Recommendations for De-icing / Anti-icing Aeroplanes on the Ground

30th Edition
July 2015

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Recommendations for De-icing/Anti-icing Aeroplanes on the Ground *30th* Edition

AEA De-icing/Anti-icing Working Group

The AEA De-icing/Anti-icing Working Group consists of dedicated member airline specialists in the de-icing/anti-icing field.

Mission Statement

The AEA De-icing/Anti-icing Working Group is the European focal point for the continuous development of safe, economical and environmentally friendly standards and procedures for the de-icing/anti-icing of aeroplanes on the ground in conjunction with related international standards organizations.

Terms of Reference

Promote and develop safe practices, effective procedures and improved technology related to aeroplane ground operations in winter conditions to ensure the highest possible levels of safety for passengers, flight crew and ground personnel.

Develop a set of commonly agreed recommended practices and procedures for the de-icing/anti-icing of aeroplanes on the ground, to reflect current industry best practice.

Publish these recommendations as the document 'AEA Recommendations for De-icing/Anti-icing Aeroplanes on the Ground'.

Update the document 'AEA Recommendations for De-icing/Anti-icing Aeroplanes on the Ground', as required, to ensure continued compliance with all relevant standards and regulatory requirements, and to ensure that it continues to reflect current industry best practice.

Develop standards and specifications related to the de-icing/anti-icing of aeroplanes on the ground in conjunction with international standards organizations.

Prepare training material for aeroplane ground de-icing/anti-icing purposes.

Harmonize with other organisations in the aeroplane ground de-icing/anti-icing field (for example SAE, ISO, IATA, ICAO and regulatory authorities).

Assess the environmental impact of processes and materials used for aeroplane ground de-icing/anti-icing, and promote measures to reduce the overall environmental impact of aeroplane ground operations in winter conditions.

July *2015*

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This document has been prepared by the AEA's De-icing/Anti-icing Working Group and has been approved by the AEA's Technical & Operations Committee (TOC).

No Chairman is assigned as the Working Group has a rotating chairmanship.

This document has been drafted according to the best knowledge of the authors on the standard procedures for de-icing/anti-icing of commercial transport aeroplanes. However, it reflects general recommendations only and local airworthiness agencies' rulemaking and guidance as well as aircraft manufacturers' documentation must always be followed. As individual icing situations or aeroplane types/models may require special procedures, this document can never replace the responsibility of the aeroplane operator's judgement. The responsibility for the correct de-icing/anti-icing of aeroplanes always stays with the operator of the aeroplane. Although great care has been taken, errors or misprints can occur for which neither the authors nor the AEA can be held liable. This is an AEA document that contains recommendations developed for the internal use of AEA member airlines in the first place. It may be amended at any time without prior indication. The AEA does not accept liability for any damage, personal injury, death or any other negative effect that may result from the use of the information contained in this document as a whole or parts thereof.
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Where the words "he", "his" or "him" appear in this document, or any other words indicating the male gender alone, they shall also mean the female gender.

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Table of Annexes

Annex A will be published separately later, after FAA Holdover Time Tables for next winter have been published.

1 Introduction

This edition completely replaces all previous editions.

The “AEA Recommendations for De-icing/Anti-icing Aeroplanes on the Ground” have been established by the AEA De-icing/Anti-icing Working Group.

See also www.aea.be for ‘Frequently Asked Questions’ and for the document "Training Recommendations and Background Information for De-icing/Anti-icing Aeroplanes on the Ground".

Editorial changes which do not have any technical or operational implication are not indicated by a revision bar.

Technical or operational changes and additional explanatory material in this year’s update are indicated in the manual by a Revision Bar and *Italic Font*:

Summary of changes:

- *Preamble*
  Updated edition number and revision date.
  Removed airline member name list.
  Contact details were changed.
- *Section 1 Introduction*
  Updated “Summary of changes”.
- *Section 2.1 SAE Documents*
  Updated document reference for Viscosity Test of Thickened De-icing/Anti-icing Fluid and Forced Air Or Forced Air/Fluid Equipment For Removal Of Frozen Contaminants.
- *Section 2.2 ISO documents*
  Deleted ISO references (ISO 11075, ISO 11076 and ISO 11078).
- *Section 2.3 AEA documents*
  Updated link to access AEA documents.
- *Section 3.9.2.4 Anti-icing fluid application strategy*
  Revised text on minimum quantity of fluid.
- *Section 3.9.3.1.1.2*
  Changed lower temperature limit.
  Updated reference to Annex A – HOT in Active Frost Conditions.
- *Section 3.14.3 Anti-icing Codes*
  Added wording about Type III anti-icing code (brand name, name of the fluid).
- *Section 3.15 Holdover time*
  Updated reference to Annex A.
  Added note about holdover time determination systems.
- *Section 3.15 Table 2 Application Table Type II, III and IV Fluids*
  Additional wording in second step of two step procedure (heated/unheated fluid).
  Deleted wording on Type III fluid.
  Added Note about Type III fluid.
- *Section 5 Aeroplane de-icing methods with forced air*
  Revised SAE reference.
- *Sections 6.1.3.2-6.1.3.4*
  Deleted ISO reference.

  The Type III fluid holdover time table is removed from Annex A as FAA and Transport Canada do not publish this generic Type III holdover time table anymore, they only publish Type III fluid specific holdover time tables from now on. Since the use of these fluid specific holdover time tables is fluid application specific, Type III fluids are also removed from the Application table 2 (now only for type II and IV fluids). For details on Type III fluids application, refer to FAA and/or Transport Canada.

2 References

Wherever in this document fluid Types I, II, III, or IV are indicated, this always refer to the latest version of the applicable SAE fluid types.
(For example: Type I fluid refers SAE Type I per AMS 1424. Type II fluid refers to SAE Type II per AMS 1428, etc).

2.1 SAE documents

Copies of the SAE publications are available from: SAE, 400 Common Wealth Drive, Warrendale, PA 15096-0001, USA.

See also www.sae.org

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

2.2 ISO documents

Copies of the ISO documents are available from: International Organization for Standardization, Case Postale 56, CH-1211, Genève 20, Switzerland.

See also www.iso.ch

ISO 11077 - Aerospace - Self-propelled de-icing/anti-icing vehicles - Functional requirements.

2.3 AEA documents

The documents are accessible via internet: *http://www.aea.be/news-media-room-media-centre/publications/9-recommendations-for-de-icing-anti-icing-of-aircraft-on-the-ground.html*

"Training Recommendations and Background Information for De-icing/Anti-icing Aeroplanes on the Ground"

3 Aeroplane de-icing/anti-icing methods with fluids

3.1 Scope

This section of the document establishes the minimum requirements for ground-based aeroplane de-icing/anti-icing methods with fluids and procedures to facilitate the safe operation of transport aeroplanes during icing conditions (see also section 3.9.3.2). This does not specify requirements for particular aeroplane types.

NOTE: Particular airline or aircraft manufacturer's published manuals, procedures or methods supplement the information contained in this document.

Frost, ice or snow deposits, which can seriously affect the aerodynamic performance and/or controllability of an aeroplane, are effectively removed by the application of the procedures specified in this document.

3.2 (Deleted)

3.3 Definitions

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

3.3.1 active frost:

Active frost is a condition when frost is forming. Active frost occurs when aeroplane surface temperature is:
- at or below 0 ºC (32°F)
  and
- at or below dew point

3.3.2 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 aeroplane for a limited period of time (holdover time).

3.3.3 anti-icing fluid:

a) mixture of water and Type I fluid;
b) Premix Type I fluid;
c) Type II fluid, Type III fluid, or Type IV fluid;
d) mixture of water and Type II fluid, Type III fluid, or Type IV fluid.

NOTE: Fluids mentioned in a) and b) must be heated to ensure a temperature of 60 °C (140 °F) minimum at the nozzle.

3.3.4 check:

An examination of an item against a relevant standard by a trained and qualified person.

