

United Kingdom Overseas Territories Aviation Circular

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OTAC 135-17

Performance Based Navigation (PBN) Approvals

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GENERAL

Overseas Territories Aviation Circulars are issued to provide advice, guidance and information on standards, practices and procedures necessary to support Overseas Territory Aviation Requirements. They are not in themselves law but may amplify a provision of the Air Navigation (Overseas Territories) Order or provide practical guidance on meeting a requirement contained in the Overseas Territories Aviation Requirements.

PURPOSE

This Overseas Territories Aviation Circular provides information regarding Performance Based Navigation and the requirements of both the AN(OT)O and OTAR Parts 121 and 135 for obtaining an approval. This guidance is also intended to provide an indication of the level of knowledge and investment in resources (both human and hardware) necessary, before an operator is ready to commence the process of applying for PBN approval.

RELATED REQUIREMENTS

This Circular relates to Part 8 (Height Keeping and Navigation) of the AN(OT)O 2013 and to Part SPA (*Specific Approvals, Section II – Operations in areas with specified navigational performance*) of OTAR Parts 39, 91, 125, 121 and 135.

CHANGE INFORMATION

Issue 2. Additions to Airworthiness and Flight Operations considerations, in Sections 2 and 3, with a new Appendix A regarding PBN certification standards. Added new OTAC 39-17 as it also relates to OTAR 39.

ENQUIRIES

Enquiries regarding the content of this Circular should be addressed to Air Safety Support International at the address on the ASSI website www.airsafety.aero or to the appropriate Overseas Territory Aviation Authority.

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EXPLANATION OF TERMS ASSOCIATED WITH PERFORMANCE BASED NAVIGATION

Note: Not all of these terms are used in this OTAC.

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.

Note: The most common form of ABAS is receiver autonomous integrity monitoring (RAIM).

Approach procedure with vertical guidance (APV). An instrument procedure which utilizes 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 ground or space-based navigation aids or within the limits of the capability of self-contained aids, or a combination of these.

Global Navigation Satellite System (GNSS). The standard generic term for satellite navigation systems that provide autonomous geo-spatial positioning with global coverage.

Navigation aid (NAVAID) infrastructure. NAVAID infrastructure refers to space-based and or ground-based NAVAIDs available to meet the requirements in the navigation specification.

Navigation specification. A set of aircraft and aircrew requirements needed to support Performance-based Navigation operations within a defined airspace. There are two kinds of navigation specification:

RNAV specification. A navigation specification based on area navigation that does not include the requirement for on-board performance monitoring and alerting, designated by the prefix RNAV, eg RNAV 5, RNAV 1.

RNP specification. A navigation specification based on area navigation that includes the requirement for on-board performance monitoring and alerting, designated by the prefix RNP, eg RNP 4, RNP APCH.

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

Note: Performance requirements are expressed in navigation specifications in terms of accuracy, integrity, continuity and functionality needed for the proposed operation in the context of a particular airspace concept. Availability of GNSS or some other NAVAID infrastructure is considered within the airspace concept in order to enable the navigation application.

Receiver Autonomous Integrity Monitoring (RAIM). A form of ABAS whereby a GNSS receiver processor determines the integrity of the GNSS navigation signals using only GPS signals or GPS signals augmented with altitude (baro-aiding). This determination is achieved by a consistency check among redundant pseudo-range measurements. At least one additional satellite needs to be available with the correct geometry over and above that needed for the position estimation, for the receiver to perform the RAIM function.

RNAV operations. Aircraft operations using area navigation for RNAV applications.

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. An RNAV system may be included as part of a flight management system (FMS).

RNP operations. Aircraft operations using an RNP system for RNP navigation applications.

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

RNP system. An area navigation system which supports on-board performance monitoring and alerting.

