CHAPTER 19 – PNEUMATIC

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LIST OF ILLUSTRATIONS

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1. INTRODUCTION

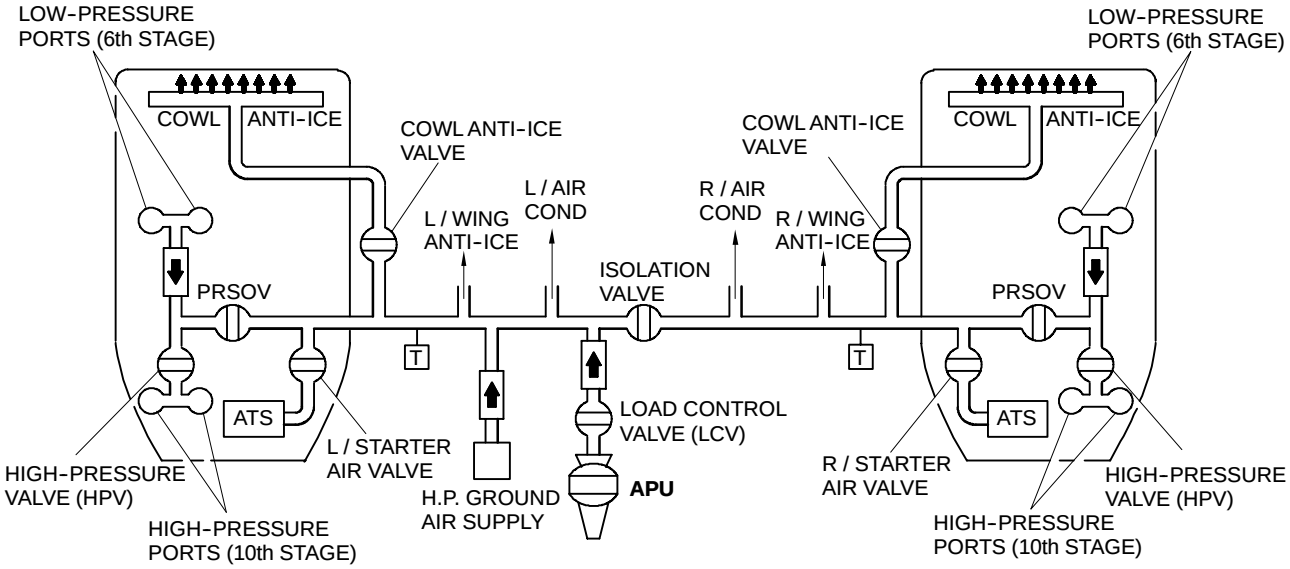
The pneumatic system is supplied bleed air from the engine compressors or from the APU compressor. The supplied air is used for:

- The aircraft environmental control system
- Wing and cowl anti-ice systems.

The pneumatic system can also receive conditioned air from a ground air cart.<1007>

Bleed air management is fully automatic. Two air conditioning system controllers monitor system health and regulate bleed air pressure to ensure air is supplied at a level of pressure compatible with proper operation of the pneumatic systems currently connected. Under non-normal situations, system isolation and manual selection of the bleed air source is possible using the bleed air panel.

The bleed air leak detection system monitors the pneumatic ducting for high temperature bleed air leaks. The system will automatically shut down the respective bleed system when a leak is detected to protect the system components.

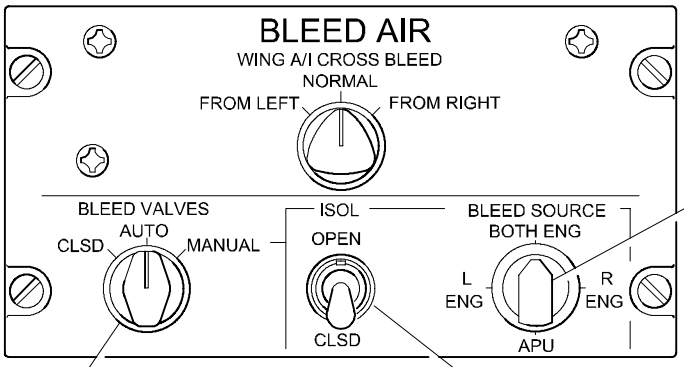


Bleed Air System Schematic
Figure 19–10–1

1. BLEED AIR SYSTEM

The bleed air system receives pressurized air from the engine compressors, APU compressor or from an external high pressure ground source.

