

CHAPTER

30

Ice and Rain Protection



CHAPTER 30
ICE AND RAIN PROTECTION

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ICE AND RAIN PROTECTION - INTRODUCTION

Purpose

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

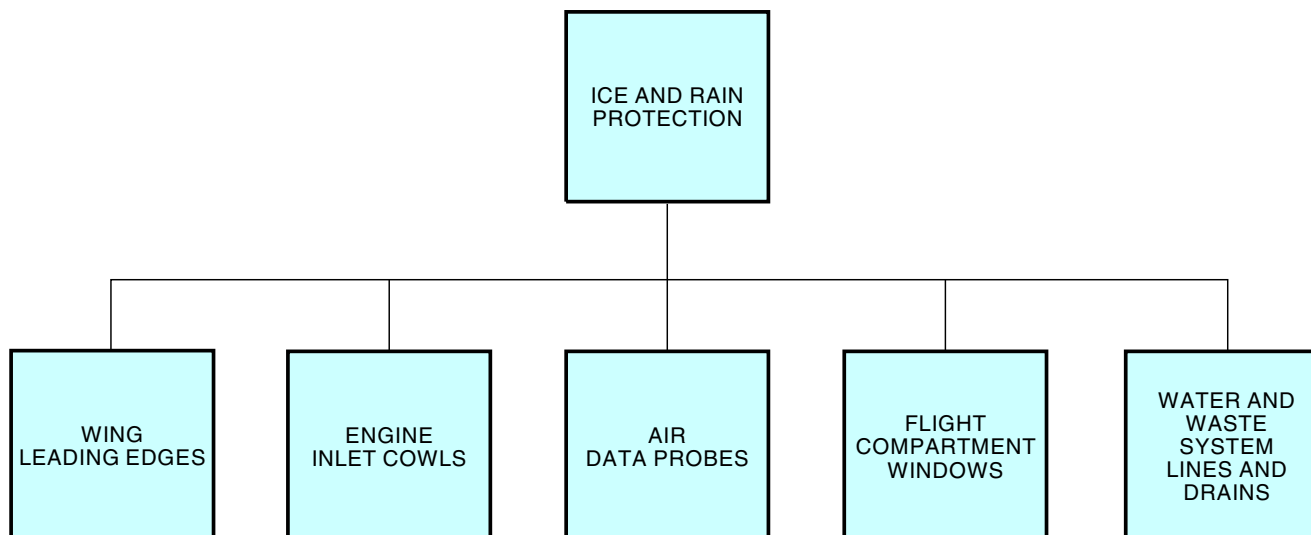
- Wing leading edges
- Engine inlet cowls
- Air data probes
- Flight compartment windows
- Water and waste system lines and drains.

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

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ICE AND RAIN PROTECTION - INTRODUCTION



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ICE AND RAIN PROTECTION - INTRODUCTION

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ICE AND RAIN PROTECTION - GENERAL DESCRIPTION

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

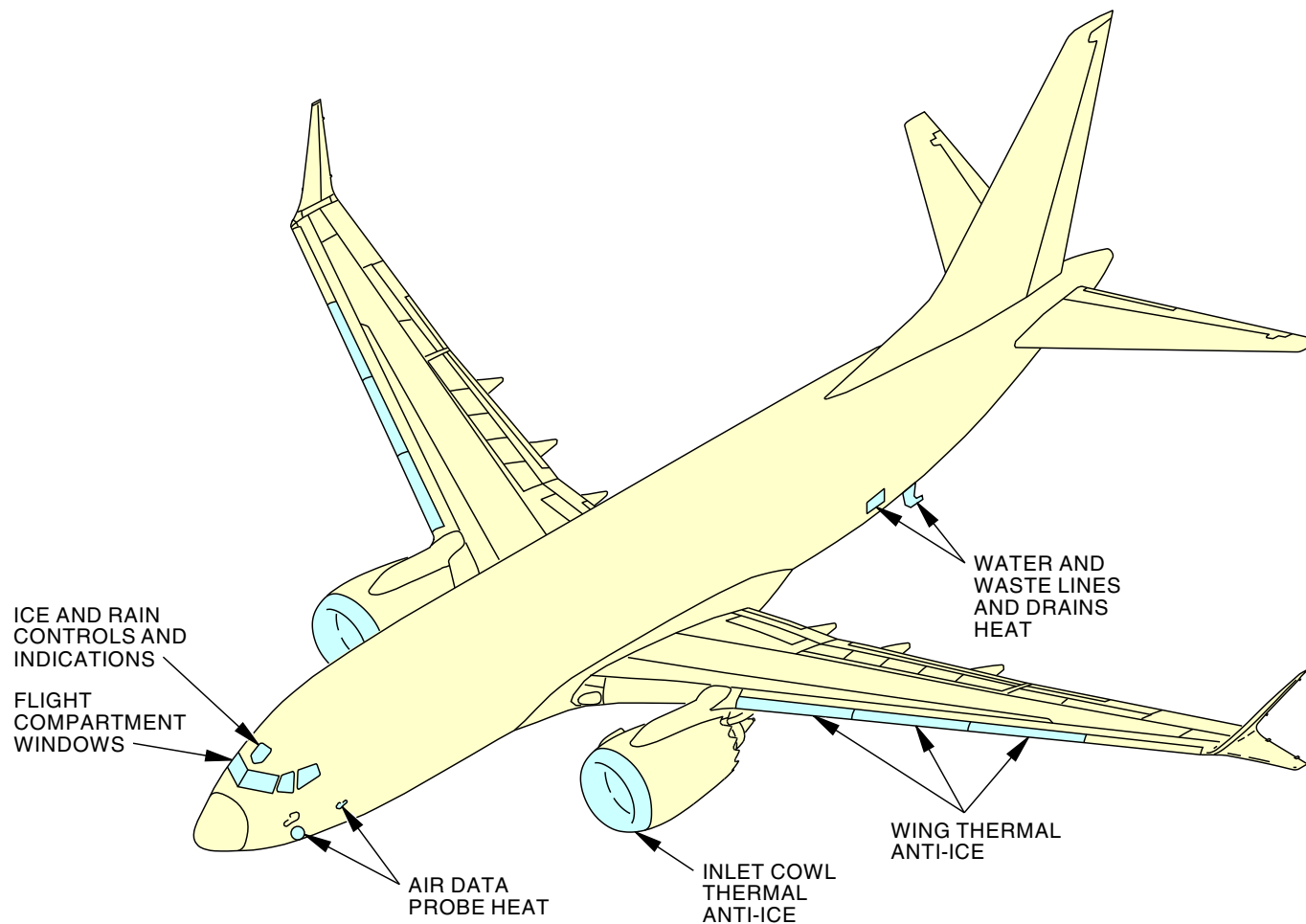
The water and waste lines and drains use electric heat to prevent ice.

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.

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ICE AND RAIN PROTECTION - GENERAL DESCRIPTION



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ICE AND RAIN PROTECTION - GENERAL DESCRIPTION

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**ICE AND RAIN PROTECTION - WTAI - INTRODUCTION****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.

Abbreviations and Acronyms

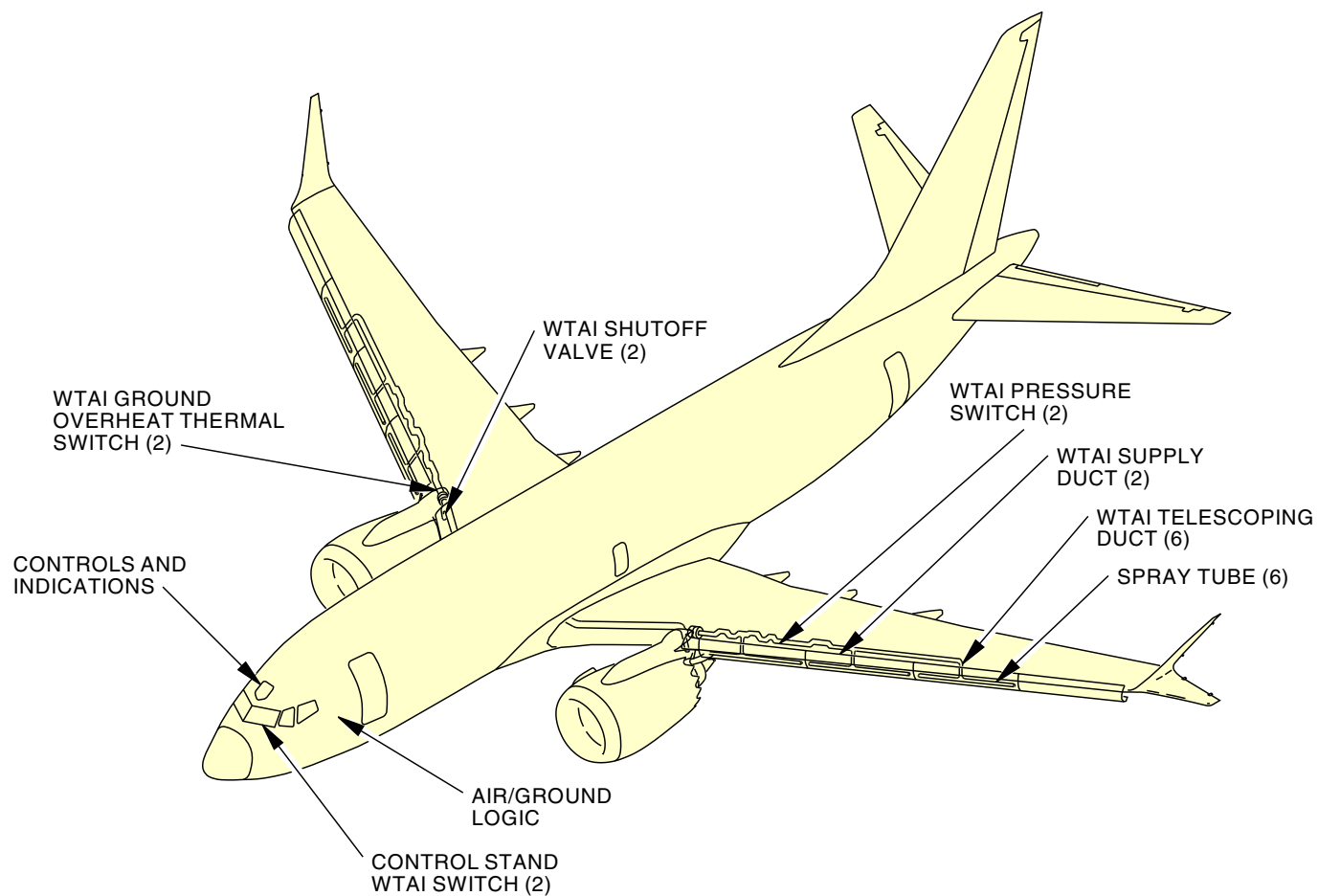
- PRSOV - pneumatic regulating shutoff valve
- WAI - wing anti-ice
- WAIV - wing anti-ice valve
- WTAI - wing thermal anti-ice

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ICE AND RAIN PROTECTION - WTAI - INTRODUCTION



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ICE AND RAIN PROTECTION - WTAI - INTRODUCTION

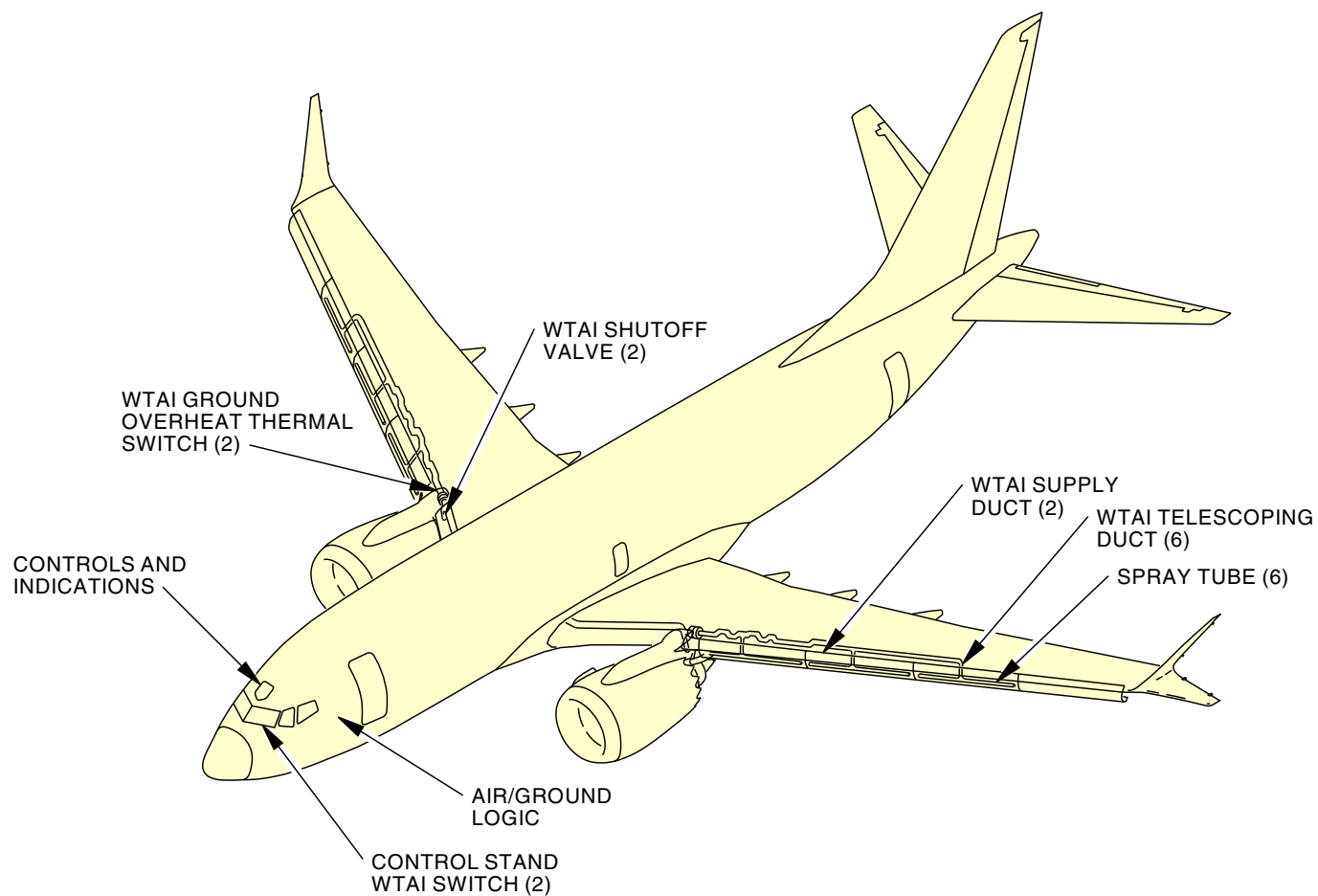
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ICE AND RAIN PROTECTION - WTAI - INTRODUCTION



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ICE AND RAIN PROTECTION - WTAI - INTRODUCTION

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**ICE AND RAIN PROTECTION - WTAI - COMPONENT LOCATION****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.

Wing Leading Edges

There are two wing anti-ice valve (WAIV). The valves are located in the wing leading edges, outboard of each engine strut.

There are two wing thermal anti-ice (WTAI) ground overheat thermal switches. They are on the WTAI duct in the wing leading edges downstream of the WAIV.

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There are two WTAI pressure switches. They are located forward of the WTAI duct on the leading edges and downstream of the WAIV.

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The WTAI supply ducts are on the forward wing spars.

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

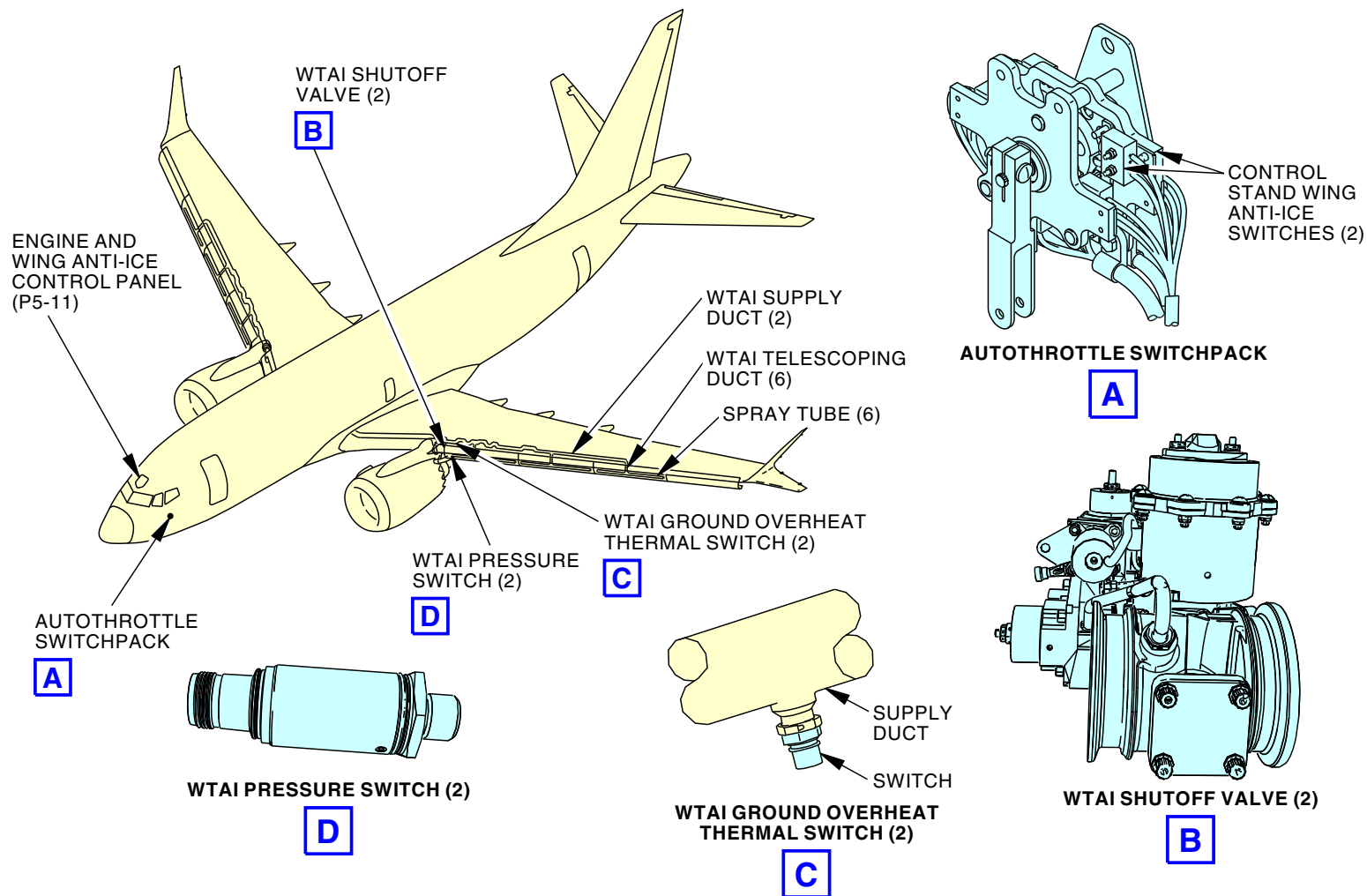
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ICE AND RAIN PROTECTION - WTAI - COMPONENT LOCATION



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ICE AND RAIN PROTECTION - WTAI - COMPONENT LOCATION

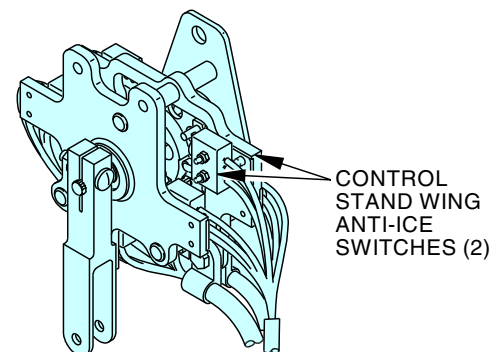
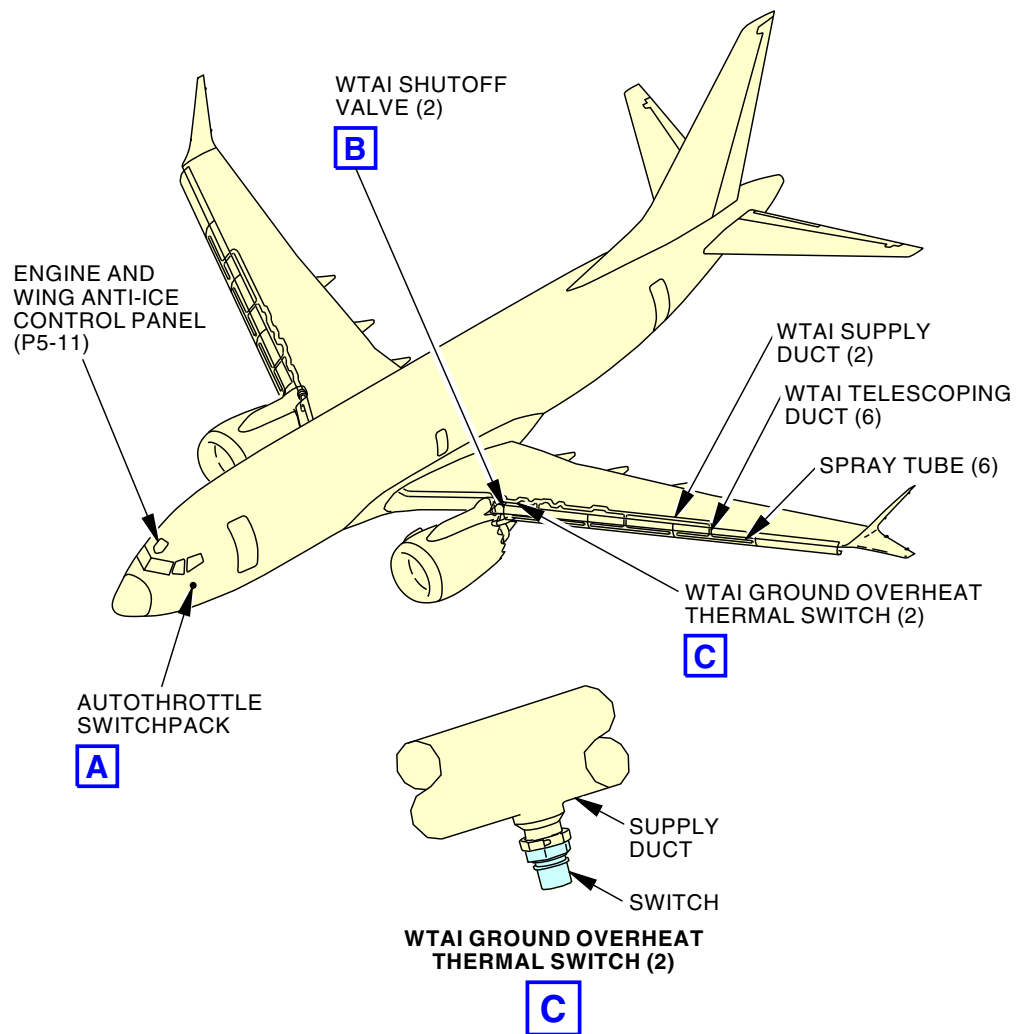
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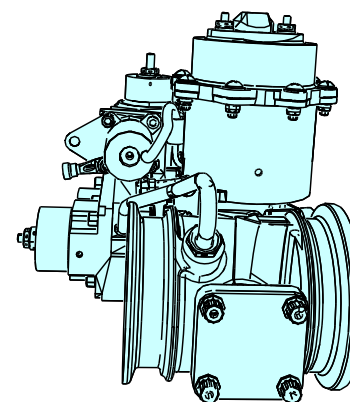
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ICE AND RAIN PROTECTION - WTAI - COMPONENT LOCATION



AUTOTHROTTLE SWITCHPACK

(A)



WTAI SHUTOFF VALVE (2)

(B)

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ICE AND RAIN PROTECTION - WTAI - COMPONENT LOCATION

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**ICE AND RAIN PROTECTION - WTAI - ANTI-ICE PANEL****Purpose**

The anti-ice panel provides these functions:

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

Location

The panel is on the P5 forward overhead panel.

