International Civil Aviation Organization

Ninth Meeting of the Performance Based Navigation Sub-Group (PBN SG/9)

(Doha, Qatar, 9 - 11 December 2024)

Agenda Item 6: PBN Planning and Implementation in the MID Region

ENHANCING PBN INSTRUMENT FLIGHT PROCEDURES IN AQABA

(Presented by Jordan)

SUMMARY

This working paper highlights the challenges faced by Aqaba Airport due to its complex terrain and vulnerability to GNSS interference. It proposes integrating DME/DME navigation as a backup for RNP 1 procedures to enhance resilience. Additionally, it explores the feasibility of expanding DME coverage to support RNAV 1 and RNAV 5 navigation across the country. The paper outlines the project's achievements, identifies current challenges, and emphasizes the need for collaborative efforts to ensure robust and reliable navigation solutions.

Action by the meeting is at paragraph 3.

REFERENCES

- PANS OPS Doc 8168, Vol. II, 7th Ed.
- PBN Manual, Doc 9613, 5th Ed.

1. INTRODUCTION

1.1 Aqaba's airspace presents unique navigation challenges, including mountainous terrain with elevations up to 6000 feet MSL. Currently, RNP 1-based STARs (Standard Terminal Arrival Routes) and RNP APCH (Approach) procedures rely heavily on GNSS. However, this region is vulnerable to GNSS jamming and spoofing, which can compromise flight safety and reliability.

1.2 To strengthen navigation resilience, a comprehensive feasibility study is essential to evaluate the integration of DME/DME navigation support as a backup to ensure RNP 1 accuracy in scenarios where GNSS signals are compromised. This initiative aims to safeguard operational continuity and enhance reliability in challenging environments.

1.3 Furthermore, the study will assess the potential for expanding DME coverage nationwide, enabling broader support for RNAV 5 operations. This expansion would facilitate more consistent and robust Performance-Based Navigation (PBN) performance, supporting seamless and efficient airspace management while reducing dependency on GNSS.

2. DISCUSSION

2.1 Advances in navigation technology and performance have enabled changes in airspace design, separation minima, route spacing, airport access, instrument procedure design, and air traffic management. These advancements are integral to the ongoing modernization of Jordan's airspace system, delivering significant improvements in safety and operational efficiency.

2.2 Currently, new Instrument Flight Procedures (IFPs) have been designed to provide Performance-Based Navigation (PBN) procedures, including Standard Terminal Arrival Routes (STARs), approach procedures, and ILS transition procedures for both runway ends, all based on the RNP 1 Navigation Specification (NAVSPEC). These enhancements aim to optimize operational efficiency and safety.

2.3 However, the reliance on GNSS for PBN operations introduces a vulnerability to Radio Frequency Interference (RFI), which can disrupt navigation and compromise the reliability of these newly designed procedures. Such interference poses a particular challenge for Aqaba, given its complex terrain and operational demands. Addressing GNSS RFI is critical to ensure the seamless execution of these procedures and to sustain the benefits of modernization.

2.4 To mitigate these risks, Jordan is exploring alternative navigation solutions, including the integration of DME/DME as a backup for RNP 1 procedures. Additionally, starting next year, Aqaba Airport will benefit from the implementation of a Multilateration (MLAT) surveillance system, which will enhance situational awareness and provide a layer of resilience against the challenges posed by GNSS RFI.

2.5 The RNP 1 specification enables connectivity between the en-route structure and terminal airspace providing RNP routes that can be supported in all geographic areas where there may be an extensive, modest or no ground NAVAID infrastructure.

2.6 RNP 1 has been primarily developed to support arrival and departure procedures, which are commonly referred to as SIDs and STARs; however, RNP 1 also applies to the initial and intermediate approach segments. RNP 1 may be used for extended terminal operations, where it may be applied in the En route continental flight phase on ATS routes or SIDs/STARs.

2.7 Availability of GNSS integrity (e.g., by RAIM) is necessary for arrival and departure operations based on RNP 1. As such, any predicted continuous loss of integrity for more than five (5) minutes during the operation should be considered as an outage. Pilots should also assess their capability to continue the procedure in the event that GNSS service is lost (e.g., interference or failure) and reversion to NAVAIDs becomes necessary.

