),
- Flight Technical Error (see APPENDIX 4),
- Flight Operation Safety Assessment (see APPENDIX 5).

This AMC also contains criteria reflecting the Agency's opinion that parts of the ICAO PBN Navigation Specification for RNP AR APCH are not appropriate for the RNP AR operations that the Agency will authorise. As a result, select criteria in the AMC are different and are clearly noted as such.

Section 3.2 of this AMC refers to documents which contribute to the understanding of the RNP concept and which may support an application for approval. However, it is important that an applicant evaluates his aircraft system against the criteria of this AMC.

Compliance with this AMC provides a basis for, but by itself does not constitute, an operational approval to conduct RNP operations. Aircraft operators should apply to their national authority for such an approval. While an objective of this AMC is interoperability and to ease operator operational approvals, some operators and manufacturers will need to consider the noted differences in requirements from the ICAO PBN Manual and FAA AC 90-101 to determine what additional aircraft or system changes are necessary, or what operational limitations must be implemented.

A glossary of terms and acronyms used in this AMC is given in APPENDIX 1.

3 REFERENCE DOCUMENTS

3.1 RELATED REQUIREMENTS

CS~~/FAR~~ 25.1301, 25.1302, 25.1307, 25.1309, 25.1316, 25.1321, 25.1322, 25.1329, 25.1431, 25.1581.

CS~~/FAR~~ 23.1301, 23.1309, 23.1311, 23.1321, 23.1322, 23.1329, 23.1335, 23.1431, 23.1581.
EU-OPS[2] 1.243, 1.420, 1.845, 1.865, 1.873
National operational regulations.

3.2 RELATED MATERIAL

3.2.1 ICAO

Doc 8168-OPS/611	Aircraft Operations (PANS OPS).
Doc 9613	Performance Based Navigation Manual
Doc 9881	Guidelines for Electronic Terrain, Obstacle and Aerodrome Mapping Information
Doc 9905	Required Navigation Performance Authorisation Required (RNP AR) Procedure Design Manual

3.2.2 EASA

AMC 20-5	Airworthiness Approval and Operational Criteria for the use of the Navstar Global Positioning System (GPS)
AMC 25-11	Electronic Display Systems.
AMC 20-27	AMC 20-27 Airworthiness Approval and Operational Criteria for RNP APPROACH (RNP APCH) Operations Including APV BARO-VNAV Operations
EASA Opinion Nr. 01/2005	The Acceptance of Navigation Database Suppliers.

3.2.3 EUROCONTROL

NAV.ET1.ST16-001 ( )	Navigation Strategy for ECAC.
Document 003-93 ( )	Area Navigation Equipment: Operational Requirements and Functional Requirements.

3.2.4 FAA

AC 25-11( )	Electronic Display Systems.
AC 20-129	Airworthiness Approval of Vertical Navigation (VNAV) Systems for Use in the U.S. National Airspace System (NAS) and Alaska
AC 20-130( )	Airworthiness Approval of Navigation or Flight Management Systems Integrating Multiple Navigation Sensors.
AC 20-138( )	Airworthiness Approval of NAVSTAR Global Positioning System (GPS) for use as a VFR and IFR Supplemental Navigation System.
AC 25-4	Inertial Navigation Systems (INS).

[2] Council Regulation (EEC) No 3922/91 of 16 December 1991 on the harmonisation of technical requirements and administrative procedures in the field of civil aviation (OJ L 373, 31.12.1991, p. 4). Regulation as last amended by Regulation (EC) No 1899/2006 of the European Parliament and of the Council of 12 December 2006 (OJ L 377, 27.12.2006, p. 1).

AC 25-15	Approval of Flight Management Systems in Transport Category Airplanes.
AC 90-97	Use of Barometric Vertical Navigation (VNAV) for Instrument Approach Operations using Decision Altitude
~~N8000.326~~	~~Airworthiness and Operational Approval for Special Required Navigation Performance (RNP) Procedures with Special Aircraft and Aircrew Authorization Required (SAAAR)~~
Order 8260.52	United States Standard for Required Navigation Performance (RNP) Approach Procedures with Special Aircraft and Aircrew Authorization Required (SAAAR)
AC 90-101	Approval for Required Navigation Performance (RNP) Procedures with Special Aircraft and Aircrew Authorization Required (SAAAR**)**
AC 120-29A	Criteria for Approval of Category I and Category II Weather Minima for Approach
AC 20-153	Acceptance of Data Processes and Associated Navigation Databases

3.2.5 Technical Standard Orders

ETSO-C115( ) / TSO-C115( )	Airborne Area Navigation Equipment Using Multi-sensor Inputs.
ETSO-C129( ) / TSO-C129( )	Airborne Supplemental Navigation Equipment Using the Global Positioning System (GPS)
ETSO-C145( ) / TSO-C145( )	Airborne Navigation Sensors Using the Global Positioning System (GPS) Augmented by the Wide Area Augmentation System (WAAS).
ETSO-C146( ) / TSO-C146( )	Stand-Alone Airborne Navigation Equipment Using the Global Positioning System (GPS) Augmented by the Wide Area Augmentation System (WAAS).
ETSO-C151( )/TSO-C151( )	Terrain Awareness and Warning System (TAWS)

3.2.6 EUROCAE / RTCA and ARINC

ED-75( ) / DO-236( )	Minimum Aviation System Performance Standards: Required Navigation Performance for Area Navigation.
DO-283A	Minimum Operational Performance Standards for Required Navigation Performance for Area Navigation
ED-76 / DO-200A	Standards for Processing Aeronautical Data.
ED-77 / DO-201A	Standards for Aeronautical Information.
DO-229( )	Minimum Operational Performance Standards for Global Positioning System/Wide Area Augmentation System Airborne equipment**.**
ARINC 424	Navigation System Data Base.

4 ASSUMPTIONS

Applicants should note that this guidance material is based on the following assumptions concerning the measures taken by the responsible airspace authorities and service providers to safeguard RNP AR operations in the European region:

4.1 NAVAID INFRASTRUCTURE CONSIDERATIONS

RNP AR approaches are only authorised based on GNSS as the primary Navaid infrastructure. The use of DME/DME as a reversionary capability (e.g. extraction when on an approach or continuation for departures) is only authorised for individual operators where the infrastructure supports the required performance. RNP AR operations should not be used in areas of known navigation signal (GNSS) interference.

Note 1: Most modern RNAV systems will prioritise inputs from GNSS and then DME/DME positioning. Although VOR/DME positioning is usually performed within a flight management computer when DME/DME positioning criteria does not exist, avionics and infrastructure variability pose serious challenges to standardisation.

Note 2: Procedure validation will entail use of an infrastructure navigation performance tool that is capable of analysing the flight procedure path and profile relative to the ground navigation aid infrastructure. This type of tool is likely to only approximate results for the actual procedure. However, due to the cost of flight checking, increased efficiency is anticipated in flight checking when augmented with an infrastructure navigation performance tool.

Note 3: With or without an infrastructure navigation performance tool, a flight check aircraft is expected to be used ~~to evaluate signal in space performance~~. Where State flight check aircraft systems do not reflect the types of aircraft or systems intending to conduct the RNP AR procedure, use of operator aircraft with systems that also provide real time calculations of their achieved performance along the procedure flight path and profile should also be used to evaluate a procedure. The selected aircraft are intended to provide confidence in the interoperability of differing systems and implementations.

Note 4: For procedures that allow aircraft to rely only on GNSS, (see paragraph 8.3), the acceptability of the risk of degraded navigation performance beyond the requirements for the operation for multiple aircraft due to satellite failure or RAIM holes, has been considered by the responsible airspace authority.

4.2 COMMUNICATION & ATS SURVEILLANCE CONSIDERATIONS

RNP AR operations described herein do not require any unique communication or ATS Surveillance considerations.

4.3 OBSTACLE CLEARANCE AND ROUTE SPACING

All RNP AR procedures:

(1) are published by an Aeronautical Information Service Provider certified according to article 7 of Regulation 550/2004[3] or

(2) are consistent with the relevant parts of ICAO Doc 8168 PANS OPS and ICAO PBN RNP AR Procedure Design Manual;

(3) take account of the functional and performance capabilities of RNP systems and their safety levels as detailed in this AMC;

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[3] Regulation (EC) No 550/2004 of the European Parliament and of the Council of 10 March 2004 on the provision of air navigation services in the single European sky (the service provision Regulation) (OJ L 096 , 31/03/2004 P. p. 10).

Note: Particular attention should be given to the constraints implied by the Airworthiness Certification objectives of paragraph 6.

(4) Require that barometric vertical navigation capability be used;

(5) Support reasonableness checking by the flight crew by including, on the charts, fix data (e.g. range and bearing to navigational aids or waypoint to waypoint);

(6) Terrain and obstacle data in the vicinity of the approach is published in accordance with ICAO Annex 15 to the Convention on International Civil Aviation and Doc 9881, Guidelines for Electronic Terrain, Obstacle and Aerodrome Mapping Information;

(7) If the contingency procedure allows a reversion in aircraft use of navigation infrastructure, e.g. GNSS to DME/DME, the obstacle clearance assessment is based on an RNP that allows either infrastructure;

(8) Barometric altitude compensation for low temperature effects is accounted for in the procedure design, and any necessary limitations are specified in the AIP;

(9) The Safety Case assessment for RNP AR operations accounts for the regulatory determination and documentation of compliance to the AMC~~s~~ detailed requirements for the navigation system, aircraft operational capability, crew procedures and continuing airworthiness, as meeting or exceeding their TLS objectives for the procedure and/or spacing:

(10) ~~Procedures~~ are designated RNAV e.g. $RNAV_{(RNP)}$ and throughout the AIP and on aeronautical charts, will specify either the sensors allowed or the RNP accuracy value required.

(11) May have attributes that depart from the standard applications of procedures described in the ICAO RNP AR Procedure Design Manual.

4.4 ADDITIONAL CONSIDERATIONS

a) Guidance in this chapter does not supersede the applicable operational requirements for equipage.

b) Current local pressure setting must be provided to support RNP AR approaches, where the aircraft's achieved vertical path is dependent on that setting. Failure to report a correct setting can lead to aircraft leaving the obstacle clearance area.

4.5 FLIGHT EVALUATION

a) As RNP AR approaches do not have a specific underlying navigation facility, there is no requirement for flight inspection of navigation signals. However, due to the importance of publishing correct data, it is recommended that flight evaluation be used prior to publication for procedure validation and obstacle validation. Flight evaluation can be accomplished through ground evaluation (e.g. simulator assessment) and actual flight.

b) Procedure validation includes confirmation of the basic flyability of the procedure in accordance with the procedure design. A thorough flyability assessment is not required prior to publication, since flyability is individually assessed by the operator as part of their database updating and maintenance process due to the unique nature of RNP AR approaches. The flight evaluation prior to publication should confirm track lengths, bank angles, descent gradients, runway alignment and compatibility with predictive terrain hazard warning functions (e.g. TSO-C151( )/ETSO-C151( ) compliant Terrain Awareness and Warning Systems). A truth system is typically not required. Due to variations in aircraft speeds, flight control system design, and

navigation system design this flight evaluation does not confirm flyability for all of the various aircraft conducting RNP AR approaches.

c) Obstacle validation through flight evaluation may be used to validate the obstacle data used to design the procedure. An obstacle flight evaluation may not be necessary if obstacle validation can be accomplished through ground inspection or validated survey techniques to the appropriate accuracy.

4.6 PUBLICATION

a) The AIP clearly indicates the navigation application is RNP AR approach and specific authorisation is required.

b) All ~~routes~~ procedures are based upon WGS 84 coordinates.

c) The navigation data published in the relevant AIP for the procedures and supporting navigation aids must meet the requirements of ~~ICAO~~ Annex 15 and Annex 4 to the Convention on International Civil Aviation (as appropriate). The original data defining the procedure should be available to the operators in a manner suitable to enable the operator to verify their navigation data.

d) The navigation accuracy for all RNP AR approach procedures is clearly published in the AIP.

e) The navigation data for the procedure(s) to be loaded into the flight management system is from database supplier holds a Type 2 Letter of Acceptance (LoA) or equivalent and has been independently validated by the operator ~~is compared with the published procedure~~.

f) Where reliance is placed on the use of radar to assist contingency procedures, its performance has been shown to be adequate for that purpose, and the requirement for a radar service is identified in the AIP.

4.7 CONTROLLER TRAINING

Air traffic controllers, who will provide control services at airports where RNP approaches have been implemented, have completed the appropriate training.

4.8 STATUS MONITORING

The Navaid infrastructure is monitored and, where appropriate, maintained by a service provider certified for navigation services according to article 7 of EC regulation 550/2004. For the use of non EU navigation service providers, timely warnings of outages (NOTAM) should be issued. Also status information should be provided to Air Traffic Services in accordance with ICAO Annex 11 to the Convention on International Civil Aviation for navigation facilities or services that may be used to support the operation.

4.9 ATS SYSTEM MONITORING

When available, radar observations of each aircraft's proximity to track and altitude are typically noted by Air Traffic Service (ATS) facilities and aircraft track-keeping capabilities are analysed. If an observation/analysis indicates that a loss of separation or obstacle clearance has occurred, the reason for the apparent deviation from track or altitude should be determined and steps taken to prevent a recurrence.

5 SYSTEM DESCRIPTION

5.1 LATERAL NAVIGATION (LNAV)

5.1.1 For lateral navigation, the RNAV equipment enables the aircraft to be navigated in accordance with appropriate routing instructions along a path defined by waypoints held in an on-board navigation database.

Note: LNAV is typically a flight guidance systems mode, where the RNAV equipment provides path steering commands to the flight guidance system, which then controls flight technical error through either manual pilot control with a path deviation display or through coupling to the flight director or autopilot.

5.1.2 For the purposes of this AMC, RNP AR operations are based upon the use of RNAV equipment that automatically determines aircraft position in the horizontal plane using inputs from the following types of positioning sensor (in no specific order of priority or combination) but whose primary basis for positioning is GNSS:

(a) Global Navigation Satellite System (GNSS).
(b) Inertial Navigation System (INS) or Inertial Reference System (IRS)~~, with automatic updating from suitable radio based navigation equipment~~.
(c) Distance Measuring Equipment giving measurements from two or more ground stations (DME/DME).

~~The RNAV system may be able to use all positioning sensor inputs simultaneously where the sensor(s) supporting the best accuracy will be used in determining the system accuracy~~. Additional guidance and requirements are in paragraphs 8.3 through 8.5.

5.2 VERTICAL NAVIGATION

5.2.1 For Vertical Navigation, the system enables the aircraft to fly level and descend relative to a linear, point to point vertical profile path that is held in an on-board navigation database. The vertical profile will be based upon altitude constraints or vertical path angles where appropriate, associated with the LNAV path waypoints.

Note 1: VNAV is typically a flight guidance systems mode, where the RNAV equipment containing VNAV capability provides path steering commands to the flight guidance system, which then controls flight technical error through either manual pilot control with a vertical deviation display or through coupling to the flight director or autopilot.

Note 2: The ARINC 424 specification data allows the definition of a vertical angle, however some system implementations preclude the specification of a vertical angle on a flight leg. In such a case it may be necessary to examine the leg types available that do and determine if the resulting lateral path is acceptable for the surrounding airspace.

Note 3: The specification of vertical angles on multiple path fixes in descent may lead to possible vertical path discontinuities (e.g. temperature effect). This type of procedure should be assessed to determine if the system response and performance can be accommodated in this situation and for other systems, or if the procedure must be changed. Climb paths are typically not included in a vertical profile e.g. departure or missed approach.

Note 4: Additionally, some system implementations may allow the manual specification of a vertical angle for a path or path segment. This capability may need to be evaluated to determine if it has the potential to alter or impact a VNAV procedure and the possible means of mitigating the potential condition e.g. design change or operational procedure.

Note 5: The system may provide the capability to determine performance optimised paths. A performance optimised path is defined by a series of straight line path segments that are designed to hold an aircraft at a specified speed while holding thrust to a constant value (e.g. typically near idle for descent) and guiding to the series of straight line paths. The elements required for the determination of the performance optimised path include gross weight, lift, drag and speed. This path capability and aircraft operation may be acceptable where the vertical path is specified with flexibility (e.g. altitude windows, AT/ABOVE). However, in the case where a linear point to point path, or flight path angle is specified, this type of systems capability with its associated vertical path errors may be unacceptable for the required operations.

Note 6: Systems may implement vertical profiles specified by AT/ABOVE constraints as a point to point path defined by AT constraints. This type of characteristic in system path definition may be acceptable.

Note 7: Systems that allow vertical paths to be defined by a combination of altitude constraints, and flight path angles, may be subject to vertical discontinuities, where a smooth or continuous vertical path is not possible. System responses to this condition may vary from possible level off manoeuvres to vertical speed captures of the flight path. The aircraft system performance must be assessed on a case by case basis for its acceptability for the required operation**,** and still may not be acceptable.

5.2.2. Temperature Compensation Systems: Systems that provide temperature-based corrections to the barometric VNAV guidance must comply with EUROCAE ED-75B, Appendix H.2. This applies to the final approach segment. Compliance to this standard should be documented to enable the operator to conduct RNP approaches when the actual temperature is below or above the published procedure design limit.

6 AIRWORTHINESS CERTIFICATION OBJECTIVES

The following performance certification criteria are defined for the airborne systems on the basis that the Assumptions of Section 4 are valid.

6.1 ACCURACY

Aircraft performance is evaluated around the path defined by the published procedure and EUROCAE/ED-75B, Section 3.2. All vertical paths used in conjunction with the final approach segment will be defined by a Flight Path Angle (EUROCAE/ED-75B, Section 3.2.8.4.3) as a straight line emanating from ~~to~~ a fix and altitude.

6.1.1. Lateral

During operations on approaches notified exclusively for RNP equipped aircraft, the lateral track keeping accuracy and along-track positioning error of the on-board navigation system shall be equal to or better than the RNP for 95% of the flight time.

Note 1: The lateral track keeping accuracy is dependent on the navigation total system error (a combination of path definition error, position estimation error, display error and Flight Technical Error (FTE)).

a) Refer to APPENDIX 4 for guidance and criteria for the assessment of FTE for RNP AR operations authorised with RF legs, reduced lateral obstacle evaluation, e.g. less than 0.3 NM in final approach, less than 1.0 NM for missed approach.

Note 2: Provided that paragraph 8.3(b) has been shown to be valid in respect of typical GNSS performance, then, for RNAV systems that have been declared (e.g. in the Aircraft Flight Manual) to be compliant with the navigation accuracy criteria of FAA AC 20-130(), or FAA AC 20-138() or AMC20-5 or AMC20-27 and the

accuracy requirements of this AMC including a statement of the operational RNP capability, the intent of this paragraph is considered as satisfied and no further accuracy demonstration is required. However, such a Flight Manual statement, by itself, does not constitute an airworthiness approval for ~~RNAV~~ RNP AR operations and compliance with all other criteria of this AMC will need to be shown.

Note 3: Some RNP system implementations may provide for multi-sensor mixing in the calculation of aircraft position. While this is not required, it provides for smoothing when positioning sources change and a means to optimise the calculation of aircraft position that is not possible for single source systems. Manufacturers should consider the effects of sensor failure or errors on lateral position during the conduct of RNP AR operations ~~an approach~~, and the potential departure, approach and missed approach RNP, in implementing system architecture, sensor switching, and redundancy.

6.1.2. Vertical

During operations on instrument approach procedures notified exclusively for RNP aircraft and where the Vertical Error Budget(VEB) applies, the vertical system error includes altimetry error (assuming the temperature and lapse rates of the International Standard Atmosphere), the effect of along-track error, system computation error, data resolution error, and flight technical error. The 99.7% of system error in the vertical direction during the stabilised constant descent path must be less than the following (in feet):

$$\sqrt{((6076.115)(1.225)\mathbf{RNP}\cdot tan\,\theta)^2+(60\,tan\,\theta)^2+75^2+\left(\left(-8.8\cdot10^{-8}\right)(\mathbf{h}+\Delta\mathbf{h})^2+\left(6.5\cdot10^{-3}\right)(\mathbf{h}+\Delta\mathbf{h})+50\right)^2}$$

Where θ the vertical navigation (VNAV) path angle, h is the height of the local altimetry reporting station and Δh is the height of the aircraft above the reporting station.

The 99.7% altimetry system error for each aircraft (assuming the temperature and lapse rates of the ISA) shall be less or equal to than the following with the aircraft in the approach configuration:

ASE = $-8.8\cdot10^{-8}\cdot H^2\cdot + 6.5\cdot10^{-3}\cdot H + 50$ (ft)

Where H is the true altitude of the aircraft.

Note 1: Current guidance for VNAV such as AC20-129, and AC90-97 has less stringent performance requirements. A supplemental analysis, assessment and regulatory approval (i.e. airworthiness) will be necessary in meeting the requirements herein ~~However, systems meeting this guidance material have been demonstrated and approved for the vertical path performance specified herein or similar guidance e.g. AC120-29A. For aircraft and systems not yet approved, a supplemental analysis, assessment and regulatory approval (i.e. airworthiness) will be necessary in meeting the requirements herein~~.

Note 2: For the vertical system error above, ~~waypoint resolution~~ vertical angle error ~~(WPR)~~ is not included and is not considered since data and database processes associated with DO-200A and DO-201A are required. In addition ATIS, automatic terminal information service temperature error is not included and is accounted for in the procedure design ~~assumed to be negligible from operational procedure~~.

6.1.3. RNP System Performance

The required demonstration of RNP system performance, including lateral and vertical path steering performance (FTE), will vary according to the type of AR operation being considered e.g. low RNP for obstacle clearance or separation in an obstacle rich environment or high density air traffic environment. It will be for the competent

Authority, responsible for the approval of the procedure, to assess the RNP level for the considered operation in accordance with the Flight Operations Safety Assessment (FOSA) see APPENDIX 5.

In supporting the FOSA exercise, the applicant will be required to have demonstrated the aircraft capability in terms of RNP system performance under a variety of operational conditions, rare normal conditions and non-normal conditions – see also APPENDIX 4. Realistic and representative procedures should be used e.g. number of waypoints, placement of waypoints, segment geometry, leg types etc. For the non-normal conditions the applicant should conduct a safety impact assessment, which identifies from the existing aircraft System Safety Assessments (SSA), those Failure Conditions that have an impact on the RNP system performance. This safety assessment process should encompass the additional Failure Conditions introduced by any specific feature designed and implemented as mitigation for RNP AR operations (e.g. lateral deviation display) and also identify and document any additional flight crew procedures and training, necessary to support the overall safety of the operation.

Specific evaluations should be conducted to assess the path excursions upon failures and the resulting RNP levels. Results should be documented in the Aircraft Flight Manual (AFM), AFM Supplement or appropriate aircraft operational support document and made available to the operator, thereby alleviating the need for similar operational evaluations.

Acceptable criterion to be used for assessing RNP significant failures under limit performance conditions (see Appendix 4 Para 4) is as follows:

a) The lateral excursions observed as a result of Probable failures should be documented against an objective of containment within 1xRNP. ~~Vertical excursions should remain within 75 feet.~~

   Note 1: The System Safety Assessment of the aircraft systems supporting RNP AR operations (RNAV systems, Flight Controls Systems, Flight Guidance Systems, etc.) should therefore be revisited to identify these Probable failures. Probable failures are failures with a probability greater than 10^{-5} per operation.

   Note 2: This demonstration can rely on crew action to intervene and place the aircraft back on the target track, or apply a contingency procedure when the guidance is lost.

b) The lateral excursions observed as a result of One Engine Inoperative (OEI) should be documented against an objective of containment within 1xRNP.

   Note 1: This demonstration can rely on crew action to intervene and place the aircraft back on the target track.

c) The lateral excursions observed as a result of Remote failures should be documented against an objective of containment within 2xRNP.

   Note 1: The demonstration should evaluate the contributions of:
   (i) Remote systems failures that may impact the RNP capability
   (ii) GNSS satellite outages

   Note 2: Remote system failures should include latent failures (integrity) and detected failures (continuity). For the detected failures, the monitor limit of the alert, the time to alert, the crew reaction time, and the aircraft

response should all be considered when ensuring that the aircraft does not exit the obstacle clearance volume. Remote failures are failures with a probability between 10^{-5} and 10^{-7} per operation.

d) A demonstration should be made that the aircraft remains manoeuvrable and a safe extraction may be flown for all Extremely Remote failures.

Note 1: Extremely Remote failures are failures with a probability ~~of less than 10^{-7} per operation~~ between 10^{-7} and 10^{-9}.

For all the above conditions the vertical excursion should not exceed 75 feet below the desired path.

6.2 INTEGRITY

6.2.1. System

a) RNP and Barometric VNAV aircraft (e.g. FMS RNAV/VNAV equipped). This AMC provides a detailed acceptable means of compliance for aircraft that use an RNP system based primarily on GNSS and a VNAV system based on barometric altimetry. Aircraft complying with this AMC provide the requisite airspace containment (i.e. satisfactory assurance that the aircraft will remain within the obstacle clearance volume) through a variety of monitoring and alerting (e.g. 'Unable RNP', GNSS alert limit, path deviation monitoring).

b) Other systems ~~(e.g. GNSS/SBAS RNAV equipped or other)~~ or alternate means of compliance. For other systems or alternate means of compliance, the probability of the aircraft exiting the lateral and vertical extent of the obstacle clearance volume (defined in ICAO PBN RNP AR Procedure Design Manual) must not exceed 10^{-7} per operation ~~approach~~, including the departure, approach and missed approach. The use of such alternatives may be satisfied by the flight operational safety assessment (see APPENDIX 5)

Note 1: ~~This~~ The 10^{-7} requirement applies to the total probability of excursion outside the obstacle clearance volume, including events caused by latent conditions (integrity) and by detected conditions (continuity) if the aircraft does not remain within the obstacle clearance volume after the failure is annunciated ~~(considering the aircraft wingspan)~~. The monitor limit of the alert, the latency of the alert, the crew reaction time, and the aircraft response should all be considered when ensuring that the aircraft does not exit the obstacle clearance volume. The requirement applies to a single approach, considering the exposure time of the operation and the Navaid geometry and navigation performance available for each published approach.

