

12.2 (ATA 21) AIR CONDITIONING & PRESSURIZATION

12.2.1 Air Conditioning

12.2.1.1 Introduction

The air conditioning pack conditions the bleed air to the proper temperature and humidity and delivers it to the air distribution system for environmental control of the cabin and flight deck.

12.2.1.2 General

The air conditioning pack is part of the Environmental Control System (ECS). It uses bleed air from the engines or Auxiliary Power Unit (APU) to supply conditioned air to the cabin and flight deck.

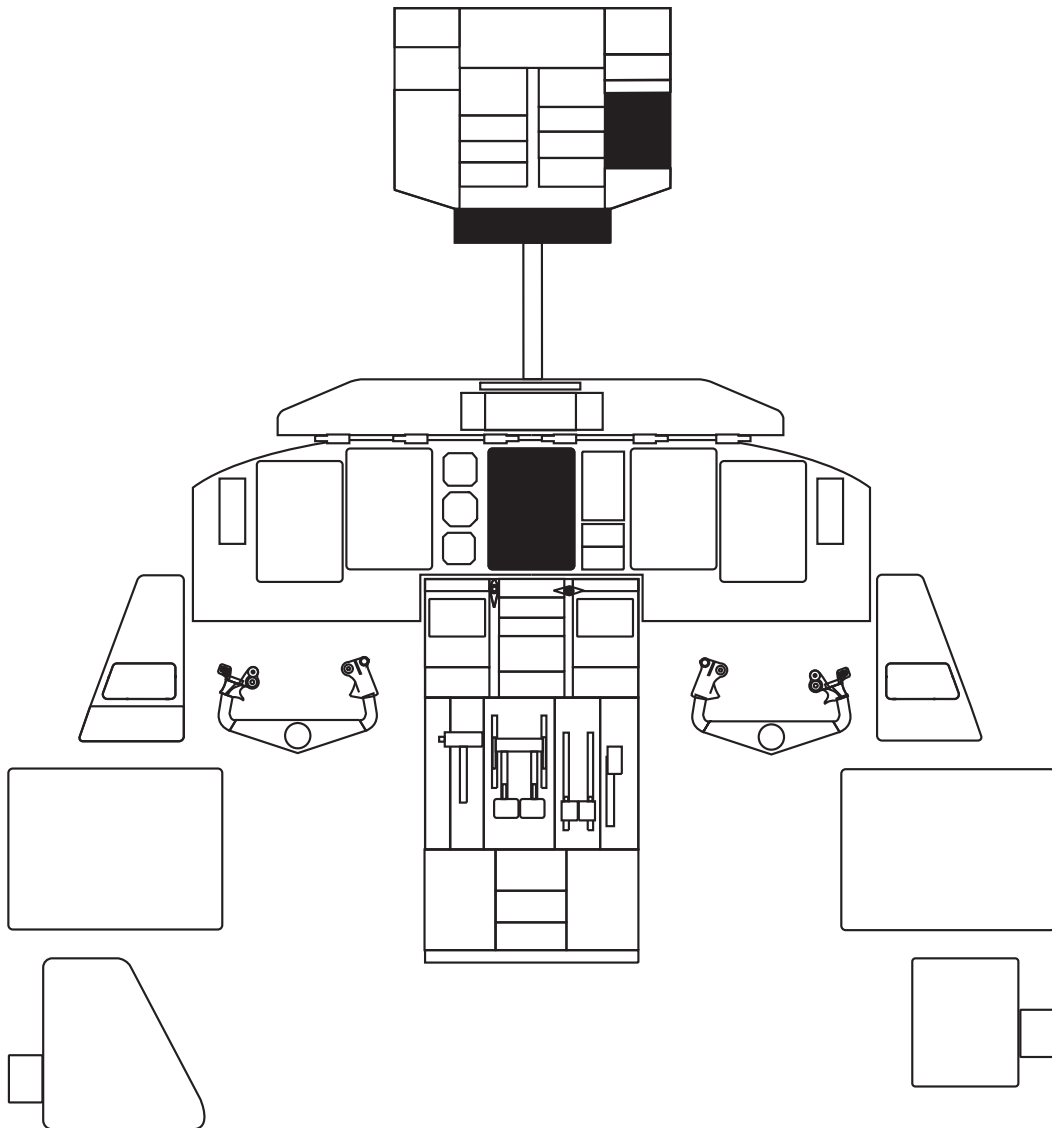
Two air cycle machines (ACM), are integrated with a single primary heat exchanger and a single secondary heat exchanger. They are located in the aft fuselage (aft equipment bay), and cool the hot bleed air coming from the two engines or from the APU. This configuration provides the redundancy of two packs while allowing access to a much larger dual heat exchanger during operation with a single ACM.

12.2.1.2.1 Ground Air Conditioning Connection

The ECS Ground Air connection is located low down on the Aft fuselage on the right hand side of the aeroplane at station X 860.00. It is protected by a latched door, which when open allows an industry standard "8" diameter supply to be connected to the aeroplane.

From the connection the ground supplied air is ducted inboard and utilizes the aeroplane air distribution system to either heat or cool the aeroplane. To prevent loss of aeroplane pressure when the aeroplane is operating pressurized a flapper style check valve, situated at the junction to the distribution system prevents reverse flow and loss of cabin pressure.

12.2.1.3 Controls and Indications - Air Conditioning



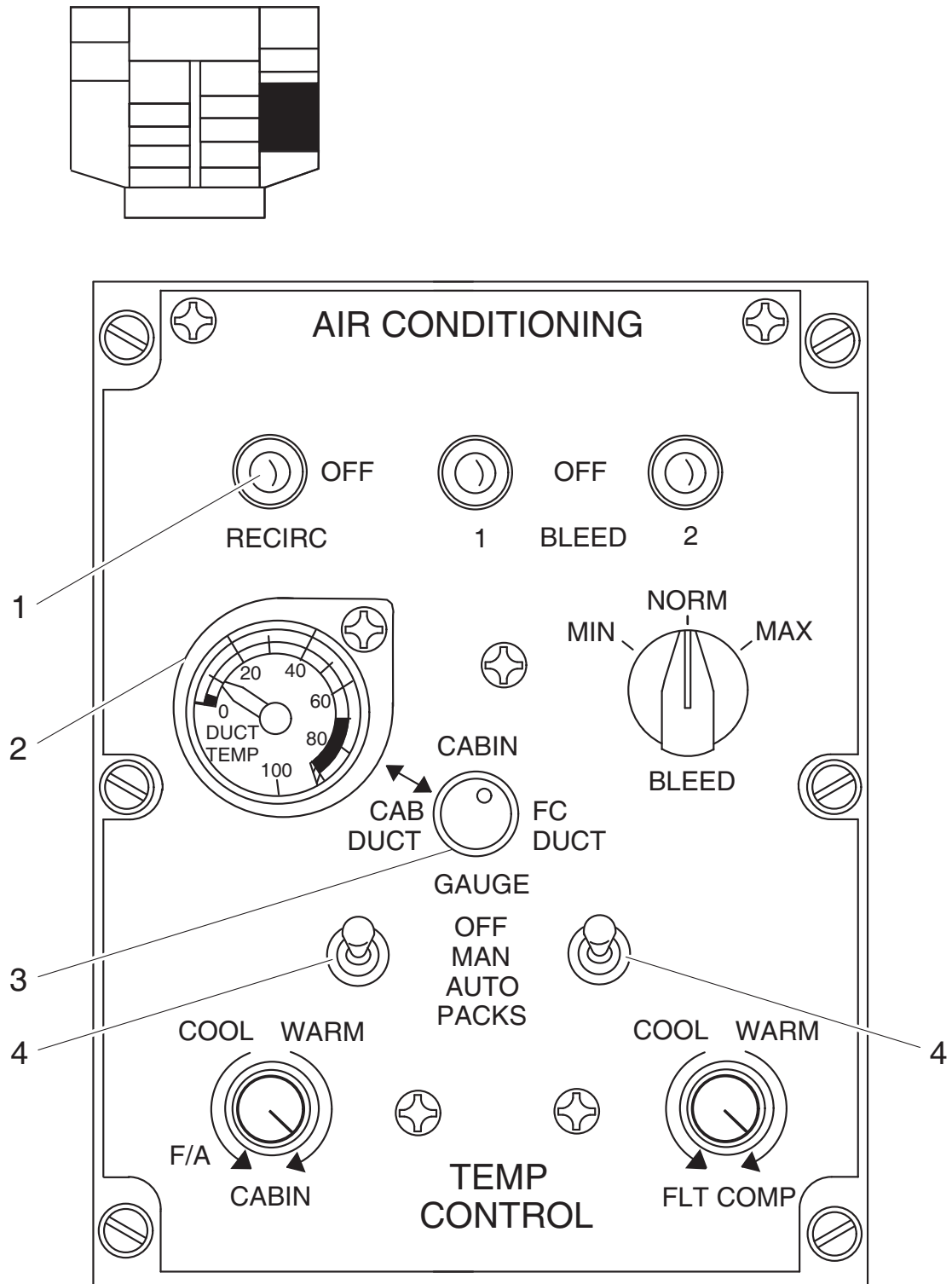


Figure 12.2-1 Air Conditioning Control Panel (1)

AIR CONDITIONING PANEL CALLOUTS (1)

1. RECIRC SWITCH (Two Position)

- aft selection turns recirculation fan off

RECIRC - turns fan on high speed. ECU automatically selects slow speed when required

- fan operates at slow speed only during single pack operation (and at start-up)

2. DUCTS TEMP GAUGE

- displays temperatures when selected by GAUGE selector in the:
- CABIN DUCT (supply) temperature
- CABIN temperature
- FLIGHT DECK DUCT (supply) temperature

3. GAUGE SELECTOR (Rotary Action)

- selects temperatures for display on the DUCT TEMP gauge:
- CABIN DUCT (supply) temperature
- CABIN temperature
- FLIGHT DECK (FC) DUCT (supply) temperature

4. PACKS CONTROL SWITCHES (Three Position)

OFF - shuts related ACM off

MAN, AUTO

For both **MAN** and **AUTO** positions:

- * modulates the pack Flow Control and Shut Off Valve
- packs start operating and supply conditioned air to the cabin and flight deck
- * modulates the Pack Bypass Valve
- * In accordance with the temp selections from the cockpit.

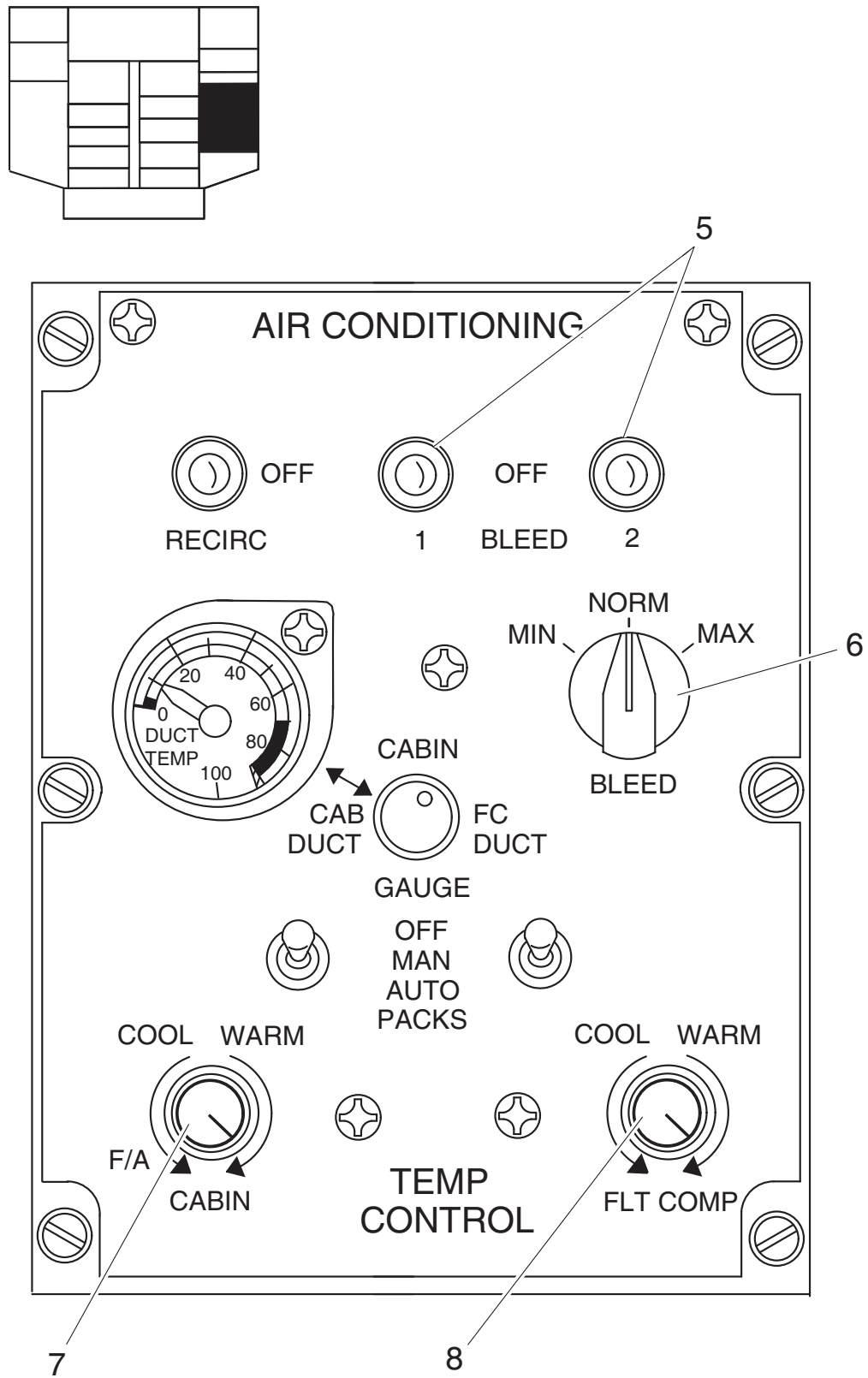


Figure 12.2-2 Air Conditioning Control Panel (2)

