



# CHAPTER 2

## AIR CONDITIONING AND PRESSURIZATION

### CONTENTS

|                                       | <b>Page</b> |
|---------------------------------------|-------------|
| <b>GENERAL .....</b>                  | <b>2-1</b>  |
| <b>SYSTEM DESCRIPTION .....</b>       | <b>2-1</b>  |
| Pneumatic System .....                | 2-1         |
| Air-Conditioning System .....         | 2-3         |
| Avionics Cooling System .....         | 2-6         |
| Cargo Bay Air Conditioning .....      | 2-6         |
| Ground Air Connection .....           | 2-8         |
| Pressurization System .....           | 2-9         |
| <b>CONTROLS AND INDICATIONS .....</b> | <b>2-13</b> |
| Pneumatic System .....                | 2-13        |
| Air-Conditioning System .....         | 2-19        |
| Avionics Cooling System .....         | 2-25        |
| Cargo Bay Air Conditioning .....      | 2-27        |
| Pressurization System .....           | 2-29        |
| Circuit Breakers .....                | 2-37        |



INTENTIONALLY LEFT BLANK



## ILLUSTRATIONS

| <b>Figure</b> | <b>Title</b>                                             | <b>Page</b> |
|---------------|----------------------------------------------------------|-------------|
| <b>2-1</b>    | ECS Synoptic Page .....                                  | <b>2-2</b>  |
| <b>2-2</b>    | Air-Conditioning Pack Schematic .....                    | <b>2-4</b>  |
| <b>2-3</b>    | Cargo Compartment Air System Diagram.....                | <b>2-7</b>  |
| <b>2-4</b>    | High Pressure Ground Air Connection Panel.....           | <b>2-8</b>  |
| <b>2-5</b>    | Low Pressure Ground Air Connection Panel .....           | <b>2-9</b>  |
| <b>2-6</b>    | Pressurization System Schematic .....                    | <b>2-11</b> |
| <b>2-7</b>    | BLEED AIR Control Panel.....                             | <b>2-13</b> |
| <b>2-8</b>    | Pneumatic EICAS Indications .....                        | <b>2-16</b> |
| <b>2-9</b>    | ECS Synoptic Page—<br>Pneumatic Indications .....        | <b>2-18</b> |
| <b>2-10</b>   | AIR-CONDITIONING Control Panel.....                      | <b>2-21</b> |
| <b>2-11</b>   | ECS Synoptic Page—<br>Air-Conditioning Indications ..... | <b>2-24</b> |
| <b>2-12</b>   | Avionics Cooling Control Panel .....                     | <b>2-25</b> |
| <b>2-13</b>   | PFD/MFD Overtemperature Indication .....                 | <b>2-28</b> |
| <b>2-14</b>   | CABIN PRESS Control Panel .....                          | <b>2-30</b> |
| <b>2-15</b>   | Pressurization EICAS Indications—<br>Primary Page .....  | <b>2-32</b> |
| <b>2-16</b>   | Pressurization EICAS Indications—<br>Status Page .....   | <b>2-34</b> |
| <b>2-17</b>   | Pressurization EICAS Indications—<br>ECS Page .....      | <b>2-37</b> |



INTENTIONALLY LEFT BLANK



TABLE

| Table | Title                                             | Page |
|-------|---------------------------------------------------|------|
| 2-1   | Power Supply and<br>Circuit-Breaker Summary ..... | 2-38 |



INTENTIONALLY LEFT BLANK



# **CHAPTER 2**

## **AIR CONDITIONING AND PRESSURIZATION**

### **GENERAL**

The environmental control system (ECS) provides conditioned air to the occupied areas and to the avionics cooling systems. Cockpit instrument panels are cooled via forced ventilation of cabin air. Cabin pressurization is automatically regulated by two outflow valves on the rear pressure bulkhead.

The pneumatic, air conditioning, and pressurization controls are located on the respective overhead BLEED AIR, AIR CONDITIONING, and CABIN PRESS panels. ECS caution and warning alerts are presented on the engine indication and crew alerting system (EICAS) primary display. ECS advisory and status messages are presented on the EICAS secondary display.

Cockpit and cabin temperature and pressure information are shown by synoptic diagrams on the EICAS secondary display, which are accessed by selecting the ECS page on the EICAS control panel (Figure 2-1).

### **SYSTEM DESCRIPTION**

#### **PNEUMATIC SYSTEM**

The pneumatic system supplies bleed air for the following uses:

- Engine starting (from the 10th stage engine compressors or, APU up to 13,000 feet). A ground cart delivering high pressure air can also be used for engine starting.
- Thrust reversers (from the 14th stage engine compressors)

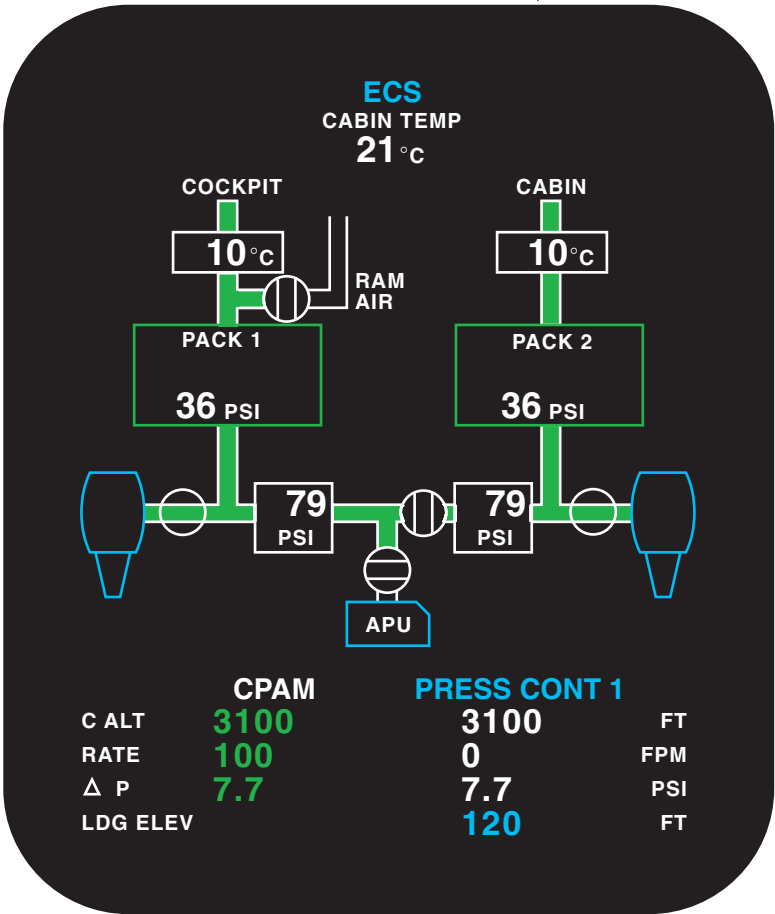
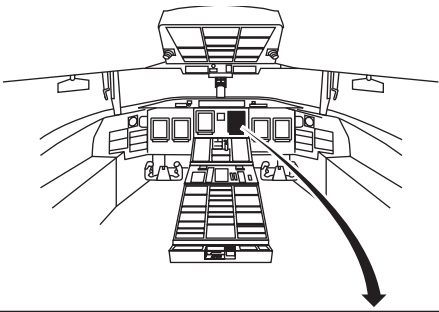


Figure 2-1 ECS Synoptic Page





- Engine and wing ice protection (from the 14th stage engine compressors).
- Air conditioning and avionics cooling (from the 10th stage engine compressors or, the APU while on ground and up to 15,000 feet). A ground cart supplying conditioned air can also be used for cabin heating or cooling. Ground air pressure is displayed at the left and right 10th-stage pressure readouts on the ECS page. There is no pressure readout on the ECS page when the airplane is operating with DC power only.

Pneumatic 10th-stage and 14th-stage bleed air flow is controlled by the respective shutoff valves via the BLEED AIR panel.

A leak detection system monitors the 10th- and 14th-stage duct systems for bleed-air leaks. If a leak is detected, visual warnings appear on the overhead control panel and the EICAS and accompanied by aural warnings. The affected duct is isolated by closing the shutoff valve. The bleed-air leak detection system can be tested via the DUCT MON switch on the BLEED AIR panel.

## AIR-CONDITIONING SYSTEM

The air-conditioning system provides ventilation and temperature regulation in the occupied areas. The system consists of two independent air-conditioning packs and a ram-air ventilation system. The air-conditioning packs (air cycle machines with related control valves and monitoring) normally work in parallel to accomplish compartment temperature control.

Each pack (Figure 2-2) is normally supplied bleed air from the inside engine. The APU directly feeds the left pack. Bleed air flow to each pack is controlled by a pressure regulating shutoff valve which is controlled by the respective pack switchlights on the AIR CONDITIONING panel. An isolation valve interconnects the pneumatic bleed air sources so that either engine or the APU can supply both packs. The isolation valve is controlled by the 10th-stage ISOL switchlight on the BLEED AIR panel.

