National Aviation Services

De-icing / Anti-Icing Manual

Kabul

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De-icing / Anti-Icing Manual

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ABBREVIATIONS

The table below shows the abbreviations sorted alphabetically

Abbreviations	Expansions
°C	Degrees Celsius
°F	Degrees Fahrenheit
AFM	Airplane Flight Manual
A/I	Anti-Icing
AIR	Aircraft Surface Coating Interaction with Aircraft Deicing/Anti-icing
AMM	Aircraft Maintenance Manual
AMS	De-icing/anti-icing fluid, aircraft, SAE Type I
APU	Auxiliary Power Unit
ARP	Aerodrome Reference Point
AS5635	Message board on de-icing facilities
ATC	Air Traffic Control
cm	Centimetre(s)
D/I	De-Icing
FAA	Federal Aviation Administration
FP	Freezing point
Gals	Gallons
GH	Ground Handling
IMC	Instrument Meteorological Conditions
in	Inch(es)
ISO	International Organization for Standardization
KM	Kilometer
LOUT	Lowest Operational Use Temperature
ml	Millilitre(s)
mm	Millimetre(s)
OAT	Outside Air Temperature
PBB	Passenger Boarding Bridge

SAE	**Society of Automotive Engineers**
S.T.W.	**Slot Tolerance Window**

SECTION 1

PROCEDURES

1. Scope

This document establishes the minimum requirements for ground-based aircraft de-icing / anti-icing methods and procedures to facilitate the safe operation of transport aircraft during icing conditions. All requirements specified herein are applicable only in conjunction with the reference documents. This document does not specify requirements for particular aircraft types.

NOTE:
Particular airline or aircraft manufactures published manuals, procedures or methods supplement the information contained in this document.
Frost, ice or snow deposits, which can seriously affect the aerodynamic performance and/or controllability of an aircraft, are effectively removed by the application of the procedures specified in this document.

2. References

Wherever in this document fluid Types I, II, III, or IV are indicated, this always refers to the latest version of the applicable ISO and SAE fluid types.

For example: Type I fluid refers to ISO Type I per ISO 11075 as well as SAE Type I per AMS 1424. Type II fluid refers to ISO Type II per ISO 11078 as well as SAE Type II per AMS 1428.Passenger services

2.1 SAE documents

AIR 6232	Aircraft Surface Coating Interaction with Aircraft Deicing/Anti-icing Fluids
AIR 9968	Viscosity Test of Thickened De-icing/Anti-icing Fluid
AMS 1424	De-icing/anti-icing fluid, aircraft, SAE Type I
AMS 1428	Fluid, aircraft de-icing/anti-icing, non-Newtonian, (pseudo plastic), SAE Types II, III, IV
AS 6284	Forced Air or Forced Air/Fluid Equipment for Removal of Frozen Contaminants
ARP 1971	Aircraft de-icing vehicle - self-propelled, large capacity
ARP 4737	Aircraft de-icing/anti-icing methods
ARP 5149	Training Program Guidelines for De-icing/Anti-icing of Aircraft on the Ground
ARP 5646	Quality Program Guidelines for Deicing/Anti-icing of Aircraft on the Ground
ARP 5660	De-icing Facilities Operational Procedures
AS 5635	Message Boards (Deicing Facilities)

2.2 ISO documents

ISO 11075 Aircraft - De-icing/anti-icing fluids, ISO Type I.
ISO 11076 Aircraft - Ground-based de-icing/anti-icing methods with fluids
ISO 11077 Aerospace - Self-propelled de-icing/anti-icing vehicles - Functional requirements.
ISO 11078 Aircraft - De-icing/anti-icing fluids, ISO Types II, III and IV.

3. Definitions

For the purposes of this document the following definitions apply:

- **De-icing**

Procedure by which frost, ice, slush and snow is removed from an aircraft in order to provide clean surfaces.

- **De-icing fluid**
  - Heated water;
  - Mixture of water and Type I fluid;
  - Premix Type I fluid;
  - Type II, Type III, or Type IV fluid;
  - Mixture of water and Type II, Type III, or Type IV fluid.

NOTE:
De-icing fluid is normally applied heated in order to assure maximum efficiency.

- **Anti-icing**

Precautionary procedure which provides protection against the formation of frost or ice and accumulation of snow or slush, on treated surfaces of the aircraft, for a limited period of time (holdover time).

- **Anti-icing fluid**
  a. ISO Type I fluid.
  b. Mixture of water and ISO Type I fluid
  c. ISO Type II fluid.
  d. Mixture of water and ISO Type II fluid.

NOTE:
Anti-icing fluid is normally applied unheated on clean aircraft surfaces, but may be applied heated.

- **De-icing/Anti-icing**
  Combination of the procedures described above. It may be performed in one or two steps.

- **Holdover time**
  Estimated time of which a De/Anti-icing fluid will prevent the formation of frost or ice and the accumulation of snow on the protected surfaces of an aircraft.

- **Check**
  An examination of an item, against a relevant standard, by a trained and qualified person.

- **Cold Soak Effect**
  The wings of aircraft are said to be 'cold soaked' when they contain very cold fuel as a result of having just landed after a flight at high altitude or from having been re-fuelled with very cold fuel. Whenever precipitation falls on a cold-soaked aircraft when on the ground, clear icing may occur. Even in ambient temperatures between –2 degrees Celsius and +15 degrees Celsius, ice or frost can form in the presence of visible moisture or high humidity if the aircraft structure remains at 0 degrees Celsius or below. Clear ice is very difficult to be detected visually and may break loose during or after takeoff. The following factors contribute to cold-soaking: temperature and quantity of fuel in fuel cells, type and location of fuel cells, length of time at high altitude flights, temperature of re-fuelled fuel and time since re-fuelling.

- **Freezing conditions**
  Conditions in which the outside air temperature is below +3 degrees Celsius (37,4F) and visible moisture in any form (such as fog with visibility below 1.5km, rain, sleet or ice crystals) or standing water, slush, ice or snow is present on the runway.

- **Frost/hoar frost**
  Ice crystals that form from ice saturated air at temperatures below 0 degrees Celsius (32 degrees F) by direct sublimation on the ground or other exposed objects.

- **Active Frost**
  Active frost is a condition when frost is forming. Active frost occurs when aircraft surface temperature is:
  At or below 0 degrees Celsius (32 Degrees F) & at or below dew point.

- **Freezing Fog**
  A suspension of numerous very small water droplets which freezes upon impact with ground or other exposed objects, generally reducing the horizontal visibility at the earth's surface to less than 1 km (5/8 mile).

- **Snow**
  Precipitation of ice crystals, most of which are branched, star shaped or mixed with un-branched crystals. At temperatures higher than –5 degrees Celsius (23 degrees F), the crystals are generally agglomerated into snowflakes.

- **Snow grains**
  Precipitation of very small white opaque particles of ice that is fairly flat or elongated with a diameter of less than 1 mm (0.04 in). When snow grains hit hard ground, they do not bounce or shatter.

NOTE:
For holdover time purposes treat snow grains as snow

- **Snow pellets**
  Precipitation of white, opaque particles of ice. The particles are round or sometimes conical, their diameter range from about 2-5 mm (0.08-0.2 in). Snow pellets are brittle, easily crushed; they do bounce and may break on hard ground.

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

- **Light freezing rain**
  Precipitation of liquid water particles which freezes upon impact with the ground or other exposed objects, either in the form of drops of more than 0.5 mm (0.02 in) or smaller drops which, in contrast to drizzle, are widely separated. Measured intensity of liquid water particles is up to 2.l5 mm/hr (0.10 in/hr)

- **Moderate and heavy freezing rain**
  Precipitation of liquid water particles which freezes upon impact with the ground or other exposed objects, either in the form of drops of more than 0.5 mm (0.02in) or smaller drops which, in contrast to drizzle, are widely separated. Measured intensity of liquid water particles is more than 2.5 mm/hr (0.10 in)

- **Rain or high humidity (on cold soaked wing)**
  Water, visible moisture or humidity forming ice or frost on the wing surface, when the temperature of the aircraft wing surface is at or below 0 degrees Celsius (32 degree F).