AIR CONDITIONING PANEL CALLOUTS (2)

5. BLEED SWITCHES (two position)

1 AND/OR 2 - starts bleed air flow from the No.1 and/or No.2 engines to the air conditioning packs.

OFF - stops bleed air flow from selected engine

6. BLEED CONTROL SELECTOR (rotary action)

- signals ECU to modulate the nacelle shut off valves
- provides air flow for one of three selected settings (for engine bleed operation)

MIN - for minimum bleed air flow

NORM - for moderate bleed air flow

MAX - for maximum bleed air flow

7. CABIN TEMPERATURE SELECTOR (rotary action)

ROTATE - adjusts cabin temperature when PACKS control switch is selected to AUTO or MAN

F/A - rotating fully counterclockwise to the cabin attendant position, allows the cabin crew member to control cabin temperature from the FLIGHT ATTENDANT'S panel

- indicated by a light on the flight attendant's panel

8. FLT COMP TEMPERATURE SELECTOR (rotary action)

ROTATE - adjusts flight deck temperature when the associated PACK control switch is selected to AUTO or MAN

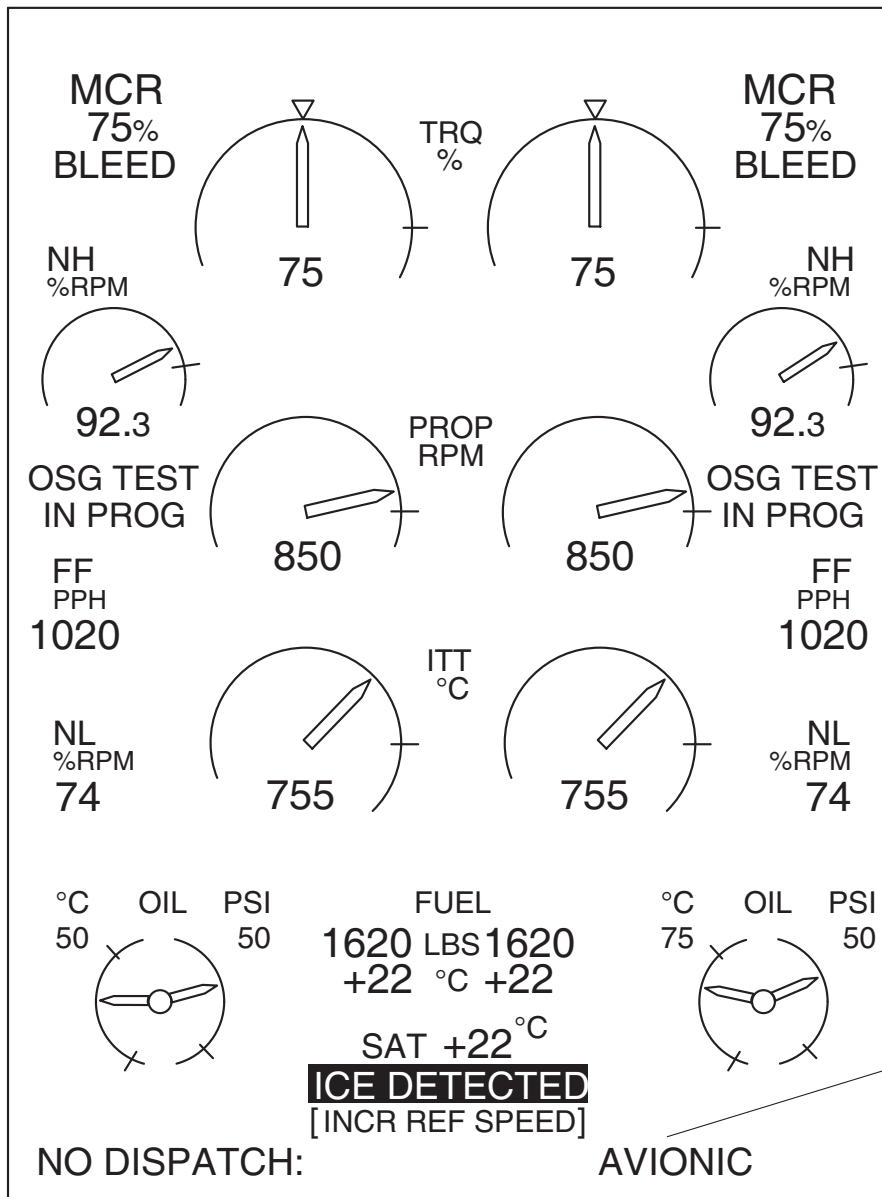
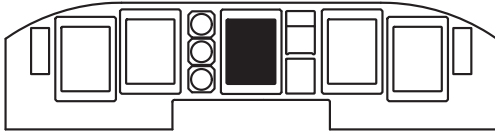


Figure 12.2-3 Engine Display

ENGINE DISPLAY CALLOUTS

1. FANS FAIL MESSAGE (white)

- Displayed if two avionic fans fail
- Standby fan is supplying avionics cooling for LCD instruments
- Fans must be rectified before the next flight
- Single fan failed indicated on CDS in maintenance mode

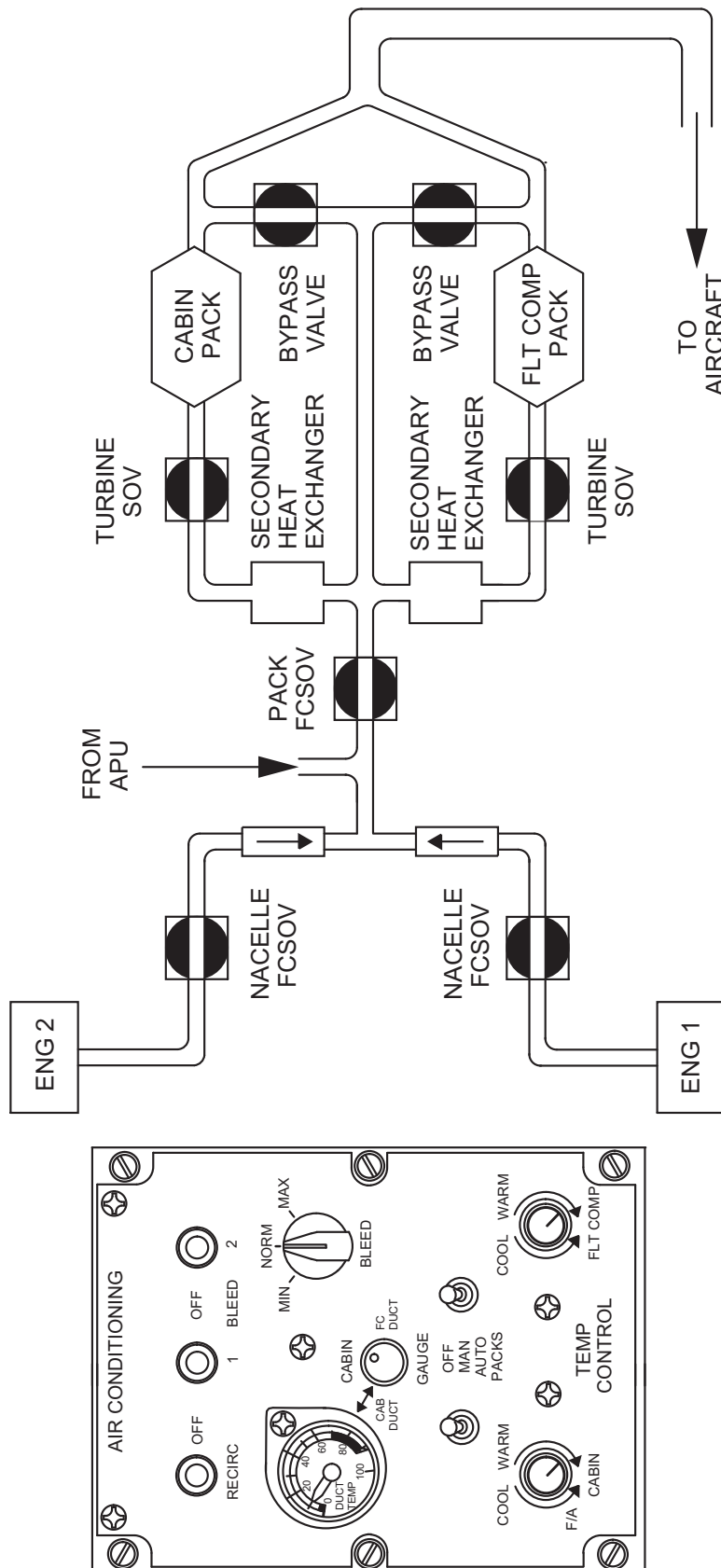


Figure 12.2-4 Air Conditioning Schematic

12.2.1.4 Air Conditioning System

The air conditioning system (Figure 12.2-4) receives bleed air when the BLEED switches on the AIR CONDITIONING control panel (Figure 12.2-2), or the BL AIR switchlight on the APU CONTROL panel are selected on. The air conditioning system is controlled by selecting the CABIN and FLT COMP PACKS switches (Figure 12.2-1) to the MAN or AUTO positions, and then adjusting the temperature using the TEMP CONTROL knobs. These switch settings determine the bleed air source, manual or automatic Environmental Control System (ECS) operation, and the air flow temperatures for the flight and passenger compartments.

The ECS Electronic Control Unit (ECU) (Figure 12.2-5) controls the two Nacelle Shut-Off Valves (NSOV) to regulate the air flow to the air conditioning packs. The ECU receives bleed air pressure and temperature data from the pack inlet absolute pressure and inlet temperature sensors. The ECU uses these data to control bleed air flow through the pack Flow Control Shut-off Valve (FCSOV). The ECU also uses this data to control bleed air flow rate when APU bleed air is selected on.

12.2.1.4.1 Pack Control

OFF/MAN/AUTO

The OFF selection for both packs closes the pack inlet FCSOV, bypass SOVs and TURBINE SOVs through the digital or analog channels.

When selecting one pack to MAN or AUTO, the ECS controller will:

- open pack inlet FCSOV
- open one Turbine SOV
- open Pack Bypass SOVs (opens both)

Only one pack will be operational. The recirculation fan will run at low speed. The system will run at reduced flow (70% of flow selection).

Selecting both packs to MAN or AUTO:

The system will operate at full performance depending on flow selections and environmental conditions. The recirculation fan will run at high speed.

If a digital function becomes inoperative, the Turbine SOV and bypass SOVs will revert to the associated analog control. The remaining digital channel will operate the pack FCSOV to adjust to required flow level.

