INTRODUCTION

The environmental control system (ECS) provides regulated conditioned air to the flight deck and passenger cabin by using an air conditioning package (PACK).

Aircraft pressurization is accomplished by regulating the overboard discharge of the conditioned air.

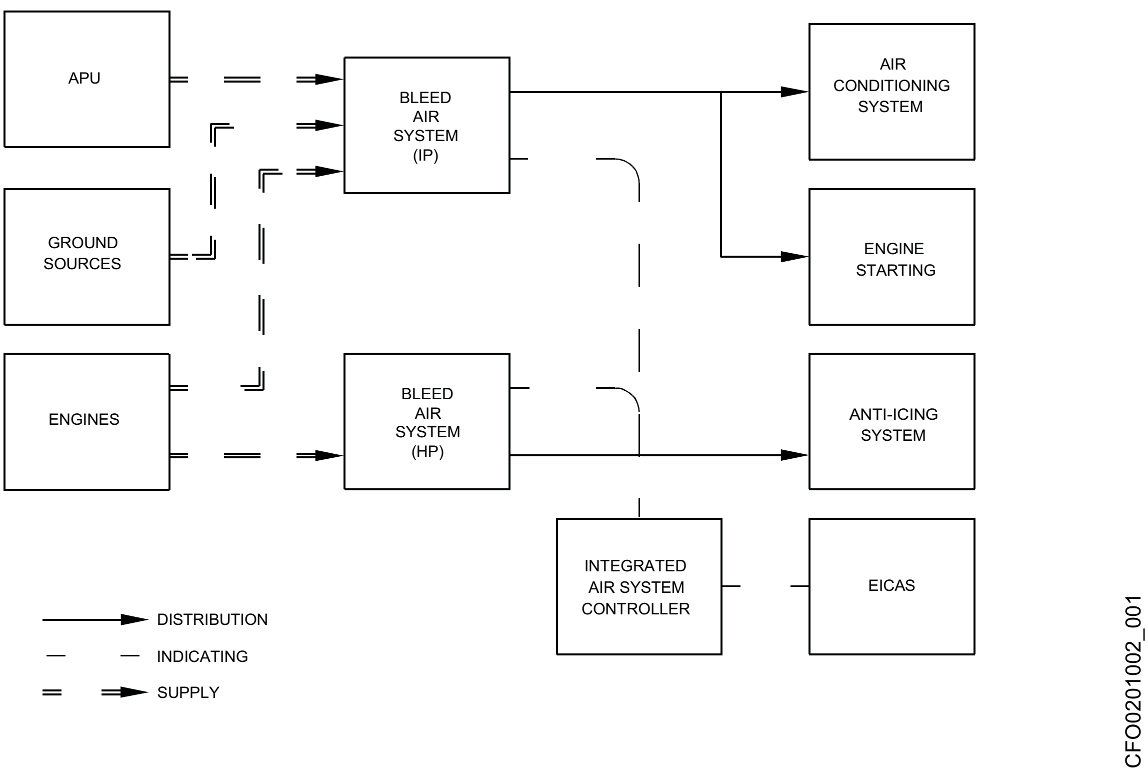
Ventilation is provided for the electronic equipment on the flight deck and avionics racks.

BLEED AIR SYSTEM

DESCRIPTION

High pressure (HP) bleed air is routed through high pressure valves in the ducting to the wing anti-ice system. Intermediate pressure (IP) air is routed through intermediate pressure valves to the environmental control system (ECS).

The IP ports of the engine supply a common manifold (isolated left and right by the cross bleed valve) that can also be supplied by the APU or an external ground cart. Regulating valves and check valves are installed in the aft equipment bay ducting to control bleed air from the left and right engines and APU. The IP bleed air system also includes air control switches and a leak detection system. Pressure sensors in the bleed air lines send information to the integrated air system controller (IASC) which processes the information for display on the EICAS.

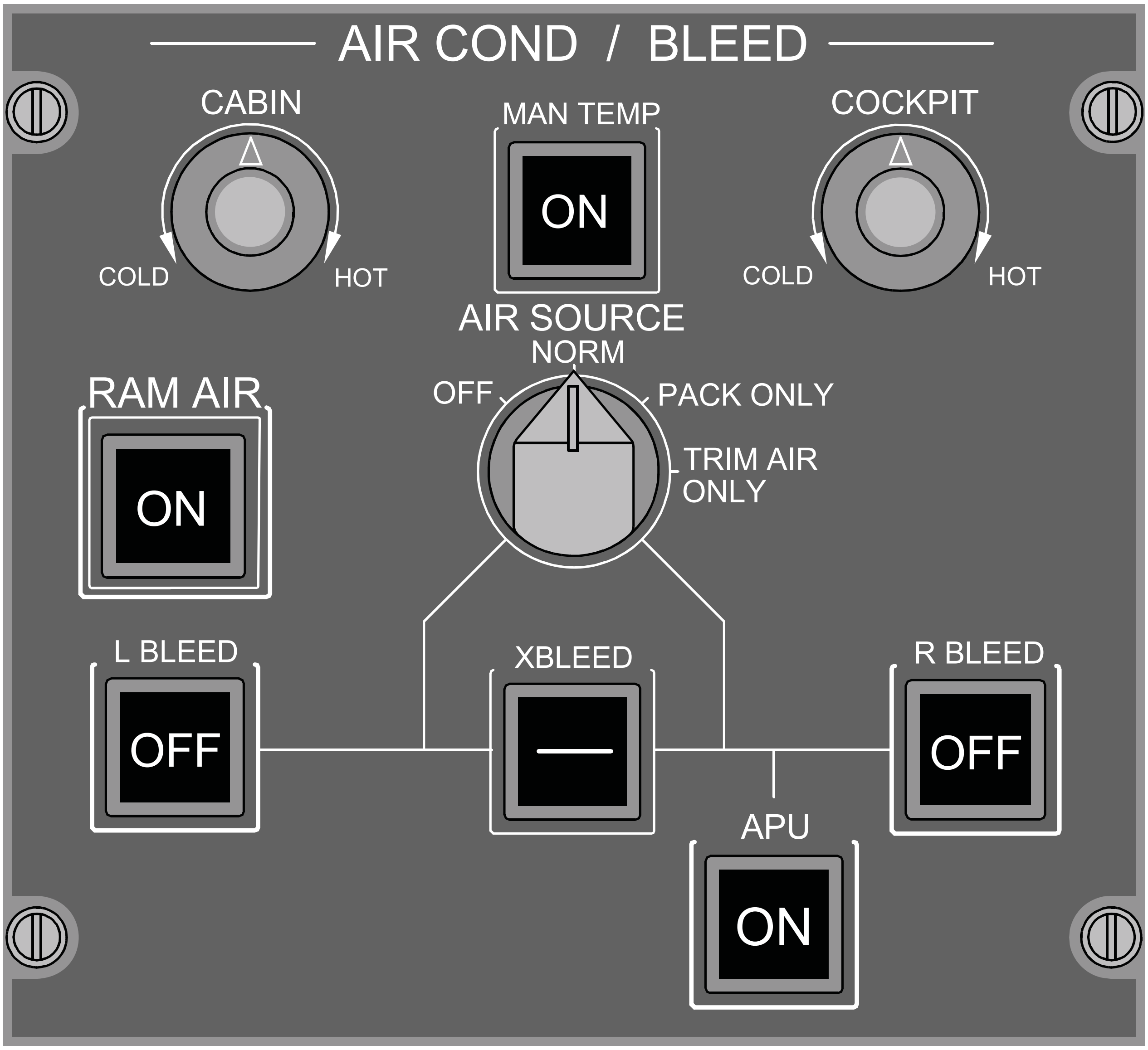


BLEED AIR DISTRIBUTION

DESCRIPTION

Air for operation of the aircraft IP bleed air system is distributed by a common manifold. Bleed air management, which consists of bleed source selection, valve operation, and air distribution, is controlled by two integrated air management system controllers (IASC).

The aircraft IP bleed air system is controlled from the AIR COND/BLEED panel. Cabin and cockpit temperatures controls range from 15 °C to 35 °C in normal mode and 10 °C to 70 °C in manual mode.



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BLEED AIR DISTRIBUTION (Cont)

COMPONENTS AND OPERATION

BLEED AIR MANIFOLD

The bleed air manifold is located in the engine pylons and aft equipment bay and is divided into the right side and left side by the crossbleed (XBLEED) valve. The engines provide bleed air to their respective sides of the manifold and the APU and ground air cart provide air into the right side of the crossbleed valve.

EXTERNAL GROUND AIR CONNECTOR

An external air connector is located aft of the equipment bay door on the exterior surface of the fuselage.

The external ground air connector and duct are not depicted on the ECS synoptic displays. However, when external air is connected, the air pressure is displayed as a manifold pressure digital readout on the ECS synoptic page.

CHECK VALVES

Four check valves are installed in various locations in the bleed air ducting.

An intermediate pressure check valve is installed in each engine bleed air duct to prevent reverse flow into the engines. Check valves are installed at the external air connector and in the APU bleed air duct. The check valve at the external connector prevents the loss of air to the atmosphere. The check valve in the APU duct prevents the reverse flow of manifold air to the APU when the APU is shut down.

Check valves are not represented on the ECS or A/ICE synoptic displays.

INTERMEDIATE PRESSURE VALVES

Engine bleed air pressure increases proportionally with N_2 compressor speed. The pressure regulating function of the intermediate pressure valve limits the engine discharge pressure to 50 ± 3 psi. When N_2 compressor speed is low and the engine bleed air pressure is less than the regulated value, and at least 10 psi or greater, the valve is fully open.

The valves are pneumatically operated and electrically controlled by the L (R) BLEED switches on the air cond/bleed panel.

The bleed air valves are in a closed position when:

- Aircraft engines are shutdown
- Power is lost to valves
- Associated ENG FIRE switch is selected
- Bleed air valves are selected closed at the AIR COND/BLEED control panel.

HIGH PRESSURE VALVES

The high pressure valves regulate the engine high pressure bleed to 36 ± 3 psi. This high pressure air is then routed to the wing anti-ice system.

The valves are pneumatically operated and electrically controlled by the WING SOURCE switch and WING switch on the ANTI-ICE control panel.

The high-pressure valves are in a closed position when:

- Aircraft engines are shutdown
- Power is lost to valves
- Associated ENG FIRE switch is selected
- Bleed air valves are selected closed at the ANTI-ICE control panel via the WING switch.

