

1. GENERAL.

The aircraft is fully equipped for all-weather operation.

The ice and rain protection system is divided into:

- Wing and stabilizer (boot) de-icing
- Engine anti-icing
- Propeller de-icing
- Windshield anti-icing
- Windshield wipers
- Pitot tube heating, Total Air Temperature probe (TAT) and angle of attack sensor heating.

Bleed air and electrical power, mainly from the 115/200 VAC system, is used for ice and rain protection. Bleed air is used for wing and stabilizer inflatable boots, engine intake, including inlet tip, torque meter shroud and engine inlet. Electrical power is used for the remaining parts of the ice and rain protection systems.

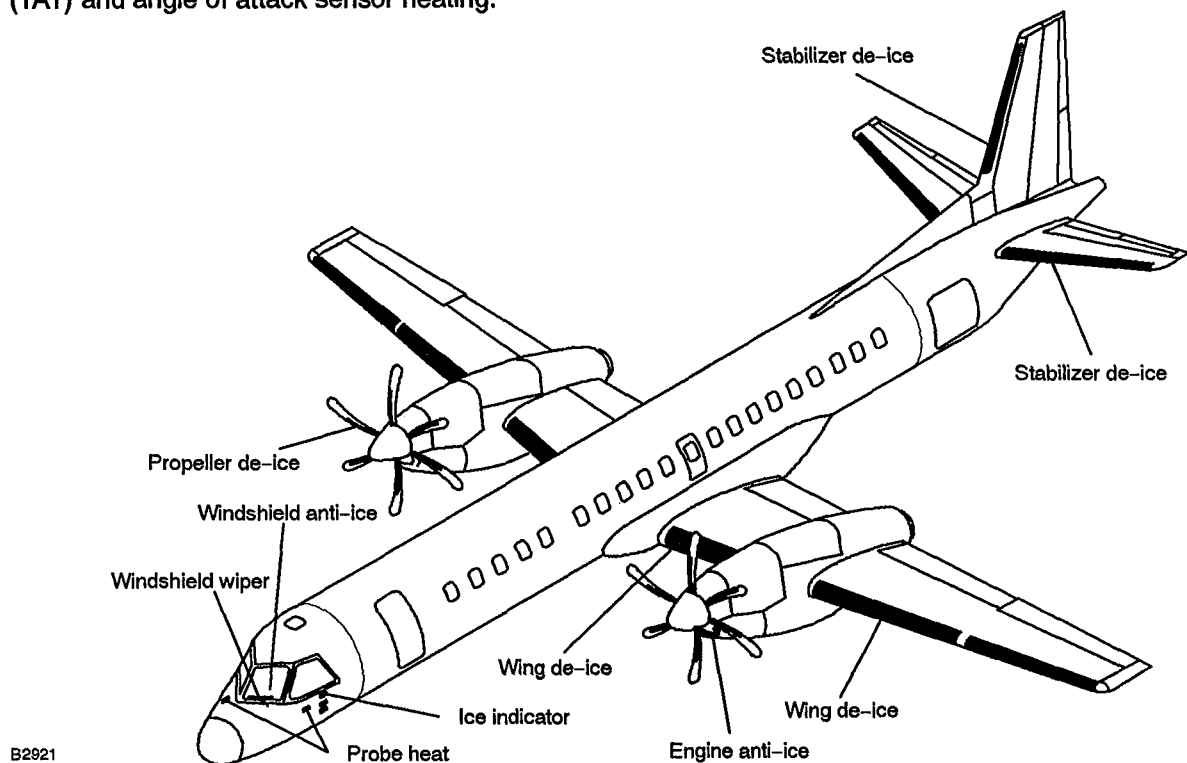


FIG 1. Ice and rain protection system.

2. MAIN COMPONENTS AND SUBSYSTEMS.**2. 1. Propeller de-icing.**

The propeller blades are equipped with electrically heated rubber boots powered from the 115/200 VAC 3 phase busses. There are 6 heat zones on each propeller blade. All zones on all blades are heated simultaneously. The system is controlled by L/R PROP pushbutton for each propeller. When selected ON the lower half of each button will indicate ON in blue and L+ R PROP D-ICE status message will be presented on EICAS status page.

During normal operation each propeller de-icer boot is powered by its associated AC generator. In the event of an engine or AC generator failure the propeller de-icer boots are automatically powered from the opposite side.

Once the de-icing system is activated the heat-ON/heat-OFF time bands will vary automatically depending on the TAT received from L/R ADC respectively. The propeller de-icing shall be used at temperatures of -1 °C or colder. If the system is selected ON at higher temperature, the heating system will not activate until the temperature is below -1°C.

To improve the ice shedding capability during climb and cruise the PRPM can be increased to 1100 by pushing the HI RPM pushbutton. Power will be unchanged.

Should the TAT input from both ADCs be lost, a default cycle for propeller de-ice will be used, corresponding to the warmest TAT time band.

L or R PROP D-ICE INOP or L or R PROP D-ICE DEGRAD will be activated together with FAULT in L or R PROP pushbutton should any of the following failures occur in the system:

- Loss of power supply
- Timer fault
- Heating zone fault
- Dual TAT input fault.

2. 2. Engine anti-ice system.