Note 2: This containment requirement derives from the operational requirement. This requirement is notably different than the containment requirement specified in RTCA/DO-236B (EUROCAE ED-75B). The requirement in RTCA/DO-236B (EUROCAE ED-75B) was developed to facilitate airspace design and does not directly equate to obstacle clearance.

6.2.2. Display

The system design must be consistent with at least a major failure condition for the display of misleading lateral or vertical guidance on an RNP AR approach.

Note: The display of misleading lateral or vertical RNP guidance is considered a hazardous (severe-major) failure condition for RNP AR approaches with an RNP accuracy value less than ~~or equal to~~ RNP 0.3. Systems designed consistent with this effect

should be documented as it may eliminate the need for some operational mitigations for the aircraft.

6.3 CONTINUITY OF FUNCTION

With respect to the airborne systems, it shall be shown that:

a) The probability of loss of all navigation information is Remote.

b) The probability of non-restorable loss of all navigation and communication functions is Extremely Improbable.

Note 1: In addition to the equipment required by EU-OPS 1, Sub-part L for IFR flight (or equivalent national requirements), at least one area navigation system is required. ~~When continued operation is required for a procedure with stringent RNP on both the approach and missed approach, the flight operational safety assessment will likely dictate the need for dual systems~~ Where continued operation is required for a procedure with stringent RNP on both the approach or missed approach, dual systems will be needed (see 7.2).

Note 2: Systems approved for RNP operations may have additional continuity requirements to ensure that the RNP capability is available for a specified RNP and operational environment e.g. dual equipage, independent systems for cross checking, etc.

Note 3: Probability terms are defined in CS AMC 25.1309, AC 23.1309-1( ) AC 27-1B or AC 29-2C ~~AMC 25.1309~~.

7 FUNCTIONAL CRITERIA

7.1 MINIMUM REQUIRED FUNCTIONS FOR RNP AR OPERATIONS

Table 1 lists and describes the system functions and features required where RNP AR operations are predicated on nominal RNP AR procedure design criteria e.g. FAA Notice 8260.52, ICAO RNP AR Procedure Design Manual.

Item	Function/Feature
	Displays
1	Continuous Display of Deviation. The navigation system must provide the capability to continuously display to the pilot flying, on the primary flight instruments for navigation of the aircraft, the aircraft position relative to the RNAV and vertical defined path (both lateral and vertical deviation) and manoeuvre anticipation. The display must allow the pilot to readily distinguish if the cross-track deviation exceeds the RNP (or a smaller accuracy value) or if the vertical deviation exceeds 75 feet (or a smaller value). Where the minimum flight crew is two pilots, means for the pilot not flying must be provided to verify the desired path and the aircraft position relative to the path. ~~For RNP < 0.3 NM, one acceptable means of compliance is~~ To achieve this, an appropriately scaled non-numeric deviation display (i.e. lateral deviation indicator and vertical deviation indicator) located in the pilot's primary field of view may be provided. ~~A fixed-scale CDI is acceptable as long as the CDI demonstrates appropriate scaling and sensitivity for the intended navigation accuracy and operation. With a scalable CDI, the scale should derive from the selection of RNP, and not require the separate selection of a CDI scale. Where a CDI is relied upon, alerting and annunciation limits must also match the scaling values. If the equipment uses default navigation accuracy to describe the operational mode (e.g. en route, terminal area and approach), then displaying the operational mode is an acceptable means from which the flight crew may derive the CDI scale sensitivity.~~ ~~An alternative for lateral deviation is a navigation map display, readily visible to the flight crew, with appropriate map scales, integral navigation map display deviation information, and giving equivalent functionality to the lateral deviation display, except that scaling may be set manually by the pilot. The use of numeric display and map display depends on the flight crew workload, the display characteristics, flight crew procedures and training.~~ Alternatively: For RNP 0.3 and above, • a navigation map display, readily visible to the flight crew, with appropriate map scales, giving equivalent functionality to an appropriately scaled non-numeric lateral deviation display, except that scaling may be set manually by the flight crew or • a numeric display of the lateral deviation , readily visible to the flight crew, with a minimum resolution of 0.1 NM and direction relative to the track, For RNP <0.3 • a numeric display of the lateral deviation, in the primary field of view, with a resolution of 0.01 NM and direction relative to the track

Item	Function/Feature
	Note 1 A fixed-scale CDI is acceptable as long as the CDI demonstrates appropriate scaling and sensitivity for the intended navigation accuracy and operation. With a scalable CDI, the scale should be derived from the selection of RNP, and shall not require the separate selection of a CDI scale. Where a CDI is relied upon, alerting and annunciation limits must also match the scaling values. If the equipment uses default navigation accuracy to describe the operational mode (e.g. en-route, terminal area and approach), then displaying the operational mode is an acceptable means from which the flight crew may derive the CDI scale sensitivity.
2	Identification of the Active (To) Waypoint. The navigation system must provide a display identifying the active waypoint either in the pilot's primary field of view, or on a readily accessible and visible display to the flight crew
3	Display of Distance and Bearing. The navigation system should provide a display of distance and bearing to the active (To) waypoint in the pilot's primary field of view. Where not viable, a readily accessible page on a control display unit, readily visible to the flight crew, may display the data.
4	Display of Groundspeed and Time. The navigation system should provide the display of groundspeed and either estimated time of arrival or time to the active (To) waypoint in the pilot's primary field of view. Where not viable, a readily accessible page on a control display unit, readily visible to the flight crew, may display the data
5	Display of To/From the active fix. The navigation system must provide a To/From display in the pilot's primary field of view. Systems with electronic map display in the pilot's primary field of view having designation of the active waypoint fulfil this requirement.
6	Desired Track Display. The navigation system must have the capability to continuously display to the pilot flying the aircraft the RNAV desired track. This display must be on the primary flight instruments for navigation of the aircraft
7	Display of Aircraft Track. The navigation system must provide a display of the actual aircraft track (or track angle error) either in the pilot's primary field of view, or on a readily accessible and visible display to the flight crew
8	Slaved Course Selector. The navigation system must provide a course selector automatically slaved to the RNAV computed path As an acceptable alternative is an integral navigation map display
9	RNAV Path Display. Where the minimum flight crew is two pilots, the navigation system must provide a readily visible means for the pilot monitoring to verify the aircraft's RNAV defined path and the aircraft's position relative to the defined path
10	Display of Distance to Go. The navigation system must provide the ability to display distance to go to any waypoint selected by the flight crew
11	Display of Distance Between Flight Plan Waypoints. The navigation system must provide the ability to display the distance between flight plan waypoints.
~~12~~	~~Display of Deviation. The navigation system must provide a numeric display of the vertical deviation with a resolution of 10 feet or less, and the lateral deviation with a resolution of 0.01 NM or less.~~
13	Display of Barometric Altitude. The aircraft must display barometric altitude from two independent altimetry sources, one in each pilots' primary field of view. The altimeter setting input must be used simultaneously by the aircraft altimetry system and by the RNAV system.

Item	Function/Feature
	Note 1: This display supports an operational cross-check (comparator monitor) of altitude sources. If the aircraft altitude sources are automatically compared, the output of the independent altimetry sources, including independent aircraft static air pressure systems, must be analysed to ensure that they can provide an alert in the pilot's primary field of view when deviations between the sources exceed ±75 feet. Such comparator monitor function should be documented as it may eliminate the need for an operational mitigation. Note 2: ~~The altimeter setting input must be used simultaneously by the aircraft altimetry system and by the RNAV system.~~ A single input is necessary to prevent possible crew error. Separate altimeter setting for the RNAV system is prohibited.
14	Display of Active Sensors. The aircraft must display the current navigation sensor(s) in use that are readily accessible to the flight crew. ~~It is recommended that this display be provided in the primary field of view.~~ ~~Note: This display is used to support operational contingency procedures. If such a display is not provided in the primary field of view, crew procedures may mitigate the need for this display if the workload is determined to be acceptable.~~
	Performance, Monitoring and Alerting
15	Navigation performance: The system should include a capability to monitor for its achieved lateral navigation performance (e.g. EPU, EPE, ACTUAL or equivalent), and to identify for the flight crew whether the operational requirement is or is not being met during an operation (e.g. 'UNABLE RNP', 'Nav Accur Downgrad', path deviation monitoring, GNSS alert limit). For vertical navigation, this may be achieved by system vertical monitoring and alerting or by a combination of indications such as barometric altitude display and vertical deviation display in combination with procedural crosschecks. Signals radiated by GNSS augmentation systems managed by certified navigation service providers may be taken into account.
16	For multi-sensor systems, automatic reversion to an alternate navigation sensor if the primary navigation sensor fails. Note: This does not preclude means for manual navigation source selection.
17	When DME is used in RNP AR operations, automatic ~~Automatic~~ tuning of DME navigation aids used for position updating together with the capability to inhibit individual navigation aids from the automatic selection process. Note: Further guidance may be found in EUROCAE ED-75B / RTCA DO-236B, Section 3.7.3.1.
18	Capability for the RNAV system to perform automatic selection (or de-selection) of navigation sources, a reasonableness check, an integrity check, and a manual override or deselect. Note 1: The reasonableness and integrity checks are intended to prevent navigation aids being used for navigation update in areas where the data can lead to radio position fixing errors due to co-channel interference, multipath, stations in test, changes in station location and direct signal screening. In lieu of using radio navigation aid designated operational coverage (DOC), the navigation system should provide checks which preclude use of duplicate frequency navaids within range, over-the-horizon navaids, and use of navaids with poor geometry.

Item	Function/Feature
	Note 2: Further guidance may be found in EUROCAE ED-75B / RTCA DO-236B, Section 3.7.3.1.
19	Failure Annunciation. The aircraft must provide a means to annunciate failures of any aircraft component of the RNAV system, including navigation sensors. The annunciation must be visible to the pilot and located in the primary field of view.
20	Navigation Database status: The system ~~should~~ must provide the means to display the validity period of the navigation database to the flight crew.
	Path Definition and Flight Planning
21	Maintaining Track and Leg Transitions. The aircraft must have the capability to execute leg transitions and maintain tracks consistent with the following paths: ~~A geodesic line between two fixes;~~ i) A geodesic line between two fixes; (TF) ~~i)~~ii) A direct path to a fix (DF) ~~ii)~~iii) A specified track to a fix, defined by a course; ~~and~~ (CF) ~~iii) A specified track to an altitude.~~ ~~iv) A radius to fix turn. (see Note 4)~~ ~~v) Holding patterns, (HM/HA/HF)~~ Note 1: Industry standards for these paths can be found in RTCA DO-236B and ARINC Specification 424, which refer to them as TF, DF, CF, ~~FA, RF~~ ~~and~~ ~~HM/HA/HF~~ path terminators, ~~and holding records~~. ~~Also, certain procedures require RF legs~~. EUROCAE ED-75A / RTCA DO-236B and EUROCAE ED-77 / RTCA DO-201A describe the application of these paths in more detail. Note 2 : Use of CF may be acceptable in missed approach only, subject to local approval ~~Note 2: The navigation system may accommodate other ARINC 424 path terminators (e.g. Heading to manual terminator (VM)); and the missed approach procedure may use these types of paths when there is no requirement for RNP containment.~~ ~~Note 3: Where such systems are intended to be used for en route operations, the capability should be provided for the creation and track keeping for fixed radius transitions between airway straight path segments~~ ~~Note 4: It should be noted that a radius to fix (RF) leg is considered a procedure design tool that is available to solve a specific operational requirement or problem. As such it may be considered a highly desired option for select RNP AR operations. In some instances, the RF will be applied in the final or missed approach, requiring additional consideration in a FOSA. Systems lacking such capability should have sufficient means to ensure that operators are aware of this limitation and that it precludes the conduct of RNP AR procedures containing an RF leg.~~
22	Fly-By and Fly-Over Fixes. The aircraft must have the capability to execute fly-by and fly-over fixes. ~~For fly-by turns, the navigation system must limit the path definition within the theoretical transition area defined in RTCA DO-236B under the wind conditions identified in the ICAO PBN RNP AR Procedure Design Manual. The fly-over turn is not compatible with RNP flight tracks and will only be used when there is no requirement for repeatable paths.~~

Item	Function/Feature
	The fly-over turn does not provide for repeatable paths, and is not compatible with RNP flight tracks. The fly-by turn may be used for limited RNP AR path changes under TF-TF or DF-TF transitions subject to procedure design requirements. When fly-by turns are required for specific RNP AR operations, the navigation system must limit the path definition within the theoretical transition area defined in RTCA DO-236B under the wind conditions identified in the ICAO PBN RNP AR Procedure Design Manual Doc 9905.
23	Waypoint Resolution Error. The navigation database must provide sufficient data resolution to ensure the navigation system achieves the required accuracy. Waypoint resolution error must be less than or equal to 60 feet, including both the data storage resolution and the RNAV system computational resolution used internally for construction of flight plan waypoints. The navigation database must contain vertical angles (flight path angles) stored to a resolution of hundredths of a degree, with equivalent computational resolution. ~~such that the system-defined path is within 5 ft of the published path.~~
24	Capability for a "Direct-To" Function. The navigation system must have a "Direct-To" function the flight crew can activate at any time. This function must be available to any fix. The navigation system must also be capable of generating a geodesic path to the designated "To" fix, without "S-turning" and without undue delay. ~~For systems with VNAV capability, a linear path should be computed from current position to a vertically constrained fix, consistent with the use of the "Direct-to" capability~~.
25	Capability to define a vertical path. The navigation system must be capable of defining a vertical path by a flight path angle to a fix. The system must also be capable of specifying a vertical path between altitude constraints at two fixes in the flight plan. Fix altitude constraints must be defined as one of the following: i) An "AT or ABOVE" altitude constraint (for example, 2400A, may be appropriate for situations where bounding the vertical path is not required); ii) An "AT or BELOW" altitude constraint (for example, 4800B, may be appropriate for situations where bounding the vertical path is not required); iii) An "AT" altitude constraint (for example, 5200); or iv) A "WINDOW" constraint (for example, 2400A3400B). Note: For RNP AR procedures, any segment with a published vertical path will define that path based on an angle to the fix and altitude.
26	Altitudes and/or speeds associated with published terminal procedures must be extracted from the navigation database.
27	The system must be able to construct a path to provide guidance from current position to a vertically constrained fix.
28	Capability to Load Procedures from the Navigation Database. The navigation system must have the capability to load the entire procedure(s) to be flown into the RNAV system from the onboard navigation database. This includes the approach (including vertical angle), the missed approach and the approach transitions for the selected airport and runway
29	Means to Retrieve and Display Navigation Data. The navigation system must provide the ability for the flight crew to verify the procedure to be flown through review of the data stored in the onboard navigation database. This includes the ability to review the data for individual waypoints and for navigation aids

Item	Function/Feature
30	Magnetic Variation. For paths defined by a course (CF ~~and FA~~ path terminators), the navigation system must use the magnetic variation value for the procedure in the navigation database.
31	Changes in Navigation accuracy. RNP changes to lower navigation accuracy must be complete by the fix defining the leg with the lower navigation accuracy, considering the alerting latency of the navigation system. Any operational procedures necessary to accomplish this must be identified
32	Automatic Leg Sequencing. The navigation system must provide the capability to automatically sequence to the next leg and display the sequencing to the flight crew in a readily visible manner.
33	A display of the altitude restrictions associated with flight plan fixes must be available to the pilot. If there is a specified navigation database procedure with a flight path angle associated with any flight plan leg, the equipment must display the flight path angle for that leg
	Navigation Database
34	The aircraft navigation system must use an on-board navigation database containing current navigation data officially promulgated for civil aviation by a certified AIS provider, which can: a) be updated in accordance with the AIRAC cycle and b) from which terminal airspace procedures can be retrieved and loaded into the RNAV system. The resolution to which the data is stored must be sufficient to ~~achieve the required track keeping accuracy~~ ensure that the assumption of no path definition error is satisfied. The database must be protected against flight crew modification of the stored data. Note: When a procedure is loaded from the database, the RNAV system is required to fly it as published. This does not preclude the flight crew from having the means to modify a procedure or route already loaded into the RNAV system. However, the procedure stored in the database must not be modified and must remain intact within the database for future use and reference.

Table 1: Required Functions

7.2 ADDITIONAL REQUIRED FUNCTIONS SUPPORTING DEMANDING ~~COMPLEX~~ RNP AR OPERATIONS

Table 2 lists and describes the system functions and features required for more ~~complex or~~ demanding operations e.g. where RNP AR operations are predicated on use of RF legs, RNP less than 0.3 or RNP less than 1.0 on missed approach.

Item	Operation/Function
	Where RNP AR ~~Approaches~~ Operations use RF Legs:
1	(1) The navigation system must have the capability to execute leg transitions and maintain tracks consistent with an RF leg between two fixes. (2) The aircraft must have an electronic map display of the selected procedure. (3) The navigation system, the flight director system and autopilot must be capable of commanding a bank angle up to 25 degrees at or above 400 feet AGL and up to 8 degrees below 400 feet AGL. (These values are consistent with those published in the ICAO Doc 9905) (4) Upon initiating a go-around or missed approach (through activation of TOGA or other means), the flight guidance mode should remain in LNAV to enable continuous track guidance during an RF leg. Other means or mitigations may be acceptable depending on the aircraft, demonstrated path tracking performance, procedures and associated FOSA for go-around and missed approach procedures that require an RNP 0.3 or greater. (5) When evaluating flight technical error on RF legs, the effect of rolling into and out of the turn should be considered. The procedure is designed to provide 5 degrees of manoeuvrability margin, to enable the aircraft to get back on the desired track after a slight overshoot at the start of the turn. Note: It should be noted that a radius to fix (RF) leg is considered a procedure design tool that is available to solve a specific operational requirement or problem. As such it may be considered a highly desired option for select RNP AR operations. In some instances, the RF will be applied in the final or missed approach, requiring additional consideration in a FOSA. Systems lacking such capability should have sufficient means to ensure that operators are aware of this limitation and that it precludes the conduct of RNP AR procedures containing an RF leg.

	Where RNP AR ~~Approach~~ Operations are less than RNP 0.3:
2	(1) *No single-point-of-failure*. No single-point-of-failure can cause the total loss of guidance compliant with the navigation accuracy associated with the approach. Typically, the aircraft must have at least the following equipment: dual GNSS sensors, dual flight management systems, dual air data systems, dual autopilots, and a single inertial reference unit (IRU). A single autopilot is acceptable provided dual independent flight directors are available and the approach permits use of the flight directors to either continue the approach or execute a missed approach. Note: If automatic switching is not available, it must be demonstrated that the time required to switch to an alternate system does not result in the aircraft exceeding the RNP accuracy value. (2) ~~*Major*~~ *Hazardous Failure*. The system design must be consistent with at least a ~~major~~ hazardous failure condition (as per AMC 25-1309) for the loss of lateral or vertical guidance ~~on an RNP AR approach where RNP less than 0.3 is required to avoid obstacles or terrain while executing an approach~~. ~~Note: For RNP AR operations requiring less than 0.3 to avoid obstacles or terrain, the loss of the display of lateral guidance is considered a hazardous (severe major) failure condition. The AFM should document systems designed consistent with this effect. This documentation should describe the specific aircraft configuration or mode of operation that achieves navigation accuracy less than 0.3. Meeting this requirement can substitute for the general requirement for dual equipment described above~~ (3) *Go-around guidance*. Upon initiating a go-around or missed approach (through activation of TOGA or other means), the flight guidance mode should remain in LNAV to enable continuous track guidance during an RF leg. ~~Other means or mitigations may be acceptable depending on the aircraft, demonstrated path tracking performance, procedures and associated FOSA~~. *(4) Loss of GNSS.* After initiating a go-around or missed approach following loss of GNSS, the aircraft must automatically revert to another means of navigation that complies with the navigation accuracy for the time necessary to fly the go-around or the missed approach.

	Where Missed Approach are less than RNP 1.0
3	(1) *Single-point-of-failure*. No single-point-of-failure can cause the total loss of guidance compliant with the navigation accuracy associated with a missed approach procedure. Typically, the aircraft must have at least the following equipment: dual GNSS sensors, dual flight management systems, dual air data systems, dual autopilots, and a single inertial reference unit (IRU). A single autopilot is acceptable provided dual independent flight directors are available and the approach permits use of the flight directors to either continue the approach or execute a missed approach. Note: If automatic switching is not available, it must be demonstrated that the time required to switch to an alternate system does not result in the aircraft exceeding the RNP accuracy value. (2) *Major Failure.* The system design assurance must be consistent with at least a major failure condition (as per AMC 25.1309) for the loss of lateral or vertical guidance ~~on an RNP AR approach where RNP less than 1.0 is required to avoid obstacles or terrain while executing a missed approach.~~ ~~Note: For RNP AR missed approach operations requiring less than 1.0 to avoid obstacles or terrain, the loss of the display of lateral guidance is considered a hazardous (severe-major) failure condition. The AFM should document systems designed consistent with this effect. This documentation should describe the specific aircraft configuration or mode of operation that achieves navigation accuracy less than 1.0. Meeting this requirement can substitute for the general requirement for dual equipment described above~~ (3) *Go-Around Guidance*. Upon initiating a go-around or missed approach (through activation of TOGA or other means), the flight guidance mode should remain in LNAV to enable continuous track guidance during an RF leg. For go-around and missed approach procedures that require an RNP 0.3 or greater other means and/or mitigations may be acceptable depending on the aircraft, demonstrated path tracking performance, procedures and associated FOSA. (4) *Loss of GNSS.* After initiating a go-around or missed approach following loss of GNSS, the aircraft must automatically revert to another means of navigation that complies with the navigation accuracy for the time necessary to fly the go-around or the missed approach.

Table 2: Procedure Specific Required Functions

8 AIRWORTHINESS COMPLIANCE

8.1 GENERAL

The following compliance guidelines assume that the aircraft is equipped in accordance with EU-OPS 1 Sub-part L for IFR flight for aeroplanes involved in commercial air transportation, or equivalent national requirements for aircraft outside the scope of EU-OPS.

Due to the unique requirements for RNP AR operations and the need for crew procedures that are specific to each particular aircraft and navigation system, RNP AR operational support documentation is required from the manufacturer. The document(s) should describe the navigation capabilities of applicant's aircraft in the context of RNP AR operations, and provide all the assumptions, limitations and supporting information necessary for the safe conduct of RNP AR operations.

It is expected that operators will use the manufacturer recommendations when developing their procedures and application for approval. Installation of equipment is not sufficient by itself to obtain approval for use on RNP AR.

8.1.1 New or Modified Installations

In demonstrating compliance with this AMC, the following specific points should be noted:

a) The applicant will need to submit, to the Agency, a compliance statement which shows how the criteria of this AMC ~~leaflet~~ have been satisfied in establishing aircraft eligibility. The statement should be based on a plan, agreed by the Agency at an early stage of the implementation programme. The plan should identify the data to be submitted which should include, as appropriate, a system description together with evidence resulting from the activities defined in the following paragraphs.

b) Aircraft Qualification

(1) Compliance with the airworthiness requirements for intended function and safety may be demonstrated by equipment qualification, system safety analysis, confirmation of appropriate software design assurance level (i.e. consistent with paragraph 6.2), performance analyses, and a combination of ground and flight tests. To support the approval application, design data will need to be submitted showing that the objectives and criteria of Sections 6 and 7 of this AMC have been satisfied.

(2) Use of the RNAV systems and the manner of presentation of lateral and vertical guidance information on the flight deck must be evaluated to show that the risk of flight crew error has been minimised. In particular, during the transition to the final approach, the display of ILS or other approved landing system information simultaneously with RNAV information to a flight crew member will need careful consideration.

(3) Equipment failure scenarios involving conventional navigation sensors and the RNAV system(s) must be evaluated to demonstrate that adequate alternative means of navigation are available following failure of the RNAV system, and that reversionary switching arrangements do not lead to misleading or unsafe display configurations. The evaluation must consider also the probability of failures within the switching arrangements.

(4) The coupling arrangements for the RNAV system to flight director/automatic pilot must be evaluated to show compatibility and that operating modes, including RNAV system failures modes and RNP alerts, are clearly and unambiguously indicated to the flight crew.

(5) To comply with Section 7, Table 1, item 21. (in particular when intercepting a CF leg) must be shown to be possible without the need for manual intervention, i.e. without disengaging the RNAV mode, and then a manual course selection. This does not preclude means for manual intervention when needed.

(6) MEL requirements and maintenance procedures should be consistent with the aircraft RNP systems availability and performance requirements

8.1.2 Existing Installations

The applicant will need to submit to the Agency a compliance statement which shows how the criteria of this AMC have been satisfied for existing installations. Compliance may be established by inspection of the installed system to confirm the availability of required features and functionality. The performance and integrity criteria of Section 6 and 7 may be confirmed by reference to statements in the Aircraft Flight Manual or to other applicable approvals and supporting certification data. In the absence of such evidence, supplementary analyses and/or tests will be required. Paragraph 9 addresses Aircraft Flight Manual changes that might be necessary.

8.2 DATABASE INTEGRITY

The navigation database should be shown to comply with EUROCAE ED-76 / RTCA DO-200A, or equivalent approved procedures.

8.3 USE OF GPS

a) The sensor must comply with the guidelines in AC 20-138(). For systems that comply with AC 20-138(), the following sensor accuracies can be used in the total system accuracy analysis without additional substantiation: GPS sensor accuracy is better than 36 meters (95%), and augmented GPS (GBAS or SBAS) sensor accuracy is better than 2 meters (95%).

   Note: The use of EGNOS may also provide the required sensor accuracy, additional information will be made available regarding EGNOS when known.

b) In the event of a latent GPS satellite failure and marginal GPS satellite geometry (e.g. Horizontal Integrity Limit (HIL) equal to the horizontal alert limit), the probability that the aircraft remains within the obstacle clearance volume used to evaluate the procedure must be greater than 95% (both laterally and vertically).

   Note: GNSS-based sensors output a HIL, also known as a Horizontal Protection Level (HPL) (see FAA AC 20-138A Appendix 1 and RTCA/DO-229C for an explanation of these terms). The HIL is a measure of the position estimation error assuming a latent failure is present. In lieu of a detailed analysis of the effects of latent failures on the total system error, an acceptable means of compliance for GNSS-based systems is to ensure the HIL remains less than twice the navigation accuracy, minus the 95% of FTE, during the RNP AR operation.

