INTERNATIONAL STANDARD

ISO 11076

Second edition
2000-03-15

Aerospace — Aircraft de-icing/anti-icing methods with fluids

Aéronautique et espace — Méthodes de dégivrage/antigivrage des aéronefs à l'aide de liquides

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 11076 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 9, *Air cargo and ground equipment*.

This second edition cancels and replaces the first edition (ISO 11076:1993), which has been technically revised.

Annexes A and B form a normative part of this International Standard.

Annexes A and B of this International Standard provide guidelines for the application of different types of de-icing/anti-icing fluids as a function of outside air temperature and of weather conditions. This data requires frequent updating. ISO/TC 20/SC 9 has agreed to delegating this task under its own guidance to an ISO Maintenance Agency. The ISO Maintenance Agency designated for this task is:

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Updated annexes to this International Standard can be obtained from ISO Central Secretariat upon request.

Aerospace — Aircraft de-icing/anti-icing methods with fluids

1 Scope

This International Standard establishes the minimum requirements for ground-based aircraft de-icing/anti-icing with fluids to ensure the safe operation of transport aircraft during icing conditions (see also 8.3.2). All requirements specified herein are applicable only in conjunction with the referenced International Standards. This International Standard does not specify requirements for particular aeroplane model types.

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 International Standard.

De-icing/anti-icing by mechanical means is not covered by this International Standard.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 11075:1993, *Aerospace — Aircraft de-icing/anti-icing Newtonian fluids, ISO type I*.

ISO 11077:1993, *Aerospace — Self-propelled de-icing/anti-icing vehicles — Functional requirements.*

ISO 11078:1994, *Aerospace — Aircraft de-icing/anti-icing non-Newtonian fluids, ISO type II*.

3 Terms and definitions

3.1
de-icing
procedure by which frost, ice, slush, or snow is removed from an aircraft in order to provide clean surfaces

3.2
de-icing fluid
defined as one of the following:

a) heated water;

b) ISO type I fluid in accordance with ISO 11075;

c) mixture of water and ISO type I fluid;

d) ISO type II, III or IV fluids in accordance with ISO 11078;

e) mixture of water and ISO type II, III or IV fluids

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

3.3
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)

3.4
anti-icing fluid
defined as one of the following:

a) ISO type I fluid in accordance with ISO 11075;

b) mixture of water and ISO type I fluid;

c) ISO type II, III or IV fluids in accordance with ISO 11078;

d) mixture of water and ISO type II, III or IV fluids

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

3.5
de-icing/anti-icing
combination of the procedures described in 3.1 and 3.3

NOTE It may be performed in one or two steps.

3.6
holdover time
estimated time for which an anti-icing fluid will prevent the formation of frost or ice and the accumulation of snow on the protected surfaces of an aircraft, under weather conditions as specified in clause 13

3.7
freezing conditions
conditions in which the outside air temperature is below +3°C (37,4 °F) and visible moisture in any form (such as fog with visibility below 1,5 km, rain, snow, sleet or ice crystals) or standing water, slush, ice or snow is present on the runway

3.8
frost/hoarfrost
ice crystals that form from ice saturated air at temperatures below 0 °C (32 °F) by direct sublimation on the ground or other exposed objects

3.9
freezing fog
suspension of numerous minute 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)

3.10
snow
precipitation of ice crystals, most of which are branched, star-shaped or mixed with unbranched crystals and at temperatures higher than −5 °C (23 °F), the crystals are generally agglomerated into snowflakes

3.11
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

3.12
light freezing rain
precipitation of liquid water particles which freezes upon impact with exposed objects, in the form of drops of more than 0,5 mm (0,02 in) which, in contrast to drizzle, are widely separated

NOTE Measured intensity of liquid water particles are up to 2,5 mm/h (0,10 inch/h) or 25 g/dm^2/h with a maximum of 2,5 mm (0,10 in) in 6 min.

3.13
rain or high humidity (on cold-soaked wing)
water forming ice or frost on the wing surface, when the temperature of the aircraft wing surface is at or below 0 °C (32 °F)

3.14
sleet
precipitation in the form of a mixture of rain and snow

NOTE Operation in light sleet is treated as light freezing rain.

