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Tel.: +1 (514) 954-8219 ext. 6718

Ref.: SP 65/4-10/53

23 July 2010

Subject: Guidance material for the issuance of required navigation performance approach (RNP APCH) operational approvals

Action required: To note and take action where applicable in accordance with paragraph 3

Sir/Madam,

1. I have the honour to invite your attention to updated guidance material concerning implementation of the required navigation performance approach (RNP APCH) navigation specification which is available in English and attached to this State letter. The guidance material was prepared by the Secretariat with the assistance of the Performance-based Navigation Study Group (PBNSG) to give credit to satellite-based augmentation system (SBAS) performance and does not invalidate operational approvals already given based on the RNP APCH navigation specification that is currently provided in the *Performance-based Navigation (PBN) Manual* (Doc 9613). It provides global guidance for operational approvals for operations on approach procedures with vertical guidance.

2. Noting the great demand by States to commence implementation of approach procedures with vertical guidance; recalling Assembly Resolution A36-23, *Performance-based navigation global goals*; and in order to avoid proliferation of operational approval requirements, this guidance material is distributed to States and international organizations prior to its incorporation as amendment to the PBN Manual, which is expected in the second quarter of 2011.

3. All States wishing to implement RNP APCH operations are urged to establish an appropriate approval process in accordance with the attached guidance material.

Accept, Sir/Madam, the assurances of my highest consideration.

Raymond Benjamin
Secretary General

Enclosure:

Guidance material concerning the implementation of RNP APCH (in English only)

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ATTACHMENT to State letter SP 65/4-10/53

GUIDANCE MATERIAL CONCERNING THE IMPLEMENTATION OF RNP APCH OPERATIONS

IMPLEMENTING RNP APCH

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PART A – RNP APCH OPERATIONS DOWN TO LNAV AND LNAV/VNAV MINIMA

A.1 INTRODUCTION

A.1.1 Background

A.1.1.1 Part A of this guidance material addresses approach applications based on GNSS which are classified RNP APCH in accordance with the PBN concept and give access to minima designated as LNAV or LNAV/VNAV.

A.1.1.2 RNP approach (RNP APCH) procedures include existing RNAV(GNSS) approach procedures designed with a straight segment. RNP APCH procedures down to LNAV or LNAV/VNAV minima are expected to be authorized by a number of regulatory agencies including the European Aviation Safety Agency (EASA) and the United States Federal Aviation Administration (FAA). The FAA has issued airworthiness criteria, AC20-138A, for GNSS equipment and systems that are eligible for such operations. EASA has developed certification material (AMC20-27) for airworthiness approval and operational criteria for RNP approach (RNP APCH) operations. While similar in functional requirements, there are slight differences between these two sets of airworthiness criteria. In order to achieve a global standard, the two sets of criteria were harmonized into a single navigation standard.

A.1.2 Purpose

A.1.2.1 Part A of this guidance material provides guidance to States implementing RNP APCH operations down to LNAV or LNAV/VNAV minima (excluding RNP AR APCH operations) and provides the ANSP with an ICAO recommendation on implementation requirements. It provides the operator with a combination of European and United States RNAV airworthiness and operational criteria. For existing stand-alone and multi-sensor RNP systems using GNSS, compliance with both European (EASA AMC 20-27) and United States (FAA AC 20-138A, AC 20-130A or TSO C115b) guidance assures automatic compliance with this ICAO specification, obviating the need for further assessment or AFM documentation. An operational approval to this standard allows an operator to conduct RNP APCH operations down to LNAV or LNAV/VNAV minima globally.

Note 1.— RNP APCH operations approval may be required by national authorities in the State of the intended operations.

Note 2.— The multi-sensor systems may use other sensor combinations such as DME/DME or DME/DME/IRU that provide the navigation performance acceptable for RNP APCH. However, such cases are limited due to the increased complexity in the NAVAID infrastructure requirements and assessment, and are not practical or cost-effective for widespread application.

A.1.2.2 This chapter addresses only the requirement for the lateral navigation aspect (2D navigation) along straight segments. Curved approaches are addressed in RNP AR APCH. The barometric-based vertical navigation requirements for this chapter are addressed in Attachment l to this volume.

Note.—The aircraft may use GNSS-based vertical guidance to conduct RNP APCH operations down to LNAV/VNAV minima (see paragraph A.3).

A.2 ANSP CONSIDERATIONS

A.2.1 Navaid infrastructure

A.2.1.1 GNSS is the primary navigation system to support RNP APCH procedures.

A.2.1.2 The missed approach segment may be based upon the conventional navaid (e.g. VOR, DME, NDB).

A.2.1.3 The acceptability of the risk of loss of RNP APCH capability for multiple aircraft due to satellite failure or loss of on-board monitoring and alerting functions (e.g. RAIM holes), must be considered by the responsible airspace authority.

A.2.2 Communication and ATS surveillance

RNP APCH does not include specific requirements for communication or ATS surveillance. Adequate obstacle clearance is achieved through aircraft performance and operating procedures.

A.2.3 Obstacle clearance

A.2.3.1 Detailed guidance on obstacle clearance is provided in PANS-OPS (ICAO Doc 8168, Volume II); the general criteria in Parts I and III apply.

A.2.3.2 Missed approach procedures may be supported by either RNAV or conventional (e.g. based on NDB, VOR, DME) segments.

A.2.3.3 Procedure design must take account of the absence of a vertical navigation capability on the aircraft.

A.2.4 Additional considerations

A.2.4.1 Many aircraft have the capability to execute a holding pattern manoeuvre using their RNP system.

A.2.4.2 Guidance in this chapter does not supersede appropriate State operating requirements for equipage.

A.2.5 Publication

The AIP should clearly indicate that the navigation application is RNP APCH. The procedure design should rely on normal descent profiles and the State publication should identify minimum segment altitude requirements, including an LNAV OCA(H). If the missed approach segment is based on conventional means, navaid facilities that are necessary to conduct the approach must be identified in the relevant publications. The navigation data published in the State AIP for the procedures and supporting navaids must meet the requirements of Annex 4 — *Aeronautical Charts* and Annex 15 — *Aeronautical Information Services* (as appropriate). All procedures must be based upon WGS-84 coordinates.

A.2.6 Controller training

Air traffic controllers, who provide control services at airports where RNP APCH operations down to LNAV or LNAV/VNAV minima have been implemented, should have completed training that covers the items listed below.

A.2.6.1 Core training

a) How area navigation systems work (in the context of this navigation specification):

   i) include functional capabilities and limitations of this navigation specification;

   ii) accuracy, integrity, availability and continuity including on-board performance monitoring and alerting;

   iii) GPS receiver, RAIM, FDE, and integrity alerts;

   iv) waypoint fly-by versus flyover concept (and different turn performances);

b) Flight plan requirements;

c) ATC procedures;

   i) ATC contingency procedures;

   ii) separation minima;

   iii) mixed equipage environment;

   iv) transition between different operating environments; and

   v) phraseology.

A.2.6.2 Training specific to this navigation specification

a) Related control procedures:

— radar vectoring techniques (where appropriate);

b) RNP approach and related procedures:

i) including T and Y approaches; and

ii) approach minima;

c) impact of requesting a change to routing during a procedure.

A.2.7 Status monitoring

A.2.7.1 The navaid infrastructure should be monitored and, where appropriate, maintained by the service provider. Timely warnings of outages (NOTAMs) should be issued.

A.2.7.2 Status information should be provided in accordance with Annex 11 — *Air Traffic Services* for navigation facilities or services that may be used to support the operation.

A.2.8 ATS system monitoring

If an observation/analysis indicates that a loss of obstacle clearance has occurred, the reason for the apparent deviation from track or altitude should be determined and steps taken to prevent a recurrence.

