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Safety Issues related to the Altimeter Setting Errors

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Introduction

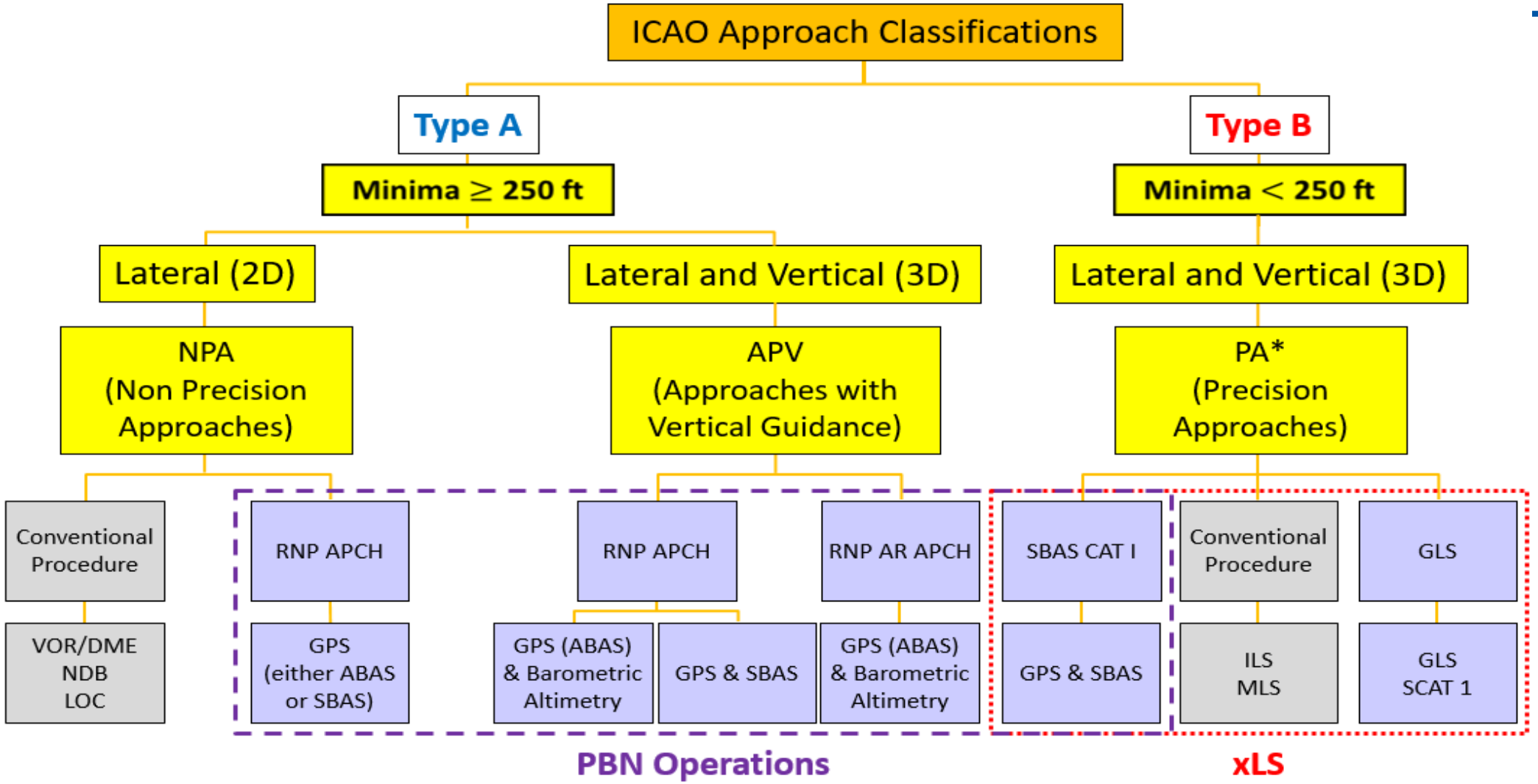
- ICAO Assembly Resolution A37-11 urged that States include in their PBN implementation plan provisions for implementation of approach procedures with vertical guidance (APV) to all runway ends serving aircraft with a maximum certificated take-off mass of 5 700 kg or more, according to established timelines and intermediate milestones.

