CHAPTER

30

Ice and Rain Protection

CHAPTER 30
Ice and Rain Protection

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A = Added, R = Revised, D = Deleted, O = Overflow, C = Customer Originated Change

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Ice and Rain Protection

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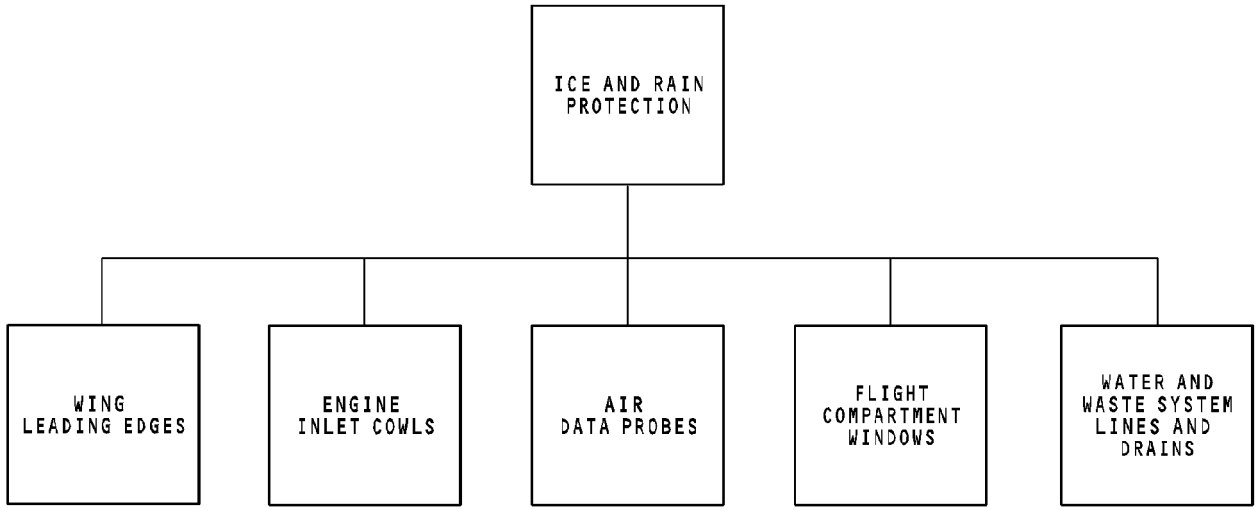
Purpose

The ice and rain protection system keeps ice from these airplane parts:

- Wing leading edges
- Engine inlet cowls
- Air data probes
- Flight compartment windows
- Water and waste system lines and drains.

Abbreviations and Acronyms

- CTAI - cowl thermal anti-ice
- TAI - thermal anti-ice
- WHCU - window heat control unit
- WTAI - wing thermal anti-ice
- TRA - thrust resolver angle
- PRSOV - pressure regulating shutoff valve



ICE AND RAIN PROTECTION - INTRODUCTION

Wing and Inlet Cowl Thermal Anti-ice Systems

The wing thermal anti-ice and the engine inlet cowl thermal anti-ice systems use hot bleed air to prevent ice.

Air Data Probe Heat

The air data probes use electric heat to prevent ice.

Flight Compartment Windows

Flight deck windows use electric heat to do these functions:

- Prevent ice formation on the windows
- Prevent fog on the windows
- Improve window impact strength.

The windows use these features to improve forward vision in rain:

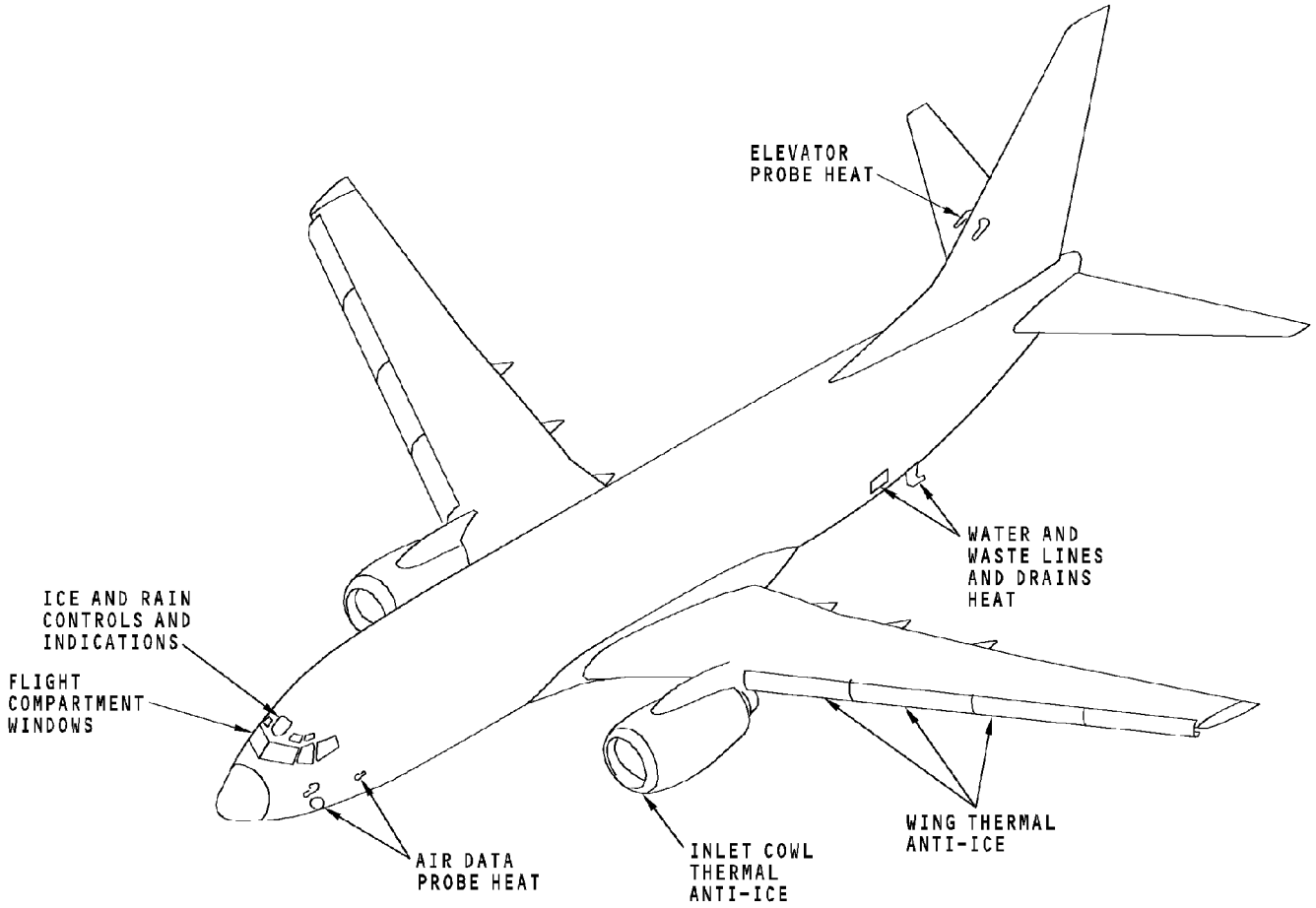
- Wipers
- Hydrophobic (rain repellent) coatings.

Water and Waste System lines and Drains

The water and waste lines and drains use electric heat to prevent ice.

Ice and Rain Controls

The controls and indications for the ice and rain protection systems are in the flight compartment on the P5 forward overhead panel.



ICE AND RAIN PROTECTION - GENERAL DESCRIPTION

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Purpose

The wing thermal anti-ice system (WTAI) keeps ice from the leading edge of the wing.

General Description

The WTAI system uses hot air from the pneumatic system to heat the three inboard leading edge slats of the wing.

A switch on the P5 forward overhead panel controls the operation of the WTAI system.

The WTAI system may operate in flight or on the ground.

When the system is on, the valves open and hot air from the pneumatic ducts goes to the leading edge of the wings. The heated air flows to the three inboard leading edge slat spray tubes. The air sprays into the slat cavities and exhausts overboard through holes in the bottom of the slats.

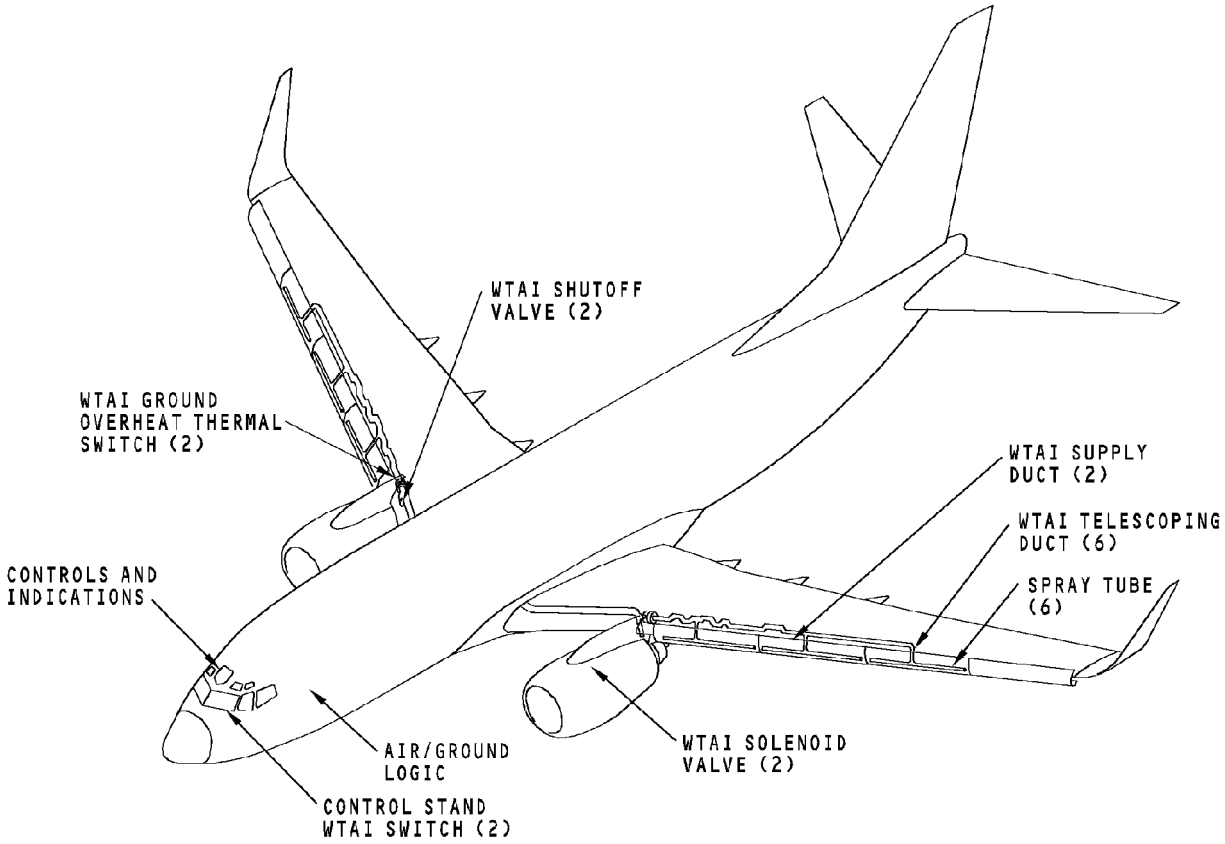
Overheat switches in each wing leading edge, protect the slats from overheat. This overheat protection operates only when the airplane is on the ground.

Switches on the control stand close the WTAI valves when you advance the engine thrust levers. This conserves engine thrust for takeoff. This thrust conservation protection only operates when the airplane is on the ground.

The air/ground logic gives the wing anti-ice system air ground sense feedback. The engine and wing anti-ice module uses this feedback to enable overheat and thrust conservation protection for the wing anti-ice system. It also turns off the WTAI system during takeoff.

EFFECTIVITY

HAP ALL



ICE AND RAIN PROTECTION - WTAI - INTRODUCTION

Flight Compartment

The engine and wing anti-ice control panel is on the P5 forward overhead panel.

Forward Equipment Compartment

There are two control stand anti-ice switches. They are on the autothrottle switchpacks. The switchpacks are in the forward equipment compartment.

Engine

There are two WTAI solenoid valves. They are on the top of the engine compressor case.

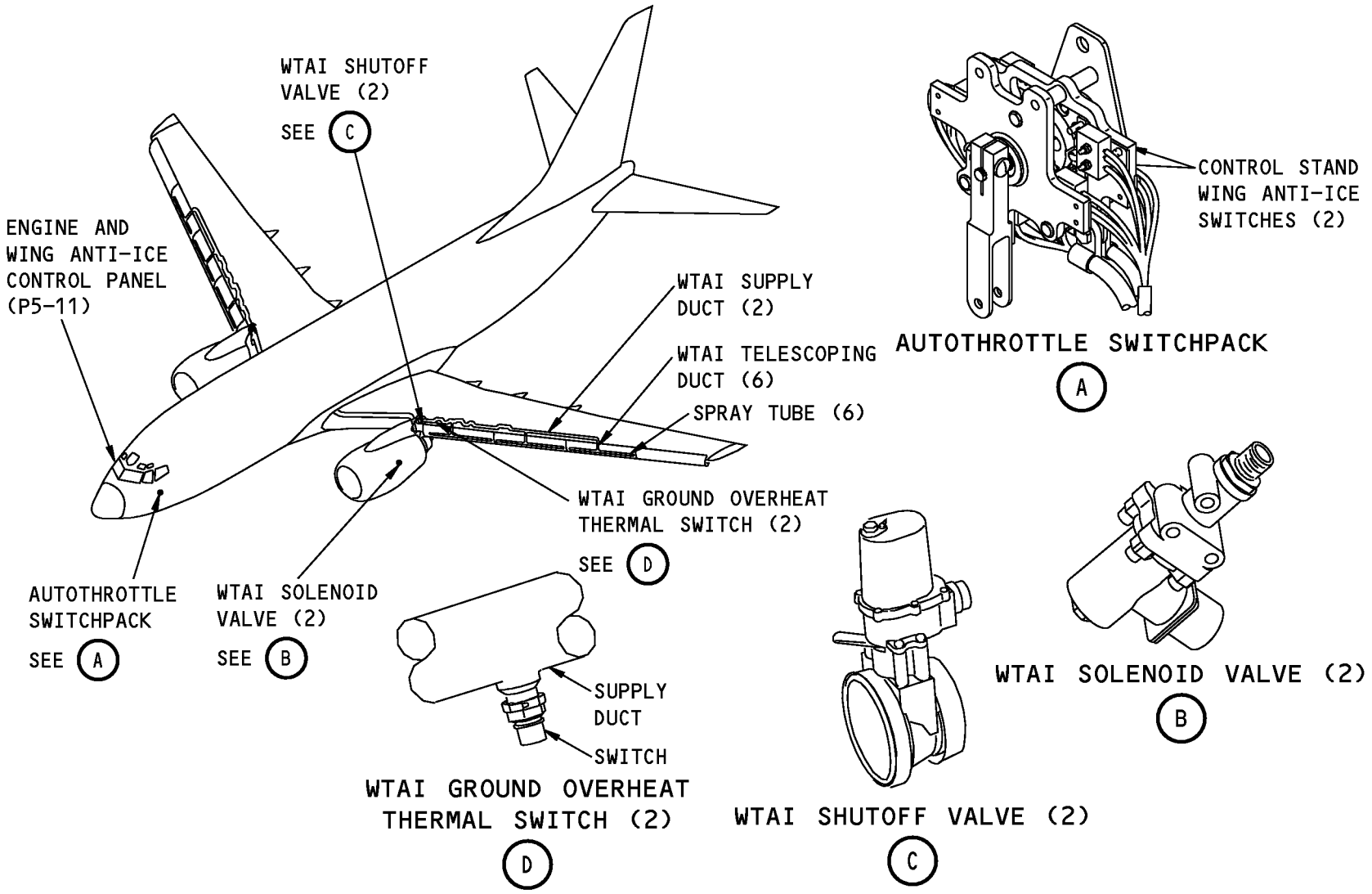
Wing Leading Edges

There are two WTAI shutoff valves. They are in the wing leading edges, outboard of each engine strut.

There are two WTAI ground overheat thermal switches, They are on the WTAI duct in the wing leading edges downstream of the WTAI valves.

The WTAI supply ducts are on the forward wing spars.

There are six WTAI telescoping ducts. They are in the wing leading edges. There are six WTAI spray tubes. They are in the three inboard slats of each wing.



ICE AND RAIN PROTECTION - WTAI - COMPONENT LOCATION

Purpose

The anti-ice panel does these things:

- Gives the flight crew interface with the wing and engine inlet cowl anti-icing systems
- Has the circuitry for control and indication of the wing anti-icing system
- Has the circuitry for control and indication of the engine inlet cowl anti-icing systems.

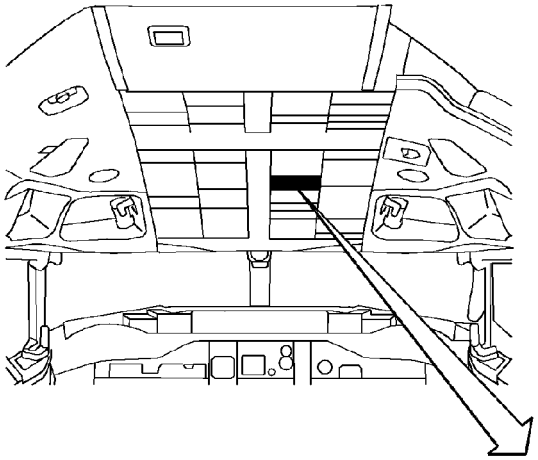
Location

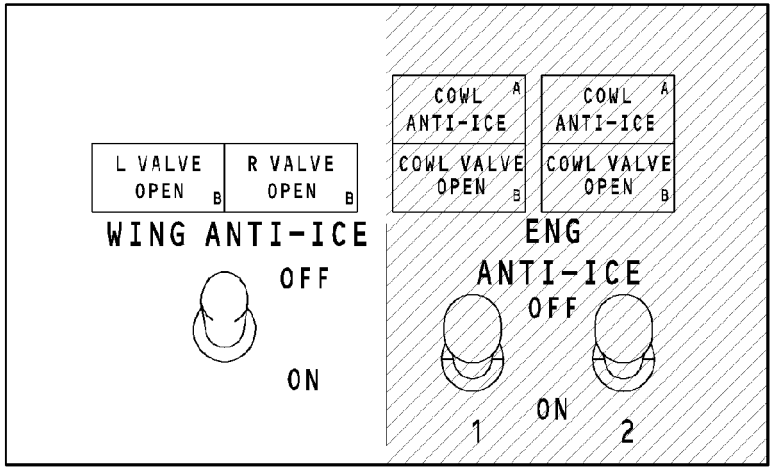
The panel is on the P5 forward overhead panel.

General Description

The wing anti-ice valve is open when the wing ant-ice switch is in the ON position. The blue VALVE OPEN light monitors the valve and switch positions. These are the light indications:

- Light is off - the switch is in the OFF position and the valve is closed
- Light is dim - the switch is in the ON position and the valve is open
- Light is bright - the switch position and valve position disagree or the valve is in transit.





ANTI-ICE PANEL (P5)

Purpose

The wing thermal anti-ice shutoff valves control air flow from the pneumatic manifold to the anti-ice supply ducts.

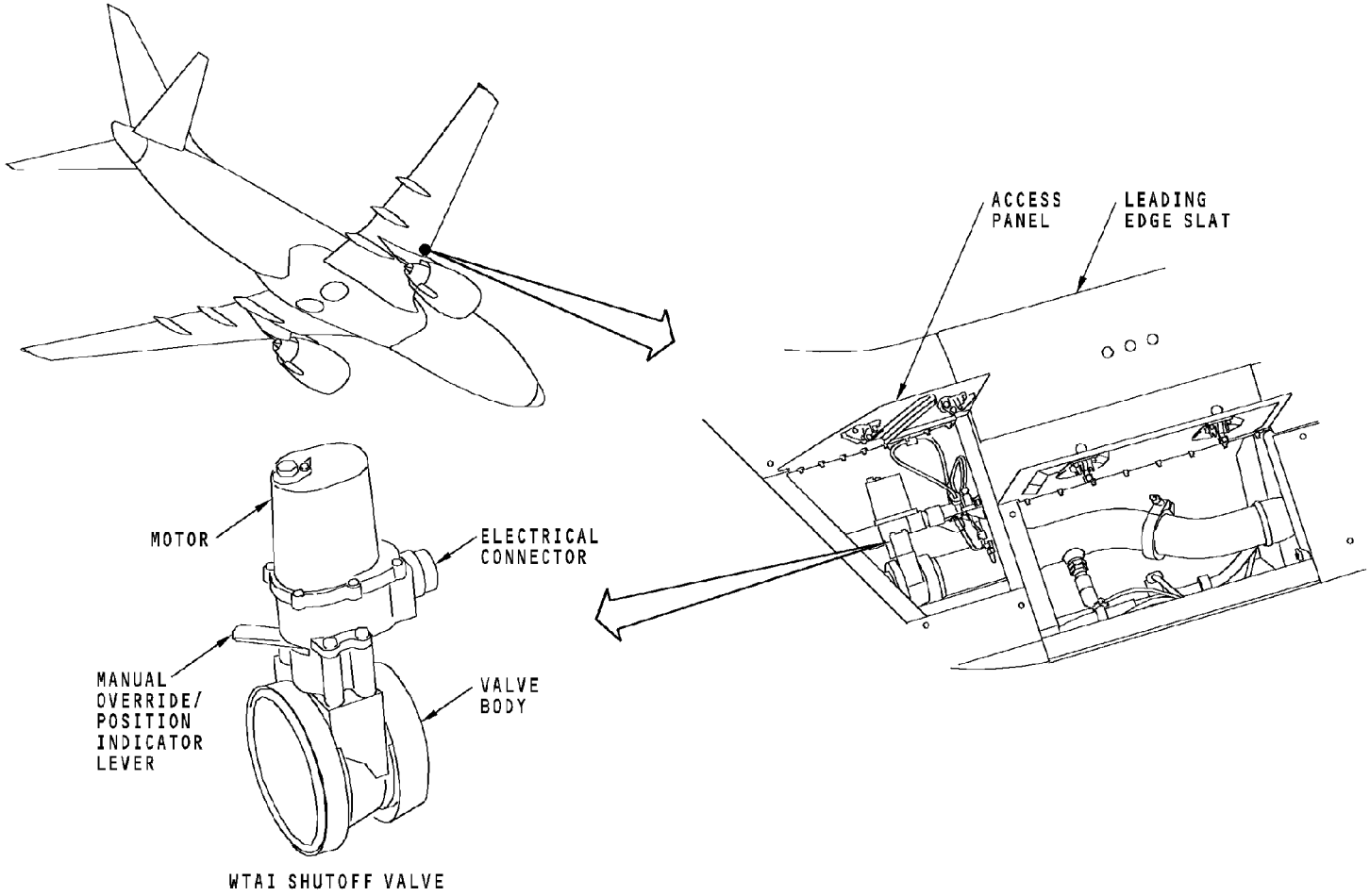
Location

There is one valve in each wing leading edge, outboard of the engine strut.

Physical Description

The valve is a motor-operated butterfly-type valve. It has a manual override and position indication lever. The valves use 115v ac power.