A.3 NAVIGATION SPECIFICATION

A.3.1 Background

A.3.1.1 This section identifies the airworthiness and operational requirements for RNP APCH operations. Operational compliance with these requirements must be addressed through national operational regulations, and, in some cases, may require a specific operational approval. For example, certain operational regulation requires operators to apply to their national authority (State of Registry) for operational approval.

A.3.1.2 This chapter addresses only the lateral part of the navigation system. If the system is approved for an APV-Baro VNAV operation, the installation must be compliant with the requirements in Attachment 1 “Barometric VNAV”. If the system is approved for APV with augmented GNSS, the installation must be compliant with the requirements in Part B, or must have demonstrated to an airworthiness authority performances at least equivalent to those described in Attachment 1 “Barometric VNAV”.

A.3.2 Approval process

A.3.2.1 This navigation specification does not in itself constitute regulatory guidance material against which either the aircraft or the operator will be assessed and approved. Aircraft are certified by their State

of manufacture. Operators are approved in accordance with their national operating rules. The navigation specification provides the technical and operational criteria, and does not imply a need for recertification.

A.3.2.2 The following steps must be completed before conducting RNP APCH operations:

a) aircraft equipment eligibility must be determined and documented;

b) operating procedures for the navigation systems to be used and the operator navigation database process must be documented;

c) flight crew training based upon the operating procedures must be documented if necessary;

d) the above material must be accepted by the State regulatory authority; and

e) operational approval must then be obtained in accordance with national operating rules.

A.3.2.3 Following the successful completion of the above steps, an RNP APCH operational approval, Letter of Authorization or appropriate operations specification (Ops Spec), if required, should then be issued by the State.

A.3.2.4 Aircraft eligibility

Airworthiness eligibility documents. Relevant documentation acceptable to the State of the Operator/Registry must be available in order to establish that the aircraft is equipped with an RNP system meeting RNP APCH requirements. To avoid unnecessary regulatory activity, the determination of eligibility for existing systems should consider acceptance of manufacturer documentation of compliance, e.g. as with the EASA AMC 20 series. RNP AR APCH systems are considered as qualified for RNP APCH operations without further examination.

A.3.2.5 Operational approval

A.3.2.5.1 The assessment of a particular operator is made by the State of the Operator/Registry for that operator and in accordance with national operating rules (e.g. JAR-OPS 1, 14 CFR Part 121) supported through appropriate advisory and guidance material. The assessment should take into account:

a) evidence of aircraft eligibility;

b) assessment of the operating procedures for the navigation systems to be used;

c) control of those procedures through acceptable entries in the operations manual;

d) identification of flight crew training requirements; and

e) where required, control of the navigation database process.

A.3.2.5.2 The operational approval will likely be documented through the State endorsing the operation specifications associated with the air operator certificate (AOC) through issue of a Letter of Authorization, appropriate operations specification (Ops Spec) or amendment to the operations manual.

A.3.2.5.3 *Description of aircraft equipment*

The operator must have a configuration list detailing pertinent components and equipment to be used for RNP APCH operation.

A.3.2.5.4 *Training documentation*

A.3.2.5.4.1 Commercial operators must have a training programme addressing the operational practices, procedures and training items related to RNP APCH operations (e.g. initial, upgrade or recurrent training for flight crew, dispatchers or maintenance personnel).

Note.— It is not required to establish a separate training programme or regimen if RNAV training is already an integrated element of a training programme. However, it should be possible to identify the aspects of RNAV that are covered within a training programme.

A.3.2.5.4.2 Private operators must be familiar with the practices and procedures identified in A.3.5 "Pilot knowledge and training".

A.3.2.5.5 *Operations manuals and checklists*

A.3.2.5.5.1 Operations manuals and checklists for commercial operators must address information/guidance on the standard operating procedures detailed in A.3.4. The appropriate manuals should contain navigation operating instructions and contingency procedures, where specified. Manuals and checklists must be submitted for review as part of the application process.

A.3.2.5.5.2 Private operators must operate using the practices and procedures identified in A.3.5 "Pilot knowledge and training".

A.3.2.5.6 *Minimum equipment list (MEL) considerations*

Operators must adjust the MEL, or equivalent, and specify the required dispatch conditions. Any MEL revisions necessary to address RNP APCH provisions must be approved.

A.3.3 Aircraft requirements

A.3.3.1 System performance monitoring and alerting

A.3.3.1.1 *Accuracy:* During operations on the initial and intermediate segments and for the RNAV missed approach, of an RNP APCH, the lateral total system error must be within ±1 NM for at least 95 per cent of the total flight time. The along-track error must also be within ±1 NM for at least 95 per cent of the total flight time.

A.3.3.1.2 During operations on the final approach segment of an RNP APCH down to LNAV or LNAV/VNAV minima, the lateral total system error must be within ±0.3 NM for at least 95 per cent of the total flight time. The along-track error must also be within ±0.3 NM for at least 95 per cent of the total flight time.

A.3.3.1.3 To satisfy the accuracy requirement, the 95 per cent FTE should not exceed 0.5 NM on the initial and intermediate segments, and for the RNAV missed approach, of an RNP APCH. The 95 per cent FTE should not exceed 0.25 NM on the final approach segment of an RNP APCH.

Note.— The use of a deviation indicator with 1 NM full-scale deflection on the initial and intermediate segments, and for the RNAV missed approach and 0.3 NM full-scale deflection on the final approach segment, has been found to be an acceptable means of compliance. The use of an autopilot or flight director has been found to be an acceptable means of compliance (roll stabilization systems do not qualify).

A.3.3.1.4 *Integrity:* Malfunction of the aircraft navigation equipment is classified as a major failure condition under airworthiness regulations (i.e. 10^{-5} per hour).

A.3.3.1.5 *Continuity:* Loss of function is classified as a minor failure condition if the operator can revert to a different navigation system and proceed to a suitable airport.

A.3.3.1.6 *On-board performance monitoring and alerting:* During operations on the initial and intermediate segments and for the RNAV missed approach of an RNP APCH, the RNP system, or the RNP 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 down to LNAV or LNAV/VNAV minima, the RNP system, or the RNP 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}.

A.3.3.1.7 *Signal-in-space:* During operations on the initial and intermediate segments and for the RNAV missed approach of an RNP APCH, the aircraft navigation equipment shall provide an alert if the probability of signal-in-space errors causing a lateral position error greater than 2 NM exceeds 10^{-7} per hour (Annex 10, Volume I, Table 3.7.2.4-1). During operations on the final approach segment of an RNP APCH down to LNAV or LNAV/VNAV minima, the aircraft navigation equipment shall provide an alert if the probability of signal-in-space errors causing a lateral position error greater than 0.6 NM exceeds 10^{-7} per hour (Annex 10, Volume I, Table 3.7.2.4-1).

Note 1.— There are no RNP APCH requirements for the missed approach if it is based on conventional means (VOR, DME, NDB) or on dead reckoning.

Note 2.— Compliance with the on-board performance monitoring and alerting requirement does not imply automatic monitoring of a flight technical error. The on-board monitoring and alerting function should consist at least of a navigation system error (NSE) monitoring and alerting algorithm and a lateral deviation display enabling the crew to monitor the flight technical error (FTE). To the extent operational procedures are used to monitor FTE, the crew procedure, equipment characteristics, and installation are evaluated for their effectiveness and equivalence as described in the functional requirements and operating procedures. Path definition error (PDE) is considered negligible due to the quality assurance process (A.3.6) and crew procedures (A.3.4).

Note 3.— The following systems meet the accuracy, integrity and continuity requirements of these criteria:

a) GNSS stand-alone systems, equipment should be approved in accordance with TSO-C129a/ ETSO-C129a Class A, E/TSO-C146() Class Gamma and operational class 1, 2 or 3, or TSO C-196();

b) GNSS sensors used in multi-sensor system (e.g. FMS) equipment should be approved in accordance with TSO C129 ( )/ ETSO-C129 ( ) Class B1, C1, B3, C3 or E/TSO C145() class 1, 2 or 3, or TSO C-196(). For GNSS receiver approved in accordance with E/TSO-C129(), capability for satellite fault detection and exclusion (FDE) is recommended to improve continuity of function; and

c) multi-sensor systems using GNSS should be approved in accordance with AC20-130A or TSO-C115b, as well as having been demonstrated for RNP APCH capability.

