Manual on Monitoring the Application of Performance-based Horizontal Separation Minima

(PBHSM Manual)

Presented to: 2nd NAT PBCS Workshop
By: Christine Falk
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Overview

• Why a PBHSM manual?
• Background
• Purpose and scope
• Duties and responsibilities associated with the functions described in the manual
• Pre- and post-implementation activities
• Next Steps
Why a PBHSM Manual?

- ICAO noted that performance-based horizontal separation minima (PBHSM) reductions in procedurally controlled airspace have been introduced or are planned for implementation in some States and Regions
  - Examples
PBHSM Examples

### Asia Pacific Region
- 50NM horizontal South China Sea and Bay of Bengal
- 30NM lateral/30NM longitudinal in most Pacific FIRs

### North Atlantic Region
- RLongSM, RLatSM Phase I planned Nov 2015 in NAT OTS
- 30NM lateral/30NM longitudinal in New York FIR
Background

• **RVSM is performance-based**
  – Altimetry system error (ASE)

• **Regional Monitoring Agency Manual (ICAO Doc 9937) published in 2011**
  – Provides guidance for procedures and practices that support the ongoing use of the RVSM

• **No comparable ICAO-provided guidance for monitoring the application of PBHSM exists**
Background

• ICAO Separation and Airspace Safety Panel (SASP)
  – RMA Manual (Doc 9937)
  – Developed an analogous manual to assist States and Regions to standardize monitoring activities in support of the implementation and continued safe use of the PBHSM
Purpose of the PBHSM Manual

• To assist groups of States or Regions in describing the functionality needed to monitor the safe application of performance-based horizontal separation minima in procedurally controlled airspace
Scope

• Applies to groups or States or Regions applying performance-based horizontal separation minima in an en-route environment where procedural separation minima are being applied

• Excludes:
  – Terminal area operations or en-route environments where ATS surveillance services are provided
Objective of the Manual

• Describes functions necessary to monitor the application of PBHSM
  – Enable measurement of any practical drift from the system safety baseline
  – Relies heavily on safety data provided by States
    • Traffic sample data
    • Data resulting from a mature safety management system
  – Assist the safety oversight group:
    • Monitors the safety of PBHSM deployed in the region
    • Taking action when the observed operational performance has deviated significantly from the system design baseline
Duties and Responsibilities

• Establish and maintain a database of operational approvals specific to the applied horizontal separation minima
  – For example: PBN, RCP, RSP

• Check approval status of aircraft
  – identify non-approved operations in the airspace (who have incorrectly identify themselves as approved), and notify the appropriate State Authority
Duties and Responsibilities

• Receive reports of large horizontal deviations
  – Large lateral deviations (LLDs) and large longitudinal deviations (LLEs)

• Communicate with relevant State authorities and operators to determine the likely cause of the deviation

• Conduct analyses to detect trends in horizontal deviations
Example – Locations of Reported Events
Duties and Responsibilities

• Establish and maintain database of operational performance
  – lateral navigation, communication, and/or surveillance

• Database structure provides observed performance by:
  – Entire airspace population
  – Aircraft types
  – Individual operators
  – Individual airframes
### Example – Operator Communication and Surveillance Performance

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Duties and Responsibilities

- Determine the appropriate method to monitor reduced longitudinal separation
  - Aircraft speed variation
    - Adherence to assigned Mach number
    - Speed variation between aircraft pairs separated close to the minimum
  - Requires aircraft position report data
Examples of Monitoring Speed Variation

Figure 4 from SASP/WG/WHL/23-WP/13

Figure 3 from SASP/WG/WHL/25-WP/32
Duties and Responsibilities

• **Conduct periodic risk assessments**
  – Reflecting performance monitoring results
  – Proactively identify aberrant changes in operational performance from agreed safety goals

• **Coordinate with oversight groups**
Duties and Responsibilities

• Monitor the level of risk resulting from reported deviations
  – Determine, when possible, the root cause of each reported deviation together with its size and duration
  – Calculate the frequency of occurrence
  – Assess the overall risk in the system against the overall safety objectives
  – Assist in identifying the need for remedial action
Example – Risk Estimation

![Graph showing lateral and longitudinal collision risk estimates for PARMO - Oakland and Anchorage Airspace*]
Duties and Responsibilities

- Submit reports as required to the PIRG/RASG through the region’s safety oversight group
**Pre- and Post-Implementation**

- PBHSM Manual provides descriptions of activities for both pre- and post-implementation
  - Difference between pre- and post-implementation is the frequency of the analysis
  - Pre-implementation activities are expected to be performed frequently
  - Post-implementation activities are expected on a periodic basis (e.g. annual)
States/ANSPs:
- Provide radar or ADS based measurements of aircraft position
- Set up a program to monitor communication, navigation, and/or surveillance performance.
- 1) Submit horizontal errors report at the end of every month including nil report.
   2) Submit TSD at the end of the year.

