



CL-350 TRAINING MANUAL

ENVIROMENTAL

10

AIRCRAFT SYSTEMS
TRAINING MANUAL

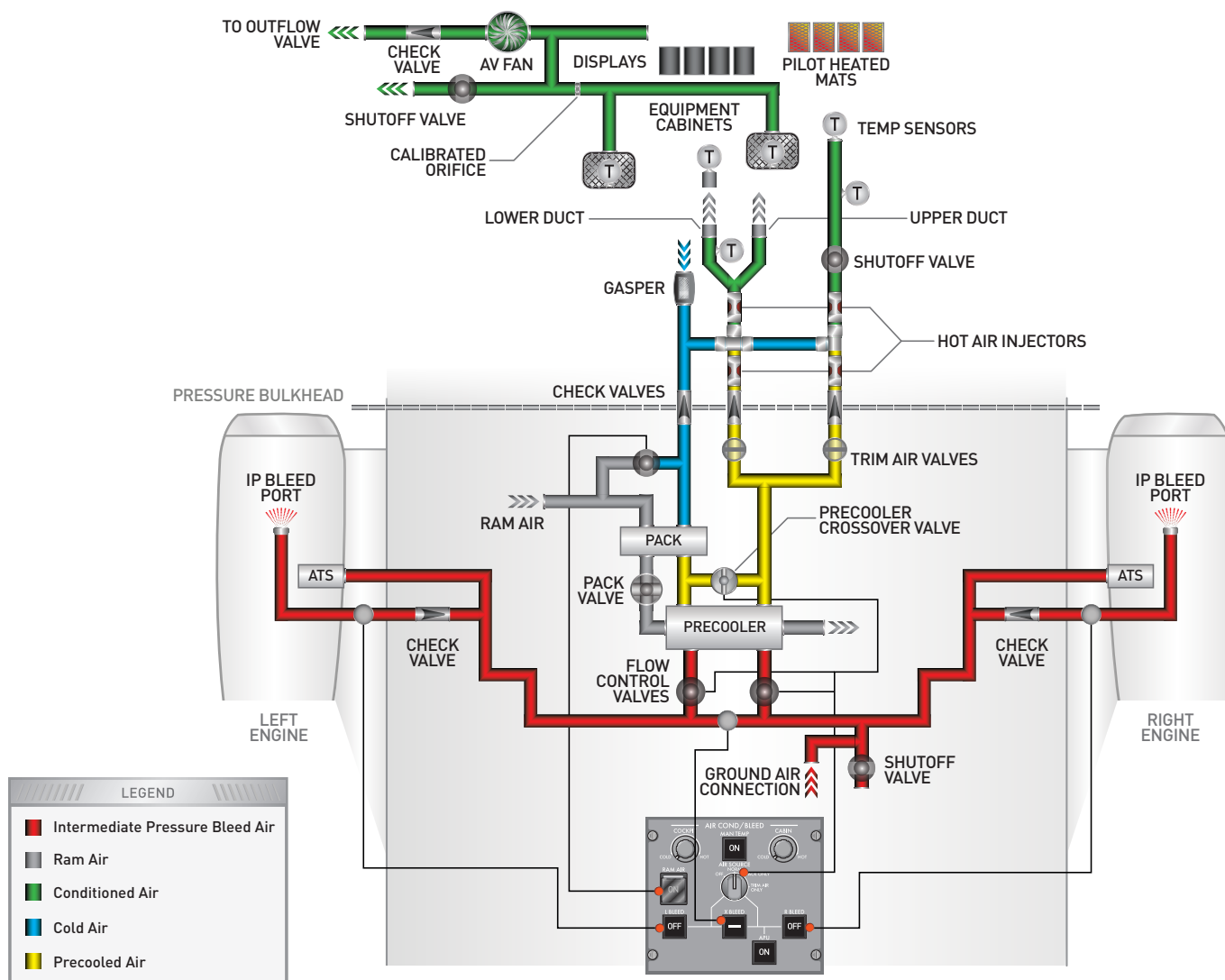
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ENVIRONMENTAL

I. INTRODUCTION

The Challenger 350 environmental control system uses hot pressurized bleed air to create a controlled atmosphere within the aircraft. Pressurized air from either the engines, APU, or a ground cart 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, managing the bleed leak detection, wing anti-ice and cabin pressurization functions throughout all phases of flight.

COCKPIT/CABIN AIR DISTRIBUTION SCHEMATIC



A. ENVIRONMENTAL SYSTEM SPECIFICATIONS

Environmental Control System Specifications

Parameter	Value
System Type	Integrated air system with PACK and Trim Air
System Controllers	Two IASCs (Integrated Air System Controllers)
IASC Locations	One under floor, one under lavatory liner above floor
IASC 1 Channel A	Air conditioning control/monitoring, avionics cooling, cabin pressurization
IASC 1 Channel B	Wing anti-ice control/monitoring, bleed leak detection, backup control, backup cabin pressure sensor
IASC 2 Channel A	Air conditioning control/monitoring, avionics cooling, cabin pressurization
IASC 2 Channel B	Wing anti-ice control/monitoring, bleed leak detection, limited backup control
Temperature Control	Independent COCKPIT and CABIN zones
Temperature Control Range (Normal)	15°C to 35°C
Temperature Control Range (Manual)	10°C to 70°C
Control Modes	Automatic and Manual
Bleed Air Sources	Left/Right engines, APU, or ground cart
Bleed Leak Detection Zones	Eight zones for EICAS presentation
Engine Bleed Pressure Regulation	50±3 psi
Bleed Fail Pressure Threshold	>60 psi
APU Bleed Air Availability	Up to 20,000 ft
Ram Air Valve Availability	Below 10,000 ft
Air Cycle Machine	Single PACK for air conditioning
Distribution System	Dual duct system with upper and lower distribution
Gasper Air Supply	Cold air only
Avionics Fan High Speed Trigger	122°F (50°C) in 60 seconds
Avionics Cooling Valve Opens	149°F (65°C) in 60 seconds above 10,000 ft

II. BLEED AIR SYSTEM

A. SYSTEM DESCRIPTION

- High pressure (HP) bleed air from engines routed through HP valves and ducting to wing anti-ice system
- Intermediate pressure (IP) air from engines routed through IP valves to environmental control system (ECS)
- IP air supplies common manifold isolated left and right by cross bleed valve
- Manifold can be supplied by auxiliary power unit (APU) or external ground cart
- Regulating valves and check valves installed in aft equipment bay ducting
- Leak detection system monitors all bleed air ducting
- Pressure sensors in bleed air lines send information to IASC for EICAS display

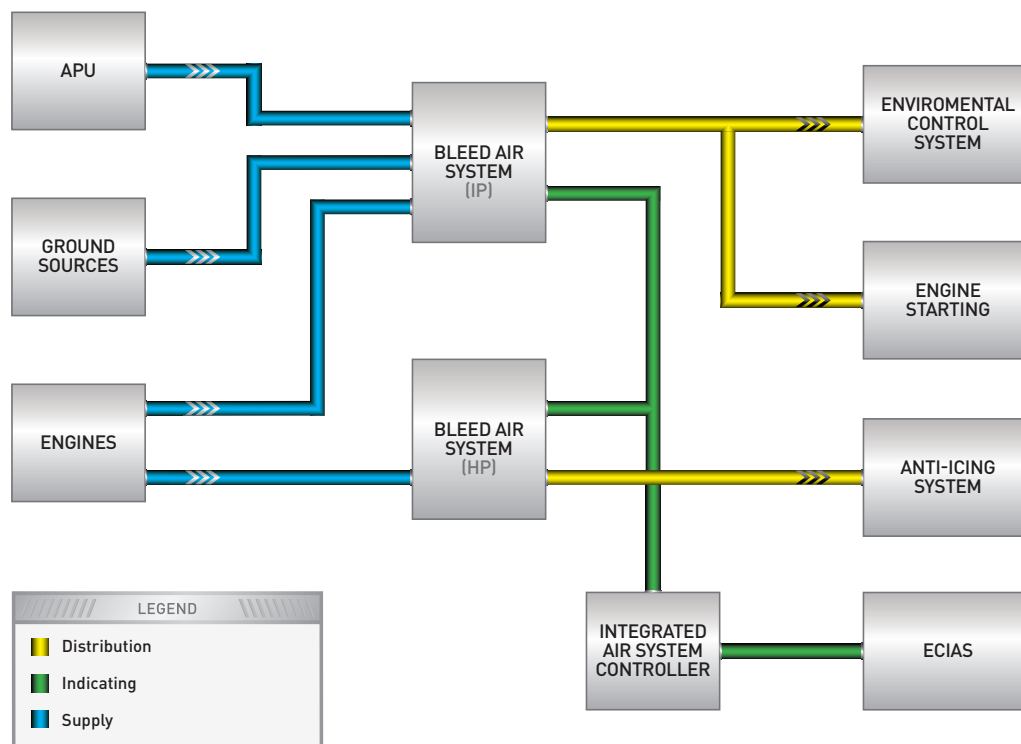
Bleed Air System Specifications

Parameter	Value
Bleed Air Sources	Left/Right engines, APU, ground cart
Bleed Valves	Electrically controlled, pneumatically operated
Crossbleed Valve	Connects left and right systems
Leak Detection Zones	Eight zones with dual-loop sensors
Leak Detection System	IASC controlled, fully automatic
Flow Control Valves	Two FCVs for PACK and TRIM AIR
Pre-cooler Crossover Valve	Directs flow to PACK or TRIM AIR
Ground Air Connection	External pneumatic supply port

