Attitude Indicator magazine is published bi-annually by Vision Air International and is distributed at no cost to the crew and operators of Vision Air International. Flight safety is very important and due to the constant changing industry, Attitude Indicator provides supplemental technical information in order to promote continuous safety and efficiency in their daily fleet operations. This includes up-to-date information in the form of articles, flyers, service bulletins and newsletters; which also assists the crew and operators in addressing regulatory requirements and specifications of Civil Aviation Authority Pakistan (CAA) and Air Transport Association. It is our goal to provide our entire team with all the necessary tools in order to ensure safe fleet operations with the articles within this magazine. [Reference: The Boeing Company]

"The desire to reach for the sky runs deep in our human psyche."

■ *Cesar Pell*

Rejected Takeoff Studies

By: Robert A. Mackinnon, Captain Boeing 747, Evergreen International Airlines

BACKGROUND

The RTO maneuver has been a fact of a pilot's life since the beginning of aviation. Each takeoff includes the possibility of an RTO and a subsequent series of problems resulting from the actions taken during the reject. Historically, the RTO maneuver occurs approximately once each 3,000 takeoffs. Because the industry now acknowledges that many RTOs are not reported, however, the actual number may be estimated at 1 in 2,000 takeoffs. For example, an unreported RTO may occur when a takeoff is stopped very early in the takeoff roll because the flight crew hears a takeoff warning horn, stops to reset trim, then taxis back to the runway and continues takeoff.

"Taking air safety to new heights with the world's *first* all rubber jet.. I give you ......the BOING 747."

According to these statistics, a pilot who flies primarily long-haul routes, such as in our Boeing 747 fleet, may be faced with an RTO decision only once in 20 years. In contrast, a pilot in our DC-9 short-haul fleet who makes 30 takeoffs per month may see an RTO every 7 years. Unfortunately, the pilot in each of these fleets must be prepared to make an RTO decision during every takeoff.

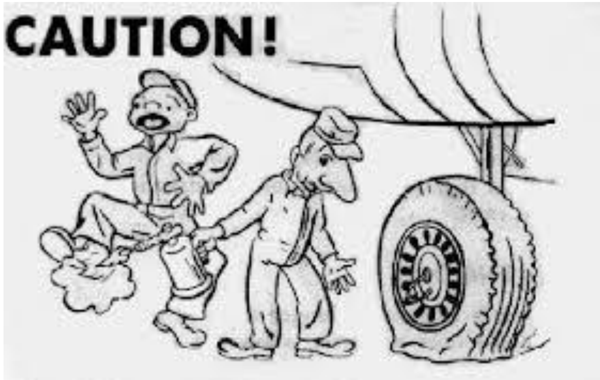
Boeing studies indicate that approximately 75 percent of RTOs are initiated at speeds less than 80 kt and rarely result in an accident. About 2 percent occur at speeds in excess of 120 kt. The overruns and incidents that occur invariably stem from these high-speed events.

A takeoff may be rejected for a variety of reasons, including engine failure, activation of the takeoff warning horn, direction from air traffic control (ATC), blown tires, or system warnings. In contrast, the large number of takeoffs that continue successfully with indications of airplane system problems, such as master caution lights or blown tires, are rarely reported outside the airline's own information system. These takeoffs may result in diversions or delays, but the landings are usually uneventful. In fact, in about 55 percent of RTOs the result might have been an uneventful landing if the take-off had been continued, as stated in the *Takeoff Safety Training Aid* published in 1992 with the endorsement of the U.S. Federal Aviation Administration (FAA).

Some of the lessons learned from studying RTO accidents and incidents include the following:

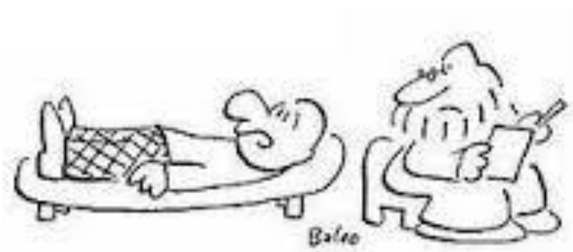
- More than half the RTO accidents and incidents reported in the past 30 years were initiated from a speed in excess of V1.
- About one-third were reported as occurring on runways that were wet or contaminated with snow or ice.
- Only slightly more than one-fourth of the accidents and incidents actually involved any loss of engine thrust.
- Nearly one-fourth of the accidents and incidents were the result of wheel or tire failures.