Two V-flange clamps mount the valve to the duct.



ICE AND RAIN PROTECTION - WTAI - WING THERMAL ANTI-ICING SHUTOFF VALVE

Purpose

The wing anti-icing ground overheat thermal switch protects the wing leading edges from overheat damage.

This protection operates only when the wing thermal anti-ice (WTAI) system is on and the airplane is on the ground.

Location

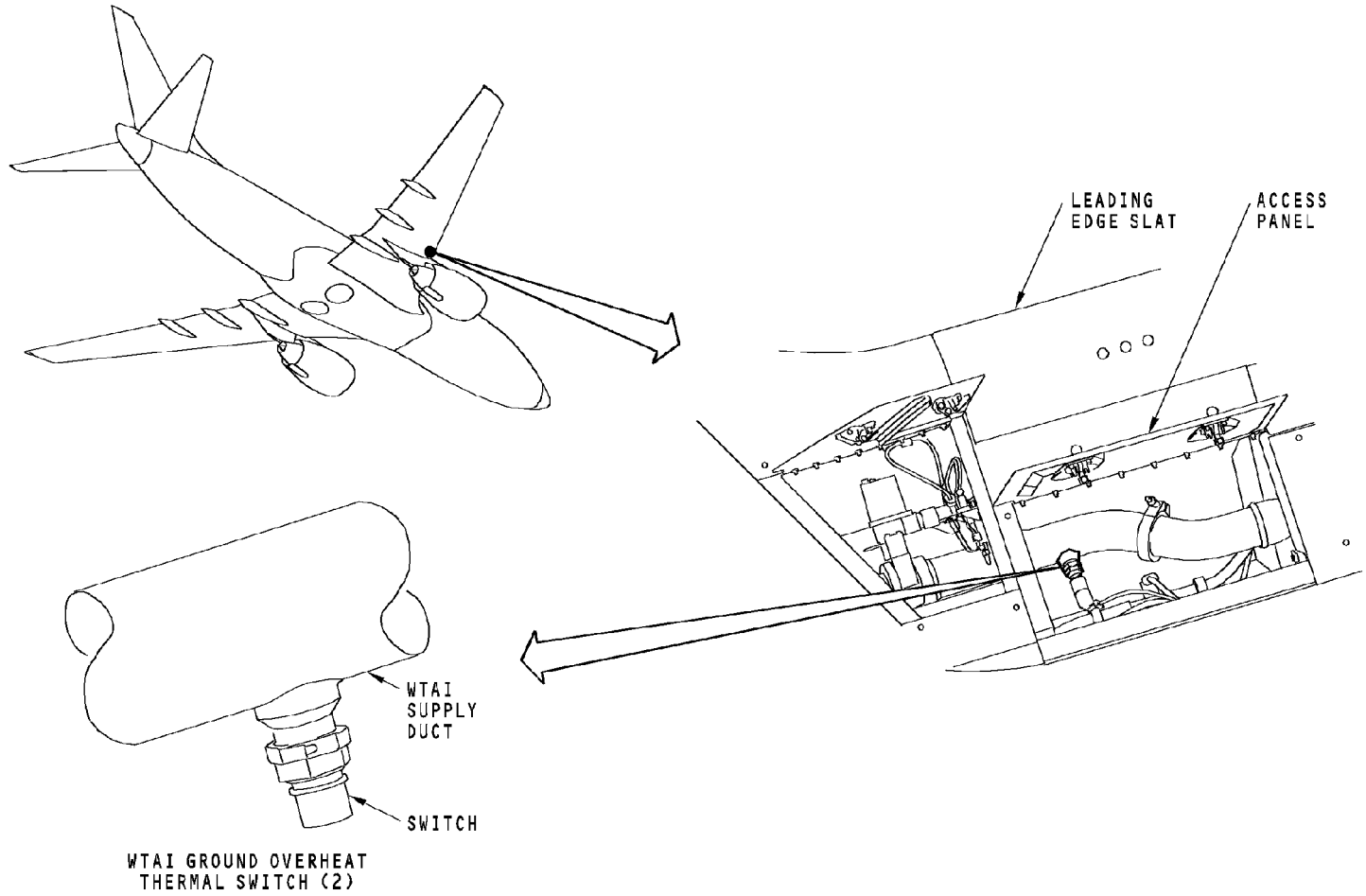
There are two wing anti-icing ground overheat thermal switches. They are in the WTAI supply ducts, downstream of the WTAI shutoff valves.

Functional Description

The switches are bimetallic. Thermal expansion closes the switch when the temperature is 257F (125C).

When the switch closes, a ground discrete signal is sent to the engine and wing anti-ice control panel (P5-11).

Both WTAI shutoff valves close in response to either thermal switch.



ICE AND RAIN PROTECTION - WTAI - WING ANTI-ICING GROUND OVERHEAT THERMAL SWITCH

EFFECTIVITY

HAP ALL

30-11-00

Purpose

The wing anti-icing telescoping ducts supply hot air to the spray tubes in the wing leading edge.

Location

There are six wing anti-icing telescoping ducts. They are in the wing leading edges between the wing thermal anti-ice (WTAI) supply duct and the three inboard slats of each wing.

Physical Description

Each wing has three wing anti-icing telescoping ducts.

The telescoping ducts have an inner and outer section. The inner and outer sections slide over each other during slat extension and retraction.

The inner tube is teflon coated to prevent binding when the two sections slide over each other.

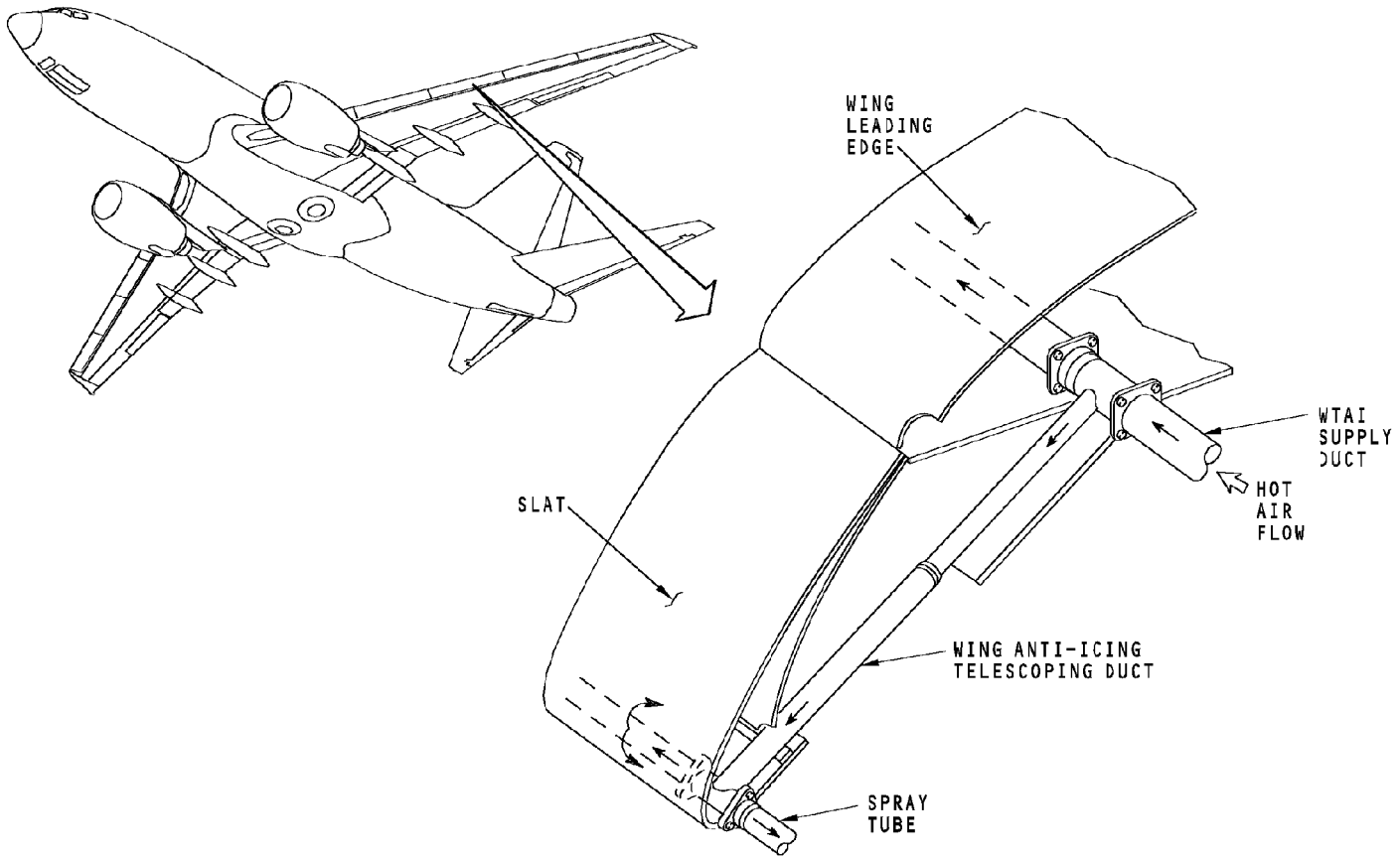
Functional Description

The anti-icing telescoping ducts let hot air from the WTAI duct flow to the slat spray tubes.

The spray tubes have holes to let the bleed air into the slat cavity. The air circulates in the cavity and warms the slat. This prevents ice formation on the slat. The air then bleeds overboard through holes in the bottom of the slat.

EFFECTIVITY

HAP ALL



SLAT SECTION VIEW, EXTENDED (TYP)

Purpose

The two control stand WTAI switches give thrust lever position feedback to the engine and wing anti-ice control panel (P5-11).

Location

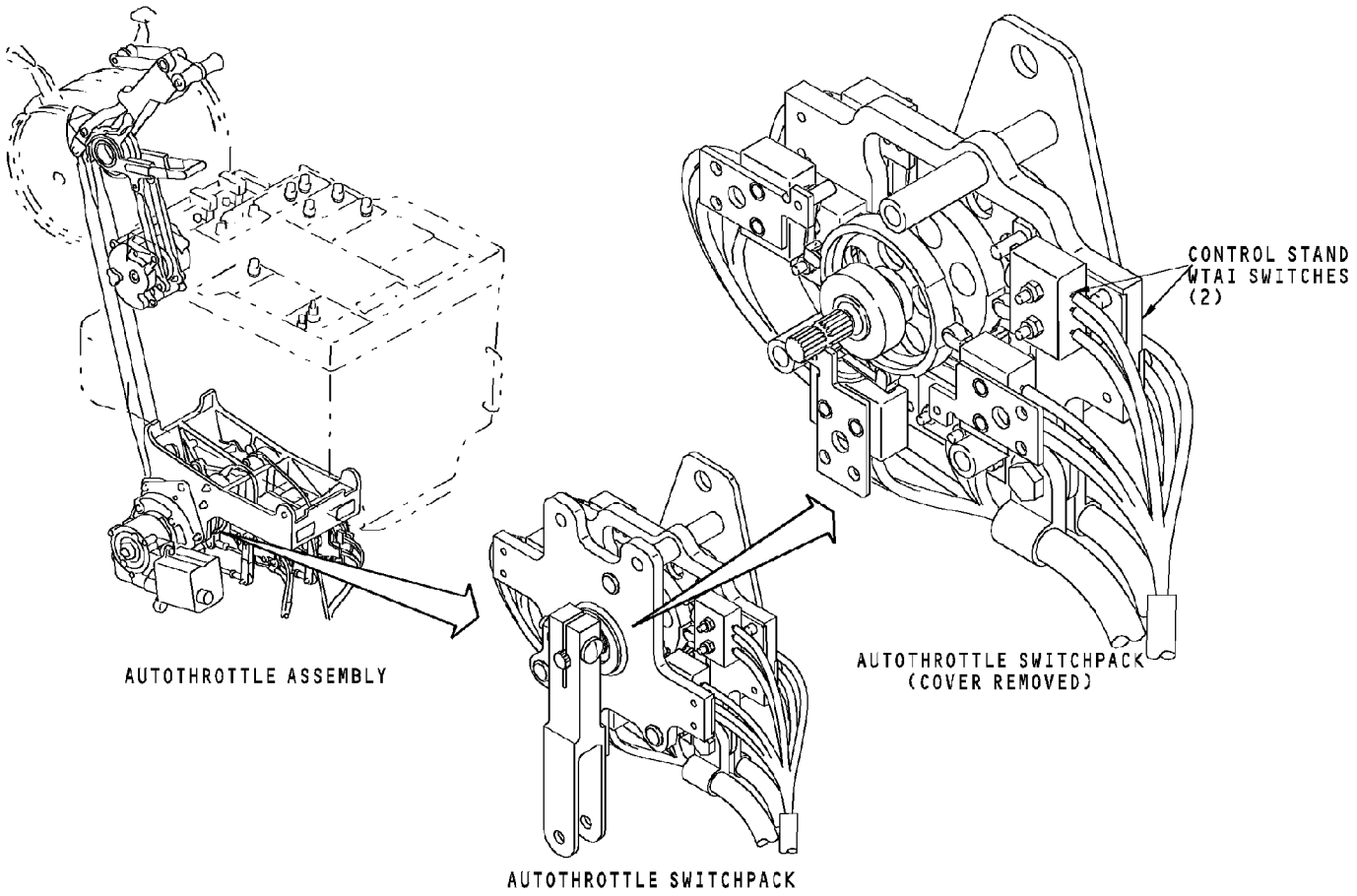
There are two control stand wing anti-ice switches.

One switch is on each of the two autothrottle switchpacks. Access is through the forward equipment compartment.

Functional Description

When you advance the throttles (approximately 60 degrees thrust resolver angle), the switches close and give ground inputs to the control panel.

The wing anti-ice control panel closes both WTAI shutoff valves in response to either control stand wing anti-ice switch. The control stand enables this protection only when the airplane is on the ground. This conserves engine power for takeoff.



ICE AND RAIN PROTECTION - WTAI - CONTROL STAND WING ANTI-ICE SWITCHES

Purpose

The wing thermal anti-ice (WTAI) solenoid valve bleeds actuator pressure from the precooler control valve. The WTAI solenoid valve operates when the wing thermal anti-icing system is used on the ground.

Location

There are two WTAI solenoid valves. There is one valve on the top of each engine. Access is by opening the thrust reverser cowl.

Physical Description

The WTAI solenoid valve is a normally closed ball-type poppet valve. It is energized to the open position with 28v dc electric power.

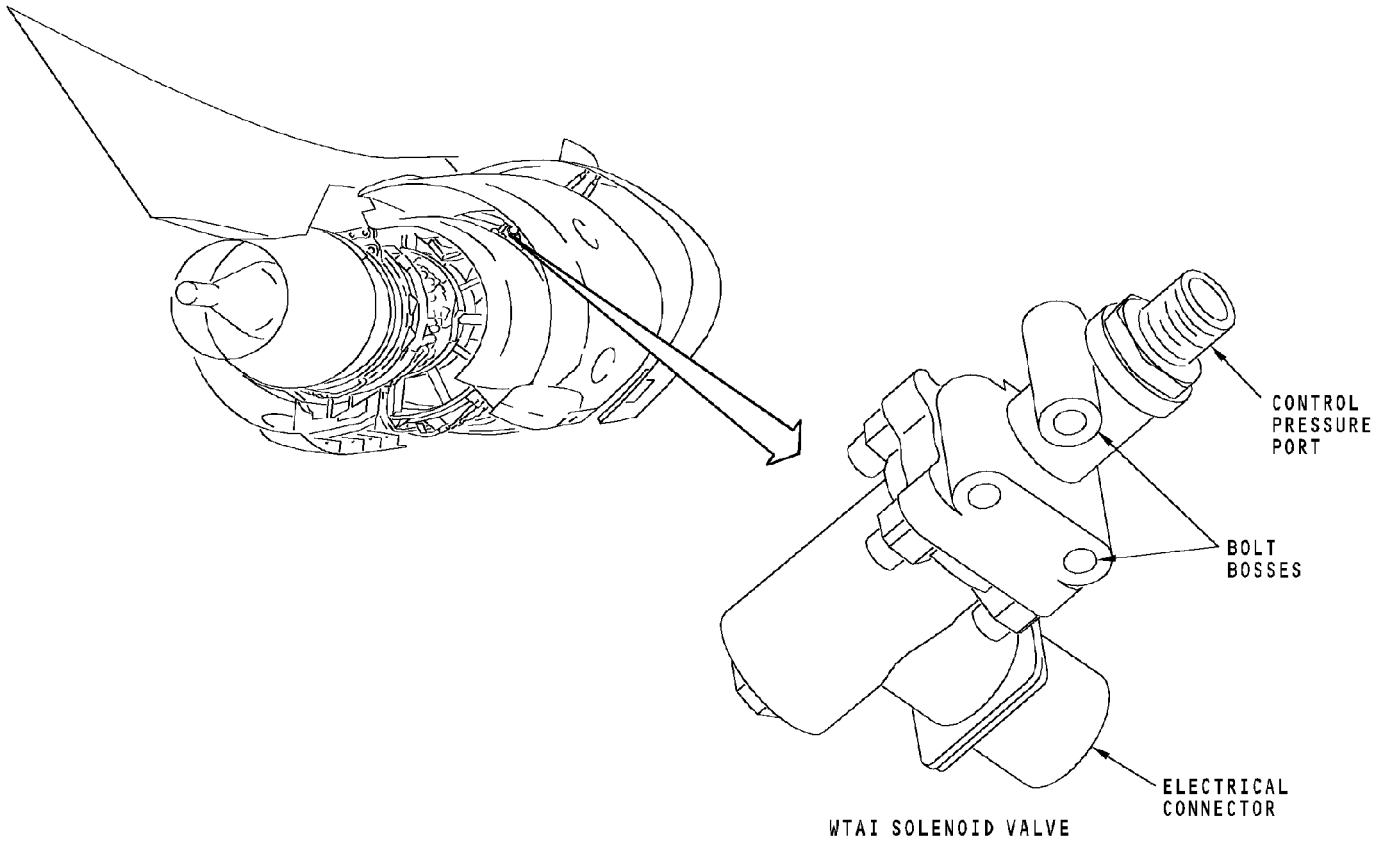
Functional Description

When the wing thermal anti-ice is used on the ground, the engine and wing anti-ice control panel (P5-11) energizes the WTAI solenoid valve. This releases the control pressure from the precooler control valve actuator. This causes the precooler control valve to open fully.

The wide open precooler control valve gives maximum cooling to the engine bleed air. This protects the wing leading edges from overheat damage.

The wing thermal anti-icing system is made to keep the leading edge of the wing free of ice accumulation during flight. During flight there is a large airflow over the wing. This airflow has a great cooling effect on the leading edges. The wing thermal anti-icing system heat output is great enough to overcome this cooling effect.

When the wing thermal anti-icing system is used on the ground, there is very little cooling airflow over the wing. In these conditions, the wing thermal anti-icing system heat output can overheat the wing leading edges. This can damage the heat treatment of the leading edges devices. To prevent overheat damage to the wing leading edge, the engine bleed air is given maximum cooling during ground operations.



ICE AND RAIN PROTECTION - WTAI - WTAI SOLENOID VALVE

General

The wing thermal anti-ice (WTAI) system uses 115v ac power to operate the WTAI shutoff valves and 28v dc for control and indication. This system operates on the ground and in flight.

The K1 relay connects power to operate the WTAI shutoff valves. When the relay is energized, it sends 115v ac power to open the WTAI shutoff valves. When the relay is de-energized, it sends 115v ac power to close the WTAI shutoff valves.

Ground Operations

When the airplane is on the ground, the K1 relay energizes to open the WTAI shutoff valves for these conditions:

- WING ANTI-ICE switch (P5-11) is in the ON position
- No overheat conditions (wing anti-icing ground overheat thermal switches)
- No engine thrust lever is advanced (control stand wing anti-ice switches).

Takeoff

When the thrust levers are >60 TRA, the WTAI valves close. This decreases engine bleed loads and conserves thrust for climb.

The WING ANTI-ICE switch is a circuit breaker type switch. Resistance in the K1 energizing circuit keeps current in the switch below its trip threshold.

During takeoff, a logic circuit in the control panel gives the switch a low resistance path to ground. This causes an overcurrent in the switch and the switch trips to the OFF position. The pilot must select WTAI after takeoff if necessary.

Flight Operations

When the airplane is in the air, the K1 relay energizes to open the WTAI shutoff valves when the wing anti-ice switch is in the ON position.

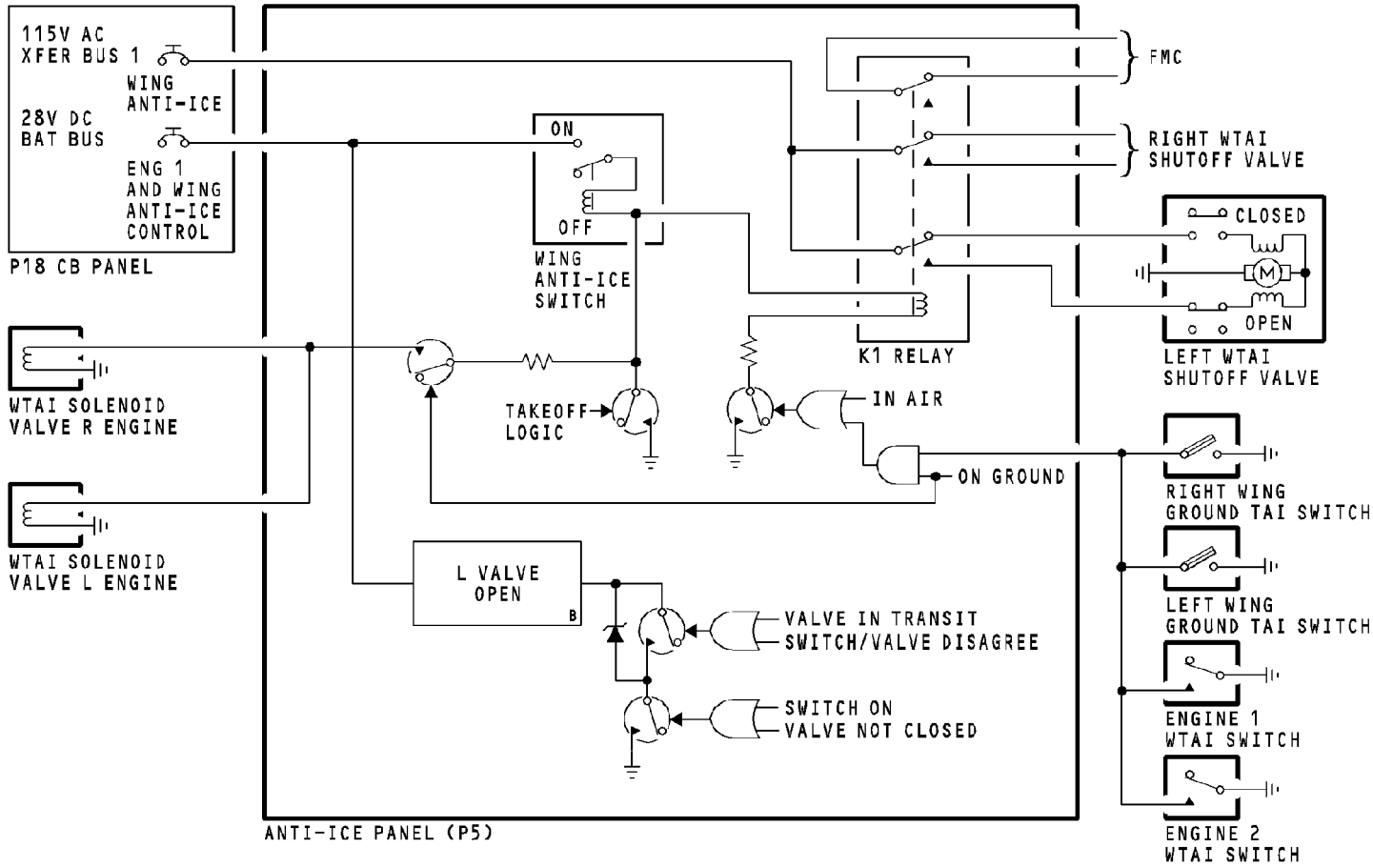
Indication

This is the control panel logic for the dimming diode control of the blue VALVE OPEN indication lights:

- Light is off - the switch is in the OFF position and the valve is closed
- Light is dim - the switch is in the ON position and the valve is open
- Light is bright - the switch position and valve position are not the same or the valve is in transit.