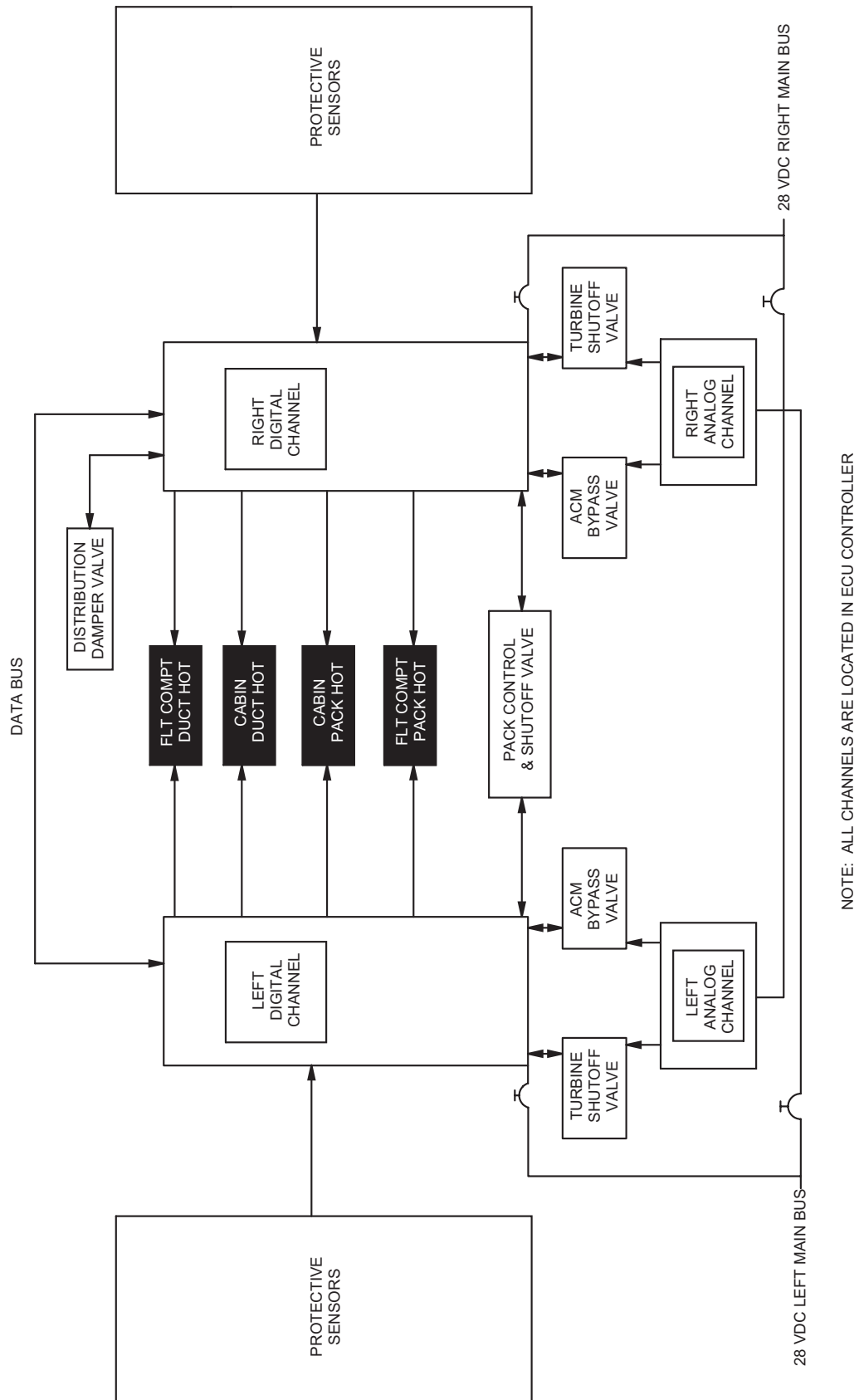


Figure 12.2-5 Electronic Control Unit Diagram

12.2.1.4.2 Flow Control

For engine operation, the digital channel in control modulates the Nacelle SOVs to set flows, to the packs and therefore to the cabin and flight deck.

Nominal flow rates set by the ECU are based upon:

- BLEED selection - MIN/NORM/MAX
- Environmental conditions (altitude)
- Mass bleed flow measured at wing duct and corrected by pack inlet pressure and temperature information
- Air source (single bleed, dual bleed, or APU)

If a malfunction occurs to the pack FCSOV, it defaults pneumatically to the open position to permit continued ECS operation. If both digital channels of the ECU lose electrical power or fail, the pack FCSOV defaults to the closed position. ECS operation stops and the air cycle machines shut off. If this occurs, air must be supplied to the cabin and flight deck using emergency ram air ventilation.

12.2.1.4.3 Normal Flow Control Operation

When both engines and at least one pack are operating, the ECU modulates the nacelle shutoff valves in the bleed air system to balance the flow of bleed air from both engines.

If one digital channel fails (analog operation), or in case of calculated flow miscomparison, the operating digital channel, regulates bleed airflow with the pack FCSOV. The ECU also regulates bleed airflow with the pack FCSOV if the APU is supplying the bleed air. APU bleed air flow is not controlled by the bleed flow selection knob, but by a flow schedule internal to the ECU.

Both digital channels of the ECU share control of the pack FCSOV. During flight, one digital channel gets full control of the pack FCSOV (the other channel gets full control during the next flight). If the digital channel in control loses electrical power or fails, the other digital channel takes control of the pack FCSOV.

The analog backup channels do not modulate the pack FCSOV, they only control it if closed or fully open.

In a dual pack configuration, the left digital channel uses approximately half of the air from the left pack to control the flight compartment temperature. The right digital channel uses the other half of the air from the left pack and all of the air from the right pack to control the cabin compartment temperature. Therefore the cabin receives a total of approximately 75% of the air flow from both packs combined.

Recirculating Fan

The recirculation fan, draws cabin air through the recirculation filter mounted behind the AFT class "C" baggage compartment. The air is routed aft, where it is mixed with pack conditioned air. The recirculation fan switch on the AIR CONDITIONING control panel controls the on/off operation of the recirculation fan independent of the ECU. However, the ECU will use the operating conditions and the length of time the fan was on to determine the fan speed.

When the switch is selected to the RECIRC position, the fan starts at low speed (to reduce initial current draw), then switches to high speed. Operating conditions determine the automatic control of the recirculation fan speed. The fan operates at low speed if one pack is turned off.

12.2.1.4.4 Temperature Control

Electronic Control Unit (ECU)

The temperature control and indication system is controlled from the AIR CONDITIONING control panel on the flight deck. The ECU is the interface between the AIR CONDITIONING control panel and the mechanical and electrical components of the air conditioning system.

Two zone supply temperature sensors measure the temperature of the air in the cabin and in the flight deck supply ducts. The ECU uses these signals to control the temperature of the air leaving the air conditioning pack. The ECU keeps the temperature in the supply ducts between 2.8°C and 71°C. The actual temperature in the supply ducts depends on the settings of the CABIN and FLT COMP temperature selectors on the AIR CONDITIONING control panel. The minimum temperature of 2.8°C makes sure that there is no ice formation on the condenser.

Two zone temperature sensors measure the cabin and flight deck temperatures and forward the data to the ECU. The ECU keeps the cabin and flight deck temperatures between 15°C and 27°C. A third sensor supplies cabin temperature to the gauge on the AIR CONDITIONING panel. Two other sensors supply Flight and Cabin duct supply temperatures to the gauge.

12.2.1.5 Temperature Control Operation

When the PACKS switches are set to AUTO, the digital channel in control opens the pack flow control and shutoff valve, the pack bypass SOVs and the turbine shutoff valves. This starts the packs which supply cold air. The ECU modulates the pack bypass valves to add warm air to the cool air coming out of the turbines. The ECU controls the pack outlet temperature based on the settings of the CABIN and FLT COMP temperature selectors on the AIR CONDITIONING control panel. In AUTO mode, the temperature control is based on feedback indication from the zone temperature sensors. A full cool selection targets a compartment temperature of 15°C and a full warm selection targets 27°C.

When the PACKS switch is set to MAN, the control is based on the duct supply temperatures. Full cool targets 2.8°C and full warm targets 71°C.

When the PACKS switches are set to OFF, this closes the pack FCSOV, the turbine shut-off valves, and the pack bypass valves shutting down the packs.

Flight Deck

The flight deck temperature is controlled by the FLT COMP temperature selector on the AIR CONDITIONING control panel. A flow control lever is located under the left and right side windows on the side wall. The levers regulate the quantity of air flowing to the flight deck.

Cabin

The CABIN temperature selector on the AIR CONDITIONING control panel has a switch at the full counter clockwise - F/A position. Turning the selector knob to the F/A position, signals the right digital channel to enable the flight attendant's control panel. This switch also turns on the FA CONTROL ENABLED light on the flight attendant's control panel. This indicates the flight attendant has control of the cabin temperature selections. Both the FA CONTROL ENABLED light and the cabin temperature gauge on the flight attendant's control panel operate independently from the ECU. The cabin compartment temperatures can also be regulated from the flight deck by rotating the CABIN selector knob out of the F/A position.

In order to obtain optimum performance out of the Environmental Control System, it is important to understand the following characteristics of the Q400 ECS:

AUTO v/s MAN Pack Operation

1. In **AUTO** control, the system automatically regulates the cabin or flight deck ambient temperatures between 15°C (59°F), at Full Cool, to 27°C (81°F) at Full Warm selection. The ECS Electronic Control Unit (ECU) determines what the appropriate duct temperatures should be to achieve the selected cabin/flight deck temperatures and regulates accordingly, based on feedback from the appropriate zone and duct sensors. Therefore, in **AUTO** control, the duct temperatures indicated on the flight deck gauge should be disregarded.

2. In **MAN** selection, the system controls duct temperatures for the cabin and flight deck between 3°C (37°F), at Full Cool, to 71°C (160°F) at Full Warm selection. The duct temperature does not relate directly to the cabin/flight deck temperature and should be used as a relative indication of proper system operation only i.e. If the cabin temperature selection is changed, the appropriate duct temperature should change accordingly. The temperature gauge in the flight deck needs to be monitored to determine if any temperature adjustments are necessary. **MAN** mode is normally intended to be used as a backup in the event of **AUTO** mode failure.

System Response

Depending on ambient conditions, and the existing cabin/flight deck temperatures, the system may take time to stabilize to the selected temperature. Any change to the duct temperature (supply from gaspers) will be felt approximately 1-3 minutes later. Changes in compartment temperatures will be noticeable after approximately 5 minutes. It is recommended that the temperature settings not be changed before compartment temperatures have stabilized.

Cabin/Flight Deck Interdependence

The cabin and flight deck temperature control is not fully independent. The cabin receives conditioned air from a separate dedicated duct, but a portion of the air supply comes from the flight compartment pack. If the flight deck and cabin temperature settings are not the same, the flight deck selection will effect the cabin temperature i.e. If more heat is demanded for the flight deck, a percentage of that hot air is distributed into the cabin, raising cabin temperature.

System Operation:

The following suggestions are intended to assist Operators in improving ECS performance.

General:

Set both packs to **AUTO** and temperature settings at 12 o'clock (both sides) initially. After the compartment temperatures have stabilized, settings can be changed, if different conditions are desired.

Cold Day Ground Operation:

1. During boarding, when doors are open, the heat demand from the cabin will drive the flight deck hot (especially on a very cold day). Changing flight deck temperature settings will have no effect on the compartment temperatures. It is recommended that the temperature settings be maintained, as temperatures will stabilize after the doors are closed.

2. To avoid temperature overshoot and triggering the Duct Hot caution light, the following interim procedure may be used. In the morning, prior to the first flight of the day, especially when the aircraft is cold soaked, the system may be started in **MAN** at 12 o'clock to 3 o'clock for 2-3 minutes. The selection can then be changed to **AUTO** and the temperature set to 12 o'clock.

Pilots (Ground & Flight) Procedures:

In order to provide adequate temperature control in the aircraft, ensure:

- a. Both lower vents should be fully open.
- b. All four gaspers on the flight deck are fully open.
- c. Both bleeds are **ON** and the flow selector is set to **NORM** (**MAX** setting, if required).
- d. The Recirculation fan is **ON**.
- e. Set both controls in **AUTO** at 12 o'clock initially.
- f. Make adjustments to temperature settings as desired, only after compartment temperatures have stabilized.

This enables the flight deck to reach selected temperatures faster, resulting in better temperature control throughout the aircraft.

