

B777



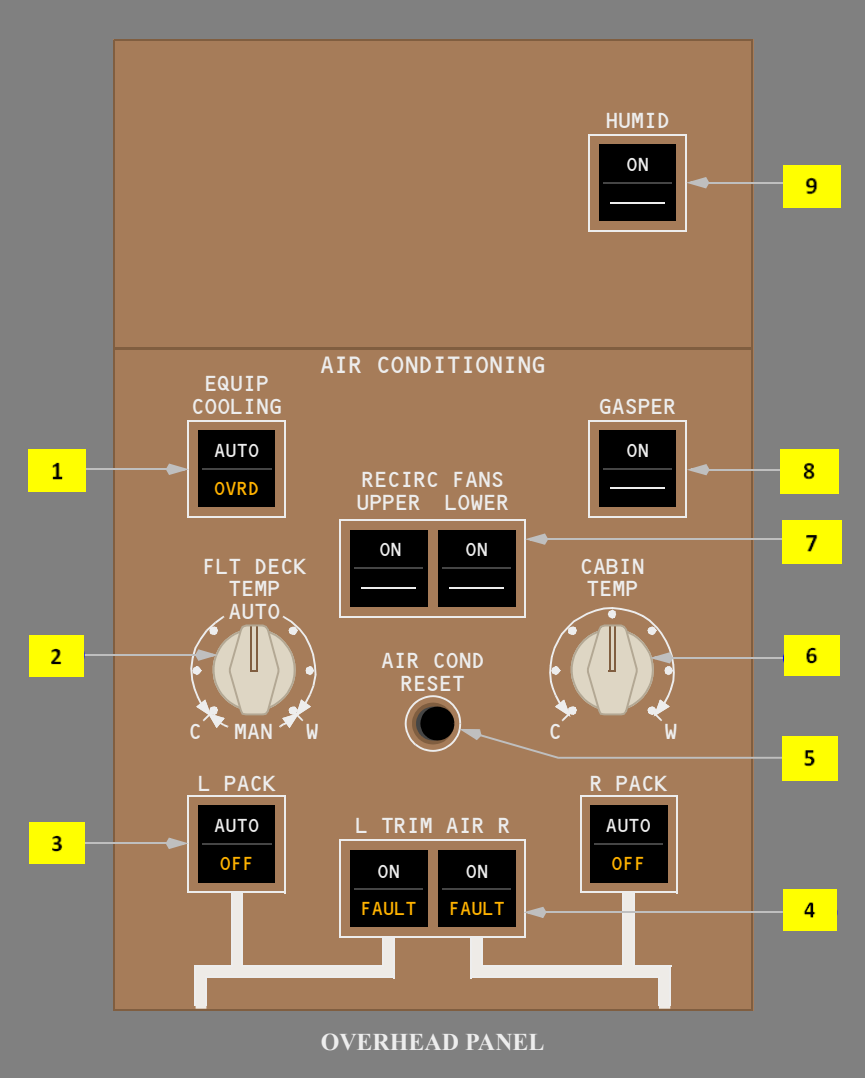
Air Systems

DO NOT USE FOR FLIGHT

Air Conditioning System

Air Conditioning Panel

[Options - Humidifier, Gasper]



1 Equipment Cooling (EQUIP COOLING) Switch

AUTO – equipment cooling mode is controlled automatically.

Off (AUTO not visible) –

- both equipment cooling supply fans are not operating
- the override valve is open
- the forward cargo heat valve is closed
- the OVRD light is illuminated

OVRD (override) illuminated (amber) – equipment cooling override valve is open.

2 Flight Deck Temperature (FLT DECK TEMP) Control

AUTO –

- provides automatic temperature control for the flight deck

[Option – °F]

- turning the control toward C or W sets the desired temperature between 65 degrees F and 85 degrees F. Mid position (12 o'clock) sets approximately 75 degrees F.

[Option – °C]

- turning the control toward C or W sets the desired temperature between 18 degrees C and 29 degrees C. Mid position (12 o'clock) sets approximately 24 degrees C.

MAN (manual) –

- provides manual control of the flight deck trim air modulating valve
- turning the control from the MAN position to the C detent drives the flight deck trim air modulating valve toward closed to provide cooler air
- turning the control from the MAN position to the W detent drives the flight deck trim air modulating valve toward open to provide warmer air.

3 PACK Switches

AUTO – the pack is automatically controlled.

OFF (AUTO not visible) – the pack flow control valves are commanded closed.

OFF illuminated (amber) – the pack flow control valves are commanded closed:

- automatically during engine start
- automatically due to a pack or compressor outlet high temperature, both flow control valves failed closed, no pneumatic air, or
- OFF is manually selected.

4 TRIM AIR Switches

ON – the trim air valve is commanded open.

Off (ON not visible) –

- the trim air valve is commanded closed, and
- FAULT illuminates.

FAULT illuminated (amber) –

- the trim air valve is failed closed
- the trim air valve is commanded closed because of a zone supply duct overheat, or
- the TRIM AIR switch is selected off.

5 Air Conditioning Reset (AIR COND RESET) Switch

Push –

- resets any closed pack flow control valves or trim air valves held closed due to overheat, control failure, or valve failure
- attempts to reset a failed recirculation fan
- resets fault protection.

6 Cabin Temperature (CABIN TEMP) Control

Provides automatic passenger cabin temperature control.

[Option – °F]

Turning the control toward C or W sets the passenger cabin master reference temperature between 65 degrees F and 85 degrees F.

[Option – °C]

Turning the control toward C or W sets the passenger cabin master reference temperature between 18 degrees C and 29 degrees C.

7 Recirculation Fans (RECIRC FANS) Switches

ON – provides automatic operation of the associated recirculation fans.

Off (ON not visible) – the selected recirculation fans do not operate.

8 GASPER Switch

ON – the gasper fan operates.

