C-172R Cold Weather Operations

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Introduction

This supplement references FAA Advisory Circular (AC) 91-13C Cold Weather Operation (CWO) of Aircraft, AC 20-113 (prevention of icing in fuel and induction systems in reciprocating-engine aircraft), aircraft manufacturer recommendations, and Operating Instructions for the Red Dragon Engine Pre-heater. The supplement provides guidance to management, pilots, Dispatch, and Maintenance personnel for operations conducted during cold weather to include aircraft preparation, starting, ground operations, flight, and pilot survival. CWO applies to all operations conducted in Bridgewater State University (BSU) aircraft, and includes:

- Guidance for initial and recurrent ground training and testing of all pilots, Dispatcher, and other personnel (as appropriate) determined by the Chief Flight Instructor.
- CWO procedures and responsibilities, pre-takeoff check procedures, operational use of de-icing/heating equipment, and pre-takeoff contamination check procedures.
- Specific procedures for each type of aircraft flown by Bridgewater State University.

CAUTION

BSU pilots and affected personnel shall review and comply with applicable items.

Initial and Recurrent Training

Initial and recurrent training for the Bridgewater State University CWO program is required for all affected personnel [pilots, maintenance personnel, fuelers, dispatchers, Bridgewater State University employees and Bridgewater State University contract personnel (if applicable)] and includes the duties, responsibilities, procedures and practices associated with all equipment used in the program.

Initial training:
- Duties and Responsibilities
- Equipment procedures
- Aircraft-specific requirements

Personnel conducting or receiving de-icing procedures will receive instruction including demonstration and performance training:
- Definitions
- Equipment familiarization / operation
- Aircraft de-icing and pre-heating procedures
- Aircraft checks and communication

Recurrent training occurs not less than annually and includes a review of the segments presented during initial training, and any employee-specific changes to the CWO program occurring since the initial or previous training period.
Aircraft, Personnel, and Equipment

Aircraft de-icing / cold weather procedures are designed to clean the aircraft of frost/ice/snow that could affect flight, and to warm up the aircraft for flight.

The section of the supplement regarding survival is a guide, and is not a replacement for proper pre-flight planning. Pilots are expected to plan accordingly for cold weather flying and should always consider the possibility of an off-airport landing.

Abbreviations and Definitions

**Induction Icing:** May be characterized as impact ice, throttle ice, or fuel (vaporization) ice. A single type or any combination of the three can lead to significant power loss resulting from improper fuel/air ratio. Most important is that induction icing is preventable by the pilot.

“OAT” means Outside Air Temperature

**Red Dragon:** A propane heating/blower unit used to pre-heat the engine and engine compartment and remove ice/snow from aircraft surfaces.

**Slush** – Partially melted snow/ice that can be splashed on the fuselage or landing gear by aircraft wheels during taxi, takeoff, and/or landing.

Cold Temperature Error Table

Table 7-2-3 below, derived from the FAR/AIM and ICAO formulas, indicates how much altimeter error can exist when flying in extremely cold temperatures. BSU pilots are frequently operating under these conditions during day and night VFR and IFR flights. To use the table, find the reported temperature in the left column, then read across the top row to locate the height above the airport/reporting station (i.e., subtract the airport/reporting elevation from the intended flight altitude). The intersection of the column and row is how many feet lower than indicated the aircraft may actually be as a result of the possible cold temperature induced error.

The possible result of the above example is obvious, especially if the aircraft is operating at a minimum altitude and/or when conducting an instrument approach. When operating in extreme cold temperatures, pilots should strongly consider compensating for the reduction in terrain clearance by adding a cold temperature correction.

ICAO Cold Temperature Error Table
### WARNING

Per 14 CFR Part 91.527, BSU aircraft are PROHIBITED from taking off with any frost or contaminants still adhering to the wings, flight controls, or other critical aircraft surfaces.

### Duties and Responsibilities

The following section lists individual personnel functions in the CWO program.

**Chief Flight Instructor**
- Overall responsibility for CWO program.
- Develops and manages the CWO program, including proper training of all personnel with duties and responsibilities related to CWO.
- Ensures proper execution of the CWO program by all participating personnel.
- Advises the Associate Dean, School of Business of necessary CWO program changes.
Dispatcher
✦ Monitors weather conditions at airports affecting Bridgewater State University flight training operations.
✦ Initiates aircraft preparation procedures in anticipation of inclement weather by alerting the evening and morning pilots, arranging for hangar space (when available) for aircraft to be used for the following morning’s first flight, and arranges for early arrival of personnel to assist with morning aircraft preparation.
✦ Coordinates refuel of Red Dragon propane tank and battery recharge with Sandpiper Air, Inc.
✦ Maintains knowledge and proficiency with CWO program to ensure safe and effective flights.

