3.3.6 Cold Weather Operations

3.3.6.1 Airplane Contamination on the Ground - Frost, Ice or Snow

Air regulation stipulate that take-off is prohibited when frost, ice or snow is adhering to any critical surface of the airplane. This principle is referred to as "**the clean airplane concept**" and is essential to the maintenance of flight safety.

Regardless of the de-icing and anti-icing procedures used, the only method of ensuring flight safety in icing conditions is by inspecting critical airplane surfaces and ensuring that they are clean before take-off. The PIC has the ultimate responsibility to determine whether or not the airplane is safe to fly.

Frost less than 3 mm in depth is permitted on the underside of the fuel tank area of the wing. This poses no concern. The frost accumulation will dissipate as of post engine start, due to heat transfer from the fuel tanks. A thin layer of hoar frost on the upper surface of the fuselage is not considered to be critical and can remain on the fuselage for take-off. Provided all vents and ports are clear of the frost and it is possible to distinguish fuselage surface features (markings and lines).

References:

- Holdover Time (HOT) Guidelines, Transport Canada
- Guidelines for Aircraft Ground-Icing Operations (TP 14052E)

NOTE: The above mentioned documents complement each other and should be used together. It is the responsibility of the end user to periodically check the Transport Canada website for updates on HOT Guidelines.

3.3.6.2 Ground De-Icing / Anti-Icing

DE-ICING is a procedure by which frost, ice or snow is removed from the airplane by applying hot water or a hot mixture of water and de-icing / anti-icing fluid. De-icing using infrared energy is an alternative procedure for removing frozen precipitation. It is accomplished through heat that breaks the bond of adhering frozen contamination. De-icing with forced air (alone or with injected fluid) is used to remove most of the contamination from aircraft surfaces. It will reduce de-icing times and fluid quantities, but it will not provide a clean wing for take-off.

ANTI-ICING consists of the application of a mixture of an anti-icing fluid or a mixture of anti-icing fluid and water to the airplane to protect against the accumulation and adherence of frost, ice or snow to airplane surfaces before the condition exists.

TYPE I FLUIDS are used for de-icing and anti-icing, but provide very limited anti-icing protection.

TYPE II FLUIDS are "thickened" and are designed to be deposited in a thicker film and to remain on the airplane surfaces until the time of take-off. TYPE II fluids are used for de-icing (when heated) and anti-icing and provide greater protection than do TYPE I fluids against frost, ice or snow formation in conditions conducive to airplane on the ground. Because of its flow-off characteristics it is not considered suitable for airplane with rotation speeds below 100 kt.

TYPE III FLUIDS are a "thickened" fluid that has properties that lie between TYPES I and II. Because of its flow-off characteristics it is considered acceptable for airplane with rotation speeds below 100 kt.

TYPE IV FLUIDS are similar to TYPE II fluids with a marked increase in holdover time capabilities.

ONE-STEP DE-ICING / ANTI-ICING consists of the application full strength or water diluted de-icing / anti-icing fluid, heated as necessary considering the ambient temperature and weather condition, to both remove and protect the surfaces from frost, ice or snow adherence and accumulation.

TWO-STEP DE-ICING / ANTI-ICING consists of de-icing with hot water only or a hot mixture of water diluted de-icing / anti-icing fluid, followed immediately by anti-icing with an overspray of anti-icing fluid. Care must be taken not to allow the airplane surfaces to re-freeze between the de-icing and anti-icing processes. To prevent re-freezing, the first mixture (de-icing) fluid concentration may have to be increased appropriate to local conditions.

NOTE: When anti-icing with SAE Type II, III and IV anti-icing fluids, it is strongly recommended that the operator use the two-step de-icing / anti-icing procedure, the first step with heated water, and / or heated SAE Type I de-icing fluid.

HOLDOVER TIME is the estimated time anti-icing fluid will prevent ice, snow and / or frost from forming or accumulating on the treated surfaces of an airplane. The protection time is dependent upon the weather conditions and fluid mixture selected and cannot be precisely determined for each application. Guidelines have been published for holdover times under varying atmospheric conditions, however, it must be emphasized that the best method to ensure a clean airplane is to inspect after treatment and just prior to take-off. If any frost, ice or snow is adhering to a critical surface, re-treatment must be requested.

