CIVIL AVIATION PUBLICATION

CAP 13

P-RNAV

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CIVIL AVIATION PUBLICATIONS

CAP 13

P-RNAV

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1. PURPOSE

This CAP provides guidance material for the approval of aircraft and operations in the European region where Precision Area Navigation (P-RNAV) is required. P-RNAV has been implemented in terminal airspace as an interim step to obtain increased operating capacity together with environmental benefits arising from route flexibility. This CAP provides guidance material for the airworthiness approval of area navigation systems and their use for P-RNAV operations. This CAP is based directly on JAA TGL 10.

Note: Refer also to CAP 11 Area Navigation (RNAV) for all RNAV requirements and definitions

This CAP provides 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.

2. SCOPE

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.

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 CAP, P-RNAV procedures 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, 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.

This CAP 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. It is important that an applicant evaluates his aircraft system and proposed operational procedures against the criteria of this CAP. Unless stated to the contrary in this CAP, 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.

3. REFERENCES

(a) ANTR-OPS 1.243, 1.420, 1.845, 1.865;

(b) ANTR-OPS 3.243, 3.845, 3.865;

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

(d) CAP 11 – Area Navigation (RNAV)

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 CAP;

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.

(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 CAP).

(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.

(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

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. For the purposes of this CAP, 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.*

(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.*

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.

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.

(2) For the purposes of obstacle clearance, a FTE of ± 0.5NM 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 ±0.1NM is assumed), ±1NM 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 ETSO-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 CAP 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.

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. 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.

6.3 Continuity of Function

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

(a) The probability of loss of all navigation information is Remote.

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

Note: In addition to the equipment required by ANTR-OPS 1, Subpart L for IFR flight, at least one area navigation system is required.

7. FUNCTIONAL CRITERIA

7.1 Required Functions

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

Table 1 – Required Functions

Item	Functional Description
1	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. 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.
2	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.
3	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.
4	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. The resolution to which the data is stored must be sufficient to achieve the required track keeping accuracy. The database must be protected against flight crew modification of the stored data. Note: When a procedure is loaded from the database, the RNAV system is required to fly it as published. This does not preclude the flight crew from having the means to modify a procedure or route already loaded into the RNAV system 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.
5	Means to display the validity period of the navigation database to the flight crew.
6	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.
7	Capacity to load from the database into the RNAV system the whole terminal procedure(s) to be flown.

Item	Functional Description
8	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.
9	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.
10	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.
11	Display of ground speed or time to the active (To) waypoint, either in the pilot's primary field of view, or on a readily accessible page on a MCDU, readily visible to the flight crew.
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.

7.2 Recommended Functions

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

Table 2 – Recommended Functions

Item	Functional Description
1	Capability to fly a path parallel to, but offset left or right from, the original active route. 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. 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.
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	Capability to execute leg transitions and maintain tracks consistent with the following ARINC 424 path terminators, or equivalent: Holding Pattern to a Manual Termination (HM) Holding Pattern to an Altitude (HA) Holding Pattern to a Fix (HF) Constant Radius to a Fix (RF). 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. (2) The RF leg type is unique to RNP-RNAV systems whereas the other types may exist in non-RNP systems.

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 ANTR-OPS 1 Subpart L for IFR flight.

8.1.1 New or Modified Installations

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

(a) The applicant will need to submit, to the CAA, a compliance statement which shows how the criteria of this CAP have been satisfied. The statement should be based on a plan, agreed by the CAA 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 CAP 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 CAA, a compliance statement which shows how the criteria of this CAP 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.

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 ETSO-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 CAP. 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 CAA.

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.

(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

For new or modified aircraft, the Aircraft Flight Manual (AFM) or the Pilot's Operating Handbook (POH), whichever is applicable, should contain a statement which identifies the equipment and aircraft build or modification standard certificated for P-RNAV operations or having RNP-1 or better capability. 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.

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

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 CAA would not normally accept an application for P-RNAV

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

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.

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.

10.2 Normal Procedures

10.2.1 Pre-flight Planning

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.

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.

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 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

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.

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.

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.

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.

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).

Where the initialisation 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

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 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.

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.

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

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.

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.

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

10.3 Contingency Procedures

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.

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. In the event of communications failure, the flight crew should continue with the RNAV procedure in accordance with the published lost communication procedure. 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 ANTR-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 Appendix 1 should be addressed in the Training Manual.

10.6 Database Integrity

The navigation database should be obtained from a supplier holding an EASA or FAA type 2 Letter Of Acceptance (LOA). This LOA demonstrates 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 a operator's notice to its flight crew, without delay.

