CL-350

CL-350 SUPPLEMENTAL MANUAL

COLD WEATHER OPERATIONS

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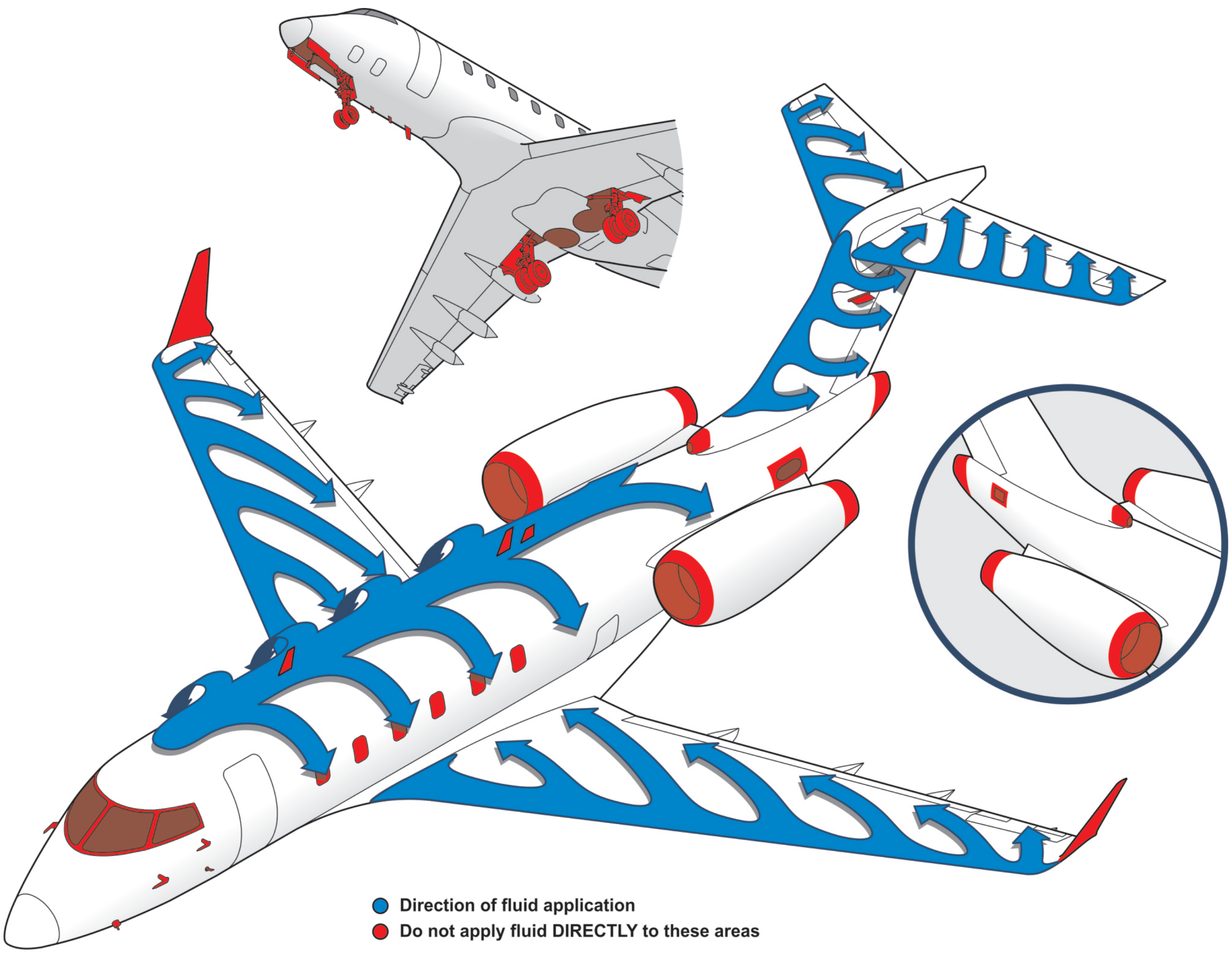
COLD WEATHER OPERATIONS

I. INTRODUCTION

The winter season presents additional challenges to airplane operations resulting in low temperatures, the potentially hazardous effects of precipitation contaminating the airplane and the aircraft movement area, and extreme turbulence. It is the ultimate responsibility of the pilot-in-command to ensure the airplane is in a condition for safe flight prior to takeoff.

