INTERNATIONAL CIVIL AVIATION ORGANIZATION

REPORT OF THE EIGHTH MEETING OF THE PERFORMANCE BASED NAVIGATION SUB-GROUP

PBN SG/8 Meeting

(Doha, Qatar, 12 – 13 December 2023)

Approved by the Meeting
and published by authority of the Secretary General

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PART I – HISTORY OF THE MEETING

1. PLACE AND DURATION

1.1 The Eighth meeting of the Performance Based Navigation Sub-Group (PBN SG/8) was successfully held in Doha, Qatar, from 12 to 13 December 2023.

2. OPENING

2.1 Mr. Ahmed Eshaq, Director of Air Navigation Department, Qatar Civil Aviation Authority, delivered an opening speech, and welcomed all the participants to Doha to participate in the PBN SG/8 Meeting.

2.2 Mr. Mohamed Smaoui, Deputy Regional Director, ICAO Middle East Office, welcomed all participants to the PBN SG/8 meeting. He expressed his sincere gratitude to the State of Qatar and especially to Mr. Ahmed Eshaq, Director of ATM of the Qatar Civil Aviation Authority for hosting this important meeting in Doha. Mr. Mohamed Smaoui thanked Qatar CAA for the warm welcome, outstanding hospitality, excellent organisation, and the decent premises provided for this important meeting. He added that the hosting of this meeting is another evidence on the support provided by Qatar for the Aviation industry and the work programme of the ICAO MID Office.

2.3 Mr. Mohamed Smaoui provided the meeting with an overview of the subjects that will be addressed during the meeting including PBN planning and implementation issues in the MID Region. Mr. Mohamed Smaoui highlighted that the meeting will be apprised of some recent Global and Regional developments related to PBN and GNSS and PBAOM and its concept of operations. He added that aviation worldwide, including ICAO member States, recognizes the reliance on Performance Based Navigation (PBN) operations that require accurate and dependable space-based Positioning, Navigation and Timing (PNT) services delivered by GNSS as noted by the ICAO Assembly in the referenced Assembly Resolutions. Disruptions to GNSS result in compromised safety, inefficiency and financial losses. Therefore, the meeting will be apprised of the safety of flight risks related to the GNSS spoofing and jamming activities reported by various AOs and international organizations and the mitigation measures for ANSPs and CAAs.

2.4 Mr. Smaoui encouraged the delegates to participate in all the activities and discussions, thanked them for their attendance and wishing them successful and productive meeting.

2.5 The meeting was chaired by Mr. Ehab Raslan Mohamed, General Manager of Research and Development, NANSC, Egypt, who welcomed the participants and wished them a successful and fruitful meeting.

3. ATTENDANCE

3.1 The meeting was attended by a total of thirty-four (34) participants from ten (10) States (Egypt, Iran, Iraq, Jordan, Libya, Oman, Qatar, Saudi Arabia, UAE and Yemen). The list of participants is at **Attachment A**.

4. OFFICERS AND SECRETARIAT

4.1 The meeting was chaired by Mr. Ehab Raslan Mohamed, General Manager of Research and Development, NANSC, Egypt, 4.2 Mr. Radhouan Aissaoui, Regional Officer, Information Management was the Secretary of the meeting. The meeting was also supported by Captain Ian Knowles, Acting Chief, OPS ICAO Air Navigation Bureau and Mr. Mohamed Smaoui, Deputy Regional Director, ICAO MID Office.

5. LANGUAGE

5.1 The discussions were conducted in the English language and documentation was issued in English.

6. AGENDA

6.1 The following Agenda was adopted:

Agenda Item 1: Adoption of the Provisional Agenda

Agenda Item 2: Follow-up on MIDANPIRG/20 Conclusions and Decisions relevant to PBN

Agenda Item 3: Global and Regional Developments related to PBN

Agenda Item 4: PBN Planning and Implementation in the MID Region

Agenda Item 5: States' PBN Implementation experience

Agenda Item 6: Working Arrangements and Future Work Programme

Agenda Item 7: Any other business

7. CONCLUSIONS AND DECISIONS – DEFINITION

7.1 The MIDANPIRG records its actions in the form of Conclusions and Decisions with the following significance:

a) **Conclusions** deal with matters that, according to the Group's terms of reference, merit directly the attention of States, or on which further action will be initiated by the Secretary in accordance with established procedures; and

b) **Decisions** relate solely to matters dealing with the internal working arrangements of the Group and its Sub-Groups.

8. LIST OF DRAFT CONCLUSIONS AND DRAFT DECISIONS

DRAFT CONCLUSION 8/1: *WEBINAR ON PERFORMANCE-BASED AERODROME OPERATING MINIMA (PB-AOM)*

DRAFT CONCLUSION 8/2: *WORKSHOP ON GNSS*

DRAFT CONCLUSION 8/3: *GUIDANCE RELATED TO ALTIMETER SETTING ERRORS DURING APV BARO-VNAV AND NONPRECISION APPROACH OPERATIONS*

DRAFT DECISION 8/4: *PBN SID AND STAR CHARTING AD HOC WORKING GROUP*

PART II: REPORT ON AGENDA ITEMS

REPORT ON AGENDA ITEM 1: ADOPTION OF THE PROVISIONAL AGENDA

1.1 The meeting reviewed and adopted the Provisional Agenda as at Para 6 of the History of the Meeting.

REPORT ON AGENDA ITEM 2: FOLLOW-UP ON MIDANPIRG/20 CONCLUSIONS AND DECISIONS RELEVANT TO PBN

2.1 The meeting noted the status of the MIDANPIRG/20 Conclusions and Decisions relevant to PBN and the follow-up actions taken by concerned parties as at **Appendix 2A**.

REPORT ON AGENDA ITEM 3: GLOBAL AND REGIONAL DEVELOPMENTS RELATED TO PBN

PerformanceBased Aerodrome Operating Minima (PB-AOM)

3.1 The subject was addressed in PPT/4 and PPT/5 presented by Capt. Ian Knowles, Acting Chief, Operational Safety Section, Air Navigation Bureau, ICAO HQ. The meeting noted that the PBAOM concept includes the use of equipment in addition to that which is required for the operation, permitting the granting of operational credit to achieve, for example, lower operational minima.

3.2 The concept of PB-AOM was explained and the meeting was informed that the Standard Aerodrome operating minima are predicated upon aircraft equipped with the minimum required equipment (the basic aircraft) for that approach. These aerodrome operating minima relate directly to the established types and categories of operations and the associated infrastructure requirements (e.g. runway lights, approach lights). Advanced Aircraft can take advantage of existing infrastructure to obtain special authorizations for enhanced approach operations to lower minimums than basic aircraft can use.

3.3 It was highlighted that the PBAOM offers reduced minima through leveraging aircraft capabilities (e.g., EFVS, SVGS, FD, Autopilot, fail-operational systems) and increased safety without requiring more ground equipment and provides finer resolution of approach minima.

3.4 The meeting noted that the FLTOPSP had developed the PBAOM CONOPS. In the PBAOM concept, the minima will be predicated upon the combined capabilities of the ground and airborne facilities, i.e. the resulting performance for providing guidance during the instrument and visual segments of the approach and landing, hence the concept "Performance Based Aerodrome Operating Minima" (PBAOM).

3.5 It was further explained that this concept will allow increased aerodrome availability and/or less costly infrastructure. The intention, however, is not to lower the existing standards for aerodromes, because those will still be needed for the aircraft without additional equipage. The ability to use improvements in either the ground or airborne components leads to a flexible implementation path, where different options can be used to generate improvements in AOM as required by the operator and aerodrome.

3.6 It was noted that the CONOPS is aiming primarily to provide information on the proposed concepts of Performance Based Aerodrome Operating Minima. The purpose is also to describe the expected impact for other domains such as aerodromes, air traffic management and navigation systems providers. Thereby, CONOPS is intended as a coordination instrument between the domains affected by attempting to describe all aspects of PBAOM. Such coordination is intended to be the first step, after which a fully coordinated CONOPS PBAOM can be developed. The CONOPS, notably with its Appendix provide practical examples how PBAOM will influence the interaction between operators, ATC and aerodromes.

3.7 In order to provide a deep understanding of the concept, the implications of PBAOM on the aerodrome design and operation, including the challenges of operating in very low visibility and the need to consider how to accommodate advanced aircraft operating at the aerodrome to expand aerodrome availability in restrictive weather conditions, the meeting agreed to the following Draft Conclusion :

DRAFT CONCLUSION 8/1: WEBINAR ON PERFORMANCE-BASED AERODROME OPERATING MINIMA (PB-AOM)

That, a Webinar on the Performance-Based Aerodrome Operating Minima (PB-AOM) be organized in 2024.

DOC 9849, GNSS Manual Update Summary

3.8 The subject was addressed in WP/6 presented by the Secretariat.

3.9 The meeting was apprised of the latest updates introduced with the release of Doc 9849, 4th Ed 2023, in particular:

- Chapter 2: Performance Requirements – This Section was reviewed for potential changes with respect to the new DFMC SBAS standards. Guidance material on GNSS performance reporting for GNSS service providers was included.
- Chapter 3: Existing Core Satellite Constellations – This Section was updated to reflect inclusion of new operational core constellations and new signal for existing constellations.
- Chapter 4: Augmentation Systems – This Section was updated to address DFMC SBAS SARPs changes and to identify new SBASs included in the SBAS SARPs amendment.
- Chapter 5: GNSS Vulnerability – Significant material was added to address recent developments and thinking with respect to jamming and spoofing.
- Chapter 6: GNSS Evolutions – Section 6.5 text was updated to reflect operational state of GALILEO and BDS while providing information on their planned future evolutions.
- Chapter 7: GNSS Implementation – Additions made for interference monitoring, interference anomaly reporting, and space weather advisory.

3.10 It was noted that, the Manual updates addressed changes required to support the recent SARPs changes and significant, outdated material within the previous GNSS Manual Edition. Another revision of the Manual would address lower priority issues.

3.11 Based on the above, in order to provide an opportunity for detailed discussions on the implementation of different GNSS elements/options and associated challenges, the meeting agreed to the following Draft Conclusion:

DRAFT CONCLUSION 8/2: WORKSHOP ON GNSS

That, ICAO organize a Workshop on GNSS in 2024, back to back with the PBN SG/9 meeting.

Magnetic to a True North Reference System

3.12 The subject was addressed in PPT/7 presented by the Secretariat.

3.13 The meeting was apprised with a brief overview of the ICAO survey results on Moving from a Magnetic to a True North Reference System for Heading and Tracking in Aviation Operations. It was noted that ICAO has circulated a survey, through State Letter AN 11/57-22/87, to seek feedback from States and their aviation industry on the level of support for ICAO to commence work on changing from a Magnetic to True North reference for heading and track in air operations. The aim of the survey is also to identify any concerns or challenges that may need to be addressed during any transition to True North. The findings from the survey will assist ICAO in determining the viability of moving to True North and may be used to guide ICAO in developing plans and strategies for a future transition.

3.14 It was highlighted that the ANC has approved the establishment of the True North Advisory Group (TRUE-AG), a multi-disciplinary expert group to assist ICAO in developing a framework for a safe and efficient global transition to True North. This group is tasked to develop an ICAO CONOPS and transition plan and assist ICAO in developing a realistic and safe framework for implementing true north globally.

ICAO UPDATE

3.15 An update on ICAO's documentation and activities that may be of interest to the Meeting was provided in IP/2 prepared by the Secretariat.

REPORT ON AGENDA ITEM 4: PBN PLANNING AND IMPLEMENTATION IN THE MID REGION

Revised MID Air Navigation Strategy/ B0 and 1 - APTA

4.1 The subject was addressed in WP/8 presented by the Secretariat. The Working Paper provided information concerning the revised MID Air Navigation Strategy in particular parts related to PBN and proposed changes to the priority 1 ASBU APTA Elements.

4.2 The meeting recalled that the ICAO MID Workshop on the Global Air Navigation Plan and National Air Navigation Plan (GANP & NANP) was successfully held in the ICAO Middle East Office in Cairo, Egypt, 5 – 8 March 2023. The meeting noted that the Workshop reviewed and updated the MID ANP Volume III and MID Region Air Navigation Strategy (ICAO MID Doc 002). Furthermore, the MID Region Air Navigation Strategy (ICAO MID Doc 002) was reviewed and endorsed by MIDANPIRG/20 meeting (Muscat, Oman, 14 – 17 May 2023) through Conclusion 20/7.

4.3 The MID Region Air Navigation Strategy edition March 2023 is available at: MID Doc 002 - MID Air Navigation Strategy - March 23.pdf (icao.int).

4.4 The meeting agreed to the following proposed changes to the priority 1 ASBU APTA Elements:

APTA							
Element		*Applicability*	*Performance Indicators/ Supporting Metrics*	*Baseline (2022)*	*Target*	*Timeline*	*KPA/ KPI*
APTA B0/1	PBN Approaches (with basic capabilities)	All RWYs ENDs at International Aerodromes	Indicator: % of Runway ends at international aerodromes ~~provided with Baro-VNAV approach procedures (LNAV/VNAV)~~ served by PBN approach procedures with basic functionalities - down to LNAV or LNAV/VNAV minima Supporting metric: Number of Runways ends at international aerodromes ~~provided with Baro-VNAV approach procedures (LNAV/VNAV)~~ served by PBN approach procedures with basic functionalities - down to LNAV or LNAV/VNAV minima	55%	100%	Dec 2017	Capacity/ KPI 10

APTA							
Element		*Applicability*	*Performance Indicators/ Supporting Metrics*	*Baseline (2022)*	*Target*	*Timeline*	*KPA/ KPI*
APTA B0/4	CDO (Basic)	OBBI, OIIE, OIKB, OIFM, OJAI, OLBA, OOMS, OTHH, OTBD, OEJN, OEMA, OEDF, OERK, HSSS, HSPN, OMAA, OMAL, OMAD, OMDW, OMDB, OMSJ, OMRK and OMFJ	Indicator*: % of International Aerodromes with CDO implemented and published as required. Supporting Metric: Number of International Aerodromes with CDO implemented and published, as required. *As per the applicability area	65%	100%	Dec 2021	Efficiency/ KPI 19
APTA B0/5	CCO (Basic)	OBBI, OIIE, OIKB, OIFM, OJAI, OLBA, OOMS, OTHH, OTBD, OEJN, OEMA, OEDF, OERK, HSSS, HSPN, OMAA, OMAL, OMAD, OMDW, OMDB, OMSJ, OMRK and OMFJ	Indicator*: % of International Aerodromes with CCO implemented and published as required. Supporting Metric: Number of International Aerodromes with CCO implemented and published, as required. *As per the applicability area	65%	100%	Dec 2021	Efficiency/ KPI 17
APTA B0/7	Performance based aerodrome operating minima – Advanced aircraft	All States To be further discussed	Indicator: % of States authorizing Performance-based Aerodrome Operating Minima for Air operators operating Advanced aircraft. Supporting Metric: ~~1-~~ Number of States ~~authorizing Performance-based Aerodrome Operating Minima for Air operators operating Advanced aircraft.~~ having provisions for operational credits to	~~85~~% 50%	100% 80%	~~Dec 2021~~ Dec 2025	Capacity/ KPI 10

APTA							
Element		*Applicability*	*Performance Indicators/ Supporting Metrics*	*Baseline (2022)*	*Target*	*Timeline*	*KPA/ KPI*
			enable lower minima based on advanced aircraft capabilities. (Reference: Annex 6 Part I para. 4.2.8.2.1) 2- Number of States having established an approval process for the operational credit to Aircraft operator conducting PBAOM operations for low visibility operations (Reference: Doc 9365 (AWO Manual)), as applicable.				

