More on Icing

This is the second article in a series of articles that is part of an on-going educational campaign aimed at increasing pilot awareness of airframe icing and its effects.

The lead article in the last issue of *Vector* gave readers an overview of the New Zealand icing environment, the main types of airframe icing, where and how they occur, and what effect they have on aerodynamics. (Try the accompanying quiz to see if you understood and retained what we published then.) This article continues to develop that theme. Specifically, it looks at other types of airframe icing, then at some of the practical aspects of ice avoidance through the identification of conditions that are conducive to icing.

Having briefly discussed clear ice, rime ice and freezing rain in the previous article, we now take up the story with other types of airframe icing.

Types of Airframe Icing (cont)

Frost

Airframe icing can occur any time an aircraft surface has cooled to below zero degrees Celsius and sufficient water exists in the air. This can happen to an aircraft on the ground during a cold night as frost, when water vapour freezes on contact with the cold aircraft surface. We are all familiar with frost covering our car on a winter's morning, and nowhere in New Zealand is immune. While frost does not have the same weight and aerodynamic penalties as true icing, it can act to disrupt the smooth surface and hence the airflow over the wing. This can lead to flow separation and reduced takeoff performance. Just like your car, frost-covered windows can degrade visibility, making navigation and lookout a problem. Unlike your car, it is not that easy to pull over and give the windows a wipe while in flight! It is therefore essential to ensure that the airframe – particularly the wings and tailplane – and all windscreens are cleared of ice before flight. Frost can be carefully brushed or washed off the aircraft. Be careful that the means you use does not scratch surfaces, or on very cold mornings just provide extra water to add more ice!

Frost can also form in flight. It usually occurs when the aircraft

A quick quiz

Without looking at the accompanying text, name the three major types of ice and the conditions in which they are most commonly encountered? Answers on page 11…

has spent long enough in temperatures below zero degrees Celsius to have 'cold soaked' to that temperature, and then encounters moist air. This can occur after takeoff on a winter's morning, or when an aircraft descends into warm moist air after a period at altitude where the temperature was below freezing. It is important to remember that this phenomenon can afflict aircraft being flown VFR in clear conditions just as much as ones flying in cloud.

Snow and Freezing Drizzle

As well as the freezing rain previously mentioned, any precipitation falling on a cold enough airframe has the potential to cause icing. Snow, sleet, freezing drizzle, and a particular form of freezing drizzle called Supercooled Drizzle Drops (SCDD) can all afflict aircraft flying in clear air below the producing cloud mass, as well as within the cloud. Again, aircraft flying VFR are not immune from picking up airframe icing in these conditions. For more information on these phenomena, refer to the *Aircraft Icing Handbook* GAP.

Icing Prediction

The previous *Vector* article noted that the most conducive conditions for icing in New Zealand occur in what are known by meteorologists as 'conveyor belt' conditions. These occur when the synoptic situation causes a stream of relatively warm and moist maritime air to be directed onto the country and lifted, either orographically or by frontal systems.

Such conditions make icing more likely, but they do not help to isolate exactly where the icing will be found, either geographically or in terms of altitude and time. Forecasts of icing conditions are often therefore not particularly specific.

In many ways it is like predicting turbulence. We know intuitively that a strong airflow over mountains will create turbulence somewhere, but it can be very difficult to predict in advance exactly where, and how severe. It is a fairly good bet that most weather systems and conveyor belt flows contain conditions conducive to icing, but the right conditions for icing can be quite localised, and therefore hard to predict. Where cumuliform clouds are involved, the lifetime of a cell producing

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conditions conducive to icing may be measured in tens of minutes, so icing may be limited to temporary periods. Stratiform clouds tend to persist for longer periods and can be more spread out, but the icing layer may be quite thin.

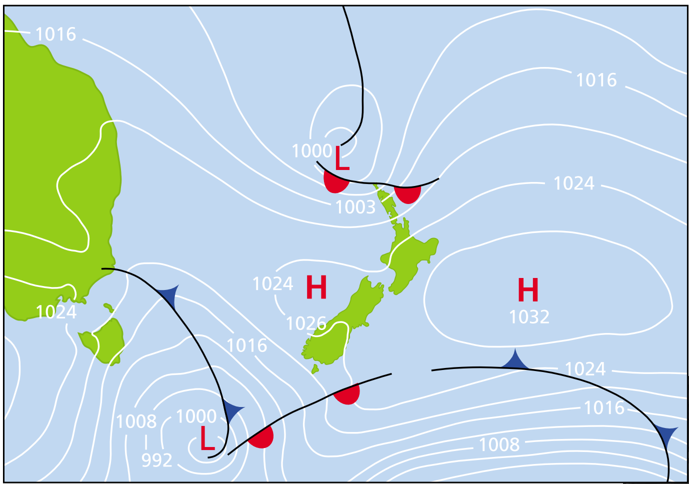
To a large extent this uncertainty about exactly where icing will occur puts the onus on the pilot to vary the flight path where possible, and as required, to avoid situations where icing appears more likely.

