Validation & Implementation Considerations
Module 14 – Activities 11 to 17

European Airspace Concept Workshops for PBN Implementation

Objective

- This module provides an overview airspace and Flight Procedure validation. It addresses Implementation considerations for PBN Airspace Concepts
Why Do Validation?

- Validate Airspace concept and resulting Procedure
- Assess if ATM objectives are achieved
- Confirm flyability of Instrument Flight Procedures
- Identify possible problems and develop mitigations
- Provide evidence design is safe
- Validation is an ongoing process

Caution

RUBBISH IN RUBBISH OUT!!!
Validation methods

- Airspace
- Chalk and talk (pencil and paper)
- Modelling
- FTS
- RTS
- Flight Procedures
- Ground checks
- PC based simulation
- Full Flight simulators
  - FMS simulator (Smiths)
- Live trials

Chalk and Talk

Can work for simple procedures
Airspace Concept Workshop 8

Airspace Concept Validation

- General Considerations
  - Aircraft performance
  - Sterile environment
  - Special events
Airspace Modelling - Advantages

- Great flexibility
- Simple
- ‘What if’ investigations
- Easy to test large number of traffic samples
- Data derived from real traffic and ATC environment

Example
Airspace Modelling - Disadvantages

- Crude
- Only high level data
- Basic aircraft performance
- Does not replicate controller interventions
- Simplified
- No representation of METEO
- Subjective

Fast Time Simulation

- Used for sector capacity
- Quality data
- Flexible
- Good acceptance of results
- Evaluate TLS
- Used for Safety Case
FTS - Disadvantages

- Simplified model
- Only statistical data
- No active controller interaction during FTS
- Accuracy of models is key
- Aircraft performance
- Low representation of METEO conditions
Research Real Time Simulator

- Best method to simulate ATC trials
- High quality data
- Feed controllers/ pseudo pilots
- Human factor
- Can be part of Safety Case
- No risk to live ops
- Unlimited scope

Training Real Time Simulator

- Limited scope
- Designed for training ATC
- Aircraft performance not representative
- HMI
- Not designed for post simulation evaluation needed for Airspace concept evaluation
Example

Example with 36 arrivals per hour on each runway

Flight Simulator

- High quality data
- Confirm design aspects
  - Fly-ability
  - Efficiency
  - Met impact
- Possible link to RTS
Flight Simulator

- But
  - Manual data collection
  - For range of aircraft types/meteo conditions time consuming and expensive
  - Pilots

Live ATC trials

- Most accurate
- Real data
- Feedback from all users

But

- Safety
- High detail required – large effort for a concept evaluation
- Limited scope
- Limited flexibility
Project Checkpoint

Project Checkpoint: Implementation Decision

Are we ‘Good to Go’?

Procedure Validation
Finalisation of Procedure Design

- Design according to Doc 8168
- Procedure ground validation
  - Obstacle
  - Data
  - Infrastructure
  - Fly ability
  - Evaluate
- Flight inspection
- ATC system considerations
- Awareness and Training material

Procedure Validation

- Ground Validation
  - Obstacle clearance
  - Charting
  - Coding
  - Flyability
- Flight Validation
  - Obstacle verification (optional)
  - Flyability (workload, charting, manoeuvring)
  - Infrastructure
- Database Validation
**Instrument Flight Procedure Validation**

- Always undertaken
  - Review of design
  - Impact on flight operations

- Qualitative assessment (ICAO Doc 9906)
  - Obstacle
  - Terrain
  - Navigation data
  - Flyability
  - Charting

**Ground Validation**

- Obstacle clearance
  - Independent review by procedure designer

- Charting
  - Independent review

- Coding
  - Software tool (e.g. Smiths PDT) or
  - Expert review

- Flyability – software tools (from PC-based to full flight simulator)
  - Not necessarily an issue with standard procedures (e.g. ‘T’ approaches), but critical for some aircraft types
  - Range of aircraft and meteo conditions
Ground Validation: Validate the Procedure

- Independent assessment
- Use of validation tools
- Use of aircraft simulators
  - more than one type
- Flight checks
- Initial operational checks

Ground Validation: Validate the Procedure Flyability
Ground Validation: Validate Again with Different Conditions
Ground Validation: Validate Again with Different Conditions

B737-300
ISA +30 °
Wind 300/20

B737-300
ISA -30 °
Wind 250/20

Known Anomalies in RVT v 1.75
Different Aircraft and Conditions

CODING:
CA 500' AGL;
DF LL001;
TF FARKS;
TF WOD;
TF CPT

B737-400
A340-300
A319
B747-400

Wind Effect

CODING:
CA 500' AGL;
DF LL001;
TF FARKS;
TF WOD;
TF CPT

ICAO WV 645
Countered by Speed Restriction
CODING:
CA 500' AGL;
DF LL001;
TF FARKS [210];
TF WOD;
TF CPT

Leg Length Too Short

ICAO WIN 0455
Leg Length – Acceptable

Flight Validation

- **Obstacle verification**
  - Necessary where full obstacle survey cannot be assured

