International Civil Aviation Organization
CAR/SAM Regional Planning and Implementation Group (GREPECAS)

WORKING PAPER

GREPECAS/22 — WP/42
20/09/24

Fourth GREPECAS–RASG-PA Joint Meeting and
Twenty-second Meeting of the CAR/SAM Regional Planning and Implementation Group (GREPECAS/22)
Virtual Phase (Asynchronous, 16 September to 11 October 2024)
In-Person Phase (Lima, Peru, 20 to 22 November 2024)

Agenda Item 5: **CAR/SAM Air Navigation Services (ANS) Implementation**
5.2 Communications, Navigation and Surveillance (CNS)

PBN LANDINGS SAFETY RECOMMENDATIONS

(Presented by France)

EXECUTIVE SUMMARY

At GREPECAS/21, France presented WP 09 *"PBN Implementation in France, a return of experience"*. This paper highlighted that France benefits from an important return of experience in PBN approach operated through Satellite Based Augmentation System (SBAS) and Barometric Vertical Guidance Navigation (Baro-VNAV) and identified potential safety impacts related to BaroVNAV operations.

Following the publication by the French Accident and Investigation Bureau, Bureau d'Enquêtes et d'Analyses (BEA), in June 2024 of the final report on one of the most serious safety incidents occurring within French airspace for the last 10 years, this paper provides an update on the main findings and related safety recommendations in relation with PBN BaroVNAV landing operations.

Action:	GREPECAS is invited to: a) Note the content of this working paper, b) Consider the BEA final report on "*Serious incident to the AIRBUS A320 registered 9H-EMU and operated by Airhub Airlines on Monday 23 May 2022 on approach to Paris-Charles de Gaulle airport*", c) Consider the need to further document the risks of QNH mis-setting and the need to coordinate further work in this area, d) Consider the integrity and precision capabilities of SBAS and the latent safety issues of Baro-VNAV in the implementation and operations of PBN approaches in the CAR/SAM region.
Strategic Objectives:	• Safety • Air Navigation Capacity and Efficiency

	• Economic Development of Air Transport
References:	• ICAO Annex 10 Volume I • PBN Manual • GANP ASBU element NAVS

1. Introduction

1.1 The implementation of Performance Based Navigation (PBN) is of great interest to support precise and advanced trajectories within airspaces. ICAO has 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*.".

1.2 France fully subscribes to the ICAO specific strategy for approaches in the implementation of PBN and has published PBN approaches for a majority of its IFR runway-ends following EU regulation.

1.3 As highlighted within GREPECAS/21 WP09, France has the largest number of IFR runway-ends in Europe and has recently seen an increase in the number of airspace users flying PBN landings. Consequently, France benefits from a wide return of experience on the use of both SBAS and Baro-VNAV in PBN approach operations.

1.4 Following the publication by French Accident and Investigation Bureau, Bureau d'Enquêtes et d'Analyses (BEA) in June 2024 of the final report on one of the most serious safety incidents occurring within French airspace for the last 10 years *"Serious incident to the AIRBUS A320 registered 9H-EMU and operated by Airhub Airlines on Monday 23 May 2022 on approach to Paris-Charles de Gaulle airport (Val-d'Oise). Transmission of incorrect altimeter setting (QNH) by air traffic service, near-collision with ground during satellite approach procedure with barometric vertical guidance",* this paper provides an update on the main findings and related safety recommendations in relation with PBN BaroVNAV landing operations.

2. Discussion

2.1 Baro-VNAV is based on the combination of on-board Flight Management System (FMS) and GPS Airborne Based Augmentation System (ABAS) for lateral guidance with barometric vertical guidance. The barometric vertical guidance relies on the barometric-altimeter reference (QNH mostly) entered manually by the pilot.

2.2 Recently, several serious Baro-VNAV approach incidents have occurred in France. These incidents on major French aerodromes are due to human errors when entering the local barometric altimeter reference (QNH) in the aircraft avionics (see GREPECAS/21 WP 09 Appendix A).

2.3 BEA has now completed a safety investigation, spanning over two years, on the most severe incident related toPBN with BaroVNAV landing, and published the final report "Serious incident to the AIRBUS A320 registered 9H-EMU and operated by Airhub Airlines on Monday 23 May 2022 on approach to Paris - Charles de Gaulle airport" available at: https://bea.aero/en/investigation-reports/notified-events/detail/serious-incident-to-the-airbus-a320-registered-9h-emu-operated-by-airhub-on-23-05-2022-at-paris-charles-de-gaulle-ad/. The main findings of the safety investigation, applicable to PBN BaroVNAV based operations in general, can be summarized as follows:

2.3.1 The approach procedures that use the Baro-VNAV function in order to have the lowest minima are the RNP APCH operations down to LNAV/VNAV minima type PBN procedures. With these procedures, it is possible to have a decision height as low as 250 ft, close to the minima for a Category I ILS approach at 200 ft. However, one of the most frequent incorrect altimeter settings in hPa is with an error of 10 hPa. This offsets the altitude and therefore the vertical profile by 280 ft to the theoretical vertical profile, which could ultimately lead to a collision with the ground before the decision altitude has been displayed to the crew.

