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Ground Deicing Program

Issue 2

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General Information

Approved by the Federal Aviation Administration (FAA)
Air Transportation Division
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Record of Revisions

Description of Change

Issue 2 replaces the previous edition of the Ground Deicing Program – General Information document dated August 2023 and should be used in conjunction with the holdover times tables and related information published on the at the FAA's Aircraft Ground Deicing website.

Sidebars indicate text which has been added, deleted or modified.

Revision	Description of Change	Affected Pages	Effective Date
Issue 2	Release of Issue 2 of Ground Deicing Program – General Information	Minor edits throughout the document.	08/06/24

1. Purpose: This document contains guidance information previously contained in the N8900.636 Revised FAA-Approved Deicing Program Updates, Winter 2022-2023, published in August 2022. This document provides information on the Federal Aviation Administration (FAA)-approved deicing program for Winter 2024–2025. It is designed to be used in conjunction with the FAA Holdover Times (HOT) Guidelines, Degree-Specific Holdover Times (DSHOT), and Regression Information Data, for Winter 2024–2025.

2. Fluid Characteristics, Associated HOTs, and Other Related Information. FAA-approved guidelines for the application of deicing/anti-icing fluids are contained in the FAA HOT Guidelines published and updated annually.

a. Type I Fluid Characteristics. Type I fluids are glycol based Newtonian fluids that tend to flow regardless of the forces acting on them, as evidenced by these fluids readily draining off stationary aircraft surfaces. Type I fluids do not contain thickening additives and are used primarily for deicing, and in a limited role as an anti-icing product. Type I fluid is thin in viscosity, dilutes rapidly under precipitation conditions, and, if dyed, is orange in color.

(1) Type I fluid, when heated and applied in accordance with FAA HOT Guidelines, is a practical anti-icing choice in conditions involving relatively light precipitation, short taxi routes between the deicing / anti-icing location and the departure end of the runway, and light traffic situations that do not delay the departure. Type I fluid is compatible with most aircraft regardless of rotation speed at takeoff. Propylene glycol (PG) versions are less toxic than ethylene glycol (EG) based fluids, a characteristic that makes the PG fluids more desirable in regions of the world that are environmentally conscientious.

(2) When applying Type I fluid for the purpose of anti-icing, the more heat an aircraft surface absorbs from the fluid, the longer the surface temperature of the aircraft will remain above the freezing point of the fluid. Continuing precipitation encountered after the anti-icing process and before the aircraft takes off, will further dilute the Type I fluid. Dilution of the fluid raises the freezing point of the fluid. At the point in time that the fluid temperature falls to equal the rising fluid freeze point temperature, one can consider the fluid 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 wingtips.

Note: FAA Type I HOT guidelines are **not approved for use with unheated** Type I fluid mixtures.

(3) Freezing Point of Type I Fluids. There is a note under the Type I HOT tables that states, "...freezing point of the mixture is at least 10 °C (18 °F) below outside air temperature." The difference between the freezing point of the fluid and the outside air temperature (OAT) is known as the temperature or freezing point buffer. In this case, the buffer is 10 °C (18 °F), which one can interpret as the freezing point of the fluid being 10 °C (18 °F) below the OAT. The 10° C (18 °F) temperature buffer accommodates inaccuracies and imprecision resulting from 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 freezing point depressant (FPD) fluid/water mixtures volumes.
- Differences between OAT and aircraft surface temperatures.
- Changes in OAT following fluid application.
- Differences in aircraft surface materials.
- Evaporation from repeated heating.
- Contamination from snow or rain entering the storage vessel.
- Wind effects.
- Solar radiation.

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 to ensure one can rely upon the HOT guideline information in the Type I HOT tables.

(4) The useful duration of a Type I HOT is considerably longer for metallic structures than for composite material structures, since composites do not transfer heat very efficiently. Thus, the thermal characteristics of an aircraft's surface affect HOTs, with metallic structures serving as better heat conductors and heat reservoirs than composite structures.

(5) The Type I FAA HOT Guidelines are therefore presented in two tables:

- Holdover Times for SAE Type I Fluid on Critical Aircraft Surfaces Composed Predominantly of Aluminum; and
- Holdover Times for SAE Type I Fluid on Critical Aircraft Surfaces Composed Predominantly of Composites.

Note: Type I fluid HOTs for aluminum surfaces also apply to other metals used in aircraft construction, such as titanium. The Type I fluid HOTs for composite surfaces should be applied to aircraft with all critical surfaces that are predominantly or entirely constructed of composite materials. However, Type I fluid HOTs for composite surfaces do not need to be applied to aircraft that are in service before 2022, have a demonstrated safe operating history using Type I fluid aluminum structure HOTs, and have critical surfaces only 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.

(6) The applied temperature requirements for Type I fluids are located in the Type I fluid application table in the FAA HOT Guidelines (Guidelines for the Application of SAE Type I Fluid- Type I Anti-icing Guidelines). Type I HOTs are based upon a minimum fluid temperature, measured at the dispensing system nozzle, of 60 C ° (140 °F). Dispensing Type I fluid for anti-icing purposes, at a temperature less than the minimum allowable temperature invalidates the published Holdover times.

(7) When applying Type I fluid in an anti-icing process, meeting or exceeding the minimum dispensed fluid temperature is essential to confirming the effectiveness of the anti-

icing process that in turn, ensures the HOTs are valid. The temperature of the fluid is especially critical due to the short HOT available in the best of cases when using Type I fluid in an anti-icing mode. CHs should specify a process that meets their needs and mitigates the risk of temperature drift or error depending upon the temperature control system installed in their anti-icing equipment, to periodically verify the minimum Type I fluid temperature is achieved meets the temperature parameters specified in the FAA HOT Guidelines.. For example, if a CH decides to use the Type I fluid temperature gauge on an aircraft ground deicing truck as their primary indicator that fluid has been sufficiently heated, they should have a documented process that indicates how they intend to ensure the truck mounted temperature gauge accurately reflects actual fluid temperature at that point. The CH is responsible (under § 121.629(c)(1)(iv)) for specifying the process they will use to ensure Type I fluid temperature readings are accurate, and that process must be acceptable to the Administrator.

(8) When establishing compliance with the temperature parameters of 60 °C (140°F) at the nozzle, as stated in the table Guidelines for the Application of SAE Type I Fluid, the FAA does not expect air carriers or deicing contractors to continually measure the fluid temperature at the nozzle. The FAA considers that establishing the temperature drop (at typical anti-icing fluid application flow rates), between the last temperature-monitored point in the plumbing chain and the nozzle, to be sufficient. Manufacturers of vehicle-based ground deicing equipment have indicated a temperature drop of 10 °C (18 °F) or less. Some manufacturers producing equipment using 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.

b. Types II, III, and IV Fluids Characteristics. Types II, III, and IV anti-icing fluids (alsoknown as Freeze Point Depressant (FPD) fluids) are thickened, non-Newtonian fluids. The viscosity (thickness) of a non-Newtonian fluid decreases to a limited extent when a shearing force (such as the force applied by the increasing airflow over aircraft surfaces on takeoff) is applied. This is also a factor that CH's and Ground deicing and anti-icing contractors should consider in properly handling non-Newtonian fluids as many can suffer irreversible viscosity reduction if mis-handled (exposed to shearing forces while being stored, piped, pumped, or sprayed incorrectly). Lower viscosity reduces HOT of the degraded fluid. Currently, EG and PGversions of Types II and IV are manufactured. The EG fluids generally have better HOT properties than PG fluids, but may not be available everywhere due to regional or national environmental restrictions. When applied to aircraft surfaces, these fluids form an anti-icing liquid coating, which absorbs freezing or frozen contamination with the exception of ice pelletsand small hail. Although thickened, Type III fluid is much thinner than Type II or IV fluids, making it compatible with lower rotation speed aircraft, as well as those with sufficiently high rotation speeds to use Type II or IV fluids. Currently, the only Type III fluid available is ethylene glycol based, and therefore is not commonly available for use in the U.S. Several aircraft manufacturers have published special takeoff procedures to enable certain airplane models that have rotation speeds below 100 knots to safely utilize Types II and IV fluids.

(1) HOTs for Types II, III, and IV fluids are primarily a function of the OAT, precipitation type and intensity, and percent fluid concentration as 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.

(2) Fluid concentration (proportional mixture expressed as a ratio in percent) for Types II, III, and IV fluids, is the amount of undiluted (neat) fluid in water. Therefore, a 75/25 mixture is 75 percent FPD fluid and 25 percent water.

(3) Most FPD fluids are Ethylene Glycol (EG)-based or Propylene Glycol (PG)-based. Under precipitation conditions, chemical additives improve the performance of Types II, III, and IV fluids when used for anti-icing. These additives thicken the fluid, which enhances fluid HOT performance and provides the fluid with non-Newtonian flow characteristics. 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 Types II and IV fluids sensitive to viscosity degradation via shearing when being pumped or sprayed. Type III fluid is less sensitive, as it has a much lower initial viscosity.

(4) Holdover Time Tables dealing with Types II and IV fluids have a footnote that states, "No holdover time guidelines exist for this condition below -10 °C (14 °F)." This statement refers only to the freezing drizzle and light freezing rain precipitation types and informs the user that, although the temperature range for various other types of precipitation is below -8 °C (18 °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).

