Safety Information Bulletin

Operations

SIB No.: 2017-10R1

Issued: 02 September 2021

Subject: **En-route Wake Turbulence Encounters**

Revision:
This SIB revises EASA SIB 2017-10 dated 22 June 2017.

Ref. Publications:
- International Civil Aviation Organization (ICAO) PANS-ATM Doc 4444.
- ICAO Doc 8643 Aircraft Type Designators and Doc 9426 Air Traffic Services Planning Manual.
- Commission Regulations (EU) No 965/2012 dated 05 October 2012 and (EU) No 923/2012 dated 26 September 2012.
- ICAO Airplane Upset Prevention and Recovery Training Aid – Revision 3 dated February 2017.
- Report "An Improved Understanding of En-route wake vortex encounters", by EUROCONTROL and Delft University of Technology.

Applicability:
National Aviation Authorities, air traffic services (ATS) providers, operators, pilots and air traffic controllers (ATC).

Description:
With the increase of the overall volume of air traffic and enhanced navigation precision, wake turbulence encounters in the en-route phase of flight above 10 000 feet (ft) mean sea level (MSL) have progressively become more frequent in the last few years.

The aim of this SIB is to enhance the awareness of pilots and ATC of the risks associated with wake turbulence encounters in the en-route phase of flight, and provide recommendations and advisories to mitigate these risks.

Every flying aircraft generates turbulence in its wake. For a fixed-wing aeroplane, this wake turbulence rolls-up into a pair of coherent, counter-rotating vortices that can persist for some minutes in the vicinity of the generating aeroplane flight path, moving generally downward and laterally with the wind. This poses a potential hazard to the safe flight of another aeroplane crossing or operating below the trajectory of the generating aeroplane, and encountering these vortices. The trailing vortices' intensity and time to dissipate depends upon factors as the weight, size and speed of the aeroplane, as well as prevailing atmospheric conditions. The relative size and weight of the generating aeroplane in comparison to the affected aeroplane is also a risk factor.

Wake turbulence encounters can occur during any phase of flight. Separation minima aim at preventing such encounters from inducing risk, but it must be noted that these provisions will not completely prevent wake encounters from occurring.

The basic effects of wake turbulence encounter on a following aeroplane are induced roll, vertical acceleration (can be negative) and loss or gain of altitude. The greatest danger is typically the induced roll that can lead to a loss of control and possible injuries to cabin crew and passengers.

En-route, the vortices evolves in altitudes at which the rate of decay leads to a typical persistence of 2-3 minutes (min), with a typical sink rate of about 400 ft/min. Wakes will also be transported by wind.

Considering the high operating air speeds in cruise and the standard 1000 ft vertical separation in Reduced Vertical Separation Minima airspace, wake can be encountered up to 25 nautical miles (NM) behind the generating aeroplane. The most significant encounters are reported within a distance of 15 NM. However, no specific horizontal wake turbulence separation minima are detailed within PANS-ATM for en-route flight, with states utilising procedural or surveillance-based separation minima.

The encounters are mostly reported by pilots as sudden and unexpected events. The awareness of hazardous traffic configuration and risk factors is therefore of particular importance to anticipate, avoid and manage possible wake encounters.

In the en-route phase of flight, three major factors contribute to increase the likelihood of wake turbulence:

1. Crossing traffic situation: If crossing traffic is climbing or descending in proximity (either the generating or following aeroplane), the wake generating aeroplane might cross the follower's trajectory with minimum time for decay, so stronger wake turbulence might be encountered.

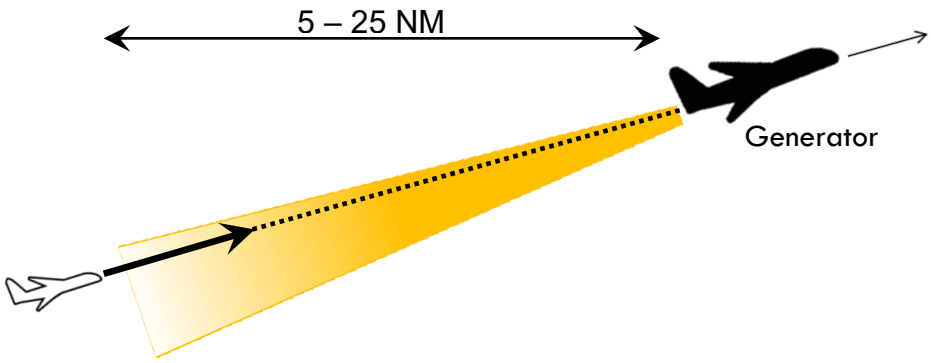
2. Thermal tropopause altitude: Wake vortex decays more slowly below the tropopause, if there is an increased risk of encountering severe wake turbulence.

