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Are you prepared for safety hazards caused by wind shear?

Weather plays a significant role in aviation safety. Some 30% of all fatal accidents are caused by or related to weather (ICAO). Wind shear is one of the most dangerous - and least known - weather phenomena in aviation.

Air traffic controllers usually have no means of directly detecting a low-level wind shear hazard. It may take even the most experienced pilots by surprise, and put them in a situation where the wrong decisions can have disastrous effects. 831 fatalities were recorded to have been caused by wind shear between 1956-1994 (FAA, NTSB Records, & Fujita), or 700 fatalities between 1970-1985 (ICAO). More recent statistics are harder to find, but the phenomenon has not disappeared. Wind shear continues to pose a threat to aviation safety all around the world. According to the US Aviation Safety Network (ASN), at least two major accidents were caused by wind shear between 1990-2000, resulting in over 90 fatalities. Also in many recent accidents, wind shear has been suspected to be a strong contributing factor - such as in the case of the TANS Airlines crash in Peru (2005), or FedEx cargo plane crash in Japan (2009).

Wind shear is a term referring to rapidly changing winds. It is a small scale meteorological phenomenon, which occurs over a very small distance. It is usually connected to rapid changes in specific weather conditions - for example, sea and land breeze, jet streams (fast flowing, narrow air currents), weather fronts, showers or thunderstorms. It has also been noted to commonly occur near mountains and coastlines. The most dangerous type of wind shear is caused by convective weather. It is very difficult to forecast due to its local nature.

Wind shear poses the greatest danger to aircraft during takeoff and landing. Airplane pilots generally regard significant wind shear to be a horizontal change in airspeed of 30 knots (15 m/s) for light aircraft, and near 45 knots (22 m/s) for airliners (FAA).

Although wind shear as a meteorological phenomenon has been recognized in aviation from the late 60s, it is still not fully understood today. Many airports suffer the effects of wind shear, but airport authorities have little information about the phenomenon and how to address it.

One of the first great eye-openers was the Boeing 727 accident at the JFK Airport in 1975, which led to systematic studies on wind shear. Tetsuya Theodore Fujita pioneered the study of wind shear and its effects. However, it wasn't until 1997 that ICAO formally established a Low-Level Wind Shear and Turbulence

Group to promote global awareness about the phenomenon.

Challenge to pilots and aircraft safety

Microbursts and wind shear go hand in hand. Microbursts are small scale intense downdrafts which, on reaching the surface, spread outward in all directions from the downdraft center. This causes the presence of both vertical and horizontal wind shears. Microbursts spread radially on the ground, causing rapid changes in wind direction and speed. They are associated with cumulonimbus clouds, as well as line squalls (severe thunderstorms). A distinction can be made between a wet microburst which consists of precipitation and a dry microburst which consists of virga - that is, precipitation that evaporates before reaching the ground. Dry microbursts present a more difficult problem because pilots have no visual clue of their occurrence, and weather radars cannot see them either.

Wind shear and microbursts are among the most dangerous of all weather-related threats to flying. The unpredictable changes in wind speed and direction make it difficult to control the aircraft, with headwinds, tailwinds and up and down drafts all in quick succession. At worst, it can cause a sudden and dramatic loss in height, and result in a serious accident.

How to address wind shear safety risks?

When wind shear occurs below 2,000 ft altitude, it is called low-level wind shear. Many airports prone to microburst and wind shear are still lacking adequate solutions to mitigate this threat.

The first step in addressing safety hazards caused by wind shear is to investigate the likelihood of the occurrence of the phenomenon at the airport in question. If a problem is recognized, different options for solving it need to be investigated in order to find the optimal solution. Each airport is unique. This work is best carried out in cooperation with the airport authorities and an expert organization with deep understanding of the phenomenon.

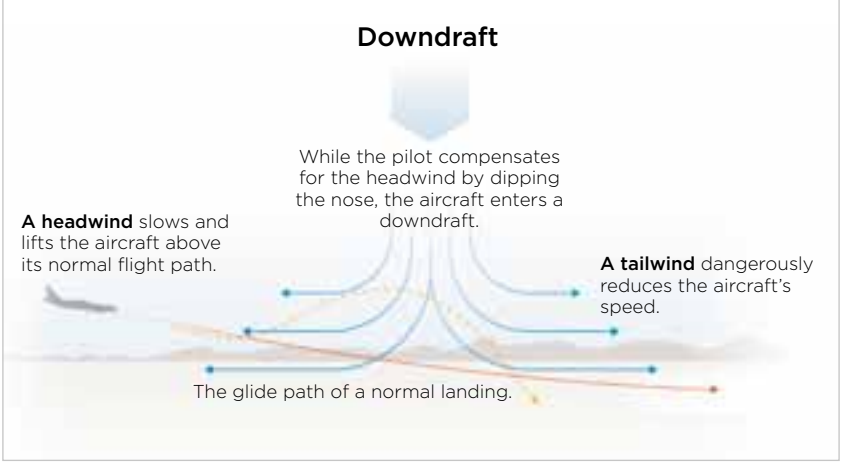
Once the existence of low-level wind shear has been verified through studying the weather conditions at the airport, the next step is to specify the optimal wind measurement site locations and measurement mast heights by studying the topology and obstructions in the area. After this, the required system and interfaces can be specified by investigating the existing infrastructure.

A Low-Level Wind Shear Alert System (LLWAS) comprises wind speed and direction sensors sited around the runway, and connected to a data collection package at the site. Wind shear alerts are presented both visually and audibly, and the affected areas can be easily identified thanks to the system. Access to wind shear data eases the air traffic controller's burden, increases the pilots' confidence at a particular airport, and improves the overall aviation safety.

All required services should also be mapped in close cooperation with the airport authorities, in order to ensure the optimal performance of the system throughout its lifecycle. Planning ahead pays dividends in the long run, as system maintenance and operations become proactive and organized, and the need for ad-hoc fixes is reduced. Good data availability can be maximized through various well-planned services, such as preventive maintenance, software upgrades, and regular solution performance verifications.

All the studies and investigations materialize in an implementation project plan. Once the low-level wind shear system has been installed, it is carefully tested to ensure that it meets all the requirements. Professional user-training as well as periodical training updates are an important part of the project. Tailored lifecycle services, designed before system implementation and according to the specific requirements, support smooth and safe operations. A professionally run wind shear project is a huge improvement in airport safety.

If you would like to discuss the implications of wind shear for airport operations and aviation safety, please contact aviationsales@vaisala.com.



Further information:
www.vaisala.com/weather/products/avi-llwas

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