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AC NO: 91-13A

DATE: 1/2/70

ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

SUBJECT: COLD WEATHER OPERATION OF AIRCRAFT

1. PURPOSE. This Circular provides background and guidelines relating to operation of aircraft in the colder climates where wide temperature changes may occur.

2. CANCELLATION. Advisory Circular 91-13 dated 16 November 1966.

3. DISCUSSION.

   a. Most aircraft and their components are designed by the manufacturers to operate within certain temperature extremes. This temperature range can be found in the Airplane Flight Manual of all turbojet airplanes and airplanes certificated under old CAR Part 4B and FAR Part 25. If this information is not readily available, all operators are urged to consult the manufacturer as to the precautions to be taken in extremely cold weather operation.

   b. Experience has shown that the advice of operators and mechanics permanently located in the area of operation is also available.

4. PREPARATION OF THE AIRCRAFT FOR COLD WEATHER.

   a. Insulation against heat loss (Reciprocating Engines). In extremely cold temperatures all oil lines, oil pressure lines, and tanks if possible should be inspected for proper insulation; to preclude the possibility of oil congealing. Inspection and installation should be accomplished by a certificated A and P mechanic using fireproof insulation.

   b. Baffling and Winter Covers. Baffles, winter fronts and oil cooler covers are recommended by some manufacturers. FAA approval is required for installation unless the aircraft manufacturer has provided for their approval.

Initiated by: FS-447

c. Oil and Grease. The viscosity of the oil and grease used is very important in cold weather operation. The synthetic oils and grease developed for jet aircraft where the normal temperature range of operation is from -80F to +120F may be adaptable for other aircraft used in extreme cold temperatures. If oil additives are used, the manufacturer's recommendations should be closely followed.

d. Oil Breather (Reciprocating Engines). The crankcase breather deserves special consideration when preparing for cold weather. Frozen breather lines have created numerous problems. Most of the water of combustion goes out of the exhaust, however, some enters the crankcase and is vaporized. When the vapor cools, it condenses in the breather line subsequently freezing it closed. Special care is recommended during the preflight to assure that the breather system is free of ice. If a modification of the system is necessary be certain that it is an approved change so as to eliminate a possible fire hazard.

e. Hose Clamps, Hoses, Hydraulic Fittings and Seals. An important phase of cold weather preparation is to inspect all hose lines, flexible tubing and seals for deterioration. After replacing all doubtful components be certain that all clamps and fittings are properly torqued to the manufacturer's specifications for cold weather.

f. Cabin Heater. Many aircraft are equipped with cabin heater shrouds which enclose the muffler or portions of the exhaust system. It is imperative that a thorough inspection of the heater system be made to eliminate the possibility of carbon monoxide entering the cockpit or cabin area. Each year accident investigations have revealed that carbon monoxide has been a probable cause in accidents that occurred in cold weather operations.

g. Control Cables. Because of contraction and expansion caused by temperature changes, control cables should be properly adjusted to compensate for the temperature changes encountered.

h. Oil Pressure Controlled Propellers. Propeller control difficulties can be encountered due to congealed oil. The installation of a recirculating oil system for the propeller and feathering system has proven helpful in the extremely cold climates. Caution should be taken when intentionally feathering propellers for training purposes to assure that the propeller is unfeathered before the oil in the system becomes congealed.

i. Care of Batteries. Both dry cell and wet cell batteries require some special consideration during cold weather.

(1) Wet Cell. It is recommended that wet cells be kept fully charged or removed from the aircraft if parked outside to prevent loss

of power caused by cold temperatures and the possibility of freezing.

(2) Dry Cell. Dry cells are usually associated with aircraft in only two applications, i.e., emergency lights and/or portable radios, including emergency locator transmitters. Manufacturer recommended batteries for this type equipment resist loss of power by freezing.

j. Wheel Wells and Wheel Pants. During thawing conditions, mud and slush can be thrown into wheel wells during taxiing and takeoff. If frozen during flight, this mud and slush could create landing gear problems. The practice of recycling the gear after a takeoff in this condition should be used as an emergency procedure only. The safest method is to avoid these conditions with retractable gear aircraft. It is recommended that wheel pants that are installed on fixed gear aircraft be removed to prevent the possibility of frozen substance locking the wheels or brakes.

5. OPERATION OF THE AIRCRAFT.

a. Preflight Inspection. The thoroughness of a preflight inspection is important in temperature extremes. At extremely low temperatures it is natural to hurry over a preflight of aircraft and equipment, particularly when the aircraft is outside and adverse weather conditions exist. This is the very time to run the most thorough preflight inspection.