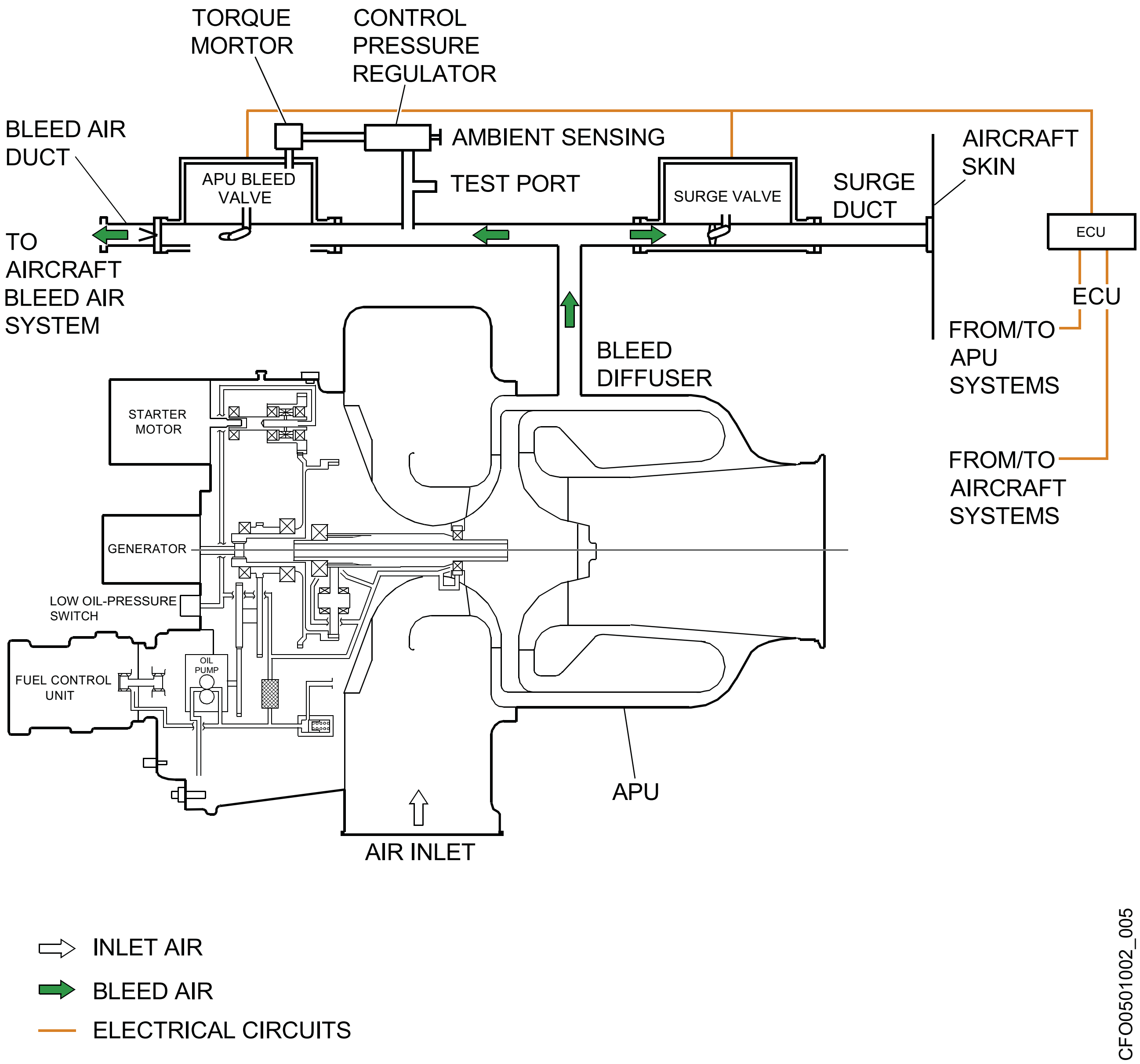
BLEED AIR DISTRIBUTION (Cont)

APU BLEED VALVE

The APU bleed valve is controlled by the APU electrical control unit (ECU). The amount of bleed air taken from the APU is controlled by the ECU sensing APU exhaust temperature. The APU bleed switch on the AIR COND/BLEED control panel sends a signal to the ECU. The ECU determines when the APU is ready for bleed air loading and controls the opening, closing, and modulation of the APU bleed valve.

When the APU bleed valve is open, APU bleed air is delivered to the right side of the bleed air manifold.

When the APU is shut down or there is a loss of signal from the ECU, the APU bleed valve moves to a fail-safe closed position.



BLEED AIR MANAGEMENT

Bleed air management is primarily ensured through pilot selections on the control panel, and consists of the control and monitoring of the valves controlling bleed air source selection. Bleed air valves are controlled from the AIR COND/ BLEED control panel and include the following:

- L (R) BLEED valves
- XBLEED valve
- APU valve (via the ECU)

INTEGRATED AIR SYSTEM CONTROLLERS

The Integrated Air System Controllers (IASC)s ensure overall system control and monitoring. There are two units in the aircraft, one located under the floor, and the other under the liner of the lavatory, above the floor. The units gather air conditioning and bleed air control functions, and monitor cabin pressure and airframe ice protection functions. IASC 1 monitors the left high pressure valve and left intermediate pressure valve; IASC 2 monitors the right high pressure valve and right intermediate pressure valve.

Each IASC consists of two channels and monitors the following system operations:

- Channel A is dedicated to the Environmental Control System and Cabin Pressure Control
- Channel B is dedicated to the wing anti-icing monitoring and control and leak detection monitoring

Bleed Air for the wing anti-ice system is controlled at the ANTI-ICE control panel which is linked to the high pressure valves.

ENGINE BLEED AIR PRESSURE REGULATION

Engine air pressure increases proportionally with N_2 compressor speed. The IPV limits the intermediate engine bleed pressure to 50 $\pm$ 3 psi. If a valve fails and manifold pressure exceeds 60 psi, a L (R) BLEED FAIL (C) CAS message is displayed.

APU/ENGINE BLEED SWITCHING

All bleed switching is done manually by the aircrew.

ENGINE START SEQUENCES

During engine starts on the ground, provided a bleed source has been selected, engaging the engine start switch will automatically sequence the valves to isolate the air conditioning system and allow bleed air to flow to the air turbine starters.

When the L (R) STARTER switch is positioned to START, the following occurs:

- Cross bleed valve opens (if previously closed)
- Flow control valves close (if previously open)
- Associated start valve opens
- Engine air turbine starter (ATS) engages

When the engine achieves a self-sustaining rpm, the ATS disengages, the start valve closes, and the flow control and cross bleed valves return to the previous position. Cross-engine bleed air (from one engine to the other) can be used to power the starter. Interstage bleed air, taken from the selected engine is used for cross-engine bleed starting.

APU/ENGINE BLEED SWITCHING SEQUENCE

Takeoffs and landings are normally done with APU bleed air switch On and engine bleed air switch Off. During climb, the pilot switches the XBLEED CLOSED, L BLEED On, APU bleed Off, R BLEED On and the APU OFF.

During approach, the pilot starts the APU and switches the R BLEED switch OFF, APU BLEED ON, L BLEED switch OFF, and the XBLEED switch OPEN.

APU BLEED VALVE OPERATION

Bleed air from the APU can be used for engine starting and air conditioning. The APU electronic control unit (ECU) controls the bleed valve and energizes the bleed air supply system and supplies compressed air from the APU power section to the applicable aircraft system through the bleed air duct. The load control valve is connected to the compressor outlet of the APU. When the load control valve is open, the ECU adjusts the butterfly plate position to supply the correct quantity of bleed air. These adjustments are controlled by the required quantity of the bleed air load and the APU exhaust gas temperature.

BLEED AIR LEAK DETECTION SYSTEM

DESCRIPTION

The bleed leak detection system monitors the bleed air and anti-ice ducts for leakage. The bleed leak detection system is controlled by the integrated air system controllers (IASC) and is fully automatic.

The bleed air leak detection system is divided into eight zones for EICAS presentation:

- Left bleed duct
- Right bleed duct
- Left wing anti-ice duct
- Right wing anti-ice duct
- Right pylon duct
- Left pylon duct
- Pack ducts
- Trim air ducts

COMPONENTS AND OPERATION

SINGLE LOOPS

Single loops are used for left and right bleed ducts and trim air ducts.

DUAL-SENSING LOOPS

Dual-sensing loops are used to monitor the following:

- Bleed air ducts in the engine pylons
- Bleed air ducts in the aft equipment bay
- Anti-ice ducts in the aft equipment bay
- Anti-ice ducts in the wing leading edges.

The dual-loop system minimizes false leak indications, and allows the aircraft to be dispatched under certain conditions with one loop inoperative. A loop FAIL indicates both loops inoperative. A loop FAULT indicates one loop inoperative.

BLEED AIR AND ANTI-ICE DUCTS

The bleed air ducts are constructed of stainless steel, titanium or aluminum and wrapped with insulation. A series of vent holes in the duct covers direct escaping bleed air to the sensing loops in the event of a bleed air leak.

TRIM AIR SYSTEM

DESCRIPTION

The trim air system provides auxiliary pressurization and temperature control in the event of complete loss of the air conditioning pack. It provides hot trim air for normal cabin temperature control and cabin pressurization.

COMPONENTS AND OPERATION

The subsystem is comprised of trim air ducting, two hot air regulating shutoff valves (HARSOV), two hot air check valves (HACKV), and three trim air injectors. Most of the components are located in the aft equipment bay.

The trim air system ducts the air from the precooler outlet (trim air side) towards two lines, one feeding the cabin low pressure distribution line and one feeding the cockpit low pressure distribution line, respectively, through two trim air injectors for the cabin supply, and one trim air injector for the cockpit supply. Each of these lines is fitted with one HARSOV, which modulates the hot air flow to adjust the air supply temperature to ensure temperature control. The valves are fitted on the trim air ducts in the unpressurized aft equipment bay.

The HACKVs are used to isolate the pressurized area of the aircraft from the unpressurized rear bay of the aircraft to prevent cabin decompression in the case of a trim air supply duct failure. The HACKs are located just down stream from the trim air bulkhead.

AIR CONDITIONING SYSTEM

DESCRIPTION

The air conditioning system uses hot pressurized bleed air to create a controlled atmosphere within the aircraft. Pressurized air from either the engines, the APU, or a ground cart is used to control the temperature within the aircraft. The pressurized air is sent through an air cycle machine (PACK) which cools the air to just above freezing. This cold air is then mixed with hot trim air to provide conditioned air at the desired temperature. Two integrated air system controllers (IASC) control a series of bleed air valves, flow control valves, the air cycle machine, the trim air valves, and the ram air regulating valve. The IASCs also control the bleed leak detection, wing anti-ice and cabin pressurization functions.

Independent temperature control systems for the COCKPIT and CABIN can be controlled in both automatic and manual modes from the AIR COND/BLEED control panel located on the center pedestal.

COMPONENTS AND OPERATION

INTEGRATED AIR SYSTEM CONTROLLERS

Two integrated air system controllers (IASCs) monitor and control the air conditioning systems.

Each controller has two channels, A and B. Channel A is dedicated to air conditioning control and monitoring, avionics cooling and cabin pressurization. Channel B is dedicated to wing anti-ice control and monitoring, bleed leak detection and limited backup control of the air conditioning system. IASC 1 channel B also has a backup cabin pressure sensor.

AIR CONDITIONING SYSTEM (Cont)

AIR CONDITIONING PACK

The air conditioning pack (PACK) provides conditioned air for the fuselage compartments by decreasing the temperature and water content of the bleed air used in the conditioning process.

The PACK is supplied with pre-cooled bleed air, for cabin air conditioning and cabin pressurization.

On leaving the precooler, bleed air is ducted into the PACK, at the primary heat exchanger inlet. The primary heat exchanger is used to reduce bleed air temperature. On leaving the primary heat exchanger, the bleed air is directed into the compressor of the air cycle machine, where the temperature and pressure increases.

The air then flows through the secondary heat exchanger, where a pressure loss occurs and the temperature is reduced by exchanging heat with the ram air before flowing to the reheater/condenser.

At the condenser outlet, the condensed water is extracted by centrifugal effect in the water extractor then routed to the reheater cold air pass where air temperature increases prior to entering the air cycle machine.