- **Rain and snow**
  Precipitation in the form of a mixture of rain and snow

NOTE:
For operation in light rain and snow treat as light freezing rain.

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

- **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 5 mm (0.2in) or less. The pellets of ice usually bounce when hitting hard ground.

- **Hail**
  Precipitation's of small balls or pieces of ice with a diameter ranging from 5mm50 greater than 50mm (0.2 to 2.0 in) falling either separately or agglomerated.

- **Rime ice:**
  Small frozen water droplets, spherical opaque/milky granular appearance looking similar to frost in a freezer. Typically rime ice has low adhesion to the surface and its surrounding rime ice particles

- **Lowest Operational Use Temperature (LOUT)**
  The lowest operational use temperature (LOUT) is the higher (warmer) of:
  a. The lowest temperature at which the fluid meets the aerodynamic acceptance test (according to AS5900) for a given type (high speed or low speed) of aircraft
  b. The freezing point of the fluid plus the freezing point buffer of 10 degrees Celsius for Type II, III or IV fluids.

  For applicable values refer to the fluid manufacturer's documentation.

- **Contamination**
  Contamination in this document is understood as all forms of frozen or semi-frozen moisture such as frost, snow, ice or slush.

4. Why and when do we de-ice?

Snow or ice on the aircraft, especially on the wings and tail surface, may fatally reduce the aerodynamic performance i.e. loss of lift/control.

Consequently, snow, frost or ice, even the thinnest of layers must be removed before the aircraft can take off.

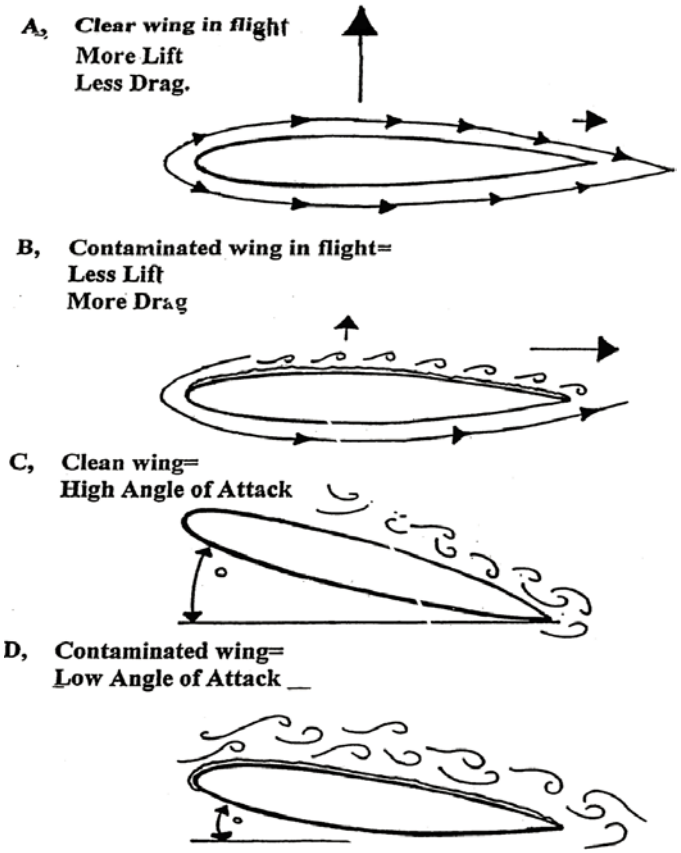
If ice, frost, or snow, has contaminated the wings it will reduce the airflow over these areas, resulting in less lift and greater drag, also the angle of attack will be reduced considerably.

This will cause the aircraft to stall and fall to the ground, because with ice or snow on the aircraft, the flaps and rudder controls etc. will not be fully responsive to the commands given by the flight crew.

The decision whether to de-ice an aircraft lies with the captain of the aircraft or the engineer. Unless there is an agreement with the airline and the ground operator to the contrary.

The de-icing rig must always be ready for use during inclement weather.

4.1 Clean Wing Concept



5. De-icing / Anti-icing in KBL

5.1 De-icing / Anti-icing Operations Coordination

5.1.1 De-icing Operations Coordinator

Location in KBL: ……
Contacts: ……
Availability: From …… To ……

NOTE:
All operators de-icing / anti-icing requests must be conveyed to NAS Ariana / KBL Airport Management, as well.

5.1.2 Start of Operations

- By Airport Manager / Assist. Airport Manager call-in
- Forecasted heavy snow fall
- Sudden intense, continuous snow fall which will seriously affect airport operation
- When Carriers intend to declare general de-icing, with or without an extended S.T.W. (Slot Tolerance Window)
- During de-icing activities
- 30 minutes after call-in during office hours / 60 minutes after call-in outside office hours

5.1.3 Duties and Competencies

- The de-icing coordination is the central steering unit for aircraft de-icing in KBL.
- Plan and initiate pre-deicing, when requested.
- Coordination of de-icing activities with all other GH services requested, during de-icing.
- Timely mobilization of de-icing rig / rig operator.
- Plan and arrange re-fill for de-icing rig.
- Plan stuff rotation.
- Arrange and coordinate trouble shooting in case of technical irregularities with the de-icing rig.
- Continuous follow-up of de-icing progress.
- Continuous information of all concerned KBL authorities and operators about de-icing delays.
- Notice to ATC for Ops start / end.

5.2 De-icing / Anti-icing on Ramp 3 / 4 ''Alfa'' / 4 ''Bravo''

5.2.1 Safety Advice

- If the airplane under service is attached to PBB, advice must be given to be detached prior to start of operation.
- De-icing supervisor must advise all GH staff to clear the area under treatment. It must be ensured that no person is in direct / indirect contact with fluid or spray.
- No de-icing / anti-icing should start, unless all airplane doors / holds are closed, and there is no fear of the fluid's spray to access the passenger / crew cabin.

5.2.2 Communication with ATC / Alert for commence of De-icing / Anti-icing Ops

- ATC must be notified about the end / start of the de-icing / anti-icing process, in order to alert in-coming traffic accordingly.
- ATC must receive timely update in the event of a malfunction to the de-icing truck.
- Potential delays due to D/I – A/I must be reported immediately to the ATC.

6. Fluid Handling

De-icing/anti-icing fluid is a chemical product with environmental impact. During fluid handling, avoid any unnecessary spillage and comply with local environmental and health laws and the fluid manufacturer's safety data sheet.

Different products shall not be mixed without additional qualification testing.

6.1 Fluid Storage

Only tanks dedicated for de-icing / anti-icing fluids shall be used.

Storage tanks shall be of a material of construction compatible with the de-icing/anti-icing fluid, as specified by the fluid manufacturer (corrosion resistant steel, plastic, etc.)

Care should be taken to avoid using dissimilar metals in contact with each other, as galvanic couples may form and degrade thickened fluids.

Tanks shall be conspicuously labelled to avoid contamination.

Tanks shall be inspected annually for corrosion and/or contamination. If corrosion or contamination is evident, tanks shall be maintained to standard or replaced. To prevent

corrosion at the liquid/vapour interface and in the vapour space, a high liquid level in the tanks is recommended.

The storage temperature limits shall comply with the fluid manufacturer's guidelines.

The stored fluid shall be checked routinely to ensure that no degradation/contamination has occurred.

6.2 Fluid Pumping

De-icing/anti-icing fluids can show degradation caused by excessive mechanical shearing. Therefore only compatible pumps and spraying nozzle shall be used. The design of the pumping systems shall be in accordance with the fluid manufacturer's recommendations.

6.3 Fluid Transfer Lines

Dedicated transfer lines shall be conspicuously labelled to prevent contamination and shall be compatible with the de-icing/anti-icing fluids to be transferred.

6.4 Fluid Heating

De-icing/anti-icing fluids shall be heated according to the fluid manufacturer's guidelines.
For Type I fluids, water loss may cause undesirable aerodynamic effects.
For Type II / III / IV fluids thermal exposure and/or water loss may cause a reduction in fluid viscosity leading to lower holdover times.

CAUTION: Avoid unnecessary heating of fluid in vehicle tanks.

Prolonged or repeated heating of fluids (directly or indirectly) may result in loss of water which can lead to performance degradation of the fluid.