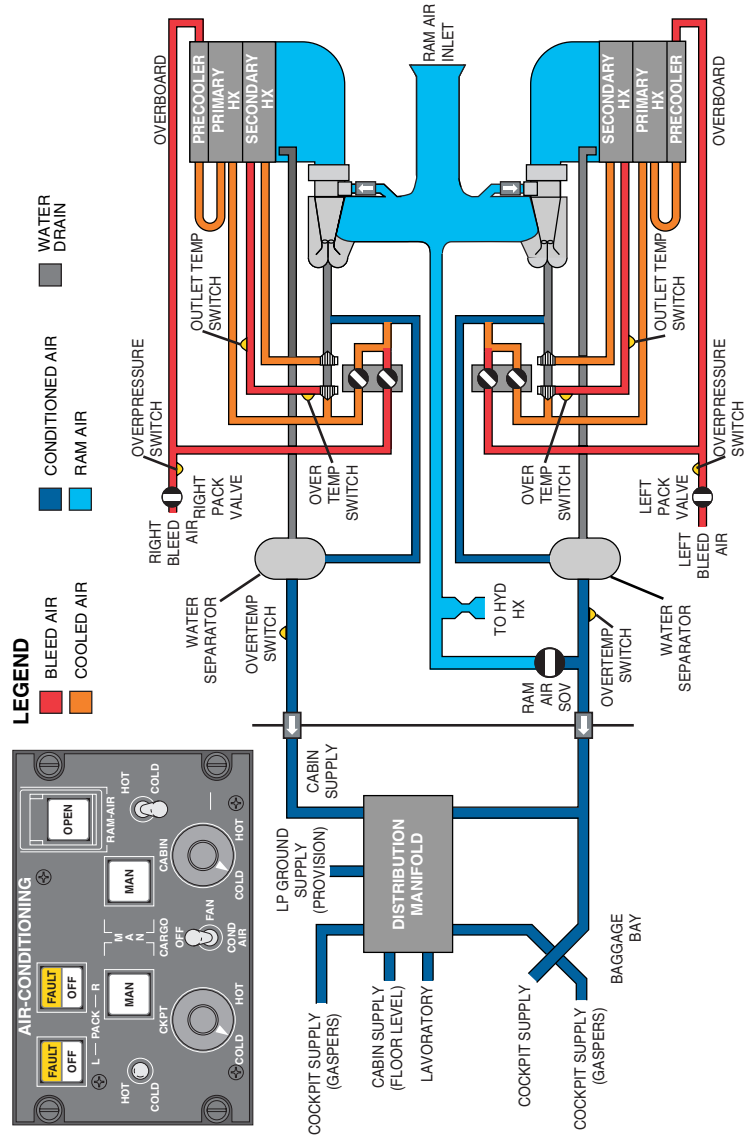


Figure 2-2 Air-Conditioning Pack Schematic



The left pack primarily supplies the flight compartment (70%) and supplements the flow to the passenger cabin (30%). The right pack primarily supplies the cabin (70%) and supplements the flow to the flight compartment (30%). Either pack can simultaneously supply conditioned air to both compartments.

Regulation of the output temperature of each pack is accomplished by the respective temperature control valve which regulates bleed air bypass around the air cycle machine (ACM). Bleed air bypassing the ACM retains its heat as it is routed to the compartments. Bleed air passing through the ACM is cooled. The temperature control valve modulates as necessary to blend bypassed hot air with cooled ACM air to achieve the selected temperature.

The cooling efficiency of each air conditioning pack is enhanced by ram air cooling via a heat exchanger. Ram air enters through an inlet at the base of the vertical stabilizer and passes through the pack heat exchangers and then exits overboard. In case of failure of both packs, ram air can be used as the sole source of ventilation. This is accomplished by opening the ram-air valve via the RAM AIR switch. Ram air then enters the occupied areas through the normal vents.

The flight compartment and the cabin have independent operating temperature control systems which control operation of the respective pack. Temperature control can be accomplished in automatic mode or manual mode. In automatic mode, the desired temperature is selected by the temperature control knobs on the AIR CONDITIONING panel. Selected temperature is relative to knob position which is rotated between COLD and HOT labels. Manual mode selection requires that the respective HOT-COLD switch be actuated in the desired direction. Manual mode temperature below 3°C may result in icing of the pack water separator and subsequent cycling of pack output. During manual mode, if duct temperature reaches 85°C, the pack shuts down, and the EICAS displays a PACK HI TEMP caution message.

Overtemperature and overpressure conditions in either pack are indicated on the EICAS displays and the switchlights on the AIR-CONDITIONING panel.



The conditioned air to the flight compartment is distributed to the side console panels, gaspers and vents, and avionics units within the instrument panel. Dedicated fans and ducts direct conditioned air over the flight compartment display units. Conditioned air to the cabin is distributed from ducts along each side of the aircraft. Exhaust air from both areas is routed underfloor to the pressurization outflow valves on the aft pressure bulkhead.

## **AVIONICS COOLING SYSTEM**

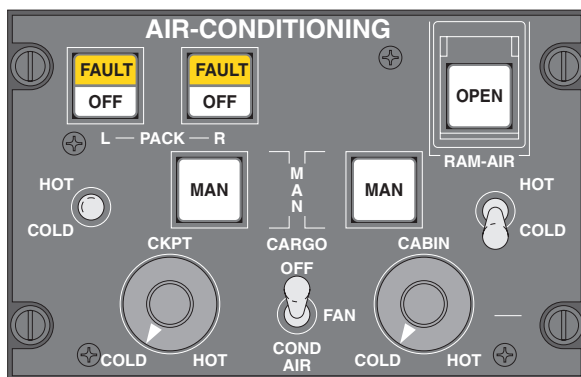
The flight compartment CRTs and control panels and the underfloor avionics bay are cooled by forced ventilation at all times. Cooling is accomplished by operation of one of three fans dedicated to each system. The flight compartment instrument and panel cooling is controlled by the DSPLY FAN knob while the avionics bay cooling is controlled by the ARINC FAN knob. Both knobs are located on the aft pedestal.

The No. 1 fan for each system operates during flight, and the No. 2 fan operates on the ground, with a standby fan for backup (DSPLY FAN) only. Automatic switching from the No. 1 to the No. 2 fan occurs through flight/ground sensing from the weight-on-wheel (WOW) system. The respective control knob permits manual rever-sionary selections in case of fan failure.

When the airplane is on the ground, the heated air is dumped through the overboard exhaust shutoff valve. When the airplane is in flight, the air is dumped through the inboard exhaust shutoff valve to the aft underfloor area and expelled through the outflow valves. The operation of the exhaust shutoff valves is monitored by the EICAS.

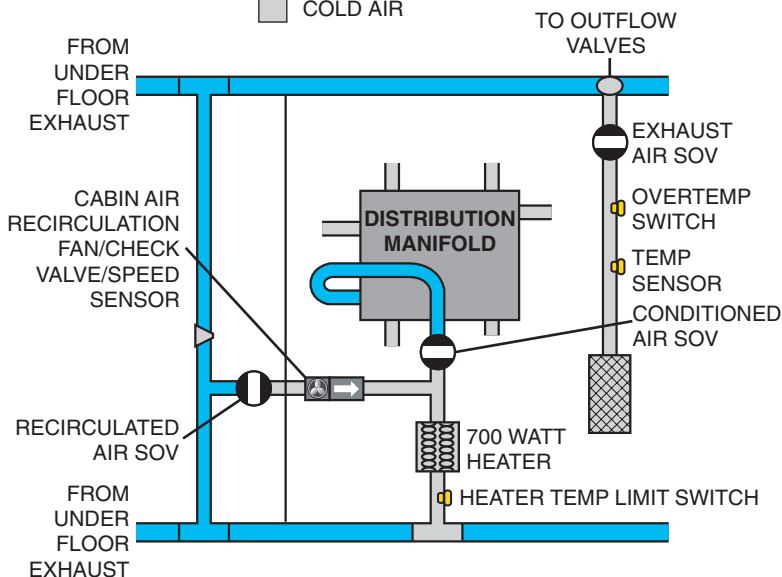
## **CARGO BAY AIR CONDITIONING**

The cargo bay air conditioning system controls temperature in the cargo bay. The cargo compartment receives conditioned and recirculated air from the passenger compartment (Figure 2-3). The air is pulled into the cargo compartment by the fan and check valve assembly. An electric heater in the supply duct supplements heating as necessary.



### LEGEND

- RECIRCULATED AIR
- COLD AIR



**Figure 2-3 Cargo Compartment Air System Diagram**

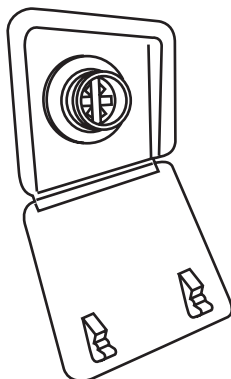


## **GROUND AIR CONNECTION**

### **High Pressure**

An external high pressure ground power cart can be used to supply the pneumatic system with a high pressure (HP) compressed source for engine starting.