3.3.5 cold-soak effect:

The wings of an aeroplane are said to be "cold-soaked" when they contain very cold fuel as a result of having just landed after a flight at high altitude or from having been re-fuelled with very cold fuel. Whenever precipitation falls on a cold-soaked aeroplane when on the ground, clear icing may occur. Even in ambient temperatures between -2 °C and +15 °C (28 °F and 59 °F), ice or frost can form in the presence of visible moisture or high humidity if the aeroplane structure remains at 0 °C (32 °F) or below. Clear ice is very difficult to be detected visually and may break loose during or after takeoff.
The following factors contribute to cold-soaking: temperature and quantity of fuel in fuel cells, type and location of fuel cells, length of time at high altitude flights, temperature of re-fuelled fuel and time since re-fuelling.

3.3.6 contamination:

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

3.3.7 contamination check:

Check of aeroplane surfaces for contamination to establish the need for de-icing.

3.3.8 de-icing:

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

3.3.9 de-icing/anti-icing:

Combination of the procedures 'de-icing' and 'anti-icing'. It may be performed in one or two steps.

3.3.10 de-icing fluid:

a) heated water;
b) mixture of water and Type I fluid;
c) Premix Type I fluid;
d) Type II, Type III, or Type IV fluid;
e) Mixture of water and Type II, Type III, or Type IV fluid.

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

3.3.11 freezing drizzle:

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

3.3.12 freezing fog:

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

3.3.13 frost/hoar frost:

Ice crystals that form from ice saturated air at temperatures below 0 °C (32 °F) by direct deposition on the ground or other exposed objects.

3.3.14 hail:

Precipitation of small balls or pieces of ice with a diameter ranging from 5 to >50 mm (0.2 to >2.0 inches) falling either separately or agglomerated.

3.3.15 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 aeroplane, under weather conditions as specified in section 3.15.

3.3.16 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 inch) or less.
The pellets of ice usually bounce when hitting hard ground.

3.3.17 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 inch) or smaller drops which, in contrast to drizzle, are widely separated. Measured intensity of liquid water particles is up to 2.5 mm/hour (0.10 inch/hour) or 25 grams/dm^2/hour with a maximum of 0.25 mm (0.01 inch) in 6 minutes.

3.3.18 Lowest Operational Use Temperature (LOUT):

The lowest operational use temperature (LOUT) is the higher (warmer) of

a) The lowest temperature at which the fluid meets the aerodynamic acceptance test (according to AS5900) for a given type (high speed or low speed) of aeroplane or
or
b) The freezing point of the fluid plus the freezing point buffer of 10 °C (18 °F) for Type I fluid and 7 °C (13 °F) for Type II, III or IV fluids.

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

3.3.19 moderate and heavy freezing rain:

Precipitation of liquid water particles which freezes upon impact with the ground or other exposed objects, either in the form of drops of more than 0.5 mm (0.02 inch) or smaller drops which, in contrast to drizzle, are widely separated. Measured intensity of liquid water particles is more than 2.5 mm/hour (0.10 inch/hour) or 25 grams/dm^2/hour.

3.3.20 negative buffer:

A negative buffer exists when the freezing point of a de-icing fluid is above the OAT.

3.3.21 rain or high humidity (on cold soaked wing):

Water, visible moisture or humidity forming ice or frost on the wing surface, when the temperature of the aeroplane wing surface is at or below 0 °C (32 °F).

3.3.22 rain and snow:

Precipitation in the form of a mixture of rain and snow.

3.3.23 rime ice:

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

3.3.24 snow:

Precipitation of ice crystals, most of which are branched, star-shaped or mixed with unbranched crystals. At temperatures higher than -5 °C (23 °F), the crystals are generally agglomerated into snowflakes.

3.3.25 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 inch). When snow grains hit hard ground, they do not bounce or shatter.

NOTE: For holdover time purposes treat snow grains as snow.

3.3.26 snow pellets:

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

NOTE: For holdover time purposes treat snow pellets as snow.

3.3.27 slush:

Snow or ice that has been reduced to a soft watery mixture.

3.4 Abbreviations

°C:	degrees Celsius
°F:	degrees Fahrenheit
AFM:	Airplane Flight Manual
AMM:	Aircraft Maintenance Manual
APU:	Auxiliary Power Unit
FAA:	Federal Aviation Administration
FP:	freezing point
LOUT:	Lowest Operational Use Temperature
OAT:	Outside Air Temperature
TC:	Transport Canada

3.5 General

A Commander shall not commence take-off unless the external surfaces are clear of any deposit which might adversely affect the performance and/or controllability of the aeroplane except as permitted in the Airplane Flight Manual.

For this reason a Contamination Check of the aeroplane surfaces shall be performed prior to departure.

3.6 Staff training and qualification

De-icing/anti-icing procedures must be carried out exclusively by personnel trained and qualified on this subject.
Companies providing de-icing/anti-icing services should have both a Qualification Programme and a Quality Assurance Programme to monitor and maintain an acceptable level of competence.

3.6.1 Training requirements

3.6.1.1 Theoretical Training

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 aeroplane 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 laid down in section 3.6.2.

The theoretical examination shall be in accordance with EASA Part 66 or any equivalent requirements. The pass mark shall be 75% and only persons passing this examination can be qualified.

3.6.1.2 Practical Training (Initial)

For personnel performing the actual de-icing/anti-icing treatment on aeroplanes for the first time, practical training with the de-icing/anti-icing equipment and an aeroplane shall be included.

An aeroplane is required in order to familiarize new trainees with the relevant typical aeroplane surfaces/ components and identification of no spray areas.

Prior to receiving final qualification, personnel performing de-icing/anti-icing operations (driving and/or spraying) shall demonstrate competence in removing frozen contamination under operational conditions, to a qualified trainer or supervisor.

Details of this assessment shall be recorded.

3.6.1.3 Practical Training /Annual Recurrent)

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

3.6.2 Training subjects shall include but are not limited to the following (when applicable):

a) Effects of frost, ice, snow, slush and fluids on aeroplane performance.
b) Basic characteristics of aircraft de-icing/anti-icing fluids, including causes and consequences of fluid degradation, fluid remaining on surfaces, and dried and/or rehydrated residues.
c) General techniques for removing deposits of frost, ice, slush, and snow from aeroplane surfaces and for anti-icing.
d) De-icing/anti-icing procedures in general and specific measures to be performed on different aeroplane types.
e) Types of checks 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) De-icing/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.
n) Conditions which can lead to the formation of ice on the aeroplane.

NOTE: Refer to the AEA document "Training Recommendations and Background Information for De-icing/Anti-icing Aeroplanes on the Ground" for more detailed information about training subjects.

3.6.3 Training Records

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

3.7 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 environmental and health laws and the fluid manufacturer's safety data sheet.

Different products shall not be mixed without additional qualification testing.

3.7.1 Storage

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

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

3.7.1.3 Tanks shall be conspicuously labelled to avoid contamination.

3.7.1.4 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.

NOTE: If the quality of the fluids is checked in accordance with section 6.3.4, the inspection interval may be longer than one year.

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

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

3.7.2 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.

3.7.3 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.

3.7.4 Heating

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

The fluids shall be checked periodically in accordance with section 6.3.

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

3.7.5 Application

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

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

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

3.8 Contamination Check

This is a check for the need to de-ice. This check shall include the areas mentioned in section 3.10.1.1 through 3.10.1.8 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 section 3.10.1.1 and 3.10.1.7, shall be removed by a de-icing treatment. If anti-icing is also required, this treatment may be performed as a one-step or two-step de-icing/anti-icing of the relevant surfaces.

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

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

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

3.9 Procedures

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

When aeroplane surfaces are contaminated, they shall be de-iced prior to dispatch. When there is a risk of contamination of the aeroplane surfaces at the time of dispatch, these surfaces shall be anti-iced. If both de-icing and anti-icing are required, the procedure may be performed in one or two steps. The selection of a one- or two-step process depends upon weather conditions, available equipment, available fluids and the holdover time to be achieved. If a one-step procedure is used, then both section 3.9.1 and 3.9.2 apply.

For guidance regarding fluid limitations, see section 3.9.3.1.

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

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

3.9.1 De-icing

Ice, snow, slush or frost may be removed from aeroplane surfaces by heated fluids, mechanical methods, alternate technologies or combinations thereof. The following procedures shall be used for their removal by fluids.

