

A330-200
TECHNICAL TRAINING MANUAL
MECHANICS / ELECTRICS & AVIONICS COURSE
36 PNEUMATIC
GE Metric

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■ FQW4200

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SYSTEM PRESENTATION

- General
- Sources
- Engine Bleed Air Supply
- Pressure Regulation
- Temperature Regulation
- Cross Bleed
- APU Bleed
- Ground Supply
- Leak Detection
- Control / Monitoring

GENERAL

The purpose of the pneumatic system is to supply aircraft users with pressurized air.

The users are :

- Air conditioning,
- Engine starting,
- Wing anti-ice
- Water tank pressurization,
- Hydraulic reservoir pressurization,
- Engine reverse.

The pneumatic system incorporates a leak detection system to ensure its safe operation.

The pneumatic system is controlled and monitored by two Bleed Monitoring Computers.

SOURCES

High pressure air is supplied from different sources:

- the engine HP compressors.
- the Auxiliary Power Unit.
- two HP ground connectors.

ENGINE BLEED AIR SUPPLY

Depending on engine speed, air is tapped either off the Intermediate Pressure stage or the High Pressure stage of the HP compressor.

At normal engine speed, air is tapped from the IP stage and the High Pressure Valve is pneumatically controlled closed.

At low engine speed, the High Pressure Valve pneumatically regulates air from the HP stage.

The HPV regulates the downstream pressure to 36 psi.

The IPC protects the IP stage from reverse flow

PRESSURE REGULATION

Bleed air from the IP or HP stage is ducted to the Pressure Regulating Valve. The Pressure Regulating Valve (PRV) regulates downstream pressure to 48 psi.

The PRV is provided with an automatic shut off function controlled by the BMC in case of fault in the system, start of corresponding engine or APU

bleed supply.

In case of overpressure, if the PRV does not operate correctly, the Overpressure Valve ensures an additional protection.

The OPV is entirely pneumatically controlled.

TEMPERATURE REGULATION

Bleed air temperature regulation is achieved by a precooler with cold airflow modulated by the Fan Air Valve.

The precooler is an air to air heat exchanger.

The FAV regulates the temperature to 200 °C in normal operation. A 150 °C regulation setting is also possible according to pack demand when wing ANTI-ICE is OFF.

CROSS BLEED

The Crossbleed Valve enables isolation or interconnection between Left Hand and Right Hand air supply systems.

APU BLEED

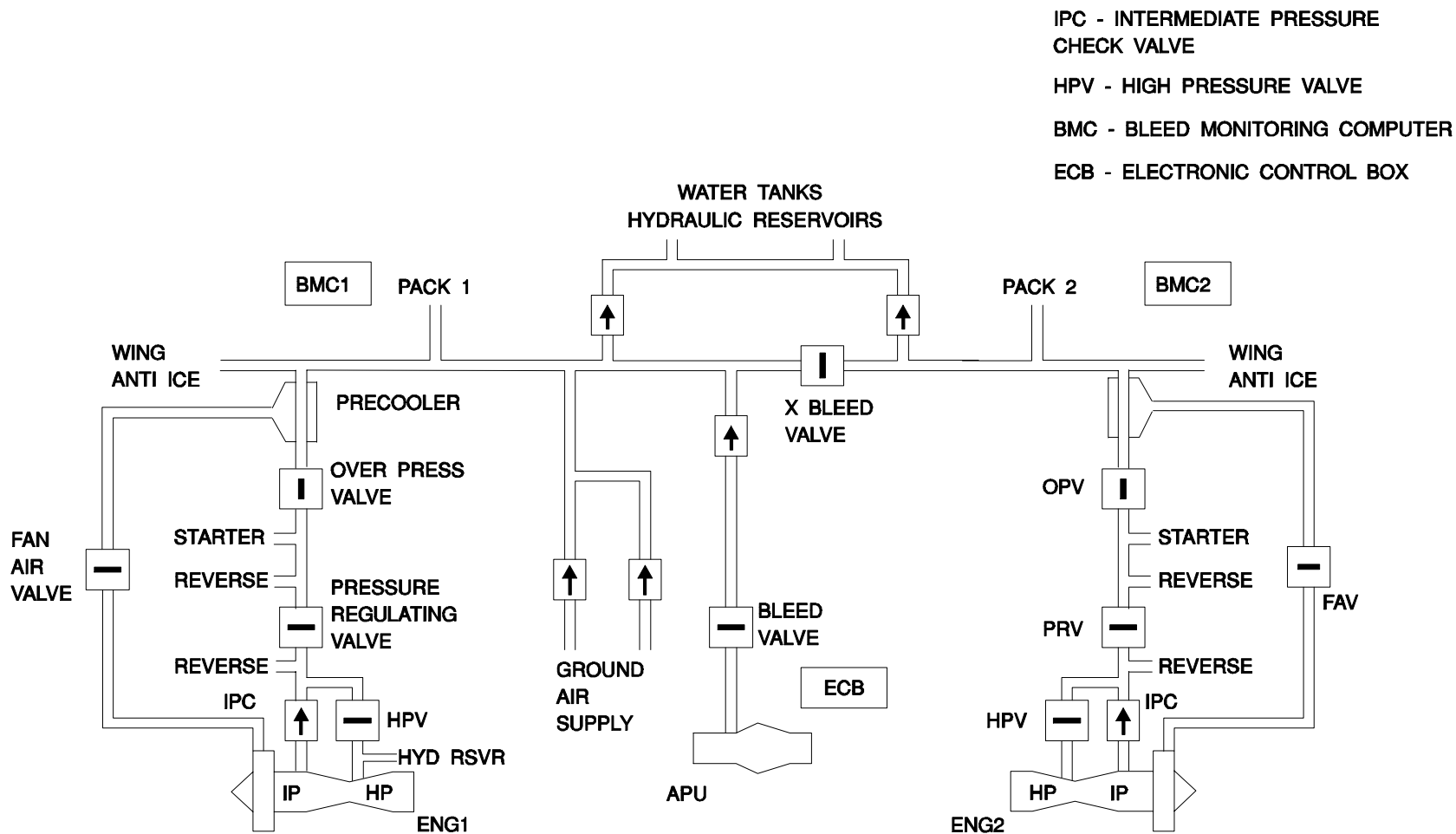
Air supplied by the Auxiliary Power Unit is available on ground and in flight through the APU Bleed Valve.

With APU air bleed supply, the Crossbleed Valve is automatically opened and the Pressure Regulating Valves are automatically closed.

GROUND SUPPLY

Air can be supplied from a ground cart to the crossbleed duct.

There are two HP ground connectors located at the bottom of the belly fairing.



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LEAK DETECTION

The leak detection system detects any ambient overheat in the vicinity of hot air ducts which run through the engine pylons, the wings, the air conditioning bay and the fuselage.

Sensing elements connected in series form the detection loops.

CONTROL / MONITORING

Manual control is performed from the AIR control panel.

Automatic control and monitoring of the system is achieved by two Bleed Monitoring Computers. Each one is dedicated to one engine bleed system. Each BMC monitors pressure, temperature, leak detection and operation of the components. If one BMC fails, the opposite BMC takes over the main warnings of the system.

The APU bleed system is controlled by the APU Electronic Control Box and is monitored by the Bleed Monitoring Computers.

The BMCs interface with :

- Engine Interface and Vibration Monitoring Units (EIVMUs),
- ECAM via System Data Acquisition Concentrators (SDACs),
- Central Maintenance Computers (CMCs),
- Air Conditioning Zone Controller.

STUDENT NOTES:

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STUDENT NOTES

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SYSTEM DESCRIPTION

HPV
IPC
PRV / ThS
OPV
Pr
Pt
FAV / ThC
Precooler
T
APU Bleed Valve
Cross Bleed Valve
ThS Functions Summary

HPV

The switching Intermediate Pressure / High Pressure is achieved pneumatically when the IP stage pressure is not sufficient.
The HPV pneumatically regulates the air supply to 36 psi.
The shut off function is achieved by a solenoid controlled either from the corresponding Engine Bleed pushbutton switch or from the Bleed Monitoring Computer.

IPC

The Intermediate Pressure Check Valve protects the IP stage from reverse flow when the High Pressure Valve is open.

PRV / ThS

The PRV pneumatically regulates bleed pressure to 48 psi.
The PRV is pneumatically controlled by an external servo-control : the Thermostat Solenoid, located downstream from the precooler.
The Thermostat Solenoid (ThS) operates in two modes : pneumatically and electrically, causing a partial or complete closure of the PRV.

Pneumatic mode :

- Overheat protection downstream from precooler by means of a thermostat to reduce the PRV flowrate.
- It is controlled closed in case of reverse flow.

Electrical mode : PRV shut off function :

- The solenoid is energized from cockpit control, (Eng. Bleed P/B selected "OFF" or Eng. Fire P/B selected on).
- or by the BMC.

OPV

The Over Pressure Valve, normally open, pneumatically closes.
The OPV starts to close at 75 psi.
It is fully closed at 85 psi.
Opens again at 49 psi.

Pr

A transducer, connected to the Bleed Monitoring Computer, reads the regulated pressure downstream from the PRV.
This pressure is indicated on the ECAM and used to monitor PRV and OPV.

Pt

A transducer, connected to the Bleed Monitoring Computer, reads the transferred pressure downstream from the HPV.
This pressure is used to monitor PRV and HPV.

FAV / ThC

The Fan Air Valve pneumatically regulates the fan air flow to the precooler for bleed air temperature regulation.
The FAV is pneumatically controlled by an external servo-control : the Thermostat Control (ThC), located downstream from the precooler.
The Thermostat Control provides two temperature settings selected by means of a solenoid.

- 200 °C for normal operation.
- 150 °C upon request from the packs and if Wing Anti Ice is OFF.

PRECOOLER

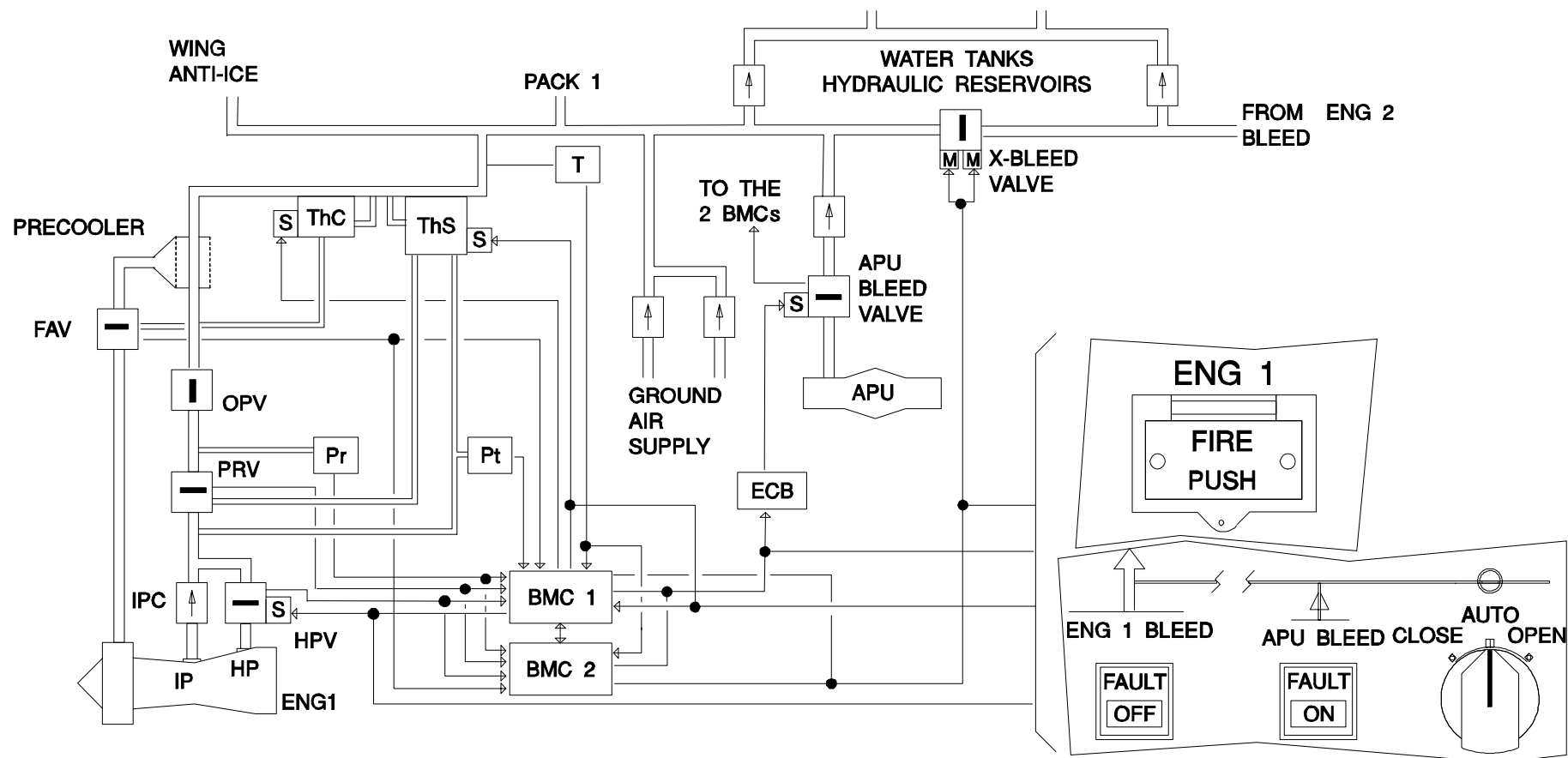
The precooler is an air to air heat exchanger.
The fan air flow regulated by the FAV crosses the hot air coming from the PRV before being discharged overboard through pylon outlets.

T

The temperature sensor, connected to the Bleed Monitoring Computer reads the regulated temperature downstream from the precooler.
This temperature is indicated on the ECAM and used to monitor the system.

APU BLEED VALVE

The APU bleed valve is a pneumatic shut off valve and is electrically controlled open or closed by means of a solenoid.



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CROSS BLEED VALVE

The Cross bleed valve is an electrically controlled shut-off valve. It is operated by two electrical motors :

- primary motor is used for AUTO mode. The position of the valve is controlled by the BMC according to APU bleed configuration.
- Secondary motor is used to override the AUTO mode.

The position of the valve is controlled by the X-bleed selector (OPEN or CLOSE) on the overhead panel.

ThS FUNCTIONS SUMMARY

The ThS controls the PRV.

PNEUMATIC MODE

Restriction : Overheat

Closure : Reverse flow.

ELECTRICAL MODE (valve closure)

P/b sw OFF

Engine fire P/b sw

APU Bleed air

Engine start

Overpressure

Overheat

Leak detection

STUDENT NOTES:

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SYSTEM CONTROLS AND INDICATING

Engine Bleed P/B Switch
APU Bleed P/B Switch
Cross Bleed Selector

ENGINE BLEED P/B SWITCH

The Engine BLEED pushbutton switch allows the Pressure Regulating Valve (PRV) and the High Pressure Valve (HPV) to be controlled by the Bleed Monitoring Computer.

On (P/B sw pressed in)

The associated PRV operates under control of the BMC provided upstream pressure is sufficient.

FAULT light comes on amber with associated ECAM warning in case of overpressure, overtemperature, leak detection or incorrect valve position detected by the BMC which closes the PRV and HPV.

OFF (P/B sw released out)

The PRV and HPV close.

APU BLEED P/B SWITCH

The APU BLEED pushbutton switch allows the ECB via the BMCs to operate the APU Bleed Valve.

ON (P/B sw pressed in)

The APU BLEED valve opens under the following conditions :

- leak sensing elements serviceable,
- no APU, LH wing and pylon leaks, except during engine start,
- APU available.

FAULT light comes on amber with associated ECAM warning in case of APU BLEED leak warning.

Off (P/B released out)

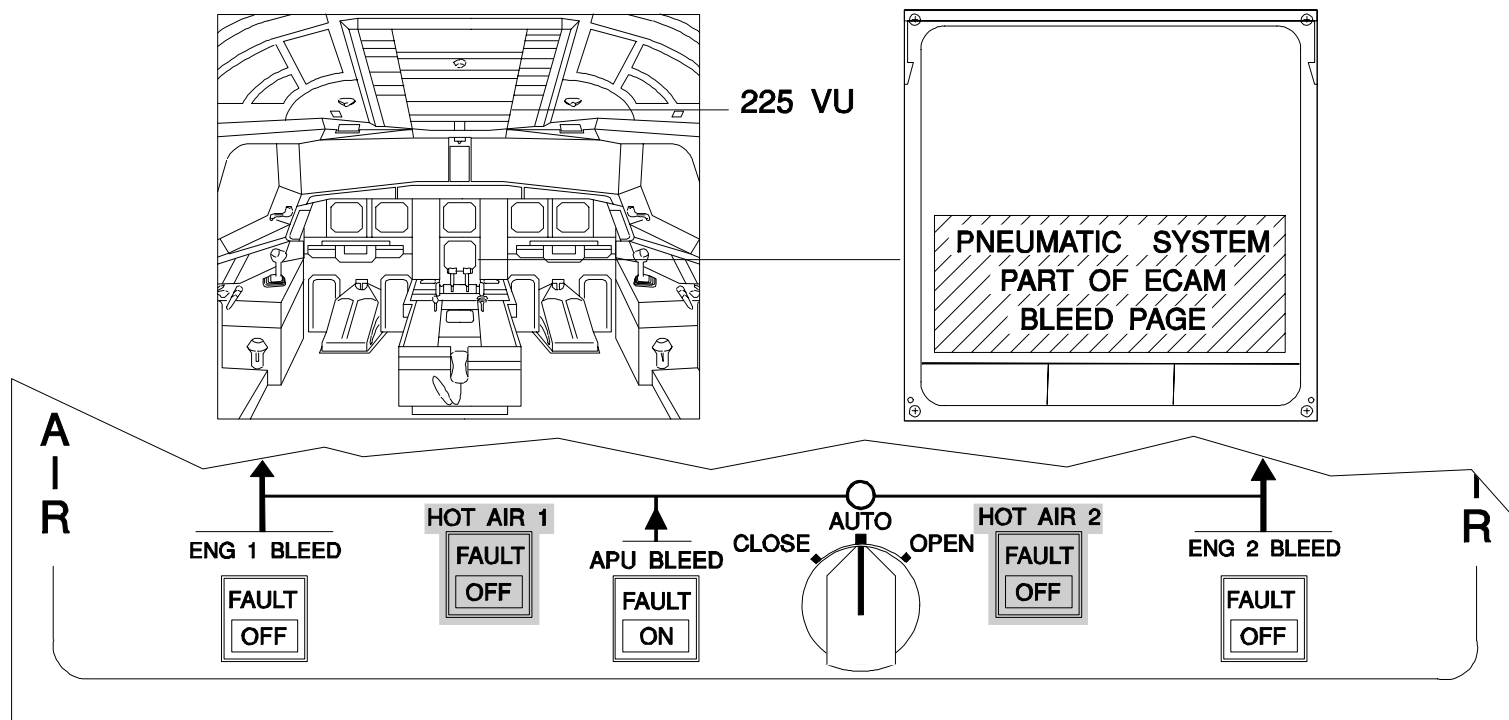
The APU BLEED valve closes.

CROSS BLEED SELECTOR

In the AUTO position, the BMCs control the crossbleed valve to take the same configuration as the APU Bleed Valve.

AUTO : Auto control of X-BLEED Valve.

The automatic operation can be overridden by selecting **OPEN** or **CLOSE**.



STUDENT NOTES :

ECAM PAGE PRESENTATION

Engine High Pressure Valve
Engine Pressure Regulating Valve
Engine Bleed Temperature
Engine Bleed Pressure
APU Bleed Valve
Cross Bleed Valve
Ground Supply Indication

ENGINE HIGH PRESSURE VALVE

HP and IP indications are always displayed in white.

green 	Valve open (not fully closed position).
green 	Valve fully closed with no disagree.
amber 	Valve fully closed and position disagree or fully closed and engine OFF.
green 	Position data not available.
amber	

ENGINE PRESSURE REGULATING VALVE

Engine number indication is displayed amber when not running, it is white otherwise.

green 	Valve open (not fully closed position).
amber 	Valve fully closed with no disagree.
green 	Valve fully closed and position disagree or fully closed and engine OFF.
amber	
green 	Valve open and position disagree.
amber	
green 	Position data not available.
amber	

ENGINE BLEED TEMPERATURE

The temperature is measured by the sensor at the precooler outlet.

200 (green) Normal temperature value.	Engine bleed
50 (amber) Low temperature.	
300 (amber) Overheat.	
XX (amber) Parameter not available.	