The engine intake including inlet tip, torque meter shroud and engine inlet are anti-iced by compressor bleed air from the engine. In addition, the air is used to anti-ice the oil cooler air inlet tip. The system is controlled by L/R ENG pushbuttons for the respective engine. When selected ON the lower half of each button will indicate ON in blue and L+ R ENG A-ICE status message will be presented on EICAS status page. The pushbutton controls the anti-ice valve on the engine, opening up the supply of hot air. If the power to the anti-ice valve is lost, the valve fails open.

L ENG A-ICE FAULT or R ENG A-ICE FAULT will be activated together with FAULT L or R in L or R ENG pushbutton if any of the following failures occur in the system:

- Anti-ice valve not open when commanded
- Anti-ice valve not closed when commanded.

2. 3. Wing and stabilizer (boot) de-ice.

Wing and stabilizer leading edges are de-iced by conventional inflatable boots. The boots are black colored, but as an option silver colored boots are available. On the silver colored boots there are black stripes to improve ice detection.

Air is normally supplied from the ECS system. Under some conditions (cold temperature and low power settings) this pressure is not enough. Under such conditions a pressure switch automatically opens the L/R AIR SUPPLY valve thereby supplying regulated air from bleed air ports on the engines. The boots are divided into four zones which forms the sequence for operation. Boot operation is controlled by a timer which in turn activates distribution valves in each boot zone.

The timer sequence is:

- Wing leading edge upper portion
- Wing leading edge lower portion
- Horizontal stabilizer upper portion and vertical stabilizer
- Horizontal stabilizer lower portion.

Boot de-icing is activated (one cycle) by pressing the CYCL pushbutton in the ICE PROTECTION panel. Each zone will be inflated for 6 seconds. During the inflation sequence, W+STAB D-ICE status message will be presented on EICAS status page. There is an approximately 1/2-inch band close to the stagnation point which is not inflatable on the wings and horizontal stabilizers. When the boots are not inflated a vacuum pressure is created to prevent inflation due to aerodynamic lift.

Do not use the boots at SAT below -40°C . The rubber becomes stiff which may result in only slight inflation and/or the inflation sequence being prolonged resulting in cautions being generated. It may also cause damage to the boots.

W+STAB CTL FAULT will come on if any of the following failures occur in the system:

- Timer failure
- Loss of electrical power to the timer.

W+STAB L AIR OVTEMP or W+STAB R AIR OVTEMP will come on if an overheat condition is detected in the supply lines. Under this condition FAULT in the L or R AIR SUPPLY pushbutton(s) will come on.

W+STAB AIR FAULT will come on if both L and R bleed air shut-off valves are not closed after ordered closed by the respective AIR SUPPLY pushbutton, and also if both L and R ECS air pressure switches fail.

If an uncommanded inflation occurs, or a boot remains inflated, one or both of the following Master Caution(s) will come on:

- WING BOOT INFLATED
- STAB BOOT INFLATED.

If a boot remains deflated, one or both of the following Master Cautions will be generated:

- WING BOOT DEFLATED
- STAB BOOT DEFLATED.

To improve scanning of the boots in darkness a wing inspection light is available, illuminating the wing leading edges outboard of the nacelles. The lights are controlled by the WING light switch.

2. 4. External probes and sensors.

The pitot tubes, temperature sensor (TAT) and angle of attack (AoA) sensors are electrically heated. Except for the TAT sensor they will all be automatically powered/heated once the respective bus is powered. The TAT sensor is powered via the weight-on-wheels switch and is only powered in the air. If anti-icing fails on any of the units, the respective Master Caution will come on.

2. 5. Windshield wipers.

Each front windshield is provided with a windshield wiper which can be operated in either HI or LO speed or in INT (interval).

2. 6. Windshield heating.

The front windshields and the forward part of the side windshields are electrically heated. In addition, air from the air conditioning system is directed to the inside of the windshields as soon as the airconditioning system is working, to prevent fogging.

The power used for heating is regulated by two controllers. The left controller powers the left front and right side windshield while the right controller powers the right front and left side windshield.

The windshields are powered when GND PWR is connected or minimum one AC GEN is on line, provided not selected off. With Mod No 6080 the side windshield are powered:

- On ground when minimum one engine driven AC GEN is on line
- In the air when minimum one AC GEN is on line (engine driven or APU driven).

There is a ramp-up function for warming up to minimize thermal stress in the windshields. Once the windshields have reached their working temperature, the controller will modulate the power output to maintain this temperature.

MC L/R FRONTW HEAT FAULT or L/R SIDEW HEAT FAULT will come on, together with FAULT light in respective pushbutton, for the following failures in the system:

- Loss of power
- Control failures, including sensor failures causing partial or total loss of heating
- Overcurrent.

2. 7. Ice indicator.

An ice indicator in the form of a cylinder shaped probe is installed at the base of the left side window. The ice indicator is illuminated by a separate light, controlled by the WING inspection light switch.

2. 8. Ice speed.

The ICE SPD pushbutton will when activated change the triggering levels (increase) for stick shaker and stick pusher. Shaker and pusher will come on at higher speed.

After take-off, the change in triggering levels is inhibited for 6 minutes after weight off wheels even if the ICE SPD is selected ON.

