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B 160 DE-ICING/ANTI-ICING

Detta AIC-B återger en sammanställning av rön från aktuell internationell forskning och operationella erfarenheter. Med hänsyn till målgruppen publiceras detta AIC enbart på engelska.

Särskild uppmärksamhet bör riktas på förkortade skyddstider för vätskor av Typ I/II och den prestandapåverkan som användning av Typ IV kan medföra. Frågor om påverkan på en specifik flygplantyp skall ställas till flygplantillverkaren.

Detta AIC ersätter: AIC B 137/1994 och AIC B 147/1995.

1. Introduction

1.1 The recommended holdover times with respect to ground de-icing have been revised. This Circular incorporates the revised recommended holdover times and revised definitions together with additional de-icing information. The times and details given in the holdover time tables originate from the AEA (Association of European Airlines), booklet titled, 'Recommendations for De-icing/Anti-icing of Aircraft on the Ground' (Fourteenth Edition).

Can be downloaded from the internet at the AEA web-site: www.aea.be/special/publications

1.2 This Aeronautical Information Circular has therefore been published to:

(a) Advise operators of revised holdover times for Type I, Type II and Type IV fluids;

(b) provide additional and revised definitions, notes and precautions;

(c) advise operators of the JAA Administrative and Guidance leaflet on de-icing;

(d) advise operators of experience from incidents.

2. Sources of Further Guidance Material

2.1 It should be noted that there are four other sources of guidance material associated with de-icing, over and above the information published by aircraft manufacturers and manufacturers of de-icing fluids. Aircraft type design organisations (manufacturers) normally publish de-icing procedures in the relevant Aircraft Maintenance Manuals. They may also publish service bulletins, service letters or letters to operators to inform operators and engineering organisations of additional information, such as lists of approved fluids, feedback from other operators, de-icing techniques, etc. Other sources of guidance material include:

(a) JAR-OPS 1.345(a) and (b), JAR OPS Temporary Guidance Leaflet (TGL) 4, AMS OPS 1.915, par. 2, section 3(vi) as well as AMC OPS 1.035, par. 4.2.2(b).

(b) ICAO Doc 9640-AN/940'Manual of Aircraft Ground De-icing/Anti-icing Operations'.

(c) The Association of European Airlines (AEA) publish

'Recommendations for De-icing/Anti-icing of Aircraft on the Ground'. This document is published annually.

(d) SAE International report number SAE ARP 4737 'Aircraft De-icing/Anti-icing Methods with Fluids'.

3. Information

3.1 Holdover protection is achieved by a layer of anti-icing fluid remaining on and protecting aircraft surfaces for a period of time. With a one-step de-icing/anti-icing procedure, the holdover time begins at the commencement of de-icing/anti-icing. With a two-step procedure, the holdover time begins at the commencement of the second (anti-icing) step. Should frozen deposits form/accumulate on an aircraft surface, the holdover time will have, in effect, run out.

3.2 Holdover time is only a guideline because other variables can reduce or enhance the effectiveness of the fluid. These include high winds, jet blast, wet snow, heavy precipitation, aircraft skin temperature lower than outside air temperature, and direct sunlight.

3.3 Operators should implement a Quality Audit Programme to satisfy themselves that the service provided by contracted organisations to de-ice and anti-ice aircraft is acceptable. The same applies for operators who have their own in-house de-ice/ anti-ice services. The AEA booklet contains an example audit pro forma and checklist.

3.4 If de-icing is completed off stand, it may not always be practicable to complete the Technical Log to include the de-icing activity. When de-icing is carried out after the Technical Log has been completed, and the tear-out copy has been removed, the operator would be expected to implement a procedure for de-icing operatives to advise the flight crew of the process, and to ensure that all the details and associated codes of the de-icing activity will be recorded. It should be noted that some aircraft types will still require a physical inspection upon completion of de-icing.

3.5 It is the operators' responsibility to ensure that de-icing anti-icing fluids used are acceptable to the aircraft manufacturer, by type and proprietary brand names.

3.6 A number of de-icing fluids only have a two year shelf life, yet shelf-life expiry dates are not in all cases marked on fluid containers. Should they not be found on fluid containers, they may be recorded on the fluid delivery notes.