General Description

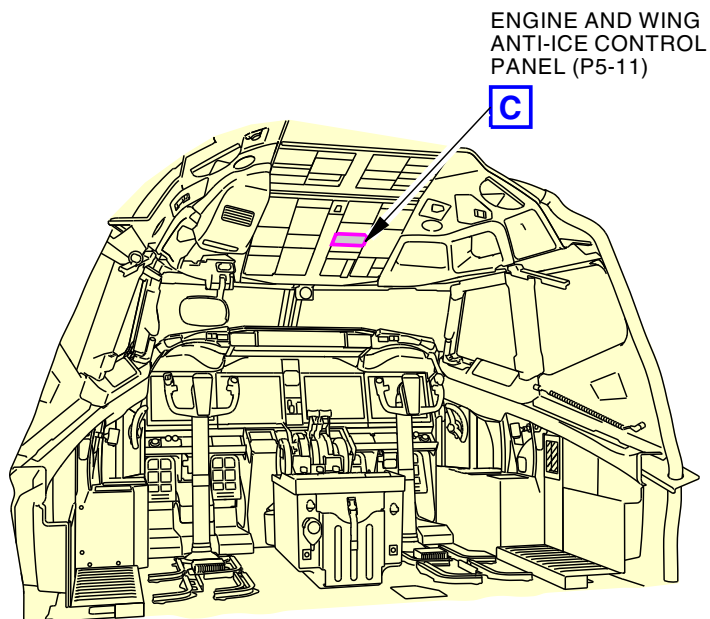
The wing anti-ice valve is open when the wing anti-ice switch is in the ON position. The L VALVE and R VALVE indication lights indicate valve position.

These are the light indications:

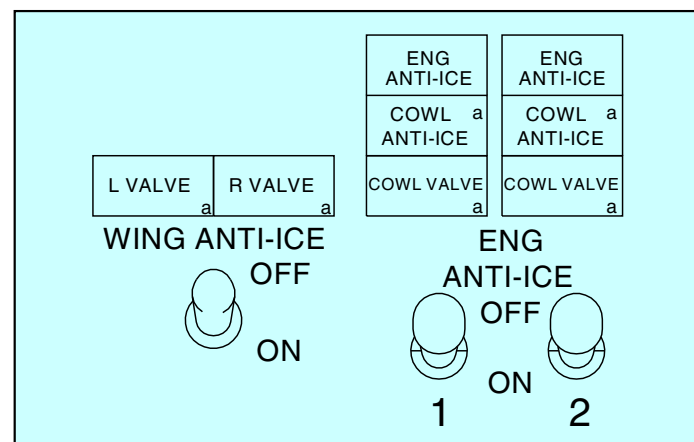
- Light is off - the WING ANTI-ICE switch is in the OFF position and the valve is closed
- Light is on - the WING ANTI-ICE switch position and valve position disagree or the valve is in transit.

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ICE AND RAIN PROTECTION - WTAI - ANTI-ICE PANEL



FLIGHT COMPARTMENT



ENGINE AND WING ANTI-ICE CONTROL PANEL (P5-11)

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ICE AND RAIN PROTECTION - WTAI - ANTI-ICE PANEL

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

Purpose

The wing anti-ice valves (WAIV) 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

This valve has a position indication needle on the outside of the valve to show open or close..

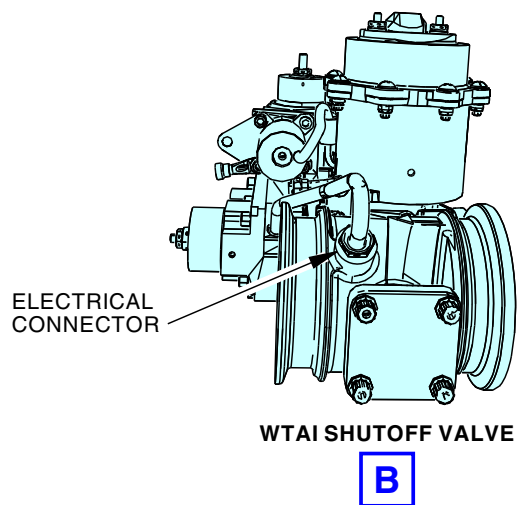
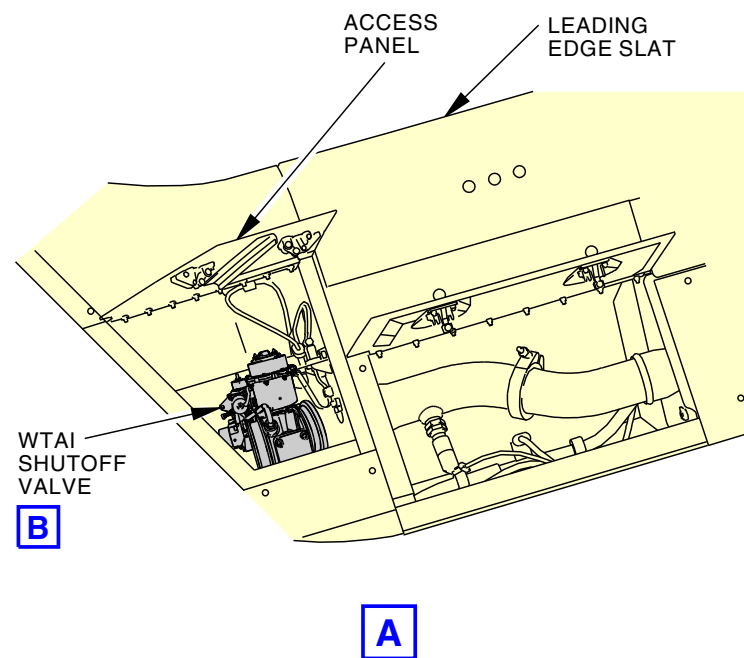
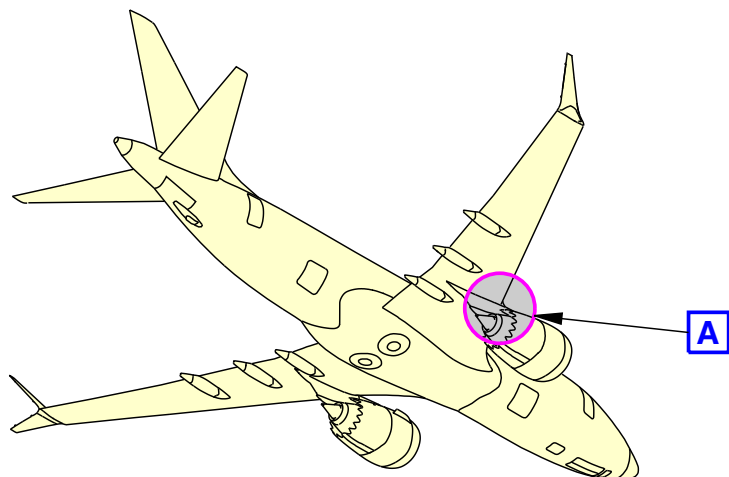
Two V-flange clamps mount the valve to the duct.

Functional Description

The WAIV is a Pneumatic Regulated Shut-Off Valve (PRSOV). Pneumatic muscle air is required to open the valve.

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



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

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

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

Functional Description

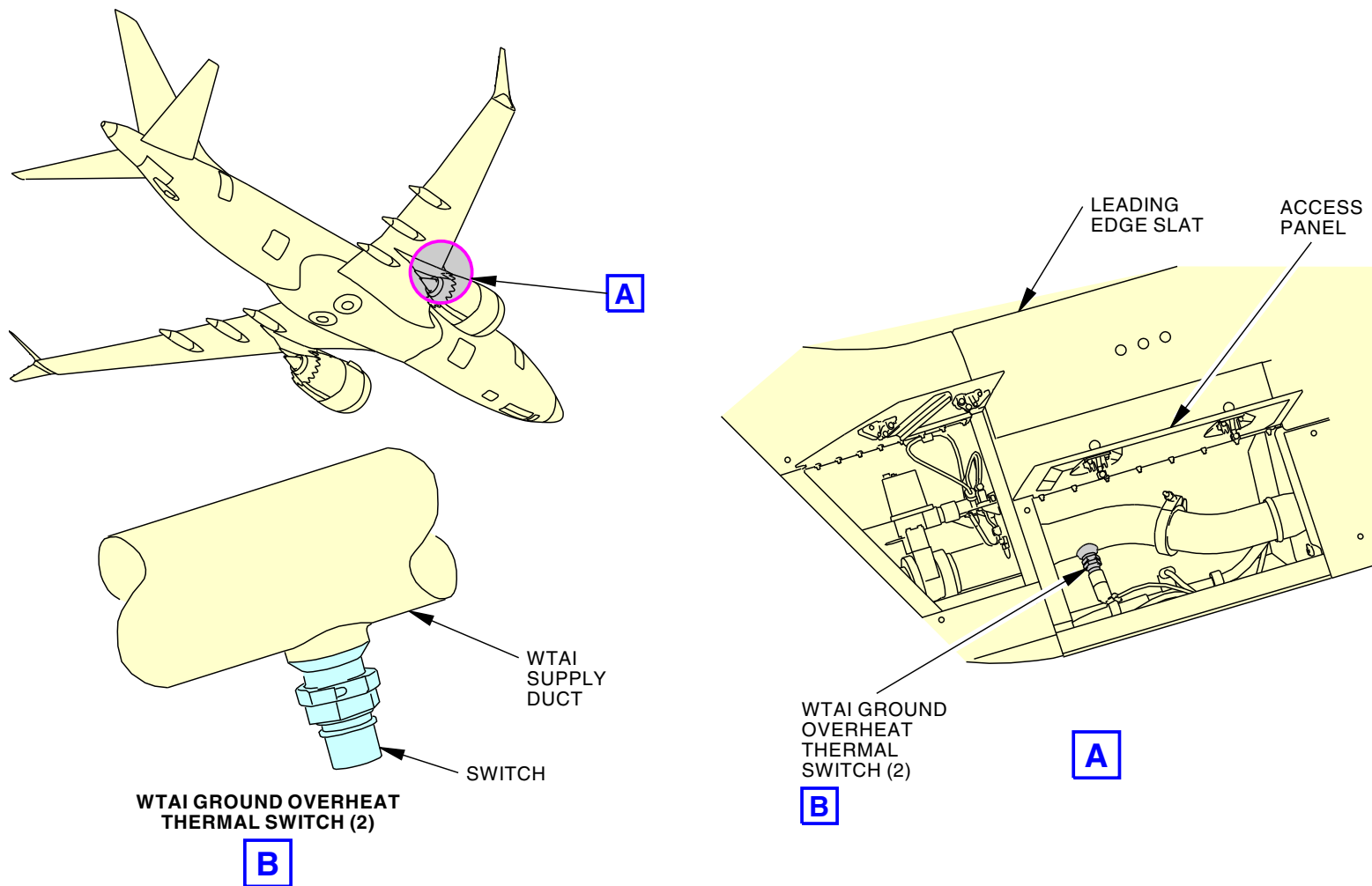
The switches are bimetallic. Thermal expansion closes the switch when the temperature is 315°F (157°C).

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.

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



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

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**ICE AND RAIN PROTECTION - WTAI - WING ANTI-ICE TELESCOPING DUCT****Purpose**

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

Location

There are six wing anti-ice 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-ice 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.

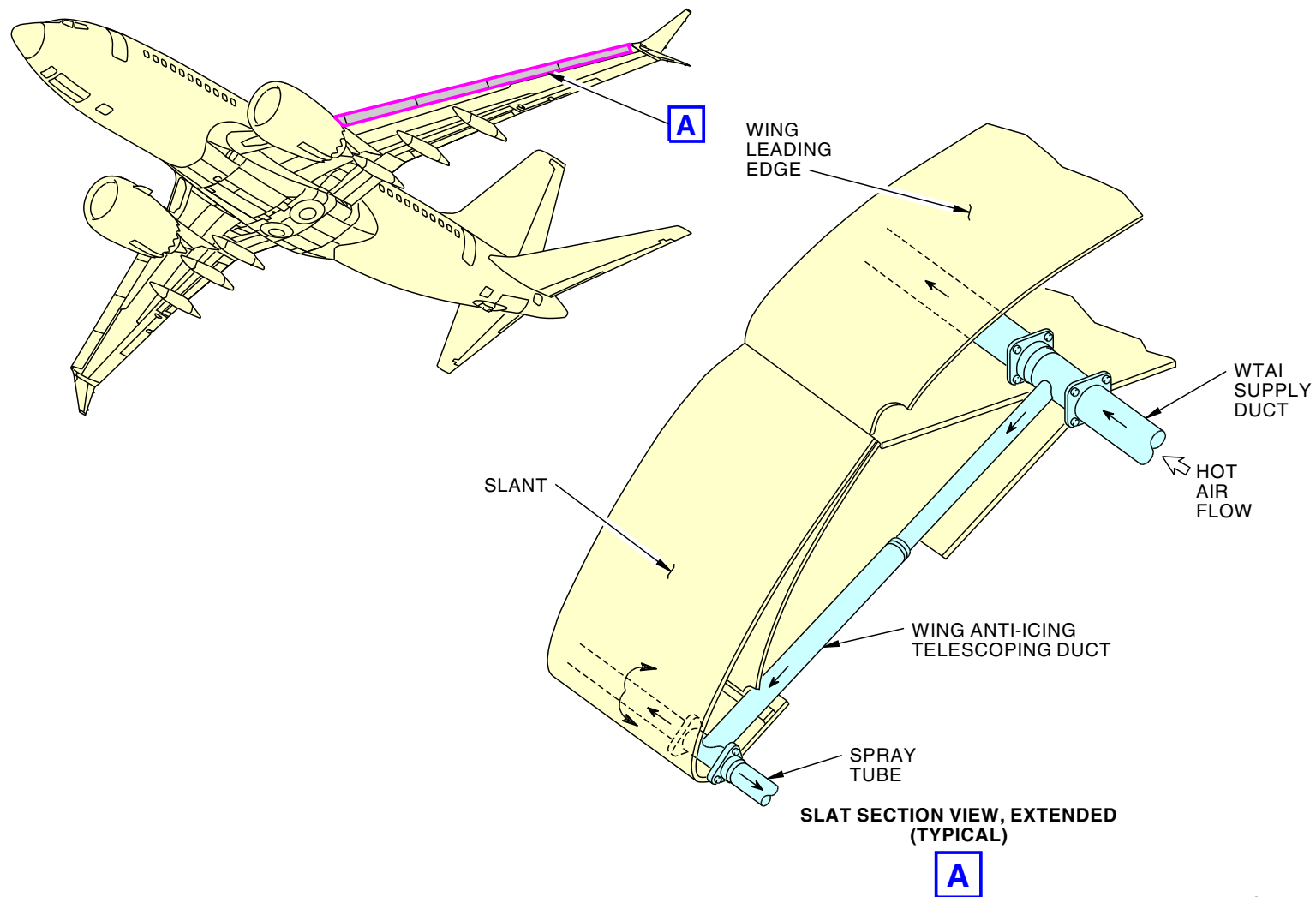
Functional Description

The anti-ice 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.

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ICE AND RAIN PROTECTION - WTAI - WING ANTI-ICE TELESOPING DUCT



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ICE AND RAIN PROTECTION - WTAI - WING ANTI-ICE TELESOPING DUCT

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

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.

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The diagrams illustrate the installation of the autothrottle system components:

- Diagram 1 (Top Left):** Shows the **AUTOTHROTTLE ASSEMBLY** being installed into the engine compartment. A callout **A** points to the assembly's mounting bracket.
- Diagram 2 (Bottom Left):** Shows the **AUTOTHROTTLE SWITCHPACK** being installed. A callout **A** points to the switchpack's mounting bracket.
- Diagram 3 (Right):** Shows the **AUTOTHROTTLE SWITCHPACK (COVER REMOVED)**. A callout **B** points to the switchpack's internal components. A separate callout **CONTROL STAND WTAI SWITCHES (2)** points to the control stand switches.

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

30-11-00



ICE AND RAIN PROTECTION - WTAI - WTAI PRESSURE SWITCH

Purpose

The Wing Thermal Anti-Ice (WTAI) external pressure switch monitors WTAI position during air operation below 28,000 ft (8534 m).

Location

There are two WTAI external pressure switches. Each switch is down stream of the WTAI.

Physical Description

The WTAI external pressure switch will verify valve position for the WTAI.

Functional Description

The WTAI pressure switch monitors the valve position during air operation below 28,000 ft (8534 m).

The WTAI pressure switch requires 13 ± 1 psig (90 ± 7 kPa) to activate and will deactivate on decreasing pressure by 9 psig (62 kPa) for hysteresis.

When activated, the WTAI pressure switch sends a discrete input to the P5-11 engine and wing anti-ice control panel to confirm the WTAI is in the open position.

When deactivated, the WTAI pressure switch sends a discrete input to the P5-11 engine and wing anti-ice control panel to confirm the WTAI is in the closed position.

When the commanded position and actual position of the WTAI disagree, a notification is sent to the flight deck control panel.

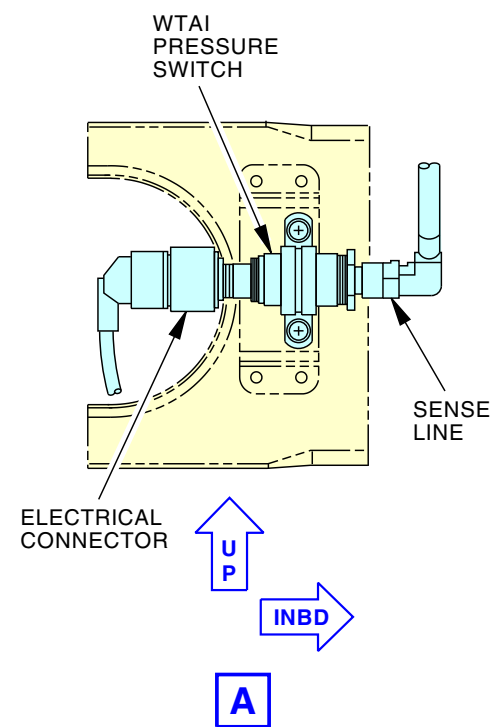
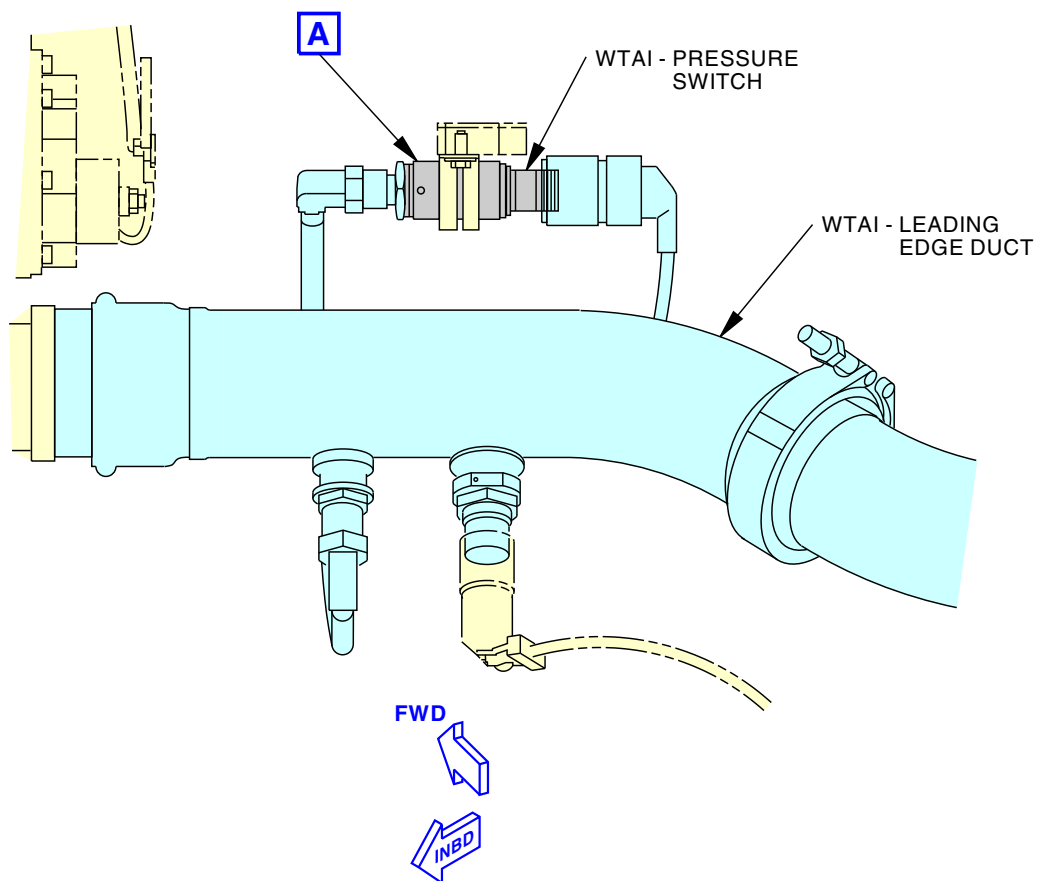
30-11-00

EFFECTIVITY
SIA 001-005 PRE SB 737-30-1075

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ECCN 9E991 BOEING PROPRIETARY - See title page for details

ICE AND RAIN PROTECTION - WTAI - WTAI PRESSURE SWITCH



2369309 S00061519276_V1

ICE AND RAIN PROTECTION - WTAI - WTAI PRESSURE SWITCH

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ECCN 9E991 BOEING PROPRIETARY - See title page for details



ICE AND RAIN PROTECTION - WTAI - FUNCTIONAL DESCRIPTION

General

The Wing Thermal Anti-Ice (WTAI) system is subject to ground and flight operations, operating continuously on the ground or in flight.

The wing leading edge is protected from overheat with a ground thermal anti-ice switch.

SIA 001-005 PRE SB 737-30-1075

The WTAI system includes a external pressure switch to open or close the Wing Anti-Ice Valve (WAIV) during air operation below 28,000 ft (8534 m).

SIA ALL

During ground operation and flight operation above 28,000 ft (8534 m), the valve position is monitored by an internal limit switch.

Ground and Takeoff Operations

When the airplane is on the ground and with the WTAI system on, the following conditions will occur to close the WAIV:

- The Ground Thermal Anti-Ice Switch will automatically close the WAIV when the air temperature is greater than 315°F (157°C).
- The left or right hand thrust resolver angles exceed 60°.
- Should the WING ANTI-ICE switch be left in the ON position during taxi and takeoff, the switch automatically returns to the OFF position at airplane takeoff.

SIA 001-005 PRE SB 737-30-1075

- When the external pressure switch detects a pressure drop below 9 psig (62 kPa).

SIA ALL

When the airplane is on the ground and with the WTAI system on, the following conditions occur to open the WAIV:

- The air temperature drops to 297°F (147°C) min.
- The left and right hand thrust resolver angles are moved to a position less than 60° and the air temperature is less than 315°F (157°C).

- During ground operation, two fan air modulation control valves, controlled by the Integrated Air System Controller (IASC), actuate to the full open position providing maximum cooling of the engine bleed air. This prevents the system from repeatedly tripping the overheat protection switch and causing the WAIV to cycle open or closed.

SIA 001-005 PRE SB 737-30-1075

- The external pressure switch requires 12 psig (83 kPa) to 14 psig (97 kPa).

SIA ALL**Flight Operations**

During flight operation the WTAI system requires manual switching of the WING ANTI-ICE switch on the overhead panel P5.

During flight operation above 28,000 ft (8534 m) the valve position is monitored by an internal limit switch.

SIA 001-005 PRE SB 737-30-1075

During flight operation below 28,000 ft (8534 m) the WAIV position is verified by a external pressure switch.

