De-Icing & Winter Operations

GENERAL

	**SUMMIT GROUP and Flight Centre are operating according to the "Clean Aircraft Concept". No aircraft may take off unless it has been determined that all critical components and surfaces are free from ice, frost or snow.**



Wind tunnel and flight tests indicate that deposits of ice, frost or snow formations on the leading edge and upper surface of a wing, having a thickness and surface roughness similar to medium or coarse sandpaper, can reduce wing lift by as much as 30 % and increase drag by up to 40 %. These changes in lift and drag will significantly increase stall speed, reduce controllability and alter airplane flight characteristics.

Thicker or rough ice accumulations in the form of frost, snow or ice deposit can have increasing effects on lift, drag, stall speed, stability and control, but the primary influence is surface roughness relative to critical portions of an aerodynamic surface. Ice on critical surfaces and the airframe may also break away during take-off and be ingested into engines, possibly damaging fan and compressor blades or cause damage to vertical and horizontal tail surfaces. Ice forming (or blocking) on pitot tubes and static ports or on angle of attack vanes may give false attitude, airspeed, angle of attack and engine power information for air data systems.

These adverse effects on the aerodynamic properties of the airfoil may result in sudden departure from the commanded flight path and may not be preceded by any indications or aerodynamic warning to the pilot:

Loss of lift: Frozen accumulations may destroy the lifting ability of air foils, including leading edge devices, resulting in failure of the aircraft to become airborne.

Increased drag: An aircraft may fail to reach take-off speed within the calculated/available distance, as a result of the increased drag placed on the airfoil due to the presence of frozen contaminants.

Decreased control: Frozen accumulations may impair the function of control surfaces, such as rudder, elevators, ailerons and trim tabs, to such a degree that the aircraft cannot be controlled.

Flutter: Accumulation of frozen contaminants may create conditions that result in separation of airflow and dynamic instability of the airfoil surface, which, in extreme cases, can cause destruction of aircraft parts.

Restricted control surface movement: Ice deposits may form in the hinge and other areas of control surfaces and restrict or prohibit their movement.

Blocked sensors: Frozen contaminants blocking pitot probes, static ports, engine pressure sensing probes and inlets can cause errors in critical instrument readings.

Ingestion damage to engines: Ice, shedding from the lower surface of the engine intake during take-off, can damage blades, vanes and other engine parts and in extreme cases may result in loss of the engine during this most critical stage of flight.

Damage to horizontal or vertical tail surfaces: Deposits of clear ice, that have formed on the upper surface of 'cold' wings during periods of rain or other periods of high humidity, may be 'shed' during take-off and damage horizontal and vertical tail surfaces.

Increased weight and/or altered balance characteristics: The build-up of frozen contaminants on aircraft surfaces increases the weight of the aircraft and may affect its ability to reach take-off speeds within the required/available distance. It will also affect the distribution of weight on the aircraft.

SUMMIT GROUP and Flight Centre follow the rules and procedures published yearly by SAE International in its documents AS6285 & AS6286. These rules and procedures were published until winter season 2016/2017 by AEA in their: "AEA recommendations for De-Icing / Anti-Icing of Aircraft on the Ground".

Description

Frost

Frost/Hoar Frost: Ice crystals formed from water vapour that freezes on surfaces, which are at or below 0°C. When the following conditions exist, frost may form on aircraft surfaces, even though the OAT is above 0ºC:

- On a cold cloudless night aircraft surface temperatures may fall to as much as 4ºC below the ambient temperature, due to the effect of long wave radiation (heat in the wing effectively radiates through the atmosphere to outer space). Frost may therefore form on aircraft surfaces, even though the outside air temperature is up to +4ºC.
- Where wing surface temperatures are at or below 0ºC, due to the presence of 'sub-zero' fuel from the previous sector, frost will tend to form on these surfaces, when the ambient temperature is above that of the wing.
- Aircraft that has previously operated a relatively long sector at high altitude will have become 'cold soaked'. Where the turnaround is short, insufficient time may exist for the temperature of parts of the structure to rise above 0ºC and frost may form on the parts of the airframe that remain at or below 0ºC, even though the OAT may be above 0ºC.

Active Frost: A frost condition demonstrating actively growing crystals that gain in mass and thickness. It typically forms at night under clear skies and calm winds when the OAT is below 0ºC and the dew point temperature spread is less than 3ºC. The temperature of the aircraft surface must be below 0ºC. As an example, if an aircraft is parked outdoors on a cold, clear night, heat can radiate from its surface at a rate greater than is absorbed from its surroundings. The net effect is that the aircraft surface temperature drops below the OAT. If this temperature is below the frost point temperature of the air, moisture will deposit in the form of hoarfrost.

