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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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Contents

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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.

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.

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

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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.

NOTE 1 Particular airline or aircraft manufacturers' published manuals, procedures or methods supplement the information contained in this International Standard.

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 standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO 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 11078:1993[1], *Aerospace — Aircraft de-icing/anti-icing non-Newtonian fluids, ISO type II.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

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

3.2 de-icing fluid:

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 fluid in accordance with ISO 11078;

e) mixture of water and ISO type II fluid.

NOTE 2 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 on treated surfaces of the aircraft for a limited period of time (holdover time).

3.4 anti-icing fluid:

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

b) mixture of water and ISO type I fluid;

c) ISO type II fluid in accordance with ISO 11078;

d) mixture of water and ISO type II fluid.

1) To be published.

NOTE 3 Anti-icing fluid is normally applied cold on clean aircraft surfaces.

3.5 de-icing/anti-icing: Combination of the procedures described in 3.1 and 3.3. 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 (26,6 °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: Crystallized deposit formed from water vapour on surfaces which are at or below 0 °C (32 °F).

NOTE 4 This definition includes hoar-frost.

3.9 freezing fog: Cloud of supercooled water droplets at freezing point that form a deposit of ice on objects in cold weather conditions.

3.10 snow: Precipitation in the form of small ice crystals or flakes.

3.11 freezing rain: Water condensed from atmospheric vapour falling to earth in supercooled drops, forming an ice cap on objects.

3.12 rain or high humidity on cold soaked wing: Water droplets from a rainfall forming an ice topping on the wing upper surface, when the temperature of the aircraft wing surface is at or below 0 °C (32 °F).

4 Abbreviations

OAT: outside air temperature.

FP: freezing point.

5 General

The various local rules governing aircraft cold weather operations are very specific and shall be strictly adhered to.

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

a) frost, snow 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 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 Staff training and qualification

Flight safety can be jeopardized if de-icing and/or anti-icing is improperly performed. Therefore the de-icing/anti-icing procedure shall be carried out exclusively by qualified and trained personnel.

6.1 Training for crews

Both initial and recurrent training for flight crew and ground crew shall be conducted.

6.2 Subjects to be covered in training

Training shall cover the following subjects

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

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

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

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

e) quality control procedures;

f) vehicle operating procedures;

g) safety precautions;

h) emergency procedures;

i) use of holdover time tables.

6.3 Records

Records of personnel training and qualifications shall be maintained.

6.4 Training operation

Training shall include actual operation of de-icing/anti-icing vehicles.

7 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 environ-

mental and health laws and the manufacturer's safety data sheet.

Products from different suppliers should not be mixed and need extra qualification testing.

NOTE 5 Slippery conditions can exist on the ground or equipment following the de-icing/anti-icing procedure. Caution should be exercised, particularly under low humidity or non-precipitating weather conditions due to increased slipperiness.

7.1 Storage

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

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

7.1.3 Tanks shall be conspicuously labelled to avoid contamination.

7.1.4 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.

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

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

7.2 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.

7.3 Transfer lines

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

7.3.2 An inline filter, constructed according to the fluid manufacturer's recommendations, should be used to remove any solid contaminant.

7.4 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.

7.5 Application

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

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

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

8 Procedures

These 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 anti-icing and de-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 8.1 and 8.2 apply.

For guidance regarding fluid limitations, see 8.3.1.

NOTE 6 Where holdover time is critical, a two-step procedure using undiluted fluid should always be considered for the second step.

8.1 De-icing

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

8.1.1 Requirements

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

8.1.2 General

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

NOTE 7 The heat in the fluid effectively melts any frost, as well as light deposits of snow 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 and the mixture strength.

8.1.3 Removal of frost and light ice

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

NOTE 8 This ensures the largest droplet pattern available, thus retaining the maximum heat in the fluid. Providing the hot fluid is applied close to the aircraft skin, a minimal amount of fluid will be required to melt the deposit.

8.1.4 Removal of snow

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

NOTE 9 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 8.1.5 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.

8.1.5 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.

8.1.6 General de-icing fluid application strategy

For effective removal of snow and ice, the following techniques shall be adopted. Certain aircraft can require unique procedures to accommodate design differences.

8.1.6.1 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.

8.1.6.2 Vertical surfaces

Start at the top and work down.

8.1.6.3 Fuselage

Spray along the top centre-line and then outboard.

8.1.6.4 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 on hot wheels and brakes.

NOTE 10 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.

8.1.6.5 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 Anti-icing

Ice, snow 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.

8.2.1 Required usage

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

8.2.2 Recommended usage

Anti-icing fluid may be applied to aircraft surfaces at the time of arrival (preferably before unloading begins)

on short turnarounds when snow or freezing rain is falling.

NOTE 11 This will minimize the ice accumulation problem prior to departure and often makes subsequent de-icing unnecessary.

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

NOTE 12 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.

8.2.3 General

For effective anti-icing, a thin, even film of undiluted ISO type I or type II fluid shall be applied over the prescribed aircraft surfaces which are clean or which have been de-iced. For maximum anti-icing protection, undiluted, unheated ISO type II 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 give a medium spray.

NOTE 13 ISO type I fluids have limited effectiveness when used for anti-icing purposes. Little benefit is gained from the minimal holdover time generated.

8.2.4 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 maintain 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;

b) tailplane 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 Limits and precautions

8.3.1 Fluid related limits

8.3.1.1 Temperature limits

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 (5,4 °F) above ambient temperature. (See also tables 1 and 2.)

8.3.1.1.1 ISO type I fluids

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.

Undiluted ISO type I fluids shall meet aerodynamic and freezing point requirements.

8.3.1.1.2 ISO type II fluids

ISO type II 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 (12,6 °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.

8.3.1.2 Application limits

An aircraft that has been anti-iced with undiluted ISO type II fluid shall not receive a further coating of anti-icing fluid directly on top of the existing film 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 3 and 4.)

8.3.2 Aircraft related limits

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

8.3.3 Procedure precautions

8.3.3.1 One-step de-icing/anti-icing is performed with an anti-icing fluid. 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 1 and 2.

CAUTION — Aircraft skin temperature and outside air temperature can differ.