3.15
slush
snow or ice that has been reduced to a soft watery mixture by rain, warm temperature and/or chemical treatment

3.16
check
examination of an item against a relevant standard by a trained and qualified person

4 Abbreviated terms

OAT outside air temperature

FP freezing point

5 General requirements

A pilot shall not take off in an aeroplane that has:

a) frost, snow, slush or ice adhering to any propeller, windshield or power plant installation or to airspeed, altimeter, rate of climb or flight altitude instrument systems;

b) snow, slush or ice adhering to the wings or stabilizing or control surfaces or any frost adhering to the upper surfaces of wings or stabilizing or control surfaces.

6 Requirements for staff training and qualifications

6.1 Personnel qualifications

De-icing/anti-icing procedures shall be carried out exclusively by trained and qualified personnel.

6.2 Training for crews

Both initial and annual recurrent training for flight crew and ground crew shall be conducted to ensure that all such crews obtain and retain a thorough knowledge of aircraft de-icing/anti-icing policies and procedures, including new procedures and lessons learned.

6.3 Subjects to be covered in training

Training shall include the following items as a minimum:

a) effects of frost, ice, slush and snow on aircraft performance;

b) basic characteristics of aircraft de-icing/anti-icing fluids;

c) general techniques for removing deposits of frost, ice, slush, and snow from aircraft surfaces and for anti-icing;

d) de-icing/anti-icing procedures in general and specific measures to be performed on different aircraft types;

e) types of checks required;

f) de-icing/anti-icing equipment operating procedures, including actual operation of equipment;

g) safety precautions;

h) emergency procedures;

i) fluid application and limitations of holdover time tables;

j) de-icing/anti-icing codes and communication procedures;

k) special provisions and procedures for contract de-icing/anti-icing (if applicable);

l) environmental considerations, for example where to de-ice, spill reporting, hazardous waste control;

m) new procedures and development, lessons learned from previous winters.

6.4 Records

Records of personnel training and qualifications shall be maintained for proof of qualification.

7 Requirements for fluid handling

7.1 Environment

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 manufacturer's safety data sheet.

7.2 Mixing of different products

Different products shall not be mixed without additional qualification testing.

7.3 Storage

7.3.1 Tanks dedicated to the storage of de-icing/anti-icing fluids shall be used.

7.3.1 Storage tanks shall be of a material of construction compatible with the de-icing/anti-icing fluids, as specified by the fluid manufacturer.

7.3.2 Tanks shall be conspicuously labelled to avoid contamination.

7.3.3 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.

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

7.3.5 The stored fluid shall be checked routinely to insure that no degradation/contamination has taken place.

7.4 Pumping

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

7.5 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.

7.6 Heating

De-icing/anti-icing fluids shall be heated according to the fluid manufacturer's guidelines. The integrity of the fluid following heating shall be checked periodically.

7.7 Application

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

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

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

8 Procedures

8.1 Need for de-icing/anti-icing

The following procedures specify the recommended methods for de-icing and anti-icing of aircraft on the ground to provide an aerodynamically clean aircraft.

When aircraft surfaces are contaminated by frozen moisture, they shall be de-iced prior to dispatch. When freezing precipitation exists and there is a risk of precipitation adhering to the surface at the time of dispatch, aircraft surfaces shall be anti-iced. If both de-icing and anti-icing are required, the procedure may be performed in one or two steps (see 3.5). The selection of a one- or two-step process depends upon weather conditions, available equipment, available fluids and the holdover time to be achieved. If a one-step procedure is used, then both 8.2 and 8.3 apply.

NOTE 1 Slippery conditions can exist on the ground or equipment following the de-icing/anti-icing procedures. Caution should be exercised, particularly under low humidity or non-precipitating weather conditions due to increased slipperiness.

For guidance regarding fluid limitations, see 8.3.1.

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.

8.2 De-icing

8.2.1 General

Ice, snow, slush, or frost may be removed from aircraft surfaces by heated fluids or mechanical methods. The following procedures shall be used for their removal when using fluids.