Any of the following situations or a combination of them can accelerate the fluid performance degradation:

a. Low fluid consumption;
b. Trucks being in standby mode with heating system on for extended periods of time;
c. High temperatures in fluid tanks;
d. High temperatures in water tanks which are in direct contact with the fluid tanks (no insulation between tanks).

6.5 Fluid Application

Application equipment shall be cleaned thoroughly before being initially filled with de-icing / anti-icing fluid in order to prevent fluid contamination.

De-icing/anti-icing fluid in trucks shall not be heated in confined or poorly ventilated areas.

The integrity of the fluid at the spray nozzle shall be checked periodically.

7. Contamination Check

This is a check for the need to de-ice. It shall be performed from points offering sufficient visibility of these parts (e.g. from the de-icing vehicle itself or any other suitable piece of equipment). Any contamination found, except frost mentioned in section and, shall be removed by a de-icing treatment. If anti-icing is also required, this treatment may be performed as a one- step or two-step de-icing/anti-icing of the relevant surfaces.

Where an airplane has been de-iced and/or anti-iced some time prior to the arrival of the Flight Crew, an additional 'Contamination Check' shall be carried out prior to departure, in order to establish whether further treatment is required.

Requests for de-icing/anti-icing shall specify the parts of the airplane requiring treatment.

NOTE:
For specific aircraft types, additional requirements may exist. E.g. special clear ice checks, such as tactile checks on wings. These special checks are not covered by the contamination check. Aircraft operators shall make arrangements for suitably qualified personnel to meet these requirements.

7.1 Procedures

These procedures specify the recommended methods for de-icing and anti-icing of airplanes on the ground to provide an aerodynamically clean airplane.

When airplane surfaces are contaminated, they shall be de-iced prior to dispatch.

When there is a risk of contamination of the airplane surfaces at the time of dispatch, these surfaces shall be anti-iced. If both de-icing and anti-icing are required, the procedure may be performed in one or two steps.

The selection of a one or two-step process depends upon weather conditions, available

equipment, available fluids and the holdover time to be achieved.

NOTE 1:
Slippery conditions can exist on the ground or equipment following the de-icing/anti-icing procedure.

NOTE 2:
Where holdover time is critical, a two-step procedure using undiluted Type II, III, or IV fluid for the second step should always be considered.

7.1.1 De-icing

Ice, snow, slush or frost may be removed from airplane surfaces by heated fluids, mechanical methods, alternate technologies or combinations thereof.

The following procedures shall be used for their removal by fluids.

NOTE 1:
Alternate technology may be used to accomplish the de-icing process, provided that the requirements in are accomplished**.**

NOTE 2:
Pre-step process to be done prior to de-icing/anti-icing. If agreed by the airplane operator, a pre-step process prior to the de-icing process, in order to remove large amounts of frozen contamination (e.g. snow, slush or ice), may be considered to reduce the quantity of glycol-based de-icing fluid that is needed. This pre-step process may be performed with various means (e.g., brooms, forced air, heat, heated water, and heated fluids with negative buffer freezing point). If the pre-step procedure is used, make sure that the subsequent de-icing process removes all frozen contamination including the contamination that may have formed on surfaces and or in cavities due to the pre-step process.

7.1.1.1 Requirements

Ice, snow, slush and frost shall be removed from airplane surfaces prior to dispatch or prior to anti-icing.

7.1.1.2 General

For maximum effect, fluids shall be applied close to the surface of the skin to minimize heat loss.

NOTE:
The heat in the fluid effectively melts any frost, as well as light deposits of snow, slush and ice. Heavier accumulations require the heat to break the bond between the frozen deposits and the structure; the hydraulic force of the fluid spray is then used to flush off the contamination.
The de-icing fluid will prevent re-freezing for a period of time depending on airplane skin and ambient temperature, the fluid used, the mixture strength and the weather.

7.1.1.3 Removal of frost and ice

7.1.1.4 General procedure

A nozzle setting giving a solid cone (fan) spray should be used. This ensures the largest droplet pattern available, thus retaining the maximum heat in the fluid.
Providing the hot fluid is applied close to the airplane skin, a minimal amount of fluid will be required to melt the deposit.

7.1.1.5 Removal of local area contamination

When no precipitation is falling or expected, a “local area” de-icing may be carried out under the below mentioned or similar conditions. In some cases a full or complete de-icing is not necessary.

When the presence of frost and/or ice is limited to localized areas on the surfaces of the airplane and no holdover time is likely to be required, only the contaminated areas will require treatment.

This type of contamination will generally be found on the wing and/or stabilizer leading edges or in patches on the wing and/or stabilizer upper surfaces. Spray the affected area(s) with a heated fluid/water mixture suitable for a One-Step Procedure. Then spray the same area(s) on the other side of the airplane. Both sides of the airplane must be treated identically (same areas, same amount and type of fluid, same mixture strength), even if the contamination is only present on one side. It is the responsibility of the De-icing Operator to ensure that the treatment is performed symmetrically and that on completion all frozen deposits have been removed.

After this check has confirmed that the treated areas are clean, the following statement shall be given to the Commander:

“Local area De-icing only. Holdover times do not apply”

7.1.1.6 Under wing de-icing procedures

Treatments must be symmetrical and may include flaps lower surfaces. Spray the affected areas with a heated fluid/water mixture suitable for a One-Step Procedure or a Two Step Procedure, as required, (see caution below), and then spray the same areas under the other wing. Both wings must be treated identically (same areas, same amount and type of fluid, same mixture strength), even if the frozen contamination is only present under one wing. No holdover times apply to underwing treatments.

It is the responsibility of the De-icing Operator to ensure that the treatment is performed symmetrically and that on completion all frozen deposits with the possible exception of frost, have been removed.

When it is confirmed that the treated areas are clean, the following statement shall be given to the Commander:

"Underwing De-icing only. Holdover times do not apply"

CAUTION:
Underwing frost and ice are usually caused by very cold fuel in the wing tanks.
Use a fluid/water mixture with a higher concentration of glycol than is usually required by the OAT to prevent re-freezing.

7.1.1.7 Removal of snow

A nozzle setting sufficient to flush off deposits and minimize foam production is recommended. Foam could be confused as snow.

NOTE:
The procedure adopted will depend on the equipment available and the depth and type of snow; i.e. light and dry or wet and heavy.

In general, the heavier the deposits the heavier the fluid flow that will be required to remove it effectively and efficiently from the airplane surfaces.

For light deposits of both wet and dry snow, similar procedures as for frost removal may be adopted.

Wet snow is more difficult to remove than dry snow and unless deposits are relatively light, selection of high fluid flow will be found to be more effective.

Under certain conditions it will be possible to use the heat, combined with the hydraulic force of the fluid spray to melt and subsequently flush off frozen deposits.

However, where snow has bonded to the airplane skin, the procedures detailed in section 6.1.1.5 should be utilized.

Heavy accumulation of snow will always be difficult to remove from airplane surfaces and vast quantities of fluid will invariably be consumed in the attempt. Under these conditions, serious consideration should be given to removing the worst of the snow manually before attempting a normal de-icing procedure.

7.1.1.8 Removal of ice

Heated fluid shall be used to break the ice bond. The method makes use of the high thermal conductivity of the metal skin.

A stream of hot fluid is directed at close range onto one spot at an angle of less than 90°, until the airplane skin is just exposed.

The airplane skin will then transmit the heat laterally in all directions raising the temperature above the freezing point thereby breaking the adhesion of the frozen mass to the airplane surface. By repeating this procedure a number of times, the adhesion of a large area of frozen snow or glazed ice can be broken.

The deposits can then be flushed off with either a low or high flow, depending on the amount of the deposit.

Non-metallic surfaces (e.g. composites) have a lower heat transfer than metallic surfaces. De-icing may take longer and more fluid may be needed.

7.1.1.9 General de-icing fluid application strategy

For effective removal of snow and ice, the following techniques shall be adopted.

Certain airplanes can require unique procedures to accommodate design differences, see aircraft manufacturer's instructions.

Ice, snow or frost dilutes the fluid. Apply enough hot de-icing fluid ensure that re-freezing does not occur and all contaminated fluid is driven off.