4.5 The meeting recalled that MIDANPIRG/20 through Decision 20/12, established the RANP/NANP Task Force to ensure alignment of the MID Region Air Navigation Strategy and MID ANP Vol III with the latest edition of the GANP and assist States developing NANPs.

4.6 Therefore, the meeting agreed to bring the proposed changes to the attention of the RANP/NANP Task Force for further consideration.

Implementation status of Resolution A37-11 and APTA THREAD BLOCK 0 & 1 in MID Region

4.7 The subject was addressed in PPT/9 presented by the Secretariat.

4.8 The meeting recalled the key requirement of ICAO Assembly Resolution A37-11, which resolved that States to complete a PBN implementation plan as a matter of urgency to achieve:

a) implementation of approach procedures with vertical guidance (APV) (Baro-VNAV and/or augmented GNSS), including LNAV-only minima, for all instrument runway ends, either as the primary approach or as a back-up for precision approaches by 2016 with intermediate milestones as follows: 30 per cent by 2010, 70 per cent by 2014; and

b) implementation of straight-in LNAV-only procedures, as an exception to a) above, for instrument runways at aerodromes where there is no local altimeter setting available and where there are no aircraft suitably equipped for APV operations with a maximum certificated takeoff mass of 5 700 kg or more;

4.9 The implementation of approach procedures with vertical guidance (APV) (Baro-VNAV and/or augmented GNSS), including LNAV-only minima, is well under way in the MID Region. The meeting noted that the Percentage of States in MID region meeting the resolution Targets is 76.6 percent.

4.10 The meeting commended the work of the States which met the resolution Targets of 100 percent and urged the remaining States to expedite implementation of ICAO Assembly Resolution A37-11.

4.11 The meeting recalled that the ICAO Assembly Resolution A37-urged States to complete a PBN implementation plan by 2009. To date, seven out of the fifteen MID States have submitted plans to the ICAO MID Office.

4.12 The meeting invited States that have yet to develop and submit PBN implementation plans to do so and meet their obligation with the greatest urgency. States with existing plans should ensure that their plans are robust and are aligned with the Regional plan and ICAO PBN requirements.

4.13 The meeting reviewed and updated the status of implementation of the APTA THREAD BLOCK 0 & 1 in MID Region as at **Appendix 4A**. The following was highlighted:

- The status of implementation of the APTA B0/1 related to PBN Approaches (with basic capabilities) reached 53.3% far behind the regional target of 100% by Dec. 2017.
- The status of implementation of the APTA B0/2 related to PBN SID and STAR procedures (with basic capabilities) is 53% behind the regional target of 70% by Dec. 2022.
- The status of implementation of the APTA B0/4 and B0/5 which reached 65.2%; each element is far behind the regional target of 100% by Dec. 2021.
- The status of implementation of the APTA B0/7 related to Performance based aerodrome operating minima – Advanced aircraft which reached 73.3% above the regional target of 50% by Dec. 2021.

4.14 The meeting urged those States behind Global and Regional targets to expedite implementation of PBN to achieve the global targets of the Assembly Resolution A37-11 and the regional targets of the MID Air Navigation Strategy.

4.15 The meeting recalled MIDANPIRG Conclusion 20/26 related to the PBN Capacity-Building And Assistance Activities and encouraged States to inform the ICAO MID Office of their needs in terms of PBN capacity-building and required assistance activities, and guidance related to PBN planning, implementation, including improvement of practices in PBN Design, operational approval, and continuous oversight.

MID eANP Volume III

4.16 The meeting reviewed and updated the MID eANP Volume III (APTA Tables), as at **Appendix 4B**.

MID Air Navigation Report-2023

4.17 The meeting recalled that the MIDANPIRG/20 meeting, through Conclusions 20/9 & 20/11 related to development of NANP & MID Region Air Navigation Report-2023. The meeting noted that a State Letter File Ref.: AN 1/7 – 23/270 dated 6 December 2023 was circulated requesting States to provide the ICAO MID Office, not later than 15 January 2024, with the following:

a) update on the status of implementation of the priority 1 ASBU Threads/Elements;

b) progress achieved in the implementation of the Performance Based Approach and development of your State National Air Navigation Plan (NANP); and

c) major achievement(s)/success story(ies) in the air navigation field in 2023.

4.18 The meeting urged the members of the PBN Sub Group to follow-up internally within their States in order to provide the ICAO MID Office with the required data in a timely manner.

GNSS disruption in MID Region

4.19 The subject was addressed in WP/10 presented by the Secretariat. Further to the increasing number of GNSS disruption events around the globe and in particular in the MID Region, the meeting recognized the safety of flight risks related to the GNSS spoofing and jamming activities reported by various AOs and international organizations and was apprised of a number of mitigation measures for ANSPs and CAAs.

4.20 The meeting noted that the effects of GNSS possible spoofing activities were observed by flight crew, including:

- Fake GPS signal (spoofed) gives the FMS the indication it is 60nm off track;
- Complete loss of navigational capability including IRS failure;
- No reliable on board navigation – ATC vectors required. One flight required ATC vectors all the way to their destination in Doha;
- Potential airspace infringements due to GNSS degradation. One operator almost entering Iranian airspace without clearance.

4.21 To address the identified issues, the meeting agreed on the following mitigation measures. These measures are to be considered wherever GNSS jamming and/or possible spoofing is identified.

➢ CAAs should:

- Ensure that contingency procedures are established in coordination with ANSPs and airspace users, and that essential conventional navigation infrastructure are retained and fully operational;
- Implement appropriate and proactive mitigating measures as a matter of high priority, including the issuance of NOTAMs, e.g. describing affected areas and related limitations (as appropriate and determined at State level).

➢ CAAs and ANSPs should:

- Establish a process to collect information on GNSS degradations, in coordination with the relevant National Communications Authorities, and promptly notify the related outcomes to air operators and to other airspace users;
- Confirm ANSPs’ readiness to provide reliable surveillance coverage that is resilient to GNSS interference, such as ground NAV aids for conventional non-satellite based navigation (Distance Measuring Equipment (DME), Very High Frequency omnidirectional range (VOR));

– Ensure that ANSPs' contingency plans include alternative procedures to be followed in case of large-scale GNSS jamming and/or possible spoofing events.

4.22 It was reiterated that States should use caution when conducting civil and military GNSS and other testing activities which could contribute to operational impact on aviation CNS systems. Airspace users should be informed accordingly. Considering the potential negative impact of GNSS testing on the safety of flights, States were strongly encouraged to further enhance civil-military coordination related to GNSS and associated testing.

4.23 The meeting recalled that the Seventeenth Meeting of the Middle East Air Navigation Planning and Implementation Regional Group and Seventh Meeting of the Regional Aviation Safety Group-Middle East MIDANPIRG/17 & RASG-MID/7, endorsed through RASG-MID CONCLUSION 7/1 the RASG-MID Safety Advisory (RSA-14) on GNSS Vulnerabilities.

4.24 The meeting recalled also that the SARPs have been recently updated to add requirements for DFMC SBAS, new core constellations and additional core constellation signal. In addition, the latest updates on the DOC 9849, GNSS Manual, in particular Chapter 5 GNSS Vulnerability with the significant material added to address recent developments with respect to jamming and spoofing.

4.25 The meeting agreed that the RASG-MID Safety Advisory (RSA-14) should be updated to reflect recent developments and changes to maintain its effectiveness and reliability.

4.26 Furthermore, the meeting recalled that the MIDANPIRG/20 endorsed through MIDANPIRG Conclusion 20/18 a NOTAM TEMPLATE FOR GNSS INTERFERENCE. Based on the recent new entry of GNSS Spoofing, the meeting expressed the need that the NOTAM Template should be updated to reflect the spoofing activities and its effect on safety of flight operations - for instance, ″GNSS MAY BE MISLEADING WITHIN″ for spoofing events. Accordingly, the meeting agreed to invite the AIM SG to consider updating the NOTAM Template for GNSS Interference based on the recent new entry of GNSS Spoofing.

4.27 The meeting noted that the ICAO EUR/MID Radio Navigation Symposium for EUR/NAT and MID Regions is planned to be held in Antalya, Turkiye, from 6 to 8 February 2024 to address emerging challenges including GNSS vulnerabilities and discuss GNSS vulnerabilities management plan, in particular possible GNSS jamming/spoofing monitoring solutions, Therefore, the meeting strongly encouraged States to participate actively in this Symposium. Moreover, the meeting noted that registration of participants are handled on a "first come first served basis" and participation assignments will be subject to availability. States were urged to send their nominations as a matter of urgency to guarantee their participation.

GNSS INTERFERENCE & GPS Anomalies

4.28 The subject was addressed in WP/11 presented by the UAE. This working paper pointed out the critical issue of GNSS interference, including GPS jamming and spoofing, and its impact on civil aviation and air traffic management. It highlighted the growing concern over safety and operational disruptions caused by these activities and proposes recommendations for regional collaboration and mitigation measures.

4.29 The meeting was apprised of the location of GPS jamming events within Emirates FIR reported in 2023 by the national carrier.

4.30 In view of the above, the meeting recalled that a number of Action Groups were established to work on the subject and for an improved efficiency, agreed on the need to have one multi-disciplinary Action Group to coordinate and propose measures to mitigate this risk. The AG should be composed of the Chairpersons of the AIM SG, ATM SG, CNS SG and PBN SG as well as from experts with different technical background/expertise from States and stakeholders, including ICAO and IATA. In addition, and in order to avoid proliferation and unnecessary duplication of efforts, the meeting agreed to raise the subject to the MIDANPIRG/21 meeting for consideration and direction.

GNSS Jamming/Spoofing in Baghdad FIR ORBB

4.31 The subject was addressed in WP/21 presented by Iraq. The working paper presented the set of procedures and actions that have been taken by the Iraqi Civil Aviation Authority (ICAA) and Iraq's ANSP (GCANS) to address the GNSS vulnerabilities and for preventing and responding to RFI events within Baghdad FIR (ORBB).

4.32 The meeting noted that in response to the significant increase in the reported GNSS vulnerabilities, a supreme committee was established by the Iraqi Prime Minister consisting of all the concerned authorities including (ICAA, GCANS, CMC Communication and Media Commission, Iraqi Airforce, and other enforcement authorities) to conduct surveys to locate and determine the sources of the interferences.

4.33 The meeting appreciated the efforts made and the collaboration between national aviation stakeholders for preventing and responding to interference.

Vulnerabilities of BARO-VNAV Approaches

4.34 The subject was addressed in WP/12 presented by the Secretariat. The working paper outlined the risks related to altimeter setting errors, in particular, during APV Baro-VNAV and non-precision approach operations and proposed a plan to mitigate altimeter setting errors.

4.35 The meeting noted that recent serious incidents have highlighted a concern on the effects of incorrect barometric altimeter settings when operating below the transition level. Operating with an incorrect altimeter setting could result in insufficient clearance with terrain and obstacles, or a loss of separation with other traffic, which may potentially lead to CFIT or mid-air collision.

4.36 To raise awareness on the risks related to altimeter setting errors during APV Baro-VNAV and non-precision approach operations, the Draft Guidance at **Appendix 4C** was developed for civil aviation regulators, Air Navigation Services Providers (ANSPs) to mitigate the risks related to altimeter setting errors, in particular during APV Baro-VNAV and non-precision approach operations.

4.37 Based on the above and with a view to sensitizing the MID aviation community to vulnerabilities of Baro-VNAV approaches, in particular their dependence on correct altimeter setting, the meeting agreed to the following Draft Conclusion:

DRAFT CONCLUSION 8/3: GUIDANCE RELATED TO ALTIMETER SETTING ERRORS DURING APV BARO-VNAV AND NON-PRECISION APPROACH OPERATIONS

That, States and stakeholders be invited to review the Draft Guidance at ***Appendix 4C****; and provide comments/inputs to the ICAO MID Office before* ***15 January 2024****, in order to consolidate the final version for endorsement by MIDANPIRG/21.*

PBN SID-STAR charting Issues

4.38 The subject was addressed in PPT/13 presented by the Secretariat. The meeting noted discrepancies in PBN SID/STAR charts published in MID States' AIPs, including issues related to chart title, chart identification and PBN Box.

4.39 The meeting noted also that ICAO State Letter 2023/07 provided requirements in Annex 4 and PANS OPS (Doc 8168) concerning PBN box and charting of PBN SIDs and STARs, however specimen charts were not included.

4.40 The meeting agreed that the lack of harmonization in SID/STAR charts can pose challenges for AUs. It might be confusing for pilots and ATC.

4.41 Given that the harmonization is crucial for promoting safety, efficiency, and standardization, there is a need for ongoing efforts to promote harmonization and consistency in the publication of PBN SID/STAR charts, the meeting agreed to the following Draft Decision :

DRAFT DECISION 8/4: PBN SID AND STAR CHARTING AD HOC WORKING GROUP

That a PBN SID and STAR Charting Ad Hoc Working Group:

a) be established to develop guidance/Specimen of PBN SID and STAR Charts, in coordination with the AIM Sub-Group.

b) be composed of:

- *Chairpersons of the PBN SG and the AIM SG*
- *Mrs. Pamela Erice (Qatar)*
- *Mr. Saqr Obaid Al Marashda (UAE)*
- *Mr. Kedari Manthanwar (UAE)*
- *Mr. Mr. Muhammad Aljuhani (KSA)*
- *Mr. Sulaiman Selmi (Oman)*
- *Mr. Suwarn Raj Upadhyay (Oman)*
- *ICAO Secretariat*

c) present its outcome to the PBN SG/9 and AIM SG/11 meetings.

Navigation Minimal Operating Networks (NAV MON)

4.42 The subject was addressed in WP/14 presented by the Secretariat. The meeting noted that the ASBU element "Navigation Minimal Operating Networks" (NAVS B0/4) has been classified as priority 1 in the revised MID Region Air Navigation Strategy (MID Doc 002). This element aims to:

- adjust conventional navaids networks through the increased deployment of satellite-based navigation systems and procedures to ensure the necessary levels of resilience for navigation.
- provide a minimum level of capabilities to accommodate State aircraft operations where there is a mismatch in terms of aircraft equipage.
- make a more efficient use of the frequency spectrum.

