Cold Weather Starting

Glad to be here.

- When the Blue Angels finish a precision flight performance they sit down to debrief the flight.
- All egos and rank are checked at the door and each member of the team confesses to any “safety” infractions small or large.

Glad to be here.

- At the end, each pilot informs his colleagues that he will make the necessary corrections the next time he or she flies.

Glad to be here.

- The pilot ends with the statement, “I’m glad to be here.
- Each pilot confesses that they are lucky to be given the opportunity to fly with the Blue Angels.

Cold Weather Starting

- This presentation is the result of a cold weather starting incident that resulted in a fire while starting a Cessna 172 in cold weather.
- The CAP pilot shares this “safety” so that you might learn from his experience.
- He can fix the issues the next time he flies in cold weather.
- He is glad to be here!

Cold Weather Starting Incident

- February 2011
- Outside air temp 0 degrees Fahrenheit.
- The mission:
  - 97 NM flight to exchange a Cessna 172 for a Cessna 182 which was finished with maintenance.
- The airplane N99553, a Cessna 172

Pre-flight

- Weather Briefing obtained – preflight initiated. Weather clear, outside temp 0 degrees Fahrenheit.
- Examination of the engine compartment revealed that the plane was plugged in.
- The extension cord has a pilot light which was glowing.
- The cord appeared to be plugged securely into the receptacle of the Tanis heater.

Pre-flight

- Examination of the oil revealed adequate oil at 7 quarts.
- The oil Appeared thicker than the pilot thought it might be with the heater operating.
- The operating glow plug on the cord led the pilot to believe the Tanis heater to be functioning.
- Electrical checks were kept to a minimum to conserve battery power.

Pre-flight

- The plane was disconnected from the power source and was promptly pulled from the hangar to begin the starting sequence.

Starting Sequence

- The engine was given 5 shots of prime
- Engine crank 1, did not start
- Engine rested
- 2 shots of prime (7)
- Engine crank 2 , did not start
- Engine rested
- Engine crank 3, did not start
- Engine rested

Starting Sequence

- 1 shot of primer (8)
- Engine crank 4, did not start
- Engine rested
- At this point the pilot was believing that the engine was not going to start but was going to give it one last try.

Starting Sequence

- 2 shots of prime (10)
- Engine crank 5, Engine started briefly.
- With encouragement from the brief start attempts were continued.
- Engine rested
- Engine crank 6, did not start

Starting Sequence

- Considered flooded engine
- Engine crank 7 with mixture pulled, did not start
- Engine rested
- 1 shot of prime, (11)
- Engine crank 8, engine starts briefly (2nd start) again giving pilot encouragement that the engine was about to start.
- Engine rested

Starting Sequence

- 1 shot of prime, (12)
- Engine cranked (9), Engine started briefly (3rd start).
- At this point without cranking the engine smoke was observed from under the cowling.
- Mixture was pulled and pilot attempted to crank the engine as per emergency checklist for engine fire during start up.

Emergency Sequence - fire

- Seeing smoke the mixture was pulled to idle and an attempt was made to crank the engine to “pull flames back into the carburetor” as per the emergency check list.
- By this time the cranking efficiency was very low.

Emergency Sequence - fire

- A shout of “fire” was heard.
- The lineman discharged a fire extinguisher and the pilot exited the aircraft.
- Master and Magnetos were turned off.
- Fuel source turned off.

Photo of C172 after fire.

Summary of start Sequence

- The engine was cranked 9 times with rest between each.
- The engine briefly started three times on attempts 5, 8, and 9, the last time resulting in smoke and fire.
- Each brief start led the pilot to believe that the engine was about to start.

Note the position of the pooled fuel and fire.

Tanis Heater Function?

- The pilot who flew the plane previously had to carve on the plastic electrical plug in order for it to fit into the Tanis heater receptacle.
- While the plug appeared to be fully engaged, the “thick oil” was a sign that it was not functioning.
- The pilot light on the extension cord gives only an indication of power at the cord, not that the system is functioning.

Tanis Heater Function?

- Examination of the system after the incident found the Tanis system to function only with further modification of the extension cord to fit more completely into the receptacle mounted on the airplane.

Priming in Cold Weather

- Review of a manual for a C172 M states under cold start with preheat:
  - 1 With ignition off and throttle closed, prime the engine four to eight strokes as the propeller is being turned over by hand.
    - Note Heavy strokes of primer for best atomization of fuel. After priming, push primer all the way in and turn to locked position.

Priming in Cold Weather

- The initial amount of primer was appropriate according to the POH.
- This assumes a pre-heated engine.
- Subsequent priming likely led to the over priming after experiencing frosted plugs.

What are Frosted Plugs?

- When an engine begins to start in cold air but does not continue to run, cold moist air is drawn across the plugs.
- The tip of the plug is like the leading edge of a wing where icing starts on an airplane.
- Moisture freezes on the electrodes of the spark plugs.
- Further attempts to start will be futile.
  - Discussion with Dirk Ellis of Tanis Aircraft

What was the source of the pooled fuel in the cowling?

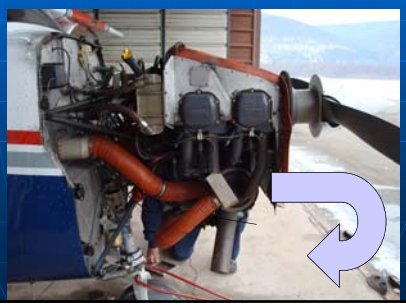
- Fuel pooling in the cowling likely came from continued priming and cranking the engine with the throttle cracked and slow cranking efficiency.
- Inadequate cranking efficiency does not permit proper fuel / air mixture.
- With throttle cracked, excess fuel is being pumped through the cylinders with no combustion.
  - (Discussions with Scott Welch, CFII, IA, Penn Tech instructor)

Comments from Scott Welch

- Slow cranking was dangerous because fuel / air ratio mixture is very rich.
- Not enough air is being pulled in for combustion.
- This lead to an excess of fuel leaking back out through the carburetor.