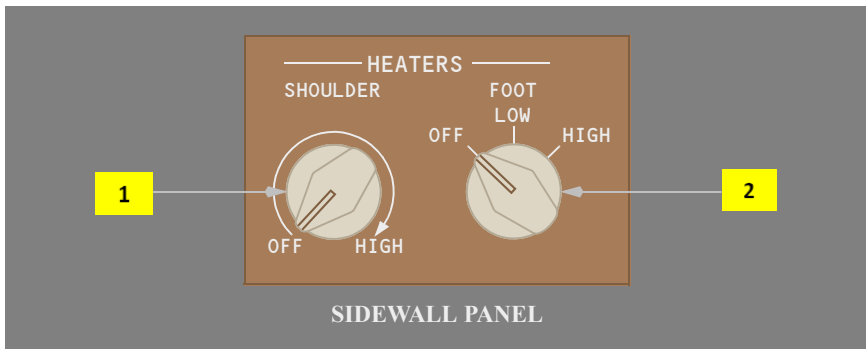
Off (ON not visible) – the gasper fan does not operate.

9 Humidification (HUMID) Switch

ON – humidification system operates automatically.

Off (ON not visible) – humidifier does not operate.

Shoulder and Foot Heaters



1 SHOULDER HEATER Control

OFF – the electric heater is not operating (no heat added to the conditioned air flowing at shoulder level).

Turn – the electric heater adds heat to the conditioned air flowing in at shoulder level at variable temperature settings up to HIGH.

2 FOOT HEATER Selector

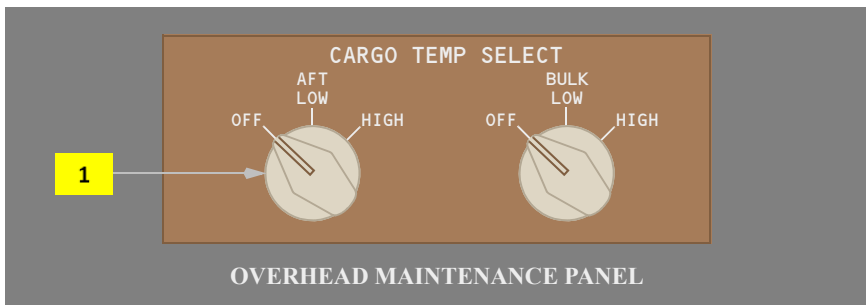
OFF – the under-floor electric heater is not operating.

LOW – the under-floor electric heater operates on low setting.

HIGH – the under-floor electric heater operates on high setting.

Cargo Temperature Control

Aft and Bulk Cargo Temperature Control



1 CARGO TEMPERATURE Selectors

OFF – shuts off bleed air to the compartment.

[Option – °C]

LOW – the compartment temperature is maintained between 4 and 10 degrees C.

[Option – °F]

LOW – the compartment temperature is maintained between 40 and 50 degrees F.

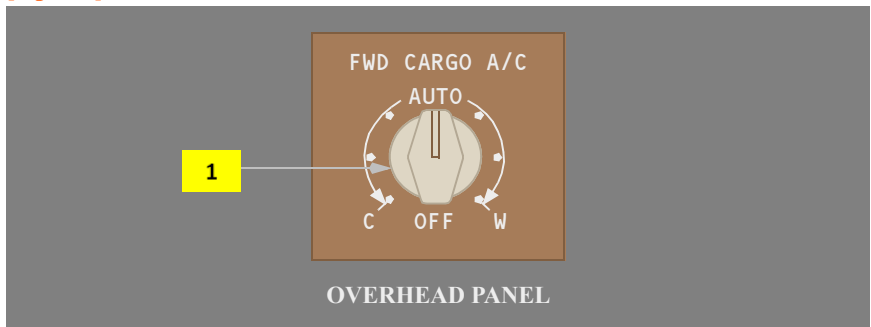
[Option – °C]

HIGH – the compartment temperature is maintained between 18 and 24 degrees C. For the bulk compartment only – the bulk compartment ventilation fan operates continuously.

[Option – °F]

HIGH – the compartment temperature is maintained between 65 and 75 degrees F. For the bulk compartment only, the bulk compartment ventilation fan operates continuously.

Forward Cargo Air Conditioning Control

[Option]

1 Forward Cargo Air Conditioning (FWD CARGO A/C) Control

AUTO –

- provides automatic temperature control for the forward cargo compartment
- disables the forward cargo compartment heating system

[Option – °F]

- turning the control toward C or W sets the desired temperature between 40 degrees F and 80 degrees F. Mid position (12 o'clock) sets approximately 60 degrees F.

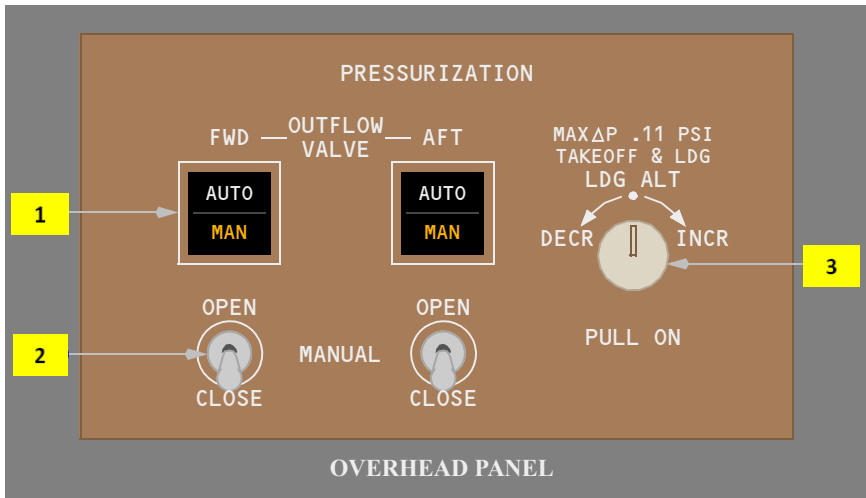
[Option – °C]

- turning the control toward C or W sets the desired temperature between 4 degrees C and 27 degrees C. Mid position (12 o'clock) sets approximately 12 degrees C.

OFF – the forward cargo compartment heating system operates.

Pressurization System

Pressurization Panel



1 OUTFLOW VALVE Switches

AUTO – outflow valve controlled automatically.

MAN (manual) illuminated (amber) –

- outflow valve is controlled manually
- bypasses automatic outflow valve control and cabin altitude limiter
- AUTO extinguished

2 OUTFLOW VALVE MANUAL Switches

OPEN – moves the outflow valve toward open.

