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FLIGHT SAFETY NEWS LETTER / SAFETY BULLETIN

- **In Focus** - Turbulence due to Climate change
- **Safety Journal** - Runway End Safety Area (RESA)

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NEWS LETTER/SAFETY BULLETIN ISSUED, UNDER THE PROVISION OF DGCA CAR SECTION 5 SERIES F, PART I – APPENDIX-D

IN FOCUS

Turbulence due to Climate change

Turbulence is one of the most unpredictable of all weather phenomena. And research shows that severe turbulence is becoming more likely as the planet warms.

Birds often encounter choppy skies. While only a few species reach the height of a cruising commercial aircraft, studying how they respond at lower altitudes could help meteorologists build better models to predict turbulence, says Emily Shepard, an expert in bird flight and air flow at Swansea University in Wales. And that's not all we could learn from our avian friends: some species have adapted to deal with "extreme turbulence", she says. Analysing how they exploit it to their advantage could inform aircraft design, especially in urban environments where smaller aircraft and unmanned aerial vehicles (UAVs) could fly.

According to a 2024 study, aircrafts encounter moderate to "severe-or-greater" turbulence 68,000 times every year. Turbulence is defined as "an irregular motion of the air" caused by eddies and vertical currents, and is associated with weather events such as fronts, wind shear and thunderstorms. Turbulence can cause a few uncomfortable bumps – or throw an aircraft out of control, inducing "chaotic rolls, pitches and yaws".

Modern aircraft are equipped with sophisticated weather radar systems that pilots use to identify and navigate around areas of turbulence. "We can successfully predict around 75% of turbulence up to 18 hours ahead," says Paul Williams, an atmospheric scientist at the University of Reading.

However, there are many types of turbulence – and some can be harder to spot. The severe turbulence that struck the Singapore Airlines flight is often caused by invisible "clear air turbulence". This can strike without warning, and is one of the biggest causes of weather-related aviation accidents.

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Clear air turbulence occurs at high altitudes, where aircraft cruise in seemingly calm blue skies. It can't be seen by the naked eye and is undetectable by onboard sensors. Even satellites can't see this kind of turbulence, only the structure and shape of the jet stream which may hint at its presence. Pilots often have to rely on any aircraft flying the same path ahead of them of them to report clear air turbulence, so they can adjust their path.
Climate change is making clear air turbulence more common, says Williams, who has studied the rise. "In simple terms, climate change is increasing the temperature difference between the warm and cold air masses that collide to form the jet stream in the upper atmosphere," he says. "This effect is making the jet stream less stable and allowing more turbulence to break out.“

Meteorologists are now seeking to develop better methods of forecasting all types of turbulence, using computer modelling. However, one source of data that's gone untapped until recently are the creatures we share the skies with: birds. Previous studies have shown that animal movements can help us determine the strength of thermal updrafts, wind direction and wind speed.

Now researchers from Swansea University say birds' experience of the winds could help provide predictions of turbulence. Birds often migrate for thousands of miles – with wind speed, direction and turbulence all dictating the route they travel and the amount of energy they have to expend. And when you're running on reserves at the end of an epic trip half way around the world, catching the wrong winds can mean the difference between life and death.

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While most species don't fly alongside cruising commercial jets, some get extremely high. Take frigate birds, for example. Their flight is a "roller-coaster", says Shepard. They rely on thermals and wind to stay aloft for months one end and can fly at extreme altitudes, as high as 13,000ft (4km/2.5 miles) above the ground. To reach this great height, they often catch strong updrafts in mountainous cumulus clouds.

"They gain altitude within these really, really turbulent cloud systems," says Shepard. "You get monstrous updrafts and downdrafts. They are operating in incredibly turbulent environments – and we know so little about how they are able to maintain flight control. "By studying how such birds respond to turbulence, Shepard and her colleaues at Swansea University's Laboratory for Animal Movement aim to "visualise the invisible", and to map what the air is doing.

The Swansea University research suggests the possibility of using bird-borne sensors to shed light on air turbulence, much like the seal-borne sensors used to measure salinity and sea temperature.
"People are already equipping animals with tags for lots of different reasons and in lots of different environments," says Shepard. "They're effectively sampling in the environment all the time.“

Birds could act as meteorological sensors on the move, she says, continuously collecting data about the turbulence they're experiencing along their flight paths. This, she adds, would be cheaper than using sensors fitted to aircraft, plus birds can fly in conditions that planes can't.

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The data revealed the lowest levels of flapping flight recorded for any free-ranging bird, with the condors spending an incredible 99% of all flight time in glide-mode – without flapping at all. One bird even remained airborne for more than five hours – covering over 170km (100 miles) – without a single flap. This research provides insight into the way soaring birds exploit thermals, knowledge which could potentially feed into the programming of autonomous flying vehicles.
Sometimes that even involves flying alongside the birds. From 2018 to 2019, Shepard's team flew an ultralight aircraft alongside a flock of homing pigeons. Using GPS, barometric pressure and acceleration data loggers attached to the birds – over 88 flights – they measured the turbulence levels during the journeys the birds took to return to their lofts.