These things control the bright and dim functions of the VALVE OPEN lights on anti-ice panel:

- System switch and valve position feedback
- Control panel solid state switch circuits
- Voltage reduction zener diodes (dim mode).



ICE AND RAIN PROTECTION - WTAI - FUNCTIONAL DESCRIPTION

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Purpose

The inlet cowl anti-icing system keeps ice from forming on the engine inlet cowl.

General Description

Each engine has an inlet cowl anti-icing system.

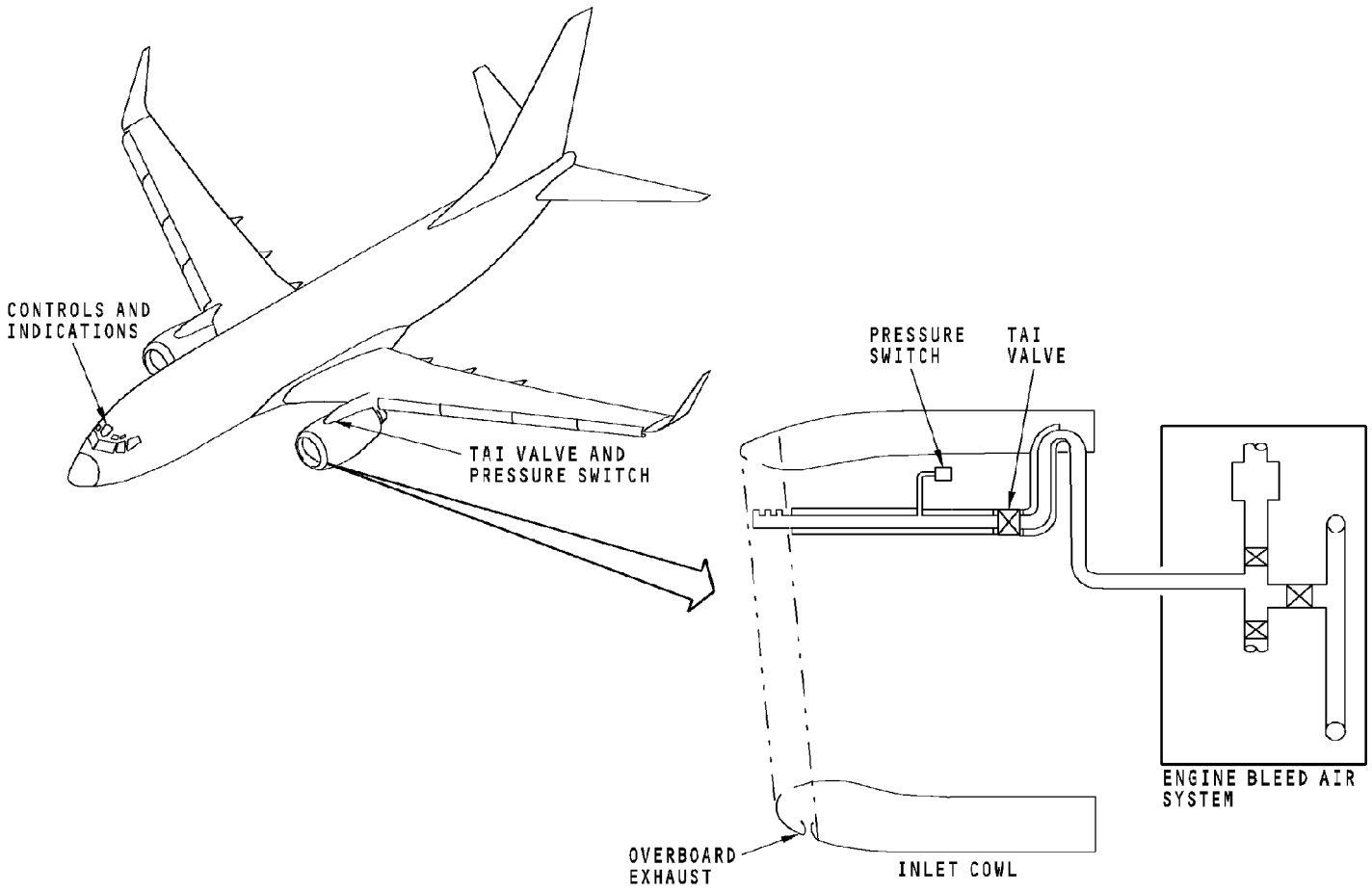
The systems operate in flight and on the ground.

A switch on the P5 forward overhead panel controls the operation of each inlet cowl anti-icing system.

When the system is on, the inlet cowl thermal anti-ice (TAI) valve opens. Hot air from the engine bleed air interstage duct goes through the valve into the hollow inlet cowl. The warm air increases the temperature in the inlet cowl. The warm air then goes overboard through a vent at the bottom of the cowl.

Each engine is the source of its inlet cowl thermal anti-icing air. Thermal anti-icing air is from the engine bleed air interstage duct, upstream of the pressure regulator and shutoff valve.

An inlet cowl TAI pressure switch monitors the pressure in the duct downstream of the inlet cowl anti-icing valve.



ICE AND RAIN PROTECTION - INLET COWL ANTI-ICING SYSTEM - INTRODUCTION

EFFECTIVITY
HAP ALL

30-20-00

Purpose

The inlet cowl thermal anti-ice (TAI) valve controls the flow of air to the engine inlet cowl.

Location

The inlet cowl TAI valve is on the right side of the engine fan case.

Physical Description

The inlet cowl TAI valve has these parts:

- Actuator
- Electrical connector
- Control solenoid
- Manual override collar/position indicator
- Flow body
- Regulator.

Downstream of the valve is a pressure switch.

Functional Description

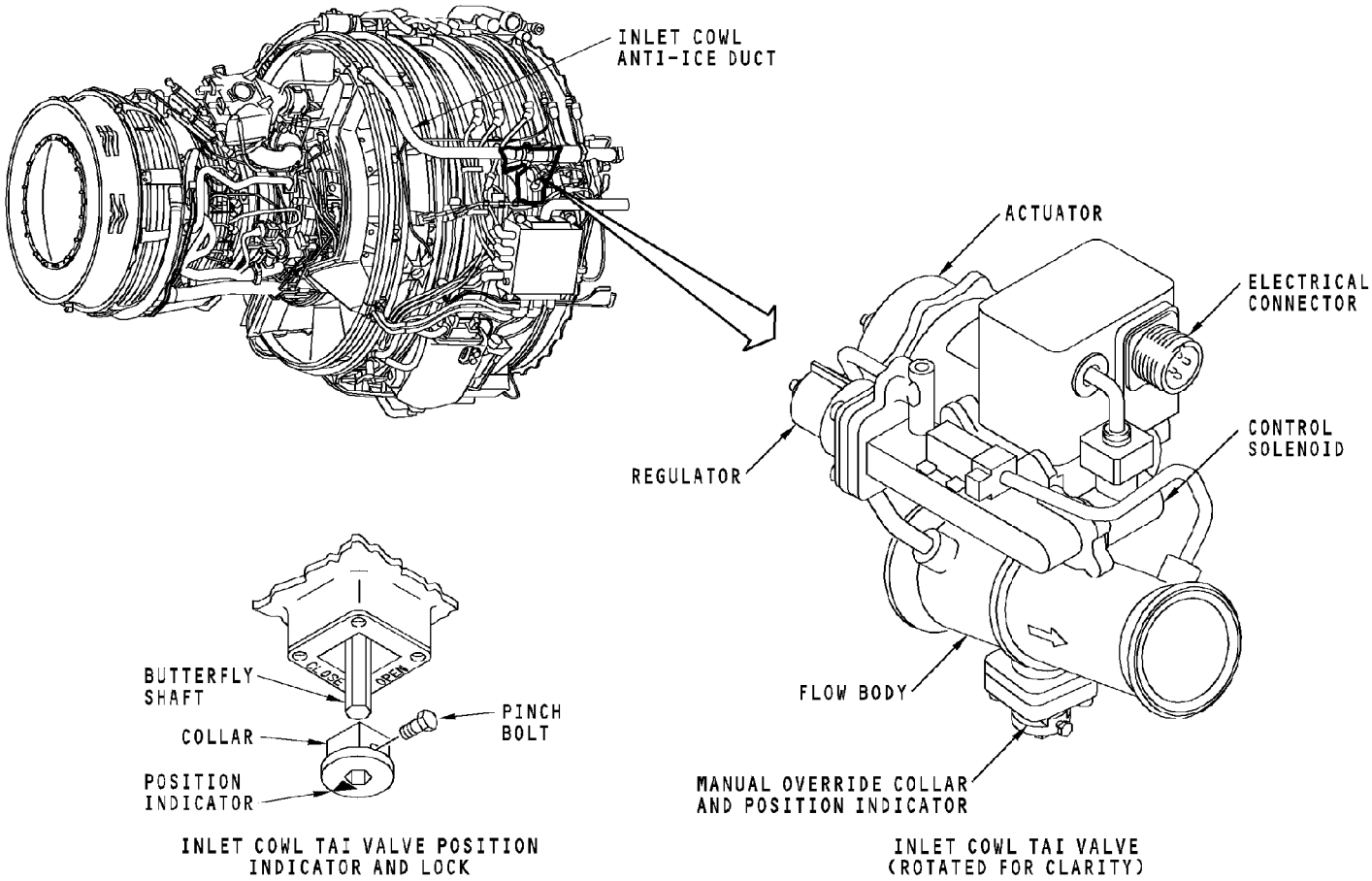
The inlet cowl anti-ice valve is an electrically controlled and pneumatically operated butterfly valve. It is spring loaded to the closed position.

When the control signal energizes the valve solenoid, the solenoid lets upstream duct pressure into the valve regulator. The regulator controls the pressure and sends it to the actuator. The actuator opens the valve against spring pressure. A downstream sense line on the valve biases the regulator. The regulator modulates the valve butterfly plate to limit downstream pressure to 50 psi maximum.

Valve limit switches give valve position feedback to the P5-11 module for system status indication.

Training Information Point

The inlet cowl TAI valve has a manual override collar. You can manually lock the valve in the full open or full closed position if the valve fails.



Purpose

The inlet cowl thermal anti-ice (TAI) pressure switch monitors pressure in the inlet cowl TAI duct downstream of the inlet cowl TAI valve.

location

The inlet cowl TAI pressure switch is on the inlet cowl TAI duct, downstream of the inlet cowl thermal anti-ice valve.

Physical Description

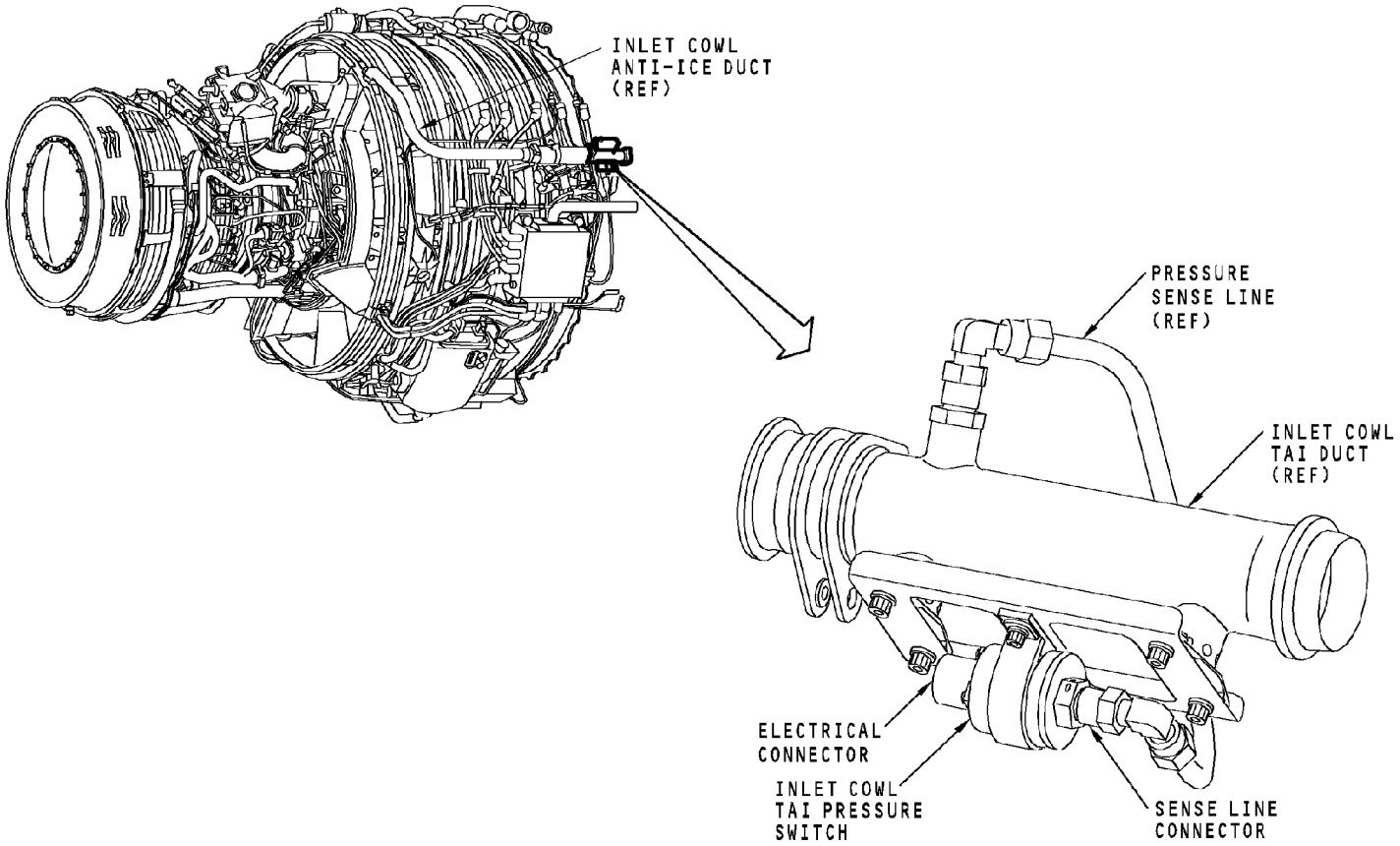
The inlet cowl TAI pressure switch has these parts:

- Sense Line connector
- Electrical connector.

Functional Description

The switch is an aneroid type switch.

When the pressure at the sense port is more than 65 psi, the switch closes. This enables the indication light on P5 forward overhead panel.



ICE AND RAIN PROTECTION - INLET COWL ANTI-ICING SYSTEM - INLET COWL TAI PRESSURE SWITCH

EFFECTIVITY
HAP ALL

ICE AND RAIN PROTECTION - INLET COWL ANTI-ICING SYSTEM - FUNCTIONAL DESCRIPTION

General

There are two inlet cowl anti-icing systems (engine 1 and engine 2). The two systems are the same. The control and indications circuits for the inlet cowl anti-icing systems use 28v dc power.

The switches and lights for the control and indication are on the P5-11 engine and wing anti-ice panel.

Inlet Cowl Anti-Icing

When you put the ENG ANTI-ICE switch in the ON position, the switch does these things:

- Sends 28v dc to energize the control solenoid on the inlet cowl TAI valve
- Gives an open loop discrete to the EEC (for engine idle control)
- Gives an open loop discrete to the FMC (to bias fuel schedules for bleed loads).

The control panel logic and a dimming diode control the blue COWL VALVE OPEN lights:

- Light is off - the switch is in the OFF position and the valve is closed
- Light is dim - the switch is in the ON position and the valve is open
- Light is bright - the switch position and valve position disagree or the valve is in transit.

These things control the bright and dim functions of the COWL VALVE OPEN lights on the anti-ice panel:

- System switch and valve position feedback
- Control panel solid state switch circuits
- Voltage reduction zener diodes (dim mode).

The closed position switch and the open position switch give valve position data.

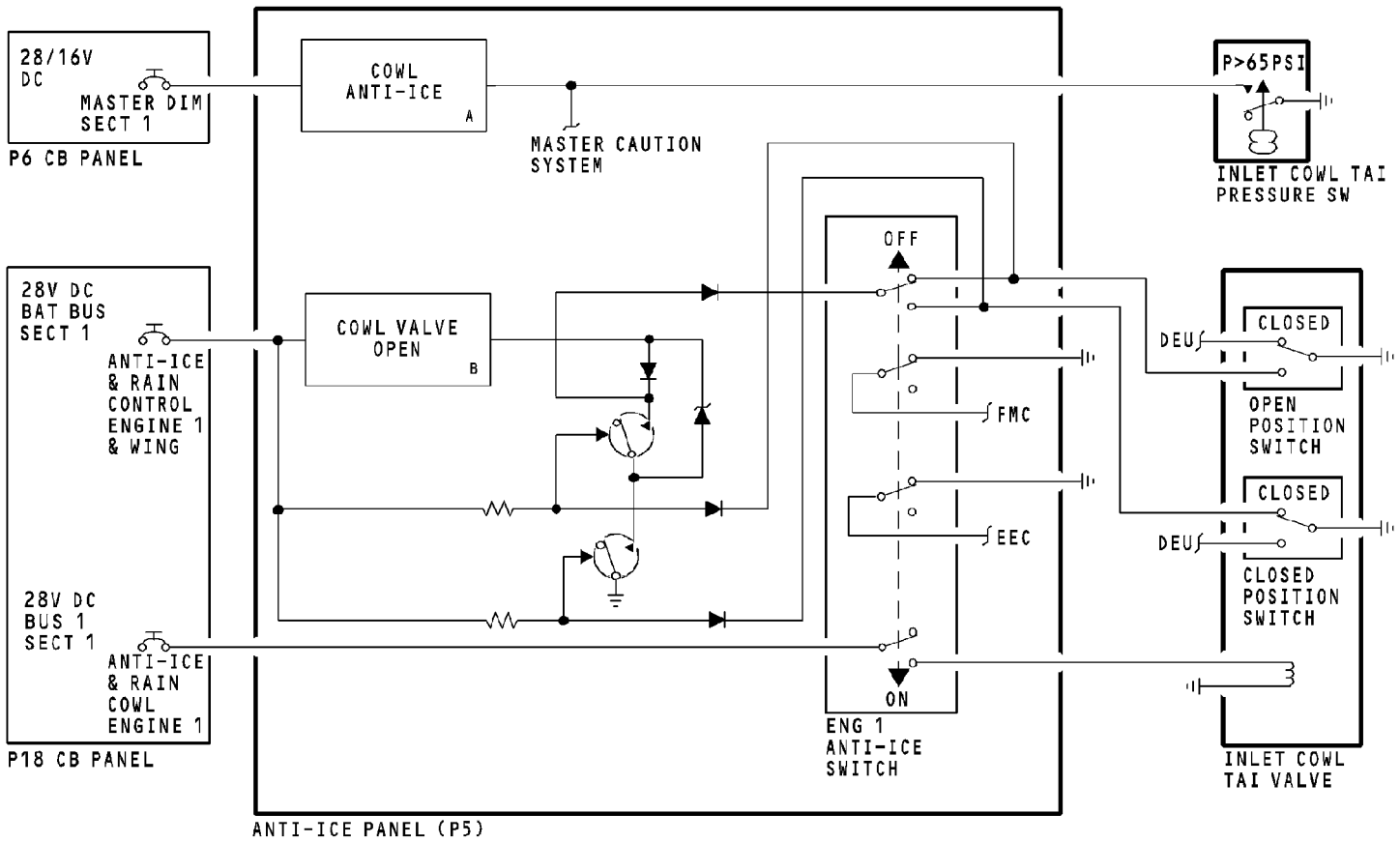
The closed position switch is in the closed position when the valve is almost closed.

The open position switch is in the open position when the valve is more than 15 degrees open.

Overpressure Indication

When the inlet cowl TAI pressure switch operates, it causes these lights to come on:

- The amber COWL ANTI-ICE light
- The MASTER CAUTION and ANTI-ICE annunciator lights.



NOTE: LEFT SYSTEM SHOWN, RIGHT SYSTEM THE SAME.

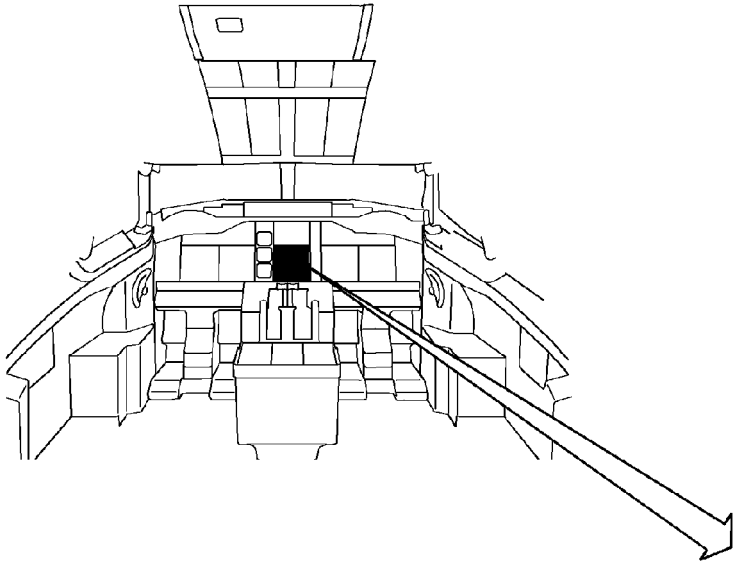
ICE AND RAIN PROTECTION - INLET COWL ANTI-ICING SYSTEM - FUNCTIONAL DESCRIPTION

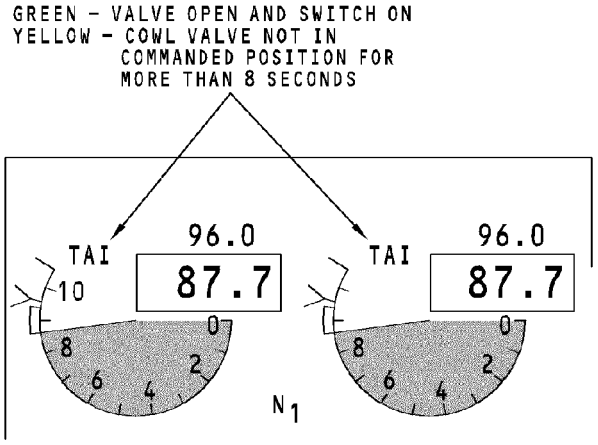
CDS Displays

The common display system (CDS) shows engine inlet cowl TAI status. The display message is TAI. It shows left of each digital N1 speed indication field.