- ICAO has also defined a specific strategy for approaches in its Annex 10 Volume I: “e) promote the use of Approach with Vertical Guidance (APV) operations, particularly those using Global Navigation Satellite System (GNSS) vertical guidance, to enhance safety and accessibility.”.

- The use of Baro-VNAV to fly vertically guided PBN approaches is currently supported by the PBN Manual as RNP APCH down to LNAV or LNAV/VNAV minima and is included in GANP ASBU element NAVS-B03. The navigation technologies used for these approaches are GPS ABAS for lateral guidance, and a barometric system for vertical guidance. It is one of the enablers of PBN with vertical guidance approaches, and brings real safety benefits over LOC, NDB and VOR approaches.

- Baro-VNAV based approaches are however significantly less robust than geometric PBN approaches enabled by GBAS (GANP ASBU element NAVS-B01) and SBAS (GANP ASBU element NAVS-B02).

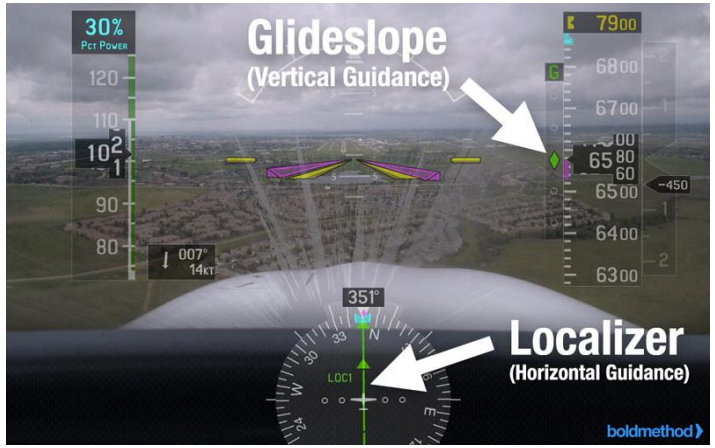
Approach Operations - Overview

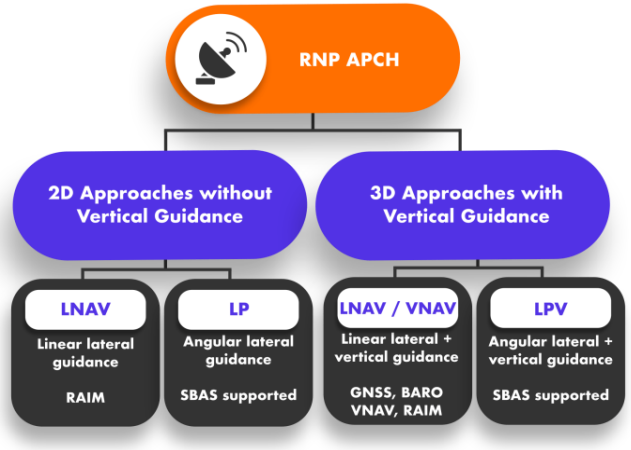


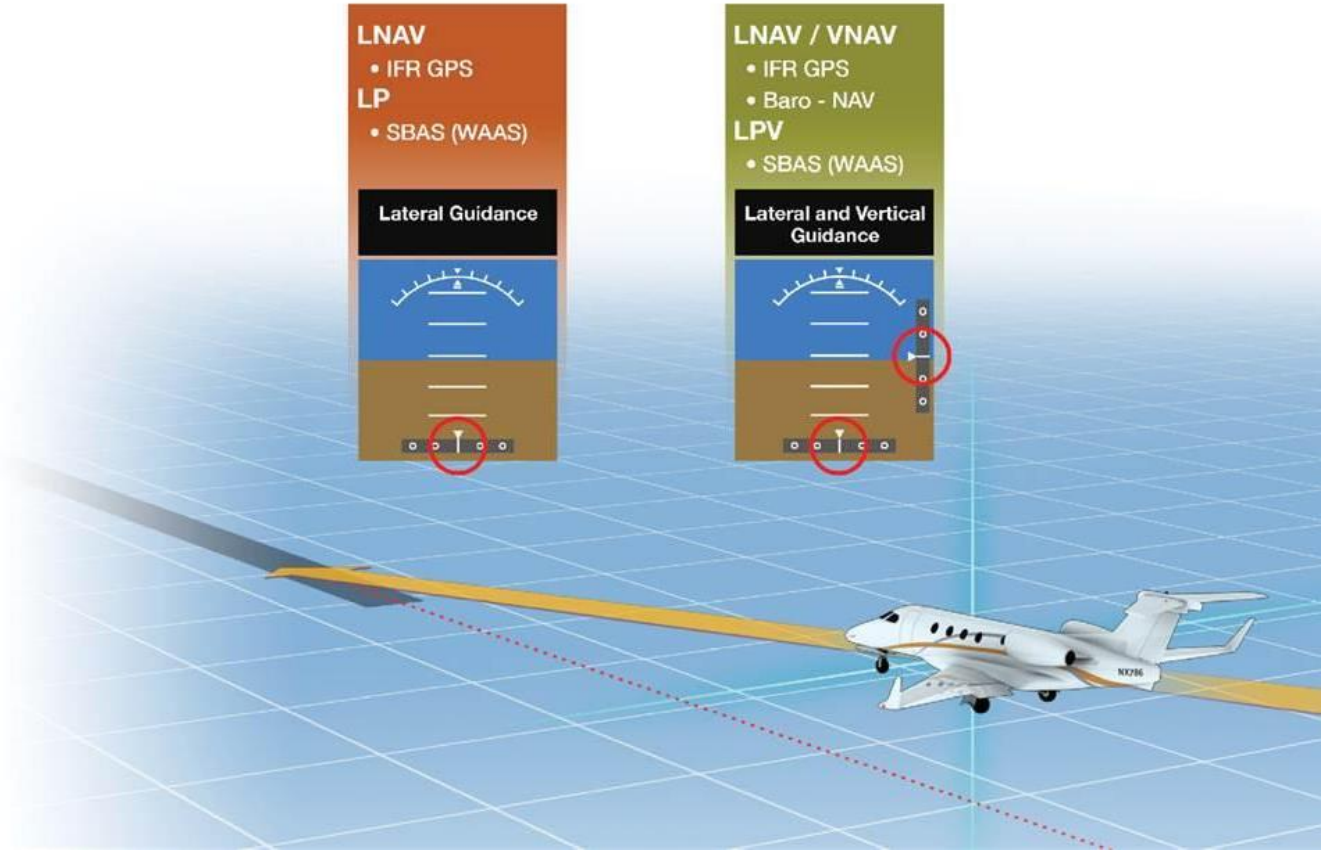
* Precision Approach (PA) can support Type A operations and there may be circumstances, such as obstacle clearance or aircraft category which does not allow a minima below 250 ft.

Approach Operations - Overview

All used to perform 3D approach operations
different source of raw information converted into the graphic VDI display





