




Implementation Processes

Process #1 - Determine Requirements
Process #2 – Identify an ICAO Navigation Specification for Implementation

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1




Overview

Learning Objectives

- How to identify the Navigation requirements for your airspace
- Identification of the opportunities and constraints provided by existing aircraft equipage and ATM environments
- Selecting appropriate RNAV or RNP specifications to apply to best meet your requirements and constraints

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2



Volume 1 Part B, Chapter 2: A Snapshot of Process #1

PROCESS 1
Determine Requirements

Step 1
Formulate
Airspace Concept

Step 2
Assess existing fleet
capability and
available Navaid
Infrastructure


Step 3
Assess
Communications and
Surveillance
Infrastructure & ATM
system

Step 4
Identify necessary
Navigation
Performance and
Functional
Requirements

Step 5
Go to
Process 2

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3



Process #1: Determine Requirements

Step 1
Formulate Airspace Concept

Step 2
Assess Existing Fleet Capability & NAVAID
Infrastructure


Step 3
Assess Existing ATS Surveillance and
Communications Infrastructure & ATM System

Step 4
Identify Necessary Navigation Performance and
Functional Requirements

Step 5
Go to Process #2

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4



Process 1 Overview Determine Requirements

Step 1 Identify Requirements:

- Formulation of the Airspace Concept
 - **What you want to achieve**
- Implications on Navigation Requirements


Step 2 Identify constraints

- Existing fleet equipage
- Navigation Infrastructure
- Potential for enhancement of either

Step 3 Assess Communications/Surveillance/ATM

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5




Process 1

Step 1

Formulate Airspace Concept

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6




Starting Point


Requirements arise from:

- Needs of airspace users
 - Consider (military/civil (air carrier /business/general aviation etc)
- Constraints on Service Providers
- ATM requirements (e.g. airspace planners, ATC)
- Policy directives (e.g. environmental mitigation requirements)
- Balancing of the overall environmental capacity and efficiency requirements of an implementation

CHALLENGE: Requirements often conflict

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7 





Process 1 Step 1 Formulate Airspace Concept

Why is it needed:

- **Identify what is going to be achieved**
 - Route spacing
 - Route structure
 - Terminal Airspace or en-route requirements
- **Sufficient detail to allow required navigation capability to be defined**
 - Nav Functions
 - Nav Infrastructure
 - Comms and Surveillance

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8 




Airspace Concept

This should address:

- Airspace organisation and management (i.e. ATS route placement, SIDs/STARs, ATC sectorisation);
- Separation minima and route spacing;
- Instrument approach procedure options;
- How ATC is to operate the airspace;
- Expected operations by flight crew;
- Airworthiness and operational approvals

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9 



Who Needs to be Involved


Airspace Concept is best developed by multi-disciplinary team

- Air Traffic Controllers,
- Airspace planners (from the ANSP),
- Operators (AOC, pilots avionics specialists etc)
- Flight procedure design specialists,
- Avionics specialists,
- Flight standards and airworthiness regulators,
- Airspace users.

**Important that the team meet face to face,
not just electronically**

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10 



Airspace User Requirements

- Addresses all users (military and civil aviation (both IFR and VFR))
- Overall safety, capacity and efficiency requirements
- Primary and alternate means of meeting requirements should be considered
- Transition implications – cost v benefit
- Implementation timing implications

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11 



Airspace Requirements

Identify:

- Current traffic and expected growth
- Traffic flows and composition
- Transition airspace - integrating operations across airspace boundaries and national borders
- Required ATS Route spacing based on the overall safety, capacity and efficiency requirements
- Surveillance and communications infrastructure
- Navigation infrastructure
- Minimum navigation functions needed to support operational requirement

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Example Functions - Turns

Turn performance

- Fly By
- Fly Over

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What are your Operational Requirements?

