

CHAPTER 19 – PNEUMATIC

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1. INTRODUCTION

The pneumatic system consists of two separate bleed air systems.

- Low pressure (10th stage) bleed air system
- High pressure (14th stage) bleed air system.

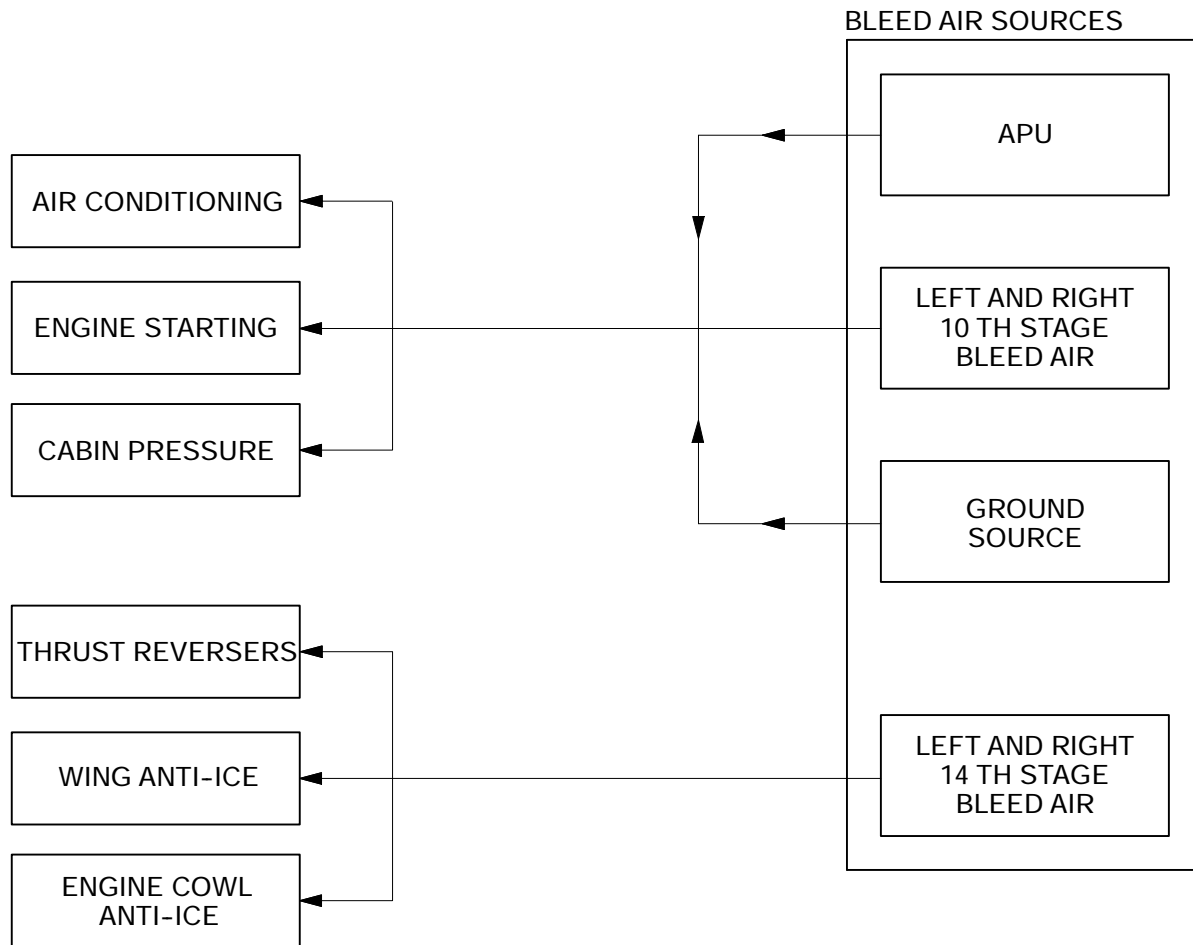
The low pressure system is supplied bleed air from the 10th stage of both engine compressors. The 10th stage air is used to supply air for the left and right environmental control systems, for pressurization and for engine starting. The APU bleed air system or high pressure air from a ground air source can also be used to meet these requirements. Normally, each engine supplies the user system on the respective side but, if the 10th stage bleed air supply is lost from one side, a bleed isolation valve is provided for cross-bleeding from the operable side.

