

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 forming on these airplane components:

- Wing leading edges
- Engine cowl leading edges
- Air data probes
- Flight deck windows
- Water and waste system lines and drains.

Windshield wipers and a permanent chemical coating give rain protection to the flight deck windows.

- MFD - multi-function display
- PFC - primary flight computer
- PRSOV - pressure regulating and shutoff valve
- PRSOVC - pressure regulating and shutoff valve controller
- SAARU - secondary attitude and air data reference unit
- TAT - total air temperature
- WAI - wing anti-ice
- WHCU - window heat control unit
- WOW - weight on wheels

Abbreviations and Acronyms

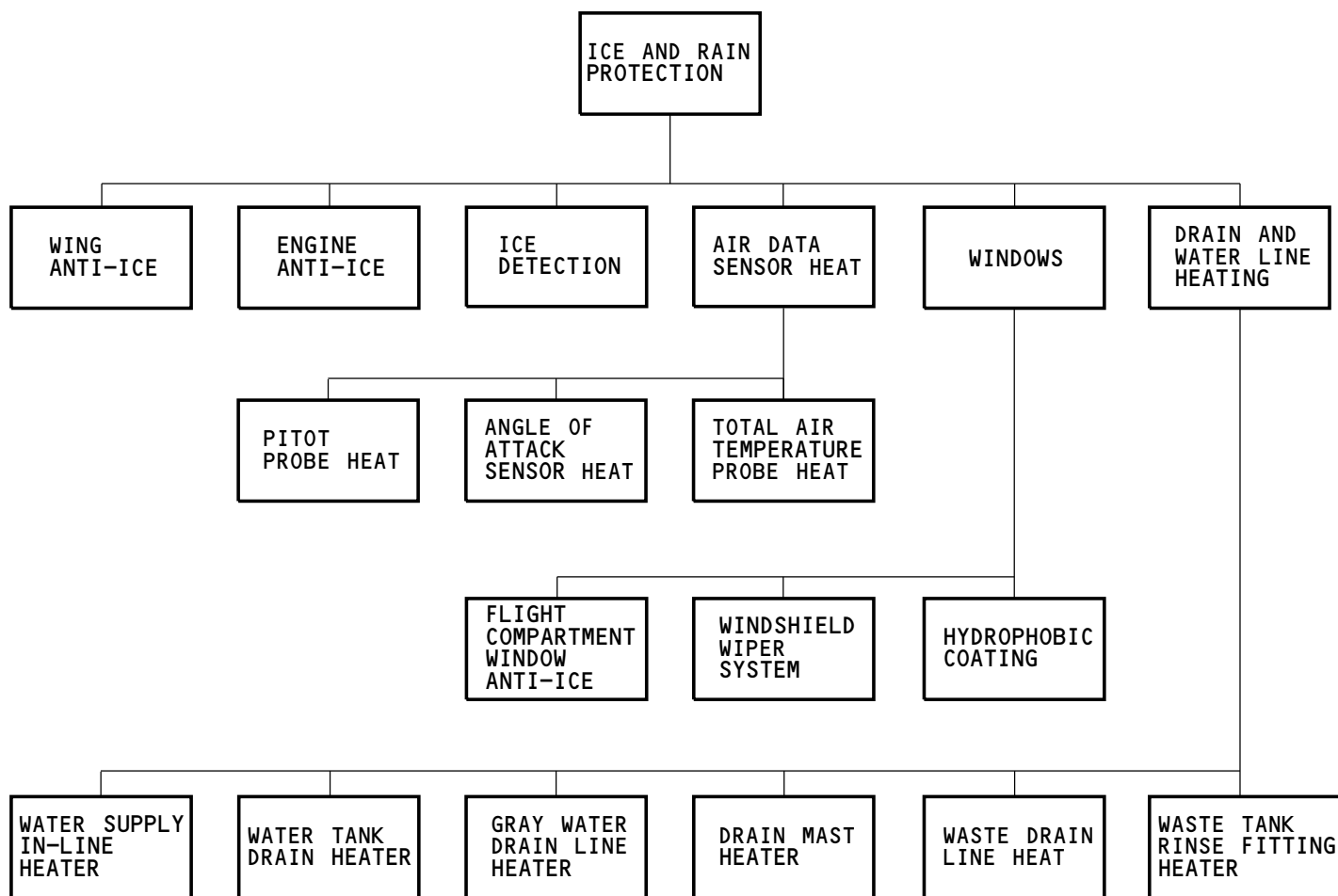
- ACIPS - airfoil and cowl ice protection system
- ADIRU - air data inertial reference unit
- ADM - air data module
- AFDC - autopilot flight director computer
- AGS - air/ground system
- AIMS - airplane information management system
- AOA - angle of attack
- CAC - controller air cooler
- CAS - computed air speed
- CMCS - central maintenance computing system
- EAI - engine anti-ice
- EEC - electronic engine control
- EICAS - engine indication and crew alerting system
- ELMS - electrical load management system
- HPFAC - high pressure fan air controller
- IDS - ice detection system
- int - intermittent
- LRU - line replaceable unit

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ICE AND RAIN PROTECTION - INTRODUCTION

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ICE AND RAIN PROTECTION - GENERAL DESCRIPTION

Wing and Engine Anti-Ice Systems

The wing anti-ice (WAI) and engine anti-ice (EAI) systems use hot air to prevent ice.

Ice Detection System

The ice detection system detects ice and automatically controls the WAI and EAI systems.

Air Data Sensor Heat

Air data sensors have electric heaters to prevent ice.

Flight Deck Windows

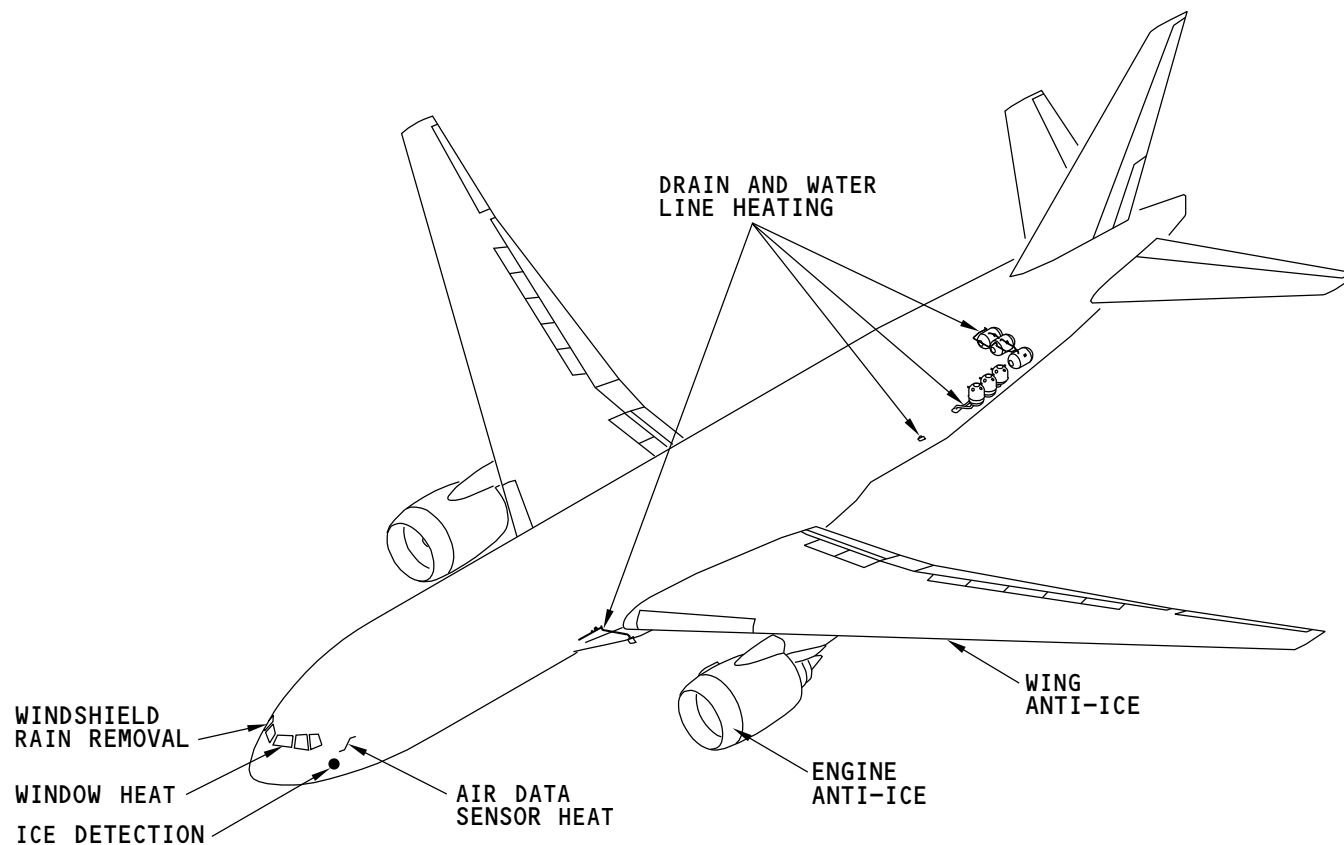
Flight deck windows have electrical heaters to prevent fog and ice.

The windshields have wipers to remove rain. They also have a hydrophobic coating to keep rain off (repel rain). The coating helps flight crew vision in rain but is not necessary for operation in rain.

Drain and Water Line Heating

Electric heaters prevent freezing in water and waste system lines and fittings.

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ICE AND RAIN PROTECTION - GENERAL DESCRIPTION

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ICE AND RAIN PROTECTION - ICE PROTECTION MAINTENANCE PAGE

General

The ice protection maintenance page shows this information:

- ALTITUDE - Airplane altitude in feet
- ENG TYPE - Engine manufacturer (GE, PW, or RR)
- TAT - Total air temperature in degrees C
- ICE DETECTOR - Status of the left and right ice detectors (OFF, ENGINE, ENGINE/WING, or FAIL)

Engine Anti-Ice

The engine anti-ice part of the maintenance page shows this information:

- FANCASE DUCT LEAK SIGNAL - Status of the fan case overheat detector (NORMAL, OVERHEAT, or FAIL)
- VALVE - EAI valve open, closed, or regulating
- SUPPLY AIR TEMP - EAI air supply temperature in degrees C
- AIR PRESS - Pressure downstream of the EAI valves in psig
- AIR FLOW - Air flow through the EAI valves in kg/min.

Wing Anti-Ice

The wing anti-ice part of the maintenance page shows this information:

- WING MANIFOLD PRESS - Pneumatic duct pressure in psig
- VALVE - WAI valve open, closed, or regulating
- AIR PRESS - Pressure downstream of the WAI valves in psig
- AIR FLOW - Air flow through the WAI valves in kg/min.

Valve positions and air flow rates are calculated from air pressure measurements upstream and downstream of the anti-ice valves.

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ICE PROTECTION		
ALTITUDE 10000	ENG TYPE --	
TAT -2		
	L	R
ICE DETECTOR	ENGINE/WING	ENGINE/WING
ENGINE ANTI-ICE:		
FANCASE DUCT LEAK SIGNAL	NORMAL	NORMAL
VALVE	REGULATING	REGULATING
SUPPLY AIR TEMP	473	473
AIR PRESS	13	13
AIR FLOW	5.9	5.9
WING ANTI-ICE:		
WING MANIFOLD PRESS	50	50
VALVE	REGULATING	REGULATING
AIR PRESS	19	19
AIR FLOW	38.6	38.6
DATE 23 JUN 90 UTC 18:54:04		

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ICE AND RAIN PROTECTION - ICE PROTECTION MAINTENANCE PAGE

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WING ANTI-ICE - INTRODUCTION

Purpose

The wing anti-ice system heats some of the leading edge slats so that ice does not collect on them in flight.

General Description

The pneumatic system supplies bleed air to heat the leading edge slats. Slats 3, 4, and 5 on the left wing and slats 10, 11, and 12 on the right wing are heated. Two wing anti-ice (WAI) valves control the air flow from the pneumatic system to WAI ducts. The WAI ducts carry the air to the slats. Holes in the bottom of each slat let the air out.

The airfoil and cowl ice protection system (ACIPS) control card - WAI controls the wing anti-ice valves. WAI pressure sensors send WAI duct air pressure data to the control card.

The wing anti-ice selector in the flight deck lets the crew set automatic or manual control. With AUTO selected, the WAI system comes on when the ice detection system finds ice. The OFF and ON positions are for manual control.

See the ice detection system section for more information (SECTION 30-81).

BITE circuits in the control card monitor the condition of the system. The AIMS gives information about the system through the EICAS display, status display, and maintenance pages. You use the MAT to do ground tests of the system.

Except for ground tests, the WAI system only operates in flight. Air/ground information from the weight on wheels (WOW) cards or airspeed data from the air data inertial reference unit (ADIRU) tells the control card when the airplane is in flight.

The wing anti-ice system has these other interfaces:

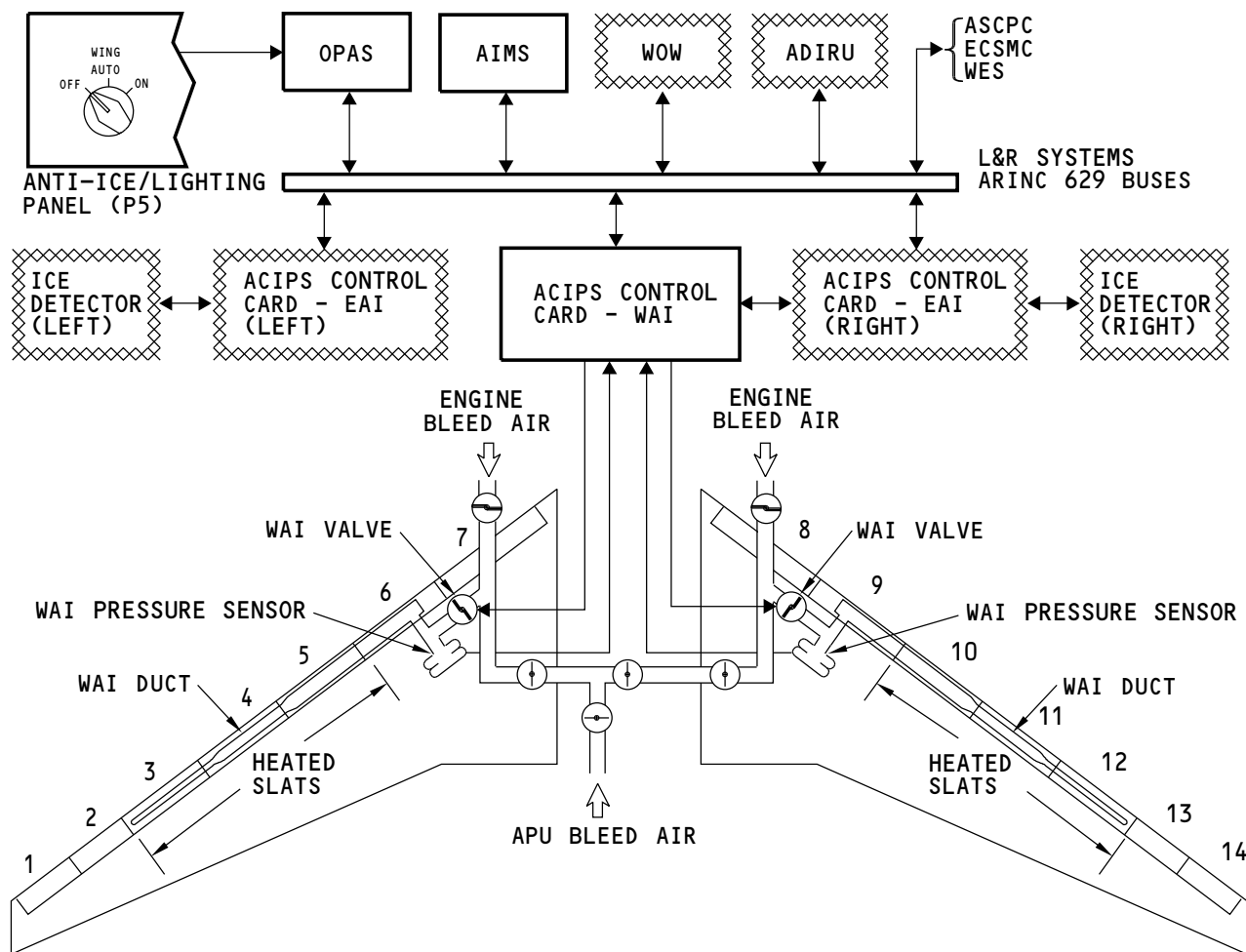
- ASCPC (air supply cabin pressure controller)
- ECSMC (ECS miscellaneous card)
- WES (warning electronic system).

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WING ANTI-ICE - INTRODUCTION

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**WING ANTI-ICE - WING COMPONENT LOCATIONS****Component Locations**

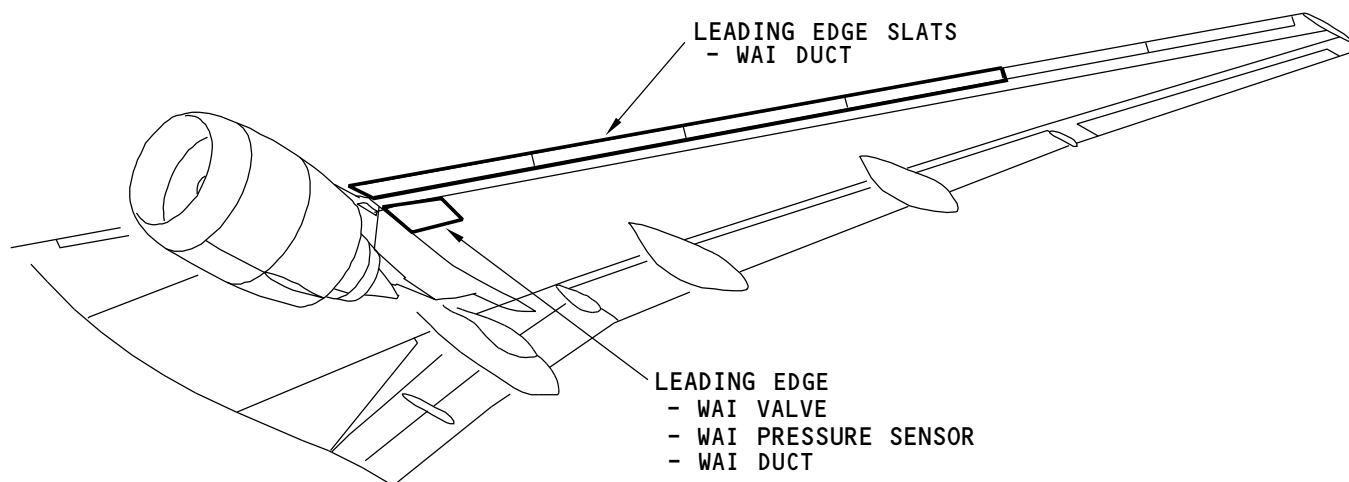
These components are in the wing leading edge next to the outboard side of the engine strut:

- WAI valve
- WAI pressure sensor
- WAI ducts.

There are also WAI ducts in the leading edge slats.

All of these components are LRUs.

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WING ANTI-ICE - WING COMPONENT LOCATIONS

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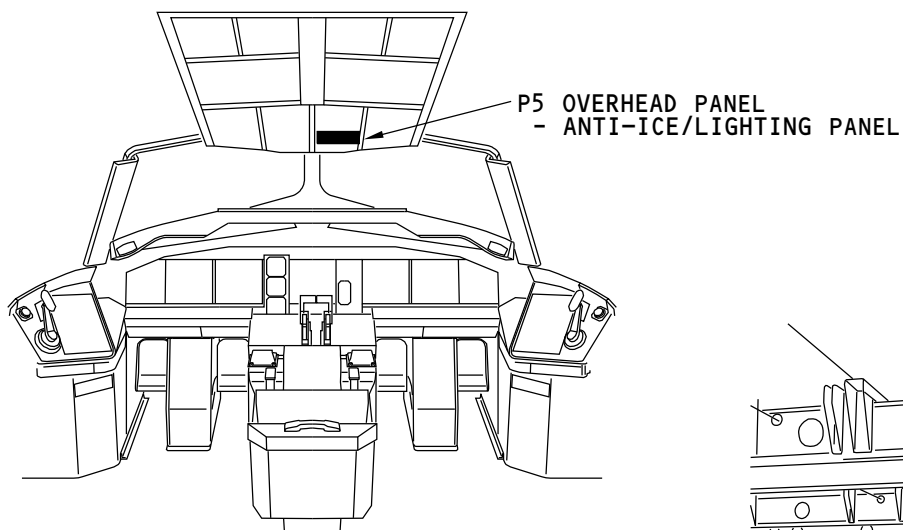


WING ANTI-ICE - FLIGHT DECK AND MEC COMPONENT LOCATIONS

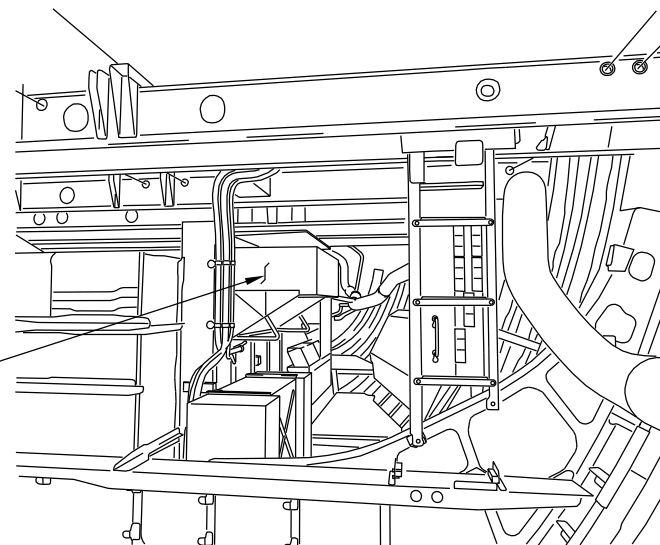
Component Locations

The anti-ice control panel is on the P5 overhead panel. The WAI airfoil and cowl ice protection system control card (WAI ACIPS control card) is in the P84 right systems card file.

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P84 RIGHT SYSTEMS CARDFILE
- WAI ACIPS CONTROL CARD



MAIN EQUIPMENT CENTER
(RIGHT SIDE LOOKING FORWARD)

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WING ANTI-ICE - FLIGHT DECK AND MEC COMPONENT LOCATIONS

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WING ANTI-ICE - WAI VALVE**Purpose**

The WAI valve controls the flow of bleed air from the pneumatic system to the wing anti-ice ducts.

Physical Description

The WAI valve has these parts:

- Body
- Pneumatic actuator
- Torque motor
- Electrical connector
- Locking crank and position indicator
- Locking screw.

The valve is electrically controlled and pneumatically actuated.

Location

The WAI valve is in the WAI duct in the leading edge of the wing. The WAI valve access door is on the bottom of the wing leading edge, outboard of the engine strut.

Functional Description

The WAI ACIPS control card controls the current through the torque motor. The torque motor controls operation of the valve. With no electrical power to the torque motor, air pressure on one side of the actuator holds the valve closed. Electrical current through the torque motor allows air pressure to open the valve. As the torque motor current increases, the valve opening increases.

Training Information Point

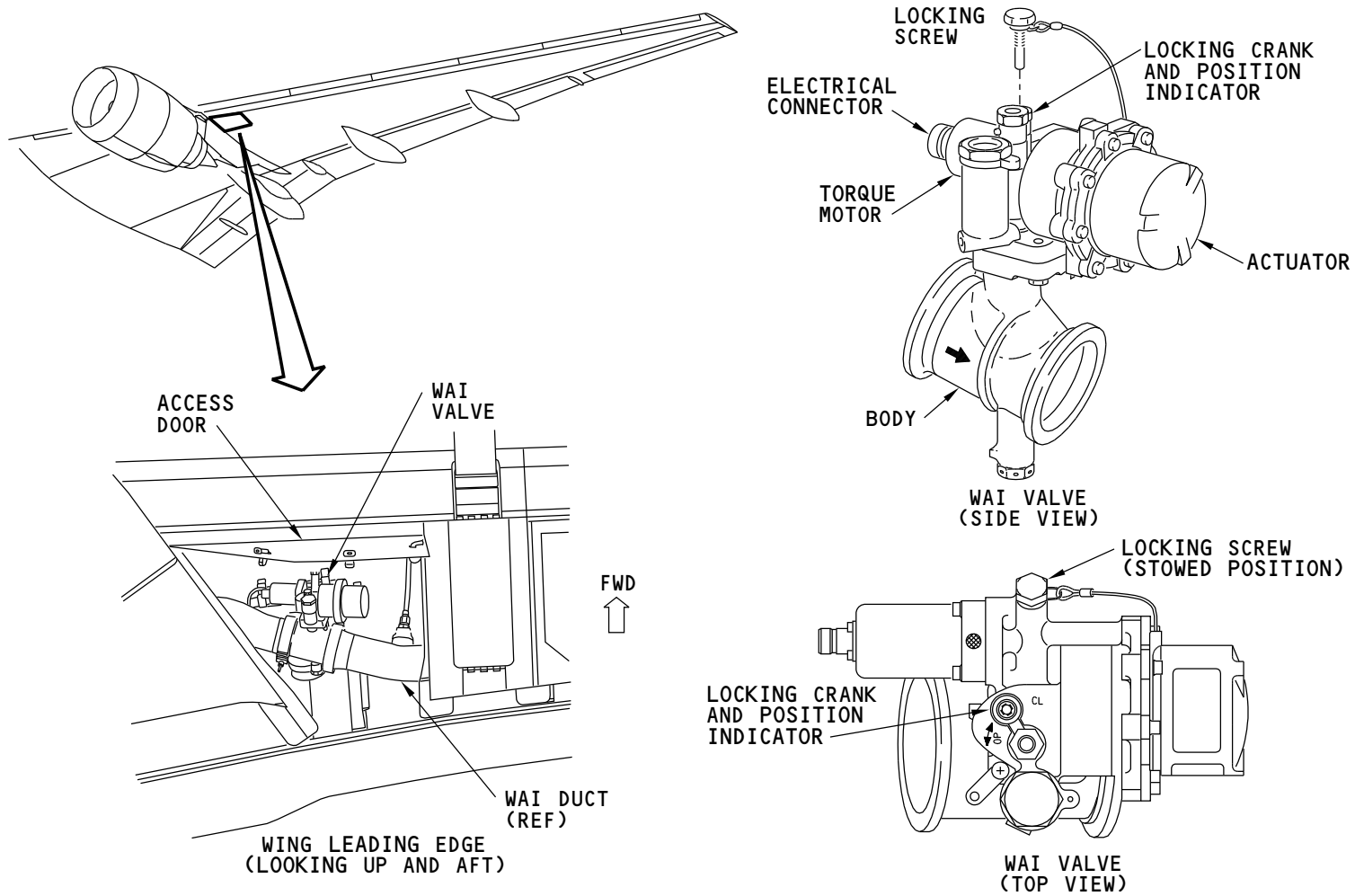
If a WAI valve does not operate, you can lock the valve closed. Remove the locking screw from the actuator. Set the locking crank to the closed position and install the locking screw into the hole in the locking crank.

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WING ANTI-ICE - WAI VALVE

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**WING ANTI-ICE - WAI PRESSURE SENSOR****Purpose**

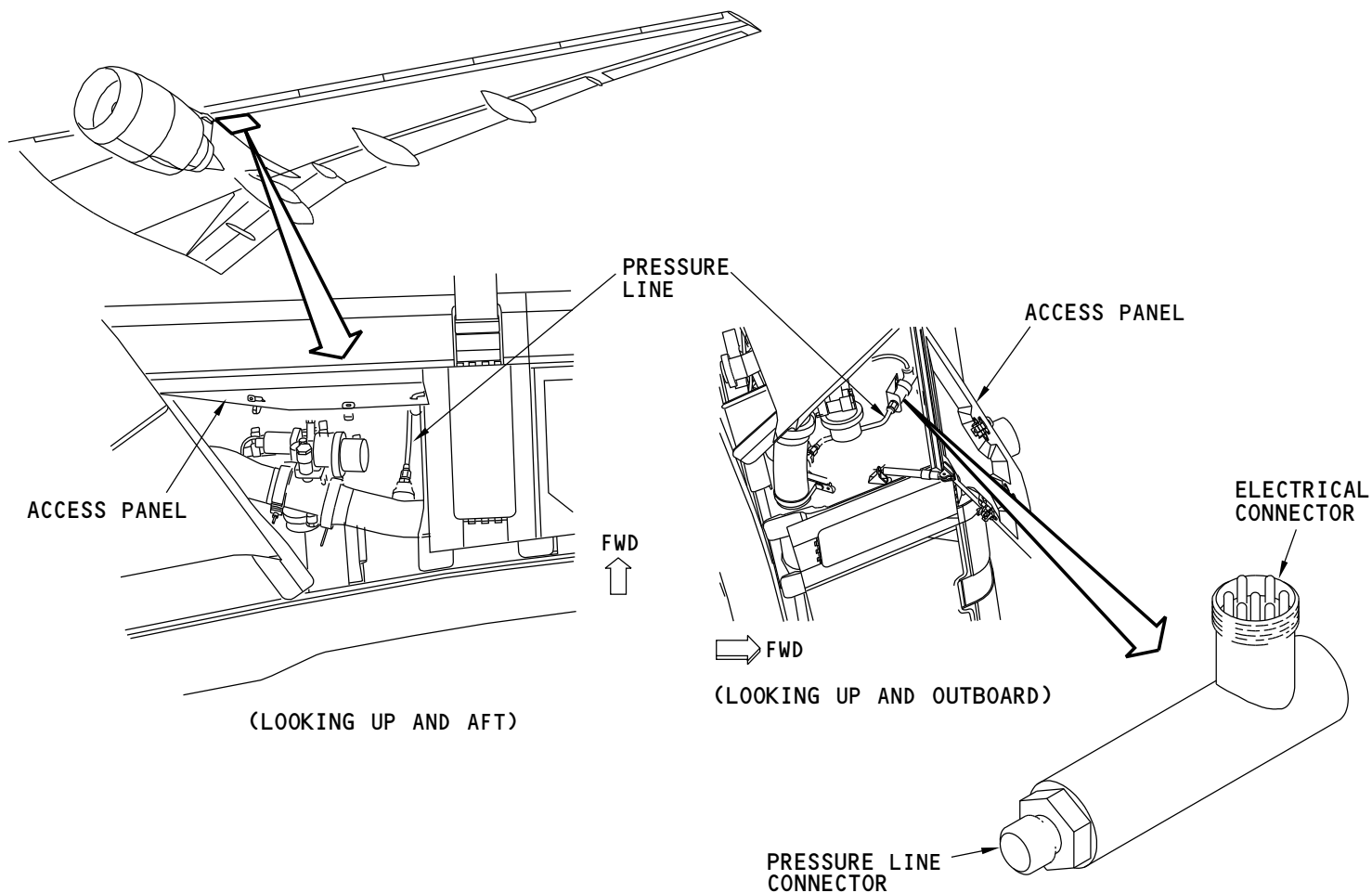
The WAI pressure sensor gets input from the air pressure in the WAI duct after the WAI valve. The center ACIPS card uses the pressure information to control the WAI system.

Physical Description

The WAI pressure sensor has a pressure line connector on one end and an electrical connector on the other end.

Location

The sensor is installed above the WAI duct in the leading edge of the wing. The access panel for the sensor is on the bottom surface of the wing leading edge next to the outboard side of the engine strut.



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WING ANTI-ICE - WAI PRESSURE SENSOR

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WING ANTI-ICE - WAI DUCTS

Purpose

The WAI ducts move air from the pneumatic system to leading edge slats which are outboard of the engines.

Physical Description

Some of the WAI ducts are perforated. The holes allow air to flow into the space in the leading edge slats. The air leaves the slats through holes in the bottom of each slat.

Some of the WAI ducts can telescope. Each telescoping duct has two sections. One section is to a duct in the wing. The other section attaches to a duct in the leading edge slat. The sections can move into each other. This permits the duct to extend or retract when the slat extends or retracts.

Locations

The perforated ducts are inside these slats:

- 3, 4, and 5 on the left wing
- 10, 11, and 12 on the right wing.

The ducts that can telescope are in the wings and in these slats:

- 6 on the left wing
- 9 on the right wing.

Access

There are duct joints between adjacent slats. The inboard and outboard end of each slat has an access panel for the duct joints between adjacent slats.