The TAI message is green when the switch is in the ON position and the CTAI valve is open.

The TAI message is amber when the switch and the valve position do not agree for more than 8 seconds.





TAI–INDICATION
(COMMON DISPLAY SYSTEM)

Purpose

The anti-ice panel does these things:

- Gives the flight crew interface with the wing and engine inlet cowl anti-icing systems
- Has the circuitry for control and indication of the cowl anti-icing system.

Location

The panel is on the P5 forward overhead panel.

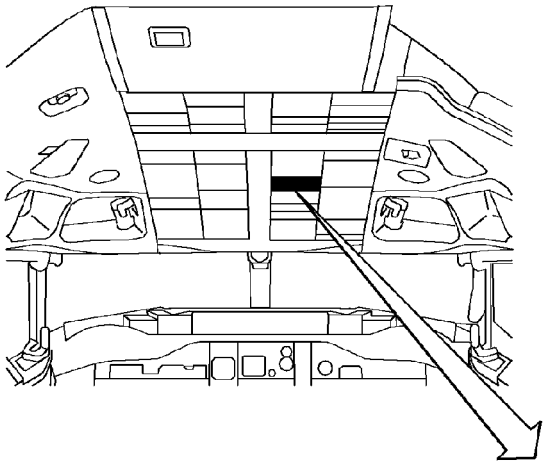
General Description

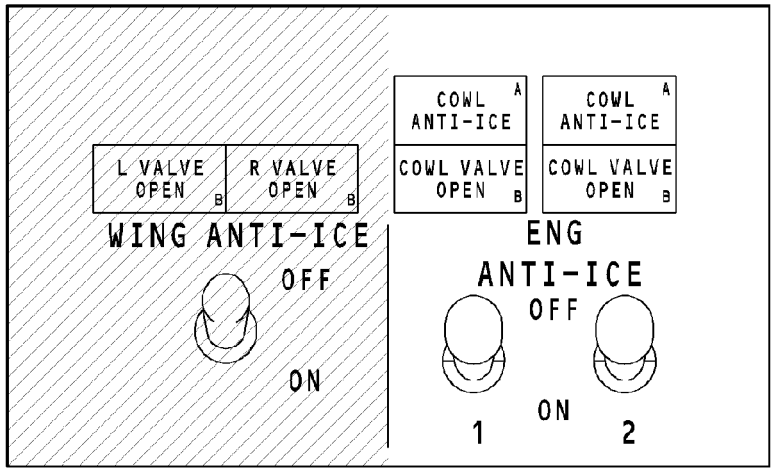
The cowl anti-ice valve opens when the switch is in the ON position on the ground or in flight. The blue COWL VALVE OPEN light shows the valve and switch positions. These are the light indications:

- Light is off - the switch is in the OFF position and the valve is closed
- Light is dim - the switch is in the ON position and the valve is open
- Light is bright - the switch position and valve position are not the same or the valve is in transit.

When the duct pressure downstream of the valve is too high, this is the indication:

- Amber COWL ANTI-ICE light
- MASTER CAUTION and ANTI-ICE annunciator lights.





ANTI-ICE PANEL (P5)

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ICE AND RAIN PROTECTION - PITOT AND STATIC - INTRODUCTION

Purpose

The probe anti-icing system prevents ice on the air data probes.

General

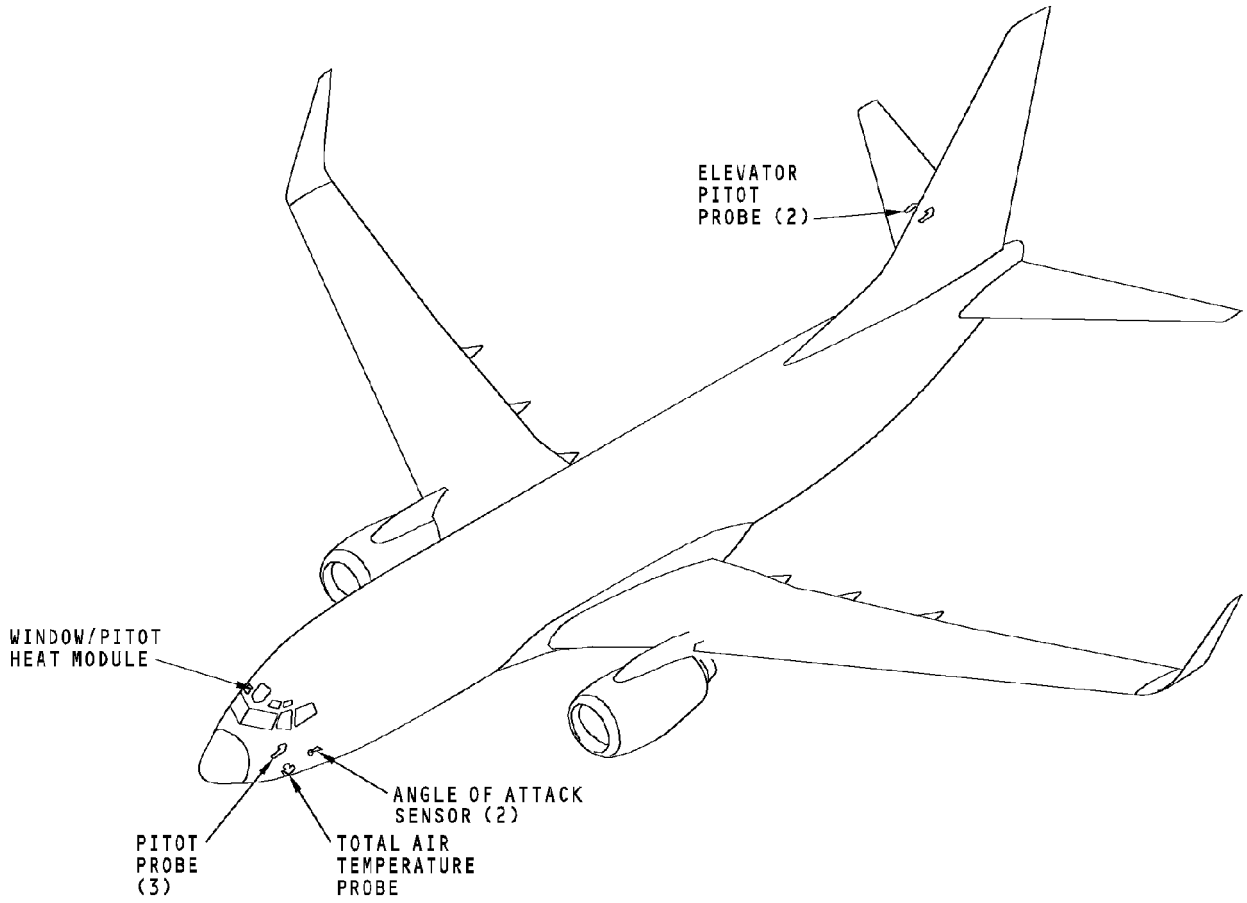
You control the probe heat from the window/pitot heat module on the P5 forward overhead panel.

The probes have integral heaters that use electrical power for heat.

The probe anti-icing system supplies heat to these probes:

- Angle of attack sensor (2)
- Total air temperature probe
- Pitot probes (5).

The static system sense ports are not part of the probe heat system. These ports are flush with the fuselage and heat is not necessary.



ICE AND RAIN PROTECTION - PITOT AND STATIC - INTRODUCTION

EFFECTIVITY

HAP ALL

30-30-00

Purpose

The window/pitot heat module does these things:

- Controls the electric power to the probe anti-icing systems
- Gives the flight crew indication of the probe anti-icing system status.

Location

The window/pitot heat module is on the P5 forward overhead panel.

General Description

There are two air data probe heater systems, A and B. These toggle switches let the crew turn on the probe heat systems:

- PROBE HEAT A
- PROBE HEAT B.

There are two system indication light banks, one for the A system and one for the B system. The lights come on when the probe heaters do not draw electrical current.

The heat for these probes is controlled through probe system A, which is powered by AC Transfer Bus 1:

- LEFT (CAPT) PITOT
- LEFT ELEVATOR PITOT
- LEFT ALPHA VANE
- TEMPERATURE PROBE

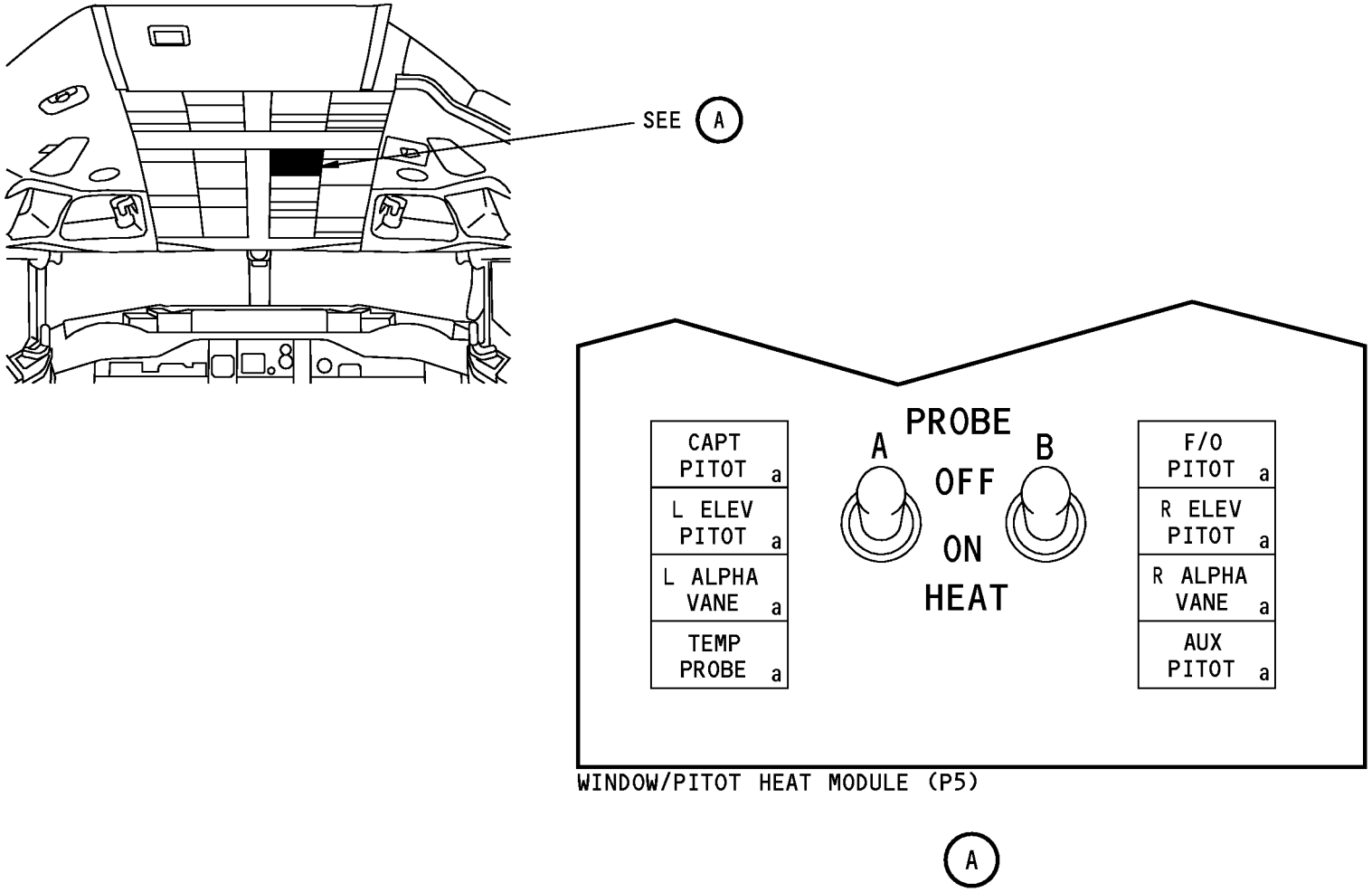
The heat for these probes is controlled through probe heater system B, which is powered by AC Transfer Bus 2:

- UPPER RIGHT (F/O) PITOT
- LOWER RIGHT (AUX) PITOT
- RIGHT ALPHA VANE
- RIGHT ELEVATOR PITOT

If system A or system B does not operate correctly, this configuration makes it possible to continue safe flight with the essential air data from the system that still operates.

EFFECTIVITY

HAP ALL



ICE AND RAIN PROTECTION - PITOT AND STATIC - WINDOW/PITOT HEAT MODULE

Purpose

The pitot probe anti-icing system prevents ice on the pitot tubes. This prevents false air data signals that ice can cause.

Physical Description

The pitot probes have these parts:

- Pitot tube with integral heat element
- Pressure sense connector
- Electrical connector
- Baseplate.

Location

There is one pitot probe (captain) on the left forward fuselage.

There are two pitot probes (first officer and auxiliary) on the right forward fuselage.

There are two elevator pitot probes on the vertical stabilizer.

General

The pitot probes have electric heaters. If a probe heater fails, you must replace the probe.

See the navigation chapter for more information on the captain, first officer, and auxiliary pitot probes. (SECTION 34-11)

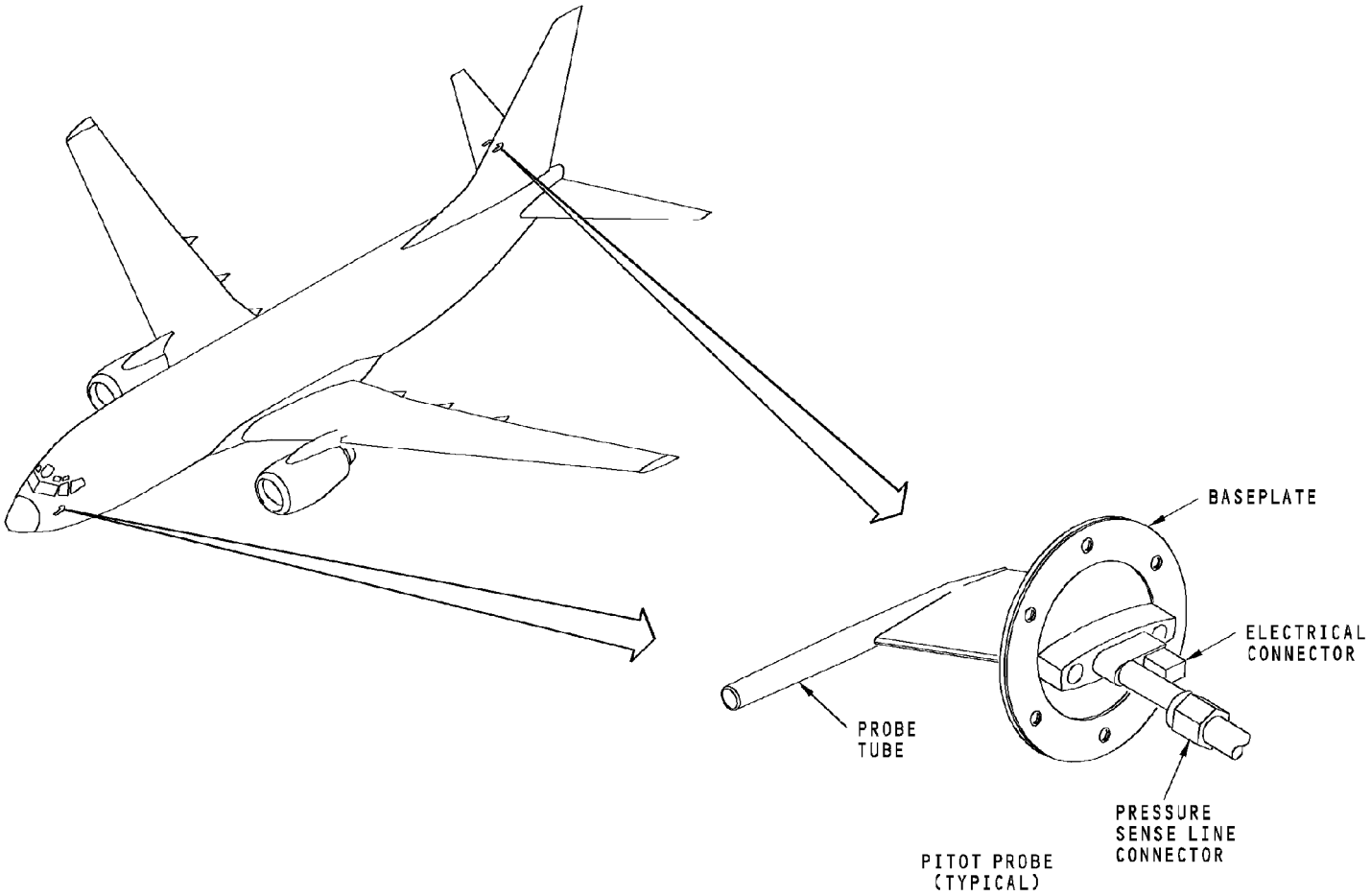
See the elevator and tab control system for more information on the elevator pitot probes. (SECTION 27-31)

Training Information Point

NOTE: Use hardwood or plastic tools when you remove or apply the sealant around the probe baseplate. Do not damage the fuselage aluminum cladding when you remove sealant.

WARNING: DO NOT TOUCH THE PROBES WHILE THE HEATERS ARE ON. BEFORE YOU TOUCH IT, FEEL FOR HEAT RADIATION FROM THE PROBE. HOT PROBES CAN BURN YOU.

Use a backup wrench when you connect the probe sense line. This will prevent damage to the probe.



ICE AND RAIN PROTECTION - PITOT AND STATIC - PITOT PROBE

Functional Description

The pitot probe anti-icing system uses electric power and resistance-type heaters in the probes.

The system uses 115v ac and 28v dc power. Each probe heater uses 115v ac power. The current detection circuit uses 28v dc power.

Each pitot probe has a heater. The heater is part of the probe. If the heater fails, you must replace the probe.

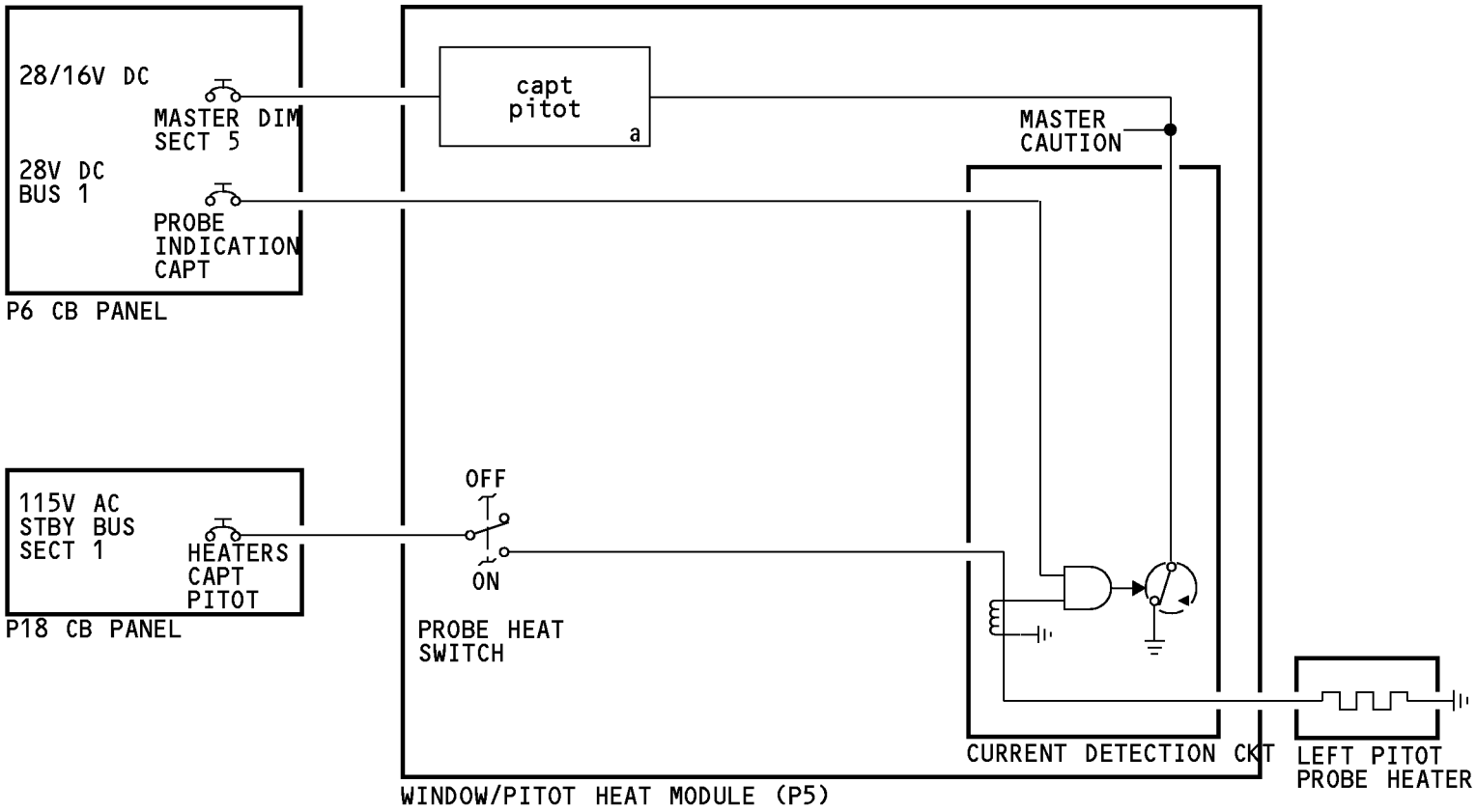
The window/pitot heat module does these things:

- Controls pitot probe heat
- Gives indication of system status.

Put the control switch to the ON position to turn on probe heat. This lets 115v ac power go through the current detection circuitry to the probe heater.

When the probe heater uses current, the current detection circuit causes the amber light to go out. If the probe heater does not use current, the circuit causes these indications:

- Amber CAPT PITOT light comes on
- Amber L ELEV PITOT light comes on
- MASTER CAUTION and ANTI-ICE annunciator lights come on.



NOTE: LEFT(CAPT) PITOT CIRCUIT SHOWN; UPPER RIGHT(F/O), LOWER RIGHT(AUX), LEFT ELEVATOR, RIGHT ELEVATOR THE SAME

ICE AND RAIN PROTECTION - PITOT AND STATIC - PITOT PROBE - FUNCTIONAL DESCRIPTION

EFFECTIVITY

HAP ALL

30-30-00

Purpose

The angle of attack (AOA) sensor anti-icing system prevents ice on the vane. This prevents false air data signals that ice can cause.

Physical Description

The AOA sensor has these parts:

- Case
- Vane
- Electrical connectors (2)
- Alignment pins (2).

NOTE: Angle of Attack sensor is also called Alpha Vane.

Location

There are two AOA sensors. One on each side of the forward fuselage.