(1) Fuel Contamination. Fuel contamination is always a possibility in cold climates. Modern fuel pumping facilities are generally equipped with good filtration equipment and the oil companies attempt to deliver pure fuel to your aircraft. However, even with the best fuel and precautions, if your aircraft has been warm and then is parked with half empty tanks in the cold, the possibility of condensation of water in the tanks exists.

(2) Fueling Facilities. Another hazard in cold climates is the danger of fueling from makeshift fueling facilities. Fuel drums or "case gas", even if refinery sealed, can contain rust and somehow contaminants can find their way into the fuel. Cases are on record of fuel being delivered from unidentified containers which was not aviation fuel. As a precaution, we suggest:

(a) Where possible, use fuel from modern fueling facilities and fill your tanks as soon as possible after landing.

(b) Be sure the fuel being delivered is, in fact, aviation fuel and is the correct grade for your engine.

(c) If a fuel source other than (a) is used, be sure to filter the fuel as it goes into your tanks. NOTE: A funnel with a dirty, worn out chamois skin is not a filter, nor will a new, clean chamois filter out water after the chamois is saturated with water. Many filters are available which are more effective than the old chamois.

(d) Special precautions and filtering are necessary with kerosene and other gas turbine fuels. Manufacturers can supply full details on handling these fuels.

(3) Aircraft fuel filters and sumps. Fuel filters and sumps (including each tank sump) should be equipped with quick drains. Sufficient fuel should be drawn off into a transparent container to see if the fuel is free of contaminants. All fuel sumps on the aircraft are drained including individual tank sumps. Extra care should be taken during changes in temperature, particularly when it nears the freezing level. Ice may be in the tanks which may turn to water when the temperature rises, and may filter down into the carburetor or fuel controller causing engine failure. During freeze-up in the fall, water can freeze in lines and filters causing stoppage.

(4) Aircraft preheat. Low temperatures can change the viscosity of engine oil, batteries can lose a high percentage of their effectiveness, instruments can stick and warning lights when "pushed to test" can stick in the pushed position. Because of the above, preheat of engines as well as cockpit before starting is considered advisable in low temperatures. Extreme caution should be used in the preheat process to avoid fire. The following precautions are recommended. Turbine engines use synthetic oils, therefore, (a) is applicable for this type equipment.

(a) Preheat the aircraft by storing in a heated hangar, if possible.

(b) Use only heaters that are in good condition and do not fuel the heater while it is running.

(c) During the heating process, do not leave the aircraft unattended. Keep a fire extinguisher handy for the attendant.

(d) Do not place heat ducting so it will blow hot air directly on parts of the aircraft; such as, upholstery, canvas engine covers, flexible fuel, oil and hydraulic lines or other items that may cause fires.

(e) When using a "fire pot" (plumbers pot) for heating, it is suggested that wire mesh be inserted in the ducting between the pot and the engine. Flaming pieces of carbon will not penetrate the wire mesh.

(5) Engine starts.

(a) In moderately cold weather, engines are sometimes started without preheat. Particular care is recommended during this type of start. Oil is partially congealed and turning the engine is difficult for the starter or by hand.

(b) There is a tendency to over-prime, which results in washed down cylinder walls and possibly scouring of the walls. This also results in poor compression and, consequently, harder starting. Aircraft fires have been started by over-prime. It is good practice to have a fire guard handy during these starts.

(c) Another cold start problem that plagues an unpreheated engine is icing over the sparkplug electrodes. This happens when an engine only fires a few revolutions and then quits. There has been sufficient combustion to cause some water in the cylinders but insufficient combustion to heat them up. This little bit of water condenses on the sparkplug electrodes, freezes to ice, and shorts them out. The only remedy is heat. When no large heat source is available, the plugs are removed from the engine and heated to the point where no more moisture is present.

(d) Engines can quit during prolonged idling because sufficient heat is not produced to keep the plugs from fouling out. Engines which quit under these circumstances are frequently found to have iced-over plugs.

(e) Turbine engines do not create additional problems in cold temperatures. However, it is recommended that a ground power unit be used whenever available and that the start be made into the wind if possible to prevent a hot start.

(6) Removal of frost, ice and snow. All frost, ice and snow should be removed from all airfoil and control surfaces. Alcohol or one of the ice removal compounds can be used or it can be melted off in a heated hangar. If it is melted off, be sure the water doesn't run into control surface hinges, or crevices and freeze when the aircraft is taken outside.