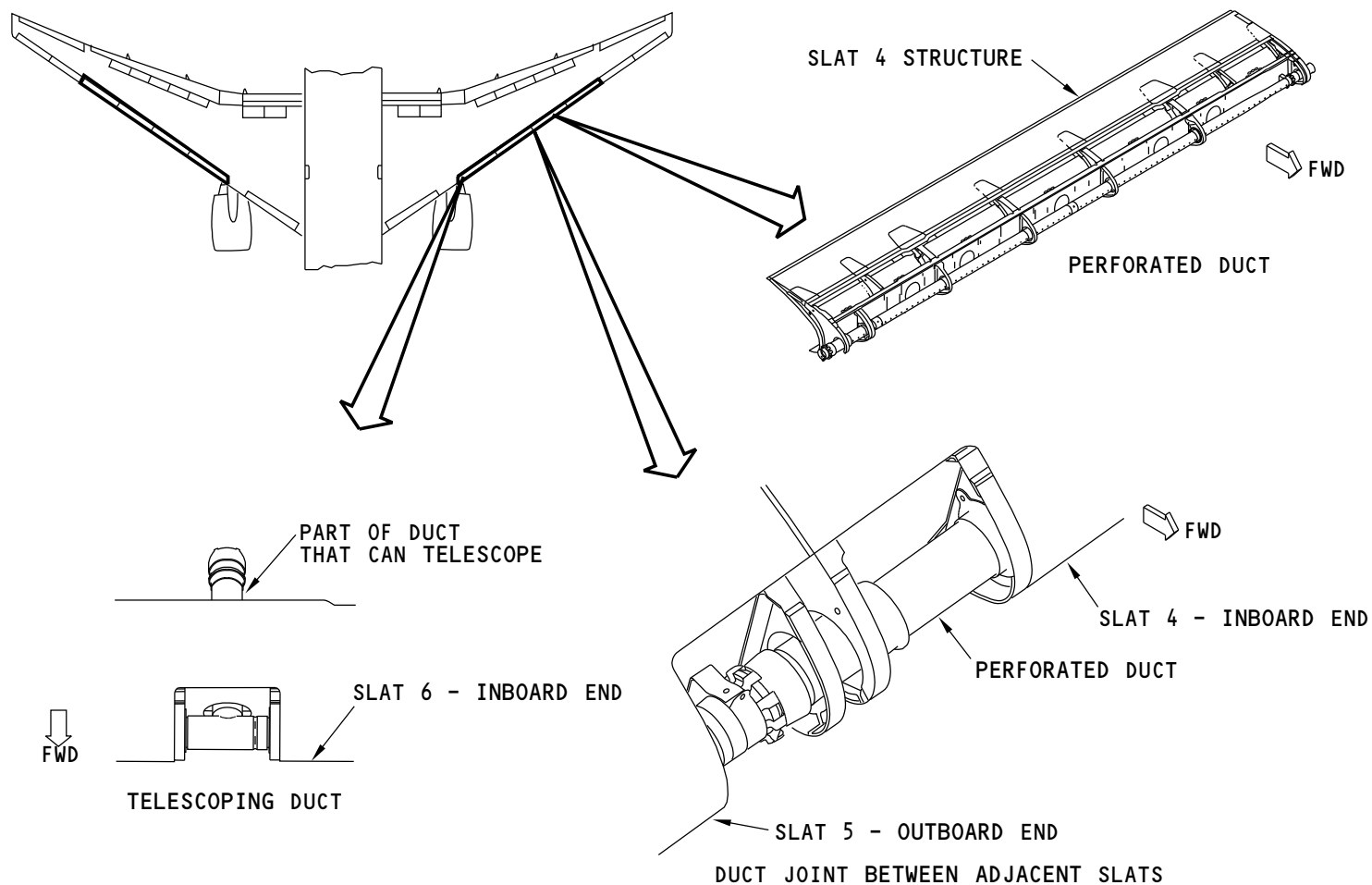
There is an access panel in the slat for the telescoping duct.

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WING ANTI-ICE - WAI DUCTS

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WING ANTI-ICE - FUNCTIONAL DESCRIPTION - ELECTRICAL

General

The WAI ACIPS control card controls both wing anti-ice valves. The required positions of the WAI valves change as bleed air temperature and altitude change. The left and right valves operate at the same time to heat both wings equally. This keeps the airplane aerodynamically stable in icing conditions.

The WAI pressure sensors supply feedback information to the WAI ACIPS card for WAI valve control and position indication. If either pressure sensor fails, the WAI ACIPS card sets the related WAI valve to either fully open or fully closed. If either valve fails closed, the WAI card keeps the other valve closed.

The WAI ACIPS control card receives ice detector data from the systems ARINC 629 buses. The data comes from the left and right ice detectors through the EAI ACIPS control cards.

There is one selector for the WAI system. The selector has three positions: AUTO, ON, and OFF.

Operational Modes

With the selector in AUTO and no operational mode inhibits, the WAI ACIPS card sends a signal to open the WAI valves when either ice detector finds ice. The valves close after a three minute delay when the ice detector no longer finds ice. The time delay prevents frequent on/off cycles during intermittent icing conditions.

See the ice detection system for more information about the ice detectors (SECTION 30-81).

With the selector ON and no operational mode inhibits, the wing anti-ice valves open. With the selector OFF, the wing anti-ice valves close.

Operational Mode Inhibits

The operational mode for the WAI valves, can be inhibited by many different sets of conditions.

The operational mode is inhibited if all of the these conditions occur:

- AUTO mode is selected
- Takeoff mode
- Airplane in the air less than 10 minutes.

With AUTO or ON selected, the operational mode is inhibited if any of these conditions occur:

- Airplane on the ground (except during an initiated or periodic BITE test)
- TAT is more than 50F (10C) and the time since takeoff is less than 5 minutes
- Auto slat operation
- Air-driven hydraulic pump operation
- Engine start
- Bleed air temperature less than 200F (93C).

The WAI valves stay closed as long as the operational mode inhibit is active. If the valves are already open, the operational mode inhibit causes the valves to close.

ARINC 629 Interfaces

The OPAS sends WAI selector position and engine start selector position to the WAI ACIPS control card.

The EAI ACIPS control cards send ice detector data to the WAI system. With AUTO selected, the ice detection system controls operation of the wing anti-ice system.

The weight on wheels cards (WOW) send air/ground status to the WAI system. Wing anti-ice does not operate on the ground.

The air data inertial reference unit (ADIRU) sends mach number, static pressure, and total air temperature data to the WAI system. Mach number is an alternative to air/ground status if air/ground data is missing or not valid. The WAI BITE compares static pressure with WAI duct air pressure to make sure the WAI duct pressure sensors work correctly.

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WING ANTI-ICE - FUNCTIONAL DESCRIPTION - ELECTRICAL

The warning electronic system (WES) sends auto slat operation data to the WAI system. The WAI valves close for a short time during auto slat operation. This makes more bleed air available to the air-driven hydraulic pumps.

The air supply and cabin pressure controller (ASCPC) sends a WAI shutoff signal to the WAI ACIPS control card if the air-driven hydraulic pumps are on or intermittent. Wing anti-ice does not operate during ADP operation.

The ASCPC sends pneumatic manifold temperature and pressure data to the WAI ACIPS control card. The control card uses this data to calculate the WAI air flow rate and valve position. The flow rate and valve position show on the ice protection maintenance page. Also, bleed air temperature less than 200F (93C) prevents wing anti-ice operation.

The ASCPC receives anti-ice air flow data from the WAI ACIPS control card. The ASCPC needs this data to calculate the bleed flow rate in the pneumatic system. The engine bleed air system flow limit function uses this flow rate. The flow rate shows on the air supply maintenance page. The ASCPC also needs anti-ice air flow data to set the air conditioning pack flow schedule.

The ECS miscellaneous cards (ECSCMC) receive WAI valve position data from the WAI ACIPS control card. The ECSCMCs need this data to control the aft and bulk cargo heating systems.

The AIMS primary display function gives EICAS messages, status messages, air synoptic information and maintenance page information related to the WAI system. The central maintenance computing function helps you isolate faults and lets you do ground tests.

The flight management computing system (FMCS) gives takeoff mode information to the WAI ACIPS card. In takeoff mode, WAI does not operate for 10 minutes after the ground to air transition if the system is set to AUTO.

BITE

BIT circuits in the WAI ACIPS control card continuously monitor the wing anti-ice system. Faults that affect dispatch cause status messages. Other faults cause CMCS maintenance messages.

The BITE in the WAI ACIPS control card also does automatic power-up and periodic tests. Faults found during these tests that affect dispatch cause status messages. Other faults cause CMCS maintenance messages.

The power-up test occurs when the card gets power. BITE does a test of the card hardware and software functions and the valve and pressure sensor interfaces. The valves do not move during this test.

The periodic test occurs when all these conditions are true:

- The airplane has been on the ground between 1 and 5 minutes
- The WAI selector is set to AUTO or ON
- Air-driven hydraulic pumps are not in intermittent operation
- Bleed pressure is sufficient to open the WAI valves
- The time since the last periodic test is more than 24 hours.

During this test, the WAI valves cycle open and closed. This test makes sure that valve malfunctions are detected.

Training Information Point

You do wing anti-ice system ground tests with the MAT. Two tests are available: one with bleed air and one without bleed air.

You use the MAT data load function to replace the WAI ACIPS control card software.

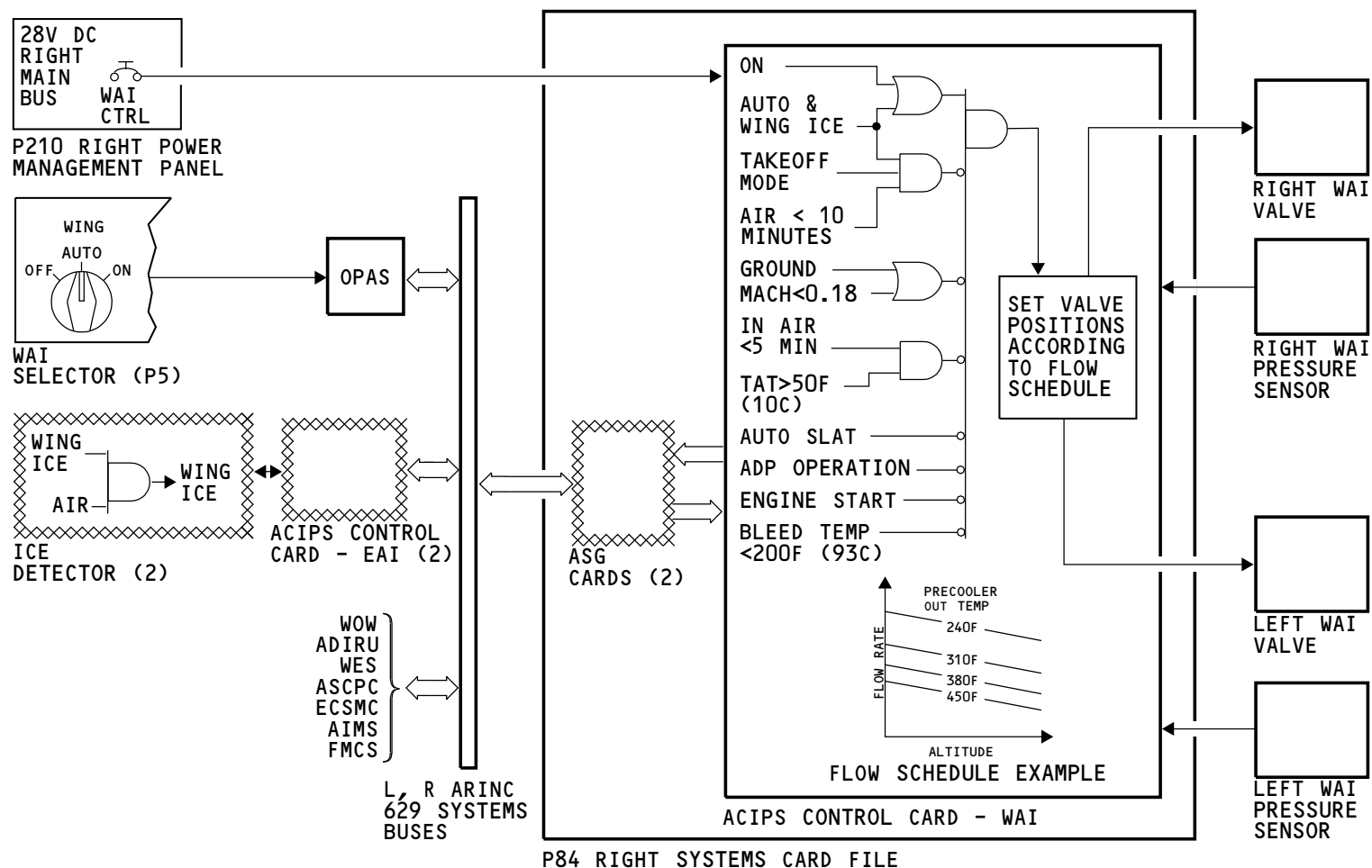
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WING ANTI-ICE - FUNCTIONAL DESCRIPTION - ELECTRICAL

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WING ANTI-ICE - OPERATION

General

The wing anti-ice selector lets the flight crew select the operational mode of the system. Indications on the EICAS display and on the air synoptic display show when the WAI valves are open.

- Valve position data not available - white circle.

Operation

The selector is on the anti-ice/lighting panel (P5). With the selector set to OFF, the WAI system does not operate. The WAI valves stay closed. The EICAS advisory message ICING WING shows if the airplane is in the air and the ice detection system finds ice. The OFF selection prevents the WAI BITE periodic ground test.

For normal operation, the crew keeps the selector in AUTO. The wing anti-ice system operates automatically. The ice detection system controls wing anti-ice system operation as long as operational mode inhibits are not active. The AUTO position enables the BITE periodic ground test.

For manual operation, the crew sets the selector to ON when wing anti-ice is needed. The WAI valves stay open as long as no operational mode inhibits are active. The EICAS advisory message ANTI-ICE ON shows if all of these conditions occur:

- Airplane is in the air
- WAI selector is set to on
- No ice is detected
- TAT is more than 50F (10C).

See the ice detection system for more information about the ice detectors (SECTION 30-81).

Air Synoptic Display

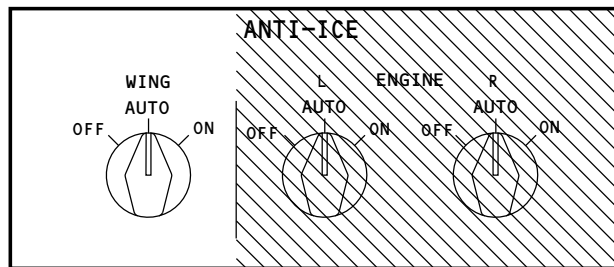
The valve symbols show these conditions:

- Valve open - white circle with a horizontal green flow bar
- Valve closed - white circle with two vertical white bars
- Valve not in commanded position - amber circle with an amber cross through it

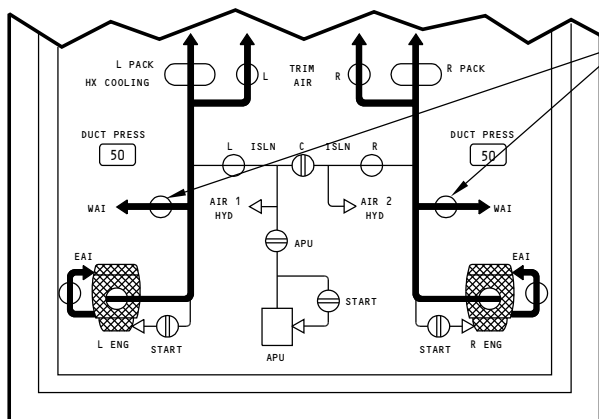
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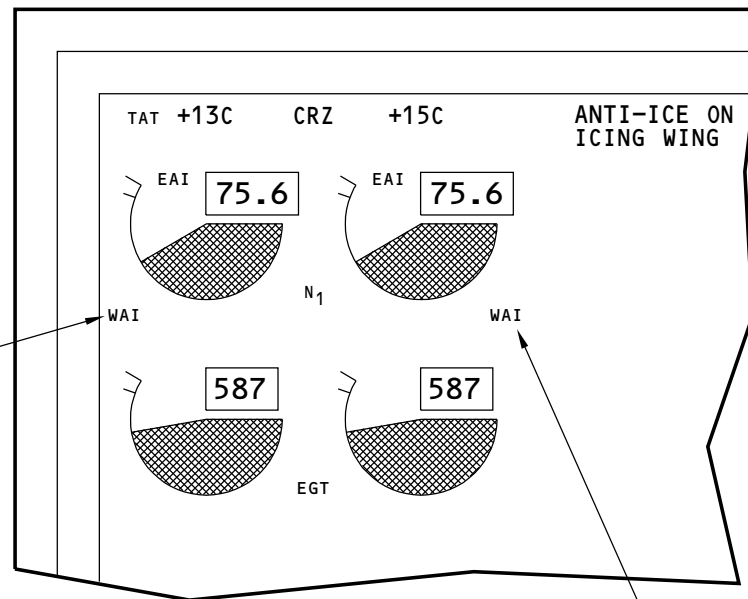
ANTI-ICE/LIGHTING (P5)



AIR SYNOPTIC DISPLAY

LEFT WAI
INDICATION
(GREEN)

WAI
VALVES



EICAS DISPLAY

RIGHT WAI
INDICATION
(GREEN)

WING ANTI-ICE - OPERATION

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WING ANTI-ICE - SYSTEM TESTS**General**

These are the wing anti-ice system tests that show when you select ATA 30 Airfoil Cowl Ice Protection System:

- Wing anti-ice (pneumatics available)
- Wing anti-ice (pneumatics not available).

Wing Anti-Ice (Pneumatics Available)

This test makes sure that the wing anti-ice system can control the bleed airflow to each wing.

During the test, hot air flows out of the leading edge on each wing. The test takes approximately 1-2 minutes.



DO NOT OPERATE THE WAI SYSTEM UNTIL ALL PERSONS ARE CLEAR OF THE WING LEADING EDGE. THE HOT AIR CAN BURN YOU.

Wing Anti-Ice (Pneumatics Not Available)

This test makes sure that the electrical interface connections of the wing anti-ice system are correct.

The test takes approximately 1-2 minutes.

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GROUND TESTS

SELECT ATA SYSTEM (48)

- 50 AIRFOIL COWL ICE PROTECTION SYSTEM**
- 50 AIR DATA SENSOR ANTI-ICE SYSTEM
- 50 WINDOW HEAT CONTROL SYSTEM
- 31 AIMS - FLIGHT DATA RECORDER SYSTEM
- 31 PRINTER
- 31 AIMS - AIRPLANE CONDITION MONITORING SYSTEM
- 31 AIMS - LEFT AIMS
- 31 AIMS - RIGHT AIMS
- 31 WARNING ELECTRONICS SYSTEM

SELECT TEST TYPE

- ☒ SYSTEM TEST
- ☐ OPERATIONAL TEST
- ☐ REPLACEMENT TEST

SELECT SYSTEM TEST (6)

- LEFT ENGINE ANTI-ICE (ENGINE RUNNING)
- LEFT ENGINE ANTI-ICE (ENGINE NOT RUNNING)
- RIGHT ENGINE ANTI-ICE (ENGINE RUNNING)
- RIGHT ENGINE ANTI-ICE (ENGINE NOT RUNNING)
- WING ANTI-ICE (PNEUMATICS AVAILABLE)
- WING ANTI-ICE (PNEUMATICS NOT AVAILABLE)

CONTINUE

HELP

GO BACK

SELECT SYSTEM TEST

(6)

LEFT ENGINE ANTI-ICE (ENGINE RUNNING)
LEFT ENGINE ANTI-ICE (ENGINE NOT RUNNING)
RIGHT ENGINE ANTI-ICE (ENGINE RUNNING)
RIGHT ENGINE ANTI-ICE (ENGINE NOT RUNNING)
WING ANTI-ICE (PNEUMATICS AVAILABLE)
WING ANTI-ICE (PNEUMATICS NOT AVAILABLE)

1 THESE ARE THE WING ANTI-ICE TESTS.

WING ANTI-ICE - SYSTEM TESTS

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ENGINE ANTI-ICE - INTRODUCTION

Purpose

The engine anti-ice (EAI) system heats the leading edge of the engine cowl so that ice does not collect on them.

General

The EAI systems for the left and right engines are identical. A high stage bleed port (HP7) on the engine supplies bleed air to heat the cowl leading edge. This is a different stage than the high stage port for the pneumatic system. An engine anti-ice valve controls the air flow from the bleed port to the EAI duct. The EAI duct moves the air to the cowl leading edge. Overboard vents in the cowl let the air out.

The EAI valve is pneumatically actuated. Control pressure for the valve comes from an EAI controller.

ACIPS Control Cards - EAI

Two airfoil and cowl ice protection system (ACIPS) control cards - EAI control the systems. The left card controls the left engine system and the right card controls the right engine system. The cards send electric signals to the EAI controllers to control the valves. EAI pressure sensors give control feedback.

Fan Case Overheat

A fan case overheat detector monitors the EAI duct for leaks. The detector is part of the duct leak and overheat detection system (DLODS). The DLODS sends a signal to the EAI ACIPS control card. The card sends a signal to close the EAI valve. See the duct leak and overheat detection system section for more information (SECTION 26-18).

Flight Deck Controls

The engine anti-ice selectors in the flight deck let the crew set automatic or manual control for each engine. With AUTO selected, the EAI system comes on when the ice detection system finds ice. The OFF and ON positions are for manual control.

See the ice detection system section for more information (SECTION 30-81).

BITE

BITE circuits in the control cards monitor the condition of the systems. The AIMS gives information about the systems through the EICAS display, status display, and maintenance page.

Interfaces

The engine anti-ice system has these other interfaces:

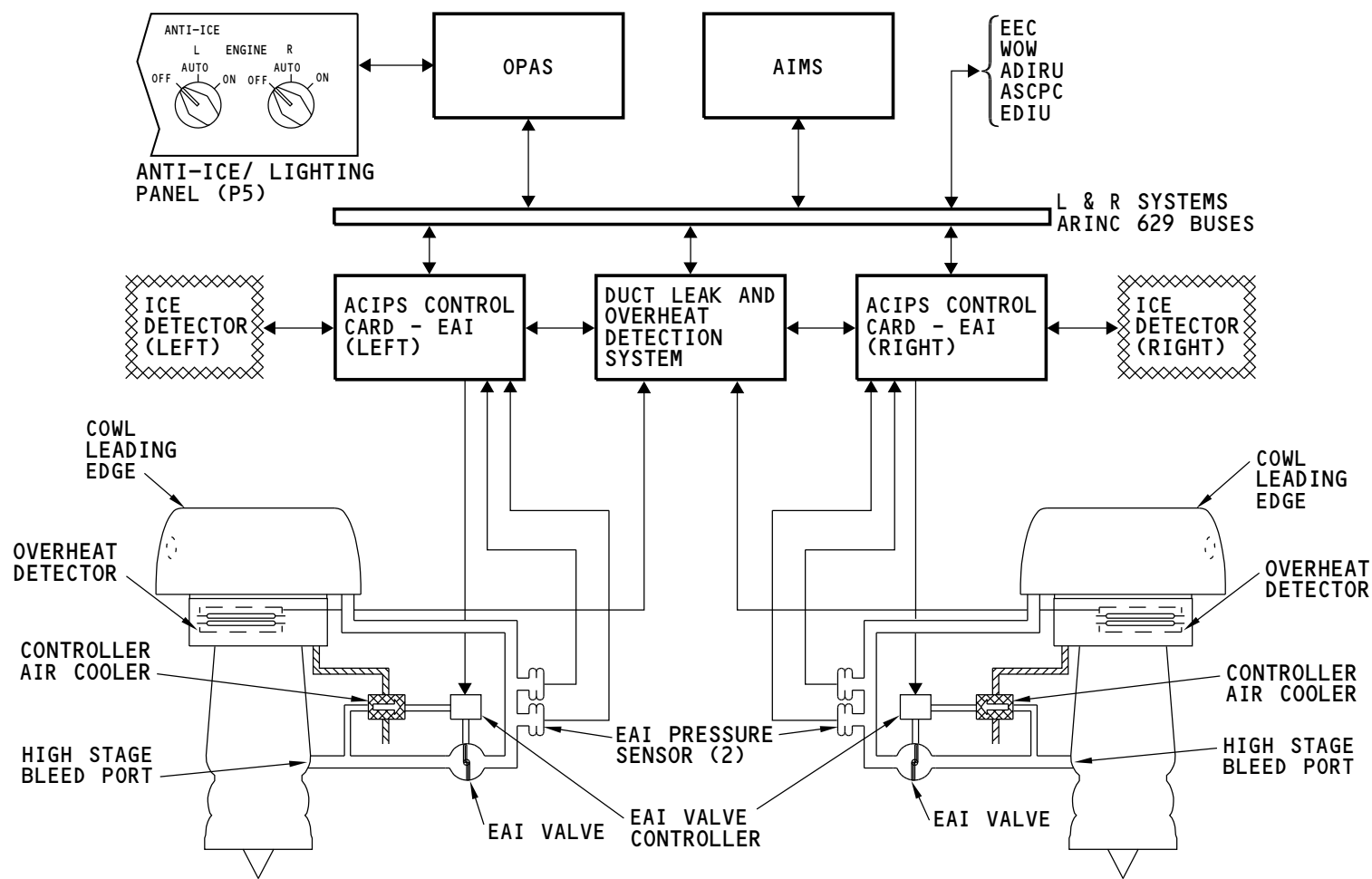
- EEC (electronic engine control)
- WOW (weight on wheels cards)
- ADIRU (air data inertial reference unit)
- ASCPC (air supply cabin pressure controller)
- EDIU (engine data interface unit).

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ENGINE ANTI-ICE - INTRODUCTION

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**ENGINE ANTI-ICE - ENGINE COMPONENT LOCATIONS****Component Locations**

The engine anti-ice (EAI) components are in these locations:

- Engine fan case - upper left side
- Engine core - upper left side
- Engine fan hub - left side
- Engine inlet - left side.

These are the components on the engine core:

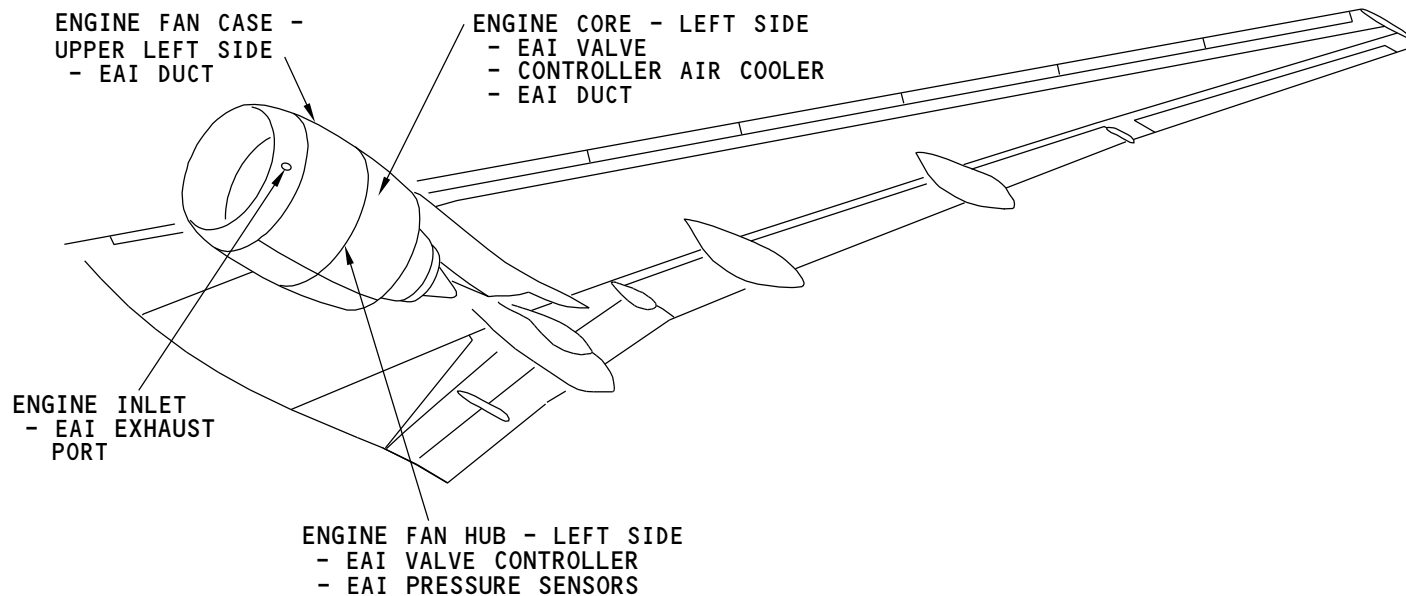
- EAI valve
- Controller air cooler
- EAI duct.

The EAI duct is in the area of the fan case on the left side the engine.

These are the components on the fan hub:

- EAI valve controller
- EAI pressure sensors.

The left side of the engine inlet has the EAI exhaust port.



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ENGINE ANTI-ICE - ENGINE COMPONENT LOCATIONS

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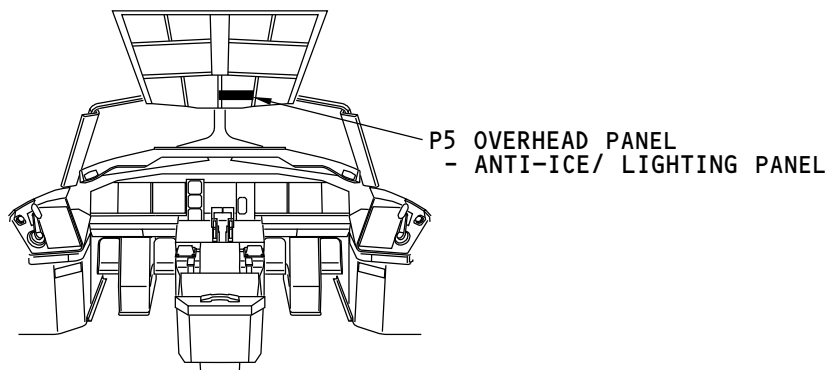
ENGINE ANTI-ICE - FLIGHT DECK AND MEC COMPONENT LOCATIONS

Component Locations

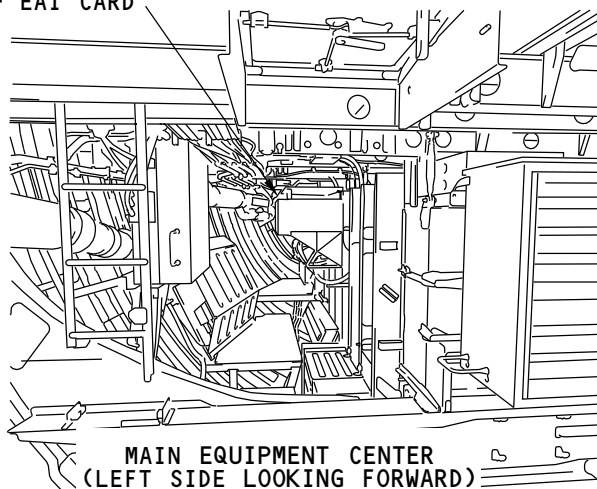
Controls for the EAI system are on the anti-ice/lighting panel (P5).

The ACIPS - EAI cards (left and right) are in the left and right systems card files.

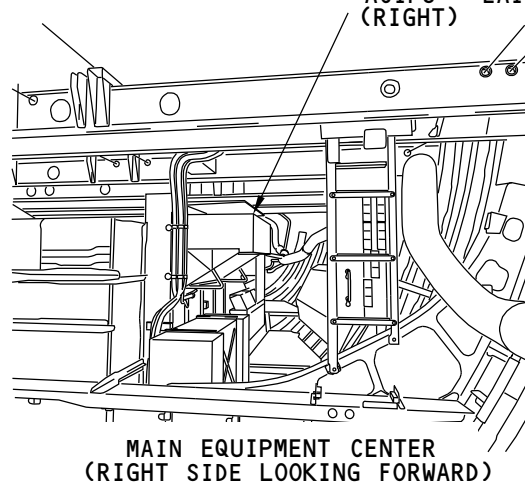
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P85 LEFT SYSTEMS CARD FILE
- ACIPS - EAI CARD
(LEFT)



P84 RIGHT SYSTEMS CARD FILE
- ACIPS - EAI CARD
(RIGHT)



ENGINE ANTI-ICE - FLIGHT DECK AND MEC COMPONENT LOCATIONS

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**ENGINE ANTI-ICE - EAI VALVE****Purpose**

The EAI valve controls the flow of engine bleed air through the EAI duct to the engine cowl leading edge.