When selected ON, EICAS status message ICE SPD in blue will be indicated together with modification of the green low-speed cue on PFD IAS scale to the new values.

■ 2.9. Ice detector (Option 30:201).

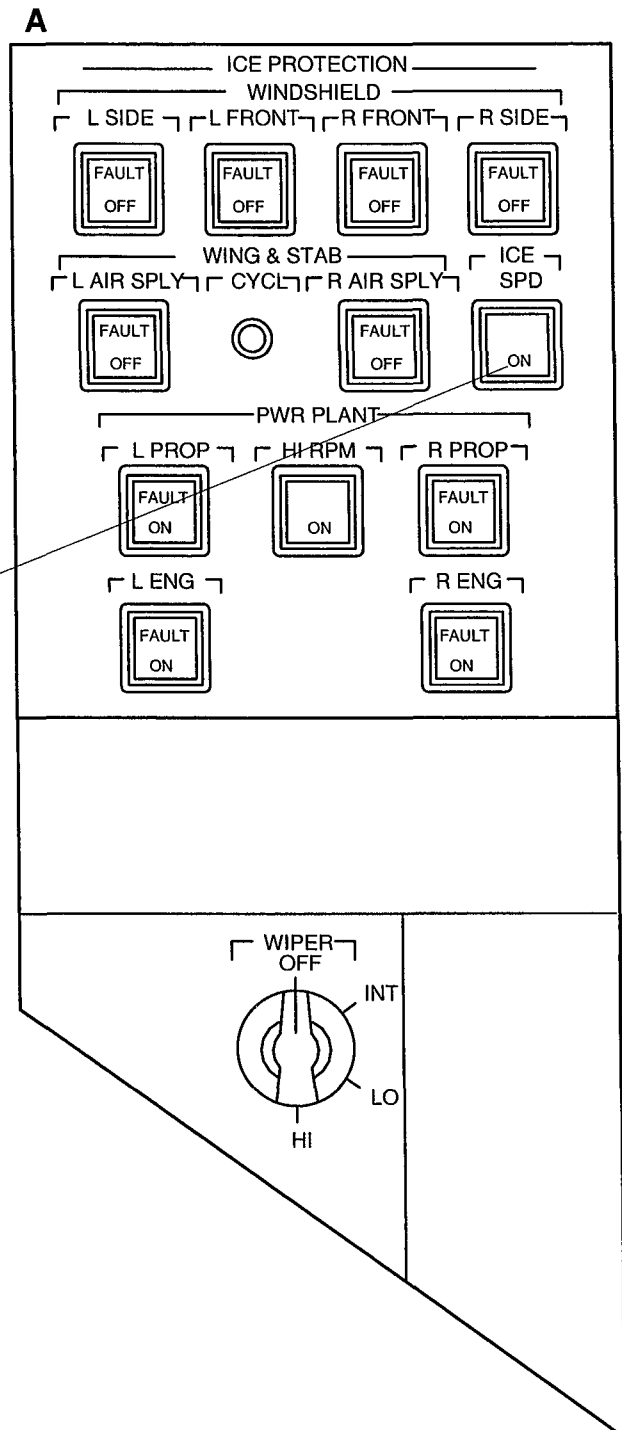
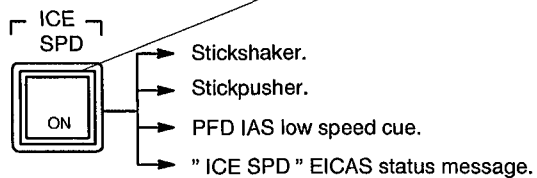
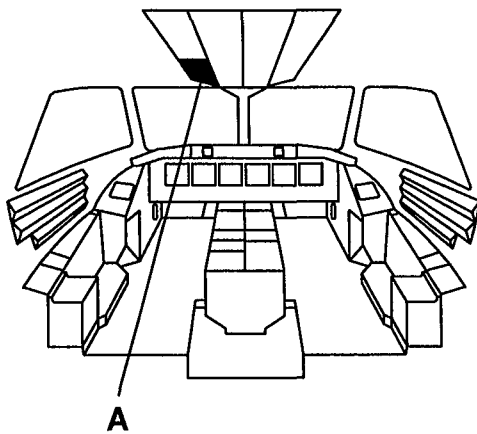
The ice detector consists of an ultrasonic axially vibrating tube as sensing element. The logic is controlled by a micro-processor built into the ice detector housing. Upon sensing ice as evident by a change in frequency, at a preset level, the micro-processor will activate the ICE COND Master Caution light on PED. The detection function is inhibited on ground, controlled by weight on wheel switches. The indication will remain on for approximately 60 seconds. Simultaneously, with the micro-processor activating the ICE COND MC light it also initiates a de-icing of the ice detector tube.

When the frequency of vibration is sensed to be at a "no ice" level the heating is switched off and a new ice detection cycle is started. The ICE COND light will be unaffected by the de-icing of the sensing tube, due to the 60 seconds latching of the icing signal.

The ice detector is provided with a fault monitoring function which activates ICE DET FAULT Master Caution should a fault be detected.

