

A photograph of a small, white, high-wing propeller airplane on a snowy runway. Several ground crew members in winter gear are visible around the aircraft. In the background, there are snow-covered evergreen trees and a clear sky.

TAKING OFF IN ICY CONDITIONS

By Michael R. Grüniger

ICE AND FROST FORMATION ON the exposed surfaces of an aircraft poses a serious danger for safe aircraft operation. Even small amounts of clear or rime ice cause a loss of lift, increase in mass and control problems. Ice, snow or frost with a thickness and roughness similar to sandpaper on the leading edge and upper surface of a wing can reduce lift by as much as 30 percent – and increase drag by 40 percent!

Modern supercritical airfoils, which are optimized for high cruise speeds, may be particularly susceptible to the effects of reduced surface smoothness. Local airflow separation occurs abruptly and may increase quickly spanwise, resulting in significant loss of lift on one wing and an uncontrollable aircraft roll.

Frost is a particularly insidious, but often underestimated threat during take-off. Although frost increases drag, the aircraft may still be able to accelerate and reach lift-off speed. The danger is that the lift produced may be insufficient for sustained flight, causing the aircraft crashes soon after take-off.

One prominent accident is the take-off crash of a Canadair CL-600-2A12, in Montrose, Colorado on November 28, 2004. The airplane collided with the ground during take-off and the commander, cabin crew member and one passenger were killed. The co-pilot

and two passengers were seriously injured. The airplane was destroyed by impact forces and post-crash fire.

The NTSB investigation concluded: “The probable cause of this accident was the flight crew’s failure to ensure that the airplane’s wings were free of ice or snow contamination that accumulated while the airplane was on the ground, which resulted in an attempted takeoff with upper wing contamination that induced the subsequent stall and collision with the ground”.

Hazardous Conditions

The hazards of winter operations are generally well known to pilots. From the time one gets their private pilot license, the dangers are instilled throughout pilot training. The problem is that often time constraints and lack of experience by crew members create an environment in which the hazards of contaminated surfaces are underestimated. Often Airplane Flight Manuals do not provide performance limitations, because the detrimental effects of contamination are difficult to describe and quantify. Instead, the AFM’s Operating Limitation section may provide a general statement that “during cold weather operations, the flight crew must ensure that the airplane fuselage, wings and tail surfaces are free from ice, snow or

frost” (example Challenger AFM as quoted in NTSB aircraft accident brief).

For crew members it is even more difficult to assess the consequences of contaminated surfaces on performance. Since often a take-off is possible with partially contaminated surfaces, crew members might fall into one of the well known human factor traps: the normalization of deviance. While the principle applies that *no contamination is acceptable*, not every take-off with some contamination results in an accident. Furthermore, pilots may have observed considerable ice accumulations on the wing’s leading edges during flight, without significant performance reductions.

Either through personal experience or based on other crews’ experiences, crew members might become (increasingly) overconfident, and a take-off is attempted with contaminated surfaces in order to save the cost of a full de-icing on the ground and the time required.

Pilots may also believe that they can simply “power through” any performance degradation from wing upper surface contamination. However, engine power cannot prevent the wing from stalling at the high angle of attack during lift-off, and power available will be insufficient when the wings turn into the proverbial “barn door”.

MISJUDGED

Although the hazards of winter operations are generally well known, they are often underestimated

Legal Requirements

Air law is one element in preventing accidents. Based on lessons learned through accident history, laws are enacted to prevent the reoccurrence by putting safeguards in place.

Regarding airworthiness and performance issues, EU-OPS 1.345 states that "an operator shall establish procedures to be followed when ground de-icing and anti-icing and related inspections of the airplane(s) are necessary" and that "a commander shall not commence take-off unless the external surfaces are clear of any deposit which might adversely affect the performance and/or controllability of the airplane except as permitted in the Airplane Flight Manual".

This legal requirement places the responsibility to be able to detect ice, snow and frost accumulation on the airframe, to discern the various types and their impact on airworthiness, to know the aircraft manufacturer's requirements, and then to decide on any remedial (de-icing) action required on the commander. At the same time, the operator is required to put in place any necessary procedures and training to enable the commander to perform his or her duty. Note that, although not explicitly stated, such procedures may involve other operational personnel such as ground-ops and dispatch.

Industry Standards

To aid operators and personnel in fulfilling legal requirements, industry standards support safety by providing guidelines on how to keep an aircraft airworthy in cold weather operations. One example is the recommendations published by the Association of European Airlines (AEA).

The procedures specify that following the de-icing/anti-icing procedures, and prior to take-off, the critical aircraft surfaces shall be clean of all frost, ice, slush and snow accumulations. More specifically no contamination – including frost is permitted on the wings, tail, control surfaces, pitot heads and static ports, air-conditioning inlets and exits, landing gear and doors and fuel tank vents.

Frost may be present on the fuselage in accordance with the manufacturer's manuals. All other surfaces shall be clear of at least ice and snow. Some frost contamination may be

acceptable in accordance with the manufacturer's manuals on the lower surface of the wing in the area cold soaked by the fuel between the forward and aft spars. However, no contamination is acceptable on the lower side of the horizontal stabilizer and elevator, as the horizontal tail pro-



duces a downward force and the underside is the "top" and stall-critical side of the airfoil.

Clearly, the critical safety task facing the crew is challenging. But the commander is only the last link in the system chain. Many decisions have been made earlier in the management system before the commander walks up to the aircraft on a winter day. These decisions directly affect his level of knowledge, judgement capability and his confidence that his employer will fully support any decision made to ensure safety in spite of time and money spent.

Management Issues

In the context of Commercial Air Transport, operators must clearly allocate responsibilities and duties to both operations management personnel and to operations personnel. EU-OPS 1.175 (i) requires a Postholder managing and supervising the activities in each of the following areas: flight operations, ground operations, maintenance system and crew training.

The task of defining and enforcing appropriate procedures for de-icing on the ground must be assigned to one of these Postholders. Other Postholders may assist the process. EU-OPS does not regulate the allocation of process

authority to a particular Postholder. But, in accordance with Appendix 1 to EU-OPS 1.1045, the operator must describe the tasks and responsibilities of operations management personnel, thus of the Postholders, in their Operations Manual Part A Section 1.3. It is therefore management's responsi-

bility to decide and clearly allocate responsibilities and ownership of processes.

The operator's management is consequently responsible to equip its flight crews with the training and skills necessary to make safe and sound decisions during operation. A strong commitment to safe operating practices as stipulated in the Accountable Managers safety policy and (hopefully) lived by the management during daily operations gives the flight crews the liberty to make that call for the ground de-icing service, even if it costs some extra time and money.



Michael R. Grüninger is the Managing Director of Great Circle Services (GCS) Aviation Safety Advisors. GCS assists in the whole range of planning and management issues, offering customized solutions to strengthen the position of a business in the aviation market. Its services include training and auditing consultancy, manual development and process engineering. He can be reached at michael.grueninger@gcs-safety.com or +41-79 442 44 89. His column, Safety Sense appears regularly in BART International.

PROCEDURES

Following to EU-OPS 1.345, operators must establish procedures for ground de-icing and anti-icing inspections.