(5) Longer HOTs for 75/25 Dilutions. For some fluids in some conditions, HOT increases when fluid concentration is reduced (proportion of water dilution is increased). This counter-intuitive phenomenon, which occurs rarely, happens when certain quantities of water added to fluids results in an increase in fluid viscosity and an enhancement in HOT performance (up to a certain point). Without knowing about this phenomenon, an operator may think that the data presented in the related HOT table is in error.

(6) HOTs for Nonstandard Dilutions of Types II, III, and IV Fluids. Use of Type II, III, or IV fluids diluted to other than the standard published 100/0, 75/25, or 50/50 dilutions, is not authorized as HOTs for other concentrations do not exist, and the relationship between fluid concentrations and HOT are not linear. It is not possible to interpolate or extrapolate the HOTs

and Lowest Operational Use Temperature (LOUT) without additional endurance time and aerodynamic acceptance testing.

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

(a) 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.

(b) During tests conducted by APS Aviation Inc. of Montreal, Canada for the FAA and Transport Canada (TC) using the existing test protocol on modern fluids, HOTs for performance of heated 60 °C (140 °F) Types II and IV fluids were found to equal or exceed the HOT performance of unheated Types II and IV fluids for the same fluid concentrations, temperatures, and precipitation conditions. Therefore, these and other test results have indicated that there is no basis for reducing the current HOT guideline values for Types II and IV fluids or using the Type I fluid HOT guidelines when heated Types II and IV fluids are properly applied.

(8) Generic and Minimum HOT Values. The FAA Type II generic HOT guidelines (refer to FAA HOT Guidelines, Generic Holdover Times for SAE Type II Fluids) and Type IV generic HOT guidelines (refer to FAA HOT Guidelines, Generic Holdover Times for SAE Type IV Fluids) comprise the generic HOT values that are derived from the minimum (worst case) HOT values for all fluids for a specific precipitation condition, precipitation rate, temperature range, and fluid mixture concentration. Each available Type II fluid is periodically analyzed to determine the Type II generic HOTs. Type IV fluids are similarly analyzed to determine the Type IV generic HOTs. Applicators should always advise the Air Carrier and Flight crewmembers of the specific name of the fluid being applied, and should confirm this fluid are listed in the FAA HOT Guidelines. If a flight crew cannot positively determine which specific Type II or IV fluid is being used, the HOT from the Generic Holdover Times for SAE Type II Fluids or Generic Holdover Times for SAE Type IV Fluids should be used.

Note: Fluids that have not undergone the full range of testing required to obtain fluid-specific HOTs in very cold snow (below -14 °C/7 °F) are given generic values. These values are different for Type IV EG- and Type IV PG-based fluids.

Note: The lowest on-wing viscosity (LOWV) of the fluid being used should always to be respected, even when the generic Type II or IV HOTs are used, otherwise the fluid may not perform as published in the HOTs.

Note: When flaps and/or slats are extended to the takeoff configuration prior to anti-icing fluid application and remain in that configuration while taxiing to takeoff, the adjusted HOT tables should be used. This includes the Type II (Adjusted Generic Holdover Times for SAE Type II Fluids) and Type IV (Adjusted Generic Holdover Times for SAE Type IV Fluids) generic tables. (Seealso- subparagraph 13c.)

c. Differences Between Type I and Types II, III, and IV Fluids HOT Guidelines Usage.

(1) A percent fluid concentration column appears in all tables dealing with Types II, III, and IV fluids, but not tables dealing with 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.
- Types II, III, and IV fluids are used 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 Types II, III, and IV fluids to maintain a minimum 7 °C (13 °F) buffer.

(2) The HOT for a Type I fluid is considerably less than that for Type II, III, or IV fluids. 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 should 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 per square meter (approximately 2 gallons per 100 square feet). In the case of a one-step application, this is achieved using a continuous process. Since composite surfaces conduct heat poorly, the composite surfaces HOTs are shorter.

(3) Although Type I fluids are normally considered deicing fluids and Types II, III, and IV fluids are considered anti-icing fluids, all fluid types have been used as both deicing and anti-icing agents. However, the performance of Type I fluid when used as an anti-icing agent is inferior to that of Types II, III, and IV fluids. Also, heated and diluted Types 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.

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

d. Lowest Operational Use Temperature (LOUT).

(1) At colder temperatures, deicing/anti-icing fluids become too thick to flow off 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. The LOUT is the lowest temperature at which a fluid has been determined to flow off aircraft critical surfaces in an aerodynamically acceptable manner while maintaining the required freezing point buffer.

(a) The freezing point buffer is 7 °C (13 °F) below OAT for SAE Types II, III, and IV fluids and 10 °C (18 °F) below OAT for SAE Type I fluids.

(b) There are three aerodynamic fluid flow-off test protocols:

1. the high-speed test for aircraft with rotation speeds generally greater than 100 knots (kts),

2. the middle-speed test for aircraft with rotation speeds generally between 80 kts and 100 kts, and

3. the low-speed test for aircraft with rotation speeds generally between 60 kts and 100 kts.

4. Types II and IV fluids typically do not pass the low-speed test. Therefore, in order for these fluids to be used on a low rotation speed aircraft, the aircraft manufacturer should conduct testing to determine if these fluids can be safely applied on these aircraft and published operational procedures that should be implemented to ensure safe operation when these fluids have been applied.

(2) Following are three examples to illustrate how LOUTs are determined:

- **Example A:** A specific Type IV fluid is aerodynamically acceptable down to -33 °C (-27 °F) and has a freezing point of -36 °C (-33 °F). Once the 7 °C (13 °F)freezing point buffer is factored in, the limiting factor is the freezing point, resulting in a LOUT of -29 °C (-20 °F).
- **Example B:** A specific Type I fluid is aerodynamically acceptable down to -30 °C (-22 °F) and has a freezing point of -35 °C (-31 °F). Once the 10 °C (18 °F) freezing point buffer is factored in, the limiting factor is the freezing point, resulting in a LOUT of -25 °C (-13 °F).
- **Example C:** A specific Type I fluid is aerodynamically acceptable down to -30 °C (-22 °F) and has a freezing point of -42 °C (-44 °F). Since the 10 °C (18 °F) freezing point buffer requirement is met at -32 °C (-26 °F), the limiting factor is the aerodynamic performance, resulting in a LOUT of -30 °C (-22 °F).

(3) LOUT information is provided for each Type I, II, III, and IV fluid in the FAA HOT Guidelines document in the list of fluid tables (Fluids Tested for Anti-Icing Performance and Aerodynamic Acceptance). This information is derived by the FAA based on data provided by fluid manufacturers. Contact the fluid manufacturer if further clarification with respect to the information in these tables is required.

(a) LOUTs for Type I fluids include the manufacturer-specified fluid/water concentration used to establish the LOUT for each fluid. This concentration should not be exceeded.

(b) There can be multiple LOUTs provided for Types II, III, and IV fluids to account for the undiluted fluid (100/0) and the 75/25 and 50/50 dilutions.

e. General. The FAA emphasizes that air carriers should read and understand all notes and cautions in the FAA HOT Guidelines document, such as the reference to the 10 °C (18 °F) buffer for Type I fluids to preclude improper usage of fluids.

3. Precipitation Intensity, Types, and Other Related Information.

a. Precipitation Intensity. In all cells of the HOT tables where two values of time are provided (except for light and very light snow, freezing drizzle, and freezing rain), the precipitation intensity is light to moderate. For the "Very Light" and "Light" snow columns, HOTs should be considered in terms of their respective rates. Very light snow has a liquid equivalent snowfall rate of 0.3 to 0.4 millimeters per hour (mm/h), and light snow has a rate of 0.4 to 1.0 mm/h. (For reference, moderate snow has a liquid equivalent rate of 1.0 to 2.5 mm/h, and heavy snow is greater than 2.5 mm/h.) 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/h. 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, heavy ice pellets, or hail. The FAA has developed allowance times and associated limitations for takeoff in light or moderate ice pellets, light ice pellets mixed with other forms of precipitation, and small hail, as listed in the ice pellet and small hail allowance times tables (refer to FAA HOT Guidelines, Allowance Times for SAE Type III Fluids, Allowance Times for SAE Type IV Ethylene Glycol (EG) Fluids, and Allowance Times for SAE Type IV Propylene Glycol (PG) Fluids). Additionally, takeoff in heavy snow may be accomplished if the requirements for operating in this condition, described in subparagraph 8d, are met.

> **Note:** In addition to following the operations in heavy snow guidance in the FAA HOT Guidelines, the FAA Propulsion and Energy Section (AIR-624) has issued the following statement: "Turbine engine power run-up procedures are defined in the Aircraft Flight Manual (AFM)." AIR-624 recommends that operators consider performing more frequent engine power run ups when operating in heavy snow conditions.

(1) Example. In the table entitled, "Holdover Times for SAE Type I Fluid on Critical Aircraft Surfaces Composed Predominantly of Aluminum" of the FAA HOT Guidelines, under the "Outside Air Temperature" column, below -3 °C to -6 °C for freezing drizzle, the HOT is 0:05 to 0:09, which is interpreted as a HOT from 0 hours, 5 minutes to 0 hours, 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.

(2) Snow Conditions.

(a) The Types I, III, and IV, and most Type II fluid-specific HOT guidelines include three separate snow columns representing 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 tests conducted by APS Aviation Inc. These tests were conducted on behalf of the FAA and TC.

