AIR CONDITIONING AND PRESSURIZATION

TABLE OF CONTENTS

CHAPTER 2

TABLE OF CONTENTS

GENERAL

The Environmental Control System (ECS) performs the following functions:

- Provides fresh air supply.
- Provides ram air in the event of total loss of ECS.
- Provides air for pressurization control.
- Controls cockpit and passenger compartment temperature control.
- Provides sufficient airflow for emergency pressurization.
- Provides air recirculation.
- Exhausts the air from the cockpit and cabin.
- Exhausts the air from toilets and galleys.
- Exhausts the air from the under floor avionics bay and cockpit displays, and
- Provides indications and warnings to EICAS and maintenance information to CAIMS.

Bleed Air System

The Bleed Air System is controlled during all phases of operation by two Bleed Management Controllers (BMC). The BMCs provide indications and warnings to EICAS and maintenance information to CAIMS.

The Bleed Air System, in normal flight operations, supplies air from the engines, to the ECS and Wing and Cowl Anti-Ice systems. For more information see Chapter 14, ICE AND RAIN PROTECTION.

On the ground, air is normally supplied from the APU. A high pressure ground air supply unit, or bleed air from the engines can also be used.

The Bleed Air System control panel is located on the overhead panel.

Air Conditioning System

The air conditioning system is controlled during all phases of operation by two Air Conditioning System Controllers (ACSC). The ACSCs provide indications and warnings to EICAS and maintenance information to CAIMS.

The air conditioning system comprises the following sub-systems:

- The Flow Control System.
- The Air Conditioning Units (2).
- The Temperature Control System.
- Air Distribution and Exhaust.
- The Emergency Pressurization System.

The Air Conditioning System control panel is located on the overhead panel.

Cabin Pressure Control System (CPCS)

The Cabin Pressure Control System (CPCS) is composed of two controllers, two outflow valves and two safety valves. The CPCS provides indications and warnings to EICAS and maintenance information to CAIMS.

The system includes safety devices which affect outflow valve travel limitation, cabin altitude limitation and differential pressure limits exceedance.

The cabin is controlled to an altitude of no more than 5,670 feet at 51,000 feet airplane altitude and no more than 4,500 feet when flying at 45,000 feet.

GENERAL (CONT'D)

Effectivity:

- *Airplanes 9002 thru 9158* ***not incorporating*** *Service Bulletin:*
  - *SB 700–21–034, Modification – Pressurization Control – Cabin Altitude Reduction During Flight for Improved Passenger Comfort.*

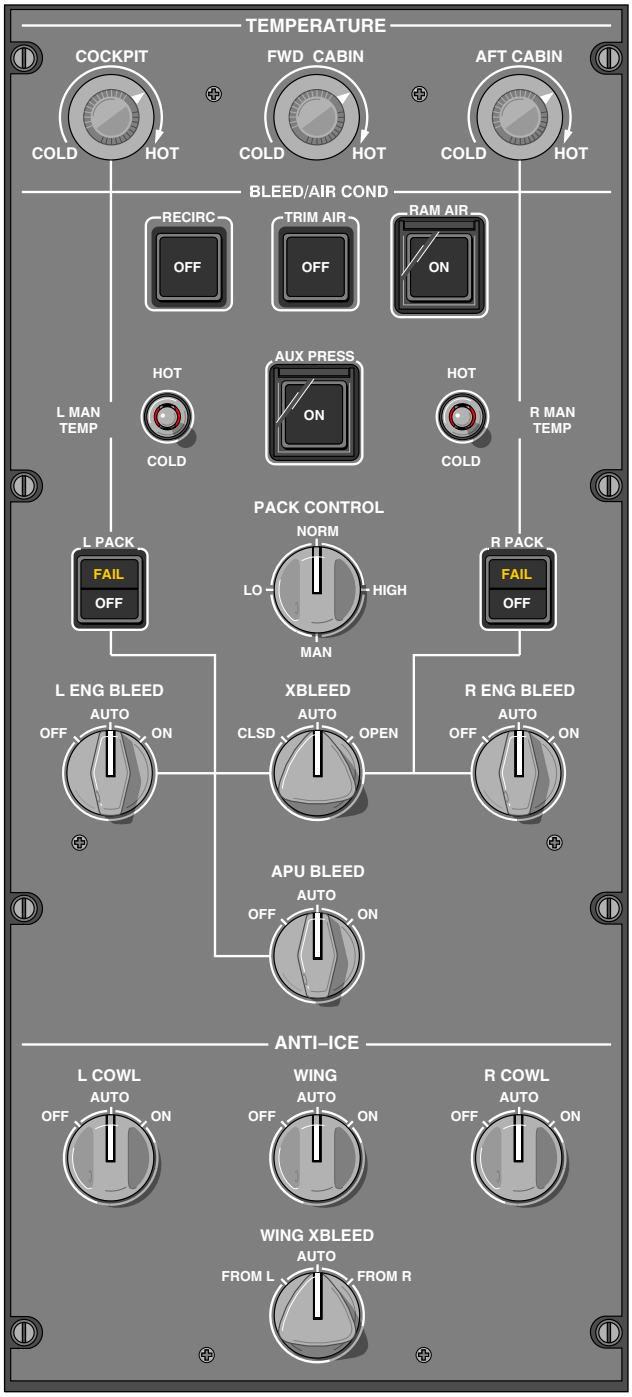
The cabin is controlled to an altitude of no more than 7,230 feet at 51,000 feet airplane altitude and no more than 6,000 feet when flying at 45,000 feet.

The CPCS controls cabin rate at 500 fpm cabin climb and 300 fpm cabin descent (normal mode) and up to a 800 fpm descent rate (high mode) in order to accommodate the maximum normal airplane operating performance.

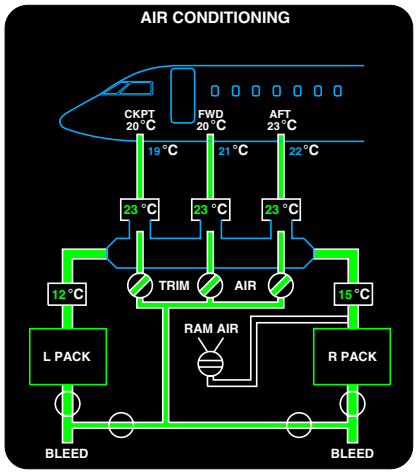
The Pressurization System control panel is located on the overhead panel.

GENERAL (CONT'D)

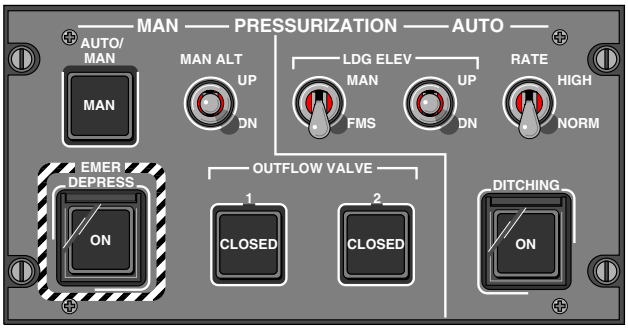
The BLEED/AIR COND/ANTI-ICE and the PRESSURIZATION panels are located on the overhead panel. Synoptics are available on the SYSTEMS electronic display unit.



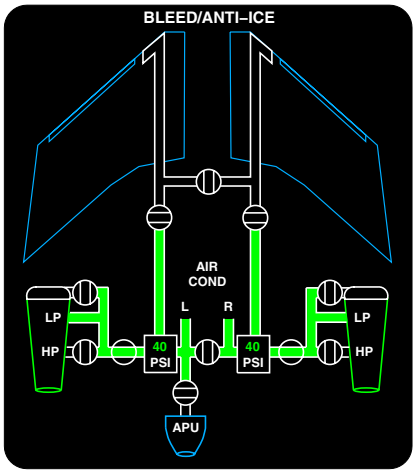
Bleed/Air Conditioning/Anti–Ice Panel



Air Conditioning Synoptic



Pressurization Panel



Bleed/Anti–Ice Synoptic

For More information, see Chapter 14 ICE AND RAIN PROTECTION.

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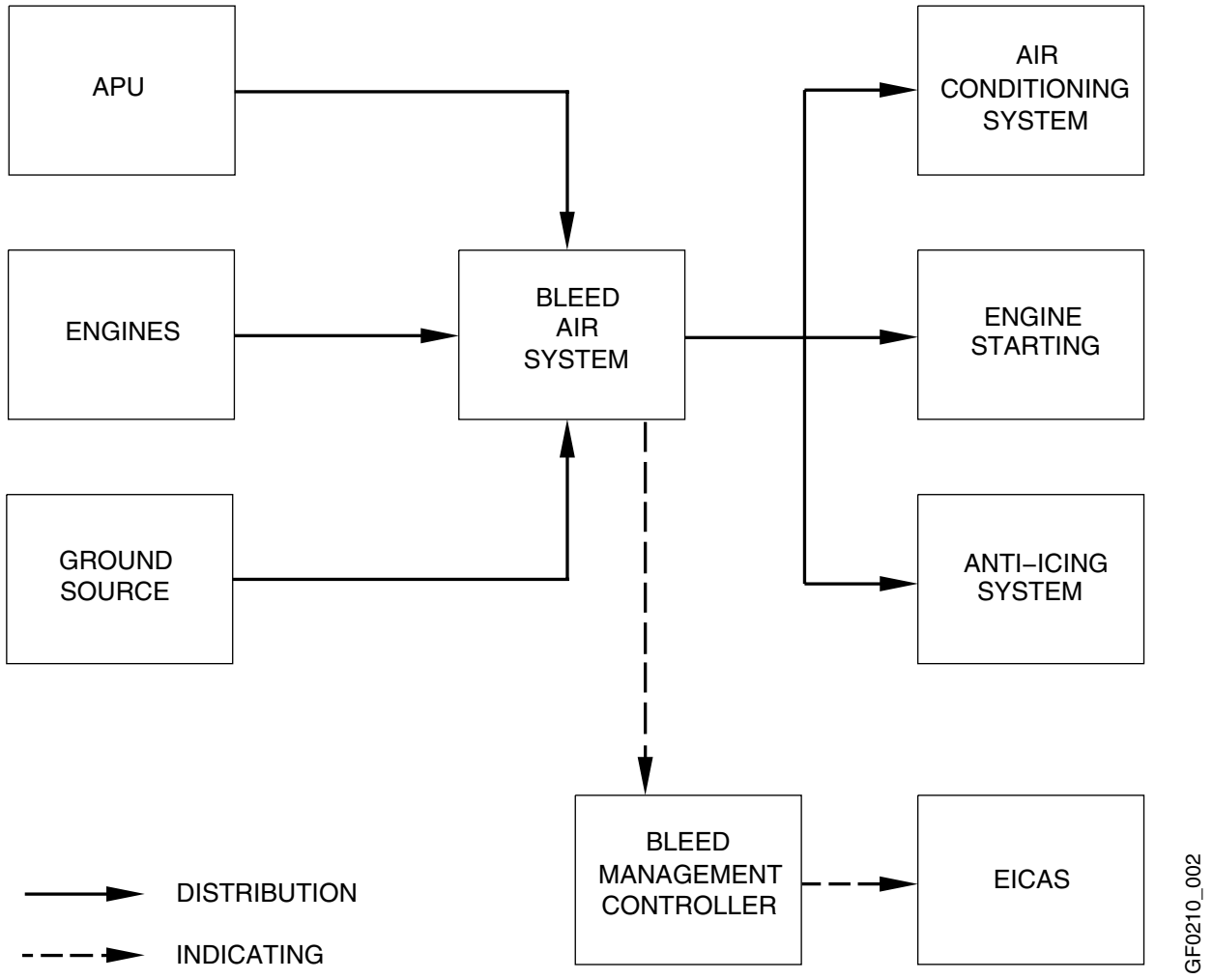
BLEED AIR SYSTEM

The pneumatic system supplies compressed air for air conditioning and pressurization, engine starting and ice and rain protection (see Chapter 14). The pneumatic air supply normally comes from the engines (inflight), and the APU or a high pressure ground air supply unit (on the ground)



BLEED AIR SYSTEM (CONT'D)

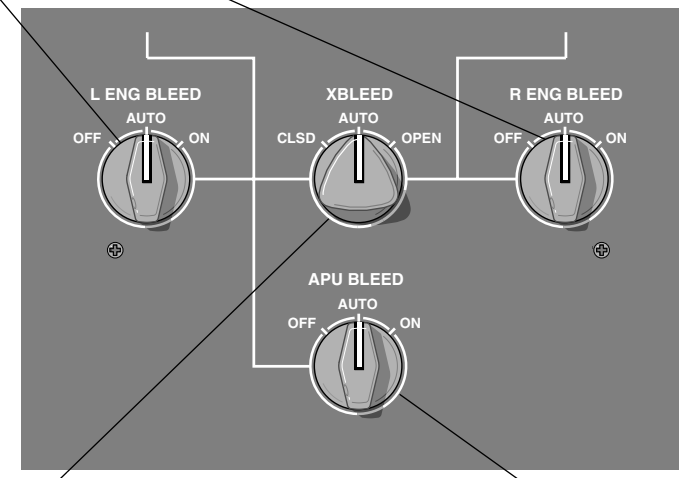
Bleed selection is available on the Bleed/Air Conditioning/Anti-Ice panel. The bleed selections are as follows:

L (R) ENG BLEED Selector

• **OFF** – Selects engine bleed air pressure regulating valve (PRV) and high pressure valve (HPV) closed.

• **AUTO** – PRV and HPV operation (open/close) is controlled by the BMC.

• **ON** – Selects PRV and HPV to open when high pressure selected by BMC or PRV open and HPV closed when low pressure selected by BMC.



XBLEED Selector

• **CLSD** – Selects crossbleed valve closed.

• **AUTO** – Crossbleed valve operation (open/close) is controlled by the BMC.

• **OPEN** – Selects crossbleed valve open and the affected side PRV is commanded to close, controlled by BMC.

APU BLEED Selector

• **OFF** – Selects LCV off.

• **AUTO** – LCV operation (open/close) is controlled by the BMC through the APU FADEC. For more information see Chapter 5, AUXILIARY POWER UNIT.

• **ON** – Selects LCV to open. BMC will reposition the other valves as required to respect bleed air rules.

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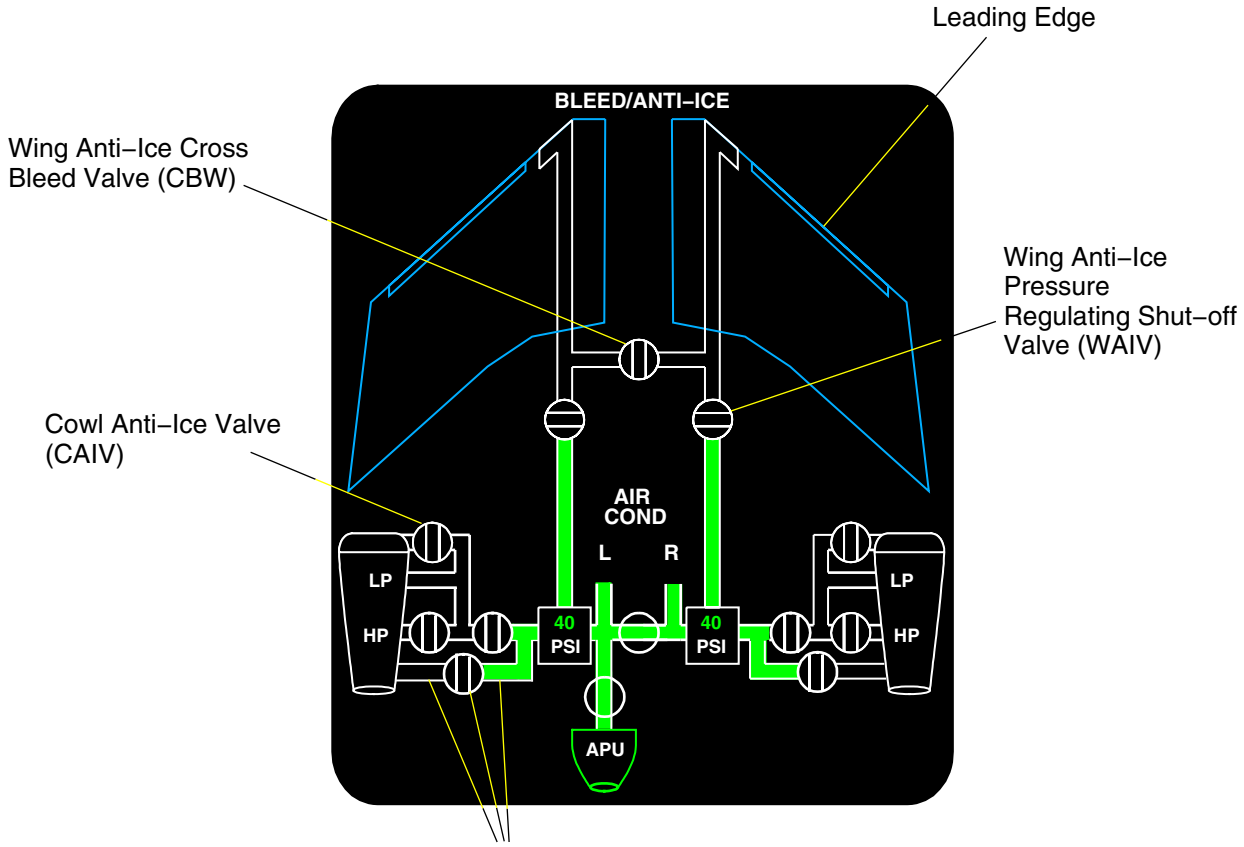
BLEED AIR SYSTEM (CONT'D)

Bleed/Anti-Ice Synoptic

The BLEED/ANTI-ICE synoptic is selected using the EICAS Control Panel, located on the pedestal.

EICAS Control Panel



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For more information on the Anti-Ice system, see Chapter 14, ICE AND RAIN PROTECTION.

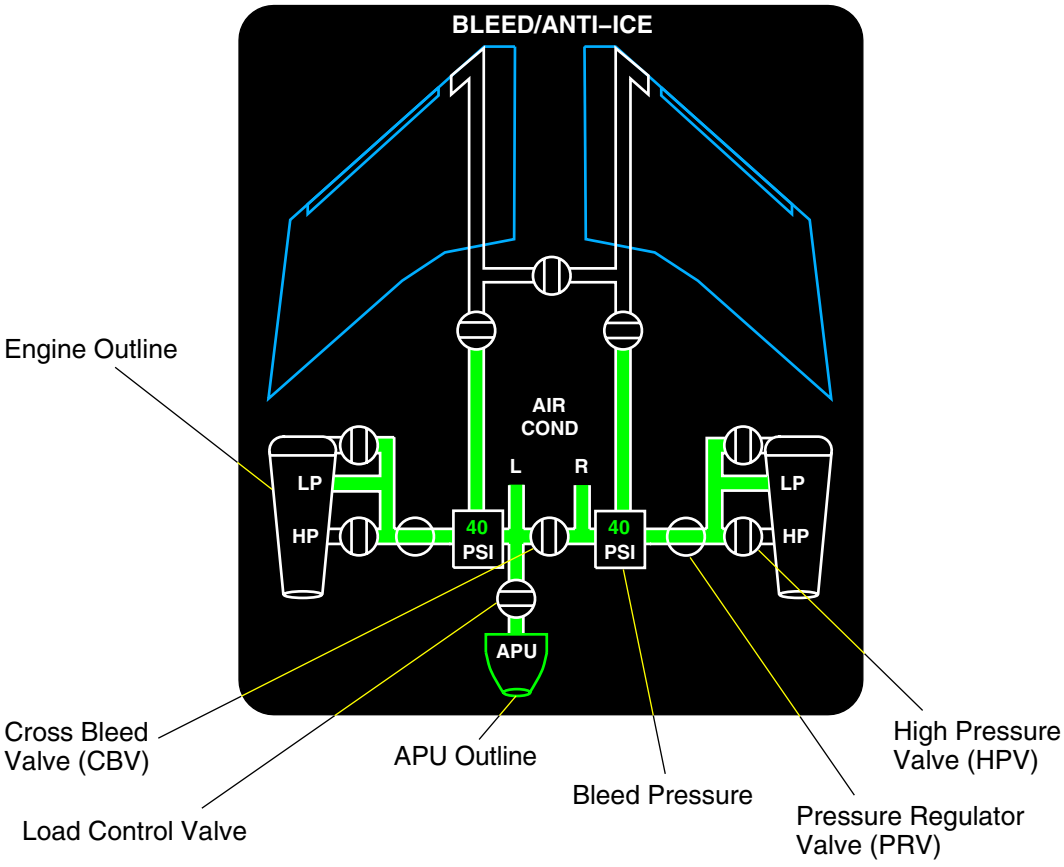
For more information on the Starter Pop-Up, see Chapter 18, POWER PLANT.

BLEED AIR SYSTEM (CONT'D)

Bleed/Anti-Ice Synoptic (Cont'd)

The BLEED/ANTI-ICE synoptic is selected using the EICAS Control Panel, located on the pedestal.

EICAS Control Panel



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For more information on the APU see Chapter 5, AUXILIARY POWER UNIT.

For more information on the engines, see Chapter 18, POWER PLANT.

BLEED AIR SYSTEM (CONT'D)

Bleed Management Controllers (BMC)

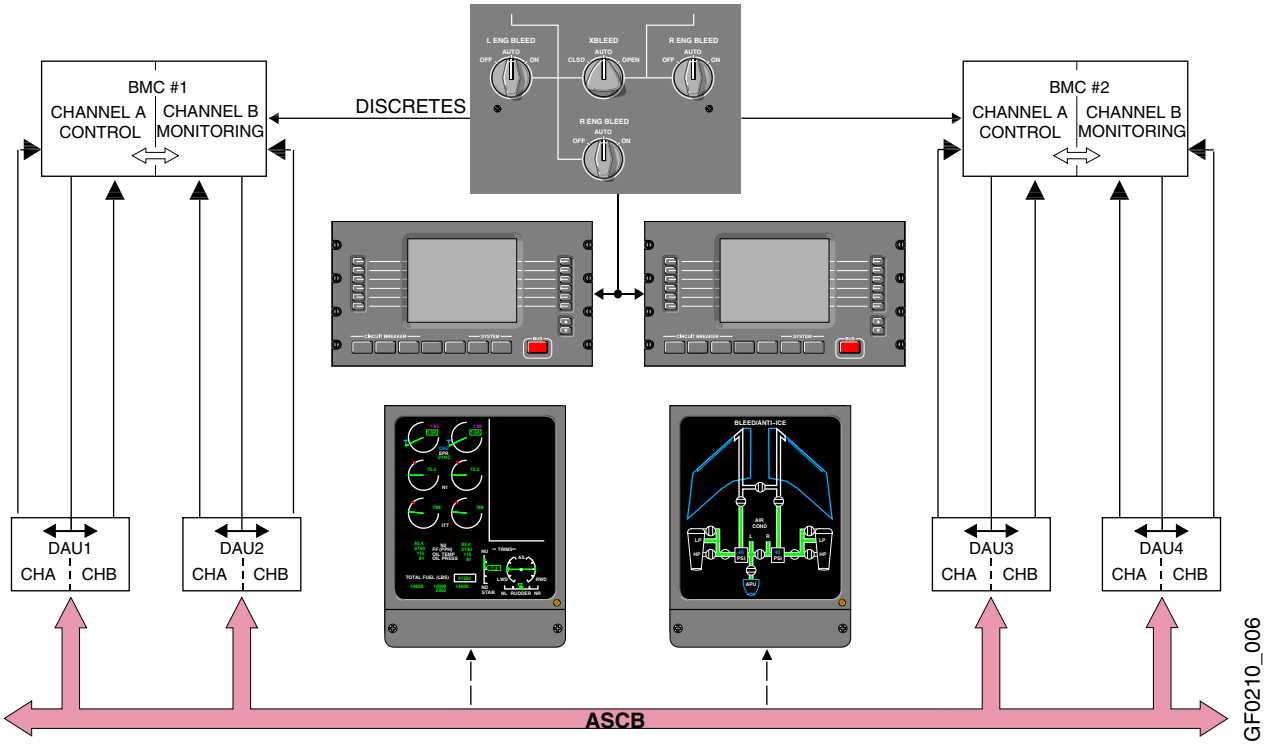
There are two BMCs, one for the left hand side and one for the right hand side of the airplane. Each BMC comprises two channels (control and monitoring).

The control channel ensures on/off switching and control functions for its associated side, as listed:

- Bleed on/off.
- Wing and cowl anti-ice on/off switching and monitoring.
- Wing anti-ice temperature regulation and monitoring.
- Crossbleed valve (CBV) and cross anti-ice functions.

The monitoring channel controls monitoring functions and leak detection and provides:

- Leak detection for the complete airplane. The redundancy on the leak detection is achieved by the two monitoring channels of the two BMCs.
- Redundancy on control and monitoring of bleed switching, anti-ice switching, wing anti-ice temperature regulation.



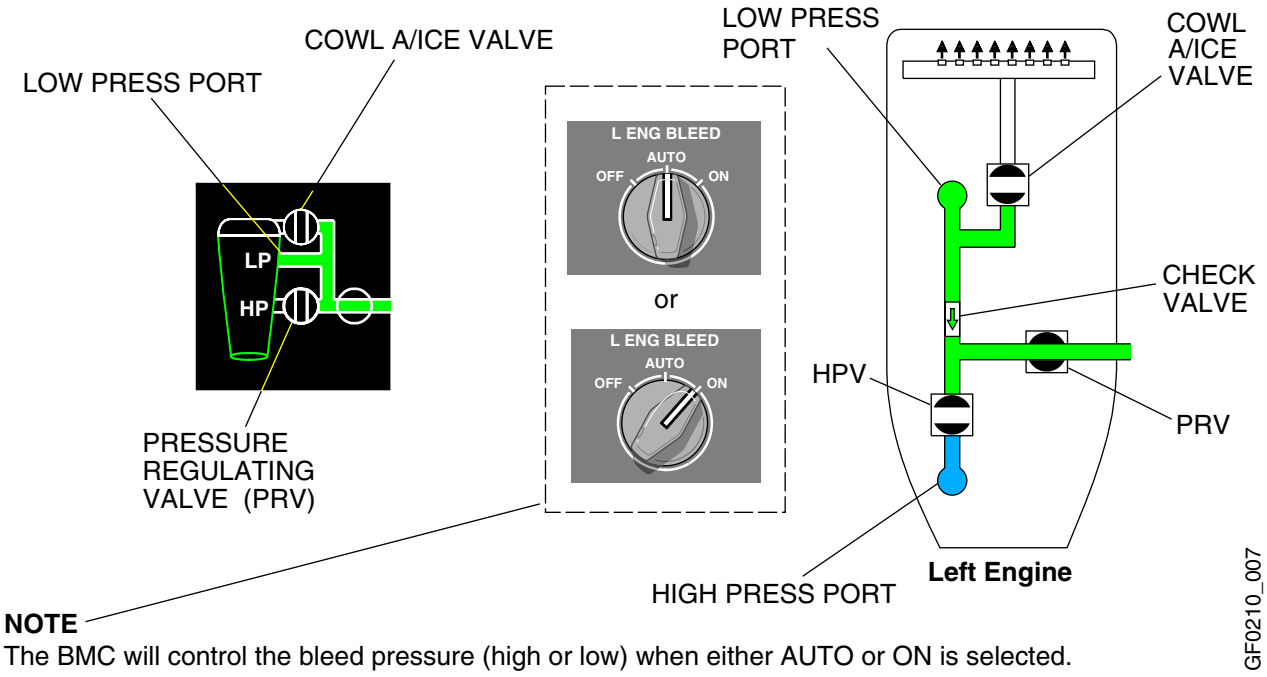
For more information on anti-ice, see Chapter 14, ICE & RAIN PROTECTION.

BLEED AIR SYSTEM (CONT'D)

Engine Bleed Air

The BMC selects air from either the low pressure port or high pressure port on the engine, depending on the pressure available. The Pressure Regulating Valve (PRV) limits the pressure supplied to 43±3 psig.

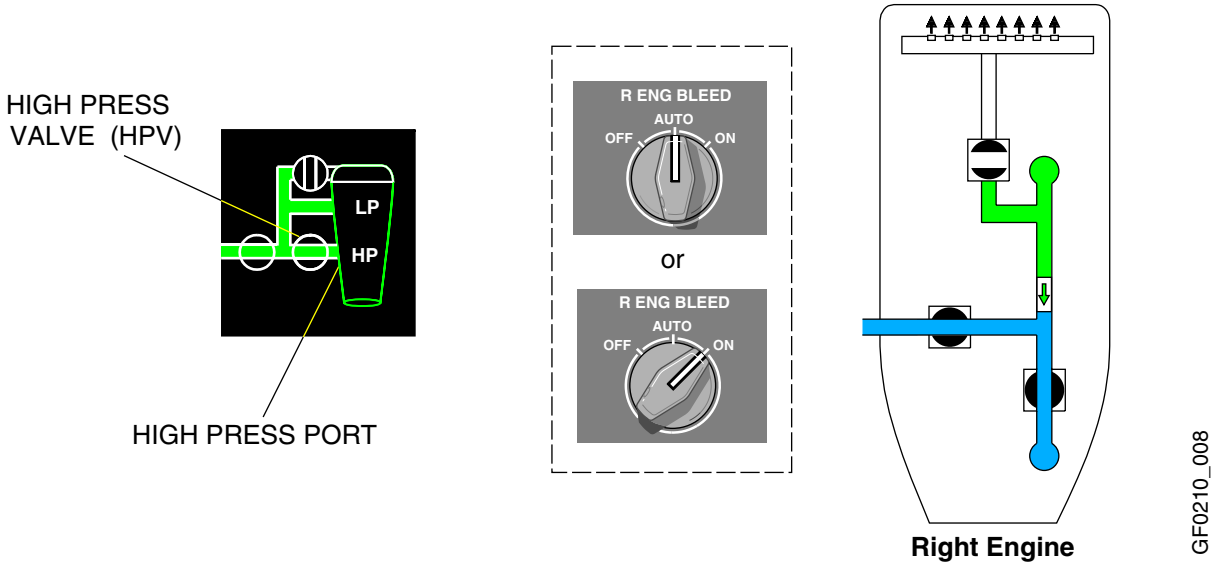
Under normal operating conditions (inflight), the air is bled from the 5th stage of compression (low pressure port). An intermediate pressure check valve, located in the engine nacelle, prevents reverse flow into the engine compressor 5th stage.



NOTE

The BMC will control the bleed pressure (high or low) when either AUTO or ON is selected.

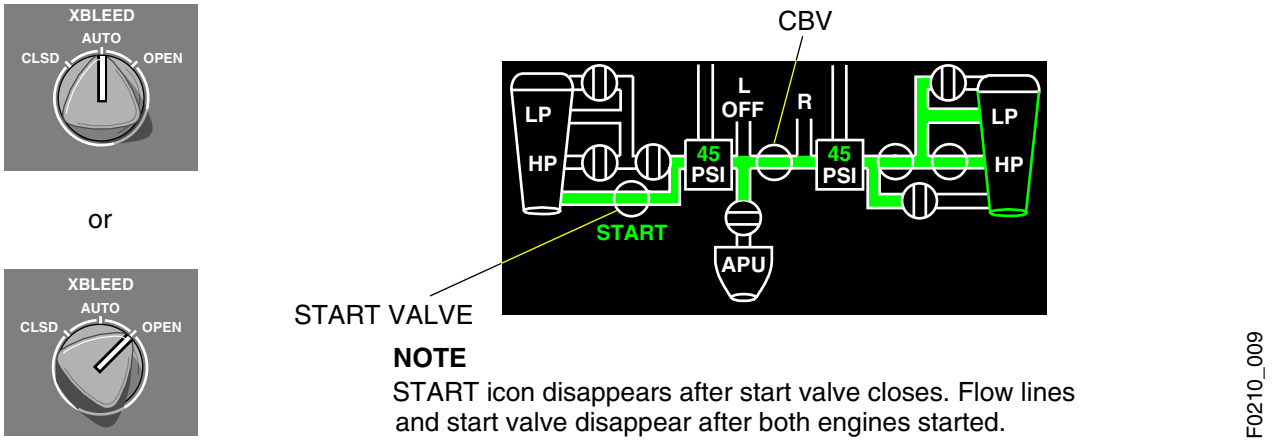
When the pressure is insufficient at the low pressure port, the HPV is signaled to open by the BMC and air from the 8th stage of compression (high pressure port) drives the intermediate pressure check valve closed.