While in most operations de-icing / anti-icing of the airplane is supervised by the maintenance organization, the following precautions are presented to familiarize flight crews with potential problem areas:

a. De-icing / anti-icing fluid concentration must be adjusted for OAT before application to the airplane. To determine the mixture percentage of de-icing / anti-icing fluid to water that should be used at a given temperature, refer to the manufacturer's specifications for the particular fluid;
b. It is strongly recommended not to operate the Engines and APU during the de-icing / anti-icing procedure. If it is necessary to have the engines running for operational reasons, select bleed air off to avoid sending fumes into the cabin.
c. Do not spray de-icing / anti-icing fluid directly into Engine or APU Inlets, Exhausts, Probe Inlets, Scoops, Vents, Drains or other areas where the fluids may pool.
d. Do not direct a solid stream of fluid perpendicular to airplane surfaces as a high pressure stream of fluid can damage airplane surfaces. Also, do not spray fluid directly on flight compartment windows and do not spray hot fluid directly on cold windows;
e. Do not force ice and snow into openings around flight control surfaces where it may re-freeze later;
f. both right and left sides of the wing and horizontal stabilizer must receive the same thorough de-icing / anti-icing treatment.
g. When using infrared energy to de-ice, wet surfaces require an application of heated de-icing fluids to preclude refreezing after removal of infrared energy source.
h. When using infrared energy other than to remove frost or leading edge ice and when OAT is at or below 0°C (32°F), an additional treatment with hot de-icing fluid shall be preformed within the infrared de-icing facility to prevent re-freezing of water, which may remain in hidden areas.
i. If the aircraft requires re-de-icing and the de-icing / anti-icing fluids had been applied before flight, conventional de-icing / anti-icing with fluids shall be preformed before entering the infrared de-icing facility.
j. The use of forced air alone to remove wet snow, especially during snowfall and cold outside air, is not a feasible alternative for either a two-step de-icing or a one-step de-icing procedure.
k. The forced air and fluid combination to remove wet snow will produce a clean wing but the time to re-freeze is very short.

Following de-icing / anti-icing, it is the PIC who is ultimately responsible to see that the airplane is free of snow, ice and frost; that pitot heads, static ports, fuel tank vents, air conditioning inlets / exits and landing gear doors are clear of snow, ice and slush. "Clear ice", which is difficult to detect, can be present below the layer of water and fluid remaining on the surface of the airplane and may require inspection by touch. If any doubt remains as to the aerodynamic readiness of airplane, request re-treatment.

Residual fluid on the airplane following de-icing / anti-icing treatment may result in detrimental effects on handling and performance. The magnitude of these effects, with the original de-icing fluid formulations (TYPE I fluids), was generally not an operational problem. With the advent of TYPE II, TYPE III and TYPE IV fluids, this is no longer true.

In general, the cruise, descent, approach and landing phases of flight are not affected by the use of de-icing or anti-icing fluids. When the airplane has been sprayed with de-icing and / or anti-icing fluids, the take-off procedures, distances and reference speeds shall be adjusted as per Sub-Chapter 4.7.

3.3.6.3 De-Icing Procedures

3.3.6.3.1 Pre-Fluid Application

Engines..... Shutdown if possible

If engines running:

Bleed Air..... Off
De-icing Operator ..... Advised

- Engine must not ingest de-icing fluid.
- Avoid direct spray on the following:
  - Intakes and exhausts, vents and drains
  - Air data probes and sensors / ports and AOA vanes
  - Windshields and all windows
  - Antennas
- Do not spray hot fluid directly on cold windows.
- Do not spray high-pressure fluid perpendicular to airplane surfaces.
- Avoid forcing snow / ice into parings around flight control surfaces.

3.3.6.3.2 Post-Fluid Application

Critical Areas ..... Inspect

- Ensure the following:
  - Airplane free of snow, ice and frost
  - Control surfaces clean
  - Protective covers removed
  - Engine inlets, pitot static ports, fuel tank vents, air conditioning inlets / exits, landing gear doors clear of snow / ice.

NOTE: Following the application of de-icing or anti-icing fluids, it is strongly recommended that the pilot conduct a slow control throw of the elevator and aileron / spoiler control circuits.
Move the control column and control wheel in both directions to the control stops.
Should a restriction of the controls or an unusual control force be noted, a take-off must not be conducted until the affected control is inspected for ice contamination and if required, another application of de-icing or anti-icing fluid is applied.

3.3.6.3.3 Taxi Precautions

Bypass Door ..... Open

- Increase distance between airplane while taxiing.
- Avoid the following:
  - Reverse thrust;
  - Excessive power to prevent displacement of applied fluids;
  - Hot gases from preceding airplane.

