

# NOTICE

## U.S. DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION

N 8900.167

National Policy

Effective Date:  
8/29/11

Cancellation Date:  
8/29/12

**SUBJ:** Revised FAA-Approved Deicing Program Updates, Winter 2011-2012

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**1. Purpose of This Notice.** This notice provides inspectors with information on holdover times (HOT), a listing of deicing/anti-icing fluids, and recommendations on various other ground deicing/anti-icing issues.

**2. Audience.** The primary audience for this notice is Flight Standards District Office (FSDO) principle operations inspectors (POI) responsible for approving an air carrier's deicing program. The secondary audience includes Flight Standards personnel in FSDOs, branches, and divisions in the regions and at headquarters (HQ).

**3. Where You Can Find This Notice.** You can find this notice on the MyFAA employee Web site at [https://employees.faa.gov/tools\\_resources/orders\\_notices](https://employees.faa.gov/tools_resources/orders_notices). Inspectors can access this notice through the Flight Standards Information Management System (FSIMS) at <http://fsims.avs.faa.gov>. Air carriers (operators) can find this notice on the Federal Aviation Administration's (FAA) Web site at <http://fsims.faa.gov>. This notice is available to the public at [http://www.faa.gov/regulations\\_policies/orders\\_notices](http://www.faa.gov/regulations_policies/orders_notices).

**Note:** Holdover tables and Ice Pellet Allowance Time tables are not contained in this document but references are provided to the Web site where they can be viewed or downloaded. The Official FAA Holdover Time Tables for 2011-2012 and Ice Pellet Allowance Time tables referenced in this document can be found at the FAA Air Transportation Division (AFS-200) Ground Deicing Web site: [http://www.faa.gov/other\\_visit/aviation\\_industry/airline\\_operators/airline\\_safety/deicing](http://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/deicing).

**4. Cancellation.** This notice cancels N 8900.144, Revised FAA-Approved Deicing Program Updates, Winter 2010-2011, dated January 6, 2011.

**5. Background.** Title 14 of the Code of Federal Regulations (14 CFR) part 121, § 121.629(c) requires that part 121 certificate holders have an approved ground deicing/anti-icing program. An alternative to complying with § 121.629(c) would be to comply with § 121.629(d). Advisory Circular (AC) 120-60, Ground Deicing and Anti-Icing Program, current edition, provides guidance for obtaining approval of a ground deicing/anti-icing program and discusses

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the use of HOTs. Title 14 CFR part 125, § 125.221, and 14 CFR part 135, § 135.227(b)(3), allow both kinds of certificate holders to comply with a part 121-approved program.

**6. HOT Guidelines for Types I, II, III, and IV Fluids.** The following subparagraphs include HOT guidelines for Type I, II, III, and IV fluids that meet Society of Automotive Engineers (SAE) aircraft deicing/anti-icing fluid specifications Aerospace Material Specification (AMS)-1424 (Type I) and AMS-1428 (Types II, III, and IV) and associated guidelines for applying these deicing/anti-icing fluid mixtures.

**a. Type I Guideline Changes.** The Type I HOT table has been divided into two tables: Table 1, FAA Guidelines for Holdover Times SAE Type I Fluid Mixtures on Critical Aircraft Surfaces Composed Predominantly of Aluminum as a Function of Weather Conditions and Outside Air Temperature, for aircraft with aluminum wing surfaces, and Table 1A, FAA Guidelines for Holdover Times SAE Type I Fluid Mixtures on Aircraft Critical Surfaces Composed Predominantly of Composites as a Function of Weather Conditions and Outside Air Temperature, for aircraft with composite wing surfaces.

(1) Composite Material Aircraft Critical Surfaces. The recent introduction of new aircraft constructed primarily of composite materials required a review of Type I fluid HOT performance when used on these aircraft. This review has shown that the HOTs of Type I fluids on composite surfaces is reduced when compared to aluminum surfaces. Type I fluid HOT evaluations were conducted over the past 4 years, and the HOTs have been developed for use on aircraft critical surfaces constructed primarily of composite materials. As a result of extensive research and testing showing that HOTs of Type I fluids are shorter on composite surfaces than aluminum surfaces, HOT values for composite surfaces have been developed and added to the Type I table and the Type I portion of the Active Frost table.

(2) The Type I fluid HOTs for composite surfaces (Table 1A) must be applied to aircraft with all critical surfaces predominantly or entirely constructed of composite materials. However, the Type I fluid HOTs for composite surfaces do not need to be applied to an aircraft that is currently in service, has a demonstrated safe operating history using Type I fluid aluminum structure HOTs, and has critical surfaces partially constructed of composite material. If there is any doubt, consult with the aircraft manufacturer to determine whether aluminum or composite HOTs are appropriate for the specific aircraft.

**Note:** In the case of frost conditions (Table 0, FAA Guidelines for Holdover Times in Active Frost, SAE Type I, Type II, Type III, and Type IV Fluids) the value of 35 minutes was added in 2010-11 for frost on composite aircraft.

**b. Type II Fluids.** Minor increases or decreases ranging from 1 to 4 minutes have been made to all eight of the Type II fluid-specific holdover tables and to the Type II generic holdover table due to changes made in the HOT rounding protocol. The lower limit of the lowest temperature band value for the fluid in the Type II fluid-specific HOTs has been changed from -25° C/13° F to the actual lowest operational use temperature (LOUT).

**c. Type IV Fluids.** Minor increases or decreases ranging from 1 to 4 minutes have been made to six Type IV fluid-specific holdover tables and to the Type IV generic holdover table due to changes made in the HOT rounding protocol. The affected tables are:

- Table 4, FAA Guidelines for Holdover Times SAE Type IV Fluid Mixtures as a Function of Weather Conditions and Outside Air Temperature;
- Table 4A, FAA Guidelines for Holdover Times ABAX AD-480 Type IV Fluid Mixtures as a Function of Weather Conditions and Outside Air Temperature;
- Table 4C, FAA Guidelines for Holdover Times CLARIANT SAFEWING MP IV 2001 Type IV Fluid Mixtures as a Function of Weather Conditions and Outside Air Temperature;
- Table 4I, FAA Guidelines for Holdover Times DOW UCAR™ FLIGHTGUARD AD-480 Type IV Fluid Mixtures as a Function of Weather Conditions and Outside Air Temperature;
- Table 4K, FAA Guidelines for Holdover Times KILFROST ABC-4<sup>SUSTAIN</sup> Type IV Fluid Mixtures as a Function of Weather Conditions and Outside Air Temperature;
- Table 4L, FAA Guidelines for Holdover Times KILFROST ABC-S Type IV Fluid Mixtures as a Function of Weather Conditions and Outside Air Temperature; and
- Table 4N, FAA Guidelines for Holdover Times LYONDELL ARCTIC SHIELD™ Type IV Fluid Mixtures as a function of Weather Conditions and Outside Air Temperature.

**Note:** The lower limit of the lowest temperature band in the Type IV fluid specific holdover tables has been changed from -25° C/-13° F or LOUT to the actual LOUT value for the fluid.

(1) A new Type IV fluid, Cryotech Polar Guard Advance, has been added to the list of fluids for 2011-2012. This action did not change any of the values in the generic Type IV HOT table.

(2) Clariant Safewing MP IV 2012 Protect and Octagon MaxFlo have been removed from the Type IV guidelines as per the protocol for removing obsolete data. Removal of these fluids caused significant increases in the HOTs in 12 cells of the Type IV generic HOTs.

**d. Historical Changes.** In addition to ground deicing/anti-icing guidance and guidelines, a review of various other ground deicing/anti-icing historical changes is included.

**Note:** The FAA, in coordination with Transport Canada (TC) and the SAE G-12 Aircraft Ground Deicing Holdover Time Committee generated the HOT guidelines published in this notice.

## 7. Discussion.

### a. HOT Guidelines.

(1) The Official FAA Holdover Time Tables for 2011-2012, which are located on the FAA Web site at [http://www.faa.gov/other\\_visit/aviation\\_industry/airline\\_operators/airline\\_safety/deicing](http://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/deicing), include FAA-approved HOT guidelines for SAE Type I, II, III, and IV fluids, ice pellet allowance times, and changes in guidance material for 2011-2012 from the previous year for the use of the HOT and ice pellet allowance times.

(2) FAA-approved and SAE guidelines for the application of these deicing/anti-icing fluids are contained in this notice and related FAA publications.

(3) The FAA Type II (Table 2, FAA Guidelines for Holdover Times SAE Type II Fluid Mixtures as a Function of Weather Conditions and Outside Air Temperature, located on the FAA Web site) and Type IV (Table 4, located on the FAA Web site) HOT guidelines comprise the generic HOT values and encompass the minimum (worst case) HOT values for all fluids for a specific precipitation condition, temperature range, and fluid mixture concentration. Air carriers may only use the fluid-specific HOT guidelines (Tables 2A-2H and Tables 4A-4O, located on the FAA Web site) when these specific fluids are used during the anti-icing process. If a carrier cannot positively determine which specific Type II or IV fluid was used, it must use the generic HOTs from Table 2 or 4, as appropriate.

(4) Also included in the FAA HOT tables (Table 8, List of Fluids Tested for Anti-icing Performance and Aerodynamic Acceptance—Winter 2011-2012, located on the FAA Web site) is a list, by fluid-specific name, of Type I, II, III, and IV deicing/anti-icing fluids that have been tested for anti-icing performance and aerodynamic acceptance according to SAE AMS 1424 for SAE Type I fluids and AMS 1428 for SAE Types II, III, and IV fluids.

**b. Type I HOT Guidelines.** The Type I HOT guidelines Tables 1 and 1A located on the FAA Web site were separated into two tables for critical aircraft surfaces composed predominantly of aluminum (Table 1) and composites (Table 1A) for the 2011-2012 winter icing season.

(1) Guidance for Heated Type I Fluids. The Type I HOT values of the guidelines primarily are based on SAE-revised test methodologies to accommodate the effects of applying heated Type I fluids in determining their time of effectiveness for the various freezing precipitation conditions.

(a) Before the 2002-2003 winter icing season, Type I HOT values had been determined based on the application of unheated fluids. Recent findings indicate that the time of protection provided by Type I fluid (unlike Types II, III, and IV) is directly related to the heat input to aircraft surfaces. This is the primary reason for the reduction in the Type I fluid HOTs for composite structures.

(b) Type I fluid dilutes rapidly under precipitation conditions; however, the heat absorbed by aircraft surfaces will tend to keep the temperature of the diluted fluid above its freezing point for a limited time, this time is considerably longer for metallic structures than for composite material structures. Within practical limits, the more heat that an aircraft surface absorbs, the longer the surface temperature will remain above the freezing point of the fluid.

Thus, the thermal characteristics of an aircraft's surface affect HOTs, with metallic structures serving as better heat conductors.

(c) Theoretically, when the temperature of the surface equals the freezing point of the fluid, the fluid is considered to have failed. Because structural mass varies throughout an aircraft with a corresponding variation in absorbed heat, the fluid will tend to fail first in:

- Structurally thin areas; and
- Areas with minimal substructure, such as trailing edges, leading edges, and wing tips.

**Note:** FAA Type I HOT guidelines are not approved for the application of unheated Type I fluid mixtures.

(2) Snow Conditions.

