



**MINISTÈRE  
CHARGÉ  
DES TRANSPORTS**

*Liberté  
Égalité  
Fraternité*



**ICAO EUR/MID radio navigation symposium  
Antalya – 6-8 Feb 2024**

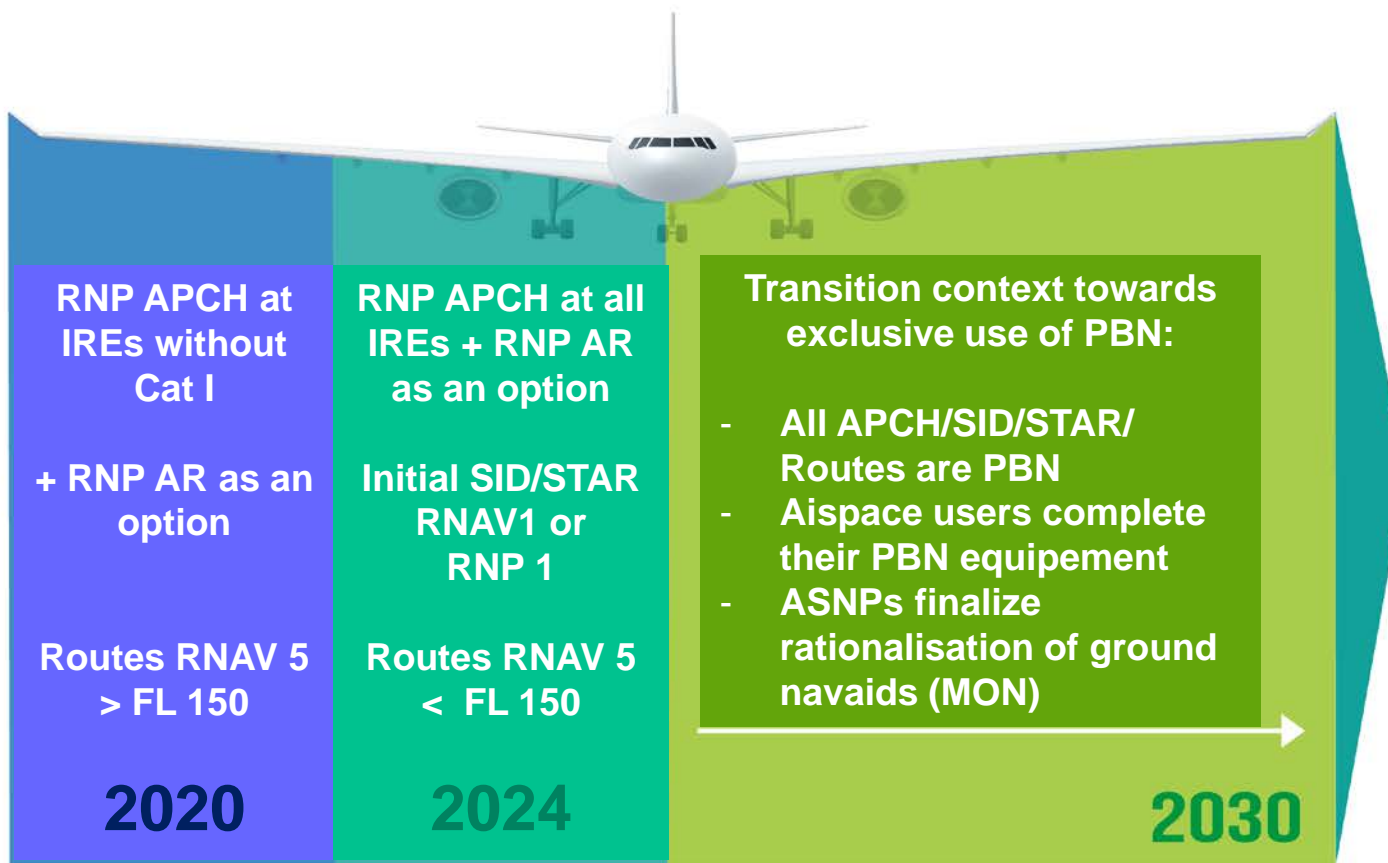
**France PBN implementation issues REX**