General

The AOA sensors have these two integral heaters:

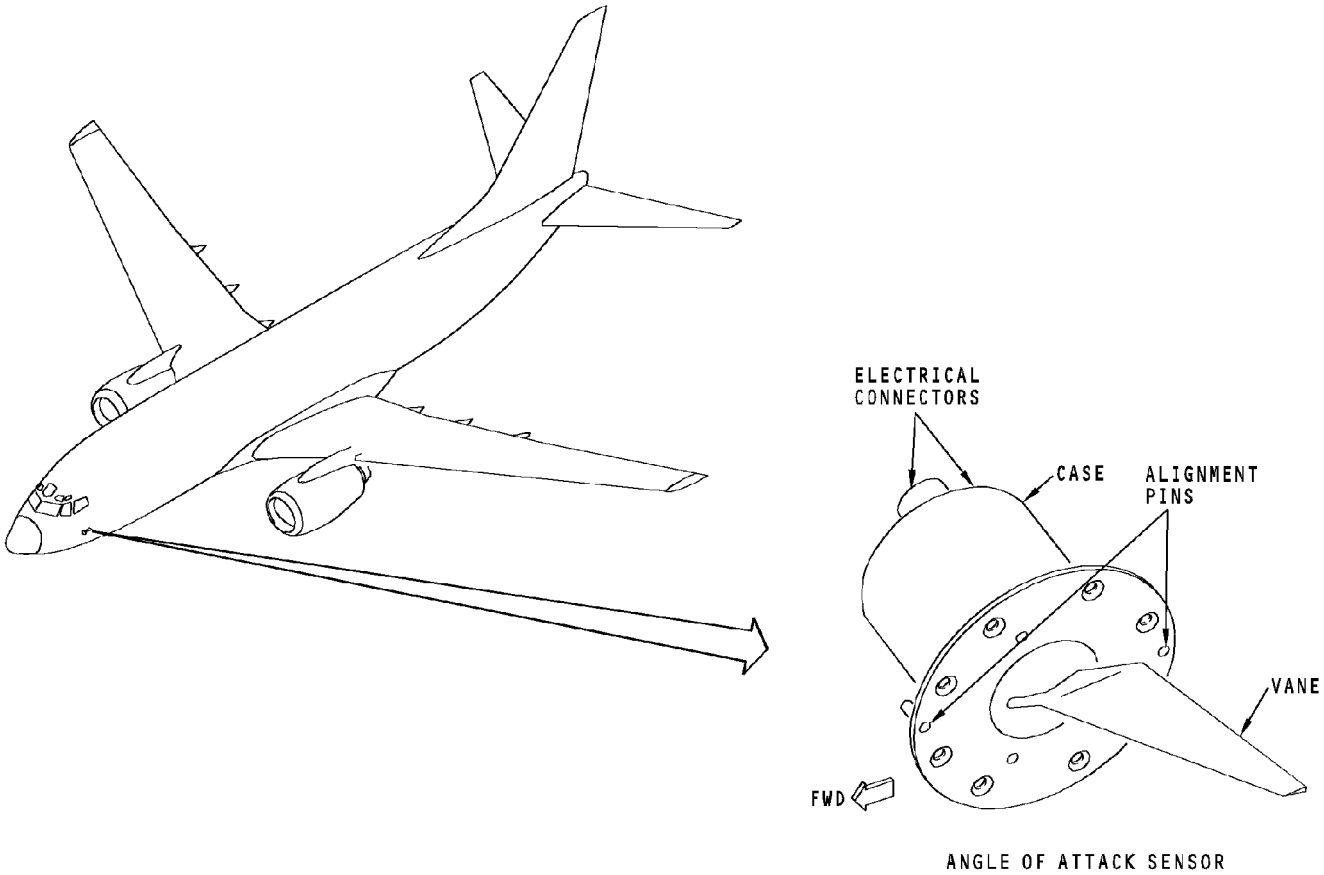
- Vane heater
- Case heater.

Training Information Point

You install the AOA sensor from the outside of the airplane.

See the navigation chapter for more information on the AOA sensor. (SECTION 34-21)

WARNING: DO NOT TOUCH PROBES WHILE HEATERS ARE ON. TEST HEATERS FOR OPERATION BY FEELING FOR HEAT RADIATION IN THE NEAR VICINITY OF HEATER BEING SUBJECTED TO TEST TO AVOID POSSIBILITY OF PERSONNEL BEING BURNED.



ANGLE OF ATTACK SENSOR

ICE AND RAIN PROTECTION - PITOT AND STATIC - ANGLE OF ATTACK SENSOR

Functional Description

The angle of attack sensor anti-icing system uses electric power and resistance-type heating elements.

The system uses 115v ac and 28v dc power. The sensor heat elements use 115v ac power. The current detection circuit uses 28v dc power.

Put the control switch to the ON position to turn on the sensor heat. This lets 115v ac power through the current detection circuit to the sensor heaters.

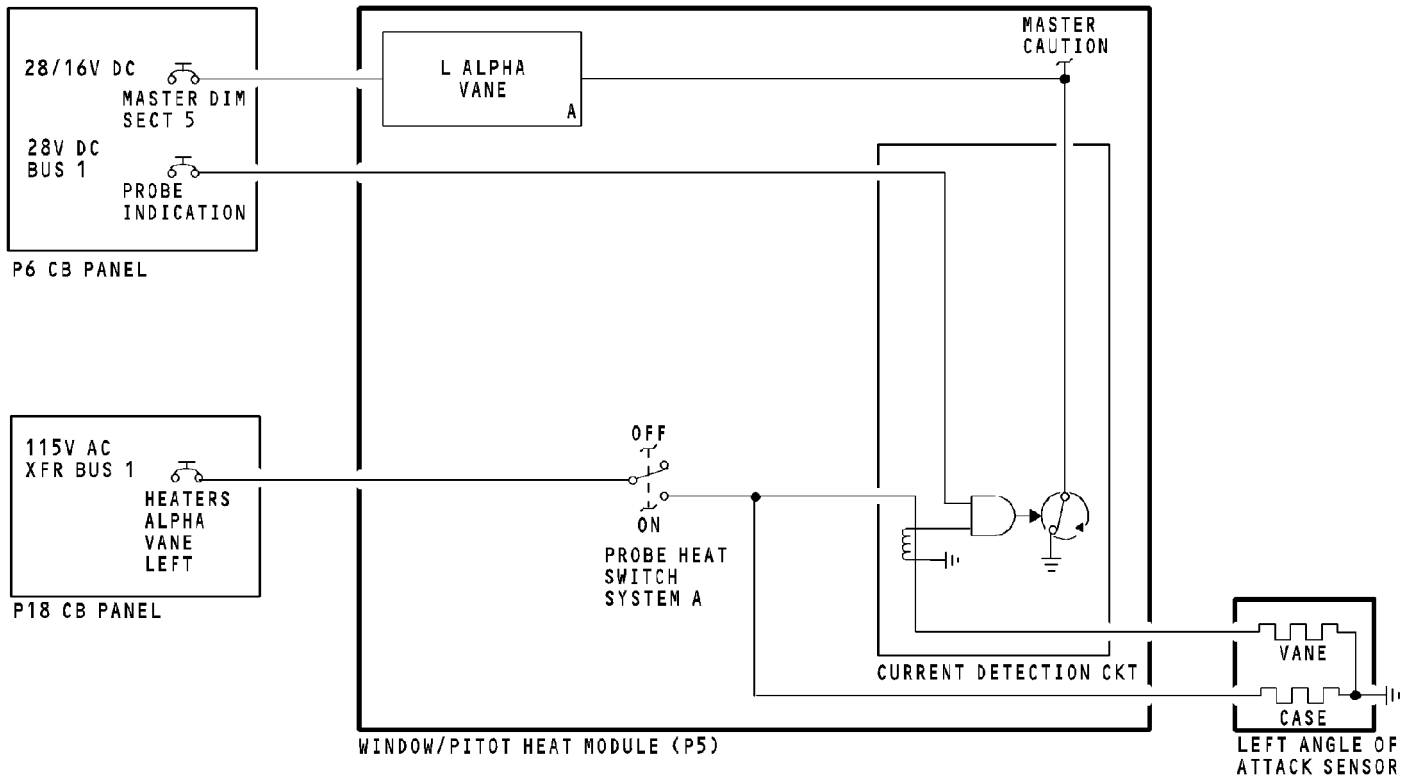
When the vane heater uses current, the current detection circuit causes the ALPHA VANE amber light to go out. If the vane heater does not use current, the circuit causes these indications:

- Amber ALPHA VANE light comes on
- MASTER CAUTION and ANTI-ICE annunciator lights come on.

Training Information Point

The current detection circuit does not monitor the case heat element.

If the vane heater element fails, you must replace the sensor.



NOTE: CAPT ANGLE OF ATTACK SENSOR CIRCUIT
SHOWN, OTHER CIRCUIT THE SAME

ICE AND RAIN PROTECTION - PITOT AND STATIC - ANGLE OF ATTACK SENSOR - FUNCTIONAL DESCRIPTION

Purpose

The total air temperature (TAT) probe anti-icing system makes sure there is no ice on the TAT probe. This prevents false air data signals that ice can cause.

Physical Description

The total air temperature probe has these parts:

- Electrical connector
- Base plate
- Strut
- Ram air sense tube.

Location

The TAT probe is on the left side of the forward fuselage.

General

There is one TAT probe on the airplane. The probe has one heating element. If the element fails, you must replace the probe.

Training Information Point

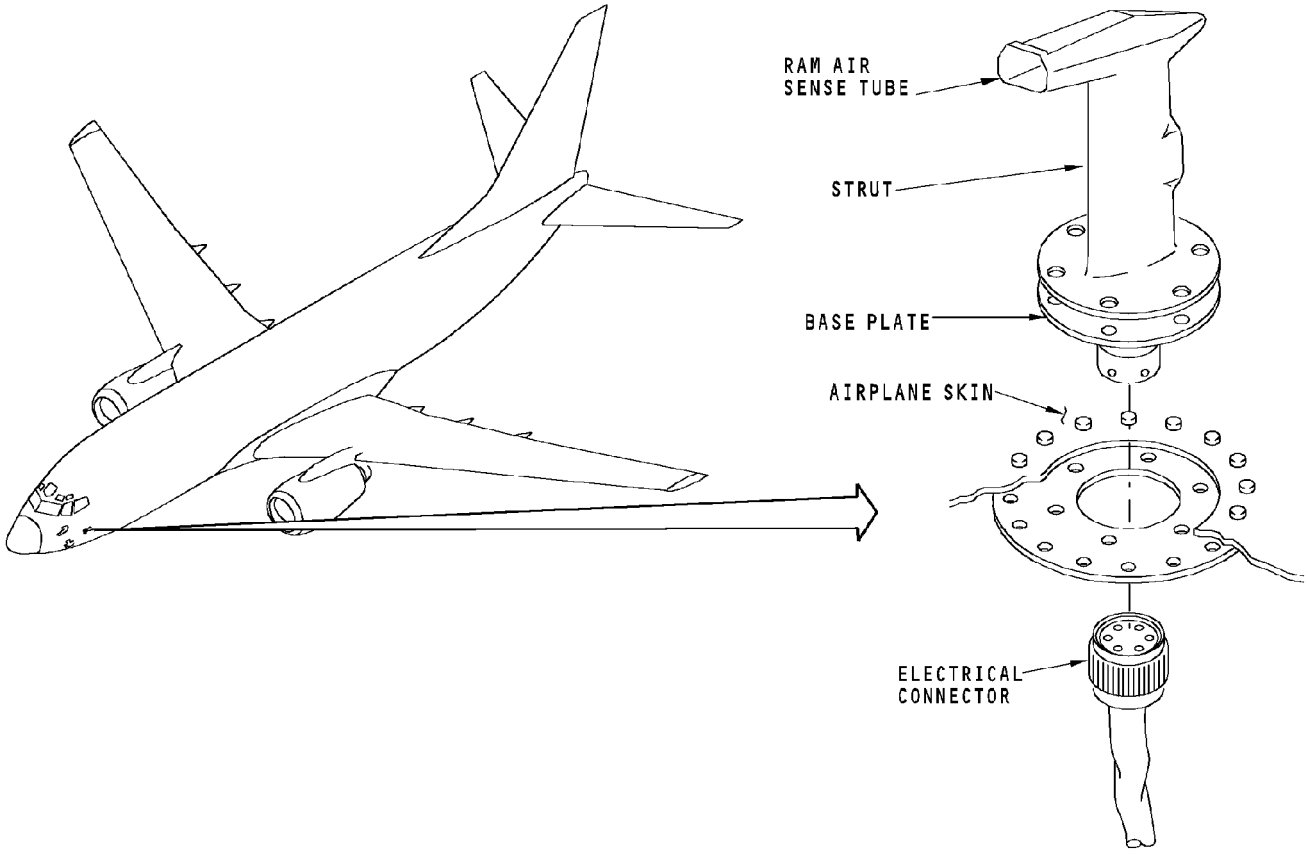
WARNING: DO NOT TOUCH PROBES WHILE HEATERS ARE ON. TEST HEATERS FOR OPERATION BY FEELING FOR HEAT RADIATION IN THE NEAR VICINITY OF HEATER BEING SUBJECTED TO TEST TO AVOID POSSIBILITY OF PERSONNEL BEING BURNED.

When you replace the TAT probe, make sure the airplane electrical lead does not fall down into the fuselage. Wires that fall into the fuselage can be difficult to get.

NOTE: Use only hardwood or plastic tools when you remove or apply the sealant around the probe base plate. Do not damage the fuselage aluminum cladding when you remove sealant.

EFFECTIVITY

HAP ALL



ICE AND RAIN PROTECTION - PITOT AND STATIC - TAT PROBE

Functional Description

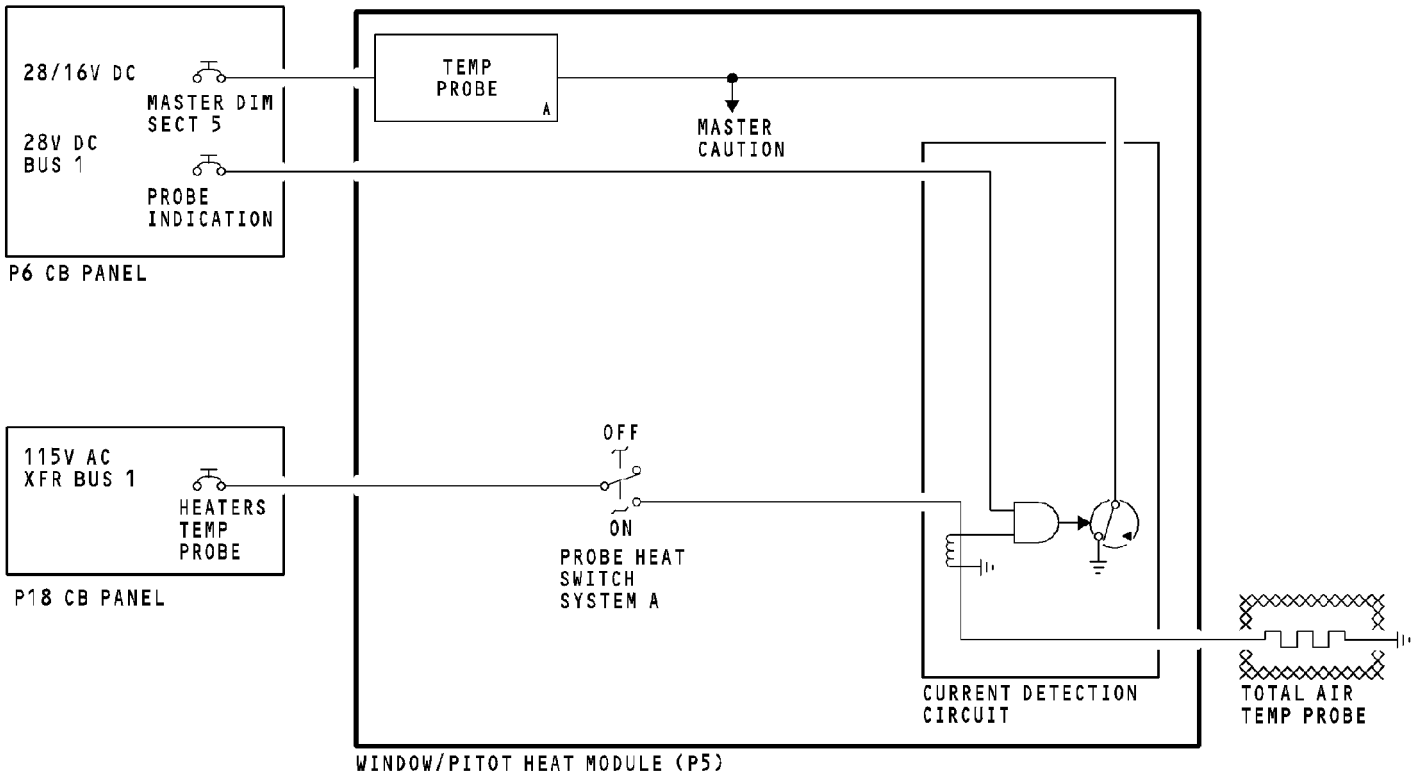
The total air temperature (TAT) probe anti-icing system uses electric power and resistance-type heating elements.

The system uses 115v ac and 28v dc power. The probe heating element uses 115v ac power. The current detection circuit uses 28v dc power.

Put the control switch to the ON position to turn on the probe heat. This lets 115v ac power through the current detection circuit to the probe heater.

When the probe heater uses current, the current detection circuit causes the amber TEMP PROBE light to go out. If the probe heater does not use current, the circuit causes these indications:

- Amber TEMP PROBE light comes on
- MASTER CAUTION and ANTI-ICE annunciator lights come on.



ICE AND RAIN PROTECTION - PITOT AND STATIC - TAT PROBE - FUNCTIONAL DESCRIPTION

Pitot and Static Anti-Icing

The PITOT HEAT switches control air data probe heat. They are two position toggle switches:

- ON
- OFF.

Put the switches in the ON position to heat the air data probes.

Put the switches in the OFF position to stop air data probe heat.

The PITOT HEAT A switch controls heat to these system A probes:

- Captain pitot
- Left elevator pitot
- Left alpha vane
- Total air temperature (TAT) probe.

The PITOT HEAT B switch controls heat to these system B probes:

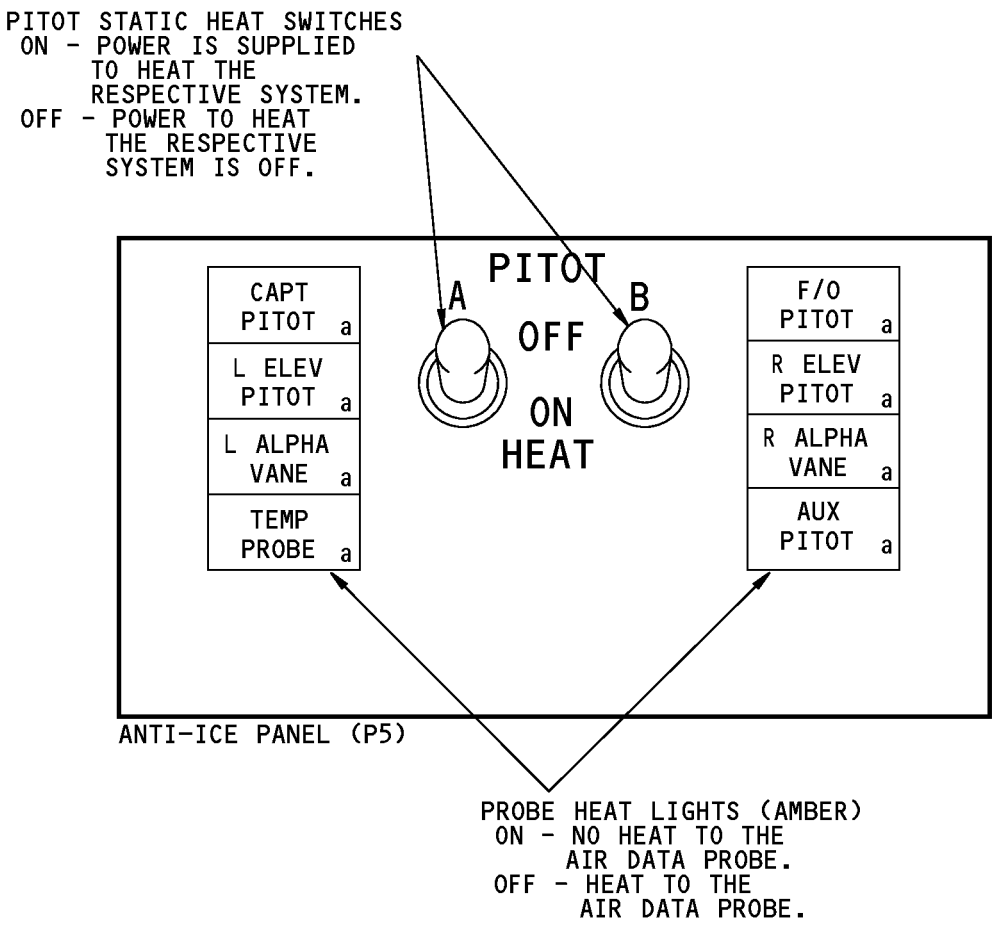
- First officer pitot
- Auxiliary pitot
- Right elevator pitot
- Right alpha vane.

Indication

There is an indication light for each air data probe. These are the indications:

- The light goes off when the related air data probe has heat
- The light comes on when the related air data probe does not have heat.

The system indication lights have the press-to-test function. You can also use the master dim and test switch to do a test of the lights.



ICE AND RAIN PROTECTION - PITOT AND STATIC - OPERATION

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Purpose

The control cabin window anti-icing system improves window impact strength and prevents ice formation on the flight compartment windows.

General Description

The control cabin anti-icing system uses electrical power to heat the flight compartment windows.

The controls and indications for the control cabin window anti-icing system are on the P5 overhead panel.

Window heat control units (WHCUs) are part of the control cabin window anti-icing system. The WHCUs do these things:

- Monitor window temperatures
- Supply OFF and OVERHEAT system indication
- Do system tests
- Program power output to the windows.

The WHCUs control power to these windows:

- No. 1 left and right
- No. 2 left and right.

