CHAPTER

21

Air Conditioning

CHAPTER 21
AIR CONDITIONING

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AIR CONDITIONING - INTRODUCTION

Purpose

The air conditioning system controls the interior environment of the airplane for flight crew, passengers, and equipment.

Air Conditioning Sub-Systems

These are the air conditioning sub-systems:

- Distribution
- Pressurization
- Equipment cooling
- Heating
- Cooling
- Temperature control.

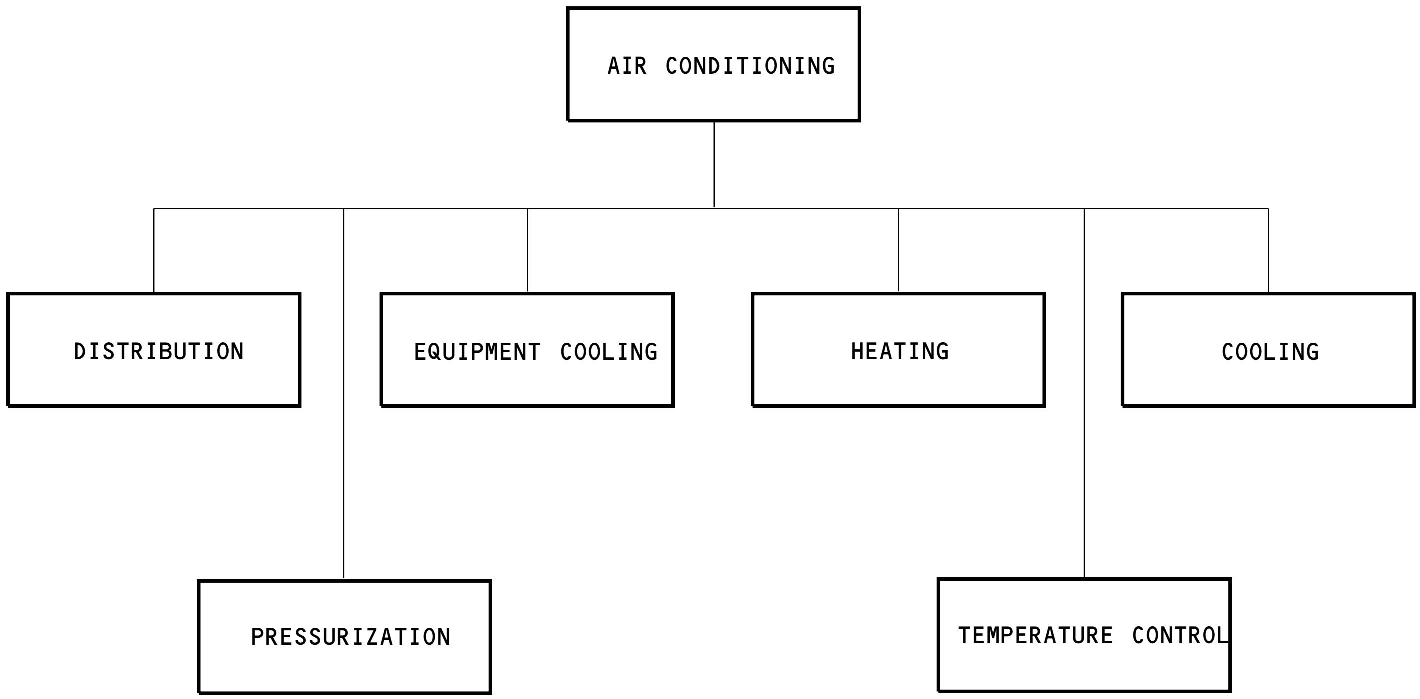
Abbreviations and Acronyms

- A/C - air conditioning
- ACAU - air conditioning accessory unit
- C - Celsius
- clng - cooling
- CPC - cabin pressure controller
- EE - electronic equipment
- F - Fahrenheit

AKS 001-021
- PZTC - pack/zone temperature controller

AKS 022-999
- PFTC - pack flow temperature controller

AKS ALL
- TCV - temperature control valve
- FLT COMPT - flight compartment



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AIR CONDITIONING - INTRODUCTION

AIR CONDITIONING - GENERAL DESCRIPTION

General

These flight compartment panels let you control the air conditioning system:

- Air conditioning/bleed air controls panel, P5-10
- Cabin temperature panel, P5-17
- Equipment cooling panel, P5
- Cabin pressure control panel, P5-6.

These components in the EE compartment control the functions of the air conditioning system:

AKS 001-021

- Two pack/zone temperature controllers

AKS 022-999

- Two pack flow temperature controllers

AKS ALL

- Two air conditioning accessory units (ACAU)
- Cabin pressure controllers (CPC).

AKS 001-021

Pack/Zone Temperature Controller

The pack/zone temperature controllers control these functions of the air conditioning system:

- Pack cooling temperature
- Trim air, regulation, on or off
- Zone temperature.
- Ram air system

AKS 022-999

Pack Flow Temperature Controller

The pack flow temperature controllers control these functions of the air conditioning system:

- Pack cooling temperature
- Trim air, regulation, on or off
- Zone temperature.

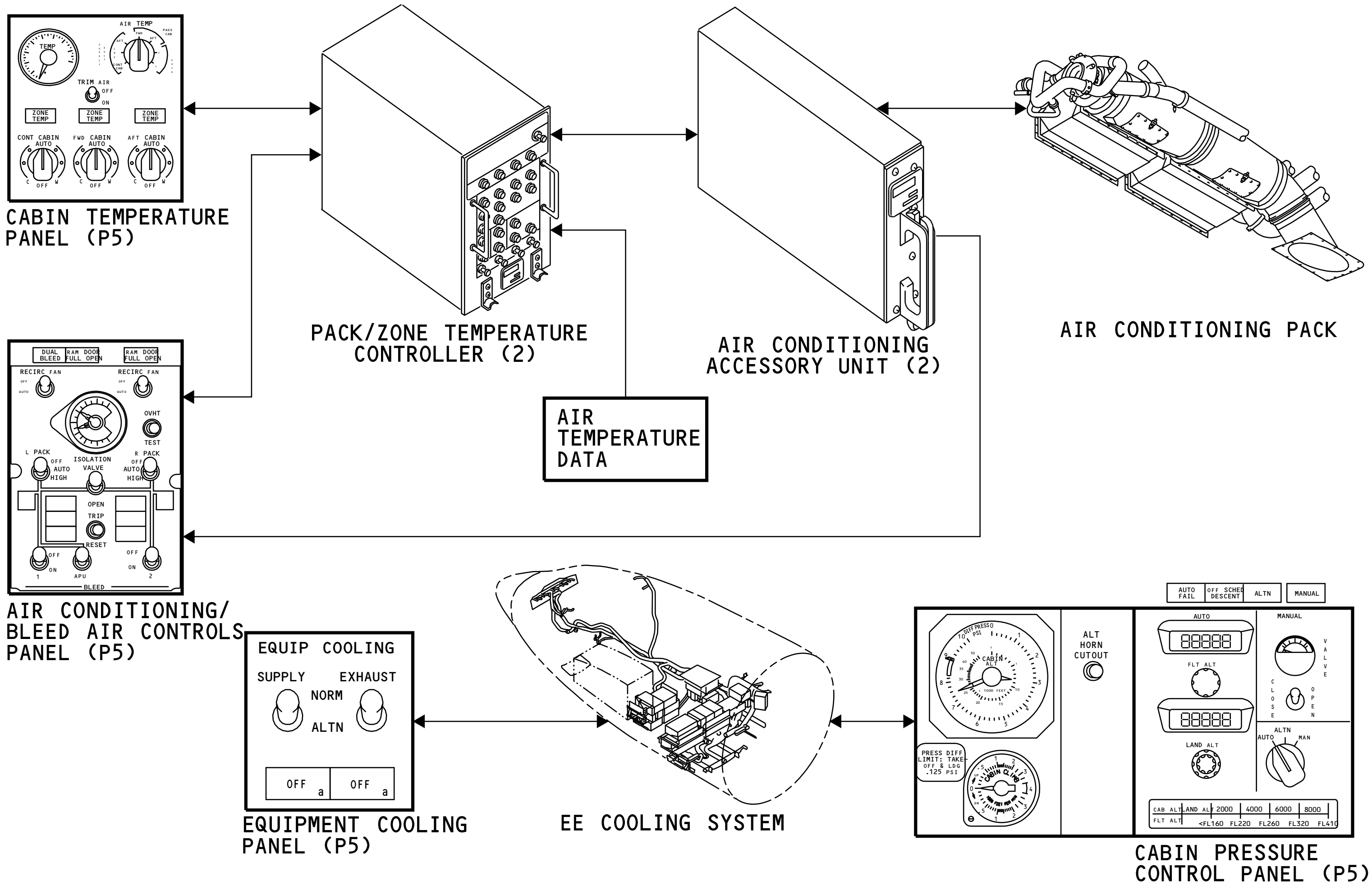
AKS ALL

Air Conditioning Accessory Unit

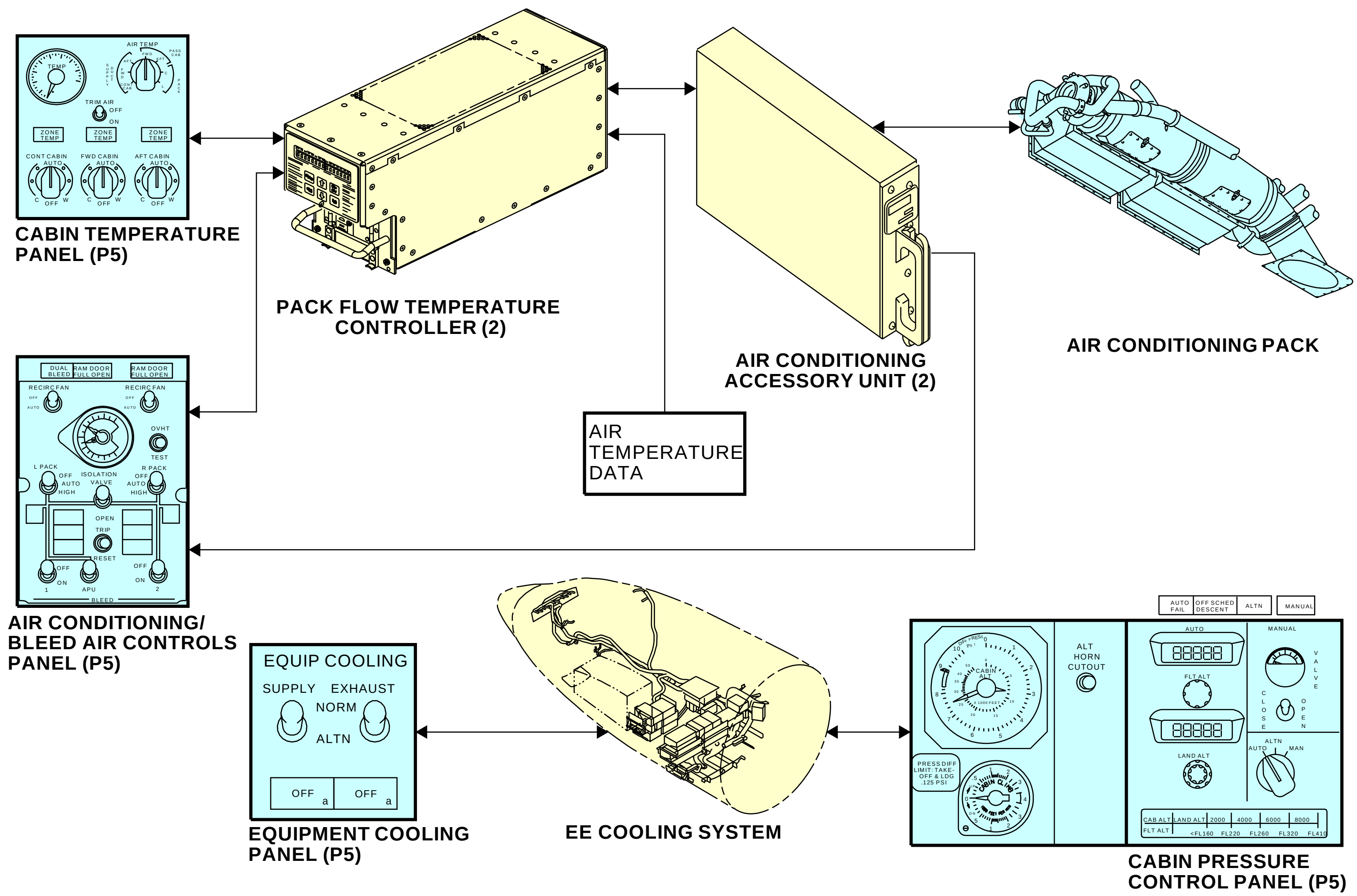
The air conditioning accessory units are the interface for the airplane operational logic and the air system.

Cabin Pressure Controller

The cabin pressure controllers control the cabin pressure function of the air conditioning system.



AIR CONDITIONING - GENERAL DESCRIPTION



AIR CONDITIONING - GENERAL DESCRIPTION

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AIR CONDITIONING - CONTROL PANELS

General

These flight compartment panels on the P5 forward overhead panel let you control the air conditioning subsystems:

- Cabin temperature panel, P5-17
- Air conditioning/bleed air controls panel, P5-10
- Equipment cooling panel, P5
- Cabin pressure control panel, P5-6
- Cabin altitude panel, P5-6.

Cabin Temperature Panel

These controls and indications are on the cabin temperature panel:

- Control cabin temperature control
- Forward cabin temperature control
- Aft cabin temperature control
- Trim air switch
- Temperature indication and selection
- Duct overheat indication.

Air Conditioning/Bleed Air Controls Panel

These controls and indications are on the air conditioning/bleed air controls panel:

- Ram air inlet door indication
- Recirculation fans switches
- Cooling pack switches
- Pack overheat and fault indication
- Pack reset.

Equipment Cooling Panel

These controls and indications are on the equipment cooling panel:

- Supply and exhaust fans switches
- No cooling indication.

Cabin Pressure Control Panel

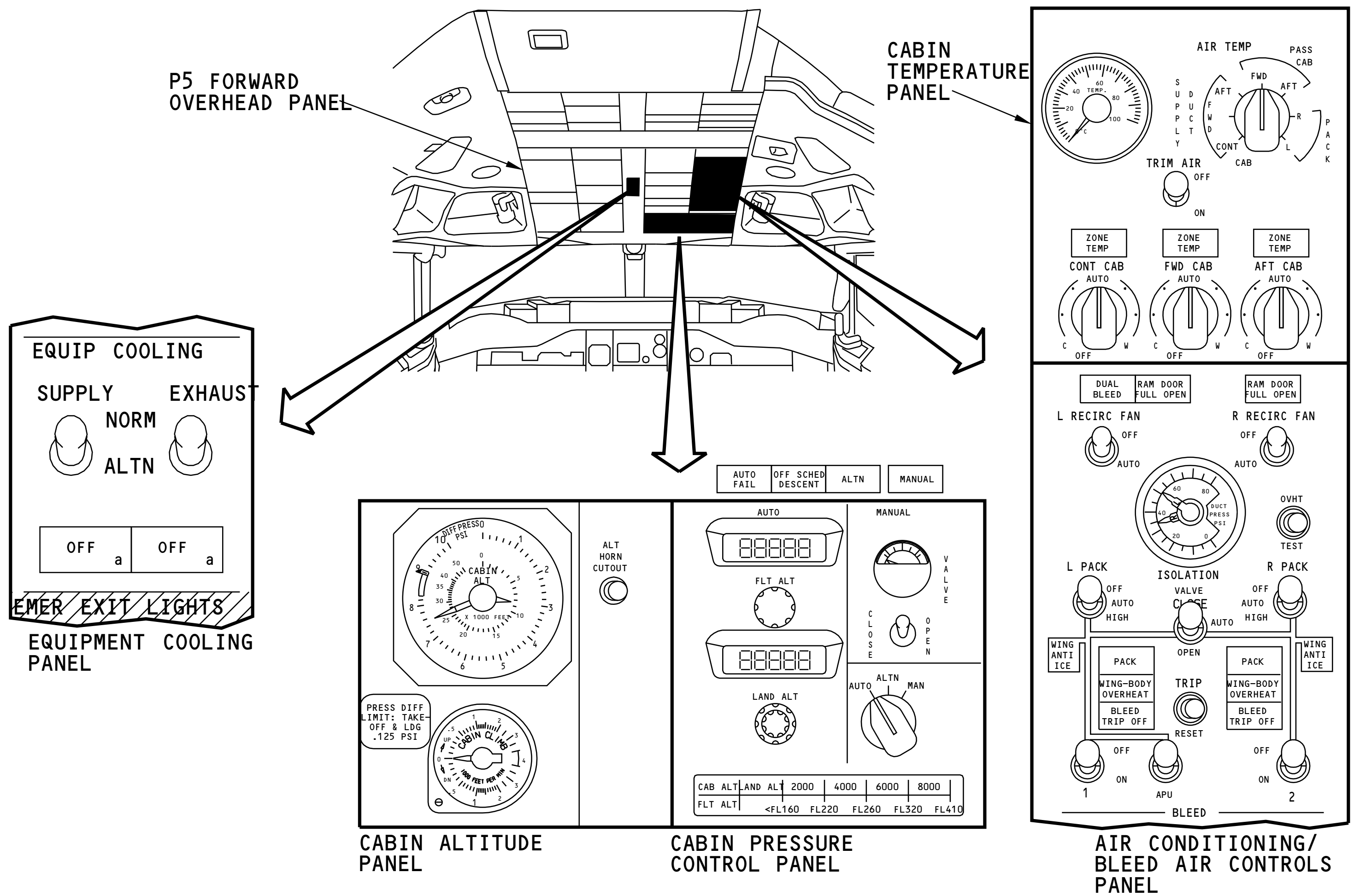
These controls and indication are on the cabin pressure control panel:

- Landing altitude selector
- Flight altitude selector
- Mode selector
- Outflow valve position indicator
- Manual control toggle switch.

Cabin Altitude Panel

These controls and indications are on the cabin altitude panel:

- Cabin altitude
- Cabin differential pressure
- Rate of change of cabin altitude
- Altitude horn cutout switch.



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AIR CONDITIONING - CONTROL PANELS

AIR CONDITIONING - COMPONENT LOCATION

Distribution

The distribution system has these components in the distribution compartment (aft of the forward cargo compartment):

- Main distribution manifold
- Recirculation fans
- Ground conditioned air connection.

The equipment cooling system has components in the EE compartment, the forward equipment compartment, and the flight compartment.

Cooling System

The two air conditioning packs are in the air conditioning compartments. The air conditioning compartments are on the left and right sides of the keel beam in the wing-to-body area. Access is from the bottom of the airplane fuselage.

Temperature Control

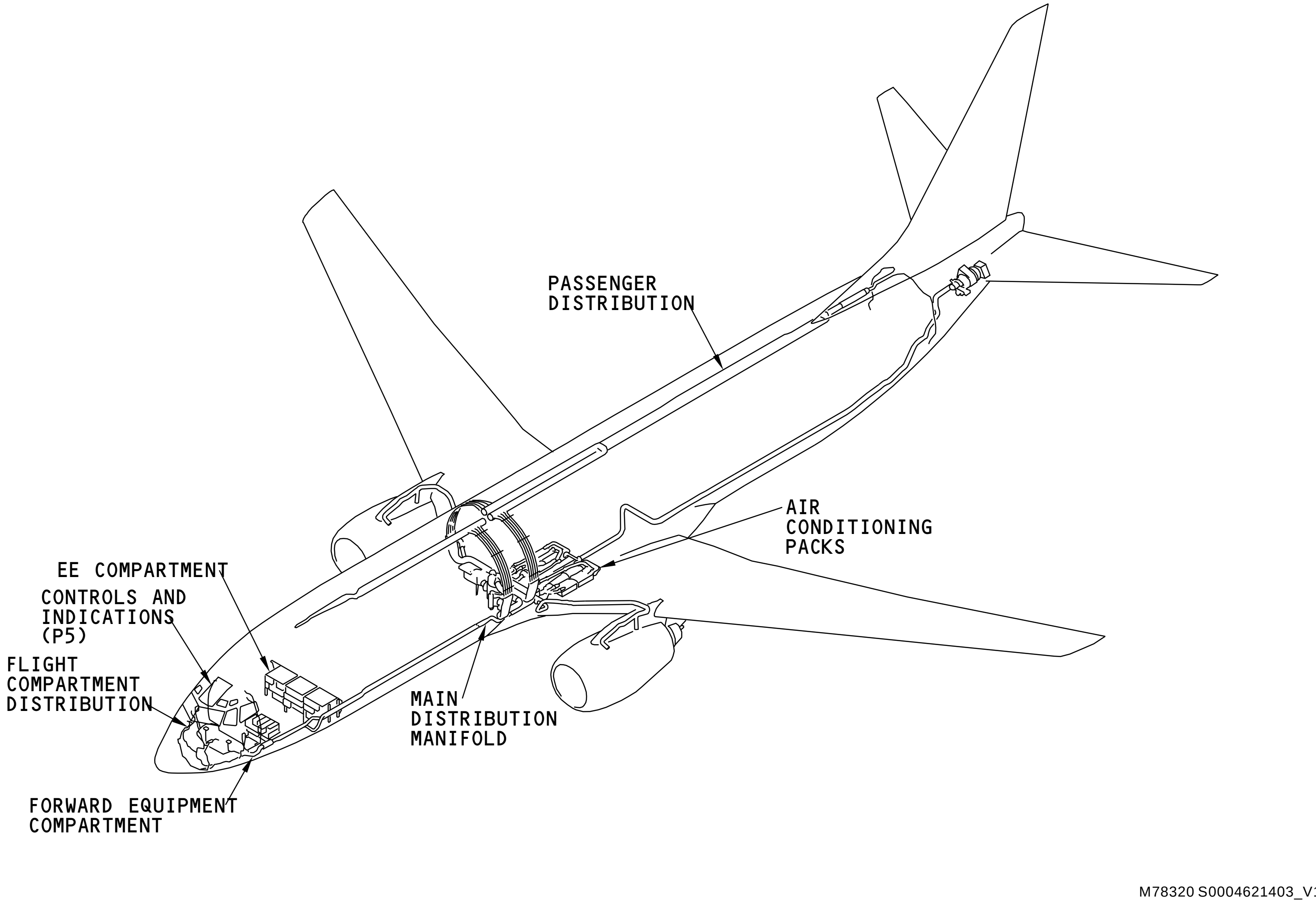
The temperature control system has components in these areas of the airplane:

- Passenger distribution ducting
- EE compartment
- Flight compartment.

Pressurization

The pressurization system has components in these areas of the airplane:

- Flight compartment
- EE compartment
- Aft cargo compartment.



AIR CONDITIONING - COMPONENT LOCATION

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AIR CONDITIONING - FUNCTIONAL DESCRIPTION

General

These are the primary parts of the air conditioning (A/C) system that have an effect on the supply of fresh air or the recirculation of conditioned air:

- Pack flow control
- Pack cooling system
- Zone temperature control
- Recirculation
- Air distribution.

The primary parts of the A/C system have these functions:

- Control fresh air flow for airplane pressurization and ventilation
- Control the flight compartment and passenger cabin temperature
- Recirculate cabin air for ventilation.

Pack Flow Control

This part of the A/C system controls the quantity of fresh air that flows into the airplane. The control is by a flow control and shutoff valve.

The quantity of fresh air necessary for ventilation is more than for pressurization. The ventilation quantity is based on a fixed value for the crew and allowable leakage, and on the number of passenger seats.

Usually, the left and right flow control systems provide the same quantity of fresh air. Fresh air flow changes when airplane conditions change.

See the pack flow control section for more information about the pack flow control systems.

Pack Cooling System

This part of the A/C system removes water as necessary and controls the temperature of the fresh air before it flows into the air distribution part of the air conditioning system. The primary components are the left and right packs.

The usual control for the left pack makes sure that it supplies air at a temperature that gives the necessary cooling for the flight compartment.

The control for the right pack makes sure that it supplies air at a temperature that gives the necessary cooling for the mix manifold.

See the pack flow control and pack cooling system section for more information about the pack flow control and pack cooling systems.

Zone Temperature Control

This part of the A/C system increases the temperature of the conditioned air that flows into the occupied areas of the airplane. It also gives pressure regulation and on/off control for the trim air part of the system. These are the primary components:

- Trim air pressure regulating and shutoff valve
- Zone trim air modulating valves
- Temperature sensors.

The system calculates the necessary pack outlet temperatures to satisfy the cooling needs to the flight compartment and the mix manifold. The system also calculates the heating necessary for each temperature control zone. These are the temperature control zones:

- Flight compartment zone
- Passenger cabin zones (2).

Air from the pneumatic system adds heat to a zone that needs warmer air. The trim air pressure regulating and shutoff valve gives on/off control and keeps trim air pressure at a necessary limit.

See the trim air pressure regulation and shutoff control section for more information about the trim air pressure regulation and shutoff control systems. (SECTION 21-60)

The zone trim air modulating valves control the heat added to the conditioned air for each zone.

See the zone temperature control section for more information about the zone temperature control systems. (SECTION 21-60)

Recirculation

This part of the A/C system recycles approximately 50 percent of the cabin air for ventilation purposes. This reduces the quantity of fresh air from the pneumatic system for ventilation. The left and right recirculation fans and filters are the primary components.

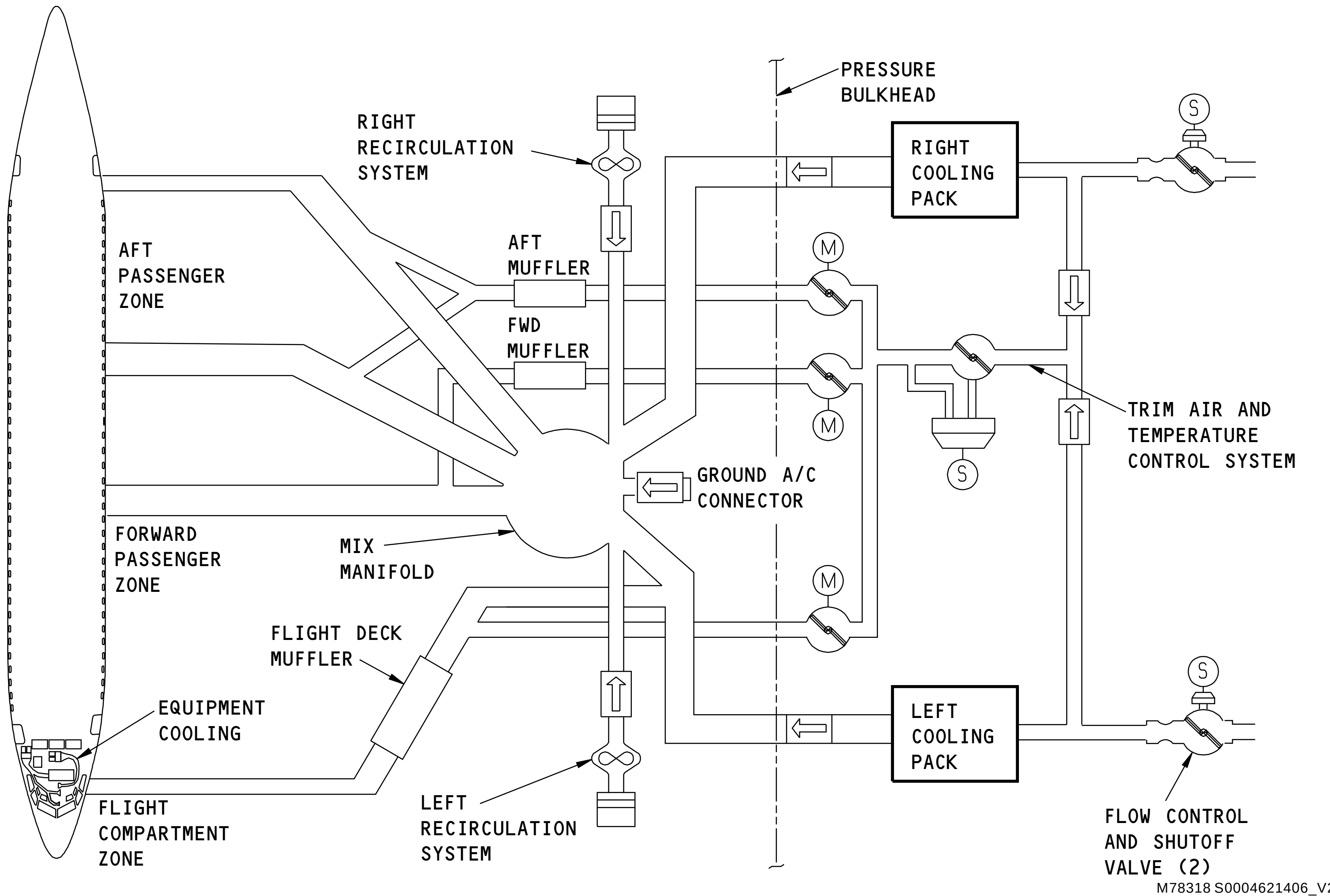
See the recirculation section for more information about the recirculation systems. (SECTION 21-25)

Air Distribution

This part of the A/C system moves conditioned air from the packs or ground air source to the temperature control zones. These are the primary components:

- Ground air connector
- Mix manifold
- Distribution ducts/risers.

See the distribution section for more information about the air distribution systems. (SECTION 21-20)



AIR CONDITIONING - FUNCTIONAL DESCRIPTION

AIR CONDITIONING - PACK/ZONE TEMPERATURE CONTROLLER - BITE

Purpose

The pack/zone temperature controllers have front face BITE that isolates system faults to the LRU interface level.

General Description

The BITE circuitry can detect failures of these components:

- Pack/Zone controller
- Ram air controller
- Pack standby controller
- Zone temperature selector
- Cabin temperature sensor
- Duct temperature sensor
- Zone trim air modulating valves
- Ram air control temperature sensor
- Ram air inlet actuator
- Standby pack temperature sensor
- Standby pack temperature control valve (TCV)
- Mix manifold temperature sensor
- Pack temperature sensor
- Pack temperature control valve (TCV).

The pack/zone temperature controller has one register for last flight memory storage.

The pack/zone temperature controller has nine registers for previous flight history memory storage.

BITE Test Switches

The pack/zone temperature controller has these switches:

- PRESS/TEST
- BIT
- PREV FLT
- VERIFY
- RESET.

The PRESS/TEST switch does a test of the 25 indicator lamps. This monitors power and indication availability.

The BIT test switch starts a system self-test. The BIT switch shows failures that occurred during the last flight.

A flight starts when the air mode is sensed for longer than 30 seconds.

The PREV FLT test switch starts a system self-test. The PREV FLT switch shows all the failures that occurred during the last nine flights.

The VERIFY test switch starts a system self-test.

WARNING: MOVE ALL PERSONS AND EQUIPMENT AWAY FROM THE RAM AIR INLET DOOR. WHEN YOU PUSH THE VERIFY SWITCH, THE RAM AIR COMPONENTS WILL MOVE AND CAN CAUSE INJURY TO PERSONS OR DAMAGE TO EQUIPMENT.

The VERIFY switch starts a real time test of the pack and zone temperature control components.

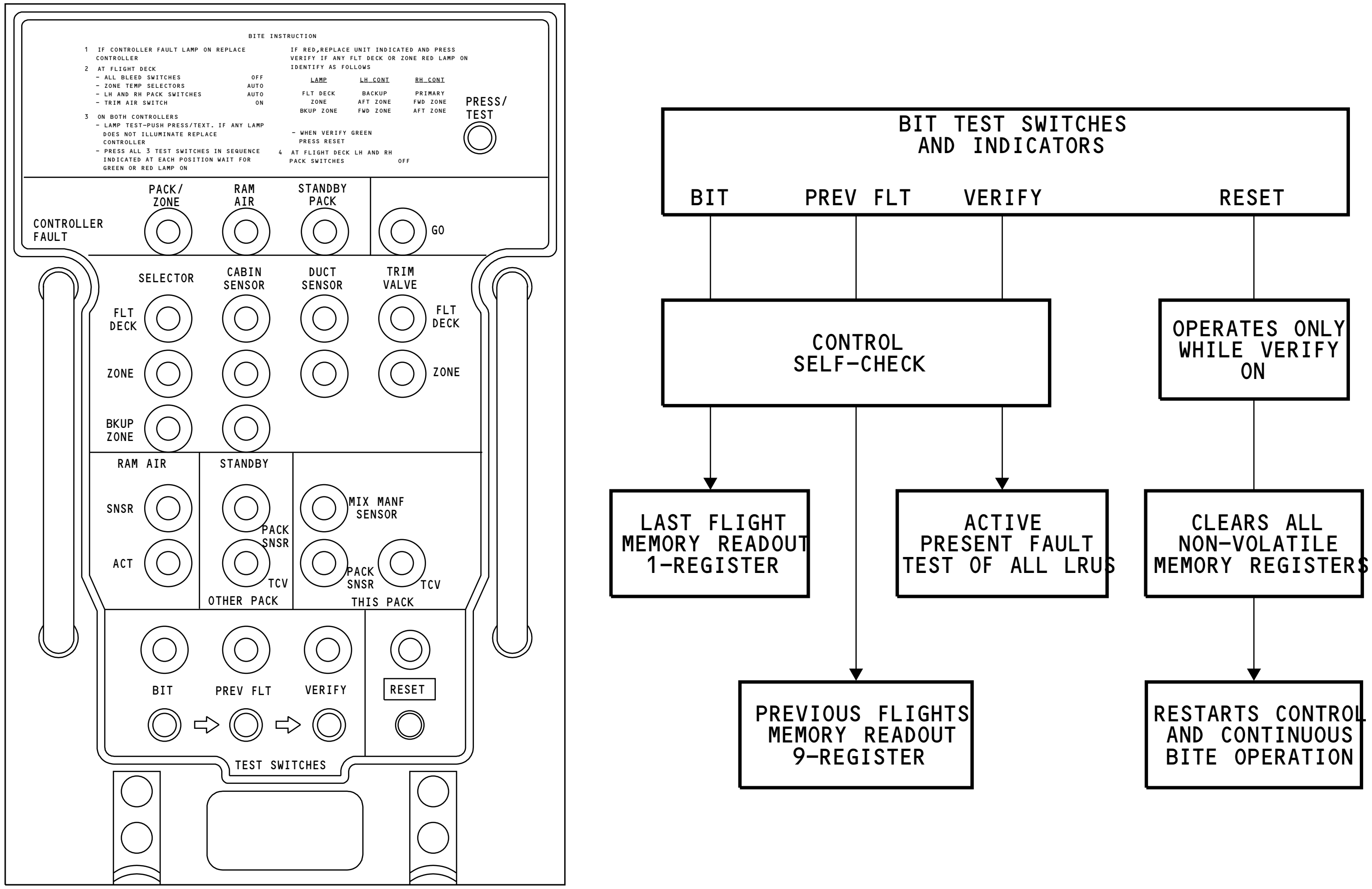
The RESET test switch is used to erase the fault history. Push the RESET switch while the VERIFY and the green GO lights are on.

BITE Indications

The pack/zone temperature controller has a red lamp for each of the LRUs.

The pack/zone temperature controller has a green lamp to show no faults are in the system.

The pack/zone temperature controller has four amber lamps to show the test in progress.



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AIR CONDITIONING - PACK/ZONE TEMPERATURE CONTROLLER - BITE

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AIR CONDITIONING - PACK FLOW TEMPERATURE CONTROLLER - BITE

Purpose

The pack flow temperature controllers (PFTC) control these functions:

- Provide temperature and flow control of the two air conditioning packs
- Provide built-in test equipment (BITE) that isolates faults to a line replaceable unit (LRU)
- Provide automatic standby control to the opposite air conditioning pack
- Control the ventilation and air temperature control of the flight deck, forward cabin and aft cabin temperature zones
- Provide system status information for display on the flight deck panels

Location

The pack flow temperatures controllers are in the E/E compartment on the E3-3 shelf

General Description

The MENU button on the front panel will display the BITE menu. The BITE has five modes of operation as listed below:

- ON/OFF
- EXISTING FAULTS
- FAULT HISTORY
- GROUND TEST
- OTHER FUNCTIONS

The PFTCs can detect failures of these components:

- Pack flow temperature controller
- Zone temperature selector
- Cabin temperature selector
- Duct temperature selector
- Zone trim air modulating valves
- Mix manifold temperature sensor
- Pack temperature sensor
- Standby pack temperature sensor
- Pack temperature control valve (TCV)
- Standby temperature control valve
- Flight deck temperature selector
- Zone temperature sensor
- Standby zone sensor
- Flight deck duct sensor
- Zone duct sensor
- Mix manifold temperature sensor
- Pack inlet pressure sensor
- Pack flow sensor
- Pack flow control and shutoff valve
- SRADA ram sensor
- SRADAs

BITE Test Switches

The pack flow temperature controller has these push-button switches:

- ON/OFF
- MENU
- YES
- NO
- Up arrow
- Down arrow

Push the ON/OFF switch to start/stop the BITE display.

The menu consists of EXISTING FAULTS, FAULT HISTORY, GROUND TESTS and OTHER FUNCTIONS.

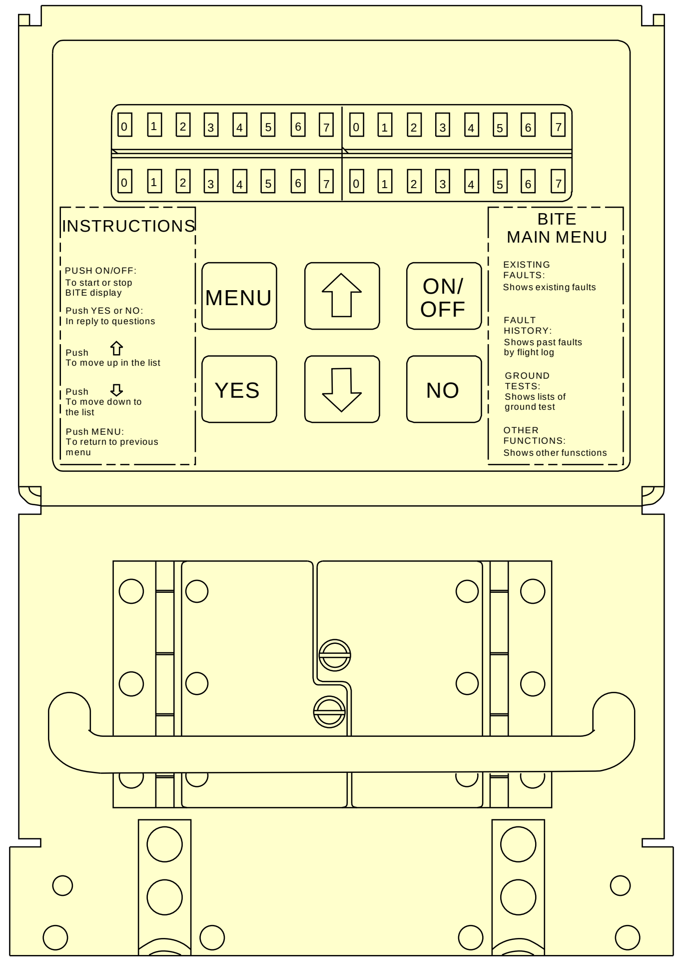
The YES or NO buttons can be used to reply to questions that show in the front panel display window.

The UP button can be used to move up in a list.

The DOWN button can be used to move down in a list.

BITE Indications

A maintenance message will be shown in the front panel display window.



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AIR CONDITIONING - PACK FLOW TEMPERATURE CONTROLLER - BITE

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AIR CONDITIONING - DISTRIBUTION - INTRODUCTION

Purpose

The distribution system has these functions:

- Divides conditioned air to the three airplane zones
- Reduces engine bleed requirements
- Removes offensive air from lavatories and galleys
- Supplies cooling air to electronic equipment.

Main Air Distribution

The main air distribution components send conditioned air to these zones:

- Flight compartment
- Forward passenger compartment
- Aft passenger compartment.

Conditioned air comes from these sources:

- Ground supplied conditioned air
- Air conditioning packs
- Recirculation system.

Flight Compartment Distribution

The flight compartment has an independent source of conditioned air. This provides a constant supply of fresh air circulation. Controls in the flight compartment permit selection of temperature and flow rates.

Passenger Cabin Conditioned Air Distribution

The passenger compartment has two zones for independently controlled air temperature. There are supply ducts that supply a constant flow to all areas. In each zone, the conditioned air goes to these areas:

- Passenger cabin
- Lavatories
- Galleys.

Recirculation System

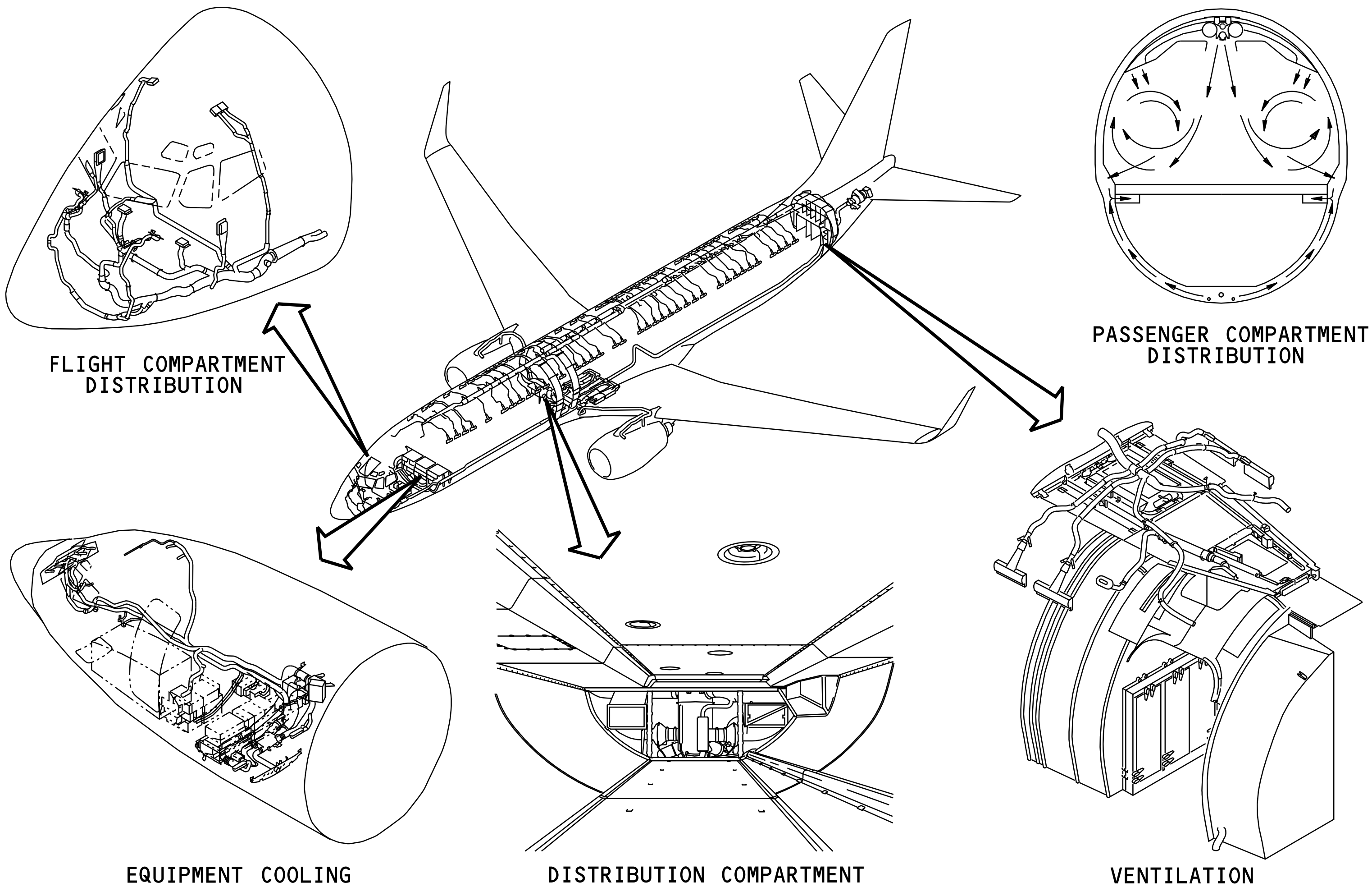
The recirculation system permits ventilation of air in the passenger cabin areas. The recirculation system decreases the use of engine bleed air. This enables better thrust management and decreases fuel consumption.

Ventilation System

Vent ports adjacent to the lavatory and galleys let air in those areas flow overboard.

Equipment Cooling

The equipment cooling system uses fans to move air around equipment in the EE compartment and flight compartment.



AIR CONDITIONING - DISTRIBUTION - INTRODUCTION

AIR CONDITIONING - DISTRIBUTION - GENERAL DESCRIPTION

General

The A/C distribution system supplies conditioned air to the passenger and flight compartments.

Main Air Distribution

The main air distribution system gets air from these sources:

- Air conditioning packs
- Ground conditioned air
- Recirculation system.

The mix manifold collects and mixes air from any combination of the sources.

Flight Compartment Distribution

The flight compartment gets conditioned air from the left pack and the mix manifold. A duct on the left side of the airplane transmits the air. The flight compartment has supply ducts and outlets to control the air flow at each station.

Passenger Compartment Distribution

The passenger conditioned air distribution gets air from the mix manifold. The air goes through riser ducts and up side walls to an overhead distribution duct. Outlets along the side walls and the center of the ceiling divide the air for symmetrical supply.

Recirculation System

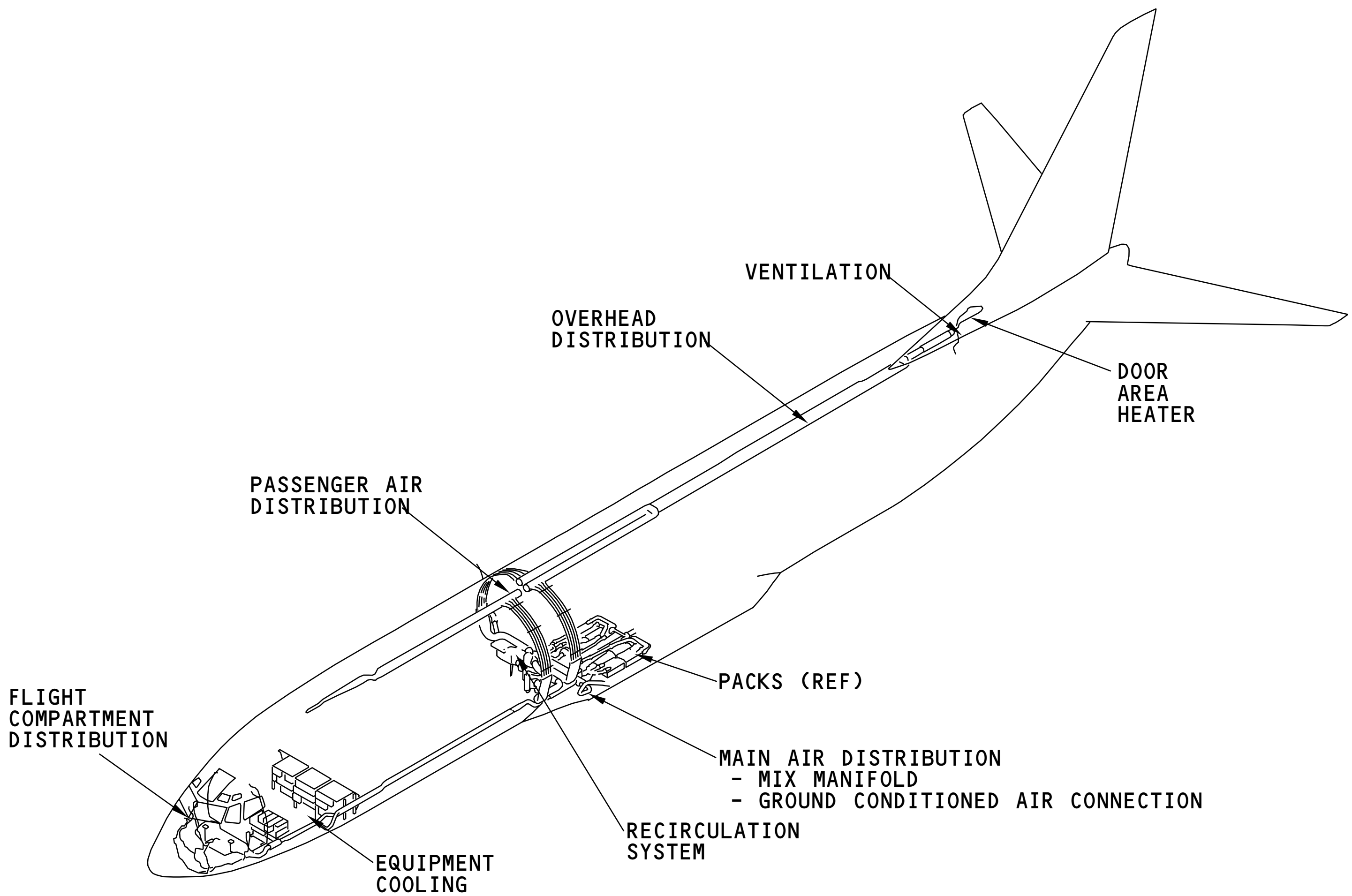
The recirculation system uses two fans to move air from the passenger compartment to the mix manifold. This system reduces the amount of air that the packs need to supply.

Ventilation

The ventilation system uses differential pressure to pull air out of the airplane. The air moves through overboard vents from the cabin galley and the lavatory areas.

Equipment Cooling System

The equipment cooling system removes heat from the equipment in the main equipment center and the flight compartment.



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AIR CONDITIONING - DISTRIBUTION - GENERAL DESCRIPTION

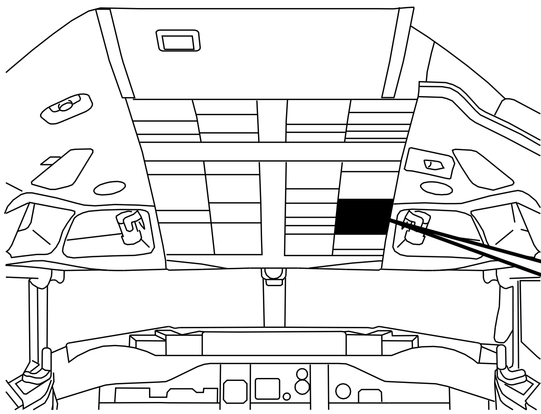
AIR CONDITIONING - DISTRIBUTION - OPERATION

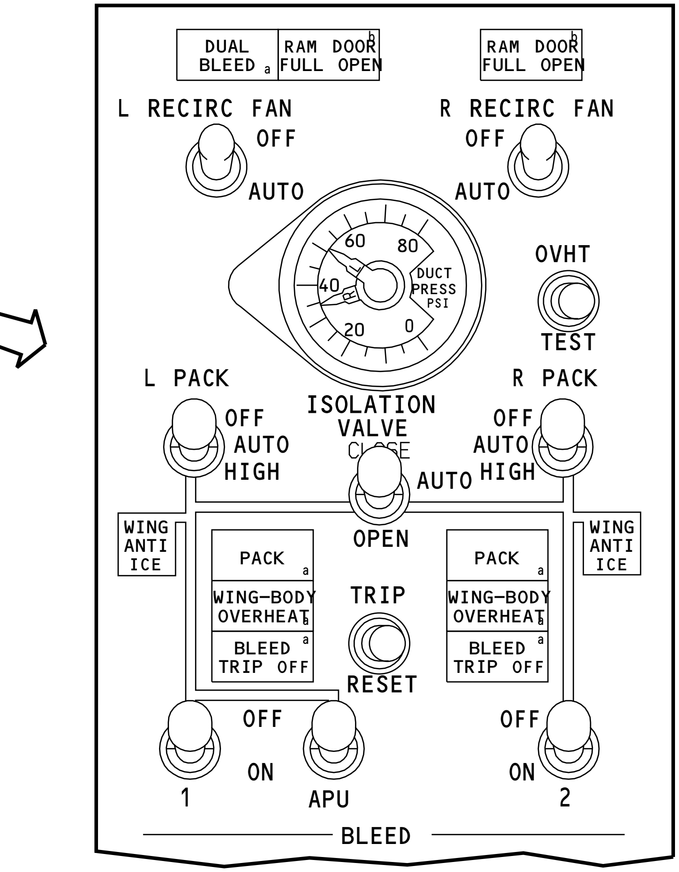
General

The controls for the air conditioning distribution system are on the air conditioning/bleed air controls panel in the flight compartment.

Recirculation System

The recirculation fans are enabled when you move the recirculation fan switches to the AUTO position. Recirculation fan operation depends on air conditioning pack operation.





AIR CONDITIONING/BLEED AIR CONTROLS PANEL (P5)

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AIR CONDITIONING - DISTRIBUTION - OPERATION

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AIR CONDITIONING - MAIN AIR DISTRIBUTION - INTRODUCTION

General

The two air conditioning packs supply the main distribution manifold with conditioned air. The main distribution manifold supplies air to the passenger compartment through riser ducts and an overhead distribution manifold. A moisture drain line lets moisture in the main distribution manifold drain overboard.

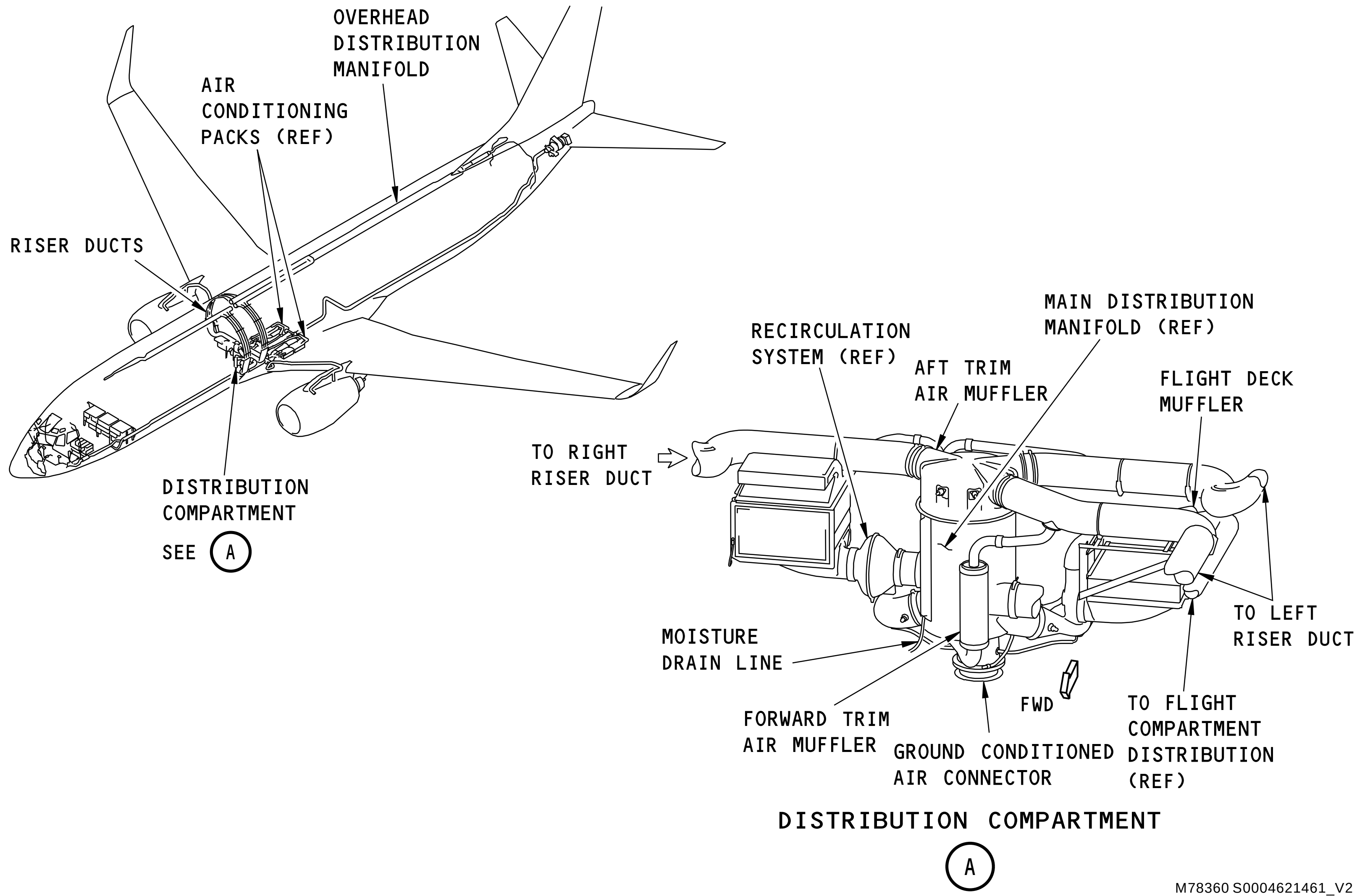
Location

The main air distribution components are in the distribution compartment aft of the forward cargo compartment. There are manifolds and ducts along the sidewalls and above the ceiling area of the passenger cabin.

Interfaces

The main air distribution subsystem has interfaces with these sub-subsystems:

- Recirculation system
- Ground conditioned air connector
- Pack conditioned air
- Distribution manifolds and ducts.



AIR CONDITIONING - MAIN AIR DISTRIBUTION - INTRODUCTION

AIR CONDITIONING - MAIN AIR DISTRIBUTION - GROUND CONDITIONED AIR CONNECTOR

Purpose

The ground conditioned air connector lets an external source of conditioned air supply the airplane air conditioning system.

Location

The ground conditioned air connector is in the main distribution compartment (aft of the forward cargo compartment). There is an external access panel forward of the air conditioning compartments.

Physical Description

The ground conditioned air connector is a short duct section with a check valve. There are two slotted connect holes on the outside fitting for the ground cart hose hook-up. The ground air connection uses a standard 8 inch bayonet connector.

Check Valve

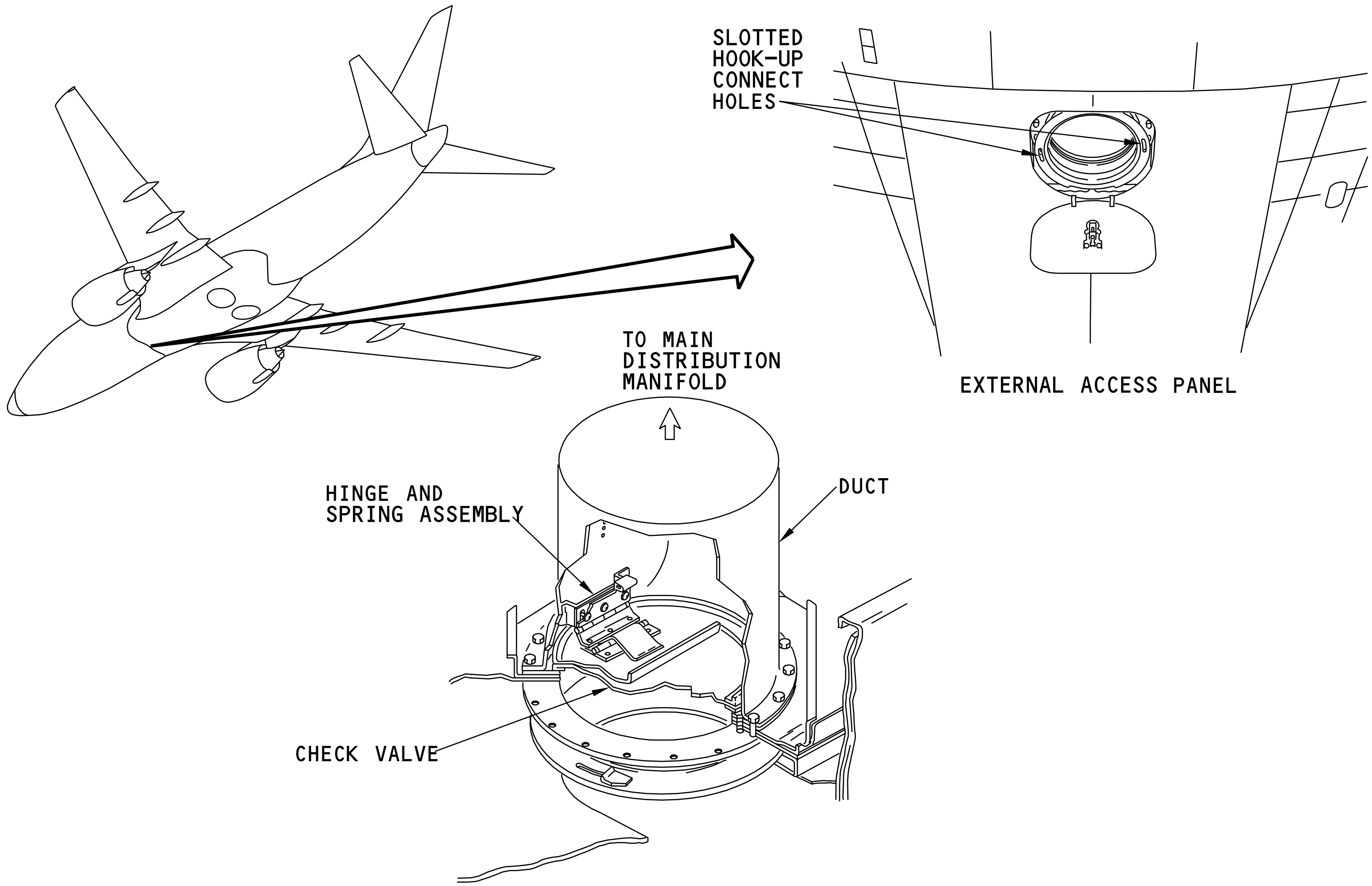
The check valve is inside the ground conditioned air connector. It prevents the loss of air through the connector when the air conditioning system is on. When you attach the ground cart hose, the check valve moves out of the air flow path. The ground conditioned air can flow into the distribution system.

Training Information Point

The ground conditioned air connector attaches to the main distribution manifold duct with band clamps. The connector fitting attaches to the skin of the airplane with a pressure seal.

A hinge on the duct and the check valve assembly has a spring. The spring holds the check valve open when the air conditioning system is off. When the air conditioning system is on, the pressure in the manifold causes the check valve to close.

Before you install the duct and check valve assembly, you must do an inspection of the check valve to make sure the spring holds the check valve open a short distance. Adjust the hinge if necessary and do a test of the check valve for correct operation.



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AIR CONDITIONING - MAIN AIR DISTRIBUTION - GROUND CONDITIONED AIR CONNECTOR

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AIR CONDITIONING - FLIGHT COMPARTMENT CONDITIONED AIR DISTRIBUTION - INTRODUCTION

Purpose

The flight compartment conditioned air distribution system supplies the flight crew with conditioned air.

General

The left air conditioning pack supplies the conditioned air for the flight compartment. The air flows through ducts that go forward along the left side of the airplane. The flight compartment distribution uses different ducts than the passenger compartment distribution.

The flight compartment receives conditioned air from the right pack if the left pack is not operational.

The flight compartment distribution lets the flight crew select a different air temperature than the other areas of the airplane.

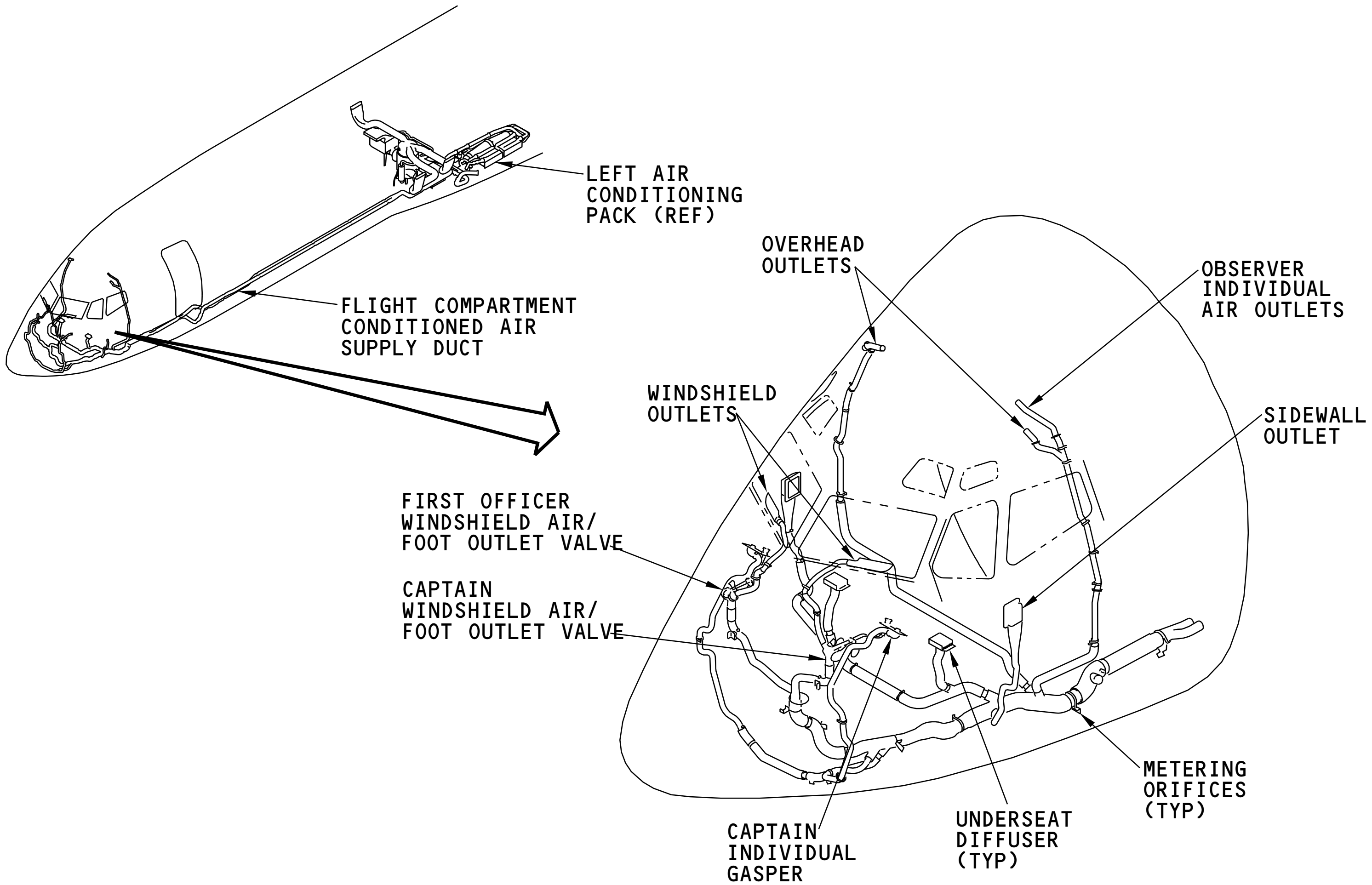
Flight Compartment Distribution

The flight compartment has these captain and first officer diffusers and outlets:

- Overhead outlets and gasper
- Underseat diffusers
- Foot air diffusers
- Windshield air diffusers
- Sidewall outlets (shoulder warmers)
- Individual panel gaspers.

You can adjust the overhead outlets airflow direction with a moveable baffle. Airflow cannot be shut off.

The air distribution supply ducts in the flight compartment include metering orifices and mufflers. The metering orifices control flow. The mufflers decrease air noise.



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AIR CONDITIONING - FLIGHT COMPARTMENT CONDITIONED AIR DISTRIBUTION - INTRODUCTION

AIR CONDITIONING - FLIGHT COMPT COND AIR DISTRIBUTION - WINDSHIELD AND FOOT AIR OUTLET VALVE

Purpose

The windshield and foot air outlet valves control airflow to the captain and first officer windshield outlets and foot outlets.

Location

The windshield outlets are forward of the captain and first officer glareshield. They supply airflow up and along the windshield pane. The windshield and foot air outlet valves are forward of the rudder pedals. The foot air outlets are inside the captain and first officer rudder pedal housings.

Physical Description

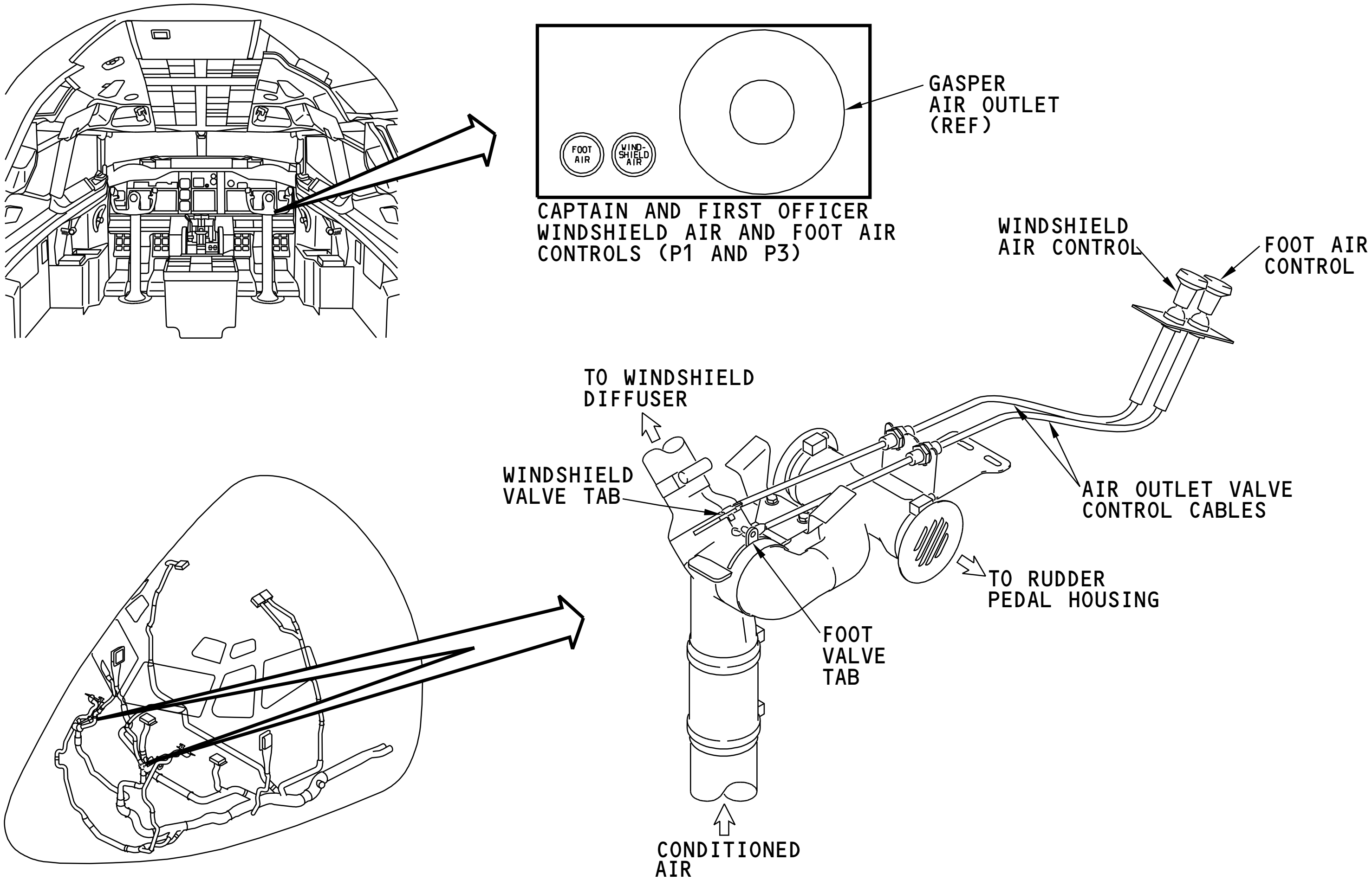
There are two segmented disks inside the windshield and foot air outlet valve housing. The disk position controls airflow from the valve. The segmented disk connects to the air outlet valve control cable to change the disk position.

Operation

The captain and first officer windshield and foot air outlet valves have manual control. The controls are on the lower portion of the P1 and P3 panels. The controls are WINDSHIELD AIR and FOOT AIR. They attach to push-pull control cables. The control cables turn the segmented disks inside the valves. You pull the knob to open the valve.

Training Information Point

Adjustment nuts on the control cables adjust the windshield air valve or foot air outlet valve.



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AIR CONDITIONING - FLIGHT COMPT COND AIR DISTRIBUTION - WINDSHIELD AND FOOT AIR OUTLET VALVE

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AIR CONDITIONING - PASSENGER CABIN CONDITIONED AIR DISTRIBUTION - INTRODUCTION

Purpose

The passenger cabin conditioned air distribution system divides the flow of conditioned air to the passenger cabin.

General

The passenger cabin conditioned air distribution system uses these components:

- Sidewall riser ducts
- Overhead distribution ducts

AKS 001-017

- Plenum/nozzle assemblies

AKS ALL

- Flexible hoses
- Sidewall diffuser outlets
- Diffuser/hose assembly.

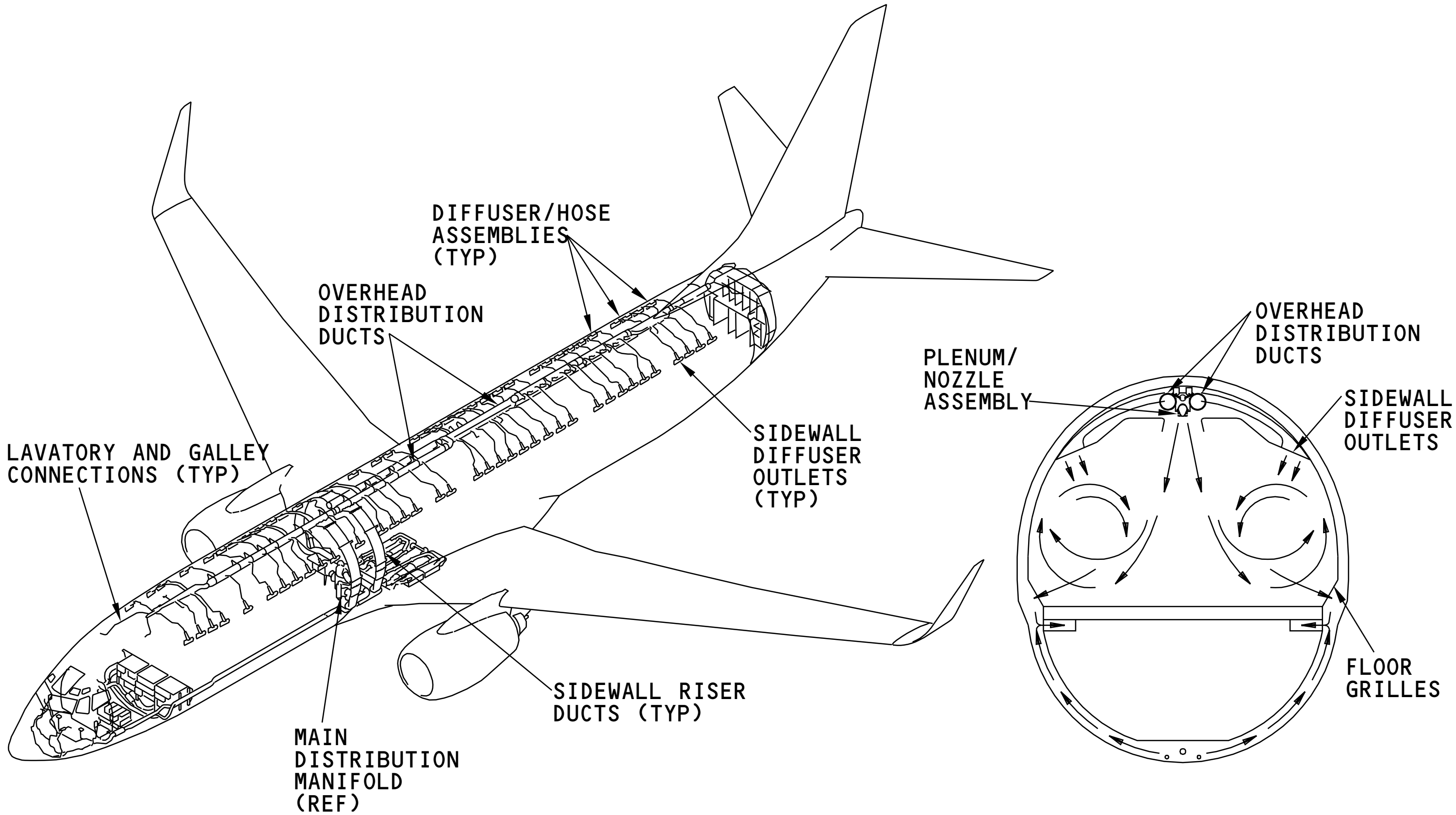
Conditioned air from the main distribution manifold flows through sidewall riser ducts. The riser ducts follow the airplane contour along the right and left fuselage. The left side has two riser sections, the right side has one. The riser ducts supply the overhead distribution ducts.

The overhead distribution ducts are along the top center of the passenger cabin.

Conditioned air from the overhead distribution ducts goes to the sidewall diffusers and plenum/nozzle assemblies through diffuser/hoses.

The overhead distribution duct connects to flexible hoses to supply the galleys and the lavatories in the front and aft cabin areas.

The passenger cabin exhaust air goes through floor grilles to the recirculation system or overboard.



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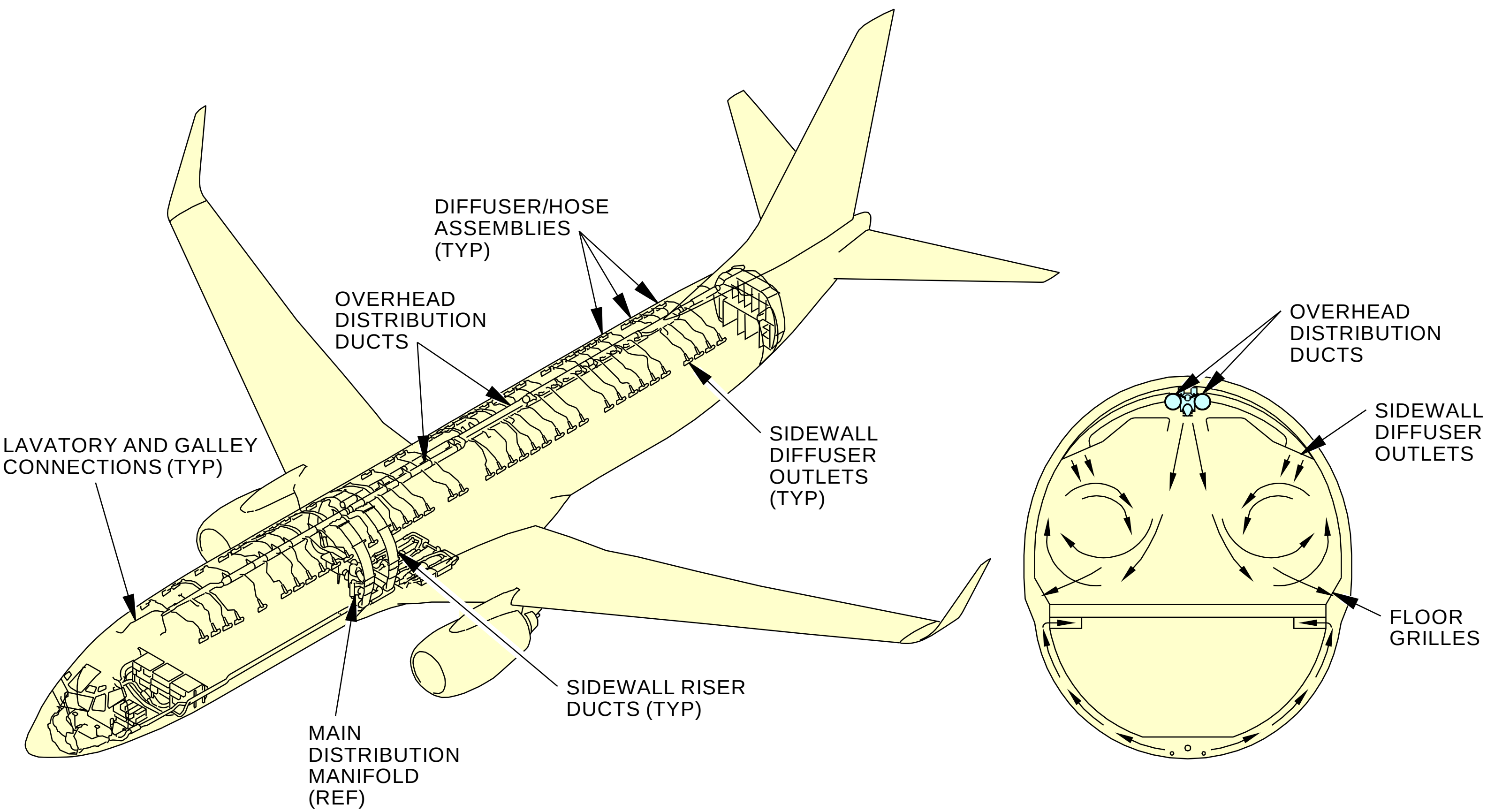
AIR CONDITIONING - PASSENGER CABIN CONDITIONED AIR DISTRIBUTION - INTRODUCTION



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AIR CONDITIONING - PASSENGER CABIN CONDITIONED AIR DISTRIBUTION - INTRODUCTION

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AIR CONDITIONING - PASSENGER CABIN CONDITIONED AIR DISTRIBUTION - OVERHEAD DISTRIBUTION DUCT

Purpose

The overhead distribution duct divides the supply of conditioned air to outlets along the center and sidewalls of the passenger cabin for a symmetrical balance of airflow.

Location

The overhead distribution duct is in the center ceiling area of the passenger compartment.

Physical Description

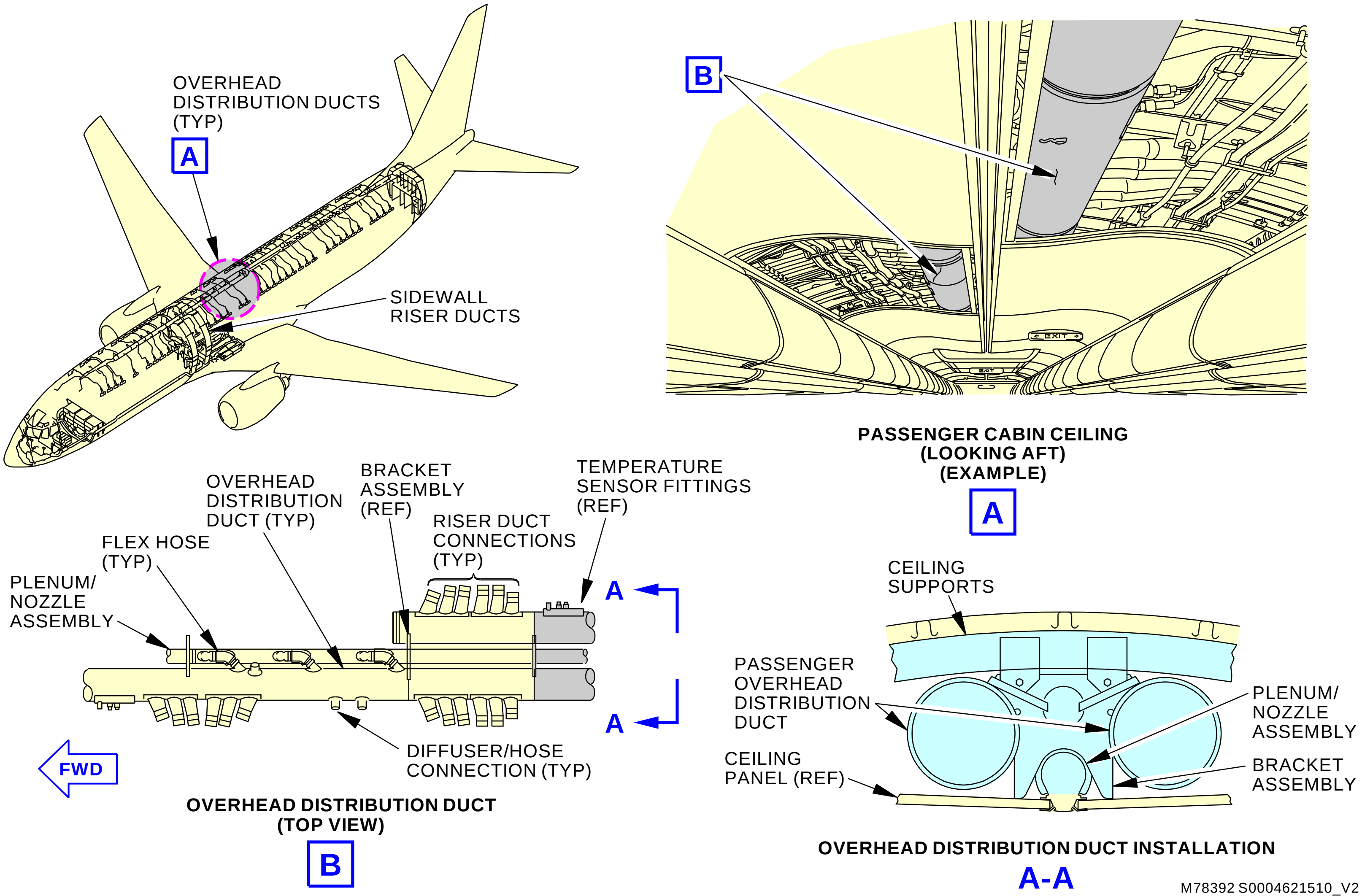
The overhead distribution duct is a cylindrical composite tube. There are outlets along its length that attach to riser ducts and flexible sidewall ducts. The fittings in the area where the sidewall riser ducts attach permit the attachment of temperature sensors.

The overhead distribution duct spuds are longer and incorporate a vent hole to provide an additional air flow and drying effect through the crown vent system.