Reduce the distance required between laterally separated parallel ATS routes

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Operational Requirements (1)

Need for increase in predictability of path flown

Enable routes where terrain or environmental impact demand increased accuracy

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Operational Requirements (2)

Improved turn performance including containment of large angle changes

Benefits expected:

- Capacity:
 - Place routes where needed
 - Enable reduced route spacing
- Environmental:
 - Design routes more efficiently to meet environmental requirements

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16

Process 1

Step 2

Assess Existing Fleet Capability & NAVAID Infrastructure

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17


Process 1 Step 2

Identify constraints

- Existing fleet equipage
- Potential for enhancement

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18



Existing Navigation Equipage

What aircraft are operating in Airspace:

- Registered in States concerned
- Entering from other Areas/Regions


Nav Equipage:

- Existing
- Natural trends (e.g. replacement aircraft)
- Cost for upgrades

NB: Cost of re-equipage (including certification & Ops approval) can be higher than value of aircraft

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19




Process 1

Step 3

Assess Existing ATS Surveillance and Communications Infrastructure & ATM System

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20




CNS/ATM Infrastructure 1

Nav Aids

- Rate of equipage with GNSS in Area
- Existing ground based network (DME/VOR)
- Renewal needs for existing ground system
- Implication on RNAV reliance if ground infrastructure not replaced
- Role of ground system to back up GNSS
 - Note: Nav System (airborne and infrastructure) failure modes and effects together with available mitigations have significant impact on route spacing

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21




CNS/ATM Infrastructure 2

Communications and Surveillance

- Reliance upon Nav Integrity to be considered (e.g.):
 - Where ATC relies on reported Position (e.g. ADS-B) with no radar
 - Where communications environment has gaps preventing ATC intervention in parts of airspace
- May place additional integrity requirements on Nav
 - could potentially require RNP

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22




CNS/ATM Infrastructure 3

ATM Systems

- What is being enabled by Navigation developments
 - Do existing tools need to be changed
 - Are new tools needed
- Alerts
- Automation
- Flight planning
- Support requirements to enable mixed mode operation

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23



Process 1

Step 4

Identify Necessary Navigation Performance and Functional Requirements

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24

Process 1 Step 4

Identify necessary navigation performance and functional requirements

- **Basic requirements**
 - accuracy, integrity, continuity, availability
- **Specific functional requirements**
 - leg transitions/path terminators, parallel offset capabilities, holding patterns navigation data bases)
- **Complexity of RNAV procedures envisaged**
 - The number of waypoints needed to define procedure
 - The spacing between waypoints
 - The need to define how a turn is executed
 - Operations below Minimum Vectoring Altitude

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25

**Example:
NAV Capability**

- **En-route Continental**
 - Accuracy
 - Offset route capability
 - Turn performance
 - Nav aid requirements
- **En-route Oceanic and Remote**
 - Accuracy
 - Self contained Navigation capability (inertial)
 - GNSS
- **Terminal Airspace**
 - Accuracy
 - TMA leg types
 - Work load implication
 - data base etc
- **Approach**
 - Straight in or curved approach
 - Missed approach requirements
 - Multiple runways

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26

Process 1

Step 5

Go To Process 2

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27

**Volume 1
Part B, Chapter 3:
A Snapshot of
Process #2**

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28

**Process #2:
Identifying ICAO
Navigation Specification(s) for Implementation**

- Step 1**
Review ICAO Navigation Specifications (Vol II)
- Step 2**
Identify the Appropriate ICAO Navigation Specification to Apply in the Specific CNS/ATM Environment
- Step 3 (if Needed)**
Identify Tradeoffs with Airspace Concept and/or Navigation Functional Requirements
- Step 4**
Select ICAO Navigation Specification(s)

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29


Process 2

Step 1

Review ICAO Navigation Specifications (Vol II)

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30




The Next Stage

Process 2,

- Identify the appropriate ICAO Navigation Specification


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Review ICAO Navigation Specifications