SIA ALL**Indication**

The overhead panel P5 has a WING ANTI-ICE switch with indication lights for the following:

- L VALVE
- R VALVE

The indication lights are amber and will show in these conditions:

- The light is OFF when the WING ANTI-ICE switch is in the OFF position and the L or R shutoff valves are closed. Or when the WING ANTI-ICE switch is in the ON position and the L or R shutoff valves are open.

30-11-00**EFFECTIVITY**
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ECCN 9E991 BOEING PROPRIETARY - See title page for details

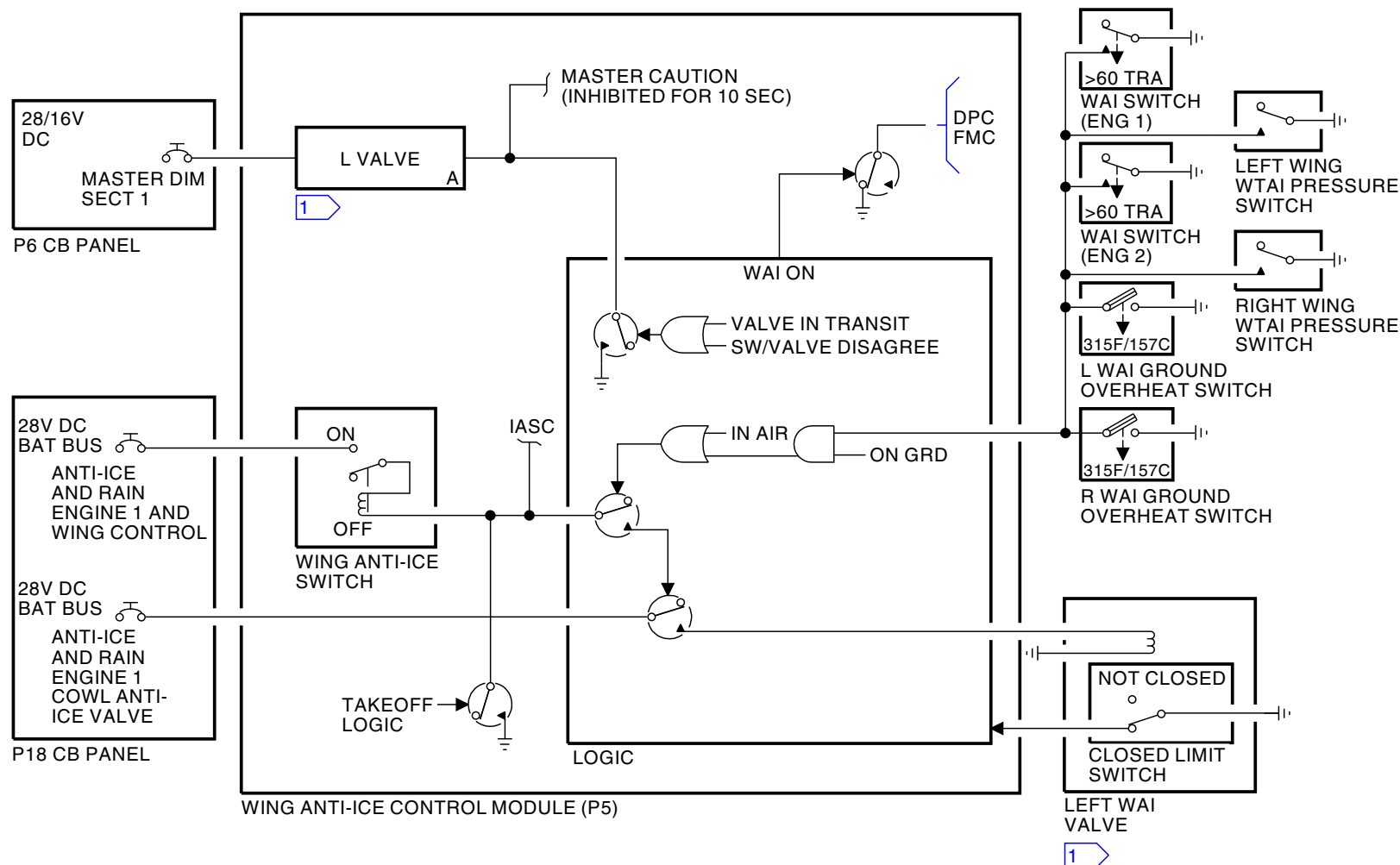


ICE AND RAIN PROTECTION - WTAI - FUNCTIONAL DESCRIPTION

- The light is ON when the positions of the WING ANTI-ICE switch and the L or R shutoff valves do not agree. Or when the L or R shutoff valves are in transit.

SIA ALL	EFFECTIVITY

ICE AND RAIN PROTECTION - WTAI - FUNCTIONAL DESCRIPTION



1 LEFT SIDE IS SHOWN, RIGHT SIDE IS SIMILAR

2369310 S00061519278_V3

ICE AND RAIN PROTECTION - WTAI - FUNCTIONAL DESCRIPTION

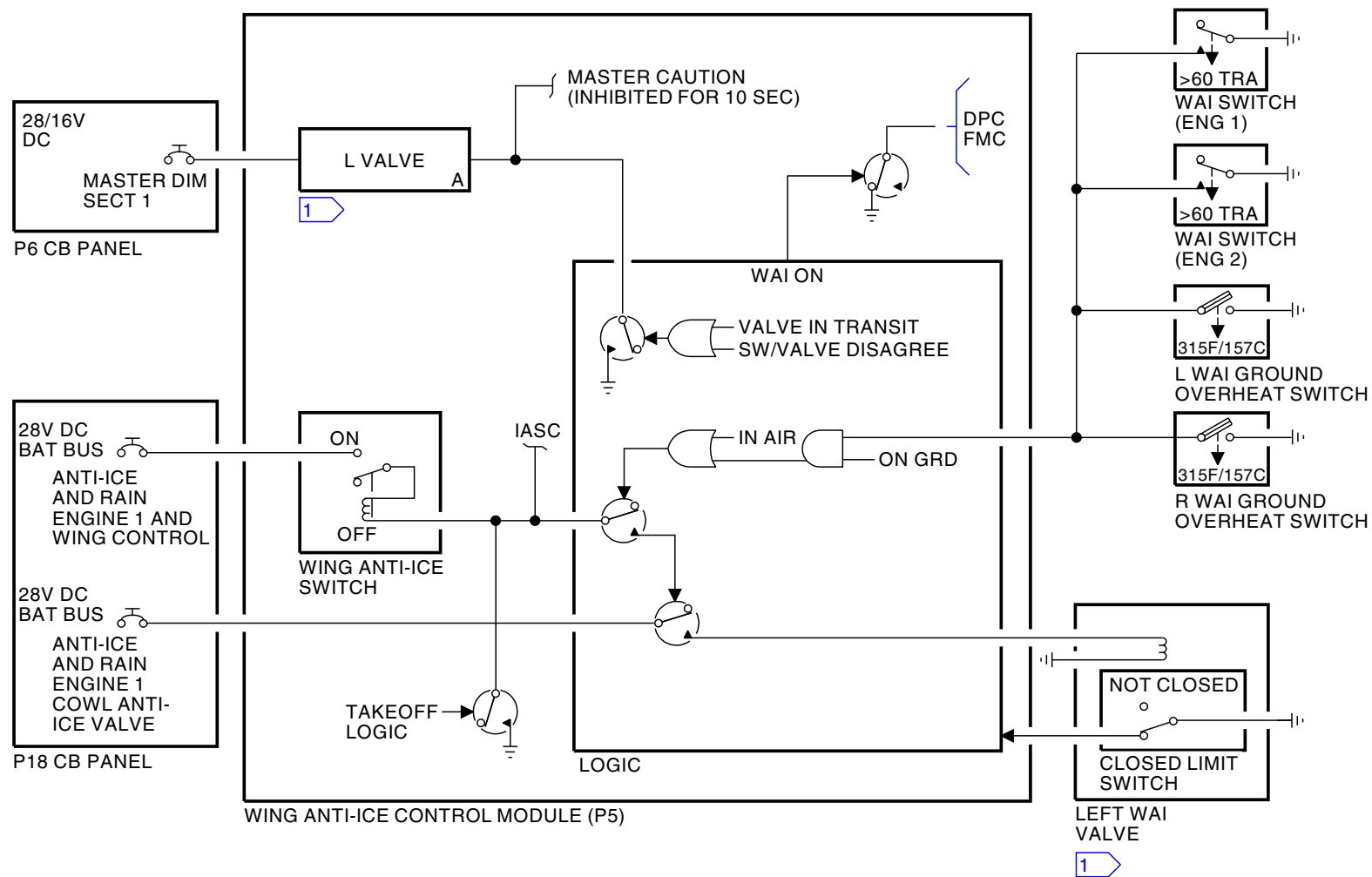
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EFFECTIVITY
SIA 001-005 PRE SB 737-30-1075

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ECCN 9E991 BOEING PROPRIETARY - See title page for details

ICE AND RAIN PROTECTION - WTAI - FUNCTIONAL DESCRIPTION



1 LEFT SIDE IS SHOWN, RIGHT SIDE IS SIMILAR

2821307 S0000652236_V3

ICE AND RAIN PROTECTION - WTAI - FUNCTIONAL DESCRIPTION

30-11-00

EFFECTIVITY
SIA 006-999; SIA 001-005 POST SB 737-30-1075

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ECCN 9E991 BOEING PROPRIETARY - See title page for details



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ECCN 9E991 BOEING PROPRIETARY - See title page for details



ICE AND RAIN PROTECTION - ENGINE ANTI-ICE SYSTEM - INTRODUCTION

Purpose

The engine 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-ice system.

When the system is on, the Engine Anti-Ice (EAI) valve opens. This lets the 10th stage or the 4th stage bleed air from the engine go through the valve and into the hollow inlet cowl. The engine bleed air system selects the 10th stage or the 4th stage bleed port. If the anti-ice supply duct bursts, the air is vented into the fan compartment by the outer duct shroud. The warm air increases the temperature in the inlet cowl and provides anti-icing on the cowl external surfaces. The warm air then goes overboard through the air exits in the D-duct and the inlet compartment through a duct on the forward bulkhead near bottom dead center.

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

SIA 001-005 PRE SB 737-30-1074

Three pressure sensors monitor pressure conditions in the bleed air duct for the EAI valve. These pressure switch sensors are downstream of the EAI valve. When the sensors find the applicable condition, an annunciator light on the overhead panel will come on.

SIA 006-999; SIA 001-005 POST SB 737-30-1074

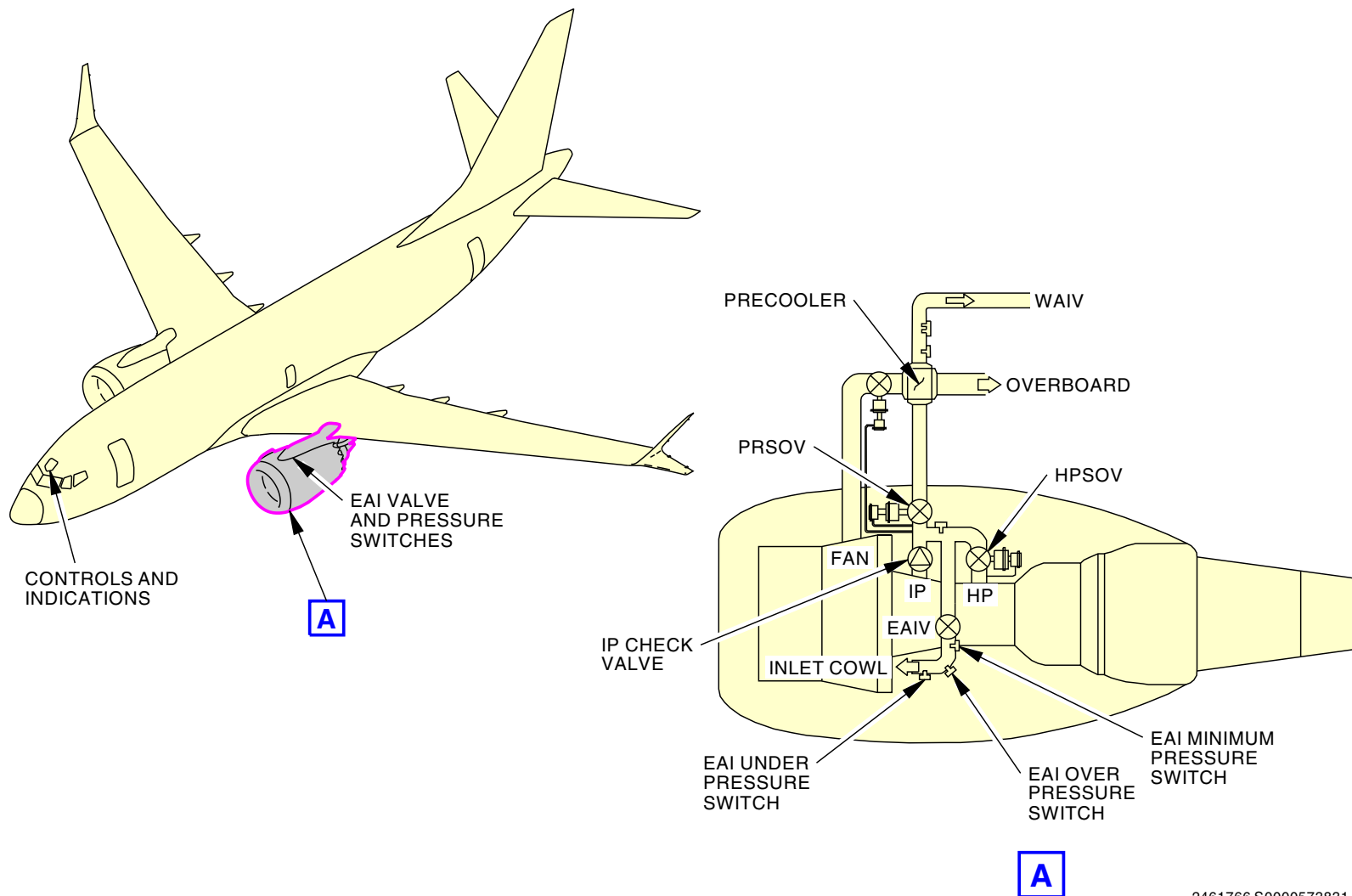
Two pressure sensors monitor pressure conditions in the bleed air duct for the EAI valve. These pressure switch sensors are downstream of the EAI valve. When the sensors find the applicable condition, an annunciator light on the overhead panel will come on.

SIA ALL

If there is an overheat alarm from the fan air modulating valve, the EAI valve will automatically shut off.

EFFECTIVITY	
SIA ALL	

ICE AND RAIN PROTECTION - ENGINE ANTI-ICE SYSTEM - INTRODUCTION



2461766 S0000573831_V3

ICE AND RAIN PROTECTION - ENGINE ANTI-ICE SYSTEM - INTRODUCTION

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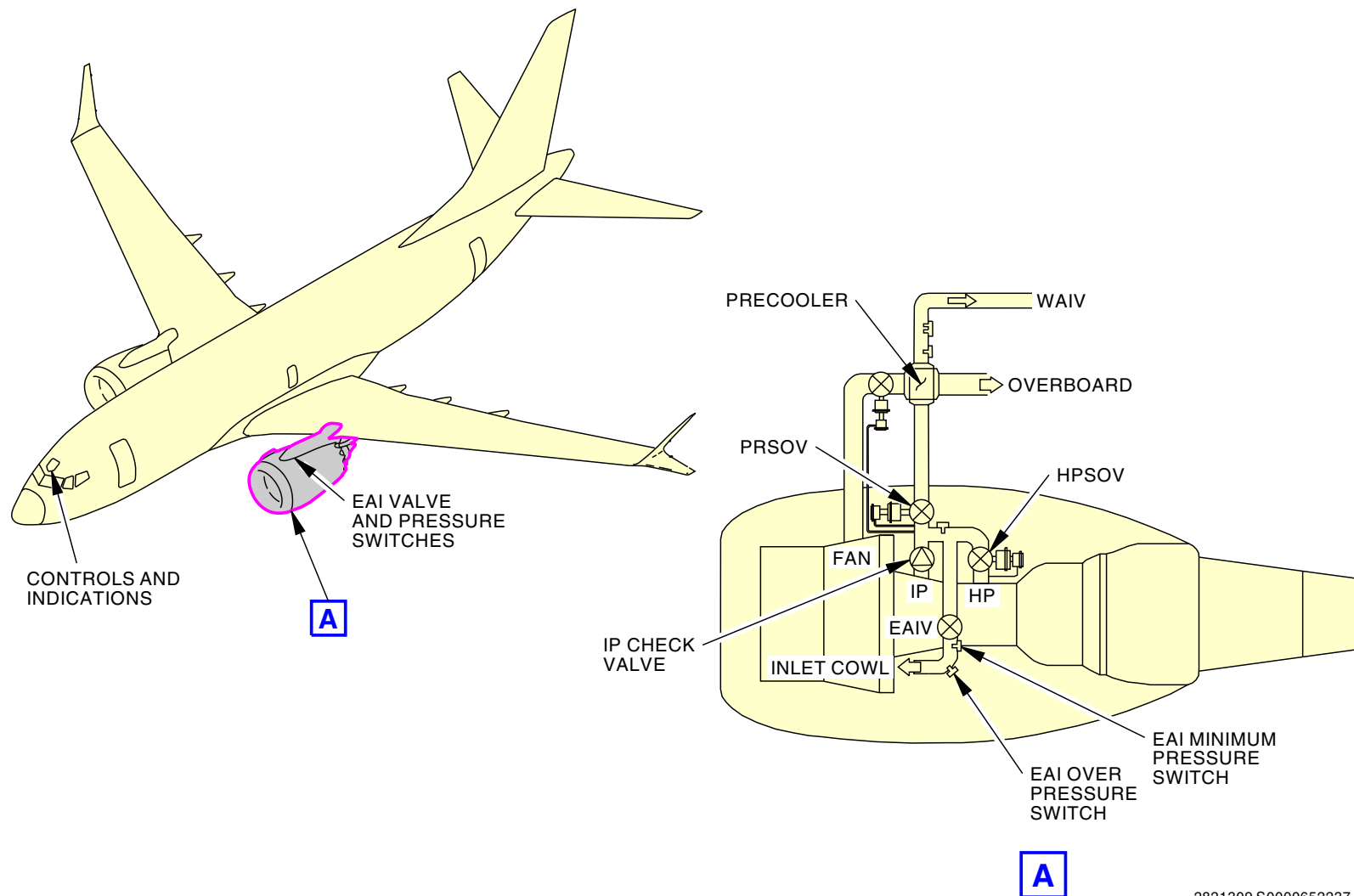
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EFFECTIVITY
SIA 001-005 PRE SB 737-30-1074

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ECCN 9E991 BOEING PROPRIETARY - See title page for details

ICE AND RAIN PROTECTION - ENGINE ANTI-ICE SYSTEM - INTRODUCTION



2821309 S0000652237_V2

ICE AND RAIN PROTECTION - ENGINE ANTI-ICE SYSTEM - INTRODUCTION

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EFFECTIVITY
SIA 006-999; SIA 001-005 POST SB 737-30-1074

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ECCN 9E991 BOEING PROPRIETARY - See title page for details

**ICE AND RAIN PROTECTION - ENGINE ANTI-ICE SYSTEM - ENGINE ANTI-ICE (EAI) VALVE****Purpose**

The Engine Anti-Ice (EAI) valve controls the flow of anti-ice bleed air to the engine inlet cowl.

Location

The shutoff valve is in the 12 o'clock strut fairing of the aft fan case.

Physical Description

The inlet cowl anti-ice shutoff valve has these parts:

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

Downstream of the valve are a pressure switches that monitors the condition of the bleed air in the anti-ice duct.

Functional Description

The engine 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. The regulator modulates the valve butterfly plate to limit downstream pressure.

Training Information Point

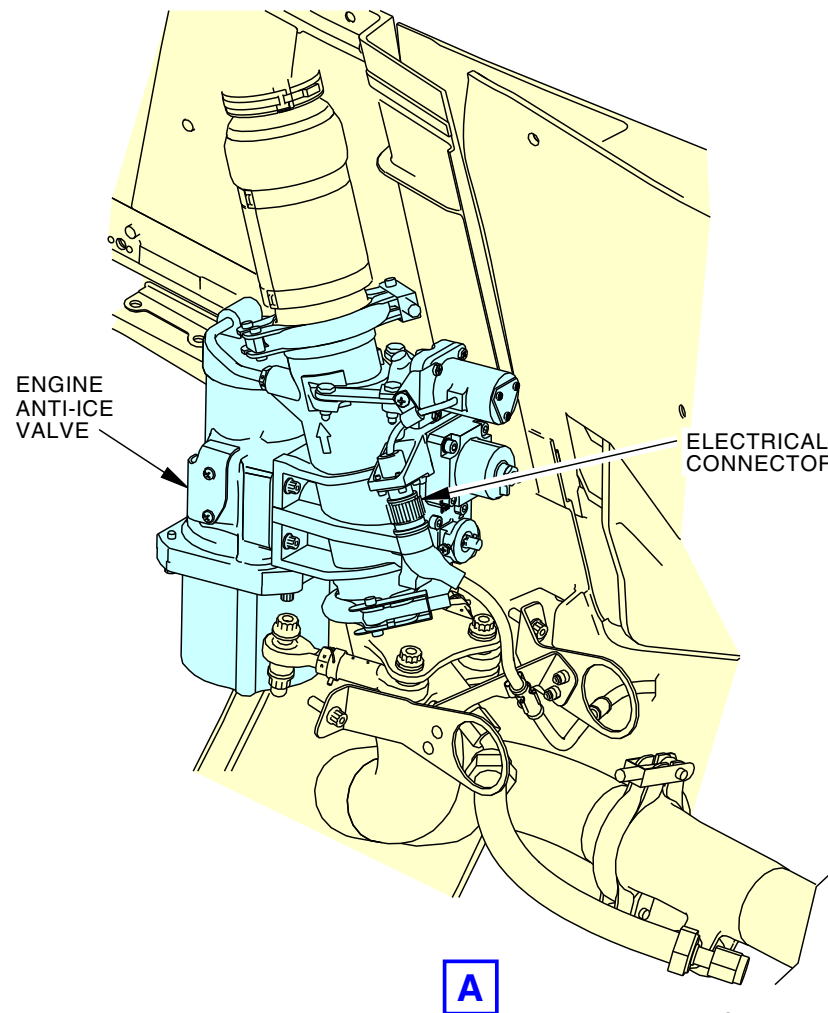
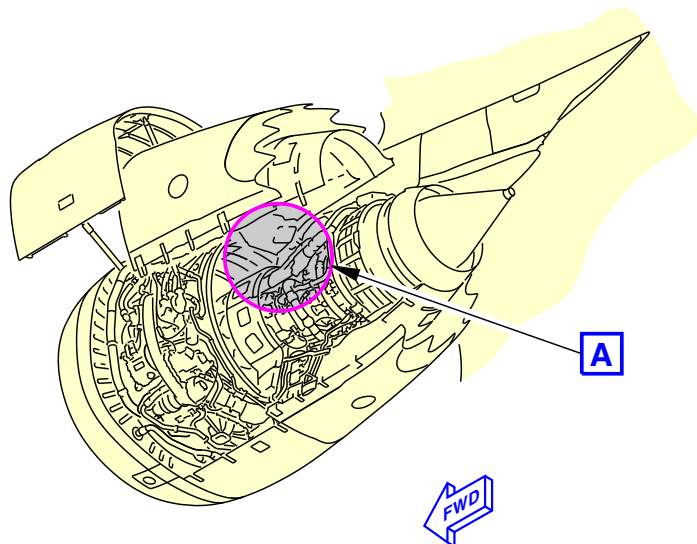
The engine anti-ice valve has a lockout feature that can be access on the engine. You can manually lock the valve in the full open or full closed position if the valve fails.

