Pakistan International

Great People to Fly With

Standard Operating Procedure

Guidelines for Aircraft De-icing / Anti-Icing Operations

Edition 01 (Revision 01)
Effective: 05th April, 2013

COPY No: --------

.

Approval of
Standard Operating Procedure (SOP)
Guidelines for Aircraft De-icing / Anti-Icing Operations

1st Edition (Revision 01)

	NAME	DESIGNATION	SIGNATURE	DATE
PREPARED BY	Rashid Qasier Siddqiui	Flight Manual Supervisor		March 15,13
VETTED BY	Capt.Sahms Qurishi	DGM-Corporate QA		March 20,13
REVIEWED BY	Capt.Amir Aftab	Chief Pilot- Standards Inspection		March 25 ,13
APPROVED BY	Capt. Arshad Khan	Director-Flight Operations		April 02,13

ISSUE DATE: April 05,2013	EFFECTIVE DATE: April 05,2013

DISTRIBUTION LIST

S.NO	POSITION	MODE
1	Director-Flight Operations	Hard Copy
2	Chief Pilot Standards Inspection Master	Hard Copy
3	Chief Pilot Technical (Operations)	Hard Copy
4	Chief Pilot Crew Training	Hard Copy
5	Director Corporate Safety& Quality Assurance	Hard Copy
6	General Manager-Passenger Handling Services	Hard Copy +CD
7	Deputy General Manager-Corporate Quality Assurance	Hard Copy
8	Deputy General Manager-Quality Assurance (Flight Operations)	Hard Copy
9	Deputy General Manager-Handling Agreements	Hard Copy +CD
10	Manuals Section-Flight Operations	Hard Copy

Standard Operating Procedure

Guidelines for Aircraft De-icing / Anti-Icing Operations

RECORD OF REVISIONS

Edition No.	Revision No.	Issue Date	Effective Date	Inserted By & Date
I	00	Feb 24th ,2009	Feb 24th,2009	Feb24th,2009
I	01	April 05th,2013	April 05th,2013	April 05th,2013

List of Effective Page

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Strange as it may seem, a very light coating of snow or ice, light enough to be hardly visible, will have a tremendous effect on reducing the performance of a modern airplane. These words are as true today as they were at the beginning of the heavier than air flight.

1.2 Icing-related accidents have captured the aviation industry's attention, and it is now widely understood that the problem is international, not just regional. Even the national air carriers of countries with balmy tropical climates are likely to fly to and from latitudes that can be gripped by icy conditions.

1.3 Test data indicate that ice, snow, or frost formations having a thickness and surface roughness similar to medium or coarse sandpaper on the leading edge or upper surface of a wing can reduce lift by as much as 30 percent and increase drag by 40 percent. To put it plainly, the purpose of the clean aircraft concept is to make sure that, before takeoff, the aircraft will meet its certified performance and handling characteristics.

1.4 These guide lines have been developed by the Standards Inspection Division of Flight Operations department, in light of the AEA(association of European airlines) recommendation on de icing/ anti icing of aero planes on the ground. The hold over time tables given in appendix A conform to European standards; the American and Canadian Standards are similar with little variance.

1.5 These guide lines shall be regularly reviewed and updated(normally every September) by the standards inspection division.

1.6 PHS division will ensure that the latest hold over time tables are available with local ground handlers at all relevant stations.(refer appendix B)

2 DEFINITIONS

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

2.1 Active frost

Active frost is a condition when frost is forming. Active frost occurs when aircraft surface temperature is: 1) at or below 0 ºC (32ºF), and 2) at or below dew point

2.2 Anti-icing

Precautionary ground servicing procedure which provides protection against the formation of frost or ice and accumulation of snow or slush on Anti-icing treated surface of the aircraft for a specified limited period of time (holdover time).

2.3 Anti-icing fluid

a. Type I fluid;
b. Mixture of water and 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 ºC minimum at the nozzle.

2.4 Check

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

2.5 Cold-soak effect

The wings of aircraft 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 aircraft when on the ground, clear icing may occur. Even in ambient temperatures between -2 ºC and + 15 ºC, ice or frost can form in the presence of visible moisture or high humidity if the aircraft structure remains at 0 ºC 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 or 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.

2.6 Contamination

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

2.7 Contamination Check

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

2.8 De-icing

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

2.9 De-icing/Anti-icing

Combination of the ground servicing procedures for 'De-icing' and 'Anti-icing'. It can be performed in one or two steps:

a. One Step De-icing/Anti-icing
The fluid used to de-ice the aircraft remains on its surfaces to provide limited anti-icing capability.

b. Two Step De-icing/Anti-icing
This consists of two distinct processes. The first step, de-icing, is followed (within 3 minutes) by the second step, anti-icing, as a separate fluid application. Anti-icing fluid is applied to protect the relevant surfaces thus providing maximum possible anti-icing capability.

CAUTION

Insufficient amount and/or improper application of anti-icing fluid, especially in the second step of a two step procedure, may cause a substantial loss of holdover time.

2.10 Deicing/Anti-icing Check

A preflight external check of the critical surfaces to determine if they are free of contamination after deicing/anti-icing has been completed. This may only be completed by a person holding the required de-icing/anti-icing qualifications.

2.11 De-icing fluid

a. Heated water;
b. Type I fluid;
c. Mixture of water and 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.

2.12 Freezing Conditions

When the outside air temperature is below 3°C and visible moisture is present in any form (such as fog, rain, snow, sleet, ice crystals) or if there is standing water, slush, ice or snow present on the runway.

2.13 Freezing drizzle

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

2.14 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 (5/8 mile).

2.15 Frost/hoar frost

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

2.16 Hail

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

2.17 Holdover time

Estimated time that an application of De-icing/Anti-icing fluid is effective in preventing frost, ice, or snow from adhering to protected surfaces. Holdover time starts at the beginning of the final application of Deicing/Anti-icing fluid. The degree of protection time is dependent on weather conditions and fluid used as specified in **Appendix 'A'** Holdover Time Tables.

2.18 Ice pellets

Precipitation of transparent (grains of ice) or translucent (small hail) pallets or ice, which are spherical or irregular, and which have a diameter of 5 mm (0.2 in.) or less. The pellets of ice usually bounce when hitting hard ground.

2.19 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 0.5mm (0.02 inch) or smaller drops which, in contrast to drizzle, are widely separated. Measure intensity of liquid water particles is up to 2.5 mm/hour (0.10 inch/hour) or 25 grams/dm²/hour with a maximum of 0.25 mm (0.01 inch) in 6 minutes.