BLEED AIR SYSTEM (CONT'D)

Engine Bleed Air (Cont'd)

A Crossbleed valve (CBV) is installed between the left and right pneumatic ducts which can be opened, automatically by the BMC or manually through the OPEN selection, to provide bleed air from one side to the other, for example engine starting. For more information, see Chapter 18, POWER PLANT.

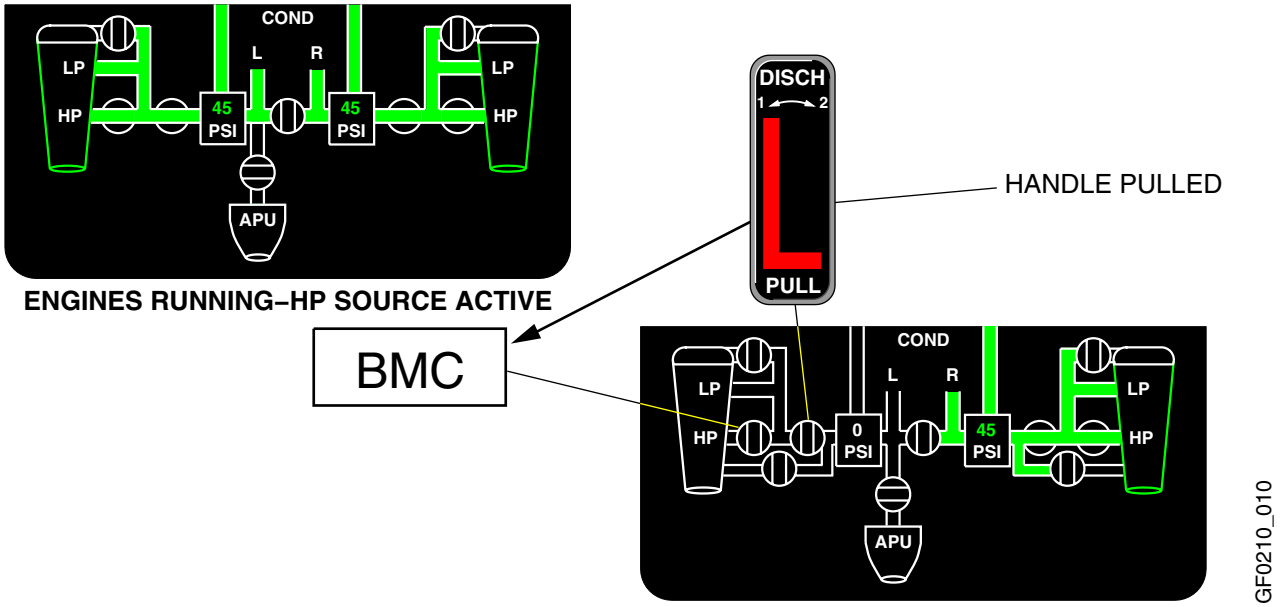


NOTE

START icon disappears after start valve closes. Flow lines and start valve disappear after both engines started.

GF0210_009

The L (R) FIRE DISCH handles, when pulled, will close the affected PRV and the BMC will close the affected HPV. For more information, see Chapter 9, FIRE PROTECTION.



GF0210_010

APU Bleed Air

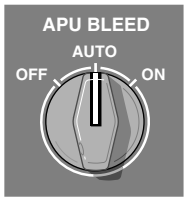
The APU can be used on the ground and in the air, to supply the pneumatic system for air conditioning or engine starting.

Opening the Load Control valve (LCV), automatically by the BMC or manually through the ON selection, allows air from the APU to feed the left pneumatic duct.

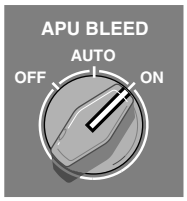
BLEED AIR SYSTEM (CONT'D)

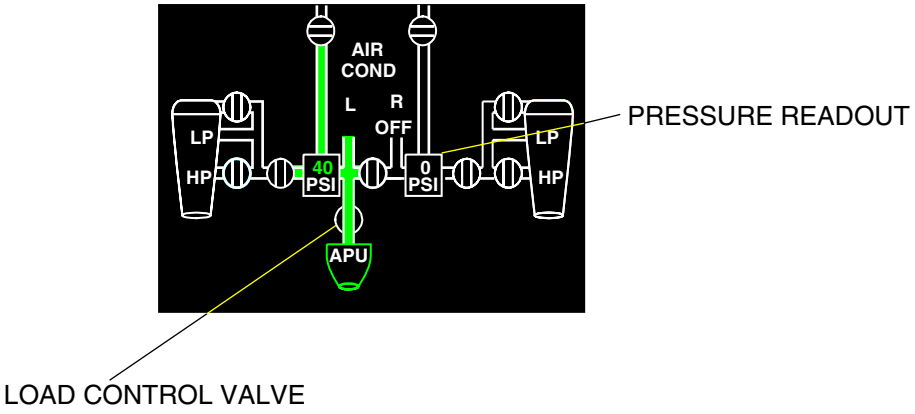
APU Bleed Air (Cont'd)

The air pressure delivered in the pneumatic duct is displayed on the synoptic page in PSI.



or





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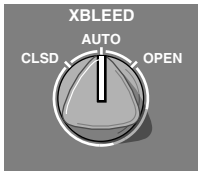
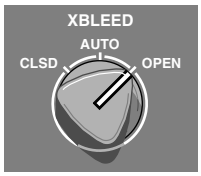
NOTE

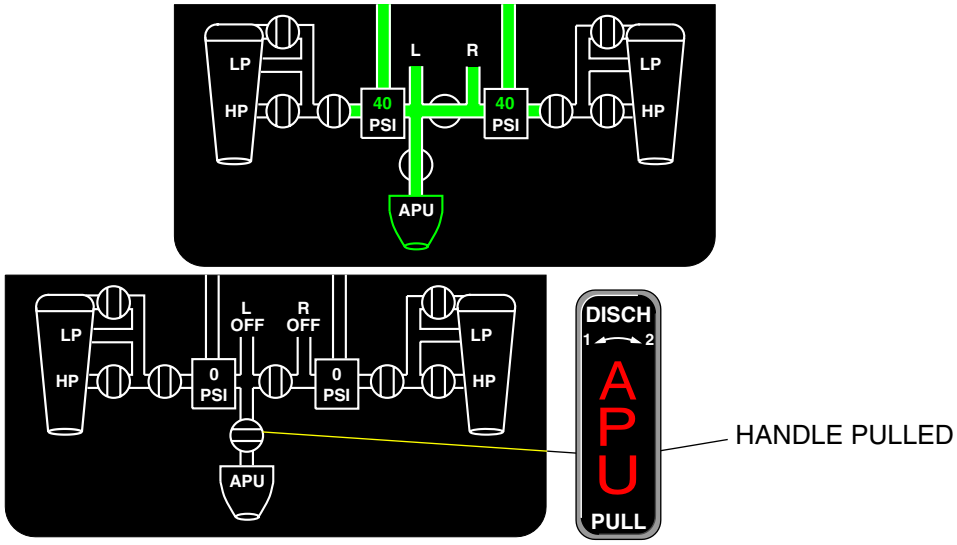
APU bleed air volume is insufficient to supply the wing anti–ice system.

Opening the crossbleed valve (CBV), automatically by the BMC or manually through the ON selection, allows air from the APU to feed the right pneumatic duct.



or





GF0210_012

The APU FIRE DISCH handle, when pulled, will close the LCV. For more information, see Chapter 9 FIRE PROTECTION.

NOTE

Engine bleed has priority over APU bleed and MAN has priority over AUTO.

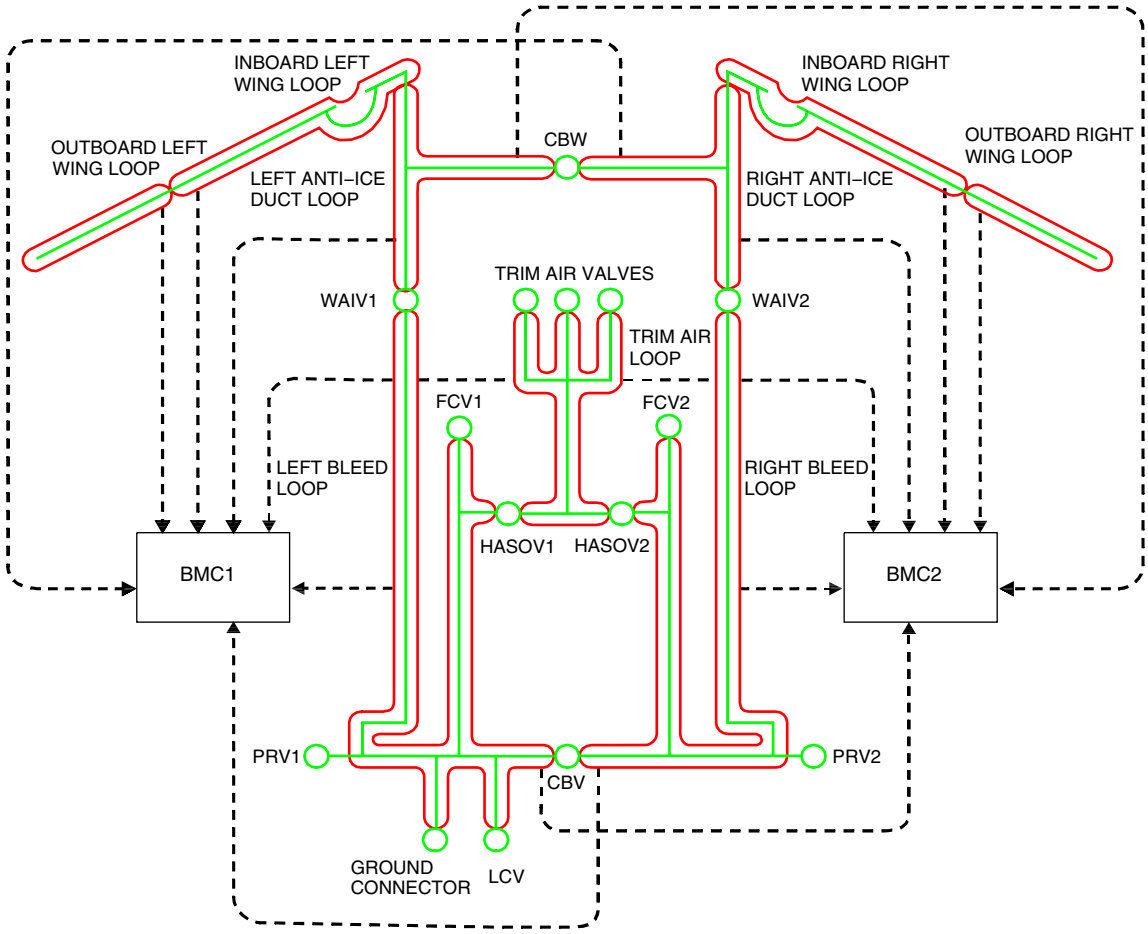
If both PRVs are open (engines running), the BMC will automatically close the LCV and the CBV, if LCV and CBV are in AUTO or Manual.

BLEED AIR SYSTEM (CONT'D)

Bleed Leak Detection

Hot air leaks are monitored in the airplane by dual loop continuous fire detection sensing elements, routed along the airplane ducts. Each dual loop consists of loop A and loop B. Loop A is connected to the left BMC monitoring channel and loop B is connected to the right BMC monitoring channel.

Leak detection elements consist of two concentric tubes. The space between the tubes is filled with an insulated eutectic salt. In case of temperature increase, the salt becomes conductive and the measured resistance between the tubes drops suddenly, triggering an EICAS message.



CBW – Wing Crossbreed Valve
FCV – Flow Control Valve
HASOV– Hot Air Shut–off Valve
LCV – Load Control Valve
PRV – Pressure Regulating Valve
WAIV – Wing Anti–ice Valve

LEGEND

- VALVE + DUCT
- LEAK DETECTION LOOP
- LINK LOOP CONTROLLER (LOOP READ BY BMC)

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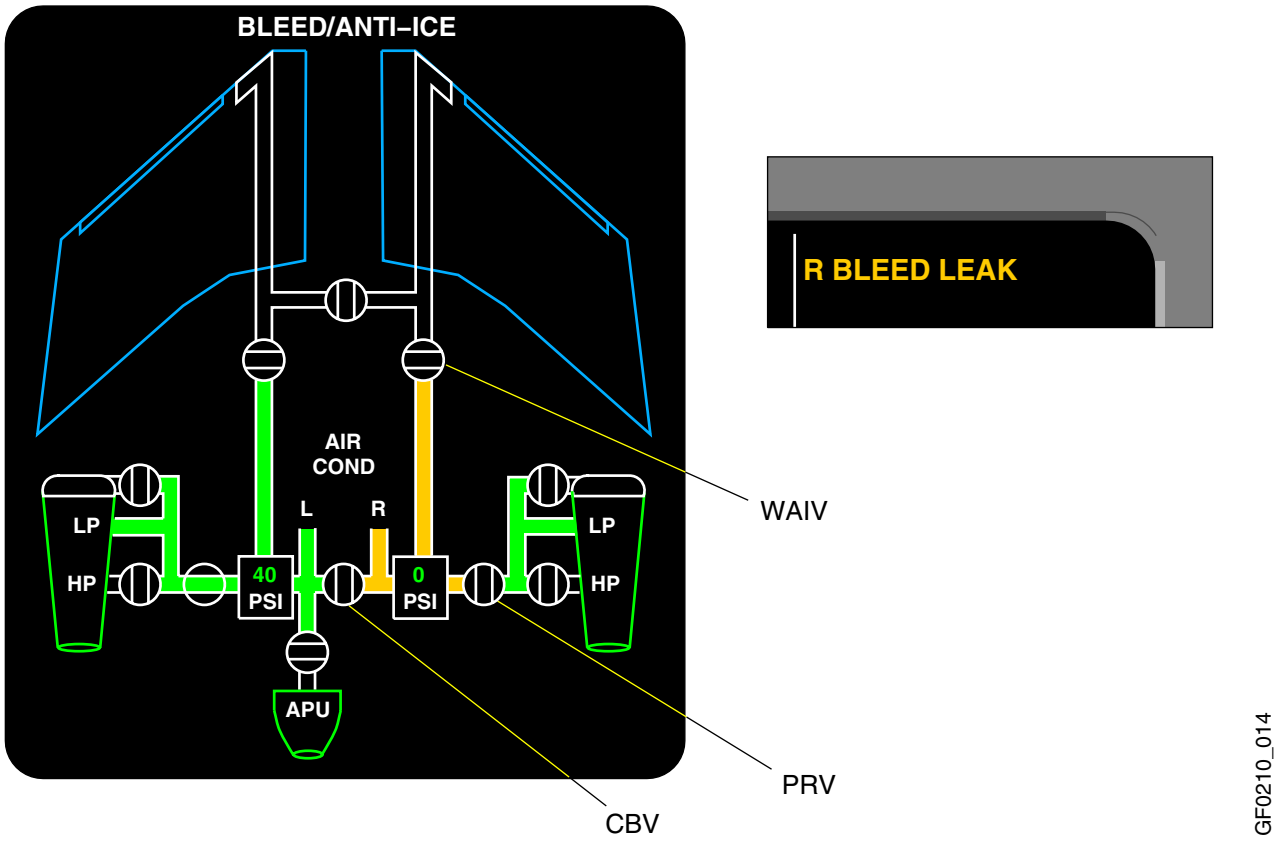
BLEED AIR SYSTEM (CONT'D)

Bleed Leak Detection (Cont'd)

When a leak is detected, a message is displayed on EICAS and the BMC will automatically close the affected PRV, the CBV and wing anti-ice pressure regulating shut-off valve (WAIV), to isolate and stop the leak.



AIR CONDITIONING CONTROLS

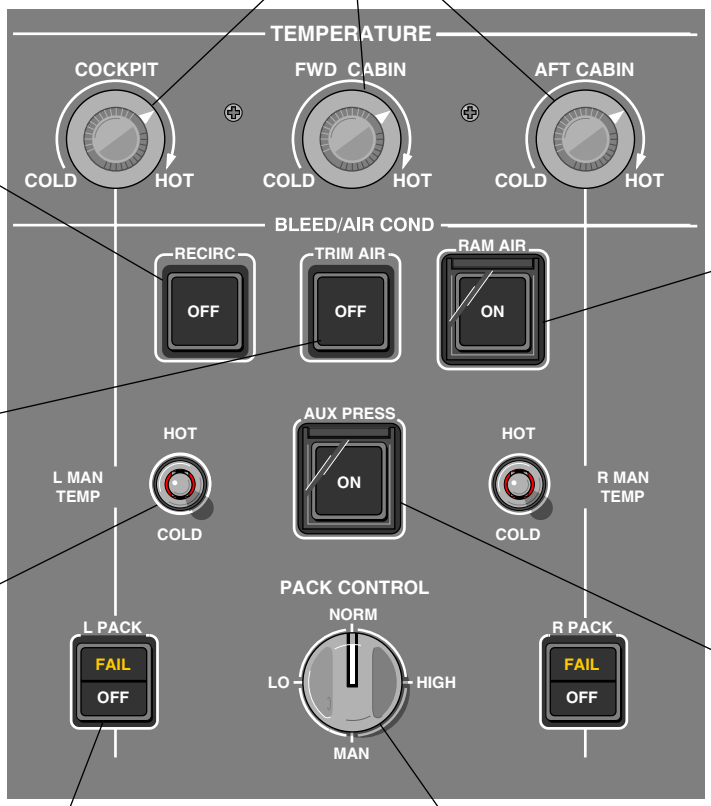
Controls are provided on the Air Conditioning Control Panel, located on the overhead panel.

TEMPERATURE Selectors
Used to select desired temperature for the cockpit and cabin.

RECIRC Switch
Used to inhibit recirculation of conditioned air.
- **OFF** – Indicates recirculation has been selected off.

TRIM AIR Switch
Used to inhibit trim air.
- **OFF** – Indicates trim air is selected off.

HOT/COLD Toggle Switches
Used to control PACK outlet temperature in manual mode.



RAM AIR Switch
Used to provide ambient air to ventilate the cockpit and cabin, in the event of dual PACK failure.
- **ON** – Ram air vent valve has been selected open.

AUX PRESS Switch
Used to control alternate air source, through the trim air system, for cabin pressurization.
- **ON** – AUX PRESS has been selected on.

L (R) PACK Switches
Used to inhibit the air conditioning units
- **FAIL** – Indicates a PACK failure.
- **OFF** – PACK has been selected off.

PACK CONTROL Selector
Used to enable Air Conditioning System Controllers (ACSC) which measure, calculate and control the airflow and all auto features.
- **NORM** – Automatic flow control.
- **LO** – Pack operates in low flow mode.
- **HIGH** – Pack operates in high flow mode.
- **MAN** – Flow control valve is driven full open (ACSC is disabled).

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AIR CONDITIONING SYSTEM

The air conditioning system is comprised of flow control valves, air conditioning units, a ram air system, distribution system, ventilation system and auxiliary pressurization system.

The flow control system regulates airflow from the pneumatic duct to the air conditioning units.

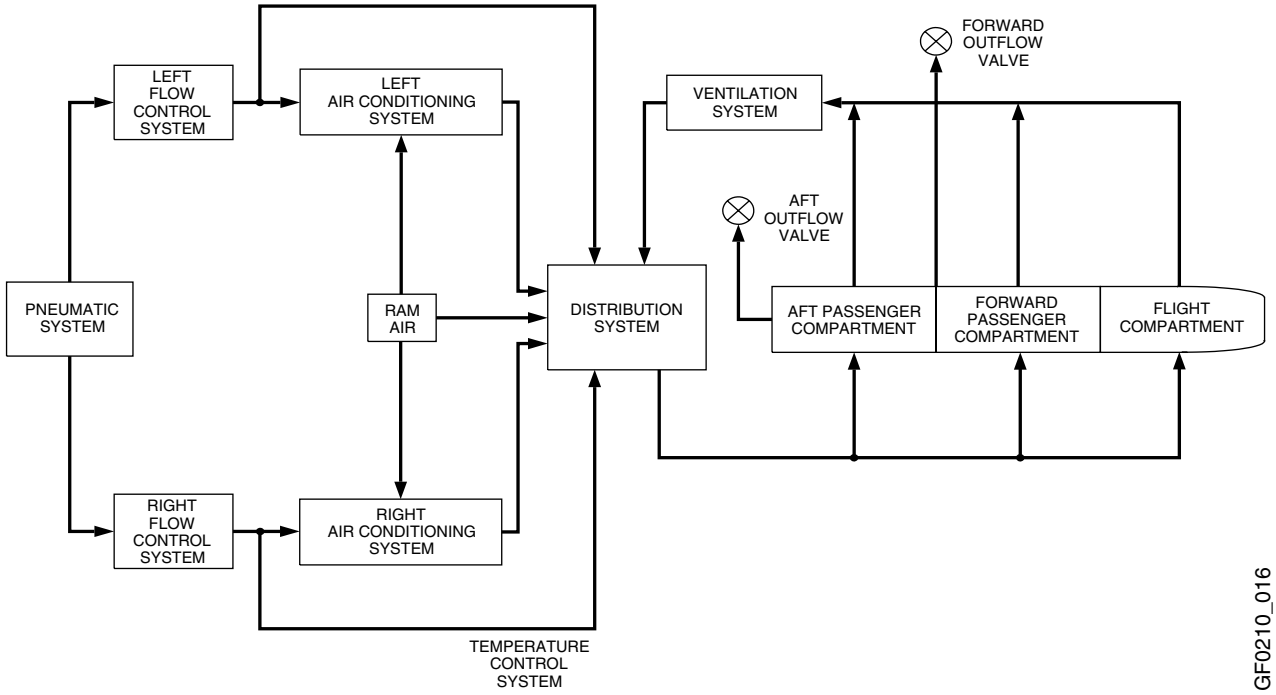
The ACUs decrease the temperature and moisture content of the bleed air from the pneumatic system. The ACUs are located in the aft equipment bay.

An alternate supply of fresh air is available via the ram air system.

Conditioned air is routed from the cooling packs to the mix manifold (distribution system).

The Avionics and Cockpit Display Exhaust system ensures the ventilation of the avionic equipment and cockpit displays to prevent excessive heating.

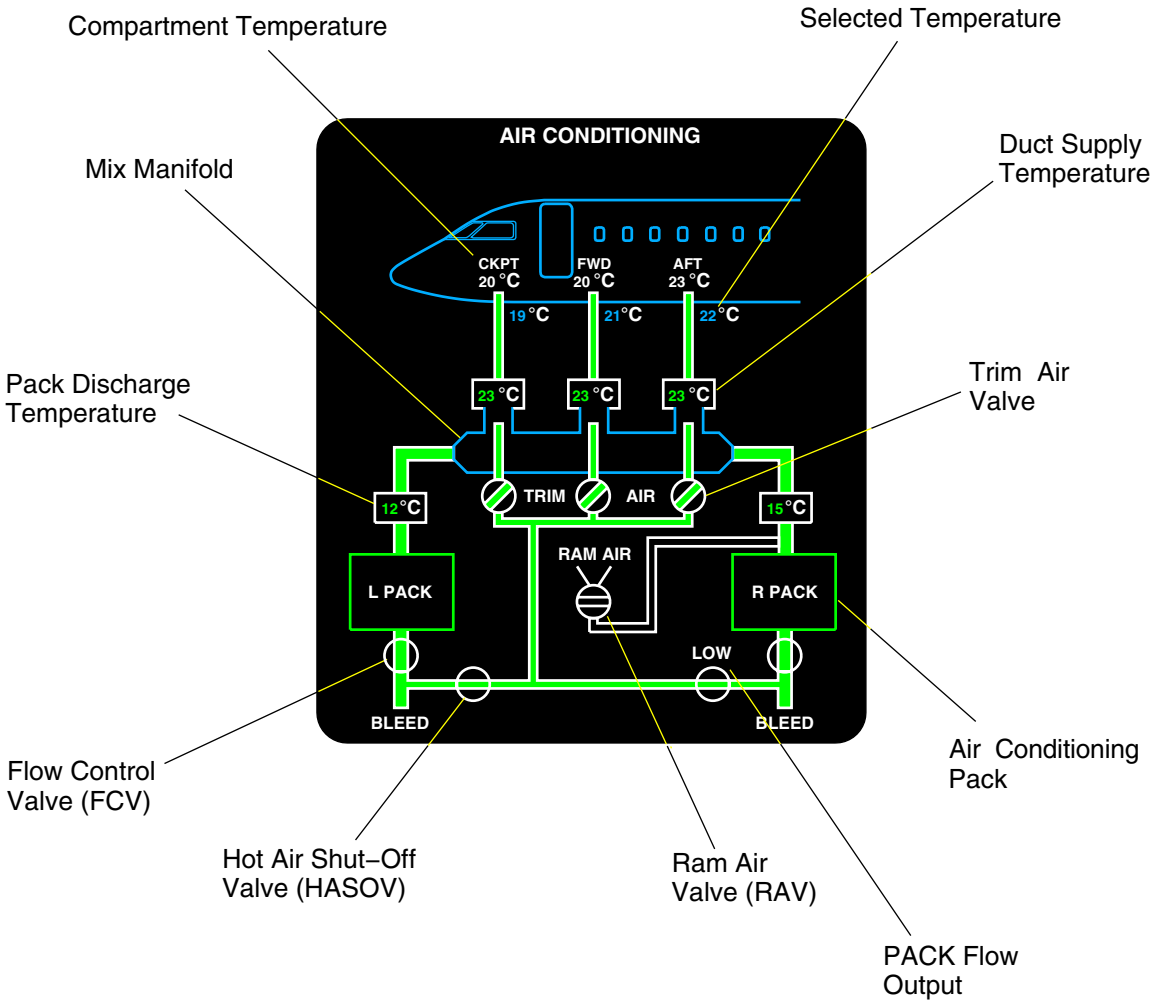
The auxiliary pressurization system provides an alternate pressurization source for the cabin, in the event of loss of both cooling packs.



AIR CONDITIONING SYSTEM (CONT'D)

The AIR CONDITIONING synoptic is selected using the EICAS Control Panel, located on the pedestal.

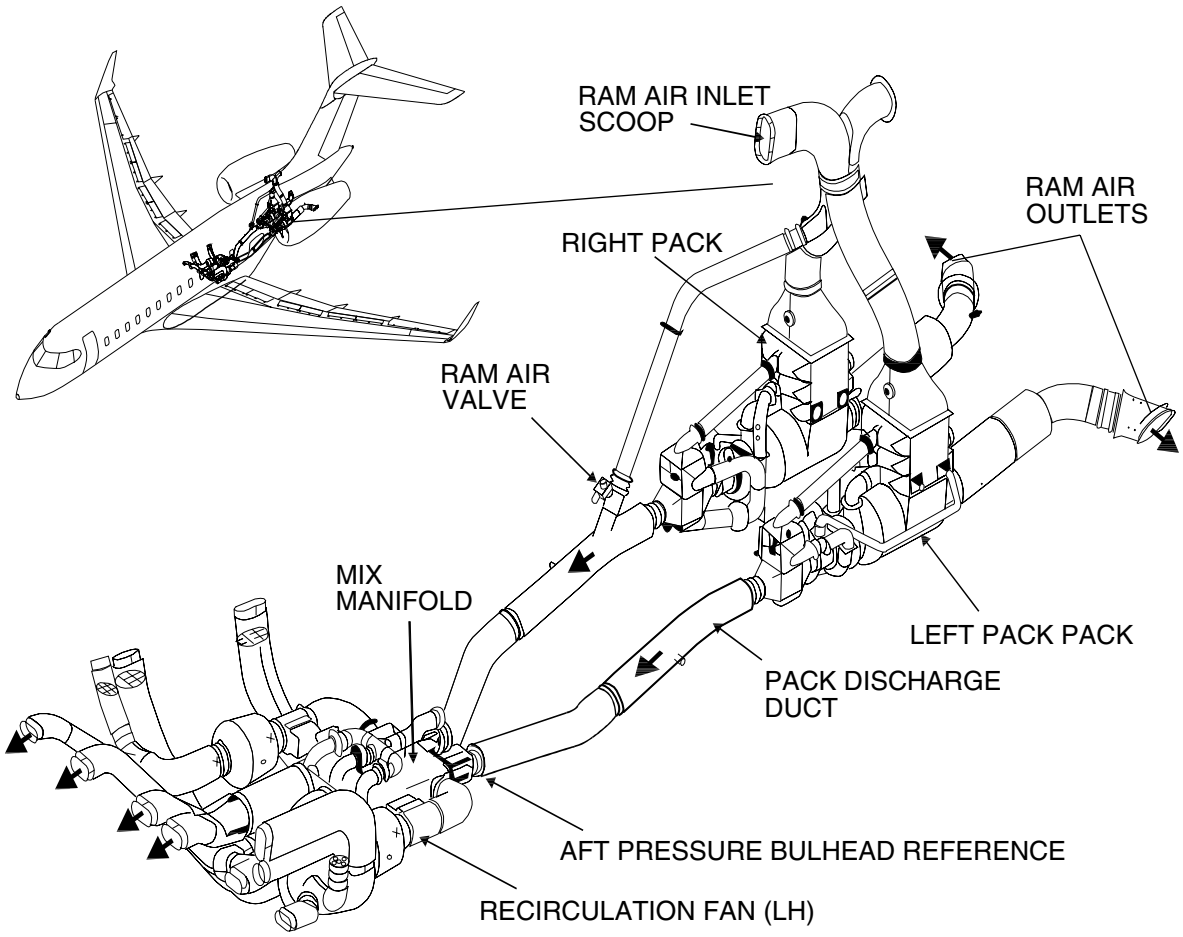
EICAS Control Panel



AIR CONDITIONING SYSTEM (CONT'D)

Air Conditioning Packages (PACKS)

The cooling packs decrease the temperature and moisture content of the bleed air from the pneumatic system. The packs are located in the aft equipment bay.



The air conditioning package is composed of two cooling packs which decrease the temperature and moisture content in the bleed air and deliver conditioned air to the mix manifold.