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EFFECTIVITY	
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ICE AND RAIN PROTECTION - ENGINE ANTI-ICE SYSTEM - ENGINE ANTI-ICE (EAI) VALVE



2464745 S0000572134_V2

ICE AND RAIN PROTECTION - ENGINE ANTI-ICE SYSTEM - ENGINE ANTI-ICE VALVE

SIA ALL	EFFECTIVITY



ICE AND RAIN PROTECTION - ENGINE ANTI-ICE SYSTEM - PRESSURE SWITCHES

Purpose**SIA 001-005 PRE SB 737-30-1074**

The EAI pressure sensor switches monitor minimum, under and over pressure conditions in the EAI duct.

SIA 006-999; SIA 001-005 POST SB 737-30-1074

The EAI pressure sensor switches monitor minimum and over pressure conditions in the EAI duct.

SIA ALLLocation

The EAI pressure sensors are located on the upper right fan case.

Physical Description

Each pressure sensor switch has these parts:

- Sense Line connector
- Electrical connector.

Functional Description**SIA 001-005 PRE SB 737-30-1074**

The switches are aneroid type switches. The pressure switches senses minimum pressure, overpressure or underpressure in the EAI duct. When the duct pressure is not in the specified range, the applicable pressure switch sensor will cause the affected annunciator light on the overhead panel to illuminate.

SIA 006-999; SIA 001-005 POST SB 737-30-1074

The switches are aneroid type switches. The pressure switches senses minimum pressure or overpressure in the EAI duct. When the duct pressure is not in the specified range, the applicable pressure switch sensor will cause the affected annunciator light on the overhead panel to illuminate.

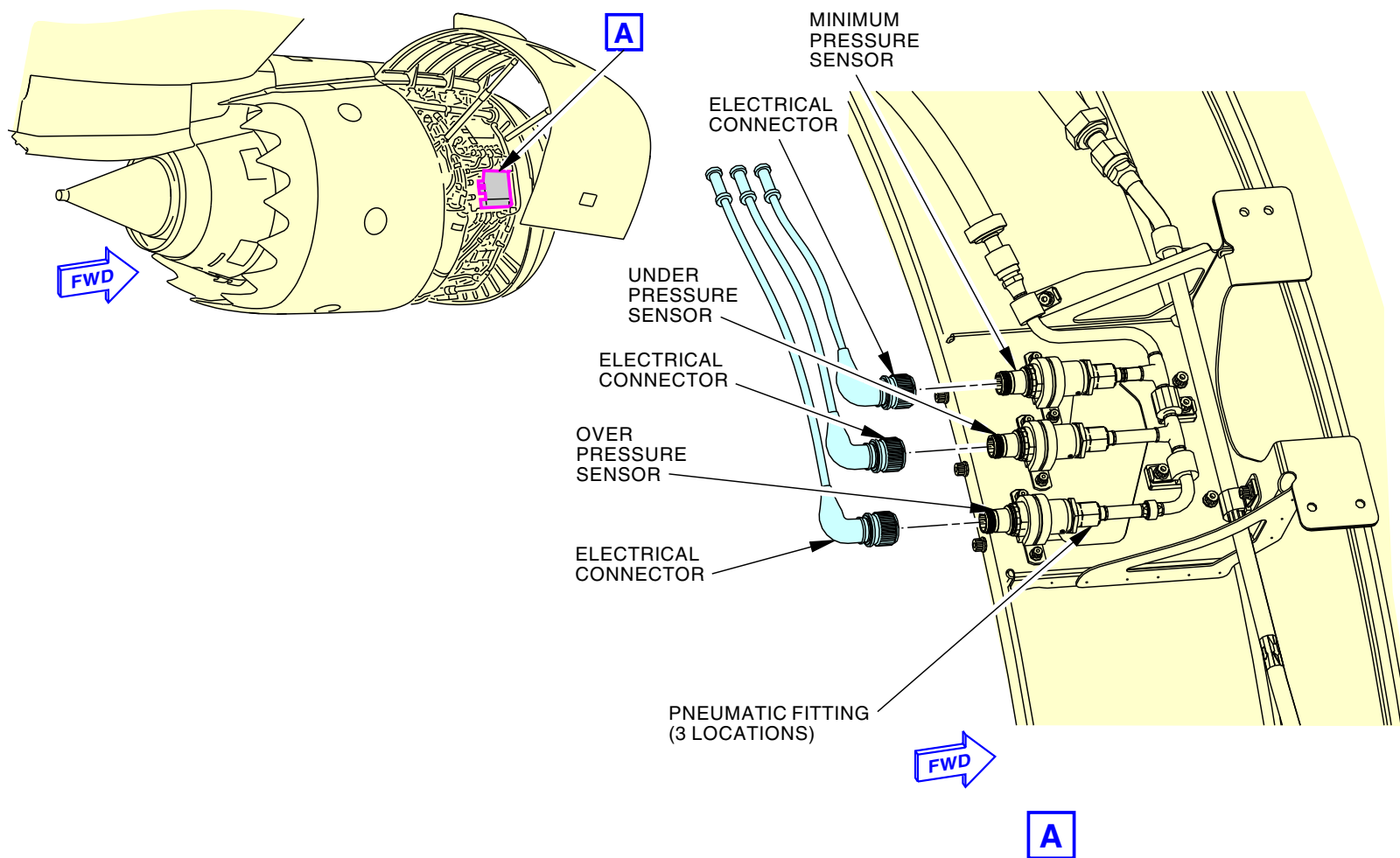
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EFFECTIVITY	
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ICE AND RAIN PROTECTION - ENGINE ANTI-ICE SYSTEM - PRESSURE SWITCHES

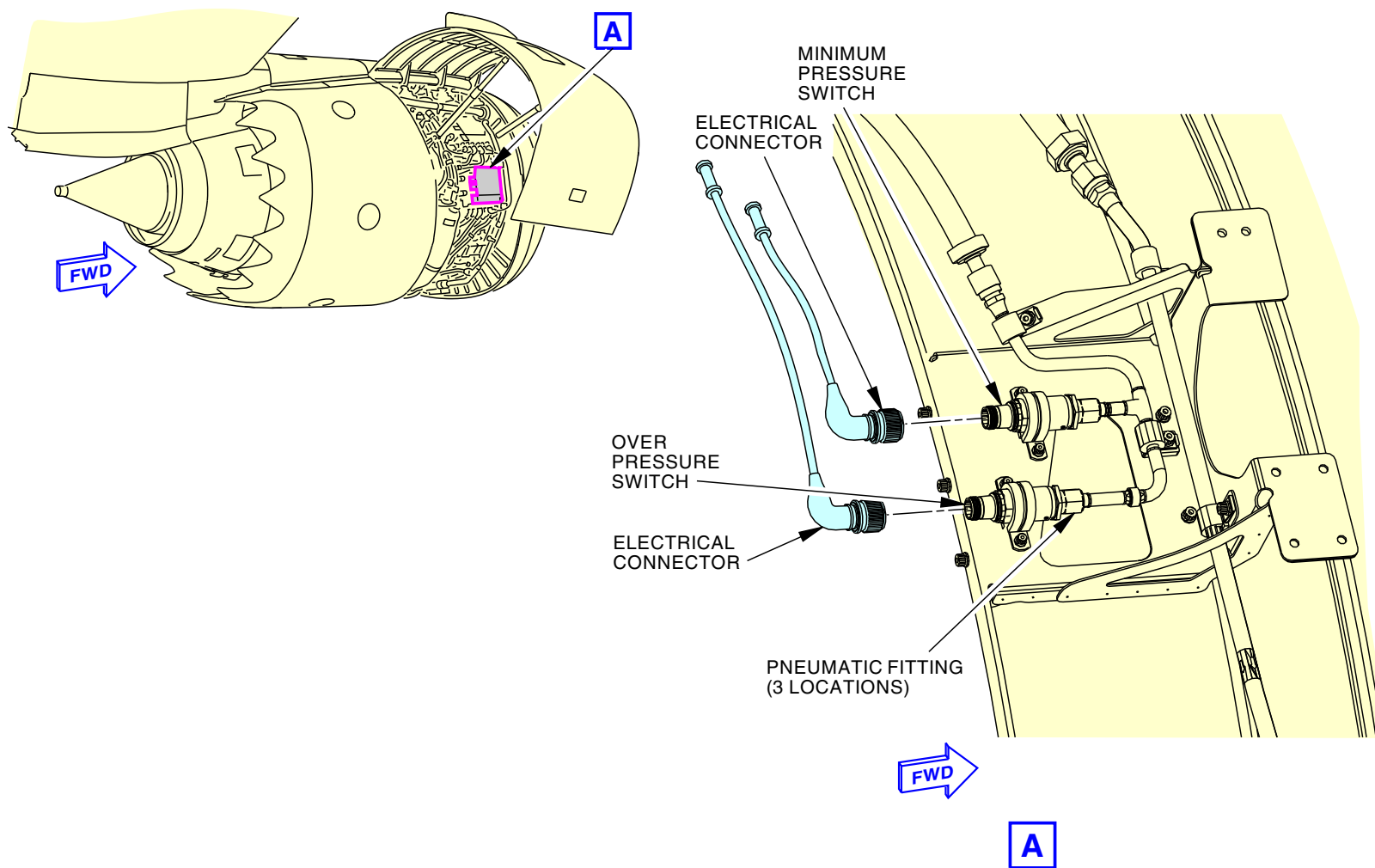


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ENGINE ANTI-ICE SYSTEM PRESSURE SWITCHES

30-20-00

ICE AND RAIN PROTECTION - ENGINE ANTI-ICE SYSTEM - PRESSURE SWITCHES



2821314 S0000652238_V1

ENGINE ANTI-ICE SYSTEM PRESSURE SWITCHES

30-20-00

EFFECTIVITY
SIA 006-999; SIA 001-005 POST SB 737-30-1074

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ECCN 9E991 BOEING PROPRIETARY - See title page for details

**ICE AND RAIN PROTECTION - ENGINE ANTI-ICE SYSTEM - FUNCTIONAL DESCRIPTION****General**

There are two identical engine anti-icing systems. One system for each engine. The control and indications circuits for the engine 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.

Engine Anti-Icing

When you put the ENG ANTI-ICE switch in the ON position, these conditions occur:

- 28V DC is sent to energize the control solenoid on the inlet cowl Thermal Anti-Ice (TAI) valve
- An open loop discrete is sent to the Electronic Engine Control (EEC) (for engine idle control)
- An open loop discrete is sent to the Flight Management Computer (FMC) (to bias fuel schedules for bleed loads).

The control panel logic controls the amber COWL VALVE lights:

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

When there is a failure of the Core Anti-Ice system (also known as Booster Anti-Ice), controlled by the EEC, the amber ENG ANTI-ICE light comes on.

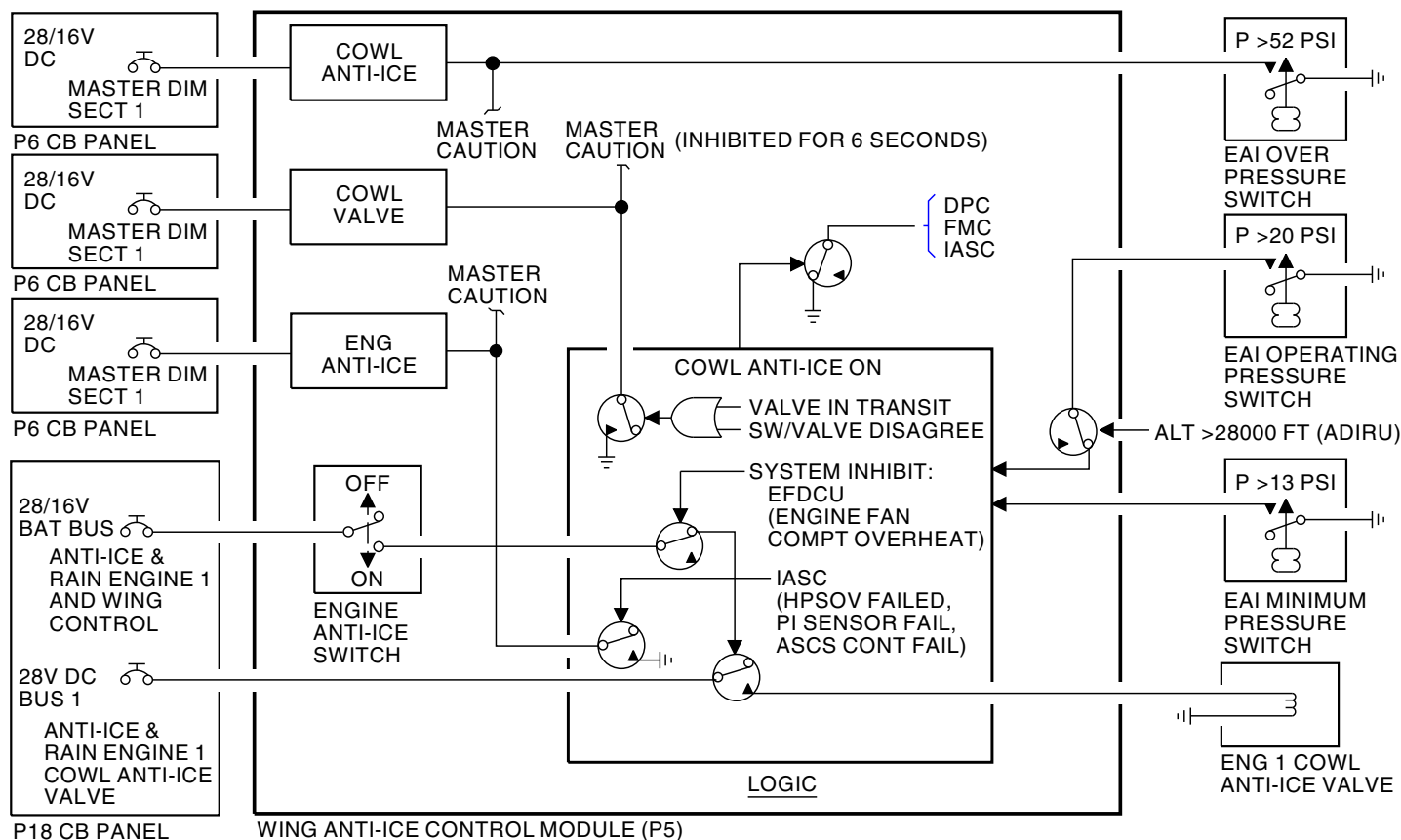
Overpressure Indication

When the anti-ice duct pressure goes above 52 ± 2 psig (359 ± 14 kPa), these lights come on:

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

EFFECTIVITY	
SIA ALL	

ICE AND RAIN PROTECTION - ENGINE ANTI-ICE SYSTEM - FUNCTIONAL DESCRIPTION



ENGINE ANTI-ICING - FUNCTIONAL DESCRIPTION

NOTE:

ENGINE 1 IS SHOWN, ENGINE 2 IS EQUIVALENT

2888506 S0000686453_V1

ICE AND RAIN PROTECTION - ENGINE ANTI-ICING SYSTEM - FUNCTIONAL DESCRIPTION

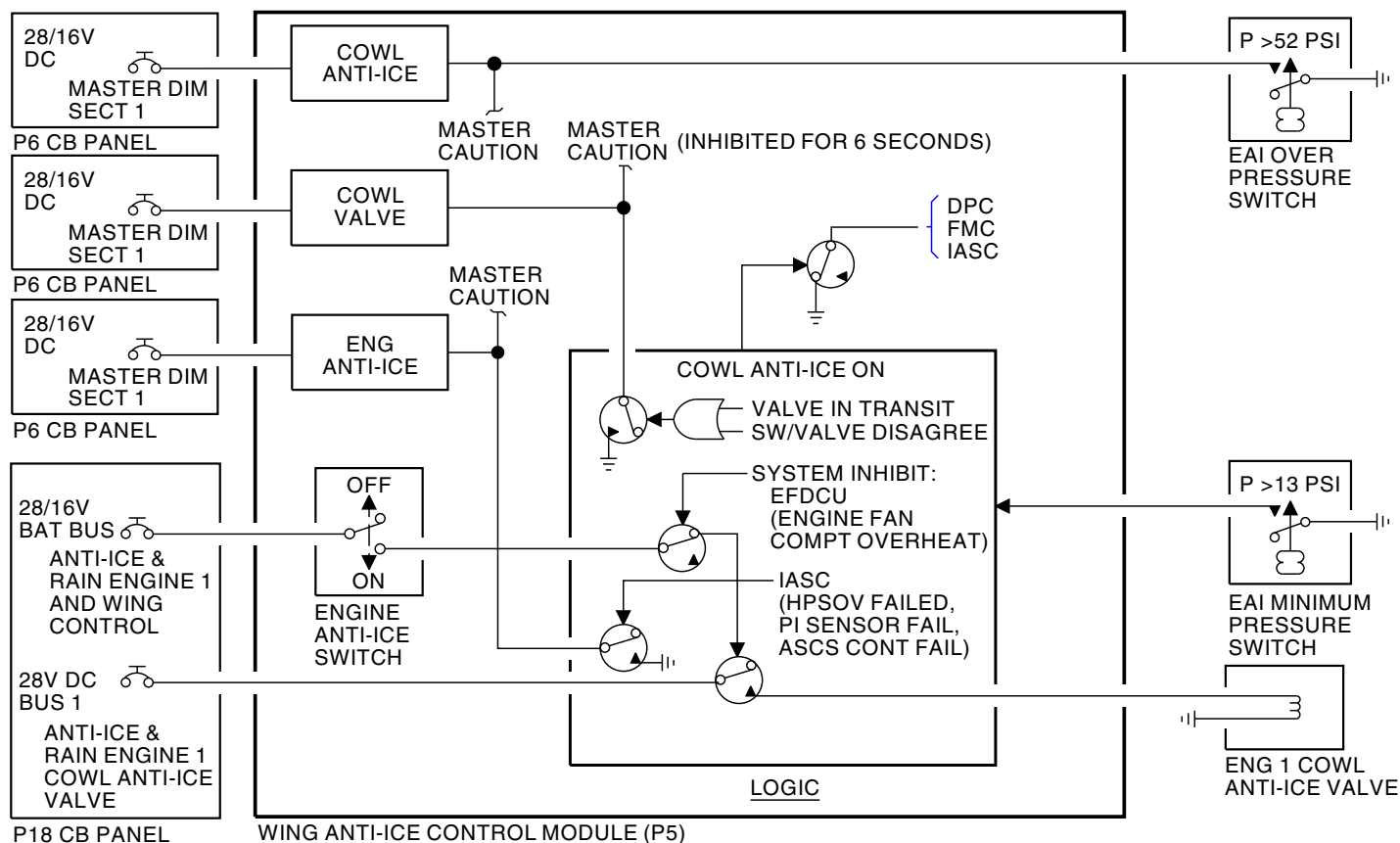
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EFFECTIVITY
SIA 001-005 PRE SB 737-30-1074

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ECCN 9E991 BOEING PROPRIETARY - See title page for details

ICE AND RAIN PROTECTION - ENGINE ANTI-ICE SYSTEM - FUNCTIONAL DESCRIPTION



ENGINE ANTI-ICING - FUNCTIONAL DESCRIPTION

NOTE:

ENGINE 1 IS SHOWN, ENGINE 2 IS EQUIVALENT

2927660 S0000707401_V1

ICE AND RAIN PROTECTION - ENGINE ANTI-ICING SYSTEM - FUNCTIONAL DESCRIPTION

30-20-00

EFFECTIVITY
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ICE AND RAIN PROTECTION - ENGINE ANTI-ICE SYSTEM - OPERATION

MDS Displays

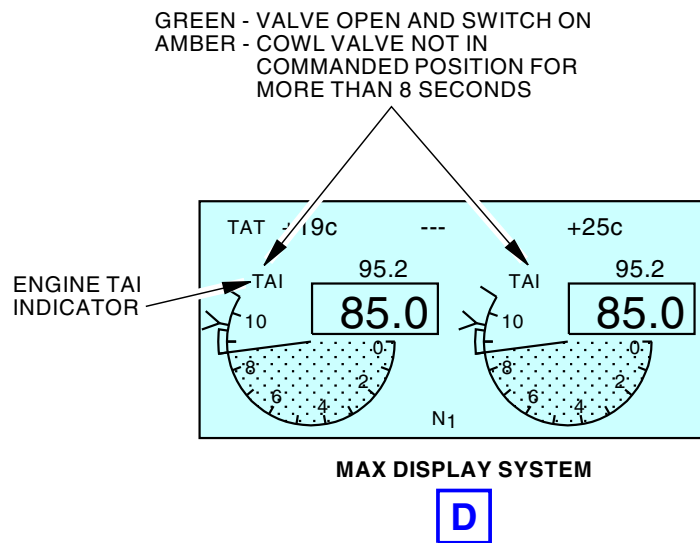
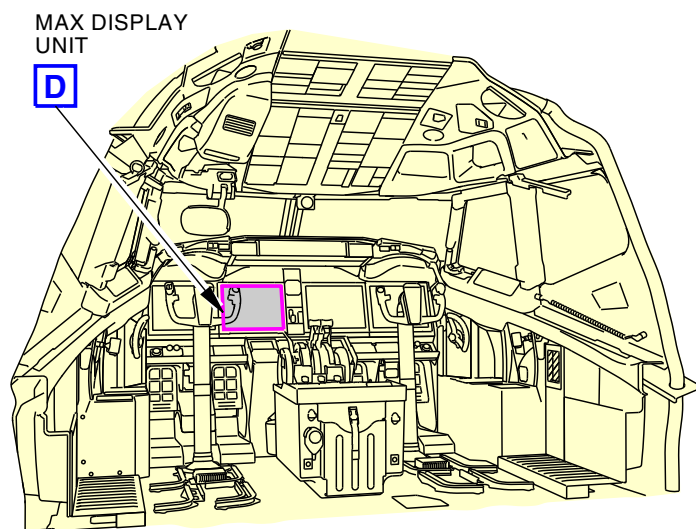
The Max Display System (MDS) shows engine inlet cowl anti-ice status. The display message is TAI shown on the upper left of each N1 speed indication.

The TAI message is green when the switch is in the ON position and the anti-ice valve is open.

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

SIA ALL	EFFECTIVITY

ICE AND RAIN PROTECTION - ENGINE ANTI-ICE SYSTEM - OPERATION



ICE AND RAIN PROTECTION - ENGINE ANTI-ICE SYSTEM - OPERATION

2464759 S0000575037_V1

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EFFECTIVITY
SIA ALL

30-20-00

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

**ICE AND RAIN PROTECTION - ENGINE ANTI-ICE SYSTEM - CONTROLS****Purpose**

The engine section of the anti-ice panel provides control of the inlet cowl anti-icing system:

- Gives the flight crew control switches for each engine anti-ice system.
- The panel has annunciator lights to indicate conditions that are not normal.

Location

The engine anti-ice switches and annunciators are located adjacent to the wing anti-ice controls on the P5-11 panel.

General Description

The engine anti-ice valve opens when the switch is in the ON position on the ground or in flight. The amber COWL VALVE light indicates the anti-ice valve status relative to the ENG ANTI-ICE switch position. These are the light indications:

- Light is off - the switch is in the OFF position and the valve is closed or switch is in the ON position and the valve is open.
- Light is on - the switch position and valve position are not in agreement or the valve is in transit.