CLOSE – moves the outflow valve toward closed.

3 Landing Altitude (LDG ALT) Selector

Pull ON, then rotate –

- sets landing altitude manually
- landing altitude followed by MAN displayed on EICAS
- landing altitude changes in 100 foot increments at first detent, 500 foot increments at second detent

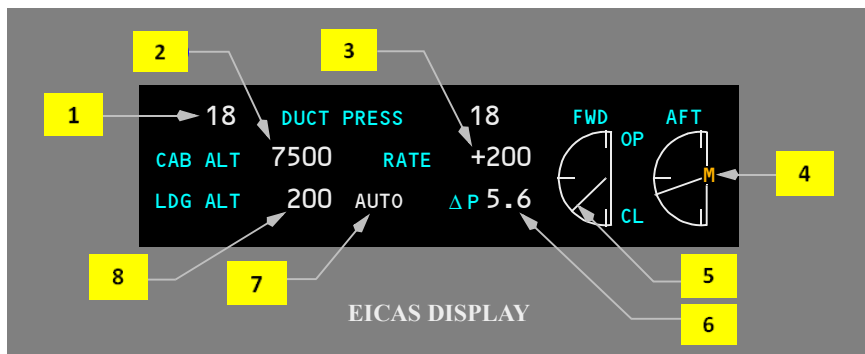
Push –

- landing altitude set automatically from FMS – Refer to Chapter 11, Flight Management Navigation – Approach
- landing altitude followed by AUTO displayed on primary EICAS

Duct Pressure and Pressurization System Indications

Pressurization system indications are displayed automatically when:

- landing altitude MAN
- either OUTFLOW VALVE switch in MAN
- cabin altitude is above normal range (amber)
- cabin differential pressure is above normal range (amber)
- cabin differential pressure is excessive (red)
- duct pressure is below normal range (amber) with the respective engine running
- AIR synoptic selected on any MFD
- the following EICAS messages are displayed:
 - CABIN ALTITUDE
 - CABIN ALTITUDE AUTO
 - LANDING ALTITUDE
 - OUTFLOW VALVE AFT
 - OUTFLOW VALVE FWD.



1 Duct Pressures

White – normal range.

Amber – below normal range.

2 Cabin Altitude

White – normal range.

Amber – above normal range.

Red – excessive cabin altitude.

3 Cabin Altitude Rate

+ (plus) – rate of climb.

– (minus) – rate of descent.

4 Outflow Valve Control Source

M (manual) (amber) – manual control.

Blank – automatic control.

5 Outflow Valves Position

OP – open.

CL – closed.

6 Cabin Differential Pressure

White – normal range.

Amber – above normal range.

Red – excessive cabin differential pressure.

7 Landing Altitude Selection

AUTO (white) – altitude set automatically from FMC.

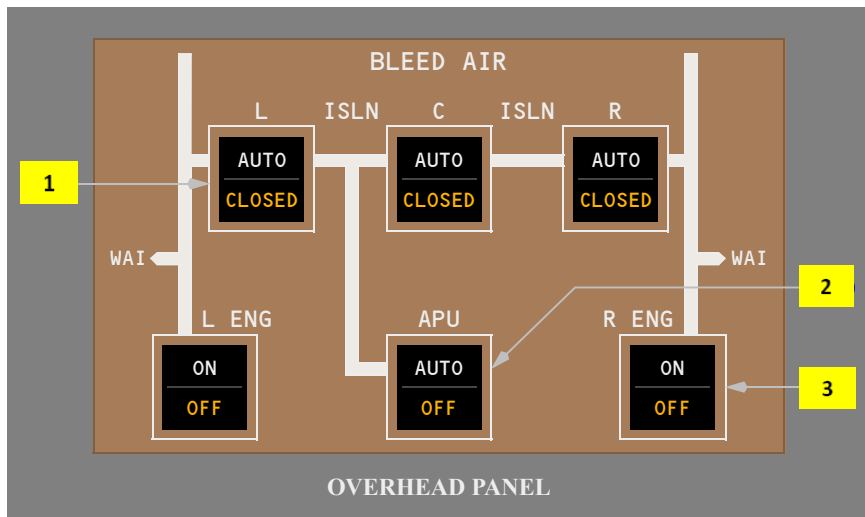
MAN (amber) – altitude set by LANDING ALTITUDE selector.

8 Landing Altitude

Landing altitude supplied by the FMC or manually selected using the LANDING ALTITUDE selector.

Blank – display is blank without valid FMC landing altitude.

Bleed Air System



1 Bleed Isolation (ISLN) Switches

AUTO – the bleed isolation valve is automatically controlled.

Off (AUTO not visible) – manually commands the respective bleed isolation valve to close.

CLOSED illuminated (amber) –

- the isolation valve is closed due to a duct leak or bleed loss
- the valve is closed because the switch is selected to off, or
- the valve fails closed.

2 APU Bleed Switch

AUTO – the APU bleed air valve is automatically controlled.

OFF (AUTO not visible) – the valve is commanded closed.

OFF illuminated (amber) – the APU bleed air valve is closed:

- automatically due to a duct leak
- because the switch is selected OFF
- due to the valve failing closed
- because the APU fire switch is pulled out.

3 Engine (ENG) Bleed Switches

ON – the engine bleed valves open when engine bleed air is available.

OFF (ON not visible) – valve is manually commanded closed.