Adherence to the procedures in this section ensures an aerodynamically clean aircraft before takeoff. When operating in such conditions, these procedures account for operational hazards associated with frozen contamination. In all cases, the decision to operate should be based on the general rules of good airmanship applicable in cold weather operations and assurance that operational and system limitations will not be exceeded.



A. COLD WEATHER DEFINITIONS

Cold weather operations refer to ground handling, takeoffs and landings conducted on surface conditions where frozen moisture is present or conditions are conducive to moisture freezing. These conditions are commonly encountered when the surface temperature is at or below 0°C (32°F), although frozen moisture may persist at higher temperatures.

COMMON CONTAMINANTS

Contaminant	Description
Slush	Snow saturated with water which displaces with a splatter when stepped on firmly. Encountered at temperatures up to 5°C.
Wet Snow	Will easily stick together and tends to form a snowball if compacted by hand.
Dry Snow	Loose and can easily be blown. If compacted by hand, will readily fall apart again.
Frost	White crystalline deposit that develops uniformly on exposed surfaces during cold, calm, cloudless nights with high ambient dewpoint.
Rime Ice	Opaque and rough ice surface that adheres to surfaces exposed to wind. Easily detected and removed with deicing fluids.
Clear Ice	Hard, smooth, glassy coating that is very difficult to detect without tactile inspection. Adheres firmly and is difficult to remove.

B. CLEAN AIRCRAFT CONCEPT

The Clean Aircraft Concept prohibits takeoff when frost, ice, snow, or other contaminants are present on critical surfaces of the aircraft. All performance data are based on the airplane being aerodynamically clean prior to takeoff.

Adverse Effects of Contamination

- Decreased thrust and lift
- Increased drag and stall speeds
- Trim changes and altered stall characteristics
- Altered handling qualities

C. CRITICAL SURFACES

Critical surfaces include wings, horizontal stabilizer, vertical stabilizer, control surfaces, and engine inlets. Although the upper fuselage is not a critical surface, it must be deiced when wing and tail surfaces require deicing. The Challenger 350 utilizes a supercritical wing design with a fixed, highly polished leading edge that lacks movable high-lift devices (such as slats), making the aircraft more susceptible to loss of lift from contamination than aircraft equipped with leading-edge devices.

Even small amounts of frost, ice, snow, or slush adhering to the wing leading edges and forward upper wing surface will significantly increase drag and decrease lift, which adversely increases the aircraft's clean stall speeds and degrades stall characteristics.

This aerodynamic deterioration presents a severe safety risk because it reduces the margin of safety provided by the Stall Protection System (SPS); contaminated surfaces may cause the wing to stall at a lower angle of attack than the SPS is calibrated for, potentially resulting in a stall or loss of control on takeoff before the stick shaker or pusher can activate. Consequently, strictly adhering to the Clean Aircraft Concept is mandatory, and flight crews should utilize windshield contamination as a potential indicator of simultaneous contamination on the wing leading edges.

WARNING: Takeoff must not be attempted if snow, ice, or frost are present in any amount on the wings and tail surfaces. It must never be assumed that dry, loose snow will be removed by the slipstream during the takeoff roll.

II. DEICING/ANTI-ICING FLUIDS

The application of deicing/anti-icing fluid is the most common means of effecting ground deicing and anti-ice protection. These fluids are water/glycol solutions classified as Type I (AMS 1424), Type II, Type III, and Type IV (AMS 1428).

A. FLUID TYPES

DEICING/ANTI-ICING FLUID TYPES

Fluid Type	Characteristics	Notes
Type I	Minimum 80% glycol, no thickening agent, low viscosity	Very short holdover time; limited anti-ice protection unless takeoff is immediate
Type II & IV	Minimum 50% glycol with thickening agents, high viscosity	Significant holdover time; fluid flows off during takeoff from slipstream shear stress
Type III	Thickened fluid with properties between Types I and II	Longer holdover than Type I but less than Type II

B. HOLDOVER TIME

Holdover time is the estimated time that an application of approved deicing/antiicing fluid is effective in preventing frost, ice, or snow from adhering to treated surfaces. It begins at the start of final fluid application and expires when the fluid is no longer effective. The FAA publishes new hold over tables yearly.

CAUTION: Heavy weather, high precipitation rates, or high wind velocity may reduce holdover time below the lowest time stated. Holdover time may also be reduced when airplane skin temperature is lower than OAT.