A.3.3.2 Criteria for specific navigation systems

RNP APCH is based on GNSS positioning. Positioning data from other types of navigation sensors may be integrated with the GNSS data provided the other positioning data do not cause position errors exceeding the total system error (TSE) budget, or if means are provided to deselect the other navigation sensor types.

A.3.3.3 Functional requirements

A.3.3.3.1 Navigation displays and required functions

A.3.3.3.1.2 Navigation data, including a to/from indication, and a failure indication, 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:

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

b) the lateral deviation display scaling should agree with any alerting and annunciation limits;

c) the lateral deviation display must also have a full-scale deflection suitable for the current phase of flight and must be based on the total system error (TSE) requirement. Scaling is ±1 NM for the initial and intermediate segments and ±0.3 NM for the final segment;

d) 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 must be known or must be available for display to the pilot commensurate with approach values;

e) as an alternate means, a navigation map display must give equivalent functionality to a lateral deviation display with appropriate map scales (scaling may be set manually by the pilot). To be approved, the navigation map display must be shown to meet the TSE requirements;

f) it is highly recommended that the course selector of the deviation display is automatically slaved to the RNAV computed path;

Note.— This does not apply for installations where an electronic map display contains a graphical display of the flight path and path deviation.

g) a flight director and/or autopilot is not required for this type of operation, however, if the lateral TSE cannot be demonstrated without these systems, it becomes mandatory. In this case, coupling to the flight director and/or automatic pilot from the RNP system must be clearly indicated at the cockpit level; and

h) enhanced navigation display (e.g. electronic map display or enhanced EHSI) to improve lateral situational awareness, navigation monitoring and approach verification (flight plan verification) could become mandatory if the RNAV installation doesn't support the display of information necessary for the accomplishment of these crew tasks.

A.3.3.3.1.3 The following system functions are required as a minimum:

a) The capability to continuously display to the pilot flying, on the primary flight instruments for navigation of the aircraft (primary navigation display), the RNAV computed desired path and aircraft position relative to the path. For aircraft where the minimum flight crew is two pilots, the means for the pilot not flying to verify the desired path and the aircraft position relative to the path must also be provided.

b) A navigation database, containing current navigation data officially promulgated for civil aviation, which can be updated in accordance with the aeronautical information regulation and control (AIRAC) cycle and from which approach procedures can be retrieved and loaded into the RNP system. The stored resolution of the data must be sufficient to achieve the required track-keeping accuracy. The database must be protected against pilot modification of the stored data.

c) The means to display the validity period of the navigation data to the pilot.

d) The means to retrieve and display data stored in the navigation database relating to individual waypoints and NAVAIDs, to enable the pilot to verify the procedure to be flown.

e) Capacity to load from the database into the RNP system the whole approach to be flown. The approach must be loaded from the database, into the RNP system, by its name.

f) The means to display the following items, either in the pilot's primary field of view, or on a readily accessible display page:

   i) the identification of the active (To) waypoint;

   ii) the distance and bearing to the active (To) waypoint; and

   iii) The ground speed or time to the active (To) waypoint.

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; and

   iv) the active navigation sensor type, if there is another sensor in addition to the GNSS sensor.

h) The capability to execute a "Direct to" function.

i) The capability for automatic leg sequencing with the display of sequencing to the pilot.

j) The capability to execute procedures extracted from the on-board database, including the capability to execute flyover and fly-by turns.

k) The capability to automatically execute leg transitions and maintain tracks consistent with the following ARINC 424 path terminators, or their equivalent:

- ARINC 424 path terminators
- 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 RTCA documents DO 236B and DO-201A.

l) The capability to display an indication of the RNP system failure, including the associated sensors, in the pilot's primary field of view.

m) The capability to indicate to the crew when NSE alert limit is exceeded (alert provided by the "on-board performance monitoring and alerting function").

A.3.4 Operating procedures

Airworthiness certification alone does not authorize an operator to conduct an RNP APCH operation down to LNAV or LNAV/VNAV minima. Operational approval is also required to confirm the adequacy of the operator's normal and contingency procedures for the particular equipment installation.

A.3.4.1 Pre-flight planning

A.3.4.1.1 Operators and pilots intending to conduct operations using an RNP APCH procedure must file the appropriate flight plan suffixes and the on-board navigation data must be current and include appropriate procedures.

Note.— Navigation databases are expected to be current for the duration of the flight. If the AIRAC cycle is due to change during flight, operators and pilots should establish procedures to ensure the accuracy of navigation data, including the suitability of navigation facilities used to define the routes and procedures for the flight.

A.3.4.1.2 In addition to the normal pre-flight planning checks, the following must be included:

a) the pilot must ensure that approaches which may be used for the intended flight (including alternate aerodromes) are selected from a valid navigation database (current AIRAC cycle), have been verified by the appropriate process (navigation database integrity process) and are not prohibited by a company instruction or NOTAM;

b) subject to a State's regulations, during the pre-flight phase, the pilot 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;

c) 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; and

d) for missed approach procedures based on conventional means (VOR, NDB), operators and flight crews must ensure that the appropriate airborne equipment required for this procedure is installed in the aircraft and is operational and that the associated ground-based navaids are operational.

A.3.4.1.3 The availability of the navaid infrastructure, required for the intended routes, including any non-RNAV contingencies, must be confirmed for the period of intended operations using all available information. Since GNSS integrity (RAIM or SBAS signal) is required by Annex 10, Volume I, the availability of these should also be determined as appropriate. For aircraft navigating with SBAS receivers (all TSO-C145()/C146()), operators should check appropriate GPS RAIM availability in areas where the SBAS signal is unavailable.

A.3.4.2 GNSS availability

A.3.4.2.1 ABAS availability

A.3.4.2.1.1 RAIM levels required for RNP APCH down to LNAV or LNAV/VNAV minima can be verified either through NOTAMs (where available) or through prediction services. The operating authority may provide specific guidance on how to comply with this requirement (e.g. if sufficient satellites are available, a prediction may not be necessary). Operators should be familiar with the prediction information available for the intended route.

A.3.4.2.1.2 RAIM availability prediction should take into account the latest GPS constellation NOTAMs and avionics model (when available). The service may be provided by the ANSP, avionics manufacturer, and other entities, or through an airborne receiver RAIM prediction capability.

A.3.4.2.1.3 In the event of a predicted, continuous loss of appropriate level of fault detection of more than five minutes for any part of the RNP APCH operation, the flight planning should be revised (e.g. delaying the departure or planning a different departure procedure).

A.3.4.2.1.4 RAIM availability prediction software does not guarantee the service, rather they are tools to assess the expected capability of meeting the required navigation performance. Because of unplanned failure of some GNSS elements, pilots/ANSP must realize that RAIM or GPS navigation altogether may be lost while airborne which may require reversion to an alternative means of navigation. Therefore, pilots should assess their capability to navigate (potentially to an alternate destination) in case of failure of GPS navigation.

A.3.4.2.2 SBAS and other Augmented GNSS availability

A.3.4.2.2.1 Part B contains criteria to assess GNSS SBAS vertical guidance availability.

A.3.4.2.2.2 If the aircraft uses other GNSS augmentations, or enhancements to a basic GNSS capability (i.e. use of multiple constellations, dual frequency,…), the RNP APCH operation must be supported by a prediction capability based on the specific characteristics of these other augmentations.