The environmental control system can also receive conditioned air from a ground air cart.
<0007>


The high pressure system is supplied hot bleed air from the 14th stage of both engine compressors. The 14th stage bleed air is used to supply the requirements of the wing and cowl anti-ice systems and for thrust reverser operations. Normally, each engine supplies the user system on the respective side but, if the 14th stage bleed air supply is lost from one side, a wing isolation valve is provided for cross-bleeding from the operable side.

The bleed air leak detection system monitors the pneumatic ducting for high temperature bleed air leaks. When the system detects a leak, visual warnings are displayed and aural warnings sound to alert the crew to turn off the affected system.

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Bleed Air Distribution
Figure 19-10-1

	PNEUMATIC Bleed Air System	Vol. 1	19-20-1
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1. BLEED AIR SYSTEM

A. Engine Bleed Air

The engine supplies both low (10th stage) and high (14th stage) pressure bleed air from the compressors to the low and high pressure manifolds.

(1) Low Pressure (10th stage)

The low pressure bleed air manifold receives pressurized air from:

- The engine compressors 10th stage or,
- The APU compressor or,
- From an external ground air source.

Low pressure operated aircraft systems include engine starting, air-conditioning and pressurization. Bleed air to the low pressure manifold is controlled by 10TH STAGE bleed air switchlights on the BLEED AIR control panel. The switchlights operate the respective L/R 10th stage bleed air shutoff valves. The left and right systems normally operate independently but can be connected by opening the bleed isolation valve. The bleed isolation valve is controlled by the 10TH STAGE ISOL switchlight on the BLEED AIR control panel.

(2) High Pressure (14th stage)

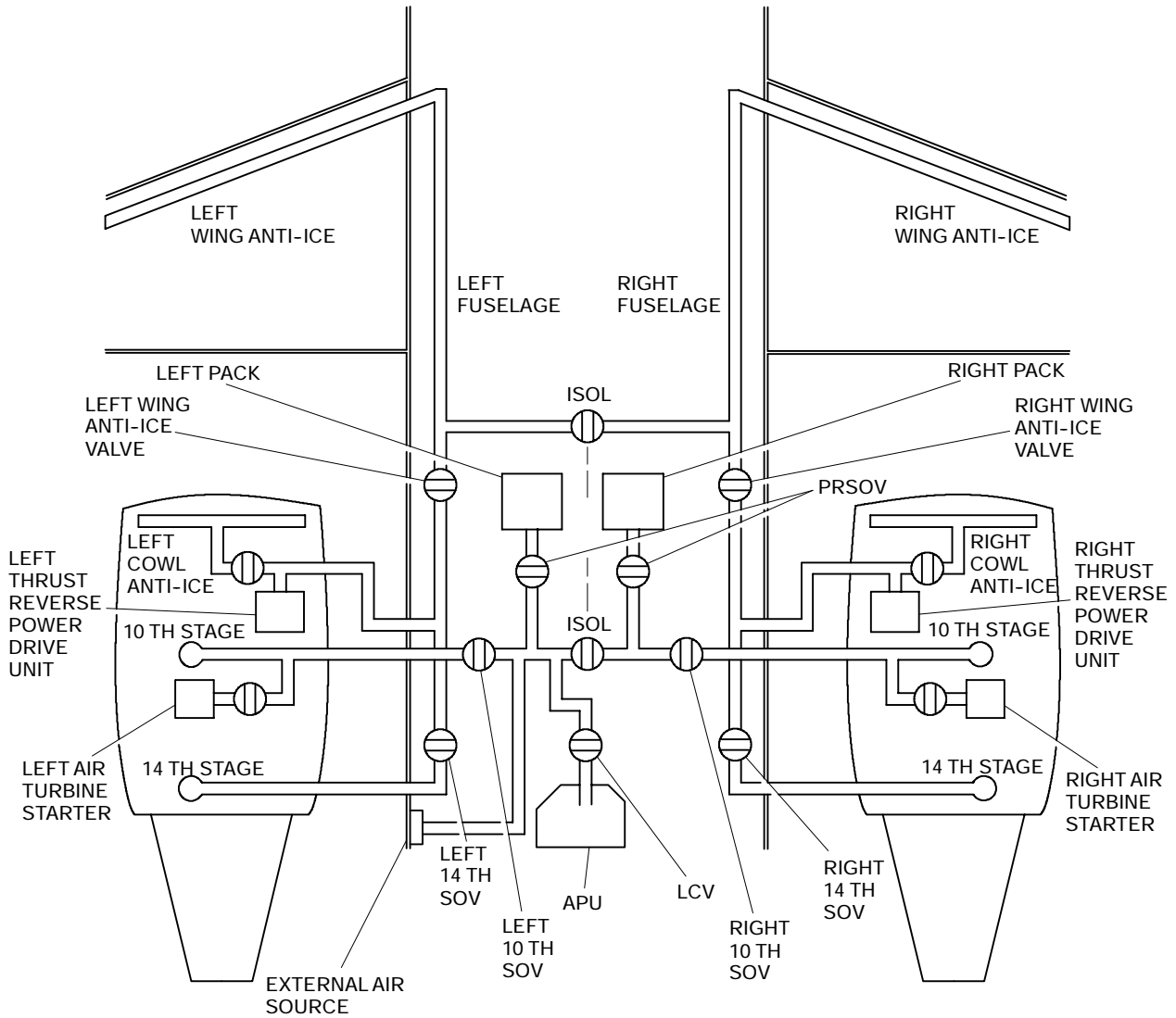
The high pressure bleed air manifold receives pressurized air from the engine compressors 14th stage.