(b) HOT values for liquid equivalent snowfall rates between 0.4 and 1 mm/h (0.02 and 0.04 inches per hour (in/h), and 4 and 10 grams per square decimeter per hour ($g/dm^2/h$)) are selected for the "Light" snow column and HOT values for liquid equivalent snowfall rates between 0.3 and 0.4 mm/h (0.01 and 0.02 in/h, and 3 and 4 $g/dm^2/h$) 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/h.
- Potential wind effects.
- Light snow variability.
- Possible safety concerns associated with pretakeoff checks.

(c) Varying Weather Conditions After Completion of Anti-Icing Procedure. During periods when the weather conditions are varying after completion of the anti-icing procedure, crews should reassess the previously selected HOT. When doing so crews should consider the following:

- Improving weather conditions—if the snowfall intensity decreases or fluctuates between the original intensity and a lower intensity, and does not stop, the original HOT should be retained.
- Worsening weather conditions—if the snowfall intensity increases beyond the intensity used to establish the original HOT, the HOT that corresponds to the worsening weather conditions should be used.

(3) Frost Conditions. Only one HOT value is provided in each cell of the FAA frost HOT table (refer to FAA HOT Guidelines, Active Frost Holdover Times for SAE Type I, Type II, Type III, and Type IV Fluids). 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.

b. 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, such as paint lines, markings, and lettering, to be distinguished, it is often referred to as hoar frost. Frost can also form on the upper or lower surfaces of the wing due to cold-soaked fuel.

(1) Frost Characteristics. Frost has the appearance of being a minor contaminant and does not display the same obvious danger signal 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 decreases lift and significantly increases drag.

(2) Frost Formation. Frost forms whenever the exposed surface temperature cools below the OAT to or below the frost point (not the dewpoint).

(3) 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 anti-icing fluid where the HOT has expired. 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.

(4) Dewpoint and Frost Point. The dewpoint is the temperature at a given atmospheric pressure to which air is cooled to cause saturation. The dewpoint can occur below or above 0 °C (32 °F). The frost point is the temperature, at or below 0 °C (32 °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 the dewpoint. METAR does not report frost point; however, it does report dewpoint. The frost point is higher (warmer) than the dewpoint for a given humidity level in the air. The frost point and the dewpoint are the same at 0 °C; at a dewpoint of -40 °C, the frost point is 3.2 °C warmer (-36.8 °C). The following table provides further examples of the correlation between dewpoint and frost point.

Dewpoint Temperature (°C)	Frost Point Temperature (°C)
0	0
-5	-4.4
-10	-8.9
-15	-13.5
-20	-18.0
-25	-22.7
-30	-27.3
-35	-32.1
-40	-36.8

(5) Frost HOTs. Frost HOTs are for active frost conditions in which frost is forming. This phenomenon occurs when aircraft surfaces are at or below 0 °C (32 °F) and at or below the frost point. Frost typically forms on cold nights with clear skies.

Note: Changes in OAT over the course of longer frost HOTs can be up to 10 °C (18 °F) or more; therefore, the pilot should shorten the HOT based on decreases in OAT that may have occurred following the deicing/anti-icing treatment. Changes in OAT over the course of longer frost HOTs can be significant; the appropriate HOT to use is the HOT provided for the coldest OAT that has occurred in the time between the deicing/anti-icing fluid application and takeoff.

c. Freezing Fog, Ice Crystals, and Freezing Mist.

(1) 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 occurs with zero wind. The measured deposition rate of freezing fog at 1 and 2.5 meters per second (m/s) wind speeds are 0.2 and 0.5 mm/h (2 and 5 $g/dm^2/h$), 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.

(2) Freezing mist is not reported in METAR; however, it can occur when mist is present at 0 °C (32 °F) and below. Freezing mist is best confirmed by observation. Mist is reported alone or is reported as mixed with ice crystals to use the HOTs in the "Freezing Fog, Freezing Mist, or Ice Crystals" column in the HOT tables. HOTs do not exist for freezing mist mixed with precipitation other than ice crystals.

d. Operations in Heavy Snow.

(1) Tactile and Visual Checks of Aircraft. No HOTs are available in the HOT Guidelines document for heavy snow conditions; however, HOTs are available through liquid water equivalent (LWE)-based HOT determination systems (HOTDS). Review of existing data from past testing has indicated takeoffs may be safely conducted with proper tactile and/or visual checks, as appropriate for the aircraft, and a determination that the fluid has not failed. A tactile and/or visual check in heavy snow conditions should be accomplished in a manner that provides an accurate assessment of the appropriate surfaces. It is imperative that the tactile and/or visual check procedures to determine if the anti-icing fluid has failed in heavy snow conditions should be at least as comprehensive as the authorized procedures for the operator's pretakeoff contamination check (when HOTs have been exceeded) for those precipitation conditions for which HOTs exist. Anti-icing fluids dissolve the snow and absorb the resulting moisture into the fluid. When the fluid begins to fail, it starts to change in appearance (e.g., less glossy and more opaque) and the snow starts to accumulate on and in the fluid. At this stage, the fluid has failed and takeoff is not authorized. If the operator's procedure to accomplish this check is different from the operator's approved pretakeoff contamination check procedures for other precipitation conditions, this check procedure should be verified and approved by the operator's POI.

(2) Takeoff in Heavy Snow Conditions. Operators with a deicing program approved in accordance with § 121.629 may be allowed to takeoff in heavy snow conditions subject to the following restrictions:

(a) The aircraft critical surfaces are required to be free of contaminants, or the aircraft should be properly deiced before the application of the anti-icing fluid.

(b) Per § 121.629(c)(4), the operator must accomplish a visual check and, if required by the AFM, a tactile check of the aircraft critical surfaces within 5 minutes of takeoff.

Note: If this check is accomplished visually from within the aircraft, the view of the critical surfaces should not be obscured by deicing/anti-icing fluid, dirt, or fogging. If the critical surfaces cannot be seen due to snowfall, distance from the viewing position, inadequate lighting, or for any other reason, the visual check or tactile check should be conducted from outside the aircraft.

(c) If a definitive fluid failure determination cannot be made using the checks prescribed, takeoff is not authorized. The aircraft should be completely deiced again, and if precipitation is still occurring, the aircraft should be anti-iced again before a subsequent takeoff.

Note: Current aircraft certification standards only require testing of flight instrument sensing devices and engine anti-icing systems in moderate snow levels. Ground operations in heavy snow conditions may exceed the capabilities or limitations of these systems and devices to adequately provide anti-icing.

e. Operations in Ice Pellet and Small Hail Conditions.

(1) HOTs vs. Allowance Times.

(a) HOTs are developed using testing protocols described in SAE Aerospace Recommended Practices (ARP) 5485, Endurance Time Test Procedures for SAE Type II/III/IV Aircraft Deicing/Anti-Icing Fluids; and ARP5945, Endurance Time Test Procedures for SAE Type I Aircraft Deicing/Anti-Icing Fluids. These protocols rely predominantly on the visual inspection of test surfaces to determine fluid failure, which occurs when the fluid is no longer able to absorb actively occurring frozen or freezing precipitation (e.g., snow and freezing drizzle). HOTs are applicable to most forms of precipitation with the exception of ice pellets. Due to their physical characteristics, ice pellets tend to become partially embedded in fluids and can take longer to melt compared to snow or other forms of precipitation. For this reason, the visual indicators conventionally used in developing HOTs cannot be applied to ice pellets.

(b) As a means to address ice pellet precipitation, a test protocol was developed that uses a combination of aerodynamic fluid flow-off performance of ice pellet-contaminated fluids in combination with visual inspection and evaluation of a wing model test surface. Since 2005, guidance has been derived from this testing protocol and is known as "allowance times." This guidance is also applicable to small hail due to inherent similarities to ice pellets.

(c) Operationally, both HOTs and allowance times provide the times for an aircraft to safely depart following proper deicing/anti-icing. The main difference between the two is the applicability of the pretakeoff contamination check to HOTs, which should not be used with allowance times. The only scenario for which an allowance time can be extended is if the precipitation stops and does not restart while still within the allowance time and the allowable 90-minute extension time.

(2) Operations Guidance.

(a) Tests have shown that ice pellets generally remain in the frozen state embedded in Types III and IV anti-icing fluid, and are not absorbed and dissolved by the fluid in the same manner as other forms of precipitation. Using current guidelines for determining anti-icing fluid failure, the presence of a contaminant not absorbed by the fluid (remaining embedded) would be an indication that the fluid has failed. These embedded ice pellets are generally not readily detectable by the human eye during pretakeoff contamination check procedures. Therefore, a visual pretakeoff contamination check in ice pellet conditions may not be of value and should not be approved. Section 135.227(b)(2) permits the use of an alternate procedure approved by the Administrator. In this case, the part 135 operator who foresees occasional authority to depart in active ice pellet precipitation may request approval to use the appropriate allowance times table.

(b) The research data has also shown that after proper deicing and anti-icing, the accumulation of light ice pellets, moderate ice pellets, and ice pellets mixed with other forms of precipitation in Types III and IV fluid will not prevent the fluid from flowing off the aerodynamic surfaces during takeoff. This flow-off, due to the shearing forces, occurs with rotation speeds consistent with Type III or IV anti-icing fluid recommended applications, and up to the applicable allowance time listed in the allowance times tables. These allowance times are from the start of the anti-icing fluid application. In constant precipitation, the allowance time ends when the fluid's allowance time expires. Additionally, if the ice pellet precipitation stops, and the allowance time has not been exceeded, the operator may consider the anti-icing fluid effective without any further action up to 90 minutes after the start of the application time of the anti-icing fluid. To use this guidance in the following conditions, the OAT should remain constant or increase during the 90-minute period:

- Light ice pellets mixed with freezing drizzle,
- Light ice pellets mixed with drizzle,
- Light ice pellets mixed with freezing rain,
- Light ice pellets mixed with rain,
- Light ice pellets mixed with freezing rain and snow, and
- Light ice pellets mixed with rain and snow.