Physical Description

The EAI valve is a pneumatically-operated, piston-type valve. The valve has these parts:

- Body
- Locking screw
- Locking crank
- Control pressure line connector.

Location

The EAI valve is on the left side of the engine core at the 11:00 position. The valve is in the EAI duct aft of the fan hub.

Functional Description

The piston freely slides on the guide tube. Control pressure pushes on the inner part of the piston to open the valve and control flow. Air from the high pressure bleed air source pushes on the outer part of the piston to move it to the closed position.

The locking screw and locking crank let you manually set the EAI valve for normal operation (unlocked position) or to the locked closed position. The locking screw keeps the locking crank in its unlocked position for normal valve operation or in the valve locked closed position. When you remove the screw from its stowed position, it lets control pressure vent and the locking crank move. When you move the locking crank to CLOSED and install the locking screw, the crank holds the piston in the closed position.

Training Information Point

You use the EAI valve controller (not shown) to manually set the EAI valve open.

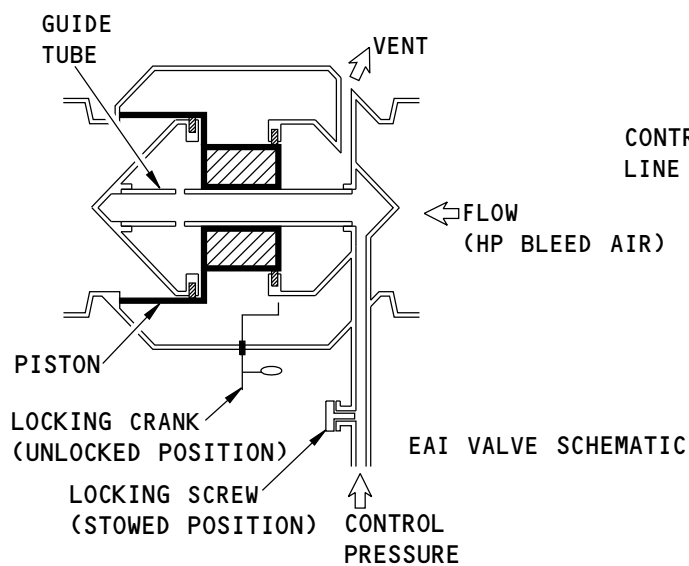
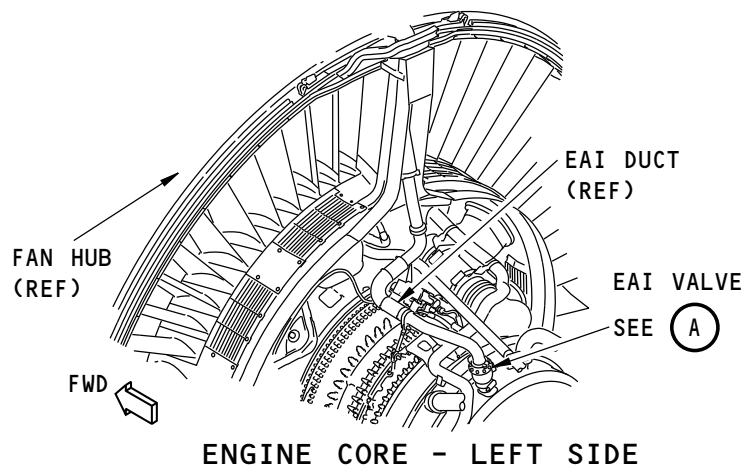
See the procedure in part II of the AMM, Preparation - Engine Anti-ice Systems Inoperative, for more information on deactivation of the engine anti-ice valve open.

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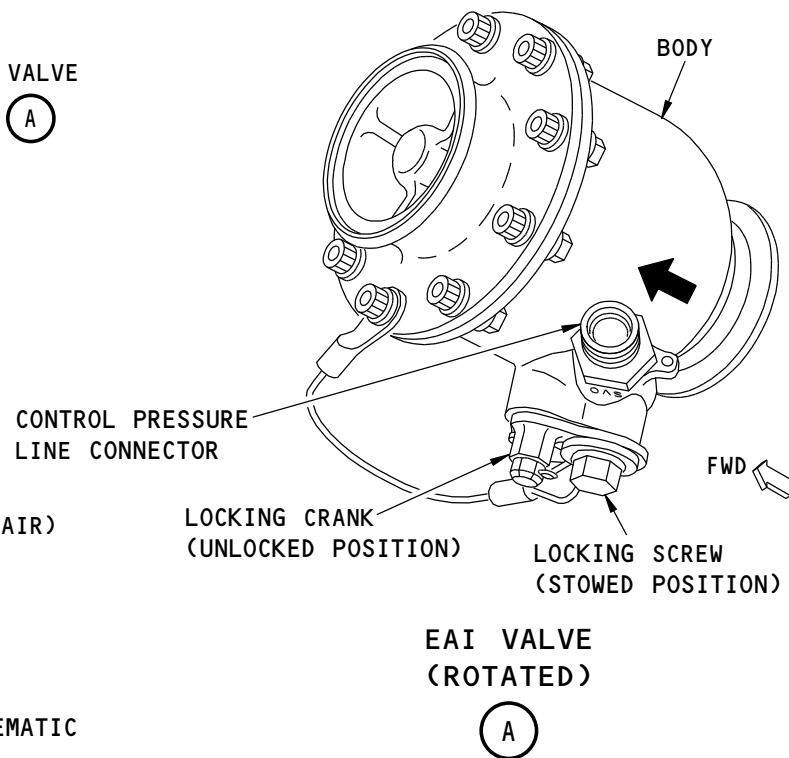
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ENGINE ANTI-ICE - EAI VALVE



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**ENGINE ANTI-ICE - EAI VALVE CONTROLLER****Purpose**

The EAI valve controller supplies control pressure to the EAI valve.

Physical Description

The EAI valve controller is an electropneumatic controller. The controller has these parts:

- Two pressure line connectors
- Body
- Torque motor
- Electrical connector.

Location

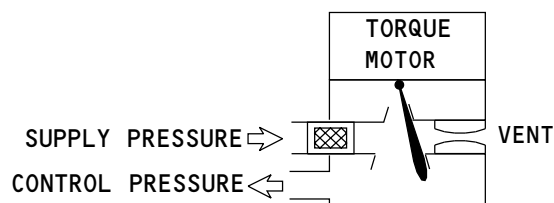
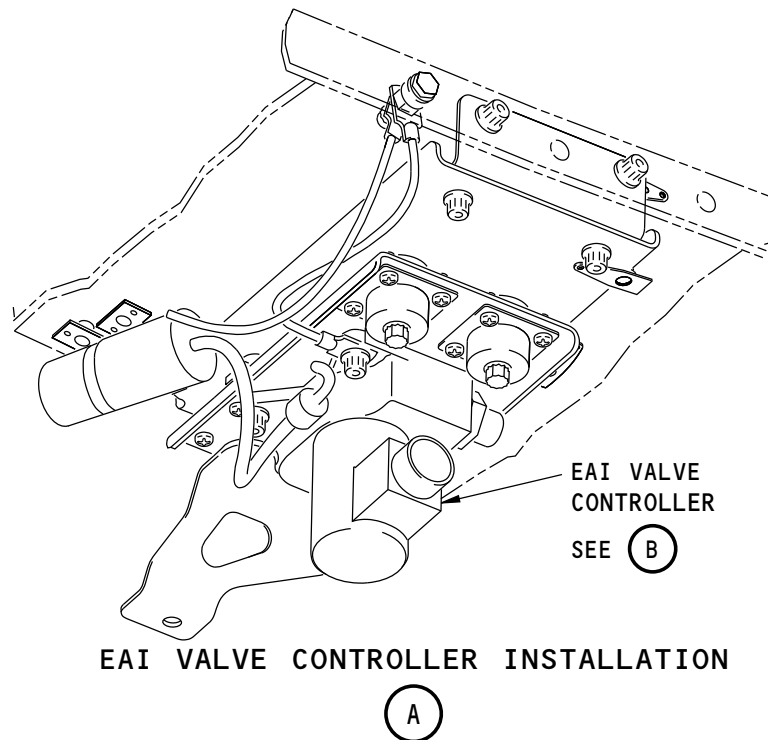
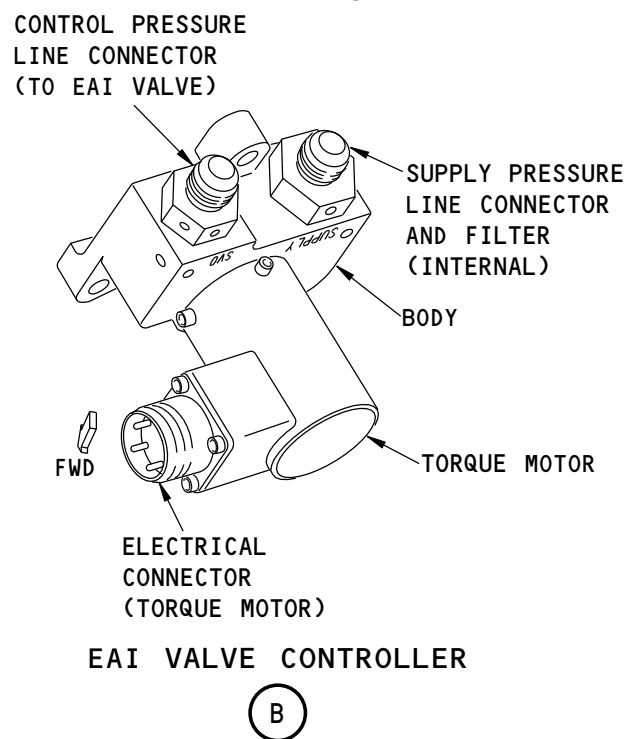
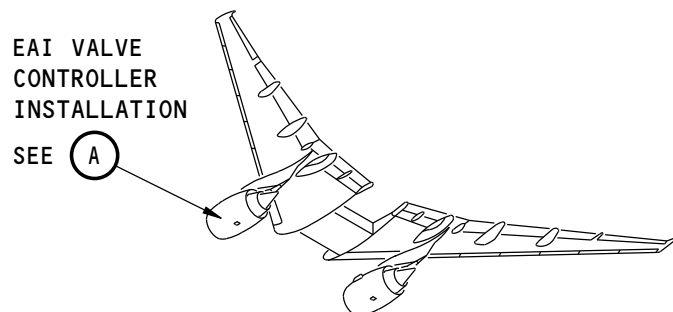
The controller is on engine fan case at the 7:00 position under the left hand fan cowl (aft of the engine looking forward).

Functional Description

The EAI controller uses the torque motor to regulate control pressure to the EAI valve. The controller gives control pressure to the valve if the torque motor has no power (fail safe on).

Training Information Point

You remove, cap, and stow the torque motor electrical connector when you want to manually set the EAI valve open.



EAI VALVE CONTROLLER SCHEMATIC
(SHOWN WITH NO POWER)

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ENGINE ANTI-ICE - EAI VALVE CONTROLLER

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**ENGINE ANTI-ICE - EAI PRESSURE SENSOR****General**

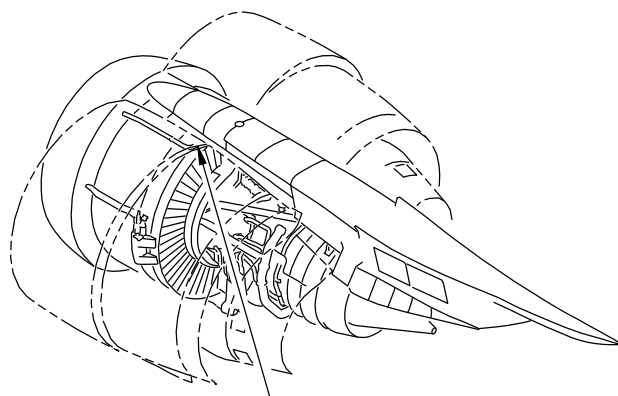
Each engine has two EAI pressure sensors. The sensors are the same. They both measure the pressure in the EAI duct downstream of the EAI valve. The left and right ACIPS - EAI control cards use the information from the pressure sensors to control the EAI system.

The pressure sensors are redundant. If one sensor fails, the system operates the same.

Each pressure sensor has a pressure line connector, a housing and an electrical connector.

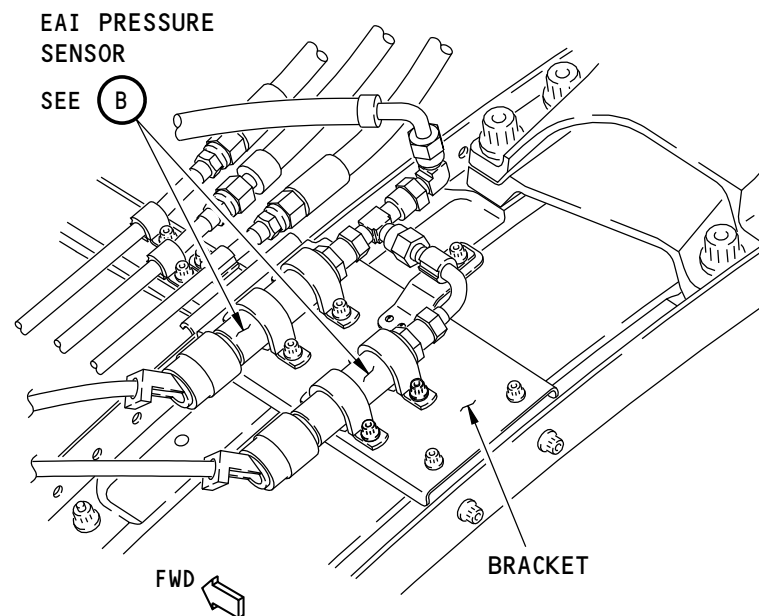
Location

The sensors are on the left side of the fan hub at the 11:00 position. The sensors attach to the same mount plate as the EAI valve controller.



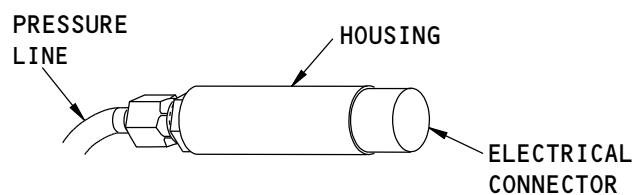
EAI PRESSURE
SENSOR
INSTALLATION

SEE (A)



EAI PRESSURE SENSOR INSTALLATION

(A)



EAI PRESSURE SENSOR
(TYPICAL)

(B)

ENGINE ANTI-ICE - EAI PRESSURE SENSOR

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**ENGINE ANTI-ICE - EAI DUCT****General**

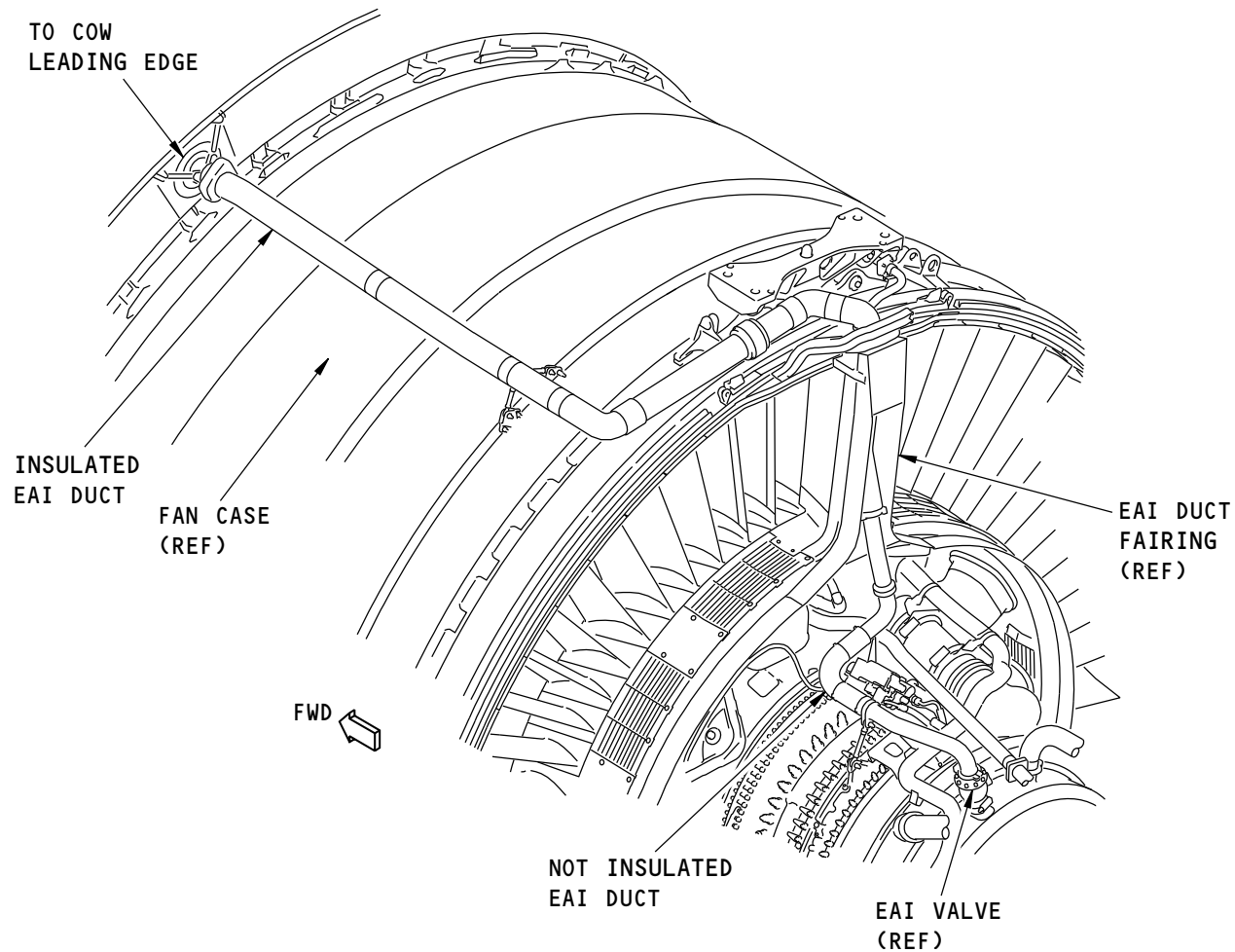
The EAI ducts move air from the engine high stage bleed port to the cowl leading edge.

There are two EAI ducts. One is not insulated and the other is insulated.

Locations

The not insulated EAI duct is on the left sides of the engine core forward of the EAI valve. The insulated EAI duct is in the EAI duct fairing and on the left side of the fan case.

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ENGINE - LEFT SIDE
ENGINE ANTI-ICE - EAI DUCT

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**ENGINE ANTI-ICE - CONTROLLER AIR COOLER****General**

The EAI controller air cooler decreases the temperature of the engine bleed air that goes to the EAI valve controller.

See the engine air supply section for more information about the engine air supply system CAC (SECTION 36-11).

Physical Description

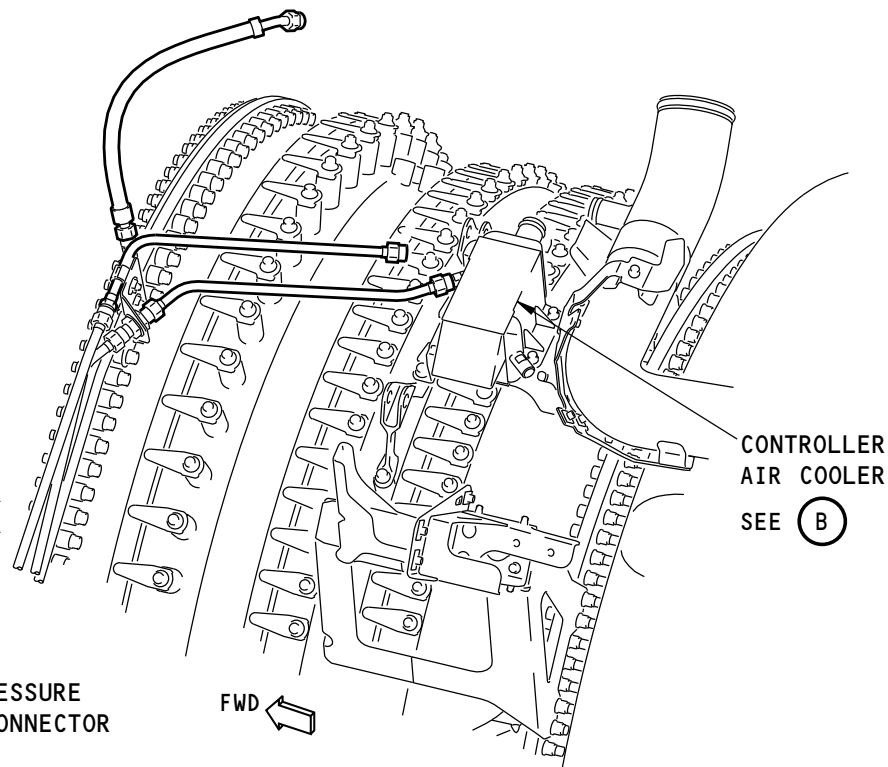
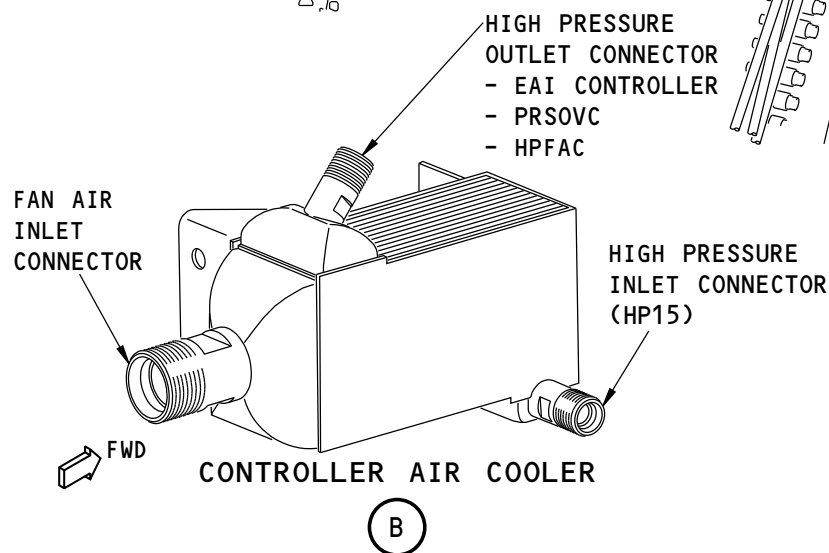
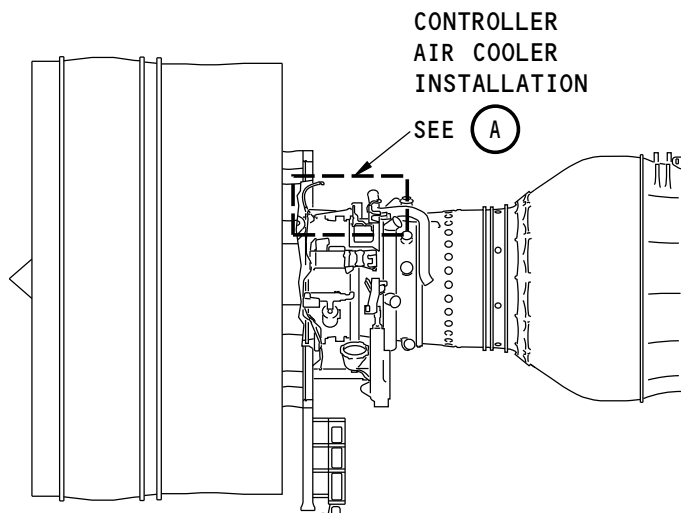
The controller air cooler is an air-to-air heat exchanger. It has three pneumatic line connectors, two high pressure and one low pressure (fan air).

Location

The controller air cooler is on the left side of the engine core at the 11:00 position. The cooler is below and forward of the engine anti-ice valve.

Functional Description

Hot air from the high stage compressor section and cool fan air flows through the controller air cooler. The cool air removes heat from the hot air. This decreases the temperature of the hot air.



CONTROLLER AIR COOLER INSTALLATION

(A)

ENGINE ANTI-ICE - CONTROLLER AIR COOLER

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ENGINE ANTI-ICE - FUNCTIONAL DESCRIPTION

General

The EAI system has two EAI selectors, one for each engine. Each selector lets you operate the EAI system for each engine independently. The selectors provide an OFF, AUTO, or ON input to their related ACIPS control card.

The left ACIPS control card controls the left EAI system. The right ACIPS control card controls the right EAI system. The ice detectors supply analog inputs to the EAI ACIPS control cards. The left detector connects to the left card. The right detector connects to the right card. Each card gives its ice detector data to the other card through the systems ARINC 629 buses.

See the ice detection system section for more information about the ice detectors (SECTION 30-81).

Operation

The EAI system operates for these conditions:

- Flight deck EAI selector is set to ON
- No engine start of related engine
- No fan case overheat.

or

- Flight deck EAI selector is set to AUTO
- Ice sensed by the ice detector(s)
- No engine start of the related engine
- No fan case overheat.

If the EAI selector position shows invalid on the 629 data bus, the ACIPS control card sets operation to AUTO.

The EAI system is off when the flight deck EAI selector is set to OFF.

When the EAI selector is set to AUTO or ON, the ACIPS control card controls the EAI valve to one of these levels of control:

- Heat flow target.
- Mass flow rate.

- Minimum distribution pressure of 10 psig.
- Full open.

The EAI system controls to a heat flow target for these conditions:

- Operation inside of the icing envelope limits
- Operation outside of the icing envelope and below the mass flow limit.

The EAI control card calculates the heat flow target as a function of altitude, ambient temperature, flight phase and mach number.

The EAI system controls to a mass flow rate while operation is outside of the icing envelope and the mass flow is at the high limit. The EAI control card calculates the mass flow rate as a function of altitude.

The icing envelope has these limits:

- Altitude; -2500 feet to 37,500 feet
- Temperature; -40F to 50F (-40C to 10C).

The EAI system keeps a minimum pressure of 10 psig in the EAI distribution duct when in operation.

The EAI valve is set to full open when any of these conditions occur:

- Both EAI pressure sensors fail
- The torque motor circuit is open.

The EAI pressure sensors supply feedback information to the ACIPS control card for valve control and indications. There are two pressure sensors on each engine. Only one sensor is necessary on each engine for the EAI system to operate in AUTO.

The ACIPS control card closes the EAI valve if any of these conditions occur:

- Engine start
- Fan case overheat
- EAI selector set to OFF
- EAI selector set to AUTO with no ice sensed.

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ENGINE ANTI-ICE - FUNCTIONAL DESCRIPTION

If the DLODS system senses a fan case overheat condition, the EAI ACIPS control card latches the EAI valve in the closed position. You can reset the system when the overheat condition is no longer present. To do this you move the EAI selector to OFF and then to AUTO or ON.

See the duct leak and overheat detection system section for more information (SECTION 26-18).

BITE Operation

At power-up, the ACIPS control cards do built-in test (BIT) on internal hardware and software functions and interfaces.

The ACIPS control cards do a periodic BIT if all of these conditions are true:

- It is more than 20 seconds and less than five minutes after landing
- No fan case overheat is present
- Time since the last periodic test is more than 24 hours.

The ACIPS control cards do an inflight automatic BIT if all of these conditions are true:

- L/R EAI valve not commanded open during current calendar day.
- Airplane in AIR.
- No L/R fancase overheat present.
- L/R EAI switch is set to AUTO.
- No icing detected.
- L/R Engine start switch is set to NORMAL.
- Bleed pressure is sufficient to open EAI valves.
- FMF flight phase is valid and transitioning from CLIMB to CRUISE <OR> FMF flight phase is invalid and the altitude climbs through 25,000ft.

You can use the maintenance access terminal (MAT) or portable maintenance access terminal (PMAT) to do these EAI ground tests:

- Engine running
- Engine not running.

The BITE in the ACIPS control card can find short and open circuits in the system. The BITE does a check of these components:

- ACIPS control cards
- EAI valve controller
- EAI valve
- EAI pressure sensors
- Ice detector.

The BITE finds a failure if either EAI valve does not:

- Open
- Close
- Regulate.

Interfaces

The ACIPS control cards gets data from these systems:

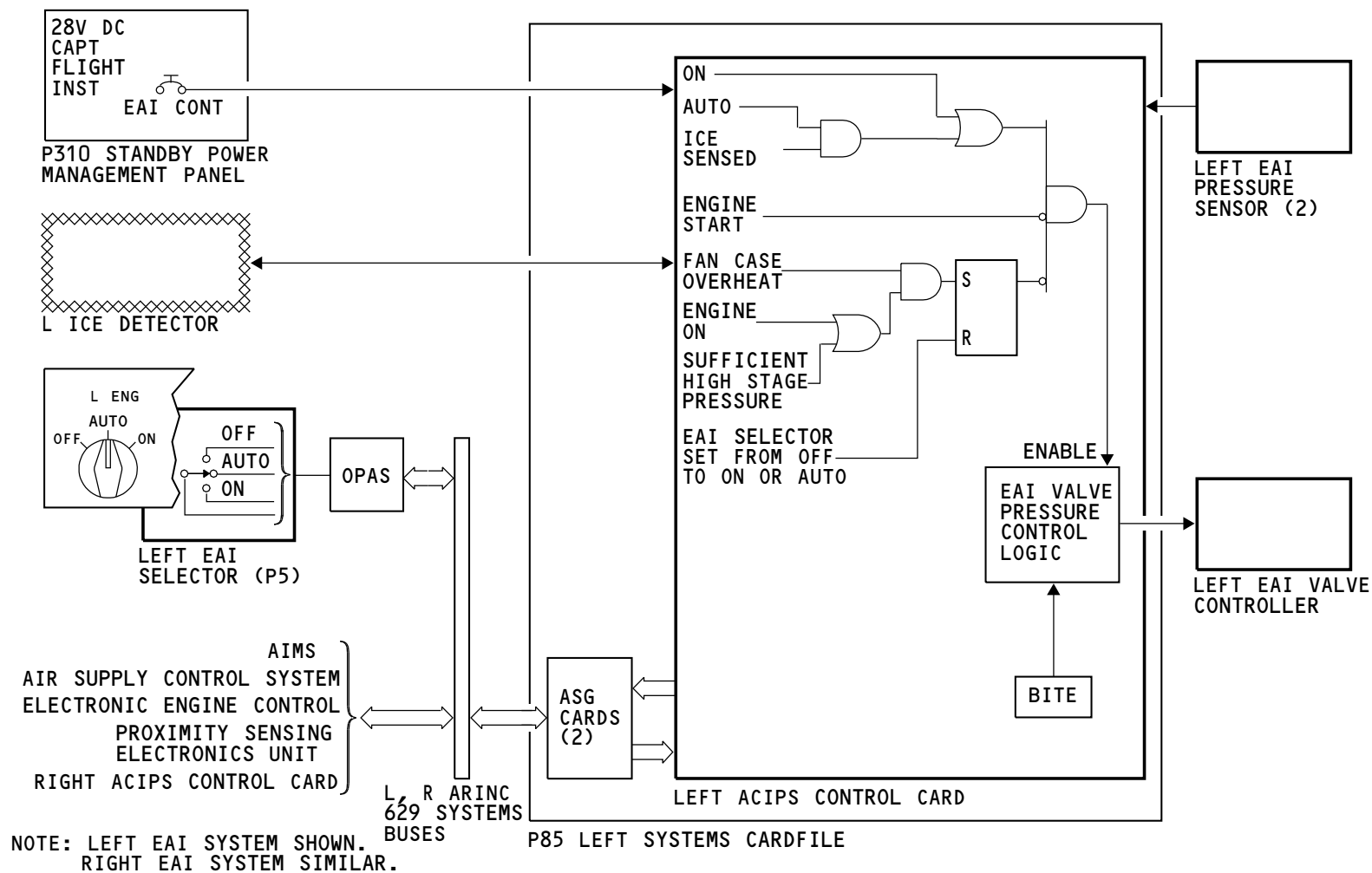
- Opposite ACIPS control card; ice sensed, failed ice detection
- OPAS; EAI selector position, engine start selector position
- DLODS; fancase overheat
- FMC; engine type, flight phase
- AIMS; engine on
- AGS; air/ground status
- ADIRU; mach number, static pressure, static air temperature, total air temperature
- EEC; P3 burner pressure, T3 selected temperature.

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ENGINE ANTI-ICE - FUNCTIONAL DESCRIPTION

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ENGINE ANTI-ICE - OPERATION

General

The engine anti-ice selectors let the flight crew select the operational mode independently for each engine. Indications on the EICAS display and on the air synoptic display show when the EAI valves are open.