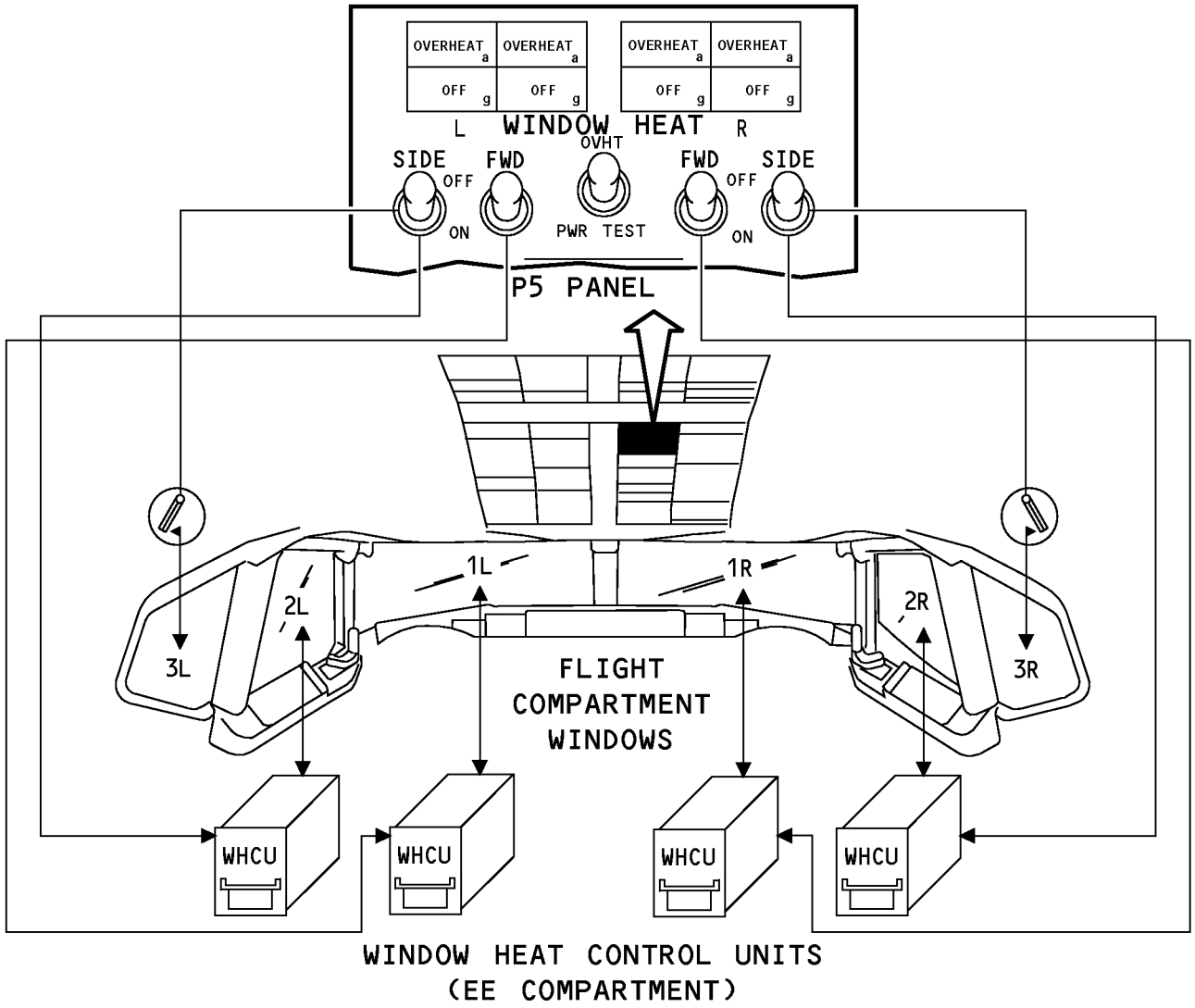
Thermal switches monitor window temperature and control power to these windows:

- No. 3 left and right
- No. 4 left and right
- No. 5 left and right.

Windows in the thermal switch control systems are not part of the P5 overhead panel indication and test functions.

EFFECTIVITY

HAP ALL



ICE AND RAIN PROTECTION - CTRL CABIN - INTRODUCTION

General

The flight compartment windows are of laminate construction. One layer is made of a conductive coating. Electric current from the window heat system flows through the conductive coating. The resistance of the conductive coating produces heat and warms the window.

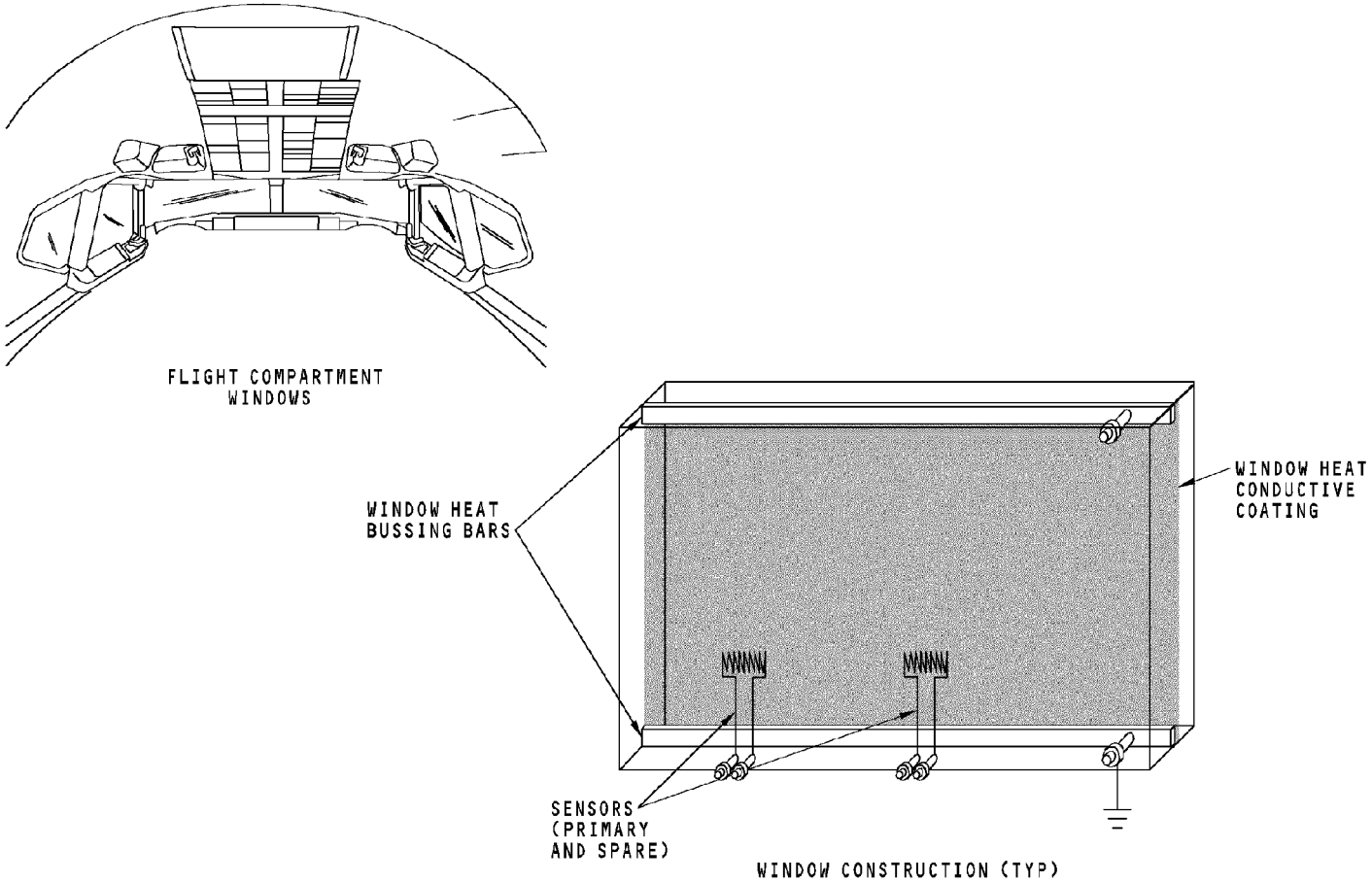
Power terminals and bussing strips in the windows connect the conductive paste to system power.

Windows 1 and 2 have resistance type temperature sensors for feedback to the window heat control units. There are two sensors in each window:

- A primary sensor
- A spare sensor.

The WHCUs use only one sensor. If the primary sensor fails, use the spare sensor. This prevents window removal for a single sensor failure.

The other windows do not use window heat control units and do not have sensors. The thermal switches control the window heat power to these windows.



ICE AND RAIN PROTECTION - CTRL CABIN - WINDOW HEAT CONDUCTIVE COATING AND SENSOR

Purpose

The window heat control units (WHCUs) do these things:

- Sense window temperature
- Apply current to the window heat system when necessary
- Control current to the window heat conductive coating to prevent thermal shock
- Control the P5-9 window heat status indication
- Have circuitry for P5-9 OVHT and PWR TEST
- BITE.

The windshield sensor switches are for the number 1 windows only. The windshield sensor switches let you change the primary sensor to the spare sensor.

Location

The window heat control units are in the EE compartment. Two are on the E4-2 shelf and two are on the E2-1 shelf.

The windshield sensor switches are on the forward outboard E4 stanchion rack.

General Description

There are four identical WHCUs. Each WHCU controls the heat to one window.

The WHCUs get 28v dc and 115v ac for control and indication of window heat to the No.1 and No. 2 windows.

WHCU output power goes to a variable voltage terminal strip. Power to the window is off of the terminal that best matches the window power requirements. This is a function of window size and the condition of its conductive layer.

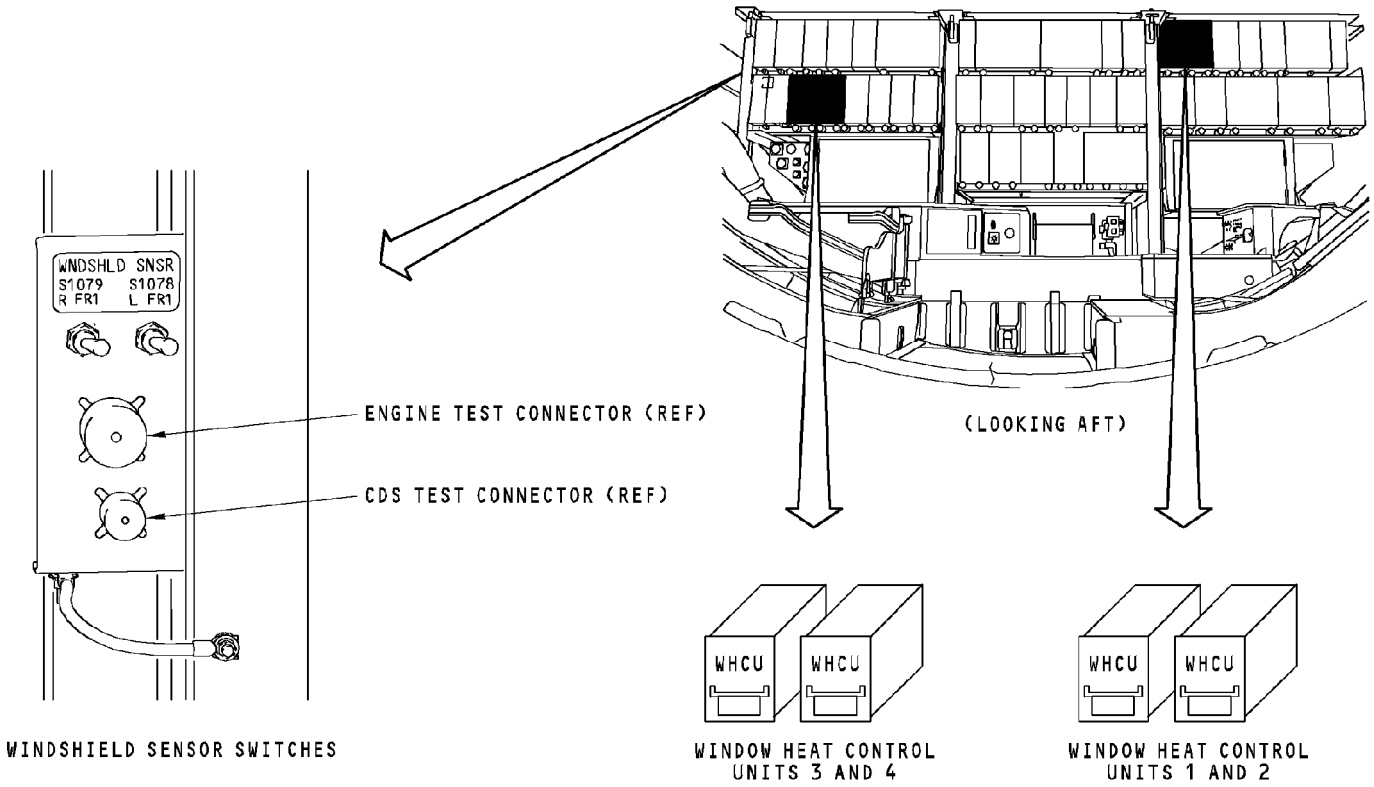
Training Information Point

CAUTION: DO NOT TOUCH THE WINDOW HEAT CONTROL UNIT BEFORE YOU DO THE PROCEDURE FOR DEVICES THAT ARE SENSITIVE TO ELECTROSTATIC DISCHARGE. ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE WINDOW HEAT CONTROL UNIT.

The WHCUs have front face BITE that isolates system faults to the LRU interface level.

For the front windows, you do a test of the resistance of the sensors with the windshield sensor switches on the forward outboard E4 stanchion rack.

For more information on the engine test connector see the FADEC system (SECTION 73-21).



Purpose

The window heat terminal connections provide a selection of voltages from an auto transformer in the window heat control unit (WHCU) to match the resistance of the window conductive coating.

Location

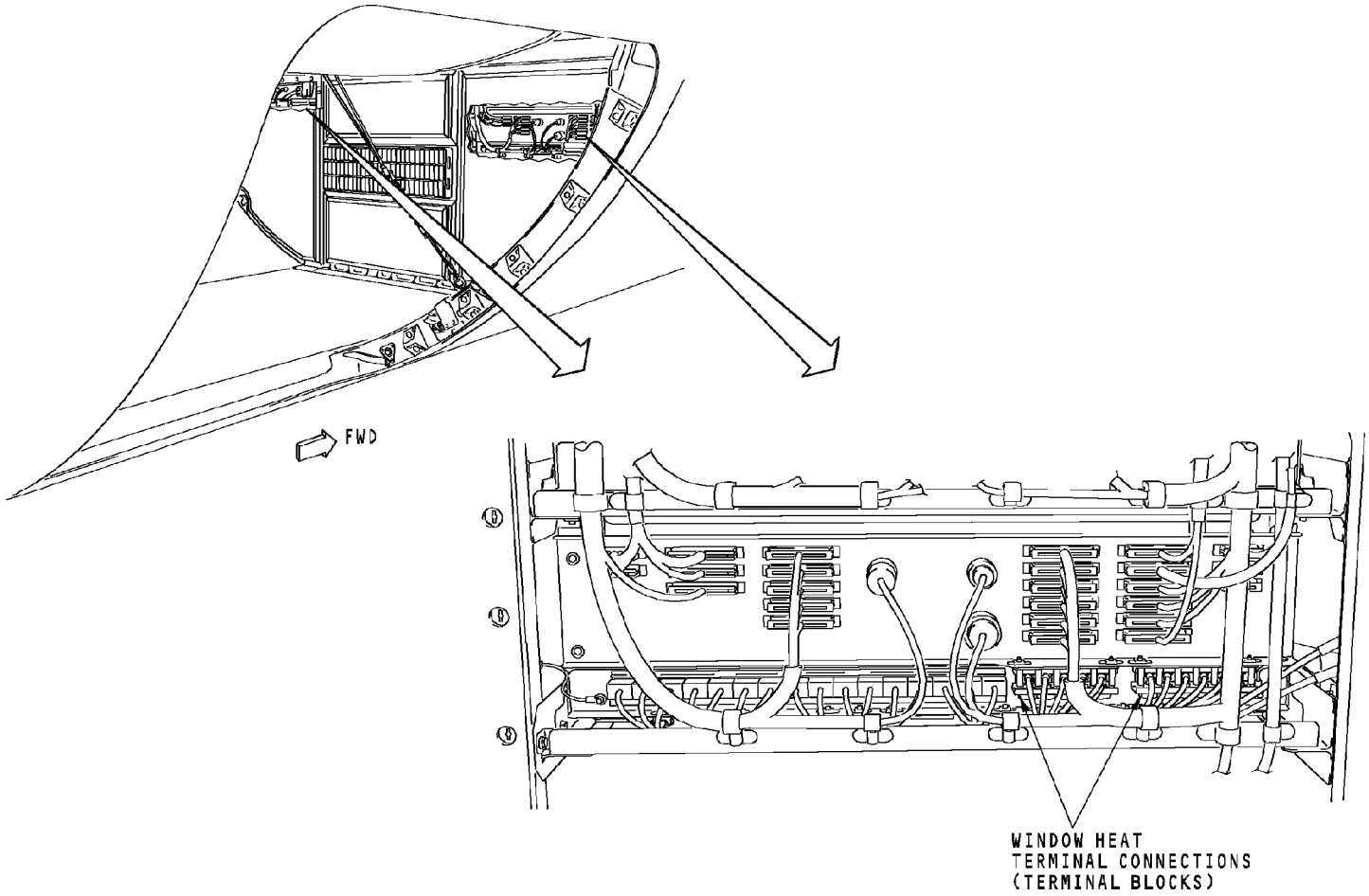
The window heat terminal connections are behind the window heat control units in the EE compartment. You get access to the connections through access panels in the forward cargo compartment.

Physical Description

The window heat terminal connections consist of taps on the terminal blocks. On No. 1 windows, five taps are used. On No. 2 windows, six taps are used.

Training Information Point

When a window is replaced, the new window has the resistance identified by a code etched in the windshield glass. The code tells you the proper transformer tap. If the window does not heat properly, check the conductive coating resistance and select the proper transformer tap.



ICE AND RAIN PROTECTION - CTRL CABIN - WINDOW HEAT CONTROL UNIT TERMINAL CONNECTIONS

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General

The window heat control units heat these windows:

- 1L
- 2L
- 1R
- 2R.

These systems use 28v dc for indication and control. The systems use 115v ac for window heat power.

The window and pitot heat control panel P5-9 has switches and lights for system control and indication. The window heat switches control the WHCUs and the window heat systems.

Each WHCU controls electric heat to one window.

The WHCUs monitor window temperatures and heat windows with electric current when the window is cold.

Power output from the WHCUs is off variable voltage terminal strips. This matches WHCU output voltage to each window power requirements.

The windows are of laminate construction, and have a layer of conductive paste. Bus bars on the windows connect the conductive layer to airplane wiring. Electric current heats the window as it moves through this layer of window structure.

Window Heat Control

When you put the WINDOW HEAT switch in the ON position you energize the system.

The WHCU monitors the window temperature sensor.

If the window temperature is less than 100F (37C), the WHCU sends electric current to the window to heat it. The application of power to the window is by a ramp function to prevent thermal shock to the window.

As the window gets near its target temperature (110F (43C) nominal), the WHCU ramps down electric current to the window. This prevents temperature overshoot.

When there is current flow to the window, sense circuitry in the WHCU deenergizes the P5-9 amber OFF light circuit. This gives an indication that the window heat circuit is active.

If the window is warmer than the target temperature when the system switch is on, these things are true:

- Window heat is not necessary
- The WHCU does not send current to the window
- The P5-9 amber OFF light is on.

A PWR TEST switch on the P5-9 panel gives the crew a confidence test of the window heat system when the window is warm. The switch does a test of all the WHCU window heat systems that are on. Hold the switch to the PWR TEST position to do the test. This causes the WHCU to send current to the window, and the P5-9 amber OFF light goes off.

Release the PWR TEST switch as soon as you verify the amber OFF light, or you can overheat the window. This will cause the WHCU overheat protection circuitry to activate.

Overheat Protection

The WHCUs have overheat protection circuitry.

If the WHCU detects both of these conditions, an overheat trip occurs:

- Window temperature more than 145F (62C)
- Electric current to the window heat circuit.

The overheat protection circuit operates only while power is applied to the window. This permits a lower overheat trip setting, and prevents nuisance system trips during operations under conditions of high ambient heat.

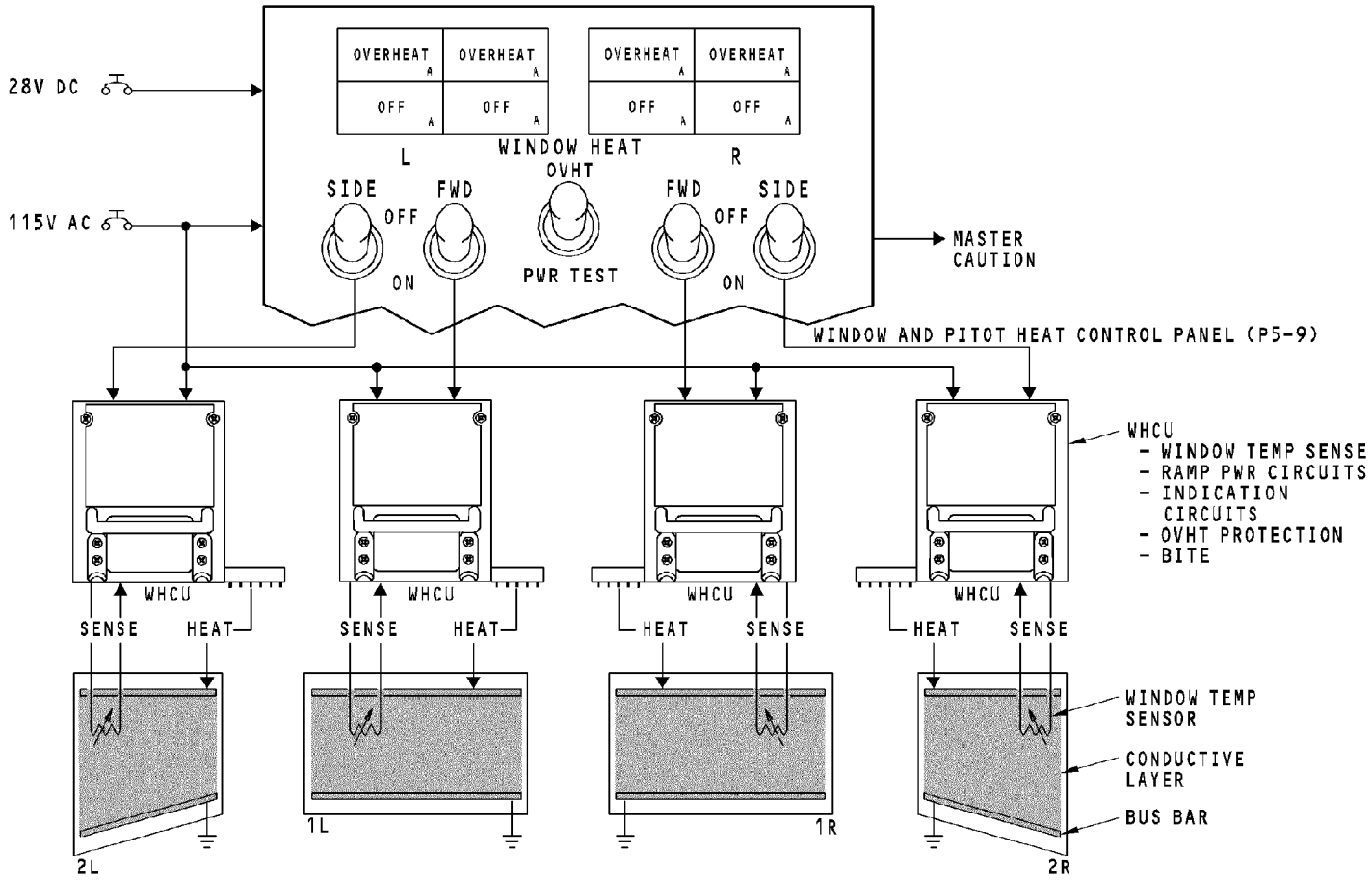
An overheat trip causes these things to happen:

- Electric current to the window is cut off
- The amber P5-9 amber OFF light comes on
- The amber P5-9 amber OVERHEAT light comes on
- The MASTER CAUTION and ANTI-ICE annunciator lights come on.