A.3.4.3 Prior to commencing the procedure

A.3.4.3.1 In addition to the normal procedure prior to commencing the approach (before the IAF and in compatibility with crew workload), the flight crew must verify the correct procedure was loaded by comparison with the approach charts. This check must include:

a) the waypoint sequence; and

b) reasonableness of the tracks and distances of the approach legs, and the accuracy of the inbound course and length of the final approach segment.

Note.— As a minimum, this check could be a simple inspection of a suitable map display that achieves the objectives of this paragraph.

A.3.4.3.2 The crew must also check using the published charts, the map display or control display unit (CDU), which waypoints are fly-by and which are flyover.

A.3.4.3.3 For multi-sensor systems, the crew must verify, during the approach, that the GNSS sensor is used for position computation.

A.3.4.3.4 For an RNP system with ABAS requiring barometric corrected altitude, the current airport barometric altimeter setting should be input at the appropriate time and location, consistent with the performance of the flight operation.

A.3.4.3.5 When the operation is predicated on the availability of ABAS, 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 processed automatically 2 NM before the FAF for an E/TSO-C129a Class A1 receiver.

A.3.4.3.6 ATC tactical interventions in the terminal area may include radar headings, “direct to” clearances which bypass the initial legs of an approach, interception of an initial or intermediate segment of an approach, or the insertion of waypoints loaded from the database. In complying with ATC instructions, the flight crew should be aware of the implications for the RNP system:

a) the manual entry of coordinates into the RNP system by the flight crew for operation within the terminal area is not permitted; and

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 degrees.

Note.— “Direct to” clearance to FAF is not acceptable.

A.3.4.3.7 The lateral 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.

A.3.4.4 During the procedure

A.3.4.4.1 The aircraft must be established on the final approach course no later than the FAF before starting the descent (to ensure terrain and obstacle clearance).

A.3.4.4.2 The crew must check the approach mode annunciator (or equivalent) is properly indicating approach mode integrity within 2 NM before the FAF.

Note.— This will not apply for certain RNP systems (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.

A.3.4.4.3 The appropriate displays must be selected so that the following information can be monitored:

a) the RNAV-computed desired path (DTK); and

b) the aircraft position relative to the path (cross-track deviation) for FTE monitoring.

A.3.4.4.4 The procedure must be discontinued:

a) if the navigation display is flagged invalid; or

b) in case of loss of integrity alerting function; or

c) if integrity alerting function is annunciated not available before passing the FAF; or

Note.— Discontinuing the procedure may not be necessary for a multi-sensor RNP 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.

d) if FTE is excessive.

A.3.4.4.5 The missed approach must be flown in accordance with the published procedure. Use of the RNP system during the missed approach is acceptable, provided:

a) the RNP system is operational (e.g no loss of function, no NSE alert, no failure indication); and

b) the whole procedure (including the missed approach) is loaded from the navigation database.

A.3.4.4.6 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 down to LNAV or LNAV/VNAV minima, and ±1.0 NM for the missed approach segment). All pilots are expected to maintain procedure centrelines, as depicted by on-board lateral deviation indicators and/or flight guidance during the whole approach procedure, unless authorized 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 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 one-times the navigation accuracy (i.e. 1.0 NM for the initial and intermediate segments), are allowable.

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

A.3.4.4.7 When Barometric VNAV is used for vertical path guidance during the final approach segment, deviations above and below the Barometric VNAV path must not exceed +22 m/–22 m (+75 ft/–75 ft), respectively.

A.3.4.4.8 Pilots must execute a missed approach if the lateral deviations or vertical deviations, if provided, exceed the criteria above, unless the pilot has in sight the visual references required to continue the approach.

A.3.4.5 General operating procedures

A.3.4.5.1 Operators and pilots must not request an RNP APCH procedure unless they satisfy all the criteria in the relevant State documents. If an aircraft not meeting these criteria receives a clearance from ATC to conduct an RNP APCH procedure, the pilot must advise ATC that he/she is unable to accept the clearance and must request alternate instructions.

A.3.4.5.2 The pilot must comply with any instructions or procedures identified by the manufacturer as necessary to comply with the performance requirements in this navigation specification.

A.3.4.5.3 If the missed approach procedure is based on conventional means (e.g. NDB, VOR, DME), related navigation equipment must be installed and be serviceable.

A.3.4.5.4 Pilots are encouraged to use flight director and/or autopilot in lateral navigation mode, if available.

A.3.4.6 Contingency procedures

A.3.4.6.1 The pilot must notify ATC of any loss of the RNP APCH capability, together with the proposed course of action. If unable to comply with the requirements of an RNP APCH procedure, pilots must advise ATS as soon as possible. The loss of RNP APCH capability includes any failure or event causing the aircraft to no longer satisfy the RNP APCH requirements of the procedure. The operator should develop contingency procedures in order to react safely following the loss of the RNP APCH capability during the approach.

A.3.4.6.2 In the event of communications failure, the flight crew must continue with the RNP APCH in accordance with the published lost communication procedure.

A.3.5 Pilot knowledge and training

The training programme must provide sufficient training (e.g. simulator, training device, or aircraft) on the aircraft's RNP system to the extent that the pilots are not just task oriented, this includes:

a) the information in this chapter;

b) the meaning and proper use of RNP systems;

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

d) knowledge regarding depiction of waypoint types (flyover and fly-by), required path terminators (IF, TF, DF) and any other types used by the operator as well as associated aircraft flight paths;

e) knowledge on the required navigation equipment in order to conduct RNP APCH operations (at least one RNP system based on GNSS);

f) knowledge of RNP system-specific information:

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

ii) functional integration with other aircraft systems;

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

iv) monitoring procedures for each phase of flight;

v) types of navigation sensors utilized by the RNP system and associated system prioritization/weighting/logic;

vi) turn anticipation with consideration to speed and altitude effects; and

vii) interpretation of electronic displays and symbols;

g) knowledge of RNAV equipment operating procedures, as applicable, including how to perform the following actions:

i) verify currency of the aircraft navigation data;

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

iii) initialize RNP system position;

iv) retrieve and fly an RNP APCH;

v) adhere to speed and/or altitude constraints associated with an approach procedure;

vi) fly interception of an initial or intermediate segment of an approach following ATC notification;

vii) verify waypoints and flight plan programming;

viii) fly direct to a waypoint;

ix) determine cross-track error/deviation;

x) insert and delete route discontinuity;

xi) when required by the State aviation authority, perform gross navigation error check using conventional NAVAIDs; and

xii) change arrival airport and alternate airport;

h) knowledge of operator-recommended levels of automation for phase of flight and workload, including methods to minimize cross-track error to maintain procedure centreline;

i) knowledge of radio telephony phraseology for RNP applications; and

j) ability to conduct contingency procedures following RNP system failures.

A.3.6 Navigation database

A.3.6.1 The navigation database should be obtained from a supplier that complies with RTCA DO 200A/EUROCAE document ED 76, Standards for Processing Aeronautical Data. A Letter of Acceptance (LOA) issued by the appropriate regulatory authority demonstrates compliance with this requirement (e.g. FAA LOA issued in accordance with FAA AC 20-153 or EASA LOA issued in accordance with EASA OPINION Nr. 01/2005.

A.3.6.2 Discrepancies that invalidate a procedure must be reported to the navigation database supplier and affected procedures must be prohibited by an operator's notice to its flight crew.

A.3.6.3 Aircraft operators should consider the need to conduct ongoing checks of the operational navigation databases in order to meet existing quality system requirements.

A.3.7 Oversight of operators

A.3.7.1 A regulatory authority may consider any navigation error reports in determining remedial action. Repeated navigation error occurrences attributed to a specific piece of navigation equipment may result in cancelling of the approval for use of that equipment.

A.3.7.2 Information that indicates the potential for repeated errors may require modification of an operator's training programme. Information that attributes multiple errors to a particular pilot crew may necessitate remedial training or licence review.