C. DEICING/ANTI-ICING METHODS

Mechanical Removal

If significant amounts of loose snow are present, mechanical removal can reduce fluid expenditure. After removal, inspect for adhering ice, frost, or snow on critical surfaces.

One-Step Deicing/Anti-Icing

Fluid is applied in one step to remove frozen contamination and provide limited antiice protection. The residual fluid film provides only very limited duration of protection.

Two-Step Deicing/Anti-Icing

First step: Apply heated deicing fluid (pure water or Type I mixture). Second step: Apply anti-icing fluid (Type II, III, or IV mixture or undiluted Type I or III). The second step must be applied within 3 minutes of the first step or before the first step fluid freezes.

TYPE I DEICING FLUID APPLICATION GUIDELINES

Outside Air Temperature (OAT)	One-Step Procedure	Two-Step Procedure	
	Deicing/Anti-icing	First Step Deicing	Second Step Anti-icing [1]
–3°C (27°F) and above	Mix of fluid and water heated to 60°C (140°F) minimum at the nozzle with a freeze point of at least 10°C (18°F) below OAT.	Water or a mix of fluid and water, heated to 60°C (140°F) minimum at the nozzle.	Mix of fluid and water heated to 60°C (140°F) minimum at the nozzle with a freeze point of at least 10°C (18°F) below OAT.
Below –3°C (27°F)		Freeze point of heated fluid mixture not more than 3°C (5°F) above OAT.	

[1] To be applied before first step fluid freezes, typically within three (3) minutes.

***General Note for Heated Fluids:** A fluid temperature of not less than 60°C (140°F) at the nozzle is desirable.

TYPE II-III-IV ANTI-ICING FLUID APPLICATION GUIDELINES

Concentrations in % by Volume

Outside Air Temperature (OAT)	One-Step Procedure	Two-Step Procedure	
	Deicing/Anti-icing	First Step Deicing	Second Step Anti-icing [1]
–3°C (27°F) and above	50/50 heated [2] Type II-III or IV	Heated water or a heated mix of Type I-II-III or IV with water.	50/50 Type II-III or IV
–14°C (7°F) and above	75/25 heated [2] Type II-III or IV	Heated suitable mix of Type I or II-III-IV and water with a freeze point of not more than 3°C (5°F) above OAT.	75/25 Type II-III or IV
–25°C (–13°F) and above	100/0 heated [2] Type II-III or IV		100/0 Type II-III or IV
Below –25°C (–13°F)	Type II-III or IV fluid may be used below –25°C (–13°F) provided the freezing point of the fluid is at least 7°C (13°F) below OAT and the aerodynamic acceptance criteria, as defined by the fluid manufacturer's data sheets, are met. Consider use of Type I fluids when Type II-III or IV cannot be used.		

[1] To be applied before first step fluid freezes, typically within three (3) minutes.

[2] Clean aircraft may be anti-iced with unheated fluid.

***General Note for Heated Fluids:** A fluid temperature of not less than 60°C (140°F) at the nozzle is desirable.

III. DEICING/ANTI-ICING PROCEDURES

A. PREPARATION FOR DEICING

Before fluid is applied:

PREPARATION FOR DEICING

Before fluid is applied:

Item	Setting/Action
Airplane Position	Head into wind if possible
FLAPS	As required (Flaps 30 recommended)
Thrust Levers	IDLE for duration of operation
APU BLEED switch	OFF
APU	Shutdown
WING ANTI-ICE switch	OFF
L and R ENG ANTI-ICE switches	OFF
AIR SOURCE switch	OFF
STAB TRIM	0 recommended (set for takeoff after deicing)

B. FLUID APPLICATION SEQUENCE

Apply deicing/anti-icing fluid to the aircraft in the following sequence:

1. Horizontal stabilizer
2. Vertical stabilizer
3. Top of fuselage
4. Sides of fuselage
5. Wings

CAUTION: On flight control surfaces, apply fluid from leading edge to trailing edge, and from outer panels to inner panels. Never direct spray at trailing edges of control surfaces, as this may force contamination into hinge mechanisms.