Results of fire at air intake.

Fuel Flow from Carburetor into the Cowling



Fuel flowed into the cowling and out of the gap at the back of the cowling

Chain of events that could have prevented accident

- A properly functioning Tanis heater should produce heat that can be felt on the engine.
  - Pilots should feel the cylinder heads for palpable warmth.

Chain of events that could have prevented accident

- Oil Check should reveal oil with a normal consistency, not thick.
  - The glow plug on the extension cord had the pilot convinced that the heater was working.
  - Tanis has recognized this issue and now offers a retrofit system where a pilot light indicates that the system is actually functioning.

Chain of events that could have prevented accident

- The initial firing of the engine likely led to frosted plugs.
  - Each short catch led pilot to believe the engine was about to start and run.
  - The concept of frosted plugs had never occurred in previous training.
    - In cold weather when the engine catches briefly and does not continue to operate one should consider frosted plugs.
    - Attempts to start the engine should be discontinued until further pre-heat can be applied.

Chain of events that could have prevented accident

- The continued decrease in cranking efficiency of the cold battery likely led to pooling of fuel in the cowling.
  - When presented with poorly cranking battery consider starting with an external power source.
  - Consider having a second pilot or lineman stand by with a fire extinguisher.

TANIS
AIRCRAFT PRODUCTS

Tanis Engine Preheat System
Owner's Manual

Lycoming and Teledyne Continental Engines

Tanis Aircraft Products
PO Box 117
Glenwood, MN 56334
800-443-2136
320-634-4772

www.TanisAircraft.com

- Information from Tanis Engine Preheat Owner's manual.

HOW LONG TO PREHEAT

The Tanis preheat system is designed to "heat soak" your engine to approximately 60 Degrees F over ambient in 5-6 hours. This is assuming that a Tanis insulated engine blanket is used to cover the cowling during preheat. Additional benefit will be found by installing an insulated prop cover. The insulated covers may also be used without the preheat system to keep the engine warm for up to 5 hours between flights.

Tanis systems are designed to the mass of the engine, will never overheat the engine, and do not need thermostatic control. Do not cycle the system on and off using timers or other devices.

Good Rules to Follow:

- Preheat the engine 4-5 hours before flight or overnight.
- The system can be left on continuously if the aircraft is flown regularly (once a week or so).
- Use an insulated engine and prop cover to increase efficiency of the preheat system.

Information from Lycoming Service Instruction on Cold Weather Starting

LYCOMING
A Textron Company

652 Oliver Street
Williamsport, PA. 17701 U.S.A.
Tel. 570-323-6181
Fax. 570-327-7101
www.lycoming.textron.com

SERVICE INSTRUCTION

DATE: July 1, 2002

Service Instruction No. 1505
Engineering Aspects are
FAA Approved

SUBJECT: Cold Weather Starting

MODELS AFFECTED: All Lycoming aircraft engines.

TIME OF COMPLIANCE: At engine start in cold weather.

In extremely low temperatures, oil congeals, battery capacity is lowered, and the starter can be overworked. Improper cold weather starting can result in abnormal engine wear, reduced performance, shortened time between overhauls, or failure for the engine to operate properly.

The use of pre-heat will facilitate starting during cold weather, and is required when the engine has been allowed to drop to temperatures below +10°F/-12°C (+20°F/-6°C for –76 series engine models).

Be sure that the engine oil is in compliance with the recommended grades.

NOTE

The use of a heated dipstick is not approved because heat is not distributed throughout the engine, and concentrated heat may damage non-metal engine parts. Proper pre-heat requires a thorough decongealing of all oil.

To pre-heat using hot air:

1. Use a high-volume hot air heater.

CAUTION

DIRECT THE HOT AIR CAREFULLY TO AVOID HEAT DAMAGE TO NON-METAL PARTS. OPEN COWL FLAPS IF INSTALLED, SO THAT HEAT BUILD-UP DOES NOT DAMAGE WIRING, HOSES, ETC.

2. Apply hot air directly to the oil sump, external oil lines, cylinders, air intake, oil cooler and oil filter in 5 to 10 minute intervals. Between intervals, feel the engine to be sure that it is retaining warmth. Also check to be sure that there is no damaging heat build-up. During the last 5 minutes, direct heat to the top of the engine.

3. Immediately after pre-heating, start the engine according to the normal starting process. Avoid cranking for more than 5 seconds each start attempt.

NOTE

Due to the battery being cold and subject to rapid discharge, an auxiliary power source is recommended.

4. Avoid rapid acceleration after a cold start. Do not exceed idle RPM, recommended in the engine Operator's Manual, until oil pressure is stabilized above the minimum idling range. Allow up to one minute for oil pressure to stabilize, since lines to the gage may remain cold. If oil pressure is not indicated within 30 seconds, shut down the engine and determine the cause. If no leaks or damage is found, repeat the pre-heat before restarting.

5. Allow the engine to warm up at idle speed until oil pressure and temperature are stabilized within normal limits and proceed to ground check in accordance with the airframe manufacturer's Pilots Operating Handbook.

6. Cycle the propeller control in accordance with the airframe and propeller manufacturer's instructions to insure warm oil is circulated into the propeller dome.

7. After completing the ground check, and before attempting takeoff, check oil pressure, oil temperature, and cylinder head temperature to be sure that all are well within their normal operating ranges.