3.3.6.4 De-Icing and Anti-Icing Fluids

A. Fluids which meet the SAE Low Speed Aerodynamic Acceptance Test for the following specification:
- SAE Type III

may be used full strength (or diluted per the fluid manufacturer's instructions) over the fluid manufacturer's recommended temperature range, under the following conditions:

(1) All approved take-off flap settings

(2) Rotation should be smooth and at a normal rate, "Avoid Rapid Rotation".

(3) No correction to the take-off distances and speeds is needed.

NOTE: If the ambient temperature is less than that recommended by the fluid manufacturer for the fluid and the fluid has been shown to pass the SAE High Speed Aerodynamic Acceptance Test, then apply the performance correction of Paragraph B below.

B. Fluids which meet the SAE High Speed Aerodynamic Acceptance Test for the following specifications:
- SAE Type I
- SAE Type II
- SAE Type IV

may be used full strength (or diluted per the fluid manufacturer's instructions) over the fluid manufacturer's recommended temperature range, under the following conditions:

(1) All approved take-off flap settings.

(2) Rotation should be smooth and at a normal rate. "Avoid Rapid Rotation".

(3) Take-off distances available and corresponding speeds must be corrected by the margins as shown in the table in Sub-Chapter 4.7.3.

(4) Where close-in obstacle(s) impact the second climb segment, the increased V_2 is to be maintained to a gross height of 400 ft AGL.
Thereafter the uncorrected V_2 must be flown to the end of the second climb segment.
For all other cases, the increased V_2 may be continued to the end of the second climb segment.

C. SAE Type I fluids containing ethylene glycol at full strength or diluted and di-ethylene glycol or propylene glycol when diluted 50:50 or more with water may be used with any flap setting over the fluid manufacturer's recommended temperature ranges for these mixtures.

No correction to the take-off distances and speeds is needed.

In all cases de-icing / anti-icing fluids do not affect the following phases of flight:

- Cruise
- Descent
- Approach
- Landing

3.3.6.4.1 Holdover Times (HOT)

Holdover Time is the estimated time which anti-icing fluid will prevent ice, snow and / or frost from forming or collecting on the treated surfaces of the airplane.

Factors that reduce HOT:

- Where conditions are worse than those given in the tables times may be reduced to the point of suspension of operations,
- High wind velocity
- Jet blast
- Aircraft skin temperature significantly lower than OAT
- Moisture content of snow, i.e. large snowflakes may produce higher than expected precipitation rates

The definition of Lowest Operational Use Temperature (LOUT) for a given fluid is the higher (warmer) of:

- the lowest temperature at which the fluid meets the aerodynamic acceptance test (according to AS 5900) for a given type of aircraft (high or low speed), or
- the actual freezing point of the fluid plus its freezing point buffer of:
  - → 10°C (18°F) - for a Type I fluid, or
  - → 7°C (13°F) - for a Type II, III or IV fluid.

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

NOTE: Fluid manufacturers state that a fluid must not be used when the Outside Air Temperature (OAT) or skin temperature is below the LOUT of the fluid

See the following tables for specific HOT.

3.3.6.4.2 Active Frost Holdover Guidelines for Winter 2012 - 2013

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature (OAT)		Approximate Holdover Times (h:min)
		Active Frost
°C	°F	Type I [1, 2]
- 1 and above	30 and above	0:45
below - 1 to - 3	below 30 to 27	
below - 3 to - 10	below 27 to 14	
below - 10 to - 14	below 14 to 7	
below - 14 to - 21	below 7 to - 6	
below - 21 to LOUT	below - 6 to LOUT	

Outside Air Temperature (OAT)		Concentration Neat Fluid / Water (Volume % / Volume %)	Approximate Holdover Times (h:min)		
			Active Frost		
°C	°F		Type II [2,3]	Type III [2,3]	Type IV [2,3]
- 1 and above	30 and above	100 / 0	8:00	2:00	12:00
		75 / 25	5:00	1:00	5:00
		50 / 50	3:00	0:30	3:00
below - 1 to - 3	below 30 to 27	100 / 0	8:00	2:00	12:00
		75 / 25	5:00	1:00	5:00
		50 / 50	1:30	0:30	3:00
below - 3 to - 10	below 27 to 14	100 / 0	8:00	2:00	10:00
		75 / 25	5:00	1:00	5:00
below - 10 to - 14	below 14 to 7	100 / 0	6:00	2:00	6:00
		75 / 25	1:00	1:00	1:00
below - 14 to - 21	below 7 to - 6	100 / 0	6:00	2:00	6:00
below - 21 to - 25	below - 6 to - 13	100 / 0	2:00	2:00	4:00

NOTES:

1 Type I Fluid / Water Mixture is selected so that the freezing point of the mixture is at least 10°C (18°F) below OAT.

2 Ensure that the LOUT is respected
(see Table 10 from Holdover Time (HOT) Guidelines - Transport Canada, Winter 2012 - 2013)

3 These fluids may not be used below - 25°C (- 13°F) in active frost conditions

CAUTION: Fluids used during ground de-icing / anti-icing do not provide in-flight icing protection.

