The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE RECOMMENDED PRACTICE

Submitted for recognition as an American National Standard

SAE ARP4737 REV. A

Issued 1992-10
Revised 1996-10

AIRCRAFT DEICING/ANTI-ICING METHODS WITH FLUIDS

FOREWORD

The purpose of this document is to provide guidelines for the methods and procedures used in performing the maintenance operations and services necessary for proper deicing and anti-icing of aircraft on the ground.

Exposure to weather conditions, on the ground, that are conducive to ice formation, can cause accumulation of frost, snow, slush, or ice on aircraft surfaces and components that can adversely affect aircraft performance, stability, and control and operation of mechanical devices such as control surfaces, sensors, flaps, and landing gear. If frozen deposits are present, other than those considered in the certification process, the airworthiness of the aircraft may be invalid and no attempt should be made to fly the aircraft until it has been restored to the clean configuration.

Regulations governing aircraft operations in icing conditions shall be followed. Specific rules for aircraft are set forth in United States Federal Aviation Regulations (FAR), Joint Aviation Regulations (JAR), Canadian Air Regulations, and others. Paraphrased, these rules relate that NO ONE SHOULD DISPATCH OR TAKE OFF AN AIRCRAFT WITH FROZEN DEPOSITS ON COMPONENTS OF THE AIRCRAFT THAT ARE CRITICAL TO SAFE FLIGHT. A critical component is one which could adversely affect the mechanical or aerodynamic function of an aircraft. The intent of these rules is to assure that no one attempts to dispatch or operate an aircraft with frozen deposits that were not approved by the regulatory authorities.

The ultimate responsibility for the determination that the aircraft is clean and meets airworthiness requirements rests with the pilot in command of the aircraft.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

1. SCOPE:

1.1 Field of Application:

1.1.1 This document establishes the minimum criteria for ground based aircraft deicing/anti-icing with fluids to ensure the safe operation of aircraft during icing conditions. This document does not specify requirements for particular airplane models.

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

1.1.2 Agreements and Contracts: This information is recommended as a basis for maintenance operations and service support agreements.

1.1.3 Safety - Hazardous Materials: While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and processes and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

1.1.4 All guidelines referred to herein are applicable only in conjunction with the referenced SAE specifications. Specific requirements for airplane model type are not included. Due to aerodynamic and other concerns application of deicing/anti-icing fluids shall be carried out in compliance with engine and aircraft manufacturers' requirements.

2. APPLICABLE DOCUMENTS:

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 1424	Deicing/Anti-icing, Aircraft, Fluid, SAE Type I
AMS 1428	Deicing/Anti-icing, Fluid, Aircraft, Non-Newtonian, Pseudoplastic, SAE Type II, III, IV
ARP1971	Aircraft Deicing Vehicle - Self-Propelled, Large Capacity
ARP4047	Aircraft Deicing Vehicle - Self-Propelled, Small Capacity

2.2 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

AC 20-117 Hazards Following Ground Deicing and Ground Operations in Conditions Conducive to Aircraft Icing

3. DEFINITIONS:

3.1 Abbreviations:

C = Celsius
F = Fahrenheit
OAT = Outside Air Temperature
FP = Freezing point
h = Hours
min = Minutes

3.2 Buffer/Freezing Points:

The difference between OAT and the freezing point of the fluids used.

3.3 Fluids:

CAUTION: SAE Type I fluids supplied as concentrates for dilution with water prior to use shall not be used undiluted, unless they meet aerodynamic performance and freezing point buffer requirement (reference AMS 1424).

3.3.1 Deicing fluids are:

a. Heated water
b. SAE Type I (see caution)
c. Heated concentrates or mixtures of water and SAE Type I fluid
d. Heated concentrates or mixtures of water and SAE Type II fluid
e. Heated concentrates or mixtures of water and SAE Type III fluid
f. Heated concentrates or mixtures of water and SAE Type IV fluid

Deicing fluid is normally applied heated to assure maximum deicing efficiency.