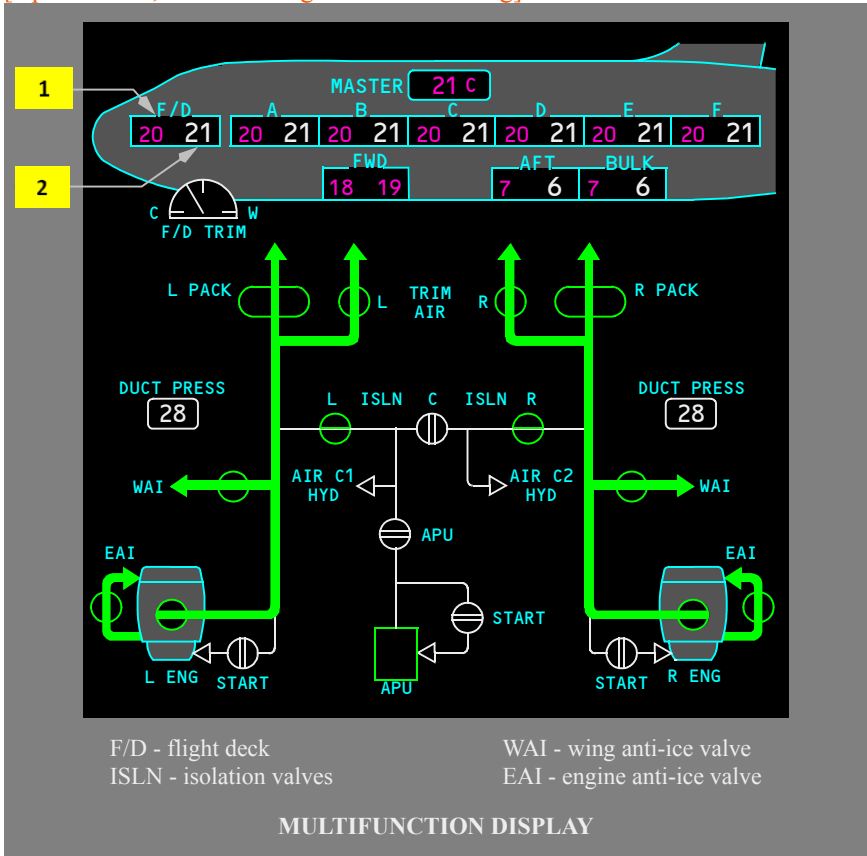
OFF illuminated (amber) – the engine bleed valves are closed:

- automatically due to a protective bleed shut down or duct leak
- because the switch is selected OFF
- because the engine is not running, or
- because the engine fire switch is pulled out.

Air Synoptic Display

The air systems synoptic is displayed by pushing the AIR synoptic display switch on the display select panel. Display select panel operation is described in Chapter 10, Flight Instruments, Displays.

[Options – °C, Forward Cargo Air-conditioning]



1 Selected Temperatures (magenta)

Selected by the FLT DECK TEMP, FWD CARGO A/C, and the CABIN TEMP controls.

2 Actual Temperatures (white)

Actual temperature sensed on the flight deck, forward cargo compartment, or the passenger zone.

Note: When the forward cargo air conditioning system is off or inoperative, the forward cargo selected temperature display is blank.

Introduction

The air conditioning system supplies conditioned bleed air and recirculated cabin air at a controlled temperature throughout the airplane.

The system supplies conditioned air to the flight deck shoulder heaters.

The system supplies ventilation for the passenger cabin:

- lavatories
- galleys

[Option – Gasper]

- individual passenger seat gaspers

[Option - Crew Rest Compartments]

The system supplies ventilation for the:

- flight deck crew rest compartment
- lower crew rest compartment
- overhead crew rest compartments

Pack control, zone temperature control, cabin air recirculation, fault detection, and overheat protection are all automatic. Backup system control modes operate automatically in the event of system failures.

The airplane is divided into seven temperature zones: the flight deck and six passenger cabin zones.

Air Conditioning Packs

Two identical air conditioning packs cool bleed air from the engines, APU, or high pressure air from a ground source. Bleed air is precooled before entering the pack. The packs are controlled by two identical pack controllers. If a controller fails, pack control switches automatically to the other controller.

Pack output is increased automatically during high pack demand periods (to compensate for a failed pack or recirculation fan), or is limited during high bleed air demand periods (such as for gear retraction).

Each pack may operate at reduced flow during certain phases of flight to reduce fuel consumption.

Pack Ground Operation

Both air conditioning packs are normally selected to AUTO for ground operations. Fuel consumption is about the same for single pack and two pack operation, and single pack operation causes higher flight line noise levels.

A ground source of conditioned air may be used to supply conditioned air directly to the cabin distribution system, eliminating the need for pack operation.

Pack Non–Normal Operation

Pack control, fault detection, and overheat protection are all automatic. If an overheat or other significant pack fault is detected, the pack shuts down automatically and the EICAS advisory message PACK (L, R) is displayed. An attempt to restore pack operation may be made by pressing the AIR CONDITIONING RESET switch.

Standby Cooling Mode

For certain internal malfunctions, pack control automatically uses standby cooling mode as a backup to normal mode. In standby cooling mode, the EICAS advisory message PACK MODE (L, R) is displayed, and STBY COOLING is displayed in amber on the AIR synoptic.

If one pack is in standby cooling and the other pack is operating normally, the pack in standby cooling mode shuts down at lower altitudes and higher outside air temperatures when ambient conditions do not permit standby cooling. The pack restarts automatically when altitude and outside air temperatures are suitable for standby cooling.

If both packs are in standby cooling mode, or if one pack is inoperative and the other pack is in standby cooling mode, the packs or pack operates continuously to maintain cabin pressurization, regardless of altitude or outside air temperature.

In standby cooling mode, pack cooling capacity may be less than in normal mode and may result in warm flight deck or cabin temperatures at lower altitudes.

Air Distribution

Recirculation fans assist the packs to maintain a constant ventilation rate through the cabin. The fans draw cabin air through filters, then reintroduce the air into the conditioned air distribution system.

The flight deck receives 100% fresh conditioned air from the left pack only, and is maintained at a slightly higher pressure than the passenger cabin to prevent smoke from entering the flight deck.

Air exhausted from the passenger cabin flows into the upper recirculation system or to the lower deck, where it is either exhausted overboard through outflow valves or drawn into the lower recirculation system. Air from the recirculation fans is mixed with pack air before entering the distribution ducts.

When one or more RECIRCULATION FAN switches is OFF, the EICAS memo message RECIRC FANS OFF is displayed. With the switches OFF, the packs operate at full flow and the cabin air exchange rate is increased. Fuel consumption increases 0.7% for each fan switch turned OFF.

Temperature Control

Hot trim air from the bleed air system is added to the pack conditioned air to control the temperature in each zone. Each trim air system supplies three zone supply ducts, with the left trim air system also supplying the flight deck.

