Overview of Continental En-route Navigation Specifications

RNAV 5, RNAV 2 and RNAV 1

Learning Objectives

- RNAV applications in a continental en-route context
- Characteristics of available navigation specifications
  - RNAV 5, RNAV 2 and RNAV 1
- Review the RNAV 5 navigation specification
  - ANSP considerations
  - Navigation specification
- Example implementation
  - ECAC Basic-RNAV (B-RNAV)
- Summary

Application of Navigation Specification by Flight Phase

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<tr>
<th>NAVIGATION SPECIFICATION</th>
<th>FLIGHT PHASE</th>
<th>En Route Oceanic / Remote</th>
<th>En Route Continental</th>
<th>Approach</th>
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<th>Intermed</th>
<th>Final</th>
<th>Missed</th>
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The PBN Manual

Volume II, Part B

Chapter 2, Implementing RNAV 5
Chapter 3, Implementing RNAV 1 and RNAV 2

Continental En-route

- Multiple navigation specifications available
- Need to assess available:
  - Communication
  - Surveillance
  - Navigation infrastructure
- Need to identify requirements for:
  - Route spacing and aircraft separation
    - Function of traffic density, operational error, route configuration etc.
  - Navigation performance
  - Aircraft functionalities

RNAV 5

- Characteristics
  - ± 5 NM for 95% of the flight time
  - Typically in a radar surveillance environment
  - Typical route spacing – Low ATC intervention rate
    - 16.5 NM uni-directional
    - 18 NM bi-directional
  - Typical route spacing – High ATC intervention rate
    - 10 -15 NM
  - Predicated on VOR/DME as a minimum
  - Designed for lowest common denominator
RNAV 2

- Characteristics
  - ± 2 NM for 95% of total flight time
  - Radar surveillance
  - Route spacing at least 8 NM
  - Typical routes (FL180 and above)
    - Authorised for GNSS or DME/DME/IRU (where the infrastructure supports such routes)
  - Typical routes (Below FL180)
    - GNSS may be required if DME/DME coverage not sufficient

RNAV 1

- Characteristics
  - ± 1 NM for 95% of total flight time
  - Radar surveillance
  - Route spacing under study
  - Authorised for GNSS or DME/DME or DME/DME/IRU (depending on available infrastructure)

- RNAV 1 implementation in Continental En-route doesn’t exist today

RNAV 2 and RNAV 1

- Also used in terminal airspace applications
  - SIDs, STARS, runway transitions
- Greater functional capability
  - Path terminators
  - Display requirements
  - Navigation database is required
- The navigation specification is the navigation specification, not the application
  - For instance RNAV 1 nav spec can be used for and Enroute navigation application but also for SID/STAR navigation application

RNAV 5

- The Navigation Specification

  - Background
    - ECAC B-RNAV
  - Purpose
    - An RNAV application
    - Not requiring onboard performance monitoring and alerting
    - Other considerations are described in the Nav spec
      - Airspace user information
      - AIPs, ICAO Regional Supplementary Procedures

RNAV 5

- ANSP Considerations
  - Navaid Infrastructure
  - Comm and ATS surveillance
  - Obstacle clearance and route spacing
    - Leg transitions (no requirement for automatic leg sequencing)
  - Publication (AIP, WGS 84)
  - Controller training
  - ATS system monitoring

RNAV 5

- Aircraft Requirements

  - System performance
    - Lateral total system error ±5 NM for 95% of the flight time
    - Integrity (misleading information = Major FC)
    - Continuity (loss of function = Minor FC)
RNAV 5 Aircraft Requirements

- Specific navigation services
  - INS/IRS (with time limitation)
  - VOR/DME
  - DME/DME
  - GNSS

RNAV 5 Aircraft Requirements

- Functional requirements
  - Continuous indication of position relative to track
  - Distance and bearing to the active (To) waypoint
  - Ground speed or time to the active (To) waypoint
  - Only 4 waypoints held in system at a time
  - Failure indication of the RNAV system

RNAV 5 Aircraft Requirements

- What RNAV 5 doesn’t have
  - No navigation database - waypoints can be manually entered
  - No fly-by capability
  - No ‘Direct To’ function

RNAV 5 Operational Considerations

- Flight planning
  - For example, ‘R’ in field 10 for B-RNAV
- ABAS availability
  - RAIM prediction
- General operating procedures
  - Cross-track error monitoring
- Contingency procedures
- Training
- Navigation database
  - No requirement, but if present, database must be current

RNAV 5 Approval Process

- Navigation specification does not in itself constitute regulatory guidance
- Aircraft eligibility (certification process)
  - Does not imply aircraft re-certification
- Operator approved under National operating rules
- B-RNAV approval is good-to-go for RNAV 5
  - EASA AMC 20-4 demonstrate compliance with RNAV 5 nav spec
  - FAA AC 90-96A demonstrate compliance with RNAV 5 nav spec
  - Operating approval (as required by the OPS authority)

Example of State Implementation - RNAV 5

- B-RNAV implemented in ECAC on 23 April 1998
- Europe’s first step of RNAV implementation
- Minimum level FL95
- Contingency predicated on continued carriage of VOR, DME
Example of State Implementation - RNAV 5

- Limitations
  - B-RNAV procedures must be above MSA/MRA (safety case assumption)
  - No more than 4 waypoints per 100 track miles
  - En-route obstacle clearance criteria from PANS-OPS apply
  - Minimum distance between waypoints – 6 NM to 41 NM depending on track angle change, type of turn and max speed

Northern France – Before RNAV 5

Northern France – After RNAV 5

Geneva – Before and After RNAV 5

Swiss Sectorisation – Before and After RNAV 5

B-RNAV Benefits

- Introduced a system of specialised routes
- Pre-organised the flows e.g., segregation of overflying traffic from climbing and descending traffic
- Track alignment – origin to destination
  - Reduce track miles and saving in fuel and on emissions
- Re-sectorisation a consequence
  - In Swiss example resulted in 30% increase in capacity
Lessons Learned from BRNAV implementation

- Only maximise benefits with an airspace re-design
- Can not do RNAV implementation in isolation
  - Consider consequences of En-route change on terminal airspace
  - E.g. connectivity into and out of that airspace
  - Particular issue given terminal airspace was non-RNAV
- Equipage and approvals
  - E.g. getting the fleet ready, managing transition period, managing exemption

Summary

- Learning objectives
  - RNAV applications in a continental en-route context
  - Characteristics of available navigation specifications
    - RNAV 5, RNAV 2 and RNAV 1
- RNAV 5 in detail
  - ANSP considerations
  - Navigation specification
- Example of State implementation - RNAV 5
  - Before and after ECAC B-RNAV
  - Lessons learned