7.1.1.10 Wings, horizontal stabilizer, and elevators

Spray from the leading edge to the trailing edge. Do not spray from the rear.
Start at the highest point of the surfaces and work to the lowest parts, i.e. on most airplanes start at the wing tip and work towards the wing root.

7.1.1.11 Vertical surfaces

Start at the top and work down.

7.1.1.12 Fuselage

Spray along the top centre-line and then outboard. Ensure that it is clear of snow, slush or ice in accordance with aircraft manufacturer's documentation.
Hoarfrost may be allowed.

7.1.1.13 Nose/Radome Area and Flight Deck Windows

Type I fluid/water mixture or manual methods of removal (such as squeegees or brushes) are recommended.

When thickened fluids are used, avoid spraying near flight deck windows, as fluid can cause a severe loss of visibility during flight.
Any thickened fluid remaining on nose areas where it could blow back onto the windscreens should be removed prior to departure, using squeegees or equivalent. If flight deck windows are contaminated with thickened fluids use water or an approved windshield cleaner (use of a low freezing point windscreen washing fluid is recommended when OAT is at or below 0 °C (32 °F)).

CAUTION:
Prior to cleaning of Flight Deck Windows ensure that the window heating system is switched off.

7.1.1.14 Landing gears and wheel bays

The application of de-icing fluid in this area shall be kept to a minimum.
De-icing fluid shall not be sprayed directly onto brakes and wheels.

NOTE:
Accumulations such as blown snow may be removed by other means than fluid (mechanically, air blast, heat etc.).
However, where deposits have bonded to surfaces, they can be removed by the application of hot

air or by spraying with hot de-icing fluids.

7.1.1.15 Engines

Deposits of snow shall be removed mechanically from engine intakes prior to departure. Any frozen deposits that have bonded to either the lower surface of the intake, the fan blades including the rear side, or propellers, shall be removed by hot air or other means recommended by the engine manufacturer.

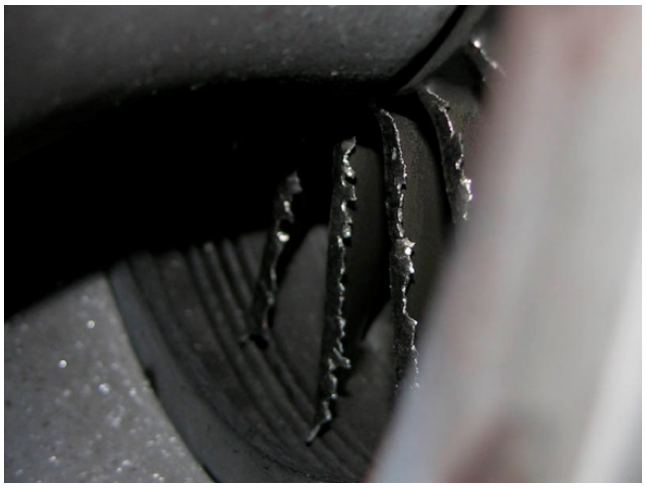


Fig. 3 Damaged fan blades

7.2 Anti-icing

Ice, snow, slush or frost will, for a period of time, be prevented from accumulating on airplane surfaces by the application of anti-icing fluids.

The following procedures shall be adopted when using anti-icing fluids.

7.2.1 Required usage

Anti-icing fluid shall be applied to the airplane surfaces when freezing rain, snow or other freezing precipitation may adhere to the airplane at the time of airplane dispatch.

7.2.2 Optional usage

Type II, III, or IV fluid may be applied onto clean airplane surfaces at the time of arrival (preferably before unloading begins) on short turnarounds during freezing precipitation and

on overnight parked airplanes. This will minimize ice accumulation prior to departure and often makes subsequent de-icing easier.

CAUTION:
This practice has the potential to build up dried residues. An appropriate inspection and cleaning program shall be established.

On receipt of a frost, snow, freezing drizzle, freezing rain or freezing fog warning from the local meteorological service, Type II, III, or IV fluid may be applied to clean airplane surfaces prior to the start of freezing precipitation.

This will minimize the possibility of snow and ice bonding or reduce the accumulation of frozen precipitation on airplane surfaces and facilitate subsequent de-icing.

CAUTION:
This practice has the potential to build up dried residues. An appropriate inspection and cleaning program shall be established.
Prior to flight, the airplane must be de-iced, unless the integrity of the anti-icing fluid can be ensured.

7.2.3 General

For effective anti-icing, an even layer of sufficient thickness of fluid is required over the prescribed airplane surfaces, which are clean (free of frozen deposits).

For longer anti-icing protection, Type II, Type III, or Type IV fluid should be used. The high fluid pressures and flow rates normally associated with de-icing are not required for this operation and, where possible, pump speeds should be reduced accordingly. The nozzle of the spray gun should be adjusted to provide a medium spray.

NOTE:
Type I fluids provide limited holdover effectiveness when used for anti-icing purposes.
Little benefit is gained from the minimal holdover time generated.

7.2.3.1 Anti-icing fluid application strategy

The process should be continuous and as short as possible. Anti-icing should be carried out as near to the departure time as operationally possible in order to utilize maximum holdover time.

- The anti-icing fluid shall be distributed uniformly and with sufficient thickness over all surfaces to which it is applied. In order to control the uniformity, all horizontal airplane surfaces shall be visually checked during application of the fluid.
- For Type I fluid a minimum of 1 l/m2 with at least 60 °C at the nozzle shall be used.
- For Type II, III and IV fluids the correct amount is indicated by fluid just beginning to run off the leading and trailing edges.
- Spray from the leading edge to the trailing edge. Do not spray from the rear.
- Start at the highest point of the surfaces and work to the lowest parts, i.e. on most airplanes start at the wing tip and work towards the wing root.
- On vertical surfaces, start at the top and work down.

The following surfaces shall be treated:

a. wing upper surfaces including leading edges and upper control surfaces;
b. horizontal stabilizer upper surfaces including leading edges and elevator upper surfaces;
c. vertical stabilizer surfaces including the rudder surfaces (both sides);
d. Fuselage upper surfaces depending upon the amount and type of precipitation (especially important on centre-line engined airplanes).

CAUTION:
Anti-icing fluids may not flow evenly over wing leading edges, horizontal and vertical stabilizers. These surfaces should be checked to ensure that they are properly coated with fluid.

7.2.4 Limits and Precautions

7.2.4.1 Fluid related limits

7.2.4.1.1 Temperature limits

When performing two-step de-icing/anti-icing, the freezing point of the fluid used for the first step shall be at OAT or below.

7.2.4.1.2 Type I fluids

The freezing point of the Type I fluid mixture used for either one-step de-icing/anti-icing or as a second step in the two-step operation shall be at least 10 °C (18 °F) below the OAT. In no case shall this temperature be lower than the LOUT.

CAUTION:
Type I fluids supplied as concentrates for dilution with water prior to use shall not be used

undiluted. For exceptions refer to fluid manufacturer's documentation.

7.2.4.1.3 Type II / Type III / Type IV fluids

Type II, III, and IV fluids used as de-icing/anti-icing agents may have a lower temperature application limit of -25 °C (-13 °F). The application limit may be lower, provided a 7 °C (13 °F) buffer is maintained between the freezing point of the neat fluid and OAT.
In no case shall this temperature be lower than the LOUT.

Note:
These fluids may not be used below -25°C (-13°F) in active frost conditions (see Table 3).

7.2.4.2 Application limits

Under no circumstances shall an airplane that has been anti-iced receive a further coating of anti-icing fluid directly on top of the contaminated film. If an additional treatment is required before flight, a complete de-icing/anti-icing shall be performed.
Ensure that any fluid remaining from previous treatment is flushed off.

Important Note:
Anti-icing only is not permitted.

7.2.4.3 Airplane related limits

The application of de-icing/anti-icing fluid shall be in accordance with the requirements of the airframe / engine manufacturers.

