CHAPTER 9

ANTI-ICING SYSTEM

Chapter 9 ANTI-ICING SYSTEM

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

DESCRIPTION AND OPERATION

General

1. The anti-icing systems of this aircraft prevent the formation of ice around the engine air-intakes, the engine air-intake cowlings, the windscreen, the air-intakes for the cabin and radio bay air conditioning systems, the pressure heads and the airstream direction detector probe. In all cases the area requiring protection is heated, hot air from the engines being used for the engine air-intakes and air-intake cowlings and electrical heaters being fitted at the remaining points. Selection of these facilities is effected by four switches on the pilot's starboard switch panel. An ice detector system, selected by a further switch on the starboard switch panel, warns the pilot when icing conditions exist.

Engine air-intakes

2. To prevent ice forming at the engine air inlets, hot air can be bled from the twelfth stage of each engine high pressure compressor and ducted forward along the top of the engine, through two combined on-off and pressure reducing valves, to supply tubes housed in an annular manifold surrounding the engine air inlet. From one of these supply tubes, air is directed down the hollow inlet guide vanes and a small amount flows to the air inlet hub fairing; the bulk of the air supply is then directed back to the manifold, again via

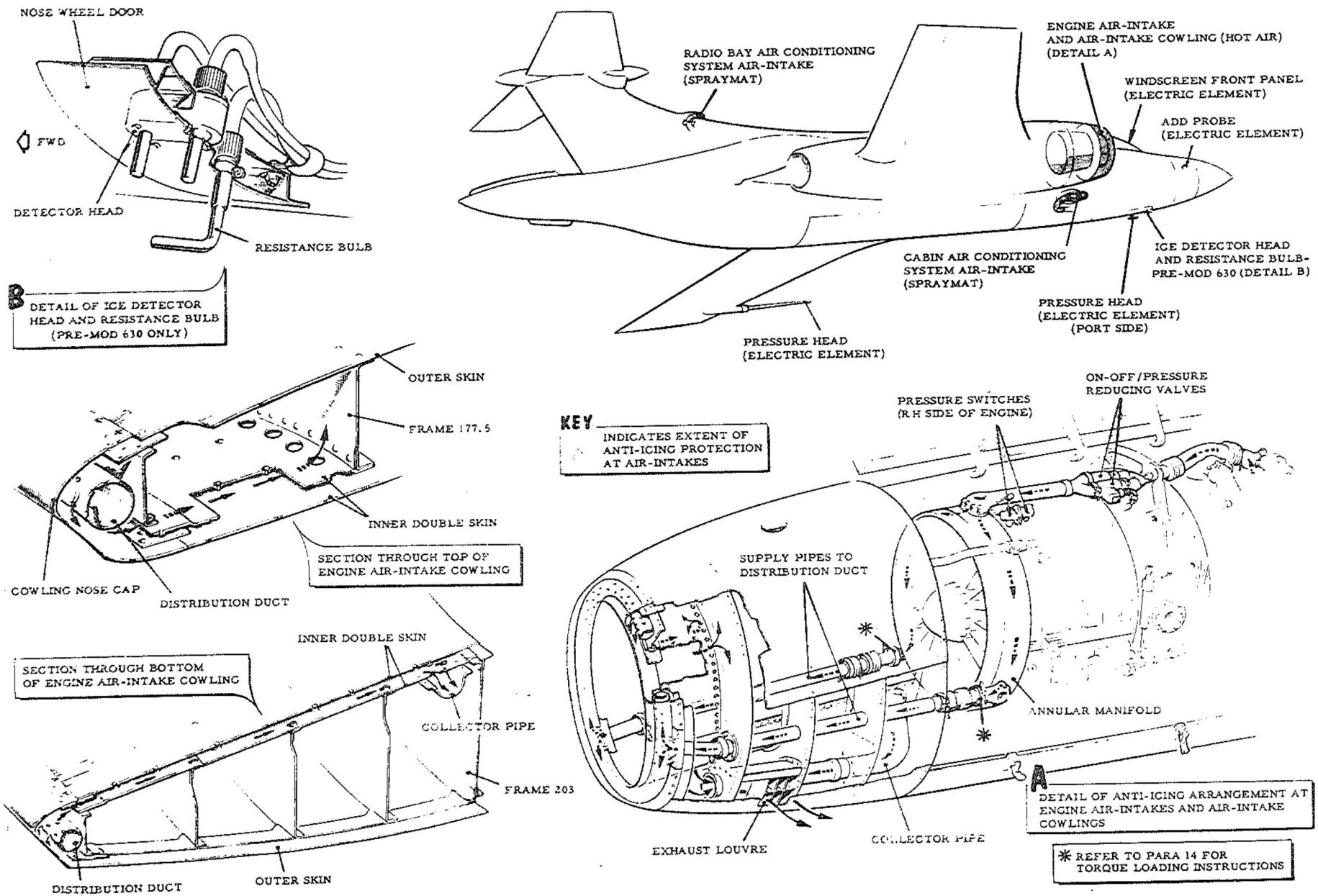

Fig. 1. Anti-icing system arrangement
(Annotation amendments)

