


# Overview of Continental En-route Navigation Specifications

## RNAV 5, RNAV 2 and RNAV 1

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## 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

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## Application of Navigation Specification by Flight Phase

NAVIGATION SPECIFICATION	FLIGHT PHASE								
	En Route Oceanic / Remote	En Route Continental	ARR	APPROACH				Missed	DEP
				Initial	Intermed	Final			
RNAV 10 (RNP 10)	10								
RNAV 5		5	5						
RNAV 2		2	2						2
RNAV 1		1	1	1	1			1	1
RNP 4	4								
Basic-RNP 1			1	1	1			1	1
RNP APCH			1	1	1	0.3		1	
RNP AR APCH				1 - 0.1	1 - 0.1	0.3 - 0.1		1 - 0.1	

\* Above MSA

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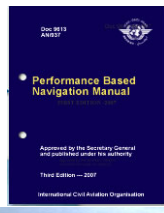
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## The PBN Manual


### Volume II, Part B

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



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## 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

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## 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


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## RNAV 2

- **Characteristics**
  - $\pm 2$  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


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## RNAV 1

- **Characteristics**
  - $\pm 1$  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**


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## 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


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## 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


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## 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**


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## RNAV 5 Aircraft Requirements

- **System performance**
  - Lateral total system error  $\pm 5$  NM for 95% of the flight time
  - Integrity (misleading information = Major FC)
  - Continuity (loss of function = Minor FC)


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 **RNAV 5 Aircraft Requirements**

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


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 **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




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 **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

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 **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

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 **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)

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 **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**

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**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

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**Northern France – Before RNAV 5**

Eurocontrol - DAS/AFN  
Network 30/01/1998  
VOR

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**Northern France – After RNAV 5**

Eurocontrol - DAS/AFN  
Network 30/01/2004  
WAYPOINT

Traffic deconfliction  
Reduce concentration and interaction

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**Geneva – Before and After RNAV 5**

Eurocontrol - DAS/AFN  
Network 30/01/1998  
Network 30/01/2004  
VOR  
WAYPOINT

Before: Bi-directional flow severely limiting capacity  
After: 2 separated flows which are unidirectional

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**Swiss Sectorisation – Before and After RNAV 5**

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**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

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## 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




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## 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




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## Audience Response System Questions



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