



**MINISTÈRE
CHARGÉ
DES TRANSPORTS**

*Liberté
Égalité
Fraternité*



GREPECAS/21 – P/09

Agenda Item 3.3

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.*
 - 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

2018

RNP APCH at
IREs without
Cat I

+ RNP AR as an
option

Routes RNAV 5
> FL 150

2020

RNP APCH at all
IREs + RNP AR
as an option

SID/STAR
RNAV1 or
RNP 1

Routes RNAV 5
> FL 65

2024

Transition period towards
exclusive use of PBN:

- Aispace users complete their PBN equipment (as required)
- ASNPs complete rationalisation of ground nav aids (MON)

2030

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

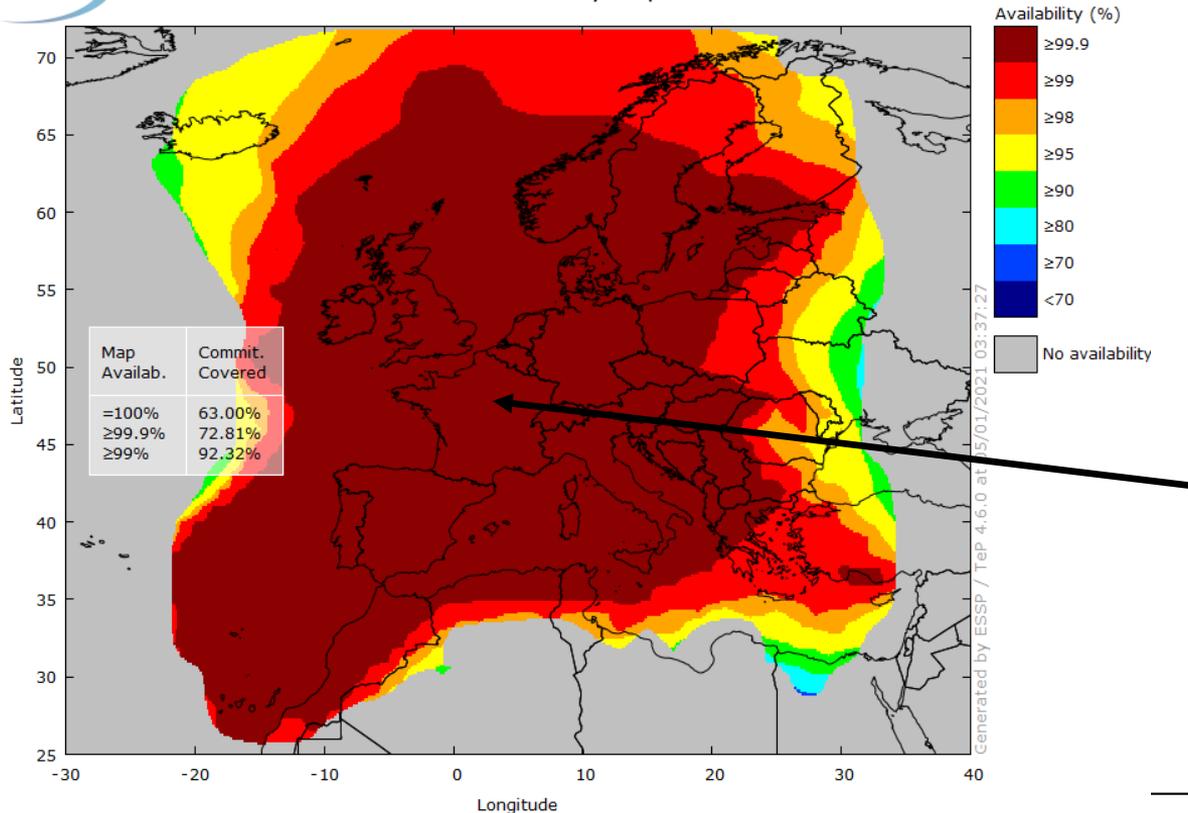
ILS Cat I
serviceable
only under
contingency

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

EGNOS PBN landings service areas



PRN 123136 - 04/01/2021 00:00:00 to 04/01/2021 23:59:59
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

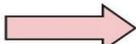
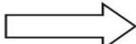
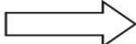
PBN RNP landings

