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AIR PILOTS - COMMERCIAL AIR TRANSPORT
SAFETY BRIEFING NOTE 08
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UNDERSTANDING RNP APPROACHES

The Context

Many years experience of Performance Based Navigation (PBN) based on GNSS (Global Navigation Satellite Systems) such as GPS for en-route and terminal area navigation has led to an extension of the same principle to RNAV approaches as an alternative to those relying entirely on ground-based aids. The further transition of RNAV approaches to RNP (Required Navigation Performance) standards has followed with particularly rapid progress being made in the USA and latterly in Europe. The primary difference between an RNAV approach and an RNP approach is that performance must be within defined limits with corresponding alerting capability. Most in-service commercial transport aircraft are now approved for RNP approaches and have an Actual Navigational Performance (ANP) capability of 0.05nm radius, much more accurate than any minimum requirements, which means that this ICAO-led global standardisation of GNSS-based Instrument Approach Procedures is likely to proceed quickly.

Freely available RNAV instrument approach procedures for fixed wing aircraft are now transitioning to the universal chart identification 'RNP X RWY xx'. These broadly enable either ICAO Type A (2D) approaches with an MDH not below 250 feet aal or ICAO Type B (3D) approaches with a DH not below 200 feet arte. These RNP procedures automatically available to all suitably equipped aeroplanes should not be confused with those annotated as AR (Authorisation Required). These are either RNP approaches complicated by procedurally or terrain-challenged environments or proximity to restricted airspace or normal 3D approaches with a DH below 200 feet arte, the latter being alternatives to ILS Cat 2 and/or Cat 3. This type of RNP approach is not further discussed here.

There are three types of 'Standard' RNP approach procedures:

- LNAV - Lateral Navigation guidance only - a 2D approach procedure with an MDH not less than 250 feet aal or the MDA equivalent.
- LNAV/VNAV - Lateral Navigation guidance in conjunction with an approved vertical navigation function - a 3D approach procedure which has a DH not below 250 feet aal or the DA equivalent. Vertical profile tracking is provided by either approach-certified Baro-VNAV systems or (where available and permitted) by SBAS (Satellite Based Augmentation Systems). Note that Baro-VNAV approaches are limited to a stated air temperature validity range based on the extent to which ambient temperature differs from ISA.
- LPV - Localiser Performance with Vertical guidance - a 3D approach which uses SBAS capability to support both lateral and vertical defined guidance to a DH not less than 200 feet arte or the DA equivalent and provides for an RNP equivalent to an ILS Cat 1 procedure.

Each runway for which a 'standard' RNP approach is available will have a single chart showing the minima for each approach type available either as a separate MDA/MDH (2D) or DA/DH (3D) plus an OCH/OCA or, depending on State policy, sometimes, only the latter. Minimum visibility or RVR will also be given for each available approach type. RNP procedures may begin directly from terminal area navigation procedures or at a designated IAF followed by one or more legs to the FAF from where continuous descent begins. Radar vectors to establish prior to the FAF may be given.

Some examples of errors when using RNP procedures

- A Boeing 787 was cleared for a day RNP approach to Abu Dhabi in 2020 for which the vertical profile flown was dependent on the correct altimeter subscale setting being set. When the crew did not set the new QNH which then remained as the one set for departure, the vertical profile flown was 360 feet too low and poor inflight visibility meant that the error was not detected

visually until four red PAPIs were seen following which a go around was commenced 1.3nm from the runway at 210 feet agl.[1]

- An Airbus A320 making a day RNP approach to Paris CDG in 2022 to LNAV/VNAV minima was given an incorrect QNH (1011 instead of 1001) by ATC and the crew then used it to fly the baro-VNAV approach to the apparently correct MDA without emerging from cloud and rain or seeing the ground before going around. The Investigation is continuing but the detailed Preliminary Report includes the finding that the lowest point in the go around was 6 feet agl when still 0.8nm from the intended landing runway. It is not yet clear why no EGPWS activation occurred.[2]

Discussion

- The process of standardising RNP approach chart title in line with the new ICAO standards is a 'work in progress'. For example, the FAA has been publishing RNP LNAV/VNAV and RNP LNAV procedures as RNAV(GPS) charts. Other anomalies are everywhere - one European State has been arbitrarily applying LNAV-standard minima to LPV approaches if Cat 1 standard ground infrastructure does not exist causing LNAV/NAV minima to be lower than LPV minima.
- RNP approach procedures do not necessarily follow a straight line track and even if they do, can also be offset from the landing runway served as with an offset ILS localiser.
- RNP approach procedures begin no later than an Intermediate Fix (IF) but descent from there to the Final Approach Fix (FAF) may be required.
- The final (continuous) descent always begins at the FAF and it is widely recommended or required that 2D RNP approaches are flown using a CDFA based on a constant vertical speed or a flight path angle monitored against the altitude-distance reference table on the chart.
- When any RNP procedure is flown with a Vertical Situation Display (VSD) available, its explicit inclusion in flight instrument scanning is a useful check. This is especially important when Baro-VNAV input provides the vertical profile rather than SBAS.

Safety Recommendations

<u>To Aircraft Operators</u>

- Ensure training adequately covers any necessary pre-flight and pre-approach validation of GNSS availability, the essential nature of altitude/height checks against procedure fixed points, especially the FAF and the extreme temperature constraints on LNAV/VNAV approaches reliant on Baro-VNAV.
- Ensure that the Operations Manual adequately describes the way in which the applicable minima must be selected from the choice available on an RNP runway approach chart.
- Ensure that relevant training and operating procedures both clearly cover the response to any aircraft display abnormality present at despatch or which becomes evident en-route and which may affect the applicable RNP minima or whether an RNP approach will be possible at all.
- Ensure that the Operations Manual includes requirements for instrument approach availability at alternates if landing off an RNP approach at destination is not possible and no alternatives exist.

<u>To Pilots</u>

- If an RNP approach may be used at a destination, review availability of alternative destination and alternate approach procedures using current serviceable ground aids.
- When LNAV or LNAV/VNAV approaches may be flown, relevant signal integrity prediction must be checked before departure. An automated integrity fault indication, which may not be within the pilots' main line of sight, must always be checked before reaching the procedure FAF.
- All RNP approaches should involve an independent check of the altitude/height at the FAF to ensure that the correct altimeter sub scale setting is being used. A distance-to-go check at the 1000 feet agl radio altimeter should also be made and the PAPI checked as soon as visible.
- For LNAV/VNAV procedures relying on Baro-VNAV, the correct pressure setting is especially important - a setting 10 hPa too high will cause the vertical profile to be 300 feet lower than required and a setting 10 hPa too low will make it 300 feet too high without changing the distance to go/altitude check. These procedures also have a permitted temperature range which should be charted and must be respected - temperatures above ISA will increase the profile gradient, those below will reduce it. A cross check at 1000 feet radio altitude is recommended.
- Ensure that an RNP approach flown to LNAV minima is always flown using a CDFA.
- Briefing for offset final approach tracks should include the expected runway visual perspective.

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[1] see:http://www.gcaa.gov.ae/en/ePublication/admin/iradmin/Lists/Incidents%20Investigation%20Reports/Attachments/151/2020-AIFN0007_2020%20Final%20Report.pdf

[2] https://bea.aero/fileadmin/user_upload/BEA2022-0219_9H-EMU_preliminary_report_for_publication_EN_finalise.pdf