Approximately 80 percent of the overrun events were potentially avoidable by following appropriate operational practices.



APPROVED PROCEDURES

In late 1992, after we received the Boeing *Takeoff Safety Training Aid* in draft form, we decided to again seek approval of the "decision speed" concept. This time we chose a speed of 8 kt for a reduction, which added approximately 2 seconds of recognition time. In the worst case the screen height was degraded to approximately 15 to 20 ft. We also expanded our efforts to include a revised airspeed call. We had been using an airspeed call of 80 kt, both for airspeed verification and for power setting completion in the 747. A 100-kt call was added,



"It's not flying I'm afraid of — it's driving to the *airport!*"

Safe Winter Operations

By Haruhiko (Harley) Oda, Flight Operations Engineer;
Philip Adrian, 737 Chief Technical Pilot;
Michael Arriaga, Service Engineer;
Lynn Davies, Aerodynamics Engineer;
Joel Hille, Service Engineer;
Terry Sheehan, 737 Technical Pilot; and
E.T. (Tom) Suter, Service Engineer

Airline engineering, maintenance, and flight personnel, as well as contracted airplane deicing service providers, need to be aware of the recent developments and recommendations for operating airplanes in winter weather conditions.

[Airlines need to be aware of recent developments in winter operations and regularly update their cold weather operations procedures.]

Safe winter operations require special procedures by airline maintenance, engineering, flight, and deicing personnel. These procedures include deicing, anti-icing, cold weather maintenance, and flight operations.

This article discusses recent developments for winter operations. Intended for both maintenance and flight crews, it provides operators with guidance for reviewing and updating cold weather operations procedures. This article also outlines general concepts and tips on safe winter operations.

THE CLEAN-AIRPLANE CONCEPT

The "clean-airplane" concept is derived from U.S. Federal Aviation Administration (FAA) Federal Aviation Regulation (FAR) 121.629, which states, "No person may take off an aircraft when frost, ice or snow is adhering to the wings, control surfaces, propellers, engine inlets, or other critical surfaces of the aircraft or when the takeoff would not be in compliance with paragraph (c) of this section. Takeoffs with frost under the wing in the area of the fuel tanks may be authorized by the Administrator."

The FAR also prohibits dispatch or takeoff any time conditions are such that frost, ice, or snow may reasonably be expected to adhere to the airplane, unless the certificate holder has an approved ground deicing/anti-icing program in its operations specifications that includes holdover time (HOT) tables.

The European Aviation Safety Agency (EASA), Transport Canada Civil Aviation (TCCA), and other regulatory authorities have requirements similar to FAR 121.629.

The clean-airplane concept describes an airplane that is aerodynamically clean — that is, free of frozen contaminants. The clean-airplane concept is important because airplane takeoff performance is based upon clean surfaces until liftoff. An airplane is designed using the predictable effects of airflow over clean wings. Contaminants such as frost, ice, or snow adhering to the wings disturb this airflow, resulting in reduced lift, increased drag, increased stall speed, potentially severe roll problems due to uneven lift, and possible abnormal pitch characteristics.

CONSIDERATIONS FOR MAINTENANCE AND GROUND CREWS

Airplane operation in cold weather conditions can cause special problems because of the effects of frost, ice, snow, slush, and low temperature. The airplane maintenance manual (AMM) provides procedures for removal of contaminants from the airplane and the prevention of subsequent accumulation of frost, ice, snow, or slush. In addition, the operator must ensure that the maintenance procedures for winter operations are appropriate for the weather conditions. (See "The basics of deicing and anti-icing" and "General precautions during winter operations" below.)