BUCCANEER S MK. 2 AIRCRAFT AIR DIAGRAM 6810AQ/MIN.	
ISSUE 2	PREPARED BY MINISTRY OF AVIATION FOR PROMULGATION BY MINISTRY OF DEFENCE

RESTRICTED

YB6/1/2/50 89970 500+500 11/66 HSAL 1423

the inlet guide vanes, and from there is routed forward through two ducts to heat the engine air-intake cowling (*para* 4) before exhausting to atmosphere. The remaining supply tube within the annular manifold exhausts directly into the manifold. The valves controlling the flow of hot air are selected by two switches marked ENGINE ANTI-ICE on the pilot's starboard switch panel. One switch, annotated No. 1 VALVES, ON–OFF, controls one valve on each engine and the other switch, annotated No. 2 VALVES, ON–OFF, controls the remaining valve on each engine.

3. A three-position magnetic indicator, mounted on the starboard dashboard shroud panel and marked ENG. ANTI-ICE, is controlled by four pressure switches – two on each engine – which sense the pressure in the ducting downstream of the valves. During flight, this indicator displays black and white diagonal stripes when the pressure at both engines is less than 5 p.s.i., e.g., system switched off, ON when the pressure at either engine is between 5 and 65 p.s.i. and O/P (over pressure) when the pressure at either engine exceeds 65 p.s.i. To enable the system on each engine to be tested individually prior to flight, a test switch marked ENGINE ANTI-ICE TEST, STBD–PORT is mounted above the two engine anti-icing switches. With the aircraft on the ground, the position of the test switch determines whether the indicator registers conditions in the ducting at the port or starboard engine. This test facility is not available when the aircraft is airborne. Details of the engine anti-icing system are in A.P.102C-1104-1, and of the electrical circuits in A.P.101B-1202-1B, Cover 1, Sect. 6, Chap. 8.

Engine air-intake cowlings

4. The leading edge of each intake cowling is heated by air taken from the annular anti-icing manifold at the engine air inlet (*para* 2). From the manifold, two supply pipes extend forward to a distribution duct fitted around the periphery of the cowling leading edge. Four rows of holes, eighty holes in each row, are drilled in the front face of the distribution duct to direct the air onto the rear face of the cowling nose cap. After heating the nose cap, the air passes rearwards to flow into the space between the two layers of a double skin forming the inner surface of the cowling. The lower portion of this double skin extends to the aft end of the cowling where a collector pipe, communicating with the space between the two layers of skin, directs the air forward to an exhaust louvre located between cowling frames 177.5 and 186, from which the air is discharged to atmosphere. The side and upper portions of the cowling inner skin only consist of a double skin as far aft as frame 177.5, where the outer of the two skins terminates and contains a series of holes to allow the anti-icing air to escape into the cowling structure, thus heating the outer surface of the cowling forward of frame 177.5 before discharging to atmosphere at the exhaust louvre. As this system uses air supplied by the engine anti-icing system, selection is effected by the switches marked ENGINE ANTI-ICE on the pilot's starboard switch panel (*para* 2).

Air conditioning systems air-intakes

5. Electrical heaters are fitted at the air-intakes of the cabin and radio bay air conditioning systems to prevent the formation of ice. Two heating elements are fitted at each air-intake, one to heat the mouth of the intake and the other to heat the ducting immediately downstream of the intake. Each heating element (Spraymat) consists of a pattern of sprayed metal embedded between two layers of insulation. To protect the forward portion of the Spraymat at each air-intake mouth from damage caused by rain erosion or the impact of hail or stones, a layer of resin loaded with stainless alloy particles (Erocoat), is applied on top of the Spraymat in this area to form a hard protective coating. This protection is not necessary for the Spraymats on the ducting as they are secured to the external surface of the ducts and are therefore not in contact with the airflow. Mod 1147 introduces improved protection in the form of a stainless steel cap which is bonded on to the Spraymat and replaces the Erocoat at the extreme tip of each air-intake where the effect of rain erosion is at its highest.

