The following systems are used to protect the aircraft and aid the air crew when operating in ice and rain conditions:

- Airframe De-Icing System
- Engine Anti-Icing System
- Ice Detection System
- Probes Heat System
- Windshield Heat System
- Windshield Wiper System

DESCRIPTION

De-icing of wing and horizontal stabilizer leading edge is accomplished by pneumatically inflated boots. The system is controlled by the DE-ICE WING & TAIL switch located on the overhead panel. Aerodynamic profile of the airfoils is maintained by vacuum which evacuates the boots when they are not in operation, and holds them firmly against the leading edges. Four caution messages on the Engine Indication and Crew Alerting System (EICAS) indicate failure in the system (Figure 5-34).

Anti-icing of engine nacelle inlets is accomplished by engine bleed air, distributed inside the leading edges through swirl tubes. Inlet $P_{TO}2/T_{TO}$ probes are electrically heated. Nacelle and probe anti-icing is controlled by the ANTI-ICE ENGINE PROBE AND NACELLE L and R, illuminated pushbutton switches located on the overhead panel. When the engine bleed pressure is insufficient, a caution message is illuminated on the EICAS.

Anti-icing for the pitot probes, static ports, Total Air Temperature (TAT) probe and Angle of Attack (AOA) probe is provided by electrical heaters and controlled by a HEAT-PROBES switch located on the overhead panel. Three caution messages on the EICAS indicate failure in these systems.

(Continued)

Windshield anti-icing is provided by electrical heating elements installed between the transparent layers of the windshields. Electrical power to the elements is controlled by the HEAT W/S L and R switches located on the overhead panel. Constant windshield temperature is maintained automatically by regulating the electrical power to the elements. A W/S HEAT TEST illuminated pushbutton located on the overhead panel tests the system. Two caution messages on the EICAS indicate failure in the system.
Two-speed electrically operated windshield wipers remove the rain from the windshields. The wipers are controlled by the L and R WINDSHIELD WIPERS selector switches located on the overhead panel. With Mod 10141 incorporated, windshield wiper system is removed.
Ice detection is provided by ice detectors, located on both sides of the forward fuselage, STA 162.20 (4120) which detect the presence of icing conditions and provide signals to the Engine Indicating and Crew Alerting System (EICAS) through the Stall Protection and Q Feel Computer (SPQC).
In addition, a windshield ice detection light, located on the glareshield and powered automatically through COCKPIT LIGHTS MASTER switch, is glowing red color on right windshield to recognize ice accumulation on windshield at night.

ICE DETECTORS

The ice detection consists of two ice detectors. Each detector contains a sensor and processing unit. Two detectors are installed for redundancy. The detector that detects ice sends the detection signal. The output is fed through the Stall Protection and Q Feel Computer (SPQC) to the EICAS.
The ice detector provides icing annunciation by counting ice accretion in 0.01 in. (0.25 mm) increments on the ice detector probe and correlating these increments to ice accretion on the aircraft surfaces. These increments are called correlation counts. **ICING CONDITION** is signalled after two counts (0.020 in (0.51 mm) ice accretion).
The SPQC monitors the ice detector status and signals the EICAS of failures (**ICE DETECT FAIL** message).