Boeing recommends that maintenance and ground crew personnel and contracted airplane deicing service providers acquaint themselves with these recent developments in the area of airplane deicing and anti-icing:

When thickened airplane deicing/anti-icing fluids (i.e., SAE International Types II, III, and IV fluids) dry, they may leave a very fine, powdery residue in critical areas in wings and stabilizers. This residue can rehydrate and expand into gel-like materials that can freeze during flight and cause restrictions in the flight control systems (see fig. 1). As a result, operators should:

- Be aware of how frequently airplanes are being deiced/anti-iced.
- Be aware of whether a one- or two-step application process is being employed. While recognizing that it is not possible at some locations, Boeing recommends using a two-step process, preferably with Type I fluid and/or hot water as the first step. The application of hot water or heated Type I fluid as the first step of a two-step process has been shown to minimize the formation of residue gels.
- Ensure that proper procedures, including storage, handling, and application of fluids, are being followed by airline personnel or contracted deicing service providers.
- Establish an inspection and cleaning schedule for thickened fluid residue to help ensure that no flight control restrictions will occur. Examine areas such as wing rear spar, wing leading edge devices, horizontal stabilizer rear spar, vertical stabilizer, auxiliary power unit bay, control tabs and linkages (when applicable), and the bilge area of the tail cone. Visually inspect for dry or rehydrated residues in these areas. This inspection and cleaning should be performed in accordance with the recommendations found in the AMM for the specific airplane model involved.
- Apply lubricants and corrosion inhibitors as necessary to the areas where residue cleaning occurs.

Figure 1: Elevator control

Maintenance and ground crews should establish an inspection and cleaning schedule for deicing/anti-icing fluid residue to help ensure that no flight control restrictions will occur.

Airplane deicing/anti-icing fluids and many runway deicing fluids are not compatible — interaction between the two may contribute to the formation of gel residues. When these fluids combine, the salts in some runway fluids enhance the separation of the polymers contained in thickened airplane fluids, leading to a more rapid formation of gel residues.

When runway deicing fluid contaminates thickened airplane anti-icing fluid, there can be significant degradation of the fluid's performance. HOT values can be reduced and adherence or unacceptable flow-off may result. Runway deicing fluid can get onto the wings and tails by various means, such as spray from the nose gear, spray kicked up by the engine exhaust of other airplanes, or from activation of the engine thrust reversers. Runway deicing fluids are hydroscopic fluids, so they don't dry out very quickly, causing them to leave a thin wet layer on the wing that can be difficult to see. This implies that the use of hot water or Type I fluid to clean the wing prior to the application of thickened anti-icing fluid (i.e., Type II, III, or IV) is even more important than previously thought. On September 14, 2010, EASA issued Safety Information Bulletin 2010-26 on this subject, recommending the use of the two-step application process.

Catalytic oxidation of carbon brakes may result from exposure of the brakes to alkali metal (i.e., organic salt)-based runway deicers. This may cause severe damage to the brakes and drastically shorten their service life. These runway deicers have also caused corrosion of electrical connectors and hydraulic system components.

Figure 2: Damage to carbon brake disks caused by runway deicers

The damaged stator disk drive lugs on this carbon heat-sink demonstrate the type of damage alkali metal-based runway deicers can cause to carbon brake disks.

Boeing has released several service letters regarding the corrosion caused by alkali metal-based runway deicers on various airplane parts, including hydraulic tubes and cadmium-plated electrical connectors.

In the 1990s, runway deicing materials containing potassium and sodium acetate were introduced (potassium and sodium formate were introduced later) as an alternative to urea and glycol runway deicers. Urea and glycol runway deicers contribute to an increase in the biological and chemical oxygen demand of water systems surrounding airports and are more toxic to aquatic life than the alkali metal-based runway deicers.

Following the introduction of the new runway deicers, some operators reported that their airplanes equipped with carbon brakes began experiencing catalytic oxidation of the carbon brake heat-sink disks (see fig. 2). In order to help operators of airplanes equipped with carbon brakes comply with FAA Special Airworthiness Information Bulletin NM-08-27 and EASA Safety Information Notice 2008-19R1, the main gear wheel removal/installation sections of applicable AMMs have been revised to recommend inspection of the carbon brake assembly for signs of catalytic oxidation damage whenever a wheel and tire assembly is removed.