3.3.2 Anti-icing fluids are:

a. SAE Type I fluid (see previous caution)
b. Mixtures of water and SAE Type I fluid
c. Concentrates or mixtures of SAE Type II fluid and water
d. Concentrates or mixtures of SAE Type III fluid and water
e. Concentrates or mixtures of SAE Type IV fluid and water

SAE Type II, III, and IV fluids for anti-icing are normally applied cold on clean aircraft surfaces but may be applied heated. SAE Type I fluid may be used cold or heated after the aircraft has been deiced (reference Figure 1 and AMS 1424).

3.3.3 Fluid terms are:

a. Newtonian fluids are defined as fluids whose viscosities are shear independent and time independent. The shear rate of a Newtonian fluid is directly proportional to the shear stress. The fluid will begin to move immediately upon application of a stress; it has no yield stress to overcome before flow begins.

NOTE: SAE Type I fluids are considered Newtonian.

b. Non-Newtonian fluids are defined as fluids whose viscosities are shear and time dependent and whose shear rate is not directly proportional to its shear stress. The fluid will not begin to move immediately upon application of a stress, it has a yield stress to overcome before flow begins.

NOTE: SAE Type II, III, or IV fluids containing thickeners demonstrate a pseudoplastic behavior which is defined as a decrease in viscosity with an increase in shear rate.

3.4 Methods/Procedures:

3.4.1 Deicing is a procedure by which frost, ice, slush, or snow is removed from the aircraft in order to provide clean surfaces.

3.4.2 Anti-icing is a procedure, which provides protection against the formation of frost or ice and accumulation of snow or slush on clean surfaces of the aircraft for a limited period of time (holdover time).

3.4.3 Deicing/anti-icing is a combination of the two procedures described previously. It can be performed in one or two steps.

3.4.3.1 One step deicing/anti-icing is carried out with an anti-icing fluid. The fluid used to deice the aircraft remains on aircraft surfaces to provide limited anti-icing capability.

3.4.3.2 Two step deicing/anti-icing consists of two distinct steps. The first step, deicing, is followed 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.

3.4.4 Holdover time is the estimated time anti-icing fluid will prevent the formation of frozen contamination on the protected surfaces of an aircraft.

3.5 Conditions Conducive to Aircraft Icing on Ground:

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

3.5.2 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).

3.5.3 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.

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

3.5.5 Light Freezing Rain: Precipitation of liquid water particles which freeze upon impact with exposed objects, either in the form of drops, which, in contrast to drizzle, are widely separated. Measured intensity of liquid water particles are up to 0.10 in/h (2.5 mm or 25 g/dm^2/h) with a maximum of 0.10 in in 6 min.

3.5.6 Rain or High Humidity (On Cold Soaked Wing): Water forming ice or frost on the wing surface, when the temperature of the aircraft wing surface is at or below 0 °C (32 °F).

3.5.7 Sleet: Precipitation in the form of a mixture of rain and snow. For operation in light sleet treat as light freezing rain.

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

3.6 Check:

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

4. TRAINING AND QUALIFICATION:

Deicing/anti-icing procedure must be carried out exclusively by trained and qualified personnel.

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

4.1.1 Training subjects shall include but are not limited to (when applicable):

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

b. Basic characteristics of aircraft deicing/anti-icing fluids

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

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

e. Types of checks required

f. Deicing/anti-icing equipment operating procedures, including actual operation of equipment

g. Safety precautions

h. Emergency procedures

i. Fluid application and limitations of holdover time tables

j. Deicing/anti-icing codes and communications procedures

k. Special provisions and procedures for contract deicing/anti-icing (if applicable)

l. Environmental considerations, e.g., where to deice, spill reporting, hazardous waste control

m. New procedures and developments, lessons learned from past winters

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

5. FLUID STORAGE AND HANDLING:

Deicing/anti-icing fluid is a chemical product with environmental impact.

During fluid handling avoid any unnecessary spillage, comply with local environmental and health laws and the manufacturer's material safety data sheet (MSDS).

Different products should not be mixed without additional qualification testing.

A slippery condition may exist on the ground or equipment following the deicing/anti-icing procedure. Caution should be exercised, particularly under low humidity or nonprecipitating weather conditions.

5.1 Storage:

5.1.1 Tanks should be dedicated to storage of the deicing and/or anti-icing fluid to avoid contamination with other fluids.

5.1.2 Storage tanks shall be constructed of materials compatible with the deicing/anti-icing fluid, as specified by the fluid manufacturer.

