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REGIÃO ADMINISTRATIVA ESPECIAL DE MACAU
民航局
AUTORIDADE DE AVIAÇÃO CIVIL
CIVIL AVIATION AUTHORITY

AC
No. : AC/OPS/022R03
Date : 17 July 2020

AERONAUTICAL CIRCULAR
CIVIL AVIATION AUTHORITY – MACAO, CHINA

SUBJECT:

Operation in Performance-based Navigation (PBN) Prescribed Airspace

EFFECTIVE DATE:

1 August 2020

CANCELLATION:

AC/OPS/022R02

GENERAL

The President of Civil Aviation Authority – Macao, China, in exercise of his power under Paragraph 89 of the Air Navigation Regulation of Macao (ANRM) and Article 35 of the Statutes of Civil Aviation Authority, approved by the Decree-Law 10/91/M, established this Aeronautical Circular (AC).

1 Introduction

According to paragraphs 37(3), 118A(3) and 176A(3) of the ANRM, an aircraft registered in Macao shall not be operated in an airspace or on a route where a navigation specification for Performance-based Navigation (PBN) has been prescribed unless the operator of the aircraft has obtained an approval from the AACM for such operations.

This AC is established to set forth the requirements for aircraft operations for where a navigation specification of PBN has been prescribed and to provide operator of Macao registered aircraft with the guidance to obtain operational approval for the PBN operations and the conditions to maintain their eligibility for such approval.

Recognizing that the various navigation specifications prescribed under PBN concept have their specific performance requirements as specified in the ICAO PBN Manual (Doc 9613), the PBN operational approval cited in this AC does not constitute a single approval to authorize all navigation specifications.

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Operational approval shall be pursued in response to the operational needs for a particular navigation specification. An aircraft approved for a navigation specification having a stringent accuracy requirement (e.g. RNP 0.3) is not automatically approved for a navigation specification having a less stringent accuracy requirement (e.g. RNP 4).

Operator desiring operational approval for PBN operations shall have a clear understanding of the PBN concept and associated functional and performance requirements towards each particular navigation specification. In this regard, Appendix 1 to this AC is established to provide an introduction to PBN operations and the common process related to the operational approval for its navigation specifications, while Appendix 2 to this AC further highlights some specific features for the RNP AR APCH navigation specification designated under PBN which requires additional levels of scrutiny, control and authorization.

To constitute the materials in preparation for a specific navigation specification, unless otherwise specified by the AACM, operator must refer to the implementation guidance provided in the relevant chapter of the ICAO PBN Manual (Doc 9613) Volume II to ensure that each detailed aspect for that navigation specification has been covered in the application.

2 Applicability

This AC applies to operators of Macao registered aircraft who intend to conduct flights along ATS routes, on an instrument approach procedure, or in a designated airspace where a PBN navigation specification has been prescribed.

3 Definitions

Area navigation (RNAV) means 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.

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

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

Navigation Specification means a set of aircraft and flight crew requirements needed to support performance-based navigation operations within a defined airspace. There are two kinds of navigation specification:

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- **Area navigation (RNAV) specification** - Navigation specification based on area navigation that does not include the requirement for performance monitoring and alerting, designated by the prefix RNAV, e.g. RNAV 5, RNAV 1.
- **Required navigation performance (RNP) specification** - Navigation specification based on area navigation that includes the requirement for performance monitoring and alerting, designated by the prefix RNP, e.g. RNP 4, RNP APCH.

Note: The ICAO Performance-based Navigation (PBN) Manual (Doc 9613), Volume II, contains detailed guidance on navigation specifications.

RNAV System means 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 System means an area navigation which supports on-board performance monitoring and alerting.

RNAV operations means aircraft operations using area navigation for RNAV applications.

RNP operations means aircraft operations using an RNP system for RNP navigation applications.

RNP route means an ATS route established for the use of aircraft adhering to a prescribed RNP navigation specification.

