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Aircraft — Ground-based de-icing/anti-icing methods with fluids

Aéronefs — Méthodes de dégivrage/d'antigivrage au sol à l'aide de liquides

Reference number
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Contents

Page

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 2.

The main task of technical committees is to prepare International Standards. 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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

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

This fourth edition cancels and replaces the third edition (ISO 11076:2000), which has been technically revised.

Introduction

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. These data require frequent updating. ISO/TC 20/SC 9 has agreed to delegating this task under its own guidance to the Association of European Airlines (AEA) and the Society of Automotive Engineers (SAE), which are organizations recognized as experts in the field of de-icing/anti-icing aircraft on the ground.

Aircraft — Ground-based de-icing/anti-icing methods with fluids

1 Scope

This International Standard establishes the minimum requirements for aircraft de-icing/anti-icing methods on the ground, in accordance with the ICAO *Manual of aircraft ground de-icing/anti-icing operations* (Doc. 9640-AN/940) and relevant national regulations, to facilitate the safe operation of transport aircraft during icing conditions. This International Standard does not specify requirements for specific aircraft model types.

Aircraft manufacturers' published manuals, procedures or methods take precedence over the information in this International standard.

Airlines' 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 referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 9001:2000, *Quality management systems — Requirements*

ISO 11075, *Aircraft de-icing/anti-icing fluids — ISO type I*

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*

ICAO doc 9640-AN/940 [1)], *Manual of aircraft ground de-icing/anti-icing operations*

JAR-OPS 1.035 [2)], *Quality system*

JAR-OPS 1.345 and ACJ 1.345 [2)], *Ice and other contaminants, ground procedures*

FAR [3)] Title 14 CFR Part 121, paragraph 121.629, *Operation in icing conditions*

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1) Available from ICAO (International Civil Aviation Organization), 999 University Street, Montreal, Canada. Phone: +1-514-954-8022 or e-mail: sales_unit@icao.int.

2) Available from JAA (Joint Aviation Authorities, Europe), P.O.Box 3000, 2130 KA Hoofddorp, The Netherlands.

3) Available from FAA (Federal Aviation Administration), USA. Website: http://www.faa.gov/, choose “regulations”.

FAA Advisory Circular AC 120-60 [4], *Ground de-icing and anti-icing program*

CAR [5] (Canadian Aviation Regulation), Part VI, Subpart 2, Operating and flight rules, item 602.11, Aircraft icing

CAR [5] (Canadian Aviation Regulation), Standard 622.11, Ground icing operations

FAA Advisory Circular AC 120-59 [4], *Air carriers internal evaluation programs*

SAE AIR9968 [6], *Viscosity Test of Thickened Aircraft Deicing/Anti-Icing Fluids*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
active frost
condition when frost is forming

NOTE Active frost occurs when aircraft surface temperature is $\leqslant$ 0 °C (32 °F) and $\leqslant$ dew point.

3.2
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)

3.3
anti-icing fluid (a)
ISO type I fluid, in accordance with ISO 11075, heated to 60 °C minimum at the spray nozzle

3.4
anti-icing fluid (b)
mixture of water and ISO type I fluid, heated to 60 °C minimum at the spray nozzle

3.5
anti-icing fluid (c)
ISO type II, III or IV fluids in accordance with ISO 11078

3.6
anti-icing fluid (d)
mixture of water and ISO type II, III or IV fluids

NOTE Anti-icing fluids types II, III and IV are normally applied unheated on clean aircraft surfaces but may be applied heated.

3.7
check
examination of an item against a relevant standard by a trained and qualified person

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4) Available from FAA (Federal Aviation Administration, USA).
Website: http://www.faa.gov/library/manuals/examiners_inspectors/8400/fsat/

5) Available from Transport Canada. Website: http://www.tc.gc.ca/civilaviation.

6) Available from SAE (Society of Automotive Engineers) Int'l, 400 Commonwealth Drive, Warrendale, PA 15096-0001, USA. Website: http://www.sae.org/.

3.8
clear ice
layer of pure, transparent, homogeneous, hard and smooth ice bonded to a surface

3.9
cold-soaked wing
condition of the wings of aircraft when they have (partly) a very low temperature due to very cold fuel (below 0 °C) in the wing tanks

NOTE This condition can result from having just landed after a flight at high altitude or from having been refuelled with very cold fuel. The following factors contribute to cold-soaking: temperature and quantity of fuel in fuel tanks, type and location of fuel cells, length of time at high altitude, temperature of refuelling fuel and time since refuelling.

3.10
contamination
all forms of frozen or semi-frozen moisture such as frost, snow, ice or slush

3.11
contamination check
check of aircraft surfaces for contamination to establish the need for de-icing

3.12
de-icing
procedure by which frost, ice, slush or snow is removed from an aircraft in order to provide clean surfaces

3.13
de-icing/anti-icing
combination of the de-icing and anti-icing procedures

NOTE It may be performed in one or two steps.

3.14
de-icing fluid (a)
heated water

3.15
de-icing fluid (b)
ISO type I fluid in accordance with ISO 11075

3.16
de-icing fluid (c)
mixture of water and ISO type I fluid

3.17
de-icing fluid (d)
ISO type II, III or IV fluids in accordance with ISO 11078

3.18
de-icing fluid (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.

3.19
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

3.20
freezing fog
suspension of numerous minute water droplets which freezes upon impact with ground or other exposed objects

NOTE Freezing fog generally reduces the horizontal visibility at the earth's surface to less than 1 km (0,62 mile).

3.21
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

3.22
hail
precipitation of small balls or pieces of ice with a diameter ranging from 5 to > 50 mm (0,2 to > 2,0 in.) falling either separately or agglomerated

3.23
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 the holdover time guidelines

NOTE See annexes.

3.24
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 (0,2 in.) or less

NOTE The pellets of ice usually bounce when hitting hard ground.

3.25
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

NOTE Measured intensity of liquid water particles is up to 2,5 mm/h (0,10 in/h) or 25 g/dm^2/h with a maximum of 0,25 mm (0,010 in) in 6 min.

3.26
local frost build-up
limited formation of frost in local wing areas sub-cooled by cold fuel or large masses of cold metal

NOTE This type of frost does not cover the entire wing.

3.27
moderate and heavy freezing rain
precipitation of liquid water particles, either in the form of drops of more than 0,5 mm (0,02 inch) or smaller drops which (in contrast to drizzle) are widely separated, which freezes upon impact with the ground

NOTE Measured intensity of liquid water particles is more than 2,5 mm/h (0,10 in/h) or 25 g/dm^2/h.