8.4 USE OF INERTIAL REFERENCE SYSTEM (IRS*)*

An inertial reference system must satisfy the criteria of US 14 CFR part 121, Appendix G, or equivalent. While Appendix G defines the requirement for a 2 NM per hour drift rate (95%) for flights up to 10 hours, this rate may not apply to an RNAV system after loss of position updating. Systems that have demonstrated compliance with FAR Part 121, Appendix G can be assumed to have an initial drift rate of 8 NM/hour for the first 30 minutes (95%) without further substantiation. Aircraft manufacturers and applicants can demonstrate improved inertial performance in accordance with the methods described in Appendix 1 or 2 of FAA Order 8400.12A.

Note 1: Integrated GPS/INS position solutions reduce the rate of degradation after loss of position updating. For "tightly coupled" GPS/IRUs, RTCA/DO-229C, Appendix R, provides additional guidance.

Note 2: INS/IRS by itself is not considered suitable for the types of RNP applications described herein. However, it is recognised that many multi-sensor navigation systems utilise INS/IRS within their navigation calculations to provide continuity when the other higher accuracy sensor(s) are momentarily unavailable.

8.5 USE OF DISTANCE MEASURING EQUIPMENT (DME)

Initiation of all RNP AR procedures is based on GNSS updating. Except where specifically designated on a procedure as Not Authorised, DME/DME updating can be used as a reversionary mode during the approach or missed approach when the system complies with the ~~navigation accuracy~~ RNP. ~~The~~ Aircraft manufacturer and applicants should identify any constraints on the DME infrastructure or the procedure for a given aircraft to comply with this requirement.

Note 1: In general, Distance Measurement Equipment (DME) (i.e. position updating from two or more ground stations, DME/DME) will not be sufficient to achieve RNP AR operations where the performance required is less than 0.3 NM. However, where

DME is sufficient, it is expected that they meet ICAO Annex 10 to the Convention on International Civil Aviation and are listed in the AIP.

8.6 USE OF VHF OMNI-DIRECTIONAL RANGE STATION (VOR)

For the initial RNP AR implementation, the RNAV system may not use VOR updating. The manufacturer should identify any constraints on the VOR infrastructure or the procedure for a given aircraft to comply with this requirement.

Note: This requirement does not imply an equipment capability must exist providing a direct means of inhibiting VOR updating. A procedural means for the flight crew to inhibit VOR updating or executing a missed approach if reverting to VOR updating may meet this requirement.

8.7 INTERMIXING OF EQUIPMENT

Installation of area navigation systems with different crew interfaces can be very confusing and can lead to problems when they have conflicting methods of operation and conflicting display formats. There can be problems even when intermixing different versions of the same equipment. For approach operations, ~~intermixing of RNAV equipment is not permitted~~ intermixing of RNAV equipment will only be permitted when specific factors have been addressed satisfactorily. As a minimum, consideration must be given to the following potential incompatibilities particularly where the flight deck architecture includes cross coupling capabilities (e.g. GNSS-2 switched to drive the number 1 displays).

a) Data entry: The two systems must have consistent methods of data entry, and similar pilot procedures for accomplishing common tasks. Any differences should be evaluated for pilot workload. If the wrong procedures are used, (for example, the data entry procedures for the offside system are used by mistake for the onside), there must be no misleading information and it must be easy to identify and recover from the mistake.

b) CDI scaling: Sensitivity must be consistent or annunciated.

c) Display symbology and mode annunciation: There must be no conflicting symbols or annunciation (e.g. a common symbol used for two different purposes), and differences should be specifically evaluated to evaluate the potential confusion they may cause.

d) Mode logic: The modes internal to the equipment and their interface to the rest of the aircraft must be consistent.

e) Equipment failure: The effect of failure of one unit must not result in misleading information.

f) Displayed data: The display of primary navigation parameters must use consistent units and a consistent notation. ~~Any inconsistency in the display of the primary information will not be approved.~~

g) Database differences: Due to the inherent data conflict, differences in the area navigation database will not be permitted.

9 AIRCRAFT FLIGHT MANUAL/PILOT OPERATING HANDBOOK

For new or modified aircraft, the Aircraft Flight Manual (AFM) or the Pilot's Operating Handbook (POH), whichever is applicable, should provide at least the following information:

a) A statement which identifies the equipment and aircraft build or modification standard certificated for RNP operation or having specific statement of RNP capability. This may include a very brief description of the RNAV/GNSS system, including the RNAV/GNSS

airborne equipment software version, CDI/HSI equipment and installation and a statement that it is suitable for RNP operations.

b) Appropriate amendments or supplements to cover RNP operations in the following sections:

- Limitations – including use of FD and AP; currency of navigation database; crew verification of navigation data; availability of RAIM or equivalent function; restrictions on use of GNSS for conventional Non Precision Approaches.
- Normal Procedures
- Abnormal Procedures – including actions in response to a Loss of Integrity (e.g. 'RAIM Position Warning', (or equivalent) message or a 'RAIM not available', (or equivalent) message or 'UNABLE REQ NAV PERF', 'NAV ACCUR DOWNGRAD', (or equivalent) or other RNP messages).

Note: This limited set assumes that a detailed description of the installed system and related operating instructions and procedures are available in other approved operational or training manuals.

10 OPERATIONAL CRITERIA

10.1 GENERAL

This section plus the considerations provided in APPENDIX 3 are provided to assist an operator in developing the necessary processes and materials supporting their application for an operational approval to conduct RNP AR operations. This includes standard operating procedures, flight operations documentation and training package. The operational criteria assume that the corresponding installation/airworthiness approval has been granted by the Agency.

Operations of the RNAV system should be in accordance with the AFM or AFM supplement. The (Master) Minimum Equipment List (MMEL/MEL) should be amended to identify the minimum equipment necessary to satisfy operations using the RNAV system.

10.2 FLIGHT OPERATIONS DOCUMENTATION

The relevant parts and sections of the Operations Manual and check lists must be revised to take account of the operating procedures detailed below (Normal Procedures and Abnormal Procedures). The operator must make timely amendments to the Operations Manual to reflect relevant RNAV AR procedure and database checking strategies. Manuals and check lists need to be submitted for review by the responsible authority as part of the approval process.

The aircraft operator should propose an amendment to the Minimum Equipment List (MEL) appropriate to RNP AR operations.

10.3 QUALIFICATION AND TRAINING

Each pilot should receive appropriate training, briefings and guidance material in order to safely conduct RNP AR procedures. The material and training should cover the normal and abnormal procedures. Standard training and checking such as recurrent training and proficiency checks should include RNP procedures. Based on this, the operator should determine what constitutes a qualified crew.

The operator should ensure that effective methods are used to implement applicable RNP AR procedures to ensure that in line operations each pilot can perform assigned duties reliably and expeditiously for each procedure to be flown, both in normal circumstances, and for probable non-normal circumstances. Additional guidance is provided in APPENDIX 2 and 3, as well as the RNP AR APCH navigation specification contained in the ICAO Performance Based Navigation Manual, Volume II.

10.4 NAVIGATION DATABASE MANAGEMENT

10.4.1 Initial Data Validation

The operator must validate every RNP AR procedure before flying the procedure in instrument meteorological conditions (IMC) to ensure compatibility with their aircraft and to ensure the resulting path matches the published procedure. As a minimum, the operator must:

a) Compare the navigation data for the procedure(s) to be loaded into the flight management system with the published procedure.

b) Validate the loaded navigation data for the procedure, either in a simulator or in the actual aircraft in visual meteorological conditions (VMC). The depicted procedure on the map display must be compared to the published procedure. The entire procedure must be flown to ensure the path is flyable, does not have any apparent lateral or vertical path disconnects, and is consistent with the published procedure.

c) Once the procedure is validated, retain and maintain a copy of the validated navigation data for comparison to subsequent data updates.

10.4.~~1~~2 Operator involved in the operation of aeroplanes for commercial air transportation

EU-OPS 1.873 for the management of navigation database applies.

10.4.~~2~~3 Operator not involved in the operation of aeroplanes for commercial air transportation

The operators should not use a navigation database for RNP APCH operations unless the navigation database supplier holds a Type 2 Letter of Acceptance (LoA) or equivalent.

An EASA Type 2 LoA is issued by EASA in accordance with EASA OPINION Nr. 01/2005 on "The Acceptance of Navigation Database Suppliers" dated 14 Jan 05. The FAA issues a Type 2 LoA in accordance with AC 20-153, while Transport Canada (TCCA) is issues an Acknowledgement Letter of an Aeronautical Data Process using the same basis. Both the FAA LoA and the TCCA Acknowledgement Letter are seen to be equivalent to the EASA LoA.

EUROCAE/RTCA document ED-76/DO-200A Standards for Processing Aeronautical Data contains guidance relating to the processes that the supplier may follow. The LoA demonstrates compliance with this standard.

10.4.~~2~~3.1 Non-approved Suppliers

If the operator's supplier does not hold a Type 2 LoA or equivalent, the operator should not use the electronic navigation data products unless the Authority has approved the operator's procedures for ensuring that the process applied and the delivered products have met equivalent standards of integrity.

10.4.2~~3~~.3 Quality Monitoring

The operator should continue to monitor both the process and the products in accordance with the quality system required by the applicable operational regulations.

10.4.2~~3~~.4 Data Distribution

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

10.4.3~~4~~ Aircraft Modifications

If an aircraft system required for RNP AR operations is modified (e.g. software change), the operator is responsible for validation of RNP AR procedures with the navigation database and the modified system. This may be accomplished without any direct evaluation if the manufacturer verifies that the modification has no effect on the navigation database or path computation. If no such assurance from the manufacturer is available, the operator must conduct initial data validation with the modified system

10.5 REPORTABLE EVENTS

A reportable event is one that adversely affects the safety of the operation and may be caused by actions/events external to the operation of the aircraft navigation system. The operator should have in place a system for investigating such an event to determine if it is due to an improperly coded procedure, or a navigation data base error. Responsibility for initiating corrective action rests with the operator.

For those operators for whom approval is granted under EU OPS-1, following events should be the subject of Occurrence Reports (see EU-OPS 1.420):

Technical defects and the exceeding of technical limitations, including:

a) Significant navigation errors attributed to incorrect data or a database coding error.
b) Unexpected deviations in lateral/vertical flight path not caused by pilot input or erroneous operation of equipment.
c) Significant misleading information without a failure warning.
d) Total loss or multiple navigation equipment failure.
e) Loss of integrity (e.g. RAIM) function whereas integrity was predicted to be available during the pre-flight planning.

10.6 FLEET APPROVALS

Normally, operational approvals for RNAV AR Procedures will be fleet specific.

10.7 RNP MONITORING PROGRAM

The operator should have an RNP monitoring program to ensure continued compliance with the guidance of this AMC and to identify any negative trends in performance. At a minimum, this program must address the following information. During the initial 90 day interim approval period, the operator must submit the following information every 30 days to the authority granting their authorisation. Thereafter, the operator must continue to collect and periodically review this data to identify potential safety concerns, and maintain summaries of this data.

a) Total number of RNP AR procedures conducted.

b) Number of satisfactory approaches by aircraft/system (Satisfactory if completed as planned without any navigation or guidance system anomalies).

c) Reasons for unsatisfactory approaches, such as:

1) UNABLE REQ NAV PERF, NAV ACCUR DOWNGRAD, or other RNP messages during approaches.

2) Excessive lateral or vertical deviation.

3) TAWS warning.

4) Autopilot system disconnect.

5) Nav data errors.

6) Pilot report of any anomaly.

d) Crew comments.

APPENDIX 1 GLOSSARY

The following are definitions of key terms used throughout this AMC.

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: RNAV functional capability is typically viewed as navigation operations in the horizontal plane, which is known also as Lateral Navigation Mode. However, an RNAV system may include functional capabilities for operations in the vertical plane, known as Vertical Navigation Mode.

Accuracy. The degree of conformance between the estimated, measured, or desired position and/or the velocity of a platform at a given time, and its true position or velocity. Navigation performance accuracy is usually presented as a statistical measure of system error and is specified as predictable, repeatable and relative.

Availability. An indication of the ability of the system to provide usable service within the specified coverage area and is defined as the portion of time during which the system is to be used for navigation during which reliable navigation information is presented to the crew, automatic pilot, or other system managing the flight of the aircraft.

Continuity of Function. The capability of the total system (comprising all elements necessary to maintain the aircraft position within the defined airspace) to perform its function without non-scheduled interruptions during the intended operation.

Integrity. The ability of a system to provide timely warnings to users when the system should not be used for navigation.

Receiver Autonomous Integrity Monitoring (RAIM). A technique whereby a GPS receiver / processor determines the integrity of the GPS navigation signals using only GPS signals or GPS signals augmented with altitude. This determination is achieved by a consistency check among redundant pseudo-range measurements. At least one satellite in addition to those required for navigation must be in view for the receiver to perform the RAIM function ~~(FAA AC 20-138, AC 90-94).~~

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 these.

The following acronyms are used in the document:

~~ACAS~~	~~Airborne Collision Avoidance System~~
AFM	Aircraft Flight Manual
AGL	Above Ground level
AIP	Aeronautical Information Publication
AIRAC	Aeronautical information regulation and control
AP	Autopilot
APCH	Approach
~~APV~~	~~Approach with Vertical Guidance~~
AR	Authorisation Required
ATC	Air Traffic Control
ATS	Air Traffic Service
BARO	Barometric
CAT	Category
CDI	Course Deviation Indicator
CF	Course to Fix
CRM	Collision risk model
CRM	Crew resource management
DA/H	Descent Altitude/Height
DF	Direct to Fix
DME	Distance Measuring Equipment
EC	European Commission
EFIS	Electronic flight instrument system
EGNOS	European Geostationary Navigation Overlay Service
ETA	Estimated Time of Arrival
EU	European Union
FAF	Final Approach Fix
FD	Flight Director
FOM	Flight Operations Manual
FMC	Flight Management Computer
FMS	Flight Management System
F/O	First Officer
FOSA	Flight Operations Safety Assessment
FTE	Flight Technical Error
GBAS	Ground-based augmentation system
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
HIL	Horizontal Integrity Limit
HSI	Horizontal situation indicator
IAF	Initial Approach Fix
IAP	Instrument approach procedure
ICAO	International Civil Aviation Organisation
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument meteorological conditions
INS	Inertial Navigation System
IRS	Inertial Reference System
IRU	Inertial Reference Unit
ISA	International standard atmosphere
KIAS	Knots indicated airspeed
LoA	Letter of Acceptance
LOE	Line Oriented Evaluation
LOFT	Line Oriented Flight Training
LNAV	Lateral Navigation
MASPS	Minimum Aviation System Performance Standards
~~MDA/H~~	~~Minimum Descent Altitude/Height~~
MEL	Minimum Equipment List
MMEL	Master Minimum Equipment List

NAV	Navigation
NM	Nautical Mile
NOTAM	Notice to Airmen
OEI	One Engine Inoperative
OEM	Original Equipment Manufacture
PBN	Performance Based Navigation
PC	Proficiency Check
POH	Pilot Operating Handbook
PT	Proficiency Training
RAIM	Receiver Autonomous Integrity Monitoring
RF	Radius to Fix
RNAV	Area Navigation
RNP	Required Navigation Performance
RTA	Required Time of Arrival
SBAS	Satellite-based augmentation system
SSA	System Safety Assessments
STC	Supplemental Type Certificates
TAWS	Terrain Awareness Warning System
TC	Type Certificates
~~TCAS~~	~~Traffic Alert and Collision Avoidance System~~
TERPS	Terminal Instrument Procedures
~~TGL~~	~~Temporary Guidance Leaflet~~
TF	Track to Fix
TLS	Target Level Of Safety
TOGA	Take off/Go around
VDI	Vertical Deviation Indicator
VEB	Vertical Error Budget
VMC	visual meteorological conditions
VNAV	Vertical Navigation
VOR	VHF Omni-directional Range
WGS	World Geodetic System

APPENDIX 2 TRAINING AND CREW QUALIFICATION ISSUES

1. INTRODUCTION

The operator must provide training for key personnel (e.g. flight crewmembers and dispatchers) in the use and application of RNP AR procedures. A thorough understanding of the operational procedures and best practices is critical to the safe operation of aircraft during RNP AR operations. This program must provide sufficient detail on the aircraft's navigation and flight control systems to enable the pilots to identify failures affecting the aircrafts RNP capability and the appropriate abnormal/emergency procedures. Required training must include both knowledge and skill assessments of the crewmembers and dispatchers duties.

1.1 FLIGHT CREW TRAINING

a) Each operator is responsible for the training of flight crews for the specific RNP AR operations exercised by the operator. The operator must include training on the different types of RNP AR procedures and required equipment. Training must include discussion of RNP AR regulatory requirements. The operator must include these requirements and procedures in their flight operations and training manuals (as applicable). This material must cover all aspects of the operator's RNP AR operations including the applicable AR authorisation. An individual must have completed the appropriate ground and or flight training segment before engaging in RNP AR operations.

b) Flight training segments must include training and checking modules representative of the type of RNP AR operations the operator conducts during line flying activities. Many operators may train for RNP AR procedures under the established training standards and provisions for any advanced qualification programs. They may conduct evaluations in Line Oriented Flight Training (LOFT) scenarios, selected event training scenarios or in a combination of both. The operator may conduct required flight-training modules in Flight Training Devices, Aircraft Simulators, and other enhanced training devices as long as these training mediums accurately replicate the operator's equipment and RNP AR operations.

1.2 FLIGHT CREW QUALIFICATION TRAINING

a) Operators must address initial RNP AR training and qualifications during initial, transition, upgrade, recurrent, differences, or stand-alone training and qualification programs in a respective qualification category. The qualification standards assess each pilot's ability to properly understand and use RNP AR procedures. The operator must also develop recurrent qualification standards to ensure their flight crews maintain appropriate RNP AR knowledge and skills (RNP AR Recurrent Qualification).

b) Operators may address RNP AR operation topics separately or integrate them with other curriculum elements. For example, an RNP AR flight crew qualification may key on a specific aircraft during transition, upgrade, or differences courses. General training may also address RNP AR qualification (e.g. during recurrent training or checking events such as recurrent proficiency check/proficiency training (PC/PT), line oriented evaluation (LOE) or special purpose operational training. A separate, independent RNP AR qualification program may also address RNP AR training (e.g. by completion of a special RNP AR curriculum at an operator's training centre or at designated crew bases).

c) Operators intending to receive credit for RNP training, when their proposed program relies on previous training (e.g. Special RNP IAP's) must receive specific authorisation from their approving authority. In addition to the current RNP training program the operator will need to provide differences training between existing training program and the RNP AR training requirements.

1.3 FLIGHT DISPATCHER TRAINING.

Training for flight dispatchers must include: training on the different types of RNP AR procedures, the importance of specific navigation equipment and other equipment during RNP AR operations and discuss RNP AR regulatory requirements and procedures. Dispatcher procedure and training manuals must include these requirements (as applicable). This material must cover all aspects of the operator's RNP AR operations including the applicable authorisation. An individual must have completed the appropriate training course before engaging in RNP AR operations. Additionally, the dispatchers' training must address how to determine: RNP AR availability (considering aircraft equipment capabilities), MEL requirements, aircraft performance, and navigation signal availability (e.g. GPS RAIM/predictive RNP capability tool) for destination and alternate airports.

2. GROUND TRAINING SEGMENTS

Ground training segments must address the following subjects as training modules in approved RNP AR academic training during the initial introduction of a crewmember to RNP AR systems and operations. For recurrent programs, the curriculum need only review initial curriculum requirements and address new, revised, or emphasised items.

2.1 GENERAL CONCEPTS OF RNP AR OPERATION

RNP AR academic training must cover RNP AR systems theory to the extent appropriate to ensure proper operational use. Flight crews must understand basic concepts of RNP AR systems operation, classifications, and limitations. The training must include general knowledge and operational application of RNP AR instrument approach procedures. This training module must address the following specific elements:

a) Definitions of RNAV, RNAV (GPS), RNP, RNP AR, RAIM, and containment areas.

b) The differences between RNAV and RNP.

c) The types of RNP AR approach procedures and familiarity with the charting of these procedures.

d) The programming and display of RNP and aircraft specific displays (e.g. Actual Navigation Performance).

e) How to enable and disable the navigation updating modes related to RNP.

f) RNP accuracy values appropriate for different phases of flight and RNP AR instrument procedures and how to select (if required).

g) The use of GPS RAIM (or equivalent) forecasts and the effects of RAIM "holes" on RNP AR procedures (flight crew and dispatchers).

h) When and how to terminate RNP navigation and transfer to traditional navigation due to loss of RNP and/or required equipment.

i) How to determine if the FMC database is current and contains required navigational data.

j) Explanation of the different components that contribute to the total system error and their characteristics (e.g. effect of temperature on BARO-VNAV, drift characteristics when using IRU with no radio updating, considerations in making suitable temperature corrections for altimeter systems).

k) Temperature Compensation. Flight crews operating avionics systems with compensation for altimetry errors introduced by deviations from ISA may disregard the temperature limits on RNP AR procedures, if pilot training on use of the temperature compensation function is provided by the operator and the compensation function is utilised by the crew. However the training must also recognise the temperature compensation by the system is applicable to the VNAV guidance and is not a substitute for the flight crew compensating for the cold temperature effects on minimum altitudes or the decision altitude.

l) The effect of wind on aircraft performance during RNP AR procedures and the need to positively remain within RNP containment area, including any operational wind limitation and aircraft configuration essential to safely complete an RNP AR procedure.

m) The effect of groundspeed on compliance with RNP AR procedures and bank angle restrictions that may impact the ability to remain on the course centreline. For RNP procedures aircraft are expected to maintain the standard speeds associated with applicable category.

n) Relationship between RNP and the appropriate approach minima line on an approved published RNP AR procedure and any operational limitations if the available RNP degrades or is not available prior to an approach (this should include flight crew procedures outside the FAF versus inside the FAF).

o) Understanding alerts that may occur from the loading and use of improper RNP accuracy values for a desired segment of an RNP AR procedure.

p) Understanding the performance requirement to couple the autopilot/flight director to the navigation system's lateral guidance on RNP AR procedures requiring an RNP of less than RNP 0.3.

q) The events that trigger a missed approach when using the aircraft's RNP capability to complete an RNP AR procedure.

r) Any bank angle restrictions or limitations on RNP AR procedures.

s) Ensuring flight crews understand the performance issues associated with reversion to radio updating, know any limitations on the use of DME and VOR updating.

2.2. ATC COMMUNICATION AND COORDINATION FOR USE OF RNP AR

Ground training must instruct the flight crews on proper flight plan classifications and any Air Traffic Control (ATC) procedures applicable to RNP AR operations. The flight crews must receive instruction on the need to advise ATC immediately when the performance of the aircraft's navigation system is no longer suitable to support continuation of an RNP AR procedure. Flight crews must also know what navigation sensors form the basis for their RNP AR compliance, and they must be able to assess the impact of failure of any avionics or a known loss of ground systems on the remainder of the flight plan.

2.3 RNP AR EQUIPMENT COMPONENTS, CONTROLS, DISPLAYS, AND ALERTS

Academic training must include discussion of RNP terminology, symbology, operation, optional controls, and display features including any items unique to an operator's implementation or systems. The training must address applicable failure alerts and limitations. The flight crews and dispatchers should achieve a thorough understanding of the equipment used in RNP operations and any limitations on the use of the equipment during those operations.

2.4 AFM INFORMATION AND OPERATING PROCEDURES

The AFM or other aircraft eligibility evidence must address normal and abnormal flight crew operating procedures, responses to failure alerts, and any limitations, including related information on RNP modes of operation. Training must also address contingency procedures for loss or degradation of RNP capability. The flight operations manuals approved for use by the flight crews (e.g. Flight Operations Manual (FOM) or Pilot Operating Handbook (POH)) should contain this information.

a) Temporary Limitations on Minima. Where Operators are new to RNP operations and whose initial application is for RNP < 0.3, it is appropriate to establish a temporary limitation for minima consistent with RNP 0.3, until operational experience is gained. This period could be based upon time (i.e. 90 days) and/or number of conducted operations (e.g. 100 RNP approaches), as agreed upon by the regulator and operator.

2.5 MEL OPERATING PROVISIONS

Flight crews must have a thorough understanding of the MEL requirements supporting RNP AR operations.

3. FLIGHT TRAINING SEGMENTS

In addition to the academic training, the flight crews must receive appropriate operational use training. Training programs must cover the proper execution of RNP AR procedures in concert with the OEM's documentation. The operational training must include RNP AR procedures and limitations; standardisation of the set-up of the cockpit's electronic displays during an RNP AR procedure; recognition of the aural advisories, alerts and other annunciations that can impact compliance with an RNP AR procedure; and the timely and correct responses to loss of RNP AR capability in a variety of scenarios embracing the breadth of the RNP AR procedures the operator plans to complete. Such training may also use approved flight training devices or simulators. This training must address the following specific elements:

a) Procedures for verifying that each pilot's altimeter has the current setting before beginning the final approach of an RNP AR procedure, including any operational limitations associated with the source(s) for the altimeter setting and the latency of checking and setting the altimeters for landing.

b) Use of aircraft RADAR, TAWS, GPWS, or other avionics systems to support the flight crew's track monitoring and weather and obstacle avoidance.

~~c) The effect of wind on aircraft performance during RNP AR procedures and the need to positively remain within RNP containment area, including any operational wind limitation and aircraft configuration essential to safely complete an RNP AR procedure.~~

~~d) The effect of groundspeed on compliance with RNP AR procedures and bank angle restrictions that may impact the ability to remain on the course centreline. For RNP procedures aircraft are expected to maintain the standard speeds associated with applicable category.~~

~~e) Relationship between RNP and the appropriate approach minima line on an approved published RNP AR procedure and any operational limitations if the available RNP degrades or is not available prior to an approach (this should include flight crew procedures outside the FAF versus inside the FAF).~~

~~f~~c) Concise and complete flight crew briefings for all RNP AR procedures and the important role Cockpit Resource Management (CRM) plays in successfully completing an RNP AR procedure.