7.2.4.4 Procedure precautions

One-step de-icing/anti-icing is performed with a heated anti-icing fluid. The fluid used to de-ice the airplane remains on the airplane surfaces to provide limited anti-ice capability. The correct fluid concentration shall be chosen with regard to desired holdover time and is dictated by OAT and weather conditions

CAUTION:
Wing skin temperatures may be lower than OAT. If this condition is identified, a stronger mixture (more glycol) may need to be used to ensure a sufficient freezing point buffer.
CAUTION:
The application of Type II, III, or IV fluid, especially when used in a one step process, may cause fluid to collect in aerodynamically quiet areas, cavities and gaps which can dry out and leave dried

residues.
Dried residues may rehydrate and freeze following a period of high humidity and/or rain conditions. This may impede flight control systems. These dried residues may require removal. Consult the aircraft manufacturer with regard to inspection methods and frequency, related maintenance requirements and airplane washing recommendations.

NOTE 1:
If a Type II, III or IV fluid is used in a one step process, then an appropriate inspection and cleaning program shall be established. Whenever suitable, de-ice and anti-ice with only Type I.
NOTE 2:
In order to detect dried residues, it may help to spray a water mist onto the affected surfaces. This causes the dried residues to rehydrate and swell into a kind of gel.
NOTE 3:
If removal of contamination is required on the lower side of the wings and the horizontal stabilizer and elevator, de-icing/anti-icing fluid shall be applied sparingly to minimize fluid flow into drain holes. Whenever possible, use Type I only. Consult the aircraft manufacturer's documentation.

Two-step de-icing/anti-icing (When the first step is performed with de-icing fluid):
The correct fluid(s) shall be chosen with regard to ambient temperature. After de-icing, a separate overspray of anti-icing fluid shall be applied to protect the relevant surfaces thus providing maximum possible anti-ice capability.

The second step is performed with anti-icing fluid.
The correct fluid concentration shall be chosen with regard to desired holdover time and is dictated by OAT and weather conditions.
The second step shall be performed before first step fluid freezes, if necessary area by area.
When treating composite surfaces, freezing may happen quickly.
It is the responsibility of the De-icing Operator to ensure that all frozen deposits have been removed from the treated surfaces, before applying the second step fluid.
When applying the second step fluid, use a spraying technique, which completely covers the first step fluid and provides a sufficient amount of second step fluid.
Where re-freezing occurs following the initial treatment, both first and second step must be repeated.

CAUTION:
Wing skin temperatures may be lower than OAT. If this condition is identified, a stronger mixture (more glycol) may need to be used to ensure a sufficient freezing point buffer.
CAUTION:
The application of Type II, III, or IV fluid, especially when used in a one step process or in the first

step of a two-step process, may cause fluid to collect in aerodynamically quiet areas, cavities and gaps, which can dry out and leave dried residues.
Dried residues may rehydrate and freeze following a period of high humidity and/or rain conditions. This may impede flight control systems. These dried residues may require removal. Consult the aircraft manufacturer with regard to inspection methods and frequency, related maintenance requirements and airplane washing recommendations.
The use of hot water or heated mixture of Type I fluid/water for the first step of a two-step de-icing/anti-icing process will minimize the formation of dried residues.

NOTE 1:
If a Type II, III or IV fluid is used in the first step of a two-step process, then an appropriate inspection and cleaning program shall be established.
Whenever suitable, de-ice and anti-ice with only Type I.
NOTE 2:
In order to detect dried residues, it may help to spray a water mist onto the affected surfaces. This causes the dried residues to rehydrate and swell into a kind of gel.
NOTE 3:
Anti-icing of the lower side of the wings and/or horizontal stabilizer and elevator is normally not foreseen. However, if these surfaces must be de-iced, the freezing point of the de-icing fluid must be low enough to prevent refreezing.

With regard to holdover time provided by the applied fluid, the objective is that it is equal to or greater than the estimated time from start of anti-icing to start of takeoff based on existing weather conditions.

De-icing treatments shall be symmetrical, that is, left-hand and right-hand side of the airplane shall receive the same treatment, even when only one side of the airplane is contaminated. Anti-icing treatments shall be also symmetrical and shall always cover the entire wing, the entire vertical stabilizer/rudder and horizontal stabilizer/elevator on both sides of the airplane.

CAUTION: Aerodynamic problems could result if these requirements are not met.

During anti-icing and de-icing, the moveable surfaces shall be in a position as specified by the aircraft manufacturer.

Engines are normally shut down but may remain running at idle during de-icing/anti-icing operations. Air conditioning and/or APU air shall be selected OFF, or as recommended by the airframe and engine manufacturer.

De-icing/anti-icing fluids shall not be sprayed directly on wiring harnesses and electrical

components (receptacles, junction boxes, etc.), onto brakes, wheels, exhausts, or thrust reversers.

De-icing/anti-icing fluid shall not be directed into the orifices of pitot heads, static ports or directly onto air stream direction detectors, probes/angle of attack airflow sensors.

All reasonable precautions shall be taken to minimize fluid entry into engines, APU, other intakes/outlets and control surface cavities.
De-icing/anti-icing fluid shall not be directed into engine inlets or directly onto engine probes / sensors.

Fluids shall not be directed onto flight deck or cabin windows as this can cause crazing of acrylics or penetration of the window seals.

In general, prior to the application of de-icing/anti-icing fluids all doors and windows should be closed and all service vehicles/personnel should be clear to prevent:

a. Galley floor areas being contaminated with slippery de-icing fluids;
b. Upholstery becoming soiled;
c. Vehicles/personnel becoming contaminated with fluid.

However, when ramp activities have been completed and all doors, except the forward passenger door, are closed, it is permissible to start de-icing/anti-icing surfaces well away from the open door, provided that:

a. The Commander is informed and has agreed to this procedure before spraying;
b. Passengers and staff will not be subjected to fluid overspray;
c. Fuselage in the vicinity of the open door is not treated;
d. Wind conditions are such that fluid or fluid overspray cannot reach the passenger door area.

This procedure is not recommended if passengers are boarding the airplane via open stairs.

NOTE:
Doors shall not be closed until all ice or snow has been removed from the surrounding area.

Any forward area from which fluid can blow back onto windscreens during taxi or subsequent takeoff shall be free of fluid prior to departure.

If Type II, III, or IV fluids are used, all traces of the fluid on flight deck windows should be removed prior to departure, particular attention being paid to windows fitted with wipers.

De-icing/anti-icing fluid may be removed by rinsing with an approved cleaner and a soft cloth.

Landing gear and wheel bays shall be kept free from build-up of slush, ice or accumulations of blown snow.

When removing ice, snow, slush or frost from airplane surfaces care shall be taken to prevent it entering and accumulating in auxiliary intakes or control surface hinge areas.
Remove snow from wings, stabilizer, ailerons and elevators by spraying from the leading edge to the trailing edge.
Start at the highest point of the surfaces and work to the lowest parts, i.e. on most airplanes start at the wing tip and work towards the wing root.

Ice can build up on airplane surfaces when descending through dense clouds or precipitation during an approach.
When ground temperatures at the destination are low, it is possible for flaps to be retracted and for accumulations of ice to remain undetected between stationary and moveable surfaces.
It is therefore important that these areas are checked prior to departure and any frozen deposits are removed.

Under freezing fog conditions, the rear side of the fan blades shall be checked for ice build-up prior to start-up.
Any deposits discovered shall be removed by directing air from a low flow hot air source, such as a cabin heater, onto the affected areas.

A flight control check should be considered according to airplane type.
This check should be performed after de-icing/anti-icing.

After frequent applications of de-icing/anti-icing fluids it is advisable to inspect aerodynamically quiet areas and cavities for dried residues of thickened de-icing/anti-icing fluid.
For these inspections it may be necessary to open access panels.
Consult airframe manufacturers for inspection and cleaning details and procedures.

A de-icing/anti-icing treatment should be continuous and as short as possible.
If a treatment is interrupted (for example a truck ran out of fluid), the Airplane Commander shall be immediately informed stating:

a. Reason for interruption;
b. Actions to be taken (in consultation with the Commander);
c. Expected time of delay.

Before continuing the treatment:

a. Inform the Commander;
b. Establish in consultation with the Commander, further treatment to be carried out, including any surfaces requiring re-treatment (in relation to Holdover time).

Carry out treatment as agreed.