The cabin temperature controllers regulate the temperature by controlling the addition of hot trim air to the zone supply ducts through the trim air valves to meet the target temperature of each of the seven temperature zones.

[Option – °F]

The CABIN TEMPERATURE selector sets a master reference temperature between 65 and 85 degrees F. The master reference temperature is increased or decreased automatically or manually to set target temperatures for each temperature zone.

[Option – °C]

The CABIN TEMPERATURE selector sets a master reference temperature between 18 and 29 degrees C. The master reference temperature is increased or decreased automatically or manually to set target temperatures for each temperature zone.

For passenger comfort, the cabin temperature controllers compensate for temperature changes as cabin air humidity and passenger activity decrease during the flight. The target temperatures automatically increase slowly during the early part of cruise flight so the flight crew does not have to manually increase the master temperature. Target temperatures decrease slowly during descent until all automatically added corrections are removed.

[Option – °F]

The target temperatures of each passenger cabin temperature zone may be further modified plus or minus 10 degrees C, within the range of 65 and 85 degrees F, using the cabin management system.

[Option – °C]

The target temperatures of each passenger cabin temperature zone may be further modified plus or minus 6 degrees C, within the range of 18 to 29 degrees C, using the cabin management system.

[Option – °F]

The flight deck temperature selector sets the flight deck temperature to between 65 and 85 degrees F. The flight deck temperature is controlled manually by setting the flight deck temperature selector to the manual mode.

[Option – °C]

The flight deck temperature selector sets the flight deck temperature to between 18 and 29 degrees C. The flight deck temperature is controlled manually by setting the flight deck temperature selector to the manual mode.

The temperature zone requiring the coolest temperature controls the pack outlet temperature.

[Option – °F]

If the flight deck or cabin temperature selector setting is unavailable to the pack temperature controller, the pack outlet temperature is regulated to achieve either the last temperature set or an average cabin temperature of 75 degrees F.

[Option – °C]

If the flight deck or cabin temperature selector setting is unavailable to the pack temperature controller, the pack outlet temperature is regulated to achieve either the last temperature set or an average cabin temperature of 24 degrees C.

Crew Rest Area Temperature Control

[Option - Crew Rest Compartments]

Crew rest area temperature can be controlled manually by the heater controls in the compartment.

Temperature Control With Loss of Trim Air

[Option – °F]

If the left or right trim air system is off, the cabin temperature controllers attempt to maintain all zones at the average target temperature. Flight deck temperature will be maintained between 65 and 85 degrees F.

[Option – °C]

If the left or right trim air system is off, the cabin temperature controllers attempt to maintain all zones at the average target temperature. Flight deck temperature will be maintained between 18 and 29 degrees C.

The flight deck may become uncomfortably warm or cool. Setting the CABIN TEMP selector to a cooler or warmer master temperature may achieve a cooler or warmer flight deck temperature.

Operation With Complete Loss of Cabin Temperature Controllers

[Option – °F]

If both cabin temperature controllers fail, or all engine and APU electrical power fails, the air supply and cabin pressurization controllers control the pack flow control valves. Pack flow rate is modulated to achieve a pack outlet temperature between 40 and 110 degrees F. All flight deck temperature controls are disabled except the PACK switches.

[Option – °C]

If both cabin temperature controllers fail, or all engine and APU electrical power fails, the air supply and cabin pressurization controllers control the pack flow control valves. Pack flow rate is modulated to achieve a pack outlet temperature between 5 and 43 degrees C. All flight deck controls are disabled except the PACK switches.

Shoulder and Foot Heaters

Flight crew shoulder heat is provided by electric elements in the side window air diffusers. The foot heaters have electric heating elements only, with no airflow. Both are available in flight only.

Flight Deck Humidification System**[Option]**

The humidification system operates during cruise when the HUMID switch is ON. The system uses water from the potable water system to introduce moisture into the circulation air. Minerals in the potable water may precipitate as solids when the humidification system operates. These solids may circulate in the cabin as dust or haze.

Gasper System**[Option]**

The gasper system fan supplies conditioned air from the aft cabin distribution duct to the passenger service unit air gasper outlets above each passenger seat.

Cargo Temperature Control System**Cargo Heat System**

The aft and bulk cargo compartments have independent bleed air heating systems. An insulated curtain separates the two compartments.

With the CARGO TEMPERATURE selector set to LOW or HIGH, the respective cargo heat shutoff valve opens and the temperature control valve opens and closes to maintain the temperature in the compartment. The lavatory/galley vent fans draw air across temperature sensors in each compartment. If both vent fans fail, cargo heat is not provided.

[Option – °F]

With the CARGO TEMPERATURE selector set to LOW and TAT less than 45 degrees F, the respective temperature control valve opens. The compartment temperature is maintained between 40 and 50 degrees F.

[Option – °C]

With the CARGO TEMPERATURE selector set to LOW and TAT less than 7 degrees C, the respective temperature control valve opens. The compartment temperature is maintained between 4 and 10 degrees C.

[Option – °F]

With the CARGO TEMPERATURE selector set to HIGH and TAT less than 70 degrees F, the respective temperature control valve opens. The compartment temperature is maintained between 65 and 75 degrees F.

[Option – °C]

With the CARGO TEMPERATURE selector set to HIGH and TAT less than 21 degrees C, the respective temperature control valve opens. The compartment temperature is maintained between 18 and 24 degrees C.

Selecting the HIGH setting on the BULK CARGO TEMPERATURE selector turns on the bulk ventilation fan, which is provided for animal carriage. The system has automatic overheat protection. When an automatic overheat shutdown occurs, cargo heat to the related compartment cannot be restored in flight. The EICAS advisory message CARGO HEAT (AFT or BULK) notifies the flight crew if a shutdown occurs or if a selector is off.

The forward cargo compartment is heated by warm air from the forward equipment ventilation system.

Forward Cargo Compartment Air Conditioning System

[Option]

The forward cargo compartment air conditioning system provides temperature control and conditioned air for the transport of perishable, live, or other temperature sensitive cargo. Automatic ventilation ensures that odors do not go from the cargo compartment to the flight deck or passenger cabin.