(7) Blowing snow. If an aircraft is parked in an area of blowing snow, special attention should be given to openings in the aircraft where snow can enter, freeze solid, and obstruct

operations. These openings should be free of snow and ice before flight. Some of these areas are as follows:

(a) Pitot tubes

(b) Wheel wells

(c) Heater intakes

(d) Carburetor intakes

(e) Tail wheel wells, especially where snow can freeze around elevator and rudder controls.

(f) Fuel vents

(8) Ski operation. Ski safety cables and shock cords on the front of the skis should be carefully inspected. If these cables or shock cords should break on takeoff, the nose of the ski can fall down to a near vertical position which seriously affects the aerodynamic efficiency of the aircraft and creates a landing hazard.

(a) Experienced bush pilots are sometimes called upon to start an engine on an aircraft equipped with skis when no one is available to handle the throttle. In a situation like this, they have been known to use a procedure similar to the following: The pilot turns the propeller and loads the engine and switch off. The fuel is then turned off and the switch on. Then the pilot props the plane and when the engine starts, goes to the cockpit and turns the fuel back on. This procedure prevents the type of accident that happens when a pilot either chases or is chased by an unoccupied aircraft. NOTE: Use caution against slipping when hand-propping under icy conditions.

(9) Fire extinguisher. Fire extinguishers should receive special winter attention. CO_2 bottles should have the proper charge. Carbon tetrachloride extinguishers should be protected against freezing.

b. Taxiing.

(1) Since skis have no brakes, a pilot should keep this in mind at all times. Special care is recommended during downwind/crosswind taxiing and turning.

(2) Operations on wheels is difficult in deep snow and on packed snow or ice, braking action is generally poor unless the temperature is well below 0 degrees F.

(3) During cold weather operation, special attention should be given to avoidance of apparently soft snow banks sometimes seen on the sides of airport runways. Frequently they may be frozen solid ice blocks.

c. Takeoff. Takeoffs in cold weather offer some distinct advantages, but they also offer some special problems. A few points to remember are as follows:

(1) Do not over-boost supercharged or turbine engines. Use the applicable power charts for the pressure altitude and ambient temperature to determine the appropriate manifold pressure or engine pressure ratio. Care should be exercised in operating normally aspirate engines. Power output increases at about 1% for each ten degrees of temperature below that of standard air. At -40 degrees F, an engine might develop 10% more than rated power even though RPM and MP limits are not exceeded.

(2) On multiengine aircraft it must be remembered that the critical engine-out minimum control speed (V_{mc}) was determined at sea level with a standard day temperature. If the appropriate power charts are not available to limit maximum rated power for takeoff, V_{mc} will be higher than that published at below sea level density altitudes.

(3) With reciprocating engines, use carburetor heat as required. In some cases, it is necessary to use heat to vaporize the fuel. Gasoline does not vaporize as readily at very cold temperatures. Do not use carburetor heat in such a manner that it raises the mixture temperature barely to freezing or just a little below. In such cases, it may be inducing carburetor icing. An accurate mixture temperature gauge is a good investment for cold weather operation. It may be best to use carburetor heat on takeoff in very cold weather.

(4) If icing conditions exist, use the anti-ice and deice equipment as outlined in the Airplane Flight Manual. If the aircraft is turbine powered, use the appropriate power charts for the condition bearing in mind that the use of bleed air will in most cases change the maximum load to be carried and the runway requirements.

d. Climb out. During climb out in reciprocating engines keep a close watch on head temperature gauges. Due to restrictions (baffles) to cooling air flow installed for cold weather operation and the possibility of extreme temperature inversions, it is possible to over

heat the engine at normal climb speeds. If the head temperature nears the critical stage, increase the airspeed or open the cowl flaps or both.

e. Enroute.

(1) Weather. Weather conditions vary considerably in cold climates. In the more remote sections of the world weather reporting stations are generally few and far between and considerable reliance must be made on pilot reports.

(a) Snow showers and white outs. Snow showers are, of course, quite prevalent in colder climates. When penetration is made of a shower, a pilot should be prepared to go on instruments since vertical visibility may be quickly lost. Another hazard which has claimed as its victims some very competent pilots is the "white out." This condition is one where within the pilot's visibility range there are no contrasting ground features. Obviously the smaller the visibility range the more chance there is of a white out, however, a white out can occur in good visibility conditions. A white out condition calls for an immediate shift to instrument flight, the pilot should be prepared for this both from the standpoints of training and aircraft equipment. If icing conditions are anticipated or exist, be certain that the anti/deice equipment is put into operation soon enough so it may function in the manner for which it was designed, i.e., anti-ice equipment is to prevent not eliminate after ice has built up.