- Aim:** Find a match between the requirements identified and those of one or more ICAO Navigation Specifications
- Assessment compares requirements of Specification against:**
 - NAV systems carried by the existing aircraft fleet
 - Available Navaid infrastructure
 - Communications
 - ATS infrastructure
 - ATM system – route structure etc


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Airspace Concept: Navigation Specifications By Flight Phase

NAVIGATION SPECIFICATION	FLIGHT PHASE							
	En Route Oceanic / Remote	En Route Continental	ARR	APPROACH				DEP
				Initial	Intermed	Final	Missed	
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	0.3	1	
RNP AR APCH				1 - 0.1	1 - 0.1	0.3 - 0.1	1 - 0.1	

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Process 2

Step 2

Identify the Appropriate ICAO Navigation Specification to Apply in the Specific CNS/ATM Environment

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Match Found

- Requirements match Specification in PBN Manual
 - Proceed to implementation

IF NOT GO TO NEXT SLIDE

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Needed where "Match Not Found"

Process 2

Step 3

Identify Tradeoffs with Airspace Concept and/or Navigation Functional Requirements

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Match Not Found

Identify Reason:

1 Compatibility with fleet capability:

- Can airspace concept be modified to achieve match?
- Is benefit of maintaining Airspace Concept sufficient to warrant re-equipage costs?
- can implementation be delayed to allow equipage levels to increase?

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37

Match Not Found

Identify Reason:

2 Compatibility with ATM environment

- The original analysis did not correctly identify all functions required for the Airspace Concept
- e.g. functional capability was omitted
- Possible actions
 - Re-assess requirements and identify appropriate ICAO specification
 - Review potential for change in airspace concept

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38

Process 2

Step 4

Select ICAO Navigation Specifications (Vol II)

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39

Way Forward

- For Safety and Economy reasons -
Seek to remain with ICAO Specifications unless this is impossible
- Requiring a change of aircraft equipage is expensive and requires advance notice – typically 7 years

Changing the Airspace Concept is often the only cost-effective way forward

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40

ECAC Example

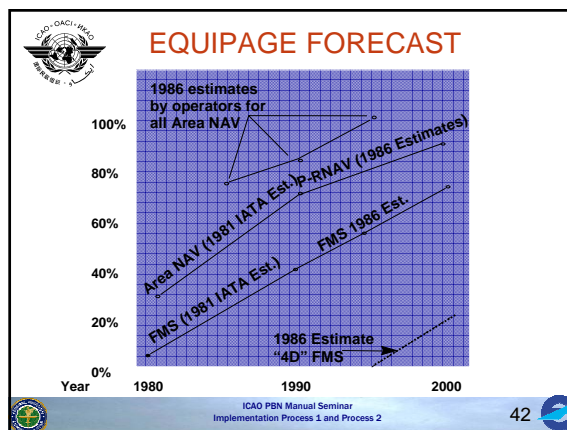
ECAC Strategy for 90s


- RNAV mandate en-route
- RNAV enable in TMA
- Target Date 1998

Identified RNAV 1 (P-RNAV) as required

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41





Implementation

Identified:


- RNAV 1 (P-RNAV) equipage rates much slower than predicted
- Reviewed Airspace Concept –
 - Main capacity benefits could be achieved with RNAV 5 (B-RNAV)

Result

- Mandated RNAV 5
- Enabled RNAV 1 to provide TMA capability

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43




Summary

- **Process 1**
 - Formulate Airspace Concept
 - Assess Existing Fleet Capability & NAVAID Infrastructure
 - Assess Existing Surv. and Comms. Infrastructure & ATM System
 - Identify Navigation Performance and Functional Requirements
- **Process 2**
 - Review ICAO Navigation Specifications
 - Identify the Appropriate ICAO Navigation Specification to apply in the Specific CNS/ATM Environment
 - If none Identify Tradeoffs with Airspace Concept and/or Navigation Functional Requirements
 - Select ICAO Navigation Specification

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Audience Response System Questions

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45