High pressure operated aircraft systems include the wing anti-ice, cowl anti-ice and thrust reverser systems. Bleed air to the high pressure manifold is through the respective L/R 14th stage bleed air shutoff valves. The shutoff valves are normally open but can be closed by selecting the 14TH STAGE bleed air switchlights on the BLEED AIR control panel. The left and right wing anti-ice systems normally operate independently but can be connected by a wing isolation shutoff valve which is controlled by the 14TH STAGE ISOL switchlight on the BLEED AIR control panel.

B. APU Bleed Air

The APU can be used on the ground to supply the low pressure manifold with bleed air for air-conditioning or engine starting. The APU can also be used in flight, to supply bleed air for engine starting (double engine failure) to a maximum altitude of 13,000 ft. and to supply the air-conditioning system to a maximum of 15,000 ft. When the APU is selected as the bleed air source, the bleed air is supplied through the APU load control valve (LCV) to the left bleed air manifold. The APU LCV is controlled by a switchlight on the BLEED AIR control panel. The 10TH STAGE bleed isolation valve must be opened to pressurize the right manifold. The APU ECU modulates the LCV to limit APU exhaust gas temperature and to prevent compressor surges.

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**Bleed Air System Schematic
Figure 19-20-1**

10th Stage Isolation Valve Switch/Light

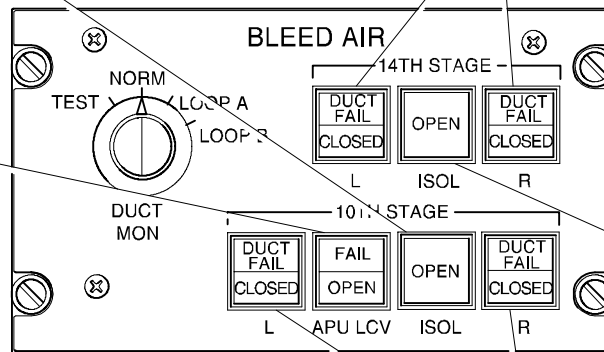
- When pressed in, bleed air isolation valve opens and OPEN (white) comes on.
- When pressed out, isolation valve closes and OPEN light goes out.

L/R 14th Stage Bleed Air Switchlights
Controls the 14th-stage bleed air shutoff valves.

- DUCT FAIL - Indicates bleed air leak in applicable duct. Illuminates during duct monitor test.
- CLOSED - Indicates shutoff valves fully closed.

APU LCV Switchlight

- OPEN - APU LCV selected open.
- FAIL - APU LCV open when commanded by the interlock protection circuit.