5.1.3 Tanks shall be conspicuously labeled to avoid contamination, e.g., SAE TYPE I Aircraft Deicing Fluid.

5.1.4 Tanks shall be examined annually for corrosion and/or contamination. If corrosion or contamination is evident, tanks shall be repaired or replaced. To minimize corrosion at the liquid/vapor interface and in the vapor space, a high liquid level in the tanks is recommended.

NOTE: Although deicing/anti-icing fluids are generally noncorrosive, their vapor can be corrosive.

5.1.5 Storage temperature limits for the fluid shall comply with manufacturer's requirements.

5.1.6 Stored fluid shall be checked routinely to assure that no degradation/contamination has taken place, e.g., at delivery and annually prior to the winter season.

5.2 Fluid Transfer Systems:

5.2.1 The performance characteristics of SAE Type II/IV deicing/anti-icing fluids may be degraded by excessive mechanical shearing or chemical contamination. Therefore, only compatible pumps, control valves, piping and application devices shall be used. The design of fluid transfer systems shall be in accordance with the fluid manufacturers' recommendations.

5.2.2 Fluid transfer systems shall be dedicated to the specific fluid being handled to prevent inadvertently mixing fluids of different types or manufacturers.

5.2.3 All fill ports and discharge points shall be conspicuously labeled to prevent contamination due to inadvertent product mixing.

5.3 Application Equipment:

5.3.1 Application equipment shall be clean before being initially filled with deicing/anti-icing fluid in order to prevent fluid contamination.

5.3.2 Correct functioning of proportioning equipment should be verified by checking dispensed fluid coming out of the spray nozzle for refractive index to ensure intended dilution. This check should be made prior to daily use, following system maintenance or after a fluid concentration change.

5.3.3 Premixed fluid contained in equipment should be checked in the tank prior to initial service.

5.3.4 Combustion heaters and trucks should not be operated in confined or poorly ventilated areas to prevent asphyxiation.

5.3.5 Requirements for suitable equipment are described in ARP1971 and ARP4047.

5.4 Special Considerations for SAE Type II, III, and IV Deicing/Anti-icing Fluids:

5.4.1 The performance characteristics of SAE Type II, III, and IV deicing/anti-icing fluids may be degraded by excessive mechanical shearing or chemical contamination. Therefore, only compatible pumps, control valves, piping, and application devices shall be used. The design of fluid transfer systems shall be in accordance with the fluid manufacturers' recommendations.

5.4.2 Heating: SAE Type II deicing/anti-icing fluids, if heated, shall be heated in a manner to preclude fluid degradation in storage or application. The integrity of the fluid following heating shall be checked periodically. Factors like heating rate and heating time cycles should be considered in determining frequency of fluid inspections. Refer to fluid manufacturers' recommendations.

6. METHODS/PROCEDURES:

These procedures establish the recommended methods for deicing and anti-icing of aircraft on the ground to provide safe takeoff.

When aircraft surfaces are contaminated by frozen moisture, they shall be deiced prior to dispatch. When freezing precipitation exists and the precipitation is adhering to the surfaces at the time of dispatch, aircraft surfaces shall be deiced/anti-iced. If both deicing and anti-icing are required, the procedure may be performed in one or two steps (see 3.3.3). 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 6.1 and 6.2 apply.

See 6.3.1 for guidance regarding fluid limitations.

NOTE: When longer holdover times are desired, use of cold, undiluted SAE Type II, III, and IV fluid should be considered.

6.1 Deicing:

Ice, slush, snow, or frost may be removed from aircraft surfaces by fluids or mechanical methods. This section establishes the procedures for removal of the frozen precipitation by fluids.

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

6.1.2 General: For maximum deicing effect, heated fluids should be applied close to the surface of the aircraft skin to minimize heat loss.

Fluid temperatures should not exceed aircraft manufacturer's recommendations.