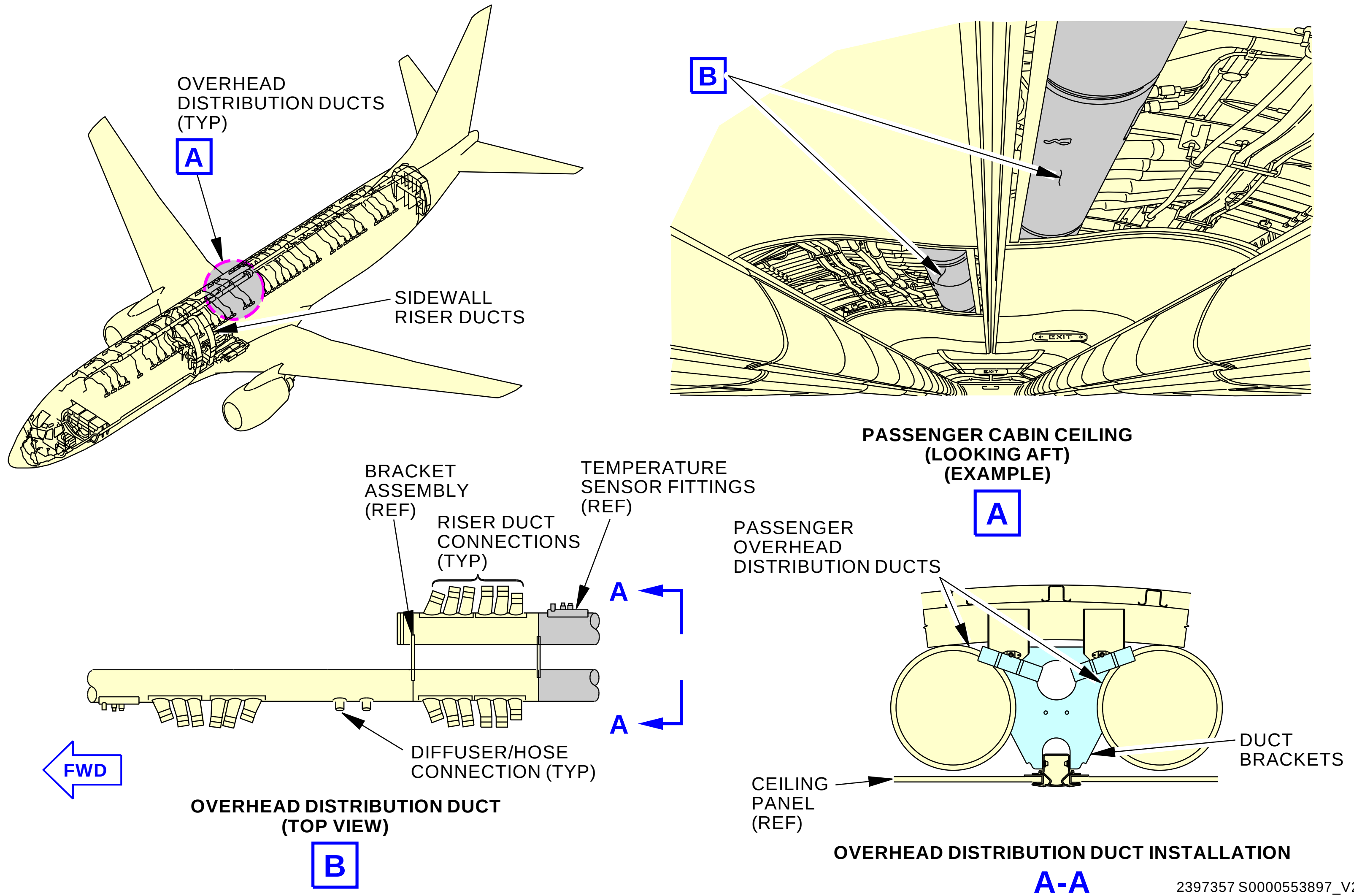
The sidewall riser ducts attach on the left and right sides of the overhead distribution manifold.

Training Information Point

You get access to the overhead distribution duct through the ceiling panels in the passenger cabin. Screws attach the diffuser outlet assembly to the overhead distribution duct. Duct brackets attach the overhead distribution duct to the ceiling supports. Diffuser/hose connections on the overhead distribution duct connect to the sidewall diffusers.



AIR CONDITIONING - PASSENGER CABIN CONDITIONED AIR DISTRIBUTION - OVERHEAD DISTRIBUTION DUCT



AIR CONDITIONING - PASSENGER CABIN CONDITIONED AIR DISTRIBUTION - OVERHEAD DISTRIBUTION DUCT

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AIR CONDITIONING - RECIRCULATION SYSTEM - INTRODUCTION

Purpose

The recirculation system supplies air for ventilation. The use of cabin air for ventilation decreases the use of air from the engine bleed system.

General Description

The recirculation system collects cabin air to use with pack air in the distribution system. The distribution system supplies air to the passenger compartment area.

The passenger cabin air moves through these recirculation components:

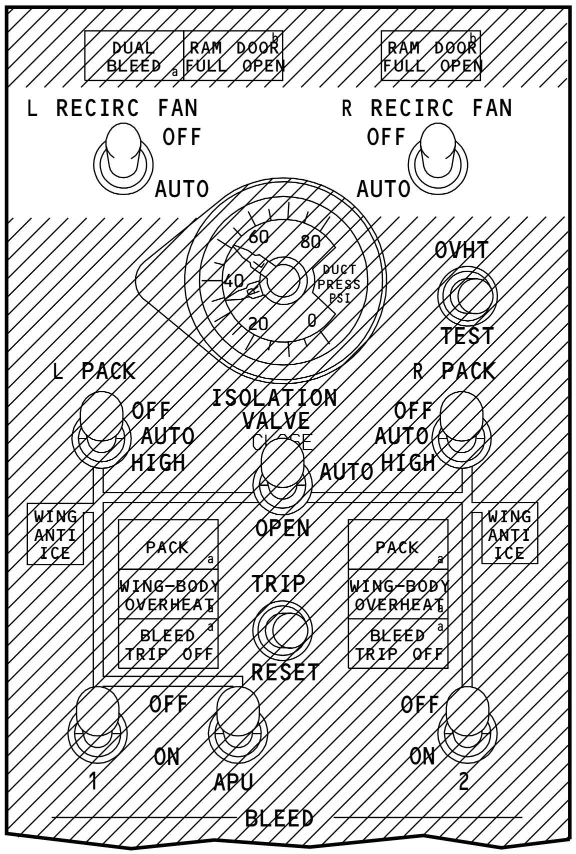
- Collector shroud
- Air filters
- Fans
- Check valves.

Location

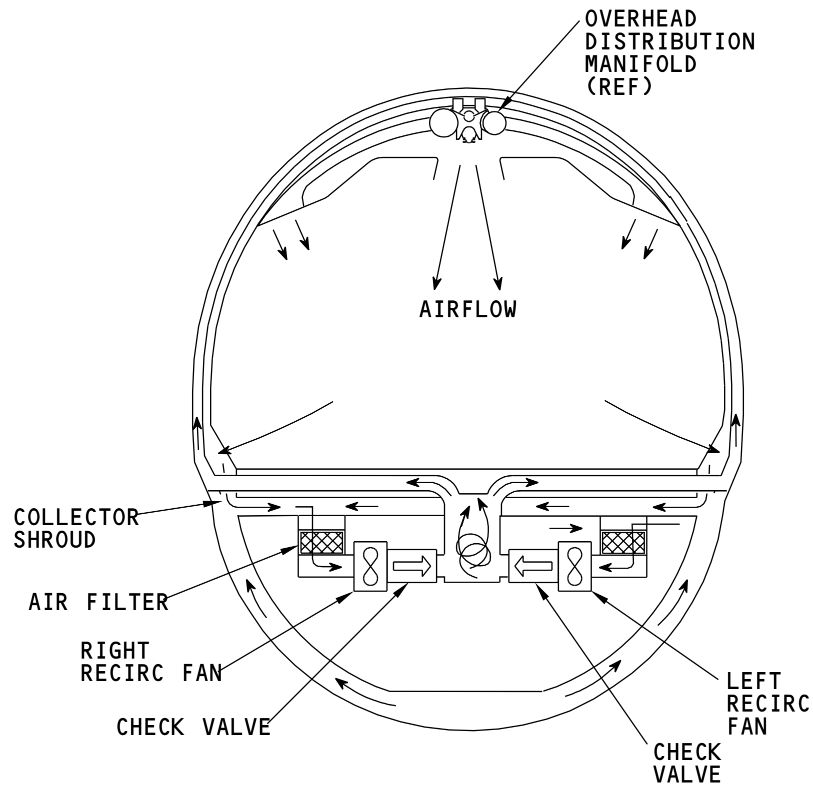
The recirculation components are in the distribution compartment.

Operation

The recirculation fans are enabled when you move the RECIRC FAN switches to the AUTO position. Recirculation fan operation depends on air conditioning pack operation.



AIR CONDITIONING/BLEED AIR CONTROLS PANEL (P5)



RECIRCULATION SCHEMATIC

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AIR CONDITIONING - RECIRCULATION SYSTEM - INTRODUCTION

AIR CONDITIONING - RECIRCULATION SYSTEM - RECIRCULATION AIR FILTER

Purpose

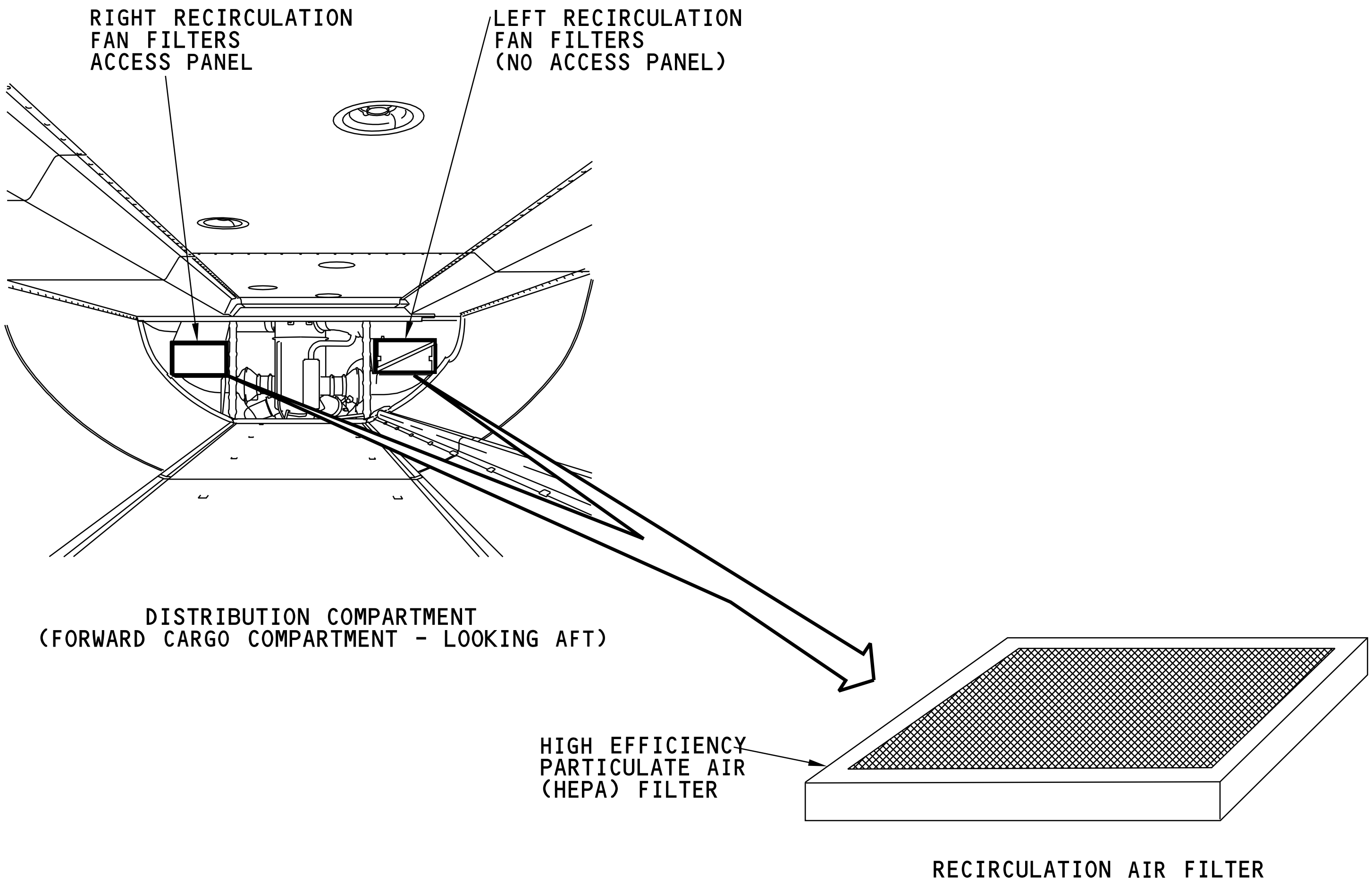
The recirculation air filters remove small particles of material from the air that flows back to the passenger cabin.

General

The recirculation fan pulls air from the passenger compartment through a high efficiency particulate air (HEPA) filter to remove very small particles at the bacteria and microorganism level.

Location

The recirculation components are in the distribution bay. The filter is in the filter support. Access to the filter is through the partition at the aft end of the forward cargo compartment.



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AIR CONDITIONING - RECIRCULATION SYSTEM - RECIRCULATION AIR FILTER

AIR CONDITIONING - RECIRCULATION SYSTEM - RECIRCULATION FAN

Purpose

The recirculation fans increase air flow to the passenger cabin in the main distribution system.

Location

There are two recirculation fans (left and right) in the distribution compartment. Access to the fans is through the partition in the forward cargo compartment.

Physical Description

Each fan has these features:

- Housing
- Mounting flanges
- Electrical connector
- Flow direction placard.

Functional Description

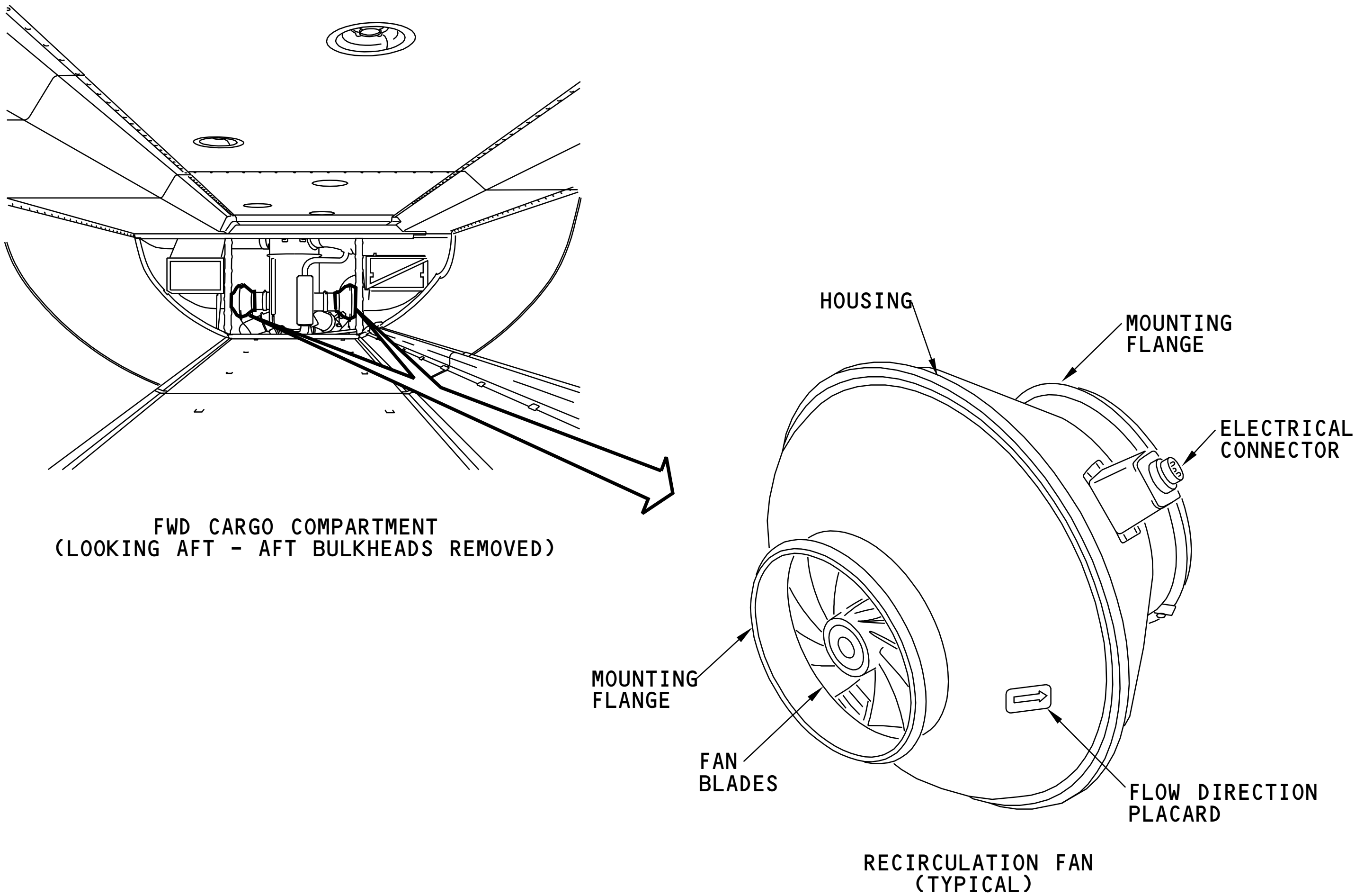
The recirculation fans pull air in from the passenger cabin and supply it into the main distribution manifold.

The right recirculation fan pulls in air from the collector shroud in the forward cargo compartment. Floor grilles in the passenger compartment permit airflow into the collector shroud.

The left recirculation fan pulls in air from the distribution compartment.

Training Information Point

When you install a recirculation fan, make sure the flow arrow on the fan is in the correct direction. The arrow should point to the distribution manifold.



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AIR CONDITIONING - RECIRCULATION SYSTEM - RECIRCULATION FAN

AIR CONDITIONING - RECIRCULATION SYSTEM - FAN CHECK VALVE

Purpose

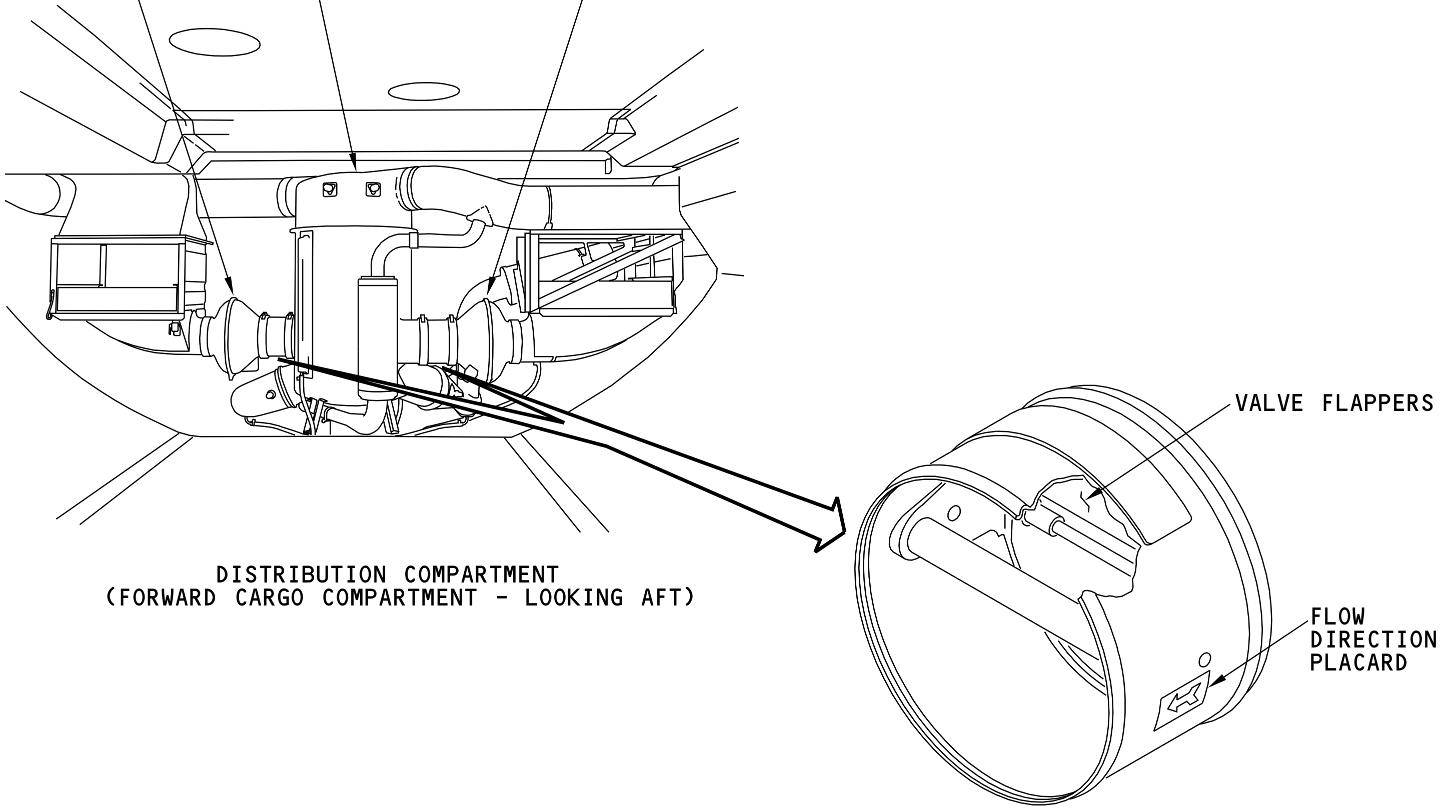
The recirculation fan check valves prevent the flow of conditioned air out of the main distribution manifold through the recirculation system.

Location

The recirculation fan check valves are in the distribution compartment. The check valves are between the recirculation fan and the main distribution manifold. Access to the check valves is through the partition at the aft end of the forward cargo compartment.

Training Information Point

The recirculation fan check valves use V-band clamps for installation. Make sure you install the check valve with the correct flow orientation.



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AIR CONDITIONING - RECIRCULATION SYSTEM - FAN CHECK VALVE

AIR CONDITIONING - RECIRCULATION SYSTEM - RIGHT RECIRCULATION FAN - FUNCTIONAL DESCRIPTION

Functional Description

The recirculation fan operates on 115v ac and control power is 28v dc.

The cabin air recirc fan relay R331 enables power to the fan. The relay is controlled by:

- Airplane is on the ground
- RECIRC FAN switch
- Recirculation fan overheat switches in the fan field coils
- Flow control valve (pack valve) closed and auto relays.

Usually, the RECIRC FAN switch is in the AUTO position and the fan overheat switches are closed.

The flow control valve closed and auto relays and air/ground relay form a logic circuit for the fan relay R331 and are in the air conditioning accessory units (ACAU). This logic looks at pack flow conditions. If one (L or R) of the pack valve closed relays is energized, the recirculation fan operates to increase cabin ventilation. If one (L or R) of the pack valves have their auto relays energized, the recirculation fan operates.

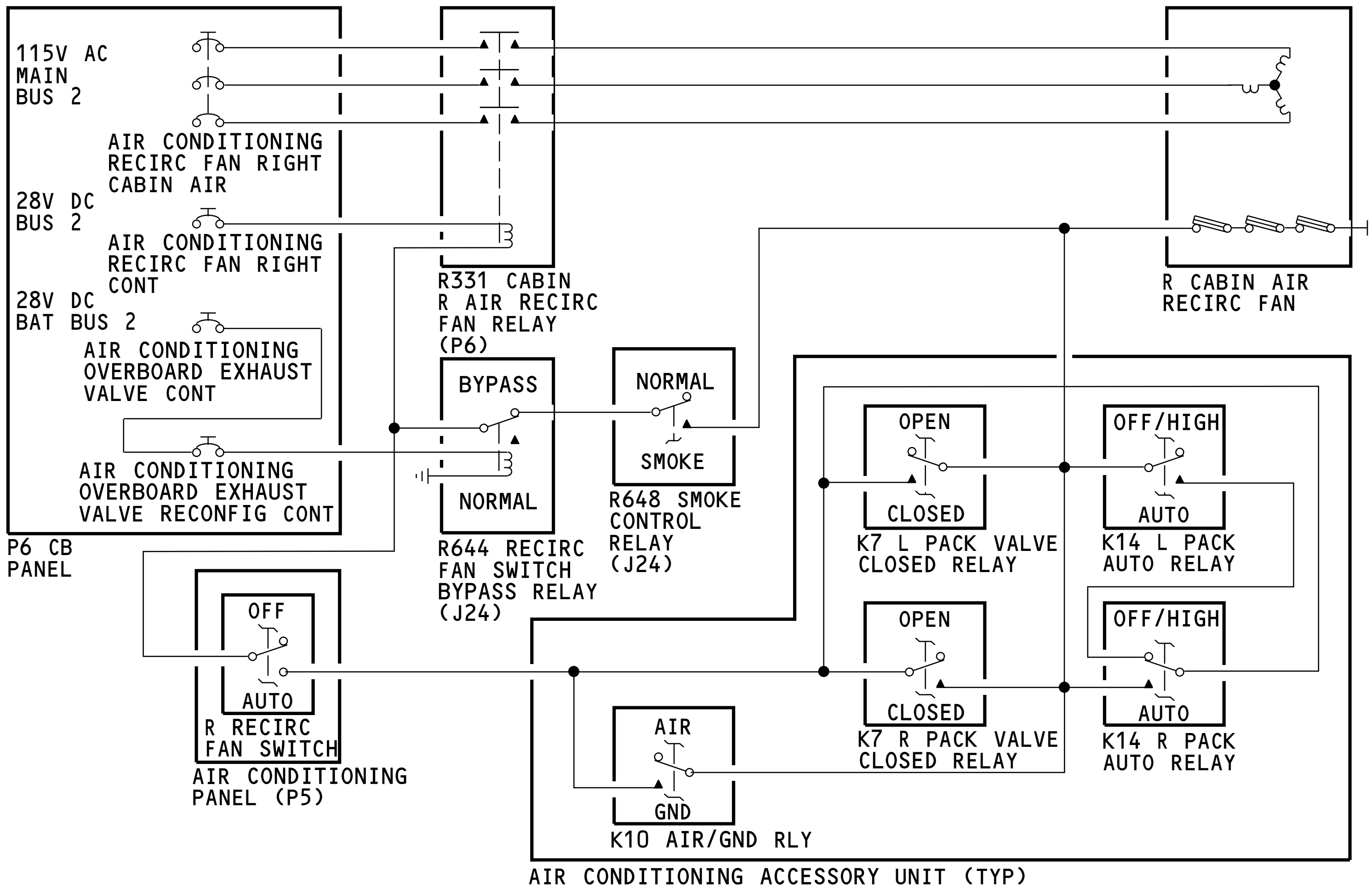
Training Information Point

The recirc fan switch bypass relay R644 is normally energized when there is battery bus power. This relay removes power from the bypass circuit for the recirculation fan.

The air conditioning overboard exhaust valve reconfig cont circuit breaker is for unpressurized dispatch. If the circuit breaker is open, the bypass circuit enables the recirculation fan to operate if the smoke control relay R648 energizes. The smoke control relay is energized during these conditions:

- Left or right pack switch is in HIGH
- Airplane is in the air
- R RECIRC FAN switch is off.

See the overboard exhaust valve system for more information about the smoke control relay. (SECTION 21-27)



AIR CONDITIONING - RECIRCULATION SYSTEM - RIGHT RECIRCULATION FAN - FUNCTIONAL DESCRIPTION

AIR CONDITIONING - RECIRCULATION SYSTEM - LEFT RECIRCULATION FAN - FUNCTIONAL DESCRIPTION

Functional Description

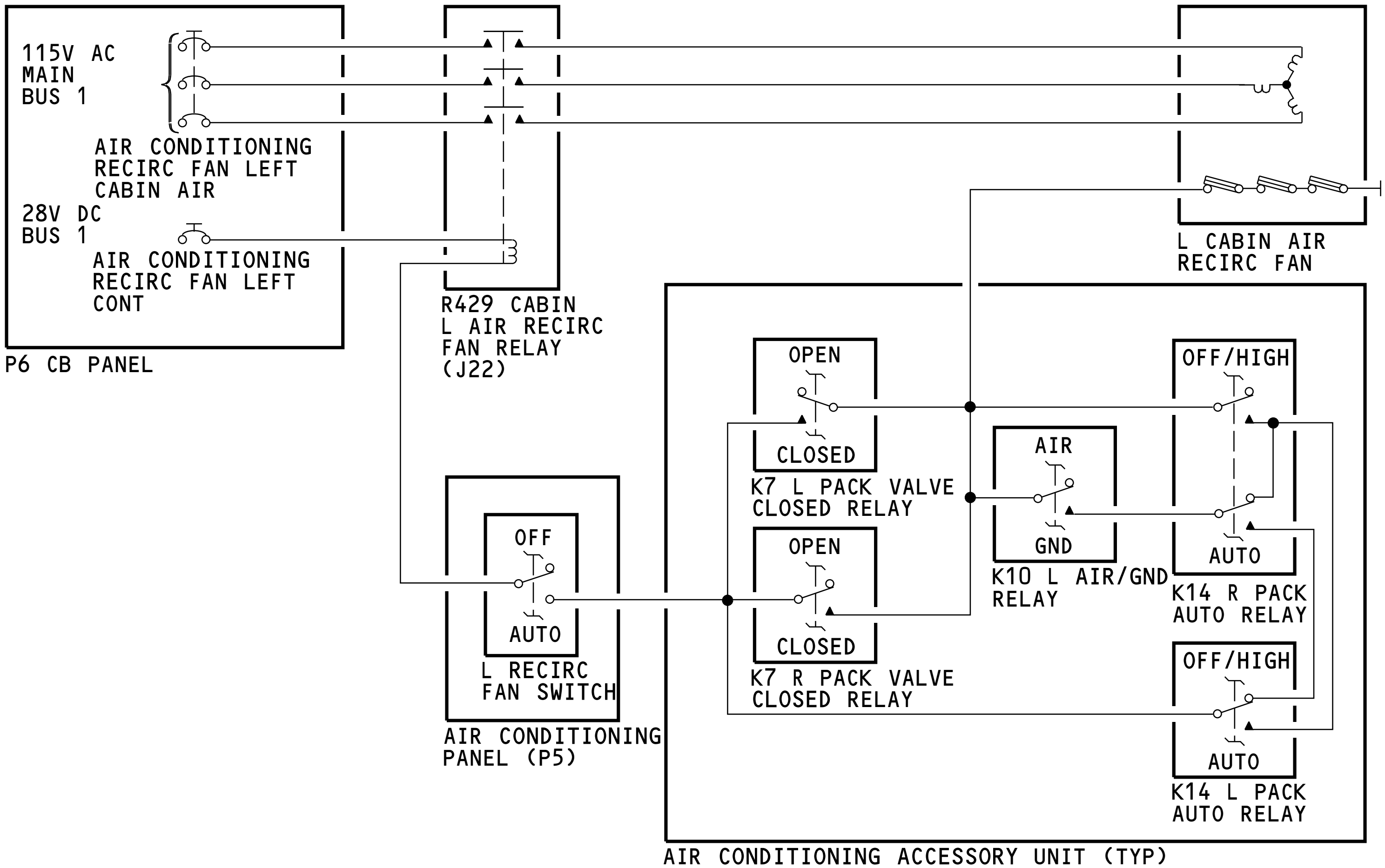
The recirculation fan operates on 115v ac and control power is 28v dc.

The cabin air recirc fan relay R429 enables power to the fan. The relay is controlled by these functions:

- Airplane is on the ground
- RECIRC FAN switch
- Recirculation fan overheat switches in the fan field coils
- Flow control valve (pack valve) closed and auto relays.

Normally the RECIRC FAN switch is in the AUTO position and the fan overheat switches are closed.

The flow control valve closed and auto relays and air/ground relay form a logic circuit for the R429 fan relay and are in the air conditioning accessory units (ACAU). This logic looks at pack flow conditions. If one (L or R) of the pack valve closed relays is energized, the recirculation fan operates to increase cabin ventilation. If one (L or R) of the pack valves have their auto relays energized, the recirculation fan operates.



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AIR CONDITIONING - RECIRCULATION SYSTEM - LEFT RECIRCULATION FAN - FUNCTIONAL DESCRIPTION

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AIR CONDITIONING - VENTILATION SYSTEM - GALLEY VENTILATION MUFFLER

Purpose

The galley ventilation muffler decreases noise levels of the air that flows out of the galleys.

General

The ventilation system uses differential pressure, cabin-to-ambient, to remove air by suction. The system uses these components to take air out of the galley:

- Galley vent inlet
- Flexible ducts
- Galley ventilation muffler
- Exhaust nozzle.

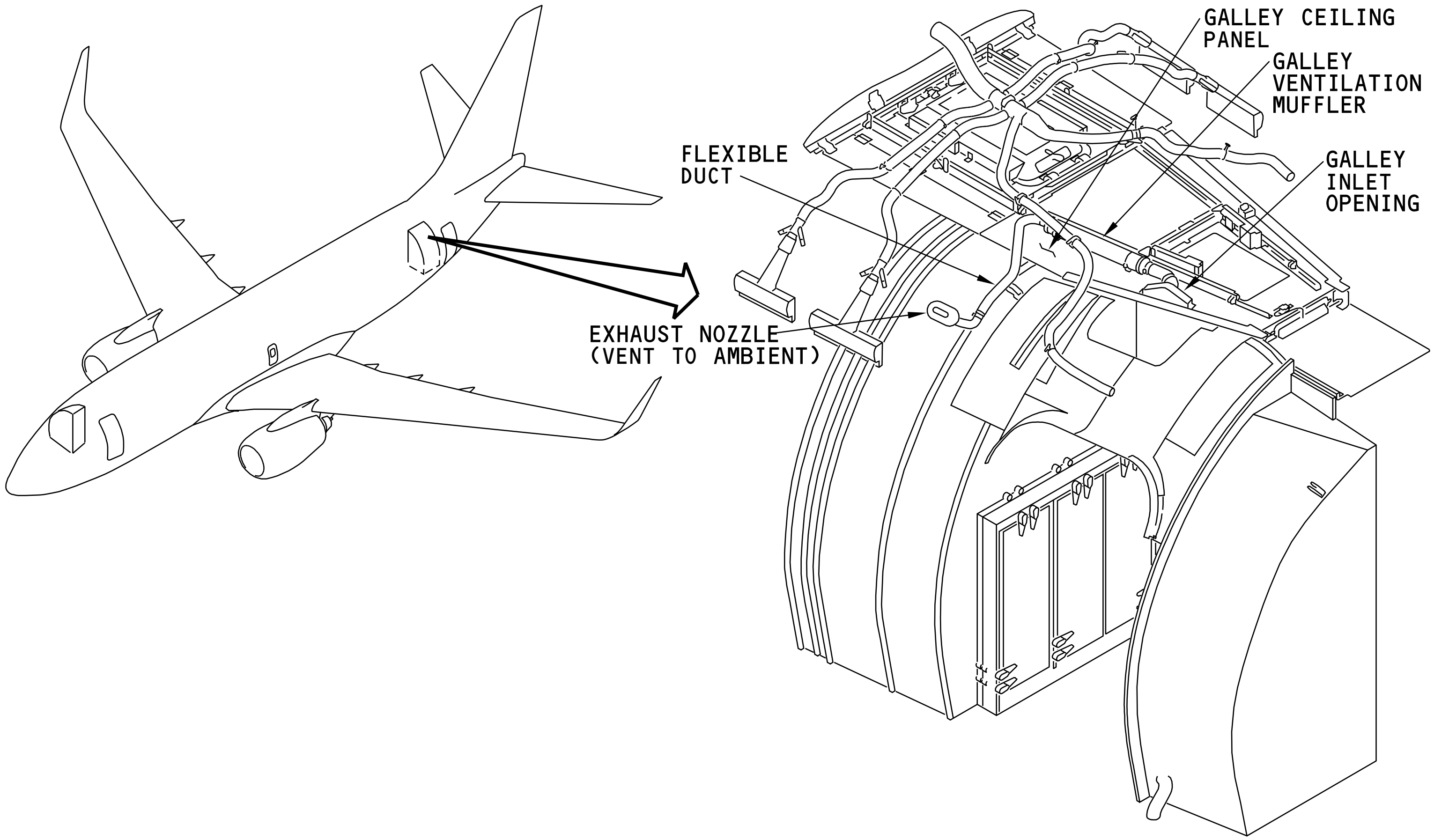
The flexible ducts connect the vent inlet opening in the galley ceiling to an exhaust nozzle in the airplane skin. The galley ventilation muffler reduces the noise of air being released from the pressurized cabin.

Location

The galley ventilation muffler is in the ceiling area above the galley.

Training Information Point

Air velocity through the galley ventilation muffler increases if the muffler shell has contamination or cracks. This can cause noise levels to increase.



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AIR CONDITIONING - VENTILATION SYSTEM - GALLEY VENTILATION MUFFLER

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AIR CONDITIONING - EQUIPMENT COOLING SYSTEM - INTRODUCTION

Purpose

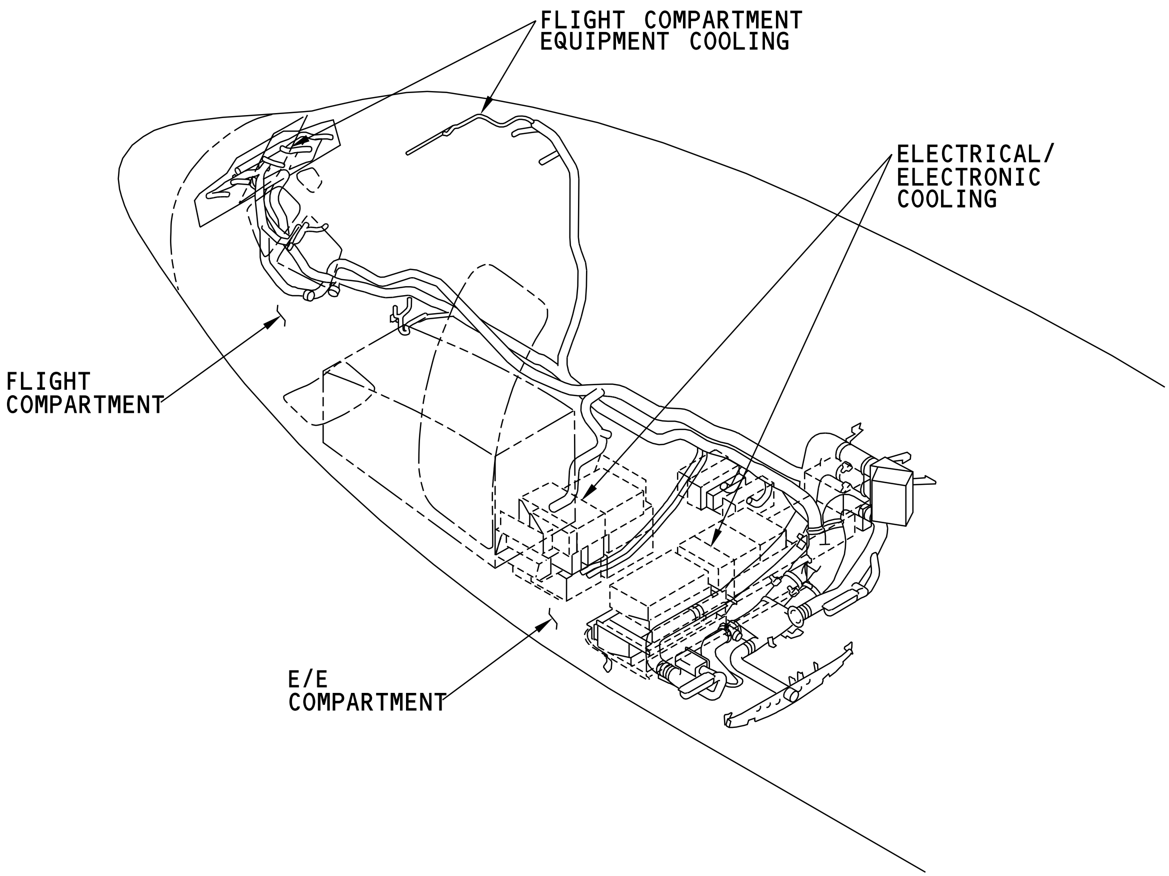
The equipment cooling system removes heat from electronic components in the flight compartment and the E/E compartment.

General

The system uses cabin air to remove heat from equipment. Fans move the air through ducts and manifolds.

Abbreviations and Acronyms

- ADIRU - air data inertial reference unit
- CDS - common display system
- cgo - cargo
- clg - cooling
- E/E - electrical and electronic
- F/C - flight compartment
- flt - flight
- FMC - flight management computer
- fwd - forward
- gnd - ground
- ht - heat
- OEV - overboard exhaust valve
- pnl - panel



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AIR CONDITIONING - EQUIPMENT COOLING SYSTEM - INTRODUCTION

AIR CONDITIONING - EQUIPMENT COOLING SYSTEM - GENERAL DESCRIPTION

General

The equipment cooling system uses these systems to remove heat from equipment:

- Supply system (pushes air)
- Exhaust system (pulls air).

The supply system and the exhaust system use fans to move air. Each system has a primary fan and an alternate fan.

The supply and exhaust fans move air through ducts and manifolds. The ducts and manifolds connect to shrouds around the electronic and electrical equipment. Low flow sensors monitor the ducts for cooling flow conditions.

Supply

The supply fans push air to these components:

- P1 and P2 (display units)
- P9 panel (FMC control display units)
- P8 (center aisle stand)
- Equipment racks in the EE compartment.

Exhaust

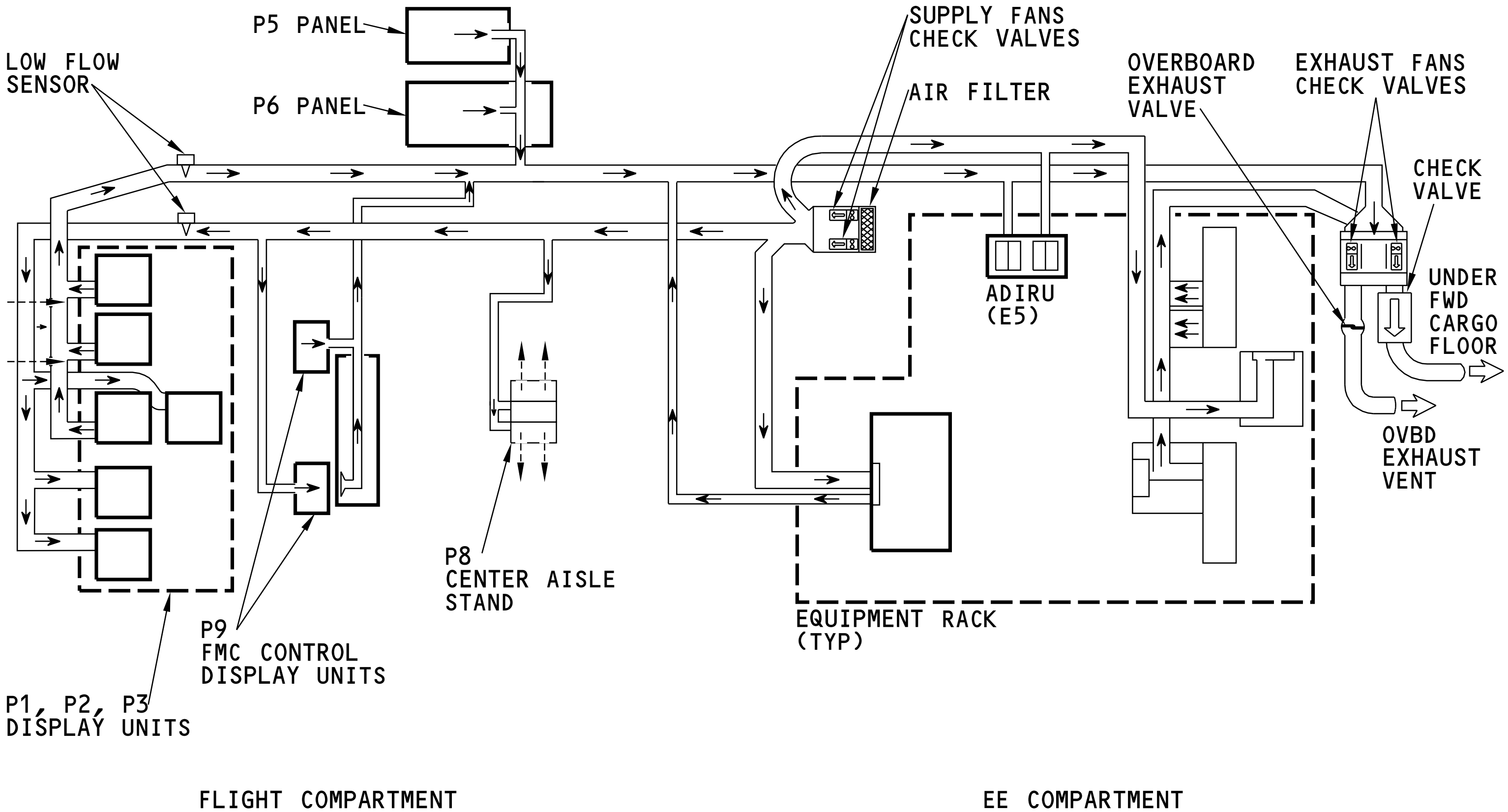
The exhaust fans pull air from these components:

- P2 and P3 (display units)
- P9 (FMC control display units)
- P6 (circuit breaker panel)
- P5 (control and indication)
- Equipment racks in the EE compartment.

The overboard exhaust valve lets exhaust air go overboard when the airplane is on the ground. The exhaust air adds to the heat in the forward cargo compartment in flight. The check valve isolates the exhaust air from the cargo compartment when the airplane is in the air and the overboard exhaust valve is open.

Low Flow Sensors

The supply and the exhaust systems use low flow sensors to monitor the cooling quality of air through the system. When a low flow or not sufficient cooling condition occurs, the low flow sensor supplies an alarm signal to the flight compartment for annunciation.



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AIR CONDITIONING - EQUIPMENT COOLING SYSTEM - GENERAL DESCRIPTION

AIR CONDITIONING - EQUIPMENT COOLING SYSTEM - COMPONENT LOCATION

General

The equipment cooling system has these parts:

- Supply
- Exhaust.

Supply

The supply duct extends forward along the right sidewall. It divides to supply the equipment racks in the EE compartment and the panels in the flight compartment.

The right sidewall section of the EE compartment contains these components:

- Normal and alternate supply fans
- Check valves
- Air Filter.

Exhaust

The aft lower section of the EE compartment contains these components:

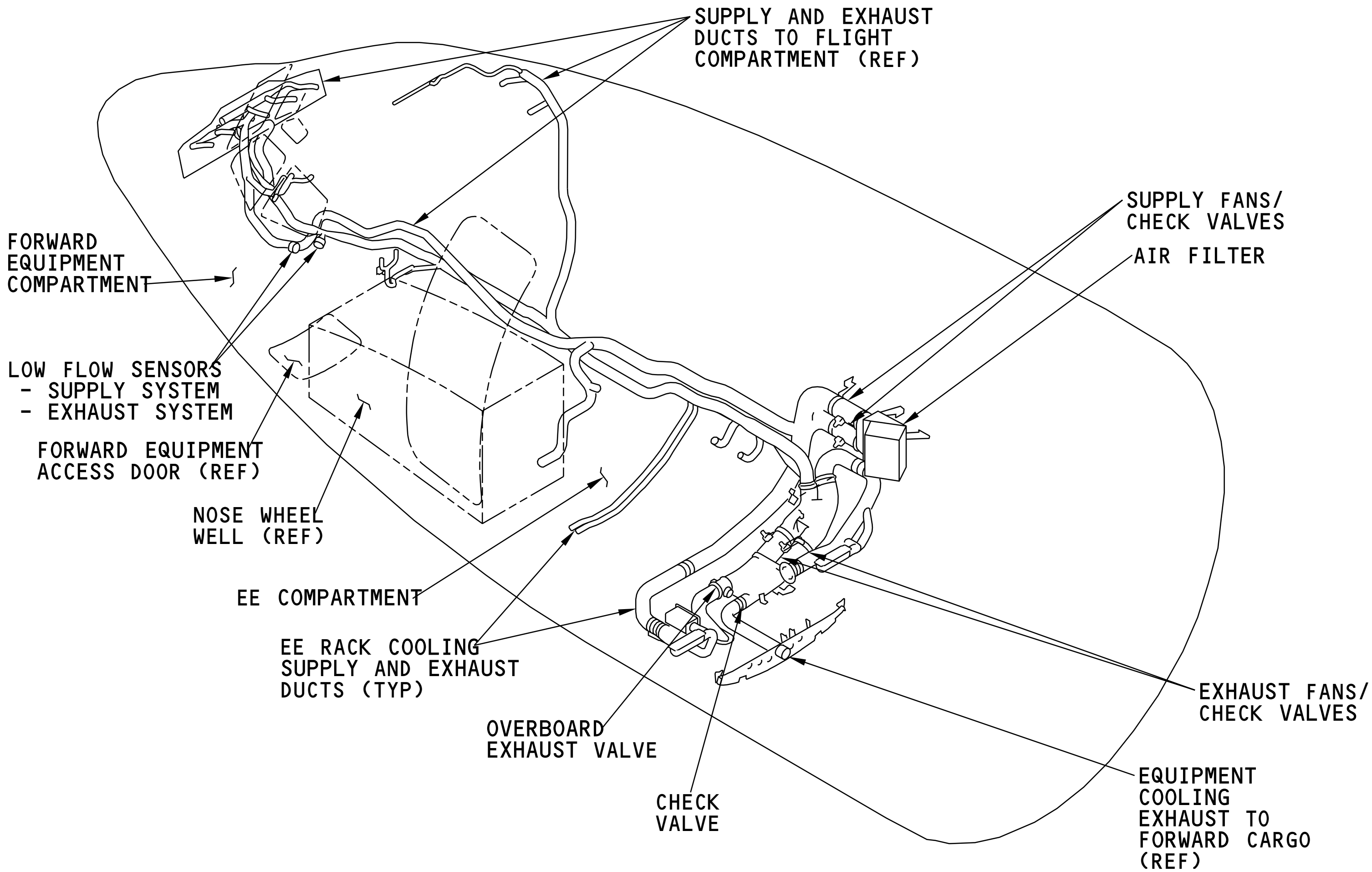
- Normal and alternate exhaust fans
- Check valves
- Overboard exhaust valve.

The overboard exhaust valve is under the floor at the center aft area of the EE compartment.

The overboard exhaust valve is under the floor structure at the center aft area of the EE compartment.

Low Flow Sensors

The supply and exhaust low flow sensors are in the forward equipment compartment. They are forward of the nose wheel well. You get access through the forward equipment compartment access door.



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AIR CONDITIONING - EQUIPMENT COOLING SYSTEM - COMPONENT LOCATION

AIR CONDITIONING - EQUIPMENT COOLING SYSTEM - OPERATION

General

The controls and indications for the equipment cooling system are on the equipment cooling panel on the P5 forward overhead panel.

Operation

The equipment cooling panel has an equipment cooling SUPPLY switch and an equipment cooling EXHAUST switch. Each switch has these two positions:

- NORM
- ALTN.

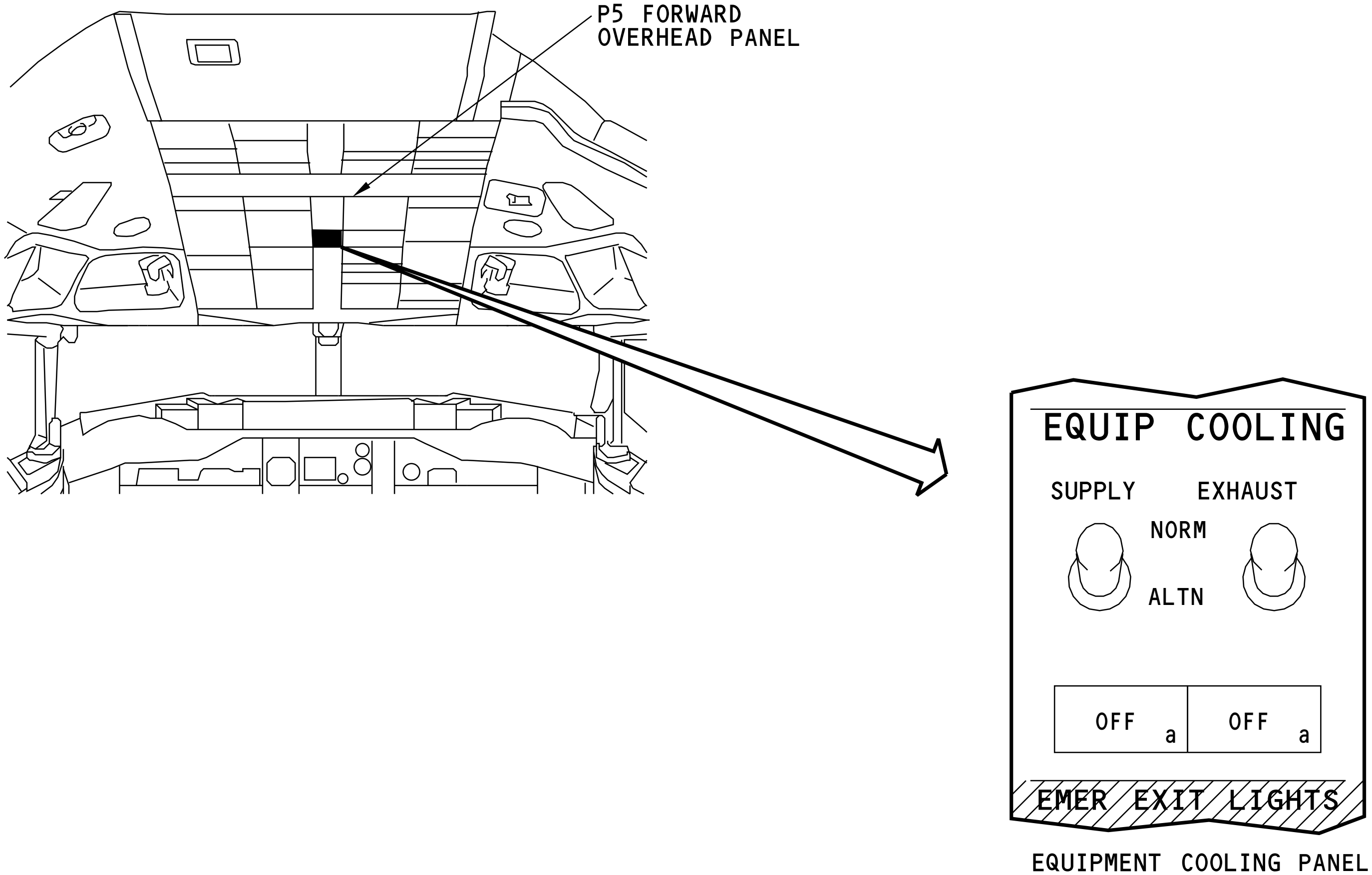
You put the switch in one of these positions to operate the normal or the alternate fan.

Indication

The equipment cooling system has low flow detectors to give a warning when there is not sufficient cooling airflow. On the ground, the crew call horn sounds when low flow is detected in the supply system. This gives you warning and that you should shut down airplane electrical systems to prevent an overheat condition.

These are the warning indications:

- Amber OFF lights on the P5 panel
- MASTER CAUTION and OVERHEAD annunciator lights.



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AIR CONDITIONING - EQUIPMENT COOLING SYSTEM - OPERATION

AIR CONDITIONING - EQUIPMENT COOLING SYSTEM - AIR FILTER

Purpose

The equipment cooling air filter removes small particles of dirt from the air before it enters the EE cooling system. This prevents contamination of the electrical and the electronic equipment.

Location

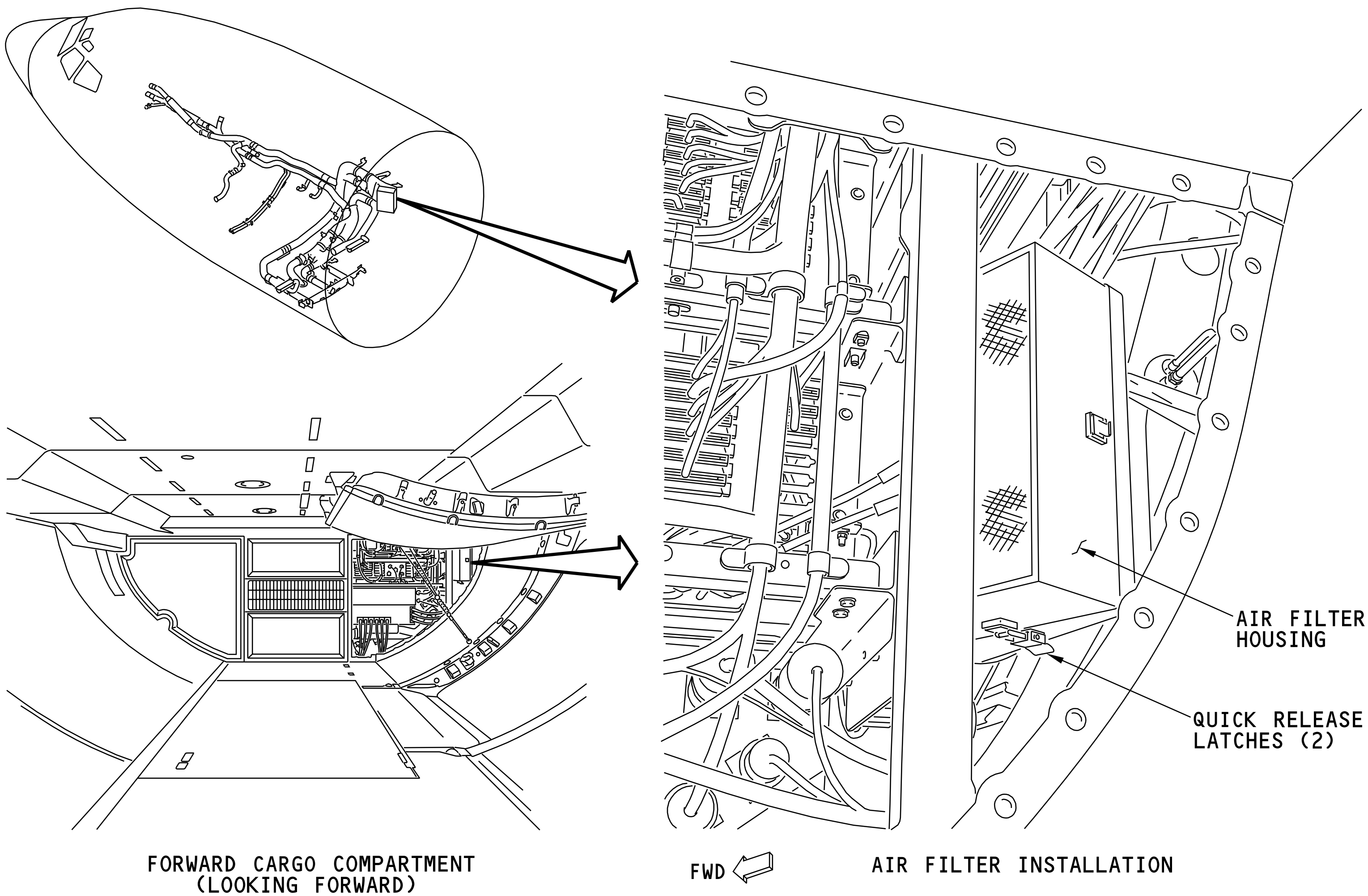
The equipment cooling air filter is in the EE compartment, on the right sidewall. It is upstream of the supply fans. Access to the air filter is from the forward cargo compartment right forward access panel.

Physical Description

The air filter is a cartridge type filter inside the air filter housing.

Training Information Point

A clogged air filter causes low flow through the equipment cooling supply system. Replacement of the air filter on a regular maintenance schedule is necessary. Release the quick release tabs on the air filter housing cover to get access to the filters.



AIR CONDITIONING - EQUIPMENT COOLING SYSTEM - AIR FILTER

AIR CONDITIONING - EQUIPMENT COOLING SYSTEM - SUPPLY AND EXHAUST FANS

Purpose

The supply and exhaust fans move air around electrical equipment to remove heat.

General Description

There are two sets of fans (normal and alternate) for the supply and the exhaust systems. One fan per system operates at a time.

Location

The supply fans and check valves are in the EE compartment. You get access to the supply fans through the EE compartment.

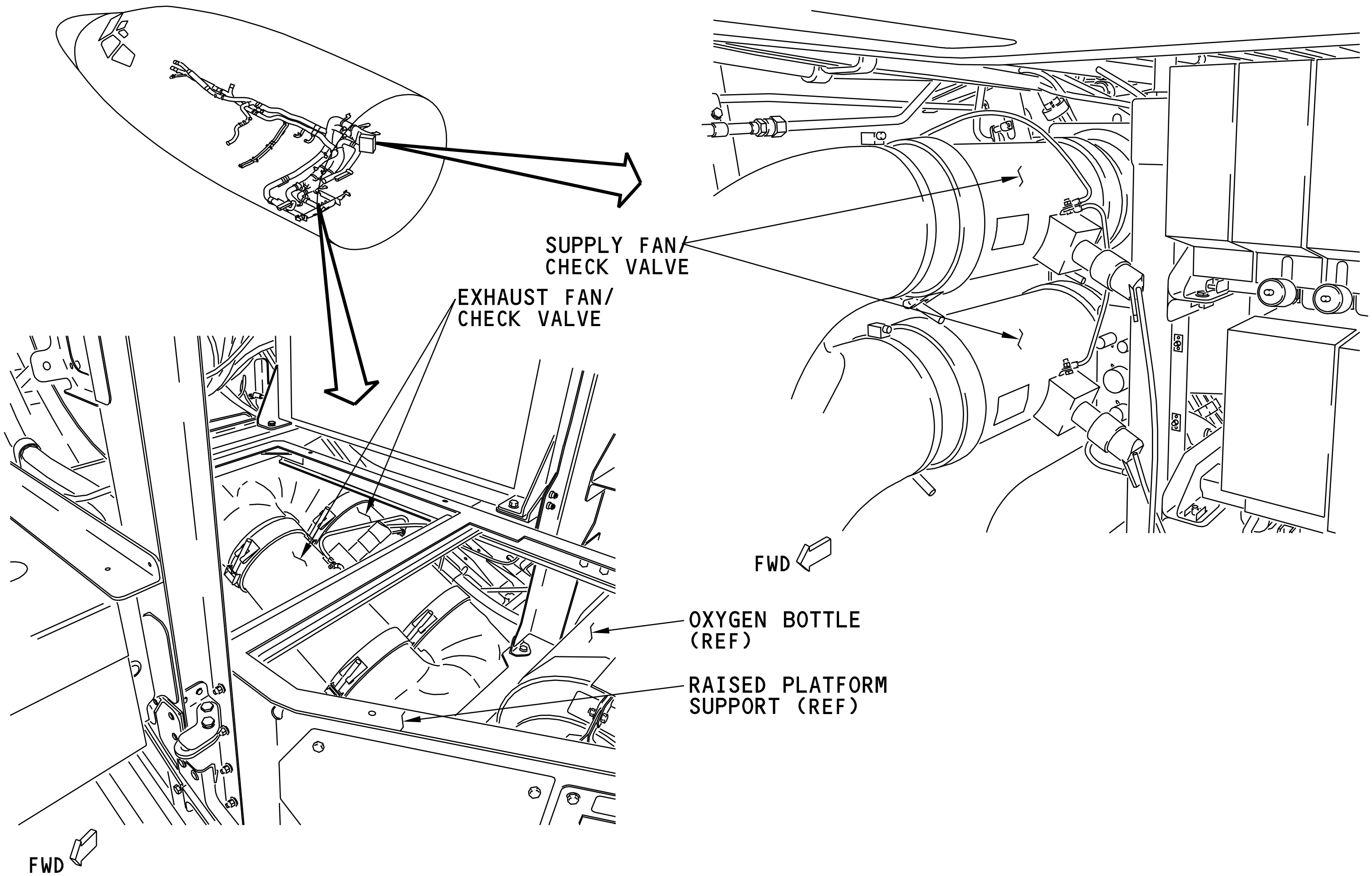
The exhaust fans and check valves are in the aft lower section of the EE compartment. You get access to the exhaust fans through the raised access panel aft of the equipment access door.

Physical Description

The fans are single-stage fans with an integral induction motor. They each have a check valve and install as a unit. The fans have thermal switches that protect the fans from overheat damage.

Training Information Point

The supply and exhaust fans install with V-band clamps. Arrows show the correct direction of flow. The supply and exhaust fans are interchangeable.



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AIR CONDITIONING - EQUIPMENT COOLING SYSTEM - SUPPLY AND EXHAUST FANS

AIR CONDITIONING - EQUIPMENT COOLING SYSTEM - LOW FLOW DETECTOR

Purpose

The low flow sensors monitor air flow for the equipment cooling system. When airflow cooling quality through the equipment is not sufficient, the sensor supplies an indication.

Location

The low flow sensors are in the forward equipment compartment. They are in the supply and exhaust ducts of the equipment cooling system. Access to the sensors is through the forward equipment compartment access door.

Functional Description

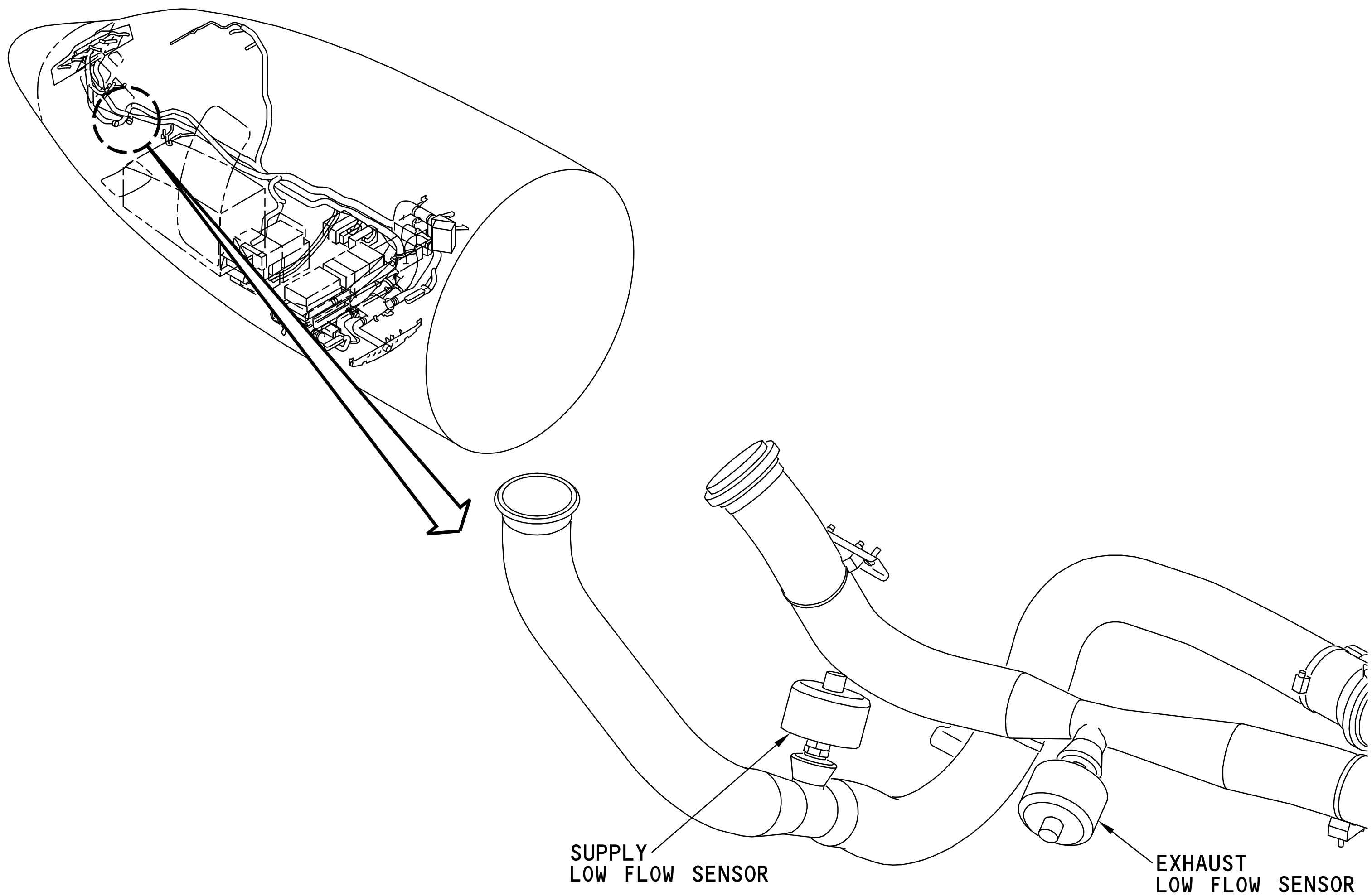
The low flow sensors are a hot wire anemometer type. The low flow sensor monitors the airflow and temperature of the equipment cooling air. The sensor sends an alarm signal when the equipment cooling airflow is not within limits.

The low flow sensors have an internal BIT. At power-up, the low flow sensors and alarm circuits do a test for correct operation. If the sensor(s) fail the BIT test, the alarm circuit causes the MASTER CAUTION light and the related EQUIP COOLING OFF light to come on.

Interfaces

The low flow sensors supply an alarm signal to these components for indication:

- Flight recorder/mach airspeed module
- The equipment cooling panel
- The ADIRS (crew call).



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AIR CONDITIONING - EQUIPMENT COOLING SYSTEM - LOW FLOW DETECTOR

AIR CONDITIONING - EQUIPMENT COOLING SYSTEM - SUPPLY FAN - FUNCTIONAL DESCRIPTION

General

The supply fan supplies cooling air to the equipment in the EE compartment and flight compartment.

There are two supply fans, normal, and alternate.

One supply fan is set to operate when you apply system power.

Normal Supply Fan Operation

The normal supply fan operates when these conditions are present:

- Thermal switches in the normal supply fan are closed (no overheat condition)
- Supply system control interrupt relay R645 is in the normal (de-energized) position
- Supply equipment cooling switch is in the NORMAL position.

The normal supply fan control relay R347 energizes to supply 115v ac 3-phase power to the fan.

Alternate Supply Fan Operation

The alternate supply fan operates when the supply equipment cooling switch is in the ALTERNATE position and the same logic conditions as the normal fan.

Fan Failure/Low Flow

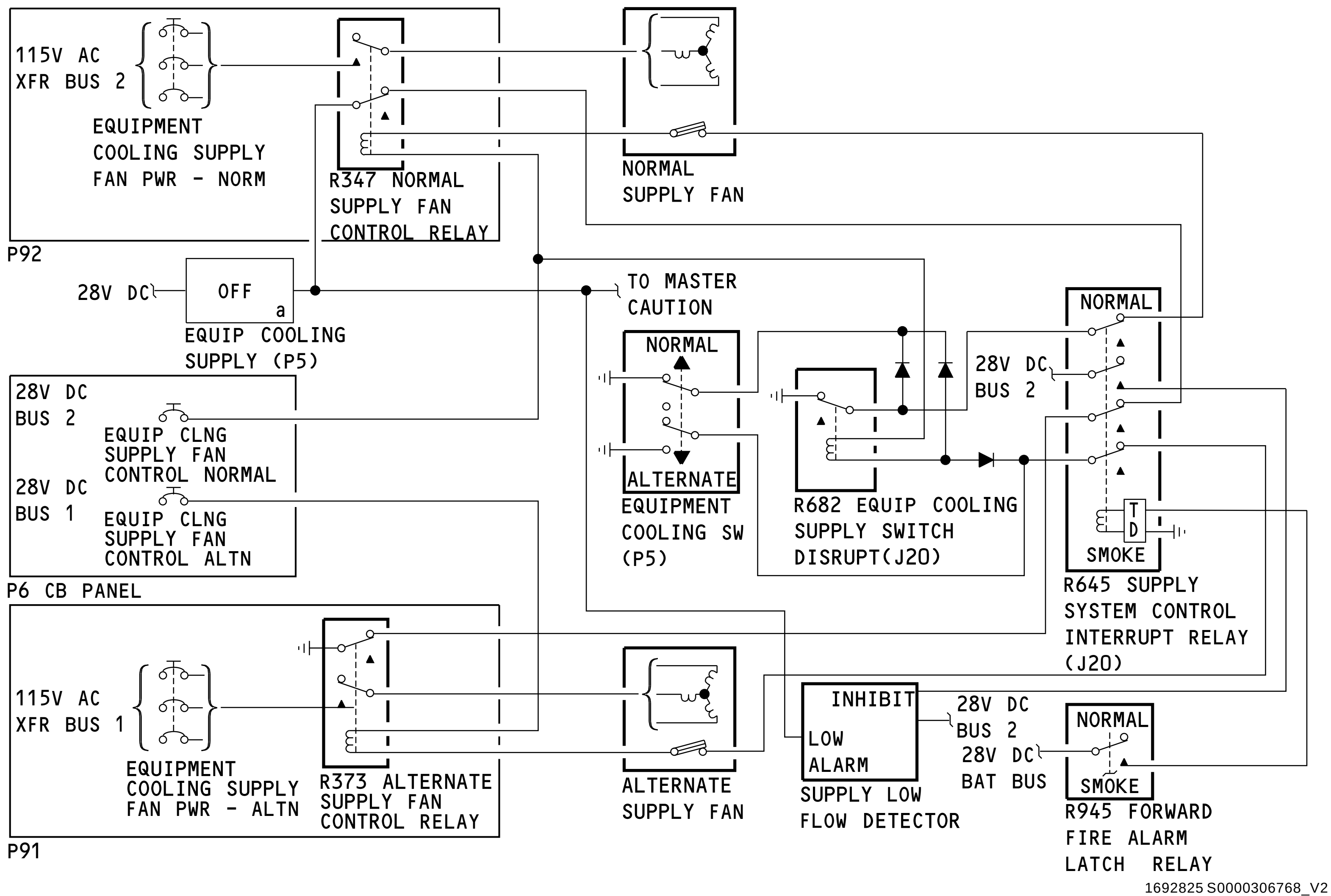
If a fan does not operate, the supply low flow detector low alarm signal operates. The system OFF light and MASTER CAUTION lights come on.

Smoke/Interrupt

When the forward fire alarm latch relay R945 energizes, it supplies 28v dc to energize the supply system control interrupt relay R645.

The supply system control interrupt relay R645 energizes and removes power to the normal and alternate fans. The supply low flow detector receives an inhibit signal. This prevents the low flow signal to cause the OFF light and MASTER CAUTION lights to come on.

The supply system control interrupt relay R645 de-energizes after a five-minute time delay.



AIR CONDITIONING - EQUIPMENT COOLING SYSTEM - SUPPLY FAN - FUNCTIONAL DESCRIPTION

AIR CONDITIONING - EQUIPMENT COOLING SYSTEM - EXHAUST FAN - FUNCTIONAL DESCRIPTION

General

The exhaust fans pull air from equipment in the EE compartment and flight compartment.

There are two exhaust fans, normal and alternate.

One exhaust fan is set to operate when you apply system power.

Normal Exhaust Fan Operation

The normal exhaust fan operates when these conditions are present:

- Thermal switches in the normal exhaust fan are closed (no overheat condition)
- Exhaust equipment cooling switch is in the NORMAL position

If the EQUIP COOLING EXHAUST switch is in the NORM position but the ground is not present at the switch, the de-energized equipment cooling exhaust switch disrupt relay R678 will provide a ground for the control circuit and energize the normal exhaust fan control relay R29 to allow power to the normal exhaust fan M98..

The normal exhaust fan control relay R29 energizes to supply 115v ac 3-phase power to the fan.

Alternate Exhaust Fan Operation

The alternate exhaust fan operates when the exhaust equipment cooling switch is in the ALTERNATE position and the same logic conditions as the normal fan.

Fan Failure/Low Flow

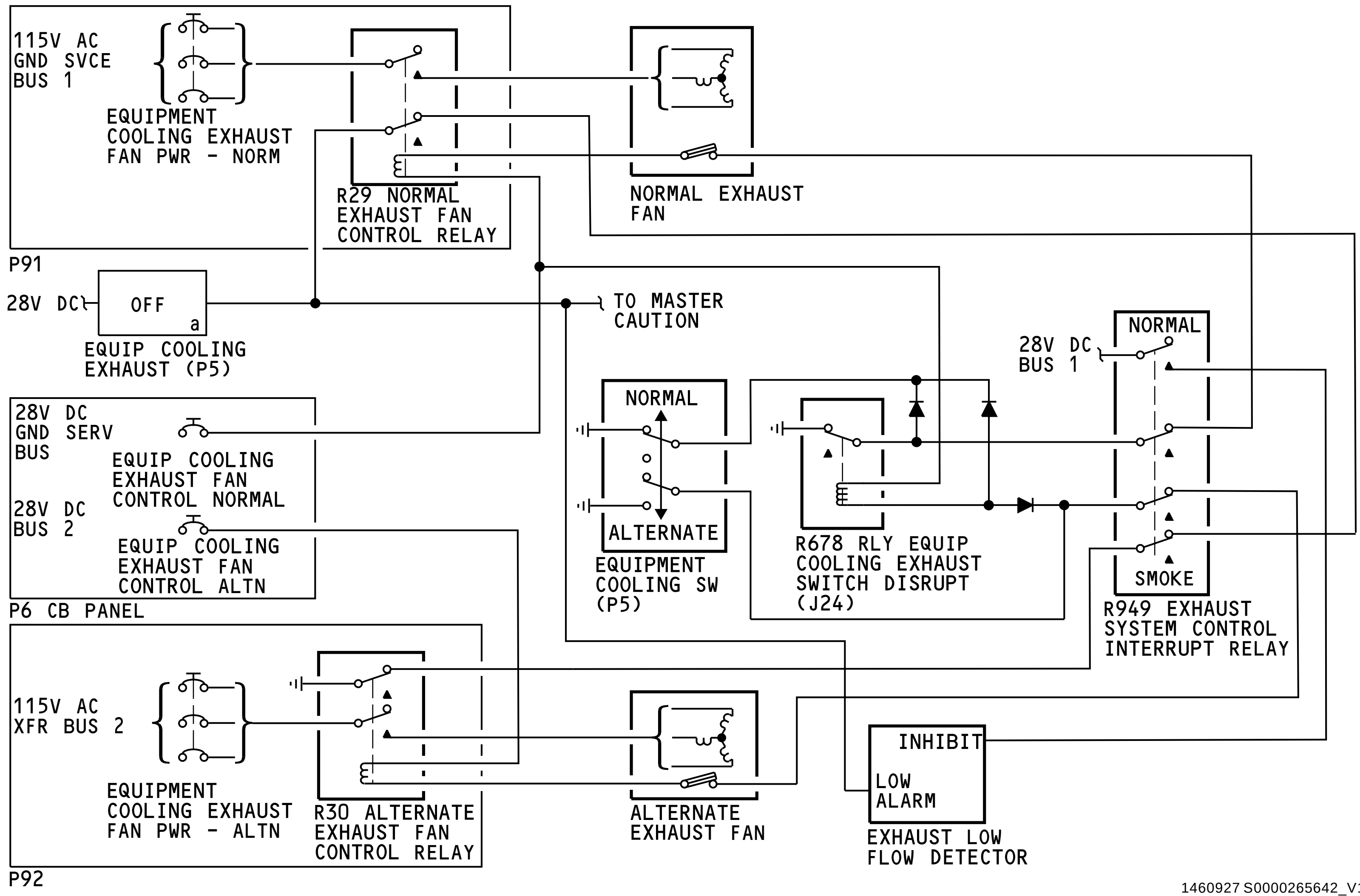
If a fan does not operate, the exhaust low flow detector low alarm signal operates. The system OFF light and the MASTER CAUTION lights come on.

Smoke/Interrupt

When the flight crew gets the forward cargo smoke alarm and takes the appropriate action, smoke control relay R648 will be energized and will allow 28v dc through contacts of an energized forward fire alarm latch relay R945 to supply 28v dc to energize exhaust system control interrupt relay, R949.

The energized exhaust system control interrupt relay R949 removes power to the normal and alternate exhaust fans. The exhaust low flow detector receives an inhibit signal. This prevents the low flow signal from causing the EQUIP COOLING EXHAUST OFF and MASTER CAUTION lights to come on.

Power to the E/E cooling exhaust system normal and alternate fans is removed for the duration of the flight to prevent smoke from entering the occupied compartments. In addition, the E/E cooling exhaust low flow sensor warning is inhibited for the remainder of the flight.



AIR CONDITIONING - EQUIPMENT COOLING SYSTEM - EXHAUST FAN - FUNCTIONAL DESCRIPTION

AIR CONDITIONING - EQUIPMENT COOLING SYSTEM - LOW FLOW DETECTOR - FUNCTIONAL DESCRIPTION

General

The low flow detectors monitor the air flow and temperature of the equipment cooling air. The detectors send an alarm signal when the equipment cooling air flow is not within limits.

Functional Description

The low flow detectors have an internal BIT. At power-up, the detectors and alarm circuits do a test for correct operation. These are the indications of a detector failure:

- Equipment cooling OFF amber light
- MASTER CAUTION and OVERHEAD annunciator lights.

The supply and exhaust low flow detectors supply a low and high alarm signals. These signals occur when the equipment cooling air flow is not within limits.

The low alarm signal gives these indications:

- Equipment cooling OFF amber light
- MASTER CAUTION and OVERHEAD annunciator lights.

The supply system control interrupt relay (R645) causes an inhibit of the low alarm signal. This occurs when the equipment cooling system is in the smoke removal mode.

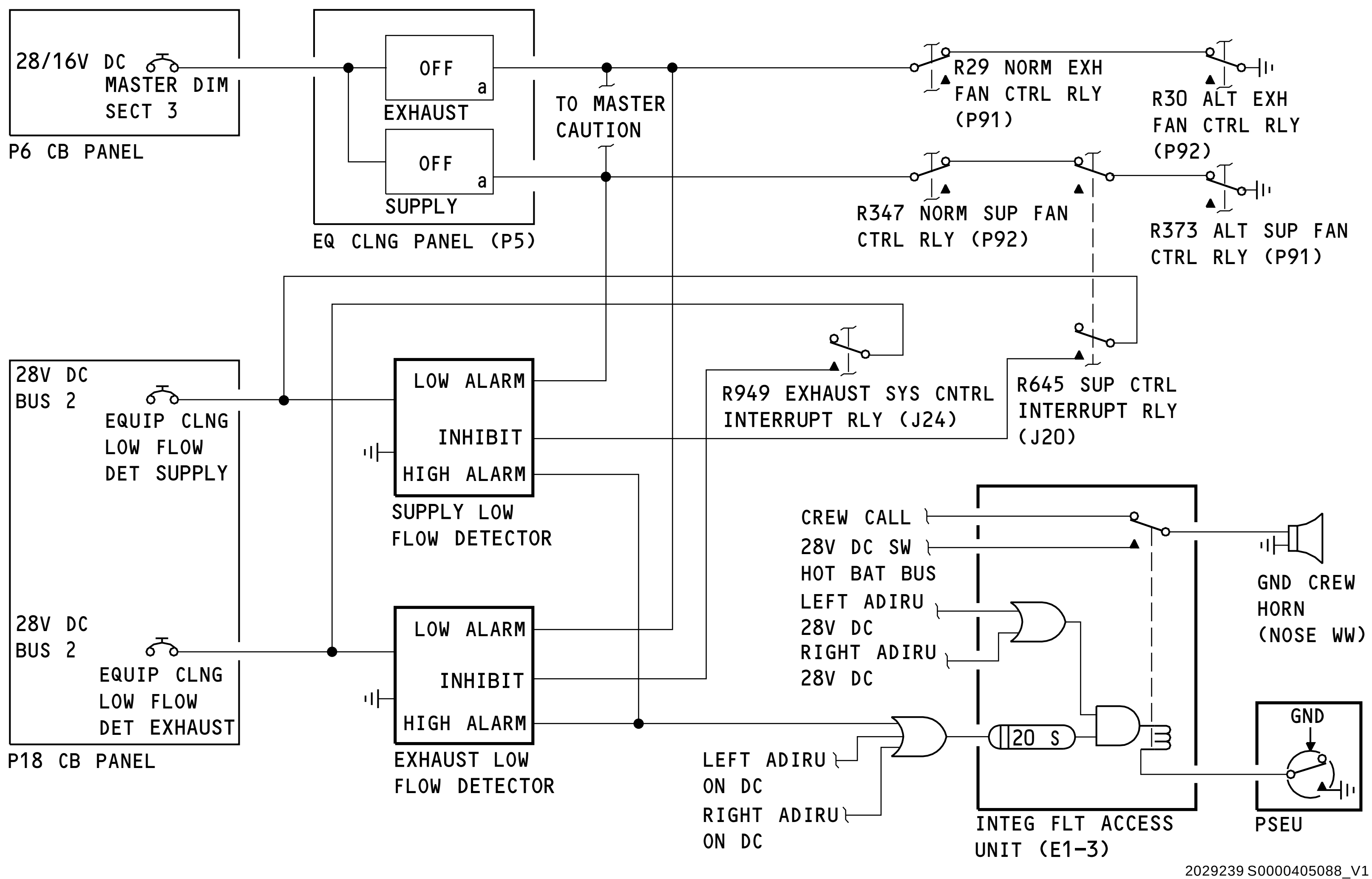
The ground crew horn automatically operates when the airplane is on the ground and these conditions are present:

- High alarm or the ON DC signal from either ADIRU is active for 20 seconds or more
- Left or right ADIRU switch is in the ALIGN or NAV position.

The exhaust system low flow sensor warning is inhibited for the duration of the flight when the smoke removal mode is initiated after a smoke warning in the forward cargo compartment.

Training Information Point

The equipment cooling system uses cabin air for cooling. The cabin air can contain contaminates such as tar, nicotine, dust, and other unwanted particles. A regular schedule to clean this equipment is necessary for proper operation of the cooling system and detectors.



AIR CONDITIONING - EQUIPMENT COOLING SYSTEM - LOW FLOW DETECTOR - FUNCTIONAL DESCRIPTION

AIR CONDITIONING - EQUIPMENT COOLING SYSTEM - OVERBOARD EXHAUST VALVE

Purpose

The overboard exhaust valve has two functions. It controls the quantity of equipment cooling exhaust air that flows overboard and it operates in a smoke removal mode.

Location

The overboard exhaust valve is in the aft center section of the EE compartment. It is below the raised platform aft of the electronic equipment access door.

Physical Description

The four-inch diameter overboard exhaust valve has these physical features:

- Valve body
- Electromechanical rotary actuator (electric motor, gear reduction train)
- Position indicator (NORMAL/SMOKE).
- Valve disk
- Damper housing (silicone oil filled).

It attaches to the overboard exhaust duct by V-band clamps.

Mechanical Functional Description

The overboard exhaust valve is an aerodynamically controlled shutoff valve. A 28v dc actuator overrides the aerodynamic control. The actuator has two positions, NORMAL and SMOKE.

When the actuator is in the NORMAL position, the valve disk can turn from full open to full closed. When the actuator is in the SMOKE position, the valve disk can turn from full open to not fully open (54 degrees).

Spring force opens the valve. When the airplane starts to pressurize, airflow through the valve increases. The valve closes when the airflow through the valve is more than 30 lbs/min (14 kg/min). When the valve is closed, 1 psi differential pressure keeps the valve closed.