NOTE 1: Alternate technology may be used to accomplish the de-icing process, provided that the requirements in section 3.10 are accomplished.

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

It is the responsibility of the De-icing Operator to ensure that all frozen deposits (with the possible exception of frost which may be allowed as described in section 3.10.1.1 and 3.10.1.7) are removed from the specified surfaces during the de-icing process.

3.9.1.1 Requirements

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

3.9.1.2 General

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

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

3.9.1.3 Removal of frost and light ice

3.9.1.3.1 General procedure

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 aeroplane skin, a minimal amount of fluid will be required to melt the deposit.

3.9.1.3.2 Removal of local area contamination

When no precipitation is falling or expected, a “local area” de-icing may be carried out under the below mentioned or similar conditions.
In some cases a full or complete de-icing is not necessary. When the presence of frost and/or ice is limited to localised areas on the surfaces of the aeroplane and no holdover time is likely to be required, only the contaminated areas will require treatment.
This type of contamination will generally be found on the wing and/or stabilizer leading edges or in patches on the wing and/or stabilizer upper surfaces.

Spray the affected area(s) with a heated fluid/water mixture suitable for a One-Step Procedure.
Then spray the same area(s) on the other side of the aeroplane.

Both sides of the aeroplane must be treated identically (same areas, same amount and type of fluid, same mixture strength), even if the contamination is only present on one side.

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

After this check has confirmed that the treated areas are clean, the following statement shall be given to the Commander: “Local Area De-icing only. Holdover times do not apply”

3.9.1.3.3 Underwing de-icing procedures

Treatments must be symmetrical and may include flaps lower surfaces. Spray the affected areas with a heated fluid/water mixture suitable for a One-Step Procedure or a Two Step Procedure, as required, (see caution below), and then spray the same areas under the other wing.

Both wings must be treated identically (same areas, same amount and type of fluid, same mixture strength), even if the frozen contamination is only present under one wing.
No holdover times apply to underwing treatments.

It is the responsibility of the De-icing Operator to ensure that the treatment is performed symmetrically and that on completion all frozen deposits (with the possible exception of frost, which may be allowed as described in section 3.10.1.1), have been removed.

When it is confirmed that the treated areas are clean, the following statement shall be given to the Commander: “Underwing De-icing only, holdover times do not apply”

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

3.9.1.4 Removal of snow

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

NOTE: The procedure adopted will depend on the equipment available and the depth and type of snow; i.e. light and dry or wet and heavy. In general, the heavier the deposits the heavier the fluid flow that will be required to remove it effectively and efficiently from the aeroplane 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 aeroplane skin, the procedures detailed in section 3.9.1.5 should be utilised.
Heavy accumulation of snow will always be difficult to remove from aeroplane 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.

3.9.1.5 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 stream of hot fluid is directed at close range onto one spot at an angle of less than 90°, until the aeroplane skin is just exposed. The aeroplane 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 aeroplane surface. By repeating this procedure a number of times, the adhesion of a large area of frozen snow or glazed ice can be broken. The deposits can then be flushed off with either a low or high flow, depending on the amount of the deposit.

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

3.9.1.6 General de-icing fluid application strategy

For effective removal of snow and ice, the following techniques shall be adopted.
Certain aeroplanes can require unique procedures to accommodate design differences, see aircraft manufacturer's instructions.
Ice, snow or frost dilutes the fluid. Apply enough hot de-icing fluid ensure that re-freezing does not occur and all contaminated fluid is driven off.

3.9.1.6.1 Wings, horizontal stabilizer, and elevators

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

NOTE: Refer to the aircraft manufacturer’s documentation for any deviation from this procedure.

3.9.1.6.2 Vertical surfaces

Start at the top and work down.

3.9.1.6.3 Fuselage

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

3.9.1.6.4 Nose/Radome Area and Flight Deck Windows

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

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

3.9.1.6.5 Landing gears and wheel bays

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

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

3.9.1.6.6 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.

3.9.2 Anti-icing

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

3.9.2.1 Required usage

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

3.9.2.2 Optional usage

3.9.2.2.1 Type II, III, or IV fluid may be applied onto clean aeroplane surfaces at the time of arrival (preferably before unloading begins) on short turnarounds during freezing precipitation and on overnight parked aeroplanes. This will minimise ice accumulation prior to departure and often makes subsequent de-icing easier.

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

3.9.2.2.2 On receipt of a frost, snow, freezing drizzle, freezing rain or freezing fog warning from the local meteorological service, Type II, III, or IV fluid may be applied to clean aeroplane surfaces prior to the start of freezing precipitation. This will minimise the possibility of snow and ice bonding or reduce the accumulation of frozen precipitation on aeroplane surfaces and facilitate subsequent de-icing.

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

Prior to flight the aeroplane must be de-iced, unless the integrity of the fluid can be ensured.
De-ice in accordance with Table 1, whenever possible, to reduce the potential for dried residue build up.

3.9.2.3 General

For effective anti-icing, an even layer of sufficient thickness of fluid is required over the prescribed aeroplane surfaces, which are clean (free of frozen deposits). For longer anti-icing protection, Type II, Type III, or Type IV fluid should be used.
The high fluid pressures and flow rates normally associated with de-icing are not required for this operation and, where possible, pump speeds should be reduced accordingly. The nozzle of the spray gun should be adjusted to provide a medium spray.

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

3.9.2.4 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 utilise 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 aeroplane surfaces shall be visually checked during application of the fluid. For Type I fluid a minimum of 1 l/m2 with at least 60 °C at the nozzle shall be used. For Type II, III and IV fluids *which flow readily over the surfaces,* the correct amount is indicated by fluid just beginning to run off the leading and trailing edges. *For fluids which form a more static fluid layer, the minimum quantity required will typically be 1l/ m^2, applied in an even layer across the surface.*
For *further* guidance on amount of fluid refer to the AEA document "Training Recommendations and Background Information for De-icing/Anti-icing Aeroplanes on the Ground" *and/or the fluid manufacturer's documentation.*
Spray from the leading edge to the trailing edge. Do not spray from the rear.
Start at the highest point of the surfaces and work to the lowest parts, i.e. on most aeroplanes start at the wing tip and work towards the wing root. On vertical surfaces, start at the top and work down.

The following surfaces shall be treated:

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

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.

It is the responsibility of the De-icing Operator to ensure that the surfaces mentioned above are free of frost, ice, slush and snow, prior to the start of the anti-icing treatment. Ensure that on completion of the treatment these surfaces are fully covered with an adequate layer of anti-icing fluid.

3.9.3 Limits and Precautions

3.9.3.1 Fluid related limits

3.9.3.1.1 Temperature limits

When performing two-step de-icing/anti-icing, the freezing point of the fluid used for the first step shall be at OAT or below. (See also Tables 1 and 2.)

3.9.3.1.1.1 Type I fluids

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

CAUTION: Type I fluids supplied as concentrates for dilution with water prior to use shall not be used undiluted. For exceptions refer to fluid manufacturer's documentation.

3.9.3.1.1.2 Type II / Type III / Type IV fluids

Type II, III, and IV fluids used as de-icing/anti-icing agents may have a lower temperature application limit of -*23* °C (-*9* °F). The application limit may be lower, provided a 7 °C (13 °F) buffer is maintained between the freezing point of the neat fluid and OAT.
In no case shall this temperature be lower than the LOUT.

Note: These fluids may not be used below -25°C (-13°F) in active frost conditions (see *Annex A, Table 1*)**.**

3.9.3.1.2 Application limits

Under no circumstances shall an aeroplane that has been anti-iced receive a further coating of anti-icing fluid directly on top of the contaminated film.
If an additional treatment is required before flight, a complete de-icing/anti-icing shall be performed (see Application Tables 1 and 2). Ensure that any fluid remaining from previous treatment is flushed off.
Anti-icing only is not permitted.