The bleed air is supplied to various systems through a common manifold which can be divided into two sections by an bleed isolation shut-off valve. Pneumatically operated aircraft systems include engine starting, cowl and wing anti-icing, air-conditioning and pressurization. Two air-conditioning system controllers (ACSC) manage the distribution of the bleed air and control the air-conditioning systems. Bleed air selection is made using the BLEED AIR panel located on the overhead panel.



BLEED SOURCE
Used to select bleed air source.
- L ENG - Left engine only
- BOTH ENG - Both left and right engines
- R ENG - Right engine only
- APU - APU only.

Bleed Air Panel
Overhead Panel

BLEED VALVES
Used to select bleed air mode.
- CLSD - Closes all bleed sources. Must be selected when using external ground source to prevent damage to engines or APU.
- AUTO - Controller manages system requirements.
- MANUAL - Allows pilot to manually configure the system.

ISOL
Used to isolate or interconnect the left and right pneumatic systems. Only operative in manual mode.

Bleed Air System Control Panel
Figure 19-20-1

A. Engine Bleed Air

The engine can supply either low or high pressure bleed air from the compressor depending on the position of the engine high pressure valve (HPV). When an engine is selected as the bleed air source, the ACSC determines whether the system will bleed air from the high pressure (10th stage) compressor port or from the low pressure (6th stage) compressor port. The ACSC will open or close the HPV depending on the bleed air manifold pressure and aircraft system requirements.

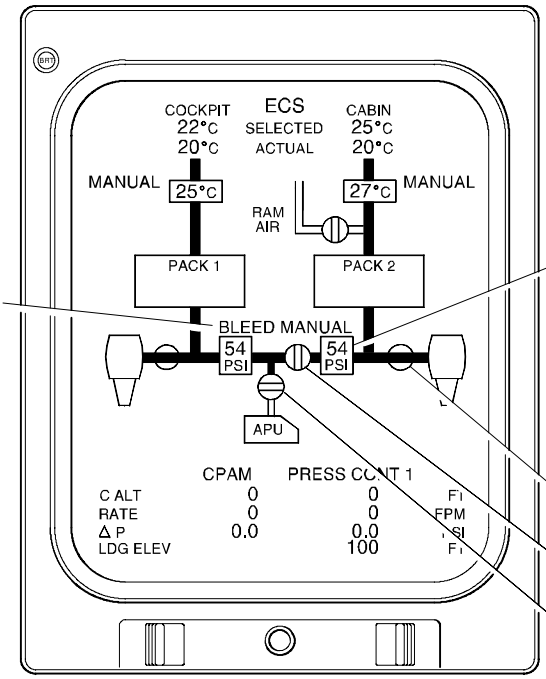
Manifold pressure is regulated to about 45 psig by the pressure regulating shut-off valve (PRSOV). When the demand cannot be supplied by the low pressure port, the ACSC commands the engine HPV open. When the 6th stage air pressure is high enough to satisfy the requirements of the connected systems, the ACSC commands the HPV closed.

B. APU Bleed Air

The APU can be used on the ground to supply the pneumatic system with a compressed air source for air-conditioning or engine starting. Under certain limitations, the APU can also be used in flight. When the APU is selected as the bleed air source, the bleed air is supplied through a load control valve (LCV) to the bleed air manifold. The ECU modulates the LCV to limit APU exhaust gas temperature. To prevent compressor surge, a small quantity of compressed air is vented overboard through a surge control valve.

C. High Pressure Ground Air Connection

An external high pressure ground power cart can be used to supply the bleed air manifold with compressed air for engine starting. For ground cart operation, the bleed valves must be selected closed to avoid reverse flow to the engines. Air pressure is indicated on the EICAS, ECS synoptic page, when AC power is available.



BLEED MANUAL (white)
Indicates that bleed valves have been selected to manual.

Bleed Pressure
Displays bleed pressure.
- White – Bleed pressure normal.
- Amber – Bleed pressure high or low.
- Amber dashes – Invalid data.