CONSIDERATIONS FOR FLIGHT CREWS

Winter or cold weather operations are generally associated with a combination of low temperatures and frost, ice, slush, or snow on the airplane, ramps, taxiways, and runways. The airplane flight manual (AFM) defines icing conditions as when the outside air temperature (OAT) on the ground or total air temperature (TAT) in flight is 50 degrees F (10 degrees C) or less and any of the following exist:

- Visible moisture (e.g., clouds, fog with visibility of one statute mile [1,600 meters] or less, rain, snow, sleet, or ice crystals).
- Ice, snow, slush, or standing water on the ramps, taxiways, or runways.

On runways contaminated by slush, snow, standing water, or ice, the use of fixed derate reduced thrust is permitted, provided that airplane-takeoff-performance planning accounts for the runway surface condition. Use of the assumed temperature reduced thrust method, alone or in combination with a fixed derate, is not permitted on contaminated runways. Boeing does not recommend takeoffs when slush, wet snow, or standing water depth is more than 0.5 inch (13 millimeters) or dry snow depth is more than 4 inches (102 millimeters). (See "General precautions during winter operations.")

Boeing recommends that flight crews make themselves aware of the following recent developments in the area of winter operations:

Starting with the 2010 winter season, HOT guidelines for Type I fluids include a new set of times to be used when the fluids have been applied to composite surfaces. Testing performed during the last three winter seasons has shown that HOT values for Type I fluids on composite surfaces are significantly shorter (on the order of 30 percent) than for aluminum surfaces. Although this topic has been discussed in the FAA Notice of its "FAA-Approved Deicing Program Updates" for the last two winter seasons, this year both the FAA and TCCA are publishing separate HOT guidelines for composite surfaces. In addition to extensive use of composites on newer models, many older models also have numerous composite surfaces (e.g., spoilers, ailerons, flaps, slats, etc.).

During taxi-out, avoid using reverse thrust on snow- or slush-covered runways, taxiways, or ramps unless absolutely necessary. Using reverse thrust on snow- or slush-covered ground can cause slush, water, and runway deicers to become airborne and adhere to wing surfaces.

AIRPLANE PERFORMANCE

Boeing currently provides two different landing-distance data sets to operators: dispatch data and in-flight operational data.

Dispatch landing data is used during flight planning to determine the maximum landing weight at which the airplane can land within the available landing distance at the destination or alternate airport. This data, referred to as certified data in the AFM, is based on standard-day temperature and accounts for airport pressure altitude and runway wind. However, it does not account for the effect of thrust reversers or runway slopes. Non-dry runway conditions are accounted for by factoring the dry runway dispatch landing-distance data.

In-flight operational data is published as advisory normal-configuration landing distance data in the performance in-flight section of a quick reference handbook (QRH). The data is provided as unfactored data for operators who use FAA requirements. The advisory data in the QRH for operators who use Joint Aviation Authorities or EASA requirements includes a 1.15 factor for non-dry runway conditions. The advisory data provided by Boeing is based on the use of reverse thrust and a 1,000-foot (305-meter) flare distance.

The FAA has chartered an aviation rulemaking committee (ARC) on takeoff and landing performance assessment (TALPA) to ensure that industry practices have adequate guidance and regulation for operation on non-dry, non-wet runways (i.e., contaminated runways). Based on the recommendations made by the ARC, the advisory normal-configuration landing-distance data for the 747-8 and 787 will include the following:

- Braking action and runway surface condition descriptions.
- 7-second air (flare) distance.
- A 1.15 factor for operators that use FAA requirements.

The 787 and 747-8 QRH advisory data will be based on the TALPA ARC recommendations. Changes to the QRH advisory data for other odels, such as the 777 and the Next-Generation 737, will await final rulemaking. However, Boeing can provide guidance on how existing QRH normal-configuration landing data can be adjusted to meet the intention of the TALPA ARC recommendations.

SUMMARY

Airlines need to be aware of recent developments in winter operations and review and update their cold weather operations procedures accordingly.