10.7 Flight Operations Documentation

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 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 CAA as part of the approval process.

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

11. APPLICATION & APPROVAL PROCESS

11.1 Application

An application for the approval for P-RNAV approval must be made by the operator, using Form ALD/OPS/F062. The appropriate charges must accompany the application, unless specifically exempted.

11.2 Supporting Documents

The documents listed below in respect of each aircraft, should normally accompany the application for grant of approval for P-RNAV.

(a) The copies of Supplemental Type Certificates (STC) for each type of RNAV equipment fitted on each aircraft respectively, that cover the following aspects:

(1) minimum level of integrity and availability; and

(2) functional criteria.

(b) Maintenance programme/approved maintenance schedule for each aircraft. (i.e. transit, periodical inspection and test).

(c) Equipment lists (MMEL and MEL) that identify the minimum equipment necessary for P-RNAV operations in respect of each aircraft.

(d) Part of the Aircraft Flight Manuals (AFMs) for each aircraft, that specifies the following:

(1) the basis for certification together with any P-RNAV system limitations; and

(2) the appropriate RNAV system operating and emergency procedures applicable to the equipment installed:

(i) Normal procedure for operating the equipment;

(ii) Equipment operating limitations; and

(iii) Emergency operating procedures.

(e) Training programmes in respect of the RNAV equipment installed in each aircraft for:

(1) Maintenance personnel; and

(2) Flight crew. All operators must submit training syllabi and other appropriate material to show that the operational practices and procedures and training items related to P-RNAV operations are incorporated in training programmes where applicable (e.g. initial, upgrade, recurrent).

(f) Operations Manual/Procedures applicable to the specific P-RNAV airspace. AOC holders and private operators must revise their operations manual and checklists to include information/guidance on standard operating procedures. Appropriate manuals should include navigation operating instructions and contingency procedures where specified i.e. weather deviation procedures. Manuals and checklists must be submitted for review as part of the application process. Practices and procedures in the following areas must be standardised and include flight planning; pre-flight procedures at the aircraft for each flight; in-flight contingency procedures and flight crew qualification requirements.

11.3 Pre-application Meeting

Each individual operator should schedule a pre-application meeting with the CAA. The intent of this meeting is to discuss airworthiness and operational requirements for approval to operate in European P-RNAV airspace, including:

(a) the contents of the operator's application,

(b) CAA's review and evaluation of the application,

(c) limitations (if any) on the approval, and

(d) conditions under which the operational approval may be cancelled by the CAA.

(e) any other operational or airspace requirements that may be established by European or other authorities for the airspace involved.

11.4 Approval

Approval to conduct PRNAV will be granted by inclusion in the Operations Specifications of the AOC holder. For private category aircraft a Certificate will be issued.

11.5 Cancellation of P-RNAV Approval

Operators are reminded that after a P-RNAV approval is issued, the CAA conducts regular surveillance on all operations using performance based navigation. When appropriate, the CAA may consider any navigation error reports in determining remedial action. Repeated navigation error occurrences, attributed to a specific piece of navigation equipment, may result in cancellation of the approval.

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

APPENDIX 1

P-RNAV TRAINING

TYPE OF OPERATION	TRAINING REQUIRED	TRAINING METHODS	CHECKING and CURRENCY
P-RNAV	Basic RNAV Concept Training; and training in the following topics: • Airspace where P-RNAV is required; • Navigational equipment required to be operational for flight in designated P-RNAV airspace, and the limitations associated with P-RNAV equipment including MEL issues; • Flight Planning requirements; • Charting, database and avionics issues including RNAV path terminator concepts especially: a) Use of the 'CF' path terminator; b) Use of the 'TF' path terminator; • Use of RNAV equipment including: a) Retrieving a procedure from the database, briefing the procedure, comparing it with the charted procedure and action to be taken if discrepancies are noted; b) Using the autopilot, flight director and autothrottle at different stages of the procedure; c) Flight mode annunciations; • Flying the procedure including: a) Use of lateral navigation mode and associated lateral control techniques; b) Use of vertical navigation mode and associated vertical control techniques; • Contingency procedures.	Some or all of: • Operations Manual content; • Handouts (paper or electronic); • CBT; • Classroom; and • Flight Simulator Training including: a) At least three P-RNAV procedures flown by each crew to include departure and arrival; b) Failures such as map shift, sensor failure etc.	Initial operator conversion training as per column 3. For currency Operator Proficiency Check (OPC) to include P-RNAV arrival with abnormality (see overlay procedures).
Note: Credit may be given/taken for previous Basic RNAV Concept Training when adding a qualification for P-RNAV operations.			

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