**B Roturier – DGAC/DSNA France**

# Introduction

- **DSNA, the French ANSP, is involved in a 3 step PBN implementation process**
  - First step was compliance with A37/11 ICAO resolution, aiming in particular to generalize approaches with vertical guidance. *Completed.*
  - Second step is implementation of PBN all phases of flight in compliance with PBN IR + rationalization of ILS/VOR/NDB. *Nearly completed (target end 2024).*
  - Third step aims to derive new benefits from PBN, in particular related to greener aviation, by implementing specific projects in close consultation with airspace users (such as increased use of CCO/CDO, PBN to ILS, RNP AR, RNP VPT,...). *In progress.*

## Step 2: European PBN Implementing Rule



**RÈGLEMENT  
D'EXÉCUTION  
(UE)  
2018/1048**

**Exclusive use of PBN at the exception of Cat II/III landings:**

**EGNOS becomes the main landing system in Europe (Cat I)**



**Use of BaroVNAV if not EGNOS equipped**

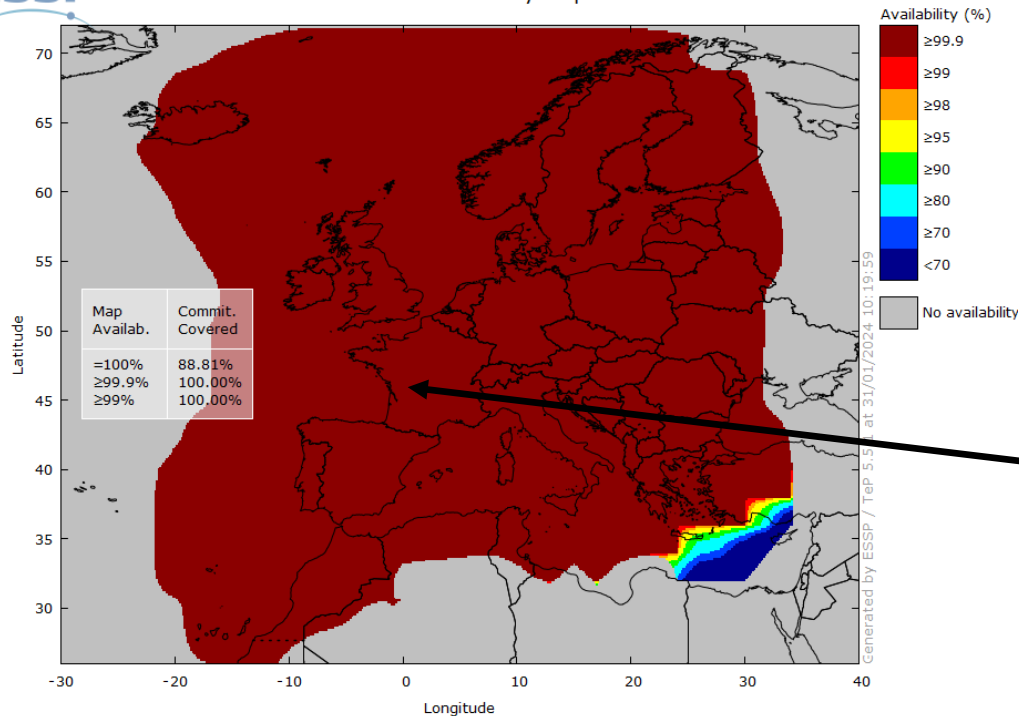
**ILS Cat I serviceable only under**

# EGNOS PBN landings service areas

ESSP

PRN 121 - 31/01/2024 09:15:00 to 31/01/2024 10:14:59

LPV200 Availability Map



**EGNOS provides a look-alike « giant » ILS signal falling from the sky**

**Free of charge for ANSPs and airspace users**

**Since 2015, Cat I certified signal**

# PBN RNP landings



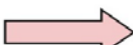
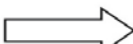
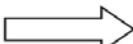
## LPV landings

Support high performance/safety  
Cat I landings « everywhere »  
without airport specific  
infrastructure