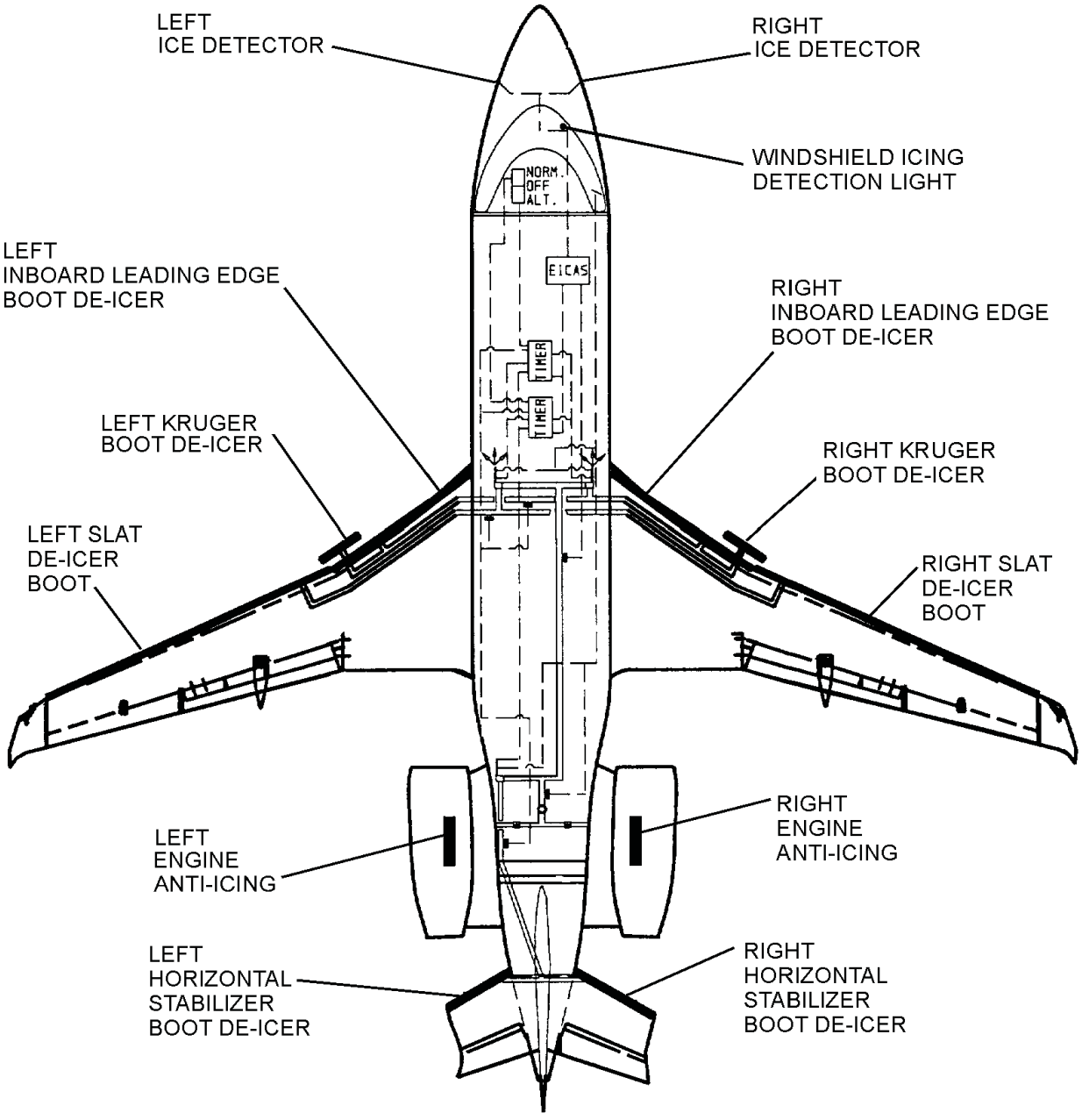

Figure 5-34. Ice and Rain Protection Systems - Sheet 1 of 2

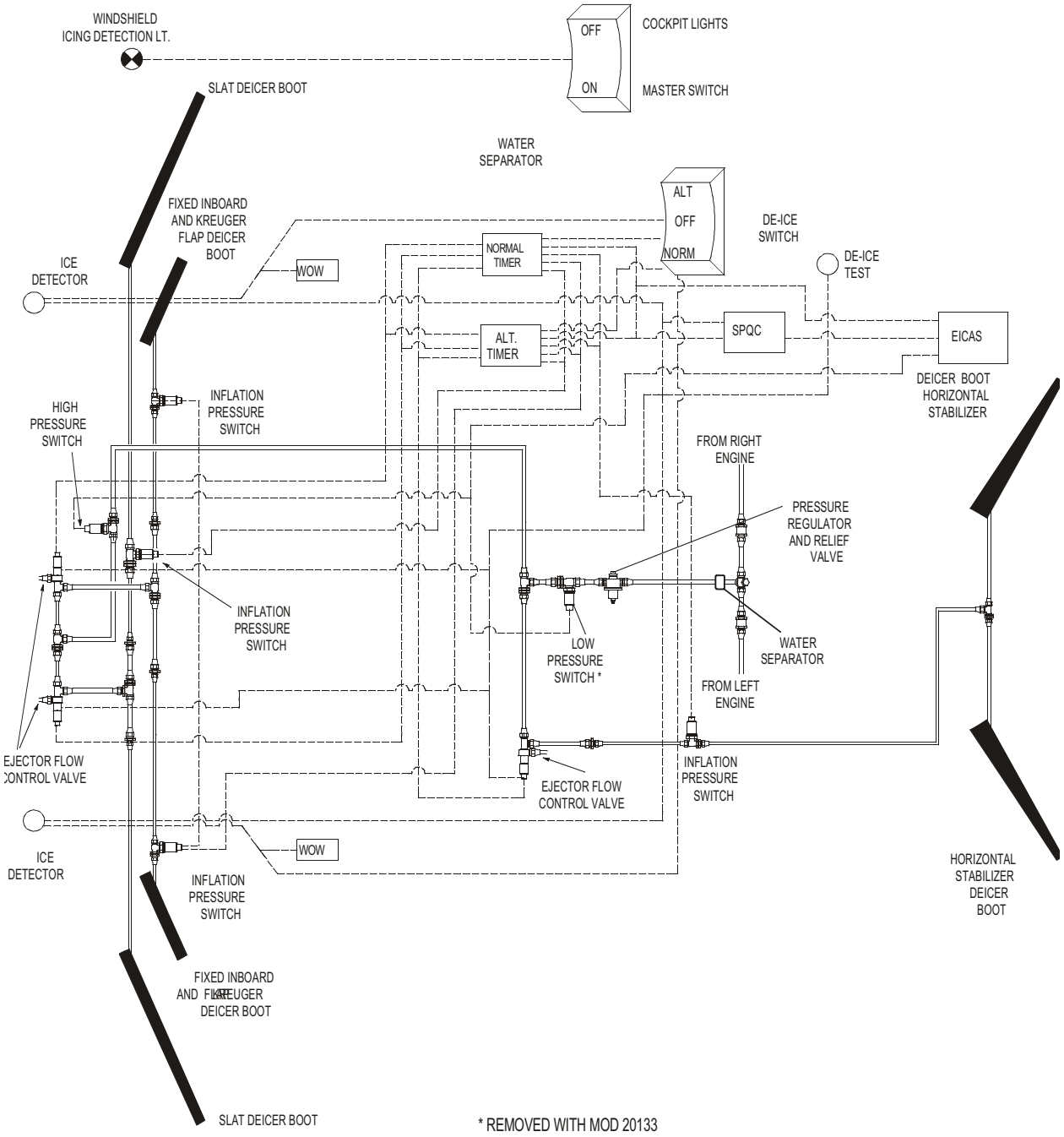

Figure 5-35. Ice and Rain Protection Systems - Sheet 2 of 2

DE-ICING SYSTEM CONTROLS AND INDICATORS

DE-ICE Switch - Controls operation of wing and tail de-ice boots according to the following positions:

OFF - System is off.

NORMAL - System operates according to timer program; a total of 18 seconds of inflation, followed by 42 seconds suction dwell before next cycle.

ALT - Same operation cycle as NORMAL position; system alternate timer.

Caution Messages

ICING CONDITION - Icing conditions detected by left or right detectors while airborne

DE-ICE SYS - Normal de-ice system malfunction or N_1 too low.

DE-ICE SYS ALT - Alternate de-ice system malfunction or N_1 too low

ICE DETECT FAIL (L/R) - Ice detector malfunction

DE-ICE LOW/HI PRESS - Underpressure (with Mod 20133 not installed) or overpressure in the system.