The basics of deicing and anti-icing

Deicing removes accumulated frost, ice, or snow from an airplane, typically through the application of hot water or a hot mixture of water and deicing fluid. Although there are other approved methods for deicing — such as infrared heat or hot air — the primary method worldwide is the use of fluids.

Anti-icing prevents the adherence of frost, ice, or snow to airplane surfaces for a certain period of time (i.e., the HOT values). While the same fluids used for deicing are also used for anti-icing, SAE Types II, III, and IV fluids are more typically used for anti-icing because they are thickened to stay on the airplane and thus provide longer HOT protection. They are most effective when applied unheated and undiluted to a clean airplane surface.

Whether used for deicing or anti-icing, the fluids must be transported, stored, and handled properly to be effective. Operators must ensure that the fluid manufacturer's guidelines are followed for the entire deicing/anti-icing process.

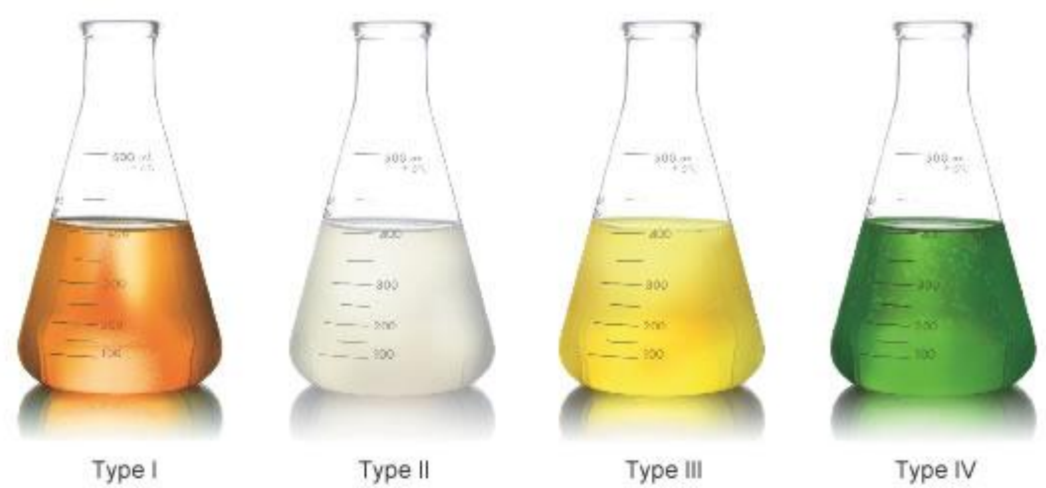
DEICING AND ANTI-ICING FLUIDS

The SAE standards define four types of deicing and anti-icing fluids. These fluids are acceptable for use on all Boeing airplanes (see fig. A):

- Type I fluids are unthickened and typically have a minimum of 80 percent glycol and a relatively low viscosity, except at very cold temperatures. These fluids provide some anti-icing protection, primarily due to the heat required for deicing, but have a relatively short HOT. Standards for Type I fluids are published in SAE Aerospace Material Specification (AMS) 1424.
- Type II, III, and IV fluids typically contain a minimum of 50 percent glycol in addition to polymer thickening agents. The thickening agents delay the flow-off of the fluids from the airplane surfaces. As a result, Type II, III, and IV fluids provide longer HOT values than Type I fluids. The flow-off characteristics of Type III fluids make them more suitable for commuter airplanes with relatively low takeoff rotation speeds. Type IV fluids provide longer HOTs than Type II fluids. Standards for Type II, III, and IV fluids are published in SAE AMS 1428.

Figure A: Identifying deicing and anti-icing fluids by color

The four types of deicing/anti-icing fluids can be readily identified by their color.



In accordance with AMS 1424 and 1428, all fluids must pass an Aerodynamic Acceptance Test to be considered qualified fluids that can be used on airplanes. All fluids must be requalified every two years.

Military (MIL) specifications for deicing/anti-icing fluids (such as MIL-A-8243D Type 1 and 2) are no longer kept up to date. Boeing recommends updating service documents to reference SAE standards if they currently reference MIL specifications.