For maximum effect, fluids should 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 residue. The de-icing fluid will prevent refreezing for a period of time depending on aircraft skin and ambient temperature, the fluid used, the mixture strength and the weather.

8.2.2 Requirements

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

8.2.3 Removal of frost and light ice

A nozzle setting giving a solid cone (fan) spray should be used.

NOTE This ensures the largest droplet pattern available, thus retaining the maximum heat in the fluid. Providing the hot fluid is applied closed to the aircraft skin, a minimal amount of fluid will be required to melt the deposit.

8.2.4 Removal of snow

A nozzle setting sufficient to flush off deposits shall be used.

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 aircraft 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 aircraft skin, the procedures detailed in 8.2.5 should be utilized. Heavy accumulation of snow will always be difficult to remove from aircraft 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.

8.2.5 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 jet of hot fluid is directed at close range onto one spot, until the bare metal is just exposed. This bare metal 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 aircraft 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.

8.2.6 De-icing fluid application strategy

8.2.6.1 General

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

8.2.6.2 Aircraft unique procedures

Certain aircraft can require unique procedures to accommodate design differences. See manufacturer's instructions.

8.2.6.3 Wings/tailplane

Spray from the tip inboard to the root from the highest point of the surface camber to the lowest. However, aircraft configurations and local conditions can dictate a different procedure.

8.2.6.4 Vertical surfaces

Start at the top and work down.

8.2.6.5 Fuselage

Spray along the top centre-line and then outboard.

8.2.6.6 Landing gear 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 wheels and brakes.

Accumulations such as blown snow can be removed mechanically. 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.

8.2.6.7 Engines

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

8.2.7 De-icing location

De-icing/anti-icing near the beginning of the departure runway provides the minimum interval between de-icing/anti-icing and takeoff.

8.3 Anti-icing

8.3.1 General

Ice, snow, slush, or frost will, for a period of time, be prevented from adhering to or accumulating on aircraft surfaces by the application of anti-icing fluids. The following procedures shall be adopted when using anti-icing fluids.

For effective anti-icing, an even film of fluid is required over the prescribed aircraft surfaces which are clean (free of frozen deposits). For longer anti-icing protection, undiluted, unheated ISO type II, III or IV fluids 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 ISO type I fluids provide limited holdover effectiveness when used for anti-icing purposes. Little benefit is gained from the minimal holdover time generated.

8.3.2 Required usage

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

8.3.3 Optional usage

Anti-icing fluid may be applied to aircraft surfaces at the time of arrival (preferably before unloading begins) on short turnarounds during freezing precipitation and on overnight parked aircraft.

NOTE 1 This will minimize ice accumulation prior to departure and often makes subsequent de-icing easier.

On receipt of a frost, snow, freezing drizzle, freezing rain or freezing fog warning from the local meteorological service, anti-icing fluid may be applied to clean aircraft surfaces prior to the start of freezing precipitation.

NOTE 2 This will minimize the possibility of snow and ice bonding or reduce the accumulation of frozen precipitation on aircraft surfaces and facilitate subsequent de-icing.

8.3.4 Anti-icing fluid application strategy

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.

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 over all surfaces to which it is applied. In order to control the uniformity, all horizontal aircraft surfaces shall be visually checked during application of the fluid. The correct amount is indicated by fluid just beginning to drop off the leading and trailing edges.

The most effective results are obtained by commencing on the highest part of the wing section and covering from there towards the leading and trailing edges. On vertical surfaces, start at the top and work down.

The following surfaces shall be protected:

a) wing upper surface and leading edges;

b) horizontal stabilizer upper surface including leading edges and elevator upper surface;

c) vertical stabilizer and rudder;

d) fuselage upper surfaces depending upon the amount and type of precipitation (especially important on centre-line engined aircrafts).

8.3.5 Anti-icing location

De-icing/anti-icing near the beginning of the departure runway provides the minimum interval between de-icing/anti-icing and takeoff.