Examples:

1. Type IV PG anti-icing fluid is applied with a start of application time of 10:00, OAT is 0 °C, light ice pellets fall until 10:20 and stop and do not restart. The allowance time stops at 10:50; however, provided that no precipitation restarts after the allowance time of 10:50, the aircraft may takeoff without any further action up to 11:30.

2. Type IV PG anti-icing fluid is applied with a start of application time of 10:00, OAT is 0 °C, light ice pellets mixed with freezing drizzle fall until 10:10 and stop and restart at 10:15 and stop at 10:20. The allowance time stops at 10:25; however, provided that the OAT remains constant or increases and that no precipitation restarts after the allowance time of 10:25, the aircraft may takeoff without any further action up to 11:30.

3. Type IV PG anti-icing fluid is applied with a start of application time of 10:00, OAT is 0 °C, light ice pellets mixed with freezing drizzle fall until 10:10 and stop and restart at 10:30 with the allowance time stopping at 10:25, the aircraft may not takeoff, no matter how short the time or type of precipitation, after 10:25 without being deiced and anti-iced if precipitation is present.

(c) Operators with a deicing program updated to include the allowance time information contained herein may be allowed, in the specified ice pellet and small hail conditions listed in the Type III, Type IV EG, and Type IV PG allowance times tables up to the specific allowance time, to commence the takeoff with the following restrictions:

1. The aircraft critical surfaces should be free of contaminants before applying anti-icing fluid. If not, the aircraft should be properly deiced and checked to be free of contaminants before the application of anti-icing fluid.

2. The allowance time is valid only if the aircraft is anti-iced with undiluted Type III or IV fluid.

3. The Type III allowance times are only applicable for unheated anti-icing fluid applications.

4. Due to the shearing qualities of Types III and IV fluids with embedded ice pellets, allowance times are limited to aircraft with a rotation speed of 100 kts or greater or 115 kts or greater, as indicated in the allowance times tables.

5. If the takeoff is not accomplished within the applicable allowance time, the aircraft should be completely deiced again, and if precipitation is still present, anti-iced again prior to a subsequent takeoff. If the precipitation stops at or before the time limits of the applicable allowance time and does not restart, the aircraft may takeoff up to 90 minutes after the start of the application of the Type III or IV anti-icing fluid, subject to the restrictions in subparagraph 8e(2)(b).

6. A pretakeoff contamination check is not authorized when using allowance times. The allowance time cannot be extended by an internal or external check of the aircraft critical surfaces.

7. If ice pellet precipitation becomes heavier than moderate or if the light ice pellets mixed with other forms of allowable precipitation exceeds the listed intensities or temperature range, the allowance time cannot be used.

8. If the temperature decreases below the temperature on which the allowance time was based, and:

- The new lower temperature has an associated allowance time for the precipitation condition and the present time is within the new allowance time, then that new time should be used as the allowance time limit.
- The allowance time has expired (within the 90-minute post-anti-icing window if the precipitation has stopped within the allowance time), the aircraft should not takeoff and the aircraft should be completely deiced again and, if applicable, anti-iced again before takeoff.

9. If an intensity is reported with small hail, the ice pellet condition with the equivalent intensity can be used (e.g., if light small hail is reported, the light ice pellets allowance times can be used). This also applies in mixed conditions (e.g., if light small hail mixed with snow is reported, use the light ice pellets mixed with snow allowance times).

f. Hail, Small Hail, Ice Pellets, Snow Grains, and Snow Pellets (METAR Codes GR, PL, SG, GS, and SHGS).

(1) Hail, small hail, ice pellets, snow grains, and snow pellets are related winter precipitation types. When anti-icing fluids are used in these conditions, guidance on their performance is provided by: (a) snow HOTs, (b) ice pellet (and small hail) allowance times, or (c) neither (see Table 1, Holdover or Allowance Times for Hail, Small Hail, Ice Pellets, Snow Grains, and Snow Pellets).

Table 1. Holdover or Allowance Times for Hail, Small Hail, Ice Pellets, Snow Grains, and Snow Pellets

Weather Condition	Applicable Holdover Times/Allowance Times
Snow Pellets	Snow Holdover Times
Snow Grains	Snow Holdover Times
Ice Pellets	Ice Pellet (and Small Hail) Allowance Times
Small Hail (less than ¼")	Ice Pellet (and Small Hail) Allowance Times
Hail (1/4" or greater)	Holdover Times or Allowance Times do not exist for hail other than small hail

(2) The way some of these precipitation types are reported by METAR varies by country. Different HOTs or allowance times may apply when the same METAR code is reported in different countries. Table 2, METAR Codes and Holdover or Allowance Times Used by Country, shows the appropriate HOTs or allowance times that should be used with METAR codes GS, GR, PL, SHGS, and SG, when they are reported in the United States, Canada, or a different country.

Table 2. METAR Codes and Holdover or Allowance Times Used by Country

UNITED STATES		
METAR Report	**Weather Condition**	**Applicable HOTs/Allowance Times**
SG	Snow Grains	Snow Holdover Times
GS	Snow Pellets	Snow Holdover Times
SHGS	Snow Pellets with Showers	Snow Holdover Times
PL	Ice Pellets	Ice Pellet (and Small Hail) Allowance Times
GR with remarks stating "less than 1/4"	Small Hail	Ice Pellet (and Small Hail) Allowance Times
GR with remarks stating "1/4 or greater"	Hail	Holdover Times or Allowance Times do not exist for hail other than small hail
CANADA		
METAR Report	**Weather Condition**	**Applicable HOTs/Allowance Times**
SG	Snow Grains	Snow Holdover Times
GS	N/A (GS never reported in isolation)	N/A
SHGS without remarks	Snow Pellets with Showers	Snow Holdover Times
SHGS with remarks stating diameter of hail	Small Hail	Ice Pellet (and Small Hail) Allowance Times
TSGS without remarks	Snow Pellets with a Thunderstorm	Snow Holdover Times
TSGS with remarks stating diameter of hail	Small Hail with a Thunderstorm	Ice Pellet (and Small Hail) Allowance Times
PL	Ice Pellets	Ice Pellet (and Small Hail) Allowance Times
GR	Hail	No HOTs or Allowance Times
REST OF WORLD		
METAR Report	**Weather Condition**	**Applicable HOTs/Allowance Times**
SG	Snow Grains	Snow Holdover Times
GS or SHGS	Snow Pellets or Small Hail	Ice Pellet (and Small Hail) Allowance Times*
GR	Hail	No HOTs or Allowance Times
PL	Ice Pellets	Ice Pellet (and Small Hail) Allowance Times

* If additional information provided with the METAR makes it clear that the weather condition is snow pellets and not small hail, then snow HOTs can be used.

(3) While most countries, including the United States and Canada, do not report an intensity with small hail, some countries do (e.g., Japan). If no intensity code (+ or -) is reported with small hail, the intensity is assumed to be moderate and the moderate ice pellet allowance times apply. If an intensity code (+ or -) is reported with small hail, the intensity can be used to

determine the applicable allowance times. (Note that this logic also applies when small hail is reported mixed with another precipitation condition.) Examples are provided in Table 3.

Table 3. Examples of Small Hail Allowance Times by Reported Intensity

Weather Condition	Applicable Allowance Times	Examples	
		Weather Reported	**Applicable Allowance Times**
Small Hail reported without intensity	Moderate Ice Pellets (or Small Hail)	Small Hail, no intensity	Moderate Ice Pellets
		Small Hail mixed with Rain, no intensity	Moderate Ice Pellets mixed with Rain
Small Hail reported with light (-) intensity	Light Ice Pellets (or Small Hail)	Small Hail, light (-) intensity	Light Ice Pellets
		Small Hail, light (-) intensity, mixed with Rain	Light Ice Pellets mixed with Rain
Small Hail reported with heavy (+) intensity	No Allowance Times (No allowance times exist for heavy conditions.)		

g. Other Conditions For Which HOTs or Allowance Times Do Not Exist (Heavy Ice Pellets, Moderate and Heavy Freezing Rain, and Hail).

(1) General. HOTs and/or allowance times do not exist for heavy ice pellets, moderate and heavy freezing rain, and hail. Therefore, HOTs or other forms of relief for dispatch in these conditions are not provided.

(2) Regulations. The regulations clearly state, "No person may take off an aircraft when frost, ice, or snow is adhering to the wings…" (refer to § 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…" (refer to § 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-icing fluids applied, and ice pellets/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 whereby previously non-adhering contaminants may adhere to the wing surfaces.

h. Mixed Icing Conditions.

(1) Flightcrews should not determine HOTs for mixed icing conditions unless those procedures are supported by data that is acceptable to the Administrator (refer to § 121.629(c)(3)).