Operation

The selectors are on the anti-ice/lighting panel (P5). With the selector set to OFF, the EAI system does not operate. The EAI valve stays closed. The EICAS caution message ICING ENG shows if the airplane is in the air and the ice detection system finds ice.

The OFF selection prevents the EAI BITE periodic ground test.

The AUTO positions enable the BITE periodic ground test.

The OFF selection prevents the inflight automatic BIT.

The AUTO positions enable the inflight automatic BIT.

In flight, when the EAI selector is in AUTO, engine anti-ice system operation is automatic. The ice detection system controls engine anti-ice system operation as long as operational mode inhibits are not active.

For manual operation, the crew sets the selectors to ON when engine anti-ice is necessary. The EAI valves stay open as long as no operational mode inhibits are active. The EICAS advisory message ANTI-ICE ON shows if all of these conditions occur:

- Airplane is in the air
- The left or right EAI selector is set to ON
- No ice is detected
- TAT is more than 50F (10C).

The selectors must be ON for the EAI system to operate on the ground.

See the ice detection system for more information about the ice detectors (SECTION 30-81).

Air Synoptic Display

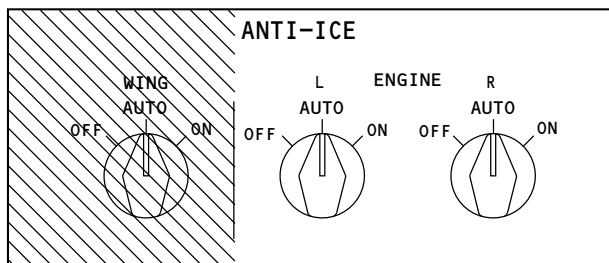
The EAI valve symbols show these conditions:

- Valve open - white circle with a vertical green flow bar
- Valve closed - white circle with two horizontal white bars
- Valve not in commanded position - amber circle with an amber cross through it
- Valve position data not available - white circle.

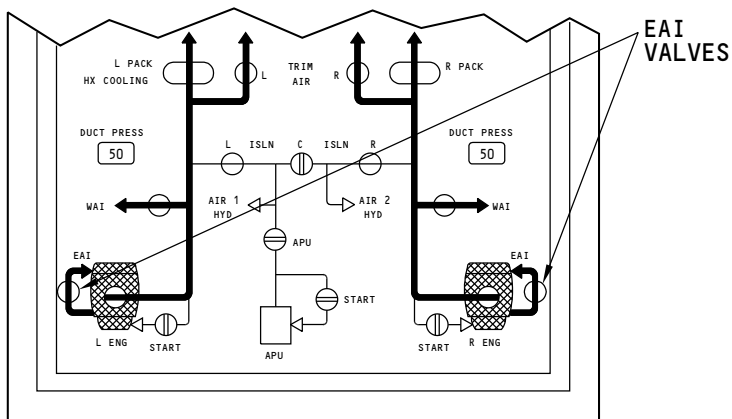
Non-Normal Indications

These EICAS messages (not shown) show non-normal conditions:

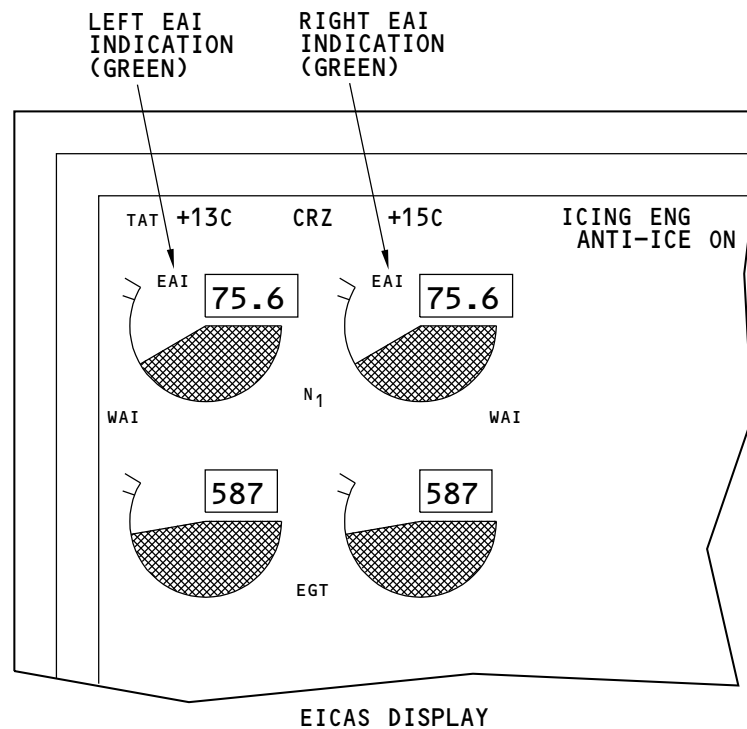
- ANTI-ICE LEAK ENG L,R (Caution) - The fan case overheat detector signals a duct leak condition
- ANTI-ICE LOSS ENG L,R (Advisory) - The EAI valve closes because of a duct leak
- ANTI-ICE ENG L,R (Advisory) - The EAI valve fails closed.



ANTI-ICE/LIGHTING (P5)



AIR SYNOPSIS DISPLAY



EICAS DISPLAY

ENGINE ANTI-ICE - OPERATION

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ENGINE ANTI-ICE - SYSTEM TESTS

General

These are the engine anti-ice system tests that show when you select ATA 30 Airfoil Cowl Ice Protection System:

- Left engine anti-ice (engine running)
- Left engine anti-ice (engine not running)
- Right engine anti-ice (engine running)
- Right engine anti-ice (engine not running).

Left and Right Engine Anti-Ice (Engine Running)

These tests make sure that the related engine anti-ice system can control the bleed airflow.

During the test, you must operate the related engine. The tests each take approximately 1-2 minutes.

Left and Right Engine Anti-Ice (Engine Not Running)

This test makes sure that the electrical interface connections of the related engine anti-ice system are correct, and that the related ice detector operates correctly.

The tests each take approximately 1-2 minutes.

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GROUND TESTS

SELECT ATA SYSTEM (48)

30 AIRFOIL COWL ICE PROTECTION SYSTEM

30 AIR DATA SENSOR ANTI-ICE SYSTEM

30 WINDOW HEAT CONTROL SYSTEM

31 AIMS - FLIGHT DATA RECORDER SYSTEM

31 PRINTER

31 AIMS - AIRPLANE CONDITION MONITORING SYSTEM

31 AIMS - LEFT AIMS

31 AIMS - RIGHT AIMS

31 WARNING ELECTRONICS SYSTEM

SELECT TEST TYPE

SYSTEM TEST

OPERATIONAL TEST

REPLACEMENT TEST

SELECT SYSTEM TEST (6)

LEFT ENGINE ANTI-ICE (ENGINE RUNNING)

LEFT ENGINE ANTI-ICE (ENGINE NOT RUNNING)

RIGHT ENGINE ANTI-ICE (ENGINE RUNNING)

RIGHT ENGINE ANTI-ICE (ENGINE NOT RUNNING)

WING ANTI-ICE (PNEUMATICS AVAILABLE)

WING ANTI-ICE (PNEUMATICS NOT AVAILABLE)

CONTINUE

HELP

GO BACK

SELECT SYSTEM TEST

(6)

LEFT ENGINE ANTI-ICE (ENGINE RUNNING)

LEFT ENGINE ANTI-ICE (ENGINE NOT RUNNING)

RIGHT ENGINE ANTI-ICE (ENGINE RUNNING)

RIGHT ENGINE ANTI-ICE (ENGINE NOT RUNNING)

WING ANTI-ICE (PNEUMATICS AVAILABLE)

WING ANTI-ICE (PNEUMATICS NOT AVAILABLE)

1 THESE ARE THE ENGINE ANTI-ICE TESTS.

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ENGINE ANTI-ICE - SYSTEM TESTS

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PITOT AND STATIC (AIR DATA SENSORS) - INTRODUCTION

General

Some probes and sensors have heaters to keep ice off, so their data is reliable. The static system does not have any heaters. These are the probes and sensors that have heaters:

- Left, right, and center pitot probes
- Total air temperature (TAT) probe
- Left and right angle of attack (AOA) sensors

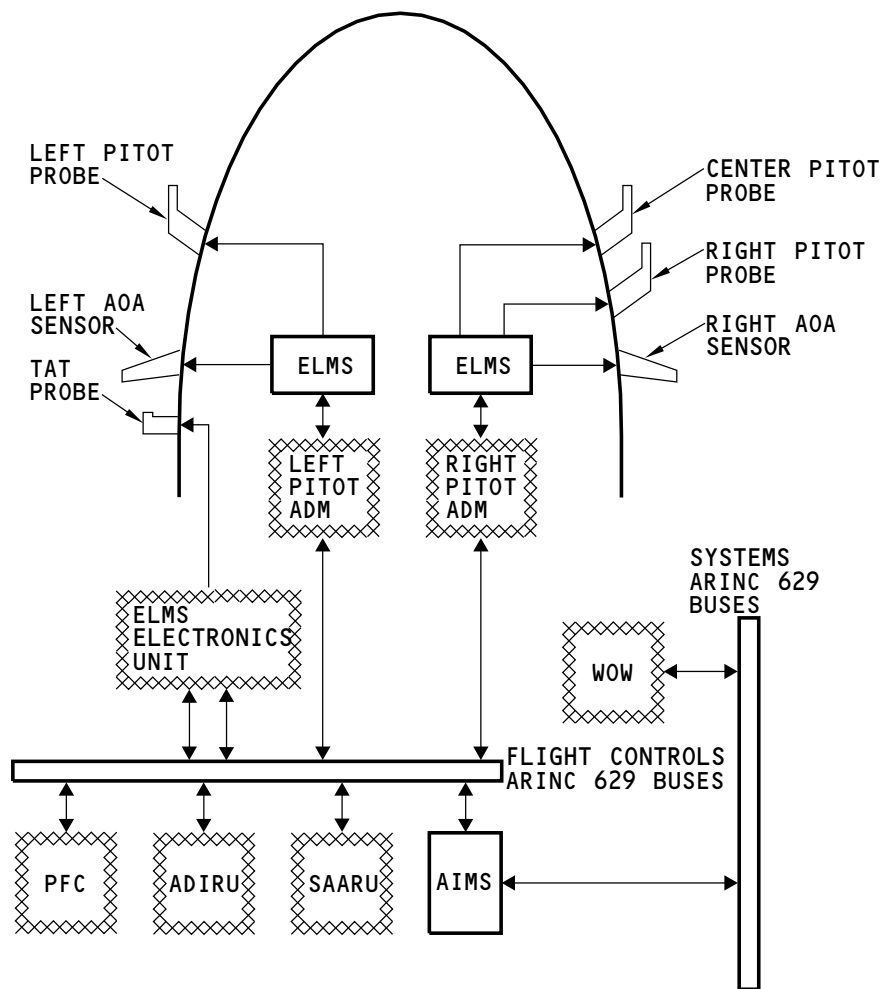
The pitot air data modules (ADMs) control the heat for the pitot probes and the AOA sensors. The pitot probes get low heat after an engine starts. They get high heat when the airspeed is more than 50 knots or the airplane is in the air. The AOA probe get heat when an engine starts.

- After an engine starts
- When the airspeed is more than 50 knots
- The airplane is in the air.

See the attitude and direction section for more information about the ADMs (SECTION 34-20).

The electrical load management system (ELMS) controls the heat for the TAT probe. The TAT probe heats when the airplane is in the air.

See the electrical load management (ELM) system section for more information about the ELMS (SECTION 24-09).



M41455 S000617862_V1

PITOT AND STATIC (AIR DATA SENSORS) - INTRODUCTION

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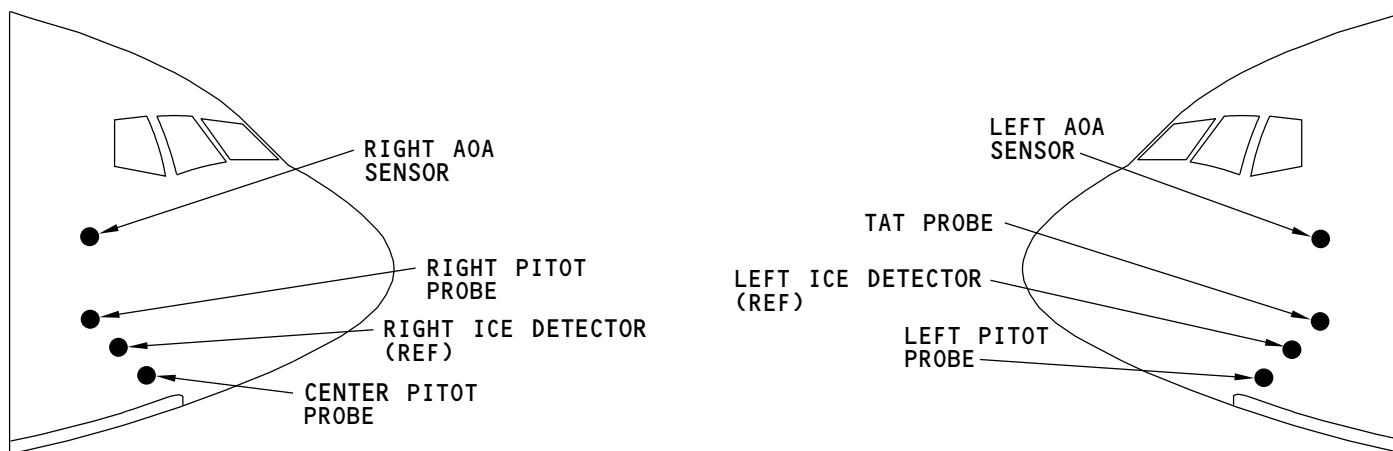
**PITOT AND STATIC (AIR DATA SENSORS) - COMPONENT LOCATIONS****Component Locations**

These probes and sensors are on the right side of the airplane nose:

- Right AOA sensor
- Right pitot probe
- Center pitot probe.

These probes and sensors are on the left side of the airplane nose:

- Left AOA sensor
- TAT probe
- Left pitot probe.



PITOT AND STATIC (AIR DATA SENSORS) - COMPONENT LOCATIONS

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PITOT AND STATIC (AIR DATA SENSORS) - GROUND TESTS

General

These are the pitot and static (air data sensors) operational tests that show when you select ATA 30 Air Data Sensor Ice System:

- Pitot/AOA heat (left) test
- Pitot/AOA heat (right) test
- Pitot heat (center) test
- TAT probe heat.

Left and Right Pitot/AOA Heat Tests

These tests make sure that the related pitot probe and the AOA sensor heaters operate correctly.

During the test, the related pitot probe and AOA sensor become very hot. The tests each take less than 1 minute.



KEEP PERSONS AND EQUIPMENT AWAY FROM THE LEFT (RIGHT) PITOT PROBES AND THE LEFT (RIGHT) ANGLE OF ATTACK VANE. THESE COMPONENTS WILL BECOME VERY HOT AND CAUSE INJURY TO PERSONS AND DAMAGE TO EQUIPMENT.

Center Pitot Heat Test

This test makes sure that the center pitot probe heater operates correctly.

During the test, the center pitot probe becomes very hot. The test takes less than 1 minute.



WARNING

KEEP PERSONS AND EQUIPMENT AWAY FROM THE CENTER PITOT PROBE. THESE COMPONENTS WILL BECOME VERY HOT AND CAUSE INJURY TO PERSONS AND DAMAGE TO EQUIPMENT.

TAT Probe Heat

This test makes sure that the TAT probe heater operates correctly.

During the test, the TAT probe becomes very hot. The test takes less than 1 minute.



WARNING

KEEP PERSONS AND EQUIPMENT AWAY FROM THE TAT PROBE. THESE COMPONENTS WILL BECOME VERY HOT AND CAUSE INJURY TO PERSONS AND DAMAGE TO EQUIPMENT.

GROUND TESTS

SELECT ATA SYSTEM (48)

30 AIRFOIL COWL ICE PROTECTION SYSTEM
30 AIR DATA SENSOR ANTI-ICE SYSTEM
30 WINDOW HEAT CONTROL SYSTEM
31 AIMS - FLIGHT DATA RECORDER SYSTEM
31 PRINTER
31 AIMS - AIRPLANE CONDITION MONITORING SYSTEM
31 AIMS - LEFT AIMS
31 AIMS - RIGHT AIMS
31 WARNING ELECTRONICS SYSTEM

SELECT TEST TYPE

SYSTEM TEST
☒ OPERATIONAL TEST
REPLACEMENT TEST

SELECT OPERATIONAL TEST (4)

PITOT/AOA HEAT (LEFT) TEST

PITOT/AOA HEAT (RIGHT) TEST

PITOT HEAT (CENTER) TEST

TAT PROBE HEAT

CONTINUE

HELP

GO BACK

SELECT OPERATIONAL TEST

(4)

PITOT/AOA HEAT (LEFT) TEST
PITOT/AOA HEAT (RIGHT) TEST
PITOT HEAT (CENTER) TEST
TAT PROBE HEAT

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PITOT AND STATIC (AIR DATA SENSORS) - GROUND TESTS

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**PITOT AND STATIC (AIR DATA SENSORS) - PITOT PROBE HEAT - GENERAL DESCRIPTION****Purpose**

The heaters in the pitot probes keep ice off of the probes so their data is reliable.

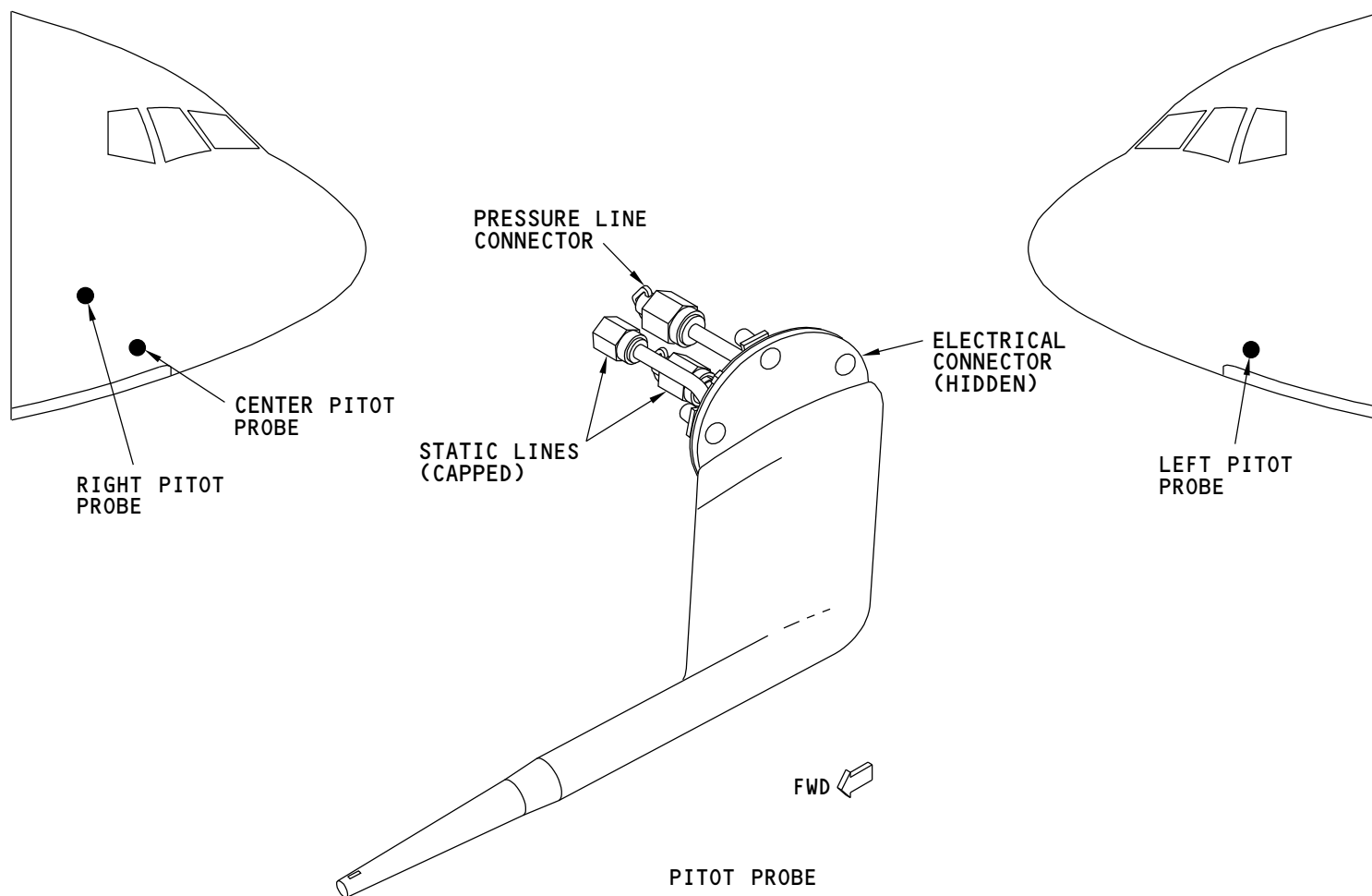
General Description

There is one pitot probe on the left and two pitot probes on the right side of the nose. Each probe has an electrical connection and a pressure line connection.

See the static and total air pressure system section for more information about the pitot probes (SECTION 34-11).

Training Information Point

The pitot probes have static ports. However, the 777 does not use the static ports on any of the pitot probes. The static lines have caps on them.



M41465 S000617875_V1

PITOT AND STATIC (AIR DATA SENSORS) - PITOT PROBE HEAT - GENERAL DESCRIPTION

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**PITOT AND STATIC (AIR DATA SENSORS) - PITOT PROBE HEAT - FUNCTIONAL DESCRIPTION****General**

The left, center, and right pitot probe heat systems operate the same. The left, right, and center pitot air data modules (ADMs) supply control and indications for the pitot probe heat systems.

Ground Mode

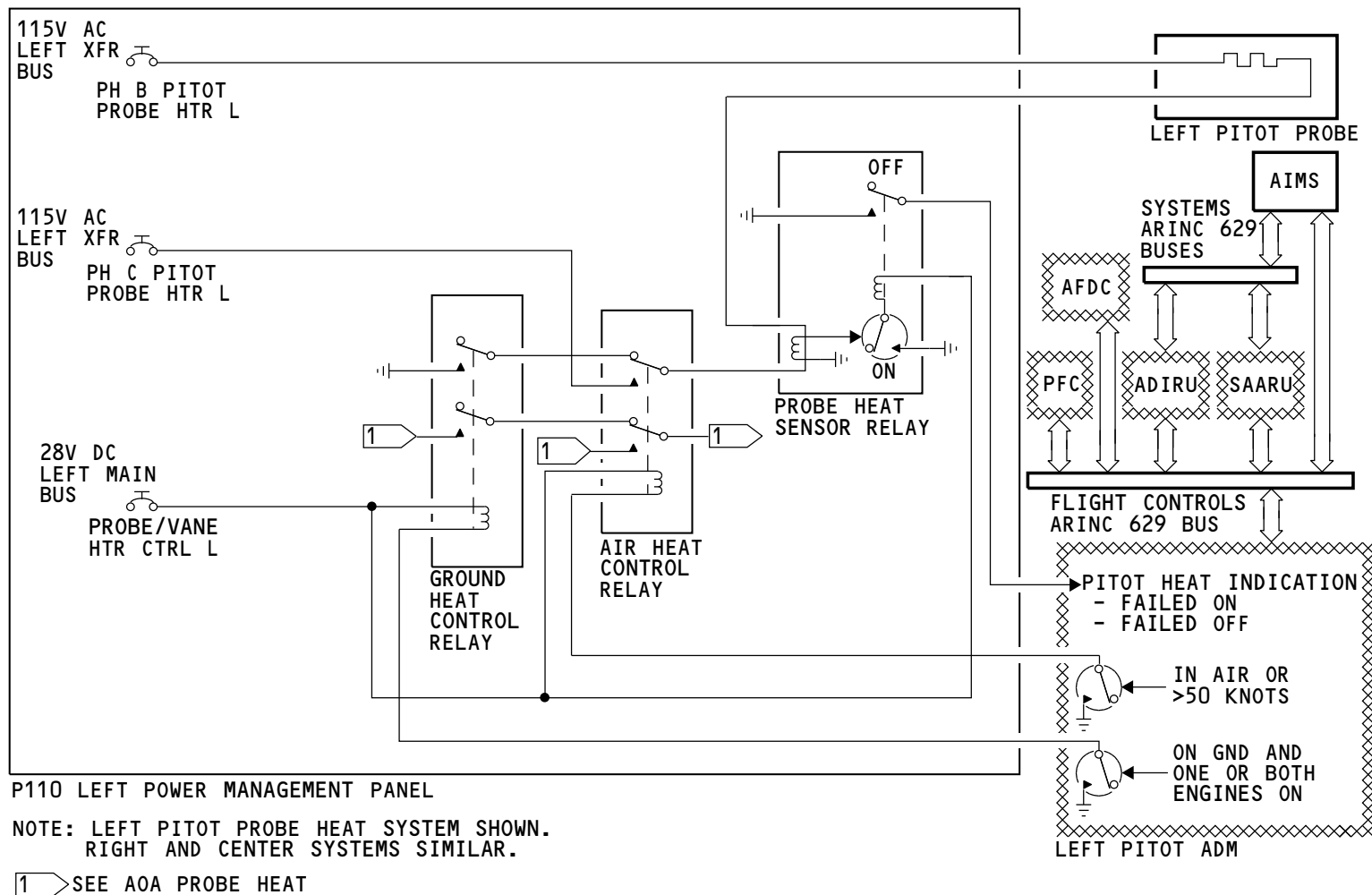
The primary flight computer (PFC) supplies air/ground signals for the ADM to energize the ground and air heat control relays. When the airplane is on the ground and either engine is on, the pitot probe gets 115v ac (phase B) through the ground and the air heat control relays.

Air Mode

When the airplane gets to 50 knots or is in the air, the air heat control relay removes the ground and connects 115v ac (phase C) to the pitot probe. This gives a phase-to-phase voltage across the pitot probe of approximately 200v ac.

Indications

The probe heat sensor relay supplies a ground signal to the ADM when the pitot heat is on. The ADM supplies the pitot heat fault information directly through the data buses to the AIMS. It also supplies the information through the air data inertial reference unit (ADIRU) and the secondary attitude air data reference unit (SAARU) for advisory and status messages.



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PITOT AND STATIC (AIR DATA SENSORS) - PITOT PROBE HEAT - FUNCTIONAL DESCRIPTION

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**PITOT AND STATIC (AIR DATA SENSORS) - ANGLE-OF-ATTACK PROBE HEAT - GENERAL DESCRIPTION****Purpose**

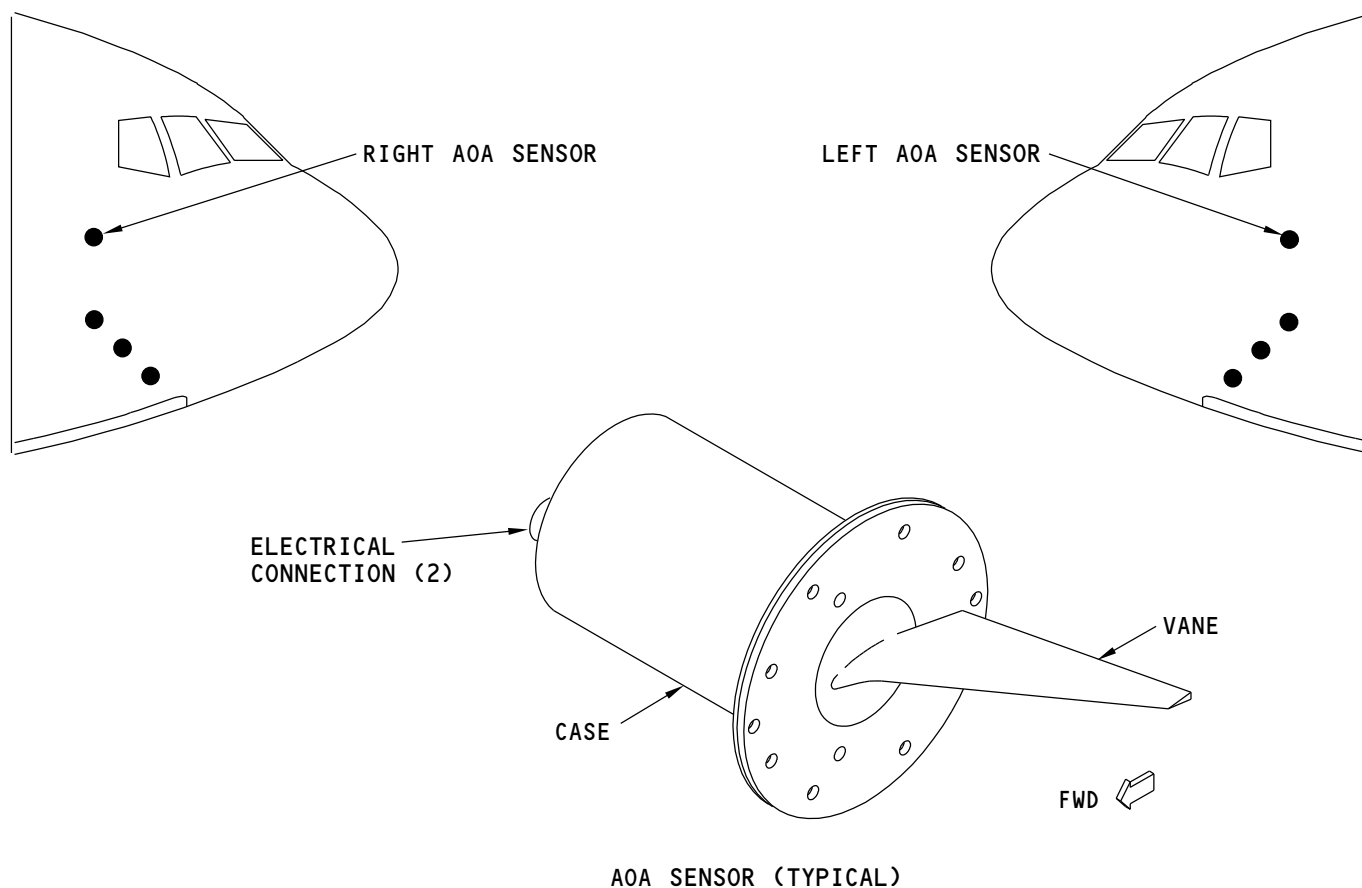
The heaters in the AOA sensors keep ice off of the sensors so the data is reliable.

General Description

There is an AOA sensor on each side of the airplane nose. The sensors are interchangeable.

The sensor has heaters for the case and for the vane. There are two electrical connectors. Each sensor is an LRU. The components on the sensors are not LRUs.

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PITOT AND STATIC (AIR DATA SENSORS) - ANGLE-OF-ATTACK PROBE HEAT - GENERAL DESCRIPTION

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PITOT AND STATIC (AIR DATA SENSORS) - ANGLE-OF-ATTACK PROBE HEAT - FUNCTIONAL DESCRIPTION

General

The left and right angle-of-attack (AOA) sensor heat systems operate the same. The left and right pitot air data modules (ADMs) supply control and indications for the related AOA sensor heat system. Each system has a heater for the case and a heater for the vane.

The ADMs use information about these airplane conditions to calculate when to make AOA probe heat come on:

- Engine on/off from the primary flight computer (PFC) and autopilot flight director computer (AFDC)
- Air/ground from the PFC and AFDC
- Computed airspeed from the air data inertial reference unit (ADIRU)
- Ground test and data load from the AIMS.

The ADMs use probe heat sensor relays in the power management panel to monitor the operation of the probe heaters. There is one sensor relay for the vane heater and one for the case heater.

Ground Mode

The left pitot ADM sets the left AOA probe heat to on if the airplane is on the ground and one or both engines are on. The ground heat control relay energizes and supplies 115v ac to the case and vane heaters.

Air Mode

The left pitot ADM sets the left AOA probe heat to on if the airplane is in the air or if the computed airspeed (CAS) is more than 50 knots. The air heat control relay energizes and supplies 115v ac to the case and vane heaters.

AOA Heater Current Monitor/Indication

The case and vane probe heat sensor relays monitor the heater current and give the status of the heaters to the left pitot ADM. The ADM gets an open (high) signal when the related heater is off and a ground signal (low) when the related heater is on. The pitot ADM sends the status of the AOA probe heaters to these components/system:

- ADIRU
- SAARU (secondary attitude and air data reference unit)
- AIMS.