8. Insure that when takeoff power is applied smoothly, oil pressure, fuel flow, manifold pressure, and RPM are steady. Surges or fluctuations may indicate that the engine is not warm enough for takeoff.

CAUTION

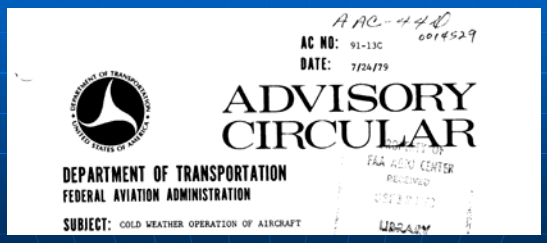
Summary of advice from Lycoming Engines.

CAUTION

THE ENGINE MAY NOT BE WARM ENOUGH FOR TAKEOFF IF THERE ARE INDICATIONS OF:

1. ENGINE ROUGHNESS
2. LOW, HIGH OR SURGING RPM
3. HIGH, LOW, OR FLUCTUATING OIL PRESSURE
4. HIGH OR LOW FUEL FLOW
5. EXCESSIVE MANIFOLD PRESSURE

Cold Weather Start Recommendations from FAA Advisory Circular



AC NO: 91-13C
DATE: 7/24/79

ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

SUBJECT: COLD WEATHER OPERATION OF AIRCRAFT

Cold Weather Start Recommendations FAA AC 91-13c

- Engine Starts
  - i. In moderately cold weather, engines may be started without preheat. Particular care is recommended during this type of start. Oil is partially congealed and turning the engine with the starter or by hand is difficult

Cold Weather Start Recommendations FAA AC 91-13c

- Engine Starts
  - ii. There is a tendency to over-prime, which washes down the cylinder walls and possible scoring of the walls may result. This also results in poor compression and, consequently, causes hard starting. Aircraft fires have been started by over-prime. It is good practice to have a fireguard handy during these starts.

Cold Weather Start Recommendations FAA AC 91-13c

- Engine Starts
  - iii. Another cold start problem that plagues an un-preheated engine is icing over the sparkplug electrodes. When this happens, the 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…..

Cold Weather Start Recommendations FAA AC 91-13c

- Engine Starts
  - iii. … 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 should be removed from the engine and heated to the point where no more moisture is present.

Cold Weather Start Recommendations FAA AC 91-13c

- Engine Starts
  - iv. Engines may 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. Prolonged idling should be avoided.

Cold Start recommendation from Dirk Ellis of Tanis Aircraft

- Prime
- Don't open Throttle too much.
- Begin cranking and reduce the throttle as you crank
  - There is no choke, this creates a choke like effect.
- Use a closed throttle or close as you are cranking.

The Take Home Message for cold weather starts.

- 1. Verify Tanis heater is functioning by feeling for heat on the engine block and looking for a normal consistency of oil.
- 2. If engine is cranking slowly from a cold battery, get assist from an external power source.

The Take Home Message for cold weather starts.

3. Have an additional pilot standby outside the aircraft with a fire extinguisher.

The Take Home Message for cold weather starts.

- 4. During a cold weather start, if you get a brief catch of the engine but the engine does not keep running, STOP, get additional heat to thaw potentially frosted plugs.

Recommendation to CAP

- Consider having existing Tanis heater systems retrofitted with a pilot light connected to the load end of the system.
- This will give the pilot a true indication of a functioning or malfunctioning System.
- Consider the purchase of insulated engine and prop covers as per Tanis recommendation.

References:

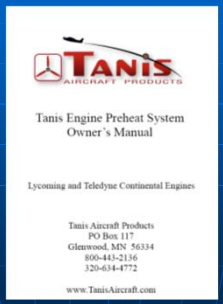
- Personal conversation with Dirk Ellis of Tanis Aircraft.
- Faa AC 91-13c Advisory Circular Cold Weather operation of Aircraft 7/24/1979
- Lycoming Service Instruction no. 1505 Cold Weather Starting

References:

http://www.faa.gov/about/office_org/field_offices/fsdo/fai/local_more/alaskan_articles/media/Winter%20Flying.pdf

References

References

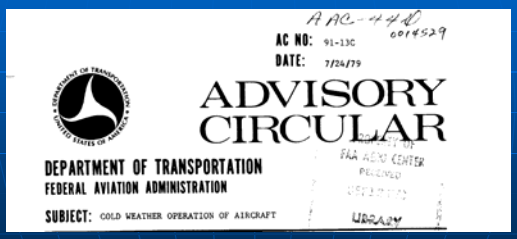


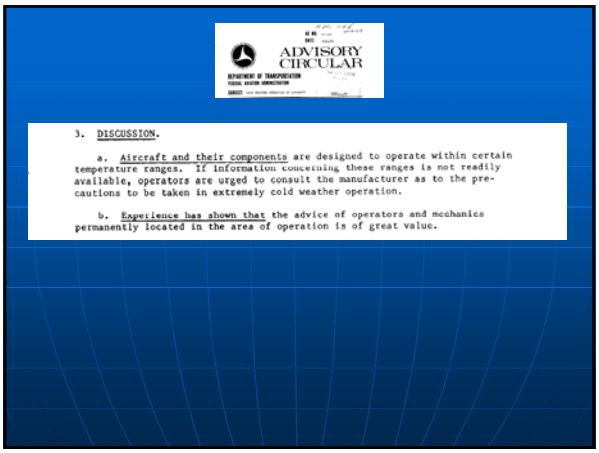
Thank you
I'm glad to be here.
Fly Safe!

Additional information

- The remaining slides cover the remainder of FAA circular FAA AC 91-13c on cold weather flying.
- It covers additional information important to cold weather flying.

Further information from FAA Advisory Circular in following slides.