### Technology

### Usual Minima

|                                |   |                 |
|--------------------------------|---|-----------------|
| ABAS                           |  | 400 – 600 ft DH |
| ABAS +<br>BaroVNAV             |  | 350 – 400 ft DH |
| SBAS APV I                     |  | 250 – 300 ft DH |
| SBAS Cat I                     |  | 200 ft DH       |
| GBAS Cat I/II/III<br>(not PBN) |  | 200 – 0 ft      |

Cat II/III

3°

LPV

LNAV/  
VNAV

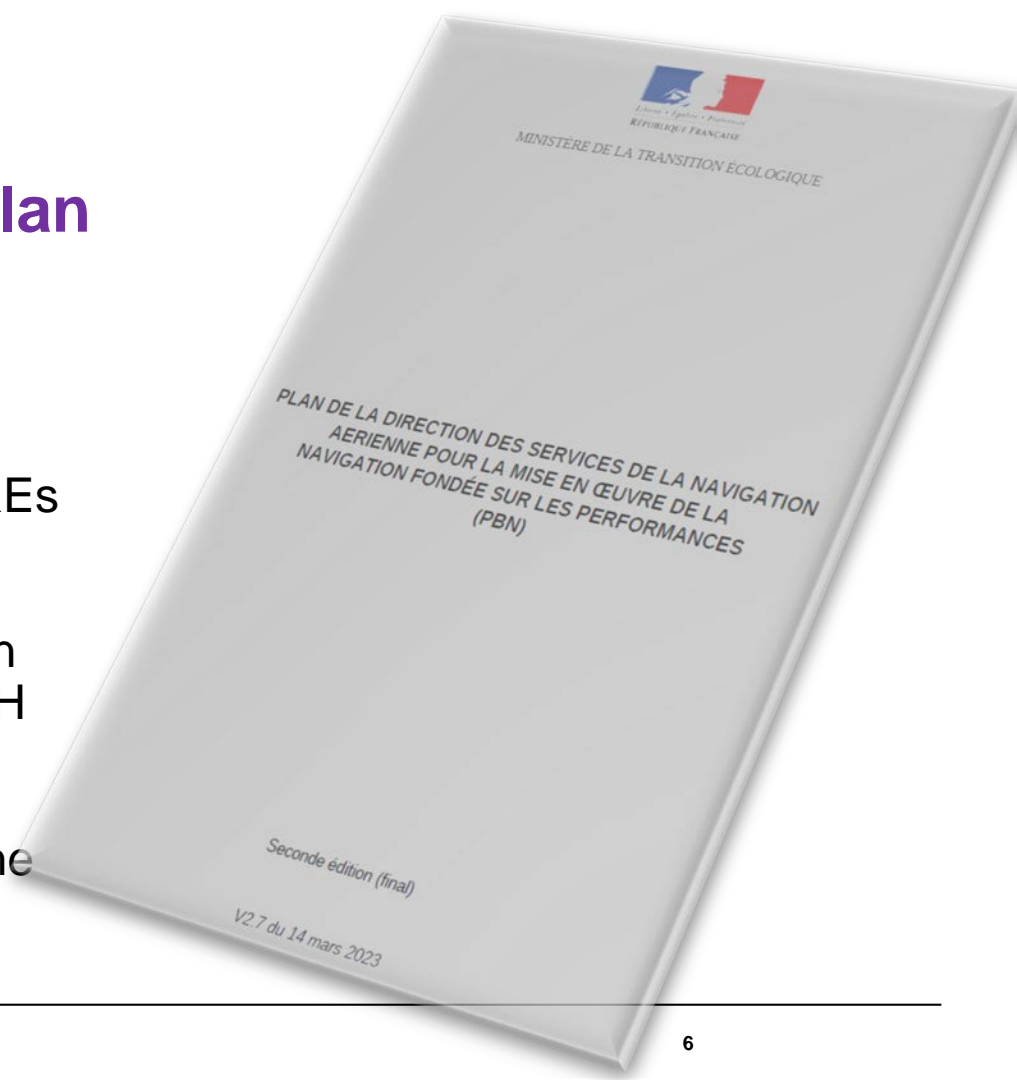
LNAV

550 m  
visibility

# PBN regulation transition plan

## The regulation requires a detailed implementation plan by ANSPs:

- DSNA in charge of 70 airports, 144 IREs for RNP APCH
- in addition, DSNA was also involved in many France AFIS airports RNP APCH publications
- DSNA is the EUR ANSP involved in the largest number of RNP APCH design, implementation, and rex.