4.43 The meeting recalled that MIDANPIRG/18, through Decision 18/42, agreed on the need to develop a template for Navigation Minimal Operating Networks (Nav. MON) Plan in line with ICAO

SARPs and Regional requirements and established NAV MON Plan Ad-Hoc Action Group, to develop a Template for NAV MON Plan.

4.44 The meeting noted also that the MIDANPIRG/20, agreed through Decision 20/46 that, the ATM SG, CNS SG and PBN SG be tasked to review and update, as deem necessary, the NAV MON Plan Template to be presented to MIDANPIRG/21 for further review and endorsement.

4.45 The meeting reviewed the Template developed by the NAV MON Plan Ad-Hoc Action Group and updated it as **at Appendix 4D**.

4.46 The meeting also proposed to divide the NAV MON Template into two separate documents: one as leaflet for guidance to States and the second one as NAV MON Plan Template.

REPORT ON AGENDA ITEM 5: STATE'S PBN IMPLEMENTATION EXPERIENCE

PBN Implementation in Jordan

5.1 The subject was addressed in PPT/22, presented by Jordan. the meeting was apprised in particular with Jordan NEW IFP PROJECT 2023-2024. In addition, the meeting noted the challenges related to GNSS RFI and future developments on MLAT and DME/DME optimisation.

Qatar PBN Implementation –A Journey of Success

5.2 The subject was addressed in PPT/16, presented by Qatar. the meeting noted the key success factors including the Validation through Peer Reviews, FTS, RTS, Planning with a Detailed Project document and well-structured project plan and Stakeholder Engagement facilitated by in depth discussions and openness to stakeholder insights, Seamless Implementation and Post-Implementation Improvement.

GBAS Project in Qatar

5.3 The subject was addressed in PPT/17, presented by Qatar. The meeting noted Qatar planning for GBAS deployment and the feasibility study carried out for the Ionospheric effect on Navigational Satellite's signals over Qatar. In addition, the meeting noted that the infrastructure was established to support the collection of iono data and its effect on GPS signals which are being analysed and recorded.

Free Route implementation in UAE

5.4 The subject was addressed in PPT/18, presented by UAE. The meeting noted the success story related to implementation of FRA in UAE FIR, as step-by-step rather than a single act, which was appreciated by airspace users. In this respect, Free Route Airspace is defined as an Airspace within which users may freely plan a route between a defined entry point and a defined exit point. The meeting noted also the Key Challenges and Lessons Learned from FRA implementation in UAE FIR along with benefits. I was highlighted that the implementation of FRA in UAE offered a number of efficiency benefits for the operators including reduced flight time, reduced CO_2 emissions and reduced fuel waste.

PBN Implementation Status - Yemen

5.5 The subject was addressed in PPT/20, presented by Yemen. the meeting noted the status of PBN implementation in Yemen. the meeting noted also the challenges faced by CAMA in PBN implementation and future plans.

5.6 The meeting commended the progress made by Member States in PBN implementation and for knowledge and experience-sharing.

5.7 It was recalled that the PBN SG meeting is a platform to address PBN implementation aspects of States in the MID Region, including sharing and exchanging of best PBN Implementation practices between States within the Region. All Members States are strongly encouraged to attend the PBN SG meetings regularly and share their experience and best practices in PBN.

REPORT ON AGENDA ITEM 6: FUTURE WORK PROGRAMME

6.1 The subject was addressed in WP/19, presented by the Secretariat.

6.2 The meeting reviewed and updated the PBN SG ToRs at **Appendix 6A**.

6.3 The meeting agreed that the PBN SG/9 meeting be held during Q4 2024 back-to-back with the GNSS Workshop.

6.4 The meeting noted with appreciation the generous offer received from Qatar to host the PBN SG/9 meeting and the GNSS Workshop. The exact venue will be communicated with the PBN SG members in due time.

REPORT ON AGENDA ITEM 7: ANY OTHER BUSINESS

OUTCOMES OF THE PBN AIRSPACE DESIGN WORKSHOP

7.1 The subject was addressed in PPT/23 presented by the Secretariat.

7.2 The meeting recalled that MIDANPIRG/20, through Conclusion 20/24, agreed that a Workshop on PBN Airspace Design Workshop be organized in 2023, in collaboration with the MIDFPP, to provide a thorough understanding of airspace design requirements; focusing on PBN based solutions to ensure an efficient, flexible and dynamic airspace structure that meets Stakeholders requirements.

7.3 The meeting noted that PBN Airspace Design Workshop was successfully conducted in Doha, Qatar during the period 10 – 11 December 2023. The Workshop was generously hosted by QCAA.

7.4 The meeting was apprised of the main key takeaways from the PBN Airspace Design Workshop, which include:

- **PBN implementation** should bring **safety, capacity and efficiency benefits** through the optimization of SID/STAR and instrument approach procedures.
  - PBN overlays procedures should be avoided.
  - Airspace re-design should be considered when implementing PBN.
- **PBN Airspace design** requires appropriate **planning, time and resources** to achieve the expected benefits.
- **PBN Airspace implementation** requires **consultation with all airspace users**.
- **GNSS** is the main enabler of PBN, therefore GNSS loss is a real threat for **PBN Airspace**.
- **PBN operations** require a **proper charting (PBN box, Nav Specs, Sensors)**
  - **PBN SID/STAR charts should be harmonized.**
- **Identification of Best Practices:** through discussions and case study, best practices were identified in PBN airspace design. These best practices can serve as valuable guidelines for future airspace design projects, promoting efficiency and consistency.
- **Capacity Building:** the workshop served as a capacity-building exercise, enhancing the skills and knowledge of participants in the field of PBN airspace design. This is vital for maintaining a workforce that is well-equipped to handle evolving challenges in aviation.
- **Continued collaboration and knowledge-sharing:** emphasis was placed on the need for continued collaboration and knowledge-sharing through similar events in the future. A call to action was made to organize regular workshops, conferences, and seminars to sustain the momentum generated and keep the community engaged.
- **The workshop not only deepened the understanding of PBN** but also fostered collaboration, identified best practices, addressed challenges, and laid the foundation for ongoing engagement through similar future events.
- **Workshop duration was a limitation,** to go through the key concepts and to allow for time to practice these concepts, then a four days' workshop is needed. Therefore, States expressed the need for similar workshop to ensure a dynamic and well-informed SME in MID States**.**

APPENDICES

APPENDIX 2A

FOLLOW-UP ACTION PLAN ON MIDANPIRG/20 CONCLUSIONS & DECISIONS

No.	CONCLUSIONS AND DECISIONS	CONCERNS/ CHALLENGES (RATIONALE)	DELIVERABLE/ TO BE INITIATED BY		TARGET DATE	STATUS/REMARKS
C. 20/7	**REVISED MID AIR NAVIGATION STRATEGY** That, the Revised MID Air Navigation Strategy (Doc 002) is endorsed and be published by the ICAO MID Office.	Identification of priority 1 ASBU threads/elements, their baseline and linked KPA/KPI, monitoring and reporting at Regional level.	Revised MID Air Navigation Strategy (ICAO MID DOC 002)	ICAO	May. 2023	**Completed** Revised MID Air Navigation Strategy (ICAO MID DOC 002) is posted and accessible through : https://www.icao.int/MID/MIDANPIRG/Documents/eDocuments/MID%20Doc%20002%20-%20MID%20Air%20Navigation%20Strategy%20-%20Feb%202021.pdf
C. 20/8	**REVISED MID ANP VOL III** That, the Revised MID ANP Vol III is endorsed and be published by the ICAO MID Office.	Need to update the ANP Vol III to align with the GANP and the Performance Based Approach	Revised MID ANP Vol III	ICAO	May. 2023	**Completed** Revised MID ANP Vol III is endorsed and published : https://www.icao.int/MID/Documents/eANP/MID%20eANP%20VOL%20III.pdf
C. 20/10	**WEB-BASED MID REGION AIR NAVIGATION REPORT - 2022** That, the Web-based MID Air Navigation Report (2022) is endorsed.	To publish the status of ASBU implementation in the MID Region for 2022	MID Air Navigation Report (2022)	ICAO	May. 2023	**Completed** MID Air Navigation Report (2022) is published and accessible through https://www.icao.int/MID/Documents/2023/AN%20Report%202022/MID%20AN%20Report%202022-V0.4-Kaveh-MS%20inputs-27Nov23.pdf

No.	CONCLUSIONS AND DECISIONS	CONCERNS/ CHALLENGES (RATIONALE)	DELIVERABLE/ TO BE INITIATED BY		TARGET DATE	STATUS/REMARKS
C 20/11	**WEB-BASED MID REGION AIR NAVIGATION REPORT (2023)** That, a) States be invited to provide the ICAO MID Office with the following data for the development of the MID Region Air Navigation Report (2023) by 1 December 2023: i. Status of ASBU Implementation; and ii. States' implementation of the Performance Based approach using the agreed Template as at Appendix 6.1A b) the MID Air Navigation Report (2023) be presented to the MIDANPIRG/21 for endorsement.	Monitoring and Reporting on ASBU and PBA implementation in the MID Region	State Letter Data for WEB-BASED AN Report 2023 WEB-BASED AN Report 2023	ICAO States ICAO	November 2023 Dec. 2023 January. 2024	**On-going**
C 20/18	**NOTAM TEMPLATE FOR GNSS INTERFERENCE** That, the NOTAM template at Appendix 6.2A be used to disseminate information on GNSS Interference.	To provide States with a standard NOTAM template to be used for GNSS Interference to facilitate operators in filtering and searching through the NOTAM on GNSS Interference	NOTAM template for GNSS RFI	ICAO	May 2023	**Completed** State Letter Ref.: AN 8/2.1-23/165 dated 10 August 2023
C 20/20	**CCO/CDO PUBLICATION, CHARTING & DATABASE CODING** That, the AIP CCO/CDO material, structure and content along with the Database coding and Charting at Appendix 6.2C are recommended for the dissemination of information on CCO/CDO.	Support States' ANS to publish CCO/CDO information (text and Charts) so text be easily found in the States AIPs	Guidance material related to the publication of CCO/CDO information (text and Charts)	ICAO	May 2023	**Actioned** State Letter Ref.: AN 8/2.1-23/166 dated 10 August 2023

No.	CONCLUSIONS AND DECISIONS	CONCERNS/ CHALLENGES (RATIONALE)	DELIVERABLE/ TO BE INITIATED BY		TARGET DATE	STATUS/REMARKS
C 20/23	**WEBINAR ON THE UPDATES TO THE PBN MANUAL – 5TH EDITION** That, ICAO MID organize a Webinar on the new edition of PBN Manual Doc 9613 (ED5) in 2023.	To provide insights on key changes to the edition 5 of the PBN manual Doc9613	Webinar on the new edition of PBN Manual Doc 9613 (ED5) in 2023	ICAO	November 2023	**On-going** The Webinar is planned for 2024
C 20/24	**PBN AIRSPACE DESIGN WORKSHOP** That: a) ICAO MID in collaboration with the MID FPP, organize a PBN Airspace Design Workshop in 2023-2024, to provide necessary knowledge about PBN based solutions for airspace design to ensure an efficient, flexible, and dynamic airspace structure that meets Stakeholders requirements in terms of safety, flight efficiency and capacity in a cost-effective manner; and b) States and International Organizations are strongly encouraged to participate actively in this Workshop.	To provide States with a thorough understanding of airspace design requirements; focusing on PBN based solutions and to promote the sharing of good practices.	PBN Airspace Design Workshop	ICAO	December 2023	**Completed**
C 20/25	**REVISED VERSION OF THE MID REGION PBN IMPLEMENTATION PLAN (DOC 007)** That, the revised version of MID Region PBN Implementation Plan (Doc 007) at Appendix 6.3A is endorsed.	To keep pace with the developments, including the GANP 6th Edition and the MID Region Air Navigation Strategy (MID Doc 002, Edition February 2021);	Updated version of the MID Region PBN Implementation Plan (MID Doc 007)	ICAO	May 2023	**Completed** MID Doc007 is published and accessible through https://www.icao.int/MID/MIDANPIRG/Documents/eDocuments/MID%20Doc%20007%20-%20MID%20Region%20PBN%20Implementation%20Plan-%20May%202023.pdf

No.	CONCLUSIONS AND DECISIONS	CONCERNS/ CHALLENGES (RATIONALE)	DELIVERABLE/ TO BE INITIATED BY		TARGET DATE	STATUS/REMARKS
C 20/26	**PBN CAPACITY-BUILDING AND ASSISTANCE ACTIVITIES** That, States are encouraged to inform the ICAO MID Office under the MEP framework of their needs in terms of PBN capacity-building and required assistance activities, including PBN National Workshops to provide specific guidance related to PBN planning, implementation, including improvement of practices in PBN Design, operational approval, and continuous oversight.	To identify MID States specific needs for technical support, capacity-building and required assistance activities	To inform the ICAO MID Office of specific needs in terms of PBN capacity-building and assistance activities	MID States	May 2023	**Actioned** State Letter Ref.: AN 6/28-23/167 dated 14 August 2023
D 20/46	**NAVMON PLAN TEMPLATE** That, in order to develop the NAV MON Plan template, the ATM SG, CNS SG and PBN SG be tasked to review and update, as deem necessary, the NAV MON Plan Template to be presented to MIDANPIRG/21 for further review and endorsement.	to review and update, as deem necessary, the NAV MON Plan Template	NAV MON Template	PBN SG	December 2023	**On-going** Update is provided in WP/14

MID REGION PBN IMPLEMENTATION STATUS

Updated on 01st December 2023

Legend		
	Red	Not implemented
	Yellow	Not feasible
	Orange	Not applicable
	Grey	Data not available
	Green	Implemented

State	Airport	RWY ends	LNAV	LNAV/ VNAV	RNAV SID	RNAV STAR	CDO	CCO	PB-AOM
Bahrain	OBBI	RWY 12R	Implemented	Implemented	Not implemented	Not implemented	Implemented	Implemented	Implemented
		RWY 12L	Implemented	Implemented	Not implemented	Implemented	Implemented	Implemented	
		RWY 30R	Implemented	Implemented	Not implemented	Implemented	Implemented	Implemented	
		RWY 30L	Implemented	Implemented	Not implemented	Not implemented	Implemented	Implemented	
Egypt	HEBA	RWY 14R	Implemented	Not implemented	Not implemented	Not implemented	Not applicable	Not applicable	Implemented
		RWY 32L	Implemented	Not implemented	Not implemented	Not implemented			
		RWY 32	Implemented	Not implemented	Not implemented	Not implemented			
	HESN	RWY 17	Implemented	Implemented	Implemented	Implemented			
		RWY 35	Implemented	Implemented	Implemented	Implemented			
	HECA	RWY 05L	Implemented	Not implemented	Not implemented	Not implemented			
		RWY 23R	Implemented	Not implemented	Not implemented	Not implemented			
		RWY 05C	Implemented	Not implemented	Not implemented	Not implemented			
		RWY 23C	Implemented	Not implemented	Not implemented	Not implemented			
		RWY 05R	Implemented	Not implemented	Not implemented	Not implemented			
		RWY 23L	Implemented	Not implemented	Not implemented	Not implemented			
	HEGN	RWY 16L	Implemented	Implemented	Not implemented	Not implemented			
		RWY 34R	Implemented	Implemented	Implemented	Implemented			
		RWY 16R	Implemented	Implemented	Not implemented	Not implemented			