Again, the analogy of turbulence can be used. Where an area of likely turbulence is observed – maybe a forming rotor cloud or other such cue – the prudent pilot will alter the flight path to avoid or minimise exposure to the upcoming bumps. In the case of icing, the Outside Air Temperature gauge and a detailed knowledge of the synoptic situation are the best cues to possible icing. Sometimes the only way of knowing where the icing is actually located is to encounter it, or to hear from someone else who has had the misfortune to do so.

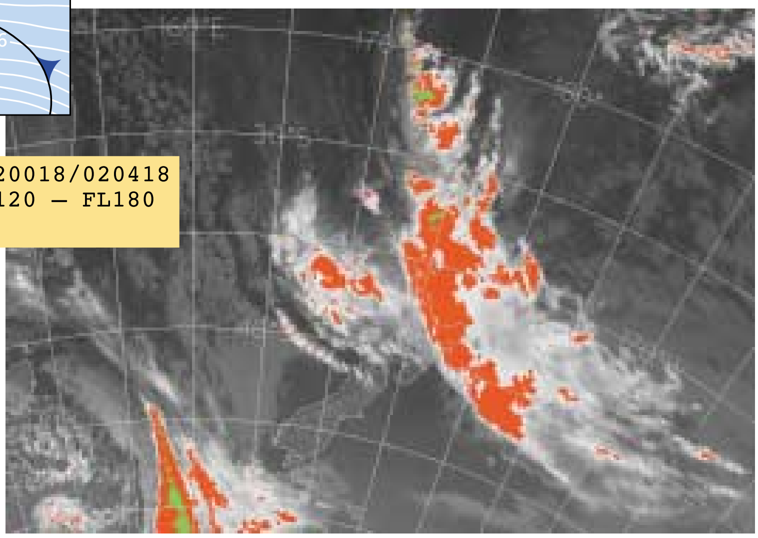
……snow was brushed from the leading edges of the wings and a takeoff was attempted with nearly a full load ... Due to hoar frost on the wings ... A token effort was made to remove frost and ice from the aircraft wings before flight, but water used for this operation froze before takeoff ... The pilot noticed some frost on the wings and tail surfaces before the aircraft was loaded but had not removed it before takeoff ... Dry snow was cleaned from the aircraft, but in the early morning light it was not realised that a layer of ice remained on the wings …....

In every instance, the aircraft failed to get airborne enough to avoid colliding with obstacles. The pilots all held CPLs. Four of the five accidents were to agricultural aircraft of various models, the other to a single-engine air transport aircraft. Three of the five accidents occurred in the North Island.

The lesson is simple. A layer of frost, snow or ice on the wings will adversely affect the ability of your aeroplane to fly.



The satellite image pictured below (at midnight on April 1st, 2001) clearly shows two conveyor belts of cloud over the North Island. The lower level conveyor belt is associated with the northeast surface flow across the northern half of New Zealand (see the accompanying MSL Analysis chart for 1200 UTC, 01-APR-2001). It can be clearly seen on the satellite image flowing out from underneath the higher-level conveyor belt and away to the west and northwest of the North Island. This flow has a long 'fetch' from well east and north of New Zealand, and is very moist. The upper level conveyor belt is carrying moist mid-tropospheric air from the tropics across Northland and Auckland, then away to the east of the North Island across Hawkes Bay. This flow is being forced to rise as it moves southwards across the North Island along the slope of the warm front drawn on the synoptic analysis chart just to the north of New Zealand. As this flow ascends and flows southwards, forced-cooling produces large super-cooled cloud droplets conducive to severe airframe icing (see accompanying SIGMET).



Images courtesy of RNZAF Met Service Ohakea

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NZZC SIGMET 04 011218/011618 UTC OR 020018/020418
NZST NZKLNZFIR ISOL SEV ICING FCST FL120 – FL180
E OF A LINE NZWK/NZNR. INTST NC.
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PIREPs

The best way to warn other pilots about actual icing conditions is to broadcast a PIREP (pilot's report).

This serves the dual purpose of warning other pilots and alerting ATC to the problem. ATC can then assist by giving you routing or altitude changes that can facilitate clearing the icing conditions as soon as practicable. The same service can then be provided to other aircraft to help them avoid the area of known icing. PIREPs help aircraft operators and aviation authorities to form a picture of where icing is most likely to occur, which is something that the whole industry can benefit from.

PIREPs are also passed on to MetService, who will use the information to update weather forecasts, and if necessary issue SIGMETs. Any information pilots can supply about icing they have encountered also serves, over a period of time, to improve the ability of MetService to more accurately predict icing conditions.