1 Introduction

- 1.1 The Air Navigation (Overseas Territories) Order requires that a Territory-registered aircraft must not fly in areas with specified performance navigation unless it is equipped with navigation equipment that complies with published requirements and the operator has been approved by the Governor.
- 1.2 OTAR Parts 91, 125, 135 & 121, (Part SPA Section II, Operations in areas with specified navigational performance), requires that the operator satisfies the following in order to gain such an approval:
- a) demonstrate that the navigation equipment meets the required performance in terms of navigation functionality, accuracy, integrity, availability and continuity; and
 - b) establish and maintain a training programme for the flight crew involved in these operations; and
 - c) establish operating procedures specifying:
 - (i) the equipment to be carried, including its operating limitations and appropriate entries in the Minimum Equipment List (MEL);
 - (ii) flight crew composition and experience requirements;
 - (iii) normal procedures;
 - (iv) contingency procedures;
 - (v) incident reporting;
 - (vi) navigation database integrity.

2 Overview of Performance Based Navigation (PBN)

- 2.1 Conventional navigation is dependent upon ground-based radio navigation aids, which have been the mainstay of aviation for the last seventy years, and pilots, operators, manufacturers and Air Navigation Service Providers (ANSPs) are all familiar with the associated technology, avionics, instrumentation, operations, training and performance.
- 2.2 Performance-based navigation (PBN) detailed in the International Civil Aviation Organisation's (ICAO) 'Performance-based Navigation (PBN) Manual (ICAO Doc 9613), is based upon area navigation principles. While various methods of area navigation have been in existence for many years, the widespread use of area navigation as a primary navigation function is a more recent phenomenon. The PBN concept is intended to better define the use of area navigation systems and is expected to replace many of the existing conventional navigation routes in the future.
- 2.3 The fundamentals of PBN operations are relatively straightforward; however, the transition to new technology, new navigation and new operational concepts and the dependence on data-driven operations require careful management. The PBN operational approval process is intended to ensure that the appropriate level of implementation and oversight is provided for all PBN operations and the benefits of PBN are achieved consistently and safely.

2.4 There are 3 components to PBN:

a) **Navigation Specifications**

A navigation specification details the performance required of the RNAV or RNP system in terms of accuracy, integrity, and continuity; which navigation functionalities the RNAV or RNP system must have; which navigation sensors must be integrated into the RNAV or RNP system; and which requirements are placed on the flight crew. An RNP specification includes a requirement for on-board performance monitoring and alerting, while an RNAV specification does not. On-board performance monitoring and alerting is the main element that determines whether the navigation system complies with the necessary safety level associated with an RNP application; whether it relates to both lateral and vertical navigation performance; and whether it allows the aircrew to detect that the navigation system is not achieving, or cannot guarantee with 10^{-5} integrity, the navigation performance required for the operation.

b) **Navigation Applications**

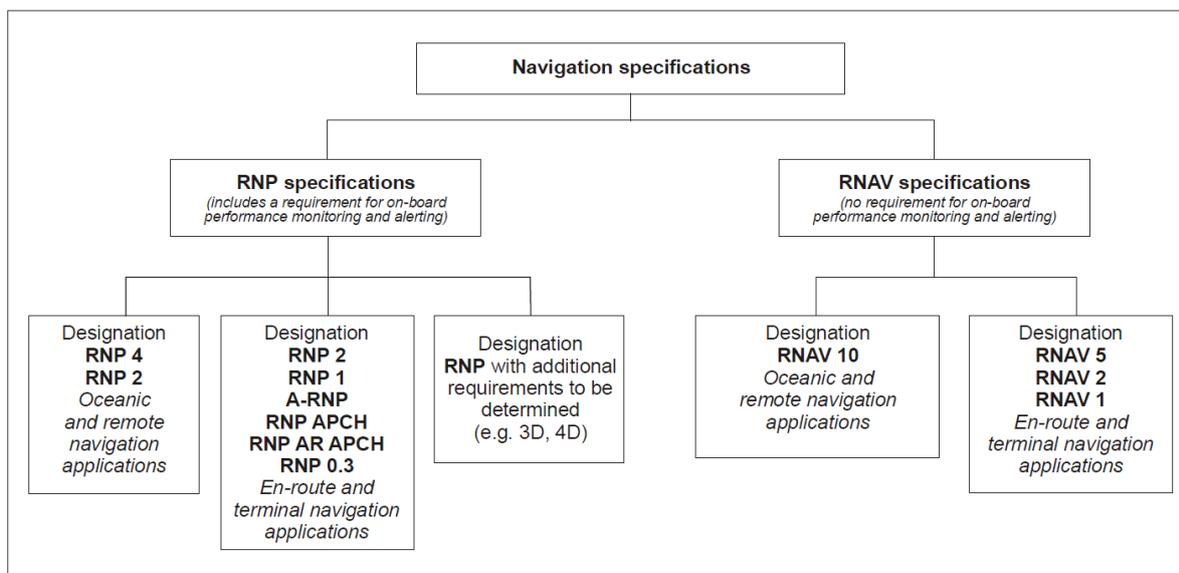
A navigation application is the use of a navigation specification and associated NAVAID infrastructure to ATS routes, instrument approach procedures and/or defined airspace. An RNP application is supported by an RNP specification; an RNAV application is supported by an RNAV specification.