As a guide, if there is frost on any object in the de-icing area (including the aircraft) and the OAT and dew point are 3ºC apart and narrowing, there is likely to be active frost. If the OAT and dew point are 3ºC apart and expanding, active frost is unlikely. If there is doubt, treat the condition as active frost.

Freezing Fog: Defined as a cloud of super cooled water droplets which freeze upon impact to form rime ice on objects in cold weather conditions. The visibility at the earth's surface is generally reduced to less than 1km (5/8 mile). The severity of this condition is dependent on the visibility and airflow.

When moisture laden air is blown into contact with a surface which is at or below 0°C, the super cooled droplets will freeze immediately. Where wind speed and direction are maintained for a period of time, a significant layer of rime ice can build up in a relatively short period of time. Clearly, the lower the visibility and/or the higher the speed of the airflow, the more severe the ice build-up.

Snow

Snow: Precipitation of ice crystals, most of which are branched, star-shaped or mixed with un-branched crystals. At temperatures above -5ºC the crystals are generally agglomerated into snowflakes.

Snow Grains: Precipitation of very small white and opaque particles of ice that are very flat or elongated with a diameter of less than 1mm (0.04 inch). When snow grains hit hard ground, they do not bounce or shatter.

Snow Pellets: Precipitation of white, opaque particles of ice. The particles are round or sometimes conical. Diameters range from about 2mm to 5mm (0.08 to 0.2 inch). Snow pellets are brittle, easily crushed; they do bounce and may break up on contact with hard ground.

ICE

Ice will occur on an aircraft when the weather conditions are cold and there is moisture on its surfaces.

(1) Ice is possible on an aircraft when:

- The temperature of the aircraft skin is 0°C or less.
- The local temperature is more than 0°C and there are strong winds (wind chill factor). This can occur at temperatures up to 10°C. It can also occur at these temperatures when there is snow on the surfaces of the aircraft.
- There is precipitation in cold conditions (freezing rain).
- There is high humidity in cold conditions.
- There is fog in cold conditions (freezing fog).

(2) Some ice is transparent. It can occur in the conditions given above and is not easy to see on the surfaces of the aircraft.

Rain & Sleet & Slush

Freezing Drizzle: Fairly uniform precipitation composed exclusively of fine drops less than 0.5mm (0.02 inch) diameter, very close together, which freezes upon impact with the ground or other exposed objects.

Light Freezing Rain: Precipitation of liquid water particles, which freeze upon impact with the ground and other exposed objects. Precipitation consists of drops, greater than 0.5mm (0.02 inch) diameter. Measured intensity of liquid water particles is up to 2.5mm/hour (0.10 inch/hour) or 25gm/dm2/hour with a maximum of 0.25mm (0.01 inch) in 6 minutes.

Moderate and Heavy Freezing Rain: Precipitation of liquid water particles, which freeze upon impact with exposed surfaces and objects. Precipitation consists of drops, greater than 0.5mm (0.02 inch) diameter. Measured intensity of liquid water particles is more than 2.5mm/hour (0.10 inch/hour) or 25gm/dm2/hour).

	**There is no holdover time guidance for this condition.**

Rain and Snow (Sleet): Precipitation in the form of a mixture of rain and snow.

Rain or High Humidity on a Cold Soaked Wing: Water droplets forming an ice topping on the wing upper surface, when the temperature of the aircraft wing surface is at or below 0°C. This phenomenon has been experienced at OATs of up to and above +15°C and will generally only occur when significant quantities of sub-zero fuel remain from the previous sector.

Ice Pellets: Precipitation of transparent (grains of ice) or translucent (small hail) pellets of ice, which are spherical or irregular and which have a diameter of 5mm (0.2 inch) or less. The pellets of ice usually bounce when hitting hard ground.

	**There is no holdover time guidance for this condition.**

Hail: Precipitation in the form of small balls or pieces of ice with a diameter ranging from 5mm to > 50mm (0.2 inch to > 2.0 inch) falling separately or agglomerated.

	**There is no holdover time guidance for this condition.**

Slush: Snow or ice that has been reduced to a soft watery mixture by rain, warm temperatures and/or chemical treatment.

Cold Soaked Wing(s)

When large quantities of 'sub-zero' fuel remain in the wings from the previous sector, for example, where round-trip fuel has been carried or a large fuel uplift was required for operational reasons, it is possible for frost or ice to form on wing surfaces, depending on the conditions. In extreme cases the built-in safety buffer, between the freezing point of the fluid used to de-ice the aircraft and the OAT, may be eroded.