**Bleed Air Panel
Overhead Panel**

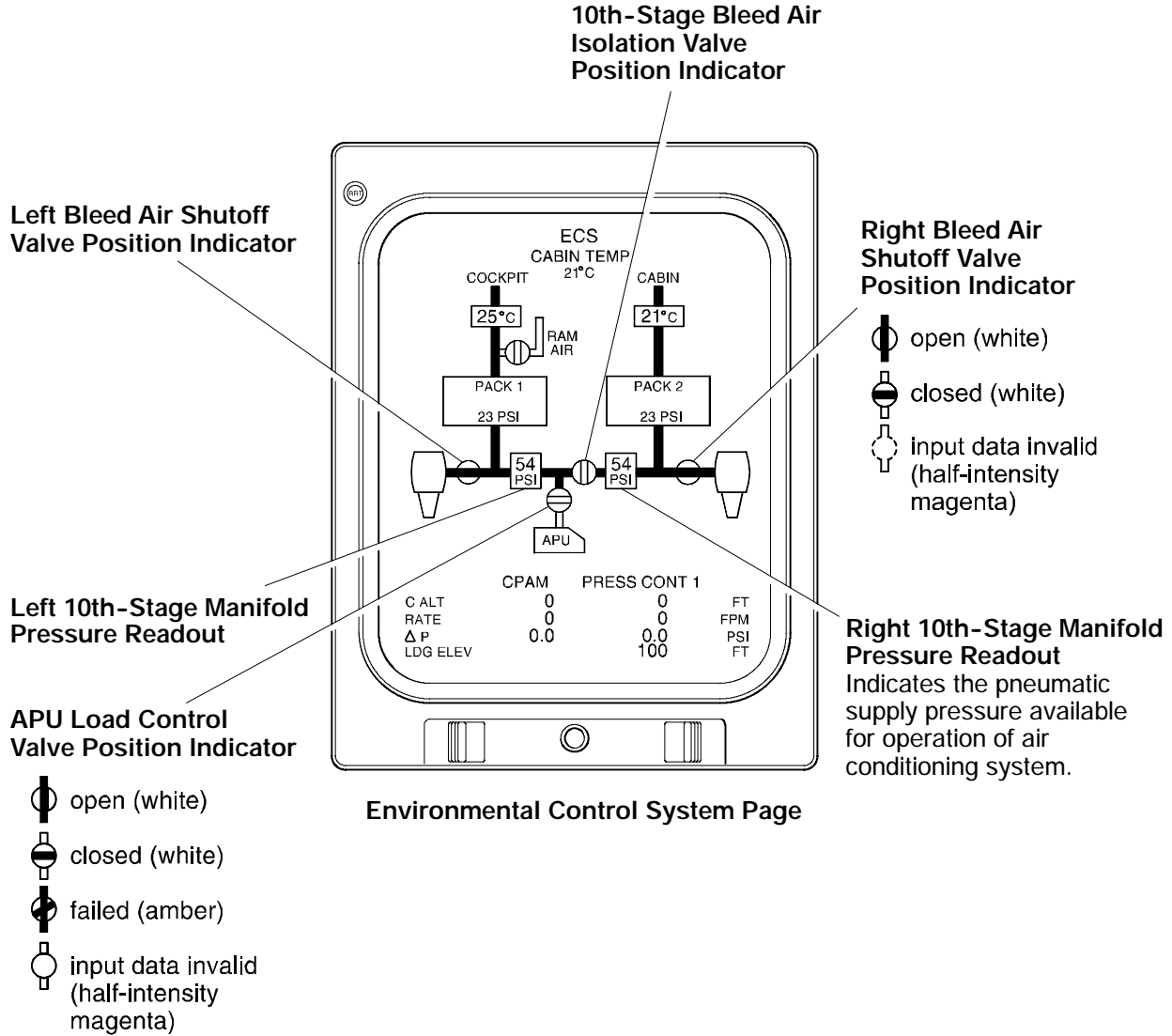
14th Stage ISOL Switchlight

- OPEN - Indicates isolation valve has been selected open.