When the duct pressure downstream of the valve is too high, these are the indications:

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

When there is an Air Supply Control System (ASCS) inhibit sent from the Integrated Air System Controller (IASC), these are the indications:

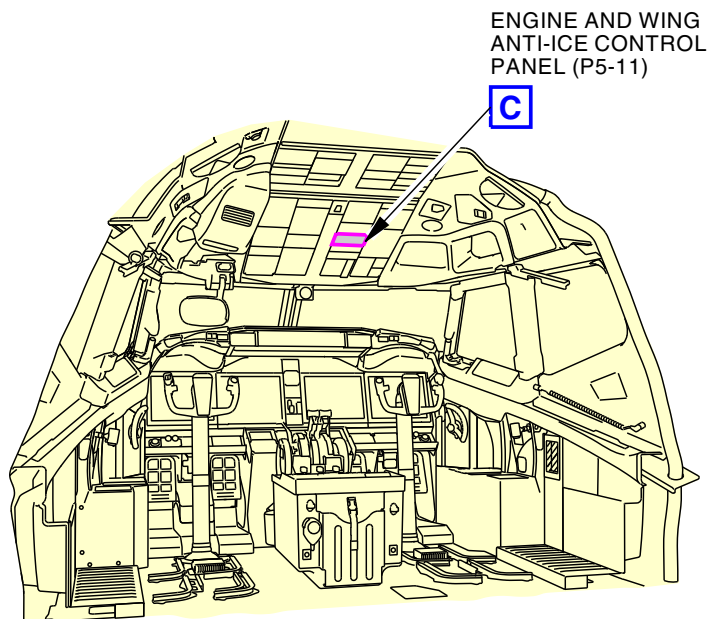
- Amber ENG ANTI-ICE light.
- MASTER CAUTION and ANTI-ICE annunciator lights.

When there is a failure of the Core Anti-Ice System (also known as Booster Anti-Ice), controlled by the Electronic Engine Control (EEC), these are the indications:

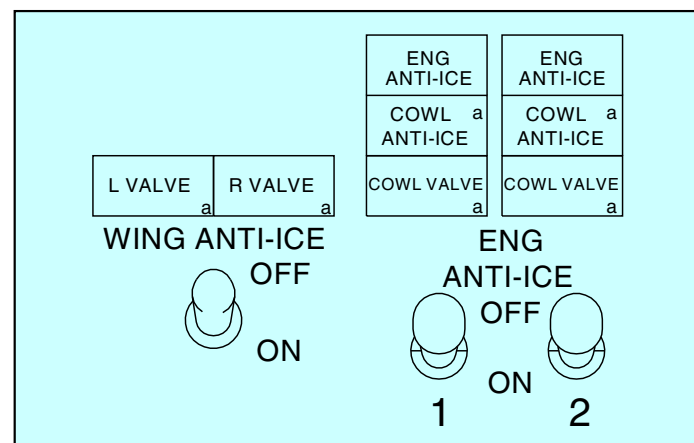
- Amber ENG ANTI-ICE light.
- MASTER CAUTION and ANTI-ICE annunciator lights.

EFFECTIVITY	
SIA ALL	

ICE AND RAIN PROTECTION - ENGINE ANTI-ICE SYSTEM - CONTROLS



FLIGHT COMPARTMENT



ENGINE AND WING ANTI-ICE CONTROL PANEL (P5-11)

2465039 S0000575050_V1

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

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SIA ALL

EFFECTIVITY

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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.

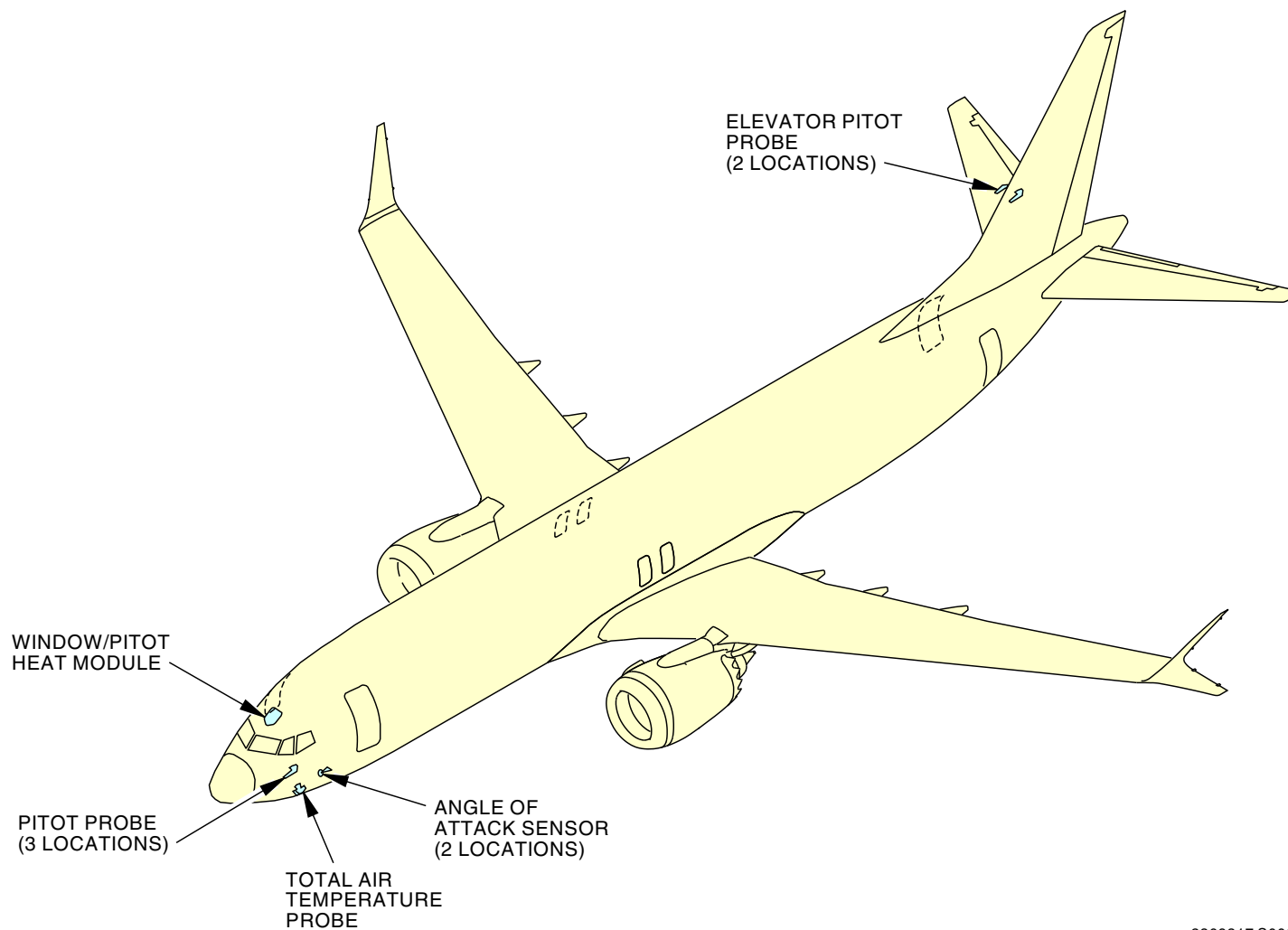
The probe anti-icing system supplies heat to these probes:

- 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.

SIA ALL	EFFECTIVITY

ICE AND RAIN PROTECTION - PITOT AND STATIC - INTRODUCTION



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ICE AND RAIN PROTECTION - PITOT AND STATIC - INTRODUCTION

30-30-00-001

SIA ALL	EFFECTIVITY

30-30-00

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ECCN 9E991 BOEING PROPRIETARY - See title page for details

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

If the crew fails to activate the probe heat systems, the probe heat systems are still automatically turned on when the engines start.

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 the following probes is controlled by probe heater system A:

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

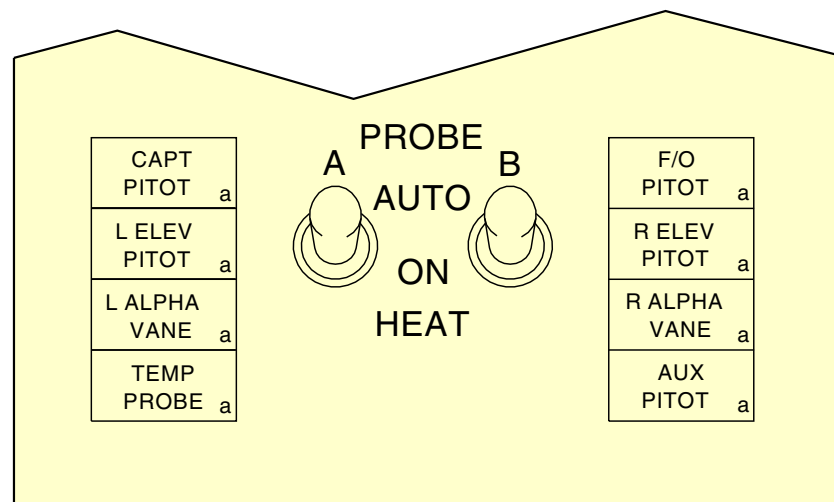
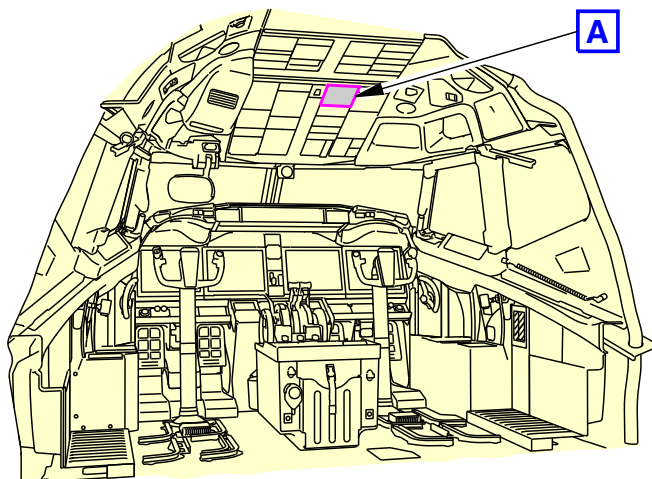
The heat for these probes is controlled through probe heater system B:

- 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	
SIA ALL	

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



WINDOW/PITOT HEAT MODULE (P5)

A

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

30-30-00

SIA ALL	EFFECTIVITY

D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details



ICE AND RAIN PROTECTION - PITOT AND STATIC - PITOT PROBE

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

There are two elevator pitot probes on the vertical stabilizer.

General

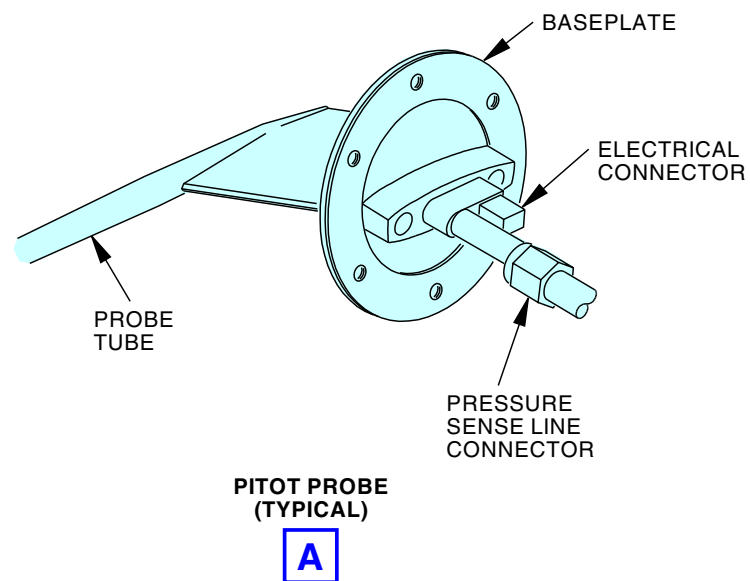
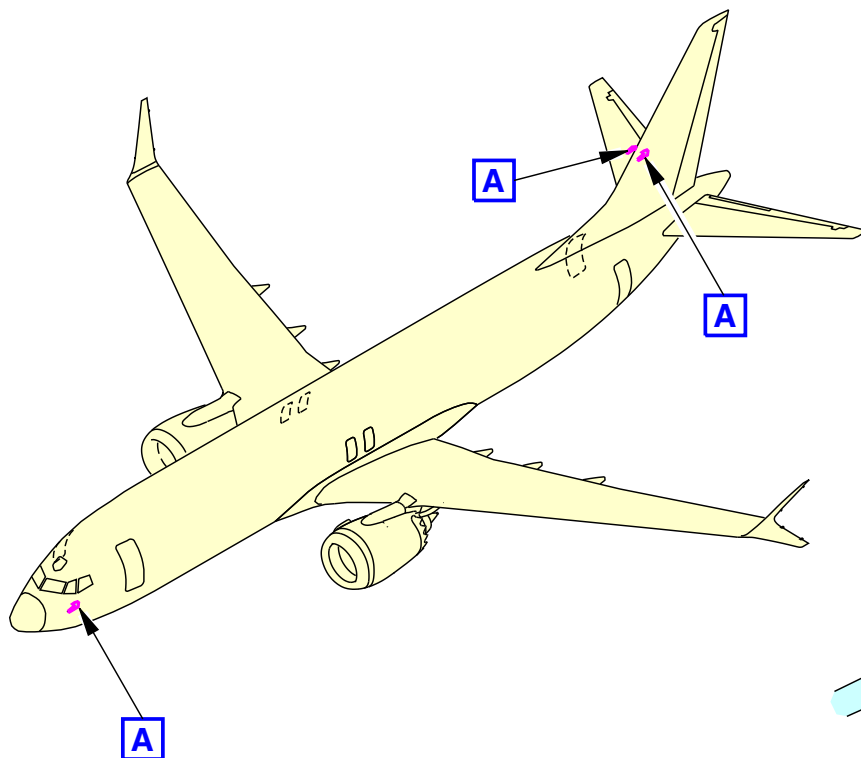
The pitot probes have electric heaters. If a probe heater fails, you must replace the probe.

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)

EFFECTIVITY	
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ICE AND RAIN PROTECTION - PITOT AND STATIC - PITOT PROBE



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ICE AND RAIN PROTECTION - PITOT AND STATIC - PITOT PROBE

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SIA ALL	EFFECTIVITY
	D633AM102-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details



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

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.

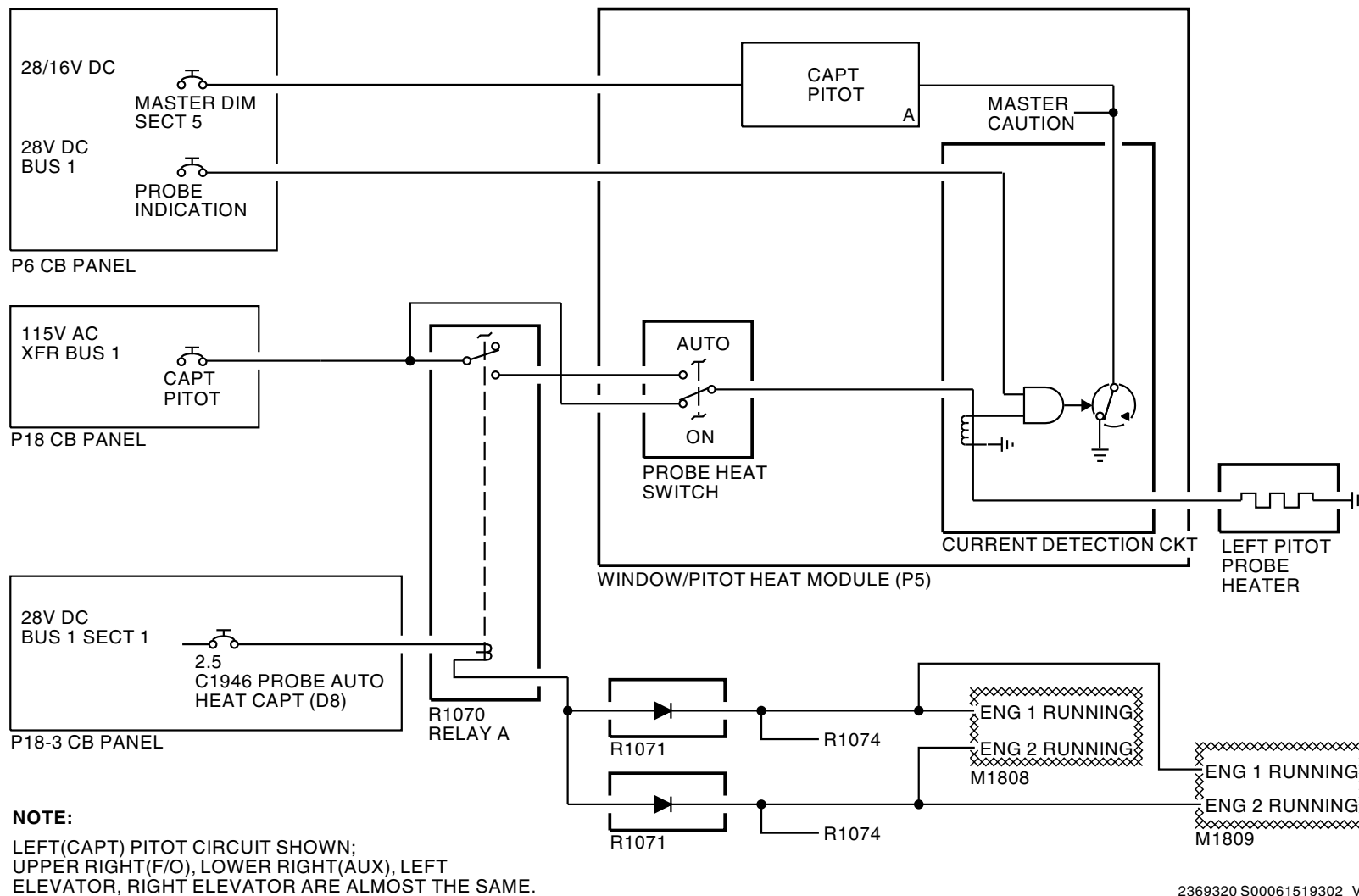
Put the control switch to the AUTO position to automatically turn on probe heat. This lets 115v ac power go through the current detection circuitry to the probe heater when the engines are running.

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.

EFFECTIVITY	
SIA ALL	

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



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

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EFFECTIVITY

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ECCN 9E991 BOEING PROPRIETARY - See title page for details



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

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.

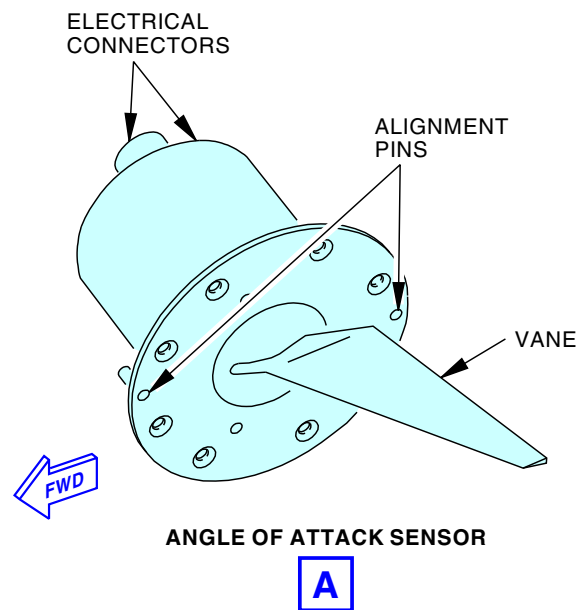
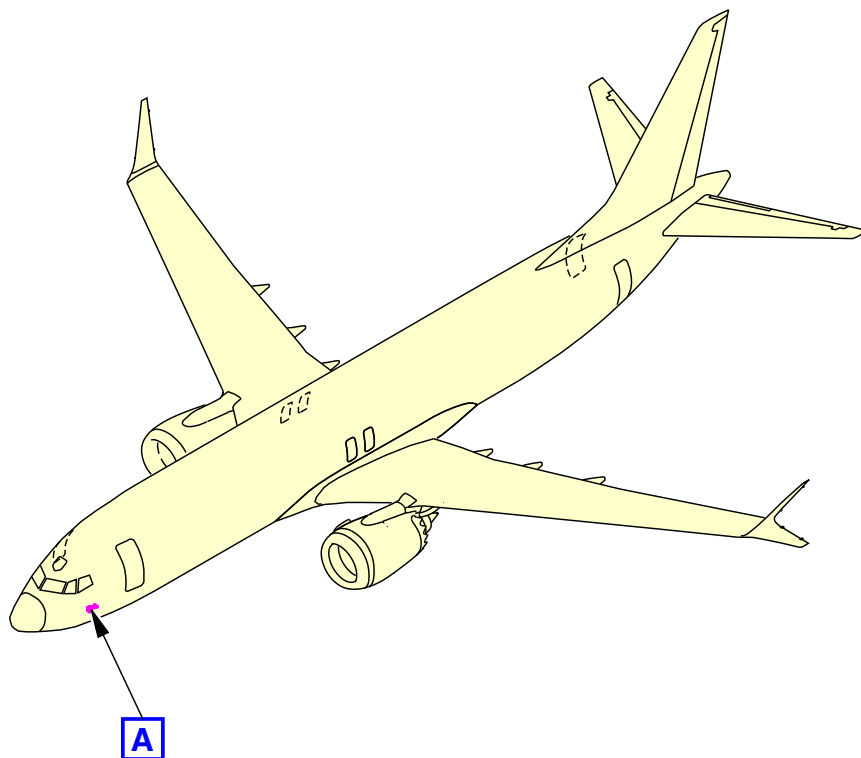
General

The AOA sensors have these two integral heaters:

- Vane heater
- Case heater.

SIA ALL	EFFECTIVITY
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ICE AND RAIN PROTECTION - PITOT AND STATIC - ANGLE OF ATTACK SENSOR



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

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ECCN 9E991 BOEING PROPRIETARY - See title page for details

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

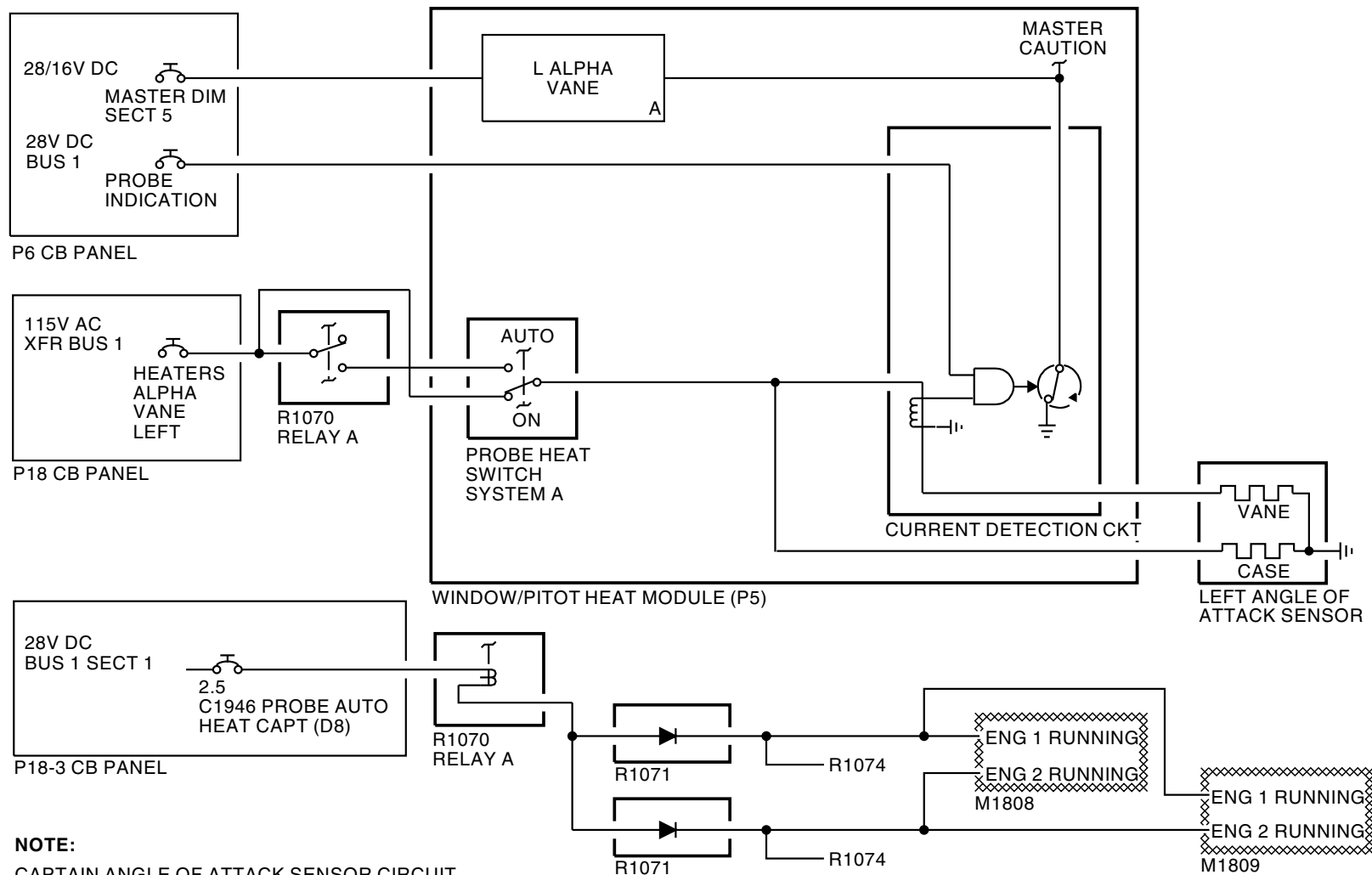
Put the control switch to the AUTO position to automatically turn on sensor heat. This lets 115v ac power go through the current detection circuitry to the sensor heaters when the engines are running.