Pilot-In-Command
✦ Conducts pre-heating and de-icing procedures as necessary for on-time departure.

Cold Weather Pre-Departure Inspections
BSU pilots shall conduct the following inspections when operating BSU aircraft within the appropriate weather conditions:

Avionics/Instrument Temperature Limitations
If temperatures are less than -20C or in excess of +55C should refer to the POH located in the respective aircraft for possible limitations of specific instrument/avionics that may affect the proposed flight.

Preflight: Normal walk-around preflight inspection conducted by the pilot, with special attention paid to any aircraft surface contamination. Initiates the required de-icing / pre-heating procedures, if appropriate.

**WARNING**

If in any doubt regarding the condition of the wings or flight control surfaces, the pilot shall DISCONTINUE THE FLIGHT and return to the ramp area.

**WARNING**

Flight into expected or known icing conditions is PROHIBITED.

Snow Removal, De-Icing and Engine Pre-Heating
BSU pilots shall adhere to the following de-icing and engine pre-heating procedures.
Snow Removal
Shovels shall only be used to remove snow from the area in front of the aircraft in order to permit taxiing. Approved brooms / brushes may be used to remove large accumulations of snow from the aircraft.

CAUTION
Specific brooms and brushes are for use ONLY for aircraft snow removal. Avoid damage to aircraft surfaces by ensuring the equipment is free of all debris and is not frozen before use.

CAUTION
Pilots are PROHIBITED from using ANY hard or sharp tool to remove ice from the aircraft surfaces, or attempt to “break” ice from the aircraft; This will likely cause damage to the aircraft in the form of dents, scratches, or punctures.

Blowing snow creates a special hazard in that the snow can enter ports, gaps, and openings and freeze. After snow removal, BSU pilots shall focus special attention on the aircraft pre-flight to ensure contaminants have been removed/have not re-frozen.

Aircraft Pre-Heating Procedures
At OAT temperatures at or below below 32°F/0°C it will likely be necessary to pre-heat the aircraft engine. The following procedures shall be used for engine pre-heating.

WARNING
ONLY properly trained and certified BSU personnel may operate pre-heating equipment. Students are PROHIBITED from using pre-heating equipment.

Night Aircraft Preparation
Prior to Training Center evening closure, and earlier in the afternoon when possible, Dispatch shall select the aircraft to be used for first flight(s) the following day. Dispatch will receive assistance from available pilots or call for additional assistance as necessary.

- Aircraft selected for hangar space shall be taxied to Sandpiper Air, Inc. for placement in the hangar. The CFI of the next day’s pilot(s) (Solo or Dual) shall be contacted and informed that his/her assigned aircraft is located at the Sandpiper hangar.
- Aircraft not selected for hangar space will be de-iced and pre-heated as necessary using the Red Dragon engine pre-heater. Dispatch shall verify that the Red Dragon battery is fully charged, sufficient propane is available for a minimum three (3) aircraft pre-heat/de-ice cycles (approximately ½ gallon of fuel per 1 hour of heating), and that the unit is secured in
Training Center Room 111. Dispatch shall alert Sandpiper, as necessary, of the possible need for assistance in refueling/charging the Red Dragon, or in obtaining additional propane.

- CFI(s) for the non-hangar aircraft (Solo or Dual) shall be contacted and informed of the non-hangar status of his/her assigned aircraft. The CFI is therefore alerted of the need to arrive well in advance of his/her scheduled event departure the following morning.
- Dispatch shall ensure that all snow removal equipment (brooms/shovels, Red Dragon) is clean, free of debris, secured, and ready for use the following morning.

**Morning Aircraft Preparation**

Any non-hangar aircraft shall be readied for flight as follows:

- CFIs for the first flight shall arrive in time to conduct pre-heating and (if necessary) de-icing prior to scheduled departure. *CFIs should allow not less than 45 minutes prior to lesson start time for full engine pre-heat / aircraft de-icing*, and arrive at the Training Center accordingly. Crews will require the use of a step ladder, broom, and the Red Dragon heating unit.
- Dispatch and assigned pilots shall coordinate efforts to utilize the BSU Red Dragon and request assistance from Sandpiper for an additional Red Dragon unit, if necessary.

