

JAA Administrative & Guidance Material
Section One: General Part 3: Temporary Guidance Leaflets

**LEAFLET NO 10: AIRWORTHINESS AND OPERATIONAL APPROVAL FOR
PRECISION RNAV OPERATIONS IN DESIGNATED EUROPEAN
AIRSPACE**

This leaflet provides guidance material for the approval of aircraft and operations in the European region where Precision Area Navigation (P-RNAV) is required. It relates to the implementation of area navigation within the context of the European Air Traffic Management Programme (EATMP) and should be read in conjunction with EUROCONTROL document 003-93(), Area Navigation Equipment: Operational Requirements and Functional Requirements.

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PREAMBLE

As a further development of the concept of area navigation within the European region, Precision Area Navigation (P-RNAV) is to be implemented in terminal airspace as an interim step to obtain increased operating capacity together with environmental benefits arising from route flexibility.

In accordance with the EUROCONTROL Navigation Strategy, the carriage of RNAV equipment capable of precision navigation will be optional enabling the initial application of P-RNAV in terminal airspace for suitably equipped aircraft. The P-RNAV application addresses a navigation performance for track keeping accuracy but does not satisfy all aspects of the Required Navigation Performance (RNP) concept promulgated by ICAO in documents 9613 and 9650. P-RNAV is expected to be progressively replaced by RNP-RNAV operations from about 2005.

This leaflet provides guidance material for the airworthiness approval of area navigation systems and their use for P-RNAV operations. The guidance is consistent with EUROCONTROL publications dealing with related operational and functional requirements, and with the design of terminal airspace procedures for DME/DME and GNSS based area navigation.

1 PURPOSE

The guidance material of this leaflet does not constitute a regulation but, when followed in its entirety, does establish an acceptable means that can be used to obtain airworthiness approval of a P-RNAV system, and to obtain the necessary operational approval for its use in designated European airspace. An applicant may elect to use an alternative means of compliance. However, that means of compliance must meet the objectives of this leaflet and be acceptable to the responsible authority. Compliance with this leaflet is not mandatory hence use of the terms *shall* and *must* apply only to an applicant who elects to comply with this leaflet as the means to obtain airworthiness and operational approval.

This leaflet may be amended periodically and will be replaced in due course by appropriate JAR Requirements, Advisory or Interpretative and Explanatory Material.

2 SCOPE

2.1 The guidance material includes airworthiness and operational approval criteria related to P-RNAV systems intended to be used under Instrument Flight Rules, including Instrument Meteorological Conditions, in designated European airspace. It addresses general certification considerations including functional requirements, accuracy, integrity, continuity of function, and system limitations together with operational considerations.

2.2 The guidance material is applicable to P-RNAV operations in terminal airspace and, where implemented by states, to en-route navigation. For the purposes of this leaflet, P-RNAV procedures are expected to apply to operations including departures, arrivals, and approaches up to the point of the Final Approach Waypoint (FAWP). For the immediate future, holding patterns are expected to be flown with conventional procedures. For P-RNAV operations in terminal airspace, obstacle clearance protection, up to the FAWP, will assume that aircraft comply with the P-RNAV accuracy requirements. It should be noted,

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however, that the navigational accuracy required for the final flight phase of the intermediate segment will be influenced by the transition to, and requirements of the subsequent flight phase.

2.3 The final approach, i.e. from the FAWP down to the runway threshold, together with the associated missed approach, will be addressed in a future leaflet. Similarly, a future leaflet will address the application of the concepts of RNP-RNAV.

2.4 The P-RNAV application addresses a navigation performance for track keeping accuracy but does not satisfy all aspects of the Required Navigation Performance concept promulgated by ICAO in documents 9613 and 9650.

2.5 This leaflet discusses operational aspects of vertical navigation but does not give certification criteria for such systems as vertical navigation capability is not mandated for P-RNAV.

2.6 Section 3.2 of this leaflet refers to documents which contribute to the understanding of the P-RNAV concept and which may support an application for approval. However, it is important that an applicant evaluates his aircraft system and proposed operational procedures against the criteria of this leaflet. Unless stated to the contrary in this leaflet, systems and procedures previously approved as compliant with earlier area navigation guidance material will need to be re-evaluated to identify where additional approval effort, if any, is needed.

2.7 Compliance with this leaflet provides a basis for, but by itself does not constitute, an operational approval to conduct P-RNAV operations. Aircraft operators should apply to their national authority for such an approval.

2.8 A glossary of terms and acronyms used in this leaflet is given in Annex A.

3 REFERENCE DOCUMENTS

3.1 Related Requirements

JAR/FAR 25.1301, 25.1307, 25.1309, 25.1316, 25.1321, 25.1322, 25.1329, 25.1431, 25.1335 25.1581.

JAR/FAR 23.1301, 23.1309, 23.1311, 23.1321, 23.1322, 23.1329, 23.1335, 23.1431, 23.1581.

JAR/FAR 27.1301, 27.1309, 27.1321, 27.1322, 27.1329, 27.1335, 27.1581.

JAR/FAR 29.1301, 29.1309, 29.1321, 29.1322, 29.1329, 29.1335, 29.1431, 29.1581.

Appendices A to JAR 27 and JAR 29: Instructions for Continued Airworthiness.

JAR-OPS 1.243, 1.420, 1.845, 1.865, as amended by NPA-OPS-7 and NPA -OPS -15.

JAR-OPS 3.243, 3.845, 3.865 as amended by NPA-OPS-8.

National operating regulations.

3.2 Related Guidance Material

3.2.1 ICAO

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Doc 8168-OPS/611 Aircraft Operations (PANS OPS).

3.2.2 JAA

AMJ 25-11 Electronic Display Systems.

JAA Leaflet No 2 Rev 1 JAA Guidance Material on Airworthiness Approval and Operational Criteria for the use of Navigation Systems in European Airspace Designated for Basic RNAV Operations.

JAA Leaflet No 3 Rev 1 Interim Guidance Material on Airworthiness Approval and Operational Criteria for the use of the Navstar Global Positioning System (GPS).

JAA Leaflet No 9 Recognition of EUROCAE Document ED-76 (RTCA DO-200A): Standards for Processing Aeronautical Data.

3.2.3 EUROCONTROL

NAV.ET1.ST16-001 () Navigation Strategy for ECAC.

NAV.ET1.ST10 () Guidance Material for the Design of Terminal Procedures for DME/DME and GNSS Area Navigation.

Document 003-93 () Area Navigation Equipment: Operational Requirements and Functional Requirements.

3.2.4 FAA

AC 25-11 Electronic Display Systems.

AC 90-45A Approval of Area Navigation Systems for Use in US National Airspace System.

AC 20-130() Airworthiness Approval of Navigation or Flight Management Systems Integrating Multiple Navigation Sensors.

AC 20-138 Airworthiness Approval of NAVSTAR Global Positioning System (GPS) for use as a VFR and IFR Supplemental Navigation System.

AC 25-4 Inertial Navigation Systems (INS).

AC 25-15 Approval of Flight Management Systems in Transport Category Airplanes.

AC 90-94 Guidelines for Using GPS Equipment for IFR En-route & Terminal Operations & for Non Precision Instrument Approaches.