(a) The Type I HOT guidelines include three separate snow columns, representing the following categories: very light snow, light snow, and moderate snow conditions. Recent surveys and analysis of worldwide snow conditions have revealed that more than 75 percent of snow occurrences fall into the light and very light snow category. Values in the very light, light, and moderate snow columns are based on extensive tests conducted by APS Aviation of Montreal, Canada, National Center for Atmospheric Research (NCAR) of Boulder, Colorado, and the Anti-Icing Materials International Laboratory (AMIL) of the University of Quebec at Chicoutimi, Canada, during several prior winter icing seasons. These tests were conducted on behalf of the FAA and TC.

(b) Previously, snow HOT guideline values were based on the then-current moderate snow conditions and a liquid equivalent snowfall rate of 1-2.54 mm/hr (0.04-0.10 in/hr of liquid equivalent snowfall). The SAE G-12 Holdover Time Subcommittee had defined light snow as a snowfall rate of less than 1 mm/hr (less than 0.04 in/hr of liquid equivalent snowfall). During the meeting of the SAE G-12 HOT Subcommittee in May 2003, values between 0.2 and 0.4 mm/hr were recommended for very light snow conditions. Thus, in the current FAA Type I HOT guideline, HOT values for liquid equivalent snowfall rates between 0.4 and 1.0 mm/hr (0.016-0.04 in/hr) are selected for the light snow column and HOT values for liquid equivalent snowfall rates between 0.2 and 0.4 mm/hr are selected for the very light snow column. Overall, these selections were based upon a number of factors, including:

- Snow intensity reporting and measurement inaccuracies for light conditions of less than 0.5 mm/hr.
- Potential wind effects.
- Light snow variability.
- Possible safety concerns associated with pretakeoff checks.

(3) Testing of Heated Type I Fluids. During the 2001-2002 winter icing period, more than 250 tests using heated Type I fluids in natural snow were conducted. These tests used an insulated thermal equivalent 7.5 cm test box to simulate the thermal response of the leading edge of an aircraft wing instead of the standard uninsulated frosticator plate used in previous years.

Extensive laboratory and field tests had determined that the insulated 7.5 cm test box more closely matched the thermal response of an aircraft wing leading edge than the frosticator plate. During the tests, fluids were diluted to a 10° C (18° F) buffer and applied at 60° C (140° F) to the 7.5 cm insulated thermal equivalent test box. HOT results from these tests were deemed to more closely coincide with those observed during actual deicing operations in snow conditions.

(4) Effectiveness of Heated Type I Fluids. The heating requirements for Type I fluids have been removed from Table 1 (located on the FAA Web site) to avoid clutter, but remain in Table 1B, located on the FAA Web site.

(a) Type I HOTs are heavily dependent on the heating of aircraft surfaces. Unlike Type II, III, and IV fluids, which contain thickeners to keep these fluids on aircraft surfaces, Type I fluids are not thickened and flow off relatively soon after application; therefore, the heating of aircraft surfaces during the Type I fluid deicing and anti-icing process contributes to the HOT by elevating the surface temperature above the freezing point of the residual fluid.

(b) When establishing compliance with the temperature requirement of 60° C (140° F) at the nozzle, as stated in Table 1B (located on the FAA Web site), the FAA does not intend for air carriers or deicing operators to continually measure the fluid temperature at the nozzle. The FAA deems that establishing the temperature drop (at nominal flow rates) between the last temperature monitored point in the plumbing chain and the nozzle is sufficient. Manufacturers of ground vehicle-based deicing equipment have indicated a temperature drop of 10° C (18° F) or less. Some manufacturers producing equipment that uses instant-on heat or last bypass heaters have indicated a temperature drop of 5° C (9° F) or less. Ensuring that the drop in fluid temperature from the last measured point in the plumbing chain to the nozzle does not result in a fluid temperature of less than 60° C (140° F) at the nozzle is sufficient.

(5) Frozen Contamination Removal. Frozen contamination removal is the deicing step of a deicing/anti-icing procedure. HOT guidelines require that an anti-icing step be performed following the deicing step. The Type I HOT guideline also provides an estimate of the time of protection under precipitation conditions. The double diamonds note on the Type I HOT guidelines specifies the quantity of fluid that must be applied over and above that required to deice (i.e., the anti-icing step).

**Note:** HOTs start as soon as the anti-icing step begins. Users who rely on the one step procedure (Table 1B of the HOTs, located on the FAA Web site) cannot assume that terminating the operation, after the frozen contamination has been removed, conforms to the intent of this table.

(6) Suggested Quantity of Type I Fluid to Use. Table 1B (located on the FAA Web site) further states that heated Type I fluid must be applied to deiced surfaces, meaning that this is the anti-icing step. The minimum quantity stated as at least 1 liter per square meter (approximately 2 gallons per 100 square feet) serves as a guide. This minimum quantity will vary depending on the aircraft, fluid application equipment, crew technique and experience, outside air temperature (OAT), and fluid spray pattern. Larger aircraft with greater skin thickness and larger internal structure may require quantities greater than 1 liter/m<sup>2</sup>. The FAA does not intend for air carriers to measure this fluid quantity during the anti-icing step. For anti-icing, a sufficient

amount of Type I fluid applied to drive off all fluids that have absorbed snow, ice, and slush during the deicing process has proven to be a safe practice. Experience with a particular aircraft can serve as the primary guide as to which surfaces are prone to fail first (e.g., wing tips, control surfaces, structurally thin areas). Such areas should receive adequate coverage of Type I fluid.

**c. Interpretation of HOT Guidelines.** The FAA intends for HOT guidelines to provide an indication of the approximate length of time that a freezing point depressant (FPD) fluid will protect aircraft surfaces during icing conditions and while on the ground. FPD fluids do not provide icing protection while airborne. Tables 2 and 4 (located on the FAA Web site) represent the generic or worst-case tables. Of all fluids tested for each Type II and Type IV fluid, the FAA has entered the lowest HOT value in each cell for each precipitation condition. Therefore, for any fluid-specific brand of fluid, its HOT will be as good as or better than the value in the appropriate worst case chart. This can be important if the fluid-specific brand of fluid is not known. In 2005, HOTs for dilutions of Type III fluid were added. Previously, the necessary data were not available. Some manufacturers of Type II and IV fluids have concurred in the publication of HOT guidelines for their particular fluid(s). These are termed “fluid-brand” HOT guidelines. They are listed in (located on the FAA Web site):

- Tables 2 and 2A through 2H (for Type II fluids).
- Tables 4 and 4A through 4O (for Type IV fluids).

(1) The HOTs for Type II, III, and IV fluids are primarily a function of the OAT, precipitation type and intensity, and percent FPD fluid concentration applied. The icing precipitation condition (e.g., frost, freezing fog, snow, freezing drizzle, light freezing rain, and rain on a cold-soaked wing) applies solely to active meteorological conditions.

**Note:** All HOT values (except for snow) are determined in the laboratory under no-wind conditions. Generally, wind reduces HOTs. Snow testing is conducted outdoors and may or may not involve varying winds. This can have varying effects on the test results.

(2) For Type II, III, and IV fluids, the percent mixture is the amount of undiluted (neat) fluid (as marketed by the manufacturer) in water. A 75/25 mixture is, therefore, 75 percent FPD fluid and 25 percent water.

(3) For Type I fluid (Table 1), note the statement in the commentary under that reads, “... freezing point of the mixture is at least 10° C (18° F) below OAT.” The difference between the freezing point of the fluid and the OAT is known as the temperature or freezing point buffer. In this case, the buffer is 10° C (18° F), which you can interpret as the freezing point of the fluid being 10° C (18° F) below the OAT. The 10° C (18° F) temperature buffer is used to accommodate inaccuracies and impreciseness in determining the many variables that affect the freezing point of a fluid mixture. Some of these variables include:

- OAT measurements.
- Refractometer freezing point measurements.
- Temperature of applied fluid/water mixture.
- Inaccuracies in FPD fluid/water mixtures volumes.

- Differences between OAT and aircraft surface temperatures.
- Changes in OAT following fluid application.
- Differences in aircraft surface materials.
- Degradation of FPD fluid strength due to aging.
- Degradation of FPD strength due to pumping equipment.
- Wind effects.
- Solar radiation.

**Note:** For example, If the OAT is -3° C (27° F), the freezing point of the Type I fluid mixture should be -13° C (9° F) or lower, and the mixture applied at a minimum temperature of 60° C (140° F) at the nozzle before the HOT guidelines information in Table 1 (located on the FAA Web site) can be used.

(a) Under the Degrees Celsius column, below -3° C to -6° C for freezing drizzle, the HOT is 0:05-0:09, which is interpreted as a HOT from 0 hours and 5 minutes to 0 hours and 9 minutes. Depending on the freezing drizzle intensity, the approximate time of protection expected could be:

- As short as 5 minutes for a moderate or heavy freezing drizzle intensity, or
- As long as 9 minutes for light freezing drizzle conditions.

(b) In all cells of Table 1 and Table 1A (located on the FAA Web site), except for light and very light snow, freezing drizzle, and freezing rain, where two values of time are entered, the precipitation intensity is light to moderate. For the very light snow and light snow columns, HOTs should be considered in terms of their respective rates. Very light snow has a liquid equivalent snowfall rate of 0.2 mm-0.4 mm/hr and for light snow has a rate of 0.4 mm-1 mm/hr. The longer times for very light snow would correspond to the lesser rate; whereas the shorter times would correspond to higher rates. For freezing rain, the range is confined to light freezing rain, which can be up to 2.5 mm/hr. Except for freezing drizzle, heavy precipitation conditions are not considered in any HOT guidelines.

**Note:** The FAA does not approve takeoff in conditions of moderate or heavy freezing rain, and hail. The FAA has developed allowance times and associated limitations for takeoff in light or moderate ice pellets, and light ice pellets mixed with other forms of precipitation listed in the ice pellet allowance time table (Table 9, Ice Pellet Allowance Times 2011-2012 (located on the FAA Web site)). Additionally, takeoff in heavy snow may be accomplished if the requirements for operating in this condition, which are located on the FAA Web site, are met.

(c) The FAA also emphasizes that air carriers should read and understand all notes and cautions, such as the reference to the 10° C (18° F) buffer, in the guidelines to preclude improper usage of the fluid.

(4) Differences exist between Types II, III, and IV, and Type I fluid HOT guideline usage.

(a) A percent fluid concentration column appears in all tables dealing with Type II, III, and IV fluids, but not in Table 1 (Type I fluids) because:



- Type I fluids are applied to maintain at least a 10° C (18° F) buffer between the OAT and the freezing point of the fluid/water mix.
- Type II, III, and IV fluids are used solely in concentrations of 100/0, 75/25, or 50/50 in the anti-icing application. The freezing point buffer for these fluids will be at least 7° C (13° F) when used according to the dilutions and temperatures shown on their corresponding HOT tables.

**Note:** HOT tests are conducted using the 10° C (18° F) buffer for Type I fluids and the appropriate fluid/water concentration (100/0, 75/25, or 50/50) for Type II, III, and IV fluids.