Clear ice precautions

Clear ice can form on airplane surfaces, below a layer of snow or slush. It is therefore important that surfaces are closely examined following each de-icing operation, in order to ensure all deposits have been removed.

Significant deposits of clear ice can form, in the vicinity of the fuel tanks, on wing upper surfaces as well as under-wing.

Aircrafts are most vulnerable to this type of build-up when:

a. Wing temperatures remain well below 0 °C (32 °F) during the turnaround/transit;
b. Ambient temperatures between -2 °C and +15 °C (28 °F and 59 °F) are experienced;
c. Ambient humidity is high and/or precipitation occurs while the airplane is on the ground.

This type of ice formation is extremely difficult to detect. However, frost or ice on the lower surface of either wing can indicate the presence of clear ice on the upper wing surfaces. Therefore when the above conditions prevail, or when there is otherwise any doubt whether clear ice has formed, a close examination shall be made immediately prior to departure, in order to ensure that all frozen deposits have in fact been removed.

NOTE 1:
Clear ice can form at other temperatures if conditions a) and c) exist.
NOTE 2:
Low wing temperatures associated with this type of build-up normally occur when large quantities of cold fuel remain in wing tanks during the turnaround / transit and any subsequent re-fuelling does not cause a sufficient increase in wing temperature.

7.3 General airplane requirements after de-icing/anti-icing

Following the de-icing/anti-icing procedures and prior to takeoff, the critical airplane surfaces shall be clean of all frost, ice, slush, and snow accumulations in accordance with the following

requirements.

7.3.1 Wings, tail and control surfaces

Wings, tail and control surfaces shall be free of ice, snow, slush, and frost except that a coating of frost may be present on wing lower surfaces in areas cold soaked by fuel between forward and aft spars in accordance with the aircraft manufacturer's published documentation.

NOTE:
Frost or any other contamination is not acceptable on the lower side of the horizontal stabilizer and elevator, unless specified otherwise in the AFM or other aircraft manufacturer's documentation.

7.3.2 Pitot heads and static ports

Pitot heads and static ports shall be clear of ice, frost, snow and fluid.

7.3.3 Engines

Engine inlets, exhaust nozzles, cooling intakes, control system probes and ports shall be clear of ice and snow.
Engine fan blades or propellers (as appropriate) shall be clear of ice, frost and snow, and shall be free to rotate.

7.3.4 Air conditioning inlets and exits

Air conditioning inlets and exits shall be clear of ice, frost and snow. Outflow valves shall be clear and unobstructed.

7.3.5 Landing gear and landing gear doors

Landing gear and landing gear doors shall be unobstructed and clear of ice, frost and snow.

7.3.6 Fuel tank vents

Fuel tank vents shall be clear of ice, frost and snow.

7.3.7 Fuselage

Fuselage shall be clear of snow, slush or ice. Frost may be present in accordance with the aircraft

manufacturer's documentation.

7.3.8 Nose / Radome Area and Flight Deck Windows

Snow, slush, or ice on the windscreens or on areas forward of the windscreens shall be removed prior to departure. Heated flight deck windows will not normally require de-icing.

7.4 Flight control check

A functional flight control check using an external observer may be required after de-icing / anti-icing depending upon airplane type. This is particularly important in the case of an airplane that has been subjected to an extreme ice or snow covering.

7.4.1 Dried fluid residues

Dried fluid residues when the airplane has not been flown after anti-icing.
Dried fluid residue could occur when surfaces have been treated but the airplane has not subsequently been flown and not been subject to precipitation.
The fluid may then have dried on the surfaces. In such situations the airplane must be checked for dried residues from de-icing/anti-icing fluids and cleaned as necessary.

7.4.2 Special maintenance considerations

Proper account should be taken of the possible side-effects of fluid use. Such effects may include, but are not necessarily limited to, dried and/or rehydrated residues, corrosion and the removal of lubricants.

7.4.3 Post De-icing/Anti-icing Check

An aircraft shall not be dispatched after a de-icing/anti-icing operation until the airplane has received the following visual check by a trained and qualified person.

This check shall cover wings, horizontal stabilizer, vertical stabilizer and fuselage.

This check shall also include any other parts of the airplane on which a de-icing/anti-icing treatment was performed according to the requirements identified during the contamination check.
The check shall be performed from points offering sufficient visibility of all prescribed surfaces (e.g. from the de-icer itself or other equipment suitable for gaining access).

Any contamination found, shall be removed by further de-icing/anti-icing treatment and the check repeated.

Before take-off the Commander must ensure that he has received confirmation that this post de-icing/anti-icing check has been accomplished.

NOTE:
For specific airplane types, additional requirements exist e.g. special clear ice checks, such as tactile checks on wings.
These special checks are not covered by the Post Deicing / Anti-icing Check.
Aircraft operators shall make arrangements for suitably qualified personnel to meet these requirements.
Where NAS Afghanistan is asked to carry out the de-icing / anti-icing process and also the post de-icing / anti-icing check, it may either be performed as a separate check or incorporated into the de-icing operation as defined below.

NAS Afghanistan shall specify the actual method adopted, where necessary by customer, in his winter procedures:

a. As the de-icing / anti-icing operation progresses the De-icing Operator will closely monitor the surfaces receiving treatment, in order to ensure that all forms of frost, ice, slush or snow (with the possible exception of frost) are removed and that, on completion of the treatment, these surfaces are fully covered with an adequate layer of anti-icing fluid..
b. Once the operation has been completed, the De-icing Operator will carry out a close visual check of the surface where treatment commenced, in order to ensure it has remained free of contamination (this procedure is not required under ‘frost only’ conditions).
c. Where the request for de-icing/anti-icing did not specify the fuselage, it shall also receive a visual check at this time, in order to confirm that it has remained free of contamination (with the possible exception of frost).
d. Any evidence of contamination that is outside the defined limits shall be reported to the Commander immediately.

7.4.4 Pre-takeoff Check

The Commander shall continually monitor the weather conditions after the performed de-icing/anti-icing treatment.
Prior to takeoff he shall assess whether the applied holdover time is still appropriate and/or if untreated surfaces may have become contaminated.

This Check is normally performed from inside the flight deck.

7.4.5 Pre-takeoff Contamination Check

This is a check of the critical surfaces for contamination.

This check shall be performed when the condition of the critical surfaces of the airplane cannot be effectively assessed by a pre-takeoff check or when the applied holdover time has been exceeded.

This check is normally performed from outside the airplane.

The alternate means of compliance to a pre-takeoff contamination check is a complete de-icing / anti-icing re-treatment of the airplane**.**

7.4.6 Communication Procedures

The person communicating with the flight crew shall have a basic knowledge of the English language in order to communicate properly.

Communication between the Commander and the de-icing crew will usually be achieved using a combination of printed forms and verbal communication.

For treatments carried out after airplane doors are closed, use of flight interphone (headset) or VHF radio will usually be required.

Use of hand signals is not recommended except for the final 'all clear' signal.

7.4.6.1 Communication prior to starting De-icing/Anti-icing treatment

i. Before de-icing/anti-icing, the Commander shall be requested to confirm the treatment required (areas to be de-iced, anti-icing requirements, special de-icing procedures).
ii. Before fluid application starts, the Commander shall be requested to configure the aircraft for de-icing/anti-icing (surfaces, controls and systems, as per airplane type requirements). The de-icing crew shall wait for confirmation that this has been completed before commencing the treatment.
iii. For treatments carried out without the flight crew present, a suitably qualified individual shall be nominated by the airplane operator to confirm the treatment required and to confirm correct configuration of the airplane.

7.4.6.2 Post De-icing/Anti-icing Communication

An aircraft shall not be dispatched for departure after a de-icing/anti-icing operation until the Commander has been notified of the type of de-icing/anti-icing operation performed.

The Anti-icing Code shall be provided by a qualified person at the completion of the treatment, indicating that the checked surfaces are free of ice, frost, snow, and slush, and in addition includes the necessary information to allow the Commander to estimate the holdover time to be expected under the prevailing weather conditions.

When a treatment is interrupted for a significant period of time (e.g. truck runs out of fluid) the flight crew shall be informed stating the reason, the action to be taken and the estimated time delay.