2.20 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 aerodynamic acceptance test (according to AS5900) for a given type (high speed or low speed) of aircraft

Or

b. The freezing point of the fluid plus the freezing point buffer of 10 ºC for Type I fluid and 7 ºC for Type II, III or IV fluids.

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

2.21 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/dm²/hour.

2.22 Radiational Cooling

A process by which temperature decrease, due to an excess of emitted radiation over absorbed radiation. On a typical calm clear night aircraft surfaces emit long wave radiation; however, there is no solar radiation (shortwave) coming in at night and this long wave emission will represent a constant net energy loss. Under these conditions the aircraft surface temperature may be up to 4 ºC or more below that of the surrounding air.

2.23 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 aircraft wing surface is at or below 0 ºC (32 ºF).

2.24 Rain and snow

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

2.25 Snow

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

2.26 Snow grains

Precipitation of very small white and opaque particles of the ice that is fairly flat or elongated with a diameter of less than 1 mm (0.04 in.). When snow grains hit hard ground, they do not bounce or shatter.

Note: *For holdover time purpose treat snow grains as snow.*

2.27 Snow pellets

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

2.28 Slush

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

2.29 Aircraft Terms

2.29.1 **Critical Surfaces and Areas**

a. Wings including upper and lower surfaces, leading edges, wingtips, control surfaces, e.g. ailerons, slats, flaps, spoilers, speed brakes and lift-dumpers.

b. Horizontal Stabilizers including upper and lower surfaces; leading edges; control surfaces, e.g. elevators and tabs.

c. Vertical Stabilizers including left and right surfaces, leading edge, control surfaces, e.g. rudder and tabs.

d. Any other stabilizing or aerodynamic surfaces, e.g. stub wings, wing fences, winglets and strakes.

e. Fuselage mounted air brakes, e.g. Bae146.

f. Engine and APU, e.g. inlets, sensors, fan blades, guide vanes and exhausts.

g. Propellers.

h. Upper Fuselage surface (on aircraft with rear-mounted engines).

i. Instrument sensors, e.g. Pitot tube, static port, probes and angle of attack vanes.

j. Fuel vent and dump outlets.

k. Undercarriage, including oleos, locking mechanisms and doors.

2.29.2 **Representative Surface**
An aircraft surface that can be clearly observed by the flight crew from inside the aircraft for judging whether or not critical surfaces are contaminated. Its condition will fairly represent the worst condition of all the critical surfaces. This will typically be the wing leading edge in conjunction with the trailing edge. Dependent upon aircraft configuration, wing spoilers may also be used to provide an indication of fluid condition.

3 DE-ICING/ANTI-ICING OPERATIONAL PRINCIPLES

A number of operational principles concerning ground de-icing/anti-icing must be understood:-

3.1 Our responsibility is to ensure compliance with the clean aircraft concept. The Captain has the final authority to determine if the aircraft is airworthy and can operate safely after being de-iced/anti-iced. Nevertheless, the ground de-icing crew shares in this responsibility by providing an aircraft that complies with the clean aircraft concept.

3.2 De-icing is a procedure for removing frozen contamination from aircraft surfaces to provide a clean surface. Normally this is done using heated (de-icing) fluids.

3.3 Anti-icing is a precautionary procedure that protects against the formation of frozen contaminates on treated surfaces of the aircraft for a limited period (the holdover time).

3.4 De-icing/anti-icing is a combination of the de-icing and anti-icing procedures. It can be performed in a one-step or two-step operation.

3.5 The one-step procedure is a combination of de-icing and anti-icing performed at the same time with the same fluid. The fluid is heated and remains on the aircraft to provide anti-icing protection. This procedure can be repeated so as to minimize the time required to complete the final application.

3.6 The two-step procedure consists of two distinct fluid applications. The first step, de-icing with a heated fluid, is followed by the second step, anti-icing as a separate fluid application. Normally, Type II to Type IV fluid is used during the second step, but Type I fluid may be used.

3.7 Type I fluid is an un-thickened fluid that is normally applied as a mixture of glycol and water. Mainly, this fluid provides protection against refreezing when there is no delay or a minimal delay between de-icing /anti-icing and takeoff and when there is not a high liquid content of freezing precipitation.

3.8 Type II fluid is a thickened fluid that provides protection against refreezing for longer periods and can be used when longer delays are anticipated. Protection time is increased compared with Type I fluid during weather conditions with high liquid content. Type II fluid provides greater protection than type I fluid against ice, frost or snow.

3.9 Type IV fluid is an enhanced-performance fluid with characteristics similar to Type II. Its anti-icing effectiveness superior to Type II fluid and holdover time (HOT) is increased significantly under most conditions.

3.10 HOT is the estimated holdover time that the anti-icing fluid will prevent the formation of frozen contaminates on treated surfaces of the aircraft during ground operations. HOT tables are used with an operator's approved program and can be developed by the operator, provided they are more conservative than those in the currently approved tables. The HOTs are intended to be used as operational guidelines for departure planning and are used in conjunction with a check of the aircraft surfaces. Because of the many factors that affect HOTs they will never be more than estimates of the fluids' effectiveness. These factors included:-

3.10.1. Aircraft component angle, contour and surface roughness

3.10.2. Ambient temperature

3.10.3. Aircraft skin temperature

3.10.4. Fluid type

3.10.5. Fluid application procedure

3.10.6. Fluid dilution/strength

3.10.7. Fluid film thickness

3.10.8. Fluid temperature

3.10.9. Operation in close proximity to other aircraft equipment and structures

3.10.10. Operation on snow or slush or wet ramps, taxiways and runways

3.10.11. Precipitation type and intensity (rate, density and moisture content)

3.10.12. Presence of fluid

3.10.13. Radiation cooling

3.10.14. Residual moisture on aircraft surface

3.10.15. Relative humidity

3.10.16. Solar radiation; and

3.10.17. Wind direction and velocity

4 HOLDOVER TIMES ESTIMATES

4.1 Only if a scientific number could be derived to cover all these variables could the pilot determine an exact number for the HOT. Tables given as **'Appendix A'** give the guideline for holdover times anticipated for Type 1, II, III and IV fluids. These tables conform to European standards; the American and Canadian Standards are similar with little variance. These HOT tables are taken from Association of European Airlines (AEA), document on De-icing/Anti-icing.

4.1.1. The HOT is determined by the pilot based on the following information:

Precipitation type and intensity – when determining intensity consider the rate, density and moisture content of the precipitation, environmental conditions, aircraft skin temperature and operational experience of the pilot. Because the HOT is only an estimate by the pilot, it will vary based on pilot awareness, experience and degree of conservatism.