"You're pretty exposed up there," says Shepard. "You're open to the elements. It's a very direct experience." The team flew in a variety of conditions; early morning when there was little ground heat to cause bumpy convective currents, later in the day when the thermals were stronger, and at different times of year.

"There were several occasions when the pilot was forced to land or decided he wasn't going to fly again that morning, because the turbulence was so strong and it was affecting his ability to maintain flight control. It was too bumpy for him," says Shepard. "But the pigeons returned to the loft with no problem. So, pigeons can deal with high levels of turbulence – more so than the ultralight. They clearly have mechanisms of coping with this turbulence.“

Safety Journal

Runway End Safety Area (RESA)

Definition : An area symmetrical about the extended runway centre line and adjacent to the end of the strip primarily intended to reduce the risk of damage to an aeroplane undershooting or overrunning the runway. [*Source: ICAO Annex 14*]

Description: Runway End Safety Areas (RESAs) are a formal means to limit the consequences when aeroplanes overrun the end of a runway during a landing or a rejected take off, or undershoot the intended landing runway.

They are constructed to provide a cleared and graded area which is, as far as practicable, clear of all but frangible objects. It should have a surface which will enhance the deceleration of aircraft in the overrun case but should not be such as to hinder the movement of rescue and fire fighting vehicles or any other aspect of emergency response activity.

Minor aircraft runway overruns and undershoots are a relatively frequent occurrence. Most data sources point to significant occurrences on average once a week worldwide and suggest that runway excursions overall are the fourth largest cause of airline fatalities. It has been stated by the U.S. Federal Aviation Administration (FAA) Airport Design Division that approximately 90% of runway undershoot or overruns are contained within 300 metres of the runway end.

Runway End Safety Area (RESA)

The contribution which RESAs can make to a reduction in the consequences of such over-runs has frequently been demonstrated as has the avoidable hazardous outcomes where they have not been present.

ICAO Annex 14 SARPs : ICAO SARPs relating to runways are determined according to runway length using the standard Runway Code categories. Code 1 runways are less than 800 metres long, Code 2 runways are 800-1199 metres long, Code 3 runways are 1200-1799 metres long and Code 4 runways are 1800 metres or more in length.

In all cases, the dimensions of a ‘Runway Strip’ are first defined as it must contain the dimensions of the designated runway surface and it should be flat, firm and free of non-frangible obstructions. For Code 3 and 4 runways, runway strips must extend at least 150 metres either side of the runway centreline and at least 60 metres beyond the end of the runway including any stopway. For Code 1 and 2 runways, the width requirement is reduced to 75 metres and for non-instrument Code 1 Runways, the length requirement is reduced to 30 metres.

ICAO RESA specifications all begin at the limit of the ‘Runway Strip’ not at the limit of the Runway/Stopway surface.

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RESA SARPs were revised in 1999 when the then Recommended Practice of a 90 metre RESA was converted into a Standard. The current Requirement is that Code 3 and 4 runways have a RESA which extends a minimum of 90 metres beyond the runway strip and be a minimum of twice the width of the defined runway width. The additional Recommended Practice for these runway codes is that the RESA length is 240 metres or as near to this length as is practicable at a width equal to that of the graded strip. For Code 1 and 2 Runways, the Recommended Practice is for a RESA length of 120 metres with a width equal to the graded strip.

RESA Implementation : Implementation of these SARPs by State Regulators is ongoing. Many have now prescribed a period within which the ICAO Standard must be adopted and the Recommended Practices carefully considered.

In the case of the USA, the FAA Airport Design requirements specify the minimum dimensions of a 'Runway Safety Area' which includes the Runway Strip defined by ICAO. Since 2002, these requirements have included a Runway Safety Area at each end of a runway which takes account of the direction of runway use when specifying the minimum length of the runway end element.

Runway End Safety Area (RESA)

The basic standard is defined for instrument runways used by transport aircraft and any such runway with an ‘approach visibility minima’ of less than 1200 metres and is 300 metres for the overrun case and 180 metres for the undershoot case. It is permissible to reduce the overrun case to 180 metres if the runway has either instrument or visual vertical guidance aids and an Engineered Materials Arresting System (EMAS) which can stop an aircraft which leaves the end of the runway at up to 70 kts groundspeed is provided.

It can be seen that the FAA overrun requirement (300 metres) is equivalent to the ICAO RESA Recommended Practice plus the required Runway Strip (also totalling 300 metres) but that the FAA undershoot requirement (180 metres) is only slightly more than the ICAO RESA Standard plus the required runway strip (totalling 150 metres).

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सादर/ Regards,

विकास शर्मा / Vikas Sharma

उड़ान संरक्षा प्रमुख / Chief of Flight Safety, Head-ERP

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