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3.2.5 Technical Standard Orders

JTSO-2C115() / TSO-C115()	Airborne Area Navigation Equipment Using Multi-sensor Inputs.
JTSO-C129a / TSO-C129a	Airborne Supplemental Navigation Equipment Using the Global Positioning System (GPS)
FAA TSO-C145	Airborne Navigation Sensors Using the Global Positioning System (GPS) Augmented by the Wide Area Augmentation System (WAAS).
FAA TSO-C146	Stand-Alone Airborne Navigation Equipment Using the Global Positioning System (GPS) Augmented by the Wide Area Augmentation System (WAAS).

3.2.6 EUROCAE / RTCA and ARINC

ED-75A / DO-236A	Minimum Aviation System Performance Standards: Required Navigation Performance for Area Navigation.
ED-76 / DO-200A	Standards for Processing Aeronautical Data.
ED-77 / DO-201A	Standards for Aeronautical Information.
DO-229B	Minimum Operational Performance Standards for Global Positioning System/Wide Area Augmentation System Airborne equipment.
ARINC 424	Navigation System Data Base.

4 ASSUMPTIONS

Applicants should note that this guidance material is based on the following assumptions concerning the measures taken by the responsible airspace authorities to safeguard P-RNAV operations in the European region:

(a) All terminal P-RNAV procedures:

- (1) are consistent with the relevant parts of ICAO Doc 8168 PANS OPS ;
 - (2) are designed following the guidelines of EUROCONTROL document NAV.ET1.ST10 'Guidance Material for the Design of Procedures for DME/DME and GNSS Area Navigation', as amended, or equivalent material;
 - (3) take account of the functional and performance capabilities of RNAV systems and their safety levels as detailed in this leaflet;
- Note: Particular attention should be given to the constraints implied by the certification objectives of paragraph 6.
- (4) take account of the lack of a mandate for vertical navigation by ensuring that traditional means of vertical navigation can continue to be used; and
 - (5) support integrity checking by the flight crew by including, on the charts, fix data (e.g. range and bearing to navigational aids) from selected waypoints.

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- (b) All routes/procedures are based upon WGS 84 co-ordinates.
- (c) The design of a procedure and the supporting navigation infrastructure (including consideration for the need of redundant aids) have been assessed and validated to the satisfaction of the responsible airspace authority demonstrating aircraft compatibility and adequate performance for the entire procedure. This assessment includes flight checking where appropriate.
- (d) If the procedure allows a choice of navigation infrastructure, e.g. DME/DME, VOR/DME or GNSS, the obstacle clearance assessment has been based upon the infrastructure giving the poorest precision.
- (e) The required navigation aids critical to the operation of a specific procedure, if any, i.e. those which must be available for the required performance, are identified in the AIP and on the relevant charts. Navigation aids that must be excluded from the operation of a specific procedure, if any, are identified in the AIP and on the relevant charts.
Note: This may include required VOR/DME beacons.
- (f) Barometric altitude compensation for temperature effects is accounted for in accordance with current approved operating practices. (Temperature compensation is not addressed as a special P-RNAV consideration in this leaflet).
- (g) The supporting navigation infrastructure, including the GNSS space segment, is monitored and maintained and timely warnings (NOTAM) are issued for non-availability of a P-RNAV procedure, if navigational aids, identified in the AIP as critical for a specific P-RNAV procedure, are not available.
- (h) For procedures which allow aircraft to rely only on GNSS, (see paragraph 5.1), the acceptability of the risk of loss of P-RNAV capability for multiple aircraft due to satellite failure or RAIM holes, has been considered by the responsible airspace authority. Similarly, the risk is considered where a single DME supports multiple P-RNAV procedures.
- (i) The particular hazards of a terminal area and the feasibility of contingency procedures following loss of P-RNAV capability are assessed and, where considered necessary, a requirement for the carriage of dual P-RNAV systems is identified in the AIP for specific terminal P-RNAV procedures, e.g. procedures effective below the applicable minimum obstacle clearance altitude, or where radar performance is inadequate for the purposes of supporting P-RNAV.
Note: Airspace authorities may need to amend their national legal code to establish the power to require that P-RNAV or dual P-RNAV systems be carried in airspace notified for the purposes of these requirements.
- (j) Where reliance is placed on the use of radar to assist contingency procedures, its performance has been shown to be adequate for that purpose, and the requirement for a radar service is identified in the AIP.
- (k) RT phraseology appropriate to P-RNAV operations has been promulgated.
- (l) Navigation aids, including TACAN, not compliant with ICAO Annex 10, are excluded from the AIP.

5 SYSTEM DESCRIPTION

5.1 Lateral Navigation

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5.1.1 For lateral navigation, the RNAV equipment enables the aircraft to be navigated in accordance with appropriate routing instructions along a path defined by waypoints held in an on-board navigation database.

5.1.2 For the purposes of this leaflet, P-RNAV operations are based upon the use of RNAV equipment that automatically determines aircraft position in the horizontal plane using inputs from the following types of positioning sensor (in no specific order of priority):

- (a) Distance Measuring Equipment giving measurements from two or more ground stations (DME/DME).
- (b) Very high frequency Omni-directional Radio range with a co-located DME (VOR/DME) where it is identified as meeting the requirements of the procedure.
- (c) Global Navigation Satellite System (GNSS).
- (d) Inertial Navigation System (INS) or Inertial Reference System (IRS), with automatic updating from suitable radio based navigation equipment.

- Notes:
- (1) LORAN-C is not an acceptable navigation sensor for terminal airspace operations.
 - (2) TACAN beacons may be included in the on-board navigation database and used to supplement DME provided they meet ICAO Annex 10 Standards and are listed in the AIP.
 - (3) The term GNSS refers to the US Department of Defence Global Positioning System (GPS) with barometric altitude augmentation and Receiver Autonomous Integrity Monitoring (RAIM), or to a GPS with Aircraft Based Augmentation System (ABAS), or Space Based Augmentation System (SBAS), e.g. EGNOS. See also JAA TGL 3 rev 1, Appendix A, paragraphs 2.4 and 2.5.
 - (4) Limitations for the use of inertial data, as the means of determining aircraft position during short periods of loss of radio updating, are discussed in further detail in paragraph 8.4.

5.1.3 Navigation parameters, such as distance and bearing to a waypoint, are computed from the aircraft position and the location of the waypoint. Guidance, referenced to the path between two waypoints, is then output to navigation displays and guidance systems to enable the desired path to be followed.

5.2 Vertical Navigation

Although this leaflet does not set criteria for the approval of vertical navigation systems, a brief description is included in Annex D to aid understanding of the overall navigation function and the relationship of VNAV to this guidance material.

6 AIRWORTHINESS CERTIFICATION OBJECTIVES FOR P-RNAV SYSTEMS

The following performance certification criteria are defined for the airborne systems on the basis that the *Assumptions* of Section 4 are valid.

6.1 Accuracy

During operations on routes or in areas notified exclusively for P-RNAV equipped aircraft, the lateral track keeping accuracy of the on-board P-RNAV system shall be equal to or better than +/- 1 NM for 95% of the flight time.