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

6.1.3 Removal of Frost and Light Ice: A nozzle setting giving a solid cone (coarse) spray is recommended.

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

6.1.4 Removal of Snow: A nozzle setting sufficient to flush off deposits is recommended.

NOTE: The method 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 effectively and efficiently remove it from the aircraft surfaces. For light deposits of both wet and dry snow, adopt a similar procedure as for frost removal. Wet snow is more difficult to remove than dry snow and unless deposits are relatively light, selection of a high fluid flow will be found to be more effective. Under certain conditions it will be possible to use the heat, combined with the hydraulic force of the fluid spray to melt and subsequently flush off frozen deposits. However, where snow has bonded to the aircraft skin, the procedures detailed in 6.1.5 should be utilized. Heavy accumulation of snow will always be difficult to remove from aircraft surfaces and vast quantities of fluid will invariably be consumed in the attempt. Under these conditions serious consideration should be given to manually removing the worst of the snow before attempting a normal deicing procedure.

6.1.5 Removal of Ice: Heated fluid shall be used to break the ice bond.

NOTE: The high thermal conductivity of the metal skin is utilized and a jet of hot fluid is directed at close range onto one spot, until the bare metal is just exposed. This bare metal will then transmit the heat laterally in all directions raising the temperature above the FP and thereby breaking the adhesion of the frozen mass with the aircraft surface. By repeating this procedure a number of times the adhesion of a large area of frozen snow or glazed ice can be broken. The deposits can then be flushed off with either a low or high flow, depending on the amount of the deposit.

CAUTION: Consult aircraft manufacturers' limitations for maximum fluid application pressure.

6.1.6 General Deicing Fluid Application Strategy: For effective removal of snow and ice the following techniques should be adopted. Aircraft may require unique procedures to accommodate design differences.

6.1.6.1 Wings/Tail Plane: Spray from tip inboard to root from highest point of surface camber to lowest. However, it is possible that aircraft configuration and local conditions may dictate a different procedure.

6.1.6.2 Vertical Surfaces: Start at top and work down.

6.1.6.3 Fuselage: Spray along top centerline and then outboard.

6.1.6.4 Landing Gear and Wheel Bays: Keep application of deicing fluid in this area to a minimum. Do not spray deicing fluid directly on wheels and brakes.

NOTE: It may be possible to mechanically remove accumulations such as blown snow, however, where deposits have bonded to surfaces they can be removed by the application of hot air or by spraying with hot deicing fluids.

6.1.6.5 Engines: Deposits of snow should be mechanically removed from engine intakes prior to departure. Any frozen deposits that may have bonded to either the lower surface of the intake or the fan blades may be removed by hot air or other means recommended by the engine manufacturer. If use of deicing fluid is permitted, do not spray directly into engine core.

6.1.7 Deicing/anti-icing near the beginning of the departure runway provides the minimum interval between deicing/anti-icing and takeoff.

6.2 Anti-icing:

Ice, snow, or frost will, for a period of time, be prevented from adhering to or accumulating on aircraft surfaces by the application of anti-icing fluids. This section provides recommended procedures for the use of anti-icing fluids.

6.2.1 Required Usage: Anti-icing fluid shall be applied to the aircraft surfaces when freezing rain, snow, or other freezing precipitation may adhere to the aircraft (at the time of dispatch).

6.2.2 Optional Usage: Anti-icing fluid may be applied to aircraft surfaces at the time of arrival (preferably before unloading begins) on short turnarounds during freezing precipitation, and on overnight aircraft. This will minimize ice accumulation prior to departure and often makes subsequent deicing easier.

6.2.2.1 On receipt of a frost, snow, freezing rain, or freezing fog warning from local meteorological service, anti-icing fluid may be applied to clean aircraft surfaces prior to the start of freezing precipitation. This will minimize the possibility of snow and ice bonding or reduce the accumulation of frozen precipitation on aircraft surfaces and facilitate subsequent deicing.

6.2.3 General: For effective anti-icing an even film of fluid is required over the prescribed aircraft surfaces which are clean or which have been deiced. For anti-icing protection undiluted, unheated SAE Type II, III, or IV fluid should be used. The high fluid pressures and flow rates normally associated with deicing are not required for this operation and, where possible, pump speeds should be reduced accordingly. The nozzle of the spray gun should be adjusted to give a medium spray.

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

6.2.4 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 possible in order to utilize available holdover time. The anti-icing fluid should be distributed uniformly. In order to control the uniformity, all horizontal aircraft surfaces shall be visually checked during application of the fluid. The amount required will be visually indicated by the fluid just beginning to drip off the leading and trailing edges.

