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
• RNAV 5
  – ANSP considerations
  – Navigation specification
• Example implementation
  – ECAC Basic-RNAV (B-RNAV)
• Summary
# Application of Navigation Specification by Flight Phase

<table>
<thead>
<tr>
<th>NAVIGATION SPECIFICATION</th>
<th>En Route Oceanic / Remote</th>
<th>En Route Continental</th>
<th>FLIGHT PHASE</th>
<th>APPROACH</th>
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<tbody>
<tr>
<td></td>
<td>ARR</td>
<td>Initial</td>
<td>Intermed</td>
<td>Final</td>
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<td>RNAV 5</td>
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<td>RNP AR APCH</td>
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<td>1 - 0.1</td>
<td>0.3 - 0.1</td>
<td>1 - 0.1</td>
</tr>
</tbody>
</table>

* Above MSA
The PBN Manual

Volume II, Part B

Chapter 2, Implementing RNAV 5
Chapter 3, Implementing RNAV 1 and RNAV 2
• 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 functionality
**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
RNADV 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 required
RNAV 1

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

• 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

- The navigation specification is the navigation specification, not the application

- See the next presentation
RNAV 5

• **Background**
  - ECAC B-RNAV

• **Purpose**
  - An RNAV application
  - Not requiring onboard performance monitoring and alerting
  - Other considerations
    - AIPs, ICAO Regional Supplementary Procedures
ANSP Considerations

• Navaid Infrastructure
• Comm and ATS surveillance
• Obstacle clearance and route spacing
  – Leg transitions
• Publication
• Controller training
• ATS system monitoring
Navigation Specification – 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)
Navigation Specification – Aircraft Requirements

• Specific navigation services
  – INS/IRS
  – VOR
  – DME
  – GNSS
Navigation Specification – 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
Navigation Specification – Aircraft Requirements

• What RNAV 5 doesn’t have
  – No navigation database - waypoints can be manually entered
  – No fly-by capability
  – No ‘Direct To’ function
Navigation Specification – Operational Considerations

- Flight planning
  - For example, “R” in field 10 for B-RNAV

- ABAS availability

- General operating procedures
  - Cross-track error monitoring

- Contingency procedures

- Training

- Navigation database
Navigation Specification – Approval Process

• Navigation specification does not in itself constitute regulatory guidance
• Aircraft certification
• Operator approved under National operating rules
• Does not require re-certification
• B-RNAV approval is good-to-go for RNAV 5
  – EASA AMC 20-4
  – FAA AC 90-96A
  – Operating approval (as required)
Example of State Implementation - RNAV 5

- B-RNAV implemented in ECAC on 23 April 1998
- Europe’s first step
- Minimum level FL95
- Contingency predicated on continued carriage of VOR, DME and/or ADF
Northern France – After RNAV 5

Eurocontrol - DAS/AFN
Network 30/01/2004
WAYPOINT
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
- Re-sectorisation a consequence
  - In Swiss example resulted in 30% increase in capacity
Lessons Learned

• 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
  – Particular issue given terminal airspace was non-RNAV

• Equipage and approvals
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
Feedback and Questions