3. Weight of the generating aeroplane: Heavier aeroplane types generate stronger wake vortices and are likely to induce more severe wake turbulence encounters, especially for smaller aeroplane types.

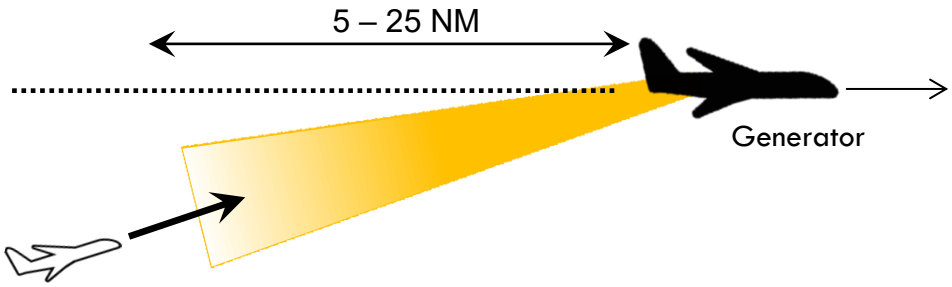
The typical hazardous trajectory crossing configurations are the following. They are shown hereafter in a vertical plane, although the respective flight path might also be crossing on the horizontal plane. When crossing horizontally, the lower the crossing angle, the higher the wake effect.