(2) The only aircraft ground deicing/anti-icing data that is currently acceptable to the Administrator is derived from testing protocols described in SAE ARP5485, Endurance Time Test Procedures for SAE Type II/III/IV Aircraft Deicing/Anti-Icing Fluids; and ARP5945,

Endurance Time Test Procedures for SAE Type I Aircraft Deicing/Anti-Icing Fluids. These protocols rely predominantly on the visual inspection of test surfaces to determine fluid failure, which occurs when the fluid is no longer able to absorb actively occurring frozen or freezing precipitation.

(3) Allowance times are provided for ice pellets mixed with several other precipitation types in the allowance times tables.

(4) Footnotes in the HOTs allow for the use of certain HOTs in the following mixed icing conditions:

(a) Light freezing rain HOTs to be used in conditions of very light or light snow mixed with light rain or drizzle.

(b) Freezing fog, freezing mist, or ice crystals HOTs to be used in conditions of ice crystals mixed with freezing fog or mist.

(c) Snow HOTs to be used in conditions of very light, light, or moderate snow mixed with ice crystals.

(5) HOTs are provided for snow mixed with freezing fog inthe Type I, II, III, and IV Holdover Time tables.

(6) It should be noted that obscurations and descriptors do not count as unique precipitation types. Therefore, when they are reported in conjunction with a single precipitation type, this is not considered a mixed precipitation condition.

(a) Obscurations include mist, dust, fog, sand, smoke, haze, and volcanic ash.

Note: The FAA HOT Guidelines provide HOTs for the obscurations freezing fog and freezing mist.

(b) Descriptors include showers, blowing, shallow, patches, thunderstorms, partial, low-drifting, and freezing.

Note: Typically HOTs are required for freezing and frozen precipitation, but not for non-freezing precipitation. The “Rain on Cold Soaked Wing” column represents a non-freezing precipitation condition.

(7) If non-freezing precipitation is reported below 0 °C, the flightcrew should determine if freezing precipitation is occurring. If it is, HOTs for the equivalent freezing precipitation type should be used.

5. Guidelines for Pilot Assessments 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 (e.g., precipitation is reported when precipitation is not actively 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 HOTs or allowance times for the higher intensity or different form of precipitation should be applied (e.g., if precipitation is being reported as light ice pellets and the pilot assessment is that it is moderate ice pellets, then the pilot should apply the allowance time for moderate ice pellets).

b. Reporting New Observation. Before a pilot takes action on their own precipitation intensity assessment, they should request that a new weather observation be taken. A pilot should not take action based on their 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(c)(2), must contain the required company coordination procedures for a pilot when they choose to take actions that are based on their precipitation intensity assessment that is less than the precipitation intensity that is being officially reported (e.g., 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 ice pellets, and by the pilot's assessment there is light snow and no ice pellets). These procedures should require coordination with the company before the pilot takes such action, or if the approved company program allows, a report of action taken after the pilot has opted to exercise this option. During snow, snow mixed with ice crystals, and snow mixed with freezing fog conditions, the use of the Snowfall Intensities as a Function of Prevailing Visibility table 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.

d. Pilot Assessment of Change in Precipitation Intensity. When a pilot acts based on their own assessment that precipitation intensity levels are lower than the official reported intensity level, a pretakeoff check per the approved procedure for the applicable aircraft should be conducted. If the precipitation intensity is higher than the original value, a revised HOT can be determined. If this new time is less than the time that has elapsed since anti-icing was initiated, then the pilot can perform a pretakeoff contamination check or return to be deiced and anti-iced again.

> **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 their own assessment of precipitation intensity levels that are less than that being officially reported. Pilot assessment of precipitation intensity levels should only be used when sufficient natural sunlight or artificial lighting is available to provide adequate exterior visibility. The Snowfall Intensities as a Function of Prevailing Visibility table provided in the FAA HOT Guidelines is based on prevailing visibility, and allowances are made in the table for the effects of night (darkness) conditions.

(1) Ice Pellets. When ice pellets are being reported, the following chart information extracted from the Federal Meteorological Handbook No. 1 (FMH-1), Surface Weather Observations and Reports, should 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 should use both visual and tactile 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 should 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 HOTs or allowance times for the higher intensity or different form of precipitation should be applied.

(3) Snow/Snow Mixed With Ice Crystals/Snow Mixed With Freezing Fog. The Snowfall Intensities as a Function of Prevailing Visibility table, published in the annual FAA HOT Guidelines document for use in determining snow intensity rates based on prevailing visibility, should be used in place of official reported intensities. Thus, this table should be used for pilot assessment of snowfall intensity rates, as well as the intensity rates for snow mixed with ice crystals and snow mixed with freezing fog.

Note: The use of Runway Visual Range (RVR) should not be used for determining visibility used with the HOT tables.

Note: Some METARs contain tower visibility as well as surface visibility. Whenever surface visibility is available from an official source, such as a

METAR, in either the main body of the METAR or in the Remarks ("RMK") section, the recommended action is to use the surface visibility value.

(4) Training Requirements. Pilots who are limited in their precipitation intensity assessments to determining whether or not precipitation is falling must (refer to § 121.629(c)(2)) receive instruction on how that assessment should be made (e.g., how and where to perform the physical feel cues to determine if precipitation is present).

(a) Pilots who determine precipitation intensity must be trained on their company's pilot precipitation intensity assessment procedures (refer to § 121.629 (c)(2)). These pilots should be trained 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 FMH-1 and the Snowfall Intensities as a Function of Prevailing Visibility table should 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.

6. Fluid Quality Control (QC). QC checks of all stored fluids should be performed before the start of the deicing season. At a minimum, the checks for all fluid types should include visual inspections of the fluid and the containers for contamination and separation, refractive index measurements, and pH measurements. All values should be within the limits recommended for the manufacturer's specific fluid type and brand.

a. Types II, III, and IV Fluids Viscosity Check. In addition, for Types II, III, and IV fluids, viscosity checks should be performed at the beginning of the icing season, periodically throughout the winter, and any time fluid contamination or damage is suspected or after major deicing truck pumping and spraying system maintenance. These checks should include samples obtained through the spray nozzles of application equipment. The checks should be conducted using one of the measurement methods in SAE AS9968 (manufacturer method or an FAA-approved alternate method) provided for the specific fluid brand/product and dilution in the tables (Type II Fluids Tested for Anti-Icing Performance and Aerodynamic Acceptance; Type III Fluids Tested for Anti-Icing Performance and Aerodynamic Acceptance, or Type IV Fluids Tested for Anti-Icing Performance and Aerodynamic Acceptance), which list fluids tested for anti-icing performance and aerodynamic acceptance. The viscosities obtained during these checks should be compared to the LOWV values provided in these tables; fluid samples with viscosities below the stated LOWV should not be used with the HOT tables, as they may not provide the HOT protection stated in the tables. Viscosity measurement methods and values for dilutions of Types II, III, and IV fluids are included in the FAA HOT Guidelines to facilitate fluid viscosity checks in locations where thickened fluids are diluted before applying and, in some cases, may be stored diluted.

(1) 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 that 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.

(2) 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.

(3) 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 that used in the actual anti-icing operation.

b. Loss of Water Content. Prolonged or repeated heating of fluids may result in loss of water content, which can lead to fluid performance degradation. 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 temperatures 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 Types 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 invalidating the applicable HOT.

> **Note:** Adding water to Types II, III, and IV fluids will not repair the damage caused by the previously mentioned conditions.

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

7. Fluid Application.

a. Fluid Application Tables. Guidelines for appropriate application of deicing/anti-icing fluids are provided in the FAA HOT Guidelines document, which includes separate tables for the application of Type I fluid (Guidelines for the Application of SAE Type I Fluid), Types II/IV fluid (Guidelines for the Application of SAE Type II and IV Fluid), and Type III unheated fluid (Guidelines for the Application of Unheated SAE Type III Fluid). These tables are updated annually, as required.

> **Note:** Fluid application tables published by other entities may not provide equivalent information to those published by the FAA. Therefore, the FAA HOTs and allowance times are not applicable unless the guidance in the FAA fluid application tables is used.

b. Fluid Application Information.

(1) During previous seasons, surveillance of deicing/anti-icing operations has indicated revealed 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 wingtip to wing root).
- Insufficient fluid temperature buffers.

- Incomplete removal of contamination.

(2) Frozen residual ground ice contamination has been observed on wing surfaces at altitude has been reported.

(3) 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 fine (small droplet size) spray mode. Also, equipment operators should maintain a safe distance between deicing equipment and aircraft surfaces to avoid contact.

(4) Additionally, cover the entire aircraft surface directly by the deicing operation (except windows or other areas where a direct spray is not recommended) rather than relying on fluid flow-back over contaminated areas. This will provide greater assurance that no frozen precipitation remains under the deicing fluid.

(5) 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 Types II, III, and IV fluids, ensure they are applied in the temperature ranges for undiluted or diluted, as shown in the HOTs, and that quantities are sufficient to displace residual deicing fluid. This can be indicated by these anti-icing fluids running off in considerable quantities on sloped surfaces and running off flat surfaces also. If applied according to the respective HOTs, the freezing point buffer requirement of at least 7 °C (13 °F) below the OAT will be achieved. 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 fluids 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.

(6) The effectiveness of Types II, III, 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.

(7) In very cold conditions (generally below -10 to -15 °C (14 to 5 °F) or colder), dry snow or ice crystals can fall onto cold aircraft wings. Under these conditions, these forms of precipitation will swirl as they blow across the wings, making it evident they are not adhering. But, if either has accumulated on the surface of the wings and it cannot be adequately

demonstrated that they are not adhering to any portion of the wing, they should be removed before takeoff. It cannot be assumed that these accumulations will blow off during takeoff.