When the valve is open, the equipment cooling exhaust air flows overboard. When the valve is closed, the equipment cooling exhaust air flows under the forward cargo compartment floor and heats the forward cargo compartment.

The damper put a limit on the rate of valve disk movement.

Training Information Point

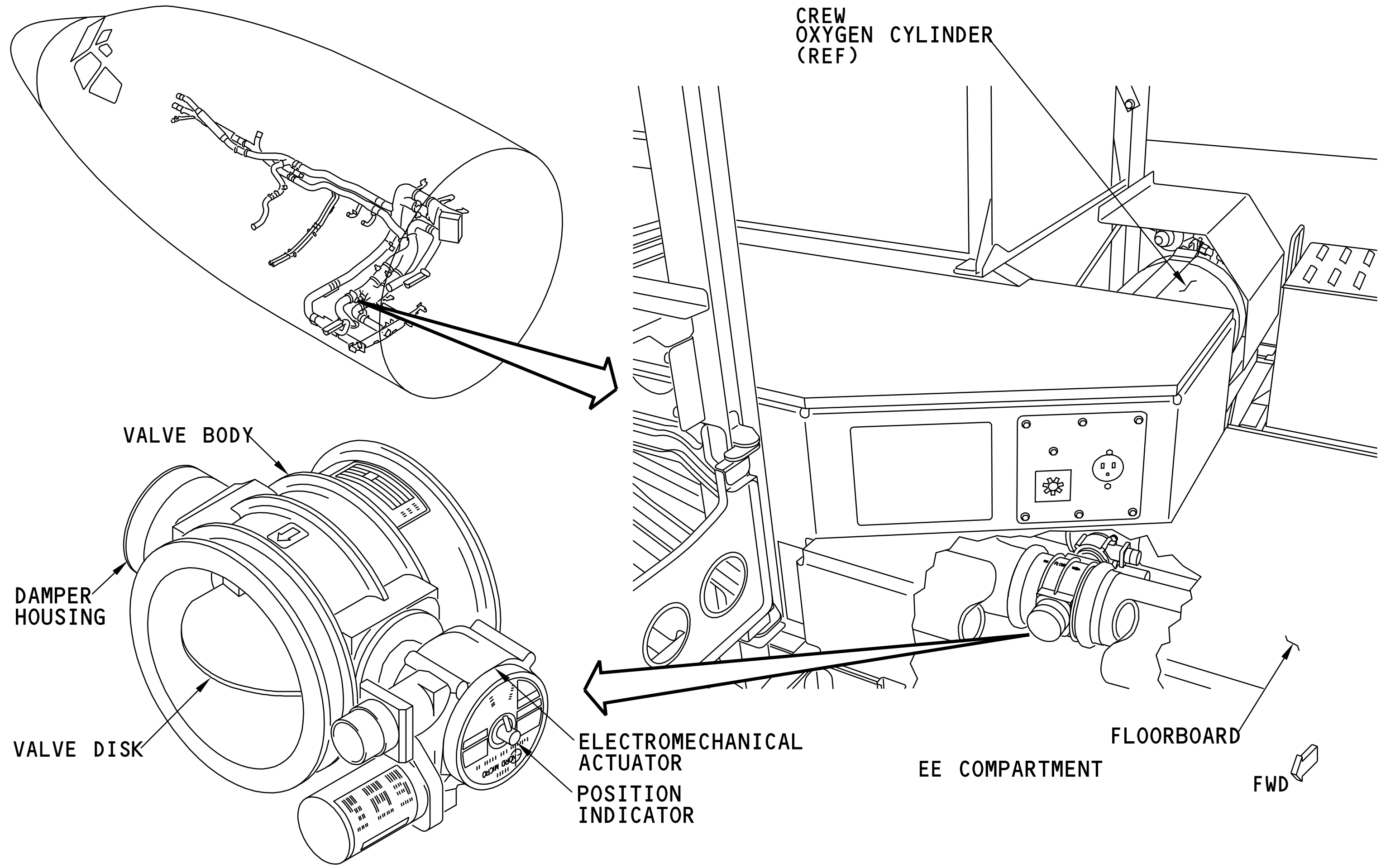
To get access to the overboard exhaust valve, you must remove the crew oxygen bottle. Obey all precautions when you work around oxygen systems. See the oxygen chapter for more information on the crew oxygen bottle. (CHAPTER 35)

CAUTION: MAKE SURE YOU REMOVE ELECTRICAL POWER FROM THE AIRPLANE. IF YOU SUPPLY ELECTRICAL POWER TO THE ELECTRICAL/ELECTRONIC EQUIPMENT WHEN THE EQUIPMENT COOLING SYSTEM IS NOT IN OPERATION, THE ELECTRICAL/ELECTRONIC EQUIPMENT CAN BECOME TOO HOT. THIS CAN CAUSE DAMAGE TO THE ELECTRICAL/ELECTRONIC EQUIPMENT.

When you do a test of the overboard exhaust valve, you must obey these precautions.

WARNING: OBEY THE PROCEDURE THAT PUTS THE AIRPLANE IN THE AIR MODE. IF YOU DO THE PROCEDURE INCORRECTLY, INJURIES TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

WARNING: MAKE SURE YOU OBEY THE PROPER PROCEDURES FOR COMPRESSION AND DECOMPRESSION WHEN YOU USE PERSONS IN A PRESSURIZED AREA. PRESSURE CHANGES THAT CAUSE PAIN MUST NOT BE DONE. IF YOU DO NOT OBEY THE PRECAUTIONS, INJURY TO PERSONS CAN OCCUR.



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AIR CONDITIONING - EQUIPMENT COOLING SYSTEM - OVERBOARD EXHAUST VALVE

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AIR CONDITIONING - EQUIPMENT COOLING SYSTEM - OEV - ELECTRICAL FUNCTIONAL DESCRIPTION

General

When the airplane is on the ground, ground sensing relay R592 is energized, smoke control relay R648 is de-energized, and overboard exhaust valve command relay R650 is de-energized. Power goes through R650 to power the overboard exhaust valve DC motor actuator to the NORMAL position. When the valve actuator is in the NORMAL position, the valve position is a function of airflow (the valve is open until the airplane pressurizes). The valve is open on the ground.

When the airplane is in the air, ground sensing relay R592 is de-energized. In pressurized flight, the normal position for the overboard exhaust valve is closed. A 28V DC motor rotary actuator opens the valve in flight for more airflow or for smoke removal.

The overboard exhaust valve has three modes of operation. These are the three modes of operation:

- Normal
- High flow
- Smoke removal.

Normal Mode

These are the switch positions for the normal mode of operation:

- Left and right pack switch - AUTO/OFF
- R RECIRC FAN switch - AUTO

When the switches are in the normal position, the overboard exhaust valve command relay R650 is not energized. Power then goes through R650 to power the valve actuator to the NORMAL position.

High Flow Mode

The high flow mode increases the ventilation of the cabin through increased air flow.

- L PACK switch or R PACK switch - HIGH
- R RECIRC FAN switch - AUTO
- When the switches are in the high flow position, power goes to time delay relay R649. The cabin pressurization system provides an open or closed enable signal to relay K1 which controls the state of relay R649.
- If an open enable signal is present at relay K1, relay R649 is de-energized and power goes through R649 to energize relay R650. Power then goes through R650 to energize the overboard equipment valve actuator to the SMOKE (open) position.
- If a closed enable signal is present at relay K1, relay R649 is energized and the overboard equipment valve actuator will stay in the NORMAL (closed) position. Relay R649 will stay energized for 5 minutes once K1 relaxes.

Smoke Removal Mode

The smoke removal mode opens the overboard exhaust valve to remove smoke from the flight deck and E/E compartment.

These are the switch positions for the smoke removal mode:

- L PACK or R PACK switch - HIGH
- R RECIRC FAN switch - OFF

When the switches are in the smoke removal position, smoke control relay R648 energizes. Power then goes through R648 and R945 to energize the overboard exhaust valve relay R650. Once R650 is energized, power will go to the OEV actuator to energize the actuator to the SMOKE position which opens the valve.

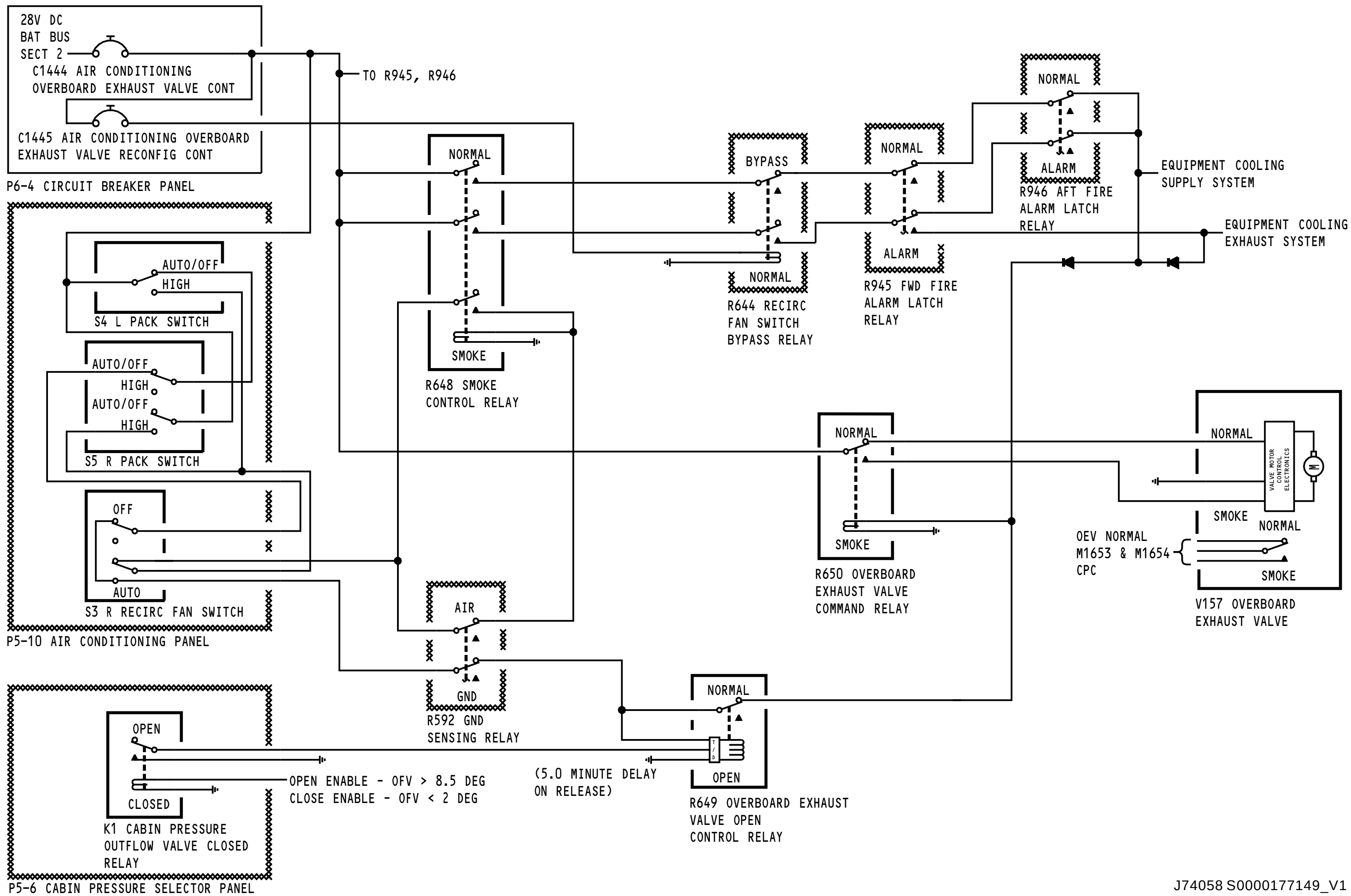
The forward fire alarm latch relay R945 and/or the aft fire alarm latch relay R946 are energized to the alarm state once the applicable FWD or AFT (or both) red cargo fire lights on the cargo fire control panel come on when given a fire indication by the smoke detectors.

Open/Close Enable Signal

The cabin pressurization system supplies an open/close enable signal. The open enable signal lets the high flow mode energize the actuator to the SMOKE (OEV open) position. The close enable signal keeps the OEV actuator in the NORMAL position (OEV closed).

The open enable signal is set when the aft outflow valve is more than 8.5 (±1.5) degrees from closed. The open enable signal stays true until the outflow valve is 2.0 (±1.5) degrees from closed.

The closed enable signal is set when the outflow valve is less than 2.0 (±1.5) degrees open. The closed enable signal energizes relay K1 which provides the ground needed to energize R649. Relay R649 remains energized until five minutes after relay K1 becomes de-energized. The five minute time delay lets the cabin pressure become stable.



AIR CONDITIONING - EQUIPMENT COOLING SYSTEM - OEV - ELECTRICAL FUNCTIONAL DESCRIPTION

AIR CONDITIONING - EQUIPMENT COOLING SYSTEM - EXHAUST FANS

Purpose

The exhaust fans remove air from around electrical equipment to remove heat.

General Description

There are two exhaust fans (normal and alternate) for the exhaust system. Only one fan operates at a time.

Location

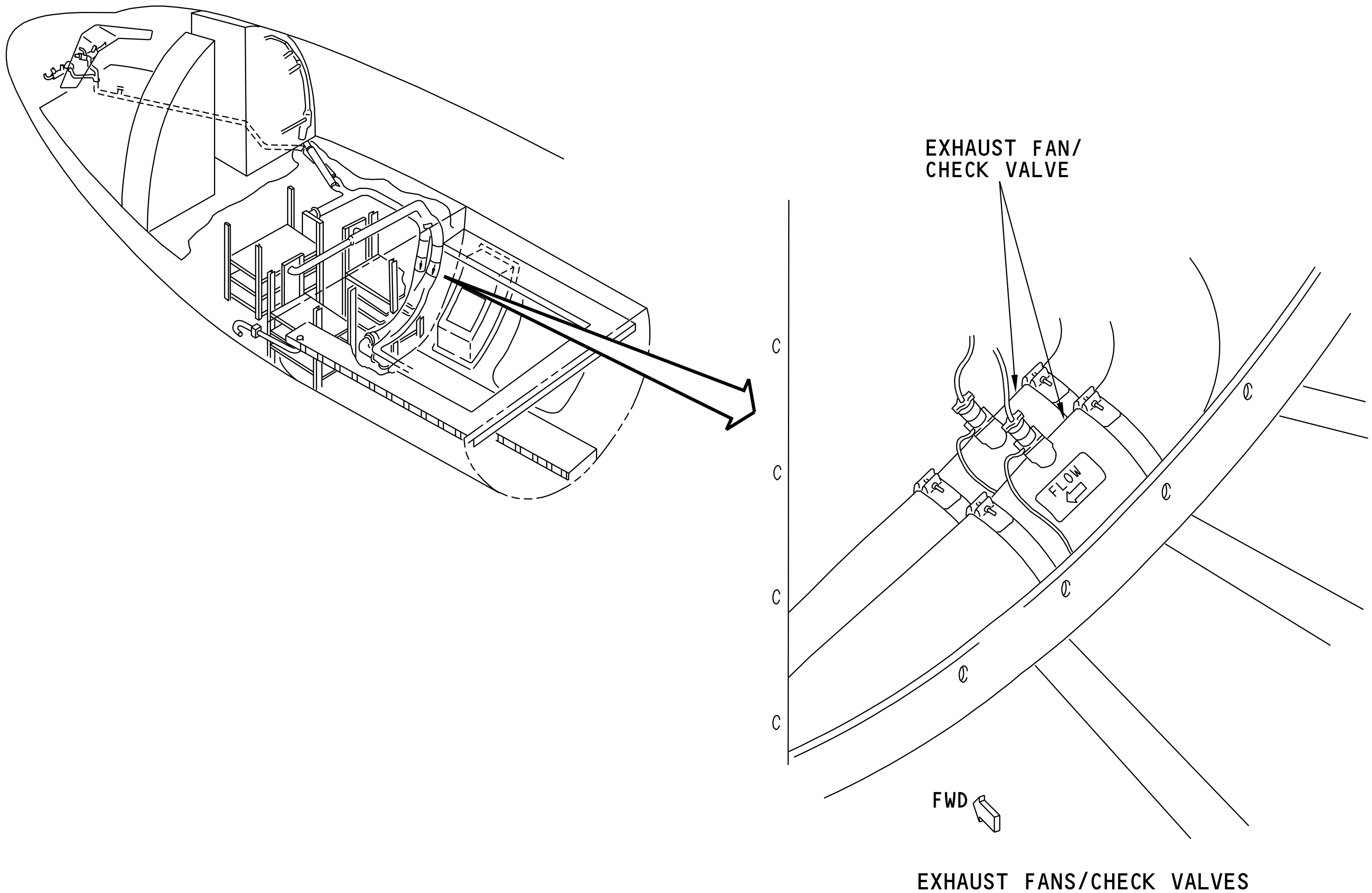
The exhaust fans and check valves are in the EE compartment. You get access to the exhaust fans through the right partition access panel of the forward cargo compartment.

Physical Description

The fans are single-stage fans with an integral induction motor. They each have a check valve and install as a single unit. The fans have thermal switches which protect the fans from overheat damage.

Training Information Point

The exhaust fans install with v-band clamps. Arrows show the proper flow direction. The exhaust fans are interchangeable.



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AIR CONDITIONING - EQUIPMENT COOLING SYSTEM - EXHAUST FANS

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AIR CONDITIONING - PRESSURIZATION CONTROL - INTRODUCTION

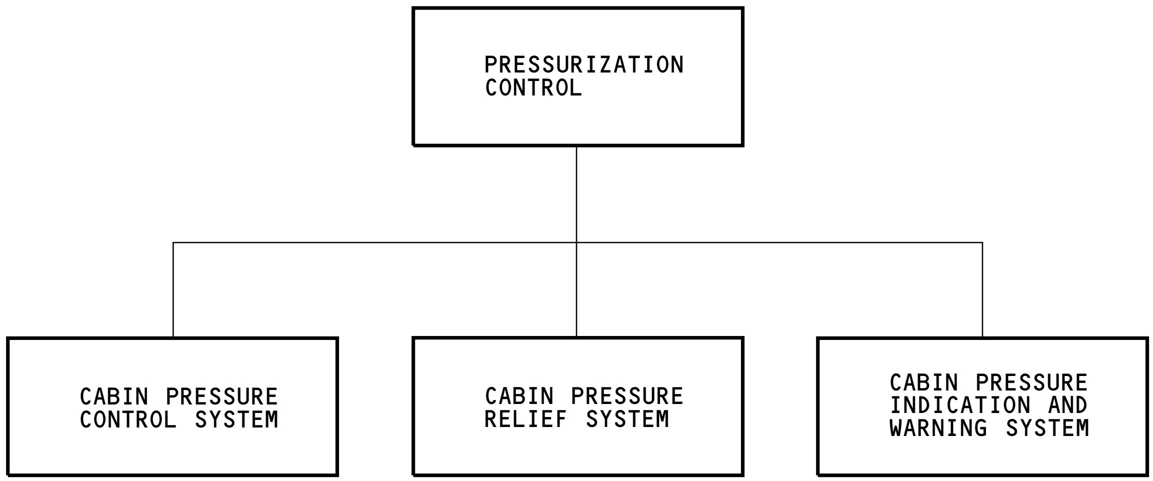
Purpose

The airplane operates at altitudes where the oxygen density is not sufficient to sustain life. The pressurization control system keeps the airplane cabin interior at a safe altitude. This protects the passengers and crew from the effects of hypoxia (oxygen starvation). These are the sub-systems of the pressurization control:

- Cabin pressure control system
- Cabin pressure relief system
- Cabin pressure indication and warning system.

Abbreviations and Acronyms

- ADIRU - air data inertial reference unit
- alt - altitude
- altn - alternate
- ARINC - Aeronautical Radio Incorporated
- auto - automatic
- BITE - built-in test equipment
- cont - controller
- CPC - cabin pressure controller
- E/E - electronic equipment
- ELACT - electronic actuator
- ESDS - electro-static discharge sensitive
- flt alt - flight altitude
- ft - foot/feet
- fwd - forward
- ISA - international standard atmosphere
- land alt - landing altitude
- man - manual
- press - pressure
- PSEU - proximity switch electronic unit
- PSI - pounds per square inch
- PSID - pounds per square inch differential
- ref - reference
- sched - schedule
- SLFPM - sea level feet per minute
- SMYDC/SMC - stall management yaw damper computer



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AIR CONDITIONING - PRESSURIZATION CONTROL - INTRODUCTION

AIR CONDITIONING - PRESSURIZATION CONTROL - GENERAL DESCRIPTION

General Description

The air conditioning packs force air into the airplane pressure vessel (cabin). Pressurization control maintains a safe cabin altitude. Pressurization control has these three sub-systems:

- Cabin pressure control
- Cabin pressure relief
- Cabin pressure indication and warning.

Cabin Pressure Control System

The cabin pressure control system controls the rate that the air flows out of the cabin. These are the components of the cabin pressure control system:

- Cabin pressure control module
- Two digital cabin pressure controllers (CPC)
- Outflow valve
- Overboard exhaust valve.

Cabin Pressure Relief System

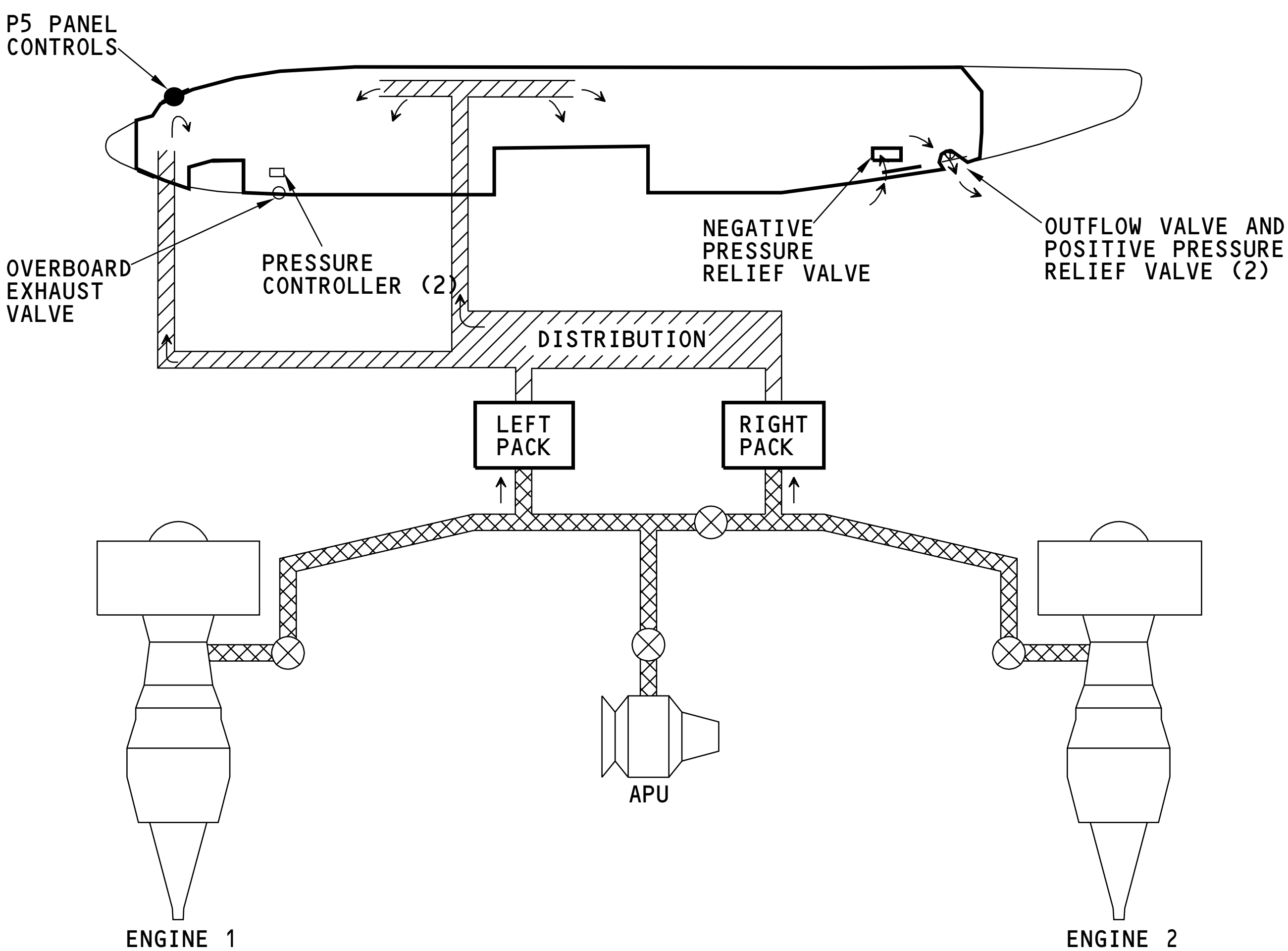
The cabin pressure relief system is a fail safe system. It protects the airplane structure from overpressure and negative pressure if the pressurization control system fails. The cabin pressure relief system has these components:

- Two positive pressure relief valves
- Negative pressure relief valve.

Cabin Pressure Indication and Warning System

The cabin pressure indication and warning system gives you data about the pressurization system status. This system has these components:

- Cabin altitude panel
- Aural warning module
- Cabin altitude warning switch.



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AIR CONDITIONING - PRESSURIZATION CONTROL - GENERAL DESCRIPTION

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AIR CONDITIONING - PRESSURIZATION CONTROL - AUTO MODE FLIGHT PROFILE - OPERATION

Purpose

The automatic (AUTO or ALTN) mode of the pressurization system controls the airplane pressure for all phases of flight:

- Ground
- Takeoff
- Climb
- Cruise
- Descent
- Landing.

Control Module Selections

To use the AUTO mode, make these selections on the cabin pressure control module:

- Select AUTO mode
- Set FLT ALT
- Set LAND ALT.

Ground

When all these conditions occur, the system is in the ground phase:

- Air/ground system shows that the left and right landing gear are on the ground
- N1 on both engines is less than 50% for at least 1.5 seconds (or engines are off)
- N2 on both engines is less than 84% for at least 1.5 seconds (or engines are off).

When the airplane is in the ground phase, the airplane is unpressurized and the outflow valve is open.

Takeoff

These changes cause the takeoff phase to start:

- N1 on both engines increases to more than 60% for at least 1.5 seconds
- N2 on both engines increases to more than 89% for at least 1.5 seconds.

In the takeoff phase, the system pressurizes the cabin to 0.1 psid below field elevation. This prevents the uncomfortable pressure bump (momentary pressure increase) at airplane rotation.

The cabin pressurization rate of change during the takeoff phase is 350 slfpm.

Climb

When the air/ground system indicates that the left and right landing gear are in the air, the climb phase starts.

The maximum cabin pressurization rate of change for depressurization is 750 slfpm.

Cruise

When the airplane external pressure decreases to within 0.25 psi of the FLT ALT selection (cruise altitude), the cruise phase starts.

In the cruise phase, the system maintains a constant cabin altitude. The cabin altitude will be the landing field elevation for flights with a flight altitude of 18,500 feet or less. For flights with a flight altitude above 18,500 feet, the cabin altitude will increase to a pressure differential that airplane is within a safe limit.

These are the pressure schedules:

FLIGHT ALTITUDE	SCHEDULE
SEA LEVEL TO 18,500	LANDING FIELD ELEVATION
18,500 TO 28,000	7.45 +/- 0.2 psid

AIR CONDITIONING - PRESSURIZATION CONTROL - AUTO MODE FLIGHT PROFILE - OPERATION

(Continued)

FLIGHT ALTITUDE	SCHEDULE
28,000 TO 37,000	7.80 +/- 0.2 psid
37,000 AND ABOVE	8.35 +/- 0.2 psid

NOTE: Deviations from flight altitude may cause the pressure to go as high as 8.45 psid to maintain a constant cabin altitude.

The maximum cabin altitude for most flights is 8,000 feet.

When the landing field elevation is more than 8,000 feet and the flight length is less than 60 minutes, this occurs:

- Flight crew enters the actual landing field elevation prior to departure
- During the cruise phase, the cabin altitude is the landing field elevation.

When the landing field elevation is more than 8,000 feet and the flight length is more than 60 minutes, this occurs:

- Flight crew enters 6,000 feet for the landing field elevation prior to departure
- During the cruise phase, the cabin altitude is per the pressure schedule
- Twenty minutes prior to landing the flight crew enters the actual landing field elevation
- The cabin altitude then climbs to the actual landing field elevation.

NOTE: When the cabin altitude increases to more than 10,000 feet, the cabin altitude warning alarm will sound. You can push the ALT HORN CUTOUT switch to deactivate the alarm.

Descent

When the airplane external pressure increases to 0.25 psi more than the FLT ALT selection, the descent phase starts.

The cabin pressure controller (CPC) sets the cabin pressure rate of change for pressurization to 750 slfpm when a cargo fire occurs. This function is inhibited on the ground.

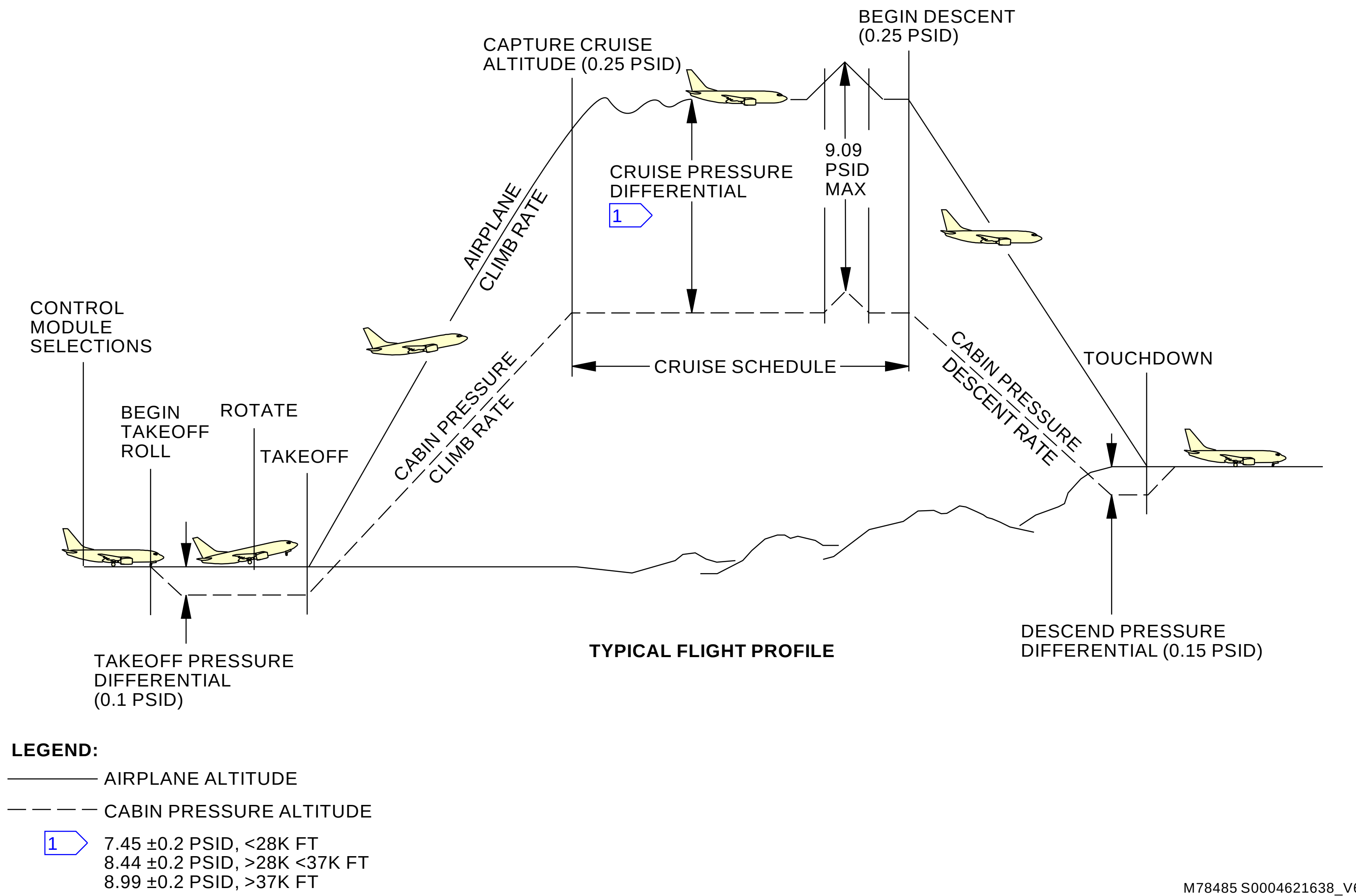
The maximum cabin pressurization rate of change for pressurization is 750 slfpm.

The system will pressurize the cabin to 0.15 psid below the LAND ALT selection (landing field elevation).

The 0.15 psid pressurization prevents pressure bumps from occurring during landing.

Landing

When the airplane lands and the requirements for the ground phase are met, the system depressurizes the cabin at a rate of 500 slfpm. When the cabin pressure is the same as the local ambient pressure, the outflow valve opens.



AIR CONDITIONING - PRESSURIZATION CONTROL - AUTO MODE FLIGHT PROFILE - OPERATION

AIR CONDITIONING - PRESSURIZATION CONTROL - COMPONENT LOCATION

Component Locations

The pressurization control system components are in these areas of the airplane:

- Flight compartment
- E/E compartment
- Forward EE compartment
- Section 47.

Flight Compartment

The cabin pressure control module and cabin altitude panel are on the P5 forward overhead panel.

EE Compartment

Cabin pressure controller 1 is on the E2-2 shelf. Cabin pressure controller 2 is on the E1-1 shelf.

Section 47

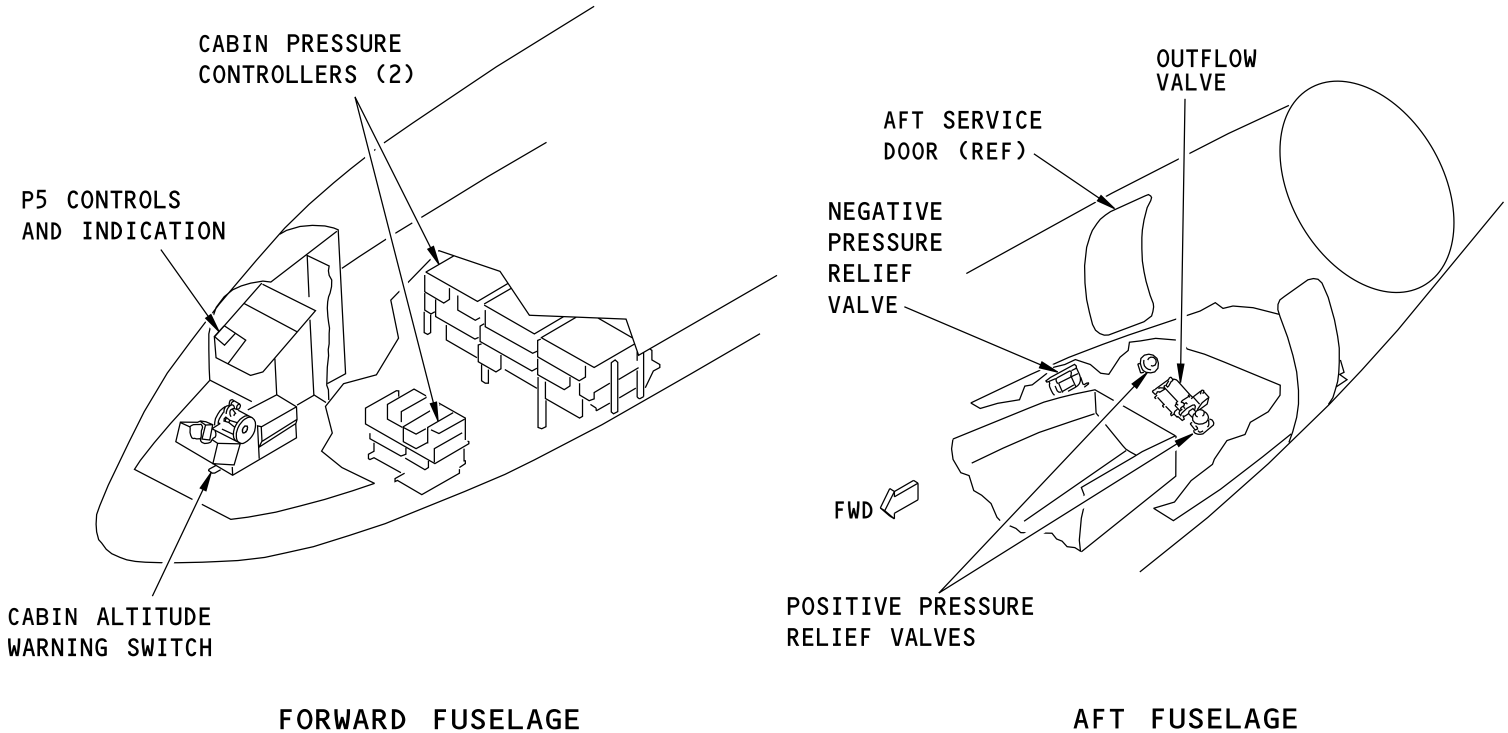
The outflow valve is on the aft right fuselage skin, below the aft service door.

There are two positive pressure relief valves. One is inboard of the outflow valve. The other is outboard of the outflow valve.

The negative pressure relief valve is on the aft right fuselage skin, forward of the outflow valve.

Forward E/E Compartment

The cabin altitude warning switches, S128 and S1153, are on the ceiling in the forward EE compartment.



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AIR CONDITIONING - PRESSURIZATION CONTROL - COMPONENT LOCATION

AIR CONDITIONING - PRESSURIZATION CONTROL - INTERFACE

General Description

Pressurization control can be automatic or manual.

There are two digital cabin pressure controllers (CPCs). Each CPC has its own systems interface and valve motor system. This gives the AUTO mode of control a dual redundant architecture. Only one CPC controls the outflow valve at any time. The other CPC is a backup. The active controller changes for every flight or when there is an autofail event.

The manual control mode overrides and bypasses the two CPCs. The manual control system has its own valve motor system. This gives the pressurization control system a triple redundant architecture.

The cabin pressure control system has these components:

- Cabin pressure control module
- Digital cabin pressure controllers (2)
- Aft outflow valve assembly with three drive motors
- Wiring, connectors, and power sources.

Electric Power

The system gets 28v dc power from these sources:

- Battery bus
- DC bus 1
- DC bus 2.

Data Input Interface

The flight crew makes these inputs to the cabin pressure control module:

- Pressurization mode
- Flight altitude
- Landing altitude.

A sensor on each CPC senses pressure in the cabin.

Each CPC gets air data from both of the air data inertial reference units (ADIRUs), engine speed data from both of the stall management and yaw damper computers (SMYDCs), and air/ground logic from the proximity switch electronics unit (PSEU).

Each CPC uses position feedback from these valves that affect the pressurization system:

- Left pack valve
- Right pack valve
- Overboard exhaust valve.

Outflow Valve Interface

The outflow valve has these three motors:

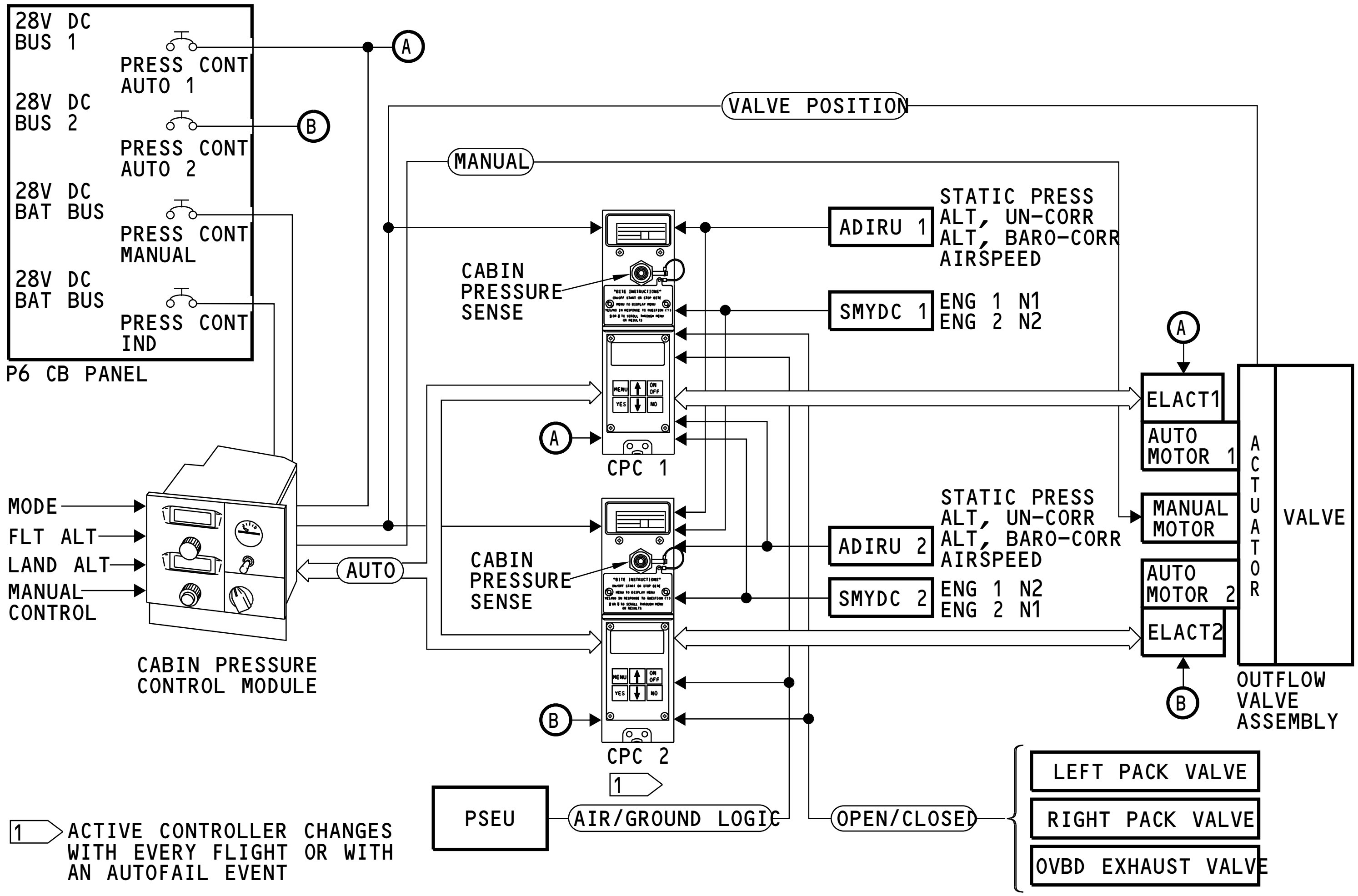
- Two AUTO motors with electronic actuators
- One MANUAL motor.

The CPCs use data buses to interface with the electronic actuators on the valve. The electronic actuators drive the auto motors. Altitude switches in each electronic actuator override CPC signals and close the outflow valve if the cabin altitude is 14,500 feet. This function does not affect the manual mode of operation of the outflow valve.

In the manual mode, the pilot uses the control module toggle switch to operate the outflow valve. The manual motor has no electronic actuator, and no pressure switch.

The outflow valve gives position feedback to these units:

- Two CPCs
- P5 forward overhead panel.



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AIR CONDITIONING - PRESSURIZATION CONTROL - INTERFACE

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AIR CONDITIONING - PRESSURIZATION CONTROL - CABIN PRESSURE CONTROL MODULE AND CABIN ALT PANEL

Purpose

The cabin pressure control module and the cabin altitude panel let the crew monitor and control the pressurization system.

Location

The cabin pressure control module and cabin altitude panel are on the P5 forward overhead panel.

Cabin Pressure Control Module

The cabin pressure control module has these controls and indications:

- Mode selector
- LAND ALT (Landing altitude) selector with display
- FLT ALT (flight altitude) selector with display
- Manual mode toggle switch
- Aft outflow valve position indicator.

The mode selector has these positions:

- AUTO
- ALT - alternate automatic operation
- MAN - manual operation.

The FLT ALT selector sets cruise altitude from -1,000 to 42,000 ft in increments of 500 feet.

The LAND ALT selector sets landing field altitude from -1,000 to 14,000 ft in increments of 50 feet.

The outflow valve switch is a three-position toggle switch, spring-loaded to the neutral position. It controls the aft outflow valve in the manual mode. These are the three positions of the outflow valve switch:

- CLOSE
- Neutral
- OPEN.

An aft outflow valve position indicator shows the aft outflow valve position in all modes of operation.

These are the four system status lights above the control panel:

- AUTO FAIL (system failure)
- OFF SCHED DESCENT (deviation from flight plan)
- ALTN (operational mode)
- MANUAL (operational mode).

Cabin Altitude Panel

These are the indications and controls on the cabin altitude panel:

- Cabin altitude/differential pressure indicator
- Cabin rate of climb indicator
- ALT HORN CUTOUT switch.

The cabin altitude and differential pressure indicator is connected to the alternate static system. The large needle on the indicator shows cabin pressure differential in 0.2 psid increments. The small needle shows cabin altitude in 1,000 ft increments.

The rate of climb indicator detects pressure changes from a port on the back of the indicator.

When cabin altitude is more than a preset limit, the aural warning unit makes an intermittent beep alarm. The ALT HORN CUTOUT switch is used to stop the intermittent beep alarm.

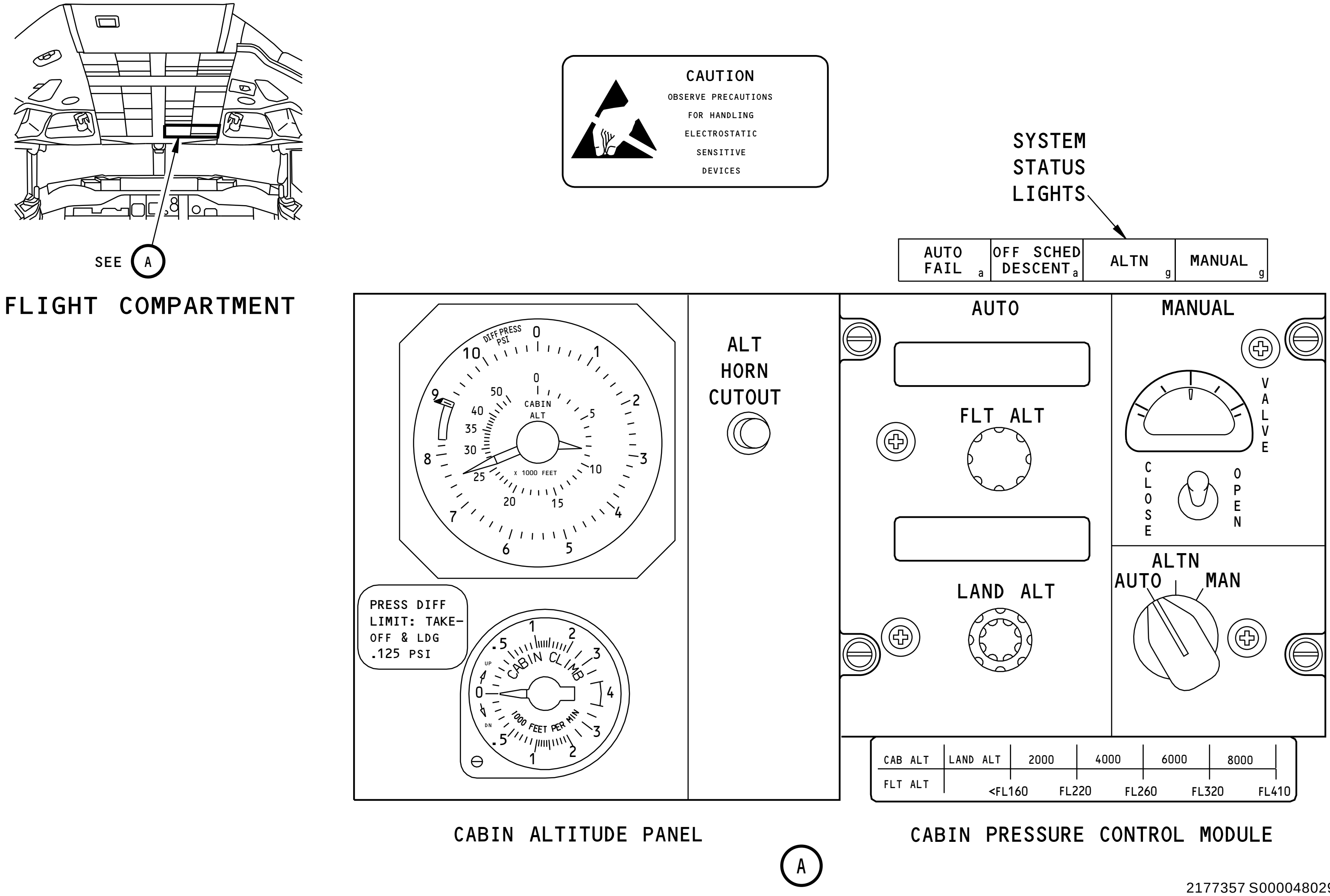
Placards on the control panels are a reference for manual mode operations. They provide a reference for:

- Takeoff and landing pressure differential maximums
- Flight altitude to cabin altitude conversions.

Training Information Point

The cabin pressure control module has integrated circuit electronics. It is an electro-static discharge sensitive (ESDS) device. Use proper care when you handle it.

Flush operations of the vacuum toilet system can cause the cabin rate of climb indicator to momentarily show a high rate of climb indication. This is normal.



2177357 S0000480298_V1

AIR CONDITIONING - PRESSURIZATION CONTROL - CABIN PRESSURE CONTROL MODULE AND CABIN ALT PANEL

AIR CONDITIONING - PRESSURIZATION CONTROL - CABIN PRESSURE CONTROLLER

Purpose

The cabin pressure controllers (CPC) control cabin pressure when the system is in the AUTO or ALTN mode of operation.

General Description

There are two CPCs. The CPCs use digital circuitry.

The CPCs are part of a dual redundant system. They are active when the system operates in the AUTO or ALTN modes. Only one CPC operates the outflow valve at any given time. The other CPC acts as a backup.

The CPCs have pin selectable control functions. This function optimizes the system for specific mission profiles.

Location

The two CPCs are in the EE compartment. CPC 1 is on the E2-2 shelf. CPC 2 is on the E1-1 shelf.

Physical Description

Each CPC has these items:

- Cabin pressure sensor
- BITE instruction plate
- Two-line LED display
- BITE control buttons.

BITE

Each CPC has these main menus:

- EXISTING FAULTS
- FAULT HISTORY
- GROUND TESTS
- SYSTEM STATUS
- SYSTEM TEST AND CLEAR.

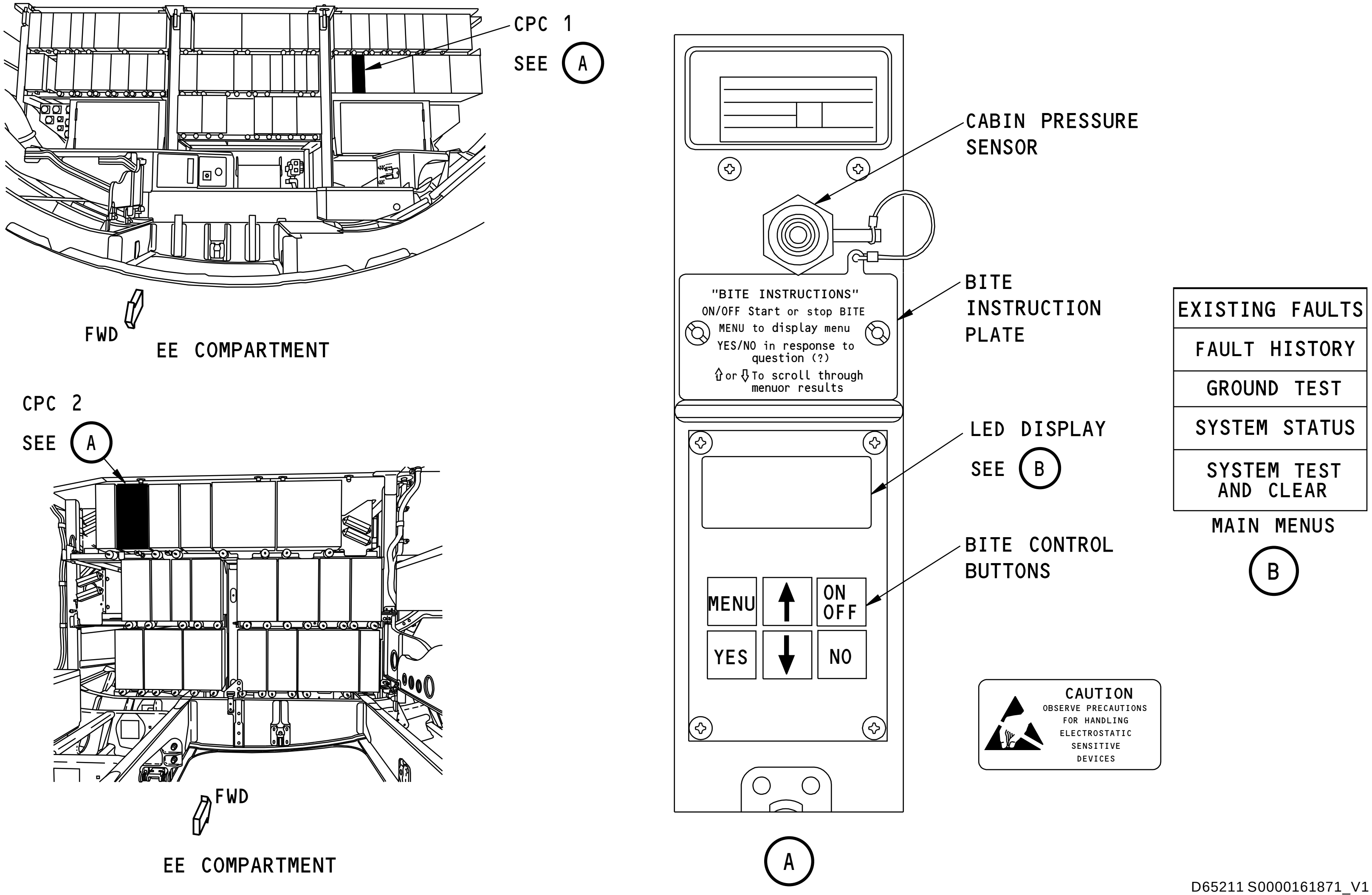
These are the functions of the BITE control buttons:

- ON/OFF button activates or de-activates the BITE functions in the CPC
- MENU button is used to display the BITE menus or to move up one level in the BITE menus
- YES button is used to respond to questions
- NO button is used to respond to questions
- Up arrow button is used to scroll up through the menu or the results of a BITE test
- Down arrow button is used to scroll down through the menu or the results of a BITE test.

Training Information Point

The CPCs show FAULT on the front panel display only when there is an existing fault.

The CPCs are electrostatic discharge sensitive (ESDS) devices. Use ESDS safe practices when you handle the CPCs.



AIR CONDITIONING - PRESSURIZATION CONTROL - CABIN PRESSURE CONTROLLER

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AIR CONDITIONING - PRESSURIZATION CONTROL - CPC - BITE - MAIN MENU

General Description

A BITE module is on the front face of each cabin pressure controller. The BITE does checks of these hardware and software:

- All system components
- System interfaces
- Overall system performance.

These selections are available when you push the MENU button and then the UP and DOWN arrows:

- EXISTING FAULTS
- FAULT HISTORY
- GROUND TESTS
- SYSTEM STATUS
- SYSTEM TEST AND CLEAR.

EXISTING FAULTS

EXISTING FAULTS shows faults that are present. From the main menu EXISTING FAULTS, there are faults and fault details.

FAULT HISTORY

FAULT HISTORY shows previous faults. From the main menu FAULT HISTORY, there are faults and fault details.

GROUND TESTS

GROUND TEST has these two submenus:

- DISPLAY TEST
- SYSTEM TEST.

The DISPLAY TEST does a test of the LED display.

The SYSTEM TEST does a test of the cabin pressurization system.

SYSTEM STATUS

SYSTEM STATUS has these two submenus:

- PRESENT STATUS
- SYSTEM CONFIGURATION (SYSTEM CONFIG).

PRESENT STATUS shows the current inputs to the cabin pressure controllers.

SYSTEM CONFIG shows the system configuration.

SYSTEM TEST AND CLEAR

The SYSTEM TEST AND CLEAR main menu selection prepares the controller for a system test and clears the FAULT HISTORY.

Training Information Point

When you push the ON/OFF button, the controller makes sure that the airplane is in the ground mode. If the airplane is not in the ground mode, A/P NOT IN GND shows for two seconds. Then BITE ABORTED shows for two seconds.

There are these two types of faults:

- Previous faults (PREV FAULTS)
- Existing faults (EXIST FAULTS).

If there is an existing fault, the cabin pressure controller shows FAULT on the front panel display.

If there are only existing faults, the display shows nn EXIST FAULTS for two seconds. Then the display shows EXISTING FAULTS.

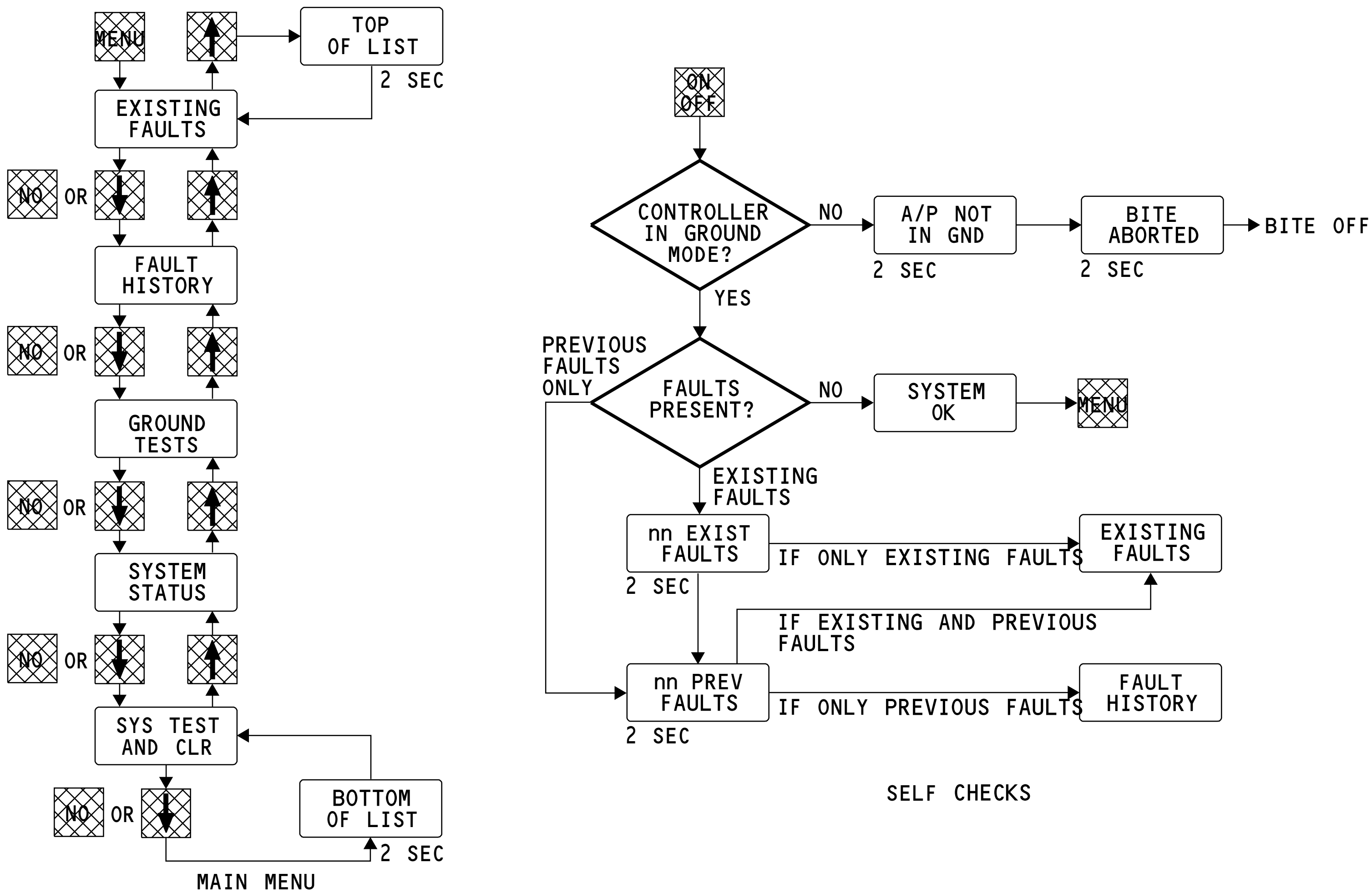
If there are only previous faults, the display shows nn PREV FAULTS for two seconds. Then the display shows FAULT HISTORY.

If there are existing and previous faults, the display shows nn EXIST FAULTS and nn PREV FAULTS for two seconds each. Then the display shows EXISTING FAULTS.

AIR CONDITIONING - PRESSURIZATION CONTROL - CPC - BITE - MAIN MENU

Training Information Point

EXISTING FAULTS and FAULT HISTORY show faults. Each fault has fault details. For more information on faults and fault details, use the Fault Isolation Manual.



M78275 S0004621660_V1

AIR CONDITIONING - PRESSURIZATION CONTROL - CPC - BITE - MAIN MENU

EXISTING FAULTS

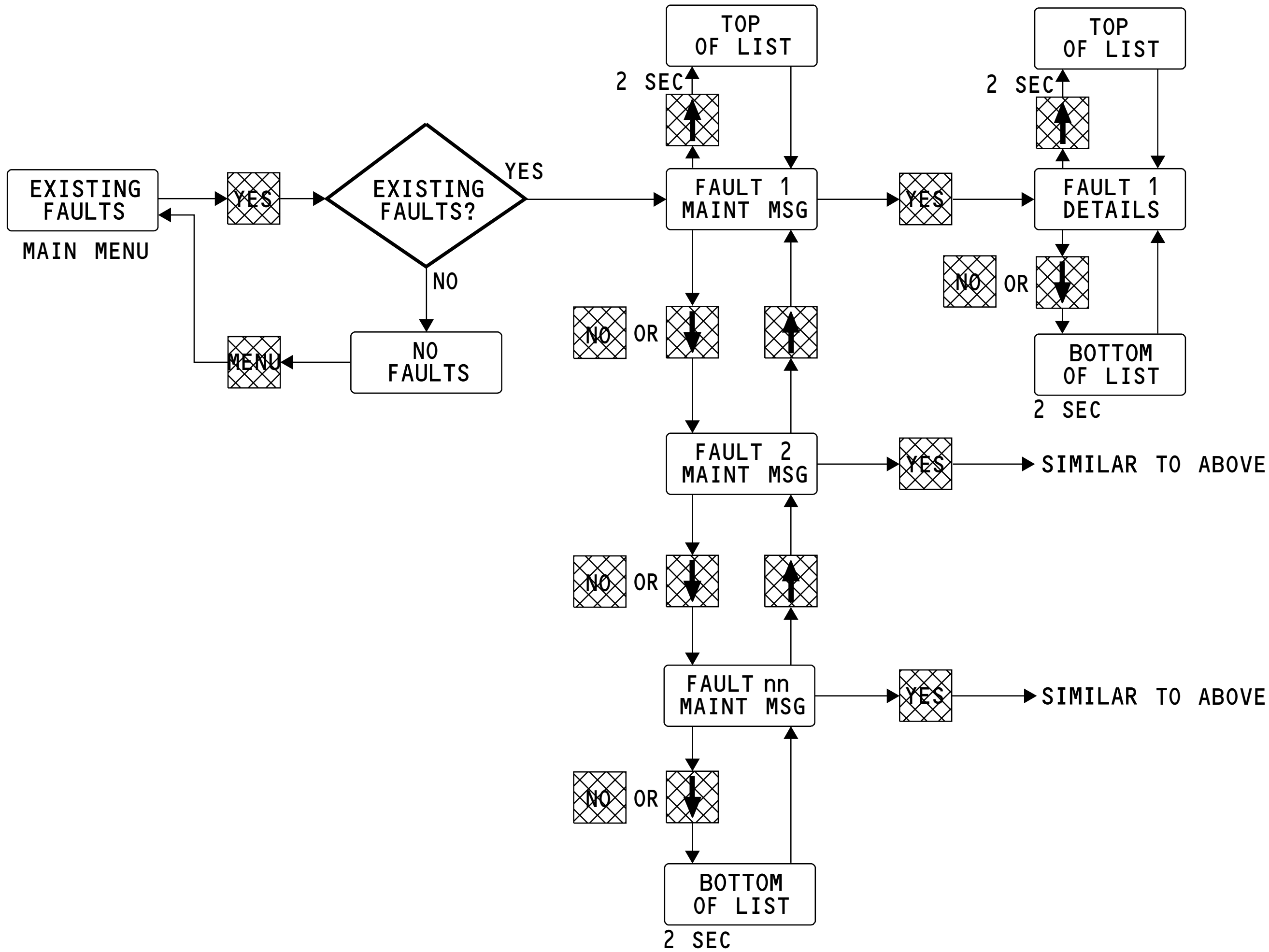
EXISTING FAULTS shows faults that are present. From the main menu EXISTING FAULTS, there are faults and fault details. Faults are maintenance messages of the primary problem. For more information of a fault, there are fault details.

From the EXISTING FAULTS menu, push the YES button. If there are no faults, the display shows NO FAULTS. To go back to the main menu, push the MENU button.

If there is a fault or faults, the first fault shows on the display. To see the next fault, push the NO or DOWN arrow button. If there are no more faults, the display shows BOTTOM OF LIST for 2 seconds.

To see the fault details for one of the faults, push the YES button. Then the display shows the fault details for that fault. If you push the NO or DOWN arrow button, the display shows the next fault detail for the same fault. If there are no more fault details, the display shows BOTTOM OF LIST for 2 seconds.

Subsequent maintenance action is needed to resolve those maintenance message(s) that show in the EXISTING FAULTS.



M78276 S0004621662_V1

AIR CONDITIONING - PRESSURIZATION CONTROL - CPC - BITE - EXISTING FAULTS

FAULT HISTORY

FAULT HISTORY shows previous faults that are in the memory and have not been cleared.

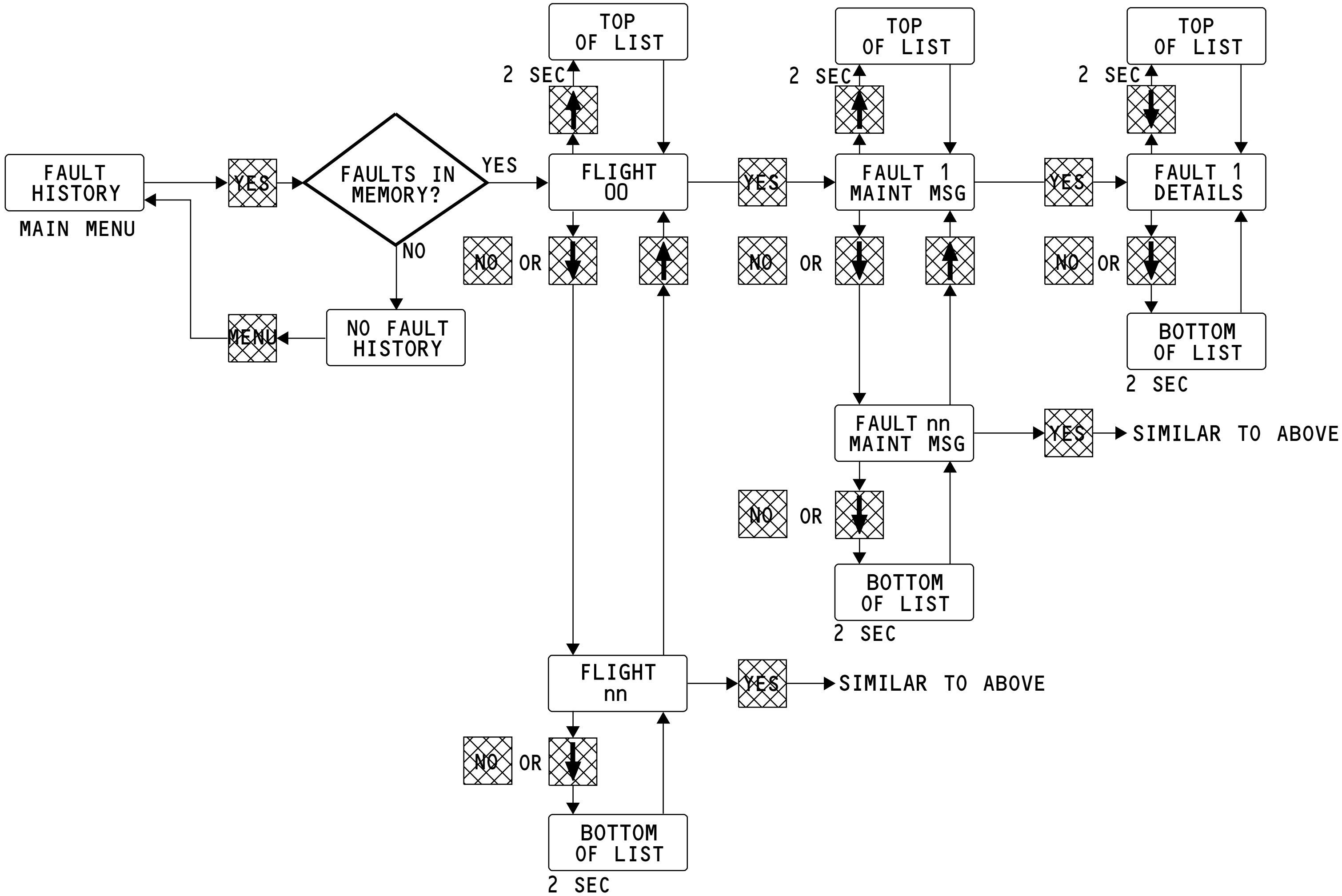
From the FAULT HISTORY menu, push the YES button. If there are no faults, the display shows NO FAULT HISTORY. To go back to the main menu, push the MENU button.

If there are faults, the display shows FLIGHT 00. To show the next flight leg, push the NO or DOWN arrow button. Then the display shows the next flight leg. If there are no more flight legs in memory, the display shows BOTTOM OF LIST for 2 seconds. The controller can have up to 10 flight legs in memory.

Each flight leg can have faults and fault details. To show a fault for a flight leg, push the YES button. The display shows the fault. If you push the NO or DOWN arrow button, the display shows the next fault. If there are no more faults, the display shows BOTTOM OF LIST for 2 seconds.

To show fault details for each fault, push the YES button. If you want to see more fault details you push the NO or DOWN arrow button. If there are no more fault details, the display shows BOTTOM OF LIST for 2 seconds.

Maintenance message(s) that show in the FAULT HISTORY are for reference only and do not require maintenance action.



AIR CONDITIONING - PRESSURIZATION CONTROL - CPC - BITE - FAULT HISTORY

AIR CONDITIONING - PRESSURIZATION CONTROL - CPC - BITE - GROUND TESTS - SYSTEM TEST

SYSTEM TEST

SYSTEM TEST does a test of the cabin pressurization system.

From the GROUND TEST menu, push the YES button. The display shows DISPLAY TEST. If you push the NO or DOWN arrow button, the display shows SYSTEM TEST.

When you push the YES button, the controller does a check to find if the system is in auto mode. If the system is not in auto mode, the display shows SYS IN MANUAL for two seconds. Then the display shows SELECT AUTO.

If you push the YES button when the system is in auto mode, the controller does a check to find if the other controller is in BITE. If the other controller is in BITE, the display shows these things:

- BOTH SYS IN IBIT for two seconds
- IBIT ABORTED for two seconds
- SYSTEM TEST.

If the other controller is not in BITE, questions appear in sequence. For each of these questions, it is necessary to push the YES or NO button. If you push the YES button after each question, the display shows the next question. If you push the YES button after the last question, the display shows TESTING.

The lower digits come on sequentially to show that the test is in progress. For older controllers, each of the 8 lower digits come on at 12 second intervals. This takes approximately 100 seconds. For newer controllers, only five of the lower digits come on.

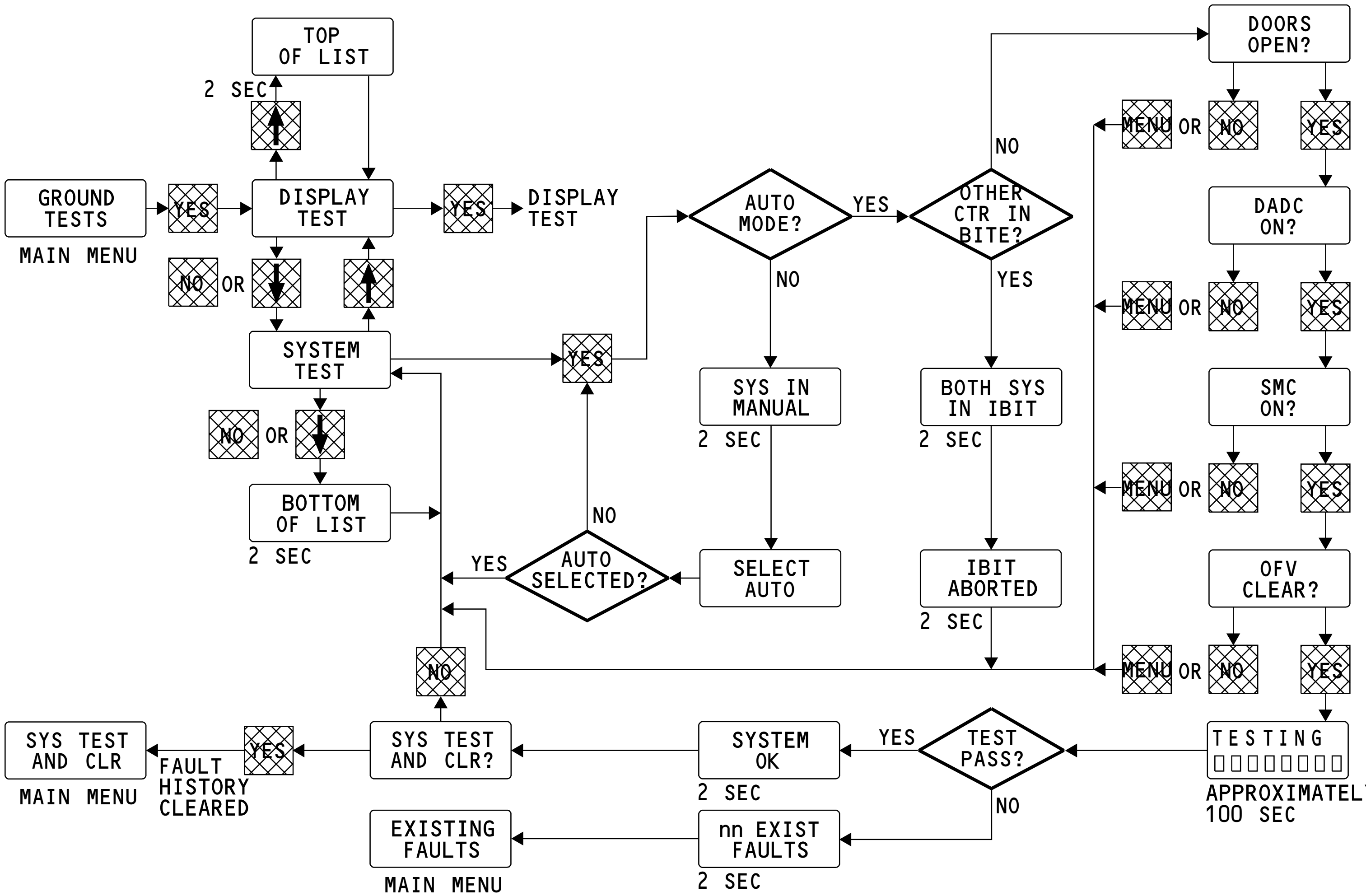
If there is no fault while in test, the display shows SYSTEM OK. Then the display shows SYSTEM TEST AND CLEAR?. If you push the YES button, all faults clear from fault history. If you push the NO button, the display shows SYSTEM TEST.

If there is a fault during TESTING, the display shows nn EXIST FAULTS for 2 seconds. Then the display shows EXISTING FAULTS menu.

If you push the menu button at any time during the system test, the display shows SYSTEM TEST.

Training Information Point

The acronym DADC refers to air data inertial reference unit. The acronym SMC refers to the stall management yaw dampener computer.



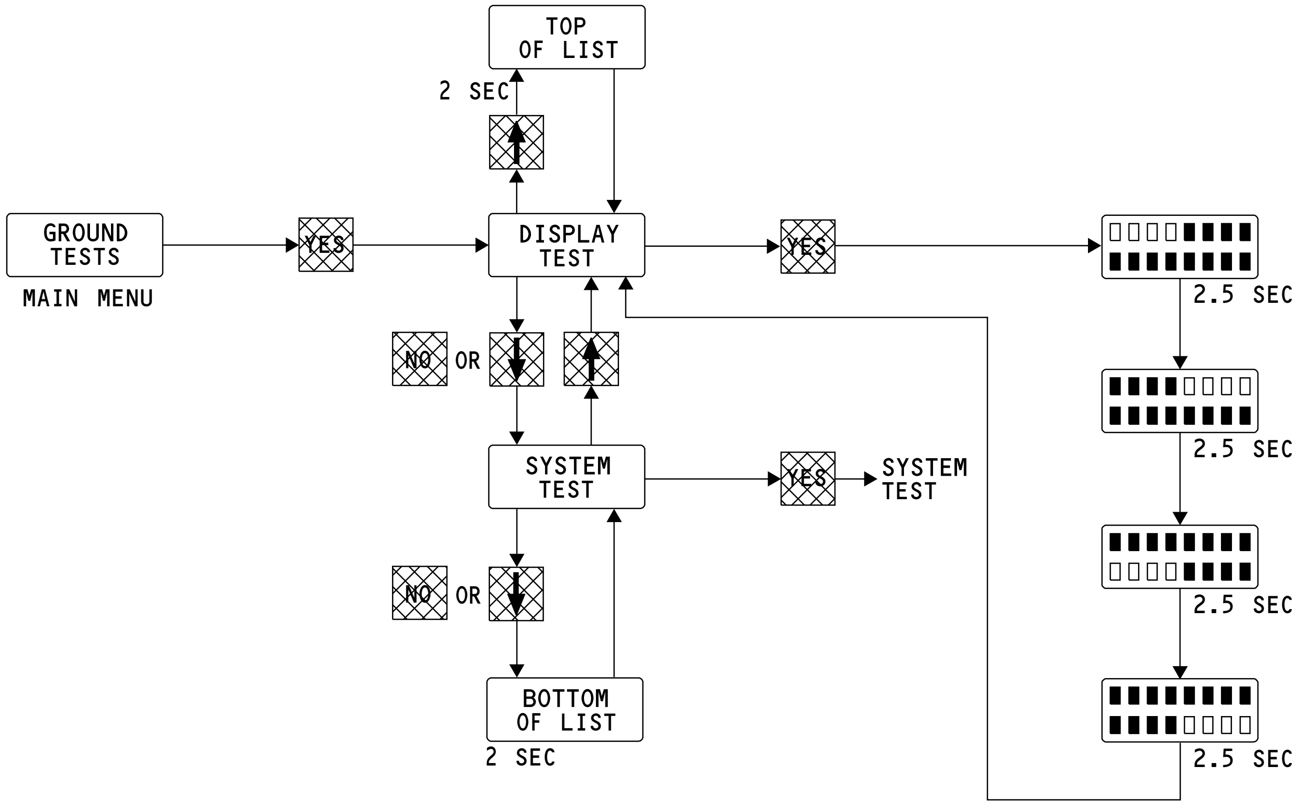
M78279 S0004621666_V2

AIR CONDITIONING - PRESSURIZATION CONTROL - CPC - BITE - GROUND TESTS - SYSTEM TEST

DISPLAY TEST

DISPLAY TEST does a test of all 16 digits of the LED display.

From the GROUND TEST menu, push the YES button. The display shows DISPLAY TEST. If you push the YES button, the test starts. Then four digits at a time turn on for 2.5 seconds. After the test is complete, the display shows DISPLAY TEST.



M78278 S0004621668_V1

AIR CONDITIONING - PRESSURIZATION CONTROL - CPC - BITE - GROUND TESTS - DISPLAY TEST

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AIR CONDITIONING - PRESSURIZATION CONTROL - CPC - BITE - SYSTEM STATUS MENU

SYSTEM STATUS

SYSTEM STATUS has these two-sub menus:

- PRESENT STATUS
- SYSTEM CONFIGURATION (SYSTEM CONFIG).

PRESENT STATUS

PRESENT STATUS shows system parameters. From the SYSTEM STATUS menu, push the YES button. Then the display shows PRESENT STATUS. If you push the YES button, the display shows the first system parameter. To see more parameters, push the NO or the DOWN arrow button. If there are no more parameters, the display shows BOTTOM OF LIST for 2 seconds.

This table shows each parameter and what they mean.

PARAMETER	MESSAGE
FLT ALT XXXXXXFT	Shows current selection of flight altitude
LAND ALT XXXXXXFT	Shows current selection of landing altitude
AUTO/MAN	Shows if the system is in Auto or Manual
OFV XXXX DEG OPEN	Shows current position of outflow valve
AUTO FAIL	Shows if auto fail is present
CAB PRES XX.XXPSI	Shows current cabin pressure
CARGO HT VALVE OP (CL)	Shows position of the cargo heat valve
L PACK FLOW ON (OFF)	Shows status of left air conditioning pack
R PACK FLOW ON (OFF)	Shows status of right air conditioning pack

SYSTEM CONFIGURATION

SYSTEM CONFIG shows the system configuration. From the SYSTEM STATUS menu, push the YES button. Then the display shows PRESENT STATUS. When you push the NO or DOWN arrow button, the display shows SYSTEM CONFIG. If you push the YES button, the display shows the first configuration item. To see more configuration items, push the NO or DOWN arrow button. If there are no configuration items, the display shows BOTTOM OF LIST for 2 seconds.

Configuration Items

This table shows each configuration items and what they mean.

CONFIGURATION ITEM	MESSAGE
CONTRLR XXXXX HRS	Hours of operation on the controller
PNL TIME XXXXX HRS	Hours of operation on the control panel
ROC SEL	HI = 600 ft/min ----------------- LOW = 750 ft/min
ROD SEL 2	See table below
MASTERID	HI - Not master controller ------ LOW = master controller
QFE SEL	HI = QFE not selected ----------- LOW = QFE selected
SLAVE ID	HI = Not slave controller ------- LOW = slave controller
OFV CONN	HI = OFV not connected ---------- LOW = OFV connected
IBIT IN	HI = Other controller not in test LOW = Other controller in test
CARGO HT	Indicates position of overboard exhaust valve actuator.

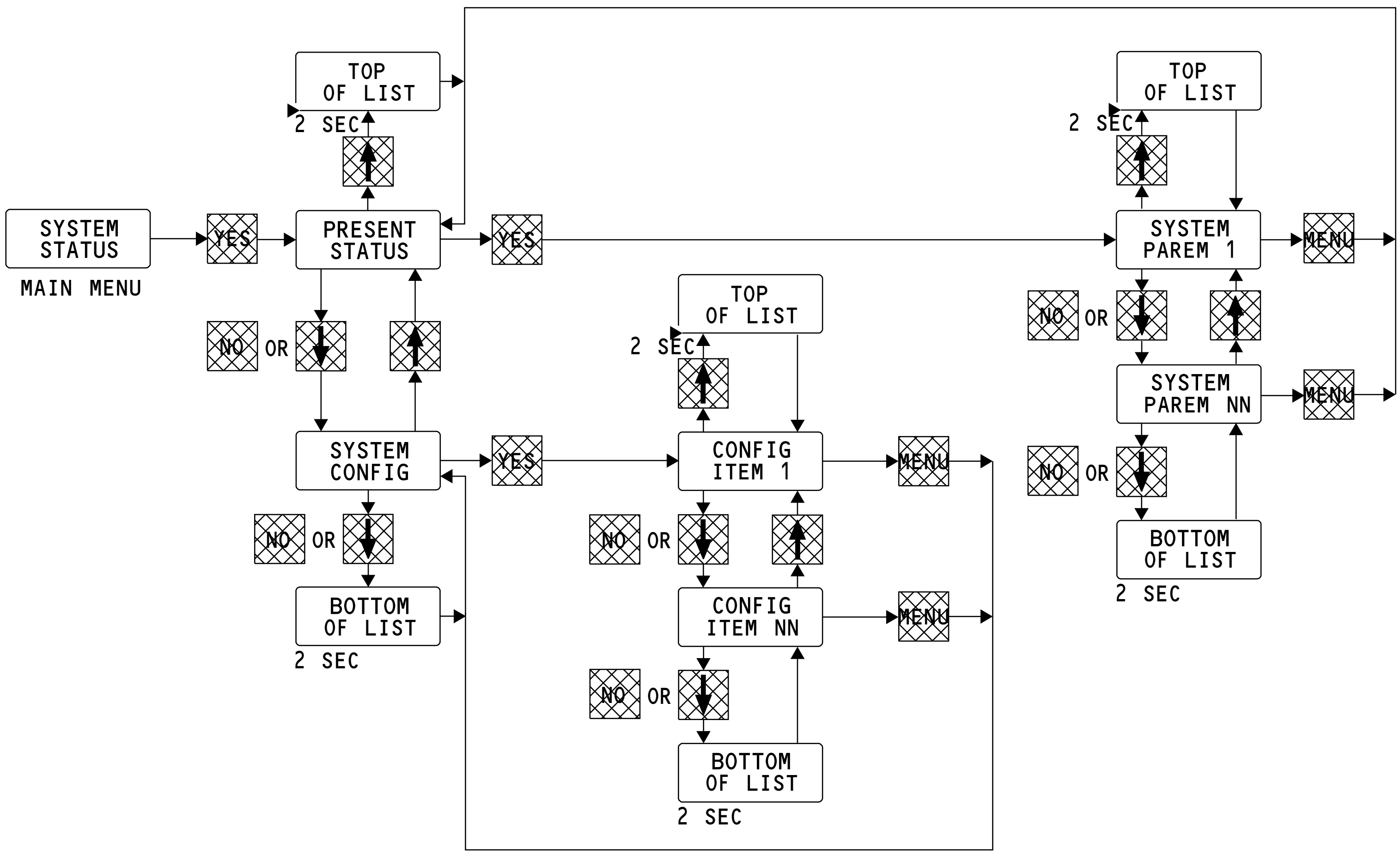
CONFIGURATION ITEM	MESSAGE
MANUAL IN	HI = Manual not selected. ------- LOW = Manual selected.
L A/G	HI = Air mode ------------------- LOW = Ground mode.
R A/G	HI = Air mode ------------------- LOW = Ground mode.
SHOP MODE	HI = Not shop mode. ------------- LOW = Shop mode.
L PACK VLV	HI = Left pack on. -------------- LOW = Left pack off.
R PACK VLV	HI = Right pack on. ------------- LOW = Right pack off.
41K SEL	HI = 41K altitude option not selected, LOW = 41K altitude option selected.
AUTO CTL IN	HI = Other controller in control. LOW = Other controller not in control.
PNL OK	HI = Selector Pnl not failed. --- LOW = Selector Pnl failed.