a) Follower climbing

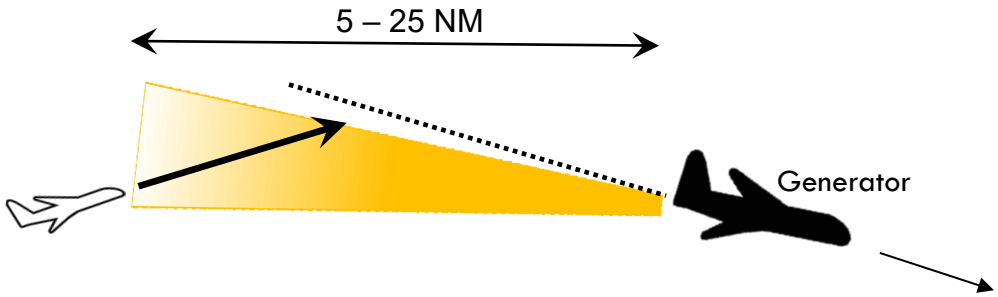
i. Generator climbing ahead



ii. Generator flying level

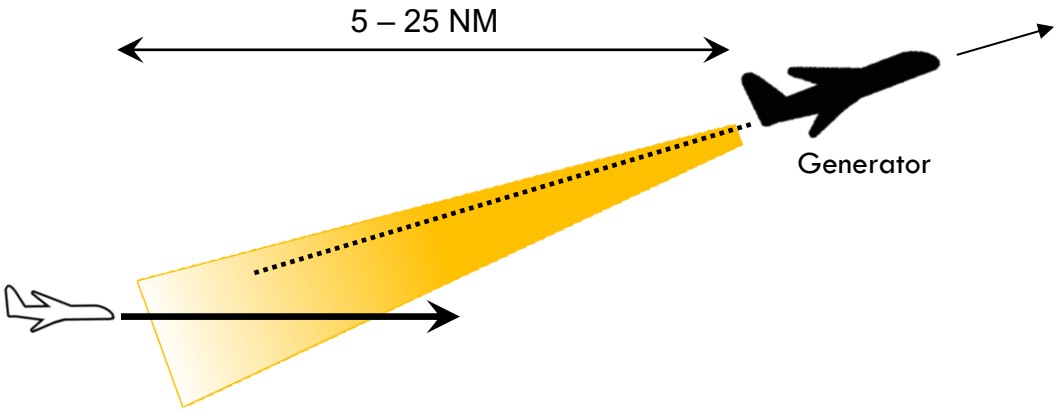


iii. Generator descending ahead

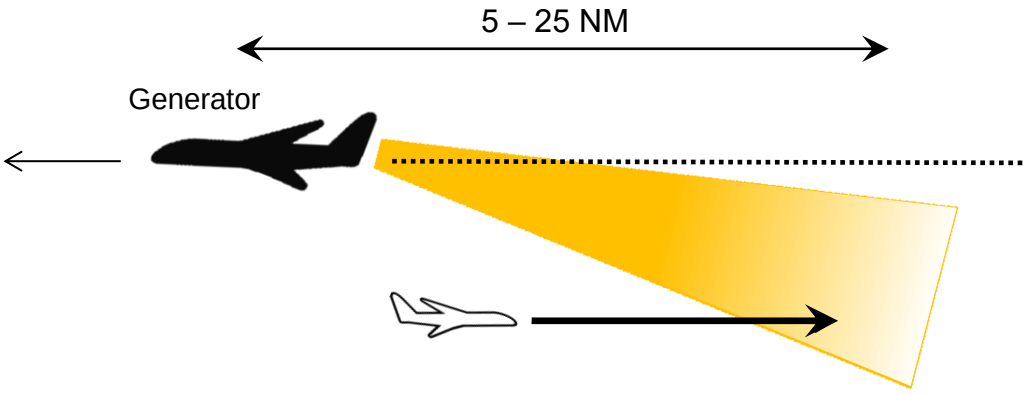


b) Follower flying level

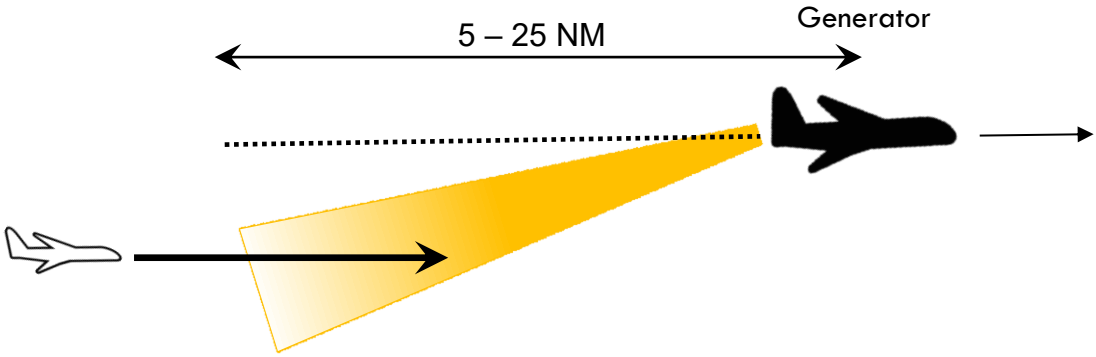
i. Generator climbing ahead



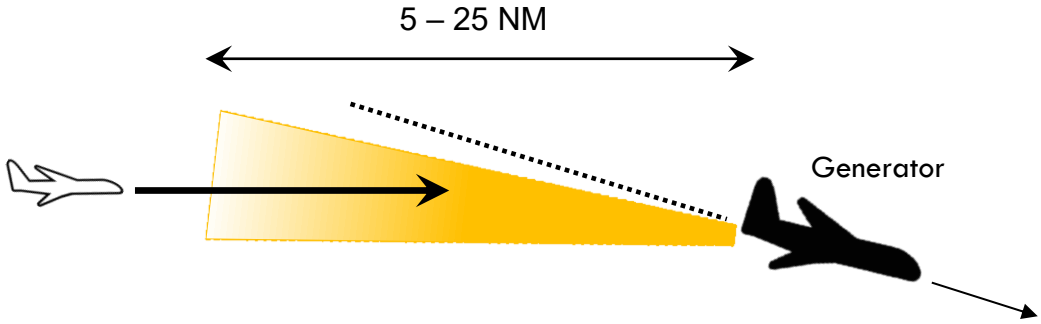
ii. Generator flying level - crossing above level in opposite direction