3.28
operator
“AOC-holder” (Air Operator Certificate holder) in accordance with civil aviation regulations

3.29
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)

3.30
rain and snow (mixture)
precipitation in the form of a mixture of rain and snow

3.31
slush
snow or ice that has been reduced to a soft watery mixture

3.32
snow
precipitation of ice crystals, most of which are branched, star-shaped or mixed with unbranched crystals

NOTE At temperatures higher than −5 °C (23 °F), the crystals are generally agglomerated into snowflakes.

3.33
snow grains
precipitation of very small white and opaque particles of ice that are fairly flat or elongated with a diameter of less than 1 mm (0,04 in)

NOTE 1 When snow grains hit hard ground, they do not bounce or shatter.

NOTE 2 For holdover-time purposes, treat snow grains as snow.

3.34
snow pellets
precipitation of white, opaque particles of ice, round or sometimes conical, with a diameter range from about 2 mm to 5 mm (0,08 in to 0,2 in)

NOTE Snow pellets are brittle, easily crushed; they bounce and may break on hard ground.

4 Symbols and abbreviated terms

OAT outside air temperature

FP freezing point

5 General requirements

Aircraft ground de-icing/anti-icing methods shall comply with this International Standard, the ICAO *Manual of aircraft ground de-icing/anti-icing operations* (Doc. 9640-AN/940), the applicable national civil aviation regulations (CAR 602.11 and 622.11, JAR-OPS 1.345 and ACJ 1.345, FAR 14 CFR 121.629 and AC 120-60) and any applicable local rules.

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

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

a) frost, snow, slush or ice present on any propeller, windscreen or power-plant installation or on airspeed, altimeter, rate of climb or flight-altitude instrument systems;

b) snow, slush or ice adhering to the wings, stabilizers, control surfaces or fuselage, in gaps between the airframe and control surfaces or in gaps between control surfaces and control tabs, or any frost on the upper surfaces of wings, stabilizers or control surfaces.

For this reason a contamination check of the aircraft surfaces shall be performed prior to departure.

6 Quality assurance programme

Operators shall establish a quality assurance programme to ensure correct de-icing/anti-icing operations at all stations where applicable.

This should be an approved programme which, in addition to the present, takes into account the requirements of carriers' internal evaluation programmes (JAR-OPS 1.035 or FAA AC 120-59) or, for non-airline subcontractors and handling agencies, ISO 9001 or equivalent pertinent standards.

This programme shall include at least:

a) auditing;

b) training;

c) methods and procedures;

d) training records;

e) qualification;

f) publications;

g) equipment and fluids.

The auditing of all parts of the de-icing/anti-icing operation is required to check the ongoing conformance with all regulations issued by authorities, operators, manufacturers and handling agents.

Training of all personnel involved in the de-icing/anti-icing operation is required to ensure the correct performance of all tasks which have to be fulfilled.

Methods and procedures shall be defined to allow the clear and safe accomplishment of all tasks that are necessary for de-icing/anti-icing an aircraft.

Training records of all de-icing/anti-icing personnel are required to guarantee that all requirements in the field of training and skill are fulfilled.

Qualification of all de-icing/anti-icing personnel is required to assure correct performance of all tasks.

Written instructions are required for the aircraft de-icing/anti-icing operation to ensure the correct accomplishment of all tasks.

Equipment and fluids have to be maintained in such a way that the correct quality is assured.

7 Requirements for staff training and qualifications

7.1 Personnel qualifications

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

Companies providing de-icing/anti-icing services shall have both a training/qualification programme and a quality assurance programme to monitor and maintain an acceptable level of competence.

7.2 Training for crews

Both initial and annual recurrent training for flight crews and ground crews 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.

Training success shall be proven by an examination/assessment which shall cover all training subjects listed in 7.3.

The theoretical examination shall be in accordance with the latest local examination rules/requirements. The pass mark shall be 75 % and only persons passing this examination can be qualified.

For personnel performing the actual de-icing/anti-icing treatment on aircraft, practical training with the de-icing/anti-icing equipment shall be included.

7.3 Subjects to be covered in training

Training shall include the following items as a minimum:

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

b) basic characteristics of aircraft de-icing/anti-icing fluids, including causes and consequences of fluid degradation and residues;

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 check required;

f) de-icing/anti-icing equipment and facilities operating procedures including actual operation;

g) safety precautions;

h) emergency procedures;

i) fluid application and limitations of holdover-time tables;

j) anti-icing codes and communication procedures;

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

l) environmental considerations, e.g. where to de-ice, spill reporting, hazardous-waste control;

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

7.4 Records

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

8 Requirements for fluid handling

8.1 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.

8.2 Fluid acceptance

8.2.1 General

Fluid acceptance will require the fluid manufacturer’s release documentation (e.g. certificate of conformance, certificate of analysis) from the supplier, visual inspection and a verification to check if the correct fluid is delivered.

It is recommended that the winter operations programme ensures and verifies that de-icing/anti-icing fluids are not degraded beyond the fluid manufacturer’s limits.

8.2.2 Fluid sampling procedure for type II, type III, or type IV fluids

8.2.2.1 Introduction

To ensure that the necessary safety margins are maintained between the start of the de-icing/anti-icing operation and take-off, the fluid used to both de-ice and anti-ice aircraft surfaces, shall be in an “ex-fluid manufacturer's” condition and at the correct concentration. Due to the possible effect of vehicle/equipment heating and/or delivery-system components on fluid condition, it is necessary for the sampling method to simulate typical aircraft application.

This section therefore describes the approved methods for collecting samples of type II, III, and IV fluids, sprayed from operational aircraft de-icing/anti-icing vehicles/equipment, prior to the necessary quality control checks (see 8.2.3) being carried out.

8.2.2.2 Method

The application is made on a clean polythene sheet (approximately 2 m $\times$ 2 m) laid directly on the ground, or on an aluminium plate with associated recovery system (an equivalent method may be used providing correlating spraying tests are done). Depending on wind speed/direction at the time of sampling the polythene sheet may require to be weighted down at the edges to prevent movement.

The distance between the spray nozzle and the surface shall be approximately 3 m and the fluid shall be sprayed perpendicular to the surface.

Where different spray patterns and flow rates are used during routine de-icing/anti-icing operations, samples shall be taken at typical nozzle settings (e.g. fine, medium or coarse) and flow rates for anti-icing.

8.2.2.3 Procedure

Select the required flow rate/spray pattern for the fluid to be sampled.

Spray the fluid to purge the lines and check the concentration of a sample, taken from the gun/nozzle after purging.

Should the refractive index indicate that the lines have not been adequately purged, repeat previous step until the concentration is correct for the fluid to be sampled (on certain vehicles it may be necessary to spray more than 50 l of fluid before the lines are completely purged).