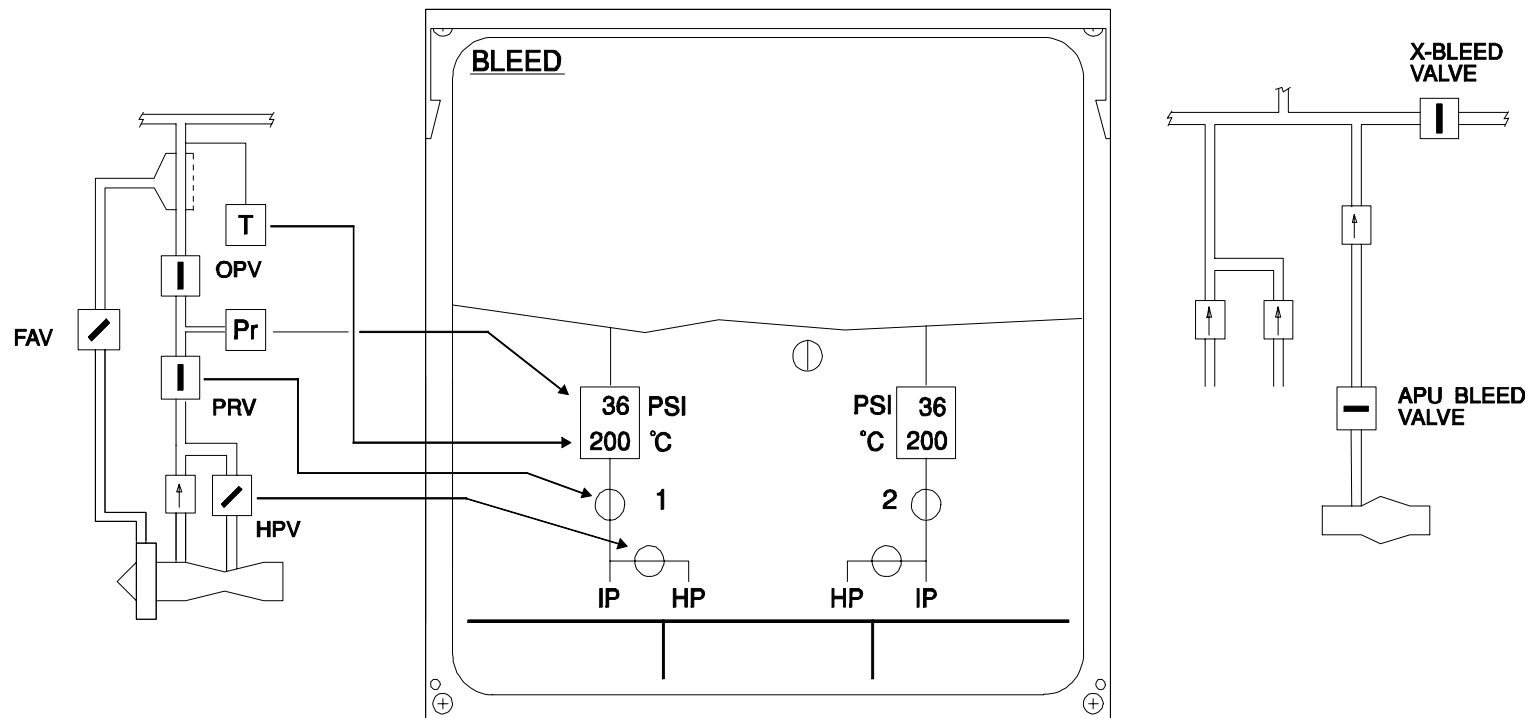
This value changes by steps of 5°C.

ENGINE BLEED PRESSURE

This digital value represents the regulated pressure.

50 (green) Normal pressure indication.
10 (amber) Low pressure.
100 (amber) High pressure.
XX (amber) Parameter not available.

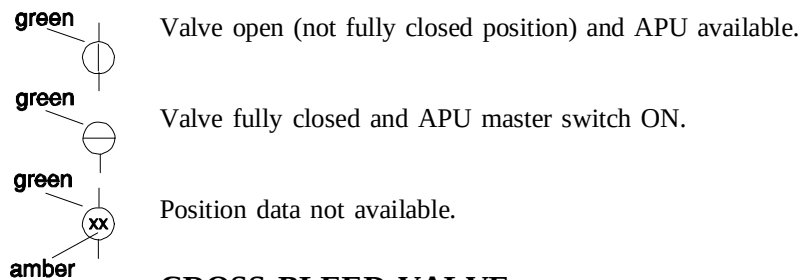
This value changes by steps of 2 psi.



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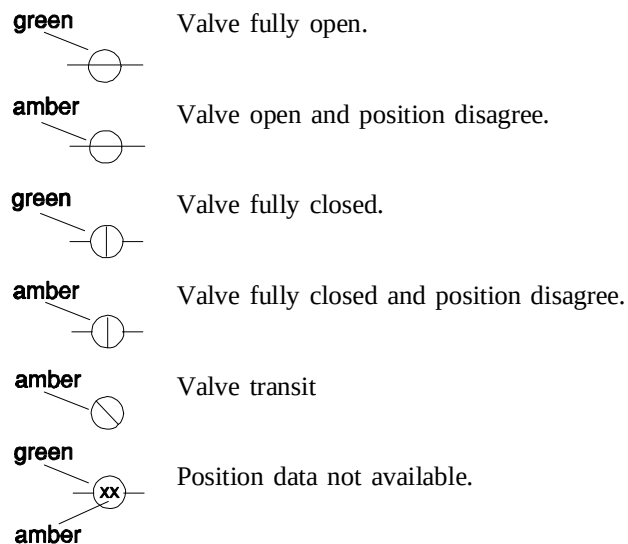
APU BLEED VALVE

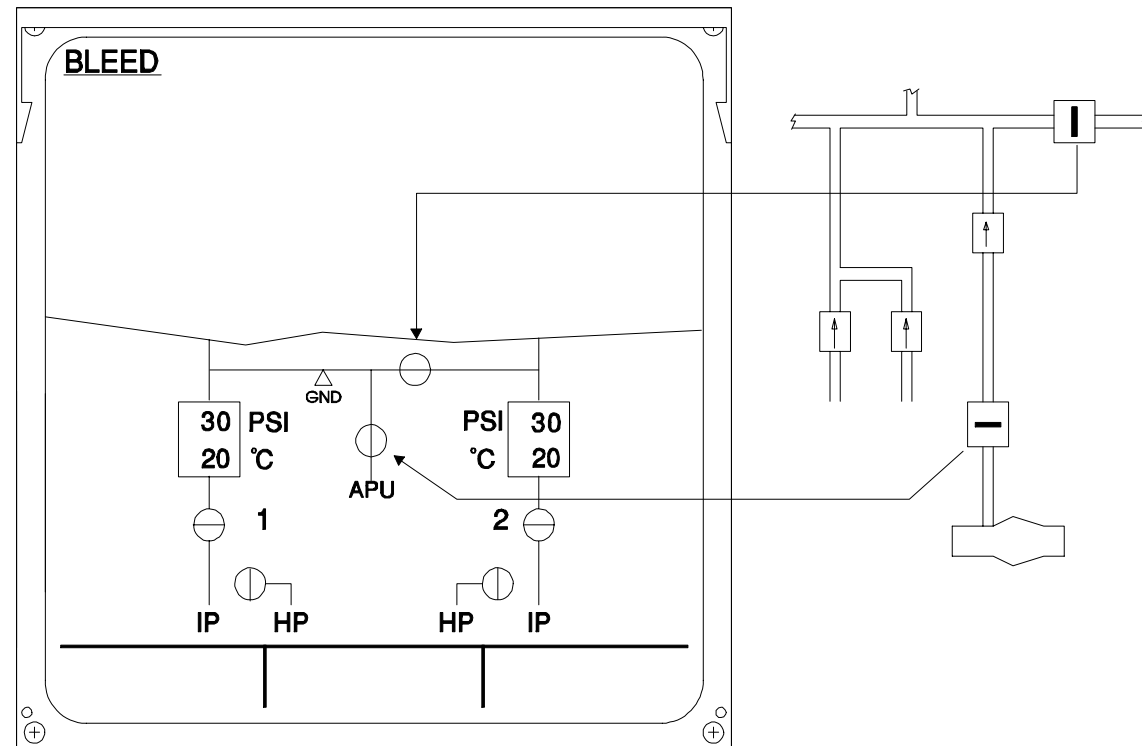
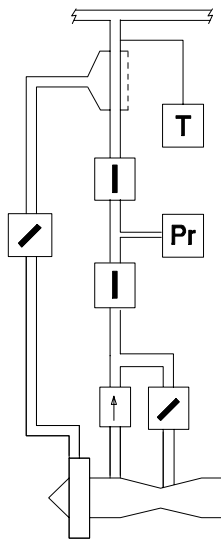
The APU valve and the APU indication are represented only if the APU is running.



CROSS BLEED VALVE

The Cross Bleed valve has a transit indication on the ECAM.





STUDENT NOTES :

ENGINE BLEED AIR : PRESS REGULATION D/O

GENERAL

PNEUMATIC TRANSFER

- General
- High Pressure Valve (HPV)
- Intermediate Pressure Check Valve (IPC)

PNEUMATIC PRESSURE REGULATION

- General
- Pressure Regulating Valve (PRV)
- Thermostat Solenoid (ThS)
- OverPressure Valve (OPV)

PRESSURE TRANSDUCER

- General
- Transferred Pressure (Pt)
- Regulated Pressure (Pr)

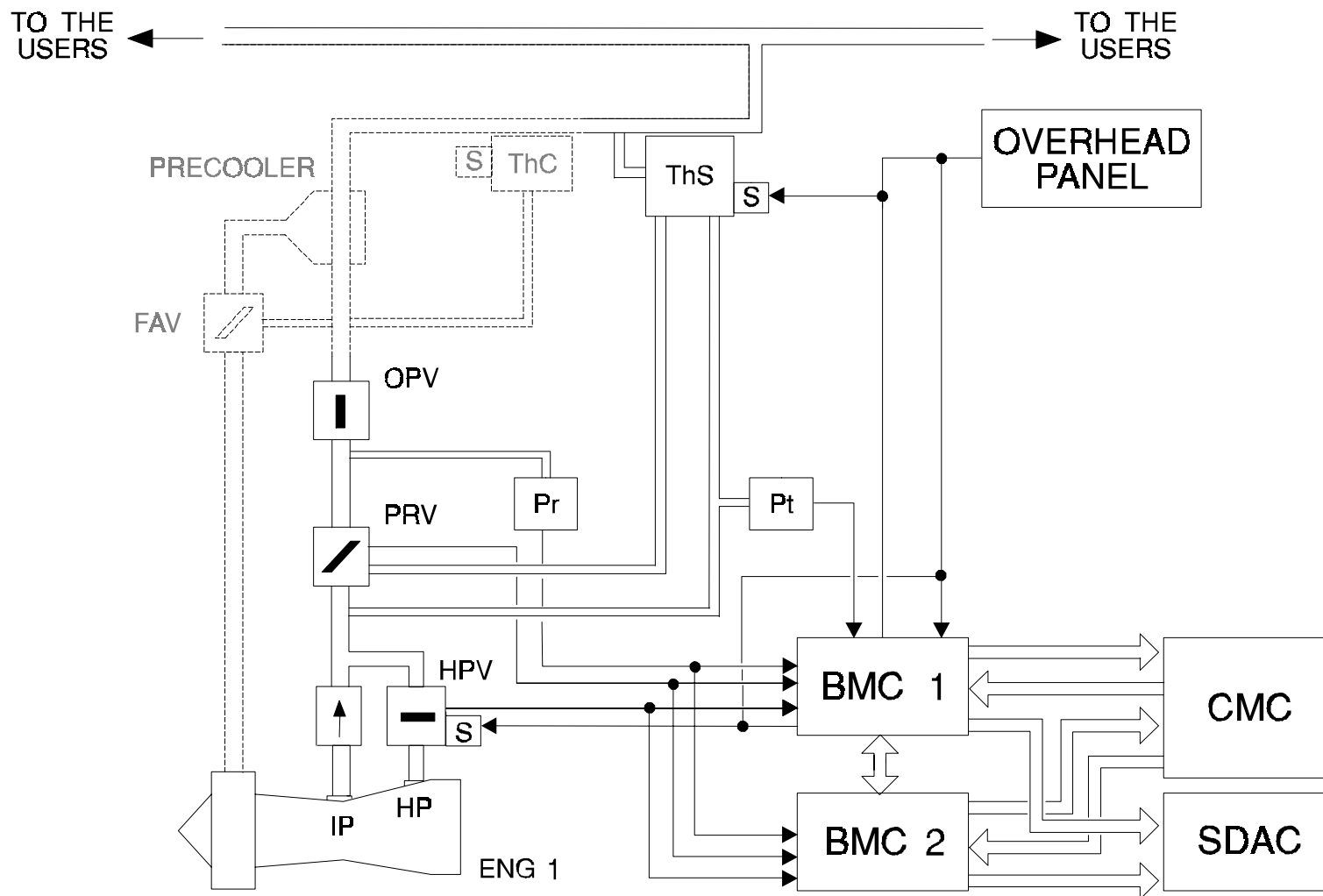
GENERAL

The purpose of this module is to describe in detail the Pressure Regulation of the engine bleed air system.

The purpose of the engine bleed air pressure regulating system is the following :

- To achieve the transfer between the two bleed High Pressure (IP/HP) compressor stages.
- To regulate the bleed air pressure.

This system is monitored by the Bleed Monitoring Computer (BMC).



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PNEUMATIC TRANSFER

GENERAL

The Pneumatic Transfer system pneumatically transfers from one bleed stage to the other by means of the High Pressure Valve (HPV).

In normal engine bleed configuration, when the Intermediate Pressure (IP) stage is higher than 36 psi (average), the air is bled from the IP stage.

At low engine speed, when the IP stage is lower than an average of 36 psi, the transfer to the High Pressure (HP) stage is pneumatically achieved by the HPV.

The pressure downstream from the HPV closes the IP Check Valve.

The untimely IP/HP transfer is inhibited by the Bleed Monitoring Computer (BMC) by closing the HPV via a solenoid during descent or on holding pattern.

This closing happens when :

- the HP pressure is higher than 85 psi, and
- Wing Anti Ice is not ON, and
- altitude is higher than 26000 ft.

or when :

- Compressor Discharge Temperature (T3) > 400°C, and
- HP pressure > 75 psi.

HIGH PRESSURE VALVE (HPV)

The High Pressure Valve (HPV) is pneumatically operated for pressure limitation and safety.

It is electrically controlled to close by a solenoid.

The HPV is normally spring loaded closed.

The minimum operating pressure of the valve is 10 psi.

It pneumatically regulates the pressure to 36 psi.

When the Intermediate Pressure (IP) stage pressure exceeds the HPV target value of an average of 36 psi, the HPV closes and air bleed is supplied by the IP stage.

If the HP/IP transfer fails, the HPV pneumatically closes when the upstream pressure is higher than 105 psi.

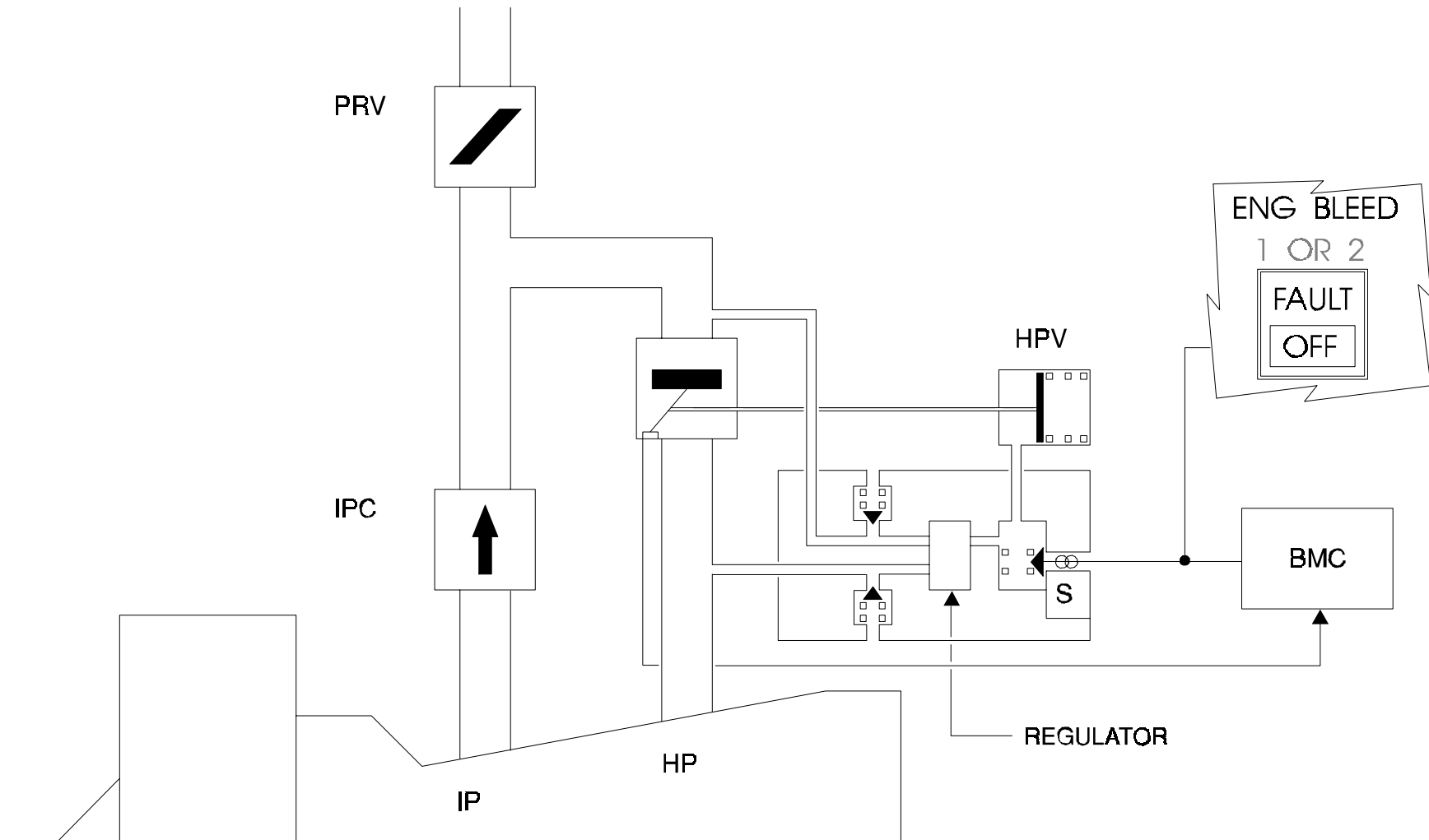
The HPV is electrically controlled to close by solenoid energization either automatically by the Bleed Monitoring Computer (BMC) or by ENG BLEED "OFF" pushbutton action.

The HPV is controlled to close by the BMC at the same time as the PRV and when the IP/HP transfer is inhibited.

The fully closed/not fully closed position is sensed by a microswitch.

INTERMEDIATE PRESSURE CHECK VALVE (IPC)

The Intermediate Pressure Check Valve prevents reverse flow from the HP to the IP stage.



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PNEUMATIC PRESSURE REGULATION

GENERAL

This system enables pneumatic users to be supplied with air at a nominal pressure.

It includes the Pressure Regulating Valve (PRV) with the Thermostat Solenoid (ThS), and the OverPressure Valve (OPV).

The PRV depends on the ThS for control and operation.

PRESSURE REGULATING VALVE (PRV)

The Pressure Regulating Valve (PRV) is fully pneumatically operated and controlled by the Thermostat Solenoid (ThS).
It regulates the pressure to 48 psi.

The PRV is also controlled by the ThS to limit the flow rate if the air temperature at the precooler outlet is higher than 235°C.

It is pneumatically controlled closed by the ThS in case of reverse flow when precooler downstream pressure is higher or equal to PRV upstream pressure.

It is also controlled closed by the ThS in case of malfunction (overpress, ovht, leak), engine start, APU Bleed supply or manual control from the overhead panel.

The PRV is normally spring loaded closed.
The minimum operating pressure of the valve is 8 psi.

The fully closed/not fully closed position is sensed by a microswitch.

THERMOSTAT SOLENOID

The Thermostat Solenoid ensures the control of the PRV.

The Thermostat Solenoid pneumatically controls the pressure regulation depending on :

- the air temperature at the precooler outlet when the temperature is higher than 235°C.

The PRV shuts upon energization of the ThS solenoids.

The solenoid is directly energized in case of :

- ENG BLEED OFF p/b action.
- ENG FIRE p/b action.

It is also energized via the BMC in case of :

- Malfunction
- APU Bleed supply
- Engine start
- Engine P/B action (for redundancy)

OVERPRESSURE VALVE

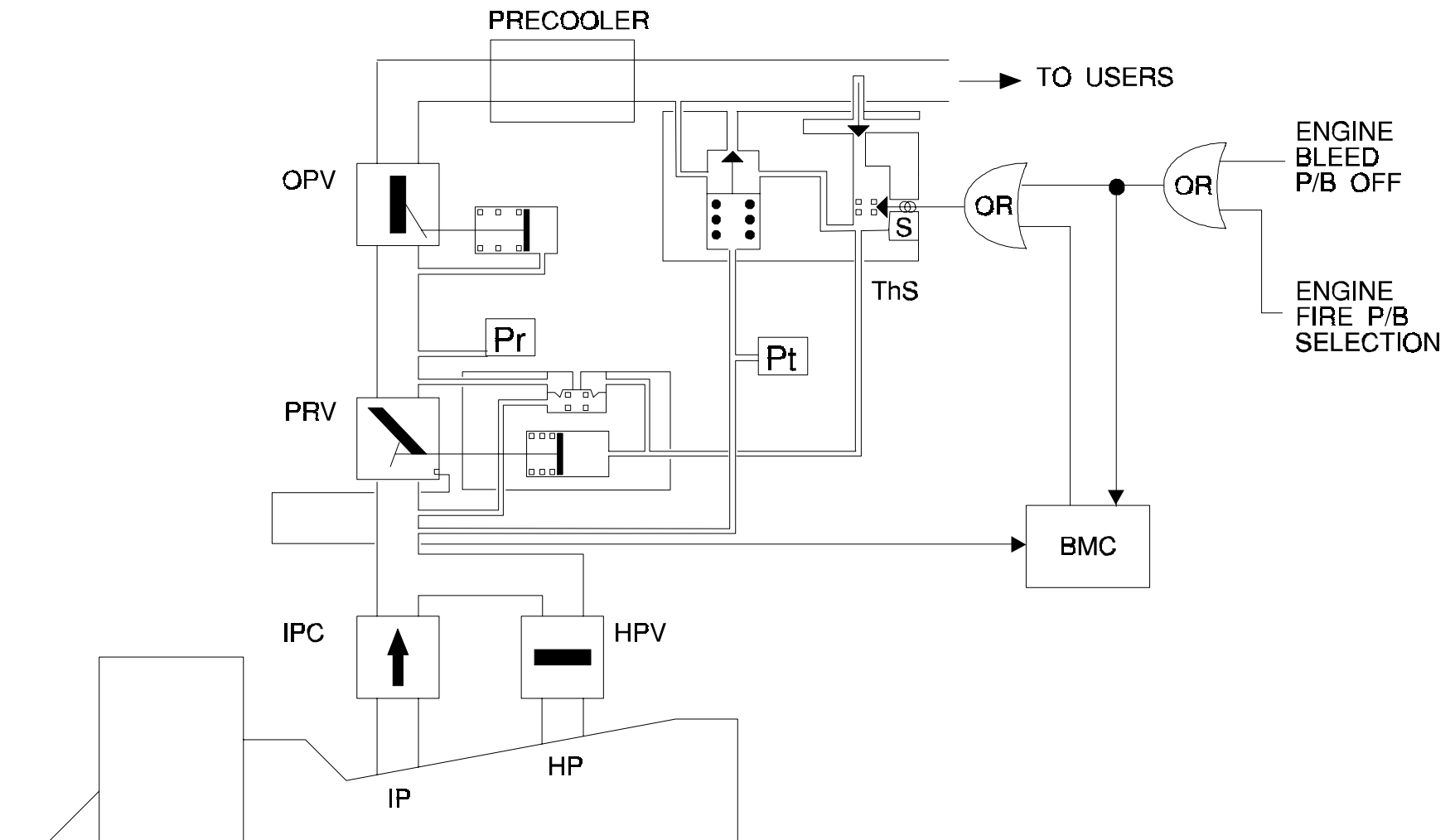
The OverPressure Valve protects the downstream pneumatic system if the Pressure Regulating Valve fails open.