The RAM AIR system has two main functions:

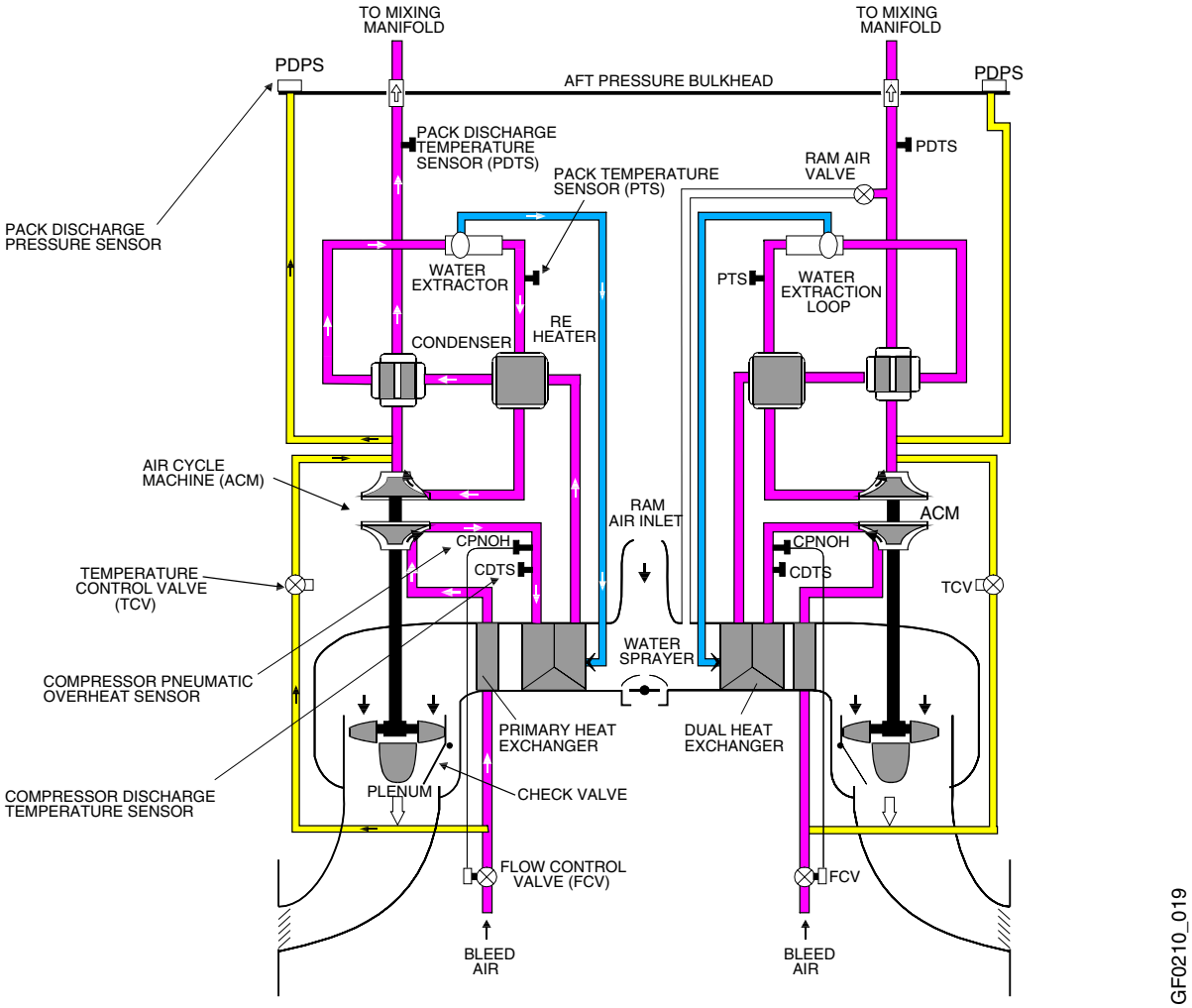
- To supply air to the cooling packs' heat exchangers.
- To cool the bleed air flow, (alternate air supply source in the event of a dual pack failure) and is designed for use inflight, at altitudes below 15,000 feet.

AIR CONDITIONING SYSTEM (CONT'D)

Cooling Packs

The cooling packs function as follows:

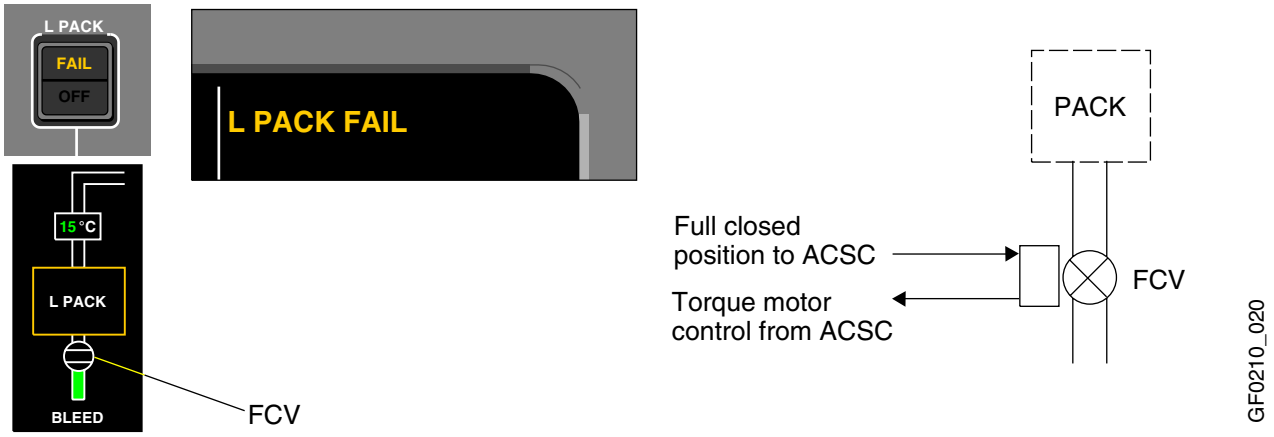
- Bleed air flows through the FCV into the primary heat exchanger, where it is cooled by ram air.
- From the primary heat exchanger, the air flows into the compressor of the air cycle machine, where the temperature and pressure are increased.
- From the compressor, the air enters the main heat exchanger, where the temperature is decreased again.
- From the main heat exchanger, the air passes into the high pressure water extraction loop (Reheater/Condenser, Water Extractor), where much of the water is removed and temperature is further decreased. The water is evacuated into the ram air cooling flow at the inlet of the heat exchangers to increase cooling efficiency by evaporation.
- From the water extraction loop, the air enters the turbine of the air cycle machine, where the temperature and pressure are decreased.
- From the turbine, the air flows back through the condenser, where the temperature is increased slightly and is ducted to the mix manifold.



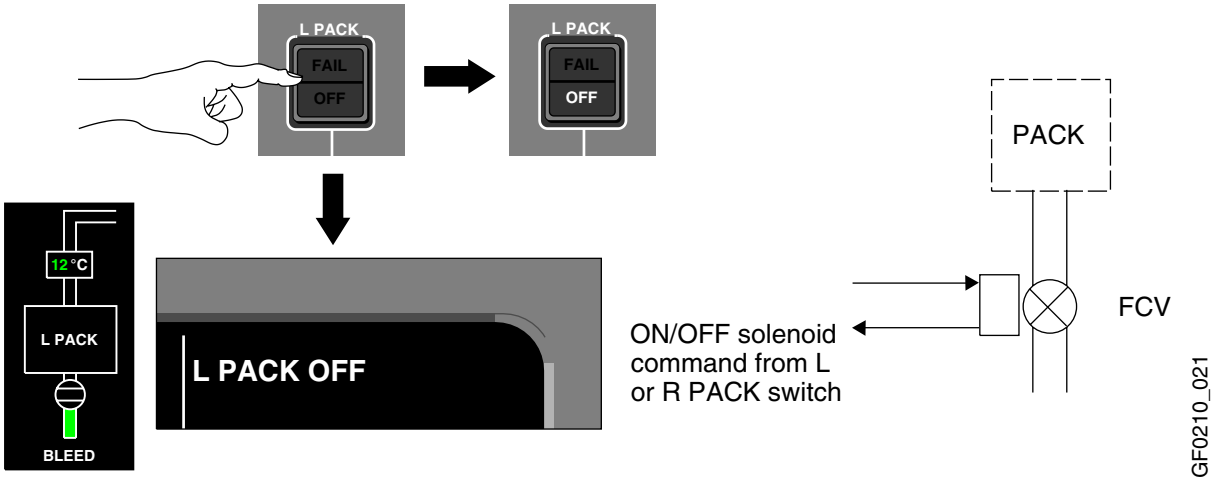
AIR CONDITIONING SYSTEM (CONT'D)

Cooling Packs (Cont'd)

- The cooling packs are shutoff (FCV closed) under the following circumstances:
  - In AUTO operation, by the ACSC acting on the FCV torque motor due to:
  - Bleed failure or shutdown (on BMC demand).
  - Engine starting (on BMC demand).
  - During ditching operation, if airplane is below 15,000 feet.
  - Pack inlet overheat.
  - Compressor discharge overheat.
  - Pack discharge overheat.
  - Pack discharge underpressure.



  - In AUTO or MANUAL operation, by the compressor pneumatic overheat sensor (CPNOH), acting pneumatically on the FCV actuator due to compressor discharge overheat or by crew selection of the PACK switch, acting on the FCV solenoid.



AIR CONDITIONING SYSTEM (CONT'D)

Flow Control System

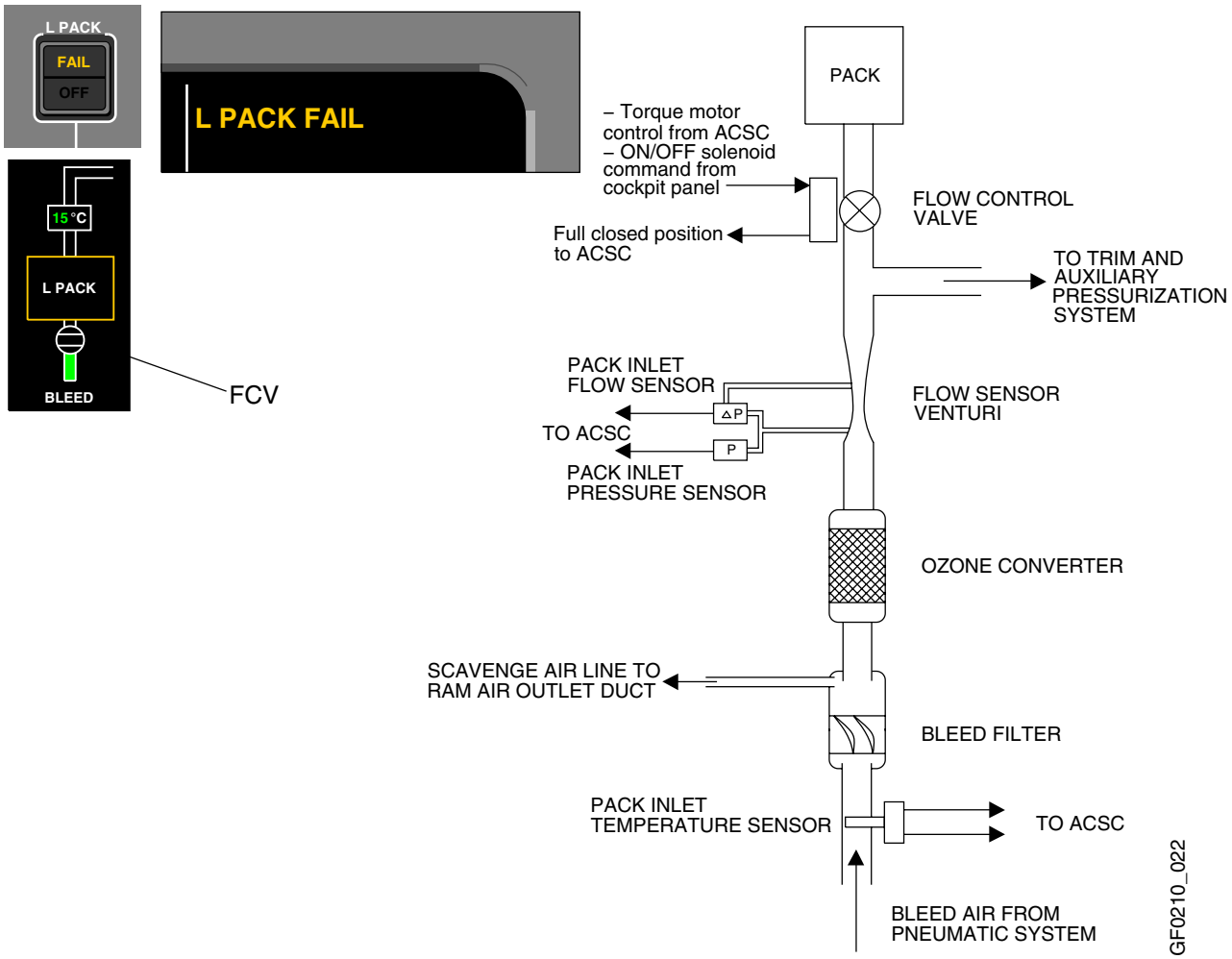
The flow control system regulates airflow from the pneumatic duct to the air conditioning units.

The flow control system interfaces with:

- Bleed Air System – The flow control system takes bleed air from the engine, the APU, or a ground source and provides filtered air into the air conditioning units.
- Air Conditioning System Controllers (ACSC) which measure, calculate and control the airflow.
- Air Conditioning Units (packs) which use the filtered air supply.

A flow control valve (FCV) will modulate to meet a preset flow schedule and is normally controlled by the Air Conditioning System Controller (ACSC).

When an overheat is detected, the ACSC will automatically close the FCV and display the affected caution message on EICAS.



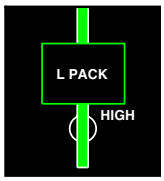
AIR CONDITIONING SYSTEM (CONT'D)

Flow Control System (Cont'd)

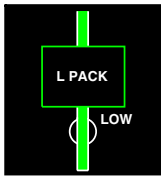
Flow selections are as follows:

NORM:
The flow demand per pack decreases linearly with airplane altitude from 30 lb/min at sea level to 18 lb/min at 51,000 feet.
Flow is limited to a maximum value of 40lb/min per pack. The BMC will prevent two packs being supplied by one engine.
In case of single pack operation, the high flow schedule is automatically selected by the ACSC.

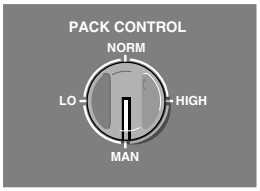
HIGH:
The flow demand per pack decreases linearly with airplane altitude, from 40 lb/min at sea level to 23 lb/min at 51,000 feet (controlled by ACSC).



LO:
The flow demand is half, 20 lb/min, of the high flow demand but is limited to a minimum of 18 lb/min (controlled by the ACSC).



MAN:
The flow control valve is driven to the full open position (ACSC is disabled).



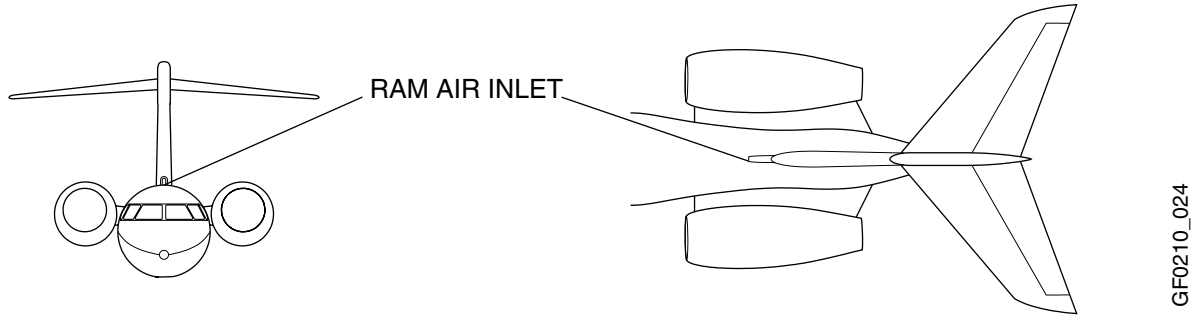
GF0210_023

AIR CONDITIONING SYSTEM (CONT'D)

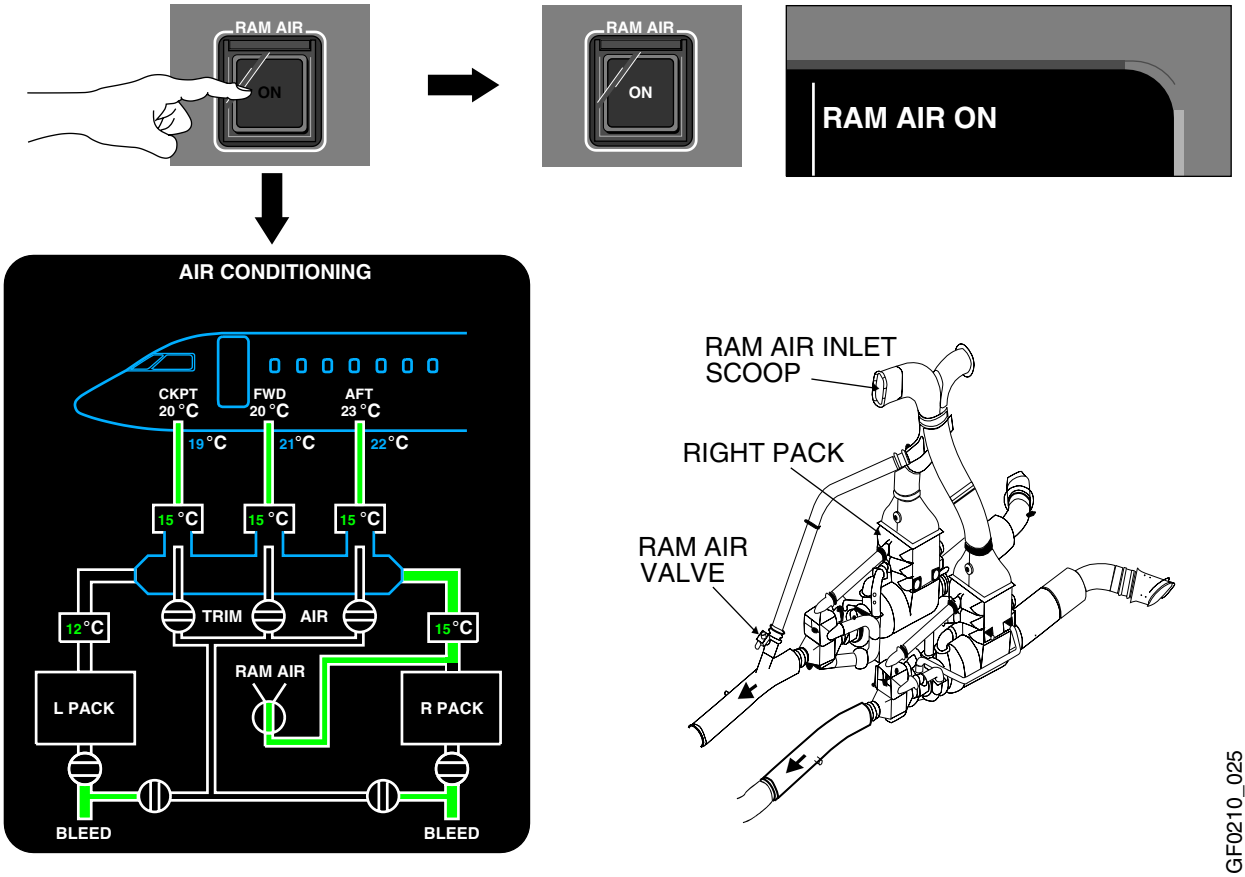
Ram Air Ventilation

An alternate supply of fresh air is available via the ram air system and has been designed for use inflight at an altitude of 15,000 feet or less.

The ram air system is picked up at the ram air inlet at the base of the vertical fin and is used primarily to provide cooling for the heat exchangers of the cooling packs.



The ram air valve is closed in normal operations. It can be switched ON manually by means of a guarded switch on the BLEED/AIR COND panel. The ram air valve is opened for unpressurized flight operations below 15,000 feet.



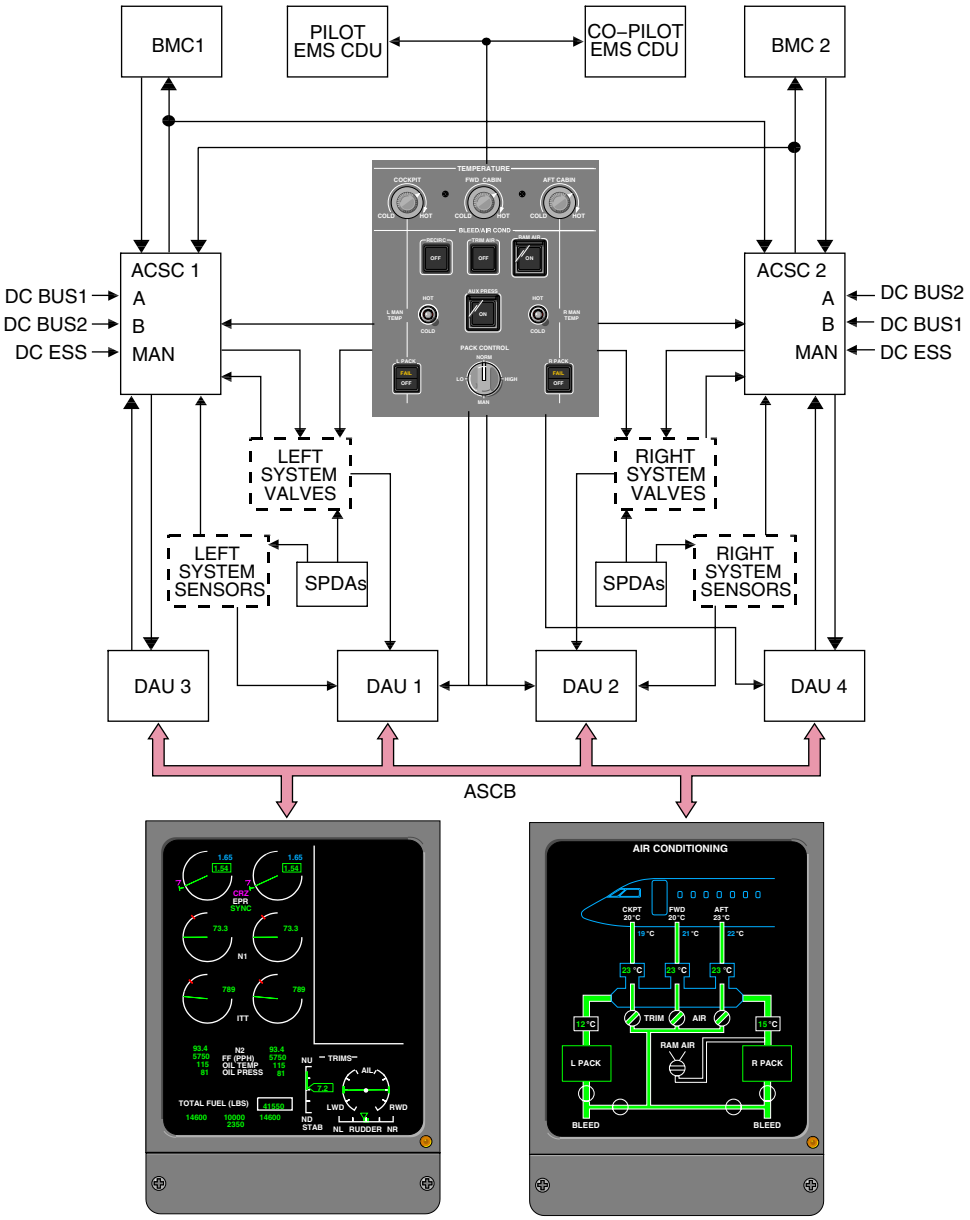
AIR CONDITIONING SYSTEM (CONT'D)

Temperature Control

In normal operation, with the packs in AUTO mode and trim system ON, the pack discharge temperature is automatically controlled by the ACSC.

Each ACSC is divided into two fully redundant channels A and B. During flight, only one channel is active and controls the ECS. The inactive channel also computes the control data but does not command outputs.

ACSC 1 controls the temperature in the cabin (forward and aft trim air valves) and ACSC 2 controls the temperature of the cockpit (cockpit trim air valve).



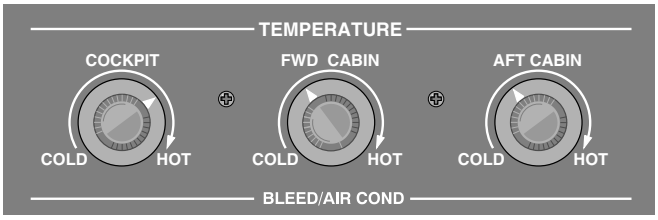
GF0210_026

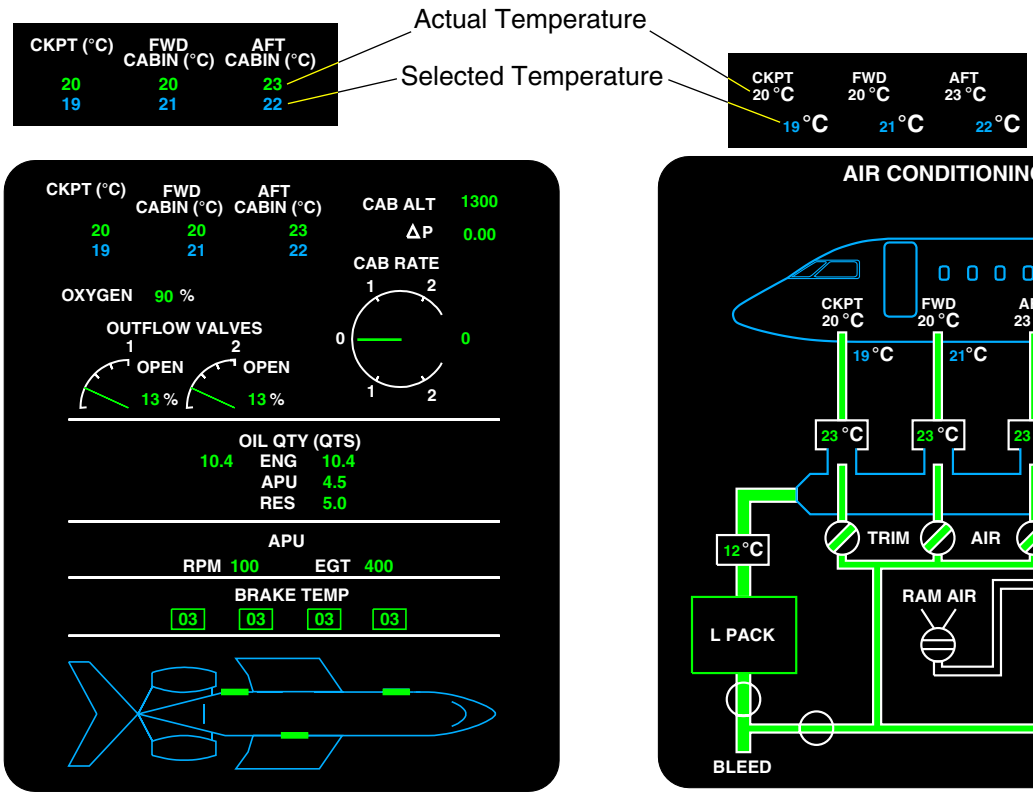
AIR CONDITIONING SYSTEM (CONT'D)

Temperature Control – AUTO

The temperature selectors, when selected COLD will cause the ACSC to modulate the TRIM AIR valves towards closed and when selected HOT will cause the ACSC to modulate the TRIM AIR valves towards open. The affected compartment trim valve will modulate to attain and maintain the selected temperature.

The selected temperature and actual temperature will be displayed on the SYSTEMS page and AIR CONDITIONING synoptic page.

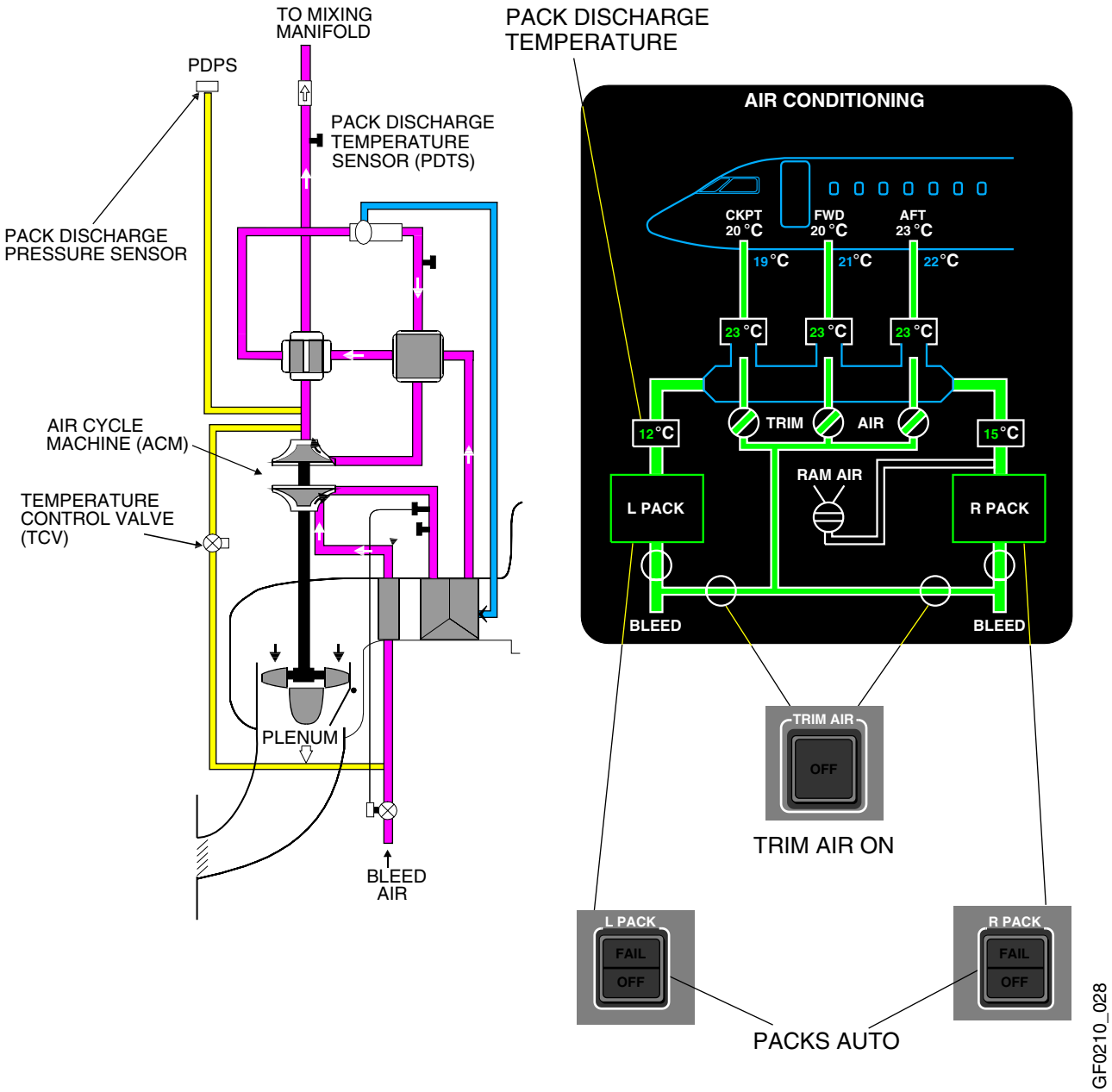




AIR CONDITIONING SYSTEM (CONT'D)

Temperature Control – AUTO (Cont'd)

With the TRIM AIR ON and the air conditioning PACKS in AUTO, the ACSC modulates the Temperature Control Valve (TCV). The TCV bypasses hot air around the pack to mix with the cool air at the Air Cycle Machine (ACM) turbine outlet, to control pack discharge temperature.

