Part I

Chapter 9—Airframe and Engine Air Intakes
Anti-icing Systems

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1 General

NOTE: Mod. 2820 renders the thermal anti-icing system inoperative on Mk. 1 aircraft. However, Mk. (K) 1 aircraft are fitted with ice protection systems to the Mk. 1A and (K) 1A standard.

A thermal anti-icing system, augmented by electrically heated mats, is provided for the engine air intakes and for the leading edges of the mainplane, tailplane, fin and elevators. The hot air supply is from the same source as the cabin pressurising and temperature supply. The engine air intakes electric heating mats are thermostatically controlled by sensing units to ensure that the temperature of the area which they cover does not exceed 150°C.

2 Control and indicators—anti-icing system

NOTE: The electrical supply to the ice detectors and heater mats is inoperative until airspeed is above 105 knots, since the 28 V supply from feeder 20 P7 is controlled by the undercarriage pitot switch.

(*a*) In order that the system may function the ENGINE BLEED ISOLATION COCKS switches should all be set to OPEN. The system is then controlled by the following switches and indicators under the second pilot's control:

1. An ICING CONDITION magnetic indicator which indicates when icing conditions are encountered.

2. Three OFF/ON switches for the PORT and STBD. wing and TAIL, together with three OVERHEAT WARNING magnetic indicators and three RESET-OFF switches. When Mod. 769 is embodied the OVERHEAT warning indicators are replaced by warning lights.

3. A magnetic indicator for each wing air exit shutter, which shows white when its associated shutter is fully open.

4. Three OFF/ON switches for the MAIN ENGINE air intake heater mats, the FRONT FUSELAGE HEATERS and the AUXILIARY (fin and wing) HEATERS. Each engine intake boundary layer and saddle heater has a temperature sensing device and amplifier, which, when the switch is ON, cause the associated boundary layer heater to be switched on provided that the temperature is sufficiently low and switched off when the temperature reaches a satisfactory level. The other two systems must be manually switched OFF.

(*b*) (i) The ICING CONDITIONS magnetic indicator shows white when icing conditions are encountered. This is an indication to switch on the systems. When icing conditions cease to exist the ICING CONDITION indicator reverts to black and indicates that the system may be switched OFF.

(ii) When the PORT, TAIL and STBD. ANTI-ICING CONTROL switches are set ON, conditioned hot air is fed to the thermal anti-icing system. In order to make the hot air supplies from the starboard engines available at the tailplane for anti-icing purposes, the navigator's bomb-bay heating switch must be selected to TAIL ANTI-ICING, BOMB-BAY HEATING. The ON selection of the PORT and STBD. switches also opens the wing air exit shutters. Conversely an OFF selection automatically closes the shutters.

(iii) If an overheat warning is given by any one of the three magnetic indicators the hot air valve is moved to the fully closed position and the cold air valve is fully opened. All air exit shutters remain open. Also, in the case of a TAIL overheat warning, the port isolation cock, in the supply lines to the tail, closes.

(iv) To reset any part of the system following an overheat warning, hold up the appropriate RESET switch. This action closes the cold air valve and the system is brought back into use again.

(*c*) A test switch for the ice detector on panel AH, may be used to test the system when the aircraft is on the ground. When held at TEST the switch provides a 28V supply from feeder 10P7.

(*d*) Circuit breakers on panel AV are as follows:

Tailplane anti-icing	1, normal control
	1, reset system
	2, isolation cocks
Mainplane anti-icing	1, per side, normal
	1, per side, reset

3 DV window de-misting (Mod. 813)

(*a*) The DV window demisting system is operative and the electrical supplies for the heater elements are taken from the 28V. DC pitot controlled feeders.

(*b*) The switches labelled WINDSCREEN HEATING on the pilots' coaming panel AZ and the associated magnetic indicator have nothing to do with DV window demisting and *do not* control this system.

(*c*) Circuit breakers on panel AV control the supplies to the DV windows, these must be made and the aircraft flying above 105 kts. before DV window demisting is operative.

4 Bomb-bay heating system

(*a*) *General*

The bomb-bay heating system is designed to maintain a temperature of +2°C. but provision is made to allow manual control within variable limits depending upon the type of store carried. The system will operate only if the starboard ENGINE BLEED ISOLATION COCKS switches are set to ON.

(*b*) *Controls and indicators*

The controls are mounted on the navigator's side panel and consist of:

(i) An OFF/AUTO/COLD/HOT, HEATING CONTROL switch.