Pressure Regulating Shut-Off Valve

Bleed Isolation Shut-Off Valve

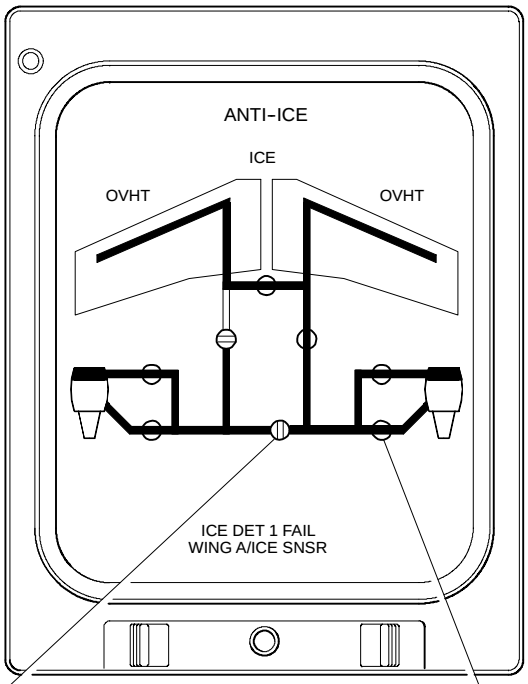
APU Load Control Valve

Environmental Control System Page

Valve Position Indication

- open (white)
  failed open (amber)
- closed (white)
  failed closed (amber)
- failed to attain commanded position (half-intensity magenta)

Bleed Air System Environmental Control System Synoptic Page
Figure 19–20–2



Anti-Ice Page

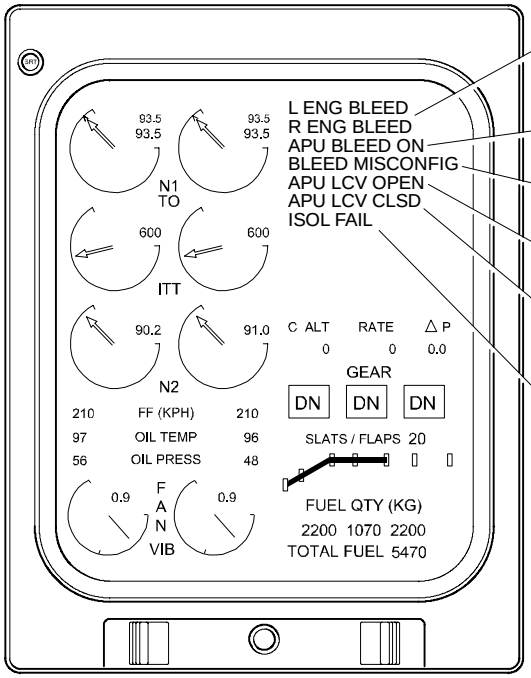
Bleed Isolation Shut-Off Valve Position Indication

- open (white) failed open (amber)
- closed (white) failed closed (amber)
- failed to attain commanded position (half-intensity magenta)

Pressure Regulating Shut-Off Valve Position Indicator

- open (white)
- closed (white)
- failed to attain commanded position (half-intensity magenta)

Bleed Air System Anti/Ice Synoptic Page
Figure 19–20–3



Primary Page

L or R ENG BLEED caution (amber)
Indicates failure of high pressure valve, pressure regulating shut-off valve or controller.

APU BLEED ON caution (amber)
Indicates APU bleed is selected above maximum altitude (25,000 feet).

BLEED MISCONFIG caution (amber)
Indicates an impossible bleed configuration in manual mode.

APU LCV OPEN caution (amber)
Indicates that APU load control valve failed to close when commanded to close.

APU LCV CLSD caution (amber)
Indicates that APU load control valve failed to open when commanded to open.

ISOL FAIL caution (amber)
Indicates that bleed isolation shut-off valve failed to attain selected position.

L or R ENG BLEED CLSD status (white)
Indicates that respective engine bleed is not selected with respective high pressure valve and pressure regulating shut-off valve closed.

L or R ENG BLEED SNSR status (white)
Indicates respective pack inlet pressure sensor has failed.