C. AREAS TO AVOID DIRECT SPRAY

A spray trajectory of 10 ft is recommended. Avoid direct contact with:

- Windshields, side windows, and cabin windows
- Pitot/static and TAT probes
- AOA vanes and static pressure ports
- Engine air intake/exhaust, APU inlet
- Antennas, vents, and drains
- Wheels and brakes

D. POST-DEICING INSPECTION

After deicing, inspect the following areas to confirm complete deicing:

- Wings - leading edges, upper and lower surfaces
- Vertical and horizontal stabilizers - all surfaces
- Flaps, flap tracks, and flap drives
- Ailerons, elevators, rudder, and spoilers
- Air data probes/sensors, stall vanes
- Antennas, fuel drains, and NACA vent scoops
- Engine and APU intakes, APU exhaust
- Landing gear and landing gear bays
- Windshield, windows, door sills, and surrounds

CLEAR ICE DUE TO COLD FUEL

Cold fuel in wing tanks can cause clear ice to form on wing surfaces even when ambient temperature is above freezing.

CAUTION: Pilots must be aware of the effect that cold fuel in the tanks may have on moisture present on the wing upper and lower surfaces. If fuel temperature is 0°C (32°F) it is possible to have clear ice on the wing with the temperature above freezing.

Condition	Required Action
Fuel temperature at or below 0°C	Perform tactile (touch) check of wing upper surface
Clear ice detected	Must be removed before flight
OAT above freezing but fuel cold	Still inspect for clear ice formation

IV. PHASE OF FLIGHT PROCEDURES

A. EXTERNAL SAFETY INSPECTION

EXTERNAL SAFETY INSPECTION

The flight crew should be diligent during pre-flight to inspect areas where contamination could affect normal operations.

Item	Action
Protective covers	Removed (pitot, static, TAT, ice detector, AOA vane, fuel NACA vent, intake/exhaust covers)
Windshield and cockpit windows	Free of ice and snow
Airplane surfaces	Free of frost, ice, snow, and slush
Landing gear area	Check clear; latching mechanisms free
Engine inlet and cowlings	Check clear; verify fan rotation

NOTE: Clear Ice is difficult to detect visually. If conditions favor Clear Ice formation, examine surfaces by hand (tactile check) to confirm absence of contamination.

B. BEFORE STARTING ENGINES

Battery temperatures must be above -20°C before takeoff.

1. COCKPIT and CABIN COLD-HOT knobs: HOT
2. Warm cabin interior as soon as APU is started
3. Confirm N1 fan freedom to rotate before engine start

NOTE: LCD displays may not function at cabin temperatures below -20°C. At extremely low temperatures, the APU generator may not automatically come online; select APU GEN switch ON if this occurs.

C. STARTING ENGINES

During cold weather starts, initial oil pressure response may be slow. Oil pressure may indicate higher than normal range and should progressively reduce to normal readings as the engine achieves normal operating temperatures.

CAUTION: No oil pressure indication by the time idle RPM is achieved requires an immediate shutdown.

Oil Temperature Requirements

- Oil temperature must be 26°C or above for normal operations
- Between 15°C and 26°C: Operations permitted if fuel contains icing inhibitor
- Between 5°C and 15°C: Engine may be operated from idle up to but not including CLB power
- Do not advance engines above idle until oil temperature reaches 5°C

D. AFTER STARTING ENGINES

Anti-Ice System Requirements

ANTI-ICE SYSTEM REQUIREMENTS

Condition	Requirement
OAT ≤10°C with visible moisture	Engine inlet anti-ice ON
OAT ≤10°C on contaminated surfaces	Engine anti-ice ON
OAT ≤5°C with visible moisture for takeoff	Wing anti-ice ON
OAT ≤5°C on contaminated runway for takeoff	Wing anti-ice ON

WARNING: When Type II, III, or IV anti-icing fluids have been applied, use of wing anti-ice heat prior to takeoff can cook the fluid onto the leading edges of the wing causing contamination.

V. TAXI AND TAKEOFF

A. TAXI CONSIDERATIONS

- Avoid large nosewheel steering inputs
- Taxi at manageable speed (10 kt maximum on contaminated surfaces)
- Maintain greater distance between aircraft when contamination present
- Keep brake application to minimum during turns
- Be aware of increased residual thrust at cold temperatures
- Do not use thrust reversers on contaminated surfaces except for safety

Brake Warming Procedure

If conditions could result in water-saturated brakes, perform 7 consecutive brake applications from 20 kt to 5 kt during the last mile of taxi prior to takeoff. Do not drag the brakes. This prevents water-saturated brakes from freezing at altitude.