4. Aircraft De-icing/Anti-icing Fluids

4.1 Three different types of de-icing/anti-icing fluids are generally available:

(a) **ISO Type 1 Fluid (Unthickened) (SAE AMS1424B)**

This fluid has a high glycol content and low viscosity in its concentrated form. De-icing performance of the fluid is good. However, due to low viscosity, it provides only limited anti-icing protection during freezing precipitation. It is used predominantly for removing frozen deposits from aircraft surfaces, either as the first step in a two step operation or where precipitation has stopped. With this type of

fluid no additional protection is provided by increasing the concentration of the fluid in the fluid/water mix. Type I fluids are not coloured.

(b) **ISO Type II Fluid (Thickened) (SAE AMS 1428C)**

This fluid generally has a lower glycol content in its concentrate form than Type I fluid due to the inclusion of a pseudo plastic thickening agent.

This effectively means that when applied to the surface of an aircraft the viscosity is high, thus allowing the fluid to remain on and protect against freezing precipitation for a period of time. However, the increasing effect of the airflow over the wing during the take-off roll will effectively 'shear' the fluid, reducing its viscosity and allowing it to readily flow off the critical surfaces. With this type of fluid the holdover time can be extended by increasing the concentration of fluid in the fluid/ water mix. Type II fluids are usually straw coloured.

(c) **ISO Type IV Fluid (Thickened) (SAE AMS 1428C)**

This fluid is similar in both composition and operation to Type II fluids. However, through the use of advanced thickening systems, it is able to provide more holdover time than Type II fluids when used in concentrated form. As with Type II fluids the holdover time can be extended by increasing the concentration of fluid in the fluid/water mix. Type IV fluids are usually coloured green.

Definitions

5.1 For the purposes of this Circular, the following definitions apply:

De-icing

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

De-icing Fluid

(a) Heated Water;

(b) ISO Type I fluid in accordance with ISO 11075;

(c) Mixture of ISO Type I fluid and water;

(d) ISO Type II, or Type IV fluid in accordance with ISO 11078;

(e) Mixture of ISO Type II, or Type IV fluid and water

Anti-icing

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

Anti-icing Fluid

(a) ISO Type I fluid in accordance with ISO 11075;

(b) Mixture of ISO Type I fluid and water

(c) ISO Type II, or Type IV fluid in accordance with ISO 11078;

(d) Mixture of ISO Type II, or Type IV fluid and water.

Note: Anti-icing fluid is normally applied unheated on de-iced aircraft surfaces, but may also be applied heated.

De-icing/Anti-icing

Combination of the two procedures described above. It may be performed in either one or two steps.

Holdover Time

Estimated time for which an anti-icing fluid will prevent the formation of frost or ice and the accumulation of snow on the protected surfaces of an aircraft, under weather conditions as specified in paragraph 17.3.

Check

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

Freezing Conditions

Conditions in which the outside air temperature is below +3° C (37.4° F) and visible moisture in any form (such as fog with visibility below 1.5 km, rain, snow, sleet or ice crystals) or standing water, slush, ice or snow is present on the runway.

Frost/Hoar Frost

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

Active Frost

Active frost is a condition when frost is forming. Active frost occurs when aircraft surface temperature is at or below 0 ° C, and at or below dew point.

Freezing Fog

A suspension of numerous minute water droplets which freezes upon impact with ground or other exposed objects, generally reducing the horizontal visibility at the earth's surface to less than 1 km

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.

Freezing Drizzle

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

Light Freezing Rain

Precipitation of liquid water particles which freeze upon impact with the ground or other exposed objects, either in the form of drops of more than 0.5 mm (0.02 ins) or smaller drops which in contrast to drizzle, are widely separated. Measured intensity of liquid water particles is up to 2.5 mm per hour (0.10 ins per hour) or 25 gms/dm²/hour) with a maximum of 0.25 mm (0.01 ins) in 6 minutes.

Moderate and Heavy Freezing rain

Precipitation of liquid water particles which freeze upon impact with the ground or other exposed objects, either in the form of drops of more than 0.5 mm (0.02 ins) or smaller drops which in contrast to drizzle, are widely separated. Measured

intensity of liquid water particles is up to 2.5 mm per hour (0.10 ins per hour) or 25 gms/dm²/hour.