(b) The HOT for a Type I fluid is considerably less than that for a Type II, III, or IV fluid. The amount of heat absorbed by aircraft surfaces during the deicing/anti-icing operations heavily influences the degree of protection provided by Type I fluid. To use the Type I HOT guidelines, the fluid must be applied heated to deiced surfaces with a minimum temperature of 60° C (140° F) at the nozzle and applied at a rate of at least 1 liter/m<sup>2</sup> (approximately 2 gallons/100 square feet). Since composite surfaces are very poor conductors of heat, the composite HOTs are shorter due to the lack of heat absorption on these non-metallic surfaces.

(c) Although Type I fluids are normally considered deicing fluids, and Types II, III, and IV are considered anti-icing fluids, all types have been used in the deicing and anti-icing mode. However, the performance of Type I fluid when used as an anti-icing agent is inferior to that of Types II, III, and IV. Also, heated and diluted Type II and IV fluids are being used for deicing and anti-icing operations. This is a common practice among many of the European airlines and in use at some foreign airports by U.S. air carriers. Type III fluid is relatively new to the market and can also be used heated and diluted. HOTs for dilutions have been developed.

**Note:** The use of HOT guidelines is associated with anti-icing procedures and does not apply to deicing.

(d) During the application of heated Type II and IV fluids in the one-step procedure, questions have arisen regarding the anticipated HOT performance of these fluids.

(e) In prior advisory information, the FAA indicated that maximum anti-icing effectiveness could be achieved from the application of unheated (cold) Type II fluids to deiced aircraft surfaces. This was based upon observations of the performance of Type II fluids in production at that time. The rationale was that a cold, unheated fluid would produce a thicker protective layer on aircraft surfaces, thus providing longer protection than a heated fluid presumably applied in a thinner layer.

(f) Some air carriers proposed using the Type I HOT guideline values instead of Type II and IV values; when these thickened, heated fluids were applied. Another carrier suggested reducing the Types II and IV HOT values by 50 percent. During tests conducted by APS Aviation for the FAA and TC using the existing test protocol, HOT performance of heated 60° C (140° F) Type II and IV fluids was found to equal or exceed the HOT performance of unheated Type II and IV fluids for the same fluid concentrations, temperature, and precipitation conditions. Therefore, these and other test results have indicated that there is no basis for

reducing the current HOT guideline values for Type II and IV fluids or using the Type I fluid HOT guidelines when heated Types II and IV fluids are properly applied.

(g) In addition, HOT guideline data were obtained for the newly-introduced Type III fluids when applied heated and unheated and no significant HOT performance differences were observed. Therefore, anti-icing applications of Type III fluid may be heated or unheated.

(h) Most FPD fluids are ethylene glycol or propylene glycol based. Under precipitation conditions, chemical additives improve the performance of Types II, III, and IV fluids when used for anti-icing. These additives thicken and provide the fluid with non-Newtonian flow characteristics. Thickening enhances fluid HOT performance and the non-Newtonian behavior results in fluid viscosity rapidly decreasing during the takeoff roll, which allows the fluid to flow off the critical wing surfaces prior to liftoff. This same characteristic makes Type II and IV fluids sensitive to viscosity degradation via shearing when being pumped or sprayed. Type III is less sensitive as it has a much lower viscosity to begin with.

(5) Tables dealing with Type II and IV fluids have a caution note (\*\*\*) that states “No holdover time guidelines exist for this condition below -10° C (14° F).” This statement informs the user that, although the temperature range is below “-3° C (27° F) to 14° C (7° F),” the FAA does not consider HOT values valid below -10° C (14° F) for freezing drizzle and light freezing rain. These conditions usually do not occur at temperatures below -10° C (14° F). On rare occasions when these conditions do occur at temperatures below -10° C (14° F), you should exercise caution regarding HOT value usage.

(6) Only one HOT value is entered under the Frost column for a given temperature band. Frost intensities or accumulations are low in comparison to other precipitation conditions and decrease at colder temperatures. This usually results in HOTs for frost being considerably longer in comparison to HOTs for other precipitation conditions. The longer HOTs should accommodate most aircraft ground operational requirements. Furthermore, when testing in the laboratory for frost, only one precipitation condition is considered rather than a range. Thus, there is no range in HOT for frost. You should only use the single time, as with all the times in the tables, as a guide. HOTs are for active frost conditions in which frost is forming. This phenomenon occurs when aircraft surfaces are at or below 0° C and at or below the dew point. Frost typically forms on cold nights with clear skies.

**Note:** HOTs for frost are for active frost conditions.

(7) A separate table, Table 7, Lowest Operational Use Temperatures of Anti-Icing Fluids (2011-2012), located on the FAA Web site, was issued in 2010 to provide LOU information, which is based on aerodynamic performance (i.e., the fluid’s ability to flow off the wing during takeoff) and the fluid’s freezing point depression capabilities. For 2011-2012, this information has been also added to the bottom row of the fluid-specific HOTs.

#### d. HOT Guidelines Overview.

(1) The FAA has constructed generic HOT guidelines for Type I, II, III, and IV fluids (Tables 1, 2, 3, and 4, respectively, located on the FAA Web site) to present information on the minimum performance times that have been observed during testing of these anti-icing fluids. Typically, each cell of the HOT values represents a range of performance times in which the fluid provides acceptable protection for varying precipitation intensities for the following conditions:

- Freezing fog.
- Snow, including snow pellets.
- Freezing drizzle.
- Light freezing rain.
- Rain on cold-soaked wings.

**Note:** Except for the light snow, very light snow, and light freezing rain conditions, the lower HOT value in a cell presents information for moderate precipitation conditions. For freezing drizzle conditions, the range covers all ranges of precipitation intensities, including heavy. The longer HOT value is representative of fluid performance for light precipitation conditions. HOT values for heavy precipitation conditions (except freezing drizzle) do not exist.

(2) For Type I HOT guidelines, testing was conducted at  $-3^{\circ}\text{C}$  ( $27^{\circ}\text{F}$ ) and applied to the above  $-3^{\circ}\text{C}$  ( $27^{\circ}\text{F}$ ) range. The FAA deemed potential differences between  $0^{\circ}\text{C}$  ( $32^{\circ}\text{F}$ ) and  $3^{\circ}\text{C}$  ( $27^{\circ}\text{F}$ ) HOT values for Type I fluid as insignificant because thermal energy is a key factor in achieving HOT performance for Type I fluid.

**e. HOTs When Anti-icing in a Hangar.** The period of time after Type IV fluid application and the air temperature in the hangar both affect the ability of the fluid to protect the aircraft when it is pulled out into freezing/frozen precipitation. The HOT for a fluid is largely based upon the fluid's thickness on the surface. The fluid thickness varies with time and temperature whereby it decreases over time and will dry out, which also causes thinning in a hangar. Therefore, start the HOT clock at the time of the beginning of the application of anti-icing fluid onto a clean wing, not when the application process is finished. It may not be started when the aircraft is first exposed to freezing/frozen precipitation.

**f. HOT Limitations.** Operators should note that although HOTs are published for conditions of freezing drizzle and light freezing rain, these conditions may exceed the aircraft's certified capacity to operate in these conditions.

#### g. Unique HOT Guidelines.

(1) In the fluid-specific Type II HOT guidelines for Kilfrost ABC-2000, Table 2E, FAA Guidelines for Holdover Times Kilfrost ABC-2000 Type II Fluid Mixtures as a Function of Weather Conditions and Outside Air Temperature, located on the FAA Web site, protection is increased in some cells when fluid concentration is reduced. Under the Freezing Fog and Snow columns, the 75/25 concentration provides a moderate increase in protection over the 100/0 concentration at  $-3^{\circ}\text{C}$  ( $27^{\circ}\text{F}$ ) and above. The addition of certain quantities of water to some neat

fluids can enhance their performance up to a certain point. For example, when water is added to Kilfrost ABC-2000, the viscosity increases. Without knowing about this particular fluid mix phenomenon, an air carrier may think that the data presented in the tables are in error.

(2) One Type IV fluid, Octagon Max-Flight 04, has a HOT of 2:00-2:00 in light freezing rain in the -3° C (27° F) and above cell. This is because this fluid demonstrated a HOT of at least 2 hours at the lower and higher precipitation rates for this condition. By convention, HOTs are limited to 2 hours for all precipitation conditions tested except freezing fog and frost. As new fluids become available this same phenomenon could be observed again in the same or different cells.

(3) Other unique fluids are the Type IV Dow UCAR Ultra+ (Table 4G, Guidelines for Holdover Times Dow UCAR™+ ADF/AAF Type IV Fluid Mixtures as a Function of Weather Conditions and Outside Air Temperature), and Dow UCAR Endurance EG106 (Table 4H, FAA Guidelines for Holdover Times Dow UCAR™ Endurance EG106 Type IV Fluid Mixtures as a Function of Weather Conditions and Outside Air Temperature, located on the FAA Web site). There are no HOT values for these fluids in the 75/25 and 50/50 concentrations.

**h. Snowfall Intensity-Visibility Table.** Table 1C, Snowfall Intensities as a Function of Prevailing Visibility, located on the FAA Web site, presents critical information on the variability of snowfall intensities as a function of prevailing visibilities. The HOT of any anti-icing fluid is directly related to the amount of moisture it can absorb before freezing. Currently, snow intensities reported by the National Weather Service (NWS) do not take into account the effect of temperature on snow moisture content.

(1) Snowflake density is a key factor in determining the moisture content of snow. Wet snow, which generally occurs at temperatures above -1° C (30° F), has a greater density than dry snow. Being heavier, it will fall faster than dry snow. Thus, for a given visibility, these two factors will cause wet snow to deposit more moisture than dry snow. Table 1C presents temperature correlation information, which more accurately relates wet snow and dry snow intensities to visibilities.

(2) During night snowfall, the visibility is about twice as good as it is during the day for the same snowfall rate. This occurs because snow reflects light at a high rate, and during the day, light comes from all directions, which makes the reflections worse. At night, there is less light and light rays are more directed toward you with reduced glare and reflections. Therefore, Table 1C also presents a differentiation between day and night conditions to make visibility a more accurate indicator of moisture content for a given snowfall intensity and temperature. Therefore, you must consult Table 1C for an accurate estimation of snowfall intensity moisture content (liquid equivalent snowfall rate), which is based on prevailing visibility and temperature.

## 8. Revisions.

### a. HOT Changes.

(1) Type I Fluids. The HOTs for Type I fluids now include values for aircraft with critical surfaces predominantly or entirely constructed of composite materials. However, these

composite values do not need to be applied to an aircraft that is currently in service, has a demonstrated safe operating history using Type I fluid aluminum structure HOTs, and has critical surfaces only partly constructed of composite material. Snow pellets have now been removed from the “Other” column and placed into the snow column for all fluid types. This action was taken after several years of research indicated HOTs in snow pellets were sufficiently similar to those in snow alone to be included in this category.

(2) Type II Fluids. Minor increases or decreases ranging from 1 to 4 minutes have been made to all eight of the Type II fluid-specific HOT tables and to the Type II generic HOT table due to changes made in the HOT rounding protocol. The lower limit of the lowest temperature band value for the fluid in the Type II fluid-specific HOTs has been changed from -25° C/13° F to the actual LOUT. No fluids were added or deleted.