This table shows the inputs for ROD SEL 1 and 2.

INPUT	INPUT STATE			
ROD SEL 2	LO	HI	LO	HI
ROD SEL 1	LO	LO	HI	HI
Descent Rate:	-750	-350	-500	-350

Training Information Point

Cargo heat valve refers to the overboard exhaust valve in equipment cooling. See the equipment cooling section for more information on the overboard exhaust valve (SECTION 21-27).



M78280 S0004621670_V1

AIR CONDITIONING - PRESSURIZATION CONTROL - CPC - BITE - SYSTEM STATUS MENU

SYSTEM TEST AND CLEAR

SYSTEM TEST AND CLEAR prepares the controller for a system test and to automatically clear the fault history.

When you push the YES button, the controller does a check to find if the system is in the auto mode. If the system is not in auto mode, the display shows SYS IN MANUAL for two seconds. Then the display shows SELECT AUTO.

If you push the YES button when the system is in the auto mode, the controller does a check to find if the other controller is in BITE. If the other controller is in BITE, the display shows these things:

- BOTH SYS IN IBIT for two seconds
- IBIT ABORTED for two seconds
- SYS TEST AND CLR.

For each of these questions, you must push the YES or NO button. If you push the YES button after each question, the display shows the next question. If you push the YES button after the last question, the display shows TESTING.

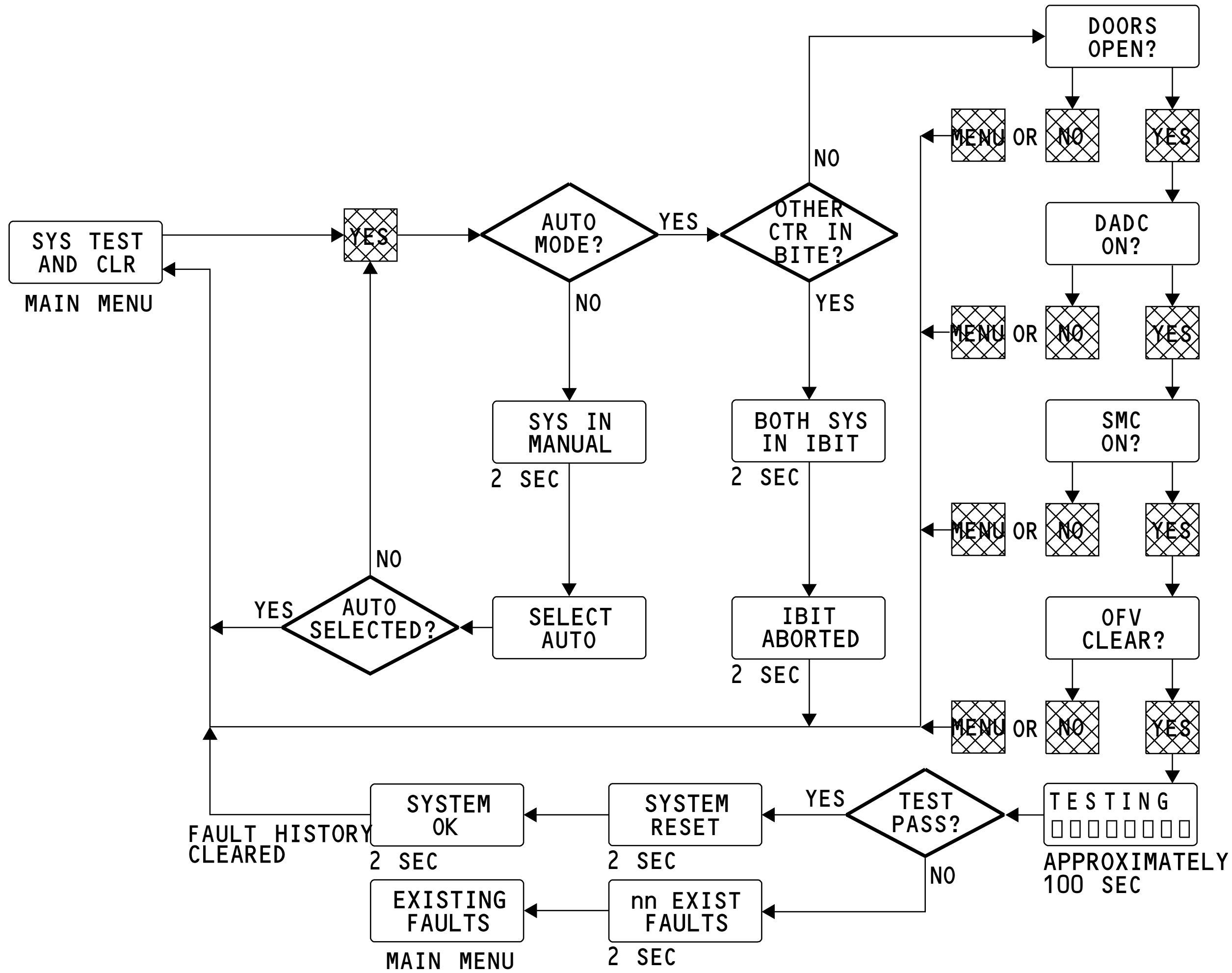
The lower digits come on sequentially to show that the test is in progress. For older controllers, each of the 8 lower digits come on at 12 second intervals. This takes approximately 100 seconds. For newer controllers, only five of the lower digits come on.

If there is no fault while in test, the display shows SYSTEM OK for 2 seconds. Then the display shows SYS TEST AND CLR.

If there is a fault during TESTING, the display shows nn EXIST FAULTS for 2 seconds. Then the display shows EXISTING FAULTS menu.

Training Information Point

The acronym DADC refers to the air data inertial reference unit. The acronym SMC refers to the stall management yaw dampener computer.



M78281 S0004621672_V1

AIR CONDITIONING - PRESSURIZATION CONTROL - CPC - BITE - SYSTEM TEST AND CLEAR

AIR CONDITIONING - PRESSURIZATION CONTROL - AFT OUTFLOW VALVE

Purpose

The aft outflow valve controls the air flow out of the airplane fuselage.

Location

The valve is on the lower right fuselage below the aft service door.

Physical Description

The outflow valve has these parts:

- Two valve gates
- Actuator assembly and linkage
- Position transducer
- Two automatic mode motors and one manual mode motor
- Two electronic actuators.

Functional Description

The valve is a thrust recovery, double gate type valve. The valve has two 28v dc motors and one 48v dc motor. Only one motor drives the valve at a time. All three motors use the same actuator mechanism.

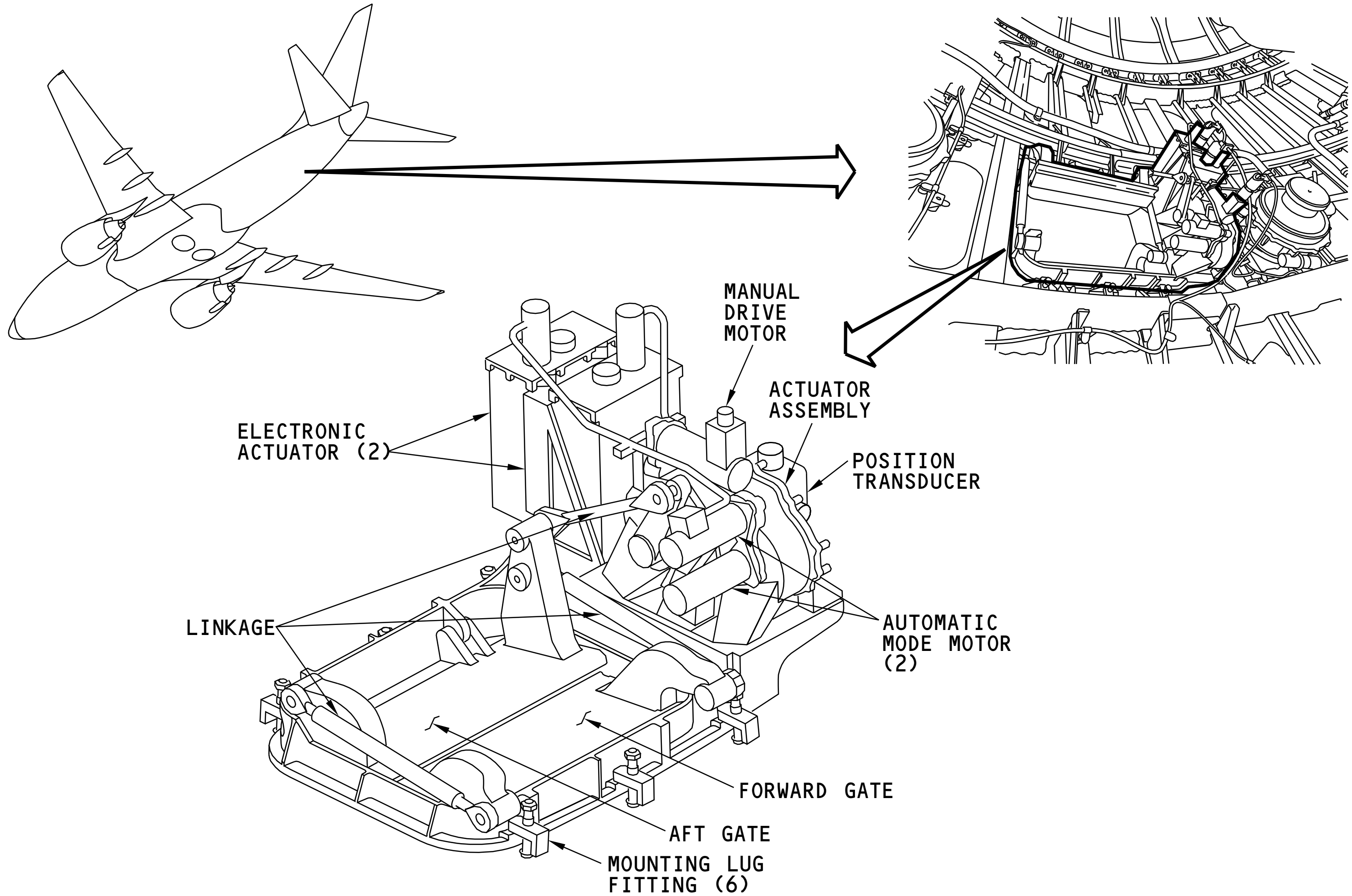
Each electronic actuator on the valve has a fail-safe aneroid switch. The switch causes the valve to go fully closed if the cabin pressure altitude gets to 14,500 ft. This function overrides normal automatic control only. It does not override manual mode of the valve.

A position transducer on the valve assembly provides a signal to the valve position indicator on the P5 forward overhead panel during all modes of operation.

The valve position transducer also sends signals to the two cabin pressure controllers. This gives the controllers valve position feedback for automatic and alternate modes of operation.

Training Information Point

The valve mount lug fittings let you remove and install the assembly from outside the airplane.



M78484 S0004621674_V1

AIR CONDITIONING - PRESSURIZATION CONTROL - AFT OUTFLOW VALVE

AIR CONDITIONING - PRESSURIZATION CONTROL - AUTO MODE - FUNCTIONAL DESCRIPTION

Purpose

The automatic (AUTO) mode of the pressurization control system keeps the airplane pressurized for all phases of the flight.

Functional Description

The AUTO mode circuitry has these parts:

- Redundant 28v dc power sources
- Cabin pressure control module on P5
- Two digital cabin pressure controllers (CPCs)
- Two AUTO mode dc motors with electronic actuators on the aft outflow valve assembly
- Circuit wiring and connectors.

When the pressurization mode selector on the cabin pressure control module is in the AUTO position, it sets the pressurization control system to automatic operation.

The automatic control system has a dual redundant architecture. The two CPCs are identical. Rack pin connections identify the controllers as CPC 1 and CPC 2.

Only one CPC controls the outflow valve at any time. The other CPC is a backup. The system changes active control from one CPC to the other with each flight. This keeps wear equal on the mechanical drive components of the two systems.

The CPCs use data from these systems to determine flight phase:

- Both air data inertial reference units (ADIRUs)
- Both stall management and yaw damper computers (SMYDCs)
- Proximity switch electronics unit (PSEU).

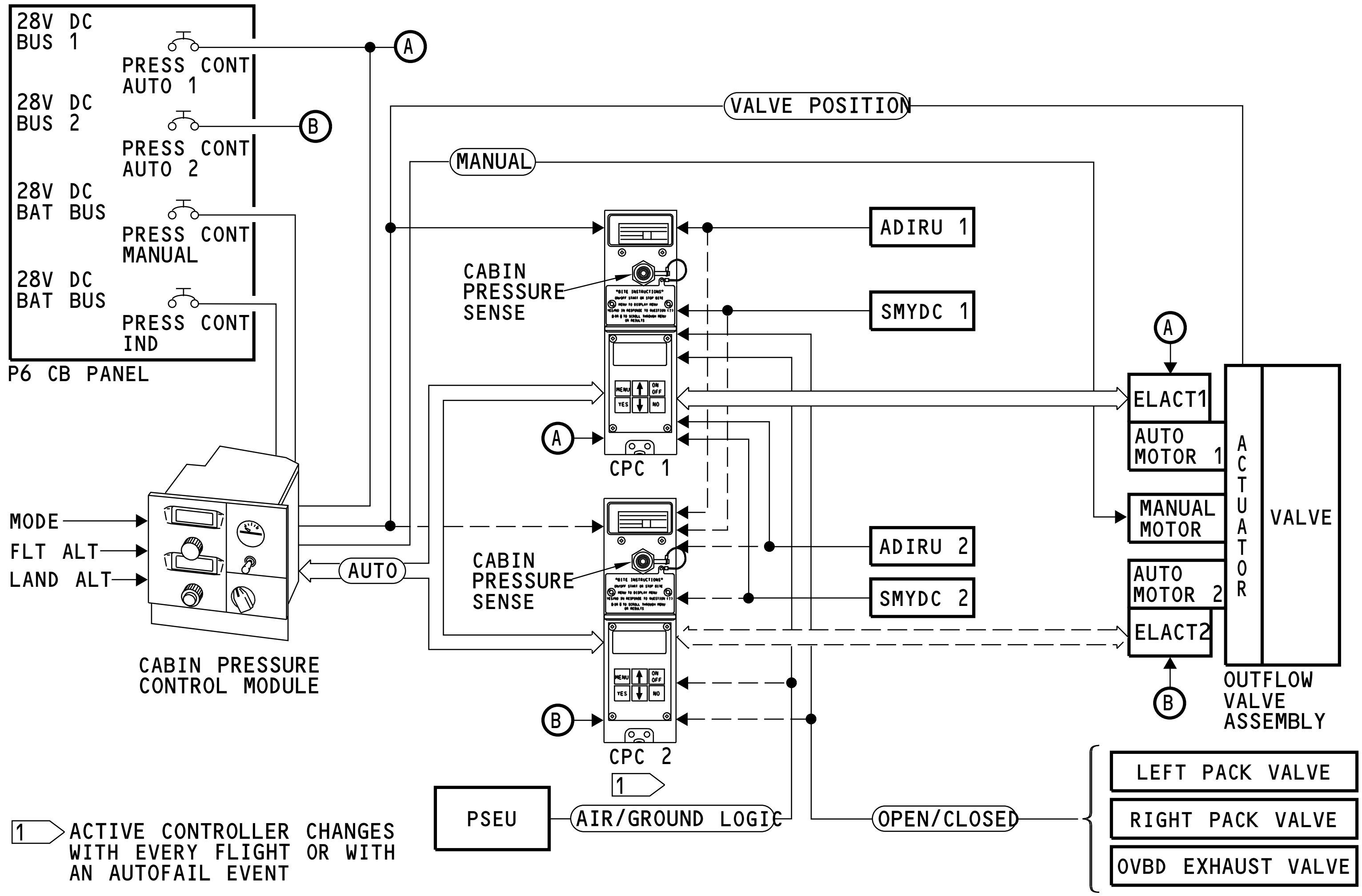
The CPC calculates a target cabin pressure in response to the flight phase and inputs from the cabin pressure control panel.

The CPC compares the target pressure to the pressure at its sense port. If there is a difference, the CPC sends an open or close command to the electronic actuator on the aft outflow valve assembly. The electronic actuator operates its valve motor. The motor moves the outflow valve through a mechanical drive train. The active controller modulates the aft outflow valve to control cabin pressure and rate of pressure change.

Outflow valve position feedback to the CPC verifies proper valve operation (closed loop feedback).

The air conditioning pack valves and the overboard exhaust valve give position feedback to the CPCs.

Both controllers run continuous BITE tests. If the active CPC becomes inoperative, the other CPC automatically takes control.



M78488 S0004621677_V1

AIR CONDITIONING - PRESSURIZATION CONTROL - AUTO MODE - FUNCTIONAL DESCRIPTION

AIR CONDITIONING - PRESSURIZATION CONTROL - AUTO FAIL

Purpose

The amber AUTO FAIL light gives the flight crew indication that one or both auto channels are inoperative.

General Description

The automatic pressurization control system has a dual redundant architecture. One digital cabin pressure controller (CPC) is active and maintains pressurization control. The other CPC is a backup.

If the active CPC controller fails, the system changes pressurization control to the backup (alternate) CPC.

The two CPCs automatically do start-up and continuous BITE tests. These tests look at both systems to the LRU level. When the active CPC BITE detects a fault or failure, it transfers active control to the backup CPC.

These things cause the auto fail function:

- Power loss
- Cabin altitude rate of change is too high (>2,000 slfpm)
- Cabin altitude is too high (>15,800 ft)
- Wiring failures
- Outflow valve component failures
- CPC failures
- Cabin differential pressure is too high (>8.75 psi).

Single Channel Failure

The system automatically changes pressurization control to the backup controller if the active controller fails.

If the system is in the AUTO mode when an auto fail event occurs, these lights come on:

- Amber AUTO FAIL light
- MASTER CAUTION and AIR COND annunciator lights
- Green ALTN light.

The ALTN light shows that the backup system is active. The AUTO FAIL light goes off when you select the ALTN position on the mode selector.

Dual Channel Failure

These are the indications when both CPC systems fail:

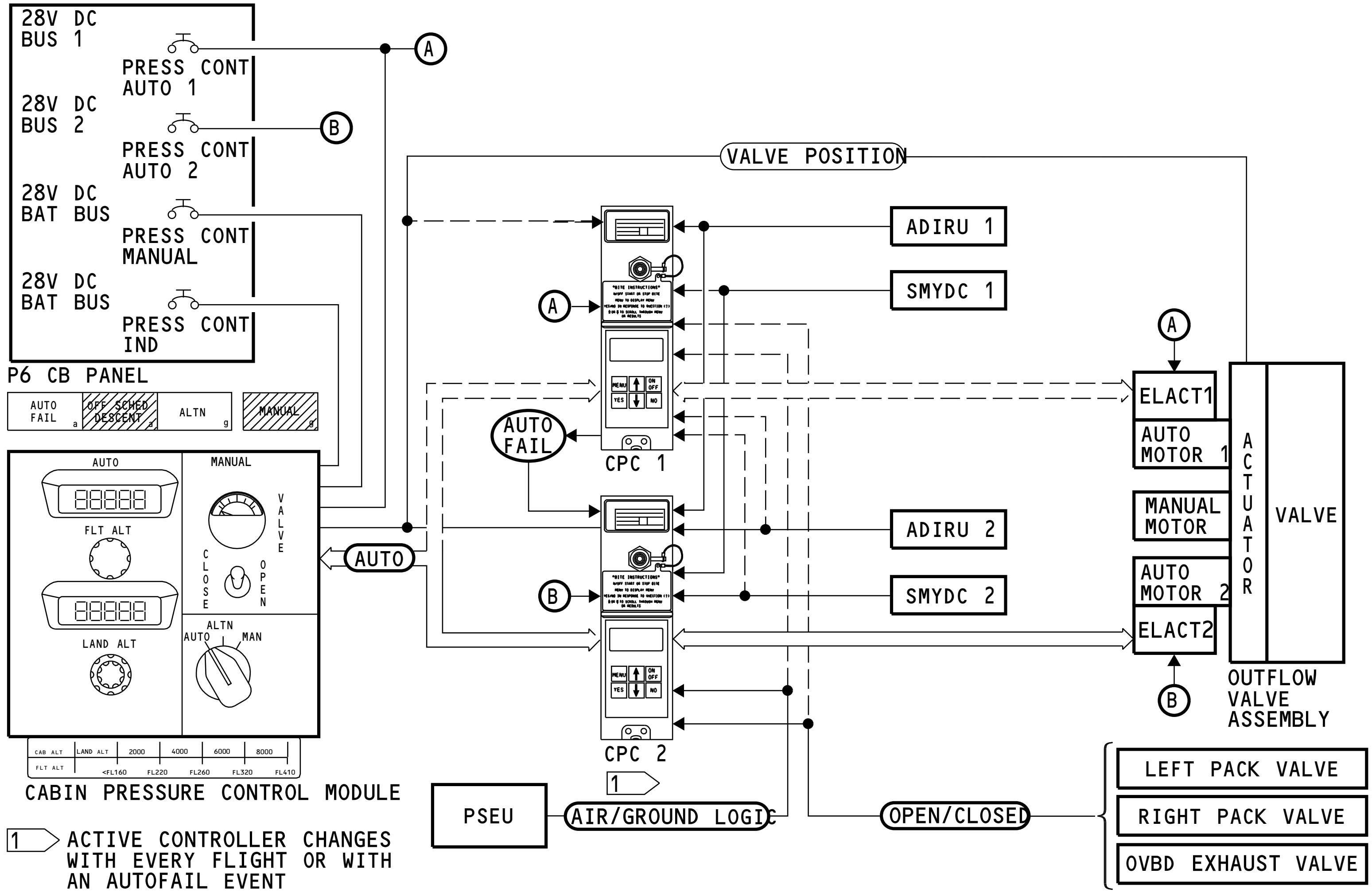
- The AUTO FAIL and MASTER CAUTION lights come on
- The FLT ALT and LAND ALT displays show five dashes (-----).

If both CPCs fail, the ALTN light does not come on. This indicates that the system cannot transfer control to an operative automatic controller.

Training Information Point

This table shows you how to find the status of the automatic system by the indication lights and the select switch position.

MODE SELECT SWITCH	AUTO FAIL LIGHT	ALTN LIGHT	STATUS/FAILURES
AUTO	OFF	OFF	FULL UP SYSTEM/NONE
AUTO	ON	ON	ONE AUTO FAIL
AUTO	ON	OFF	DUAL AUTO FAIL
ALTN	OFF	ON	ONE AUTO FAIL
ALTN	ON	OFF	DUAL AUTO FAIL



M78491 S0004621683_V1

AIR CONDITIONING - PRESSURIZATION CONTROL - AUTO FAIL

AIR CONDITIONING - PRESSURIZATION CONTROL - INDICATION - FUNCTIONAL DESCRIPTION

General

The cabin pressure control system has these indications:

- AUTO FAIL
- OFF SCHED DESCENT
- ALTN
- MANUAL.

AUTO FAIL Light

The AUTO FAIL light is usually controlled by the cabin pressure control module. If the cabin pressure control module fails, the AUTO FAIL light is controlled by relays R556, R557, and R558.

OFF SCHED DESCENT Light

The OFF SCHED DESCENT light is controlled by these units:

- CPC 1
- CPC 2.

The CPC turns on the OFF SCHED DESCENT light when an off schedule descent is detected by a CPC.

ALTN Light

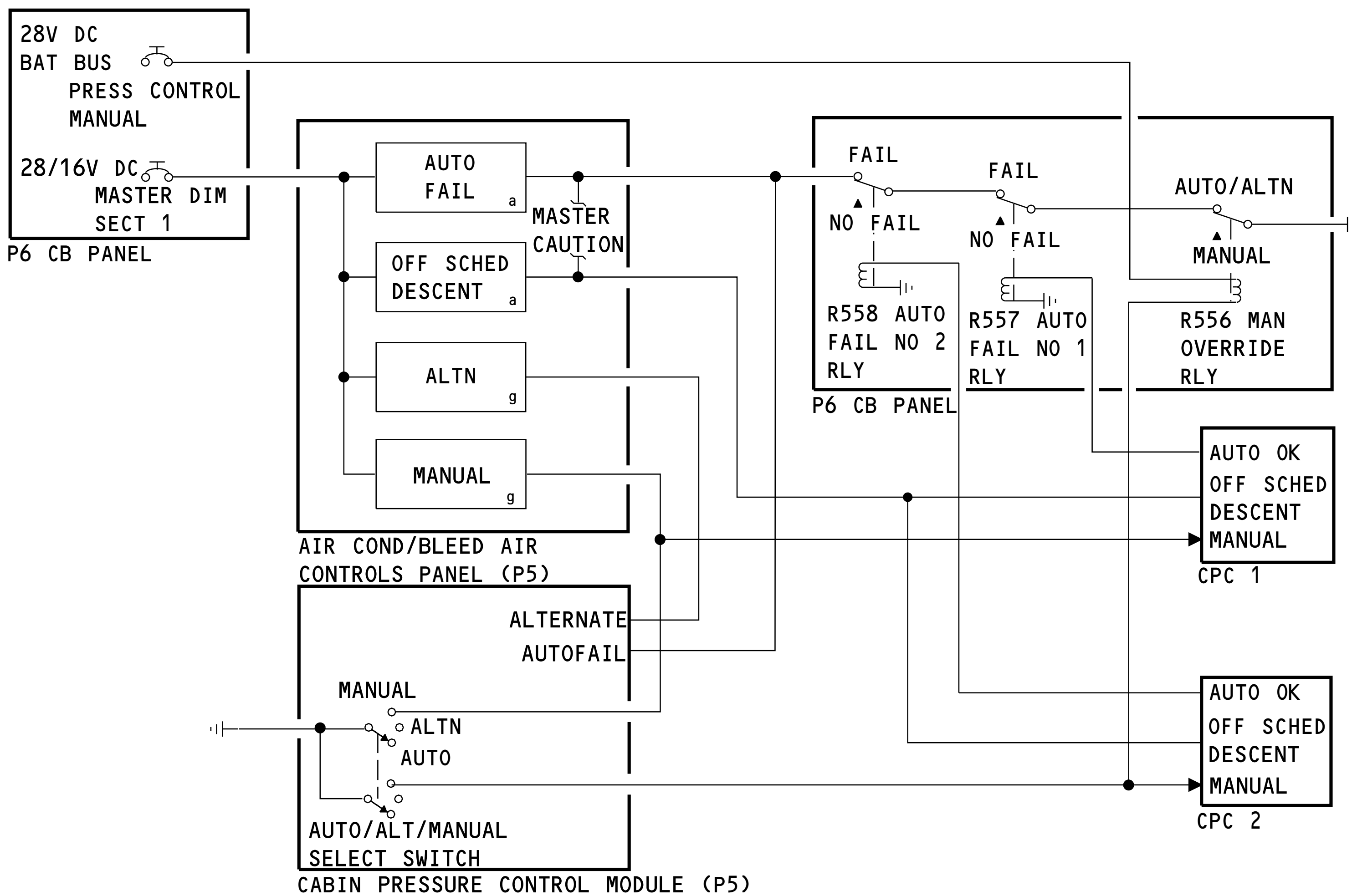
The ALTN light is controlled by the cabin pressure control module.

The cabin pressure control module turns on the ALTN light when the backup CPC is active.

MANUAL Light

The MANUAL light is controlled by the cabin pressure control module.

The CPCs are deactivated and the MANUAL light comes on when the selector switch is in the MANUAL position.



AIR CONDITIONING - PRESSURIZATION CONTROL - INDICATION - FUNCTIONAL DESCRIPTION

AIR CONDITIONING - PRESSURIZATION CONTROL - OFF SCHED DESCENT LIGHT

General Description

The off schedule descent feature works only in the AUTO and ALTN modes. It is not a feature of the MANUAL mode.

If it is necessary to land immediately after takeoff, the pressurization control system programs the pressurization system for landing. The off schedule descent (OFF SCHED DESCENT) indication is part of this feature. The light tells you that the system will control cabin pressure for a return to the take-off field.

An off schedule descent begins when the airplane starts to descend off schedule (before it gets to cruise altitude).

Functional Description

If the airplane begins a descent before it gets to the FLT ALT selected on the control module, these things happen:

- OFF SCHED DESCENT light comes on
- MASTER CAUTION and AIR COND annunciator lights come on
- Pressurization control system schedules the cabin pressure for return to the take-off field.

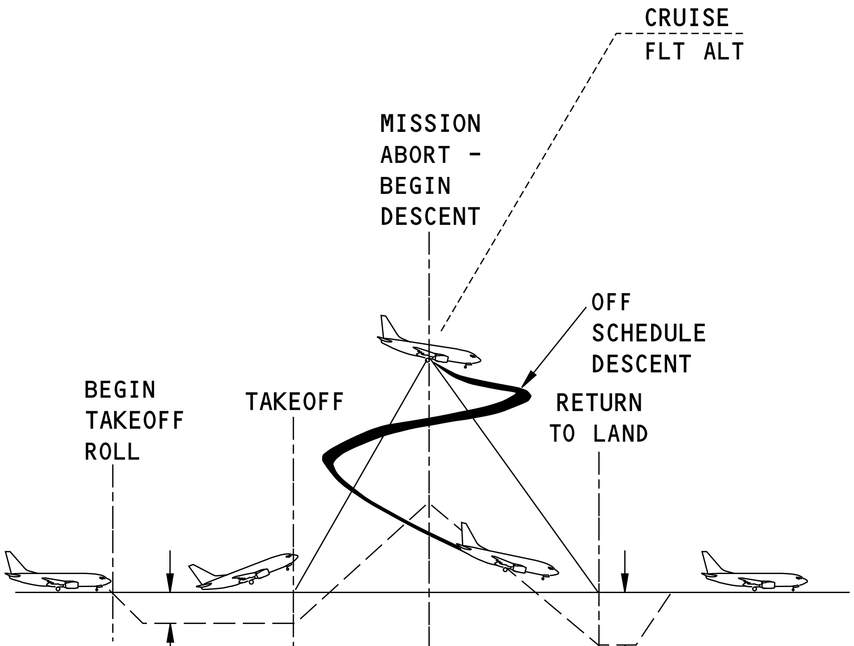
The OFF SCHED DESCENT light will go out if any one of these conditions occur:

- Airplane begins to climb again
- FLT ALT is reset to the current altitude
- Pilot selects manual (MAN) mode
- Airplane lands.

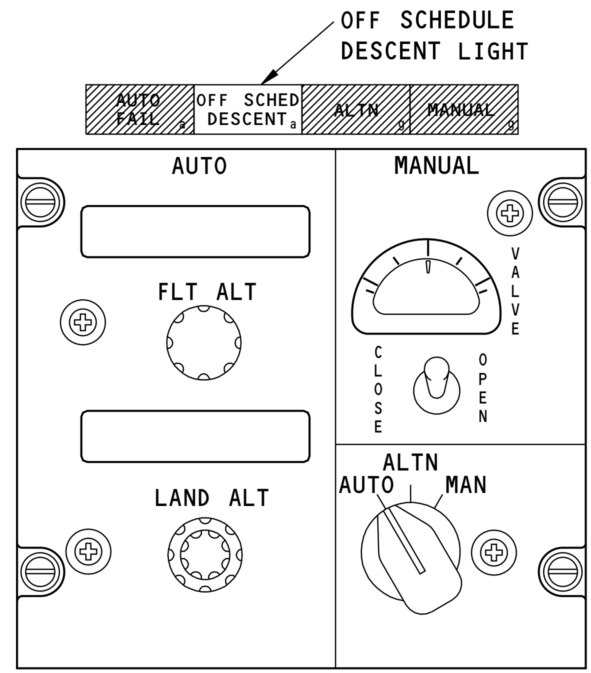
If the flight crew diverts to a field other than the take-off field, the flight crew must do these steps to reset the pressure controller:

- Reset the FLT ALT to the current altitude
- Set the landing altitude in the LND ALT window on the control panel to the landing field elevation.

The pressure control system cancels the off schedule descent feature for the flight when the airplane gets to the FLT ALT set on the cabin pressure control module.



TYPICAL OFF SCHEDULE DESCENT PROFILE



CABIN PRESSURE CONTROL MODULE (P5)

AIRPLANE ALTITUDE
CABIN PRESSURE ALTITUDE
MISSION SCHEDULE ALTITUDE

2177360 S0000480303_V1

AIR CONDITIONING - PRESSURIZATION CONTROL - OFF SCHED DESCENT LIGHT

AIR CONDITIONING - PRESSURIZATION CONTROL - MANUAL MODE - GENERAL DESCRIPTION

Purpose

The MANUAL mode gives the flight crew direct control of the outflow valve.

General Description

The MANUAL mode has these parts:

- 28v dc bat bus power sources
- Cabin pressure control module
- MANUAL mode DC motor on the aft outflow valve assembly
- Circuit wiring and connectors.

When the mode selector is in the MANUAL position, these things occur:

- Automatic control systems are disarmed
- Control module outflow valve switch arms
- Green MANUAL system indication light comes on.

The aft outflow valve switch is a three position toggle switch. These are the three positions:

- CLOSE
- Neutral
- OPEN.

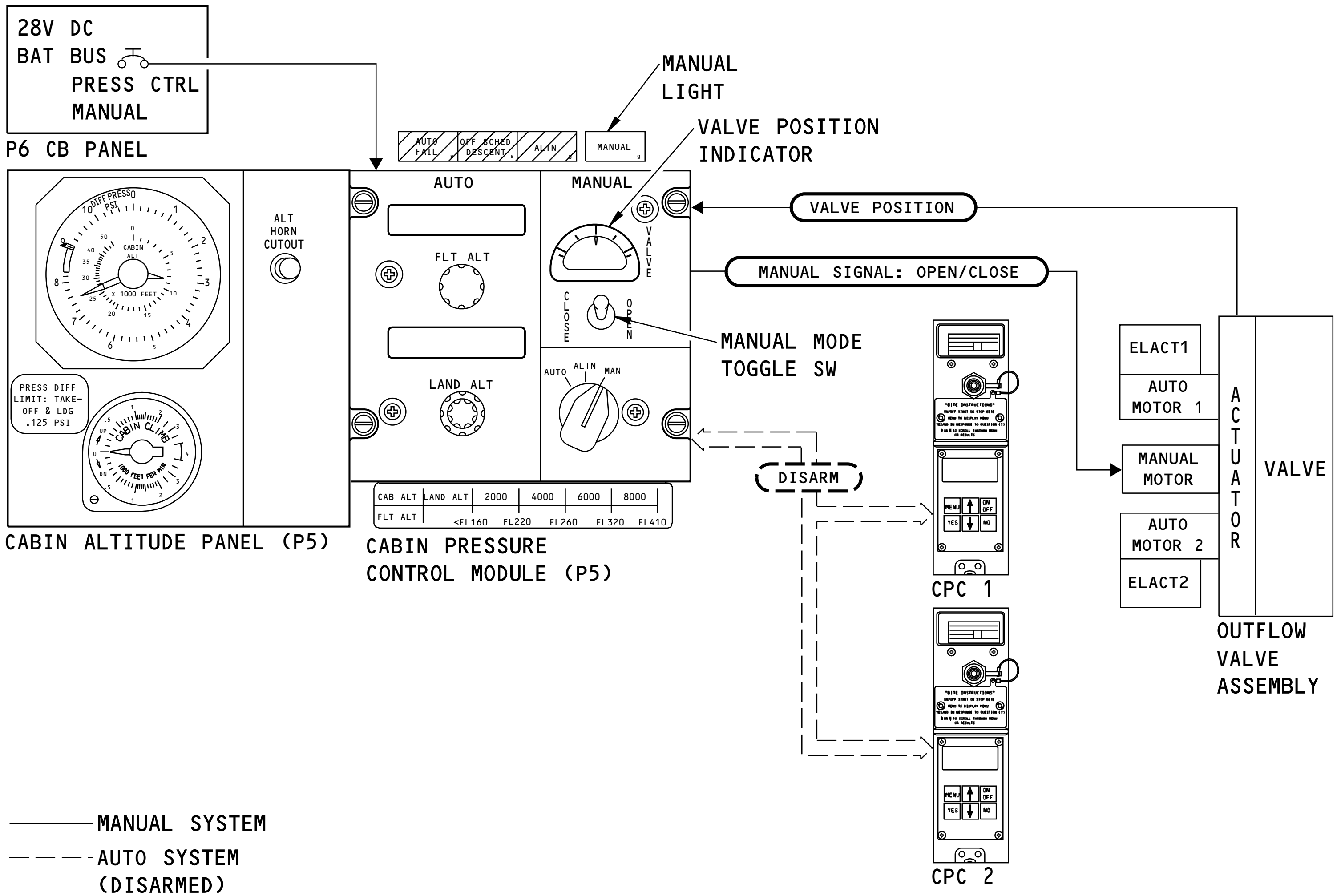
The switch is spring-loaded to the neutral position.

Signals from the outflow valve switch go to the manual motor on the aft outflow valve assembly. When the switch is in the CLOSE position, the motor closes the valve. When the switch is in the OPEN position, the motor opens the valve.

The position transducer on the aft outflow valve assembly gives valve position feedback to the outflow valve position indicator.

You can use these instruments and placards on the cabin altitude panel for reference during manual operation of the pressurization system:

- Cabin altitude and differential pressure indicator
- Cabin rate of climb indicator
- Pressure limitation placard
- Cabin/flight altitude conversion placard.



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AIR CONDITIONING - PRESSURIZATION CONTROL - MANUAL MODE - GENERAL DESCRIPTION

AIR CONDITIONING - PRESSURIZATION CONTROL - MANUAL MODE - FUNCTIONAL DESCRIPTION

General

The pressurization outflow valve can operate in the manual mode. To do this, put the pressurization mode selector to the MANUAL position. The valve can then be opened or closed by the outflow valve switch. The pressurization mode selector and the outflow valve switch are on the cabin pressure control panel on the P5 overhead panel.

Functional Description

When the pressurization mode selector is in the MANUAL position, these things happen:

- The green MANUAL light comes on
- CPC 1 and CPC 2 stop automatic and alternate modes of valve operation.

When the outflow valve switch is in the open or close position, these things happen:

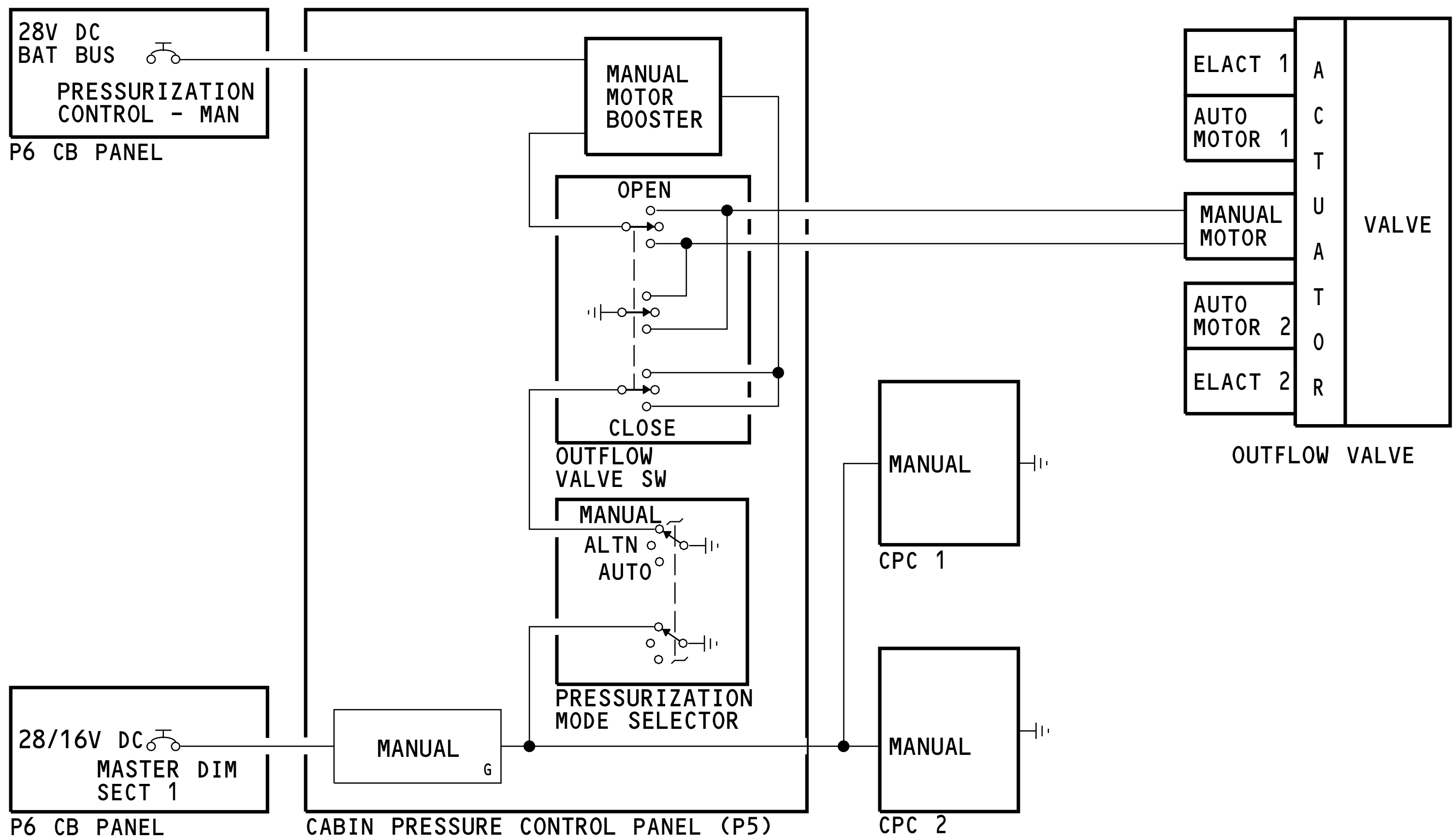
- The manual motor booster changes 28v dc to 48v dc for valve motor operation
- Power from the booster goes to the valve manual motor.

The direction of valve operation for the open/close functions is controlled by change of the power supply and return by the switch positions.

Training Information Point

You can do a check of the valve operation with the manual mode of valve operation.

WARNING: OUTFLOW VALVE IS MOTOR OPERATED. DO NOT INSERT HAND OR TOOLS IN OUTLET DURING ANY GROUND OPERATION OR INJURY TO PERSONS CAN OCCUR.



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AIR CONDITIONING - PRESSURIZATION CONTROL - MANUAL MODE - FUNCTIONAL DESCRIPTION

AIR CONDITIONING - PRESSURIZATION CONTROL - POSITIVE PRESSURE RELIEF VALVE

Purpose

The positive pressure relief valves prevent over pressure damage to the airplane structure.

Location

There are two positive pressure relief valves. They are on the lower, aft airplane fuselage. One valve is on each side of the aft outflow valve.

General Description

The positive pressure relief valves are fail safe devices that bleed fuselage pressure overboard if the aft outflow valve fails closed.

The positive pressure relief valves are mechanical devices and operate independently. They do not interface with other airplane pressurization systems and no crew action is necessary.

The positive pressure relief valves are pneumatically operated by cabin-to-ambient pressure differential. They control pressure to a nominal 8.95 +/- 0.15 psi more than ambient.

When the differential pressure is too high, the valve opens. The open valve lets air out of the airplane. This relieves the cabin pressure. When the cabin-to-ambient pressure is safe, the valve closes.

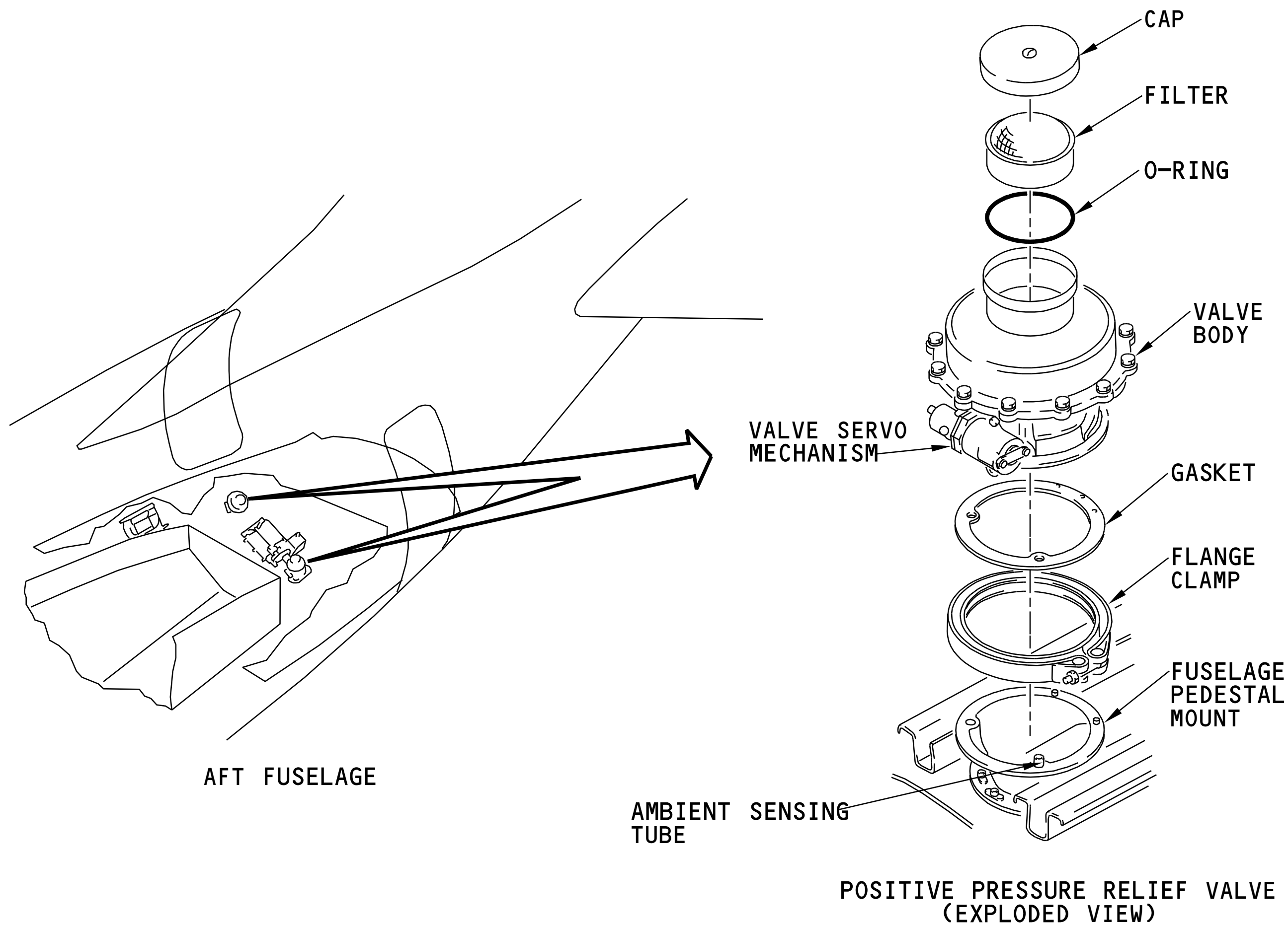
The positive pressure relief valves have filters. The filters clean the air used in the internal servo and actuator mechanisms.

They attach to pedestals with gaskets and flange clamps.

Training Information Point

Make sure you install the positive pressure relief valve and gasket correctly during installation. Incorrect installation can block sense ports for the valve servo mechanism.

Keep the servo mechanisms dry. Moisture in the mechanism can freeze and prevent valve operation.



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AIR CONDITIONING - PRESSURIZATION CONTROL - POSITIVE PRESSURE RELIEF VALVE

AIR CONDITIONING - PRESSURIZATION CONTROL - NEGATIVE PRESSURE RELIEF VALVE

Purpose

The negative pressure relief valve prevents negative differential pressure (vacuum pressure) damage to the airplane structure. This can prevent structure damage during a rapid descent.

Location

The negative pressure relief valve is on the lower aft fuselage, on the right side, near the aft service door.

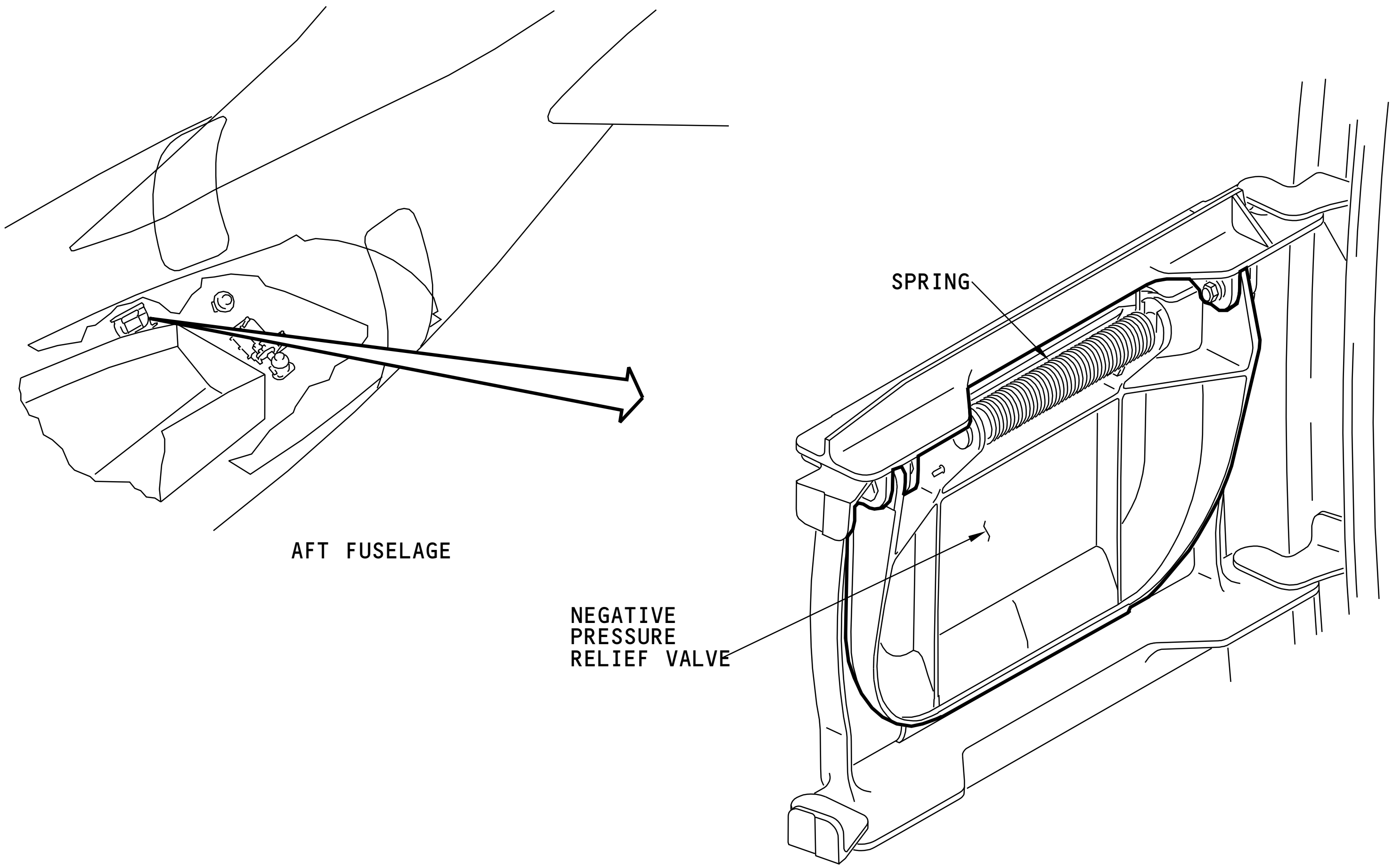
Access to the valve is from the aft cargo compartment.

General Description

The negative pressure relief valve is a mechanical device and operates independently. It does not interface with other airplane pressurization systems and requires no crew action.

The negative pressure relief valve is a flapper type valve. The valve hinges on its top edge and opens inward. A spring on its hinge pin holds the valve closed.

Negative differential cabin-to-ambient pressure opens the valve. The valve opens when pressure outside of the airplane is 1.0 psi more than the pressure inside of the airplane (-1.0psid).



AIR CONDITIONING - PRESSURIZATION CONTROL - NEGATIVE PRESSURE RELIEF VALVE

AIR CONDITIONING - PRESSURIZATION CONTROL - CARGO COMPARTMENT BLOWOUT PANEL

Purpose

The cargo compartment blowout panels prevent damage to the airplane structure during sudden decompression.

Physical Description

The ceiling blowout panel has these parts:

- Blowout panel
- Frame
- Cap strip.

The bulkhead blowout panel has these parts:

- Blowout panel
- Frame
- Cap strip
- Grate.

Location

The cargo compartment blowout panels are in these places:

- Cargo compartment ceilings
- Cargo compartment bulkheads.

Functional Description

During rapid decompression, differential pressure pushes the panels out of their frames. When the panels push out of their frames, the pressures in the upper and lower fuselage lobes equalize quickly. This equalization of pressure prevents damage to the airplane structure.

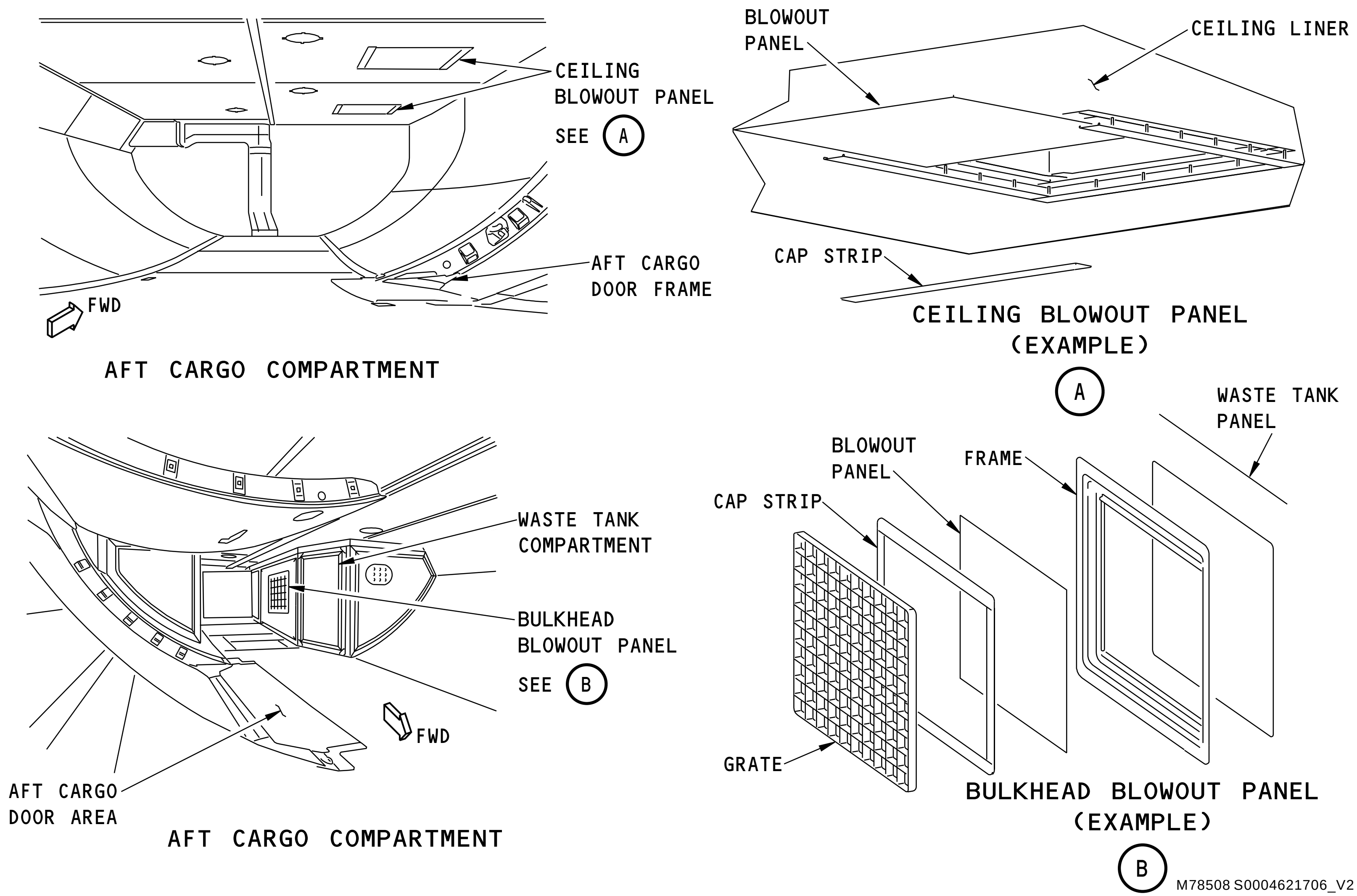
A differential pressure of 1.0 psid will push the blowout panel out of the frame.

The blowout panels on the cargo compartment bulkheads have grates. The grates do not let baggage hit the blowout panels.

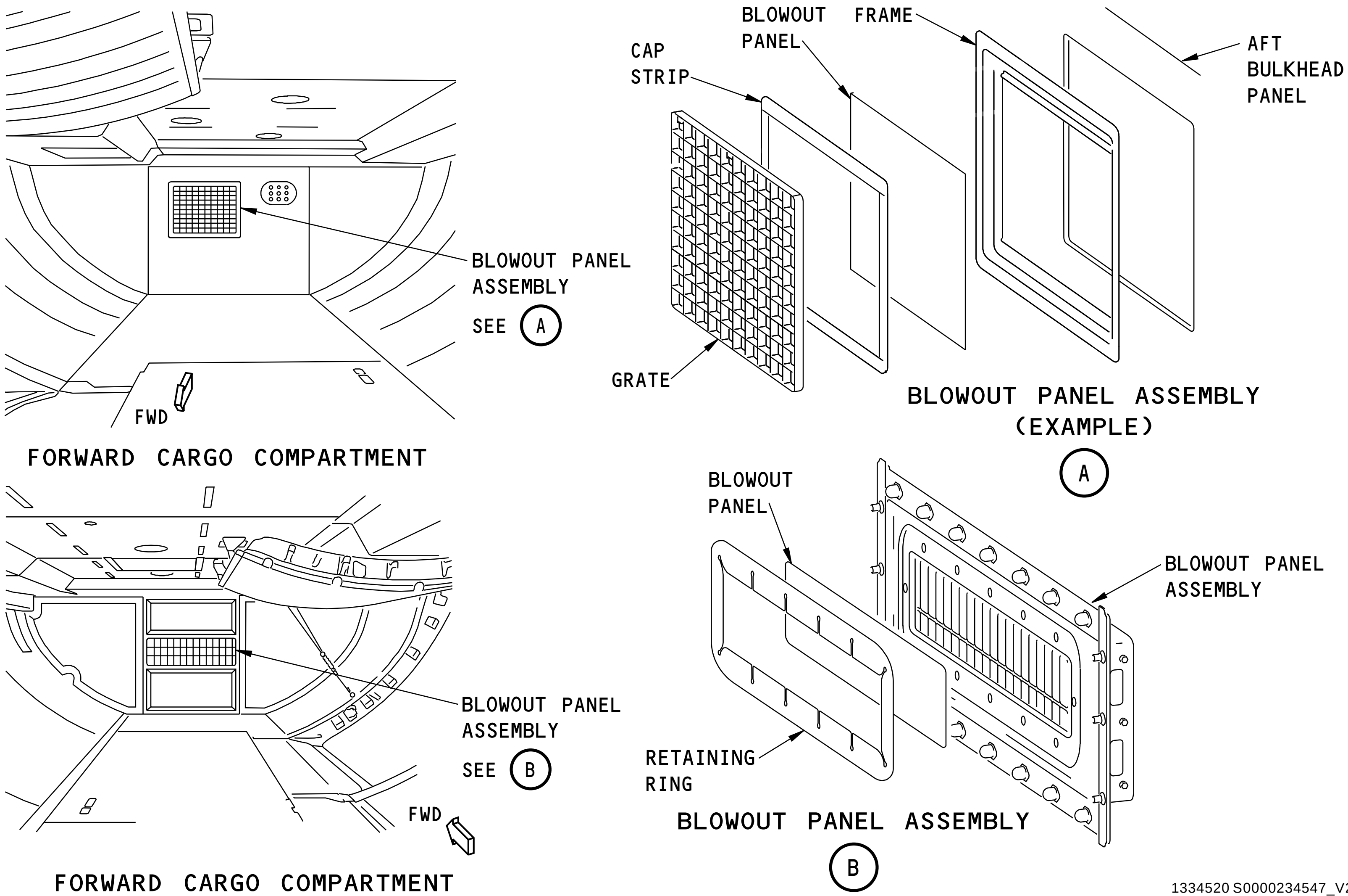
Training Information Point

If the aft cargo door does not open from the outside, you can use the aft ceiling blowout panel to get access from the passenger compartment. If the forward cargo door does not open from the outside, you can use an access panel to get access from the passenger compartment.

See the equipment and furnishings chapter for more information on the forward cargo compartment access panel (SECTION 25-50).



AIR CONDITIONING - PRESSURIZATION CONTROL - CARGO COMPARTMENT BLOWOUT PANEL



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AIR CONDITIONING - PRESSURIZATION CONTROL - CARGO COMPARTMENT BLOWOUT PANEL

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AIR CONDITIONING - PRESSURIZATION CONTROL - PRESSURE EQUALIZATION VALVE

Purpose

The pressure equalization valves allow air to flow into or out of the cargo compartments to keep the cargo compartment pressure the same as cabin pressure.

Physical Description

The cargo compartment pressure equalization valve has two swing check valves spring-loaded to the closed position. One valve hinges away from the cargo compartment and the other hinges to the cargo compartment.

Location

The forward cargo compartment has a pressure equalization valve on the aft bulkhead.

The aft cargo compartment has a pressure equalization valve on the forward portion of the vacuum waste bulkhead.

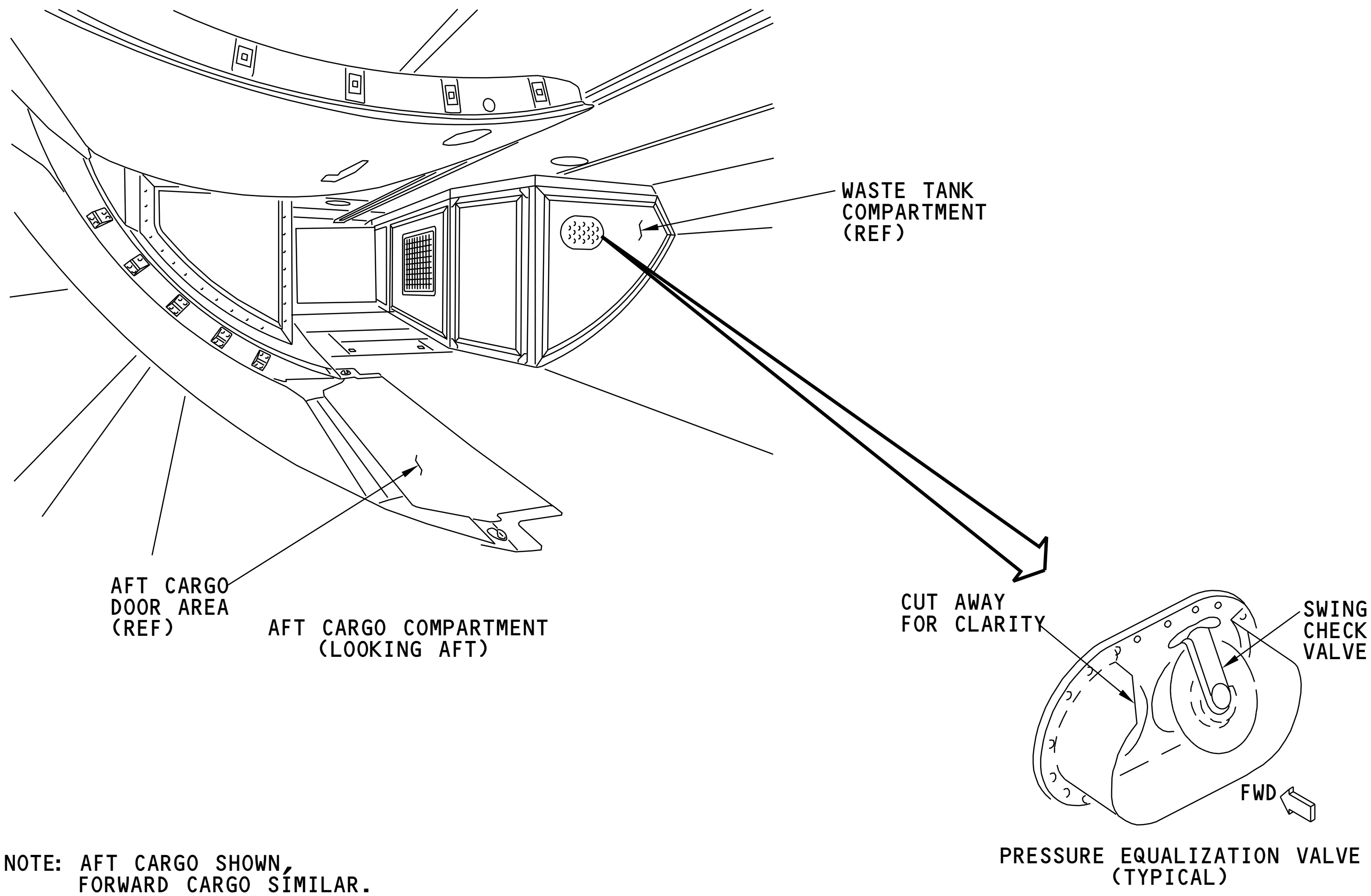
Functional Description

One valve lets air into the cargo compartment during airplane pressurization and one valve lets air out of the cargo compartment during airplane depressurization.

Training Information Point

The cargo compartments are tightly sealed by a fire resistant liner. The liner isolates the cargo compartments from the airplane air conditioning system. This is necessary for fire protection.

The pressure equalization valves isolate the cargo compartments from active air conditioning, but let cargo compartment pressures change.



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AIR CONDITIONING - PRESSURIZATION CONTROL - PRESSURE EQUALIZATION VALVE

AIR CONDITIONING - PRESSURIZATION CONTROL - CABIN ALTITUDE WARNING SWITCH

Purpose

The cabin altitude warning switches, S128 and S1153, warn the flight crew when cabin altitude is critical. Two switches provide redundancy in the cabin altitude warning indication system if one of the switches fails.

Location

The cabin altitude warning switches, S128 and S1153, are on the ceiling in the forward EE compartment.

General Description

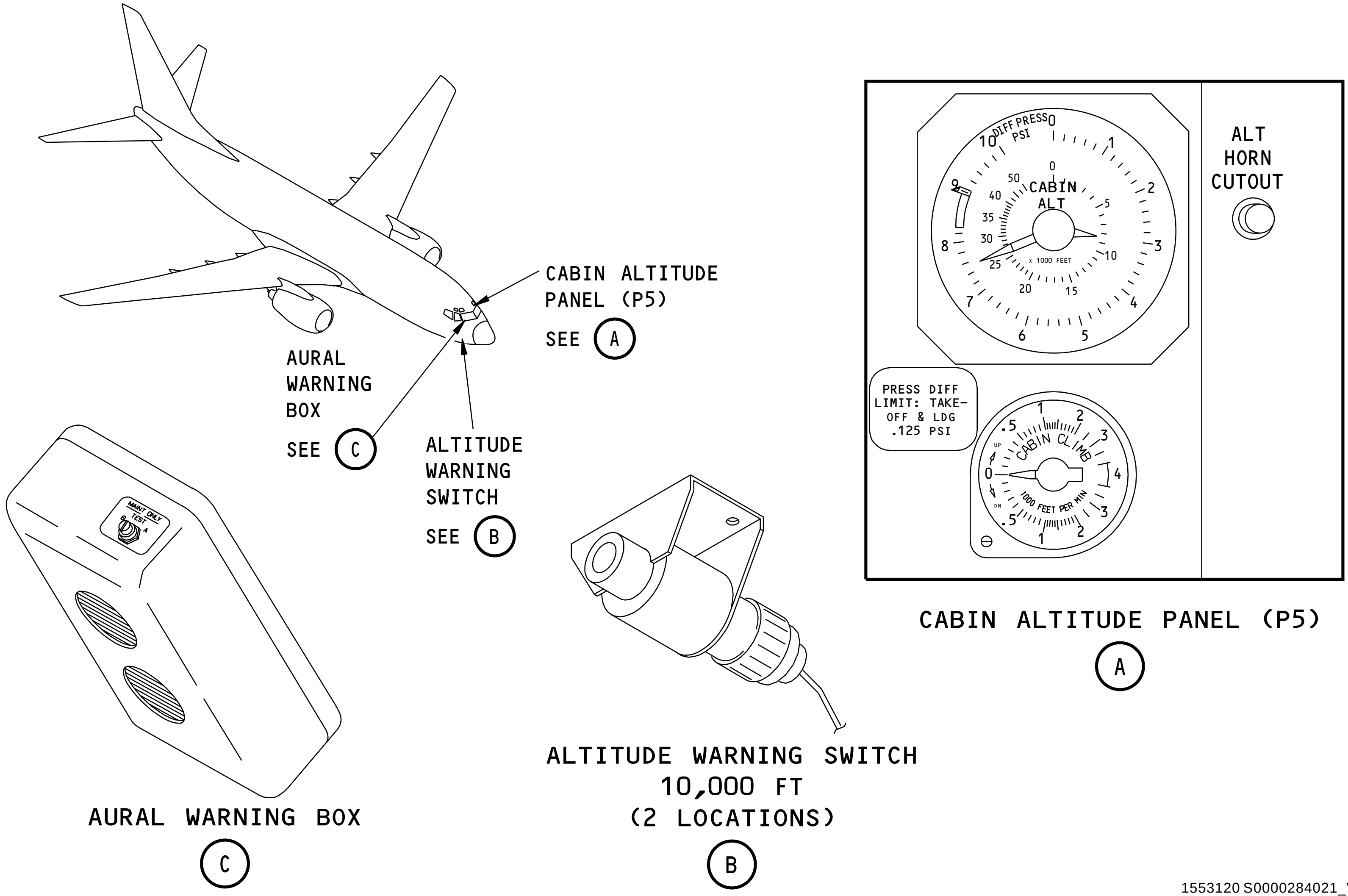
The cabin altitude warning switch S128 is an aneroid type pressure switch. When the cabin altitude gets to 10,000 feet above mean sea level, switch S128 closes.

The cabin altitude warning switch S1153 is an aneroid type pressure switch. When the cabin altitude gets to 10,000 feet above mean sea level, switch S1153 closes.

The cabin altitude warning switches S128 and S1153 are functionally identical but either switch may close anywhere between 9,000 and 11,000 feet of cabin altitude. The two switches provide an increased safety factor with their redundancy.

When energized, the cabin altitude warning circuit causes an intermittent beep from the aural warning unit.

The ALT HORN CUTOUT push-button switch lets the crew deactivate the warning alarm until the next high cabin altitude event.



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AIR CONDITIONING - PRESSURIZATION CONTROL - CABIN ALTITUDE WARNING SWITCH

AIR CONDITIONING - PRESSURIZATION CONTROL - CABIN ALT WARNING SWITCH - FUNCTIONAL DESCRIPTION

Functional Description

Cabin altitude warning switches S128 and S1153 are functionally identical. The switches close when the cabin altitude is between 9,000 and 11,000 feet. Either one of the switches can close first or they can both close at the same cabin altitude. The two redundant switches ensure that the cabin altitude warning system will operate if one of the switches fails.

When the cabin altitude warning switch closes, these things occur:

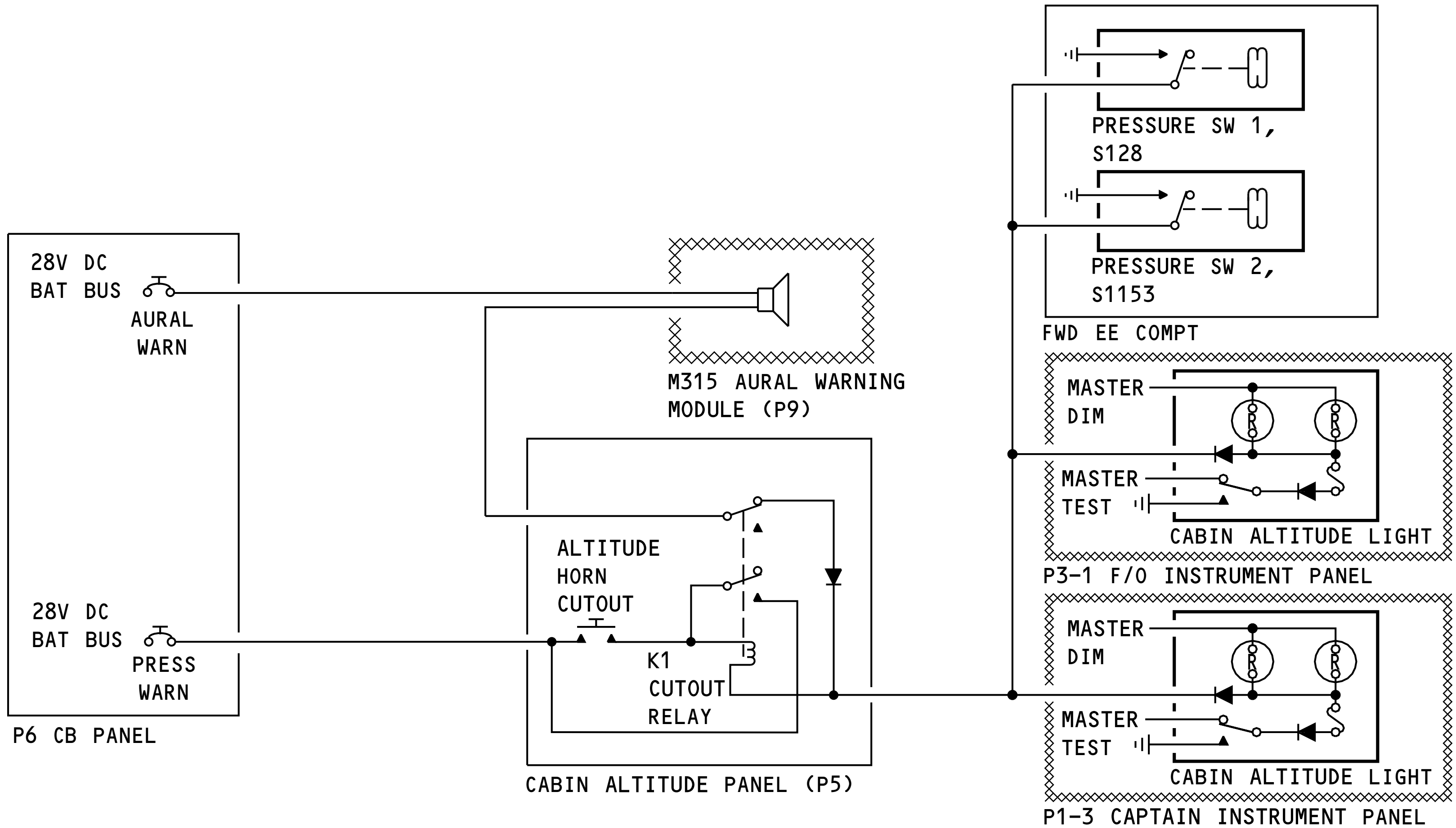
- The switch grounds the horn circuit which energizes the system
- The aural warning module makes an intermittent beep alarm.
- The red CABIN ALTITUDE indicator lights on the captain's instrument panel P1-3 and the first officer's instrument panel P3-1 will come on.

When you push the ALT HORN CUTOUT switch on the cabin altitude panel, these things occur:

- K1 relay energizes
- The aural warning module horn goes off
- K1 latches through the pressure switch.

When the cabin altitude goes below 10,000 feet, the cabin altitude warning switch opens, and these things occur:

- K1 de-energizes
- The warning circuit is reset for the next event.
- The red CABIN ALTITUDE indicator lights on the captain's instrument panel P1-3 and the first officer's instrument panel P3-1 go off.



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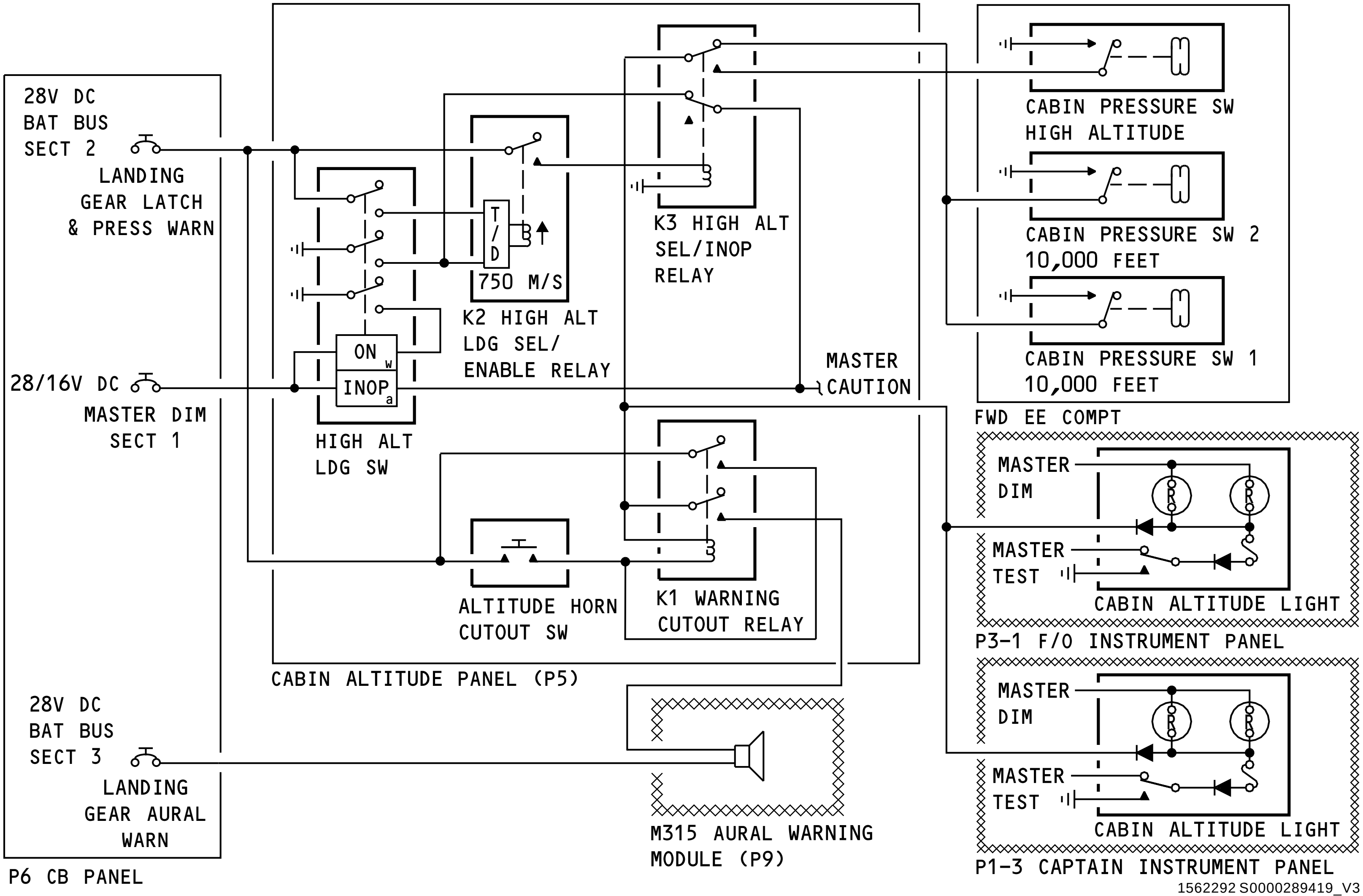
AIR CONDITIONING - PRESSURIZATION CONTROL - CABIN ALTITUDE WARNING SWITCH - FUNCTIONAL DESCRIPTION



AIR CONDITIONING - PRESSURIZATION CONTROL - CABIN ALTITUDE WARNING SWITCH - FUNCTIONAL DESCRIPTION

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AIR CONDITIONING - HEATING - INTRODUCTION

Purpose

The heating system supplies warm air to areas to prevent freezing or to increase temperature for comfort.

General

These are the parts of the heating system:

- Forward cargo compartment heating
- Supplemental heating
- Aft cargo compartment heating.

Cargo Compartments

The cargo compartments receive heat from equipment cooling exhaust and passenger compartment air.

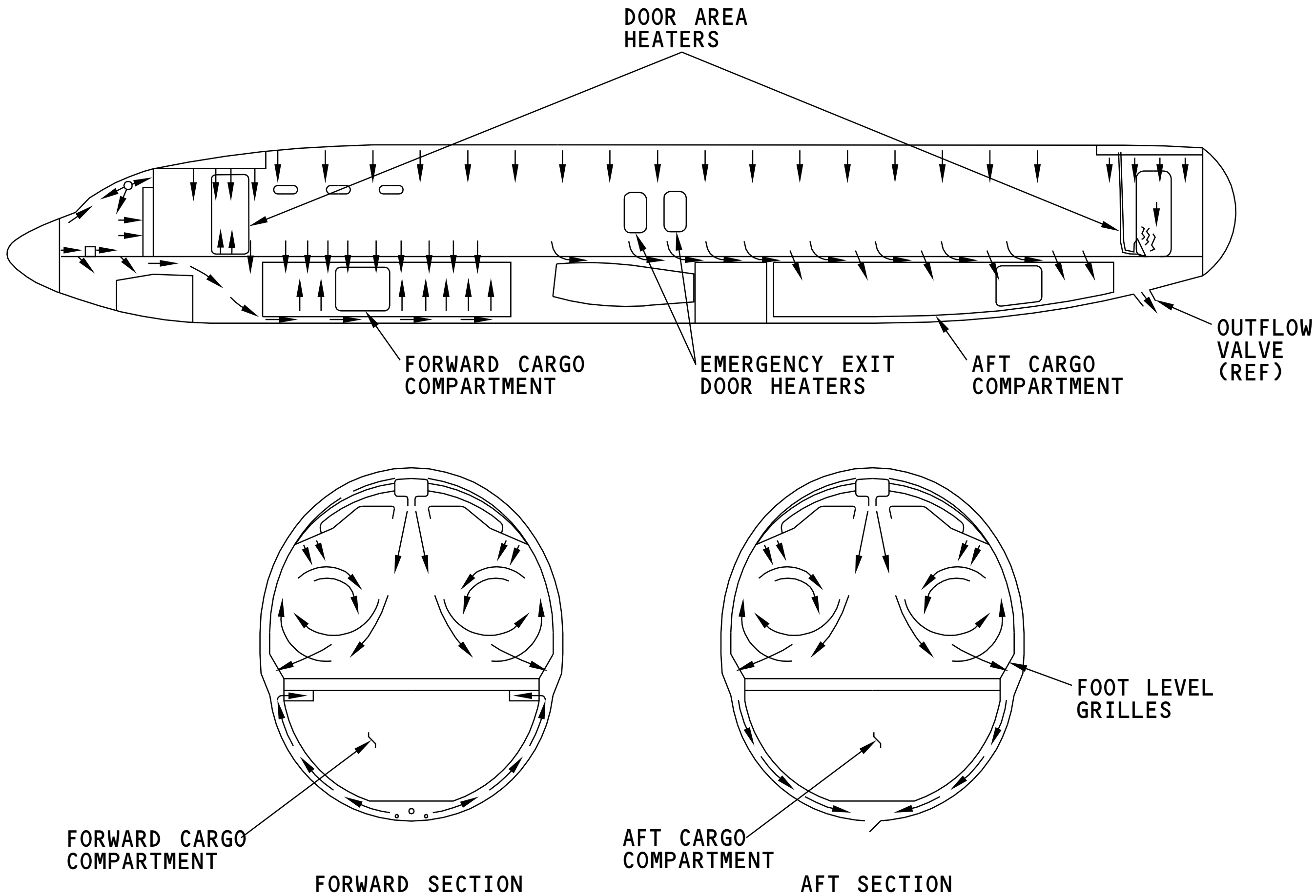
Warm equipment cooling exhaust air flows under the forward cargo compartment floor and along the sidewalls. The air mixes with passenger compartment air in the main distribution manifold.

The aft cargo compartment air comes from the passenger compartment through the foot level grilles. The air goes into the sidewall area around and under the aft cargo compartment through the outflow valve.

The warm air on all sides of the cargo compartments is an insulator. It prevents the transfer of heat through the skin by conduction.

Supplemental Heating

In the passenger compartment, door area heaters supply more heat around the two main entry doors. Also, heater blankets supply more heat around the emergency escape doors.



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AIR CONDITIONING - HEATING - INTRODUCTION

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AIR CONDITIONING - SUPPLEMENTAL HEATING - DOOR AREA HEATER

Purpose

The door area heaters supply added heat to prevent cold zones around the doors.