Direct the fluid on to the sampling surface and spray an adequate amount of fluid to allow for a 1 l sample to be taken.

Where a polythene sheet is used for sampling purposes, carefully lift the corners of the sheet and collect 1 l of the fluid in a clean and dry bottle.

8.2.2.4 Reference fluid

For reference purposes, take a 1 l sample of the base fluid from the storage facility and a 1 l sample from the fluid tank of the de-icing/anti-icing equipment/vehicle being sampled.

8.2.2.5 Identification of samples

Attach to each sample a label carrying the following data:

— brand name and type of the fluid (e.g. Kilfrost ABC-3/Type II, Clariant MPII 1951/Type II, etc.);

— identification of de-icing/anti-icing equipment/vehicle (e.g. Elephant Beta DT04, Fixed Rig R001, etc.);

— indicate flow rate and spray pattern;

— detail where the sample was taken from (e.g. nozzle, storage tank or equipment/vehicle tank);

— mixture strength (e.g. 100/0, 75/25, etc.);

— station (e.g. BAK, etc.);

— date sample was taken.

8.2.3 Checking procedure for aircraft de-icing/anti-icing fluids

8.2.3.1 Introduction

This checking procedure for aircraft de-icing/anti-icing fluids ensures that the required safety standards concerning the de-icing/anti-icing fluids' quality are maintained. When discrepancies are found, further investigation has to be conducted prior to use of the fluid.

8.2.3.2 Delivery check for fluids

Before filling the tank with the de-icing/anti-icing fluid it shall be established that the brand name and the concentration of the product mentioned in the packing list corresponds to the brand name and the concentration mentioned on the storage tank.

A sample of the delivered product shall be taken and checked from each batch before the storage tank/vehicle is filled.

Perform the delivery check for fluids as follows.

Type I fluid:
— perform a visual contamination check according to 8.2.3.6.1;
— perform a refractive-index check according to 8.2.3.6.2;
— perform a pH-value check according to 8.2.3.6.3.

Type II, type III and type IV fluids:

— perform a visual contamination check according to 8.2.3.6.1;

— perform a refractive index check according to 8.2.3.6.2;

— perform a pH-value check according to 8.2.3.6.3;

— perform a field viscosity check according to 8.2.3.6.4.

8.2.3.3 De-icing/anti-icing vehicle fluid checks

8.2.3.3.1 Concentration checks

Fluids or fluid/water mixture samples shall be taken from the de-icing/anti-icing vehicle nozzles on a daily basis when vehicles are in use. In addition, from trucks without a mixing system, mixture samples shall be taken (after sufficient mixing/stirring to ensure a uniform mixture) each time the tanks are (re)filled with water and/or de-icing/anti-icing fluid. The sample shall be protected against precipitation. Perform a refractive index check according to 8.2.3.6.2.

For trucks without a mixing system, samples may be taken from the truck tank instead of the nozzle.

For trucks with proportional mixing systems, operational setting for flow and pressure shall be used. Allow the selected fluid concentration to stabilize before taking sample (see also 8.2.2.3).

For trucks with an automated fluid mixture monitoring system, the interval for refractive index checks shall be determined by the handling company in accordance with the system design.

8.2.3.3.2 Checks on (directly or indirectly) heated fluids

Fluid or fluid/water mixture samples shall be taken from the de-icing/anti-icing vehicle tanks. As a guideline, the interval should not exceed two weeks, but it may be adjusted in accordance with local experience.

Perform a refractive index check in accordance with 8.2.3.6.2.

8.2.3.4 Laboratory checks for fluids

The laboratory checks shall be performed for the fluids at the start and in the middle of the de-icing season and upon request by the airline. Fluid samples shall be taken from all de-icing/anti-icing vehicle spray nozzles of all vehicles and from all storage tanks in use.

For thickened de-icing/anti-icing fluids, take the sample as described in fluid sampling procedure for type II, type III, and type IV fluids (see 8.2.2).

Perform the laboratory check for fluids as follows.

Type I fluid:

— perform a visual contamination check according to 8.2.3.6.1;

— perform a refractive-index check according to 8.2.3.6.2;

— perform a pH-value check according to 8.2.3.6.3.

Type II, type III and type IV fluids:

— perform a visual contamination check according to 8.2.3.6.1;

— perform a refractive-index check according to 8.2.3.6.2;

— perform a pH-value check according to 8.2.3.6.3;

— perform a laboratory viscosity check according to 8.2.3.6.5 (not applicable to samples taken from spray nozzle(s) used for de-icing exclusively).

8.2.3.5 Field check for fluids

A field check for fluids shall always be made when station inspection is made. The samples shall be taken from the storage tank and from the de-icing/anti-icing equipment nozzle.

For thickened de-icing/anti-icing fluids, take the sample as described in the fluid-sampling procedure for type II, type III or type IV fluids (see 8.2.2).

Perform the field test for fluids as follows.

Type I fluid:

— perform a visual contamination check according to 8.2.3.6.1;

— perform a refractive-index check according to 8.2.3.6.2;

— perform a pH-value check according to 8.2.3.6.3.

Type II, type III and type IV fluids:

— perform a visual contamination check according to 8.2.3.6.1;

— perform a refractive-index check according to 8.2.3.6.2;

— perform a pH-value check according to 8.2.3.6.3;

— perform a field viscosity check according to 8.2.3.6.4.

8.2.3.6 Fluid check methods

8.2.3.6.1 Visual contamination check

— Put fluid from the sample into a clean glass bottle or equivalent;

— check for any kind of contamination (e.g. rust particles, metallic debris, rubber parts, etc.);

— the check can be made by any equivalent method.

8.2.3.6.2 Refractive-index check

— Make sure the refractometer is calibrated and clean;

— put a fluid drop taken from the sample or from the nozzle on to the test screen of the refractometer and close the prism;

— read the value on the internal scale and use the correction factor given by the manufacturer of the fluid in case the temperature of the refractometer is not 20 °C;

— compare the value with the figures from the fluid manufacturer;

— clean the refractometer and return it into the protective cover;

— the check can be made by any equivalent method.

8.2.3.6.3 pH-value check

— Take a piece of pH paper and put it into the fluid so that the pH paper becomes wetted with the fluid;

— remove the pH paper from the fluid and compare its colour with the colour of the table provided with the pH paper and read the corresponding pH value;

— compare the pH-value with the figures from the fluid manufacturer;

— the check can be made by any equivalent method.