2.8 Jordan seeks the support of the PBN SG expert group in several key areas, including technical guidance on DME/DME integration, assessment methodologies for terrain and infrastructure challenges, and recommendations for optimizing DME network design to meet RNP and RNAV requirements. This collaboration is crucial to ensure the successful planning and implementation of the study, aligning with international best practices and enhancing the region's navigation capabilities.

Coverage Study for RNP 1 Accuracy Using DME/DME or DME/DME/IRU

2.9 To ensure a reliable backup in case of GNSS failure, it is essential to conduct a comprehensive coverage study to verify that DME/DME can consistently meet RNP 1 navigation specifications. This study will be critical in confirming the effectiveness of DME/DME as a navigation solution, particularly in GNSS-compromised scenarios. To support this effort, guidance is requested on how to conduct the DME coverage study, including the technical standards, methodologies, and ICAO

regulatory requirements necessary to ensure RNP 1 accuracy when using DME/DME as an alternative navigation system.

2.10 Note that a comprehensive coverage study has been done on the same area of interest with variety of available sites in MLAT project which at some point might share the same concept of DME/DME in terms of line of site and coverage.

Procedure Modification Assessment:

2.11 It is important to determine whether modifications to the current RNP procedures, including STARs and approach paths, are needed to integrate DME/DME navigation. Since the existing IFPs are designed for RNP 1 based on GNSS-only navigation, adjustments may be necessary to reconcile with the permitted sensor requirements for non-GNSS-based navigation specifications, such as DME/DME or DME/DME/IRU. Support is requested for technical assistance on identifying the specific modifications required to align these procedures with ICAO PBN standards for non-GNSS-based operations.

Publication Process for New Procedures and DME Locations

2.12 It is essential to establish a clear publication process to reflect changes in procedures, charts, and DME locations, ensuring smooth integration of the updated navigation systems. This process will be crucial in maintaining accuracy and consistency across all relevant documents. Support is requested for guidance on ICAO publication standards for updating aeronautical information, ensuring that the changes are properly documented and compliant with international regulations.

Information Feasibility Study for DME Expansion to Support RNAV 5 Navigation

2.13 It is important to explore the feasibility of expanding DME coverage nationwide to support RNAV 5 specifications, which would benefit a broader range of airspace users. This expansion is crucial, as all en-route segments are currently based on PBN RNAV 5 Navigation Specifications. The available DVORs could be utilized in the cockpit for cross-checking, and they are already published in the AIP for each en-route segment. Support is requested for assistance in planning a feasibility study, including the technical considerations for widespread DME distribution. Additionally, guidance is needed on whether the proposed DME sites, which will be co-located with VORs for conventional navigation purposes, could impact the overall DME/DME distribution. Specifically, there are four proposed DME sites that will be co-located with VORs, and it is important to assess how this may affect the integration of DME/DME as a backup for RNAV 5 operations.

2.14 The question is whether the co-location of DMEs with VORs will affect the proposed DME/DME distribution, as four of the proposed DME sites will be co-located with VORs for conventional navigation purposes.

Airline Industry Capability to Use DME/DME/IRU for Approaches

2.15 It is crucial to assess the ability of airline fleets to adopt DME/DME/IRU navigation for approaches and to identify any operational barriers that may arise. This evaluation will help determine the readiness of fleets to integrate this navigation system and ensure seamless operations. Support is requested in gathering insights from ICAO and airline stakeholders on industry readiness, including any potential training requirements, equipment upgrades, or modifications necessary to facilitate this transition and ensure smooth adoption of DME/DME/IRU navigation for approach procedures.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) review and discuss the content of this Working Paper;

b) support the conduct of a Feasibility Study for DME/DME Integration to assess the ability to integrate DME/DME as a backup for RNP 1 procedures; and

c) provide guidance on technical standards, publication processes, and the readiness of airline fleets to adopt DME/DME/IRU navigation.

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