4 Aircraft operations in Performance-Based Navigation (PBN) prescribed airspace

4.1 For operations where a navigation specification for performance-based navigation has been prescribed, the operator of an aircraft shall ensure that:

(a) the aircraft is provided with navigation equipment which will enable it to operate in accordance with the operational flight plan, the requirements of air traffic services and the prescribed navigation specification(s);

(b) the aircraft has information relevant to the aircraft navigation specification capabilities listed in the flight manual or other aircraft documentation and included in the MEL;

4.2 The operator of an aircraft shall have established and documented:

(a) normal and abnormal procedures including contingency procedures;

(b) flight crew qualification and proficiency requirements in accordance with the appropriate navigation specifications;

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(c) a training programme for relevant personnel consistent with the intended operations; and

(d) appropriate maintenance procedures to ensure continued airworthiness in accordance with the appropriate navigation specifications.

5 Approval for Operations in PBN Prescribed Airspace

Operator requesting an approval to operate flights in PBN prescribed airspace shall demonstrate to AACM's satisfaction with regard to the following aspects:

(a) Evidence of aircraft eligibility for the intended operation;

(b) Operating procedures for the navigation system to be used;

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

(d) Identification of training requirements;

(e) The relevant manuals or procedures in respect of continuing airworthiness;

(f) Control of the navigation database process; and

(g) Navigation error reporting.

Note: Guidance on the approval for operation with PBN specification is set out in Appendix 1 to this AC.

6 Oversight to Approval Holders

Non-compliance to the applicable requirements, repeated reports of navigation error occurrences attributed to a specific piece of navigation equipment or operational procedure without satisfactory remedial action, may result in suspension or withdrawal of the operational approval regarding the particular PBN operation.

Information that indicates the potential for repeated errors may require modification of an operator's training programme, maintenance programme or specific equipment certification. Information that attributes multiple errors to a particular pilot crew may necessitate remedial training or crew license review.

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Appendix 1 Approval for Operations in PBN Prescribed Airspace

1 Introduction to Performance-Based Navigation (PBN)

1.1 The PBN Concept

1.1.1 The performance-based navigation (PBN) concept specifies that aircraft RNAV and RNP system performance requirements be defined in terms of the *accuracy*, *integrity*, *continuity* and *functionality*, which are needed for the proposed operations in the context of a particular airspace concept.

1.1.2 The PBN concept represents a shift from sensor-based to performance-based navigation. Performance requirements are identified in navigation specifications, which also identify the choice of navigation sensors and equipment that may be used to meet the performance requirements.

1.1.3 Under PBN, generic navigation requirements are defined based on operational requirements. Within an airspace concept, PBN requirements will be affected by the communication, ATS surveillance and ATM services, the NAVAID infrastructure, and the functional and operational capabilities needed to meet the ATM application. PBN requirements also depend on what reversionary, conventional navigation techniques are available and what degree of redundancy is required to ensure adequate continuity of functions.

1.2 Navigation Specification

1.2.1 A navigation specification is a set of aircraft and aircrew requirements needed to support a navigation application within a defined airspace concept. The navigation specification defines the performance required by the RNAV or RNP system as well as any functional requirements such as the ability to conduct curved path procedures or to fly parallel offset routes.

1.2.2 A navigation specification that includes a requirement for on-board navigation performance monitoring and alerting is referred to as an RNP specification. One not having such requirements is referred to as an RNAV specification.

1.2.3 Both RNAV and RNP specifications include requirements for certain navigation functionalities. At the basic level, these functional requirements may include:

a) continuous indication of aircraft position relative to track to be displayed to the pilot flying on a navigation display situated in his primary field of view;
b) display of distance and bearing to the active (To) waypoint;
c) display of ground speed or time to the active (To) waypoint;
d) navigation data storage function; and
e) appropriate failure indication of the RNAV or RNP system, including the sensors.

More sophisticated navigation specifications include the requirement for navigation databases and the capability to execute database procedures.