Advisory Messages

ICE DETECT TEST OK (L/R) - Successful ice detector system test

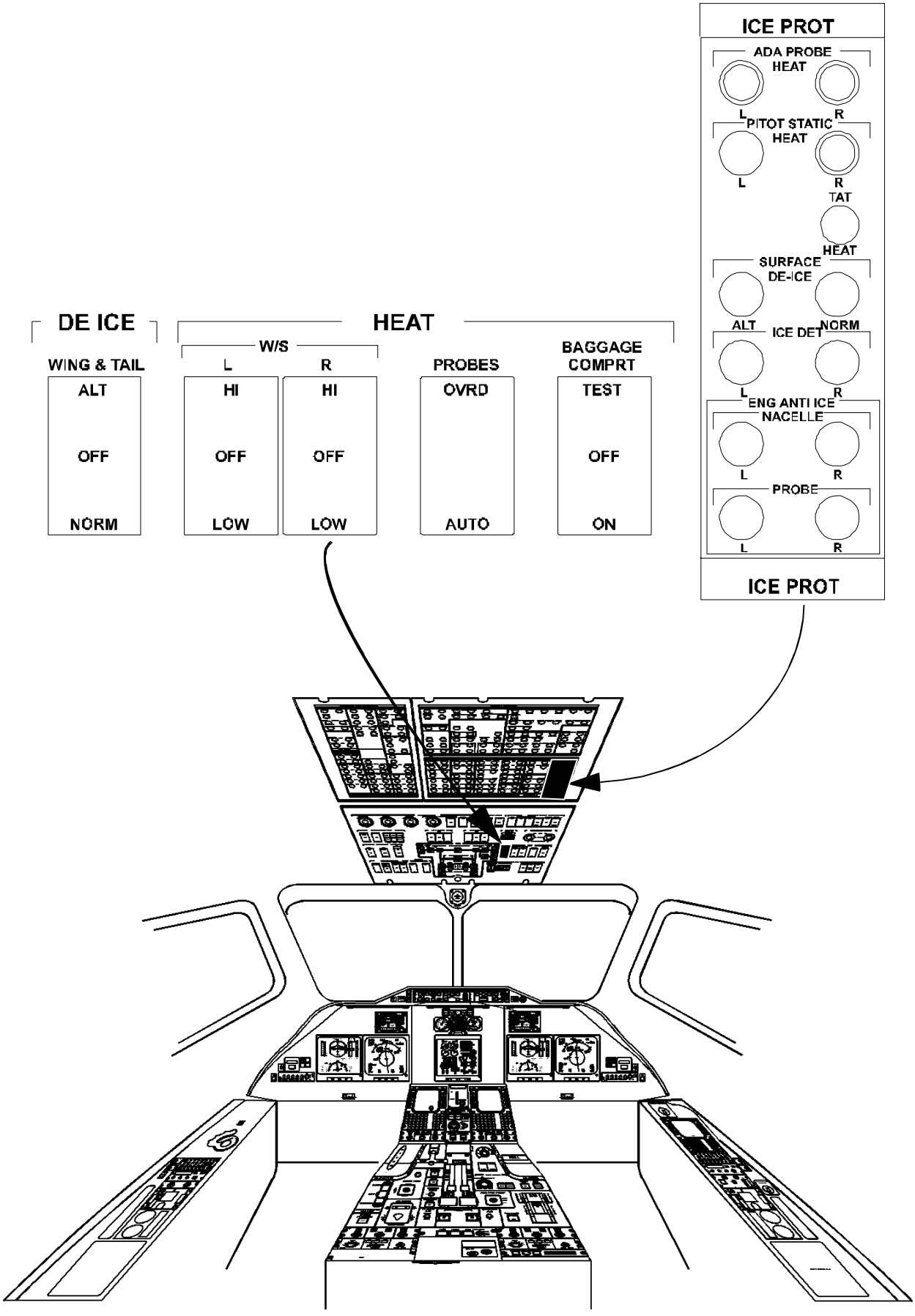

Figure 5-36. De-icing System Controls and Indicators

ENGINE/NACELLE ANTI-ICE SYSTEM

Description

Nacelle inlet cowl anti-icing equipment consist of insulated pneumatic ducts connected to engine outboard high pressure bleed port, a pressure regulating shut-off valve (PRSOV) and an air pressure transducer, connected via tube assembly to the duct (Figure 5-37).

Pressure Transmitter

The air pressure transducer is installed downstream the PRSOV with the bracket on the aft side of the engine flange A, and supplies electrical signal to EICAS. The caution message **ENG NAC ANTI ICE (L/R)** is provided by EICAS logic when anti-ice air pressure is out of the range determined for certain flight conditions limits.

Pressure Regulating Shut-Off Valve (PRSOV)

The PRSOV is normally open, electrically operated, piston modulating, pressure regulating and shut-off valve. The valve functions to maintain constant downstream air pressure in response to changing supply pressure. The valve will be energized to the closed position by EEC just before engine start and whenever engine anti-icing is deselected by the pilot.

The PRSOV is clamped to, and supported by the engine anti-ice duct at the aft side of the engine flange A.