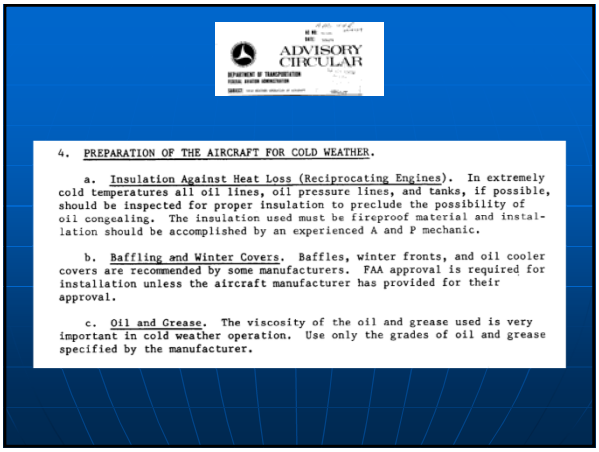

AC NO: 91-13C
DATE: 7/24/79
ADVISORY CIRCULAR
DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
SUBJECT: COLD WEATHER OPERATION OF AIRCRAFT


ADVISORY CIRCULAR

3. DISCUSSION.

a. Aircraft and their components are designed to operate within certain temperature ranges. If information concerning these ranges is not readily available, 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 of great value.

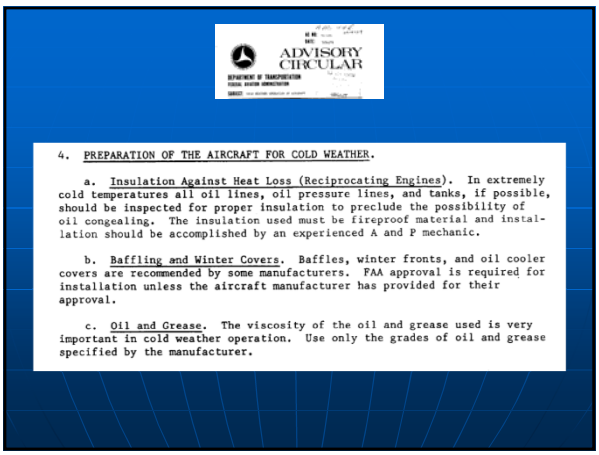

ADVISORY CIRCULAR

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. The insulation used must be fireproof material and installation should be accomplished by an experienced A and P mechanic.

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.

c. Oil and Grease. The viscosity of the oil and grease used is very important in cold weather operation. Use only the grades of oil and grease specified by the manufacturer.

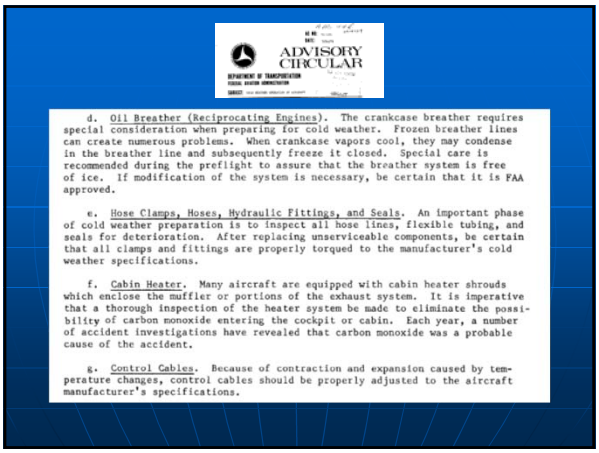

ADVISORY CIRCULAR

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. The insulation used must be fireproof material and installation should be accomplished by an experienced A and P mechanic.

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.

c. Oil and Grease. The viscosity of the oil and grease used is very important in cold weather operation. Use only the grades of oil and grease specified by the manufacturer.



ADVISORY CIRCULAR

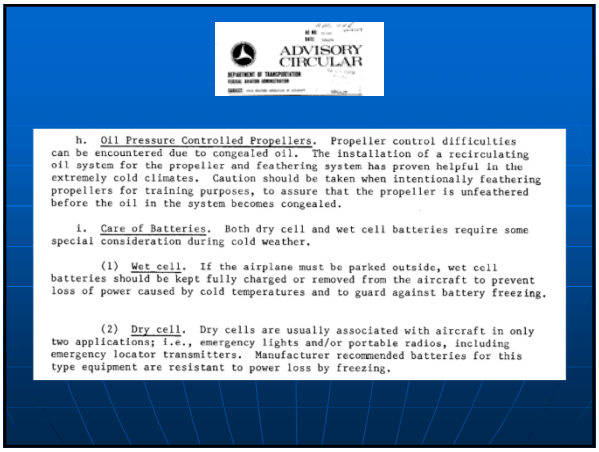
DEPARTMENT OF TRANSPORTATION

d. Oil Breather (Reciprocating Engines). The crankcase breather requires special consideration when preparing for cold weather. Frozen breather lines can create numerous problems. When crankcase vapors cool, they may condense in the breather line and subsequently freeze it closed. Special care is recommended during the preflight to assure that the breather system is free of ice. If modification of the system is necessary, be certain that it is FAA approved.

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 unserviceable components, be certain that all clamps and fittings are properly torqued to the manufacturer's cold weather specifications.

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. Each year, a number of accident investigations have revealed that carbon monoxide was a probable cause of the accident.

g. Control Cables. Because of contraction and expansion caused by temperature changes, control cables should be properly adjusted to the aircraft manufacturer's specifications.