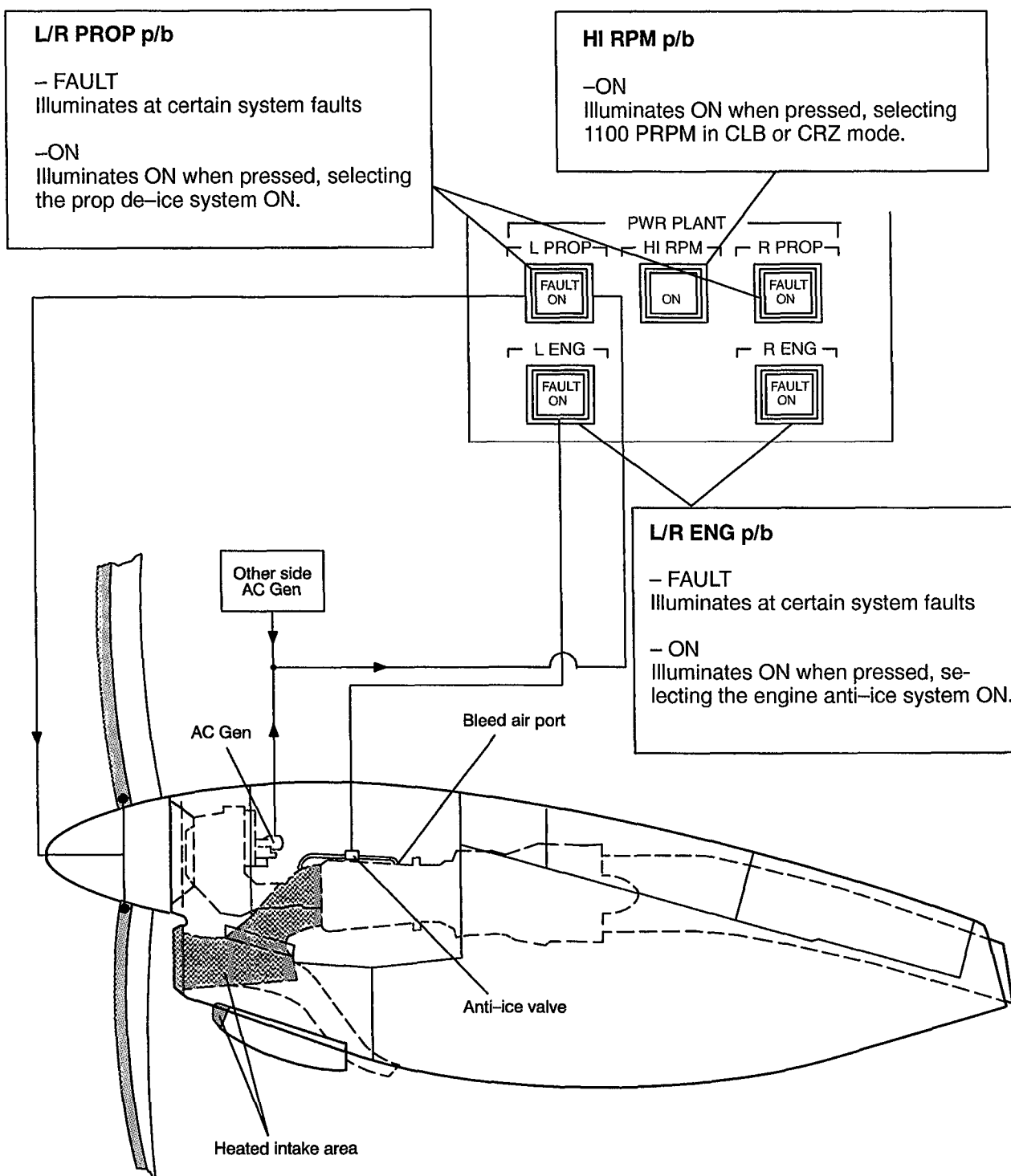
CAUTION: IT IS VERY IMPORTANT TO UNDERSTAND THAT THE ICE DETECTOR WARNING SHALL NOT BE USED AS THE CUE FOR SWITCHING ON ENGINE ANTI-ICE: THE ICE DETECTOR FUNCTION SHALL BE CONSIDERED AN ALERT SHOULD ICING CONDITIONS BE ENTERED UNNOTICED FOR ANY REASON.