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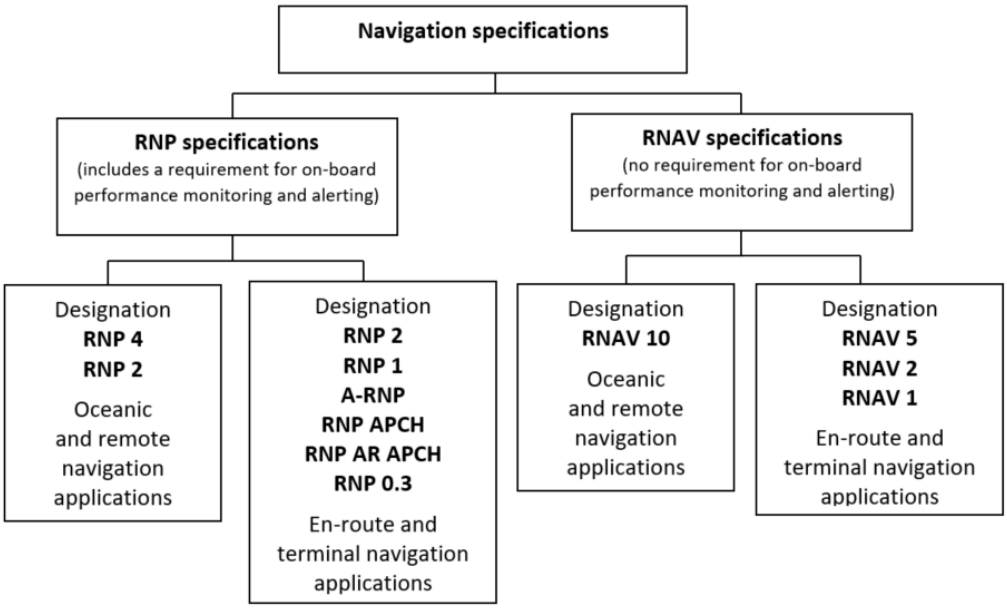
1.2.4 The following schema shows the designations of existing RNAV / RNP specifications:



1.2.5 For oceanic, remote, en-route and terminal operations, RNAV specification is designated as RNAV X, e.g. RNAV 1. RNP specification is designated as RNP X, e.g. RNP 4. If two navigation specifications share the same value for X, they may be distinguished by the use of a prefix. Where a navigation specification covers various phases of flight and permits different lateral navigation accuracy in nautical miles in various flight phases, a prefix is used, without a suffix, e.g. A-RNP. The expression "X" (where stated) refers to the lateral navigation accuracy in nautical miles, which is expected to be achieved at least 95 per cent of the flight time by the population of aircraft operating within the airspace, route or procedure.

1.2.6 Approach navigation specifications cover all segments of the instrument approach. RNP specifications are designated using RNP as a prefix and an abbreviated textual suffix, e.g. RNP APCH or RNP AR APCH. There are no RNAV approach specifications.

1.2.7 Where navigation accuracy is used as part of the designation of a navigation specification, it should be noted that navigation accuracy is only one of the functional and performance requirements included in a navigation specification. Because functional and performance requirements are defined for each navigation specification, an aircraft approved for an RNP specification is not automatically approved for all RNAV specifications. Similarly, an aircraft approved for an RNP or RNAV specification having a stringent accuracy requirement (e.g. RNP 0.3) is not automatically approved for a navigation specification having a less stringent accuracy requirement (e.g. RNP 4). An aircraft approved to the more stringent accuracy requirements may not necessarily meet some of the functional requirements of the navigation specification having a less stringent accuracy requirement.

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2 Operational Approval for a Navigation Specification

2.1 General

2.1.1 Aircraft must be equipped with an RNAV or RNP system able to support the desired navigation application. The RNAV or RNP system and aircraft operations must be compliant with the requirements affiliated with the navigation specification developed for a particular navigation application as specified and approved by the appropriate regulatory authority.

2.1.2 The navigation specification details the flight crew and aircraft requirements needed to support the navigation application. This specification includes the level of navigation performance, functional capabilities, and operational considerations required for the RNAV or RNP system. RNAV and RNP system installation shall be certified in accordance with ICAO Annex 8 – Airworthiness of Aircraft, and operational procedures shall respect the applicable aircraft flight manual limitations, if any.