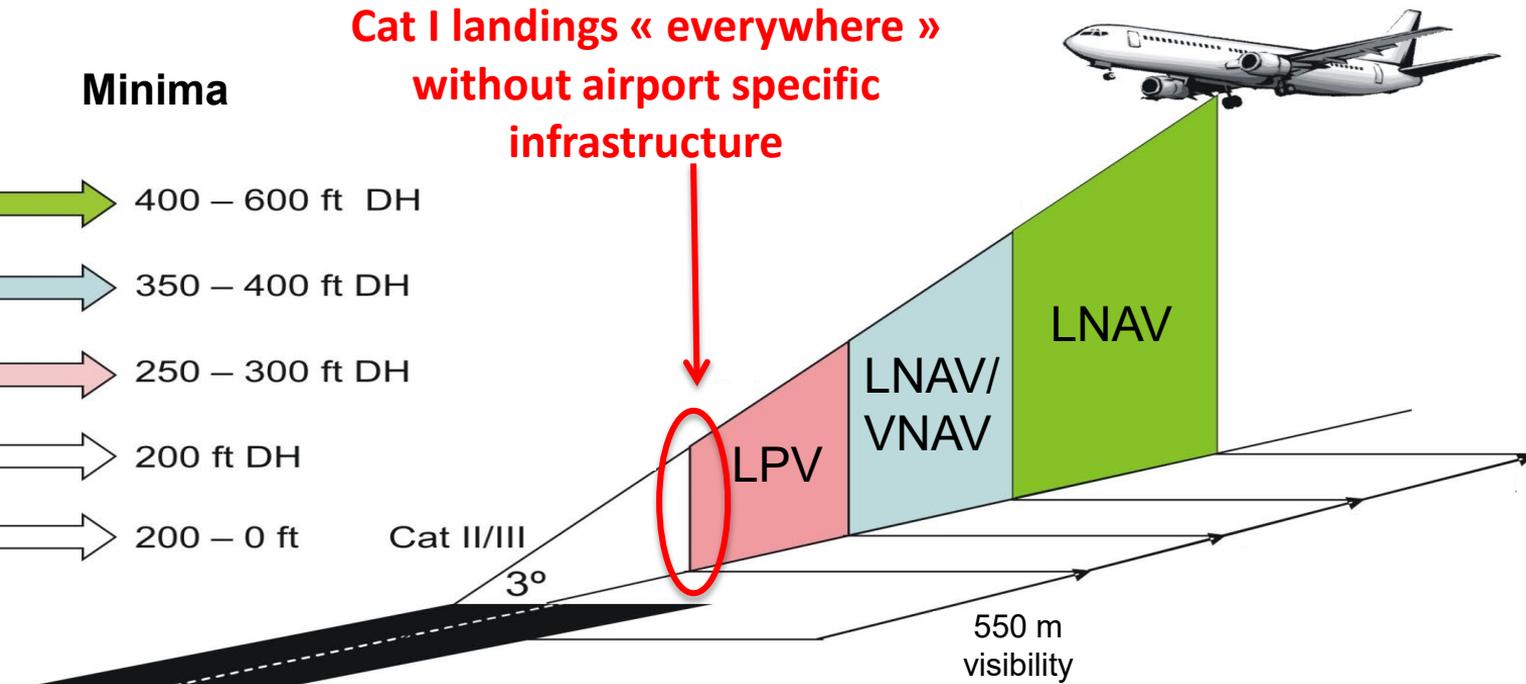
LPV landings

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

Technology

Minima

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



PBN regulation transition plan

The regulation requires a detailed implementation plan by ANSPs. For DSNA:

- 70 airports, 144 IREs for RNP APCH
- includes airports in the CAR/SAM area submitted to the regulation (Cayenne, Martinique, Pointe à Pitre)



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 probably see more things, a bit in advance
- **We had several significant BaroVNAV incidents recently, two of them under enquiry of BEA**
 - DGAC now convinced that SBAS (LPV minima) is a much more robust PBN technology than BaroVNAV