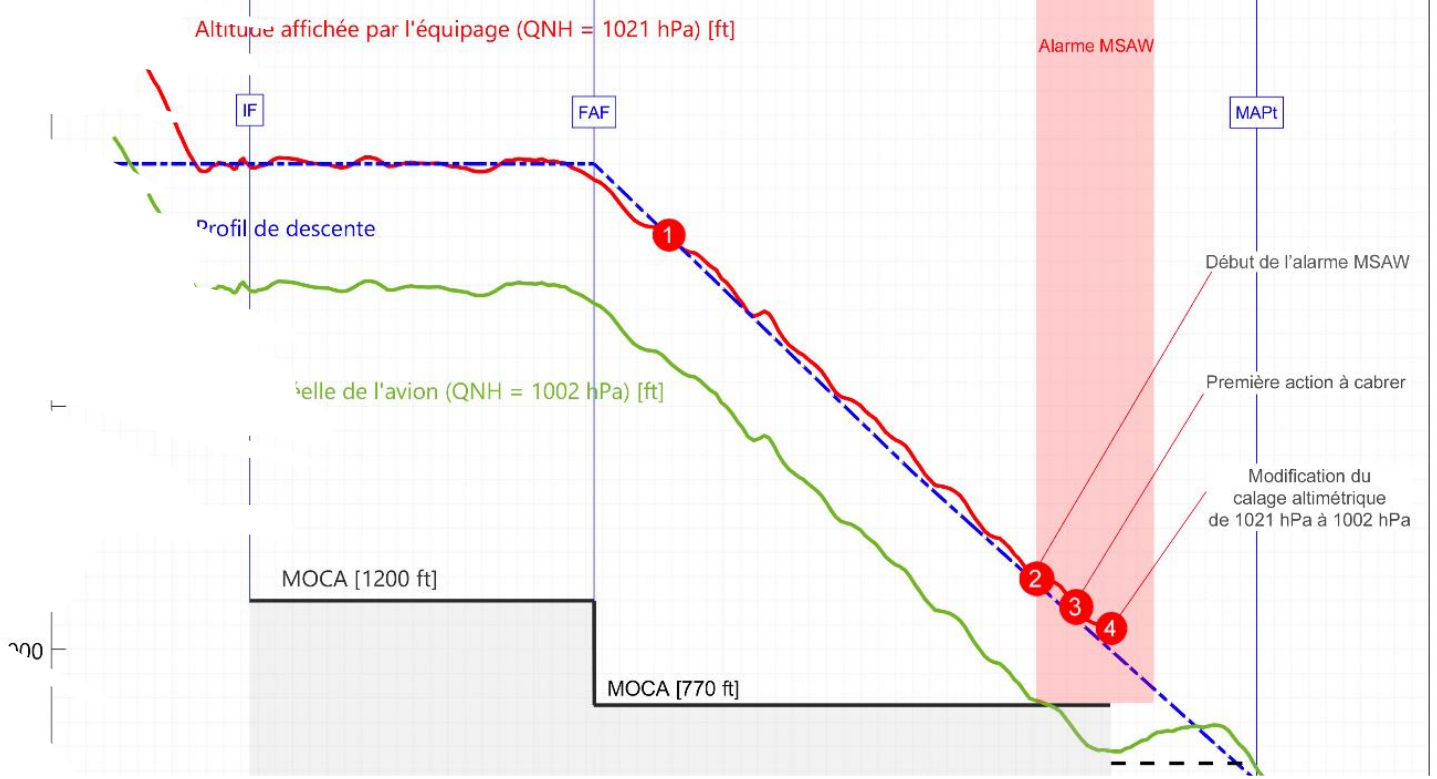


Nantes QNH mis-setting

- Before starting the RNP approach for runway **21**, the air traffic control unit cleared the crew to descend to 3,000 ft **QNH 1002**.

- The crew read back **QNH 1021**.

- During the final approach, the MSAW was activated.



Serious incident to the Bombardier CRJ operated by Air France Hop on 20/10/2

SUMMARY

aint Exupéry (69) - AD Nantes (44).

Altimeter Setting Errors Safety Issues

BEA
Bureau d'Enquêtes et d'Analyses
pour la sécurité de l'aviation civile
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PRELIMINARY REPORT

Serious incident to the AIRBUS A320
Registered **9H-EMU**
On 23 May 2022
On approach to Paris-Charles de Gaulle airport (95)

Time	Around 11:40[1]
Operator	Airhub Airlines (Maltese operator)
Type of flight	Commercial air transport, scheduled flight
Persons on board	Captain (PF), co-pilot (PM), 4 cabin crew, 172 passengers
Consequences and damage	None

Incorrect QNH information, RNP approach with LNAV/VNAV minima conducted below the descent profile, near CFIT, go-around performed at low height before the runway without visual references, second approach performed below descent profile