3. CONTROLS AND INDICATORS.



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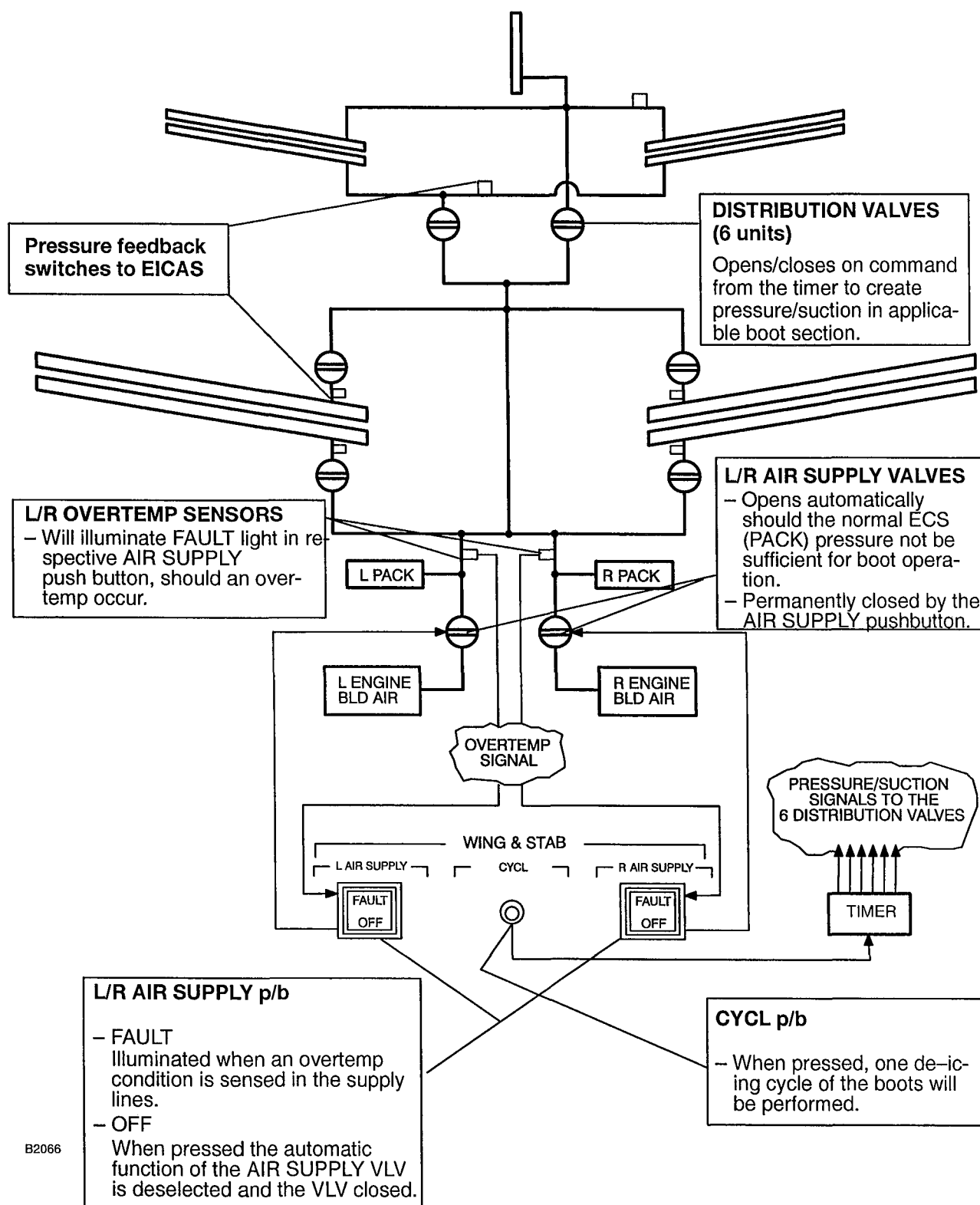
FIG. 2. Ice protection panel and ICE SPD pushbutton.



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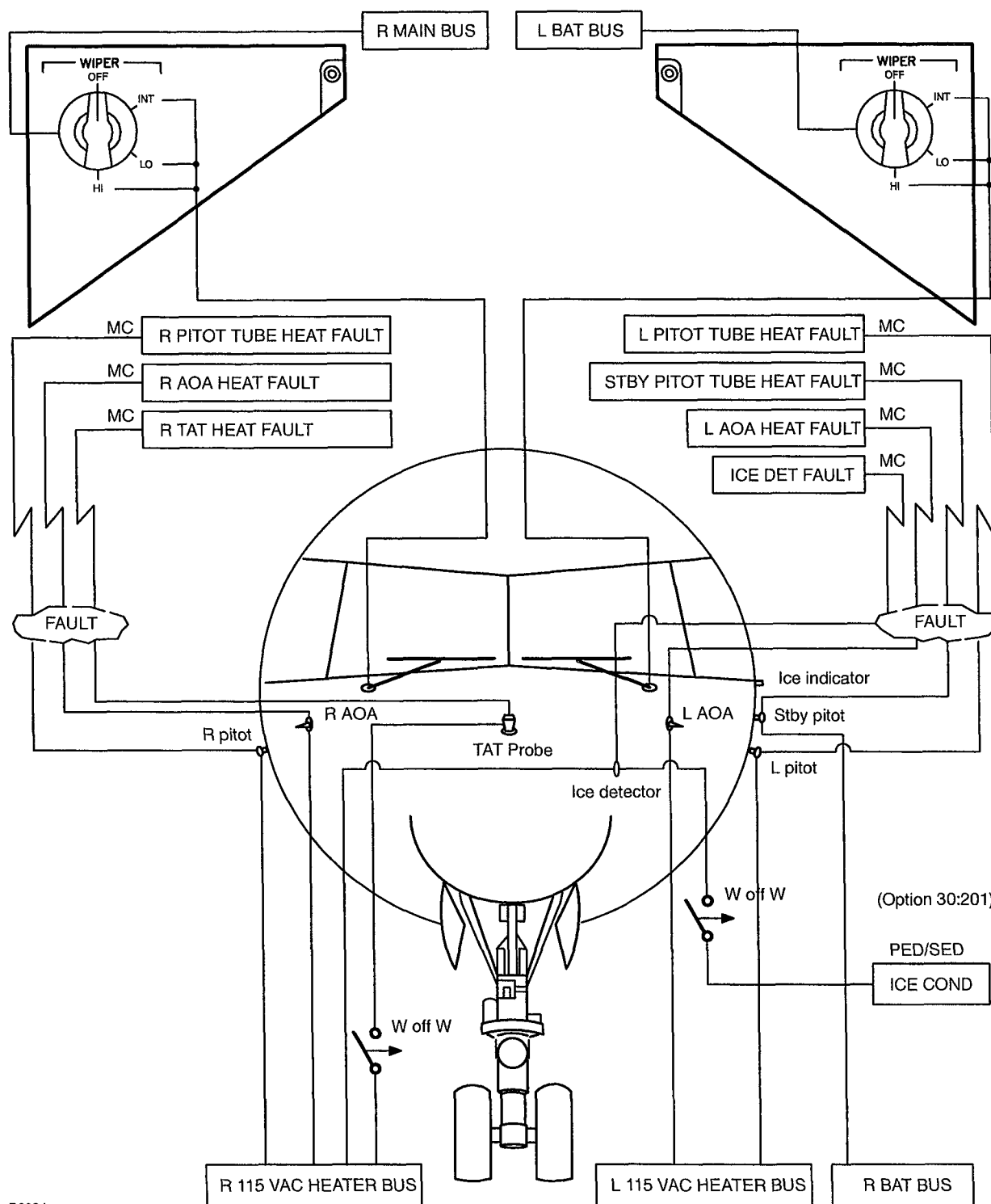
FIG. 3. Propeller de-icing and Engine anti-icing system.

