50 YEARS AFTER MUNICH

On 6 February 1958, Manchester United football team were returning home to England after a European Cup match against Red Star Belgrade. They were flying in an Airspeed Ambassador aeroplane chartered from British European Airways (BEA) and captained by Captain James Thain. The aircraft stopped to refuel at Munich, where the runway was covered with slush.

Captain Thain tried to take off twice, but both attempts were aborted due to engine surging. When a third take-off was attempted, the aircraft did not accelerate sufficiently, and after take-off it failed to gain adequate height. It crashed into the fence surrounding the airport and then into a house. The left wing and part of the tail was torn off. The house caught fire. The left side of the cockpit hit a tree. The right side of the fuselage hit a wooden hut, inside which was a truck filled with tyres and fuel, which exploded.

23 of the 44 passengers and crew on board died, either at the time or shortly afterwards. These included 8 members of the football team, as well as the co-pilot, a steward and 8 journalists. Of the 9 surviving team members, two never played again. This accident has entered the folklore of British football as "The Munich Air Disaster" and is an example of aircraft accident prevention - and investigation - of which we cannot be proud.

In his book, The Naked Pilot[6], David Beaty states that the Canadian authorities and KLM were aware of the problems associated with slush-covered runways but "BEA took no notice". Captain Thain was held to be responsible, his airline transport pilot's licence was taken away and he was dismissed by BEA. It was not until 1968 that a new British commission cleared Captain Thain of all blame.

Understanding of the effects of ice, slow and slush contamination on runways and taxiways, and also on aircraft in the air, has increased enormously over the last 50 years; but we still do not know all the answers. The reality is that the presence of ice, snow or slush anywhere near an aeroplane must be regarded as a serious safety hazard and treated accordingly.

There are two main areas of concern:

- Runway and taxiway contamination; and,
- Ice on a parked or taxiing aircraft.

RUNWAY AND TAXIWAY CONTAMINATION

The hazards associated with an aircraft parked on an icy stand are fairly obvious. Engineers, ground crew and flight crew run the risk of falling and injuring themselves. Vehicles unable to stop may crash into the aircraft. When engines are started, the aircraft may slide from its parked position even if the brakes are applied and may push the wheel chocks out of the way. The push-back, too, will be dangerous due to poor adhesion between the tug's wheels and the tarmac.

Taxiway contamination is not systematically assessed in the same way as for runway condition. Once taxiing has commenced, there will be difficulty maintaining directional control if the taxiway is contaminated; braking will also be problematic. If snow or slush obscures taxiway markings, the aircraft may take a wrong turning or proceed further than the taxi clearance allows. Snow, ice or slush may be thrown up from the taxiway by the blast from the engines or by the mere passage of the tyres through the contaminant; this may damage aircraft components or contaminate the aircraft itself.

Take-off from a contaminated runway poses additional hazards. The presence of even a very thin film of snow or slush on the runway will reduce acceleration, delaying the time taken to reach take-off speed. Maintaining directional control using nose-wheel steering alone may be difficult, especially in the presence of a cross-wind. If the take-off has to be abandoned, then the effectiveness of the aircraft brakes will be greatly reduced. Finally, contamination of the underside of the aircraft, especially the landing gear and wing flaps, by spray thrown up from the runway will be hard to avoid.

Once in the air the problems are not over. If the aircraft has been contaminated by spray from the taxiway or runway then its aerodynamic properties will have changed, increasing drag and reducing lift. Snow or slush thrown up onto the landing gear or flaps will not necessarily prevent retraction, but it will probably freeze in flight and may prevent subsequent extension. Recommended

[6] The Naked Pilot by David Beaty, first published by Methuen in 1991.

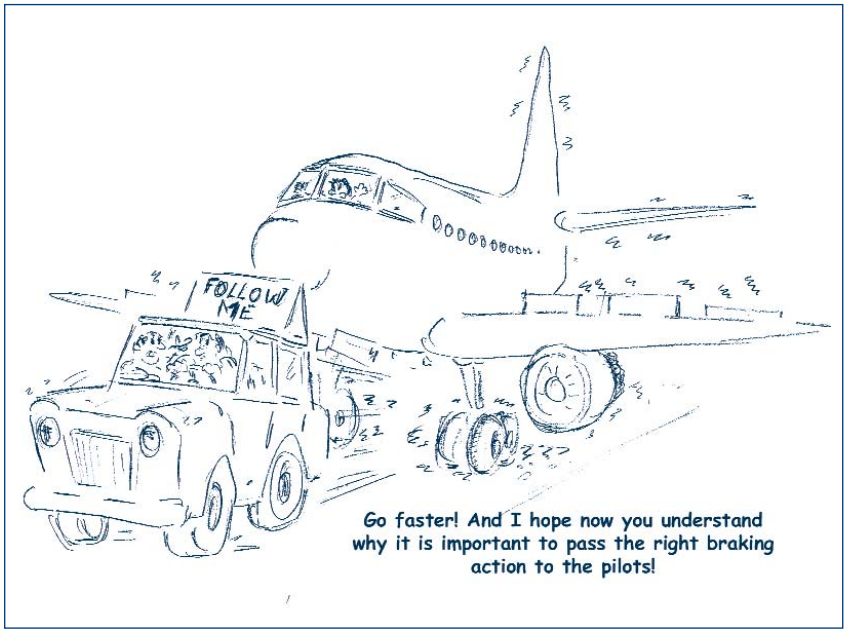
practice these days is to recycle the landing gear several times before final retraction to shed as much contamination as possible. Contamination of sensors, for example, the pitot head or static vents, will result in erroneous information being fed to aircraft instruments and to the different aircraft systems that rely on their output.