HOLDOVER TIME

HOT is the length of time that anti-icing fluid will prevent ice and snow from adhering to and frost from forming on the treated surfaces of an airplane. These times are only guidelines; a number of variables can reduce protection time, including:

- The heavier the precipitation, the shorter the HOT.
- High winds or jet blast that cause the fluid to flow off, decreasing the protection afforded by the fluid layer.
- Wet snow, which causes fluids to dilute and fail more quickly than dry snow.
- An airplane skin temperature lower than outside air temperature.
- Direct sunlight followed by precipitation.
- The use of incorrect equipment to apply fluids.

For each winter season, the FAA publishes an annual Approved Deicing Program Update in an 8900.xx Notice (where the "xx" changes each year) that includes HOT guidelines for all commercially available deicing/anti-icing fluids that are currently qualified.

Similarly, TCCA annually publishes tables of HOT values in its Transport Canada Holdover Time Guidelines.

APPLYING DEICING/ANTI-ICING FLUIDS

There are two methods for applying deicing and anti-icing fluids.

One-step process: This process accomplishes both the deicing and anti-icing steps with a single fluid application. Typically a heated mixture of thickened fluid and water is applied.

Two-step process: This process involves deicing with heated Type I fluid, a heated mixture of Type I fluid and water, or a heated mixture of water and thickened (Type II, III, or IV) fluid, followed by a separate application of thickened fluid for

Anti-Icing protection. Experience and testing have shown that deicing with heated Type I fluid or a heated mixture of water and Type I fluid will help remove residue from previous anti-icing fluid treatments. Deicing with heated thickened fluid may contribute to residue formation.

General precautions during winter operations

For maintenance crews

These are general guidelines; refer to the AMM for definitive information.

- Ice that has accumulated on the fan blades while the airplane has been on the ground for a prolonged stop is called "ground-accumulated ice" and must be removed before engine start.
- Ice that has accumulated on the fan blades while the engine is at idle speed is called "operational ice" and is allowed to remain on the fan blades before taxi because the ice will be removed by engine run-ups prior to takeoff.
- The right and left sides of the wing and horizontal stabilizer (including the elevator) must receive the same fluid treatment, and both sides of the vertical stabilizer must receive the same fluid treatment.
- Treat the wings and tails from leading edge to trailing edge and outboard to inboard.
- Treat the fuselage from the nose and work aft. Spray at the top centerline and work outboard.

- Do not point a solid flow of fluid directly at the surfaces, gaps in airframe structure, or antennas. Instead, apply the fluid at a low angle to prevent damage, while pointing aft for proper drainage.
- Make sure that all of the ice is removed during deicing. There may be clear ice below a layer of snow or slush that is not easy to see. As a consequence, it may be necessary to feel the surface to adequately inspect for ice.
- Do not spray deicing/anti-icing fluids directly into auxiliary power unit (APU) or engine inlets, exhausts, static ports, pitot-static probes, pitot probes, or TAT probes.
- Do not spray hot deicing/anti-icing fluid or hot water directly on windows as it may cause damage.
- Ensure that ice or snow is not forced into areas around flight controls during deicing.
- Remove all ice and snow from passenger doors and girt bar areas before closing.
- Cargo doors should be opened only when necessary. Remove the ice and snow from the cargo containers before putting them on the airplane.
- If SAE Type II, III, or IV fluids are used, remove all of the deicing/anti-icing fluid from the cockpit windows prior to departure to ensure visibility.
- Deicing/anti-icing fluid storage tanks must be constructed of a compatible material. For thickened fluids, the tanks must be of a material that is not susceptible to corrosion (e.g., stainless steel or fiberglass). This is particularly important for thickened fluids because their viscosity can be permanently decreased if they are contaminated or exposed to excessive heat or mechanical shear during handling and application.
- When there is ice, slush, snow, or standing water on the runways or taxiways during taxi-in, examine the airplane when it gets to the ramp. Look for any damage to the airplane surfaces and for contamination that may have collected on the airplane. Carefully remove the contamination.
- Proper maintenance procedures for landing gear during cold weather operation as defined in the AMM can help reduce degradation of the structural joints and ensure optimal shock strut performance.
- Operating during cold weather can adversely affect the ability to properly lubricate the landing gear joints. Where possible, perform scheduled lubrication at maintenance bases where the temperature is above freezing. A heated hangar is the next most effective means of ensuring proper lubrication. If lubrication must be accomplished outside a heated hangar in temperature below freezing, the landing gear structure itself should be heated by blowing hot air directly onto the structure or into an enclosure around the structure.
- The temperature surrounding the airplane has a direct effect on both the volume of the gas and the viscosity of the oil in the shock strut. Boeing multi-model service letters provide procedures to ensure optimum strut performance if an airplane operates between two different regions with significantly different temperatures.
- Do not point a spray of deicing/anti-icing fluid directly onto wheels or brake assemblies.
- Remove contamination (e.g., frost, ice, slush, or snow) from the area where the main and nose gear tires will be positioned when the airplane is parked at the gate. If tires are frozen to the ramp, the airplane should not be moved until they are free.