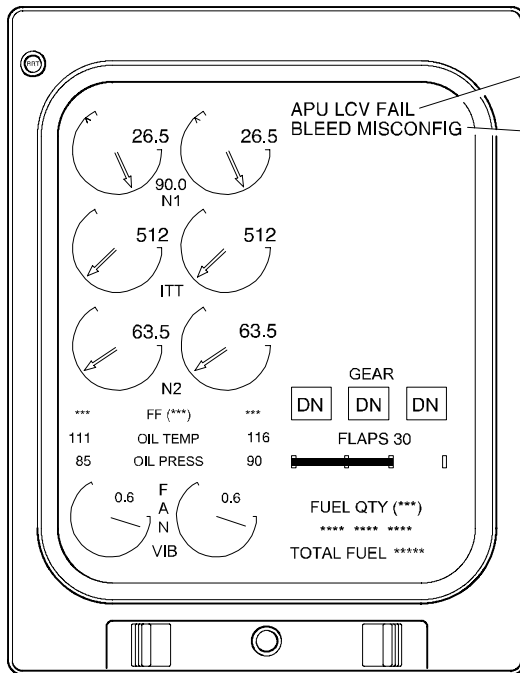
**10th Stage Left and Right Bleed Air
Switch/Lights**

- When pressed in, associated bleed air shutoff valve opens and CLOSED (white) goes out.
- When pressed out, associated bleed air valve closes and CLOSED (white) comes on.
- DUCT FAIL (red) - Comes on if bleed leak detector sensors detect a failure in associated duct section. DUCT FAIL goes out when the failed duct is isolated and temperature sensor cools.

**Bleed Air System Controls
Figure 19-20-2**



ECS Page
Figure 19-20-3



Primary Page

APU LCV FAIL caution (amber)
Load control valve has failed (either open or closed).

BLEED MISCONFIG caution (amber) <0039>
Comes on to indicate that the 10th and 14th stage bleeds are misconfigured for take-off and landing. (i.e., the wing/cowl anti-ice are in use and the 10th stage bleeds are not closed for take-off or landing).

<0006>
FLAPS 20

APU LCV OPEN status (white)
APU load control valve is open. 10th stage, APU LCV OPEN switch/light comes on.

L/R 10TH SOV CLSD status (white)
Comes on to indicate that corresponding SOV is closed. Corresponds to 10th stage switch/lights indicating CLOSED (white). <0039>

10TH ISOL OPEN status (white)
Comes on to indicate that 10th stage isolation valve is open. Corresponds to 10th stage ISOL switch/light indicating OPEN (white).

14TH ISOL OPEN status (white)
Comes on when 14th stage bleed air isolation valve is open.

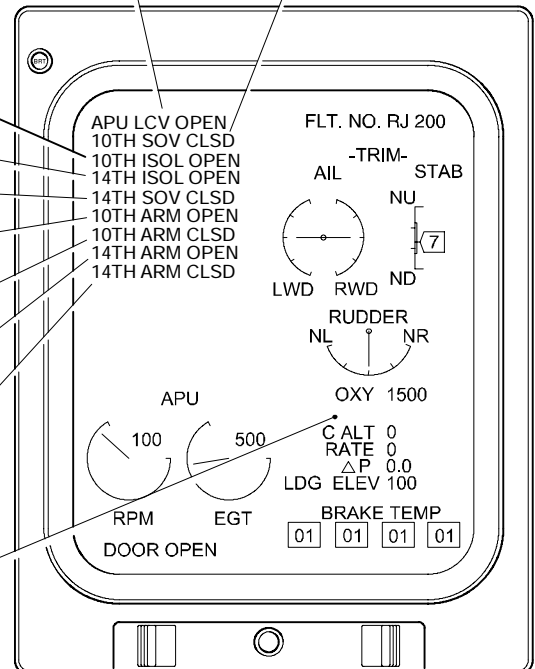
14TH SOV CLSD status (white)
L/R 14th stage bleed air SOV open when switch/light unlatched (CLSD position).

L/R 10TH ARM OPEN status (white) <0039>
Comes on to indicate that the applicable 10th-stage switch is selected open but the SOV is closed.