3.9.3.2 Aeroplane related limits

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

3.9.3.3 Procedure precautions

3.9.3.3.1 One-step de-icing/anti-icing is performed with a heated anti-icing fluid (see section 3.3.3).

The fluid used to de-ice the aeroplane remains on the aeroplane surfaces to provide limited anti-ice capability.
The correct fluid concentration shall be chosen with regard to desired holdover time and is dictated by OAT and weather conditions (see Application Tables 1 and 2).

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

CAUTION: The application of Type II, III, or IV fluid, especially when used in a one step process, may cause fluid to collect in aerodynamically quiet areas, cavities and gaps which can dry out and leave dried residues..
Dried residues may rehydrate and freeze following a period of high humidity and/or rain conditions. This may impede flight control systems.
These dried residues may require removal.
Consult the aircraft manufacturer with regard to inspection methods and frequency, related maintenance requirements and aeroplane washing recommendations.

NOTE 1: If a Type II, III or IV fluid is used in a one step process, then an appropriate inspection and cleaning program shall be established. Whenever suitable, de-ice and anti-ice with only Type I.

NOTE 2: In order to detect dried residues, it may help to spray a water mist onto the affected surfaces. This causes the dried residues to rehydrate and swell into a kind of gel.

NOTE 3: If removal of contamination is required on the lower side of the wings and the horizontal stabilizer and elevator, de-icing/anti-icing fluid shall be applied sparingly to minimise fluid flow into drain holes.
Whenever possible, use Type I only.
Consult the aircraft manufacturer's documentation.

3.9.3.3.2 Two-step de-icing/anti-icing (When the first step is performed with de-icing fluid):

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

The correct fluid concentration shall be chosen with regard to desired holdover time and is dictated by OAT and weather conditions (see Application Tables 1 and 2).

The second step shall be performed before first step fluid freezes, if necessary area by area.
When treating composite surfaces, freezing may happen quickly.

It is the responsibility of the De-icing Operator to ensure that all frozen deposits have been removed from the treated surfaces, before applying the second step fluid.

When applying the second step fluid, use a spraying technique, which completely covers the first step fluid (for example using the method described in section 3.9.2.4) and provides a sufficient amount of second step fluid. For guidance on amount of fluid refer to the AEA document "Training Recommendations and Background Information for De-icing/Anti-icing Aeroplanes on the Ground".

Where re-freezing occurs following the initial treatment, both first and second step must be repeated.

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

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

NOTE 1: If a Type II, III or IV fluid is used in the first step of a two step process, then an appropriate inspection and cleaning program shall be established
Whenever suitable, de-ice and anti-ice with only Type I.

NOTE 2: In order to detect dried residues, it may help to spray a water mist onto the affected surfaces. This causes the dried residues to rehydrate and swell into a kind of gel.

NOTE 3: Anti-icing of the lower side of the wings and/or horizontal stabilizer and elevator is normally not foreseen. However, if these surfaces must be de-iced, the freezing point of the de-icing fluid must be low enough to prevent refreezing.

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

3.9.3.3.4 De-icing treatments shall be symmetrical, that is, left-hand and right-hand side of the aeroplane shall receive the same treatment, even when only one side of the aeroplane is contaminated.

Anti-icing treatments shall be also symmetrical and shall always cover the entire wing, the entire vertical stabilizer/rudder and horizontal stabilizer/elevator on both sides of the aeroplane.

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

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

3.9.3.3.6 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.

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

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

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

De-icing/anti-icing fluid shall not be directed into engine inlets or directly onto engine probes/sensors.

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

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

a) galley floor areas being contaminated with slippery de-icing fluids;
b) upholstery becoming soiled;
c) vehicles/personnel becoming contaminated with fluid.

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

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

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

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

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

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

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

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

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

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

3.9.3.3.17 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, onto the affected areas.

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

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

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

a) reason for interruption;
b) actions to be taken (in consultation with the Commander);
c) expected time of delay.

Before continuing the treatment:

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

Carry out treatment as agreed.

3.9.3.4 Clear ice precautions

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

3.9.3.4.2 Significant deposits of clear ice can form, in the vicinity of the fuel tanks, on wing upper surfaces as well as under-wing. Aeroplanes are most vulnerable to this type of build-up when:

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

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

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

NOTE 2: Low wing temperatures associated with this type of build-up normally occur when large quantities of cold fuel remain in wing tanks during the turnaround/ transit and any subsequent re-fuelling does not cause a sufficient increase in wing temperature.

3.10 General aeroplane requirements after de-icing/anti-icing

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

3.10.1.1 Wings, tail and control surfaces

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

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

3.10.1.2 Pitot heads and static ports

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

3.10.1.3 Engines

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

3.10.1.4 Air conditioning inlets and exits

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

3.10.1.5 Landing gear and landing gear doors

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

3.10.1.6 Fuel tank vents

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

3.10.1.7 Fuselage

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

3.10.1.8 Nose/Radome Area and Flight Deck Windows

Snow, slush, or ice on the windscreens or on areas forward of the windscreens shall be removed prior to departure (refer to section 3.10.1.7).
Heated flight deck windows will not normally require de-icing.

3.10.2 Flight control check

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

3.10.3 Dried fluid residues when the aeroplane has not been flown after anti-icing

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

3.10.4 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.

3.11 Post De-icing/Anti-icing Check

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

This check shall cover wings, horizontal stabilizer, vertical stabilizer and fuselage.
This check shall also include any other parts of the aeroplane on which a de-icing/anti-icing treatment was performed according to the requirements identified during the contamination check.

The check shall be performed from points offering sufficient visibility of all prescribed surfaces (e.g. from the de-icer itself or other equipment suitable for gaining access). Any contamination found, shall be removed by further de-icing/anti-icing treatment and the check repeated.

Before take-off the Commander must ensure that he has received confirmation that this Post De-icing/Anti-icing Check has been accomplished.

NOTE: For specific aeroplane types, additional requirements exist e.g. special clear ice checks, such as tactile checks on wings. These special checks are not covered by the Post De-icing/Anti-icing Check. Aeroplane operators shall make arrangements for suitably qualified personnel to meet these requirements.

Where the de-icing provider is carrying out the de-icing/anti-icing process and also the Post De-icing/ Anti-icing Check, it may either be performed as a separate check or incorporated into the de-icing operation as defined below.
The de-icing provider shall specify the actual method adopted, where necessary by customer, in his winter procedures:

a) As the de-icing/anti-icing operation progresses the De-icing Operator will closely monitor the surfaces receiving treatment, in order to ensure that all forms of frost, ice, slush or snow (with the possible exception of frost, which may be allowed as described in section 3.10.1.1 and 3.10.1.7) are removed and that, on completion of the treatment, these surfaces are fully covered with an adequate layer of anti-icing fluid..

b) Once the operation has been completed, the De-icing Operator will carry out a close visual check of the surface where treatment commenced, in order to ensure it has remained free of contamination (this procedure is not required under 'frost only' conditions).

c) Where the request for de-icing/anti-icing did not specify the fuselage, it shall also receive a visual check at this time, in order to confirm that it has remained free of contamination (with the possible exception of frost which may be allowed as described in 3.10.1.7).

d) Any evidence of contamination that is outside the defined limits shall be reported to the Commander immediately.

3.12 Pre-takeoff Check

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

3.13 Pre-takeoff Contamination Check

This is a check of the critical surfaces for contamination.
This check shall be performed when the condition of the critical surfaces of the aeroplane cannot be effectively assessed by a pre-takeoff check or when the applied holdover time has been exceeded.
This check is normally performed from outside the aeroplane.
The alternate means of compliance to a pre-takeoff contamination check is a complete de-icing/anti-icing re-treatment of the aeroplane.

3.14 Communication Procedures

The person communicating with the flight crew shall have a basic knowledge of the English language in order to communicate properly (Operational level or equivalent according to AEA Training Recommendations).
Communication between the Commander and the de-icing crew will usually be achieved using a combination of printed forms and verbal communication. For treatments carried out after aeroplane doors are closed, use of flight interphone (headset) or VHF radio will usually be required.
Electronic message boards may also be used in 'off stand' situations (see section 8.1 for details). Use of hand signals is not recommended except for the final 'all clear' signal (see section 3.14.5).
For de-icing/anti-icing operations with engines running see also section 8.1.

