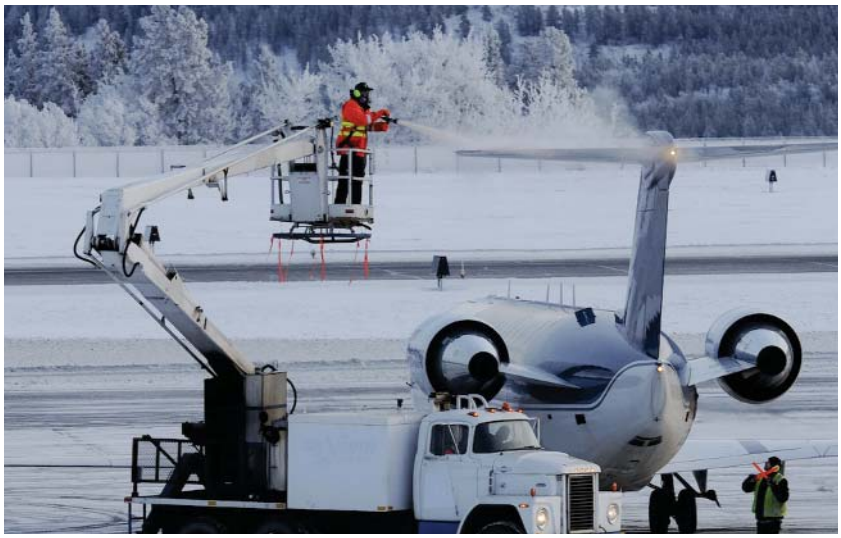
DE-ICING



By Michael R. Grüninger and Capt. Carl C. Norgren of Great Circle Services AG (GCS)

On January 4th, 2002, N90AG, a Bombardier CL600-2B16 Series 604 started its take-off roll at Birmingham International Airport, UK. Immediately after takeoff from Runway 15 the aircraft began a rapid left roll, which continued despite the prompt application of full opposite aileron and rudder. The left winglet contacted the runway shoulder, the outboard part of the left wing detached and the aircraft struck the ground inverted, structurally separating the forward fuselage. Fuel released from ruptured tanks ignited and all 5 occupants of the aircraft perished.

Frost deposits had formed on the aircraft while parked overnight in temperatures below the freezing point. The pilots did not request aircraft de-icing and the aircraft was not de-iced before takeoff. Frost contamination of aircraft lifting surfaces was present when the aircraft took-off. As the aircraft lifted off, the left wing stalled at an abnormally low angle of attack, causing the aircraft to roll rapidly to the left. The roll could not be stopped despite immediate and full application of corrective aileron and rudder controls.

The small degree of wing surface roughness caused a major reduction in the wing stall angle of attack. Wing surface roughness associated with frost contamination caused sufficient flow disturbance to result in a wing stall at an abnormally low angle of attack. The stall protection system was ineffective in this situation the AAIB noted in the accident report.

VITAL
Neglecting di-icing an aircraft's surface can be seriously compromised.

And again

Two years later, on November 28th, 2004, a Canadair CL-600- 2A12 collided with the ground during takeoff at Montrose Regional Airport (MTJ), Montrose, Colorado. Instrument meteorological conditions prevailed, and snow was falling. Of the six occupants on board, the captain, the flight attendant, and one passenger were killed, and the first officer and two passengers were seriously injured. The airplane was destroyed by impact forces and post crash fire.

Immediately after liftoff the airplane rolled to the left despite full-right-aileron and right-rudder application by the flight crew. Within 3.5 seconds after liftoff, the bank angle aural warning and the stick shaker activated, and the airplane struck the ground about 5.5 seconds after liftoff at a bank angle of 111º left-wing down and a pitch angle of 13º airplane-nose down.

The roll had resulted from the left wing stalling at an abnormally low angle of attack due to flow disturbance resulting from frost contamination of the wing. A relatively small degree of wing surface roughness had a major adverse effect on the wing stall characteristics. The stall protection system was ineffective in this situation.

To prevent the airplane from entering a natural aerodynamic stall, the CL-600-2A12 airplane is equipped with a stall protection system that uses AOA sensor vanes that activate the system at an AOA lower than that at which a natural aerodynamic stall occurs. In the event that the airplane achieves an AOA sufficient to activate the system, the system responds with a series of progressive reactions. For example, as the AOA increases, the system first responds by activating the engine auto ignition, then it activates the artificial stall identification (stick shaker), and, lastly, it engages the stick pusher (concurrent with the stick pusher horn) to decrease the airplane's AOA and prevent the onset of stall. Because the stick pusher is designed to activate before a stall condition can develop, it is described as a pre-stall pusher.

Lessons learned?