The Overpressure Valve is normally fully open.

It starts to close at 75 psi.

It is fully closed at 85 psi.

It re-opens automatically when the pressure drops below 49 psi.



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PRESSURE TRANSDUCER

GENERAL

Two Pressure Transducers are connected to the pneumatic duct.

TRANSFERRED PRESSURE (Pt)

The Transferred Pressure (Pt) is measured upstream from the Pressure Regulating Valve (PRV).

The transferred pressure sensor signal is used by the Bleed Monitoring Computer (BMC) for the following functions :

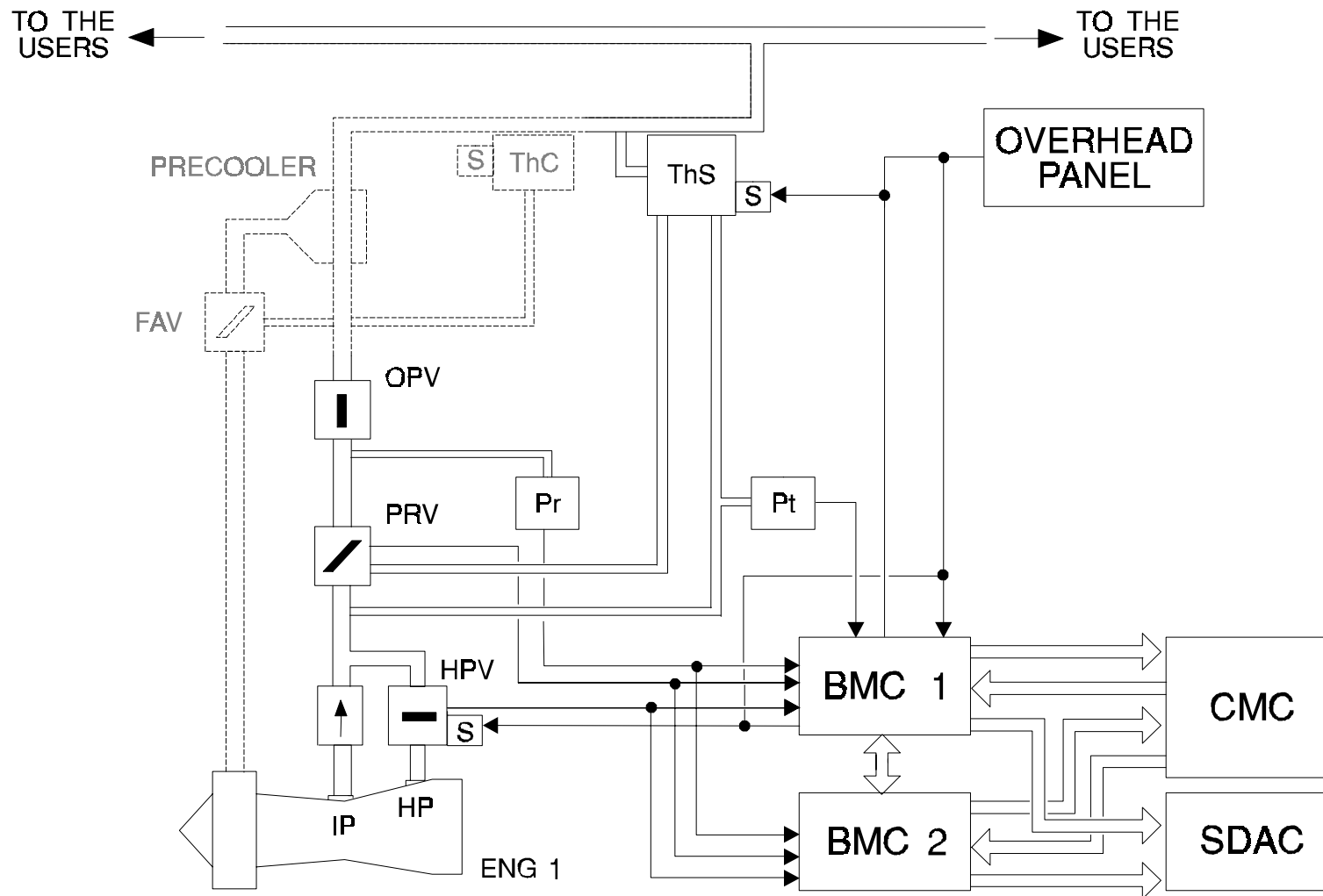
- Pressure Regulation Monitoring (HPV & PRV).
- Maintenance analysis (HPV & PRV).

REGULATED PRESSURE (Pr)

The Regulated Pressure (Pr) is measured downstream from the Pressure Regulating Valve (PRV).

The regulated pressure sensor signal is used by the Bleed Monitoring Computer (BMC) for the following functions :

- Pressure indication on the ECAM BLEED page.
- Pressure Regulation Monitoring (PRV).
- Maintenance analysis (PRV & OPV).



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SUMMARY

The engine bleed air pressure is pneumatically regulated

- by the High Pressure Valve (HPV) when air is supplied by the HP stage,
- by the Pressure Regulating Valve (PRV) associated with the Thermostat Solenoid (ThS) when air is supplied by the IP stage.

The OverPressure Valve (OPV) is a fully pneumatic protection in case of overpressure.

Two pressure transducers read the transferred and the regulated pressures to send information to the Bleed Monitoring Computer (BMC).

ENGINE BLEED AIR : TEMPERATURE REGULATION DESCRIPTION AND OPERATION

- General
- Fan Air Valve (FAV)
- Control Thermostat (ThC)
- Precooler
- Temperature (T)
- Summary

GENERAL

The temperature regulation system enables the aircraft systems to be supplied with air at 200°C during normal operation and at 150°C in case of pack low temperature demand.

This system includes a Fan Air Valve associated with a Control Thermostat, and a precooler.

The Bleed Monitoring Computer (BMC) monitors the engine bleed air temperature.

FAN AIR VALVE (FAV)

The Fan Air Valve controls the engine fan air flow rate through the precooler to regulate the engine bleed air temperature. The valve is spring loaded closed.

The Fan Air Valve (FAV) is fully pneumatically operated and controlled by the Control Thermostat (ThC).

Microswitches sense the valve fully open or fully closed position.

CONTROL THERMOSTAT (ThC)

The Control Thermostat consists of two temperature probes and a solenoid.

The Control Thermostat supplies and controls the Fan Air Valve muscle pressure depending on the precooler outlet temperature.

The temperature settings are :

- 200°C when the solenoid is not energized, for normal operation, the first probe operates.
- 150°C when the solenoid is energized by the BMC in case of pack low temperature demand and Wing Anti Ice OFF, the second probe operates.

Note : The solenoid energization (150°C setting) is inhibited when the Wing Anti Ice is ON.

PRECOOLER

The precooler cools the hot air from the engine compressor by a heat exchange process using air from the engine fan airstream, via the Fan Air Valve.

TEMPERATURE (T)

A temperature sensor is installed at the precooler outlet.

It is electrically connected to its corresponding BMC and the opposite BMC.

The temperature sensor signal is used by the BMC for the following functions :

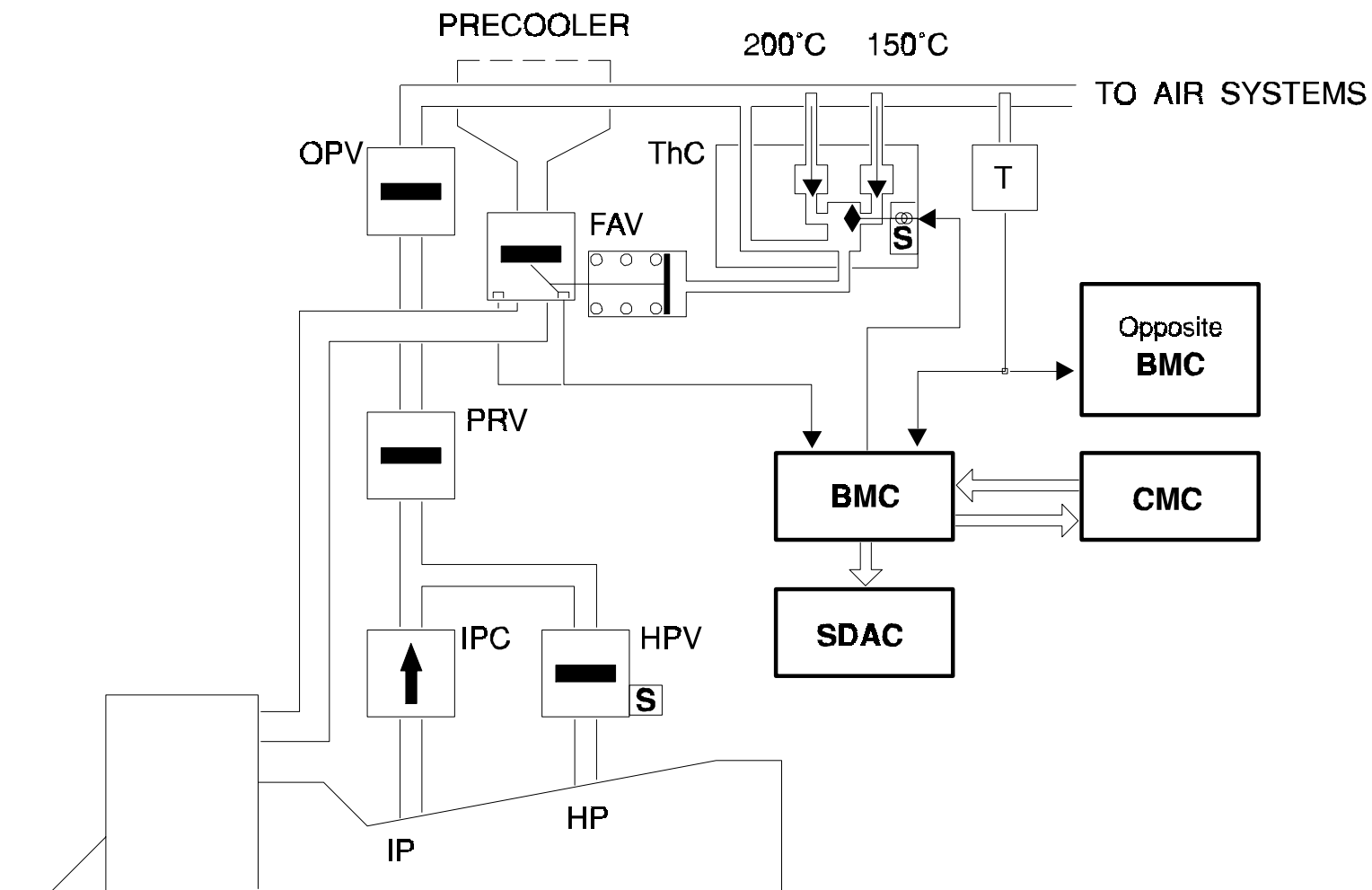
- Temperature indication on the ECAM BLEED page,
- Temperature regulation monitoring (warning at 257°C),
- Maintenance analysis.

SUMMARY

The engine bleed air temperature is regulated by the Fan Air Valve (FAV) controlled by the Control Thermostat (ThC) :

- at 200°C in normal operation
- at 150°C in case of pack low temperature demand and Wing Anti Ice OFF.

A temperature sensor reads the temperature downstream from the precooler and sends information to the Bleed Monitoring Computer (BMC) and ECAM.



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STUDENT NOTES:

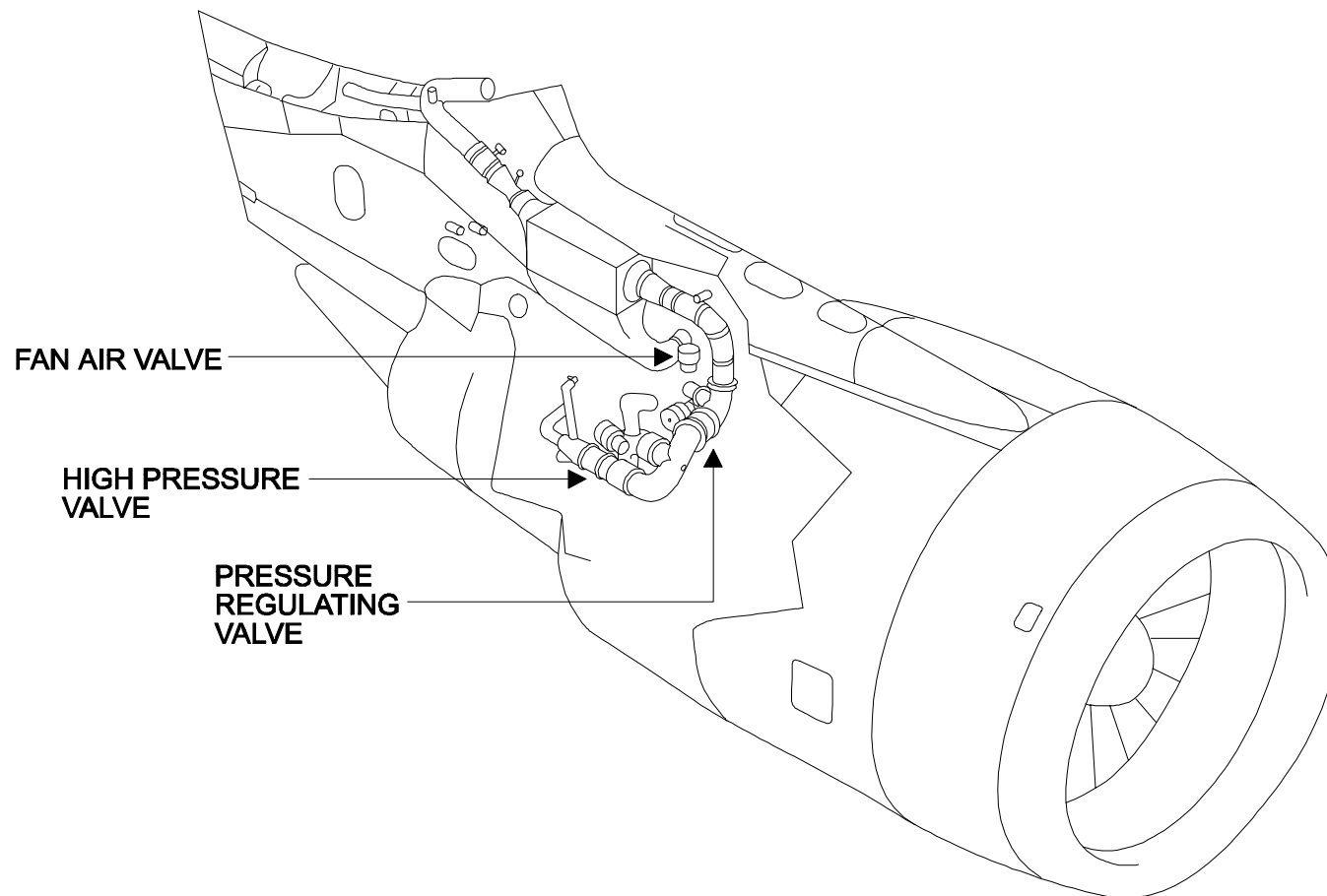
COMPONENTS / 1

Safety Precautions
High Pressure Valve (HPV)
Pressure Regulating Valve (PRV)
Fan Air Valve (FAV)
Crossbleed Valve

SAFETY PRECAUTIONS

WARNING : Make sure that the pneumatic system is depressurized before you start work. Pressurized air can cause injury to personnel.

WARNING : Do not touch the bleed components immediately after engine shutdown. The engine components stay hot for some time and can burn you.



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HIGH PRESSURE VALVE (HPV)

FIN : 4000HA1, 4000HA2

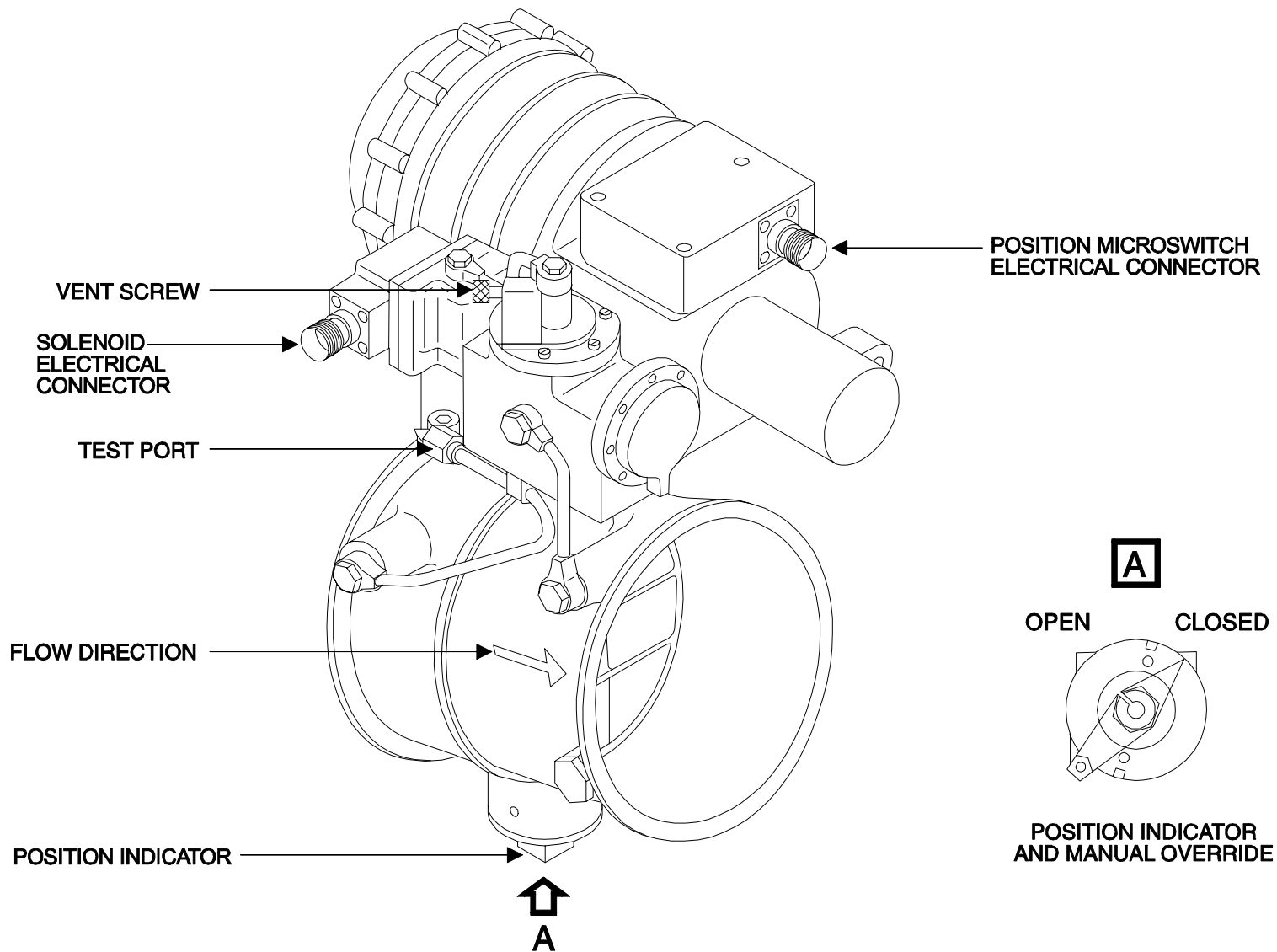
ZONE : 417,427

COMPONENT DESCRIPTION

The High Pressure Valve is pneumatically operated :

- for pressure limitation ,
- for switching between Intermediate Pressure / High Pressure stage of the engine compressor.

The position indicator has a threaded hole which enables the butterfly to be locked in the closed position with the vent screw.