- Notes:
- (1) The track keeping accuracy is dependent on the navigation system error (a combination of path definition error, position estimation error and display error) and Flight Technical Error (FTE). It corresponds to the accuracy component of RNP-1 and RNP-1 RNAV. Further explanation may be found in documents ED-75A / DO-236A.

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- (2) For the purposes of obstacle clearance, a FTE of $\pm 0.5\text{NM}$ is assumed for the departure (except at the departure end of the runway where, in accordance with PANS-OPS Doc 8168, Volume II, Part II, 7.3.2 and 8.1, a value of $\pm 0.1\text{NM}$ is assumed), $\pm 1\text{NM}$ for the initial and intermediate segments, and 2NM for en-route.
- (3) The objective behind this chosen level of performance is to enable RNAV systems based on DME/DME, as currently installed in many aircraft, to be used in terminal airspace on P-RNAV procedures designed according to the published criteria without further evaluation of system accuracy.
- (4) Provided that the assumption of paragraph 4(c) has been shown to be valid in respect of typical DME performance, then, for RNAV systems that have been declared (e.g. in the Aircraft Flight Manual) to be compliant with the 2D navigation accuracy criteria of FAA AC 90-45A, AC 20-130(), FAA TSO-C115(), or JAA JTSO-2C115(), the intent of this paragraph is considered as satisfied and no further accuracy demonstration is required. However, such a Flight Manual statement, by itself, does not constitute an airworthiness approval for P-RNAV and compliance with all other criteria of this leaflet will need to be shown.

6.2 Integrity

With respect to the airborne system, the probability of displaying hazardously misleading navigational or positional information simultaneously to both pilots shall be Remote.

- Notes:
- (1) In the context of P-RNAV operations in the terminal area, *hazardous* should be interpreted as involving misleading information without a timely warning and which, in the absence of other cues, is unlikely to be detected by the flight crew.
 - (2) An airborne safety objective of *Remote* is an alleviation to the current guidelines of paragraph 4.a.(3)(viii) of AMJ 25-11, which specifies *Extremely Remote* for the departure, arrival and approach phases of flight. This alleviation recognises that the PANS-OPS procedure design, and PANS-RAC air traffic separation criteria, account for and accommodate these type of aircraft and their system integrity in current airspace. Furthermore, conservative safety margins are used in the design of P-RNAV procedures such that the risks are not increased above those currently experienced.
 - (3) A safety objective of *Extremely Remote* will continue to be applicable to a precision approach on the final segment i.e. from the FAWP down to the runway.
 - (4) Systems approved for RNP operations have capabilities exceeding that required for P-RNAV operations. These systems provide higher navigation integrity through implementation of containment and by giving the flight crew better awareness of accuracy through the availability of estimated position uncertainty.
 - (5) Probability terms are defined in JAA AMJ 25.1309.

6.3 Continuity of Function

With respect to the airborne systems, it shall be shown that:

- (a) The probability of loss of all navigation information is Remote.
- (b) The probability of non-restorable loss of all navigation and communication functions is Extremely Improbable.

- Notes:
- (1) In addition to the equipment required by JAR-OPS 1, Sub-part L for IFR flight (or equivalent national requirements), at least one area navigation system is required.
 - (2) Probability terms are defined in JAA AMJ 25.1309.

7 FUNCTIONAL CRITERIA

7.1 Required Functions

Table 1 lists and describes the minimum system functions required for P-RNAV operations.

Item	Functional Description
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Item	Functional Description
1	<p>Display elements, e.g. CDI, (E)HSI, each with a lateral deviation display, To/From flag, and failure indicator, for use as primary flight instruments for navigation of the aircraft, for manoeuvre anticipation, and for failure/status/integrity indication, visible to the pilot and located in the primary field of view when looking forward along the flight path. The course selector of the deviation display shall be automatically slaved to the RNAV computed path. The deviation display shall have a full-scale deflection suitable for the phase of flight and based on the required track keeping accuracy. Scaling may be set automatically by default logic or to a value obtained from a navigation database. The full-scale deflection value must be known or made available for display to the flight crew. For P-RNAV operations, a value of ± 1 NM is acceptable. An acceptable alternative is a navigation map display, readily visible to the flight crew, with appropriate map scales and giving equivalent functionality to the lateral deviation display, except that scaling may be set manually by the pilot.</p> <p>Note: JAA JTSO-C129a, for GPS equipment, prescribes scaling values of 5.0 NM for en-route, 1.0 NM for terminal airspace, and 0.3 NM for a non-precision approach.</p>
2	<p>Capability to continuously display to the pilot flying, on the primary flight instruments for navigation of the aircraft, the RNAV computed desired path (DTK) and aircraft position relative to the path.</p>
3	<p>Where the minimum flight crew is two pilots, means for the pilot not flying to verify the desired path and the aircraft position relative to the path.</p>
4	<p>A navigation database, containing current navigation data officially promulgated for civil aviation, which can be updated in accordance with the AIRAC cycle and from which terminal airspace procedures can be retrieved and loaded into the RNAV system.</p> <p>The resolution to which the data is stored must be sufficient to achieve the required track keeping accuracy.</p> <p>The database must be protected against flight crew modification of the stored data.</p> <p>Note: When a procedure is loaded from the database, the RNAV system is required to fly it as published. This does not preclude the flight crew from having the means to modify a procedure or route already loaded into the RNAV system as permitted by Section 10. However, the procedure stored in the database must not be modified and must remain intact within the database for future use and reference.</p>
5	<p>Means to display the validity period of the navigation database to the flight crew.</p>
6	<p>Means to retrieve and display data stored in the navigation database relating to individual waypoints and navigation aids, to enable the flight crew to verify the procedure to be flown.</p>
7	<p>Capacity to load from the database into the RNAV system the whole terminal procedure(s) to be flown.</p>
8	<p>Display of the active navigation sensor type, either in the pilot's primary field of view, or on a readily accessible page on an MCDU together with a means of determining navigation system performance.</p>
9	<p>Display of the identification of the active (To) waypoint, either in the pilot's primary field of view, or on a readily accessible page on an MCDU, readily visible to the flight crew.</p>
10	<p>Display of distance and bearing to the active (To) waypoint in the pilot's primary field of view. Where impracticable, the data may be displayed on a readily accessible page on an MCDU, readily visible to the flight crew.</p>
11	<p>Display of ground speed or time to the active (To) waypoint, either in the pilot's primary field of view, or on a readily accessible page on a MCDU, readily visible to the flight crew.</p>

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Item	Functional Description
12	Where the MCDU is to be used to support the accuracy checks of Section 10, display of lateral deviation with a resolution of 0.1NM.
13	Automatic tuning of VOR and DME navigation aids used for position updating together with the capability to inhibit individual navigation aids from the automatic selection process. Note: Further guidance may be found in ED-75A/DO-236A, Section 3.7.3.1.
14	Capability for the P-RNAV system to perform automatic selection (or de-selection) of navigation sources, a reasonableness check, an integrity check, and a manual override or deselect. Further guidance may be found in ED-75A/DO-236A, Section 3.7.3.1.
15	Capability for the “Direct to” function.
16	Capability for automatic leg sequencing with display of sequencing to the flight crew.
17	Capability to execute database procedures including fly-over and fly-by turns.
18	Capability to execute leg transitions and maintain tracks consistent with the following ARINC 424 path terminators, or their equivalent: Initial Fix (IF), Track between Two Fixes (TF), Course to a Fix (CF) Course from a Fix to an Altitude (FA), Direct to a Fix (DF) Note: Path terminators are defined in ARINC Specification 424, and their application is described in more detail in documents EUROCAE ED-75A/ RTCA DO-236A, ED-77/ DO-201A, and EUROCONTROL document NAV.ET1.ST10.
19	Indication of the RNAV system failure, including the associated sensors, in the pilot’s primary field of view.
20	For multi-sensor systems, automatic reversion to an alternate RNAV sensor if the primary RNAV sensor fails. Note: This does not preclude means for manual navigation source selection.
21	Alternative means of displaying navigation information, sufficient to perform the checking procedures of Section 10.