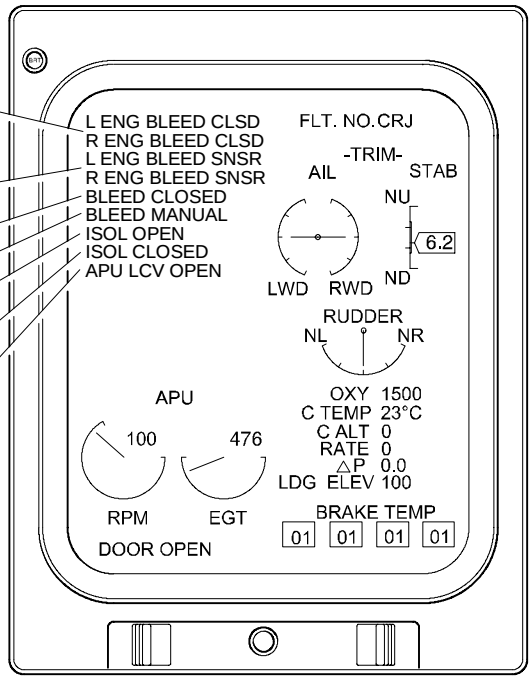
BLEED CLOSED status (white)
Indicates that all bleeds are closed.

BLEED MANUAL status (white)
Indicates that bleed system is in manual mode.

ISOL OPEN status (white)
Indicates that bleed isolation shut-off valve is fully open.

ISOL CLOSED status (white)
Indicates that bleed isolation shut-off valve is fully closed.

APU LCV OPEN status (white)
Indicates that APU load control valve is not closed.



Status Page

Bleed Air System EICAS Indications <1001>
Figure 19-20-4

D. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Bleed Air	Shut-Off Valves	L BLEED SOV	DC ESSENTIAL	2	S10	
		R BLEED SOV			S11	

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1. BLEED AIR LEAK DETECTION

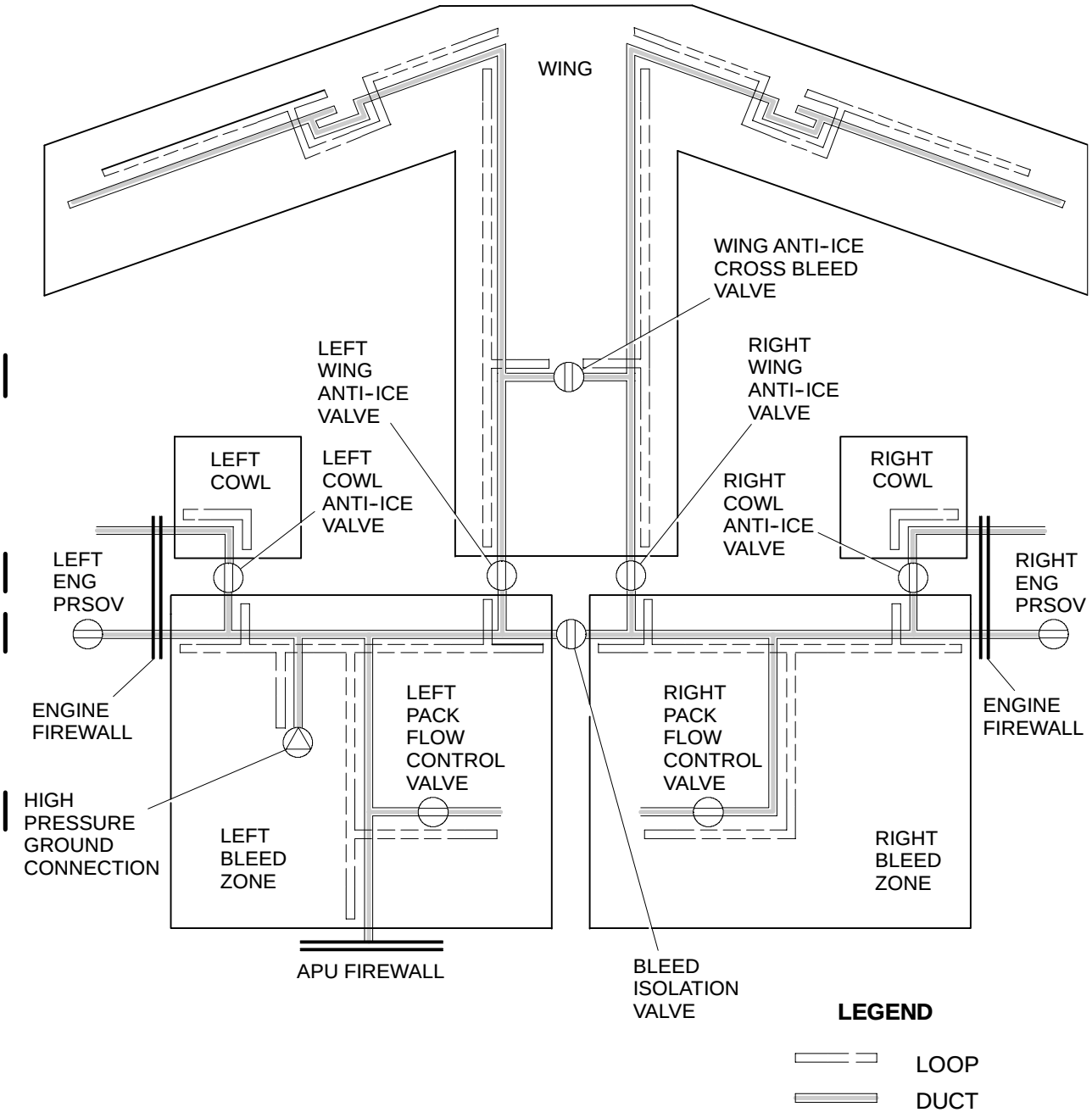
The bleed air leak detection system monitors the pneumatic and anti-ice ducting for high temperatures associated with bleed air leakage. EICAS messages and system control is provided by an anti-ice and leak detection controller (AILC).