B. TAKEOFF LIMITATIONS

Takeoff is not recommended when:

TAKEOFF CONTAMINATION LIMITS

Takeoff is not recommended when runway contamination exceeds:

Contaminant	Maximum Depth
Standing Water	0.25 in
Slush	0.25 in
Wet Snow	0.50 in
Dry Snow	2.00 in

- During extreme weather conditions (freezing rain)
- When braking action is reported to be poor

C. TAKEOFF TECHNIQUE

- If wing leading edge roughness is observed or suspected, DO NOT attempt takeoff
- Apply power symmetrically to avoid yawing moments
- Anticipate lags in nosewheel steering response
- Use aerodynamic control as soon as available (ailerons improve directional control 60-100 kts)
- Anticipate tendency to overrotate at rotation
- Abort for minor discrepancies, even at low speeds

VI. CLIMB AND CRUISE

A. CLIMB PROCEDURES

- Delay landing gear retraction until excess water/snow/slush is thrown off by wheel rotation
- Increasing airspeed by 100 knots at low altitude can cause TAT rise of 16°F, helping shed ice formations

WARNING: Operation in areas where super-cooled large droplet (SLD) icing conditions exist is prohibited. SLD icing conditions are indicated by ice accretion on the flight compartment side windows.

B. CRUISE CONSIDERATIONS

WARNING: Even small accumulations of ice on the wing leading edge can change stall speed, stall characteristics, or warning margin. Do not reduce speed below VREF or land with visible ice on the wing except under failure conditions.

Icing Conditions

Icing conditions exist in flight at TAT of 50°F or below with visible moisture (clouds, rain, snow, sleet, or ice crystals), except when SAT is -40°F or below.

NOTE: Higher than normal engine vibration of a fluctuating nature may be experienced in icing conditions. Advancing engines to 70% N1 momentarily may shed the ice.

VII. DESCENT AND LANDING

A. APPROACH CONSIDERATIONS

- Avoid holding in icing conditions longer than necessary
- Coordinate intentions with ATC
- Ensure cleared runway width is sufficient
- Note applicable PIREPs for braking conditions
- Plan for stabilized approach on speed, on glide path
- Start APU early to help warm cabin

B. LANDING DIVERSION CRITERIA

A diversion should be considered when:

LANDING DIVERSION CRITERIA

A diversion should be considered when runway contamination exceeds:

Contaminant	Maximum Depth
Standing Water	0.50 in
Slush	0.50 in
Wet Snow	1.00 in
Dry Snow	2.40 in

C. LANDING TECHNIQUE

- Avoid landing during tailwind conditions on contaminated runways
- Make positive touchdown to ensure wheel spin-up and break out frozen brakes
- Lower nose wheel immediately; hold light forward column pressure
- Use maximum reverse thrust as soon as possible (most effective at high speed)
- Do not pump brakes; apply steadily increasing pressure
- Maintain directional control with rudder (effective to 50 kts)
- Anticipate skidding and hydroplaning

VIII. TAXI IN AND PARKING

CAUTION: Do NOT retract flaps to fully up position after landing on a contaminated runway. Confirm no significant ice/slush/snow in flap mechanism before completing retraction.

Taxi-In Considerations

- Anticipate that movement areas may be slippery
- Reverse thrust may be necessary to stop
- Park on clear or sanded area if possible
- Park into wind if possible

A. SHUTDOWN PROCEDURES

SHUTDOWN PROCEDURES

Item	Action
Wheel Chocks	Check in place
PARK/EMER BRAKE	OFF (to prevent brake freeze)
Protective Covers	Install
Water System	Perform cold weather servicing (purge if OAT <5°C)
Lavatory Waste System	Perform cold weather servicing (add anti-freeze)
Batteries	Remove if exposure to -22°F >10 hours
All Doors	Close

IX. SUPER-COOLED LARGE DROPLET (SLD) ICING

A. RECOGNITION

Super-cooled large droplet (SLD) conditions are distinct from normal icing due to the large mass and inertia of the water droplets, which impact leading edge surfaces further aft than smaller droplets. The presence of SLD can only be determined by observation of ice accumulation on the flight compartment side windows.

B. PROCEDURES

WARNING: Operation in SLD icing conditions is prohibited. Following recognition of SLD icing conditions by observation of side window icing, engine and wing anti-icing systems must be activated and it is necessary to leave SLD icing conditions immediately.