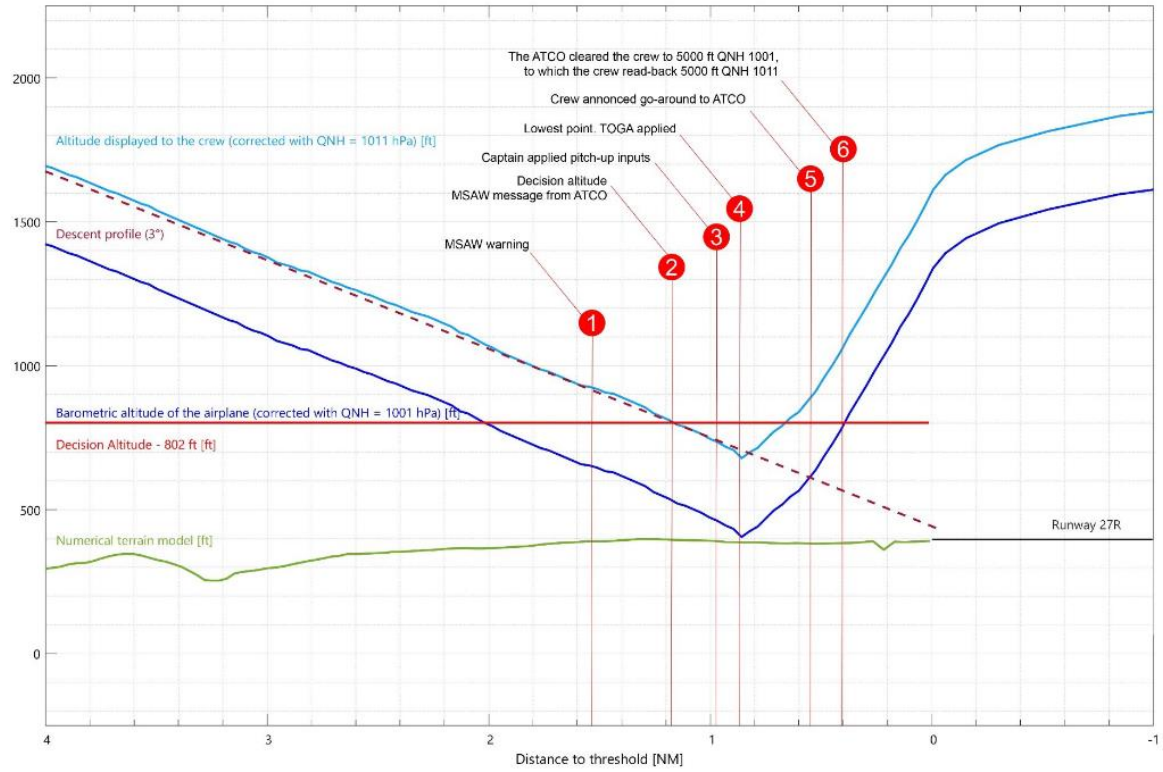

Figure 1: First approach profile, flight path computed from recorded flight parameters (source: BEA)

other recent cases in Norway and Abu Dhabi:

Recent serious incidents investigations:

- 22/12/2022, DHC-8, LOC/DME approach in Norway,
  QNH let to standard vs 987hPa (-730ft) => TAWS warning
- 23/05/2022, this A320 CDG event
- 20/10/2021, CRJ1000, LNAV approach at Nantes,
  QNH 1021 vs 1002 (-530ft), MSAW alert
- 06/06/2020, B787, LNAV/VNAV at Abu Dhabi, QNH 1009 vs 999 (-280ft),
  MSAW alert

Coordination with ICAO

- **France initially addressed the BaroVNAV safety issues with ICAO EUR during EASPG/4 Dec 22:**
  - EASPG concluded that a regional bulletin alerting on issues should be edited. The bulletin has been published 28 July 2023
- **The issue adressed and the lack of standardized QNH mis-setting mitigation means within ICAO documents within NSP/7 Jan 23**
  - NSP/7 meeting reort concluded: *« It was clear that human factors, communication and ATC issues, modernization of aircraft were related to the issue reported here. Baro-VNAV will continue to be used, even in exclusive use of PBN areas, when ground navaids are used as a fallback mode. … Therefore, communication through the aviation community was key and the options indicated by the Secretary should be considered to brief the ANC”*

AIR NAVIGATION COMMISSION, 224TH SESSION, Minutes of the Third Meeting (ANC Chamber, Tuesday, 10 October 2023 at 1000 hours)

….