The air is then expanded through the turbine of the air cycle machine to a pressure close to cabin air pressure, and subsequently, the air temperature is reduced.

From the turbine outlet, the air flows through the condenser heat exchanger where it is used as a coolant for the water separation loop.

The air temperature at the PACK discharge can be adjusted by opening or closing the temperature control valve. The temperature control valve modulates the hot air flow which by-passes the air cycle machine between the primary heat exchanger inlet and the air cycle machine turbine outlet.

The ram air is supplied upstream of the dual heat exchanger by the ram air system. It then flows through the dual heat exchanger and is collected by the plenum.

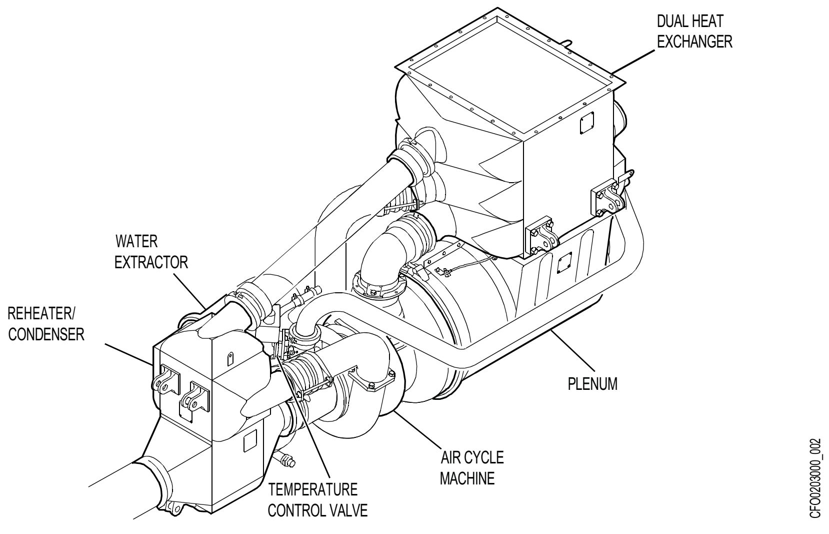
On ground static aircraft operation, the ram air flow is generated by the suction effect of the air cycle machine fan. This suction closes the plenum check valve. Whenever dynamic air is available at ram air inlet, the plenum check valve opens, and the air cycle machine fan is by-passed; the ram air is then driven by the total pressure available at ram air inlet.

Upon leaving the plenum, the air is ducted towards the dual pre-cooler heat exchanger, then ducted overboard.

FLOW CONTROL VALVES

Flow control valves (FCVs), are used to control the mass airflow through the PACK and TRIM AIR system. The flow control valves are electrically controlled, pneumatically operated, modulating shutoff valves. The AIR SOURCE selector on the AIRCOND/BLEED control panel operate the opening and closing of these valves.

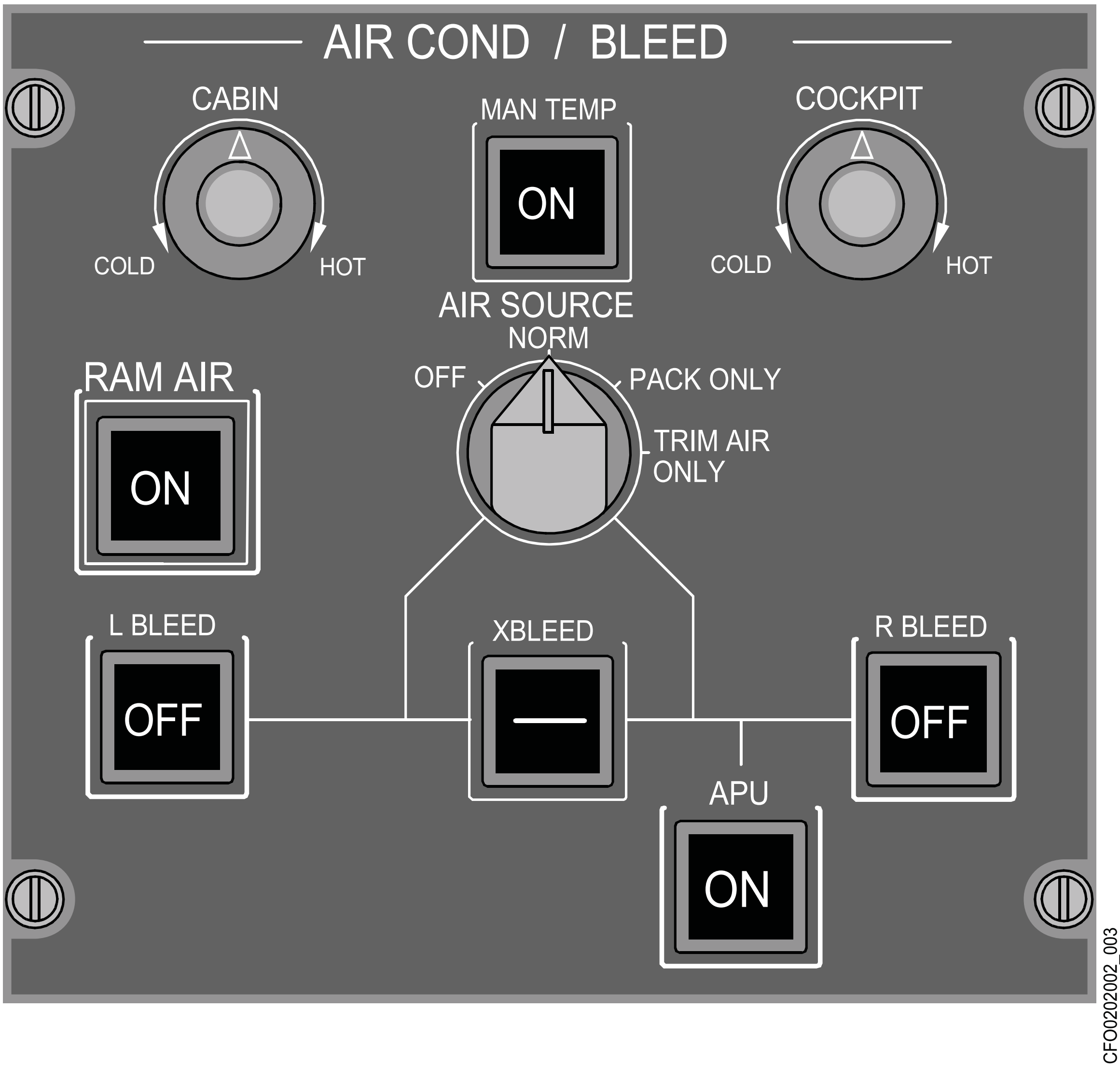
The FCVs are automatically closed when the engine START switch is selected. Shutting down the air conditioning system, ensures that the air turbine starters (ATS) receive sufficient airflow for starter operation. When the start valve closes, the air source returns to the previous selection.



AIR CONDITIONING SYSTEM (Cont)

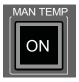
AIR CONDITIONING CONTROLS

Controls for the air conditioning system are located at the AIR COND/BLEED panel on the center pedestal.



AIR CONDITIONING SYSTEM (Cont)

Temperature selectors — Used to select desired temperature for the cockpit and cabin.



MAN TEMP — Used when automatic temperature control using cabin or cockpit ventilation sensors is not working.

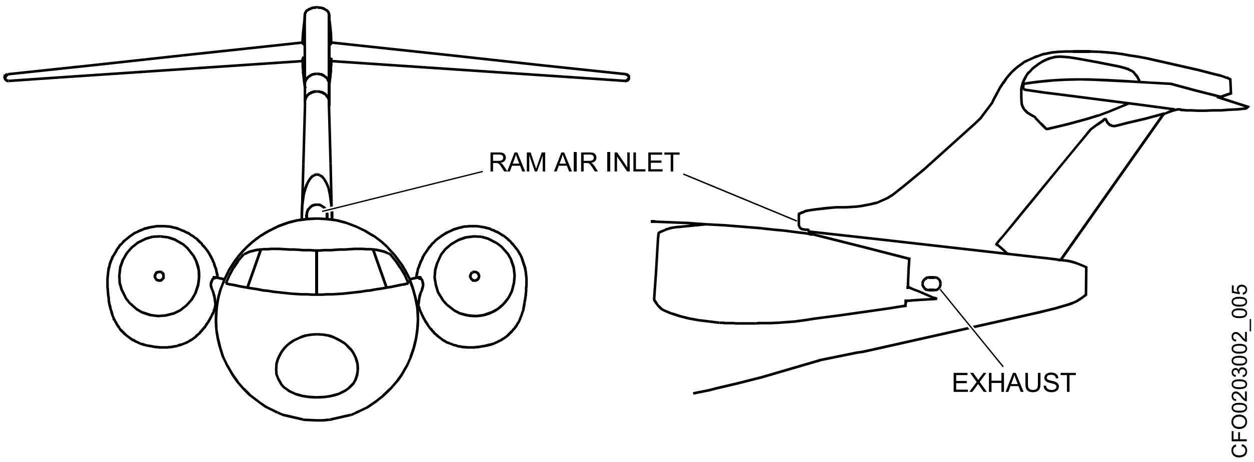
AIR SOURCE selector —

- **OFF** - both flow control valves will be closed, preventing bleed air for pressurization and air conditioning from entering the cabin
- **NORM** - The normal switch position. This setting allows bleed air from the left and right sides of the manifold to flow through the PACK and the TRIM AIR valves, providing conditioned air to the cabin
- **PACK ONLY** - Opens the left flow control valve and closes the right flow control valve and precooler crossover valve (PCV), resulting in all bleed air flowing through the PACK and none through the trim air valves. This selection is used when a TRIM AIR failure exists. A PACK ONLY (S) CAS will be displayed.
- **TRIM AIR ONLY** - Opens the right flow control valve and closes the left flow control valve and (PCV), resulting in all bleed air flowing through the trim air valves and none through the PACK. This selection is used when a PACK failure exists. A TRIM AIR ONLY (S) CAS will be displayed.

RAM AIR INLET

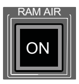
Ram air enters the aircraft at the ram air inlet at the base of the vertical fin. Ram air is used as the cooling medium for the air-to-air heat exchangers. Ram air passes through the secondary, primary, and precooler heat exchangers where heat is extracted from the air circulated through the air conditioning system. After passing through the heat exchangers, the air is discharged overboard through the exhaust vents.

On the ground, airflow through the ram air inlet is inadequate for cooling the heat exchangers. A fan located in the ram air duct, mechanically driven by the air cycle machine, increases airflow through the duct to cool the heat exchangers.



RAM AIR VALVE

If the air conditioning system fails, ram air can be used to ventilate the cockpit and cabin at low altitude. After descending below 10 000 ft, selecting the guarded RAM AIR switch to ON opens the ram air valve to provide air flow into the aircraft.



RAM AIR — Used to provide ambient air to ventilate the cockpit and cabin, in the event of PACK and TRIM AIR failure.

AIR CONDITIONING SYSTEM (Cont)

PNEUMATIC SOURCES

IN FLIGHT OPERATIONS

The engines can provide bleed air at all altitudes. The APU can provide bleed air up to 20 000 ft.

GROUND OPERATIONS

The air conditioning PACK can be operated with air from the APU, aircraft engines, or external ground cart. However, due to low pressure from the engines at ground idle, it is recommended to use the APU during ground operations.