For flight crews

These are general guidelines; refer to the Boeing flight crew operations manuals (FCOM) for definitive information.

PRIOR TO TAXI

- Carefully inspect areas where surface snow, ice, or frost could change or affect normal system operations. Perform a normal exterior inspection with increased emphasis on checking surfaces, pitot probes and static ports, air-conditioning inlets and exits, engine inlets, fuel-tank vents, landing-gear doors, landing-gear truck beam, brake assemblies, and APU air inlets. Takeoff with a light coating of frost (up to 1/8 inch [3 millimeters] thick) on *lower* wing surfaces caused by cold fuel is allowable. However, all leading-edge devices, all control surfaces, the horizontal tail, vertical tail, and *upper* surface of the wing must be free of snow, ice, and frost.
- Perform the normal engine start procedures, but note that oil pressure may be slow to rise. Displays may require additional warm-up time before engine indications accurately show changing values. Displays may appear less bright than normal.
- Engine anti-ice must be selected ON immediately after both engines are started, and it must remain on during all ground operations when icing conditions exist or are anticipated. Do not rely on airframe visual icing cues before activating engine anti-ice. Use the temperature and visible moisture criteria.
- Operate the APU only when necessary during deicing/anti-icing treatment.
- Do not operate the wing anti-ice system on the ground when thickened fluids (e.g., SAE Type II, III, or IV) have been applied. Do not use the wing anti-ice system as an alternative method of ground deicing/anti-icing.
- If the taxi route is through ice, snow, slush, or standing water, or if precipitation is falling with temperatures below freezing, taxi out with the flaps up. Taxiing with the flaps extended subjects flaps and flap devices to contamination.
- Check the flight controls and flaps to ensure freedom of movement.
- If there are any questions as to whether the airplane has frozen contamination, request deicing or proceed to a deicing facility. Never assume that snow will blow off; there could be a layer of ice under it. In rainy conditions with OAT near freezing, do not assume that raindrops on surfaces have remained liquid and will flow off; they could have frozen onto the surface. A similar issue can occur due to cold-soaked fuel in the wing tanks.
- Ice that has accumulated on the fan blades while the airplane has been on the ground for a prolonged stop is called “ground-accumulated ice” and must be removed before engine start.
- Ice that has accumulated on the fan blades while the engine is at idle speed is called “operational ice” and is allowed to remain on the fan blades before taxi because the ice will be removed by engine run-ups prior to takeoff.

DURING TAXI

This guidance is applicable for normal operations using all engines during taxi.

- Allowing greater than normal distances between airplanes while taxiing will aid in stopping and turning in slippery conditions. This will also reduce the potential for snow and slush being blown and adhering onto the airplane or engine inlets.

- Taxi at a reduced speed. Taxiing on slippery taxiways or runways at excessive speed or with strong crosswinds may cause the airplane to skid. Use smaller nose-wheel steering and rudder inputs. Limit thrust to the minimum required.
- Use of differential engine thrust assists in maintaining airplane momentum through a turn. When nearing turn completion, placing both engines at idle thrust reduces the potential for nose-wheel skidding. Differential braking may be more effective than nose-wheel steering on slippery or contaminated surfaces.
- Nose-wheel steering should be exercised in both directions during taxi. This circulates warm hydraulic fluid through the steering cylinders and minimizes the steering lag caused by low temperatures.
- During prolonged ground operations, periodic engine run-ups should be performed per the Boeing FCOM to shed the accreted ice.