ENGINE/NACELLE ANTI-ICE SYSTEM CONTROLS AND INDICATORS

ANTI-ICE ENG PROBE & NACELLE (L & R) pushbuttons and indicating light - When pressed, nacelle anti-ice air supply valve opens, engine anti-ice solenoid valve opens, and electrical power to heat inlet air $P_{TO}2/T_{TO}$ probe is energized

Caution Messages

ENG NAC ANTI ICE (L/R) - Engine bleed pressure insufficient for anti icing or, engine/nacelle anti-ice control has failed, or PRSOV has failed to reduce bleed pressure to protect the inlet from over temperature

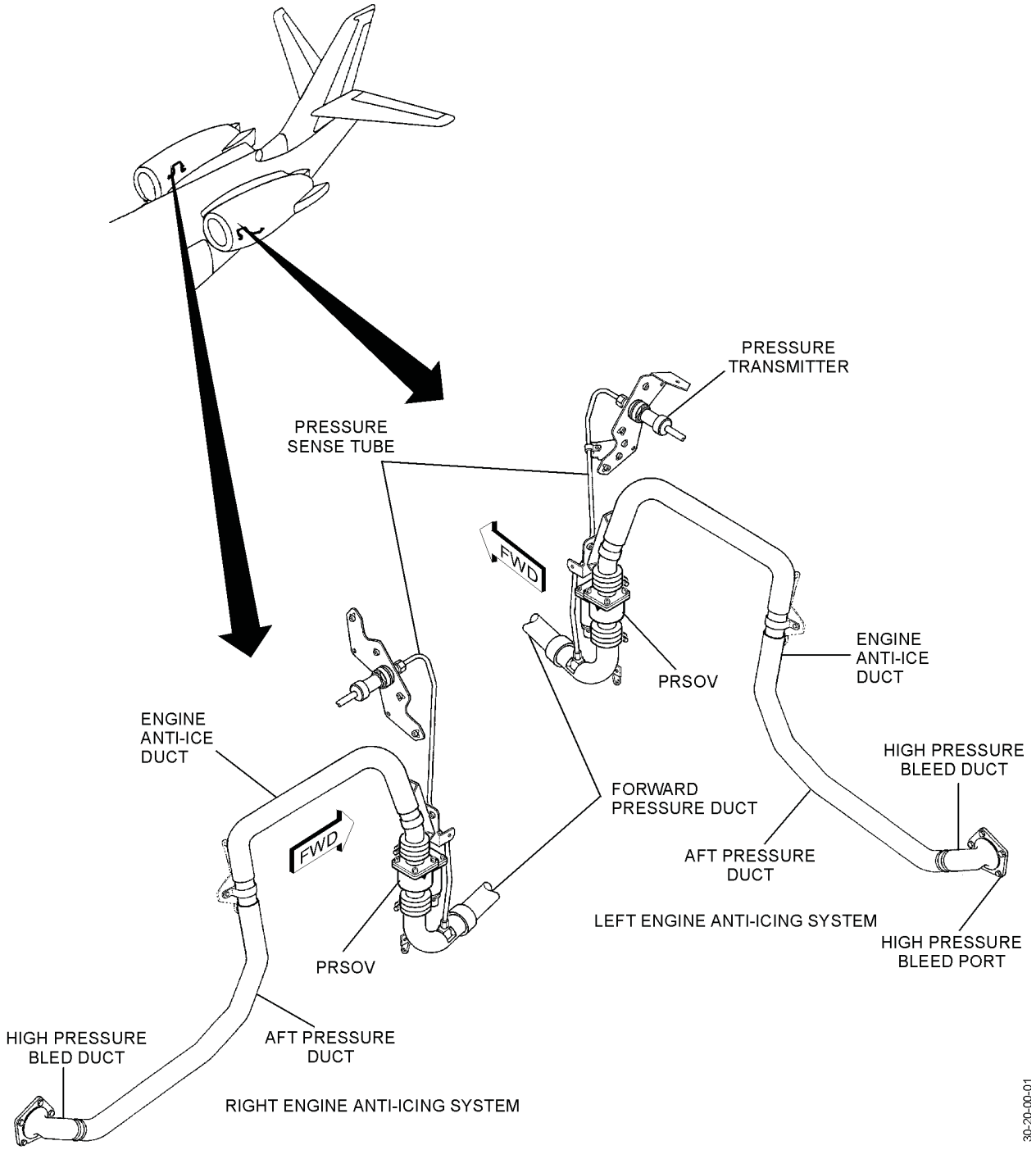

Figure 5-37. Engine/Nacelle Anti-Ice System - Schematic

PITOT-STATIC HEAT SYSTEM

General

Left and right pitot probes, three left and three right static ports, left and right Angle Of Attack (AOA) probe, and the Total Air Temperature (TAT) probe are electrically heated to prevent ice accumulation. All heaters are controlled by a single PROBES HEAT switch on the overhead panel.
Left and right heated pitot probes are mounted on the nose section and three left and right heated static ports are mounted on the fuselage sides. Left pitot probe, two left and one right static ports heaters are powered from left distribution bus through the L PITOT STATIC HEAT circuit breaker. Right pitot probe, two right and one left static ports heaters are powered from the emergency bus through the R PITOT STATIC HEAT circuit breaker. The nose gear oleo switch interrupts power to the heaters when the switch is in AUTO position and the aircraft is on the ground.