B. BLEED AIR DISTRIBUTION

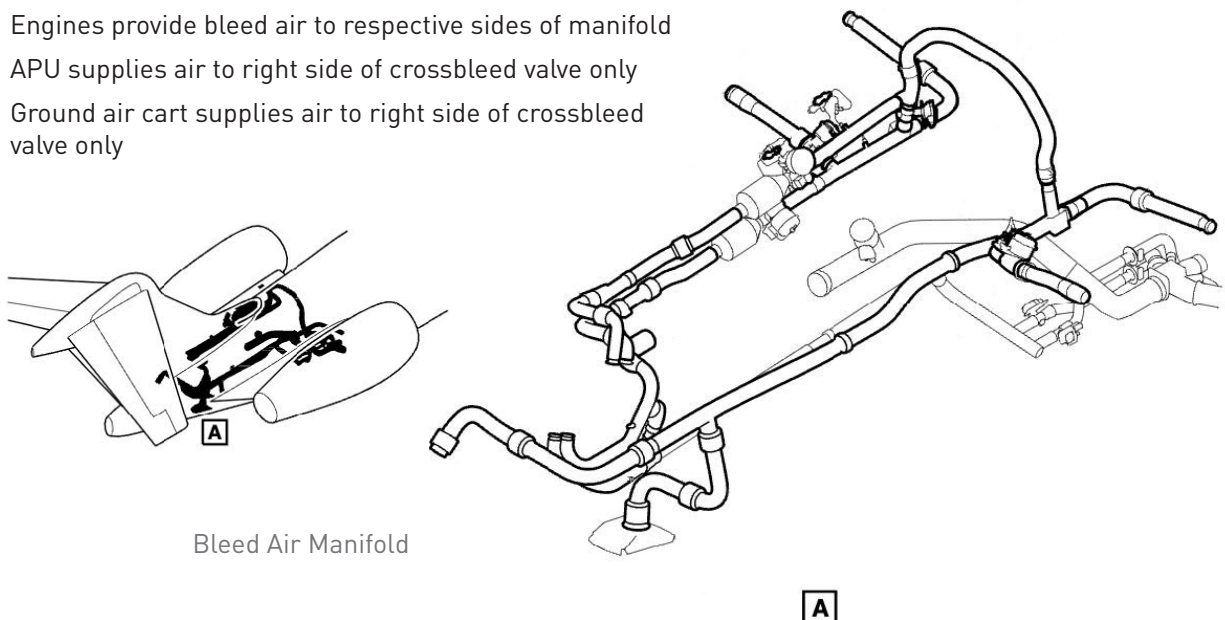
- Air for aircraft IP bleed air system distributed by common manifold
- **Bleed air management consists of:**
 - Bleed source selection
 - Valve operation
 - Air distribution
- Controlled by two integrated air system controllers (IASC)
- Pilot control from AIR COND/BLEED panel on center pedestal

BLEED AIR DISTRIBUTION



C. BLEED AIR MANIFOLD

- Located in engine pylons and aft equipment bay
- Divided into right side and left side by crossbleed (XBLEED) valve
- Engines provide bleed air to respective sides of manifold
- APU supplies air to right side of crossbleed valve only
- Ground air cart supplies air to right side of crossbleed valve only



D. CHECK VALVES

Four check valves installed in bleed air ducting:

- Intermediate pressure check valve in each engine bleed air duct (prevents reverse flow into engines)
- Check valve at external ground air servicing connector (prevents air loss to atmosphere)
- Check valve in APU bleed air duct (prevents reverse flow to APU when shut down) (Check valves not depicted on ECS or ANTI-ICE synoptic displays)

E. EXTERNAL GROUND AIR SERVICING

- Connector located to right of centerline towards rear fuselage
- Not depicted on ECS synoptic displays
- When connected, air pressure displayed as manifold pressure digital readout on ECS synoptic page

F. BLEED AIR VALVES

L (R) BLEED Valves

- Controlled from AIR COND/BLEED control panel
- IASC 1 monitors left HP valve and left IP valve
- IASC 2 monitors right HP valve and right IP valve
- HP valves regulate HP bleed to 36 ± 3 psi

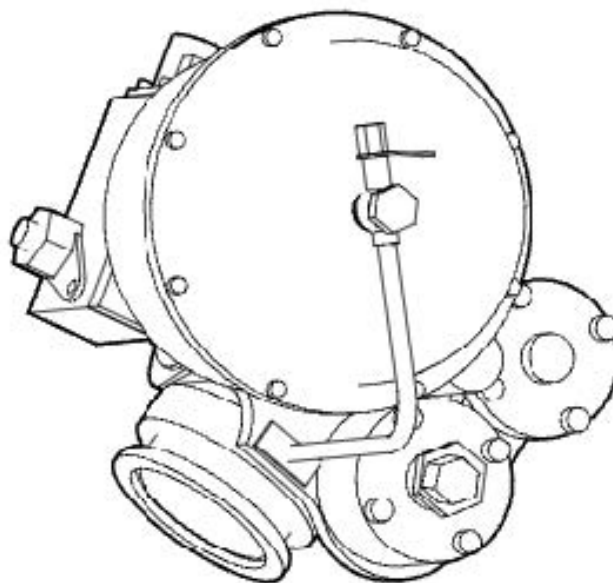
XBLEED Valve

- Controlled from AIR COND/BLEED control panel
- Enables cross-engine bleed operations

APU BLEED Valve

- Controlled via APU Electronic Control Unit (ECU)
- Amount of bleed air controlled by ECU sensing APU
- APU bleed switch on panel sends signal to ECU
- ECU determines when APU ready for bleed air load
- Controls opening, closing, and modulation of valve
- When open, delivers air to right side of bleed manifold
- Moves to fail-safe closed position when APU shut down or signal lost

High Pressure Bleed Valve



G. ENGINE BLEED AIR PRESSURE REGULATION

- Engine air pressure increases in proportion with N_2 compressor speed
- IPV limits intermediate engine bleed pressure to 50 ± 3 psi
- If valve fails and manifold pressure exceeds 60 psi: **L (R) BLEED FAIL** (C) CAS message displayed

Note: 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

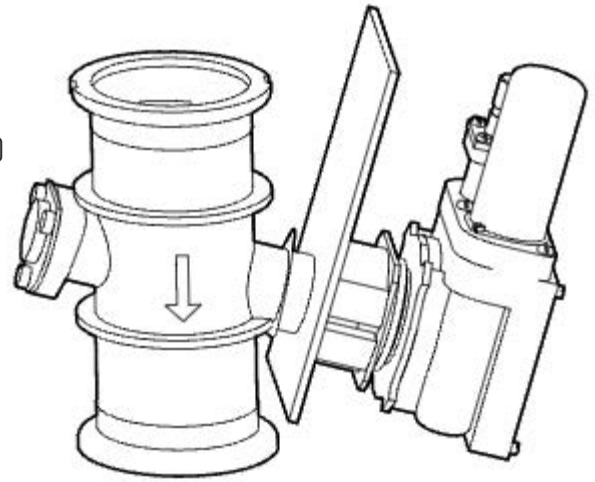
H. ENGINE START SEQUENCES

When L (R) STARTER switch positioned to start:

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

After engine achieves self-sustaining speed:

- ATS disengages
- Start valve closes
- Flow control and cross bleed valves return to previous position
- Cross-engine bleed air can be used to power starter
- Interstage bleed air taken from selected engine for cross-engine bleed starting
- 32 psi minimum bleed pressure for crossbleed engine start; starting with a tailwind may require higher



Cross Bleed Valve

I. APU/ENGINE BLEED SWITCHING

- All bleed switching done manually by aircrew from AIR COND/BLEED control panel

Normal Takeoff and Landing Configuration:

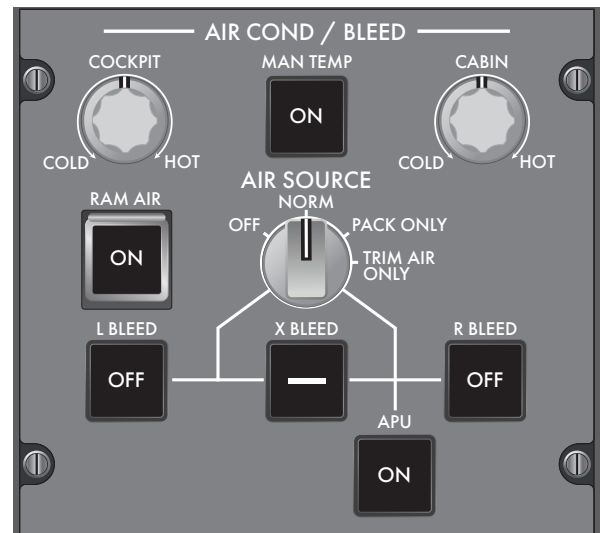
- APU bleed air switch ON
- Engine bleed air switches OFF
- XBLEED switch OPEN

During Climb:

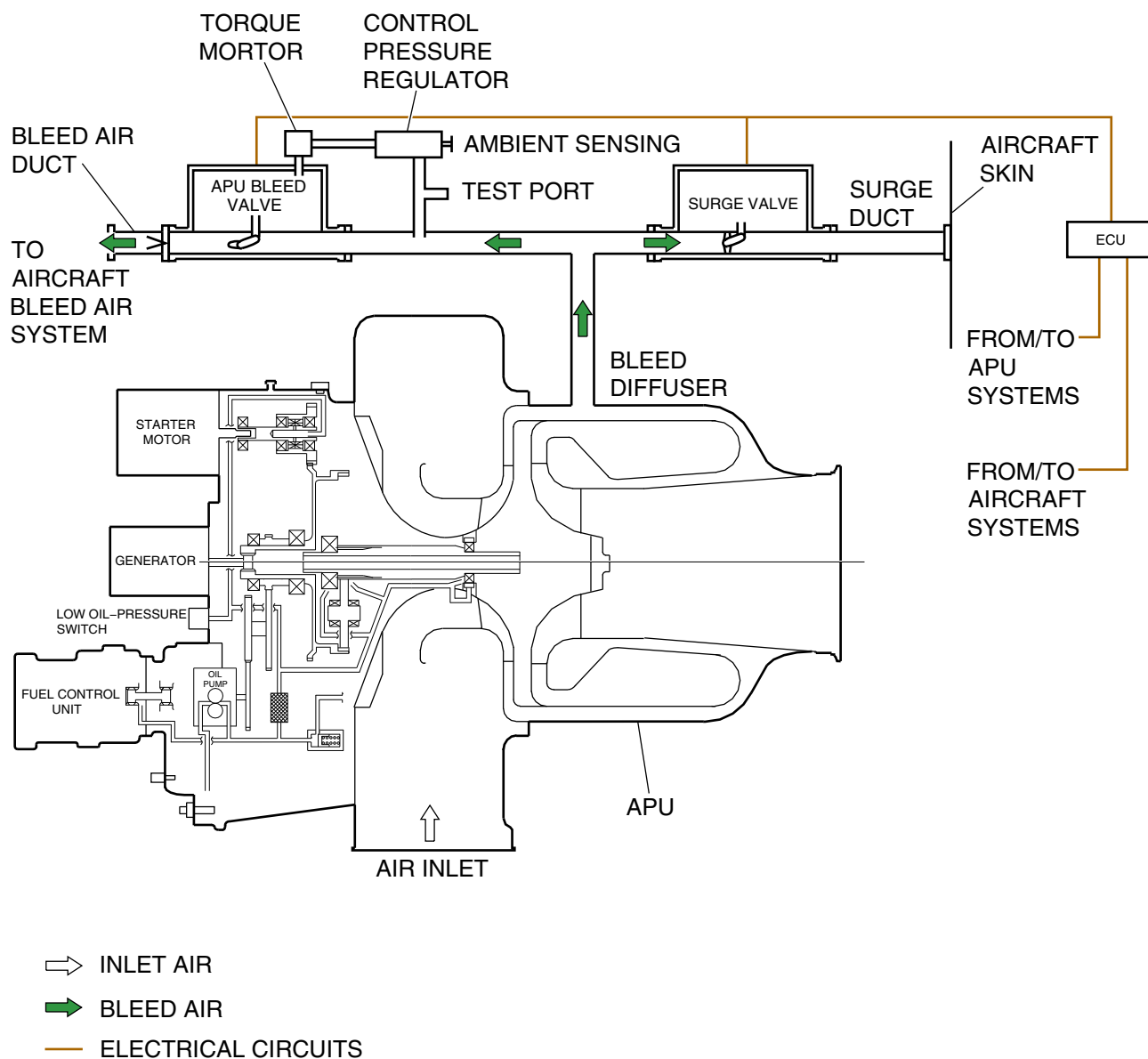
- XBLEED CLOSED
- L BLEED ON
- APU bleed OFF
- R BLEED ON
- APU OFF

During Approach:

- Start APU
- R BLEED switch OFF
- APU BLEED ON
- L BLEED switch OFF
- XBLEED switch OPEN
- Sequence designed so that only one source of bleed air is feeding any given duct



III. BLEED AIR LEAK DETECTION SYSTEM



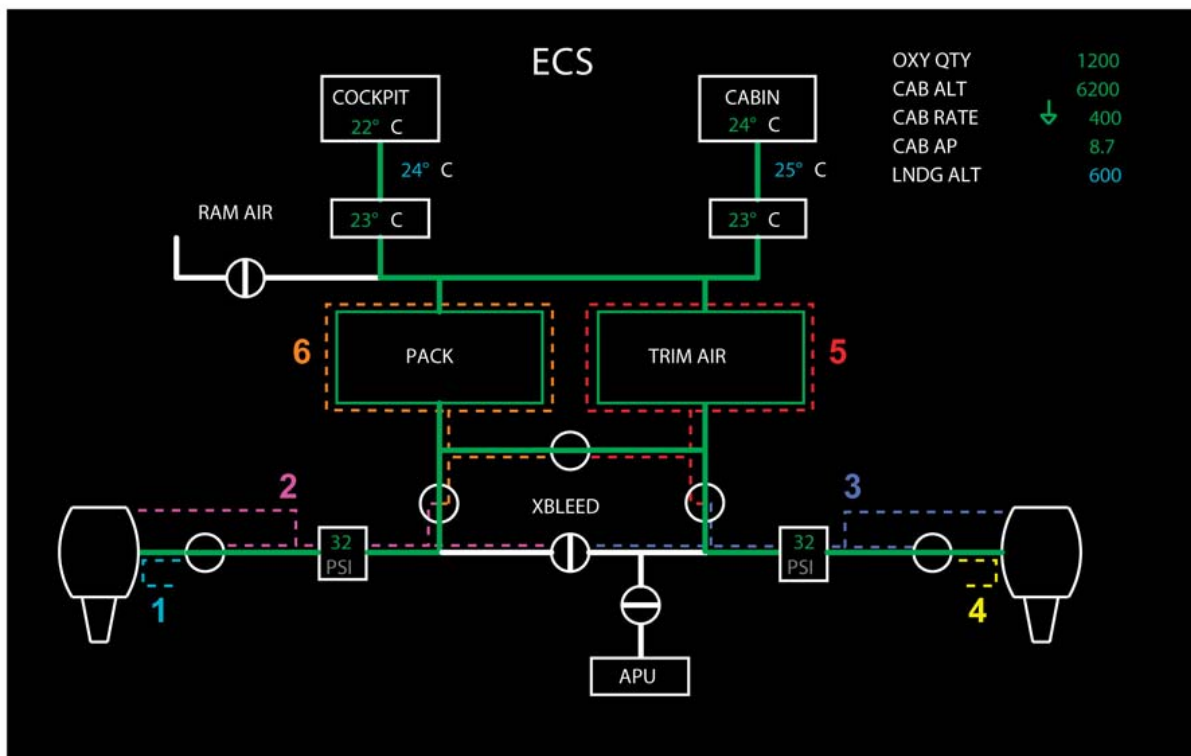
APU Bleed System

A. SYSTEM DESCRIPTION

- Monitors bleed air and anti-ice ducts for leakage
- Controlled by integrated air system controllers (IASC)
- Fully automatic system
- Divided into eight zones for EICAS presentation

B. EIGHT DETECTION ZONES

1. Left bleed duct
2. Right bleed duct
3. Left wing anti-ice duct
4. Right wing anti-ice duct
5. Right pylon duct
6. Left pylon duct
7. Pack ducts
8. Trim air ducts



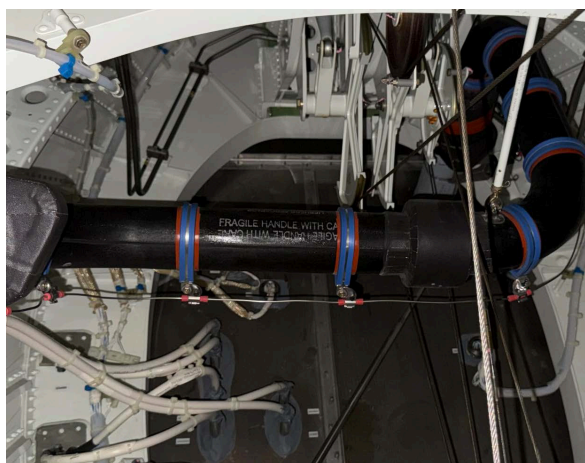
C. SINGLE LOOPS

- Used for left and right bleed ducts
- Used for trim air ducts

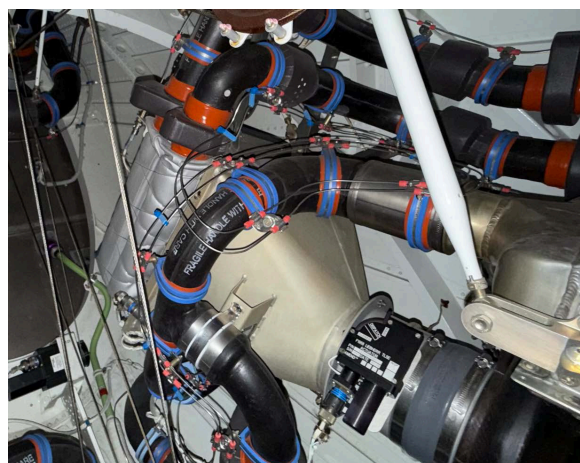
D. DUAL-SENSING LOOPS

Used to monitor:

- Bleed air ducts in engine pylons
- Bleed air ducts in aft equipment bay
- Anti-ice ducts in aft equipment bay
- Anti-ice ducts in wing leading edges
- Dual-loop system minimizes false leak indications
- Allows aircraft dispatch under certain conditions with one loop inoperative
- Loop FAIL message indicates both loops inoperative
- Loop FAULT message indicates one loop inoperative