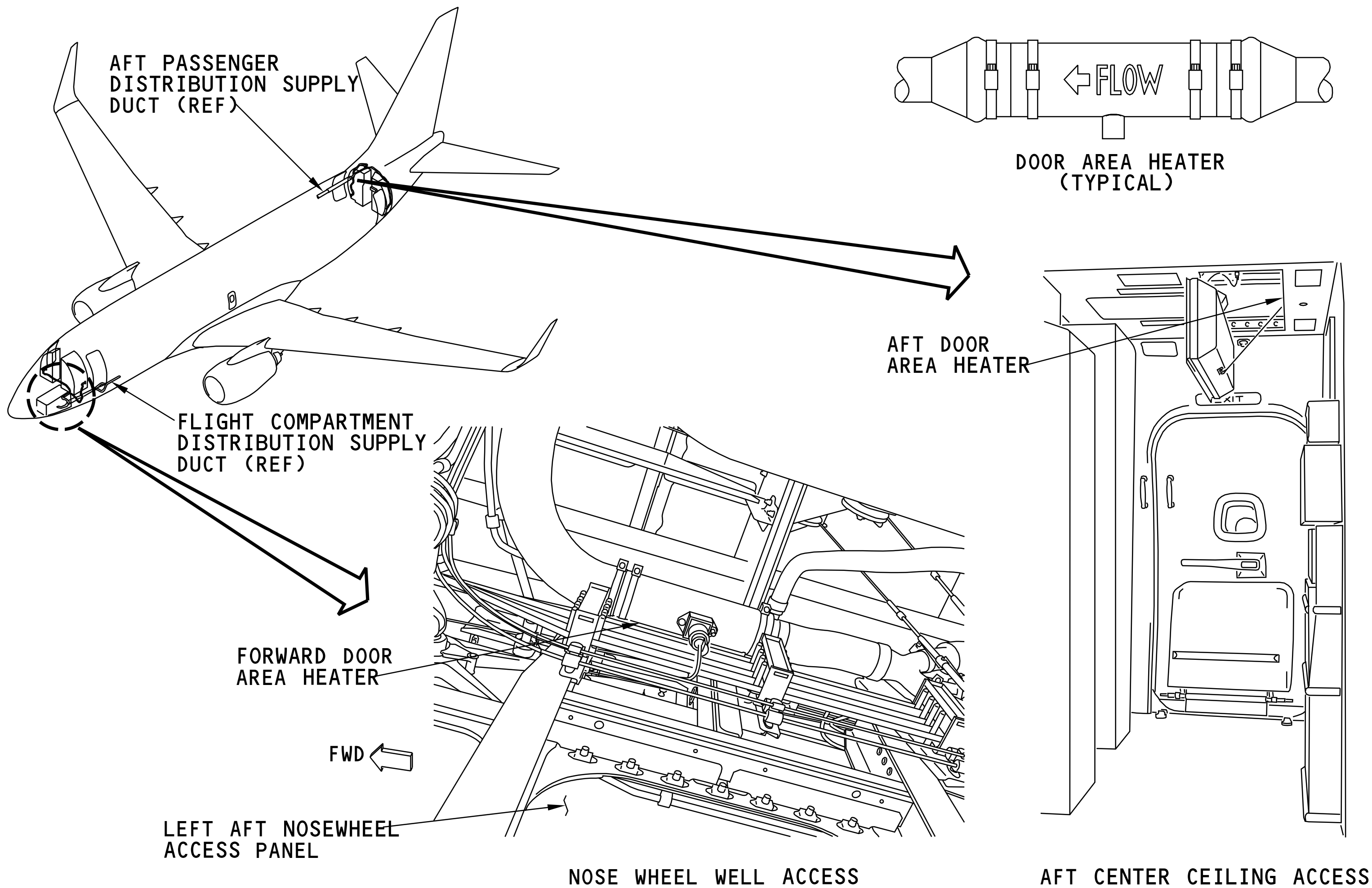
Location

The forward door area heater is on the left outboard side of the nose wheel well. Remove the aft left access panel from inside the nose wheel well to get access to the heater.

Physical Description

The door area heaters are electrical heat elements in a cylindrical housing. There is an electrical connector on the housing. Flexible hoses connect conditioned air distribution supply ducts to the door area heaters. A flexible hose connects the outlet side of the heater to a fitting at the base of the door.

The forward door heater uses conditioned air from the flight compartment distribution supply.



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AIR CONDITIONING - SUPPLEMENTAL HEATING - DOOR AREA HEATER

AIR CONDITIONING - SUPPLEMENTAL HEATING - EMERGENCY ESCAPE DOOR - HEATER BLANKETS

Purpose

Additional heating is necessary in the emergency escape door areas. Electric heater blankets provide this additional heating.

Location

The blankets are behind the decorative trim around each door.

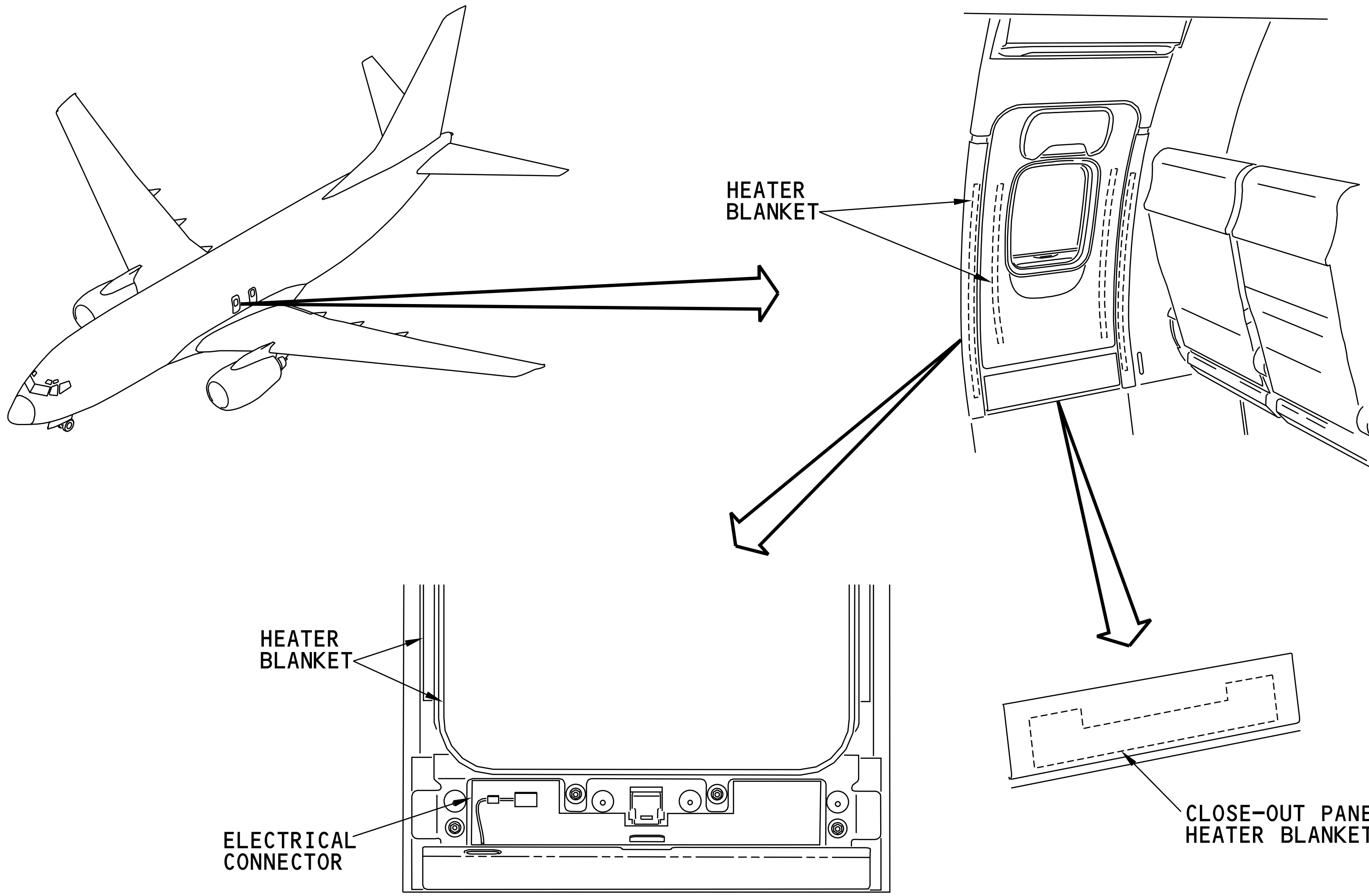
Emergency Escape Door Heater Blankets

The emergency escape doors are heated with heater blankets behind the lining, door trim, and close out panels.

There are two types of emergency escape door heater blankets:

- 10 watts (one heater blanket)
- 50 watts (four heater blankets).

The 10 watt close-out panel heater blanket is behind the lining below the escape door. The 50 watt heater blankets are behind the escape door lining and door trim.



AIR CONDITIONING - SUPPLEMENTAL HEATING - EMERGENCY ESCAPE DOOR - HEATER BLANKETS

AIR CONDITIONING - SUPPLEMENTAL HEATING - FUNCTIONAL DESCRIPTION

General

The air conditioning system controls operation of the door area heaters.

The logic for the door area heaters comes from the air/ground system and air conditioning pack valve operation.

Functional Description

The fwd and aft door area heater power relay (R560) controls power to the area heaters. When the airplane is in the air and one of the pack flow control and shutoff valves is open, the relay energizes. When the relay energizes, 115v ac power from main bus 1 goes to the heaters.

Door Area Heaters

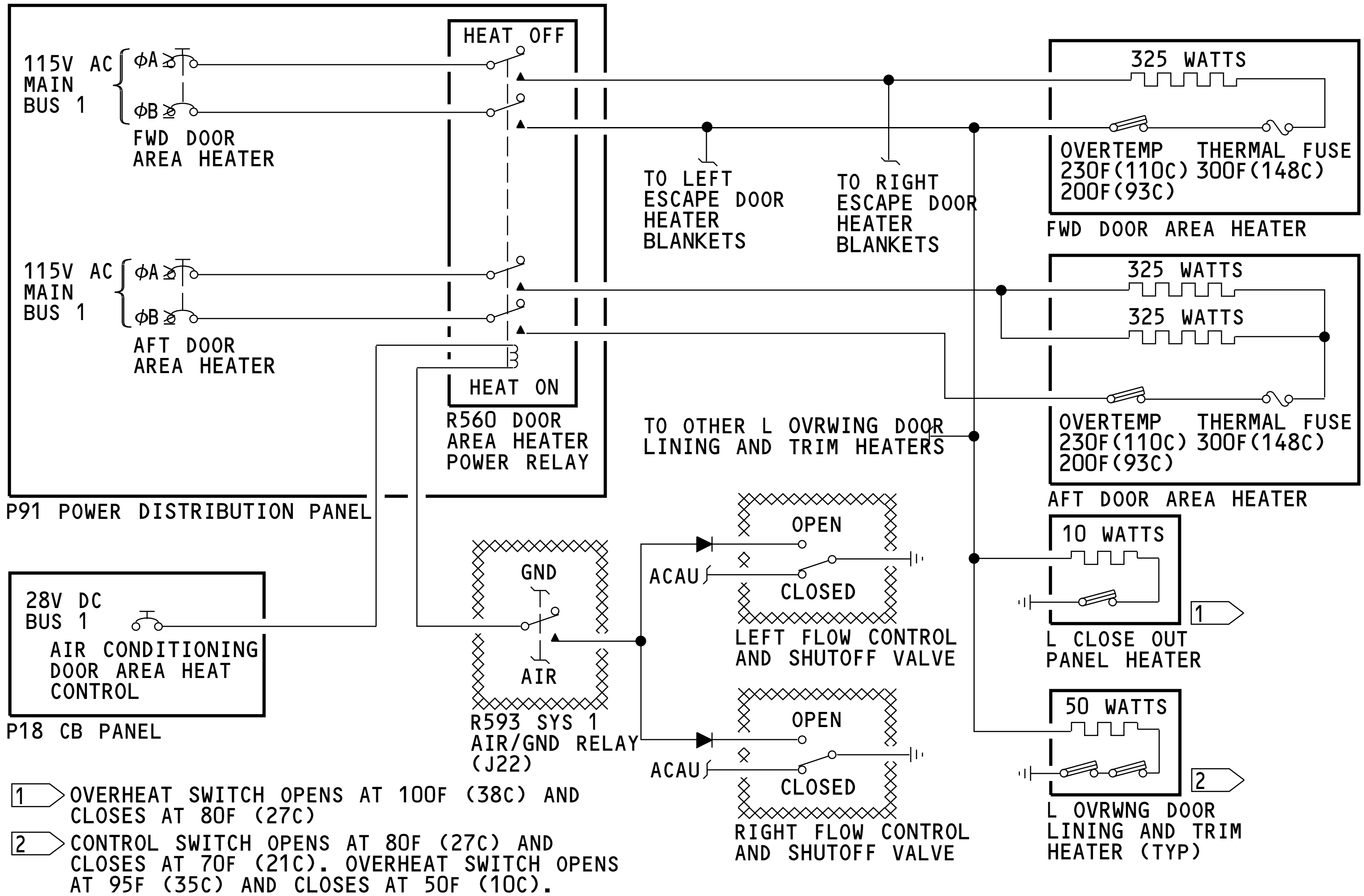
The door area heaters use phase-to-phase power. Each heat element uses 325 watts. There are internal temperature control components that keep the temperature to a limit. The overheat switch opens at 230°F (110°C) and closes at 200°F (93°C). The thermal fuse opens at 300°F (148°C).

Overwing Emergency Exit Door Heaters

The overwing emergency exit doors are heated with heaters behind the lining, door trim, and close out panels.

The close out panel heater uses 10 watts. An overheat switch keeps the temperature to a limit. The overheat switch opens at 100°F (38°C) and closes at 80°F (27°C).

The door lining and trim heaters use 50 watts. There are internal temperature control components that keep the temperature to a limit. The temperature control switch opens at 80F (27C) and closes at 70F (21C). The overheat switch opens at 95°F (35°C) and closes at 50°F (10°C).



AIR CONDITIONING - SUPPLEMENTAL HEATING - FUNCTIONAL DESCRIPTION

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AIR CONDITIONING - COOLING - INTRODUCTION

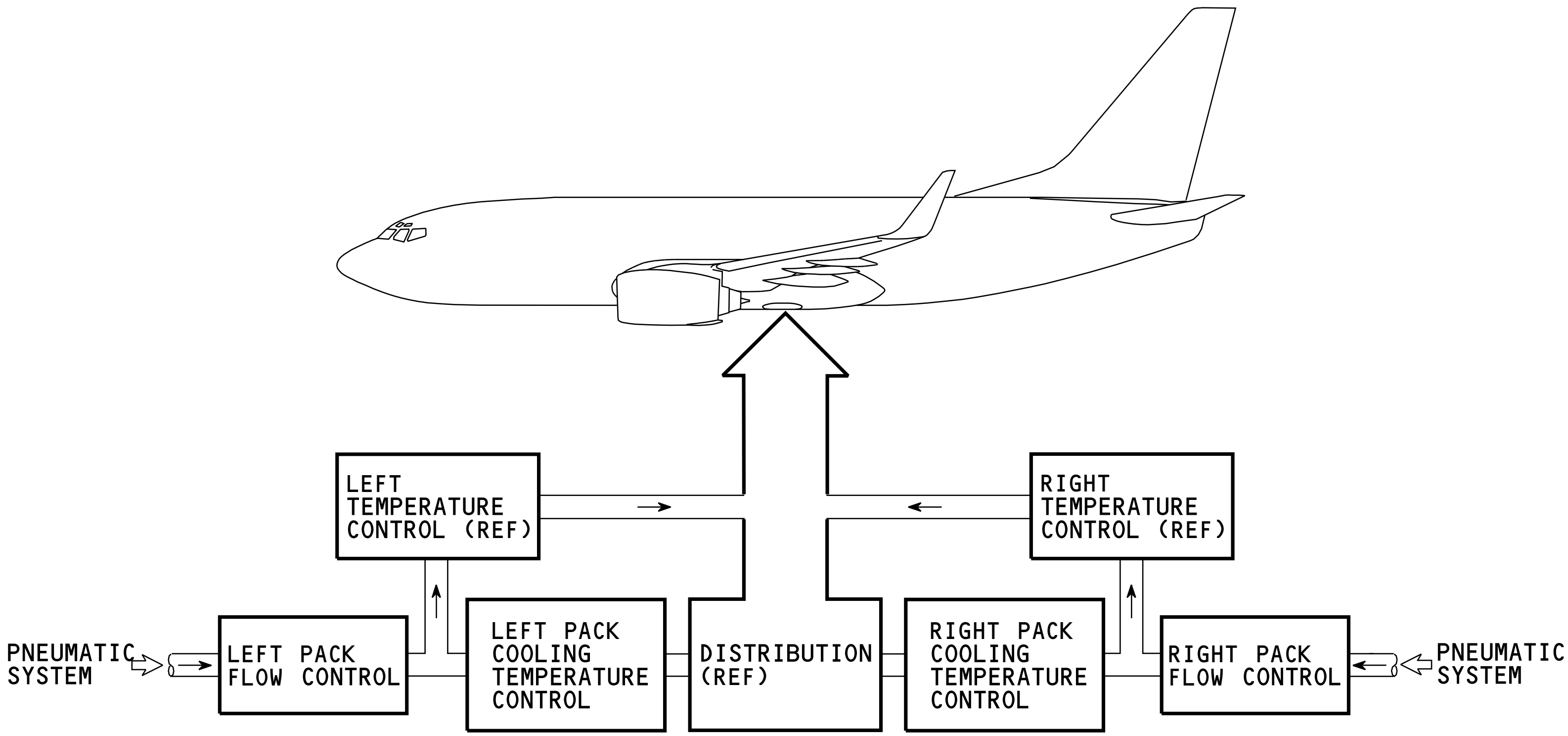
Purpose

These are functions of the cooling system:

- Control the quantity of air from the pneumatic system to the pack
- Remove heat from the air that enters the pack
- Control the output temperature and moisture of the pack.

Abbreviations and Acronyms

- A/C - air conditioning
- ACM - air cycle machine
- ACAU - air conditioning accessory unit
- APU - auxiliary power unit
- C - Celsius
- F - Fahrenheit
- FCSOV - flow control and shutoff valve
- FMCS - flight management computer system
- gnd - ground
- HPWS - high pressure water separator
- OVHT - overheat
- SRADA - smart ram air door actuator
- sw - switch
- vlv - valve



AIR CONDITIONING - COOLING - INTRODUCTION

AIR CONDITIONING - COOLING - GENERAL DESCRIPTION

General

The cooling system uses these components and systems to cool the bleed air:

- Air conditioning/bleed air controls panel
- Flow control and shutoff valve
- Heat exchangers (2)
- Air cycle machine
- Reheater
- Condenser
- Ram air system
- Water extraction.

Air Conditioning/Bleed Air Controls Panel

The air conditioning/bleed air controls panel gives control and indications of the cooling system. These are the controls and indications of the cooling system:

- RAM DOOR FULL OPEN lights
- L/R PACK switches
- PACK lights
- TRIP RESET button.

Flow Control and Shutoff Valve

Bleed air from the pneumatic system supplies bleed air to the flow control and shutoff valve. The valve controls the flow of bleed air into the pack. After the bleed air goes through the flow control and shutoff valve it enters the primary heat exchanger.

Primary Heat Exchanger

The primary heat exchanger receives bleed air from the flow control and shutoff valve. As the bleed air goes through the heat exchanger, ram air removes heat. The cooled bleed air goes to the compressor section of the air cycle machine.

Air Cycle Machine

The air cycle machine is a three wheel, air bearing air cycle machine.

Cooled bleed air from the primary heat exchanger enters the air cycle machine where it is compressed. The compressed air then goes to a secondary heat exchanger, a water separator system and then back to the air cycle machine where the bleed air is rapidly expanded and sent to a condenser.

Secondary Heat Exchanger

The secondary heat exchanger receives compressed air from the air cycle machine. As the air goes through the heat exchanger, ram air removes heat. After the compressed air is cooled it goes through a water extractor duct and back to the air cycle machine.

Reheater

The reheater increases the temperature of the air in the air conditioning pack before it enters the turbine of the air cycle machine.

Condenser

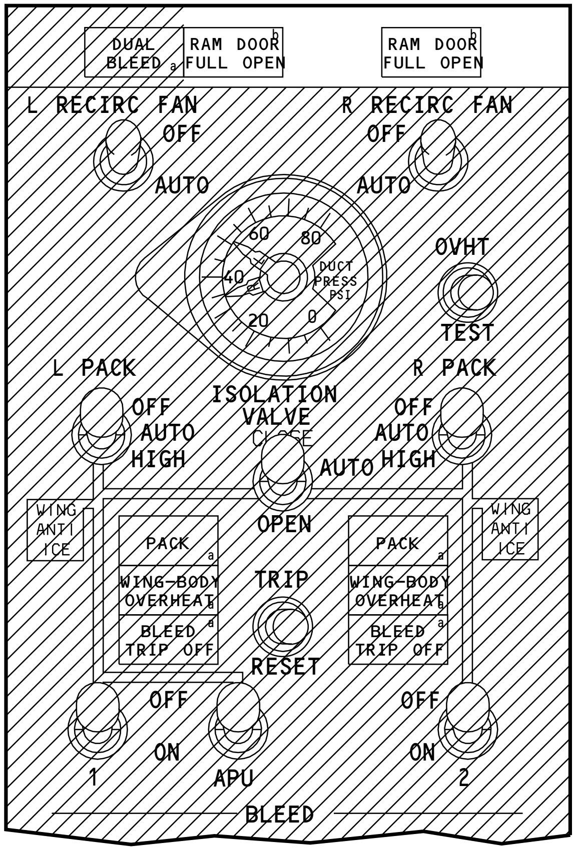
The condenser decreases the temperature of the air in the air conditioning pack to below the dew point, changing water vapor into liquid.

Ram Air System

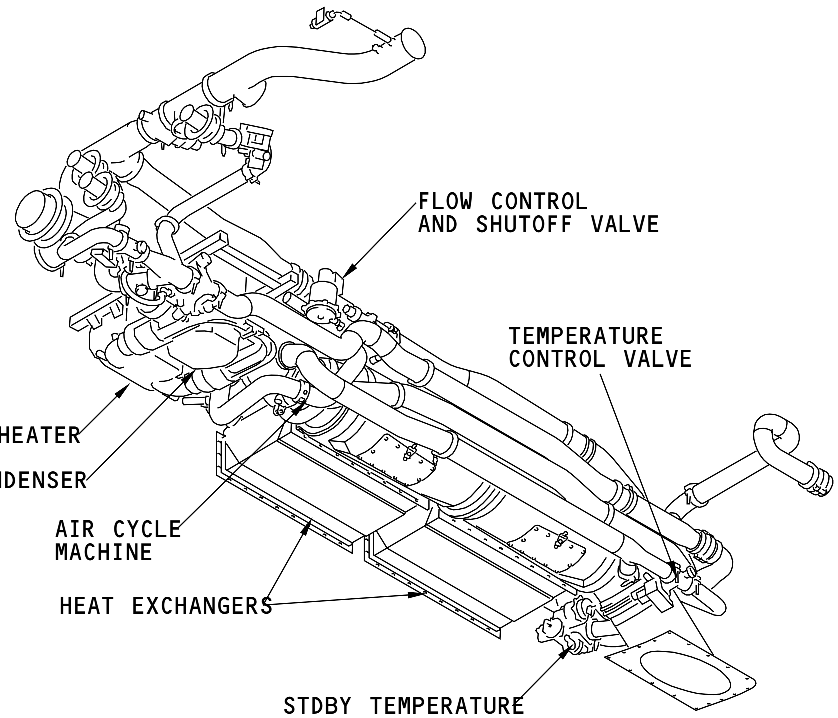
The ram air system controls the quantity of outside ambient air that flows through the heat exchangers.

Water Extraction

The water extraction collects and removes moisture from the air before it goes into the distribution system.



AIR CONDITIONING/BLEED AIR CONTROLS PANEL (P5)



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AIR CONDITIONING - COOLING - GENERAL DESCRIPTION

AIR CONDITIONING - COOLING - COMPONENT LOCATION

Component Locations

The air conditioning cooling system components are in these areas of the airplane:

- Flight compartment
- EE compartment
- Distribution compartment
- Air conditioning compartment and wing-to-body fairing.

Flight Compartment

The air conditioning/bleed air controls panel is on the P5 overhead panel.

EE Compartment

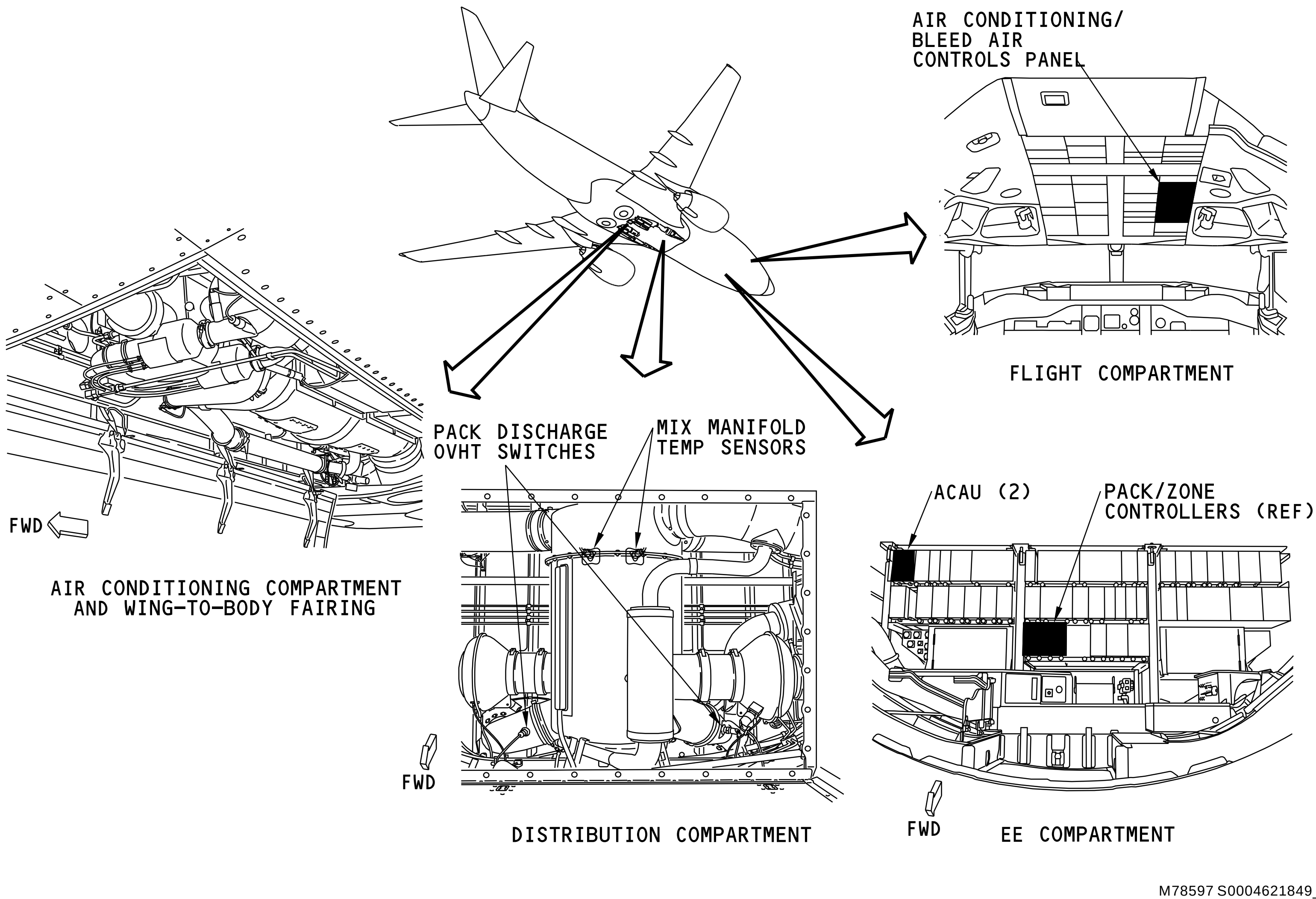
The air conditioning accessory units (ACAUs) are on the E4-1 shelf.

Distribution Compartment

The mix manifold temperature sensors and pack discharge overheat switches are in the distribution compartment.

Air Conditioning Compartment and Wing-to-Body Fairing

The air conditioning pack systems are in the air conditioning compartments. The ram air system is in the wing-to-body fairing. This is the area forward and outboard of the air conditioning compartment.



AIR CONDITIONING - COOLING - COMPONENT LOCATION

AIR CONDITIONING - COOLING - AIR CONDITIONING ACCESSORY UNITS

Purpose

The air conditioning accessory unit (ACAU) is the interface of the airplane operational logic and the air systems.

Location

The ACAUs are in the EE compartment on the E4-1 shelf.

Interfaces

The air conditioning accessory unit has an interface with these systems:

- Flight controls (flaps not up switch)
- Landing gear (air/ground)
- Engine starting
- Air conditioning
- Pneumatic/bleed air
- Flight management computer (FMC).

The ACAU receives signals from these airplane components:

- Engine start valves
- Flap control unit
- Flap up switch
- Air/Gnd relays
- Pack flow control and shutoff valve
- Ram air actuators
- Pack overheat switches

AKS 001-021

- Pack/Zone temperature controller

AKS 022-999

- Pack Flow temperature controller

AKS ALL

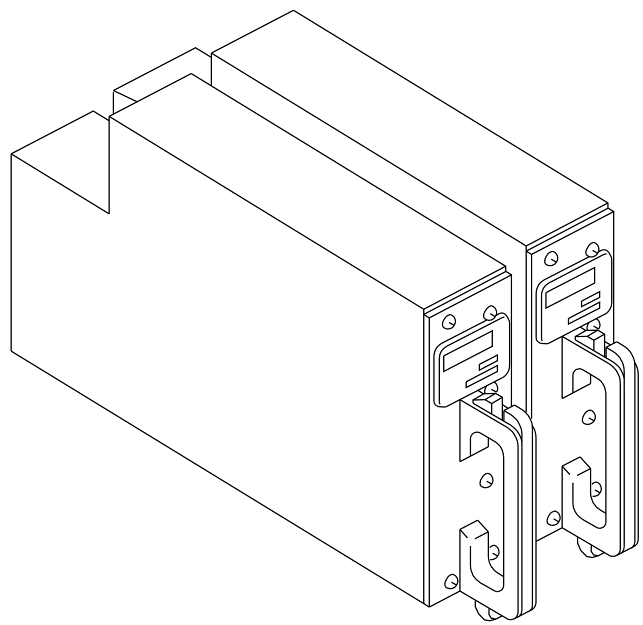
- Engine bleed switches
- Duct overheat switches
- Pneumatic system valves
- Air conditioning/bleed air controls panel
- Cabin temperature panel
- Pressurization outflow valve
- Recirculation fans
- Overboard exhaust valve
- Pneumatic system ovht/ovpress switches
- FMC.

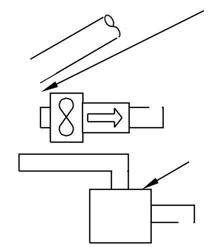
The ACAU sends signals to these components:

- Air conditioning/bleed air controls panel
- Cabin temperature panel
- Bleed air regulators
- Engine start valves
- Pack flow control and shutoff valves
- Ram air actuators
- Outflow valve
- Recirculation fans
- EE cooling fans
- FMC.

Training Information Point

You must do an adjustment/test after you replace the ACAU.





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AIR CONDITIONING - COOLING - AIR CONDITIONING ACCESSORY UNITS

AIR CONDITIONING - COOLING - FLOW CONTROL AND SHUTOFF VALVE

Purpose

The flow control and shutoff valve controls and adjust the airflow to the pack.

Location

The flow control and shutoff valve is in the air conditioning compartment. It is adjacent to the keel beam and air cycle machine.

AKS 001-021

Physical Description

The flow control and shutoff valve is electrically controlled and pneumatically actuated. It is spring-loaded to the closed position. These are the parts of the flow control and shutoff valve:

- Butterfly plate
- Visual position indicator
- Actuator
- Auto flow servo
- Venturi
- Cabin pressure sense port
- Solenoid A (APU/high flow)
- Solenoid B (auto flow)
- Solenoid C (open-close)
- APU/High flow servo

It has four electrical connections and one cabin pressure sense line connection.

AKS 022-999

Physical Description

The flow control and shutoff valve is electrically controlled and pneumatically actuated. It is spring-loaded to the closed position. These are the parts of the flow control and shutoff valve:

- Butterfly plate
- Visual position indicator
- Actuator
- Open-close solenoid
- Flow body assembly
- Control servo
- Torque motor

It has three electrical connectors.

AKS 001-021

Training Information Point

The position indicator lets you inspect the valve for trouble shooting.

A manual control shaft on solenoid C lets you open the solenoid manually.

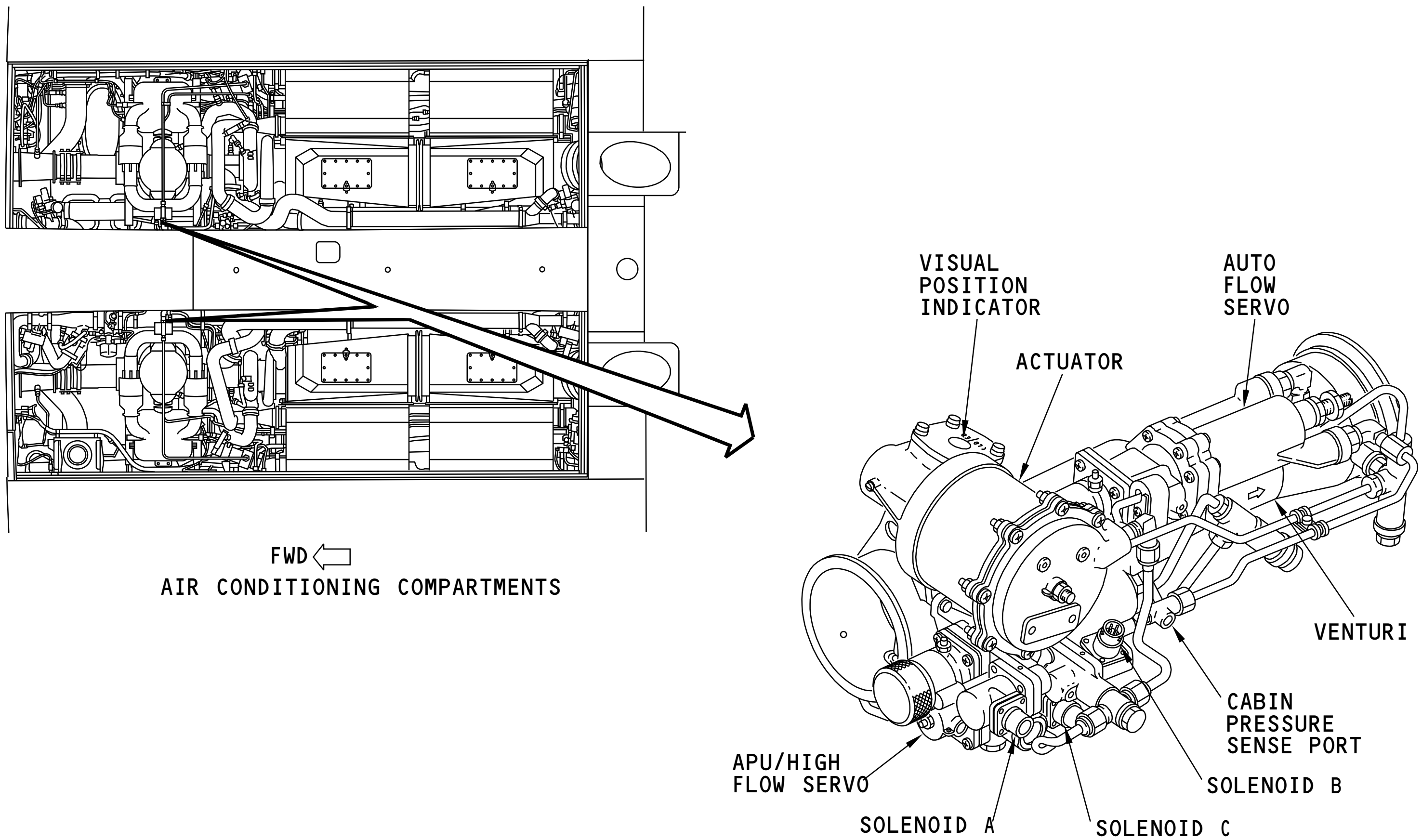
AKS 022-999

Training Information Point

The position indicator allows you to determine if the valve is open or closed for fault isolation purposes.

A manual control shaft allows you to open the latching solenoid valve.

AKS ALL



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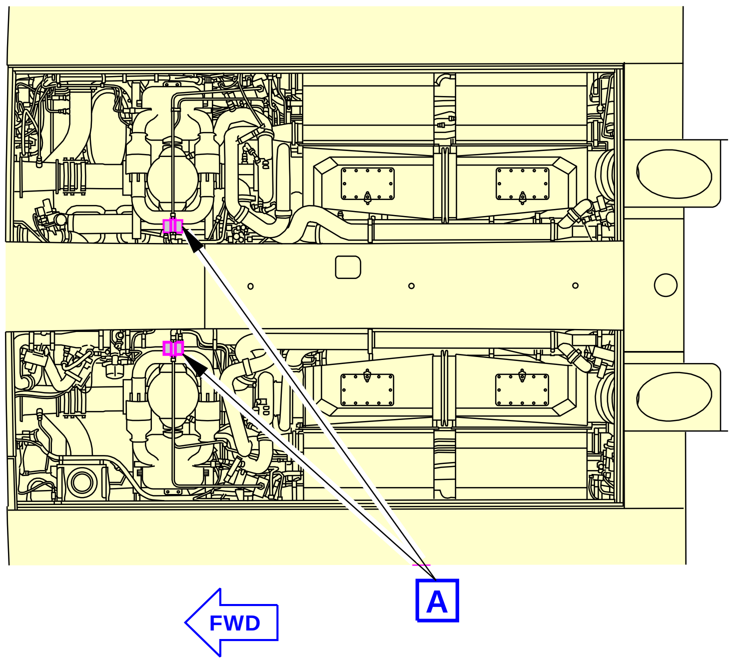
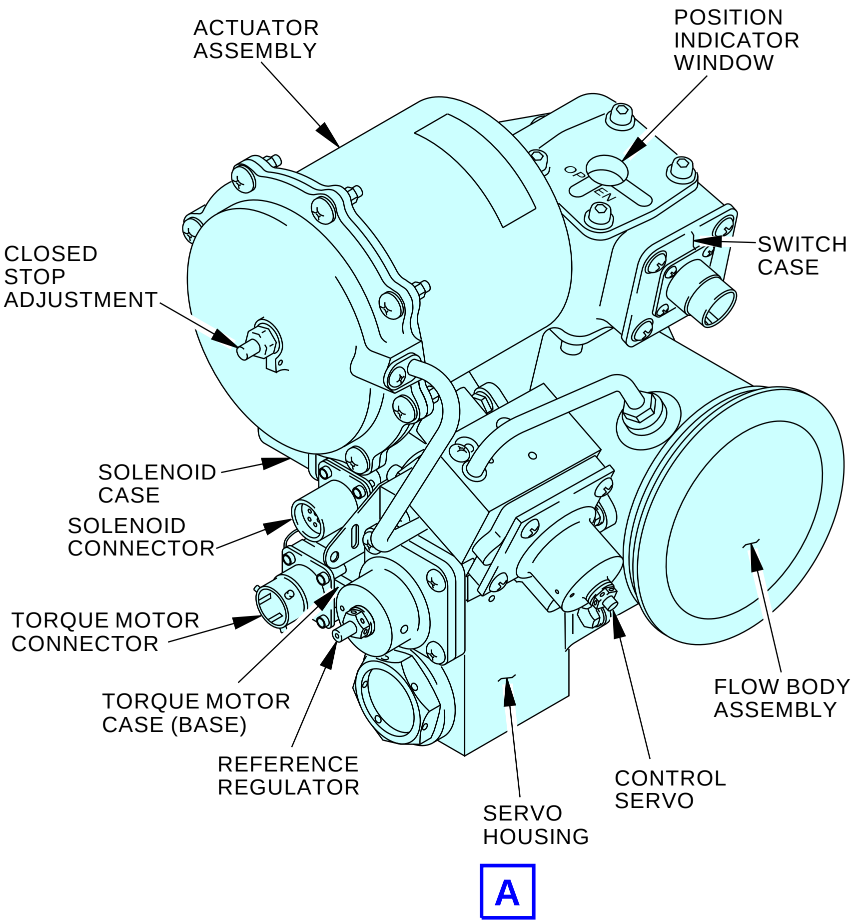
AIR CONDITIONING - COOLING - FLOW CONTROL AND SHUTOFF VALVE



AIR CONDITIONING COMPARTMENTS



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AIR CONDITIONING - COOLING - FLOW CONTROL AND SHUTOFF VALVE

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AIR CONDITIONING - COOLING - FLOW CONTROL AND SHUTOFF VALVE - MECHANICAL FUNCTIONAL DESCRIPTION

Functional Description

The flow control and shutoff valve is electrically controlled and pneumatically actuated. It is spring-loaded to the closed position. The valve operates by a pneumatic actuator which moves a butterfly plate. When the pack switch is in the OFF position, 28v dc energizes solenoid C to the close position. This moves a ball valve that prevents air pressure from going to the actuator to open the valve.

When the pack switch is in the AUTO or HIGH position, solenoid C receives power to the open coils. The pressurized air flows to the actuator. It pushes against spring force in the actuator to open the butterfly plate (valve open). When the valve opens, air flows to the static pressure sense port and the downstream (total pressure) sense port.

The static and total pressure sense ports balance actuator opening pressure for the auto and high flow servos. These ports permit a measure of differential pressure in the venturi which corresponds to the rate of airflow.

Solenoid B changes flow modes between the normal flow and the high flow modes. It energizes when the pack switch is in the AUTO position. This lets air flow to the auto flow servo (normal flow mode). The auto flow servo controls flow rate as cabin air pressure changes. The cabin pressure sense port provides a cabin air pressure signal to the auto flow servo internal bellows. This allows the flow control and shutoff valve to maintain the desired flow rate as cabin pressure decreases. Normal flow mode has an airflow rate of 75 pounds per minute (ppm).

When the pack switch is in the HIGH position, solenoid B de-energizes (high flow mode). Actuator air flows to the APU/high flow servo. The high flow servo has a strong bias to close. This will let more air pressure go to the valve actuator. This increases airflow. High flow mode is 105 ppm.

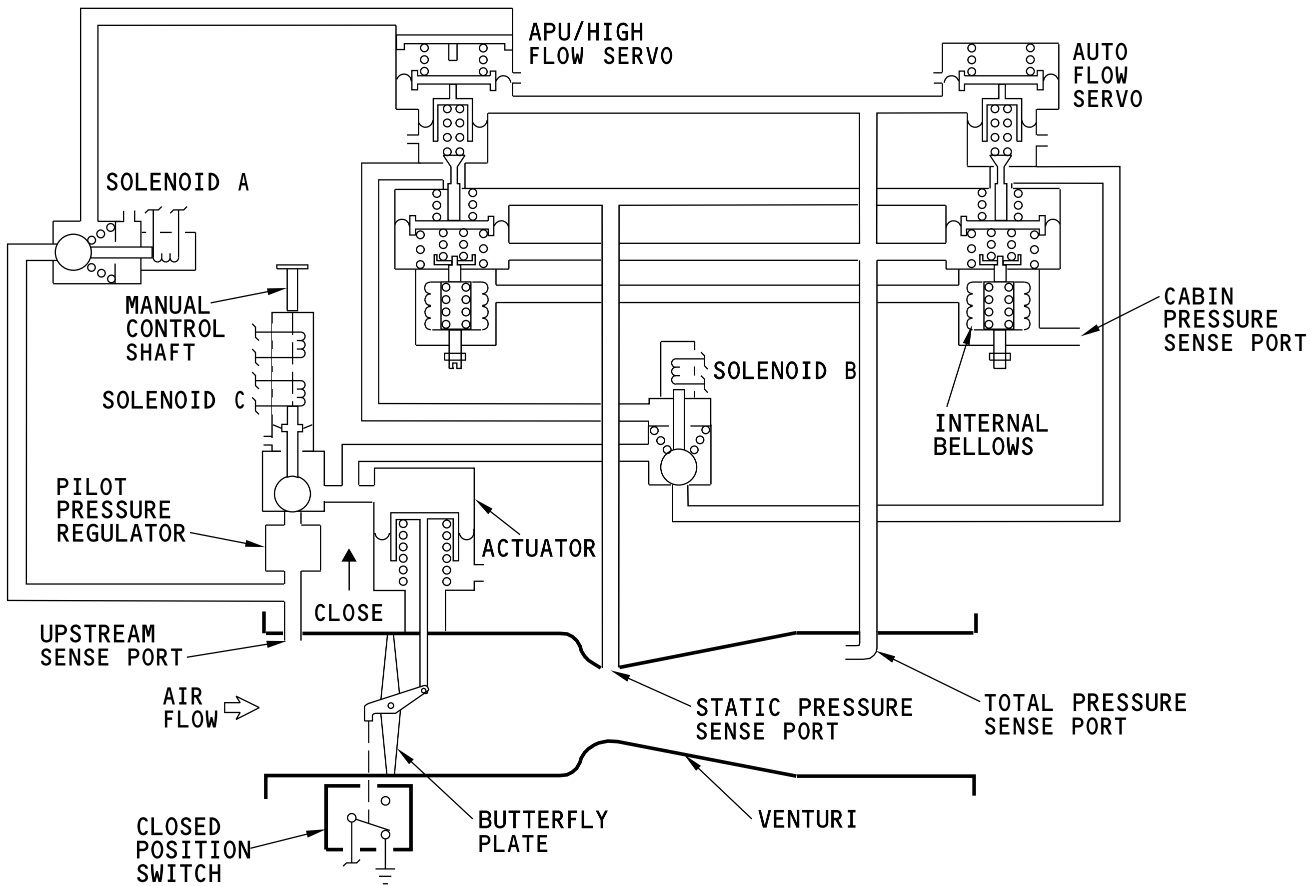
In cruise, if a pack shuts down from an overheat or if a (L or R) pack switch is OFF, solenoid B de-energizes. This sets the operating pack to high flow mode.

The APU high flow mode energizes solenoid A. The APU /high flow servo has one more actuating piston than high flow. This results in a higher spring-bias to close the servo. This lets more pressure go to the valve actuator. APU/high flow mode has an airflow rate of 131 ppm.

Training Information Point

A manual control shaft on solenoid C lets you open the solenoid manually.

The flow control and shutoff valve cabin pressure sense port is connected by a sense line to an open port in the distribution bay. This port must be clean for the flow control and shutoff valve to properly control airflow.



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AIR CONDITIONING - COOLING - FLOW CONTROL AND SHUTOFF VALVE - MECHANICAL FUNCTIONAL DESCRIPTION

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AIR CONDITIONING - COOLING - FLOW CONTROL AND SHUTOFF VALVE - MECHANICAL FUNCTIONAL DESCRIPTION

Functional Description

The valve is a pneumatically actuated and electrically controlled pressure regulating valve. The valve is spring-loaded closed and is shown depressurized and de-energized.

Pressurized air enters the inlet of the valve and is prevented from flowing further by the closed butterfly plate. Pressure is ported through a downstream-facing probe and servo filter to the base of the supply pressure regulator. Air flows through the base of the regulator, around the poppet, and to the outlet of the regulator. Air also flows into the sensing chamber where it acts on the diaphragm to produce a force that tends to retract the poppet and close the regulator. This closing force acts in opposition to the calibration spring force that tends to open the poppet. When the pressure in the sensing chamber rises to the level where it generates a closing force sufficient to overcome the spring force, the poppet retracts and causes the flow area through the regulator to be restricted. The force balance between the pneumatically generated retraction force and the spring is such that any change in pressure downstream of the regulator will cause the poppet to move in the direction to restore the force balance. In this manner, the pressure downstream of the supply pressure regulator is held constant.

Regulated output pressure from the supply pressure regulator is ported to a parallel vent orifice, through a control orifice to the inlet of the solenoid valve, and to the supply nozzle of the torque motor. Air flow through the solenoid valve is ported to the actuator opening chamber and the control servo poppet.

Pressure Regulation

To open the valve, the opening coil of the solenoid is energized, and the torque motor remains de-energized. Electromagnetic force causes the solenoid ball to move to from the supply seat to the vent seat. With the ball against the vent seat, the ambient vent in the solenoid is blocked and air pressure is admitted to the actuator opening chamber and the control servo poppet. Control pressure in the opening chamber of the actuator acts on the diaphragm to produce an opening force. This force is greater than the closing force of the actuator closing spring, and the butterfly plate rotates open.

As the butterfly opens, air flows from the valve inlet to downstream. Pressure downstream of the butterfly plate is ported through the sense port and to the feedback chamber of the control servo. When the pressure acting on the feedback diaphragm reaches a predetermined setpoint, the resulting force exceeds the spring loads and moves the poppet to open a vent area. The resulting flow produces a pressure drop across the control orifice, thereby reducing the control pressure in the actuator opening chamber. The force balance in the control servo is such that any change in the sensed downstream pressure will result in the butterfly moving in the direction that will tend to restore the downstream pressure and force balance. In this manner, the valve regulates downstream pressure to the desired value.

To control valve downstream pressure to a lower value, operation is identical as described above except current is applied to the torque motor. As the current command is increased to the torque motor, the torque motor flapper moves away from the supply nozzle towards the vent nozzle. This results in an increase in the pressure in the reset chamber of the control servo. When the pressure acting on the reset diaphragm increases, the resulting force increases the opening force balance set point in the control servo and decreases the valve downstream pressure accordingly. In this manner, the valve downstream pressure is a function of the electrical current to the torque motor.

Closing the Valve

To close the valve, the closing coil of the solenoid is energized. When the closing coil is energized, the solenoid ball moves and latches on the supply seat as shown, thus closing off the actuator air supply and venting the actuator. The actuator spring will then move the butterfly to the closed position.

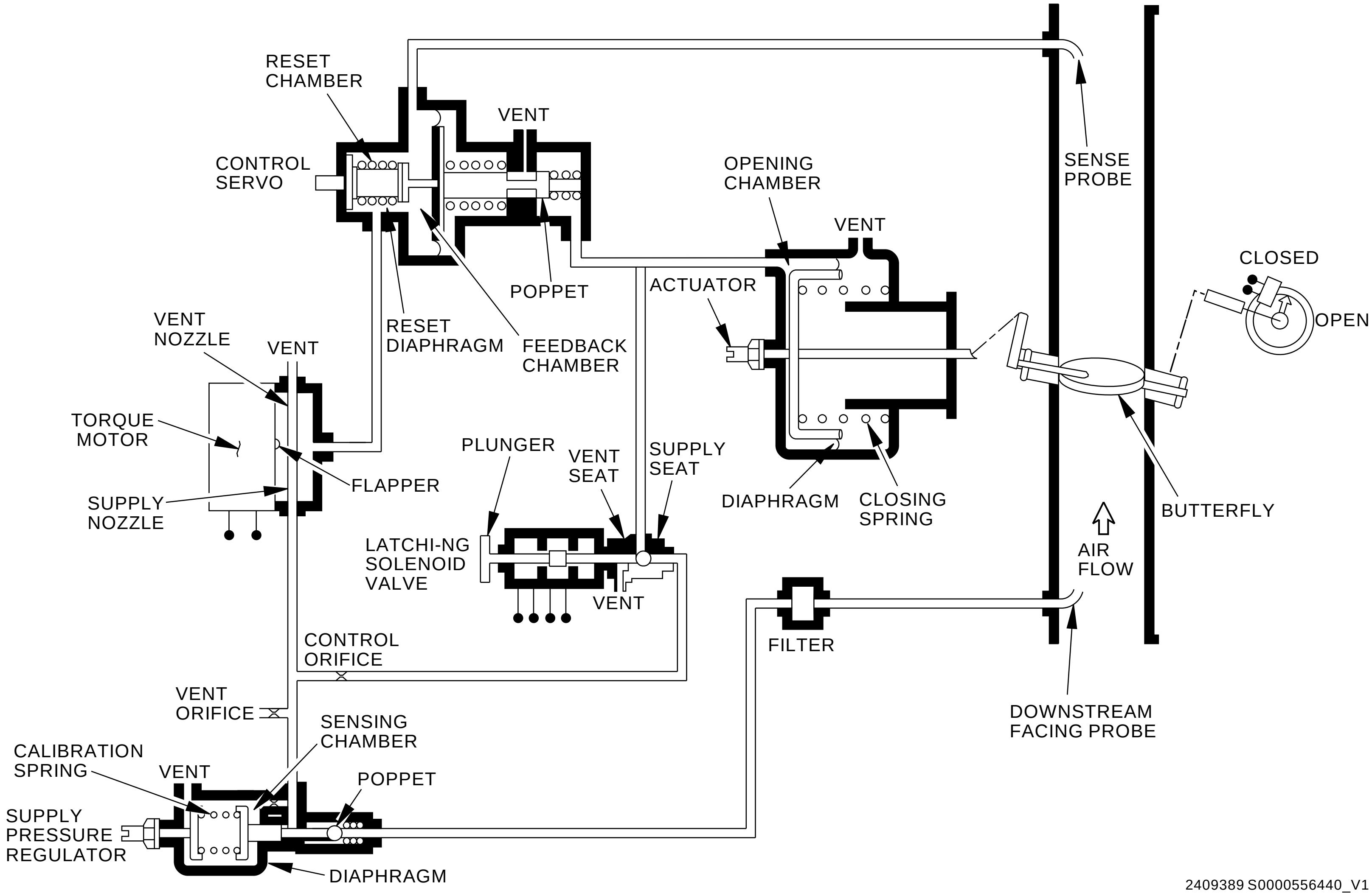
The solenoid also has an externally accessible plunger that may be utilized to manually latch the solenoid in the closed position, thus providing a means to manually place the valve in the closed position via pneumatic lockout.

Other Features

The valve incorporates electrical butterfly position indication via a mechanical position switch, indicating the valve is either “closed” or “not closed”. The valve also incorporates a visual position indicator.

AIR CONDITIONING - COOLING - FLOW CONTROL AND SHUTOFF VALVE - MECHANICAL FUNCTIONAL DESCRIPTION

When operating in pneumatic regulation mode (with zero torque motor current) the valve regulates between 42 to 70 psig for inlet pressures between 50 psig and 194.4 psig



AIR CONDITIONING - COOLING - FLOW CONTROL AND SHUTOFF VALVE - MECHANICAL FUNCTIONAL DESCRIPTION

Pack Switch OFF

When the pack switch is in the OFF position, 28v dc (battery bus) energizes the close coil of solenoid C. When the close coil is energized, the flow control and shutoff valve is closed.

Pack Switch AUTO

When the pack switch is in the AUTO position, 28v dc energizes the open coil of solenoid C. When open coil of solenoid C is energized, the FCSOV opens. This also moves a position switch to open. The position switch gives a discrete signal to these systems:

- Flight management computer system
- Common display system
- Pressurization system
- Temperature control system
- Recirculation system.

When either engine bleed switch is on, 28v dc energizes solenoid B through the low flow mode relay (K18).

When solenoid B is energized, the FCSOV operates in the low flow mode.

Solenoid B deenergizes when K18 energizes. K18 energizes when both engine bleed switches are in the OFF position.

Also, solenoid B deenergizes when these things occur:

- Airplane in the air (the pack air/gnd relay (K10) goes to the AIR position)
- Flaps up (the flap not up relay (K19) goes to the UP position).
- The opposite FCSOV closes.

When solenoid B de-energizes, the FCSOV operates in the high flow mode.

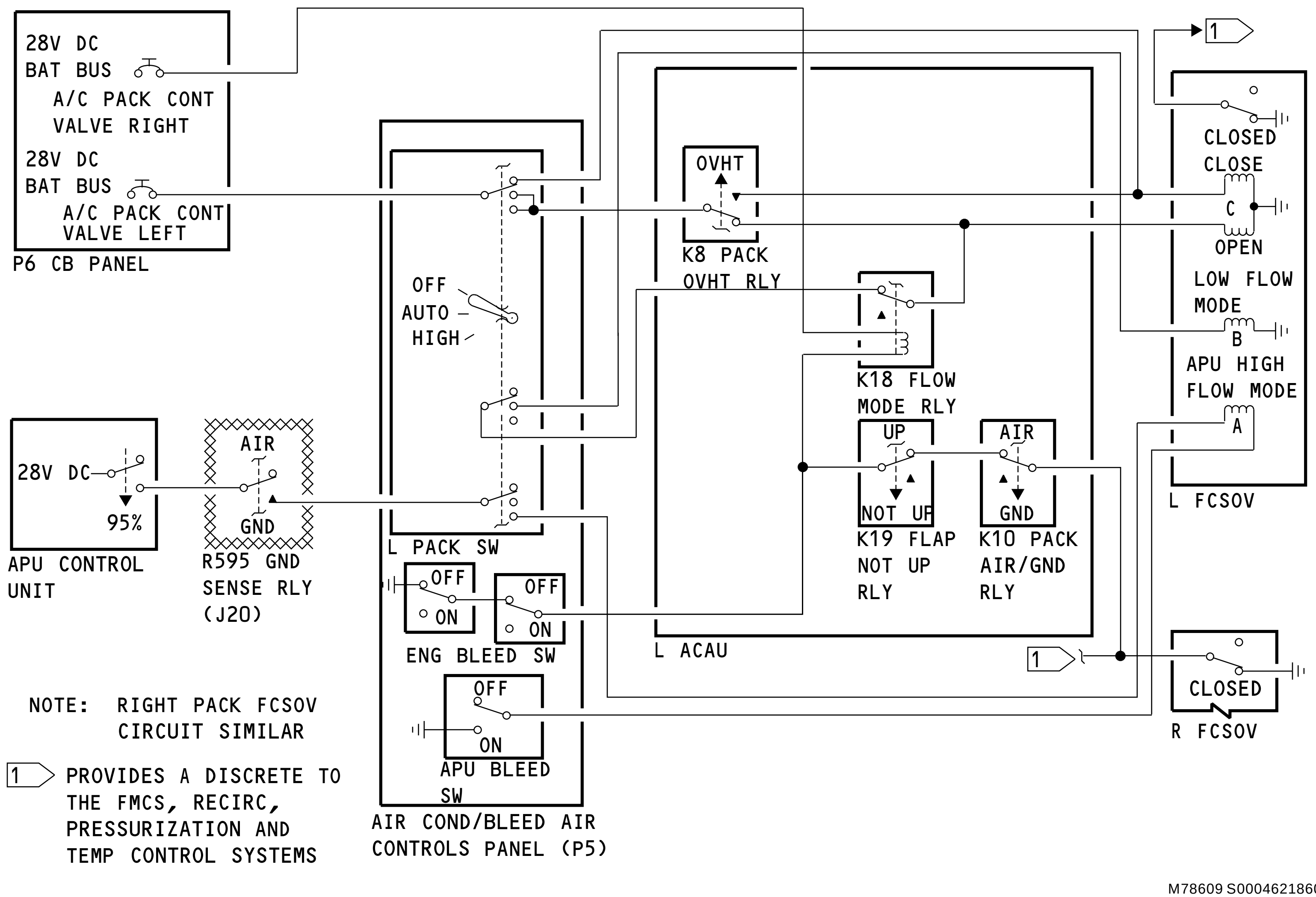
Pack Switch HIGH

When the switch is in the HIGH position, solenoid B is deenergized. When solenoid B is deenergized, the FCSOV is in the high flow mode.

Solenoid A is energized when the all of these conditions are true:

- The pack switch is in the HIGH position
- The APU bleed switch is in the ON position
- The APU operates above 95%
- The airplane is on the ground.

When solenoid A is energized the FCSOV operates in the APU high flow mode.



AIR CONDITIONING - COOLING - FLOW CONTROL AND SHUTOFF VALVE - ELECTRICAL FUNCTIONAL DESCRIPTION

AIR CONDITIONING - COOLING - FLOW CONTROL AND SHUTOFF VALVE - ELECTRICAL FUNCTIONAL DESCRIPTION

Pack Switch OFF

When the pack switch is in the OFF position, 28V DC (battery bus) energizes the close coil of a solenoid which closes the flow control and shutoff valve.

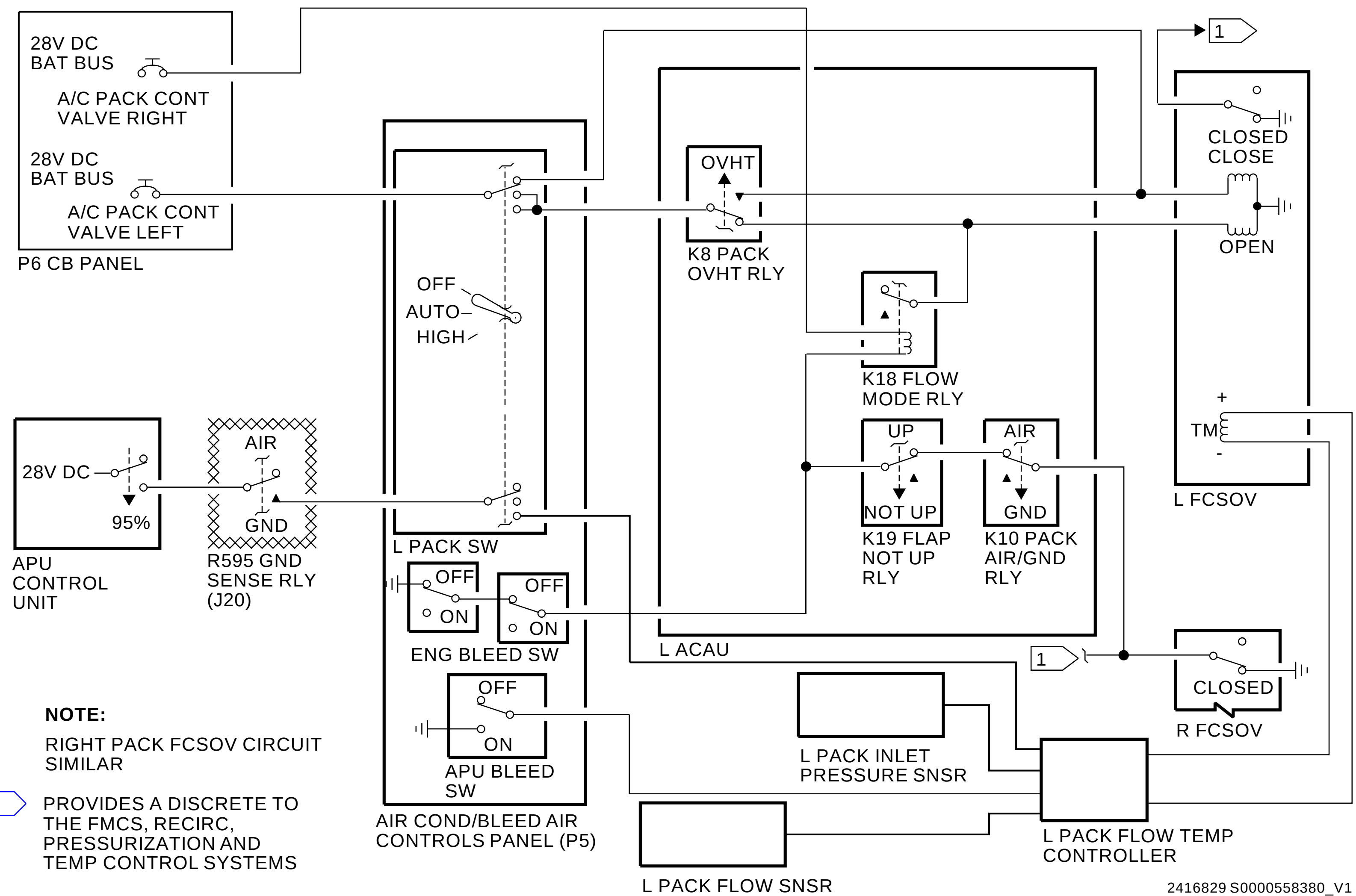
Pack Switch AUTO

When the pack switch is in the AUTO position, 28V DC energizes the open coil of the solenoid which opens the flow control and shutoff valve. The action of the flow control and shutoff opening also causes a valve open/close indication switch to open. This open/close indication switch provides a discrete signal to these systems:

- Flight management computer system
- Common display system
- Pressurization system
- Temperature control system
- Recirculation system

Pack Valve Modulation

The pack valve flow is modulated by varying the current flow to the torque motor in the valve. Signals sent from a flow sensor and the pack inlet pressure sensor to the pack flow temperature controller are used to determine the amperage sent to the torque motor.



NOTE:

RIGHT PACK FCSOV CIRCUIT SIMILAR

1 PROVIDES A DISCRETE TO THE FMCS, RECIRC, PRESSURIZATION AND TEMP CONTROL SYSTEMS

AIR CONDITIONING - COOLING - FLOW CONTROL AND SHUTOFF VALVE - ELECTRICAL FUNCTIONAL DESCRIPTION

AIR CONDITIONING - COOLING - PRIMARY HEAT EXCHANGER AND PLENUM/DIFFUSER ASSEMBLY

Purpose

The primary heat exchanger (HX) removes heat from bleed air going to the compressor section of the air cycle machine (ACM).

The primary plenum/diffuser lets ram air flow through the primary heat exchanger and out the ram air exhaust.

Location

The primary heat exchanger and plenum/diffuser are in the aft, outboard section of the air conditioning compartment.

Physical Description

The primary heat exchanger is an air-to-air, plate-fin, cross-flow type heat exchanger. Two isolated airstreams flow through thin walled channels. The channel walls are made up of plates and fins that increase surface area.

The primary plenum/diffuser has an outer duct and an inner duct. The outer duct is the plenum and the inner duct is the diffuser. The inner duct has a fan bypass check valve. The fan bypass check valve is a hinged door assembly in the lower aft section of the diffuser.

Functional Description

Air from the FCSOV flows through the primary heat exchanger. A cross flow of ram air removes heat before the air enters the ACM compressor inlet.

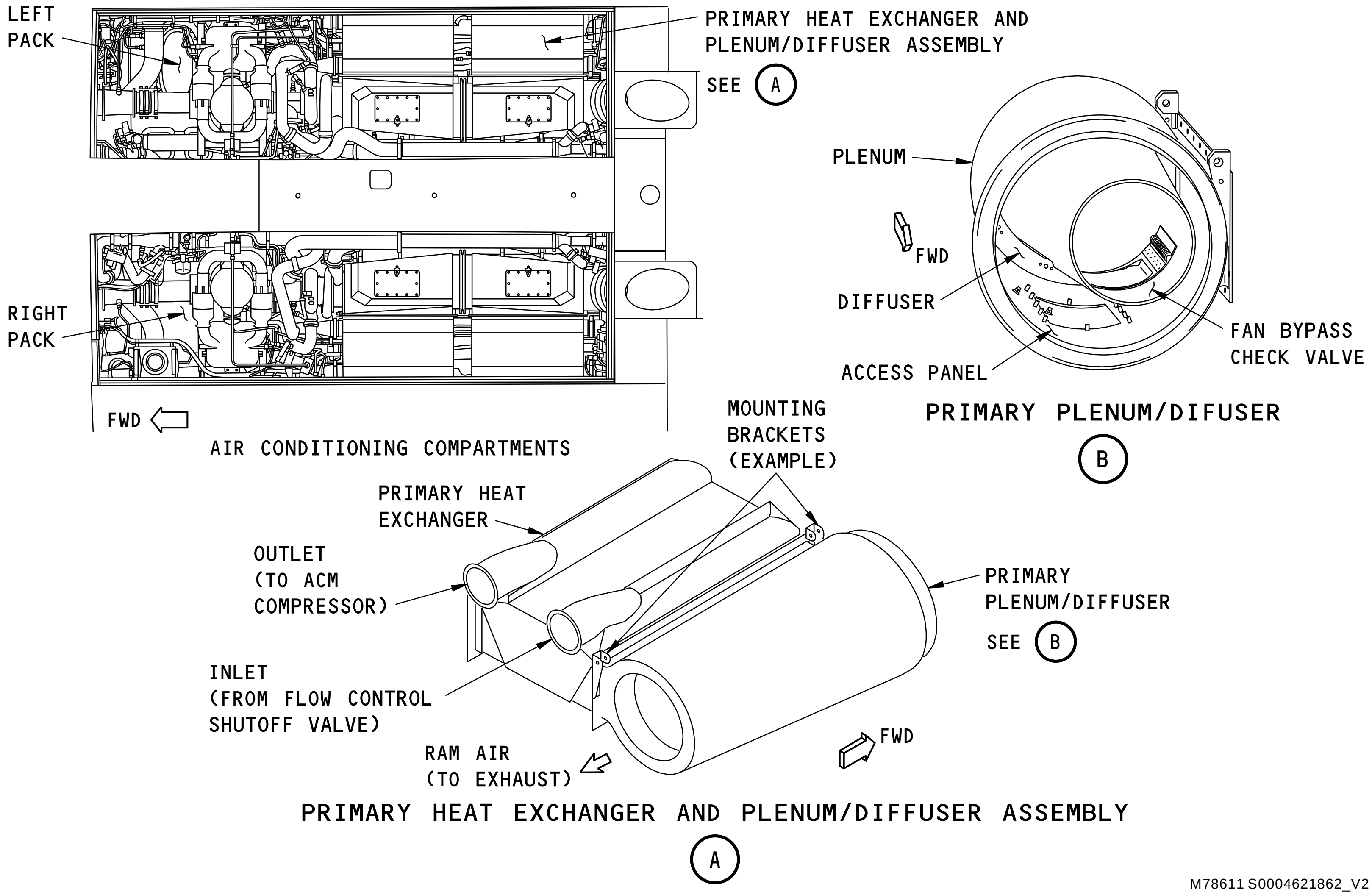
When the airplane is on the ground, the ACM impeller fan makes a low pressure zone. This pulls air through the heat exchangers and up through the plenum to the impeller fan. Then the impeller fan sends the air through the diffuser and out the ram air exhaust. The air pressure in the diffuser keeps the check valve closed.

When the airplane is in flight, ram air pressure opens the fan bypass check valve.

Training Information Point

The primary heat exchanger efficiency decreases as dirt and contamination collect on the cooling surfaces. A RAM DOOR FULL OPEN light that stays on in flight can be an indication of a dirty heat exchanger.

The primary heat exchanger plenum has an access panel for inspection and clean out.



AIR CONDITIONING - COOLING - PRIMARY HEAT EXCHANGER AND PLENUM/DIFFUSER ASSEMBLY

AIR CONDITIONING - COOLING - RAM AIR DUCTS

Purpose

The ram air inlet ducts let cooling air flow from the ram air inlet to the heat exchangers. The ram air exhaust ducts let air flow from the heat exchangers discharge overboard.

Location

The ram air inlet ducts are outboard of the air conditioning compartment. They extend forward to the ram air inlet in the wing-to-body fairing.

The ram air exhaust ducts are aft of the air conditioning compartments. You get access to the exhaust ducts from the air conditioning compartment.

Physical Description

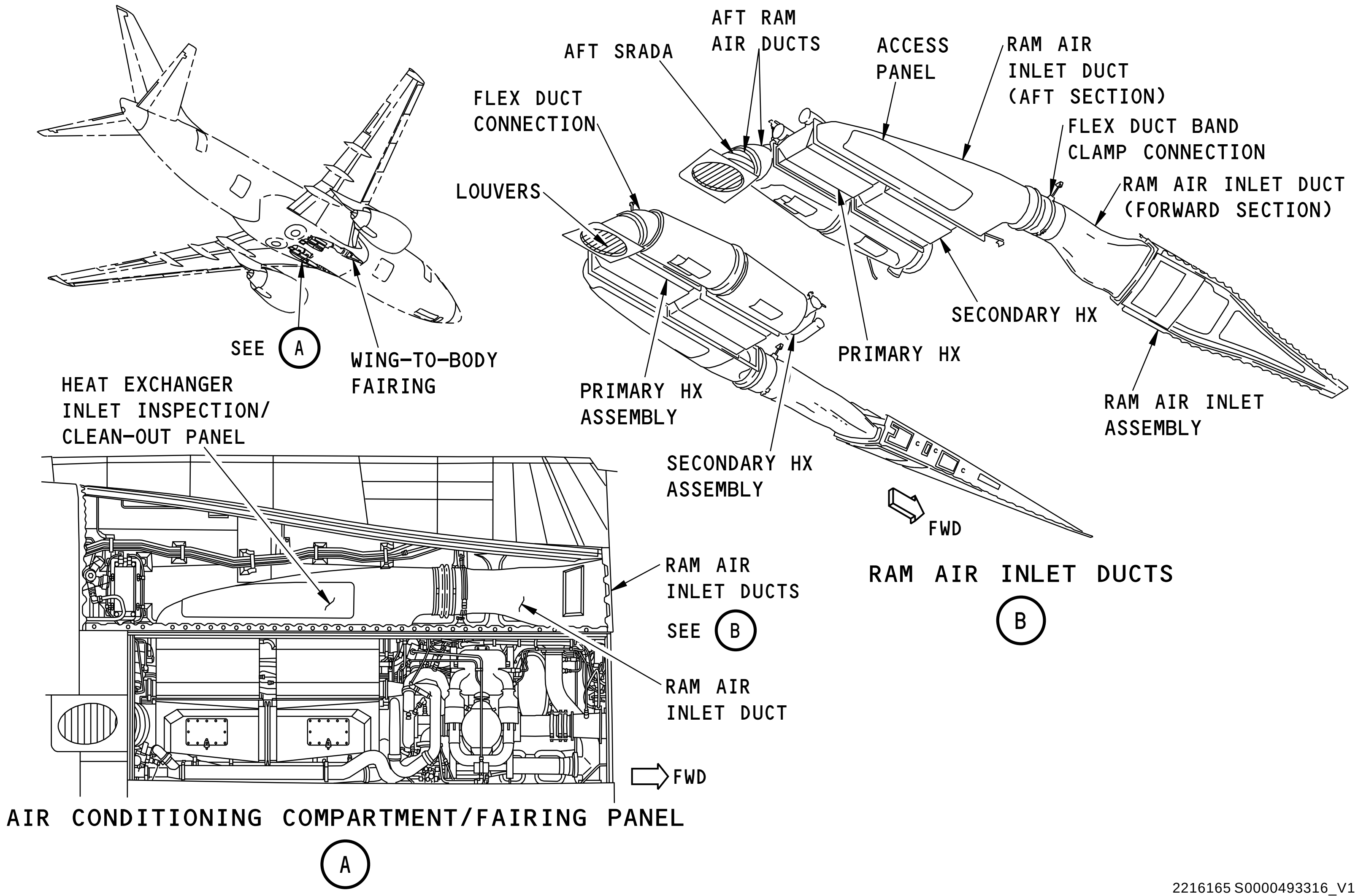
There are two ram air ducts, forward inlet and aft exhaust. The forward duct is made of fiberglass reinforced polymer, the aft duct is made of kevlar. The forward section of the inlet ducts attach to the airplane structure at the forward part of the ram air inlet. They attach to the aft section with a flex duct and band clamps. There are tie-rods that attach the ducts to the structure at the center connection of the forward and aft ducts. The aft duct has a flange connection to a web on the outboard side of the heat exchangers. An inspection door is in the aft inlet duct at the aft end. The ram air exhaust ducts attach to the aft end of the pack primary plenum/diffuser. They attach to the airplane structure at their aft end with a flex duct and band clamps. Each ram air exhaust duct incorporates a smart ram air door actuator (SRADA), associated linkage and three louvers to modulate the ram air exhaust flow in concert with the ram air inlet panels.

Training Information Point

There is a heat exchanger inlet inspection/clean-out panel in the inlet ducts. This permits access to the primary and secondary heat exchanger inlets. The access panel is in the lower area of the duct, adjacent and outboard of the heat exchangers. You get access to the ram air inlet duct through the fairing panels. They are outboard of the air conditioning doors.

A special tool lets you clean the heat exchangers when they are dirty.

You can repair the ducts if they have cracks or leaks.



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AIR CONDITIONING - COOLING - RAM AIR DUCTS

AIR CONDITIONING - COOLING - RAM AIR ACTUATOR

Purpose

The smart ram air door actuators (SRADAs) move the ram air inlet deflector door, the ram air inlet modulation panels and the ram air exit louvers.

Location

The forward SRADA is in the wing-to-body fairing forward of the air conditioning compartments. The actuator attaches to the ram air inlet support assembly. You get access to the actuator from the bottom of the fuselage, through an access panel. There is a forward ram air actuator for the left and the right ram air systems.

The aft SRADA is outboard of the ram air exhaust duct at the lower end of the duct. The actuator attaches to linkages which control the movement of three louvers that modulate ram air exit flow in response to signals from the forward SRADA. You get access to the actuator through an access panel in the bottom of the fuselage. There is an aft SRADA for the left and the right ram air systems.

Physical Description

The smart ram air door actuator (SRADA) is a 28v dc motor-operated linear actuator. It has these parts:

- 28 VDC brushless motor
- Limit switches
- Jackscrew
- Two electrical connectors
- Four indication lights

Training Information Point

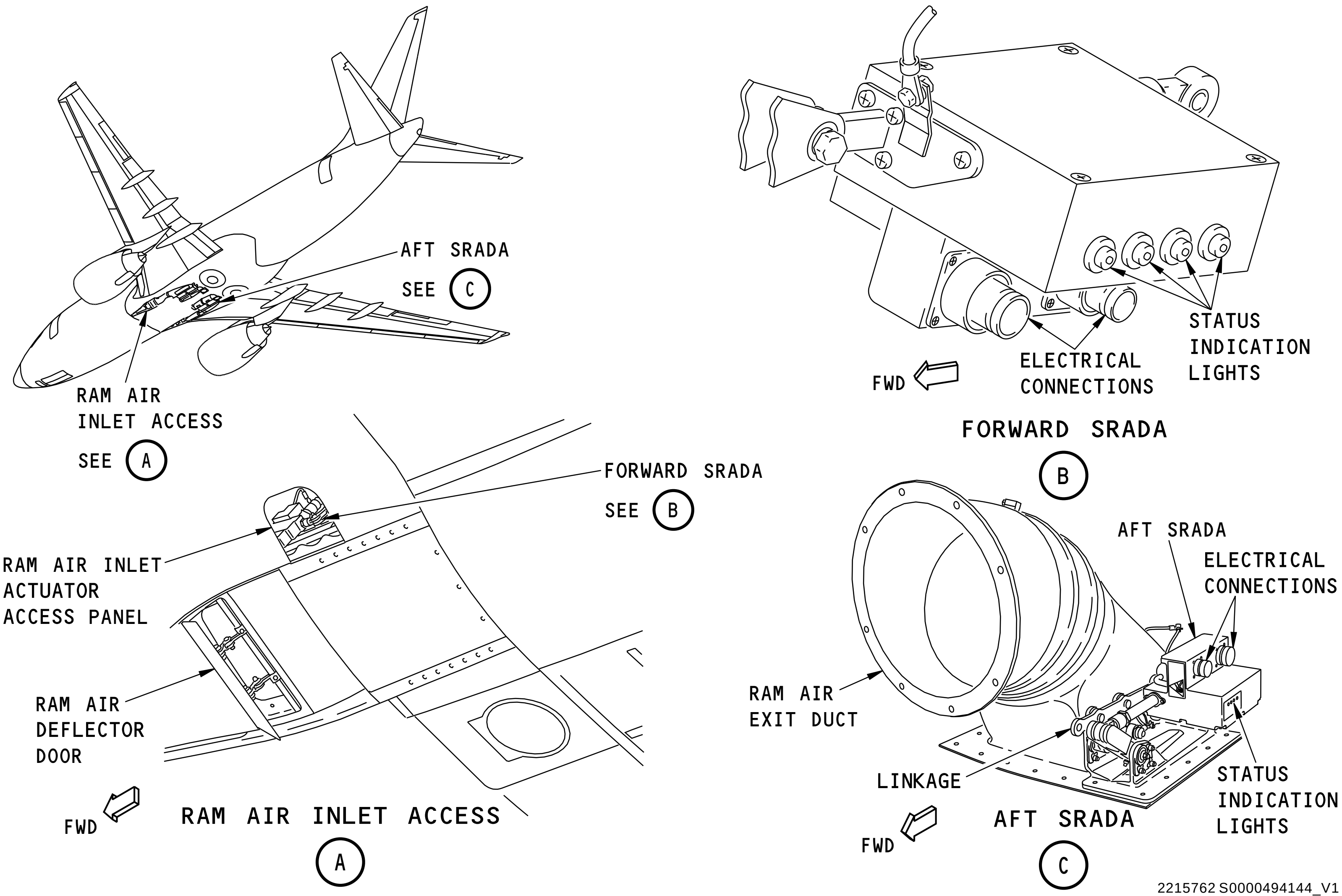
The SRADA Actuators are electrostatic discharge (ESDS) sensitive devices. Use ESDS safe handling techniques.

Interfaces

The forward SRADA receives WOW and flap position signals from the air conditioning accessory unit (ACAU) and resistance values from the ram air sensor. The aft SRADA receives signals from the forward SRADA.

Functional Description

The control signals for the actuator go through the internal limit switches. The internal limit switches sequence the order of control signals to the motor. The motor turns a linear jackscrew. The jackscrew on the forward SRADA moves the ram air inlet modulation panels and deflector door through mechanical linkages. The jackscrew on the aft SRADA moves three ram air exit louvers through mechanical linkages in response to signals from the forward SRADA.



AIR CONDITIONING - COOLING - RAM AIR ACTUATOR

AIR CONDITIONING - COOLING - RAM AIR INLET DOOR ASSEMBLY

Purpose

The ram air inlet assembly controls airflow into the ram air system for heat exchanger cooling.

Location

The ram air inlet assembly is in the wing-to-body fairing forward of the air conditioning compartments.

Physical Description

The ram air inlet assembly has these two major assemblies:

- Ram air inlet modulation panel
- Ram air inlet deflector door.

Ram Air Inlet Modulation Panel

The ram air inlet modulation panel is made of two panel sections. The two panels are hinged together. The forward panel has a hinge at the forward end that connects to the airplane structure. The aft panel has slide blocks in tracks at the aft end. On the aft panel, clevis fittings on the mid section and the upper surface connect link arms to the shaft assembly.

Ram Air Inlet Deflector Door

The ram air inlet deflector door is a flat surface that is spring-loaded closed. The shaft assembly is a torque tube with two tie-rods and a preloaded spring. The tie-rods connect to clevis fittings on the deflector door.

The ram air inlet deflector door makes sure ice, rocks, and other unwanted material do not go into the ram air inlet.

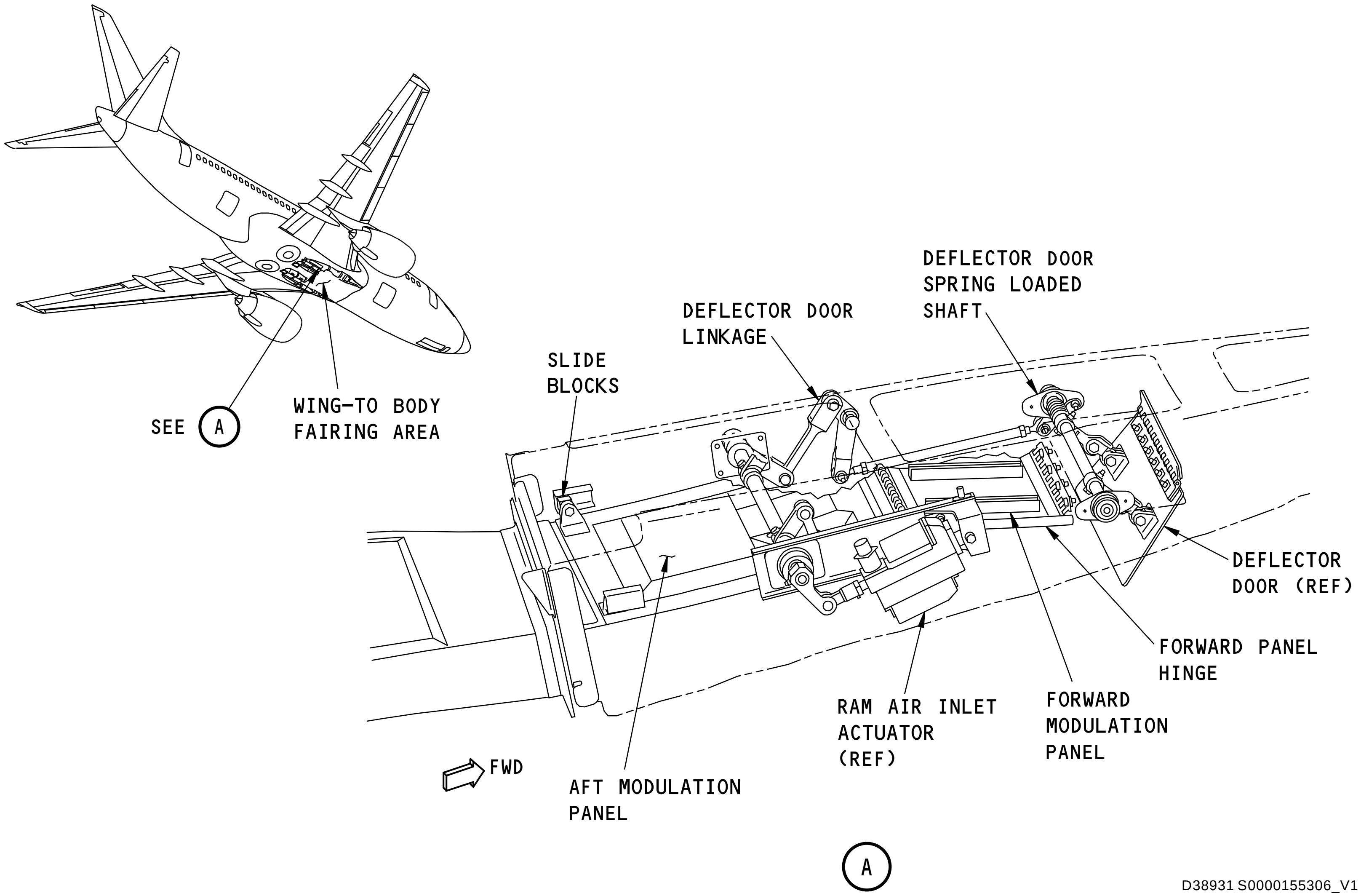
The shaft assembly moves the deflector door.

Functional Description

The ram air actuator moves the modulation panel. Linear movement of the actuator arm transmits movement through a link arm to the modulation panel shaft assembly. The shaft turns link arms that lift or lower the two panels. The aft panel has rollers that let it move forward or aft as the two panels move up or down. The modulation panel and the ram air inlet deflector door are mechanically connected.

The ram air inlet deflector door has two positions. When the airplane is on the ground, the door extends to give protection to the ram air inlet. When the airplane is in the air, the deflector door retracts.

The ram air actuator transmits motion through tie-rods and link arms to the shaft assembly. The shaft assembly transmits motion to the deflector door.



AIR CONDITIONING - COOLING - RAM AIR INLET DOOR ASSEMBLY

AIR CONDITIONING - COOLING - RAM AIR TEMPERATURE SENSOR

Purpose

The ram air sensor supplies temperature data to the forward SRADA.

Location

The ram air sensor is in the air conditioning compartment. It is in the duct that connects the compressor section of the ACM to the secondary heat exchanger.

There is a ram air sensor for each pack ram air system.