# PBN IR implementation main REX

- **France is concerned with the increasing number of serious incidents with BaroVNAV technology,**
  - BaroVNAV is used as PBN primary mean to fly down to LNAV/VNAV minima and as recommended advisory mean for LNAV minima
  - PBN IR is enforcing LNAV and LNAV/VNAV while reducing the number of ILS: more exposition rate to BaroVNAV deficiencies now
  - DSNA is the European ANSP with much more RNP APCH than others:
    - we see more things, a bit in advance
- **We had several significant BaroVNAV incidents recently, two of them under enquiry of BEA:**
  - Nantes Oct 2021
  - Paris CDG May 2022

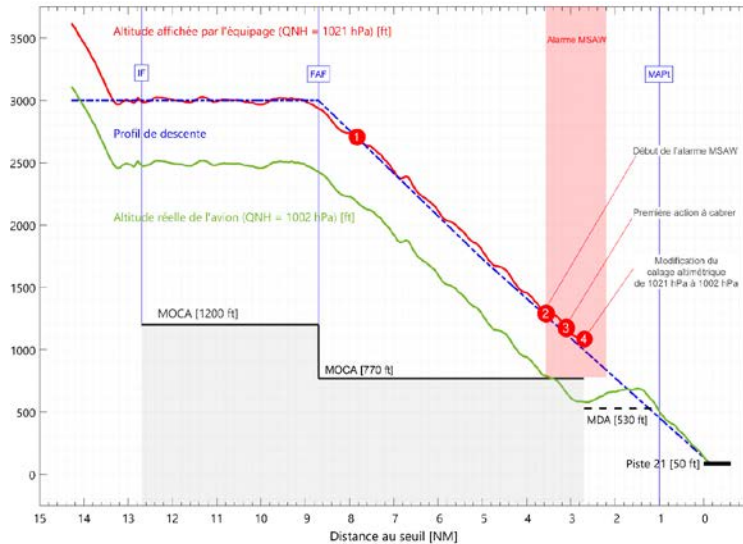
# Nantes QNH mis-setting



Serious incident to the Bombardier CRJ 1000 registered F-HMLD operated by Air France Hop on 20/10/2021 near Nantes

## SUMMARY

Vol AD Lyon-Saint Exupéry (69) - AD Nantes (44).



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 AIRBUS A320

Registered **9H-EMU**

On 23 May 2022

On approach to Paris-Charles de Gaulle airport (95)

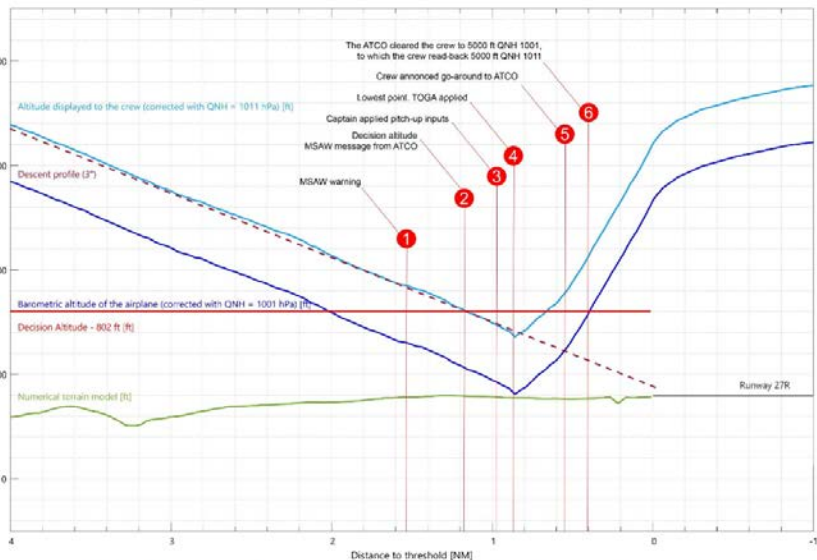


Figure 1: First approach profile, flight path computed from recorded flight parameters (source: BEA)

|                                |   |
|--------------------------------|---|
| <b>Time</b>                    | Around 11:40 <sup>1</sup>                                 |
| <b>Operator</b>                | Airhub Airlines (Maltese operator)                        |
| <b>Type of flight</b>          | Commercial air transport, scheduled flight                |
| <b>Persons on board</b>        | Captain (PF), co-pilot (PM), 4 cabin crew, 172 passengers |
| <b>Consequences and damage</b> | 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**