BEFORE/DURING TAKEOFF

- Do the normal Before Takeoff Procedure. Extend the flaps to the takeoff setting at this time if they have not been extended because of slush, standing water, icing conditions, or because of deicing/anti-icing.
- Verify that airplane surfaces are free of ice, snow, and frost before moving into position for takeoff.
- In icing conditions, refer to the Boeing FCOM for guidance regarding static engine run-up before takeoff.
- Before brake release, check for stable engine operation. After setting takeoff engine pressure ratio (EPR), or N1, check that engine indications are normal, in agreement, and in the expected range. Check that other flight deck indications are also normal.
- Rotate smoothly and normally at V_R. Do not rotate aggressively when operating with deicing/anti-icing fluid.
- Retract flaps at the normal flap retraction altitude and on the normal speed schedule.
- A larger temperature difference from International Standard Atmosphere (ISA) results in larger altimeter errors. When the temperature is colder than ISA, true altitude is lower than indicated altitude. Consider applying the Boeing FCOM Cold Temperature Altitude Corrections, especially where high terrain and/or obstacles exist near airports in combination with very cold temperatures (-22 degrees F/-30 degrees C or colder). Operator coordination with local and en-route air traffic control facilities is recommended.

DESCENT

- Unless the airplane has fully automatic activation of ice protection systems, anticipate the need for activating the engine and/or wing anti-ice systems at all times, especially during a descent through instrument meteorological conditions or through precipitation.
- When anti-ice systems are used during descent, be sure to observe Boeing FCOM minimum EPR/N1 limits (if applicable).

LANDING

- The flight crew must be aware of the condition of the runway with respect to ice, snow, slush, or other contamination.
- Follow the normal procedures for approach and landing. Use the normal reference speeds unless otherwise directed by the Boeing FCOM.
- Arm the auto brake and auto spoiler systems, if available, before landing.

- The airplane should be firmly flown onto the runway at the aiming point.
- Immediately after main-gear contact with the runway, deploy the speed brakes if not already deployed by the automatic system.
- Without delay, lower the nose-wheel to the runway to gain nose-wheel directional control. Do not hold the nose gear off the runway when operating on slippery or icy runways.
- Use of auto brakes is recommended. They will allow the pilot to better concentrate on directional control of the airplane. If manual braking is used, apply moderate to firm steady pedal pressure symmetrically until a safe stop is assured.
- Let the anti-skid system do its work. Do not pump the brake pedals.
- Do not use asymmetric reverse thrust on an icy or slippery runway unless necessary to arrest a skid.
- When using reverse thrust, be prepared for a possible downwind drift on a slippery runway with a crosswind.
- During winter operations, it is even more important than usual that the flight crew not attempt to turn off the runway until the airplane has slowed to taxi speed.
- Taxi at a reduced speed. Taxiing on slippery taxiways or runways at excessive speed or with strong crosswinds may cause the airplane to skid.
- The Cold Weather Operations Supplementary Procedure in the Boeing FCOM specifies how far the flaps may be retracted after landing in conditions where ice, snow, or slush may have contaminated the flap areas. If the flap areas are found to be contaminated, flaps should not be retracted until maintenance has removed the contaminants.
- Use the engine anti-ice system during all ground operations when icing conditions exist or are anticipated.

Flying is so many parts skill, so many parts planning, so many parts maintenance, and so many parts luck. The trick is to reduce the luck by increasing the others.

- ***David L. Baker***

"No one can realize how substantial the air is, until he feels its supporting power beneath him. It inspires confidence at once."

- ***Otto Lilienthal, German Inventor of the first successful glider, 1893***

Editor

Captain Abid Mustafa

Vision Air International

A-3, BC-14, Avenue 3, Street 3, Clifton 5,
Karachi, Pakistan

Phone: +9221 35360657, +9221 35360659
Fax: +9221 35360659
Email: info@visionairintl.com