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

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

3.14.2 Post De-icing/Anti-icing Communication

An aeroplane shall not be dispatched for departure after a de-icing/anti-icing operation until the Commander has been notified of the type of de-icing/anti-icing operation performed (Anti-icing Code).
The Anti-icing Code (section 3.14.3) shall be provided by a qualified person at the completion of the treatment, indicating that the checked surfaces (see section 3.11) are free of ice, frost, snow, and slush, and in addition includes the necessary information to allow the Commander to estimate the holdover time to be expected under the prevailing weather conditions with reference to section 3.15.
When a treatment is interrupted for a significant period of time (e.g. truck runs out of fluid) the flight crew shall be informed stating the reason, the action to be taken and the estimated time delay.
When continuing the treatment, the previously treated surfaces must be fully de-iced and anti-iced again, when the holdover time of the treatment from before the interruption is not sufficient (see section 3.9.3.3.20).

3.14.3 Anti-icing Codes

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

a) the fluid Type; i.e. Type I, II, III, IV
b) the concentration of fluid within the fluid/water mixture, expressed as a percentage by volume;
NOTE 1: No requirement for Type I fluid.
c) the local time (hours:minutes), either
- for a one-step de-icing/anti-icing: at the start of the treatment
or
- for a two-step de-icing/anti-icing: at the start of the second step (anti-icing);
d) the date (written: day, month, year);
NOTE 2: Required for record keeping, optional for Commander notification.
e) the complete name of the anti-icing fluid (so called "brand name").
NOTE 3: *for Type III fluids only, optional* for Type II and IV fluids.
f) the statement "Post de-icing/anti-icing check completed"
NOTE 4: For specific aeroplane types, additional requirements exist e.g. special clear ice checks, such as tactile checks on wings.
Additional confirmation for these checks is required.

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

TYPE II/75 13:35 (20 Feb 2011) (Complete name of anti-icing fluid)
"Post de-icing/anti-icing check completed".

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

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

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

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 de-icing/anti-icing check.

3.14.5 All clear signal

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

3.15 Holdover time

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

Holdover time will have effectively run out when frozen deposits start to form/accumulate on treated aeroplane surfaces.
Due to their properties, Type I fluids form a thin liquid wetting film, which provides limited holdover time, especially in conditions of freezing precipitation. With this type of fluid no additional holdover time would be provided by increasing the concentration of the fluid in the fluid/water mixture.

Type II, III, and IV fluids contain a pseudo plastic thickening agent, which enables the fluid to form a thicker liquid wetting film on external aeroplane surfaces. This film provides a longer holdover time especially in conditions of freezing precipitation.
With this type of fluid additional holdover time will be provided by increasing the concentration of the fluid in the fluid/water mixture, with maximum holdover time available from undiluted fluid.
The *tables in Annex A* 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 time, these times should not be considered as minimums or maximums as the actual time of protection may be extended or reduced, depending upon the particular 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 indicates the estimated time of protection during light precipitation.

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

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 aeroplane skin temperature is lower than OAT.
Therefore, the indicated times should be used only in conjunction with a pre-takeoff check.

CAUTION: Surface coatings are currently available that may be identified as ice phobic or hydro phobic, enhance the appearance of aeroplane external surfaces and/or lead to fuel savings.
Since these coatings may affect the fluid wetting capability and the resulting fluid thickness of de-icing/anti-icing fluids they have the potential to affect holdover time and aerodynamics.
For more information see SAE AIR 6232 and consult the aircraft manufacturers

NOTE 1: Certain fluids may be qualified according to fluid specifications but may not have been tested during winter to develop the holdover time guidelines specified in this document. Holdover time guidelines in this document are not applicable to these fluids.

NOTE 2: For use of holdover time guidelines consult fluid manufacturer's technical literature for minimum viscosity limits of fluids as applied to aeroplane surfaces.

NOTE 3: A degraded Type II, Type III, or Type IV fluid may be used, provided the holdover time guidelines for Type I fluids (*Annex A, Table 1 or 2* as applicable) are used.
A Type II, Type III, or Type IV fluid is considered to be degraded if the viscosity is below the minimum limit as provided by the fluid manufacturer.
The Type II fluid holdover time guideline (*Annex A, Table 3*) may be used with degraded Type IV fluids only after substantiation by holdover time testing.

NOTE 4: Holdover time guidelines can also be obtained for individual fluid products and these ”brand name” holdover times will be found to differ from the tables published here.
If an airline decides to use these brand name tables it shall refer to the FAA or TC documentation, particularly for the application of the ‘light’ and ‘very light snow’ columns.

NOTE 5: Holdover time determination systems (HOTDS) are available to determine holdover times based on liquid water equivalent (LWE) and OAT. These holdover times may differ from those published in Annex A of this document.

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

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

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

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

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

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

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

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

OAT [1]	Concentration of neat fluid/water mixture in vol%/vol%		
	One-Step Procedure	Two-Step Procedure	
	De-icing/ Anti-icing	First step: De-icing	Second step: Anti-icing [2]
0 °C (32 °F) **and above**	**50/50** Heated [3] Type II or IV fluid/water mixture	Heated water or a heated Type I, II or IV fluid/water mixture	**50/50** *Heated/unheated* Type II or IV fluid/water mixture
below 0 °C (32 °F) to **-3 °C** (27 °F)	**50/50** Heated [3] Type II or IV fluid/water mixture	Heated Type I, II or IV fluid/water mixture with a freezing point at OAT or below	**50/50** *Heated/unheated* Type II or IV fluid/water mixture
below -3 °C (27 °F) **to -14 °C** (7 °F)	**75/25** Heated [3] Type II or IV fluid/water mixture	Heated Type I, II or IV fluid/water mixture with a freezing point at OAT or below	**75/25** *Heated/unheated* Type II or IV fluid/water mixture
below -14 °C (7 °F) **to -*23* °C** (- *9* °F)	**100/0** Heated [3] Type II or IV	Heated Type I, II or IV fluid/water mixture with a freezing point at OAT or below	**100/0** *Heated/unheated* Type II or IV
below -*23* °C (- *9* °F)	Type II /Type IV fluid may be used below -*23* °C (-*9* °F) provided that the freezing point of the fluid is at least 7 °C (13 °F) below OAT and that aerodynamic acceptance criteria are met (LOUT). NOTE: Type II/Type IV fluid may not be used below -25°C (-13°F) in active frost conditions. Consider the use of Type I fluid/water mixture when Type II or IV fluid cannot be used (see Table 1).		

[1] Fluids must only be used at temperatures above their LOUT.
[2] To be applied before first step fluid freezes.
[3] Clean aeroplanes may be anti-iced with unheated fluid.

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

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

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

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

NOTE: Type III fluid has been removed from this table since the application of the current Type III fluids is fluid specific and does not fit this table.

4 Aeroplane de-icing methods with infrared technology

Refer to SAE ARP 4737 section 6 for cautions and minimum requirements to be considered for this method.

5 Aeroplane de-icing methods with forced air

Refer to *AIR* 6284 for cautions and minimum requirements to be considered for this method.

6 Quality Assurance Programme

6.1 Station Quality Assurance Programme for Aeroplane De-icing/Anti-icing Operations

6.1.1 Introduction

A programme, which ensures compliance with the relevant sections of EU-OPS, shall be introduced for all on-line Stations where aeroplane de-icing/anti-icing is either normally carried out, or where local conditions may periodically lead to a requirement for aeroplane to be de-iced/anti-iced. Deficiencies, in regard to a Station's local de-icing/anti-icing procedures, shall be identified and subsequently actioned through this Programme, thereby ensuring that the required safety standards are maintained.
It is the responsibility of *..... to ensure;

1) compliance with this programme
2) that any outstanding deficiencies (negative responses) identified, are resolved as a matter of urgency
3) that an effective audit programme is maintained.

(* Official nominated by aeroplane operator)

NOTE: An example for a "De-icing/Anti-icing - Quality Assurance Checklist and Report" is given in section 6.1.4. However, it should be noted that this list is just an example and therefore might not reflect today's practices.