APU Single Bleed Loop



PACK Dual Bleed Loop

E. DUCT CONSTRUCTION

- Bleed air ducts constructed of:
 - Stainless steel
 - Titanium
 - Aluminum
- Wrapped with insulation
- Series of vent holes in duct covers direct escaping bleed air to sensing loops

IV. ENVIRONMENTAL CONTROL SYSTEM

A. INTEGRATED AIR SYSTEM CONTROLLERS

- Two IASCs monitor and control air conditioning systems
- Each controller has two channels:
 - Channel A: Air conditioning control/monitoring, avionics cooling, cabin pressurization
 - Channel B: Wing anti-ice control/monitoring, bleed leak detection, limited backup air conditioning
- IASC 1 Channel B also has backup cabin pressure sensor

Location of units:

- One located under floor
- One under liner of lavatory, above floor

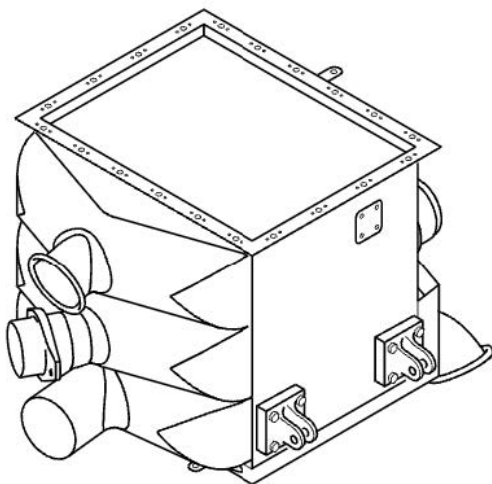
Monitoring functions:

- Collect data from air conditioning and bleed air control functions
- Monitor cabin pressure and airframe ice protection functions
- Pilot control of wing anti-ice from ANTI-ICE control panel on center pedestal

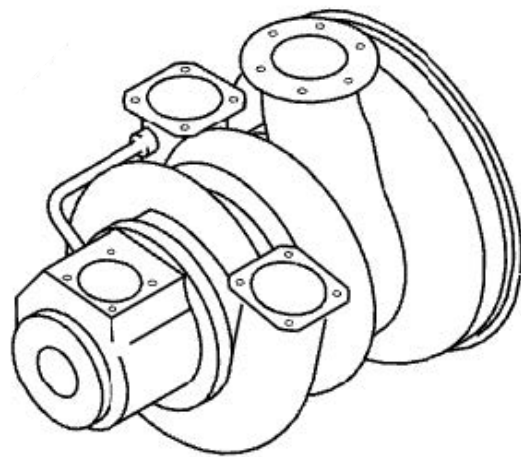
B. AIR CONDITIONING PACK

The PACK, or Air Conditioning Unit, conditions bleed air from the engines to provide a comfortable cabin environment. After passing through the precooler, bleed air is first cooled in the primary heat exchanger, then compressed by the air cycle machine (ACM) compressor before passing through the secondary heat exchanger, where it sheds heat to ram air. It continues through the reheater/condenser, where water is extracted, and then expands across the ACM turbine, which both cools the air and reduces it to near-cabin pressure.

A final pass through the condenser heat exchanger enhances cooling efficiency. Outlet temperature is controlled by a modulating temperature control valve that blends in bypassed hot air as needed. Ram air drives the heat exchangers in flight, while the ACM fan pulls airflow on the ground. Flow control valves, commanded by the AIR SOURCE selector, regulate overall pack airflow to the cabin.

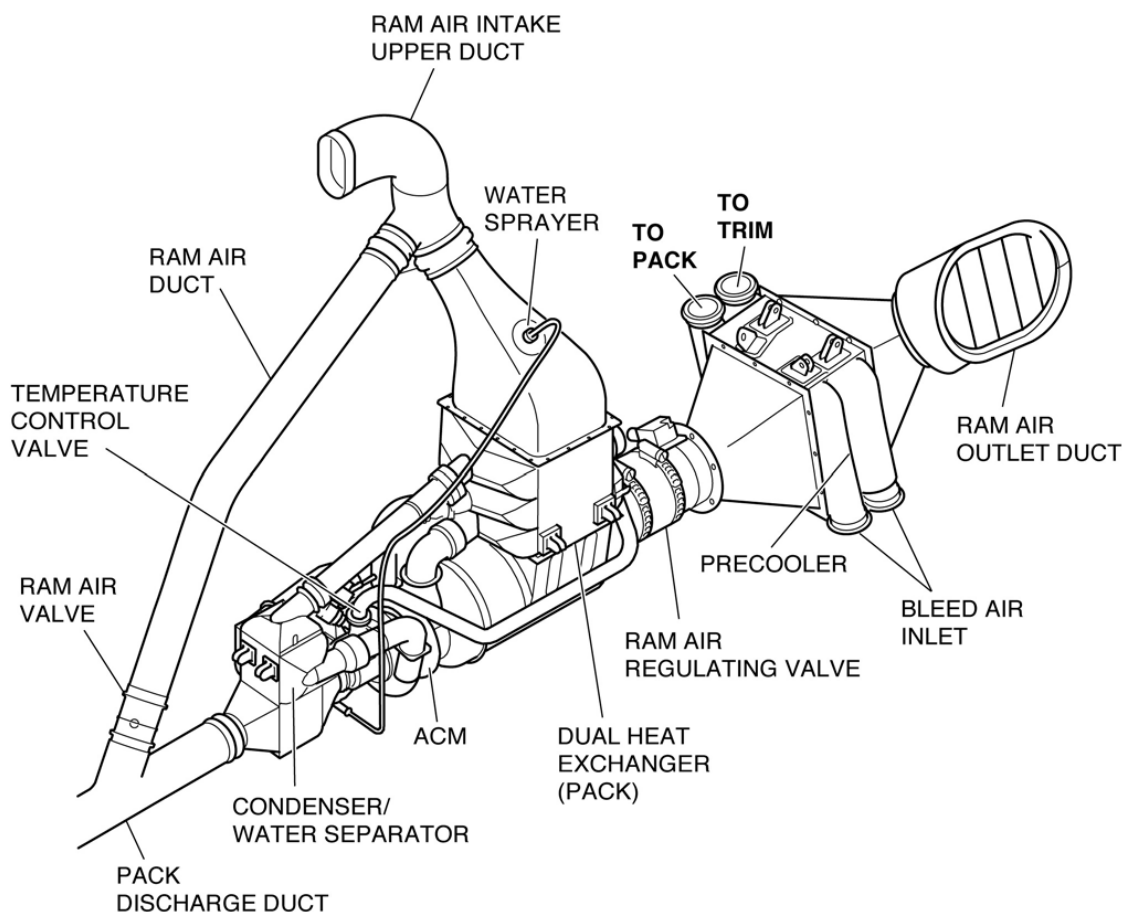


Dual Heat Exchanger



Air Cycle Machine

- Provides conditioned air for fuselage compartments
- Decreases temperature and water content of bleed air
- Supplied with pre-cooled bleed air for cabin air conditioning and cabin pressurization
- Air flow through PACK:
 - After passing through the precooler, bleed air enters at primary heat exchanger inlet
 - Primary heat exchanger reduces bleed air temperature
 - Air directed into compressor of air cycle machine (temperature and pressure increase)
 - Flows through secondary heat exchanger (pressure loss and temperature reduction)
 - Flows to reheater/condenser
 - Water extracted by centrifugal effect in water extractor
 - Routed to reheater cold air pass (temperature increases)
 - Expanded through turbine of air cycle machine to near cabin pressure
 - Temperature reduced at turbine outlet
 - Flows through condenser heat exchanger as coolant for water separation loop



Air Conditioning PACK Specifications

Parameter	Value
Pack Type	Air cycle machine with turbine expansion
Heat Exchangers	Primary and Secondary dual heat exchangers
Pre-cooler	Dual pre-cooler heat exchanger
Water Extraction	Centrifugal water extractor
Temperature Control	Modulating temperature control valve
Ram Air Cooling	Ram air through heat exchangers
Ground Cooling	ACM-driven fan for static operation
Pack Outlet Temperature	Just above freezing
Flow Control Valves	Electrically controlled, pneumatically operated

C. TEMPERATURE CONTROL VALVE

- Adjusts air temperature at PACK outlet by opening or closing
- Modulates hot air flow
- Bypasses air cycle machine between primary heat exchanger inlet and turbine outlet

D. FLOW CONTROL VALVES (FCVs)

- Control mass airflow through PACK and TRIM AIR system
- Electrically controlled, pneumatically operated, modulating shutoff valves
- Operated by AIR SOURCE selector on AIR COND/BLEED control panel

E. RAM AIR COOLING

- Ram air supplied upstream of dual heat exchanger by ram air system
- Flows through dual heat exchanger and collected by plenum

Ground operations:

- Ram air flow generated by suction effect of air cycle machine fan
- Suction closes plenum check valve

Flight operations:

- Dynamic air available at ram air inlet
- Plenum check valve opens
- Air cycle machine fan bypassed
- Ram air driven by total pressure at ram air inlet
- Air ducted towards dual pre-cooler heat exchanger then overboard



F. TEMPERATURE CONTROL

- Independent temperature control for COCKPIT and CABIN
- Controlled in automatic and manual modes from AIR COND/BLEED panel

Temperature ranges:

- Normal mode: 15°C to 35°C
- Manual (MAN) mode: 10°C to 70°C

V. AIR CONDITIONING CONTROLS

A. CONTROL PANEL LOCATION

- AIR COND/BLEED panel on center pedestal

B. TEMPERATURE SELECTORS

- Used to select desired temperature for cockpit and cabin
- MAN TEMP: Used when automatic temperature control using cabin or cockpit ventilation sensors not working

C. AIR SOURCE SELECTOR POSITIONS

OFF

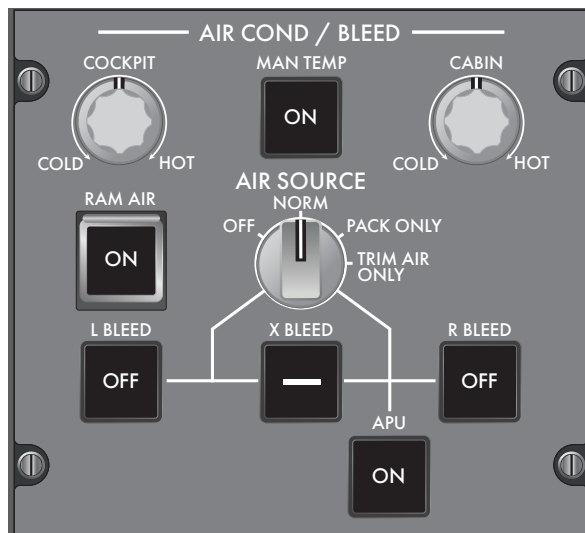
- Both flow control valves closed
- Prevents bleed air for pressurization and air conditioning from entering cabin
- **AIR SOURCE OFF** (S) CAS message displayed

NORM

- Normal switch position
- Allows bleed air from left and right sides of manifold
- Flow through PACK and TRIM AIR valves
- Provides conditioned air to cabin

PACK ONLY

- Opens left flow control valve
- Closes right flow control valve
- Closes precooler crossover valve (PCV)
- All bleed air flows through PACK
- None through trim air valves
- Used when TRIM AIR failure exists
- **PACK ONLY** (S) CAS message displayed



TRIM AIR ONLY

- Opens right flow control valve
- Closes left flow control valve
- Closes PCV
- All bleed air flows through trim air valves
- None through PACK
- Used when PACK failure exists

AIR SOURCE Selector Positions

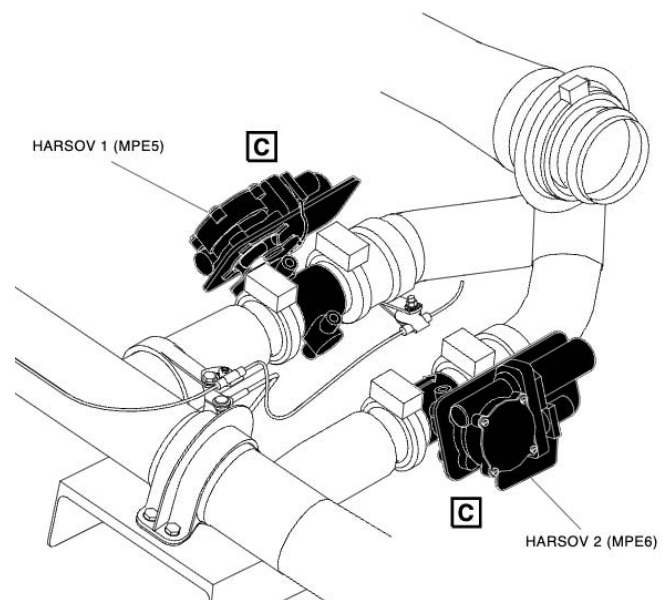
Position	Configuration
OFF	Both FCVs closed, no bleed air to cabin
NORM	Normal operation through PACK and TRIM AIR
PACK ONLY	Left FCV open, right FCV and PCV closed
TRIM AIR ONLY	Right FCV open, left FCV and PCV closed

VI. TRIM AIR SYSTEM**A. SYSTEM DESCRIPTION**

- Provides auxiliary pressurization and temperature control in event of complete PACK loss
- Provides hot trim air for normal cabin temperature control and cabin pressurization

B. SYSTEM COMPONENTS**Trim air ducting****Two Hot Air Regulating Shutoff Valves (HARSOV)**

- One for cabin low pressure distribution line
- One for cockpit low pressure distribution line
- Modulate hot air flow to adjust air supply temperature
- Ensure temperature control
- Fitted on trim air ducts in unpressurized aft equipment bay



Two Hot Air Check Valves (HACKV)

- Isolate pressurized area from unpressurized rear bay
- Prevent cabin decompression in case of trim air supply duct failure
- Located just downstream from trim air bulkhead

Three Trim Air Injectors

- Two for cabin supply
- One for cockpit supply
- Most components located in aft equipment bay

C. SYSTEM OPERATION

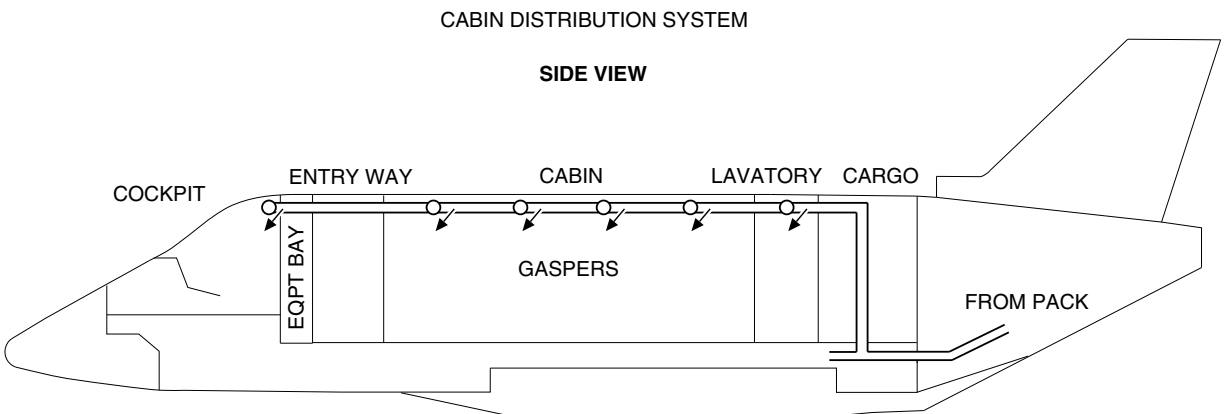
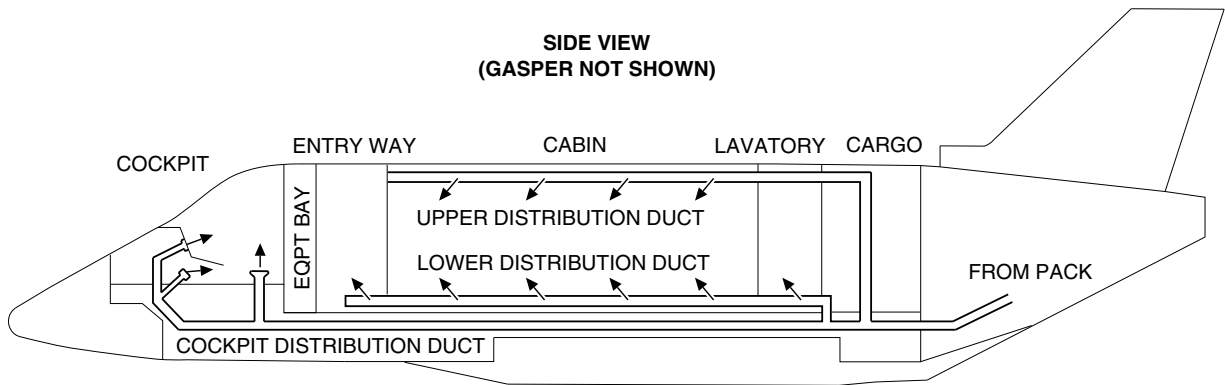
Air ducted from precooler outlet (trim air side) towards two lines:

- Line feeding cabin low pressure distribution through two cabin trim air injectors
- Line feeding cockpit low pressure distribution through one cockpit trim air injector

Trim Air System Specifications

Parameter	Value
Function	Temperature control and auxiliary pressurization
Hot Air Regulating Shutoff Valves	Two HARSOVs (cockpit and cabin)
Hot Air Check Valves	Two HACKVs for bulkhead isolation
Trim Air Injectors	Three (two cabin, one cockpit)
Installation Location	Aft equipment bay
Air Source	Pre-cooler outlet (trim air side)
Distribution	Separate cockpit and cabin lines
Temperature Modulation	HARSOV valve positioning

VII. AIR DISTRIBUTION AND EXHAUST SYSTEM



A. SYSTEM DESCRIPTION

- Distributes and exhausts conditioned air to and from the flight deck, cabin, and lavatory areas
- Consists of low-pressure ducting installed below and above aircraft floor

B. FLIGHT DECK DISTRIBUTION

Conditioned air distributed by:

- Duct connected to bulkhead check valve manifold
- Runs under aircraft floor from aft pressure bulkhead area to cockpit

Distribution outlets:

- Foot and leg level on each side of instrument panel
- Grill outlet on each side console
- Overhead gaspers (cold air only)
- All outlets except gaspers are temperature controlled



C. PASSENGER CABIN DISTRIBUTION

- Two main ducts connected to bulkhead check valve manifold provide air at:
 - Foot level (temperature controlled)
 - Head Level via gaspers