- **Flyability**
  - Detailed workload and charting assessments, but
  - High level qualitative assessment of manoeuvring only (rely mainly on Ground Validation)

- **Infrastructure assessment**
  - Runway markings, lighting, communications, navigation etc
Flight Inspection

- Flight inspection determined by:
  - Infrastructure assessment
  - Identified in Activity 6 and validation process
- Undertaken in accordance with ICAO Doc 8071
  - Checking NAVAIDs in compliance with SARPS

Flight Inspection

- Flight Inspection addresses:
  - Navaid performance for DME/DME RNAV
  - Unintentional interference for GNSS
DME Tasks

- Need to confirm valid DME pairs
  - Expected coverage and field strength
    - If gaps are present, need to know exact area
  - Range accuracy within Annex 10
- Need to identify DME’s that degrade the navigation solution
  - Propagation distortions
    - Either effect can be removed (small local reflector) or
    - Pilot needs to deselect

RNAV DME Flight Inspection Planning

- Infrastructure Assessment preparation to make inspection efficient
- Identify:
  - Candidate DME pairs and associated coverage
    - Including expected gaps in coverage, if any
  - Candidates for exclusion:
    - Propagation path near horizon or significant terrain
    - Second DME on same channel within line of sight
    - ILS/DME facilities (offset bias?)
  - Minimum/maximum height profile for Navaid coverage validation
- PANS-OPS, ATC Operations, Engineering and Flight Inspection Organisation jointly plan inspection flight
Publication and Coordination with Data houses

RNAV Procedure Description

- Procedures are currently published as charts and as textual descriptions.
- The charts are used by the pilots and ATC.
- Database providers require clear, and unambiguous procedure descriptions and use the charts to validate/check.
RNAV Procedure Description

- RNAV procedures defined by:
  - Sequence of waypoints
    - Identifier
    - Co-ordinates
    - Fly-over/fly-by/fixed radius
  - Path Terminators - ARINC 424
  - Altitude restrictions
  - Speed restrictions
  - Direction of turn
  - Required navaid

Procedure Description for Pilots

Waypoint sequence
Fly-over/fly-by/fixed radius
Speed/Altitude Restrictions
Leg distance & magnetic track
Fix information
Turn direction
Procedure Description for Database Providers

- Textual description is usually used to provide formal statement of procedure.
  - Often open to interpretation.
- RNAV procedures require more specific details including path terminators.
  - Can result in lengthy descriptions.
  - Alternative descriptive methods were adopted by OCP (now IFPP):
    - Tabular layout
    - Formalised textual description preferred by data houses
    - Formalised short-hand description

Waypoint Identification

- Significant points
  - identified by co-located navaid or by unique five-letter pronounceable “name-code” (5LNC).
- Some waypoints (Tactical Waypoints) in the terminal area used for vectoring for sequencing and must be easy to enter in an RNAV system.
  - 5LNCs not appropriate for this (ALECS, ALEKS, ALEX).
  - No information on order in procedure for “Go Direct”.
  - Naming confusion
- IFPP introduced concept of strategic and tactical waypoints
RNAV Procedure Identification

- RNAV RWY 23
- RNAV\textsubscript{(DME/DME)} RWY 23
- RNAV\textsubscript{(GNSS)} RWY 23
- RNAV\textsubscript{(RNP)} RWY 23

STATE LETTER – SL24/2013 proposed changes.
Introduced into PANS OPS in Nov 2014:
To be implemented by 1 December 2022

Charting Altitude Restrictions

- An altitude window: FL220
- An “at or above” altitude: 7000
- A “hard” altitude: 3000
- An “at or below” altitude: 5000
FMS/RNAV Limitations

- Airspace Design often wants STARS to a metering fix and STARs to join to initial approach Fix for each runway
- Cannot have two STARs in FMS
- Airway and approach transitions needed
Go/No Go Decision

Pre-Implementation Review

- Are goals met?
- Does design meet needs?
- Safety and performance requirements met?
- Are training requirements established?
- Are changes to ATM system and AIP needed?

ATC System Integration Considerations

- May be required
- Could include:
  - Modifying FDP
  - Changes to RDP
  - Changes to ATC situation display
  - New or modified ATC support tools
  - Alterations on issuance of NOTAMS
Awareness and Training

- Success relies on good understanding
- Must address all involved stakeholders
- Nav Specs provide training requirements for:
  - Flight Crew
  - ATCos
- Must be timely but not rushed
- Use Implementation team as ‘champions’

Implementation

- Team members to support OPS
  - At least 2 days prior
  - During
  - A minimum of one week after
- Monitor process
  - Redundancy or contingency procedures
  - Support controllers and pilots
- Keep LOG system for Post Implementation review
Post Implementation Review

- Keep LOG system Post Implementation review
  - Determine if objectives are met
  - Mitigate any unforeseen events
  - Measure!
  - Collect Evidence for System Safety Assessment
  - Demonstrate Safety of System assured
    - i.a.w. ICAO Safety Management Manual Doc 9859