State	Airport	RWY ends	LNAV	LNAV/ VNAV	RNAV SID	RNAV STAR	CDO	CCO	PB-AOM
		RWY 34L							
	HELX	RWY 02							
		RWY 20							
		RWY 02L							
		RWY 20R							
	HEMA	RWY 15							
		RWY 33							
	HESH	RWY 04L							
		RWY 22R							
		RWY 04R							
		RWY 22L							
Iran	OIKB	RWY 03R							
		RWY 21L							
	OIFM	RWY 08L							
		RWY 26R							
		RWY 08R							
		RWY 26L							
	OIMM	RWY 13L							
		RWY 31R							
		RWY 13R							
		RWY 31L							
	OISS	RWY 29L							

State	Airport	RWY ends	LNAV	LNAV/ VNAV	RNAV SID	RNAV STAR	CDO	CCO	PB-AOM
		RWY 29R							
	OITT	RWY 12L							
		RWY 30R							
	OIIE	RWY 11L							
		RWY 29R							
	OIII	RWY 11R							
		RWY 29L							
		RWY 11L							
		RWY 29R							
	OIYY	RWY 13							
		RWY 31							
	OIZH	RWY 17R							
		RWY 35L							
Iraq	ORNI	RWY 28							
		RWY 10							
	ORBI	RWY 15R							
		RWY 33L							
		RWY 15L							
		RWY 33R							
	ORMM	RWY 32							
		RWY 14							
	ORER	RWY 18							
		RWY 36							
	ORSU	RWY 31							

State	Airport	RWY ends	LNAV	LNAV/ VNAV	RNAV SID	RNAV STAR	CDO	CCO	PB-AOM
		RWY 13							
Jordan	OJAM	RWY 06							
		RWY 24							
	OJAI	RWY 08R							
		RWY 26L							
		RWY 08L							
		RWY 26R							
	OJAQ	RWY 01							
		RWY 19							
Kuwait	OKBK	RWY 15R							
		RWY 33L							
		RWY 15L							
		RWY 33R							
Lebanon	OLBA	RWY 03							
		RWY 21							
		RWY 16							
		RWY 17							
Libya	HLLB	RWY 15L							
		RWY 33R							
		RWY 15R							
		RWY 33L							

State	Airport	RWY ends	LNAV	LNAV/ VNAV	RNAV SID	RNAV STAR	CDO	CCO	PB-AOM
	HLLS	RWY 13							
		RWY 31							
	HLLT	RWY 09							
		RWY 27							
Oman	OOMS	RWY 08L							
		RWY 26R							
	OOSA	RWY 07							
		RWY 25							
Qatar	OTBD	RWY 15							
		RWY 33							
	OTHH	RWY 16L							
		RWY 34R							
		RWY 16R							
		RWY 34L							
Saudi Arabia	OEDF	RWY 16L							
		RWY 34R							
		RWY 16R							
		RWY 34L							
	OEJN	RWY 16R							
		RWY 34L							
		RWY 16C							
		RWY 34C							

State	Airport	RWY ends	LNAV	LNAV/ VNAV	RNAV SID	RNAV STAR	CDO	CCO	PB-AOM
		RWY 16L							
		RWY 34R							
	OEMA	RWY 17							
		RWY 35							
		RWY 18							
		RWY 36							
	OERK	RWY 15L							
		RWY 33R							
		RWY 15R							
		RWY 33L							
Sudan	HSOB	RWY 01							
		RWY 19							
	HSSK	RWY 18							
		RWY 36							
	HSNN	RWY 04							
		RWY 22							
	HSPN	RWY 16							
		RWY 34							
Syria	OSAP	RWY 09							
		RWY 27							
	OSDI	RWY 05L							
		RWY 23R							
		RWY 05R							

State	Airport	RWY ends	LNAV	LNAV/ VNAV	RNAV SID	RNAV STAR	CDO	CCO	PB-AOM
		RWY 23L							
	OSLK	RWY 17							
		RWY 35							
UAE	OMAA	RWY 13 R							
		RWY 31 L							
		RWY 13 L							
		RWY 31 R							
	OMAD	RWY 13							
		RWY 31							
	OMAL	RWY 01							
		RWY 19							
	OMDW	RWY 12							
		RWY 30							
		RWY 13							
		RWY 31							
	OMDB	RWY 12L							
		RWY 30R							
		RWY 12R							
		RWY 30L							
	OMFJ	RWY 11							
		RWY 29							
	OMRK	RWY 16							
		RWY 34							

State	Airport	RWY ends	LNAV	LNAV/ VNAV	RNAV SID	RNAV STAR	CDO	CCO	PB-AOM
	OMSJ	RWY 12							
		RWY 30							
Yemen	OYAA	RWY 08							
		RWY 26							
	OYHD	RWY 03							
		RWY 21							
	OYRN	RWY 06							
		RWY 24							
	OYSN	RWY 18							
		RWY 36							
	OYTZ	RWY 01							
		RWY 19							

APTA : Improve arrival and departure operations

TABLE -APTA 3-1

EXPLANATION OF THE TABLE

Column	
1	Name of the State / International Aerodromes' Location Indicator
2	Runway Designator
3, 4, 5	Conventional Approaches (ILS / VOR or NDB)
6, 7, 8, 9	Elements of APTA B0/1 PBN Approaches with basic capabilities (Status of PBN Plan and implementation of LNAV, LNAV/VNAV), where:
	Y – Yes, implemented
	N – No, not implemented
10	PBN Runway: where any type of PBN approach is implemented
12, 15	Elements of APTA B0/2 PBN SID and STAR procedures (with basic capabilities)
	Y – Yes, implemented
	N – No, not implemented
11, 13	Elements of APTA B0/5 CCO basic (Status of implementation of CCO) per runway end and per aerodrome, where:
	Y – Yes, implemented
	N – No, not implemented
14, 16	Elements of APTA B0/4 CDO basic (Status of implementation of CDO) per runway end and per aerodrome, where:

	Y – Yes, implemented
	N – No, not implemented
17	Elements of APTA B0/7 Performance based aerodrome operating minima – Advanced aircraft (Compliance with the requirements for PB AOM) per State, where:
	FC – Fully compliant
	NC – Not compliant
18	Remarks

Int'l AD (Ref. MID ANP) (1)	RWY (2)	Conventional Approaches (3)			APTA (6)				CCO (11)				CDO (14)				PB AOM (17)	Remarks (18)
		Precision (4)		VOR or NDB (5)	PBN PLAN (7)	LNAV (8)	LNAV / VNAV (9)	PBN RWY (10)	RNAV SID (12)		CCO (13)		RNAV STAR (15)		CDO (16)			
		xLS	CAT		Update date				RWY	AD	RWY	AD	RWY	AD	RWY	AD		
BAHRAIN																		
OBBI	12L	ILS	II	VORDME		Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	
	12R			VORDME		Y	Y	Y	N	N	N	N	N	N	N	N		
	30L			VORDME		Y	Y	Y	N	N	N	N	N	N	N	N		
	30R	ILS	II	VORDME		Y	Y	Y	N	N	Y	N	Y	N	Y	N		
Total	4	2		4	Y	4	4	4	0	0	2	1	2	1	2	1	-	

%		50		100	Y	100	100	100	0	0	50	100	50	100	50	100	100	
EGYPT																		
HEBA	14					Y	N	Y	N	Y	N	N	N	N	N	N		
	32	ILS	I			Y	N	Y	Y	N	N	N	N	N	N	N		
HESN	17			VORDME		Y	Y	Y	Y	Y	N	N	Y	Y	N	N		
	35	ILS	I	VORDME		Y	Y	Y	Y	N	N	N	Y	N	N	N		
HECA	05L	ILS	I	VORDME		Y	N	Y	N	N	N	N	N	N	N	N		
	05C	ILS	II	VORDME		Y	N	Y	N	N	N	N	N	N	N	N		
	05R	ILS	II			Y	N	Y	N	N	N	N	N	N	N	N		
	23L	ILS	II	VORDME		Y	N	Y	N	N	N	N	N	N	N	N		
	23C	ILS	II	VORDME		Y	N	Y	N	N	N	N	N	N	N	N		
	23R	ILS	I	VORDME		Y	N	Y	N	N	N	N	N	N	N	N	Y	
HEGN	16L			VORDME		Y	Y	Y	N	Y	N	N	N	Y	N	N		
	16R			VORDME		Y	Y	Y	N	N	N	N	N	N	N	N		
	34L			VORDME		Y	Y	Y	Y	N	N	N	Y	N	N	N		
	34R	ILS	I	VORDME		Y	Y	Y	Y	N	N	N	Y	N	N	N		
HELX	2	ILS	I	VORDME		Y	Y	Y	Y	Y	N	N	Y	Y	N	N		
	20	ILS	I	VORDME		Y	Y	Y	Y	N	N	N	Y	N	N	N		
HEMA	15			VORDME		Y	N	Y	Y	Y	N	N	Y	Y	N	N		
	33			VORDME		Y	N	Y	Y	N	N	N	Y	N	N	N		
HESH	04L	ILS	I	VORDME		Y	Y	Y	Y	Y	N	N	Y	Y	N	N		

	04R			VORDME		Y	Y	Y	Y	N	N	N	Y	N	N	N		
	22L					Y	Y	Y	Y	N	N	N	Y	N	N	N		
	22R					Y	Y	Y	Y	N	N	N	Y	N	N	N		
Total	22	12		17	Y	22	12	22	13	6	0	0	12	5	0	0	-	
%		55		77	Y	100	55	100	59	86	0	0	55	71	0	0	100	
I.R. IRAN																		
OIKB	03L					N	N	N	N	N	N	N	N	N	N	N		
	03R			VORDME / NDB		N	N	N	N	N	N	N	N	N	N	N		
	21L	ILS	I	VORDME / NDB		N	N	N	N	N	N	N	N	N	N	N		
	21R					N	N	N	N	N	N	N	N	N	N	N		
OIFM	08L			VORDME / NDB		N	N	N	N	N	N	N	N	N	N	N	Y	
	08R			VORDME / NDB		N	N	N	N	N	N	N	N	N	N	N		
	26L			VORDME / NDB		N	N	N	N	N	N	N	N	N	N	N		
	26R	ILS	I	VORDME / NDB		N	N	N	N	N	N	N	N	N	N	N		
OIMM	13L			VORDME		N	N	N	N	N	N	N	N	N	N	N		
	13R			VORDME		N	N	N	N	N	N	N	N	N	N	N		

	31L			VORDME / NDB		N	N	N	N	N	N	N	N	N	N	N	
	31R	ILS	I	VORDME / NDB		N	N	N	N	N	N	N	N	N	N	N	
OISS	11L					N	N	N	N	N	N	N	N	N	N	N	
	11R					N	N	N	N	N	N	N	N	N	N	N	
	29L	ILS	I	VORDME / NDB		N	N	N	N	N	N	N	N	N	N	N	
	29R			VORDME / NDB		N	N	N	N	N	N	N	N	N	N	N	
OITT	12L			VORDME / NDB		N	N	N	N	N	N	N	N	N	N	N	
	12R			VORDME / NDB		N	N	N	N	N	N	N	N	N	N	N	
	30L	ILS	I	VORDME / NDB		N	N	N	N	N	N	N	N	N	N	N	
	30R	ILS	I	VORDME / NDB		N	N	N	N	N	N	N	N	N	N	N	
OIIE	11L	ILS	I	VORDME		Y	Y	Y	N	N	N	N	Y	Y	N	N	
	11R			VORDME		N	N	N	N	N	N	N	Y	N	N	N	
	29L					N	N	N	N	N	N	N	Y	N	N	N	
	29R	ILS	II	VORDME		Y	Y	Y	N	N	N	N	Y	Y	N	N	
OIII	11L			VORDME		N	N	N	N	N	N	N	N	N	N	N	

	11R			VORDME		N	N	N	N	N	N	N	N	N	N	N		
	29L	ILS	I	VORDME		Y	Y	Y	N	N	N	N	N	N	N	N		
	29R			VORDME		N	N	N	N	N	N	N	N	N	N	N		
OIZH	17R					Y	Y	Y	N	N	N	N	Y	Y	N	N		
	17L					N	N	N	N	N	N	N	N	N	N	N		
	35L	ILS	I	VORDME		Y	Y	Y	N	N	N	N	Y	N	N	N		
	35R					N	N	N	N	N	N	N	N	N	N	N		
OIYY	13			VORDME		Y	N	Y	N	N	N	N	N	N	N	N		
	31	ILS	I	VORDME		Y	Y	Y	N	N	N	N	N	N	N	N		
Total	34	11		26	Y	7	6	7	0	0	0	0	6	3	0	0	-	
%		32		76	Y	21	18	21	0	0	0	0	18	9	0	0	100	
IRAQ																		
ORBI	15L	ILS	I	VORDME		N	N	N	N	N	N	N	N	N	N	N		
	15R					Y	N	Y	N	N	N	N	N	N	N	N		
	33L					Y	N	Y	N	N	N	N	N	N	N	N		
	33R	ILS	I	VORDME		N	N	N	N	N	N	N	N	N	N	N	N	
ORMM	14			VORDME		N	N	N	N	N	N	N	N	N	N	N		
	32	ILS	I	VORDME		N	N	N	N	N	N	N	N	N	N	N		
ORER	18	ILS	II			Y	N	Y	N	N	N	N	N	N	N	N		
	36	ILS	I			Y	N	Y	N	N	N	N	N	N	N	N		

ORSU	13	ILS	I	VOR		Y	N	Y	N	N	N	N	N	N	N	N		
	31	ILS	I	VOR		Y	N	Y	N	N	N	N	N	N	N	N		
ORNI	10	ILS	I	VOR		Y	Y	Y	Y	Y	N	N	Y	Y	N	N		
	28	ILS	I	VOR		Y	Y	Y	Y	N	N	N	Y	N	N	N		
ORBM	15					N	N	N	N	N	N	N	N	N	N	N		
	33					N	N	N	N	N	N	N	N	N	N	N		
Total	14	9		8	N	8	2	8	2	1	0	0	2	1	0	0	-	
%		64		57		57	14	57	14	17	0	0	14	16.67	0	0	0	
JORDAN																		
OJAI	08L	ILS	I	NDB		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
	08R			NDB		Y	Y	Y	Y	N	N	N	Y	N	N	N		
	26L	ILS	II	VOR		Y	Y	Y	Y	N	N	N	Y	N	N	N		
	26R	ILS	I	VORDME		Y	Y	Y	Y	N	N	N	Y	N	N	N		
OJAQ	1	ILS	I			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
	19	ILS	I			Y	N/A	Y	Y	N	N	N	Y	N	N	N		LNAV/VNAV not feasible
Total	6	5		4	Y	6	6	6	6	2	2	2	6	2	2	2	-	
%		83		67		100	100	100	100	100	33	100	100	100	33	100	100	
KUWAIT																		
OKBK	15L	ILS	II	VORDME		Y	Y	Y	Y	Y	N	N	Y	Y	N	N	N	
	15R	ILS	II	VORDME		Y	Y	Y	Y	N	N	N	Y	N	N	N		