(8) The aircraft operator should test multiple areas along the entire length and width of both wings, and should take into consideration the location of heat-releasing components in the fuel tanks such as hydraulic fluid heat exchangers. The testing should be accomplished after refueling. Factors that could affect adherence should be taken into consideration. These would include weather, temperature, aircraft parking location (e.g., one wing in the sun), and potentially other factors.

c. Anti-Icing Application Guidelines. The anti-icing process is not properly accomplished if an insufficient amount of fluid has been used and which results in incomplete or inadequate coverage of the surfaces to be treated. For the second step of a two-step procedure, a sufficient amount of aircraft anti-icing fluid should be applied to completely cover the surfaces and form an adequate coating. The HOT table values are based upon the application of sufficient fluid. Insufficient coverage results in a thin layer and reduced protection of uncertain duration. The application process should be continuous and as short as possible. Anti-icing should be carried out as near to the departure time as possible in order to utilize available HOT. While thickness will vary in time over the profile of the wing surface, the anti-icing fluid should be distributed uniformly. In order to control the uniformity, all horizontal aircraft surfaces should be visually checked during application of the fluid. As a rule of thumb, a sufficient amount of fluid has been applied when it can be visually confirmed that the fluid is just beginning to run off the leading and trailing edges of the surfaces.

8. Alternative and New Technologies.

a. Forced Air Systems (FAS).

(1) General. FAS are designed to remove frozen contamination by the use of forced air and/or forced air augmented with Type I fluid injected into or sprayed over a high-speed air stream, or to apply Type II, III, or IV fluids over the air stream as an anti-icing process. In the case of Type I fluids, aircraft surfaces should be anti-iced with heated Type I fluid without using forced air if Type I HOTs are used. Depending on the specific system, the operator may select from several FAS modes, including:

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

(2) Possible Concerns with FAS.

(a) Testing has indicated that the viscosity of Types II and IV fluids can degrade when applied by FAS. This degradation is influenced by the velocity and pressure of the forced air stream and the distance between the forced air nozzle and surface being anti-iced. Additionally, FAS-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

Types II, III, and IV fluids. When FAS are dispensing Types II, III, or IV fluid, viscosity should be tested.

(b) Another factor that may reduce HOTs is the apparent tendency of the high-speed air stream to thin out the fluid film as it is being applied. Therefore, operators should ensure that surfaces to be anti-iced are covered adequately in order to use the published Types II, III, and IV HOTs. The operator should 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. This usually means applying fluid in such quantities whereby the Type I deicing fluid is displaced, and the Type II, III, or IV fluid is running off in considerable amounts on sloped surfaces and running off flat surfaces as well.

(c) Before using Type II, III, or IV fluid-specific or generic HOTs, each operator should demonstrate, by spraying and viscosity testing, that its equipment, or equipment operated by other parties to deice/anti-ice the operator's aircraft, is capable of applying these fluids without excessive shearing, such that they would no longer meet LOWV requirements. The lowest acceptable delivered viscosity can be determined by multiplying the LOWV by the ratio of the fluid viscosity in the storage device divided by the fluid viscosity from the forced air spray sample recovered from the wing, and for Types II and IV fluids, rounded up to the nearest 500 millipascal seconds (mPa·s).

Note: CHs should use the manufacturer's viscosity test method from the Fluids Tested for Anti-Icing Performance and Aerodynamic Acceptance tables, in the FAA HOT Guidelines document while conducting these or similar tests.

Note: The APS Aviation Inc. test procedure, Test Program – Forced Air Systems – Type II/III/IV Fluid Applied Over the Forced Air Stream, provides an example of how these tests can be conducted and the calculations required to determine the lowest acceptable delivered viscosity of a fluid intended to be used with an FAS.

(d) The FAA recommends that nozzles be kept at a low angle to the surface of the aircraft to avoid excessive fluid shear damage, aircraft surface damage, and foaming. Fluid applied with forced air augmentation should not result in a foamy, milky-white, or frothy appearance, that indicates excessive shear and degradation of the fluid below the LOWV. Fluid 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).

Note: Except for application equipment and fluids that have been tested, and using fluid of sufficient viscosity to meet LOWV requirements in the air assist mode, published HOT guidelines (including generic) should not be used when using forced air unless followed by the application of anti-icing fluid without forced air.

(e) Adhere to airframe manufacturer cautions when operating FAS. For example, operators should not exceed the airframe manufacturer's limits regarding surface temperature and impact pressure on aircraft surfaces. This information is usually found in the Aircraft Maintenance Manual (AMM).

(3) Additional Precautions for FAS.

(a) Ear protection should be worn when noise levels exceed 85 decibels (dB).

(b) Exercise caution around ground personnel. The potential for blowing ice chunks that may 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, and vents).
- Blowing snow or slush into landing gear and wheel wells.
- Blowing ice, snow, and slush into aircraft engine inlets, auxiliary power unit (APU) inlets, and control surface hinges.
- Allowing loose debris to impact other aircraft surfaces.

Note: Information regarding a specific system can be obtained from the manufacturer's technical literature. SAE Aerospace Information Report (AIR) 6284, Forced Air or Forced Air/Fluid Equipment for Removal of Frozen Contaminants, provides some information on FAS usage, limitations, and precautions. This document is available at https://www.sae.org/standards/content/air6284.

b. Liquid Water Equivalent Systems (LWES). LWES have been in development for a number of years. They include HOTDS. At this time, SureHOT and SureHOT+, provided by SureWx Inc., are the only LWES available by Operations Specification (OpSpec) A323, Liquid Water Equivalent System (LWES). All of these systems convert snowfall data, freezing drizzle data, and light freezing rain data into LWE data, which is then used to develop a HOT. The precipitation rate determined by these devices is matched with HOT data developed when fluids are tested in natural snow conditions, and artificial conditions for other precipitation types, to determine a HOT for a particular fluid type in the case of Type I fluids, and for a specific fluid name brand and type for Types II, III, and IV fluids. FAA Order 8900.1, Volume 3, Chapter 27, Section 5, Liquid Water Equivalent Systems, describes the approval process for using these devices to determine HOTs as part of an FAA-approved program.

c. Electronic Hand-Held Devices to Determine Electronic HOTs (eHOT). Electronic devices that determine eHOTs may be used as part of an air operator's § 121.629 winter operations plan submitted to the FAA for approval. If, for any reason, the device or application fails, or if the user has any concern regarding the accuracy of the data being displayed, printed tables sourced from the FAA HOT Guidelines should be used as a fallback information source. Questions regarding the use of these devices should be submitted via email to timothy.mcclain@faa.gov or via phone at 703-999-6648.

9. Guidelines for the Use of Degree-Specific HOTs (DSHOT).

a. Background and General Information Relating to DSHOTs.

(1) The FAA publishes an annual database of DSHOTs for snow and snow-related precipitation conditions (including snow, snow grains, snow pellets, snow mixed with ice crystals, and snow mixed with freezing fog). The DSHOT database contains an expanded set of snow precipitation HOTs (very light snow, light snow, and moderate snow) for all undiluted Type II, III, and IV anti-icing fluids listed in the FAA HOT Guidelines. The DSHOT data is provided in the form of a set of reference tables ("xls" format) contained within an annually updated FAA DSHOT data publication. The data is obtainable from the following website: https://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/deicing/.

(2) The DSHOT database is an extension of the FAA HOT Guidelines. The data it contains is derived from the same natural snow test data that is used to calculate the snow HOT values within the standard HOT tables. Within a typical HOT table, HOTs are provided for defined temperature ranges (e.g., -3 °C to -8 °C). The HOTs provided within a given temperature range are based on the coldest temperature of that range. Within the DSHOT database, specific HOT values are provided for each Type II, III, and IV fluid at all temperatures decrementing down to a given fluid's LOUT. A 1 °C safeguard is incorporated in all DSHOT calculations (i.e., all published DSHOT values are calculated using a temperature that is 1 °C colder than the listed temperature).

(3) DSHOTs are provided as single values for precipitation rates of 3, 4, 10, and 25 $g/dm^2/h$. These precipitation rates correspond with the lower and upper precipitation rate boundaries for very light snow (3 to 4 $g/dm^2/h$), light snow (4 to 10 $g/dm^2/h$), and moderate snow (10 to 25 $g/dm^2/h$) used in the HOT Guidelines. Certain Type II fluid-specific HOT tables do not include information for very light snow or light snow. Correspondingly, no DSHOT values have been provided at these intensities for these fluids.

(4) Fluid-specific DSHOTs have only been determined for snow conditions where the standard snow HOTs are derived through regression analysis. There are some exceptions where DSHOTs cannot be calculated, these are:

(a) Snow HOTs below -14 °C for fluids with generic snow HOTs below -14 °C; and

(b) Snow HOTs below -25 °C for fluids with:

1. Fluid-specific snow HOTs below -14 °C, and

2. Fluid LOUTs colder than -29.0 °C.

Note: In the above-mentioned instances, the related data in the DSHOT database has been populated with the applicable standard (i.e., non-degree-specific) HOTs.

(5) In addition to the fluid-specific DSHOT values, the DSHOT database also contains a set of generic DSHOTs for both Type II and Type IV fluids. The generic DSHOT values for a

given fluid type and temperature represent the lowest calculated DSHOT value of all fluids of that type at the specified temperature.