In case of inadvertent entry into SLD icing conditions:

- Leave icing conditions immediately when side window icing occurs
- Wing anti-icing system must be ON
- Engine anti-icing system must be ON
- After leaving SLD conditions, observe wing leading edges for ice formation on unheated surfaces aft of the leading edge

X. COLD TEMPERATURE COMPANSATION DURING APPROACHES

A. INTRODUCTION

Temperature has a significant effect on altimeter accuracy as it relates to true altitude. When the air is warmer than standard, the airplane is higher than the altimeter indicates. Conversely, when the air is colder than standard, the airplane is lower than indicated. When flying into a colder air mass while maintaining a constant indicated altitude, true altitude is decreasing.

B. ICAO COLD TEMPERATURE ERROR TABLE

The following table, derived from ICAO formulas, indicates how much error can exist when the temperature is extremely cold. Find the reported temperature in the left column, then read across to locate the height above the airport/reporting station. The intersection indicates how much lower the airplane may actually be:

ICAO COLD TEMPERATURE ERROR TABLE

Temperature has a significant effect on altimeter accuracy. When the air is colder than standard, the airplane is lower than indicated. The table below shows how much lower (in feet) the airplane may actually be:

WARNING: The colder the temperature, the greater the difference between true altitude and indicated altitude. In extreme cold conditions, especially in mountainous areas, pilots should exercise caution in flight planning both in regard to route and altitude to ensure adequate enroute and terminal area clearance.

°C	200	300	400	500	600	700	800	900	1000	1500	2000	3000	4000	5000
HEIGHT ABOVE AIRPORT IN FEET														
+10	10	10	10	10	20	20	20	20	20	30	40	60	80	90
0	20	20	30	30	40	40	50	50	60	90	120	170	230	280
-10	20	30	40	50	60	70	90	90	100	150	200	290	390	490
-20	30	50	60	70	90	100	130	130	140	210	260	420	570	710
-30	40	60	80	100	120	140	170	170	190	280	380	570	760	950
-40	50	80	100	120	150	170	220	220	240	360	480	720	970	1210
-50	60	90	120	150	180	210	270	270	300	450	590	890	1190	1500

C. EXAMPLE CALCULATION

Temperature –30°C (–22°F), and the airplane altitude is 3,000 ft above the airport elevation during a procedure turn. The chart shows that the reported current altimeter setting may place the airplane as much as 570 ft below the altitude indicated on the altimeter. When operating in a non-controlled environment, the procedure turn should be flown at 3,600 ft to ensure obstacle clearance. ATC radar vectoring altitudes are normally compensated for temperature.

D. FMS TEMPERATURE COMPENSATION

The altitude correction should be applied to all published altitudes, specifically minimum altitude (DA/MDA). The FMS INDEX Menu has a TEMP COMP feature. It is basically a calculator that can be used to find the corrected barometric altitude. Crew should use the TEMP COMP function of the FMS to carry on approaches in cold weather (usually below 0°C).

FMS TEMPERATURE COMPENSATION

The altitude correction should be applied to all published altitudes, specifically minimum altitude (DA/MDA).

Item	Procedure
FMS TEMP COMP Feature	Located in the FMS INDEX Menu; use as a calculator to find corrected barometric altitude
When to Use	Approaches in cold weather (usually below 0°C)
Baro Minimums	Set to compensated altitudes when temperature compensation is used
ATC Notification	Required when flying with temperature compensated altitudes

NOTE: The temperature restrictions in the notes section of approach charts must be observed. Temperatures that are well below standard cause a reduction in true altitude, which may infringe obstacle clearance criteria.

E. COLD WEATHER CONSIDERATIONS

COLD WEATHER CONSIDERATIONS SUMMARY

Key Points
• Apply temperature corrections to all published altitudes
• Use FMS TEMP COMP function for approaches in cold weather
• Be aware of icing conditions and activate anti-ice systems as required
• Consider increased fuel consumption at low temperatures
• Verify de-icing/anti-icing holdover times
• Monitor for any CAS messages related to ice protection systems
• Perform tactile checks for clear ice when cold fuel is suspected
• Notify ATC when flying temperature compensated altitudes

XI. REFERENCES

Transport Canada publishes guidance in the following documents:

- TP 14052 - Guidelines for Aircraft Ground-Icing Operations
- FAA Holdover Time Guidelines
- Airplane Flight Manual CSP 100-1 and CSP 100-6

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