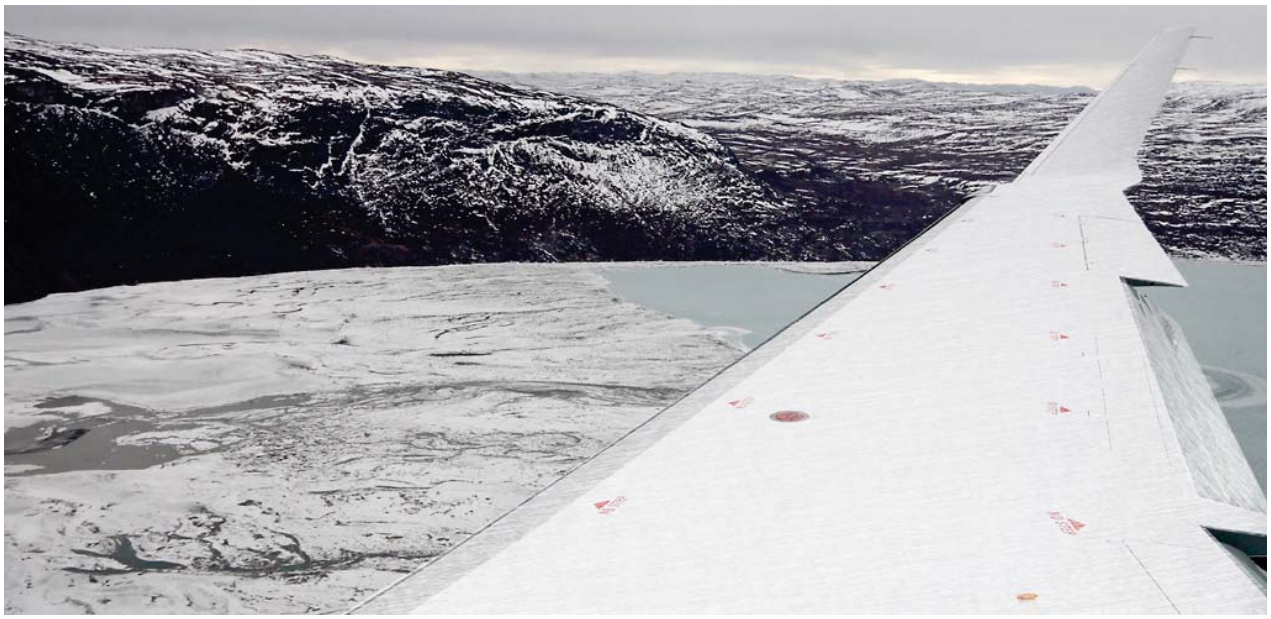
Isn't it scary to observe how, despite all theories about learning from other's errors, humans tend not to learn from them?

Contaminated aircraft surfaces affect the aerodynamic considerably. Often crews get away with it, nothing happens. Eventually the trap snaps and the aircraft loses its ability to fly.

The crews in our sample accidents were aware of the hazard posed by contaminated wings and actually discussed the issue.

The CVR recorded that, before engine start, the captain asked the first officer, "how do you see the wings?" The first officer stated, "good," and the captain replied, "looks clear to me."

Even though the crew discussed the contamination, they obviously did not correctly perceive the hazard posed by the contamination and the level of risk associated. In fact, according to the NTSB even "almost visually impercep-



tible amounts" of upper wing surface contamination pose significant hazards.

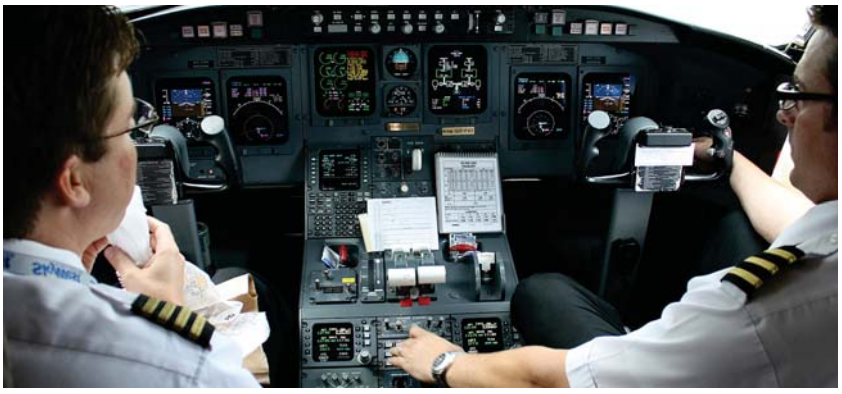
The Safety Board concludes that, had the flight crewmembers conducted a visual and tactile examination of the wings, they likely would have detected accumulated contamination.

Contamination-sensitive aircraft designs

In both these accidents the flight crews lost control of their aircraft shortly after lift-off due to contamination on the wing. The substantially lower lift and increased drag of the contaminated wing caused a stall without any stall warning and subsequent impact with the ground. How could experienced pilots take off with contaminated wings from airports with the required de-icing capabilities?

Modern jet aircraft with swept wings are optimized for flight at high speeds and high altitudes. Such wing profiles do not tolerate any contamination for take-off. ICAO early on published guidance on de-icing and defined the 'clean aircraft concept'. According to the ICAO Manual of Aircraft Ground De-icing/Anti-icing Operations (Doc 9640) 'During conditions conductive to aeroplane icing during ground operations, take-off shall not be attempted when ice, snow, slush or frost is present or adhering to the wings, propellers, control surfaces, engine inlets or other critical surfaces.'

Aircraft certification is performed with a clean aeroplane flying in a clean environment. When ice formations other than those considered in the certification process are present, the airworthiness of the airplane may be invalid and no attempt should be made to fly the airplane until it has been restored to the clean configuration.



The clean aircraft concept is repeated in most Aircraft Flight Manuals (AFM) and is also mandated by most national aviation legislations. EASA has adopted this concept in CAT.OP.MPA.250 'Ice and other contaminants — ground procedures' which state that 'The commander shall only commence take-off if the aircraft is clear of any deposit that might adversely affect the performance or controllability of the aircraft.' Exemptions to this rule shall be specifically included in the procedures to be followed when ground de-icing and anti-icing and related inspections of the aircraft are necessary to allow the safe operation of the aircraft and in accordance with the AFM.

Trust your fingers

Trusting solely visual perception and neglecting tactile perceptions is a dangerous business when it comes to detecting aircraft surface contamination. As you learned to feel your aircraft by the seat of the pants, learn to sense surface contamination by the tip of your finger.

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PERCEPTION Assessing an aircraft's surface requires both sight and touch.