	33L	ILS	II	VORDME		Y	Y	Y	Y	N	N	N	Y	N	N	N		
	33R	ILS	II	VORDME		Y	Y	Y	Y	N	N	N	Y	N	N	N		
Total	4	4		4	Y	4	4	4	4	1	0	0	4	1	0	0	-	
%		100		100		100	100	100	100	100	0	0	100	100	0	0	0	
LEBANON																		
OLBA	3	ILS	I	VORDME		Y	N	Y	N	N	Y	Y	Y	Y	Y	Y		
	16	ILS	I	VORDME		Y	N	Y	N	N	Y	N	Y	N	Y	N		
	17	ILS	I	VORDME / NDB		Y	N	Y	N	N	Y	N	Y	N	Y	N		
	21					Y	N	Y	N	N	Y	N	Y	N	Y	N	Y	
	34	N/A		N/A		N	N	N	N	N	Y	N	N	N	N	N		Not used for landing
	35	N/A		N/A		N	N	N	N	N	Y	N	N	N	N	N		Not used for landing
Total	4	5		5	N	4	0	4	0	0	6	1	4	1	4	1	-	
%		125		125		100	0	100	0	0	150	100	100	100	100	100	100	
LIBYA																		
HLLB	15R			VORDME		N	N	N	N	N	N	N	N	N	N	N		
	15L			VORDME		N	N	N	N	N	N	N	N	N	N	N		
	33R			VORDME		N	N	N	N	N	N	N	N	N	N	N	Y	
	33L	ILS	I	VORDME		N	N	N	N	N	N	N	N	N	N	N		
HLLS	13	ILS	I	VORDME		N	N	N	N	N	N	N	N	N	N	N		

	31			VORDME		N	N	N	N	N	N	N	N	N	N	N		
HLLT	9			VORDME		N	N	N	N	N	N	N	N	N	N	N		
	27	ILS	I	VORDME		N	N	N	N	N	N	N	N	N	N	N		
Total	8	3		8	N	0	0	0	0	0	0	0	0	0	0	0	-	
%		38		100		0	0	0	0	0	0	0	0	0	0	0	100	
OMAN																		
OOMS	08L	ILS	I	VORDME		Y	Y	Y	Y	Y	N	N	Y	Y	N	N		
	26R	ILS	I	VORDME		Y	Y	Y	Y	N	N	N	Y	N	N	N	Y	
OOSA	7	ILS	I	VORDME		Y	Y	Y	Y	Y	N	N	Y	Y	N	N		
	25	ILS	I	VORDME		Y	Y	Y	Y	N	N	N	Y	N	N	N		
Total	4	4		4	Y	4	4	4	4	2	0	0	4	2	0	0	-	
%		100		100		100	100	100	100	100	0	0	100	100	0	0	100	
QATAR																		
OTBD	15	ILS	I	VORDME		Y	N/A	Y	Y	Y	Y	Y	Y	Y	Y	Y		LNAV/VNAV not feasible
	33	ILS	II/III	VORDME/NDB		Y	Y	Y	Y	N	Y	N	Y	N	Y	N	Y	CCO/CDO tactically achieved
OTHH	16L	ILS	I/II/III	VORDME		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		CCO/CDO tactically achieved

	16R	ILS	I/II/III	VORDME		Y	Y	Y	Y	N	Y	N	Y	N	Y	N		CCO/CDO tactically achieved
	34L	ILS	I/II/III	VORDME		Y	Y	Y	Y	N	Y	N	Y	N	Y	N		CCO/CDO tactically achieved
	34R	ILS	I/II/III	VORDME		Y	Y	Y	Y	N	Y	N	Y	N	Y	N		CCO/CDO tactically achieved
Total	6	6		6	Y	6	6	6	6	2	6	2	6	2	6	2	-	
%		100		100		100	100	100	100	100	100	100	100	100	100	100	100	
SAUDI ARABIA																		
OEDF	16L	ILS	I	-		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
	16R	ILS	I	VORDME		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
	34L	ILS	I	VORDME		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
	34R	ILS	I	VORDME		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
OEJN	16L	ILS	I			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
	16C	ILS	I			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
	16R	ILS	I	VORDME		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
	34L	ILS	I	VORDME		NP	NP	N	Y	Y	Y	Y	Y	Y	Y	Y		(NP): Not Published due to operationally unacceptable

																		OCA
	34C	ILS	I	VORDME		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
	34R	ILS	I			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
OEMA	17	ILS	I	VORDME		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
	18			VORDME		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
	35	ILS	I	VORDME		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
	36	ILS	I	VORDME		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
OERK	15L	ILS	I	VORDME		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
	15R	ILS	I	VORDME		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
	33L	ILS	I			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
	33R	ILS	I	VORDME		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
Total	18	17		13	Y	18	18	18	18	18	18	18	18	18	18	18		
%		94		72	Jan 2023	100	100	100	100	100	100	100	100	100	100	100	100	
SUDAN																		
HSNN	4					Y	N	Y	Y	Y	N	N	Y	Y	N	N		
	22					Y	N	Y	Y	N	N	N	Y	N	N	N		
HSOB	1					Y	N	Y	Y	Y	N	N	Y	Y	N	N	N	
	19					Y	N	Y	Y	N	N	N	Y	N	N	N		
HSSS	18	ILS	I	VORDME		Y	N	Y	Y	Y	N	N	Y	Y	N	N		
	36	ILS	I	VORDME		Y	N	Y	Y	N	N	N	Y	N	N	N		

HSPN	17			VORDME / NDB		Y	N	Y	Y	Y	N	N	Y	Y	N	N		
	35	ILS	I	VORDME / NDB		Y	N	Y	Y	N	N	N	Y	N	N	N		
Total	8	4		4	Y	8	0	8	8	4	0	0	8	4	0	0	-	
%		50		50		100	0	100	100	100	0	0	100	100	0	0	0	
SYRIA																		
OSAP	9			VORDME		N	N	N	N	N	N	N	N	N	N	N		
	27	ILS	II	VORDME / NDB		N	N	N	N	N	N	N	N	N	N	N		
OSLK	17	ILS	I	VORDME / NDB		N	N	N	N	N	N	N	N	N	N	N		
	35					N	N	N	N	N	N	N	N	N	N	N	N	
OSDI	05L			VOR		N	N	N	N	N	N	N	N	N	N	N		
	05R	ILS	II	VORDME / NDB		N	N	N	N	N	N	N	N	N	N	N		
	23L			VORDME / NDB DME		N	N	N	N	N	N	N	N	N	N	N		
	23R	ILS	II	VORDME		Y	Y	Y	N	N	N	N	N	N	N	N		
Total	8	4		7		1	1	1	0	0	0	0	0	0	0	0	-	
%		50		88		13	13	13	0	0	0	0	0	0	0	0	0	
UNITED ARAB EMIRATES																		
OMAA	13L	ILS	II			AR	AR	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	RNP AR

	13R	ILS	I	VOR		AR	AR	Y	Y	N	Y	N	Y	N	Y	N	RNP AR
	31L	ILS	II/III	VOR		AR	AR	Y	Y	N	Y	N	Y	N	Y	N	RNP AR
	31R	ILS	II			AR	AR	Y	Y	N	Y	N	Y	N	Y	N	RNP AR
OMAD	13			VORDME		Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	
	31	ILS	I	VORDME		Y	N	Y	Y	N	Y	N	Y	N	Y	N	
OMAL	1	ILS	I	VOR		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
	19			VOR		Y	Y	Y	Y	N	Y	N	Y	N	Y	N	
OMDB	12L	ILS	I/II/III			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
	12R	ILS	I/II/III			Y	Y	Y	Y	N	Y	N	Y	N	Y	N	
	30L	ILS	I/II/III			Y	Y	Y	Y	N	Y	N	Y	N	Y	N	
	30R	ILS	I/II/III			Y	Y	Y	Y	N	Y	N	Y	N	Y	N	
OMDW	12	ILS	II/III			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
	30	ILS	II/III			Y	Y	Y	Y	N	Y	N	Y	N	Y	N	
OMFJ	11					N/A	N/A	N/A	Y	Y	Y	Y	N	Y	N	Y	Not used for landing
	29	ILS	I	VOR		Y	Y	Y	Y	N	Y	N	Y	N	Y	N	
OMRK	16			VOR		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
	34	ILS	I	VOR		Y	Y	Y	Y	N	Y	N	Y	N	Y	N	
OMSJ	12	ILS	I			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	RNP AR

	30	ILS	II			Y	Y	Y	Y	N	Y	N	Y	N	Y	N		RNP AR
Total	20	16		9	Y	20	18	20	20	8	20	8	19	8	19	8	-	
%		80		45		100	90	100	100	100	100	100	95	100	95	100	100	
YEMEN																		
OYAA	8					Y	N	Y	N	N	N	N	N	N	N	N	Y	
	26					Y	N	Y	N	N	N	N	N	N	N	N		
OYHD	3			VOR		N	N	N	N	N	N	N	N	Y	N	N		
	21			VOR / NDB		Y	N	Y	N	N	N	N	Y	N	N	N		
OYRN	6					N	N	N	N	N	N	N	N	N	N	N		
	24			VORDME		N	N	N	N	N	N	N	N	N	N	N		
OYSN	18	ILS	I	VORDME/NDB		Y	Y	Y	Y	Y	N	N	Y	Y	N	N		
	36			VOR		Y	Y	Y	Y	N	N	N	Y	N	N	N		
OYTZ	1					N	N	N	N	N	N	N	N	N	N	N		
	19					N	N	N	N	N	N	N	N	N	N	N		
Total	10	1		5		5	2	5	2	1	0	0	3	2	0	0	-	58
%		10		50		50	20	50	20	10	0	0	30	20	0	0	100	
Results					Plans	LNAV	LNAV/VNAV	PBN RWYs		SID		CCO		STAR		CDO		

Total	168	104		126	13	106	83	115	79	30	49	14	94	35	51	17	10 PBN APV + 101 ILS (111/166)
Percentage (%)		63		76	87	64	50	69	48	45	30	24	57	52	31	24	67% RWY Ends with Vertical guidance
58	Aerodromes																
Note. 6 RNP AR Approach were implemented in UAE (OMAA and OMSJ)																	

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Guidance on Risks related to altimeter setting errors during APV Baro-VNAV and non-precision approach operations

Date: December 2023

Disclaimer

This document has been compiled by the MID Region civil aviation stakeholders to raise awareness on the Risks related to altimeter setting errors during APV Baro-VNAV and non-precision approach operations by providing guidance for civil aviation regulators, Air Navigation Services Providers (ANSPs) to mitigate the risks related to altimeter setting errors, in particular during APV baro-VNAV and non-precision approach operations.

It is not intended to supersede or replace existing materials produced by the National Regulator or in ICAO SARPs. The distribution or publication of this document does not prejudice the National Regulator's ability to enforce existing National regulations.

This guidance material should be thorough, accessible, and regularly updated to reflect changes in technology and regulations. It should serve as a valuable resource for aviation authorities, operators, and pilots to enhance safety during APV Baro-VNAV operations.

To the extent of any inconsistency between this document and the National/International regulations, standards, recommendations or advisory publications, the content of the National/International regulations, standards, recommendations and advisory publications shall prevail**.**

TABLE OF CONTENTS

Risks related to altimeter setting errors during APV Baro-VNAV and non-precision approach operations

1. BACKGROUND

1.1 Using an erroneous barometric reference setting during approach may cause the aircraft to fly lower than the published approach path, when the vertical guidance and trajectory deviations use the barometric reference. This can lead to a risk of controlled flight into terrain in poor visibility conditions or at night.

1.2 Recent incidents have highlighted that an erroneous altimeter setting can have serious consequences on flight safety during final approach operations.

1.3 This safety advisory explains the potential consequences of an erroneous barometric reference. It aims to draw renewed and refreshed attention to the risk of Controlled Flight into Terrain (CFIT) when flying instrument approach operations with the pressure altimeter sub-scale set to an incorrect pressure setting and provides a set of recommendations to mitigate altimeter setting errors.

2. RISKS

2.1 The technical characteristics of the altimeter induce two risks that could lead to the determination of an erroneous altitude:

a) The incorrect altimeter setting;
b) The temperature effect (difference between the real atmosphere and the standard atmosphere).

2.2 Barometric altimeter setting errors can lead to significant altimeter deviations. Each 1hPa error equates to 28 ft of height difference; therefore, an altimeter setting error of 10 hPa would result in an altitude error of about 280 ft. The diagram below highlights what the situation might look like :

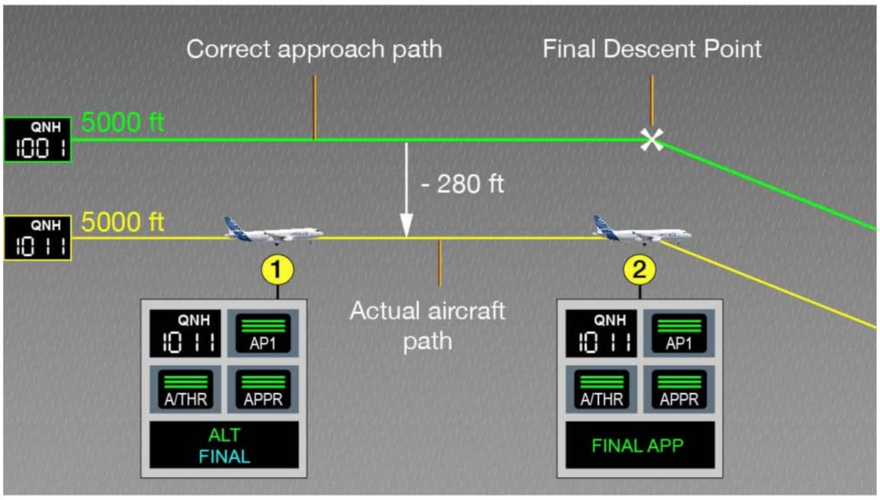

Figure 1 – Example of altitude deviation resulting from altimeter setting error

2.3 Temperature has an effect on the accuracy of barometric altimeters, indicated altitude, and true altitude. The standard temperature at sea level is 15 degrees Celsius. The temperature gradient from sea level is minus 2 degrees Celsius per 1,000 feet.