During winter months fuel temperatures down to –25°C are not uncommon. Where the temperature of the wing remains both below that of the freezing point and the OAT, moisture from the surrounding air will condense on these surfaces and frost will form, even though the OAT may be above 0°C.

When the above conditions exist and the surrounding air is highly saturated, significant amounts of 'clear ice' may form in the vicinity of the fuel tanks, on both upper and lower wing surfaces, even when the OAT is up to +10°C or higher.

This type of ice formation is extremely difficult to detect; therefore, when the above conditions exist, or when there is otherwise any doubt that clear ice may have formed, a close inspection of the wing upper surface must be made, using a suitable means of access. Should de-icing be found to be required, a

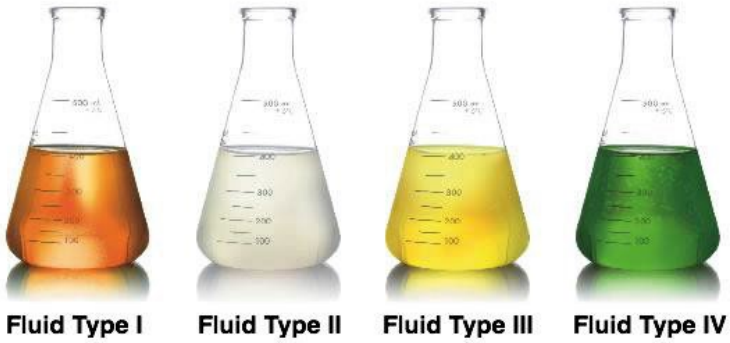
further close inspection must be made immediately after the de-icing operation, in order to ensure that all frozen deposits have in fact been removed.

It should be stressed that the low wing temperatures associated with this type of build-up, normally only occur when large quantities of cold fuel remain in wing tanks during the turnaround/transit and any subsequent fuel uplift is insufficient to cause a significant increase in fuel temperature.

De-Icing Fluids

There are currently four different fluid types. These fluids are called Type-I, -II, -

III and –IV. The compound of each individual certified fluid varies but the types are known and accepted all over the world.



The fluid must be accepted (among others) according to its type for holdover times, aerodynamic performance and material compatibility.

The colouring of these fluids is also standardized:

- Glycol in general is colourless as can be seen with older certified fluids when colouring was not standardized (older generation Type-I and Type-II).
- Currently orange is the colour for Type-I fluids, water white/pale straw is the colour for type-II fluids and green is the colour for Type-IV fluids.
- The colour for Type-III is yellow.
- In general De-Icing/Anti-Icing fluid may be uncoloured if requested.

Other tests are also conducted on De-Icing plants on airports. These tests are made at the start of each shift, each time the rig is filled and whenever a new product arrives at the airport. These tests are kept on file and consist of:

- Refractometer.
- Visual Contamination.
- PH-Value.
- Viscosity check (except for Type-I Fluid).

Alkali Organic Salt-based Aircraft De-Icing Fluids

The majority of the aircraft de-icing fluids compliant with SAE AMS 1424 (known as Type-I) use a glycol (or a glycol/water dilution) as freezing point depressant. In recent years, some fluid manufacturers have developed Type-I fluids based on sugars. Most recently, some fluid manufacturers have developed new fluids based on alkali organic salt dilutions. Those organic alkali salts might have two adverse effects on the flight operation and on the aircraft itself: reducing the length of the Hold over Time and, over time, may cause galvanic corrosion on metallic parts.