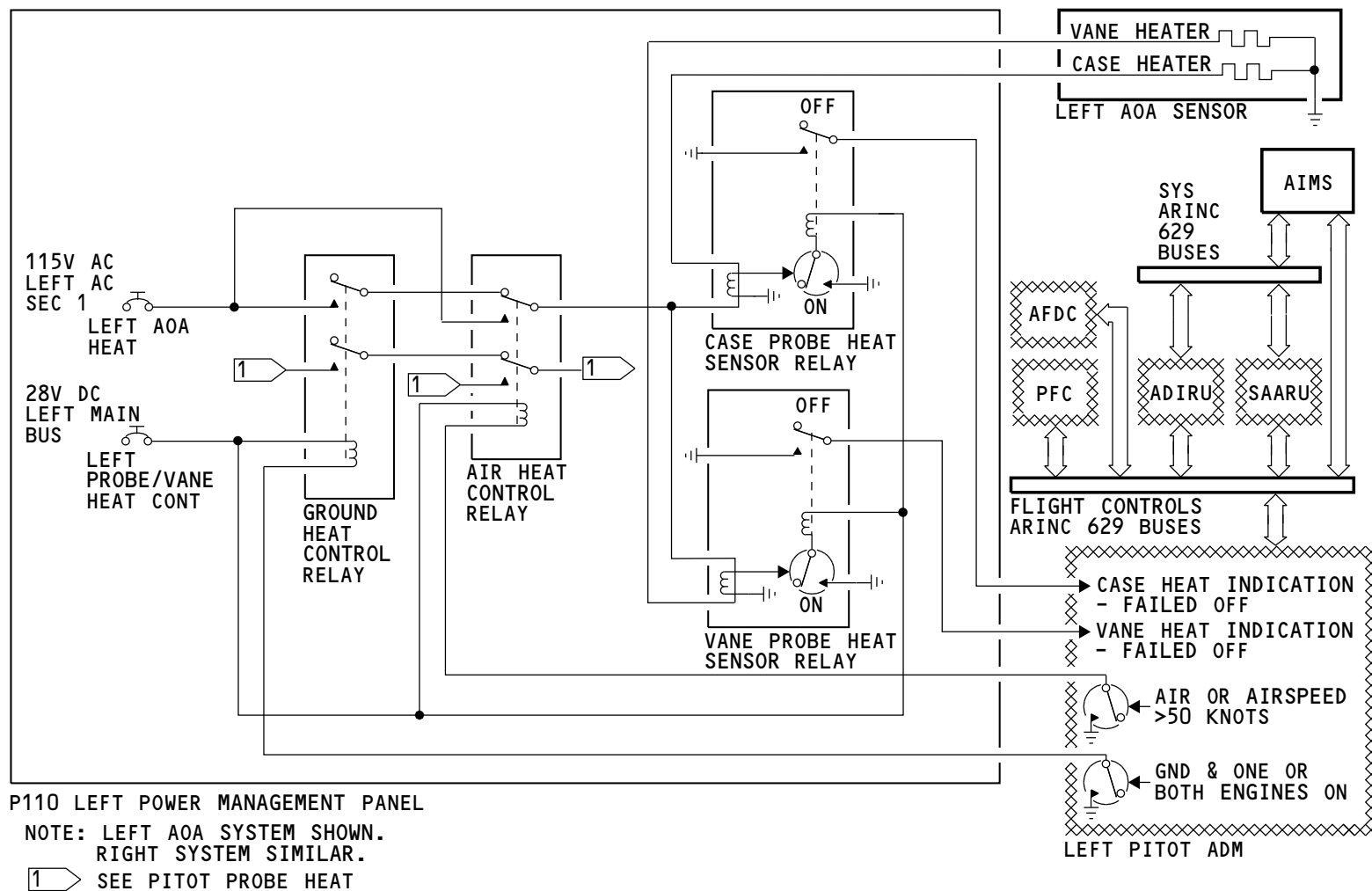
The ADIRU and SAARU use heater status to calculate if AOA data is valid.

See the attitude and direction section for more information about the AOA sensor, ADIRU and SAARU (SECTION 34-20).

The AIMS gets heater fault information two ways:

- Directly through the data buses for maintenance messages
- Through the ADIRU and SAARU for status messages.

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PITOT AND STATIC (AIR DATA SENSORS) - ANGLE-OF-ATTACK PROBE HEAT - FUNCTIONAL DESCRIPTION

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**PITOT AND STATIC (AIR DATA SENSORS) - TOTAL AIR TEMPERATURE PROBE HEAT - GENERAL DESCRIPTION****Purpose**

The heaters in the TAT probe keep ice off of the probe so its data is reliable.

General Description

There is one TAT probe on the left side of the nose. The probe has an electrical connector and a connector for air. The air is from the air supply distribution system.

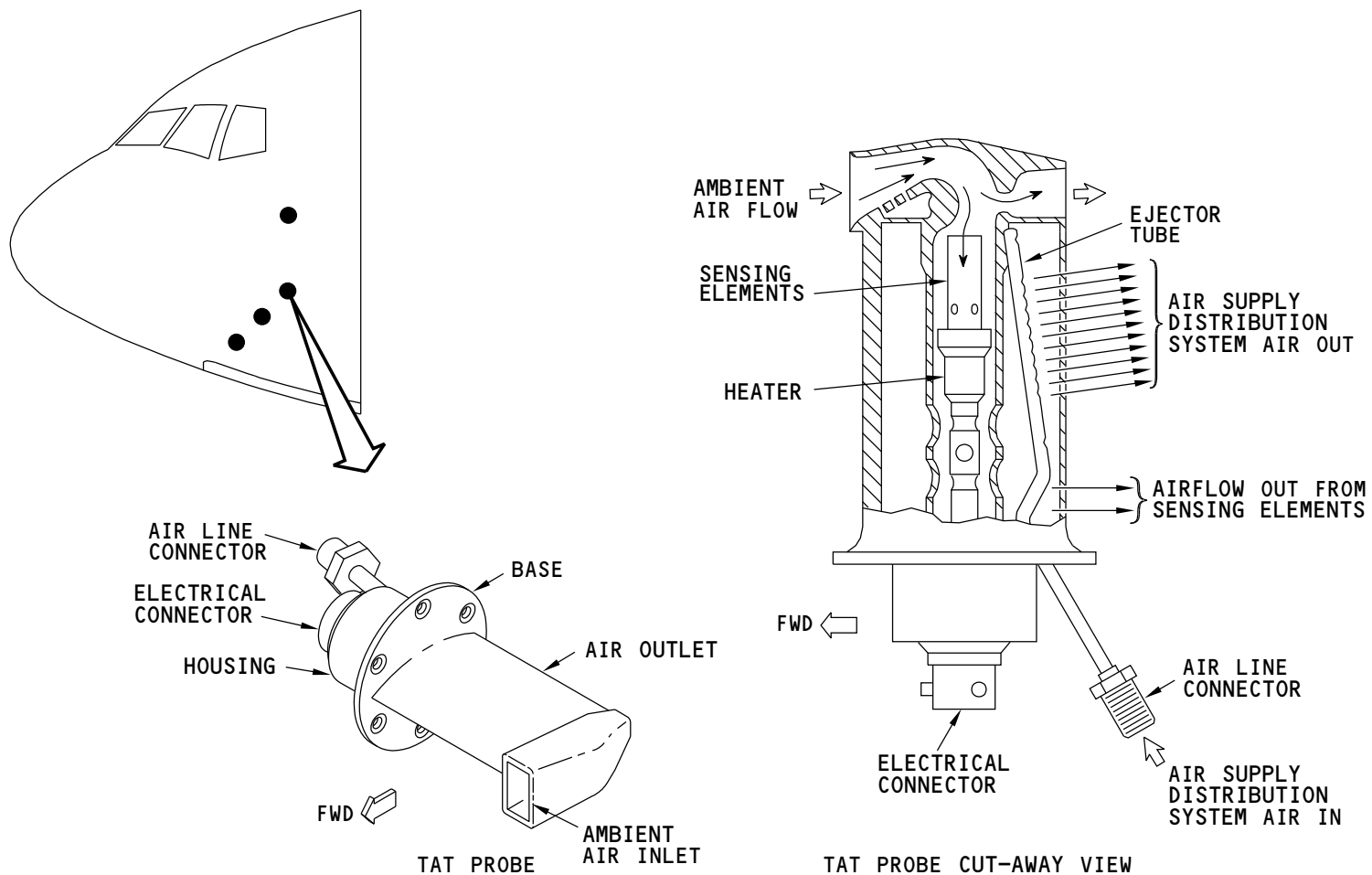
Ambient air temperature is measured by the sensing elements. To make sure the sensing elements have a sufficient amount of ambient air flow near them for correct temperature sensing, the probe has an ejector tube and a flow of air from the air supply distribution system.

A small amount of air from the air supply distribution system flows through the ejector tube, this makes a vacuum near the sensing elements. The vacuum makes ambient air flow near the sensing elements and then out of the probe near the base.

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PITOT AND STATIC (AIR DATA SENSORS) - TOTAL AIR TEMPERATURE PROBE HEAT - GENERAL DESCRIPTION

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**PITOT AND STATIC (AIR DATA SENSORS) - TOTAL AIR TEMPERATURE PROBE HEAT - FUNCTIONAL DESCRIPTION****General**

The Electrical Load Management System (IELMS) supplies control and indications for the TAT probe heat system.

Functional Description

Power for the TAT heater comes through the TAT probe heater relay. The ELMS supplies the ground signal to energize the relay.

The relay supplies power to the heater when the airplane is in the air. The heater does not receive power when the airplane is on the ground.

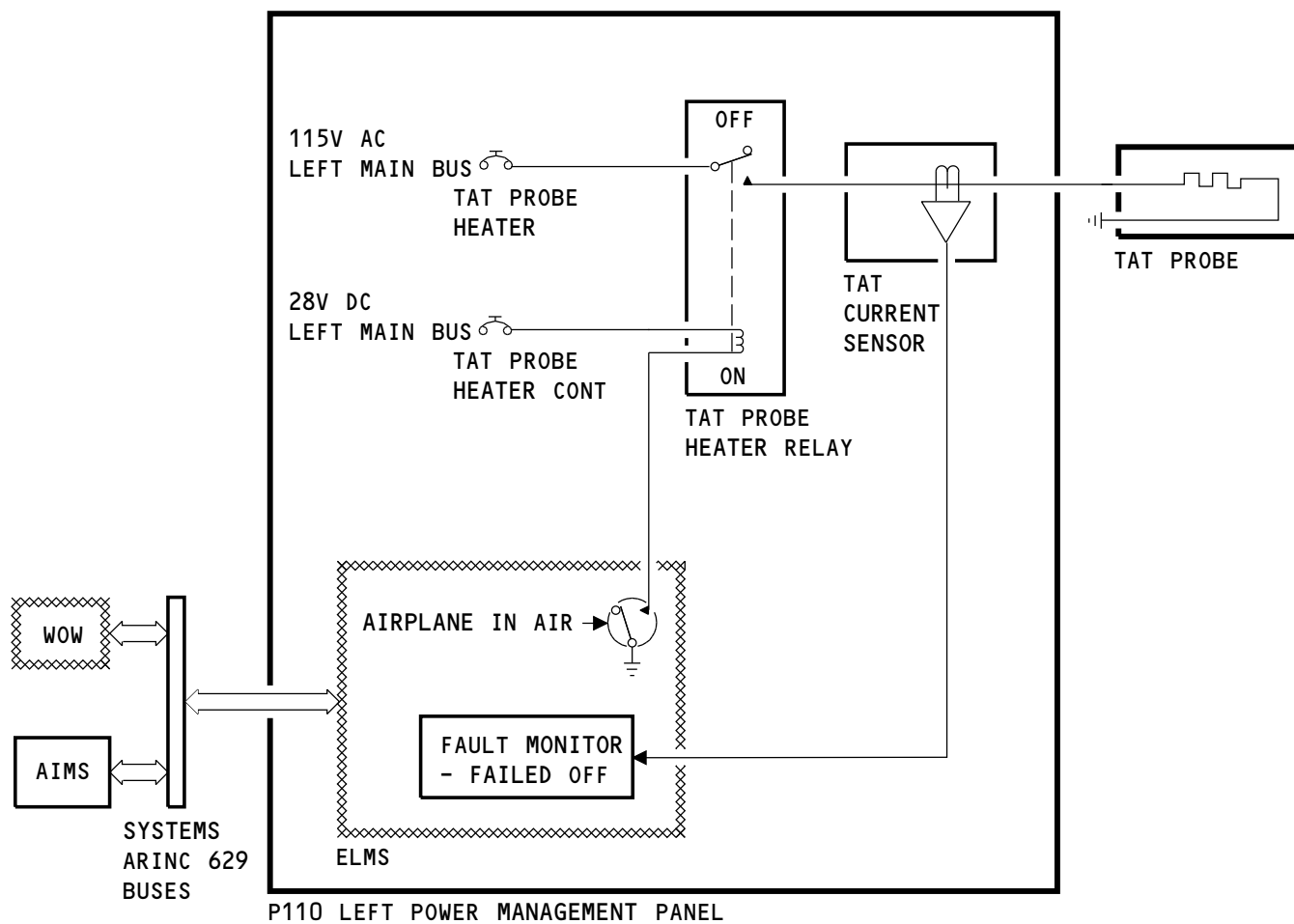
The TAT current sensor supplies current information to the ELMS. The ELMS supplies the TAT probe heat fault status to the AIMS.

The ELMS receives the air/ground information from the weight on wheels (WOW) card.

Indications

There are status and maintenance messages if there are failures of the probe heater circuits.

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PITOT AND STATIC (AIR DATA SENSORS) - TOTAL AIR TEMPERATURE PROBE HEAT - FUNCTIONAL DESCRIPTION

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**FLIGHT DECK WINDOW ANTI-ICE SYSTEM - INTRODUCTION****Purpose**

The window heat system prevents ice and fog on the flight deck windows.

General Description

Electric heaters in the window laminations heat the flight deck windows.

The window heat switches enable the window heat system. With window heat ON, the window heat control units (WHCUs) control the power to the windows. With window heat OFF, the backup window heat system can operate.

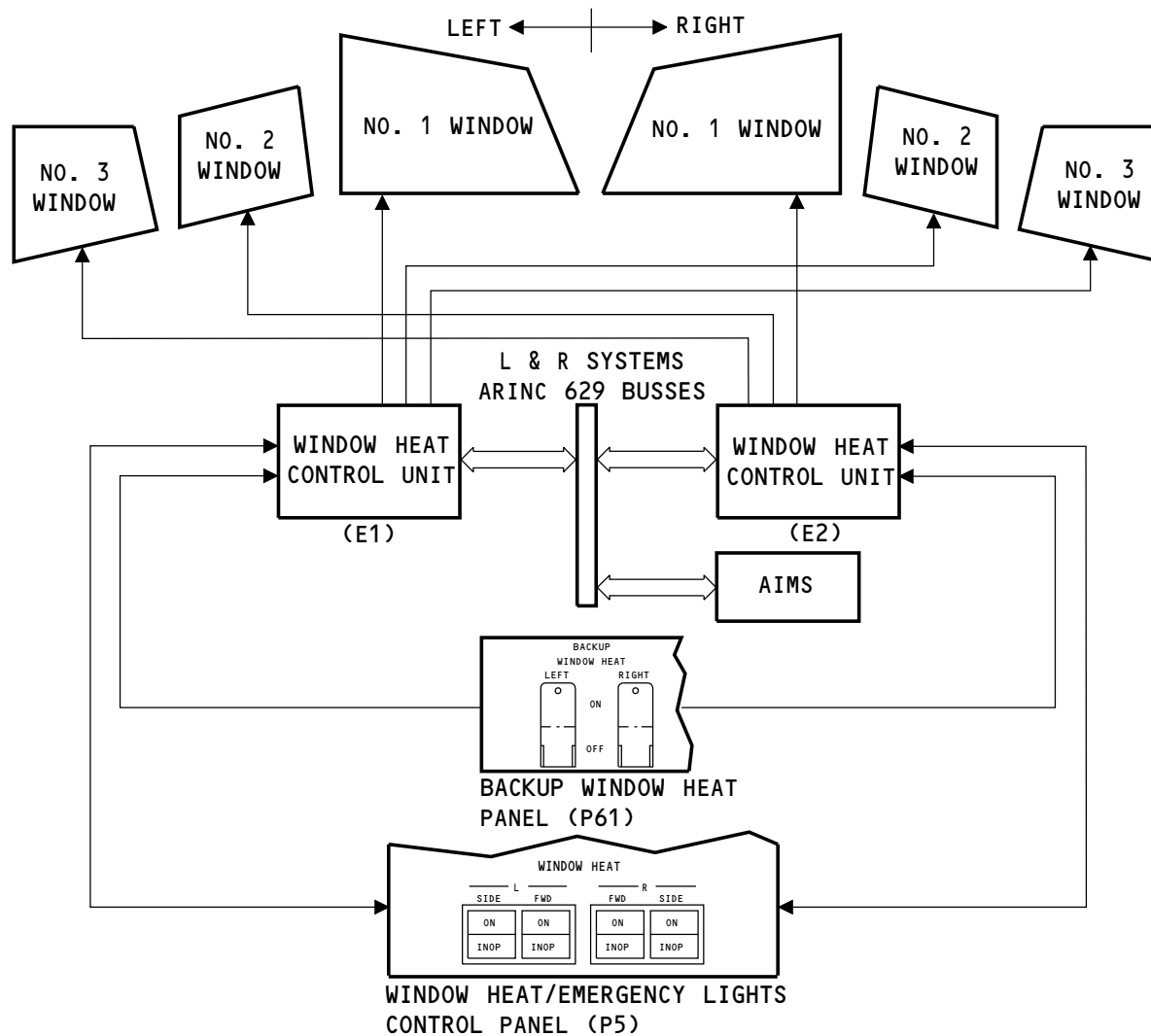
The number 1 windows have a backup heat system. The backup window heat switches let you remove power from the backup window heat system for maintenance.

There are no test switches for the window heat system. The BITE automatically tests the system. You can use the MAT to do initiated BITE tests of the window heat system.

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FLIGHT DECK WINDOW ANTI-ICE SYSTEM - INTRODUCTION

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FLIGHT DECK WINDOW ANTI-ICE SYSTEM - COMPONENT LOCATIONS

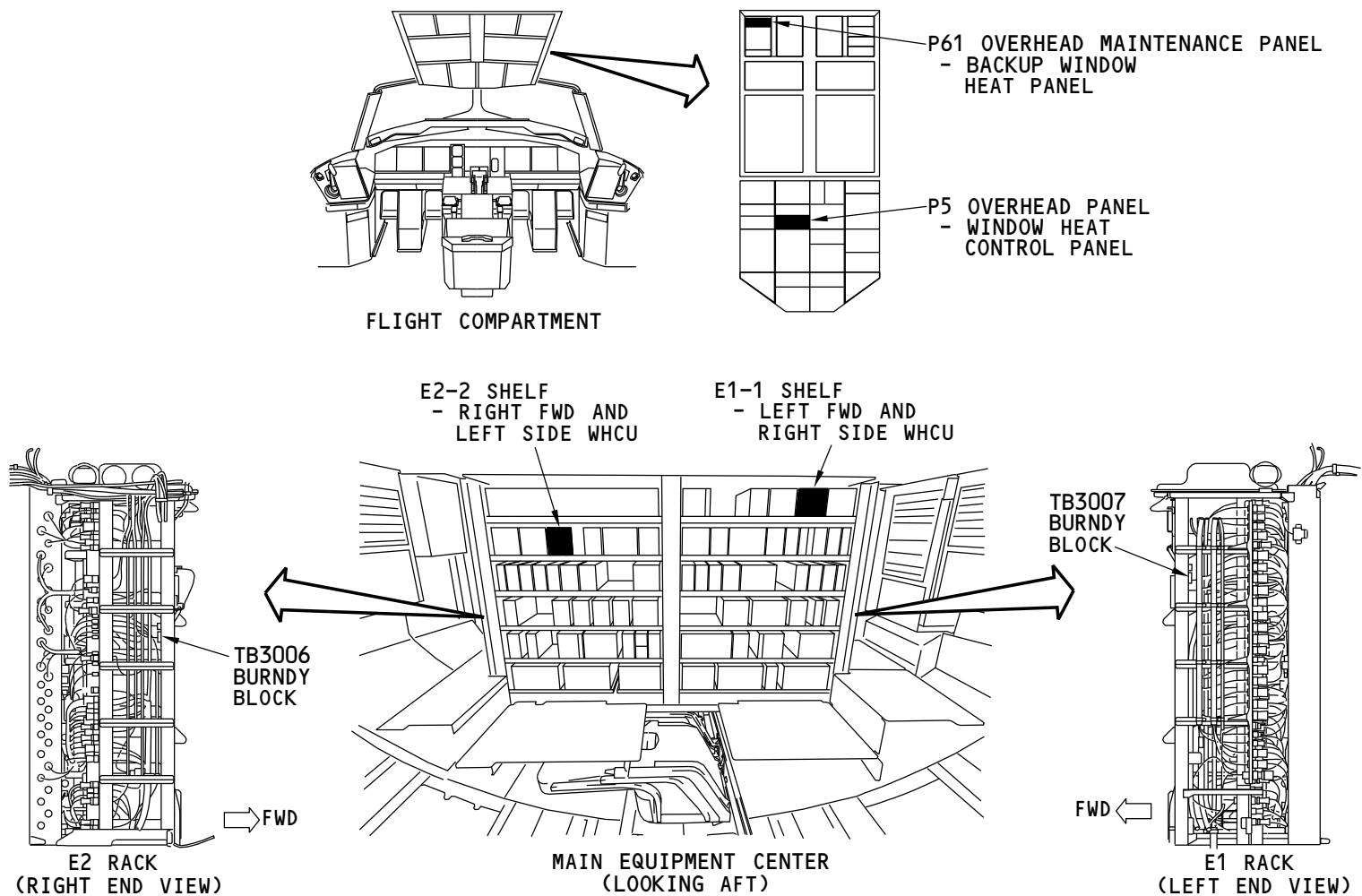
Component Locations

The window heat control panel is on the P5 overhead panel. The backup window heat panel is on the P61 overhead maintenance panel.

The two window heat control units (WHCUs) are on the E1 and E2 main equipment racks. The left forward and right side WHCU is on the E1-1 shelf. The right forward and left side WHCU is on the E2-2 shelf.

Burndy blocks for the spare window heat sensors are on the outboard ends of the E1 and E2 rack.

ARO ALL	EFFECTIVITY



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FLIGHT DECK WINDOW ANTI-ICE SYSTEM - COMPONENT LOCATIONS

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**FLIGHT DECK WINDOW ANTI-ICE SYSTEM - FUNCTIONAL DESCRIPTION - 1****General**

There are two WHCUs. One WHCU is for the left forward and right side windows. The other WHCU is for the right forward and left side windows. The WHCUs are the same.

Each WHCU has a separate power supply for each heater circuit in the flight deck windows. Each WHCU also has a separate power supply for BITE.

The power supplies for the heater circuits are 115v ac. The power supply for the BITE is 28v dc.

Each WHCU receives air/ground status from two air/ground relays. The inputs are analog. They are redundant.

Power Supply Circuits

The number 1 window uses two phase ac. The number 2 and 3 windows use single phase ac.

Air/Ground Inputs

The WHCU uses the air/ground status for these functions:

- The WHCUs decrease the power to all of the window heaters during the first four minutes of operation on the ground
- The WHCU inhibits initiated BITE tests in flight.

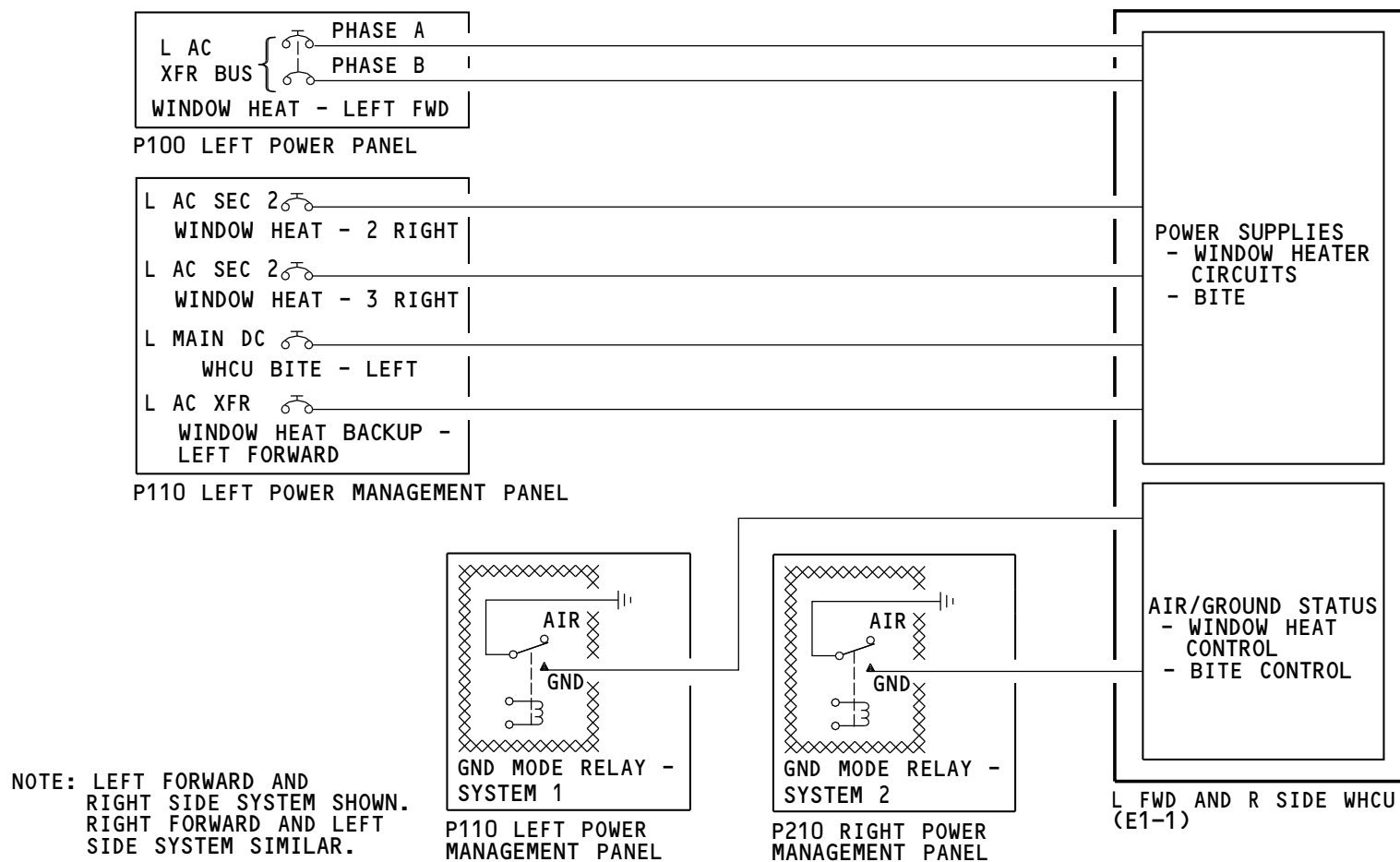
The initiated BITE tests occur during power-up of the WHCU, and when you do the window heat ground test on the MAT.

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FLIGHT DECK WINDOW ANTI-ICE SYSTEM - FUNCTIONAL DESCRIPTION - 1

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FLIGHT DECK WINDOW ANTI-ICE SYSTEM - FUNCTIONAL DESCRIPTION - 2

General

These control switches connect to one WHCU (left forward and right side WHCU):

- Left forward window heat switch
- Right side window heat switch
- Left backup window heat switch.

The other switches connect to the other WHCU (right forward and left side WHCU).

Each window heat switch has an ON light and an INOP light. The backup window heat switches do not have indications.

These heater circuits are for normal operation:

- Number 1 window anti-ice heater circuit
- Number 2 window anti-fog heater circuit
- Number 3 window anti-fog heater circuit.

The anti-fog heater circuit in the number 1 window is for backup operation.

The WHCU supplies control power to the window heaters. The WHCU also has BITE.

Window Heat Enable

The left forward window heat switch enables the anti-ice heater circuit in the left number 1 window. The right side window heat switch enables the anti-fog heaters in the right number 2 and 3 windows.

The INOP lights are on when the window heat switches are OFF. The INOP light shows that the heater circuit is not enabled.

When you push the switches, a mechanical ON label shows switch position. The ON light comes on if the instrument lights system has power. The INOP light goes out to show the heater circuit is enabled.

Window Heat Control

A temperature sensor in each window supplies control feedback to the WHCU. The WHCU controls the temperature of each window independently. The WHCU does not supply power to the heater circuit if the window temperature is too warm.

BITE Operation

The BITE in the WHCU tests for failures in these components:

- WHCU
- Heater
- Temperature sensor.

The WHCU can remove all power to a window heater if the BITE in the WHCU finds a failure. The INOP light comes on to show that the heater circuit is not enabled.

There are continuous BITE tests and initiated BITE tests. The continuous BITE tests occur during normal operation. The initiated BITE tests occur during power-up of the WHCU and when you do the window heat ground test on the MAT.

Window Heat Backup

The WHCU supplies electrical power to the anti-fog heater in the number 1 window if the backup window heat switch is ON and either of these conditions exists:

- Forward window heat switch OFF
- Forward window heat switch ON and no power to the anti-ice heater in the number 1 window.

A backup temperature sensor supplies feedback.

To remove backup heat from the number 1 window, move the backup window heat switch to the OFF position.



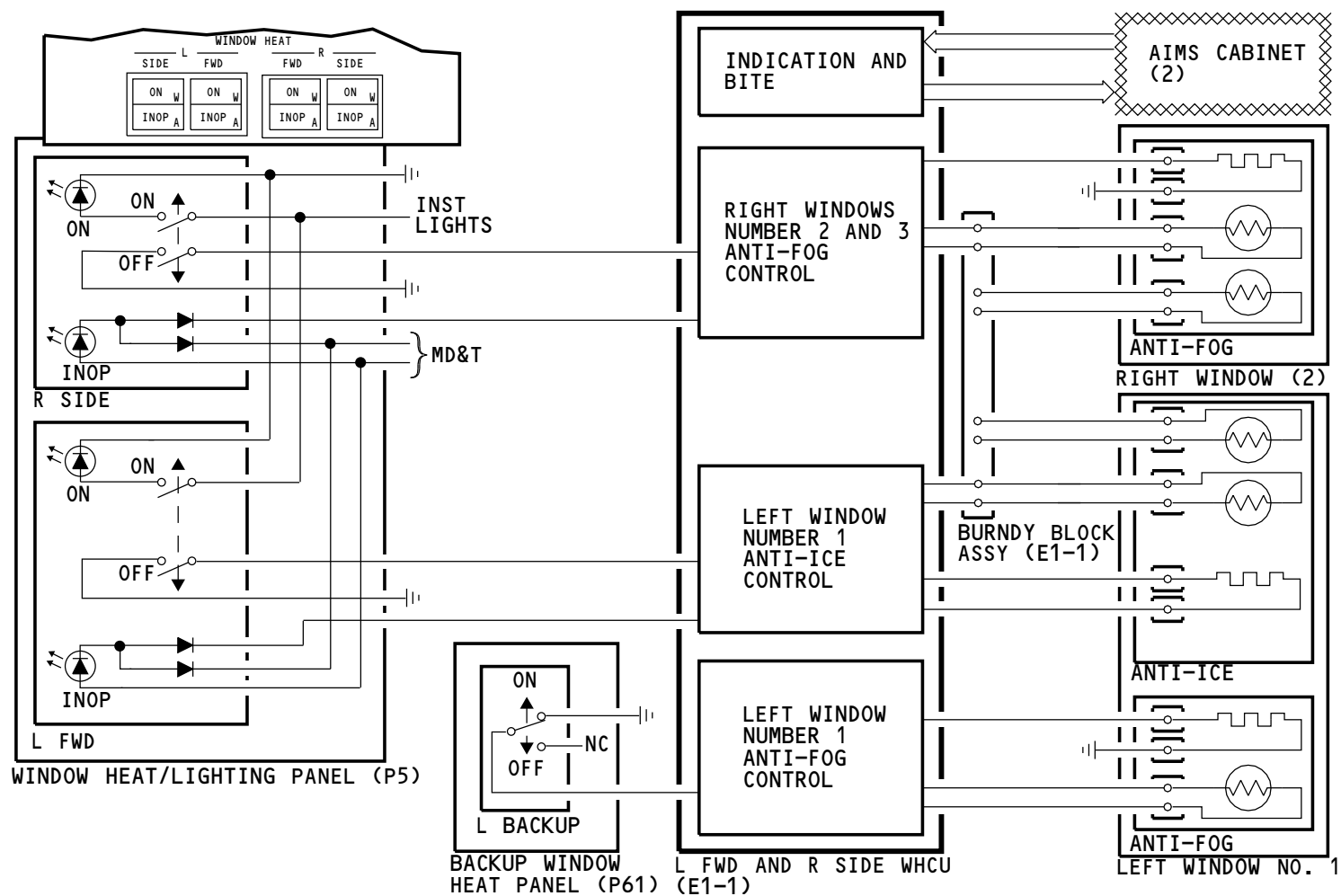
FLIGHT DECK WINDOW ANTI-ICE SYSTEM - FUNCTIONAL DESCRIPTION - 2

Training Information Point

To remove power from the window heater circuits, select the window heat switches and the backup window heat switches OFF. You need to do this for safety before you clean the windows or do maintenance on the windows.