For example, if the OAT is - 40 °C then for a 2000 ft indicated altitude the true altitude is 1520 ft thus resulting in a lower than anticipated terrain separation and a potential obstacle-clearance hazard.

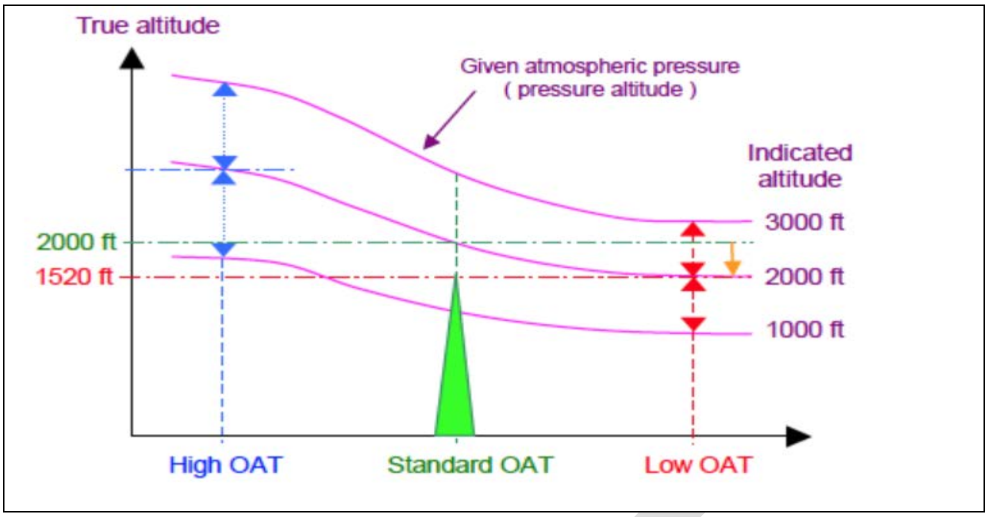

Figure 2 – Effect of Outside Air Temperature (OAT) on True Altitude

2.4 The effects of temperature can be anticipated because they are directly related to the deviation from the standard ISA temperature. They can lead to a reduction of safety margins, but technical solutions exist, as well as operational procedures, already in place, which allow to limit these effects, in particular by cold temperature corrections.

Note – Further guidance on the "RNP approach and RNP AR approach operations in non-standard temperature conditions" is available in the Performance-Based Navigation (PBN) Manual (Doc 9613), Fifth Edition, Volume II, Attachment B.

3. FINAL APPROACH OPERATIONS

3.1 The consequences of an erroneous altimeter setting will be more severe on the final segment of the approach for which the obstacle clearance margins are reduced. Most final approach operations can be affected by an erroneous altimeter setting. But they will not all be affected in the same manner.

3.2 ILS, SBAS (RNP APCH to LPV minima) or GBAS provide vertical guidance to the runway that is not dependent on barometric altitude. Once established on the glide path, an altimeter setting error will not affect the vertical profile. As a result, only the Decision Altitude (DA) based on barometric altitude, may still be subject to an error, such that the crew might make the decision either to land or go around higher or lower than expected, depending on the error of the altimeter setting.

3.3 On the other hand, non-precision approach procedures (NPAs) operated as either Dive & Drive (stepdown) or using a Continuous Final Descent Approach (CDFA) technique, as well as RNP APCH to LNAV or LNAV/VNAV minima and RNP AR operations rely heavily on the accuracy of altitude information provided by the pressure altimeters. If the appropriate pressure setting is set incorrectly on the altimeter sub-scale, the aircraft could be significantly above or below the safe vertical profile as determined by the procedure.

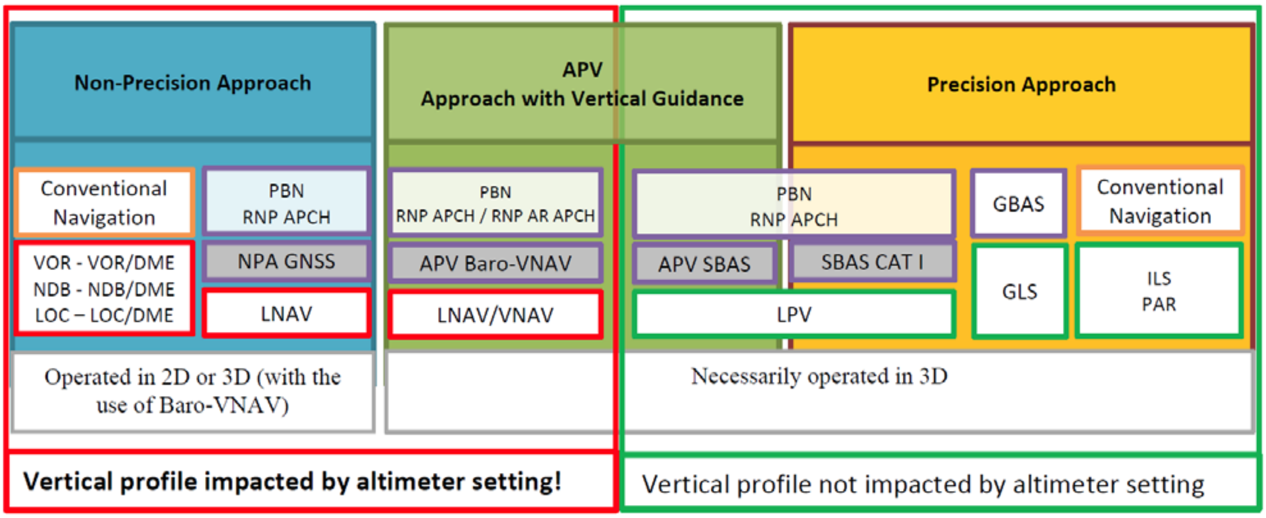

Figure 3 – Approach procedures and Altimeter setting

4. APPROACH OPERATIONS UTILIZING BAROMETRIC VERTICAL NAVIGATION (BARO-VNAV) EQUIPMENT

4.1 Baro-VNAV equipment can be used in two different scenarios to provide vertical guidance on a 3D approach operation:

a) Approach operations on APV procedures designed for 3D operations. In this case, the use of a baro-VNAV system is required.
b) Approach operations on non-precision approach procedures. In this case, the use of a baro-VNAV system is not required but auxiliary to facilitate the CDFA technique. This means that advisory VNAV guidance is being overlaid on a non-precision approach.

4.2 An undetected erroneous BARO setting can cause an aircraft to fly above or below the published final approach flight path when following approach guidance that uses a barometric reference. Vertical deviation indications are shown as correct, even if the aircraft is not on the correct flight path, with an incorrect BARO setting.

4.3 It is emphasised that a Terrain Awareness Warning System (TAWS) may not provide a ground proximity alert close to an aerodrome when the aircraft is in the landing configuration as shown the figure below.

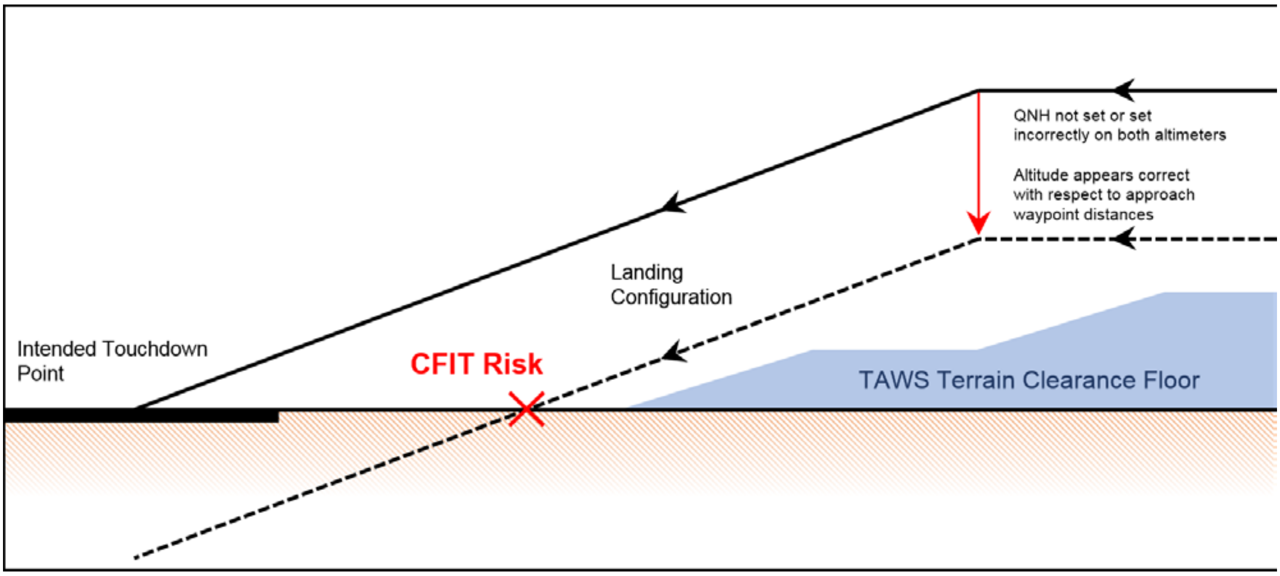

Figure 4 The TAWS may not detect a too low flight path

4.4 It is particularly worth highlighting that when using barometric altimetry for vertical navigation, altitude/distance cross checks in the standard operating procedures do not detect an incorrect barometric altimetry setting. Standard altitude-vs-distance checks will wrongly confirm that an aircraft is on the correct trajectory, because it uses the same erroneous barometric reference. If visual conditions are not sufficient, the flight crew may not be able to detect that their aircraft is on an incorrect flight path in time to adjust their trajectory or perform a go-around.

4.5 Baro-VNAV approach operations shall only be flown with a current local altimeter setting source available and the QNH/QFE, as appropriate, set on the aircraft's altimeter. Baro-VNAV procedures shall not be authorized with a remote altimeter setting.

5. OPERATIONS AT TEMPERATURES DIFFERING FROM ISA

5.1 Non-standard temperatures affect the measurement of pressure altitude by the aircraft's barometric altimetry systems. The measured pressure altitude can then negatively impact the actual vertical flight path and the VNAV guidance an aircraft's RNP system provides during RNP APCH and RNP AR APCH operations. During cold temperatures the aircraft's vertical path can be lower than indicated and reduced enough to potentially compromise the vertical protection procedural barometric altitudes provide during an instrument approach. In contrast, during hot temperatures, the aircraft's vertical path can be higher than indicated and result in aircraft VNAV guidance for a vertical path that is actually steeper than desired, potentially creating difficulties for energy management on the final approach segment.

5.2 Operations at temperatures differing from ISA will cause Barometric Temperature Error. Even a small difference from ISA temperatures can cause the approach flightpath to be steeper or shallower than published. Whilst this is allowed for in instrument procedure design within charted limits, it changes the relationship between indicated Barometric Altitude and Radio Altitude (RA) during the approach. This might make it more difficult to detect a mis-set QNH or could give the appearance of a mis-set QNH when in fact the flightpath error is caused by non-ISA temperatures. The diagram below refers.

5.3 The effects of temperature can be anticipated because they are directly related to the deviation from the standard ISA temperature. They can lead to a reduction of safety margins, but technical solutions exist, as well as operational procedures, already in place, which allow to limit these effects, in particular by cold temperature corrections.

Note – Further guidance on the "RNP approach and RNP AR approach operations in non-standard temperature conditions" is available in the Performance-Based Navigation (PBN) Manual (Doc 9613), Fifth Edition, Volume II, Attachment B.

6. Operational and Human Factors Involved in Altimeter-setting Errors

6.1 The following operational and human factors as causes of or contributing factors to altimeter-setting errors :

- Incorrect determination of the local barometric pressure, use of regional pressure instead of local barometric pressure values or transmission of a wrong value by the meteorological service provider,
- Provision of incorrect QNH through ATIS (where available)
- Ineffective ATC-Pilot communication, such as: wrong value given by ATC, incorrect read back not detected by ATC, radio/frequency issue, etc.
- Incorrect selection of the altimeter setting by the crew due to different factors such as: high workload during descent / approach, confusion in the unit of the barometric setting (Inch Hg instead of hPa), confusion between QNH and QFE, absence of effective crosscheck between crew members, flight deck system failure, etc.

7. Mitigation Actions

7.1 Aircraft operators and ANSPs are reminded of the importance of ensuring that the correct barometric altimetersetting is provided and entered in the aircraft's systems.

7.2 Some mitigations are as follows:

At aircraft operator's level

- Encourage the use of those 3D operations where final segment profiles cannot be impacted by wrong barometric altimeter setting (ILS, RNP APCH down to LPV minima, GLS).
- Establishment and strict adherence to the standard operating procedures for the use of the VNAV function.
- Consider adjusting the operating minima by taking into account the operational exposure and/or crew experience with approach procedures that are vulnerable to QNH errors.
- Apply Crew Resource Management techniques, such as cross-checking and monitoring.
- Consider altitude callouts, whereby the aircraft's radio altimeter can provide height callouts to the pilot when passing specific values (e.g. 500 ft and 1000 ft), which can be interpreted to assess whether the

aircraft is deviating from the intended vertical profile. This mitigation is more effective when the terrain is relatively flat.

- Configure correct QNH in all altimeters (main, standby) and FMS. The flight crew should pay attention to a barometric reference that significantly differs from the one used for approach preparation. That could be the symptom of a barometric reference error. The flight crew should consider cross-checking of the barometric references from all available sources (METAR, ATIS and ATS).
- Apply standard communication and phraseology between the pilot and air traffic services.
- Pilots should use effective Threat & Error Management (TEM) techniques to identify and mitigate against incorrect altimetry when preparing to fly an approach that relies directly on an accurate pressure altimeter sub-scale setting (e.g. use of Baro-VNAV, non-precision approaches).

<u>At ANSP level</u>

- Consider fixed and harmonized transition altitudes/levels which can harmonize the switch from 1013.2 hPa to QNH.
- Consider using the barometric pressure settings provided by Mode S EHS (Enhanced Surveillance) and ADS-B equipped aircraft, to enable the timely identification of aircraft operating with incorrect barometric altimeter setting.
- Consider introducing procedures to provide aircraft with the QNH at different phases of approach, including when clearing an aircraft for the approach or at first contact with the tower.
- Apply standard communication and phraseology between the pilot and air traffic services.

<u>Technical solutions</u>

- Consider using those 3D approach procedures where the final segment cannot be impacted by wrong QNH setting (ILS, RNP APCH down to LPV minima or GLS).
- Use of recovery safety nets, such as Minimum Safe Altitude Warning (MSAW) and Approach Path Monitor (APM) by ATC and Terrain Avoidance and Warning System (TAWS) by pilots, which can alert actors and thus lead to recovery actions associated with operational procedures.
  Note – these safety nets are not available in all aircraft or ATS units and their technology varies from one site to another. Their intrinsic characteristics, in particular resulting from choices intended to limit the false alarm rate, lead them, in certain cases, not to be triggered, without this being a malfunction. To get the most consistent alerts, aircraft operators should ensure that the latest available software version and the latest terrain and obstacle database are loaded in the TAWS.
- Consider the use of datalink for transmission of MET information, including QNH, to aircraft.
- Consider other emerging monitoring solutions that would offer comparison between barometric altitude with GNSS-driven altitude.

