DGAC SAFETY LEAFLET

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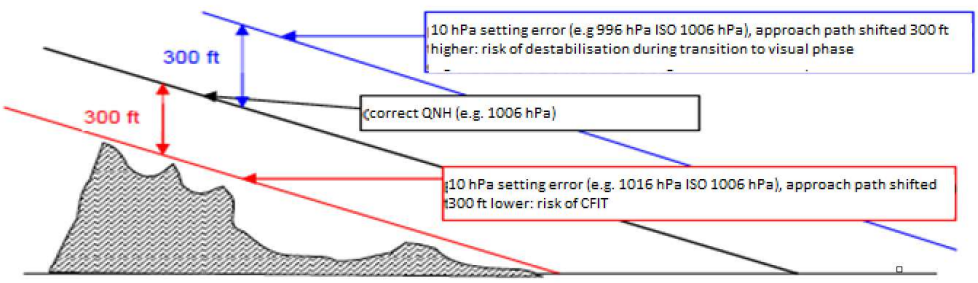
Operators concerned	Aircraft operators Instrument rated pilots Air Navigation Service Providers
Topic	Risks related to altimeter setting errors, in particular during APV baro-VNAV and non-precision approach operations *NB: this safety information does not address malfunctions of the barometric system, which can also have consequences on the flight.*
Objectives	Raise operators' awareness and encourage the implementation of safety actions
Context	The altimeter of an aircraft is a barometer that provides a pressure altitude. It measures the atmospheric pressure at a given location, compares it to a reference pressure (QNH, 1013 hPa, QFE...) and converts the pressure difference into an altitude difference according to the calibration law of the standard atmosphere. In case of an erroneous setting, the crew will have an erroneous altitude indication. Despite the operational procedures in place and the various margins applied, particularly in the design of instrument approach procedures, an altimeter setting error can have serious consequences, including CFIT, runway excursion or airborne collision. Possible deviations may be due to one or more of the following factors: - ATS transmission of an incorrect QNH ; - misunderstanding by the crew and non-detection by the ATS of a readback error by the crew; - incorrect entry of the QNH value by the crew. An on-board error may escape detection despite the cross-check or be induced by a faulty cross-check. To mitigate this risk, pilots must check and compare their altimeters at each change of setting and reference (1013 or QNH variations). In addition, they must follow the QNH variations provided by the air traffic service and make the necessary adjustments according to the flight phase. Also, the aircraft's navigation system must be set up with the actual QNH and pilots must ensure that the QNH entries in the navigation system and the barometric altimeter are identical. In the final approach phase, the altitude checks against the remaining distance to the runway threshold do not allow the detection of setting errors. In fact, the aircraft will follow a higher profile (QNH entered/displayed < local QNH) or a lower profile (QNH entered/displayed > local QNH) than the theoretical profile, while the altitude values provided for by the approach procedure are still displayed. As a result, the crew mistakenly thinks they are on the glide path. 

	Since the QNH entered by the crew on board is not a parameter available to controllers or AFIS agents, a possible altimeter setting error cannot, as such, be directly detected by ATS. To perform 3D approach operations with a barometric vertical reference, the crew uses the PBN capabilities of their aircraft. The approach trajectory is coded in 3D (lateral trajectory and vertical profile) in the database of the navigation system (FMS, GNSS...); the latter determines the lateral positioning of the aircraft (GNSS source that can be consolidated by other sensors) and uses the barometric altimeter to determine the vertical positioning of the aircraft. This type of operation does not meet the same performance requirements (i.e. accuracy, integrity, continuity, availability) as precision approaches, which provide geometric guidance to the runway (ILS, LPV, GLS). An altimeter setting error can lead to an incorrect vertical positioning of the aircraft on final approach, thus generating an increased risk of collision with the terrain due to a misleading feeling of safety in conjunction with the vertical guidance provided by the navigation system. Indeed, the absence of geometric vertical guidance leads to a risk of non-standard trajectory with an ending point displaced from the runway threshold, which is critical for CFIT if it is located before, and a factor of runway overrun if it is located beyond. There are several available barriers to reduce risk exposure. Among the most important: - The establishment and strict adherence to the standard operating procedures for the use of the VNAV function can help to ensure that the aircraft is flown within safe parameters and thus reduce the risk of misuse. - Communication and phraseology protocols, through their levels of clarity and consistency between the pilot and air traffic services, can help to reduce the risk of miscommunication. - Crew resource management techniques, such as cross-checking and monitoring, in particular the coordination of altimeter settings and navigation system configuration, can help to improve situational awareness and ensure that all crew members can ascertain the correct position of the aircraft both laterally and vertically at all times. - Altitude callouts: the aircraft's radio altimeter can provide height callouts to the pilot when passing remarkable values, which can be interpreted to assess whether the aircraft is deviating from the intended vertical profile. - The pilots' consideration of the expected QNH at destination during flight preparation, or in preparation for the descent, can detect a possible significant deviation. The preparation of the descent must include the verification of consistency between METAR, ATIS and ATS data. - Recovery barriers, such as MSAW (ATC), TAWS (on-board) and ALTSM (Altimeter Setting Monitoring, on-board) which, for the latter, compares barometric altitude with GNSS altitude, can alert actors and thus lead to recovery actions associated with operational procedures. However, these barriers are not available in all aircraft or ATS units. 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. - The systematisation of the transmission of the QNH at several stages of the flight and the verification of the readback contribute to reducing the risk of inserting an erroneous QNH. - Training and simulator practice for pilots can help ensure that they are proficient in the use of baro-VNAV approaches and can identify and respond effectively to any potential threat. To ensure that stakeholders are well aware of the risks and consequences of an incorrect altimeter setting, it is important to anticipate this major hazard, for example by using TEM (Threat and Error Management) or another method to manage threats and errors.
Recommended Actions	Therefore, in order to better manage the risks related to altimeter setting errors, in particular during APV baro-VNAV and non-precision approach operations, the DGAC recommends to aircraft operators, IFR pilots and air traffic service providers (ATC and AFIS) to - ensure that awareness of the risk of altimeter setting errors and their consequences is shared; - to assess the robustness of the above barriers, and to consider implementing mitigation measures, when relevant

	- to report all situations that have generated deviations in order to improve the visibility of this type of event with a view to appropriate treatment; - 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.
References	***Documents (mostly French only):*** Guide DSAC « Introduction aux opérations 2D/3D », Ed3 V0 mars 2022: https://meteor.dsac.aviation-civile.gouv.fr/meteor-externe/#communication/17020 Safety First Airbus, edition oct. 2022: https://safetyfirst.airbus.com/use-the-correct-baro-setting-for-approach/ https://www.skybrary.aero/articles/altimeter-setting-procedures https://www.ecologie.gouv.fr/sites/default/files/Info_securite_Threat_and_Error_Management.pdf https://www.ecologie.gouv.fr/sites/default/files/guide_notifier_incident_0.pdf ***Evénements de sécurité :*** https://bea.aero/fileadmin/user_upload/BEA2022-0219_9H-EMU_rapport_preliminaire_pour_publication_FR_finalise.pdf http://avherald.com/h?article=5046534f&opt=0 https://bea.aero/les-enquetes/evenements-notifies/detail/incident-grave-du-bombardier-crj-1000-immatricule-f-hmld-exploite-par-air-france-hop-survenu-le-20-10-2021-pres-de-nantes-44/