c) **RNP/RNAV Designations**

RNP and RNAV designations are based upon lateral accuracy in nautical miles. An aircraft must remain + or – the numerical value stated (in nautical miles) for 95% of the total flight time:

RNP Designations (requires on-board performance monitoring and alerting)		
RNP 0.3 (Helicopter Operations)		En-Route and terminal navigation applications
RNP 1		
RNP 2	Oceanic and remote navigation applications	
RNP 4	Oceanic and remote navigation applications	
A-RNP		En-Route and terminal navigation applications
RNP APCH		
RNP AR APCH		

RNAV Designations (no requirement for on-board performance monitoring and alerting)		
RNAV 1		En-Route and terminal navigation applications
RNAV 2		
RNAV 5		
RNAV 10	Oceanic and remote navigation applications	



RNP Approach Designations

(i) Non-Precision or 2D Approaches

LNAV (Lateral Navigation): This is a Non-Precision or 2D Approach with Lateral only navigation guidance provided by GNSS.

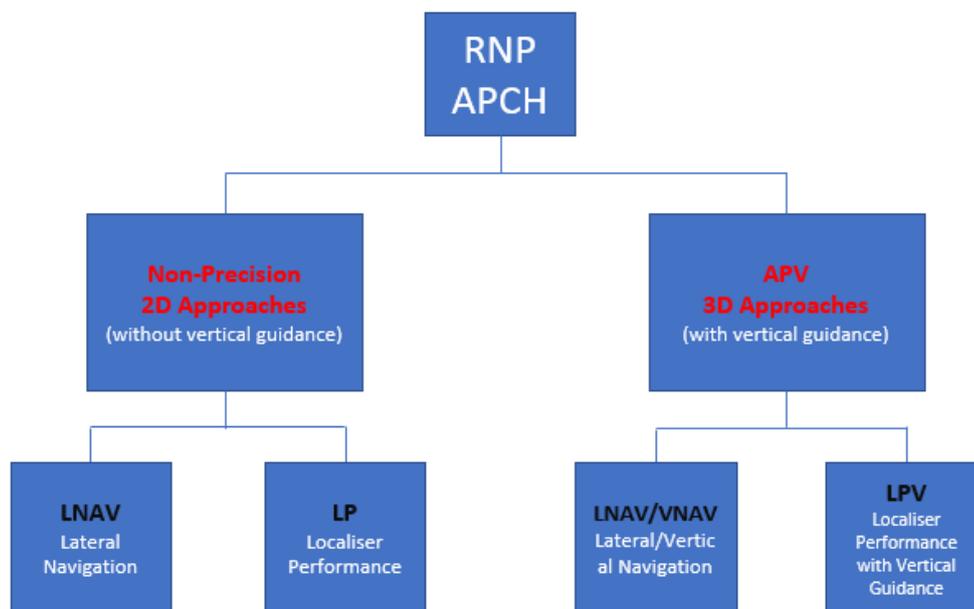
LP (Localiser Performance): This is a Non-Precision or 2D Approach with Lateral only navigation guidance provided by GNSS.

