UNITED KINGDOM

AERONAUTICAL INFORMATION CIRCULAR

AIC 106/2004
(Pink 74)
11 November

National Air Traffic Services Ltd
Aeronautical Information Service
Control Tower Building, London Heathrow Airport
Hounslow, Middlesex TW6 1JJ
Editorial: 020-8745 3457
Distribution: 0870-8871410 (Documedia Solutions Ltd)
Content: 01293-573521 (Flight Operations Policy)
Web site: www.ais.org.uk

Cancels AIC 93/2000 (Pink 8)

FROST, ICE AND SNOW ON AIRCRAFT

1 Introduction

1.1 The purpose of this Circular is to emphasise the hazards of aircraft icing to all classes of aeroplanes and helicopters and to remind those concerned of the importance of thorough pre-flight preparation and of the appropriate instructions in relevant publications. The Flight Manual, Operations Manual and the Maintenance Manual contain basic requirements concerning the use and maintenance of anti-icing and de-icing equipment, which must be strictly adhered to.

1.2 All procedures and associated precautions should be checked before each winter, ideally as part of a pre-planned Winter Operations refresher or training programme.

1.3 Nevertheless, icing can occur during flight at any time of the year, and given the global nature of UK air transport operations, frost, ice and snow may be found at times which do not correspond to the European winter period. Therefore the advice, information and instructions contained in this Circular will always be relevant. It should be remembered that any contamination of aircraft aerofoil surfaces will adversely affect performance and handling and even small amounts can have disastrous consequences. It is therefore important that any flight in icing, or potential icing conditions is fully in accordance with the icing clearance of the aircraft.

1.4 The Annex lists some reported incidents and accidents in which icing or other cold weather hazards have been causative factors. These have been included as reminders of the hazards associated with winter period operations and in some cases illustrate the subtle onset of danger.

2 Pre-Flight Preparation

2.1 The aircraft should be free from deposits of frost, ice and snow. When necessary use a de-icing fluid to achieve effective removal of any frost or ice and to provide a measure of protection against any further formation. Only fluids approved for the purpose should be used. The efficiency of the fluid under varying atmospheric conditions is dependant upon the correct mixture strength and methods of application, which must be strictly in accordance with recommended procedures. For example, using fluid diluted with water will effectively remove ice; however, its ability to prevent further ice formation will be significantly reduced. Under certain conditions the fact that the aircraft surfaces have been made wet will actually enhance further accumulation, leading to a dangerous situation if there is a considerable delay between de-icing and take-off. Poor decision-making as to whether or not to de-ice/anti-ice is probably the single biggest cause of icing-related fatal accidents. The importance of making a safe decision cannot be over-emphasised.

2.2 In the absence of adequate advice on approved fluids in the aircraft maintenance manuals, guidance on mixture strength and methods of application should be sought from the aircraft manufacturer and the supplier of the fluid. Ensure, in particular, that aerofoil sections, or all rotor blades, have received similar treatment. After removal of ice, if precipitation is present or conditions are conducive to frost formation, a fluid with anti-icing properties should be applied and the appropriate holdover time guidelines applied. **Note:** Fluids flow off the aircraft before rotation and provide no in-flight ice protection.

2.3 Fit engine blanks and pitot/static covers before de-icing as required. Particular attention should be paid to all leading edges, control surfaces, flaps, slats, their associated mechanisms, hinges and gaps. Excessive use of any non-volatile, viscous de-icing fluids on control surfaces may create out of balance problems by increasing the weight of the surfaces to the aft of the hinge points. Deposits left in operating mechanisms, hinges and gaps may re-freeze during flight and jam controls. Some de-icing fluids can also dilute or wash away essential lubricating greases.

2.4 Ensure that all orifices and guards (eg generator cooling inlets, fuel vents, APU inlets, pressurisation inlets and outlets, static plates, helicopter snow guards, etc) and exposed operating mechanisms (eg nosewheel steering, emergency door and window locks, helicopter rotor heads, etc) are cleared of snow or slush and de-iced when so recommended. As the ingress of moisture, snow, rain and slush to door seals is more likely to occur when the doors are open, the time that they are open should be kept to the minimum practicable and a check made for contamination prior to departure.

2.5 Ensure that the implications of cockpit indications are fully understood. For example, the cockpit indications in relation to an inflatable boot de-icing system may not necessarily confirm the actual operation of the system. Verify, by visual inspection, or by other recommended independent means, the satisfactory operation of any de-icing and/or anti-icing systems.

2.6 Damage to inflatable boots can result in leaks, which will prevent full inflation and significantly reduce their effectiveness and/or allow the ingress of moisture which may subsequently freeze. Their location on leading edges makes them particularly susceptible to damage by erosion, impact or contact with ground equipment. Winter conditions invariably increase the risk of such damage and the importance of regular inspection and functional testing cannot be over-emphasised.