Upper feed line:

- Runs upwards between aircraft skin and liner of cargo compartment
- Integral to interior furniture on either side of aircraft at head level
- Overhead gaspers: Cold air only

D. LAVATORY VENTILATION

- Gasper supplies fresh air to lavatory compartment
- More air exhausted underfloor than supplied by conditioned air system
- Prevents unpleasant odors in passenger cabin
- Vent installed in lavatory wall to equalize pressure

E. AIR EXHAUST AND VENTILATION PATH

- Fresh air supplied to cabin and cockpit dumped overboard through cabin pressure control system
- Air path designed for optimum comfort and equipment ventilation management

Cabin exhaust air:

- To under-floor area and outflow valve through holes in floor sill
- Some directed under floor to ventilate and heat battery compartment
- Then directly dumped overboard through avionic valve

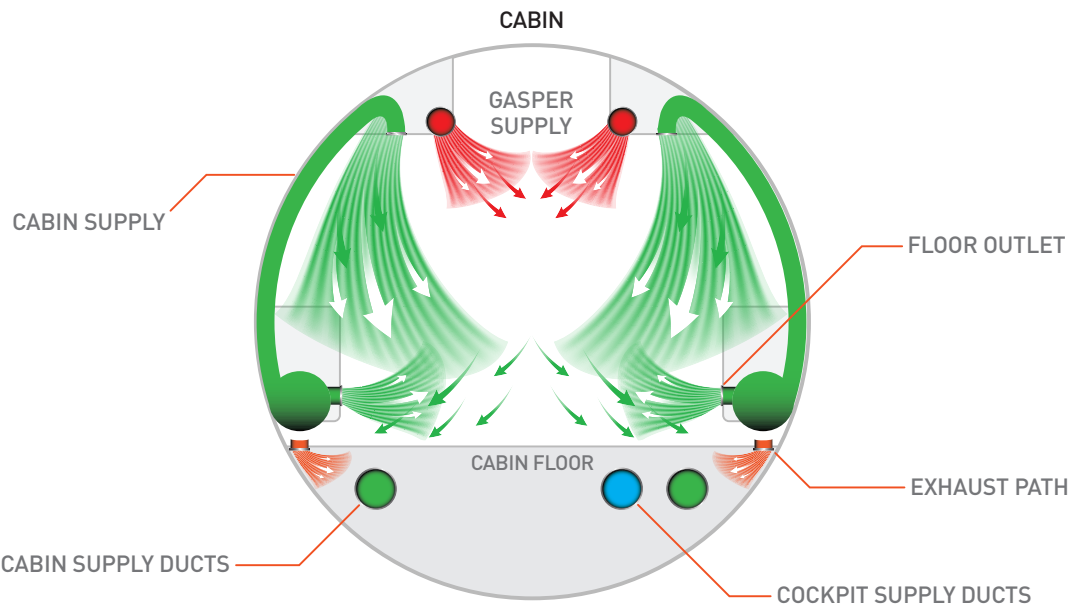
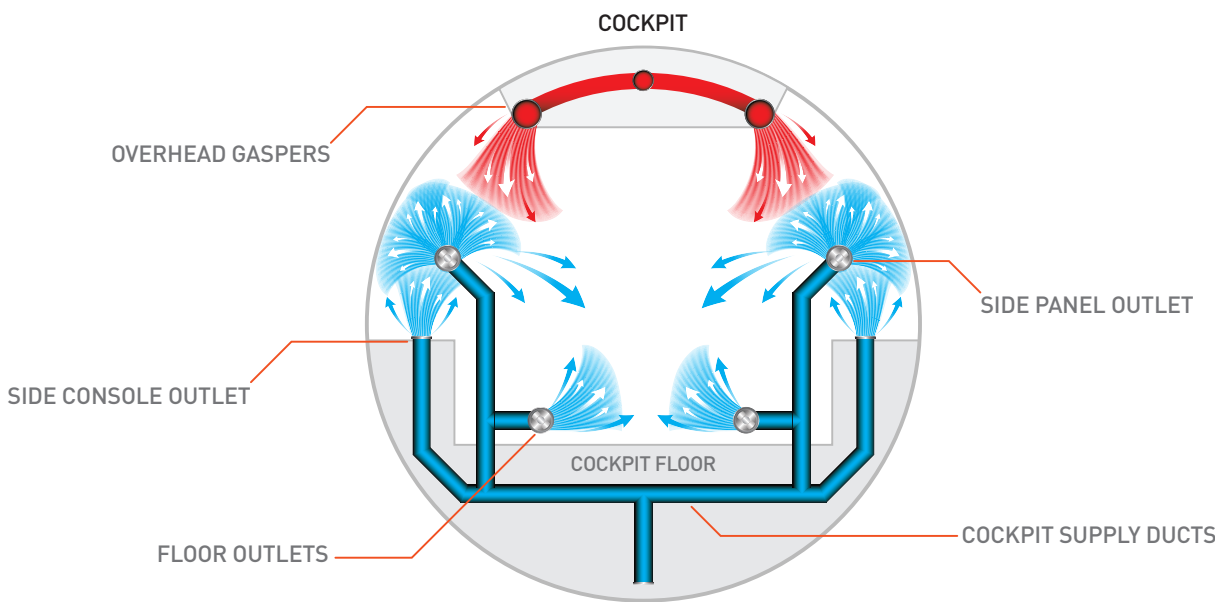
Cockpit exhaust air:

- To under-floor area and outflow valve through holes in cockpit floor
- Through holes in center pedestal
- Air circulation provided at back of cockpit display through specially designed grilles

F. AIR DISTRIBUTION FLOW PATHS

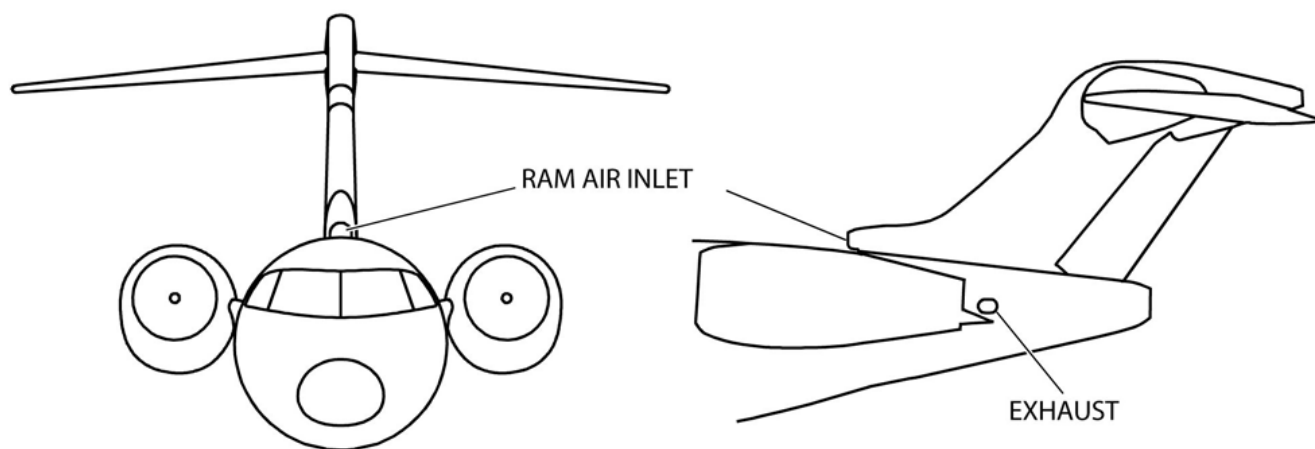
- Cockpit distribution duct
- Upper distribution duct
- Lower distribution duct
- Entry way distribution
- Cabin to lavatory to cargo flow pattern

AIRFRAME AIR DISTRIBUTION SCHEMATIC



LEGEND	
	Cockpit & Cabin Gaspers Supply
	Cockpit Conditioned Air Supply
	Cabin Conditioned Air Supply
	Exhaust Path

VIII. RAM AIR SYSTEM



A. RAM AIR INLET

- Located at base of vertical fin
- Ram air used as cooling medium for air-to-air heat exchangers

Ram air flow path:

- Passes through secondary heat exchanger
- Passes through primary heat exchanger
- Passes through precooler heat exchangers
- Heat extracted from air conditioning system
- Discharged overboard through exhaust vents

B. GROUND OPERATIONS

- Airflow through ram air inlet inadequate for cooling heat exchangers
- Fan located in ram air duct
- Mechanically driven by air cycle machine
- Increases airflow through duct to cool heat exchangers

C. RAM AIR VALVE

- Used if air conditioning system fails
- Provides cockpit and cabin ventilation below 10,000 ft

Operation:

- Descend below 10,000 ft
- Select guarded RAM AIR switch to ON
- Opens ram air valve to provide airflow into aircraft
- Used to provide ambient air ventilation in event of PACK and TRIM AIR failure

D. PNEUMATIC SOURCES

In Flight Operations:

- Engines provide bleed air at all altitudes
- APU provides bleed air up to 20,000 ft

Ground Operations:

- Air conditioning PACK can operate with APU, engines, or external ground cart
- APU recommended due to low pressure from engines at ground idle

Ram Air System Specifications

Parameter	Value
Ram Air Inlet Location	Base of vertical fin
Heat Exchanger Cooling	Secondary, Primary, and Pre-cooler
Ground Operation Fan	ACM-driven for static cooling
Ram Air Valve	Emergency ventilation below 10,000 feet
Plenum Check Valve	Opens with dynamic pressure available
Maximum Operation Altitude	10,000 feet
Control Switch	Guarded RAM AIR switch
Emergency Use	PACK and TRIM AIR failure