4.1.2. The HOT begins when the final application of de-icing/anti-icing fluid begins. During some weather conditions aircraft may have to be de-iced/anti-iced repeatedly, flight crew should know the start time of the final application. The ground crew communicates to the flight crew the start time of the final application of fluid and other necessary information, e.g., type of fluid and percent of glycol mix for Type II and Type IV, and that the aircraft critical surfaces have been checked.

4.1.3. HOTs do not mean that it is safe to take off in all weather conditions. The de-icing/anti-icing fluids provide no protection in flight. Therefore, during the HOT, pilot vigilance and awareness are necessary to avoid takeoff in precipitation conditions in which the aircraft is not certificated to fly.

4.1.4. The tables are only for six types of weather conditions: Active frost, freezing fog, snow/Snow Grains, freezing drizzle, light freezing rain and rain on cold-soaked wing. The times listed depend on the type of anti-icing fluid, weather and temperature.

4.1.5. Takeoff should occur before the determined holdover time expires, as shown below:-

```
Start        Start          Stop
De-icing     Anti-icing     Anti-icing                    Takeoff
  I-----------------I------------------I--------------------Taxi--------------I
                 Holdover                                  Holdover
                 Time Starts                               Time Expires
                 I---------------Holdover time-----------------------------------I
```

4.1.6. When determining the HOT, pilots must consider the numerous factors that affect the fluid's ability to provide protection against frozen contamination. Therefore, the HOT is only approximate and must be adjusted after considering all the variables.

4.1.7. Precipitation categories specify a time range or a single time. Generally, when a range is given the lower time is for moderate conditions and the upper time is for light conditions. During heavy weather conditions the HOT will be less than the lower time in the range. When a single time is given it may be necessary to adjust the HOT downward after considering all the variables.

4.1.8. It will be necessary to adjust the HOT based on the numerous factors mentioned earlier.

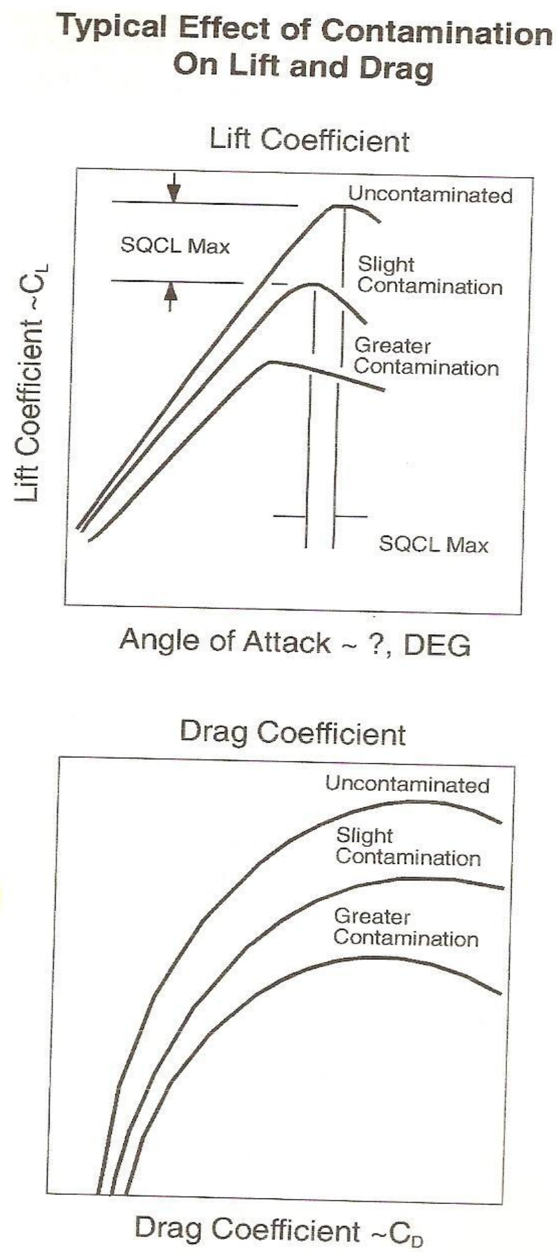
4.1.9. The HOT expires when the applied fluid loses its effectiveness or when the time determined by the flight crew expires.

5 CLEAN AIRCRAFT CONCEPT

5.1 Test data indicate that ice, snow, or frost formations having a thickness and surface roughness similar to medium or coarse sandpaper on the leading edge and upper surface of a wing can ***reduce wing lift by as much as 30 percent and increase drag by 40 percent.*** **(See Figure 01 on Page No. 15)**

5.2 These changes in lift and drag significantly increase stall speed, reduce controllability, and alter aircraft flight characteristics. Thicker or rougher frozen contaminants can have increasing effects on lift, drag, stall speed, stability and control, with the primary influence being surface roughness located on critical portions of an aerodynamic surface. These adverse effects on the aerodynamic properties of the airfoil may result in sudden departure from the commanded flight path and may not be preceded by any indications or aerodynamic warning to the pilot. Therefore, it is imperative that takeoff not be attempted unless the Pilot-in-Command has ascertained, as required by regulation that all critical surfaces of the aircraft are free of adhering ice, snow, or frost formations.

FIGURE 01



5.3 More than 30 factors have been identified that can influence whether ice, snow or frost may accumulate and cause surface roughness on an aircraft and affect the anti-icing abilities of Freezing Point Depressant FPD fluids. These factors include ambient temperature; aircraft surface (skin) temperature; de-icing fluid type, temperature, and concentration; relative humidly; and wind velocity and direction. Because many factors affect the accumulation of frozen contaminants on the aircraft surface, FPD fluids used for de-icing, anti-icing, or both should not be considered to have anti-icing qualities for a finite period. There is always a need for close inspection before takeoff.

5.4 Numerous techniques for complying with the clean aircraft concept have been developed by the aviation industry. The consensus of the aviation community is that the primary method of ensuring safe flight operations in conditions conducive to aircraft icing is through visual or physical inspection of critical aircraft surfaces to ascertain that they are clean before takeoff. This consensus is valid regardless of the de-icing and anti-icing techniques used.

5.5 Snow, frost, slush and other ice formations on other components of the aircraft, can cause undesirable local airflow restrictions of air and fluid vents. They can cause mechanical interference and restricted movement of flight controls, flap, slat, speed brake, landing gear retraction, and other mechanisms which are necessary for safe flight.