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PRESSURE REGULATING VALVE (PRV)

FIN : 4001HA1, 4001HA2

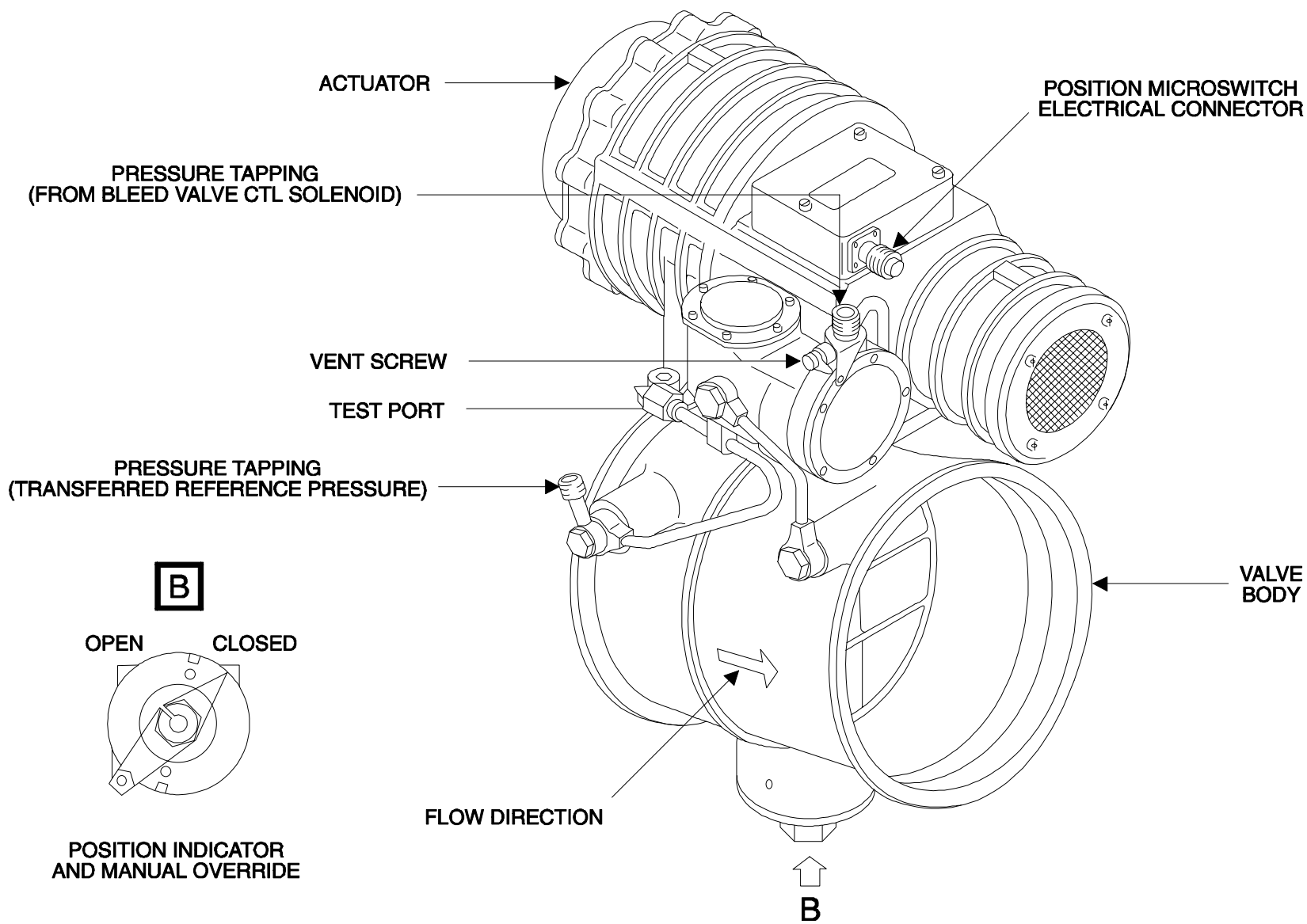
ZONE : 417,427

COMPONENT DESCRIPTION

The Pressure Regulating Valve is pneumatically operated and controlled by the Thermostat Solenoid (ThS).

It regulates the engine bleed pressure.

The position indicator has a threaded hole which enables the butterfly to be locked in the closed position with the vent screw.



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FAN AIR VALVE (FAV)

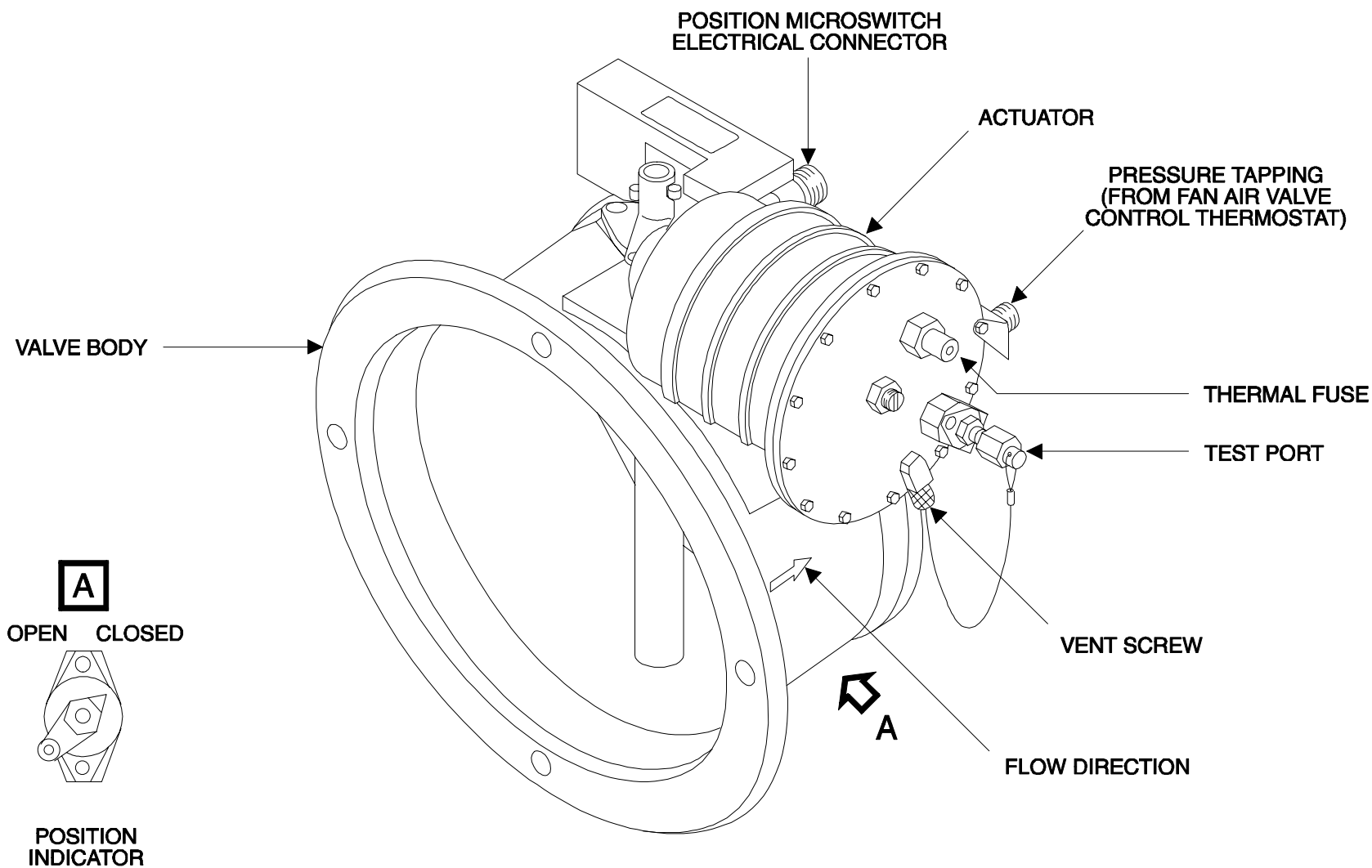
FIN : 12HA1, 12HA2

ZONE : 417,427

COMPONENT DESCRIPTION

The Fan Air Valve pneumatically regulates the fan air flow to the precooler for bleed air temperature regulation. The FAV is pneumatically controlled by the Thermostat Control (ThC).

The position indicator has a threaded hole which enables the butterfly to be locked in the closed position with the vent screw.



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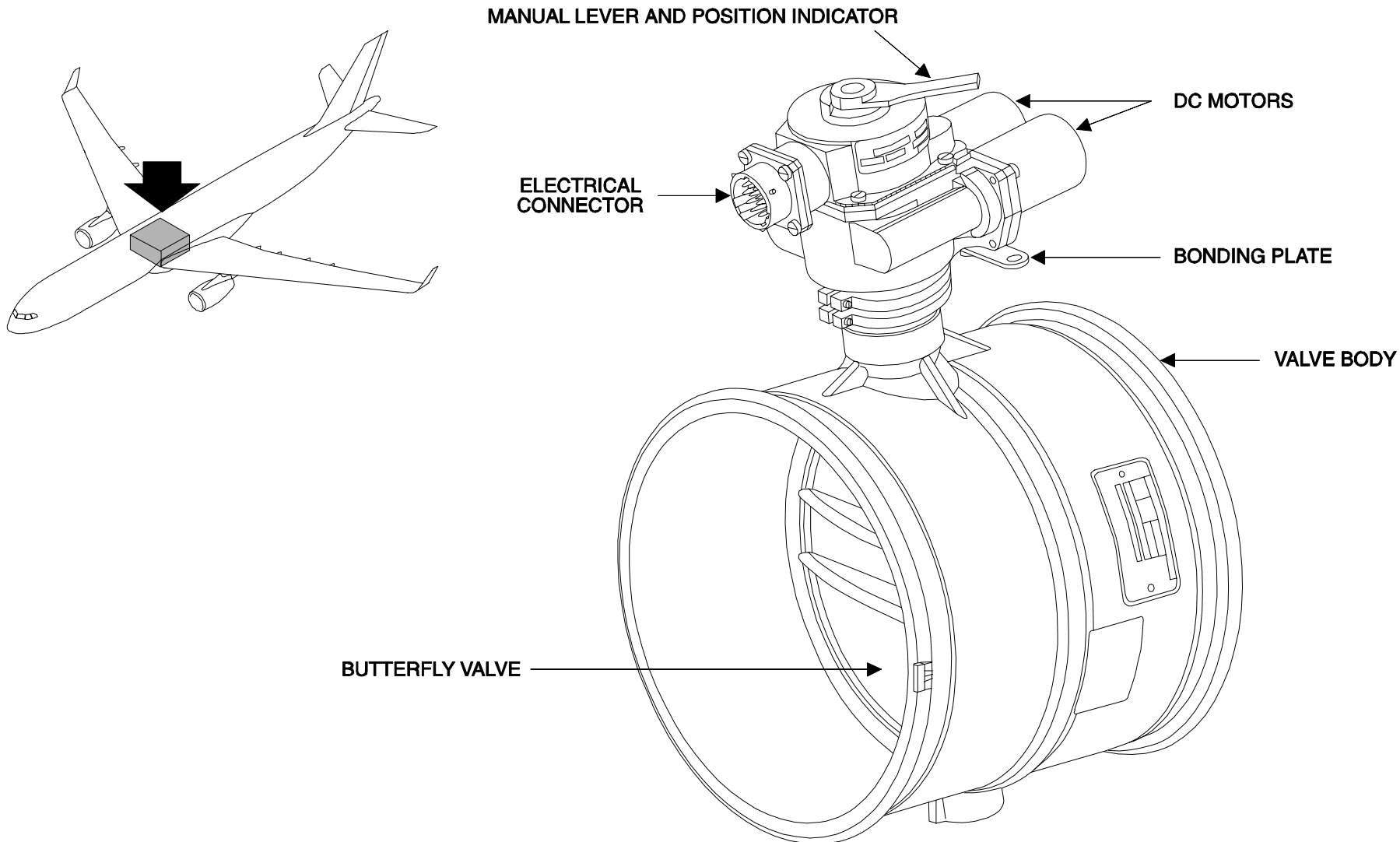
CROSSBLEED VALVE

FIN : 6HV
ZONE : 132

COMPONENT DESCRIPTION

The Crossbleed Valve enables isolation or interconnection between Left Hand and Right Hand air bleed systems. It is electrically operated by two electrical motors :

- one for automatic mode,
- one for manual mode.



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STUDENT NOTES

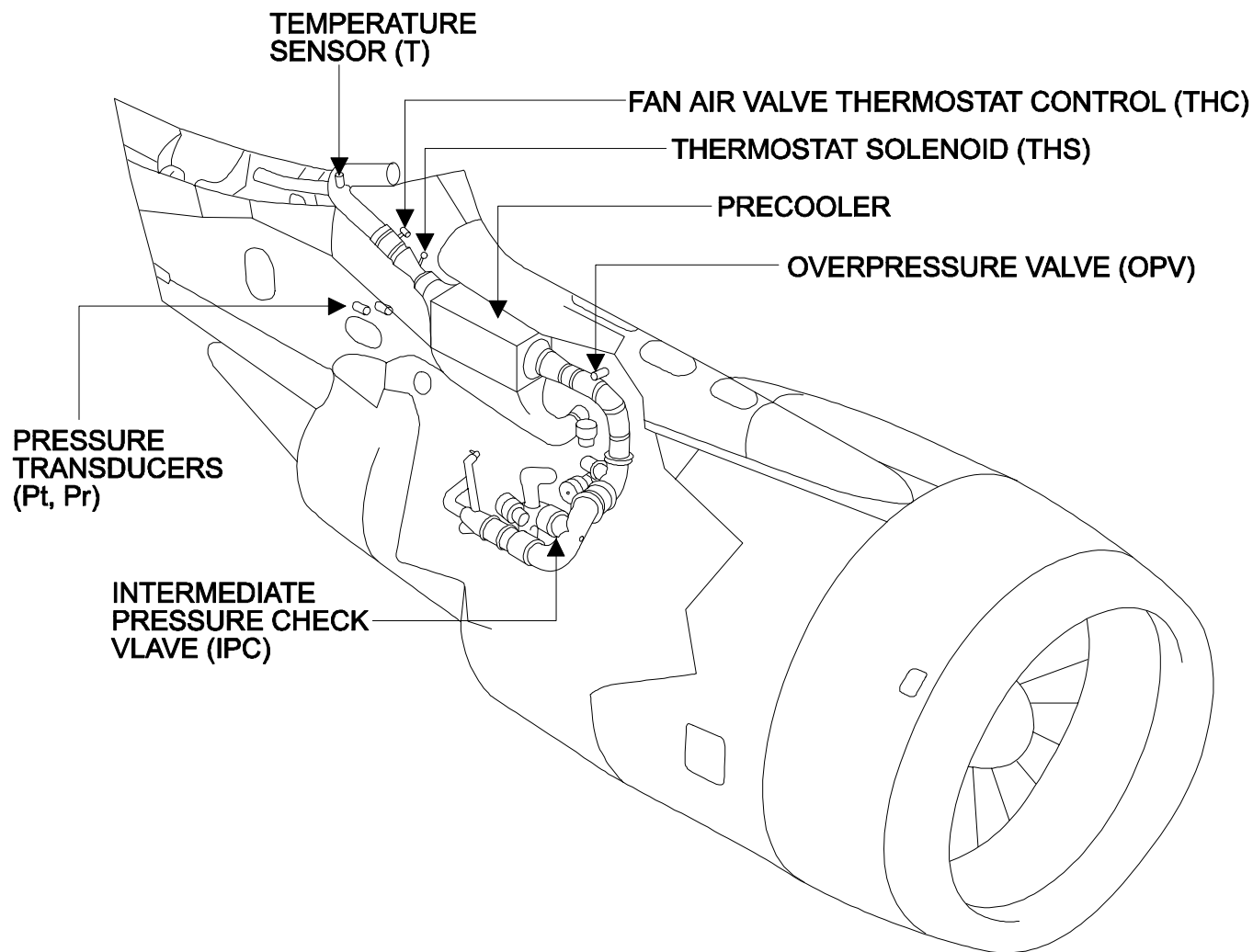
COMPONENTS / 2

- Safety Precautions
- Intermediate Pressure Check Valve (IPC)
- Overpressure Valve (OPV)
- Thermostat Solenoid (ThS)
- Precooler
- Fan Air Valve Thermostat Control (ThC)
- Temperature Sensor (T)
- Transferred Pressure Transducer (Pt)
- Regulated Pressure Transducer (Pr)
- Bleed Monitoring Computer (BMC)

SAFETY PRECAUTIONS

WARNING : Make sure that the pneumatic system is depressurized before you start work. Pressurized air can cause injury to personnel.

WARNING : Do not touch the bleed components immediately after engine shutdown. The engine components stay hot for some time and can burn you.



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INTERMEDIATE PRESSURE CHECK VALVE (IPC)

FIN : 7110HA1, 7110HA2

ZONE : 417,427

COMPONENT DESCRIPTION

Each engine has an Intermediate Pressure Check valve of the split flapper type. A torsion spring maintains the flaps in the closed position when the pressure upstream of the valve is not sufficient. A stop pin prevents the two flaps from being positioned on the same side of the shaft.

OVERPRESSURE VALVE (OPV)

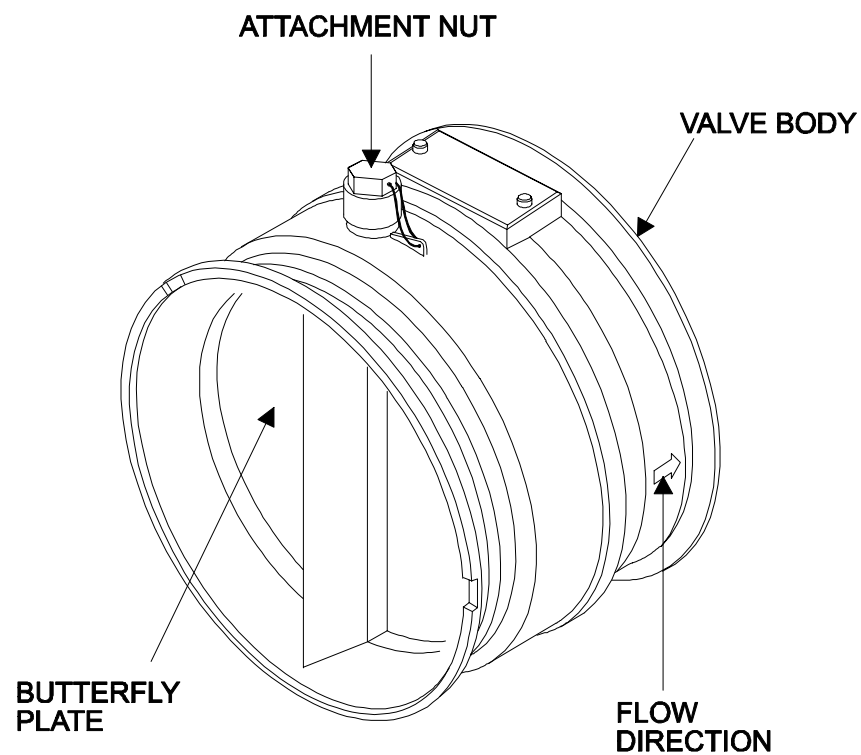
FIN : 13HA1, 13HA2

ZONE : 417,427

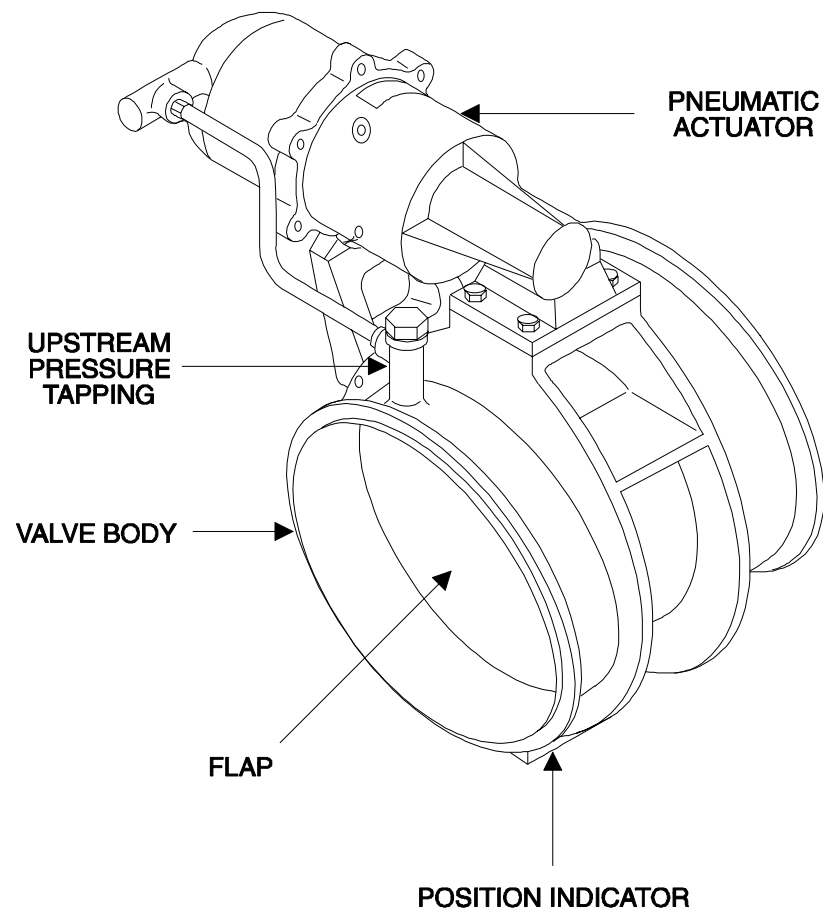
COMPONENT DESCRIPTION

The Overpressure Valve protects the downstream pneumatic system if the Pressure Regulating Valve does not operate correctly (overpressure). It is pneumatically operated and normally open. A position indicator is linked to the shaft.

INTERMEDIATE PRESSURE CHECK VALVE



OVERPRESSURE VALVE



FQW4200 GE Metric

THERMOSTAT SOLENOID (ThS)

FIN : 7HA1, 7HA2

ZONE : 452,462

COMPONENT DESCRIPTION

The Thermostat Solenoid pneumatically controls the Pressure Regulating Valve. It consists of:

- a thermostat,
- a solenoid valve,
- a non return sub-assembly.