~~g. Understanding alerts that may occur from the loading and use of improper RNP values for a desired segment of an RNP AR procedure.~~

~~h) Understanding the performance requirement to couple the autopilot/flight director to the navigation system's lateral guidance on RNP AR procedures requiring an RNP of less than RNP 0.3.~~

~~i~~d) The importance of aircraft configuration to ensure the aircraft maintains any required speeds during RNP AR procedures.

~~j) The events that trigger a missed approach when using the aircraft's RNP capability to complete an RNP AR procedure.~~

~~k) Any bank angle restrictions or limitations on RNP AR procedures~~.

~~l~~e) The potentially detrimental effect of reducing the flap setting, reducing the bank angle or increasing airspeeds may have on the ability to comply with an RNP AR procedure.

~~m~~f) Develop flight crew knowledge and skills necessary to properly conduct RNP AR operations (RNP AR Procedure Training).

~~n~~g) Ensure flight crews understand and are capable of programming and operating the FMC, autopilot, autothrottles, RADAR, GPS, INS, EFIS (including the moving map), and TAWS in support of RNP AR procedures.

~~o~~h) Handling of TOGA while in a turn.

~~p~~i) Monitoring of FTE and related go-around operation.

~~q~~j) Handling of loss of GPS during a procedure.

~~r) Ensuring flight crews understand the performance issues associated with reversion to radio updating, know any limitations on the use of DME and VOR updating.~~

~~s~~k) Flight crew contingency procedures for a loss of RNP capability during a missed approach. Due to the lack of navigation guidance, the training should emphasise the flight crew contingency actions that achieve separation from terrain and obstacles. The operator should tailor these contingency procedures to their specific, approved AR procedures.

~~t~~l) As a minimum, each pilot must complete two RNP approach procedures that employ the unique AR characteristics of the operator's approved procedures (i.e., RF legs, RNP missed). One procedure must culminate in a transition to landing and one procedure must culminate in execution of an RNP missed approach procedure.

4 EVALUATION

4.1 INITIAL EVALUATION OF RNP AR KNOWLEDGE AND PROCEDURES

The operator must evaluate each individual flight crewmember on their knowledge of RNP AR procedures prior to employing RNP AR procedures. As a minimum, the review must include a thorough evaluation of pilot procedures and specific aircraft performance requirements for RNP AR operations. An acceptable means for this initial assessment includes one of the following:

a) An evaluation by an ~~authorised instructor evaluator or check airman~~ examiner using an approved simulator or training device.

b) An evaluation by an authorised instructor evaluator or check airman during line operations, training flights, PC/PT events, operating experience, route checks, and/or line checks.

c) Line Oriented Flight Training (LOFT)/Line Oriented Evaluation (LOE). LOFT/LOE programs using an approved simulator that incorporates RNP AR operations that employ the unique AR characteristics (i.e., RF legs, RNP missed) of the operator's approved procedures.

4.2 SPECIFIC ELEMENTS THAT MUST BE ADDRESSED IN THIS EVALUATION MODULE ARE:

a) Demonstrate the use of any RNP AR limits/minimums that may impact various RNP AR operations.

b) Demonstrate the application of radio-updating procedures, such as enabling and disabling ground-based radio updating of the FMC (i.e., DME/DME and VOR/DME updating) and knowledge of when to use this feature. If the aircraft's avionics do not include the capability to disable radio updating, then the training must ensure the flight crew is able to accomplish the operational actions that mitigate the lack of this feature.

c) Demonstrate the ability to monitor the actual lateral and vertical flight paths relative to programmed flight path and complete the appropriate flight crew procedures when exceeding a lateral or vertical FTE limit.

d) Demonstrate the ability to read and adapt to a RAIM (or equivalent) forecast including forecasts predicting a lack of RAIM availability.

e) Demonstrate the proper setup of the FMC, the weather RADAR, TAWS, and moving map for the various RNP AR operations and scenarios the operator plans to implement.

f) Demonstrate the use of flight crew briefings and checklists for RNP AR operations with emphasis on CRM.

g) Demonstrate knowledge of and ability to perform an RNP AR missed approach procedure in a variety of operational scenarios (i.e., loss of navigation or failure to acquire visual conditions).

h) Demonstrate speed control during segments requiring speed restrictions to ensure compliance with an RNP AR procedure.

i) Demonstrate competent use of RNP AR approach plates, briefing cards, and checklists.

j) Demonstrate the ability to complete a stable RNP AR approach: bank angle, speed control, and remaining on the procedure's centreline.

k) Know the operational limit for deviation below the desired flight path on an RNP AR approach and how to accurately monitor the aircraft's position relative to vertical flight path.

5. RECURRENT TRAINING OF RNP AR KNOWLEDGE AND PROCEDURES

5.1 RNP AR Recurrent Training. The operator should incorporate recurrent RNP training that employs the unique AR characteristics of the operator's approved procedures as part of the overall program.

5.2 A minimum of two RNP AR approaches must be flown by each pilot for each duty position (pilot flying and pilot monitoring), with one culminating in a landing and one culminating in a missed approach, and may be substituted for any required "precision-like" approach.

NOTE: Equivalent RNP approaches may be credited toward this requirement.

APPENDIX 3 RNP OPERATIONAL CONSIDERATIONS

1. GENERAL

This appendix provides guidance on the conduct of RNP operations where authorisation is required (AR). In addition to the guidance of this appendix, the operator must continue to ensure they comply with the general RNAV operating requirements; checking Notices to Airmen (NOTAMS), availability of Navigational Aids (NAVAID), airworthiness of aircraft systems, and aircrew qualification.

2. OPERATIONAL CONSIDERATIONS

a) Minimum Equipment List. Operators minimum equipment list should be developed /revised to address the equipment requirements for RNP instrument approaches. Guidance for these equipment requirements is available from the aircraft manufacturer. The required equipment may depend on the intended navigation accuracy and whether or not the missed approach requires RNP less than 1.0. For example, GNSS and autopilot are typically required for small navigation accuracy. Dual equipment is typically required for approaches when using a line of minima less than RNP-0.3 and/or where the missed approach has an RNP less than 1.0. An operable Class A Terrain Awareness Warning System (TAWS) is required for all RNP AR approach procedures. It is recommended that the TAWS use altitude that is compensated for local pressure and temperature effects (e.g. corrected barometric and GNSS altitude), and include significant terrain and obstacle data. The flight crew must be cognisant of the required equipment.

b) Autopilot and Flight Director. RNP procedures with RNP accuracy values less than RNP 0.3 or with RF legs require the use of autopilot or flight director driven by the RNAV system in all cases. Thus, the autopilot/flight director must operate with suitable accuracy to track the lateral and vertical paths required by a specific RNP AR approach procedure. When the dispatch of a flight is predicated on flying an RNP AR approach requiring the autopilot at the destination and/or alternate, the flight crew ~~dispatcher~~ must determine that the autopilot is installed and operational.

c) Dispatch RNP Assessment. The operator should have a predictive performance capability, which can determine whether or not the specified RNP will be available at the time and location of a desired RNP operation. This capability can be a ground service and need not be resident in the aircraft's avionics equipment. The operator should establish procedures requiring use of this capability as both a pre-flight dispatch tool and as a flight-following tool in the event of reported failures. The RNP assessment should consider the specific combination of the aircraft capability (sensors and integration), as well as their availability.

   (1) RNP assessment when GNSS updating. This predictive capability must account for known and predicted outages of GNSS satellites or other impacts on the navigation system's sensors. The prediction program should not use a mask angle below 5 degrees, as operational experience indicates that satellite signals at low elevations are not reliable. The prediction must use the actual GPS constellation with the (RAIM) (or equivalent) algorithm identical to that used in the actual equipment. For RNP AR approaches with high terrain, use a mask angle appropriate to the terrain.

   (2) Initially, RNP AR approach procedures require GNSS updating.

d) NAVAID Exclusion. The operator should establish procedures to exclude NAVAID facilities in accordance with NOTAMs (e.g. DMEs, VORs, localisers). Internal avionics reasonableness checks may not be adequate for RNP operations.

e) Navigation Database Currency. During system initialisation, pilots of aircraft equipped with an RNP-certified system, must confirm that the navigation database is current. Navigation databases are expected to be current for the duration of the flight. If the AIRAC cycle will change during flight, 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. Traditionally, this has been accomplished by verifying electronic data against paper products. One acceptable means is to compare aeronautical charts (new and old) to verify navigation fixes prior to dispatch. If an amended chart is published for the procedure, the database must not be used to conduct the operation.

3. FLIGHT CONSIDERATIONS

a) Modification of Flight Plan. Pilots should not be authorised 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 accepting a clearance to go direct to a fix in the approach procedure that is before the FAF and that does not immediately precede an RF leg. The only other acceptable modification to the loaded procedure is to change altitude and/or airspeed waypoint constraints on the initial, intermediate, or missed approach segments flight plan fixes (e.g. to apply cold temperature corrections or comply with an ATC clearance/instruction).

b) Required Equipment. The flight crew should have either a required list of equipment for conducting RNP approaches or alternate methods to address in flight equipment failures that would prohibit RNP approaches (e.g. crew warning systems, quick reference handbook).

c) RNP Management. The flight crew's operating procedures should ensure the navigation system uses the appropriate RNP accuracy values throughout the approach. If the navigation system does not extract and set the navigation accuracy from the on-board navigation database for each leg of the procedure, then the flight crew's operating procedures must ensure that the smallest navigation accuracy required to complete the approach or the missed approach is selected before initiating the approach (e.g. before the initial approach fix (IAF)). Different IAF's may have different navigation accuracy, which are annotated on the approach chart.

d) Loss of RNP ~~GNSS Updating~~. ~~Initially all RNP AR instrument approach procedures require GNSS updating of the navigation position solution~~. The flight crew must ensure that no loss of RNP annunciation is received ~~verify GNSS updating is available~~ prior to commencing the RNP AR approach. During the approach, if at any time a loss of RNP annunciation is received ~~GNSS updating is lost and the navigation system does not have the performance to continue the approach~~, the flight crew must abandon the RNP AR approach unless the pilot has in sight the visual references required to continue the approach.

e) Radio Updating. Initiation of all RNP AR procedures is based on GNSS updating. Except where specifically designated on a procedure as Not Authorised, DME/DME updating can be used as a reversionary mode during the approach or missed approach when the system complies with the navigation accuracy. VOR updating

is not authorised at this time. The flight crew must comply with the operator's procedures for inhibiting specific facilities.

f) Approach Procedure Confirmation. The flight crew must confirm that the correct procedure has been selected. This process includes confirmation of the waypoint sequence, reasonableness of track angles and distances, and any other parameters that can be altered by the ~~pilot~~ flight crew, such as altitude or speed constraints. A procedure must not be used if validity of the navigation database is in doubt. A navigation system textual display or navigation map display must be used.

g) Track Deviation Monitoring. ~~Pilots~~ The flight crew must use a lateral deviation indicator, flight director and/or autopilot in lateral navigation mode on RNP AR approach procedures. ~~Pilots~~ The flight crew of aircraft with a lateral deviation indicator must ensure that lateral deviation indicator scaling (full-scale deflection) is suitable for the navigation accuracy associated with the various segments of the RNP AR approach procedure. All ~~pilots~~ flight crew are expected to maintain procedure centrelines, as depicted by onboard lateral deviation indicators and/or flight guidance during all RNP operations described in this manual unless authorised to deviate by ATC or under emergency conditions. For normal operations, cross-track error/deviation (the difference between the RNP system computed path and the aircraft position relative to the path) should be limited to ~~+/- ½~~ the navigation accuracy (RNP) associated with the procedure segment. ~~Brief lateral deviations from this standard (e.g. overshoots or undershoots) during and immediately after turns, up to a maximum of 1 times the navigation accuracy of the procedure segment, are allowable~~.

~~The vertical deviation must be within 75 feet during the final approach segment~~. Vertical deviation should be monitored above and below the glide-path; The vertical deviation must be within ±75 feet of the glide-path during the final approach segment ~~while being above the glide path provides margin against obstacles on the final approach, it can result in a go-around decision closer to the runway and reduce the margin against obstacles in the missed approach~~.

~~Pilots~~ Flight crew must execute a Missed Approach if the lateral deviation exceeds 1xRNP or the vertical deviation exceeds 75 feet, unless the pilot has in sight the visual references required to continue the approach.

(1) ~~Some aircraft navigation displays do not incorporate lateral and vertical deviations scaled for each RNP AR approach operation in the primary optimum field of view.~~ Where a moving map, low-resolution vertical deviation indicator (VDI), or numeric display of deviations are to be used, flight crew training and procedures must ensure the effectiveness of these displays. Typically, this involves demonstration of the procedure with a number of trained crews and inclusion of this monitoring procedure in the recurrent RNP AR approach training program.

(2) For installations that use a CDI for lateral path tracking, the aircraft flight manual (AFM) or aircraft qualification guidance should state which navigation accuracy and operations the aircraft supports and the operational effects on the CDI scale. The flight crew must know the CDI full-scale deflection value. The avionics may automatically set the CDI scale (dependent on phase of flight) or the flight crew may manually set the scale. If the flight crew manually selects the CDI scale, the operator must have procedures and training in place to assure the selected CDI scale is appropriate for the intended RNP operation. The deviation limit must be readily apparent given the scale (e.g. full-scale deflection).

h) System Cross-check. For approaches with RNP accuracy value less than RNP 0.3, the flight crew should ensure the lateral and vertical guidance provided by the navigation system is consistent with other available data and displays provided by an independent means.

Note: This cross-check may not be necessary if the lateral and vertical guidance systems have been developed and/or evaluated consistent with extremely remote failure conditions and if the normal system performance supports 1xRNP containment.

i) Procedures with RF Legs. An RNP procedure may require the ability to execute an RF leg to avoid terrain or obstacles. As not all aircraft have this capability, flight crews should be aware of whether or not they can conduct these procedures. ~~When flying an RF leg, flight crew compliance with the desired path is essential to maintain the intended ground track~~.

(1) If initiating a go-around during or shortly after the RF leg, the flight crew must be aware of the importance of maintaining the published path as closely as possible. Operational procedures are required for aircraft that do not stay in LNAV when a go-around is initiated to ensure the RNP AR APCH ground track is maintained.

(2) Pilots must not exceed the maximum airspeeds shown in Table 1 throughout the RF leg segment. For example, a Category C A320 must slow to 160 KIAS at the FAF or may fly as fast as 185 KIAS if using Category D minima. A missed approach prior to DA may require the segment speed for that segment be maintained.

Table 1: Maximum Airspeed by Segment and Category

Indicated Airspeed (Knots)					
Segment	Indicated Airspeed by Aircraft Category				
	Cat A	Cat B	Cat C	Cat D	Cat E
Initial & Intermediate (IAF to FAF)	150	180	240	250	250
Final (FAF to DA)	100	130	160	185	As Specified
Missed Approach (DA to MAHP)	110	150	240	265	As Specified
Airspeed Restriction*	As Specified				

*Airspeed restrictions may be used to reduce turn radius regardless of aircraft category.

j) Temperature Compensation. For aircraft with temperature compensation, flight crews may disregard the temperature limits on RNP procedures if the operator provides pilot training on the use of the temperature compensation function. Temperature compensation by the system is applicable to the VNAV guidance and is not a substitute for the flight crew compensating for the cold temperature effects on minimum altitudes or the decision altitude. Flight crews should be familiar with the effects of the temperature compensation on intercepting the compensated path described in EUROCAE ED-75B/RTCA DO-236B Appendix H.

k) Altimeter Setting. Due to the performance based obstruction clearance inherent in RNP instrument procedures, the flight crew should verify the most current airport altimeter is set prior to the final approach fix (FAF). Operators should take precautions to switch altimeter settings at appropriate times or locations and request a current altimeter setting if the reported setting may not be recent, particularly at times when pressure is reported or is expected to be rapidly decreasing. Execution of an RNP instrument procedure requires the current altimeter setting for the airport of intended landing. Remote altimeter settings are not allowed.

l) Altimeter Cross-check. The flight crew should complete an altimetry crosscheck ensuring both pilots' altimeters agree within ±100 feet prior to the final approach fix (FAF) but no earlier than when the altimeters are set for the airport of intended landing. If the altimetry crosscheck fails then the procedure must not be continued.

Note: This operational cross-check is not necessary if the aircraft systems automatically compare the altitudes to within 75 feet.

~~m) Non-Standard Climb Gradient. The operator should be aware that a non-standard missed approach climb gradient may be associated with a DA/H. The aircraft and payload should be evaluated to ensure such procedures can be performed, and any associated conditions or procedures are identified, and provided to the flight crew.~~

~~n~~m) Go-Around or Missed Approach. Where possible, the missed approach will require RNP 1.0. The missed approach portion of these procedures is similar to a missed approach of an RNP APCH procedure. Where necessary, navigation accuracy less than RNP 1.0 will be used in the missed approach. To be approved to conduct these approaches, equipage and procedures must meet criteria in paragraph 7, Table 2 (Requirements for Approaches with Missed Approach less than RNP 1.0).

(1) In many aircraft when executing a go-around or missed approach activating Take-off/Go-around (TOGA) may cause a change in lateral navigation. In many aircraft, activating TOGA disengages the autopilot and flight director from LNAV guidance, and the flight director reverts to track-hold derived from the inertial system. LNAV guidance to the autopilot and flight director should be re-engaged as quickly as possible.

(2) The flight crew procedures and training must address the impact on navigation capability and flight guidance if the pilot initiates a go-around while the aircraft is in a turn. When initiating an early go-around, the flight crew should follow the rest of the approach track and missed approach track unless issued a different clearance by ATC. The flight crew should also be aware that RF legs are designed based on the maximum true airspeed at normal altitudes, and initiating an early go-around will reduce the manoeuvrability margin and potentially even make holding the turn impractical at missed approach speeds.

(3) Upon loss of GNSS updates, the RNAV guidance may begin to "coast" on IRU, if installed, and drift, degrading the navigation position solution. Thus, when the RNP AR APCH missed approach operations rely on IRU "coasting" the inertial guidance can only provide acceptable navigation performance ~~RNP guidance~~ for a specified amount of time.

~~o~~n) Contingency Procedures

(1) Failure while En Route. The aircraft RNP capability is dependent on operational aircraft equipment and GNSS satellites. The flight crew should be able to assess the impact of equipment failure on the anticipated RNP approach and take appropriate action.

(2) Failure on Approach. The operator's contingency procedures should address at least the following conditions:

a) Failure of the RNP system components, including those affecting lateral and vertical deviation performance (e.g. failures of a GPS sensor, the flight director or automatic pilot)

b) Loss of navigation signal-in-space (loss or degradation of external signal)

~~p~~o) Engine-Out Procedures. Aircraft may demonstrate acceptable flight technical error with one engine inoperative to conduct RNP AR operations. Otherwise, flight crews are expected to take appropriate action in event of engine failure during an approach so that no specific aircraft qualification is required. The aircraft qualification should identify any performance limits in event of engine failure to support definition of appropriate flight crew procedures.

APPENDIX 4 ACCEPTABLE METHODS FOR FTE ASSESSMENT FOR RNP

This appendix outlines criteria for assessment of "Flight Technical Error" (FTE) related to RNP capability and other navigation applications (e.g. instrument approach capability, etc.). This criteria is available for use for FMS/EFIS based applications, RNP applications, or other navigation applications related to this AMC or as otherwise determined to be acceptable by the appropriate regulatory authority. It may be used in lieu of FTE assumptions referenced in other Advisory Circulars.

1. BACKGROUND

For RNPs of 0.3 NM or greater, industry standard default values for FTE e.g. RTCA DO-208, AC20-130, etc are used and present a convenience to an operator or applicant in enabling a quick determination of what combinations of systems, capabilities, features and performance are allowable for the conduct of operations. However, the default value is the dominant error as RNP accuracy values are reduced below 0.3 NM. As a result, use of the standard defaults limit the extent that a system may be utilised, i.e. for RNP 0.15 an FTE of 0.125 NM is assumed when coupled to an autopilot. For RNP less than 0.15 NM, the standard ~~PSE~~ FTE values are insufficient such that an aircraft may not be used even with a precision source such as GNSS, until there is a reduction in FTE.

FTE estimates or assumptions are typically added to navigation system error characteristics to permit specification of "protected airspace" for obstacle clearance or aircraft-to-aircraft separation (using various mathematical statistical methods such as "Root Sum Squared"). Protected airspace may pertain to procedure obstacle clearance surfaces, establishing route or airway widths, setting oceanic track separation values, definition of ICAO Obstacle Clearance Limits, or other similar applications.

Previous FTE assessments were based on very limited samples of normal performance of a population of aircraft that included "worst case aircraft types and least capable systems" and is not representative of modern, advanced aircraft. This penalises, or does not appropriately credit, modern systems which have resulted in improved FTE performance.

Further, some assessments of FTE usually consider only "normal performance", and do not appropriately assess path displacements for "rare normal performance" (e.g. strong winds), or "non-normal performance" (e.g. flight path performance related to failures - engine failure while on RF turn, extraction, etc).

2. OBJECTIVES

A major element of aircraft and navigation system performance assessment is the proper characterisation of Flight Technical Error (FTE). This appendix provides uniform criteria for assessing FTE to be used in conjunction with AC120-29A, and other relevant regulatory and industry references.

This FTE method:

a) Establishes FTE for modern aircraft in a way that provides improved pilot situation information over that provided in previous generation aircraft,
b) Comprehensively considers the factors which affect FTE,
c) Establishes a means to provide credit to an aircraft and navigation system design which includes features which provide for significantly reduced FTE,
d) Permits improved partitioning of the application and use of FTE between airworthiness assessment, operational authorisation, and procedure development

and implementation (e.g. for definition of RNP routes, use of PANS-OPS or TERPS applications etc.),

e) Provides operational incentives, and consequential design incentives for good FTE performance,

f) Allows proactive rather than reactive applications (e.g. eliminate the need for lengthy and costly in service data collection)

g) Properly addresses "real" safety factors related to functional hazard assessments,

h) Establishes consistent application with the desired navigation evolution to RNP, 4D, MASPS, etc.

i) Permits the eventual introduction of new methods of risk assessment (i.e. performance based design) as alternatives to the traditional, conservative methods such as "Collision Risk Model (CRM)", and

j) Facilitates the transition to GPS, GNSS, and other modern navigation techniques.

3. CRITERIA

The following criteria are provided for this appendix and incorporation in various other regulatory references as those references are either updated or developed. The criteria provide a means for applicants to demonstrate improved FTE performance which may be used in lieu of previous standard FTE assumptions that may not be appropriate for certain modern aircraft and systems.

Items in section (d) address FTE demonstration criteria. Items in section (e) address acceptable methods for data collection and presentation of results.

4. FTE Demonstration Criteria

a) USE OF REALISTIC TASKS

Tasks selected should address relevant flight phases applicable to the FTE measurements sought (e.g. takeoff, climb, cruise, descent, approach, landing, and missed approach). Tasks should be realistic in providing appropriate lateral, vertical, and longitudinal elements, even though capability in only one or several dimensions is being assessed. Realistic and representative procedures should be used (e.g. Number of waypoints, placement of waypoints, segment geometry, leg types, etc.).

b) REPRESENTATIVE TEST METHODS AND TEST SUBJECTS

(1) TEST METHODS

An acceptable combination of analysis, simulation, and flight verification should be used to establish alternative FTE performance. A plan acceptable to the appropriate regulatory authority should be provided by the applicant prior to testing.

(2) TEST SUBJECTS

Test crews should represent an appropriate mix of flight experience, currency, and qualification (Captain, F/O, etc.).

c) PERFORMANCE ASSESSMENT

Normal performance (straight and turning flight), Rare Normal Performance (e.g. strong winds and wind gradient effects), and Non-Normal Performance (e.g. engine failure effects) should each be considered. Functional hazard assessments should be the basis for deciding how to assess non-normal performance. Characterisation of performance should address "95%" and "limit performance" for a suitable sample size. Emphasis should be on practical and realistic flight

scenarios rather than on rigorous statistical demonstrations that may not be representative of "in service" conditions.

Successful demonstration of procedures intended for terminal area applications (e.g. approach, missed approach) may generally be considered to also cover en-route applications.

Note: Probable failures are in accordance with AMC 25-1309, and 10^{-5} per operation.

The demonstration of Flight Technical Error must be completed in a variety of operational conditions, rare-normal conditions and non-normal conditions (e.g. see FAA AC 120-29A, paragraphs 5.19.2.2 and 5.19.3.1). Realistic and representative procedures should be used (e.g. Number of waypoints, placement of waypoints, segment geometry, leg types, etc.). The non-normal assessment should consider the following:

(1) An acceptable criteria to be used for assessing probable failures and engine failure during the aircraft qualification is to demonstrate that the aircraft trajectory is maintained within a 1xRNP corridor laterally or 75 feet vertically. Proper documentation of this demonstration in the Aircraft Flight Manual (AFM), AFM extension, or appropriate aircraft operational support document alleviates the operational evaluations. This performance should consider the operational conditions assumed in the design of the RNP AR procedure, e.g. wind, turns, etc.

(2) RNP-significant improbable failure cases should be assessed to show that under these conditions the aircraft can be safely extracted from the procedure. Failure cases might include dual system resets, flight control surface runaway and complete loss of flight guidance function while in NAV.

(3) The aircraft performance demonstration during the operational evaluations can be based on a mix of analysis and flight technical evaluation using expert judgment.

RNP AR procedures with navigation accuracy less than RNP 0.3 or with RF legs require the use of autopilot or flight director driven by the RNAV system in all cases. Thus, the autopilot/flight director must operate with suitable accuracy to track the lateral and vertical paths required by a specific RNP AR approach procedure.

d) REFERENCE PATH SELECTION

For FTE assessments a nominal path may be used (magenta line) that does not include consideration of specific navigation sensor/system anomalies (e.g. DME updating anomaly characteristics etc.). The applicant should, however, indicate how any FTE effects related to navigation system anomalies, if any, should be operationally addressed.