AIR DISTRIBUTION AND EXHAUST SYSTEM

The Air Distribution and Exhaust System is used to distribute, and ensure air exhaust of conditioned air to the flight deck, cabin, and lavatory areas. The system is consists of low pressure ducting installed below and above the aircraft floor.

FLIGHT DECK DISTRIBUTION

Flight deck air distribution is ensured by a duct connected to the bulkhead check valve manifold. This duct runs under the aircraft floor, from the aft pressure bulkhead area to the cockpit. Air is then distributed by outlets at foot and leg level, on each side of the instrument panel, and a grill outlet on each side console. There are also overhead gaspers that distribute cold air only. All other outlets are temperature controlled.

PASSENGER CABIN DISTRIBUTION

Cabin air distribution is provided by two main lines connected to the bulkhead check valve manifold. These lines provide air at foot and head level. Air distribution from the overhead gaspers is cold air only. Air from provided at floor level is temperature controlled. The upper feed line runs upwards between the aircraft skin and the liner of the cargo compartment and is integral to the interior furniture located on either side of the aircraft at head level.

LAVATORY VENTILATION

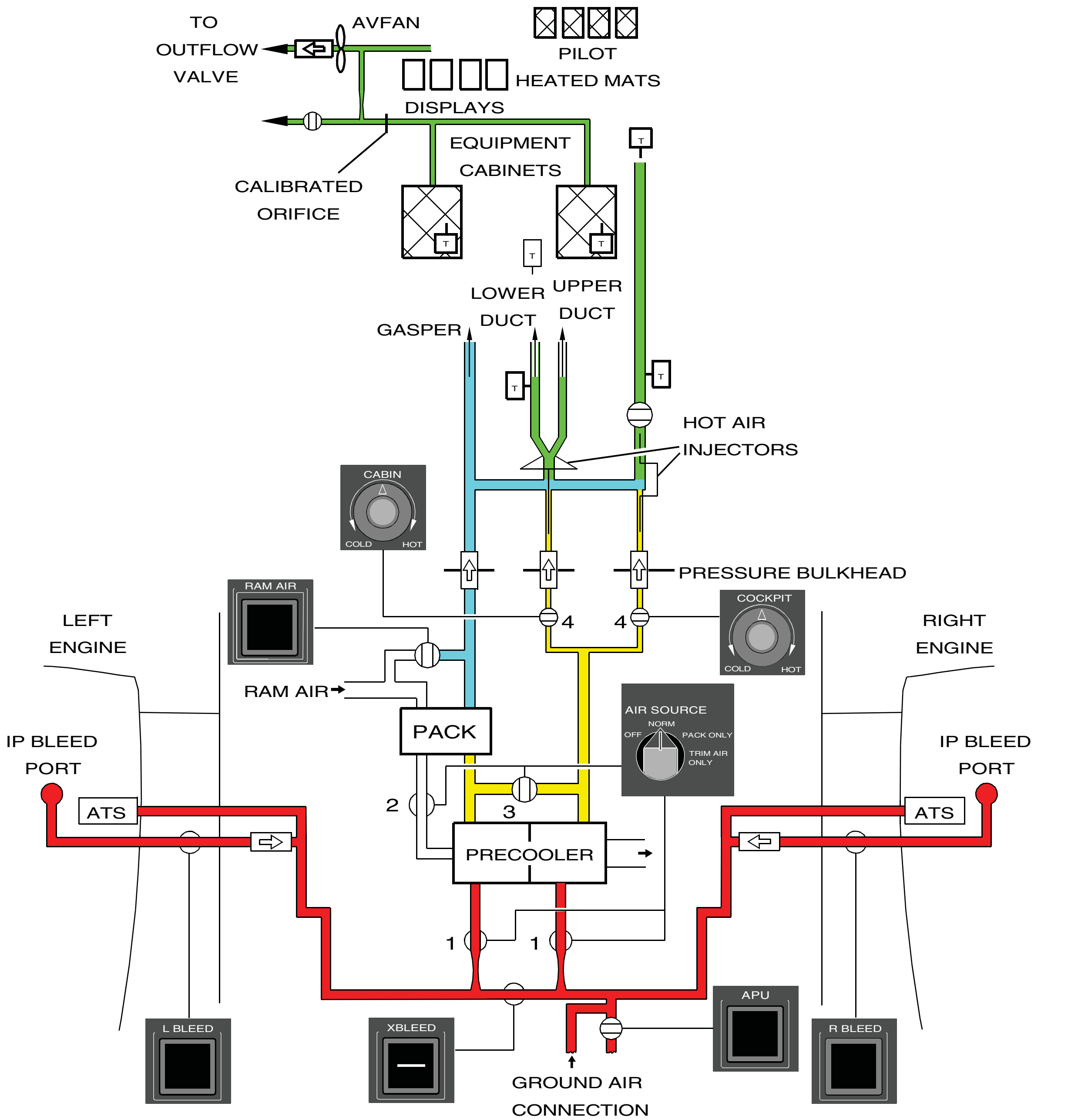
A gasper supplies fresh air to the lavatory compartment.To avoid unpleasant odors in the passenger cabin, more air from the lavatory is exhausted underfloor than is supplied by the conditioned air system. A vent is installed in the lavatory wall to equalize pressure.

AIR EXHAUST AND VENTILATON PATH

After fresh air is supplied to the cabin and cockpit, it is dumped overboard through the cabin pressure control system. The air path in the cabin is designed for optimum comfort of the passengers and crew and optimum equipment ventilation management. Cabin exhaust air to the under-floor area and outflow valve is ensured through holes in the floor sill. Some of the cabin air exhaust is also directed under the floor, to ventilate and heat the battery compartment, and directly dumped overboard through the avionics valve. Cockpit exhaust air to the under-floor area and outflow valve is ensured through holes in the cockpit floor and center pedestal. Air circulation is also provided at the back of the cockpit displays through specially designed grilles.

AIR CONDITIONING SYSTEM (Cont)

COCKPIT/CABIN AIR DISTRIBUTION SCHEMATIC



LEGEND

- Temperature Sensor
- Shutoff Valve
- Check Valve
- Intermediate Pressure Bleed Aair
- Ram Air
- Conditioned Air
- Cold Air
- Precooled Air

1- Flow Control Valves
2- Pack Valve
3- Precooler Crossover Valve
4- Trim Air Valve

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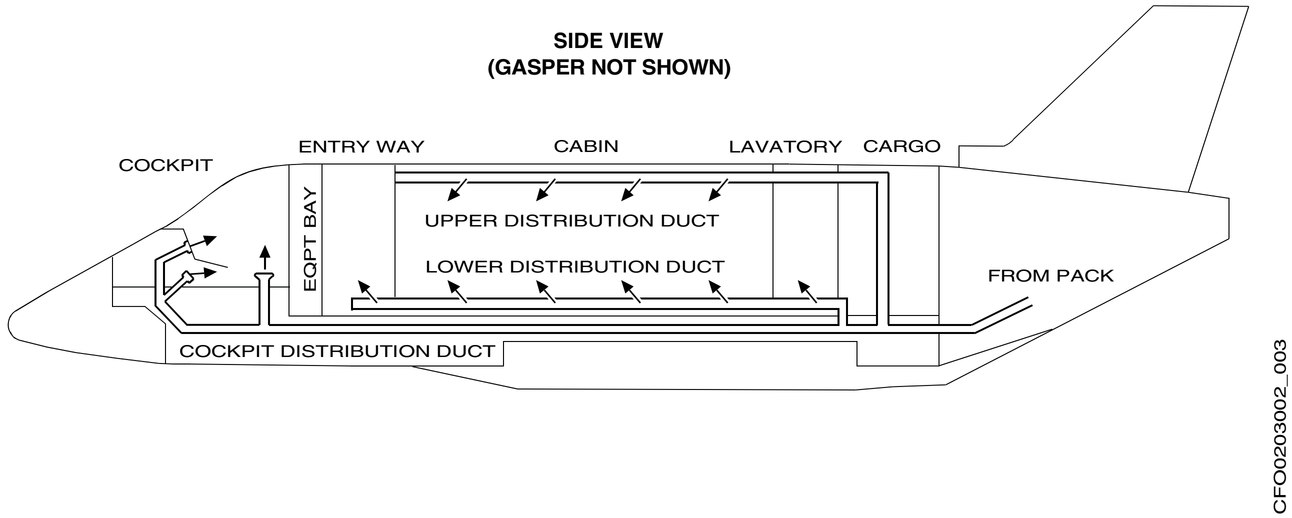
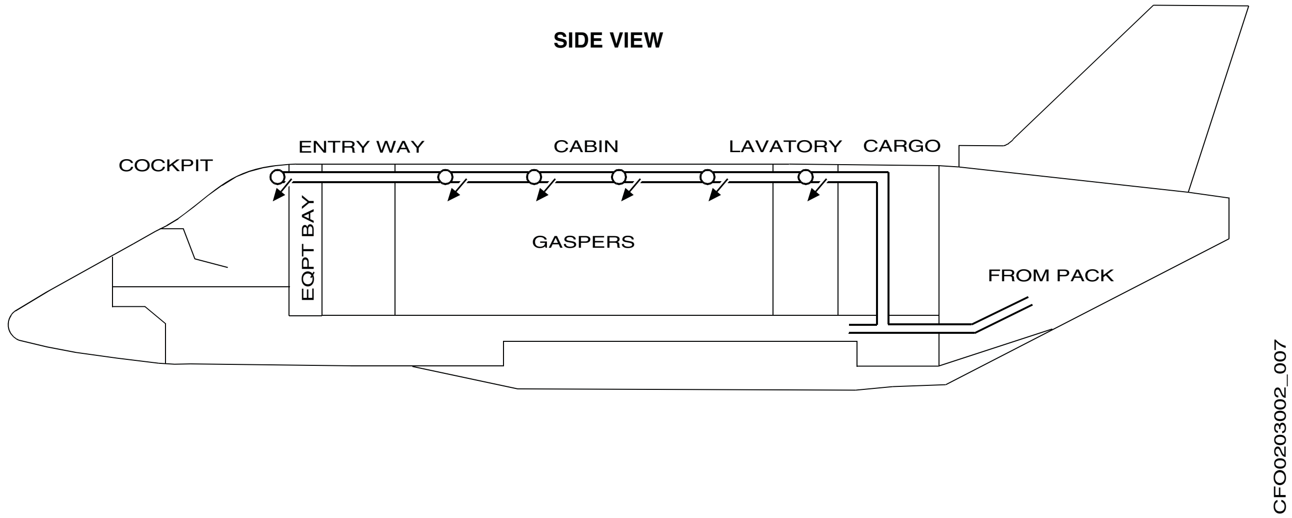
AIR CONDITIONING SYSTEM (Cont)