The window anti-ice system has burndy blocks on the left of the E1 rack and right of the E2 rack. This lets you switch to the spare sensor if the primary sensor fails.

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FLIGHT DECK WINDOW ANTI-ICE SYSTEM - FUNCTIONAL DESCRIPTION - 2

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FLIGHT DECK WINDOW ANTI-ICE SYSTEM - OPERATION

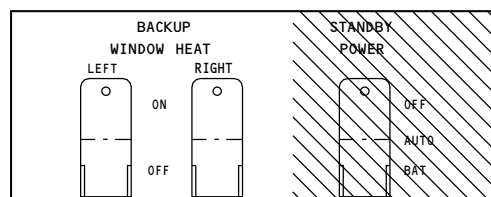
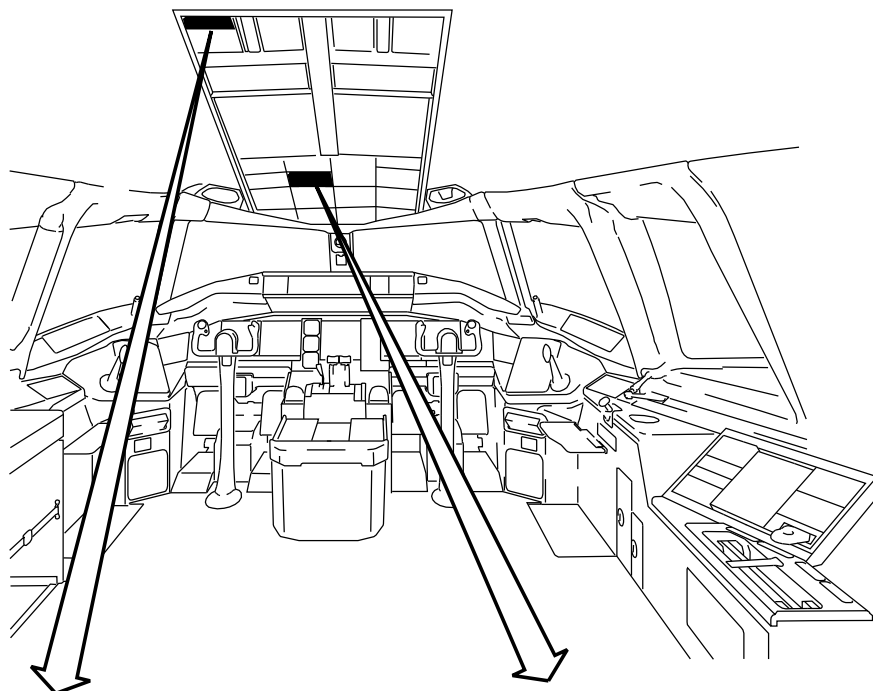
Window Heat Switches

There are four window heat switches, two for the windows on the left side of the flight compartment, and two for the windows on the right side of the flight compartment.

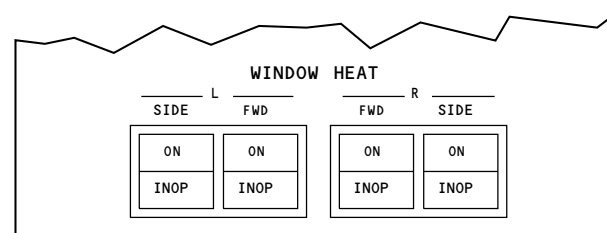
The left and right forward window heat switches enable the heater circuits in the left and right number 1 windows. The left and right side window heat switches enable the heater circuits for the left and right number 2 and 3 windows.

Backup Window Heat Switches

There are two backup window heat switches, one for each of the left and right number 1 windows. The switches are normally in the ON position. The switches have guards. You move the backup window heat switch to the OFF position to remove power from the backup window heat system.



BACKUP WINDOW HEAT/STANDBY POWER
PANEL (P61)



WINDOW HEAT/EMERGENCY LIGHTS PANEL (P5)

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FLIGHT DECK WINDOW ANTI-ICE SYSTEM - OPERATION

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**FLIGHT DECK WINDOW ANTI-ICE SYSTEM - SYSTEM TESTS****General**

These are the flight deck window anti-ice system tests that show when you select ATA 30 Window Heat Control System:

- Window heat control unit - L
- Window heat control unit - R.

Left and Right Window Heat Control Unit

These tests make sure that the related window heat control unit operates correctly.

During the test, the window heat control unit applies power to the related flight deck window. The tests each take approximately 1-2 minutes.

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GROUND TESTS

SELECT ATA SYSTEM (48)

- 30 AIRFOIL COWL ICE PROTECTION SYSTEM
- 30 AIR DATA SENSOR ANTI-ICE SYSTEM
- 30 WINDOW HEAT CONTROL SYSTEM**
- 31 AIMS - FLIGHT DATA RECORDER SYSTEM
- 31 PRINTER
- 31 AIMS - AIRPLANE CONDITION MONITORING SYSTEM
- 31 AIMS - LEFT AIMS
- 31 AIMS - RIGHT AIMS
- 31 WARNING ELECTRONICS SYSTEM

SELECT TEST TYPE

- ☒ SYSTEM TEST
- ☐ OPERATIONAL TEST
- ☐ TROUBLESHOOTING TEST
- ☐ REPLACEMENT TEST

SELECT SYSTEM TEST (2)

WINDOW HEAT CONTROL UNIT - L

WINDOW HEAT CONTROL UNIT - R

CONTINUE

HELP

GO BACK

SELECT SYSTEM TEST

(2)

WINDOW HEAT CONTROL UNIT - L

WINDOW HEAT CONTROL UNIT - R

FLIGHT DECK WINDOW ANTI-ICE SYSTEM - SYSTEM TESTS

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**WINDSHIELD WIPER SYSTEM - INTRODUCTION****Purpose**

The windshield wiper system removes water from the left and right number one flight deck windows.

Windshield Wipers

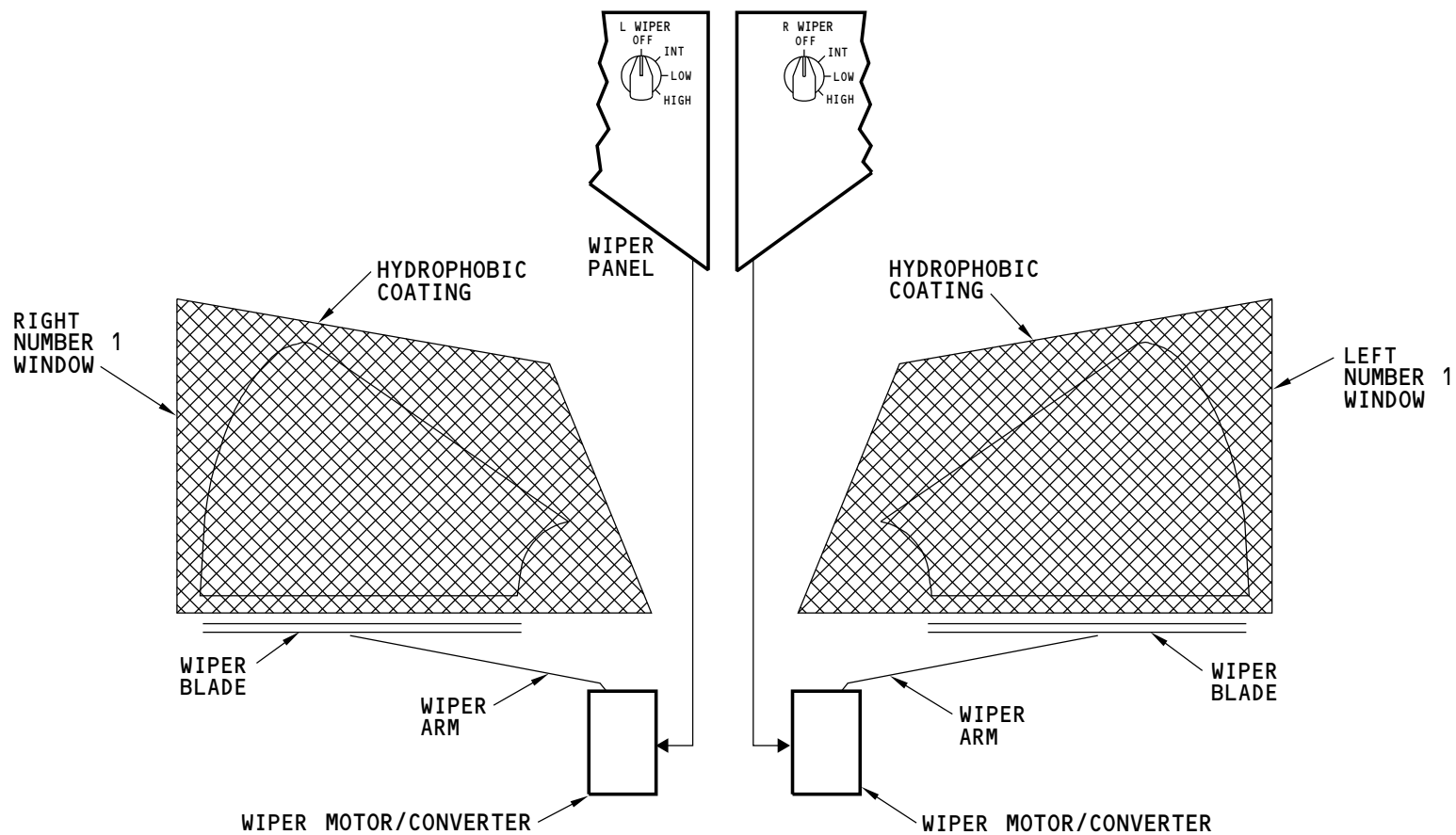
There are two windshield wipers, one for each of the number one windows. Each windshield wiper assembly has these components:

- Wiper
- Wiper arm
- Wiper motor/converter.

There is a switch on the P5 overhead panel for each wiper.

Hydrophobic Coating

A hydrophobic coating on each forward window repels rain. The windshield does not have a liquid rain repellent system because there is a hydrophobic coating.



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WINDSHIELD WIPER SYSTEM - INTRODUCTION

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**WINDSHIELD WIPER SYSTEM - COMPONENT LOCATION****Wiper Panel**

The left and right wiper panels are on the lower part of the P5 overhead panel.

Windshield Wipers

The windshield wipers are forward of the windshields.

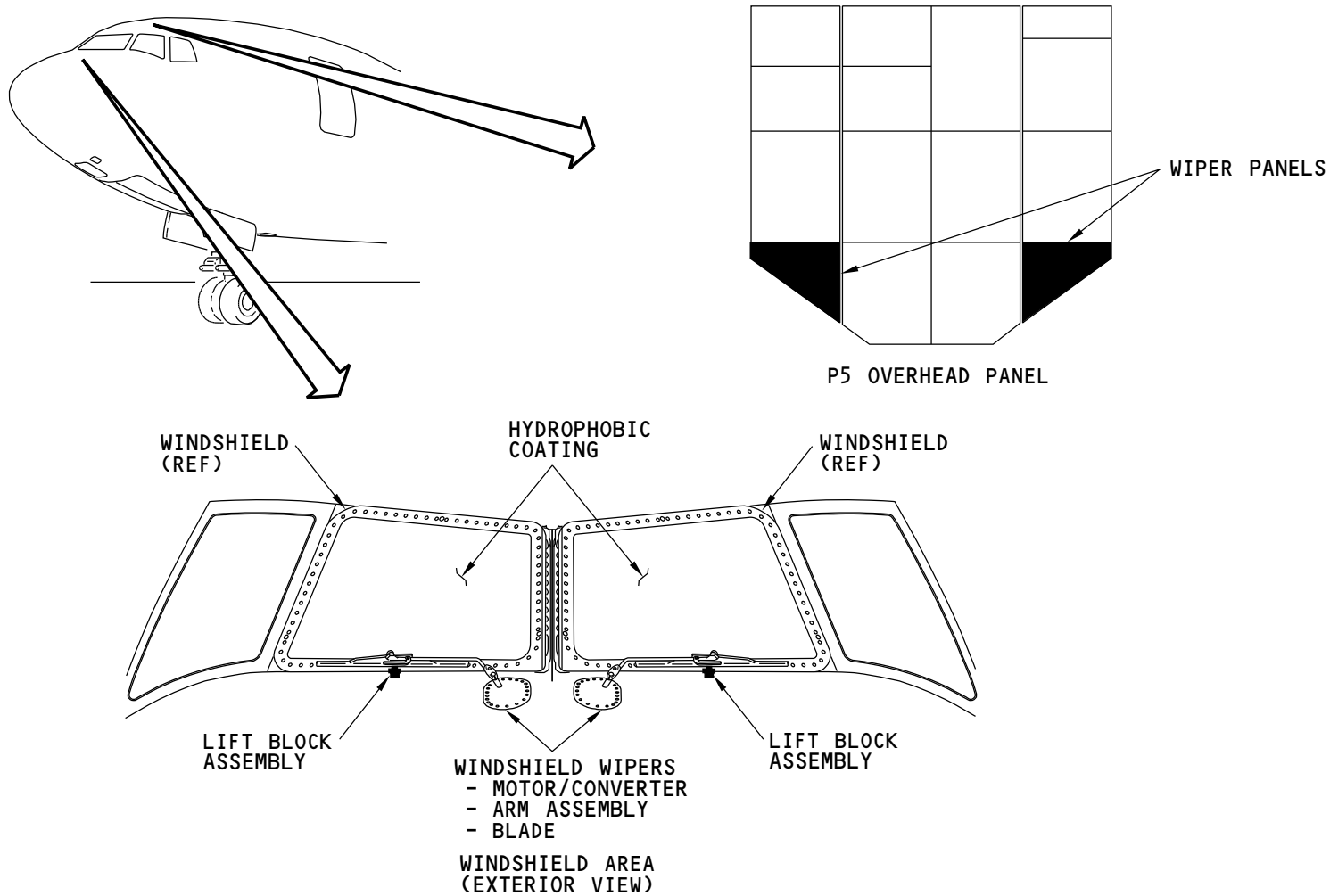
Windshield Wiper Lift Block Assemblies

The lift blocks are forward and below the windshields.

Hydrophobic Coating

The hydrophobic coating is on the outside surface of the windshields (left and right number one windows).

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WINDSHIELD WIPER SYSTEM - COMPONENT LOCATION

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WINDSHIELD WIPER SYSTEM - WIPERS, LIFT BLOCKS, AND HYDROPHOBIC COATING

Purpose

The left and right windshield wiper systems remove precipitation from the windshields.

The windshield wiper lift blocks make the wiper blades move up and off of the windshields when the wiper arms go to the park (OFF) position. The blocks also push on the lock levers to make the wiper blades go to the park (OFF) position.

The hydrophobic windshield coating reduces the need for wipers and gives the flight crew better visibility during heavy rain (0.6 inch of rain or more per hour).

Windshield Wiper

The windshield wiper system has these components:

- Wiper motor/converter
- Wiper arm assembly
- Wiper blade
- Lift block bumper.

All components are LRUs. You access the components from outside the airplane.

The motor/converter has these parts:

- Gear assembly, internal
- 28v dc motor, internal
- Two printed circuit (PC) cards, internal
- Housing
- Output shaft
- Electrical connector.

The unit has an approximate weight of 11 pounds (4.1 kg). The PC cards control the motor. The gear assemblies connect the motor to the output shaft. The gears reduce output speed and increase torque to the output shaft. The output shaft gives a place to connect the wiper arm assembly.

The wiper arm assembly has these parts:

- Adapter - connects the arm to the output shaft of the motor/converter and you use it to adjust wiper arm tension
- Arm - supplies a rigid link between the motor/converter and the wiper blade
- Wiper blade pivot mechanism - moves the wiper blade to the park position and supplies a place to attach the wiper blade.

The wiper blade has a rigid part that attaches to the wiper arm and a soft part that wipes precipitation from the windshield.

The lift block has these parts:

- Housing - connects the block to the airplane
- Shield - moves the wiper blade off of the windshield
- Bumper - stops the wiper arm in the park position and sets the wiper blade pivot mechanism to the park position.

Hydrophobic Coating

The word hydrophobic means to repel or not absorb water. The windshield hydrophobic coating is on the external surface of the left and right number one flight deck windows (windshields). The coating causes raindrops to bead up and roll off, this allows you to see through the windshield with very little distortion.

Training Information Point

 WARNING	BEFORE YOU DO MAINTENANCE ON THE WINDSHIELD WIPER SYSTEM, OPEN THE WINDOW HEAT CIRCUIT BREAKERS. IF YOU DO NOT OPEN THESE CIRCUIT BREAKERS YOU CAN GET AN ELECTRICAL SHOCK WHEN YOU TOUCH THE WINDOW.
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WINDSHIELD WIPER SYSTEM - WIPERS, LIFT BLOCKS, AND HYDROPHOBIC COATING



DO NOT LIFT THE ARM ASSEMBLY MORE THAN 0.5 INCH. YOU CAN CAUSE DAMAGE TO THE ARM ASSEMBLY AND MAKE IT UNSERVICEABLE.



DO NOT OPERATE THE WIPER ON A DRY WINDSHIELD. YOU CAN DAMAGE THE WINDSHIELD.



DO NOT USE ABRASIVE CLEANERS OR CLEANER THAT CONTAIN FLUORIDES ON HYDROPHOBIC COATING.

NOTE: Do not apply polish or wax to the windows that have a hydrophobic coating.

You should use a 50/50 solution of isopropanol alcohol and de-ionized or distilled water applied with as soft cloth or non-abrasive paper towel to clean the windshields.

Particles can be removed from coated windows with the cleaning solution and a plastic cleaning pad. When using a cleaning pad, extreme care must be taken that the removed particles do not become caught in the pad and become a potential cause of scratches in the coating or glass.

The life of the hydrophobic coating is affected by wiper blade tension. If the tension is too high, the coating will wear off quickly.

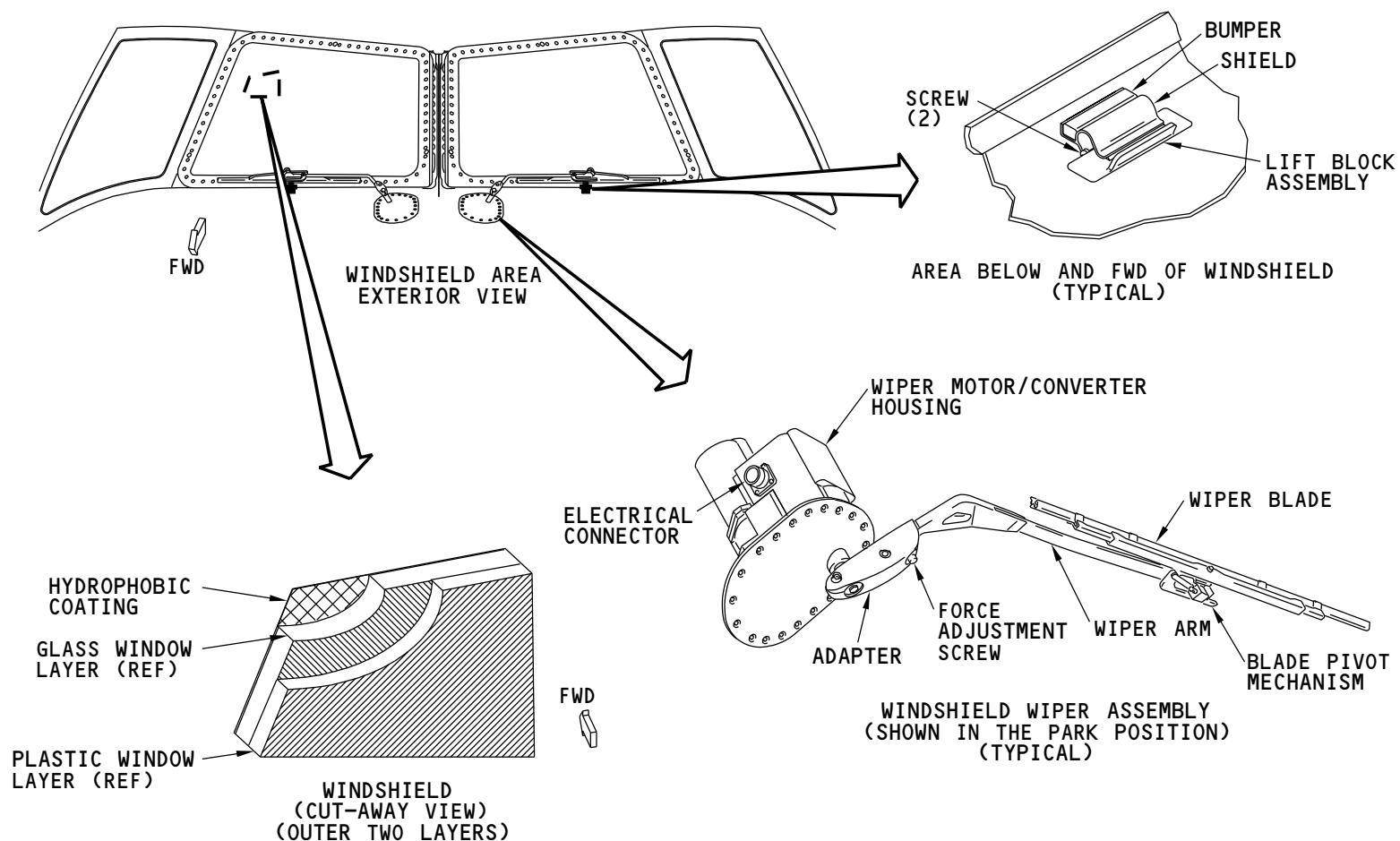
See the servicing section in part II of the AMM (12-16-02) for more information about cleaning the flight compartment windows.

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WINDSHIELD WIPER SYSTEM - WIPERS, LIFT BLOCKS, AND HYDROPHOBIC COATING

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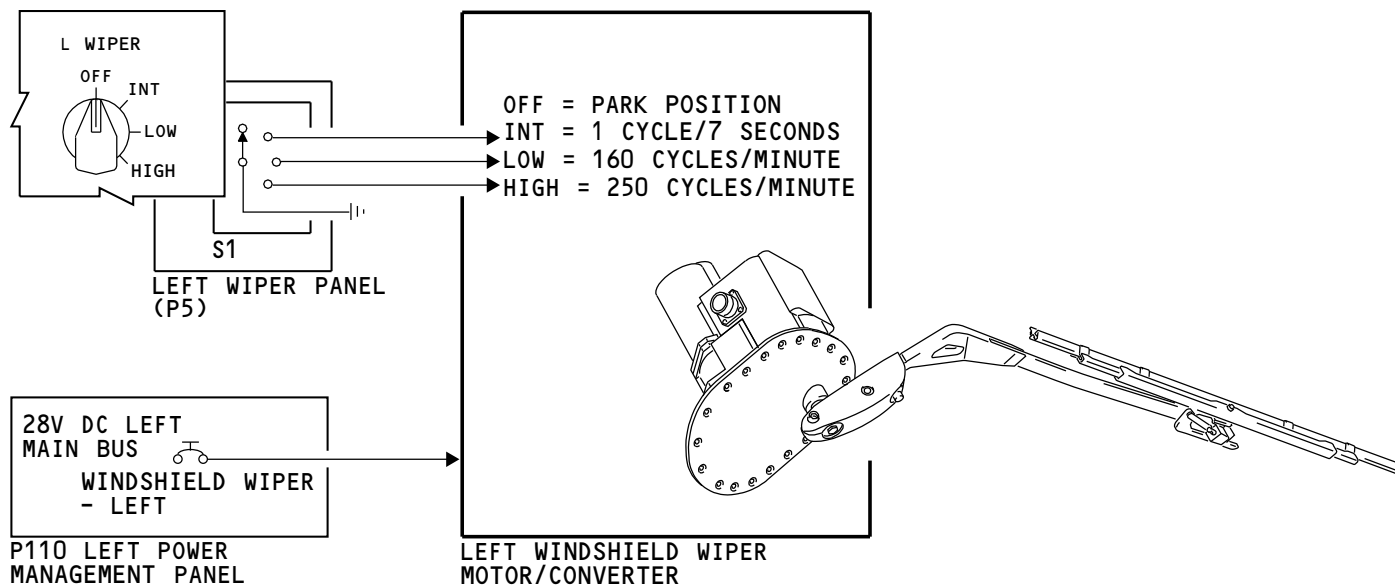
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WINDSHIELD WIPER SYSTEM - FUNCTIONAL DESCRIPTION**Functional Description**

The control circuits for the left and right windshield wipers are similar, the left circuit is shown. The wiper selector supplies mode selection information to the motor/converter. The motor/converter operates and controls the mode of operation for the windshield wiper. The motor/converter supplies these modes:

- OFF, sets the wiper to the park position
- INT, sets the wiper to operate 1 cycle every 7 seconds
- LOW, sets the wiper to operate 160 cycles per minute
- HIGH, sets the wiper to operate 250 cycles per minute.



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WINDSHIELD WIPER SYSTEM - FUNCTIONAL DESCRIPTION

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WINDSHIELD WIPER SYSTEM - OPERATION

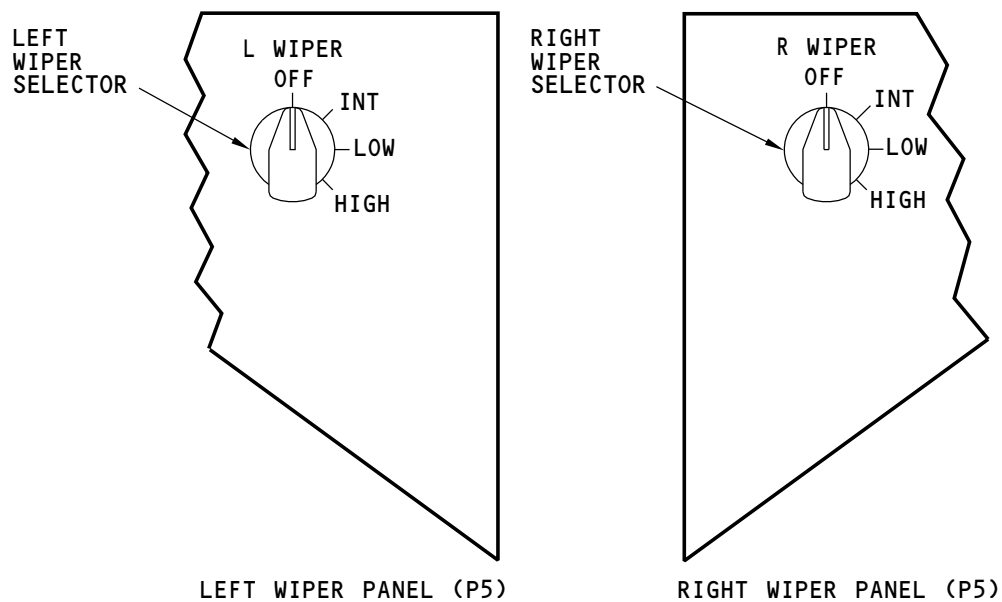
Wiper Selectors

The wiper selectors are on the wiper panel (P5).

Each selector has these positions:

- OFF
- INT
- LOW
- HIGH.

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WINDSHIELD WIPER SYSTEM - OPERATION

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DRAIN AND WATER SUPPLY LINE HEATING - INTRODUCTION

Purpose

Electric heaters prevent ice in the water and waste systems.

General Description

These heaters are in the potable water system:

- Water supply line heaters
- Water tank drain hose heater.

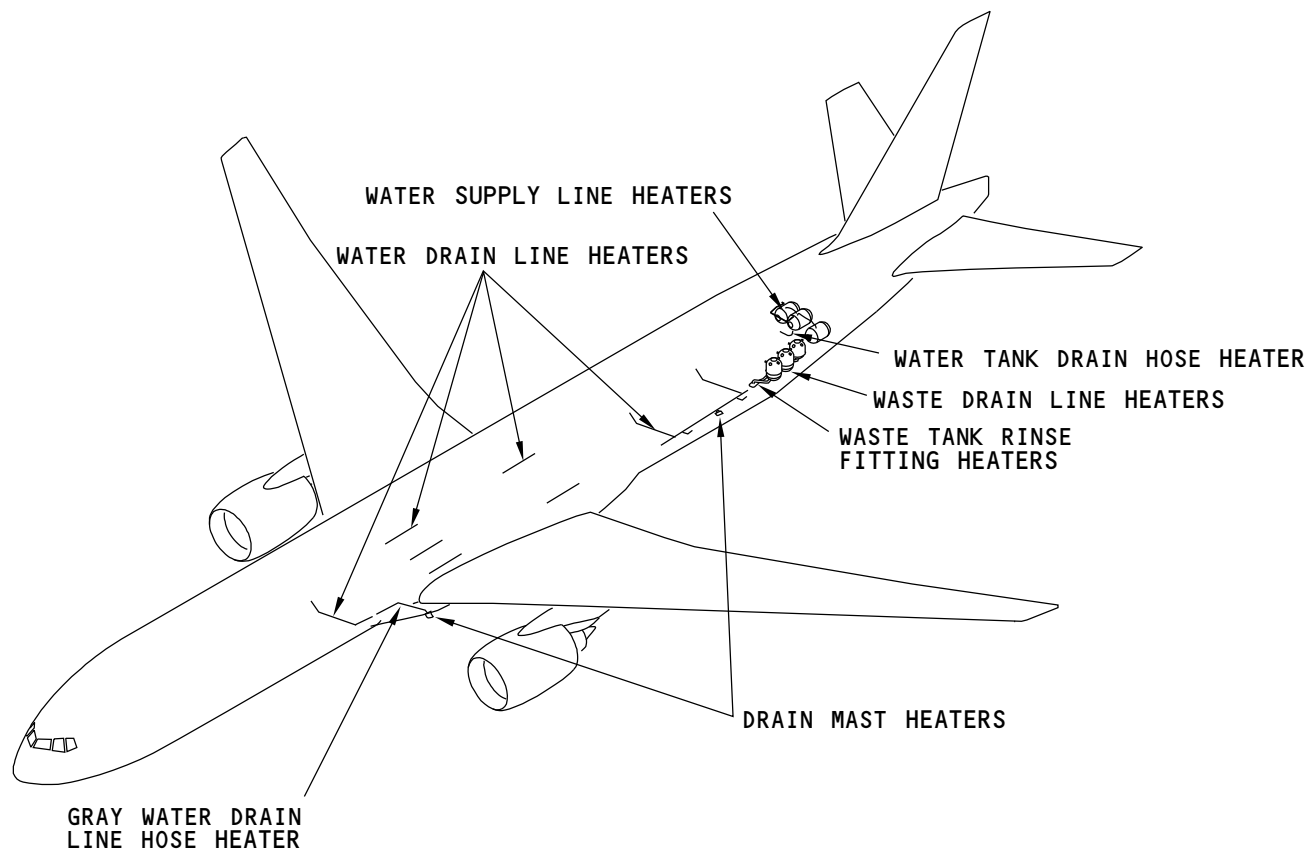
These heaters are in the waste system:

- Waste drain line heaters
- Waste tank rinse fitting heaters.

These heaters are in the gray water drain system:

- Drain mast heaters
- Gray water drain line hose heater
- Water drain line heaters.

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DRAIN AND WATER SUPPLY LINE HEATING - INTRODUCTION

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**DRAIN AND WATER SUPPLY LINE HEATING - WATER SUPPLY IN-LINE HEATER - INTRODUCTION****General**

Water lines carry water from the potable water tanks to the lavatories and galleys.

Each water line has a water supply in-line heater, controller and thermostat.

Some heaters have remote thermostats. The heaters and the remote thermostats are LRUs. Each LRU has an electrical connector.

Two heaters have integral thermostats in the controllers. These thermostats are not separate LRUs.