6.1.2 Inspection requirements

Prior to the start of each winter period complete a "De-icing/Anti-icing - Quality Assurance Checklist and Report". Distribute copies of this report to the addressees listed at the end of this report. Ensure that all negative responses are actioned within the time scale annotated in this report. Then complete and distribute updated copies of this report.

When a new Station is to be opened up, an initial inspection must be carried out, before the start of operations. Firstly, complete a "De-icing/Anti-icing - Quality Assurance Checklist and Report", then distribute copies of this report to the addressees listed at the end of this report. Immediately prior to the start of operations carry out a follow up inspection, ensuring that all negative responses have been actioned. Then complete and distribute updated copies of the "De-icing/Anti-icing - Quality Assurance Checklist and Report".

6.1.3 Responsibilities

Responsibility for the delegation, regulation and control of aeroplane ground de-icing/anti-icing operations are defined in Company procedure ……
The following responsibilities apply in regard to aeroplane operating under snow and ice conditions:

6.1.3.1 *..... shall be responsible for ensuring that the necessary infrastructure is in place at the Stations under their control, in order to maintain safe operations during ground icing conditions.

(* Official nominated by aeroplane operator)

6.1.3.2 The Company responsible for the de-icing/anti-icing operation (further called “de-icing company”) shall maintain vehicles/equipment, fluids, training and procedures, in accordance with the latest edition of the relevant ISO specifications or SAE documents (ARP 4737, AMS 1424, AMS 1428, ARP 1971) or the AEA recommendations on de-icing.

6.1.3.3 Personnel carrying out the de-icing/anti-icing operation are responsible for ensuring that the task is performed in accordance with the requirements detailed in the latest edition of the Aircraft Maintenance Manual or SAE ARP 4737 or AEA recommendations on de-icing.

6.1.3.4 The person responsible for final release/dispatch of the aeroplane is responsible for ensuring that the aeroplane has been de-iced/anti-iced in accordance with the requirements detailed in the latest edition of the Aircraft Maintenance Manual or SAE ARP 4737 or AEA recommendations on de-icing ensuring that relevant surfaces are free of frost, ice, slush and snow at the time of dispatch.

6.1.3.5 After receiving the Anti-icing Code, the Commander (pilot in command) is responsible for ensuring that the relevant surfaces remain free of frost, ice, slush and snow until takeoff.

6.1.4 De-icing/Anti-icing Quality Assurance Checklist and Report

STATION NAME: ..... **DATE:** ..... **Report No.:** .....

INSPECTED BY: ..... **TITLE:** ..... **AIRLINE:** .....

Type of inspection Initial: o Annual: o Follow up: o Other: .....

I Handling company performing de-icing/anti-icing: .....

Type of company:

Airline ☐ Ground handling ☐ Other (specify) ..... ISO 9000 certified ☐

Airlines using the company for de-icing/anti-icing services:

.....

II Handling company performing inspection after de-icing/anti-icing: Same as above ☐
(Fill in if not the same as above)

.....

Type of company:

Airline ☐ Ground handling ☐ Other (specify) ..... ISO 9000 certified ☐

Airlines using the company for inspection after de-icing/anti-icing services:

.....

Findings/Recommendations (for details see checklist and findings summary on last page):

No findings ☐	Minor findings ☐	Safety related findings ☐

Restrictions: Yes ☐ No ☐
(Specify if yes)
.....

Corrective measures required prior to de-icing/anti-icing operation: Yes ☐ No ☐
Follow-up audit required prior to de-icing/anti-icing operation: Yes ☐☐ No ☐

Recommended audit interval (specify) ..... Remarks: .....

Signature: ..... Date: .....

6.1.4. A General Information
6.1.4. A 1 Contact Addresses

I Handling company performing de-icing/anti-icing: .....

Responsible Mgr: ..... Telephone: .....

Address: ..... Fax: .....

..... E-Mail: .....

..... SITA Telex: .....

II Handling company performing inspection after de-icing/anti-icing: Same as above ☐
(Fill in if not the same as above)

.....

Responsible Mgr: ..... Telephone: .....

Address: ..... Fax: .....

..... E-Mail: .....

..... SITA Telex: .....

6.1.4.A 2 Fluids *

		Specification fluid released to				
		ISO11075	ISO11078	AMS1424	AMS1428	others
Fluid A:	Manufacturer:					
	Brand name/type:					
Fluid B:	Manufacturer:					
	Brand name/type:					
Fluid C:	Manufacturer:					
	Brand name/type:					

* Specify above all de-icing/anti-icing fluids likely to be used on the aeroplane by the previously named Handling Company.
It is up to the individual Airline to approve the listed fluid(s)

6.1.4 A 3 Miscellaneous

De-icing/anti-icing procedure manuals are available from following Airlines	
Valid contracts are signed with the following Airlines	
Are valid AEA recommendations, ISO 11076 or ARP4737 available (specify)	
Start of winter operation (readiness of vehicles/fluids)	
End of winter operation	
List companies , which may be called on to provide ad-hoc de-icing/anti-icing operations and complete separate audit survey for each Handling Company if they are providing services	
List companies, which may be called on to provide ad-hoc inspection after de-icing/anti-icing operations and complete separate audit survey for each Handling Company if they are providing services	

6.1.4 B Station Inspection Checklist

Complete the following Inspection Checklist during each winter period.

Request by a separate letter to the Handling Company that all negative responses are rectified within a time scale.

Checklist details:
Items should be answered with Y (yes) or N (no) or recorded as 'N/A' if not applicable
Unsatisfactory items should be marked with 'X' or as 'C' and comments recorded.
Certain other items call for specific values to be recorded.
In the case that an observation may not always be possible for any reasons, the items should be marked as 'N/O'.

Q-Nr.	Questions	Y/N/ X/C	Comments
	De-icing/anti-icing Fluids		
1.	Are fluid release documents (Certificate of Conformance) received from the fluid manufacturer for each fluid delivery/batch and retained by the consignee for inspection, as necessary		
2.	Are records of refractive index checks, carried out on fluids sprayed from each operational piece of de-icing/anti-icing equipment, maintained and is the information available to aeroplane operators (where vehicles are equipped with a proportional mixture system, a representative range of samples, taken from the nozzle at typical operational settings, shall be checked)		
3.	Are records of viscosity checks, carried out on samples of Type II, III and IV fluids sprayed from the nozzle of each appropriate piece of de-icing/anti-icing equipment at typical operational settings, maintained and is the information available to aeroplane operators.		
4.	Viscosity spot checks shall be performed on each vehicle type used by the handling company. Samples shall be taken under supervision of auditor/inspector from spraying nozzles, vehicle tank and storage tank for laboratory analyses. Note identification number of vehicle from which the sample was taken (a different vehicle number should be checked at next inspection if possible). NOTE: Viscosity must be within the limits published by the fluid manufacturer		Vehicle no. checked: ....

6.1.4 B Station Inspection Checklist (continued)

Q-Nr.	Questions	Y/N/ X/C	Comments
	Training and Qualification; Personnel of company performing de-icing/anti-icing		
5.	Do the personnel carrying out the de-icing/anti-icing operation receive training in cold weather operations		
6.	What standard are they trained to Specify:		( ) AEA Recommendations ( ) ISO 11076 ( ) SAE ARP 4737 ( ) Company Procedure (specify) ( ) Others (specify)
7.	Do they receive annual refresher training		
8.	Are training records maintained		
9.	How is the success of the training evaluated		( ) Theoretical Test ( ) Practical Test ( ) No Test

Q-Nr.	Questions	Y/N/ X/C	Comments
	Training and Qualification; Personnel of company performing inspection after de-icing/anti-icing		
10.	Do the personnel who carry out the check after de-icing/anti icing receive training in cold weather operations		
11.	What standard are they trained to Specify:		( ) AEA Recommendations ( ) ISO 11076 ( ) SAE ARP 4737 ( ) Company Procedure (specify) ( ) Others (specify)
12.	Do they receive annual refresher training		
13.	Are training records maintained		
14.	How is the success of the training evaluated		( ) Theoretical Test ( ) Practical Test ( ) No Test