Rain or High Humidity (On Cold Soaked Wing)

Water forming ice or frost on the wing surface, when the temperature of the aircraft wing surface is at or below O° C (32 °F).

Rain and Snow (Sleet)

Precipitation in the form of a mixture of rain and snow. For operation in light rain and snow (sleet) treat as light freezing rain.

Slush

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

Ice Crystals/Diamond Dust

A fall of unbranched ice crystals (snow crystals are branched) in the form of needles, columns or plates.

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

Snow Pellets

Precipitation of white and opaque grains of ice. These grains are spherical or sometimes conical; their diameter is about 2-5 mm (0.1-0.2 ins). Grains are brittle, easily crushed; they bounce and break on hard ground.

Snow Grains

Precipitation of very small white and opaque grains of ice. These grains are fairly flat or elongated; their diameter is less than 1 mm (0.04 ins.). When the grains hit hard ground they do not bounce or shatter.

Hail

Precipitation of small balls or pieces of ice with a diameter ranging from 5 to > 50 mm (0.2-2 ins) failing either separately or agglomerated.

6. Operational Considerations

6.1 The application of de-icing/anti-icing fluids must be in accordance with the aircraft manufacturers practices and procedures.

6.2 The operator should comply with any operational requirements such as an aircraft mass decrease and/or an increased take-off speed when operating with a particular fluid applied to the aircraft. Thickened fluids are known to have caused loss of aerodynamic lift problems on, particularly, turbo-prop aircraft with rotation speeds of less than 100 kts, and turbo-jet aircraft have been similarly affected.

6.3 The operator should take into account any changes to flight handling procedures, stick force, rotation speed and rate, take-off speed, aircraft attitude, etc. stipulated by the aircraft manufacturers associated with a particular fluid applied to the aircraft.

6.4 The limitations or handling procedures resulting from paragraphs 6.2 and 6.3 should be included in the flight crew pre take-off briefing.

7. Subcontracting (see also JAR-OPS 1 AMC-OPS 1.035 Sections 4 and 5)

7.1 The operator should ensure that the ground handling agency or de-icing subcontractor is aware of the de-icing/anti-icing requirements for a particular aircraft type. Such subcontracting is normally determined in accordance with the IATA Airport Handling Manual, Standard Ground Handling Agreement AHM810 Annex A Section 7 Aircraft Servicing paragraph 6.

The contract should address the:

(a) Provision of the fluid to be used (it must include the proprietary or brand name which must be one specified by the aircraft manufacturer);

(b) specific aircraft type requirements which will include the application of fluids to an aircraft, details of no spray areas, techniques, aircraft configuration, inspections etc.;

(c) concentration, viscosity and degradation checks of fluids prior to use;

(d) supervision of the completion and performance of the de-icing/anti-icing operation;

(e) perform a final inspection of the aircraft after the de-icing/anti-icing operation and inform flight crew of the result.

8. Communications

8.1 Before the aircraft is to be treated with the flight crew on board, the ground crew should confirm with the former, the type of fluid to be used, the extent of treatment and any aircraft type specific procedures to be used.

8.2 The operators procedure should include an anti-icing code which indicates the process which has been applied to the aircraft. The code provides flight crew with the minimum details necessary to assess holdover time and confirms that the aircraft is clear of ice.

9. The Technical Log

9.1 An entry must be made in the aircraft technical log to record the process, even in the case of an interrupted or failed application (see JAR-OPS AMC-OPS 1.915 paragraph 2, section 3 vi). JAR-OPS requires the time the de-icing and/or anti-icing process started, the fluid type used and the mixture ratio, fluid/water, to be recorded in the aircraft technical log.

10. Pre-Take-Off Check

10.1 The commander should continually monitor the environmental situation after the performed de-icing/anti-icing treatment. Prior to take-off the commander should assess whether the applied holdover time is still appropriate and, to the extent possible, inspect the aircraft and especially any surfaces that have been de-iced remain free of contamination.