To reset the system, you must move the WINDOW HEAT switch to the OFF position, and then back to the ON position.

An overheat cannot be reset until the window cools.

An OVHT switch on the P5-9 panel panel gives the crew a confidence test of the WHCU overheat protection circuitry during system operation. The switch does a test of all the WHCU window heat systems that are switched ON. Hold the switch to the OVHT position for one second then release to do the test. This causes the WHCU circuitry to simulate a window overheat. The indications of a successful test are the same as an actual overheat condition. To reset the system, move the window heat switch to the OFF position, and then back to the ON position.



ICE AND RAIN PROTECTION - CTRL CABIN - WINDOW HEAT CONTROL UNIT - GENERAL DESCRIPTION

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Window Heat Control

When you put the window heat switch in the ON position, you energize the system.

The WHCU monitors the window temperature sensor.

If the window temperature is less than 100F (37C), the control circuits keep K1 energized. This sends electric current to the window to heat it. The application of power to the window is by a ramp function to prevent thermal shock to the window. The control circuits energizes K2, this keeps the amber P5 overhead panel OVERHEAT light off.

As the window gets near its target temperature of 110F (43C), the WHCU ramps down electric current to the window. This prevents temperature overshoot.

When there is current flow to the window, the power demand detector in the WHCU energizes K3 and the amber OFF light on P5-9 panel goes out. This gives an indication that the window heat circuit is active.

If the window is warmer than the target temperature when the system switch is ON, these things are true:

- Window heat is not necessary
- The WHCU does not send current to the window
- The amber OFF light on P5-9 panel comes on.

Overheat Protection

The WHCUs have overheat protection circuitry.

If the WHCU detects both of these conditions, an overheat trip occurs:

- Window temperature more than 145F (62C)
- Electric current to the window heat circuit.

The overheat protection circuit operates only while power is applied to the window. When an overheat condition is sensed K1 and K2 are relaxed. This removes power from the window. This also provides a ground for the amber OVERHEAT light on P5-9 panel.

An overheat trip causes these things to happen:

- Electric current to the window is off
- The amber OFF light on P5-9 panel comes on.
- The amber OVERHEAT light on P5-9 panel comes on.
- The MASTER CAUTION and ANTI-ICE annunciator lights come on.

To reset the system, move the WINDOW HEAT switch to the OFF position, and then back to the ON position.

An overheat cannot be reset until the window cools.

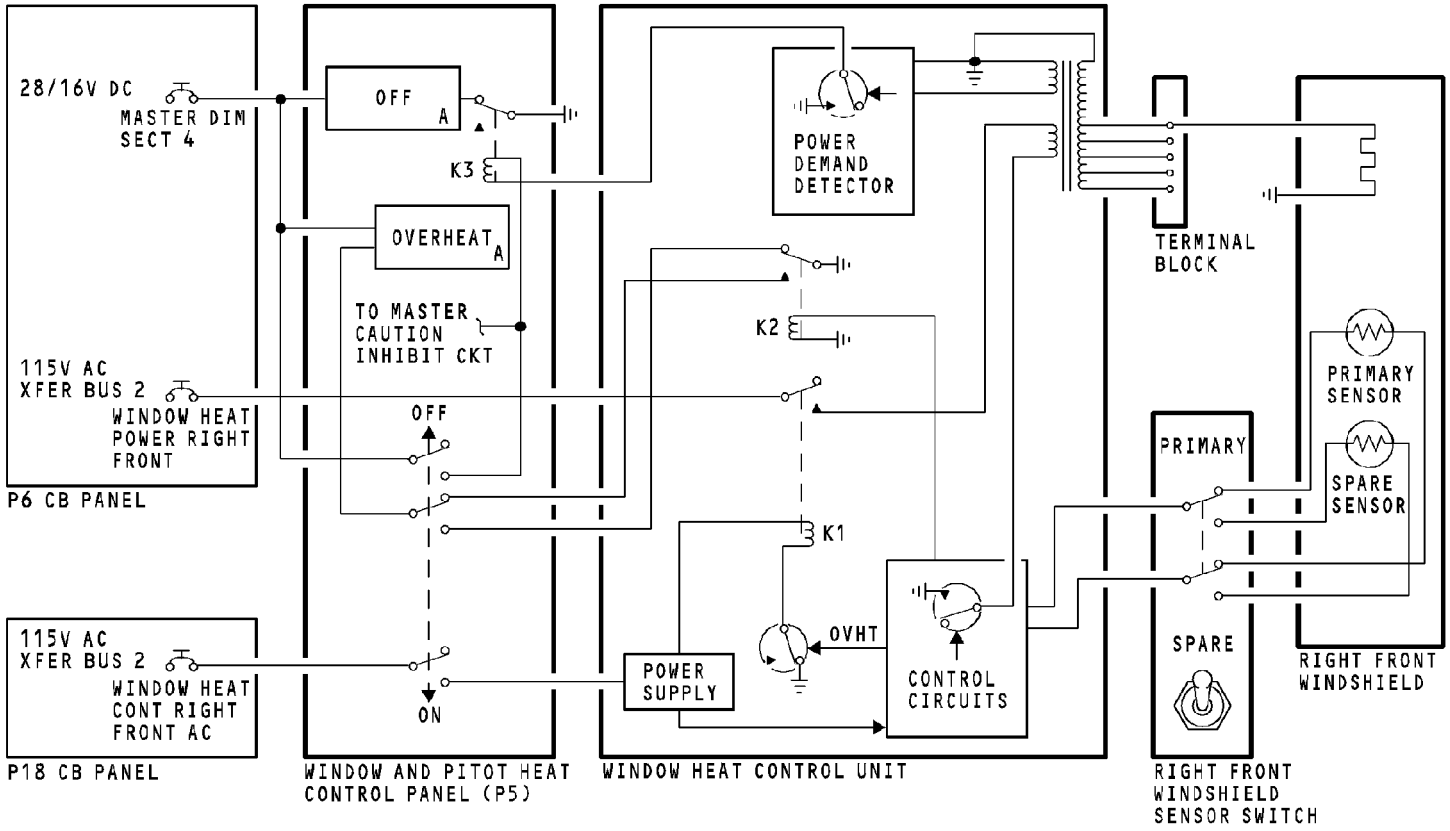
On the ground, the MASTER CAUTION and ANTI-ICE annunciator lights are inhibited for the amber OFF light when left engine throttle is retarded.

Training Information Point

There are two temperature sensors in each window:

- Primary sensor
- Spare sensor.

If the primary sensor fails, you can use the spare sensor. This prevents the need to change a window if the primary sensor fails.



ICE AND RAIN PROTECTION - CTRL CABIN - WINDOW HEAT CONTROL UNIT - FUNCTIONAL DESCRIPTION

EFFECTIVITY

HAP ALL

30-41-00

Purpose

Thermal switches on the No. 5 windows control power to the No. 4 and 5 windows.

Thermal switches on the No. 3 windows control power to the No. 3 windows.

General Description

A bracket with a torsional spring secures the switch to the window.

A conductive paste improves heat transfer from the window to the switch and prevents a temperature lag between the switch and the window.

Functional Description

The thermal switch is a normally-closed, single-pole, snap action bimetallic device. It operates by thermal expansion.

The thermal switches are wired in series with the windows they control.

Put the related side window heat switch to ON to energize the system. 115v ac power passes through a thermal switch to the resistive layer of each window. The resistance of the layer to the current produces heat and warms the window.

The switch opens at a temperature of 110F (43C) or more. This opens the circuit, and removes power to the windows.

The switch opens at a temperature of 95F (35C) or more. This opens the circuit, and removes power to the windows.

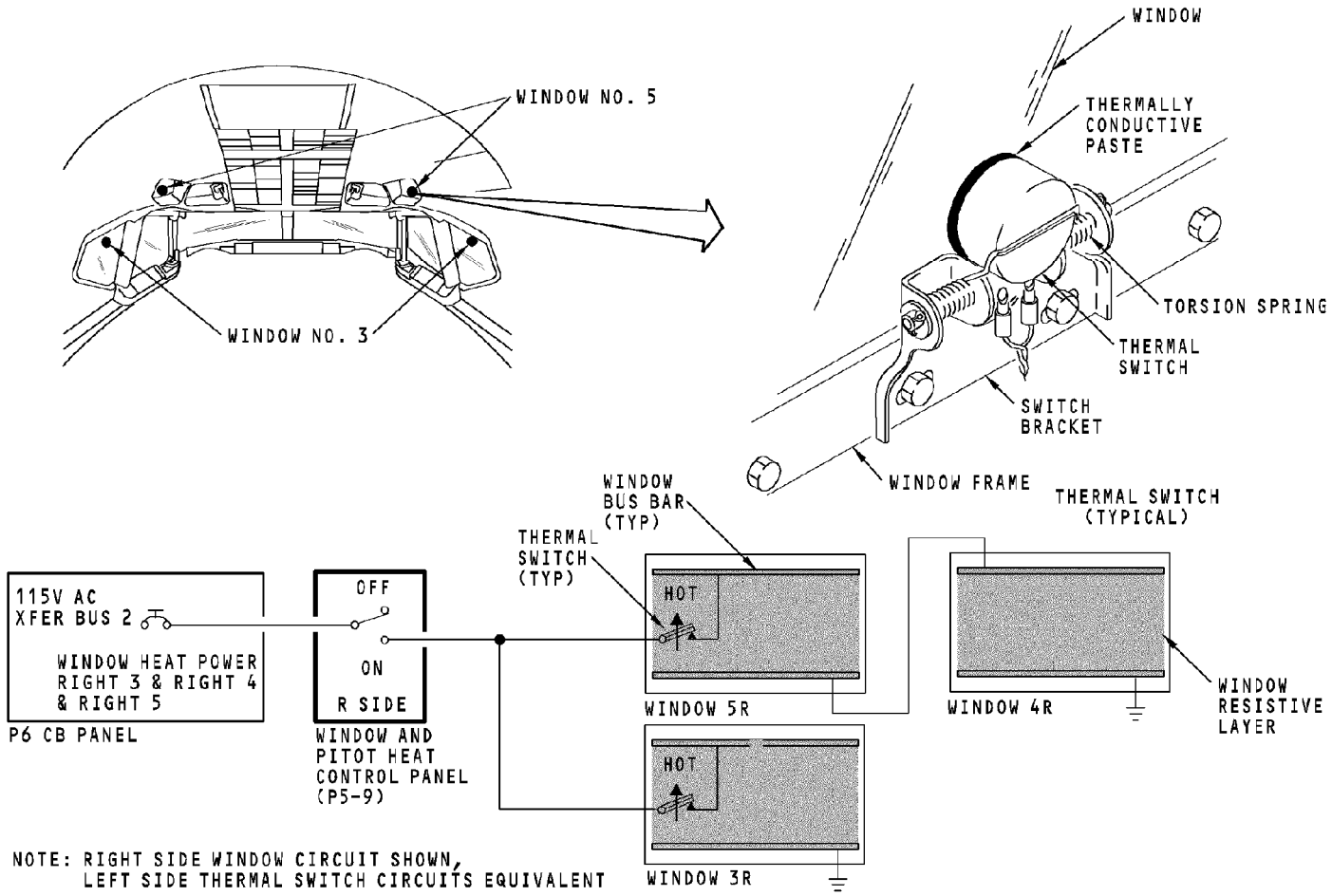
When the No. 5 window and thermal switch temperature decreases to 90F (32C), the switch closes and completes the heat circuit. This starts the window heat again.

When the No. 3 window and thermal switch temperature decreases to 75F (24C), the switch closes and completes the heat circuit. This starts the window heat again.

Training Information Point

These windows are not part of the anti-ice panel indication or test systems.

These windows do not have overheat protection. If the thermal switch fails or detaches from its conductive paste, the windows can overheat. The windows should be warm to the touch, but not hot. If bubbles appear in the window layers, this may be an indication of window overheat (thermal breakdown and outgassing of vinyl layers).



ICE AND RAIN PROTECTION - CTRL CABIN - WINDOW NO. 5 THERMAL SWITCH

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Purpose

The WHCUs have front face BITE that isolates system faults to the LRU interface level.

General Description

The BITE circuitry detects failures in these:

- WHCU internal faults
- Window
- Temperature sensor
- Control power input
- Bus power input
- Associated wiring.

The WHCU has a 10-register FAULT HISTORY memory storage capability.

BITE Test Switches

The WHCU has these switches:

- LAMP TEST
- BIT VERIFY
- FAULT HISTORY
- BIT LAMP RESET.

The LAMP TEST switch does a test of the six BIT indicator lamps. This verifies power and indication availability.

The BIT VERIFY switch starts a system self test. This does a check of system faults.

The FAULT HISTORY switch shows the last 10 registers one register at a time.

The BIT LAMP RESET switch clears the fault from the WHCU.

BITE Indications

The BIT TEST OK lamp shows that a BIT VERIFY test is complete and found no faults. The lamp stays on for 15 seconds.

The WHCU has these red fault lamps:

- WHCU-LRU
- WINDOW SENSOR
- BUS POWER
- WINDOW POWER
- P5-9/CONTROL POWER.

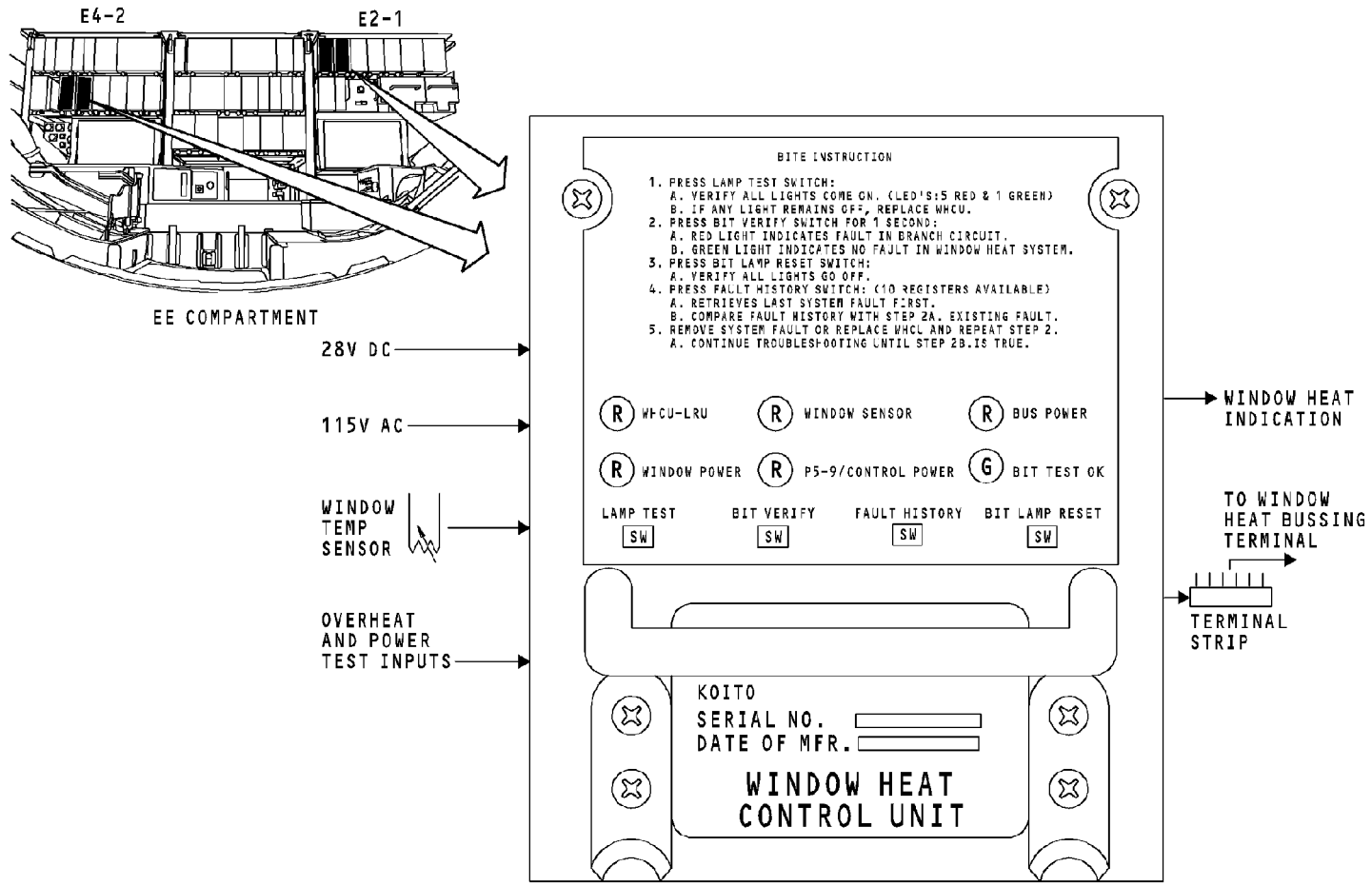
The WHCU-LRU lamp shows a failure of the WHCU unit.

The WINDOW SENSOR lamp shows a failed sensor due to opens, shorts, or wiring problems.

The BUS POWER lamp shows that there is no power to the WCHU bus.

The WINDOW POWER lamp shows that there is no window power or there is over current to the window. This is due to either a window, wiring, or a connector open or shorted problem.

The P5-9/CONTROL POWER lamp shows that there is no power to the WHCU.



ICE AND RAIN PROTECTION - CTRL CABIN - WINDOW HEAT CONTROL UNIT - BITE

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Purpose

The windshield wiper system removes rain, sleet, and snow from the No. 1R and No. 1L flight compartment windows.

General

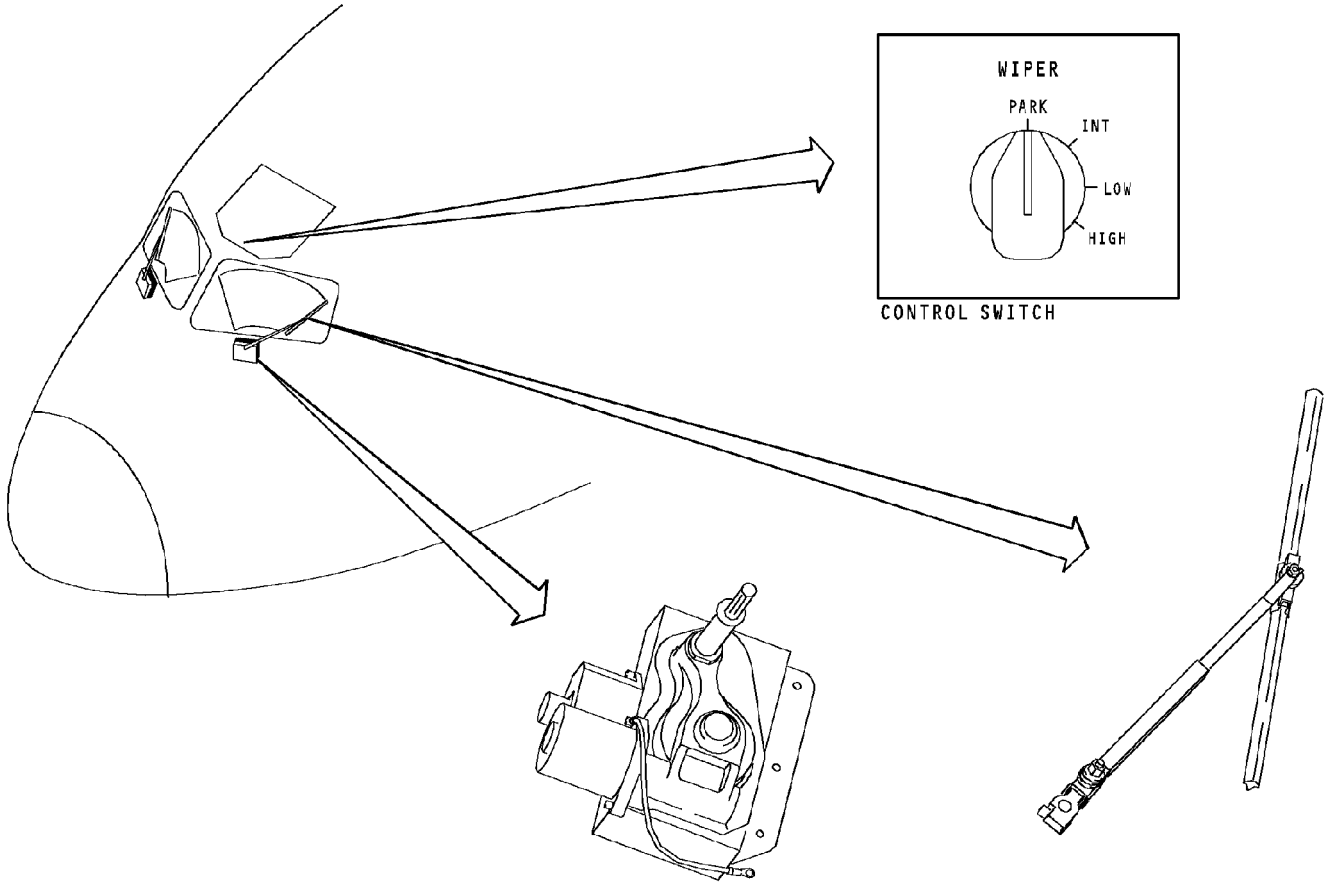
Two wiper control switches on the P5 forward overhead panel give the flight crew control of the system. The system has two windshield wiper and drive assemblies.

Location

The WIPER control switches are on the P5 forward overhead panel.

The two windshield wiper assemblies are on the No. 1R and No. 1L flight compartment windows.

The two windshield wiper drive assemblies are on the No. 1R and No. 1L window sills. You get access to the windshield wiper drive assemblies from under the P7 glareshield.



ICE AND RAIN PROTECTION - WINDSHIELD WIPER SYSTEM - INTRODUCTION

EFFECTIVITY

HAP ALL

30-42-00

Purpose

The windshield wiper and drive assembly does these things:

- Moves the windshield wiper
- Controls the force the wiper applies on the windshield
- Gives rigging adjustments for wiper sweep.

Location

The windshield wipers are in front of the No. 1 right and No. 1 left flight compartment windows.

There are two windshield wiper drive assemblies. They are on the windshield sill beam behind the P1 and P2 panels.

You get access to the windshield wiper drive assemblies through panels under the P7 glareshield.

General Description

Each windshield wiper drive assembly moves its windshield wiper.

Each windshield wiper drive assembly has these parts:

- 28v dc motor
- Rotary to oscillatory reduction gearbox
- Output shaft
- Wiper arm
- Wiper blade.

General

There are two windshield wiper assemblies.

Each windshield wiper assembly has these parts:

- Wiper arm
- Wiper blade.

The wiper arm adjustment nut sets the force the wiper blade applies to the window.

The arm attachment fittings adjust clocking of the wiper arm to the output shaft of the windshield wiper drive assembly.