(ii) APV 3D Approaches

(Note: VNAV (Vertical Navigation). APV (Approach with Vertical Guidance): defined as an instrument procedure which utilises lateral and vertical guidance but does not meet the requirements established for precision approach and landing operations.)

LNAV/VNAV (also known as APV/Baro VNAV): This is a 3D Approach Procedure with Vertical Guidance. The lateral navigation guidance is provided by GNSS. The vertical guidance is provided by a Barometric Altimeter.

LPV (Localiser Performance with Vertical Guidance): This is a 3D Approach Procedure with both the Lateral and Vertical guidance provided by GNSS.



d) **Navaid Infrastructure**

The NAVAID infrastructure refers to ground- or space-based NAVAIDs. Ground-based NAVAIDs include DME and VOR. Space-based NAVAIDs include GNSS elements.

2.5 PBN requires that aircraft meet certain airworthiness certification standards, including the necessary navigation system performance and functionality, as well as development of the operator's flight operations procedures and flight crew training/competency requirements:

- a) **Airworthiness:** The airworthiness element ensures that the aircraft meets aircraft eligibility and safety requirements for the functions and performance defined in the navigation specifications. The installation will need to meet the relevant airworthiness standards, eg US 14 CFR Part 25/EASA CS-25 and the applicable AC/AMC. The AC/AMC may also include other non-navigation equipment required to conduct the operation such as communications and surveillance equipment.
- b) **Continued Airworthiness:** The operator is expected to demonstrate that the navigation system will be maintained compliant with the type design. For navigation system installations there are few specific continued airworthiness requirements other than database and configuration management, systems modifications and software revisions.
- c) **Flight Operations:** The flight operations element considers the operator's infrastructure for conducting PBN operations, including flight crew operating procedures, training (to include classroom and flight training, initial and recurrent, and competency demonstrations). This element also considers the operator's Minimum Equipment List (MEL), Operations Manual (OM), checklists, instrument flight procedure approval processes, navigation database validation procedures, flight planning and dispatch procedures, etc.

3 PBN Operational approval requirements

3.1 AIRWORTHINESS

a) Airworthiness Approval

- (i) An aircraft is eligible for a particular PBN application provided there is a clear statement of its PBN capability in the TC (Type Certificate), the STC (Supplemental Type Certificate), or the associated documentation — AFM or equivalent document; or a compliance statement from the manufacturer, which has been approved by the State of Design. The operator must have a configuration list detailing the pertinent hardware and software components and equipment used for the PBN operation.
- (ii) The aircraft shall be required to hold an airworthiness approval or have been modified in accordance with approved data (often a Supplemental Type Certificate), for the type of envisaged PBN, for its navigation system operations.
- (iii) Guidance on the certification standards that are often referenced in the AFM/RFM sections associated with PBN is given in Appendix A.

b) Continued Airworthiness

- (i) Procedures shall be in place to maintain the aircraft to conform to its type design and with the requirements for all navigation approvals held.
- (ii) The aircraft maintenance programme must take account of all operational approvals and maintain navigation systems so that they are compliant with navigation approvals.
- (iii) The continuing airworthiness management organisations and their contracted maintenance organisation shall ensure that staff have received PBN training.

3.2 FLIGHT OPERATIONS

a) Minimum Equipment List (MEL)

The MEL should identify the minimum equipment necessary to satisfy the intended navigation function required.

b) Electronic Navigation Data Management

Procedures shall be in place for electronic navigation data products, that are for use in the air and on the ground, to ensure:

- (i) acceptable standards of data integrity and compatibility with the intended function;
- (ii) continual monitoring of the related data processes and the products; and
- (iii) the timely distribution and insertion of electronic navigation data.