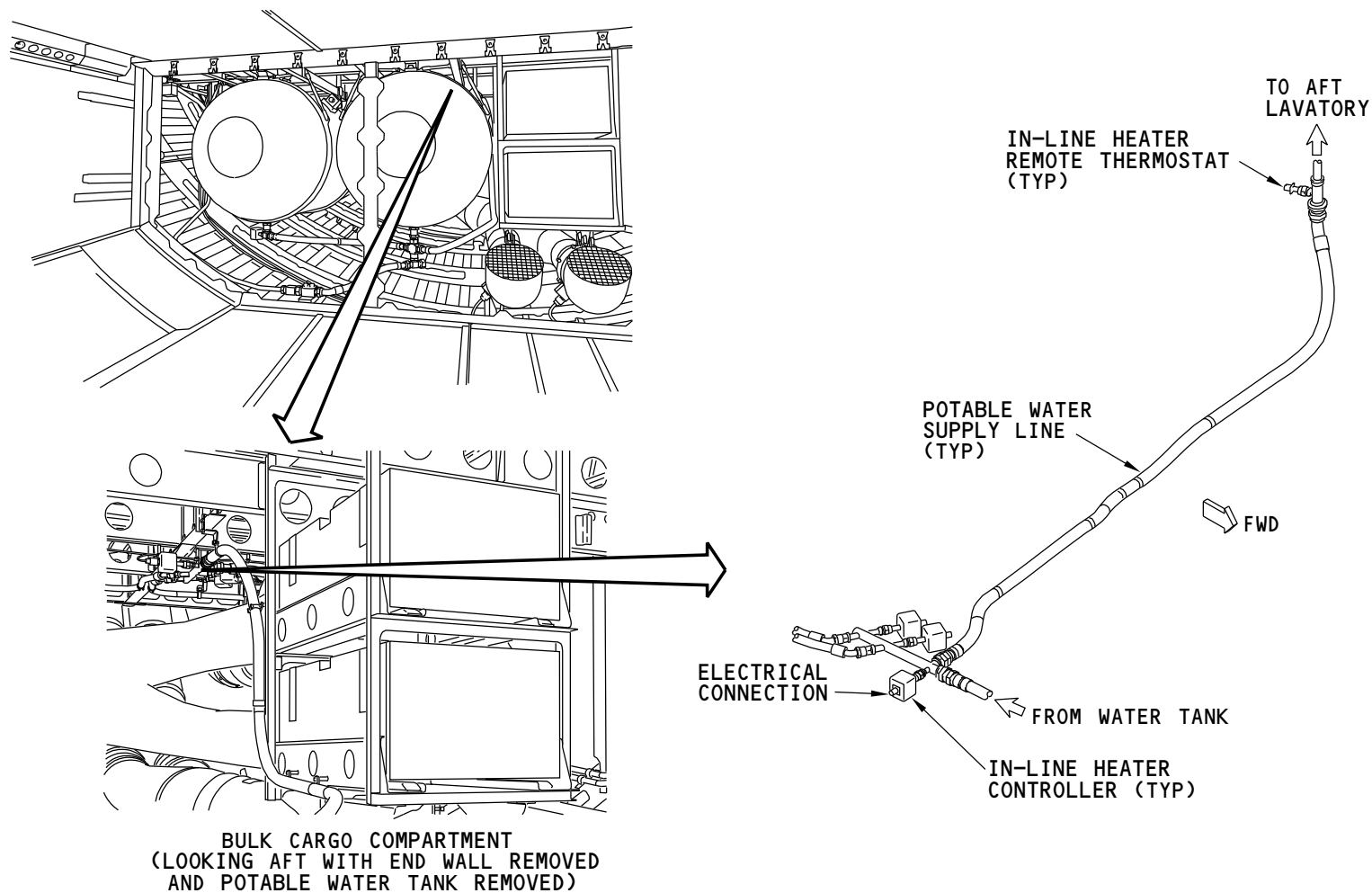
Location

The water supply in-line heaters are near the potable water tanks. Access to the heaters is through the end wall of the bulk cargo compartment.

Training Information Point

It is not necessary to splice the wires when you replace an LRU.

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DRAIN AND WATER SUPPLY LINE HEATING - WATER SUPPLY IN-LINE HEATER - INTRODUCTION

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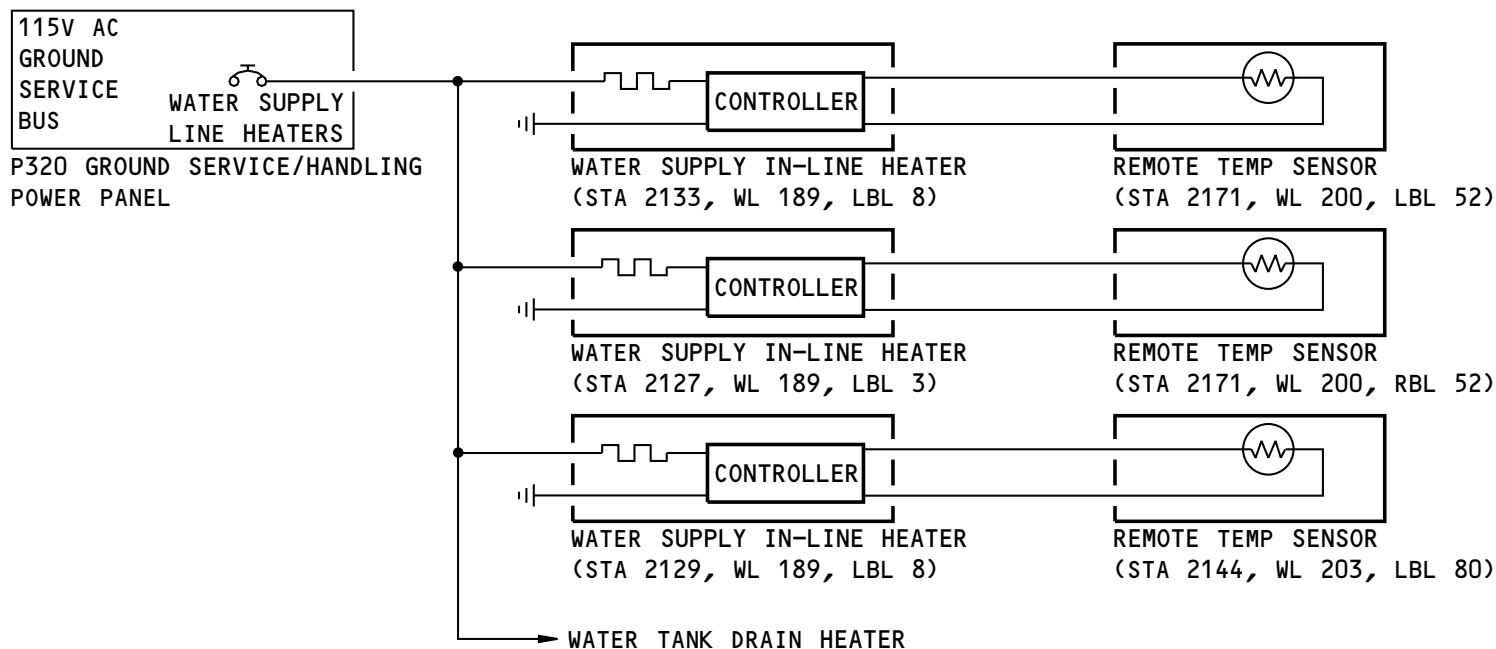
**DRAIN AND WATER SUPPLY LINE HEATING - WATER SUPPLY IN-LINE HEATER - FUNC. DESC.****General**

The heaters in the distribution lines have remote thermostats. The heaters below the left and right potable water tanks have integral thermostats in the controllers. The heaters operate the same.

Functional Description

The thermostat supplies electrical continuity as temperature decreases below freezing. As temperature increases, the thermostat stops continuity to prevent too much heat. The thermostat stops continuity when the temperature is greater than 60F (15C). Continuity comes back when the temperature is less than 45F (7C).

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NOTE: HEATER OFF WHEN TEMPERATURE
IS >60 °F (15 °C)

HEATER ON WHEN TEMPERATURE
IS <45 °F (7 °C)

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DRAIN AND WATER SUPPLY LINE HEATING - WATER SUPPLY IN-LINE HEATER - FUNC. DESC.

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**DRAIN AND WATER SUPPLY LINE HEATING - WATER TANK DRAIN HEATER****General**

The drain line for the potable water tanks has an integral water tank drain heater. The heater prevents freezing in the line. This heated hose is an LRU.

The heater wires on the heated hose do not have electrical connectors. You must splice the wires when you replace a drain hose.

Location

The heated hose is below the space between the right and center potable water tanks. Removable panels provide access to the hose through the aft cargo compartment.

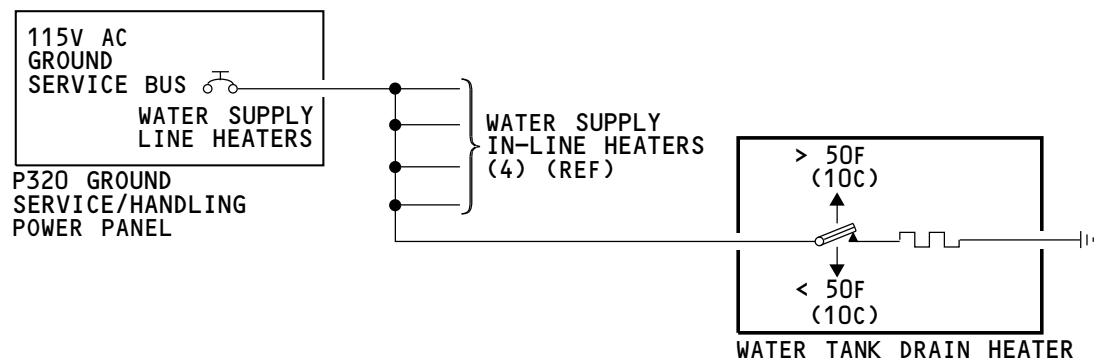
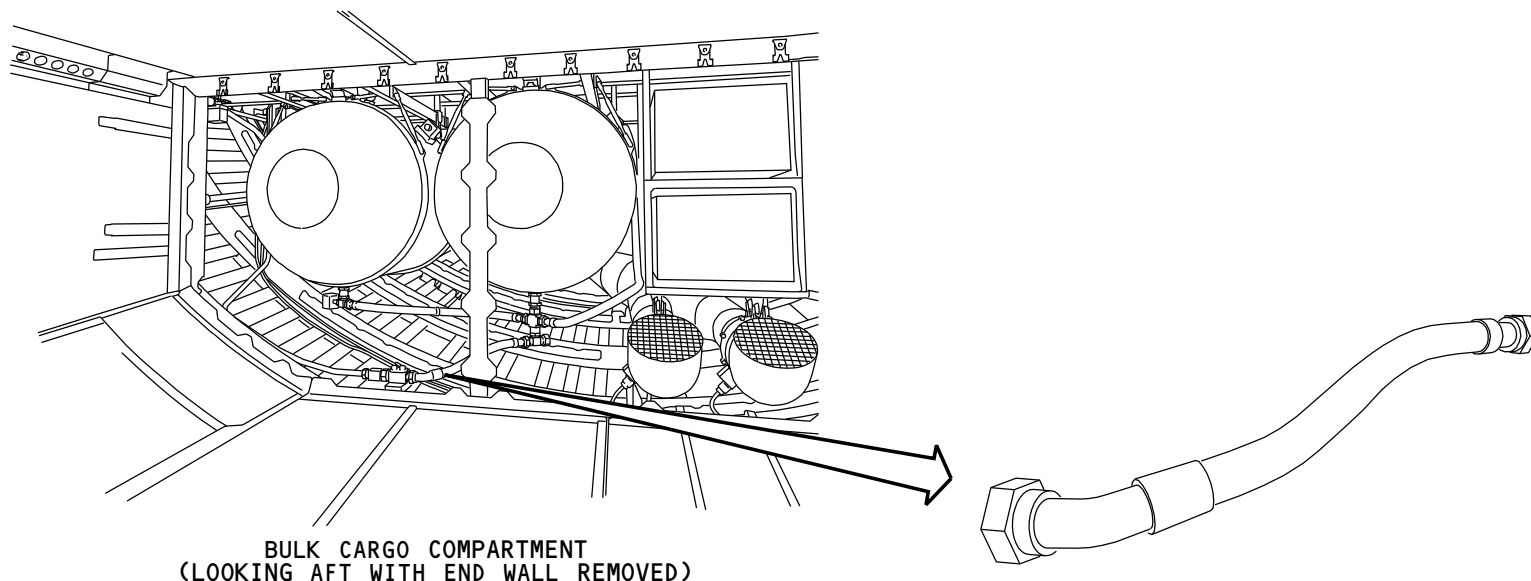
Functional Description

The heated hose has an integral thermostat. The thermostat supplies electrical continuity as temperature decreases below the freeze point. As temperature increases, the thermostat opens the circuit to prevent too much heat. The thermostat opens the circuit when the temperature is greater than 50F (10C). The thermostat closes the circuit when the temperature is less than 50F (10C).

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DRAIN AND WATER SUPPLY LINE HEATING - WATER TANK DRAIN HEATER

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**DRAIN AND WATER SUPPLY LINE HEATING - GRAY WATER DRAIN LINE HEATER AND THERMOSTAT****General**

The forward drain mast has a heated hose identified as the gray water drain line hose heater.

The heated hose has a remote thermostat identified as the gray water drain line hose heater thermostat.

Each component, the hose and the thermostat, is an LRU. The wires do not have electrical connectors. To replace a component you must splice the wires together.

The aft drain mast does not have a heated hose.

Location

The heated hose and its thermostat are in the forward left wing-to-body fairing.

An access panel aft of the drain mast supplies access to the thermostat.

Functional Description

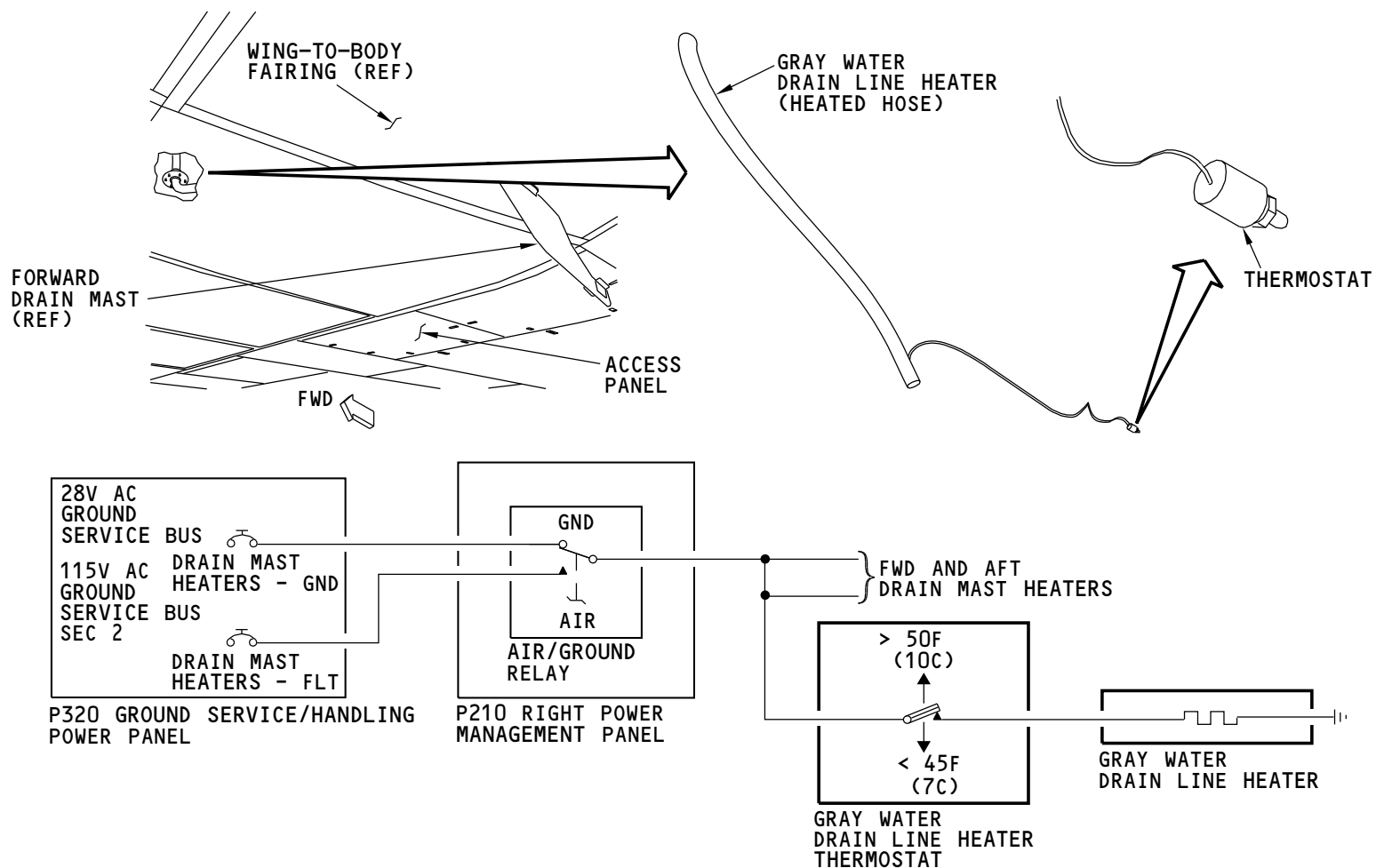
Power for the drain mast heaters comes through an air/ground relay. The heaters get 28v ac on the ground and 115V ac in the air.

The thermostat opens the circuit when the temperature is more than 50F (10C). The circuit closes when the temperature is less than 45F (7C).

Training Information Point

You can remove the drain mast to get better access to the heated hose.

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DRAIN AND WATER SUPPLY LINE HEATING - GRAY WATER DRAIN LINE HEATER AND THERMOSTAT

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**DRAIN AND WATER SUPPLY LINE HEATING - DRAIN MAST HEATER****General**

There are drain mast heaters in the forward and aft drain masts to prevent freezing. Each drain mast is an LRU and is interchangeable with the other.

The heater wires on the drain masts do not have electrical connectors. You must splice the wires when you replace a drain mast.

Location

Both drain masts are on the left wing-to-body fairing.

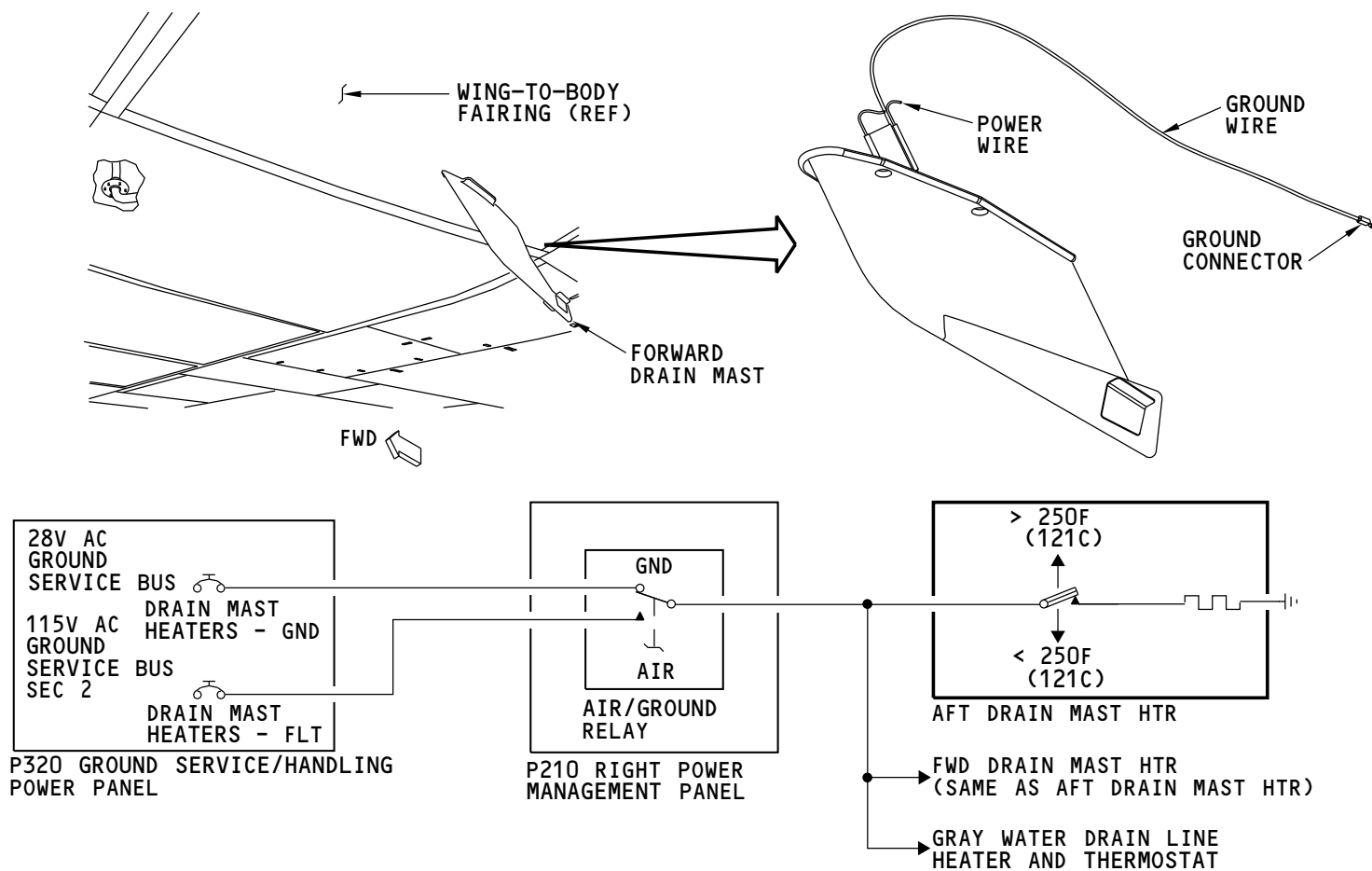
You can remove the drain mast from the fairing. It is not necessary to open a panel to get access to the drain mast.

Functional Description

Power for the drain mast heaters comes through an air/ground relay. The heaters get 28v ac on the ground and 115v ac in the air.

An overheat thermostat will opens the circuit when the temperature is greater than 250F (121C). The circuit closes when the temperature is less than 250F (121C).

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DRAIN AND WATER SUPPLY LINE HEATING - DRAIN MAST HEATER

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DRAIN AND WATER SUPPLY LINE HEATING - WATER DRAIN LINE HEATERS - INTRODUCTION**Purpose**

Water drain line heaters keep the gray water drain lines in the lower part of the fuselage from freezing.

General Description

The heater is a flexible element installed around the drain line. The heater also includes an overheat switch (not shown). Electrical connectors attach to the heater and to ground studs. Metal clamps attach the ground studs to the drain line. (Some assemblies have only one connector and ground stud.)

Thermal insulation (held in place with tape) covers the drain line and heating element. Adhesive markers identify the flow direction and part number. On some drain lines, a clamp holds a thermostat.

Location

Some of the heated gray water drain lines are below the floor panels and walkways of the forward, aft, and bulk cargo compartments. Other lines (not shown) are below the passenger compartment floor above the wing center section.

Training Information Point

The heater is an LRU. In some places it is easier to replace the heater if you remove the drain line from the airplane. If you do this, you must do a leak check when you install the drain line.

When you replace a heater, you need to do an operational test. Cool the thermostat with crushed ice or freeze spray and use a clamp-on ammeter to measure current through the heater.

**CAUTION**

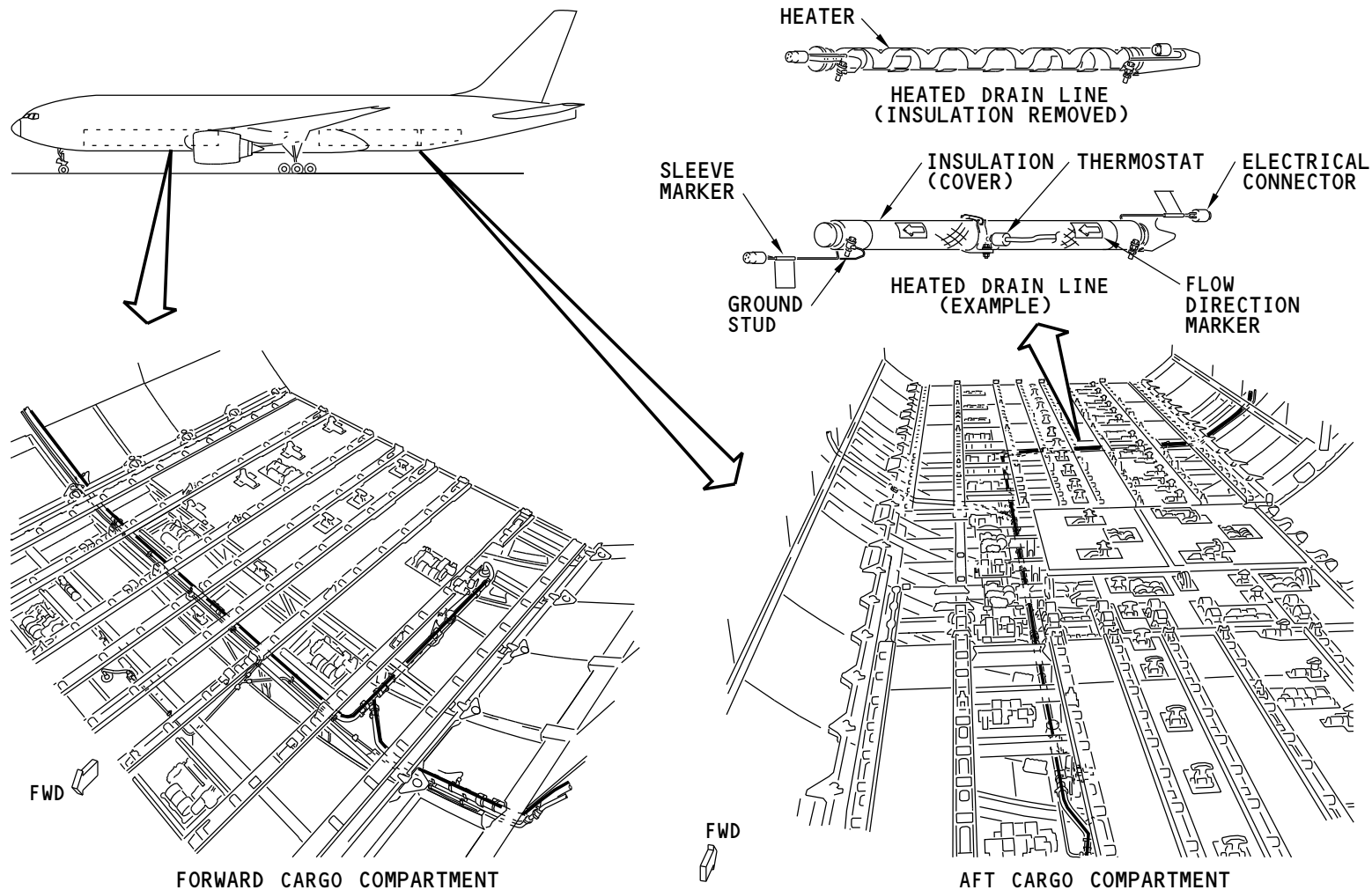
MAKE SURE YOU PUT THE CORRECT HEATER ASSEMBLY ON THE TUBE ASSEMBLY. IF THE HEATER ASSEMBLY IS INCORRECT, IT WILL CAUSE THE DRAIN LINES TO FREEZE OR BECOME TOO HOT.

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DRAIN AND WATER SUPPLY LINE HEATING - WATER DRAIN LINE HEATERS - INTRODUCTION

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**DRAIN AND WATER SUPPLY LINE HEATING - WATER DRAIN LINE HEATERS - FUNCTIONAL DESCRIPTION****General**

The ground service bus supplies 115v ac power to the water drain line heater circuits. There are two circuit breakers for the forward drain line heaters and two circuit breakers for the aft drain line heaters. The forward drain lines connect to the forward drain mast and the aft drain lines connect to the aft drain mast.

Functional Description - Fwd And Aft Heaters

All thermostats (bi-metallic switches), except thermostat B30105, open the heater circuit when the temperature at the thermostat is 60°F (16°C) or more. When the temperature is 45°F (7°C) or less, all the thermostat except thermostat B30105, close the heater circuit. In most circuits, the thermostats control power to more than one heater.

The thermostat B30105 opens the heater circuit when the temperature at the thermostat is 70°F (21°C) or more. When the temperature is 55°F (18°C) or less, the thermostat closes the heater circuit. In most circuits, the thermostat controls power to more than one heater.

An overheat switch in the heater opens if the temperature is 243°F (117°C) or more. The overheat switch does not reset. Most circuits have several heaters in series. If an overheat switch opens, it removes power from all the heaters in the series circuit.

Functional Description - Overwing Heaters

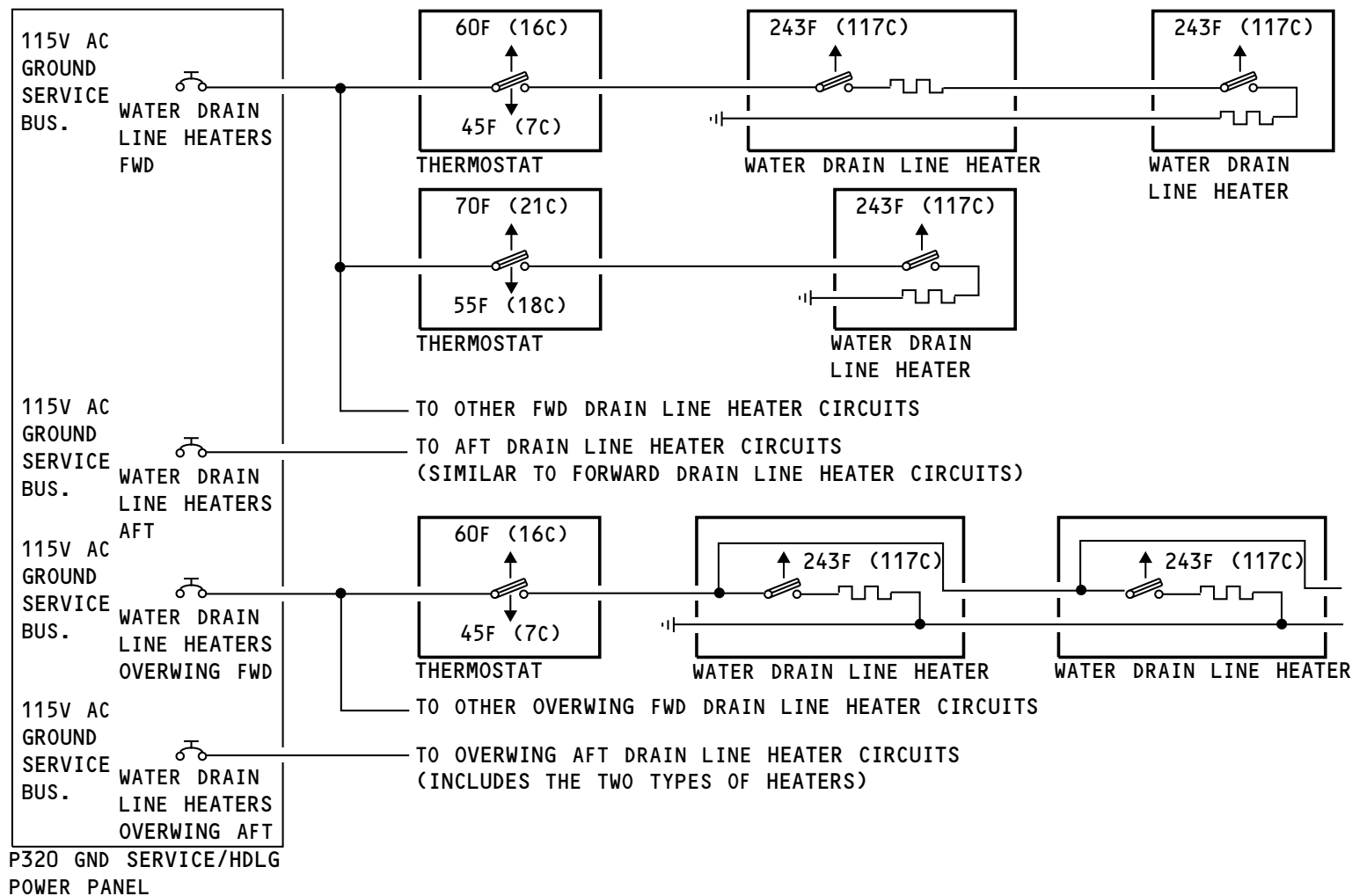
The forward overwing heaters are different from the forward or aft heaters. In a forward overwing circuit, an open overheat switch removes power only from the related heater. The other heaters in the circuit continue to operate as usual.

