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Federal Aviation Agency

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GENERAL OPERATING AND FLIGHT RULES

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ADVISORY CIRCULAR

SUBJECT: COLD WEATHER OPERATION OF AIRCRAFT

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1. PURPOSE. This circular is designed to highlight important factors relating to operation of aircraft in the colder climates particularly where wide fluctuations in temperature occur.

2. DISCUSSION.

   a. Most mechanical equipment, including aircraft and their components, are designed by the manufacturers to operate within certain temperature extremes. Some aircraft and their component parts have never been tested to temperature extremes which may be encountered in service. Manufacturers generally can predict their product's performance in temperature extremes and outline precautions to be taken to prevent premature failures. Accordingly, all operators are urged to consult the manufacturer when in doubt as to the precautions to be taken in extremely cold weather operation.

   b. Experience has shown that the advice of operators who are located in the area where the operation is contemplated is valuable, since they are in a position to judge requirements and limitations for operation in their particular area.

3. PREPARATION OF THE AIRCRAFT FOR COLD WEATHER.

   a. Insulation against heat loss in oil lines and tanks (lagging). This a must for extremely cold temperatures since oil can congeal and cause engine failure in flight if lagging is not used. The amount of insulation depends on how far the lines and tanks are from the heat source, the rate of oil flow and, of course, the temperatures to be encountered in service.

   b. Baffling and winter covers. Baffles are recommended by some manufacturers to be used in augmenter tubes. Winter fronts, oil cooler covers and cowl flaps are also added to some engine installations. FAA approval is required for installation of these items unless the

aircraft manufacturer has provided for their approval. When baffles or cowl flaps are installed on an aircraft, a cylinder head temperature gauge is recommended particularly if wide temperature differences are encountered.

c. Oil and grease. The oil and grease used is extremely important in low temperatures. For example, often overlooked is the grease used in working parts of the landing gear. Some operators have found that the synthetic oils and grease developed for high altitude jets are adaptable for extremely low temperatures. Kerosene oil has also been used but manufacturer limitations in this region should be closely followed.

d. Oil breather.

(1) The crankcase breather deserves special consideration in cold weather preparation. There have been a number of engine failures attributed to a frozen breather line which causes pressure to build up in the crankcase sometimes blowing the oil filter cap off or rupturing a seal and pumping the oil supply over the side. The water which causes this freezing is a natural byproduct of the combustion of fuel and air. Most of the water of combustion goes out the exhaust, however, some enters the crankcase and is vaporized by the hot oil. Trouble will occur when vaporized water is cooled in the breather line and freezes it closed.

(2) Special care is recommended on preflight to see that the breather is free of ice. Some operators drill a small hole in the breather line inside the cowling or cut a slit (if the line is a hose) to relieve the pressure in case of freezing. The hole results in a dirty engine compartment but has proved effective in preventing the loss of all the oil. Care should be used in locating the pressure relief opening so that oil and vapor are not directed toward an exhaust pipe.

e. Hose clamps, hoses, hydraulic fittings, and seals. Hose clamps, hydraulic tubing, other flexible tubing and seals have a habit of shrinking in cold temperatures. Part of the precold weather preparation is to torque all hose clamps to manufacturer specifications. When torquing, it is a good time to inspect all hoses for deterioration and replace all doubtful hose lines. Extra flexibility, a mushy feeling, or excessive outside "weathering"are indications of deteriorated hoses. Fittings in the hydraulic system also deserve attention; these too shrink and can cause leaks. Consult a mechanic who is experienced in cold weather operations, operating in a cold weather area, or the manufacturer to determine proper torquing and any special tool to be used. Dried out or deteriorated seals are recommended to be replaced with "live" seals of recent manufacture.

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 the muffler or enclosed exhaust pipe be carefully inspected prior to cold weather operation. Any leaks in piping, muffler, or joints can be hazardous. During cold weather operation, the cabin is usually tightly closed, long warm-up periods occur, and even a little carbon monoxide leaking through the heater into the cabin can seriously impair the faculties of the pilot or other crewmen. Each year in the colder climates, the FAA investigates accidents caused by faulty cabin heaters.

g. Control cables. Proper tension on control cables can prevent costly repairs and improperly rigged control surfaces. The aircraft itself expands and contracts at a different rate than the control cables and can cause undue pressure on pulleys or fairleads if too tight or conversely, if too loose can cause slack cables resulting in inadequate control surface movement. Control cables should be carefully adjusted to compensate for the temperature expected to be encountered. An experienced mechanic knowledgeable on the particular equipment and located in the area where operation is contemplated can recommend the best adjustment.

h. Oil pressure controlled propellers. There have been numerous incidents in which multiengine aircraft have landed with a feathered propeller due to the flight crew being unable to unfeather the propeller in flight. In certain cases, a propeller has been feathered for training purposes and the oil congealed in the cold propeller making it impossible to unfeather. Other propeller control difficulties can be encountered due to congealed oil. Lagging of lines can help, however, some operators in extremely cold climates have installed a recirculating system on their aircraft which continually recirculates hot oil through the propeller and feathering system. This has proved to be helpful in some cases in reducing propeller control difficulties.

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

(1) Wet cell. Wet cell batteries must be kept fully charged to keep them from freezing. Even moderately cold temperatures can cause marked loss of power. After a battery is frozen, it may explode if left installed in aircraft and subject to high charge rate. It may just burst and drench parts of the aircraft with a very corrosive sulphuric acid solution. We recommend that when aircraft are parked outside, operators keepbatteries fully charged or remove them from the aircraft and keep them in a warm place.