In accordance with ICAO Doc 9613 databases for RNAV 1, RNAV 2, RNP 2, RNP 1, RNP 4, RNP APCH, RNP AR APCH, A-RNP and RNP 0.3 operations should have a Type 2 Letter of Acceptance (LoA) issued to the database supplier from the appropriate regulatory authority.

A copy of this LoA should be provided to the operator.

The LoA confirms the database meets the data quality requirements of RTCA DO200A/EUROCAE document ED 76, Standards for Processing Aeronautical Data.

A Type 2 LoA permits a databases supplier to deliver a Navigation database product to end users.

c) **Flight Crew composition and experience requirements**

The Operations Manual should contain details of the crew composition required for PBN operations, the qualifications required and the experience required to obtain those qualifications.

d) **Standard operating procedures (SOPs)**

Standard operating procedures (SOPs) must be developed to cover both normal and non-normal (contingency) procedures for the systems used in the PBN operation. The SOPs must be documented in the OM and address the following:

- (i) preflight planning requirements, including the MEL, appropriate nav aids, the navigation database, and, where appropriate, RNP/RAIM prediction;
- (ii) actions to be taken prior to commencing the PBN operation;
- (iii) actions to be taken during the PBN operation;
- (iv) actions to be taken in the event of a contingency (e.g. equipment failures and/or weather conditions) that could affect the aircraft's ability to maintain navigation accuracy. These procedures would also require the flight crew to state their intentions, coordinate a plan of action and obtain a revised ATC clearance in case of contingencies, including the reporting to the operator and to the Overseas Territory Aviation Authority (OTAA) of significant incidents.

e) **Monitoring and incident reporting**

Flight crew responsibilities must be laid down in SOPs, with respect to the performance monitoring and alerting provided by the navigation system, together with reporting to the operator and OTAA of significant incidents such as:

- (i) navigation errors not associated with transitions from an inertial navigation mode to a radio navigation mode;
- (ii) unexpected deviations in lateral or vertical flight path attributed to incorrect navigation data;
- (iii) significant misleading information without failure warning;
- (iv) total loss or multiple failures of the PBN navigation equipment; or
- (v) problems with ground navigation facilities leading to significant navigation errors.

e) Training programme

Each pilot must receive appropriate training, briefings and guidance material in order to safely conduct any operation. The training programme needs to cover both ground training and flight training and to cover the following areas:

- (i) Area navigation principles;
- (ii) Navigation system principles;
- (iii) Equipment operation and functionality;
- (iv) Flight planning;
- (v) Operating procedures;
- (vi) Performance monitoring and alerting.

f) Recurrent Training

The flight crew training programme must include provision for the management of recurrent training and the demonstration of competency.

4 PBN Operational approvals

Operational Approvals, in accordance with the AN(OT)O, are stated on the Operation Specifications section of the Air Operator Certificate and detail the PBN approvals that an operator has been granted and, therefore, the PBN operations they are authorised to conduct:

RNP & APV 3D Approach Designations
RNP 0.3 *
RNP 1
RNP 2
RNP 4
RNP APCH (LNAV)
RNP APCH (LPV)
RNP APCH (LNAV/VNAV)

RNAV & Non-Precision 2D Approach Designations
RNAV 1
RNAV 2
RNAV 5
RNAV 10
LNAV
LP

* RNP 0.3 is intended for helicopter operations

5 Obtaining an approval

For details on the process for applying for a PBN approval, operators/owners will need to contact the relevant OTAA.

6 Further reading

Skybrary:

[https://www.skybrary.aero/index.php/Performance Based Navigation \(PBN\)](https://www.skybrary.aero/index.php/Performance_Based_Navigation_(PBN))

Doc 9613: Performance-Based Navigation Manual (Advance 4th ed.):

<https://www.skybrary.aero/bookshelf/content/bookDetails.php?bookId=2991>

Eurocontrol:

<https://www.eurocontrol.int/articles/performance-based-navigation-pbn-applications>

Boeing:

http://www.boeing.com/commercial/aeromagazine/articles/qtr_2_08/AERO_Q208_article3.pdf

END

APPENDIX A

PBN Certification Standards

This Appendix provides an overview of the certification requirements associated with the various PBN Specifications. It is intended to assist OTAA's in determining the compliance status of the installed systems on the aircraft. Usually this will be accomplished by reviewing the AFM supplement and assessing the compliance declarations in the Limitations section, together with the STC drawings and data.