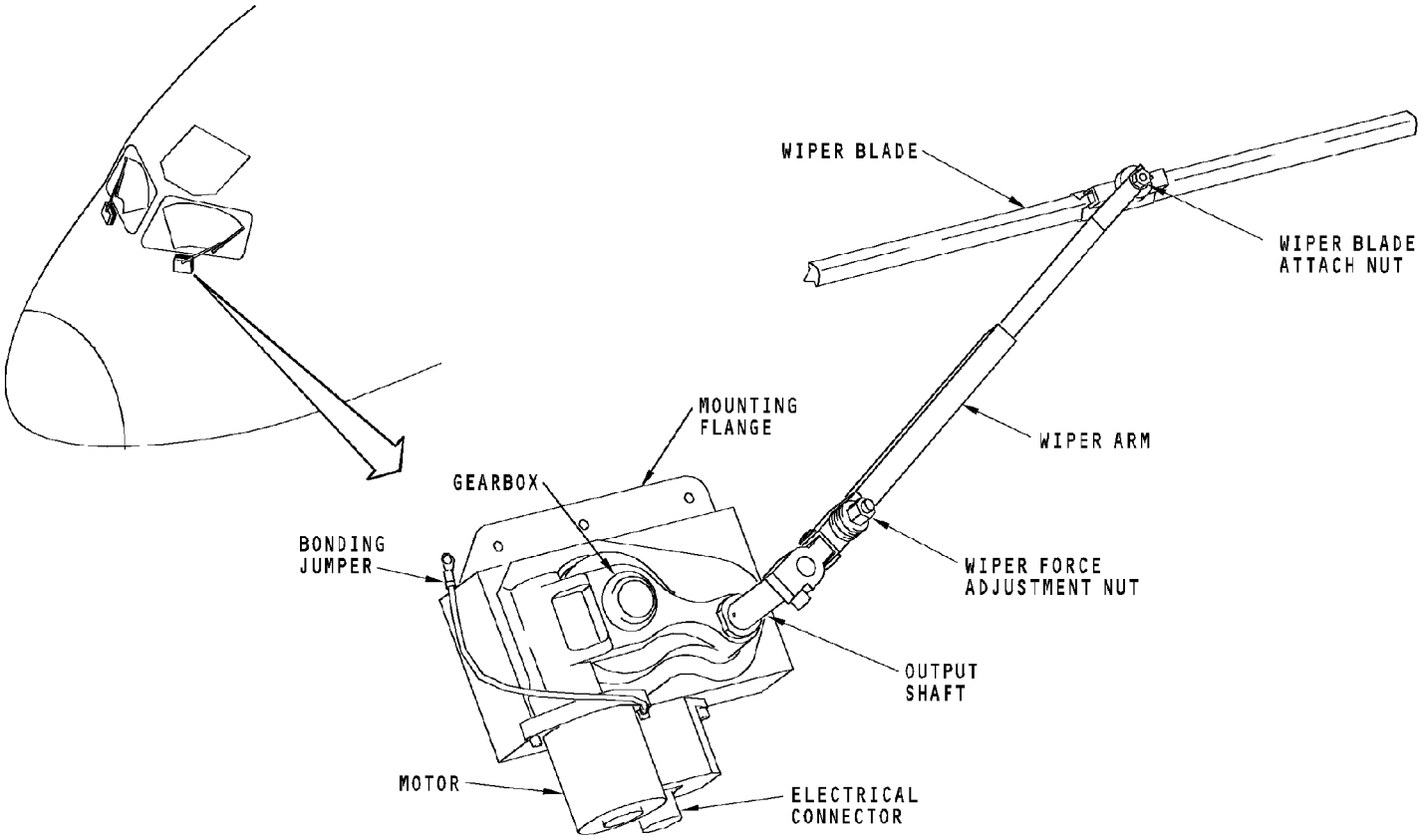
The blade attach nut and fittings set the angle between the blade and the wiper arm.

Training Information Point

Do not operate the wipers on dry windshields. This can do these things:

- Scratch the window
- Decrease wiper blade service life
- Remove windshield hydrophobic (rain repellent) coating.

EFFECTIVITY
HAP ALL



WINDSHIELD WIPER ANDDRIVE ASSEMBLY

General

The windshield wiper system uses 28v dc power.

Two switches on the P5 forward overhead panel control the two wiper motors.

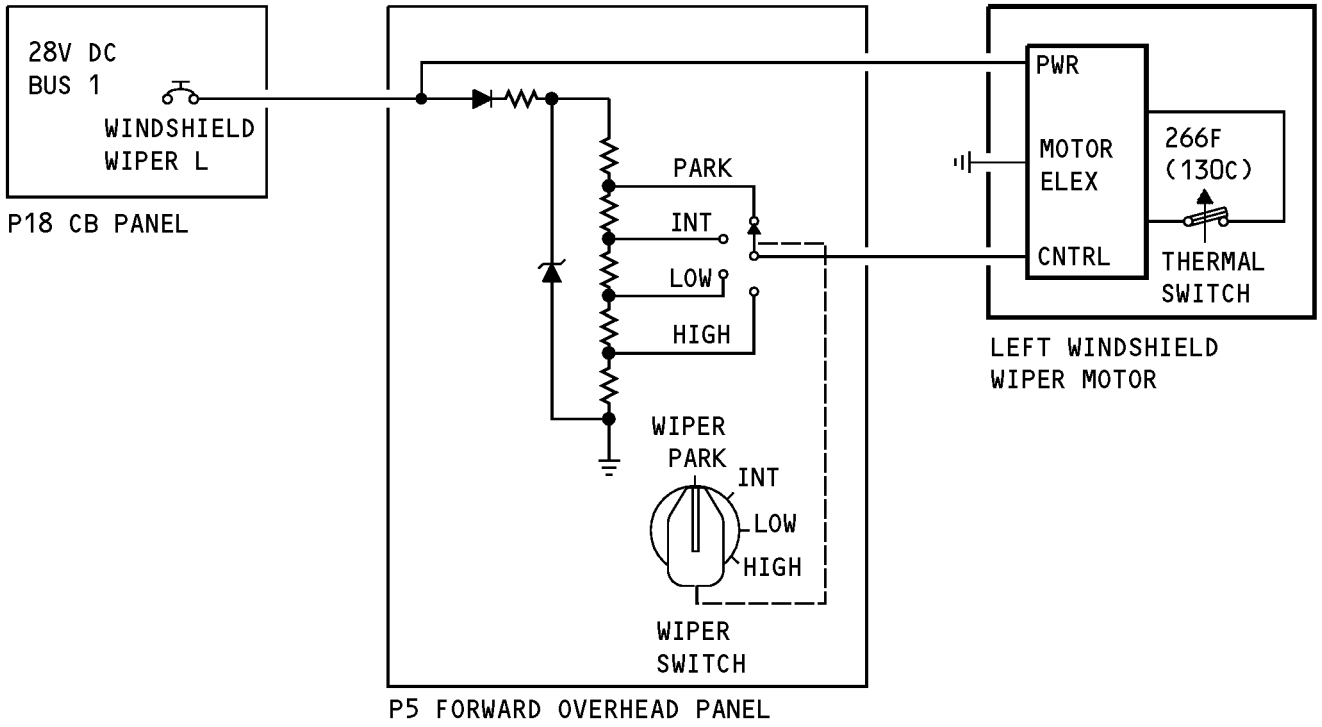
Functional Description

The WIPER switch is a four-position (PARK, INT, LOW, HIGH) selector. It is a voltage divider and sends different voltage signals to the motor electronic control package to provide intermittent, low, and high speed wiper operation.

The motor electronic control package controls the motor speed in response to the WIPER switch position signal.

A thermal switch in the motor assembly cuts out motor operation if the temperature in the motor gets to 266F (130C). The thermal switch resets automatically when the motor cools.

The PARK position will cause both blades to rotate outboard to the lower window edge and stay there.



NOTE: LEFT SYSTEM IS SHOWN,
RIGHT SYSTEM IS EQUIVALENT.

ICE AND RAIN PROTECTION - WINDSHIELD WIPER SYSTEM - FUNCTIONAL DESCRIPTION

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ICE AND RAIN PROTECTION - RAIN REPELLENT SYSTEM - HYDROPHOBIC WINDSHIELD COATING

Purpose

The hydrophobic windshield coating improves visibility in heavy rain.

Location

Hydrophobic windshield coatings are on the outside surface of the left and right number 1 flight compartment windows.

General Description

Hydrophobic (water repellent) windshield coatings are transparent films. The coatings repel water. This causes water drops to bead up and roll off the windshields. The coatings do not affect windshield strength or optical clarity.

The hydrophobic coatings wear down over time. Wear depends on these things:

- Wiper use
- Route structure
- Windshield maintenance practices.

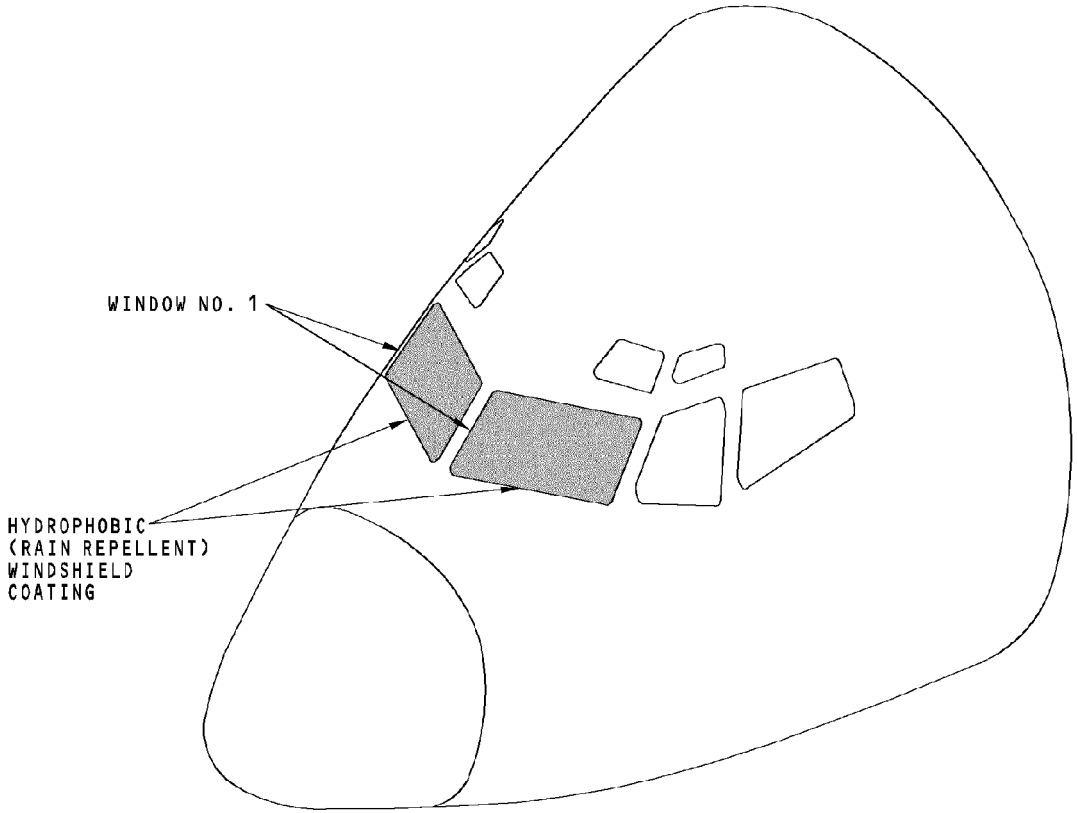
As the coatings wear, they do not repel water droplets as satisfactorily. When this happens, apply a new hydrophobic coating on the windshield. It is not necessary to remove the windshield to do this.

Training Information Point

For maintenance of the hydrophobic coatings, regularly clean the windshields. Use a 50 percent solution of isopropanol in distilled water and a soft cloth to clean the windshields.

Do not use abrasive cleaning pads or cleaners. Do not use cleaning solutions with fluorides.

Make sure the force of the blades on the window is proper. Worn or incorrectly set-up windshield wipers wear the coatings.



ICE AND RAIN PROTECTION - RAIN REPELLENT SYSTEM - HYDROPHOBIC WINDSHIELD COATING

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ICE AND RAIN PROTECTION - WATER LINES - INTRODUCTION

Purpose

The water and toilet drain anti-ice system prevents ice formation in theses areas:

- Potable water system service and supply components
- Gray water system drain components
- Vacuum waste system drain and service components.

General

It is important to prevent ice formation in the water and toilet systems. Ice formation in the systems can cause these problems:

- Ice expansion damage
- Line blockage that prevents normal system operation
- Line blockage that prevents normal service operations
- Ice formations on the forward drain mast can break off and damage airplane structure.

The water and toilet drain anti-icing systems use electric power for heat.

These system components have integral heaters:

- Service panel fittings
- Drain masts
- Hoses with integral heating elements.

Components without integral heaters get heat from these components:

- Heater tape (ribbon heaters)
- Heater blankets.

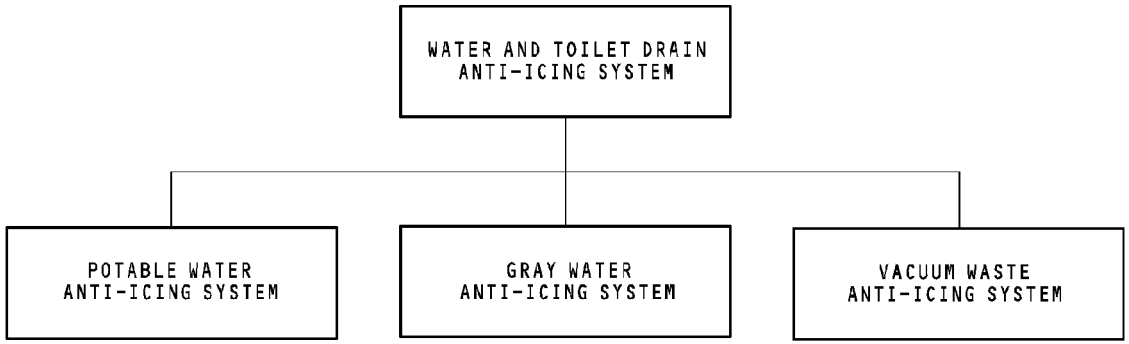
Training Information Point

The water and toilet drain anti-icing systems require electric power.

If you park the airplane in freezing conditions with no electric power, drain the water and toilet systems to prevent ice formation.

Pull the circuit breakers for the water tank compressor and water heaters before you drain the potable water system.

EFFECTIVITY
HAP ALL



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Purpose

The potable water anti-icing system prevents ice formation in these areas:

- The potable water fill fitting
- The potable water fill hose
- The potable water supply hoses.
- The potable water main tank heater blanket.
- The potable water auxiliary tank heater blanket.

Potable Water Fill Fitting

The potable water fill fitting has a built in heater element.

The fitting heater uses 28v dc power. A circuit breaker controls power to the fitting. Heat is constant and automatic when power is on the airplane.

Potable Water Fill Hose

The potable water fill hose has a built-in heater element.

The hose heater element uses 115v ac power. A circuit breaker controls power to the hose. Heat is constant and automatic when power is on the airplane.

Potable Water Supply Hoses

Some of the potable water supply hoses have built-in heater elements.

The hoses use 115v ac power. Thermostatic switch in the hose controls heat to the hoses.

Heat to the hoses is automatic when power is on the airplane.

Potable Water Tank Heater Blankets

The potable water tank heater blanket prevents freezing and provides regulated heat to the bottom of the water storage tanks within specified temperature limits. Water tank heaters use electrical power to keep tanks from freezing both in flight and on the ground.

Location

There are two water tank heaters located aft of the cargo compartment. You must remove the aft bulkhead cargo linining to get access to these tank heaters:

- Main potable water tank heater
- Auxiliary potable water tank heater

Physical Description

The water tank heaters consist of these parts:.

- Heater element
- Grommet
- Lacing cord
- Primary thermostat
- Manual reset back up thermostat

A simplified design wrapped around the bottom half of the water tank with lacing cord to allow easy removal and installation.

Designed with etched foil or wire-wound resistance elements for dependable heater performance.

The main tank heater consists of a single heater element wrapped around the lower half of the tank with cutout sections to mold around the tank attachment mounts.

The auxiliary tank heater consists of three separated elements attached the same way as the main tank.

Functional Description

The heater blankets use 115 vac power, 400 watts maximum and is controlled by a primary thermostat opening at 75 to 85 degrees F. and closes at 40 to 50 degrees F. A manually reset backup thermostat opens at 122 to 138 degrees F. and closes at 85 degrees F.

Training Information Point

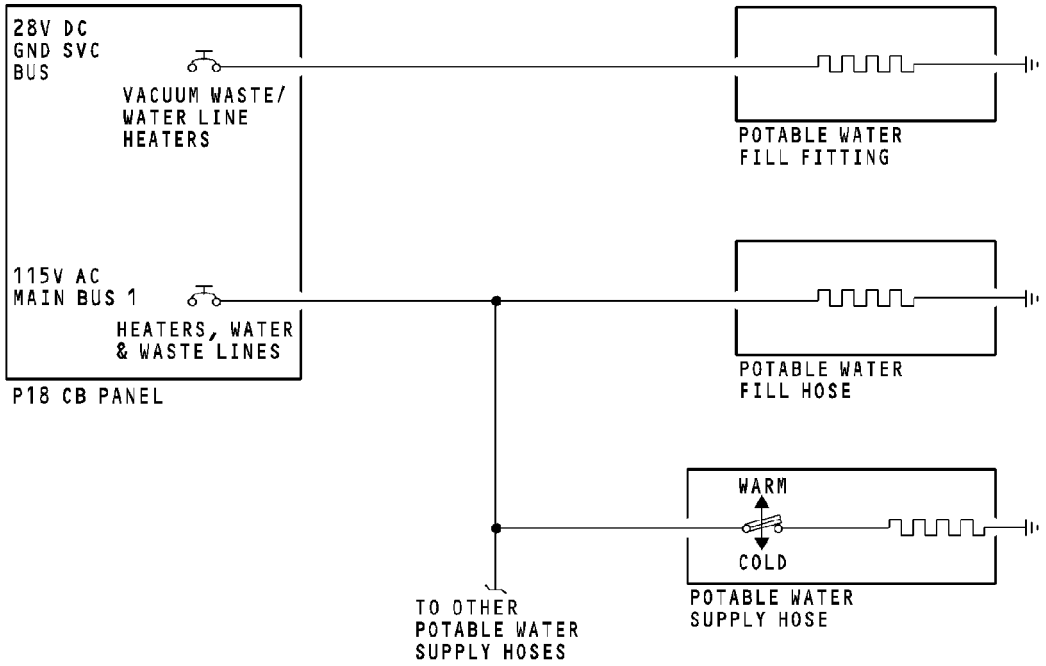
It is important to prevent ice formation in the water tank installations. Ice formation in these tanks may cause these problems:

- Ice expansion damage
- Line blockage preventing normal system operation
- Damage to lavatory and galley heater systems with no available water

The heater is powered any time the power is applied to the airplane

If you park the airplane in freezing conditions with no electrical power, drain the water and toilet systems to prevent ice formation.

Pull the circuit breakers for the water tank compressor and water heaters before you drain the potable water system.



Purpose

The gray water anti-icing system prevents ice formation in these areas:

- The gray water drain lines
- The drain masts.

Gray Water Drain Valve/Lines

Tape heaters warm the gray water drain lines.

The tape heaters use 115v ac power. Circuit breakers control electric power to the tape heaters. Heat is constant and automatic when power is on the airplane.

An in-line thermostatic switch controls heat to the drain mast inlet line.

Drain Masts

The drain masts have integral electric heater elements.

Heat to the mast is constant and automatic when power is on the airplane.

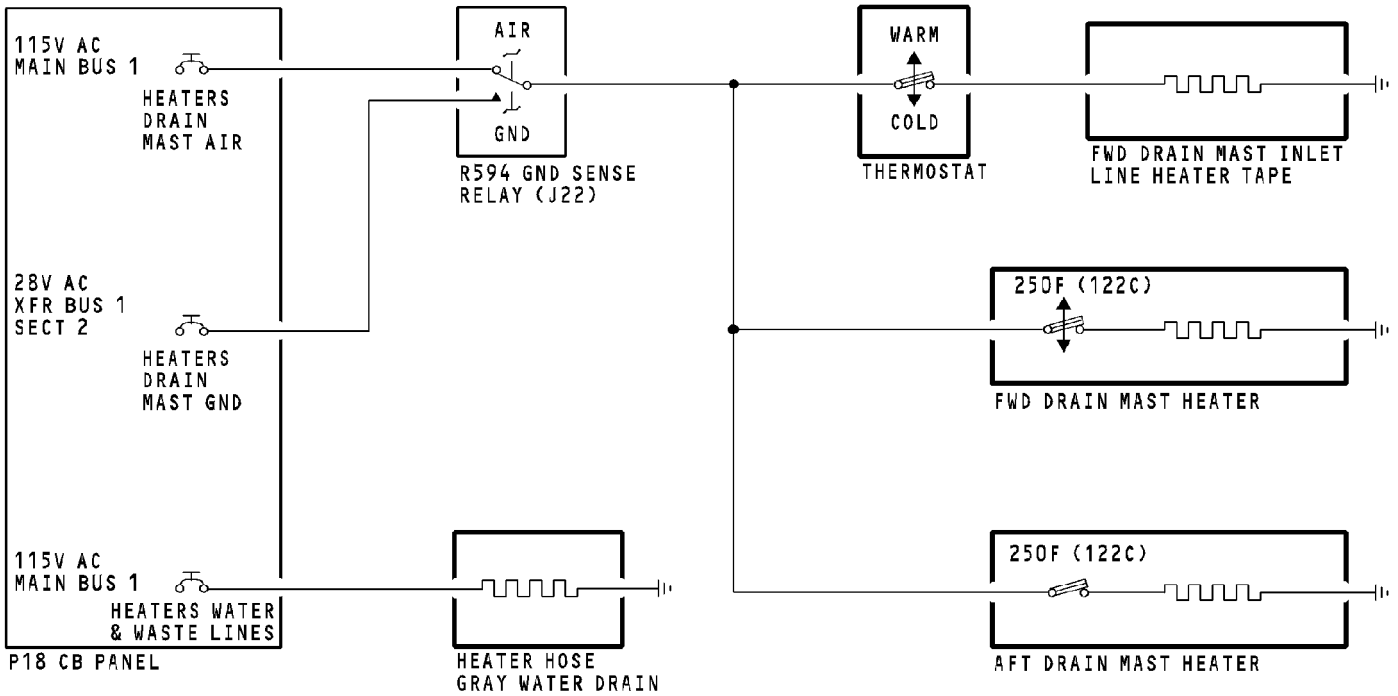
The drain mast heating elements operate on these two voltages:

- 115v ac in flight
- 28v ac on the ground.

The drain mast heat uses a reduced voltage on the ground to prevent a burn hazard to personnel. This also extends the drain mast service life.

Training Information Point

Do not overlap the wraps of the tape heaters. If the tape is too long, increase the number of wraps.



Purpose

The vacuum waste anti-icing system prevents freeze-plugging of the waste system drain and service lines.

General

The system uses resistance type electric heaters in these areas:

- Vacuum waste tank drain (ball) valve
- Vacuum waste tank rinse line.

Waste Tank Drain (Ball) Valve

A blanket heater warms the waste tank drain (ball) valve.

The blanket heater uses 115v ac. Heat to the valve is automatic when power is on the airplane.

Waste Tank Rinse Line

A rinse line tape heater warms the waste tank rinse line.

The line heater uses 28v dc. Heat to the rinse line is automatic when power is on the airplane.