3.3.6.4.3 SAE TYPE I Fluid Holdover Guidelines on Aluminum Wing Surfaces for Winter 2012 - 2013 [1]

Guideline for Holdover Times (HOT) anticipated for SAE TYPE I Fluid Mixture as a Function of Weather Conditions and Outside Air Temperature (OAT)

Table 1-C (*SAE TYPE I Fluid Holdover Guidelines on **Composite** Wing Surfaces*) from Holdover Time (HOT) Guidelines - Transport Canada, Winter 2012 - 2013, is not applicable.

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

OAT [2]		Approximate Holdover Times under Various Weather Conditions (min)							
			Snow, Snow Grains or Snow Pellets						
°C	°F	Freezing Fog	Very Light [3]	Light [3]	Moderate	Freezing Drizzle [4]	Light Freezing Rain	Rain on Cold Soaked Wing [5]	Other [6]
- 3 and above	27 and above	11 - 17	18	11 - 18	6 - 11	9 - 13	4 - 6	2 - 5	
below - 3 to - 6	below 27 to 21	8 - 13	14	8 - 14	5 - 8	5 - 9	4 - 6	CAUTION:	
below - 6 to - 10	below 21 to 14	6 - 10	11	6 - 11	4 - 6	4 - 7	2 - 5		
below - 10	below 14	5 - 9	7	4 - 7	2 - 4	No HOT Guidelines exist			

NOTES:

1 Type I Fluid / Water Mixture is selected so that the freezing point of the mixture is at least 10°C (18°F) below OAT

2 Ensure that the LOUT is respected

3 Use light freezing rain HOT in conditions of very light or light snow mixed with light rain.

4 Use light freezing rain HOT if positive identification of freezing drizzle is not possible.

5 No HOT Guidelines exist for this condition for 0°C (32°F) and below

6 Heavy snow, ice pellets, moderate and heavy freezing rain and hail.

CAUTIONS:

- **The only acceptable decision-making criterion, for take-off without a pre-take-off contamination inspection, is the shorter time within the applicable HOT table cell.**
- **The time of protection will be shortened in heavy weather conditions, heavy precipitation rates or high moisture content.**
- **High wind velocity or jet blast may reduce HOT.**
- **HOT may be reduced when aircraft skin temperature is lower than OAT.**
- **Fluids used during ground de-icing / anti-icing do not provide in-flight icing protection.**

3.3.6.4.4 SAE TYPE I De-Icing / Anti-Icing Fluid Application Procedures

Guidelines for the application of SAE TYPE I Fluid Mixtures at minimum concentrations for the prevailing Outside Air Temperature (OAT)

<table>
<tr><th rowspan="2">OAT [1]</th><th>One-Step Procedure</th><th colspan="2">Two-Step Procedure</th></tr>
<tr><th>De-icing / Anti-icing</th><th>First Step: De-icing</th><th>Second Step: Anti-icing [2]</th></tr>
<tr><td>- 3°C (27°F) and above</td><td rowspan="2">Heated mix of fluid and water with a freezing point of at least 10°C (18°F) below OAT</td><td>Heated water or a heated mix of fluid and water</td><td rowspan="2">Heated mix of fluid and water with a freezing point of at least 10°C (18°F) below OAT</td></tr>
<tr><td>Below - 3°C (27°F)</td><td>Freezing point of heated fluid mixture shall not be more than 3°C (5°F) above OAT</td></tr>
</table>

1 Fluids must not be used at temperatures below their Lowest Operational Use Temperature (LOUT).

2 To be applied before first step fluid freezes, typically within 3 min.
(This time may be higher than 3 min in some conditions, but potentially lower in heavy precipitation or colder temperature.
If necessary, the second step shall be applied area by area.)