5.6 Ice formations on external instrumentation sensors, such as pitot-static ports, and angle of attack sensors can cause improper indications or improper operation of certain system and components that may be critical to safe flight.

6 PRACTICES FOR PILOTS TO ENSURE CLEAN AIRCRAFT

6.1 Be knowledgeable of the adverse effects of surface roughness on aircraft performance and flight characteristics.

6.2 Be knowledgeable of ground de-icing and anti-icing practices and procedures being used on your aircraft, whether this service is being performed by your company, a service contractor, a fixed-base operator, or others.

6.3 Do not allow de-icing and anti-icing until you are familiar with the ground de-icing practices and quality control procedures of the service organization.

6.4 Be knowledgeable of critical areas of your aircraft and ensure that these areas are properly de-iced and anti-iced.

6.5 Ensure that proper precautions are taken during the de-icing process to avoid damage to aircraft components and surfaces.

6.6 Ensure that a thorough post-de-icing/anti-icing check is performed prior to takeoff even through this may also be the responsibility of the organizations or personnel.

6.7 Be knowledgeable of the function, capabilities, limitations and operations of the ice protection systems installed on the aircraft.

6.8 Perform additional post-de-icing checks related to de-icing or anti-icing as necessary or as required.

6.9 Be aware that the time of effectiveness of FPD de-icing or anti-icing treatments can only be estimated because of the many variables that influence this time (holdover time).

6.10 Be knowledgeable of the variables that can reduce time of effectiveness (holdover time) and the general effects of these variables.

6.11 Ensure that de-icing and anti-icing are performed at the latest possible time before taxi to the takeoff position.

6.12 Do not start engines or engage rotor blades until it has been ascertained that all ice deposits have been removed. Ice particles shed from rotating components may damaged the aircraft or injure ground personnel.

6.13 Be aware that certain operations may produce recirculation of ice crystals, snow or moisture.

6.14 Be aware that operations in close proximity to other aircraft can induce snow, other ice particles, or moisture to be blown onto critical aircraft components or can cause dry snow to melt and refreeze.

6.15 Do not takeoff if snow or slush is observed splashing onto critical areas of the aircraft, such as wing leading edges, during taxi.

6.16 Do not takeoff if positive evidence of a clean aircraft cannot be ascertained.

7 POST-DEICING/ANTI-ICING CHECK

7.1 Post-deicing/anti-icing checks should be performed during or immediately following the ground deicing and anti-icing process. Areas to be inspected depend on the aircraft design and should be identified in a post-deicing checklist. The checklist should include, at minimum, all items recommended by the aircraft manufacturer. Generally checklist of this type includes the following items:-

7.1.1. Wing leading edges, upper surfaces, and lower surfaces;

7.1.2. Vertical and horizontal stabilizing devices, leading edges, upper surfaces, lower surfaces and side panels;

7.1.3. High-lift devices such as leading-edge slats and leading or trailing-edge flaps;

7.1.4. Spoilers and speed brakes;

7.1.5. All control surfaces and control balance bays;

7.1.6. Propellers;

7.1.7. Engine inlets, particle separators and screens;

7.1.8. Windshields and other windows necessary for visibility;

7.1.9. Antennas;

7.1.10. Fuselage;

7.1.11. Exposed instrumentation devices such as angle-of-attack vanes, pitot-static pressure probes and static ports;

7.1.12. Fuel tank and fuel cap vents;

7.1.13. Cooling and auxiliary power unit (APU) air intakes, inlets, and exhausts and

7.1.14. Landing gear

7.2 Once it has been determined through the post-deicing check that the aircraft is clean and adequately protected, the aircraft should be released for takeoff as soon as possible. This procedure is especially important in conditions of precipitation or high relative humidly (small temperature/dew point spread).

8 PRE-TAKEOFF CHECK

8.1 Shortly before the aircraft takes the active runway for takeoff or initiates takeoff roll, a visual pre-takeoff check is strongly recommended. The components that can be inspected vary by aircraft design. In some aircraft, the entire wing and portions of the empennage are visible from the cockpit or the cabin. In other aircraft, these surfaces are so remote that only portions of the upper surface of the wings are in view. Undersurface of wings and the undercarriage are viewable only in high-wing-type aircraft. A practice in use by some operators is to perform a visual inspection of wing surfaces, leading edges, engine inlets, and other components of the aircraft that are in view from either the Cockpit or Cabin, whichever provides the maximum visibility. The PIC may require the assistance of trained and qualified ground personnel to assist in the pre-takeoff check.

8.2 If any aircraft surfaces have not been treated with FPD fluid, the PIC or another crew member should look for, and examine any evidence of, melting snow and possible freezing. In addition, any evidence of ice formation that may have been induced by taxi operations should be removed. If the aircraft has been treated with FPD fluids, aircraft surfaces should appear glossy, smooth, and wet. If these checks indicate accumulations of ice, snow, or frost, the aircraft should be returned for additional deicing and, where appropriate, additional anti-icing.

8.3 Conducting a pre-takeoff check in the manner described requires the PIC and other crew members to be knowledgeable of ground deicing procedures and danger signs. The post-deicing check should ensure that ground deicing and anti-icing were conducted in a thorough and uniform manner and that critical surfaces or components not in view from the cockpit or cabin are also clean. The pre-takeoff check provides final confirmation for the pilot that the aircraft is free of frozen contaminants.

8.4 The decision to take off following the pre-takeoff check remains the responsibility of the PIC.

9 NEED FOR A CLEAN AIRCRAFT

9.1 FAR §§ 121.629, 125.221, 135.227, and 91.527, ICAO ANNEX 6 and similar JAR regulations prohibit takeoff when snow, ice, or frost is adhering to wings, propellers, or control surfaces of an aircraft. This is commonly referred to as the clean aircraft concept. The degradation in aircraft performance and changes in flight characteristics when frozen contaminants are present are wide ranging, unpredictable, and highly dependent upon individual aircraft design. The magnitude of these effects can be significant. It is imperative that takeoff not be attempted unless the PIC has ascertained, as required by the regulations, that all critical components of the aircraft are free of ice, snow, or frost formations.
Flight safety following ground operations in conditions conducive to icing encompasses the clean aircraft concept. Understanding the need for a clean aircraft requires knowledge of:

9.1.1. Adverse effects of ice, snow, or frost on aircraft performance and flight characteristics, which are generally reflected in the form of decreased thrust, decreased lift, increased stall speed, trim changes, and altered stall characteristics and handling qualities;
9.1.2. Various procedures available for aircraft ground de-icing and anti-icing, including the use and effectiveness of FPD fluids;
9.1.3. Capabilities and limitations of theses procedures in various weather conditions;
9.1.4. Critical areas of aircraft such as the wings and tail; and
9.1.5. Recognition that final ensurance of a safe takeoff rests in confirmation of a clean aircraft.