Nothing is Ever New

An article in a 1992 *New Zealand Flight Safety Supplement* (the predecessor to *Vector*) contained the following extracts from past New Zealand accident reports:

You must remove the deposit completely before attempting to take off. The removal process must be done carefully to avoid introducing further hazards. If you use water to wash away frost or snow, it can create its own problem; if it does not completely drain away, it can later freeze and the resulting expansion cause damage or control imbalance.

Summary

Frost can form on the ground or in the air, as long as sufficient moisture is present and the airframe temperature is below zero. Precipitation (eg, snow, sleet, and freezing drizzle) impacting on an airframe cooled to below freezing can also form significant icing. In all cases temperature is the key.

Accurate prediction of icing is difficult. It is, however, possible to identify the general synoptic conditions that make icing more probable, and plan the flight accordingly.

PIREPs are an essential tool to warn other aircraft about the presence and location of icing, make ATS aware of your problem, allow MetService to update weather information, and help in forming a picture of where icing is likely to occur. They should be made whenever icing is encountered or suspected.

While airframe icing is primarily a problem for IFR pilots, pilots of VFR aircraft need to remember that they are not immune from it.

Further articles in the series will examine what to do if the worst happens and, despite your best attempts at avoidance, you end up in icing conditions. Recovery techniques from upsets and stalls caused by airframe icing will be discussed, as will airframe certification standards for flight in icing conditions. ■

Answers to quiz:

Hopefully, your answers were:

1. Clear ice – normally caused by large supercooled water droplets in cumuliform cloud immediately above the freezing level.
2. Rime ice – normally from smaller drops that instantaneously freeze on the aircraft and are found in stratiform cloud at temperatures between –10 to –20 degrees Celsius.
3. Freezing rain – where rain from warmer air falls through a cold layer, often associated with cold sectors below warm fronts.

Note that in practice, most icing encounters in cloud will involve a mixture of the two types – clear and rime, leading to what is known as mixed or cloudy ice. To encounter clear or rime ice the aircraft must be in cloud. Freezing rain is normally associated with a reasonably narrow band quite close to a front. Hopefully not too many VFR pilots will get into any of these situations, so they may be excused for thinking that icing is something for IFR operators to worry about. WRONG!

The assistance of Greg Reeve (Meteorologist Ohakea) and NZ MetService staff in the preparation of this article is greatfully acknowledged.

Friendly Fire!

The November/December 2000 issue of *Vector* highlighted the dangers of flying into permanently restricted military airspaces, particularly incursions into the military airspace surrounding the Desert Road VFR corridor, in an article titled "In the Line of Fire". The type of material likely to be flying about was described to enhance pilot appreciation of just how dangerous straying into these areas can be. Subsequent letters to the *Vector* editor suggested that CAA was perhaps being a bit dramatic.

This was not, however, the view taken by a BK117 helicopter pilot transiting the Desert Road corridor last February, when he and his crew suddenly encountered at least three large incandescent parachute flares burning around them, which required evasive manoeuvres to avoid. The pilot reported literally 'feeling' the concussion of the flares as they ignited. A collision with any one of these burning objects and their drogue chutes might have resulted in a very different ending to the flight.

Investigation has shown that the flares were fired by NZ Army personnel from outside of the boundaries of Military Operational Areas (MOAs) M300 and M301 either side the VFR corridor. A full Army internal inquiry is under way as to how this happened.

The immediate lesson is that the dangers in or near a MOA are real, and that when operational protections fail or are violated by any party, the risk of being involved in an incident increases. Hence the need to heed the safety advice given in articles like "In the Line of Fire", even if does not seem immediately relevant to you and the type of flying you do.

To reiterate, be familiar with all the restricted airspace associated with your proposed route, know what the hazards contained within and near them are, navigate accurately, and remain vigilant at all times. ■

New Video

Survival – First Aid

A new CAA safety video entitled *Survival – First Aid* has just been released. This 26-minute video highlights the importance of pilots being competent in first aid, to be able to assist their passengers if injuries are suffered as a result of a forced landing.

Dr Terry Richardson and paramedic Tony Nunan cover essential first aid techniques such as the primary assessment of injuries (ABCs and administering CPR are covered), the recovery position, bleeding control, burns management, and fracture immobilisation.

This video can be viewed in conjunction with two other survival videos in our series, *Survival* and *Mountain Survival*. These video titles, combined with a first-aid and/or survival course, are strongly recommended. You never know when you will need such skills as the pilot in command of an accident situation.

AIP Supplement Cut-off Dates

Do you have a significant event or airshow coming up soon? If so, you should have the details published in an *AIP Supplement* – relying on a NOTAM is not as effective, and the information may not reach all affected users. In order that such information can be promulgated in a timely manner, you need to submit it to the CAA with adequate notice (at least 90 days before the event). Please send the relevant details to the CAA (ATS Approvals Officer or AIS Coordinator) **at least** one week before the cut-off date(s) indicated below.

Supplement **Cycle**	*Supplement* **Cut-off Date**	*Supplement* **Effective Date**
01/6	14 June 01	9 August 01
01/7	21 June 01	6 September 01