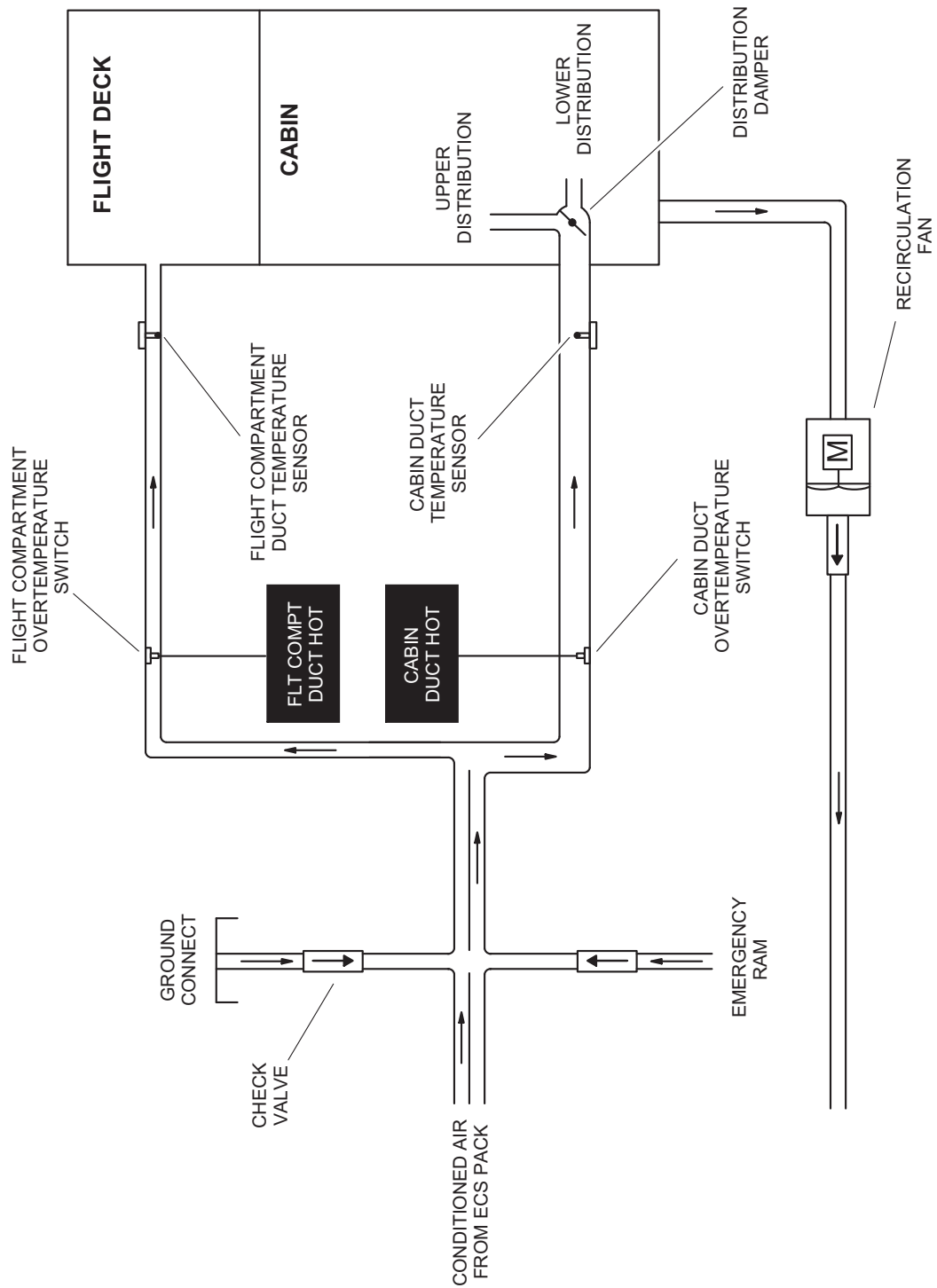
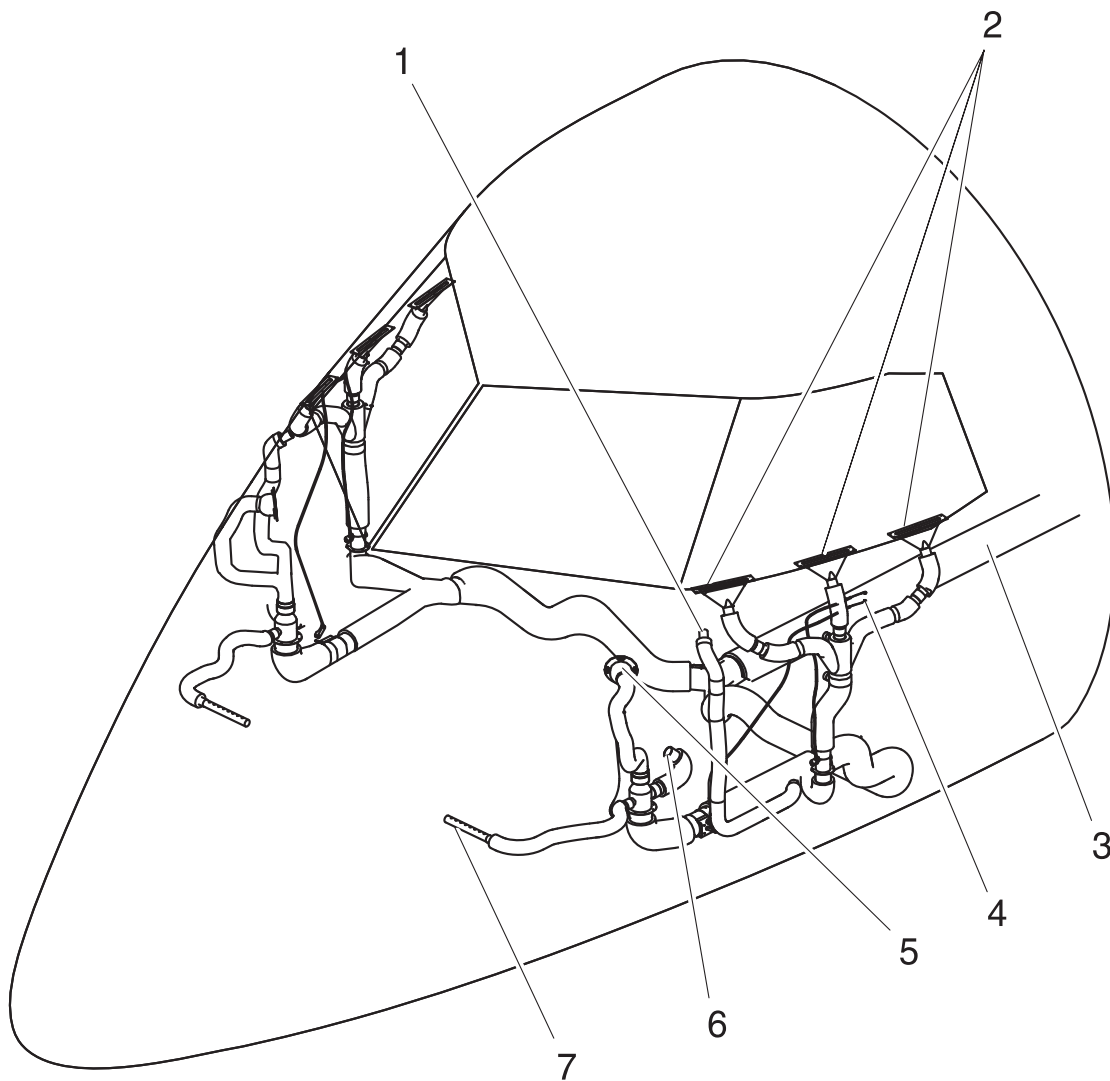


Figure 12.2-6 Cabin/Flight Deck Air Distribution



LEGEND

- 1. Small Gasper.
- 2. Window De-Mist Nozzles.
- 3. Supply Duct.
- 4. Flow Control Levers.
- 5. Flex Torso Gasper.
- 6. Side Grille Gasper.
- 7. Foot Warming Piccolo Tube.

Figure 12.2-7 Flight Deck Air Distribution

12.2.1.6 Air Distribution

Conditioned air from the Pack is supplied to the flight deck and cabin (Figure 12.2-6).

Flight Deck

Conditioned air is supplied to the flight deck to maintain a comfortable environment for the flight deck crew, side window demisting and aeroplane pressurization.

Air supply to the flight deck (Figure 12.2-7) is ducted from the air conditioning pack, through the rear pressure bulkhead, then divided so that the left side supplies flight deck air while the right side supplies cabin air, along the right side of the aeroplane below the cabin floor. Before reaching the flight deck, the distribution system also supplies conditioned air to the aft baggage compartment inlet, forward lavatory gasper and the forward cabin attendant's gasper.

At the flight deck bulkhead, the flight compartment duct splits, supplying the airflow into two individual but identical distribution systems, one for the left side and the other for the right side. On the flight deck, the distribution system has lower level and upper level outlets. The upper level outlets are demist nozzles for the pilot's and copilot's side windows. The lower level outlets include a foot warming piccolo tube (near the rudder pedals), a fixed grille near knee height and a large torso gasper.

The ECU monitors a supply duct temperature sensor, an over temperature switch and a flight deck temperature sensor.

A manual flow control valve is at floor level. A flow control lever located at shoulder height regulates the quantity of air flowing through the valve. The airflow from the control valve is then directed to the side windows through three demist nozzles installed at the window sill level. A small manually controlled gasper at window height is also provided.

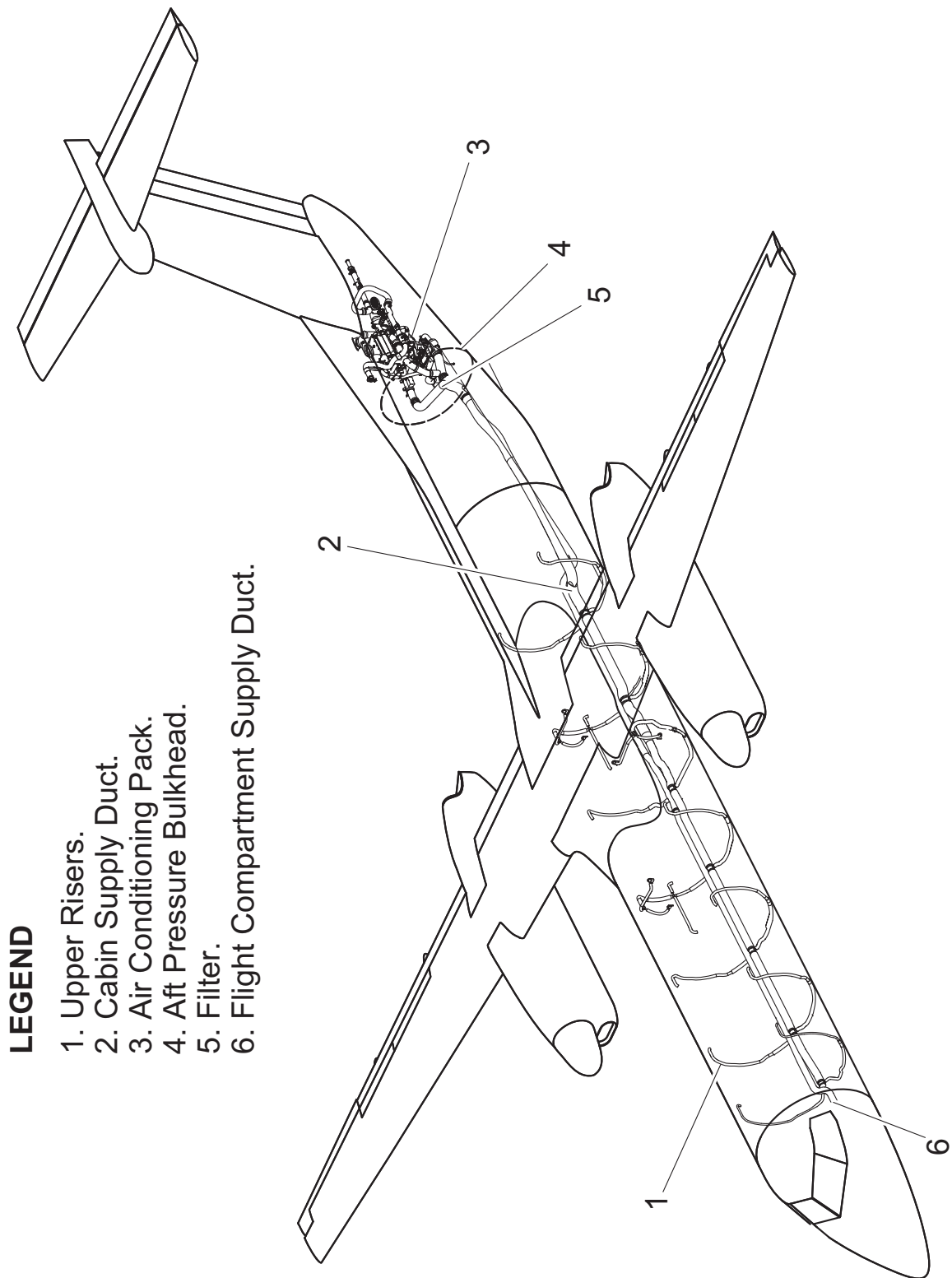


Figure 12.2-8 Cabin Air Distribution

Cabin

Conditioned air is supplied to the cabin (Figure 12.2-8) to maintain a comfortable environment for the passengers and crew. Conditioned air is also used for aeroplane pressurization. Air supply to the cabin is ducted from the air conditioning pack into the fuselage at the centre of the rear pressure bulkhead. The air is then ducted under the baggage compartment floor, where it splits into an upper and lower supply duct for each side of the cabin. The upper cabin distribution duct supplies the Passenger Service Unit (PSU) gaspers and the sidewall down wash and ceiling up wash vents. The lower cabin distribution duct supplies the dado panels.