The bleed leak detection consists of continuous sensing loops routed in parallel along the pneumatic ducting. The system is divided into five zones and each zone can be isolated by means of a shut-off valve. The five zones are left and right bleed zone, left and right cowl anti-ice zones and wing anti-ice zone. The wing anti-ice zone is subdivided into four loops. They are left and right fuselage loops and left and right wing loops. The supply ducting is encased in a protective cover. If a leak occurs, holes in the protective cover directs the hot bleed air towards the sensing loops.

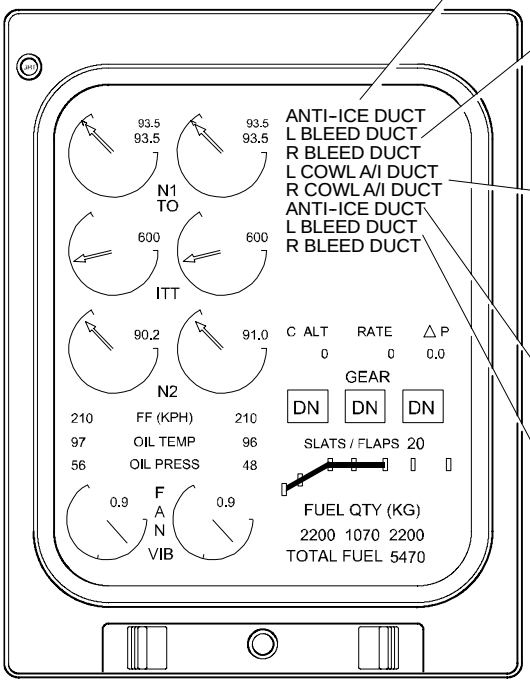
The dual sensing loops are used to ensure dispatch reliability and to minimize system false warnings. To prevent false indications, both loops must detect a leak before an EICAS message is posted. The leak detection sensing loops consists of two wires mounted coaxially inside a flexible metal tube. The ends of each sensing loop are connected to the controller. When hot air escapes from a leak in the ducting it is sensed by the controller which posts a EICAS message identifying the leakage zone. The duct is then isolated by closing the appropriate shut-off valve.

For normal wing anti-icing, hot bleed air from the supply ducting is released through piccolo tubes to heat the wing leading edges. The dual loops and a skin temperature sensor located in the wing leading edge are used to detect failures in the wing anti-ice ducting.