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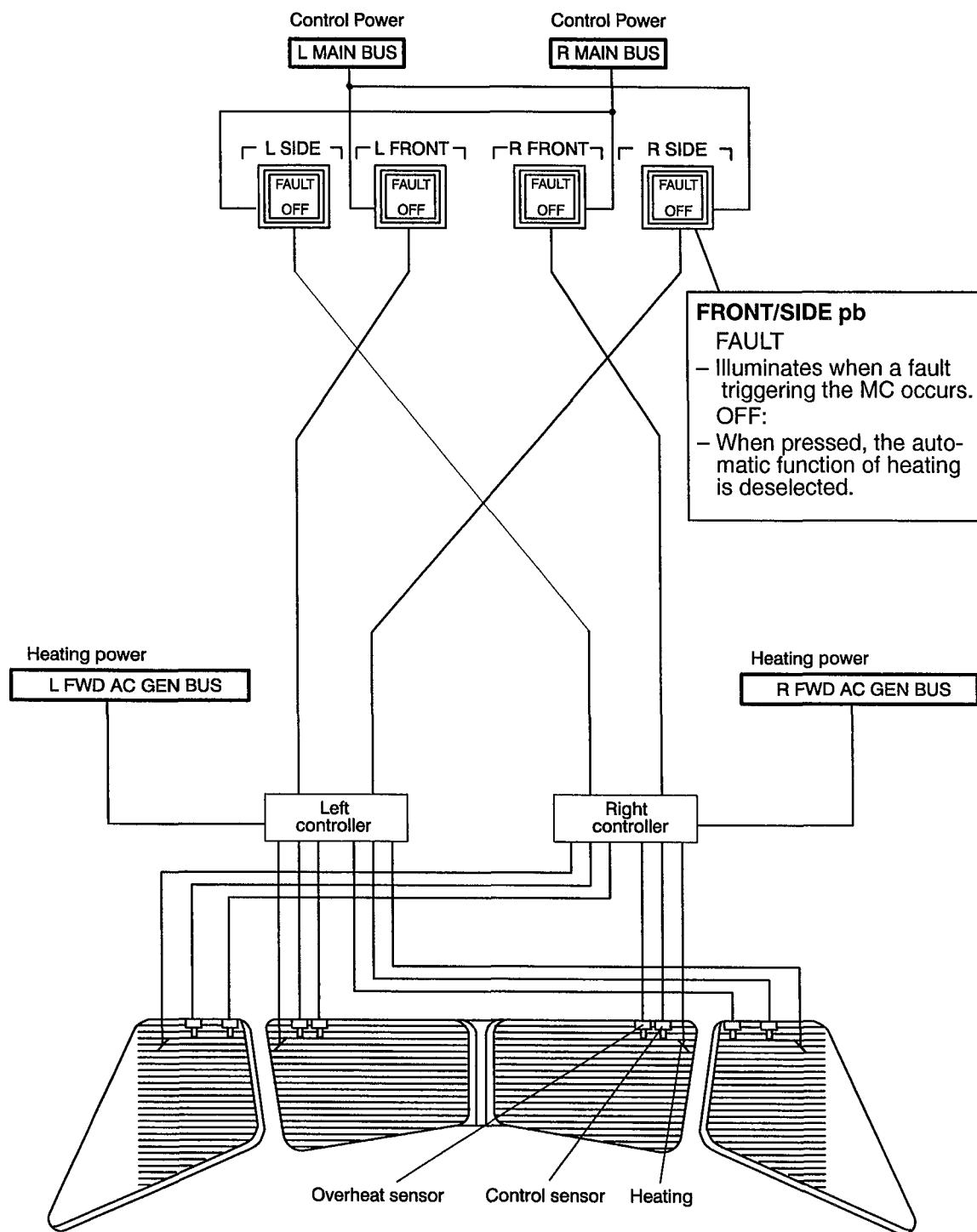
FIG. 4. Wing and stabilizer (boot) de-icing.