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.

SIA ALL	EFFECTIVITY

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



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

**ICE AND RAIN PROTECTION - PITOT AND STATIC - TAT PROBE****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

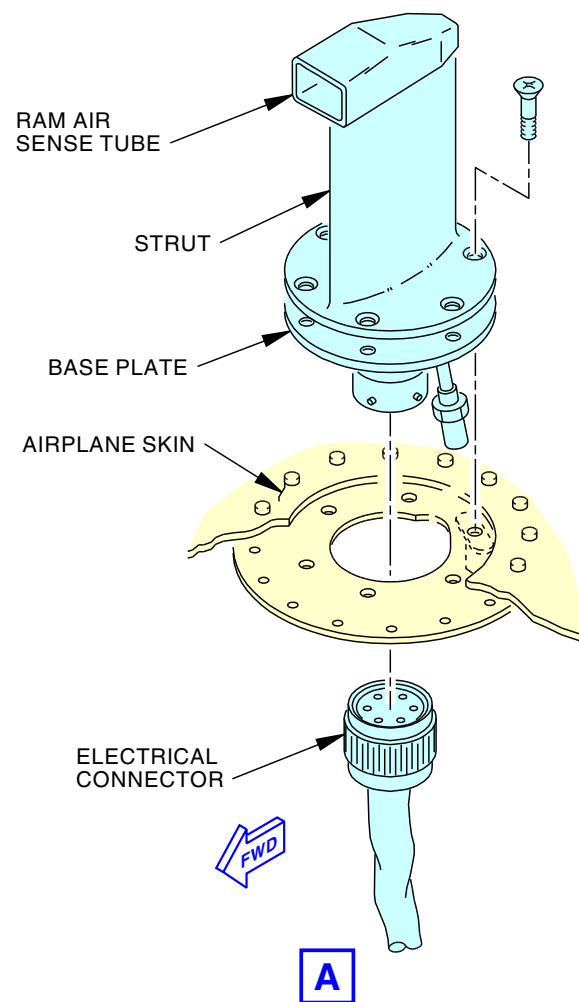
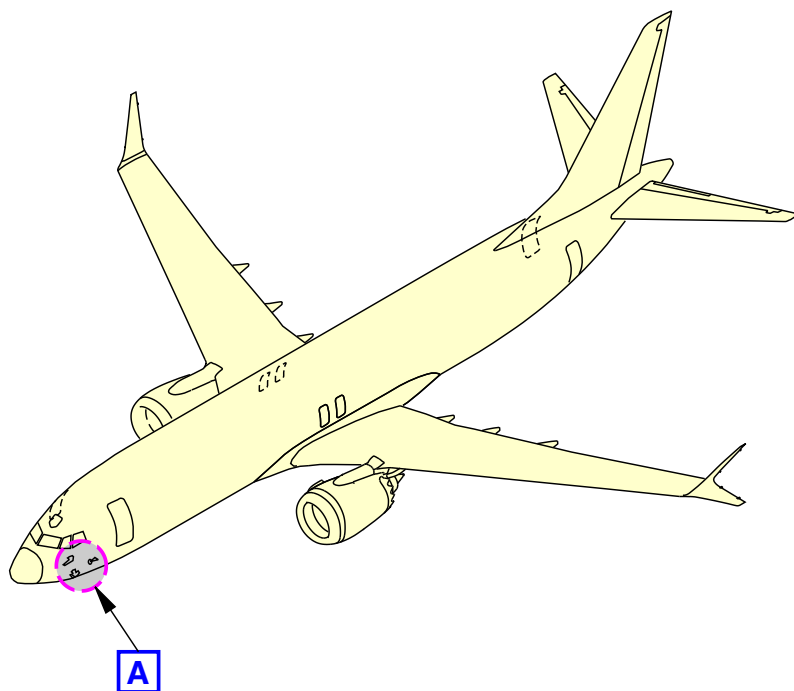
The TAT probe is on the left side of the forward fuselage.

General

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

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ICE AND RAIN PROTECTION - PITOT AND STATIC - TAT PROBE



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ICE AND RAIN PROTECTION - PITOT AND STATIC - TAT PROBE

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

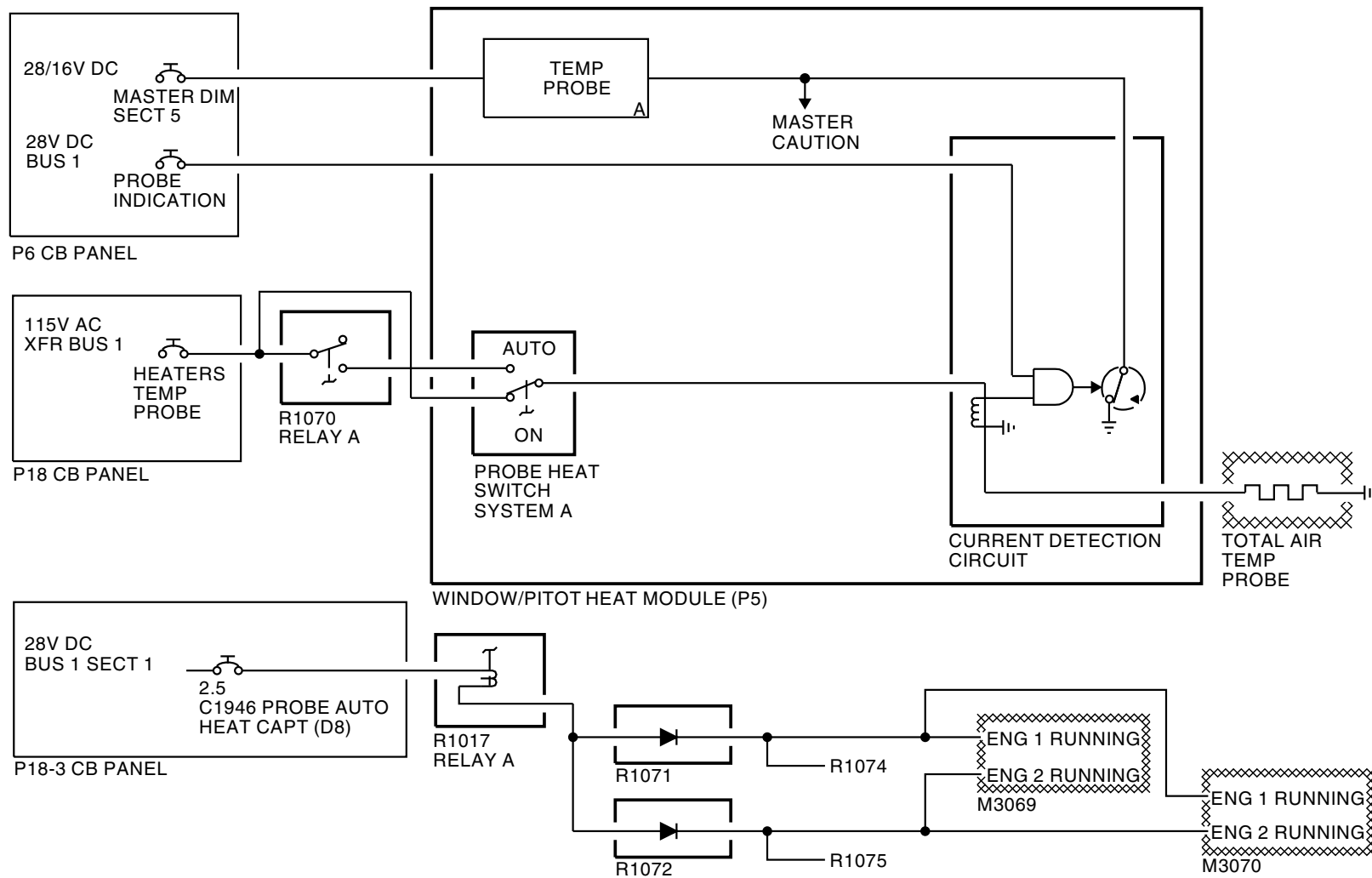
Put the control switch to the AUTO position to automatically turn on probe heat. This lets 115v ac power go through the current detection circuitry to the probe heater when the engines are running.

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.

SIA ALL	EFFECTIVITY

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



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

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EFFECTIVITY	
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ECCN 9E991 BOEING PROPRIETARY - See title page for details

**ICE AND RAIN PROTECTION - PITOT AND STATIC - OPERATION****Pitot and Static Anti-Icing**

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

- ON

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

Put the switches in the AUTO position to automatically apply heat to the air data probes when the engines are running.

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

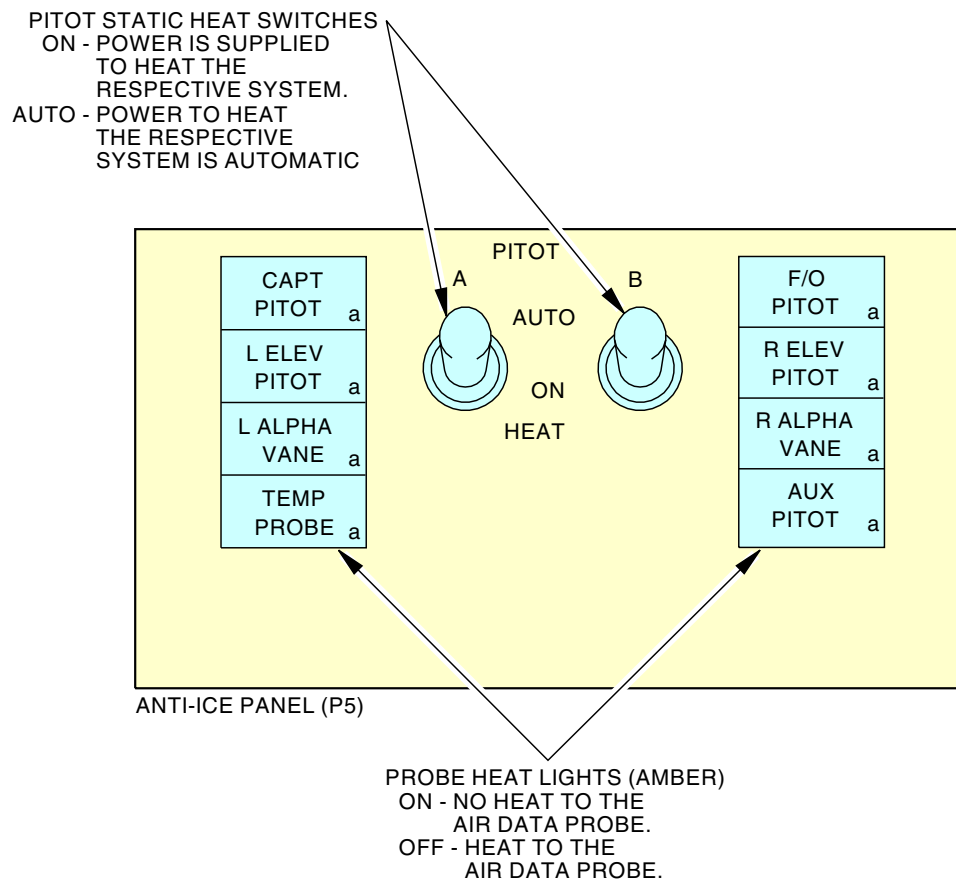
There is an indication light for each air data probe. These are the indications:

- 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.

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ICE AND RAIN PROTECTION - PITOT AND STATIC - OPERATION



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ICE AND RAIN PROTECTION - PITOT AND STATIC - OPERATION

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ECCN 9E991 BOEING PROPRIETARY - See title page for details

**ICE AND RAIN PROTECTION - CTRL CABIN - INTRODUCTION****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 ON and OVERHEAT system indication
- Do system tests
- Program power output to the windows.

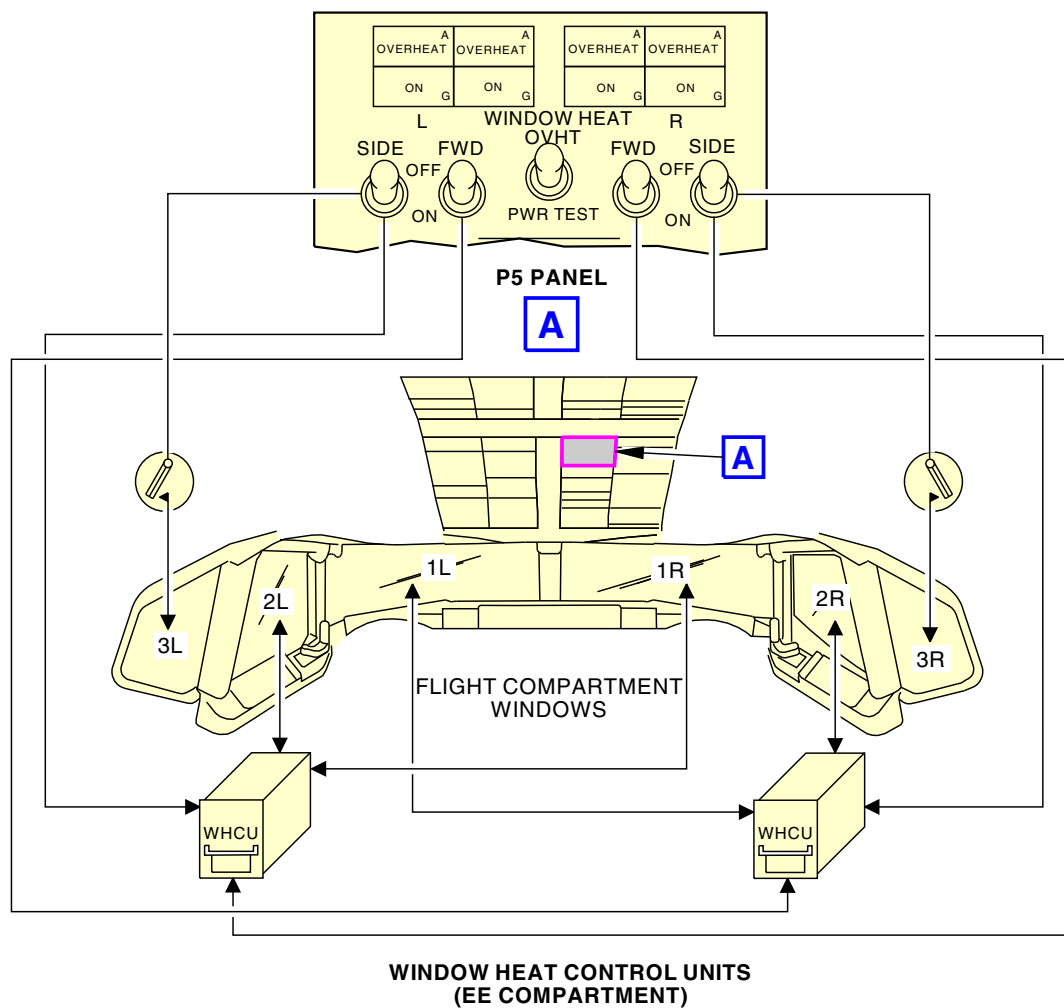
The WHCUs control power to these windows:

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

Thermal switches monitor window temperature and control power to No.3 left and right windows.

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ICE AND RAIN PROTECTION - CTRL CABIN - INTRODUCTION



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ICE AND RAIN PROTECTION - CTRL CABIN - INTRODUCTION

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ECCN 9E991 BOEING PROPRIETARY - See title page for details

**ICE AND RAIN PROTECTION - CTRL CABIN - WINDOW HEAT CONDUCTIVE COATING AND SENSOR****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 bus bars 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:

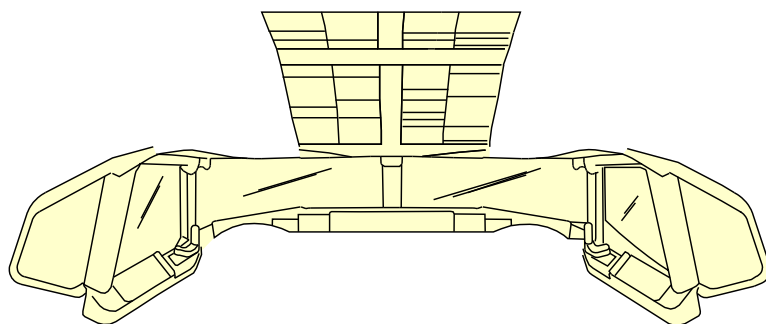
- A primary sensor
- A spare sensor.

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

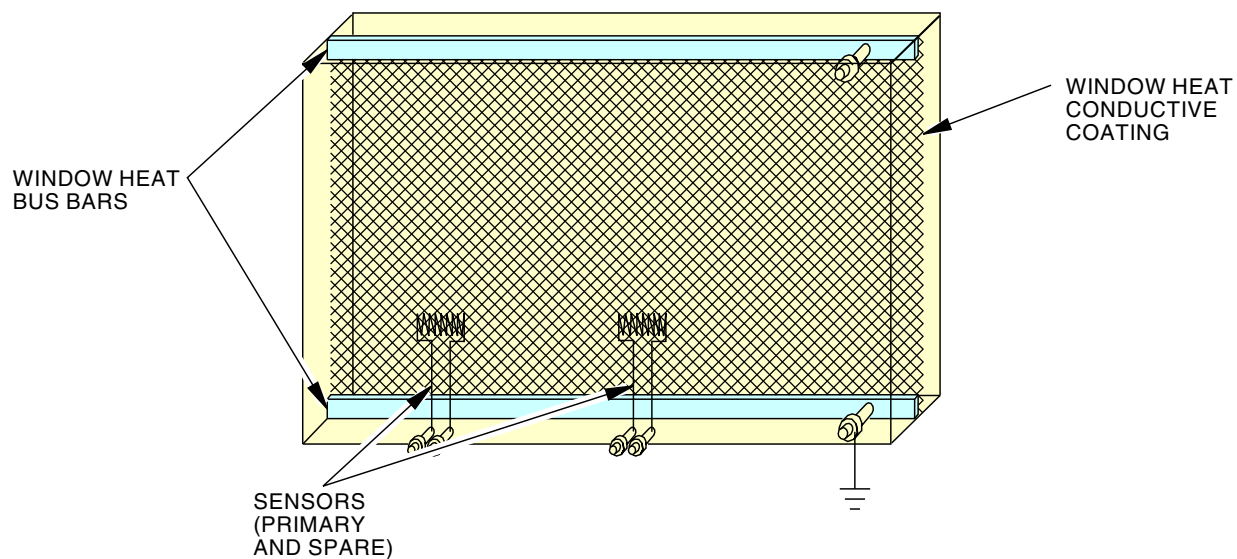
The other windows do not use window heat control units and do not have sensors. The thermal switches control the window heat power to these windows.

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



FLIGHT COMPARTMENT
WINDOWS



WINDOW CONSTRUCTION
(TYPICAL)

2369327 S00061519318_V2

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

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EFFECTIVITY

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ECCN 9E991 BOEING PROPRIETARY - See title page for details

**ICE AND RAIN PROTECTION - CTRL CABIN - WINDOW HEAT CONTROL UNIT****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.

Location

The window heat control units are in the EE compartment. One is on the E4-2 shelf and one is on the E2-1 shelf.

General Description

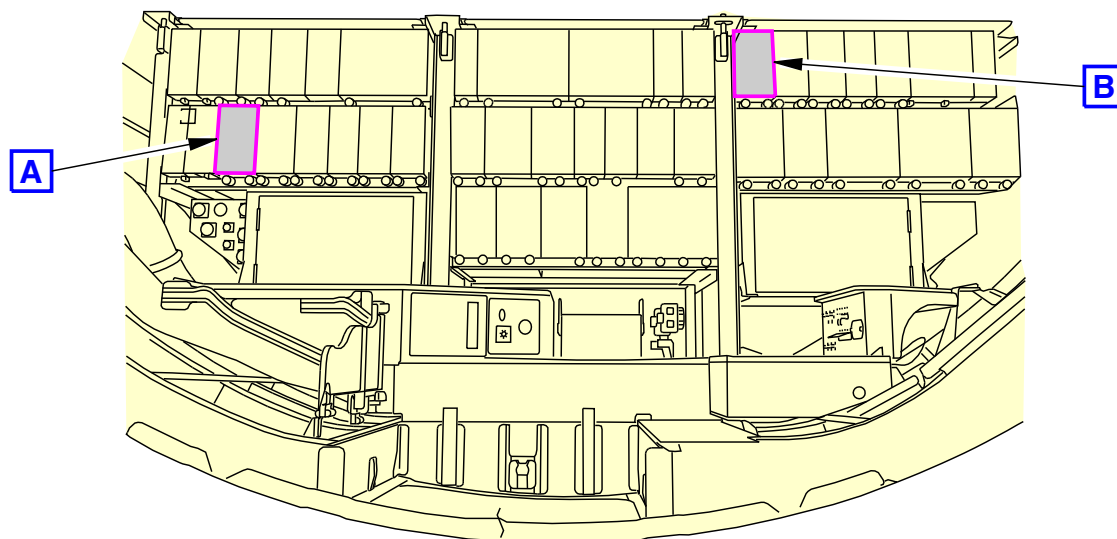
There are two identical WHCUs. Each WHCU controls the heat to two windows.

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

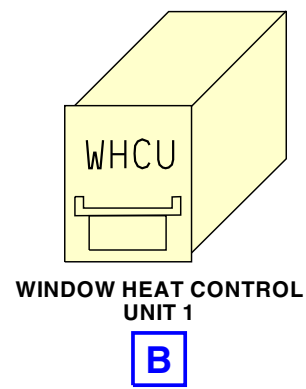
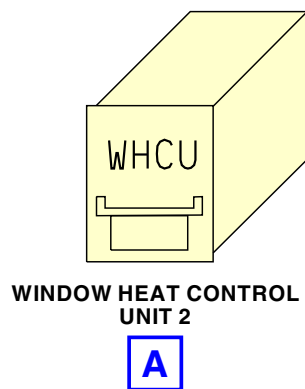
WHCU output power goes to a variable voltage terminal strip. Power to the window is off of the terminal that best matches the window power requirements. This is a function of window size and the condition of its conductive layer.