L/R 10TH ARM CLSD status (white) <0039>
Comes on to indicate that the applicable 10th stage bleed air switch is selected closed but the SOV is open.

L/R 14TH ARM OPEN status (white) <0039>
Comes on to indicate that the applicable 14th stage switch is selected open but the SOV is closed.

L/R 14TH ARM CLSD status (white) <0039>
Comes on to indicate that the applicable 14th stage bleed air switch is selected closed but the SOV is open.



Status Page

**Bleed Air System EICAS Indications <MST>
Figure 19-20-4**



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C. High Pressure Ground Air Connection

The high pressure ground connection is located on the aft left side of the fuselage below No.1 engine. External high pressure air from a ground power cart can be used to pressurize the 10th stage bleed air manifold with compressed air for engine starting. The external air pressure is indicated on the EICAS, ECS synoptic page.

NOTE

When the aircraft is only operating on DC power, the pressure readout on the ECS synoptic page is not displayed.

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D. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Bleed Air system	10th Stage Bleed Air	10 ST B/AIR ISOL	DC ESSENTIAL	4	B1	
		10 ST B/AIR SOV L	DC BUS 1	1	F11	
		10 ST B/AIR SOV R	DC BUS 2	2	F11	
	14th Stage Bleed Air	14 ST B/AIR ISOL	DC BUS 1	1	F9	
		14 ST B/AIR SOV L			F10	
		14 ST B/AIR SOV L	DC BUS 2	2	F10	




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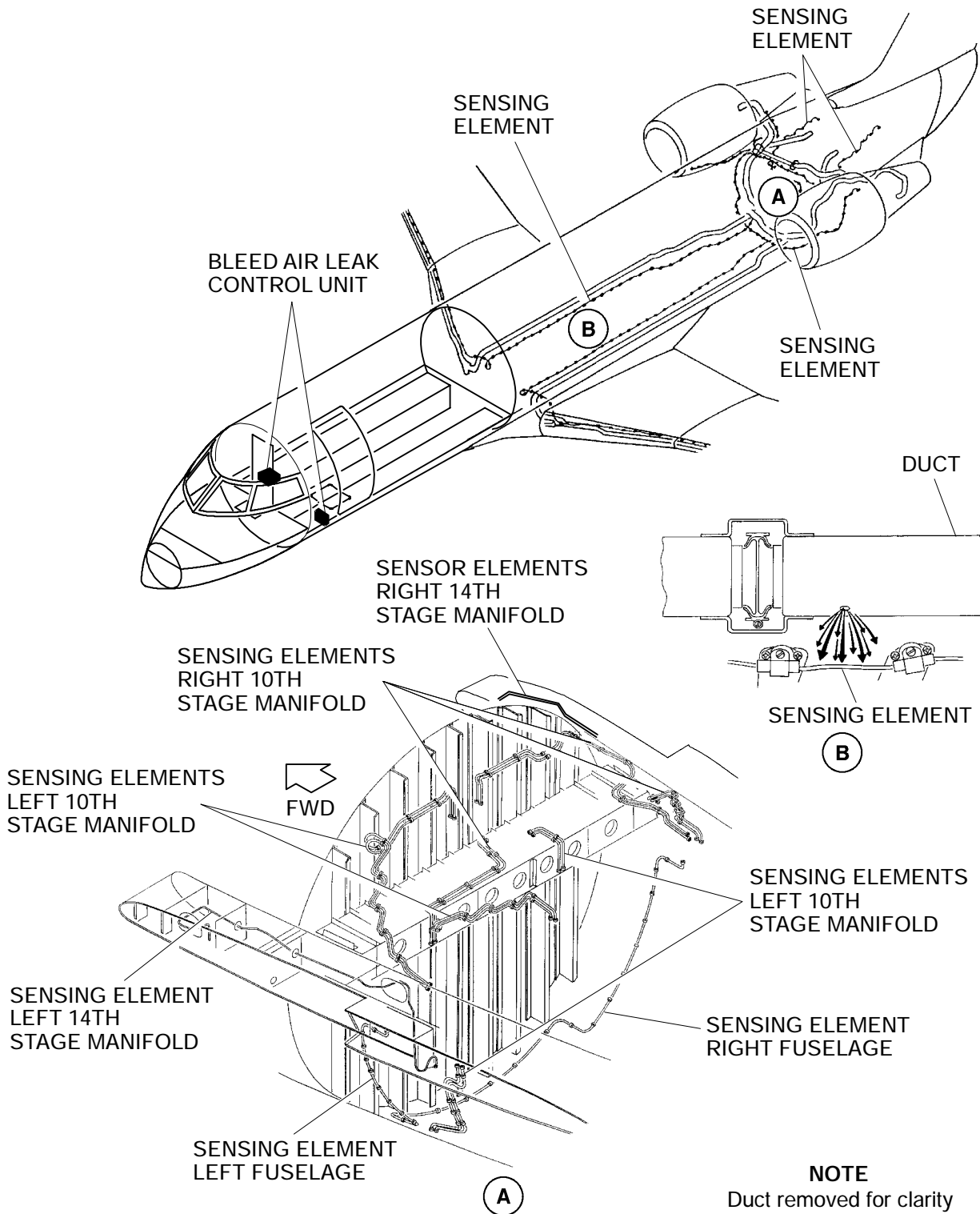
1. BLEED AIR LEAK DETECTION