A distribution damper is set automatically depending on the cabin supply duct temperature (Figure 12.2-8). The right digital channel of the ECU controls the electric motor of the distribution damper. If the right digital channel or the electric motor fails, the damper valve will remain in its last position. Three position switches in the damper valve send discrete signals to the ECU indicating whether the valve is in the full warm or the full cool position. The distribution damper valve position will be automatically controlled to one of three positions (up, middle, or down) depending on the cabin supply temperature. When the valve is at full up mechanical position, 70% of the flow will be delivered through upper distribution ducts and 30% flow will be distributed through lower distribution vents.

The ECU uses the signal from the cabin zone supply temperature sensor to determine which mode to apply to the distribution damper. During heating operations, the distribution damper directs 70% of the warm air to the lower cabin dado panels, and 30% of the air to the PSU (gaspers, side down wash and ceiling up wash vents).

During cooling operations 70% of the cool air is directed to the PSU (gaspers, side down wash and ceiling up wash vents), and 30% to the lower dado panels. During standard temperatures, half of the air is directed to the overhead vents and half to the lower vents.

The aft baggage compartment has an inlet and outlet ventilation valve. They are normally open but close when smoke is detected in the baggage compartment and/or when electrical power is lost. Two white advisory lights on the Fire Protection Panel turn on when the inlet valves are closed.

12.2.1.7 Non-Normal Operation

The left digital channel has on/off control of the left pack and the right digital channel has on/off control of the right pack by closing the applicable turbine shut-off valve. The digital channel in control will shut off the pack flow control and shutoff valve (and stop pack operation) if:

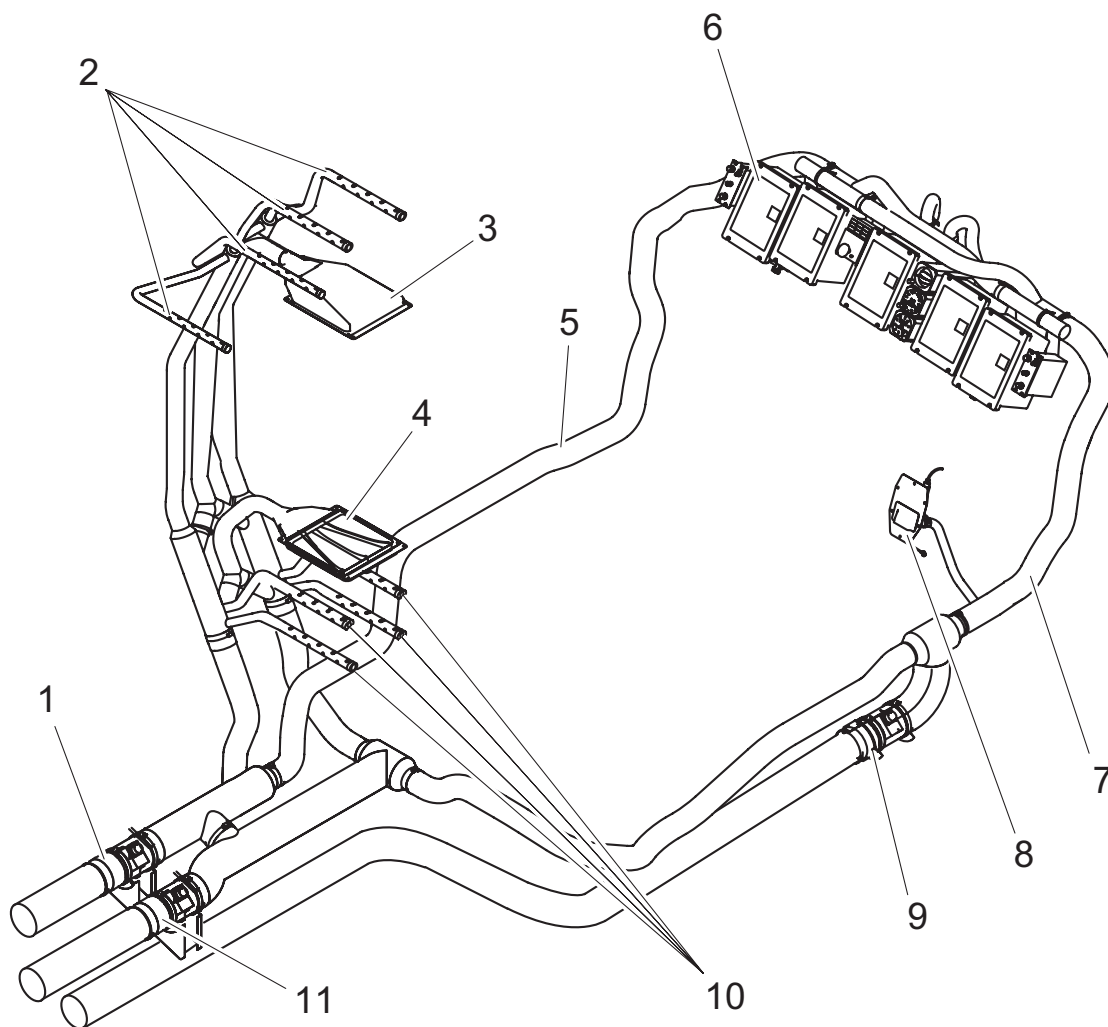
- Both PACKS switches on the AIR CONDITIONING control panel selected to OFF.
- The Built In Test (BIT) function of the ECU detects an unacceptable condition.

If the CABIN PACK HOT or FLT COMPT PACK HOT caution light turns on, this causes the associated pack to shut down, i.e. the associated turbine SOV. If FLT COMPT DUCT HOT or CABIN DUCT HOT caution light turns on, this causes the associated pack to shut down, i.e. the associated turbine SOV.

If an overheat condition occurs, the digital channel in control will turn on a caution light:

- FLT COMPT DUCT HOT the flight deck supply duct temperature is too hot.
- CABIN DUCT HOT the cabin supply duct temperature is too hot.
- CABIN PACK HOT right pack is too hot
- FLT COMPT PACK HOT left pack is too hot.

The caution light will remain on until the over temperature condition or BIT fault goes away, and the associated pack switch has been turned off.



LEGEND

- | | |
|-----------------------------------|---|
| 1. Fan 1 (Pilot Side). | 8. Zone Temperature Sensor and Housing. |
| 2. Upper Piccolo Tubes. | 9. Fan 3 (Standby). |
| 3. Upper Plenum. | 10. Lower Piccolo Tubes. |
| 4. Lower Plenum. | 11. Fan 2 (Copilot Side). |
| 5. Left Underfloor Duct. | |
| 6. Flight Instruments (LCD). | |
| 7. Right Forward Underfloor Duct. | |

Figure 12.2-9 Avionics Cooling Distribution

12.2.1.8 Emergency Ram Ventilation

If both packs are shut down cabin airflow and pressurization will be lost. During unpressurized flight the cabin and flight deck can be ventilated with outside ram air (see 12.2.2. Pressurization).

12.2.1.9 Avionics Cooling

The avionics cooling system has three fans. The system removes hot air from the avionics equipment, five liquid crystal displays in the instrument panel and the wardrobe rack (Figure 12.2-9).

The aeroplane has an extraction type cooling system for the avionics and Liquid Crystal Displays (LCD). Control of the system is automatic and requires no pilot action for both normal and abnormal operation. The cooling system has three identical fans, each of which can supply half the required cooling flow when operating at high speed. Only two of the three fans are required to be operational for dispatch. The electrical and ducting systems have been designed so that single failures do not result in the loss of all the displays.

Each duct assembly has a cooling fan connected to the:

- 5 LCDs
- Avionics Rack
- Wardrobe Rack.

The hot air is ducted under the floor behind the flight deck to the fwd of the canted bulkhead. Each duct assembly alone can supply enough cooling for continuous operation of the LCDs. Fan 1 and Fan 2 start running whenever the electrical power is applied to the aeroplane DC main bus. If either of these fans fail, the standby fan (Fan 3) automatically starts operating.

When only the battery power is available, Fan 1 operates at low speed and Fan 2 turns off. If Fan 1 is not available, Fan 2 operates at low speed. Fan 3 is not available when operating on battery power. This operational mode is capable of supplying the minimum air flow required for the LCDs to operate at reduced brightness.

With minimum air flow and reduced brightness, the LCDs will operate with higher internal temperatures, but below the automatic shutoff threshold. A fan operating at Low Speed Mode (LSM) can supply enough airflow to meet the avionics and LCD cooling requirements while still meeting the battery loading requirements. Failure of any fan is recorded in the Central Diagnostic System (CDS). There is no indication of a single fan failure to the flight crew. If two fans fail, a **FANS FAIL** message is shown in white on the Engine Display (ED) (Figure 12.2-3). The fans must be rectified before the next flight.

Failure of two fans on ground will illuminate "Avionics" caution light. There is no caution light for 2 fan failures during flight.

During flight with electrical power supplied, the fan speed control unit operates as follows:

- Three fans available, two fans operating at HSM
- Two fans available, two fans operating at HSM
- One fan available, one fan operating at HSM.

The ducting for each avionics cooling fan has a connection to one of two zone temperature switches located under the LCDs. These switches inhibit the fan operation on the ground, when the flight deck temperature is below 5°C. This allows the LCD internal heater to operate during cold day starts without interference from the fans. The temperature switches are disabled when the aeroplane is airborne.

LEGEND

1. Forward Pressure Bulkhead.
2. Forward Safety Valve.
3. Pressurization Control Panel.
4. Aft Pressure Dome.
5. Aft Outflow Valve.
6. Aft Safety Valve.