A.4 REFERENCES

Copies of EUROCONTROL documents may be requested from EUROCONTROL, Documentation Centre, GS4, Rue de la Fusee, 96, B-1130 Brussels, Belgium; (Fax: 32 2 729 9109). Website: http://www.ecacnav.com

Copies of EUROCAE documents may be purchased from EUROCAE, 102 rue Etienne Dolet, 92240 Malakoff, France (Fax: +33 1 46 55 62 65). Website: www.eurocae.eu

Copies of FAA documents may be obtained from Superintendent of Documents,

government Printing Office, Washington, DC 20402-9325, USA. Website: http://www.faa.gov/aircraft_cert/ (Regulatory and Guidance Library)

Copies of RTCA documents may be obtained from RTCA Inc., 1140 Connecticut Avenue, N.W., Suite 1020, Washington, DC 20036-4001, USA, (Te.l: 1 202 833 9339). Website: www.rtca.org

Copies of ARINC documents may be obtained from Aeronautical Radio Inc., 2551 Riva Road, Annapolis, Maryland 24101-7465, USA. Website: http://www.arinc.com

Copies of JAA documents are available from JAA's publisher Information Handling Services (IHS). Information on prices, where and how to order, is available on the JAA website: http://www.jaa.nl and on the IHS websites: http://www.global.his.com and http://www.avdataworks.com

Copies of EASA documents may be obtained from EASA (European Aviation Safety Agency), 101253, D-50452 Koln, Germany.

Copies of ICAO documents may be purchased from The International Civil Aviation Organization, Customer Services Unit, 999 University Street, Montréal, Quebec, Canada H3C 5H7 (Fax: 1 514 954 6769 or e-mail: sales_unit@icao.org) or through sales agents listed on the ICAO website: www.icao.int

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PART B – RNP APCH OPERATIONS DOWN TO LP AND LPV MINIMA

B.1 INTRODUCTION

B.1.1 Background

B.1.1.1 Part B of this guidance material addresses approach applications based on augmented GNSS which are classified RNP APCH in accordance with the PBN concept and give access to minima designated as LP and LPV. While SBAS is one mean of compliance, other GNSS systems providing either lateral and/or vertical guidance performance in accordance with Annex 10 requirements (Table 3.7.2.4-1 - APV 1, APV 2 or Cat 1), may also be used to support RNP APCH down to LP or LPV minima, when employed in accordance with the provisions in this navigation specification.

B.1.1.2 RNP approach (RNP APCH) procedures include existing RNAV(GNSS) approach procedures conducted down to LP or LPV minima. These RNP APCH procedures are authorized by a number of regulatory agencies including the European Aviation Safety Agency (EASA) and United States Federal Aviation Administration (FAA). The FAA has issued airworthiness criteria, AC20-138(), for GNSS equipment and systems that are eligible for such operations. EASA has developed certification material (AMC 20-28) for airworthiness approval and operational criteria for RNP Approach (RNP APCH) operations consistently with FAA Advisory Circular AC 20-138() (LPV approach operation airworthiness approval section). In order to achieve a global standard, the two sets of criteria were harmonized into a single navigation standard.

B.1.1.3 RNP APCH down to LPV minima may give access to a different range of minima, depending on the performance of the navigation systems and the assessment of the responsible airspace authority. The provisions given in this navigation specification are consistent with these different sets of LPV minima, down to 200 ft.

B.1.2 Purpose

B.1.2.1 Part B of this guidance material provides guidance to States implementing RNP APCH operations down to LP or LPV minima. For the Air Navigation Service Provider, it provides a consistent ICAO recommendation on what to implement. For the operator, it provides a combination of European and United States RNAV airworthiness and operational criteria. For existing stand-alone and multi-sensor RNP systems using GNSS augmented by SBAS, compliance with both European (EASA AMC 20-28) and United States (FAA AC 20-138(), AC 20-130A or TSO C115b) guidance assures automatic compliance with this ICAO specification, obviating the need for further assessment or AFM documentation. An operational approval to this standard allows an operator to conduct RNP APCH Part B operations globally.

Note.— RNP APCH operations approval may be required by national authorities in the State of the intended operations.

B.1.2.2 Part B of this guidance material addresses only the requirement for the navigation aspect along a final approach straight segment and the straight continuation of the final approach in the missed approach.

The navigation requirements for the initial and intermediate segments, and other segments of the missed approach are addressed in Part A. Curved approaches are addressed in RNP AR APCH.

Note.— LP Approach Procedures. At some airports, it may not be possible to meet the requirements to publish an approach procedure with LPV vertical guidance. This may be due to: obstacles and terrain along the desired final approach path, airport infrastructure deficiencies, or the inability of SBAS to provide the desired availability of vertical guidance (i.e., an airport located on the fringe of the SBAS service area). When this occurs, a State may provide an LP approach procedure based on the lateral performance of SBAS. The LP approach procedure is a non-precision approach procedure with angular lateral guidance equivalent to a localizer approach. As a non-precision approach, an LP approach procedure provides lateral navigation guidance to a minimum descent altitude (MDA); however, the SBAS integration provides no vertical guidance. With the notable exception of material directly related to SBAS vertical guidance, the guidance material in Part B applies to both LPV and LP approach operations.

B.2 ANSP CONSIDERATIONS

B.2.1 Navaid infrastructure

B.2.1.1 Augmented GNSS is the primary navigation system to support RNP APCH operation down to LP or LPV minima.

B.2.1.2 The missed approach segment may be based upon GNSS or conventional navaid (e.g., VOR, DME, NDB).

B.2.1.3 The acceptability of the risk of loss of RNP APCH approach capability for multiple aircraft due to satellite failure and/or augmented GNSS system failure will be considered by the responsible airspace authority.

B.2.2 Communication and ATS surveillance

B.2.2.1 RNP APCH approach operation down to LP or LPV minima using augmented GNSS does not include specific requirements for communication or ATS surveillance. Adequate obstacle clearance is achieved through aircraft performance and operating procedures.

B.2.3 Obstacle clearance

B.2.3.1 Detailed guidance on obstacle clearance is provided in PANS-OPS (ICAO Doc 8168, Volume II). The general criteria in Parts I and III apply, together with the approach criteria from Doc 8168, Volume II, Part III, Section 1, Chapter 5 and Section 3, Chapter 5 regarding SBAS.

B.2.3.2 Missed approach procedure may be supported by either RNAV or conventional (e.g. based on NDB, VOR, DME) segments.

B.2.4 Additional considerations

B.2.4.1 The State must verify that the augmented GNSS system and that the service provider of the GNSS system, used to support RNP APCH operations, are approved according to the appropriate regulation.

B.2.4.2 Guidance in this chapter does not supersede appropriate State operating requirements for equipage.

B.2.5 Publication

B.2.5.1 The AIP should clearly indicate that the navigation application is RNP APCH. Charting will follow the standards of ICAO Annex 4 — *Aeronautical Charts* for the designation of an RNAV procedure where the vertical path is geometrically specified by a Final Approach Segment (FAS) data block. The charting designation will remain consistent with the current convention and will be promulgated as a LP or LPV OCA(H).

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

B.2.5.2 If the missed approach segment is based on conventional means, navaid facilities that are necessary to conduct the approach will be identified in the relevant publications.

B.2.5.3 The navigation data published in the State AIP for the procedures and supporting navigation aids will meet the requirements of Annex 4 and Annex 15 — *Aeronautical Information Services* (as appropriate).

B.2.5.4 All procedures will be based upon WGS 84 coordinates.

B.2.5.5 The final approach segment of RNP APCH operations down to LP or LPV minima is uniquely characterized by a geometrically defined Final Approach Segment (FAS). The FAS is the approach path which is defined laterally by the Flight Path Alignment Point (FPAP) and landing Threshold point/Fictitious Threshold Point (LTP/FTP), and defined vertically by the Threshold Crossing Height (TCH) and Glide Path Angle (GPA). The Final Approach Segment (FAS) will be promulgated using the FAS data block process. This FAS data block contains the lateral and vertical parameters, which define the approach to be flown. Each FAS data block ends with a CRC, which wraps around the approach data.