(3) Type III Fluids. A Type III fluid, Clariant Safewing MP III 2031 ECO, was introduced for the 2004-2005 winter icing season with a corresponding generic HOT guideline for undiluted fluid only. In 2005, HOT values were developed for dilutions (Table 3, FAA Guidelines for Holdover Times SAE Type III Fluid Mixture as a Function of Weather Conditions and Outside Air Temperature, located on the FAA Web site). Type III fluid is designed to accommodate aircraft with low rotation/takeoff speeds, although it works equally well on aircraft with higher rotation/takeoff speeds and offers substantial improvements in anti-icing performance when compared to Type I fluid. Also, it does not require specialized low shear application and transfer equipment. This particular fluid was designed to be used in Type I storage tanks and application equipment, either diluted or undiluted for deicing and for anti-icing. Type III fluids can be applied heated or unheated for anti-icing. For 2011-2012, there are no changes to the Type III HOT values.

(4) Type IV Fluids. Minor increases or decreases ranging from 1 to 4 minutes have been made to six Type IV fluid-specific HOT tables and to the Type IV generic HOT table due to changes made in the HOT rounding protocol. The affected tables are:

- Table 4,
- Table 4A,
- Table 4C,
- Table 4I,
- Table 4K,
- Table 4L, and
- Table 4N.

**Note:** The lower limit of the lowest temperature band in the Type IV fluid specific holdover tables has been changed from -25° C/-13° F or LOUT to the actual LOUT value for the fluid.

(5) New Type IV Fluid. A new Type IV fluid, Cryotech Polar Guard Advance, has been added to the list of fluids for 2011-2012. This action did not change any of the values in the generic Type IV HOT table. Clariant Safewing MP IV 2012 Protect and Octagon MaxFlo have been removed from the Type IV guidelines as per the protocol for removing obsolete data.

Removal of these fluids caused significant increases in the HOTs in 12 cells of the Type IV generic HOTs.

**b. Type I Fluid Application Table (Table 1B, located on the FAA Web site).** In 2006, a line was added to Table 1B, FAA Guidelines for the Application of SAE Type I Fluid Mixture Minimum Concentrations as a Function of Outside Air Temperature, that states “fluids must only be used at temperatures above their lowest operational use temperature (LOUT).”

(1) The LOUT is the lowest temperature at which a fluid has been determined in a wind tunnel to flow off an aircraft in an aerodynamically acceptable manner while maintaining the required freezing point buffer which is 10° C (18° F) for Type I fluids.

(2) For example, if a Type I fluid is aerodynamically acceptable to -30° C (-22° F), but the freezing point is -35° C (-31° F), the limiting factor (LOUT) would be the freezing point plus the required 10° C (18° F) buffer or -25° C (-13° F). In another example, if a different Type I fluid was aerodynamically acceptable to -30° C (-22° F), and the freezing point was 42° C (44° F) the LOUT would be limited by the aerodynamic performance and the LOUT would be -30° C (-22° F), since the 10° C (18° F) buffer requirement is met at -32° C (-26° F).

(3) At colder temperatures FPD fluids become too thick to flow off the aircraft properly during takeoff and/or their freezing point temperature is reached and they are no longer able to keep aircraft surfaces from freezing in the presence of active precipitation.

(4) In 2003, the FAA, in coordination with the SAE G-12 Methods Subcommittee, modified the temperature application requirements for the one-step and the two-step deicing/anti-icing procedures to reflect the requirement for applying heated Type I fluid. The revised note states: “Mix of fluid and water heated to 60° C (140° F) minimum at the nozzle with a freezing point of at least 10° C (18° F) below OAT.” Also, the following note was added: “NOTE: This table is applicable for the use of Type I Holdover Time Guidelines. If holdover times are not required, a temperature of 60° C (140° F) at the nozzle is desirable.” In essence, this note clarified the requirements for heated Type I fluids mixtures if Type I HOTs are required.

**c. Types II, III, and IV Fluids Application Table (Table 5, FAA Guidelines for the Application of SAE Type II, Type III, and Type IV Fluid Mixtures Minimum Concentrations as a Function of Outside Air Temperature, located on the FAA Web site).**

(1) As in Table 1A, the Type I fluid application table, the same note was added in 2006 to Table 5 stating “fluids must only be used at temperatures above their lowest operational use temperature (LOUT).” The only difference is that the freezing point buffer for Type II, III, and IV fluids is 7° C (13° F).

(2) An example of a LOUT for these fluids would be if a specific Type IV fluid is aerodynamically acceptable down to -33° C (-27° F) with a freezing point of -36° C (-33° F), the limiting factor would be the freezing point when the 7° C (13° F) buffer is factored in giving a resulting LOUT of -29° C (-20° F).

(3) In 2005, several changes were incorporated into Table 5. All of these changes, which appear under both the one-step and two-step procedures, were related to the addition of HOTs for dilutions of Type III fluid.

## **9. Other Concerns/Conditions.**

**a. Early Fluid Failure on Extended Slats and Flaps.** Research has determined that fluid degradation (via increased flow off) may be accelerated by the steeper angles of the flaps/slats in the takeoff configuration. The degree of potential degradation is significantly affected by the specific aircraft design. Further research is anticipated to characterize the extent of the effect on the HOTs and Allowance Times. The FAA advises all air operators to review their policies and procedures in light of this information to assure appropriate consideration.

### **b. Aircraft Failure to Rotate when Anti-iced with Type IV Fluid.**

(1) The FAA has become aware of some instances where aircraft failed to rotate after being anti-iced with Type IV fluid. This situation has been confined mostly to slower rotation speed turboprop aircraft; however, one occurrence involved a small corporate jet. Typically, these aircraft have nonpowered flight controls that rely on aerodynamic forces to achieve rotation.

(2) When excessive amounts of Type IV fluids are sprayed on the tail surfaces, the gap between the horizontal stabilizer and the elevator can become blocked with fluid and restrict the air flow needed for proper deflection of the elevator, resulting in difficulties with rotation, including high stick forces being encountered by pilots. Operators are cautioned to avoid spraying these aircraft tail areas from the rear, and should always apply fluid in the direction of airflow, from front to rear. Although they should be completely covered, these aft areas should not be flooded with excessive amounts Type IV fluids.

**Note:** These concerns apply equally to applications of Type II fluids.

### **c. Possible Effects of Runway Deicer on Thickened Aircraft Anti-icing Fluids.**

(1) Most current runway deicing/anti-icing material contains salts that are not compatible with thickened aircraft anti-icing fluids. These salts cause the thickening agents within the aircraft deicing fluids to breakdown, reducing the viscosity of the anti-icing fluid and causing it to flow off the airframe more quickly. This reduction in the amount of anti-icing fluid will have an impact on the length of time that the anti-icing fluid will continue to provide adequate anti-icing protection. Research into the likelihood of this occurring and the severity of its impact in an operational environment is ongoing.

(2) During landing if runway deicing fluid is expected to have been splashed or blown up onto a critical surface, those surfaces should be thoroughly washed with deicing fluid or hot water (if temperature appropriate) prior to applying anti-icing fluids. This is normally accomplished during a routine two-step deicing/anti-icing process; however, during a preventive anti-icing fluid application, this cleansing step is often not accomplished. During taxi operation for takeoff on taxiways that have been deiced/anti-iced, flightcrews should be conscious of the

effects of having the runway deicing fluid blown up onto the aircraft by preceding aircraft jet blast.

**d. Pretakeoff Contamination Checks.** Pretakeoff contamination checks are required to be accomplished within 5 minutes of takeoff after exceeding any maximum HOT in the certificate holder's HOT table.

**e. Inspection of Single-engine, High Wing Turboprop Aircraft.**

(1) In recent years, there has been a disproportionate number of ground icing accidents associated with improper checking/inspection of single-engine, high wing turboprop aircraft employed in commercial service. This is especially true of such aircraft operated from remote locations with minimum facilities. In several of these accidents, it could not be determined whether the aircraft had been inspected/checked by the operator/pilot prior to departure. HOTs were not an issue because at the time of attempted departure there was no active precipitation. Typically, these accidents occurred during the first flight of the day, following a freezing precipitation event that had occurred earlier.

(2) For these types of operations, the single pilot/operator was usually the final person to perform the pretakeoff check. On one aircraft in particular, it has been shown that it is difficult to see clear frozen contamination from a glancing view of the upper wing surface area (looking rearward from the wing's leading edge) when the pilot uses the wing strut/step to see the aft portion of the wing. Visual inspections can best be achieved by using inspection ladders or deicing ladders to achieve a higher vantage point to view the aft upper wing surface area. A number of ladder manufacturers provide wing inspection ladders that are ideal for this task. POIs are encouraged to discuss these observations with their operators, and to ensure that operators employ adequate means to allow a pilot to clearly see the entire upper wing surface from a suitable height above the wing.

**f. Tactile Inspection of Hard Wing Airplanes (no leading edge devices/slats).** The following guidance is provided for tactile inspection clarification for part 121 operators of hard wing airplanes with an approved § 121.629(c) deicing program. There are three possible times that a tactile check should be accomplished in this type of operation:

(1) The conditions are such that frost or ice might be adhering to the aircraft, such as 10° C (50° F) or colder and high humidity or cold soaked wings, all without active precipitation. Under this condition, a tactile check should be performed as part of the cold weather preflight requirements.

(2) If the aircraft is deiced, the post deicing check to confirm that all the contaminants have been removed from the critical surfaces should be accomplished through the use of a visual and tactile check.

(3) The aircraft has been anti-iced with anti-icing fluids and the prescribed HOTs have been exceeded, the required pretakeoff contamination check required within 5 minutes before takeoff must be accomplished through a visual and tactile check of the critical surfaces.



**g. Anti-icing Quality Assurance (QA).** Operators must ensure that that sufficient anti-icing fluid is applied to remove/replace remaining deicing fluid. Anytime orange color from Type I fluid can be seen mixed with the green color from Type IV fluid, the Type I fluid was not adequately removed from the aircraft surfaces when the Type IV fluid was being applied. Also it is critically important to completely cover the aircraft critical surfaces with a coating of Type IV fluid (the thickness of the anti-icing fluid should be approximately the thickness of a U.S. dime). The anti-icing protective coating must completely cover and run over the front of the wings' leading edges as well as have a uniform coating over all the critical surfaces. Operators are required to monitor deicing/anti-icing applications to confirm that fluids are being applied properly.

**h. Fluid Quality Control (QC).**

(1) Prolonged or repeated heating of fluids may result in loss of water content, which can lead to performance degradation of the fluid. Deicing/anti-icing fluids should not be heated to application temperatures until necessary for application, if possible, and cycling the fluid to application temperatures and back to ambient should be avoided. For Type I fluids, the water loss caused by prolonged/repeated heating may cause undesirable aerodynamic effects at low ambient temperatures. For Type II, III, and IV fluids, the thermal exposure and/or water loss may cause a reduction in fluid viscosity, leading to earlier failure of the fluid and therefore invalidates the applicable HOT.

(2) Other types of fluid degradation may result from chemical contamination, or in the case of Type II and IV fluids, excessive mechanical shearing attributed to the use of improper equipment/systems such as pumps, control valves, or nozzles.