8.4 Limits and precautions

8.4.1 Fluid-related limits

8.4.1.1 Temperature limits

8.4.1.1.1 Two-step de-icing/anti-icing

When performing two-step de-icing/anti-icing, the freezing point of the fluid used for the first step shall not be more than 3 °C (5 °F) above ambient temperature. (See also Tables A.1 and B.1.)

8.4.1.1.2 ISO type I fluid

CAUTION — ISO type I fluid supplied as a concentrate for dilution with water prior to use shall not be used undiluted, unless it meets aerodynamic performance and freezing point buffer requirements specified in ISO 11075.

The freezing point of the ISO 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 ambient temperature.

8.4.1.1.3 ISO type II, III and IV fluids

CAUTION — Some type IV fluids may, over a period of time under certain low humidity conditions, thicken and affect the aerodynamic performance of the fluid during subsequent takeoff. If gel residues of type IV fluids are found at departure, the surface shall be cleaned and reprotected as necessary.

ISO type II, III and IV fluids used as de-icing/anti-icing agents 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 outside air temperature. In no case shall this temperature be lower than the lowest operational use temperature as defined by the aerodynamic acceptance test.

8.4.1.2 Application limits

An aircraft that has been anti-iced with an undiluted ISO type II, III or IV fluid shall not receive a further coating of anti-icing fluid directly on top of the contaminated fluid under any circumstances. If it is necessary for an aircraft to be reprotected prior to the next flight, the external surfaces shall first be de-iced with a hot fluid mix before a further application of anti-icing fluid is made. (See also Tables A.2, B.2, and B.3.)

8.4.2 Aircraft-related limits

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

8.4.3 Procedure precautions

8.4.3.1 One-step de-icing/anti-icing is performed with a heated anti-icing fluid (3.4). The fluid used to de-ice the aircraft remains on aircraft surfaces to provide limited anti-ice capability. The correct fluid concentration shall be chosen with regard to desired holdover time and is dictated by outside air temperature and weather conditions. See Tables A.1 and B.1.

CAUTION — Wing-skin temperature can be lower than OAT. A stronger mix (more glycol) may be used under these conditions.

8.4.3.2 Two-step de-icing/anti-icing: the first step is performed with de-icing fluid (3.2). The correct fluid 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 (3.4). The correct fluid concentration shall be chosen with regard to desired holdover time and is dictated by outside air temperature and weather conditions. (See Tables A.1 and B.1.)

The second step shall be performed before first step fluid freezes (typically within 3 min), if necessary area by area.

When applying the second step fluid, use a spraying technique which effectively flushes away the first step fluid (for example using the method described in 8.2.6.2) and provides a sufficient amount of second step fluid to completely cover the surfaces with an adequate film thickness. Where re-freezing occurs following the initial treatment, both the first and the second step shall be repeated.

CAUTION — Wing-skin temperature can be lower than OAT. A stronger mix (more glycol) may be used under these conditions.

CAUTION — When a fluid in conformance with ISO 11078 (type II, III and IV fluid) is used to perform step two in a two-step de-icing/anti-icing operation, and the fluid used in step one is a type I fluid conforming to ISO 11075, a test shall be made to confirm that the combination of these fluids does not significantly reduce the anti-icing performance of the ISO 11078 fluid.

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

8.4.3.4 Aircraft shall be treated symmetrically, that is, left-hand and right-hand side shall receive the same treatment.

NOTE Aerodynamic problems could result if this requirement is not met.

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

8.4.3.6 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.

8.4.3.7 De-icing/anti-icing fluids shall not be sprayed directly onto brakes, wheels, exhausts or thrust reversers.

8.4.3.8 De-icing/anti-icing fluids shall not be directed into the orifices of pitot heads, static vents or directly onto airstream direction detectors probes/angle of attack airflow sensors.

8.4.3.9 All reasonable precautions shall be taken to minimize fluid entry into engines, other intakes/outlets and control surface cavities.

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

8.4.3.11 All doors and windows should be closed to prevent:

a) galley floor areas from being contaminated with slippery de-icing fluids;

b) upholstery from becoming soiled.

8.4.3.12 Before the application of anti-icing/de-icing fluids, doors shall not be closed until all ice or snow has been removed from the surrounding area.