11. Maintenance Inspections and other procedures.

11.1 Repetitive application of thickened de-icing/anti-icing fluids (SAE AMS 1428) may lead to the subsequent formation/build up of a dried residue in aerodynamically quiet areas, such as cavities and gaps. This residue will re-hydrate if exposed to high humidity conditions and/or precipitation and increase to many times its original size/volume. This residue will freeze if exposed to conditions at or below 0 degrees C. This may cause moving parts such as elevators, ailerons, and flaps actuating mechanisms to stiffen or jam in flight.

Re-hydrated residues may also form on exterior surfaces, which can reduce lift, increase drag and stall speed.

Re-hydrated residues may also collect inside control surface structures and cause clogging of drain holes or flight controls imbalance.

Residues may also collect in hidden areas: Around flight control hinges, pulleys, grommets, on cables and in gaps.

The malfunction risk is especially applicable to aeroplane types with non-powered flight controls.

11.2 Detected residues must be removed before take-off.

11.3 Additional maintenance inspections may therefore be required to ensure no build up of residual or thickened anti-ice fluids has occurred in critical areas.

11.4 The operator shall request guidance/instructions from the aeroplane manufacturer.

11.5 The operator are strongly recommended to request information about the fluid dry-out and rehydration characteristics from the fluid manufacturers and to select products with optimised characteristics.

11.6 Additional information should be obtained from fluid manufactures for handling, storage, application and testing of products.

11.7 Measures related to a specific aeroplane type or operation have to be described and promulgated in details to all staff involved.

11.8 The operator shall report all associated incidents to Civil Aviation Administration, Sweden.

12. Guidance/instructions to be provided by the aeroplane manufacture

12.1 This should include but not be limited to:

- Establish satisfactory procedures to prevent, detect and remove residues of dried fluid.
- Establish appropriate inspection intervals.
- Establish appropriate maintenance procedures.

Applicability

Applicable to all aeroplane types with non-powered flight controls.

Recommended to all aeroplanes with powered flight controls.

13. Procedures

13.1 The operator should provide procedures to ground handling agencies, engineering and flight crew personnel, detailing processes, duties, and responsibilities for ground de-icing and anti-icing. Those responsibilities and tasks contracted to ground handling agencies should be subject to regular quality reviews.

14. Training Requirements

14.1 An operator should establish and provide appropriate initial and recurrent de-icing/anti-icing training for both flight and ground crew personnel. When de-icing/anti-icing is contracted out to ground handling agencies, the operator should ensure that their staff have also been suitably trained.

15. Quality

15.1 The operators Quality System should monitor that de-icing/anti-icing activities are carried out in accordance with the operators procedures at all stations where de-icing/anti-icing is carried out.

16. Application Limits

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

16.2 If an additional treatment is required before flight, a complete de-icing/anti-icing process must be performed to ensure that any residues from the previous treatment have been re-moved. Anti-icing only is not adequate.

16.3 The following Tables 1 and 2 provide guidelines for the application of Type I and Type II fluids, and they include a number of notes and cautions.

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

<table>
<tr><th>OAT</th><th>One step Procedures
De-icing/Anti icing</th><th colspan="2">Two Step Procedures</th></tr>
<tr><td></td><td></td><td>First step:
De-icing</td><td>Second Step: 1)
Anti-icing</td></tr>
<tr><td>-3° C (27° F)
and above</td><td rowspan="2">FP of heated fluid 2)
mixture shall be
at least 10° C (18° F)
below actual OAT</td><td>Water heated to 60° C
(140 °F) minimum
At the nozzle
Or a heated mix
Of fluid and water</td><td rowspan="2">FP of fluid mixture shall
be at least 10° C (18° F)
below actual OAT</td></tr>
<tr><td>Below
-3° C (27° F)</td><td>FP of heated fluid mixture
shall not be more than
3° C (5° F) above actual OAT</td></tr>
<tr><td colspan="4">NOTE: For heated fluids, a fluid temperature not less than 60° C (140° F) at the nozzle is desirable.
Upper temperature limit shall not exceed fluid and aircraft manufacturers recommendations.</td></tr>
<tr><td colspan="4">CAUTION: Wing skin temperature may be lower than OAT. A stronger mix (more glycol) can be used under these conditions.</td></tr>
<tr><td colspan="4">(1) To be applied before first step fluid freezes, typically within 3 minutes.
(2) Clean aircraft may be anti-iced with unheated fluid.</td></tr>
</table>