IX. AVIONICS AND COCKPIT DISPLAYS VENTILATION

A. SYSTEM DESCRIPTION

- Provides ventilation for avionics and cockpit displays
- Ensures aircraft reliability and safety requirements

B. SYSTEM COMPONENTS

- Underfloor fan
- Avionics cooling valve

Both can pull air from:

- Cockpit panel area behind displays
- Above avionics racks

C. OPERATING MODES

Ground Operations:

- Fan operated in high-speed mode

Flight Operations:

- Fan operated at low speed normally
- Fan operates at high speed if temperature in avionics racks reaches 122°F (50°C) in 60 seconds
- Above 10,000 ft: If temperature rises above 149°F (65°C) during 60 second period:
 - Fan turned off
 - Avionics cooling valve opened by IASC

D. SYSTEM CONTROL

- Normal control and monitoring by IASC 1

Degraded mode:

- Controlled by IASC 2
- Avionics fan turned on
- If fan failed, avionics cooling valve opens

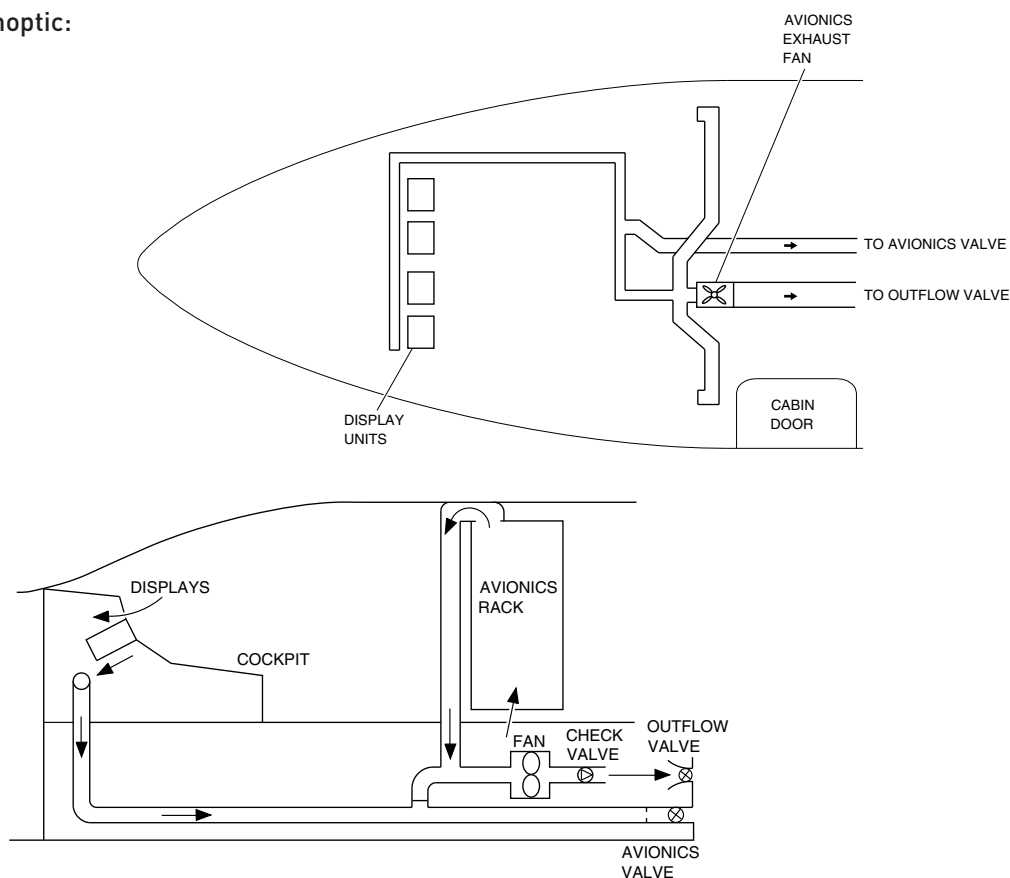
E. FAILURE INDICATIONS

- **EQPT RACK COOL FAULT** (C) CAS message if fan or valve fails
- **EQPT RACK TEMP HIGH** (C) CAS message if overheat condition occurs in avionics rack

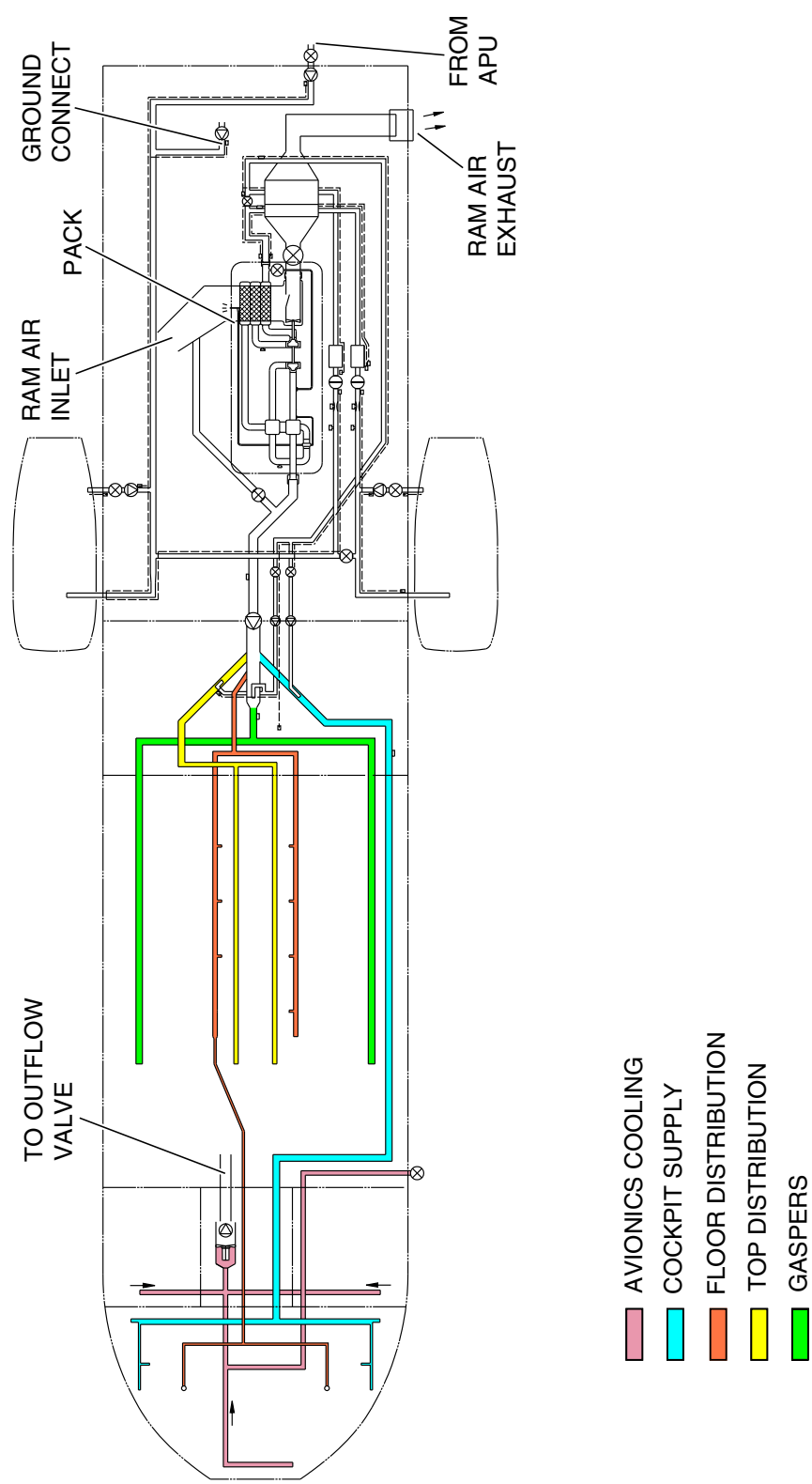
F. CABIN AND COCKPIT AIR DISTRIBUTION SYSTEM

Components shown on synoptic:

- Ram air inlet
- PACK
- Ground connect
- From APU
- Ram air exhaust
- To outflow valve
- Top distribution
- Cockpit supply
- Floor distribution
- Gaspers
- Avionics cooling



CABIN AND COCKPIT AIR DISTRIBUTION SYSTEM





X. EICAS MESSAGES

A. WARNING MESSAGES

WARNING MESSAGES

Immediate crew action required

Message	Meaning	Inhibits
CABIN ALTITUDE	Excessive Cabin Altitude (9,400' Normal; +1,550' T/O above 7,850'; Max 14,300')	TO/LAND
CABIN DELTA P	Excessive cabin differential pressure (greater than 9.2 psid or less than -0.5 psid)	TO/LAND
L (R) BLEED LEAK	A leak has been detected in the indicated bleed duct	TO/LAND
L (R) PYLON BLEED LEAK	Leak has been detected in the indicated engine pylon or tail cone	TO/LAND
PACK LEAK	A leak has been detected in the pack ducting	TO/LAND
TRIM AIR LEAK	Leak detected in trim air duct	TO/LAND