6.1.4 B Station Inspection Checklist (continued)

Q-Nr.	Questions	Y/N/ X/C	Comments
	De-icing/anti-icing Equipment (vehicles of each separate type/modification state to be specified)		
15.	Manufacturer/Model: ..... / ..... Total number of vehicles of this model: ..... Tank 1 Fluid*: ...../ ..... Tank 2 Fluid*: ...../ ..... Tank 3 Fluid*: ...../ ..... * Type/concentration of fluid		
16.	Are vehicle tanks/filling ports labelled for fluid Type and/or Mixture		
17.	How is Fluid Mixed		( ) By vehicle proportional mixture system ( ) Manually in vehicle ( ) In storage tank
18.	What temperature is the de-icing fluid applied at (Temperature at nozzle)		Temperature: ~ ..... °C
19.	Can Type II, III or IV fluid (undiluted or hot mixture) be sprayed without degrading the fluid beyond required limits (Refer to questions 3 and 4)		
20.	Can the de-icing fluid spray reach all appropriate parts of the aeroplane		
21.	Do vehicles fulfil the requirements of ISO 11077 (or equivalent)		
22.	Are spraying nozzles properly marked with fluid type and/or mixture rate when more than one nozzle is installed		
23.	Are vehicles maintained to a maintenance schedule		

Q-Nr.	Questions	Y/N/ X/C	Comments
	De-icing/anti-icing Equipment (vehicles of each separate type/modification state to be specified)		
24.	Manufacturer/Model: ..... / ..... Total number of vehicles of this model ..... Tank 1 Fluid*: ...../ ..... Tank 2 Fluid*: ...../ ..... Tank 3 Fluid*: ...../ ..... * Type/concentration of fluid		
25.	Are vehicle tanks/filling ports labelled for fluid Type and/or Mixture		
26.	How is Fluid Mixed		( ) By vehicle proportional mixture system ( ) Manually in vehicle ( ) In storage tank
27.	What temperature is the de-icing fluid applied at (Temperature at nozzle)		Temperature: ~ ..... °C
28.	Can Type II, III or IV fluid (undiluted or hot mixture) be sprayed without degrading the fluid beyond required limits (Refer to questions 3 and 4)		
29.	Can the de-icing fluid spray reach all appropriate parts of the aeroplane		
30.	Do vehicles fulfil the requirements of ISO 11077 (or equivalent)		
31.	Are spraying nozzles properly marked with fluid type and/or mixture rate when more than one nozzle is installed		
32.	Are vehicles maintained to a maintenance schedule		

6.1.4 B Station Inspection Checklist (continued)

Q-Nr.	Questions	Y/N/ X/C	Comments
	De-icing/anti-icing Equipment (vehicles of each separate type/modification state to be specified)		
33.	Manufacturer/Model: ..... / ..... Total number of vehicles of this model: ..... Tank 1 Fluid*: ...../ ..... Tank 2 Fluid*: ...../ ..... Tank 3 Fluid*: ...../ ..... * Type/concentration of fluid		
34.	Are vehicle tanks/filling ports labelled for fluid Type and/or Mixture		
35.	How is Fluid Mixed		( ) By vehicle proportional mixture system ( ) Manually in vehicle ( ) In storage tank
36.	What temperature is the de-icing fluid applied at (Temperature at nozzle)		Temperature: ~ ..... °C
37.	Can Type II, III or IV fluid (undiluted or hot mixture) be sprayed without degrading the fluid beyond required limits? (Refer to questions 3 and 4)		
38.	Can the de-icing fluid spray reach all appropriate parts of the aeroplane		
39.	Do vehicles fulfil the requirements of ISO 11077 (or equivalent)		
40.	Are spraying nozzles properly marked with fluid type and/or mixture rate when more than one nozzle is installed		
41.	Are vehicles maintained to a maintenance schedule		

Q-Nr.	Questions	Y/N/ X/C	Comments
	De-icing/anti-icing Facilities		
42.	Where are de-icing/anti-icing operations carried out		( ) Gate ( ) After Pushback* ( ) Remote/Centralised Position* ( ) End of Runway* ( ) Other (specify) * see question 43
43.	* Are local AIP and NOTAM/Instructions available from the Airport Authority and incorporated in the procedures of the handling company		
44.	Is the de-icing/anti-icing location negotiable		
45.	Where de-icing/anti-icing is carried out at an area away from the gate, who certifies that the aeroplane has been correctly de-iced/anti-iced and that appropriate surfaces are free of all forms of frost, ice, slush and snow		specify
46.	Does Airline personnel have access to the remote de-icing/anti-icing position		
47.	Is fluid heated in storage tanks		
48.	If heated in storage tanks, what method of heating is employed and to what temperature		Temperature: ~ ..... °C
49.	How is fluid stored		( ) Fixed Tanks ( ) Mobile Tank(s) ( ) Barrels
50.	Are all storage tanks and filling ports labelled for fluid type/mixture		
51.	Are all components of storage facility checked in accordance with ISO 11076		

6.1.4 C Comments

6.1.4 D Findings Summary

Request remedial actions for finding(s) by a letter to the Handling Company

Item / Q-Nr	Findings description

Distribution / Copies to *

* Nominated by aeroplane operator

(End of Checklist)

6.2 Fluid Sampling Procedure for Type II, Type III, or Type IV Fluids

6.2.1 Introduction

To ensure that the necessary safety margins are maintained between the start of the de-icing/anti-icing operation and takeoff, the fluid used to both de-ice and anti-ice aeroplane surfaces, must be in an ”ex-fluid manufacturers” 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 aeroplane application.
This section therefore describes the approved methods for collecting samples of Type II, III, and IV fluids, sprayed from operational aeroplane de-icing/anti-icing vehicles/equipment, prior to the necessary quality control checks (see section 6.3) being carried out.

6.2.2 Method

The preferred method is to spray the fluid onto a purpose built stand, consisting of a suitable plate (for fluid application) and an associated fluid collection system. In the absence of such a stand, the application can be made onto a clean polythene sheet (approx. 2m x 2m) laid directly on the ground.
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 3m 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.

6.2.3 Procedure

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

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

6.2.3.3 Should the refractive index indicate that the lines have not been adequately purged, repeat the 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 litres of fluid, before the lines are completely purged).

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

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

6.2.4 Reference Fluid

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

6.2.5 Identification of Samples

Attach a label to each sample, providing the following data:

6.2.5.1 Brand name and Type of the fluid (e.g. Dow UCAR ADF Concentrate/Type I, Kilfrost ABC-3/Type II, Clariant Safewing MPIV Launch/Type IV, etc.)

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

6.2.5.3 Detail where the sample was taken from (e.g. nozzle, storage tank or equipment/vehicle tank)

6.2.5.4 Mixture strength (e.g. 100/0, 75/25, etc.)

6.2.5.5 Station (e.g. BAK, etc.)

6.2.5.6 Date sample was taken

6.3 Checking Procedure for Aircraft De-icing/Anti-icing Fluids

6.3.1 Introduction

This checking procedure for aircraft de-icing/anti-icing fluids is in compliance with AEA station quality assurance programme for aeroplane de-icing/anti-icing operations and with the relevant sections of EU-OPS 1.345. The procedure ensures that the required safety standards concerning the de-icing/anti-icing fluids quality are maintained When discrepancies are found investigate and rectify, i.e. ensure the fluid is within limits prior to use.

6.3.2 Fluid Acceptance at Delivery

6.3.2.1 Check of documentation

Check that the fluid delivered corresponds to the fluid ordered.
Make sure the brand name and concentration of the product specified in the delivery documents corresponds to the delivered fluid. Each container/road tanker shall be checked.
Make sure that the brand name and the concentration of the delivered fluid corresponds to the brand name and the concentration of the storage or vehicle tanks.

6.3.2.2 Fluid Sample Checks

Before the first use of the delivered fluid for filling a storage tank or vehicle tank, take a sample from the container/road tanker (each separate compartment if applicable) and perform the following checks:

Type I fluid:
- Perform a visual contamination check according to section 6.3.6.1
- Perform a refractive index check according to section 6.3.6.2
- Perform a pH-value check according to section 6.3.6.3 *)

Type II, Type III, and Type IV fluids:
- Perform a visual contamination check according to section 6.3.6.1
- Perform a refractive index check according to section 6.3.6.2
- Perform a pH-value check according to section 6.3.6.3 *)
- Perform a field viscosity check according to fluid manufacturer's instruction(s), section 6.3.6.4, or any equivalent method.