The cowl anti-ice ducts, located in the engine pylons, consist of inner and outer ducts. Bleed air for anti-icing travels through the inner the duct. The area between the inner and outer duct is monitored by a pressure transducer. In the event of a failure or crack of the inner duct, the pressure transducer will sense the air pressure change and send a signal to the AILC to post an EICAS warning message.



Bleed Air Leak Detection System
Figure 19–30–1



Primary Page

ANTI-ICE DUCT warning (red)
Indicates that a bleed air leak has been detected by the anti-ice and leak detection controller in the wing anti-ice ducting or piccolo tubes.

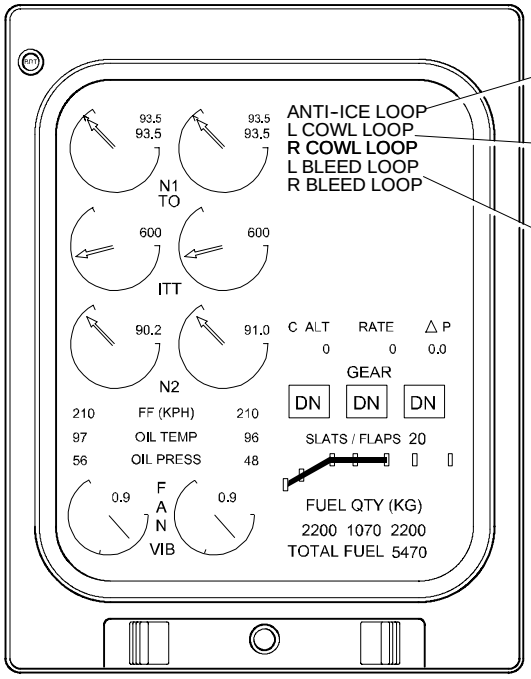
L or R BLEED DUCT warning (red)
Indicates a bleed air leak has been detected by the anti-ice and leak detection controller in the respective engine bleed ducting.

L or R COWL A/I DUCT warning (red)
Indicates that the respective cowl anti-ice duct pressure is above 17 psig or a bleed air leak has been detected by the anti-ice and leak detection controller.

ANTI-ICE DUCT caution (amber)
Indicates bleed shutdown after bleed leak detected and system not selected off.

L or R BLEED DUCT caution (amber)
Indicates respective bleed shutdown after bleed leak detected and system has not been reconfigured.

Bleed Air Leak Detection Anti−Ice − Duct EICAS Indications <1001>
Figure 19−30−2



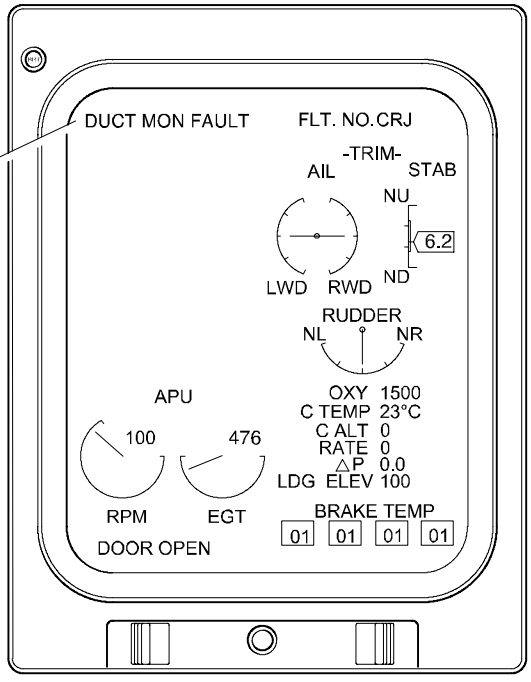
Primary Page

ANTI-ICE LOOP caution (amber)
Indicates loss of both wing anti-ice leak detection loops during power-up test.

L (R) COWL LOOP Caution (amber)
Indicates a loss of both left or right cowl bleed air leak detection loops during power-up test.

L (R) BLEED LOOP Caution (amber)
Indicates a loss of both left or right engine bleed air leak detection loops during power-up test.

DUCT MON FAULT status (white)
Indicates a loss of redundancy in bleed leak detection system.



Status Page

Bleed Air Leak Detection – Loop EICAS Indication <1001>
Figure 19–30–3