8. RECOMMENDATIONS

8.1 In order to better manage the risks related to altimeter setting errors, in particular during APV Baro-VNAVand non-precision approach operations, the followings are recommended:

a) General recommendations:

- to ensure that awareness of the risk of altimeter setting errors and their consequences is shared;
- to assess the robustness of the mitigation measures described in the previous point, and to consider implementing them, when relevant;
- to report all situations that have generated deviations in order to improve the visibility of this type of event, preferably with a perspective of the appropriate treatment in each case;
- to contribute collectively to training on this risk, to disseminate best practices and to promote exchanges between domains in order to better understand the limits of the systems;
- MET Service providers to ensure provision of quality-assured MET information to users;
- aircraft operators, to investigate methods to identify incorrect altimeter setting with the Flight Data Monitoring (FDM) Program; and

- Relevant ANC Panel(s), to assess the potential review of APV Baro-VNAV criteria concerning thelikelihood of QNH errors.

b) Recommendations on Training:

- Barometric altitude setting is largely dependent on human factors. Therefore, it is recommended to consider appropriate initial and recurrent training subjects to pilots and ATCOs, including the following:

  For pilots:

  - o Initial and recurrent training should address the limits of barometric altimetry, and the impact of incorrect barometric pressure settings on vertical position including those factors outlined inthis bulletin.
  - o Training and/or promotional initiatives on altimeter setting procedures, different impacts of QNH errors between geometric and barometric approaches and possible mitigation measures, use of standard phraseologies, adhering to read back and hear back, etc.
  - o Training on 3D operations including the difference between 3D depending on Baro-VNAV and other 3D approach operations, highlighting the critical importance of Barometric setting for Baro-VNAV operations.
  - o Training on 3D RNP operations highlighting the RNP chart layout where LNAV/VNAV and LPV minima co-exist.

  For ATCO:

  - o Initial and recurrent training should address the limits of barometric altimetry, and the impact of incorrect barometric pressure settings on vertical position including those factors outlined inthis bulletin.
  - o Training and/or promotional initiatives on altimeter setting procedures, different impacts of QNH errors between geometric and barometric approaches and possible ATC mitigation measures on erroneous setting of altimeter setting by flight crew, use of standard phraseologies for transmitting QNH information to pilots, paying attention to pilots' read back and hear back, etc.

- Flight Crew and Air Traffic Control Officer (ATCO) training should include how, why, and when MSAW (Minimum Safe Altitude Warning) alerts are generated as well as necessary actions and R/T calls as set out in PANS-ATM Doc 4444.

References

- ICAO Annex 3 – Meteorological Service for International Air navigation
- ICAO Annex 5 – Units of Measurement
- ICAO Annex 6 – Operations of Aircraft, Part I – International Commercial Air transport – Aeroplane,
- Procedures for Air Navigation Services – Rules of the Air and Air Traffic Services (PANS-ATM, Doc 4444).
- ICAO – Procedures for Air navigation Services – Aircraft Operations (PANS-OPS, Doc 8168), Volume I – Flight procedures
- EUR OPS Bulletin Serial Number: 2023_001
- EASA SIB No.: 2023-03
- UK Civil Aviation Authority SAFETY NOTICE Number: SN–2023/003
- Airbus Approach & Landing Briefing

Navigation Minimal Operating Networks Template
(NAVS MON)

State Name

Table of Contents

TBA

Executive Summary

~~TBA~~

The shift from facility-referenced navigation to coordinate-based navigation enabled by performance-based navigation (PBN) provides significant benefits, in particular by supplying the flexibility required to design airspace and associated routes and procedures according to operational needs. The most suitable navigation infrastructure to support PBN is GNSS. Consequently, the role of conventional navigation aids is currently evolving towards that of a reversionary terrestrial infrastructure capable of maintaining safety and an adequate level of operations in case of unavailability of GNSS (for example due to outages). During this evolution, terrestrial aids may also enable PBN operations for users not yet equipped with GNSS.

Until a solution to ensure adequate GNSS resilience is available, it is essential that a terrestrial navigation infrastructure, suitably dimensioned to be capable of maintaining safety and continuity of aircraft operations, be provided.

In line with the ASBU elements NAVS-B0/4 element, this plan encompasses the definition of the Minimum Operating Network (MON) of legacy Navaids to sustain the system in case of PBN disruption or degraded operations and addresses the PBN contingency modes.

This plan, developed in partnership with the national authorities (ANSP, Operators and Airspace users), should be revisited with the introduction of new navigation capabilities and frequently updated and considered as a living document.

1. ~~2.~~ Introduction

The implementation of Performance-Based Navigation (PBN) on a wide scale in all phases of flight is well under way and is itself a prerequisite for ground-based navigation aids (navaids) rationalization. This is because PBN procedures are enabled by GNSS as the primary navigation means. While some of the ground systems can also support PBN operations (e.g. DME), the role of the ground based navigation infrastructure will evolve towards providing a reversion capability for GNSS and supporting contingency operations in the case of GNSS becoming unusable. This offers the opportunity to rationalize some of the terrestrial infrastructure while retaining a Minimal Operational Network to maintain ATM operations using only ground-based Navaids.

This plan supports the evolution of PBN as the preferred means of navigation by sustaining and expanding the use of GNSS, providing a PBN-capable backup with the DME, and a minimum operational network of VORs to ensure aircraft can navigate safely during GNSS outages.

~~The GANP has the objective of a future harmonized global navigation capability based on area navigation (RNAV) and performance-based navigation (PBN) supported by the global navigation satellite system (GNSS)~~

~~The optimistic planning that was considered at the time of the Eleventh Air Navigation Conference for all aircraft to be equipped with GNSS capability and for other GNSS constellations to be available, together with dual frequency and multi-constellation avionics capability being carried by aircraft have not been realized~~

~~The shift from facility-referenced navigation to coordinate-based navigation enabled by performance-based navigation (PBN) provides significant benefits, in particular by supplying the flexibility required to design airspace and associated routes and procedures according to operational needs. The most suitable navigation infrastructure to support PBN is GNSS. Consequently, the role of conventional navigation aids is currently evolving towards that of a reversionary terrestrial infrastructure capable of maintaining safety and an adequate level of operations in case of unavailability of GNSS (for example due to outages). During this evolution, terrestrial aids may also enable PBN operations for users not yet equipped with GNSS.~~

~~It had initially been expected that the rationalization of the legacy navigation infrastructure would have been a consequence of a top-down process where the implementation of PBN and GNSS within volumes of airspace would result in navigation aids being made totally redundant so they could be simply be switched off~~

~~NAVS ASBU Elements:~~

~~Element ID~~	~~Title~~
~~NAVS-B0/1~~	~~Ground Based Augmentation System (GBAS)~~
~~NAVS-B0/2~~	~~Satellite Based Augmentation System (SBAS)~~

~~NAVS-B0/3~~	~~Aircraft Based Augmentation System (ABAS)~~
~~NAVS-B0/4~~	~~Navigation Minimal Operating Networks (Nav.MON)~~
~~NAVS-B1/1~~	~~Extended GBAS~~
~~NAVS-B2/1~~	~~Dual Frequency Multi Constellation (DF MC) GBAS~~
~~NAVS-B2/2~~	~~Dual Frequency Multi Constellation (DF MC) SBAS~~
~~NAVS-B2/3~~	~~Dual Frequency Multi Constellation (DF MC) ABAS~~

2. NAVS-B0/4 Navigation Minimal Operating Networks (Nav. MON):

The new element "Navigation Minimal Operating Networks" (NAVS B0/4) has been classified as priority 1 in the MID Region Air Navigation Strategy (MID Doc 002). ~~The NAV MON element allows the rationalization of the ground based conventional infrastructure through the definition of minimal networks of ground navaids. Consultations and agreements from airspace users and aircraft operators including MIL are required to define this element. The MON should be revisited with the introduction of new navigation capabilities.~~ The main purposes of the NAV MON Element (NAVS B0/4) are:

- To adjust conventional navaids networks through the increased deployment of satellite based navigation systems and procedures to ensure the necessary levels of resilience for navigation.
- To provide a minimum level of capabilities to accommodate State aircraft operations where there is a mismatch in terms of aircraft equipage.
- To make a more efficient use of the frequency spectrum

~~MIDANPIRG Conclusion related to NAV MON TBA and Link to MID AN Strategy~~

~~3. **3. Performance-based navigation impact on NAVAID infrastructure planning**~~

~~4. Infrastructure planning is complex, particularly with the increased integrated reliance on global navigation satellite system (GNSS) by communication, navigation and surveillance (CNS) and the increased pressure to decommission unnecessary terrestrial NAVAID infrastructure. Therefore, NAVAID infrastructure planners cannot look at the NAVAID infrastructure in isolation, but need to work closely with ATM system engineers, surveillance and communication infrastructure, operators and regulators when planning the infrastructure for both normal and contingency operations. The removal of conventional navigation aids and associated procedures constitutes an airspace change. In this respect, extensive consultation needs to take place with all impacted stakeholders.~~

~~5. PBN implementation will require infrastructure planners to consider:~~

~~6. a) the infrastructure requirements for normal operations;~~

~~7. b) the infrastructure required for contingency operations (a function of the objective of the contingency operations (such as safety only, required levels of service, compliance with regulatory requirements); and~~

~~8. c) how CNS supports both normal and contingency PBN operations (trade-offs between C-N-S can be made)~~

~~9. ICAO Twelfth Air Navigation Conference ANC 12 adopted the following Recommendations in this respect, published in ICAO Doc 10007:~~

~~10. *Recommendation 6/8* – Planning for mitigation of global navigation satellite system vulnerabilities That States: a) Assess the likelihood and effects of global navigation satellite system vulnerabilities in their airspace and apply, as necessary, recognized and available mitigation methods; …. f) where it is determined that terrestrial aids are needed as part of a mitigation strategy, give priority to retention of distance measuring equipment (DME) in support of inertial navigation system (INS)/DME or DME/DME area navigation, and of instrument landing system at selected runways.~~

~~11. *Recommendation 6/10* – Rationalization of terrestrial navigation aids That, in planning for the implementation of performance-based navigation, States should:~~

~~12. a) assess the opportunity for realizing economic benefits by reducing the number of navigation aids through the implementation of performance-based navigation;~~

~~13. b) ensure that an adequate terrestrial navigation and air traffic management infrastructure remains available to mitigate the potential loss of global navigation satellite system service in their airspace; and~~

~~14. c) align performance-based navigation implementation plans with navigation aid replacement cycles, where feasible, to maximize cost savings by avoiding unnecessary infrastructure investment.~~

~~15.~~

~~16. The overview of the ICAO Global context given above shows that in general,~~

3. ICAO Strategy

T~~t~~he role of the ground-based Navaids will evolve towards providing a reversion for GNSS and supporting contingency operations in case of GNSS becoming unusable. This evolution offers the opportunity for the rationalization of some of the terrestrial infrastructure and retaining only a Minimum Operational Network (MON) which is designed to efficiently provide reversion service.

However, each Navaid can fulfil different operational roles irrespective of the availability of ATS Surveillance:

- During normal ATM operations, ground-based Navaids support

- PBN applications as a primary positioning source;
- PBN applications as a secondary positioning source to GNSS
- Conventional procedures (e.g. either in an environment where there are no PBN procedures; or to accommodate non-PBN capable aircraft.)

- During ATM contingency operations, ground-based Navaids support

- PBN applications as a back up positioning source due to GNSS outage;
- Conventional procedures as a means of reversion during a GNSS outage;

In order to plan the evolution of the navigation infrastructure in MID Region, it is important to have a thorough picture of the type of operations that can be supported by each type of terrestrial Navaid as per MID PBN Implementation Plan. This understanding will enable States to develop both an optimization and decommissioning plan of Navaids as well as a coordinated evolution to a reversionary terrestrial infrastructure. Table below identifies which ground-based Navaid support which PBN specification.

MID Navigation Specifications and (**R**equired or **O**ptional) Navaid Infrastructure

	GNSS	IRU	DME/DME	DME/DME/ IRU	VOR/DME
RNAV 10[1]	O	O			
RNAV 5[1]	O	O	O	O	O
RNAV 1[1]	O		O	O	
RNP 1	R		TBD[2]	TBD[2]	
RNP APCH	R				

RNP AR	R	O			

Note 1: For this navigation specification without required navaid infrastructure at least one navaid is requested for the associated navigation application.

Note 2: the use of DME/DME for this navigation specification requires a specific State authorization.

Note 3: IRU may be integrated with the GNSS sensor to improve performance and continuity of the operation.

3.1 ICAO reversion strategy

Annex 10 Attachment H defines a global “Strategy for rationalization of conventional radio navigation aids and evolution toward supporting performance based navigation”. The objective of Attachment H is to provide guidance to the States for both the rationalization and reversion of the terrestrial Navaid infrastructure. The recommendations included in this high-level strategy are based on the residual roles foreseen for each type of Navaid to support PBN operations and/or conventional procedures.

Furthermore, consideration of this strategy should be given when deciding investments into new facilities or on facility renewals. As this strategy is highly relevant to the objectives of this plan, key points of this strategy are included below, customized for the MID region.