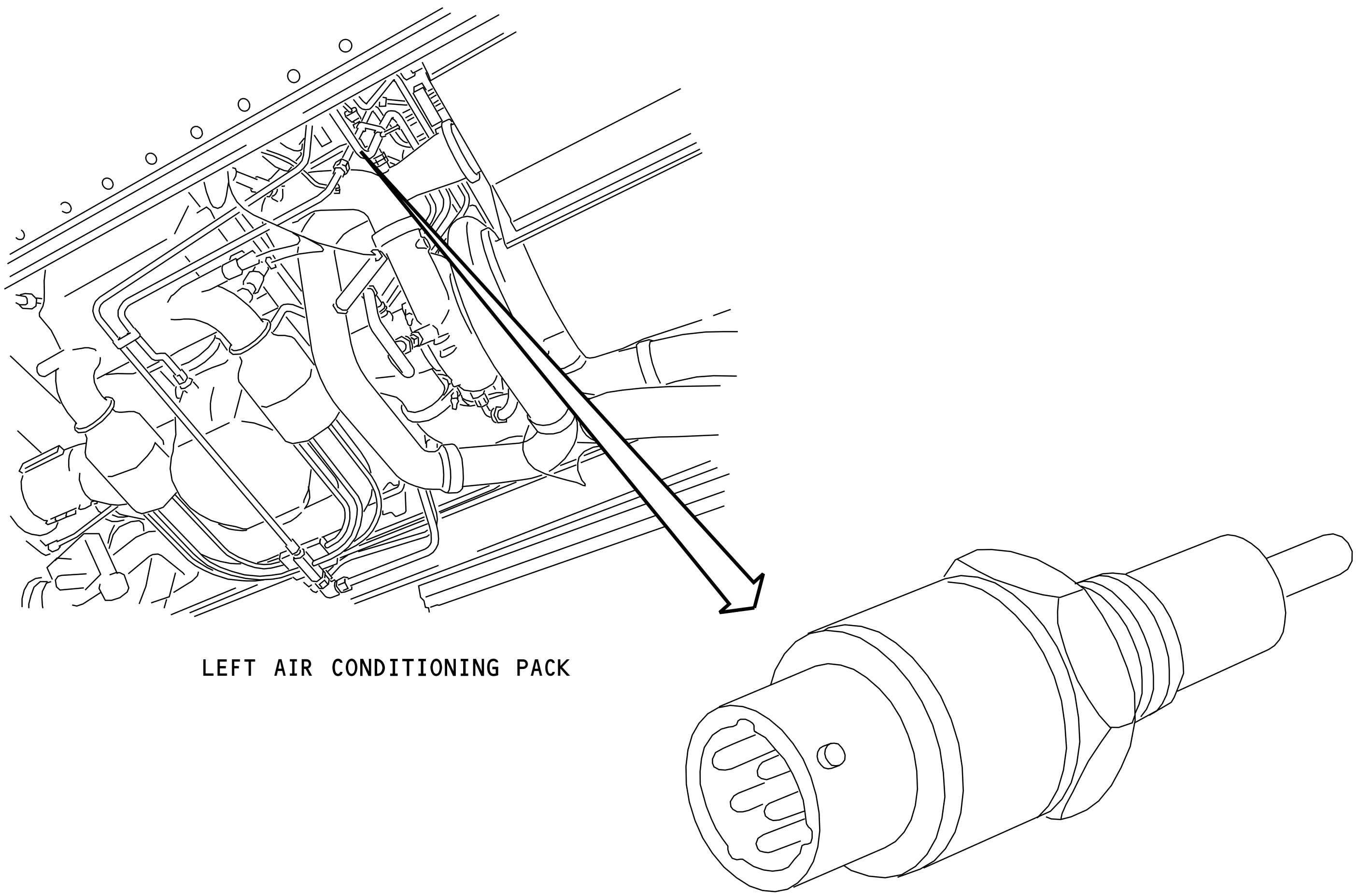
Physical Description

The ram air sensor has a stainless steel probe housing. The probe housing attaches to the electrical connector and is hermetically sealed.

Functional Description

The ram air sensor is a thermistor bead element. The resistance of the temperature sensing element changes as the air temperature changes.

The forward SRADA uses the resistance of the temperature sensor in a control bridge. When the temperature is more or less than 230F (110C), the controller changes the position of the ram air inlet modulation panels and the ram air exit louvers..



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AIR CONDITIONING - COOLING - RAM AIR TEMPERATURE SENSOR

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AIR CONDITIONING - COOLING - RAM AIR SYSTEM - FUNCTIONAL DESCRIPTION

General

The ram air system controls the air flow through the primary and secondary heat exchangers. These are the ram air control components:

- Pack/zone temperature controller
- Forward SRADA
- Aft SRADA
- Ram air control temperature sensor
- Ram air inlet deflector door
- Ram air inlet modulation panels
- Ram air ducts.
- Ram air exit louvers

The forward SRADA controls the position of the ram air deflector door and the modulation panels. The forward SRADA is the primary controller for the ram air system. The aft SRADA is commanded by the forward SRADA.

The forward SRADA gets this information for control of the ram air system:

- Airplane on ground and not on ground
- Flaps up and flaps not up
- ACM compressor discharge temperature from the ram air sensor
- BITE initializing from the pack/zone temperature controller (PZTC)

The forward SRADA sends this data to the PZTC:

- No LRU fault
- Forward SRADA fault
- Aft SRADA fault
- Ram air sensor fault

The forward SRADA sends this data to the aft SRADA:

- On ground or not on ground
- Flaps up or not up
- ACM compressor discharge temperature from the ram air sensor

These are the three modes of control for the ram air system:

- Ground
- Flight (flaps not up)
- Flight (flaps up).

The air conditioning accessory unit (ACAU) relays control power to the pack/zone temperature controller and the ram air inlet actuator.

There are separate control circuits for the left and right ram air systems.

Ground Mode

When the airplane is on the ground, the PSEU system cards supply a discrete (ground) to the forward SRADA.

The forward SRADA moves the ram air inlet modulation panels to the full open position and extends the deflector door to the unfaired position. The aft SRADA moves the ram air exhaust louvers to their full open position.

The forward SRADA provides a ground for the applicable RAM DOOR FULL OPEN light on the P5-10 air conditioning panel which then comes on.

Flight (Flaps Not Up)

At takeoff, the ram air inlet deflector doors move to the faired position. The ram air exit louvers do not move. The RAM DOOR FULL OPEN light remains on.

Flight Cruise (Flaps Up)

In flight with the flaps in the full up position, the ground discrete is removed at the S1051 trailing edge flaps up switch (M1746 flap/slat electronic unit). The forward SRADA modulates the ram air inlet panels to a more closed position. The RAM DOOR FULL OPEN light is now off.

BITE

Each SRADA has continuous fault monitoring. There are four indication lights on each SRADA. One green light indicates there are no LRU faults. There are three red fault lights, one for a forward SRADA fault, one for an aft SRADA fault and one for a ram air sensor fault.

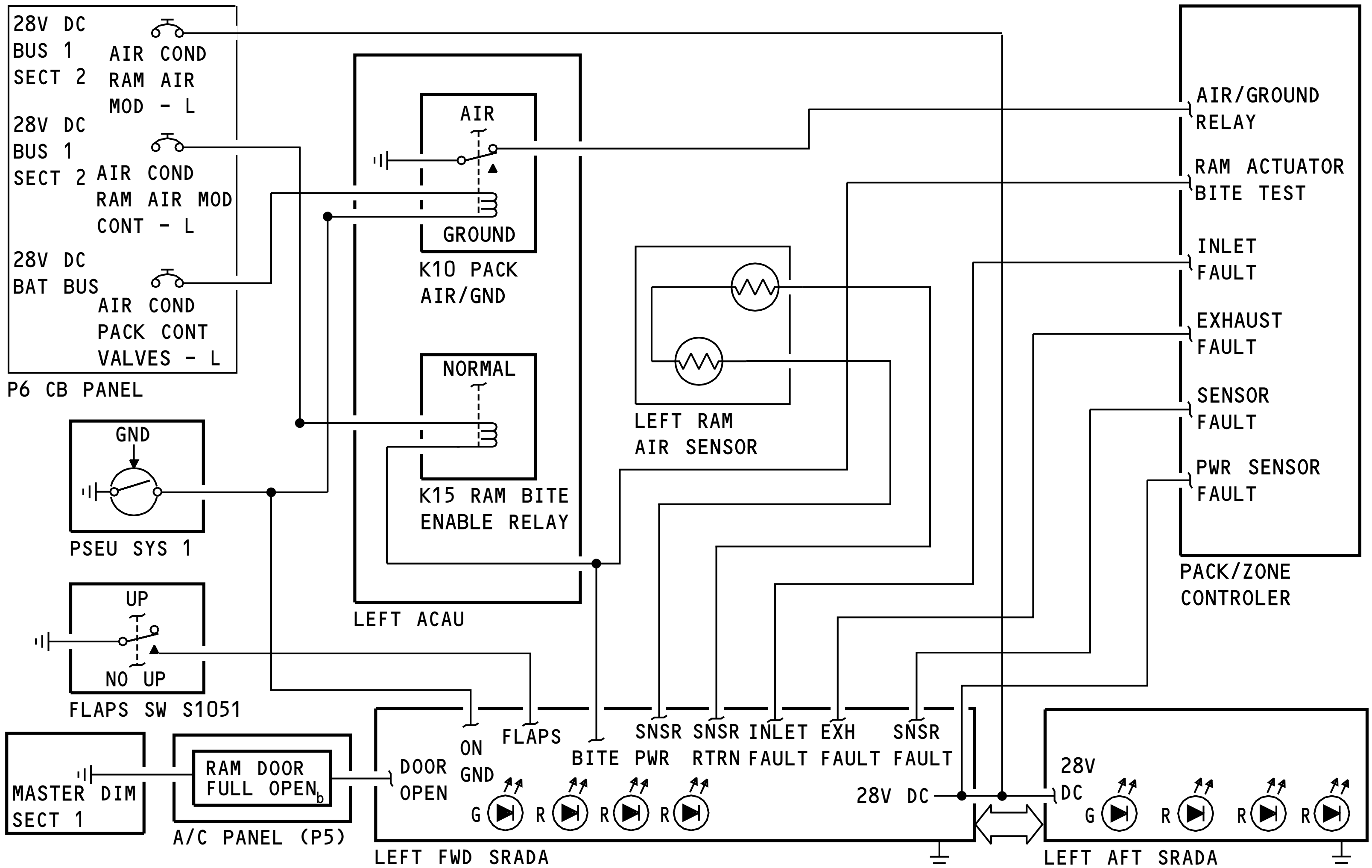
The smart ram air control system built-in test equipment (B.I.T.E.) will communicate control/component faults to the associated PZTC where they will be displayed on the PZTC front panel during a BIT on the controller.

Training Information Point

If the DOOR FULL OPEN LIGHT is on during flight cruise mode, it may be one of these three possible problems:

- Ram air system may have a blockage
- Heat exchangers are dirty
- Electrical failure.

NOTE: The left side uses the flap switch and the right side uses the flap/slat electronics unit.



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AIR CONDITIONING - COOLING - RAM AIR SYSTEM - FUNCTIONAL DESCRIPTION

AIR CONDITIONING - COOLING - AIR CYCLE MACHINE

Purpose

The air cycle machine (ACM) decreases air temperature, by expansion through a turbine.

Location

The air cycle machine is in the air conditioning compartment. There is an ACM for each of the left and right pack systems.

Physical Description

The air cycle machine is a high-speed rotating assembly. It has these three sections connected by a common shaft:

- Turbine
- Compressor
- Impeller Fan.

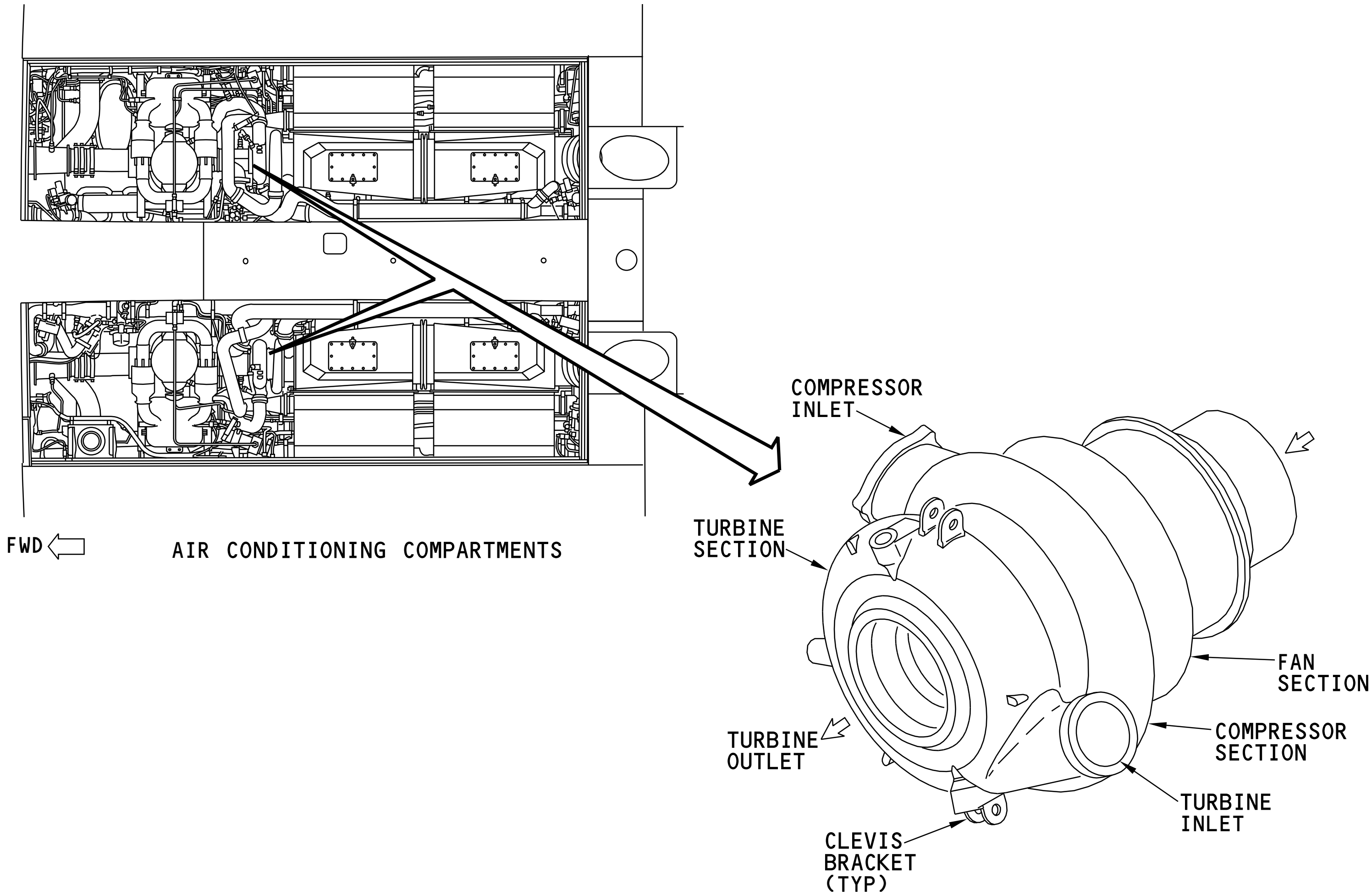
Foil air bearings support the shaft. The air bearings permit the ACM to rotate at high speed with little friction.

Training Information Point

You can cause damage to the air bearings if the shaft turns in the wrong direction.

It is not necessary to do servicing of air cycle machines that have air bearings.

The ACM is part of the secondary pack assembly. It has two clevis brackets for attachment to the structure in the air conditioning compartment.



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AIR CONDITIONING - COOLING - AIR CYCLE MACHINE

AIR CONDITIONING - COOLING - SECONDARY HEAT EXCHANGER AND PLENUM/DIFFUSER ASSEMBLY

Purpose

The secondary heat exchanger (HX) removes heat from bleed air that comes from the compressor section of the air cycle machine (ACM).

The secondary plenum/diffuser permits ram air to flow through the secondary heat exchanger and out the ram air exhaust.

Location

The secondary heat exchanger and plenum/diffuser assembly is forward of the primary heat exchanger and plenum/diffuser assembly.

Physical Description

The secondary heat exchanger is an air-to-air, plate-fin, cross-flow type heat exchanger. Two isolated airstreams flow through thin walled channels. The channel walls are made up of plates and fins that increase surface area.

The secondary plenum/diffuser has an outer duct and an inner duct. The outer duct is the plenum and the inner duct is the diffuser.

Functional Description

Air from the ACM compressor outlet flows through the secondary heat exchanger. A cross flow of ram air removes heat before the air enters the ACM turbine inlet.

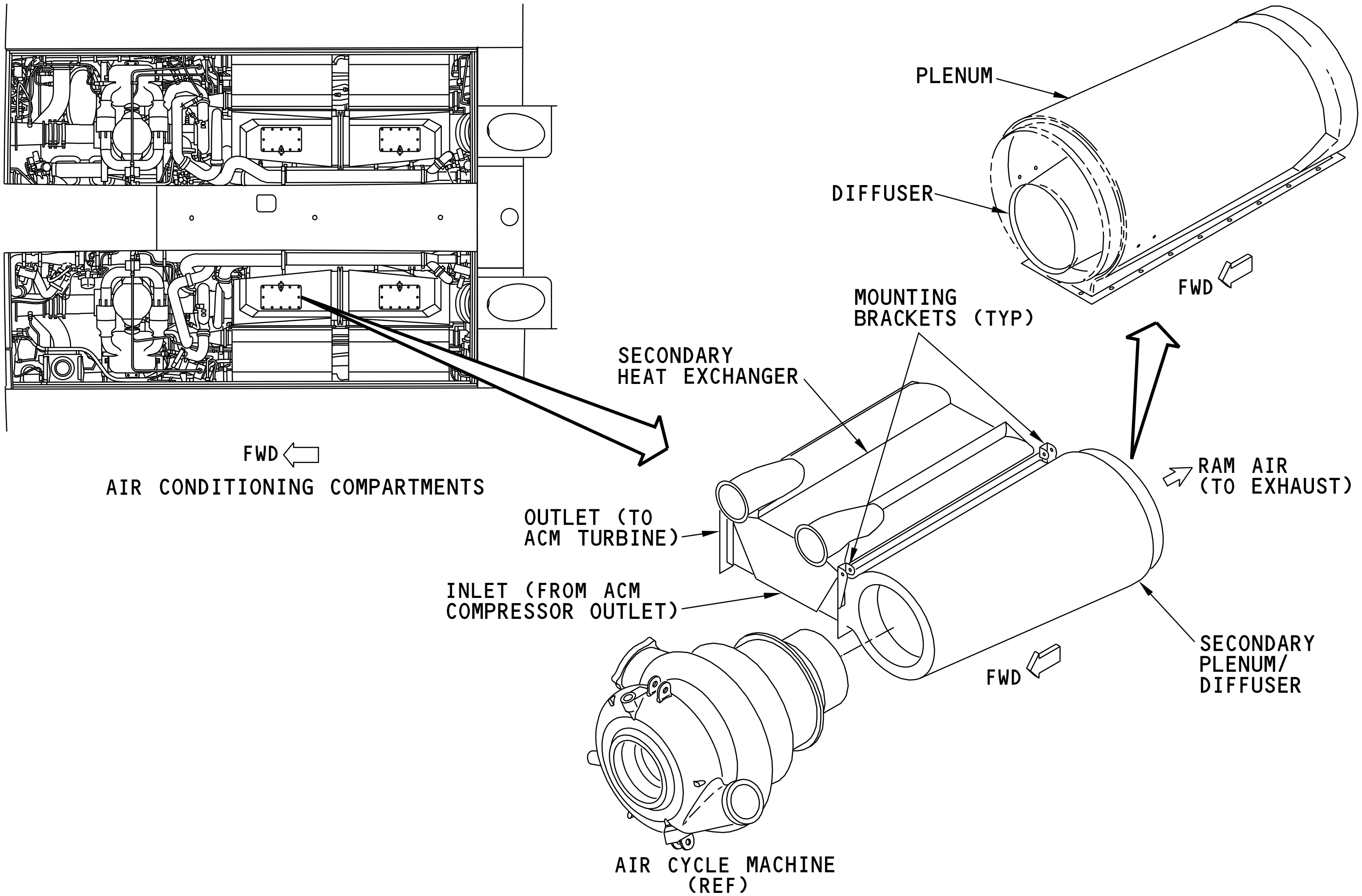
When the airplane is on the ground, the ACM impeller fan makes a low pressure zone. This pulls air through the heat exchangers and up through the plenum to the impeller fan. Then the impeller fan sends the air through the diffuser and out the ram air exhaust.

When the airplane is in flight, the ram air pressure flows down the plenum and out the fan bypass check valve.

Training Information Point

The secondary heat exchanger efficiency decreases as dirt and contamination collect on the cooling surfaces.

The secondary heat exchanger plenum has a access panel for inspection and clean out.



AIR CONDITIONING - COOLING - SECONDARY HEAT EXCHANGER AND PLENUM/DIFFUSER ASSEMBLY

AIR CONDITIONING - COOLING - WATER EXTRACTOR DUCT

Purpose

The water extractor duct removes water from the air conditioning pack ducts.

Location

There are two water extractor ducts, one in each air conditioning pack. The water extractor ducts are in the air conditioning ducts downstream of the secondary heat exchangers.

Physical Description

The water extractor ducts have these parts:

- Inlet
- Outlet
- Sump
- Drain boss.

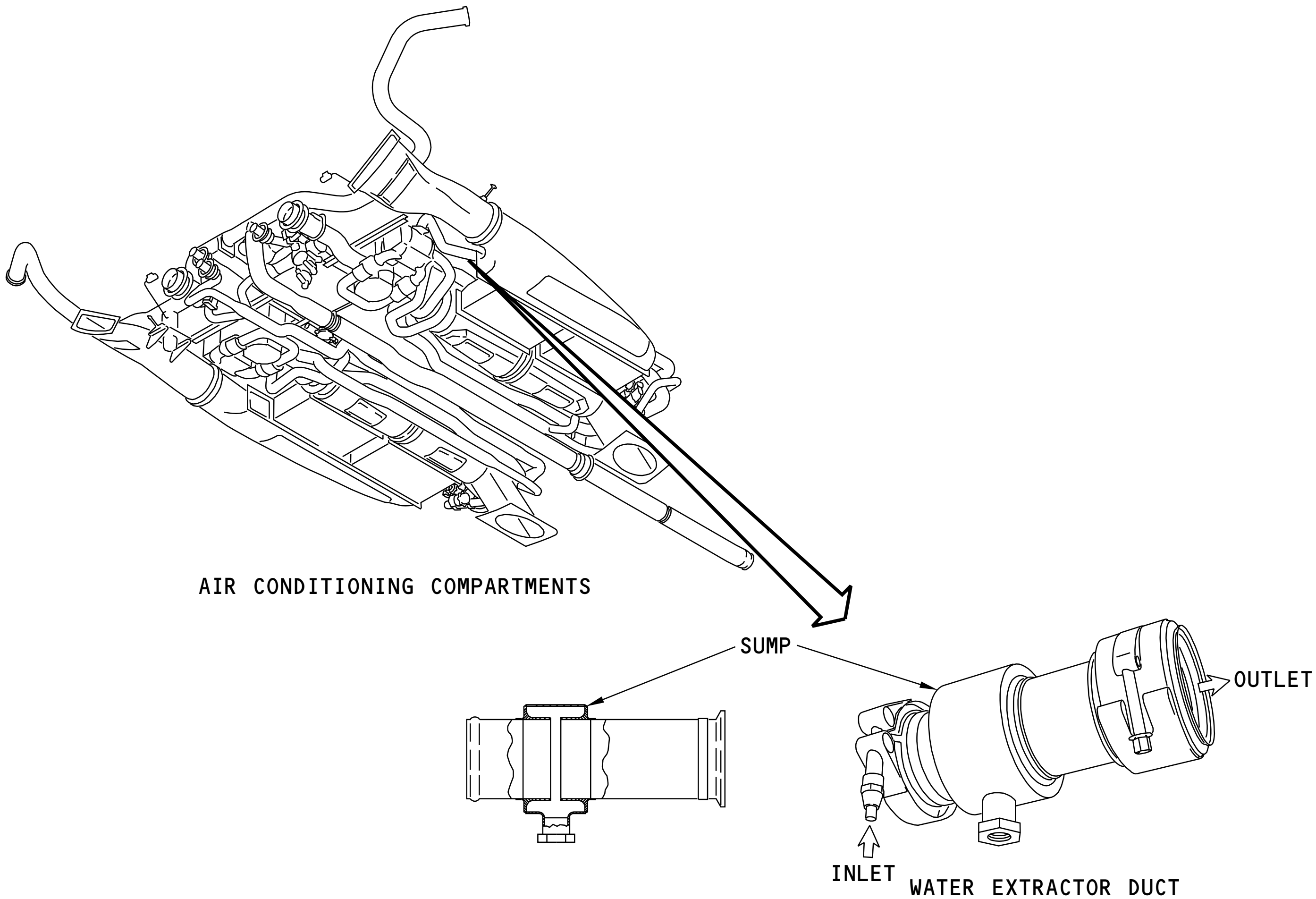
These devices support the extractor ducts:

- Flange clamp (inlet)
- Rubber hose and band clamps (outlet).

Functional Description

The water extractors are coaxial split-can type gravity fluid separators.

Water in the airstream falls into the sump of the water extractor duct. The sump collects the water and pressure in the extractor forces the water out of the sump into the drain boss. A line connects the drain boss to the water spray nozzle.



M78620 S0004621897_V1

AIR CONDITIONING - COOLING - WATER EXTRACTOR DUCT

AIR CONDITIONING - COOLING - REHEATER

Purpose

The reheater increases the temperature of the air in the air conditioning pack before it enters the turbine of the air cycle machine. This increases the efficiency of the turbine.

Location

There are two reheaters, one for each air conditioning pack. The reheaters are part of high pressure water separator assemblies. These assemblies are in the forward area of the air conditioning pack compartments.

Physical Description - Reheaters

The reheaters have these features:

- Inlet (hot stream from secondary heat exchanger)
- Outlet (cooled) to condenser
- Reheater core case
- Inlets (cold stream from water extractors)
- Outlet (warmed) to air cycle machine turbine
- Pack sensor bosses.

These pack bulbs are on the reheater:

- Pack temperature sensor
- Pack temperature bulb.

Functional Description

The reheater is a plate-fin, single-pass, crossflow, air-to-air heat exchanger. It is made of aluminum.

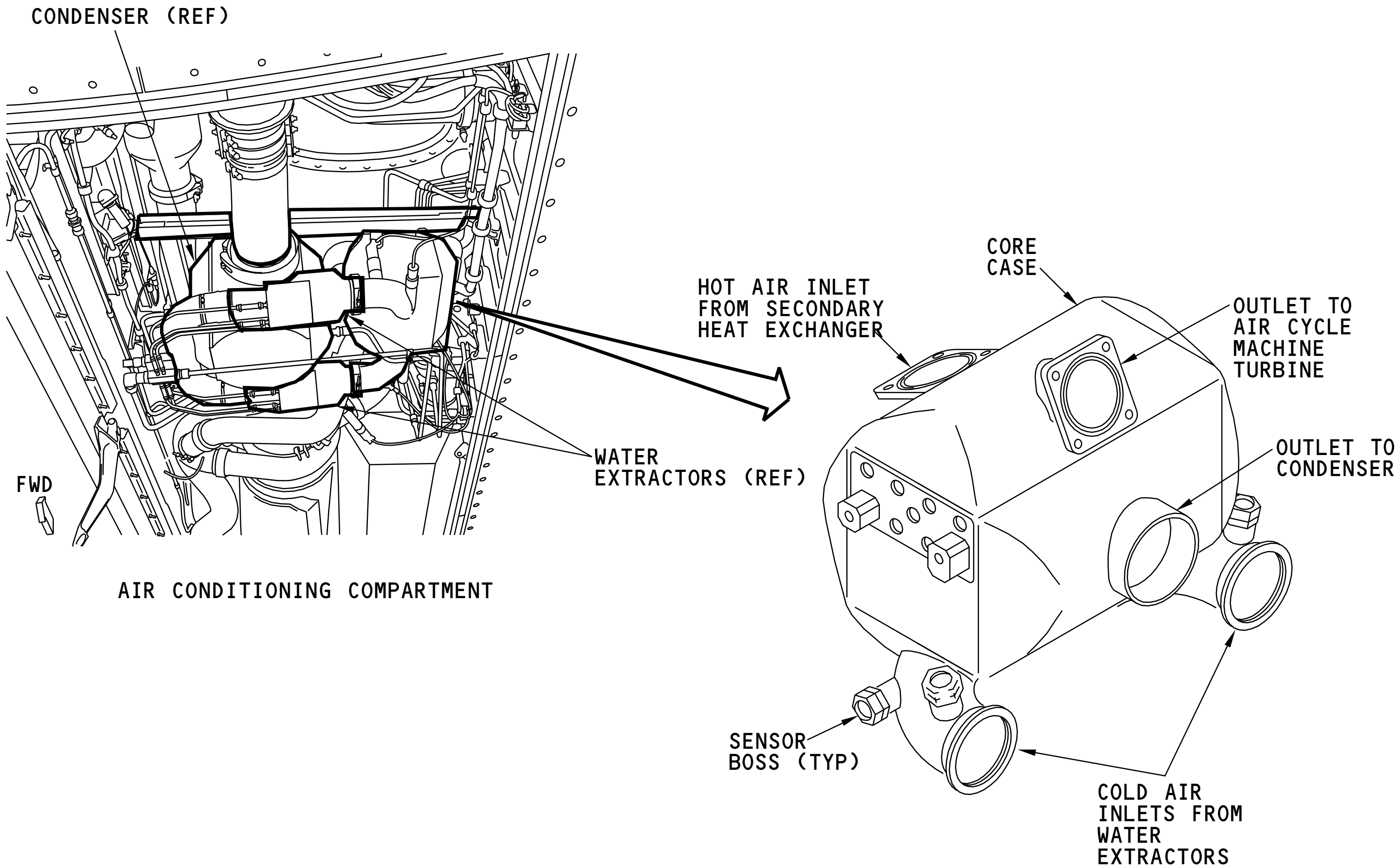
The reheater is a regenerative-type heat exchanger. It has these functions:

- Precools the pack air from the secondary heat exchanger before it enters the condenser
- Reheats the pack air as it leaves the water extractors.

Training Information Point

The reheater is part of the high pressure water separator assembly. To remove the reheater, first remove the water separator assembly.

You must remove the left air conditioning pack high pressure water separator to get access to the center fuel tank access panel.



AIR CONDITIONING - COOLING - REHEATER

AIR CONDITIONING - COOLING - CONDENSER

Purpose

The condenser decreases the temperature of the air in the air conditioning pack to below the dew point. This causes the water vapor in the airstream to go into a liquid form.

Location

There are two condensers, one in each air conditioning pack. The condensers are part of the high pressure water separator assemblies. These assemblies are in the forward area of the air conditioning pack compartments.

Physical Description

The condenser has these parts:

- Inlet (hot stream from reheater)
- Outlet (warmed) to pack discharge check valve
- Outlet manifold (cooled) to water extractors
- Condenser core case
- Inlet (cold stream from turbine discharge)
- Delta pressure sense line bosses.

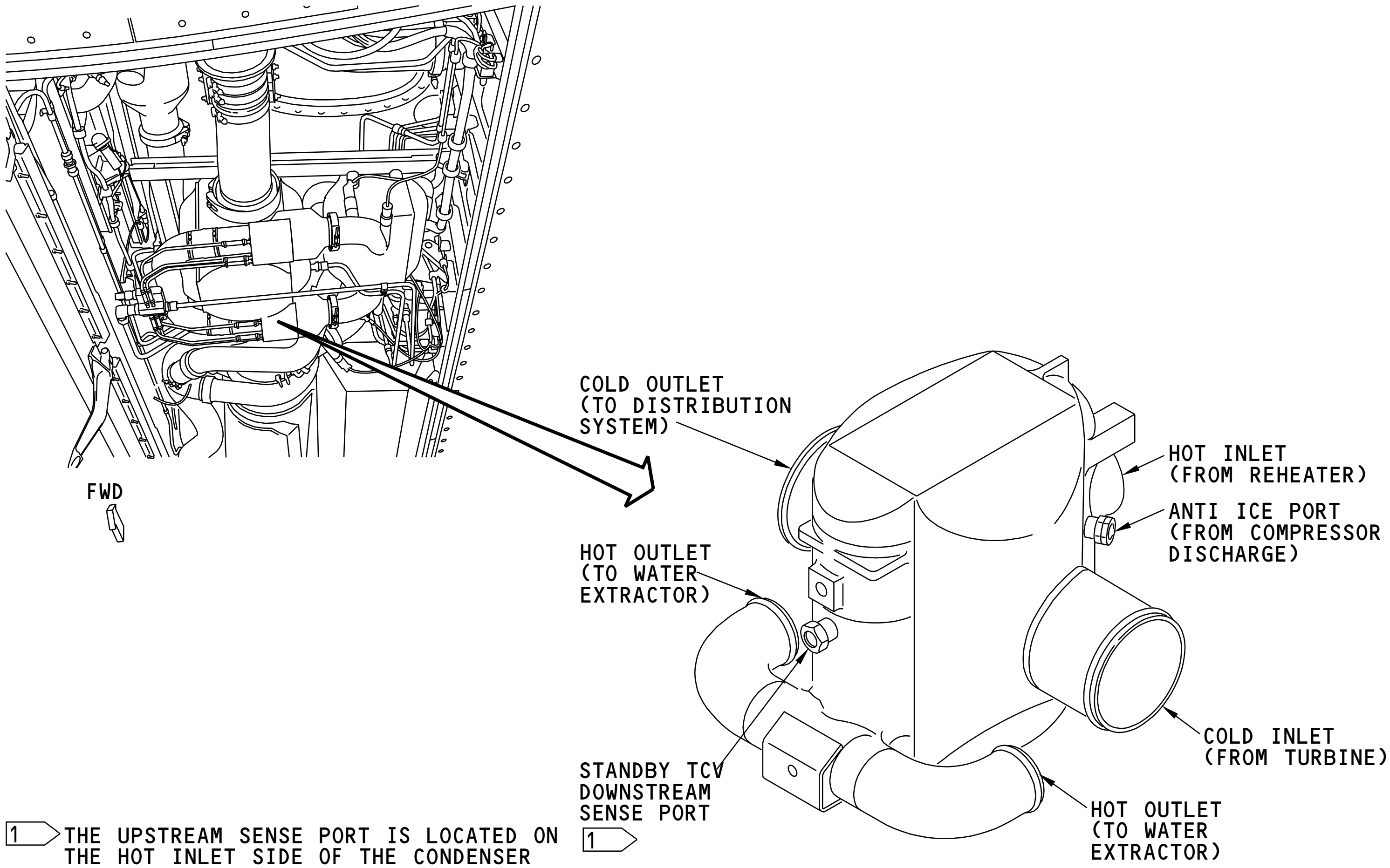
Functional Description

The condenser is a plate-fin, single-pass, crossflow, air-to-air heat exchanger. It is made of aluminum.

The condenser uses turbine discharge air to cool the pack air after it makes the first pass through the reheater.

The air cools enough to condense moisture. Part of the cold air bypasses around the condenser core and warm air comes through de-icing passages in the face of the core to prevent ice on the cold air face of the core. A free passage between the two condenser cores is an fail-safe if there is ice.

Delta pressure sense line bosses connect the sense lines to the pneumatic servo-actuator of the standby temperature control valve. Ice in the condenser creates a differential pressure that is enough to open the standby temperature control valve. Warm air from the standby temperature control valve, ported into the high pressure water separator mix muff, warms the condenser and melts the ice.



M78625 S0004621903_V1

AIR CONDITIONING - COOLING - CONDENSER

AIR CONDITIONING - COOLING - WATER EXTRACTOR

Purpose

The water extractors remove water from the air conditioning pack air.

Location

There are four water extractors, two in each air conditioning pack. The water extractors are part of high pressure water separator assemblies. These assemblies are in the forward area of the air conditioning pack compartments.

Physical Description

The water extractors have these parts:

- Inlet
- Outlet
- Swirl chamber
- Sump
- Water drain nipples.

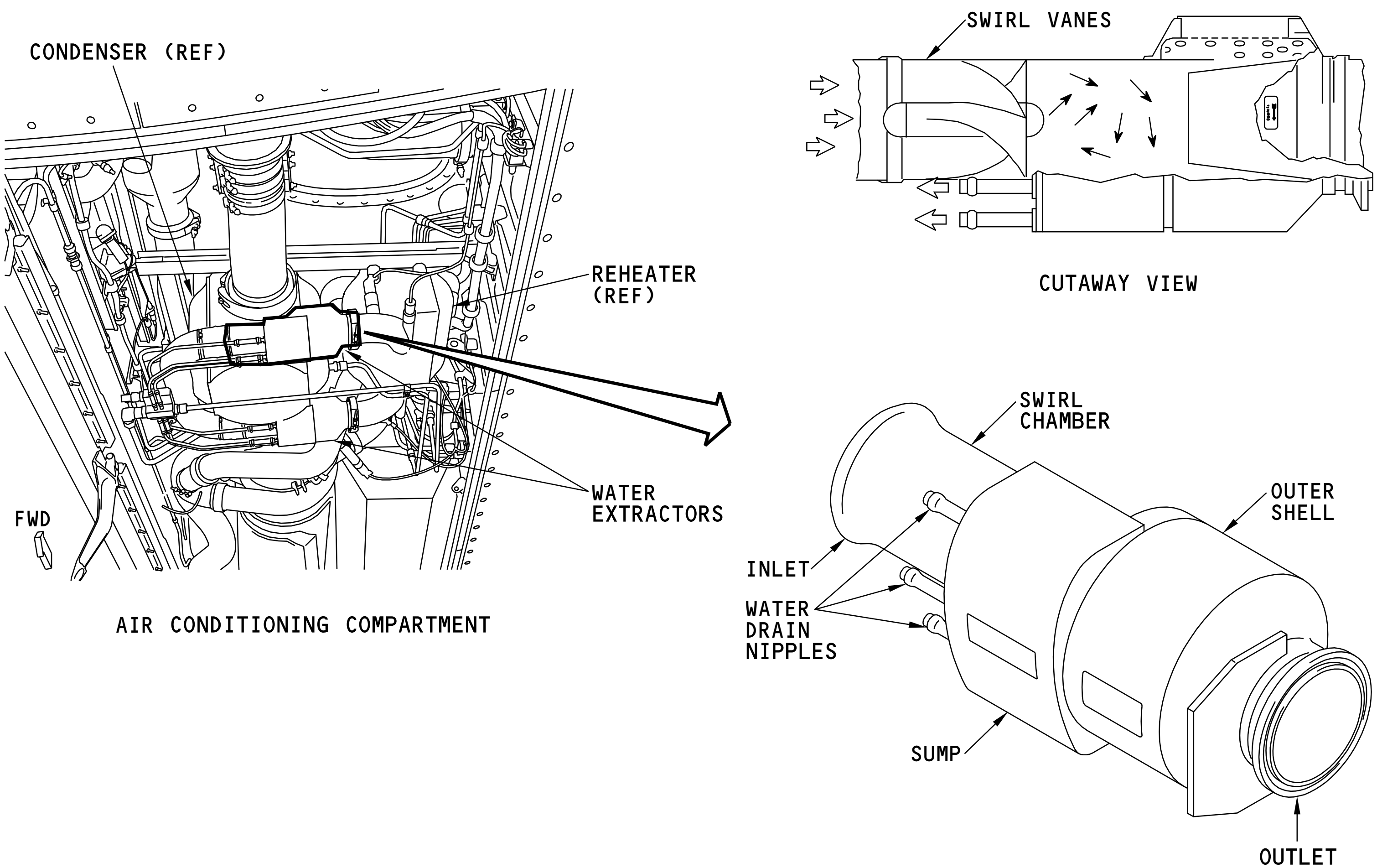
A rubber hose and band clamps connect the water extractor inlet to the condenser. A flange clamp connects the water extractor outlet to the reheater. Hoses and band clamps connect the water drain nipples to the water spray nozzle lines.

Functional Description

The water extractors are inertial-type centrifugal flow fluid separators.

The inlet of the water extractor has a swirl chamber to create a vortex airflow. The water part of the airstream goes into the outer shell of the extractor by centrifugal force. A sump collects the water and pressure in the extractor forces the water out of the sump into the drain nipples. Lines connect the drain nipples to the water spray nozzle.

The water spray nozzle injects the water into the ram air duct. This cools the ram air stream by evaporation.



M78626 S0004621906_V1

AIR CONDITIONING - COOLING - WATER EXTRACTOR

AIR CONDITIONING - COOLING - WATER COLLECTION MANIFOLD

Purpose

The water collection manifold collects the water separated from the air conditioning pack water extractor duct and the two water extractors for distribution into the ram air airstream.

Location

There are two water collection manifolds, one in each air conditioning pack. Each water collection manifold is attached to the inboard, lower side of the associated condenser.

Physical Description

The water collection manifold has these features:

- Six input ports for water from the two water extractors
- One input port for water from the water extractor duct
- One overflow port
- One water output port
- One air output port
- Sump

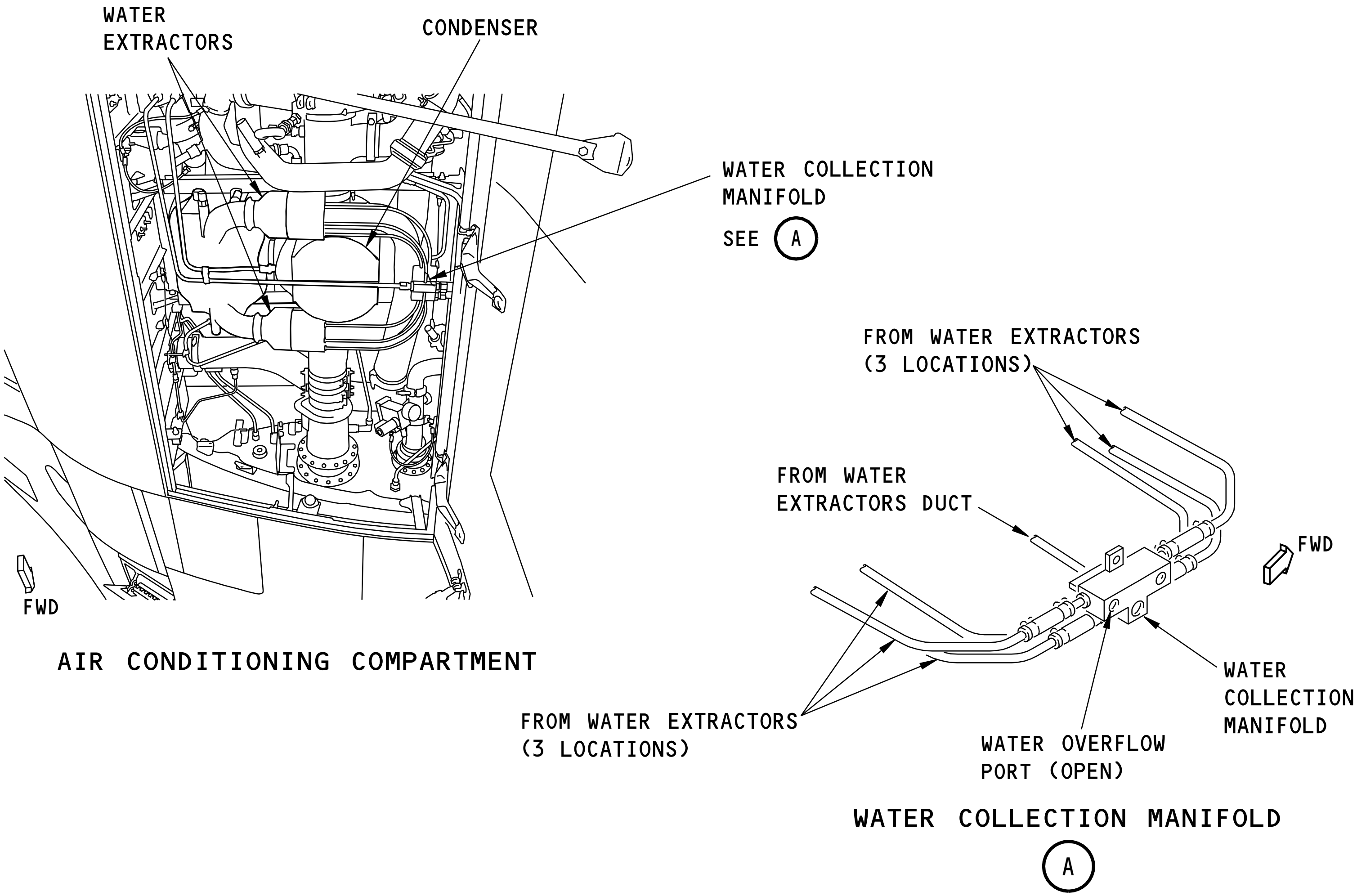
Functional Description

The water collection manifold is the point of collection for all separated water that is subsequently routed to the water spray nozzle and into the ram air cooling airstream.

There is a water overflow port in the water collection manifold. This port will discharge water into the pack bay in the event that the water spray nozzle becomes plugged. This is to prevent water from entering the turbine section of the ACM and freezing which can possibly damage the ACM and condenser.

Training Information Point

One of the three outlet ports in the manifold is a water overflow port that will discharge water into the pack bay in case the water spray nozzle becomes plugged. The water collection manifold comes with a plastic plug in this port that must be removed at the time of installation.



N93190 S0000110583_V1

AIR CONDITIONING - COOLING - WATER COLLECTION MANIFOLD

AIR CONDITIONING - COOLING - WATER SPRAY NOZZLE

Purpose

The water spray nozzle takes water from the air conditioning pack water extractor devices and injects it into the ram air inlet duct.

Location

There are two water spray nozzles, one for each air conditioning pack. They are on the outboard bulkhead of the air conditioning compartments.

Physical Description

The water spray nozzles have these parts:

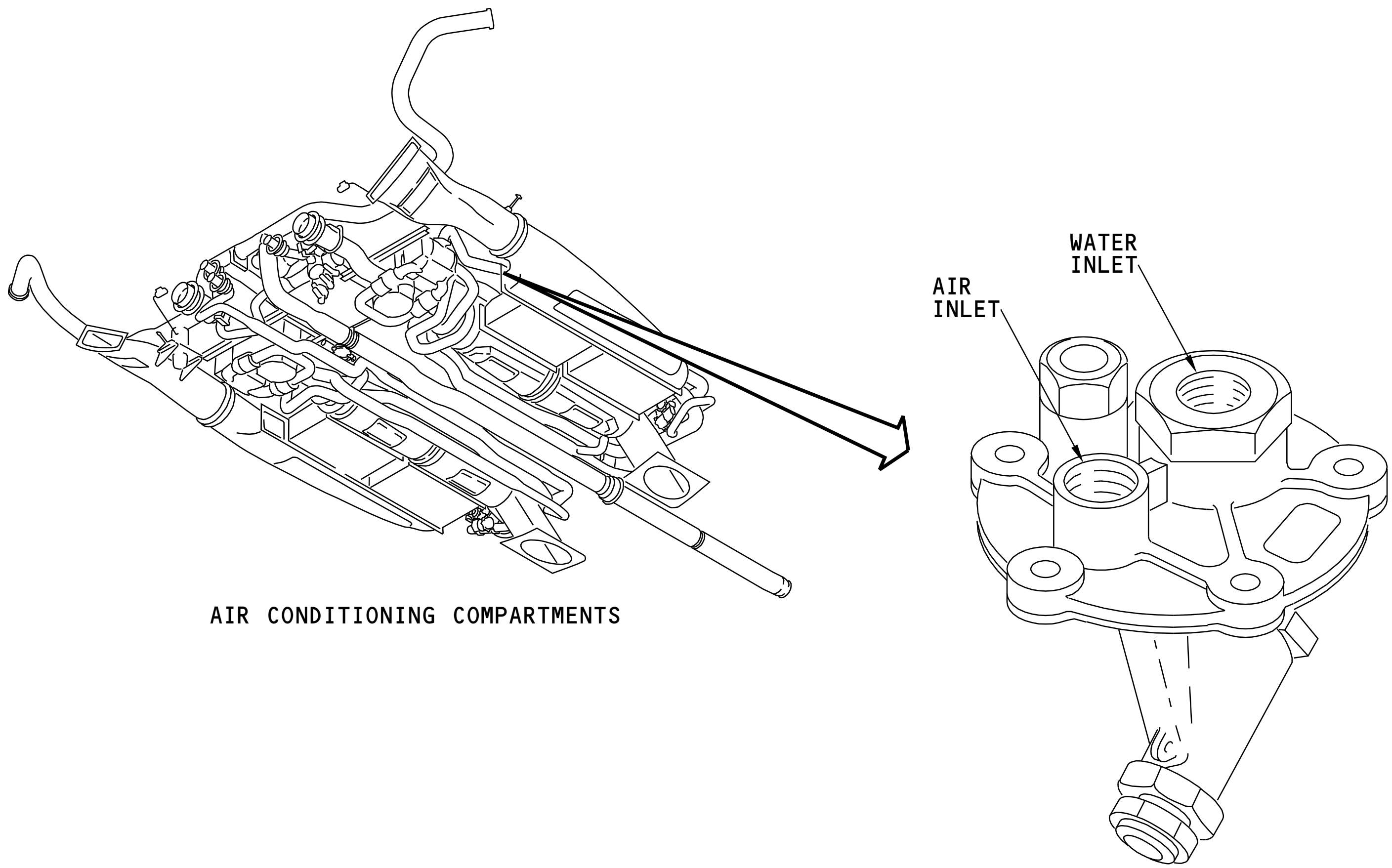
- Water line inlets
- Spray nozzle.

Functional Description

Water extractor devices remove water in the air conditioning pack airstream. Lines carry the water from the extractors to the water spray nozzles. The water spray nozzle injects the water into the ram air duct. This cools the ram air stream by evaporation.

Training Information Point

If there is a clogged nozzle, a drain on the HPWS dumps the water into the air conditioning bay so it will not go into the air cycle machine turbine.



AIR CONDITIONING - COOLING - WATER SPRAY NOZZLE

AIR CONDITIONING - COOLING - HIGH PRESSURE WATER SEPARATOR MIX MUFF

Purpose

The high pressure water separator mix muff mixes the warm air from the pack temperature control valves with the cold discharge air from the air cycle machine turbine.

Location

There are two high pressure water separator mix muffs. They are in the air conditioning pack compartments between the air cycle machines and the condensers.

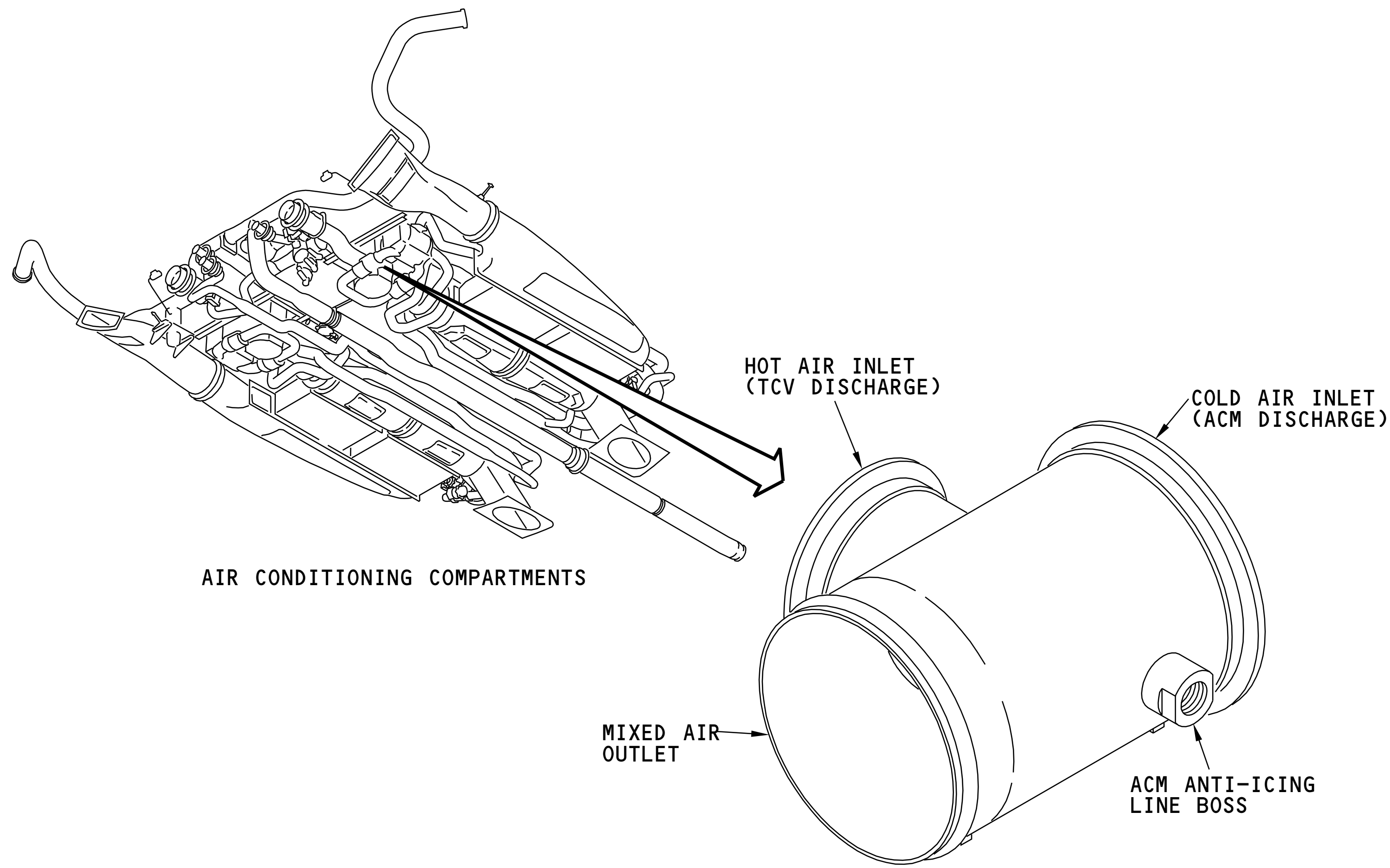
Physical Description

The high pressure water separator mix muffs have these parts:

- Temperature control valve inlets
- Turbine discharge inlet
- Outlet
- Air cycle machine de-icing line boss.

Functional Description

The high pressure water separator mix muffs are duct manifolds. They have interior baffles to mix the hot and cold input airstreams.



M78630 S0004621912_V1

AIR CONDITIONING - COOLING - HIGH PRESSURE WATER SEPARATOR MIX MUFF

AIR CONDITIONING - COOLING - CONDITIONED AIR CHECK VALVE

Purpose

The conditioned air check valve lets one-way air flow from the pack to the main distribution manifold.

The packs supply pressurized air through the check valve to the distribution system. The check valve prevents airflow from the pressurized distribution system to the unpressurized air conditioning compartment.

Location

The conditioned air check valve is in the forward section of the air conditioning bay.

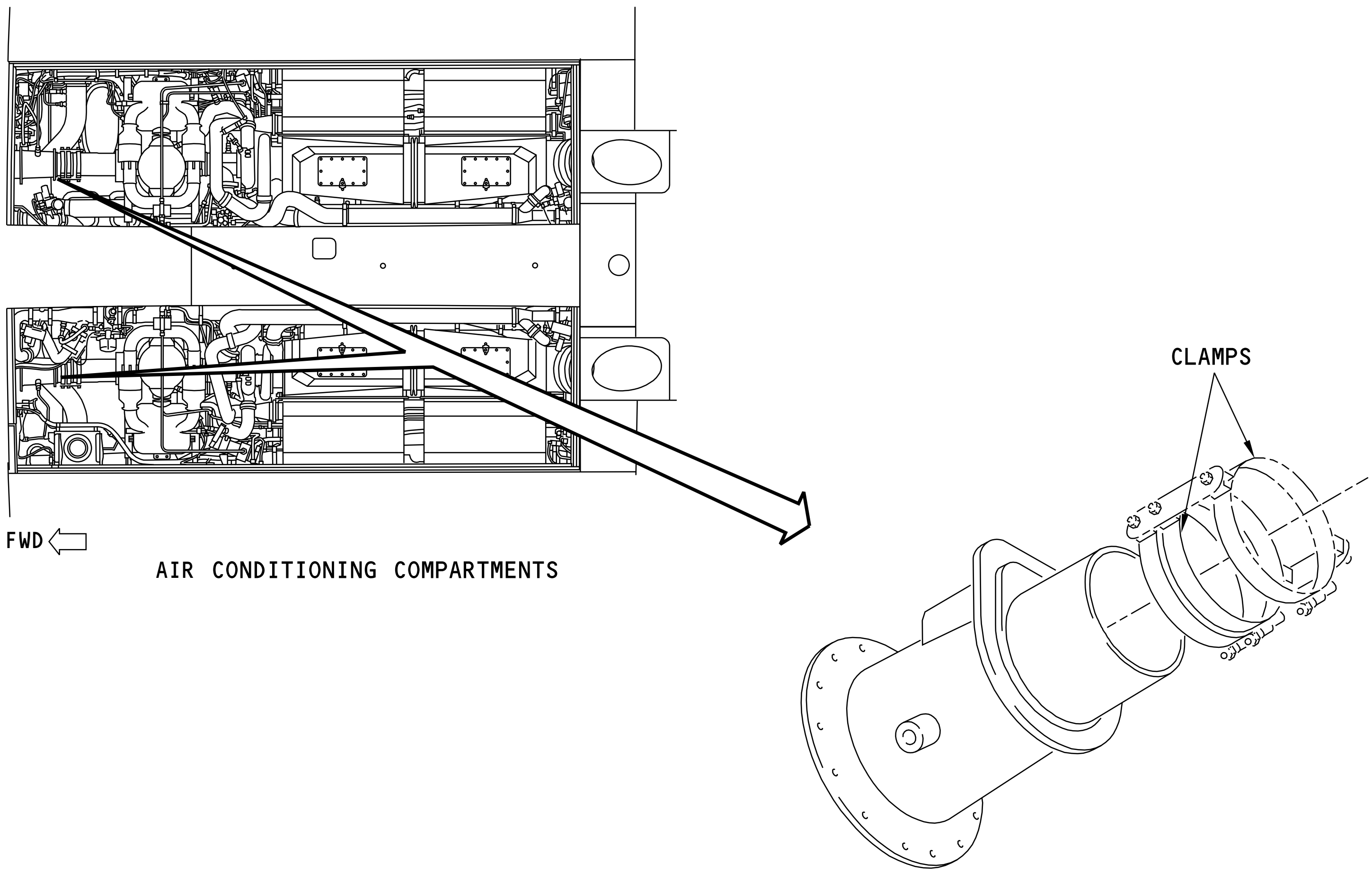
Physical Description

The conditioned air check valve is a swing type check valve. An arrow on the outside of the valve shows the flow direction.

There is one conditioned air check valve in each pack system.

Functional Description

The check valve prevents airflow to the pack. It opens to permit air flow from the air conditioning pack to the main distribution manifold.



M78639 S0004621915_V1

AIR CONDITIONING - COOLING - CONDITIONED AIR CHECK VALVE

AIR CONDITIONING - COOLING - PACK TEMPERATURE SENSOR

Purpose

The pack temperature sensor measures the temperature in the air conditioning pack. It gives feedback to the pack/zone temperature controllers.

Location

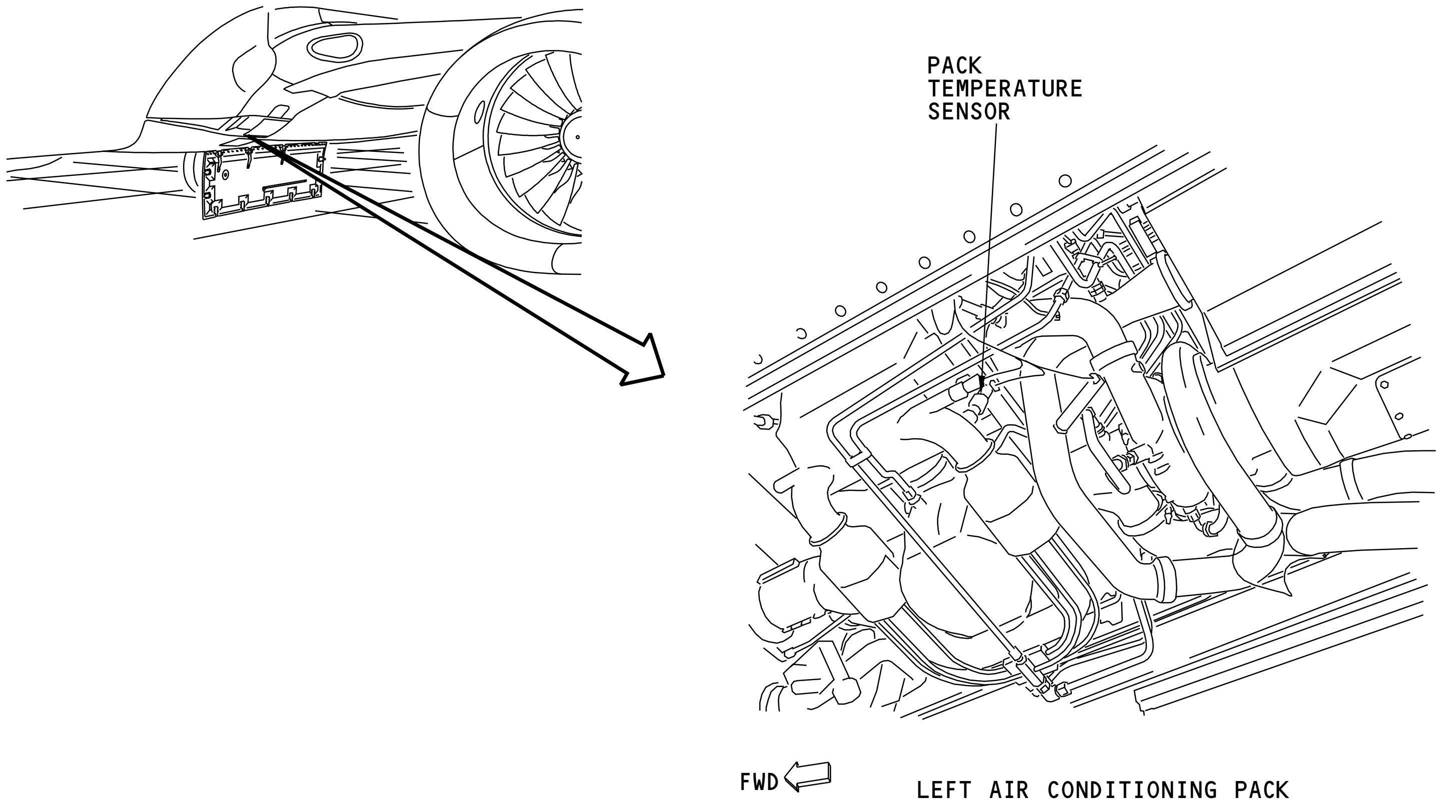
There are two pack temperature sensors, one in each air conditioning pack. They are on the pack high pressure water separator assemblies. Access is through the air conditioning compartment doors.

Functional Description

The pack temperature sensors are thermistor devices. Their resistance changes with temperature.

The temperature sensor resistance is the feedback to the pack/zone temperature controller. The pack/zone temperature controller uses the feedback to control the discharge temperature of the air conditioning system.

Each pack temperature sensor has two sense elements. One element to give feedback to each of the two pack/zone temperature controllers. One element gives pack temperature feedback to the auto (normal) control of its related pack/zone temperature controller. The other element gives pack temperature feedback to the standby control of the opposite pack/zone temperature controller.



M78652 S0004621918_V1

AIR CONDITIONING - COOLING - PACK TEMPERATURE SENSOR

AIR CONDITIONING - COOLING - PACK INLET PRESSURE SENSOR

Purpose

The pack inlet pressure sensor supplies inlet pressure information to the pack flow temperature controller.

Description

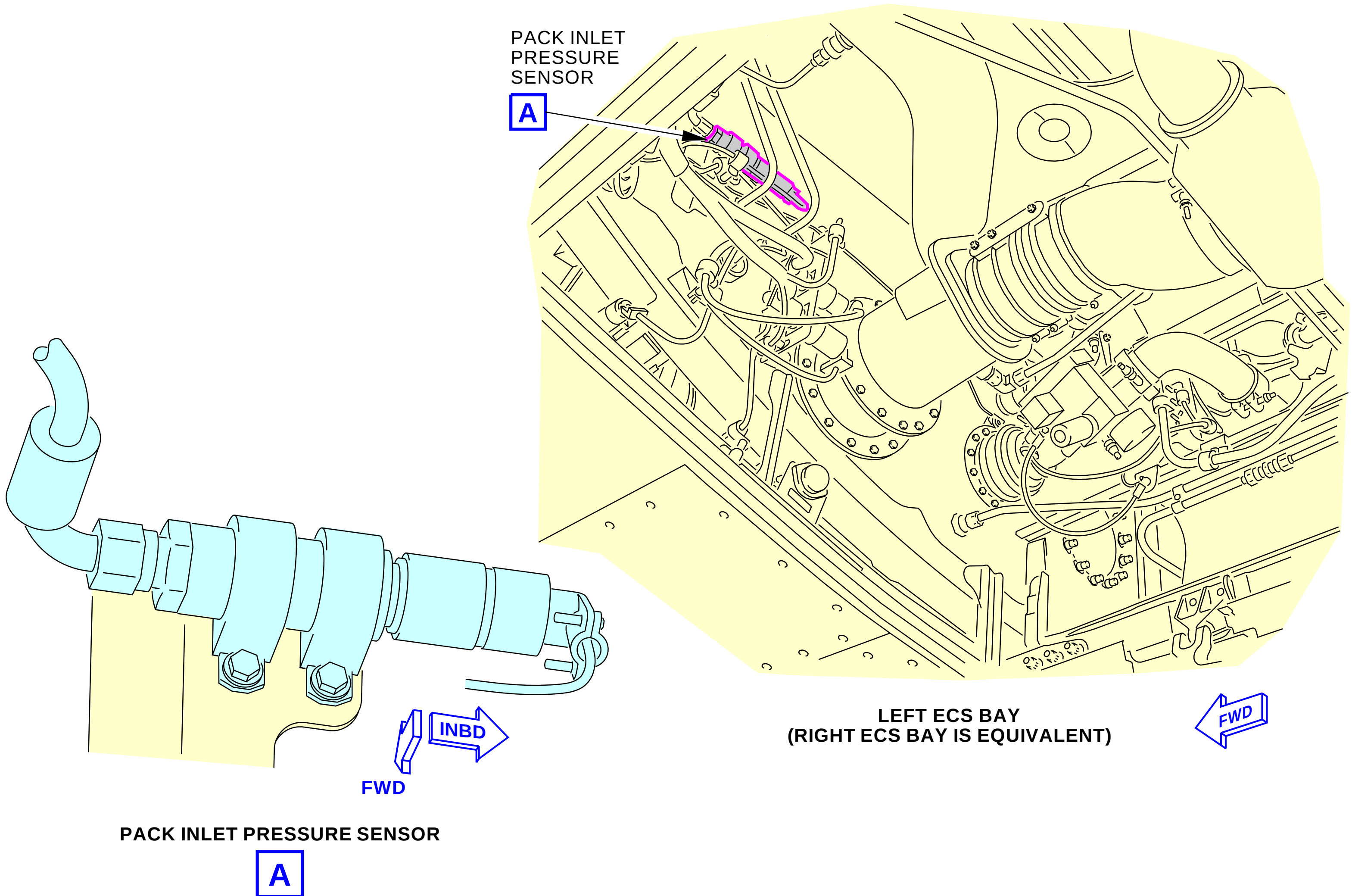
The pack inlet pressure sensor (PIPS) has a silicon strain gauge on the pressure sensing diaphragm with an integrated circuit for error correction. The sensor provides a linear output of 4 to 20 mA which corresponds to a pressure range of 0 to 100 psig.

Location

There is a pack inlet pressure sensor for each pack. The sensors are located in the left and right pack bays near the front of the bay and outboard of the air conditioning check valves.

Functional Description

The function of the pack inlet pressure sensor (PIPS) is to sense bleed pressure downstream of the flow control and shutoff valve and upstream of the inlet to the pack primary heat exchanger. The pressure data is sent to the pack flow temperature control for pressure and flow control.



AIR CONDITIONING - COOLING - PACK INLET PRESSURE SENSOR

AIR CONDITIONING - COOLING - FLOW SENSOR

Purpose

The flow sensor supplies flow data to the pack flow temperature controller.

Location

There is a flow sensor for each ECS pack. The flow sensors are located inboard of the primary plenum/diffuser assembly.

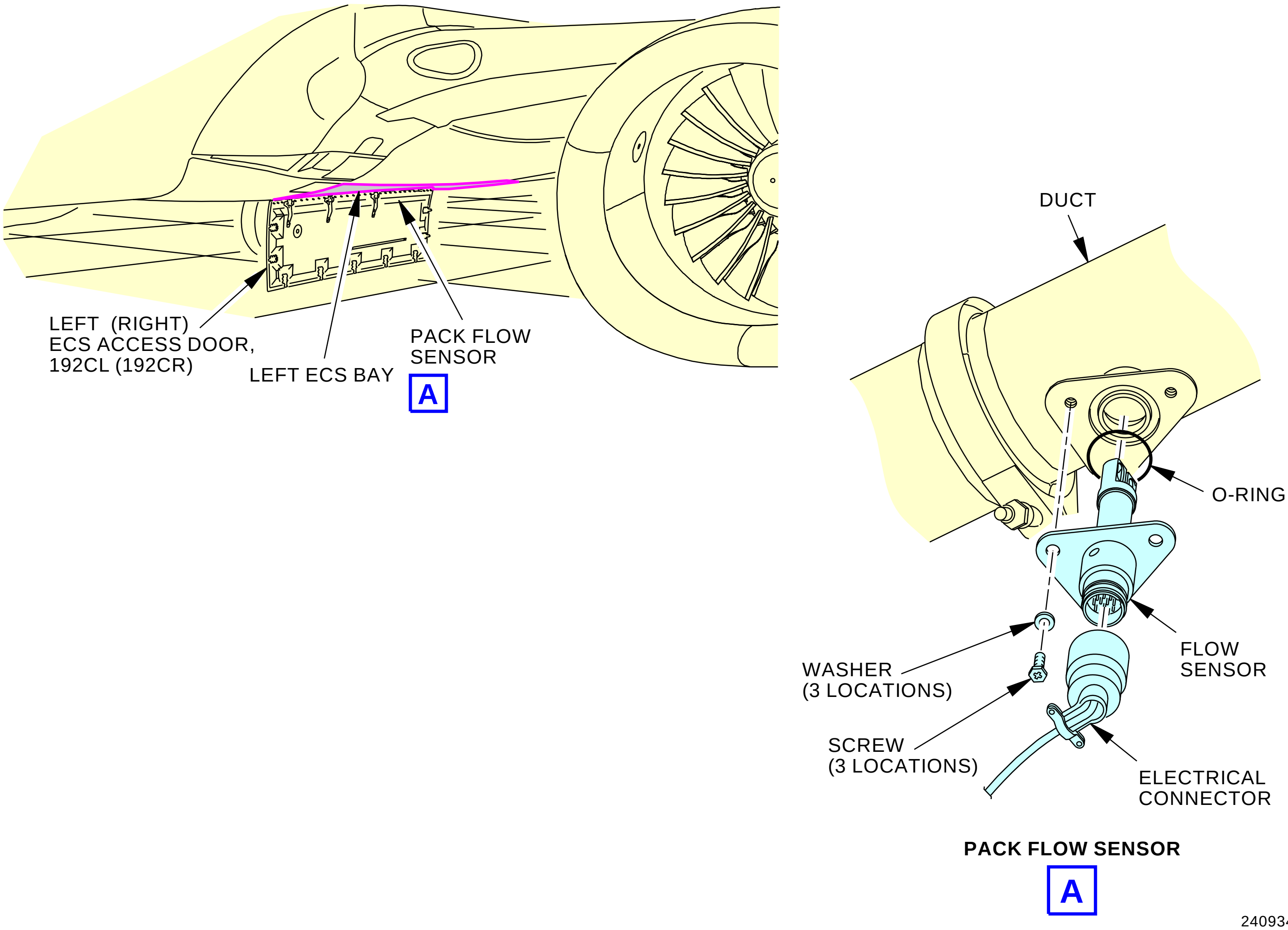
Description

The flow sensor is a hot wire anemometer that is hermetically sealed. It includes one heated and one unheated 1000 ohm platinum temperature element and a customer heater made from 20 ohm NiChrome wound wire encased in ceramic. The unheated temperature element measures the ambient (bleed air temperature inside the duct). The entire assembly is housed in passivated stainless steel.

During sensor calibration, two signature resistors (one for gain, one for offset) are selected and installed in the flow sensor in order to compensate for variation in the production build process. This is performed in order to align the sensor characteristic of the unit being tested to within the required accuracy of a nominal curve. The nominal curve correlates the flow (ppm) versus heater current as measured in the air duct.

Functional Description

The pack flow temperature controller provides current to the heated element to maintain a temperature difference of 45°F between the heated and the ambient temperature elements. The controller uses the current required to maintain this temperature differential to determine the mass flow rate of air flowing into the pack. The resultant mass flow reading includes empirically-determined compensation for the pressure and temperature of the bleed air. For normal flow control, the duct ambient temperature element reading and the pressure reading from the pack inlet pressure sensor are used to determine the volumetric flow rate of air flowing into the pack.



AIR CONDITIONING - COOLING - FLOW SENSOR

AIR CONDITIONING - COOLING - MIX MANIFOLD TEMPERATURE SENSOR

Purpose

The mix manifold temperature sensors measure the temperature in the mix manifold of the air conditioning system. They give feedback to the pack/zone temperature controllers.

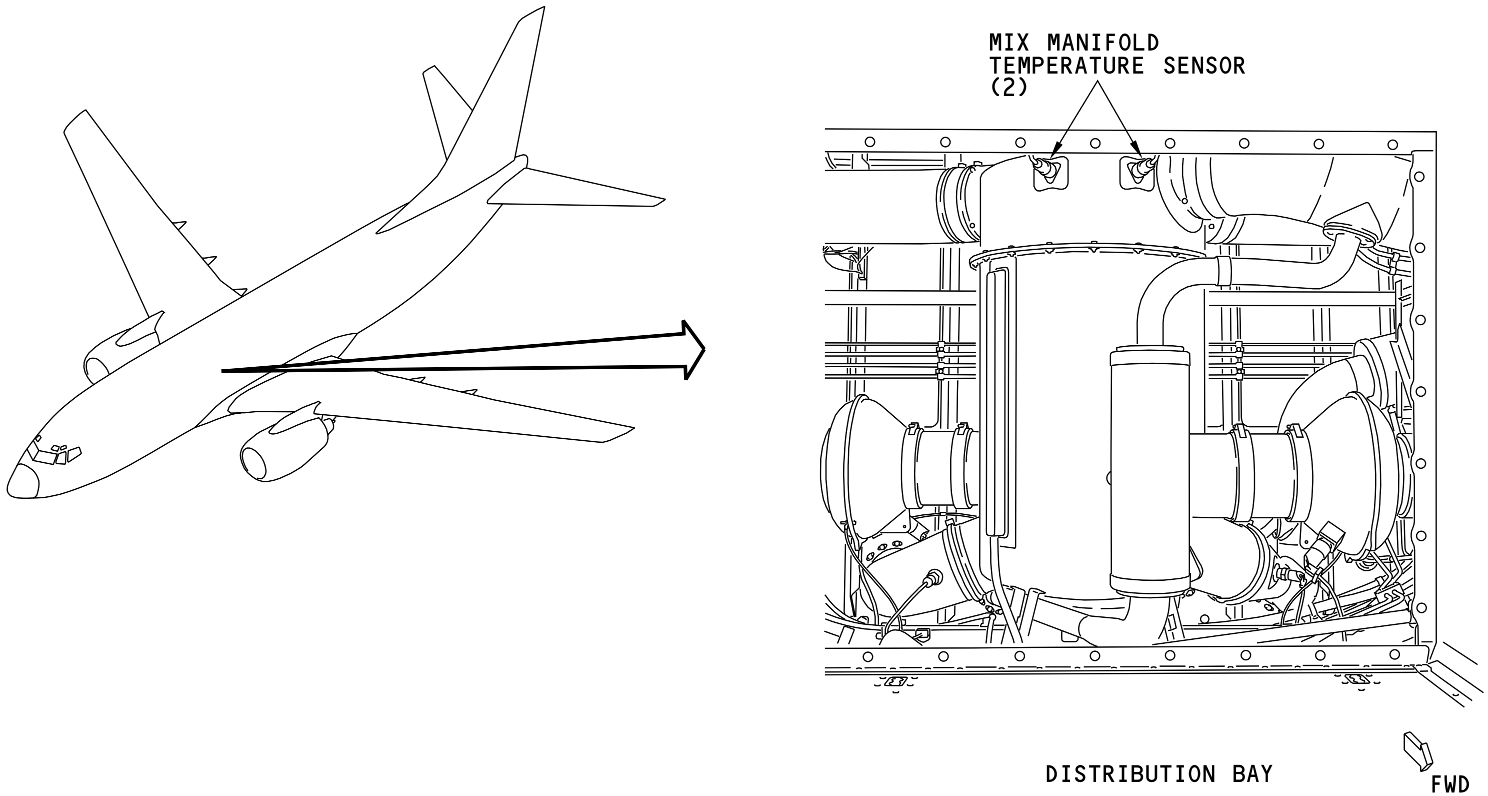
Location

There are two mix manifold temperature sensors. They are similar in design and operation. They are on the upper forward wall of the mix manifold. Access is through the center aft bulkhead panel in the forward cargo compartment.

Functional Description

The mix manifold temperature sensors are thermistor devices. Their resistance changes with temperature.

The temperature sensor resistance is the feedback to the pack/zone temperature controller. The pack/zone temperature controller uses the feedback to prevent freezing temperatures in the air conditioning distribution system.



M78651 S0004621921_V1

AIR CONDITIONING - COOLING - MIX MANIFOLD TEMPERATURE SENSOR

AIR CONDITIONING - COOLING - TEMPERATURE CONTROL VALVE

Purpose

The temperature control valve is the primary valve to control the discharge temperature of the air conditioning pack.

Location

There are two temperature control valves, one for each air conditioning pack. They are in the air conditioning compartments.

Physical Description

The temperature control valve has these parts:

- Valve flow body
- Electric motor actuator assembly
- Position indicator
- Manual override knob.

Two vee-flange clamps support the valve.

Functional Description

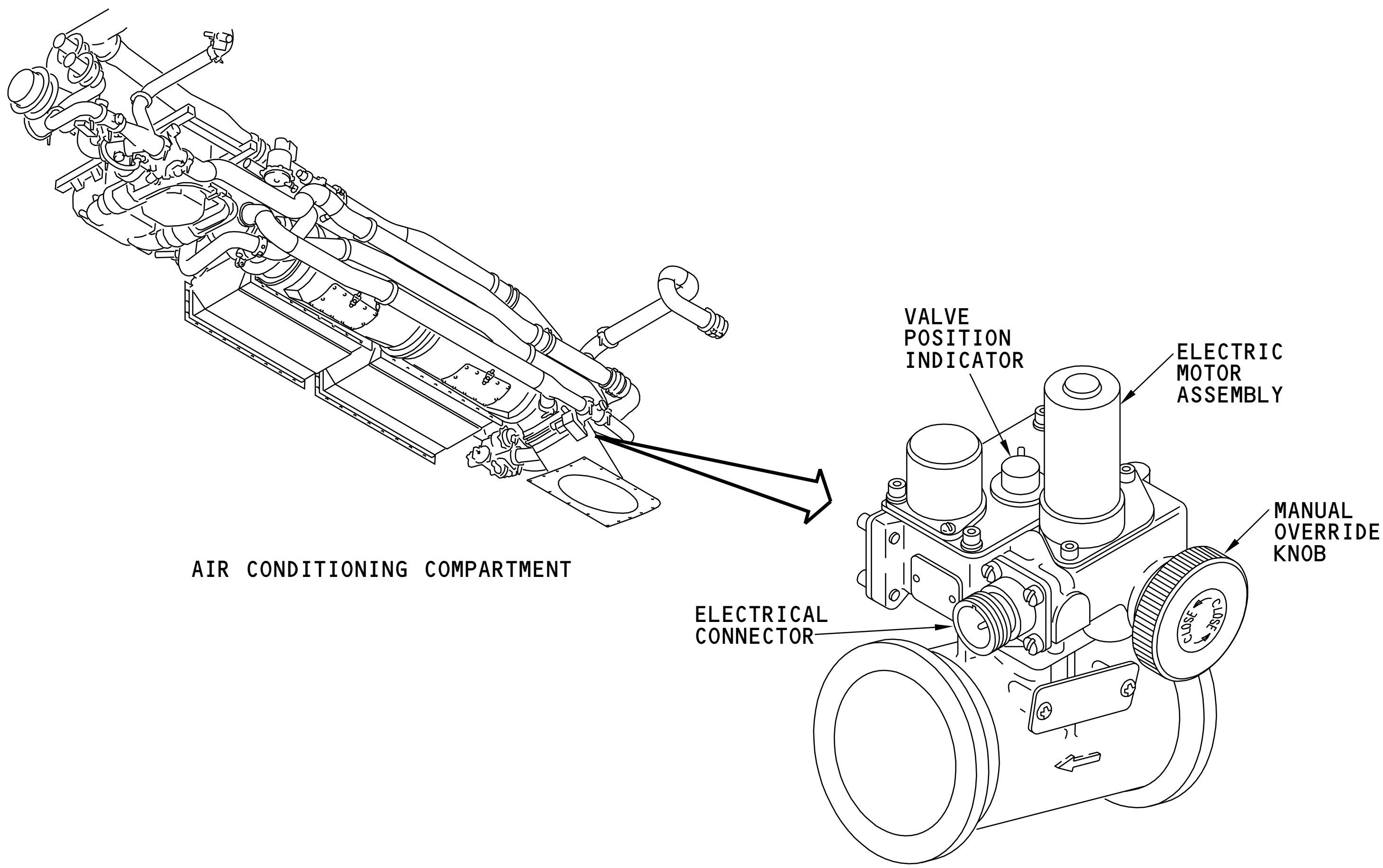
The valve is an electric motor-driven single plate butterfly valve. A mechanical gear train with a slip clutch transfers motor motion to the valve.

The valve uses 115v ac power. The valve drive signal comes through the ACAU from the pack zone controllers.

Training Information Point

There is a position indicator on the temperature control valve. The valves are normally in the closed position when the packs are off.

You can manually close the valve with the manual override knob if the electric motor fails. Turn the knob in the direction shown on the knob placard.



M78634 S0004621923_V1

AIR CONDITIONING - COOLING - TEMPERATURE CONTROL VALVE

AIR CONDITIONING - COOLING - STANDBY TEMPERATURE CONTROL VALVE

Purpose

The standby temperature control valve does these things:

- Gives backup control for the discharge temperature of the air conditioning pack (normal temperature control system failure)
- Increases the temperature of pack discharge air to prevent ice formation in the condenser.

Location

There are two standby temperature control valves, one for each air conditioning pack. They are in the air conditioning pack compartments.

Physical Description

The standby temperature control valve has these parts:

- Valve flow body
- Electromagnetic control valve assembly
- Delta pressure servo control assembly
- Pneumatic actuator
- Position indicator
- Sense ports.

Two V-band clamps support the valve.

Functional Description

The valve is a pneumatically actuated butterfly-type modulating and shutoff valve. It is spring-loaded to the closed position.

Control pressure to the actuator opens and modulates the valve. The control pressure source is the upstream side of the valve. These valve devices control the pressure to the valve actuator:

- Electromagnetic control valve assembly
- Delta pressure servo control assembly.

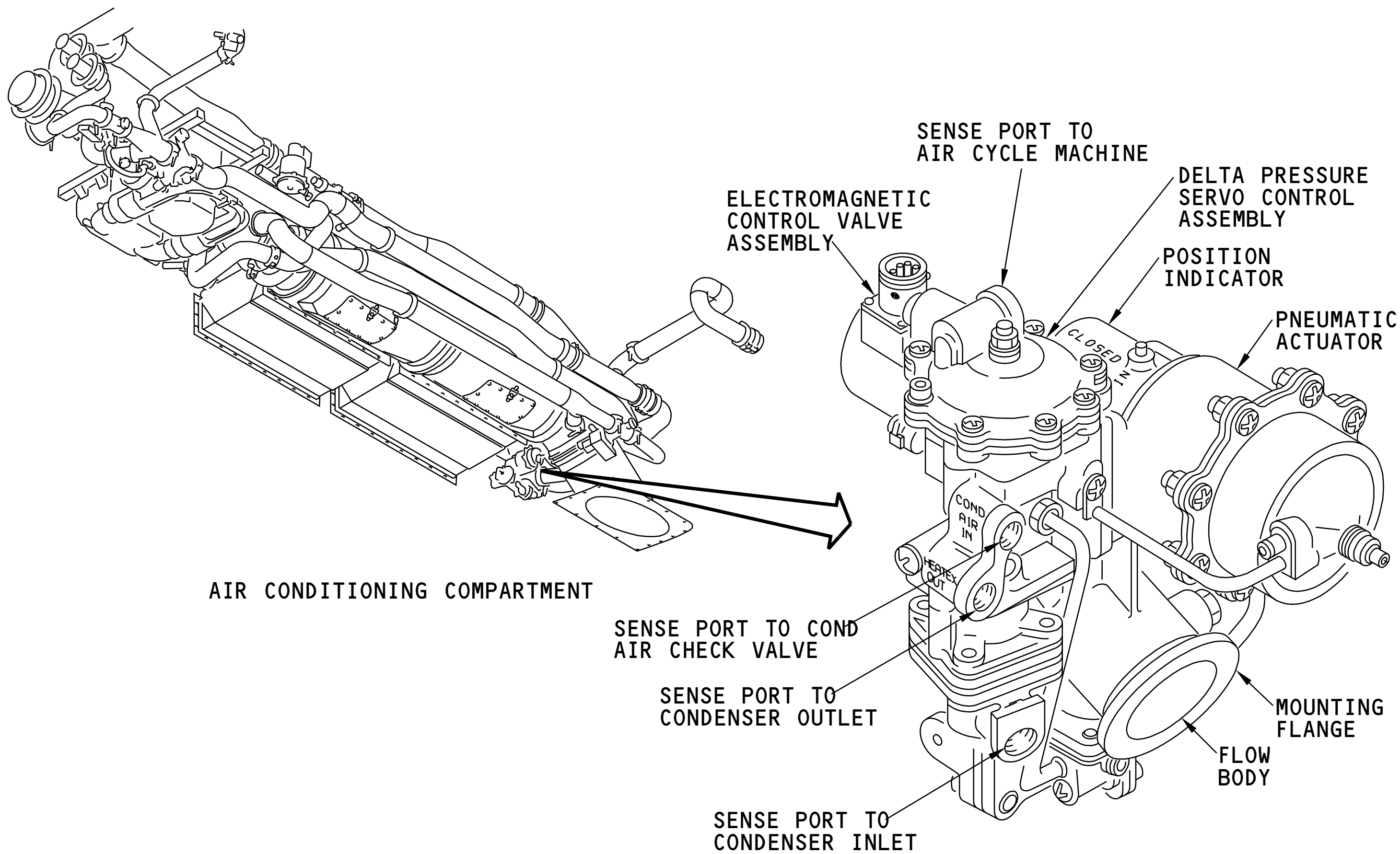
A signal from the pack zone controller standby pack control channel drives the electromagnetic control device.