8.2.3.6.4 Field viscosity check

This check shall be made using a falling ball method, where, in two sealed tubes, the reference liquids represent the minimum and maximum permitted viscosities of the tested product. A third empty tube is for the sample:

— put the sample into a clean sample tube;

— insert the steel ball into the glass, fill it up completely and close it;

— return the glass to the test tool, turn it vertically and let all steel balls reach the lower end of the test tubes;

— after all three balls have reached the bottom of the tubes, turn the tool ± 180° to a full vertical position;

— the balls will move downwards at different speeds;

— the speed of the middle steel ball shall be between the speed of the two other balls or be equal to the speed of one of them;

— the check can be made by any equivalent method.

8.2.3.6.5 Laboratory viscosity check

— Perform the viscosity check in accordance with SAE AIR 9968 or the fluid manufacturer's specific instructions, if different from AIR 9968;

— the measurements shall be carried out at rotation speeds of 0,005 s^{-1} (0,3 rpm);

— the temperatures at which the measurements are made and the spindle number shall be reported;

— compare the viscosity values with figures from the fluid manufacturer;

— the check can be made by any equivalent method.

8.3 Mixing of different products

Different products shall not be mixed without additional qualification testing.

8.4 Storage

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

8.4.2 Storage tanks shall be of materials compatible with the de-icing/anti-icing fluids, 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.

8.4.3 Tanks shall be conspicuously labelled to avoid contamination.

8.4.4 Tanks shall be inspected annually for corrosion and/or contamination. If corrosion or contamination is evident, tanks shall be maintained to standard or be replaced. To prevent corrosion at the liquid/vapour interface and in the vapour space, a high liquid level in the tanks is recommended.

NOTE If the quality of the fluids is checked in accordance with 8.2.3, the inspection interval may be longer than one year.

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

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

8.5 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.

8.6 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.

8.7 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 and IV fluids thermal exposure and/or water loss may cause a reduction in fluid viscosity leading to lower holdover times.

The fluids shall be checked periodically in accordance with 8.2.3.

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 that are in direct contact with the fluid tanks (no insulation between tanks).

8.8 Application

8.8.1 Application equipment shall meet the requirements of ISO 11077 and be cleaned thoroughly before being initially filled with a de-icing/anti-icing fluid in order to prevent fluid contamination.

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

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

9 Contamination check

This is a check for the need to de-ice. This check shall include the areas mentioned in 12.1 to 12.8 and any other as recommended by the aircraft manufacturer. 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 12.2 and 12.8, 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.

10 Procedures

10.1 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 contamination adhering to the surfaces 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 3.13). 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 10.2 and 10.3 apply.

De-icing/anti-icing location: de-icing/anti-icing as close as possible to the beginning of the departure runway provides the minimum interval between de-icing/anti-icing and take-off.

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

For guidance regarding fluid limitations, see 11.1.

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.

10.2 De-icing

10.2.1 General

Ice, snow, slush or frost may be removed from aircraft surfaces by heated fluids, mechanical methods, alternate technologies or combinations thereof. The following procedures shall be used for their removal when using fluids and/or infrared de-icing.

NOTE 1 Alternate technology can be used to accomplish the de-icing process, provided that the requirements in Clause 12 be accomplished.

NOTE 2 A pre-step process can be done prior to de-icing/anti-icing.

If agreed to by the aircraft 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), can be considered to reduce the quantity of glycol-based de-icing fluid needed.

This pre-step process can be performed with various means (e.g. brooms, forced air, heat, heated water, 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.

10.2.2 Requirements

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

10.2.3 De-icing with fluids

10.2.3.1 General

This section establishes the procedures for removal of frozen contamination by fluids.

For maximum effect, fluids should be applied close to the surface of the aircraft 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.

10.2.3.2 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 close to the aircraft skin, a minimal amount of fluid will be required to melt the deposit.

10.2.3.3 Removal of snow

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

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 10.2.3.4 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.

10.2.3.4 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 on to one spot at an angle of less than 90°, until the aircraft skin is just exposed. The aircraft 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 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.

10.2.3.5 De-icing fluid application strategy

10.2.3.5.1 General

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

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

10.2.3.5.2 Aircraft-unique procedures

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

10.2.3.5.3 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 may dictate a different procedure.

10.2.3.5.4 Vertical surfaces

Start at the top and work down.

10.2.3.5.5 Fuselage

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

10.2.3.5.6 Landing gear and wheel bays

The application of de-icing fluid in this area shall be kept to a minimum. De-icing fluid shall neither be sprayed directly on to wheels and brakes, nor on towbarless tractor cradles.

Accumulations such as blown snow may be removed by other means than fluid (mechanically, forced air, 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.

10.2.3.5.7 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.

10.2.4 De-icing by infrared technology

10.2.4.1 This section establishes the procedures for removal of frozen contamination by using infrared de-icing technology.

NOTE Specific information on facility requirements, as well as their inclusion in aircraft ground de-icing programmes, can be found in publications FSAT 00-05 and FSAW 00-02 listed in the bibliography section of this document.

10.2.4.2 General requirements: Ice, slush, snow and frost shall be removed from aircraft surfaces prior to dispatch from the facility and/or prior to anti-icing.

10.2.4.3 De-icing using infrared energy is accomplished through heat that breaks the bond of adhering frozen contamination. The application of infrared energy may be continued to melt and evaporate frozen contaminants. Wet surfaces require an application of heated de-icing fluids to preclude refreezing after

removal of the infrared energy source. When required, for operations other than frost or leading edge ice removal and when OAT is at or below 0 °C (32 °F), an additional treatment with hot de-icing fluid shall be performed within the facility to prevent re-freezing of water which may remain in hidden areas.

CAUTION — If the aircraft requires additional de-icing and de-icing/anti-icing fluids have been applied before flight, conventional de-icing/anti-icing with fluids shall be performed.

10.2.4.4 The aircraft shall be inspected in accordance with the requirements in Clause 12 (general aircraft requirements after de-icing/anti-icing).

10.2.4.5 If anti-icing is required, it shall be accomplished in accordance with section 10.3. If anti-icing is performed inside the facility, infrared power levels shall be adjusted as required during the anti-icing process to prevent the re-accumulation of frozen contamination due to the effect of blowing snow through the facility and to maintain fluid integrity for the time the aircraft is in the facility. Dehydration of the fluid can negatively impact the fluid performance.

10.3 Anti-icing

10.3.1 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 layer of fluid of sufficient thickness is required over the prescribed aircraft surfaces that are clean (free of frozen deposits). For maximum anti-icing protection, undiluted, 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.

10.3.2 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.

10.3.3 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 warning of frost, snow, freezing drizzle, freezing rain or freezing fog 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.

10.3.4 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 and with sufficient thickness 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 run off the leading and trailing edges.

NOTE For guidance on the amount of fluid, refer to the AEA publication[3].

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 treated:

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).