Compressed air at the HIGH PRESSURE AIR GROUND CONNECTION panel (Figure 2-4), feeds through the 10th-stage manifold and duct system. Flight compartment indications of ground air pressure are at the left/right 10th-stage manifold pressure readouts on the ECS page. There is no pressure readout on the ECS page when the airplane is operating with DC power only.

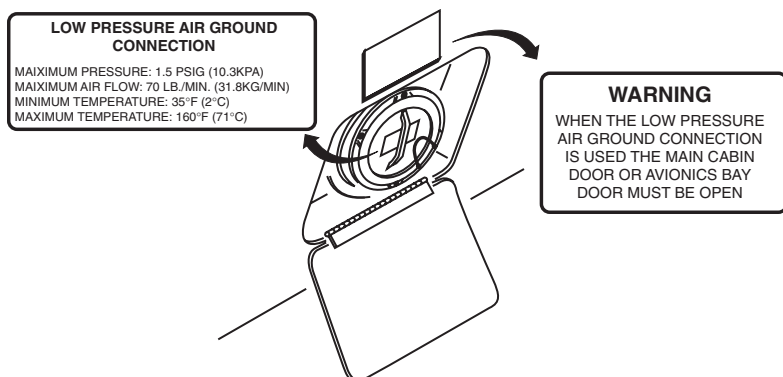


**Figure 2-4 High Pressure Ground Air Connection Panel**

### **Low Pressure**

An external low pressure ground power cart can be used for air conditioning.

Low pressure (LP) compressed air at the LOW PRESSURE AIR GROUND CONNECTION panel feeds directly into the cabin distribution system.



**Figure 2-5 Low Pressure Ground Air Connection Panel**

## PRESSURIZATION SYSTEM

The pressurization system controls the escape of conditioned air from the occupied areas. Cabin altitude is normally limited to 8.6 psid maximum. At maximum differential, cabin altitude is approximately 8,000 while at FL 410. Cabin altitude rate of change is limited to 500 fpm while ascending and 300 fpm while descending. Pressurization is normally controlled automatically by two pressurization controllers which regulate the opening of two outflow valves on the rear pressure bulkhead. All pressurization controls and indications are located on the CABIN PRESS panel and EICAS, respectively (Figure 2-6).

The pressurization system includes two identical controllers. Only one controller is active at any time. In case of controller failure, the standby controller automatically assumes pressurization control. In case of failure of both controllers, pressurization may be manually controlled.

The pressurization system includes a cabin pressure acquisition module (CPAM) which generates cabin altitude and rate of change, and differential pressure for indication on the EICAS. The CPAM also triggers automatic deployment of the passenger oxygen masks when cabin altitude reaches 14,000 feet and illumination of the seat belt and no smoking signs when cabin altitude reaches 10,000 feet,

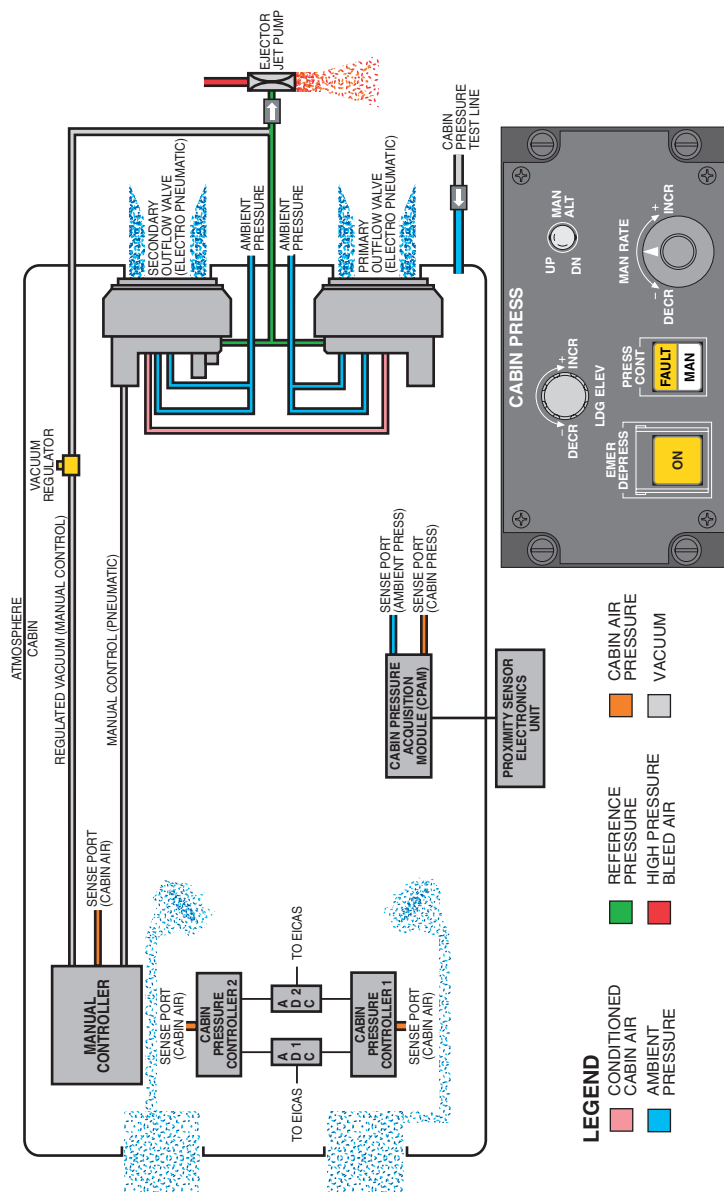


with auto mode selected for the signs. In case of CPAM failure, the standby pressurization controller generates the above indications. In such case, the oxygen masks do not automatically deploy and the signs do not automatically illuminate.

During automatic mode, pressurization is controlled in accordance with four phases of operation (flight):

- Ground phase. Both outflow valves are full open to prevent any cabin pressurization.
- Takeoff phase. When the thrust levers are advanced to take-off, the cabin pressurizes to 150 feet below airport elevation.
  - If the thrust levers are subsequently retarded (aborted take-off), the cabin depressurizes at 500 fpm for 20 seconds. Thereafter, the outflow valves remain full open.
  - If the airplane maintains an altitude of 6,000 feet or less above the takeoff airport elevation, and then begins descent at 1,000 fpm or more, the system assumes the landing elevation is the departure airport elevation. This prevents the crew from having to reset the landing elevation during an emergency return.
- Climb/Cruise phase. Cabin pressurization is maintained in accordance with the cabin altitude vs. airplane altitude schedule programmed in the automatic controllers. During descent, cabin altitude decreases at 300 fpm to either landing elevation or maximum differential, whichever is higher. When the landing elevation exceeds 8,000 feet, cabin altitude is maintained at maximum differential until the airplane descends at which time the cabin altitude increases to the set landing elevation.
- Landing phase. The cabin altitude decreases below field elevation, then increases at 500 fpm for 60 seconds. Thereafter, the outflows are maintained full open.







Manual pressurization is accomplished via the MAN ALT and MAN RATE controls on the CABIN PRESS panel. Transition to manual mode is controlled by the PRESS CONTROL switch. In this mode, cabin altitude is controlled by the MAN ALT lever which operates a 3-way valve. The valve ports pressure or vacuum to the outflow valves which causes them to close and open, respectively. Cabin altitude and rate of change are shown on the EICAS.

The outflow valves are electrically controlled (by signals from the pressurization controller) and pneumatically operated. In automatic operation, the left outflow valve is the master and the right outflow is slaved. In manual operation, the right outflow is the primary and the left is secondary. Open and close signals from the controller cause opening of the pressure or vacuum metering valve inside each outflow valve. Pressure from the pneumatic system causes the outflow valves to close while vacuum opens the valves. Vacuum is developed by porting pneumatic pressure through a jet pump.

Each outflow valve independently limits cabin pressure to 8.6 psid via an integral positive pressure limiting valve. Negative pressure is limited by a integral negative pressure relief valve to .5 psid. Each outflow valve also incorporates a maximum altitude limiter which limits cabin altitude to approximately  $14,250 \pm 750$  independent of the controller signals. The altitude limiters also limit cabin altitude to approximately  $14,250 \pm 750$  feet after emergency depressurization has been selected on the EMER DEPRESS switchlight.



## CONTROLS AND INDICATIONS

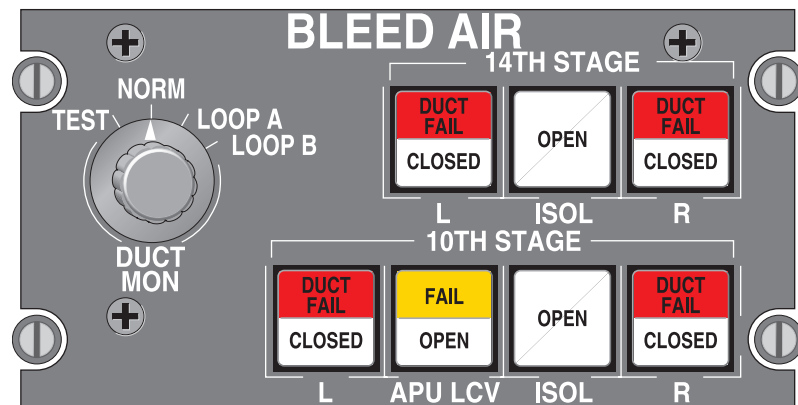
### PNEUMATIC SYSTEM

#### BLEED AIR Control Panel

The BLEED AIR control panel on the overhead panel provides pneumatic system monitoring and control (Figure 2-7).