iii. Generator flying level above and ahead in same direction

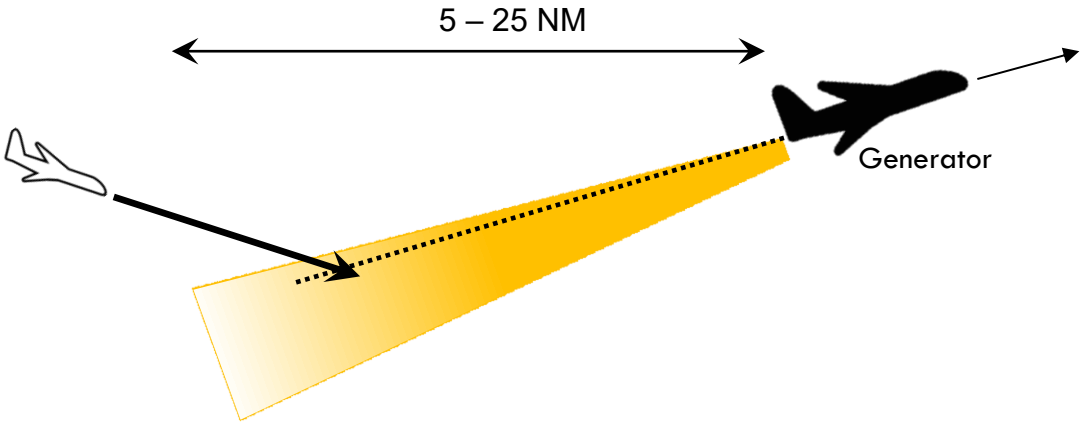


iv. Generator descending ahead

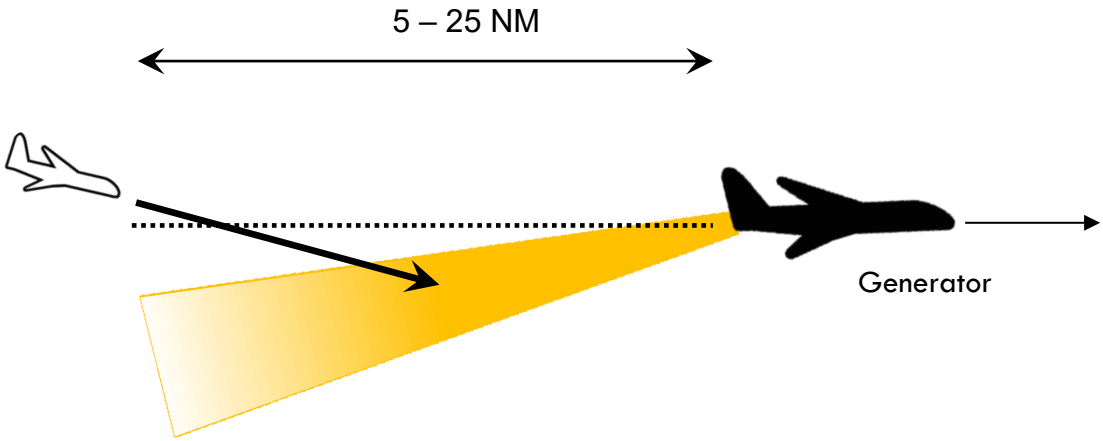


c) Follower descending

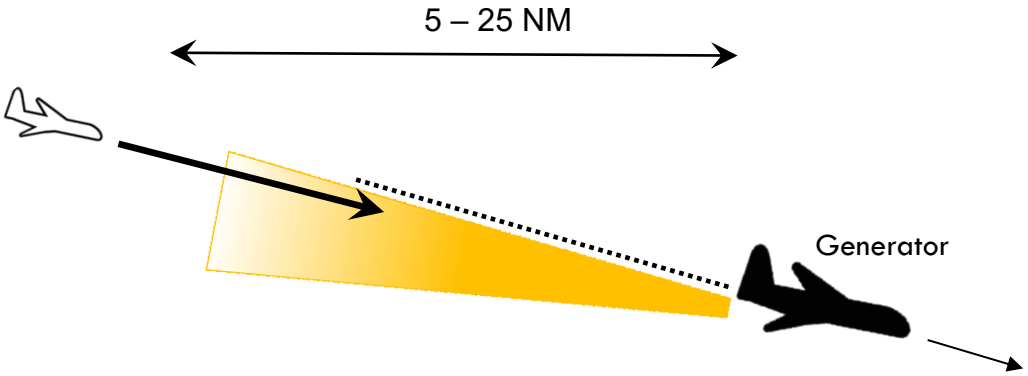
i. Generator climbing ahead



ii. Generator flying level



iii. Generator descending ahead



Note: The variability in the generator aeroplane rate of climb or descent makes it quite difficult to estimate exactly, where the vortex is. Consequently, during the en-route phase of flight, pilots should expect possible wake encounters, when other traffics in proximity appear to be on similar tracks ahead, crossing above their level, climbing or descending ahead through their flight path, while wind direction is likely to move the wake towards their trajectory.