Surfaces to be protected include:

a. Wing upper surface and leading edges
b. Horizontal stabilizer and elevator upper surfaces
c. Vertical stabilizer and rudder
d. Fuselage upper surfaces on center engine aircraft, depending on amount and type of precipitation

CAUTION: It is possible that 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.

CAUTION: An insufficient amount of anti-icing, 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 (deicing).

6.2.5 Deicing/anti-icing near the beginning of the departure runway provides the minimum interval between deicing/anti-icing and takeoff.

6.3 Limits/Precautions:

6.3.1 Fluid Related Limits:

CAUTION: SAE Type I fluids supplied as concentrates for dilution with water prior to use shall not be used undiluted, unless they meet aerodynamic performance and freezing point buffer requirement (reference AMS 1424). This is due to adverse aerodynamic effects of propylene glycol and diethylene glycol based fluids and the freeze point characteristics of ethylene glycol and diethylene glycol based fluid.

6.3.1.1 Temperature Limits (see appropriate figures): When performing two step deicing/anti-icing, the FP of the fluid used for the first shall not be more than 3 °C (5 °F) above ambient temperature (refer to 6.3.3.2).

6.3.1.1.1 SAE Type I Fluids: The FP of the SAE Type I fluid mixture used for either one step deicing/anti-icing or as a second step in the two step operation shall be at least 10 °C (18 °F) below the ambient temperature.

6.3.1.1.2 SAE Type II fluids used as deicing/anti-icing agents may have a lower temperature application limit of -25 °C (-13 °F). The application limit may be lower, provided a 7 °C (13 °F) buffer is maintained between the FP of the concentrated fluid and OAT. In no case shall this temperature be lower than the lowest operational use temperature as defined by the aerodynamic acceptance test.

6.3.1.2 Application Limits (see applicable figures): Under no circumstances shall an aircraft that has been anti-iced receive a further coating of anti-icing fluid directly on top of the contaminated film. Should it be necessary for an aircraft to be reprotected prior to the next flight, the external surfaces shall first be deiced with a hot deicing fluid mix before a further application of anti-icing fluid.

6.3.2 Aircraft Related Limits: The application of deicing/anti-icing fluid shall be in accordance with the requirements of the airframe/engine manufacturers.

6.3.3 Procedure Precautions:

6.3.3.1 One Step Deicing/Anti-icing: It is performed with an anti-icing fluid (see 3.2.2). The correct fluid concentration is chosen with regard to desired holdover time, dictated by OAT and weather conditions.

CAUTION: Wing skin temperature may differ and in some cases may be lower than OAT. A stronger mix can be used under the latter conditions

6.3.3.2 Two Step Deicing/Anti-icing: The first step is performed with deicing fluid (see 3.3.1). The correct deicing fluid mixture is chosen with regard to OAT. The second step is performed with anti-icing fluid (see 3.3.2). This fluid and its concentration are chosen with regard to desired holdover time, which is dictated by OAT and weather conditions. The second step shall be performed before first step fluid freezes (typically within 3 min); if necessary area by area. If freezing has occurred on the critical areas of the aircraft, step 1 shall be repeated.

When a fluid conforming to AMS 1428A is used to perform step two in a two step deicing/anti-icing operation, and the fluid used in step one is a Type I fluid conforming to AMS 1424A, a test shall be made to confirm that the combination of these fluids does not significantly reduce the WSET performance of the AMS 1428A fluid.

6.3.3.2 (Continued):

CAUTION: Wing skin temperature may differ and in some cases may be lower than OAT. A stronger mix can be used under the latter conditions.

6.3.3.3 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.

6.3.3.4 Aircraft shall be treated symmetrically, that is, left hand and right hand side shall receive the same and complete treatment.

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

6.3.3.5 Engines are normally shut down but may remain running at idle during deicing/anti-icing operations. Airconditioning and/or APU air must be selected OFF, or as recommended by the airframe and engine manufacturer.

6.3.3.6 Do not spray deicing/anti-icing fluids directly onto brakes, wheels, exhausts, or thrust reversers.

6.3.3.7 Deicing/anti-icing fluid shall not be directed into the orifices of pitot heads, static vents, or directly onto airstream direction detectors probes/angle of attack airflow sensors.