PRECOOLER

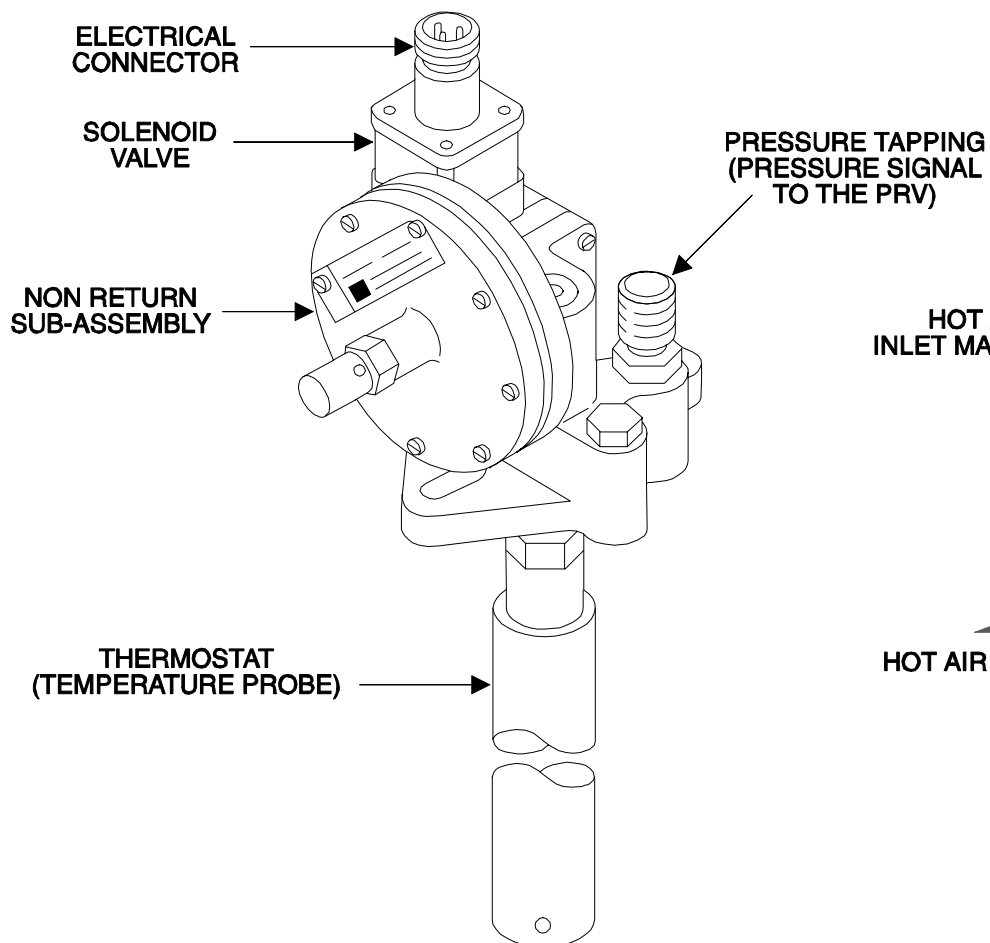
FIN : 7150HA1, 7150HA2

ZONE : 452,462

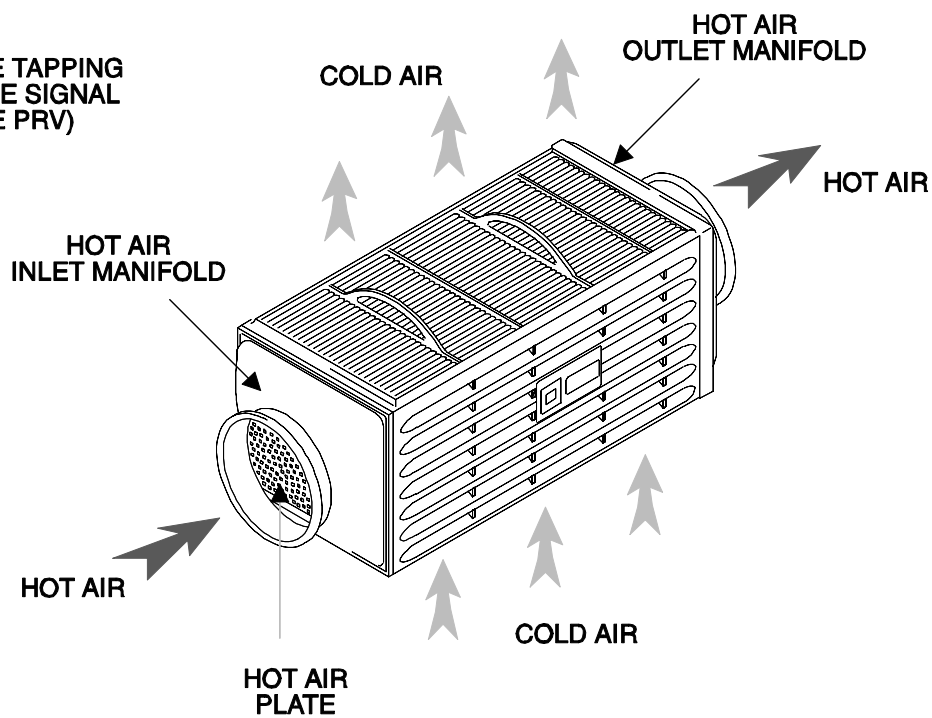
COMPONENT DESCRIPTION

The precooler is an air to air heat exchanger. It is tubular on the hot air side and the cooling air flows over the tubes in a crossflow configuration.

THERMOSTAT SOLENOID



PRECOOLER



FQW4200 GE Metric

FAN AIR VALVE THERMOSTAT CONTROL (ThC)

FIN : 5HA1, 5HA2

ZONE : 452,462

COMPONENT DESCRIPTION

The Thermostat Control pneumatically controls the Fan Air Valve. It consists of :

- an assembly comprising two temperature probes corresponding to two temperature settings selected by means of a solenoid,
- a pressure reducing assembly.

TEMPERATURE SENSOR (T)

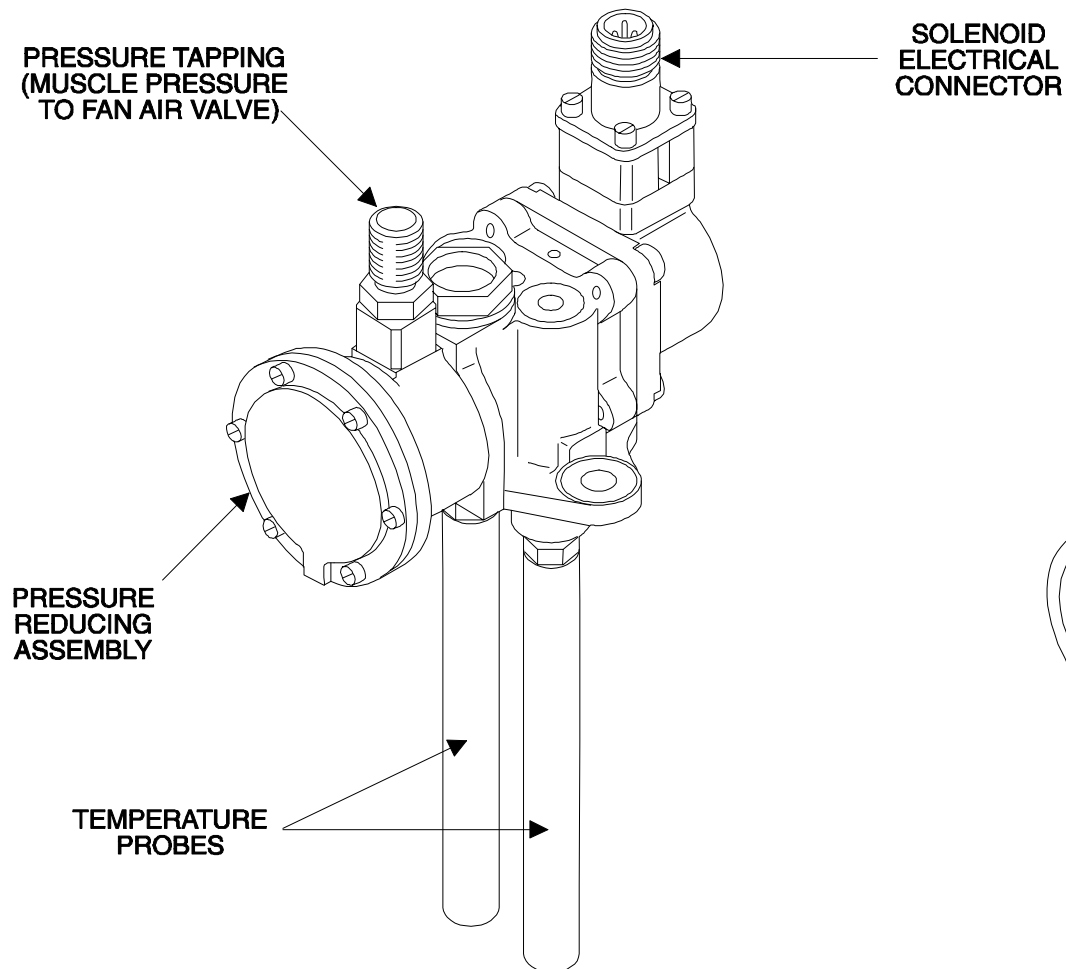
FIN : 10HA1, 10HA2

ZONE : 452,462

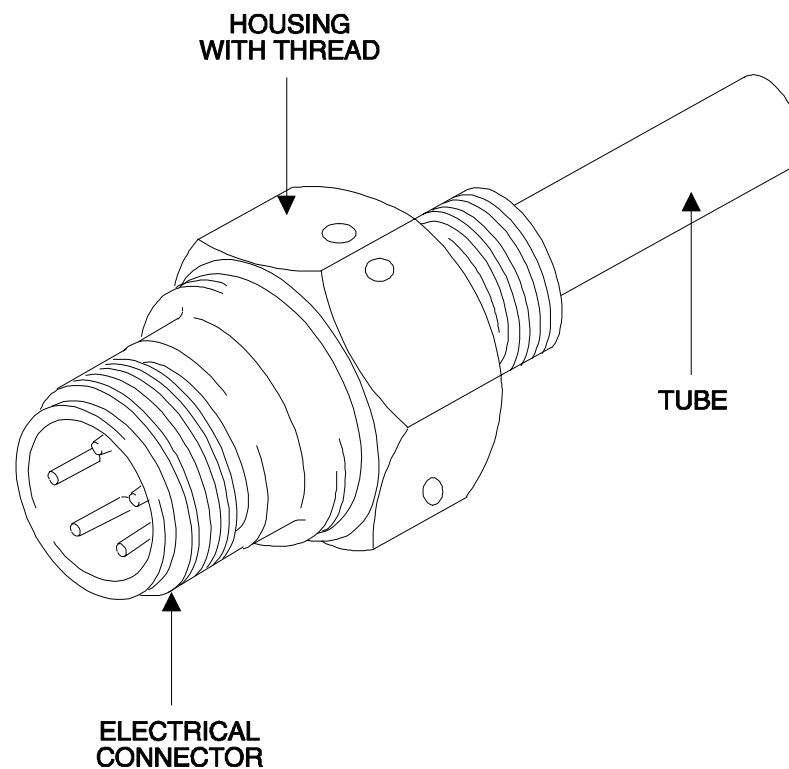
COMPONENT DESCRIPTION

An exchanger outlet temperature sensor is installed downstream from the precooler exchanger. Each temperature sensor is electrically connected to its corresponding BMC.

FAN AIR VALVE CONTROL THERMOSTAT



TEMPERATURE SENSOR



TRANSFERRED PRESSURE TRANSDUCER (Pt)

FIN : 9HA1, 9HA2

ZONE : 453,463

COMPONENT DESCRIPTION

A sense line connects the bleed transferred pressure transducer to the pneumatic duct downstream from the HPV. Each pressure transducer is electrically connected to its corresponding BMC.

REGULATED PRESSURE TRANSDUCER (Pr)

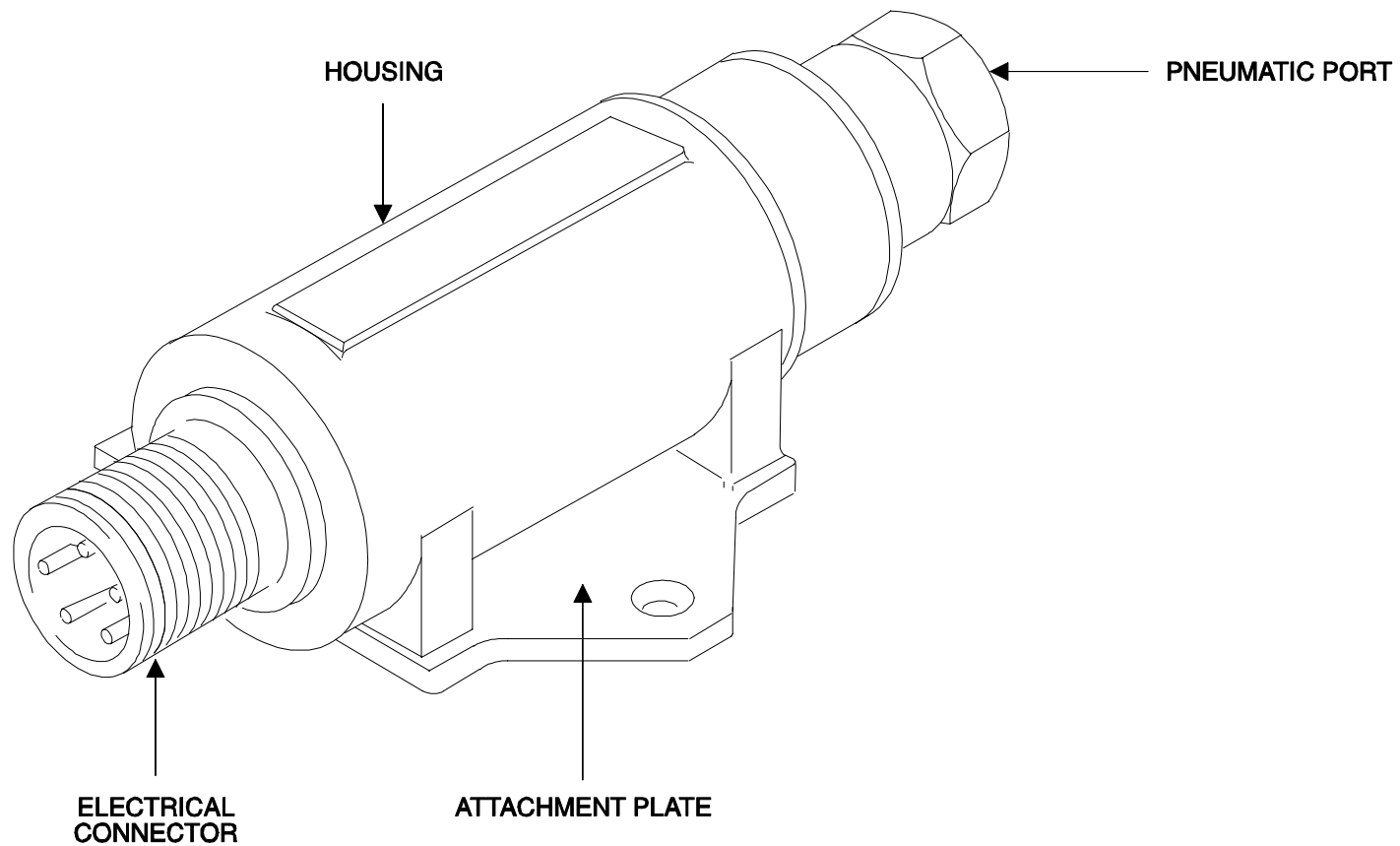
FIN : 8HA1, 8HA2

ZONE : 453,463

COMPONENT DESCRIPTION

A sense line connects the bleed regulated pressure transducer to the pneumatic duct downstream from the PRV. Each pressure transducer is electrically connected to its corresponding BMC.

**TRANSFERRED PRESSURE TRANSDUCER
OR REGULATED PRESSURE TRANSDUCER**



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BLEED MONITORING COMPUTER (BMC)

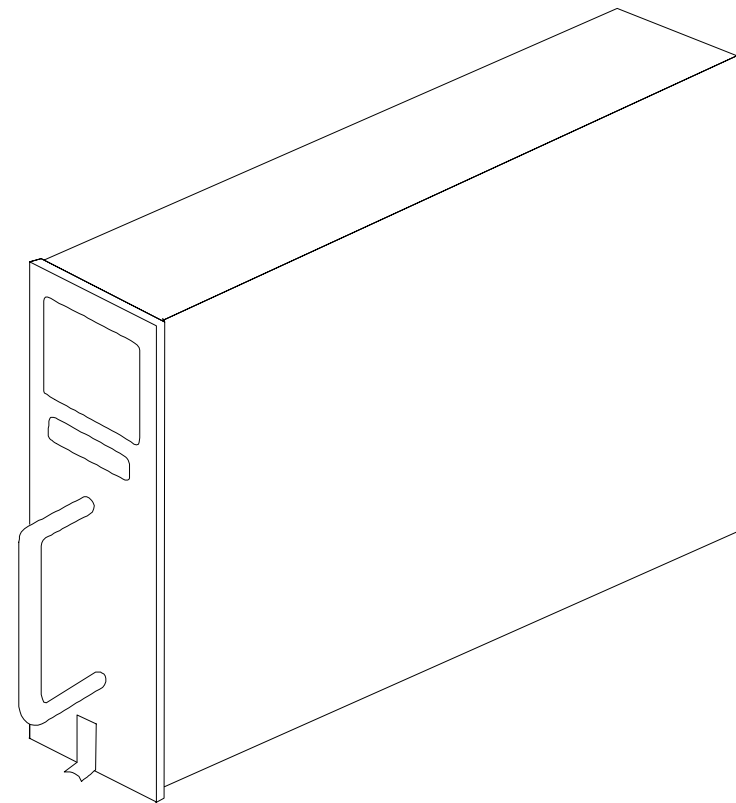
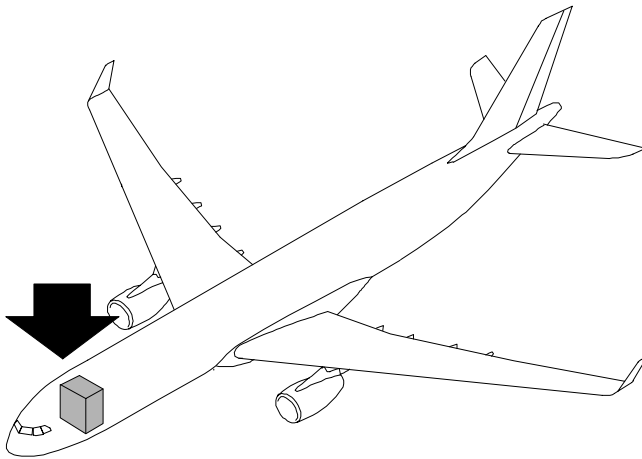
FIN : 1HA1, 1HA2

ZONE : 121

COMPONENT DESCRIPTION

Two Bleed Monitoring Computers, each identical, are installed in the avionics compartment. They receive ARINC 429 digital inputs, analog inputs and discrete inputs from the interface components or systems. They process these inputs and transmit ARINC 429 digital outputs and discrete outputs.

BLEED MONITORING COMPUTER



FQW4200 GE Metric

STUDENT NOTES

FQW4200 GE Metric

APU BLEED AIR SUPPLY, CROSSBLEED DESCRIPTION AND OPERATION

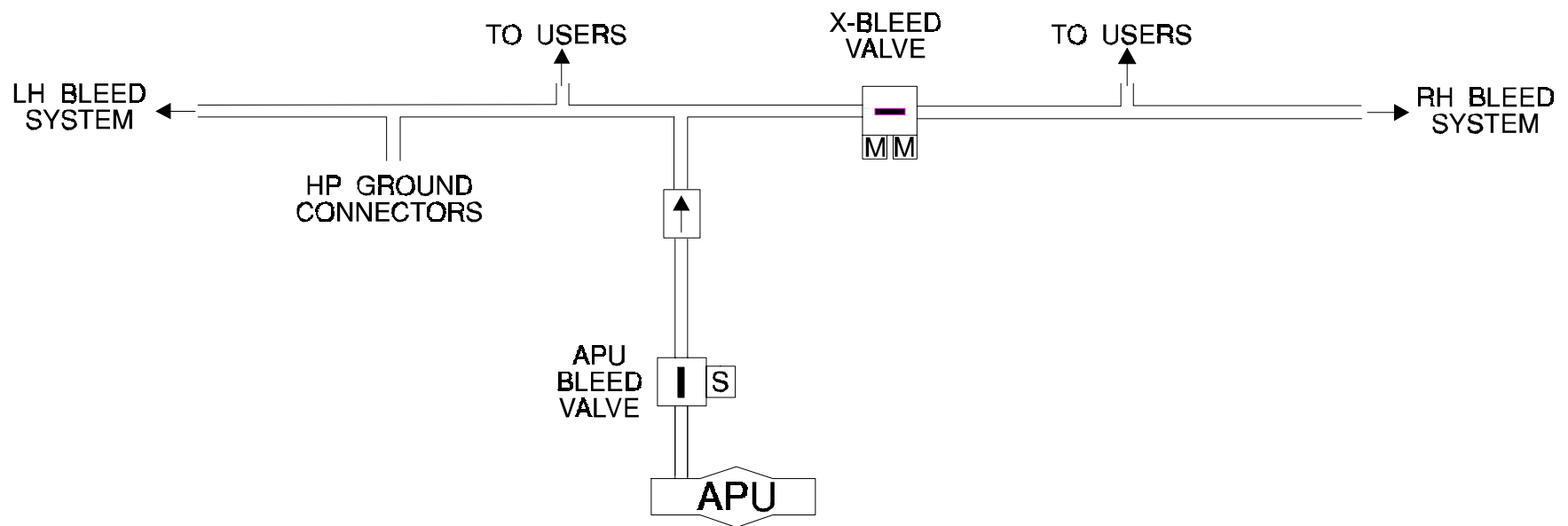
General
APU Bleed Air Supply
Crossbleed System

GENERAL

The APU can supply bleed air to the pneumatic users on ground and in flight.
The Crossbleed Valve connects or disconnects the Left Hand and the Right Hand air supply systems.