Designated monitoring organization:
1) Conduct airspace analysis.
2) Conduct a safety assessment on the airspace.
3) Submit report to the oversight group.

Pre-implementation:
- Meets TLS?
  - Yes: Safety Assessment supports the implementation or continued safe use of the PBHSM
  - No: Continue to review the monitoring results to uncover systemic problems and report findings

Post-implementation:
- Meets TLS?
  - Yes: Meets TLS?
    - Yes: Safety Assessment supports the implementation or continued safe use of the PBHSM
    - No: Suggest remedial actions (e.g. set up a scrutiny group)
  - No: Continue to review the monitoring results to uncover systemic problems and report findings
Pre-Implementation

- Responsibilities and Practices
  - Review operational concept to identify any features of airspace use which may influence risk
  - Conduct pre-implementation safety assessment
    - Review related ICAO material for PBHSM
      - Annex 11 – Air Traffic Services
      - Doc 4444
    - Compare assumptions, enablers, and system performance requirements contained in these documents with regional operational environment, infrastructure and capability
Pre- and Post-Implementation

• Establish a database of operators and aircraft types/systems approved for PBCS operations by the appropriate authority
# Approval Database

- Example of some of the database content:

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<th>Field</th>
<th>Description</th>
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<td>Aircraft’s current registration mark</td>
</tr>
<tr>
<td>Manufacturer Serial Number</td>
<td>Aircraft Serial Number as given by manufacturer</td>
</tr>
<tr>
<td>Aircraft Type</td>
<td>Aircraft Type as defined by ICAO document 8643</td>
</tr>
<tr>
<td>State of Registry</td>
<td>State to which the aircraft is currently registered</td>
</tr>
<tr>
<td>Operator Identifier</td>
<td>ICAO code for the current Operator</td>
</tr>
<tr>
<td>Operator Name</td>
<td>Name of the current Operator</td>
</tr>
<tr>
<td>State of Operator</td>
<td>State of the current Operator</td>
</tr>
<tr>
<td>PBC, PBN and/or PBS approval type</td>
<td>Approval types - e.g. RCP240, RNP4, RSP180, etc</td>
</tr>
<tr>
<td>Date PBC, PBN, and/or PBS approved</td>
<td>Date of PBC, PBN, and/or PBS Approval</td>
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<td>Date of PBC, PBN, and/or PBS expiry</td>
<td>Date of Expiry for PBC, PBN, and/or PBS Approval</td>
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Pre- and Post-Implementation

• **Coordination with States and Other Regions**
  
  – Monitoring organizations should publish a list of FIRs and/or ICAO contracting States for which they provide monitoring services
  
  • This is currently the practice amongst regional monitoring agencies (RMAs)
  
  • Example: http://natcma.com/
RVSM Approvals Database

One of the functions of a Regional Monitoring Agency (RMA) is to establish a database of aircraft approved by its State Airworthiness Authorities for operations in RVSM airspace in the region for which the RMA has responsibility. This information is necessary for two reasons:

1. The RMA is responsible for verifying the approval status of all aircraft operating within its region; and
2. Height-keeping performance data must be correlated to an approved airframe.

In order for RMA’s to achieve this State Authorities who issue RVSM Approvals are required to notify their RMA of the Approval or Withdrawal of Approval of an aircraft.