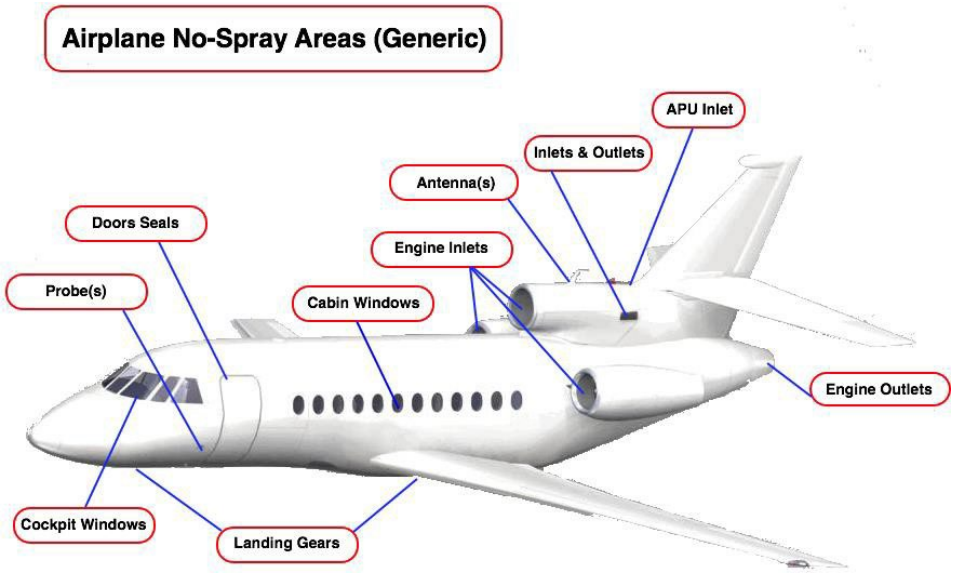
In view of this SUMMIT GROUP and Flight Centrestrongly recommends to avoid the use of Type-I fluids that could negatively affect the hold-over time provided by the anti-icing fluid in a two-step de-icing operation. If unavoidable, apply special care when washing-off the Type-I fluid in the second step (anti-icing) and perform a pre take-off contamination check.

Following procedure will be respected:

- When operating on non-European airports, the Commander will ascertain that no Alkali Salt based de-icing fluids are used.
- If the use of Alkali based de-icing product is unavoidable, apply special care when washing-off the Type I fluid in the second step (anti-icing) and perform a pre take-off contamination check.
- If Alkali based de-icing fluid was used, the Commander will file an Occurrence Report to the respective SUMMIT GROUP and Flight Centre Maintenance/Engineering department.

General Precautions during Winter Operations

These are general guidelines; refer to the specific aircraft AMM (consultation via the respective SUMMIT GROUP and Flight Centre Maintenance Department) and SAE International documents AS6285 & AS6286 for definitive information.



- Ice that has accumulated on the fan blades while the airplane has been on the ground for a prolonged stop is called “ground-accumulated ice” and must be removed before engine start.
- Ice that has accumulated on the fan blades while the engine is at idle speed is called “operational ice” and is allowed to remain on the fan blades before taxi because the ice will be removed by engine run-ups prior to take- off.
- The right and left sides of the wing and horizontal stabilizer (including the elevator) must receive the same fluid treatment, and both sides of the vertical stabilizer must receive the same fluid treatment.
- Treat the wings and tails from leading edge to trailing edge and outboard to inboard.
- Treat the fuselage from the nose and work aft. Spray at the top centerline and work outboard.
- Do not point a solid flow of fluid directly at the surfaces, gaps in airframe structure, or antennas. Instead, apply the fluid at a low angle to prevent damage, while pointing aft for proper drainage.
- Do not spray De-Icing/Anti-Icing fluids directly into/onto
    - engine inlets, exhausts,
    - protruding antennas,
    - static ports, static vents,
    - pitot-static probes,
    - Air inlets/exits,
    - vicinity of landing gear wheels, aircraft brake assemblies,
    - landing and taxi lights on wing leading edges.



- Ensure that ice or snow is not forced into areas around flight controls during De-Icing.
- Look for any damage to the airplane surfaces and for contamination that may have collected on the airplane. Carefully remove the contamination.
- Remove contamination (e.g., frost, ice, slush, or snow) from the area where the main and nose gear tires will be positioned when the airplane is parked at the gate. If tires are frozen to the ramp, the airplane should not be moved until they are free.

Anti Icing - Application

GENERAL

Anti-Icing procedures must be carried out exclusively by personnel trained and qualified on this subject.

Companies providing De-Icing/Anti-Icing services should have both a Qualification Program and a Quality Assurance Program to monitor and maintain an acceptable level of competence.

	**Both wings and stabilisers must receive the same and complete treatment on both sides of the aircraft. Serious aerodynamic problems could result if this requirement is not met.**
	**Guidelines for Application of De-Icing Fluids are to be consulted in the yearly edition of SAE International documents AS6285 & AS6286.**

PROCEDURE

Before commencing treatment, make sure all doors and hatches are closed. A suitable Anti-Icing procedure is to apply an even film on all the aircraft surfaces which are to be protected. Start the spray on the highest part of the aircraft and cover evenly down to the lower parts. The correct thickness is applied when fluid just starts to run off the aircraft.

Anti-Icing fluid can be applied over a light frost covering, but a heavy frost covering must be de-iced followed by the Anti- Icing film. A thin coating of Anti-Icing paste may be applied to the leading edges of control surfaces to prevent adherence of any accumulation during taxi.