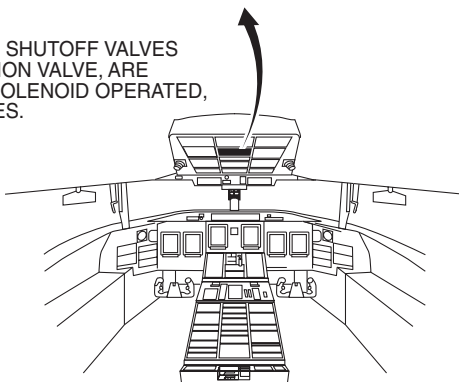
#### 10TH STAGE Bleed-Air Switchlights

These switchlights control the respective bleed-air shutoff valves.



#### NOTE:

THE 10TH STAGE BLEED-AIR SHUTOFF VALVES AND THE BLEED-AIR ISOLATION VALVE, ARE SPRING-LOADED CLOSED, SOLENOID OPERATED, PNEUMATIC SHUTOFF VALVES.



**Figure 2-7 BLEED AIR Control Panel**



Pressed in—The bleed-air shutoff valve opens, and the white CLOSED light extinguishes.

Released out —The bleed-air valve closes and the white CLOSED light illuminates.

DUCT FAIL red light—Illuminates if a bleed leak is detected in the associated duct section. The light automatically extinguishes when the duct temperature cools sufficiently. The light also illuminates during testing.

## **APU Load Control Valve Switchlight**

The APU LCV switchlight monitors and controls the APU load control valve.

Pressed in— The valve opens and the white OPEN light illuminates.

Released out —The valve closes and the white OPEN light extinguishes.

FAIL amber light—Illumination indicates the valve position does not agree with the selected position.

## **ISOL Switchlights**

The 10th- and 14th-stage ISOL switchlights control the isolation valve that interconnects the respective left and right bleed air sources.

Pressed in—The bleed-air isolation valve opens and the white OPEN light illuminates.

Released out—The bleed-air isolation valve closes and the OPEN light extinguishes.



## **Duct Monitor Switch**

The DUCT MON switch checks the bleed-air leak detection system.

**TEST**—Tests 10th- and 14th-stage loops by grounding the loop to simulate a duct failure. The following indications are given:

- L and R 10TH DUCT warning messages and illumination of the DUCT FAIL light in the switchlights
- L and R 14TH DUCT warning messages and illumination of the DUCT FAIL in the switchlights
- ANTI-ICE DUCT warning message and illumination of the DUCT FAIL portion of the wing anti-ice test switchlight
- “Bleed-air duct” aural warning

**NORM**—Normal (neutral) switch position. The switch is spring-loaded to this position.

**LOOP A**—Tests loop A of the 10th stage for continuity to ensure that the loop is not shorted to ground.

**LOOP B**—Tests loop B of the 10th stage for continuity to ensure that the loop is not shorted to ground.

## **EICAS Indications**

See Figure 2-8 for EICAS indications.

### **Primary Display—Primary Page**

#### **Warning Messages (Red)**

**L or R 10TH DUCT**—Indicates a leak in the respective 10th-stage manifold (Figure 2-8). The message is accompanied by a “Bleed-air duct” aural warning.



L or R 14TH DUCT—Indicates a leak in the respective 14th-stage manifold. The message is accompanied by a “Bleed-air duct” aural warning.

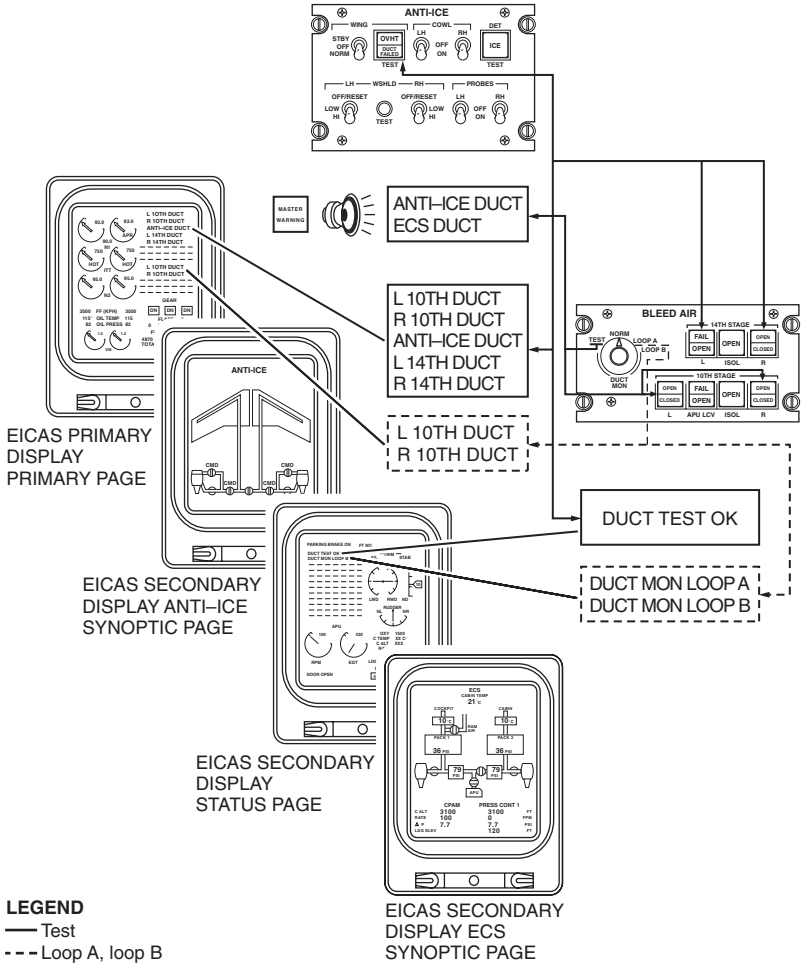


Figure 2-8 Pneumatic EICAS Indications



## Caution Messages (Amber)

**APU LCV FAIL**—The APU load control valve has failed (either open or closed).

**APU BLEED ON**—The APU load control valve is open and aircraft altitude is greater than 15,000 feet.

**BLEED MISCONFIG**—Illuminates with the selection of flaps  $>0^{\circ}\text{C}$  whenever either wing or cowl anti-ice is selected ON and the bleeds are configured with the 10th stage bleeds ON.

## Secondary Display—Status Page

### Advisory Message (Green)

**DUCT TEST OK**—Indicates that 10th- and 14th-stage bleed leak detection tests are successful

### Status Messages (White)

**DUCT MON LOOP A**—Indicates that the 10th-stage loop A is under test

**DUCT MON LOOP B**—Indicates that the 10th-stage loop B is under test

Bleed misconfiguration:

- L 10TH ARM OPEN
- R 10TH ARM OPEN

**L 10TH SOV CLSD**—Indicates the left 10th-stage bleed-air shutoff valve is closed. Message is accompanied by illumination of the white CLOSED light in the left 10th-stage bleed-air switchlight.

**R 10TH SOV CLSD**—Indicates the right 10th-stage bleed-air shutoff valve is closed. Message is accompanied by illumination of the white CLOSED light in the right 10th-stage bleed-air switchlight.



**10TH ISOL OPEN**—Indicates that the 10th-stage isolation valve is open. Message is accompanied by illumination of the white OPEN light in the 10th-stage ISOL switchlight.

**APU LCV OPEN**—Indicates that the APU load control valve is open. Message is accompanied by illumination of the white OPEN light in the APU LCV switchlight.

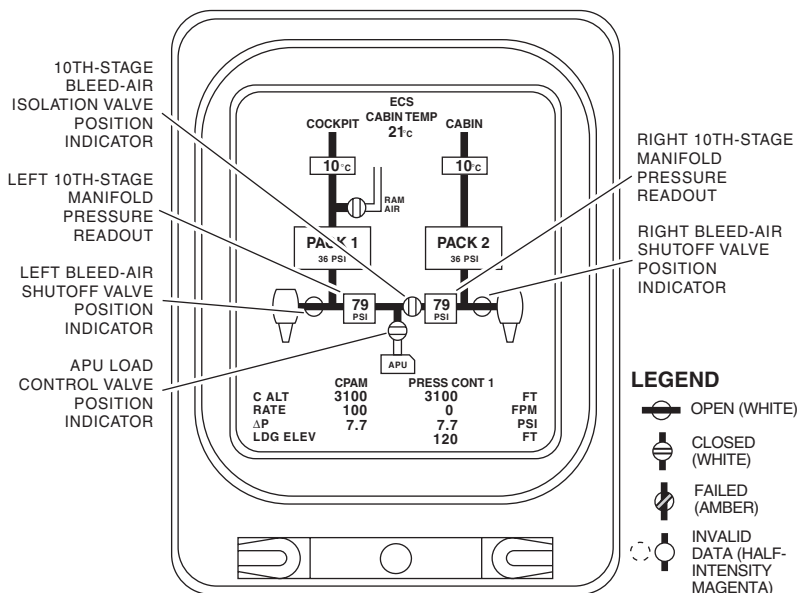
## Secondary Display—ECS Synoptic Page

**Left 10th-stage manifold pressure readout**—Indicates the pneumatic supply pressure available for operation of the air-conditioning system or engine starts (Figure 2-9).