2.3.2 It should also be noted that in the design of the procedures, the method of calculating decision heights for RNP APCH down to LNAV/VNAV minima, notably based on obstacle clearance margins in the ICAO PANS-OPS, was revised in 2004 to increase airport accessibility, and results in lower decision altitudes. The threats inherent in the Baro-VNAV function, such as an incorrect altimeter setting, were not taken into account when this revision was introduced, and the reduction in minima for these approaches did not give rise to a safety study by ICAO.

2.3.3 The CFIT risk linked to the threat of an incorrect altimeter setting for barometric approaches, and in particular Baro-VNAV approaches, although known for decades, was not sufficiently taken into account by the entire international aviation community. In the light of this serious incident and the many similar occurrences of incorrect altimeter settings, it can be considered that the hypothesis that current training, procedures and systems are sufficient to limit this risk is not true. In fact, neither the design of these IFR procedures, nor their execution by crews, nor the air traffic controller procedures, nor the on-board or ground systems are sufficiently robust to systematically deal with this threat.

2.3.4 This risk was probably not sufficiently taken into account by the aviation community as a whole in the various risk analyses, because the majority of approaches in commercial air transport have for several decades been carried out using ILS precision approaches and their vertical profiles are not affected by incorrect altimeter settings, thus masking these errors and their consequences.

2.3.5 In PBN, SBAS LPV is the only option that enables approaches to be flown with a safety level equivalent to that of ILS or GLS approaches, where the vertical profile is not affected by an incorrect altimeter setting.

2.3.6 The report also investigates why the United States is one of the countries with the highest number of publications regarding RNP APCH operations down to LNAV/VNAV minima, but few noticeable events associated with incorrect altimeter settings have been reported. The report suggests that three main differences with Europe (and other regions) may explain this difference. Consequently, using the return of experience of United States over PBN BaroVNAV landings by regions which implement differently PBN BaroVNAV operations may not be appropriate:

> 2.3.6.1 The altimeter setting is given as inches of mercury (in Hg), not as hectopascals (hPa). Standard pressure at 1013 hPa corresponds to 29.92 in Hg. Altimeter settings in the United States therefore generally vary between 28.XX and 30.XX in Hg, with 29.XX in Hg being the most common value. The most common error observed in Europe of ± 1 on the second digit (± 10 hPa – around 300 ft) thus corresponds to an error of one tenth of an inch of mercury on an altimeter set to the US setting (e.g.: 29.82 -> 29.92),

which only offsets the altitude by around 100 ft. Having a 10 hPa error equivalent to the 9H-EMU serious incident would mean an error of three tenths, which is much larger, easier to detect and therefore less frequent. In addition, local best practices recommend using “high” before a 30.XX in Hg altimeter setting and “low” before a 28.XX in Hg altimeter setting. This also limits substantial errors.

2.3.6.2 Transition level of FL180, and the altimeter setting provided en route by the controller during the descent. This high transition level generally means that the altimeter setting is changed from the STD to the local reference during a low-workload phase for the crew compared with FL080-FL050, which is the transition level generally used in Europe. This also gives the crew and controllers more time to identify any altitude deviation.

2.3.6.3 The language used (English) is the mother tongue of air traffic controllers and of a large proportion of pilots, thereby reducing the risk of transmission errors, read-back errors or incorrect information not being detected.

2.4 In conclusion, the safety investigation speficies that given the increasing use of satellite approaches with barometric vertical guidance, the threat of an incorrect altimeter setting, although known about for decades, has become preponderant again and the associated risk for commercial air transport unacceptable in view of today's global safety requirements, which are much higher than in the last century. The BEA final report in consequence addresses new safety recommendations to the French ANSP DSNA, EASA, European Commission and ICAO.

2.5 The recommendation to ICAO, of interest to GREPECAS, is reproduced below:

That ICAO, in collaboration with the manufacturers, authorities and operators, carry out an overall reassessment of the CFIT risk and the associated mitigation measures, in connection with the threat of an incorrect altimeter setting for Baro-VNAV approach operations. These measures could consist of updating the standards and recommended practices and associated documents and defining incentives, or even stipulations, to ensure the development of new safety barriers or the improvement of existing ones.
[Recommendation FRAN-2024-006].

3. Suggested action

3.1 The GREPECAS is invited to:

a) Note the content of this working paper,
b) Consider the BEA final report on “*Serious incident to the AIRBUS A320 registered 9H-EMU and operated by Airhub Airlines on Monday 23 May 2022 on approach to Paris-Charles de Gaulle airport*”,
c) Consider the need to further document the risks of QNH mis-setting and the need to coordinate further work in this area,
d) Consider the integrity and precision capabilities of SBAS and the latent safety issues of Baro-VNAV in the implementation and operations of PBN approaches in the CAR/SAM region.

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