Table 1: Required Functions

7.2 Recommended Functions

Table 2 lists and describes system functions recommended for P-RNAV operations.

Item	Functional Description
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Item	Functional Description
1	<p>Capability to fly a path parallel to, but offset left or right from, the original active route.</p> <p>The system should provide for entry of an offset distance of at least 20 NM in increments of 1 NM. Operation in offset mode should be clearly indicated to the flight crew. When in offset mode, the system should provide reference parameters (e.g. cross-track deviation, distance-to-go) relative to the offset path and offset reference points. An offset should not be propagated through route discontinuities, unreasonable path geometry, or beyond the initial approach waypoint. Prior to the end of the offset path, indication should be provided to the flight crew, to allow sufficient time to return to the original active route. Once a parallel offset is activated, it should remain active for all route segments of the flight plan until either it is removed automatically, until the flight crew enter a Direct-To routing, or until flight crew (manual) cancellation.</p> <p>Note: The purpose of this function is to enable offsets for tactical operations authorised by ATC (e.g. weather avoidance). It is not intended to be used for strategic offsets which will be promulgated and coded in the navigation database as separate parallel routes.</p>
2	Coupling to the flight director and /or automatic pilot from the RNAV system with unambiguous mode indication. (See also paragraph 8.1.1 (e)).
3	Capability for vertical navigation based upon barometric inputs. (See Annex D).
4	For an RNAV system using DME/DME updating, supported by IRS, means for automatic runway position update at the start of the take-off run including means to enter a distance offset for situations where the published threshold and the actual start of the take of run differ (i.e. take-off shift).
5	Display of the navigation mode in the pilot's primary field of view.
6	<p>Capability to execute leg transitions and maintain tracks consistent with the following ARINC 424 path terminators, or equivalent:</p> <p style="padding-left: 40px;">Holding Pattern to a Manual Termination (HM)</p> <p style="padding-left: 40px;">Holding Pattern to an Altitude (HA)</p> <p style="padding-left: 40px;">Holding Pattern to a Fix (HF)</p> <p style="padding-left: 40px;">Constant Radius to a Fix (RF).</p> <p>Notes: (1) Path terminators are defined in ARINC Specification 424, and their application is described in more detail in documents EUROCAE ED-75A/ RTCA DO-236A, ED-77/ DO-201A, and EUROCONTROL document NAV.ET1.ST10.</p> <p>(2) The RF leg type is unique to RNP-RNAV systems whereas the other types may exist in non-RNP systems.</p>

Table 2: Recommended Functions

8 ACCEPTABLE MEANS OF AIRWORTHINESS COMPLIANCE

8.1 General

Where practicable, to get a concurrent process that ensures the operational evaluation rationale is based on the certification rationale for the particular equipment installation, the airworthiness assessment of this Section should be performed in conjunction with the operational evaluation of Section 10, taking account of the proposed normal and contingency procedures. The following compliance guidelines assume that the aircraft is equipped in accordance with JAR-OPS 1 Sub-part L for IFR flight, or equivalent national requirements.

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8.1.1 New or Modified Installations

In demonstrating compliance with this leaflet, the following specific points should be noted:

- (a) The applicant will need to submit, to the responsible authority, a compliance statement which shows how the criteria of this leaflet have been satisfied. The statement should be based on a plan, agreed by the responsible authority at an early stage of the implementation programme. The plan should identify the certification data to be submitted which should include, as appropriate, a system description together with evidence resulting from the activities defined in the following paragraphs.
- (b) Compliance with the airworthiness requirements for intended function and safety may be demonstrated by equipment qualification, system safety analysis, confirmation of appropriate software design assurance level (i.e. consistent with paragraph 6.2), performance analyses, and a combination of ground and flight tests. To support the approval application, design data will need to be submitted showing that the objectives and criteria of Sections 6 and 7 of this leaflet have been satisfied.
- (c) Use of the RNAV systems and the manner of presentation of lateral and vertical guidance information on the flight deck must be evaluated to show that the risk of flight crew error has been minimised. In particular, during the transition to the final approach, the display of ILS information simultaneously with RNAV information to a flight crew member will need careful consideration.
- (d) Equipment failure scenarios involving conventional navigation sensors and the RNAV system(s) must be evaluated to demonstrate that adequate alternative means of navigation are available following failure of the RNAV system, and that reversionary switching arrangements, e.g. VOR#2 on HSI#1, do not lead to misleading or unsafe display configurations. The evaluation must consider also the probability of failures within the switching arrangements
- (e) The coupling arrangements for the RNAV system to flight director/automatic pilot must be evaluated to show compatibility and that operating modes, including RNAV system failures modes, are clearly and unambiguously indicated to the flight crew.
- (f) To comply with Section 7, Table 1, item 18, and Table 7.2, item 6 (if applicable), the execution of all leg types (in particular when intercepting a CF leg) must be shown to be possible without the need for manual intervention, i.e. without disengaging the RNAV mode, and then a manual course selection. This does not preclude means for manual intervention when needed.

8.1.2 Existing Installations

The applicant will need to submit, to the responsible authority, a compliance statement which shows how the criteria of this leaflet have been satisfied for existing installations. Compliance may be established by inspection of the installed system to confirm the availability of required features and functionality. The performance and integrity criteria of Section 6 may be confirmed by reference to statements in the Aircraft Flight Manual or to other applicable approvals and supporting certification data. In the absence of such

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evidence, supplementary analyses and/or tests may be required. Paragraph 9.3 addresses Aircraft Flight Manual changes that might be necessary.

8.2 Database Integrity

The navigation database updating process shall comply with EUROCAE ED-76 / RTCA DO--200A, or equivalent approved procedures (see paragraph10.6).

8.3 Use of GPS Equipment

8.3.1 The use of GPS to perform P-RNAV operations is limited to equipment approved under FAA TSO-C145 and TSO-146, and JTSO-C129a/ TSO-C129 (), in the equipment classes: A1, B1, C1, B3 and C3, and which support the minimum required system functions specified in Section 7, Table 1 of this leaflet. Receiver Autonomous Integrity Monitoring (RAIM), or an equivalent means of integrity monitoring as part of a multi-sensor navigation system, must be provided.

8.3.2 To complete the compliance statement of paragraph 8.1.1(a) for JTSO-C129a/TSO-C129() equipment, the criteria of JAA Guidance Leaflet No.3, revision 1, paragraph 5.4, needs to be taken into consideration when stand-alone GPS equipment is the only installed means of meeting the P-RNAV criteria.