(3) Checks of fluid quality should be made before the start of the deicing season of all stored fluids. At a minimum, the checks for all fluids, Types I, II, III, and IV, should include visual inspections of the fluid and the containers for contamination and separation, refractive index measurements, and pH measurements. All values must be within the limits recommended for the manufacturer's specific fluid type and brand.

(4) In addition, for Type II, III, and IV fluids, viscosity checks (per the fluid manufacturer's recommendations) should be performed at the beginning of the icing season and periodically throughout the winter, and any time fluid contamination or damage is suspected. These viscosity checks include samples obtained through the spray nozzles of application equipment. Viscosity values for dilutions of Type II, III, and IV fluids have been added to Table 6, Lowest On-wing Viscosity Values for Anti-icing Fluids, to facilitate fluid viscosity checks in locations where thickened fluids are diluted before applying, and in some cases, may be stored diluted.

(a) Nozzle samples should be collected from suitable, clean surfaces such as aluminum plates or plastic sheets laid on a flat surface, or the upper surface of an aircraft wing. The fluid should be sprayed in a similar manner as used in an actual anti-icing operation. A small squeegee can be used to move the fluid to the edge of the sheet or wing so it can be collected in a clean, nonmetallic, wide-mouthed sample bottle.

(b) Nozzle samples may also be sprayed into clean containers, such as a large trash can or containers with clean plastic liners such as trash bags.

(c) With all of these collection methods, samples should be sprayed onto the wing/sheet or into the container at a similar distance from the nozzle and at the same flow rate and nozzle pattern setting as used in the actual anti-icing operation.

#### **i. Fluid Dry-Out.**

(1) Reported incidents of restricted movement of flight control surfaces, while in-flight, attributed to fluid dry-out have continued. Testing has shown that diluted Type II and IV fluids can produce more residual gel than neat fluids. This is primarily due to the practice in some geographic locations of using diluted, heated Type II and IV fluids for deicing and anti-icing. Operators should be aware of the potential for fluid residue on their aircraft when operating to locations in Europe or other locations where deicing and anti-icing is conducted with diluted Type II or Type IV fluids.

**Note:** Changing from Type IV fluid to Type II fluid will not necessarily reduce fluid dry-out problems.

(2) Such events may occur with repeated use of Type II and IV fluids without prior application of hot water or Type I fluid mixtures. This can result in fluid collecting in aerodynamically quiet areas or crevices, which do not flow off the wing during the takeoff ground roll. These accumulations can dry to a gel-like or powdery substance. Such residues can re-hydrate and expand under certain atmospheric conditions such as high humidity or rain. Subsequently, the residues freeze, typically during flight at higher altitudes. Re-hydrated fluid gels have been found in and around gaps between stabilizers, elevators, tabs, and hinges. This especially can be a problem with nonpowered controls. Some pilots reported that they have descended to a lower altitude until the frozen residue melted, which restored flight control movement.

(3) Some European air carriers have reported this condition in which the first (deicing) step was performed using a diluted heated Type II or IV fluid followed by a Type II or IV fluid as the second (anti-icing) step, or by using these heated, thickened fluids in a one-step deicing/anti-icing process. To date, North American air carriers have not reported such occurrences. Typically, North American air carriers use a two-step deicing/anti-icing procedure in which the first step is generally a hot Type I fluid mixture.

(4) Operators should check aircraft surfaces, quiet areas, and crevices for abnormal fluid thickening, appearance, or failure before flight dispatch if Type II or IV fluids are used exclusively to deicing/anti-ice their aircraft. If an operator suspects residue as a result of fluid dry out, an acceptable solution to spray the area with water from a spray bottle and wait 10 minutes. Residue will re-hydrate in a few minutes and be easier to identify. This residue may require removal before takeoff.

(5) If aircraft are exposed to deicing/anti-icing procedures likely to result in dehydrated fluid build up, clean the aircraft in accordance with the aircraft manufacturers' recommendations.

This cleaning should be accomplished with hot Type I fluid and/or water mix, or other aircraft manufacturer recommended cleaning agents. These cleaning procedures may require subsequent lubrication of affected areas. If evidence of fluid dry out is present, an increase in the frequency of inspection of flight control bays and actuators may be necessary.

**j. Freezing Fog.** The freezing fog condition is best confirmed by observation. If there is accumulation in the deicing area, then the condition is active and freezing fog accumulation will tend to increase with increasing wind speed. The least accumulation ( $0.5 \text{ g/dm}^2/\text{hr}$ ) occurs with zero wind. The measured deposition rate of freezing fog at 1 and 2.5 meters/sec wind speeds are 2 and  $5 \text{ g/dm}^2/\text{hr}$ , respectively. Higher accumulations are possible with higher wind speeds. Freezing fog can accumulate on aircraft surfaces during taxi since taxi speed has a similar effect as wind speed.

**k. Frost.** Frost occurs frequently during winter operating conditions. Frost due to radiation cooling is a uniform thin white deposit of fine crystalline texture, which forms on exposed surfaces that are below freezing, generally on calm cloudless nights where the air at the surface is close to saturation. When the deposit is thin enough for surface features underneath the frost such as paint lines, markings, and lettering to be distinguished, it is often referred to as hoarfrost. Frost can also form on the upper or lower surfaces of the wing due to cold soaked fuel. Frost has the appearance of being a minor contaminant and does not offer the same obvious signal of danger as do other types of contamination such as snow or ice. However, frost is a serious threat to the safety of aircraft operations because it always adheres to the aircraft surface, is rough, and causes significant lift degradation and increased drag. Frost forms whenever the exposed surface temperature cools below the OAT to, or below, the frost point (not dew point). The mechanisms for cooling include:

- Radiation cooling, or
- Conductive cooling (due to cold soaked fuel).

(1) Active Frost. Active frost is a condition when frost is forming. During active frost conditions, frost will form on an unprotected surface or re-form on a surface protected with deicing/anti-icing fluid where the HOT has expired.

**Note:** If the exposed surface temperature is equal to or below the frost point, frost will begin to accrete on the surface. Once formed, residual accreted frost may remain after the active frost phase if the exposed surface temperature remains below freezing.

(2) Dew Point and Frost Point. The dew point is the temperature at a given pressure to which air must be cooled to cause saturation. The dew point can occur below or above  $0^\circ \text{C}$ . The frost point is the temperature, at or below  $0^\circ \text{C}$  ( $32^\circ \text{F}$ ), at which moisture in the air will undergo deposition as a layer of frost on an exposed surface. The frost point occurs between the OAT and dew point. The Aviation Routine Weather Report (METAR) does not report frost point; however, it does report dew point. The frost point is higher (warmer) than the dew point for a given humidity in the air. The frost point and the dew point are the same at  $0^\circ \text{C}$ ; at a dew point of  $-40^\circ \text{C}$ , the frost point is  $3.2^\circ \text{C}$  warmer ( $-36.8^\circ \text{C}$ ). The following table provides further examples of the correlation between dew point and frost point.

Dew Point Temperature (°C)	Frost Point Temperature (°C)
0	0.0
-5	-4.4
-10	-8.9
-15	-13.5
-20	-18.0
-25	-22.7
-30	-27.3
-35	-32.1
-40	-6.8

(3) Radiation Cooling. Radiation cooling will generally occur during clear sky (sky clear (SKC), high FEW or high scattered (SCT)), low wind (less than 10 knots), and low light (shade, at night, or in low angle/obscured sun) conditions. These conditions will cause the exposed surface temperature to cool below the OAT. Once the exposed surface temperature cools to the frost point or below, active frost occurs. Certain surface finishes and material compositions may be more susceptible to radiation cooling and, as a result, frost may begin to form on different areas of an aircraft at different times. Radiation cooling can cause an exposed surface to cool several degrees below the OAT; therefore, frost can form on an exposed surface at an OAT several degrees above 0° C. Depending on conditions, time for frost formation may range from minutes to hours. As a result, a surface that appears free of frost during an early inspection may become contaminated later. When conditions are favorable for active frost formation, a direct inspection of critical surfaces conducted as close as possible to the departure time is recommended.

(4) Cold Soaked Fuel Cooling. Cold soaked fuel cooling results from conductive cooling due to very cold fuel onboard at destination or from refueling with fuel that may be cooler than the OAT. Cold soaked fuel conditions are highly variable; therefore, only direct surface temperature readings are accurate but not available at most stations. Fuel temperature does not accurately predict cold soaked fuel conditions but may provide an initial indication, particularly in the period after landing and prior to fueling. The presence of frost under the wing is a good indication of cold soaked fuel conditions.

**Note:** In cases of cold soaked fuel at OATs well above freezing, frost forms deposits on surfaces that are at or below the frost point. In extreme cases, cold soaking may reduce the surface temperature below the fluid LOUT and cause a risk of fluid freezing.

(5) Combined Radiation and Cold Soaked Fuel Cooling Effects. Cold soaked fuel cooling combined with radiation cooling effects can cause reductions in active frost HOTS. This is

particularly true for Type I fluid HOTs as these are shorter in duration; therefore, use of a thickened anti-icing fluid should be considered.

(6) Deicing/Anti-Icing in Active Frost Conditions. Frost reforming after removal is an indication of active frost. During active frost, anti-icing protection is required and operations should be conducted in accordance with HOT guidelines and minimum fluid quantity and temperature application procedures therein. In active frost conditions, deicing alone is insufficient; therefore, once the frost has been removed, a preventative anti-icing coating is required.

(7) Fluid HOTs for Active Frost Conditions. Fluid HOTs in active frost conditions differ from HOTs in other conditions as they incorporate an allowance for the temperature differential (typically 6° to 8° C) between the OAT and the exposed surface temperature due to radiation cooling. As a result of this allowance, the OAT should be used to determine the appropriate active frost HOT. Active frost HOTs may be reduced in the presence of combined cooling effects or extreme surface cooling. In extreme cases, the surface temperature may be below the fluid LOUT and cause a risk of fluid freezing.

(8) Frost on the Underside of the Wing. Takeoff with frost under the wings in the area of the fuel tanks that is caused by cold soaked fuel within limits established by the aircraft manufacturer, approved by the FAA, and stated in aircraft maintenance and flight manuals is permitted.

(9) Frost on the Fuselage. Despite the requirement to clean contamination from critical surfaces, it is acceptable for aircraft, including those with aft fuselage mounted engines, to takeoff when frost is adhering to the upper surface of the fuselage if it is the only remaining contaminant and is thin enough for observers to visually distinguish aircraft paint surface features underneath it (e.g., paint lines, markings and lettering features), provided all vents and ports are clear. Contact the aircraft manufacturer for further details.

## **10. Alternative Technology.**

### **a. Gas-Fired Infrared (IR) Systems.**

(1) A gas-fired IR system contained in a modular shelter facility is in operation at John F. Kennedy International Airport (JFK). This system uses gas-fired units suspended from the ceiling of the modular shelter facility. It imparts sufficient IR-focused energy on the aircraft surfaces, which melts the frozen contaminants on the aircraft's surfaces that are in the line of sight of the IR units.

(2) With regard to such facilities, frozen contamination should be removed from aircraft surfaces before dispatch from the facility or anti-icing. The latter is generally accomplished within the facility after the deicing step, with the IR radiant energy at a reduced intensity. The reduced intensity during the anti-icing step is intended to prevent re-accumulation of frozen contamination (e.g., snow) that may blow through the open ends of the facility.