The bleed air leak detection system monitors the 10th and 14th stage pneumatic and anti-ice ducting for high temperatures associated with bleed air leakage. EICAS messages and system control is provided by two bleed leak detection control units, one for the left bleed system and one for the right bleed system. A test switch on the BLEED AIR control panel is used to check for continuity in the leak detection system.

Overheat sensing elements are installed along the entire length of the 10th and 14th stage ducting in the fuselage and pylon areas. The 10th stage bleed air system is monitored by dual-loop overheat detectors and the 14th stage is monitored by a single-loop overheat detection system. The wing anti-ice system uses single-loop detectors in the fuselage and thermal switches in the wing leading edges. The dual sensing loops are used to ensure dispatch reliability and to minimize system false warnings. To prevent false indications, both loops must detect a leak before an EICAS message is posted. The supply ducting is encased in a protective cover. If a leak occurs, holes in the protective cover will direct the hot bleed air towards the sensing loops.

For normal wing anti-icing, hot bleed air from the 14th stage supply ducting is released through piccolo tubes to heat the wing leading edges. Thermal switches in the leading edge of each wing are used to detect leaks in the wing leading edge anti-ice ducting.

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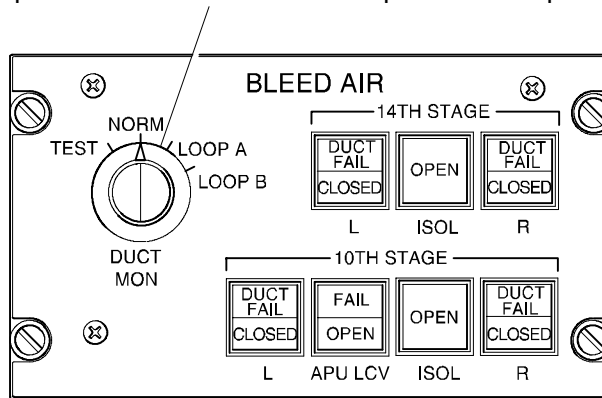


Bleed Air Leak Detection and Warning System
Figure 19-30-1

Monitor Selector Switch

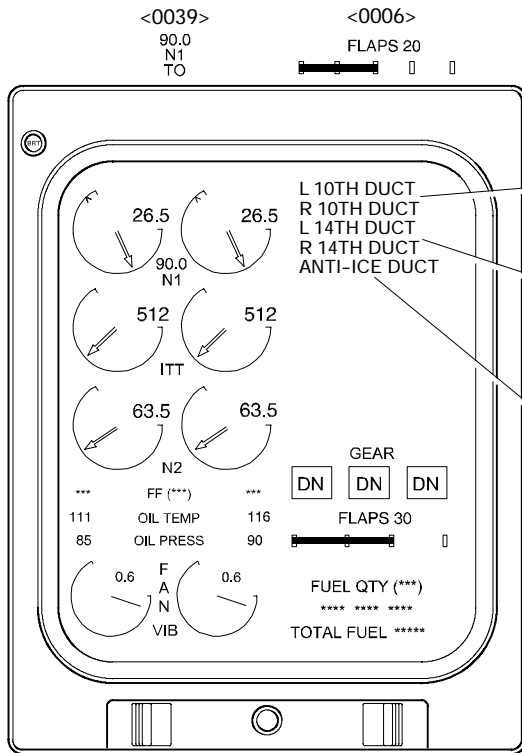
Used to check serviceability of detector loops in left and right sections of 10th and 14th stage systems.