°C Degrees Celsius OAT Outside Air Temperature
°F Degrees Fahrenheit FP Freezing Point

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

<table>
<tr><th colspan="4">Concentration of neat fluid/water mixture in vol%/vol%</th></tr>
<tr><th rowspan="2">OAT</th><th rowspan="2">One step Procedure
De-icing/Anti icing</th><th colspan="2">Two Step Procedure</th></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td><td>First step:
De-icing</td><td>Second step: 1)
Anti-icing</td></tr>
<tr><td>-3° C (27° F)
and above</td><td>50/50 Heated 2)
Type II or IV</td><td>Water heated to 60° C (140° F)
minimum at the nozzle or a heated
mix of Type I, II or IV with water</td><td>50/50
Type II or IV</td></tr>
<tr><td>Below
-3° C (27° F)
to
-14º C (7º F)</td><td>75/25 Heated 2)
Type II or IV</td><td>Heated suitable mix of Type I, II or
IV with FP not more than 3° C
(5° F) above actual OAT</td><td>75/25
Type II or IV</td></tr>
<tr><td>Below
-14° C (7° F)
to
-250 C (-13º F)</td><td>100/0 Heated 2)
Type II or IV</td><td>Heated suitable mix of Type I, II or
IV with FP not more than 3° C
(5° F) above actual OAT</td><td>100/0
Type II or IV</td></tr>
<tr><td>Below
-25° C (-13°F)</td><td colspan="3">ISO Type II/ Type IV fluid may be used below -25°C (- 13° F) provided that the freezing point of the fluid is at least 7°C (13° F) below OAT and that aerodynamic acceptance criteria are met.
Consider the use of ISO Type I when Type II or IV fluid cannot be used (see Table 1).</td></tr>
<tr><td colspan="4">NOTE: For heated fluids, a fluid temperature not less than 60° C (140° F) at the nozzle is desirable.
Upper temperature limit shall not exceed fluid and aircraft manufacturers recommendations.</td></tr>
<tr><td colspan="4">CAUTION: Wing skin temperature may be lower than OAT.
A stronger mix (more glycol) can be used under these conditions. As fluid freezing may occur, 50/50 Type II 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.

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).</td></tr>
<tr><td colspan="4">(1) To be applied before first step fluid freezes, typically within 3 minutes. (2) Clean aircraft may be anti-iced with unheated fluid.</td></tr>
</table>

°C Degrees Celsius OAT Outside Air Temperature
°F Degrees Fahrenheit FP Freezing Point

17. Fluid Limitations

17.1 ISO Type I Fluids

The freezing point of the ISO Type I fluid used for either one-step de-icing/anti-icing or as the second step in a two-step operation must be at least 10°C below the ambient temperature.

The freezing point of the ISO Type I fluid mixture used for the first step in a two-step operation must not be more than 3°C above the ambient temperature.

17.2 ISO Type II and Type IV Fluids

(a) Approved concentrations of ISO Type II and Type IV fluids, use for either one-step de-icing/anti icing or as the second step in a two-step operation, are listed below, together with details of the lowest temperatures at which the various concentrations may be applied to aircraft surfaces:

Mixture Strength (fluid/water)	**Lower Temperature Limit For Application (OAT)**
50/50	-3° C
75/25	-14 °C
100/0	-25° C

(b) Approved concentrations of ISO Type II and Type IV fluids, used for the first step in a two-step operation, are listed below, together with details of the lowest temperatures at which the various concentrations may be applied to aircraft surfaces:

Mixture Strength (fluid/water)	**Lower Temperature Limit For Application (OAT)**
0/100 (hot water no glycol)	-3° C
25/75	-6° C
50/50	-13° C
75/25	-23 ° C
Upper wing skin temperatures may, under certain circumstances, be lower than the OAT. When this is suspected, e.g. when large quantities of 'cold' fuel remain from the previous sector, consideration should be given to selecting a stronger mix than would be required by the existing OAT. This will ensure that an adequate buffer is maintained between the freezing point of the fluid used and the temperature of the upper wing surface.	

18. De-icing/Anti-icing Holdover Times

18.1 The recommended holdover times published in the following Tables 3, 4 and 5 include notes and cautions which must be read in accordance with the tables.