In the future, appropriate system support functions to inform and warn air traffic controllers of potentially hazardous wake encounters may be developed.

At this time, the safety concern described in this SIB does not warrant the issuance of an operational directive under Regulation (EU) 965/2012, Annex II, ARO.GEN.135(c).

Recommendation(s):

As precautionary measures, operators and pilots should be aware that:

- As foreseen in Reg. 965/2012 AMC1 to CAT.OP.MPA.170, the announcement to passengers should include an invitation to keep their seat belts fastened, even when the seat belt sign is off, unless moving around the cabin. This minimises the risk of passenger injury in case of a turbulence encounter en-route (wake or atmospheric).
- As indicated in ICAO PANS-ATM, for aeroplanes in the heavy wake turbulence category or for Airbus A380-800 aeroplanes, the word “HEAVY” or “SUPER”, respectively, should be included immediately after the aeroplane call sign in the initial radiotelephony contact between such aeroplanes and ATS units.
- When possible, condensation trails may be used to visualise wakes and estimate, if their flight path brings them across. However, as wake and contrails may propagate differently, they only represent a gross indication.
- More attention should be given when flying below the tropopause altitude, as the likelihood of wake encounter increases. The tropopause altitude varies (between days, between locations) and can be found on meteorological charts.
- Lateral offset should be used, if the risk of a wake encounter is suspected, if possible to the upwind direction, when allowed by airspace regulations or after specific ATC clearance. Also, a change of Flight Level to cross “HEAVY” or “SUPER” traffics from above can be used, when feasible and authorised by ATC.

ATS providers should be aware that:

- To an important mitigating measure belongs ensuring the awareness of en-route ATC about the risk factors and configurations, based on the information provided in this document and other relevant material, and about local sector traffic flows at high risk of wake turbulence encounters. This objective could be achieved through flyers, e-learning, and a refresher training module.
- Precautionary best practices may consist of the following:
    - Assess the local needs for the mitigation of en-route wake turbulence encounter risks, and for implementing appropriate system support functions to inform and warn ATC of potentially hazardous wake encounters, in view of warning pilots and/or taking appropriate actions. Until a systemic solution is available, initial measures may consist of introducing local practices for the types of aircraft and traffic geometries/configurations considered as high risk of generating potentially hazardous wake turbulence to trailing aircraft, considering the separation minima applied in that volume of airspace.
    - When an en-route ATS identifies a traffic proximity situation with risk of a potentially hazardous wake encounter, providing traffic information to the trailing aircraft, including a caution for potential wake turbulence and when possible, proposing a change of lateral or vertical flight path, as appropriate.

It is however acknowledged that the use of the best practices described above is subject to factors like density of air traffic and ATC workload.

In case of a wake encounter, pilots should:

- Be aware that experience has demonstrated that if the pilot reacts at the first roll motion, when in the core of the vortex, the roll motion could be potentially amplified by this initial piloting action.
- Be aware that some in-flight incidents have demonstrated that pilot inputs may exacerbate the unusual attitude condition with rapid roll control reversals carried out in an “out of phase” manner.
- Be aware that if the autopilot is engaged, intentional disconnection can complicate the scenario, and the autopilot will, in most cases, facilitate the recovery.
- Try to avoid large rudder deflections that can create important lateral accelerations, which could then generate very large forces on the vertical stabiliser that may exceed the structural resistance. Although some recent aircraft types are protected by fly-by-wire systems, typically, the use of the rudder does not reduce the severity of the encounter nor does it improve the ease of recovery.
- Make use of specific guidance in the Aircraft Operating Manual for their specific type(s)/fleet, where available.

Contact(s):

For further information contact the EASA Safety Information Section, Certification Directorate.
E-mail: ADs@easa.europa.eu.