Airframe Icing

— Rules, Certification, and Flight in Icing Conditions —

This is the last in our series of articles on airframe icing. Previous articles have looked at the way in which different types of icing form and how to recognise conditions conducive to icing. Induction icing has also been covered. This article looks at the rules regarding flight in icing conditions and aircraft certification. It then discusses what to do should you inadvertently enter icing conditions.

CAA Rules and Aircraft Certification

Rules Requirements

Part 91 *General Operating and Flight Rules* of Civil Aviation Rules contains the following two rules with regards to aircraft icing. Firstly:

> **91.315 Operating in Snow and Ice Conditions**
>
> No pilot-in-command of an aircraft shall perform a take-off under VFR in an aircraft that has snow, ice, or frost, adhering to the wings, stabiliser or control surfaces.

and secondly:

> **91.421 Operating in Icing Conditions**
>
> (a) Except as provided in paragraph (b), a pilot-in-command operating an aircraft under IFR shall not–
>
> (1) perform a take-off in an aircraft that has–
>
> (i) snow, ice or frost adhering to any propeller, windscreen or powerplant installation, or to an airspeed, altimeter, rate of climb or flight attitude instrument system; or
>
> (ii) snow, ice or frost adhering to the wings, stabiliser, or control surfaces; and
>
> (2) fly an aircraft into known or forecast icing conditions unless the aircraft is certificated with ice protection equipment for flight in the type of known icing conditions.
>
> (b) A pilot-in-command may perform a take-off in an aircraft that has snow, ice or frost adhering to the aircraft if the take-off is performed in accordance with the aircraft Flight Manual, or instructions and data provided by the aircraft manufacturer, for take-off in such conditions.
>
> (c) If weather reports and briefing information immediately prior to the flight indicate to the pilot-in-command that the forecast icing conditions that would otherwise prohibit the flight will not be encountered during the flight because of changed weather conditions, the restriction in paragraph (a)(2) based on the forecast conditions shall not apply.

The prohibition on takeoff with snow, ice or frost on the wings is fairly obvious for most aircraft, whether IFR or VFR. Performance and control degradation may result from both the extra weight and the disruption to the airflow over the lifting surfaces. The aircraft centre of gravity might also be affected by accumulated icing, to the point where controllability is degraded.

A few aircraft (generally higher performance jet aircraft) are permitted to take off with some ice on their airframe, in accordance with rule 91.421 (b). Operators of those aircraft will be well aware of this aspect of their aircraft's operation. They should also be aware that overseas accident literature contains many examples of aircraft taking off with airframe icing where it has all gone wrong. Be careful!

"If icing is reported or forecast and your aircraft is not certificated for flight in those conditions, you cannot fly in that area …"

Note that, apart from this exemption for some aircraft, IFR aircraft are actually more limited with regard to taking off with airframe icing than VFR aircraft are. This is understandable given that the IFR aircraft may well spend the rest of the flight in IMC conditions. This could exacerbate any icing already present on takeoff. Pilots of IFR aircraft are also far more reliant on their instruments than VFR pilots are.

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Rule 91.421 (b) prohibits flight into known or forecast icing conditions unless the aircraft is certificated for flight in those conditions. The rule is quite unequivocal in this regard. If icing is reported or forecast and your aircraft is not certificated for flight in those conditions, you cannot fly in that area, either in the relevant height band or the forecast location.

Rule 91.421 (c) gives pilots an out in that a known change of weather may allow the pilot to fly into an area of previously known or forecast icing. Pilots should treat this option with some care. In obvious cases, where, for instance, a front has passed through, and the flight is to be conducted in an airmass with different characteristics, the icing conditions may well have cleared and are therefore unlikely to be encountered. If the general situation and airmass has not significantly changed, then just because a preceding aircraft does not encounter icing does not mean it is not present. Icing is like turbulence in this regard. Two aircraft can fly the same route within a short time – one might encounter severe turbulence while the other gets a better ride, having missed the worst bumps by chance. The atmosphere can be fickle. Don't leave it to chance.