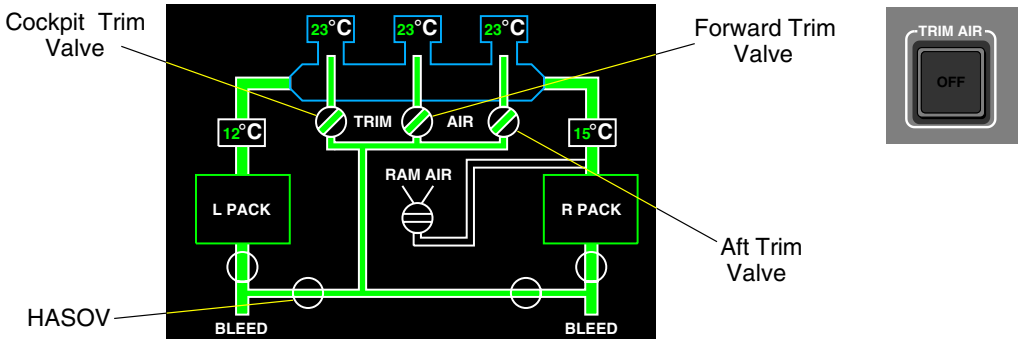


In AUTO mode, the temperature is controlled between a minimum of 3°C to a maximum of 70°C.

AIR CONDITIONING SYSTEM (CONT'D)

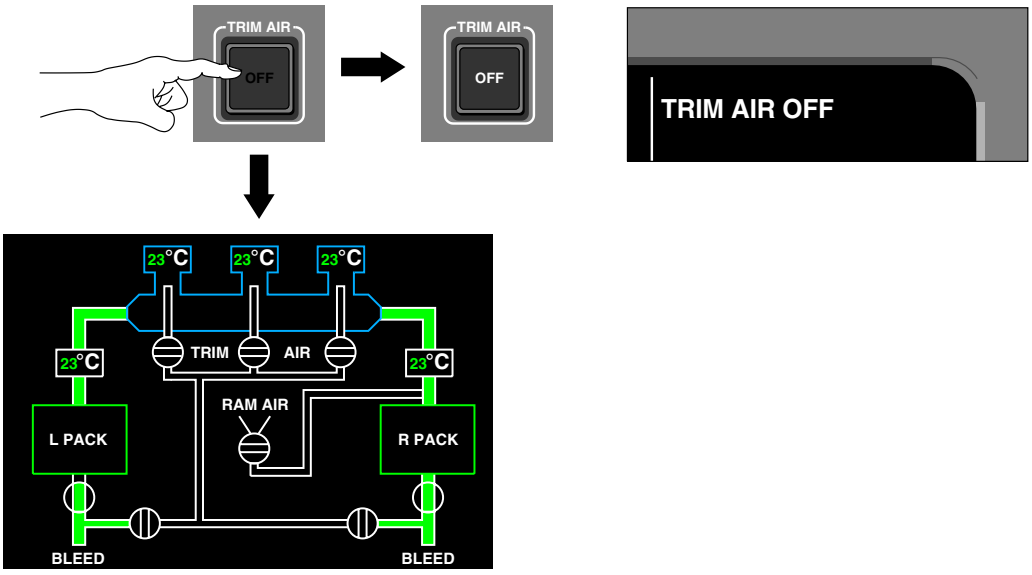
Temperature Control – AUTO (Cont'd)

- The TRIM AIR switch in the ON position, opens the Hot Air Shutoff Valves (HASOV) and the ACSC modulates the cockpit, forward and aft trim valves.



GF0210_029

- The TRIM AIR switch, when selected in the OFF position, closes the Hot Air Shutoff Valves (HASOV) and the ACSC closes the cockpit, forward and aft trim valves.



GF0210_030a

NOTE

In the event of a single ACSC failure (both channels), the trim air valve(s) on the affected side will not be controlled. Select the trim air switch to OFF.

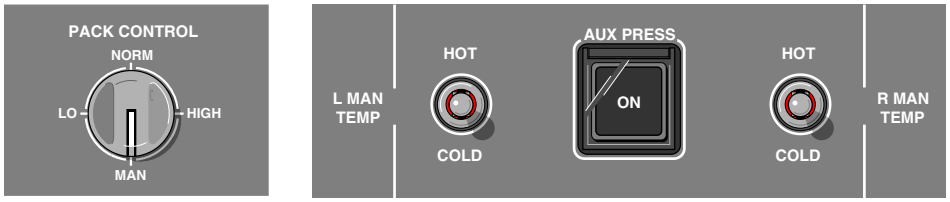
In the event of a dual ACSC failure, operate the packs in MAN.

GF0210_031

AIR CONDITIONING SYSTEM (CONT'D)

Temperature Control – MAN

In the event of loss of all automatic control, the cooling pack can be manually controlled by the crew, by selecting the PACK control selector to MAN. The temperature is controlled by the HOT/COLD toggle switches located on the BLEED/AIR CONDITIONING control panel.



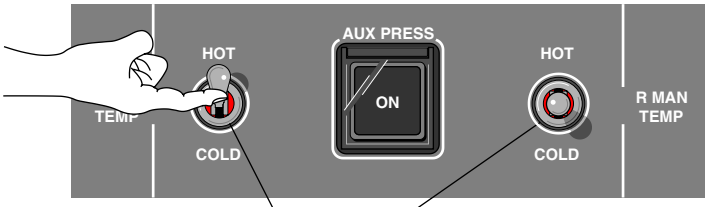
GF0210_032

The TCV opening is controlled by the toggle switches, which control the packs discharge temperature. During manual operation, the crew should monitor the pack discharge temperatures to ensure that the temperatures remain in acceptable limits. A minimum of 5°C to avoid ice build up and a maximum of 60°C for passenger comfort, are recommended.

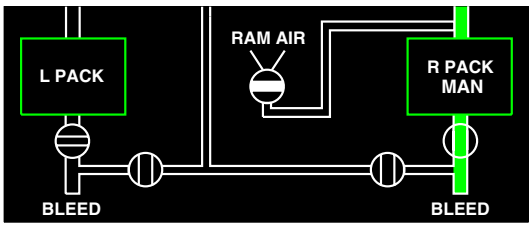
Effectivity:

- *Airplanes 9005 thru 9024 and 9026 thru 9060* ***not incorporating*** *Service Bulletin:*
  - *SB 700–31–009, IAC – Introduction of New Units for Full Functionality Certification.*

The TCV opening is controlled by the toggle switches, which control the packs discharge temperature. During manual operation, the crew should monitor the pack discharge temperatures to ensure that the temperatures remain in acceptable limits. A minimum of 5°C to avoid ice build up and a maximum of 80°C for passenger comfort, are recommended.



HOT/COLD Toggle Switches
Selecting the spring-loaded toggle switch to HOT or COLD will control temperature of PACK discharge through the TCV, when PACK control is selected to MAN.

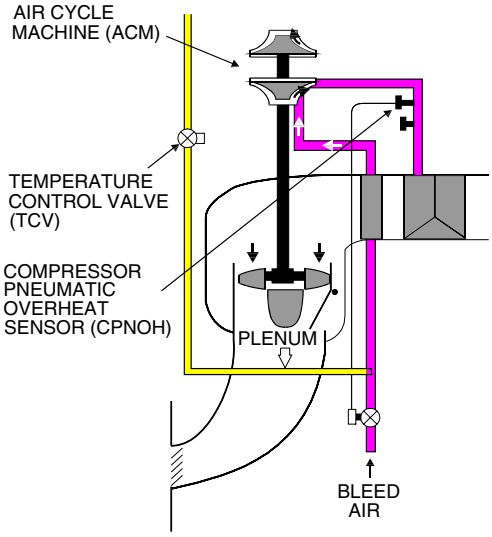


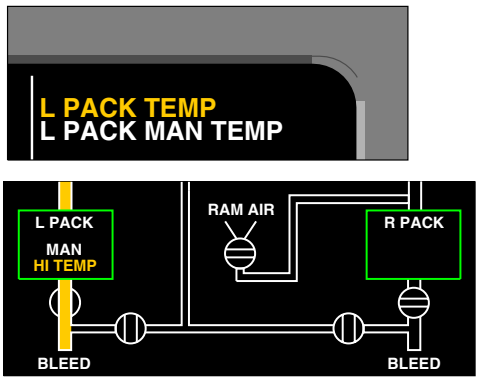
GF0210_033a

AIR CONDITIONING SYSTEM (CONT'D)

Temperature Control – MAN (Cont'd)

In manual mode, compressor overheat protection is carried out by the compressor pneumatic overheat sensor (CPNOH), since the ACSC is not active. In the event of an overtemperature, monitor the pack discharge temperature and use the toggle switch to cool.



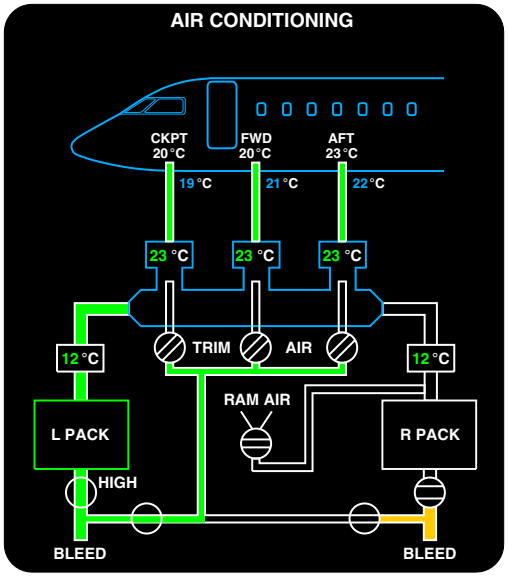


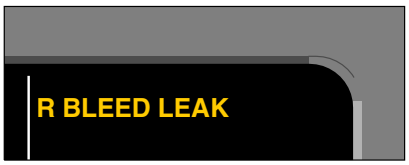
NOTE
To avoid "overshooting" desired temperature, do not toggle for more than two seconds duration.

GF0210_034a

Air Conditioning Bleed Leak Detection

When a leak is detected, a message is displayed on EICAS and the BMC will automatically close the affected FCV, PRV, XBLEED, and the LCV to isolate and stop the leak.

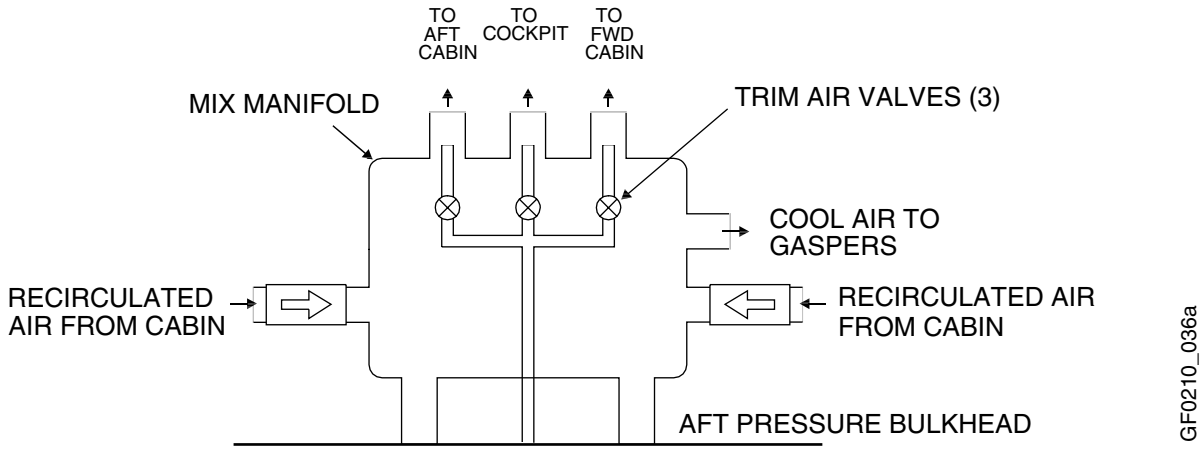




GF0210_035a

AIR DISTRIBUTION AND EXHAUST

Conditioned air is routed from the cooling packs to the mix manifold. The mix manifold also receives recirculated air from the passenger cabin.



Flow Control

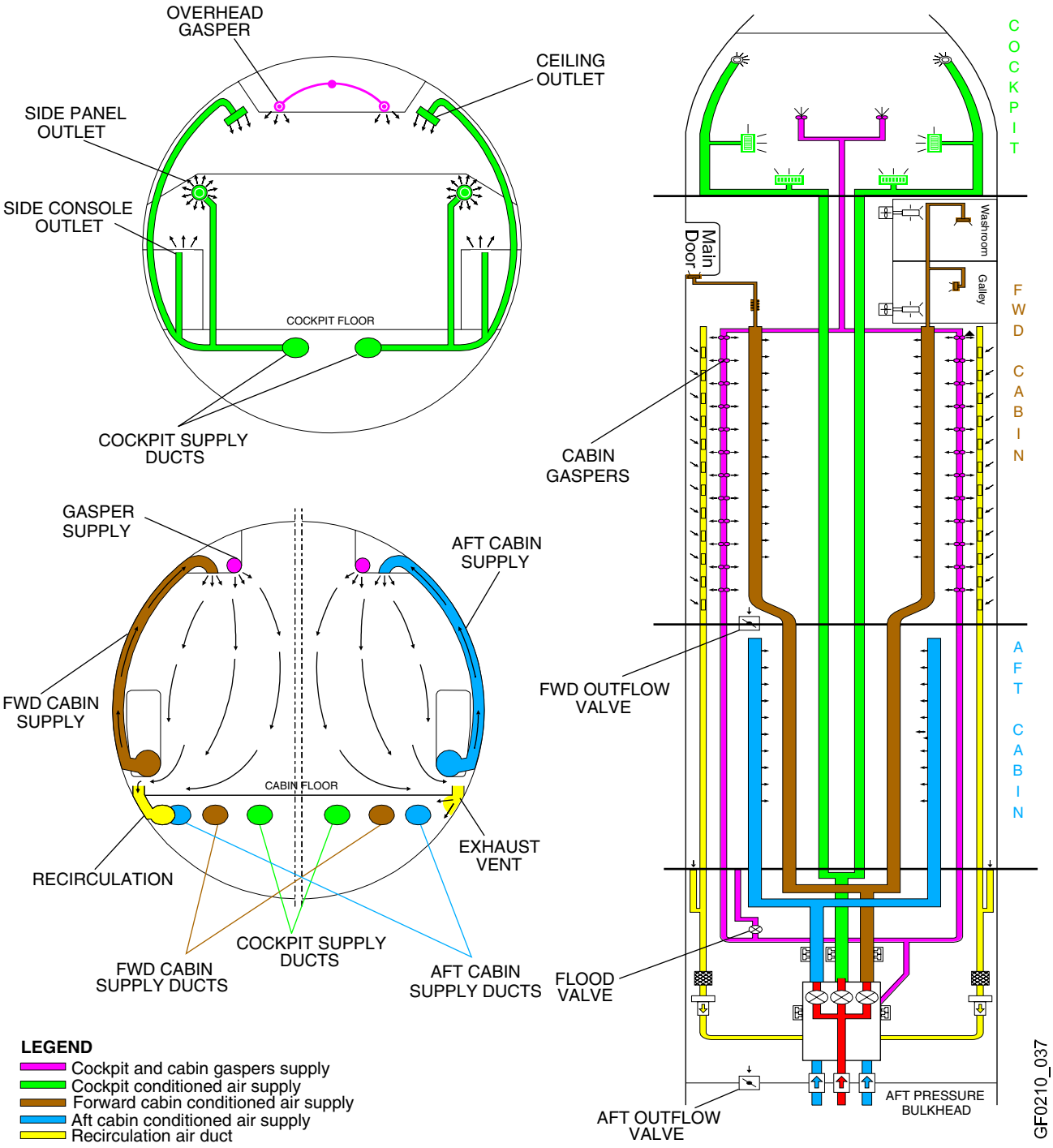
The mix manifold, mounted underfloor, receives fresh air from the packs and passenger cabin via the recirculation system. The quantity of air distributed to the various occupied compartments and the thermal requirement of each compartment are preset values. The split of flows to the three compartments is through suitably sized orifices at the exit ports of the mix manifold.

The distribution of airflow under steady state conditions is as follows:

- Cockpit – 22% of total flow
- FWD Cabin – 39% of total flow
- AFT Cabin – 39% of total flow

AIR DISTRIBUTION AND EXHAUST (CONT'D)

Air Distribution and Flow Paths



Gasper Supply

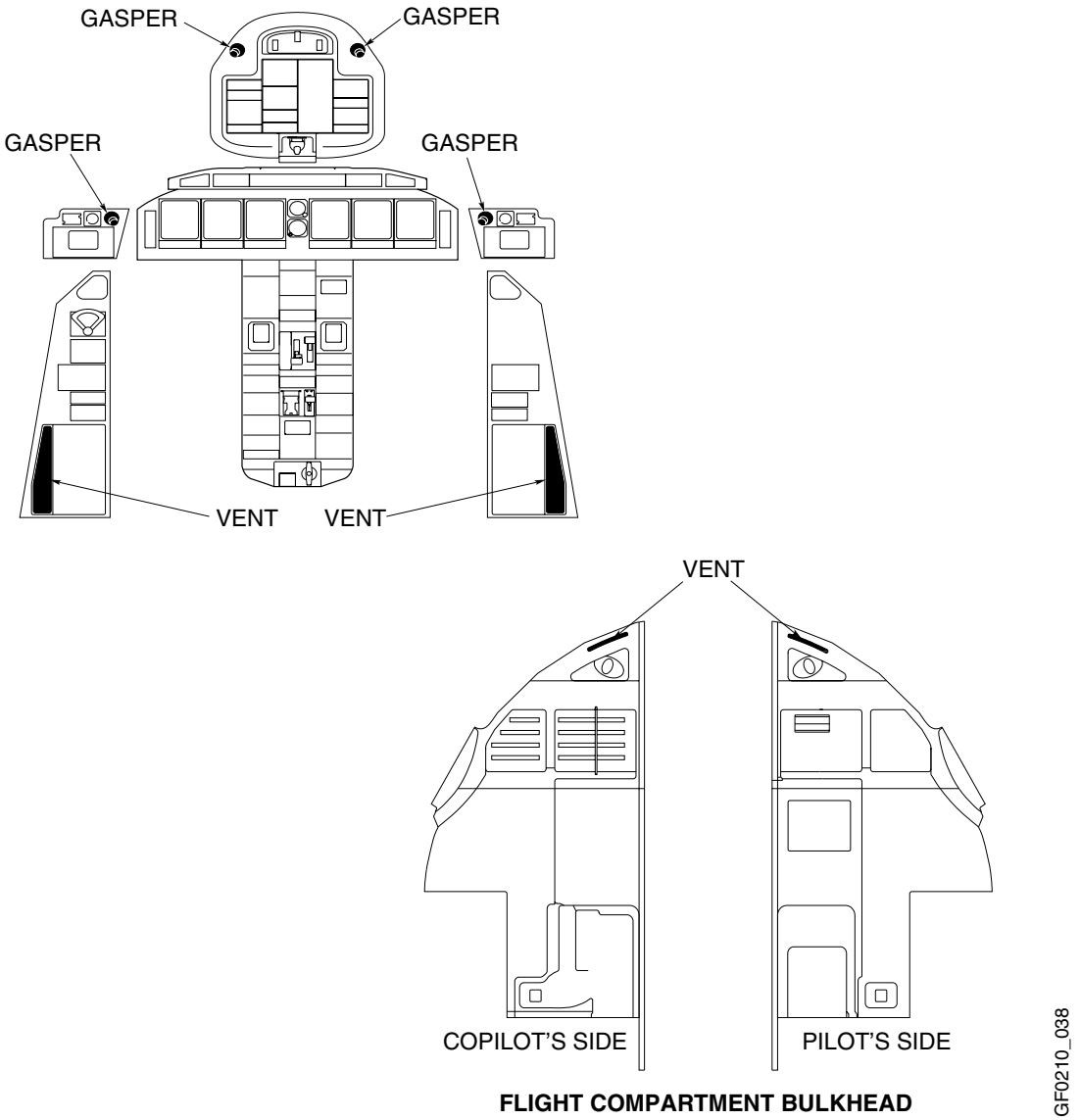
Conditioned air is also distributed via the gasper line. This picks up the air in the cooler area of the mix manifold, and passes through a duct. The duct runs the length of the cabin and into the cockpit, incorporating individual gasper outlets in the cabin and flight deck.

AIR DISTRIBUTION AND EXHAUST (CONT'D)

Cockpit Ventilation

In the cockpit, the following air outlets are provided:

- An upward facing outlet in each side console, not adjustable.
- A forward facing outlet on each side at roof level, above the crew, not adjustable.
- One gasper type on each side of the instrument panel, adjustable for flow and direction.
- One gasper outlet on each side of the overhead panel, adjustable for flow and direction.

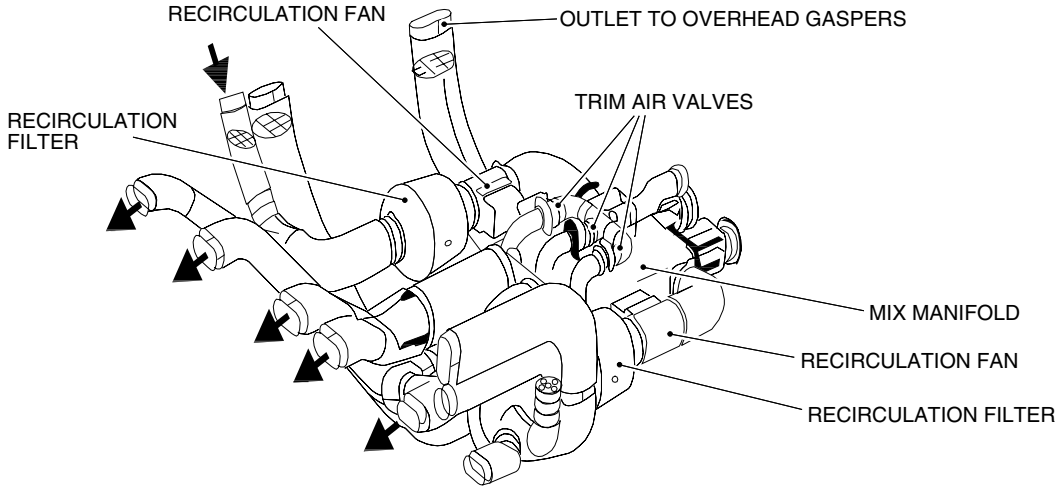


FLIGHT COMPARTMENT BULKHEAD

AIR DISTRIBUTION AND EXHAUST (CONT'D)

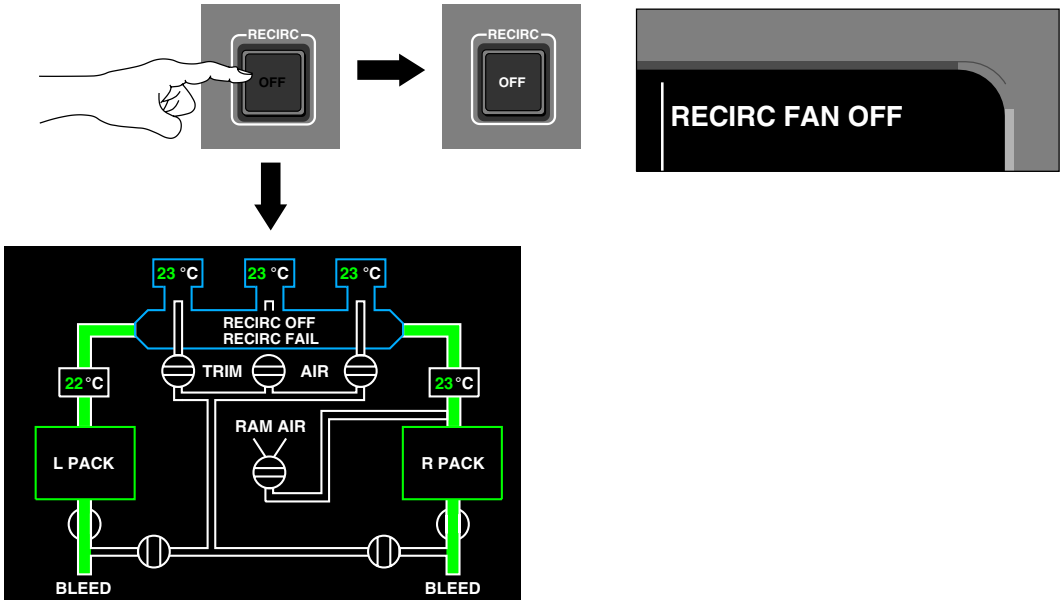
Recirculation

Two recirculation fans pull air from the cabin back to the mix manifold. The air is extracted from each side of forward and aft cabins through holes in the cabin side sills and is ducted under the floor to the recirculation filters. From the filters, the air enters the recirculation fans and is blown into the mix manifold to be mixed with incoming air from the packs.



The ACSC controls the fan speed. In normal operation, fan speed is at minimum but can be increased when the mix manifold temperature is too low or too high. In manual mode, no speed command is sent by the ACSC, but the fan will run at minimum speed.

Each fan converter unit can detect internal failures (overheat, overcurrent). If a failure is detected, the converter unit will shut off fan power and reset the fan. The converter will attempt to restart the fan (up to three starts), then if failure is still detected, it will shut off the fan and a message is posted on EICAS. The crew can turn off the RECIRC FAN located on the BLEED/AIR CONDITIONING control panel.



AIR DISTRIBUTION AND EXHAUST (CONT'D)

Avionics and Cockpit Display Ventilation

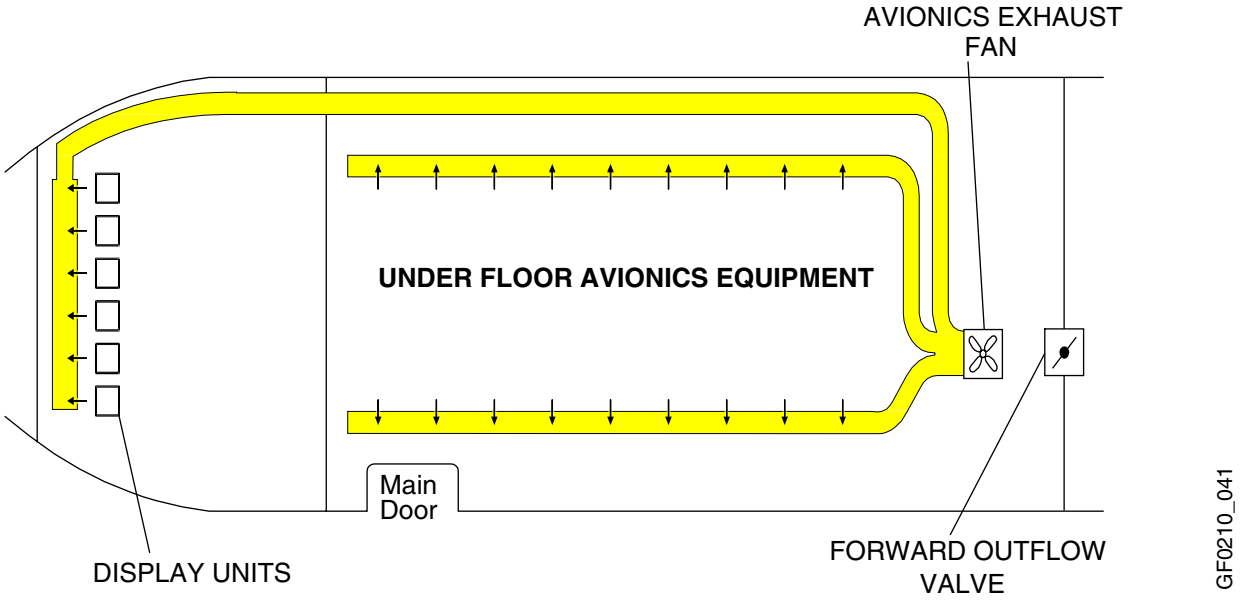
The Avionics and Cockpit Display Exhaust system ensures the ventilation of the avionic equipment and cockpit displays to prevent excessive heating. Air exhausts through the underfloor and by recirculation.

The main items ventilated are:

- All cockpit display units, by extracting air from immediately behind them.
- All electronic boxes in avionics bay, by extracting air from above them.

The cockpit displays are each ventilated internally by two integral fans, which pick up ambient air at their forward lower edge and dump the hot exhaust air from exits on the higher part of their back panel. This hot exhaust air enters the space behind the cockpit displays and is ventilated by the avionics ventilation fan.

Both avionics bay and cockpit displays ventilation is accomplished by a single Avionics fan. The fan is mounted at the rear of the avionics bay and is oriented to direct its exhaust directly through ducts towards the forward outflow valve.



The avionics fan can run at two speeds, high or low and is controlled by ACSC 2.

- The fan is driven at high speed when cockpit ventilated temperature is above 0°C and (both packs are OFF or the main door is not closed and locked).
- The fan is driven at low speed otherwise.

In the case of a failure, the avionics fan is automatically powered OFF by its converter.

AIR DISTRIBUTION AND EXHAUST (CONT'D)

Avionics and Cockpit Display Ventilation (Cont'd)

The converter tries to restart the fan by automatic reset (up to three times), then if failure is still detected, it will shut off the fan and post a message on EICAS.

NOTE
Check limits on ground operations with failed Avionics fan and ECS OFF.
Maximum operating time of 30 minutes at 35 °C.

GF0210_042

In case of a fan underspeed failure detected by the converter, a fault signal is provided to CAIMS, but the fan remains running.

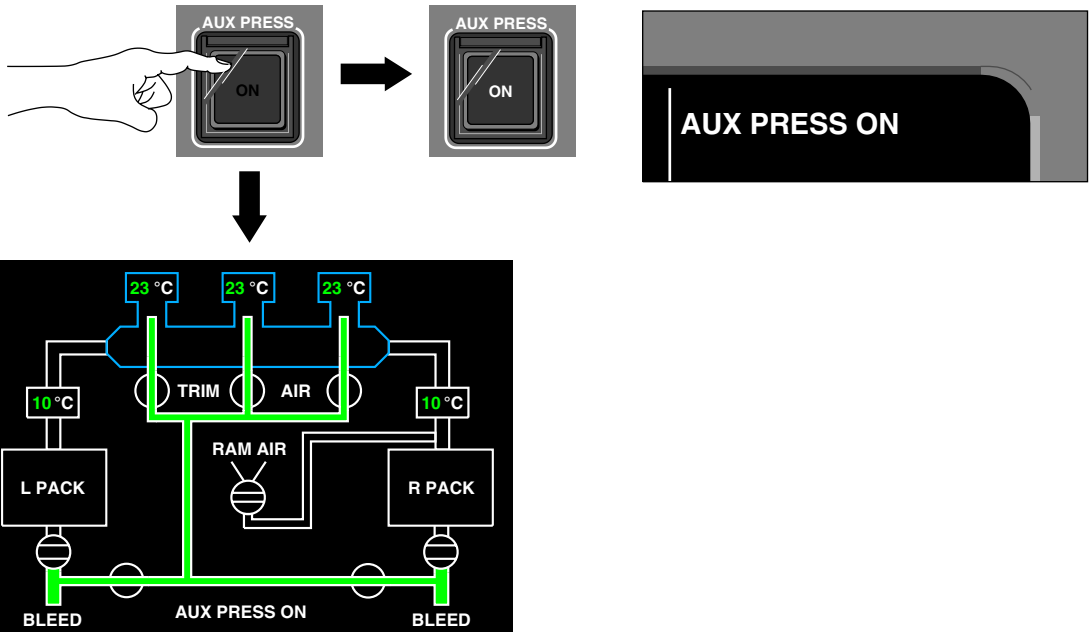
Auxiliary Pressurization

The auxiliary pressurization system provides an alternative pressurization source for the cabin, in the event of loss of both cooling packs.

The AUX PRESS switch, when selected ON, sends a signal to each ACSC. The ACSC commands the HASOVs to mid position and the trim valves to full open, for use of trim air, for pressurization.