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FIG. 5. External probes and sensors – windshield wipers and ice indicator.

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FIG. 6. Windshield heating without Mod No 6080.

4. ELECTRICAL POWER SUPPLY.**Wing and stabilizer de-Ice.**

Timer control	L MAIN BUS	K-26	MAIN CTL
Timer control (back-up)	R BAT BUS	S-26	BACK UP CTL
L wing upper surf. valves	R BAT BUS	S-27	L UPR VLV
R wing upper surf. valves	R BAT BUS	S-28	R UPR VLV
L wing lower surf. valves	L BAT BUS	K-27	L LWR VLV
R wing lower surf. valves	L BAT BUS	K-28	R LWR VLV
L and R stab. upper surf + fin valve	R BAT BUS	S-29	UPR & FIN VLV
L and R stab lower surf. valve	L BAT BUS	K-29	LWR STAB VLV
L Air supply valve	L MAIN BUS	K-25	L AIR SPLY CTL
R Air supply valve	R MAIN BUS	S-25	R AIR SPLY CTL
Lower heater blanket	L AC HEATER BUS	K-30	LWR HTR BLANKET
Upper heater blanket	R AC HEATER BUS	S-30	UPR HTR BLANKET

Engine anti-Ice.

L anti-Ice valve	L MAIN BUS	J-30	L ENG A-ICE CLT
R anti-Ice valve	R MAIN BUS	R-30	R ENG A-ICE CLT

Propeller de-Ice.**Left propeller.**

PWR Ø A	L REAR AC GEN BUS		No CB on flight deck
PWR Ø B	L REAR AC GEN BUS		No CB on flight deck
PWR Ø C	L REAR AC GEN BUS		No CB on flight deck
Control	L MAIN BUS	J-31	L PROP D-ICE CTL

Right propeller.

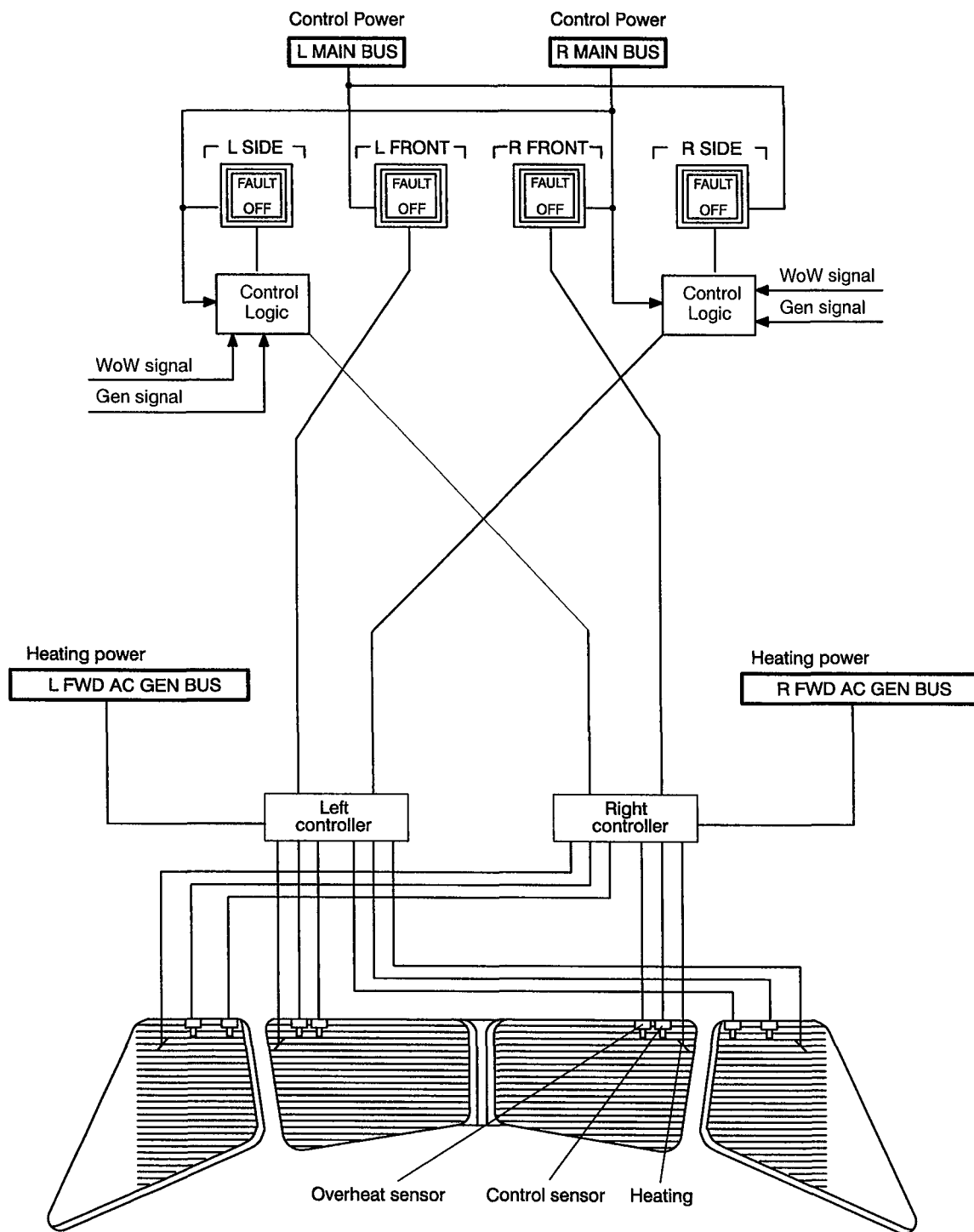
PWR Ø A	R REAR AC GEN BUS		No CB on flight deck
PWR Ø B	R REAR AC GEN BUS		No CB on flight deck
PWR Ø C	R REAR AC GEN BUS		No CB on flight deck
Control	R MAIN BUS	R-31	R PROP D-ICE CTL

