

APPENDIX B

PBN implementation in France: return of experience

Mitigation measures implemented following serious incidents in BaroVNAV operations

1.1 It should be noted that APPENDIX A documents a few examples only of the three main types of categories of incidents with significant impact in the operations of BaroVNAV PBN approaches: error within the ATC system, error transmitted by ATC, error made by the aircrew.

1.2 Many other less severe incidents are also documented by the French civil aviation authority and in other incident databases.

1.3 Given the EU regulation requirements on PBN implementation and in particular the exclusive use of PBN phase from June 2030, aircrafts that are not equipped with SBAS will have to rely on BaroVNAV as an alternative to ILS. It is expected that more and more operators will use BaroVNAV PBN operations in Europe, and possibly in other regions as well. Consequently, an increase in the occurrence of such incidents is to be foreseen in the future.

1.4 From what is observed in France, BaroVNAV may be useful in the first phase of introduction of vertical guidance at runway-ends where it was not available previously. Nonetheless, the return of experience shows that the latent failures of BaroVNAV will require significant additional operational mitigation measures which make it difficult to identify BaroVNAV as a long-term primary landing aid.

1.5 In the same time, the European Union Aviation Safety Agency (EASA) has recently warned aircraft operators of the risk of losing Cat I landings capability in Europe after June 2030 unless they upgrade their aircrafts avionics (<https://www.easa.europa.eu/en/newsroom-and-events/news/easa-publishes-communication-aircraft-operators-pbn-implementation>).

Additional operational mitigation measures are implemented for BaroVNAV operations in France

1.6 Following the analysis of the serious incidents in the use of BaroVNAV PBN approaches, France decided to implement additional operational mitigation measures to increase the level of safety in operating PBN LNAV and LNAV/VNAV approaches.

1.7 While determining the mitigation measures, several significant issues were raised and pointed out in the working paper “*Issue with PBN implementation in France*” proposed to the ICAO Navigation System Panel in the NSP/7 meeting in January 2023:

- i. the absence of ICAO standards describing the failure modes of BaroVNAV,
- ii. the absence of guidance material for States on the appropriate mitigation measures to implement in relation to the limitations in performance of a technology.

1.8 In the absence of ICAO standards, France defined additional mitigation measures:

- i. Reinforcement of QNH information exchanges at all aerodromes between ATCOs and Aircrews

QNH is now announced 3 times by Air Traffic Control (ATC): 1- ATIS, 2- approach ATCO (ITM), 3- tower ATCO (LOC),

- ii. Additional operational requirements at aerodromes using a Minimum Safe Altitude Warning (MSAW) safety net

ATC is now required to issue a go around instruction in case of MSAW alert, whatever its cause.

1.9 In addition to the above, the most frequently observed QNH error being a confusion of 10 millibars equivalent to 280 ft, the decision has been made to increase by 300 ft the operational minima of Nantes airport runway 21, subject to several MSAW alerts recently as the approach trajectory overflies the city of Nantes. This specific mitigation measure is implemented only at Nantes airport for the time being¹.

1.10 It is still too early to confirm whether these operational mitigation measures need to be maintained, reinforced, or alleviated as their implementation also has an operational impact.

1.11 In addition, France currently:

- i. investigates other technologies to mitigate the safety issues raised by BaroVNAV such as the mode S downlink of the on-board QNH. This will enable the ATC system to compare its value with the QNH known by ATC, and possibly to alert the ATCO in case of divergence.
- ii. monitors evolutions in new generation aircrafts that are not yet widely available, where on-board QNH errors are automatically detected.

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¹ It may be noted within the BEA AirHub CDG report that the involved airline had a policy of an “add-on” of 50 ft over the published LNAV/VNAV minima. Since at the lowest point of its vertical trajectory the aircraft was only 6 ft above the ground ahead of the runway, this minima add-on probably saved the aircraft that day. Increasing LNAV/VNAV or LNAV minima is a potentially useful safety mitigation.