8.3.3 GPS with the capability for satellite Fault Detection and Exclusion (FDE) is recommended to improve Continuity of Function.

8.4 Use of Inertial Data

In the event of unavailability or loss of radio sensor derived automatic position updating, it is permissible to use, for a short period of time, data from an inertial system as the only means of positioning. For such operations, in the absence of a position integrity indication, the applicant must establish how long the aircraft can maintain the required accuracy using only inertial data. Both take-off and terminal area operations will need to be considered and may need to be addressed in the contingency procedures. The limits may be based on an acceptable drift rate model as agreed by the responsible aircraft operations authority .

8.5 Intermixing of Equipment

Installation of area navigation systems with different crew interfaces can be very confusing and can lead to problems when they have conflicting methods of operation and conflicting display formats. There can be problems even when intermixing different versions of the same equipment. For approach operations, intermixing of RNAV equipment is not permitted. As a minimum, consideration must be given to the following potential incompatibilities particularly where the flight deck architecture includes cross coupling capabilities (e.g. GNSS-2 switched to drive the number 1 displays).

(a) Data entry: The two systems must have consistent methods of data entry, and similar pilot procedures for accomplishing common tasks. Any differences should be evaluated for pilot workload. If the wrong procedures are used, (for example, the data entry procedures for the offside system are used by mistake for the onside), there must be no misleading information and it must be easy to identify and recover from the mistake.

(b) CDI scaling: Sensitivity must be consistent or annunciated.

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- (c) Display symbology and mode annunciation: There must be no conflicting symbols or annunciation (e.g., a common symbol used for two different purposes), and differences should be specifically evaluated to evaluate the potential confusion they may cause.
- (d) Mode logic: The modes internal to the equipment and their interface to the rest of the aircraft must be consistent.
- (e) Equipment failure: The effect of failure of one unit must not result in misleading information.
- (f) Displayed data: The display of primary navigation parameters must use consistent units and a consistent notation. Any inconsistency in the display of the primary information will not be approved.
- (g) Database differences: Due to the inherent data conflict, differences in the area navigation database will not be permitted.

9 AIRCRAFT FLIGHT MANUAL

9.1 For new or modified aircraft, the Aircraft Flight Manual (AFM) or the Pilot's Operating Handbook (POH), whichever is applicable, should provide at least the following information. This limited set assumes that a detailed description of the installed system and related operating instructions and procedures are available in other approved operating or training manuals.

- (a) A statement which identifies the equipment and aircraft build or modification standard certificated for P-RNAV operations or having RNP-1 or better capability.

9.2 In the absence of suitable material in other approved operating or training manuals, appropriate amendments or supplements to cover P-RNAV operations will need to be provided for the following sections of the Flight Manual, or the Pilot's Operating Handbook, whichever is applicable:

- Limitations
- Normal Procedures
- Abnormal Procedures
- Emergency Procedures
- Performance

9.3 For existing aircraft already equipped with an RNAV system but where the Flight Manual or Pilot's Operating Handbook does not define, or is unclear about, the system capability, the aircraft operator may adopt, as an alternative to Change Sheets or Supplements produced by the aircraft constructor, one of the following options, subject to agreement of the responsible authority:

- (a) Submit a compliance statement as discussed in 8.1.2 together with a proposed Supplement, devised by the operator, in accordance with the guidelines of 9.1, and in a format using the template given in Annex E; or
- (b) Submit a compliance statement as discussed in 8.1.2 together with a proposed Operational Specification that includes information equivalent to that normally contained in a Flight Manual.

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9.4 Systems approved for RNP operations have capabilities exceeding that required for P-RNAV operations. These systems provide higher navigation integrity through implementation of containment integrity and by giving the flight crew better awareness of accuracy through the availability of estimated position uncertainty. Therefore, reference in the AFM to specific RNP(s) of the system may then be used in determining compatibility of the RNAV capability with the performance required for specific flight operations.

10 OPERATIONAL CRITERIA

10.1 General

10.1.1 An operational evaluation based on the criteria /rationale of paragraphs 8.1.1(c) to (f), or paragraph 8.1.2, as applicable, will need to be made to confirm the adequacy of the operator's normal and contingency procedures for the particular equipment installation.

10.1.2 The following guidelines may be used by the operator to develop operating procedures that are appropriate to the aircraft installation and to the environment within which the aircraft will be operated. It should be noted that airworthiness approval alone does not authorise flight in airspace, along routes, or for terminal area procedures for which P-RNAV approval is required. Operational approval will be stated in the applicable Air Operator Certificate, or issued in accordance with national procedures, as appropriate.

10.2 Normal Procedures

10.2.1 Pre-flight Planning

10.2.1.1 During the pre-flight planning phase, the availability of the navigation infrastructure, required for the intended operation, including any non-RNAV contingencies, must be confirmed for the period of intended operation. Availability of the onboard navigation equipment necessary for the route to be flown must be confirmed. The onboard navigation database must be appropriate for the region of intended operation and must include the navigation aids, waypoints, and coded terminal airspace procedures for the departure, arrival and alternate airfields.

10.2.1.2 Where the responsible airspace authority has specified in the AIP that dual P-RNAV systems are required for specific terminal P-RNAV procedure, the availability of dual P-RNAV systems must be confirmed. This typically will apply where procedures are effective below the applicable minimum obstacle clearance altitude or where radar coverage is inadequate for the purposes of supporting P-RNAV. This will also take into account the particular hazards of a terminal area and the feasibility of contingency procedures following loss of P-RNAV capability.

10.2.1.3 If a stand-alone GPS is to be used for P-RNAV, the availability of RAIM must be confirmed with account taken of the latest information from the US Coastguard giving details of satellite non-availability.

Note: RAIM prediction may be a function of the equipment provided that satellite non-availability data can be entered. In the absence of such a function, an airspace service provider may offer an approved RAIM availability service to users.

10.2.2 Departure

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10.2.2.1 At system initialisation, the flight crew must confirm that the navigation database is current and verify that the aircraft position has been entered correctly. The active flight plan should be checked by comparing the charts, SID or other applicable documents, with the map display (if applicable) and the MCDU. This includes confirmation of the waypoint sequence, reasonableness of track angles and distances, any altitude or speed constraints, and, where possible, which waypoints are fly-by and which are fly-over. If required by a procedure, a check will need to be made to confirm that updating will use a specific navigation aid(s), or to confirm exclusion of a specific navigation aid. A procedure shall not be used if doubt exists as to the validity of the procedure in the navigation database

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

10.2.2.2 The creation of new waypoints by manual entry into the RNAV system by the flight crew is not permitted as it would invalidate the affected P-RNAV procedure. Route modifications in the terminal area may take the form of radar headings or 'direct to' clearances and the flight crew must be capable of reacting in a timely fashion. This may include the insertion in the flight plan of waypoints loaded from the database.

10.2.2.3 Prior to commencing take off, the flight crew must verify that the RNAV system is available and operating correctly and, where applicable, the correct airport and runway data have been loaded.