Windshield heat**L front**

PWR Ø A	L FWD AC GEN BUS	J-27	L FRONT PWR Ø A
PWR Ø B	L FWD AC GEN BUS	J-26	L FRONT PWR Ø B
Control	L MAIN BUS	J-25	L FRONT CTL

L side

PWR Ø A	R FWD AC GEN BUS	R-28	L SIDE PWR Ø A
Control	R MAIN BUS	R-29	L SIDE CTL



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FIG. 6. Windshield heating with Mod No 6080.

4. ELECTRICAL POWER SUPPLY.**Wing and stabilizer de-ice.**

Timer control	L MAIN BUS	K-26	MAIN CTL
Timer control (back-up)	R BAT BUS	S-26	BACK UP CTL
L wing upper surf. valves	R BAT BUS	S-27	L UPR VLV
R wing upper surf. valves	R BAT BUS	S-28	R UPR VLV
L wing lower surf. valves	L BAT BUS	K-27	L LWR VLV
R wing lower surf. valves	L BAT BUS	K-28	R LWR VLV
L and R stab. upper surf + fin valve	R BAT BUS	S-29	UPR & FIN VLV
L and R stab lower surf. valve	L BAT BUS	K-29	LWR STAB VLV
L Air supply valve	L MAIN BUS	K-25	L AIR SPLY CTL
R Air supply valve	R MAIN BUS	S-25	R AIR SPLY CTL
Lower heater blanket	L AC HEATER BUS	K-30	LWR HTR BLANKET
Upper heater blanket	R AC HEATER BUS	S-30	UPR HTR BLANKET

Engine anti-ice.

L anti-ice valve	L MAIN BUS	J-30	L ENG A-ICE CLT
R anti-ice valve	R MAIN BUS	R-30	R ENG A-ICE CLT

Propeller de-ice.**Left propeller.**

PWR Ø A	L REAR AC GEN BUS		No CB on flight deck
PWR Ø B	L REAR AC GEN BUS		No CB on flight deck
PWR Ø C	L REAR AC GEN BUS		No CB on flight deck
Control	L MAIN BUS	J-31	L PROP D-ICE CTL

Right propeller.

PWR Ø A	R REAR AC GEN BUS		No CB on flight deck
PWR Ø B	R REAR AC GEN BUS		No CB on flight deck
PWR Ø C	R REAR AC GEN BUS		No CB on flight deck
Control	R MAIN BUS	R-31	R PROP D-ICE CTL

Windshield heat**L front**

PWR Ø A	L FWD AC GEN BUS	J-27	L FRONT PWR Ø A
PWR Ø B	L FWD AC GEN BUS	J-26	L FRONT PWR Ø B
Control	L MAIN BUS	J-25	L FRONT CTL

L side

PWR Ø A	R FWD AC GEN BUS	R-28	L SIDE PWR Ø A
Control	R MAIN BUS	R-29	L SIDE CTL

R front

PWR Ø B	R FWD AC GEN BUS	R-25	R FRONT PWR Ø B
PWR Ø C	R FWD AC GEN BUS	R-26	R FRONT PWR Ø C
Control	R MAIN BUS	R-27	R FRONT CTL

R side

PWR Ø C	L FWD AC GEN BUS	J-29	R SIDE PWR Ø C
Control	L MAIN BUS	J-28	R SIDE CTL

Windshield wipers

Wiper L	L BAT BUS	J-32	L WIPER
Wiper R	R MAIN BUS	R-32	R WIPER

Probes and sensors

L Pitot	L AC HEATER BUS Ø C	H-30	L PITOT
R Pitot	R AC HEATER BUS Ø A	P-32	R PITOT
Standby pitot PWR	R BAT BUS	P-33	STBY PITOT PWR
Standby pitot CTL	R BAT BUS	P-34	STBY PITOT CTL
L Angle of attack	L AC HEATER BUS Ø A	H-31	L ALPHA
R Angle of attack	R AC HEATER BUS Ø C	P-31	R ALPHA
TAT sensor	R AC HEATER BUS Ø A	P-30	OAT
Ice detector	R AC HEATER BUS Ø C	R-33	ICE DET