Serious incident to the AIRBUS A320

Registered **9H-EMU**

On 23 May 2022

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

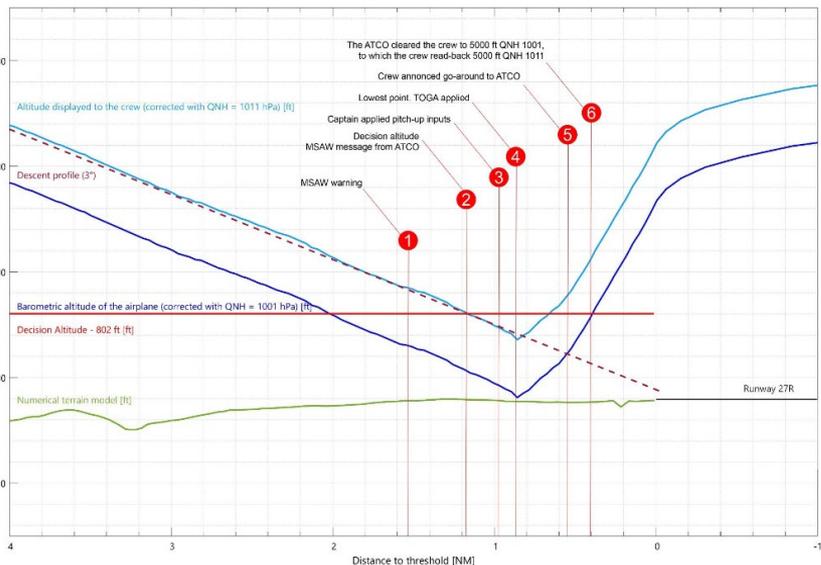


Figure 1: First approach profile, flight path computed from recorded flight parameters (source: BEA)

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

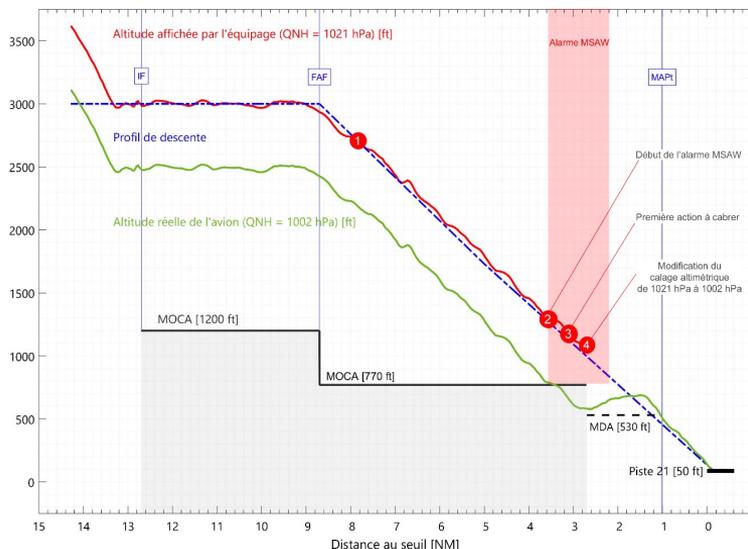
Nantes QNH mis-setting



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.

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 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 RAAC/17, Apr 2023**
 - ICAO NACC proposed to further address the issue with GREPECAS/21 meeting



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

 	<p align="center">DGAC SAFETY LEAFLET 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: https://www.ecologie.gouv.fr/info-securite-dgac</p>	
<p>Operators concerned</p>	<p>Aircraft operators Instrument rated pilots Air Navigation Service Providers</p>
<p>Topic</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:

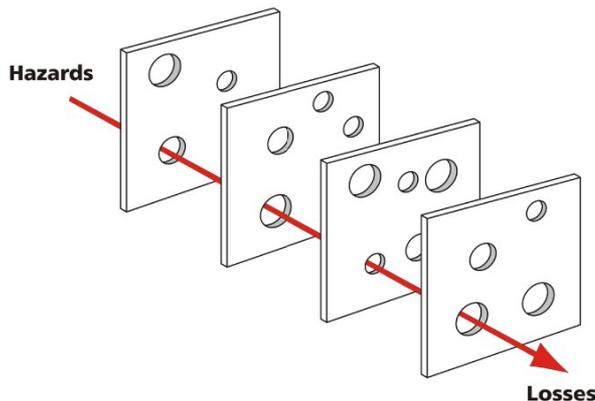
....