10.2.2.4 Unless automatic updating of the actual departure point is provided, the flight crew must ensure initialisation on the runway either by means of a manual runway threshold or intersection update, as applicable. This is to preclude any inappropriate or inadvertent position shift after take-off. Where GNSS is used, the signal must be acquired before the take-off roll commences and GNSS position may be used in place of the runway update.

10.2.2.5 During the procedure and where feasible, flight progress should be monitored for navigational reasonableness, by cross-checks, with conventional navigation aids using the primary displays in conjunction with the MCDU. Where applicable and when used, the flight crew procedures will need to include monitoring to verify automatic updating of the inertial systems to ensure the period without updating does not exceed the permitted limit. (See paragraph 8.4).

10.2.2.6 Where the initialisation of paragraph 10.2.2.4 is not achieved, the departure should be flown by conventional navigation means. A transition to the P-RNAV structure should be made at the point where the aircraft has entered DME/DME coverage and has had sufficient time to achieve an adequate input.

Note: If a procedure is designed to be started conventionally, then the latest point of transition to the P-RNAV structure will be marked on the charts. If a pilot elects to start a P-RNAV procedure using conventional methods, there will not be any indication on the charts of the transition point to the P-RNAV structure.

10.2.3 Arrival

10.2.3.1 Prior to the arrival phase, the flight crew should verify that the correct terminal procedure has been loaded. The active flight plan should be checked by comparing the charts with the map display (if applicable) and the MCDU. This includes

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confirmation of the waypoint sequence, reasonableness of track angles and distances, any altitude or speed constraints, and, where possible, which waypoints are fly-by and which are fly-over. If required by a procedure, a check will need to be made to confirm that updating will exclude a particular navigation aid. A procedure shall not be used if doubt exists as to the validity of the procedure in the navigation database.

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

10.2.3.2 The creation of new waypoints by manual entry into the RNAV system by the flight crew would invalidate the P-RNAV procedure and is not permitted.

10.2.3.3 Where the contingency to revert to a conventional arrival procedure is required, the flight crew must make the necessary preparation.

10.2.3.4 During the procedure and where feasible, flight progress should be monitored for navigational reasonableness by cross-checks with conventional navigation aids using the primary displays in conjunction with the MCDU. In particular, for a VOR/DME RNAV procedure, the reference VOR/DME used for the construction of the procedure must be displayed and checked by the flight crew. For RNAV systems without GNSS updating, a navigation reasonableness check is required during the descent phase before reaching the Initial Approach Waypoint (IAWP). For GNSS based systems, absence of an integrity alarm is considered sufficient. If the check fails, a conventional procedure must then be flown.

Notes: (1) For example, where feasible, display bearing/range to a VOR/DME from the RNAV system and compare the result with the RMI read-out (selected to same VOR/DME).
(2) For some systems the accuracy may be derived from the navigation mode or accuracy mode.
(3) Where the MCDU shows only integers and is unable to display errors with sufficient resolution for P-RNAV accuracy checks, an alternative means of checking will need to be followed.

10.2.3.5 Route modifications in the terminal area may take the form of radar headings or 'direct to' clearances and the flight crew must be capable of reacting in a timely fashion. This may include the insertion of tactical waypoints loaded from the database. Manual entry or modification by the flight crew of the loaded procedure, using temporary waypoints or fixes not provided in the database, is not permitted.

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

Note: Annex D provides further information on vertical navigation.

10.3 Contingency Procedures

10.3.1 Contingency procedures will need to be developed by the operator to address Cautions and Warnings for the following conditions:

- (a) Failure of the RNAV system components including those affecting flight technical error (e.g. failures of the flight director or automatic pilot).
- (b) Multiple system failures.
- (c) Failure of the navigation sensors.
- (d) Coasting on inertial sensors beyond a specified time limit.

10.3.2 The flight crew must notify ATC of any problem with the RNAV system that results in the loss of the required navigation capability, together with the proposed course of action.

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10.3.3 In the event of communications failure, the flight crew should continue with the RNAV procedure in accordance with the published lost communication procedure.

10.3.4 In the event of loss of P-RNAV capability, the flight crew should invoke contingency procedures and navigate using an alternative means of navigation which may include the use of an inertial system. The alternative means need not be an RNAV system.

10.4 Incident Reporting

Significant incidents associated with the operation of the aircraft which affect or could affect the safety of RNAV operations, need to be reported in accordance with JAR-OPS 1.420. Specific examples may include:

- (a) Aircraft system malfunctions during P-RNAV operations which lead to:
 - (i) Navigation errors (e.g. map shifts) not associated with transitions from an inertial navigation mode to radio navigation mode.
 - (ii) Significant navigation errors attributed to incorrect data or a navigation database coding error.
 - (iii) Unexpected deviations in lateral or vertical flight path not caused by pilot input.
 - (iv) Significant misleading information without a failure warning.
 - (v) Total loss or multiple navigation equipment failure.
- (b) Problems with ground navigational facilities leading to significant navigation errors not associated with transitions from an inertial navigation mode to radio navigation mode.

10.5 Flight Crew Training

All flight crews must receive appropriate training, briefings and guidance material in the operation of RNAV-based departure and arrival procedures. This should cover the normal and contingency procedures identified in paragraphs 10.2 (Normal Procedures) and 10.3 (Contingency Procedures). Wherever practicable, standard training events (simulator checks/proficiency checks) should include departures and arrivals using the RNAV-based procedures. The operator must ensure that the Training Manual contains appropriate material to support P-RNAV operations. As a minimum, the items listed in Table 3 should be addressed in the Training Manual.

Subject
Theory of RNAV, including the differences between B-RNAV, P-RNAV and RNP-RNAV.
Limitations of RNAV
Charting, database and avionics issues including: <ul style="list-style-type: none">Waypoint naming concepts.RNAV Path terminator concepts and especially:<ul style="list-style-type: none">Use of the 'CF' path terminator.Use of the 'TF' path terminator.Fly-by and fly-over waypoints.

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Use of the RNAV equipment including, where appropriate: Retrieving a procedure from the database. Verification and sensor management. Tactically modifying the flight plan. Addressing discontinuities. Entering associated data such as: Wind. Altitude/Speed constraints. Vertical Profile/Vertical Speed. Flying the procedure. Use of Lateral Navigation Mode and associated lateral control techniques. Use of Vertical Navigation Mode and associated vertical control techniques. Use of automatic pilot, flight director and auto-throttle at different stages of the procedure.
RT phraseology for RNAV
The implications for RNAV operations of system malfunctions which are not RNAV related (e.g. hydraulic failure or engine failure).

Table 3: RNAV Training Items

10.6 Database Integrity

10.6.1 The navigation database should be obtained from an approved supplier who has complied with EUROCAE/RTCA document ED-76/DO-200A, Standards for Processing Aeronautical Data.

10.6.2 Until such approved suppliers become available, prior to the effective date of the navigation database, as a minimum, the operator must implement navigation database integrity checks using appropriate software tools or approved manual procedures to verify data relating to waypoints below the applicable minimum obstacle clearance altitude. Such checks are in addition to any checks previously performed by the Aeronautical Information Services, unapproved navigation database suppliers, or navigation equipment manufacturers. The integrity checks need to identify any discrepancies between the navigation database and the published charts/procedures. Integrity checks may be performed by an approved third party.