Selecting the FWD CARGO A/C control to AUTO disables the forward cargo heating system and allows the selection of a target temperature for the forward cargo compartment. Target and actual temperatures are displayed on the AIR synoptic.

[Option – °F]

The flight crew can set the forward cargo compartment temperature control reference to between 40 and 80 degrees F using the FWD CARGO A/C control.

[Option – °C]

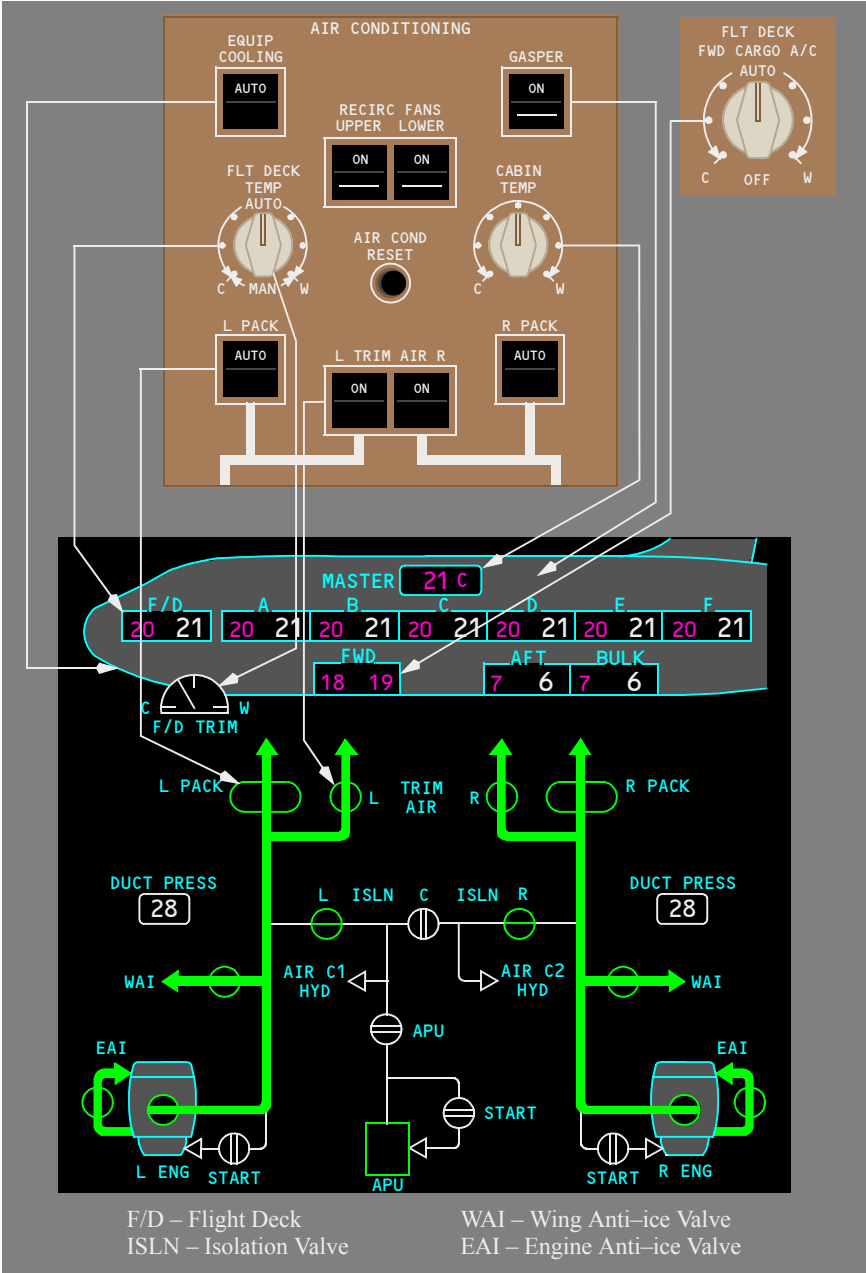
The flight crew can set the forward cargo compartment temperature control reference to between 4 and 27 degrees C using the FWD CARGO A/C control.

Note: If the flight deck control fails, the packs maintain the last selected target temperature.

Normal forward cargo heating is provided when the FWD CARGO A/C control is in the OFF position. The selected temperature display on the AIR synoptic is blanked.

The EICAS advisory message CARGO A/C FWD is displayed when a fault is detected in the forward cargo compartment air conditioning system.

Air Conditioning System Schematic



Equipment Cooling, Equipment Ventilation, Lavatory and Galley Ventilation

The forward equipment cooling and ventilation provides cooling and ventilation for the electrical and electronic equipment on the flight deck and in the forward electrical and electronic (E & E) compartment equipment racks.

The forward systems use internal fans and valves to direct air drawn from the cabin to the equipment and ventilates the warm exhaust air into the forward outflow valve or the forward cargo compartment, if the compartment requires additional heat. There are two cooling system supply fans, a primary and a backup. If the primary supply fan fails, the backup supply fan operates automatically.

The forward system reconfigures automatically to an override mode when:

- the EQUIP COOLING switch is off, or
- in flight, both supply fans fail, or
- in flight, low airflow is detected, or
- smoke is detected in the forward equipment cooling system or the forward equipment ventilation system, or
- the FWD CARGO FIRE ARM switch is ARMED

In the override mode when the FWD CARGO FIRE ARM switch is not ARMED, the vent valve opens, both supply fans are inoperative, and the forward cargo heat valve is closed.

In the override mode when the FWD CARGO FIRE ARM switch is ARMED, the vent valve remains closed, both supply fans are inoperative, and the forward cargo heat valve is closed.

Cabin differential pressure draws air through the flight deck panels and into the E & E equipment compartment to create a reverse flow of air across the equipment, then through the override valve to an overboard vent.

The override mode supplies adequate cooling while the airplane is in cruise, but the airflow decreases as the airplane descends as the cabin pressure differential decreases.

In flight, the EQUIP COOLING switch in OVRD aids smoke evacuation from the flight deck.

On the ground, the EICAS advisory message EQUIP COOLING is displayed and the ground crew call horn in the wheel well sounds if the forward equipment cooling system is inoperative.