10 FROZEN CONTAMINANTS

10.1 Frozen contaminants in the form of ice, snow, or frost can accumulate on exterior surfaces of an aircraft on the ground. The type of accumulation on the aircraft surface is a key factor in determining the type of deicing/anti-icing procedure that should be used.

10.2 Ice, snow, and frost should be removed before takeoff, Dry, powdery snow can be removed by blowing cold air or nitrogen gas across the aircraft surface. Heavy, wet snow or ice can be removed by using solutions of heated FPD fluids and water or by mechanical means such as brooms and squeezes

1.3 Frozen contaminants can also be removed from the surface of an aircraft by using FPD fluids. There are a number of FPD's available for use on commercial large transport category aircraft. The FPD's used most often are glycol-based fluids produced by a number of North American, European, and Russian chemical manufacturers.

11 DE-ICING OF AIRCRAFT SURFACES

11.1 An aircraft must be systematically de-iced and anti-iced in weather conditions conducive to icing. Each aircraft surface requires a specific technique to achieve a clean aircraft. Figure 2 on Page No. 25 depicts the systematic De-icing of aircraft in conditions conducive to icing.

11.2 The wings are the main lifting surfaces of the aircraft and must be free of contaminants to operate efficiently. An accumulation of upper-wing frost, snow, or ice changes the airflow characteristics over the wing, reducing its lifting capabilities, increasing drag, increasing stall speed, and changing pitching moments. The weight increase is slight, and its effects are secondary to those caused by surface roughness.

11.3 On most aircraft, de-icing of the wing should begin at the leading-edge wing tip, sweeping in the aft and inboard direction. This process avoids increasing the snow-load on outboard wing sections, which under some very heavy snow conditions could produce excessive wing stresses. This method also reduces the possibility of flushing ice or snow deposits into the balance bays and cavities.

11.4 If ice accumulation is present in areas such as flap tracks and control cavities, it may be necessary to spray from the trailing edge forward. Also under some weather or ramp conditions, it is necessary to spray from the trailing edge.

11.5 The extendable surfaces of the wing (i.e. leading-edge slats and trailing-edge flaps) should be retracted to avoid accumulating frost, snow or ice during time at the gate or in overnight parking. A surface that is extended in weather conditions requiring de-icing and anti-icing should be visually inspected to ensure that the surface, tracks, hinges, seals and actuators are free of any contaminants before retraction. Flaps and slats retracted during anti-icing will not receive a protective film of FPD fluid and may freeze in precipitation or frost conditions. Consult the relevant aircraft FCOM to ascertain the most appropriate slat and flap management procedures.

11.6 The tail surfaces require the same caution afforded to the wing during the de-icing procedure. The balance bay area between moveable and stationary tail surfaces should be closely inspected. For some aircraft, positioning the horizontal stabilizer in the leading-edge-down position allows the FPD fluid and contaminants to run off rather than into balance bays.

11.7 For some aircraft, the horizontal stabilizer must be in the leading-edge-up position during de-icing.

11.8 Balance bays, control cavities, and gap seals should be inspected to ensure cleanliness and proper drainage. When contaminants do collect in the surface juncture, they must be removed to prevent the seals from freezing and impeding the movement of the control surface.

11.9 The fuselage should be de-iced and anti-iced from the top down. Clearing the top of the fuselage manually instead of by spraying requires the personnel to use caution not to damage protruding equipment (e.g. antennas) while de-icing. Spraying the upper section with heated FPD fluid first allows the fluid to flow down, warming the sides of the fuselage and removing accumulations. This is also effective when de-icing the windows and windshield of the aircraft, since direct spraying of the surfaces can cause thermal shock resulting in cracking or crazing of the windows. The FPD fluid must be removed from the crew's windows to maintain optimal visibility.

11.10 De-icing the top of the fuselage is especially important on aircraft with aft-mounted centerline and fuselage mounted engines. The ingestion of ice or snow into an engine may result in compressor stalls or damage to the engine.

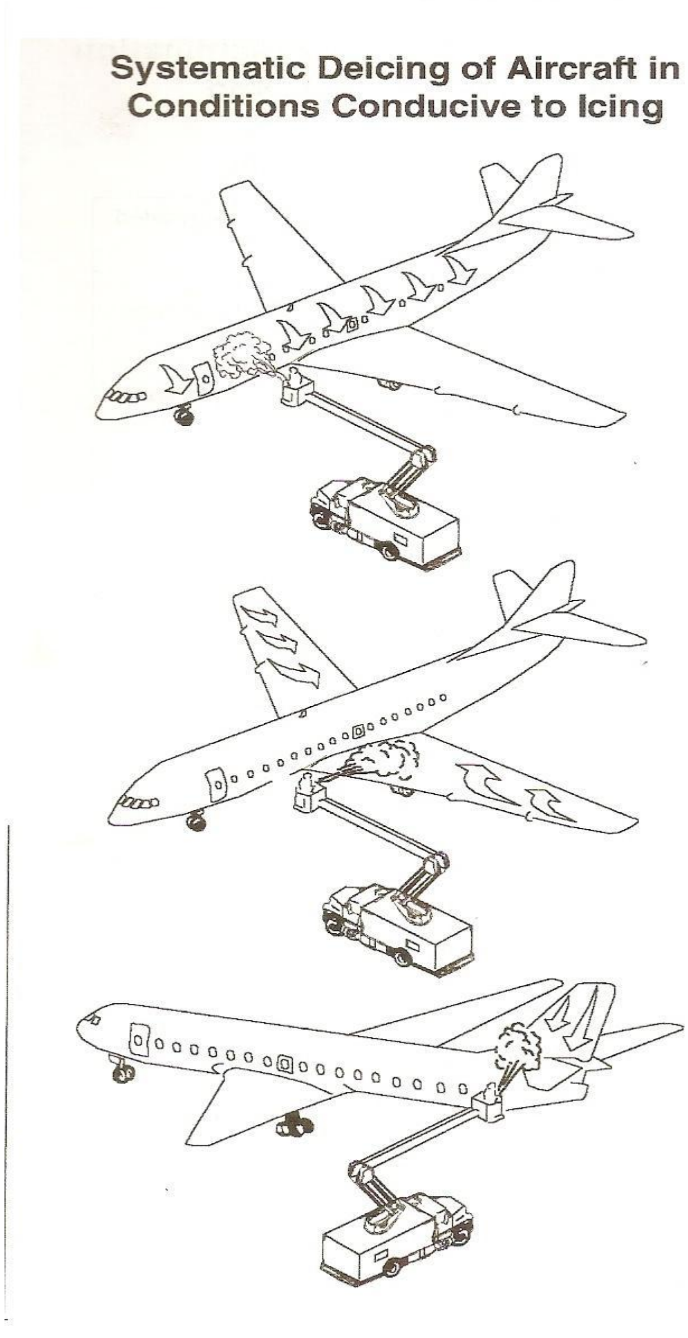
11.11 The radome or nose of the aircraft should be de-iced to eliminate snow or ice accumulations from being projected into the crew's field of vision during takeoff. This area also contains navigation and guidance equipment; therefore, it must be cleared of accumulations to ensure proper operation of these sensors.