# Not only France concerned by QNH mis-setting !

**BEA identified other recent cases in Norway and Abu Dhabi:**

Recent serious incidents investigations:

- 22/12/2022, DHC-8, LOC/DME approach in Norway, QNH set 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

# Since Paris CDG BaroVNAV near CFIT, several activities have been conducted over 3 main areas:

- 1. Coordinate with ICAO on the issue**
- 2. Work on evolution of the QNH mis-setting mitigations**
- 3. Document the level of risk of BaroVNAV technology**

# 1. Coordinate with ICAO on the issue

- **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
- **France addressed the issue and the lack of standardized QNH mis-setting mitigation means within ICAO documents within NSP/7 Jan 23**
  - NSP/7 meeting report 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 nav aids 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* »
- **France addressed the issue during SouthAm RAAC/17, Apr 2023**
  - ICAO NACC proposed to further address the issue with GREPECAS/21 meeting, Nov 2023



# EUR OPS BULLETIN



Safety Information Bulletin  
Operations – ATM/ANS

SIB No.: 2023-03

Issued: 09 March 2023

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.

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

|   |  |
|---|--|
| <br>  | <p align="center"><b>DGAC SAFETY LEAFLET</b><br/>N° 2023/02</p>  |
| <p>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: <a href="https://www.ecologie.gouv.fr/info-securite-dgac">https://www.ecologie.gouv.fr/info-securite-dgac</a></p> |  |
| <p><b>Operators concerned</b></p>   | <p>Aircraft operators<br/>Instrument rated pilots<br/>Air Navigation Service Providers</p>                                 |
| <p><b>Topic</b></p>   | <p>Risks related to altimeter setting errors, in particular during APV baro-VNAV and non-precision approach operations</p> |

# 1. Coordinate with ICAO on the issue

## 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:

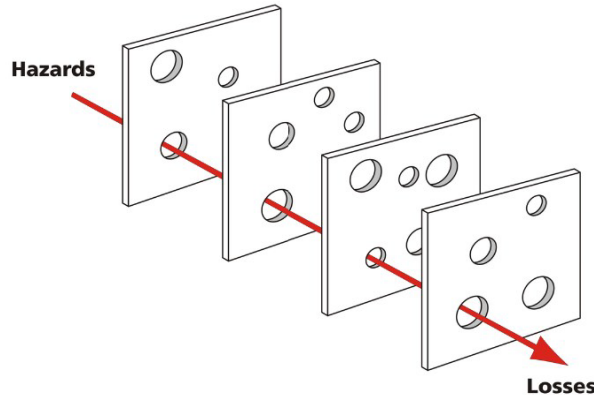
....

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.***

## 2. Work on evolution of the QNH mis-setting mitigations

- The main barrier which was retained within the generic BaroVNAV safety case defined in Europe in the 2010s was a double announcement of the QNH by ATC:
  - E.g. on the ATIS + at first contact with the approach ATCO
  - It was implemented as such in France until Paris CDG near CFIT
  - Quasi CFIT + further analysis suggest that this barrier is not sufficient



## 2. Work on evolution of the QNH mis-setting mitigations

- **Following the BEA recommendations in the preliminary report, DSNA immediately 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.