Aircraft Icing Certification

The aircraft Flight Manual will clearly state what, if any, icing can be entered, and what equipment (eg, anti-icing or de-icing) must be serviceable and used to do so. Pilots of aircraft that are permitted to enter icing conditions will also have to take into account the extra fuel burnt or changes in performance that result from the use of anti-icing devices, such as bleed air from the engines.

The process by which aircraft are certificated for flight in icing conditions is complicated and outside the scope of this article. Further information can be found in the *Aircraft Icing Handbook* GAP available on the CAA web site (www.caa.govt.nz) by clicking on **Safety Information/Publications/Good Aviation Practice Booklets** or in hard copy from The Colour Guy (Tel: 0800 438 785).

Flight in Icing Conditions

Inadvertent Entry

It is possible that, despite all your careful planning and precautions, you could still encounter icing conditions in flight. The question then becomes how to best handle the situation. A simple answer might be to get out of the icing, but as with a lot of things in life and aviation there is more to it than that. Your response to a bit of light icing picked up at high altitude while in descent to VMC during an instrument arrival in a high-performance aircraft might be quite different from getting the same icing in a light single-engine aircraft without de-icing equipment while flying at MSA over mountainous terrain. The former happens fairly regularly in air transport operations – any icing not cleared by the de-icing system will usually rapidly clear as the aircraft descends out of icing-conducive conditions. The latter could turn into a really bad situation with an ice-laden aircraft descending below MSA in IMC.

"Pilots must be totally familiar with the types of icing and how they form if they are to be able to make reasoned decisions on the best way to proceed."

The author of this article once experienced exactly that while flying IFR in a light single-engine aircraft in the vicinity of Taumarunui. Icing was not forecast, but moderate icing was encountered. Performance degraded in a matter of minutes to the point that level flight was not possible. A break in the cloud enabled a descent in VMC conditions and the flight to be continued safely VFR below MSA. Not a pleasant experience!

Pilot Actions

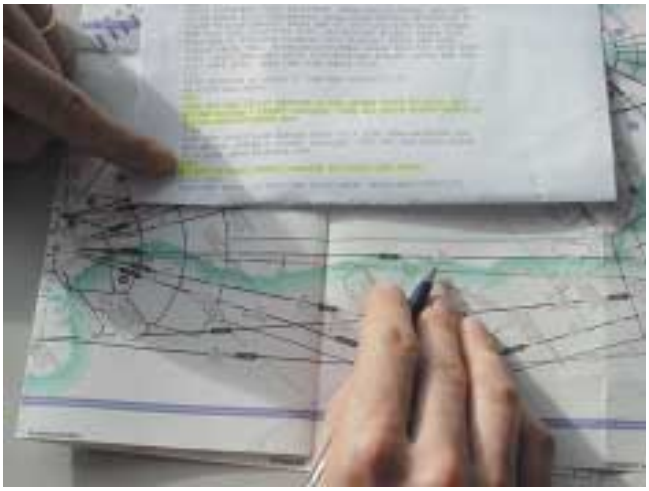
The actions taken by the pilot on encountering icing are very dependent on the situation as discussed above. One way of looking at the problem is to break it into the following three questions:

How do I get out of the icing?

An important consideration when trying to get out of icing conditions is the type of icing being encountered and the sort of cloud or conditions producing it. Flight in stratiform cloud around the freezing level, for example, may quickly lead to ice formation. An altitude change of only a few thousand feet, however, can take you out of the icing layer. In contrast, icing associated with cumuliform clouds can occur through a much wider temperature range, so an altitude change is less likely to take you out of the icing conditions. Cumulus clouds are, however, limited in horizontal extent. A change of heading, particularly out of a line of cumulus, may therefore be sufficient to get out of the icing conditions. If you know you are in an isolated cloud, or are taking the shortest distance through a line of clouds, then simply holding heading might be the best bet.

Pilots must be totally familiar with the types of icing and how they form if they are to be able to make reasoned decisions on the best way to proceed. If in doubt, then a change in altitude combined with a change of flight path may be the best way to proceed, with ATC in the loop.