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

10.6.4 Aircraft operators should consider the need to continue their own database checks even for products obtained from approved suppliers.

Note: See JAR-OPS 1.035 Quality Systems

10.6.5 To aid database integrity checking, a suitable tool having functionality as defined in Annex B may be used.

10.7 Flight Operations Documentation

10.7.1 The aircraft Operations Manual (e.g. Aircraft or Flight Crew Operating Manuals (A/FCOM)) and check lists must be revised to take account of the information specified in

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9.1, 9.2 and 9.3, and the operating procedures detailed in paragraphs 10.2 (Normal Procedures) and 10.3 (Contingency Procedures). The operator must make timely amendments to his Operations Manual to reflect relevant P-RNAV procedures and database checking strategies. Manuals and checklists need to be submitted for review by the responsible authority as part of the approval process.

10.7.2 The aircraft operator should propose an amendment to the Minimum Equipment List (MEL) appropriate to P-RNAV operations.

11 AVAILABILITY OF DOCUMENTS

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 www.ecacnav.com.

Copies of EUROCAE documents may be purchased from EUROCAE, 17 rue Hamelin, 75783 PARIS Cedex 16, France, (Fax : 33 1 45 05 72 30). Web site: www.eurocae.org.

Copies of FAA documents may be obtained from Superintendent of Documents, Government Printing Office, Washington, DC 20402-9325, USA.

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](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 (www.jaa.nl) and on the IHS web sites www.global.ihs.com and www.avdataworks.com.

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

ANNEX A GLOSSARY

The following are definitions of key terms used in the context of area navigation. For the purposes of P-RNAV, these definitions have been adapted from those given in corresponding ICAO, EUROCAE and RTCA documents.

Area Navigation (RNAV). A method of navigation which permits aircraft operation on any desired flight path.

Accuracy. The degree of conformance between the estimated, measured, or desired position and/or the velocity of a platform at a given time, and its true position or velocity. Navigation performance accuracy is usually presented as a statistical measure of system error and is specified as predictable, repeatable and relative.

Availability. An indication of the ability of the system to provide usable service within the specified coverage area and is defined as the portion of time during which the system is to be used for navigation during which reliable navigation information is presented to the crew, automatic pilot, or other system managing the flight of the aircraft.

Continuity of Function. The capability of the total system (comprising all elements necessary to maintain aircraft position within the defined airspace) to perform its function without non-scheduled interruptions during the intended operation.

Integrity. The ability of a system to provide timely warnings to users when the system should not be used for navigation.

Receiver Autonomous Integrity Monitoring (RAIM). A technique whereby a GNSS receiver / processor determines the integrity of the GNSS navigation signals using only GNSS signals or GNSS signals augmented with altitude. This determination is achieved by a consistency check among redundant pseudo-range measurements. At least one satellite in addition to those required for navigation must be in view for the receiver to perform the RAIM function (FAA AC 20-138, AC 90-94).

Vertical Navigation. A method of navigation which permits aircraft operation on a vertical flight profile using altimetry sources, external flight path references, or a combination of these.

The following acronyms are used in the document:

ADF	Automatic Direction Finding
AFM	Aircraft Flight Manual
AIP	Aeronautical Information Publication
AIRAC	Aeronautical Information Regulation and Control
AIS	Aeronautical Information Service
ATC	Air Traffic Control
B-RNAV	Basic RNAV
CDI	Course Deviation Indicator
CF	Course to a Fix
CG	Centre of Gravity
CNF	Computer Navigation Fix
DF	Direct to a Fix
DME	Distance Measuring Equipment
DTK	Desired Track
EGNOS	European Geo-stationary Navigation Overlay System
(E)HSI	(Electronic) Horizontal Situation Indicator

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FA	Course from a Fix to an Altitude
FACF	Final Approach Course Fix
FAWP	Final Approach Waypoint
FDE	Fault Detection and Exclusion
FMS	Flight Management System
FTE	Flight Technical Error
GPS	Global Positioning System
GNSS	Global Navigation Satellite System
HA	Holding Pattern to an Altitude
HF	Holding Pattern to a Fix
HM	Holding Pattern to a Manual Termination
ICAO	International Civil Aviation Organisation
IF	Initial Fix
IFR	Instrument Flight Rules
ILS	Instrument Landing System
INS	Inertial Navigation System
IRS	Inertial Reference System
MASPS	Minimum Aviation System Performance Standards
MCDU	Multi-function Control Display Unit
MEL	Minimum Equipment List
MLS	Microwave Landing System
NDB	Non Directional Beacon
NM	Nautical Mile
NOTAM	Notice to Airmen
P-RNAV	Precision RNAV
RAIM	Receiver Autonomous Integrity Monitoring
RF	Radius to a Fix
RMI	Radio Magnetic Indicator
RNAV	Area Navigation
RNP	Required Navigation Performance
RTA	Required Time of Arrival
SID	Standard Instrument Departure
STAR	Standard Arrival Route
TF	Track between Two Fixes
VOR	VHF Omni-directional Range
WGS	World Geodetic System

ANNEX B SPECIFICATION FOR A DATABASE INTEGRITY CHECK TOOL

A database integrity check tool is a software tool which enables an aircraft operator to conduct independent checks on specific data areas in a navigation database to ensure that integrity is maintained. These checks can be delegated to a service organisation. The software tool does not have to be qualified in accordance with EUROCAE ED-12B/ RTCA DO-178B.

The tool should include the following functionality:

- (a) Allow a user to specify the data areas to be checked and the critical data items to be monitored.
- (b) Detect any changes in monitored data items.
- (c) Generate reports listing all identified changes.
- (d) Provide a full data history to support configuration control.
- (e) Maintain non editable log-files of all online actions.
- (f) Provide analyses of database quality and changes in quality levels by tracking of rates of discovered errors.
- (g) Provide a flexible data input interface to enable database integrity checks for a variety of database providers.

**ANNEX C EVOLUTION FROM CONVENTIONAL TERMINAL AIRSPACE
PROCEDURES TO RNP-RNAV**

There are a number of steps envisaged in the transition from today's conventional terminal airspace procedures to future RNP-RNAV procedures:

(a) Conventional Procedure

A conventional procedure design (VOR radials, NDB bearings and DME fixes/arcs, ILS, MLS). Flown with conventional means (VOR, DME, ADF, ILS and MLS).

(b) Conventional Procedure flown by an RNAV system coded to ARINC 424

A conventional procedure design but stored in a navigation database using the full set of ARINC 424 Path Terminators (currently 23 different leg types).

(c) Conventional Procedure meeting RNAV criteria

A conventional procedure designed specifically to meet RNAV criteria using sensors such as VOR/DME, DME/DME and GNSS. This procedure is published as a conventional procedure and may reference VOR radials, NDB bearings and DME fixes. However, it will have associated waypoints to define the RNAV path. This removes the ambiguity/approximations found in conventional procedures of paragraph (b), when flown using RNAV systems and ensures repeatability of the intended path over the ground.

Note: This is the first step towards achieving predictable track-keeping resulting from consistent and correct coding in the navigation databases, published waypoints and the application of fly-by turns. This can be used as a learning period for designers, chart and AIS providers, introducing as it does the concepts of path terminators, procedure validation, database issues, charting and publication issues.