(2) Dry cell. Dry cells are usually associated with aircraft in only two applications; i.e., in flashlights or portable radios. When dry cells freeze, they often lose their power very rapidly.

We suggest the use of alkaline dry cell batteries in any cold weather use associated with aircraft. These batteries 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. When lower temperatures of higher altitudes are encountered, this mud or slush freezes and has caused accidents due to landing gear troubles. Experienced operators avoid operation during these conditions. They find that some flights must be aborted if they pick up too much mud or slush during taxi or the initial takeoff run. The practice of operating in this condition and then cycling the landing gear during climb out is recommended as an emergency procedure only. We suggest one stay out of the condition entirely with retractable gear aircraft. Wheel pants are another part of the aircraft that can cause trouble in freezing slush or freezing mud conditions. It is suggested that wheel pants be removed during the cold weather months. Wheel pants full of frozen snow, slush, or mud can lock up a wheel. Brake difficulty may also be encountered in freezing mud or slush conditions.

4. 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 of 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 exist.

(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, 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 (octane) 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. Most imitation chamois will not filter water.

(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. Experienced operators place the aircraft in level flight position, and the fuel is allowed to settle before sumps and filters are drained. 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 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:

(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. Sometimes aircraft fires have been started by over prime, when the engine fires and the exhaust system contains raw fuel. Other fires are caused by backfires through the carburetor. 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.

(6) Removal of frost, ice and snow. Ideally, all frost, ice and snow are recommended to 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. The aircraft can be flown with some frost on the airfoils if it is polished smooth. This is practiced by experienced "bush pilots," but is not recommended to be attempted by the inexperienced. This is a judgment area where the old timers' advice is very valuable.

(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 operation. 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.

(8) Fuel vents. Fuel tank vents should be checked before each flight. A vent plugged by ice or snow can cause engine stoppage, collapse of the tank, and possibly very expensive damage. Some manufacturers have located tank vents inside wheel wells, which are very susceptible to plugging by blowing snow or freezing slush.

(9) 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 effects the aerodynamics 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 with 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.

(10) Fire extinguisher. Fire extinguishers should receive special winter attention. CO_2 bottles are charged with both CO_2 and dry nitrogen. Dry type chemical extinguishers are charged with dry nitrogen and a dry extinguisher agent. Carbon tetrachloride extinguishers can freeze at the lower temperatures.

b. Taxiing.

(1) Since skis have no brakes, a pilot should keep this in mind at all times. Short turns are not recommended on skis, as this puts torque on the landing gear in excess of that for which it was designed. Special care is recommended during down wind taxiing.

(2) Operation 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°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 engines. This is easy to do because due to low density altitude, the engine "thinks" it is operating as much as 8,000 feet below sea level in certain situations. Care should be exercised in operating normally asperated engines. Power output increases at about 1% for each ten degrees of temperature below that of standard air. At -40°F. an engine will develop 10% more than rated power even though RPM and MP limits are not exceeded.

(2) Find out the critical engine out minimum control speed (V_{mc}) for below sea level density altitudes on multiengine aircraft and fly the aircraft accordingly.

(3) If the temperature rises do not expect the same performance from your aircraft, as when it was operated at the lower density altitudes of cold weather.

(4) 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.

d. Climb out. During climb out keep a close watch on head temperature gauges. Due to restrictions (baffles) to cooling air flow installed for cold weather operation and the possiblity 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 IFR, 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, 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.

(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) Successful cold weather survival depends more than anything else on the state of mind of the individual. The WILL to survive is most important. Cases are on record of people with little knowledge of survival techniques and little equipment who have survived for weeks, while on the other hand, very knowledgeable individuals with plenty of equipment have perished in a few hours. Even survival in water as cold as 27°F. is possible as demonstrated by a man who spent the night in the Arctic Ocean hanging onto the float of an

inverted seaplane. Good survival techniques were used in that all clothing was left on and a sleeping bag was worked around him, but the important thing was that in an apparently hopeless situation, he kept intact his WILL to survive.

(3) Skis.

(a) In level flight, 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 the 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 effect ski operation. Prolonged takeoff runs in deep powder are expected and it may be deep enough that no takeoff is possible under existing conditions. 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.

(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°F. and below. It is found close to populated areas, since a necessary element in its formation is hydrocarbon nuclei such as found in automobile exhaust gas or the gas from smoke stacks.

(c) Both of the above conditions can form very rapidly and are only a few feet thick (usually no more than 50 feet) and may be associated with clear enroute weather. A careful check of the forecast, weather, and cautious preflight planning for alternate courses of action should always be accomplished.

g. Landing.

(1) A landing surface can be very treacherous in cold weather operation. In addition, caution is advised to 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, remember it is very nearly as embarrassing as forgetting to lower the landing gear to land on a clear, hard surface with the skis extended; or to go beyond the embarrassment stage and land in deep snow with the wheels extended.

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 and save yourself from a snow or frost removal job in the morning. NOTE: Do not use wing landing lights with wing covers installed due to heat generated.

(4) Control locks or tied controls are suggested if the aircraft is left outside, and there is a chance of high wind conditions. Tie downs are, of course, also suggested in high winds. Advisory Circular 20-35 gives some good advice on tie downs.

(5) If the aircraft is equipped with an oil dilution system, consider the advisability of dilution of the engine oil. If it is decided to dilute, manufacturers' recommendations should be carefully followed commensurate with the temperature expected.

(6) During 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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