The Pressure Regulating Valves (PRV) of both engines automatically close and the Crossbleed Valve automatically opens when the APU supplies bleed air to the users.

When the APU supplies bleed air and the Crossbleed selector is in the "CLOSE" position, the PRV N°2 regulates.



FQW4200 GE Metric

APU BLEED AIR SUPPLY

The APU load compressor supplies pneumatic users on ground and in flight until the aircraft reaches 23000 ft.

The APU supplies bleed air through the APU Bleed Valve. The valve is an ON/OFF pneumatic valve.

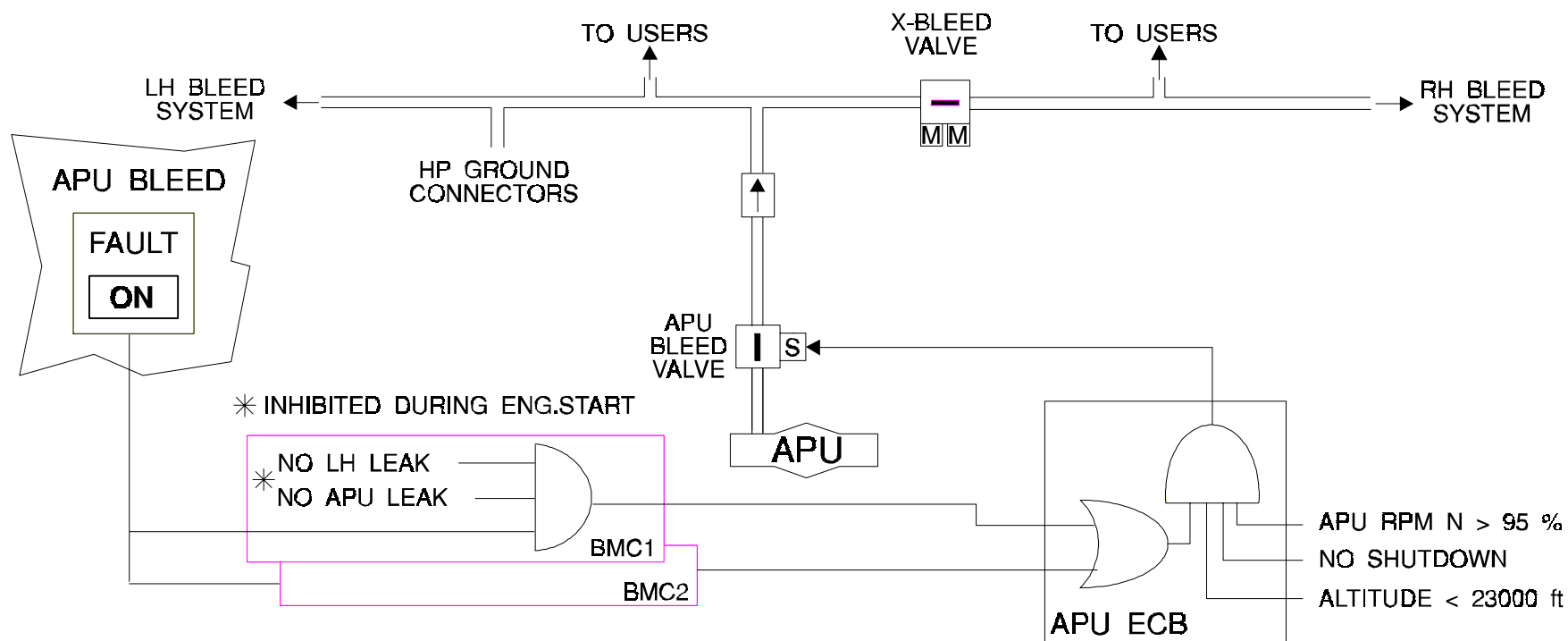
The valve is normally springloaded closed and electrically controlled to open by a solenoid when energized.

The fully open or fully closed position of the valve is indicated to the ECB and to both BMCs by a limit switch.

The APU Electronic Control Box (ECB) monitors the bleed air supply and controls the APU Bleed Valve.

In order to protect the surrounding area the APU Bleed Valve does not open when a leak occurs on the Left Hand side of the Crossbleed Valve.

A check valve protects the APU from reverse flow when another source supplies bleed air at a higher pressure.



CROSSBLEED SYSTEM

The Crossbleed Valve is an electrically controlled shut off valve, operated by two electrical motors.

The fully open or fully closed position of the valve is indicated to the two BMCs by a microswitch.

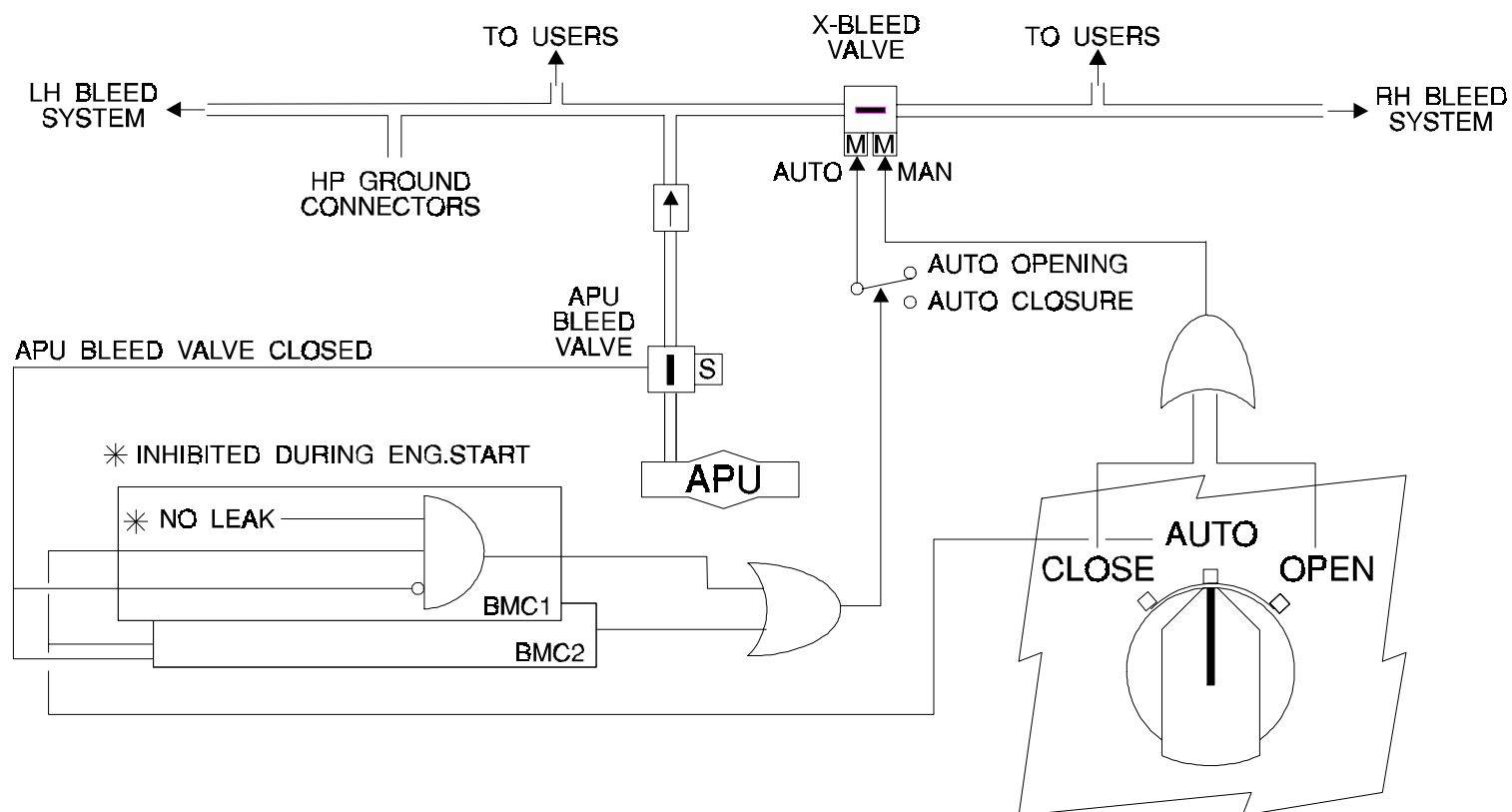
The primary motor is used for automatic mode : The position of the valve is controlled by the BMCs according to APU bleed configuration.

The secondary motor is used for manual mode, to override the AUTO mode.

The position of the valve is controlled by the Crossbleed selector (OPEN or CLOSE) on the overhead panel.

The manual OPEN control is used for the following cases :

- Cross supply to the air conditioning packs,
- Engine cross start,
- One engine bleed failure,
- Engine 2 start from ground air supply.



STUDENT NOTES:

FQW4200 GE Metric

APU, XBLEED COMPONENTS & HP GROUND CONNECTORS

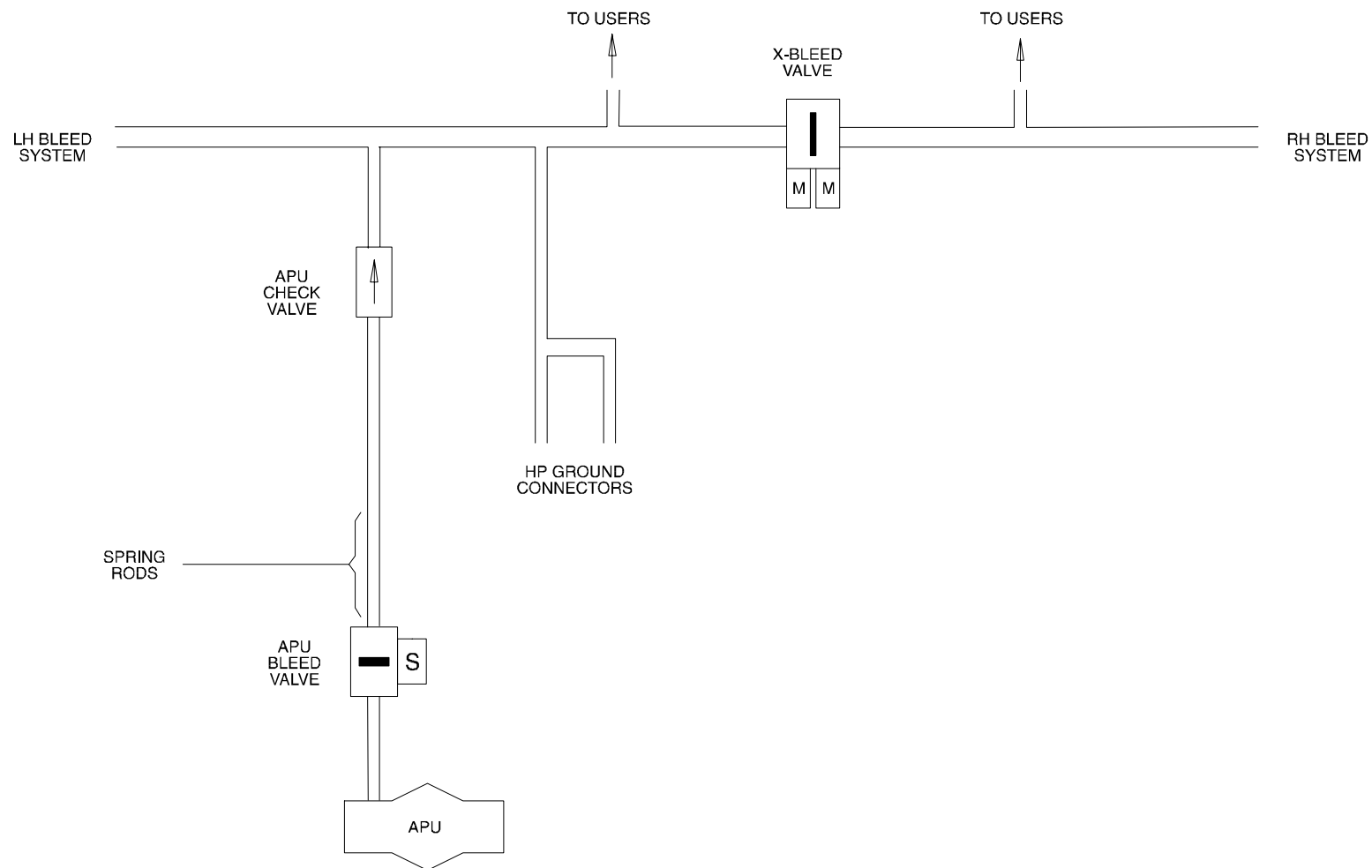
Safety Precautions
Spring Rod
APU Check Valve
HP Ground Connectors

FQW4200 GE Metric

SAFETY PRECAUTIONS

WARNING ; Make sure that the pneumatic system is depressurized before you start work. Pressurized air can cause injury to personnel.

WARNING ; Do not touch the bleed components immediately after engine shutdown. The components stay hot for some time and can burn you.



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SPRING ROD

FIN / ZONE

FIN :

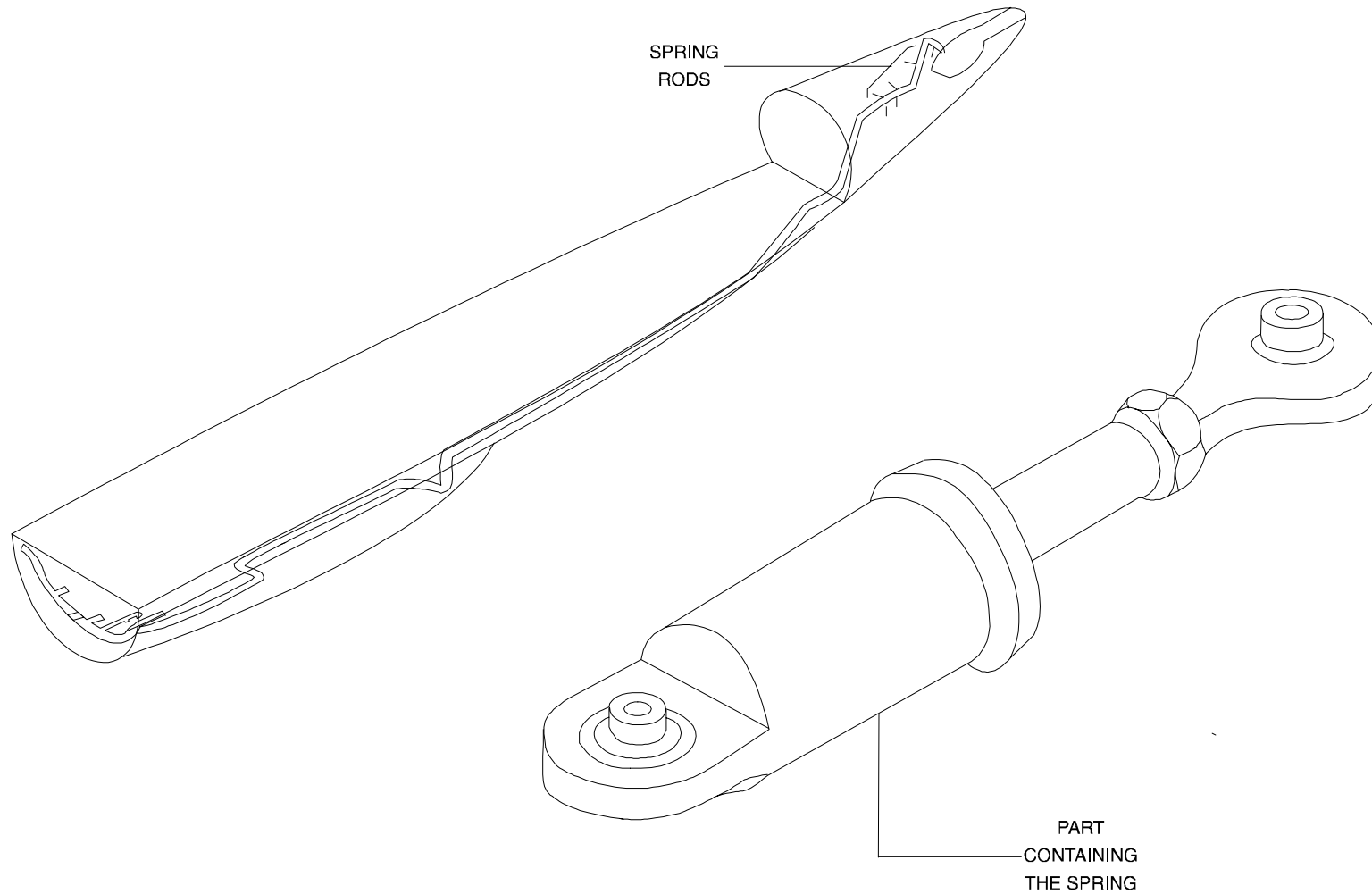
Zone : 311

313

COMPONENT DESCRIPTION

Spring rods serve to attach APU bleed duct.

They enable a relative movement between the fuselage and the duct.



FQW4200 GE Metric

APU CHECK VALVE

FIN / ZONE :

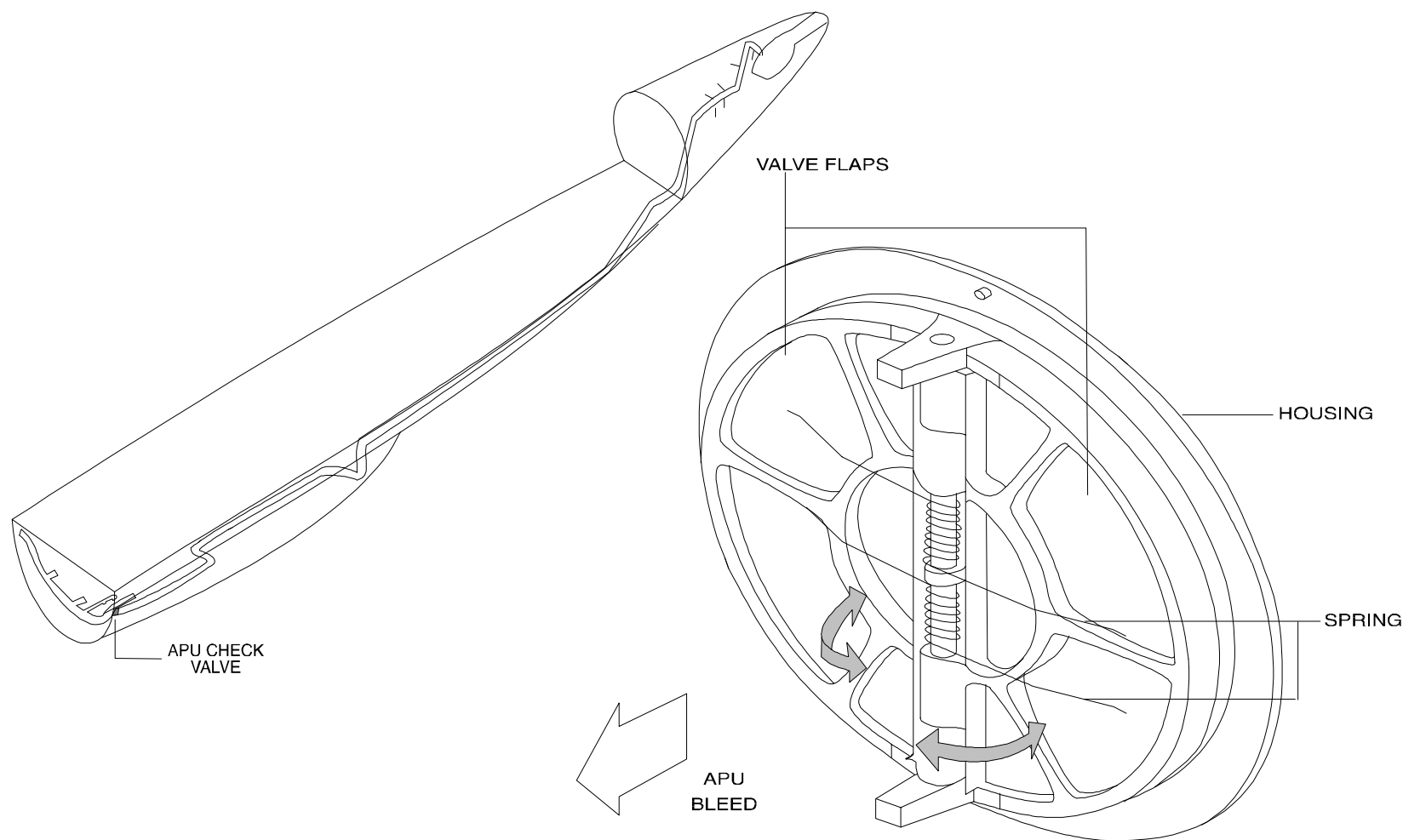
FIN : 7260 HA

Zone : 191

COMPONENT DESCRIPTION

The APU check valve is a flapper type of valve.

It protects the APU from reverse flow when another source supplies bleed air at a higher pressure.