The recirculation system should be selected ON, to reduce the supply temperatures in the distribution ducts. Duct overheat detection is carried out by the ACSCs.

An EICAS message is displayed when AUX PRESS switch is selected.



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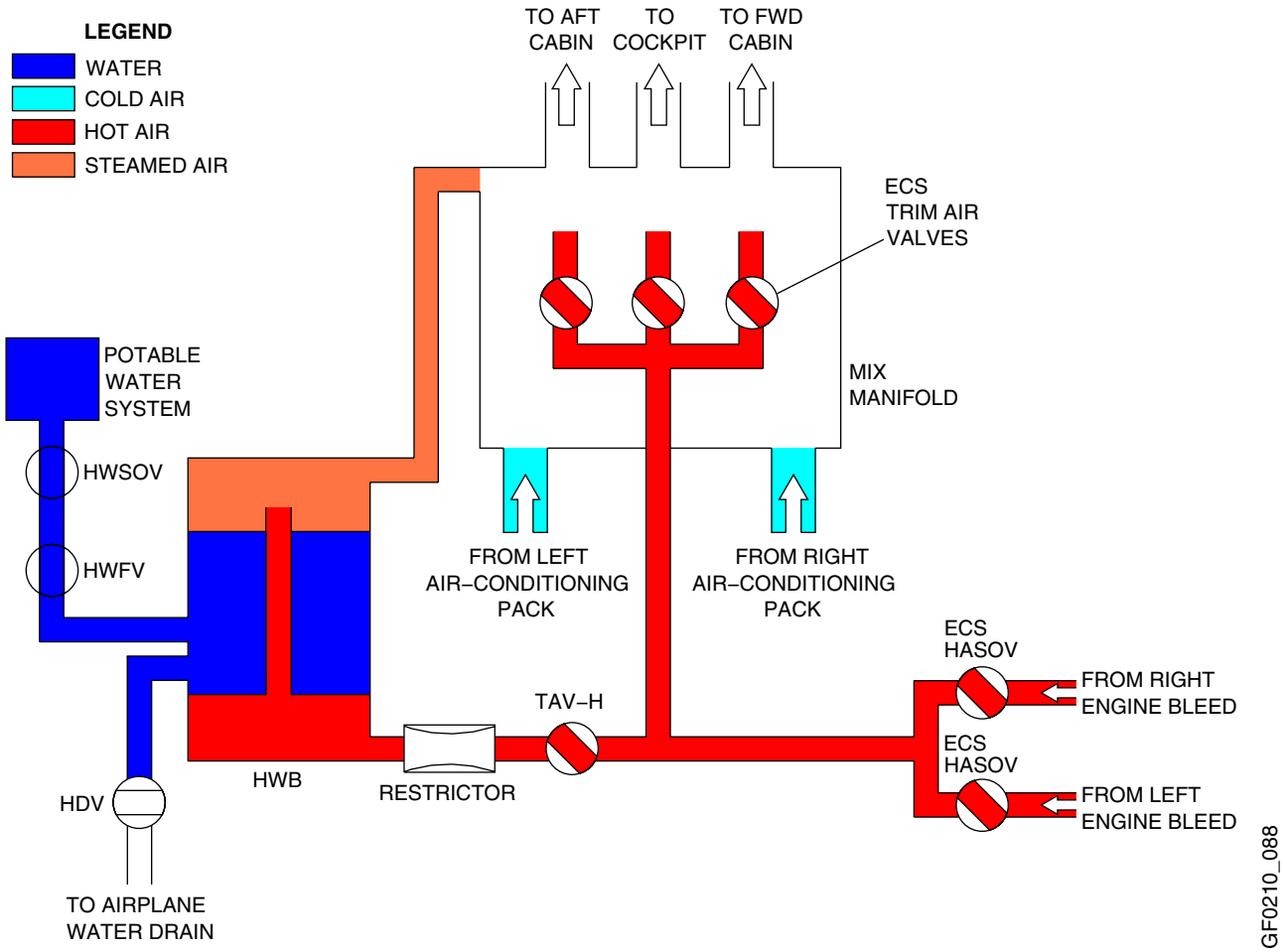
AIR DISTRIBUTION AND EXHAUST (CONT'D)

Humidifier System (Option)

The humidifier system provides additional humidity to the aircraft cabin compartments during high altitude cruise. The humidity is provided directly to the Environment Control System (ECS) mix manifold and then supplied to the cabin compartments via the ECS distribution ducting. The humidifier system is comprised of the following main components:

- Humidifier water boiler assembly (HWB);
- humidifier trim air valve (TAV-H);
- humidifier water shutoff valve (HWSOV);
- humidifier water feed valve (HWFV);
- humidifier drain valve (HDV);
- humidifier cabin humidity sensor (HCHS); and
- humidifier control unit (HCU).



AIR DISTRIBUTION AND EXHAUST (CONT'D)

Humidifier System (Option) (Cont'd)

Water is taken form the potable water system and routed to the boiler via 2 normally closed valves. When the system is activated, the Humidifier Control Unit (HCU) will open both valves to replenish the boiler. Trim air is used to heat the boiler. The generated steam is then supplied to the ECS mix manifold. A humidity sensor (HCHS) is installed in the aft cabin to monitor the temperature and moisture level. The reading from the sensor is feed to the HCU to determine the amount of steam needed to bring the humidity level within the acceptable range. The amount of steam generated by the boiler is controlled by the humidifier Trim Air Valve (TAV-H). The TAV-H modulates the air flow that reaches the boiler thus affecting the amount of steam generated. A restrictor is added to limit the maximum amount of trim air supplied to the boiler.

The system is activated through the EMS CDU SWITCH CONTROL page.

Effectivity:

- *Airplanes 9002 thru 9122* ***not incorporating*** *Service Bulletin:*
  - *SB 700–24–045, AC and DC Power Distribution – Unit Change and Activation of Build 4 Electrical System.*

Power is routed to the HCU via the EMS CDU SWITCH CONTROL page. The system is activated with a toggle switch located on the co-pilot bulkhead.

The humidifier will operate when all of the following condition are met:

- the aircraft altitude is greater than 31,000 feet;
- one of the ECS hot air SOV (HASOV) is open;
- the AUXILIARY PRESS is OFF;
- water tank is not empty;
- the cabin dew point is below 0°C.

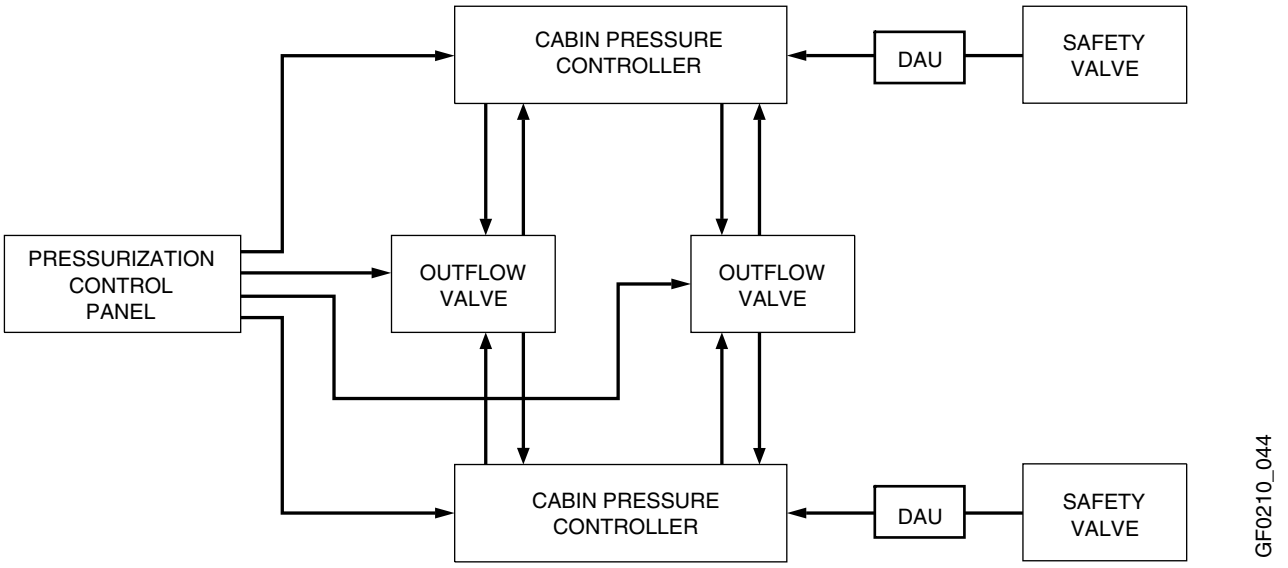
The humidifier will turn OFF for any of the following conditions:

- communication between the ASCS and HCU is inoperative;
- the aircraft altitude is less than 29,000 feet;
- both ECS HASOV are closed;
- the AUXILIARY PRESS is ON;
- water tank is empty;
- the cabin dew point is above 0°C.

In order to avoid icing in the components during ground cold soak or bacteria proliferation during storage in warm weather, the system is drained after each flight. When the aircraft altitude falls below 20,000 ft, the HCU will close both the HWSOV and the HWFV, and open the Humidifier Drain Valve (HDV).

PRESSURIZATION

The Cabin Pressure Control System (CPCS), is an electrical system, except for pressure relief function, which is composed of two cabin pressure controllers, two electrical Outflow Valves (OFV), two safety valves (SFV) and an electrical control panel.



Each controller contains two automatic channels and a manual channel. The two automatic channels are fully redundant. The manual channel is almost fully redundant, except for cabin altitude limitation, where the signal output from each manual channel affects only one OFV.

The CPCS includes three independent control channels:

- Two identical, independent and AUTO channels are available from the two digital CPCs. Either CPC drives both electrical OFVs in turn.
- One MANUAL control channel performs the control of both OFVs. The control is done by moving a toggle switch located on the Cabin Pressurization Control Panel, to raise or lower the cabin altitude.

The cabin is controlled to an altitude of no more than 5,670 feet at 51,000 feet airplane altitude and no more than 4,500 feet when flying at 45,000 feet.

Effectivity:

- *Airplanes 9002 thru 9158* ***not incorporating*** *Service Bulletin:*
  - *SB 700–21–034, Modification – Pressurization Control – Cabin Altitude Reduction During Flight for Improved Passenger Comfort.*

The cabin is controlled to an altitude of no more than 7,230 feet at 51,000 feet airplane altitude and no more than 6,000 feet when flying at 45,000 feet.

The CPCS allows for two cabin rate selections in automatic control:

- NORMAL – Provides 300 fpm cabin descent and 500 fpm climb rate limit.
- HIGH – Provides a variable rate limit, up to 800 fpm, depending on airplane vertical speed.

The system includes safety devices, which override AUTO and MANUAL mode for OFV travel limitation, cabin limitation and differential pressure limits.

PRESSURIZATION (CONT'D)

In both AUTO and MANUAL modes, the CPCS provides indication of cabin pressure parameters on the STATUS page and any failures are displayed on EICAS.

The CPCS provides means to rapidly depressurize the cabin, through an EMER DEPRESS switch on the pressurization Control Panel. Additionally, a DITCHING switch performs the shutdown of both packs and depressurizes the cabin, prior to closing both OFVs.

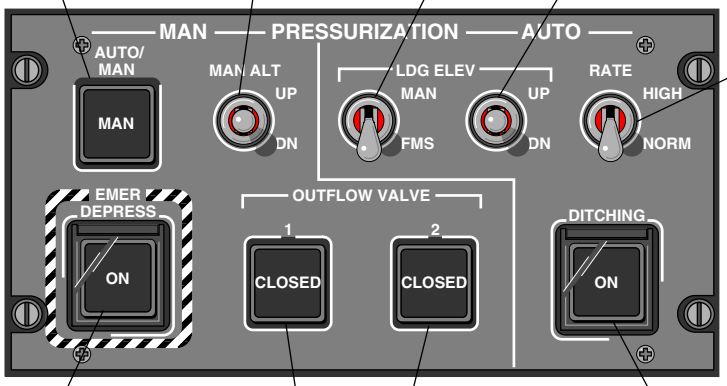
Controls are provided on the Pressurization Control Panel, located on the overhead panel.

MAN ALT Toggle switch
Used to control cabin altitude in manual mode.
UP – Commands cabin to climb.
DN – Commands cabin to descend.
Mid – Spring–loaded to mid position keeps outflow valve to last commanded position.

LDG ELEV Toggle switch
Used to select the mode of operation for landing elevation.
• MAN – Manual selection of the landing field elevation.
• FMS – FMS selects landing field elevation.

AUTO/MAN switch
Used to select mode of operation.
MAN –Indicates MAN mode is selected.

UP/DN Toggle switch
Used to manually set landing field altitude, up or down (feet).



RATE switch
Used to select cabin climb rate of change.
• HIGH – Up to 800 ft/min climb and up to 800 ft/min descent.
• NORM – 500 ft/min climb and 300 ft/min descent.

NOTE
During high elevation airfield operation the cabin rate is controlled independent of switch position. See Rate Limit Selection for detail rate, pre and post SB 700–21–034.

EMER DEPRESS switch
Used to select emergency depressurization of airplane.
– Indicates EMER DEPRESS selected.

DITCHING switch
Used to:
Depressurize cabin.
Shut-off packs.
Close outflow valves.
– Indicates DITCHING selected.

OUTFLOW VLV switch
Used to select outflow valve(s) closed.
– Indicates valve is closed.

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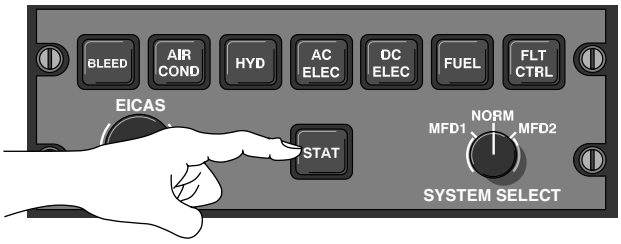
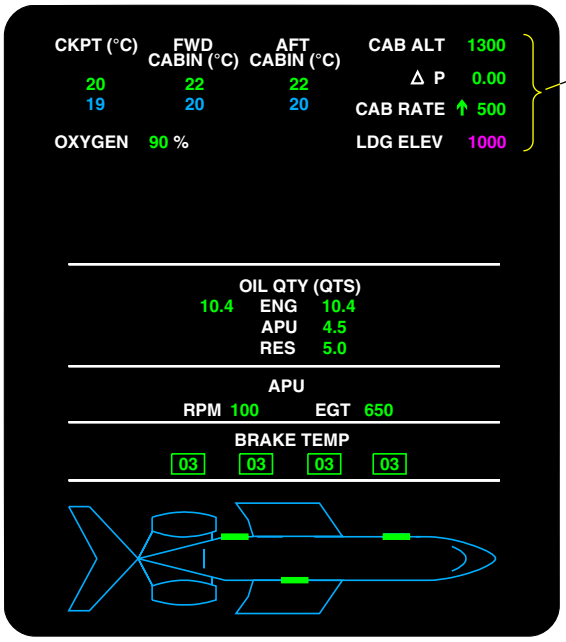
PRESSURIZATION (CONT'D)

To view pressurization data, select STAT on EICAS Control Panel, located on the pedestal.

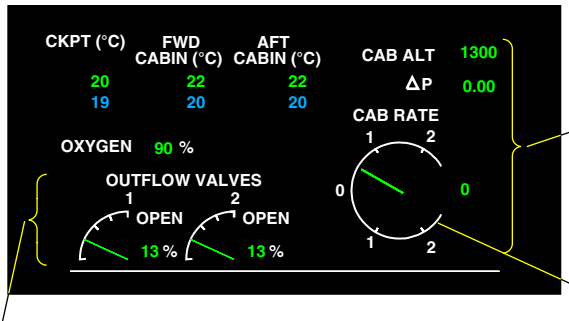


EICAS Control Panel



AUTO Mode Data Display

CAB ALT – Displayed in feet (pressure altitude).
ΔP – Displayed in psid.
CAB RATE – Displayed in feet/min.
LDG ELEV – Displayed in feet (MSL).



MAN Mode Data Display

CAB ALT – Displayed in feet.
ΔP – Displayed in psid.
CAB RATE – Sweep range displayed in ft/min.
LDG ELEV – Not displayed.

CAB RATE Indicator
Displayed when MAN selected.

OUTFLOW VALVES Position Indicators
Displayed when MAN selected and measured in percent. Also displayed when EMER DEPRESS selected, or OUTFLOW VLV closed, or DITCHING selected.

FGF0210_016

MODES OF OPERATION

Pressurization operating modes are as follows:

Automatic Mode

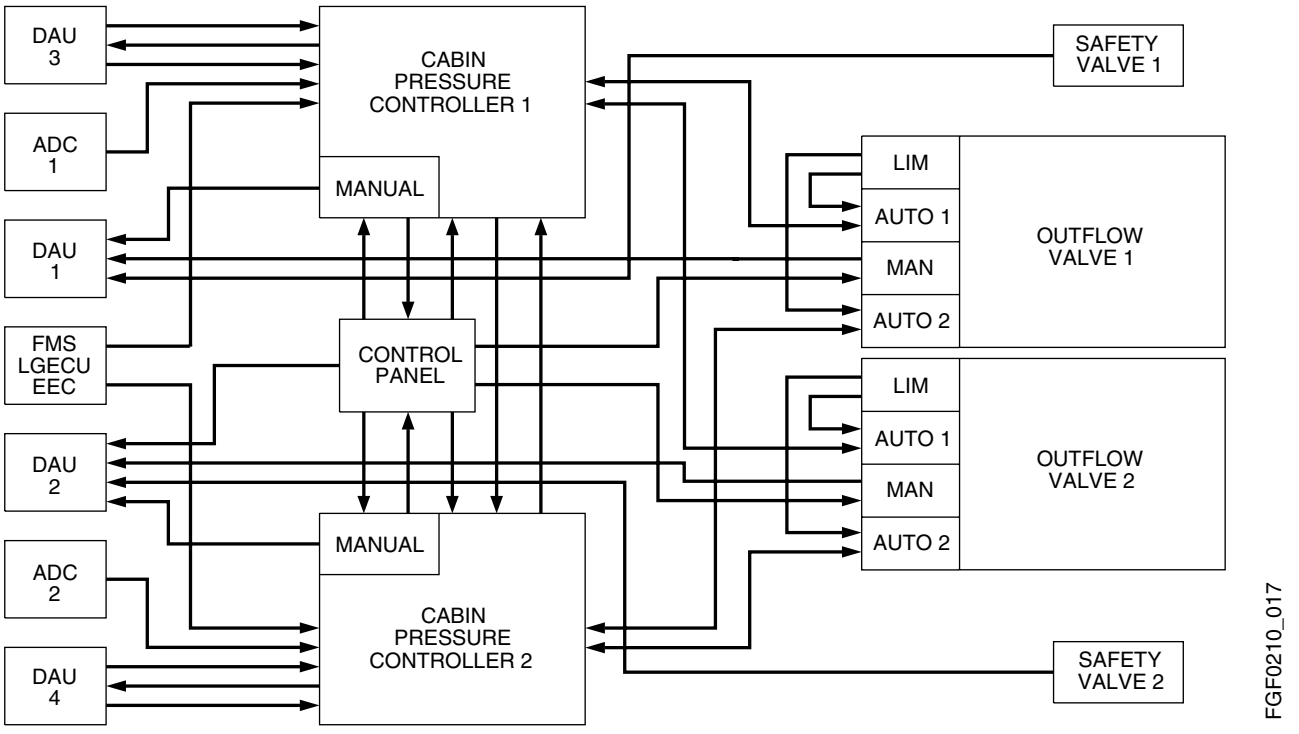
Two identical and independent “AUTO” control channels (one in each CPC), are available from two CPCs.

The automatic controller performs the following functions:

- Automatic control of cabin altitude, rate regulation and rate limitation.
- Ditching sequence.
- Door open protection.
- Generating outputs for EICAS display and messages.
- CAIMS function and interface.

AUTO mode is dependent upon the following information:

- Airplane altitude, vertical speed and barometric correction received from ADCs and DAUs or scheduled flight information from FMS when available.
- Landing elevation from FMS when available, or directly selected from the switch on the cabin pressure control panel.
- Rate limit selection from cabin pressure control panel.
- Weight on wheels and door open position from Landing Gear Electronic Control Unit (LGECU).
- Engine throttle position from Electronic Engine Controllers (EEC).

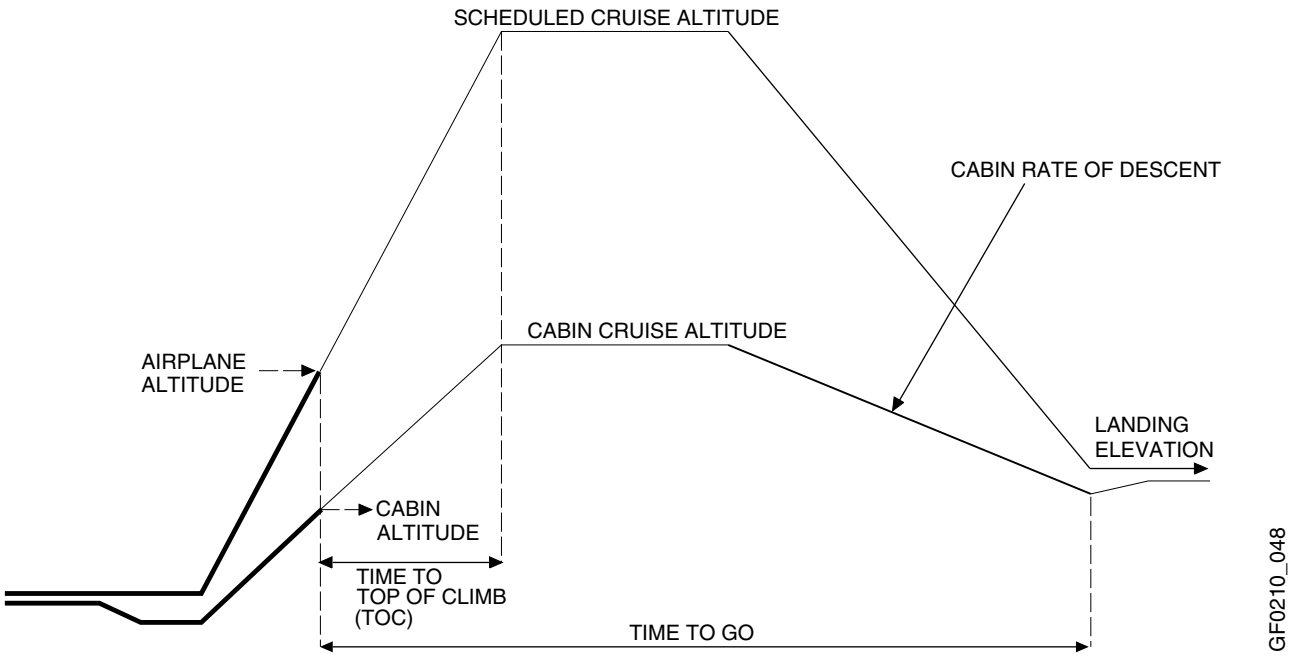


There are two modes of operation while the CPCS is controlled in AUTO, the PRIMARY and the SECONDARY mode.

MODES OF OPERATION (CONT'D)

Automatic Mode (Cont'd)

The PRIMARY mode uses information from the FMS to minimize cabin altitude pressure rate and maximize cabin comfort. In primary mode the CPC uses time to go, time to top of climb, cruise flight level and landing information from the FMS to compute the cabin pressurization schedule for the flight. The CPCS operates in primary mode when FMS information has been programmed and the landing elevation source is selected on FMS. In all other cases, the system defaults to secondary mode.



In SECONDARY mode the CPC uses the airplane pressure altitude and vertical speed to compute the pressurization schedule for the flight. The secondary mode requests the landing elevation to be selected on the cabin pressurization control panel if it has not been entered. The system will also enter the secondary mode if the LAND ELEV selector was changed to the MAN position.

In either AUTO mode, the CPC controls the cabin pressure through the opening of both electrical outflow valves.

Only one AUTO system is in operation while the other AUTO system is in active standby. Transfer from one AUTO system to the other automatically occurs each day (CPC 1 on odd days, CPC 2 on even days). With FMS information available to the CPC, cabin altitude and cabin altitude rate control are automatic, during ground and flight sequences.

In case of a failure of the active system, manual transfer from one CPC to the other can be accomplished by sequencing the AUTO/MAN switch located on the Pressurization control panel, from AUTO to MAN then back to AUTO.

Transferring to alternate AUTO control when operating around high elevation airfield (with landing elevation ≥5,670 feet) may cause cabin pressure drifting to max cruise cabin altitude (i.e. 5,670 feet) before returning to normal cabin pressure schedule. This drift is caused by mismatch of CPC operating sequence between AUTO control due to sensor tolerance.

MODES OF OPERATION (CONT'D)

Automatic Mode (Cont'd)

Effectivity:

- *Airplanes 9002 thru 9158* ***not incorporating*** *Service Bulletin:*
  - *SB 700–21–034, Modification – Pressurization Control – Cabin Altitude Reduction During Flight for Improved Passenger Comfort.*

Transferring to alternate AUTO control when operating around high elevation airfield (with landing elevation ≥7,230 feet) may cause cabin pressure drifting to max cruise cabin altitude (i.e. 7,230 feet) before returning to normal cabin pressure schedule. This drift is caused by mismatch of CPC operating sequence between AUTO control due to sensor tolerance.

In case of unannounced system malfunction, operate system with manual control.

Automatic Pre-Pressurization Sequence On Ground

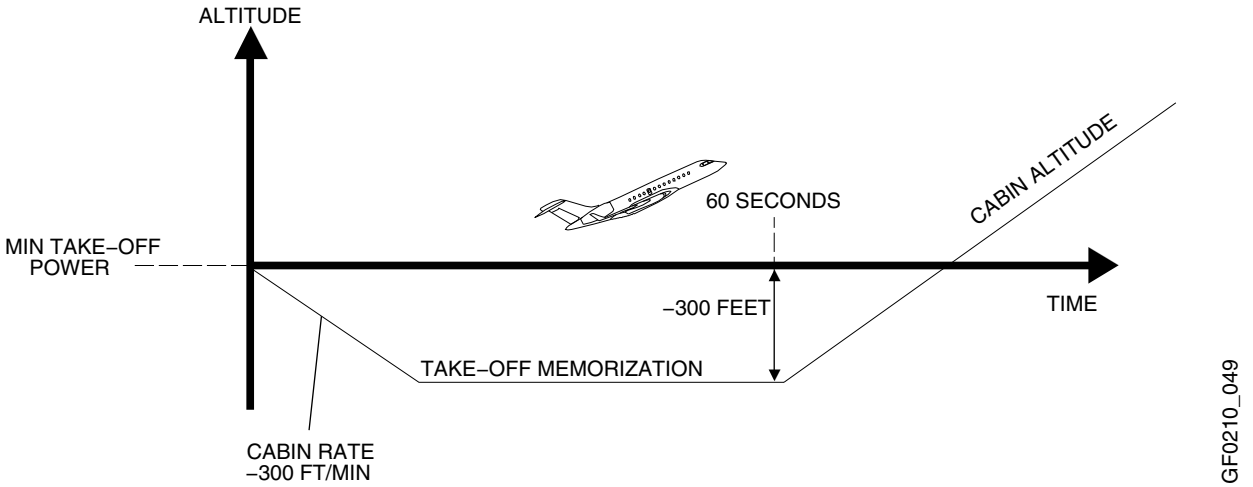
The purpose of automatic pre-pressurization is to avoid cabin "bump" at take-off.

When the LGECU indicates an airplane weight on wheels condition and both thrust lever angles are higher than 20°, the pre-pressurization sequence is initiated.

During this sequence:

- The scheduled cabin pressure is equal to the last measured cabin value (take-off memorization), before the engine FADEC gives the "take-off power" position.
- The reference cabin pressure moves by computation towards the scheduled cabin pressure with a pressure rate limit change equal to –300 ft/min.

In case of take-off with air conditioning packs operating, cabin pressurization is controlled with a pressure rate equal to –300 ft/min limited to a cabin pressure altitude of 300 S. L. feet below airfield.



In case of take-off without packs, this sequence will close both outflow valves.

MODES OF OPERATION (CONT'D)

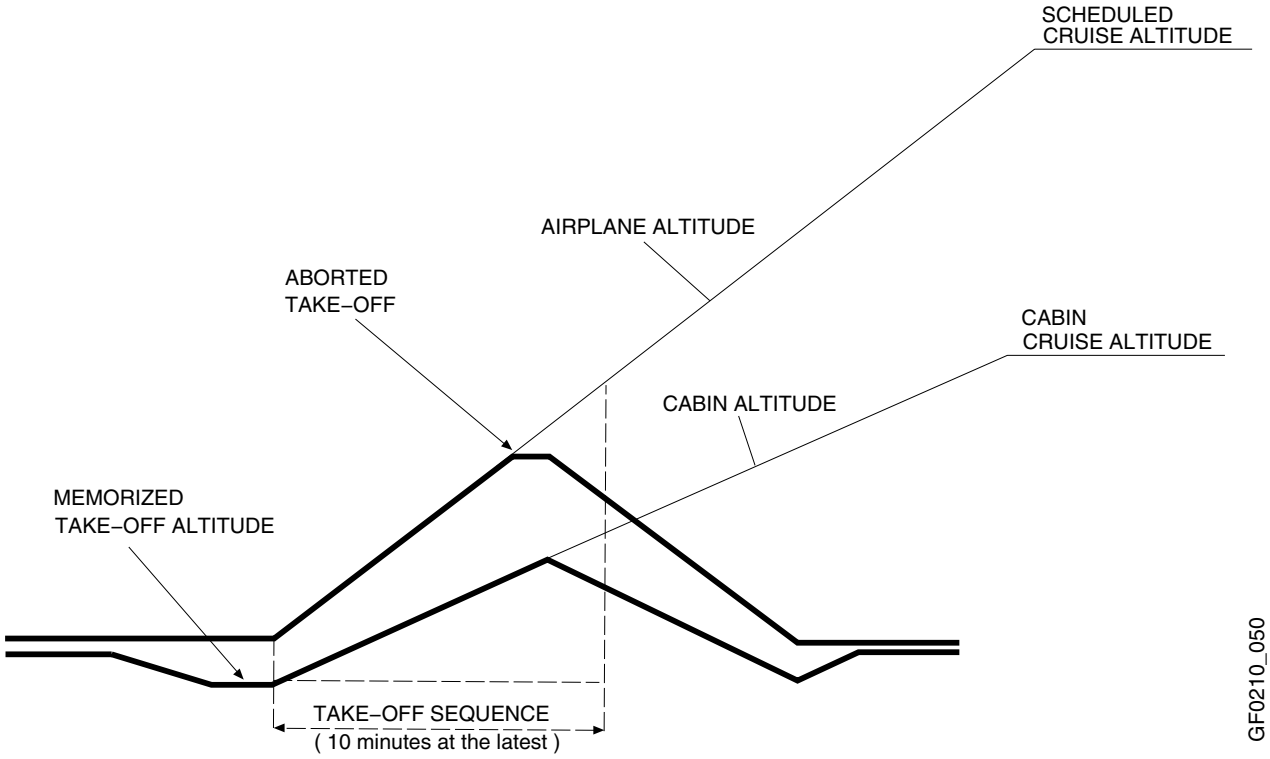
Take-Off Sequence

The purpose of this sequence is to avoid the requirement to manually re-select the landing altitude in case of an aborted flight and emergency return to the departure airport.

When the LGECU indicates the airplane is no longer Weight on Wheels, the automatic take-off sequence is initiated.