The TAT probe is mounted on the upper right fuselage. The probe heating element is powered from the right distribution bus through TAT HEAT circuit breaker on the overhead panel.
Each heating element has a current sensor. If heating elements fail when system is operating, **L** or **R PITOT HEAT** message comes on.

The AOA probes are mounted on the left and right sides of the fuselage. The probes have two separate heating elements, both powered from the emergency bus through AOA PROBE HEAT circuit breaker on the overhead panel. The AOA probe case heating element incorporates a thermostat and is powered continuously. The main AOA probe heating element is fully powered in flight or when PROBE HEAT switch is set to OVRRD position. When aircraft is on ground and PROBE HEAT switch is set to AUTO position, the heating element receives low power through a circuit incorporating a resistor.

PITOT-STATIC HEAT SYSTEM CONTROLS AND INDICATORS

PROBES HEAT switch has two position:

AUTO - Normal position. Pitot, TAT and static ports are powered in flight. Oleo switch cuts power on ground

OVRD - Pitot, TAT and static ports are powered in flight and on ground

Caution Messages

AOA HEAT (L/R) - In flight - Discontinuity in power line
PITOT HEAT (L/R) - In flight - power supply failure
TAT PROBE HEAT - In flight - power supply failure

WINDSHIELD HEAT SYSTEM

Description and Operation

The windshield heat consists of the following major components:
Three temperature controllers (for left and right windshields and left side window) or four temperature controllers with Mod Nos. 7185, 10022 or 20054 (for left / right windshields and left / right side windows), temperature sensors (three multiple layer transparencies in left side window and both windshields), control switches and a test switch.
The controller receives the windshield temperature sensed by the sensor installed in the left and right windshield and left side window. The controller drives a contactor which connects electric power to a windshield resistor heating element according to the windshield surface temperature. In addition, each controller provides a caution signal in case of overheating and/or malfunction.
The test switch activates a simulating circuit of the controller for an open circuit or short circuit sensor.

(Continued)

The sides of the windshields do not accumulate ice. It is possible to look through these areas if the windshields accumulate ice and forward visibility is lost. The left side window is also heated, to prevent residual ice accumulation as a result of windshield anti-ice operation.

The pilot windshield and side window and the copilot windshield (and side window with Mod Nos. 7185, 10022 or 20054) are made of multiple layer transparencies. Electrical heating elements are embedded between layers of each windshield and left side window. The pilot side is powered from the left main bus and its temperature controller by the left distribution bus. The copilot side is powered from the right main bus. Heating elements are protected by L and R WINDSHIELD HEAT POWER circuit breakers on the overhead panel. Temperature control units are protected by the L and R WINDSHIELD CONTR circuit breakers.

Each side has a temperature sensor embedded in the windshield, connected to a temperature controller behind the instrument panel, and L and R HEAT W/S switch on the overhead panel. An illuminated pushbutton, SYSTEM/WARN TEST W/S HEAT, on the overhead panel, is used to test and indicate system failures by displaying windshield heat message on EICAS.

W/S HEAT switch controls three zones on left and right windshields. In the LOW position all three zones are powered by a fixed current. In the HIGH position only the central zone is powered to provide a high heat.

WINDSHIELD HEAT SYSTEM CONTROLS AND INDICATORS

W/S HEAT (L and R) switch has three positions:

HI - Current is supplied to two center zone heating elements for use during ice accumulation

LOW - current is supplied to all three zones heating elements during low ice accumulation

OFF - Windshield heat is off

W/S HEAT TEST button - pressed to test windshield heat system when W/S HEAT switches are in HI or LOW position. all **WINDSHIELD HEAT** and **SIDE WINDOW HEAT** messages come on if test is successful

Caution Messages

WINDSHIELD HEAT (L/R) - Windshield heat systems malfunction

SIDE WINDOW HEAT - Left side window heat malfunction. With Mod 7185, 10022 or 20054 installed, left or right side windows heat malfunction