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

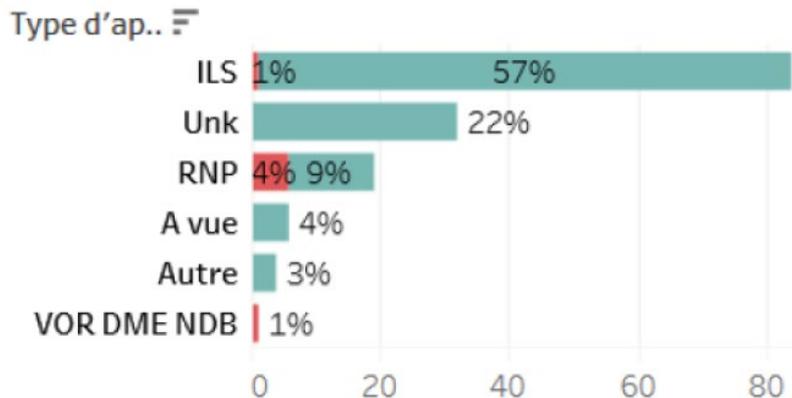
- **Following the BEA recommendations in the preliminary report, DSNA immediatly enforced two additional mitigations at all French airports:**
 - Third announcement of QNH by the Tower (LOC) ATCO. No incident reported since this implementation.
 - Requires the ATCO to order a go around immediatly after an MSAW alert. But, following return of experience, we now went back to the nominal disposition which do not require a go-around.
- **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.

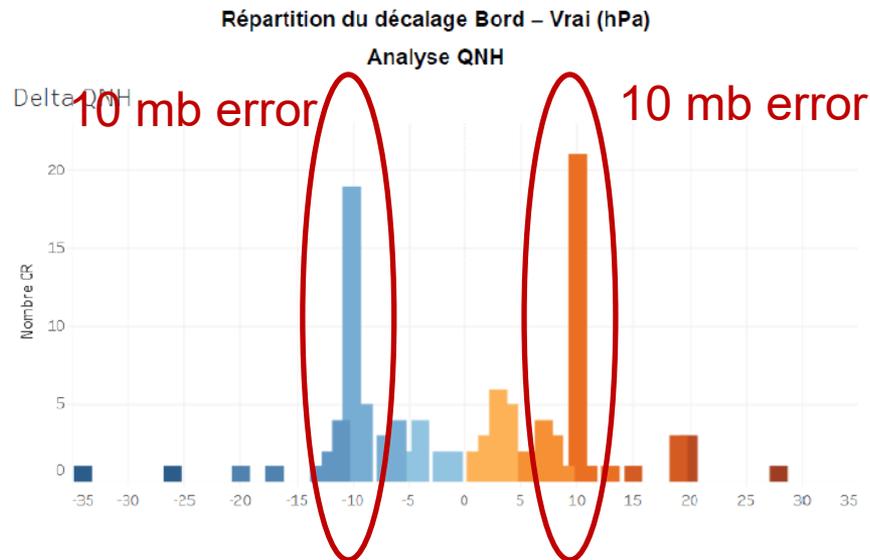
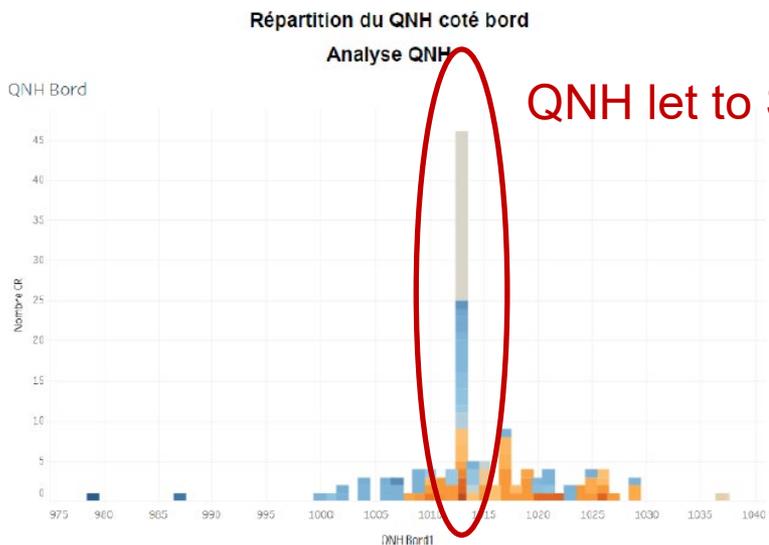
3. Document the level of risk of BaroVNAV technology

- 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...)**
- **It was agreed that the meeting material will be further shared with all interested parties (e.g. Skybrary)**
 - **For more information, contact: david.de-smedt@eurocontrol.int**

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.
 - France continue its efforts to better document and mitigate BaroVNAV safety issues
- **GREPECAS is invited to consider the integrity and precision capabilities of SBAS and the safety issues of Baro-VNAV in the implementation and operations of PBN approaches in the CAR/SAM region**



Thank you! Questions?