During this sequence, in primary mode:

- When the airplane vertical speed is ≥–500 ft/min, the scheduled cabin pressure is equal to the lowest value between theoretical pressure and destination landing pressure.
- When the airplane vertical speed is <–500 ft/min (aborted take-off), the sequence switches over to secondary mode (without FMS) and the cabin pressure is controlled with nominal rate change (500 ft/min to –300 ft/min sea level) towards the scheduled cabin pressure value of the pre-pressurization sequence.

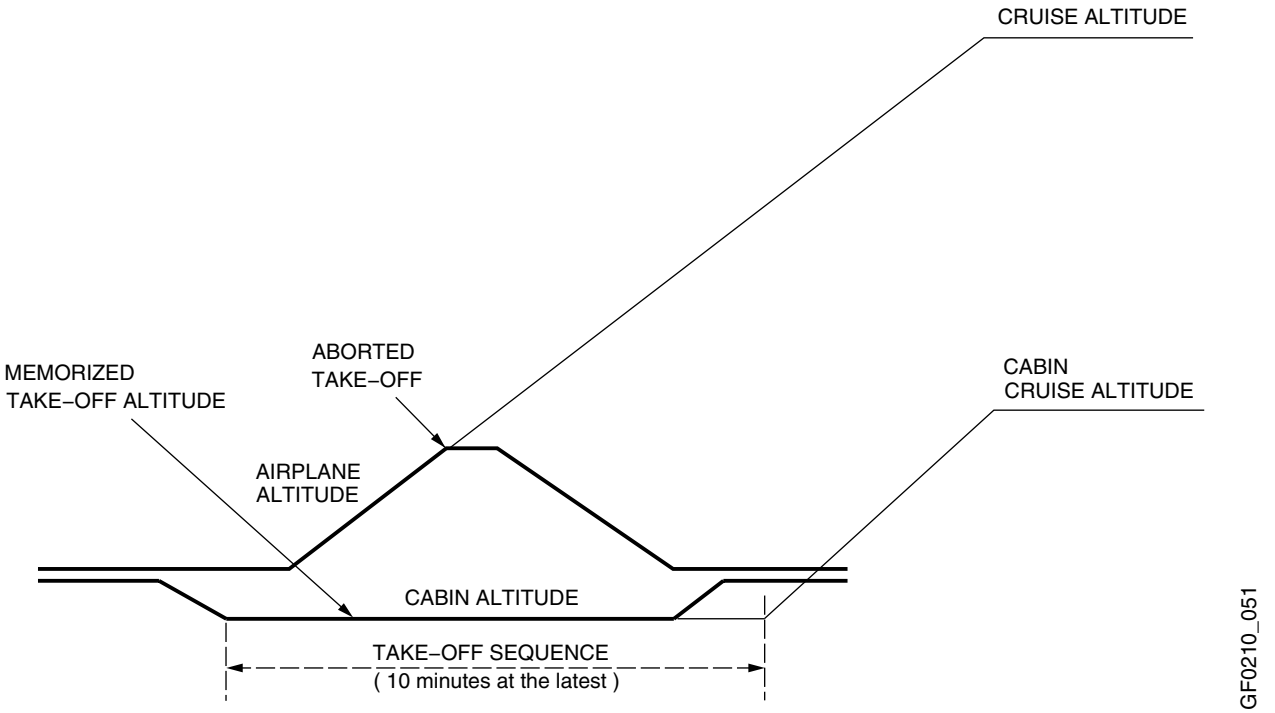


MODES OF OPERATION (CONT'D)

Take-Off Sequence (Cont'd)

During this sequence, in secondary mode:

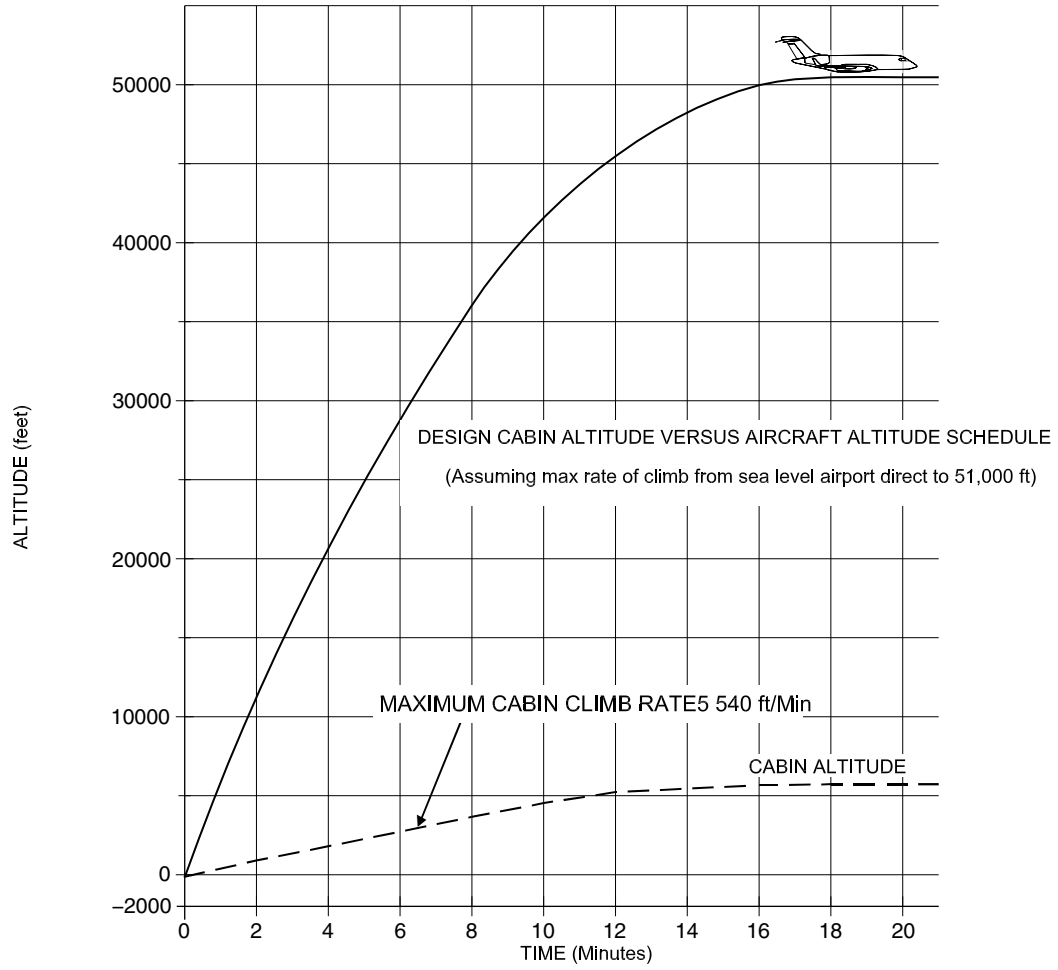
- The scheduled cabin pressure remains constant, equal to the scheduled cabin pressure of the pre-pressurization sequence for 10 minutes or as long as scheduled cabin pressure is lower than the theoretical cabin pressure.



MODES OF OPERATION (CONT'D)

Flight Sequences with FMS (Primary Mode)

When the LGECU indicates that the airplane is in flight, the flight sequence with FMS (primary mode) is initiated (except during the take-off sequence).

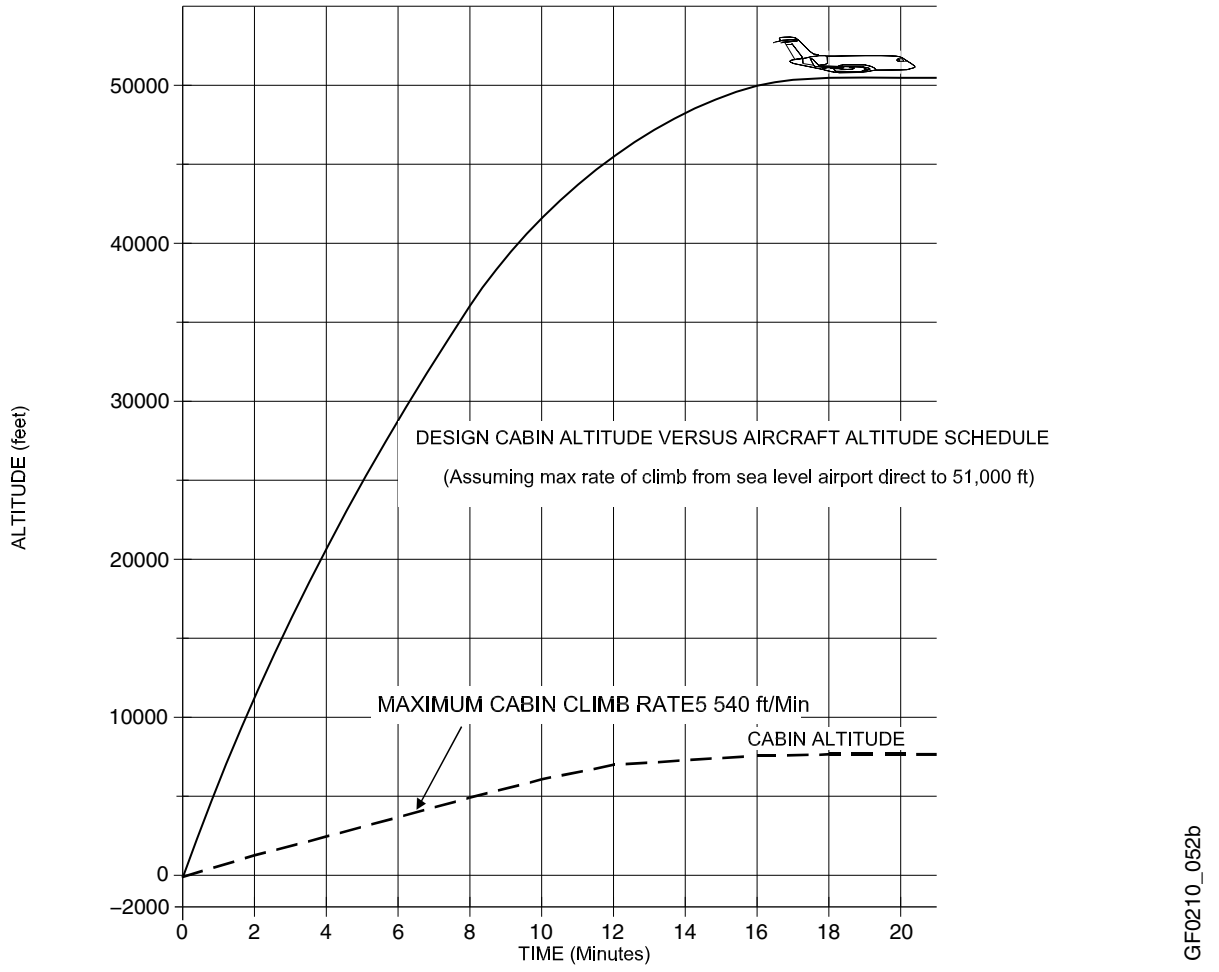


MODES OF OPERATION (CONT'D)

Flight Sequences with FMS (Primary Mode) (Cont'd)

Effectivity:

- *Airplanes 9002 thru 9158* ***not incorporating*** *Service Bulletin:*
  - *SB 700–21–034, Modification – Pressurization Control – Cabin Altitude Reduction During Flight for Improved Passenger Comfort.*



During this sequence, in primary mode:

- Climb – This sequence is active as long as cabin pressure is lower than the theoretical cabin pressure. The scheduled cabin pressure takes the lowest value between theoretical cabin pressure, destination landing pressure plus –300 ft, plus barometric correction. Theoretical cabin pressure is computed from the airplane altitude cruise flight level, received from FMS.

With CPC Rate at NORM, the rate of climb is limited to 500 fpm.

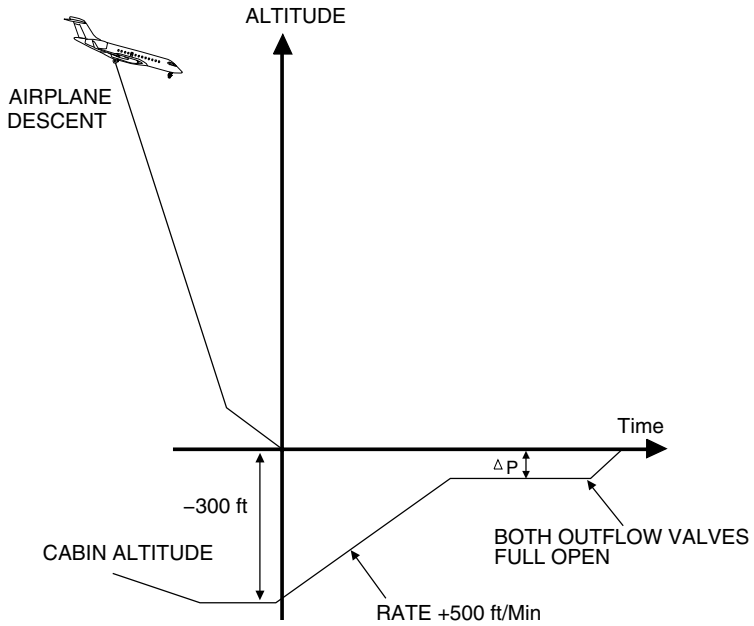
With CPC Rate at HIGH, the rate of climb is automatically limited to:

- 540 ft/min if airplane vertical speed is <2300 ft/min.
- 800 ft/min if airplane vertical speed is >6000 ft/min.
- Between the above values the cabin rate of change is proportional to airplane vertical speed.

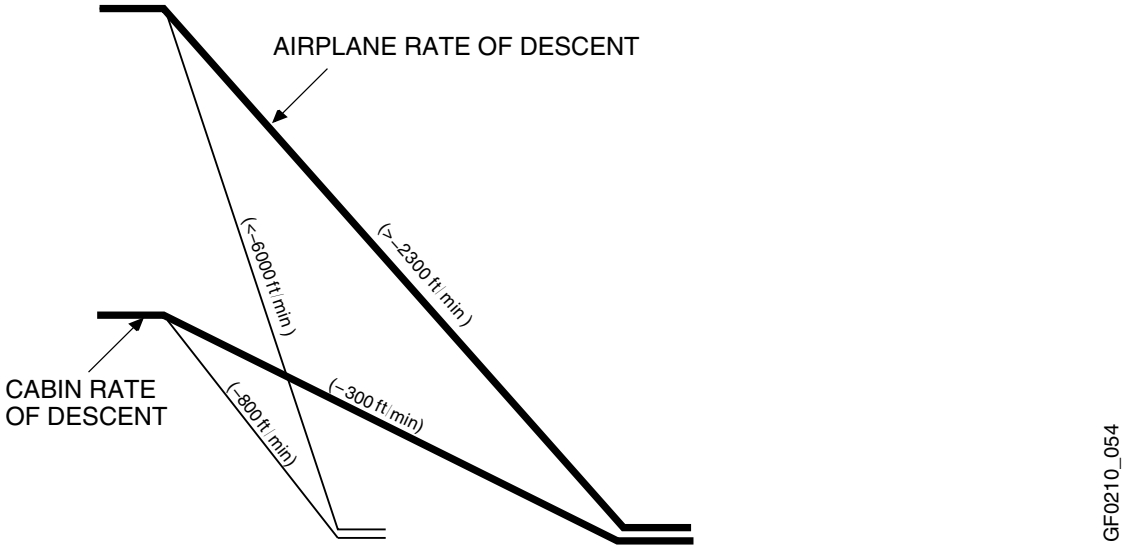
MODES OF OPERATION (CONT'D)

Flight Sequences with FMS (Primary Mode) (Cont'd)

- Descent – This sequence is active as long as the airplane is descending >500 fpm. The scheduled cabin pressure takes the lowest value between the theoretical cabin pressure and destination landing pressure –300 ft plus barometric correction.



- With CPC Rate at NORM, the rate of descent is limited to 300 fpm.
- With CPC Rate at HIGH, the rate of descent is automatically limited to:
  - –300 ft/min if airplane vertical speed is < –2300 ft/min.
  - –800 ft/min if airplane vertical speed is > –6000 ft/min.
  - Between the above values the cabin rate of change is proportional to airplane vertical speed.



MODES OF OPERATION (CONT'D)

Flight Sequences without FMS (Secondary Mode)

When the LGECU indicates the airplane is in flight, the normal flight sequence is initiated (except during the take-off sequence).

During this sequence:

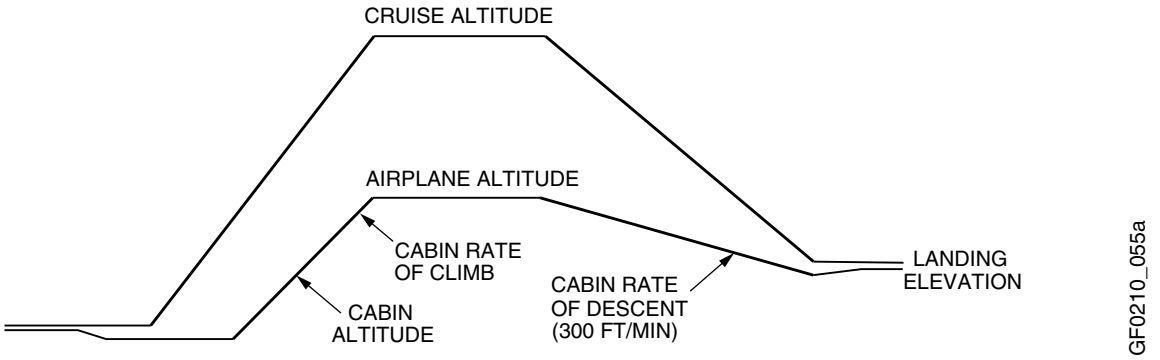
- Cabin pressurization is controlled with calculated rates of change according to selected landing elevation and theoretical cabin altitude schedule.
- The theoretical cabin altitude schedule provides a relation between airplane altitude and theoretical cabin altitude/pressure by taking into account the maximum climb performance of the airplane at the minimum airplane weight and the maximum differential pressure (10.33 psid) providing a cabin altitude of 5,670 feet at 51,000 feet. The theoretical schedule is designed in order to reach the maximum differential pressure at the lowest airplane altitude, with a minimum cabin rate of climb.

Effectivity:

- *Airplanes 9002 thru 9158* ***not incorporating*** *Service Bulletin:*
  - *SB 700–21–034, Modification – Pressurization Control – Cabin Altitude Reduction During Flight for Improved Passenger Comfort.*

The theoretical cabin altitude schedule provides a relation between airplane altitude and theoretical cabin altitude/pressure by taking into account the maximum climb performance of the airplane at the minimum airplane weight and the maximum differential pressure (9.64 psid) providing a cabin altitude of 7,230 feet at 51,000 feet. The theoretical schedule is designed in order to reach the maximum differential pressure at the lowest airplane altitude, with a minimum cabin rate of climb.

The rate of change is automatic during Climb. The rate of climb is directly taken from the theoretical cabin altitude schedule and the cabin rate of change is proportional to airplane vertical speed. The rate of climb will be maximized and limited to climb of 540 ft/min with CPC Rate at HIGH. The rate of climb will be limited to 500 ft/min with CPC Rate at NORM.



- Descent – The nominal rate of descent is limited to –300 ft/min. In case of high speed descent. In case of high speed descent with CPC Rate at HIGH, the rate of descent is increased according to the calculation of the remaining flight time. The remaining flight time is calculated from the airplane speed received from the ADC. This increased cabin rate of change demand is automatically limited, according to the airplane vertical speed:
- 300 ft/min if airplane vertical speed is < –2300 ft/min.
- 800 ft/min if airplane vertical speed is > –6000 ft/min.
- Between the above values the cabin rate of change is proportional to airplane vertical speed.

MODES OF OPERATION (CONT'D)

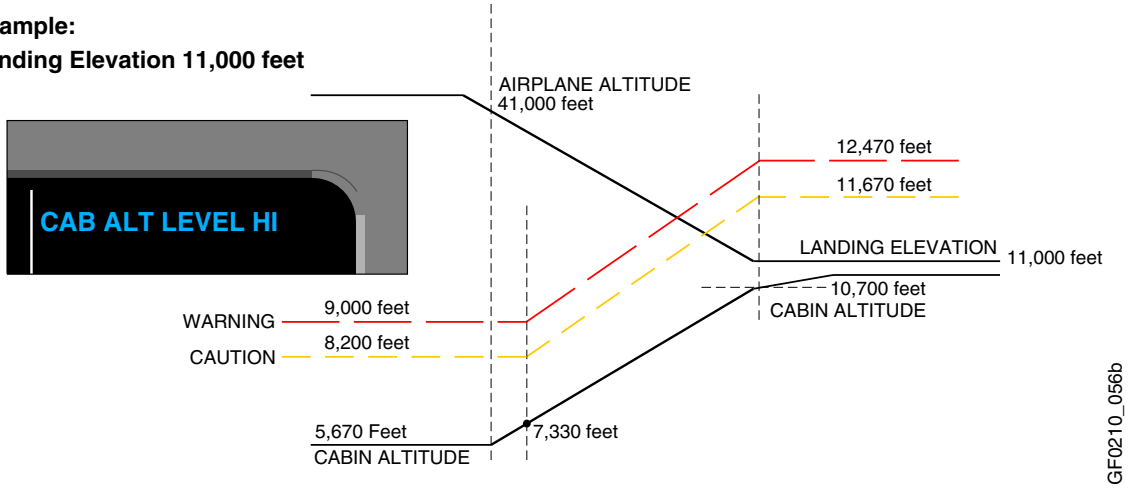
Landing Sequence at Field Elevation greater than 5,670 Feet

NOTE

This sequence is not active during manual pressurization operation.

This sequence does not require additional crew action, if the actual landing field elevation was selected prior to take-off. The scheduled cabin pressure is normally limited to 5,670 feet during cruise and then automatically reset to the landing field elevation as airplane is descending for landing.

Example:
Landing Elevation 11,000 feet



The CABIN ALT caution (cabin altitude exceeds limits) is normally set for 8,200 feet and theCABIN ALT warning is set for 9,000 feet. When the airplane altitude decreases below 41,000 feet, with landing elevation selected to 7,230 feet or higher, the CABIN ALT caution and CABIN ALT warning start to increase proportionally to the airplane altitude. The CABIN ALT caution is active up to 1,000 feet above landing field elevation and the CABIN ALT warning up to 1,800 feet above the landing field elevation. Both CABIN ALT caution and CABIN ALT warning are limited to 14,500 feet. An advisory message, CAB ALT LEVEL HI is displayed on EICAS, informing the crew that the warning and caution limits have been reset.

MODES OF OPERATION (CONT'D)

Effectivity:

- *Airplanes 9002 thru 9158* ***not incorporating*** *Service Bulletin:*
  - *SB 700–21–034, Modification – Pressurization Control – Cabin Altitude Reduction During Flight for Improved Passenger Comfort.*

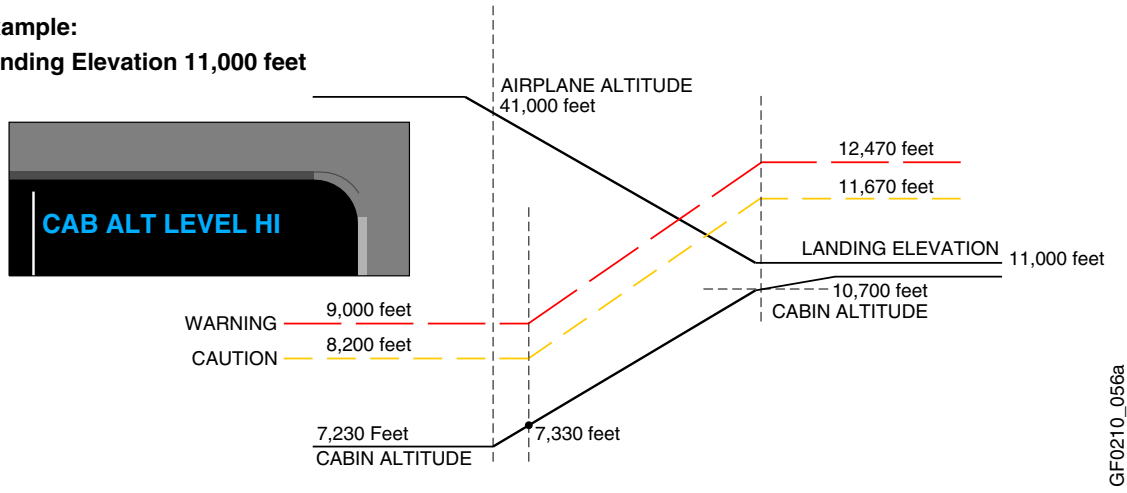
Landing Sequence at Field Elevation greater than 7,230 Feet

NOTE

This sequence is not active during manual pressurization operation.

This sequence does not require additional crew action, if the actual landing field elevation was selected prior to take-off. The scheduled cabin pressure is normally limited to 7,230 feet during flight and then automatically reset to the landing field elevation.

Example:
Landing Elevation 11,000 feet



The **CABIN ALT** caution (cabin altitude exceeds limits) is normally set for 8,200 feet and the**CABIN ALT** warning is set for 9,000 feet. When the airplane altitude decreases below 41,000 feet, the **CABIN ALT** caution and **CABIN ALT** warning start to increase proportionally to the airplane altitude. The **CABIN ALT** caution is active up to 1,000 feet above landing field elevation and the **CABIN ALT** warning up to 1,800 feet above the landing field elevation. Both **CABIN ALT** caution and **CABIN ALT** warning are limited to 14,500 feet. An advisory message, **CAB ALT LEVEL HI** is displayed on EICAS, informing the crew that the warning and caution limits have been reset.

Landing Sequence at Field Elevation greater than 5,670 Feet – Levelling Off During Descent

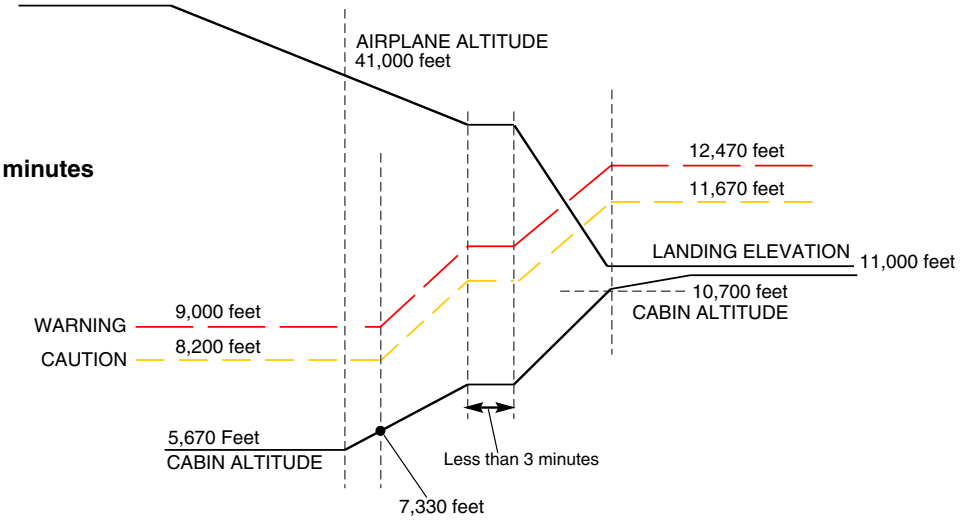
NOTE

This sequence is not active during manual pressurization operation.

MODES OF OPERATION (CONT'D)

Landing Sequence at Field Elevation greater than 5,670 Feet – Levelling Off During Descent (Cont'd)

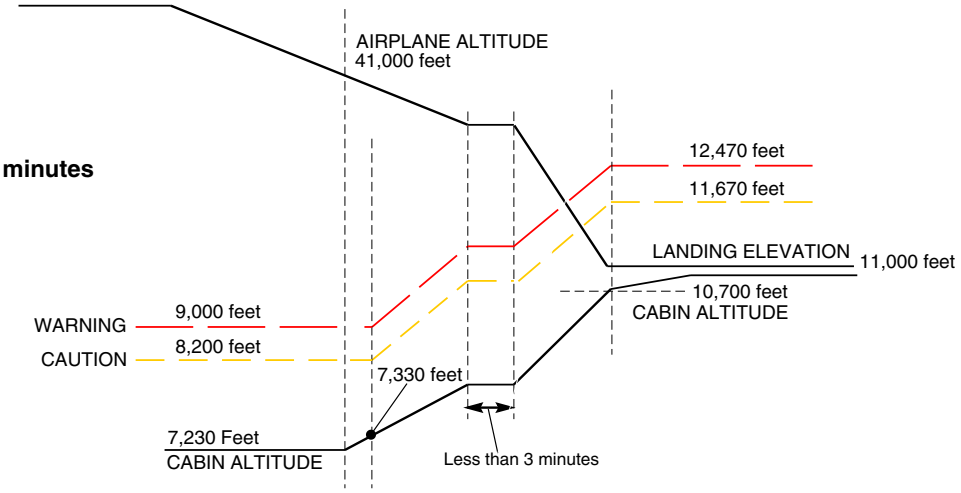
If a levelling off occurs above 41,000 feet during descent, the cabin remains at 5,670 feet. If levelling off occurs at or below 25,000 feet during descent, the cabin remains at current altitude. If levelling off between 41,000 and 25,000 feet, the cabin altitude will remain at the current altitude for 3 minutes.



Effectivity:

- *Airplanes 9002 thru 9158* ***not incorporating*** *Service Bulletin:*
  - *SB 700–21–034, Modification – Pressurization Control – Cabin Altitude Reduction During Flight for Improved Passenger Comfort.*

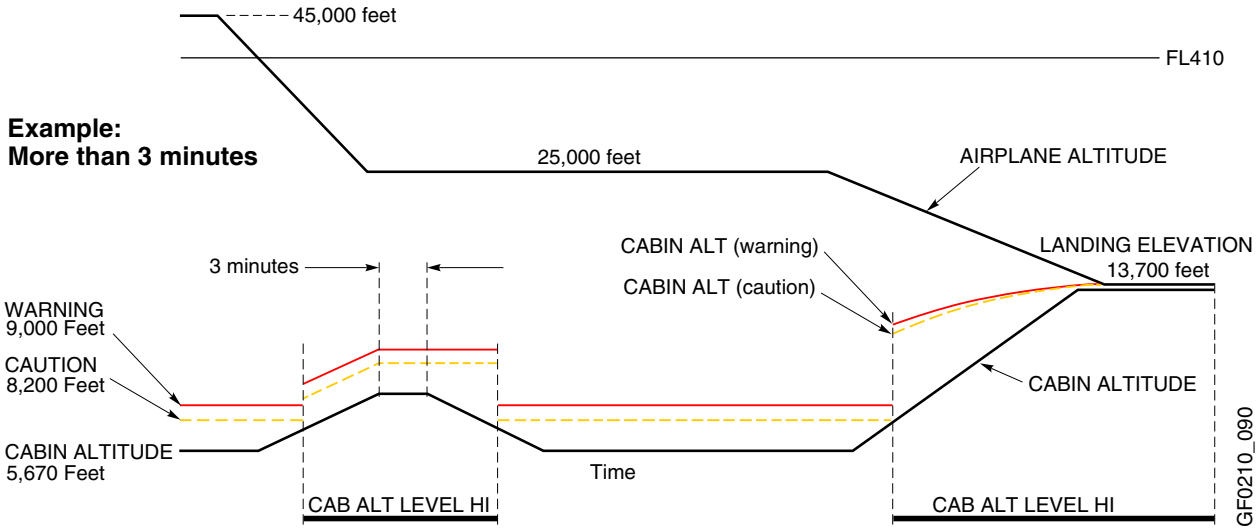
If a levelling off occurs above 41,000 feet during descent, the cabin remains at 7,230 feet. If levelling off occurs at or below 25,000 feet during descent, the cabin remains at current altitude. If levelling off between 41,000 and 25,000 feet, the cabin altitude will remain at the current altitude for 3 minutes.