**Note:** The dehydration of Type II and IV fluids, which may occur during constant and uninterrupted exposure to IR radiation, can adversely affect fluid performance. The FAA advises the user to contact the manufacturer of the IR deicing facility and/or fluid manufacturer to determine the limit of IR exposure to which the fluid can be safely subjected without a degradation of fluid performance.

(3) The IR units may continue to operate between the deicing and anti-icing steps to evaporate the frozen contamination that has melted. The FAA cautions that heated aircraft surfaces must not exceed manufacturer's limits and the aircraft manufacturer must approve the use of IR deicing on the composite structures of the aircraft. After removal of the IR energy source, surfaces that remain wet will require an application of heated deicing fluid to preclude refreezing. When required (for operations other than frost or leading edge ice removal and when the OAT is at or below 0° C (32° F), an additional treatment with heated deicing (Type I) fluid must be performed within the facility to prevent refreezing of water, which may remain in hidden areas.

**Note:** IR deicing systems should not be used to remove previously applied deicing/anti-icing fluid from aircraft surfaces.

**b. Mobile IR Systems.** A mobile IR deicing system that melts frozen contaminants from exposed aircraft surfaces continues to be developed. This system consists of a moveable, boom-mounted heating panel installed on a truck. Temperature-controlled flameless catalytic heaters fueled by natural or propane gas generate the IR heat. During operations, these heater panels are normally situated several feet from the aircraft surfaces and use temperature sensors to measure aircraft surface temperatures. This system was used in the United States Air Force (USAF)-sponsored Aircraft Ground Deicing Evaluation exercise, conducted at the USAF Eglin Air Force Base (AFB) McKinley Cold Chamber in the spring of 2002. The FAA anticipates that these units will usually be employed in pairs (or more).

**c. Forced Air Deicing Systems (FADS).**

(1) Overview. The military and foreign air carriers have used FADS for years, but these were largely limited to the removal of loose snow. Many of these systems were converted auxiliary power units (APU) and had a tendency to be unwieldy.

(a) The current generation of FADS is easier to handle and is designed to remove frozen contamination by the use of forced air and forced air augmented with a Type I fluid injected into the high-speed air stream. Although heated fluid is more effective, the fluid can be heated or unheated; however, the aircraft surfaces will need to be deiced and anti-iced with heated Type I fluid after deicing with forced air if Type I HOTs are to be used. Depending on the specific FADS, the operator may be able to select from several FADS modes, including:

- Forced air alone.
- Forced air augmented by Type I fluid.
- Type II, III, or IV fluids applied over, or injected into the forced air stream.

**Note:** These capabilities make the current generation of FADS more versatile than its predecessors.

(b) Some systems have an additional mode of operation: a fluid-only mode. This mode is not as effective as the application of Type I fluid using conventional equipment, mainly because some FADS expel less fluid.

(c) Some systems have been retrofitted onto operational deicing vehicles without compromising the vehicle's original capability. This modification allows the vehicle to operate as a FADS or conventional deicing unit. A separate vehicle and deicing system operator are usually required. However, some units may be fully operated from the deicing bucket/cab. In a manner similar to typical deicing operations, directional control of the discharge nozzle is accomplished from controls in the deicing bucket/cab.

## (2) Possible Concerns with FADS.

(a) The guidelines previously noted that Type I fluid was injected into the high-speed air stream. Generally, FADS units are not limited to Type I fluid. However, testing has indicated that the viscosity of Type II and IV fluids may degrade when applied by FADS. This degradation appears to be influenced by the velocity and pressure of the forced air stream and the distance between the forced air nozzle and surface being deiced. For direct injections, FPD fluid viscosity has been shown to degrade more as the forced air velocity increased and as the distance between the FADS nozzle to the surface being deiced decreased.

(b) Additionally, FADS-applied fluid/mixtures may be unduly aerated as evidenced by an overly foamy, milky white, or frothy appearance. This may result in lower-than-published HOTs for Type II and IV fluids.

(c) Another factor that may reduce HOT in the air/fluid mode for all fluids is the apparent tendency of the high-speed air stream to thin out the fluid film as it is being applied. The operator must ensure that an adequate coating of fluid is applied to aircraft surfaces, a procedure that may require several passes of the fluid spray over the area being protected.

(d) During the 2002-2003 winter icing season, the FAA and TC, in conjunction with two air carriers, conducted tests to characterize the deicing performance of FADS and their effects on HOT guidelines. Tests were conducted at several locations, using the FADS in both the fluid injection mode and in the air-assist mode.

(e) In the injection mode, Type IV anti-icing fluids were injected directly into the forced air stream of the forced air delivery system; in the air-assist mode, anti-icing fluids were applied over the forced air stream and allowed to drip/fall into the forced air stream. The desired results included validation of the ease of application of anti-icing fluids to include increased application distances and easier spreading of fluids on aircraft surfaces. Also tested was the potential for the use of less fluid during the anti-icing procedure.

(f) Following application using both the injection mode and the air-assist mode, the applied fluids were recovered and analyzed for viscosity, aeration, and HOT performance.

Results of viscosity evaluations from the fluids recovered from the air-injection mode were determined to be unacceptable. Significant decreases in the fluids' viscosities on the order of 40-50 percent were observed. Thus, the conclusion was that the HOT guidelines should not be used when the anti-icing fluids are directly injected into the forced air stream. Use of the air-assist mode to apply anti-icing fluid to deiced surfaces produced viscosities that were endorsed for the 2003-2004 winter icing season. The units/equipment/fluid involved included:

- FMC LMD deicing truck.
- Forced air delivery pressure @ 13 pounds per square inch (psi).
- Type IV fluid nozzle rated @ 20/25 gpm @ 50 psi.
- Fluid-specific brand: Clariant Safewing MP IV 2001.

(g) During the 2003-2004 winter icing season, additional tests were conducted in conjunction with an air carrier. These tests, employing six Type IV fluids, were designed primarily to assess the effects of applying Type IV fluids in the air-assist mode from a FADS. The fluids were applied employing both conventional anti-icing applications methods and the forced air-assist method. FMC LMD-2000 and the FMC Tempest II Ground Deicing Equipment with standard application pressures and flow-rates were employed in the tests. Before measuring viscosities, the fluid samples were centrifuged to remove entrapped air bubbles as recommended in Brookfield viscosity measurement practices. Two fluid viscosity measurement samples were taken from four sources/locations during the process. These included:

- Fluid Delivery Tote.
- Truck Tank.
- Test wing employing conventional anti-icing application.
- Test wing employing forced air-assist application.

(h) Results were mixed. Shearing in four of the six fluids tested produced viscosities below acceptable lowest on-wing viscosities (LOWV) and these fluids were deemed to be unsatisfactory for forced air-assist applications. The LOWV represents the lowest viscosity that a fluid should have after it has been applied to an aircraft wing. Applied fluids with viscosities lower than the LOWV may produce HOTs shorter than those given in the HOT guidelines. Two of the fluids produced samples that exhibited viscosities above the LOWV values. The acceptable viscosities were deemed to be a function of the initial viscosities of the samples tested. One fluid, Clariant Safewing MP IV 2001, was found to produce acceptable viscosity values above its LOWV when its initial viscosity was 90 percent of the upper end of its production range of 30,000 mPas. The other fluid, Clariant Safewing MP IV 2012 Protect, was found to produce acceptable viscosity values above its LOWV when its initial viscosity was 75 percent of the upper end of its production range of 20,000 mPas, although this fluid is no longer available.

(i) Additional anti-icing fluids employing forced air delivery systems that have been optimized for anti-icing applications (e.g., lower air pressures, different fluid velocities and spray patterns, different contact angles between the forced air stream and the fluid spray) may prove to provide acceptable HOT results when applied in the air-assist mode.



(j) During the 2004-2005 winter icing season, additional tests were conducted in which the air pressures and fluid flow rates were optimized to reduce fluid shearing while still providing an effective fluid spray pattern. This round of tests again used FMC LMD-2000 and FMC Tempest II deicing vehicles that had been modified as follows:

- The fluid and air nozzles were separated 7 inches centerline to centerline by inserting 3-inch spacers.
- The Type IV fluid flow rate was increased from 20 to 25 gpm.
- The forced air delivery pressure was decreased from 13 to 6 psi.

(k) The tip of the spray nozzle was positioned 4.75 feet above the wing and 10.5 feet from the spray target marked on the wing. Fluid samples were taken from fluid delivery tote containers before spraying and from the surface of a Lockheed Jet Star wing used as a spray target. All tote and wing samples were centrifuged before viscosity testing to remove air bubbles that can affect viscosity testing accuracy. Tests were run with and without an air sleeve inserted into the forced air nozzle. The air sleeve is a removable cross-shaped device that runs the length of the air nozzle chamber. It splits the air into four quadrants before it exits the nozzle and produces less turbulent airflow.

(l) Additional tests were run in 2007 with FMC Tempest, FMC LMD-2000, and with Global Air Plus forced air-equipped trucks at reduced air pressure at the air nozzle (6 psi for the FMC, 6 to 9 psi for the Global), with an air sleeve installed in the air nozzle chamber, 7 inches between the air and fluid nozzles centerlines on the FMC trucks, 8 inches on the Global, and a fluid flow rate of 25 gallons per minute. The results were included in the table below. The fluid used during this series of tests was Clariant Safewing MP IV Launch.

(m) Tests were also run in 2007 with FMC Tempest, and Global Air Plus trucks using the Type III fluid, Clariant Safewing MP III 2031 ECO. The air pressure was reduced to 6 psi on the Global, and 11 psi on the FMC truck. Two flow rates, 10 gpm and 60 gpm were used, with the 10 gpm setting being used when spraying the fluid over the air stream in a similar manner to Type IV fluid air application for anti-icing, and the 60 gpm setting used when the Type III fluid was injected into the air stream to be used for deicing, a practice (injection) not recommended for anti-icing with Type IV fluid, but acceptable after confirmatory testing with Type III fluids.

Fluid Viscosities Chart

Fluid	Lowest On-Wing Viscosity (mPas)	Lowest Acceptable Delivered Fluid Viscosity (mPas) FMC Tempest II		Lowest Acceptable Delivered Fluid Viscosity (mPas) FMC LMD 2000		Lowest Acceptable Delivered Fluid Viscosity (mPas) Global Air Plus	
		With air sleeve	Without air sleeve	With air sleeve	Without air sleeve	With air sleeve	Without air sleeve
Clariant Safewing MP IV 2001	18,000	22,000	22,500	21,000	23,000	Not tested	Not tested
Kilfrost ABC-S	17,000	21,000	21,500	20,500	22,000	Not tested	Not tested
Octagon Max-Flight 04	5,540	8,500	8,500	7,500	7,500	Not tested	Not tested
Clariant Safewing MP IV Launch	7,550	9,000	Not tested	8,500	Not tested	9,500	Not tested
Clariant Safewing MP III 2031 ECO	30	N/A	105	Not tested	Not tested	Not tested	105

(n) The lowest acceptable delivered viscosity was determined by multiplying the LOWV by the ratio of the fluid viscosity in the tote container divided by the fluid viscosity from the spray sample recovered from the wing, and for Type IV fluids, rounded up to the nearest 500 mPas. Results are in the Fluid Viscosities Chart above:

**Note:** Use the manufacturer's test viscosity method from Table 6 conducting these or similar tests.

(o) For example, in the table above, Kilfrost ABC-S would need to go into the Tempest II tank with a viscosity of at least 21,500 mPas and be sprayed without the air sleeve in place to achieve a LOWV of 17,000 mPas. If the operator preferred to use the air sleeve, the viscosity of the Kilfrost fluid in the tank before spraying would need to be at least 21,000 mPas.