11.12 Also, special precautions are necessary to ensure that residual fluids do not enter sensitive instrumentation or flow over the cockpit windows during taxi or takeoff.

11.13 The cargo and passenger doors must be de-iced and anti-iced in order to ensure proper operation. All hinges and tracks should be inspected to ensure that they are free of accumulation. Although accumulation may not impair operation on the ground, it may freeze at flight altitude and prevent normal operation at the aircraft's destination. Frozen accumulation may also cause damage and leakage on cargo and passenger door hatches.

11.14 Sensor orifices and probes along the fuselage require caution during the application of FPD fluid. Direct spraying into these openings and resulting fluid residue can result in faulty instrument readings. Also, when protective covers used during applications are not removed, faulty instrument readings can result.

FIGURE 02


Systematic Deicing of Aircraft in
Conditions Conducive to Icing

12 DE-ICING THE ENGINE AREA

12.1 Minimal amounts of FPD fluid should be used to de-ice the engine area and APU, FPD fluids ingested in the APU can cause smoke and vapors to enter the cabin. Engine intake areas should be inspected for the presence of ice immediately after shutdown. Any accumulation should be removed while the engine is cooling and before installation of plugs and covers. Any accumulation of water must be removed to prevent the compressor from freezing. A light coating of de-icing fluid applied to the plug may prevent the plugs from freezing to the nacelle.

12.2 Fluid residue on engine fan or compressor blades can reduce engine performance or cause stall or surge. In addition, this could increase the possibility of, or the quantity of, glycol vapors entering the aircraft through the engine.

13 KEY POINTS

13.1 The following list provides key points regarding operations in ground icing conditions and aircraft de-icing and anti-icing procedures for aircraft:-

13.1.1. Most ground de-icing related accidents have occurred when the aircraft was not de-iced before takeoff attempt.

13.1.2. The de-icing process is intended to restore the aircraft to a clean configuration so that neither degradation of aerodynamic characteristics nor mechanical interference from contaminants will occur.

13.1.3. The decision of whether or not to de-ice an aircraft is an integral part of the de-icing process.

13.2 It is essential that the PIC have thorough understandings of the de-icing and anti-icing process and the approved procedures necessary to ensure that the aircraft is clean for takeoff.

13.3 Most turbojet and turboprop engine manufacturers recommend and some AFM’s require, that thrust levers be periodically advance to an N1 rpm of 70 percent to 80 percent during ground operations. This practice prevents ice buildup that can result in reduced thrust, dynamic imbalance or the fan or compressor, or excessive induction of shed ice. The pilot must be aware of these operating procedures and should comply with procedures established for the aircraft.

14 CLEAR ICE PHENOMENA

14.1 Some aircraft have experienced formations of clear ice on the upper surfaces of wings in the vicinity of integral fuel tanks. Such ice is difficult to see and in many instances cannot be detected other than by touch with the bare hand or by means of special purpose ice detector. These phenomena typically occur on aircraft that have flown high altitude missions for a sufficient time to cold soak the fuel in tanks, and the fuel remaining in wing tanks at the destinations is sufficient to contact upper wing skins when rain or high humidity is present. Upper wing frost can also occur under conditions of high relative humidity.

14.2 In either case, ice or frost formation on upper wing surfaces must be removed prior to takeoff. Skin temperature should be increased to preclude formation of ice prior to take off. This is often possible by refueling with warm fuel.

14.3 Clear ice formations of this type can cause aircraft performance changes and can break loose at rotation or during flight, causing engine damage on some aircraft types, primarily those with rear mounted engines.

15 REMOTE DE-ICING

15.1 De-icing and anti-icing near the departure end of the runway has obvious advantages. This practice:

15.1.1. Reduces the time between de-icing / anti-icing and takeoff;

15.1.2. Facilitates the recycling of FPD in the de-icing mixture;

15.1.3. Reduces the potential environmental impact and

15.1.4. Facilitates the application of correct ratio FPD/water for existing environmental conditions at departure.

15.2 This practice is encouraged where adequate facilities exist and if performed by qualified personnel. It should not be substituted for a pre-takeoff check unless performed just prior to takeoff.

15.3 Engine running deicing is authorized at remote locations as noted on the Jeppesen pages. At all remote locations de-icing coordinator is the final authority in deciding if engine running deicing/anti-icing will be accomplished.

15.4 An operative APU is not required for engine running de-icing. During remote deicing operations at these locations, Ground Power Unit and Airstart equipment will be staged at or as near the remote locations. If engines need to be shut down at remote location, immediately inform the ground handling agent. Ground equipment shall be immediately dispatched to the aircraft to facilitate the recovery.

15.5 Aircraft specific procedures for engine running deicing can be found in the FCOM, Cold/Adverse Weather Section.

16 DE-ICING/ANTI-ICING CREW TRAINING & QUALIFICATION

16.1 De-icing/anti-icing procedures must be carried out exclusively by personnel trained and qualified on this subject.

16.2 Handling Agents 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.

16.2.1. Training for crews

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

b. Training success shall be proven by an examination/assessment which shall cover all training subjects laid down in 16.2.2

c. The theoretical examination shall be in accordance with EASA Part 66 / JAR-66 or any equivalent requirements.

d. The pass mark shall be 75% and only persons passing this examination can be qualified.