10.4 Local frost prevention in cold-soaked wing areas

10.4.1 Introduction

Wing surface temperatures can be considerably below ambient due to contact with cold fuel and/or close proximity to large masses of cold-soaked metal. In these areas, frost can build up on wing surfaces and may result in the entire wing being de-iced/anti-iced prior to the subsequent departure.

This procedure provides recommendations for the prevention of local frost formation in cold-soaked-wing tank areas during transit stops in order to make de-icing/anti-icing of the entire wings unnecessary under such circumstances. This procedure does, however, not supersede standard de-icing/anti-icing procedures and has to fulfil the requirements of Clause 12. This procedure also does not obviate any requirements for treatment and inspections in accordance with aircraft-manufacturer manuals.

10.4.2 Procedure

Using suitable spray equipment, apply a proper coating of undiluted type II or IV anti-icing fluid on the wings in the limited cold-soaked areas where formation of frost may be expected due to contact of the wing skin with sub-cooled fuel or masses of cold metal.

A proper coating completely covers the treated area with visible fluid.

NOTE For limitations see 10.4.3.

10.4.3 Limits and precautions

— This local frost prevention procedure does not substitute standard de-icing/anti-icing procedures in accordance with 10.1 to 10.3, clear-ice checks or any other aircraft-manufacturer requirements, nor the requirement that aircraft surfaces are clear of frost, slush, snow and ice accumulation.

— This local frost prevention procedure shall only be carried out if approved by the operator of the aircraft to be treated, and it shall only be carried out by properly qualified and trained personnel.

— This local frost prevention procedure shall be applied on clean wings immediately following arrival of the aircraft. Application is acceptable at the latest when frost is just starting to build up, but in this case the fluid shall be applied at a minimum temperature of 50 °C. If precipitation occurs between application of the fluid and dispatch of the aircraft and/or if precipitation is expected before take-off, a standard de-icing/anti-icing treatment shall be performed in accordance with 10.1 to 10.3.

— The wings shall receive the same and symmetrical treatment, i.e. the same area in the same location shall be sprayed, also when conditions would not require the treatment of both wings.

CAUTION — Aerodynamic problems could result if this requirement is not met.

— A holdover time shall not be assigned to a local frost prevention treatment since the treatment does not cover the entire aircraft or wing surface.

10.4.4 Final check

A tactile check of the treated areas and a visual check of the untreated areas of both wings shall be performed immediately before the aircraft leaves the parking position. These checks are conducted to ensure that both wings are clean and free of frost. The applied de-icing/anti-icing fluid shall still be liquid and shall show no indication of failure, such as colour turning to white, loss of gloss, becoming viscous, showing ice crystals, etc.

10.4.5 Cockpit crew information

The following information shall be provided to the cockpit crew: "Local frost prevention was accomplished".

11 Limits and precautions

11.1 Fluid-related limits

11.1.1 Temperature limits

11.1.1.1 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).

11.1.1.2 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. For exceptions, refer to the fluid manufacturer's documentation.

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.

11.1.1.3 ISO type II, III and IV fluids

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). These fluids may be used below this temperature provided that the freezing point of the fluid is at least 7 °C below the actual outside air temperature and the aerodynamic acceptance criteria are met. For this lowest operational use temperature, refer to the fluid manufacturer's documentation.

11.1.2 Application limits

Under no circumstances shall an aircraft that has been anti-iced receive a further coating of anti-icing fluid directly on top of the contaminated fluid.

If an additional treatment is required before flight, a complete de-icing/anti-icing shall be performed (see application guidelines in Tables A1 and B1). Ensure that any residues from previous treatments are flushed off. Anti-icing only is not permitted.

CAUTION — The repeated application of type II, III or IV fluid may cause residues to collect in aerodynamically quiet areas, cavities and gaps. Dried residues may rehydrate and freeze following a period of high humidity and/or rain conditions. This may impede flight control systems. These residues may require removal. Consult the aircraft manufacturer with regard to inspection methods and frequency, related maintenance requirements and aircraft washing recommendations. The use of hot water or heated type I fluid/water mix for the first step of a two-step de-icing/anti-icing process may minimize the formation of residues.

NOTE When checking for residues, their visibility may be facilitated by misting with water.

11.2 Aircraft-related limits

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

11.3 Procedure precautions

11.3.1 One-step de-icing/anti-icing is performed with a heated anti-icing fluid. The fluid used to de-ice the aircraft remains on aircraft surfaces to provide limited anti-icing 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 temperatures may be lower than OAT. If this condition is identified, a stronger mix (more glycol) may need to be used to ensure a sufficient freezing-point buffer.

11.3.2 In two-step de-icing/anti-icing the first step is performed with de-icing fluid. 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-icing 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 outside air temperature and weather conditions. (See Tables A.1 and B.1.)

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

When applying the second-step fluid, use a spraying technique that completely covers the first-step fluid (for example using the method described in 10.3.4) and that provides a sufficient amount of second-step fluid. For guidance on the amount of fluid, refer to the AEA publication[3]. Where re-freezing occurs following the initial treatment, both the first and the second step shall be repeated.

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

11.3.3 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 take-off based on existing weather conditions.

11.3.4 Aircraft shall be treated symmetrically, that is, left-hand and right-hand side shall receive the same treatment, even when only one side of the aircraft is contaminated.

If the wing and/or the horizontal stabilizer/elevator is to be treated, the treatment shall always cover the entire wing and/or the entire horizontal stabilizer/elevator on both sides of the aircraft.

CAUTION — Aerodynamic problems could result if this requirement is not met.

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

11.3.6 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.

11.3.7 De-icing/anti-icing fluids shall not be sprayed directly on to wiring harnesses and electrical components (receptacles, junction boxes, etc.), brakes, wheels, exhausts or thrust reversers.

11.3.8 De-icing/anti-icing fluids shall not be directed into the orifices of pitot heads, static ports or directly on to air-stream direction detector probes/angle of attack airflow sensors.

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

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

11.3.11 Prior to the application of de-icing/anti-icing fluids, 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.

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

11.3.12 Any forward area from which fluid can blow back on to windscreens during taxiing or subsequent take-off shall be free of fluid residues prior to departure.

11.3.13 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. Pay particular attention to windows fitted with wipers.

De-icing/anti-icing fluids may be removed with an approved cleaner and a soft cloth or by flushing with type I fluid.

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

11.3.15 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.

11.3.16 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 be checked prior to departure and any frozen deposits removed.

11.3.17 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, on to the affected areas.

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

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

11.4 Clear-ice precautions

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

11.4.2 Significant deposits of clear ice can form in the vicinity of the fuel tanks, on wing upper surfaces as well as under wings. 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 air 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 the 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 as to 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 refuelling is insufficient to cause a significant increase in fuel temperature.