A further part of the decision-making process is to determine whether to climb or descend out of icing conditions. Climbing has the obvious advantage of taking you away from the ground, and if you are already at or near MSA – it may be your only option anyway. Note, that if the power available to climb is already marginal, it takes very little ice accumulation to reduce your potential rate of climb to nil. Also note, that the use of carb heat will reduce the engine power available, but may be essential to keep it running at all – a neat Catch 22. A decision to climb must be made early. It is quite common in New Zealand to find stratus or stratocumulus layers up to around 6,000 to 8,000 feet with clear skies above. An early climb into



sunny conditions might be the fastest way of both getting out of the ice and helping to clear it.

Sometimes descending is your only option, particularly if icing has accumulated to the point that performance is impaired. Be mindful of the MSA. Ice can take a long time to clear when the aircraft has become 'cold soaked' and is being flown below a stratus layer. If an inversion is present, as is often the case in ice-conducive conditions, a descent may actually take you into colder air, also reducing the rate at which the ice clears.

Let ATC know as soon as you encounter icing, and if in difficulty, do not be afraid to say so. A Pan call advising of your situation may be warranted.

"... if the power available to climb is already marginal, it takes very little ice accumulation to reduce your potential rate of climb to nil."

How do I get rid of icing?

It goes without saying that all your anti-ice and de-ice equipment should be employed to get rid of the icing as soon as possible. Once clear of icing conditions, the ice should eventually clear itself – although, as noted above, this can take some time if still flying in cloud or even in cold clear air without sunshine. Be aware that once the ice does start to clear, it may break off in chunks, with the potential to damage other parts of the airframe. Propeller ice can be a particular problem.

How do I cope with icing?

The key problems in coping with an ice build-up are retaining control and ensuring performance enables you to maintain MSA. There have been numerous studies in recent years into aircraft handling difficulties following airframe icing, particularly the possibility of upsets or loss of control due to ice accumulation on control surfaces. Most manufacturers recommend disconnecting the autopilot (if fitted), since the autopilot may mask any control problems encountered as the ice accumulates.

The author has once again had a nasty experience when an elevator froze in a light aircraft, apparently due to ice bridging the gap between the tailplane and elevator. The elevator was eventually freed with a strong jerk on the controls. Thereafter the control column was moved gently backwards and forwards, both to ensure control was still available, and to reduce the chances of ice forming there again. Obviously, moving the controls all the time makes IMC flight more difficult, but was in this case necessary.

Speed should be kept as close to normal as possible during an icing encounter, thereby ensuring that good control authority and a margin well above the stall are maintained. Icing will cause the stall speed to increase, sometimes significantly, and may also negate stall-warning systems – so you may not know that you are approaching the stall. Do not be tempted to raise the nose in order to maintain height at the expense of airspeed – it is likely to result in a stall or loss of control. When performance is limited, it may be necessary to lose height in order to maintain speed. What actions you take will depend on the circumstances.

The subject of handling ice encounters, particularly in larger aircraft, is comprehensively discussed in the *Aircraft Icing Handbook* GAP.

Reporting

Pilots should report any significant (moderate to heavy) in-flight icing encounters to ATC. Such pilot reports (PIREPs) are essential for ATC to be able to help pilots of other aircraft avoid these areas. PIREPs also help aircraft operators to form a picture of where icing is most likely to occur in the future, which is extremely useful information when flight planning. PIREPs are also passed to the MetService, who will use the information to update weather forecasts, and if necessary issue a SIGMET.

Whenever in-flight icing is encountered that has or could have an effect on flight safety, it should be reported to the CAA under Part 12 *Accidents, Incidents and Statistics*. That way any statistical icing trends may be identified by the CAA and fed back to the aviation industry.

Summary

If you fly in cloud long enough, then one day you will encounter icing. Depending on your aircraft type, it may be no more than an inconvenience. But on the other hand, it can also get **very** scary **very** quickly. Pilots must be fully aware of the mechanisms and conditions associated with ice formation, and how to recognise and, where possible, avoid them. They must be aware of the certification state of their aircraft and what they may and may not legally do when icing is forecast. Where a worst-case icing scenario is encountered, pilots must quickly decide what they intend to do about it, particularly if in lower-performance aircraft. Waiting and hoping for it to clear are not options. ■

Get out of it, get rid of it, and be prepared to cope with it.