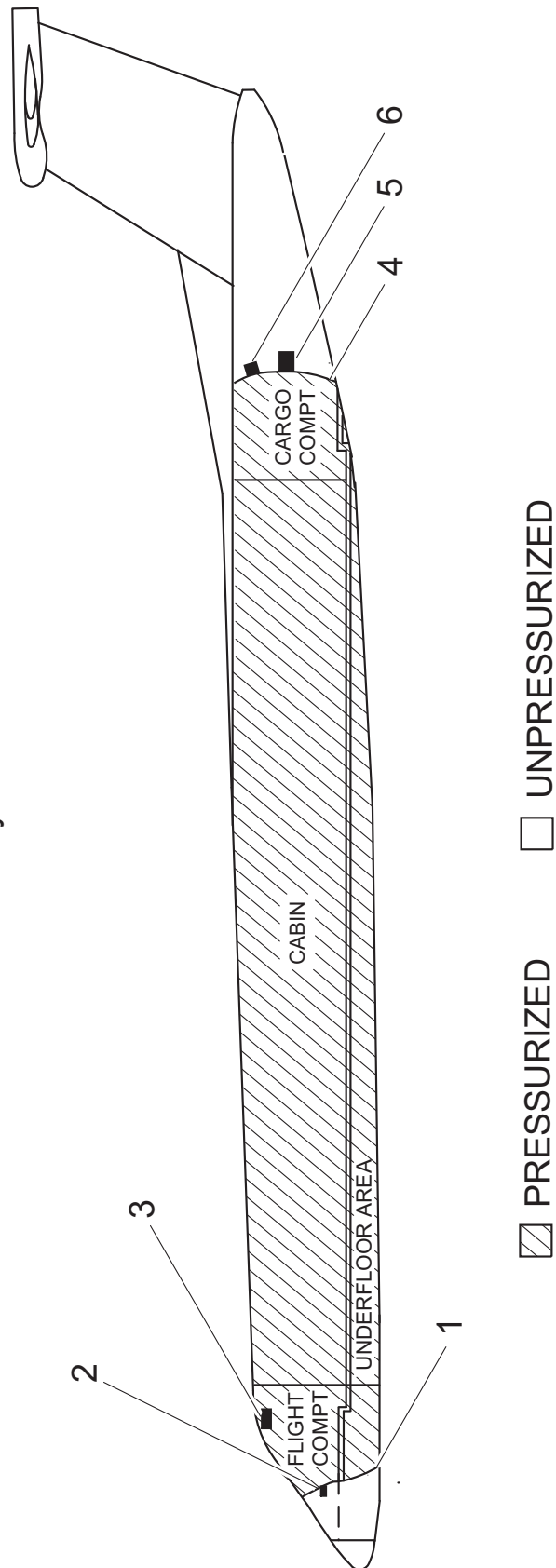


Figure 12.2-10 Pressurized Areas

12.2.2 PRESSURIZATION

12.2.2.1 Introduction

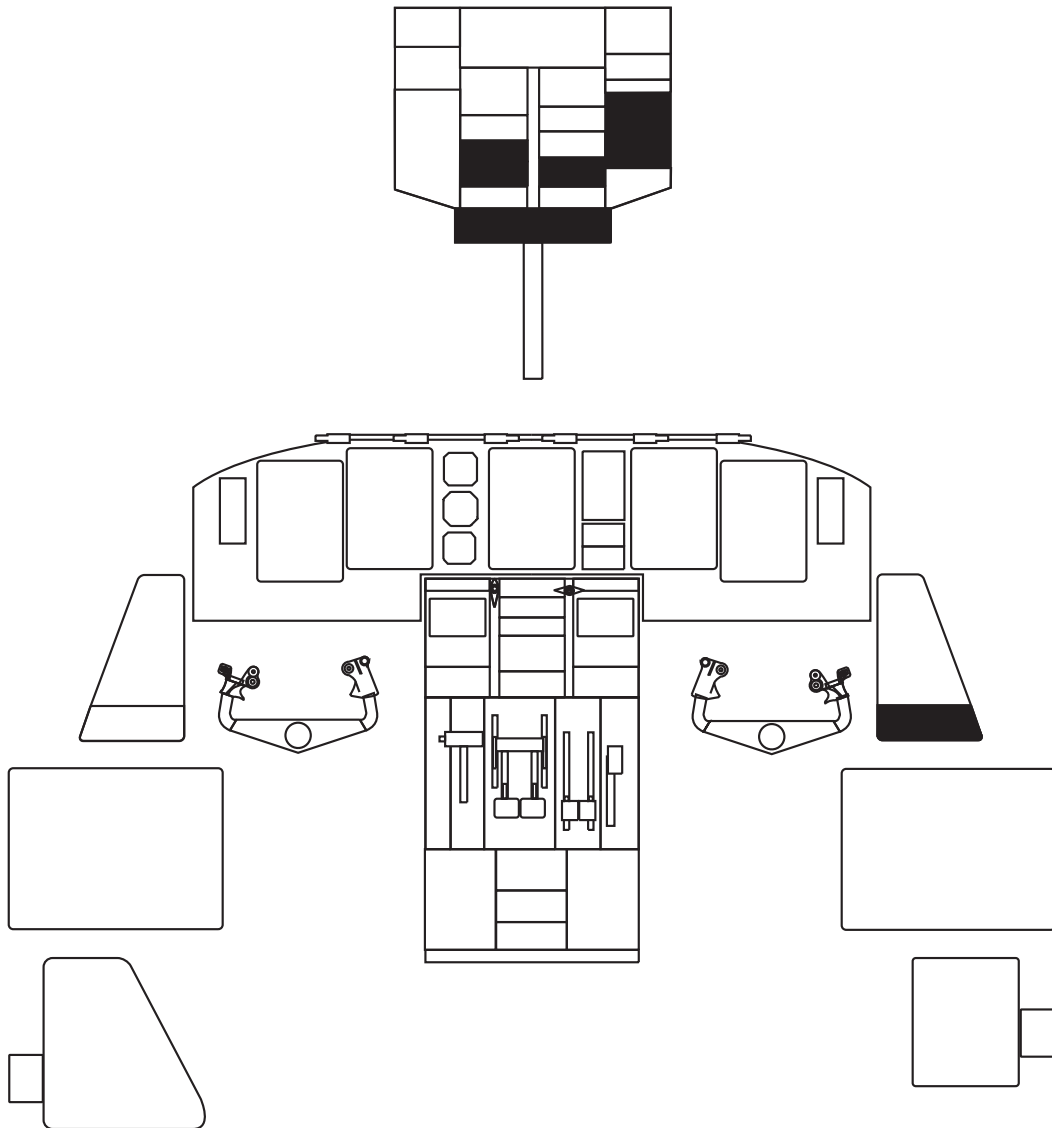
The aeroplane is pressurized by engine bleed air supplied to and distributed by the air-conditioning system. Pressure is maintained and controlled by the cabin pressure control system which governs the rate of outflow from the pressurized areas (Figure 12.2-10) of the aeroplane. An aft outflow valve primarily controls the outflow of air, and is assisted by two safety valves.

12.2.2.2 General

The aft outflow valve is controlled from the Cabin Pressure Control panel on the flight deck overhead panel. There are independent controls and indicators to operate and monitor the system. The aft outflow valve and an aft safety valve are located on the aft pressure dome. A forward safety outflow valve is located on the forward pressure bulkhead.

If cabin altitude is too high, a flight deck warning light comes on.

12.2.2.3 Controls and Indications - Pressurization



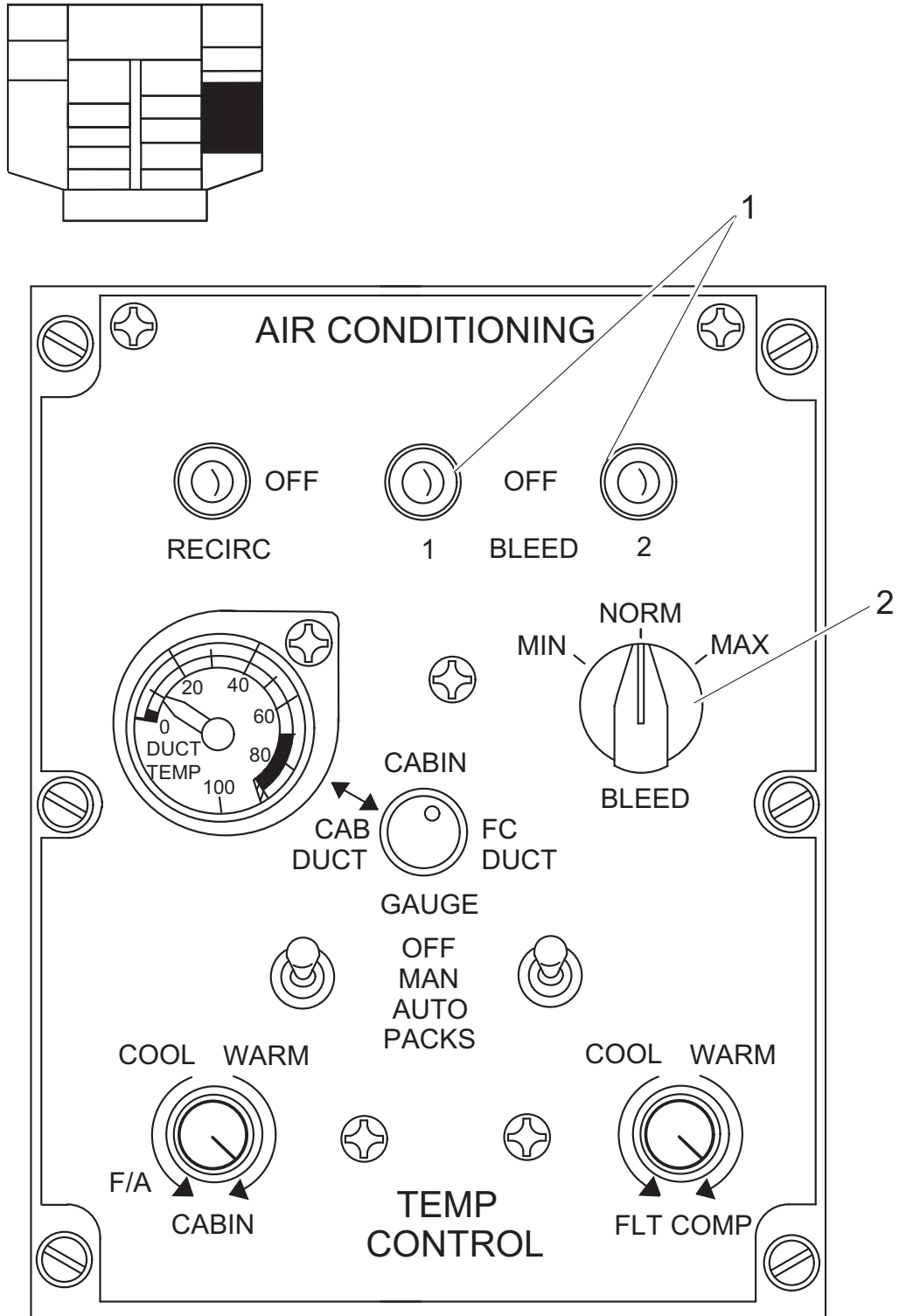


Figure 12.2-11 Air Conditioning Control Panel

A/C PANEL CALLOUTS PERTAINING TO PRESSURIZATION

1. BLEED 1 AND 2 SWITCHES (two position)

1 or 2 - starts bleed airflow from the No. 1 and/or No. 2 engine to the air conditioning packs
OFF - stops bleed airflow from the selected engine by closing the following

2. BLEED SELECTOR (three position, rotary action)

MIN - allows Environmental Control System (ECS) controller to modulate the amount of bleed air from both engines at a minimum level

- the only selection permitted for take-off
- with the BLEED switches on, and NTOP or MTOP set, shows BLEED (white) on the Engine Display (ED)

NORM, MAX - allows ECS controller to modulate the amount of bleed air from both engines at increased levels

- with the BLEED switches on, and NTOP set, indicates BLEED (amber) on the ED
- with the BLEED switches on, and MTOP set, rating display changes to, and indicates MCP. BLEED is not displayed

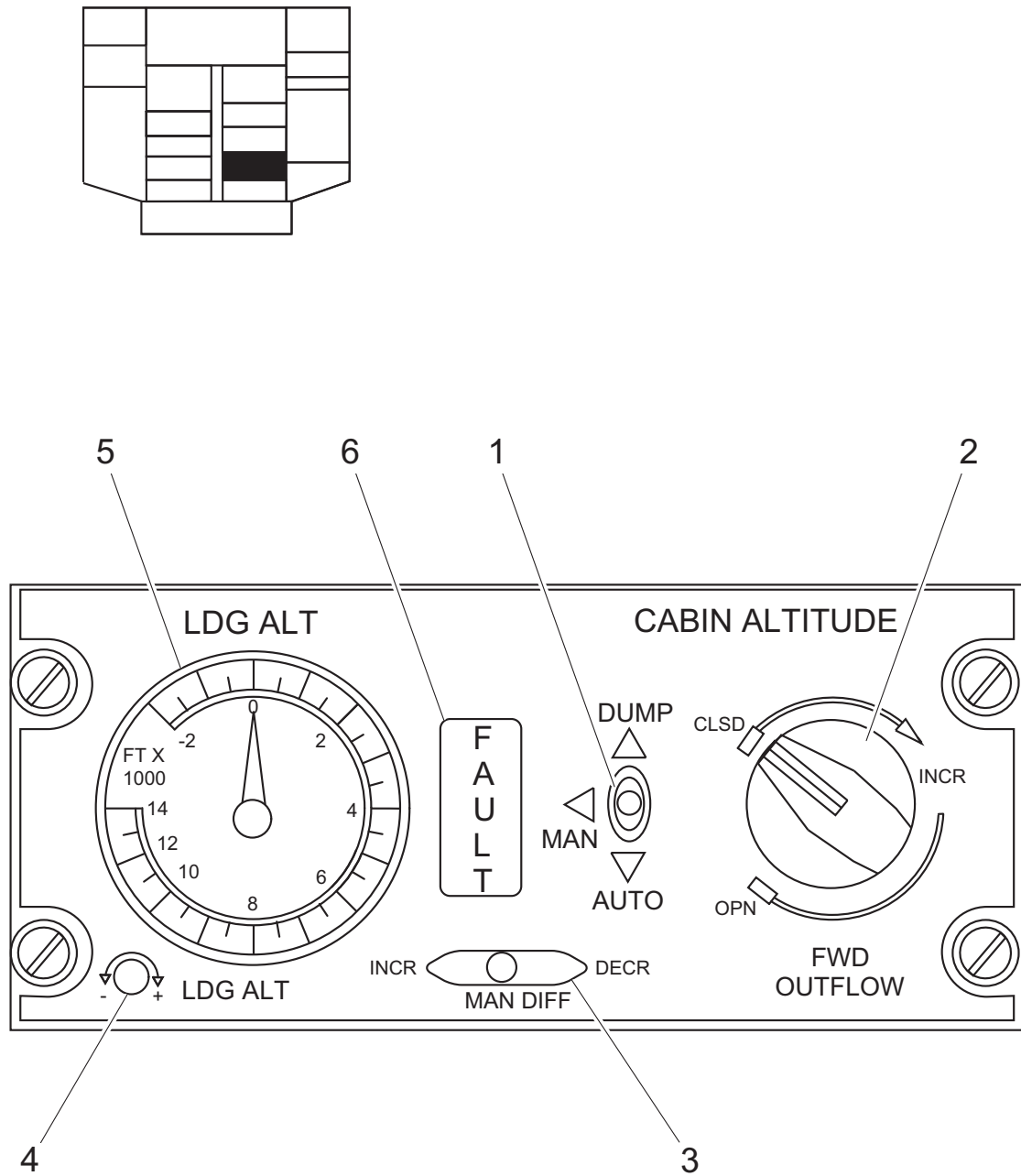


Figure 12.2-12 Pressurization Control Panel

PRESSURIZATION CONTROL PANEL

1. REAR OUTFLOW VALVE CONTROL Switch (three position)

DUMP - releases pressure by fully opening the aft outflow valve

MAN - turns off the cabin pressure controller

- enables manual control of the aft outflow valve and the cabin differential pressure using the MAN DIFF switch