**Red Dragon Operating Procedures**

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**WARNING**

The Red Dragon Engine Pre-heater shall be used in accordance with the published Operating Instructions.

**Safety Checks**

1. Obtain the Red Dragon from storage Room 111.
2. Check fuel quantity (LP gas cylinder): Approximately ½ gal. is required per hour of heating operation. To determine fuel quantity, estimate approx. weight of cylinder, and subtract tare weight (T.W.) as stamped on cylinder collar from estimated total weight.
3. Divide the result by 4.24 (propane) or 4.81 (butane). The resultant figure is the number of gallons of remaining fuel in the cylinder.
4. Ensure hose is properly connected at heating/blower unit junction. Request assistance if the hose is loose or has come disconnected.
5. Verify battery terminals are free of corrosion, connectors are properly secured, and battery box cap is secured in place.

**Red Dragon Start-Up**

1. Do not attempt Start-up indoors.
2. Ensure fire extinguisher is charged and on hand during use of Red Dragon.
3. Depress safety valve button. Adjust regulator until a small amount of gas is escaping, then release button. Gas should stop immediately.
4. Depress fan switch to engage fan motor. Ensure fan blower is operating.
5. Depress safety valve button and hold down.
6. Press igniter plunger and repeat gently until ignition occurs, then hold red safety valve button down for 15 seconds. At this time release the button, and the burner should continue to function. If the burner goes out, re-attempt the start again from Step 4.
7. Gently adjust regulator (red knob) to obtain the desired amount of heat.
   a. For engine pre-heat, set maximum 10 – 12 psig.
   b. For wing de-icing, set maximum 15-20 psig.
8. NEVER exceed 25 psig. operating pressure. NOTE: Turning the regulator knob to the right increases the flow.
9. NEVER use the Red Dragon to melt snow/ice from Plexiglas components (i.e. windscreen, windows, etc.)

**CAUTION**
Avoid prolonged contact of heating hose with synthetic material (e.g. clothing such as jackets, gloves) when operating at higher heat settings, as the Red Dragon will generate sufficient heat to melt such material.

**CAUTION**
If the fan stops or the unit overheats, immediately shut off the fuel at the fuel cylinder.

**CAUTION**
At NO time is the Red Dragon to be left unattended while it is running.

**Red Dragon Shut-Down**
1. Reduce regulator press. so that only a low roar can be heard from the pre-heater (10 – 20 psi).
2. Turn propane tank valve OFF and let the remaining gas burn out of the hose.
3. Turn Regulator pressure down for storage.
4. Replace the Red Dragon unit in Room 111. Keep the heating hose from dragging on the ground to avoid damage and extend service life.
5. Always store fuel cylinders in their proper upright position.

**Troubleshooting**
For any problems associated with proper operation of the Red Dragon unit, consult the Operating Instructions and Parts Manual pp. 4 -5.
Tips

- To improve heater efficiency and save fuel use the shortest run of ducting and avoid bends as much as possible. The 12’ hose reaches the entire upper wing surface of the QMA-11E.
- For engine pre-heating, place the heater hose end into the cowling space on the underside of the fuselage, between the exhaust pipes. Avoid the breather lines that protrude from the cowling, and position the hose directly beneath the engine block. Apply pre-heat for a minimum of 15 min.
- Do NOT place heating hose so that it blows hot air directly on combustible aircraft components (e.g. upholstery, or flexible fuel, oil, and hydraulic lines).
- For wing and control surface de-icing, apply only enough heat to wing and flight control surfaces to gradually and steadily melt any snow/ice contamination. Ensure liquid contaminants do not re-freeze at hinge joints or inside flight control surfaces.

**WARNING**

During Red Dragon operations, qualified Bridgewater State University personnel shall ensure that a fire extinguisher is in the vicinity at all times.

**Starting Aircraft**

Pre-heat procedures are required for all Bridgewater State University aircraft when the outside air temperature is below 32° F (0°C). Normal engine starting procedures shall be used until temperatures fall below 20° F (-7°C) with and without pre-heating.

- Aircraft flown within the previous hour do not require pre-heating.
- Starting engines without pre-heat below 32° F (0°C) or beyond the one-hour between-flight interval requires prior authorization from the Chief Flight Instructor or his/her designee.
- All cold-weather starts are to be conducted in the following manner:
  - Master Switch OFF
  - Magneto OFF
  - Ignition Key OUT of Ignition and visible to crew member outside the aircraft.
  - Parking Brake engaged.
  - Qualified pilot at aircraft controls.
  - After pre-heating period, propeller pulled counter-clockwise (as viewed from cockpit) through 2-3 full cycles by qualified pilot or Maintenance personnel.
  - Red Dragon shut down and secured, and moved away from propeller area.
  - Attempt engine start using appropriate checklist.