(ii) A COOL/NORMAL/WARM rotary TEMP. SETTING CONTROL switch.

(iii) A bomb-bay TEMPERATURE INDICATOR.

(iv) A TAIL ANTI-ICING BOMB-BAY HEATING/BOMB-BAY ISOLATED switch. The switch must be selected to TAIL ANTI-ICING, BOMB-BAY HEATING. With the switch thus set tailplane anti-icing is also in use; with the switch set to BOMB-BAY ISOLATED the starboard isolation cock is closed, bomb-bay heating is inoperative and tail anti-icing is fed from the port engines only.

(v) A magnetic indicator which shows white when the heating is off and black when it is on.

5 Management of the systems

(*a*) *Control of the thermal anti-icing system*

(i) To switch on the system the following procedure should be used:

Appropriate circuit breakers on panel AV . . .	Closed
Engine isolation cocks . .	ON
Anti-icing control switches .	ON. Exit shutter indicators white

(ii) The thermal anti-icing system should be switched on in the following circumstances:

1 During taxying and for take-off in conditions where the air temperature is below +3°C and the relative humidity exceeds 90%.

2 If visual inspection shows ice formation on the windscreen and build-up of ice on the wing leading edges.

(iii) If an OVERHEAT WARNING is given the affected section is automatically switched off. To bring the section back into use, hold up the RESET switch when the indication should be cancelled. If a further warning is given switch OFF the affected system.

(*b*) *Control of the electric heater mats*

In conditions of (*a*) (ii) 1, the heater mats may be switched on prior to take-off, the airspeed switch keeping them inoperative until a speed of 105 knots is attained.

(*c*) *Flying procedure during icing conditions*

NOTE: See also Part IV, Chap. 1, para. 8.

(i) *Climb*

Partial protection only is to be expected by climbing at 300 knots at 98% RPM. Optimum protection is achieved at 250 knots at 98% RPM. Decrease in forward speed will result in some range loss. A greater range loss may ensue from the increased drag, caused in severe icing conditions by the ice accretion on the outer wing.

(ii) *Descent*

1 The 208v variable-frequency power for the electrically-heated mats is normally supplied by the outboard engines and during descent under icing conditions it is important to keep No. 1 and No. 4 alternators in high power, and to keep RPM as high as possible to give maximum amount of heat for anti-icing the aircraft structure. During a descent under icing conditions where OAT is above −10°C, descent should be made with Nos. 2 and 3 engines throttled fully back and Nos. 1 and 4 engines maintained at 80% RPM with airspeed controlled to 240 knots by use of air brakes. For temperatures below −10°C the maximum continuous icing conditions will not extend through a layer of more than 10,000 ft. Under these conditions a rapid descent at 300 knots should be made through the icing layer, so that time spent under these conditions should not exceed 1½ to 2 mins. Again Nos. 1 and 4 engines should be kept at maximum power

consistent with a forward speed at 300 knots, and Nos. 2 and 3 engines throttled fully back. During a rapid descent under conditions below −10°C some ice may build up on the outer wings and in the engine intake. Run back, due to incomplete evaporation, is likely to occur down the engine intake and refreeze in rivulet form, which may break away and pass through the engine. After the descent, OAT should be approaching −10°C at let-down height of 2,500 feet, and a normal landing should be made.

2 The above procedures are recommended using power on outboard engines to provide heat for wing de-icing and to use the normal 208v supply for heating mats. If an outboard engine fails, the inboard engine should be used, at as high power as possible, to provide the maximum amount of heat for anti-icing. Under these conditions the inboard alternator, which is normally at standby, will provide AC power for the electric heater mats.

3 Cold weather icing tests carried out on Sapphire engines indicate that the engine can accept limited quantites of ice through the compressor without affecting running, but after descent through severe icing conditions inspection of compressor blades should be carried out.

(iii) Pre-Mods. 2548 and 2802B & C if thermal anti-icing is an operational necessity during climb to or descent below 20,000 feet normal drills should be followed and the occurrence reported in F.700.

(d) Control of the bomb-bay heating system

(i) All bomb-bay heating controls are at the navigator's station. The system should normally be operated at AUTO with a temperature setting suitable for the stores carried. Should the automatic system fail, the temperature can be controlled manually by moving the heating control switch to HOT or COLD as necessary.

(ii) Pre-Mods. 2548 and 2802B & C if bomb-bay heating is required either No. 3 or No. 4 engine bleed valve must be opened but that engine must not exceed 85% RPM.