NOTES:

- Temperature of water or fluid / water mixtures shall be at least 60°C (140°F) at the nozzle.
Upper temperature limit shall not exceed fluid and aircraft manufacturers' recommendations.
- To use Type I HOT Guidelines in all conditions including active frost, at least 1 L/m^2 (~ 2 gal/100 ft^2) must be applied to the de-iced surfaces.
- This table is applicable for the use of Type I HOT Guidelines in all conditions including active frost.
If HOT are not required, a temperature of 60°C (140°F) at the nozzle is desirable.
- The LOUT for a given fluid is the higher of:
  a) The lowest temperature at which the fluid meets the aerodynamic acceptance test for a given aircraft type, or
  b) The actual freezing point of the fluid plus its freezing point buffer of 10°C (18°F)

CAUTION: Wing skin temperatures may differ and in some cases may be lower than OAT; a stronger mix (more glycol) may be needed under these conditions.

3.3.6.4.5 SAE TYPE II Fluid Holdover Guidelines for Winter 2012 - 2013 [1]

Guideline for Holdover Times (HOT) anticipated for SAE TYPE II Fluid Mixture as a Function of Weather Conditions and Outside Air Temperature (OAT)

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

OAT [2]		Type II Fluid Concentration Neat Fluid / Water (Vol % / Vol %)	Approximate Holdover Times under Various Weather Conditions (h: min)					
°C	°F		Freezing Fog	Snow, Snow Grains or Snow Pellets [3]	Freezing Drizzle [4]	Light Freezing Rain	Rain on Cold Soaked Wing [5]	Other [6]
- 3 and above	27 and above	100 / 0	0:35 - 1:30	0:20 - 0:45	0:30 - 0:55	0:15 - 0:30	0:08 - 0:40	
		75 / 25	0:25 - 1:00	0:15 - 0:30	0:20 - 0:45	0:10 - 0:25	0:05 - 0:25	
		50 / 50	0:15 - 0:30	0:05 - 0:15	0:08 - 0:15	0:05 - 0:90		
below - 3 to - 14	below 27 to 7	100 / 0	0:20 - 1:05	0:15 - 0:30	0:20 - 0:45 [7]	0:10 - 0:20 [7]	CAUTION:	
		75 / 25	0:25 - 0:50	0:10 - 0:20	0:15 - 0:30 [7]	0:08 - 0:15 [7]		
below -14 to -25 or LOUT	below 7 to - 13 or LOUT	100 / 0	0:15 - 0:35	0:15 - 0:30	No HOT Guidelines exist			

NOTES:

1. Based on the lowest HOT of the fluids listed in Table 5-2 (*Tested Type II De / Anti-Icing Fluids*) and Table 5-4 (*Tested Type IV De / Anti-Icing Fluids*) from Holdover Time (HOT) Guidelines - Transport Canada, Winter 2012 - 2013
2. Ensure that the LOUT is respected. Consider use of Type I when Type II fluid cannot be used.
3. Use light freezing rain HOT in conditions of light snow mixed with light rain.
4. Use light freezing rain HOT if positive identification of freezing drizzle is not possible.
5. No HOT Guidelines exist for this condition for 0°C (32°F) and below.
6. Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain and hail.
7. These HOT only apply to OAT to - 10°C (14°F) under freezing drizzle and light freezing rain.

CAUTIONS:

- **The only acceptable decision-making criterion, for take-off without a pre-take-off contamination inspection, is the shorter time within the applicable HOT table cell.**
- **The time of protection will be shortened in heavy weather conditions, heavy precipitation rates or high moisture content.**
- **High wind velocity or jet blast may reduce HOT.**
- **HOT may be reduced when aircraft skin temperature is lower than OAT.**
- **Fluids used during ground de-icing / anti-icing do not provide in-flight icing protection.**

3.3.6.4.6 SAE TYPE III Fluid Holdover Guidelines for Winter 2012 - 2013

Guideline for Holdover Times (HOT) anticipated for SAE TYPE III Fluid Mixture as a Function of Weather Conditions and Outside Air Temperature (OAT)

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

OAT [1]		Type III Fluid Concentration Neat Fluid / Water (Vol% / Vol%)	Approximate Holdover Times Under Various Weather Conditions (min)							
° C	° F		Freezing Fog	Snow, Snow Grains or Snow Pellets			Freezing Drizzle [3]	Light Freezing Rain	Rain on Cold Soaked Wing [4]	Other [5]
				Very Light [2]	Light [2]	Moderate				
- 3 and above	27 and above	100 / 0	20 - 40	35	20 - 35	10 - 20	10 - 20	8 - 10	6 - 20	
		75 / 25	15 - 30	25	15 - 25	8 - 5	8 - 15	6 - 10	2 - 10	
		50 / 50	10 - 20	15	8 - 15	4 - 8	5 - 9	4 - 6	CAUTION:	
below -3 to -10	below 27 to 14	100 / 0	20 - 40	30	15 - 30	9 - 15	10 - 20	8 - 10		
		75 / 25	15 - 30	25	10 - 25	7 - 10	9 - 12	6 - 9		
below - 10	below 14	100 / 0	20 - 40	30	15 - 30	8 - 15	No HOT Guidelines exist			