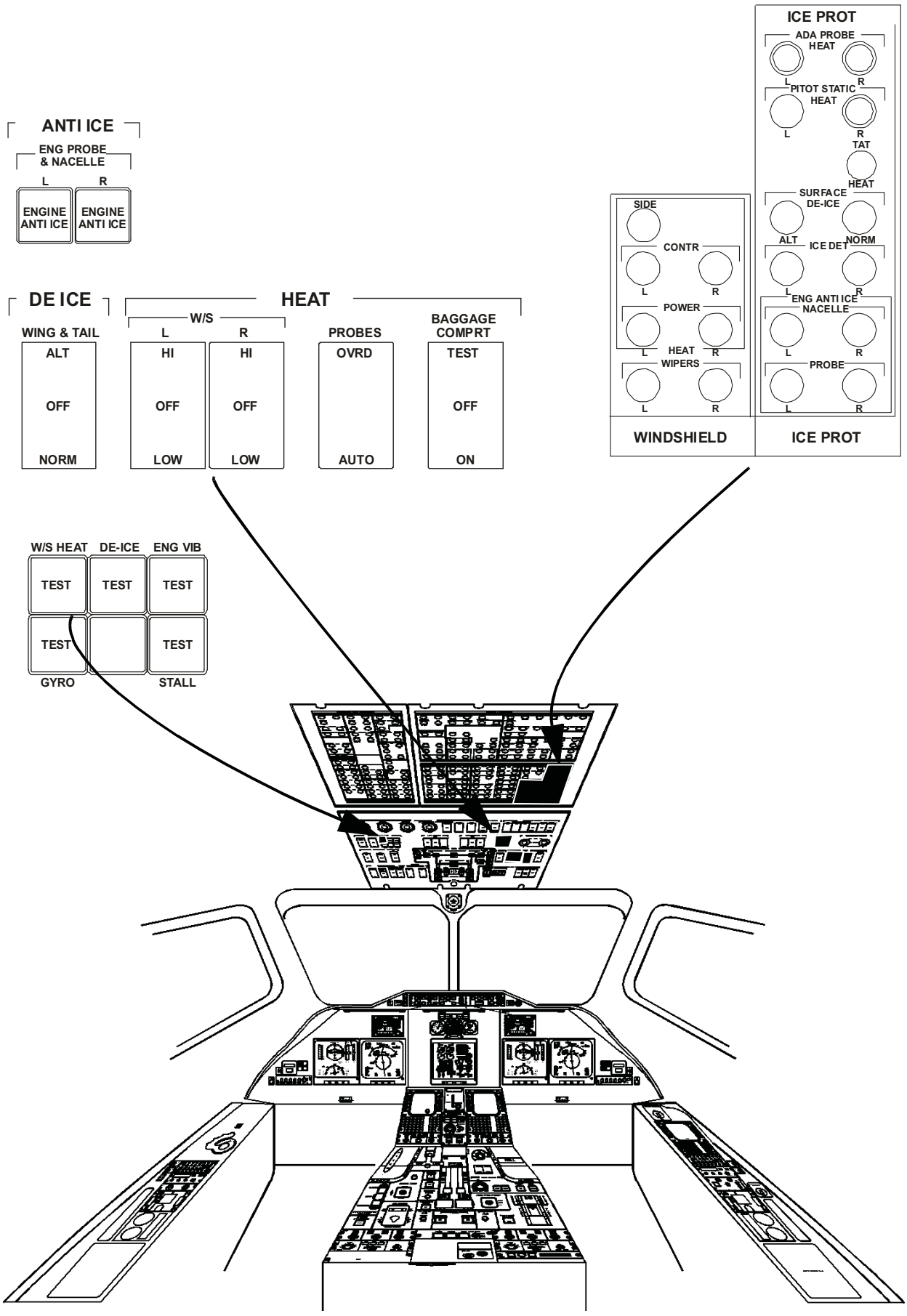

Figure 5-38. Anti-ice System - Controls and Indicators

WINDSHIELD WIPER SYSTEM (PRE MOD 10141)

Description and Operation

The windshield wiper system is designed to remove rain water and clean windshield to the degree necessary for an adequate field of vision in heavy rain during taxiing, takeoff, approach and landing, at airspeeds of up to 160 knots. With Mod 10141 incorporated, windshield wiper system is removed.

The left and right systems are symmetrical and completely independent.

Each wiper has a 28 Vdc motor, arm assembly and blade. It is controlled by the WINDSHIELD WIPERS knob on the overhead panel. No. 1 and No. 2 distribution buses supply 28 Vdc power to left and right sides, respectively, through L and R WINDSHIELD WIPER circuit breakers.