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

8.4.3.14 If ISO 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 fluids may be removed with an approved cleaner and a soft cloth.

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

8.4.3.16 When removing ice, snow, frost, or slush from aircraft surfaces care shall be taken to prevent it entering and accumulating in auxiliary intakes or control surface hinge areas, i.e. remove snow from wings and stabilizer surfaces forward towards the leading edge and remove from ailerons and elevators back towards the trailing edge.

8.4.3.17 Ice can build up on aircraft 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.

8.4.3.18 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.

8.4.3.19 A flight control check should be considered according to aircraft type (see relevant manuals). This check should be performed after de-icing/anti-icing.

8.4.4 Clear-ice precautions

8.4.4.1 Clear ice can form on aircraft 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 that all deposits have been removed.

8.4.4.2 Significant deposits of clear ice can form, in the vicinity of the fuel tanks, on wing upper surfaces as well as underwing. Aircraft 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;

NOTE 1 Clear ice can form at other temperatures if conditions a), c) and d) exist.

c) precipitation occurs while the aircraft is on the ground;

d) frost or ice is present on lower surface of either wing.

The formation of clear ice is extremely difficult to detect. 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 2 This type of build-up normally occurs at low wing temperatures and when large quantities of cold fuel remain in wing tanks during the turnaround/transit and any subsequent refueling is insufficient to cause a significant increase in fuel temperature.

9 General aircraft requirements after de-icing/anti-icing

9.1 General

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

9.2 Wing, 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 manuals.

9.3 Pitot heads and static ports

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

9.4 Engine inlets

Engine inlets shall be clear of internal ice and snow and fan shall be free to rotate.

9.5 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.

9.6 Landing gear and landing-gear doors

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

9.7 Fuel tank vents

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

9.8 Fuselage

Fuselage shall be clear of ice and snow. Adhering frost may be present in accordance with the aircraft manufacturer's manuals.

9.9 Flight control check

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

10 Final check before aircraft dispatch

An aircraft shall not be dispatched for departure under icing conditions or after a de-icing/anti-icing operation until the aircraft has received a final check by a responsible authorized person.

The check shall visually cover all critical parts of the aircraft and be performed from points offering sufficient visibility of these parts (for example from the de-icer itself or another elevated piece of equipment).

The authorized person shall indicate the check results in accordance with clause 9 by documentation, if applicable, according to airline or local airworthiness authority requirements.

11 Pre-takeoff check

When freezing precipitation exists, aerodynamic surfaces shall be checked just prior to the aircraft taking the active runway or initiating the takeoff roll in order to confirm that they are free of all forms of frost, ice, slush and snow.

This is particularly important when severe conditions are experienced or the published holdover times have either been exceeded or are about to run out. When deposits are in evidence, the de-icing operation shall be repeated.

If aircraft surfaces cannot adequately be checked from inside the aircraft, it is desirable to provide a means of assisting the flight crew in determining the condition of the aircraft. This check should be conducted as near as practical to the beginning of the departure runway.

12 Communications/procedures

12.1 De-icing/anti-icing operation

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

The standardized notification performed by qualified personnel, indicates that the aircraft critical parts are checked free of ice, frost, snow and slush, and in addition, includes the necessary de-icing/anti-icing code as specified in 12.2 to allow the flight crew to estimate the holdover time to be expected under the prevailing weather conditions with reference to clause 13.

12.2 De-icing/anti-icing codes

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

a) the ISO fluid type, i.e. type I for ISO type I, type II, for ISO type II, type III for ISO type III and type IV for ISO type IV;

b) the concentration of the fluid (except for type I fluid) within the fluid/water mixture, expressed as a percentage by volume;

c) the local time (hours/minutes) at the beginning of the final de-icing/anti-icing step;

d) the date (written day, month, year/date required for record keeping, optional for crew notification).

Transmission of elements a), b), and c) to the flight crew confirms that a post de-icing/anti-icing check was completed and the aircraft is clean.