AIR DISTRIBUTION AND FLOW PATHS

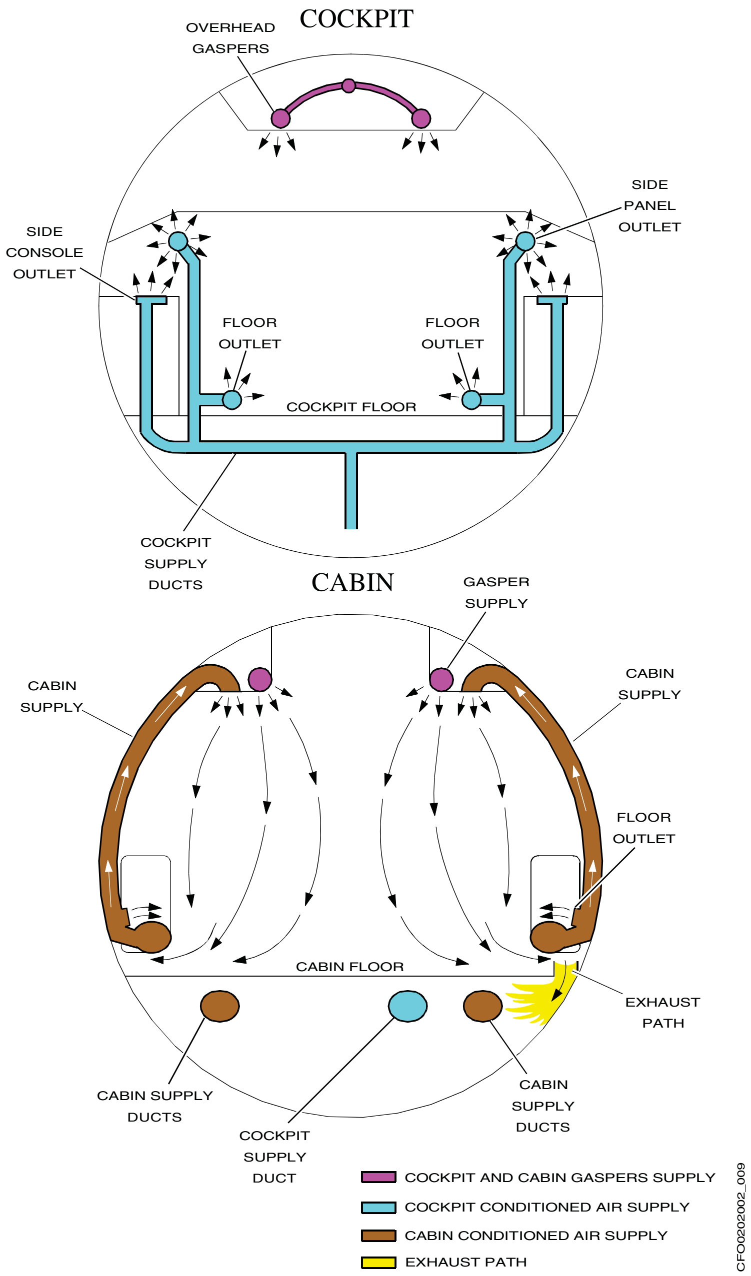


CABIN DISTRIBUTION SYSTEM



AIR CONDITIONING SYSTEM (Cont)

AIR DISTRIBUTION AND FLOW PATHS (Cont)



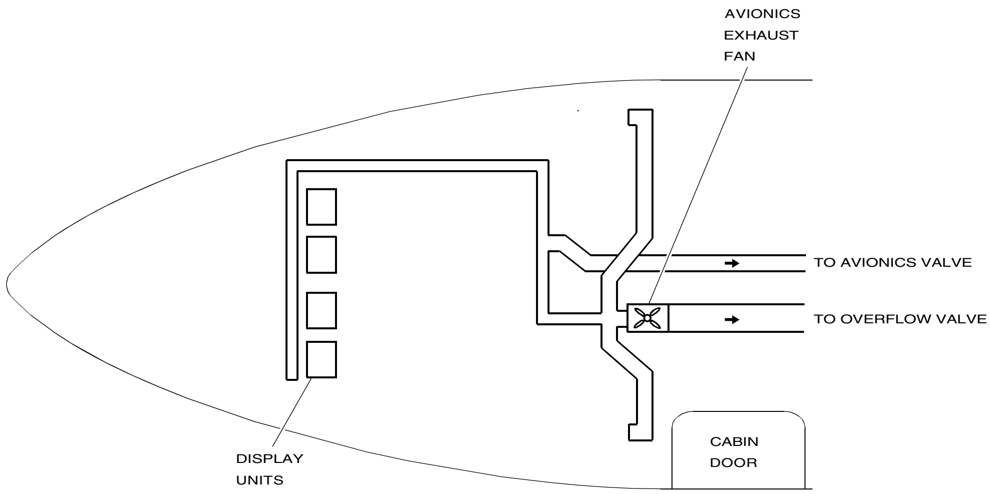
AVIONICS AND COCKPIT DISPLAYS VENTILATION

DESCRIPTION

The avionics and cockpit displays cooling system ensures the ventilation of the avionics and displays in order to comply with aircraft reliability and safety requirements.

The system consists of an underfloor fan and avionics cooling valve, either of which pulls air from the cockpit panel area behind the displays and from above the avionics racks. During ground operations, the fan is operated in high speed mode. During flight the fan is operated at low speed unless the temperature in the avionics racks reaches 122 °F (50 °C) in 60 seconds, then the fan operates at high speed. If the temperature rises above 149 °F (65 °C) during a 60 second time period while the aircraft is above 10 000 ft the fan is turned off and the avionics cooling valve is opened by the IASC. If the fan or valve fails, an EQPT RACK COOL FAULT (A) CAS message is displayed. If an overheat condition occurs in the avionics rack, an EQPT RACK TEMP HIGH (C) CAS message is displayed.

Control and monitoring is normally operated by IASC 1, in the event of failure in the system, a degraded mode, controlled by IASC 2 is activated and the avionics fan is turned on. If the fan has failed, then the avionics valve opens.



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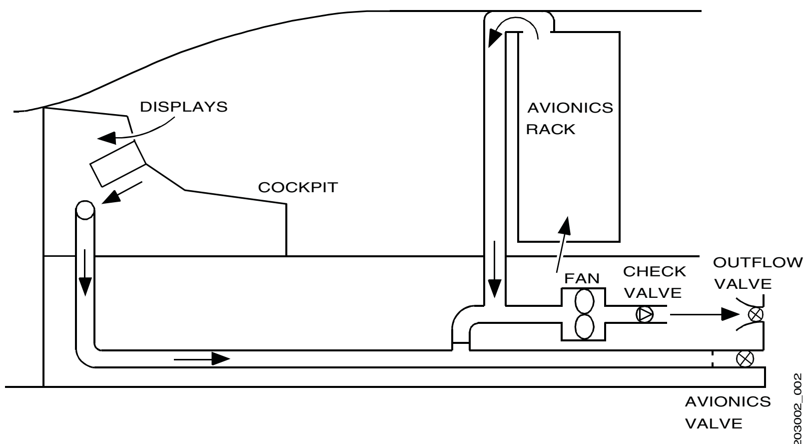

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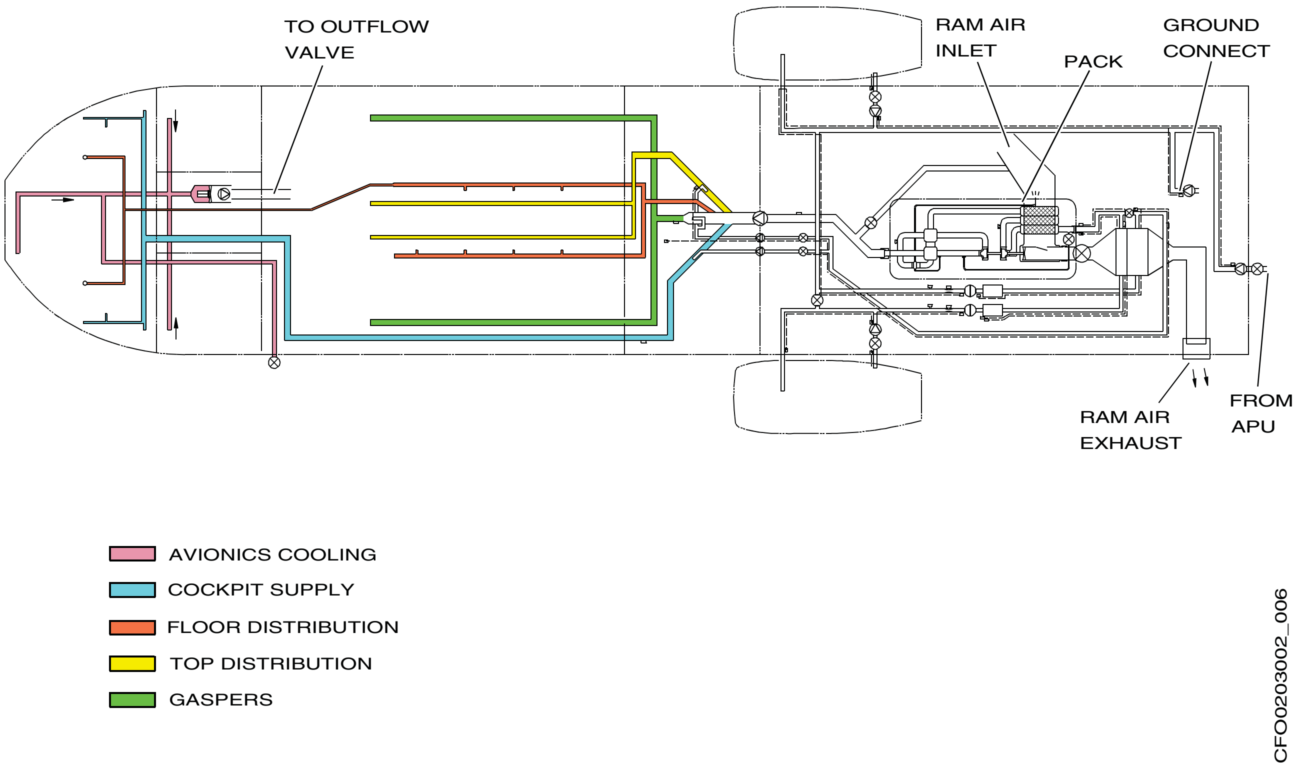
CABIN and COCKPIT AIR DISTRIBUTION SYSTEM



PRESSURIZATION

DESCRIPTION

Cabin pressurization is achieved by controlling the leakage rate, or outflow of cabin air through an outflow valve.

The pressurization system has three independent modes of operation:

- Two automatic modes are available from two digital controllers within the Integrated Air System Controllers (IASC). Each IASC drives the outflow valve through the AUTO drive mechanism of its actuator
- One manual mode is operated from the cabin pressure control panel through IASC 1 analog circuitry which drives the out flow valve through the manual drive mechanism of its actuator

Two safety valves are pneumatically operated to prevent cabin overpressure and negative pressure conditions. The safety valves operate independently of the automatic and manual pressurization modes to provide an additional level of protection.

Normal operation of the pressurization system is automatic when the destination airport is programed into the FMS and the FMS sends the correct landing altitude to the IASC. The crew has the option of manually setting the landing altitude using the SOURCE SELECT to MAN and setting the landing altitude using the ALT switch.

Pressurization system control indications are displayed on the ECS and SUMMARY synoptic displays. CAB ALT and CAB RATE are displayed on the captain's MFD.

COMPONENTS AND OPERATION

INTEGRATED AIR SYSTEM CONTROLLERS (IASC)

Two IASCs control all automatic phases of pressurization. Only one controller is active at a time, with the other controller in standby. If the operating controller fails, the standby controller automatically takes the active role.

Unless a failure is detected in IASC 1, it becomes the active controller after power up tests are complete. IASC 2 is operated as a standby mode.

OUTFLOW VALVE

The electrical outflow valve consists of a composite flow body, butterfly plate and electrical double actuator. The actuator has two motors, one for manual operation and the other for automatic operation.