B.2.5.6 The final approach segment may be intercepted by an approach transition (e.g. RNAV1), or initial and intermediate segments of an RNP APCH approach, as described in Part A of this guidance material, or through vectoring (e.g. interception of the extended final approach segment).

B.2.6 Controller training

Air traffic controllers, who will provide control services at airports where RNP APCH down to LP or LPV minima have been implemented, should have completed training that covers the items listed below.

B.2.6.1 Core training

a) How area navigation systems work (in context of this navigation specification):

   i) include functional capabilities and limitations of this navigation specification;

   ii) accuracy, integrity, availability and continuity including on-board performance monitoring and alerting;

   iii) GPS and augmented GNSS receiver, RAIM, FDE, and integrity alerts;

   iv) waypoint fly-by versus fly-over concept (and different turn performance);

   v) final Approach Segment Data Block (FAS DB);

   vi) difference between barometric and geometric approach slopes;

b) flight plan requirements;

c) ATC procedures

   i) ATC contingency procedures;

   ii) separation minima;

   iii) mixed equipage environment;

   iv) transition between different operating environments; and

   v) phraseology.

B.2.6.2 Training specific to this navigation specification

a) Related control procedures;

   — Radar vectoring techniques (where appropriate);

b) RNP approach and related procedures:

   i) including T and Y approaches;

   ii) approach minima; and

c) impact of requesting a change to routing during a procedure.

B.2.7 Status monitoring

B.2.7.1 The Navaid infrastructure should be monitored and, where appropriate, maintained by the service provider. Timely warnings of outages (NOTAM) should be issued.

B.2.7.2 Status information should be provided in accordance with Annex 11 — *Air Traffic Services* for navigation facilities or services that may be used to support the operation.

B.2.8 ATS system monitoring

If an observation/analysis indicates that a loss of obstacle clearance has occurred, the reason for the apparent deviation from track or altitude should be determined and steps taken to prevent a recurrence.

B.3 NAVIGATION SPECIFICATION

B.3.1 Background

B.3.1.1 This section identifies the airworthiness and operational requirements for RNP APCH operation down to LP or LPV minima using augmented GNSS. Operational compliance with these requirements must be addressed through national operational regulations, and may require a specific operational approval in some cases. For example, certain operational regulations require operators to apply to their national Authority (State of Registry) for operational approval.

B.3.1.2 This chapter addresses the lateral and vertical part of the navigation system.

B.3.2 Approval process

B.3.2.1 This navigation specification does not in itself constitute regulatory guidance material against which either the aircraft or the operator will be assessed and approved. Aircraft are certified by their State of manufacture. Operators are approved in accordance with their national operating rules. The navigation specification provides the technical and operational criteria, and does not imply a need for recertification.

B.3.2.2 The following steps must be completed before conducting RNP APCH operations down to LP or LPV minima:

a) aircraft equipment eligibility must be determined and documented;

b) operating procedures for the navigation systems to be used and the operator navigation database process must be documented;

c) flight crew training based upon the operating procedures must be documented if necessary;

d) the above material must be accepted by the State regulatory authority; and

e) operational approval must then be obtained in accordance with national operating rules.

B.3.2.3 Following the successful completion of the above steps, a RNP APCH operational approval, letter of authorization or appropriate operations specification (Ops Spec), if required, should then be issued by the State.

B.3.2.4 Aircraft eligibility

Airworthiness eligibility documents. Relevant documentation acceptable to the State of operation must be available to establish that the aircraft is equipped with an airborne system meeting RNP APCH operations down to LP or LPV minima requirements.

B.3.2.5 Operational approval

B.2.3.5.1 The assessment of a particular operator is made by the State of Operator/Registry for that operator and in accordance with national operating rules (e.g., JAR-OPS 1, 14 CFR Part 121) supported through appropriate advisory and guidance material. The assessment should take into account:

a) evidence of aircraft eligibility;

b) assessment of the operating procedures for the navigation systems to be used;

c) control of those procedures through acceptable entries in the Operations Manual;

d) identification of flight crew training requirements; and

e) where required, control of navigation database process

B.2.3.5.2 The operational approval will likely be documented through the State endorsing the Air Operators Certificate (AOC) through issue of a letter of authorisation, appropriate operations specification (Ops Spec) or amendment to the operations manual.

B.3.2.5.3 *Description of aircraft equipment*

The operator must have a configuration list detailing pertinent components and equipment to be used for RNP APCH operation down to LP or LPV minima.

B.3.2.5.4 *Training documentation*

B.3.2.5.4.1 Commercial operators must have a training program addressing the operational practices, procedures and training items related to RNP APCH operations down to LP or LPV minima (e.g. initial, upgrade or recurrent training for flight crew, dispatchers or maintenance personnel).

Note.— It is not required to establish a separate training programme or regimen if RNAV training is already an integrated element of a training programme. However, it should be possible to identify what aspects of RNAV are covered within a training programme.

B.3.2.5.4.2 Private operators must be familiar with the practices and procedures identified in paragraph 5.B.3.5 “Pilot Knowledge/Training” of this guidance material.

B.3.2.5.5 *Operations manuals and checklists*

B.3.2.5.5.1 Operations manuals and checklists for commercial operators must address information/guidance on the standard operating procedures detailed in the “operating procedures” section of this guidance material. The appropriate manuals should contain navigation operating instructions and contingency procedures where specified. The operator should make timely amendments to the operations

manual to reflect relevant procedure and data base checking strategies and check lists need to be submitted for review by the responsible authority as part of the authorization process.

B.3.2.5.5.2 Private operators must operate using the practices and procedures identified in paragraph B.3.5 “Pilot Knowledge/Training” of this guidance material.

B.3.2.5.6 *Minimum Equipment List (MEL) considerations*

Operators must adjust the MEL, or equivalent, and specify the required dispatch conditions. Any minimum equipment list (MEL) revisions necessary to address RNP APCH operations down to LP or LPV minima provisions must be approved.

B.3.3 Aircraft requirements

B.3.3.1 System performance, monitoring and alerting

B.3.3.1.1 *Accuracy*: Along the final approach segment and the straight continuation of the final approach in the missed approach, the lateral and vertical Total System Error is dependent on the Navigation System Error (NSE), Path Definition Error (PDE) and Flight Technical Error (FTE).

- NSE: the accuracy itself (the error bound with 95 per cent probability) changes due to different satellite geometries. Assessment based on measurements within a sliding time window is not suitable for GNSS. Therefore, GNSS accuracy is specified as a probability for each and every sample NSE requirements are fulfilled without any demonstration if the equipment computes three dimensional position using linearized, weighted least square solution in accordance with RTCA DO 229C (or subsequent version) Appendix J.

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

- PDE: PDE is considered negligible based upon the process of path specification to data specification and associated quality assurance that is included in the FAS data-block generation process which is a standardized process. The responsibilities for FAS data block generation lies with the Air Navigation Service Provider.

Note.— FTE performance is considered acceptable if the approach mode of the Flight Guidance System is used during such approach.

B.3.3.1.2 *Integrity*: Presenting misleading lateral guidance simultaneously with misleading vertical guidance and simultaneously with misleading distance data during an RNP APCH operation down to LP or LPV minima is considered to be a hazardous failure condition (extremely remote).

B.3.3.1.3 *Continuity*: Loss of approach capability 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 operation down to LP or LPV minima at least one system is required.

B.3.3.1.4 *On-board performance monitoring and alerting*: Operations on the final approach segment of an RNP APCH operation down to LP and LPV minima, the on-board performance monitoring and alerting function is fulfilled by:

- NSE monitoring and alerting (see *Signal-in-space* section).