NOTES:

1. Ensure that the LOUT is respected.
   Consider use of Type I when Type III fluid cannot be used.
2. Use light freezing rain HOT in conditions of very light or light snow mixed with light rain.
3. Use light freezing rain HOT if positive identification of freezing drizzle is not possible.
4. No HOT Guidelines exist for this condition for 0°C (32°F) and below.
5. Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain and hail.

CAUTIONS:

- **The only acceptable decision-making criterion, for take-off without a pre-take-off contamination inspection, is the shorter time within the applicable HOT table cell.**
- **High wind velocity or jet blast may reduce HOT.**
- **HOT may be reduced when aircraft skin temperature is lower than OAT.**
- **Fluids used during ground de-icing / anti-icing do not provide in-flight icing protection.**

3.3.6.4.7 SAE TYPE IV Fluid Holdover Guidelines for Winter 2012 - 2013 [1]

Guideline for Holdover Times (HOT) anticipated for SAE TYPE IV Fluid Mixture as a Function of Weather Conditions and Outside Air Temperature (OAT).

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

OAT [2]		Type IV Fluid Concentration Neat Fluid / Water (Vol % / Vol %)	Approximate Holdover Times under Various Weather Conditions (h: min)					
° C	° F		Freezing Fog	Snow, Snow Grains or Snow Pellets [3]	Freezing Drizzle [4]	Light Freezing Rain	Rain on Cold Soaked Wing [5]	Other [6]
- 3 and above	27 and above	100 / 0	1:20 - 3:10	0:35 - 1:15	0:45 - 1:30	0:25 - 0:40	0:10 - 1:15	
		75 / 25	1:00 - 1:45	0:30 - 0:55	0:35 - 1:05	0:25 - 0:35	0:09 - 0:50	
		50 / 50	0:15 - 0:35	0:07 - 0:15	0:10 - 0:20	0:07 - 0:10		
below - 3 to - 14	below 27 to 7	100 / 0	0:20 - 1:20	0:25 - 0:50	0:20 - 1:00[7]	0:10 - 0:25[7]	**CAUTION:**	
		75 / 25	0:25 - 0:50[8]	0:20 - 0:35[8]	0:15 -1:00[7,8]	0:10 -0:25[7,8]		
below -14 to -25 or LOUT	below 7 to - 13 or LOUT	100 / 0	0:15 - 0:40[9]	0:15 - 0:30[9]	**No HOT Guidelines exist**			

NOTES:

1. Based on the lowest HOT of the fluids listed in Table 5-4 (*Tested Type IV De / Anti-Icing Fluids*) from Holdover Time (HOT) Guidelines - Transport Canada, Winter 2012 - 2013.
2. Ensure that the LOUT is respected. Consider use of Type I when Type IV fluid cannot be used.
3. Use light freezing rain HOT in conditions of light snow mixed with light rain.
4. Use light freezing rain HOT if positive identification of freezing drizzle is not possible.
5. No HOT Guidelines exist for this condition for 0°C (32°F) and below.
6. Heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain and hail.
7. These HOT only apply to OAT to - 10°C (14°F) under freezing drizzle and light freezing rain.
8. For Lyondell Arctic Shield, the temperature is limited to - 9.5°C (14.9°F) and For Cryotech Polar Guard, the temperature is limited to - 5.5°C (22.1°F). If the fluid is unknown, these HOT only apply down to - 5.5°C (22.1°F).
9. For Cryotech Polar Guard, the temperature is limited to - 23.5°C (- 10.3°F) For Dow Ultra+, the temperature is limited to - 24°C (- 11.2°F) and For Lyondell Arctic Shield, the temperature is limited to - 24.5°C (- 12.1°F). If the fluid is unknown, these HOT only apply down to - 23.5°C (- 10.3°F).