### NOTE:

WHEN ECS VALVES ARE SELECTED OPEN, THERE IS A SIGNIFICANT TIME DELAY BEFORE THE VALVE POSITION INDICATORS ACTUALLY INDICATE OPEN.

THERE ARE FALSE PRESSURE INDICATIONS ON THE ECS PAGE WHEN THE 10TH-STAGE VALVES ARE CLOSED, PACKS ARE OFF AND APU LCV IS CLOSED. THIS IS A NORMAL INDICATION CAUSED BY VALVE LEAKAGE.



**Figure 2-9 ECS Synoptic Page—Pneumatic Indications**





Right 10th-stage manifold pressure readout—Indicates the pneumatic supply pressure available for operation of the air-conditioning system or engine starts.

10th-stage bleed-air isolation valve position indicator—The valve symbol indicates whether the valve is open or closed.

Left bleed-air shutoff valve position indicator—The valve symbol indicates whether the valve is open or closed. Invalid data is indicated by the symbol turning half-intensity magenta.

Right bleed-air shutoff valve position indicator—The valve symbol indicates whether the valve is open or closed. Invalid data is indicated by the symbol turning half-intensity magenta.

APU load control valve position indicator—The valve symbol indicates whether the valve is open or closed, or has failed (amber). Invalid data is indicated by the symbol turning half-intensity magenta.

Duct symbols—Displayed in green when duct pressure is 5 psi or greater. The symbols turn red to indicate a duct failure. Pressure transducers monitor duct pressure on each side of the isolation valve. When a leak occurs in the respective manifold, the respective 10th-stage flow line on the synoptic page displays red. When a 14th-stage duct leak occurs, the applicable flow line indicates red on the ANTI-ICE synoptic page. When the DUCT MON switch is held in the TEST position, the ECS and ANTI-ICE synoptic pages show all flow lines in red.

APU duct symbol—Displayed in green when the APU is ready to load and aircraft altitude below 15,000 feet. The symbol turns amber when the APU is ready to load and aircraft altitude is above 15,000 feet.

## **AIR-CONDITIONING SYSTEM**

### **AIR-CONDITIONING Control Panel**

The AIR-CONDITIONING panel contains the controls for the air conditioning system (Figure 2-10).



## **CKPT and CABIN Temperature Control Knobs**

The CKPT and CABIN temperature control knobs adjust the temperature setting for the related compartment. Rotate the related knob to achieve the desired temperature.

## **CKPT MAN and CABIN MAN Mode Switchlights**

Pressing in the CKPT MAN and CABIN MAN switchlights changes the temperature control mode for the related compartment to manual mode. The white MAN light illuminates and the associated CKPT or CABIN TEMP MAN status message appears on the EICAS display. If the switchlight is pressed again, the system reverts to automatic mode.

## **HOT–COLD Switches**

During manual temperature control mode, these switches control air temperature in the applicable compartment. Holding the switch in the COLD position progressively drives the temperature control valve toward the cold position. Holding the switch in the HOT position progressively drives the temperature control valve toward the hot position.

## **PACK Switchlights**

The L and R pack switchlights control the related pack valves.

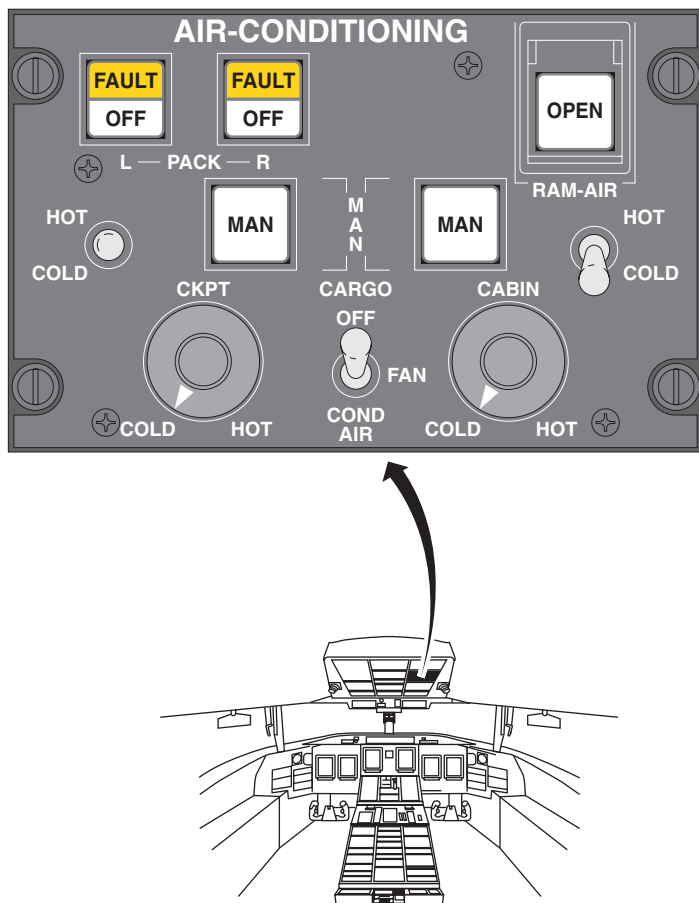
Pushed out—The related pack valve closes and the white OFF light illuminates.

Pushed in—The related pack valve opens and the white OFF light extinguishes.

FAULT light—Indicates an overpressure or overtemperature condition has been detected. The pack valve automatically closes.

## **RAM-AIR Switchlight**

The RAM-AIR switchlight controls the ram-air shutoff valve.



**Figure 2-10 AIR-CONDITIONING Control Panel**



Pushed in—The ram air valve opens and the white OPEN light illuminates. The RAM AIR OPEN status message appears on the EICAS secondary page.

Released out—The valve closes and the OPEN light extinguishes.

## **EICAS Indications**

### **Primary Display—Primary Page**

#### **Caution Messages (Amber)**

L or R PACK HI TEMP—An overtemperature condition (85°C) has been detected, and the pack has automatically shut down.

L or R PACK HI PRESS—An overpressure condition (51 psi) has been detected, and the pack has automatically shut down.

### **Secondary Display—Status Page**

#### **Status Messages (White)**

CKPT TEMP MAN—The temperature control for the flight compartment is in manual mode.

CABIN TEMP MAN—The temperature control for the passenger compartment is in manual mode.

L or R PACK OFF—An overpressure or overtemperature condition has been detected, and the pack valve has automatically closed.

RAM AIR OPEN—The ram-air valve is open.



## **Secondary Display—ECS Synoptic Page**

**MANUAL** message (white)—Indicates that the CKPT or CABIN MAN switchlight has been selected.

**Cabin temperature indicator**—Displays cabin temperature in degrees Celsius (Figure 2-11).

**Cabin supply duct temperature indicators**—Display temperature sensed in cabin and cockpit air-conditioning supply ducts in degrees Celsius.

**HI TEMP** caution message (amber)—Appears on the related pack indication box to indicate an overtemperature condition has been detected and the pack has automatically shut down. Message appears in conjunction with appropriate PACK HI TEMP message and FAULT light.

**HI PRESS** caution message (amber)—Appears on the related pack indication box to indicate an overpressure condition has been detected and the pack has automatically shut down. Message appears in conjunction with appropriate PACK HI PRESS message and FAULT light.

**Pack pressure readout**—Normal indication is 5 to 46 psi. A reading of 47 to 51 psi is displayed as a caution indication.

**Duct symbols**—Displayed in green when duct pressure is 5 psi or greater. The symbols turn red to indicate duct failure.