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



(VIEW IN THE AFT DIRECTION)



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

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

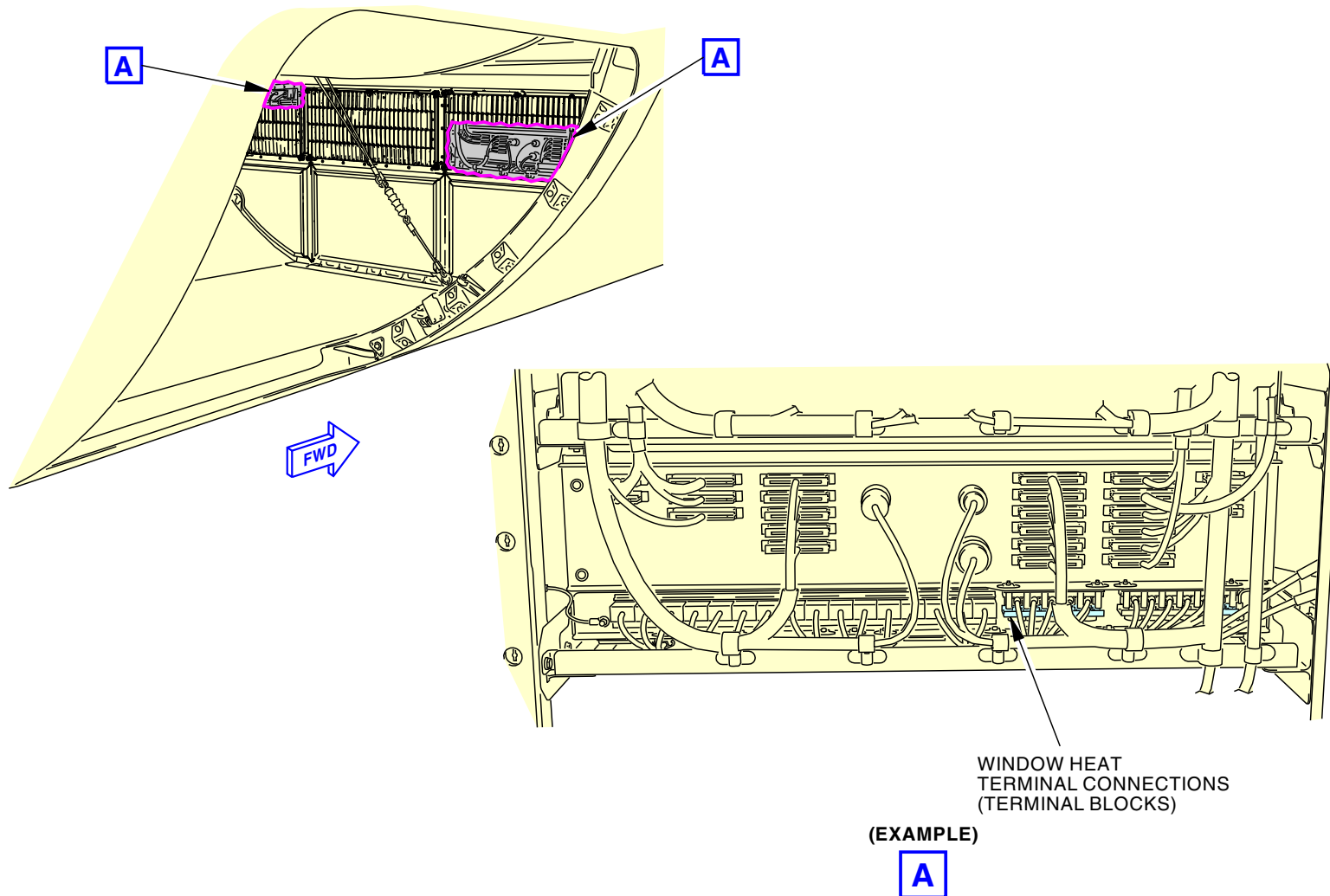
The window heat terminal connections are behind the window heat control units in the EE compartment. You get access to the connections through access panels in the forward cargo compartment.

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. The WHCU has internal transformers which provides auto-adjustable taps to control voltage for window heat power.

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



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

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

The window heat control units heat these windows:

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

These systems use 115v ac 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 two windows.

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 energizes the P5-9 green ON light circuit. The ON light comes on. 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 green ON light is off.

A PWR TEST switch on the P5 overhead 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 green P5 overhead panel ON light comes on.

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

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ECCN 9E991 BOEING PROPRIETARY - See title page for details

**ICE AND RAIN PROTECTION - CTRL CABIN - WINDOW HEAT CONTROL UNIT - GENERAL DESCRIPTION****Window Heat System Operation**

The temperature sensor selection operation is set by the WHCU BITE panel. There are two modes of operation:

- **Override Mode** - In override mode, the OVERRIDE MODE green LED on the BITE panel illuminates. The WHCU will automatically select a working sensor when a sensor fails. No failure indication will annunciate in the flight compartment. Only when both sensors fail will the P5-9 OVERHEAT light turn on.
- **Normal Mode** - The sensor used by WHCU will alternate every time the window ON/OFF control switch is cycled. The OVERRIDE MODE LED will not be illuminated on the WHCU BITE panel. When the selected sensor fails, the OVERHEAT light on the P5-9 panel will illuminate. The pilot will have to cycle the window heat control ON/OFF switch to get the WHCU to select the other sensor. At the next switch cycle, the WHCU will switch back to the failed sensor. The WHCU BITE panel will show the failed sensor indication. To prevent alternating between the working sensor and failed sensor, the OVERRIDE mode can be selected. Then only the working sensor will be active.

Single Sensor Operation (Window #2)

- If the WHCU is not connected to the Window #2 spare sensor and the program pin is not connected, the WHCU will use single sensor operation. If the working sensor fails, the OVERHEAT light will turn on and no heat will be provided to the window. The WHCU program pin (P1-5) is open in single sensor operation and the override mode will not be functional.

Dual Sensor Operation (Window #2)

- To take advantage of a spare sensor, wiring provisions for the second sensor to the left and right side windows are available. In order to use the second sensor, the WHCU program pin (P1-5) is grounded and a section of wire is added inside the window frame. Adding the wire to the window frame makes that window incompatible with airplanes that are not configured for the dual sensor operation.

Electrical Power Source

- Window heat system uses 115VAC transfer bus 1 and 2 for window heat control unit, which provides system control, and indication. The WHCU has internal transformers with auto-adjustable taps to control voltage for window heat power. Electric current flows through the window conductive coating to heat the windows. The window resistance is automatically measured at power up. The WHCU auto-adjusts the output voltage and power to the window accordingly.

Bus Power Transfer Operation

- To avoid nuisance indications during bus power interruptions, WHCU software receive low voltage trigger from hardware (AC input is less than 80 volts). This trigger generates a processor NMI interruption. During the NMI interruption process, the WHCU output is temporarily stopped. Any faults generated during this process are also masked. Normal operation (all fault monitoring and power outputs) is restored after normal power (input power is above 80 VAC) is restored.

WHCU Thermal Protection

The Window Heat Control Unit has internal hardware protection for transformer overheat failures. The Hardware protection will shut down the power if the transformer temperature reaches 230°F (110°C). Software protection will gradually limit the power if the WHCU internal transformer temperature exceeds 194°F (90°C). Power will gradually decrease as follows:

Internal Transformer Temperature	Output Power
<194°F (90°C)	100%
>194°F (90°C)	80%
>212°F (100°C)	50%
>230°F (110°C)	0% (Hardware Shutdown)

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ECCN 9E991 BOEING PROPRIETARY - See title page for details



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

Overheat Protection

The WHCUs have overheat protection circuitry.

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

- Window temperature more than 144°F (62°C)
- There is electric current to the window heat circuit

The overheat protection circuit operates only while power is applied to the window.

NOTE: 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 stops
- The green P5-9 green ON light goes out
- The amber P5-9 amber OVERHEAT light comes on
- The MASTER CAUTION and ANTI-ICE annunciator lights come on.

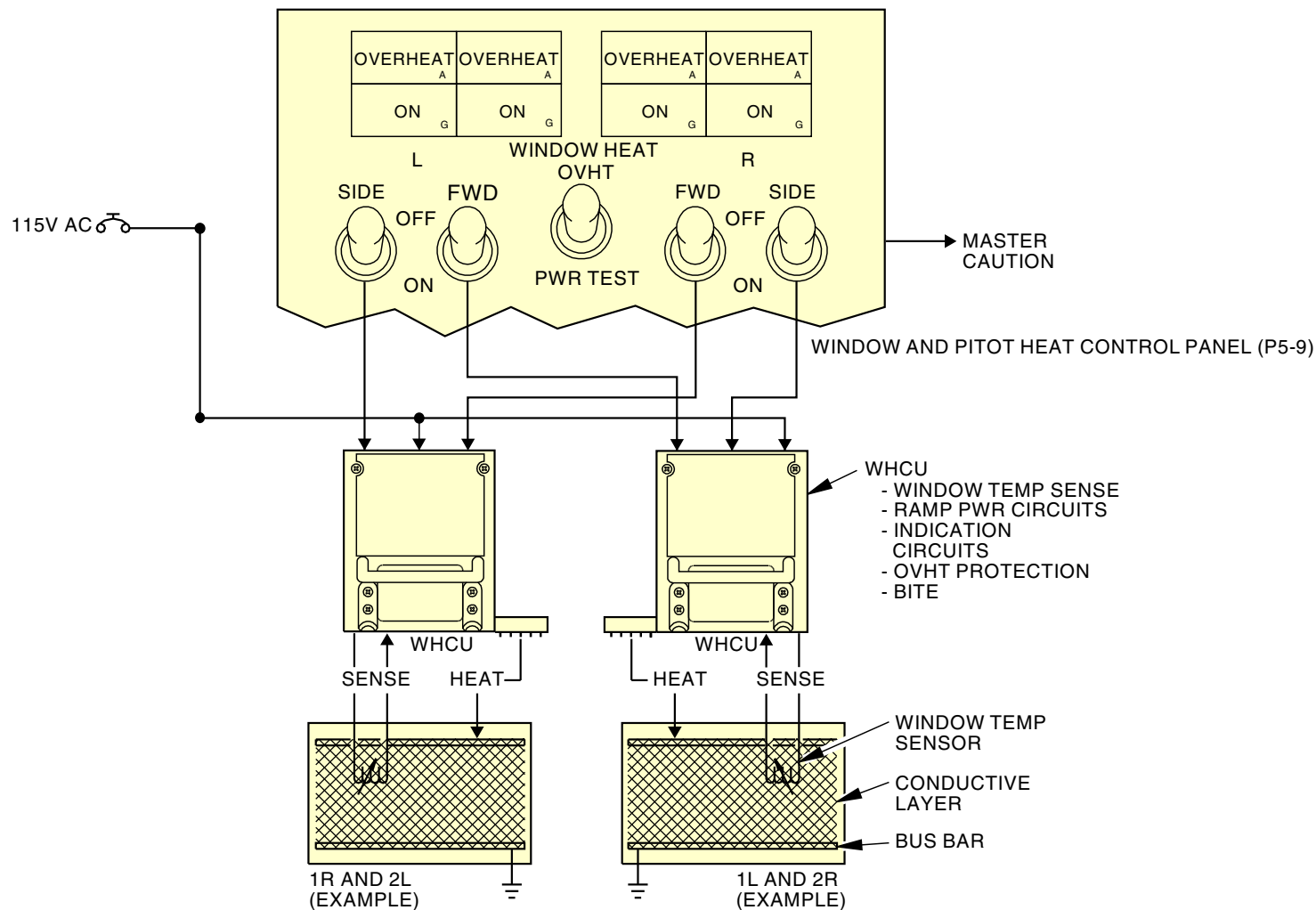
To reset the system, you must move the WINDOW HEAT switch to the OFF position, and then back to the ON position.

An overheat cannot be reset until the window cools.

An OVHT switch on the P5-9 panel 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.

EFFECTIVITY	
SIA ALL	

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



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

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

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 the green ON light circuit. The ON light on P5-9 panel comes on. 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 green ON light on P5-9 panel is off.

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 green ON light on P5-9 panel is off.
- 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.

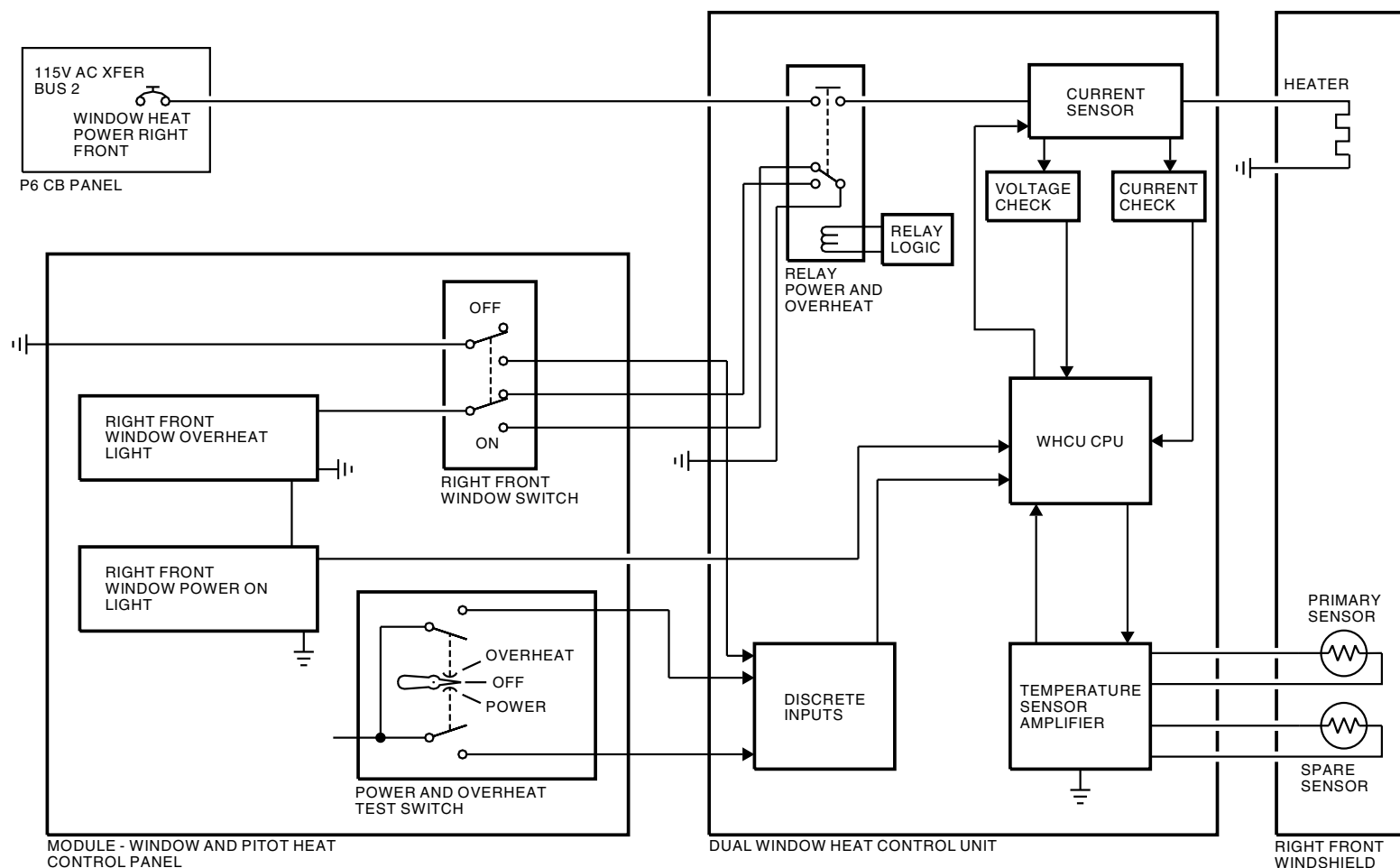
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EFFECTIVITY	
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ICE AND RAIN PROTECTION - CTRL CABIN - WINDOW HEAT CONTROL UNIT - FUNCTIONAL DESCRIPTION



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

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SIA ALL	EFFECTIVITY

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ECCN 9E991 BOEING PROPRIETARY - See title page for details

**ICE AND RAIN PROTECTION - CTRL CABIN - WINDOW THERMAL SWITCHES****Purpose**

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.

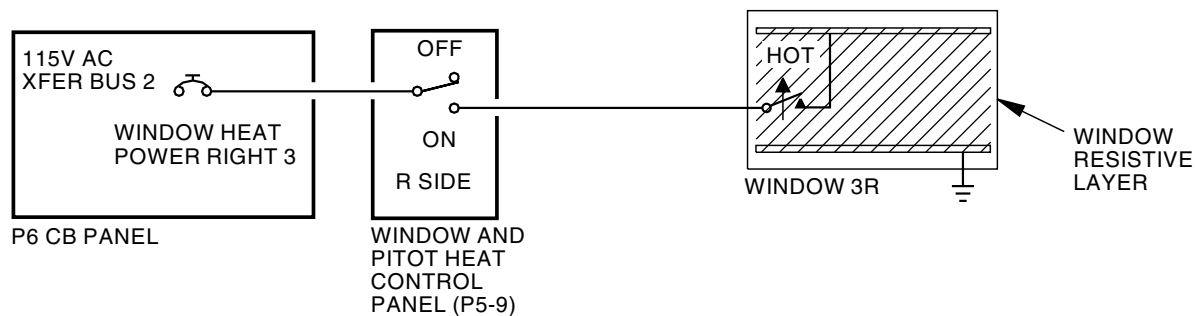
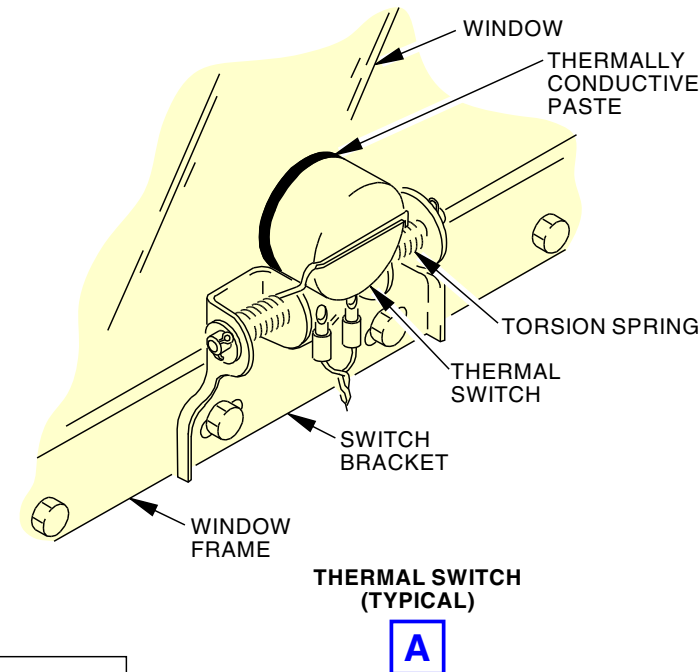
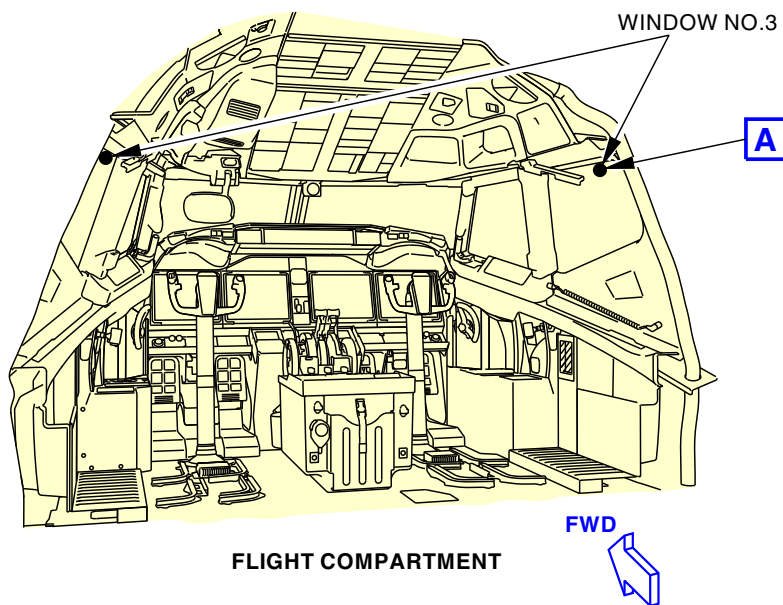
Put the related side window heat switch to ON to energize the system. 115v ac power passes through a thermal switch to the resistive layer of each window. The resistance of the layer to the current produces heat and warms the window.

When the No. 3 window thermal switch opens at a temperature of 95F (35C) or more. This opens the circuit, and removes power to the windows.

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

EFFECTIVITY	
SIA ALL	

ICE AND RAIN PROTECTION - CTRL CABIN - WINDOW THERMAL SWITCHES



NOTE: RIGHT SIDE WINDOW CIRCUIT SHOWN, LEFT SIDE THERMAL SWITCH CIRCUITS EQUIVALENT.

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ICE AND RAIN PROTECTION - CTRL CABIN - WINDOW THERMAL SWITCHES

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30-41-00

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

The Window Heat Control Unit (WHCU) has a 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.

Cycling through the faults show the faults from the most recent to the oldest fault registered in the WHCU.

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.

Cycling through the faults show the faults from the most recent to the oldest fault registered in the WHCU.

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 1
- WINDOW SENSOR 2
- BUS POWER
- WINDOW POWER
- P5-9

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.

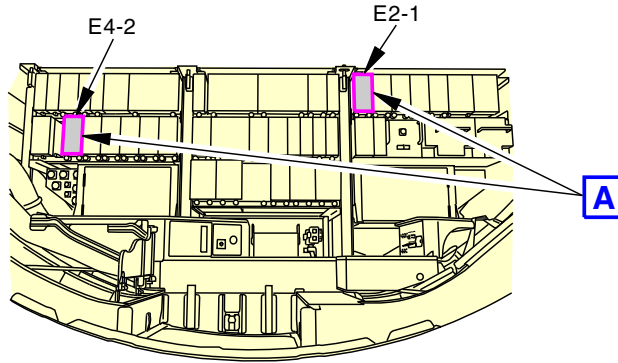
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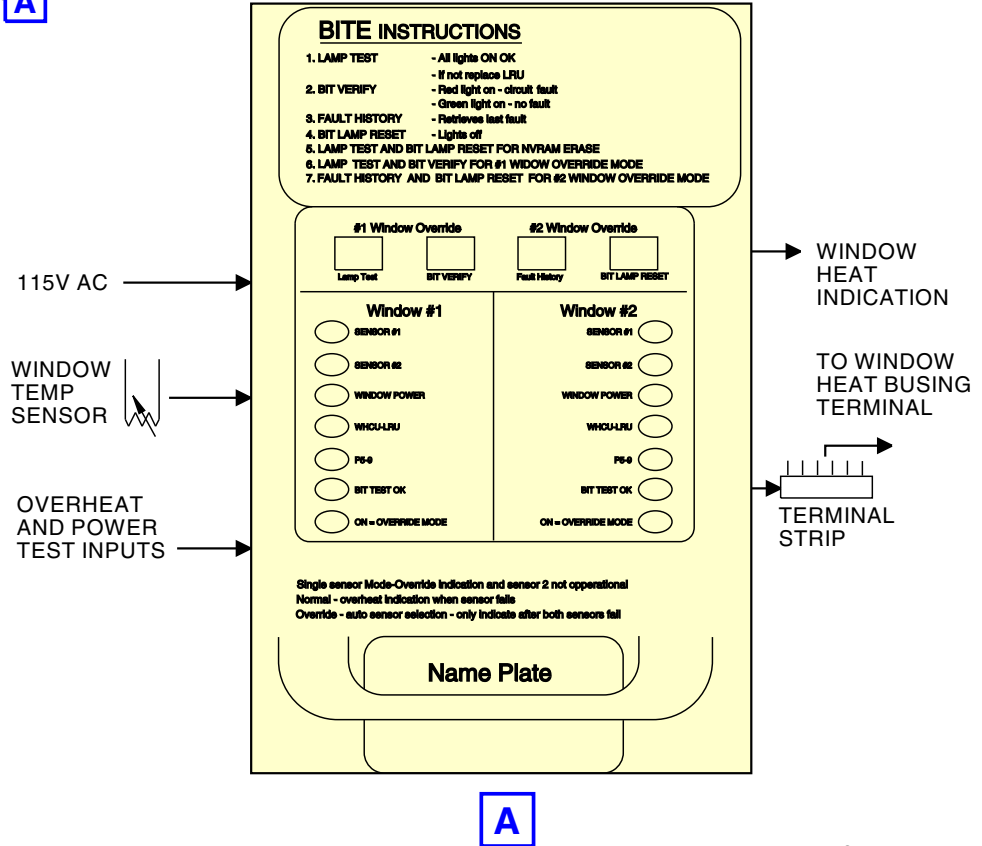
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ICE AND RAIN PROTECTION - CTRL CABIN - WINDOW HEAT CONTROL UNIT - BITE



EE COMPARTMENT



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



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ICE AND RAIN PROTECTION - WINDSHIELD WIPER SYSTEM - INTRODUCTION

Purpose

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

General

One wiper control switch on the P5 forward overhead panel gives the flight crew control of the system.