CAUTIONS:

- **The only acceptable decision-making criterion, for take-off without a pre-take-off contamination inspection, is the shorter time within the applicable HOT table cell.**
- **The time of protection will be shortened in heavy weather conditions, heavy precipitation rates or high moisture content.**
- **High wind velocity or jet blast may reduce HOT.**
- **HOT may be reduced when aircraft skin temperature is lower than OAT.**
- **Fluids used during ground de-icing / anti-icing do not provide in-flight icing protection.**

3.3.6.4.8 SAE TYPE II, TYPE III and TYPE IV Anti-icing Fluid Application Procedures

Guidelines for the application of SAE TYPE II, III and IV fluid mixtures (minimum concentrations in % by volume) as a function of Outside Air Temperature (OAT)

OAT [1]	One-Step Procedure	Two-Step Procedure	
	De-icing / Anti-Icing	First Step: De-icing	Second Step: Anti-Icing [2]
- 3°C (27°F) and above	50 / 50 Heated [3] type II / III / IV	Heated water or a heated mix of Type I, II, III or IV with water	50 / 50 Type II / III / IV
- 14°C (7°F) and above	75 / 25 Heated [3] type II / III / IV	Heated suitable mix of Type I, Type II / III / IV and water with freezing point not more than 3°C (5°F) above actual OAT	75 / 25 Type II / III / IV
- 25°C (- 13°F) and above	100 / 0 Heated [3] type II / III / IV	Heated suitable mix of Type I, Type II / III / IV and water with freezing point not more than 3°C (5°F) above actual OAT	100 / 0 Type II / III / IV
Below - 25°C (- 13°F)	Type II / III / IV fluid may be used below - 25°C (- 13°F) provided that the OAT is at or above the LOUT. Consider the use of Type I when Type II / III / IV fluid cannot be used (Sub-Chapter 3.3.6.4.4 SAE TYPE I De-Icing Fluid Application Procedure)		

1 Fluids must not be used at temperatures below their LOUT.

2 To be applied before first step fluid freezes, typically within 3 min.
(This time may be higher than 3 min in some conditions, but potentially lower in heavy precipitation or colder temperatures.
If necessary, the second step shall be applied area by area.)

3 Clean aircraft may be anti-iced with unheated fluid.

NOTES:

- For heated fluids, a fluid temperature not less than 60°C (140°F) at the nozzle is desirable.
When the first step is performed using a fluid / water mix with a freezing point above OAT, the temperature at the nozzle shall be at least 60°C (140°F) and at least 1 L/m^2 (2 gal/100 ft^2) shall be applied to the surfaces to be de-iced.
- Upper temperature limit shall not exceed fluid and aircraft manufactures' recommendations.
- The LOUT for a given fluid is the higher of:
  a) The lowest temperature at which the fluid meets the aerodynamic acceptance test for a given aircraft type, or
  b) The actual freezing point of the fluid plus its freezing point buffer of 7°C (13°F)

CAUTIONS:

- **Wing skin temperatures may differ and in some cases may be lower than OAT; a stronger mix (more glycol) may be needed under these conditions.**
- **Whenever frost or ice occurs on the lower surface of the wing in the area of the fuel tank, indicating a cold soaked wing, the 50 / 50 dilutions of Type II, III or IV should not be used for the anti-icing step because fluid freezing may occur.**
- **An insufficient amount of anti-icing fluid may cause a substantial loss of HOT. This is particularly true when using a Type I fluid mixture for the first step in a two-step procedure.**

3.3.6.4.9 Visibility In Snow vs Snowfall Intensity Chart [1]

Lighting	Temperature Range		Visibility In Snow - km (SM)			
	°C	°F	Heavy	Moderate	Light	Very Light
Darkness	- 1 and above	30 and above	≤ 1.6 (≤ 1)	> 1.6 to 4.0 (> 1 to $2^1/_2$)	> 4.0 to 6.4 (> $2^1/_2$ to 4)	> 6.4 (> 4)
	Below - 1	Below 30	≤ 1.2 (≤ $^3/_4$)	> 1.2 to 2.4 (> $^3/_4$ to $1^1/_2$)	> 2.4 to 4.8 (> $1^1/_2$ to 3)	> 4.8 (> 3)
Daylight	- 1 and above	30 and above	≤ 0.8 (≤ $^1/_2$)	> 0.8 to 2.4 (> $^1/_2$ to $1^1/_2$)	> 2.4 to 4.8 (> $1^1/_2$ to 3)	> 4.8 (> 3)
	Below - 1	Below 30	≤ 0.6 (≤ $^3/_8$)	> 0.6 to 1.4 (> $^3/_8$ to $^7/_8$)	> 1.4 to 3.2 (> $^7/_8$ to 2)	> 3.2 (> 2)

[1] Based on:
Relationship between Visibility and Snowfall Intensity (TP 14151E), TC, Nov 2003 and
Theoretical Considerations in the Estimation of Snowfall Rate Using Visibility (TP 12893E), TC, Nov 1998.