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HP GROUND CONNECTORS

FIN / ZONE :

FIN : 7300 HA

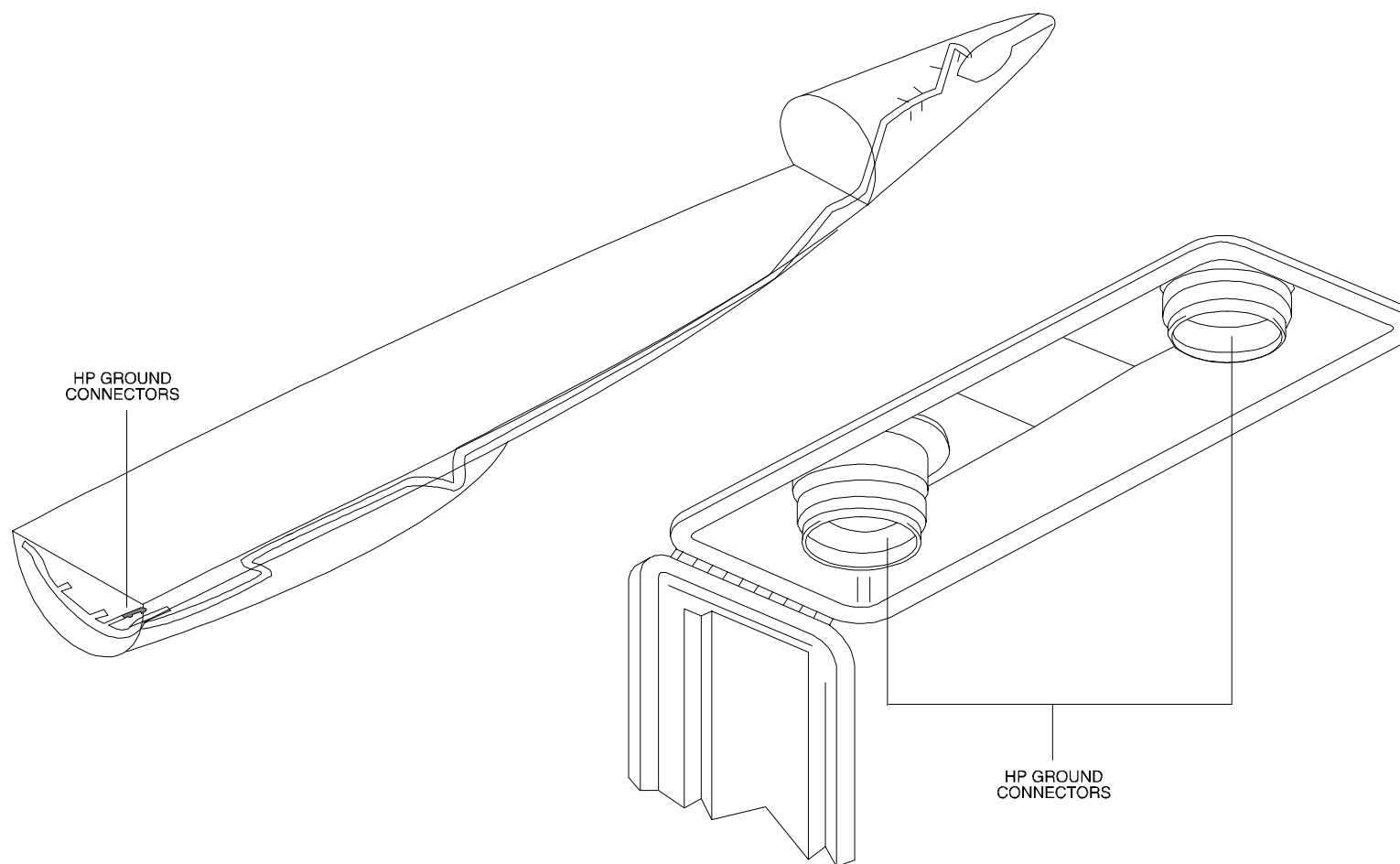
7302 HA

Zone : 193

COMPONENT DESCRIPTION

Each HP ground connector contains a non return valve and a built-in-nipple.

A duct connects the HP ground connectors with the crossfeed duct on the left side of the crossbleed valve.



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STUDENT NOTES

PNEUMATIC LEAK DETECTION

General
Routing
Architecture
Fault Logic
Leak Consequences

GENERAL

The leak detection system detects any ambient overheat in the vicinity of hot air ducts which run through the engine pylons, the wings, the air conditioning bay and the fuselage for the Auxiliary Power Unit bleed.

The leak detection system is divided into two subsystems :

- the right hand and the left hand subsystems.

Each subsystem operates independently and is monitored by both Bleed Monitoring Computers (BMCs).

ROUTING

The engine pylons are monitored by a single loop.

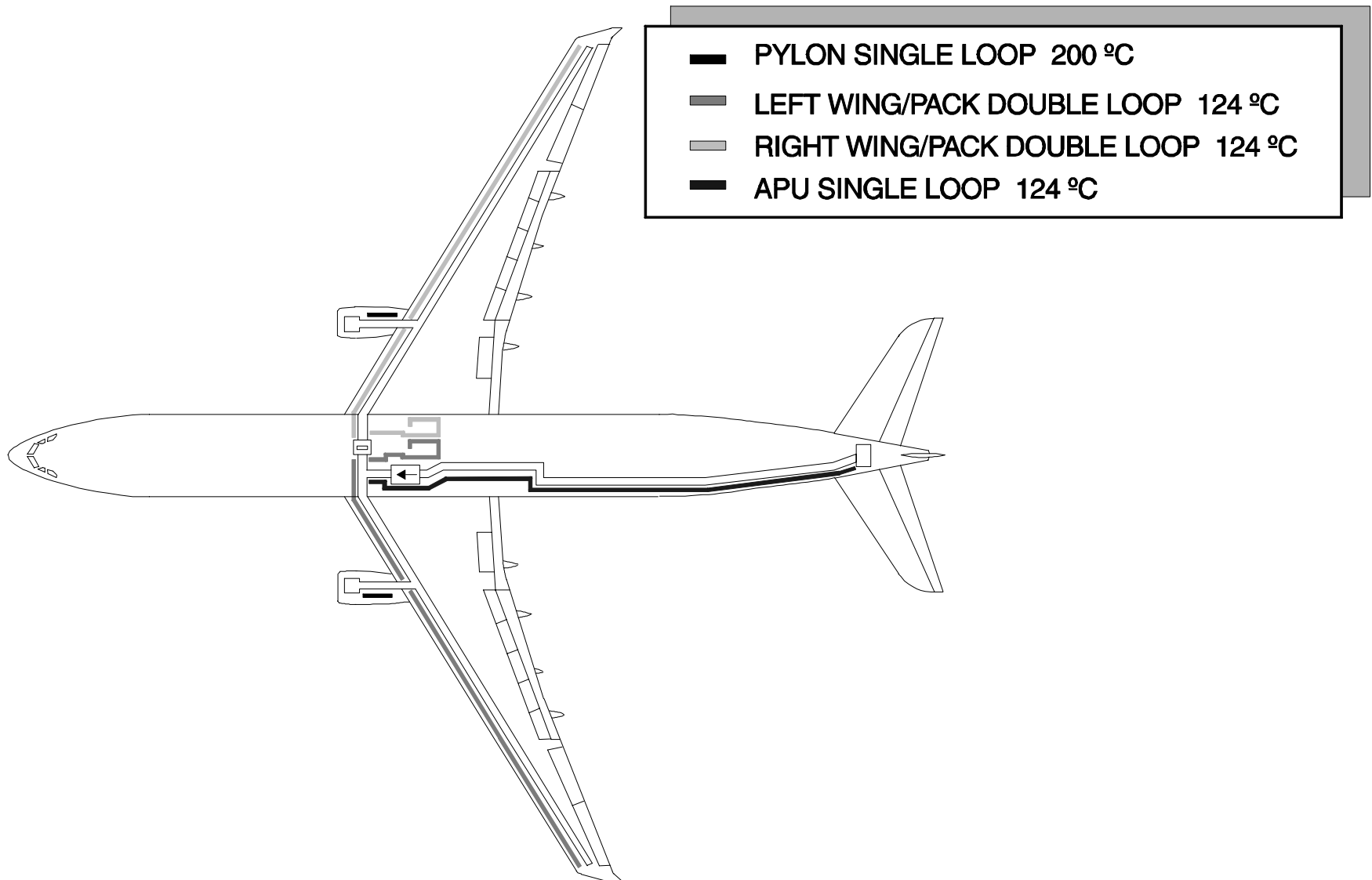
Detection Threshold : $200^{\circ}\text{C} \pm 5^{\circ}\text{C}$

Each wing and pack is monitored by a double loop of sensing elements. The loops are interconnected in the BMCs with an AND logic to prevent spurious warnings.

Detection Threshold : $124^{\circ}\text{C} \pm 7^{\circ}\text{C}$

The APU duct is monitored by a single loop of sensing elements.

Detection Threshold : $124^{\circ}\text{C} \pm 7^{\circ}\text{C}$



ARCHITECTURE

The two BMCs monitor and detect the leaks along the hot air ducts.

Each BMC monitors three detection loops :

- one in the engine pylon,
- one in the RH wing and above the RH pack,
- one in the LH wing and above the LH pack.

BMC 1 also monitors the APU loop.

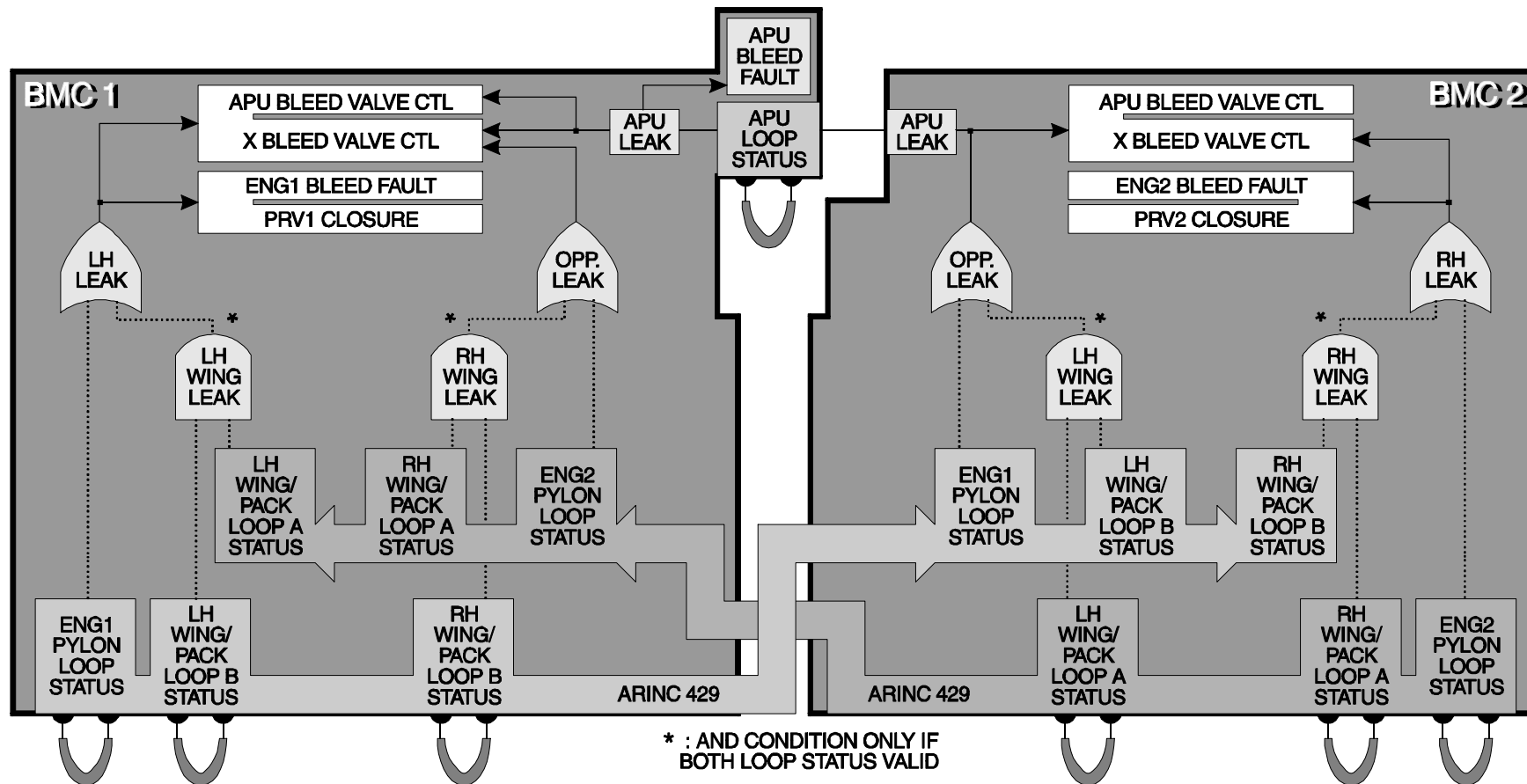
Both BMCs exchange loop status data via ARINC buses.

BMC 1 sends an APU leak discrete signal to BMC 2.

An opposite leak logic is also used for the APU bleed valve and the cross bleed valve closure control.

If one BMC operation is lost, the other BMC takes over for wing and pack leak monitoring but the corresponding pylon leak detection is lost.

If BMC 1 fails, APU leak detection is lost.



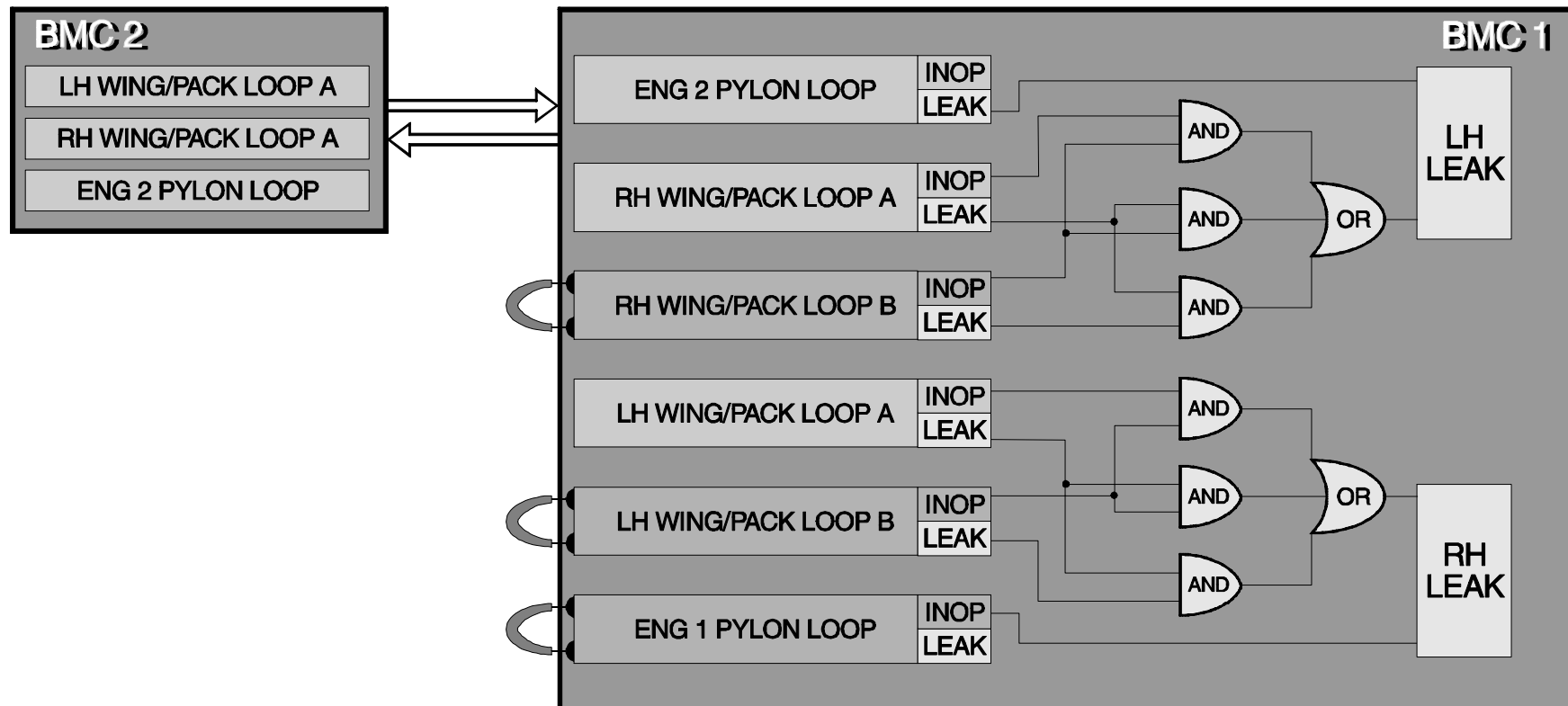
FQW4200 GE Metric

FAULT LOGIC

The engine bleed FAULT light comes on when a wing/pack leak or a pylon leak is detected according to the displayed logic.

If one wing/pack loop is inoperative, the overheat is detected by the remaining one.

If the other wing/pack loop is inoperative, the corresponding leak detection system is lost.

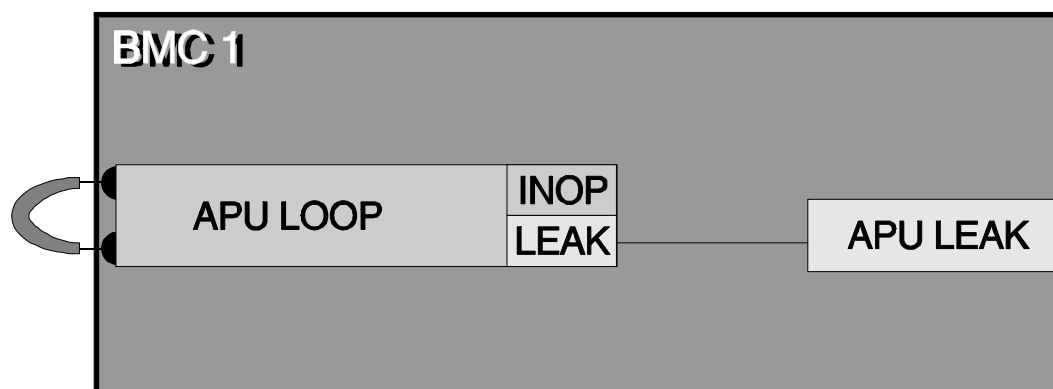


FQW4200 GE Metric

FAULT LOGIC

The APU bleed FAULT light comes on when an APU leak is detected.

Note : Any failed system can be reset when no leak is detected and only by switching OFF the corresponding p/b.

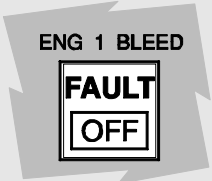
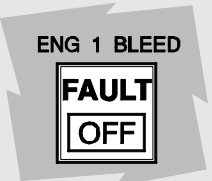
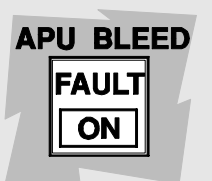
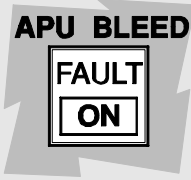
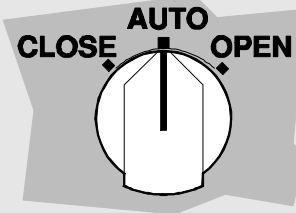
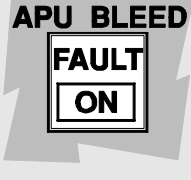


LEAK CONSEQUENCES

The consequences of a leak are the following :

- FAULT light in the corresponding p/b comes on,
- Master caution lights come on,
- Single chime sounds,
- Message on Engine Warning Display,
- BLEED page on System Display.

The only reset action necessary is to switch the corresponding pushbutton off, provided the leak fault is over.

LEAK	LH LEAK		RH LEAK	APU LEAK
FAULT comes on as long as the fault exists.	IF PYLON 1 LEAK : 	IF LEFT WING/PACK LEAK : 	SAME AS LH LEAK WITH ENG 2	APU BLEED P/B : 
AUTOMATIC CLOSURE	APU BLEED VALVE PRV 1 if  and engine start not initiated	CROSS BLEED VALVE if cross bleed valve in AUTO mode 	SAME AS LH LEAK EXCEPT FOR APU BLEED VALVE	APU BLEED VALVE if  and engine start not initiated

STUDENT NOTES:

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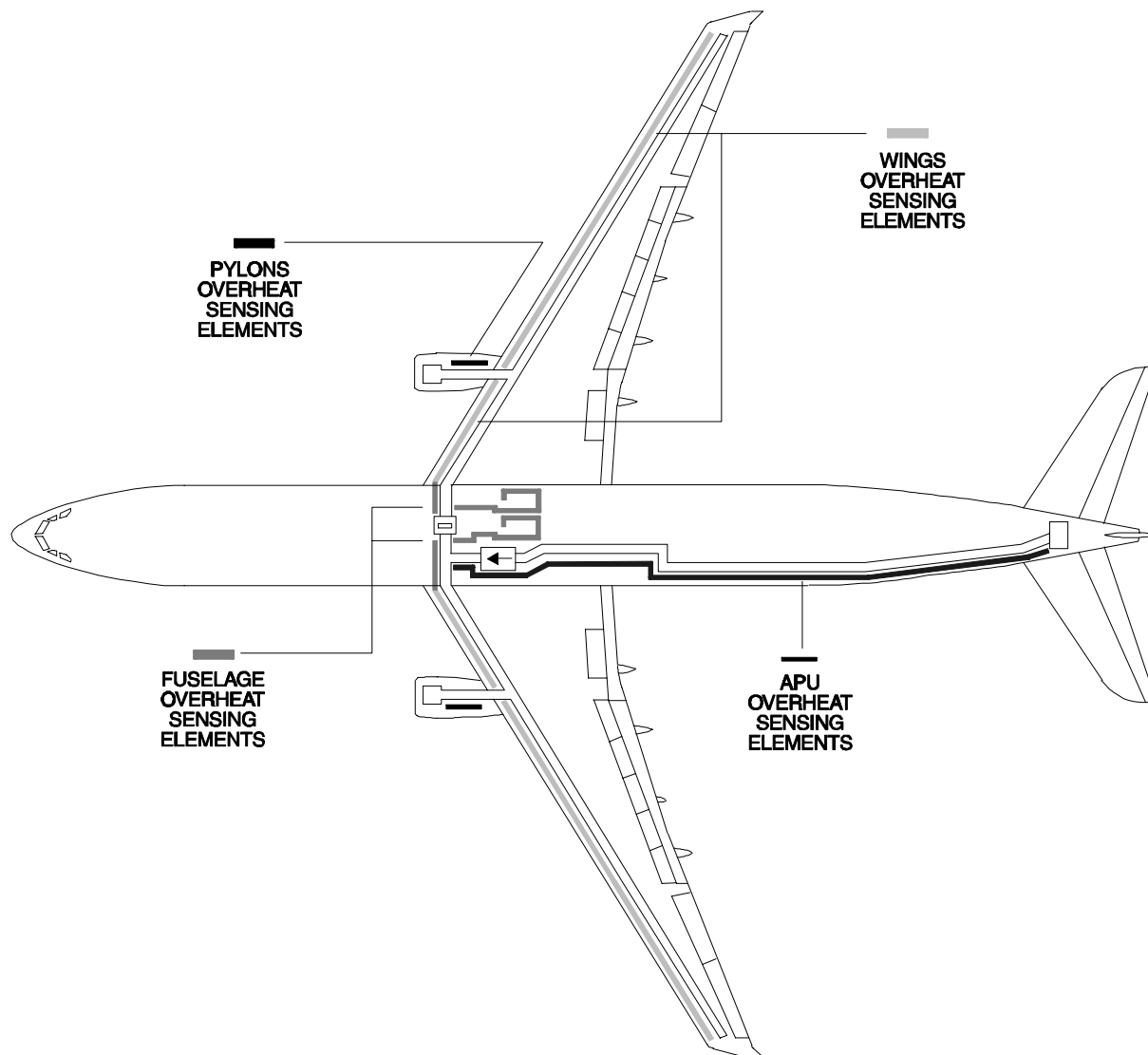
LEAK DETECTION COMPONENTS

- Safety Precautions
- Pylons Overheat Sensing Element
- Wings Overheat Sensing Element
- Fuselage Overheat Sensing Element
- APU Overheat Sensing Element

SAFETY PRECAUTIONS

WARNING : Make sure that the pneumatic system is depressurized before you start work. Pressurized air can cause injury to personnel.