2.7 Ice may block the pitot static system, or melting ice or heavy rain may cause water to enter the pitot static system causing lost or intermittent indications of airspeed. On more integrated fly by wire aircraft, erroneous airspeed indications may cause other system failures also. Make sure you are familiar with how to check pitot heat if it is listed as a crew task in the walk around inspection. Make sure you understand the abnormal checklist procedures associated with loss of air data, locating alternate static sources, etc.

3 Start-up, Taxi, and Take-off Precautions

3.1 Operations to or from runways contaminated with snow, slush or water, by all classes of aeroplane, should be avoided whenever possible. Such operations involve a significant element of risk. The wisest course of action would be to delay departure until conditions improve or, if airborne, and bad conditions are broadcast, divert to a more suitable airfield.

3.2 On some types of engines, icing of engine pressure probes can cause an over-reading in instruments used to indicate engine power delivery. To minimise this possibility and thus of damage to, or flame-out of, the engine, engine anti-icing should be switched on if icing conditions are present or possible. In the absence of Flight Manual, Operations Manual or Pilots Operating Handbook guidance, engine icing can be assumed to be possible if the OAT is less than +10°C and the RVR is less than 1000 m or there is precipitation or standing water. Use carburettor heat and propeller de-icing as appropriate.

3.3 During taxiing in icing conditions, the use of reverse thrust on engines in pods should be avoided, as this can result in ice contamination of leading edges, slats and other flight critical devices. For the same reason, a good distance behind the aircraft ahead should be maintained. In no circumstances should an attempt be made to de-ice an aircraft by positioning it in the jet efflux of the aircraft ahead.

3.4 Before take-off ensure that the wings have remained uncontaminated by ice or snow. Operate the appropriate fuel, propeller, airframe, carburettor, and engine anti-icing or de-icing controls, before, during and after take-off in accordance with the Flight Manual, Operations Manual or Pilots Operating Handbook. Take-off power and aircraft performance should be monitored on more than one instrument.

4 In-Flight Precautions

4.1 The build-up of ice in flight may very rapidly degrade aircraft performance and controllability and pilots should avoid icing conditions for which their aircraft are not approved. Crews should check regularly and thoroughly for the build-up of ice. The instructions in the Flight Manual, Operations Manual or Pilots Operating Handbook, concerning the use of anti-icing and de-icing systems must be followed.

4.2 On some types of aircraft, when ice is present on the tailplane, the action of flap lowering may cause a reduction of longitudinal control. When this happens, the tailplane can stall with a subsequent loss of control from which it may not be possible to recover in the time and height available. Allowing the speed to increase with the flaps extended may also increase this risk of tailplane stall. If longitudinal control difficulties are experienced and it is suspected that ice may have formed on the tailplane, it may be prudent not to lower flaps, or to immediately change the flap setting. It is important that this condition, caused by icing, is not confused with normal pitch changes associated with flap selection or de-selection. Before a decision is taken to carry out a flapless or partial flap landing, the landing performance aspects of such a decision must be assessed. Consideration should be given to diverting to a more suitable aerodrome if runway length and/or condition are limiting factors.

4.3 Operation of anti-icing or de-icing equipment can affect performance and fuel consumption. These effects must be allowed for if flight in icing conditions is planned or possible.

4.4 If pilots or operators have any doubts about the susceptibility of their aircraft to any type of control problem when icing is involved, they should consult the Manufacturer or the Design and Production Standards Division of the Civil Aviation Authority.

5 General Aviation

5.1 This Circular and additional documents listed at paragraph 6 (a), (b), and (c) are applicable to all classes of aeroplane; more specific guidance relating to turbo-prop aeroplanes is at paragraph 6 (d) and that for general aviation is contained in paragraphs 6 (e) and (f).

6 Additional Documents

6.1 Further guidance on specific subjects is contained in the following publications:

(a) AIC 61/1999 (Pink 195) - Risks and Factors Associated with Operations on Runways Affected by Snow, Slush or Water;

(b) CAP 512 - Ground De-icing of Aircraft; www.caa.co.uk > publications > Flight Operations;

(c) AIC 105/2003 (Pink 61) - Recommendations for De-icing/Anti-icing of Aircraft on the Ground;

(d) AIC 98/1999 (Pink 200) - Turbo-prop and Other Propeller Driven Aeroplanes: Icing-Induced Stalls;

(e) AIC 145/1997 (Pink 161) - Induction System Icing on Piston Engines as Fitted to Aeroplanes, Helicopters and Airships;

(f) Winter Flying - General Aviation Safety Sense Leaflet 3C; www.caa.co.uk > publications > General Aviation;

(g) Ice Aware CD-ROM.

Note: A copy of the Ice Aware CD-ROM can be obtained free of charge from the Civil Aviation Authority, Flight Operations Department Admin Section, Tel: 01293-573450 or Fax: 01293-573991.