AUTO - cabin altitude is controlled using the aft outflow valve which modulates to maintain a pre-programmed cabin altitude schedule

2. FWD OUTFLOW VALVE ROTARY KNOB (rotary action)

CLSD - decreases the cabin altitude by closing the forward safety valve

OPN - increases the cabin altitude by opening the forward safety valve

- usually set fully counterclockwise (CLSD) when in AUTO mode
- independent of rear outflow valve operation

3. MAN DIFF SWITCH (three position, spring loaded to center)

INCR - increases cabin pressure when AUTO/MAN/DUMP switch is in the MAN position

DECR - decreases cabin pressure when AUTO/MAN/DUMP switch is in the MAN position

4. LDG ALT ROTARY SWITCH (rotary action)

- selects the field elevation for take-off and landing as shown on the LDG ALT indicator

Note:

The Cabin Indication Module (CIM) is indicating according to QNE (1013.25 hPa International Standard Atmosphere at sea level) and has no barometric correction, therefore it will show different cabin altitudes, at same station, with different pressures.

5. LDG ALT Indicator

- displays the landing altitude selected with the LDG ALT rotary switch

6. FAULT ANNUNCIATOR Light (amber)

- on continuously when the cabin pressure control system detects a fault
- on momentarily during the power up test mode

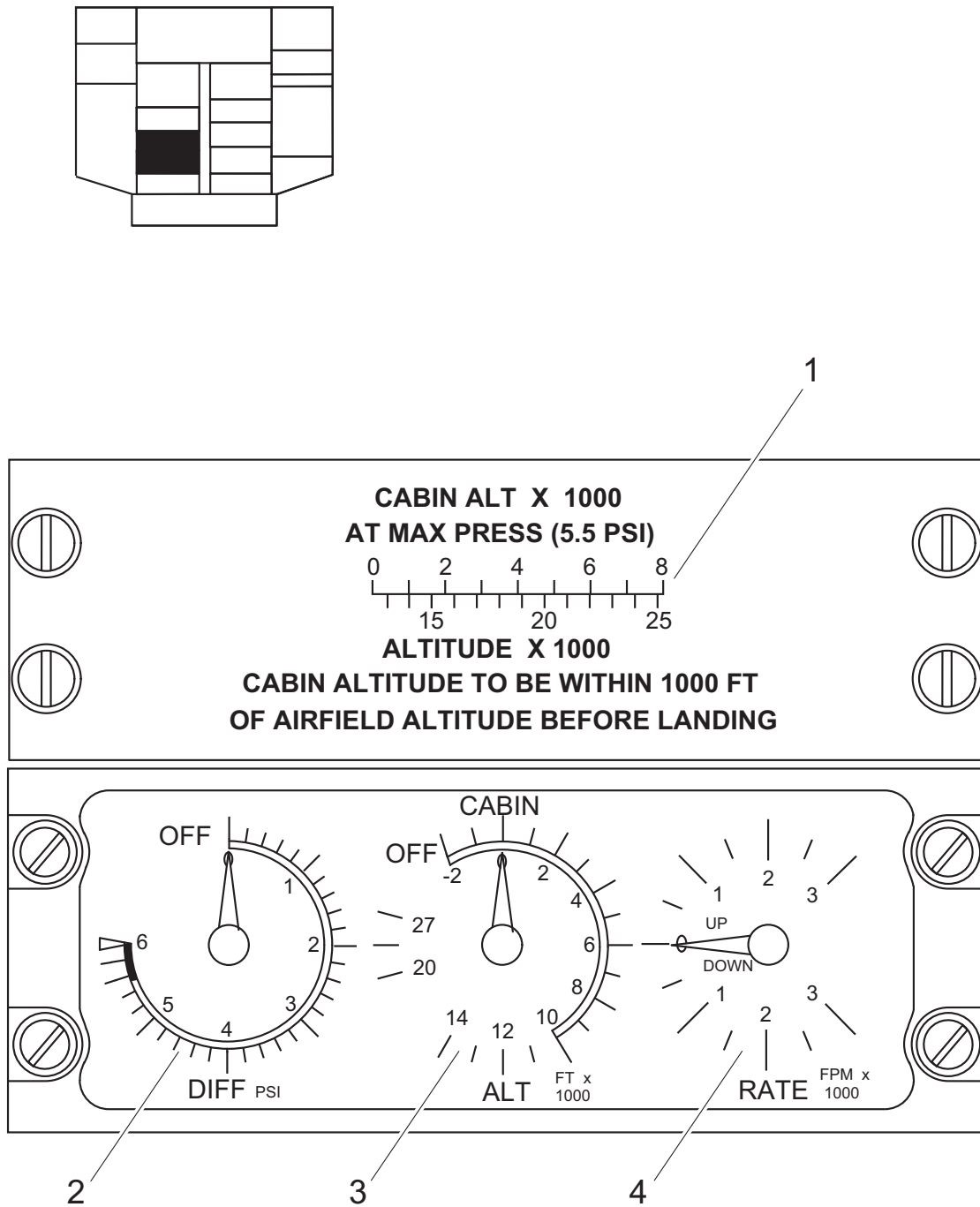


Figure 12.2-13 Pressurization Indicator Panel

PRESSURIZATION INDICATOR PANEL

1. MANUAL CABIN ALT/DIFFERENTIAL PRESSURE SCHEDULE

- used as a guide to set cabin differential pressure using the MAN DIFF switch in MAN mode

2. DIFF PRESSURE INDICATOR

- shows the differential pressure between cabin and aeroplane flight altitude pressure in pounds per square inch