- FTE monitoring and alerting: LPV approach guidance must be displayed on a lateral and vertical deviation display (HSI, EHSI, CDI/VDI) including a failure indicator. The deviation display must have a suitable full-scale deflection based on the required track keeping accuracy. The lateral and vertical full scale deflection are angular and associated to the lateral and vertical definitions of the final approach segment contained in the FAS data block.

- Navigation database: Once the FAS data block has been decoded, the equipment shall apply the CRC to the data block to determine if the data is valid. If the FAS data block does not pass the CRC test, the equipment shall not allow activation of the LP or LPV approach operation.

B.3.3.1.5.1 Signal-in-space:

B.3.3.1.5.1.1 Between 2NM from the FAP and the FAP, the aircraft navigation equipment shall provide an alert within 10 seconds if the signal-in-space errors causing a lateral position error is greater than 0.3 NM, with a probability of $1\text{-}10^{-7}$ per hour (Annex 10, Table 3.7.2.4-1).

B.3.3.1.5.1.2 After sequencing the FAP and during operations on the final approach segment of an RNP APCH operation down to LP or LPV minima:

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

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

Note 1.—There are no RNP APCH requirements for the missed approach if it is based on conventional means (VOR, DME, NDB) or on dead reckoning. The requirements for the straight continuation of the final approach, in the missed approach, are in accordance with RTCA DO 229C (or subsequent version).

Note 2.— Compliance with the performance monitoring and alerting requirement does not imply an automatic monitor of flight technical error. The on-board monitoring and alerting function should consist at least of a navigation system error (NSE) monitoring and alerting algorithm and a lateral and vertical deviation display enabling the crew to monitor the flight technical error (FTE). To the extent operational procedures are used to monitor FTE, the crew procedure, equipment characteristics, and installation are evaluated for their effectiveness and equivalence as described in the functional requirements and operating procedures. Path definition error (PDE) is considered negligible due to the quality assurance process (paragraph B.3.6) and crew procedures (paragraph B.3.4).

Note 3.— The following systems meet the accuracy, integrity and continuity requirements of these criteria:

a) GNSS SBAS stand-alone equipment approved in accordance with E/TSO C146a (or subsequent version). Application of this standard guarantees that the equipment is at least compliant with RTCA DO 229C. The equipment should be a Class Gamma, operational class 3;

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

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

ii) The GNSS SBAS sensor is approved in accordance with E/TSO C145a class Beta, operational class 3;

c) approach system incorporating a class Delta GNSS SBAS equipment approved in accordance with E/TSO C146a (or subsequent version). This standard guarantees that the equipment is at least compliant with RTCA DO 229C. The equipment should be a Class Delta 4; and

d) future augmented GNSS systems are also expected to meet these requirements.

B.3.3.2 Criteria for specific navigation systems

RNP APCH operations down to LP or LPV minima is based on augmented GNSS positioning. Positioning data from other types of navigation sensors may be integrated with the GNSS data provided it does not cause position errors exceeding the total system error (TSE) budget**,** or if means are provided to deselect the other navigation sensor types.

B.3.3.3 Functional requirements

B.3.3.3.1 *Navigation displays and required functions*

B.3.3.3.1.2 Approach guidance must be displayed on a lateral and vertical deviation display (HSI, EHSI, CDI/VDI) including a failure indicator and must meet the following requirements:

a) this display must be used as primary flight instruments for the approach;

b) 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; and

c) the deviation display must have a suitable full-scale deflection based on the required track keeping accuracy.

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

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

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

B.3.3.3.1.3 The following system functions are required as a minimum:

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

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

c) The navigation database must contain all the necessary data/information to fly the published approach procedure (final approach segment). Although data may be stored or transmitted in different ways, the data has to be organized in data blocks for the purpose of computing the CRC. This format provides integrity protection for the data it contains. Consequently, each final approach segment is defined by a specific "FAS data block" containing the necessary lateral and vertical parameters depicting the approach to be flown. Once the FAS data block has been decoded, the equipment shall apply the CRC to the data block to determine if the data is valid. If the FAS data block does not pass the CRC test, the equipment shall not allow activation of the approach operation.

d) The capacity to select from the data base into the installed system the whole approach procedure to be flown (SBAS channel number and/or approach name).

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

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

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

Note.— These requirements are limited to the final approach segment, the straight continuation of the final approach in the missed approach, and to the interception of the extended final approach segment. If the installed system is also able to fly the initial, intermediate and missed approach segments of the approach it must be approved in accordance with the corresponding requirement (e.g. RNP APCH Part A or RNAV1 criteria).

B.3.4 Operating procedures

Airworthiness certification alone does not authorize operator to conduct RNP APCH operation down to LP or LPV minima. Operational approval is also required to confirm the adequacy of the operator's normal and contingency procedures for the particular equipment installation.

B.3.4.1 Pre-flight planning

B.3.4.1.1 Operators and pilots intending to conduct RNP APCH operation down to LP or LPV minima must file the appropriate ATC flight plan suffixes. The on board navigation data must be current and must include the appropriate procedures.

Note. – Navigation databases are expected to be current for the duration of the flight. If the AIRAC cycle is due to change during flight, operators and pilots should establish procedures to ensure the accuracy of navigation data, including suitability of navigation facilities used to define the routes and procedures for flight.

B.3.4.1.2 In addition to the normal pre-flight planning the following checks must be carried out:

a) The pilot must ensure that approach procedures which may be used for the intended flight (including 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.

b) Subject to State's regulations, during the pre-flight phase, the pilot should ensure sufficient means are available to navigate and land at the destination or at an alternate aerodrome in the case of loss of LP or LPV airborne capability.

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

d) If the missed approach procedure is based on conventional means (e.g. VOR, DME) 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 installed in the aircraft and must be operational.

B.3.4.1.3 The availability of the navaid infrastructure, required for the intended routes, including any non-RNAV contingencies, must be confirmed for the period of intended operations using all available information. Since GNSS integrity is required by Annex 10, the availability of these should also be determined as appropriate.

B.3.4.2 Augmented GNSS availability

B.3.4.2.1 Service levels required for RNP APCH operations down to LP or LPV minima can be verified either through NOTAMs (where available) or through prediction services. The operating authority may

provide specific guidance on how to comply with this requirement. Operators should be familiar with the prediction information available for the intended route.

B.3.4.2.2 LP or LPV service availability prediction should take into account the latest GPS constellation and SBAS system status NOTAMs and avionics model (when available). The service may be provided by the ANSP, avionics manufacturer, other entities or through an airborne receiver LP or LPV service prediction capability.

B.3.4.2.3 In the event of a predicted, continuous loss of appropriate level of fault detection of more than five minutes for any part of the RNP APCH operation, the flight planning should be revised (e.g. delaying the departure or planning a different departure procedure).

B.3.4.2.4 Service availability prediction software does not guarantee the service, they are tools to assess the expected capability to meet the required navigation performances. Because of unplanned failure of some GNSS or SBAS elements, pilots/ANSP must realize that GPS or SBAS navigation altogether may be lost while airborne which may require reversion to an alternative means of navigation. Therefore, pilots should assess their capability to navigate (potentially to an alternate destination) in case of failure of GPS plus SBAS navigation.

B.3.4.2.5 These availability prediction services are expected to be developed also for future GNSS systems with performances equivalent to SBAS.

B.3.4.3 Prior to commencing the procedure

B.3.4.3.1 In addition to normal procedure prior to commencing the approach (before the IAF and in compatibility with crew workload), the flight crew must verify the correctness of the loaded procedure 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; and

Note. — As a minimum, this check could be a simple inspection of a suitable map display.

c) the vertical path angle.