This Circular is issued for information, guidance and necessary action.

Printed and distributed by Documedia Solutions Ltd, Cheltenham, Glos.

ANNEX

Frost, Ice and Snow on Aircraft

Incidents and Accidents with Frost, Ice or Snow as a causative factor

1 Frost, Ice and/or snow on aircraft will adversely affect performance and handling and even small amounts have had disastrous consequences. Accidents and incidents have been caused by:

(a) Ice build-up on engine inlet pressure probes causing erroneous indications of engine power;

(b) a thin layer of ice on control surfaces inducing flutter and consequent structural damage;

(c) severe tailplane icing leading to a loss of control on selection of landing flap;

(d) very small deposits of ice on wing leading edges dangerously eroding performance;

(e) windscreens being obscured by snow when operating with an unserviceable heater, leading to a loss of directional control on take-off;

(f) attempting a take-off with wet snow on the wings and tailplane surfaces which had accumulated after earlier de-icing with diluted fluid;

(g) snow/slush on helicopter upper fuselage surfaces entering engine intakes after engine start causing flame-out and engine damage;

(h) engine breather pipes freezing;

(i) inability to open doors after a successful landing. (Although to date such occurrences have not resulted in serious consequences, these conditions could be extremely hazardous in an emergency situation). This problem has been caused by external coverings of ice; ice in locking mechanisms, hinges and seals; and freezing moisture in pressure locking systems;

(j) non-use of engine igniters in potential icing conditions which, in conjunction with other factors, contributed to a double engine failure and consequent forced landing;

(k) very low ambient temperatures at high altitude resulting in apparent fuel freezing leading to subsequent multiple engine rundown, in spite of application of fuel heating systems. (Given a sufficiently long exposure time to low ambient air temperatures, fuel will eventually cool to this temperature which can be well below the freezing point of the fuel). Pilots should therefore be aware of the freezing points of their specified fuels and/or the operational limitations of these fuels and plan accordingly. There are certain aircraft types, including those with piston engines, where the use of special fuel anti-freeze additives are specified as being mandatory in certain conditions;

(l) contamination of retractable landing gear, doors, bays, micro-switches by snow; wet mud or slush. Any contamination should be removed before flight;

(m) carburettor icing. (However, it should be emphasised that this particular problem is not confined to winter operations);

(n) wing upper surface icing due to very low fuel temperatures. Such ice is usually clear and very difficult to detect visually. In addition to any aerodynamic effects caused by this contamination of wing surfaces, there is a potential serious hazard to rear engine aircraft if this ice breaks off. This will often occur during take-off and in such cases ice ingestion and turbine damage have occurred. Typical factors favouring the formation of such ice include:

  (i) Low temperature of up-lift fuel close to departure;

  (ii) previous long flight times in low ambient temperatures resulting in fuel being cold-soaked to 0°C or below and subsequent cooling of the wing surfaces either by the fuel itself or by conduction from surfaces in contact with the cold fuel. If this is coupled with ambient ground conditions involving high humidity, drizzle, rain or fog in conjunction with temperatures in the range of 0°C to +10°C, ice will form. (However, it should be noted that ice formation has been reported in drizzle and rain even in temperatures between +8°C and +14°C). When carrying out a physical check of the wing upper surface in such conditions it must be borne in mind that this ice may have formed below a layer of slush or snow thus compounding the detection and removal problem.

(o) a twin-engine aeroplane landing in winter conditions experienced a significant wing drop accompanied by a nose-up pitch. Despite application of power and full opposite aileron and rudder the aircraft was slow to recover and the wing tip struck the ground. Control was regained and a safe landing made. Although no ice was seen during a visual check of the wing surfaces prior to landing, the aircraft had been operating all day in icing conditions and prior to this flight had been delayed on the ground in rain conditions for 40 minutes;

(p) a twin-engine aeroplane stalled at an IAS considerably above the basic stall speed and at a much lower than normal angle of attack; the approach to the stall was so insidious that the pilot was unaware that the aircraft had stalled. The pilot did not have the expected visual cues on the rapid accretion of ice and the action of the autopilot in correcting for the aerodynamic effects of the accretion was to actually drive the aircraft further into the stall configuration. Heavy stall buffeting, which was mistaken for propeller icing caused the pilots difficulty in reading instruments. The temperature was much warmer than usual and large water droplets were present;

(q) a twin-engine aeroplane stalled on the approach to an airport, probably as a result of becoming uncontrollable at a speed well above its stalling and minimum control speeds. It was deduced that its handling and flying characteristics had been degraded by ice accumulation;

(r) another twin-engine aeroplane suffered a double engine failure, possibly as a result of ice ingestion. There have been a number of reported flame-outs from this cause, most of which have been suspected as being due to either late or non-selection of engine icing protection systems.