2.1.3 The RNAV or RNP system shall be operated in accordance with recommended practices described in ICAO Annex 6 – Operation of Aircraft and PANS-OPS (Doc 8168) Volume I. Flight crew and/or operators shall respect the operational limitations required for the navigation application.

2.1.4 Each item of the area navigation equipment installed shall be assessed to ensure it is of the type and design appropriate to its intended function and that the installation functions properly under foreseeable operating conditions. Limitations and information relevant to the approval of RNAV and RNP system installations are documented in the AFM, or AFM Supplement, as applicable, and shall be considered for operational approval.

2.1.5 Operators and flight crew are responsible for checking that the installed RNAV or RNP system is operated in areas where the airspace concept and the NAVAID infrastructure described in the navigation specification are fulfilled. To ease this process, certification and/or operational documentation shall clearly identify compliance with the related navigation specification.

2.1.6 During operation, flight crew should respect any limitations set out in the AFM and AFM supplements. Normal procedures include detailed necessary crew action to be conducted during preflight planning, prior to commencing the procedure and during the procedure. Abnormal procedures include detailed crew action to be conducted in case of on-board RNAV or RNP system failure and in case of system inability to maintain the prescribed performance of the on-board monitoring and alerting functions.

2.1.7 Flight crew procedures are embodied in the company operating manual. These procedures could include that the flight crew notify ATC of contingencies (i.e. 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

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clearance in case of contingencies. At a regional level, operators shall make contingency procedures available to permit the flight crew to follow such procedures in the event that it is not possible to notify ATC of their difficulties.

2.1.8 The minimum equipment list (MEL) shall identify the minimum equipment necessary to satisfy the navigation application.

2.1.9 The operator shall have in place a system for investigating events affecting the safety of operations in order to determine their origin (coded procedure, accuracy problem, etc.).

2.1.10 Each pilot must receive appropriate training, briefings and guidance material in order to safely conduct an operation. What pilots need to know about PBN operations is whether the aircraft and flight crew are qualified to operate in the airspace, on a procedure or along an ATS route. They also require a basic understanding of area navigation concepts, the relationship between RNAV and RNP operations, and how their implementation affects control procedures, separation and phraseology. Understanding of how RNAV and RNP systems work as well as their advantages and limitations are necessary.

2.1.11 Compliance with specific requirements regarding the navigation database may be included in the approval process, particularly if the navigation database integrity is supposed to demonstrate compliance with an established data quality assurance process, as specified in DO 200A/EUROCAE ED 76.

2.2 Overview of the Approval Process

2.2.1 The approval process which results in the issuance of operational approval for a navigation specification designated under PBN consists of the following phases:

(a) Pre-application
(b) Formal application
(c) Technical evaluation
(d) Demonstration/validation of operator maintenance and operations capability
(e) Decision on application – issuance of operational approval

2.2.2 Operator shall set up a pre-application meeting with AACM prior to the submission of a formal application. Operator will provide its detailed planning and work schedule of the proposed operations. AACM will make the operator fully aware of the regulatory requirements which must be met in order to obtain the desired operational approval.

2.2.3 After the pre-application meeting, if the operator intends to proceed with the application process, a formal application shall be submitted to AACM, with all the required supporting documentation, at least 3 months before the proposed start date of PBN operations.

2.2.4 A compliance matrix with respect to the applicable provisions in the ICAO PBN Manual for the requested navigation specification shall be compiled and submitted with the formal application to demonstrate that the requirements are met. Sample compliance matrix can be provided upon request during pre-application meeting.

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2.2.5 Upon receipt of the submitted documentation, AACM will initiate the technical evaluation phase by assessing the application package on both airworthiness and operations aspects to ensure compliance of the requirements set forth in this AC.