(p) Based on this information, operators using forced air application equipment modified in the same or a near similar manner, especially with regard to reduced air pressure and fluid nozzle spacing above the air stream, as the test vehicles listed, could reasonably expect to apply the listed Type IV fluids at similar lowest acceptable delivered viscosity values and have the fluid on the wing test at a viscosity above the LOWV. Likewise, they may be able to achieve appropriate values for other fluid-specific brands, again with the listed or similarly-modified equipment, whereby the fluid being sprayed onto aircraft surfaces will be above the LOWV required for that particular fluid-specific brand of fluid. These viscosity values must be confirmed by spraying and viscosity testing.

(q) Before using Type IV fluid-specific generic HOTs for these Type IV fluids, and similarly for Type II, or III fluids, each operator will need to demonstrate, by spraying and viscosity testing, that its equipment, or equipment operated by other parties to deice the operator's aircraft is capable of applying these fluids without excessive shearing, such that they would no longer meet LOWV requirements.

(r) The FAA strongly recommends that operators avoid getting significantly closer to aircraft surfaces than the 10.5 feet used in the test protocol and that the nozzles be kept at an angle of 45 degrees or less to the surface of the aircraft to avoid excessive fluid shear damage and foaming. Fluid applied by forced air should not contain excessive foam, as evidenced by a frothy, overly foamy, or milky appearance, and should be applied in an even coverage coating, which may require several passes over the area on the aircraft being anti-iced. The coating should be similar in thickness to a coating of fluid applied by conventional means (using a nozzle designed to apply thickened fluids usually at a reduced flow setting).

(s) Also, note that forced air or air/fluid applications may not eliminate the need for conventional fluid deicing and anti-icing for all types of freezing/frozen precipitation.

**Note:** Except for application equipment and fluids that have been tested as previously described in this section and using fluid of sufficient viscosity to meet LOWV requirements in the air-assist mode, published HOT guidelines should not be used when using forced air unless followed by the application of deicing and anti-icing fluid without forced air. Fluids must be applied in accordance with standard application procedures, such as presented in this notice and/or SAE document ARP4737, Aircraft Deicing/Anti-Icing Methods.

(t) FADS vary in many respects (e.g., airflow pressure and rate, fluid flow pressure and rate, and optimum effective distance with and without fluid injection). Currently, these factors make it difficult to be specific with procedures without conducting actual tests. Adhere to the usual manufacturer cautions when operating FADS. For example, do not exceed the airframe manufacturer's limits regarding surface temperature and pressure in the air or air/fluid impact areas. The FADS and airframe manufacturer literature should be consulted.

### (3) Additional Precautions for FADS.

(a) Ear protection will normally be used and is required when noise levels exceed 85 decibels (dB).

(b) Exercise caution around ground personnel. The potential for blowing ice chunks that strike ground personnel, and restricted visibility due to blowing loose snow are possible problems.

(c) Exercise caution to avoid the following:

- Directing forced air into sensitive aircraft areas (e.g., pitot tubes, static ports, vents).
- Blowing snow or slush into landing gear and wheel wells.

- Blowing ice, snow, and slush into aircraft engine inlets, APU inlets, and control surface hinges.

**Note:** You should obtain information regarding a specific system from its manufacturer's technical literature. The SAE document ARD50102, Forced Air or Forced Air/Fluid Equipment for Removal of Frozen Contaminants, provides information on forced air systems and their usage.

**d. Non-Glycol Based Deicing/Anti-icing Fluids.** In recent years, new non-glycol-based Type I deicing/anti-icing fluid have been qualified to the requirements of AMS-1424. These fluids, based upon glucose-lactate combinations and other formulations, successfully completed qualification tests and were considered to be environmentally benign when compared to glycol based deicers.

**e. Ground Ice Detection System (GIDS).** GIDS developments have continued during the past year. These include wide-area, remotely mounted (usually on a deicing truck) ice detection systems that use advanced optical technology capable of quickly detecting aircraft contamination from distances up to 100 feet from the aircraft. GIDS have shown potential for more efficient and thorough deicing operations; the FAA is currently sponsoring testing and analysis to determine circumstances for which GIDS can do as well as or better than humans in detecting ice with a threshold consistent with safety and efficient ground operations in icing conditions.

## 11. Action.

**a. Distribution.** POIs must distribute the HOTs to all parts 121, 125, and 135 certificate holders who have an approved part 121 deicing/anti-icing program. They also should distribute HOT and application guidelines to operators who are not required to have an approved program but who deice or anti-ice with fluids and use these guidelines during winter weather operations. The attached HOT and application guidelines supersede all previously-approved HOT and application guidelines for application of deicing/anti-icing fluid mixtures.

**b. HOT Guidelines.** POIs must inform their certificate holders of the approved HOT guidelines and application procedures attached to this notice. POIs should recommend that these HOT tables and application guidelines be incorporated into the certificate holder's procedures or programs. Certificate holders should use these tables and application guidelines or the data contained in them to develop tables and guidelines that are acceptable to the Administrator.

**c. Information for Deicing/Anti-icing Updates.** POIs must provide the carriers with the following information, which should be incorporated into their approved ground deicing/anti-icing updates for the 2011-2012 winter season:

### (1) Fluid Application.

(a) During previous seasons, surveillance of deicing/anti-icing operations has indicated several problems in fluid application. These findings include:

- Instances when fluid was applied in the reverse order of company-approved procedures, (e.g., approved procedure being wing-tip to wing-root).
- Insufficient fluid temperature buffers.
- Incomplete removal of contamination.

(b) Frozen contamination on wing surfaces at altitude has been reported.

(c) To minimize such occurrences, when performing a deicing/anti-icing procedure, accomplish the first step (deicing) by applying the hot fluid with the nozzle as close to the surface as possible without damaging aircraft surfaces. Increasing the distance from the nozzle to the surface results in progressively greater loss of fluid heat and deicing capability. This condition is aggravated as the fluid application pattern is adjusted toward a spray mode. Also, maintain a safe distance between deicing equipment and aircraft surfaces to avoid contact.

(d) Additionally, cover the entire aircraft surface by the deicing operation rather than relying on fluid flow-back over contaminated areas. This will provide greater assurance that no frozen precipitation remains under the deicing fluid.

(e) As a final precautionary step, apply sufficient fluid to ensure that any remaining diluted fluid on the deiced surfaces (as a result of the deicing process) is displaced by a fluid with a freezing point of at least 10° C (18° F) below the OAT if anti-icing with Type I fluid. In the case of Type II, III, and IV fluids, ensure they are applied in the temperature ranges for undiluted or diluted as shown in the holdover tables. If applied according to the respective holdover tables, the freezing point buffer requirement of at least 7° C (13° F) below the OAT will be met. Determine this by checking the refractive index/BRIX (refer to the manufacturer's information).

**Note:** The freezing point of 10° C (18° F) below the OAT refers only to a Type I fluid. Historically, Types I, II, and IV application guidelines have recommended a minimum fluid temperature of 60° C (140° F) at the nozzle for deicing. Field testing using properly functioning deicing equipment has shown that fluid temperatures of 60° C (140° F) at the nozzle are readily obtained and usually 10° C (18° F) higher.

(f) Ground testing the effectiveness of Type II and IV fluids is highly dependent on the training and skill of the individual applying the fluids. When these fluids are used, ground personnel should ensure that they are evenly applied so that all critical surfaces, especially the leading edge of the wings, are covered with fluid. In addition, an insufficient amount of anti-icing fluid, especially in the second step of a two-step procedure, may cause reduced HOT because of the uneven application of the second-step fluid.

(g) In very cold conditions (generally below -10 to -15° C (14 to 5° F) or colder) dry snow can fall onto cold aircraft wings. Under these conditions, dry snow will swirl as it blows across the wings, making it evident the snow is not adhering. But, if snow has accumulated on the surface of the wings, it has to be removed before takeoff. It cannot be assumed that accumulations of snow will blow off during takeoff.

(2) Communication.

(a) Communication among all personnel involved in the deicing/anti-icing of an air carrier's aircraft is critical to ensure that the pilot has the information needed to make the final determination that the aircraft is free of adhering contamination before flight. Approved programs should emphasize that all personnel (e.g., management personnel, dispatchers, ground personnel, and flight crewmembers) who perform duties, as outlined in the approved program, clearly and concisely communicate essential information to ensure that no frozen contaminants are adhering to any critical surfaces of the aircraft. In Canada, a centralized deicing facility has introduced electronic signs to aid in the transmission of critical information to the flightcrews. This includes aircraft ground control information at the deicing pad and information on the ongoing deicing/anti-icing procedure and fluid application. Long-range plans are underway to employ Airborne Communications Addressing and Reporting System (ACARS) datalink systems of aircraft to relay deicing information to the flightcrews.

(b) Specifically, review approved programs to determine whether the ground personnel accomplishing the deicing/anti-icing procedure communicate the following information to the pilot:

- The Type fluid used (for Types II, III, and IV fluids, the specific manufacturer name and Type fluid, or SAE Type II, SAE Type III, or SAE Type IV).
- The percentage of fluid within the fluid/water mixture (for Types II, III, and IV fluids only (not necessary for Type I fluid)).
- The local time the final deicing/anti-icing began.
- The results of the post-deicing/anti-icing check, unless the approved program has other procedures for ensuring this information is conveyed to the pilot.

(c) Although reporting the results of the post-deicing/anti-icing check may be redundant in some cases, it confirms to the pilot that all contamination has been removed from the aircraft.

(3) First Areas of Fluid Failure. Aircraft testing indicates that the first fluid failures on test aircraft appear to occur on the leading and/or trailing edges rather than the mid-chord section of the wing. Tests also indicate that fluid failures may be difficult to visually identify. POIs should insure that those aircraft representative surfaces currently included within the air carrier's approved program provide the pilot a proper indication of the status of the aircraft's critical surfaces. Where possible, representative surfaces should:

- Include a portion of the wing leading edge; and
- Be visible by the pilot from within the aircraft.

**d. Operations during Light Freezing Rain/Freezing Drizzle.**

(1) POIs should inform air carriers electing to operate in light freezing rain or freezing drizzle weather conditions to use Type II, III, or IV anti-icing fluid. Approved programs should clearly state that deicing/anti-icing fluids do not provide any protection from contamination once the aircraft is airborne.

(2) Air carriers not electing to use Type II, III or IV anti-icing fluid while operating during light freezing rain or freezing drizzle conditions should develop and use special procedures. Examples of special procedures include:

- An approved external pretakeoff contamination check.
- A remote deicing capability.
- Other special means of enhancing the safety of operation during these conditions (such as the use of advanced wide area optical technology capable of detecting aircraft contamination).