22417 Review of the report of the seventh meeting of the Navigation Systems Panel (NSP/7) AN-WP/9697

13 The AN-WG/SRP Chairperson drew attention to paragraph 2.9 which emphasized the need for a holistic discussion about Baro-VNAV mitigation encompassing OPS, ATM and technology domains. He advised that, subsequent to the AN-WG/SRP meeting, the issue had been brought to the attention of the Flight Operations Panel (FLOPSP) who had recommended that global dissemination of existing material relating to Baro-VNAV to raise awareness be considered and that the topic be referred to the FLOPSP.

14 Concluding its consideration of AN-WP/9697, the Commission:

….

c) *requested* the Secretary to promote existing material related to Baro-VNAV QNH setting error and current mitigations in order to raise awareness; and

d) *requested* the FLTOPSP to further review the Baro-VNAV issue to determine if additional mitigations could be developed.

EUR OPS BULLETIN

Serial Number: **2023_001** Effective: **27 July 2023**

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

1. Introduction and scope

1.1 Recent incidents have highlighted that an erroneous altimeter setting can have serious consequences on flight safety during final approach operations. After recalling how aircraft barometric altitude is determined and used in certain approach operations, this bulletin lists a set of recommendations to mitigate altimeter setting errors.

EASA
European Union Aviation Safety Agency

Safety Information Bulletin

Operations – ATM/ANS

SIB No.: 2023-03

Issued: 09 March 2023

Subject: **Incorrect Barometric Altimeter Setting**

Ref. Publications:
None.

Applicability:
Aircraft operators and Air Navigation Service Providers.

Description:
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

Safety first

The Airbus Safety magazine

Use the Correct BARO Setting for Approach

Using an erroneous barometric reference setting during approach may cause the aircraft to fly lower than the published approach

dgac DSAC

DGAC SAFETY LEAFLET

N° 2023/02

A safety Info Leaflet is a document widely distributed by DSAC, without regulatory obligation, whose purpose is to draw the attention of certain actors in the aviation sector to an identified risk or to promote best practices. This safety Info Leaflet is available on: https://www.ecologie.gouv.fr/info-securite-dgac

Operators concerned	Aircraft operators Instrument rated pilots Air Navigation Service Providers
Topic	Risks related to altimeter setting errors, in particular during APV baro-VNAV and non-precision approach operations

civile

QNH mis-setting mitigations

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

- ***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.
- Configure correct QNH in all altimeters (main, standby) and FMS.
- Apply standard communication and phraseology between the pilot and air traffic services.

QNH mis-setting mitigations

At ANSP level

• 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.tion and phraseology between the pilot and air traffic services.

Work on evolution of the QNH mis-setting mitigations

- **Following the BEA recommandations in the preliminary report, DSNA immediatly enforced two additional mitigations at all French airports, only one retained now:**
  - Third announcement of QNH by the Tower (LOC) ATCO.
  - No incident reported since this implementation.
- **At Paris CDG, the airline had a specific mitigation: a 50 ft add-on over the LNAV/VNAV minima, which saved the aircraft on that day.**
  - Increasing BaroVNAV operations minima is also a mitigation.
  - 300 ft minima increase has been implemented by DSNA at Nantes 21 as a mitigation to several MSAW alerts incidents. No incident reported since this implementation.

Technical solutions

- 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.

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 the likelihood of QNH errors.

Recommendations on Training

For pilots:

- 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 in this bulletin.
- 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.
- 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.
- Training on 3D RNP operations highlighting the RNP chart layout where LNAV/VNAV and LPV minima co-exist.

Recommendations on Training

For ATCO:

- 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 in this bulletin.
- 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.

Action by meeting :

- Note the information provided; and
- Encourage States to raise awareness, better share, document and mitigate BaroVNAV safety issues.

Thank You!

ICAO