6. These facilities are selected by the engine anti-icing switch marked No. 1 VALVES, ON–OFF (*para* 2) in conjunction with a contactor sensing the air speed of the aircraft. Provided that the aircraft is flying at an air speed greater than 145 knots (pre-Mod 1468) or greater than 95 knots (post-Mod 1468), a selection of the engine anti-icing No. 1 valves switch to ON causes an electrical supply to be extended to the heaters which then commence to warm up. With the system switched on, the heaters are controlled thermostatically, being switched on when the temperature

of the Spraymat falls to 45 deg C and off when the temperature rises to 50 deg C. A reduction in air speed to 115 knots (pre-Mod 1468) or less than 95 knots (post-Mod 1468), or an OFF selection on the engine anti-icing No. 1 valves switch, disconnects the electrical supply to the heaters thereby rendering the system inoperative. Further details of the Spraymats and the electrical circuits are in A.P.1464D, Vol. 1 and A.P. 101B-1202-1B, Cover 1, Sect. 6, Chap. 8 respectively.

Windscreen

7. To prevent the formation of ice on the windscreen front panel, the glass is heated electrically. The heating elements are incorporated within the laminated panel. The heater is selected by a switch, marked W/SCR HEAT, ON–OFF, mounted on the pilot's starboard switch panel. With the switch selected to ON, heating of the windscreen is controlled automatically, the elements being switched on when the temperature at the windscreen falls below 40 deg C and off when the windscreen temperature rises to 50 deg C. Full voltage is not available to the elements until the aircraft is airborne. Should a fault in the control system allow the windscreen temperature to rise to 65 deg C, an overheat sensing element detects the rise in temperature and the system is switched off to prevent damage to the windscreen. On the starboard dashboard shroud panel is a three-position indicator marked W/SR HEATER, which shows black and white diagonal stripes when the system is switched off, NORM when the control system is operating normally and O/HT with an overheat condition. Detailed information on this system is contained in A.P.101B-1202-1B, Cover 1, Sect. 6, Chap. 8.

Pressure heads and A D D probe

8. Two pressure heads, one on the port outer plane and the other at the forward end of the front fuselage on the port side, can be heated electrically by selecting a switch marked PRESSURE HEADS, ON–OFF to the ON position. This switch, located on the pilot's starboard switch panel, also controls a heating element in the A D D probe on the starboard side of the folding nose. Information on these systems is in A.P.101B-1202-1B, Cover 1, Sect. 6, Chap. 8.

Ice detector

9. An ice detector system is fitted to give the pilot indication when icing conditions prevail. The system may be either one of two different types, depending upon whether Mod 630 is embodied or not. Both types of system are briefly described in the following paragraphs and detailed information, including testing, is in A.P.101B-1202-1B, Cover 2, Sect. 7, Chap. 6.

Pre-Mod 630 system

10. This system consists of an ice detector head and a resistance bulb, both at the forward end of the nose wheel door (*detail* B, *fig* 1), a control unit, a two-position electro-magnetic indicator marked ICE on the starboard dashboard shroud panel and a switch marked ICE DETECTOR, ON – OFF on the pilot's starboard switch panel. With the switch selected to ON, the detector head and resistance bulb sense the onset of icing conditions and the control unit completes an electrical circuit which energizes the indicator to show ICE. Under normal conditions the indicator shows black. To prevent damage to the detector head, which incorporates a heater, it is rendered inoperative until the aircraft attains an air speed of 145 knots (pre-Mod 1468) or 95 knots (post-Mod 1468).

Post-Mod 630 system

11. An ice detector, comprising a 3-phase a.c. motor driving a serrated rotor which protrudes through the aircraft skin into the airflow, forms the basis of the post-Mod 630 system. Located on the port side of the folding nose between stations 60-9 and and 65-8 (*fig* 2), the ice detector is controlled by a switch marked ICE DETECTOR, ON – OFF on the pilot's starboard switch panel. Indication is provided by a two-position electro-magnetic indicator marked ICE on the starboard dashboard shroud panel. When the switch is selected to ON, the rotor commences to revolve in close proximity to a knife edge and, under normal conditions, the indicator shows black (de-energized). With the onset of icing conditions, any formation of ice on the rotor and knife edge tends to prevent the rotor from turning; this resistance to rotation is utilized to complete an electrical circuit to the indicator which then displays ICE.

SERVICING

General

12. Servicing requirements are confined to visual examination, replacement of defective parts and testing the individual facilities. A test of the engine air-intake and air-intake cowling anti-icing systems is in this chapter and tests of the electrical heating systems are in A.P.101B-1202-1B, Cover 1, Sect. 6, Chap. 8.