(d) RNAV Procedure (Not RNP)

A procedure designed specifically for RNAV using sensors such as DME/DME, GNSS and VOR/DME. Use is made of waypoints located according to minimum distance requirements as laid down in PANS-OPS. This procedure is identified as an RNAV procedure and the sensor used for the design must be published. The procedure is intended for Precision RNAV or RNP-RNAV certified system.

(e) RNP-RNAV Procedure

A procedure designed according to RNP-RNAV criteria. This procedure is identified as RNP-RNAV and may be used for all applicable sensors, and is protected as such. The procedure is intended for RNP-RNAV certified systems.

The conventional procedure of paragraph (a) was originally designed for hand-flown operations and does not always lend itself to the use of RNAV systems. Navigation database providers have had to interpret the procedure specification using the leg types available in the full ARINC 424 tool kit. This has resulted in the need for additional fixes (Computer Navigation Fixes (CNF)) to be defined in order to construct a best fit to the procedure path. In general, these aspects are transparent to ATC, but can result in path deviations under given conditions of aircraft type, configuration (weight, CG), FMS

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manufacturer, and wind. The RNAV system, whilst commanding path steering, may be restricted by built-in bank angle or performance limits. The consequence of such limits may be a path deviation which may be recovered automatically or may require pilot intervention.

At all times, the conventional procedure, be it coded according to ARINC 424 or not, may be monitored by the flight crew against raw radio aid data, and the integrity of the navigation database is not really an issue. From the aircraft perspective, the safety of flight envelope is maintained, although separation from obstacles or other traffic may be lost. Hence, the major concern with these types of procedures is their compatibility with the RNAV system and how well the procedure can be flown under all conditions for all aircraft types. It would be preferable for conventional procedures to be designed to take into account the limitations and constraints of the RNAV system.

When P-RNAV is subsequently mandated, the underlying conventional procedure may be withdrawn leaving a stand-alone RNAV procedure.

The RNP-RNAV procedures of paragraph (e) are expected to be introduced initially to take advantage of the reduced obstacle clearance requirements associated with RNP<1 instrument procedures and RNP MASPS compliant systems. They are expected to replace all RNAV procedures.

ANNEX D VERTICAL NAVIGATION

(a) Although this leaflet does not set criteria for approval of vertical navigation systems, the following provides a brief description to aid understanding of the overall navigation function and the relationship of VNAV to this the guidance material. The flight crew must clearly understand the application of vertical navigation mode and/or speed management, as appropriate, particularly in the context of a continuous descent profile.

(b) For vertical navigation, the system compares the determined vertical position (barometric altitude) with a desired vertical profile derived from altitude data, a vertical angle, or a vertical flight profile, applicable to that route or procedure and selected from an on-board navigation database. The desired vertical profile to be followed and the difference between it and the determined vertical position are then output to the following types of system to enable the profile to be followed:

- Vertical Profile Deviation Indicator
- Vertical Profile Display.
- Automatic Thrust System.
- Flight Director.
- Automatic pilot.

(c) Some systems may provide the capability to determine optimised climb and descent profiles based on aircraft performance characteristics (including engine performance), aircraft weight, aircraft speed, prevailing meteorological conditions, operator cost constraints, and published altitude and speed constraints associated with a particular arrival/approach/departure procedure.

(d) A VNAV capability is optional for P-RNAV. It should be possible to fly a published descent profile conventionally manually, given adequate flight deck information and with appropriate crew training.

(e) Unless a published VNAV procedure is being flown, the vertical profile between two altitude constraints is always at the pilot's discretion. However, the flight crew should aim, wherever possible, to adhere to the optimum vertical profile. Crews should recognise that there are a number of methods by which adherence to the path can be achieved. Where a VNAV procedure is published, the flight crew are required to fly in accordance with the published constraints.

(f) Use of GNSS is only considered as a sensor for the purposes of lateral navigation and its use for vertical navigation is not addressed by this leaflet.

(g) Further description of VNAV functionality and performance requirements, and their relationship with RNP-RNAV, may be found in EUROCAE/RTCA documents ED-75A/DO-236A.

Annex E Flight Manual Change Sheet Template

(Aircraft Type) Aircraft Flight Manual [*or POH if applicable*]
Document Reference (1234)

(Name Of Organisation)

CHANGE SHEET NO. : (...) ISSUE : (...)

Aircraft Serial No: (...)

Registration Mark: (...)

COMPLIANCE WITH AREA NAVIGATION CRITERIA

Modification Number : *(abc, if applicable)*

ADDITIONAL LIMITATIONS AND INFORMATION FOR CERTIFICATION

The limitations and information contained herein either supplement or, in the case of conflict, override those in the flight manual.

LIMITATIONS

1 Area Navigation System (*xyz system*) has satisfied only the requirements defined in [delete or add as applicable]:

- (a) **P-RNAV** JAA Temporary Guidance Material, Leaflet No. (*this leaflet*): Airworthiness and Operational Approval for Precision RNAV Operations in Designated European Airspace.
- (b) **B-RNAV** JAA Temporary Guidance Material, Leaflet No. No. 2 Rev. 1: JAA Guidance Material On Airworthiness Approval And Operational Criteria For The Use Of Navigation Systems In European Airspace Designated For Basic RNAV Operations.
- (c) **GNSS** JAA Temporary Guidance Material, Leaflet No. 3 Rev. 1: JAA Interim Guidance Material On Airworthiness Approval And Operational Criteria For The Use Of the NAVSTAR Global Positioning System (GPS).
- (d) **OCEANIC/REMOTE** FAA Notice N8110.60: GPS As A Primary Means Of Navigation For Oceanic/Remote Operations.

2 The (*xyz system*) is not approved for [delete as applicable] :

- (a) RNAV instrument approach operations;
- (b) Non Precision instrument approach operations;
- (c) Vertical Navigation;
- (d) Specific Modes (*define as applicable*).

To be inserted in the flight manual facing Section (...), Page (...), and the revisions record sheet amended accordingly.

Page 1 of

Authority Approval

Signature:

Date:

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NOTES ON THE PRODUCTION OF FLIGHT MANUAL CHANGE SHEET

- (a) The supplement/change sheet should be written to fit the size and style of the Flight Manual supplied by the aircraft constructor and to which it refers, preferably without resorting to photo-reduction.
- (b) A company logo can be included if desired.
- (c) Each change sheet must be uniquely identifiable within a referenced Flight Manual.
- (d) A log of change sheets should be provided for inclusion in the front of the manual.
- (e) Aircraft identification (Registration etc.) should be added to the copy which goes in the aircraft copy of the Flight Manual. Where several aircraft on the same Flight Manual document have the same equipment, copies of the same change sheet may be issued to each aircraft.
- (f) In addition to the Limitations specified on the template and In the absence of suitable material in other approved operating or training manuals, appropriate amendments or supplements to cover P-RNAV operations will need to be provided for the following sections of the Flight Manual, or the Pilot's Operating Handbook, whichever is applicable:
 - Normal Procedures
 - Abnormal Procedures
 - Emergency Procedures
 - Performance

JAA Administrative & Guidance Material
Section One: General Part 3: Temporary Guidance Leaflets

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