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

12.1 General

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

12.2 Wing, tail and control surfaces

Wing, 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.

12.3 Pitot heads and static ports

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

12.4 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.

12.5 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.

12.6 Landing gear and landing-gear doors

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

12.7 Fuel-tank vents

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

12.8 Fuselage

The fuselage shall be clear of ice and snow. Frost may be present in accordance with the aircraft manufacturer's manuals.

12.9 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.

12.10 Dried-fluid residues when the aircraft has not been flown after anti-icing

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

12.11 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.

13 Post-de-icing/anti-icing-treatment check

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

This check, in accordance with Clause 12, 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). Any contamination found shall be removed by further de-icing/anti-icing treatment and the check repeated.

The anti-icing code according to 15.2 shall not be transmitted before the post de-icing/anti-icing treatment check is completed.

14 Pre-take-off check and pre-take-off contamination check

14.1 Pre-take-off check

The commander shall continually monitor the environmental situation after the performed de-icing/anti-icing treatment. Prior to take-off he shall assess whether the applied holdover time is still appropriate.

This check is normally performed from inside the flight deck.

14.2 Pre-take-off contamination check

A check of the critical surfaces for contamination shall be performed when the condition of the critical surfaces of the aircraft cannot be effectively assessed by a pre-take-off check or when the applied holdover time has been exceeded.

This check is normally accomplished from outside the aircraft.

The alternate means of compliance to a pre-take-off contamination check is a complete de-icing/anti-icing re-treatment of the aircraft.

15 Communication procedures

15.1 De-icing/anti-icing operation

An aircraft shall not be dispatched for departure after a de-icing/anti-icing operation until the pilot-in-command (PIC) 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 anti-icing code as specified in 15.2 to allow the PIC to estimate the holdover time to be expected under the prevailing weather conditions with reference to Clause 17.

In a remote (away from the gate) de-icing/anti-icing operation, a ground de-icing/anti-icing crew member shall be designated to maintain a positive communication link with the aircraft cockpit crew throughout the total de-icing/anti-icing process.

15.2 Anti-icing code

The following information shall be recorded and communicated to the pilot-in-command 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 complete product name of the anti-icing fluid (so-called “brand name”), optional for type II and IV fluids only [the complete product name (brand name) shall only be given when the product (brand name) holdover-time table for that specific product may be used];

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

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

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

EXAMPLE A de-icing/anti-icing treatment whose last step is the use of a mixture of 75 % of the ISO type II fluid with product name “Dexo, ADF XY-100" and 25 % water commencing at 13:35 local time on 20 April 2004 is recorded as follows:

Type II/Dexo ADF XY-100/75 %/13:35 (20 April 2004)

It is orally transmitted to the pilot-in-command as follows:

“Your anti-icing code is: Type II, product Dexo ADF XY-100, concentration 75 %, 13 h 35, local time.”

The word “concentration” shall be used orally to avoid any confusion between product name (which may contain a number) and concentration.

15.3 Post-treatment check and transmission of the anti-icing code to the pilot-in-command

It shall be clearly defined by the aircraft operator which company is responsible for carrying out the post-treatment check and providing the pilot-in-command with the anti-icing code.

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

The company carrying out the de-icing/anti-icing treatment shall be responsible for the treatment and pass all information about the treatment to the company carrying out the post-treatment check.

Transmission of elements a), b), c) and d) of 15.2 to the pilot-in-command confirms that a post-de-icing/anti-icing check was completed and the aircraft is clean (see Clause 12).

15.4 All-clear signal

The pilot-in-command 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.

15.5 Emergency procedures

When accomplishing de-icing/anti-icing treatments at either a remote de-icing/anti-icing location or a centralized de-icing/anti-icing facility, local procedures shall be established to ensure that either aircraft or ground emergencies are handled safely and expeditiously and are co-ordinated with the airport operations emergency plan.

15.6 Aircraft movement

When de-icing/anti-icing is to be accomplished at either a remote de-icing/anti-icing location or a centralized de-icing/anti-icing facility, local procedures shall be established to ensure that the aircraft enters and exits the de-icing/anti-icing position in a safe co-ordinated manner.

16 Off-gate de-icing/anti-icing procedures

16.1 Communications

During off-gate de-icing/anti-icing a two-way communication between flight crew and de-icing/anti-icing operator/supervisor shall be established prior to the de-icing/anti-icing treatment. This may be done either by intercom or by VHF radio. In case VHF is used, the register or “tail number” of the aircraft instead of flight number shall be used during all communications. An alternate means of communication may be the use of electronic message boards. In the event of conflict, verbal communication shall take precedence. Before and after the treatment, all necessary information to the cockpit shall be given by this means (beginning of treatment, treatment of sections requiring de-activation of aircraft systems, anti-icing code, etc.). Contact with flight crew may be closed after anti-icing code and readiness for taxi-out has been announced. For standard phrases see 16.5.

16.2 Taxi guidance

When an off-gate de-icing/anti-icing area is entered by taxiing, a sufficient taxi and stopping guidance shall be arranged, or marshaller assistance shall be given. In case radio contact is established before entering the de-icing/anti-icing area, the signs with clearly marked operation frequency shall be visible from the cockpit before entering this area.

16.3 General instructions

The de-icing/anti-icing operator together with the airport authorities shall publish all necessary information about how to operate on the off-gate site by NOTAM (Notices for Airman) or in local AIP (Aerodrome Information Publication). This information shall include at least the location of, and standard taxi routing to, the de-icing/anti-icing area, means to coordinate the de-icing/anti-icing operation, means to communicate before and during the de-icing/anti-icing operation and information about taxi and stopping guidance.

16.4 Responsibilities

The qualified person who performs the departure check at the gate is responsible for determining the need for de-icing/anti-icing before dispatch of the aircraft. When there is a need for de-icing/anti-icing, this information shall be given in writing or orally to the commander of the aircraft, who is after that responsible for proceeding in order to get proper treatment. After treatment, the result shall be checked by a trained and qualified person and the anti-icing code shall be given to the commander, after which the commander is responsible for the airworthiness of the aircraft.

16.5 Terminology

The following standard communication terminology is recommended when performing the off-gate de-icing/anti-icing treatment:

— DAS (= De-icing/Anti-icing Supervisor): “Set parking-brakes, confirm aircraft is ready for treatment, inform of any special requests.”

After aircraft is configured for treatment:

— PIC (= Pilot-In-Command): “Brakes are set, you may begin treatment and observe.....(any special requests, like ice under wing/flaps, clear-ice on top of wing, snow on fuselage, ice on landing-gear, anti-ice with type IV fluid, etc.)”;

— DAS: “We begin treatment now and observe…(special request given, like ice under wing, etc.). I will call you back when ready”.