The North Atlantic Central Monitoring Agency (NATCMA) has established and maintains an RVSM Approvals database for the following State Authorities for which it is the designated RMA:

- Bermuda
- Iceland
- Ireland
- Norway
- Portugal
Pre- and Post-Implementation

- Designated monitoring organizations coordinate with the appropriate State authorities to maintain the required approval information
  - The PBHSM Manual provides forms that can be used for communication with State authorities
Pre- and Post-Implementation

• Monitoring of Operator Compliance with State Approval Requirements
  – Flow chart
  – Responsibility for action (if needed) lies with the State authority, not the designated monitoring organization
  – Monitoring organization’s responsibility is to notify the State authority of the discrepancy, and provide advice or information as requested
Other monitoring organizations

States/ANSPs

State of the Operator or State of Registry, as appropriate

Submit New PBC/PBN/PBS approvals or withdrawal without delay

At the end of the year, submit a:
1) Consolidated list of State PBC/PBN/PBS approvals.
2) A list of TSD of aircraft conducting operations in the airspace of interest.

Designated monitoring organization

Compare PBC/PBN/PBS approvals database with FPL from operators/aircraft pairs conducting operations in the airspace of interest

PBC/PBN/PBS approvals confirmed in database?

Yes

No

No action

No

Contact the relevant State authorities for clarification of the discrepancy

Update the Performance-based Operations Database accordingly
Pre- and Post-Implementation

• Monitoring of Communication, Navigation, and Surveillance Performance
  – Core navigational performance
  – Reports of Large Lateral Deviations (LLDs) and Large Longitudinal Errors (LLEs)
    • Submitted by ANSPs/Operators, reviewed by NAT SG
  – Longitudinal separation – speed variation
Pre- and Post-Implementation

• Monitoring of Communication, Navigation, and Surveillance Performance (continued)
  – Communication and surveillance performance monitoring
    • Performance criteria provided in Doc 9869
    • Assumptions to verify in the collision risk model:
      – Overdue ADS-C reports
      – Uplink messages with no response or an UNABLE response
      – Communication service provider outages and the effect on operations in the airspace
Pre- and Post-Implementation

• **Doc 4444 - Communication & Surveillance Assumptions**
  – Paragraph 5.4.2.6.4, Longitudinal Distance-Based Separation Minima in an RNP RNAV Environment Using ADS-C
    • Further on in paragraph 5.4.2.6.4.3.2 – allows for 4 minutes for controller to intervene using normal means of communication (CPDLC). A total time of 10 ½ minutes are assumed should the normal means of communication fail (HF).
    • Next paragraph, 5.4.2.6.4.3.3 – A total time of 13 ½ minutes are assumed when an ADS-C report is lost
Pre- and Post-Implementation

• Conducting Safety Assessments and Reporting Results
  – Traffic sample data (TSD)
    • ANSPs are required to provide these data
    • Typical data fields in a TSD include:
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<tr>
<td>Aircraft registration mark</td>
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<tr>
<td>PBC, PBN, and PBS approval type</td>
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<tr>
<td>Aircraft type</td>
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<td>Origin and destination aerodrome</td>
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<td>time, FL, assigned speed)</td>
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<td>Exit position information (fix or latitude/longitude,</td>
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<tr>
<td>time, FL, assigned speed)</td>
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<tr>
<td>Position information at prescribed locations within</td>
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<td>airspace (e.g. 60W, 50W, 40W, 30W, 20W, 15W)</td>
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Pre- and Post-Implementation

• Conducting Safety Assessments and Reporting Results
  – Know your airspace analysis (example provided in Appendix E of PBHSM Manual)
  – Estimate collision risk associated with the horizontal separation standard
  – Compare assumptions and system performance requirements with observed performance
  – Example safety assessments provided in the PBHSM manual (Appendices G and H)
Pre- and Post-Implementation

- Determine whether safety assessment satisfies the target level of safety (TLS)
- Examine contributors to risk
  - Technical risk
    - Example - aircraft equipment failures resulting in deviation from the cleared flight path
  - Operational risk
    - Example - crew misunderstanding an ATC clearance, resulting in the aircraft operating on a flight path other than cleared
Pre- and Post-Implementation

• Remedial Actions
  – Measures taken to remove causes of systemic problems associated with factors affecting the safe use of the performance-based horizontal separation minima, examples:
    • Failure of an aircraft to comply with performance based operation requirements
    • Aircraft operating practices resulting in LLDs and LLEs
    • Operational error trend detected
  – Scrutiny group (NAT SG)
Next Steps

• SASP has completed initial development of the manual
• Currently being distributed for Regional review
• Planned publication date for version 1.0 is November 2016