The aft equipment cooling and ventilating system provides cooling and ventilating air for the aft electronic equipment and ventilating air for the lavatories and galleys.

Two aft ventilation fans, a primary and a backup, draw air through the aft electronic equipment and from the galleys and lavatories. The warm exhaust air is discharged through the aft outflow valve. Conditioned air is supplied to the galleys from the air distribution system.

Introduction

Cabin pressurization is controlled by regulating the discharge of conditioned cabin air through the outflow valves.

Two outflow valves are installed: one forward and one aft. Normally, most of the outflow is through the aft outflow valve. This improves ventilation and smoke removal. Cabin altitude and full ventilation rates can be maintained by either valve.

Positive and negative pressure relief valves protect the fuselage against excessive pressure differential.

The pressurization system has automatic and manual operating modes. Other than accomplishing normal procedures for entering FMC data, no specific flight crew action is required for fully automatic operation.

Pressurization System Automatic Operation

In flight, the cabin altitude controller operates in a climb mode, a cruise mode, or a descent mode.

The controller uses ambient pressure and flight plan data from the FMC to calculate a cabin pressurization schedule. The schedule provides a comfortable cabin climb to cruise altitude.

For takeoff, the system supplies a small positive pressurization prior to rotation to cause a smooth cabin altitude transition to the cabin altitude climb schedule.

In cabin altitude controller climb mode, cabin altitude increases on a schedule related to the airplane climb rate and flight plan cruise altitude. When the FMC climb path has a planned level segment, it is included in the total time required for the airplane to reach the top of climb. Cabin altitude continues to increase during the level segment. When the airplane climb flight path is above the FMC climb path and maximum cabin pressure differential is reached during the climb, cabin rate then becomes a function of airplane climb rate so maximum cabin differential pressure is not exceeded.

If cruise altitude is unavailable from the FMC in AUTO, the cabin altitude controllers assume a cruise altitude of 39,000 feet.

In cabin altitude controller cruise mode, maximum cabin altitude is 8,000 feet. When the takeoff field elevation is higher than 8,000 feet, the cabin descends to the cabin cruise altitude while the airplane is climbing.

When the destination airport elevation is greater than 8,000 feet, cabin altitude controller cruise mode maintains a cabin altitude of 8,000 feet.

The cabin altitude controllers enter cabin altitude controller descent mode at T/D or at initial descent of approximately 1,000 feet from cruise altitude, regardless of T/D.

In cabin altitude descent mode, cabin altitude decreases or increases to slightly below the FMC planned landing altitude in AUTO or the landing altitude set in MAN. The slight altitude difference ensures a small positive pressurization at touchdown. In MAN, FMC altitude information is bypassed and the cabin altitude controller uses internal rate schedules to control cabin altitude.

Landing elevation limits are 1,000 feet below sea level to 14,000 feet above sea level. The captain's altimeter setting provides landing altitude barometric pressure correction.

At touchdown, the outflow valves open to depressurize the cabin.

The cabin altitude limiter closes both outflow valves if cabin altitude exceeds 11,000 feet.

Full automatic operation of cabin altitude is possible with one outflow valve operating automatically and the other outflow valve not operating.

Cabin Altitude Controller Automatic Operation With Loss of Landing Altitude

If landing altitude is unavailable from the FMC, and not set in MAN, the EICAS advisory message LANDING ALT is displayed and the cabin altitude controller assumes a landing altitude of 2,000 feet.

Pressurization System Manual Operation

If both Outflow Manual switches are ON, all automatic cabin altitude control functions are bypassed.

Introduction

Bleed air can be supplied by the engines, APU, or a ground air source.

Bleed air is used for:

- air conditioning
- pressurization
- wing and engine anti-ice
- APU and engine start
- aft cargo heat
- air driven hydraulic pumps
- hydraulic reservoir pressurization
- potable water tank pressurization
- TAT probe aspiration.

Engine Bleed Air Supply

Engine bleed air is supplied from either the high stage or the low stage engine sections. Low stage air is used during high power setting operations. High stage air is used during descent and other low power setting operations.

The engine bleed air valves are armed when the ENGINE bleed switches are selected ON. The valves are pressure actuated and remain closed until engine bleed air pressure is sufficient to cause forward flow. The engine bleed valves close automatically:

- during start
- for bleed source loss
- for bleed air overtemperature
- for bleed air overpressure
- for a bleed air duct leak
- when an engine fire switch is pulled
- when a ground cart is supplying air.

APU Bleed Air Supply

APU bleed air is used primarily during ground operations for pack operation and engine starting. In flight, APU bleed air is available below approximately 22,000 feet.

The check valve in the APU supply line prevents reverse flow of bleed air from the duct into the APU.

Ground Bleed Air Supply

External connectors are provided to connect a ground source of high pressure air directly to the bleed air duct.

Check valves prevent reverse flow of bleed air from the bleed air duct to the connectors.