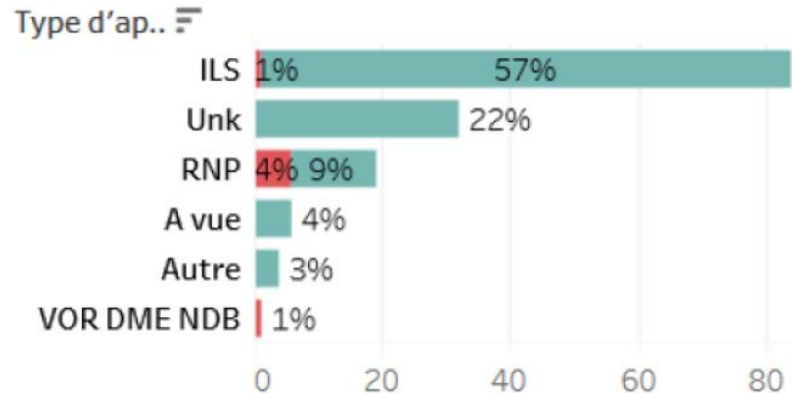
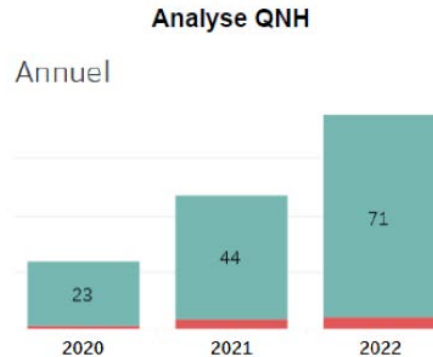


## 2. Work on evolution of the QNH mis-setting mitigations

- **Some new barriers discussed/considered now**
  - System indicating to the ATCO step discrepancy (e.g. >5 hPa) between the airborne QNH (obtained by Mode S datalink) and local QNH.
  - Already implemented by NATS at Heathrow, however this is not accessible to all airports
- **For PBN operations, obviously SBAS/LPV does not require any of these barriers.**
  - Performance limitations of BaroVNAV are the driver here.

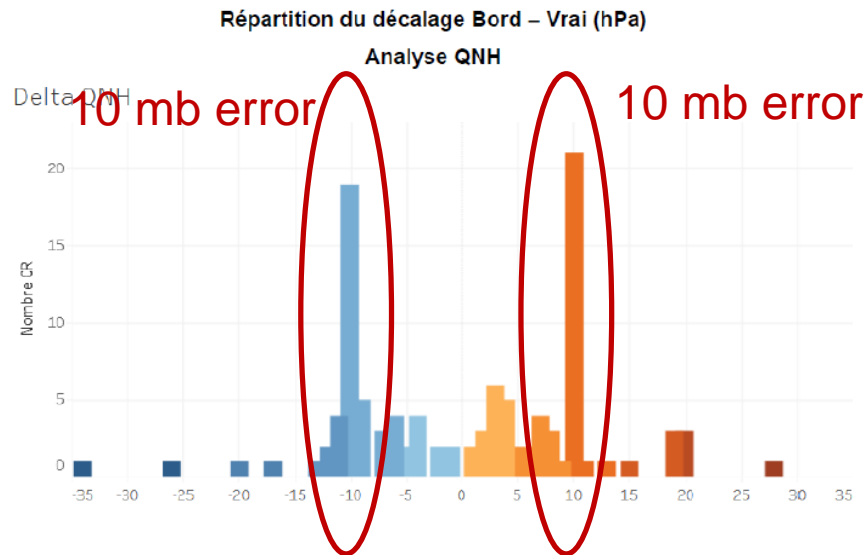
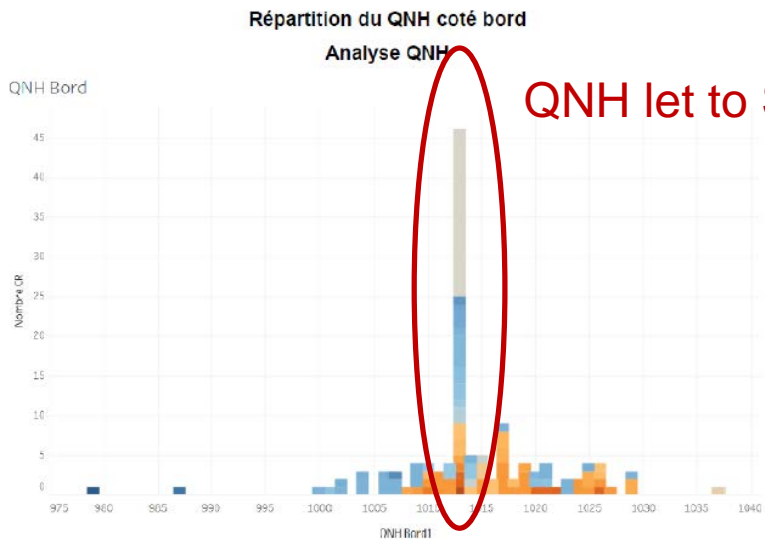
# 3. Document the level of risk of BaroVNAV technology: two studies