**Ram-air valve position indicator**—Valve symbol changes to indicate that the valve is open, is closed, or has failed.

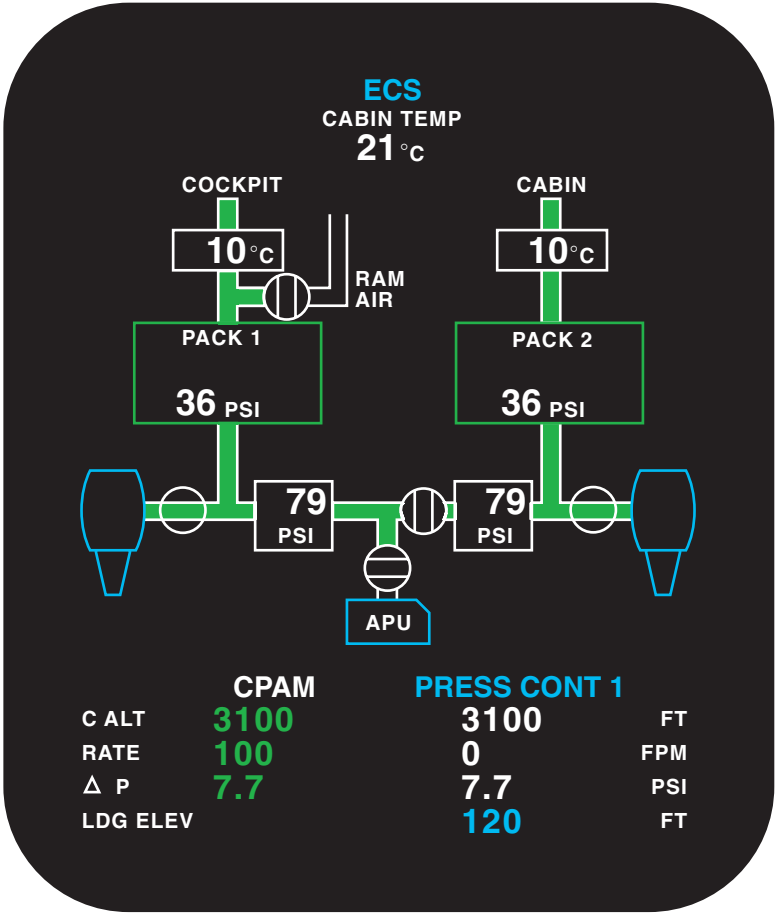
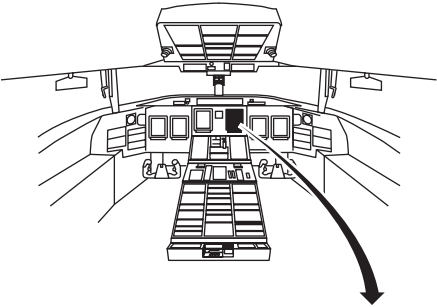


Figure 2-11 ECS Synoptic Page—Air-Conditioning Indications



## AVIONICS COOLING SYSTEM

### Avionics Cooling Control Panel

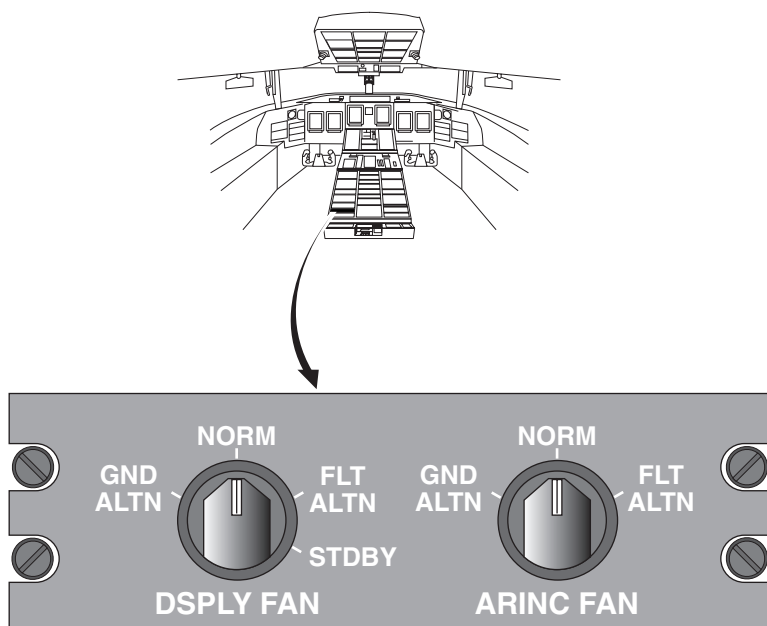
The avionics cooling control panel is located on the aft pedestal (Figure 2-12).

#### ARINC FAN Switch

**NORM**—A WOW signal automatically activates the appropriate fan for flight or ground mode. The No. 1 fan is used in flight, while the No. 2 fan is used on the ground.

**FLT ALTN**— Activates the No. 2 (ground) fan in flight if the normal fan fails.

**GND ALTN**—Activates the No. 1 (flight) fan on the ground if the normal fan fails.



**Figure 2-12 Avionics Cooling Control Panel**



## **DSPLY FAN Switch**

**NORM**—A WOW signal automatically activates the appropriate fan for flight or ground mode. The No. 1 fan is used in flight, while the No. 2 fan is used on the ground.

**FLT ALTN**— Activates the No. 2 (ground) fan in flight if the normal fan fails.

**GND ALTN**—Activates the No. 1 (flight) fan on the ground if the normal fan fails.

**STBY**—The standby fan is activated.

## **EICAS Indications**

### **Primary Display—Primary Page**

#### **Caution Messages (Amber)**

**OVBD COOL**—Overboard exhaust valve is open when passenger and service doors are closed.

### **NOTE**

The avionics cooling overboard shutoff valve (OVBD COOL SOV) is used during ground operations to flush cool the avionics system and dump hot air overboard. The valve is normally open on the ground and closed during flight. The aircraft will not pressurize to normal levels if the overboard cooling shutoff valve is failed open.

**DISPLAY COOL**—CRT display No. 1 or No. 2 fan has failed, or CRT display low cooling flow is sensed.

**ARINC COOL**—ARINC No. 1 or No. 2 fan has failed, or ARINC low cooling flow is sensed.





## **Secondary Display—Status Page**

### **Status Messages (White)**

OVBD COOL FAIL—Overboard exhaust valve is closed when passenger and service doors are not locked.

INBD COOL FAIL—Inboard exhaust valve is closed when passenger and service doors are locked.

### **NOTE**

The inboard cooling shutoff valve (INBD COOL SOV) is used during flight to flush cool the avionics system equipment. The valve is normally closed on the ground and open during flight.

CKPT COOL FAIL—The avionics cooling air valve is closed on the ground or open in flight.

COOL EXHAUST FAIL—Exhaust fan has failed, or exhaust low cooling flow is sensed.

## **PFD/MFD Overtemperature Indication**

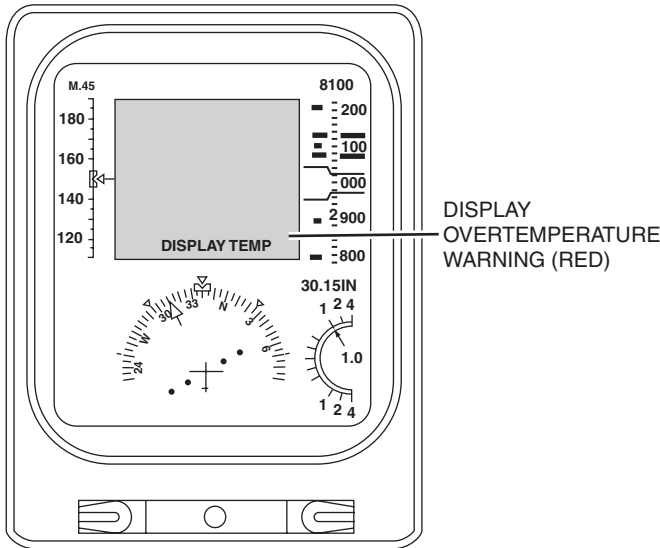
DISPLAY TEMP—Display overtemperature warning message (red) appears on the PFD or MFD to indicate an approaching thermal shutdown (Figure 2-13). The sky and ground raster is removed to delay the shutdown.

## **CARGO BAY AIR CONDITIONING**

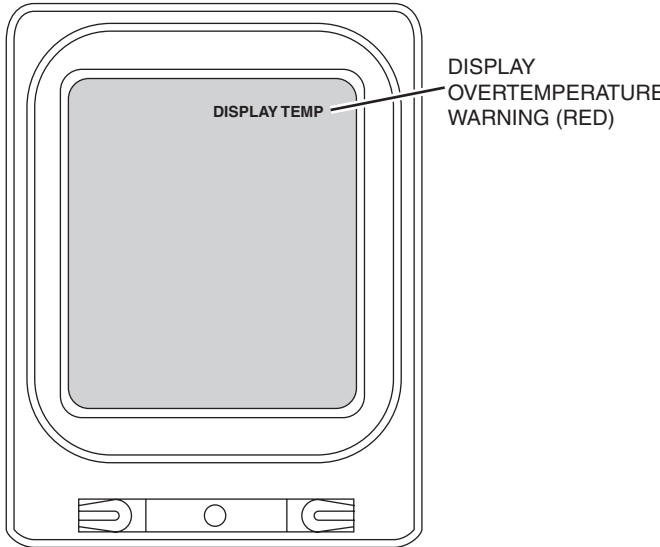
### **CARGO Switch**

The CARGO switch on the overhead panel controls cargo bay air conditioning (See Figure 2-10).

COND AIR—Conditioned and recirculated cabin air flows to the cargo bay.



PRIMARY FLIGHT DISPLAY (PFD)



MULTIFUNCTION DISPLAY (MFD)

Figure 2-13 PFD/MFD Overtemperature Indication



FAN—Only cabin recirculated air flows to the cargo compartment.

OFF—Air flow is shutoff to the cargo bay.

### **NOTE**

The cargo air-conditioning system has a limited temperature pull-down capability.

For ground operations with the cargo bay door open, the cargo air-conditioning switch may be set to COND AIR. For ambient temperatures above 30°C (86°F) this may result in a cargo overheat caution message. The cargo switch must be reset to FAN after the cargo bay door has been closed.