6.3.3.8 All reasonable precautions shall be taken to minimize fluid entry into engines, other intakes/outlets, and control surface cavities. See relevant manuals.

6.3.3.9 Do not direct fluid onto flight deck or cabin windows as this can cause cracking of acrylic or penetration of the window seals.

6.3.3.10 All doors and windows should be closed to prevent:

a. Floor areas being contaminated with slippery fluids
b. Upholstery becoming soiled

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

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

NOTE: Deicing/anti-icing fluid can be removed by rinsing with approved cleaner and a soft cloth.

6.3.3.13 Landing gear and wheel bays shall be kept free from buildup of slush, ice, or accumulations of blown snow.

6.3.3.14 When removing ice, snow, or slush from aircraft surfaces care shall be taken to prevent it entering and accumulating in auxiliary intakes or control surface hinge areas, e.g., remove snow from wings and stabilizer surfaces forward towards the leading edge and remove from ailerons and elevators back towards the trailing edge.

6.3.3.15 Ice can build up on aircraft surfaces during flight through dense clouds or precipitation. When ground OAT at the destination is low, it is possible for flaps and other moveable surfaces 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 removed.

6.3.3.16 Under freezing fog, or other freezing precipitation conditions, it is necessary for the front and rear side on the fan blades to be checked for ice buildup prior to start-up. Any deposits discovered are to be removed by directing air from a low flow hot air source or other means recommended by the aircraft and engine manufacturer.

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

6.3.4 Clear Ice Precautions:

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

6.3.4.2 Significant deposits of clear ice can form in the vicinity of the fuel tanks, on wing upper surfaces as well as underwing. Aircraft are most vulnerable in regard to this type of buildup when one or more of the following conditions exist:

a. Wing temperatures remain well below 0 °C (32 °F) during the turnaround transit.

b. Ambient temperatures between -2 °C (28 °F) and +15 °C (59 °F) are experienced, although clear ice may form at other temperatures if conditions (a), (c), and (d) exist.

c. Precipitation occurs while the aircraft is on the ground.

d. When frost or ice is present on lower surface of either wing.

6.3.4.3 Clear ice formation is extremely difficult to detect. Therefore, when the above conditions prevail, or when there is otherwise any doubt that clear ice may have formed, a close examination shall be made prior to departure, in order to ensure that all frozen deposits have in fact been removed.

NOTE: Low wing temperatures associated with this type of buildup normally occur when large quantities of cold fuel remain in wing tanks during the turnaround/transit and any subsequent refueling is insufficient to cause a significant increase in fuel temperature.

7. GENERAL AIRPLANE REQUIREMENTS AFTER DEICING/ANTI-ICING:

After application of the deicing/anti-icing procedures the critical aircraft surfaces shall be "clean." In order to accomplish this "clean" condition, the following paragraphs apply:

7.1 Wings, Tail, and Control Surfaces:

Shall be free of ice, slush, snow, or frost. Some coating of frost may be permissible on wing tank lower surfaces cold-soaked by fuel. Consult aircraft manufacturers' manuals for specific requirements.

7.2 Pitot Heads, Static Ports, Airstream Direction Detector Probes, and Angle of Attack Sensors:

Clear of ice, frost, snow, slush, fluid residues, and protective covers.

7.3 Engine Inlets:

Clear of internal ice and snow and fan shall be free to rotate.

7.4 Airconditioning Inlets/Exits:

Clear of ice, frost, and snow. Outflow valves clear and unobstructed.

7.5 Landing Gear and Landing Gear Doors:

Unobstructed and clear of ice, slush, frost, and snow.

7.6 Fuel Tank Vents:

Clear of ice, frost, slush, and snow.

7.7 Fuselage:

Clear of ice and snow. In accordance with the aircraft manufacturers' manuals adhering frost may be allowed. Do not close any door until all ice or snow has been removed from the surrounding area.

7.8 Flight Control Check:

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

7.9 An authorized person shall indicate the check result by documentation (if applicable) to establish a trail of accountability.

8. CHECKS:

8.1 Type of Checks Required:

8.1.1 Flight Crew/Ground Crew Preflight Inspection/Cold Weather Preflight Inspection Procedures: This is the normal walk around preflight inspection conducted by the flight crew. This inspection should note any aircraft surface contamination and direct any required deicing/anti-icing operations.