B.3.4.3.2 ATC tactical interventions in the terminal area may include radar headings, ‘direct to’ clearances which by-pass the initial legs of an approach, interception of an initial or intermediate segment of an approach or the insertion of waypoints loaded from the database. In complying with ATC instructions, the flight crew should be aware of the implications for the navigation system.

a) The manual entry of coordinates into the navigation 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 FAP is not acceptable.

B.3.4.3.3 The approach system provides the capability for the pilot to intercept the final approach track well before the FAP (vector to final (VTF) function or equivalent). This function should be used to respect a given ATC clearance.

B.3.4.4 During the procedure

B.3.4.4.1 The approach mode will be activated automatically by the RNP system. When a direct transition to the approach procedure is conducted (e.g. when the aircraft is vectored by the ATC to the extended final approach segment and crew selects the VTF function or an equivalent function), the LP or LPV approach mode is also immediately activated.

B.3.4.4.2 The system provides lateral and/or vertical guidance relative to the LP or LPV final approach segment or to the extended final approach segment (for the direct transition).

B.3.4.4.3 The crew must check that the GNSS approach mode indicates LP or LPV (or an equivalent annunciation) 2 NM before the FAP.

B.3.4.4.4 The final approach segment should be intercepted no later than the FAP in order for the aircraft to be correctly established on the final approach course before starting the descent (to ensure terrain and obstacle clearance).

B.3.4.4.5 The appropriate displays should be selected so that the following information can be monitored:

a) aircraft position relative to the lateral path;

b) aircraft position relative to the vertical path; and

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

B.3.4.4.6 The crew should respect all published altitude and speed constraints.

B.3.4.4.7 Prior to sequencing the FAP, the crew should abort the approach procedure if there is:

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

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

c) low altitude alert (if applicable).

B.3.4.4.8 After sequencing the FAP, the procedure must be discontinued, unless the pilot has in sight the visual references required to continue the approach, if:

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

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

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

c) FTE is excessive and cannot be timely corrected.

B.3.4.4.9 Pilots must execute a missed approach if excessive lateral and/or vertical deviations are encountered and cannot be timely corrected, unless the pilot has in sight the visual references required to continue the approach. The missed approach must be flown in accordance with the published procedure (e.g. conventional or RNAV).

B.3.4.5 General operating procedures

B.3.4.5.1 Operators and pilots must not request an RNP APCH operation down to LP or LPV minima unless they satisfy all the criteria in the relevant State documents. If an aircraft not meeting these criteria receives a clearance from ATC to conduct such an approach procedure, the pilot must advise ATC that he/she is unable to accept the clearance and must request alternate instructions.

B.3.4.5.2 The pilot must comply with any instructions or procedures identified by the manufacturer as necessary to comply with the performance requirements in this chapter.

B.3.4.5.3 If the missed approach procedure is based on conventional means (e.g. NDB, VOR, DME), related navigation equipment must be installed and be serviceable.

B.3.4.5.4 Pilots are encouraged to use flight director and/or autopilot in lateral navigation mode, if available.

B.3.4.6 Contingency procedures

B.3.4.6.1 The operator should develop contingency procedure in order to react safely following the loss of the approach capability during the approach.

B.3.4.6.2 The pilot must notify ATC of any loss of the RNP APCH capability, together with the proposed course of action. If unable to comply with the requirements of an RNP APCH procedure, pilots must advise Air Traffic Service as soon as possible. The loss of RNP APCH capability includes any failure or event causing the aircraft to no longer satisfy the RNP APCH requirements of the procedure.

B.3.4.6.3 In the event of communications failure, the flight crew should continue with the procedure in accordance with published lost communication procedures.

B.3.7. Pilot knowledge and training

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

a) RNP approach concept containing LP or LPV minima:

   i) theory of approach operations;

   ii) approach charting;

iii) use of the approach system including:

1) selection of the LP or LPV approach procedure;

2) ILS look alike principle;

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

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

vi) R/T phraseology for LP or LPV approach operations;

vii) the implication for LP or LPV approach operations of systems malfunctions which are not related to the approach system (e.g. hydraulic or engine failure); and

b) RNP approach operation containing LP or LPV minima:

i) definition of LP or LPV approach operations and its direct relationship with RNAV(GNSS) procedures;

ii) regulatory requirements for LP or LPV approach operations;

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

1) GPS concepts and characteristics;

2) augmented GNSS characteristics; and

3) MEL; and

iv) procedure characteristics:

1) chart depiction;

2) aircraft display depiction;

3) minima; and

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

vi) Change arrival airport and alternate airport;

vii) Flying the procedure:

1) use of autopilot, autothrottle and flight director;

2) flight Guidance(FG) mode behaviour;

3) Lateral and vertical path management;

4) adherence to speed and/or altitude constraints;

5) fly interception of an initial or intermediate segment of an approach following ATC notification;

6) fly interception of the extended final approach segment (e.g. using the VTF function);

7) consideration of the GNSS approach mode indication (LP, LPV, LNAV/VNAV, LNAV,…); and

8) the use of other aircraft equipment to support track monitoring, weather and obstacle avoidance; and

viii) ATC procedures;

ix) abnormal procedures; and

x) contingency procedures.

B.3.6 Navigation database

B.3.6.1 The operator should not use a navigation database for these approach operations unless the navigation database supplier holds a Type 2 Letter of Acceptance (LoA) or equivalent.

B.3.6.2 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 January 2005. The FAA issues a Type 2 LoA in accordance with AC 20-153, while Transport Canada (TCCA) issues an Acknowledgement Letter of an Aeronautical Data Process using the same basis.

B.3.6.3 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.

B.3.6.3 The operator should continue to monitor both the process and the products in accordance with the quality system required by the applicable operational regulations.

B.3.6.4 The operator should implement procedures that ensure timely distribution and insertion of current and unaltered electronic navigation data to all aircraft that require it.

B.3.7 Oversight of operators

B.3.7.1 A regulatory authority may consider any navigation error reports in determining remedial action. Repeated navigation error occurrences attributed to a specific piece of navigation equipment may result in cancellation of the approval for use of that equipment.

B.3.7.2 Information that indicates the potential for repeated errors may require modification of an operator's training program. Information that attributes multiple errors to a particular pilot crew may necessitate remedial training or license review.

B.4 REFERENCES

Copies of EUROCONTROL documents may be requested from EUROCONTROL, Documentation Centre, GS4, Rue de la Fusee, 96, B-1130 Brussels, Belgium; (Fax: 32 2 729 9109). Web site: http://www.ecacnav.com

Copies of EUROCAE documents may be purchased from EUROCAE, 102 rue Etienne Dolet – 92240 Malakoff – France (FAX: +33 1 46 55 62 65) – Web site: www.eurocae.eu

Copies of FAA documents may be obtained from Superintendent of Documents, Government Printing Office, Washington, DC 20402-9325, USA. Web site: http://www.faa.gov/certification/aircraft/ (Regulation and Guidance Library)

Copies of RTCA documents may be obtained from RTCA Inc., 1140 Connecticut Avenue, N.W., Suite 1020, Washington, DC 20036-4001, USA, (Tel: 1 202 833 9339). Web site www.rtca.org.

Copies of ARINC documents may be obtained from Aeronautical Radio Inc., 2551 Riva Road, Annapolis, Maryland 24101-7465, USA. Web site: http://www.arinc.com

Copies of JAA documents are available from JAA's publisher Information Handling Services (IHS). Information on prices, where and how to order, is available on the JAA web site, http://www.jaa.nl, and on the IHS web sites http://www.global.his.com , and http://www.avdataworks.com .

Copies of EASA documents may be obtained from EASA (European Aviation Safety Agency), 101253, D- 50452 Koln, Germany.

Copies of ICAO documents may be purchased from Document Sales Unit, International Civil Aviation Organization, 999 University Street, Montreal, Quebec, Canada H3C 5H7, (Fax: 1 514 954 6769, or e-mail: sales_unit@icao.org) or through national agencies.

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