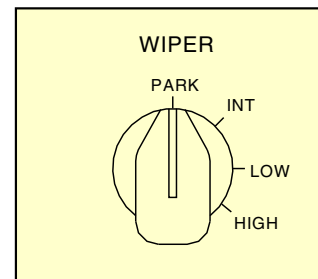
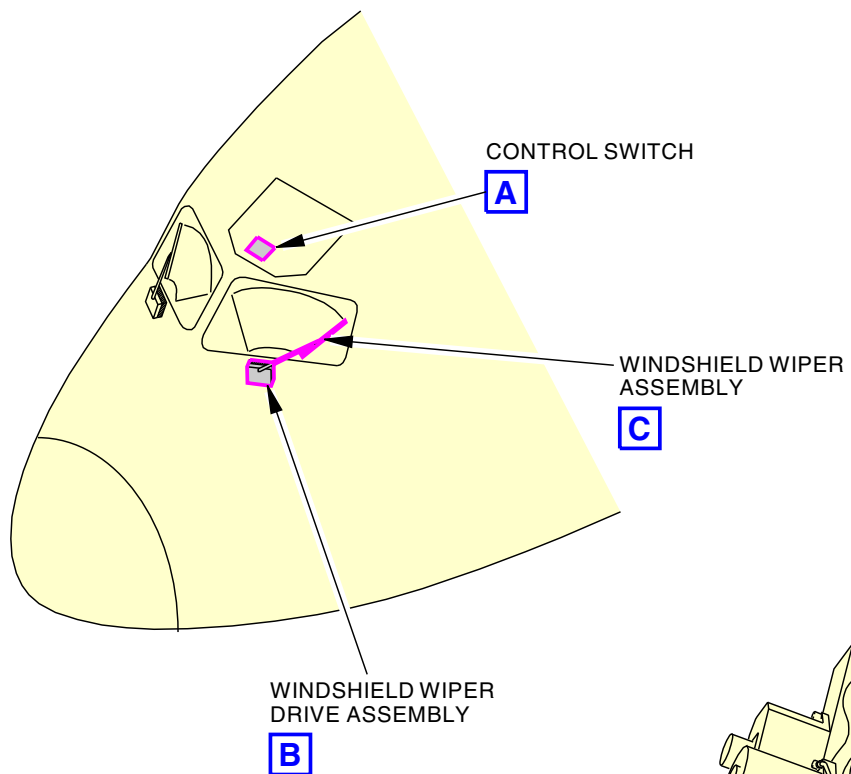
Location

The WIPER control switch is on the P5 forward overhead panel.

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

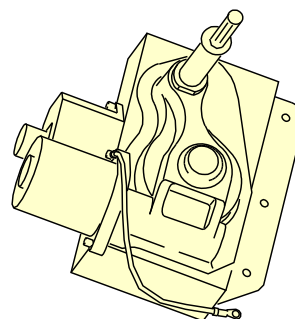
The two windshield wiper drive assemblies are on the No. 1R and No. 1L window sills. You get access to the windshield wiper drive assemblies from under the P7 glareshield.

ICE AND RAIN PROTECTION - WINDSHIELD WIPER SYSTEM - INTRODUCTION



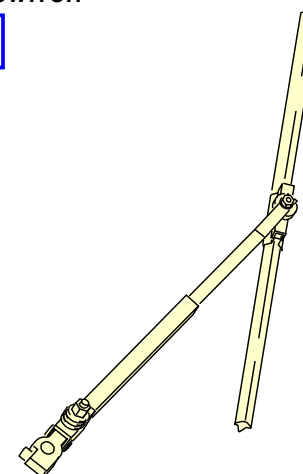
CONTROL SWITCH

(A)



WINDSHIELD WIPER DRIVE ASSEMBLY

(B)



WINDSHIELD WIPER ASSEMBLY

(C)

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ICE AND RAIN PROTECTION - WINDSHIELD WIPER SYSTEM - INTRODUCTION

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**ICE AND RAIN PROTECTION - WINDSHIELD WIPER SYSTEM - WINDSHIELD WIPER AND DRIVE ASSEMBLY****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.

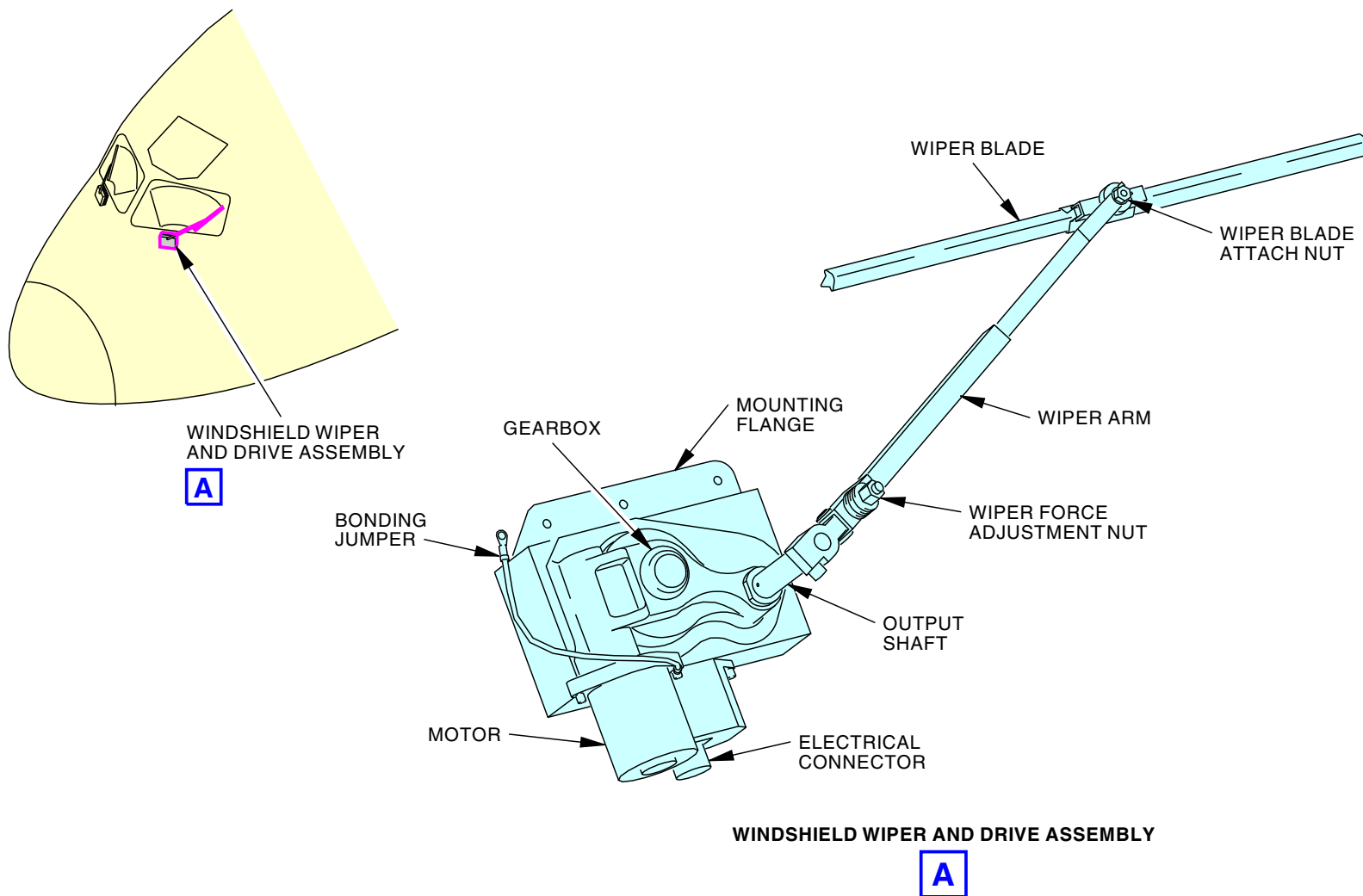
The blade attach nut and fittings set the angle between the blade and the wiper arm.

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.

ICE AND RAIN PROTECTION - WINDSHIELD WIPER SYSTEM - WINDSHIELD WIPER AND DRIVE ASSEMBLY



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ICE AND RAIN PROTECTION - WINDSHIELD WIPER SYSTEM - WINDSHIELD WIPER AND DRIVE ASSEMBLY

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**ICE AND RAIN PROTECTION - WINDSHIELD WIPER SYSTEM - FUNCTIONAL DESCRIPTION****General**

The windshield wiper system uses 28v dc power.

One switch on the P5 forward overhead panel controls both 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.

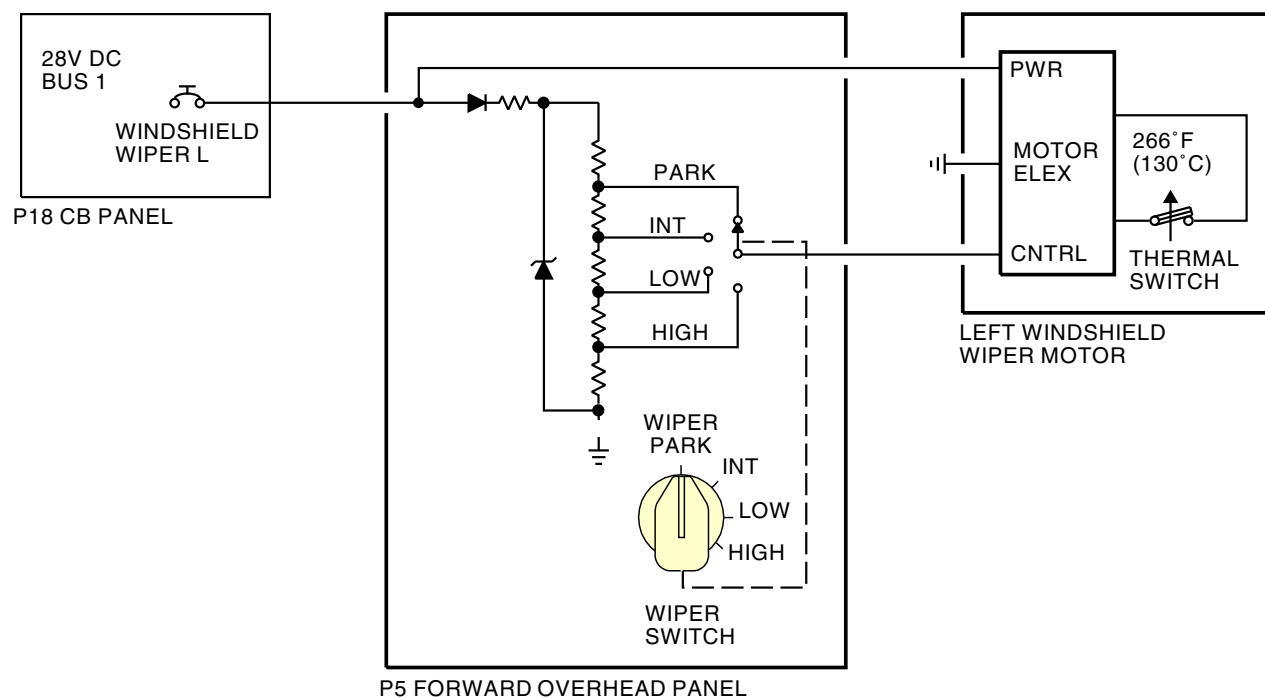
The motor electronic control package controls the motor speed in response to the WIPER switch position signal.

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.

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ICE AND RAIN PROTECTION - WINDSHIELD WIPER SYSTEM - FUNCTIONAL DESCRIPTION



NOTE:

LEFT SYSTEM IS SHOWN,
RIGHT SYSTEM IS EQUIVALENT.

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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.

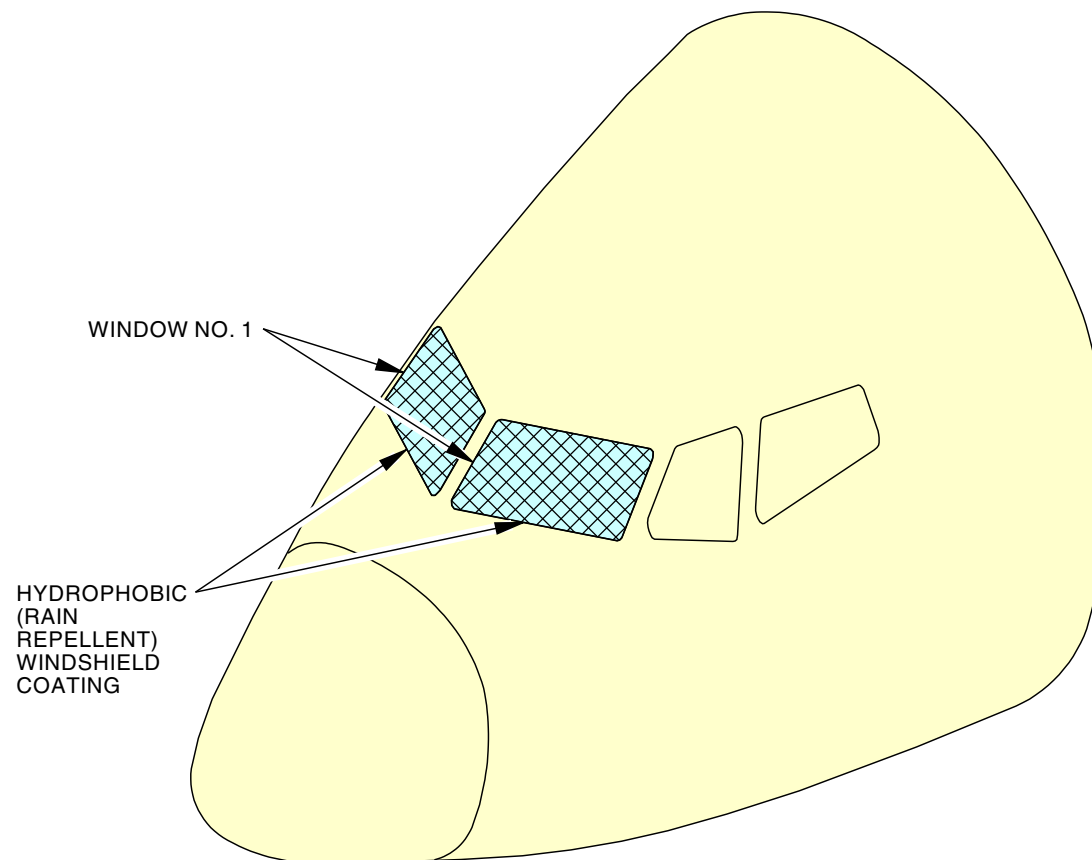
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ICE AND RAIN PROTECTION - RAIN REPELLENT SYSTEM - HYDROPHOBIC WINDSHIELD COATING



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

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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 these 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

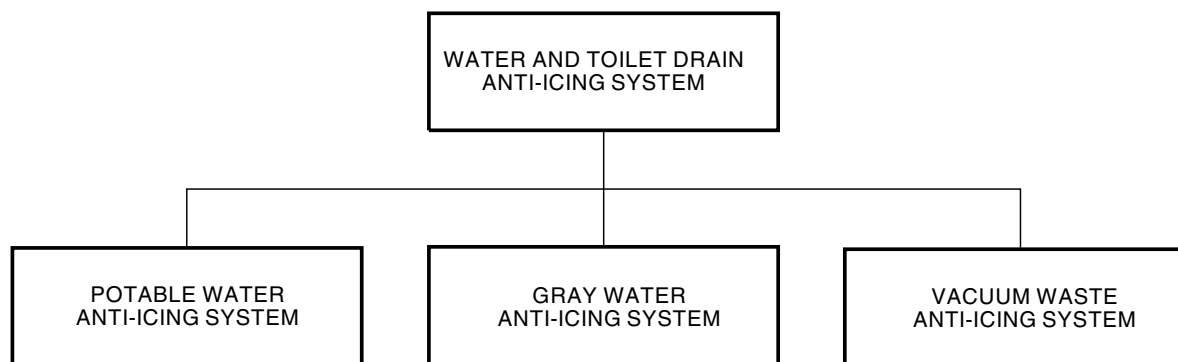
Components without integral heaters get heat from these components:

- Heater tape (ribbon heaters)
- Heater blankets

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ICE AND RAIN PROTECTION - WATER LINES - INTRODUCTION



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ICE AND RAIN PROTECTION - WATER LINES - INTRODUCTION

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ICE AND RAIN PROTECTION - WATER LINES - POTABLE WATER - FUNCTIONAL DESCRIPTION

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 lining 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 115V AC power, 400 watts maximum and is controlled by a primary thermostat opening at 75°F (24°C) to 85°F (29°C) and closes at 40°F (4°C) to 50°F (10°C). A manually reset backup thermostat opens at 122°F (50°C) to 138°F (59°C) and closes at 85°F (29°C).

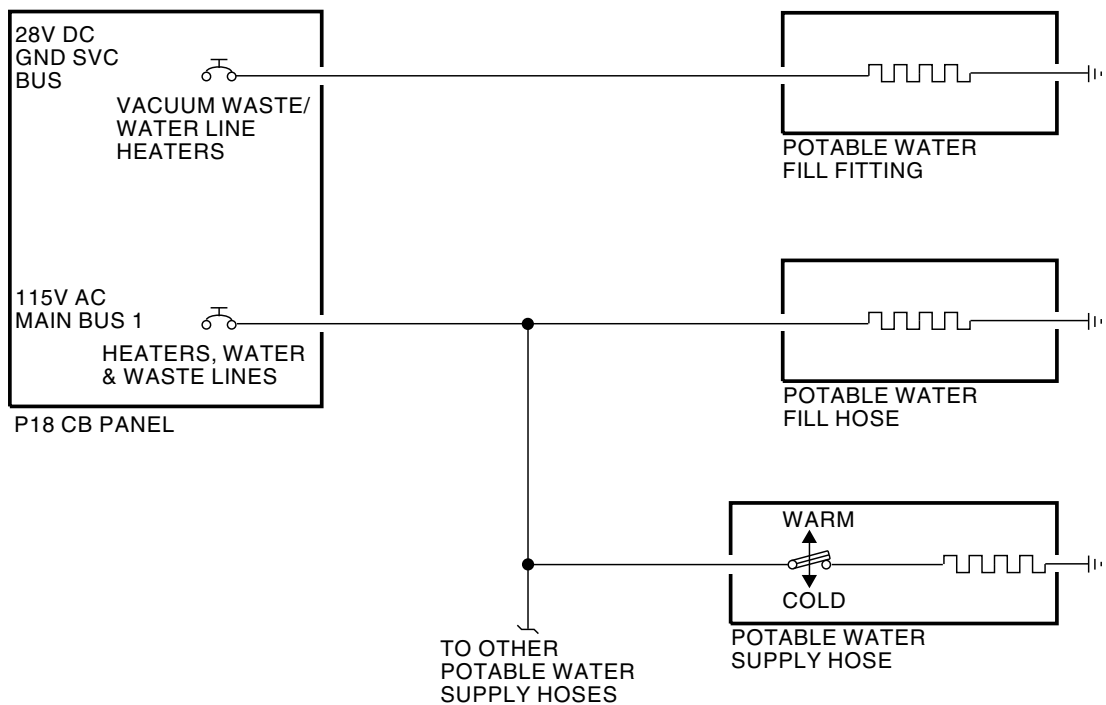
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ICE AND RAIN PROTECTION - WATER LINES - POTABLE WATER - FUNCTIONAL DESCRIPTION



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ICE AND RAIN PROTECTION - WATER LINES - POTABLE WATER - FUNCTIONAL DESCRIPTION

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**ICE AND RAIN PROTECTION - WATER LINES - GRAY WATER - FUNCTIONAL DESCRIPTION****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.

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115V AC MAIN BUS 1

HEATERS DRAIN MAST AIR

HEATERS DRAIN MAST GND

HEATERS WATER & WASTE LINES

28V AC XFR BUS 1 SECT 2

115V AC MAIN BUS 1

P18 CB PANEL

AIR

GND

R594 GND SENSE RELAY (J22)

WARM

COLD

THERMOSTAT

FWD DRAIN MAST INLET LINE HEATER TAPE

250F (122C)

FWD DRAIN MAST HEATER

250F (122C)

AFT DRAIN MAST HEATER

HEATER HOSE GRAY WATER DRAIN

ICE AND RAIN PROTECTION - WATER LINES - GRAY WATER - FUNCTIONAL DESCRIPTION

EFFECTIVITY	
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**ICE AND RAIN PROTECTION - WATER LINES - VACUUM WASTE - FUNCTIONAL DESCRIPTION****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.

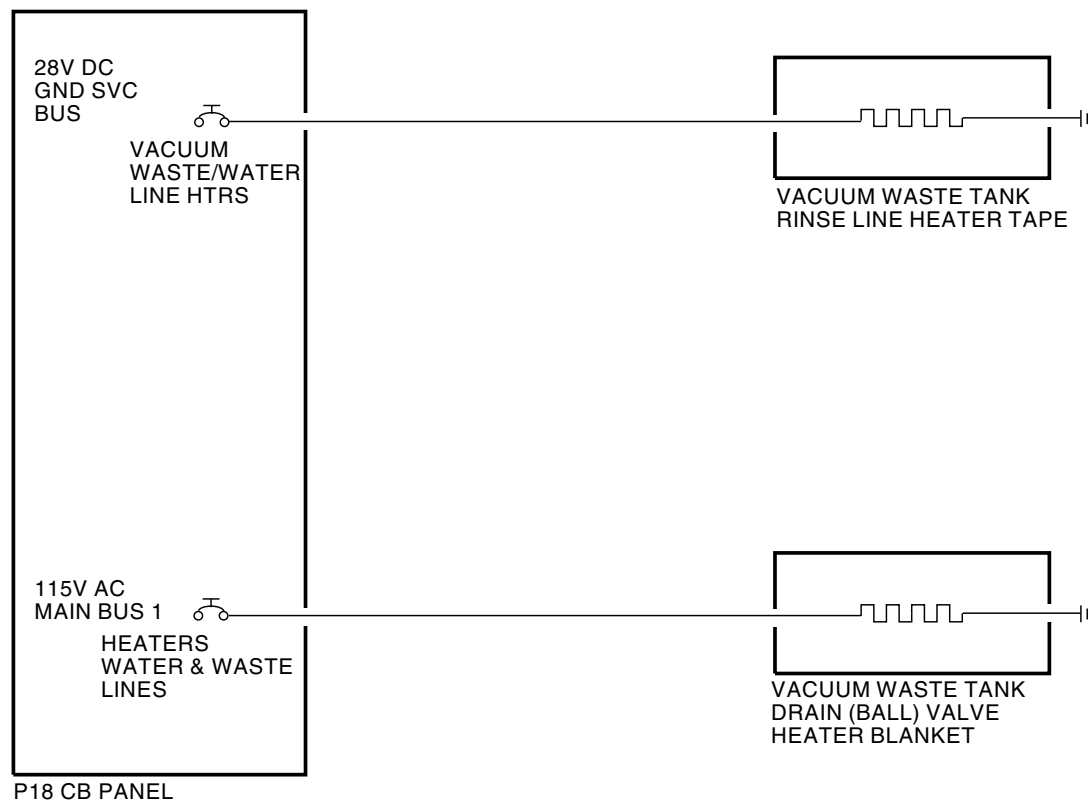
Waste Tank Rinse Line

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.

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ICE AND RAIN PROTECTION - WATER LINES - VACUUM WASTE - FUNCTIONAL DESCRIPTION



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ICE AND RAIN PROTECTION - WATER LINES - VACUUM WASTE - FUNCTIONAL DESCRIPTION

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