5. PARAMETERS TO BE MEASURED AND PRESENTATION OF RESULTS

a) FTE ASSESSMENT PARAMETER MEASUREMENT.
Parameters measured should include:

(1) Pertinent lateral and vertical path displacements,

(2) Longitudinal performance as applicable (speed errors, ETA/RTA errors, etc.),

(3) Other parameters as necessary to assure realistic operational performance (bank angles, pitch attitudes, thrust changes, track/heading variation, G loading, etc.).

b) FTE ASSESSMENT METHODS

Unless otherwise agreed by the regulator, demonstrations should be based on appropriate simulations, and be verified by flight trials.

c) FTE ASSESSMENT RESULT PRESENTATION

Data may be presented in various AFM provisions related to demonstrated performance for levels of "RNP", instrument approach and landing capability, etc.

6. EXAMPLES OF REGULATORY RESPONSIBILITY FOR ASSESSMENT OF FTE AND USE OF FTE EVALUATION RESULTS

The Agency will:

a) typically conduct assessments of FTE in conjunction with Type Certification/Supplemental Type Certification (TC/STC) projects, when a TC/STC applicant has made such a request. Special circumstances may exist where assessments acceptable to the Agency will be conducted by other organisations (FAA, etc.)

b) participate in FTE assessments in conjunction with aircraft certification projects, and assure that appropriate flight standardisation provisions are identified.

c) assure proper application of FTE as specified in AFMs for particular applications (e.g. RNP authorisations).

d) address crew qualification requirements necessary to achieve the intended FTE performance.

7. FTE ASSESSMENT PROCESS

Applicants apply through normal channels to Agency. The Agency will evaluate the application for applicable criteria and specific evaluation plans.

APPENDIX 5 FLIGHT OPERATION SAFETY ASSESSMENTS

1. SAFETY ASSESSMENT

The safety objective for RNP AR operations is to provide for safe flight operations. Traditionally, operational safety has been defined by a target level of safety and specified as a risk of collision of 10^{-7} per approach. For RNP AR approaches a flight operational safety assessment (FOSA) methodology may be used. The FOSA is intended to provide a level of flight safety that is equivalent to the traditional TLS, but using methodology oriented to performance-based flight operations. Using the FOSA, the operational safety objective is met by considering more than the aircraft navigation system alone. The FOSA blends quantitative and qualitative analyses and assessments for navigation systems, aircraft systems, operational procedures, hazards, failure mitigations, normal, rare-normal and abnormal conditions, hazards, and the operational environment. The FOSA relies on the detailed criteria for aircraft qualification, operator approval and instrument procedure design to address the majority of general technical, procedure and process factors. Additionally, technical and operational expertise and experience are essential to the conduct and conclusion of the FOSA.

An overview of the hazards and mitigations is provided to assist States in applying these criteria. Safety of RNP AR approach operations rests with the operator and the air navigation service provider as described in this chapter.

A FOSA should conducted for each RNP AR approach procedure where more stringent aspects of the nominal procedure design criteria are applied (e.g. RNP 0.1 missed approach, RF legs, and RNP missed approaches less than 1.0) or where the application of the default procedure design criteria is in an operating environment with special challenges or demands to ensure that for each specific set of operating conditions, aircraft, and environment that all failure conditions are assessed and where necessary mitigations implemented to meet the operational safety objective. The assessment should give proper attention to the inter-dependence of the elements of design, aircraft capability, crew procedures and operating environment.

The following hazard conditions are examples of some of the more significant hazards and mitigations addressed in the aircraft, operational and procedure criteria:

Normal performance: Lateral and vertical accuracy are addressed in the aircraft requirements, aircraft and systems operate normally in standard configurations and operating modes, and individual error components are monitored/truncated through system design or crew procedure.

Rare-Normal and Abnormal Performance: Lateral and vertical accuracy are evaluated for aircraft failures as part of the determination of aircraft qualification. Additionally, other rare-normal and abnormal failures and conditions for ATC operations, crew procedures, infrastructure and operating environment are also assessed, Where the failure or condition results are not acceptable for continued operation, mitigations are developed or limitations established for the aircraft, crew and/or operation.

2. AIRCRAFT FAILURES

a) System Failure: Failure of a navigation system, flight guidance system, flight instrument system for the approach, or missed approach (e.g. loss of GNSS updating, receiver failure, autopilot disconnect, FMS failure etc.). Depending on the aircraft, this may be addressed through aircraft design or operational procedure to cross-check guidance (e.g. dual equipage for lateral errors, use of terrain awareness and warning system).

b) Malfunction of air data system or altimetry: Crew procedure cross-check between two independent systems mitigates this risk.

3. AIRCRAFT PERFORMANCE

a) Inadequate performance to conduct the approach: the aircraft qualification and operational procedures ensure the performance is adequate on each approach, as part of flight planning and in order to begin or continue the approach. Consideration should be given to aircraft configuration during approach and any configuration changes associated with a go-around (e.g. engine failure, flap retraction, re-engagement of LNAV mode).

b) Loss of engine: Loss of an engine while on an RNP AR approach is a rare occurrence due to high engine reliability and the short exposure time. Operators will take appropriate action to mitigate the effects of loss of engine, initiating a go-around and manually taking control of the aircraft if necessary.

4. NAVIGATION SERVICES

a) Use of a navigation aid outside of designated coverage or in test mode: Aircraft requirements and operational procedures have been developed to address this risk.

b) Navigation database errors: Procedures are validated through flight validation specific to the operator and aircraft, and the operator is required to have a process defined to maintain validated data through updates to the navigation database.

5. ATC OPERATIONS

a) Procedure assigned to incapable aircraft: Operators are responsible for declining the clearance.

b) ATC vectors aircraft onto approach such that performance cannot be achieved: ATC training and procedures must ensure obstacle clearance until aircraft is established on the procedure, and ATC should not intercept on or just prior to a curved segments of the procedure.

6. FLIGHT CREW OPERATIONS

a) Erroneous barometric altimeter setting: Crew entry and cross-check procedures mitigate this risk.

b) Incorrect procedure selection or loading: crew procedure to verify loaded procedure matches published procedure, aircraft requirement for map display.

c) Incorrect flight control mode selected: training on importance of flight control mode, independent procedure to monitor for excessive path deviation.

d) Incorrect RNP entry: crew procedure to verify RNP loaded in system matches the published accuracy value.

e) Go-Around/Missed Approach: Balked landing or rejected landing at or below DA (H).

f) Poor meteorological conditions: Loss or significant reduction of visual reference that may result in or require a go-around.

7. INFRASTRUCTURE

a) GNSS satellite failure: This condition is evaluated during aircraft qualification to ensure obstacle clearance can be maintained, considering the low likelihood of this failure occurring.

b) Loss of GNSS signals: Relevant independent equipage (e.g. IRU) is required for RNP AR approaches with RF legs and approaches where the accuracy for the missed approach is less than 1 NM. For other approaches, operational procedures are used to approximate the published track and climb above obstacles.

c) Testing of ground Navaid in the vicinity of the approach: Aircraft and operational procedures are required to detect and mitigate this event.

8. OPERATING CONDITIONS

a) Tailwind conditions: Excessive speed on RF legs will result in inability to maintain track. This is addressed through aircraft requirements on the limits of command guidance, inclusion of 5 degrees of bank manoeuvrability margin, consideration of speed effect and crew procedure to maintain speeds below the maximum authorised.

b) Wind conditions and effect on flight technical error: nominal flight technical error is evaluated under a variety of wind conditions, and crew procedures to monitor and limit deviations ensure safe operation.

c) Extreme temperature effects of barometric altitude (e.g. extreme cold temperatures, known local atmospheric or weather phenomena, high winds, severe turbulence etc.): The effect of this error on the vertical path is mitigated through the procedure design and crew procedures, with an allowance for aircraft that compensate for this effect to conduct procedures regardless of the published temperature limit. The effect of this error on minimum segment altitudes and the decision altitude are addressed in an equivalent manner to all other approach operations.

APPENDIX 6 AMC 20-26/PBN MANUAL/AC90-101 COMPARISON

This appendix contains a comparison of the AMC guidance, requirements and criteria relative to the ICAO Performance Based Navigation Manual and the US AC90-101. In general, the AC is the same as the PBN Manual Navigation Specification for RNP AR APCH. The AMC contains some differences that are noted as follows.

The matrix does not highlight the unique requirements introduced by AC 90-101 and not contained within this AMC.

Regular = Same/Comparable

Italic = areas where AMC provides additional information, guidance or criteria

ALL CAP = areas where PBN Manual is more extensive

Bold = areas where AMC is more stringent than PBN Manual and/or AC90-101 criteria

Section	AMC 20-26	Para	PBN Vol II, Chap 6	Section	AC90-101	Comment
	Preamble					NC
1	Purpose	6.1.2	Purpose	1	Purpose	NC
1.1	Background	--	--	--	--	NC
2	Scope	--	--	--	--	NC
3	Reference Documents	--	--	4	Related Documents	NC
3.1	Related Requirements	--	--	--	--	NC
3.2	Related Guidance Material	--	--	2	Related CFR Sections	NC
3.2.1	ICAO	--	--	--	--	NC
3.2.2	EASA/JAA	--	--	--	--	NC
3.2.3	Eurocontrol	--	--	--	--	NC
3.2.4	FAA	--	--			NC
3.2.5	TSO	--	--			NC
3.2.6	EUROCAE /RTCA, ARINC	--	--	--	--	NC
4	*Assumptions*	*6.2*	*ANSP Considerations*	--	--	*AMC expands assumptions for procedure design, infrastructure, publication, status monitoring, controller training, flight evaluation.*
5	System Description	--	--	--	--	NC
5.1	LNAV			--	--	NC
5.1.1		--	--	--	--	AMC descriptive info
5.1.2	*Position Determination and Sensors*	*6.3.3.2*	*Criteria for Specific Navigation Services*	*App 2, 3.a*	*Position Estimation*	*AMC has more explicit description, PBN implies more*
5.2	VNAV	--	--	--	--	AMC provides descriptive info

Section	AMC 20-26	Para	PBN Vol II, Chap 6	Section	AC90-101	Comment
5.2.1	Temperature Compensation Systems	6.3.3.2	Criteria for Specific Navigation Services, Temperature Compensation Systems	App 2, 3.a(7)	Temperature Compensation Systems	Same
6	Airworthiness Certification Objectives	--	--	--	--	AMC ties criteria to assumptions
6.1	Accuracy	6.3.3.1	System Performance, Monitoring and Alerting, Path Definition	App 2, 2.a	Path Definition	Same
6.1.1	Lateral	6.3.3.1	System Performance, Monitoring and Alerting, Lateral Accuracy	App 2, 2.b	Lateral Accuracy	More notes of clarification and expanded considerations
6.1.2	Vertical	6.3.3.1	System Performance, Monitoring and Alerting, Airspace Containment	App 2, 2.c	Vertical Accuracy	More notes of clarification and expanded considerations
6.1.2	Vertical	6.3.3.2	Criteria for Specific Navigation Services, Altimetry System Error	App 2, 3.a(6)	99.7% ASE	Same
6.1.3	**RNP System Performance**	**6.3.3.3**	**Functional Requirements, Demonstration of Path Steering Performance**	**App 2, 3.c**	**Path Steering Performance**	**AMC has More Stringent Requirements**
6.2	Integrity	--	--	--	--	--
6.2.1, a)	Operational	6.3.3.1	System Performance, Monitoring and Alerting, Airspace Containment	App 2, 2.d(1)	RNP and BARO-VNAV	me
6.2.1, b)	Operational	6.3.3.1	System Performance, Monitoring and Alerting, Airspace Containment	App 2, 2.d(2)	Other Systems or Alternate Means of Compliance	me
6.2.2	Design	6.3.3.3	Functional Requirements, Design Assurance	App 2, 3.e	Design Assurance	me

Section	AMC 20-26	Para	PBN Vol II, Chap 6	Section	AC90-101	Comment
6.3	*Continuity*	--	--	--	--	*AMC contains explicit requirements. AC requirement is implied through airspace containment and predetermined through MEL requirements*
7	Functional Criteria			--	--	NC
7.1, 1	Lateral/Vertical Deviation	6.3.3.3	Functional Requirements, Displays	App 2, 3.d(1)	Lateral/Vertical Deviation	Same
7.1, 1	For RNP < 0.3, Fixed CDI or Scaled to RNP	6.3.3.3	Functional Requirements, Displays	App 2, 3.d(1) (a)	Recommendation ; Fixed CDI or scaled to RNP	~~AMC has More Stringent Requirement~~ Same
7.1, 1	For RNP < 0.3, Fixed CDI or Scaled to RNP	6.3.3.3	Functional Requirements, Displays	App 2, 3.d(1) (b)	Numeric display not in primary field of view	~~Alternative not allowed by AMC~~ Same
7.1, 1	Navigation Map display alternative	6.3.3.3	Functional Requirements, Displays	App 4, 3.g(1)	Moving map, VDI or numeric display of deviation	~~AMC offers alternative, others only mention as an operational consideration~~ Same
7.1, 2	Identification of the Active (To) Waypoint.	6.3.3.3	Functional Requirements, Displays	App 2, 3.d(2)	Identification of the Active (To) Waypoint.	Same
7.1, 3	Display of Distance and Bearing.	6.3.3.3	Functional Requirements, Displays	App 2, 3.d(3)	Display of Distance and Bearing.	Same
7.1, 4	Display of Groundspeed or Time	6.3.3.3	Functional Requirements, Displays	App 2, 3.d(4)	Display of Groundspeed or Time	Same
7.1, 5	Display of To/From the active fix.	6.3.3.3	Functional Requirements, Displays	App 2, 3.d(5)	Display of To/From the active fix.	Same
7.1, 6	Desired Track Display	6.3.3.3	Functional Requirements, Displays	App 2, 3.d(6)	Desired Track Display	Same
7.1, 7	Display of Aircraft Track.	6.3.3.3	Functional Requirements, Displays	App 2, 3.d(7)	Display of Aircraft Track.	Same
7.1, 8	Slaved Course Selector	6.3.3.3	Functional Requirements, Displays	App 2, 3.d(9)	Slaved Course Selector	Same
7.1, 9	RNAV Path Display	6.3.3.3	Functional Requirements, Displays	App 2, 3.d(10)	RNAV Path Display	Same
7.1, 10	Display of Distance to Go.	6.3.3.3	Functional Requirements, Displays	App 2, 3.d(11)	Display of Distance to Go.	Same

Section	AMC 20-26	Para	PBN Vol II, Chap 6	Section	AC90-101	Comment
7.1, 11	Display of Distance Between Flight Plan Waypoints.	6.3.3.3	Functional Requirements, Displays	App 2, 3.d(12)	Display of Distance Between Flight Plan Waypoints.	Same
7.1, 12	Display of Deviation	6.3.3.3	Functional Requirements, Displays	App 2, 3.d(13)	Display of Deviation	Same
7.1, 13	Display of Barometric Altitude	6.3.3.3	Functional Requirements, Displays	App 2, 3.d(14)	Display of Barometric Altitude	Same
7.1, 14	Display of Active Sensors	6.3.3.3	Functional Requirements, Displays	App 2, 3.d(15)	Display of Active Sensors	Same
7.1, 15	*Navigation Performance*	*6.3.3.1*	*System Performance, Monitoring and Alerting*	*App 2, 2.e*	*System Monitoring.*	*AMC provides additional guidance for vertical*
7.1, 16	Multi-Sensor Systems	6.3.3.2	Criteria for Specific Navigation Services	App 2, 3.a(5)	Multi-Sensor Systems	Same
7.1, 17	*Auto tuning of DME*	*--*	*--*	*--*	*--*	*More explicit guidance for reversion capability in AMC. PBN/AC implies through position estimation criteria for DME*
7.1, 18	*Auto selection/ de-selection of navigation sources*	*--*	*--*	*--*	*--*	*More explicit guidance in AMC. PBN/AC are implies through position estimation criteria*
7.1, 19	Failure Annunciation	6.3.3.3	Functional Requirements, Displays	App 2, 3.d(8)	Failure Annunciation	Same
7.1, 20	Navigation Database Status	6.3.3.3	Functional Requirements, Displays	App 2, 3.f(3)	Display the Validity Period	Same
7.1, 21	Maintain Track and Leg Transitions	6.3.3.3	Functional Requirements, Path Definition and Flight Planning	App 2, 3.b(1)	Maintain Track and Leg Transitions	~~AMC contains more stringent requirement for Holding pattern and RF leg. Also includes mention of enroute fixed radius transition.~~ Same
7.1, 22	Fly-by and Fly-over Fixes	6.3.3.3	Functional Requirements, Path Definition & Flight Planning	App 2, 3.b(2)	Fly-by and Fly-over Fixes	Same
7.1, 23	Waypoint Resolution Error	6.3.3.3	Functional Requirements, Path Definition & Flight Planning	App 2, 3.b(3)	Waypoint Resolution Error	Same

Section	AMC 20-26	Para	PBN Vol II, Chap 6	Section	AC90-101	Comment
7.1, 24	*Capability for a "Direct-To" Function*	*6.3.3.3*	*Functional Requirements, Path Definition & Flight Planning*	*App 2, 3.b(4)*	*Capability for a "Direct-To" Function*	*AMC contains additional guidance for VNAV, not in AC*
7.1, 25	Capability to define a vertical path	6.3.3.3	Functional Requirements, Path Definition & Flight Planning	App 2, 3.b(5)	Capability to define a vertical path	Same
7.1, 26	Altitudes and/or Speeds	6.3.3.3	Functional Requirements, Path Definition & Flight Planning	App 2, 3.b(6)	Altitudes and/or Speeds	Same
7.1, 27	Construct a Path	6.3.3.3	Functional Requirements, Path Definition & Flight Planning	App 2, 3.b(7)	Construct a Path	Same
7.1, 28	Capacity to Load Procedures from the Navigation Database.	6.3.3.3	Functional Requirements, Path Definition & Flight Planning	App 2, 3.b(8)	Capacity to Load Procedures from the Navigation Database.	Same
7.1, 29	Means to Retrieve and Display Navigation Data.	6.3.3.3	Functional Requirements, Path Definition & Flight Planning	App 2, 3.b(9)	Means to Retrieve and Display Navigation Data.	Same
7.1, 30	Magnetic Variation	6.3.3.3	Functional Requirements, Path Definition & Flight Planning	App 2, 3.b(10)	Magnetic Variation	Same
7.1, 31	Changes in Navigation Accuracy	6.3.3.3	Functional Requirements, Path Definition & Flight Planning	App 2, 3.b(11)	Changes in RNP Value	Same
7.1, 32	Automatic Leg Sequencing.	6.3.3.3	Functional Requirements, Path Definition & Flight Planning	App 2, 3.b(12)	Automatic Leg Sequencing.	Same
7.1, 33	Display of Altitude Restrictions	6.3.3.3	Functional Requirements, Path Definition & Flight Planning	App 2, 3.b(13)	Display of Altitude Restrictions	Same
7.1, 34	Navigation Database	6.3.3.3	Functional Requirements	App 2, 3.f(1)	Navigation Database	Same
7.1, 34	Navigation Database	6.3.3.3	Functional Requirements	App 2, 3.f(2)	Database Protection	Same
7.1, 34	Navigation Database	6.3.3.3	Functional Requirements	App 2, 3.f(3)	Display the Validity Period	Same
7.2, 1	Where RNP AR Approaches use RF Legs	6.3.3.3	Functional Requirements, Requirements for RNP AR Approaches with RF Legs	App 2, 4	Requirements for RNP SAAAR Approaches with RF Legs	Conditional requirements tied to RF, RNP less than procedure defaults for approach and missed approach.

Section	AMC 20-26	Para	PBN Vol II, Chap 6	Section	AC90-101	Comment
7.2, 2	**Where RNP AR Approach and Missed Approach are less than RNP 0.3**	**6.3.3.3**	**Functional Requirements, Requirements for RNP AR Approaches to less than RNP 0.3**	**App 2, 5**	**Requirements for Using Lines of Minima less than RNP 0.3**	**AMC is more stringent by removing the alternative for when aircraft lacks continuous LNAV capability**
7.2, 3	**Where Approaches with Missed Approach are less than RNP 1.0**	**6.3.3.3**	**Functional Requirements, Requirements for Approaches with Missed Approach less than RNP 1.0**	**App 2, 6**	**Requirements for Approaches with Missed Approach less than RNP 1.0**	**AMC is more stringent by removing the alternative for when aircraft lacks continuous LNAV capability**
8	Acceptable Means of Airworthiness Compliance	--	--	--	--	NC
8.1	General	6.3.2	Approval Process	6.a	Overview	Comparable
8.1.1(a)	New or Modified Installations – Compliance Statement	6.3.2	Approval Process	6.b(1)	Aircraft Qualification Documentation	Comparable
8.1.1(b)(1)	Design data to support compliance	6.3.2	Approval Process	6.b(1)	Aircraft Qualification Documentation	Comparable
8.1.1(b)(2)	RISK OF FLIGHT CREW ERROR	6.3.4	OPERATING PROCEDURES, TRACK DEVIATION MONITORING	APP 4, 3.G	TRACK DEVIATION MONITORING	PBN MANUAL/AC PROVIDE MORE EXPLICIT GUIDANCE
8.1.1(b)(3)	Equipment failures and reversion	6.3.4	Operating Procedures, Contingency Procedures	App 4, 3.p	Contingency Procedures	Comparable
8.1.1(b)(4)	Coupling arrangements	6.3.4	Operating Procedures, Autopilot & Flight Director	App 4, 2.b	Autopilot & Flight Director	Comparable
8.1.1(b)(5)	*Intercepting CF*	--	--	--	--	*AMC is more explicit for this condition*
8.1.1(b)(6)	MEL & maintenance	6.3.2.2.4	MEL Considerations	App 4, 2.a	MEL	Comparable
8.1.1	*Existing Installations*	--	--	--	--	*AMC unique*
8.2	Database Integrity	6.3.6	Navigation Database	6.b(2)	RNP SAAAR Operational Documentation	Same
8.3	Use of GPS	6.3.3.2	Criteria for Specific Navigation Services	App 2, 3.a(1)	GPS	Same
8.4	Use of IRS	6.3.3.2	Criteria for Specific Navigation Services	App 2, 3.a(2)	IRS	Same
8.5	Use of DME	6.3.3.2	Criteria for Specific Navigation Services	App 2, 3.a(3)	DME	Same

Section	AMC 20-26	Para	PBN Vol II, Chap 6	Section	AC90-101	Comment
8.6	Use of VOR	6.3.3.2	Criteria for Specific Navigation Services	App 2, 3.a(4)	VOR	Same
8.7	*Intermixing of Equipment*	--	--	--	--	*AMC contains additional guidance and criteria*
8.8	Manufacturer Operational Support Documentation	6.3.2	Approval Process	6.b(2)	RNP SAAAR Operational Documentation	Comparable
9	Aircraft Flight Manual	6.3.5	Pilot/Dispatch/Operator Knowledge and Training	6.b(3)	FAA Acceptance	Comparable
10	Operational Criteria	--	--	--	--	NC
10.1	*General*					*AMC general info*
10.2	*Flight Operations Documentation*	*6.3.2*	*Approval Process*	*6.b*	*FAA Acceptance*	*AC provides more guidance*
10.3	*Qualification and Training*	*6.3.5*	*Pilot/Dispatch/Operator Knowledge and Training*	*App 5*	*Training*	*AC is more extensive*
10.4	Navigation Database Management	6.3.6	Navigation Database	App 3	Navigation Data Validation Program	Comparable
10.5	*Reportable Events*	--	--	--	--	*AMC is more extensive*
10.6	*Fleet Approvals*	--	--	--	--	*AMC unique*
10.7	RNP Monitoring Program	6.3.7	Oversight Of Operators	App 6	RNP Monitoring Program	Comparable
Appendix 1	Glossary	--	--	3	Definitions	NC
Appendix 2	TRAINING AND CREW QUALIFICATION ISSUES	6.3.5	Pilot/Dispatch/Operator Knowledge and Training	App 5	Training	Comparable
Appendix 3	Operational Considerations	6.3.4	Operating Procedures	App 4	Operational Considerations	Comparable
Appendix 4	*Acceptable Methods for FTE Assessment for RNP*	--	--	--	--	*AMC unique*
Appendix 5	*FOSA*	*6.4*	*Safety Assessment*	*App 2, 2.d(2)*		*AMC guidance consistent with PBN manual. AC contains a mention to OSA only.*

Appendix C

AMC 20-27 Airworthiness Approval and Operational Criteria for RNP APPROACH (RNP APCH) Operations Including APV BARO-VNAV Operations

1. PURPOSE

This AMC provides an acceptable means that can be used to obtain airworthiness approval of an RNAV system based on a GNSS stand-alone receiver or multi-sensor system including at least one GNSS sensor in order to conduct RNP Approach (RNP APCH) operations.

RNP APCH procedures are characterised by existing charted RNAV (GNSS) approach procedures designed with straight final approach segments.

This AMC also defines operational criteria necessary to conduct safely RNP APCH operations in designated European airspace.

This AMC addresses RNP APCH operation without vertical guidance (NPA operation) and with vertical guidance based on barometric VNAV (APV BARO-VNAV operation). Final approaches utilizing SBAS (Localiser Performance with Vertical guidance (LPV) operation) are addressed in separate AMC material.

APV BARO-VNAV systems are based on barometric altimetry for the determination of the aircraft position in the vertical axis. The final approach segment of VNAV instrument flight procedures are performed using vertical guidance to a vertical path computed by the on-board RNAV system. The vertical path is contained in the specification of the instrument procedure within the RNAV system navigation database. For other phases of flight, barometric VNAV provides vertical path information that can be defined by ~~vertical angles or~~ altitudes at fixes in the procedure. It should be noted that there is no vertical requirement in this AMC associated to the use of VNAV guidance outside of the final approach segment. Vertical navigation on the initial or intermediate segment can be conducted without VNAV guidance.

An applicant may elect to use an alternative means of compliance. However, that means of compliance must meet the objectives of this AMC and be acceptable to the Agency or the competent authority. Compliance with this AMC is not mandatory. Use of the terms *shall* and *must* apply only to an applicant who elects to comply with this AMC in order to obtain airworthiness approval or to demonstrate compliance with the operational criteria.