(6) In conditions of snow mixed with ice crystals, the DSHOTs for snow conditions can be used.
(7) In conditions of snow mixed with freezing fog, the DSHOTs for mixed snow and freezing fog columns should be used..

(8) Separate sets of DSHOT values are provided for standard anti-icing operations, and for operations where flaps and slats are extended to the takeoff configuration prior to deicing/anti-icing (identified as "Adjusted" DSHOT values).

(9) All notes and cautions that would be applicable to standard and adjusted HOTs within a given HOT table in the FAA HOT Guidelines are also applicable to their corresponding DSHOTs. All users of the DSHOT data shall ensure that the applicable notes and cautions are available for reference.

b. Presentation of DSHOT Data.

(1) The DSHOT database is impractical for direct use in its published format. There are several possible methods by which an air operator can present the published DSHOT data, including:

(a) Internal publication of a modified paper HOT table.

(b) Incorporation of the DSHOT data into a verified digital display (e.g., an eHOT app).

(2) An air operator's chosen DSHOT data presentation can incorporate the DSHOT database in full, or in a customized format as preferred by the operator. For example:

(a) Air operators flying exclusively within North America may choose not to include Type II data.

(b) Air operators who opt not to use fluid-specific HOT tables may choose not to include them.

(c) Air operators who operate with their flaps and slats extended to the takeoff configuration prior to deicing/anti-icing may choose to list only the adjusted DSHOT values.

(3) Any data presentation used should be updated annually (or whenever the DSHOT database is updated) and shall incorporate the relevant notes and cautions that would be found in the corresponding FAA HOT Guidelines tables.

c. Validation of DSHOT Data.

(1) Data integrity can be compromised when the original data source (i.e., the DSHOT database) is manipulated to provide the data in a different format. Any operator making use of the DSHOT data in a modified format should employ a detailed verification process to ensure

that the data presented is accurate and complete. This verification process should consist of a series of manual checks of the DSHOT data within a DSHOT data presentation (e.g., a modified paper table or an eHOT app) against the corresponding values published in the most recent FAA DSHOT database publication. At a minimum, the air operator should ensure the following information is verified for each individual anti-icing fluid that will be used from the DSHOT database:

(a) Fluid name.

(b) Temperature at each degree (°C) decrement down to the fluid's LOUT. For each degree (°C):

1. The DSHOT value at a precipitation rate of 3 g/dm²/h (lower threshold of very light snow).

2. The DSHOT value at a precipitation rate of 4 g/dm²/h (upper threshold of very light snow and lower threshold of light snow).

3. The DSHOT value at a precipitation rate of 10 g/dm²/h (upper threshold of light snow and lower threshold of moderate snow).

4. The DSHOT value at a precipitation rate of 25 g/dm²/h (upper threshold of moderate snow).

(2) A record of the verification process should be kept and maintained and this record shall clearly demonstrate that all DSHOT values within a data presentation have been verified. The verification process should be updated and/or repeated on an annual basis (or whenever the DSHOT database or its data presentation is updated, whichever comes first).

d. Temperature Inputs for Use With DSHOTs.

(1) Operators should consider weather reporting requirements under § 121.101 or § 135.213, when using DSHOT data. The current edition of AC 00-45, Aviation Weather Services, provides guidance on appropriate sources of temperature data.

(2) Pilots should ensure the conditions (including the OAT) used to determine the DSHOT value are current at takeoff.

10. Concerns/Conditions.

a. Referencing Industry Standards. Industry standards that include but are not limited to SAE AS6285 and AS6286 may be used when developing a ground icing program.

b. Starting and Stopping the HOT Clock. The HOT clock begins at the start time of the anti-icing operation. If a one-step procedure is used, the clock starts at the beginning of fluid application. If a two-step procedure is used, the HOT clock begins at the start of the final (anti-icing) step. The HOT ends when the fluid's HOT expires. Once the HOT time clock has been started, it should not be stopped for intermittent precipitation. Intermittent precipitation conditions during ground icing operations are a common occurrence at some airports. As precipitation falls on an aircraft that has been anti-iced, the fluid is diluted. The more diluted the fluid becomes, the more readily it flows off the aircraft, and the higher the freezing point becomes. Even if the precipitation stops, the diluted fluid will continue to flow off the aircraft due to gravity. There is no practical way to determine how much residual anti-icing fluid is on the wing under these circumstances. HOT values under these conditions have not been assessed. Therefore, after the anti-icing HOT clock has been started, it should not be stopped. HOT credit should not be given due to the fact that the precipitation has temporarily stopped falling.

c. Flight Crew Awareness of Conditions Affecting the Aircraft Anti-Icing Treatment Following Deicing and Anti-Icing Operations. The operator's deicing plan must provide a process that informs the captain of the time of the deicing/anti-icing treatment and conditions that could have affected the aircraft anti-icing treatment since that time (refer to § 121.629(c)(2)). If the flight crew is not present at the time of the deicing/anti-icing application, the crew should review this information before calculating the HOT.

d. Early Fluid Failure on Extended Slats and Flaps.

(1) Research into HOTs on deployed flaps/slats began in Winter 2009–2010, and since Winter 2011–2012 has included cooperative efforts with industry. Data collected has provided a substantive amount of evidence that demonstrates extended flaps/slats can accelerate anti-icing fluid runoff from aircraft wings, in turn negatively affecting the protection capacity of the fluid. This results in a potential safety risk. The protection capacity of the fluid is affected by many elements: the aircraft design, the slope of the surface, the type of fluid, the aircraft skin and ambient temperature, the type of precipitation, the amount of fluid applied, and the effective wind.

(2) To mitigate this safety risk, it was determined by the FAA and TC that adjusting the published deicing/anti-icing fluid HOTs and allowance times to 76 percent of the current published values would provide the sufficient safety margin to safely allow operations when flaps and slats are deployed prior to deicing/anti-icing. Therefore, when flaps and/or slats are extended to the takeoff configuration prior to deicing/anti-icing fluid application and remain in that configuration while taxiing to takeoff, the HOT and allowance times tables identified as "Adjusted" must be used (refer to § 121.629(c)). Note that the standard HOTs and allowance times can be used if flaps and slats are deployed as close to departure as safety allows.

> **Note:** Industry data indicates the possibility of increased takeoff misconfigurations when the selection of takeoff flaps is delayed later in the taxi regime. Whether an air carrier chooses to select the flaps/slats to the takeoff configuration prior to beginning the anti-icing process, operators should have robust procedures in place to ensure that the aircraft is properly configured prior to takeoff. Air carriers should follow the manufacturer's recommended procedures regarding anti-icing operations and the configuration of flaps/slats while taxiing.

e. Aircraft Failure to Rotate When Anti-Iced With Type II or 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 non-powered 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 airflow 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 of Type IV fluids.

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

f. Deicing and Anti-Icing Fluid Compatibility.

(1) Research has indicated that the effectiveness of Type II and Type IV fluids can be seriously diminished if proper procedures are not followed when applying them over Type I fluid; specifically, a sufficient quantity of Type II or Type IV fluid should be applied to displace any remaining Type I fluid from the aircraft surfaces.

(2) Operators should ensure that the Type I and Type II/IV fluids being used on their aircraft are compatible. This can be accomplished by contacting the respective fluid manufacturer(s).

g. Non-Glycol Deicing Fluids Containing Alkali Organic Salts (AOS). There has been evidence that some non-glycol-based Type I fluids may pose a significant safety hazard when given their impact on anti-icing fluid. Specifically, Type I fluids containing AOS have been shown to significantly degrade thickening agents contained in anti-icing fluids, potentially resulting in a reduction of the fluid's viscosity and HOT. Operators should ensure that the Type I and Type II/IV fluids being used on their aircraft are compatible. This can be accomplished by contacting the respective fluid manufacturer(s). It is preferable that operators avoid the use of any deicing fluid containing AOS. In operational situations where this may not be possible, special attention should be given to ensure that a sufficient amount of anti-icing fluid has been applied to ensure complete removal of this deicing fluid so that the anti-icing fluid will have the appropriate HOT.

h. Possible Effects of Runway Deicer on Thickened Aircraft Anti-Icing Fluids.

(1) Most current runway deicing/anti-icing material contains organic salts that are not compatible with thickened aircraft anti-icing fluids. These salts cause the thickening agents within the aircraft deicing fluids to break down, 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.

(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, flight crews should be conscious of the effects of having the runway deicing fluid blown up onto the aircraft by preceding aircraft jet blast.

i. 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.

j. Tactile Inspection of Hard-Wing Airplanes (No Leading Edge Devices/Slats) With Aft-Mounted, Turbine-Powered Engines. 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, if specified in the AFM.

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

k. 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 Types II and IV fluids can produce more residual gel than undiluted or neat fluids. This is primarily due to the practice in some geographic locations of using diluted, heated Types 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 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 Types 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 does not flow off the wing during the takeoff ground roll. These accumulations can dry to a gel-like or powdery substance. Such residues can rehydrate and expand under certain atmospheric conditions such as high humidity or rain. Subsequently, the residues freeze, typically during flight at higher altitudes. Rehydrated fluid gels have been found in and around gaps between stabilizers, elevators, tabs, and hinges. This especially can be a problem with non-powered 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 diluted, heated Type II or IV fluids followed by Type II or IV fluids 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 heated 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 deice/anti-ice their aircraft. If an operator suspects residue as a result of fluid dry-out, an acceptable solution is to spray the area with water from a spray bottle and wait 10 minutes. Residue will rehydrate 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 buildup, 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.

l. Representative Surfaces.