2.3 Operational Approval Considerations

2.3.1 Aircraft Eligibility

The aircraft eligibility has to be determined through demonstration of compliance against the relevant airworthiness criteria (e.g. EASA AMC 20-4, 20-26 or FAA AC 90-96A, etc.) by means of appropriate airworthiness certification documents. In some cases, the original equipment manufacturer (OEM) or the holder of the installation approval for the aircraft, e.g. supplemental type certificate (STC) holder, will demonstrate compliance to their national airworthiness authority (NAA) (e.g. EASA, FAA), and the approval might have been documented in the manufacturer's documentation or relevant supplement (e.g. service letters, aircraft flight manual etc).

2.3.2 Description of Aircraft Equipment

The operator shall have a configuration list detailing the pertinent components and equipment to be used for the intended PBN operation.

2.3.3 Maintenance Programme

The operator shall have an established maintenance programme for the individual navigation systems pertinent to intended operations. The operator shall submit necessary changes to its maintenance programme, including a reliability programme (if applicable), for approval at the time of the application.

2.3.4 Minimum Equipment List (MEL)

The operator's minimum equipment list (MEL) shall be amended and adjusted to identify the minimum equipment, and to specify the required dispatch conditions, necessary to satisfy the operations with the navigation specification.

2.3.5 Past Performance

An operating history of the operator shall be included in the application, in which the operator shall address any events or incidents related to navigation errors that have been covered by training, procedures, and maintenance, or the aircraft/navigation system modifications which are to be used.

2.3.6 Operations Manuals and Checklists

Operations manuals and checklists shall address information/guidance on the standard operating procedures, navigation operating instructions and contingency procedures for the intended PBN operations.

The operator's normal operating procedures shall detail necessary crew action to be conducted during preflight planning, prior to commencing the procedure and during the procedure; and the abnormal procedures shall addressed relevant crew action to be conducted in case of on-board RNAV system failure and in case of system inability to maintain the prescribed performance of the on-board monitoring and

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alerting functions. During operation, flight crew member shall respect any limitations set out in the AFM and AFM supplements. Manuals and checklist shall be submitted to AACM for review as part of the application process.

2.3.7 Training and Evaluation Programme

The operator shall have a training programme addressing operational practices, procedures and training items related to the operations for the desired navigation specification (e.g. initial, recurrent training for flight crew members, flight operations officers or maintenance personnel).

The operator shall not designate a person as a flight crew member or flight operations officer (if applicable) to participate in the PBN operations, unless he/she has completed appropriate initial and recurrent PBN operations training curriculum approved by AACM.

The training curriculum for each navigation specification shall ensure that each flight crew member and flight operations officer (if applicable) is qualified in the type of operation in which he/she serves and in any specialized or new equipment, procedures, and techniques, including but not limited to:

(a) Introduction to PBN regulations;
(b) Routes and aerodromes to be used in the PBN operations;
(c) Knowledge of specialized navigation procedures;
(d) Knowledge of specialized equipment;
(e) SIDs and STARs (if applicable);
(f) The ability of airborne equipment to fly the designed flight path, this may involve pilot intervention where the equipment functionality is limited;
(g) Management of changes (procedure, runway, track, etc.);
(h) Turn management (turn indications, airspeed and bank angle, lack of guidance in turns);
(i) Route modification (insertion/deletion of waypoints, direct to waypoint) and restrictions on route modification;
(j) Intercepting route, radar vectors; and
(k) Where GNSS is used, GNSS principles.

The training curriculum shall comprise evaluation(s) to ensure that each pilot and flight operations officer (if applicable) is competent to a defined standard of knowledge and performance.

2.3.8 Navigation Database Management

The navigation database shall be obtained from a supplier holding a Letter of Acceptance (LOA) or other equivalent means issued by the appropriate regulatory authority to demonstrate compliance with EUROCAE/RTCA document ED-76/DO-200A, Standards for Processing Aeronautical Data.

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. The operator shall consider the need to conduct periodic checks of the

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operational navigation databases in order to meet existing quality system requirements.