2. BACKGROUND

This document addresses and defines airworthiness and operational criteria related to RNAV systems approved for RNP APCH based on GNSS with or without vertical guidance based on BARO-VNAV. It relates to the implementation of area navigation within the context of the Single European Sky[4], in particular in relation to the verification of conformity of the airborne constituents, per Article 5 of EC Regulation 552/2004. It addresses general certification considerations of stand-alone and multi-sensor systems onboard aircraft, including their functional requirements, accuracy, integrity, continuity of function, and limitations, together with operational considerations.

This document is applicable to RNP APCH operations only. It does not address RNP AR APCH operations (see ~~the relevant~~ AMC 20-26).

~~This AMC supersedes the approach section of AMC 20-5 or equivalent document.~~

[4] Regulation (EC) No 549/2004 of the European Parliament and of the Council of 10 March 2004 laying down the framework for the creation of the single European sky (the framework Regulation) (OJ L 96, 31.03.2004, p. 1).

~~It is not intended that aircraft which have received airworthiness approval for the lateral navigation part in compliance with AMC 20-5 or equivalent (JAA TGL 3 or ACJ 20X5) should be reinvestigated.~~

This AMC identifies the airworthiness and operational requirements for RNP APCH operations including APV BARO-VNAV operation. Operational compliance with these requirements must be addressed through national operational regulations, and may require a specific operational approval in some cases.

Use of BARO-VNAV information for RNP APCH with LNAV minima only ~~not published as APV BARO-VNAV approach (e.g. approach with LNAV minima only~~ is possible using the CDFA (Continuous Descent Final Approach) concept. This use is possible provided the navigation system is able to compute a vertical continuous descent path on the Final Approach segment and operator complies with EU OPS 1.430 section. It should be noted that this AMC does not address such operational approval authorisation.

3. SCOPE

The guidance material includes airworthiness and operational criteria related to RNAV systems based on a GNSS stand-alone receiver, or multi-sensor systems including at least one GNSS sensor, intended to be used under Instrument Flight Rules, including Instrument Meteorological Conditions, in designated European airspace. It contains also airworthiness and operational criteria related to systems based upon the use of barometric altitude and RNAV information in the definition of vertical paths and vertical tracking to a path to conduct APV BARO-VNAV operation.

Section 4.2 of this AMC refers to documents which contribute to the understanding of the RNP APCH concept and which may support an application for approval. However, it is important that an operator evaluates his aircraft system and the proposed operational procedures against the criteria of this AMC. ~~Unless stated to the contrary in this AMC, systems and procedures previously approved as compliant with earlier area navigation guidance material will need to be re-evaluated to identify where additional approval effort, if any, is needed.~~

Compliance with this AMC does not, by itself, constitute an operational authorisation to conduct RNP APCH operations. Aircraft operators should apply to their national authority. Since this AMC has been harmonised with other RNP implementation and operational criteria outside of Europe, i.e. USA/FAA, it is expected to facilitate interoperability and ease the effort in obtaining operational authorisation by operators.

This AMC does not cover RNP approaches where special authorisation is required (RNP AR APCH). RNP AR APCH is addressed in a separate AMC.

4. REFERENCE DOCUMENTS

4.1 Related Requirements

- CS~~/FAR~~ 25.1301, 25.1302, 25.1307, 25.1309, 25.1316, 25.1321, 25.1322, 25.1325, 25.1329, 25.1431, 25.1581.
- CS~~/FAR~~ 23.1301, 23.1309, 23.1311, 23.1321, 23.1322, 23.1325, 23.1329, 23.1335, 23.1431, 23.1581.
- Equivalent requirements of CS/FAR 27 and 29 if applicable.
- EU-OPS[5] 1.035, 1.220, 225, 1.243, 1.290, 1.295, 1.297, 1.400, 1.420, 1.845, 1.865, 1.870, 1.873 and 1.975.
- JAR-OPS 3.243, 3.845, 3.865.

[5] OJ L 373, 31.12.1991, p. 4. Regulation as last amended by Regulation (EC) No 1899/2006 of the European Parliament and of the Council of 12 December 2006 (OJ L 377, 27.12.2006, p. 1).

- National operational regulations.

4.2 Related Material

4.2.1 ICAO

ICAO Annex 10	International Standards and Recommended Practices-Aeronautical Telecommunications
ICAO Doc 7030/4	Regional Supplementary Procedures
ICAO Doc 9613	Performance Based Navigation Manual (PBN)
ICAO Doc 8168	PANS OPS (Procedures for Air Navigation Services-Aircraft Operations)

4.2.2 EASA

AMC 25-11	Electronic Flight Deck Display
AMC 20-5	Airworthiness Approval and Operational Criteria for the use of the Navstar Global Positioning System (GPS).
ETSO-C115( )	Airborne Area Navigation Equipment using Multi-Sensor Inputs
ETSO-C129( )	Airborne Supplemental Navigation Equipment Using the Global Positioning System (GPS).
ETSO-C145( )	Airborne Navigation Sensors Using the Global Positioning System (GPS) Augmented by the Wide Area Augmentation System (WAAS).
ETSO-C146( )	Stand-Alone Airborne Navigation Equipment Using the Global Positioning System (GPS) Augmented by the Wide Area Augmentation System (WAAS).
ETSO-C106( )	Air Data Computer
~~ETSO-C115( )~~	~~Airborne Area Navigation Equipment using Multi-Sensor Inputs~~
EASA OPINION Nr. 01/2005	~~Conditions for Issuance of Letters of Acceptance for Navigation Database Suppliers by the Agency (i.e. an EASA Type 2 LoA). EASA OPINION Nr. 01/2005 on~~ "The Acceptance of Navigation Database Suppliers" dated 14 Jan 05.

4.2.3 FAA

AC 25-4	Inertial Navigation Systems (INS).
AC 25-11 ( )	Electronic Display Systems.
AC 20-129	Airworthiness Approval of Vertical Navigation (VNAV) Systems or use in the U.S. National Airspace System (NAS) and Alaska
AC 20-138 ( )	Airworthiness Approval of GNSS equipment.
AC 20-130A	Airworthiness approval of navigation or flight management systems integrating multiple navigation sensors.
AC 23-1309-1C	Equipment, systems, and installation in Part 23 airplanes.
AC 20-153	Acceptance of data processes and associated navigation data bases.

4.2.4 Technical Standard Orders

FAA TSO-C115( )	Airborne Area Navigation Equipment using Multi-Sensor Inputs

FAA TSO-C129( )	Airborne Supplemental Navigation Equipment Using the Global Positioning System (GPS)
FAA TSO-C145( )	Airborne Navigation Sensors Using the Global Positioning System (GPS) Augmented by the Wide Area Augmentation System (WAAS).
FAA TSO-C146( )	Stand-Alone Airborne Navigation Equipment Using the Global Positioning System (GPS) Augmented by the Wide Area Augmentation System (WAAS).
FAA TSO-C106( )	Air Data Computer
~~FAA TSO-C115( )~~	~~Airborne Area Navigation Equipment using Multi-Sensor Inputs~~

4.2.5 EUROCAE / RTCA~~, SAE~~ and ARINC

ED 26	MPS for airborne Altitude measurements and coding systems
ED 72A	Minimum Operational Performance Specification for Airborne GPS Receiving Equipment
ED-75( ) / DO-236( )	Minimum Aviation System Performance Standards: Required Navigation Performance for Area Navigation.
ED-76 / DO-200A	Standards for Processing Aeronautical Data.
ED-12( )/ DO-178( )	Software considerations in airborne systems and equipment certification.
ED-77 / DO-201A	Standards for Aeronautical Information.
DO 88	Altimetry
DO 187	Minimum operational performances standards for airborne area navigation equipments using multi-sensor inputs
DO 208	Minimum Operational Performance Standards for Airborne Supplemental Navigation Equipment Using Global Positioning System (GPS)
DO-229( )	Minimum Operational Performance Standards for Global Positioning System/Wide Area Augmentation System Airborne equipment**.**
ARINC 424	Navigation System Data Base.
ARINC 706	Mark 5 Air Data System

5. ASSUMPTIONS

Applicants should note that this guidance material is based on the following assumptions:

5.1 Navaid infrastructure

GNSS is the primary navigation system to support RNP APCH procedures.

~~For APV BARO-VNAV operation, the procedure design is based upon the use of a barometric altimetry by an airborne RNAV system whose capability supports the required operation. The procedure design will take into account the performance and the functional capabilities required by this AMC.~~

The acceptability of the risk of loss of RNP APCH capability for multiple aircraft due to satellite failure, ~~or~~ loss of the on board monitoring ~~and~~ , alerting function (e.g. RAIM holes) and radio frequency interference, will be considered by the responsible airspace authority.

5.2 Obstacle clearance

5.2.1 RNP APCH without BARO-VNAV guidance

Detailed guidance on obstacle clearance is provided in PANS-OPS (Doc 8168, Volume II). Missed approach procedure may be supported by either RNAV or conventional (e.g. based on NDB, VOR, DME) segments.

Procedures design will take account of the absence of a VNAV capability on the aircraft.

5.2.2 APV BARO-VNAV

BARO-VNAV is applied where vertical guidance and information is provided to the flight crew on instrument approach procedures containing a vertical path defined by a vertical path angle.

Detailed guidance on obstacle clearance is provided in PANS-OPS (Doc 8168, Volume II). Missed approach procedure may be supported by either RNAV or conventional (e.g. based on NDB, VOR, DME) segments.

5.3 Publication

The instrument approach chart will clearly identify the RNP APCH application as $RNAV_{(GNSS)}$.

For non APV BARO-VNAV operation, the procedure design will rely on normal descent profiles and the chart will identify minimum altitude requirements for each segment, including an LNAV OCA(H).

For APV BARO-VNAV operation, charting will follow the standards of ICAO Annex 4 to the Convention on International Civil Aviation for the designation of an RNAV procedure where the vertical path is specified by a glide path angle. The charting designation will remain consistent with the current convention and will promulgated a LNAV/VNAV OCA(H)

If the missed approach segment is based on conventional means, the navaid facilities or airborne navigation means that are necessary to conduct the missed approach will be identified in the relevant publications (e.g. approach charts).

The navigation data published in the applicable AIP for the procedures and supporting navigation aids will meet the requirements of ICAO Annex 15 and Annex 4 to the Convention on International Civil Aviation ~~(as appropriate)~~. The chart will provide sufficient data to support navigation data base checking by the crew (including waypoint name, track, distance for each segment and vertical path angle).

All procedures will be based upon WGS 84 coordinates.

5.4 Communication, ATS surveillance and ATC coordination

RNP APCH does not include specific requirements for communication or ATS surveillance. Adequate obstacle clearance is achieved through aircraft performance, ~~and~~ operating procedures and procedure design. Where reliance is placed on the use of radar to assist contingency procedures, its performance will be shown to be adequate for that purpose, and the requirement for a radar service will be identified in the AIP.

RT phraseology appropriate to RNP APCH operations will be promulgated.

It is expected that ATC will be familiar with aircraft VNAV capability, as well as issues associated with altimeter setting and temperature effect potentially affecting the integrity of the APV BARO-VNAV operation.

The particular hazards of a terminal and approach area and the impact of contingency procedures following multiple loss of RNP APCH capability will be assessed.

ATC may use radar vectoring techniques to place aircraft onto final approach axis when the RNAV system supports this function. ~~A State intending to authorise this technique will instruct a certified AIS provider to include such information in the relevant AIP~~. Air Navigation Service Providers implementing such operation in their airspace should inform airspace users of this operational possibility in the relevant AIP.

5.5 Service provider assumption for APV BARO-VNAV operation.

It is expected that air navigation service provision will include data and information to enable correct and accurate altimeter setting on-board the aircraft, as well as local temperature. This data will be from measurement equipment at the airport where the approach is to take place (remote or regional pressure setting are not authorised).
The specific medium for transmission of this data and information to the aircraft may include voice communication, ATIS or other media. In support of this, it is also expected that MET service providers will assure the accuracy, currency and availability of meteorological data supporting APV BARO-VNAV operations. In order to minimise the potential for miss-setting of barometric reference Air Traffic Controllers will confirm QNH with flight crews prior to commencement of the approach.

6. RNP APCH AIRWORTHINESS CRITERIA

6.1 General

The following airworthiness criteria are applicable to the installation of RNAV system intended for IFR approach operation, certified according to CS-23, -25, -27 and -29

This AMC uses FAA Advisory Circulars AC 20-138/AC 20-138A (GPS stand-alone system) or AC 20-130A (Multi-sensors systems) as the basis for the airworthiness approval of an RNAV system based on GNSS. For APV BARO-VNAV operation, this AMC uses FAA Advisory Circular AC 20-129 as the airworthiness basis with additional requirements.

This AMC is to be used as Interpretative Material to show compliance with the applicable CS codes, on each application e.g. xx.1301 and xx.1309.

6.2 Equipment qualification

6.2.1 General

If the RNAV installation is based on GNSS stand-alone system, the equipment ~~should~~ shall be approved in accordance with TSO-C129a/ ETSO-C129a Class A1 or ETSO-C146()~~a~~/TSO-C146()~~a~~ Class Gamma, operational class 1, 2 or 3.

If the RNAV installation is based on GNSS sensor equipment used in a multi-sensor system (e.g. FMS), the GNSS sensor ~~should~~ shall be approved in accordance with TSO-C129 ( )/ ETSO-C129 ( ) Class B1, C1, B3, C3 or ETSO-C145( )/TSO-C145( ) class Beta, operational class 1, 2 or 3 .

Multi-sensor systems using GNSS should be approved in accordance with AC20-130A or ETSO-C115b/TSO-C115b, as well as having been demonstrated for RNP capability.

Note 1: For GNSS receiver approved in accordance with ETSO-C129()/TSO-C129(), capability for satellite Fault detection and Exclusion (FDE) is recommended, to improve Continuity of function.

Note 2: GNSS receivers approved in accordance with ETSO-145/TSO-C145a or ETSO-C146/TSO-C146a (DO 229C) and used outside SBAS coverage area may trigger inappropriate Loss of Integrity (LOI) warning. DO229D paragraph 2.1.1.6 addresses the satellite selection scheme problematic ~~provides a correct satellite selection scheme requirement to address this issue~~. Although most of the ETSO-C145/TSO-C145a or ETSO-146/TSO-C146a approved receivers comply with this satellite selection scheme, a confirmatory statement from the equipment manufacturer is still necessary. It should be noted that such confirmatory statement is not necessary for equipment compliant with TSO-C145b or TSO-C146b

6.2.2 Altimeter sensor requirement for APV BARO-VNAV operation

In addition to requirements of paragraph 6.2.1 above, the RNAV equipment that automatically determines aircraft position in the vertical plane should use inputs from equipment that can include:

a) ETSO-C106/TSO-C106, Air Data Computer
b) Air data system, ARINC 706, Mark 5 Air Data System, ARINC 738 (Air Data and Inertial Reference System)
c) Barometric altimeter system compliant with DO-88 "Altimetry" and/or ED-26 "MPS for Airborne Altitude Measurements and Coding Systems"
d) Type certified integrated systems providing an Air Data System capability comparable to item b).

6.3 Accuracy

6.3.1 Horizontal

The Lateral and Longitudinal Total System Error (TSE) of the on-board navigation system must be equal to or better than:

a) ±1 NM for 95% of the flight time for the initial and intermediate approach segments and for the RNAV missed approach.

   Note: There is no specific RNAV accuracy requirement for the missed approach if this segment is based on conventional means (VOR, DME, NDB) or on dead reckoning.

b) ±0.3 NM for 95% of the flight time for the final approach segment.

The Lateral Total System Error (TSE) is dependent on the Navigation System Error (NSE), Path Definition Error (PDE) and Flight Technical Error (FTE).

In order to satisfy the ±0.3 NM TSE accuracy for the final approach segment, FTE (95%) should not exceed ±0.25 NM whatever the operating mode (manual, Flight Director or Autopilot):

a) ~~An~~ A demonstrated FTE (95%) of ±0.25NM is assumed for manual mode if a standardised CDI is installed (compliant with the full-scale deflection sensitivity requirement of TSO-C129a paragraph (a).3.(viii) or RTCA/DO-229() paragraph 2.2.1.4.2.1) Otherwise, it should be demonstrated that an FTE of ±0.25 NM can be maintained under all foreseeable conditions through a dedicated flight test evaluation.

b) ~~An~~ A demonstrated FTE (95%) of ±0.25NM is assumed when coupled to a flight director.

c) ~~An~~ A demonstrated FTE (95%) of ±0.125 NM is assumed when coupled to an autopilot.

Outside of the Final Approach Segment, ~~an~~a demonstrated FTE of ±0.5 NM may be assumed.

Positioning data from other types of navigation sensors may be integrated with the GNSS data provided it does not cause position errors to exceed the ~~Navigation~~ Total System Error (~~N~~TSE) budget, otherwise a means must be provided to deselect the other navigation sensor types.

Note: The horizontal positioning error component of TSE is assumed to be equal to the 2D navigation accuracy of systems/sensors qualified to AC20-138, 20-138A, and 20-130A.

An acceptable means of complying with these accuracy requirements is to have an RNAV system approved for RNAV approaches in accordance with 2D navigation accuracy criteria of FAA AC 20-138, AC 20-138A or AC 20-130A.

6.3.2 Vertical accuracy for APV BARO-VNAV operation

a) Altimetry System Error (ASE)

Altimetry system performance is demonstrated separately from the APV BARO-VNAV certification through the static pressure system certification process. With such approval (e.g. CS 25.1325), each system must be designed and installed so that the error in indicated pressure altitude, at sea-level, with a standard atmosphere, excluding instrument calibration error, does not result in an error of more than ±9 m (±30 ft) per 185 km/hr (100 knots) speed for the appropriate configuration in the speed range between 1·23 VSR0 with wing-flaps extended and 1·7 VSR1 with wing-flaps retracted. However, the error need not be less than ±9 m (±30 ft).

Altimetry systems meeting such a requirement will satisfy the Altimetry System Error (ASE) requirements for APV BARO-VNAV operation. No further demonstration or compliance is necessary.

~~The ASE at a specific altitude (MSL) is computed using the following formula:~~

~~$ASE\ (ft) = -8.8\ 10^{-8}.(h+\Delta h)^2 + 6.5.\ 10^{-3}\ (h+\Delta h) + 50$~~

~~where h is the height of the local altimetry reporting station and Δh is the height of the aircraft above the reporting station.~~

Note 1: Altimetry Error refers to the electrical output and includes all errors attributable to the aircraft altimetry installation including position effects resulting from normal aircraft flight attitudes. In high performance aircraft, it is expected that altimetry correction will be provided. Such correction should be done automatically. In lower performance aircraft, upgrading of the altimetry system may be necessary.

Note 2: Positioning data from other sources may be integrated with the barometric altitude information provided it does not cause position errors exceeding the vertical accuracy requirement.

b) **VNAV Equipment Error**

The error of the airborne VNAV equipment (excluding altimetry, horizontal coupling and flight technical error) on a 99.7 percent probability basis should be demonstrated to be less than:

	~~Climb/~~Descent Along Specified Vertical Profile (angle) (ft)
At or below 5000 ft (MSL)	100
5000 ft to 10000 ft (MSL)	150
10000 ft to 15000 ft (MSL)	~~220~~ 150

Note 1: VNAV Equipment Error is the error associated to the vertical path computation. It includes path definition error (PDE) and approximation made by the VNAV equipment for the vertical path construction if any.

Note 2: VNAV equipment error requirement is more stringent compared with AC 20-129 and the ICAO PBN manual where 220 ft (from 10000 ft to 15000 ft MSL) is required.

c) **Horizontal Coupling Error**

The Horizontal coupling error (vertical error component of along track positioning error) is a function of the horizontal ~~TSE~~ NSE (see 6.3.1) and is directly reflected in the along track tolerance offset used in APV BARO-VNAV procedure design criteria.

This Horizontal Coupling error in this context is assumed to be 96 ft on a 99.7 percent probability basis using a longitudinal accuracy of 0.2 NM at 95% and a vertical path of 3°.

Note: For straight approaches it is assumed that longitudinal accuracy does not include an FTE component. An arbitrary TSE (based on NSE) of 0.2NM is applied instead of 0.3NM.

d) **Vertical Flight Technical Error (FTE)**

The vertical FTE on a 99.7 percent probability basis should be demonstrated to be less than

	~~Climb/~~Descent Along Specified Vertical Profile (angle) (ft)
At or below 5000 ft (MSL)	150
5000 ft to 10000 ft (MSL)	150
10000 ft to 15000 ft (MSL)	150

Note 1: FTE performance requirements are more stringent compared with AC 20-129 and the ICAO PBN manual where 200 ft (at or below 5000 ft MSL) and 300 ft (from 5000 ft to 15000 ft MSL) are required.

Note 2: ~~The~~ Where a statistical demonstration of FTE has not been accomplished ~~may be supplemented by~~ flight crew procedures requiring intervention when the Vertical Deviation exceeds either ~~150~~ 100 ft or a tighter operational limit are an acceptable alternative.

Note 3: Use of a flight director or autopilot could be required to support such an FTE requirement.

e) **Vertical Total System Error (TSE)**

The Vertical Total System Error (using the Root Sum Square (RSS) of all errors components described above) on a 99.7 percent probability basis is as follow:

	Altimeter System Error[6]	VNAV Equipment error	Horizontal coupling error	Flight Technical Error	**Vertical Total System error**
At or below 5000 ft (MSL)	80 ft	100 ft	96 ft	150 ft	**219 ft**
5000 ft to 10000 ft MSL)	106 ft	150 ft	96 ft	150 ft	**256 ft**
10000 ft to 15000 ft MSL)	127 ft	150 ft	96 ft	150 ft	**265 ft**

The vertical TSE values are compatible with the vertical obstacle clearance criteria applied by PANS-OPS where the maximum vertical clearance of 322 ft, which is provided on a 3 degree vertical path, is intended to accommodate a 3σ TSE with an additional buffer for abnormal operations. The manual monitoring of the altimeters to comply with the DA/DH is independent of the BARO-VNAV system and provides additional mitigation

f) **Vertical Path Error at FAP due to the vertical fly by transition**

Error due to the capture of the vertical path starting from the FAP altitude should be limited. This momentary deviation below the published minimum procedure altitude at the FAP is acceptable provided the deviation is limited to no more than 50 feet (assuming no VNAV equipment error).

Note: ED-75 B paragraphs 1.5.7.2 and 3.2.8.5 provides guidance regarding the VNAV path transitions and in particular the vertical fly by transition

6.4 Integrity

During operations on instrument approach procedures, the probability of displaying misleading navigational or positional information to the flight crew during the approach, including the final segment, shall be remote.

~~In the horizontal plane, the system must provide an alert if the accuracy requirement is not met, or if the probability that the TSE exceeds 0.6 NM (for the final approach segment) or 2NM (for initial, intermediate and missed approach segment) is greater than 10^{-5}~~
In the horizontal plane and during operations on the initial, intermediate segment and for the RNAV missed approach of an RNP APCH, the system, or the system and pilot in combination, shall provide an alert if the accuracy requirement is not met, or if the probability that the lateral TSE exceeds 2 NM is greater than 10^{-5}. During operations on the final approach segment of an RNP APCH, the system, or the system and pilot in combination, shall provide an alert if the accuracy requirement is not met, or if the probability that the lateral TSE exceeds 0.6 NM is greater than 10^{-5}.

For APV BARO-VNAV operation, in the vertical plane the integrity is relying on system development assurance, crew procedures and use of airborne systems independent from the

[6] The ASE value has been computed using the following formula:

ASE (ft) = $-8.8\ 10^{-8} \times (h+\Delta h)^2 + 6.5\ 10^{-3} \times (h+\Delta h) + 50$
where h is the height of the local altimetry reporting station and Δh is the height of the aircraft above the reporting station.

VNAV computer system (e.g. primary altimeter system). The integrity requirement is satisfied by applying appropriate quantitative numerical methods, qualitative operational and procedural considerations and mitigations. The airborne VNAV system must be designed in accordance with the major failure condition regarding the computation of an erroneous vertical guidance. Two independent altimetry systems (sources and displays) must be operational and crew must crosscheck the displayed altitude during the approach and in particular when determining the Decision Altitude (DA). Operator procedures and crew training should highlight importance of having the current altimeter setting for the selected instrument procedure and runway and the respect of temperature limitation if the VNAV system does not compensate automatically.

Note 1 An airborne safety objective of Remote recognises that not only is the navigation system design evaluated consistent with known industry and regulatory system safety assessment views, but is now augmented with a comprehensive assessment of system performance assurance, system features/functions, human interface, flight crew procedures, maintenance and training, that is unique for RNP. The result is that the safety assurance provided greatly exceeds that of conventional navigation systems.

Note 2: An airborne objective of Remote is applicable to an instrument approach in particular on the final segment i.e. from the FAF down to the runway. It is possible to satisfy this objective when considering the RNP system's unique requirements for RNP monitoring and integrity alerting, situational awareness information, error checking via the human machine interface and cockpit displays of independent flight information. Moreover the pilot should respect all vertical constraints associated to the procedure (start of descent, step-down fix,…) in order to respect obstacle clearance.

Note 3: The probability to fail to detect a GPS-induced position error larger than 0.3 NM is less than 10^{-7}/Fh if the receiver is compliant with ETSO-C129( )/TSO-C129( ), ETSO-C145/TSO-C145a or ETSO-C146/TSO-C146a. This 10^{-7}/Fh criteria is the combined probability of the missed detection probability (less than or equal to 10^{-3}/Fh) and the probability of receiving an erroneous satellite signal (less than or equal to10^{-4}/Fh).

Note 4: Traditionally, this requirement has not specifically addressed the airborne system operational software or airborne system databases (e.g. navigation database). However, it is expected that where the RNAV airborne software has been previously shown compliant with the criteria of ED-12B/DO-178B, Level C, as a minimum, it is acceptable for the operations associated with this AMC.

Note 5: Probability terms are defined in CS AMC 25.1309, AC 23.1309-1(), AC 27-1B or AC 29-2C ~~CS AMC 25.1309 or equivalent AMC for CS 23, 27 and 29 aircraft~~.