When continuing the treatment, the previously treated surfaces must be fully de-iced and anti-iced again, when the holdover time of the treatment from before the interruption is not sufficient (see section 7.4.6.3).

7.4.6.3 Anti-icing Codes

The following information shall be recorded and be communicated to the Commander by referring to the last step of the procedure and in the sequence provided below:

a. The fluid Type; i.e. Type I, II, III, IV
b. The concentration of fluid within the fluid/water mixture, expressed as a percentage by volume;

NOTE 1: No requirement for Type I fluid.

c. The local time (hours : minutes), either- for a one-step de-icing/anti-icing: at the start of the treatment or - for a two-step de-icing/anti-icing: at the start of the second step (anti-icing);
d. The date (written: day, month, year);

NOTE 2: Required for record keeping, optional for Commander Notification.

e. The complete name of the anti-icing fluid (so called “brand name”).

NOTE 3: Optional; for Type II and IV fluids only.

f. The statement "Post de-icing/anti-icing check completed”

NOTE 4: For specific aircraft types, additional requirements exist e.g. special clear ice checks, such as tactile checks on wings.
Additional confirmation for these checks is required.

EXAMPLE
A de-icing/anti-icing procedure whose last step is the use of a mixture of 75% of a Type II fluid and 25% water, commencing at 13:35 local time on 20 February 2011, is reported and recorded as follows:

TYPE II/75 13:35 (20 December 2014) (Complete name of anti-icing fluid) "Post de-icing/anti-icing check completed".

7.4.6.4 Post De-icing/Anti-icing Check and transmission of the Anti-icing Code to the Commander

It shall be clearly defined by the airplane operator which company is responsible for carrying out the post de-icing/anti-icing check and providing the Commander with the Anti-icing Code.

If two different companies are involved in the de-icing/anti-icing treatment and post de-icing / anti-icing check, it must be ensured that the Anti-icing Code is not given before the post de-icing / anti-icing check is completed.

7.4.6.5 All clear signal

The flight crew shall receive a confirmation from the ground crew that all de-icing / anti-icing operations are complete and that all personnel and equipment are clear before reconfiguring or moving the aircraft.

7.4.7 Holdover time

Holdover time is obtained by anti-icing fluids remaining on the aircraft surfaces.
With a one-step de-icing/anti-icing the holdover time begins at the start of the treatment and with a two-step de-icing/anti-icing at the start of the second step (anti-icing).

Holdover time will have effectively run out when frozen deposits start to form/accumulate on treated aircraft surfaces.

Due to their properties, Type I fluids form a thin liquid wetting film, which provides limited holdover time, especially in conditions of freezing precipitation.

With this type of fluid no additional holdover time would be provided by increasing the concentration of the fluid in the fluid/water mixture.

Type II, III, and IV fluids contain a pseudo plastic thickening agent, which enables the fluid to form a thicker liquid wetting film on external aircraft surfaces.

This film provides a longer holdover time especially in conditions of freezing precipitation.

With this type of fluid additional holdover time will be provided by increasing the concentration of the fluid in the fluid/water mixture, with maximum holdover time available from undiluted fluid.

CAUTION:
Heavy precipitation rates or high moisture content, high wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may also be reduced when aircraft skin temperature is lower than OAT. Therefore, the indicated times should be used only in conjunction with a pre-takeoff check.

CAUTION:
Surface coatings are currently available that may be identified as ice phobic or hydro phobic, enhance the appearance of aircraft external surfaces and/or lead to fuel savings. Since these coatings may affect the fluid wetting capability and the resulting fluid thickness of de-icing / anti-icing fluids they have the potential to affect holdover time and aerodynamics.

NOTE 1:
Certain fluids may be qualified according to fluid specifications but may not have been tested during winter to develop the holdover time guidelines specified in this document.
Holdover time guidelines in this document are not applicable to these fluids.
NOTE 2:
For use of holdover time guidelines consult fluid manufacturer's technical literature for minimum viscosity limits of fluids as applied to aircraft surfaces.
NOTE 3:
A degraded Type II, Type III, or Type IV fluid may be used, provided the holdover time guidelines for Type I fluids are used. A Type II, Type III, or Type IV fluid is considered to be degraded if the viscosity is below the minimum limit as provided by the fluid manufacturer.
The Type II fluid holdover time guideline may be used with degraded Type IV fluids only after substantiation by holdover time testing.
NOTE 4:
Holdover time guidelines can also be obtained for individual fluid products and these "brand name" holdover times will be found to differ from the tables published here. If an airline decides to use these brand name tables it shall refer to the FAA documentation, particularly for the

application of the 'light' and 'very light snow' columns.

Table 1 - Guidelines for the application of Type I fluid/water mixtures (minimum concentrations) as a function of OAT

OAT	One-Step Procedure	Two-Step Procedure	
	De-icing/Anti-icing	First step: De-icing	Second step: Anti-icing (1)
0 °C (32 °F) and above	Heated fluid/water mixture with a freezing point of at least 10 °C (18 °F) below OAT	Heated water or a heated fluid/water mixture	Heated fluid/water mixture with a freezing point of at least 10 °C (18 °F) below OAT
below 0 °C (32 °F) down to LOUT		Heated fluid/water mixture with a freezing point *at OAT or below*	

(1) To be applied before first step fluid freezes.

NOTE 1: Temperature of water or fluid/water mixtures shall be at least 60 °C (140 °F) at the nozzle. Upper temperature limit shall not exceed fluid and aircraft manufacturer's recommendations.

NOTE 2: This table is applicable for the use of Type I Holdover Time Guidelines. If holdover times are not required, a temperature of 60 °C (140 °F) at the nozzle is desirable.

NOTE 3: To use Type I Holdover Time Guidelines, at least 1 litre/m^2 (~2 Gals/100ft^2) must be applied to the de-iced surfaces.

CAUTION: Wing skin temperatures may be lower than OAT. If this condition is identified, a stronger mixture (more glycol) may need to be used to ensure a sufficient freezing point buffer.

Table 2 - Guidelines for the application of Type II, Type III, and Type IV fluid/water mixtures (minimum concentrations) as a function of OAT

OAT [1]	Concentration of neat fluid/water mixture in vol%/vol%		
	One-Step Procedure	Two-Step Procedure	
	De-icing/ Anti-icing	First step: De-icing	Second step: Anti-icing [2]
0 °C (32 °F) and above	50/50 Heated [3] Type II, III, or IV fluid/water mixture	Heated water or a heated Type I, II, III, or IV fluid/water mixture	50/50 Type II, III, or IV fluid/water mixture
below 0 °C (32 °F) to -3 °C (27 °F)	*50/50 Heated [3] Type II, III, or IV fluid/water mixture*	*Heated Type I, II, III, or IV fluid/water mixture with a freezing point at OAT or below*	*50/50 Type II, III, or IV fluid/water mixture*
below -3 °C (27 °F) to -14 °C (7 °F)	75/25 Heated [3] Type II, III [4], or IV fluid/water mixture	Heated Type I, II, III, or IV fluid/water mixture with a freezing point *at OAT or below*	75/25 Type II, III [4], or IV fluid/water mixture
below -14 °C (7 °F) to -25 °C (- 13 °F)	100/0 Heated [3] Type II, III [4], or IV	Heated Type I, II, III, or IV fluid/water mixture with a freezing point *at OAT or below*	100/0 Type II, III [4], or IV
below -25 °C (- 13 °F)	Type II/Type III/Type IV fluid may be used below -25 °C (-13 °F) provided that the freezing point of the fluid is at least 7 °C (13 °F) below OAT and that aerodynamic acceptance criteria are met (LOUT). NOTE: Type II/Type III/Type IV fluid may not be used below -25°C (-13°F) in active frost conditions Consider the use of Type I fluid/water mixture when Type II, III, or IV fluid cannot be used (see Table 1).		

[1] Fluids must only be used at temperatures above their LOUT.
[2] To be applied before first step fluid freezes.
[3] Clean aeroplanes may be anti-iced with unheated fluid.
[4] Type III fluid may be used below -10 °C (14 °F) provided that the freezing point of the fluid is at least 7 °C (13 °F) below OAT and that aerodynamic acceptance criteria are met (LOUT).