MODES OF OPERATION (CONT'D)

Landing Sequence at Field Elevation greater than 5,670 Feet – Levelling Off During Descent (Cont'd)

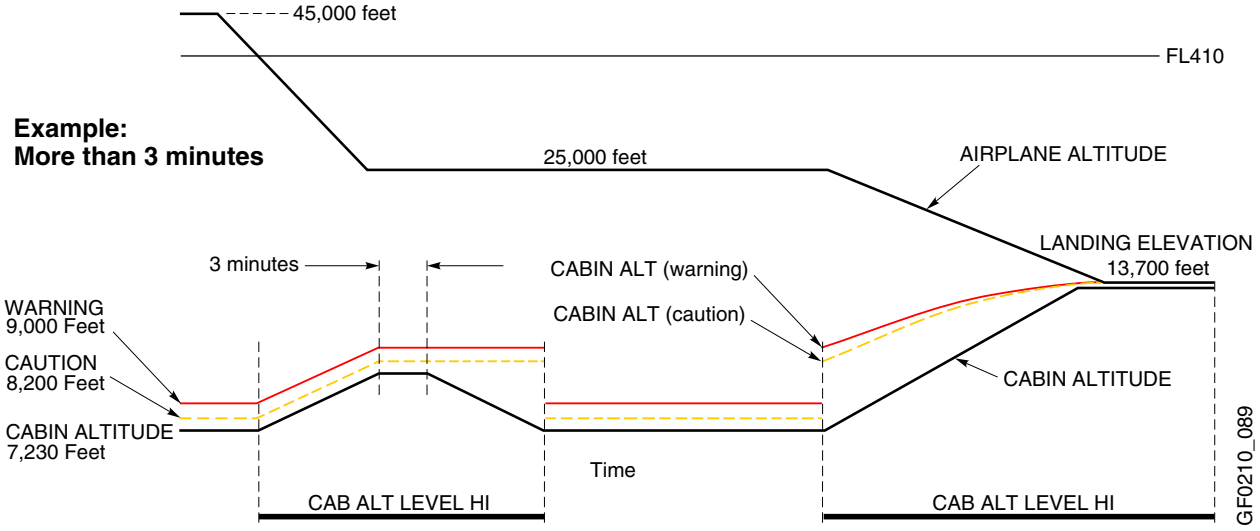
If the levelling off lasts for more than 3 minutes, the cabin altitude will descent for a 5,670 feet target cabin altitude until aircraft descent is resumed. As cabin altitude reaches 7,330 feet, the **CAB ALT LEVEL HI** message will be removed and the **CABIN ALT** caution and **CABIN ALT** warning messages will reset to the normal thresholds of 8,200 feet and 9,000 feet respectively.



Effectivity:

- *Airplanes 9002 thru 9158* ***not incorporating*** *Service Bulletin:*
  - *SB 700–21–034, Modification – Pressurization Control – Cabin Altitude Reduction During Flight for Improved Passenger Comfort.*

If the levelling off lasts for more than 3 minutes, the cabin altitude will descent for a 7,230 feet target cabin altitude until aircraft descent is resumed. As cabin altitude reaches 7,330 feet, the **CAB ALT LEVEL HI** message will be removed and the **CABIN ALT** caution and **CABIN ALT** warning messages will reset to the normal thresholds of 8,200 feet and 9,000 feet respectively.



MODES OF OPERATION (CONT'D)

Take-Off at Field Elevation greater than 7,230 Feet

NOTE

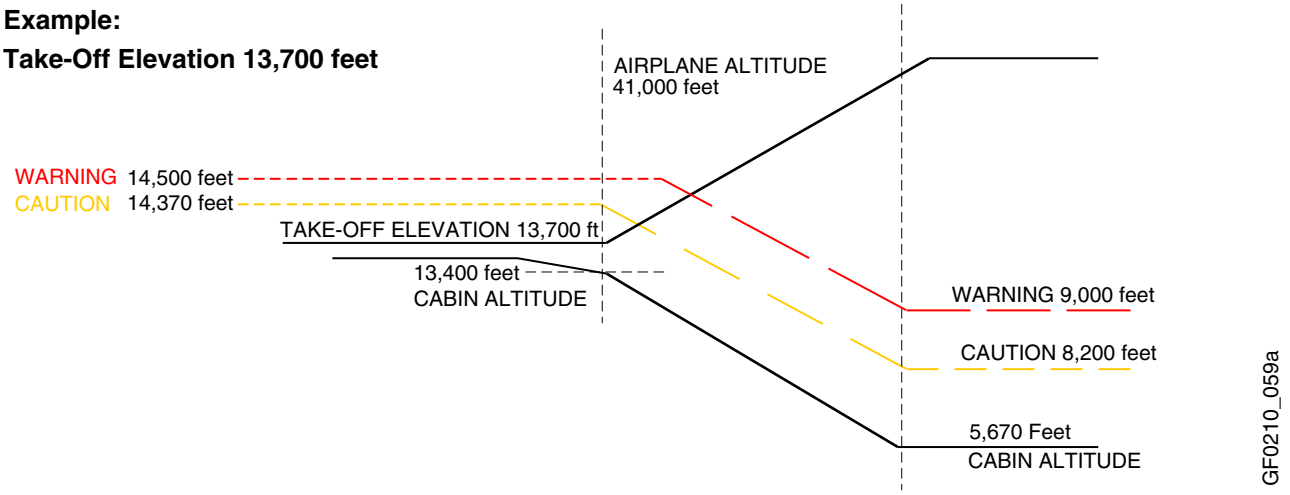
This sequence is not active during manual pressurization operation.

When the airplane is in the climb, the **CABIN ALT** warning and **CABIN ALT** caution decrease proportionally to the airplane altitude. As soon as cabin altitude reaches 7,330 feet or airplane reaches 41,000 feet or above, the **CABIN ALT** caution is reset to 8,200 feet and the **CABIN ALT** warning is reset to 9,000 feet.

If the Landing Elevation is switched to less than 7,230 feet before cabin altitude reaches 7,330 feet, **CABIN ALT** caution / **CABIN ALT** warning message may be displayed as the CPC is reverted to the normal message threshold of 8,200 feet and 9,000 feet respectively.

Example:

Take-Off Elevation 13,700 feet

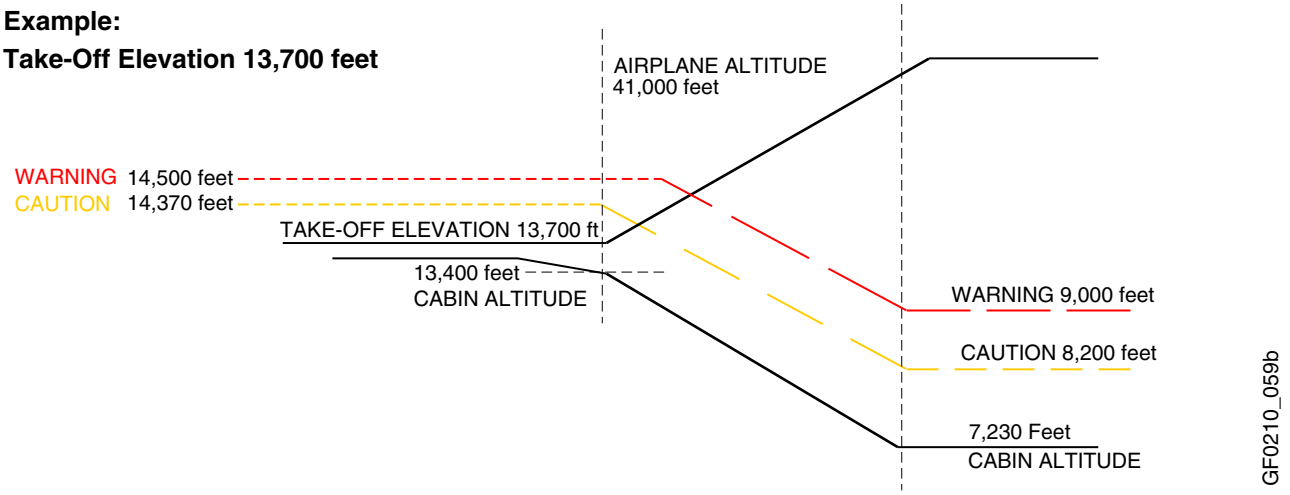


Effectivity:

- *Airplanes 9002 thru 9158* ***not incorporating*** *Service Bulletin:*
  - *SB 700–21–034, Modification – Pressurization Control – Cabin Altitude Reduction During Flight for Improved Passenger Comfort.*

Example:

Take-Off Elevation 13,700 feet



MODES OF OPERATION (CONT'D)

Aborted Take-Off Above 7,230 feet

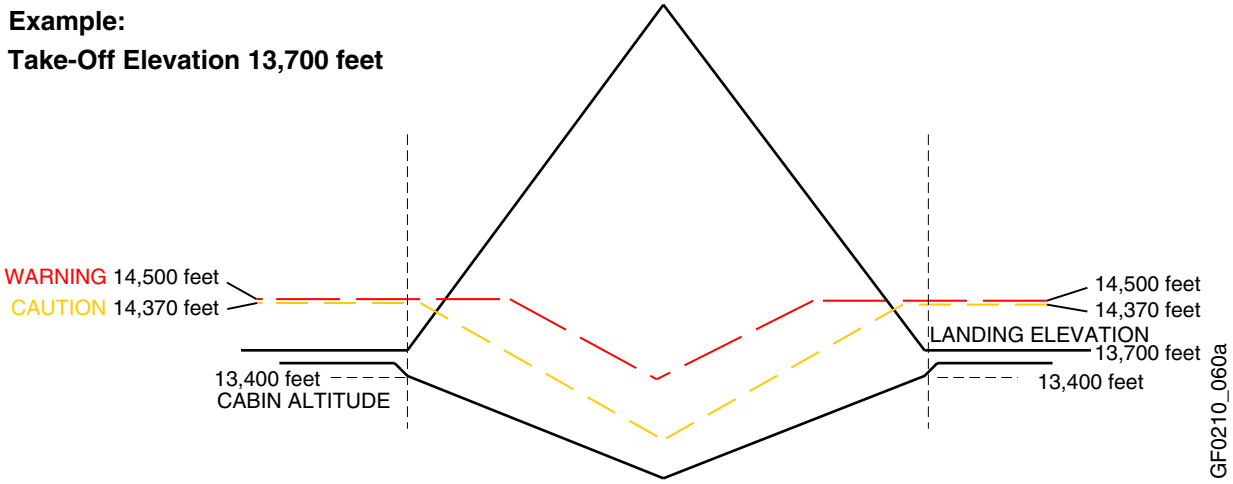
NOTE

This sequence is not active during manual pressurization operation.

The take-off is identical to normal take-off above 7,230 feet. When the airplane starts to descend, an aborted take-off sequence is initiated. The landing is similar to landing above 7,230 feet.

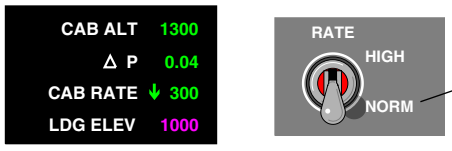
Example:

Take-Off Elevation 13,700 feet



Rate Limit Selection

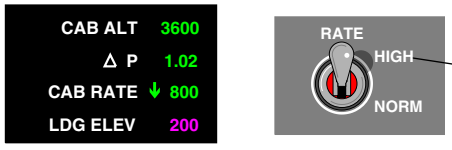
Cabin rate of change control is automatically controlled during ground and flight sequences. The airplane is normally flown with the rate limit selector set to NORM position. The automatic rate of change control is based upon +500 fpm and –300 fpm. The airplane cabin altitude rate will vary within these normal limits, to follow the pressurization schedule. The cabin rate is displayed on the STAT page. If the cabin is in a climb, the arrow will indicate ↑. If the cabin is in descent, the arrow will indicate ↓.



NORM: 500 fpm up, 300 fpm down.

GF0210_061

It is possible to manually override the automatic rate of change control limits, through the rate limit selection on the Pressurization Control Panel. In the HIGH position, the rate limits are up to +800 fpm and –800 fpm. The cabin rate will vary between these two limits as required to maintain the pressurization schedule.



HIGH: 800 ft/min up, 800 ft/min down.

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With Landing Elevation set to 5,674 feet or higher, the cabin rate of change is automatically controlled by the CPC independent of CPC RATE selection when the airplane is descending with cabin altitude higher than 5,674 feet.

MODES OF OPERATION (CONT'D)

Rate Limit Selection (Cont'd)

The rate of climb is automatically limited to:

- 540 fpm if airplane vertical speed is ≤ –1150 fpm.
- 2457 fpm if airplane vertical speed is ≥ –3450 fpm.
- Between the above values the cabin rate of change is proportional to airplane vertical speed.

The rate of descent is automatically limited to:

- 300 fpm if airplane vertical speed is ≤ +1428 fpm.
- 1260 fpm if airplane vertical speed is ≥ +6000 fpm.
- Between the above values the cabin rate of change is proportional to airplane vertical speed.

Effectivity:

- *Airplanes 9002 thru 9158* ***not incorporating*** *Service Bulletin:*
  - *SB 700–21–034, Modification – Pressurization Control – Cabin Altitude Reduction During Flight for Improved Passenger Comfort.*

During High Elevation Airfield operation, with **CAB ALT LEVEL HI** advisory message displayed, the cabin rate of change is automatically controlled by the CPC independent of CPC RATE selection.

The rate of climb is automatically limited to:

- 540 fpm if airplane vertical speed is ≤ –2570 fpm.
- 1260 fpm if airplane vertical speed is ≥ –6000 fpm.
- Between the above values the cabin rate of change is proportional to airplane vertical speed.

The rate of descent is automatically limited to:

- 300 fpm if airplane vertical speed is ≤ +1428 fpm.
- 1260 fpm if airplane vertical speed is ≥ +6000 fpm.
- Between the above values the cabin rate of change is proportional to airplane vertical speed.

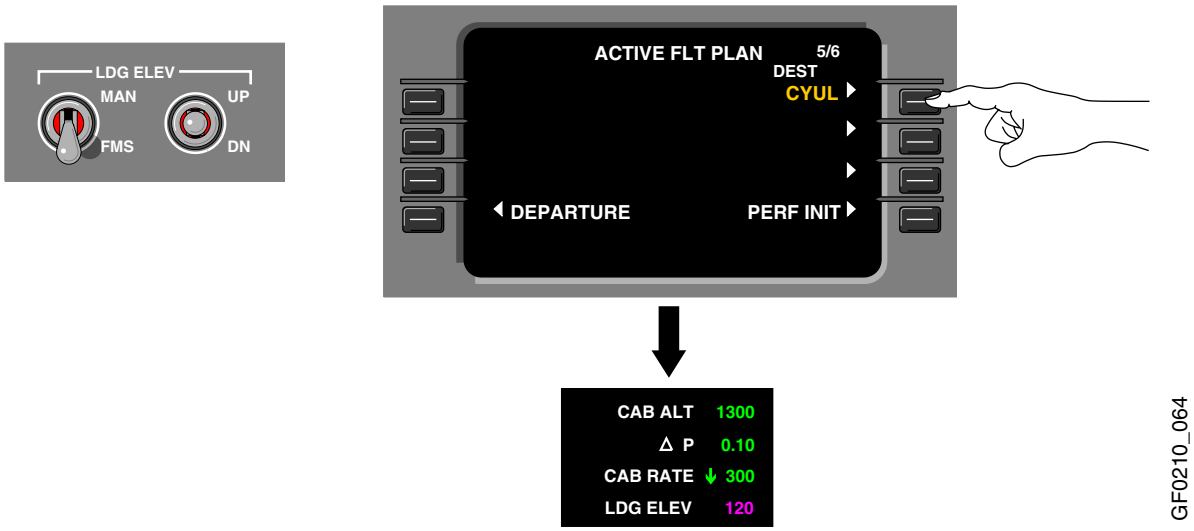
Landing Elevation

Landing elevation information is transmitted by the FMS or from the manual selection on the Pressurization Control Panel. The value used for pressurization control by the CPCs is displayed on the STAT page.

MODES OF OPERATION (CONT'D)

Landing Elevation (Cont'd)

When the LDG ELEV FMS/MAN selector is set to FMS, the landing destination information has been programmed in the FMS and the flight plan activated, the LDG ELEV is displayed on the STAT page.



When the LDG ELEV FMS/MAN selector is set to MAN, the LDG ELEV selection is made from the Pressurization Control Panel. The LDG ELEV is defaulted to 0 feet on the ground and 5,670 feet in flight. A message is displayed on EICAS and will remain posted until a selection of UP or DN.

Effectivity:

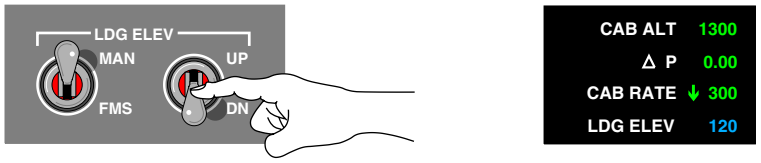
- *Airplanes 9002 thru 9158* ***not incorporating*** *Service Bulletin:*
  - *SB 700–21–034, Modification – Pressurization Control – Cabin Altitude Reduction During Flight for Improved Passenger Comfort.*

When the LDG ELEV FMS/MAN selector is set to MAN, the LDG ELEV selection is made from the Pressurization Control Panel. The LDG ELEV is defaulted to 0 feet on the ground and 7,230 feet in flight. A message is displayed on EICAS and will remain posted until a selection of UP or DN.

MODES OF OPERATION (CONT'D)

Landing Elevation (Cont'd)

To enter a new LDG ELEV, hold the UP/DN switch until desired field elevation is reached.



GF0210_066

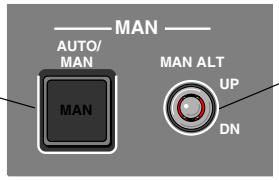
Manual Mode

In the manual mode, cabin pressure is manually controlled by the crew selecting the applicable switches on the Pressurization control panel.

AUTO/MAN switch
Used to select mode of operation.

MAN –Indicates AUTO mode is selected.

MAN –Indicates MAN mode is selected.

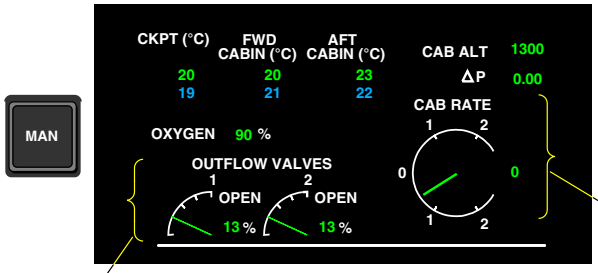


MAN ALT Toggle switch
Used to control cabin altitude in manual mode.
Spring loaded to mid position.
UP – Commands cabin to climb.
DN – Commands cabin to descend.

NOTE
Selecting the AUTO/MAN switch to MAN then back to AUTO will enable the other CPC.

GF0210_067

Selecting MAN will display both outflow valve position indicators, display an analog rate of change gauge and eliminate the LDG ELEV on the status page and display a status message on EICAS.

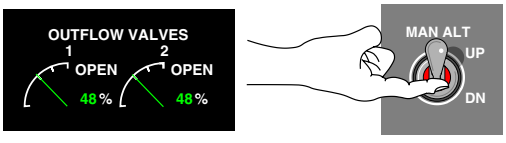


MAN Mode Data Display
CAB RATE – Sweep range displayed in feet (–2500 to 2500 fpm).
LDG ELEV – Not displayed. Crew must monitor CAB ALT.

OUTFLOW VALVES Position Indicators
Displayed when MAN selected and measured in percent. Also displayed when EMER DEPRESS selected, or OUTFLOW VLV closed, or DITCHING selected.

GF0210_068

When the MAN ALT (spring loaded) toggle switch is selected to UP, both outflow valves open slowly, and the cabin altitude increases proportionally to the outflow change.

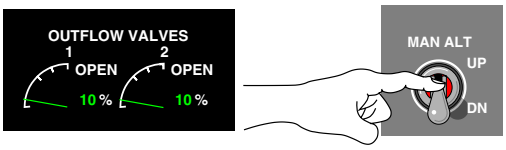


GF0210_069

MODES OF OPERATION (CONT'D)

Manual Mode (Cont'd)

When the MAN ALT toggle switch is selected to DN, both outflow valves close slowly and the cabin altitude decreases proportionally to the outflow change.



GF0210_070

The desired control (climb, level, descent) is maintained by adjusting, if necessary, the outflow valve positions, according to flow or differential pressure changes.

Manual Mode Operation

Operate pressurization, MAN/ALT toggle switches as required:

- To increase cabin altitude, select MAN/ALT toggle switch to UP momentarily and monitor climb rate and cabin altitude.
- To decrease cabin altitude, select MAN/ALT toggle switch to DN momentarily and monitor descent rate and cabin altitude.
- To maintain cabin altitude, select MAN/ALT toggle switch to mid position, when reaching target cabin altitude (see the chart below).

Cruise Flight Level	180	200	220	240	260	280	290	310	330
Target Cabin Altitude	600	800	1000	1200	1400	1700	1900	2200	2400
Target Δ P	7.05	7.55	8.00	8.40	8.75	9.05	9.20	9.40	9.65
Cruise Flight Level	350	370	390	410	430	450	470	490	510
Target Cabin Altitude	2700	2900	3300	3700	4100	4500	4900	5300	5700
Target Δ P	9.90	10.05	10.20	10.25	10.30	10.30	10.30	10.30	10.30

MODES OF OPERATION (CONT'D)

Manual Mode Operation (Cont'd)

Effectivity:

- *Airplanes 9002 thru 9158* ***not incorporating*** *Service Bulletin:*
  - *SB 700–21–034, Modification – Pressurization Control – Cabin Altitude Reduction During Flight for Improved Passenger Comfort.*

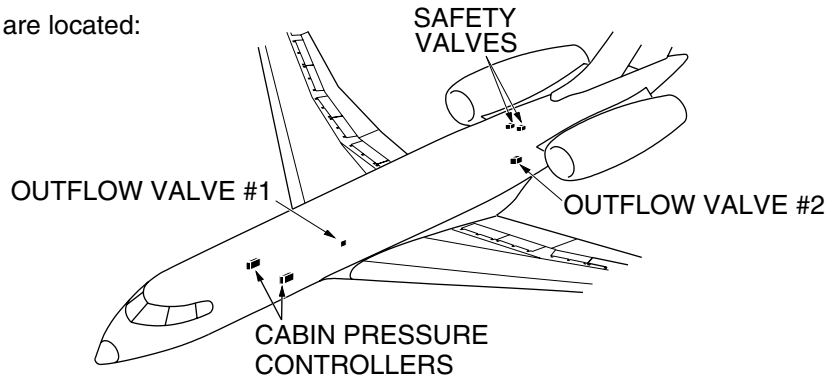
Cruise Flight Level	180	200	220	240	260	280	290	310	330
Target Cabin Altitude	1100	1400	1600	1900	2200	2600	2800	3100	3400
Target Δ P	6.75	7.20	7.65	8.00	8.35	8.60	8.70	8.95	9.15
Cruise Flight Level	350	370	390	410	430	450	470	490	510
Target Cabin Altitude	3800	4100	4500	5000	5500	6000	6400	6900	7200
Target Δ P	9.35	9.50	9.60	9.60	9.60	9.60	9.60	9.60	9.60

- During descent, select MAN/ALT toggle switch adjust Up or DN to attain landing elevation. Select MAN/ALT toggle switch to mid position, to maintain landing elevation.

OUTFLOW VALVES (OFV)

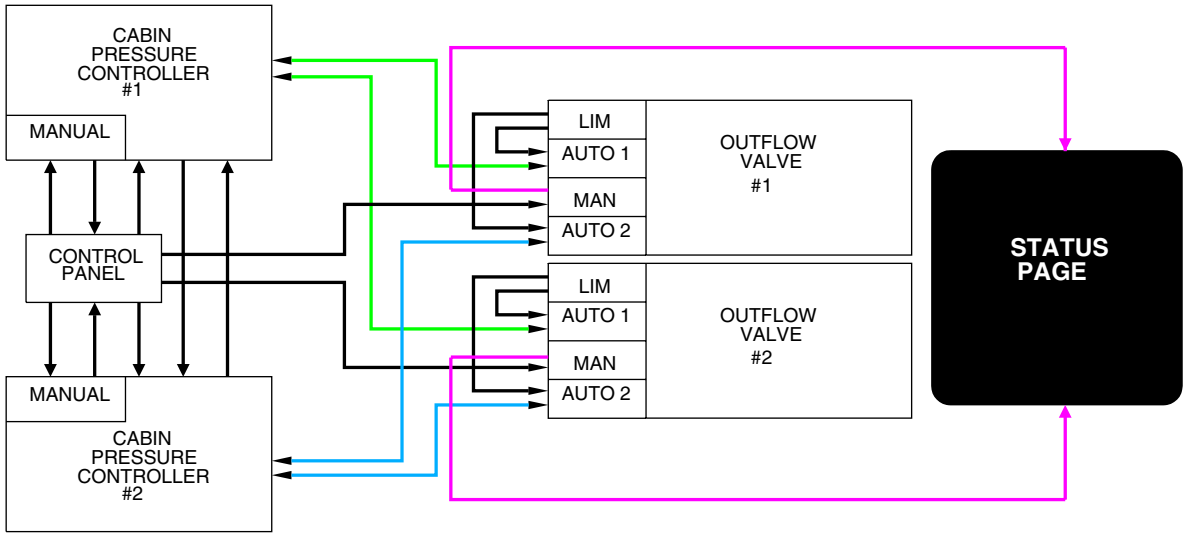
The two electrical OFVs modulate the discharge airflow to control cabin pressure in both AUTO modes and in the Manual mode.

The two OFVs are located:



GF0210_071

In both AUTO modes, the OFV provides its position to the CPC. In Manual mode it provides its position to the STATUS page.



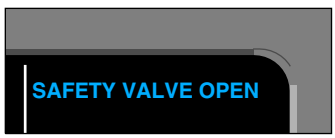
GF0210_072

The two outflow valves operate in a “slave and master” mode. During normal operations, OFV 2 is master on day 1 and 2 in a four day cycle and OFV 1 is master on day 3 and 4 in the same four day cycle.

SAFETY VALVES

The two safety valves (SFV 1 and SFV 2) are located on the aft bulkhead.

Each SFV ensures overpressure relief and negative pressure relief and provides an OPEN position signal to EICAS.



GF0210_073

SYSTEM SAFETIES

The system safety features incorporated in the CPCS are:

- Dual redundant positive and negative pressure relief valves.
- Dual (segregated) cabin altitude limiters, each dedicated to one outflow valve (OFV).
- An OFV travel limiter on each OFV.
- Automatic Ditching provision.
- Emergency Depressurization provision.
- Two OFV closure override circuitry.
- Door Open Protection.

Overpressure Relief

Overpressure relief is ensured pneumatically by each identical SFV and overrides the operation of both AUTO and MAN mode. When maximum differential pressure is reached, an overpressure valve, located on the safety valve, opens to outside pressure. The differential pressure shall not exceed 0.1 psi during taxi and 1.0 psi upon initial landing. The maximum positive differential pressure is controlled at 10.73 psi. At 10.63± 0.1 psi, the safety valve opens, and at 10.85 psi **CABIN DELTA P** will be displayed on EICAS and the digital readout on the STAT page will appear red.

Effectivity:

- *Airplanes 9002 thru 9158* ***not incorporating*** *Service Bulletin:*
  - *SB 700–21–034, Modification – Pressurization Control – Cabin Altitude Reduction During Flight for Improved Passenger Comfort.*

Overpressure relief is ensured pneumatically by each identical SFV and overrides the operation of both AUTO and MAN mode. When maximum differential pressure is reached, an overpressure valve, located on the safety valve, opens to outside pressure. The differential pressure shall not exceed 0.1 psi during taxi and 1.0 psi upon initial landing. The maximum positive differential pressure is controlled at 10.02 psi. At 9.92 ± 0.1 psi, the safety valve opens, and at 10.15 psi **CABIN DELTA P** will be displayed on EICAS and the digital readout on the STAT page will appear red.

GF0210_074

Negative Pressure Relief

Negative pressure relief is ensured pneumatically by each identical SFV and overrides the operation of both AUTO and MAN mode. During an emergency descent, without cabin airflow, when the outside pressure becomes slightly greater than cabin pressure, the SFV opens to control negative pressure at a value lower than or equal to – 0.5 psid. A warning message will be displayed on EICAS and the digital readout on the STAT page will appear red.

GF0210_075

SYSTEM SAFETIES (CONT'D)

Cabin Altitude Limitation

The cabin altitude limiters override the operation of both AUTO and MAN mode. Two cabin altitude limiters are provided, one for each OFV. When the cabin altitude reaches 14,500 ± 500 feet, the cabin altitude limiter signal is active.

This signal isolates the automatic control and the manual control of the OFV and closes the OFV through the manual channel of the OFV, until the cabin altitude drops below 14,500 ± 500 feet.

The cabin altitude limitation function includes a cabin rate limitation of 3,000 ft/min to close the OFV, when the cabin altitude rate exceeds the setting value. The altitude rate limitation is not active in case of Emergency Depressurization and Ditching.

GF0210_076

Outflow Valve Travel Limiter

An OFV travel limiter device is included on each OFV to limit the OFV opening (for differential pressure higher than 7 ± 0.5 psid) to a safe value (maximum 50%) at high altitudes.

When the pressure differential is above 7 ± 0.5 psid, the travel limiter device prevents the OFV opening beyond 50%. The travel limiter will not prevent movement from open to close.

GF0210_077

Ditching

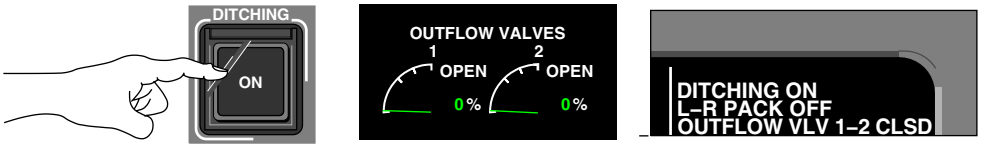
Safety in case of ditching is achieved in both AUTO and MAN modes, ensuring that the cabin is fully depressurized and that the outflow valves are fully closed.

The AUTO sequence is generated from the DITCHING switch selection and the following occurs:

- PACKS flow shutoff.
- Cabin is depressurized.
- OFVs are driven to the closed position.

The AUTO ditching sequence is inhibited above 15,000 feet. The altitude rate limitation is inoperative, whenever DITCHING is selected ON.

When the DITCHING switch is selected ON, the OFVs are displayed on the STAT page and status messages are displayed on EICAS.