(1) Function of Representative Surfaces. Particularly for large aircraft where very limited portions of the aircraft can be seen from inside, representative surfaces may be used to judge the condition of the aircraft's critical surfaces during ground icing conditions.

(a) Representative surfaces are intended to be used, as a tool in gauging the contaminated state of critical surfaces on an aircraft after having used deicing and anti-icing fluids to clean the aircraft and then protect the aircraft from the freezing precipitation occurring during ground icing conditions.

(b) An aircraft's representative surface is a portion of the aircraft that can be readily and clearly observed by the flightcrew from inside the aircraft and is used to judge whether or not the surface has become contaminated. By determining the state of the representative surface, it can then be reasonably expected that other critical surfaces will be in the same (or better) condition.

(c) Prior to takeoff, a visual check of the representative surfaces may be carried out by a pilot to ensure that contamination is not present at this stage of the departure; depending upon the requirements of the approved ground icing program. If conclusive, the aircraft may proceed to takeoff, otherwise the aircraft should be deiced again.

(2) Representative Surface Selection Guidelines.

(a) The choice of representative surfaces should first consider any recommendations made by the aircraft manufacturer.

(b) Operational and other pertinent experience can be very useful in choosing a representative surface. This is especially valuable when the aircraft manufacturer hasn't offered any guidance on making the selection.

(c) Representative surfaces will normally be located on a critical surface of the aircraft.

(d) The surface being chosen should not be heated.

(e) The surface should be clearly visible and close enough for the viewer to determine that it is free of contamination. The location of the representative surface and the position inside the aircraft from which the surface is to be viewed should be specified for each aircraft type. This information should be clear and concise.

(f) If the surface is not adequately visible under all weather and lighting conditions, restrictions on its use should be clearly identified. Consideration should be given to locating representative surfaces in areas that can be illuminated by aircraft external lighting systems.

(g) Under some circumstances the presence of contrasting colors may be necessary in order to visually detect the presence of contamination. If a surface does not contain such contrast it may become necessary to paint a portion of the surface in contrasting colors to aid the flight crew.

(h) The representative surface should not be located in an area where the fluid tends to pool during anti-icing procedures. This fluid pooling would not result in the area being representative of the critical surfaces of the aircraft.

(i) Representative surfaces should be designated for both sides of the aircraft in the event that weather and wind conditions are such that contamination is more likely to form on one side of the aircraft than on the other side of the aircraft.

(j) Representative surfaces that can be clearly observed by the flight crew from insidethe aircraft may be suitable for judging whether or not critical surfaces are contaminated.

(k) Research has indicated that fluid failure occurs last at the mid-chord sections of wings. Therefore, whether painted or not, areas located at mid-chord sections of wings and previously used for checking fluid conditions are not suitable alone for evaluating fluid failure and should no longer be used exclusively as representative surfaces. Portions of the leading and trailing edges of the wings should be included.

(l) Pretakeoff contamination checks should concentrate on the leading edge in conjunction with the trailing edge of the wing. Dependent upon aircraft configuration, wing spoilers may also be used to provide an indication of fluid condition.

(3) Guidelines on the Use of Representative Surfaces.

(a) In accordance with § 121.629(c)(2), the air operator’s ground icing operations program must specify the ground and flightcrew training to be conducted regarding the purpose, procedures, and limitations with respect to representative surfaces. Training on the assessment procedures to be followed to determine whether or not the fluid has failed should be included in the program.

(b) This technique may be used when the aircraft manufacturer has identified representative surfaces which can be readily and clearly observed by the flightcrew during day and night operations, and which are suitable for judging whether or not critical surfaces are contaminated.

(c) Representative surfaces may not be particularly effective during conditions when clear ice is forming on the aircraft’s critical surfaces. Clear ice is even difficult to identify under ideal lighting conditions from outside the aircraft. Additional aircraft type specific procedures, such as tactile inspections, may be required.

(d) Other surfaces which are visible from inside the aircraft should also be inspected whenever possible, in addition to the representative surfaces. For example, under very good lighting conditions it may be possible to examine the surface of the wing beyond the representative surface.

(e) For large aircraft where it is necessary for one pilot to leave the flight deck in order to accomplish the pretakeoff contamination check, there is the potential for the disruption of "checklist flow". The operator's ground icing plan should therefore specify at what point the inspection should take place in order to minimize any such disruption.

(f) The flightcrew should be made aware that the use of representative surfaces for contamination detection may not be feasible in poor weather under very poor lighting conditions. The presence of contaminants on the cabin or cockpit windows may also make it difficult to properly observe the representative surfaces. Under conditions such as these it is prudent to have an external inspection conducted, to return for deicing and anti-icing or to delay the flight until conditions improve and a safe takeoff can be assured.

m. Wingtip Devices Identified as Critical Surfaces. Wingtip devices have various names, including winglets, strakes, sharklets, or raked wingtips. The following guidance applies to these devices.

(1) **For wingtip devices installed on airframes other than Boeing products discussed in paragraph 3 below, without Split Scimitars or Strakes (Winglets, Sharklets, etc.):** These devices should be confirmed to be free of frozen contamination as part of the pretakeoff check. Current practice used to ensure that no frozen contamination is present on the wingtip devices at takeoff is incorporated in the pretakeoff check. This incorporates a visual scan or the use of representative surface(s) as specified in the operator's FAA-approved ground deicing program and as discussed below in paragraph (2).

(2) **For wingtip devices with Split Scimitars, Strakes, or Similar Devices (other than Boeing products as discussed in paragraph (3) below:** This paragraph applies only to aircraft with split scimitar wingtip devices. The most recent development of drag reducing wingtip devices, the strake, has been introduced and is part of the split scimitar. The strake is installed outboard of the vertical component of the wingtip device and extends downward. Therefore, the strake cannot be observed from inside the aircraft. Manufacturers may designate the upper inboard surface of the vertical element of the wingtip device as a surface representative of the strake. If no frozen adhering contamination is present on the upper one foot of the inboard surface of the vertical element of the wingtip device, it can be inferred that the strake is also free of adhering contamination. The anti-icing fluid application procedures must require this inboard surface to be anti-iced first, starting at the top and working downward. The strake is anti-iced after the inboard surface application is completed. A visual scan of the designated representative surface (upper one foot of the inboard surface of the vertical element of both wingtips) is required prior to takeoff as part of the pretakeoff check. This guidance will be revised when new wingtip types become available.

(3) **For Boeing Wingtip Devices currently in use on the B737 (including Wingtip Devices with Split Scimitar Elements), B747, B757, B767, and MD11:** Boeing has demonstrated that these wingtip devices do not require a visual inspection as part of the pretakeoff check if a complete deicing of these wingtip device surfaces is accomplished during the aircraft deicing procedure. Following the accomplishment of the wingtip device deicing procedure, no further action concerning the wingtip device is required as long as the determined HOT does not expire before departure. In accordance with § 121.629(c)(3)(i), upon expiration of

the HOT determined prior to departure, a pretakeoff contamination check must be accomplished. This check must include a visual inspection of the wingtip devices, and even if adhering frozen contamination is detected only on the winglet, the aircraft must return for appropriate ground deicing/anti-icing retreatment prior to departure.

n. Cold Soaked Fuel Frost (CSFF). Exemptions for Boeing 737 NG -600/-700/-800/-900 and 737 MAX -8/-9 series aircraft have been granted to allow takeoff with CSFF adhering to the top of the wing. Operators may petition for an exemption under 14 CFR part 11.

o. Fluid Freezing in Flight. It is possible for anti-icing fluid to flow back to aerodynamically quiet areas of aircraft wings after takeoff, where the residual fluid can partially freeze or appear thickened. Research indicates that this can occur on a regular basis and poses no risk to safety. Anti-icing fluids are designed such that most of the fluid will flow off aircraft wings, particularly from the leading edge. The leading edge is the most aerodynamically critical section of the wing, whereas its trailing edge can accrue some residual fluid and remain acceptable for safe operations.

p. Anti-Icing in a Hangar.

(1) There are operational conditions when air operators may choose to anti-ice their aircraft while the aircraft is in a heated hangar. This is one way to reduce the consumption of deicing fluid and to minimize the environmental impact of deicing.

(2) The period of time after fluid application and the air temperature in the hangar both have an effect on the ability of the fluid to protect the aircraft when it is pulled out of the hangar and into freezing/frozen precipitation. The HOT for a Type II or IV fluid is based largely on the fluid's thickness on the surface which varies with time and temperature. Unless otherwise approved in an air operator's program, the HOT clock should be started at the time of the first application of anti-icing fluid onto a clean wing, not when the aircraft is first exposed to freezing/frozen precipitation.

(3) When anti-icing T-tail aircraft in a hangar, care should be taken to ensure that the horizontal stabilizer/elevator of the aircraft is not in close proximity to ceiling mounted forced air or radiant heating systems. Excessive heating of these critical surfaces during and after anti-icing can reduce applied anti-icing fluid thickness below what is required to achieve the HOT.

(4) If it is impossible to position the aircraft in such a way that the tail section is not below a heating element, consider disabling the heating element before, during, and after anti-icing. Alternately, consider opening the hangar doors to cool all surfaces if this can be done without exposing the aircraft to additional contamination.