The outflow valve is located on the bottom of the fuselage. An access panel in front of the wing allows access to the outflow valve.

In the manual mode, the outflow valve is controlled electrically by the MAN RATE switch on the PRESSURIZATION control panel. From the control panel, the pilot can manually control the rate at which the cabin altitude climbs (UP) or descends (DN). To hold a particular cabin altitude, the pilot can command a zero cabin rate of climb.

SAFETY VALVE

Two safety valves located on the aft pressure bulkhead provide overpressure and negative pressure relief.

The safety valves are pneumatically operated and are spring-loaded closed. When cabin differential pressure exceeds normal limits the safety valves automatically open to relieve excess cabin pressure.

If a negative pressure condition develops (ambient pressure is greater than cabin pressure), the safety valves automatically open to equalize cabin pressure.

PRESSURIZATION (Cont)

AUTOMATIC PRESSURIZATION MODES

The following automatic pressurization modes are a function of the active IASC:

- Pre-pressurization mode
- Takeoff and return to base sequence
- Climb mode
- Cruise mode
- Descent mode
- Depressurization sequence on ground

PRE-PRESSURIZATION MODE

The pre-pressurization mode is activated on the ground when the thrust levers are advanced for takeoff. Pre-pressurizing the aircraft will allow the outflow valve to achieve a controlling position prior to takeoff to eliminate any noticeable pressure changes at takeoff. The cabin is pressurized to 300 ft below actual field elevation.

TAKEOFF AND RETURN TO BASE SEQUENCE

When the aircraft leaves the ground, the takeoff sequence is initiated. The system will maintain the pre-pressurization cabin altitude of 300 ft below field elevation until the aircraft reaches 6000 ft MSL or differential from takeoff, or 10 minutes has elapsed. If a descent is initiated the cabin altitude will descent to the takeoff altitude and the landing field elevation does not have to be reset.

CLIMB MODE

Cabin pressurization is programmed according to selected landing elevation and a theoretical schedule of cabin altitude versus aircraft altitude. The cabin climb profile varies directly with the aircraft's climb rate. A typical cabin climb rate is approximately 300-500 sea level fpm. For light aircraft climbs at the best climb rate, the maximum cabin climb rate is 635 sea level fpm (slfpm).

NOTE: When step climbs are performed at flight altitudes greater than 25 000 ft and at aircraft climb rates greater than 6000 fpm, the cabin climb rate might exceed the max normal limit of 635 sea level fpm for automatic overpressure protection. For comfortable cabin climb rates during step or zoom climb it is recommended to use a maximum aircraft climb rate of 6000 fpm.

CRUISE MODE

Cabin pressurization is programmed to activate cruise mode if the aircraft rate of climb is less than 500 sea level fpm for more than 10 seconds, or the aircraft is climbing at any rate with the aircraft altitude greater than 25 000 ft. The cabin altitude will be stabilized at a level in accordance with the pressure schedule.

DESCENT MODE

The rate of cabin descent is directly related to the aircraft's rate of descent. In the case of a high-speed descent, the rate of cabin descent is increased according to the calculation of remaining flight time. The remaining flight time is calculated from the aircraft speed received from the ADC. A typical cabin descent rate is approximately 300 sea level fpm.

For example, if the aircraft's descent rate is 2000 fpm the cabin will descend at approximately 300 sea level fpm. If the aircraft is descending at greater than 5000 fpm the cabin will descend at 750 sea level pm.

Cabin altitude will descend on schedule until the cabin altitude is approximately 300 feet below the selected landing destination elevation.

DEPRESSURIZATION SEQUENCE ON GROUND

After landing or after an aborted takeoff, the cabin will depressurize at a rate of 500 sea level feet to equalize cabin, then OFV will go to full open and remain in that configuration while on ground.

PRESSURIZATION (Cont)

MANUAL PRESSURIZATION MODE

When MANUAL is selected on the PRESSURIZATION control panel the outflow valve is manually controlled. The MAN RATE knob is used to select the desired cabin pressure altitude rate of change. An UP selection on the MAN RATE knob will cause an increase in cabin altitude. A DN selection of the MAN RATE knob will cause a decrease in cabin altitude. When the MAN RATE knob is set directly between UP and DN, cabin altitude will be maintained regardless of changes to aircraft altitude. The maximum rate of change in the MANUAL mode is 2500 fpm.

BEFORE TAKEOFF

Before takeoff, note cabin altitude and start to pre-pressurize the aircraft by adjusting the MAN RATE switch toward the DN position (it is recommended to select approximately -300 fpm, although any rate may be selected). Cabin pressure will slowly start to increase (cabin altitude will go down), due to the lack of initial delta P.

If enough time is allowed before the actual takeoff run, upon reaching 300 ft below noted cabin altitude, select cabin rate of climb to zero, and allow cabin to stabilize (CAB RATE shows as 0 FPM on the EICAS ECS synoptic page). If actual takeoff is performed prior to cabin pre-pressurization, pressure bumps may occur.

TAKEOFF AND CLIMB

Before takeoff, cabin altitude may be selected as desired. Selected altitude is displayed on the ECS synoptic summary page.

Monitor CAB ALT and CAB △P, and make the necessary adjustments to keep the delta P within limits. Adjustments may be performed through the MAN RATE switch (+ 500 fpm to raise cabin altitude, and -300 fpm to descend cabin altitude, although any rate may be selected).

CRUISE

During cruise, cabin altitude can be selected as desired, provided applicable limits for cabin altitude and delta P are observed.

DESCENT AND LANDING

The desired cabin altitude for landing should be set to 300 ft below the field elevation. For initial descent steps, any comfortable cabin rate may be selected.

For final descent and landing, or if an unrestricted descent is intended, the cabin rate should be proportional to the aircraft descent time. For example, if the aircraft is at 27 000 ft and a 3000 fpm descent is desired, it will take approximately 9 minutes to land. To determine the rate of descent, divide the difference between the current cabin altitude and the landing altitude.

NOTE: Monitor cabin delta P during descent and approach to make the necessary adjustments to keep delta P less than 1 psid (maximum allowed for landing).

AFTER LANDING

After landing, depressurize the aircraft by adjusting the MAN RATE switch toward the UP position until field elevation is attained.

PRESSURIZATION (Cont)

PRESSURIZATION SCHEDULE — CLIMB AND CRUISE

Aircraft Altitude (ft)	Cabin Altitude (ft)	Cabin Delta P (PSID)	Aircraft Altitude (ft)	Cabin Altitude (ft)	Cabin Delta P (PSID)	Aircraft Altitude (ft)	Cabin Altitude (ft)	Cabin Delta P (PSID)
-1500	-1786	0.1	15 000	1379	5.8	33 000	4955	8.3
-1000	-1273	0.1	16 000	1504	6.0	34 000	5272	8.3
0	-245	0.1	17 000	1637	6.3	35 000	5612	8.3
1000	-135	0.6	18 000	1778	6.5	36 000	5877	8.3
1500	-81	0.8	19 000	1926	6.8	37 000	6076	8.4
2000	-26	1.0	20 000	2091	7.0	38 000	6331	8.5
3000	81	1.4	21 000	2258	7.2	39 000	6586	8.5
4000	187	1.9	22 000	2429	7.4	40 000	6827	8.5
5000	294	2.3	23 000	2608	7.6	41 000	7056	8.5
6000	399	2.7	24 000	2795	7.7	42 000	7272	8.5
7000	504	3.0	25 000	2984	7.7	43 000	7476	8.6
8000	610	3.4	26 000	3189	8.0	44 000	7669	8.7
9000	716	3.8	27 000	3404	8.2	45 000	7850	8.8
10 000	816	4.1	28 000	3628	8.3	-	-	-
11 000	925	4.4	29 000	3864	8.3	-	-	-
12 000	1036	4.8	30 000	4111	8.3	-	-	-
13 000	1150	5.1	31 000	4375	8.3	-	-	-
14 000	1268	5.4	32 000	4653	8.3	-	-	-

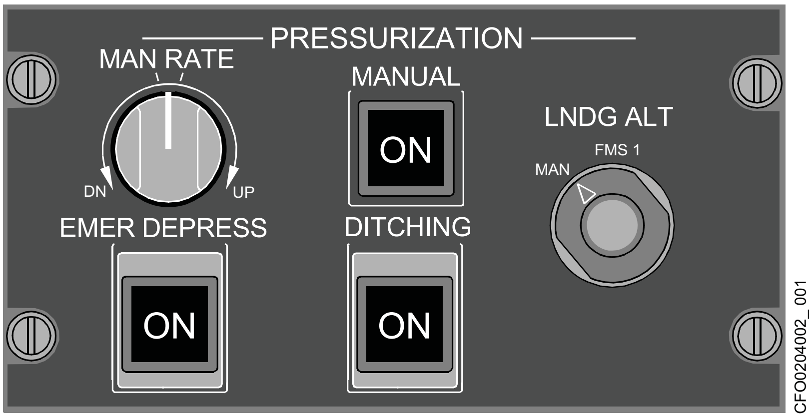
PRESSURIZATION SCHEDULE — DESCENT AND HOLD (<25 000 FT)

Aircraft Altitude (ft)	Cabin Altitude (ft)	Cabin Delta P (PSID)	Aircraft Altitude (ft)	Cabin Altitude (ft)	Cabin Delta P (PSID)	Aircraft Altitude (ft)	Cabin Altitude (ft)	Cabin Delta P (PSID)
-1500	-1786	0.1	15 000	1118	5.8	33 000	4699	8.5
-1000	-1291	0.1	16 000	1229	6.0	34 000	5098	8.5
0	-299	0.1	17 000	1347	6.3	35 000	5487	8.5
1000	-202	0.6	18 000	1473	6.5	36 000	5782	8.5
1500	-155	0.8	19 000	1606	6.8	37 000	6064	8.6
2000	-107	1.0	20 000	1756	7.0	38 000	6332	8.6
3000	-13	1.5	21 000	1907	7.2	39 000	6587	8.6
4000	80	1.9	22 000	2063	7.4	40 000	6828	8.6
5000	173	2.3	23 000	2226	7.6	41 000	7057	8.7
6000	264	2.7	24 000	2396	7.7	42 000	7273	8.7
7000	356	3.1	25 000	2569	7.9	43 000	7477	8.7
8000	448	3.5	26 000	2754	8.0	44 000	7670	8.8
9000	540	3.9	27 000	2948	8.2	45 000	7850	8.8
10 000	626	4.2	28 000	3151	8.3	-	-	-
11 000	721	4.6	29 000	3366	8.4	-	-	-
12 000	818	4.9	30 000	3591	8.5	-	-	-
13 000	918	5.2	31 000	3873	8.5	-	-	-
14 000	1022	5.5	32 000	4291	8.5	-	-	-

Note: For holding above 25 000 ft following descent, the pressurization schedule for Climb and Cruise applies.

CONTROLS AND INDICATIONS

PRESSURIZATION CONTROL PANEL



MANUAL RATE KNOB

The MAN RATE knob allows the crew to control how fast the cabin pressurization system reaches the desired cabin altitude. The switch allows adjustments to the manual pressurization rate toward DN or UP positions, as described below:

- The 12 o’clock position corresponds to 0 SLFPM
- The cabin rate of change demand from -1000 to +1000 SLFPM (sea level feet per minute) is obtained over approximately two thirds of the potentiometer angle range to allow easy selection by the aircrew
- The cabin rate of change is limited to 2500 SLFPM, which is obtained by setting the potentiometer in the full counter-clockwise position, full clockwise position, which corresponds to the max DN and UP positions, respectively.