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

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

a. Effects of frost, ice, snow, slush and fluids on aircraft performance.

b. Basic characteristics of aircraft de-icing/anti-icing fluids, including causes and consequences of fluid degradation and residues.

c. General techniques for removing deposits of frost, ice, slush, and snow from aircraft surfaces and for anti-icing.

d. De-icing/anti-icing procedures in general and specific measures to be performed on different aircraft types.

e. Types of checks required.

f. De-icing/anti-icing equipment and facilities operating procedures including actual operation.

g. Safety precautions.

h. Emergency procedures.

i. Application and limitations of holdover time tables.

j. De-icing/anti-icing codes and communication procedures.

k. 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 aircraft.

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

17 QUALITY ASSURANCE

17.1 The captain is the approving authority and will make the determination of whether or not the aircraft has been properly De-iced/Anti-iced.

17.2 Handling Agreements Section (PHS Division) coordinates the monitoring surveillance of the De-icing/Anti-icing Handling Agents thru the Station Manager, at stations where de-icing / anti-icing is required on PIA Aircraft. (Refer SOP No 5 "SOP for Surveillance/Oversight Programme" as given in the PIA "Handling Agreement Manual PHS/HAM/01").The list of PIA route network stations where De-Icing/Anti-Icing is required is attached as 'Appendix-B'. An up-dated list of the De-Icing/Anti-icing Stations will be provided by the Handling Agreements Section, whenever any route station is added / deleted.

17.3 The Corporate Quality Assurance will conduct internal audits of the De-icing/Anti-icing Handling Agents at stations where de-icing / anti-icing is required on PIA Aircraft. (Refer Chapter 11.10.2 of "PIA Corporate Quality Manual CQA/M/01").

APPENDIX 'A'

Table 1 - Guidelines for holdover times anticipated for Type I, II, III and IV fluid mixtures in Active Frost Conditions as a function of OAT (Valid for metallic and composite surfaces)

Approximate Holdover Time (hours:minutes) Active Frost	OAT		Type II, III, and IV Fluid Concentration Neat Fluid/Water Vol %/Vol %	Approximate Holdover Times (hours:minutes) Active Frost		
Type I (1) (2)	°C	°F		Type II (3)	Type III (3)	Type IV (3)
0:35	-1 and above	30 and above	100/0	8:00	2:00	12:00
			75/25	5:00	1:00	5:00
			50/50	3:00	0:30	3:00
	below -1 to -3	below 30 to 27	100/0	8:00	2:00	12:00
			75/25	5:00	1:00	5:00
			50/50	1:30	0:30	3:00
	below -3 to -10	below 27 to 14	100/0	8:00	2:00	10:00
			75/25	5:00	1:00	5:00
	below -10 to -14	below 14 to 7	100/00	6:00	2:00	6:00
			75/25	1:00	1:00	1:00
	below -14 to -21	below 7 to -6	100/0	6:00	2:00	6:00
	below -21 to -25	below -6 to -13	100/0	2:00	2:00	4:00

(1) Type I fluid/water mixture is selected so that the freezing point of the mixture is at least 10 °C (18 °F) below the outside air temperature.
(2) May be used below -25 °C (-13 °F) provided the lowest operational use temperature (LOUT) of the fluid is respected.
(3) These fluids may not be used below -25 °C (-13 °F) in active frost conditions.

De-icing/anti-icing fluids used during ground de-icing/anti-icing are not intended for - and do not provide - protection during flight.

APPENDIX 'A'

Table 2 - Guidelines for holdover times anticipated for Type I fluid mixtures as a function of weather conditions and OAT (Valid for metallic and composite surfaces)

OAT (1)		Approximate Holdover Times under various weather conditions (hours:minutes)					
°C	°F	Freezing Fog	Snow/ Snow Grains/ Snow Pellets (2)	Freezing Drizzle (3)	Light Freezing Rain	Rain on Cold Soaked Wing	Other (4) (5)
-3 and above	27 and above	00:09 - 0:16	0:03 - 0:06	0:08 - 0:13	0:02 - 0:05	0:01 - 0:05 (6)	
below -3 to -6	below 27 to 21	0:06 - 0:08	0:02 - 0:05	0:05 - 0:09	0:02 - 0:05	**CAUTION:** No Holdover Time Guidelines exist	
below -6 to -10	below 21 to 14	0:04 - 0:08	0:02 - 0:05	0:04 - 0:07	0:02 - 0:05		
below -10	below 14	0:04- 0:07	0:02 - 0:04				

(1) Ensure that the lowest operational use temperature (LOUT) is respected.
(2) In light "Rain and Snow" conditions use "Light Freezing Rain" holdover times
(3) If positive identification of "Freezing Drizzle" is not possible use "Light Freezing Rain" holdover times
(4) Other conditions are: Heavy snow, ice pellets, hail, moderate freezing rain and heavy freezing rain
(5) For holdover times under active frost conditions see the separate frost table (Table 3)
(6) No holdover time guidelines exist for this condition for 0 °C (32 °F) and below

Type I Fluid/water Mixture is selected so that the Freezing Point of the mixture is at least 10 °C (18 °F) below actual OAT

CAUTION: The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity or jet blast may reduce holdover time below the lowest time stated in the range.
Holdover time may also be reduced when the aeroplane skin temperature is lower than OAT.
<u>Therefore, the indicated times should be used only in conjunction with a pre-takeoff check</u>.

De-icing/anti-icing fluids used during ground de-icing/anti-icing are not intended for - and do not provide - protection during flight.

APPENDIX ‘A’

Table 3 - Guidelines for holdover times anticipated for Type II fluid mixtures as a function of weather conditions and OAT
(Valid for metallic and composite surfaces)

OAT [1] °C	OAT [1] °F	Type II Fluid Concentration Neat-Fluid/ Water (Vol %/Vol %)	Approximate Holdover Times under various weather conditions (hours:minutes): Freezing Fog	Snow/ Snow Grains/ Snow Pellets [2]	Freezing Drizzle [3]	Light Freezing Rain	Rain on Cold Soaked Wing	Other [4] [5]
-3 and above	27 and above	100/0	0:35 - 1:30	0:20 - 0:45	0:30 - 0:55	0:15 - 0:30	0:08 - 0:40 [6]	
		75/25	0:25 - 1:00	0:15 - 0:30	0:20 - 0:45	0:10 - 0:25	0:05 - 0:25 [6]	
		50/50	0:15 - 0:30	0:05 - 0:15	0:08 - 0:15	0:05 - 0:09	**CAUTION:** No Holdover Time Guidelines exist	
below -3 to -14	below 27 to 7	100/0	0:20 - 1:05	0:15 - 0:30	0:20 - 0:45 [7]	0:10 - 0:20 [7]		
		75/25	0:25 - 0:50	0:10 - 0:20	0:15 - 0:30 [7]	0:08 - 0:15 [7]		
below -14 to -25 or LOUT	below 7 to -13 or LOUT	100/0	0:15 - 0:35	0:15 - 0:30				