8.1.2 Aircraft deicing/anti-icing procedures include a check performed by qualified ground personnel after the deicing/anti-icing fluid application has been completed. This check is an integral part of the aircraft deicing/anti-icing procedure. No aircraft shall be dispatched for departure after a deicing/anti-icing operation unless the aircraft has received a final check by a responsible authorized person.

8.1.3 A pretakeoff check is performed by the flight crew prior to takeoff and within the holdover time. This is a check normally conducted from inside the cockpit. Identification of representative surfaces and continual assessment of environmental and other situational conditions should be included in the operator's program.

8.1.4 Pretakeoff Contamination Check: This check is accomplished after the holdover time has been exceeded and must be completed within 5 min prior to beginning takeoff. Each carrier must define aircraft type-specific pretakeoff contamination check procedures. The check must cover all critical parts of the aircraft and be performed from points offering sufficient visibility on these parts (e.g., from the deicer itself or another elevated piece of equipment).

9. PRETAKEOFF CHECK:

9.1 When freezing precipitation exists, aerodynamic surfaces shall be checked just prior to the aircraft taking the active runway or initiating the takeoff roll, in order to confirm that they are free of ice, slush, snow, and objectionable frost. This is particularly important when severe conditions are experienced. When adhering deposits are in evidence, it will be necessary for the deicing operation to be repeated (see AC 20-117).

9.2 If aircraft surfaces cannot adequately be checked from inside the aircraft, it is desirable to provide a means of assisting the flight crew in determining the condition of the aircraft. The check should be conducted as near as practical to the beginning of the departure runway.

10. FLIGHT CREW INFORMATION:

10.1 General:

The flight crew shall be provided with information about the deicing/anti-icing process prior to dispatch. Agreements/contracts for deicing/anti-icing should be established to include this information. The information includes:

NOTE: No flight crew communication is required and no holdover time applies if the aircraft is deiced for overnight frost in the absence of further precipitation or self-generating frost.

10.1.1 The results of the final check by qualified personnel, indicating that the aircraft critical areas are free of ice, frost, slush, and snow.

10.1.2 The type of final fluid coating applied, the mixture of fluid (percent by volume), and the time of application. This information is intended to be used by flight crews and other personnel in conjunction with Section 11 for operational planning purposes.

10.2 Deicing/Anti-icing Codes:

The codes to be used for flight crew information shall be as follows:

a. ELEMENTS A, B, C, D

This information shall be recorded and be communicated to the flight crew by referring to the last step of the procedure.

10.2.1 The code elements shall be used in the sequence provided below:

a. Element A: Specify "Type" I for SAE Type I fluid, "Type" II for SAE Type II fluid, "Type" III for SAE Type III fluid, and "Type" IV for SAE Type IV fluid.

b. Element B: Specify the percentage of fluid within the fluid/water mixture (e.g., 100 = 100% fluid, 0% water and 75 = 75% fluid, 25% water).

NOTE: The concentration of any mixture is measured by volume.

c. Element C: Specify in local time the beginning of the final deicing/anti-icing step (e.g., 1330).

d. Element D: Specify date (day, written month, year) (e.g., 20 April 1990).

NOTE: Element D is required for record keeping, optional for crew notification.

NOTE: Transmission of elements A-C to the flight crew confirms that a post deicing/anti-icing check was completed and the aircraft is clean.

10.2.1.1 Deicing/Anti-icing Information Format: Examples of the format to be used for flight crew information is as follows:

Element A B C D

Type II - 100% - 1400 - 20 Apr 90
Type II - 75% - 1100 - 20 Apr 90
Type I - 50% - 0942 - 17 Feb 91

11. HOLDOVER TIME:

11.1 Holdover time is obtained by anti-icing fluids remaining on aircraft surfaces. With a one step deicing/anti-icing operation the holdover 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.

11.2 Holdover time guidelines are presented in Figures 2, 4, and 5. These are for operational planning purposes only and are not a substitute for the pretakeoff check.

11.3 Due to their properties, SAE 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.

11.4 SAE Type II, III, and IV fluids contain thickening agents 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.

11.5 Figures 2, 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, 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 freezing precipitation.