The PBN specification is given in the left column, the European and FAA requirements are in the centre columns. Additional information such as required input sensors and the application use of the PBN specification are given in the right column.

For background information, regarding the European standards, the JAA then EASA initially used JAA TGLs as the certification basis for some RNAV applications. Then as EASA progressed from 2003 it produced AMC20 documents to address some more of the applications. In 2019 EASA created a dedicated Certification Specification CS-ACNS to address all the applicable PBN Specifications. The CS-ACNS document will be used for new PBN related STCs and Design Changes. In the OTAA's it is more likely that for the present, the compliance will be against the older standards (ie TGLs and EASA AMC 20 documents).

PBN Spec	European Certification Requirements	FAA	Other Information
RNAV 5	AMC 20-4A; JAA TGL 2; CS-ACNS Subpart C Sub 2;	20-138D App, AC90-96A	Can use VOR/DME; DME/DME; GNSS and/or INS sensors. Was known as Basic RNAV. Used Continental En-Route
RNAV 1	JAA TGL 10; CS-ACNS Subpart C Sub 2	AC20-138D AC90-100A	DME/DME; DME/DME/IRU or GNSS. Used En-Route Continental, arrival, and departure and Intermediate Approach. Database requires a LoA.
RNAV 2	CS-ACNS Subpart C Sub 2; ICAO Doc 9613	AC-20-138D 90-100A	DME/DME; DME/DME/IRU or GNSS. Used En-Route Continental, arrival, and departure. Database requires a LoA.
RNAV 10	AMC 20-12; CS-ACNS Subpart C Sub 2	FAA Order 8400.12a, AC20-138D & Appendix 1 AC90-105A	least two independent and serviceable LRNSs comprising an INS, an IRS FMS or a GNSS. Used in Oceanic/Remote. Database requires a LoA.
RNP 1	CS-ACNS Subpart C Sub 1,2	AC20-138D AC90-105A	GNSS. Used for arrival and departure. Database requires a LoA.
RNP 2	CS-ACNS Subpart C Sub 1,2	AC20-138D AC90-105A	GNSS. Used Oceanic, En-Route Continental and Remote Operations Database requires a LoA.

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RNP 4	ICAO Doc 9613; CS-ACNS Subpart C Sub 1,2,10	AC20-138D & Appendix 1; FAA Order 8400.33 AC90-105A	2 Independent LRNs with GNSS. Used Oceanic/Remote. Database requires a LoA.
RNP APCH with Baro VNAV	AMC20-27A; CS- ACNS Subpart C Sub 1,2, 3, 5	AC20-138D AC90-105A	Tends to be installed on Large aircraft (Airbus/Boeing). GNSS and Baro VNAV. Database requires a LoA.
LPV Approach using SBAS	AMC20-28; CS- ACNS Subpart C Sub 1,2,3, 5	AC20-138D AC90-105A	Small Business jet and Retrofit applications. GNSS Augmented with WAAS/EGNOSS. Database requires a LoA.
RNP AR APCH	AMC-26A; CS- ACNS Subpart C Sub 1,2,3,4, 5,6, 8	AC20-138D & Appendix 2	GNSS and Baro VNAV. Database requires a LoA. Requires a TAWS and AP/FD coupling
A-RNP	CS-ACNS Subpart C Sub 1,2,3,5, 7, 8, 10	AC20-138D & Appendix 3 AC90-105A	GNSS Based, Covers RNAV 5 RNAV 1 RNAV 2 RNP 2 RNP 1 RNP APCH. Database requires a LoA
RNP 0.3	CS-ACNS Subpart C Sub 1,2	AC20-138D AC90-105A	GNSS based. Used for Helicopters only. Requires Database requires a LoA. Requires AP/FD coupling