EXAMPLE A de-icing/anti-icing procedure whose last step is the use of a mixture of 75 % of an ISO type II fluid and 25 % water commencing at 13:35 local time on 20 April 1992 is recorded as follows:

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13 Holdover time

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 conjuction with a pre-takeoff check.

Holdover time is obtained by anti-icing fluids remaining on the aircraft surfaces. With a one-step de-icing/anti-icing operation the holdover time begins at the start of the operation and with a two-step operation at the start of the final (anti-icing) step. Holdover time will have effectively run out when frozen deposits start to form/accumulate on the treated aircraft surfaces.

Due to its properties, ISO type I fluid forms 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 mix.

ISO type II, III and IV fluids contain a pseudoplastic 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 mix, with maximum holdover time available from undiluted fluid.

Tables A.2, B.2 and B.3 give an indication as to the time frame of protection that could reasonably be expected under conditions of precipitation. However, due to the many variables that can influence holdover times, these times should not be considered as minimums or maximums as the actual time of protection may be extended or reduced, depending upon the particulate conditions existing at the time. The lower limit of the published time span is used to indicate the estimated time of protection during moderate precipitation and the upper limit indicate the estimated time of protection during light precipitation.

The responsibility for the application of these data remains with the user.

NOTE 1 Fluids qualified in accordance with ISO 11078 may not have been tested during winter to develop the holdover time guidelines specified in this International Standard.

NOTE 2 No tables for type III fluid are incorporated as for the moment no type III fluids are available on the market.

Annex A
(normative)

Guidelines for the application of and holdover times anticipated for ISO type I fluid/water mixtures

Table A.1 — Guidelines for the application of ISO type I fluid/water mixtures as a function of OAT

OAT [a]	**Minimum requirements of the heated fluid**		
	One-step procedure de-icing/anti-icing	**Two-step procedure**	
		First step: de-icing	Second step: anti-icing [b]
−3 °C (27 °F) and above	FP [c] of heated fluid [d] mixture shall be at least 10 °C (18 °F) below actual OAT	Water heated to 60 °C (140 °F) minimum at the nozzle or a heated mixture of fluid and water	FP of fluid mixture shall be at least 10 °C (18 °F) below actual OAT
Below −3 °C (27 °F)		FP of heated fluid mixture shall not be more than 3 °C (5 °F) above actual OAT	
CAUTION — Wing-skin temperatures may be lower than OAT. A stronger mix (more glycol) can be used under these conditions. NOTE For heated fluids, a fluid temperature no less than 60 °C (140 °F) at the nozzle is desirable. Upper temperature limit shall not exceed fluid and aircraft manufacturer's recommendations.			
a OAT = outside air temperature. b To be applied before the first-step fluid freezes, typically within 3 min. c FP = freezing point. d Clean aircraft may be anti-iced with *unheated* fluid.			

Table A.2 — Guidelines for holdover times anticipated for ISO type I fluid mixtures as a function of weather conditions and OAT

OAT [a]	Approximate holdover times under various weather conditions min					
	Frost [b]	**Freezing fog**	**Snow**	**Freezing drizzle** [c]	**Light freezing rain**	**Rain on cold-soaked wing**
> 0 °C (> 32 °F)	45	12 to 30	6 to 15	5 to 8	2 to 5	2 to 5
0 °C to –10 °C (32 °F to 14 °F)	45	6 to 15	6 to 15	5 to 8	2 to 5	—
Below –10 °C (Below 14 °F)	45	6 to 15	6 to 15	—	—	—

CAUTION — The time of protection will be shortened in heavy weather conditions, 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 the aircraft skin temperature is lower than OAT. Therefore, the indicated times should be used only in conjunction with a pre-takeoff check.

ISO type I fluid/water mixture is selected so that the freezing point of the mixture is at least 10 °C (18 °F) below actual OAT.

ISO type I fluids used during ground de-icing/anti-icing are not intended for and do not provide ice protection during flight.

[a] OAT = outside air temperature.

[b] During conditions that apply to aircraft protection for ACTIVE FROST.

[c] Use LIGHT FREEZING RAIN holdover times if positive identification of FREEZING DRIZZLE is not possible.