(3) POIs should use special emphasis surveillance during periods of light freezing rain and freezing drizzle. Surveillance should affirm that approved checks or other special procedures, as stated above, are effective and conducted in accordance with the air carrier's approved deicing/anti-icing program.

**Note:** Exercise care in examining engine air inlets for clear ice. Such frozen contamination can be dislodged and drawn into engines after start up. High rear-mounted engines may be difficult to inspect. The problem is compounded because clear ice may be difficult to detect visually and require tactile examination. Additionally, wide-area GIDS have been shown to be very effective in locating ice lodged in the air inlets of turbojet engines.

## **12. Other Conditions for Which HOTs Do Not Exist (heavy ice pellets, moderate and heavy freezing rain, and hail).**

**a. General.** No testing has been conducted in these conditions; therefore, this notice does not provide HOTs or other forms of relief for dispatch in these conditions.

**b. Regulations.** The regulations clearly state "No person may take off an aircraft when frost, ice, or snow is adhering to the wings..." (§ 121.629(b)) and "...no person may dispatch, release or take off an aircraft any time conditions are such that frost, ice, or snow may reasonably be expected to adhere to the aircraft..." (§ 121.629(c)). Under some conditions the aircraft critical surfaces may be considered free of contaminants when a cold, dry aircraft has not had deicing and/or anti-ice fluids applied, and ice/snow pellets are not adhering and are not expected to adhere to the aircraft critical surfaces. Refueling with fuel warmer than the wing skin temperature may create a condition that previously non-adhering contaminants may adhere to the wing surfaces.

## **13. Guidelines for Pilot Assessment of Precipitation Intensity Procedures.**

**a. Pilot Discretion.** Pilots may act based on their own assessment of precipitation intensity only in those cases where the officially reported meteorological precipitation intensity is grossly different from that which is obviously occurring. (For example: precipitation is reported when there is no actual precipitation occurring.) As always, if, in the pilot's judgment, the intensity is greater, or a different form of precipitation exists than that being reported, then the appropriate course of action and applicable holdover/allowance times for the higher intensity or different form of precipitation must be applied. (For example: precipitation is being reported as light ice

pellets and the pilot assessment is that it is moderate ice pellets, then the pilot must apply the allowance time for moderate ice pellets.)

**b. Reporting New Observation.** Before a pilot takes action on his/her own precipitation intensity assessment, he/she will request that a new observation be taken. A pilot must not take action based on his/her own precipitation intensity assessment unless either a new observation is not taken and reported, or the new precipitation intensity officially reported remains grossly different from that which is obviously occurring.

**c. Use of Company Coordination Procedures.** The company's approved deicing program in accordance with § 121.629 must contain the required company coordination procedures for a pilot when he or she chooses to take actions that are based on his or her precipitation intensity assessment that is less than the precipitation intensity that is being officially reported. (Example: The official weather report is moderate freezing rain, and the pilot's assessment is that there is no liquid precipitation, or the reported weather is moderate snow and light ice pellets and by the pilot's assessment there is light snow and no ice pellets.) These procedures require coordination with the company before the pilot takes such action, or a report of action taken after the pilot has opted to exercise this option.

**d. Pretakeoff Contamination Check.** When a pilot acts based on his or her own assessment that precipitation intensity levels are lower than the official reported intensity level, a check at least as comprehensive as the operator's pretakeoff contamination check (when HOTs have been exceeded) per the approved procedure for the applicable aircraft is required within 5 minutes of beginning the takeoff.

**Note:** Unlike other forms of precipitation, individual ice pellets may be seen, if viewed close up, or felt embedded in the fluid since they are not readily absorbed into the anti-icing fluid like other forms of precipitation. Under ice pellet conditions and within the appropriate allowance times, if ice pellets are visible they should appear as individual pellets and not form a slushy consistency indicating fluid failure. This distinction is very difficult to make from inside the aircraft. If through an internal or external visual check or a tactile check (as appropriate for the aircraft), the ice pellets mixed with the anti-icing fluid form a slushy consistency or are adhering to the aircraft surface, then the intensity level that the pilot based the allowance time on was not accurate and the takeoff should not be conducted.

**e. Permissible Use of Pilot Assessment of Precipitation Intensity.** Under the following conditions a pilot may act based on his/her own assessment of precipitation intensity levels that are less than that being officially reported. Pilot assessment of precipitation intensity levels may only be used when adequate natural sunlight or adequate artificial lighting is available to provide adequate exterior visibility. The snowfall rate chart provided in Table 1C is based on prevailing visibility and allowances are made in the chart for the effects of night light conditions.

(1) Ice Pellets. When ice pellets are being reported, the following chart information extracted from the Federal Meteorological Handbook (FMH 1) must be used to assess their actual intensity rate:



(a) Light—Scattered pellets that do not completely cover an exposed surface regardless of duration.

(b) Moderate—Slow accumulation on ground.

(c) Heavy—Rapid accumulation on ground.

(2) Drizzle/Freezing Drizzle and Rain/Freezing Rain. The differentiations between these various conditions are based on droplet size and require careful observation. Therefore, when drizzle/freezing drizzle or rain/freezing rain is being reported, a pilot must use both visual and physical (feel) cues in determining the presence of precipitation. If precipitation is present to any degree by visual or physical cues the official reported precipitation type and intensity must be used for determining the appropriate course of action and applicable HOTs. If the pilot determines no precipitation is present, the aircraft should be deiced if necessary and consideration given to treating the aircraft with anti-icing fluid as a precaution for encountering the reported precipitation on taxi out. As always, if, in the pilot's judgment the intensity is greater, or a different form of precipitation exists, than that being reported, then the appropriate course of action and applicable holdover/allowance times for the higher intensity or different form of precipitation must be applied.

(3) Snow. The snowfall visibility table attached in Table 1C has previously been published with the annual FAA HOT tables for use in determining snow intensity rates based on prevailing visibility and can be used in place of official reported intensities. Thus the table should be used for pilot assessment of snowfall intensity rates when the actual snowfall intensity is obviously different from that being officially reported or at any other time.

(4) Training Requirements. Pilots that are limited in their precipitation intensity assessments to whether or not precipitation is falling will only be required to have instruction on how that assessment should be made. (Example: How and where to perform the physical feel cues to determine if precipitation is present.)

(a) All other pilots will be required to be trained on their company's pilot precipitation intensity assessment procedures. Pilots will need training on the methods used by weather observers to determine precipitation types and intensities and on how to conduct their own assessment under the different precipitation conditions. The Federal Meteorological Handbook FMH 1 and Snowfall Intensities as a Function of Prevailing Visibility, Table 1C, must be used as the source documents for this training.

(b) Additionally, § 121.629 requires anti-icing fluid failure recognition training under the various precipitation conditions for pilots and all other persons responsible for conducting pretakeoff contamination checks if anti-icing fluids are used.

**Table 1C. Snowfall Intensities as a Function of Prevailing Visibility**

Time of Day	Temp.		Visibility (Statute Mile)							Snowfall Intensity
	Degrees Celsius	Degrees Fahrenheit	≥ 2 1/2	2	1 1/2	1	3/4	1/2	≤ 1/4	
Day	colder/equal -1	colder/equal 30	Very Light	Very Light	Light	Light	Moderate	Moderate	Heavy	
	warmer than -1	warmer than 30	Very Light	Light	Light	Moderate	Moderate	Heavy	Heavy	
Night	colder/equal -1	colder/equal 30	Very Light	Light	Moderate	Moderate	Heavy	Heavy	Heavy	
	warmer than -1	warmer than 30	Very Light	Light	Moderate	Heavy	Heavy	Heavy	Heavy	

NOTE 1: This table is for estimating snowfall intensity. It is based upon the technical report, “The Estimation of Snowfall Rate Using Visibility,” Rasmussen, et al., Journal of Applied Meteorology, October 1999 and additional in situ data.

NOTE 2: This table is to be used with Type I, II, III, and IV fluid guidelines.

HEAVY = Caution—No Holdover Time Guidelines Exist

**Note:** During snow conditions alone, the use of Table 1C in determining snowfall intensities does not require pilot company coordination or company reporting procedures since this table is more conservative than the visibility table used by official weather observers in determining snowfall intensities.

**Note:** Because the FAA Snow Intensity Table, like the FMH 1 Table, uses visibility to determine snowfall intensities, and if the visibility is being reduced by snow along with other forms of obscuration such as fog, haze, smoke, etc., the FAA Snow Intensity Table does not need to be used to estimate the snow fall intensity for HOT determination. Use of the FAA Snow Intensity Table under these conditions may needlessly overestimate the actual snowfall intensity and therefore the snowfall intensity being reported by the weather observer or automated service observing system (ASOS), from the FMH 1 Table may be used.

**f. References.** Refer to FAA Order 8900.1, Flight Standards Information Management System (FSIMS), Volume 6, Chapter 2, Section 15, Ground Deicing/Anti-Icing Inspections for Parts 121 and 135; and Volume 3, Chapter 27, Ground Deicing/Anti-Icing Programs.

**14. Program Tracking and Reporting Subsystem (PTRS) Input.** POIs must make a PTRS entry to record the actions directed by this notice with each of their operators. List the PTRS entry as “1381” and enter it into the “National Use” field as “N8900.167” (no quotes or punctuation). POIs should use the comments section to record comments of interaction with the operators.

**15. Air Transportation Oversight System (ATOS) Action.** Within 30 days of receiving this notice, POIs will ensure that the Director of Safety (DOS) of his or her assigned air carrier is aware of it.

**a. Recommendations.** The POI must assess the air carrier’s response to the recommendation. An air carrier’s failure to implement these recommendations into its existing program could result in an increase in risk in several areas.

**b. Additional Surveillance and Action.** The POI must determine if additional surveillance is required or further air carrier action is necessary to address the potential increased risk. Possible additional actions may include retargeting the Comprehensive Assessment Plan (CAP) to include accomplishing appropriate Safety Attribute Inspections (SAI) or Element Performance Inspections (EPI), convening a System Analysis Team (SAT), or re-evaluating air carrier approvals or programs.

**16. ATOS Reporting.** POIs will make an ATOS entry using the “Other Observation DOR” functionality to record the actions directed by this notice. The POI will access the “Create DOR” option on their ATOS homepage, select the “Other Observation” tab, and:

- Select System: 3.0 Flight Operations.
- Select Subsystem: 3.1 Air Carrier Programs and Procedures.
- Select the appropriate air carrier from the drop down menu.
- Select “1381” from the “PTRS Activity Number” drop down menu.
- Enter the date the activity was started and completed.
- Enter the location where the activity was performed.
- Enter “N8900167” in the “Local/Regional/National Use” field.
- Use the “Comments” field to record any comments reflecting interaction with the air carrier and the air carrier’s response to the recommendation.
- Input any actions taken in the “Reporting Inspector Action Taken” field.
- Select the “Save” button after all entries have been made.

**17. Disposition.** We will incorporate the information in this notice into FAA Order 8900.1 before this notice expires. Direct questions concerning this notice to the Air Carrier Operations Branch (AFS-220) at 202-493-1422.

ORIGINAL SIGNED BY

/s/ John McGraw for

John M. Allen

Director, Flight Standards Service

Inactive Doc