

# Coping with climate

From the icebox of Antarctica to the oven-heat of the desert, aero engines are expected to perform in spite of the climatic conditions they encounter.

David Carter

As they sleep off their beef, chicken or tagliatelle, most long-haul passengers are blissfully unaware of the adverse conditions just outside their window. Since air temperature drops by 2°C with every 1,000ft increase in altitude, it could be minus 65°C just the other side of their pillow.

While high-speed, high-level air travel brings its own design and operational challenges, the most challenging environments are found at lower altitudes.

Safely back on the ground, aircraft often stand in the baking sun, lashing rain, howling gales or driving snow. Climates vary widely. Worldwide temperatures alone have ranged from 58°C in Libya to minus 89°C in Antarctica.

**Temperature testing:** To cope with desert and other hot climates, modern aircraft are tested in temperatures of up to 55°C. As part of their certification, engines are tested in a “hot and high environment” to ensure they perform well in arduous conditions.

Sand can cause some erosion of engine fan blades and other components and surfaces. It can also accumulate in cooling vents, melt on turbine blades, raise operating temperatures and reduce efficiency.

By using larger and specially shaped cooling holes, sand falls away before causing serious damage. Airlines operating largely in desert climates can also specify engines with sand traps and thermal barrier coatings.

In hot, humid, tropical climates, on-board air-conditioning may have to work harder to maintain the right cabin environment. A more severe climatic chal-

lenge, however, can come from tropical downpours. While elsewhere, 20-30mm an hour is a heavy rainstorm, tropical storms can unleash this much rain in five minutes.



PHOTO: ROLLS-ROYCE PLC

Modern turbofan engines “spin” most of the water outwards to the bypass flow. Any remaining water entering the engine evaporates before reaching the combustor.

Like any other equipment, cold climates also place demands on aircraft. Ice on the runway, on the aircraft and in the engine can present a difficult challenge.

Aircraft and systems are tested in ground temperatures as low as minus 55°C. In one test, on-board heating must raise cabin temperature to 21°C within 30 minutes. Engines must start quickly from minus 40°C.

**Icy landings:** Landings on icy runways can reduce braking efficiency and directional control and increase the effects of crosswinds. To offset this, airports clear runways using sweeping and de-icing chemicals.

Many aircraft can use their reverse thrust to improve their braking performance. Ice can impede or alter airflow, reduce lift, increase drag and add weight. Even small amounts of ice can adversely affect aircraft performance.

In response, aircraft can be sprayed with de-icing and anti-icing fluids before a flight. In-flight measures include hot air anti-icing, mechanical de-icing “boots”, heated windshields and ice detectors to indicate when these need to be used.

On the engine, ice can accumulate on the intake leading edge, fan spinner, fan blades and further into the engine. While heated elements reduce the problem, fan blades and front-end compressors are designed to cope with ingested ice. Lightweight ice-impact panels protect the fan-case lining from ice shed from the fan blades.

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