ONLY AFTER EQUIPMENT IS CLEARED FROM AIRCRAFT AND ALL CHECKS ARE MADE:

— DAS: “De-icing/anti-icing completed, anti-icing code is:.....(plus any additional info needed). I am disconnecting. Standby for clear signal at right/left and/or contact ground/tower for taxi clearance”;

— PIC: “De-icing/anti-icing completed, anti-icing code is……”.

17 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 conjunction with a pre-take-off 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 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 mix, with maximum holdover time available from undiluted fluid.

Holdover time guidelines 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 to indicate the estimated time of protection during light precipitation.

Holdover-time guidelines are established and published by several organizations/agencies. These guidelines are for operational planning purposes only and are not a substitute for the pre-take-off check.

An appropriate set of holdover-time guidelines, established under the responsibility of the operator (AOC-holder), shall be used in conjunction with this International Standard.

Holdover-time guidelines are not a part of this International Standard. In the process of establishing their own holdover-time guidelines, operators (AOC-holders) shall use the data from the guidelines contained in the latest published issues of relevant documents by:

a) AEA (Association of European Airlines);

b) FAA (Federal Aviation Agency, USA);

c) Transport Canada.

Examples of holdover-time guidelines can be found in Tables A.2 and B.2. For the latest actual holdover-time guidelines, refer to documents of the organizations/agencies mentioned in the annexes.

The responsibility for the application of these holdover-time guidelines remains with the user.

NOTE 1 Fluids qualified in accordance with ISO 11075 and ISO 11078 may not have been tested during winter to develop the holdover-time guidelines. For specific information on tested fluids, refer to the FAA or Transport Canada websites (see annexes).

NOTE 2 For use of holdover-time guidelines, consult the 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 with the holdover-time guideline for type I fluids. 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, but only after substantiation by holdover-time testing.

NOTE 4 Holdover-time guidelines can also be obtained for individual fluid products and these 'brand-name-specific' holdover-time guidelines will be found to differ from the type-general ("generic") holdover-time guidelines.

Annex A
(normative)

Guidelines for the application of, and example of 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

<table>
<tr><th rowspan="3">OAT [a]</th><th colspan="3">Minimum concentration of fluid</th></tr>
<tr><th rowspan="2">One-step procedure de-icing/anti-icing</th><th colspan="2">Two-step procedure</th></tr>
<tr><th>First step: de-icing</th><th>Second step: anti-icing [b]</th></tr>
<tr><td>−3 °C (27 °F) and above</td><td rowspan="2">FP [c] of heated fluid mixture shall be at least 10 °C (18 °F) below actual OAT</td><td>Heated water or a heated mixture of fluid and water</td><td rowspan="2">FP of heated fluid mixture shall be at least 10 °C (18 °F) below actual OAT</td></tr>
<tr><td>Below −3 °C (27 °F)</td><td>FP of heated fluid mixture shall not be more than 3 °C (5 °F) above actual OAT</td></tr>
<tr><td colspan="4">CAUTION — Wing-skin temperatures may be lower than OAT. If this condition is identified, a stronger mix (more glycol) may need to be used to ensure a sufficient freezing point buffer.</td></tr>
<tr><td colspan="4">[a] OAT = outside air temperature.
[b] To be applied before the first-step fluid freezes, typically within 3 min.
[c] FP = freezing point.</td></tr>
</table>

The temperature of water or fluid/water mixtures shall be at least 60 °C (140 °F) at the nozzle. The upper temperature limit shall not exceed fluid and aircraft manufacturers' recommendations. 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 only desirable. To use Type I holdover-time guidelines, at least 1 l/m^2 (~2 Gals/100 ft^2) shall be applied to the de-iced surfaces.

OAT [a]	Approximate holdover times under various weather conditions min						
	Active frost	**Freezing fog**	**Snow [b] and/or snow grains**	**Freezing drizzle [c]**	**Light freezing rain**	**Rain on cold-soaked wing**	**Other [d]**
–3 °C (27 °F) and above	45	11 to 17	6 to 11	9 to 13	2 to 5	2 to 5	
Below –3 °C (27 °F) to –6 °C (21 °F)	45	8 to 13	5 to 8	5 to 9	2 to 5	No holdover-time guidelines for these conditions exist	
Below –6 °C (21 °F) to –10 °C (14 °F)	45	6 to 10	4 to 6	4 to 7	2 to 5		
Below –10 °C (14 °F)	45	5 to 9	2 to 4				
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-take-off check.							
NOTE 1 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.							
NOTE 2 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] In light “rain-and-snow” conditions use “light freezing rain” holdover times.							
[c] If positive identification of “freezing drizzle” is not possible, use “light freezing rain” holdover times.							
[d] Other conditions include heavy snow, snow pellets, ice pellets, hail, moderate and heavy freezing rain.							

Figure A.1 — Example of a table showing guidelines for holdover times anticipated for ISO type I fluid mixtures as a function of weather conditions and OAT

Figure A.1 is an example only. For latest information on holdover times refer to the following websites:

— AEA (Association of European Airlines), http://www.aea.be/ and select under “Publications” the item “de-icing/anti-icing” and open the “Recommendations for de-icing/anti-icing of aircraft on the ground”.

— FAA (Federal Aviation Administration of the USA), http://www.faa.gov/library/manuals/examiners_inspectors/8400/fsat/, select in last column the latest “FAA-Approved de-icing Program Updates, winter XXXX-XXXX” (on the XXXX fill out the years for the current winter season). Example: for winter 2003-2004 you will find FSAT 03-01.

— TC (Transport Canada), http://www.tc.gc.ca/civilaviation/commerce/holdovertime/menu.htm, select “Holdover Time (HOT) Guidelines”.