Note 6: For RNP APCH operation, the on-board monitoring and alerting function is provided through the use of ABAS (RAIM or an equivalent algorithm) in conjunction with crew monitoring of the FTE

Note 7: For aircraft and systems approved for RNP AR operations, per AMC 20-26, the crew alerting based upon RNP is an acceptable alternative.

6.5 Continuity of function

It shall be demonstrated that:

(a) The probability of loss of all navigation information is Remote.
(b) The probability of non-restorable loss of all navigation and communication functions is Extremely Improbable.

Loss of the RNP APCH functions with or without BARO-VNAV guidance is considered a minor failure condition if the operator can revert to a different navigation system and proceed to a suitable airport. For RNP APCH operations at least one RNAV system is required.

Note 1 From an operational point of view, the operator should develop contingency procedure for the loss of the RNP APCH capability during the approach.

Note 2: Probability terms are defined in CS AMC 25.1309, AC 23.1309-1(), AC 27-1B or AC 29-2C ~~CS AMC 25.1309 or equivalent AMC for CS 23, 27 and 29 aircraft~~.

7. FUNCTIONAL CRITERIA

7.1 Required Function for RNP APCH

Item	Functional Description
1	Navigation data, including a to/from indication and a failure indicator, must be displayed on a lateral deviation display (CDI, (E)HSI) and/or a navigation map display. These must be used as primary flight instruments for the navigation of the aircraft, for manoeuvre anticipation and for failure/status/integrity indication. They must meet the following requirements: 1) The displays must be visible to the pilot and located in the primary field of view (±15 degrees from pilot's normal line of sight) when looking forward along the flight path. 2) The lateral deviation display scaling ~~should~~ must agree with any alerting and annunciation limits, if implemented. 3) 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 total system accuracy. For installations having a lateral deviation display, its full-scale deflection ~~should~~ must be suitable for the phase of flight and based on the required track keeping accuracy. Scaling is ±1NM for the initial and intermediate segments and ±0.3 NM for the final segment ~~(See also ETSO/TSO C129a)~~. 4) The display scaling may be set automatically by default logic or set to a value obtained from a navigation database. The full-scale deflection value ~~should~~ must be known or made available for display to the flight crew. Enhanced navigation display (e.g. electronic map display or enhanced EHSI) to improve lateral situational awareness, navigation monitoring and approach (flight plan) verification could become mandatory if the RNAV installation does not support the display of information necessary for the accomplishment of these crew tasks. ~~mentioned above. This is particularly true for GNSS stand-alone receiver (see 8.4.2).~~ ~~Flight director and/or autopilot is not required for this type of operation. However if the TSE cannot be demonstrated without these systems, it becomes mandatory. In this case coupling to the flight director and/or automatic pilot from the RNAV system should be indicated with an unambiguous mode~~.
2	Capability to continuously display, to the pilot flying, the RNAV computed desired path (DTK), and the aircraft position relative to the path (XTK), on the primary flight instruments for navigation of the aircraft. Note: Where the minimum flight crew is two pilots, it ~~should~~ shall be possible for the pilot not flying to verify the desired path and the aircraft position relative to the path.
3	A navigation database, containing current navigation data officially promulgated for civil aviation; a) which can be updated in accordance with the AIRAC cycle and

Item	Functional Description
	b) from which approach procedures can be retrieved in their entirety and loaded into the RNAV system. The resolution to which the data is stored ~~should~~ must be sufficient to ~~achieve the required track keeping accuracy~~ ensure that the assumption of no path definition error is satisfied. The database ~~should~~ shall be protected against flight crew modification of the stored data. Note: When a procedure is loaded from the database, the RNAV system is required to fly it as published. This does not preclude the flight crew from having the means to modify a procedure or route already loaded into the RNAV/GNSS system as permitted by paragraph 10~~.1.2~~. However, the procedure stored in the database must not be modified and must remain intact within the database for future use and reference.
4	Means to display the validity period of the navigation database to the flight crew.
5	Means to retrieve and display data stored in the navigation database relating to individual waypoints and navigation aids, to enable the flight crew to verify the procedure to be flown.
6	Capacity to load from the database into the RNAV system the whole approach procedure to be flown.
7	Display of the identification of the active (To) waypoint, either in the pilot's primary field of view, or on a readily accessible page on the RNAV CDU, readily visible to the flight crew.
8	Display of distance and bearing to the active (To) waypoint in the pilot's primary field of view. Where impracticable, the data may be displayed on a readily accessible page on the RNAV CDU, readily visible to the flight crew.
9	Display of distance between flight plan waypoints. The navigation system must provide the ability to display the distance between flight plan waypoints.
10	Display of distance ~~to go~~ from present position to any selected waypoint. The navigation system must provide the ability to display the distance ~~to go~~ to any waypoint selected by the flight crew. Such selection should not impact the active flight plan.
11	Display of ground speed or time to the active (To) waypoint, either in the pilot's primary field of view, or on a readily accessible page on the RNAV CDU, readily visible to the flight crew.
12	Capability for the "Direct to" function.
13	Capability for automatic leg sequencing with display of sequencing to the flight crew.
14	Capability to execute database procedures including: a) fly-over and b) fly-by turns.

Item	Functional Description
15	Capability to execute leg transitions and maintain tracks consistent with the following ARINC 424 path terminators (automatic capability), or their equivalent: Initial Fix (IF), Track to Fix (TF), Direct to Fix (DF) Note: Path terminators are defined in ARINC Specification 424, and their application is described in more detail in documents PANS-OPS, EUROCAE ED-75~~A~~()/RTCA DO-236~~A~~(), ED-77/RTCA DO-201A, and EUROCONTROL Document NAV.ET1.ST10.
16	Capability to automatically execute leg transitions consistent with ARINC 424 FA path terminators, or the RNAV system must permit the pilot to fly a course ~~track~~ and turn at a designated altitude. If manual intervention is necessary to turn at the designated altitude , the associated crew workload ~~should~~ shall be assessed
17	Indication of the RNAV system failure leading to the loss of navigation function in the pilot's primary field of view (e.g. by means of a navigation warning flag on the navigation display).
18	Indication of the Loss Of Integrity (LOI) function (e.g. loss of RAIM) in the pilot's normal field of view (e.g. by means of an appropriately located annunciator). Note: Systems providing RNP alerts that reflect loss of GNSS integrity are considered acceptable.
19	Capability for the accomplishment of holding patterns and procedure turns. Activation of this function shall at least: a) Change automatic waypoint sequencing to manual. b) Permit the pilot to readily designate a waypoint and select a desired course (by means of a numerical keypad entry, HSI course pointer, CDI omni-bearing selector, etc.) to or from the designated waypoint (TO/FROM mode operation is acceptable). c) Retain all subsequent waypoints in the active flight plan in the same sequence. d) Permit the pilot to readily return to automatic waypoint sequencing at any time prior to the designated fix ("TO" waypoint) and continue with the existing flight plan.

7.2 Additional required function for APV BARO-VNAV operation

In addition to the required function specified in paragraph 7.1, the system ~~should~~ shall meet the following requirements:

<table>
<tr><th>Item</th><th>Functional Description</th></tr>
<tr><td>1</td><td>APV BARO-VNAV deviation must be displayed on a vertical deviation display (HSI, EHSI, VDI).

This display must be used as primary flight instruments for the approach. The display must be visible to the pilot and located in the primary field of view (±15 degrees from pilot's normal line of sight) when looking forward along the flight path.

The deviation display shall have a suitable full-scale deflection based on the required vertical track error.

The non-numeric display must allow the ~~pilot~~ fight crew to readily distinguish if the vertical deviation exceeds ~~+100/-50~~ ±100 feet.

If the non-numeric display does not permit the fight crew to readily distinguish excessive vertical deviations, the approach must be conducted with the Flight Director and/or the autopilot and a numeric display should allow the pilot to readily distinguish if the vertical deviation exceeds +100/-100 feet

~~Flight director and/or autopilot is not required for this type of operation however if the accuracy requirement cannot be demonstrated without these systems, it becomes mandatory.~~

~~When flight director or automatic pilot is coupled to the system it should be indicated with an unambiguous mode.~~</td></tr>
<tr><td>2</td><td>Capability to continuously display, to the pilot flying, the vertical deviation relative to the Final approach segment on the primary flight instruments for navigation of the aircraft.

Note: Where the minimum flight crew is two pilots, a means for the pilot not flying to verify the desired path and the aircraft position relative to the path ~~should~~ shall be provided.</td></tr>
<tr><td>3</td><td>The navigation system must be capable of defining a vertical path in accordance with the published vertical path.

Note: The VNAV equipment error budget (see 6.3.2.b) includes the path approximation error</td></tr>
<tr><td>4</td><td>User Interface (Displays and Control)
The display readout and entry resolution for vertical navigation information ~~should~~ shall be as follow:

<table>
<tr><th colspan="2">Parameter</th><th>Display resolution</th><th>Entry resolution</th></tr>
<tr><td rowspan="2">Altitude</td><td>Above altitude transition level</td><td>Flight Level</td><td>Flight Level</td></tr>
<tr><td>Below altitude transition level</td><td>1 foot</td><td>1 foot</td></tr>
<tr><td colspan="2">Vertical Path Deviation</td><td>10 feet</td><td>Not applicable</td></tr>
<tr><td colspan="2">Flight Path Angle</td><td>0.1 degree (*)</td><td>0.1 degree</td></tr>
<tr><td colspan="2">Temperature</td><td>1 degree</td><td>1 degree</td></tr>
<tr><td colspan="2">(*) A Display resolution of 0.01 degree is recommended</td><td colspan="2"></td></tr>
</table>
</td></tr>
<tr><td>5</td><td>The navigation database must contain all the necessary data/information to fly the published APV BARO-VNAV approach. The navigation database must contain the waypoints and associated vertical information (~~TCH and~~ e.g. VPA) for the procedure.
Vertical Constraints associated with published procedures must be automatically extracted from the navigation database upon selecting the approach procedure.</td></tr>
</table>

Item	Functional Description
6	Indication of 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 vertical navigation display.
7	The aircraft must display barometric altitude from two independent altimetry sources, one in each pilots' primary field of view. When single pilot operation is permitted the two displays must be visible from the pilot position.

7.3 Recommended Function for RNP APCH

Item	Functional Description
1	Capability, following ATC instructions, to immediately provide horizontal track deviation indications relative to the extended final approach segment, in order to facilitate the interception of this extended final approach segment from a radar vector.
2	Course selector of the deviation display automatically slaved to the RNAV computed path. Note: Systems with electronic map display in the pilot's primary field of view having a depiction of the active route are sufficient.

7.4 Recommended Function for APV BARO-VNAV operation

Item	Functional Description
1	Temperature compensation: Capability to automatically adjust the vertical flight path for temperature effects. The equipment should provide the capability for entry of altimeter source temperature to compute temperature compensation for the vertical flight path angle. The system should provide clear and distinct indication to the flight crew of this compensation/adjustment.
2	Capability to automatically intercept the vertical path at FAP using a vertical fly by technique. Note: Vertical Fly By performance is described in ED-75 B paragraphs 1.5.7.2 and 3.2.8.5

8. AIRWORTHINESS COMPLIANCE

8.1 General

This section details a means of airworthiness compliance for new or modified installations (Para 8.2) and for existing installations (Para 8.3). It also details specific points that should be considered during these approval processes (Para 8.4).

Relevant documentation demonstrating airworthiness compliance should be available to establish that the aircraft is equipped with an RNAV systems meeting RNP APCH requirements without or with vertical guidance (APV BARO-VNAV).

8.2 New or Modified Installations

In demonstrating compliance with this AMC, the following specific points should be noted:

The applicant will need to submit, to the Agency, a compliance statement which shows how the criteria of this AMC have been satisfied. The statement should be based on a plan, agreed by the Agency at an early stage of the implementation programme. The plan should identify the certification data to be submitted which should include, as appropriate, a system description together with evidence resulting from the activities defined in the following paragraphs.

Compliance with the airworthiness requirements for intended function and safety may be demonstrated by equipment qualification, system safety analysis, confirmation of appropriate software design assurance level (i.e. consistent with paragraph 6.4), performance analyses, and a combination of ground and flight tests. To support the approval application, design data will need to be submitted showing that the objectives and criteria of Sections 6 and 7 of this AMC have been satisfied.

Use of the RNAV systems and the manner of presentation of lateral and vertical (if provided) guidance information on the flight deck should be evaluated to show that the risk of flight crew error has been minimised.

8.2.1 Specific Installation criteria

The following points need to be taken into consideration during the airworthiness approval process.

a) Where other conventional navigation systems, apart from the RNAV system, provide display and/or guidance to a Flight Director/Autopilot, means should be provided for
   - a navigation system source selector as the only means of selection;
   - clear annunciation of the selected navigation system on or near the navigation display;
   - display of guidance information appropriate to the selected navigation system; and
   - delivery of guidance information to a Flight Director/Autopilot appropriate to the selected navigation system.

b) Annunciation for Flight Director, Autopilot and selected navigation system should be consistent, and compatible with the original design philosophy of the cockpit.

c) Loss of navigation capability should be indicated to the flight crew.

d) Equipment failure scenarios involving conventional navigation systems and the RNAV system(s) should be evaluated to demonstrate that:
   - adequate alternative means of navigation are available following failure of the RNAV system, and
   - reversionary switching arrangements, e.g. VOR/GPS#2 on HSI#1, do not lead to misleading or unsafe display configurations.

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

e) If barometric altitude input is used by the RNAV system (e.g. Baro aiding for RAIM function), loss of altitude information should be indicated by the RNAV system.

f) The coupling arrangements between the RNAV system and the flight director/automatic pilot should be evaluated to show compatibility and to demonstrate that operating modes, including RNAV system failures modes, are clearly and unambiguously indicated to the flight crew.

g) The use of the RNAV system and the manner of presentation of lateral and vertical (if provided) guidance information on the flight deck should be evaluated to show that the risk of flight crew error has been minimised. The crew should be aware, at any time, of the system used for navigation.

h) The installation configuration features provided by the RNAV system which affect airworthiness approval or operational criteria, such as: external CDI selection; external CDI calibration; entering of GPS antenna height above ground; serial Input/Output port configuration; reference datum, should not be selectable by the pilot. Instructions on how to configure the RNAV system for the particular installation should be listed in the appropriate manual.

i) Controls, displays, operating characteristics and pilot interface to RNAV system should be assessed in relation to flight crew workload, particularly in the approach environment. Essential design considerations include:

- Minimising reliance on flight crew memory for any system operating procedure or task. Developing a clear and unambiguous display of system modes/sub modes and navigational data with emphasis on enhanced situational awareness requirements for any automatic mode changes if provided.
- Use of context sensitive helps capability and error messages (for example, invalid inputs or invalid data entry messages should provide a simple means to determine how to enter "valid" data).
- Placing particular emphasis on the number of steps and minimising the time required to accomplish flight plan modifications to accommodate ATS clearances, holding procedures, runway and instrument approach changes, missed approaches and diversions to alternate destinations.
- Minimising the number of nuisance alerts so the flight crew will recognise and react appropriately when required.

8.3 Existing Installations

Aircraft that are approved for RNP AR APCH operations are considered compliant with this AMC.

An existing statement in the AFM that indicates the aircraft is approved:

- to perform RNP 0.3 GNSS approaches or,
- for instrument approaches including a specification of RNP GNSS capability that meets RNP 0.3

is considered acceptable for lateral performance.

If this is not the case ~~T~~the applicant will need to submit, to the Agency, a compliance statement which shows how the criteria of this AMC have been satisfied for existing installations. Compliance may be established by inspection of the installed system to confirm the availability of required features and functionality. The performance and integrity criteria of Sections 6 and 7 may be confirmed by reference to statements in the Aircraft Flight Manual or to other applicable approvals and supporting certification data. In the absence of such evidence, supplementary analyses and/or tests may be required.

To avoid unnecessary regulatory activity, the determination of eligibility for existing systems should consider acceptance of manufacturer documentation. In this specific case an AFM amendment is recommended to reflect the RNP APCH aircraft capability. The addition of this aircraft capability in the AFM without any technical modification applied to the aircraft could be considered as a Minor change by the Agency.

8.4 Specific Installation assessment

8.4.1 Lateral and vertical Fly-By transition mechanism

The applicant should demonstrate that the turn indication during lateral fly-by transitions is accurate enough to keep the aircraft within the theoretical transition area as described in ED-75 B paragraph 3.2.5.4. Lateral Fly-by transition assessment should be evaluated in manual and in autopilot mode. If the equipment provides positive course guidance through the turn (during the fly-by transition) then no specific flight test is required.

The applicant should demonstrate that the vertical indication during vertical fly-by transitions is accurate enough to keep the aircraft within the profile described in ED-75 B paragraph

3.2.8.5. Vertical Fly-by transition assessment should be evaluated in manual and in autopilot mode. It is recalled that momentary deviation below the published minimum procedure altitude at the FAP is acceptable provided the deviation is limited to no more than 50 feet assuming no VNAV equipment error.

8.4.2 Enhanced navigation displays

It is recognised that enhanced navigation display (such as IFR approved electronic moving map or enhanced EHSI) improves crew lateral situational awareness and navigation monitoring. It is strongly recommended that the RNAV installation incorporates an IFR approved moving map display. This may be a stand-alone display or may be integrated within the aircraft electronic display system or directly integrated within the GNSS stand-alone receiver. For certain cases an enhanced navigation display is required (see Para 7.1 Item 1).

The graphical map display should incorporate at least the active flight plan, map ranges consistent with the flight operation, available navigation aids, and airports. Design and installation of enhanced navigation display should be approved during the approval process; in particular the evaluation of the man machine interface (colour, symbol, cluttering aspect, display location, display size,…).

Enhanced navigational display is considered, ~~for certain installation (e.g. GNSS stand-alone receiver installation), as~~ an essential function for the crew to verify the approach procedure loaded from the navigational data-base. ~~For the vast majority of GNSS stand-alone receiver installations (e.g. ETSO/TSO C 129() class A1 equipment)~~ This display is also a key element for the navigation crew monitoring (e.g. flight plan progress) ~~and for the verification of the approach procedure loaded from the navigation data-base~~.

8.4.3 Intermixing of equipment

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

9. AIRCRAFT FLIGHT MANUAL/PILOT OPERATING HANDBOOK

For new or modified aircraft, the Aircraft Flight Manual (AFM) or the Pilot's Operating Handbook (POH), whichever is applicable, should provide at least the following information:

a) A statement which identifies the equipment and aircraft build or modification standard certificated for RNP APCH operation with or without vertical guidance (APV BARO-VNAV). This may include a very brief description of the RNAV/GNSS system, including the RNAV/GNSS airborne equipment software version, CDI/HSI equipment and installation and a statement that it is suitable for RNAV operations. A brief introduction to the RNAV(GNSS) approach concept using ICAO RNP APCH terminology may also be included.

b) Appropriate amendments or supplements to cover RNP APCH approach operations in the following sections:

- Limitations – including use of VNAV, FD and AP; currency of navigation database; crew verification of navigation data; availability of RAIM or equivalent function; restrictions on use of GNSS for conventional Non Precision Approaches.
- Normal Procedures
- Abnormal Procedures – including actions in response to a Loss of Integrity (e.g. 'RAIM Position Warning', (or equivalent) message or a 'RAIM not available', (or equivalent) message).

Note: This limited set assumes that a detailed description of the installed system and related operating instructions and procedures are available in other approved operational or training manuals.

10. RNP APCH OPERATIONAL CRITERIA

This section describes acceptable operational criteria for approach operations, subject to the limitations given below. The operational criteria assume that the corresponding installation/airworthiness approval has been granted by the Agency.

Operational criteria apply to the use of the RNAV system for RNP APCH operations on any aircraft operated under IFR in accordance with EU legislation or the applicable operational regulations in the fields for which the EU legislation has not yet been established.

Operations of the RNAV system should be in accordance with the AFM or AFM supplement. ~~The items to be address in the AFM or AFM supplement~~ The operational procedures to be addressed by the operator are detailed in APPENDIX 4. The (Master) Minimum Equipment List (MMEL/MEL) should be amended to identify the minimum equipment necessary to satisfy operations using the RNAV system.

The operator should determine the operational characteristics of the procedure to be flown. It is recommended that the process described in paragraph 10.3 and APPENDIX 2 of this AMC should be followed, to validate its operational use by the crew.

Depending on the aircraft capability and the approach procedure, RNP APCH procedures may be conducted with lateral (LNAV), lateral/vertical (LNAV/VNAV) or equivalent mode engaged, and coupling with either a flight director or autopilot.
Prior to the operation, the operator need to be authorised by his/her competent authority for such operations

10.1 Flight Operations Documentation

The relevant parts and sections of the Operations Manual (e.g. Aircraft Operations Manual, check lists, training of crew) should be revised to take account of the operating procedures detailed ~~below (Normal Procedures and Abnormal Procedures)~~ in this section and in particular those in APPENDIX 4. The operator should make timely amendments to the Operations Manual to reflect relevant RNP APCH procedure without or with vertical guidance (APV BARO-VNAV) and database checking strategies. Manuals and check lists need to be submitted for review by the responsible authority as part of the authorisation process.

The aircraft operator should propose an amendment to the Minimum Equipment List (MEL) appropriate to RNP APCH operations.

10.2 Flight Crew Training

Each pilot should receive appropriate training, briefings and guidance material in order to safely conduct RNP APCH operations without or with vertical guidance (APV BARO-VNAV). This material and training should cover both normal and abnormal procedures. Standard training and checking, such as recurrent aeroplane/STD training and proficiency checks, should include RNP APCH procedures. Based on this, the operator should determine what constitutes a qualified crew.

The operator should ensure that during line operations each pilot can perform assigned duties reliably and expeditiously for each procedure to be flown in:
a) normal operations and
b) abnormal operations

The operator should ensure that altimeter settings procedures and cold temperature limitations during APV BARO-VNAV operation are respected.

a) Altimeter setting

Flight Crews should take precautions to switch altimeter settings at appropriate times or locations and request a current altimeter setting if the reported setting is not recent, particularly at times when pressure is reported or is expected to be rapidly decreasing. Remote (regional) altimeter settings are not allowed.

Note: The operational crosscheck between altimeter read-out and charted altitude values at FAF or other profile fixes does not protect against altimeter setting errors.

b) Cold Temperature
When cold weather temperatures exist, the pilot should check the chart for the instrument approach procedure to determine the limiting temperature for the use of BARO-VNAV capability. If the airborne system contains a temperature compensation capability, manufacturer instructions should be followed for use of the BARO-VNAV function, and the operational use of the temperature compensation function must be authorised by the Air Navigation Service Provider.

A training program should be structured to provide sufficient theoretical and practical training. An example of training syllabus is describes in APPENDIX 5

10.3 Aerodrome competence and Operator verification

Before planning a flight to an aerodrome (destination or alternate) with the intent to use an RNAV procedure contained in the Navigation Database, the operator should determine the operational characteristics of the procedure in accordance with EU OPS 1.975 or the applicable operational regulations. Further details are provided in APPENDIX 2.

Based on this assessment, the appropriate information should be given to the crew. If the aerodrome access requires a specific competence, the designated crew shall have a validated competence.

Note: This AMC addresses only RNP APCH procedures which are designed with straight segment (e.g. T or Y approach). It is therefore anticipated that in most cases no specific competence should be required to fly such approach procedure.

10.4 Navigation Database Management

10.4.1 Operator involved in the operation of aeroplanes for commercial air transportation

EU-OPS 1.873 for the management of navigation database applies.

10.4.2 Operator not involved in the operation of aeroplanes for commercial air transportation

The operators should not use a navigation database for RNP APCH operations unless the navigation database supplier holds a Type 2 Letter of Acceptance (LoA) or equivalent.

An EASA Type 2 LoA is issued by EASA in accordance with EASA OPINION Nr. 01/2005 on "The Acceptance of Navigation Database Suppliers" dated 14 Jan 05. The FAA issues a Type 2 LoA in accordance with AC 20-153, while Transport Canada (TCCA) is issues an Acknowledgement Letter of an Aeronautical Data Process using the same basis. Both the FAA LoA and the TCCA Acknowledgement Letter are seen to be equivalent to the EASA LoA.

EUROCAE/RTCA document ED-76/DO-200A Standards for Processing Aeronautical Data contains guidance relating to the processes that the supplier may follow. The LoA demonstrates compliance with this standard.

10.4.2.1 Non-approved Suppliers

If the operator's supplier does not hold a Type 2 LoA or equivalent, the operator should not use the electronic navigation data products unless the Authority has approved the operator's procedures for ensuring that the process applied and the delivered products have met equivalent standards of integrity. An acceptable methodology is described in APPENDIX 3 of this AMC.

10.4.2.3 Quality Monitoring

The operator should continue to monitor both the process and the products in accordance with the quality system required by the applicable operational regulations.

10.4.2.4 Data Distribution

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

10.5 Reportable Events

A reportable event is one that adversely affects the safety of the operation and may be caused by actions/events external to the operation of the aircraft navigation system. The operator should have in place a system for investigating such an event to determine if it is due to an improperly coded procedure, or a navigation data base error. Responsibility for initiating corrective action rests with the operator.

For those operators for whom approval is granted under EU OPS 1, the following events should be the subject of Occurrence Reports (see EU-OPS 1.420):

Technical defects and the exceeding of technical limitations, including:

a) Significant navigation errors attributed to incorrect data or a database coding error.
b) Unexpected deviations in lateral/vertical flight path not caused by pilot input or erroneous operation of equipment.
c) Significant misleading information without a failure warning.
d) Total loss or multiple navigation equipment failure.
e) Loss of integrity (e.g. RAIM) function whereas integrity was predicted to be available during the pre-flight planning.

11. AVAILABILITY OF DOCUMENTS

JAA documents are available from the JAA publisher Information Handling Services (IHS). Information on prices, where and how to order is available on the JAA website and at ~~www.avdataworks.com~~ www.jaa.nl.

EASA documents may be obtained from EASA (European Aviation Safety Agency), 101253, D-50452 Koln, Germany. Website: www.easa.europa.eu.