- TEST - Tests 10th/14th stage loops by grounding loop to simulate a duct failure.
- LOOP A - Tests Loop A of 10th stage for continuity, to ensure that loop is not shorted to ground.
- LOOP B - Tests Loop B of 10th stage for continuity, to ensure that loop is not shorted to ground.
- NORM - Normal switch position. Leak detection on Loops A and B is provided.



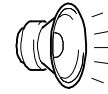
**Bleed Air Panel
Overhead Panel**

Bleed Air System Control Panel
Figure 19-30-2



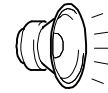
Primary Page

L/R 10TH DUCT warning (red)
Comes on if temperature sensors detect failure in 10th stage duct segment. Corresponds to DUCT FAIL L/R switch/light (red) on BLEED AIR panel.



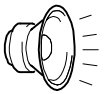
BLEED AIR DUCT

L/R 14TH DUCT warning (red)
Comes on if temperature sensors detect failure in 14th stage duct segment. Corresponds to DUCT FAIL L/R switch/light (red) on BLEED AIR panel.



BLEED AIR DUCT

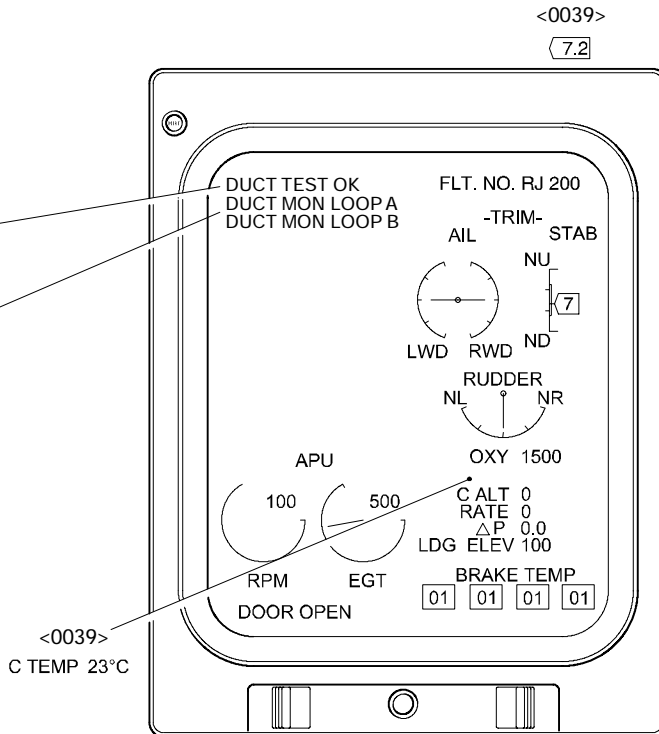
ANTI-ICE DUCT warning (red)
Comes on when bleed air leak is detected in left and/or right fuselage or wing anti-ice ducts. Accompanied by voice alert:



ANTI-ICE DUCT

DUCT TEST O.K. advisory (green)
Comes on to indicate that corresponding loop test is successful (all 5 duct warnings will be displayed).

DUCT MON LOOP A/B status (white)
Comes on to indicate that corresponding loop is under test.



Status Page

**Bleed Air Leak Detection – Loop EICAS Indications <MST>
Figure 19-30-3**



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A. SYSTEM CIRCUIT BREAKERS

SYSTEM	SUB-SYST	CB NAME	BUS BAR	CB PANEL	LOCATION	NOTES
Bleed Air System	Bleed Leak Detection	BLEED LEAK TEST	DC ESS	4	B2	
		CONT L	AC ESS	3	B1	
		CONT R			B2	



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