When the desired cabin altitude is approached, rotate the switch to center position, to stabilize the cabin at the selected altitude.

MANUAL PRESSURIZATION SWITCH

Manual control of the pressurization system is initiated by pressing the MANUAL switch ON.

LNDG ALT KNOB

The LDG ALT knob is used to select landing field elevation during automatic pressurization mode. The LNDG ALT control consists of two concentric knobs. The outer knob can be selected between MAN and either FMS (for a single installation) or FMS 1 and FMS 2 (for a dual installation). Selection of one of the FMS settings will allow the pressurization landing altitude to be set from the applicable FMS destination airport database. Selection of MAN allows the inner knob to control the pressurization landing altitude

EMER DEPRESS SWITCH

The EMER DEPRESS switch is an alternate-action switch located on the PRESSURIZATION panel. A guard is installed over the switch to prevent inadvertent actuation. The switch is used to depressurize the cabin for smoke and fume evacuation. The EMER DEPRESS function is available in both automatic and manual modes. In AUTO mode, when EMER DEPRESS is selected ON, the cabin will depressurize at 2500 SLFPM up to 14 000 ft ± 100 ft or the aircraft altitude, whichever is lower. In MANUAL mode, when EMER DEPRESS is selected ON, the cabin will depressurize at 3000 SLFPM up to 14 500 ft ± 500 ft or the aircraft altitude, whichever is lower.

NOTE: In manual mode, the cabin may also be depressurized by selecting MAN RATE to max UP from the control panel.

DITCHING SWITCH

The DITCHING switch is used to depressurize the cabin, shut off the air conditioning, and then keep the OFV closed in the event of a water landing. The sequence activates automatically, and is inhibited above 15 000 ft.

NOTE: The ditching function is not available in manual mode. To close the outflow valve, turn the MAN RATE knob to max down.

CONTROLS AND INDICATIONS (Cont)

LANDING SEQUENCES AT FIELD ELEVATION GREATER THAN 7850 FT

This sequence does not require additional crew action, if the actual landing field elevation was selected prior to takeoff. The scheduled cabin pressure altitude is normally limited to 7850 ft during flight and then automatically reset to the landing field pressure altitude.

The CABIN ALTITUDE (C) CAS message is normally set for 8500 ft and the CABIN ALTITUDE (W) CAS message and aural "CABIN ALTITUDE" voice warning is set for 9400 ft. When the aircraft descends below 41 000 ft, the caution and warning thresholds start to increase as a function of the aircraft altitude and aircraft rate of descent.

The CABIN ALT WARN HIGH (A) CAS message is displayed, informing the crew that the warning and caution limits have been reset to higher than normal values.

The CABIN ALTITUDE (C) message increases up to 650 ft above landing field pressure altitude and the CABIN ALTITUDE (W) message increases up to 1550 ft above the landing field pressure altitude. Both thresholds are limited to 14 300 ft pressure altitude.

LEVELING OFF DURING DESCENT

If a leveling off occurs above 41 000 ft during descent:

- The cabin altitude remains at 7850 ft
- The CABIN ALTITUDE caution and warning remain at 8500 ft and 9400 ft respectively

If leveling off between 41 000 and 25 000:

- The cabin altitude as well as caution and warning thresholds will level also as a function of aircraft altitude
- If the leveling off lasts for more than 3 minutes, the cabin altitude will descend at a rate of -300 sea level fpm backwards towards 7850 ft. The caution and warning thresholds will also descend at a rate of -300 fpm until aircraft descent is initiated

If leveling off occurs at or below 25 000 ft during descent:

- The cabin will reach and remain at targeted landing field pressure altitude minus 300 ft
- The CABIN ALTITUDE caution and warning thresholds will reach and remain at landing field pressure altitude +650 ft and + 1550 ft respectively with both limited to 14 300 ft

If a short climb followed by a level off is performed below 25 000 ft, cabin altitude will descend at a rate of -300 sea level fpm back towards 7850 ft. A subsequent aircraft descent will automatically initiate the return to the landing field pressure altitude and decrease the caution and warning thresholds.

TAKEOFF AND RETURN TO BASE SEQUENCE AT FIELD ELEVATION GREATER THAN 7850 FT

Similar to the takeoff at lower field elevations, as the aircraft leaves the ground, the takeoff sequence is initiated. The system will maintain the pre pressurization cabin altitude of 300 ft below takeoff pressure altitude until the aircraft reaches 6000 ft AGL or 10 minutes has elapsed. If a return to base is initiated the aircraft will land slightly pressurized at the pre pressurization value to avoid cabin bumps and the landing field elevation does not have to be reset. During this sequence, the caution and warning thresholds will be maintained at the takeoff pressure altitude.

CLIMB MODE WITH SELECTED LANDING FIELD ELEVATION GREATER THAN 7850 FT

When the aircraft is in climb following a takeoff from an airfield above 7850 ft, the cabin altitude will decrease at a rate of -500 sea level fpm towards the maximum normal limit of 7850 ft. The caution and warning thresholds decrease as a function of the aircraft altitude and the aircraft rate of climb, but at a minimum rate of -500 sea level fpm in order for the caution threshold to reach 8500 ft and the warning threshold to reach 9400 ft before the aircraft reaches 41 000 ft.

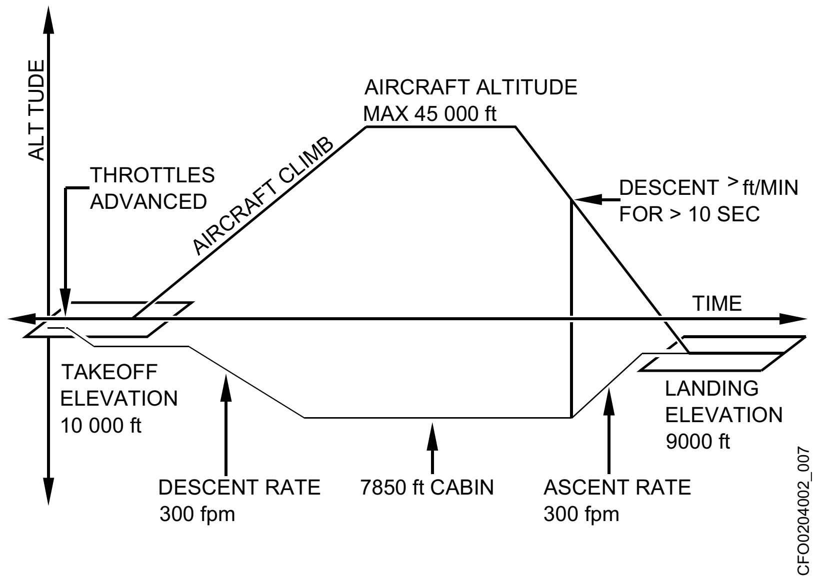
CRUISE MODE WITH SELECTED LANDING FIELD ELEVATION GREATER THAN 7850 FT

When the aircraft is in cruise following a takeoff and climb from an airfield above 7850 ft, the cabin altitude will continue to decrease at a rate of -300 sea level fpm until the maximum normal cabin altitude limit for 7850 is reached.

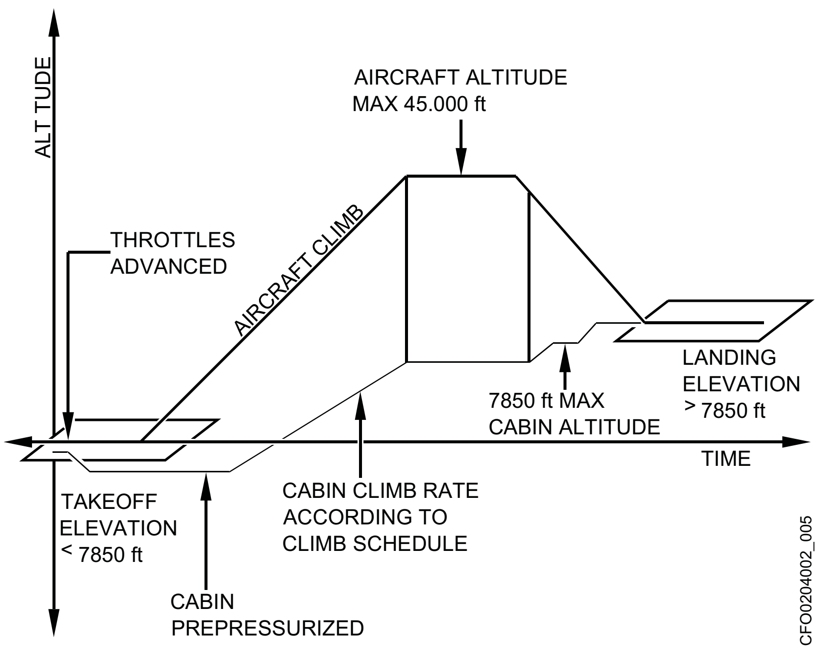
The warning and caution thresholds will continue to decrease at a rate of -300 fpm until the caution threshold of 8500 ft and the warning threshold reaches 9400 ft.

CONTROLS AND INDICATIONS (Cont)

TAKEOFF FROM AIRFIELD ABOVE 7850 FT AND LANDING FIELD ELEVATION ABOVE 7850 FT

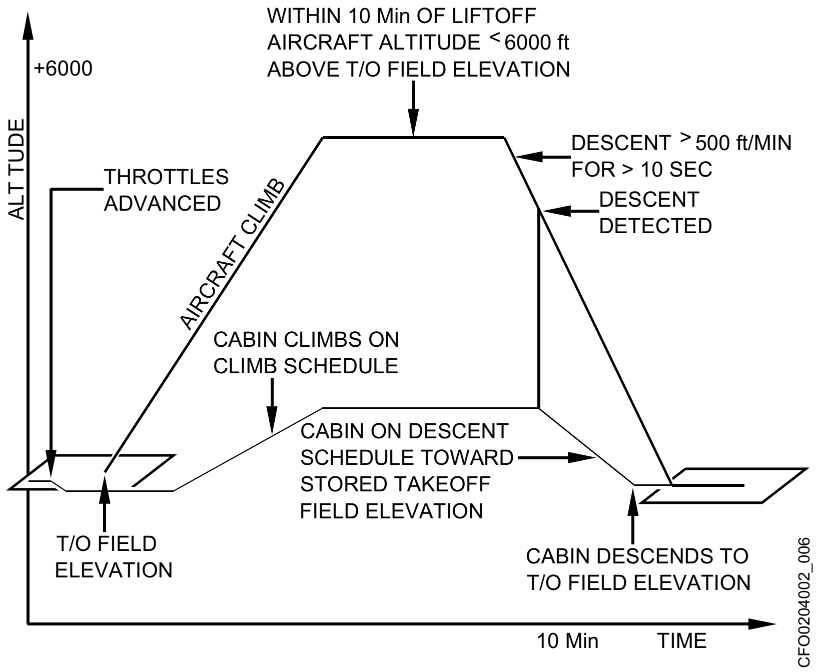


TAKEOFF FROM AIRFIELD LESS THAN 7850 FT AND LANDING FIELD ELEVATION ABOVE 7850 FT



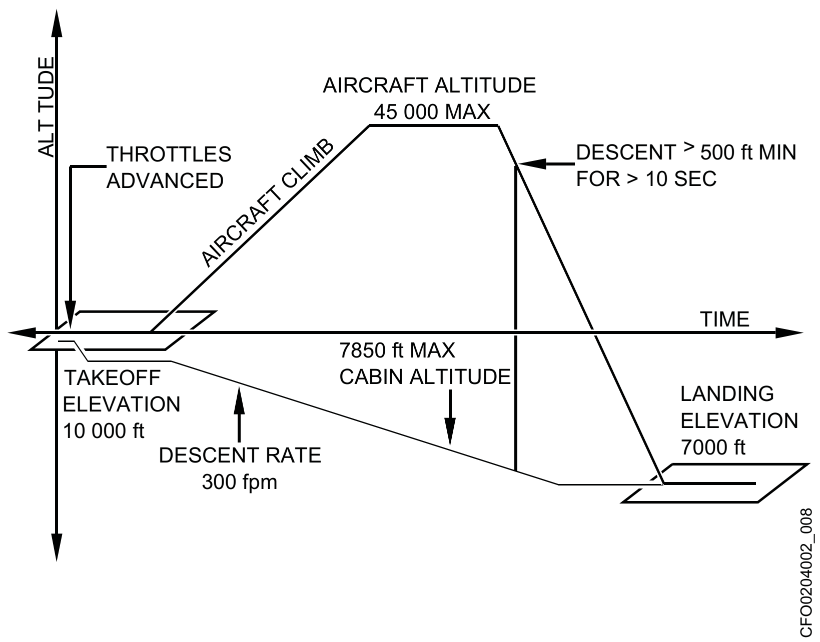
CONTROLS AND INDICATIONS (Cont)