EUROCAE documents may be purchased from EUROCAE, 102 rue Etienne Dolet, 92240 MALAKOFF, France, (Fax: 33 1 46 55 62 65). Website: www.eurocae.net.

FAA documents may be obtained from Superintendent of Documents, Government Printing Office, Washington, DC 20402-9325, USA. Website: www.faa.gov/aviation.htm.

RTCA documents may be obtained from RTCA Inc, 1828 L Street, NW., Suite 805, Washington, DC 20036, USA, (Tel: 1 202 833 9339; Fax 1 202 833 9434). Website: www.rtca.org.

ICAO documents may be purchased from Document Sales Unit, International Civil Aviation Organisation, 999 University Street, Montreal, Quebec, Canada H3C 5H7, (Fax: 1 514 954 6769, e-mail: sales_unit@icao.org) or through national agencies.

APPENDIX 1: GLOSSARY

The following are definitions of key terms used throughout this AMC.

Aircraft-Based Augmentation System (ABAS): An augmentation system that augments and/or integrates the information obtained from the other GNSS elements with information available on board the aircraft.

APV (Approach Procedure with Vertical guidance)**:** An instrument approach procedure which utilises lateral and vertical guidance but does not meet the requirements established for precision approach and landing operations.

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.

Accuracy: The degree of conformance between the estimated, measured, or desired position and/or the velocity of a platform at a given time, and its true position or velocity. Navigation performance accuracy is usually presented as a statistical measure of system error and is specified as predictable, repeatable and relative.

ASE (Altimetry System error)**:** Altimetry error refers to the electrical output and includes all errors attributable to the aircraft altimetry installation including position effects resulting from normal aircraft flight attitudes.

Availability: An indication of the ability of the system to provide usable service within the specified coverage area and is defined as the portion of time during which the system is to be used for navigation during which reliable navigation information is presented to the crew, automatic pilot, or other system managing the flight of the aircraft.

BARO-VNAV (Barometric Vertical NAVigation) is a navigation system that presents to the pilot a computed vertical guidance based on barometric altitude. ~~referenced to a specified vertical path angle (VPA), nominally 3°. The computer-resolved vertical guidance is based on barometric altitude and is specified as a VPA from reference datum height (RDH).~~

Basic GNSS operation: Operation that are based on GNSS Aircraft Based Augmentation System (ABAS). An ABAS system is typically a GNSS receiver with fault detection ~~RAIM~~ compliant to E/TSO C 129a, E/TSO-C145() or E/TSO-C146().

Continuity of Function: The capability of the total system (comprising all elements necessary to maintain aircraft position within the defined airspace) to perform its function without non-scheduled interruptions during the intended operation.

DA(H): 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.

FAP: Final Approach Point

Fault Detection and Exclusion (FDE): FDE is a receiver processing scheme that autonomously provides integrity monitoring for the position solution, using redundant range measurements. The FDE consist of two distinct parts: fault detection and fault exclusion. The fault detection part detects the presence of an unacceptably large position error for a given mode of flight. Upon the detection, fault exclusion follows and excludes the source of the

unacceptably large position error, thereby allowing navigation to return to normal performance without an interruption in service.

GNSS stand-alone receiver: A GNSS system incorporating the GNSS sensor, the navigation capability and the navigation data base.

GNSS sensor: A GNSS system incorporating only the GNSS receiving and positioning part. It doesn't incorporate the navigation capability and the navigation data base.

HCE (Horizontal Coupling Error)**:** The vertical error component of an along track positioning error.

Integrity: The ability of a system to provide timely warnings to users when the system should not be used for navigation.

MDA(H): Minimum descent altitude (MDA) or minimum descent height (MDH). A specified altitude or height in a non-precision approach or circling approach, below which, descent should not be made without the required visual reference.

NSE (Navigation System Error)**:** The difference between true position and estimated position.

OCA/H. In a precision approach procedure (or APV), the OCA/H is defined as the lowest altitude/height at which a missed approach must be initiated to ensure compliance with the appropriate obstacle clearance design criteria.

On board Monitoring and Alerting function: This function is the main element which determines if the navigation system complies with the necessary safety level associated to a RNP application; it relates to both lateral and longitudinal navigation performance.
On-board performance monitoring and alerting allows the flight crew to detect that the RNAV system is not achieving the navigation performance required. On-board performance monitoring and alerting is concerned with the monitoring of all type of errors which may affect the aircraft ability to follow the desired flight path.

TCH: Threshold Crossing Height. The height of the Glide Path above the threshold.

TSE (Total System Error)**:** The difference between true position and desired position. This error is equal to the root sum square (RSS) of the Flight Technical Error (FTE), Path Definition Error (PDE), and Navigation System Error (NSE).

PDE (Path Definition Error)**:** The difference between the defined path and the desired path.

Receiver Autonomous Integrity Monitoring (RAIM): A technique whereby a GNSS receiver/processor determines the integrity of the GNSS navigation signals using only GPS signals or GPS signals augmented with altitude. This determination is achieved by a consistency check among redundant pseudo range measurements. At least one satellite in addition to those required for navigation should be in view for the receiver to perform the RAIM function.

RNAV System: A navigation system 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. A RNAV system may be included as part of a Flight Management System (FMS).

RNAV (GNSS) approach: A GNSS RNAV approach promulgated by a state and designed in accordance with PANS-OPS Criteria Doc 8168, Volume II, Part III, Section 1, Chapter 2 and

Section 3, Chapter 3 (Basic GNSS). Such approach should be flown by using an airborne RNAV system approved for RNP APCH operations.

SBAS: Satellite Based Augmentation System. SBAS augments core satellite constellation by providing ranging, integrity and correction information via geostationary satellites. This system comprises a network of ground reference stations that observe satellites signals, and master stations that process observed data and generate SBAS messages for uplink to the geostationary satellites, which broadcast the SBAS message to the users.

RNP APCH: RNP AProaCH. A RNP approach defined in the ICAO Performance Based Manual (PBN) manual. An approach equivalent to the RNAV (GNSS) one.

TSO-C129()/ETSO- C129a GPS Class A equipment: Equipment incorporating both the GNSS sensor and navigation capability. This equipment incorporates RAIM as defined by TSO/ETSO-C129( ).

TSO-C129()/ETSO-C129 a GPS Class B and C equipment: GNSS sensor providing GNSS data (position, integrity,..) to an integrated navigation system (e.g. FMS).

TSO-C146() Class GAMMA: This functional class corresponds to equipment consisting of both the GNSS/SBAS position sensor and a navigation function, so that the equipment provides path deviations relative to a selected path. The equipment provides the navigation function required of a stand-alone navigation system. This equipment also provides integrity in the absence of ~~WAAS~~ SBAS signal through the use of FDE. In addition, this class of equipment requires a data base, display outputs and pilot controls.

TSO-C145() class BETA: Equipment consisting of a GNSS/SBAS sensor that determines position (with integrity) and provides position and integrity to an integrated navigation system (e.g. flight management system, multi sensor navigation system). This equipment also provides integrity in the absence of the SBAS signal through the use of fault detection and exclusion (FDE).

TSO-C146( ) or TSO-C145( ) Operational Class 1: This operational class supports oceanic and domestic en-route, terminal and non precision approach, and departure operation.

TSO- C146( ) or TSO-C145( ) Operational Class 2: This operational class supports oceanic and domestic en-route, terminal and non precision approach, LNAV/VNAV and departure operation.

TSO-C146( ) or TSO-C145 ( ) Operational Class 3: This operational class supports oceanic and domestic en-route, terminal and non precision approach, LNAV/VNAV, LPV ~~precision approach (APV II and GLS)~~ and departure operation.

"T" approach: T approach is defined in ICAO document 8168 and in RTCA/EUROCAE DO 201A/ED 77. "T" approach is composed of two initial approach segments perpendicular to the intermediate approach segment.

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 these.

VPA (Vertical Path Angle): Angle of the published final approach descent.

VTF: Vector To Final.

VSR: Reference Stall Speed.

"Y" approach: Y approach is defined in ICAO document 8168 and in RTCA/EUROCAE DO 201A/ED 77. "Y" approach is derived from the "T" approach but the initial segments are establishing at 70° to the intermediate segment rather than 90°.

APPENDIX 2: OPERATIONAL CHARACTERISTICS OF THE PROCEDURE AND ITS OPERATIONAL USE

The operator should show evidence that consideration has been given to the evaluation of any new or modified RNP APCH procedures.

RNP APCH procedure should be design using straight segments; the operator should check that the selected procedure fulfils this requirement.

Particular attention should be paid to procedures:

- in mountainous environments,
- within the proximity of well known obstacles,
- that may require adequate knowledge for the aerodrome access or aerodrome competence qualification, as specified in EU-OPS 1.975 or the applicable operational requirements.
-

~~The~~ Competence may be required specifically for this RNAV procedure or the procedure may be published for an aerodrome already listed as requiring an aerodrome competence. ~~The~~ This ~~required competence~~ may be aircraft type related and subject to periodic revalidation.

- In the absence of radar coverage,
- When missed approach trajectory involve turns, especially at low altitudes,
- Subject to a declared exemption to the procedure design rules specified by the ICAO PANS OPS,
- Every other case considered necessary to be evaluated by the operator.

The operator may develop an internal process (e.g. filtering methods or tools covering the AIP review) to detect RNP APCH procedure(s) showing one or more of the above-listed characteristics.

The operational evaluation of a RNP APCH procedure showing evidence of the above mentioned operational characteristics may include, at operator discretion, an approach conducted with the aircraft in VMC or the use of a full flight simulator (FFS) in order to evaluate if the procedure is correctly executed by the RNAV system and fly-able with the aircraft type.

APPENDIX 3: ALTERNATE NAVIGATION DATABASE INTEGRITY CHECK

If operator's navigation database supplier has no Type 2 LOA, the operator should develop and describe a method to demonstrate an acceptable level of integrity of the navigation data base content used by the RNAV system onboard the aircraft.

The operator should implement navigation database integrity checks for all RNP APCH procedures they wish to operate, using manual verification procedures or appropriate software tools, at each AIRAC Cycle.

The objective of this integrity check is to identify any significant discrepancies between the published charts/procedures and the navigation database content.

Integrity checks may be conducted by a designated third party, under the operator responsibility.

1 Elements to be verified

At least the following elements of an RNP APCH should be verified:

- Coordinates/location verification of IAF, IF, FAF, MAPt, and other waypoints between IAF and MAPt (if any).
- Tracks between these waypoints
- Distance between these waypoints
- Vertical path angle (for APV BARO-VNAV operation)

2 Means to verify those elements

2.1 The Operator verification process

The operator should, at the very least, verify the information listed in paragraph ~~C.~~1 of this appendix, by comparison with the official published data.

As the data may evolve at each AIRAC Cycle, this verification should be done at every AIRAC cycle using comparison with source documents or a reference database (gold-standard).

The operator should describe the method used to verify the navigation database integrity which can be based on a:

a) Manual method, with or without software support, whereby the airborne data base is compared with the original published data or
b) Recurrent method with a reference database whereby any changes identified between the latest database and the reference database are checked against the original published data. Once the latest database has been verified, it becomes the reference database for the next AIRAC cycle.

The recurrent method relies on the integrity of the initial database, and requires that the check of every RNP APCH procedure has been properly conducted and validated at the very first time. It also relies on the assumption that every change in the database is properly identified and checked. It is recommended that software tools are used to compare the contents of one (N) AIRAC cycle database with the contents of the previous (N-1) AIRAC cycle database.

Whatever the method, data to be checked must come from the final source to be loaded on the aircraft.

2.2 The means to enable this verification

In many cases the RNAV system and an enhanced navigation display are necessary to access the data (on the aircraft or on a flight simulator).

An RNAV system comparable to the one installed on the aircraft (i.e. using the same algorithms) may also be used, as well as appropriate simulation software tools. The RNAV system manufacturer should be consulted on the adequacy of specific software for this purpose.

Data may also be acquired through a tool able of unpacking the data encoded on the files (e.g. decompactor) developed by the RNAV system manufacturer.

Whatever software tool is used, it should be validated for its intended use by the operator.

3 Feed back and reporting errors found

In case of errors found, the operator should take appropriate actions.

In particular, significant errors (i.e. those that would affect the flight path of the aircraft) should be reported to the database supplier and the competent authority and affected procedures should be prohibited by a company instruction or NOTAM.

Note: Integrity checks could be conducted for several operators by a same designated third party. In this case, it is strongly recommended that any problem recorded by this third party be reported to all its client operators.

APPENDIX 4: ~~AFM~~ OPERATIONAL PROCEDURES

This appendix ~~may~~ should be used by the operator ~~(S)TC holder's~~ to amend ~~their~~ the relevant parts and sections of the Operations Manual as described in 10.1 ~~AFM, as part of the airworthiness approval~~, to support these types of operations.

1 Normal Procedures

1.1 Pre-flight Planning

Operators and ~~pilots~~ flight crew intending to conduct operations on RNP APCH procedures must file the appropriate flight plan suffixes. The on board navigation data must be current and must include the appropriate procedures.

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

a) The instrument approach chart should clearly identify the RNP APCH operation as $RNAV_{(GNSS)}$ or equivalent (e.g.: $RNAV_{(GNSS)}$ RWY 27,…). The operator should determine in accordance with the promulgated OCA(H) and the operational requirement (e.g. EU-OPS 1.430) the Minimum Descent Altitude/Height (MDA(H)) for LNAV approaches or the Decision Altitude/Height (DA(H)) for APV BARO-VNAV operation.

b) ~~The pilot~~ Flight crew must ensure that RNP APCH procedures which may be used for the intended flight (including alternates aerodromes) are selectable from a valid navigation data base (current AIRAC cycle) ~~have been verified by the appropriate process~~ and are not prohibited by a company instruction or NOTAM.

   ~~The pilot~~ Flight crew could check approach procedures (including alternate aerodromes) as extracted by the system (e.g. CDU flight plan page) ~~and~~ or presented graphically on the moving map, in order to confirm the correct loading and the reasonableness of the procedure content. The vertical path of the APV BARO-VNAV procedure could be checked as extracted from the navigation data base on the RNAV Man Machine Interface (e.g. ~~M~~CDU).

   If above verification is not satisfactory, the flight crew should not use the procedure, and not consider this approach(es) during the selection of aerodromes for the intended flight.

c) ~~The pilot~~ Flight crew should ensure sufficient means are available to navigate and land at the destination or at an alternate aerodrome in the case of loss of RNP APCH airborne capability.
   In particular, the pilot should check that:
   - a non-RNP APCH procedure is available at the alternate, where a destination alternate is required
   - at least one non-RNP APCH procedure is available at the destination aerodrome, where a destination alternate is not required

d) Operators and flight crews must take account of any NOTAMs or operator briefing material that could adversely affect the aircraft system operation, or the availability or suitability of the procedures at the airport of landing, or any alternate airport.

e) If the missed approach procedures is based on conventional means (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 navaids must also be operational.

   If the missed approach procedure is based on RNAV (no conventional or dead reckoning missed approach available), the appropriate airborne equipment required to fly this procedure must be available and serviceable onboard the aircraft.
   ~~— Two systems must be available and serviceable onboard the aircraft or,~~

~~- an operator contingency procedure permitting a safe approach extraction must be possible in case of system failure.~~

f) For those GNSS systems relying on RAIM, its availability 15 min before Estimated Time of Arrival (ETA) until 15 min after ETA should be verified during the pre flight planning. In the event of a predicted continuous loss of fault detection of more than five (5) minutes, the flight planning should be revised (e.g. delaying the departure or planning a different approach procedure).

Note 1: For certain systems, prediction is not systematic but is only required in specific cases and shall be detailed in the relevant section of the AFM

Note 2: RAIM availability prediction services may be provided to users by the air navigation service provider (ANSP), an avionics manufacturer or other entities.

g) Any MEL restriction should be observed

1.2 Prior to Commencing the Procedure

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 by comparison with the appropriate approach charts. This check must include:
a) The waypoint sequence.
b) Reasonableness of the tracks and distances of the approach legs, and the accuracy of the inbound course and mileage of the final approach segment.

Note: As a minimum, this check could be a simple inspection of a suitable map display.

c) The vertical path angle.

~~The crew must also check from the published charts, map display or Control Display Unit (CDU), which waypoints are fly-by and which are fly-over.~~

For multi-sensor systems, the crew must verify during the approach that GNSS sensor is used for position computation.

For an RNAV system with ABAS requiring barometric corrected altitude, the current airport barometric altimeter setting, should be input at the appropriate time, consistent with the performance of the flight operation.

For those GNSS systems relying on RAIM and necessitating a check of its availability for RNP APCH, the flight crew should perform a new RAIM availability check if ETA is more than 15 minutes different from the ETA used during the pre-flight planning. This check is also performed automatically for ETSO/TSO-C129a Class A1 receiver, 2 NM before the FAF.

Note: Systems providing RNP alerts that reflect loss of GNSS integrity are considered acceptable and no flight crew RAIM availability check is required.

For APV BARO-VNAV operation, the crew must confirm the correct altimeter setting. The procedure must only be flown with:
a) a current local altimeter setting source available; and
b) the QNH/QFE, as appropriate, set on the aircraft's altimeters.
Procedures using a remote (regional) altimeter setting source cannot support APV BARO-VNAV approach.

For APV BARO-VNAV operation, pilots are responsible for any necessary cold temperature compensations to all published minimum altitudes/heights. This includes:

a) the altitudes/heights for the initial and intermediate segment(s);
b) the DA/H; and
c) subsequent missed approach altitudes/heights.

APV BARO-VNAV procedures are not permitted when the aerodrome temperature is below the promulgated minimum aerodrome temperature for the procedure, unless the RNAV system is equipped with approved cold temperature compensation for the final approach.

ATC tactical interventions in the terminal area may include radar headings, 'direct to' clearances which by-pass the initial legs of an approach, interceptions of an initial or intermediate segments of an approach or the insertion of additional waypoints loaded from the database. In complying with ATC instructions, the flight crew should be aware of the implications for the RNAV system.

a) The manual entry of coordinates into the RNAV system by the flight crew for operation within the terminal area is not permitted.
b) 'Direct to' clearances may be accepted to the Intermediate Fix (IF) provided that the resulting track change at the IF does not exceed 45°.

Note: Direct to clearance to FAF is not acceptable. Modifying the procedure to intercept the final approach course prior to the FAF is acceptable for radar vectored arrivals or at other times with ATC approval.

The lateral and vertical (for APV BARO-VNAV operation) definition of the flight path between the FAF and the Missed Approach Point (MAPt) must not be revised by the flight-crew under any circumstances.

1.3 During the Procedure

The final approach trajectory must be intercepted no later than the FAF in order for the aircraft to be correctly established on the final approach course before starting the descent (to ensure terrain and obstacle clearance).

The crew must check the RNAV approach mode annunciator (or equivalent) is properly indicating approach-mode integrity 2 NM before the FAF.

Note: This will not apply for certain RNAV system (e.g. aircraft already approved with demonstrated RNP capability). For such systems, other means are available including electronic map displays, flight guidance mode indications, etc. which clearly indicate to the crew that the approach mode is activated.

For APV BARO-VNAV operation, the crew should check that the two altimeters provide equivalent altitude (difference of 100 feet max) at or before FAF. This check must be made after the crew has set the correct altimeter setting.

The crew should also check the consistency between the VNAV guidance and the primary altimeters indications commensurate with pilot workload (e.g. after the aircraft is established on the vertical path).

During the descent crew should check that the vertical speed is consistent with the VNAV angle to be flown.

The appropriate displays must be selected so that the following information can be monitored:
a) The RNAV computed desired path (DTK), and
b) Aircraft position relative to the lateral path (Cross-Track Deviation) for FTE monitoring
c) Aircraft position relative to the vertical path (for APV BARO-VNAV operation)

The crew should respect all published altitude and speed constraints.

The procedure must be discontinued:
a) If RNAV failure is annunciated (e.g. warning flag),

b) If the NSE alarm is triggered (e.g. RAIM alert),
c) In case of loss of the NSE alerting function (e.g. RAIM loss),
d) If lateral or vertical (if provided) FTE is excessive,
e) If VNAV trajectory is not consistent with aircraft altimetry system information or vertical speed information.

Note: Discontinuing the procedure may not be necessary for a multi-sensor RNAV system that includes demonstrated RNP capability without GNSS. Manufacturer documentation should be examined to determine the extent the system may be used in such configuration.

The missed approach must be flown in accordance with the published procedure. Use of the RNAV system during the missed approach is acceptable provided:
a) The RNAV system is operational (e.g. no loss of function, no RAIM alert, no failure indication).
b) The whole procedure (including the missed approach) is loaded from the navigation data-base.

During the RNP APCH procedure, pilots must use a lateral deviation indicator, flight director and/or autopilot in lateral navigation mode.
Pilots of aircraft with a lateral deviation indicator (e.g. CDI) must ensure that lateral deviation indicator scaling (full-scale deflection) is suitable for the navigation accuracy associated with the various segments of the procedure (i.e., ±1.0 nm for the Initial and Intermediate segments, ±0.3 nm for the Final Approach segment, and ±1.0 nm for the Missed Approach segment).
All pilots are expected to maintain procedure centrelines, as depicted by onboard lateral deviation indicators and/or flight guidance during all the approach procedure unless authorised to deviate by ATC or under emergency conditions.
For normal operations, cross-track error/deviation (the difference between the RNAV system computed path and the aircraft position relative to the path) should be limited to ± ½ the navigation accuracy associated with the procedure (i.e., 0.5 nm for the Initial and Intermediate segments, 0.15 nm for the Final Approach segment, and 0.5 nm for the Missed Approach segment).
Brief deviations from this standard (e.g. overshoots or undershoots) during and immediately after turns, up to a maximum of 1 times the navigation accuracy (i.e., 1.0 nm for the Initial and Intermediate segments), are allowable.

In addition, during APV BARO-VNAV procedures pilots must use a vertical deviation indicator, flight director and/or autopilot in vertical navigation mode.
Deviations above and below the vertical path must not ~~respectively~~ exceed ±~~+~~100/~~-~~~~50~~ feet (It is recommended operating procedures align this figure with any other operating procedures that have a lower limit (e.g. RNP AR)). Pilots must execute a Missed Approach if the vertical deviation exceeds the criteria above, unless the pilot has in sight the visual references required to continue the approach.

In the event of failure of one RNAV system during a procedure where two systems are necessary, the crew should abort the procedure if the failure occurs before FAF but could continue the approach if the failure occurs after FAF.

Use of GNSS altitude information by the crew is prohibited.

2 Abnormal Procedures

Abnormal procedures to address Cautions and Warnings resulting from the following conditions should be developed:
a) Failure of the RNAV system components, including those affecting Flight Technical Error (e.g. failures of the flight director or automatic pilot).
b) RAIM (or equivalent) alert or loss of integrity function.

In the event of communications failure, the flight crew should continue with the procedure in accordance with published lost communication procedures.

The flight crew should notify ATC of any problem with the RNAV system that results in the loss of the approach capability.

APPENDIX 5: FLIGHT CREW TRAINING SYLLABUS

The flight crew training program should be structured to provide sufficient theoretical and practical training, using a simulator, training device, or line training in an aircraft, in the concept of RNP APCH operations without or with vertical guidance (APV BARO-VNAV) and the use of the aircraft's RNAV system in such operations to ensure that pilots are not just task oriented. The following syllabus should be considered as minimum amendment to the training programme to support ~~these~~ RNP APCH including APV BARO-VNAV operations:

Note: Operators who are already using procedures to fly other types of approaches, may receive appropriate credit for common training and procedural elements.

1 GENERAL RNAV CONCEPTS INCLUDING:

1. Theory of RNAV including differences between types of RNAV operations
2. Limitations of RNAV
3. Limitations of BARO-VNAV
4. Charting and database issues including:
   i. Waypoint naming concepts
   ii. Vertical path angle
   iii. Fly-by and fly-over waypoints
5. Use of RNAV equipment including:
   i. Verification and sensor management
   ii. Tactically modifying the flight plan
   iii. Addressing discontinuities
   iv. Entering associated data such as:
      - Wind
      - Altitude/speed constraints
      - Vertical profile/vertical speed
6. Use of lateral navigation mode(s) and associated lateral control techniques
7. Use of vertical navigation mode(s) and associated vertical control techniques
8. R/T phraseology for RNAV operations
9. The implication for RNAV operations of systems malfunctions which are not RNAV related (e.g. hydraulic or engine failure)

2 RNP APCH concepts including:

1. Definition of RNP APCH operations and its direct relationship with RNAV (GNSS) procedures.
2. Regulatory requirements for RNP APCH operations
3. Required navigation equipment for RNP APCH operations:
   i. GPS concepts and characteristics
   ii. RNP/ANP requirements
   iii. RAIM
   iv. BARO-VNAV
   v. MEL
4. Procedure characteristics
   i. Chart depiction
   ii. Aircraft display depiction
   iii. Minima
5. Retrieving a RNP APCH(or a RNAV(GNSS)) approach procedure from the database
6. Procedure change at destination airport, ~~Change~~ change arrival airport and alternate airport
7. Flying the procedure:

i. Use of autopilot, auto throttle and flight director
ii. Flight Guidance(FG) mode behaviour
iii. Lateral and vertical path management
iv. Adherence to speed and/or altitude constraints
v. Fly direct to a waypoint
vi. Determine lateral and vertical-track error/deviation
vii. Fly interception of an initial or intermediate segment of an approach following ATC notification
viii. Where the RNAV system supports interception of the extended final approach segment then flight crew should be trained in use of the function.
ix. The use of other aircraft equipment to support track monitoring, weather and obstacle avoidance
x. Contingency procedures in case of lateral mode failure (LNAV) and/or vertical mode failure (VNAV)

8. For APV BARO-VNAV operation, a clear understanding of specific crew requirements:
   i. for comparisons of VNAV guidance with primary altimeter information
   ii. for altitude crosschecks between primary altimeters (e.g. altimetry comparisons of 100 feet),
   iii. for temperature limitations on instrument procedures
   iv. for altimeter settings in term of currency, accuracy and integrity.
9. The effect of temperature deviation and its compensation
10. ATC procedures
11. Abnormal procedures
12. Contingency procedures