Where a navigation database is carried and used, it must be current and appropriate for the region of intended operation and must include the navigation aids and waypoints required for the route.

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 shall establish procedures to ensure the accuracy of the navigation data, including the suitability of navigation facilities used to define the routes for the flight.

2.3.9 Navigation Error Control

The operator shall establish a process whereby navigation error reports can be submitted and analyzed for remedial action. Repeated navigation error occurrences attributed to a specific piece of navigation equipment need to be followed up and action taken to remove the causal factor(s).

The nature of the error cause will determine the remedial action which could include the need for remedial training, restrictions in the application of the system, or requirements for software changes in the navigation system.

The nature and severity of the error may result in suspension or withdrawal of the approval for the particular PBN operation until the cause of the problem has been identified and rectified.

2.4 Issuance of Approval

2.4.1 Operational approval will only be issued if the technical evaluations in both the airworthiness and flight operations aspects have rendered satisfactory results.

2.4.2 For commercial operators, operational approval should be granted through the issuance of a variation of the AOC Operations Specifications.

2.4.3 For operator not in possession of an AOC, the operational approvals will take the form of a certificate and will identify the operator, each individual aircraft the approval covers, and any conditions applied on the operational approval.

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Appendix 2

Appendix 2 Introduction to the RNP AR APCH Navigation Specification

1 **RNP AR APCH**

1.1 RNP Authorization Required Approaches (RNP AR APCH) navigation specification represents the ICAO global standard for developing instrument approach procedures to aerodromes where limiting obstacles exist and/or where significant operational efficiencies can be gained. These procedures require additional levels of scrutiny, control and authorization. The increased risks and complexities associated with these procedures are mitigated through more stringent RNP criteria, advanced aircraft capabilities and increased aircrew training.

1.2 A large number of RNP AR approach and departure procedures have been developed by the industry, commonly sponsored by airlines and designed using commercially developed design criteria. These operations have been approved in a number of States following evaluation on a case-by-case basis, normally for a specific aircraft type and individual operator.

1.3 The European Aviation Safety Agency (EASA) has developed equivalent guidance in AMC 20-26 for Airworthiness Approval and Operational Criteria for RNP Authorization Required (RNP AR) Operations. The implication of AR is that improvements in operational safety and efficiency gained by the utilization of the capability of advanced navigation capability are matched by an appropriate level of detailed evaluation of aircraft, operations and procedure design. Only qualified operators are permitted to conduct RNP operations which are identified as Authorization Required.

1.4 Flight Operational Safety Assessment shall be conducted for RNP AR APCH procedures where aircraft specific characteristics, operational environment, obstacle environment, etc., warrant an additional review to ensure operational safety objectives are achieved. The assessment shall give proper attention to the interdependence of the elements of design, aircraft capability, crew procedures and operating environment.

1.5 The characteristics of RNP AR APCH operations that combine to improve the capability of this type of operation includes:

- Supports navigation accuracy with RNP value less than 0.3;
- Obstacle clearance lateral tolerance 2 × RNP value;
- Final approach vertical obstacle clearance provided by a Vertical Error Budget;
- Radius-to-Fix (RF) legs enabling circular flight paths to be flown; and
- Reduced navigation tolerances in missed approach.

1.6 It shall be noted that low RNP value is only one of the characteristics to support RNP AR APCH procedures. Some RNP AR APCH operations do not require RNP less than 0.3. An RNP AR APCH operation with RNP 0.3 shall not be confused with an RNP APCH which uses RNP 0.3 capability.

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1.7 After receiving the RNP AR APCH operational approval, operators desiring to perform RNP AR APCH operations in other States will still require authorizations from the authorities of those States.

1.8 Requirements on the operational approval for RNP AR APCH navigation specification are detailed in ICAO Doc 9613 Volume II, Part C, Chapter 6.

Note: EASA AMC 20-26 is used as the reference acceptance criteria for the RNP AR APCH operational approval, applicant shall ensure that both airworthiness and operations aspects for the proposed operation has been covered in the application.

– END –

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