- Analysis of non-reported (all) QNH events – on-going study,
  - initial results suggest that the QNH mis-setting integrity risk is of the order of  **$10^{-3}$  / approach**
  - To be compared to ILS/SBAS/GBAS integrity risk of  **$10^{-7}$  / approach**
- Analysis of reported (only) QNH events French airspaces (138 events – 2020 to 2022):



# 3. Document the level of risk of BaroVNAV technology

- Analysis of reported QNH events French airspaces (138 events – 2020 to 2022) showed 3 typical mis-setting errors



# A one day vertical navigation safety workshop was recently organized by Eurocontrol

- A lot of QNH mis-setting useful information shared by the community (ANSPs, safety agencies, airlines, aircrew, european institutions, etc...)
- Many videos of the presentations and discussions available in skybrary

<https://skybrary.aero/themes/conferences-and-events/safety-vertical-navigation-final-approach-workshop>

## Agenda

### Friday 20 October 2023

|               |   |
|---------------|---|
| 09:00 - 09:10 | <b>Welcome Speech</b><br><i>Iacopo Prissinotti, Director NM</i>   |
| 09:10 - 09:30 | <b>Intro - RNP approach operations &amp; fleet equipage</b><br><i>EUROCONTROL/ESSP</i>                                    |
| 09:30 - 10:00 | <b>Safety incidents with RNP APCH using Baro-VNAV</b><br><i>Thierry Rozec, Bureau d'Enquêtes et d'Analyses (BEA)</i>      |
| 10:00 - 10:30 | <b>From safety risk assessment to safety actions, NSA &amp; ANSP View</b><br><i>Muriel Broussy, DSNA/Yoni Malka, DSAC</i> |
| 10:30 - 11:00 | <b>Break</b>  |
| 11:00 - 11:30 | <b>Pilots Perspective</b><br><i>Henrik Ekstrand, Novair/Marco van Roon, Transavia</i>                                     |
| 11:30 - 12:00 | <b>Pilots Perspective</b><br><i>Moritz Buerger, European Cockpit Association (ECA)</i>                                    |
| 12:00 - 12:30 | <b>ANSP View &amp; ATC Tools</b><br><i>Roman Kienast, Austro Control</i>  |
| 12:30 - 13:30 | <b>Lunch</b>  |
| 13:30 - 14:00 | <b>ANSP View &amp; ATC Tools</b><br><i>Bart Banning, LVNL</i>   |
| 14:00 - 14:30 | <b>ANSP View &amp; ATC Tools</b><br><i>Adam Exley, NATS</i>   |
| 14:30 - 15:00 | <b>Manufacturer View</b><br><i>Dirk De Winter/Julien Bernage, Airbus</i>  |
| 15:00 - 15:30 | <b>Break</b>  |
| 15:30 - 16:00 | <b>Manufacturer View</b><br><i>Mark Brown/David Zeitouni, Boeing</i>  |
| 16:00 - 16:30 | <b>EASA View</b><br><i>Raúl Sanchez, EASA</i>   |
| 16:30 - 17:00 | <b>Wrap-up &amp; Conclusions</b>  |

# Conclusion and recommendation

- **BaroVNAV was not designed as a self-standing approach and landing system, by contrast to geometric vertical guidance systems such as ILS, GBAS or SBAS.**
- **As evidenced by several serious recent incidents in France and others, BaroVNAV approaches are significantly less robust than geometric PBN approaches enabled by SBAS.**
  - The main vulnerability of BaroVNAV approaches lies in their dependency on correct altimeter setting through human in the loop.
  - DGAC disagrees with the notion of equivalency between SBAS and BaroVNAV, which has been promoted in the past, and encourages increasing the pace of transition to SBAS.
  - France continue its efforts to better share, document and mitigate BaroVNAV safety issues.



# Thank you! Questions?