(2) Survival gear and clothing.

(a) If the country over which the flight is planned is such that a survival problem would be created in a forced landing, appropriate survival gear should be carried. Survival gear will vary with individual needs, temperature, and routes. There are many fine survival kits on the market. Some fixed-base operators offer these kits for rent. Probably the most important piece of survival gear is the clothing of the aircraft occupants. Survival clothing should be worn as much as possible or kept handy so that if the aircraft is forced down and a fire ensues the survival clothing will not be lost.

(b) When flying over mountainous terrain and other isolated areas where rescue operations may be hampered, the installation of an emergency locator transmitter is highly desirable.

(3) Skis.

(a) In level flights, skis due to their relatively dirty profile, will cut cruising speed to some extent. In addition to some loss of aerodynamic efficiency, skis have other disadvantages. They require more care in operation because bare spots must be avoided to keep from wearing the bottom coating of the skis, although the bottom coating must be renewed on some skis periodically. There is now on the market an anti-friction tape which is very useful for this purpose. Skis equipped with anti-friction coating do not freeze to the surface as those which expose bare metal to the snow. Another method of keeping skis from freezing to the snow is to taxi the aircraft up onto poles placed across and under the skis. This prevents them from touching the snow for most of their length.

(b) Extra care in use of skis during takeoff and landing is also recommended. Rutted snow and ice can cause loss of ground control and even failure of skis or landing gear parts. Deep powder snow can adversely affect ski operation by prolonging takeoff runs. In this case, experienced operators pack a takeoff path with snow shoes or taxi back and forth until an adequately packed runway is available.

f. Let down.

(1) Engine operation. During let down there may be a problem of keeping the engine warm enough for high power operation if needed. It may be desirable to use considerably more power than normal, which may require extension of gear or flaps to keep the airspeed within limits. Carburetor heat may also be necessary to help vaporize fuel and enrichen the mixture in reciprocating engines. Letdowns through icing conditions with turbine powered aircraft often require the extension of speed brakes/flaps/gear to create enough drag so that adequate power can be maintained to supply sufficient bleed air for the anti/deice equipment without exceeding the desirable airspeed.

(2) Blowing snow and ice fog.

(a) Blowing snow can be a hazard on landing, and a close check should be maintained throughout the flight as to the weather at destination. If the weather pattern indicates rising winds, then blowing snow may be expected which may necessitate an alternate course of action.

(b) Ice fog is a condition opposite to blowing snow and can be expected in calm conditions about -30 degrees F. and below. It is most likely found close to populated areas.

(c) Both of the above conditions can form very rapidly and may be associated with clear enroute weather. A careful check of the forecast weather and complete preflight planning should always be accomplished.

g. Landing.

(1) A landing surface can be very treacherous in cold weather operation. In addition, be aware of other hazards such as snow banks on the sides of the runways and poorly marked runways. Advance information about the current conditions of the runway surface should be gained and if not readily available, take the time to circle the field before landing to look for drifts or other obstacles.

(2) Ski wheels. Ski wheel combinations are popular and very convenient, however, care must be taken to make the proper selection for the type of runway condition existing at the destination airport.

(3) Braking action may be poor. If the aircraft is equipped with reversible propellers or thrust reversers installed on a turbine engine, exercise care so as not to reduce your forward visibility by blowing snow, caused by the reverse thrust. Foreign object damage can also be caused by reverse thrust at slow forward speeds on marginal surfaces.

h. Post Flight. The following are a few items to consider before leaving the aircraft after the flight:

(1) As soon as possible fill the tanks with the proper grade of clean aviation fuel, even if the aircraft is going into a heated hangar.

(2) If the aircraft is to be left outside, put on engine covers and pitot covers.

(3) If the weather forecast is for snow or "clear and colder", put on wing covers if available.

(4) Control locks or tied controls are suggested if the aircraft is left outside. Tie downs are, of course, also suggested. Advisory Circular 20-35A gives good advice on tie downs.

(5) If the aircraft is equipped with an oil dilution system and it is decided to dilute, manufacturer's recommendations should be carefully followed.

(6) During reciprocating engine shutdown, a good practice is to turn off the fuel and run the carburetor dry. This lessens the fire hazard during preheat the next morning.

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