B. CAUTION MESSAGES

CAUTION MESSAGES

Timely crew awareness/action needed

Message	Meaning	Inhibits
AIR COND TEMP FAIL	Automatic temperature control system has failed	TO/LAND
AIR COND TEMP HIGH	Excessive air temperature has been detected in the air distribution duct	TO/LAND
AUTO PRESS FAIL	Automatic cabin pressurization control has failed	TO/LAND
L (R) BLEED FAIL	Indicated engine bleed air valve has failed, or pressure is outside limit (high or low)	TO/LAND
L (R) BLEED LOOP FAIL	Both bleed air leak detection loops in the indicated zone have failed	TO/LAND
CABIN ALTITUDE	Excessive Cabin Altitude (8,500 ft for Normal Operations)	TO/LAND
CABIN PRESS FAULT	Either the pressure sensor has failed or cabin altitude limiter function has failed	TO/LAND
DITCHING NOT AVAIL	Ditching switch has been selected on with the pressurization switch in the manual mode	—
EQPT RACK TEMP HIGH	Overheat condition has occurred in the avionics rack	TO/LAND
OXYGEN QUANTITY LOW	Oxygen is less than 700 liters	TO/LAND
OXYGEN VALVE CLOSED	Oxygen bottle valve is closed or there is a miscompare on the electrical pneumatic actuating valve	TO/LAND

B. CAUTION MESSAGES

CAUTION MESSAGES

Timely crew awareness/action needed

Message	Meaning	Inhibits
PACK FAIL	A failure has been detected in the pack system	TO/LAND
PACK LOOP FAIL	Both bleed air leak detection loops in the pack have failed	TO/LAND
PACK TEMP HIGH	Overheat detected in the air conditioning pack system	TO/LAND
PAX OXYGEN AUTO FAIL	Automatic mask deployment function has failed	TO/LAND
TRIM AIR FAIL	A hot air regulating valve has failed	TO/LAND
TRIM AIR LOOP FAIL	Both bleed air leak detection loops in the TRIM AIR have failed	TO/LAND
XBLEED FAIL	Crossbleed valve has failed to move to the commanded position	TO/LAND

C. ADVISORY MESSAGES

ADVISORY MESSAGES

Crew awareness - no immediate action required

Message	Meaning	Inhibits
AIR COND FAULT	A fault has been detected in the air conditioning system, or there has been a loss of temperature sensing	TO/LAND
L (R) BLEED FAULT	The bleed pressure data is invalid, or the indicated flow control valve is failed closed	TO/LAND
BLEED LOOP FAULT	A fault has been detected in the bleed leak detection loop system and redundancy is lost	TO/LAND
CABIN ALT WARN HIGH	A high-altitude airport takeoff or landing has been initiated and the pressurization system is in the automatic mode	—
EQPT RACK COOL FAULT	A fault has been detected in the avionics equipment rack cooling system	TO/LAND
MANUAL PRESS FAIL	Manual mode is not operational (on the ground only)	TO/LAND
PACK COOL AIR FAIL	Ram air regulating valve supplying cooling air to the air conditioning pack heat exchanger has failed	TO/LAND
L (R) PYLON LOOP FAIL	A bleed leak detection loop in the indicated pylon has failed	TO/LAND
RAM AIR FAIL	The ram air ventilation valve has failed	TO/LAND



D. STATUS MESSAGES

STATUS MESSAGES

Information only - no crew action required

Message	Meaning
AIR COND MAN TEMP ON	The air conditioning temperature control is in manual mode
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.
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
PAX OXYGEN OFF	The passenger oxygen switch has been selected OFF
PAX OXYGEN ON	Pressure has been detected in the passenger oxygen lines
RAM AIR ON	The RAM AIR switch has been selected ON, providing ram air ventilation
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
XBLEED OPEN	The crossbleed valve is open

NOTES

- All warning messages are accompanied by a triple chime
- All caution messages are accompanied by a single chime
- "TO/LAND" indicates the message is inhibited during takeoff and landing phases
- "TO" indicates the message is inhibited during takeoff only
- L (R) notation indicates the message can appear for either left or right system
- The bleed leak detection system uses dual-sensing loops in critical areas to minimize false indications

XI. LIMITATIONS

Environmental System Altitude Limitations

Parameter	Maximum Altitude
TRIM AIR ONLY	Prohibited on the ground
APU Bleed Air for ECS	20,000 feet
APU Bleed Air for Engine Start	20,000 feet
Trim Air Only Operation (PACK Failed)	35,000 feet
Oxygen Quantity Low	25,000 feet
Cabin Pressure Fault	31,000 feet
Unpressurized Flight	9,000 feet
Ram Air Ventilation	10,000 feet
Use of Engine Bleed during Steep Approach	Prohibited

Note: The pack must be operating (APU or engine running and AIR SOURCE switch – NORM or PACK ONLY) when the airplane electrical power is on (BATTs or EXT PWR – On) for more than 30 minutes and the OAT is above 40°C (104°F).

XII. ENVIRONMENTAL SYSTEM CIRCUIT BREAKERS

Environmental System Circuit Breakers

CB Name	Bus	Location
ALT LIM/ECS XVLV PWR 1	RIGHT ESS	CB2-D13
ALT LIM/ECS XVLV PWR 2	LEFT ESS	CB1-D13
AUTO DEP THERAPTC	LEFT MAIN	CB3-D5
BLEED VALVES L	LEFT ESS	CB1-D15
BLEED VALVES R	RIGHT ESS	CB2-D15
FOOT WARM L	LEFT AUX	CB3-D7
FOOT WARM R	RIGHT AUX	CB4-D7
OXYGEN MAN DEP/IND	RIGHT ESS	CB4-D1
PRESS 1/PACK	LEFT ESS	CB1-D14
PRESS 2/TRIM	RIGHT MAIN	CB2-D14
RAM AIR/OFV PWR 1	RIGHT MAIN	CB4-D6
RAM AIR/OFV PWR 2	LEFT ESS	CB3-D6
X BLEED VALVE	RIGHT ESS	CB2-D12



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XIII. ENVIRONMENTAL QUIZ

1. How many zones is the bleed leak detection system divided into for EICAS presentation?
 - A) Six zones
 - B) Seven zones
 - C) Eight zones
 - D) Nine zones
2. What type of loops are used for the trim air ducts in the bleed leak detection system?
 - A) Dual-sensing loops
 - B) Single loops
 - C) Triple loops
 - D) No loops
3. At what pressure does the IPV limit intermediate engine bleed pressure?
 - A) 40 ± 3 psi
 - B) 45 ± 3 psi
 - C) 50 ± 3 psi
 - D) 60 ± 3 psi
4. Where are the two IASCs located in the aircraft?
 - A) Both in cockpit
 - B) Both in aft equipment bay
 - C) One under floor, one under lavatory liner above floor
 - D) Both under floor
5. What is the temperature control range in normal mode?
 - A) 10°C to 35°C
 - B) 15°C to 35°C
 - C) 15°C to 70°C
 - D) 10°C to 70°C
6. How many check valves are installed in the bleed air ducting?
 - A) Two
 - B) Three
 - C) Four
 - D) Five
7. Which side of the bleed manifold does the APU supply air to?
 - A) Left side only
 - B) Right side only
 - C) Both sides
 - D) Center only

8. In the PACK ONLY position, which flow control valve is open?
- A) Right FCV
 - B) Left FCV
 - C) Both FCVs
 - D) Neither FCV
9. How many trim air injectors are in the system?
- A) Two
 - B) Three
 - C) Four
 - D) Five
10. At what temperature does the avionics fan switch to high speed in flight?
- A) 100°F (38°C) in 60 seconds
 - B) 122°F (50°C) in 60 seconds
 - C) 149°F (65°C) in 60 seconds
 - D) 165°F (74°C) in 60 seconds
11. Below what altitude can the ram air valve be used for ventilation?
- A) 8,000 ft
 - B) 10,000 ft
 - C) 15,000 ft
 - D) 20,000 ft
12. What drives the fan in the ram air duct during ground operations?
- A) Electric motor
 - B) Hydraulic pump
 - C) Air cycle machine
 - D) APU bleed air
13. How many HARSOVs are in the trim air system?
- A) One
 - B) Two
 - C) Three
 - D) Four
14. What happens to the APU bleed valve when the APU is shut down?
- A) Remains in last commanded position
 - B) Moves to fail-safe open position
 - C) Moves to fail-safe closed position
 - D) Modulates based on temperature
15. During normal takeoff and landing, what is the APU bleed configuration?
- A) APU bleed OFF
 - B) APU bleed ON
 - C) APU bleed modulating
 - D) APU bleed in standby



16. Which IASC channel is dedicated to wing anti-ice control and bleed leak detection?

- A) Channel A
- B) Channel B
- C) Both channels
- D) Neither channel

17. What type of valves are the flow control valves?

- A) Hydraulically controlled, electrically operated
- B) Electrically controlled, pneumatically operated
- C) Manually controlled, pneumatically operated
- D) Pneumatically controlled, electrically operated

18. At what manifold pressure does a **L (R) BLEED FAIL** (C) CAS message appear?

- A) Exceeds 50 psi
- B) Exceeds 55 psi
- C) Exceeds 60 psi
- D) Exceeds 65 psi

19. Where do the overhead gaspers in the cockpit supply air from?

- A) Hot trim air
- B) Mixed temperature air
- C) Cold air only
- D) Ram air

20. What materials are the bleed air ducts constructed from?

- A) Composite materials only
- B) Aluminum only
- C) Stainless steel, titanium, or aluminum
- D) Carbon fiber and titanium

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