

Chapter 4 RNAV 1 and 2

1. General

RNAV 1 and 2 navigation specifications constitute harmonization between European Precision RNAV (P-RNAV) and United States RNAV (US-RNAV) criteria.

The RNAV 1 and RNAV 2 navigation specification applies to:

- all ATS routes, including those established in the en-route domain;
- standard instrument departures and arrivals (SID/STAR); and
- instrument approach procedures up to the final approach fix (FAF)/final approach point (FAP).

As RNAV 1 and 2 operations can be based on DME/DME or DME/DME IRU, the navaid infrastructure must be assessed to ensure adequate DME coverage. This is the responsibility of the ANSP and is not part of the operational approval.

There is no difference in the operational approval for RNAV 1 and RNAV 2, and a single RNAV 1 and 2 approval only is issued. An operator with an RNAV 1 and 2 approval is qualified to operate on both RNAV 1 and RNAV 2 routes. RNAV 2 routes may be promulgated in cases where the navaid infrastructure is unable to meet the accuracy requirements for RNAV 1.

2. Operational Approval

For operators holding either a P-RNAV approval or a US-RNAV approval or both the operational approval is relatively simple and minimal regulatory effort is required.

However, as there are some small differences between the existing European and US specifications, migration to RNAV 1 and 2 approval is not automatic unless the operator holds both US and European approvals.

Operators holding *both* P-RNAV and US-RNAV approvals qualify for an ICAO RNAV 1 and 2 operational approval without further examination.

For operators holding only a P-RNAV approval, or a US-RNAV approval, it is necessary to ensure that any additional requirements for RNAV 1 and 2 are met. The PBN Manual provides tables identifying these additional requirements. (Part B, Chapter 3 para 3.3.2.7)

Operators not holding a B-RNAV or US-RNAV approval need to be evaluated to determine that they meet the requirements for RNAV 1 and 2.

It should be noted that there is no obligation on an operator to obtain an RNAV 1 and 2 approval or to migrate an existing approval to ICAO RNAV 1 and 2 if their existing approval is applicable to the area of operation. Operators that operate only in P-RNAV airspace or only in US-RNAV airspace can continue to do so in accordance with a P-RNAV or US-RNAV approval respectively.

3. Summary

For RNAV 1 and 2 operational approval:

- A single RNAV system only is required.
- The RNAV system may be based on:
 - DME/DME
 - DME/DME/IRU
 - GNSS (including GNSS/IRU)
- A navigation database is required.
- Navigation displays in the pilot's forward view must be sufficient to permit track following and manoeuvring.
- The maximum cross-track error deviation permitted is $\frac{1}{2}$ navigation accuracy
 - 0.5NM for RNAV 1
 - 1.0 NM for RNAV 2
- An RNAV system failure indication is required.

4. GNSS

GNSS approved in accordance with ETSO C129 (A), FAA TSO C129 (A) or later meets the requirements of RNAV 1 and 2.

Stand-alone receivers manufactured to ETSO C129 or FAA TSO C129 are also applicable provided they include pseudo-range step detection and health word checking functions.

GNSS based operations require prediction that a service (with integrity) will be available for the route. Most GNSS availability prediction programs are computed for a specific location (normally the destination airport) and are unable to provide predictions over a route or large area. However for RNAV 1 and 2 the probability of a loss of GNSS integrity is remote and the prediction requirement can normally be met by determining that sufficient satellites are available to provide adequate continuity of service.

The PBN Manual makes reference to the possibility of position errors caused by the integration of GNSS data and other positioning data and the potential need for deselection of other navigation sensors. This method of updating is commonly associated with IRS/GNSS systems and the weighting given to radio updating is such that it is unlikely that any potential reduction in positioning accuracy will be significant in proportion to RNAV 1 and 2 navigation accuracy.

5. Functionality

The PBN Manual lists the functional requirements for RNAV 1 and 2.

For the majority of air transport aircraft equipped with FMS, the required functionalities, with the exception of the provision of a non-numeric lateral deviation display are normally available. For this category of aircraft lateral deviation is displayed on a map display, usually with a numeric indication of cross-track error in $1/10^{\text{th}}$ NM. In some cases a numeric indication of cross-track error may be provided outside the primary field of view (e.g. CDU). Acceptable lateral tracking accuracy for both RNAV 1 and RNAV 2 routes is adequate provided the autopilot is engaged or flight director is used.

Aircraft equipped with stand-alone GNSS navigation systems, should be installed to provide track guidance via a CDI or HSI. A lateral deviation display is often incorporated in the unit, but is commonly not of sufficient size nor suitable position to allow either pilot to manoeuvre and adequately monitor cross-track deviation.

Caution should be exercised in regard to the limitations of stand-alone GNSS systems with respect to ARINC 424 path terminators. Path terminators involving an altitude termination are not normally supported due to a lack of integration of the lateral navigation system and the altimetry system. For example, a departure procedure commonly specifies a course after takeoff until reaching an specified altitude (CA path terminator). Using a basic GNSS navigation system it is necessary for the flight crew to manually terminate the leg on reaching the specified altitude and then navigate to the next waypoint, ensuring that the flight path is consistent with the departure procedure. This type of limitation does not preclude operational approval (as stated in the PBN Manual functional requirements) provided the operator's procedures and crew training are adequate to ensure that the intended flight path and other requirements can be met for all SIDs and STAR procedures.

6. Operating procedures

Operators with en-route RNAV experience will generally meet the basic requirements of RNAV 1 and 2 and the operational approval should focus on procedures associated with SIDs and STARs.

Particular attention should be placed on selection of the correct procedure from the database, review of the procedures, connection with the en-route phase of flight and the management of discontinuities. Similarly an evaluation should be made of procedures manage selection of a new procedures, including change of runway, and any crew amendments such as insertion or deletion of waypoints.

As RNAV 1 and 2 operations are typically conducted in areas of adequate navaid coverage, contingency procedures will normally involve reversion to conventional ground-based radio navigation.

7. Pilot Knowledge and Training

During the operational approval, particular attention should be placed on the application of the pilot knowledge and training to the conduct of RNAV 1 and 2 SIDs and STARs. Most crews will already have some experience RNAV operations, and many of the knowledge and training items will have previously been covered in past training.

Execution of SIDs and STARs, connection with the enroute structure and transition to approach procedures require a thorough understanding of the airborne equipment, and its functionality and management.

Particular attention should be placed on:

- The ability of the airborne equipment to fly the designed flight path. This may involve pilot intervention where the equipment functionality is limited
- Management of changes (procedure, runway, track)
- Turn management (turn indications, airspeed & bank angle, lack of guidance in turns)

- Route modification (insertion/deletion of waypoints, direct to waypoint)
- Intercepting route, radar vectors

Where GNSS is used, flight crews must be trained in GNSS principles related to en-route navigation.

Flight training for RNAV 1 and 2 is not normally required, and the required level of competence can normally be achieved by classroom briefing, computer based training , desktop simular training, or a combination of these methods. Computer based simulator programs are available from a number of GPS manufacturers which provide a convenient method for familiarity with programming and operation of stand-alone GNSS systems.

Although not specifically mentioned in the PBN Manual RNAV 1 and 2 navigation specification, where VNAV is used for SIDs and STARs attention should be given to the management of VNAV and specifically the potential for altitude constraints to be compromised in cases where the lateral flight path is changed or intercepted.