When it comes to landing, the main problem will be maintaining directional control and stopping before the end is reached. Other than that, similar hazards to those listed above will be present, although there will of course be an opportunity to clean away any contamination once the aircraft has parked.

If operations are to be maintained while snow is falling, frequent checks must be made of all paved surfaces and any adjacent areas over which engines may pass. It will usually be necessary to clear any fallen snow or change the taxiing plan so that aircraft do not have to use contaminated areas. If drains are not kept clear, then pooling water melting from the paved surface may pose as big a problem as snow or ice contamination.

At aerodromes where snow is present for a large part of the year, the use of ice or compacted dry snow (gritted or ungritted) may be authorised, in which case special conditions will apply and must be rigorously applied.

Runway inspections must be supplemented by frequent checks of braking action; this is particularly important in the presence of precipitation, which



may cause quite rapid changes to runway conditions. Braking action on snow and slush can be measured fairly accurately; at present water contamination cannot.

Because of the hazards, some operators prohibit or severely restrict operation from contaminated runways. Where they are permitted, the pilot will need to know the depth and type of contaminant as well as the braking action, for use in making performance calculations. It is essential that the assessment of runway conditions is accurate at the time of operations as take-off or landing performance may be marginal.

Pilots must be notified immediately if conditions deteriorate, even if information provided is provisional while a detailed assessment of conditions is being conducted.

ICE ON PARKED OR TAXIING AIRCRAFT

Ice or other contamination on parked aircraft can have two main effects: it may alter the aerodynamic properties of the aircraft and it may affect aircraft components. In addition to the aerodynamic effects, ice on control surfaces may prevent their free movement, while wet contamination may freeze after take-off preventing normal operation. Landing gear and flap contamination has already been mentioned.

Contamination of the pitot-static system is a particular problem if covers have been left off the sensors for some time while precipitation is in progress. Moisture may enter vents and freeze, causing blockage and erroneous readings.

Clearing ice and snow from parked aircraft is a specialist task. First, loose snow is brushed from the wings and

fuselage, then the aircraft is treated using a spray of de- and anti-icing fluids (sometimes heated). Holdover protection is achieved by a layer of anti-icing fluid remaining on and protecting aeroplane surfaces for a period of time. With a one-step de-icing/anti-icing procedure, the holdover time (HOT) begins at the commencement of de-icing/anti-icing. With a two-step procedure, the holdover time begins at the commencement of the second (anti-icing) step. The holdover protection runs out:

- At the commencement of take-off roll (due to aerodynamic shedding of fluid) or
- When frozen deposits start to form or accumulate on treated aeroplane surfaces, thereby indicating the loss of effectiveness of the fluid.

Strangely enough, there are no international standards for these fluids, but in Europe, an AEA (Association of European Airlines) working group carries out an annual review of available products and publishes a guidance document, which may be downloaded from their website[7]. This document lists recommended procedures and best practice as well as the characteristics of each type of available fluid. These characteristics include the period of time for which a de-icing operation may be valid before repeat application (holdover time).

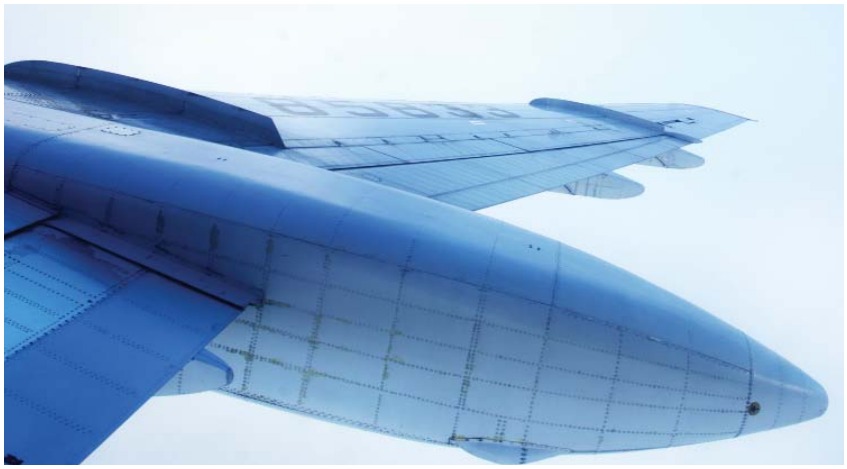
Once an aircraft has been de-iced, delay before take-off must be kept to a minimum to ensure the contaminant does not re-freeze before take-off. On the take-off run, the fluid is shed from the wings and other surfaces so that its presence does not affect the aerodynamic performance in flight. At some airports, de-icing is carried out at a remote de-icing stand on the aircraft's route to the take-off point; this permits the collection and ecologically safe disposal of surplus fluid.

Some de-icing fluids remain on aircraft after landing and the dried deposits may collect in aerodynamically quiet areas. These deposits must be washed from aircraft with unpowered flying controls as they may re-hydrate and freeze at a later point in suitable environmental conditions, causing jamming of control surfaces.

Once taxiing of an uncontaminated aircraft has commenced, falling snow may build up on the aircraft. This is likely to become dangerous if departure is delayed for any reason. Therefore, pilots should be informed immediately if accretion is observed by controllers on taxiing aircraft; in this case, it may be necessary for the aircraft to return to the de-icing bay for re-treatment.

CONCLUSION

Although we have come a long way since 1958 in our understanding of icing problems, the annual toll of accidents resulting from this hazard demonstrates that the problem is not yet under control. Only by continued application of best practice and constant vigilance by all members of the flying team - pilots, air traffic controllers, meteorological forecasters, engineers and airport staff - can the target of zero icing-related accidents ever be achieved.



[7] The publication: Recommendations for De-icing/Anti-icing of Aircraft on the Ground is available from the AEA website www.aea.be.