TAKEOFF AND RETURN TO BASE



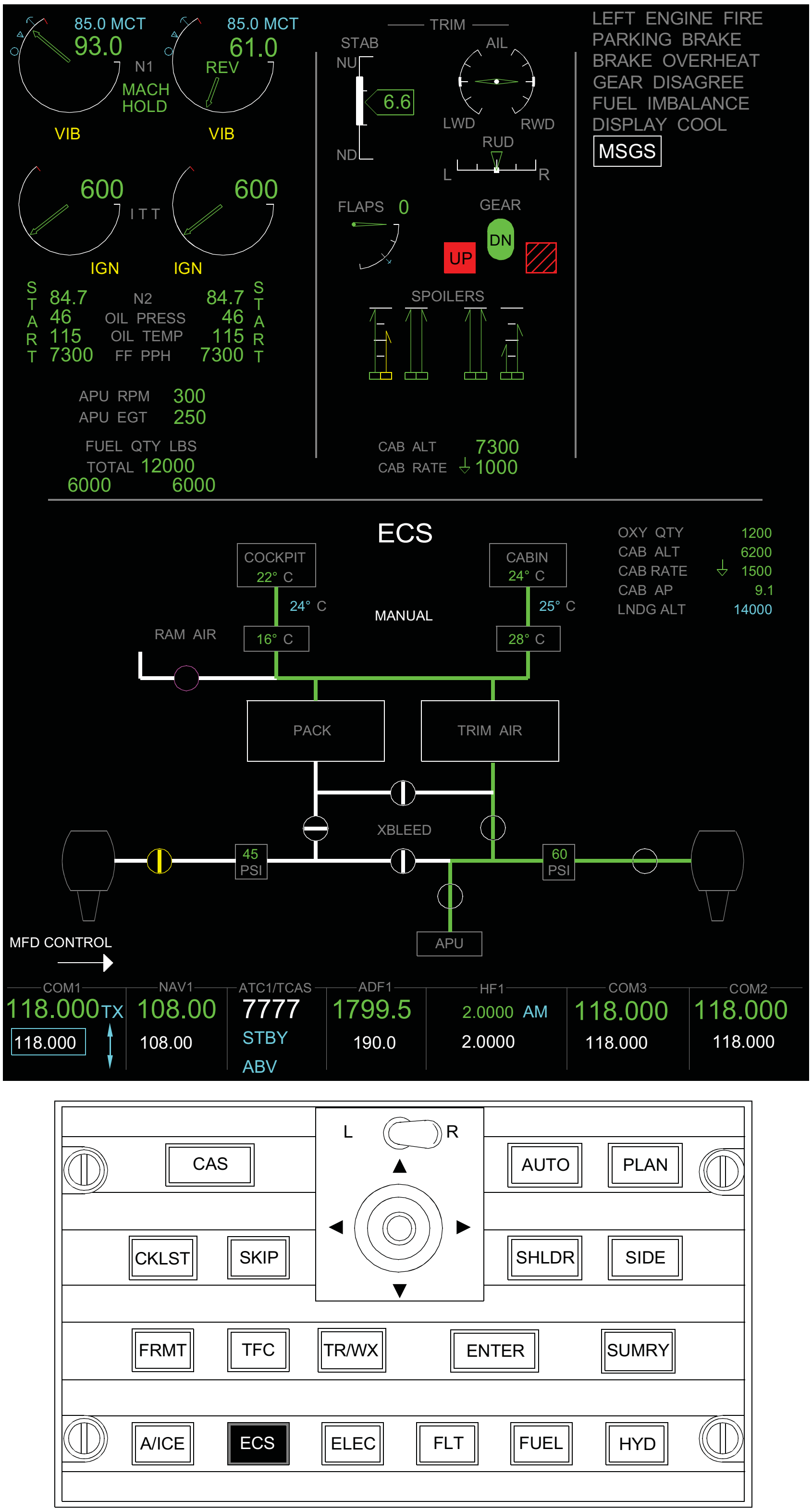
TAKEOFF FROM AIRFIELD ABOVE 7850 FT AND LANDING FIELD ELEVATION LESS THAN 7850 FT

During climb and cruise mode, the target for the cabin altitude will be the normal cabin pressure schedule which is below the maximum normal limit of 7850 ft for aircraft altitudes below 45 000 ft. The warning and caution thresholds will decrease until the caution threshold reaches 8500 ft and the warning threshold reaches 9400 ft



CONTROLS AND INDICATIONS (Cont)

ECS SYNOPTIC PAGE



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EICAS MESSAGES

The air conditioning/pressurization system CAS messages and voice aurals are listed below. A brief explanation of each message is provided.

MESSAGE	INHIBITS	MEANING	AURAL WARNING
CABIN ALTITUDE	TO/LAND	The normal cabin altitude warning is at 9400 ft When a takeoff or landing is conducted above 7850 ft, the warning is at the field elevation + 1550 ft, but limited to no higher than 14 300 ft	“Cabin Altitude”
CABIN DELTA P	TO/LAND	The cabin differential pressure is greater than 9.2 psid or less than -0.5 psid	
L (R) BLEED LEAK	TO/LAND	A leak has been detected in the bleed air ducting downstream of the bleed valve	
PACK LEAK	TO/LAND	A leak has been detected in the pack ducting	
TRIM AIR LEAK	TO/LAND	A leak has been detected in the bleed air ducting downstream of the right flow control valve, up to the precooler crossover and up to the trim air check valve	
L (R) PYLON BLEED LEAK	TO/LAND	A leak has been detected in the engine pylon or tail cone (before shutoff valve)	
AIR COND TEMP FAIL	TO/LAND	The automatic temperature control system has failed	
AIR COND TEMP HIGH	TO/LAND	Excessive air temperature has been sensed in the cabin or cockpit air distribution duct	
AUTO PRESS FAIL	TO/LAND	Both automatic pressurization modes have failed	
L (R) BLEED FAIL	TO/LAND	The affected engine bleed air valve has failed or a temperature or pressure has exceeded limits or the sensor has failed. Under certain low thrust conditions (ground idle at high field elevations or idle with single bleed on), there may be insufficient pressure to keep the bleed valve open	
L (R) BLEED LOOP FAIL	TO/LAND	A failure (open or short circuit) has been detected in the bleed leak detection system	
CABIN ALTITUDE	TO/LAND	Normal cabin altitude caution is 8500 ft During takeoff or landing above 7850 ft, the caution is set to field altitude + 650 ft with a maximum limit of 14 300 ft	
CABIN PRESS FAULT	TO/LAND	Either the pressure sensor has failed or cabin altitude limiter function has failed	

MESSAGE	INHIBITS	MEANING	AURAL WARNING
DITCHING NOT AVAIL		The ditching switch has been selected On with the pressurization switch in the manual mode	
EQPT RACK TEMP HIGH	TO/LAND	The temperature in either equipment rack is high	
PACK FAIL	TO/LAND	A failure has been detected in the PACK system	
PACK LOOP FAIL	TO/LAND	Both bleed air leak detection loops in the PACK have failed during the power up self test	
PACK TEMP HIGH	TO/LAND	An overheat has been detected in the air conditioning PACK system	
L (R) PYLON LOOP FAIL	TO/LAND	Both bleed leak detection loops in the respective pylon have failed during the power up self test	
TRIM AIR FAIL	TO/LAND	A hot air regulating valve has failed	
TRIM AIR LOOP FAIL	TO/LAND	The bleed air leak detection loops around the trim air ducting have failed	
XBLEED FAIL	TO/LAND	The crossbleed valve has failed to move to the commanded position	
AIRCOND FAULT	TO/LAND	A fault has been detected in the air conditioning system or there has been a loss of temperature sensing	
BLEED LOOP FAULT	TO/LAND	A fault has been detected in the bleed leak detection loop system and redundancy is lost	
L (R) BLEED FAULT	TO/LAND	The bleed pressure data is invalid, or the affected flow control valve is failed closed	
CABIN ALT WARN HIGH	LAND	A high airport takeoff or landing has been initiated and the pressurization system is in the automatic mode	
EQPT RACK COOL FAULT	TO/LAND	A fault has been detected in the avionics equipment rack cooling system	
MANUAL PRESS FAIL	TO/LAND	The manual pressurization mode is not operational	
PACK COOL AIR FAIL	TO/LAND	The ram air regulating valve supplying cooling air to the PACK heat exchanger has failed	
RAM AIR FAIL	TO/LAND	The RAM AIR ventilation valve has failed to move to the commanded position	
AIR COND MAN TEMP ON		The air conditioning temperature control is in manual mode	

MESSAGE	INHIBITS	MEANING	AURAL WARNING
AIR SOURCE OFF		The AIR SOURCE switch is in the OFF position resulting in no conditioned air entering the cabin	
BLEED OFF		The L, R, and APU BLEEDs are OFF	
DITCHING ON		The DITCHING switch/indicator has been selected ON. This closes the flow control valves and commands the outflow valve open for 100 seconds or 10 seconds after cabin differential pressure decreases below 1595 psid. The outflow valve then closes	
EMER DEPRESS ON		Emergency depressurization has been selected. Emergency depressurization commands the outflow valve open, but will attempt to limit the cabin altitude to approximately 15 000 ft	
MANUAL PRESS ON		The MANUAL PRESSURIZATION mode has been selected	
PACK ONLY		The AIR SOURCE switch is in the PACK ONLY position, resulting in all air conditioning bleed air being routed through the PACK	
RAM AIR ON		The RAM AIR switch has been selected ON, providing ram air ventilation	
XBLEED OPEN		The cross bleed valve is open	
TRIM AIR ONLY		The AIR SOURCE switch is in the TRIM AIR ONLY position, resulting in all air conditioning bleed air being routed through the trim air system. The air will be warm	