18.2 Holdover times are only guidelines because ambient weather conditions and the aircraft skin temperature can reduce the effectiveness of the fluid.

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

18.3.1 Due to their properties, ISO 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 mix.

18.3.2 ISO Type II/IV fluids contain a pseudo plastic thickening agent which enable the fluid to form a thicker liquid wetting film on external aircraft surfaces. This film provides a longer holdover time especially in conditions of freezing precipitation. With this type of fluid additional holdover time will be provided by increasing the concentration of the fluid in the fluid/water mix, with maximum holdover time available from undiluted fluid.

18.3.3 The tables 3, 4 and 5 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.

18.3.4 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.

Caution:

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

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

Table 3. Guidelines for Holdover Times Anticipated for ISO Type I Fluid Mixtures as a Function of Weather Conditions and OAT

OAT Approximate Holdover Times Anticipated Under Various Weather Conditions (hours: minutes)							
°C	°F	*Frost	Freezing Fog	Snow (including snow grains)	**Freez-ing Drizzle	Light Freezing Rain	Rain on cold Soaked Wing
Above 0	Above 32	0:45	0:12-0:30	0:07-0:12	0:05-0:08	0:02-0:05	0:02-0:05
0 to - 10	32 to 14	0:45	0:06-0:11	0:03-0:06	0:05-0:08	0:02-0:05	
Below-10	below 14 .	0:45	0:06-0:09	0:02-0:04			

°C Degrees Celsius OAT Outside Air Temperature
°F Degrees Fahrenheit

*) During conditions that apply to aircraft protection for ACTIVE *FROST.*
***)* Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
Type I Fluid/Water mixture is selected, so that the freezing point of the mixture is at least 10° C (18º F) below actual OAT.

***Caution* 1:** The time *of* protection will be *shortened in* heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity or jet blast may reduce *holdover time* below the lowest time stated in the range. Holdover time may also be reduced when the aircraft skin temperature is lower than that *of* the OAT. Therefore, the *indicated times* should be used *only in conjunction with* a pre take-off *check.*
***Caution* 2:** *Fluids used* during ground de-icing/anti-icing are not intended for and do not provide ice protection during flight.
***Caution* 3:** No *Holdover Time* guidelines have been established for snow pellets, ice pellets, hail, moderate freezing rain and heavy freezing rain.

Table 4. Guidelines for Holdover Times Anticipated for ISO Type II Fluid Mixtures as a Function of Weather Conditions and OAT

OAT		**ISO Type II Fluid Concen-tration Fluid/Water (Vol%/Vol %)**	**Approximate Holdover Times Anticipated Under Various WeatherConditions** (hours: minutes)					
°C	°F		*Frost	Freezing Fog	Snow (including snow grains)	**Freezing Drizzle	Light Freezing Rain	Rain on cold Soaked Wing
Above 0	Above 32	100/0	12:00	0:35-1:30	0:20-0:55	0:30-0:55	0:15-0:30	0:05-0:40
		75/25	6:00	0:25-1:00	0:15-0:40	0:20-0:45	0:10-0:25	0:05-0:25
		50/50	4:00	0:15-0:30	0:05-0:15	0:05-0:15	0:05-0:10	
0 to –3	32 to 27	100/0	8:00	0:35-1:30	0:20-0:45	0:30-0:55	0:15-0:30	
		75/25	5:00	0:25-1:00	0:15-0:30	0:20-0:45	0:10-0:25	
		50/50	3:00	0:15-0:30	0:05-0:15	0:05-0:15	0:05-0:10	
Below	Below 27	100/0	8:00	0:20-1:05	0:15-0:35	***0:15-0:45	***0:10-0:30	
-3 to –14	to 7	75/25	5:00	0:20-0:55	0:15-0:25	***0:15-0:30	***0:10-0:20	
Below -14 to -25	Below 7 to -13	100/0	8:00	0:15-0:20	0:15-0:30			
Below -25	Below -13	100/0	ISO Type II fluid may be used below -25°C (-13°F) Provided the freezing point of the fluid is at least 7° C (13° F) below the OAT and the aerodynamit acceptance criteria are met. Consider use of ISO Type I fluid when ISO Type II fluid cannot be used (see table 3)					

°C Degrees Celsius OAT Outside Air Temperature
°F Degrees Fahrenheit Vol Volume

*) During conditions that apply to aircraft protection for ACTIVE FROST
**) Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
***) No holdover time guidelines exist for this condition below -10° C (14° F).