WINDSHIELD WIPERS - CONTROLS

WINDSHIELD WIPERS knob (L and R) - Located on overhead panel. It controls operation of left and right windshield wipers, respectively

OFF/PARK - Switches wiper off and returns wiper to stowed position

SLOW - Slow wiper speed

FAST - Fast wiper speed

CAUTION

DO NOT OPERATE WINDSHIELD WIPERS ON DRY WINDSHIELD.

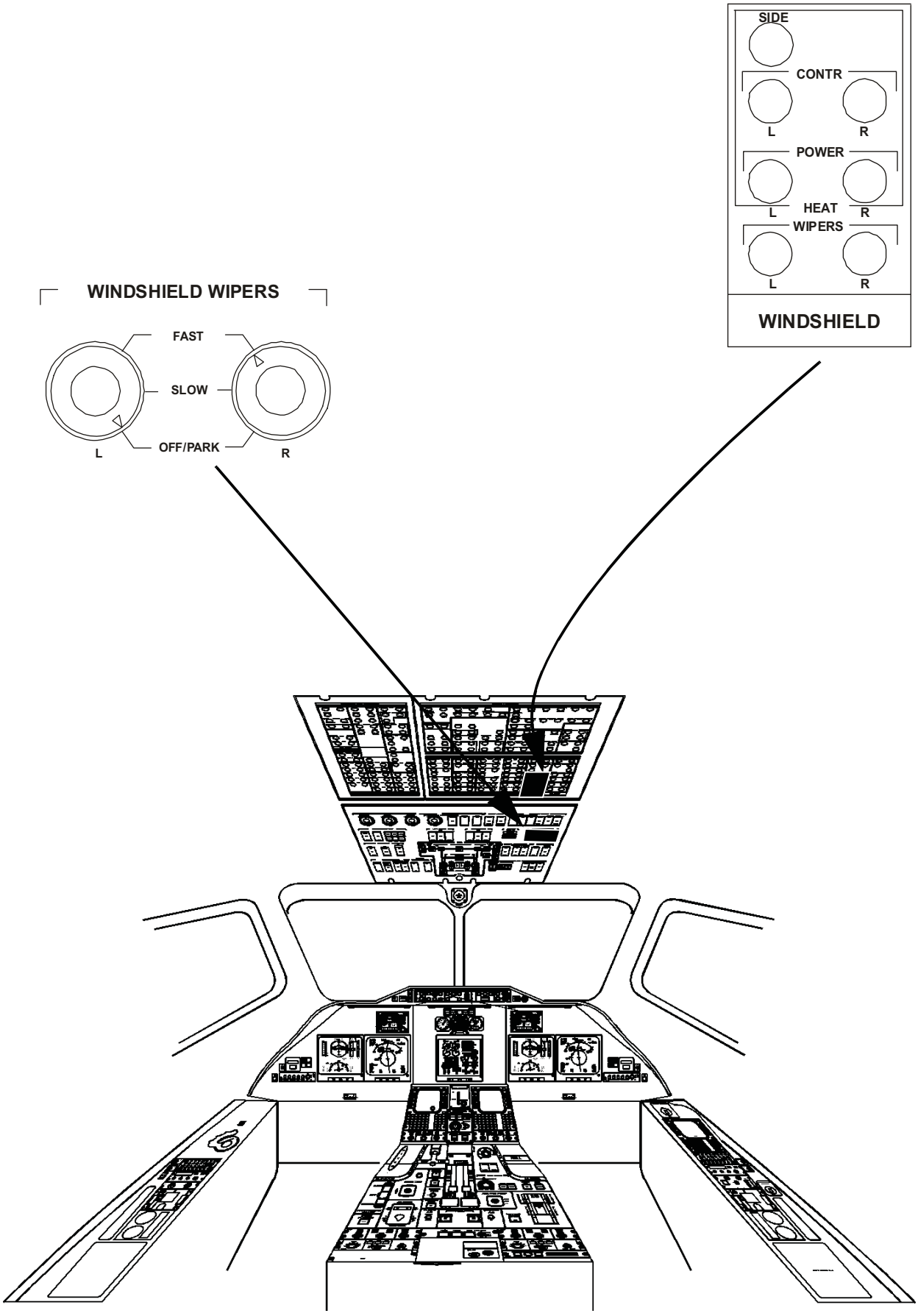

Figure 5-39. Windshield Wipers Controls