NOTE:
For heated fluid and fluid mixtures, a temperature not less than 60 °C (140 °F) at the nozzle is desirable. When the first step is performed using a fluid/water mixture with a freezing point at OAT, the temperature at the nozzle shall be at least 60 °C (140 °F) and at least 1 litre/m2(~2 Gals/100 ft2) must be applied to the surfaces to be de-iced.
Upper temperature limit shall not exceed fluid and aircraft manufacturer's recommendations.

CAUTION:
Wing skin temperatures may be lower than OAT. If this condition is identified, it shall be verified if a stronger mixture (more glycol) may need to be used to ensure a sufficient freezing point buffer. As fluid freezing may occur, 50/50 Type II, III, or IV fluid shall not be used for the anti-icing step of a cold soaked wing as indicated by frost or ice on the lower surface of the wing in the area of the fuel tank.

CAUTION:
An insufficient amount of anti-icing fluid, especially in the second step of a two-step procedure, may cause a substantial loss of holdover time.
This is particularly true when using a Type I fluid mixture for the first step (de-icing).

CAUTION:
Some fluids shall only be used undiluted. For some fluids the LOUT may differ.
For details refer to fluid manufacturer's documentation.

8. The Refractometer

The refractometer is the device used to measure the mixture of the de-icing fluid.

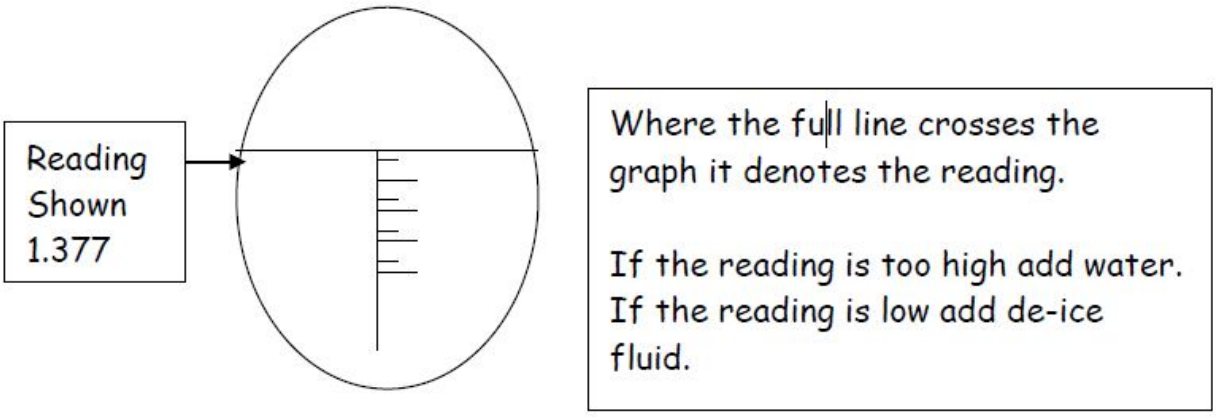
The refractometer is the device used to measure the mixture of the de-icing fluid.

When taking a refractive reading you must undertake the test in the crew room at room temperature or if taken inside the rig cab the temperature in the cab should be no more than 20 degrees centigrade. If this practice is not followed the reading will be incorrect, due to the temperature drop of the refractometer.

Open the end of the refractometer and place the fluid as described below. (Again avoid contact with hands, as this will alter the reading) The refractive reading should be 1.377.

1. Place small amount of fluid on prism.
2. Close flap.
3. Hold up to the light to view.

View through the Refractometer



Where the shaded line crosses the graph it denotes the reading.

Reading shown 1.377

-15 - 1.37°
-10 - 1.36°
-5 - 1.35°
-2.5 - 1.34°

If the reading is too high add Water

If the reading is too low add de-icing Fluid

8.1 Refractive index (KILFROST)

KILFROST ABC K Plus TYPE II

Fluid Manufacturer:	Kilfrost
Fluid Brand Name:	ABC K Plus
Fluid Type Specification:	ISO Type II SAE Type II
Original Colour:	Clear, straw coloured fluid
Customer Colour:	None
Specific Gravity:	1.038 +/- 0.015
PH Value (20ºC):	7.0 +/- 0.5
Storage Life Time:	2 years in sealed drum (min retest sample as life can be extended by Kilfrost)
Approved Mixtures:	50/50, 75/25, 100/0

9. Fluid Check Methods (Viscosity Check Procedure)

To be completed every 10 'heat ups' for each rig.

Take a sample of fluid from the tank and nozzles of each gun and put into a clean dry sample bottle.

Ensure that the viscometer is clean and dry prior to use.

Pour a minimum of 400ml of fluid into a clean container with an opening diameter of not less than 50 mm.

Immerse the cup in the container and leave for one minute, in order to reach thermal equilibrium.

Determine the temperature of the fluid using thermometer.

Raise the cup vertically out of the fluid in a quick and steady motion. As the top edge of the cup breaks the surface of the fluid, start the stopwatch.

During the time of flow, hold the cup vertically no more than 15 cm (6 inches) from the surface of the fluid.

Stop timing when a continuous flow of fluid breaks from the cup orifice.

Check the flow time against the limits provided by Kilfrost for the specific fluid type and dilution at the temperature of measurement.

Caution

- Check that the flow cup has fully drained at the end of each measurement. If fluid remains in the cup the measurement should be disregarded and the flow cup cleaned and dried thoroughly prior to making subsequent measurements.
- Heavily aerated fluids may give artificially high flow times.
- Use water or mild soap and water to clean the viscometer.
- Dry the viscometer thoroughly after use.
- Never use metal tools in contact with the flow cups. Any damage caused to the flow cup orifice can seriously affect the accuracy of results.

9.1 Visual Contamination Check

To be completed for each rig whilst doing viscosity check.

This test should be performed every 10 'heat ups' or at least every 2 days regardless of use to ensure fluid is compliant.

Once sample bottle is filled with sample taken from nozzle of the gun, and temperature has equalized, look at liquid for any contamination.

Record result in viscosity log.

NOTE
A similar sample should also be taken from the storage tank, vehicle, and spray nozzles and tested in the same way and records maintained.

10. Failure Procedure

If fluid is found to have failed, the following Field Checks shall be conducted:

- Rig will be taken off service.
- Samples sent to Kilfrost.
- If fluid fails then Rig thoroughly cleaned.
- Fluid disposed.
- Rig refilled with New Fluid and samples sent to Kilfrost for tests.
- Rig put back to service on conformation of Fluid passing.

Failure would result in downgrade to Type I fluid, (if Kilfrost recommend).

The fluid may be used as a Type I fluid if all other fluid checks are within the set limits.

11. Checking procedure for aircraft de-icing / anti-icing fluid on delivery

11.1 Delivery Checks for Fluids

On receipt of fluid all consignment documentation shall be checked.

Barrels / IBC & bulk fluid delivery must be checked against documentation, identified with correct labelling and concentration.

A sample should be taken of the delivered product and checked prior to be added to storage tank or vehicles.

Checks as follows:

Ensure the refractive index is within the limits published by the manufacturer for the fluid as delivered:

- Visual contamination
- Refractive test
- pH value check
- Viscosity test
- Sign delivery note with results of tests and date

All of the above checks must be recorded on a delivery form.

An area designated, dedicated to the storage of de-icing/anti-icing fluid, clearly labelled.

Storage tanks/barrels shall be constructed of a material compatible with de-icing/anti-icing fluid (corrosive resistant steel or plastic.) The area shall be inspected regularly (minimum annually) for corrosion/contamination.

Liquids shall be stored at a temperature compliant with the manufacturer's guidelines.

Stored fluid shall be routinely checked to ensure that no degradation/contamination has occurred.

NOTE:
Fluid checks shall be performed as a minimum requirement at the start and middle of the de-icing season and upon request of the airlines. Fluid samples being taken from all de-icing/anti-icing vehicles, spray nozzles, vehicle tanks and storage tanks; with samples taken in all concentrations used.

At bases where more than one fluid is in use extreme care should be taken against cross contamination of fluid both in storage and testing.