ADVISORY CIRCULAR

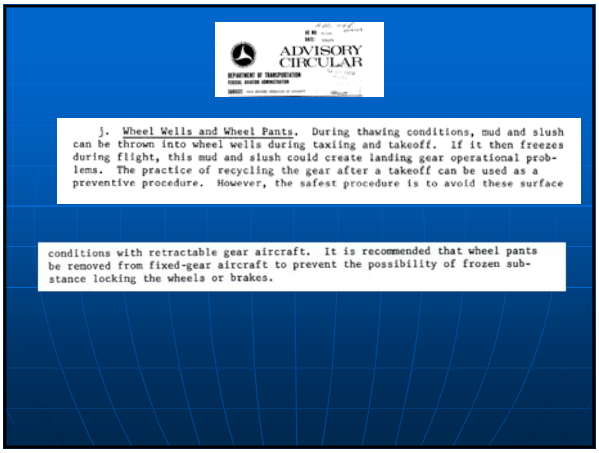
DEPARTMENT OF TRANSPORTATION

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. If the airplane must be parked outside, wet cell batteries should be kept fully charged or removed from the aircraft to prevent loss of power caused by cold temperatures and to guard against battery 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 are resistant to power loss by freezing.

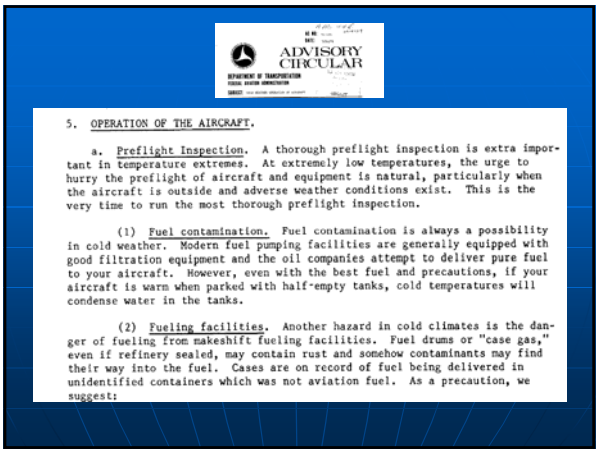


ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION

j. Wheel Wells and Wheel Pants. During thawing conditions, mud and slush can be thrown into wheel wells during taxiing and takeoff. If it then freezes during flight, this mud and slush could create landing gear operational problems. The practice of recycling the gear after a takeoff can be used as a preventive procedure. However, the safest procedure is to avoid these surface

conditions with retractable gear aircraft. It is recommended that wheel pants be removed from fixed-gear aircraft to prevent the possibility of frozen substance locking the wheels or brakes.



ADVISORY CIRCULAR

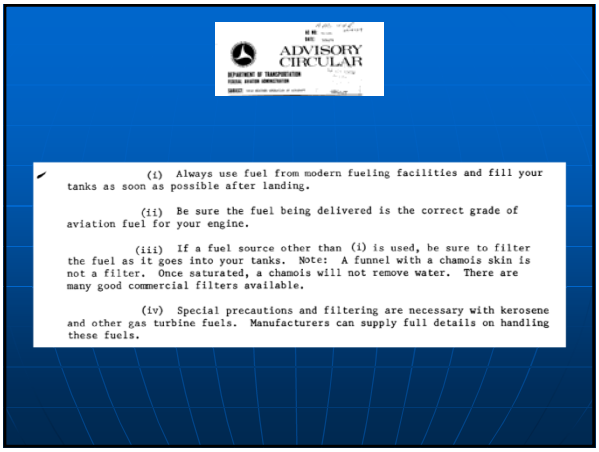
DEPARTMENT OF TRANSPORTATION

5. OPERATION OF THE AIRCRAFT.

a. Preflight Inspection. A thorough preflight inspection is extra important in temperature extremes. At extremely low temperatures, the urge to hurry the preflight of aircraft and equipment is natural, 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 weather. 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 is warm when parked with half-empty tanks, cold temperatures will condense water in the tanks.

(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, may contain rust and somehow contaminants may find their way into the fuel. Cases are on record of fuel being delivered in unidentified containers which was not aviation fuel. As a precaution, we suggest:



ADVISORY CIRCULAR

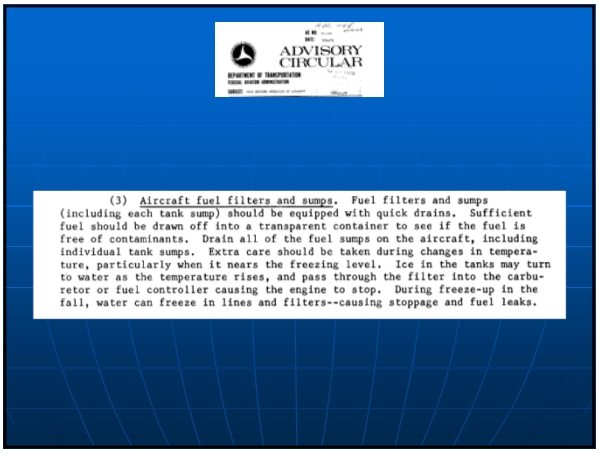
DEPARTMENT OF TRANSPORTATION

(i) Always use fuel from modern fueling facilities and fill your tanks as soon as possible after landing.

(ii) Be sure the fuel being delivered is the correct grade of aviation fuel for your engine.

(iii) If a fuel source other than (i) is used, be sure to filter the fuel as it goes into your tanks. Note: A funnel with a chamois skin is not a filter. Once saturated, a chamois will not remove water. There are many good commercial filters available.