3. CABIN ALTITUDE INDICATOR

- shows the cabin altitude in thousands of feet

4. CABIN ALTITUDE RATE OF CLIMB INDICATOR

- shows cabin altitude rate of climb or descent in thousands of feet per minute

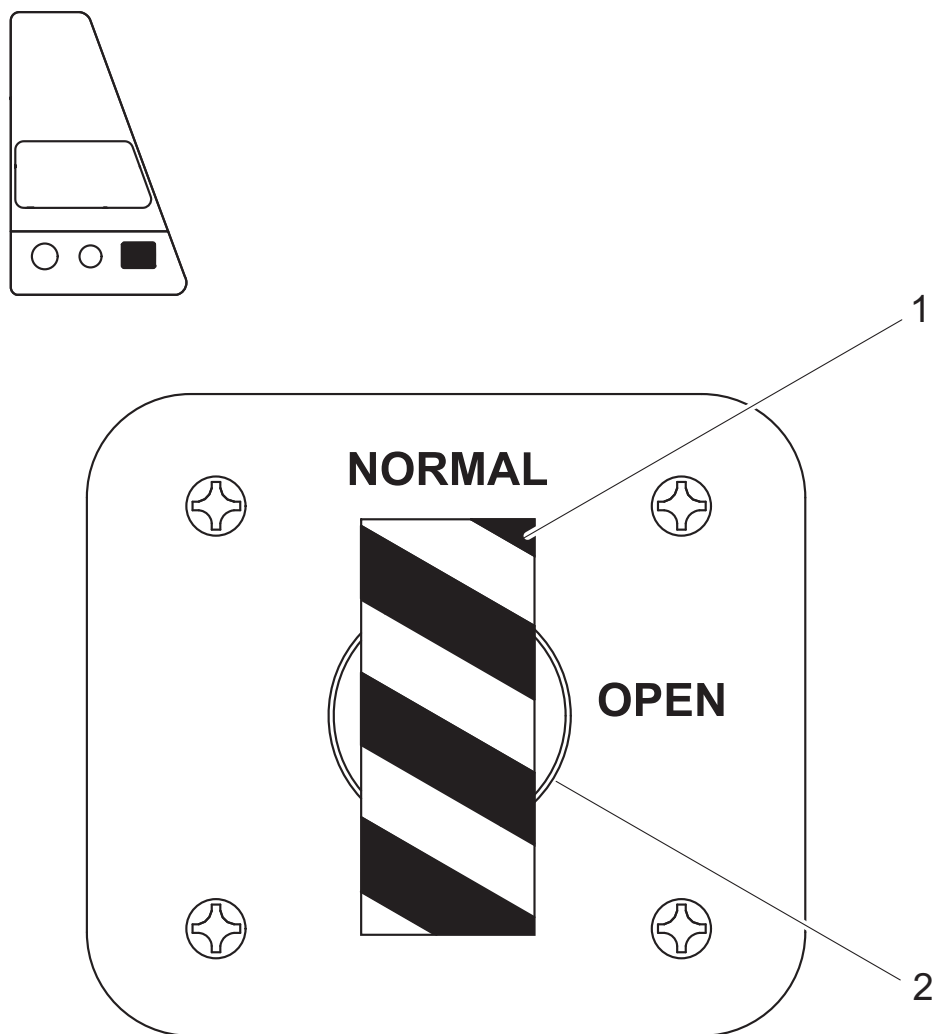


Figure 12.2-13 Forward Safety Valve Selector

FORWARD SAFETY VALVE SELECTOR

1. SAFETY GUARD

- lift to access forward safety valve selector

2. FORWARD SAFETY VALVE SELECTOR (two position)

NORMAL - forward safety valve fully closed

OPEN - opens the forward safety valve fully for emergency operations

NOTE: The forward safety valve cannot be modulated using this selector

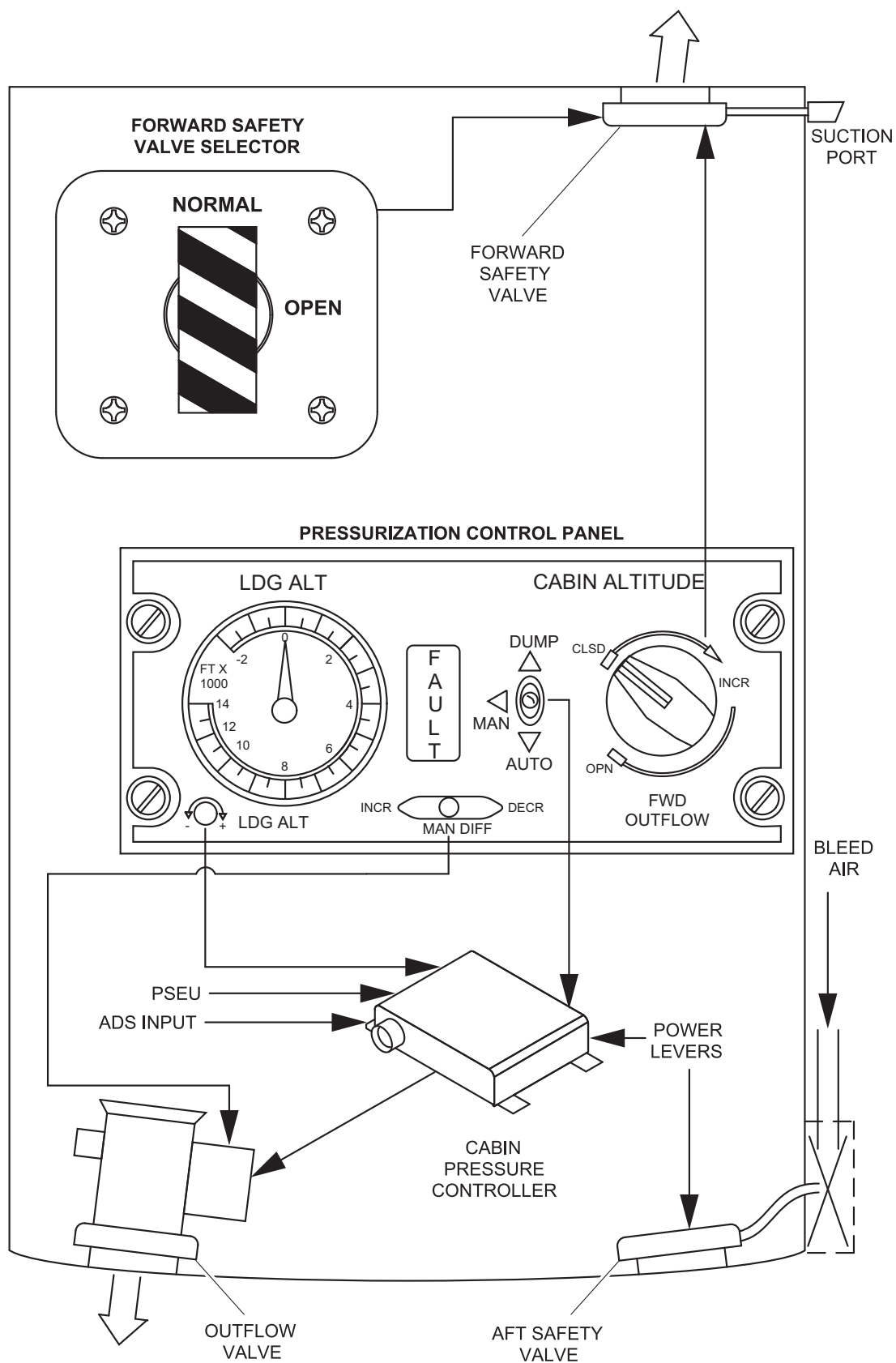


Figure 12.2-14 Pressurization Schematic

12.2.2.4 Pressurization Description

Except for the pressure relief function, pressurization is controlled primarily by the electrically operated aft outflow valve. It is used for automatic and manual control, and can also be used to dump the pressurization. The forward safety valve is for emergency operation and for smoke removal from the flight deck. The aft safety valve and the forward safety valve have positive and negative pressure relief valves.

The pressurization system can be controlled in either of four modes:

- Automatic
- Manual
- Emergency/Smoke Removal
- Pressure Dump

12.2.2.4.1 Automatic

When electrical power is first supplied to the system, a full power up self test is done. The **FAULT** alert light, on the Cabin Pressure Control (CPC) panel comes on momentarily during the power up test mode. If there is a failure in the system, the light will stay on. The system operation is fully automatic with the data programmed into the controller (Figure 12.2-14).

With the system in AUTO mode, a pre programmed cabin pressure controller does all pressure scheduling from take-off to landing with minimal crew input. The computer receives inputs from the crew and various aeroplane systems, and modulates the aft outflow valve. This keeps a fixed schedule of cabin altitude versus airplane altitude for complete regulation of cabin pressure.

12.2.2.4.2 On Ground

When the aeroplane is on the ground and the engine power lever angles are set at less than 60 degrees, the aft outflow valve is positioned at the fully open position to prevent aeroplane pressurization. The aft safety valve located on the aft pressure bulkhead, also opens on the ground when at least one engine is running at idle, or the APU is operating.

12.2.2.4.3 Take-off

When the engine power levers angles are set to greater than 60 degrees the controller sends a signal to the aft outflow valve to modulate, as necessary, to provide two take-off sequences:

- Pre-pressurization
- Take-off abort

The aft outflow valve moves from the fully open position and starts to modulate to control the pressure changes that occur during take-off. After take-off (as sensed by the PSEU), the aft outflow valve modulates to keep the set aeroplane pressure.

a) Pre-Pressurization

The purpose of automatic pre-pressurization is to avoid a cabin pressure “bump” at take-off. During this sequence the cabin is pressurized to 400 ft. below the take-off altitude at a rate of - 300 ft./min.

In the case of a take-off without bleed air selected, this sequence leads to both the aft outflow valve and the aft safety valve closing.

b) Take-off Abort

The Cabin Pressure Controller (CPC) is in take-off mode for at most 10 minutes after lift off. This avoids the requirement to reselect the landing altitude in case of an aborted flight and emergency return to the departure airport. During 10 minutes after the take-off the pre-pressurization remains in effect as long as:

- The scheduled cabin altitude is higher than the theoretical cabin altitude, or
- The aeroplane altitude is less than the take-off altitude plus 5,000 ft. (valid only for take-off altitude over 8,000 ft.).

Once one of the above conditions is met, the CPC begins flight scheduling.

12.2.2.4.4 Flight

The flight sequence is initiated when the take-off sequence is over, and AUTO mode is selected. During this sequence, the cabin pressurization is controlled by the CPC in accordance with the pre programmed pressurization schedule.

12.2.2.4.5 Descent

During descent, the cabin rate of change is achieved automatically. In the case of a high speed descent, the rate of descent increase sequence is initiated.

12.2.2.4.6 Landing

Aeroplane depressurization is controlled automatically during landing. If the set field altitude is higher than actual field altitude, the aeroplane will land unpressurized. If the field altitude is set less than actual field altitude, the aeroplane will land pressurized. In this case, on landing, the cabin altitude will go back to field altitude at the rate programmed for one minute, before cabin pressure is bled to ambient. This is achieved when the outflow valve, and the aft safety valve are fully open.

12.2.2.5 Manual

The manual mode is used if the automatic pressurization mode does not operate. Pressurization can be manually controlled through the aft outflow valve, when the **AUTO-MAN-DUMP** switch is set to **MAN**. When the toggle switch is moved and held to the **DECR** position, the aft outflow valve opens and decreases the cabin pressure, increasing the cabin altitude. When the toggle switch is moved and held to **INCR**, the aft outflow valve closes and the cabin pressure increases to decrease the cabin altitude.

NOTE: When operating in manual mode, the cabin altitude, cabin differential pressure, and cabin rate of change indicators should be monitored carefully.

12.2.2.6 Emergency/Smoke Removal

Pressurization can be controlled through the forward safety valve when the aft outflow valve becomes unserviceable. Cabin pressure can be regulated by turning the **FWD OUTFLOW** knob, as necessary, to adjust the amount of pressure bleed to get the required pressurization selection. When the control knob is turned clockwise the forward safety valve opens and the cabin pressure decreases. Pressurization can also be reduced rapidly by turning the forward safety valve selector on the copilot's side console. This opens the forward safety valve fully.

NOTE: When operating in emergency mode, the cabin altitude, cabin differential pressure, and cabin rate of change indicators should be monitored carefully.

Electrical power is not required to operate either the **FWD OUTFLOW** knob, or the forward safety valve selector.

The forward safety valve may be used with the automatic system operating during flight to evacuate smoke from the flight deck, without depressurizing the airplane. Turning the **FWD OUTFLOW** knob clockwise meters suction caused by the slipstream to open the forward safety valve. With the **AUTO/MAN/DUMP** switch set to **AUTO**, the automatic system, trying to maintain cabin pressure, will begin to close the aft outflow valve. This exhausts air and smoke through the forward outflow valve.

12.2.2.7 Pressure Dump

The fast depressurization function may be done in the automatic and the manual modes. The **AUTO/MAN/DUMP** switch set to **DUMP** fully opens the aft outflow valve. In the manual mode, the aft outflow valve opens when the toggle switch is moved and held in the **DECR** position. In **DUMP** mode the aft outflow valves stay fully open, preventing the aeroplane from pressurizing. **DUMP** mode may also be used for maximum smoke evacuation.

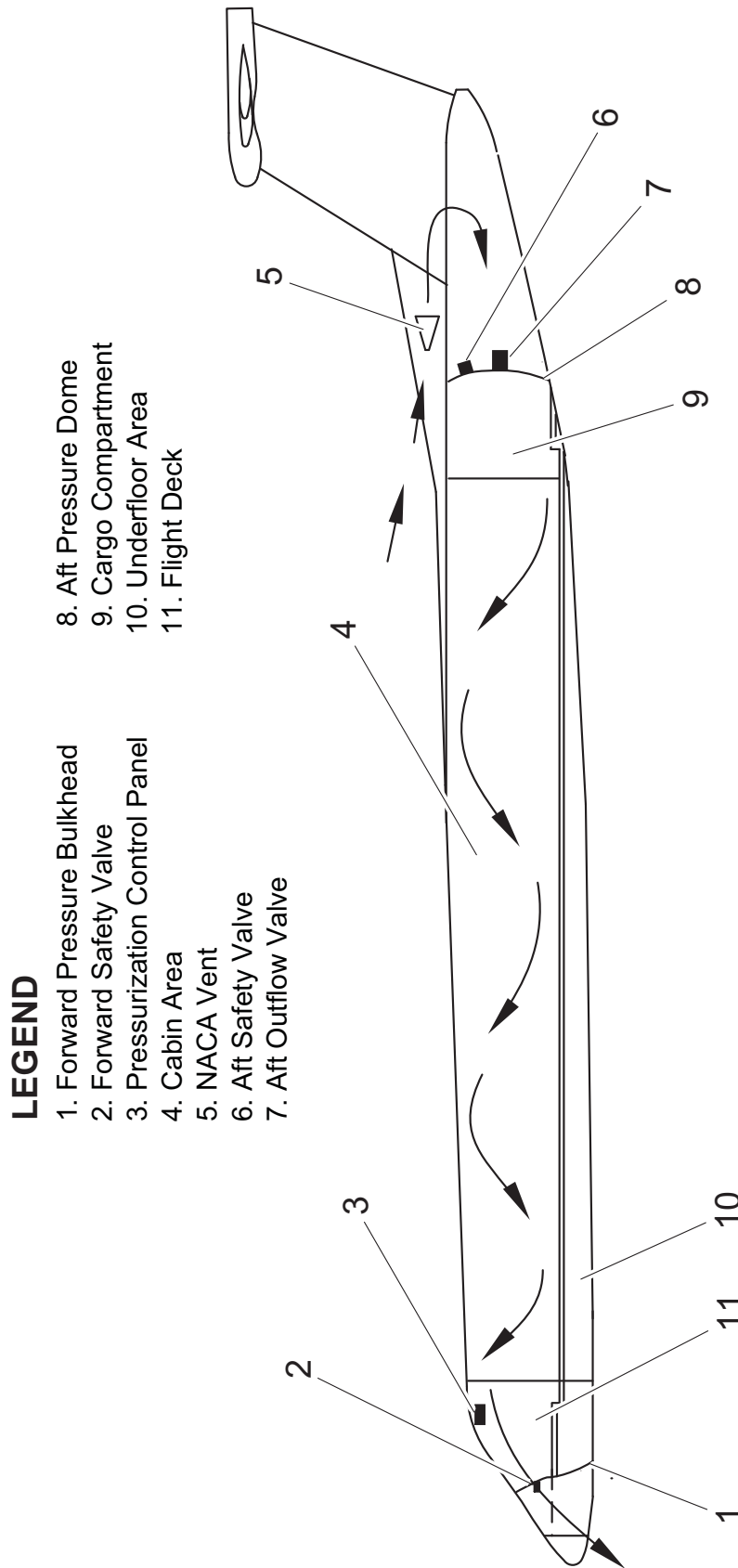


Figure 12.2-15 Ram Air Ventilation

12.2.2.8 Emergency Ram-air Ventilation

During unpressurized flight the cabin and flight deck can be ventilated with outside ram air (Figure 12.2-15). Without bleed air the ram air enters through the dorsal fin NACA vent, through a check valve and into the air conditioning ducting downstream of the packs. The ram air ventilates the cabin and flight deck and then exhausts through the forward outflow valve, as the aft outflow valve is closed when the **AUTO/MAN/DUMP** switch is set to the **MAN** position.

12.2.2.9 Cabin Pressure Controller

The maximum differential pressure permitted by the cabin pressure controller is 5.46 psi, which gives a cabin altitude of 8,000 feet at 25,000 feet ambient altitude. If differential pressure is more than 5.8 ± 0.15 psi, a pressure limiter in both the forward and aft safety valves opens to release the pressure. Both safety valves also have a negative pressure relief valve which will operate at -0.5 psi differential to prevent external atmospheric pressure from being more than internal cabin pressure. When on the ground with the power levers at flight idle or low power settings, the cabin pressure controller holds the aft outflow valve and the aft safety valve fully open.

A CABIN PRESS warning light will come on if cabin altitude is more than 9,800 feet.