Bleed Air Duct System

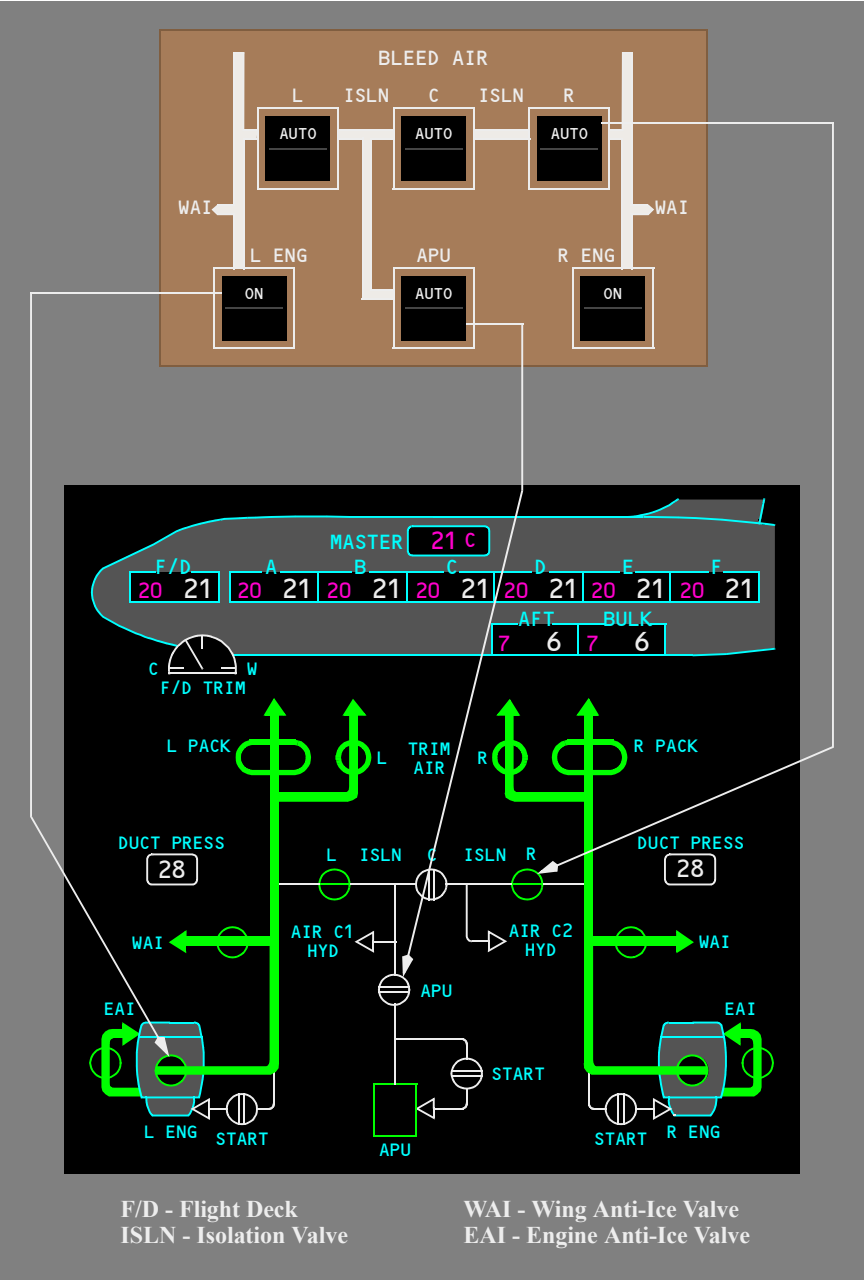
The left, center, and right isolation valves separate the bleed air duct into isolated segments. The automatic system operates with the left and right isolation valves normally open. The center isolation valve is normally closed, except for engine start or single bleed source operation.

Duct Leak and Overheat Detection System

If a duct leak is detected, the system automatically isolates the leak. The EICAS caution message BLEED LEAK is displayed. The automatic isolation logic may include one, two, or three sequential steps. During isolation, the ENGINE and/or APU bleed switch OFF lights and the ISOLATION switch CLOSED lights illuminate and extinguish as the respective valves close and open.

When the temperature in the affected duct area cools, the BLEED LEAK EICAS message is no longer displayed. The valves isolating the leak remain closed and the appropriate EICAS message BLEED LOSS is displayed. The switch OFF or CLOSED lights are illuminated for the respective valves which remain closed to isolate the affected duct area.

Bleed Air System Schematic



Air Systems EICAS Messages

The following EICAS messages can be displayed.

| Message | Level | Aural | Condition |
|------------------------------|----------|--------|---|
| BLEED ISLN CLOSED C, L, R | Advisory | | Isolation valve remains closed when commanded open or bleed isolation switch is OFF. |
| BLEED ISLN OPEN C, L, R | Advisory | | Isolation valve remains open when commanded closed. |
| BLEED LEAK BODY | Caution | Beeper | High temperature bleed air leak is detected in the body area. |
| BLEED LEAK L, R | Caution | Beeper | High temperature bleed air leak is detected in the wing or pack bay area. |
| BLEED LEAK STRUT L, R | Caution | Beeper | High temperature bleed air leak is detected in the strut area. |
| BLEED LOSS BODY | Advisory | | Bleed air from the left and right body ducts is no longer available. |
| BLEED LOSS BODY L, R | Advisory | | Bleed air from the body duct is no longer available. |
| BLEED LOSS WING L, R | Advisory | | Bleed air from the wing duct is no longer available. |
| BLEED OFF APU | Advisory | | APU bleed valve is closed for a system fault or APU bleed switch is OFF. |
| BLEED OFF ENG L, R | Advisory | | Engine bleed valve is closed for a system fault or engine bleed switch is OFF. |
| CABIN ALTITUDE | Warning | Siren | Cabin altitude is excessive. |
| CABIN ALTITUDE AUTO | Caution | Beeper | Automatic pressurization control has failed or both outflow valve switches are in manual. |
| CARGO HEAT AFT, BULK | Advisory | | Cargo heat is inoperative or cargo temperature selector is OFF. |

| Message | Level | Aural | Condition |
|---------|-------|-------|-----------|
|---------|-------|-------|-----------|

[Option - forward cargo air conditioning]

| | | | |
|---------------|----------|--|--|
| CARGO A/C FWD | Advisory | | The forward cargo air conditioning is inoperative. |
|---------------|----------|--|--|

| | | | |
|------------------------|----------|--|--|
| EQUIP COOLING | Advisory | | Forward equipment cooling is inoperative. |
| EQUIP COOLING OVRD | Advisory | | Equipment cooling system is in override mode. |
| LANDING ALTITUDE | Advisory | | FMC has failed to provide a landing altitude or landing altitude selector is pulled. |
| OUTFLOW VALVE AFT, FWD | Advisory | | Automatic control has failed or outflow valve switch is in MAN. |
| PACK L, R | Advisory | | Pack is shut down. |

[AIMS BP03 installed]

| | | | |
|----------|---------|--------|---------------------------|
| PACK L+R | Caution | Beeper | Both packs are shut down. |
|----------|---------|--------|---------------------------|

| | | | |
|-----------------|----------|--|---|
| PACK MODE L, R | Advisory | | Pack is operating in standby mode. |
| RECIRC FANS OFF | Memo | | One or both recirculation fan switches are in the off position. |
| TRIM AIR L, R | Advisory | | Trim air is shut off. |