If live cargo is being transported at high ambient temperatures, the cargo switch should only be set to COND AIR after takeoff.

## **EICAS Indications**

### **Primary Display—Primary Page**

#### **Caution Messages (Amber)**

CARGO OVHT—Cargo compartment temperature has increased to more than 35°C. Message also appears if the air temperature in the supply duct increases to more than 49°C.

### **Secondary Display—Status Page**

#### **Status Messages (White)**

CARGO FAN FAIL—Fan speed is less than 60% of its normal speed.

CARGO SOV FAIL—One of the three valves regulating air flow to the cargo bay has failed.



## PRESSURIZATION SYSTEM

### CABIN PRESS Control Panel

The CABIN PRESS control panel is located on the overhead panel (Figure 2-14).

#### Landing Elevation Selector

The LDG ELEV selector sets the elevation of the destination airport. The selector is rotated clockwise to increase (INCR) or counterclockwise to decrease (DECR) the elevation readout.

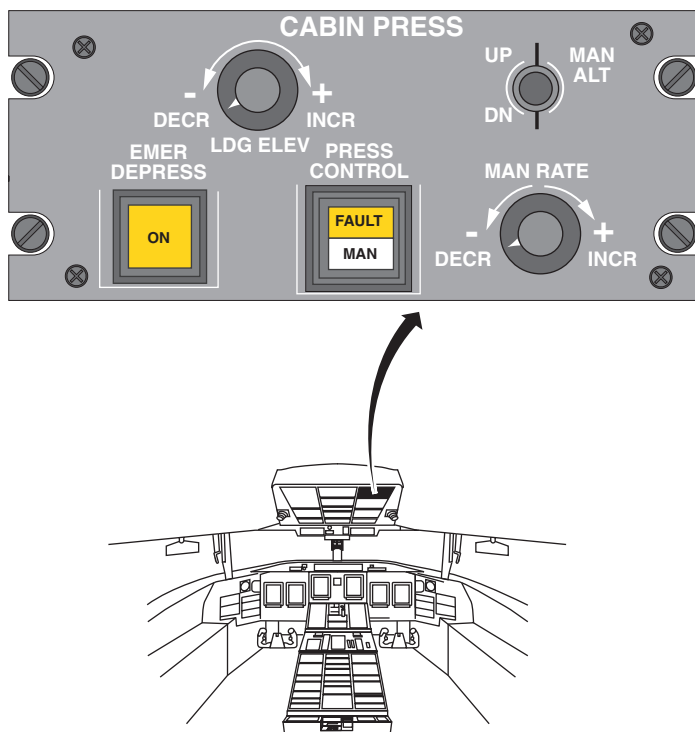


Figure 2-14 CABIN PRESS Control Panel



## **Manual Altitude Switch**

The MAN ALT switch controls cabin altitude during manual pressurization.

UP—Opens the outflow valves to increase cabin altitude

DN—Closes the outflow valves to decrease cabin altitude

Center—Neutral position—No change of cabin altitude

## **Manual Rate Selector**

The MAN RATE selector controls the rate of climb or descent of cabin altitude during manual pressurization control. The selector is rotated clockwise to increase (INCR) or counterclockwise to decrease (DECR) the rate of change.

## **PRESS CONTROL Switchlight**

Pushed once—Changes the system from automatic to manual mode of operation—The MAN light (white) on the switchlight illuminates.

Pushed twice—Activates the standby controller

FAULT light (amber)—Illuminates if both cabin pressure controllers fail

## **EMER DEPRESS Switchlight**

The guarded EMER DEPRESS switchlight controls emergency cabin depressurization. When pushed, both outflow valves open fully.

## **EICAS Indications**

### **Primary Display—Primary Page**

Pressurization readouts (manual mode) appear when the PRESS CONTROL switchlight is selected to MAN (Figure 2-15):

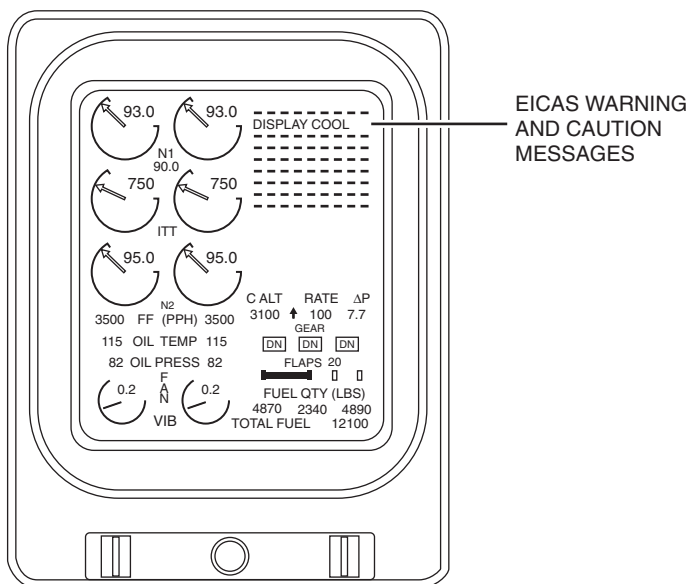


- **C ALT**—Indicates current cabin altitude
- **RATE**—Indicates rate of change in feet per minute (increments of 100 fpm) and direction via arrow symbol
- **ΔP**—Indicates cabin differential pressure

The landing elevation readout is not displayed. The readouts are removed from the primary page when automatic mode is selected.

## Warning Messages (Red)

**CABIN ALT**—Cabin altitude exceeds 10,000 feet. Message is accompanied by a “Cabin pressure” aural warning and illumination of the NO SMOKING and FASTEN SEAT BELT signs. Also, the NO SMOKING and SEAT BELTS status messages appear on the secondary display when the NO SMKG and SEAT BLTS switches on the PASS SIGNS panel are in the AUTO position.



**Figure 2-15 Pressurization EICAS Indications—Primary Page**



**DIFF PRESS**—The cabin differential pressure has exceeded 8.5 psi. The message is accompanied by a “cabin pressure” aural warning.

### **Caution Messages (Amber)**

**AUTO PRESS**—Both cabin pressure controllers have failed.

**CABIN ALT**—Cabin altitude is between 8,500 and 10,000 feet.

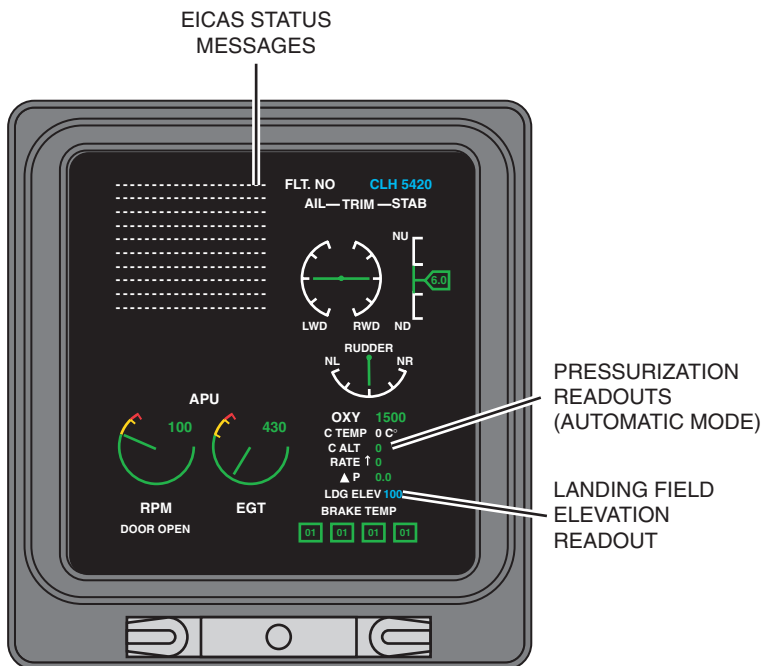
**EMER DEPRESS**—The EMER DEPRESS switchlight has been selected on.



## Secondary Display—Status Page

Pressurization readouts (automatic mode) appear when the pressurization system is operating in automatic mode (Figure 2-16):

- **C ALT**—Indicates current cabin altitude—Readout turns amber if cabin altitude is between 8,500 and 10,000 feet. The readout turns red when cabin altitude is 10,000 feet or above.
- **RATE**—Indicates rate of change in feet per minute (increments of 100 fpm) and direction via arrow symbol



**Figure 2-16 Pressurization EICAS Indications—Status Page**





- $\Delta P$ —Indicates cabin differential pressure—The readout turns red when differential pressure exceeds 8.57 psid.
- LDG ELEV—The landing field elevation readout displays elevation (in 20-foot increments), as set with the LDG ELEV selector. Amber dashes are displayed if the input value is invalid, greater than 14,000 feet, or less than -1,000 feet. The elevation readout is removed from the status page when manual mode is selected.

## Status Messages (White)

AUTO PRESS 1 or 2 FAIL—The No. 1 or No. 2 cabin pressure controller has failed.