Operational Considerations for terrestrial Navaids and reversion strategy

		Operational Roles	**Navigation Performance**	**Specific Limitations**	**Opportunities And Solutions (Residual roles – PBN/conventional)**
NDB	**PBN**	Exceptionally, can be used for extraction on the missed approach for RNP APCH. This operation is not encouraged.	None	N/A	Rationalize NDB and associated conventional procedures and if NDBs are used to define PBN ATS Routes they should be replaced by RNAV waypoints. Non—Precision Approaches based on NDB should be replaced by RNP APCH. Similarly, if NDBs are used as ILS locators associated with an RNAV procedure intercept, RNAV Waypoints should replace these.
	CONV	Can support en route operations and ATS Routes, SIDS/STARs and NPAs. This is not encouraged. NDB may be paired with a DME.	Can enable homing to a beacon. When co-located with a DME, ranging information is also available.	Ref Annex 10, Chapter3	
VOR	**PBN**	Can be used in the en-route phase of flight and arrival segment of an IFP. On the missed approach it can be used for extraction of an RNP APCH.	Can support a position estimation for RNAV 5. This enables operations in FRA and on RNAV 5 ATS Routes.	(*) Maximum range of conventional VOR typically 60 NM; Doppler VOR, typically 75 NM.	The opportunity arises to rationalize some VORs providing cost savings. Introduction of new VORs is not encouraged, but existing ones may be needed to support reversion operations; enhance situational; provide limited inertial updating if DME/DME not available; exceptionally to be used for NPAs if no other option is available; to support aircraft only able to navigate conventionally (this may include state aircraft) and support procedural separation. The use of VOR(/DME) to support RNAV 5 should be considered only in exceptional cases: • in areas where DME/DME coverage is not possible (e.g. islands environment) • in areas where DME/DME coverage is achievable only with high investment and operational cost (e.g. near the bottom of enroute airspace in terrain rich environment)
	CONV	Paired (or not) with a DME can support en route operations and SIDS/STARs and NPA and intercept to the ILS or missed approach.	Can provide bearing information and enable homing to a beacon. When co-located with a DME, range and bearing information is available.	Ref Annex 10, Chapter3	
DME	**PBN**	Can be used in all phases of flight except final approach. On the missed approach it can be used for extraction.	Can support a position estimation for RNAV 5 and RNAV 1 operations. This enables operations in FRA, RNAV 5 ATS Routes and RNAV 1 SIDS/STARs.	Minimum range of 3NM and maximum range of 160 NM for RNAV 1; Below 40° above the horizon as viewed from the	DME/DME provides a fully redundant capability to GNSS for RNAV applications, and a suitable reversionary capability to RNAV 1 for RNP applications requiring a lateral accuracy performance of ±1 NM (95%), providing there is an adequate DME infrastructure. Many DMEs are co-located with VORs which creates certain limitations. When VORs are decommissioned,

				DME facility; geometric limitations between DME pairs of 30° to 150°;	this can be an opportunity to optimise the DME network. In such instances, to save costs or to improve DME/DME performance, DME's can be re-located (ideally with other CNS assets) if a co-located VOR is withdrawn. To be operationally robust, efficient DME network design should fill gaps and provide DME/DME coverage as low as possible without requiring more investment unless needed for safety reasons. (Other solutions such as requiring on-board IRU, reliance on ATS surveillance and/or military TACANS may be viable alternatives). Cross-border use of DME facilities is encouraged supported by the necessary authorisations and/or agreements. Deployment of new DME stations should avoid that part of the frequency spectrum close to the GNSS L5/E5 band (1164 – 1 215 MHz). CONCLUSION: The application of the above principles should enable uniformity of DME deployment across the MID region; It is recognized that in some areas, the provision of D/D navigation is not possible or practical, such as at very low altitudes, in terrain-constrained environments, or on small islands, remote areas and airspace over the water. Finally, it is possible that in some countries there could be an increase in the number of DMEs to support A-PNT. Note: Some FMS may exclude the use of ILS-associated DMEs. Consequently, it is not possible to ensure consistent D/D service is available to all D/D-equipped users based on ILS-associated DMEs. Therefore, those facilities should not be planned in the provision of such D/D service (regardless of whether they are published in the en-route section of the AIP), without an appropriate fleet assessment.
	CONV	Paired with a VOR, ILS or NDB, it can support conventional operations. Stand-alone it can enable the flying of DME arcs.	Can provide range when co-located with a VOR, NDB or ILS.	Ref Annex 10, Chapter3	

(*) If a State wished to use a VOR in excess of the typical ranges stated, then an implementation safety assessment based on a flight inspection demonstration may enable such non-standard use, subject to approval by the competent authority.

3.2 Evolution Strategy

There is a need to consult aircraft operators and international organizations, and to ensure safety, efficiency and cost-effectiveness of the proposed infrastructure solutions. Based on the above, the global strategy is to:

a) Rationalize NDB and VOR and associated conventional procedures;
b) Align rationalization planning with equipment life cycles and PBN implementation planning;
c) Replace conventional approaches without vertical guidance with vertically guided approaches;
d) Where a terrestrial navigation reversion capability is required, evolve the existing DME infrastructure towards providing a PBN infrastructure complementary to GNSS; and
e) Provide a residual capability based on VOR (or VOR/DME, if possible) to cater to airspace users not equipped with suitable DME/DME avionics, where required.

~~**Operational considerations**~~

~~*NDB-related considerations* : NDBs serve no role in PBN operations except as a means for position cross-checking and general situational awareness. These minor roles should not lead to the requirement to retain NDB facilities.~~

~~Add MIDANPIRG Conclusion regarding decommissioning of NDB~~

~~*VOR related considerations* : The only PBN navigation specification enabled by VOR, provided a co-located DME is present, is RNAV 5. Provision of RNAV 5 based on VOR/DME is subject to significant limitations, since integrated multi-sensor navigation makes very little use of VOR/DME, in some cases limiting the range of use to 25 NM. Also, only very few aircraft operators have a certified RNAV 5 capability which is based only on VOR/DME. Consequently, the use of VOR/DME to provide PBN services is discouraged. The only exception to this could be to support RNAV 5 routes at or near the bottom of en-route airspace (above minimum sector altitude, MSA) where achieving DME/DME coverage is challenging. In principle, to enable cost savings, VOR facilities should be withdrawn in the context of an overall PBN plan. No new stand-alone VOR facilities (e.g. at new locations) should be implemented. However, VORs may be retained to serve the following residual operational purposes such as as a reversionary navigation capability.~~

~~The analysis concerning VOR's operational role should consider all the other potential residual roles described in ICAO Annex 10 Attachment H. The following minimum set of considerations is recommended.~~

~~En route & TMA~~

~~Identify where VOR (/DME) is needed to support:~~

- ~~RNAV 5 operations in FRA or on ATS routes;~~
- ~~Conventional ATS routes defined by VOR/DME which are required to be maintained;~~
- ~~the operations of State aircraft or aircraft of lower capabilities on ATS Routes;~~
- ~~the provision of:~~
  - ~~Navigation, cross-checking and situational awareness (e.g. during contingency operations, in support of radar vectoring or to avoid airspace infringements) within an airspace volume.~~
  - ~~procedural separation within an airspace volume;~~

Approach and landing Identify where VOR(/DME) is required to support:

- Conventional instrument approach procedures that will be maintained or potentially redesigned. The analysis should consider the aerodromes which are designated as alternates for major aerodromes and/or for aerodromes where only RNP APCH procedures are foreseen;
- ILS IAP (LOC intercept and; avoid premature automatic flight control system arming for ILS intercept);
- Missed Approach Operations;

DME-related considerations : DME/DME fully supports PBN operations based on the RNAV 1, RNAV 2 and RNAV 5 navigation specifications. Consequently, DME/DME (for equipped aircraft) is the most suitable current terrestrial PBN capability. DME/DME provides a fully redundant capability to GNSS for RNAV applications, and a suitable reversionary capability for RNP applications requiring an accuracy performance of ±1 NM (95 per cent) laterally, where supported by an adequate DME infrastructure.

Consequently, the following to be considered when identifying the future operational roles of the DME network:

En route & TMA

Identify where DME/DME is needed to support:

- RNAV 5 operations in FRA or ATS routes, in ENR airspace volumes;
- RNAV 1 operations (SIDs/STARs) in terminal airspace volumes;
- RNP 1 reversion operations (actually RNAV 1, SIDs/STARs) terminal airspace volumes;

What type of operation requires DME or DME/DME and where is this coverage needed?

What is the required performance of the DME (DME/DME) signal-in-space?

- Conventional ATS Routes incl. SIDS/STARS in en route or terminal airspace volumes, where DMEs are co-located with VORs;

Approach and landing

Identify where DME is required, as a co-located facility, to support:

- The intercept, approach or missed approach of conventionaNol approach procedures.

Add para decommissioning plan including lifetime, spare parts,...etc

4. National Navigation Minimal Operating Networks

4.1 Main operations supported by VORs in the GNSS contingency concept

VOR ID	Location	Main operations supported in the GNSS contingency concept								
		IAP	TMA			EN-ROUTE				
		IAP - intercept - Final - Missed	Conventional SIDs/STARs	cross-checking and situational awareness	Conventional Holding	RNAV 5 and FRA	Conventional Routes and procedural separation	Situational Awareness & Reach Alternate A/D	RNAV Holding	Conventional Holding

~~4.1 Ground based Navigation Aids~~

Description to be ~~added~~

~~4.2 Space based operation~~

~~*Description to be added*~~

~~*Add para about coverage analysis tool*~~

~~Phase of flight (enroute, terminal, approach)~~	~~Area of operation~~	~~NAV Facility(ies)~~			
		~~Normal operation~~	~~Augmentation~~	~~Contingency operation~~	~~Facility ID~~
~~RNAV5~~	~~Enroute~~	~~GNSS~~	~~ABAS~~	~~VOR/DME~~	

4.2 Evolution of the ground infrastructure towards MON configuration

Type of NAV facility	Location	ID	Facility life cycle		Rationalization plan		relocation of existing facilities or installation of new facilities
			Start	End	Decommissioning	Replacement	

4.14.34.3 Future components of the National Navigation Minimal Operating Networks

Description to be added

Type of NAV facility	Location	ID	Range	Decommissioning Plan		
				Date	Replacing facility type	

Type of NAV facility	Location	ID	Phase of flight (enroute, terminal, approach)	Range	Purpose of operation	
					Normal operation	Contingency operation

APPENDIX 6A

PERFORMANCE BASED NAVIGATION SUB-GROUP (PBN SG)

1. Terms of Reference

1.1 The terms of reference of the PBN Sub-Group are:

a) ensure that the implementation of PBN in the MID Region is coherent and compatible with developments in adjacent regions, and is in line with the Global Air Navigation Plan (GANP), the Aviation System Block Upgrades (ASBU) framework and the MID Region Air Navigation Strategy;

b) monitor the status of implementation of the MID Region PBN-related ASBU threads/elements included in the MID Region Air Navigation Strategy as well as other required PBN supporting infrastructure, identify the associated difficulties and deficiencies and provide progress reports, as required;

c) keep under review the MID Region PBN performance objectives/priorities, develop action plans to achieve the agreed performance targets and propose changes to the MID Region PBN plans/priorities, as appropriate;

d) seek to achieve common understanding and support from all stakeholders involved in or affected by the PBN and GNSS developments/activities in the MID Region;

e) provide a platform for harmonization of developments and deployments of PBN concentrating on PBN for approach and terminal areas;

f) monitor and review the latest developments in the area of PBN and procedure design, provide expert inputs for PBN-related issues; and propose solutions for meeting ATM operational requirements;

g) monitor and review the latest GNSS developments and activities;

h) provide regular progress reports to MIDANPIRG concerning its work programme; and

i) review periodically its Terms of Reference and propose amendments, as necessary.

1.2 In order to meet the Terms of Reference, the PBN Sub-Group shall:

a) provide necessary assistance and guidance to States to ensure harmonization and interoperability in line with the GANP, the MID ANP and ASBU framework;

b) provide necessary inputs to the MID Region Air Navigation Strategy through the monitoring of the agreed Key Performance Indicators related to PBN;

c) identify and review those specific deficiencies and problems that constitute major obstacles to the provision of efficient PBN implementations, and recommend necessary remedial actions;

~~c)~~d) Address PBN implementation aspects of States in the MID Region, including States National PBN Implementation Plans, Share and exchange best PBN Implementation practices between States within the Region

~~d)~~e) review and support the MID Flight Procedure Programme activities, as required, including coordination of capacity building activities related to training and qualification of the procedure design personnel and all other personnel involved in PBN implementation;

f) monitor the progress of studies, projects, trials and demonstrations by the MID Region States, and other ICAO Regions in PBN and GNSS; ~~and~~

g) Review and update MID PBN Regional Plan (MID Doc 007), as needed

~~e)~~h) Address and promote operational improvements and benefits accrued from PBN implementation, through review of the existing global and regional guidance materials; and provide further guidance, as needed; and

~~f)~~i) Coordinate with relevant MIDANPIRG and RASG-MID Subsidiary bodies issues with common interests.

2. Composition

2.1 The Sub-Group is composed of:

a) MIDANPIRG Member States;

b) concerned International and Regional Organizations as observers; and

c) other representatives from provider States and Industry may be invited on ad hoc basis, as observers, when required.

3. WORKING ARRANGEMENTS

3.1 The Chairperson, in close co-operation with the Secretary, shall make all necessary arrangements for the most efficient working of the Subgroup. The Subgroup shall at all times conduct its activities in the most efficient manner possible with a minimum of formality and paper work (paperless meetings). Permanent contact shall be maintained between the Chairperson, Secretary and Members of the Subgroup to advance the work. Best advantage should be taken of modern communications facilities, particularly video-conferencing (Virtual Meetings) and e-mails.

3.2 Face-to-face meetings will be conducted when it is necessary to do so.

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ATTACHMENT A

ICAO MID

الهيئة العامة للطيران المدني
CIVIL AVIATION AUTHORITY
QATAR قطر

PBN SG/8 Meeting

(Doha, Qatar, 12 – 13 December 2023)

List of Participants/Attended

State Org/Industries		Name	Remarks
Egypt	1.	Mr. Ehab Raslan	
	2.	Ms. Asmaa ElKhososy	
	3.	Mr. Walid Rawash	
Iran	4.	Mr. Alireza Adnan	
Iraq	5.	Mr. Waleed Abdulameer	
	6.	Mr. Maher Jasim Khayoon	
	7.	Mr. Husam Sabah Abdulzahra	
	8.	Mr. Ahmed Muneer I. Al- Zaide	
	9.	Mr. Ahmed Saad M. Almuktar	
Jordan	10.	Mr. Sameer M. Abu Khadra	
	11.	Mr. Mohammad Jamil Abu- Salah	
Libya	12.	Mr. Abdulhamid Salem M. Abani	
	13.	Mr. Kamal Faraj Abraheem Alahjal	
Oman	14.	Mr.Abdullah Said Khamis	
	15.	Mr. Hilal Ali Mohammed Al Maqbali	
Qatar	16.	Mr. Ahmed Al-Eshaq	
	17.	Ms. Pamela Erice	
	18.	Mr. Tilak Priyankara N M	
	19.	Mr. Peliyagoda Christo	
	20.	Mr. Pubudu Sandaruwan	
	21.	Mr. Mansoor Alam	
	22.	Ms. Hanan AlHaddad	
	23.	Mr. Proietti Marco	
	24.	Mr. Dan Cucu	
	25.	Mr. Roumel Mercado	
	26.	Mr. Roel Marcelino Santiago	
	27.	Mr. Antonio Jose Cardoso	
Saudi Arabia	28.	Mr. Muhammad Aljuhani	
	29.	Mr. Anas Ibrahim A. Fallah	
	30.	Mr. Nasser Akdemees Alotaibi	
UAE	31.	Mr. Saqr Al Marashda	
	32.	Mr. Mohamed Abdulla Salem Al Ameri	
Yemen	33.	Mr. Ashhab Shehab Saeed Omar	
	34.	Ms. Samara Ahmed Abdullah	
ICAO MID & HQs	35.	Mr. Mohamed Smaoui	
	36.	Mr. Radhouan Aissaoui	
	37.	Captain Knowles Ian	
	38.	Mr. Sorin Dan Onitiu	