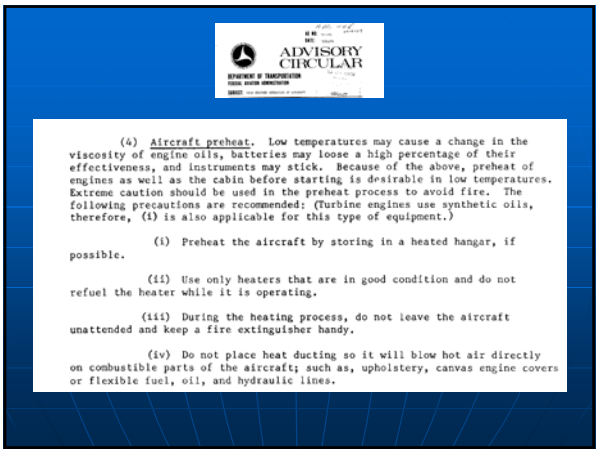
(iv) Special precautions and filtering are necessary with kerosene and other gas turbine fuels. Manufacturers can supply full details on handling these fuels.



ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION

(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. Drain all of the fuel sumps on the aircraft, including individual tank sumps. Extra care should be taken during changes in temperature, particularly when it nears the freezing level. Ice in the tanks may turn to water as the temperature rises, and pass through the filter into the carburetor or fuel controller causing the engine to stop. During freeze-up in the fall, water can freeze in lines and filters--causing stoppage and fuel leaks.



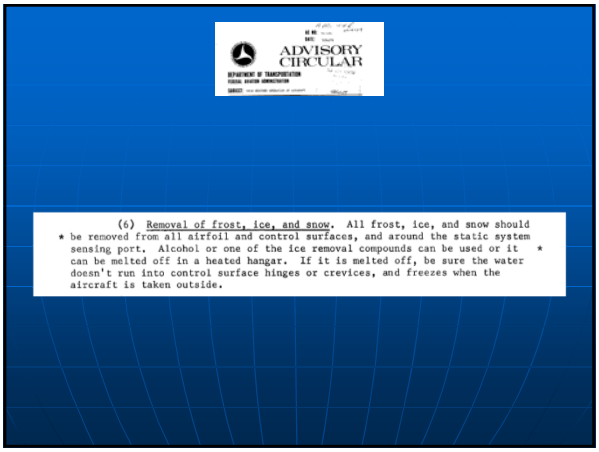
(4) Aircraft preheat. Low temperatures may cause a change in the viscosity of engine oils, batteries may loose a high percentage of their effectiveness, and instruments may stick. Because of the above, preheat of engines as well as the cabin before starting is desirable in low temperatures. Extreme caution should be used in the preheat process to avoid fire. The following precautions are recommended: (Turbine engines use synthetic oils, therefore, (i) is also applicable for this type of equipment.)

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

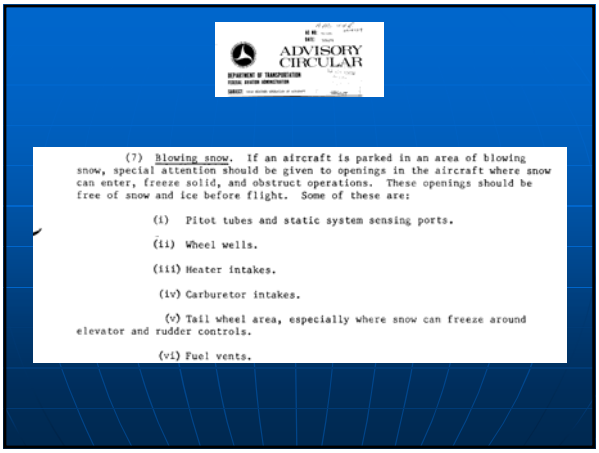
(ii) Use only heaters that are in good condition and do not refuel the heater while it is operating.

(iii) During the heating process, do not leave the aircraft unattended and keep a fire extinguisher handy.

(iv) Do not place heat ducting so it will blow hot air directly on combustible parts of the aircraft; such as, upholstery, canvas engine covers or flexible fuel, oil, and hydraulic lines.



(6) Removal of frost, ice, and snow. All frost, ice, and snow should be removed from all airfoil and control surfaces, and around the static system sensing port. 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 freezes 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 are:

(i) Pitot tubes and static system sensing ports.

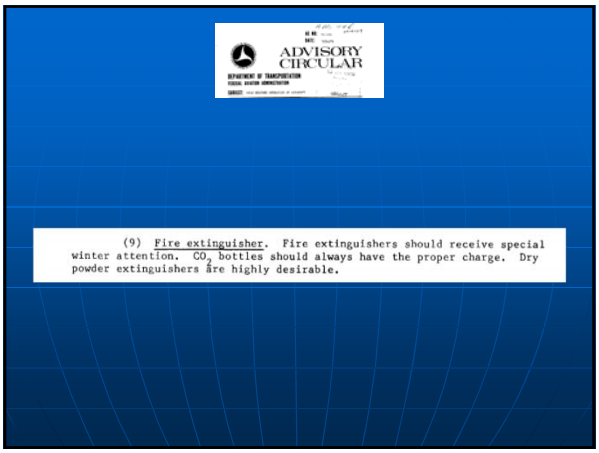
(ii) Wheel wells.

(iii) Heater intakes.

(iv) Carburetor intakes.

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

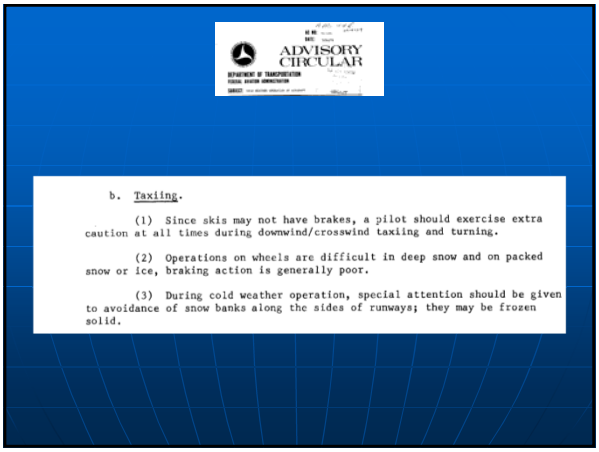
(vi) Fuel vents.



ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION

(9) Fire extinguisher. Fire extinguishers should receive special winter attention. CO_2 bottles should always have the proper charge. Dry powder extinguishers are highly desirable.



ADVISORY CIRCULAR

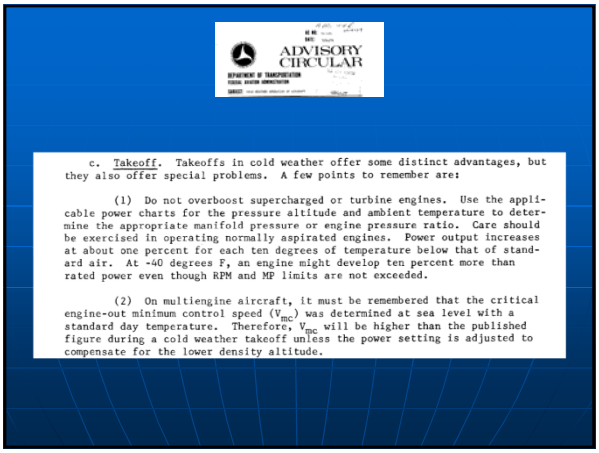
DEPARTMENT OF TRANSPORTATION

b. Taxiing.

(1) Since skis may not have brakes, a pilot should exercise extra caution at all times during downwind/crosswind taxiing and turning.

(2) Operations on wheels are difficult in deep snow and on packed snow or ice, braking action is generally poor.

(3) During cold weather operation, special attention should be given to avoidance of snow banks along the sides of runways; they may be frozen solid.



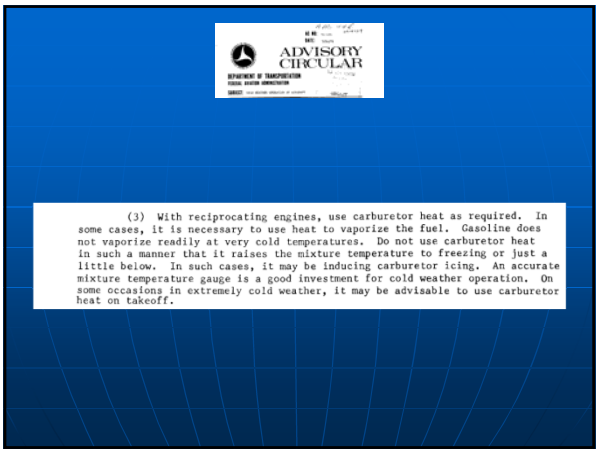
ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION

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

(1) Do not overboost 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 aspirated engines. Power output increases at about one percent for each ten degrees of temperature below that of standard air. At -40 degrees F, an engine might develop ten percent more than rated power even though RPM and MP limits are not exceeded.

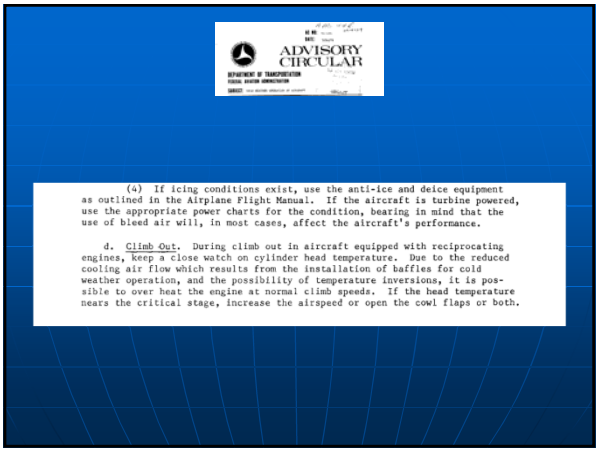
(2) On multiengine aircraft, it must be remembered that the critical engine-out minimum control speed (V_{mc}) was determined at sea level with a standard day temperature. Therefore, V_{mc} will be higher than the published figure during a cold weather takeoff unless the power setting is adjusted to compensate for the lower density altitude.



ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION

(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 readily at very cold temperatures. Do not use carburetor heat in such a manner that it raises the mixture temperature 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. On some occasions in extremely cold weather, it may be advisable to use carburetor heat on takeoff.

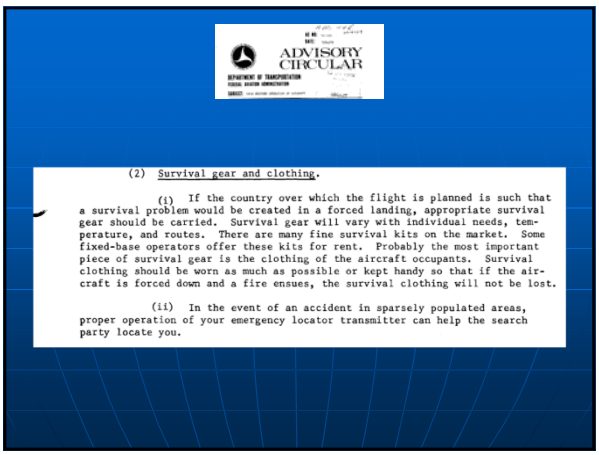


ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION

(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, affect the aircraft's performance.

d. Climb Out. During climb out in aircraft equipped with reciprocating engines, keep a close watch on cylinder head temperature. Due to the reduced cooling air flow which results from the installation of baffles for cold weather operation, and the possibility of 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.