DO NOT FORGET

- POST IMPLEMENTATION ASSESSMENT
  - Objectives met
  - Safety issues
  - Improvements
  - Quality process
Lessons Learned

- B-RNAV
  - Phased
  - Connectivity
- P-RNAV
  - Chicken and the egg
  - Capable versus approved
- TMA projects

THANK YOU
### Tabular Description

#### RNAV Approach - EGTE

<table>
<thead>
<tr>
<th>Designator</th>
<th>Sequence Number</th>
<th>Waypoint Name</th>
<th>Fly-over</th>
<th>Course Track (°)</th>
<th>Turn Direction</th>
<th>Level Constraint</th>
<th>Speed Constraint</th>
<th>Co-ordinates</th>
<th>Remarks and Distance to MAPI</th>
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</thead>
<tbody>
<tr>
<td>R28R</td>
<td>001</td>
<td>IF LETSI</td>
<td>N</td>
<td>-</td>
<td>-</td>
<td>2800</td>
<td>185</td>
<td>505138.81N 0005070.56W</td>
<td>IAF BHD R030 D31.2</td>
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<tr>
<td>R28R</td>
<td>002</td>
<td>TF TE261</td>
<td>N</td>
<td>183° (185.3°)</td>
<td>RIGHT</td>
<td>2000</td>
<td>185</td>
<td>533450.72T 0002707.35W</td>
<td>IF / 10.5NM</td>
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<td>R28R</td>
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<td>TF TE241</td>
<td>N</td>
<td>258° (258.3°)</td>
<td>-</td>
<td>2200</td>
<td>185</td>
<td>604429.77N 0003150.45W</td>
<td>FAP / 5.5NM</td>
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<td>Y</td>
<td>258° (258.3°)</td>
<td>-</td>
<td>-</td>
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<td>R28R</td>
<td>005</td>
<td>TF TEMO1</td>
<td>Y</td>
<td>258° (226.1°)</td>
<td>-</td>
<td>-</td>
<td>185</td>
<td>633212.16N 0003350.16W</td>
<td>AT TEMO1 revert to conventional navigation</td>
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#### RNAV SID – EGSS RNP1 with RF Final Trail

<table>
<thead>
<tr>
<th>Designator</th>
<th>Sequence Number</th>
<th>Waypoint Name</th>
<th>A/FAC Code</th>
<th>Magnetic Variation</th>
<th>Distance (NM)</th>
<th>Turn Direction</th>
<th>Level Constraint</th>
<th>Speed Constraint</th>
<th>Magnetic Performance</th>
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<tbody>
<tr>
<td>GUN</td>
<td>001</td>
<td>T F</td>
<td>N</td>
<td>220°</td>
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<td>0.9</td>
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<td>15NM</td>
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<tr>
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<td>S</td>
<td>231°</td>
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<td>210</td>
<td>15NM</td>
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<tr>
<td>GUN</td>
<td>003</td>
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<td>S</td>
<td>231°</td>
<td>0.0</td>
<td>0.6</td>
<td>210</td>
<td>15NM</td>
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<tr>
<td>GUN</td>
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<tr>
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<tr>
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<td>T G</td>
<td>N</td>
<td>220°</td>
<td>0.0</td>
<td>10.0</td>
<td>4500</td>
<td>25NM</td>
<td>9.2</td>
</tr>
</tbody>
</table>

### Formalised Description

#### RNAV SID

<table>
<thead>
<tr>
<th>ARINC Designator</th>
<th>Formal Description</th>
<th>Abbreviated Description</th>
<th>Expected Path Terminator</th>
<th>Fly Over Request</th>
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<tbody>
<tr>
<td>[SPY/417]</td>
<td>To ETH05 on course 220° WARC</td>
<td>ETH25 (W119)</td>
<td>ETH25 (W119)</td>
<td>CF (SPL)</td>
</tr>
<tr>
<td></td>
<td>To ETH05 on course 220° WARC</td>
<td>ETH25 (W119)</td>
<td>ETH25 (W119)</td>
<td>CF (SPL)</td>
</tr>
<tr>
<td></td>
<td>To ETH05 on course 220° WARC</td>
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</tr>
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For additional requirements see AD 2.22 §1.1.4 and §1.5.2, specific remark B.

**NOT TO SCALE**
Strategic Waypoint

- A waypoint in the terminal area which is:
  - Of such significance to the ATS provider that it must be easily remembered and stand out on any display, or
  - Used as an ‘activation point’ to generate a message between computer systems when an aircraft passes it.
- Strategic waypoints are identified with 5LNCs unless they are co-located with a navaid, when the 3 letter navaid ID is used.

Tactical Waypoint

- Tactical: a waypoint which is defined solely for use in the specific terminal area and has not been designated a strategic waypoint.
- Identified as AAXNN, where:
  - AA - the last two characters of the aerodrome location indicator;
  - X - a numeric code from 0 to 9 (N, E, W and S may be used instead if a State has a requirement for quadrantal information)
  - NN - a numeric code from 00 to 99.