HOW TO READ THE TABLE

This visibility table applies to all fluid Types I, II, III and IV.

Assume that the daytime visibility in snowfall is 1.6 km (1 SM) and the temperature is - 7°C (19°F).

Based on these conditions, the snowfall intensity is light.

This snowfall intensity is used to determine which HOT Guideline value is appropriate for the fluid in use.

3.3.6.4.10 Allowance Times regarding Ice Pellets

The meteorological definition of Ice Pellets is a type of precipitation consisting of transparent or translucent pellets of ice, 5 mm or less in diameter.

They may be spherical, irregular or (rarely) conical in shape. Ice Pellets usually bounce when hitting hard ground, and make a sound upon impact.

Now internationally recognized, Ice Pellets include 2 basically different types of precipitation, those which are known in the United States as sleet and small hail.

Thus a 2-parts definition is given:

Sleet or Grains of Ice: generally transparent, globular, solid grains of ice which have formed from the freezing of raindrops or the refreezing of largely melted snowflakes when falling through a below-freezing layer of air near the earth's surface.

Small Hail: generally translucent particles, consisting of snow pellets encased in a thin layer of ice.
The ice layer may form either by the accretion of droplets upon the snow pellet, or by the melting and refreezing of the surface of the snow pellet.

Operational Guidelines

The ice pellet allowances are contingent on the operator's approved ground icing program being updated to incorporate the ice pellet information contained herein, including the following conditions and restrictions that must be satisfied:

a. The aircraft critical surfaces must be properly de-iced before the application of Type IV anti-icing fluid;
b. The Allowance Time is valid only if the aircraft is anti-iced with undiluted Type IV fluid;
c. These Allowance Times are applicable from the start of the Type IV anti-icing fluid application,
d. If the take-off is not accomplished within the applicable Allowance Time in next table, the aircraft must be completely de-iced and if precipitation is still present, anti-iced again prior to a subsequent take-off
e. The Allowance Time cannot be extended by an inspection of the aircraft critical surfaces from either inside or outside the aircraft;

f. If the temperature decreases below the temperature on which the Allowance Time was based, where 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 must be used as the Allowance Time limit;

g. 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;

h. If the precipitation condition stops at, or before, the time limit of the applicable Allowance Time in table below and does not restart, the aircraft may take-off up to 90 min after the start of the application of the Type IV anti-icing fluid.
However, the OAT must remain constant or increase during the 90 min period under the following conditions:

- light ice pellets mixed with light or moderate freezing drizzle
- light ice pellets mixed with light freezing rain
- light ice pellets mixed with light rain
- light ice pellets mixed with moderate rain

NOTE: For more information on the ice pellet research and examples, visit TC and FAA websites on Ice Pellet Allowance Times.

3.3.6.4.11 Ice Pellet Allowance Times for Winter 2012 - 2013

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

	Outside Air Temperature (OAT)		
	- 5°C (23°F) and above	**less than - 5°C to - 10°C (23°F to 14°F)**	**less than - 10°C (14°F)**
Light Ice Pellets	50 min	30 min	30 min [1]
Moderate Ice Pellets	25 min [2]	10 min	10 min [1]
Light Ice Pellets mixed with **Light** or **Moderate Freezing Drizzle**	25 min	10 min	
Light Ice Pellets mixed with **Light Freezing Rain**	25 min	10 min	
Light Ice Pellets mixed with **Light Rain**	25 min [3]	**CAUTION: No allowance times currently exist**	
Light Ice Pellets mixed with **Moderate Rain**	25 min [4]		
Light Ice Pellets mixed with **Light Snow**	25 min	15 min	
Light Ice Pellets mixed with **Moderate Snow**	10 min		

NOTES:

1. No allowance times exist for Propylene Glycol (PG) fluids, for rotation speeds less than 115 kt.
If the fluid type is not known, assume zero allowance time.
The maximum allowable increase in rotation speed is 7 kt when using Type IV fluid (Sub-Chapter 4.7.3).
If the rotation speed after adding that speed increment is less than 115 kt, assume zero allowance time
2. Allowance time is 15 min for PG fluids or when the fluid type is unknown.
3. No allowance times exist in this condition for temperatures below 0°C;
Consider use of light ice pellets mixed with light freezing rain.
4. No allowance times exist in this condition for temperatures below 0°C.