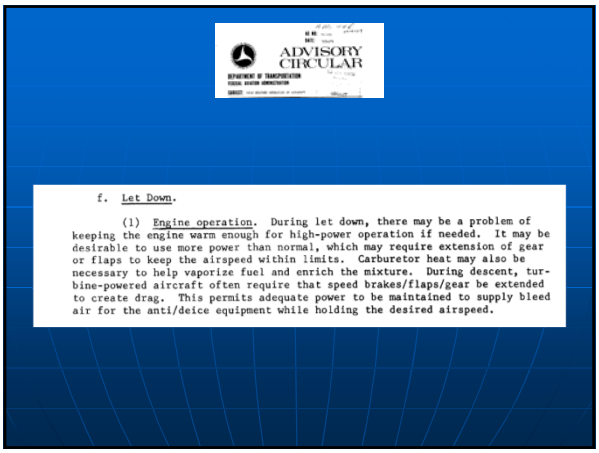
ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION

(2) Survival gear and clothing.

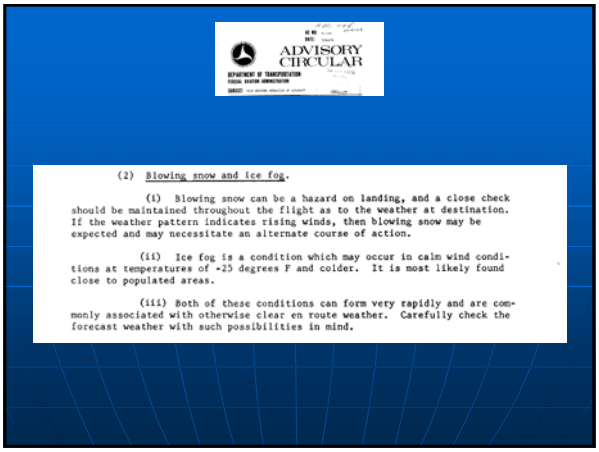
(i) If the country over which the flight is planned is such that a survival problem would be created in a forced landing, appropriate survival gear should be carried. Survival gear will vary with individual needs, temperature, and routes. There are many fine survival kits on the market. Some fixed-base 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.

(ii) In the event of an accident in sparsely populated areas, proper operation of your emergency locator transmitter can help the search party locate you.



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 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 enrich the mixture. During descent, turbine-powered aircraft often require that speed brakes/flaps/gear be extended to create drag. This permits adequate power to be maintained to supply bleed air for the anti/deice equipment while holding the desired airspeed.

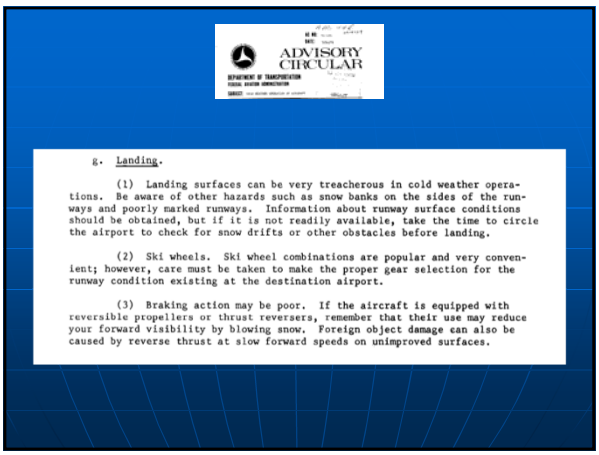


(2) Blowing snow and ice fog.

(i) 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 and may necessitate an alternate course of action.

(ii) Ice fog is a condition which may occur in calm wind conditions at temperatures of -25 degrees F and colder. It is most likely found close to populated areas.

(iii) Both of these conditions can form very rapidly and are commonly associated with otherwise clear en route weather. Carefully check the forecast weather with such possibilities in mind.

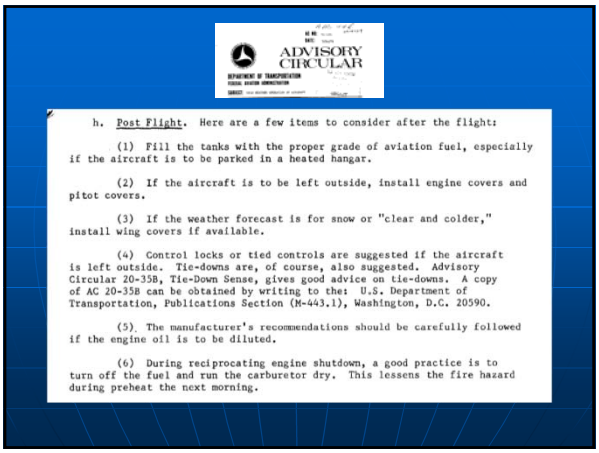


g. Landing.

(1) Landing surfaces can be very treacherous in cold weather operations. Be aware of other hazards such as snow banks on the sides of the runways and poorly marked runways. Information about runway surface conditions should be obtained, but if it is not readily available, take the time to circle the airport to check for snow drifts or other obstacles before landing.

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

(3) Braking action may be poor. If the aircraft is equipped with reversible propellers or thrust reversers, remember that their use may reduce your forward visibility by blowing snow. Foreign object damage can also be caused by reverse thrust at slow forward speeds on unimproved surfaces.



ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION

h. Post Flight. Here are a few items to consider after the flight:

(1) Fill the tanks with the proper grade of aviation fuel, especially if the aircraft is to be parked in a heated hangar.

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

(3) If the weather forecast is for snow or "clear and colder," install 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 20-35B, Tie-Down Sense, gives good advice on tie-downs. A copy of AC 20-35B can be obtained by writing to the: U.S. Department of Transportation, Publications Section (M-443.1), Washington, D.C. 20590.

(5) The manufacturer's recommendations should be carefully followed if the engine oil is to be diluted.

(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.