Pneumatic lines sense condenser differential pressure and drive the delta pressure servo control device. Ice in the condenser increases the pressure differential.

If the electromagnetic and the delta pressure controls operate at the same time, the device that gives the largest valve open pressure will control.

Training Information Point

There is a position indicator on the standby temperature control valve. The valve is normally in the closed position when the pack is off.



M78632 S0004621926_V1

AIR CONDITIONING - COOLING - STANDBY TEMPERATURE CONTROL VALVE

Functional Description

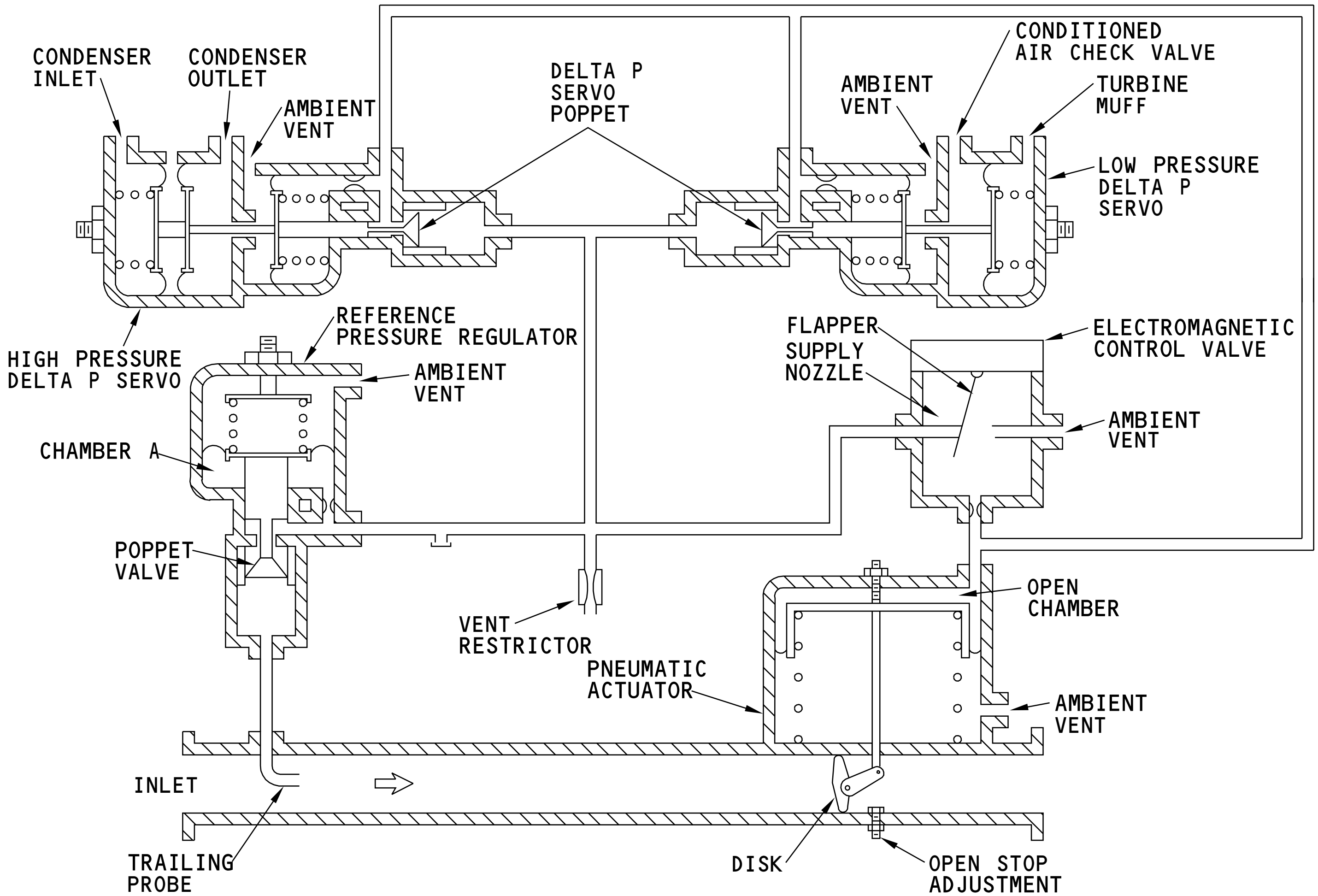
The standby temperature control valve is electrically and pneumatically controlled and pneumatically operated.

If the condenser begins to ice, differential pressure across the condenser is sensed. This differential pressure acts on the high or low pressure delta P servo.

The servo operates a poppet valve to control the actuation pressure that goes from the reference pressure regulator to the pneumatic actuator. This opens the valve and increases the hot air flow into the condenser. With the increased hot airflow, the condenser will deice and the valve closes.

Electrical control of the standby temperature control valve is part of the standby mode of operation. The standby temperature control electrically moves a flapper in the electromagnetic control valve to control actuation pressure to the pneumatic actuator.

If there are simultaneous signals from the differential pressure sensors and the electromagnetic control valve, the device with the higher demand has priority.



M78637 S0004621929_V1

AIR CONDITIONING - COOLING - STANDBY TEMPERATURE CONTROL VALVE - FUNCTIONAL DESCRIPTION

AIR CONDITIONING - COOLING - AUTO CONTROL - FUNCTIONAL DESCRIPTION

Functional Description

When you put the pack switch to the AUTO/HIGH position, K13 PACK/HIGH relay energizes if the K7 pack valve closed relay is open. When K13 is energized, the pack/zone controller is enabled and the K17 pack temperature control valve inop relay is energized.

K21 alternate power relay gives two possible sources for electrical power. When K21 energizes, it gives 28v dc from bus 1. When K21 de-energizes, it gives 28v dc from the battery bus. 28v dc goes to these relays:

- K13 pack AUTO/HIGH relay
- K17 pack TCV INOP relay.

The pack/zone temperature controller controls the position of the temperature control valve. To move the temperature control valve, the auto pack control in the pack/zone temperature controller compares the temperature requirements of the three zones. The pack/zone temperature controller satisfies the temperature requirement of the zone that needs the most cooling. The controller uses this temperature requirement as a PACK DEMAND signal to establish the temperature output of the pack. The temperature requirement is compared with the actual pack outlet temperature sensed by the pack temperature sensor. This signal is compared with a 35F (2C) limit for ice protection of the mix manifold.

Ice protection is provided for the mix manifold by a 35F (2C) temperature limit to the output of the pack. The mix manifold temperature input to the pack/zone controller is from two sensors on the mix manifold. The pack/zone temperature controller compares the two inputs and uses the coldest signal. The mix manifold temperature and the PACK DEMAND are then compared with a 35F (2C) limit and the controller controls the temperature control valve.

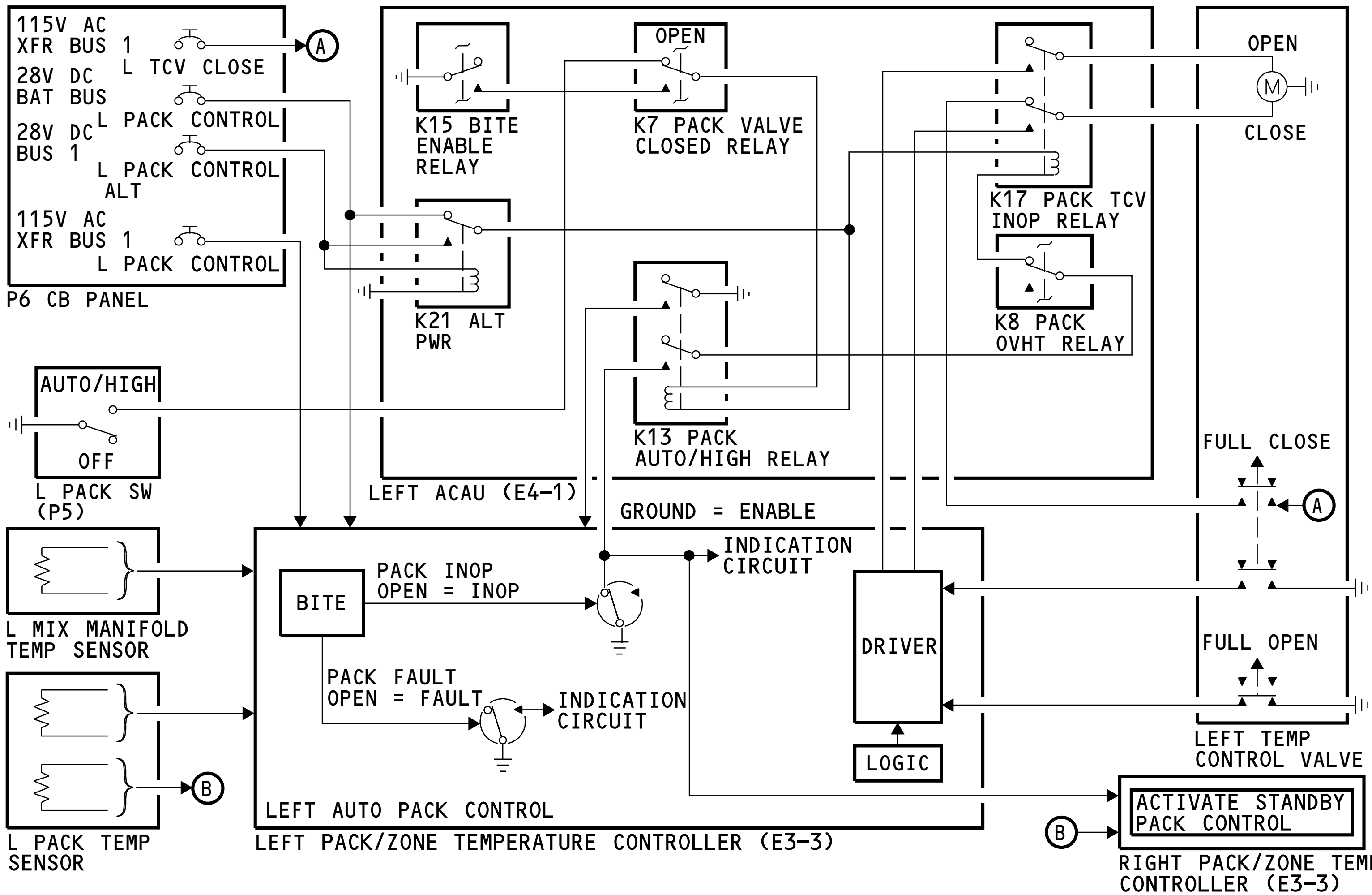
Open and close limit switches in the temperature control valve provide feedback signals to the pack/zone temperature controllers.

When the zone temperature selectors are in the OFF position, the pack/zone temperature controllers will control the left pack to maintain a fixed temperature of 75°F (24°C) and the right pack to maintain a fixed temperature of 65°F (18°C) as measured at the pack temperature sensors.

These are the failures that cause the temperature control valve to close and activate the standby temperature control in the opposite controller:

- Pack control
- Pack sensor or interface
- Temperature control valve or driver.

These failures set the pack INOP and FAULT switches.



M78599 S0004621932_V1

AIR CONDITIONING - COOLING - AUTO CONTROL - FUNCTIONAL DESCRIPTION

AIR CONDITIONING - COOLING - STANDBY CONTROL - FUNCTIONAL DESCRIPTION

Purpose

The standby temperature control provides temperature control of the pack output if there is a pack automatic control failure.

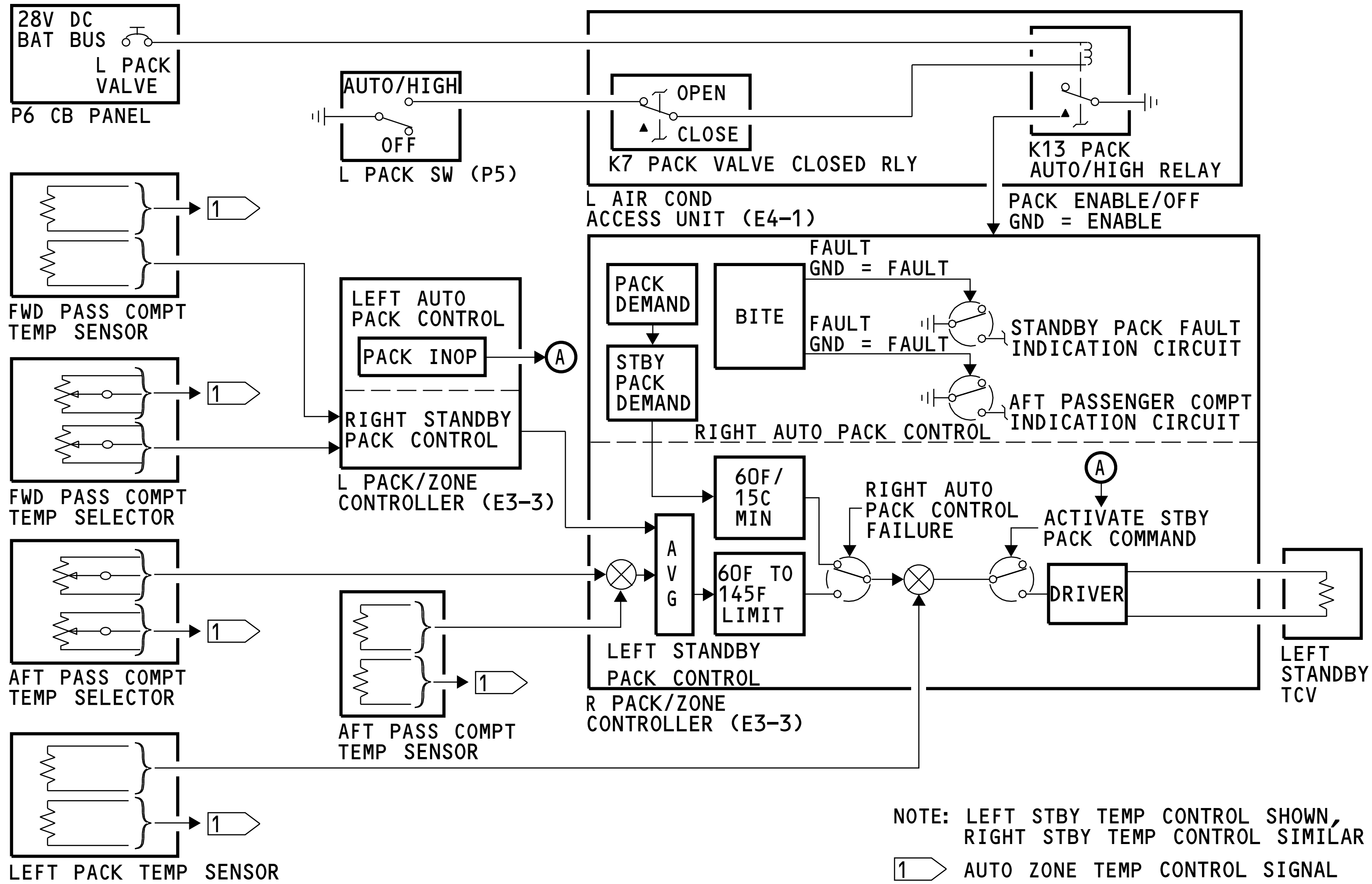
Functional Description

When you put the pack switch to the AUTO/HIGH position, K13 PACK/HIGH relay energizes if the K7 pack valve closed relay is open. When K13 is energized, the pack/zone controller is enabled. If the pack automatic temperature control fails, there is an activate standby pack command signal. This connects the opposite controller to the standby temperature control valve for temperature control.

The standby pack control uses the standby temperature control valve to regulate the output of the pack.

If all zone and auto pack temperature controls fail, the analog standby pack temperature controls will satisfy the average temperature demand of the two passenger cabin zones. The flight compartment zone is not used.

NOTE: If the auto and standby pack temperature controls fail, the pack should be shutdown. If this is not done, the pack continues to operate until an overtemperature condition occurs.



M78601 S0004621935_V1

AIR CONDITIONING - COOLING - STANDBY CONTROL - FUNCTIONAL DESCRIPTION

AIR CONDITIONING - COOLING - PACK OVERHEAT SWITCHES

Purpose

These temperature switches monitor the pack for an overheat condition:

- Compressor discharge overheat switch
- Turbine inlet overheat switch
- Pack discharge overheat switch.

Location

There is a compressor discharge overheat switch and a turbine inlet overheat switch in each air conditioning compartment.

The compressor discharge overheat switch is in the duct between the air cycle machine compressor section and the secondary heat exchanger.

The turbine inlet overheat switch is in the duct from the reheater to the air cycle machine turbine section.

The pack discharge overheat switch is in the input duct to the mix manifold in the distribution bay.

Functional Description

The overheat switches look similar. The compressor discharge overheat switch and the turbine inlet overheat switch have different operation temperatures.

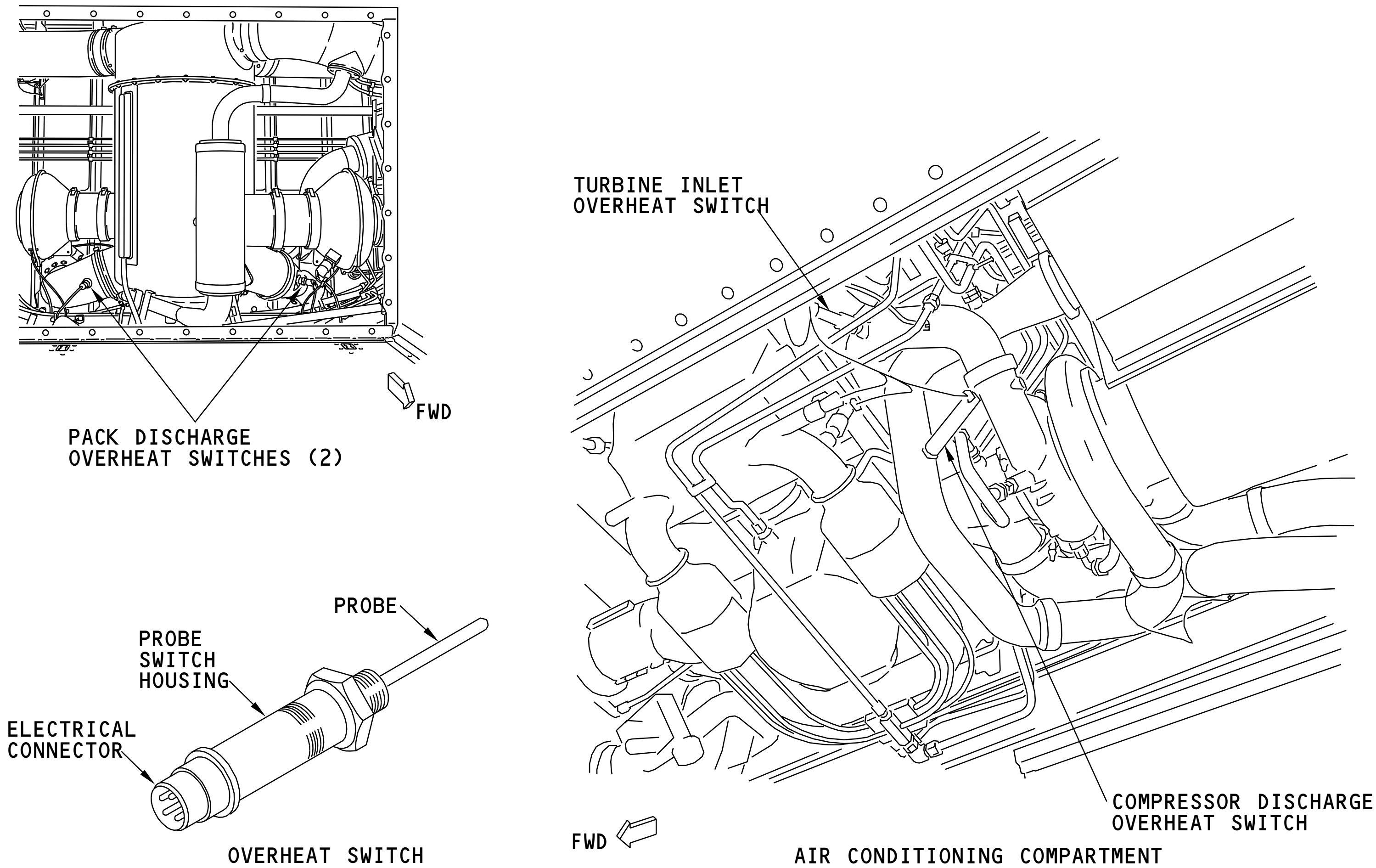
The compressor discharge overheat switch has an operation temperature of 390F (199C).

The turbine inlet overheat switch has an operation temperature of 210F (99C).

The pack discharge overheat switch has an operation temperature of 250F (121C).

Training Information Point

CAUTION: USE TWO WRENCHES WHEN YOU REMOVE/INSTALL THE SWITCH IN/OUT OF THE BOSS. THIS WILL PREVENT DAMAGE TO THE DUCT.



M78649 S0004621938_V1

AIR CONDITIONING - COOLING - PACK OVERHEAT SWITCHES

AIR CONDITIONING - COOLING - PACK PROTECTION - FUNCTIONAL DESCRIPTION

Functional Description

Pack protection is a function of these three switches:

- Compressor discharge overheat switch
- Turbine inlet overheat switch
- Pack discharge duct overheat switch

The switches are normally open. When an overheat condition occurs, the overheat switch closes. This energizes the pack overheat relay. When the pack overheat relay energizes, power is supplied to the close solenoid of the flow control and shutoff valve.

These are the indications when a pack trip occurs:

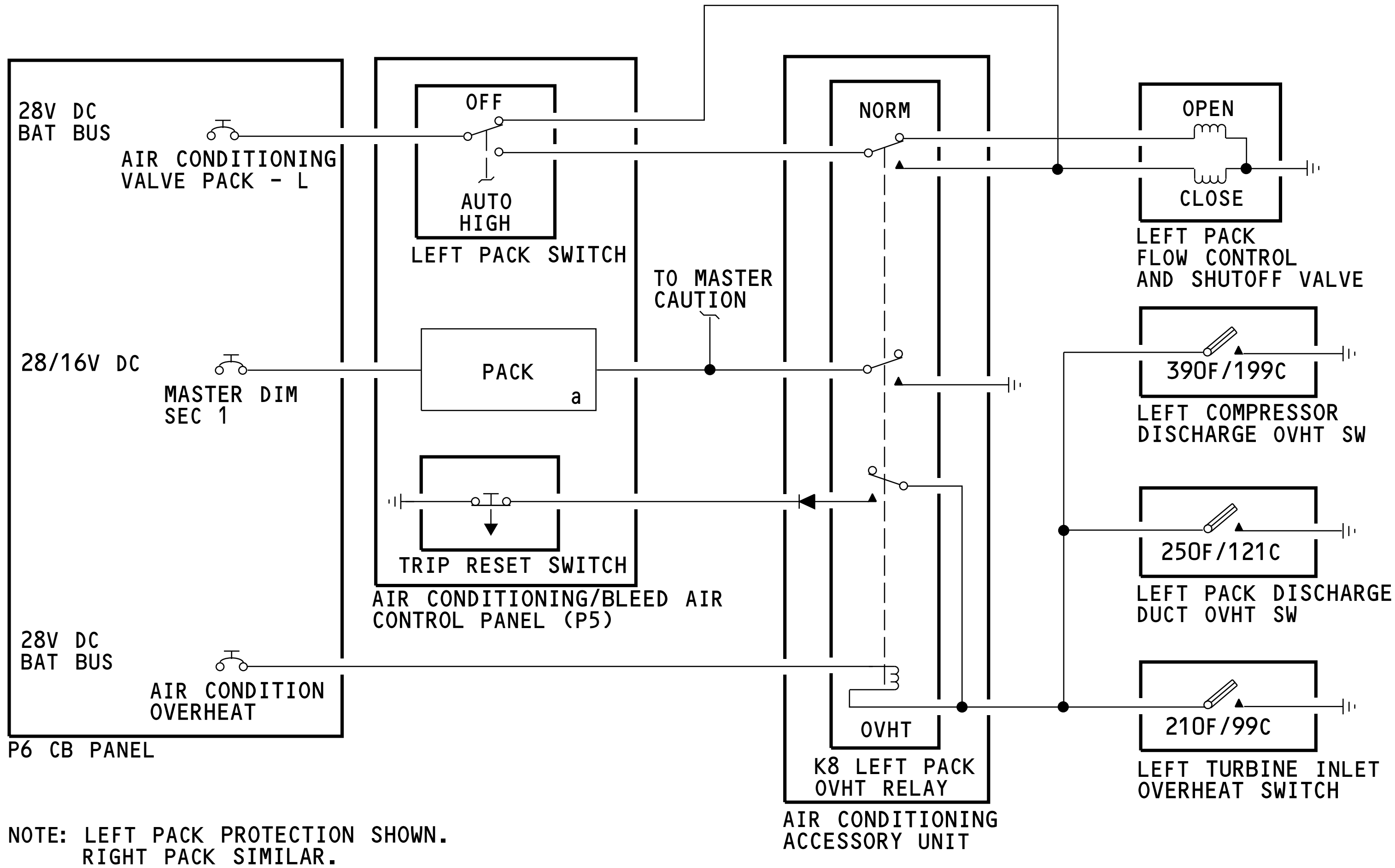
- PACK amber light
- MASTER CAUTION and AIR COND annunciator lights.

The overheat relay latches in the overheat position. When the condition that caused the pack trip off is corrected, push the TRIP RESET switch on the air conditioning/bleed air control panel to de-energize the overheat relay.

Training Information Point

If the PACK light comes on and the pack can be reset, the heat exchangers may be obstructed or dirty.

If the PACK light comes on and the pack can not be reset, do a test of the compressor discharge and turbine inlet overheat switches.



M78638 S0004621940_V1

AIR CONDITIONING - COOLING - PACK PROTECTION - FUNCTIONAL DESCRIPTION

AIR CONDITIONING - COOLING - FUNCTIONAL DESCRIPTION

Functional Description

The flow control and shutoff valve gets hot bleed air from the pneumatic manifold. The flow control and shutoff valve controls the flow of hot bleed air to the trim air system, primary heat exchanger and to the two temperature control valves. A hot air connection downstream of the FCSOV supplies hot bleed air to the turbine case. This prevents ice in the turbine case.

The ram air system controls the flow of ram air to the primary and secondary heat exchangers. These are the ram air system components:

- Ram air control temperature sensor
- Pack/zone temperature controller
- Ram air inlet actuator
- Ram air inlet deflector door
- Ram air inlet modulation panels
- Impeller fan
- Fan bypass check valve.

When bleed air goes through the primary heat exchanger, ram air removes some of the heat. This partially cool bleed air goes to the compressor section of the air cycle machine.

The compressor section increases the pressure and temperature of the partially cool bleed air. This compressed air goes to the secondary heat exchanger.

When the compressed air goes through the secondary heat exchanger, ram air removes some of the heat. This bleed air goes through the water extractor duct and into the reheater.

Bleed air that leaves the secondary heat exchanger goes through the hot side of the reheater. Air that goes through the reheater the first time is cooled by colder air from the condenser. The temperature of the bleed air increases as it goes through the reheater a second time and into the turbine section of the air cycle machine.

Air that leaves the turbine goes through the cold side of the condenser. Air flow from the condenser divides into two paths, each path goes through a water extractor.

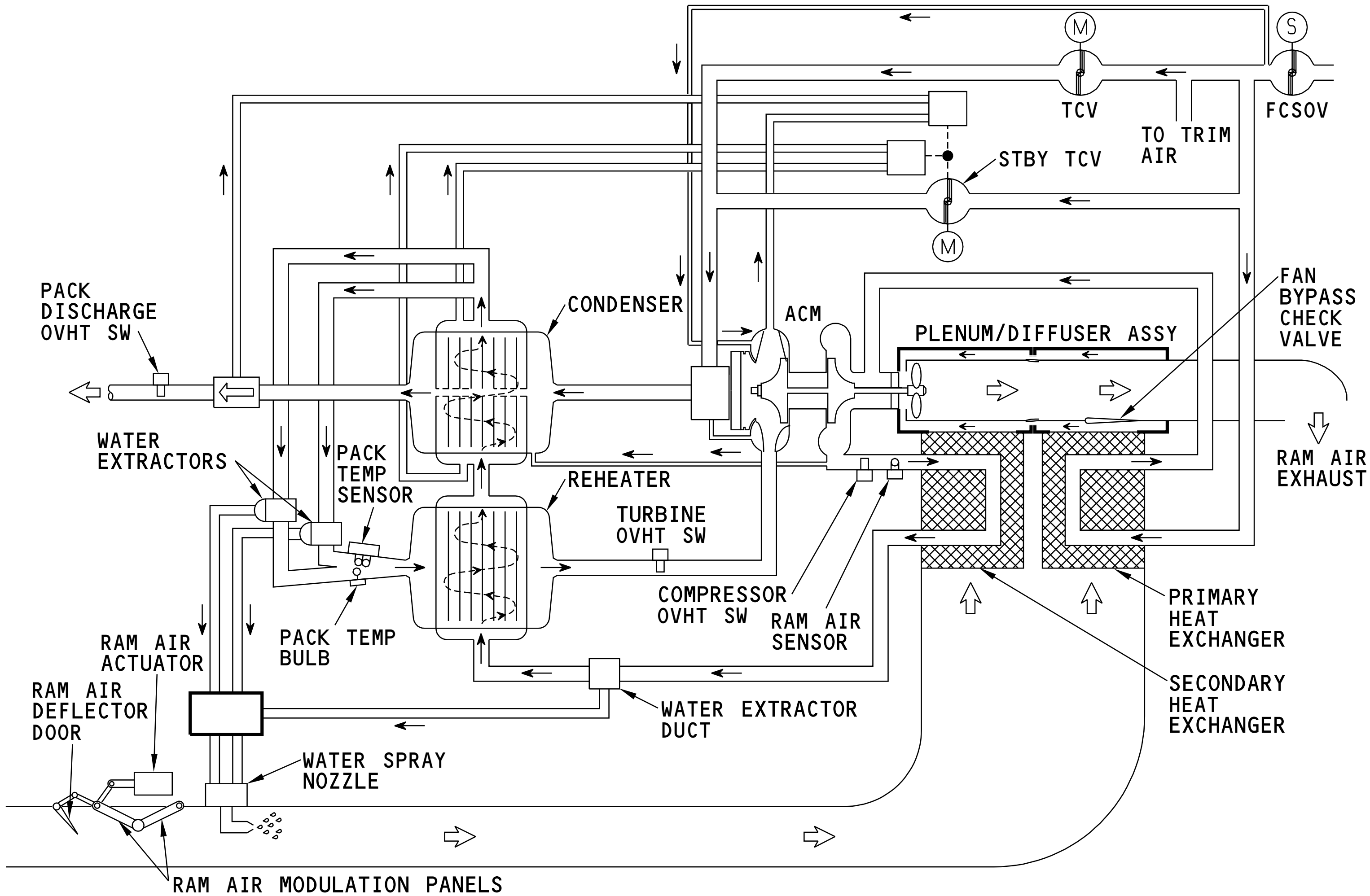
The water extractors remove moisture. This moisture goes to the water spray nozzle. The water spray nozzle sprays the water into the ram air duct.

Part of the cold air bypasses through the condenser core to prevent ice in the condenser. This supplies warm air through deicing passages in the core and by a mix of hot bleed air into the turbine muff at the cold air inlet. The standby temperature control valve senses condenser ice conditions and sends hot bleed air to the turbine muff.

Overheat Protection

The pack has overheat protection components that automatically stop operation of the pack. These are the overheat protection components:

- Compressor discharge overheat switch 390F (199C)
- Turbine inlet overheat switch 210F (99C)
- Pack discharge overheat switch 250F (121C).



M78595 S0004621943_V1

AIR CONDITIONING - COOLING - FUNCTIONAL DESCRIPTION

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AIR CONDITIONING - TEMPERATURE CONTROL - INTRODUCTION

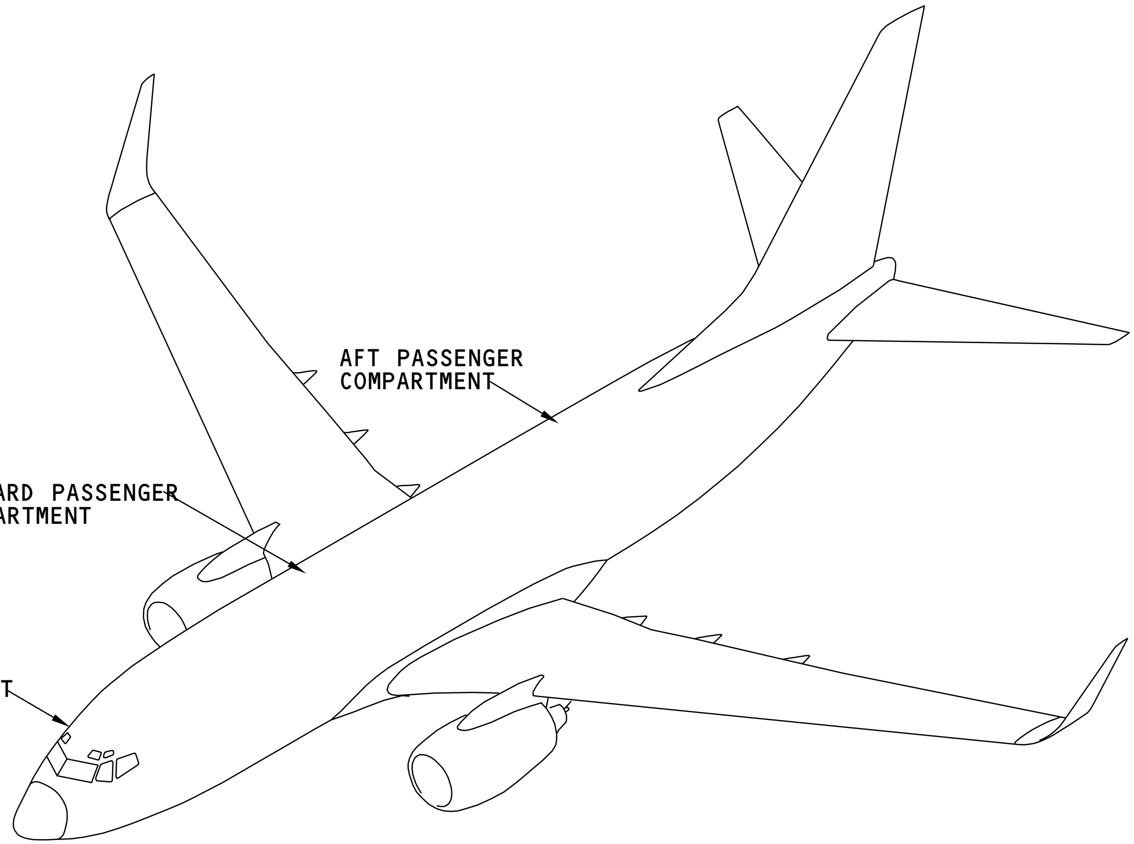
Purpose

The temperature control system controls the air temperature in these locations:

- Flight compartment
- Forward passenger compartment
- Aft passenger compartment.

Abbreviations and Acronyms

- ACAU - air conditioning accessory unit
- auto - automatic
- compt - compartment
- ctrl - control
- dk - deck
- EE - electronic equipment
- flt - flight
- FWD - forward
- OVHT - overheat
- PASS - passenger
- prsov - pressure regulating shutoff valve
- ref - reference
- STBY - standby
- vlv - valve



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AIR CONDITIONING - TEMPERATURE CONTROL - INTRODUCTION

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AIR CONDITIONING - TEMPERATURE CONTROL - GENERAL DESCRIPTION

General Description

The temperature control system can operate when the air conditioning packs operate. The packs operate when there is a bleed source from the pneumatic system.

The air conditioning accessory units (ACAU) monitor the operation logic for the pneumatic and air conditioning systems. It enables the temperature control system when the air systems are serviceable.

The pack/zone temperature controllers receive control signals from the temperature control panel and the forward and aft cabin attendant panels. Temperature sensors send temperature data from the flight and passenger compartments. The pack/zone temperature controllers send control and operation signals through the ACAU for temperature control.

The temperature control system has overheat switches in the supply ducts. The overheat switches give indication and stop operation when the temperature is out of limits.

Temperature bulbs in the passenger cabin and duct monitor and send temperature data to the cabin temperature control panel. The temperature control panel shows air temperatures.

Temperature Control Panel

The temperature control panel is the flight crew interface for system control and indication.

The flight crew selects the temperature set points for the three airplane zones with the temperature selectors.

Cabin Attendant Panels

Temperature set points can be adjusted for the forward and aft passenger airplane zones with the LCD touch screen on the cabin attendant panels.

AKS 001-021

Pack/Zone Temperature Controllers

There are two pack/zone temperature controllers. They monitor system parameters and control the air conditioning temperatures for the three air conditioning zones.

The pack/zone temperature controllers are part of a redundant, fault tolerant control system. The system re-configures to give optimum performance when there are faults.

The controllers process inputs from these things:

- Zone temperature selectors
- Zone cabin temperature sensors
- Zone duct temperature sensors
- Pack temperature sensors
- Mix manifold sensors.

The controllers modulate these valves in response to temperature control requirements:

- Pack temperature control valves (normal and standby)
- Zone trim air modulating valves.

AKS 022-999

Pack Flow Temperature Controllers

There are two pack flow temperature controllers. They monitor system parameters and control the air conditioning temperatures for the three air conditioning zones.

The pack flow temperature controllers are part of a redundant, fault tolerant control system. The system re-configures to give optimum performance when there are faults.

The controllers process inputs from these components:

- Zone temperature selectors

AKS 022-999 (Continued)

- Zone cabin temperature sensors
- Zone duct temperature selectors
- Pack temperature sensors
- Mix manifold sensors
- Pack flow sensors
- Pack input pressure sensor (PIPS)

The controllers modulate these valves in response to temperature control requirements:

- Pack temperature control valves (normal and standby)
- Zone trim air modulating valves

AKS ALL

Pack Temperature Control Valves (Normal and Standby)

The temperature control valves control the discharge temperature of the air conditioning packs.

The temperature control valve is the normal valve for control of pack output temperature

The standby temperature control valve does these functions:

- Controls pack output temperature if the normal system components fail
- Operates to prevent icing in the condenser.

Trim Air Pressure Regulating and Shutoff Valve

The trim air pressure regulating and shutoff valve does these functions:

- Controls airflow to the zone trim air modulating and shutoff valves
- Controls the pressure of the airflow to the zone trim air modulating valves.

Zone Trim Air Modulating Valves

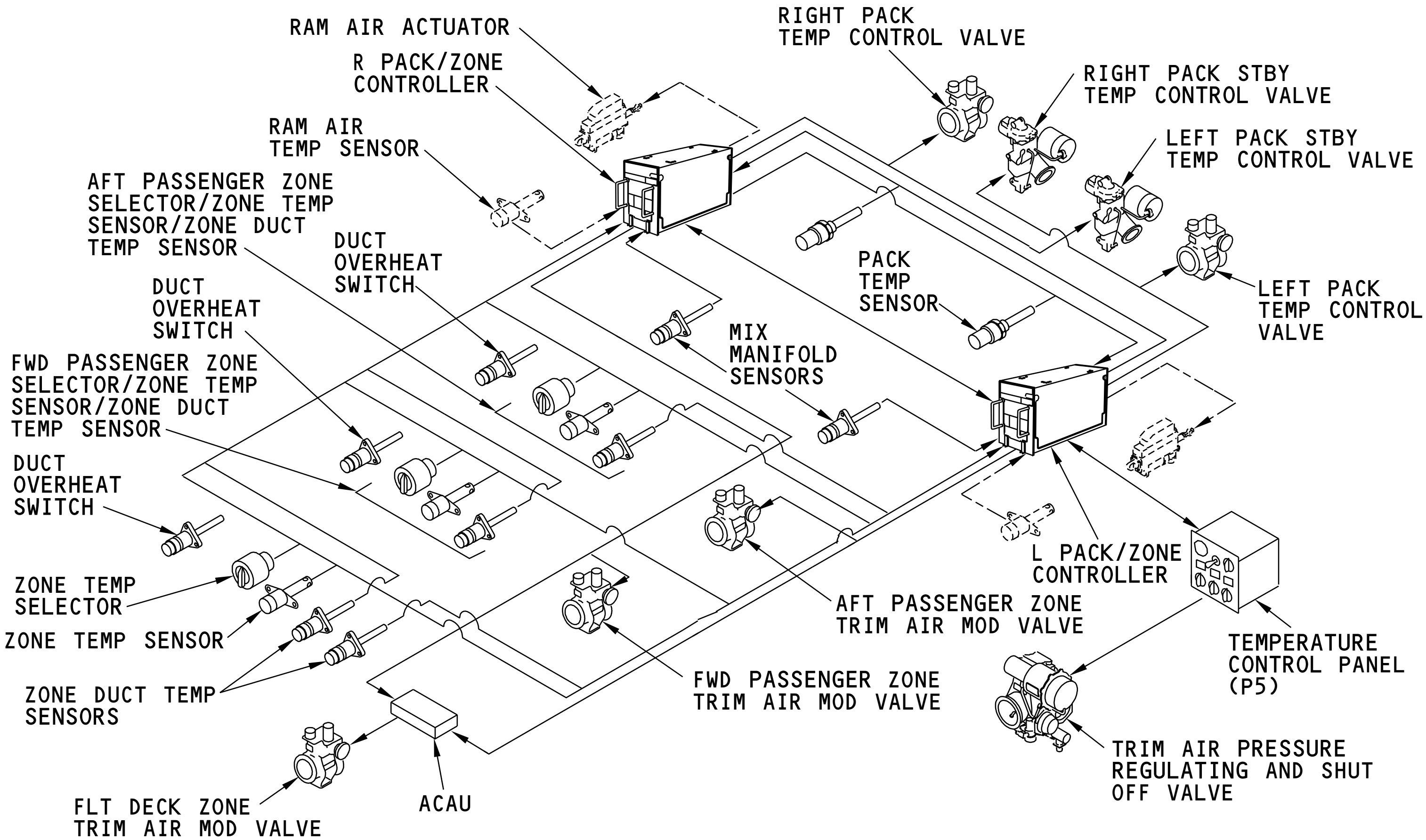
The zone trim air modulating valves control the trim air flow to the three air conditioning zones. Hot trim air goes to the zones that have hotter demands.

Zone Trim Air Mufflers

The forward zone trim air muffler reduces the amount of air distribution noise that is sent to the forward air conditioning zone. The aft zone trim air muffler reduces the amount of air distribution noise that is sent to the aft air conditioning zones.

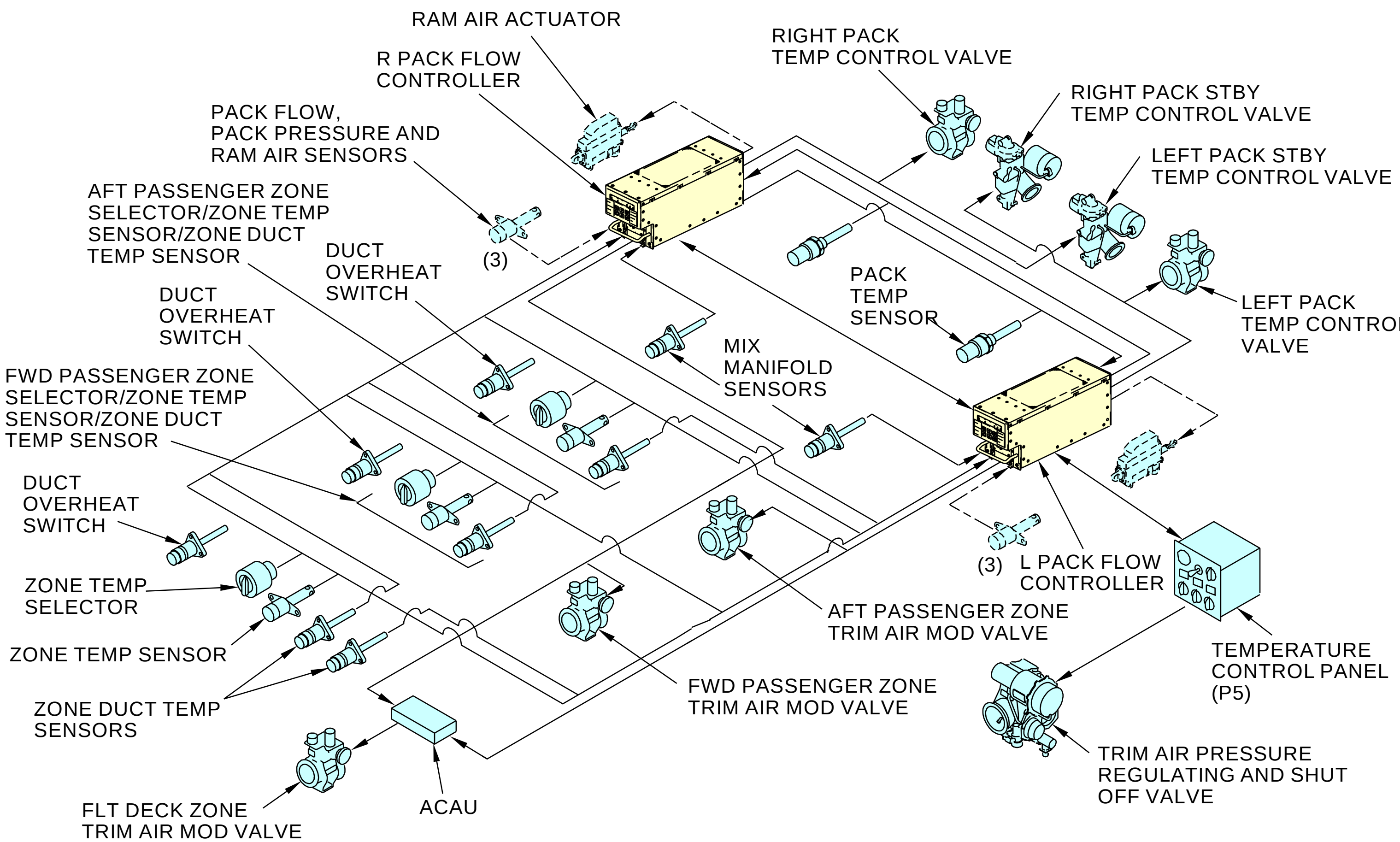
Duct Overheat Switch

The duct overheat switch provides overheat protection of the supply ducts. When the supply duct temperature is 190F (88C), the switch energizes a relay in the ACAU. The relay closes the trim air modulating valve.



M78708 S0004622024_V1

AIR CONDITIONING - TEMPERATURE CONTROL - GENERAL DESCRIPTION



2475538 S0000562229_V1

AIR CONDITIONING - TEMPERATURE CONTROL - GENERAL DESCRIPTION

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AIR CONDITIONING - TEMPERATURE CONTROL - OPERATION

General

The temperature controls panel is the air conditioning indication and control interface for the flight crew.

The temperature controls panel has these features:

- Temperature selectors (3)
- Duct overheat lights (3)
- Trim air switch
- Temperature indicator
- Air temperature source selector.

Temperature Selectors

The three flight crew temperature selectors give automatic temperature control for their related zones.

The selector has these temperature setpoints:

- C (cool) sets a temperature of 65F (18C)
- W (warm) sets a temperature of 85F (30C)
- Intermediate selector positions set proportionate temperature.

Turn the selector to the OFF position to close the related trim air modulating valve.

The LCD touch screen temperature selectors on the cabin attendant panels can adjust the temperature approximately 3F of the flight crew temperature selectors.

ZONE TEMP Light

The three ZONE TEMP lights turn on for overtemperature or control channel failures.

Trim Air Switch

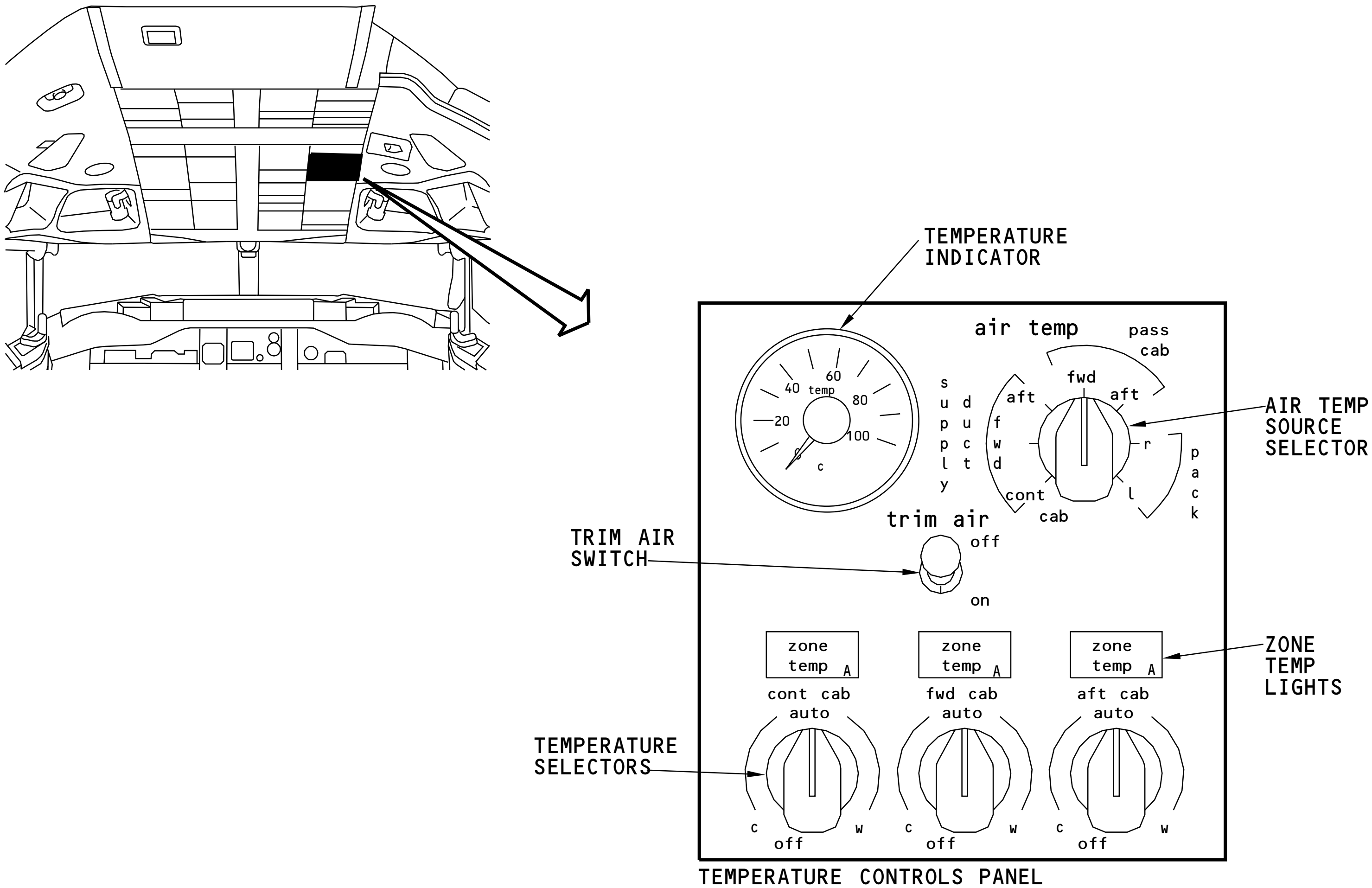
The trim air switch controls the trim air pressure regulating and shutoff valve. It has these two positions:

- ON - The trim air pressure regulating and shutoff valve opens. Zone trim air channels in pack/zone controllers are enabled.
- OFF - The trim air pressure regulating and shutoff valve closes. Zone trim air channels in the pack/zone controllers are disabled.

Temperature Indicator and Air Temperature Source Selector

The temperature indicator shows the temperature at the location selected with the air temperature source selector. These are the positions:

- SUPPLY DUCT - Selects related zone supply duct temperature
- PASS CABIN - Selects FWD or AFT passenger cabin temperature
- PACK - Selects water extractor discharge temperature (pack temperature).



M78710 S0004622026_V1

AIR CONDITIONING - TEMPERATURE CONTROL - OPERATION

AIR CONDITIONING - TEMPERATURE CONTROL - CABIN TEMPERATURE SENSOR ASSEMBLY

Purpose

The cabin temperature sensor assembly provides a flow of filtered air over a cabin temperature sensor and bulb. The cabin temperature sensor provides compartment temperature data to the pack/zone temperature controllers.

Location

The flight compartment cabin temperature sensor assembly is in the ceiling of the flight compartment.

There are two passenger cabin temperature sensor assemblies in the right side of the passenger cabin. They are each on a panel above the seats and between the PSUs.

Physical Description

These components are part of the cabin temperature sensor assembly:

- Cabin temperature sensor
- Inlet grille
- Air filter
- Temperature sensor fan

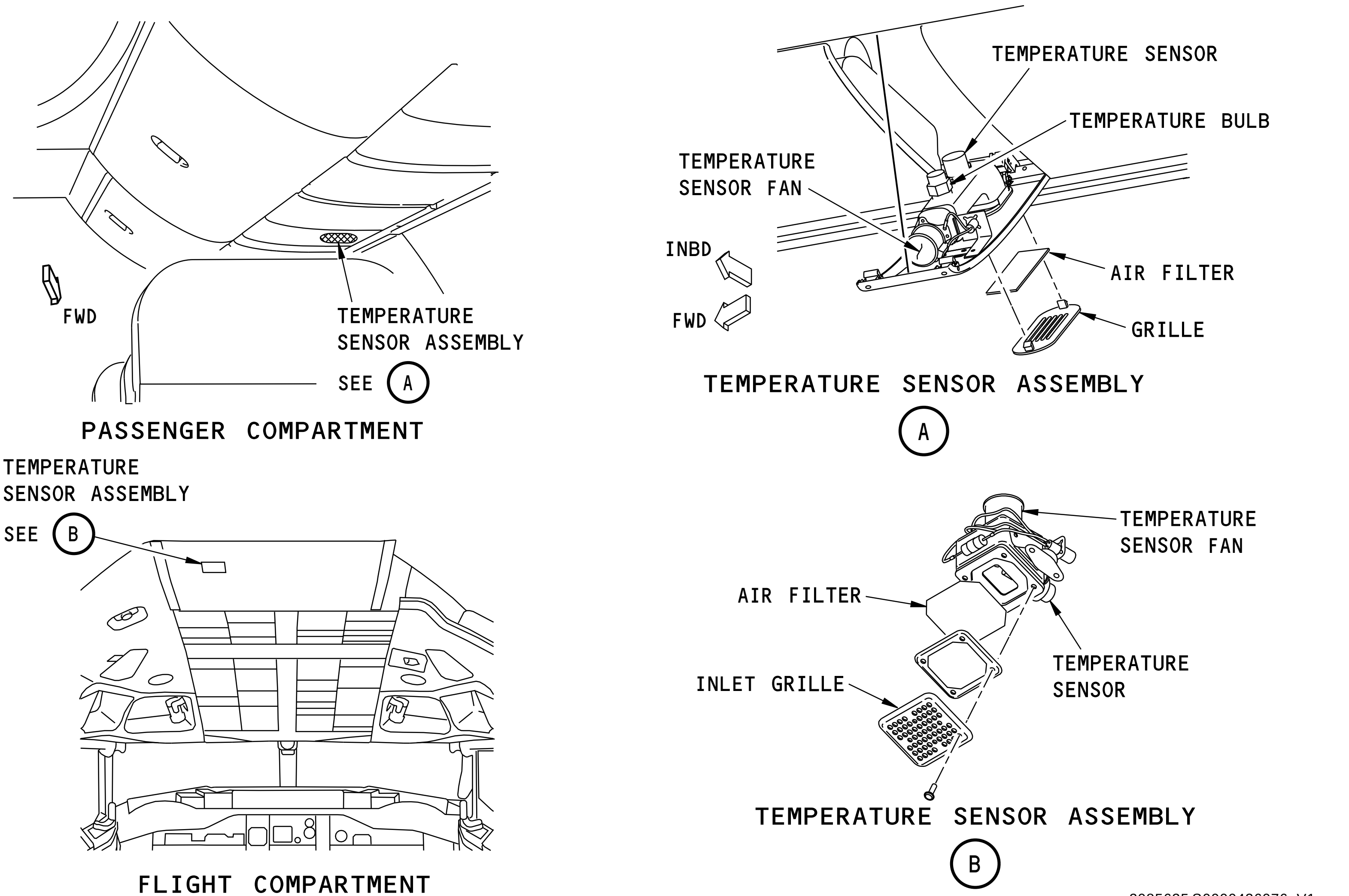
The cabin temperature sensor has two sensing elements.

Functional Description

The fan pulls in cabin air through the inlet grille and air filter. The cabin temperature sensor elements send the air temperature to the pack/zone temperature controllers. The pack/zone temperature controllers use this data to compare with the cabin temperature selectors.

Training Information Point

You must clean the cabin temperature sensor air filter regularly.



2085635 S0000436076_V1

AIR CONDITIONING - TEMPERATURE CONTROL - CABIN TEMPERATURE SENSOR ASSE

AIR CONDITIONING - TEMPERATURE CONTROL - DUCT TEMPERATURE SENSOR

Purpose

AKS 001-021

The duct temperature sensor gives duct temperature feedback to the pack/zone temperature controllers.

AKS 022-999

The duct temperature sensor gives duct temperature feedback to the pack flow temperature controllers.

AKS ALL

Location

There is a flight compartment duct temperature sensor and a backup duct temperature sensor. They are in the EE compartment on the left side adjacent to the E2 rack.

There is a forward and an aft passenger cabin duct temperature sensor. The forward cabin duct temperature sensor is in the overhead duct forward of the left forward riser. The aft passenger cabin duct temperature sensor is in the overhead duct aft of the right riser.

Physical Description

The duct temperature sensor is a single element sensor.

AKS 001-021

Functional Description

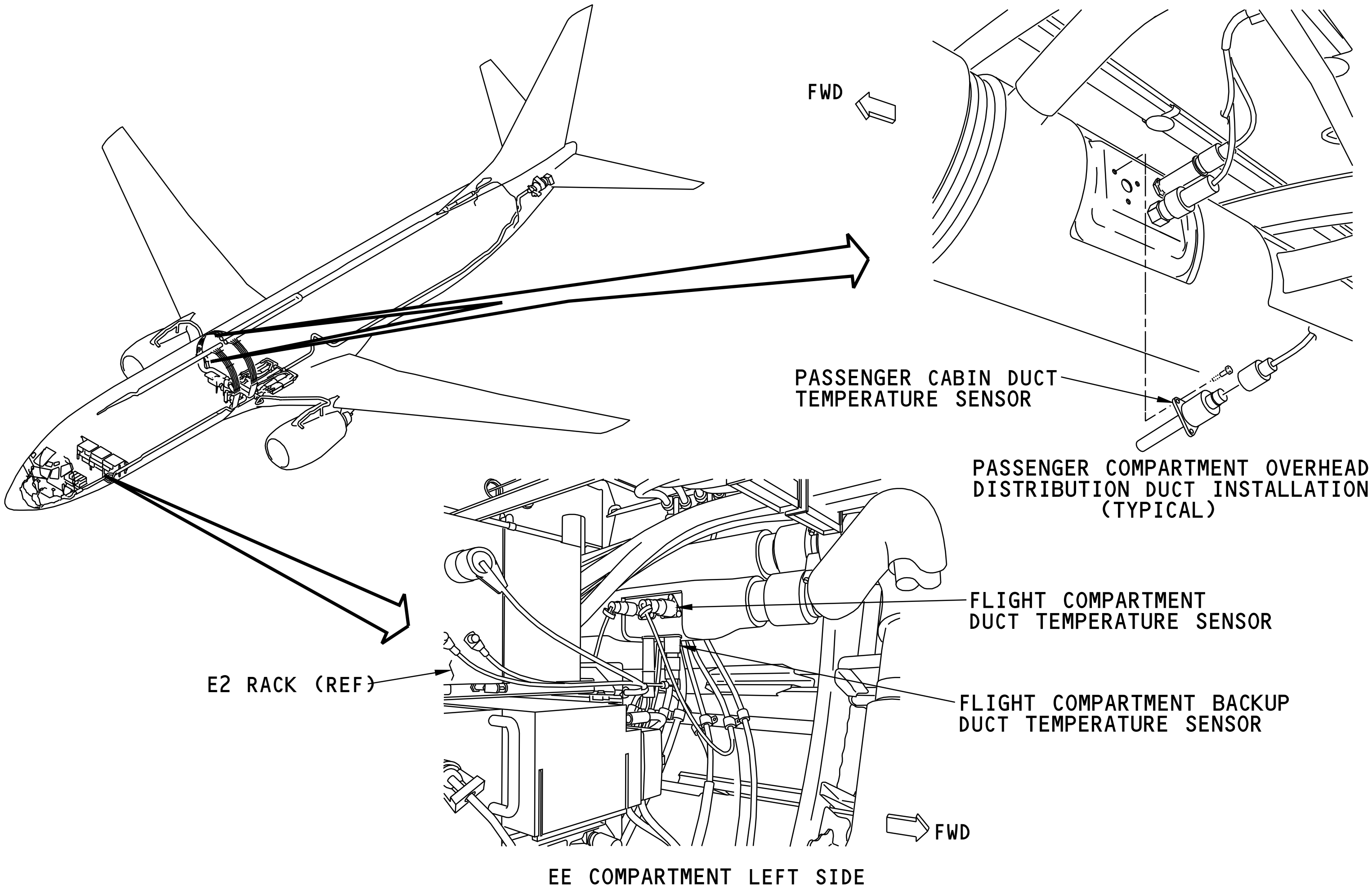
The duct temperature sensor sends the duct temperature to the pack/zone temperature controller. The pack/zone temperature controller uses this data to compare with a cabin temperature selector and cabin temperature sensor.

AKS 022-999

Functional Description

The duct temperature sensor sends the duct temperature to the pack flow temperature controller. The pack flow temperature controller uses this data to compare with a cabin temperature selector and cabin temperature sensor.

AKS ALL



M78723 S0004622031_V1

AIR CONDITIONING - TEMPERATURE CONTROL - DUCT TEMPERATURE SENSOR

AIR CONDITIONING - TEMPERATURE CONTROL - PACK/ZONE TEMPERATURE CONTROLLER

Purpose

The pack/zone temperature controllers do these functions:

- Control their air conditioning pack
- Give automatic standby control to the opposite air conditioning pack
- Control two zone trim air control channels
- Control their air conditioning pack ram air actuators
- Provide built-in test equipment (BITE) that isolates faults to the line replaceable unit (LRU).

Location

The pack/zone temperature controllers are in the EE compartment on the E3-3 rack.

General Description

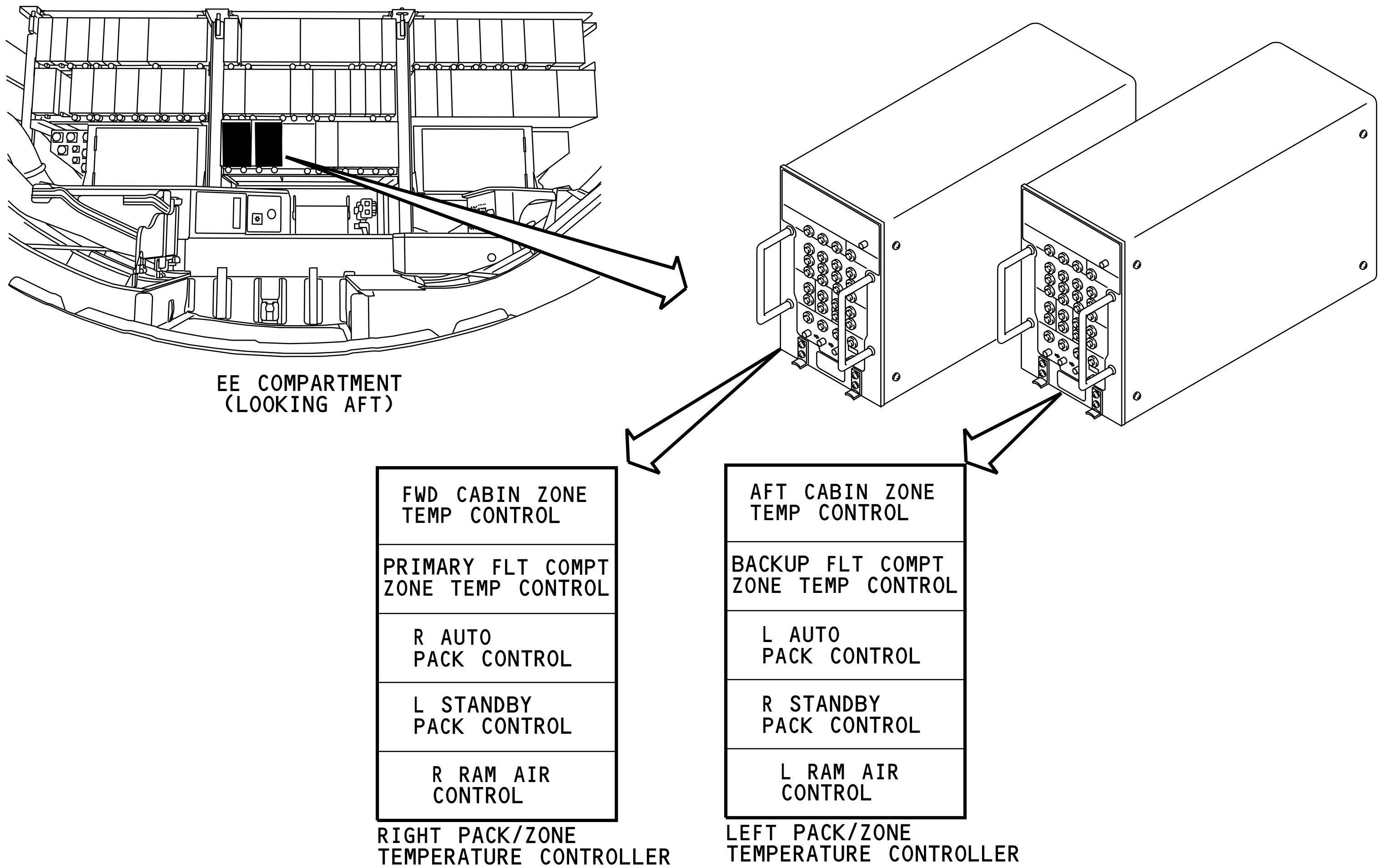
The pack/zone temperature controllers are identical and interchangeable. Their pin interface with the rack identifies them to the airplane systems.

Each pack/zone temperature controller has these control channels:

- Flight compartment zone temperature control channel
- Passenger cabin zone temperature control channel
- Auto pack temperature control channel
- Standby pack temperature control channel
- Ram air actuator control channel.

Training Information Point

The pack/zone temperature controllers are electrostatic discharge sensitive (ESDS) devices. Use ESDS safe handling techniques.



M78717 S0004622034_V1

AIR CONDITIONING - TEMPERATURE CONTROL - PACK/ZONE TEMPERATURE CONTROLLER

AIR CONDITIONING - TEMPERATURE CONTROL - PACK FLOW TEMPERATURE CONTROLLER

Purpose

The pack flow temperature controllers (PFTC) control these functions:

- Control the assigned air conditioning pack
- Provide automatic standby control to the opposite air conditioning pack
- Control two zone trim air control channels
- Provide Build-In Test Equipment (BITE) that isolates faults to a line replaceable unit (LRU)

Location

The pack flow temperature controllers are installed on the E3-3 rack in the E/E compartment.

General Description

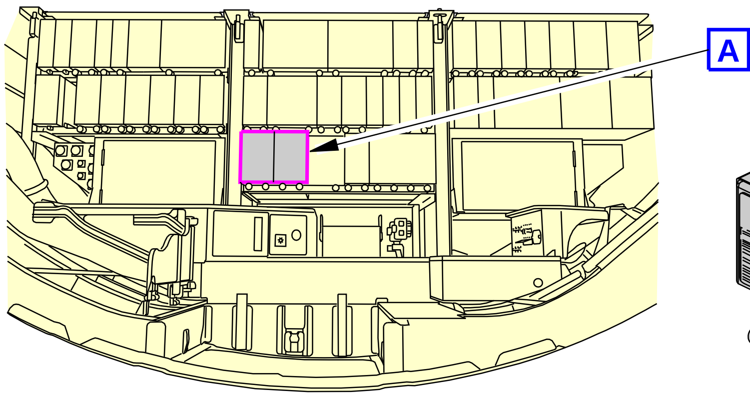
The pack flow temperature controllers are identical and interchangeable. Their pin interface with the rack identifies them to the airplane systems.

Each pack flow temperature controller has these control channels:

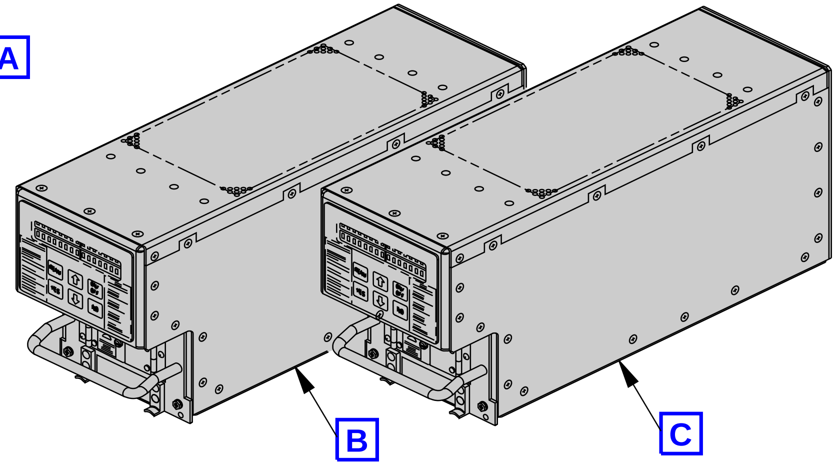
- Flight compartment zone temperature control channel
- Passenger cabin zone temperature and flow control channels
- Auto pack temperature control channel
- Standby pack temperature control channel

Training Information Point

The pack flow temperature controllers are electrostatic discharge sensitive (ESDS) devices. Use ESDS safe handling techniques.



EE COMPARTMENT
(LOOKING AFT)



A

FWD CABIN ZONE TEMP CONTROL
PRIMARY FLT COMPT ZONE TEMP CONTROL
R AUTO PACK CONTROL
L STANDBY PACK CONTROL

RIGHT PACK FLOW
TEMPERATURE CONTROLLER

B

AFT CABIN ZONE TEMP CONTROL
BACKUP FLT COMPT ZONE TEMP CONTROL
L AUTO PACK CONTROL
R STANDBY PACK CONTROL

LEFT PACK FLOW
TEMPERATURE CONTROLLER

C

2462519 S0000562048_V1

AIR CONDITIONING - TEMPERATURE CONTROL - PACK FLOW TEMPERATURE CONTROLLER

AIR CONDITIONING - TEMPERATURE CONTROL - TRIM AIR CHECK VALVE

Purpose

The trim air check valve prevents reverse airflow in the trim air supply ducts.

Location

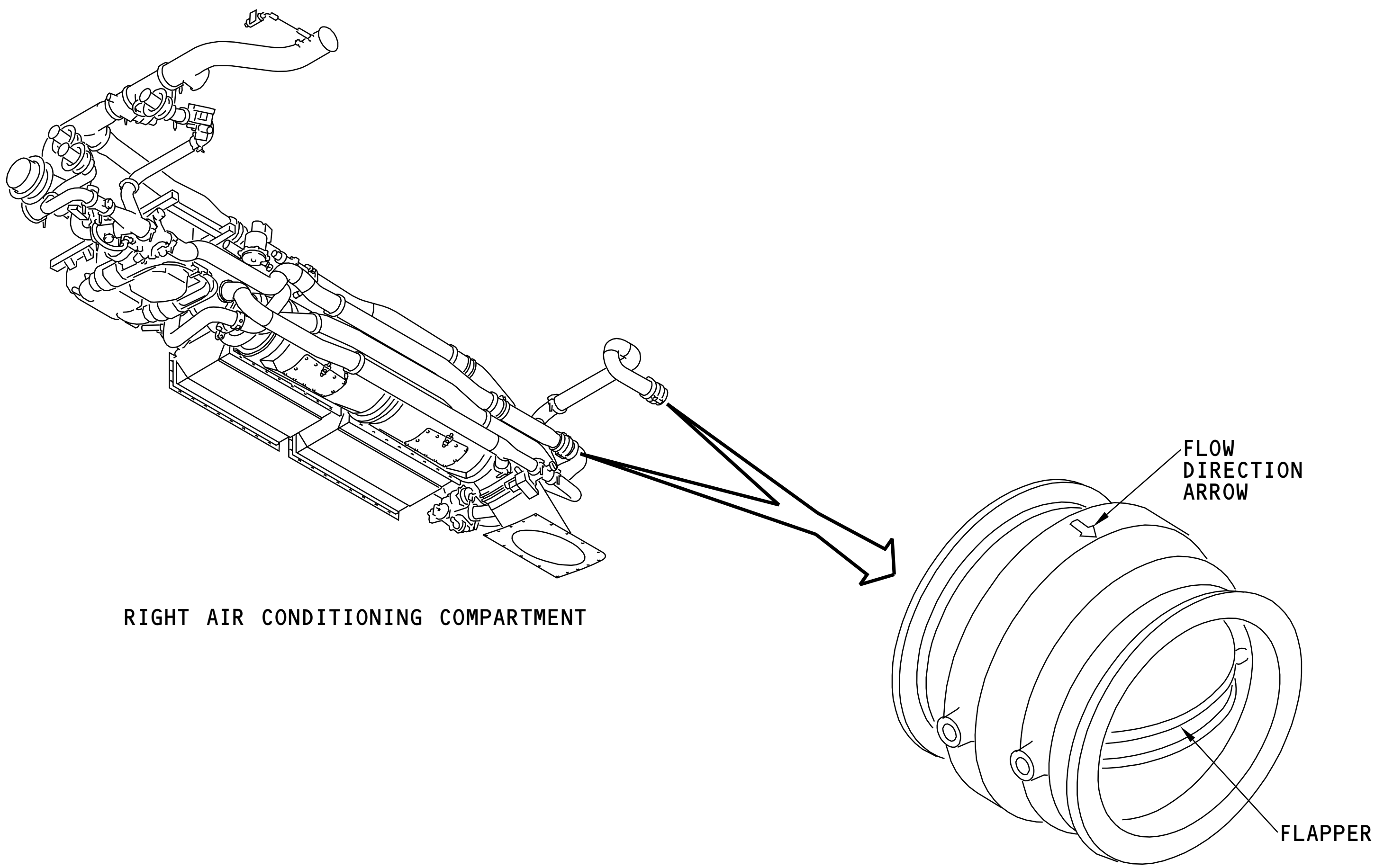
There are two trim air check valves. They are in the aft inboard area of the ECS bays.

Physical Description

The trim air check valves are split-flapper type check valves. They have a flow direction arrow cast into their flow bodies.

Training Information Point

The trim air check valves are identical and interchangeable.



M78719 S0004622037_V1

AIR CONDITIONING - TEMPERATURE CONTROL - TRIM AIR CHECK VALVE

AIR CONDITIONING - TEMPERATURE CONTROL - TRIM AIR PRESSURE REGULATING AND SHUTOFF VALVE

Purpose

The trim air pressure regulating and shutoff valve controls the flow and pressure of air to the zone trim air modulating valves.

Location

The trim air pressure regulating and shutoff valve is in the right air conditioning compartment.

Physical Description

The trim air pressure regulating and shutoff valve is a modulating and shutoff butterfly-type valve. The valve is spring-loaded to the closed position. It is electrically controlled and pneumatically actuated.

The valve has these parts:

- Solenoid valve assembly
- Actuator assembly
- Servo regulator assembly
- Manual override cam and position indicator
- Electrical connector.

Functional Description

The trim air pressure regulating and shutoff valve is the master trim air valve. It supplies trim air to the three zone trim air modulating valves. If the trim air pressure regulating and shutoff valve is closed, the three zone trim air systems are mechanically and electrically disabled.

The valve is spring loaded-closed. When the control solenoid is energized, it sends upstream pressure to the valve actuator. Pressure in the actuator opens the valve. The servo regulator moves the valve to keep pressure downstream of the valve 4.0 psi above airplane cabin altitude. This prevents pressure variation due to various flow demands of the zone trim air modulating valves.

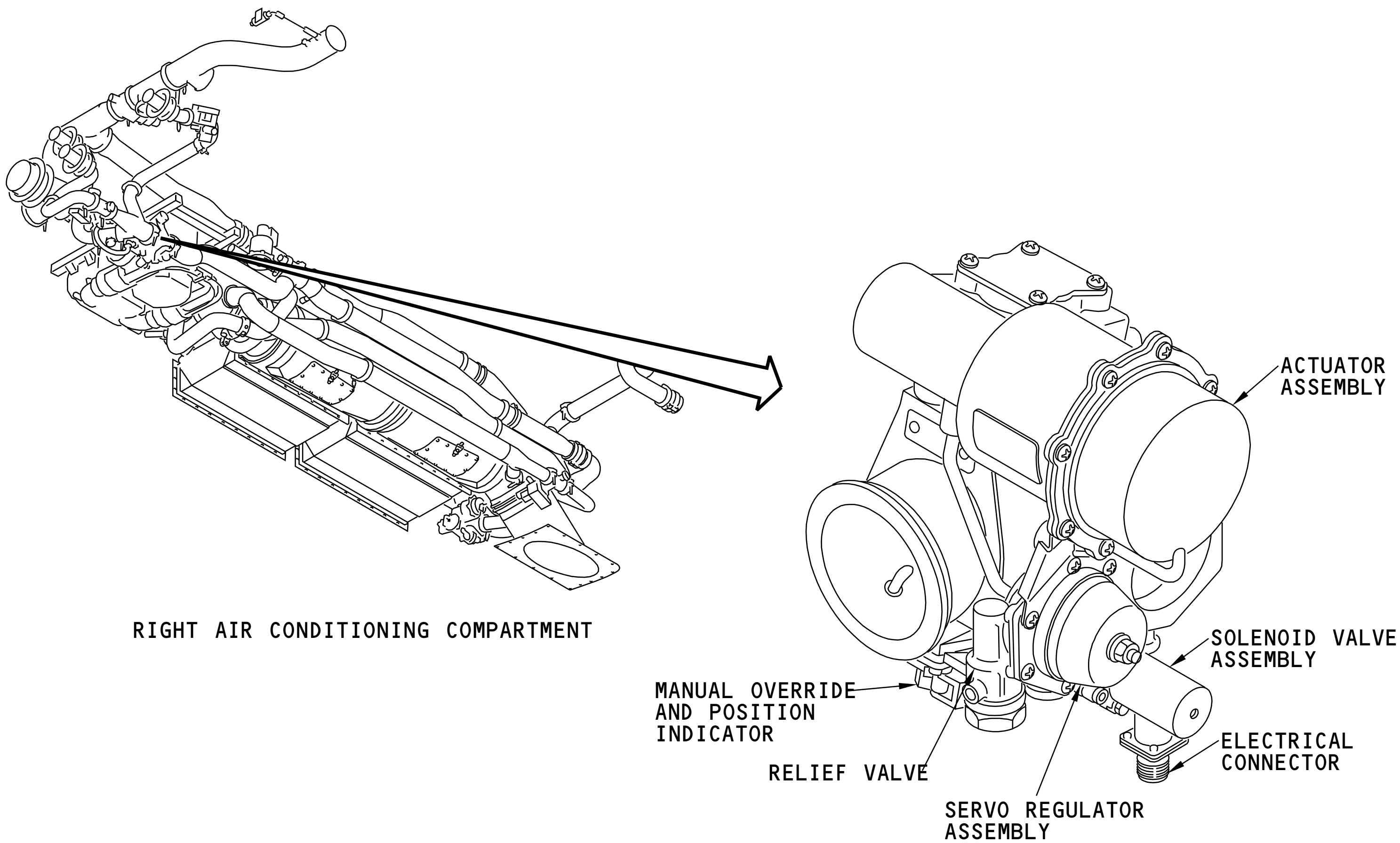
When the control solenoid de-energizes, it bleeds off the actuator pressure. The trim air pressure regulating and shutoff valve spring then pushes the valve closed.

Put the TRIM AIR switch to ON to open the trim air pressure regulating and shutoff valve. This also enables the zone trim air channels in the pack/zone temperature controllers.

Put the TRIM AIR switch to OFF to close the trim air pressure regulating and shutoff valve. This also disables the zone trim air system.

Training Information Point

There is a manual override cam and position indicator on the trim air pressure regulating and shutoff valve. You can manually turn the valve to the MANUAL CLOSED position. This vents the valve actuator and the valve closes.



M78721 S0004622040_V1

AIR CONDITIONING - TEMPERATURE CONTROL - TRIM AIR PRESSURE REGULATING AND SHUTOFF VALVE

AIR CONDITIONING - TEMPERATURE CONTROL - TRIM AIR PRSOV - FUNCTIONAL DESCRIPTION

Functional Description

The trim air pressure regulator and shutoff valve (PRSOV) gets unregulated air from the flow control and shut off valves (FCSOV).

The unregulated air goes to these components:

- Solenoid valve
- Relief valve
- Servo regulator (chamber A).

The servo regulator decreases the unregulated air to a constant control pressure.

The relief valve prevents damage to the pneumatic actuator if the servo regulator fails.

The solenoid valve controls the flow of control air to chamber B. Control air to chamber B opens the trim air PRSOV. Air then flows to the downstream sense port.

The downstream sense port supplies bleed air to the following:

- Chamber C
- Chamber D

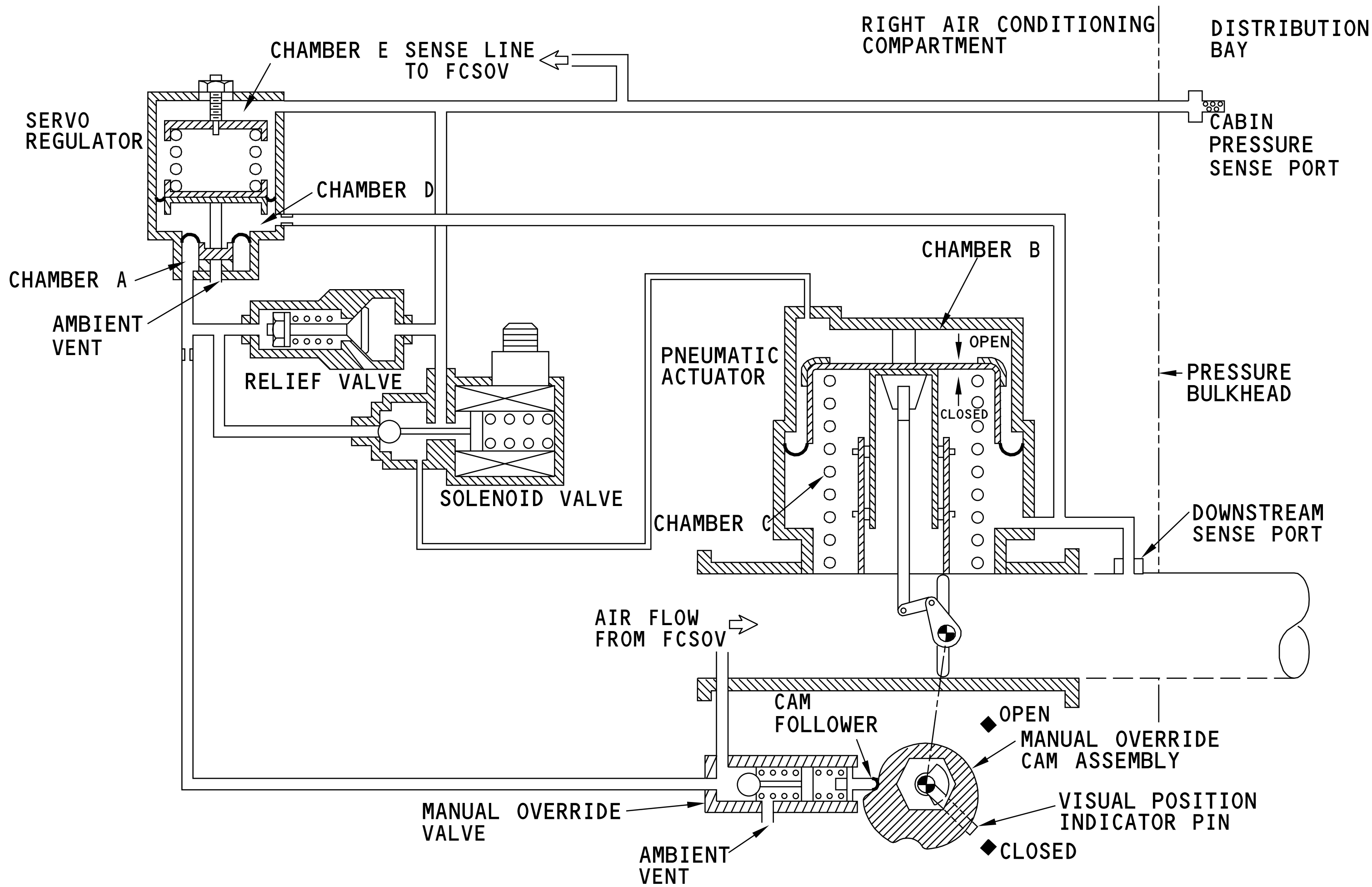
Bleed air in chamber C helps the actuator spring control the trim air PRSOV.

Bleed air in chamber D acts against cabin pressure and a spring in chamber E. This action controls the control air to chamber B. When the pressure in chamber B increases, the trim air PRSOV opens more. When pressure in chamber B decreases, the trim air PRSOV moves toward closed.

NOTE: The cabin sense port supplies cabin pressure to the FCSOV to control flow.