Annex B
(normative)

Guidelines for the application of, and example of holdover times anticipated for, ISO type II, type III and type IV fluid/water mixtures

Table B.1 — Guidelines for the application of ISO type II, type III and type IV fluid/water mixtures as a function of OAT

<table>
<tr><th rowspan="3">OAT [a]</th><th colspan="3">Minimum volume fraction of fluid in water
%</th></tr>
<tr><th rowspan="2">One-step procedure de-icing/anti-icing</th><th colspan="2">Two-step procedure</th></tr>
<tr><th>First step: de-icing</th><th>Second step: anti-icing [b]</th></tr>
<tr><td rowspan="2">−3 °C (27 °F) and above</td><td rowspan="2">Heated [c] type II, III or IV
50 %</td><td rowspan="2">Water heated to 60 °C (140 °F) minimum at the nozzle or a heated mix of type I, II, III or IV with water</td><td>Type II, III or IV</td></tr>
<tr><td>50 %</td></tr>
<tr><td rowspan="2">Below −3 °C (27 °F) to −14 °C (7 °F)</td><td rowspan="2">Heated [c] type II, III or IV
75 %</td><td rowspan="4">Heated suitable mix of type I, II, III or IV and water with FP [d] not more than 3 °C (5 °F) above actual OAT</td><td>Type II, III or IV</td></tr>
<tr><td>75 %</td></tr>
<tr><td rowspan="2">Below −14 °C (7 °F) to −25 °C (−13 °F)</td><td rowspan="2">Heated [c] type II, III or IV
100 %</td><td>Type II, III or IV</td></tr>
<tr><td>100 %</td></tr>
<tr><td>Below −25 °C (−13 °F)</td><td colspan="3">ISO type II, III or 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. Consider the use of ISO type I fluid/water mixture when type II, III or IV fluid cannot be used (see Table A.1).</td></tr>
<tr><td colspan="4">CAUTION 1 — Wing-skin temperatures may be lower than OAT. If this condition is identified, verify if a stronger mix (more glycol) needs to be used to ensure a sufficient freezing point buffer. As fluid freezing may occur, 50 % type II, type III or type IV fluid cannot 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 2 — 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 3 — Some fluids can only be used undiluted. For some fluids the lowest operational use temperature may differ. For details refer to fluid manufacturer’s documentation.</td></tr>
<tr><td colspan="4">[a] OAT = outside air temperature.
[b] To be applied before first-step fluid freezes, typically within 3 min.
[c] Clean aircraft may be anti-iced with unheated fluid.
[d] FP = freezing point.</td></tr>
</table>

For heated fluids and heated fluid mixtures, a fluid temperature not less than 60 °C (140 °F) at the nozzle is desirable. When using in the first step a heated fluid/water mix with a freezing point above OAT, it is strongly recommended that the temperature at the nozzle is at least 60 °C and at least 1 l/m^2 (~2 Gals/100 ft^2) is applied to the surfaces to be de-iced. Upper temperature limit shall not exceed fluid and aircraft manufacturers’ recommendations.

<table>
<tr><th rowspan="2">OAT [a]</th><th rowspan="2">Volume fraction of ISO type IV fluid in water</th><th colspan="7">Approximate holdover times under various weather conditions</th></tr>
<tr><th>Active Frost</th><th>Freezing fog</th><th>Snow [b] and/or snow grains</th><th>Freezing drizzle [c]</th><th>Light freezing rain</th><th>Rain on cold-soaked wing</th><th>Other [e]</th></tr>
<tr><td rowspan="3">Above 0 °C (Above 32 °F)</td><td>100 %</td><td>18 h</td><td>1 h 5 min to 2 h 15 min</td><td>35 min to 1 h 5 min</td><td>40 min to 1 h 10 min</td><td>25 min to 40 min</td><td>10 min to 50 min</td><td rowspan="3"></td></tr>
<tr><td>75 %</td><td>6 h</td><td>1 h 5 min to 1 h 45 min</td><td>30 min to 1 h 5 min</td><td>35 min to 50 min</td><td>15 min to 30 min</td><td>5 min to 35 min</td></tr>
<tr><td>50 %</td><td>4 h</td><td>15 min to 35 min</td><td>5 min to 20 min</td><td>10 min to 20 min</td><td>5 min to 10 min</td><td rowspan="6">No holdover-time guidelines for these conditions exist</td></tr>
<tr><td rowspan="3">0 °C to −3 °C (32 °F to 27 °F)</td><td>100 %</td><td>12 h</td><td>1 h 5 min to 2 h 15 min</td><td>30 min to 55 min</td><td>40 min to 1 h 10 min</td><td>25 min to 40 min</td></tr>
<tr><td>75 %</td><td>5 h</td><td>1 h 5 min to 1 h 45 min</td><td>25 min to 50 min</td><td>35 min to 50 min</td><td>15 min to 30 min</td></tr>
<tr><td>50 %</td><td>3 h</td><td>15 min to 35 min</td><td>5 min to 15 min</td><td>10 min to 20 min</td><td>5 min to 10 min</td></tr>
<tr><td rowspan="2">Below – 3 °C to −14 °C (Below 27 °F to 7 °F)</td><td>100 %</td><td>12 h</td><td>20 min 1 h 20 min</td><td>20 min to 40 min</td><td>20 min [d] to 45 min</td><td>10 min [d] to 25 min</td></tr>
<tr><td>75 %</td><td>5 h</td><td>25 min to 50 min</td><td>20 min to 35 min</td><td>15 min [d] to 30 min</td><td>10 min [d] to 20 min</td></tr>
<tr><td>Below −14 °C to −25 °C (Below 7 °F to −13 °F)</td><td>100 %</td><td>12 h</td><td>15 min to 40 min</td><td>15 min to 30 min</td><td></td><td></td></tr>
<tr><td>Below −25 °C (Below −13 °F)</td><td>100 %</td><td colspan="7">ISO 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 the actual OAT and the aerodynamic acceptance criteria are met. Consider use of ISO type I fluid when ISO type IV fluid cannot be used.</td></tr>
<tr><td colspan="9">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-take-off check.</td></tr>
<tr><td colspan="9">NOTE ISO type IV fluids used during ground de-icing/anti-icing are not intended for, and do not provide, ice protection during flight.</td></tr>
<tr><td colspan="9">[a] OAT = outside air temperature.
[b] In light “rain-and-snow” conditions use “light freezing rain” holdover times.
[c] If positive identification of “freezing drizzle” is not possible, use “light freezing rain” holdover times.
[d] No guidelines for holdover times exist for temperatures below −10 °C (14 °F) under these conditions.
[e] Other conditions include heavy snow, snow pellets, ice pellets, hail, moderate freezing rain and heavy freezing rain.</td></tr>
</table>

Figure B.1 — Example of a table showing guidelines for holdover times anticipated for ISO type IV fluid mixtures as a function of weather conditions and OAT

Figure B.1 is an example only. For latest information on holdover-time guidelines refer to the following websites:

— AEA (Association of European Airlines), http://www.aea.be/ and select under “Publications” the item “de-icing/anti-icing” and open the “Recommendations for de-icing/anti-icing of aircraft on the ground”.

— FAA (Federal Aviation Administration of the USA), http://www.faa.gov/library/manuals/examiners_inspectors/8400/fsat/, select in last column the latest “FAA-Approved de-icing Program Updates, winter XXXX-XXXX” (on the XXXX fill out the years for the current winter season). Example: for winter 2003-2004 you will find FSAT 03-01.

— TC (Transport Canada), http://www.tc.gc.ca/civilaviation/commerce/holdovertime/menu.htm, select “Holdover Time (HOT) Guidelines”.

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