**CAUTION**
Pilots shall avoid over-priming the engine, as this washes down cylinder walls, makes engine starts more difficult, and increases the risk of fire during engine start.

Starting Engine Below 20° F (-7°C)

**CAUTION**

*Pilots shall not attempt more than two (2) engine starts without assistance from Maintenance, the Chief Flight Instructor, or his/her designee.*

**WARNING**

*Do not attempt flight if voltage output shows outside of IFR requirement.*
Standing Water, Ice, Slush and Snow
Pilots are likely to encounter standing water, slush, ice, snow or a combination of these on the runway and/or taxiways at their home or other airport. BSU CFI’s must use good judgment and common sense in dealing with this operational concern.

- Note performance reductions expected of the aircraft. Refer to appropriate performance data as necessary. Know what to expect.
- Tires can freeze to the ramp surface. If the aircraft cannot be moved under normal power, do not apply more power to dislodge the tires. The aircraft may break free, but is likely doing so onto an equally frozen surface where it will then move rapidly forward and endanger other aircraft and personnel.
- Increase taxi spacing/distance behind other aircraft when ramps and taxiways are contaminated, to allow greater time to bring the aircraft to a stop. If taxiing behind turbine aircraft, keep in mind that their exhaust can cause dry snow to melt and freeze on aircraft surfaces, and may cause ice and sand to be blown onto trailing aircraft.
- Verify that flight controls have full freedom of movement prior to takeoff.
- Change altitude immediately if severe ice is encountered.
- Select an altitude above the clouds or at least one that reduces icing exposure. Question returning crews, if available, and/or ATC about any icing encounter or potential for same.
- Radio static may occur in cumulus clouds at OATs between 0°C and -15°C. A change in airspeed or altitude may help alleviate the problem. Notify ATC of the situation if communications are adversely affected.
- During descent, super cooled clouds at low altitude can increase the potential for icing. The probability of increased exposure time in holding patterns can make matters worse. If assigned a holding pattern in areas where icing is possible, maintain vigilance for icing build-up, and request an immediate deviation from ATC as necessary to exit the icing conditions.
- If landing on an iced runway, land firmly and at the minimum safe speed. Avoid the temptation to “grease it on.”
- On ice-covered ramps the aircraft will likely creep forward even with chocks installed. Avoid heavy use of brakes while taxiing on ice, as they are likely to lock rapidly and render the aircraft un-steerable. Taxi s-l-o-w-l-y.
- Ensure that the parking brake is released to prevent frozen brakes on the next departure.

Survival in Cold Weather
Although much of the area over which BSU training flights occur is generally well populated, the terrain is heavily wooded, rocky, and contains numerous large ponds and other water
hazards. Longer cross-country flights are conducted over inhospitable mountainous terrain. Pilots should always consider the unlikely event of a forced landing during all training operations.

**In cold weather, survival depends on several important factors:**

- **The will to survive:** Perhaps the most important element of survival.
- **Proper gear:** Survival gear varies with individual needs, temperature, and route. There are numerous survival kits on the market, or one can be developed using basic resources and planning. Basic kits include water container, magnetic compass, water-proof matches, cutting tool or multi-tool, string or rope, visual signaling device (flashlight), audible signaling device (whistle), small assortment of first-aid supplies, possibly a survival blanket.
- **Proper clothing:** *Likely the most important piece of gear.* Survival clothing only works if it is being worn. Pilots should wear their gear (preferred) or have it immediately available in the event of a forced landing. Wearing the clothing removes the need to remember to retrieve it in the event of a post-landing fire.
- **Physical status, i.e. level of injury:** A non-injured person’s likelihood of survival is good, under the right conditions. Under any conditions, the survival rate for a severely injured person (broken bones, lacerations, internal organ damage, severe burns, etc.) drops dramatically. Such injuries decrease mobility, physical stamina, and can weaken the psychological state of a downed airman. For an injured person, it is imperative then that rescue assistance be obtained as soon as possible.
- **Effective use of communications** (squawk 7700 and IDENT well prior to landing, contact ATC or others on 121.5 Emergency frequency, personal cell phone, handheld transceiver).
- **Proper use of ELT:** Remember that the ELT can be removed, and should be activated before landing if possible. ELTs are designed to activate automatically in the event of a hard landing similar to the type expected in an off-airport scenario.