(1) Ensure that the lowest operational use temperature (LOUT) is respected. Consider the use of Type I fluid when Type II fluid cannot be used.
(2) In light "Rain and Snow" conditions use "Light Freezing Rain" holdover times
(3) If positive identification of "Freezing Drizzle" is not possible use "Light Freezing Rain" holdover times
(4) Other conditions are: Heavy snow, ice pellets, moderate and heavy freezing rain, hail
(5) For holdover times under Active Frost conditions see the separate frost table (Table 3)
(6) No holdover time guidelines exist for this condition for 0 °C (32 °F) and below
(7) No holdover time guidelines exist for this condition below -10 °C (14 °F)

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

De-icing/anti-icing fluids used during ground de-icing/anti-icing are not intended for - and do not provide - protection during flight.

APPENDIX 'A'

Table 4 - Guidelines for holdover times anticipated for Type III fluid mixtures as a function of weather conditions and OAT
(Valid for metallic and composite surfaces)

OAT [1]		Type III Fluid Concentration Neat Fluid/ Water (Vol %/Vol %)	Approximate Holdover Times under various weather conditions (hours:minutes)					
°C	°F		Freezing Fog	Snow/ Snow Grains/ Snow Pellets [2]	Freezing Drizzle [3]	Light Freezing Rain	Rain on Cold Soaked Wing	Other [4] [5]
-3 and above	27 and above	100/0	0:20 - 0:40	0:10 - 0:20	0:10 - 0:20	0:08 - 0:10	0:06 - 0:20 [6]	
		75/25	0:15 - 0:30	0:08 - 0:15	0:08 - 0:15	0:06 - 0:10	0:02 - 0:10 [6]	
		50/50	0:10 - 0:20	0:04 - 0:08	0:05 - 0:09	0:04 - 0:06	**CAUTION:** No Holdover Time Guidelines exist	
below -3 to -10	below 27 to 14	100/0	0:20 - 0:40	0:09 - 0:15	0:10 - 0:20	0:08 - 0:10		
		75/25	0:15 - 0:30	0:07 - 0:10	0:09 - 0:12	0:06 - 0:09		
below -10	below 14	100/0	0:20 - 0:40	0:08 - 0:15				

(1) Ensure that the lowest operational use temperature (LOUT) is respected. Consider the use of Type I fluid when Type III fluid cannot be used.
(2) In light "Rain and Snow" conditions use "Light Freezing Rain" holdover times
(3) If positive identification of "Freezing Drizzle" is not possible use "Light Freezing Rain" holdover times
(4) Other conditions are: Heavy snow, ice pellets, moderate and heavy freezing rain, hail
(5) For holdover times under active frost conditions see the separate frost table (Table 3)
(6) No holdover time guidelines exist for this condition for 0 °C (32 °F) and below

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

De-icing/anti-icing fluids used during ground de-icing/anti-icing are not intended for - and do not provide - protection during flight.

APPENDIX'A'

Table 5 - Guidelines for holdover times anticipated for Type IV fluid mixtures as a function of weather conditions and OAT (Valid for metallic and composite surfaces)

OAT [1] °C	OAT [1] °F	Type IV Fluid Concentration Neat Fluid/ Water (Vol %/Vol %)	Freezing Fog	Snow/ Snow Grains/ Snow Pellets [2]	Freezing Drizzle [3]	Light Freezing Rain	Rain on Cold Soaked Wing	Other [4] [5]
-3 and above	27 and above	100/0	1:45 - 3:10	0:40 - 1:20	0:50 – 1:30	0:35 - 0:55	0:10 - 1:15 [6]	CAUTION: No Holdover Time Guidelines exist
		75/25	1:00 - 1:45	0:30 - 0:55	0:40 – 1:05	0:25 - 0:40	0:09 - 0:50 [6]	
		50/50	0:20 - 0:35	0:07 - 0:15	0:10 - 0:20	0:07 - 0:10		
below -3 to -14	below 27 to 7	100/0	0:20 - 1:20	0:30 - 0:55	0:20 - 1:00 [7]	0:10 - 0:25 [7]		
		75/25	0:25 - 0:50	0:20 - 0:40	0:15 - 1:00 [7]	0:10 - 0:25 [7]		
below -14 to -25 or LOUT	below 7 to -13 or LOUT	100/0	0:15 - 0:40	0:15 - 0:30				

Approximate Holdover Times under various weather conditions (hours:minutes)

(1) Ensure that the lowest operational use temperature (LOUT) is respected. Consider the use of Type I fluid when Type IV fluid cannot be used.
(2) In light "Rain and Snow" conditions use "Light Freezing Rain" holdover times
(3) If positive identification of "Freezing Drizzle" is not possible use "Light Freezing Rain" holdover times
(4) Other conditions are: Heavy snow, ice pellets, moderate and heavy freezing rain, hail
(5) For holdover times under Active Frost conditions see the separate frost table (Table 3)
(6) No holdover time guidelines exist for this condition for 0 °C (32 °F) and below
(7) No holdover time guidelines exist for this condition below -10 °C (14 °F)

CAUTION: The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity or jet blast may reduce holdover time below the lowest time stated in the range.
Holdover time may also be reduced when the aeroplane skin temperature is lower than OAT.
<u>Therefore, the indicated times should be used only in conjunction with a pre-takeoff check.</u>

De-icing/anti-icing fluids used during ground de-icing/anti-icing are not intended for - and do not provide - protection during flight.

APPENDIX 'B'

LIST OF PIA ROUTE NETWORK STATIONS WHERE DE-ICING / ANTI-ICING IS REQUIRED

LIST OF STATIONS

Station IATA Code

IATA Airport/City Code	City	Country
YYZ	Toronto	Canada
JFK	New York	USA
MAN	Manchester	United Kingdom
GLA	Glasgow	United Kingdom
LHR	London (Heathrow)	United Kingdom
BHX	Birmingham	United Kingdom
LBA	Leeds / Bradford	United Kingdom
STN	London (Stansted)	United Kingdom
IST	Istanbul	Turkey
CDG	Paris	France
CPH	Copenhagen	Denmark
MXP	Milan	Italy
NRT	Tokyo (Narita)	Japan
OSL	Oslo	Norway
PEK	Beijing (Peking)	China
AMS	Amsterdam	Netherlands
SVO	Moscow	Russia