The aft overwing heater circuits mix the two types of heaters.

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DRAIN AND WATER SUPPLY LINE HEATING - WATER DRAIN LINE HEATERS - FUNCTIONAL DESCRIPTION

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DRAIN AND WATER SUPPLY LINE HEATING - WASTE TANK RINSE FITTING HEATERS**General**

There are three waste tank rinse fittings. The rinse fittings connect the waste tank rinse lines to the waste drain service panel. Each rinse fitting has a heater boot identified as the waste tank rinse fitting heater. The rinse fitting heaters are interchangeable LRUs.

The waste tank rinse fitting heater has a power wire and a ground wire. The power wire does not have an electrical connector. You need to splice the power wire when you replace a rinse fitting heater.

The waste tank rinse fitting heater has an integral thermostat and an integral overheat thermostat.

Location

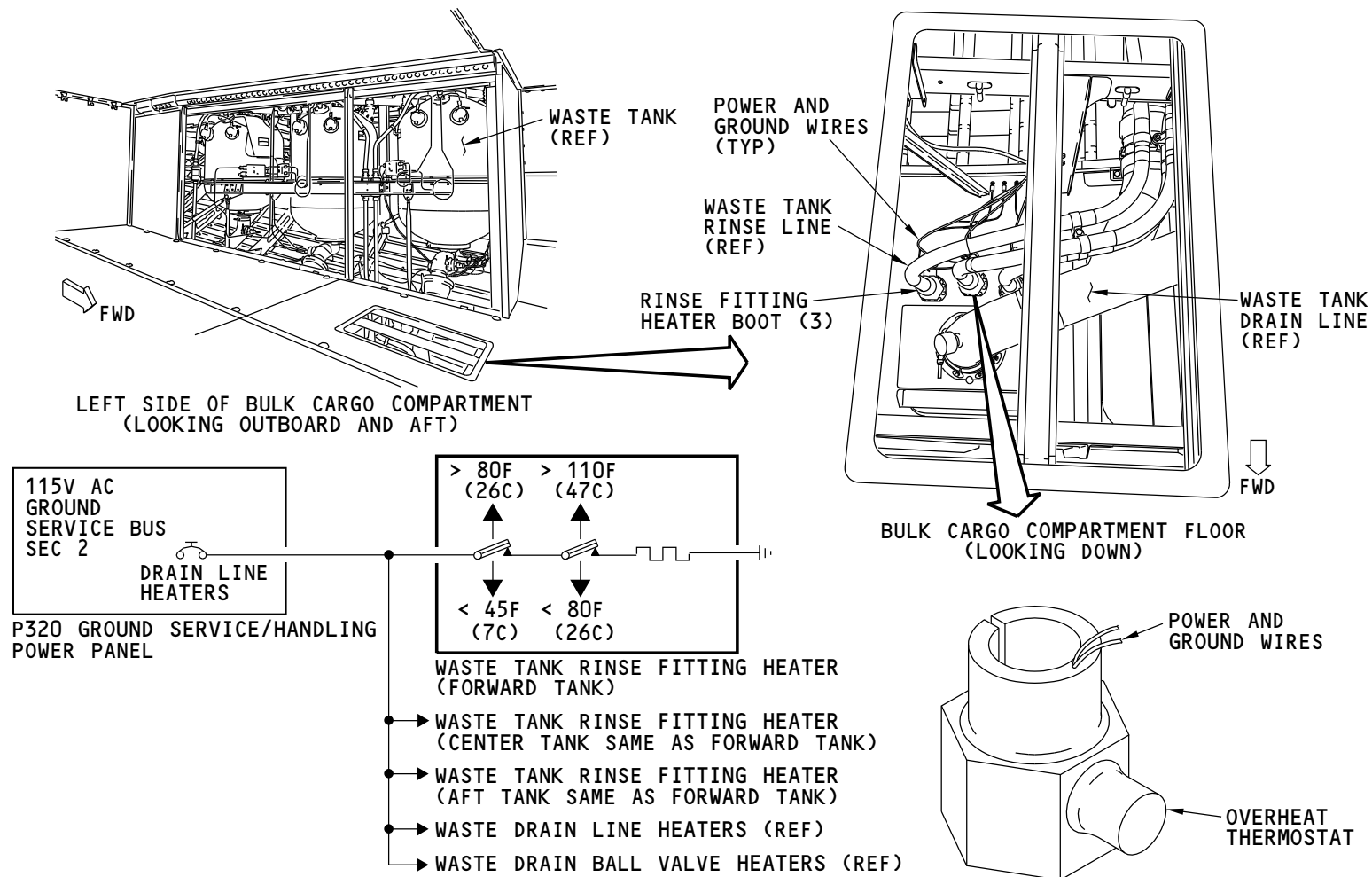
The waste tank rinse fitting heaters are below the bulk cargo compartment floor. You can access the heaters through an access panel on the floor of the bulk cargo compartment.

Functional Description

The integral thermostat controls the power for the waste tank rinse fitting heater. The thermostat closes the circuit as temperature decreases below the freeze temperature. The thermostat opens the circuit to prevent too much heat.

The integral overheat thermostat prevents damage to the heater if the integral thermostat fails.

The integral thermostat opens the circuit when the temperature is greater than 80°F (27°C). The circuit closes when the temperature is less than 45°F (7°C). The integral overheat switch opens the circuit when the temperature is greater than 110°F (43°C). The circuit closes when the temperature is less than 80°F (27°C).



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DRAIN AND WATER SUPPLY LINE HEATING - WASTE TANK RINSE FITTING HEATERS

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**DRAIN AND WATER SUPPLY LINE HEATING - WASTE TANK DRAIN LINE HEATERS - INTRODUCTION****General**

There are three waste tank drain lines. Each drain line has a valve. The lines and valves all have thermostatically-controlled heater blankets.

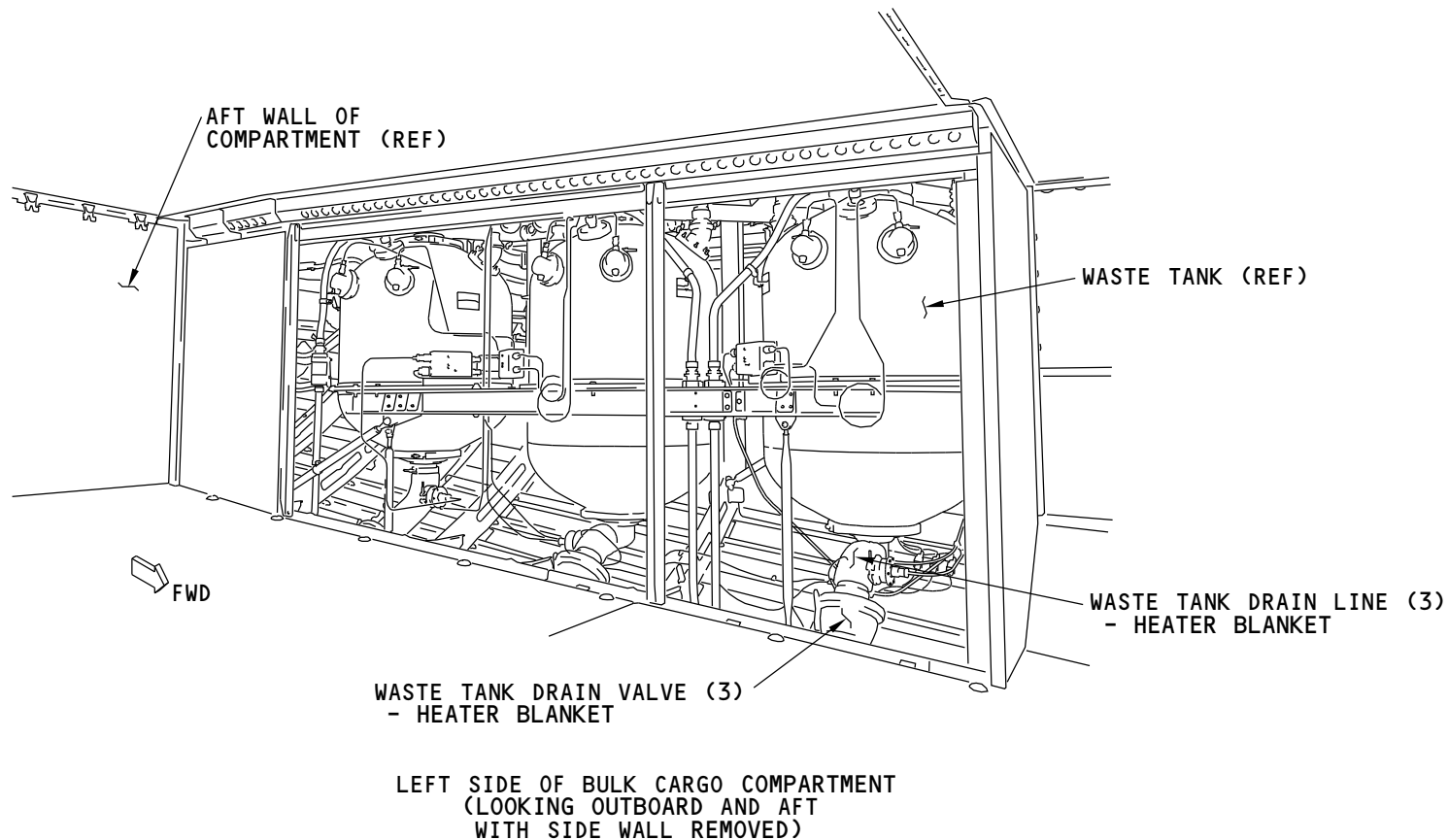
Each heater blanket has an integral thermostat and a overheat switch that can not be reset. Each heater is an LRU. Drain line blankets are not interchangeable. Valve blankets are interchangeable. Drain line blankets are not interchangeable with valve blankets.

The heater blankets have electrical connectors.

Location

The heater blankets are below the waste tanks. You can get access to them through the same panels that supply access to the waste tanks.

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DRAIN AND WATER SUPPLY LINE HEATING - WASTE TANK DRAIN LINE HEATERS - INTRODUCTION

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**DRAIN AND WATER SUPPLY LINE HEATING - WASTE TANK DRAIN LINE HEATERS - FUNC. DESC.****General**

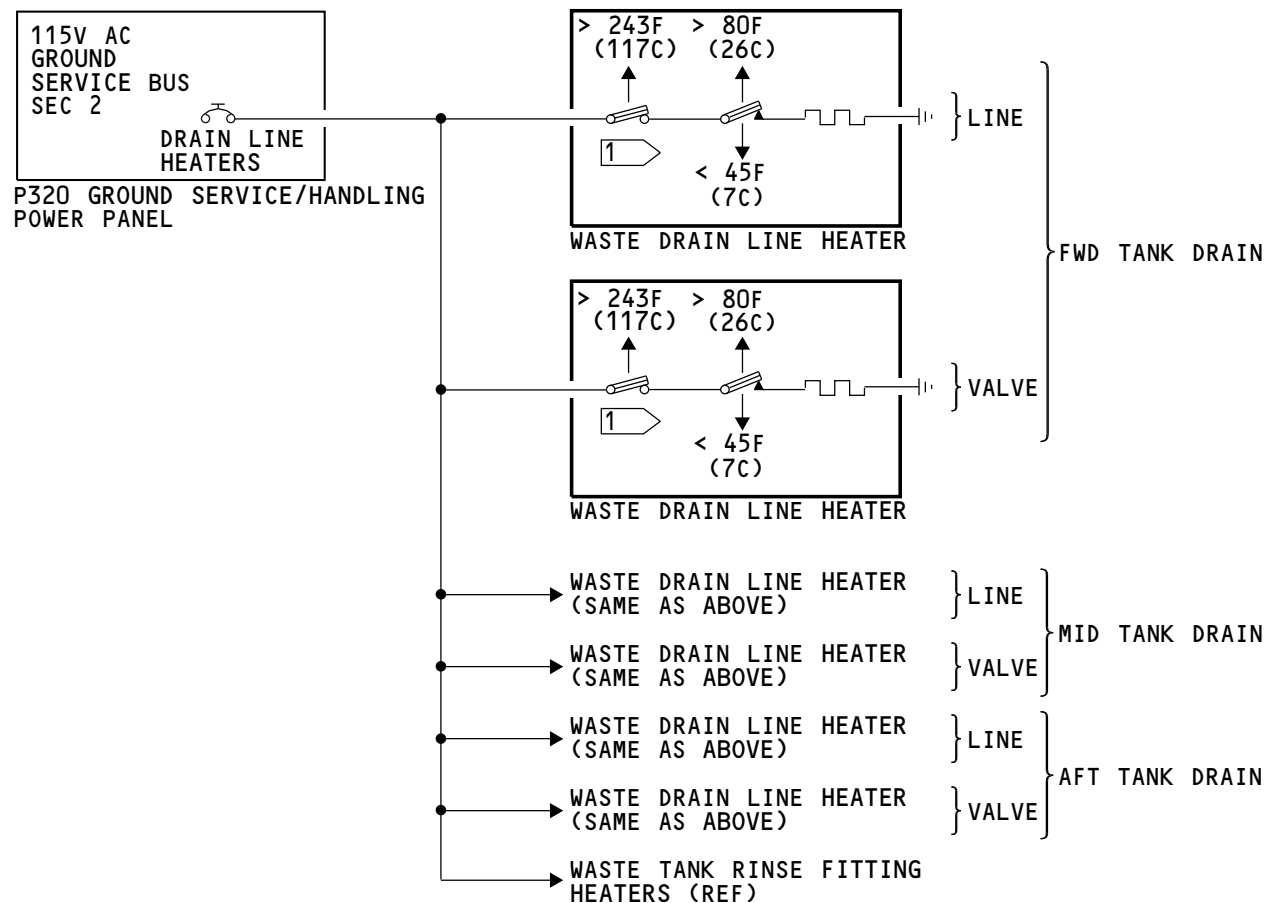
The heater blankets on the waste tank drain lines operate the same as the heater blankets on the drain valves.

Functional Description

Each heater blanket has an integral thermostat and an overheat switch. The thermostat supplies electrical continuity as temperature decreases below freezing. As temperature increases, the thermostat opens the circuit to prevent too much heat. The thermostat opens the circuit when the temperature is greater than 80°F (27°C). The thermostat closes the circuit when the temperature is less than 45°F (7°C). The overheat switch opens the circuit when the temperature is greater than 243°F (117°C). If the overheat switch opens the circuit, the circuit will not automatically reset.

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1 THE SWITCH DOES NOT RESET.

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DRAIN AND WATER SUPPLY LINE HEATING - WASTE TANK DRAIN LINE HEATERS - FUNC. DESC.

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ICE DETECTION SYSTEM - INTRODUCTION

Purpose

The ice detection system (IDS) supplies information about ice conditions to the wing anti-ice (WAI) and the engine anti-ice (EAI) systems.

General Description

The IDS has two ice detectors that operate independently. The left detector connects to the ARINC buses through the left EAI ACIPS card. The right detector connects to the ARINC buses through the right EAI ACIPS card.

Each ice detector has a circuit that calculates when the EAI systems should be on or off and a circuit that calculates when the wing anti-ice system should be on or off. The circuits give separate signals to the EAI ACIPS control cards.

On the ground, the signals are inhibited (ground mode).

In the air, the ACIPS control cards use the signals to control the applicable anti-ice systems and EICAS messages (air mode). The ice signal to the EAI system occurs first (ice detected for a short period of time). If ice is detected for a longer period of time, the ice signal goes to the WAI system. When no ice is detected for more than three minutes, the detectors remove the ice signals to the EAI and the WAI systems.

All ACIPS control cards get information from both ice detectors, directly or through the ARINC 629 buses. An ice signal from either detector is used for control and indication.

See the wing anti-ice section for more information about the wing anti-ice system (SECTION 30-11). See the engine anti-ice section for more information about the engine anti-ice system (SECTION 30-21).

BITE circuits in the ice detectors monitor the condition of internal functions. BITE circuits in the left and right EAI ACIPS control cards make the detectors do a test when the detectors first get power and periodically do a test of these interfaces:

- Power to the detectors
- Output signals (ice for engine, ice for wing and fault).

The AIMS gives information about the system through the EICAS display, status display, and the ice protection maintenance page. You use the MAT to do a ground test for the system and to see maintenance messages.

The IDS has these other interfaces:

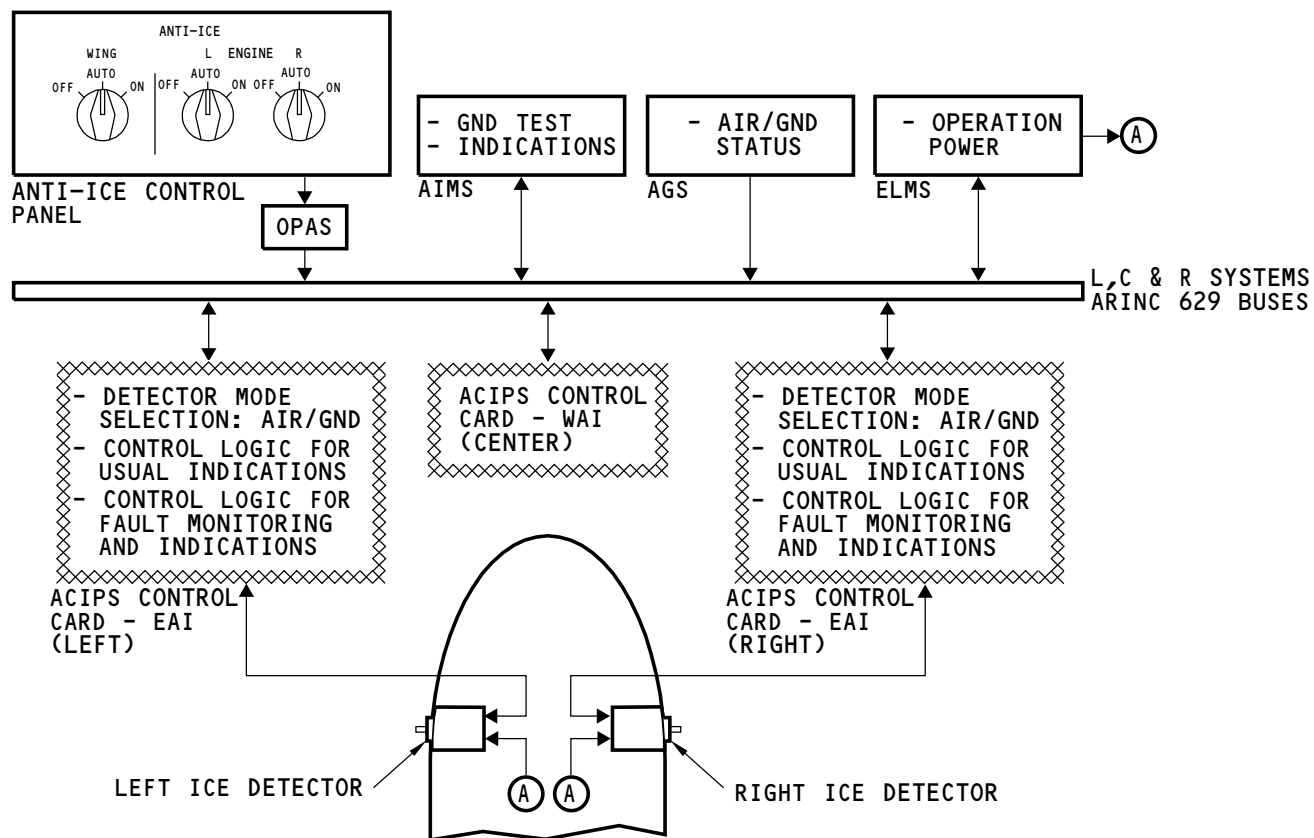
- Air ground system (AGS)
- Electrical load management system (ELMS).

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ICE DETECTION SYSTEM - INTRODUCTION

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ICE DETECTION SYSTEM - ICE DETECTORS

Purpose

The ice detectors monitor for ice conditions and supply the information to the airfoil and cowl ice protection system (ACIPS).

Location

The ice detectors are on the left and right sides of the nose section of the fuselage (STA 209 WL 162).

Physical Description

The left and right ice detectors are the same. The detectors have these parts:

- Electrical connector
- Housing
- Circuit cards, internal to the housing
- Microprocessor, internal to the housing
- Probe (sensing-element) with a heater
- Strut.

The detectors are LRUs, they have no parts that are LRUs.

Functional Description

Each ice detector operates independently. The ice detector probe vibrates at approximately 40,000 Hz. The probe vibrates at a lower frequency when it collects ice. A heater for the probe turns on when the probe vibrates less than 39,867 Hz. The heater stays on until the probe vibration returns to its usual value or the heater operates for 25 seconds. The usual time that the heater is on is 5 - 7 seconds. If the heater is on for 25 seconds, the heater turns off, and a fault condition is latched.

Control logic in the detector counts the number of heater on to off cycles.

If there are two or more cycles, and the airplane is in the air, the ice detector gives an engine icing signal to the ACIPS. The detector also gives an engine icing signal if the airplane is in the air, and the heater is on for 15 seconds or more.

If there are ten cycles and the airplane is in the air, the detector gives a wing icing signal to the ACIPS.

The icing signals stay on until any of these conditions occur:

- No ice for more than three minutes
- The airplane is on the ground
- The heater is on for 25 seconds.

The detectors have circuits that monitor operation and give a fault signal if necessary. The detectors also have BIT circuits that become active by a push-to-test (PTT) signal from the ACIPS.

See the wing anti-ice section for more information about wing anti-ice (SECTION 30-11). See the engine anti-ice section for more information about engine anti-ice (SECTION 30-21).

Training Information Point



WARNING

THE PROBE OF THE ICE DETECTOR CAN CAUSE SERIOUS BURNS WHEN THE HEATER IS ON.



CAUTION

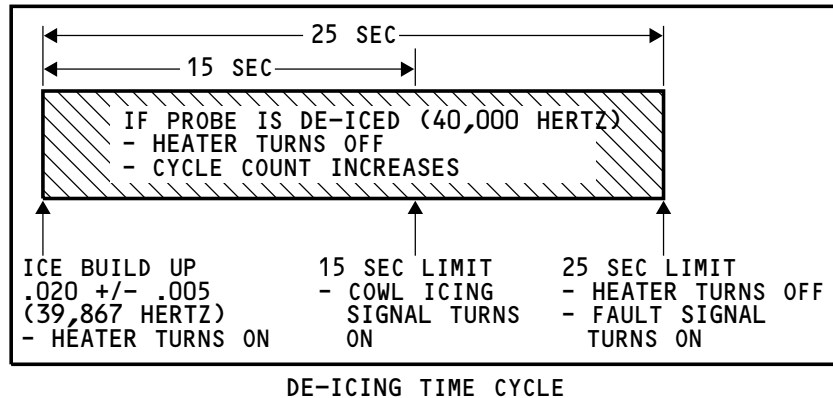
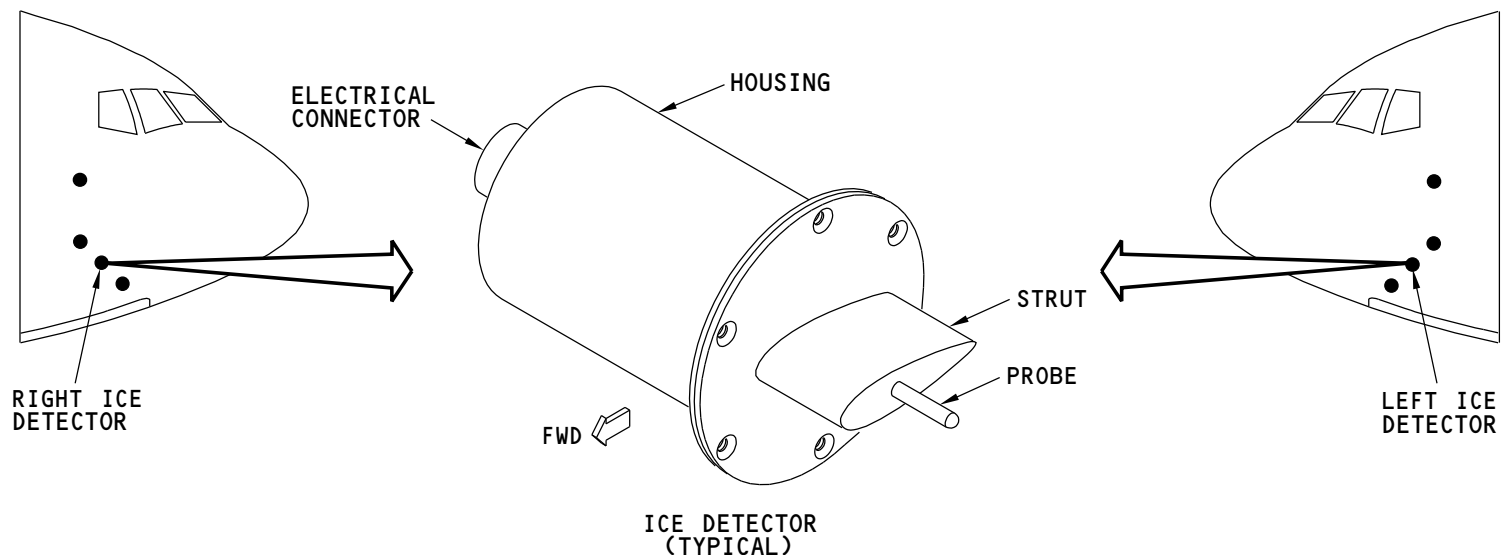
THIS EQUIPMENT CONTAINS DEVICES THAT CAN BE DAMAGED BY ELECTROSTATIC DISCHARGE (ESD). ESD HANDLING PRECAUTIONS REQUIRED.

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ICE DETECTION SYSTEM - ICE DETECTORS

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ICE DETECTION SYSTEM - FUNCTIONAL DESCRIPTION

General

The ice detection system (IDS) has a left ice detector and a right ice detector. The detectors get 115v ac from the left or right main bus. The left detector has connections to the left EAI ACIPS control card. The right detector has connections to the right EAI ACIPS control card. These are the connections:

- Fault signal (output)
- Engine icing signal (output)
- Wing icing signal (output)
- Push-to-test (PTT) signal (input)
- Air/ground signal (input).

These are the three ACIPS control cards:

- Left engine anti-ice ACIPS control card
- Right engine anti-ice ACIPS control card
- Wing anti-ice ACIPS control card.

Each card connects to the other two cards through the systems ARINC 629 buses. The left and right EAI ACIPS control cards do these functions for the IDS:

- Does a power-up test (automatic)
- Does a periodic test (automatic)
- Does the PTT (MAT, ground test)
- Sets the mode of operation (ground or air)
- Gives fault information to AIMS for indications
- Resets latched faults (during pwr-up, gnd test, or after the IDS gives a fault signal).

See the wing anti-ice section for more information about wing anti-ice ACIPS control card (SECTION 30-11). See the engine anti-ice section for more information about engine anti-ice ACIPS control card and system test (SECTION 30-21).

Ground Operation

When the IDS operates in the ground mode (on the ground and airspeed < 0.180 mach), the wing and engine icing output signals are inhibited. The PTT input and the fault output signals are enabled. The ACIPS continuously does a check of the operation of the ice detectors.

The PTT input signal operates when these conditions occur:

- ACIPS gets power
- IDS gets power
- IDS gives a fault signal
- System test of the EAI system from the MAT.

The PTT makes the applicable ice detector and the ACIPS do a full check of the ice detector and its interfaces.

Air Operation

When the IDS operates in the air mode, the wing and engine icing and the fault output signals are enabled. The PTT input signal is inhibited.

An engine icing signal or an engine and wing icing signal can come from either or both ice detectors. The signal from one detector goes directly to one EAI ACIPS control card. The card that receives the signal(s) directly, sends the signal(s) to the other two ACIPS control cards. The cards use the information about icing with other airplane conditions to calculate when to turn on the EAI and WAI systems. The cards also use the information about icing to control related EICAS messages for the EAI and WAI systems. See the wing anti-ice section for more information about the wing anti-ice system operation and messages (SECTION 30-11). See the engine anti-ice section for more information about the engine anti-ice system operation and messages (SECTION 30-21).

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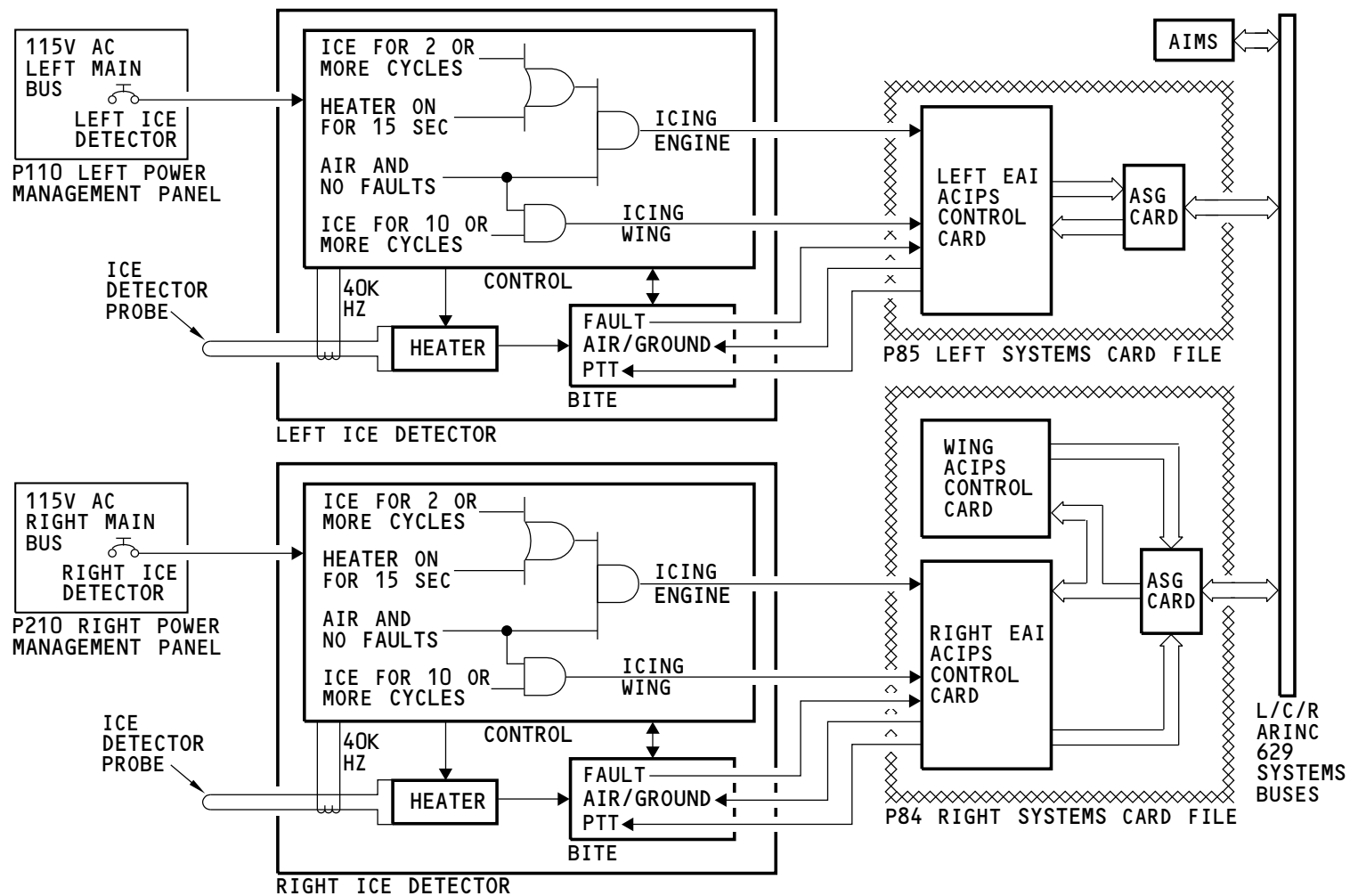
**ICE DETECTION SYSTEM - FUNCTIONAL DESCRIPTION****Faults**

The detectors and the EAI ACIPS control cards can find faults. If there is a fault, the ACIPS sends the fault information to AIMS. AIMS shows a status message, ICE DETECTOR L (R) for the detector that has a fault. If both detectors fail, AIMS shows an advisory message, ICE DETECTORS. AIMS also shows maintenance messages that help you isolate the fault.

Training Information Point

You can do a check of the status of the outputs from the IDS on the ice protection maintenance page. See the ice and rain protection section for more information about the ice protection maintenance page (SECTION 30-00).

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ICE DETECTION SYSTEM - FUNCTIONAL DESCRIPTION

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