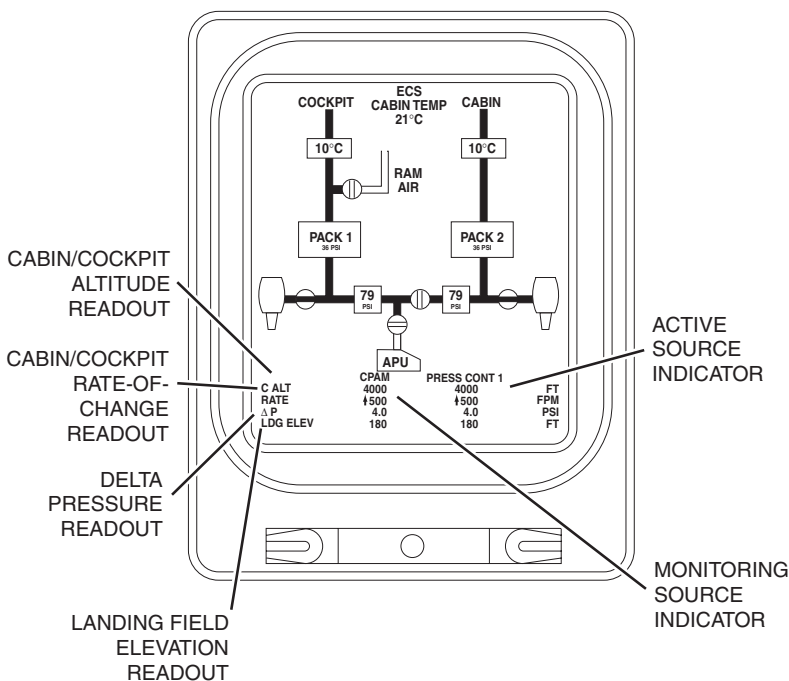
CABIN PRESS MAN—The PRESS CONTROL switchlight has been selected to MAN.

CPAM FAIL— The cabin pressure acquisition module has failed.



### Secondary Display—ECS Synoptic Page

Cabin altitude readout—Displays current cabin altitude (in automatic or manual mode) (Figure 2-17)



**Figure 2-17 Pressurization EICAS Indications—ECS Page**



Cabin rate-of-change readout—Displays rate of change in feet per minute and direction

Delta pressure readout—Displays cabin differential pressure

Landing field elevation readout—Displays elevation (in 20-foot increments) as set with the LDG ELEV selector

Active source indicator—Indicates (in cyan) which pressure controller is active: PRESS CONT 1, PRESS CONT 2, or PRESS MAN—The active controller's data is displayed below the indication.

AUTO PRESS 1 or 2 FAIL status message (white)—Indicates failure of No. 1 or No. 2 cabin pressure controller (corresponds to same message on status page)

Monitoring source indicator—Indicates (in white) the monitoring source: CPAM, PRESS CONT 1, or PRESS CONT 2—The monitored data is displayed below the indication. If the CPAM fails, the standby controller becomes the monitoring source. If all sources fail, amber dashes appear.

CPAM FAIL status message (white)—Indicates CPAM failure (corresponds to same message on status page)

## **CIRCUIT BREAKERS**

Table 2-1 lists the power supplies and circuit breakers for the pneumatic, air-conditioning, and pressurization system components.



**Table 2-1 POWER SUPPLY AND CIRCUIT-BREAKER SUMMARY**

| SYSTEM                             | SUB-SYSTEM                             | CB NOMEN-<br>CLATURE                | BUS<br>BAR  | CB<br>PANEL<br>NO. | CB<br>LOCA-<br>TION |
|------------------------------------|----------------------------------------|-------------------------------------|-------------|--------------------|---------------------|
| Pneu-<br>matic<br>System           | 10th-<br>Stage<br>Bleed Air            | 10TH STAGE<br>BLEED AIR<br>SOV L    | DC<br>BUS 1 | 1                  | F11                 |
|                                    |                                        | 10TH STAGE<br>BLEED AIR<br>SOV R    | DC<br>BUS 2 | 2                  | F11                 |
|                                    |                                        | 10TH STAGE<br>BLEED AIR<br>SOV ISOL | DC<br>ESS   | 4                  | B1                  |
|                                    | Bleed<br>Leak<br>Detection             | BLEED<br>LEAK TEST                  |             |                    | B2                  |
|                                    |                                        | B/LEAK<br>CONT L                    | AC<br>ESS   | 3                  | B1                  |
|                                    |                                        | B/LEAK<br>CONT R                    |             |                    | B2                  |
| Air Condi-<br>tioning<br>(Cockpit) | Left Pack                              | L AIR COND<br>UNIT                  | DC<br>BUS 1 | 1                  | J1                  |
|                                    | Cockpit<br>Temp-<br>erature<br>Control | CKPT TEMP<br>CONT                   |             |                    | J2                  |
|                                    |                                        | CKPT TEMP<br>MAN CONT               |             |                    | J3                  |
|                                    |                                        | CKPT FAN                            | AC<br>BUS 1 |                    | C8                  |
|                                    | Ram Air                                | RAM AIR<br>SOV                      | DC<br>BAT   | 2                  | P5                  |



**Table 2-1 POWER SUPPLY AND CIRCUIT-BREAKER SUMMARY (Cont)**

| SYSTEM                   | SUB-SYSTEM                | CB NOMEN-CLATURE      | BUS BAR  | CB PANEL NO. | CB LOCATION |
|--------------------------|---------------------------|-----------------------|----------|--------------|-------------|
| Air Conditioning (Cabin) | Right Pack                | R AIR COND UNIT       | DC BUS 2 | 2            | J1          |
|                          | Cabin Temperature Control | CABIN TEMP CONT       |          |              | J2          |
|                          |                           | CABIN TEMP CONT MAN   |          |              | J3          |
|                          |                           | GALLEY & LAVATORY FAN | AC BUS 2 |              | C5          |
|                          |                           | CABIN FAN             |          |              | C8          |
| Galley Heating           | Heater 1                  | GALLEY HTRS           | AC BUS 2 | 2            | B11         |
|                          | Heater 2                  |                       |          |              |             |
|                          | Fan                       |                       |          |              |             |



**Table 2-1 POWER SUPPLY AND CIRCUIT-BREAKER SUMMARY (Cont)**

| SYSTEM                        | SUB-SYSTEM                            | CB NOMEN-<br>CLATURE | BUS<br>BAR  | CB<br>PANEL<br>NO. | CB<br>LOCA-<br>TION |
|-------------------------------|---------------------------------------|----------------------|-------------|--------------------|---------------------|
| Avionics<br>Cooling<br>System | Display<br>Fans                       | DISPLAY<br>FAN 1     | AC<br>ESS   | 3                  | C9                  |
|                               |                                       | DISPLAY<br>FAN 2     | AC<br>BUS 1 | 1                  | D2                  |
|                               |                                       | DISPLAY<br>FAN STBY  | AC<br>ESS   | 3                  | C6                  |
|                               |                                       | EXHAUST<br>FAN       | AC<br>BUS 1 | 1                  | C5                  |
|                               | ARINC<br>Chassis<br>Fans              | ARINC<br>FAN 1       | AC<br>ESS   | 3                  | C12                 |
|                               |                                       | ARINC<br>FAN 2       | AC<br>BUS 2 | 2                  | D2                  |
|                               | Controller<br>and Shut-<br>off Valves | CONT 2               | DC<br>BUS 2 | 2                  | L2                  |
|                               |                                       | CKPT SOV             |             |                    | L3                  |
|                               |                                       | I/B SOV              |             |                    | L4                  |
|                               |                                       | O/B SOV              | DC<br>BUS 1 | 1                  | L4                  |
|                               |                                       | AVIONICS<br>CONT 1   | DC<br>ESS   | 4                  | C4                  |



**Table 2-1 POWER SUPPLY AND CIRCUIT-BREAKER SUMMARY (Cont)**

| SYSTEM                           | SUB-SYSTEM          | CB NOMEN-CLATURE  | BUS BAR  | CB PANEL NO. | CB LOCATION |
|----------------------------------|---------------------|-------------------|----------|--------------|-------------|
| Cargo Bay Conditioned Air System | Controller          | BAGG COMPT CONT   | DC BUS 1 | 1            | L3          |
|                                  | Heater              | BAGG COMPT HEATER | AC BUS 1 | 1            | B8          |
|                                  | Fan                 | BAGG COMPT FAN    | AC BUS 1 | 1            | D5          |
|                                  | Shutoff Valve       | BAGG COMPT SOV    | DC ESS   | 4            | A12         |
| Cargo Bay Firex System           | Cargo Firex Squib 1 | CARGO FIREX 1     | DC BAT   | 1            | P1          |
|                                  | Cargo Firex Squib 2 | CARGO FIREX 2     | DC BUS 1 | 1            | G1          |
| Pressurization System            | Control Panel       | CONT PNL          | DC ESS   | 4            | A10         |
|                                  | Controller 1        | CONT 1            |          |              | A8          |
|                                  | Controller 2        | CONT 2            |          |              | A9          |
|                                  | CPAM                | CABIN PRESS MOD   | DC BAT   | 2            | P6          |



INTENTIONALLY LEFT BLANK