Engine anti-icing system

13. The precautions necessary when starting and running the engines, prior to testing the engine air-intake and air-intake cowling anti-icing systems, are in Cover 1, Sect. 2, Chap. 2. If, during operation, an indication of over pressure is obtained on the indicator at the pilot's station, the system should be switched off immediately and the fault investigated. In addition, the appropriate intake cowling should be exam-

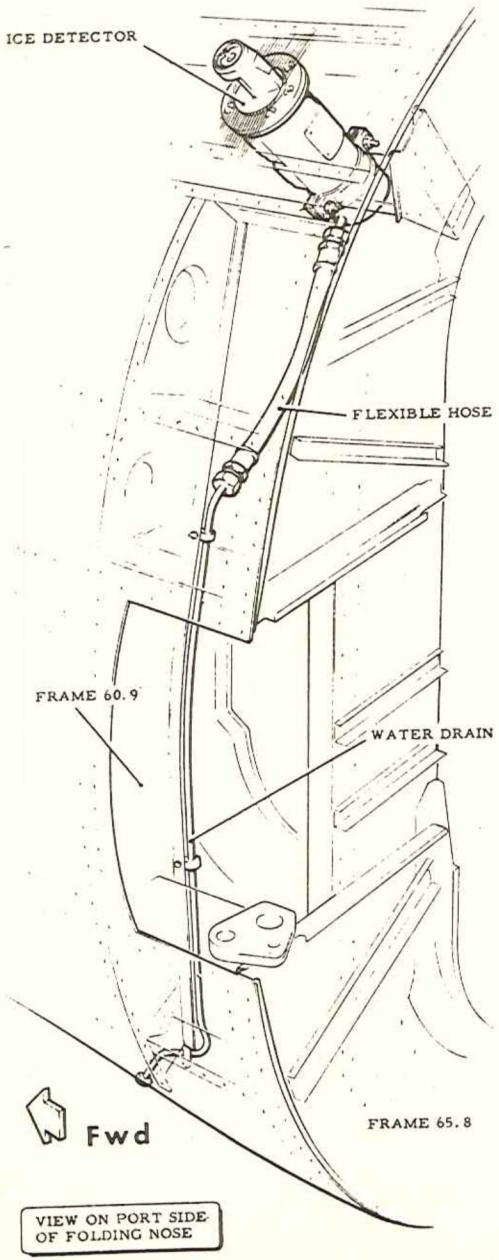

Fig. 2. Ice detector (post-Mod 630)

ined for signs of damage over the areas which are anti-iced, especially to the nose cap at the leading edge of the cowling.

Conoseal couplings – method of assembly

14. To ensure a satisfactory joint, Conoseal couplings in the hot air supply ducts should be assembled and, with the exception of the two couplings marked with an asterisk on fig 1, torque loaded as detailed in Cover 1, Sect. 2, Chap. 4. As the two exceptions at each engine incorporate light-alloy flanges, they should be torque loaded to 25 ± 5 lb in. only.

Function test

15. Apart from making the necessary selection on the engine anti-icing test switch, the following test procedure is applicable to either engine. If Mod 1023 is not embodied, references to the anti-icing indicator and test switch should be ignored. If Mod 1090 is not embodied, the upper engine cowling door must be open when performing the test. With the appropriate engine running at idling speed, the engine anti-icing test switch selected to either PORT or STBD, depending upon which system is being tested, and both engine anti-icing switches selected to OFF, proceed as follows:-

Caution...

*During the following test it is necessary to check that air is discharging from the exhaust louvre on the air-intake cowling. Personnel performing this check must remain within the bounds of the safety zone (*Cover *1,* Sect. *2,* Chap. *2) at all times, must stand as far behind the engine air-intake as possible and are warned that the discharging air will be at a high temperature. If protective headgear is being worn it must be securely fastened before approaching the air-intake.*

(1) Increase the speed of the engine under test to maximum and ensure that the engine anti-icing indicator shows black and white diagonal stripes.

(2) Select the engine anti-icing No. 1 valves switch to ON. Ensure that air issues from the anti-icing exhaust louvre on the appropriate air-intake cowling and the engine anti-icing indicator shows ON.

(3) Select the No. 1 valves switch to OFF, ensure that the flow of air from the exhaust louvre ceases and the indicator shows black and white diagonal stripes.

(4) Repeat operation (2) and (3) making selections on the engine anti-icing No. 2 valves switch in lieu of the No. 1 valves switch.

(5) Reduce the engine speed to idling.