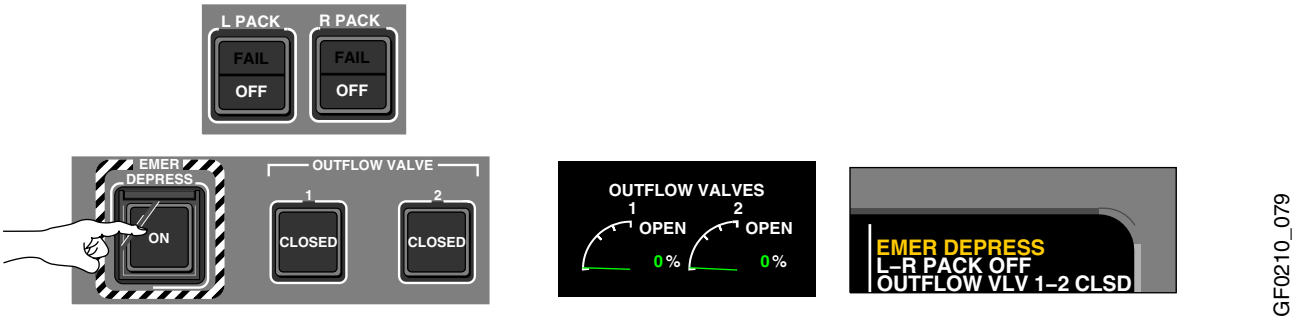
GF0210_078

SYSTEM SAFETIES (CONT'D)

Ditching (Cont'd)

The MAN sequence is:

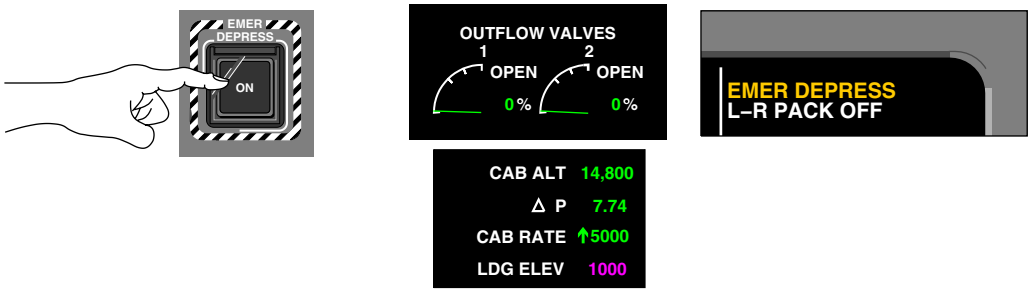
- Select PACKS OFF.
- Select EMER DEPRESS ON.
- Select both OUTFLOW VLVs CLOSED.



Emergency Depressurization

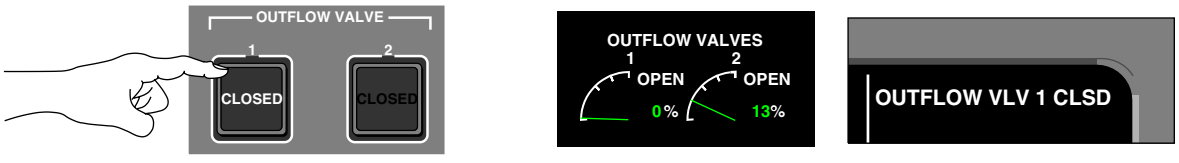
When the EMER DEPRESS switch is selected ON, a fast depressurization is performed, in AUTO or MAN mode, by opening both OFVs through the manual drive of the OFVs.

Cabin altitude limitation functions override this function and will not allow the cabin altitude above 14,500 ± 500 feet. The cabin rate of climb limitation is inoperative.



Close Outflow Valve

The OFVs can be manually closed, both in AUTO and MAN, by selecting the OUTFLOW VLV switch(es) on the Cabin Pressure Control Panel. The OFV is driven to the closed position, through the manual drive of its actuator. The outflow valves' position will be displayed on the STATUS page and a message is displayed on EICAS.



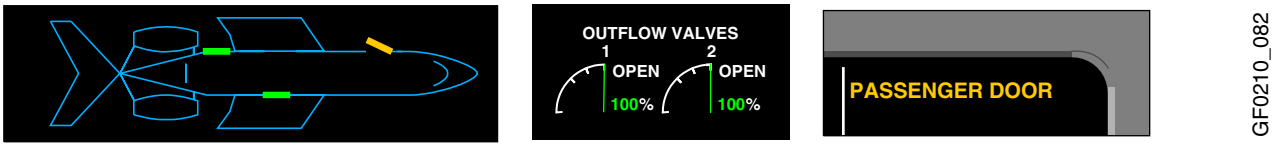
SYSTEM SAFETIES (CONT'D)

Door Open Protection

Door open protection, prevents cabin pressurization if the main entrance door is not closed and fully locked.

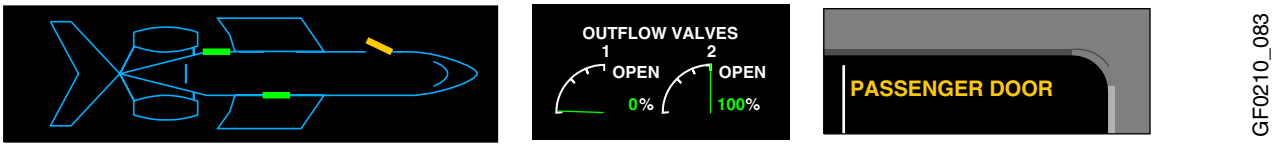
If the main entrance door is open:

- If both packs are ON, both outflow valves are driven to the open position.



GF0210_082

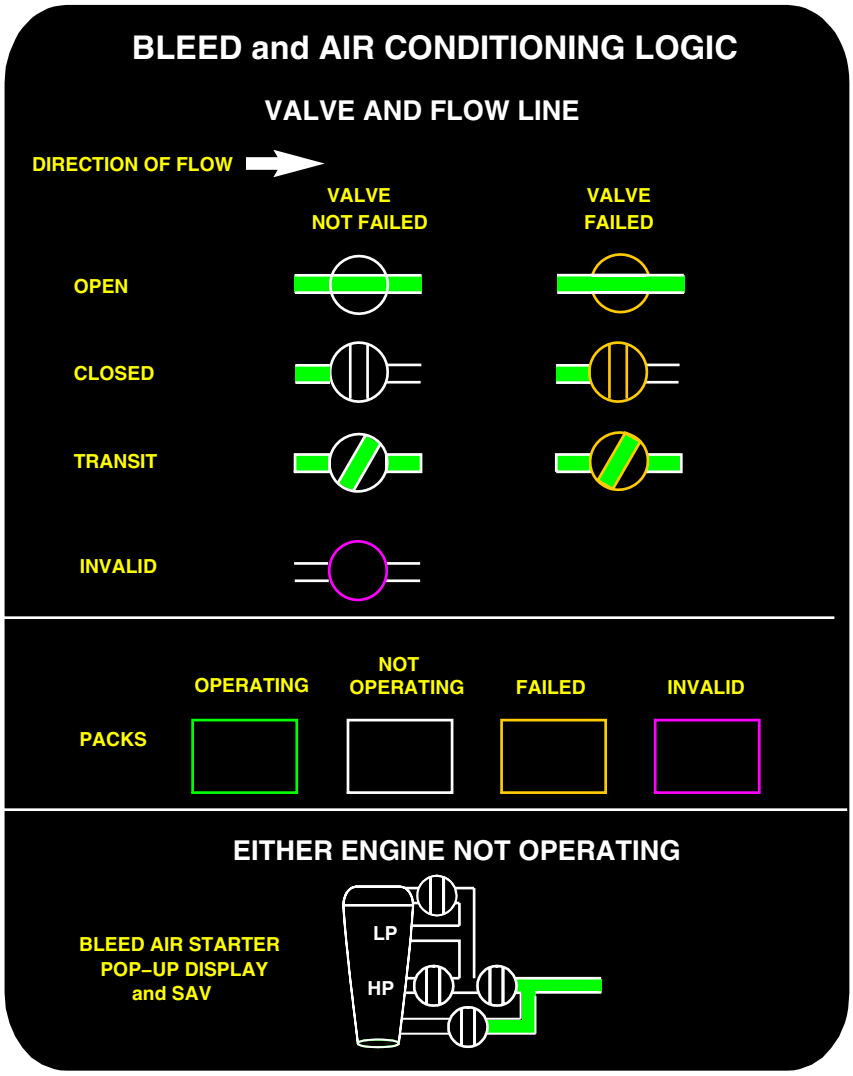
- If one pack is OFF, one OFV is driven close with preference to aft OFV over forward OFV (i.e. if forward OFV is already closed, the aft OFV will not then be driven close).



GF0210_083

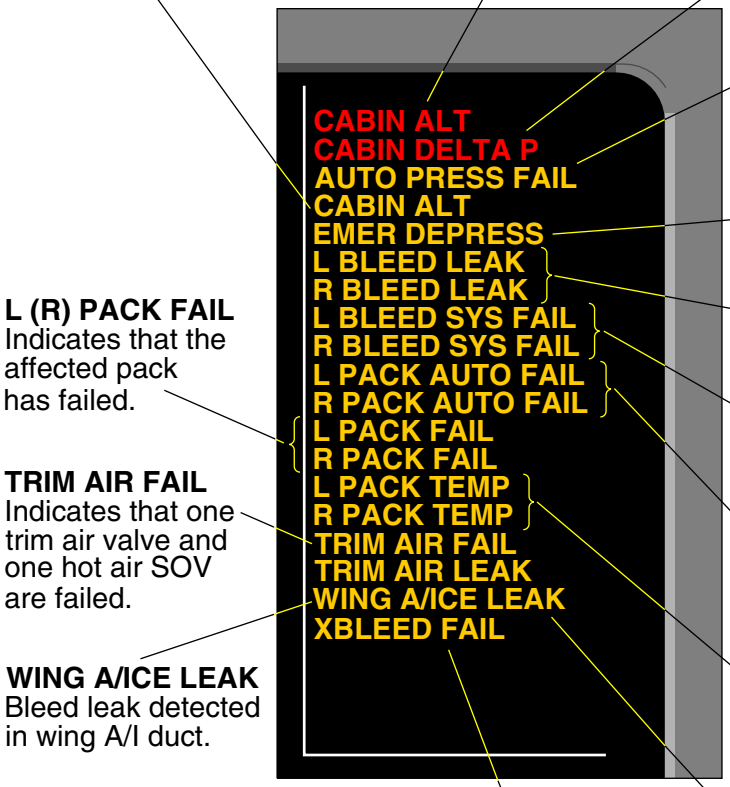
EICAS PHILOSOPHY

The following represents the EICAS symbols and logic for the BLEED and AIR CONDITIONING synoptic pages. The symbols are shown in serviceable and failure conditions.



GF0210_084

BLEED/AIR CONDITIONING/PRESSURIZATION EICAS MESSAGES



CABIN ALT
Indicates that cabin altitude is 9,000 feet or greater.

CABIN ALT
Indicates that cabin altitude is between 8,200 and 9,000 feet.

CABIN DELTA P
Indicates that cabin differential pressure is greater than 10.85 psid.

AUTO PRESS FAIL
Indicates that both channels of the pressurization control are inoperative.

EMER DEPRESS
Indicates that EMERG DEPRESS switch has been selected ON.

L (R) PACK FAIL
Indicates that the affected pack has failed.

L (R) BLEED LEAK
Indicates that a bleed leak has been detected in the L or R bleed ducts.

L (R) BLEED SYS FAIL
Indicates that the affected bleed system has failed.

TRIM AIR FAIL
Indicates that one trim air valve and one hot air SOV are failed.

L (R) PACK AUTO FAIL
Indicates that the affected automatic pack control is inoperative.

WING A/ICE LEAK
Bleed leak detected in wing A/I duct.

L (R) PACK TEMP
Indicates that the manual temperature selection is out of range.

TRIM AIR LEAK
Indicates that a leak has been detected in the trim air ducts.

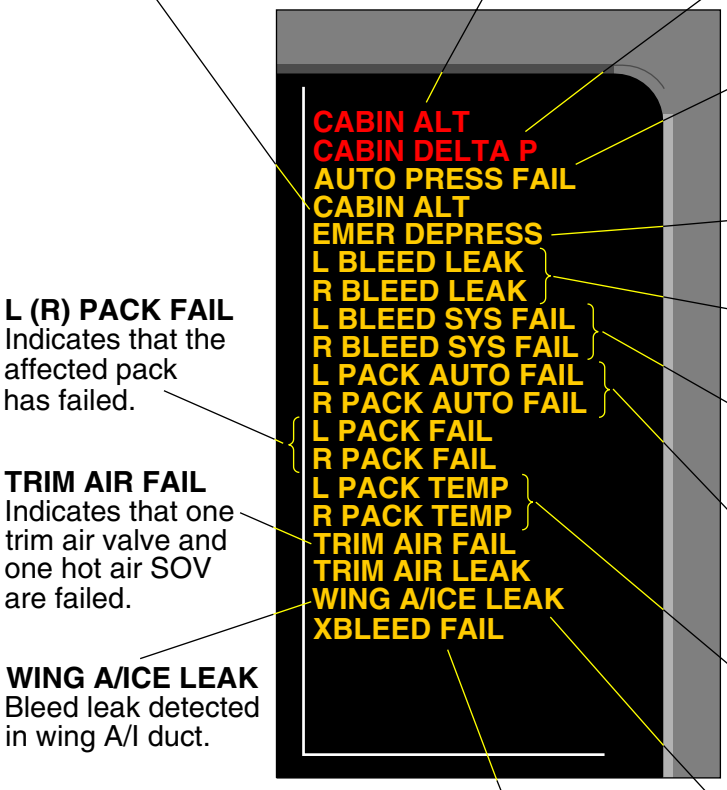
XBLEED FAIL
Indicates that the bleed crossfeed has failed, open or closed.

GF0210_085c

BLEED/AIR CONDITIONING/PRESSURIZATION EICAS MESSAGES (CONT'D)

Effectivity:

- *Airplanes 9002 thru 9158* ***not incorporating*** *Service Bulletin:*
  - *SB 700–21–034, Modification – Pressurization Control – Cabin Altitude Reduction During Flight for Improved Passenger Comfort.*



CABIN ALT
Indicates that cabin altitude is 9,000 feet or greater.

CABIN ALT
Indicates that cabin altitude is between 8,200 and 9,000 feet.

CABIN DELTA P
Indicates that cabin differential pressure is greater than 10.15 psid.

AUTO PRESS FAIL
Indicates that both channels of the pressurization control are inoperative.

EMER DEPRESS
Indicates that EMERG DEPRESS switch has been selected ON.

L (R) BLEED LEAK
Indicates that a bleed leak has been detected in the L or R bleed ducts.

L (R) BLEED SYS FAIL
Indicates that the affected bleed system has failed.

L (R) PACK AUTO FAIL
Indicates that the affected automatic pack control is inoperative.

L (R) PACK TEMP
Indicates that the manual temperature selection is out of range.

L (R) PACK FAIL
Indicates that the affected pack has failed.

TRIM AIR FAIL
Indicates that one trim air valve and one hot air SOV are failed.

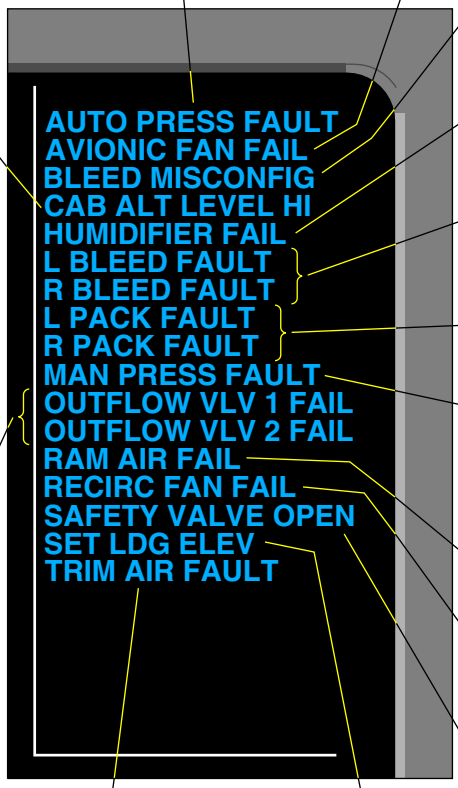
TRIM AIR LEAK
Indicates that a leak has been detected in the trim air ducts.

WING A/ICE LEAK
Bleed leak detected in wing A/I duct.

XBLEED FAIL
Indicates that the bleed crossfeed has failed, open or closed.

GF0210_085b

BLEED/AIR CONDITIONING/PRESSURIZATION EICAS MESSAGES (CONT'D)



AUTO PRESS FAULT
Indicates that one channel of the cabin pressure automatic control is inoperative.

AVIONICS FAN FAIL
Indicates that the avionics fan has failed.

BLEED MISCONFIG
Indicates that the bleed air configuration is incorrect for operation.

CAB ALT LEVEL HI
Indicates that CABIN ALT warning and caution levels have been reset for high altitude landing and take-off.

HUMIDIFIER FAIL
Indicates that the humidifier in the cooling pack has failed.

L – R BLEED FAULT
Indicates that there is a loss of redundancy in the bleed system.

L – R PACK FAULT
Indicates that the affected pack has a fault.

MAN PRESS FAULT
Indicates that one of the two altitude limiters is inoperative. If the airplane is above 20,000 feet, the affected outflow valve, will close automatically.

RAM AIR FAIL
Indicates that the ram air valve is failed in last selected position.

RECIRC FAN FAIL
Indicates that the recirculation fan has failed due to an underspeed.

SAFETY VALVE OPEN
Indicates that safety valve 1 or 2 is not fully closed.

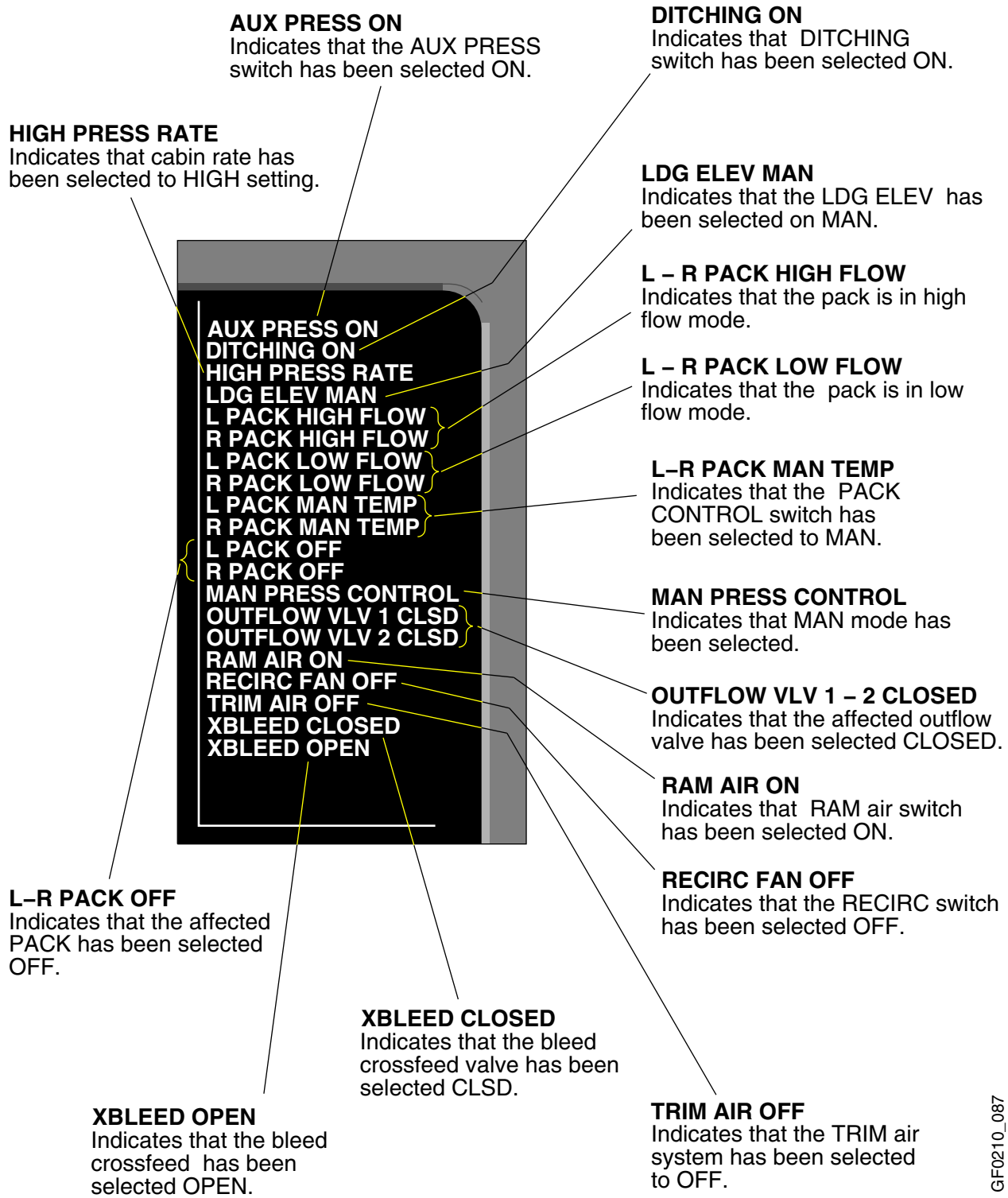
OUTFLOW VLV 1–2 FAIL
Indicates that the affected outflow valve has failed.

SET LDG ELEV
Indicates that landing information has not been received from FMS, or LDG ELEV is selected to MAN and no value was selected.

TRIM AIR FAULT
Indicates that there is a trim air fault.

GF0210_086

BLEED/AIR CONDITIONING/PRESSURIZATION EICAS MESSAGES (CONT'D)



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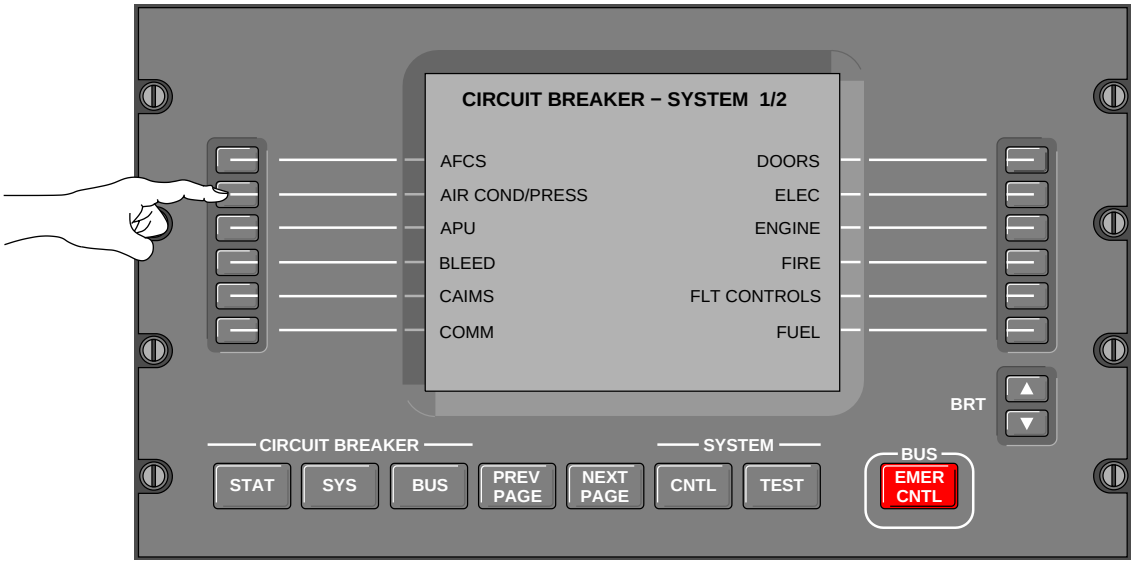
CB - AIR COND/PRESS SYSTEM



CB − AIR COND/PRESS SYSTEM 1/5

AUTO PRESS 1	DC ESS	IN
AUTO PRESS 2	DC ESS	IN
AVIONICS FAN	AC 4	IN
CAB TEMP SENSOR	DC 1	IN
CKPT TEMP SENSOR	DC 2	IN
GALLEY FAN	DC 2	IN

CB − AIR COND/PRESS SYSTEM 2/5

HUMIDIFIER	DC 2	IN
L ECS HASOV	DC ESS	IN
L ECS PRESS XDCR	DC 1	IN
L FOOTWARMER	DC 1	IN
L PACK CTL VLV	DC ESS	IN
L PACK CTLR CH A	DC 1	IN

CB − AIR COND/PRESS SYSTEM 3/5

L PACK CTLR CH B	DC 2	IN
L PACK DUCT HEAT	DC 2	IN
L RECIRC FAN	AC 1	IN
MAN OUTFLOW VLV	BATT	IN
MAN PRESS 1	BATT	IN
MAN PRESS 2	BATT	IN

CB − AIR COND/PRESS SYSTEM 4/5

R ECS HASOV	DC ESS	IN
R ECS PRESS XDCR	DC 2	IN
R FOOTWARMER	DC 2	IN
R PACK CTL VLV	DC ESS	IN
R PACK CTLR CH A	DC 2	IN
R PACK CTLR CH B	DC 1	IN

CB − AIR COND/PRESS SYSTEM 5/5

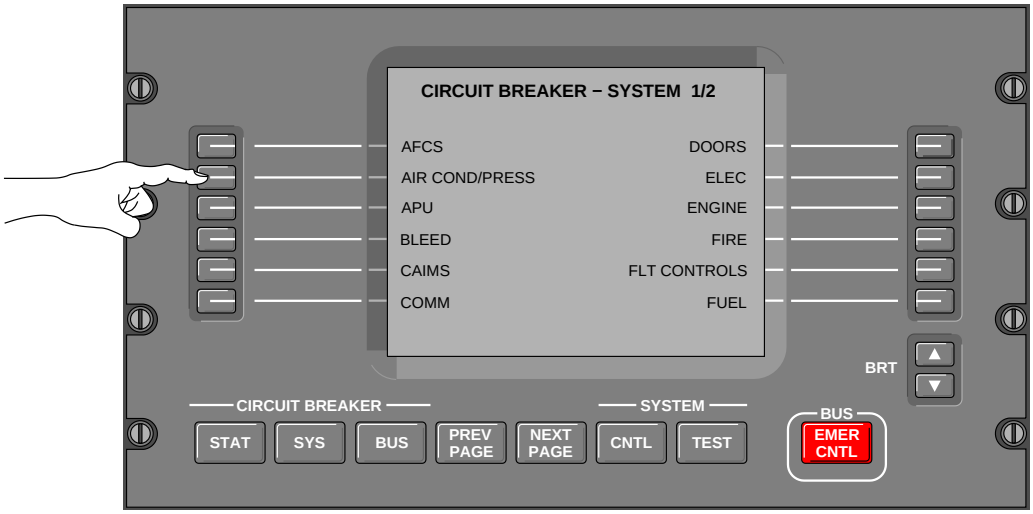
R PACK DUCT HEAT	DC 1	IN
R RECIRC FAN	AC 4	IN
RAM AIR VLV	DC ESS	IN
TOILET FAN	DC 1	IN
TRU BAY FAN	AC 1	IN
TRU BAY FAN CTL	DC 2	IN

GF0220_001

CB - AIR COND/PRESS SYSTEM (CONT'D)

Effectivity:

- *Airplanes 9002 thru 9122* ***not incorporating*** *Service Bulletin:*
  - *SB 700−24−045, AC and DC Power Distribution − Unit Change and Activation of Build 4 Electrical System.*



CB − AIR COND/PRESS SYSTEM 1/5

AUTO PRESS 1	DC ESS	IN
AUTO PRESS 2	DC ESS	IN
AVIONICS FAN	AC 4	IN
CAB TEMP SENSOR	DC 1	IN
CKPT TEMP SENSOR	DC 2	IN
GALLEY FAN	DC 2	IN

CB − AIR COND/PRESS SYSTEM 2/5

HUMIDIFIER	DC 2	IN
L ECS HASOV	DC ESS	IN
L ECS PRESS XDCR	DC 1	IN
L FOOTWARMER	DC 1	IN
L PACK CTL VLV	DC ESS	IN
L PACK CTLR CH A	DC 1	IN

CB − AIR COND/PRESS SYSTEM 3/5

L PACK CTLR CH B	DC 2	IN
L PACK DUCT HEAT	DC 2	IN
L RECIRC FAN	AC 1	IN
MAN OUTFLOW VLV	BATT	IN
MAN PRESS 1	BATT	IN
MAN PRESS 2	BATT	IN

CB − AIR COND/PRESS SYSTEM 4/5

R ECS HASOV	DC ESS	IN
MR ECS PRESS XDCR	DC 2	IN
R FOOTWARMER	DC 2	IN
R PACK CTL VLV	DC ESS	IN
R PACK CTLR CH A	DC 1	IN
R PACK CTLR CH B	DC 2	IN

CB − AIR COND/PRESS SYSTEM 5/5

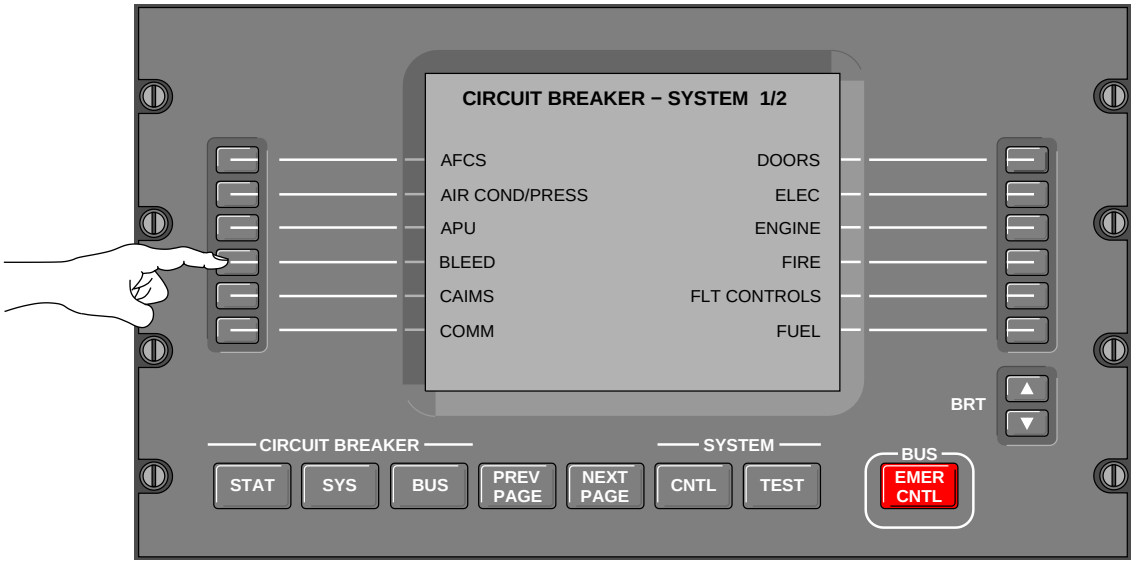
R PACK DUCT HEAT	DC 1	IN
R RECIRC FAN	AC 4	IN
RAM AIR VLV	DC ESS	IN
TOILET FAN	DC 1	IN
TRU BAY FAN	AC 1	IN
TRU BAY FAN CTL	DC 2	IN

NOTE

The EMS CDU indicates R PACK CTLR CH A is on DC BUS 1 and R PACK CTLR CH B is on DC BUS 2, of SPDA # 3. The EMS CDU should indicate R PACK CTLR CH A on DC BUS 2 and R PACK CTLR CH B on DC BUS 1.

GF0220_002

CB - BLEED SYSTEM



CB − BLEED SYSTEM		1/2
L BMC CH A	DC 1	IN
L BMC CH B	DC 2	IN
L BMC SENSORS	DC ESS	IN
L ENG BLEED VLV	DC ESS	IN
L ENG HP VLV	DC ESS	IN
R BMC CH A	DC 2	IN

CB − BLEED SYSTEM		2/2
R BMC CH B	DC 1	IN
R BMC SENSORS	DC ESS	IN
R ENG BLEED VLV	DC ESS	IN
R ENG HP VLV	DC ESS	IN
XBLEED CTL	BATT	IN
XBLEED VLV	BATT	IN

GF0220_003

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