When you turn the manual override cam assembly, the manual override cam assembly moves the cam follower to close the manual override valve. This will shutoff unregulated air to these components:

- Solenoid valve
- Relief valve
- Servo regulator.



M78725 S0004622043_V2

AIR CONDITIONING - TEMPERATURE CONTROL - TRIM AIR PRSOV - FUNCTIONAL DESCRIPTION

AIR CONDITIONING - TEMPERATURE CONTROL - ZONE TRIM AIR MODULATING VALVE

Purpose

There are three zone trim air modulating valves. Each zone valve controls the flow of trim air to its related air conditioning zone:

- Flight compartment zone
- Forward passenger compartment zone
- Aft passenger compartment zone.

Location

The flight compartment zone trim air modulating valve is in the left air conditioning compartment.

The forward and aft zone trim air modulating valves are in the right air conditioning compartment.

Physical Description

The zone trim air modulating valves are electric motor-driven single plate butterfly valves. They are identical and interchangeable.

The valves have these parts:

- Electric motor assembly
- Position indicator
- Manual override knob
- Electrical connector.

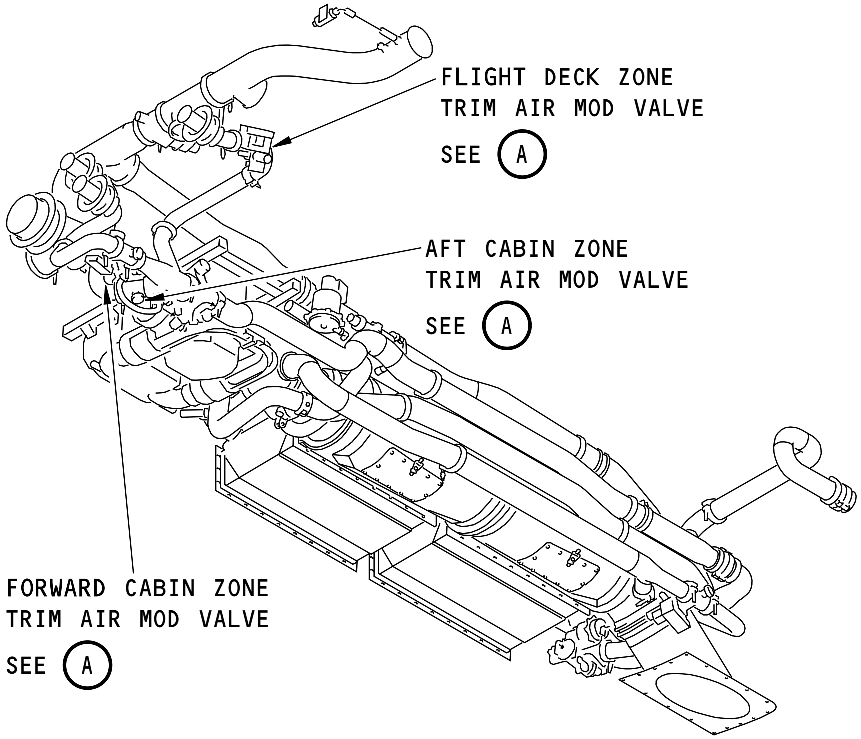
Functional Description

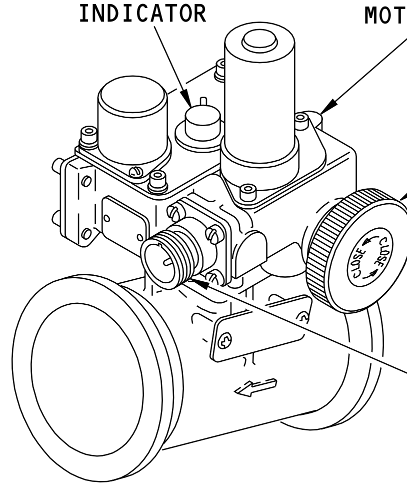
The valves use 115v ac power. The valve drive signals come from the pack zone controllers. A mechanical gear train with a slip clutch transfers motor motion to the valve.

Training Information Point

There is a position indicator on the zone trim air modulating valves. The valves are normally in the closed position when the trim air is off.

You can manually close the valve with the manual override knob if the electric motor fails. Turn the knob in the direction shown on the knob placard.





ZONE TRIM AIR MODULATING VALVE
(EXAMPLE)
A

M78726 S0004622045_V2

AIR CONDITIONING - TEMPERATURE CONTROL - ZONE TRIM AIR MODULATING VALVE

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AKS 001-021

Normal Function

When the trim air switch is in the ON position and the flight compartment temperature selector is in AUTO, the flight compartment trim air modulating valve connects to the right pack/zone temperature controller. This sends an enable signal to the two controllers to start control of the flight compartment temperature.

The selected zone temperature goes to the right pack/zone temperature controller and is compared with the actual temperature in the flight compartment. The difference makes a zone duct temperature demand. It is limited to 35F to 145F (2C to 63C). This demand is compared with the actual supply duct temperature and the difference is used to move the flight compartment trim air modulating valve.

The alternate power relay (K21) supplies electrical power from one of two different sources. When K21 energizes, 28v dc is from bus 1. When K21 deenergizes, 28v dc is from the battery bus.

AKS 022-999

Normal Function

When the trim air switch is in the ON position and the flight compartment temperature selector is in AUTO, the flight compartment trim air modulating valve connects to the right pack flow temperature controller. This sends an enable signal to the two controllers to start control of the flight compartment temperature.

The selected zone temperature goes to the right pack flow temperature controller and is compared with the actual temperature in the flight compartment. The difference makes a zone duct temperature demand. It is limited to 35F to 145F (2C to 63C). This demand is compared with the actual supply duct temperature and the difference is used to move the flight compartment trim air modulating valve.

The alternate power relay (K21) supplies electrical power from one of two different sources. When K21 energizes, 28v dc is from bus 1. When K21 de-energizes, 28v dc is from the battery bus.

AKS ALL

Non-Normal Function - System Overheat

When the temperature in the duct is 190F (88C), the duct overheat switch closes. This energizes the K6 flight deck zone overheat relay to the overheat position. When K6 is in the overheat position, K4 energizes to the close position, and the flight deck zone trim air modulating valve closes.

Non-Normal Function - Failure

The FAULT and INOP switches are set by these primary flight compartment component failures:

- Cabin temperature sensor
- Cabin temperature sensor interface
- Duct temperature sensor
- Duct temperature sensor interface
- Cabin temperature selector
- Cabin temperature selector interface
- Zone trim air modulating valve
- Zone trim air modulating valve driver.

When the FAULT switch is set, K3 relaxes. This connects the backup flight compartment zone control to the flight compartment zone trim air valve. The backup flight compartment zone control controls the flight compartment trim air modulating valve with the same logic as the primary flight compartment zone control.

The backup FAULT switch is set by these backup flight compartment component failures:

- Cabin temperature sensor
- Cabin temperature sensor interface
- Duct temperature sensor

- Duct temperature sensor interface
- Cabin temperature selector
- Cabin temperature selector interface
- Zone trim air modulating valve
- Zone trim air modulating valve driver.

The backup INOP switch is set by these backup flight compartment component failures:

- Cabin temperature sensor
- Cabin temperature sensor interface
- Cabin temperature selector
- Cabin temperature selector interface.

NOTE: Failure of the temperature selector causes a default to a 75F (24C) set point.

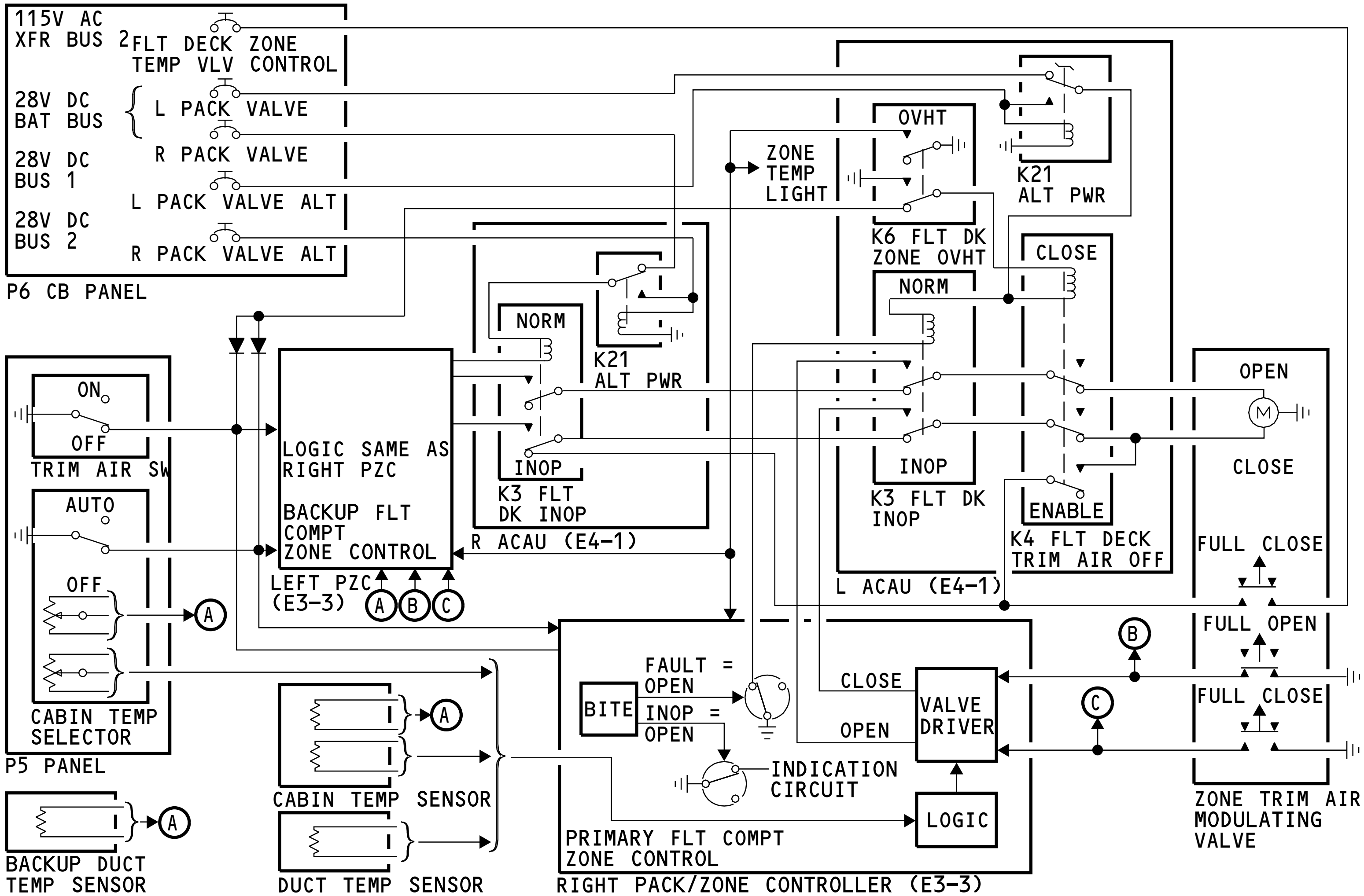
AKS 001-021

When the primary and backup flight compartment zone controls fail, the zone temperature control system is off. This off signal goes to the pack control section of the pack/zone controllers. The left pack/zone controller controls the left pack to satisfy the flight compartment zone duct demand. The right pack/zone controller controls the right pack to satisfy the coolest temperature requirements for the passenger compartments.

AKS 022-999

When the primary and backup flight compartment zone controls fail, the zone temperature control system is off. This off signal goes to the pack control section of the pack flow controllers. The left pack flow controller controls the left pack to satisfy the flight compartment zone duct demand. The right pack flow controller controls the right pack to satisfy the coolest temperature requirements for the passenger compartments.

AKS ALL



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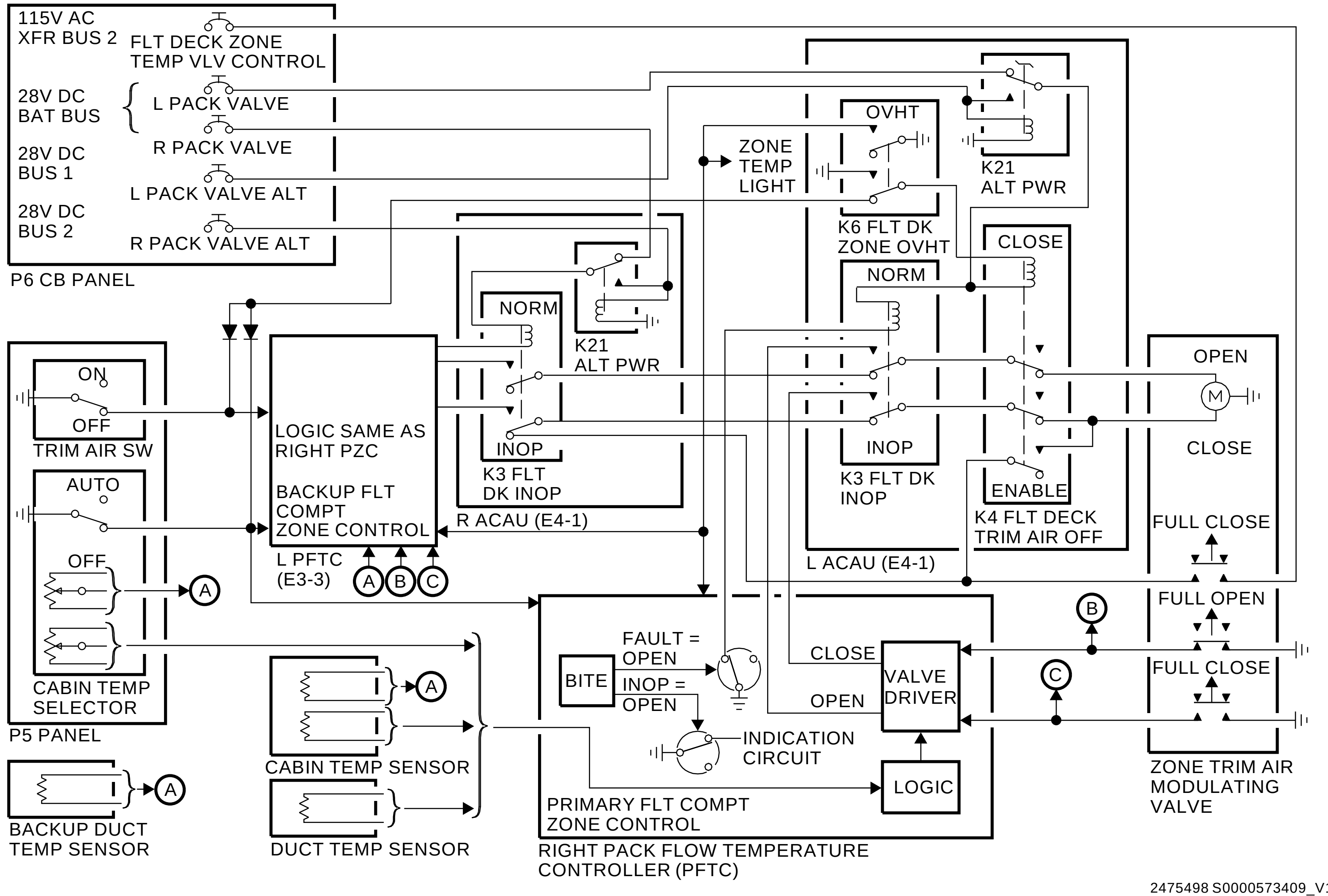
AIR CONDITIONING - TEMPERATURE CONTROL - FLIGHT COMPARTMENT - FUNCTIONAL DESCRIPTION



AIR CONDITIONING - TEMPERATURE CONTROL - FLIGHT COMPARTMENT - FUNCTIONAL DESCRIPTION

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AIR CONDITIONING - TEMPERATURE CONTROL - PASSENGER COMPARTMENT - FUNCTIONAL DESCRIPTION

AKS 001-021

Normal Function

When the trim air switch is in the ON position and the passenger compartment temperature selector is in AUTO, the passenger compartment trim air modulating valve connects to the right pack/zone temperature controller.

The alternate power relay (K21) supplies electrical power from one of two different sources. When K21 energizes, 28v dc is from bus 1. When K21 de-energizes, 28v dc is from the battery bus.

The selected zone temperature goes to the pack/zone temperature controller and is compared with the actual temperature in the passenger compartment. The difference makes a zone duct temperature demand. The limits are 35F to 160F (2C to 71C). This demand is compared with the actual supply duct temperature and the difference is used to move the passenger compartment trim air modulating valve.

AKS 022-999

Normal Function

When the trim air switch is in the ON position and the passenger compartment temperature selector is in AUTO, the passenger compartment trim air modulating valve connects to the right pack flow temperature controller.

The alternate power relay (K21) supplies electrical power from one of two different sources. When K21 energizes, 28v dc is from bus 1. When K21 de-energizes, 28v dc is from the battery bus.

The selected zone temperature goes to the pack flow temperature controller and is compared with the actual temperature in the passenger compartment. The difference makes a zone duct temperature demand. The limits are 35F to 160F (2C to 71C). This demand is compared with the actual supply duct temperature and the difference is used to move the passenger compartment trim air modulating valve.

AKS ALL

Non-Normal Function - System overheat

When the temperature in the duct is 190F (88C), the duct overheat switch closes. This energizes K1 passenger zone overheat relay to the overheat position. When K1 is in the overheat position, K2 passenger trim air off relay energizes to the close position and the passenger zone trim air modulating valve closes.

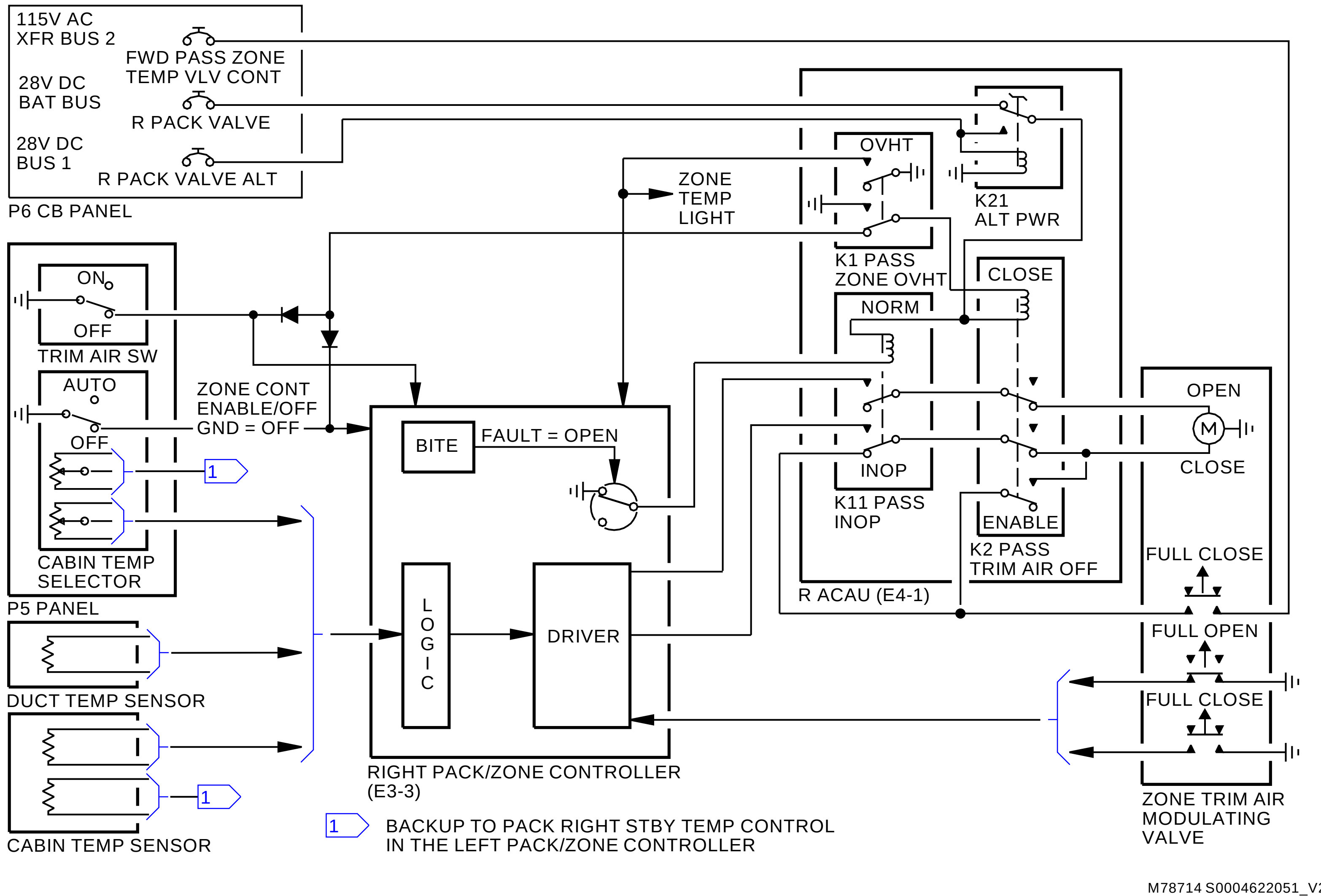
Non-Normal Function - System Failure

The FAULT switch is set by these passenger compartment failures:

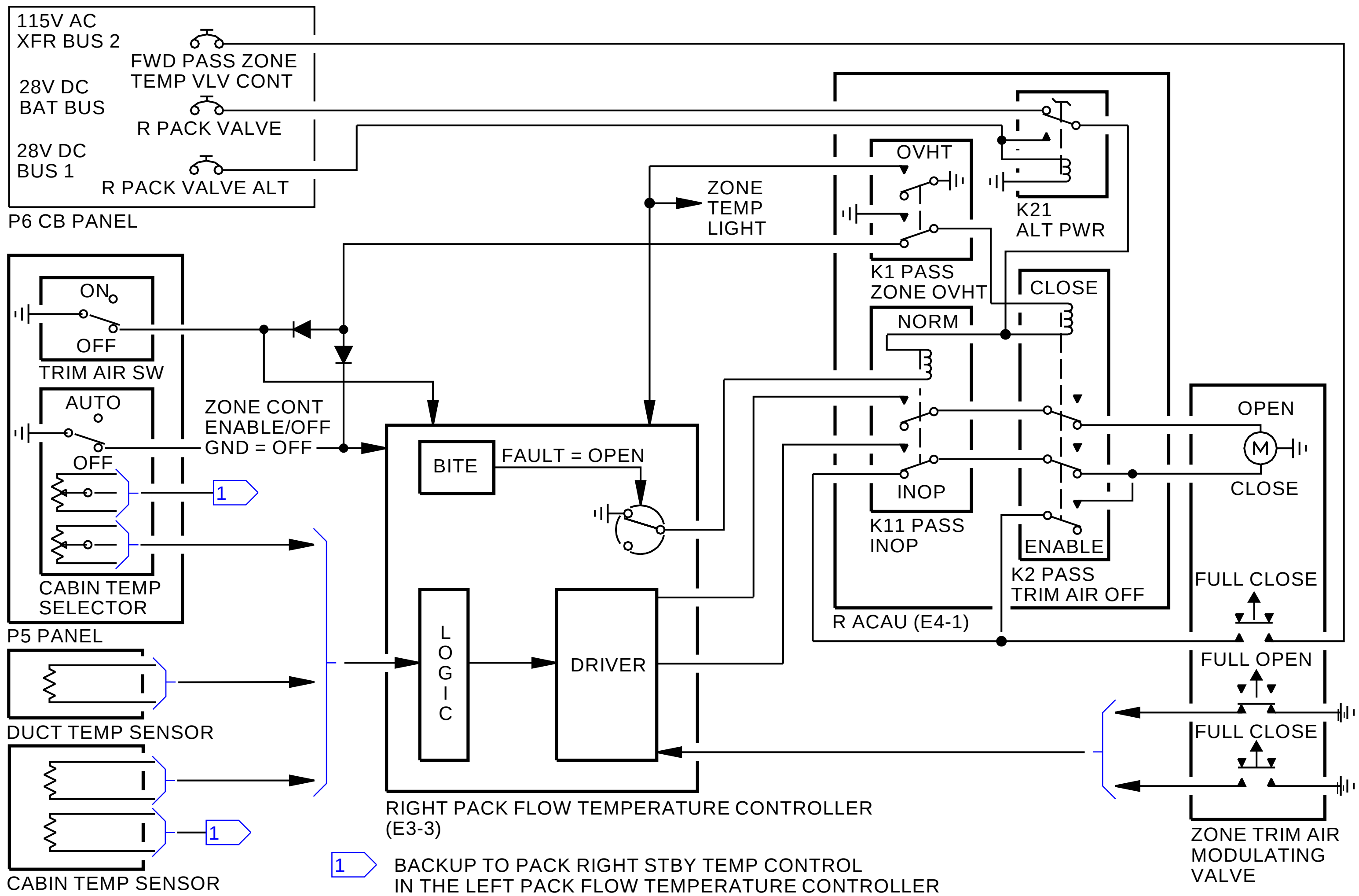
- Cabin temperature sensor
- Cabin temperature sensor interface
- Duct temperature sensor
- Duct temperature sensor interface
- Cabin temperature selector
- Cabin temperature selector interface
- Zone trim air modulating valve
- Zone trim air modulating valve driver.

NOTE: Failure of the temperature selector causes a default to a 75F (24C) set point.

These failures cause K11 passenger INOP relay to relax and command the passenger zone trim air modulating valve to close.



AIR CONDITIONING - TEMPERATURE CONTROL - PASSENGER COMPARTMENT - FUNCTIONAL DESCRIPTION



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AIR CONDITIONING - TEMPERATURE CONTROL - PASSENGER COMPARTMENT - FUNCTIONAL DESCRIPTION

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AIR CONDITIONING - TEMPERATURE CONTROL - DUCT OVERHEAT SWITCH

Purpose

The duct overheat switch sends an overheat signal to close the trim air modulating valve. Also, it sends a signal to turn on the ZONE TEMP light.

Location

The flight compartment duct overheat switch is in the EE compartment on the left side adjacent to the E2 rack.

There is a forward and an aft passenger cabin duct overheat switch. The forward cabin duct overheat switch is in the overhead duct forward of the left forward riser. The aft passenger cabin duct overheat switch is in the overhead duct aft of the right aft riser.

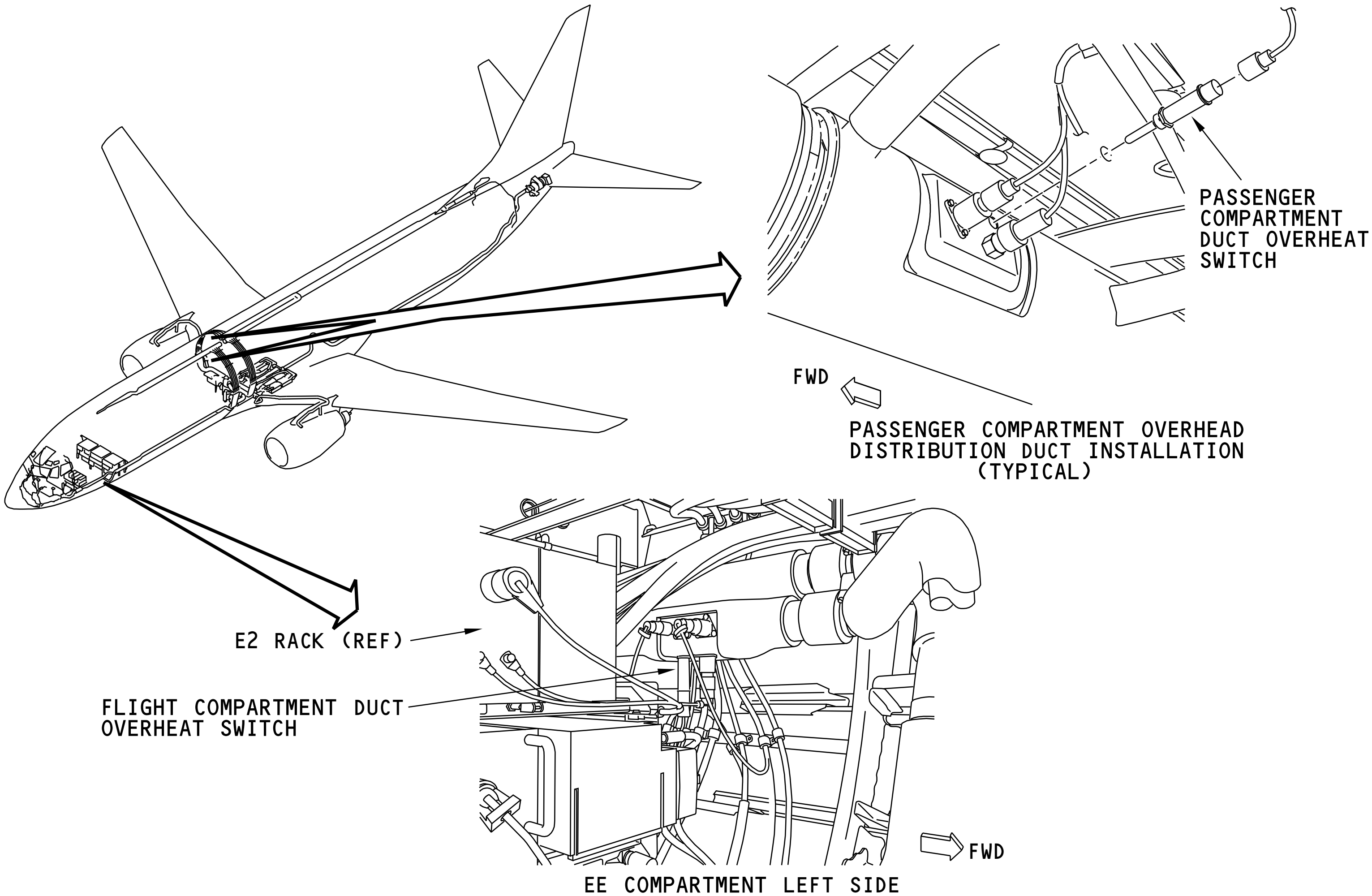
Physical Description

The duct overheat switch is vapor pressure actuated switch. The duct overheat switch has these parts:

- Probe
- Electrical connector

Functional Description

When the temperature in the duct is 190F (88C), a liquid in the probe creates a vapor. The vapor in the probe operates a spring that operates an electrical switch. This energizes a relay in the air conditioning accessory unit. The relay turns on the ZONE TEMP light and closes the trim air modulating valve.



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AIR CONDITIONING - TEMPERATURE CONTROL - DUCT OVERHEAT SWITCH

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AIR CONDITIONING - TEMPERATURE CONTROL - FUNCTIONAL DESCRIPTION

General

The airplane has two cooling packs that convert hot, high pressure air from the engine compressor into cool, low pressure air for the cabin areas. The packs are controlled by two integrated pack/zone cabin temperature controllers (CTCs). Each CTC has a digital primary channel to control its associated cooling pack, and an analog channel that provides backup control for the opposite cooling pack.

The CTCs also control the trim air system that allows independent temperature control of the flight compartment and passenger cabin. The temperature control system provides independent temperature control in each of these three zones:

- Control Cabin
- Forward Passenger Cabin
- Aft Passenger Cabin.

The CTCs control the cooling pack outlet temperature to match the zone with the lowest temperature requirement and the trim air system adds heat to the other zones to meet their temperature requirement.

The right CTC provides temperature control for the forward passenger zone and primary temperature control for the flight compartment zone. The left CTC provides temperature control for the aft passenger zone and standby temperature control for the flight compartment zone.

The temperature control system operation is automatic, including automatic re-configuration of standby and backup functions to maintain temperature control during failure conditions.

Control

The temperature controls and indications for the flight compartment (CONT CAB), forward passenger compartment (FWD CAB), and the aft passenger compartment (AFT CAB) are located on the cabin temperature control panel, P5-17.

Three temperature selector switches allow different temperature settings for each zone. The temperature signal from the selector switch goes to the CTC. The CTC compares the requested zone temperature setting to the actual temperature values from the zone, duct and pack temperature sensors. Each temperature selector switch also has an OFF position that removes trim air from the associated zone.

The TRIM AIR switch is in the ON position for normal operation. Putting the TRIM AIR switch in the OFF position disables the trim air supply to all zones.

Operation

The temperature control system operates when the pack Flow Control and Shutoff Valve is open and there are no critical fault conditions. The air conditioning accessory units (ACAU) provide the discrete outputs that enable or disable operation of the cooling pack and the temperature control system components.

The TRIM AIR switch is in the ON position for normal operation. This causes the Trim Air Pressure Regulating and Shutoff Valve (PRSOV) to open and regulate the pressure in the trim air ducts to approximately 4 psi above the cabin pressure. Putting the TRIM AIR switch in the OFF position closes the Trim Air PRSOV to disable the trim air supply to all zones.

The temperature selector switches allow a range of desired temperature settings from approximately 65F to 85F (18C to 29C). There is also an OFF position for each temperature selector switch that closes the associated zone trim air modulating valve to remove the trim air supply from the zone.

For normal operation, the CTC calculates the correct pack outlet temperature for the zone with the lowest temperature setting. Both packs are controlled to provide the pack outlet temperature that matches the zone with the lowest setting. Hot trim air is supplied to the other two zones by the trim air modulating valves to increase the supply duct air temperature to match the desired zone temperature.

If the CTC detects a fault associated with the flight compartment trim air supply, then the trim air system operates in the split packs mode. In this mode, the left pack outlet temperature is controlled to match the temperature setting for the flight compartment and the right pack outlet temperature is controlled to match the lower of the temperature settings for the forward and aft passenger compartments. Hot trim air is supplied to the other passenger cabin zone to increase its supply duct air temperature to match the desired zone temperature.

If the CTC detects a fault associated with the passenger cabin trim air supply, or if the trim air supply is selected off, then the trim air system operates in the average zone mode. In this mode, the left pack outlet temperature is controlled to match the temperature setting for the flight compartment and the right pack outlet temperature is controlled to match the average of the temperature settings for the forward and aft passenger compartments. Trim air is commanded off.

Each CTC provides the following functions:

- Control of the pack outlet temperature by positioning the temperature control valve (TCV)

AKS 001-021

- Standby control of the opposite pack outlet temperature by positioning the standby TCV

AKS ALL

- Control of the pack compressor temperature by modulating the ram air flow
- Control of the cabin zone temperature to values between 65F and 85F (18C to 29C)
- Control of the zone supply duct temperature to values between 35F and 145F (2C and 63C)
- Automatic re-configuration of standby and backup functions for fault conditions
- Automatic fault detection and fault isolation of associated components (BITE)
- Output of system status information for display on the P5 temperature control panel.

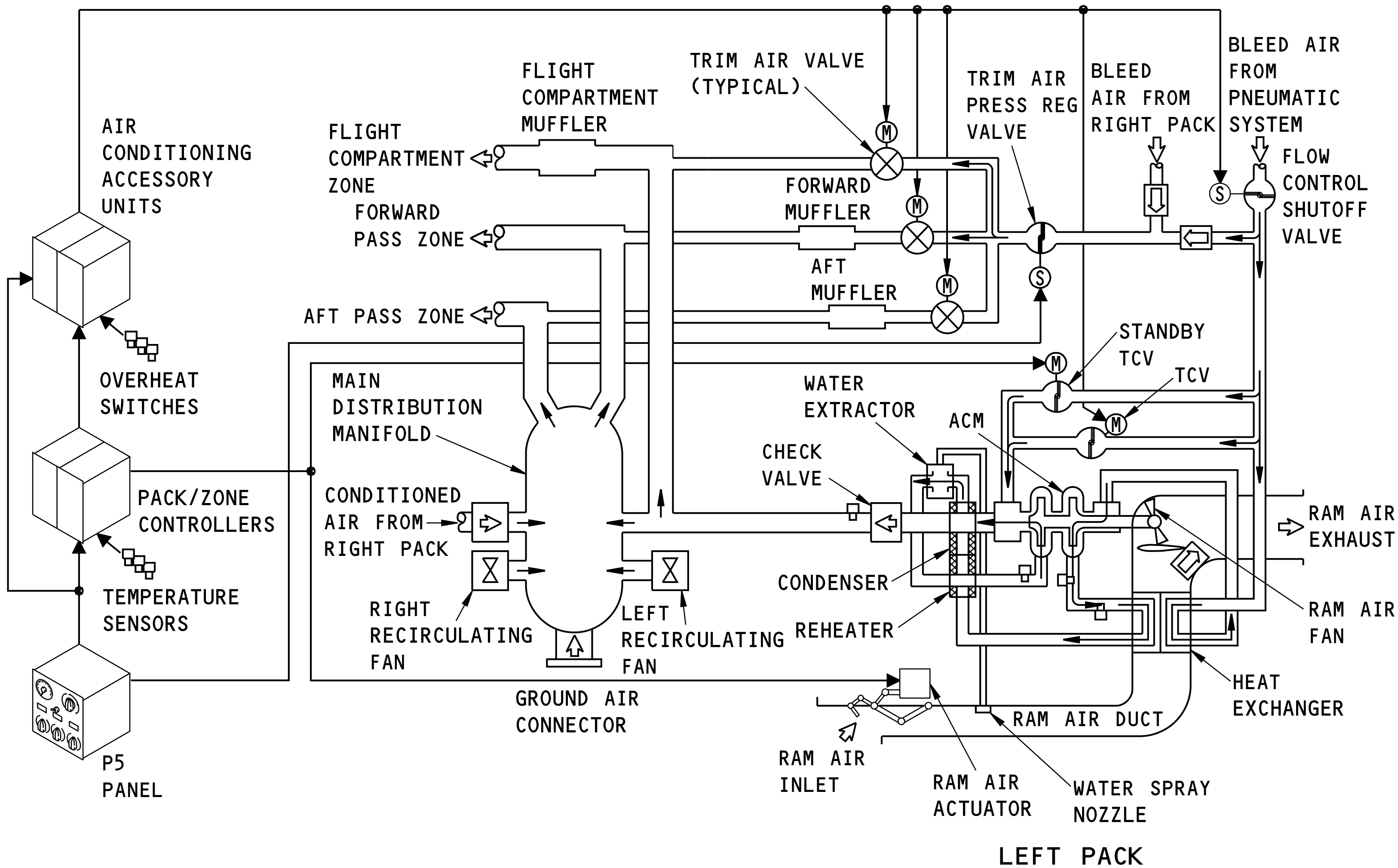
Indication

The TEMP (temperature) indicator can show the temperature in any of these areas:

- Control cabin supply duct
- Forward passenger cabin supply duct
- Aft passenger cabin supply duct
- Forward cabin zone
- Aft passenger cabin zone
- Left pack outlet
- Right pack outlet.

. The AIR TEMP selector switch connects different temperature sensors to the indicator to provide the desired indication.

If the temperature in a zone distribution duct is more than 190F (88C), the duct overheat switch sends a signal to the ACAU. The ACAU sends a signal to activate the ZONE TEMP light on the P5 temperature control panel and commands the TCV to the full cold position (closed).



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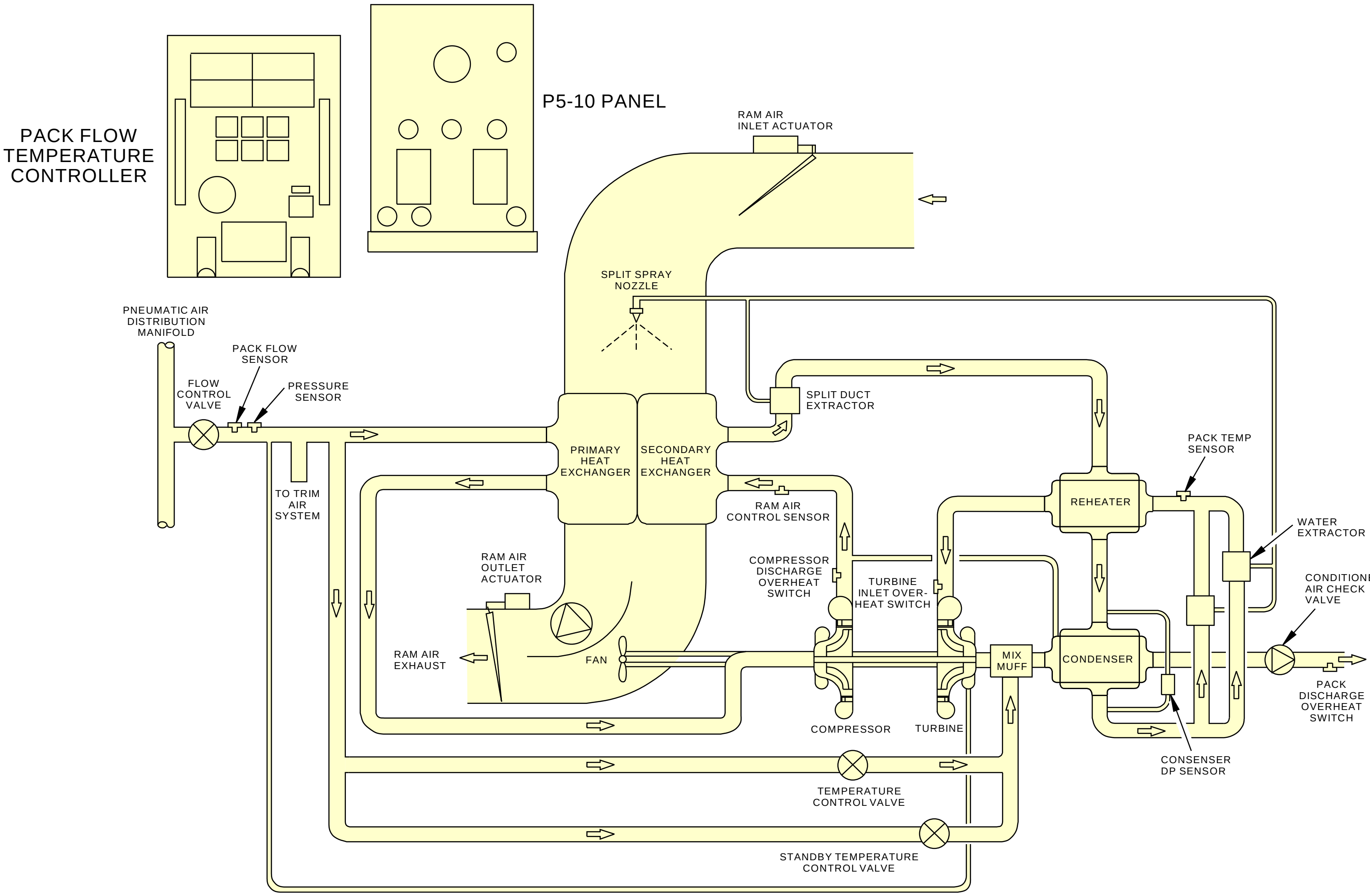
AIR CONDITIONING - TEMPERATURE CONTROL - FUNCTIONAL SCHEMATIC



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AIR CONDITIONING - TEMPERATURE CONTROL - FUNCTIONAL SCHEMATIC

AIR CONDITIONING - TEMPERATURE CONTROL - BALANCED MODE - FUNCTIONAL DESCRIPTION

General Description

The temperature control system controls the temperature in three airplane air conditioning zones:

- Flight compartment
- Forward passenger compartment
- Aft passenger compartment.

The temperature control system is automatic. The flight crew makes the necessary selections on the temperature controls panel to operate the system.

AKS 001-021

During operation, the pack/zone temperature controllers control pack discharge temperature to the requirements of the zone that requires the most cooling. They control the temperature control valves to control the pack discharge temperature. Both packs output the same temperature. This is called balanced mode.

The pack/zone temperature controllers control the trim air modulating valves to inject hot trim air into the ducts of the other zones. This increases the temperature of the air supply to the three zones.

AKS 022-999

During operation, the pack flow temperature controllers control pack discharge temperature to the requirements of the zone that requires the most cooling. They control the temperature control valves to control the pack discharge temperature. Both packs output the same temperature. This is called balanced mode.

The pack flow temperature controllers control the trim air modulating valves to inject hot trim air into the ducts of the other zones. This increases the temperature of the air supply to the three zones.

AKS 001-021

Functional Description

In the compartment zone temperature controls, the pack/zone temperature controllers compare the compartment temperature selections with the temperature in the zone. The error signal from this comparison is called DUCT DEMAND. This signal is used for two purposes. It is used in the zone temperature controls to control the trim air modulating valves. Also, it is used in the auto pack controls to control the temperature control valves.

The DUCT DEMAND signal has a 35F(2C) to 145F(63C) temperature limit for the flight compartment duct and a 35F(2C) to 160F(71C) for the passenger compartment duct. It is compared with the temperature in the duct and the result is used to control the trim air modulating valves.

The DUCT DEMAND signal from the compartment zone temperature controls are compared in the auto pack controls to find the coolest demand of the zones. This signal is called PARTIAL PACK DEMAND. The PARTIAL PACK DEMAND is shared between the two pack/zone temperature controllers and compared to find the coolest signal. This signal is called PACK DEMAND and has a 35F(2C) to 145F(63C) temperature limit. The PACK DEMAND is used to control the temperature control valves in each of the packs. It is also used as the STANDBY PACK DEMAND signal for the other pack in case of a failure. The mix manifold temperature sensors provide feedback to the auto pack controls. They are used to prevent ice in the mix manifold.

AKS 022-999

Functional Description

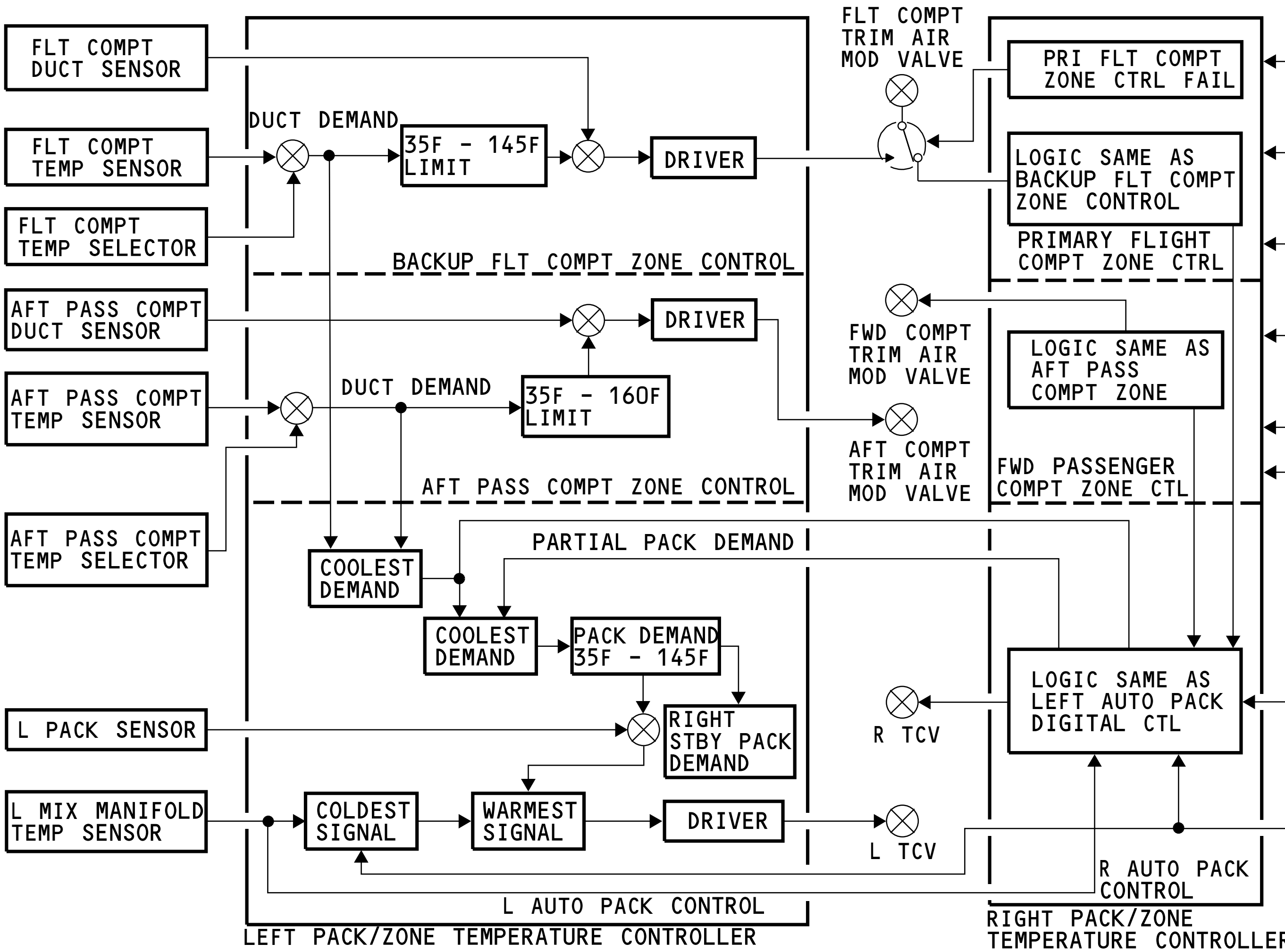
In the compartment zone temperature controls, the pack flow temperature controllers compare the compartment temperature selections with the temperature in the zone. The error signal from this comparison is called DUCT DEMAND. This signal is used for two purposes. It is used in the zone temperature controls to control the trim air modulating valves. Also, it is used in the auto pack controls to control the temperature control valves.

AKS 022-999 (Continued)

The DUCT DEMAND signal has a 35F(2C) to 145F(63C) temperature limit for the flight compartment duct and a 35F(2C) to 160F(71C) for the passenger compartment duct. It is compared with the temperature in the duct and the result is used to control the trim air modulating valves.

The DUCT DEMAND signal from the compartment zone temperature controls are compared in the auto pack controls to find the coolest demand of the zones. This signal is called PARTIAL PACK DEMAND. The PARTIAL PACK DEMAND is shared between the two pack flow temperature controllers and compared to find the coolest signal. This signal is called PACK DEMAND and has a 35F(2C) to 145F(63C) temperature limit. The PACK DEMAND is used to control the temperature control valves in each of the packs. It is also used as the STANDBY PACK DEMAND signal for the other pack in case of a failure. The mix manifold temperature sensors provide feedback to the auto pack controls. They are used to prevent ice in the mix manifold.

AKS ALL



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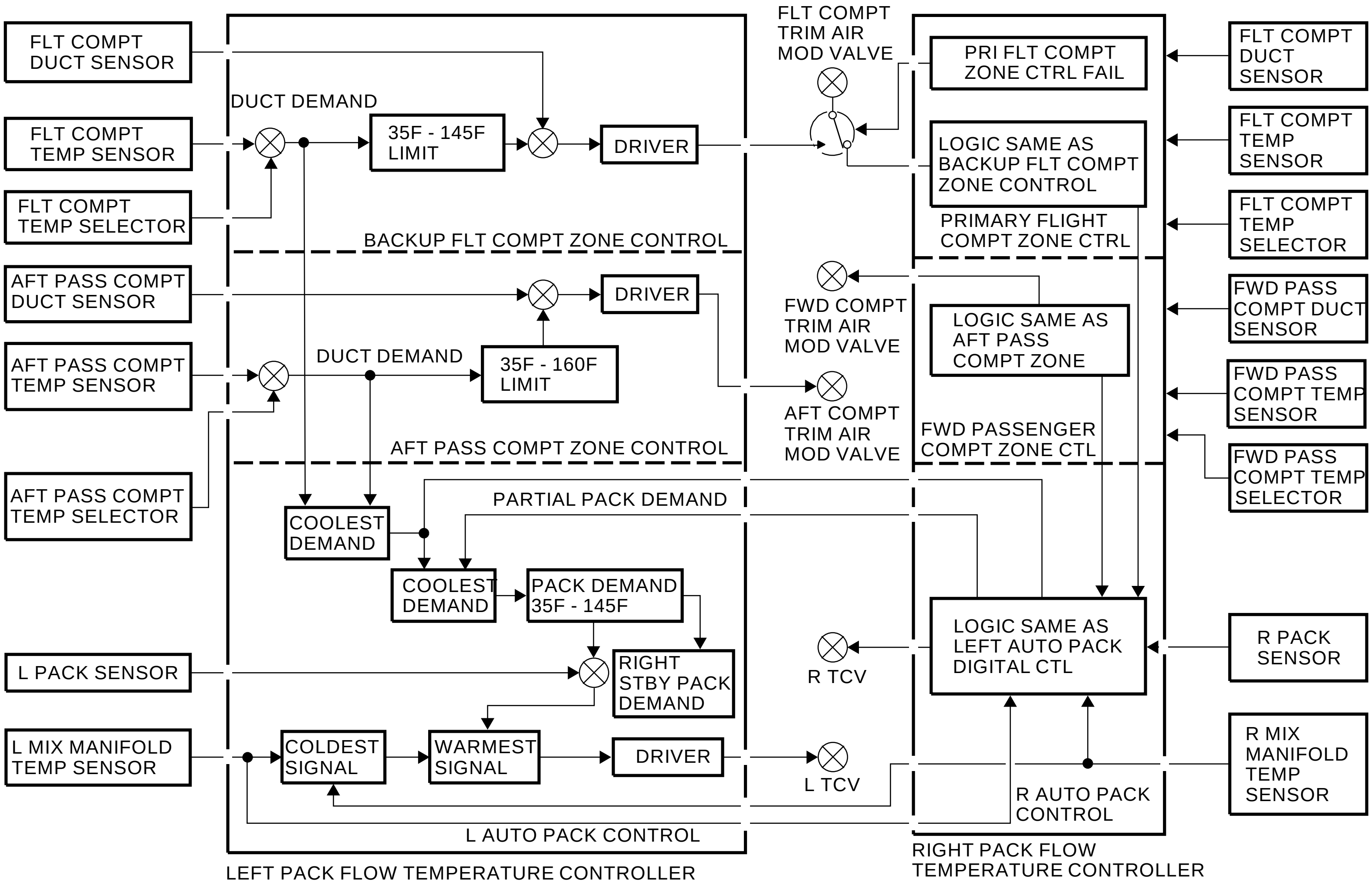
AIR CONDITIONING - TEMPERATURE CONTROL - BALANCED MODE - FUNCTIONAL DESCRIPTION



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AIR CONDITIONING - TEMPERATURE CONTROL - BALANCED MODE - FUNCTIONAL DESCRIPTION

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AIR CONDITIONING - TEMPERATURE CONTROL - UNBALANCED MODE - FUNCTIONAL DESCRIPTION

General Description

The unbalanced mode is when the flight compartment trim air system fails or the trim air switch is OFF.

There are two unbalanced modes of operation:

- Unbalanced
- Unbalanced average.

Unbalanced

The right pack is controlled to satisfy the colder demand of the two passenger compartment temperature zones. The left pack is controlled to satisfy only the temperature requirements of the flight compartment.

The backup flight compartment cabin temperature sensor and cabin temperature selector provide the pack demand signal to the left auto pack control.

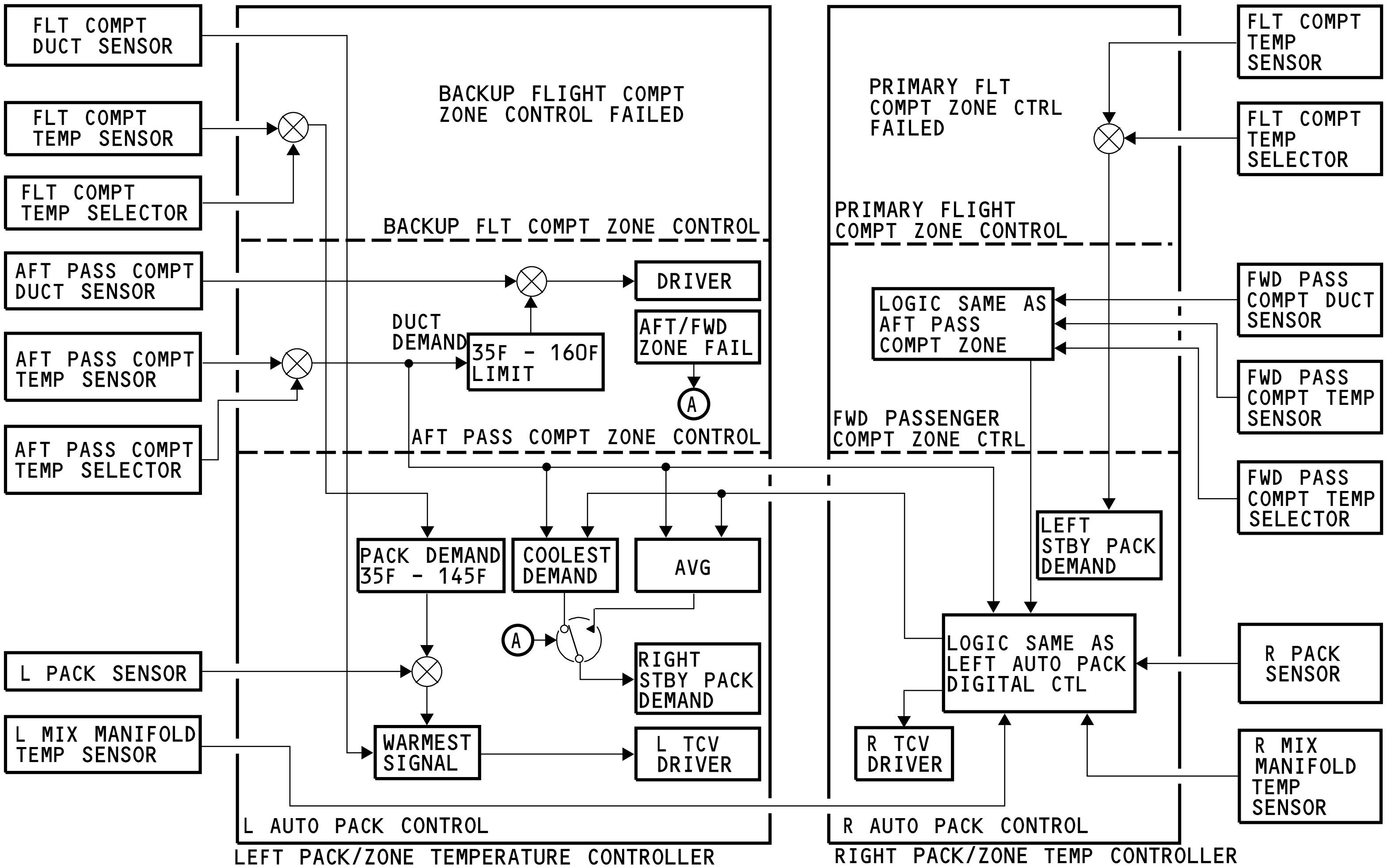
The backup flight compartment duct temperature sensor signal is used to provide a 35F(2C) limit in the flight compartment duct.

The primary flight compartment cabin temperature sensor and cabin temperature selector provide the standby pack demand signal to the right auto pack control.

Unbalanced Average Mode

The unbalanced average mode of operation is activated if the trim air switch is OFF or if either of the passenger compartment temperature zones fail.

This mode is the same as the unbalanced mode except for the right pack. The right pack is controlled to satisfy the average temperature requirements of the two passenger compartment temperature zones.



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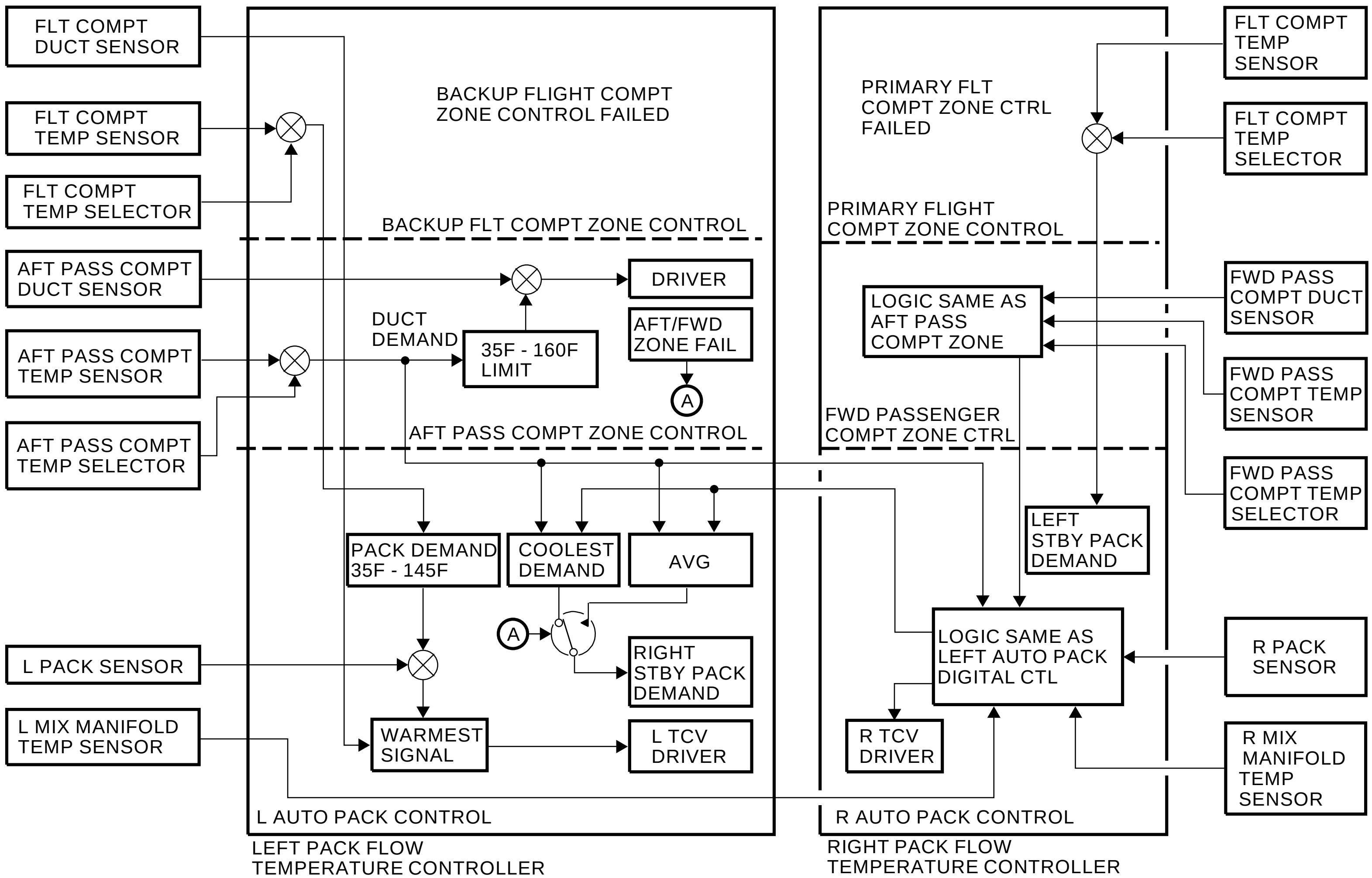
AIR CONDITIONING - TEMPERATURE CONTROL - UNBALANCED MODE - FUNCTIONAL DESCRIPTION



AIR CONDITIONING - TEMPERATURE CONTROL - UNBALANCED MODE - FUNCTIONAL DESCRIPTION

AIR CONDITIONING - TEMPERATURE CONTROL - ZONE TEMP INDICATION - FUNCTIONAL DESCRIPTION

Purpose

The system provides an indication of an overheat condition in the zone supply ducts or the failure of the temperature control system.

Power Interruption

Power interruption indication is provided by two power interrupt indication relays, K1 and K2.

If there is a power interruption, the ZONE TEMP light on the P5 panel comes on immediately. The zone temperature control system is reset after power has been restored.

Overheat Indication

Overheat protection is provided by overheat switches in the flight compartment supply duct and in the supply ducts for the passenger cabin.

If there is an overheat condition, the ZONE TEMP light on the P5 panel comes on immediately. Push the TRIP RESET switch on the P5 panel after the duct has cooled to reset the zone temperature control system.

Flight Compartment Temperature Control System Failure Indication

A failure of the primary or backup flight compartment temperature control or a malfunction in the system causes the ZONE TEMP light to come on only when the master caution system is recalled. This shows that a BITE check of the controllers is necessary.

If there is a complete loss of temperature control for the flight compartment, the ZONE TEMP light comes on immediately and cannot be reset.

The primary flight compartment INOP switch is set by these primary flight compartment failures:

- Cabin temperature sensor
- Cabin temperature sensor interface
- Duct temperature sensor
- Duct temperature sensor interface
- Cabin temperature selector
- Cabin temperature selector interface
- Zone trim air modulating valve
- Zone trim air modulating valve driver.

The backup flight compartment INOP switch is set by these backup flight compartment failures:

- Cabin temperature sensor and selector
- Cabin temperature sensor interface and selector
- Cabin temperature sensor and selector interface
- Cabin temperature sensor interface and selector interface.

The backup flight compartment FAULT switch is set by these backup flight compartment failures:

- Cabin temperature sensor
- Cabin temperature sensor interface
- Duct temperature sensor
- Duct temperature sensor interface
- Cabin temperature selector
- Cabin temperature selector interface
- Zone trim air modulating valve
- Zone trim air modulating valve driver.

Passenger Compartment Temperature Control System Failure Indication

A failure of the passenger zone temperature control causes the ZONE TEMP light to come on only when the master caution system is recalled. This shows that a BITE check of the controllers is necessary.

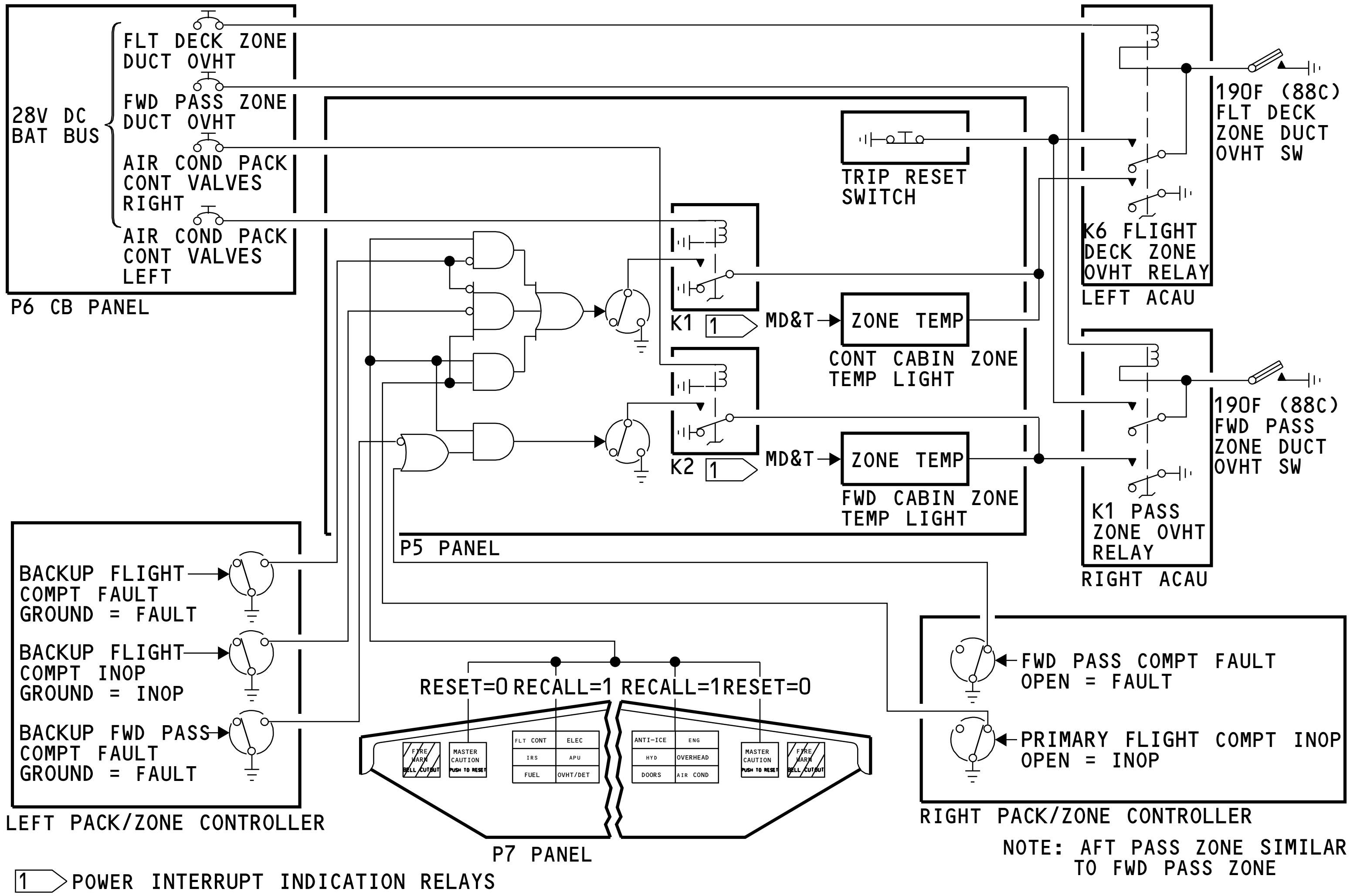
The passenger compartment FAULT switch is set by these passenger compartment failures:

- Cabin temperature sensor
- Cabin temperature sensor interface
- Duct temperature sensor

- Duct temperature sensor interface
- Cabin temperature selector
- Cabin temperature selector interface
- Zone trim air modulating valve
- Zone trim air modulating valve driver.

The backup passenger compartment FAULT switch is set by these backup passenger compartment failures:

- Cabin temperature sensor
- Cabin temperature selector
- Other controller backup error signal output
- Standby pack-cabin loop electronics.



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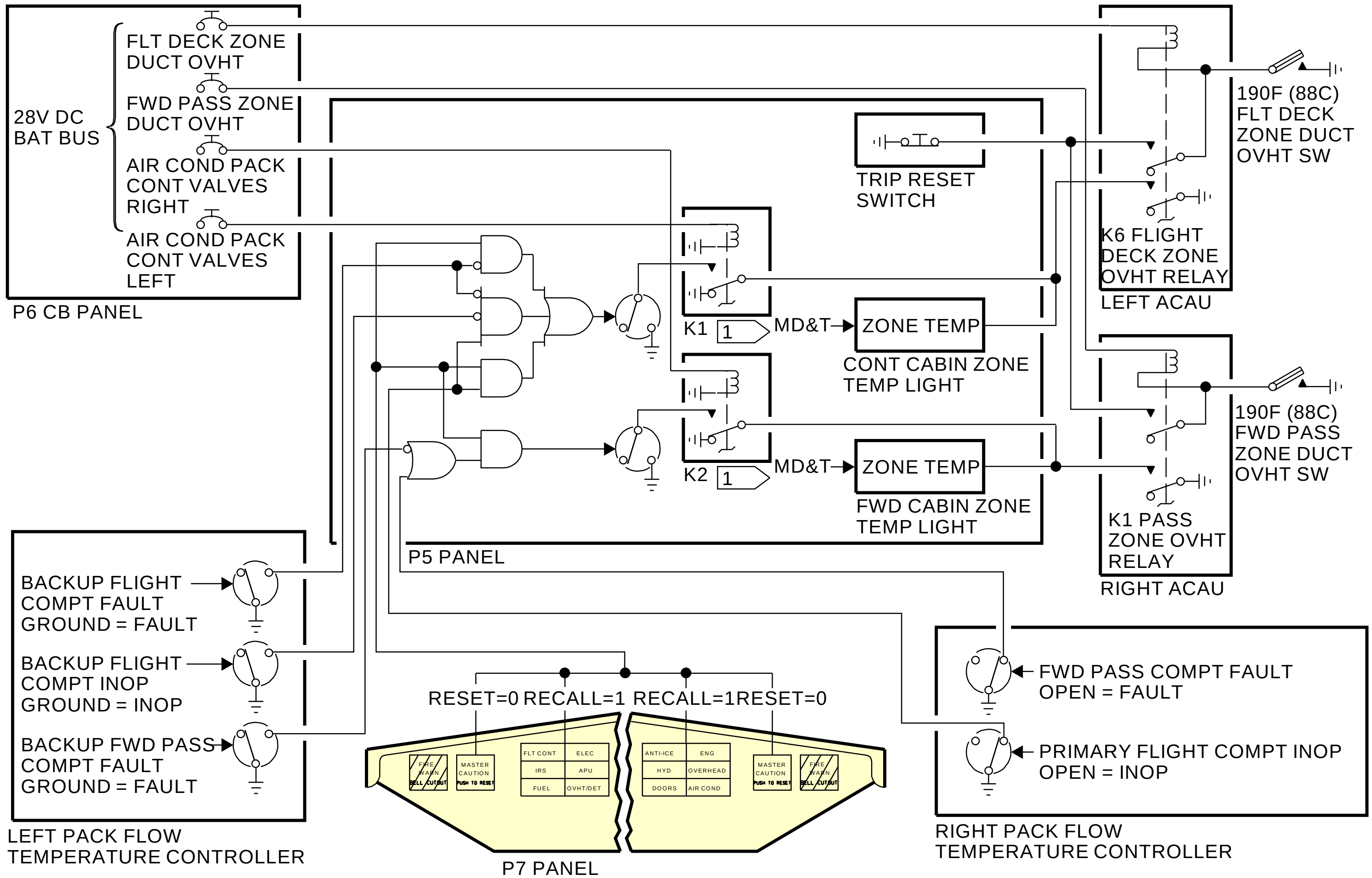
AIR CONDITIONING - TEMPERATURE CONTROL - ZONE TEMP INDICATION - FUNCTIONAL DESCRIPTION



1 POWER INTERRUPT INDICATION RELAYS

NOTE: AFT PASS ZONE SIMILAR TO FWD PASS ZONE

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AIR CONDITIONING - TEMPERATURE CONTROL - ZONE TEMP INDICATION - FUNCTIONAL DESCRIPTION

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AIR CONDITIONING - TEMPERATURE CONTROL - PACK LIGHT INDICATION - FUNCTIONAL DESCRIPTION

Purpose

The pack light turns on for over temperature conditions, and failures of the air conditioning temperature control system.

Power Interruption

Power interruption indication is given by power interrupt indication relays.

If a power interruption is sensed, the PACK light on the P5 panel comes on. The pack temperature control system is reset after power has been restored.

Over Temperature Indication

Over temperature protection for the cooling pack is supplied by these three thermal switches:

- Turbine inlet overheat (210F/99C)
- Pack discharge overheat (250F/121C)
- Compressor discharge overheat (390F/198C).

If an overheat condition is sensed, the PACK light on the P5 panel comes on. Push the TRIP RESET switch on the P5 panel after the cooling pack has cooled to reset the pack temperature control system.

Air Conditioning Packs Temperature Control System Failure indication

A single failure of the pack control system causes the PACK light to come on only when the master caution system is recalled. This shows a BITE check of the controllers is necessary.

If a complete loss of temperature control for the pack control system occurs, the PACK light comes on and cannot be reset.

The standby pack FAULT switch is set by these standby pack component failures:

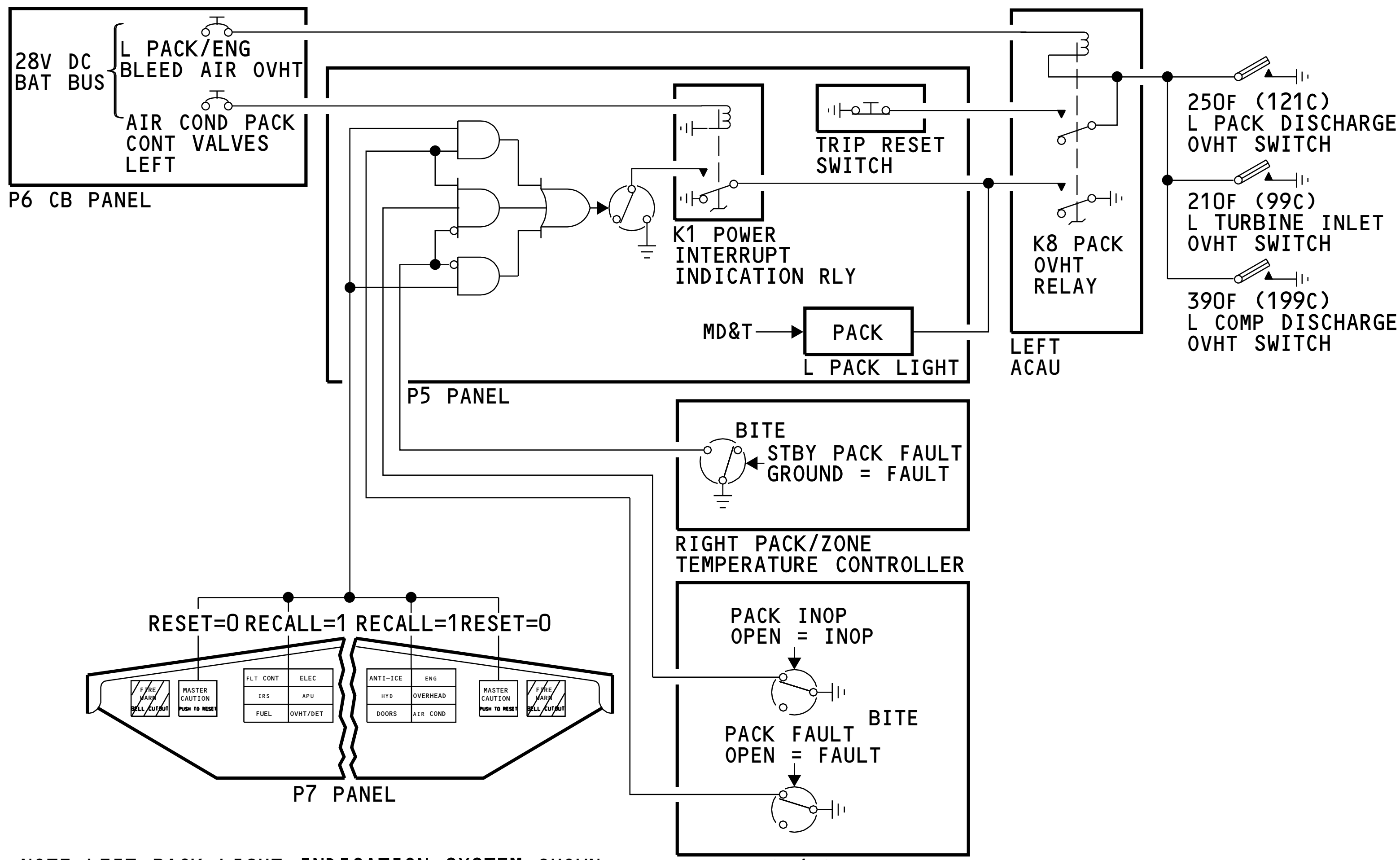
- Pack temperature sensor
- Temperature control valve
- Pack control.

The pack INOP and pack FAULT switch is set by these pack component failures:

- Pack temperature sensor or interface
- Temperature control valve or driver
- Pack control.

The pack FAULT switch is set by these pack component failures:

- Mix manifold temperature sensor or interface
- Mix manifold temperature sensor or interface from opposite controller
- Zone duct demand signal or interface from opposite controller
- Partial pack demand signal or interface from opposite controller
- Ram air temperature sensor or interface
- Ram air door actuator or interface.



NOTE: LEFT PACK LIGHT INDICATION SYSTEM SHOWN
RIGHT PACK LIGHT INDICATION SYSTEM SIMILAR

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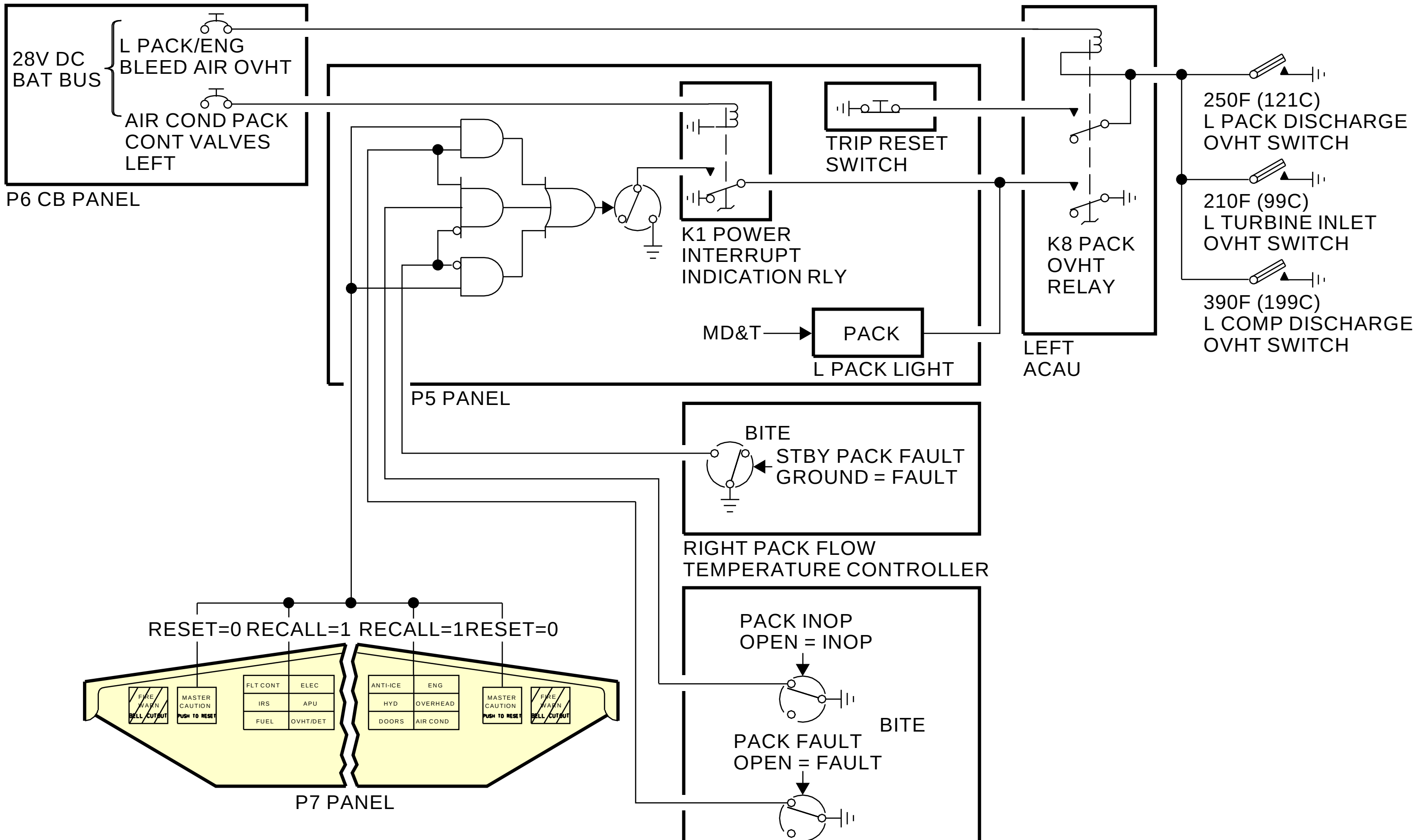
AIR CONDITIONING - TEMPERATURE CONTROL - PACK LIGHT INDICATION - FUNCTIONAL DESCRIPTION



NOTE: LEFT PACK LIGHT INDICATION SYSTEM SHOWN
RIGHT PACK LIGHT INDICATION SYSTEM SIMILAR

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AIR CONDITIONING - TEMPERATURE CONTROL - PACK LIGHT INDICATION - FUNCTIONAL DESCRIPTION

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AIR CONDITIONING - TEMPERATURE CONTROL - TEMPERATURE BULB

Purpose

The temperature bulbs measure temperature in the critical areas of the air conditioning system. The temperature bulbs are for indication only and are not part of the automatic temperature control system.

Physical Description

The temperature bulb has these parts:

- Sensing element
- Electrical connector.

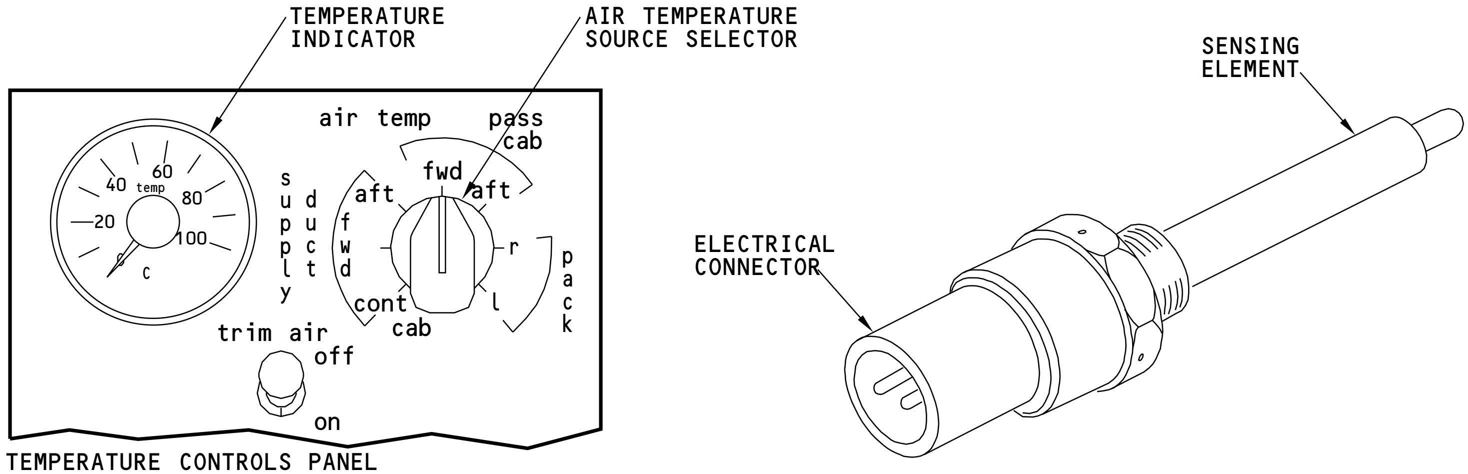
Location

There are seven temperature bulbs in the system. They are similar in design and operation. There are temperature bulbs in these locations:

- The flight compartment air conditioning duct in the EE compartment on the left hand side next to the E2 rack
- The forward passenger cabin air conditioning supply duct in the overhead, forward of the left hand forward riser
- The aft passenger cabin air conditioning supply duct in the overhead, aft of the right hand aft riser
- The forward passenger cabin forward right side of the passenger cabin bullnose area
- The aft passenger cabin aft right side of the passenger cabin bullnose area
- The right air conditioning pack on the right high pressure water separator assembly
- The left air conditioning pack on the left high pressure water separator assembly.

Training Information Point

Handle the temperature bulbs gently. Use approved cleaning materials to clean the temperature bulbs.



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AIR CONDITIONING - TEMPERATURE CONTROL - TEMPERATURE BULB