*) Perform this check if it is suitable to identify contaminants in the fluid and/or detect degradation of the fluid used.

6.3.3 De-icing/Anti-icing Vehicle Fluid Checks

6.3.3.1 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. Where possible the sample shall be taken immediately before or during the first de-icing/anti-icing operation of the day. To preserve the integrity of the sample, it shall be protected against precipitation. Perform a refractive index check according to section 6.3.6.2 and record the results.

NOTE 1: Trucks without a mixing system
Samples may be taken from the truck tank instead of at the nozzle. Ensure that the fluid is at a uniform mixture.

NOTE 2: Trucks with proportional mixing systems
Operational setting for flow and pressure shall be used. Allow the selected fluid concentration to stabilise before taking sample (see also section 6.2.3).

NOTE 3: Trucks with automated fluid mixture monitoring system
The interval for refractive index checks has to be determined by the handling company in accordance with the system design.

6.3.3.2 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 section 6.3.6.2.

6.3.4 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 section 6.2). Samples shall be taken in all concentrations used for anti-icing.

Perform the laboratory check for fluids as follows:

Type I fluid:

- Perform a visual contamination check according to section 6.3.6.1
- Perform a refractive index check according to section 6.3.6.2
- Perform a pH-value check according to section 6.3.6.3

Type II, Type III, and Type IV fluids:

- Perform a visual contamination check according to section 6.3.6.1
- Perform a refractive index check according to section 6.3.6.2
- Perform a pH-value check according to section 6.3.6.3
- Perform a laboratory viscosity check according to section 6.3.6.5 *)

*) Not applicable to samples taken from spray nozzle(s) used for de-icing exclusively.

6.3.5 Field Check for Fluids

Field check for fluids shall be made always 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 fluid sampling procedure for Type II, Type III, or Type IV fluids (see section 6.2).

Perform the field test for fluids as follows:

Type I fluid:

- Perform a visual contamination check according to section 6.3.6.1
- Perform a refractive index check according to section 6.3.6.2
- Perform a pH-value check according to section 6.3.6.3 *)

Type II, Type III, and Type IV fluids:

- Perform a visual contamination check according to section 6.3.6.1
- Perform a refractive index check according to section 6.3.6.2
- Perform a pH-value check according to section 6.3.6.3 *)
- Perform a field viscosity check according to section 6.3.6.4

*) Perform this check if it is suitable to identify contaminants in the fluid and/or detect degradation of the fluid used.

6.3.6 Fluid Check Methods

The following checks can be performed by any equivalent method.

6.3.6.1 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.)

6.3.6.2 Refractive Index Check

- Make sure the refractometer is calibrated and clean
- Put a fluid drop taken from the sample or from the nozzle onto the test screen of the refractometer and close the prism
- Read the value on internal scale and use the correction factor given by the manufacturer of the fluid in case the temperature of the refractometer is not 20 ºC (68 °F)
- Compare the value with the refractive index limits provided by the fluid manufacturer, to ensure it is within tolerance.
- Clean the refractometer and return it into the protective cover

6.3.6.2.1 Delivery Check (All Fluids)

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

6.3.6.2.2 In-Service Check (Type I Fluid)

Ensure the freezing point of the fluid is either

a) not less than 10ºC (18ºF) below the OAT for a one-step procedure and the second step in a two-step procedure, or

b) at OAT or below for the first step fluid in a two-step procedure, and

c) that in neither case the maximum permitted concentration has been exceeded.

6.3.6.2.3 In-Service Check (Type II, III and IV Fluid)

Ensure the refractive index is within the 'in-service' limits published by the manufacturer for fluid at the applicable concentration.
For Type II, III and IV fluid/water mixtures (50/50 or 75/25) a tolerance range from the setting of -0% to + 7% may apply, depending on the product.

6.3.6.3 pH-Value Check

This check may be performed either with pH indicator paper (litmus paper) or with a calibrated or functionally tested pH measurement instrument.

NOTE: The pH check in the laboratory should be performed with a calibrated or functionally tested pH measurement instrument.

6.3.6.4 Field Viscosity Check

This check may be performed with a falling ball method, where the reference liquids represent the minimum and maximum allowed viscosities of the tested product.

- 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 into the test tool and turn it vertically and let all steel balls reach the lower end of the test tubes
- After all 3 balls have reached the bottom of the tubes, turn the tool ±180 degrees to a full vertical position
- The balls will move downwards with a different speed
- 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

6.3.6.5 Laboratory Viscosity Check

- Perform the viscosity check in accordance with SAE AIR 9968
- The measurements shall be carried out at rotation speeds of 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 fluid manufacturer

7 Local Frost Prevention in Cold Soaked Wing Areas

7.1 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 section 3. This procedure also does not relieve from any requirements for treatment and inspections in accordance with aircraft manufacturer's documentation.

7.2 Definitions

Local frost build-up: Limited formation of frost in local wing areas sub-cooled by cold fuel or large masses of cold metal; this type of frost does not cover the entire wing!

7.3 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 section 7.4.

7.4 Limits and Precautions

- This Local Frost Prevention procedure does not substitute standard de-icing/anti-icing procedures in accordance with section 3, clear ice checks or any other aircraft manufacturer requirements, nor the requirement that aeroplane 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 aeroplane 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 aeroplane. Application is acceptable at the latest when frost just starts to build up, but in this case the fluid shall be applied at a minimum temperature of 50 °C (122 °F).
  If precipitation occurred between application of the fluid and dispatch of the aeroplane and/or if precipitation is expected before takeoff, a standard de-icing/anti-icing treatment shall be performed in accordance with section 3.
- Both 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 procedure since the treatment does not cover the entire aeroplane or wing surface respectively.

7.5 Final check

A tactile check (by touch) of the treated areas and a visual check of the untreated areas of both wings shall be performed immediately before the aeroplane leaves the parking position.
These checks are conducted to insure 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, getting viscous, showing ice crystals etc.

7.6 Flight Crew Information

Following information shall be provided to the flight crew:

"Local frost prevention was accomplished".

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

8.1 Communications

During off-gate de-icing/anti-icing a two-way communication between flight crew and de-icing/anti-icing operator/supervisor must 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 aeroplane instead of flight number must 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.

During treatment all necessary information to cockpit must be given by this means (Beginning of treatment, treatment of sections requiring de-activation of aeroplane 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 refer to section 8.5.

During de-icing/anti-icing operations with engines running, both verbal and visual communications are strongly recommended to control aeroplane movement.

8.2 Taxi guidance

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

8.3 General instructions

The de-icing/anti-icing operator together with the airport authorities must publish all necessary information about how to operate on the off-gate site by NOTAM or in local AIP. This information has to 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.

8.4 Responsibilities

The responsibility to determine the need for de-icing/anti-icing before dispatch rests with the trained and qualified ground crew or flight crew who performs the Contamination Check at the gate. This information must be given in writing or verbally to the Commander of the aeroplane, who is after that responsible to proceed in order to get proper treatment.

After treatment, the result must be checked by a trained and qualified person (see section 3.11) and the anti-icing code must be given to the Commander (see section 3.14.3), after which the Commander is responsible for the airworthiness of the aeroplane.

8.5 Terminology

Following standard communication terminology is recommended during off-gate de-icing/anti-icing procedures:

(DIS = De-icing/anti-icing supervisor)
(COMMANDER = Pilot in command)

DIS: "Set parking-brakes, confirm aeroplane is ready for treatment, inform on any special requests."

After aeroplane is configured for treatment:

COMMANDER: "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.)".

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

Only after all equipment is cleared from aeroplane and all checks are completed:

DIS: "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."

COMMANDER: "De-icing/anti-icing completed, Anti-icing code is …….....”

9 Standardised training

For guidelines see "AEA Training Recommendations and Background Information for De-icing/ Anti-icing Aeroplanes on the Ground".