Caution 1: The time *of* protection will be *shortened in* heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity or jet blast may reduce *holdover time* below the lowest time stated in the range. Holdover time may also be reduced when the aircraft skin temperature is lower than that *of* the OAT. Therefore, the *indicated times* should be used only in conjunction with a pre take-off *check.*

Caution 2: *Fluids used* during ground de-icing/anti-icing are not intended for and do not provide ice protection during flight.
Caution 3: No *Holdover Time* guidelines have been established for snow pellets, ice pellets, hail, moderate freezing rain, and heavy freezing rain.

Table 5. Guidelines for Holdover Times Anticipated for SAE Type IV Fluid Mixtures as a Function of Weather Conditions and OAT

OAT		**SAE Type IV Fluid Neat Fluid/Water (Vol%/Vol%)**	**Approximate Holdover Times Anticipated Under Various Weather Conditions** (hours: minutes)					
°C	°F		*Frost	Freezing Fog	Snow (including s n o w grains)	**Freezing Drizzle	Light Freezing Rain	Rain on cold Soaked Wing
Above 0	Above 32	100/0	18:00	1:05-2:15	0:35-1:05	0:40-1:10	0:25-0:45	0:10-0:50
		75/25	6:00	1:05-1:45	0:20-0:40	0:35-0:50	0:15-0:30	0:05-0:35
		50/50	4:00	0:15-0:35	0:05-0:20	0:10-0:20	0:05-0:10	
0 to -3	32 to 27	100/0	12:00	1:05-2:15	0:30-0:55	0:40-1:10	0:25-0:45	
		75/25	5:00	1:05-1:45	0:20-0:35	0:35-0:50	0:15-0:30	
		50/50	3:00	0:15-0:35	0:05-0:15	0:10-0:20	0:05-0:10	
Below -3 to -14	Below 27 to 7	100/0	12:00	0:20-1:20	0:20-0:40	***0:20-0:45	***0:10-0:25	
		75/25	5:00	0:25-0:50	0:15-0:25	***0:15-0:30	***0:10-0:20	
Below -14 to -25	Below 7 to-13	10010	12:00	0:15-0:40	0:15-0:30			
Below -25	Below -13	100/0	SAE Type IV fluid may be used below -25°C (-13°F) Provided the freezing point of the fluid is at least 7° C(13° F) below the OAT and the aerodynamic acceptance criteria are met. Consider use of ISO Type I fluid when SAE Type IV fluid cannot be used (see table 3).					

°C Degrees Celsius OAT Outside Air Temperature
°F Degrees Fahrenheit Vol Volume

*) During conditions that apply to aircraft protection for ACTIVE FROST.
**) Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
***) No holdover time guidelines exist for this condition below -10° C (14° F).

Caution 1: The time *of protection w*ill be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high *wind* velocity or jet blast may reduce holdover time below the lowest time stated *in* the range. Holdover time may also be reduced *when* the aircraft *skin* temperature is lower *than that* of the OAT. Therefore, the indicated times should be used *only in conjunction with* a pre *take-off check.*

Caution 2: Fluids used during ground de-icing/anti-icing are *not intended for and do* not *provide ice* protection during flight.

Caution 3: No *Holdover Time* guidelines have been established for snow pellets, ice pellets, hail, moderate freezing rain and heavy freezing ram.

19. Experience From Incidents

19.1 Examples include:

- De-icing crews being called back to the aircraft following flight crew and engineering inspection.
- Problems following de-ice fluids being sprayed into no spray areas.
- Cabin crews advising flight crew of ice on upper surfaces of the wings.
- Differences between operator and contracted de-icing ground crews on the definition of a clean wing.
- Inadequate de-icing procedures and communication between de-icing crews and flight deck.
- Failures of de-icing equipment.

19.1.1 It is therefore recommended that consideration is given to the foregoing when operations and maintenance procedure are reviewed

This Circular is issued for information, guidance and necessary action.

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