Bundesstelle für
Flugunfalluntersuchung

German Federal Bureau of
Aircraft Accident Investigation

Flight Safety Information

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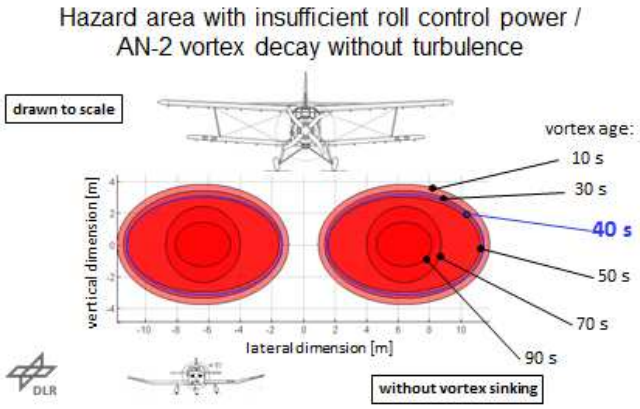
Wake Vortex Influence in General Aviation

On 9 September 2012, an accident during an air show took place at Backnang-Heinigen Airfield, involving a four-seater, single engine DR 400/180 R aircraft. Four persons were on board the airplane. Witnesses observed a continuous roll about its longitudinal axis to the right after take-off. Subsequently, the aircraft crashed onto the airfield from a low altitude and burnt out. During the on-site investigation extensive video footage and photos of the accident could be seized and later analysed. It was determined that 39 seconds prior to the accident aircraft an AN-2 had taken off for a sightseeing flight. The BFU commissioned the Deutsche Zentrum für Luft- und Raumfahrt (DLR), Institut für Flugsystemtechnik Braunschweig, to carry out a simulation if wake vortices might have had an influence in this accident (file number: 3X134-12).

The result was that the AN-2 can generate a wake vortex with two individual vortices rotating in opposite directions, whose rolling moment, when an airplane flies directly into the vortex, can be so large that for an airplane such as the DR 400 it is not possible to sufficiently counteract the rolling moment with aileron deflections.



The graph of the hazard area of the wake vortex clearly shows that **in calm weather** the dimensions of the hazard area can still be so distinct approximately 1 - 1.5 minutes after the tip vortex generation that it poses a serious threat to aircraft such as a DR 400. Initially, the respective dimensions are approximately 11 m in width and approximately 6 m in height. Around the core diameter of approxi-

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mately 1 m the vortex rotates with approximately 12 - 14 m/s. During decay of the wake vortex without turbulence the diameter of the hazard area decreases after approximately 40 s by only about one meter. Only after about one minute the effect of the wake vortex decreases significantly. According to the calculation model, decay of the wake vortex occurs after 140 seconds! These calculation results are based on **calm weather conditions without convective influence**. Decay of the wake vortex is significantly accelerated by turbulences due to wind, weather, or terrain.

On 3 July 2014 flight tests were conducted with an AN-2 and a DR 400 at Reinsdorf Airfield to verify if the calculations meet the results of the practical tests and to document the effects of wake vortices on aircraft. Smoke charges on the ground were used to make the dimensions of the wake vortices and their decay visible. On the AN-2 smoke charges were fitted, which made the left tip vortex of the wake vortex visible. The DR 400 was flown by a test pilot. Due to the visible wake vortex, he was able to target the wake vortex area of the preceding AN-2 from different distances. The analysis of the flight tests confirmed the DLR calculations regarding the generation of wake vortices behind an AN-2 with regard to size, strength and decay. The flight tests very impressively documented the effect of wake vortices on succeeding aircraft. During six flights into the wake vortex the DR 400 was turned by approximately 90° about its longitudinal axis. The BFU documented the flight tests with a flight safety video. Link to the Video

Overview of the DR 400 flights into the left tip vortex of the AN-2

Distance behind the AN-2 (m)	Maximum roll angle (°)	Maximum roll rate (°/s)
900	104	65
680	50	49
650	98	60
550	88	62
500	51	58
400	88	47
380	58	73
250	86	61
240	91	59
180	65	63

The BFU recommends:

- Note that in calm weather the wake vortices of aircraft with more than 5 t take-off mass may be dangerous for up to one minute after take-off
- Hold sufficient distance to preceding aircraft and either maintain the same altitude or go higher to avoid entering the wake vortex
- During landing behind larger aircraft choose a touch-down point, if possible, behind the one of the other aircraft therefore avoiding entering the wake vortex.

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