WARNING : Do not touch the bleed components immediately after engine shutdown. The components stay hot for some time and can burn you.



PYLONS OVERHEAT SENSING ELEMENT

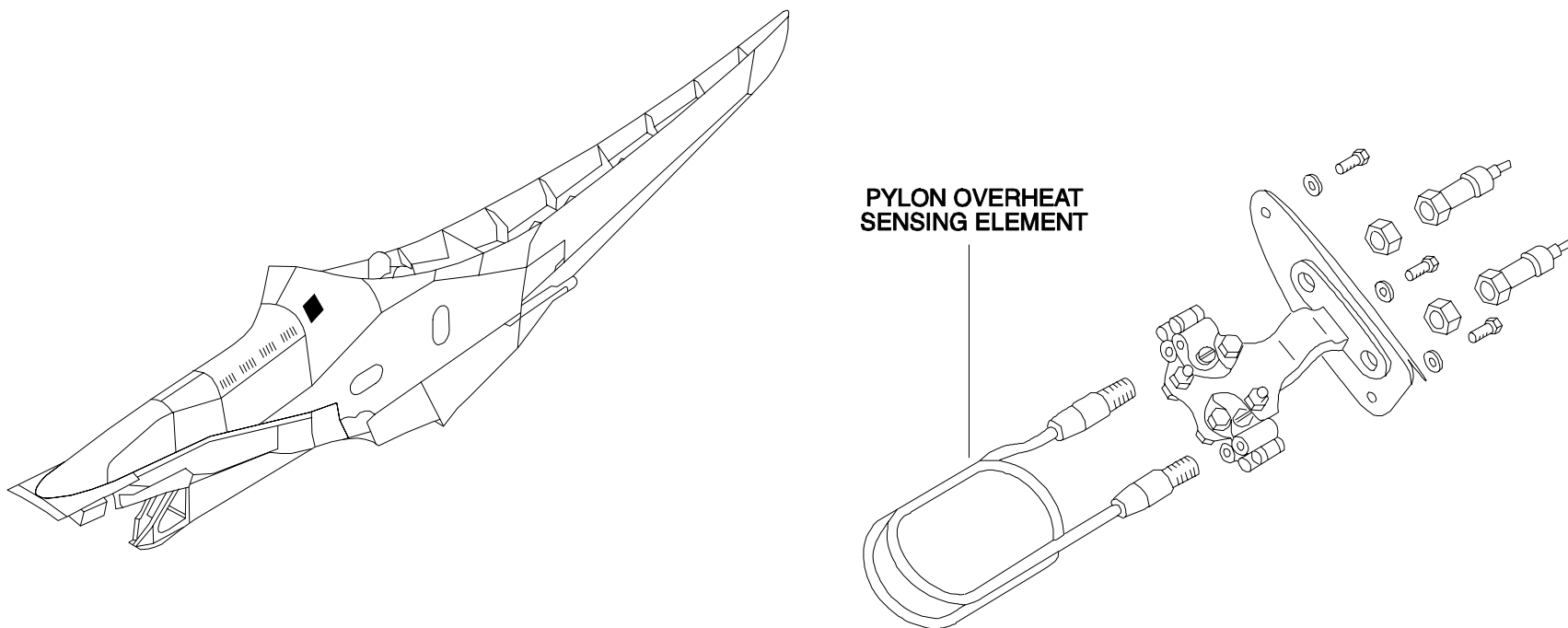
FIN / ZONE

FIN : 2HF1,2HF2

Zone : 452,462

COMPONENT DESCRIPTION

The overheat sensing elements have a solid nickel center conductor embedded in a ceramic insulation of porous aluminum oxide. An inconel tube contains these components and is sealed at both ends. When it is exposed to a heat source, continuity is established between the tube and the conductor. A ground signal is sent. The overheat signal is triggered for a temperature of 200°C plus or minus 5°C.



WINGS OVERHEAT SENSING ELEMENT

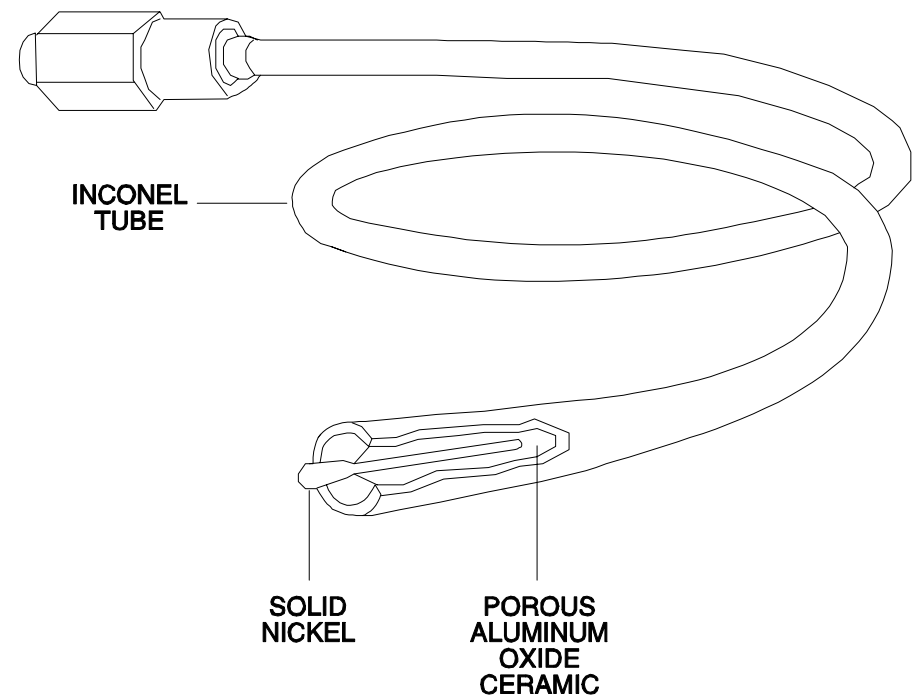
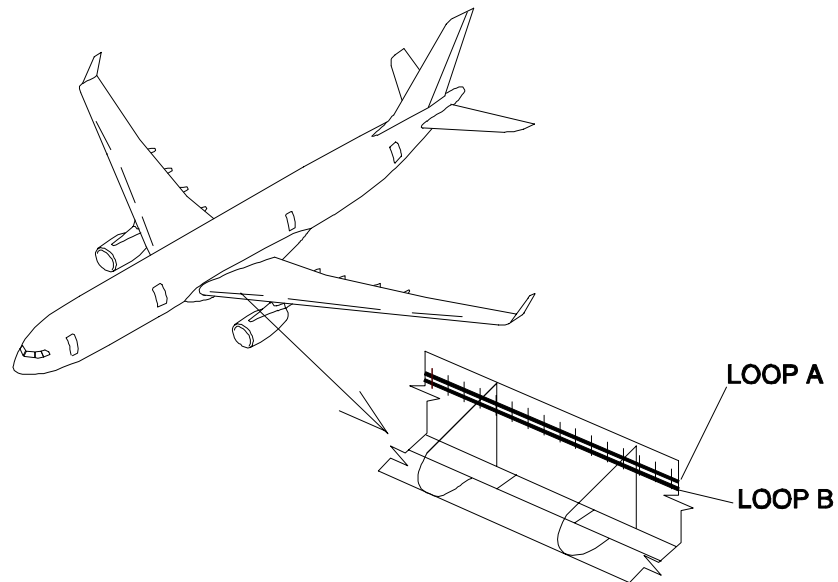
FIN / ZONE

FIN : LH loop A : 5HF,...,13HF
LH loop B : 36HF,...,44HF
RH loop A : 54HF,...,62HF
RH loop B : 71HF,...,79HF
Zone : LH : 523,522,521
RH : 623,622,621

COMPONENT DESCRIPTION

The overheat sensing elements have a solid nickel center conductor embedded in a ceramic insulation of porous aluminum oxide. An inconel tube contains these components and is sealed at both ends. When it is exposed to a heat source, continuity is established between the tube and the conductor. A ground signal is sent. The overheat signal is triggered for a temperature of 124°C plus or minus 7°C.

WING OVERHEAT SENSING ELEMENT LOOPS A & B



FUSELAGE OVERHEAT SENSING ELEMENT

FIN / ZONE

FIN :

LH loop A : 16HF,17HF,20HF,87HF,90HF,93HF,...,96HF,136HF

LH loop B : 47HF,48HF,51HF,103HF,106HF,109HF,...,113HF

RH loop A : 65HF,68HF,114HF,117HF,120HF,...,124HF

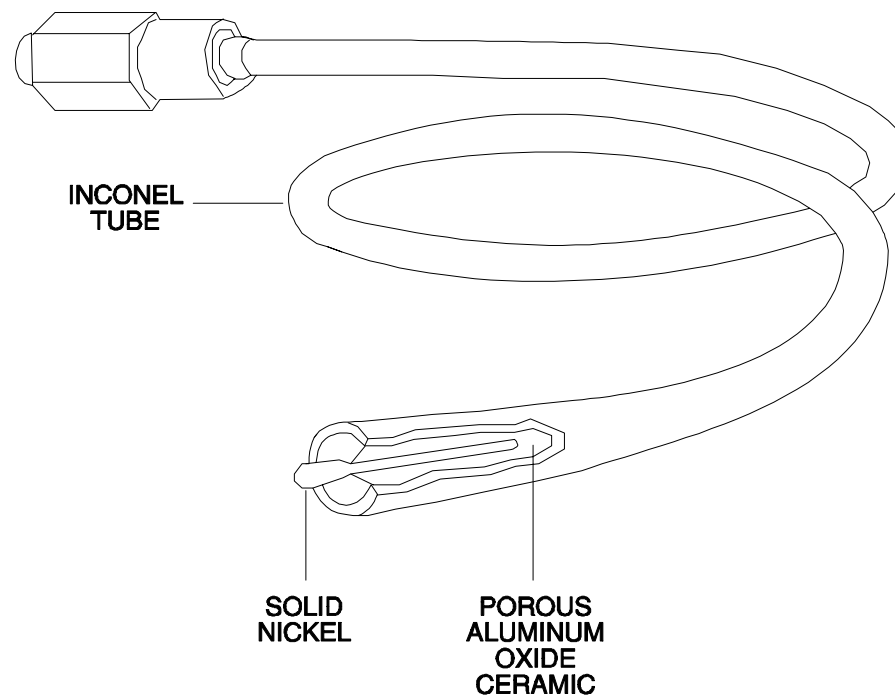
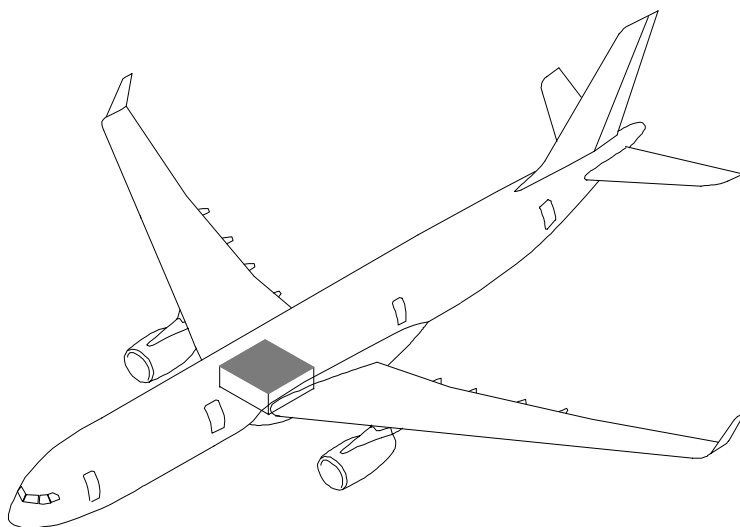
RH loop B : 82HF,85HF,125HF,128HF,131HF,...,135HF

Zone : 141,142

COMPONENT DESCRIPTION

The overheat sensing elements have a solid nickel center conductor embedded in a ceramic insulation of porous aluminum oxide. An inconel tube contains these components and is sealed at both ends. When it is exposed to a heat source, continuity is established between the tube and the conductor. A ground signal is sent. The overheat signal is triggered for a temperature of 124°C plus or minus 7°C.

FUSELAGE OVERHEAT SENSING ELEMENT LOOPS A & B



APU OVERHEAT SENSING ELEMENT

FIN / ZONE

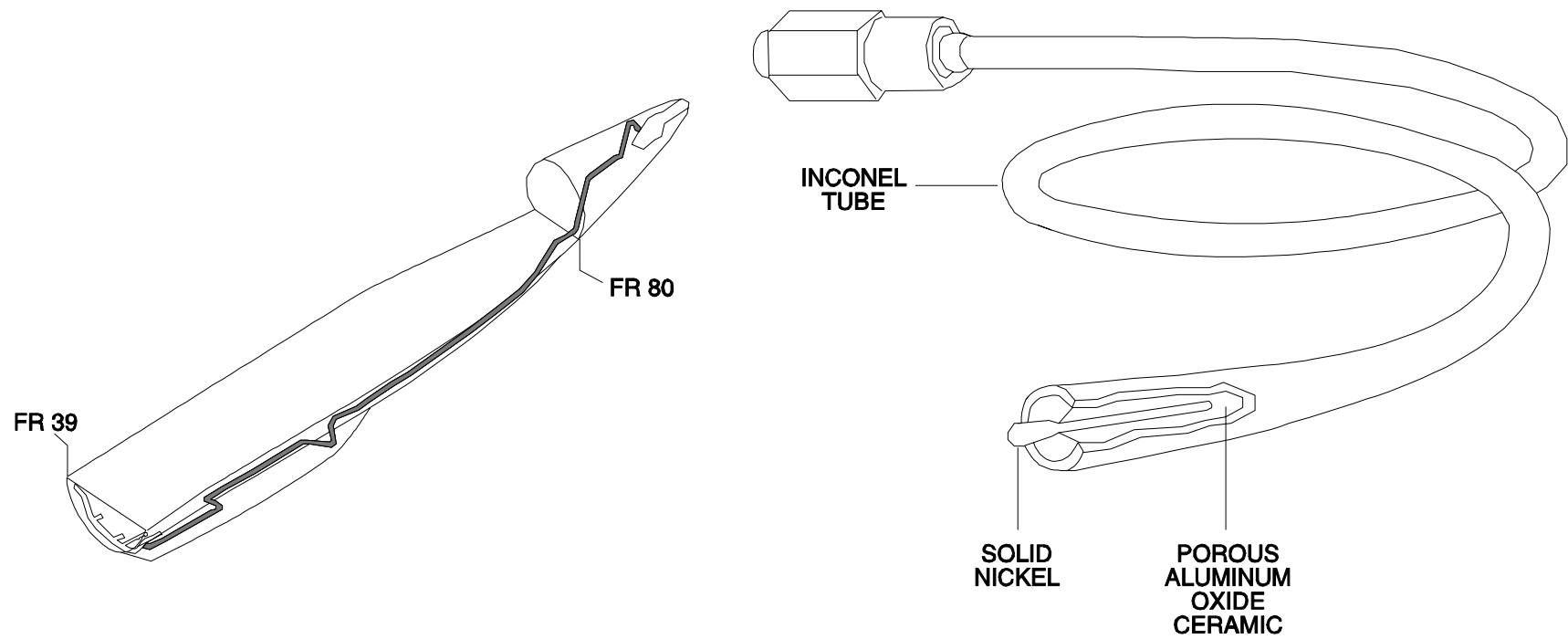
FIN : 97HF,...,102HF,23HF,...,33HF,139HF,140HF

Zone : 191,195,147,197,154,164,171,311,313

COMPONENT DESCRIPTION

The overheat sensing elements have a solid nickel center conductor embedded in a ceramic insulation of porous aluminum oxide. An inconel tube contains these components and is sealed at both ends. When it is exposed to a heat source, continuity is established between the tube and the conductor. A ground signal is sent. The overheat signal is triggered for a temperature of 124°C plus or minus 7°C.

APU OVERHEAT SENSING ELEMENT



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STUDENT NOTES

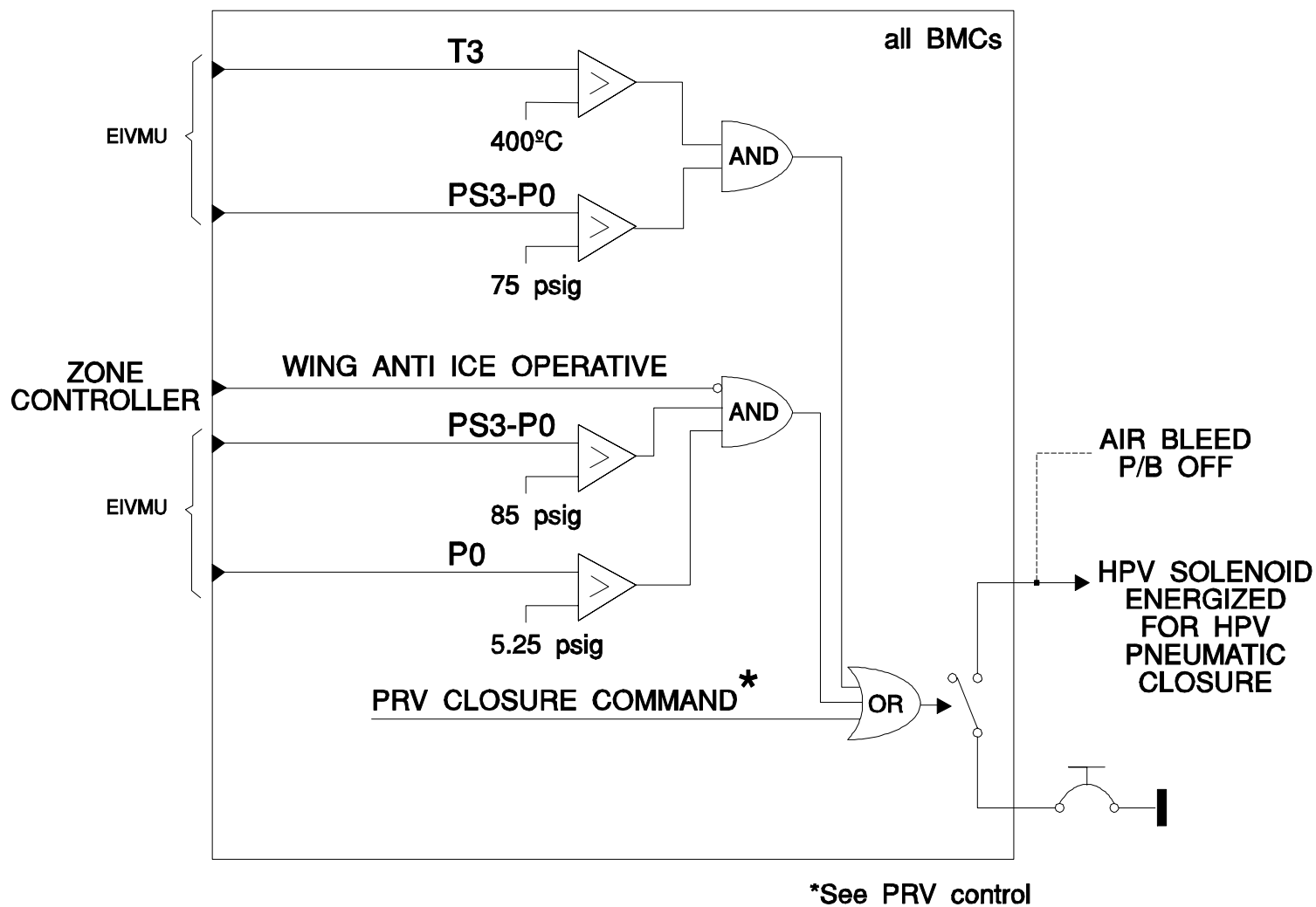
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BLEED MONITORING COMPUTER (BMC) MAIN FUNCTIONS

- Hight Pressure Valve (HPV) Closure Control
- Pressure Regulating Valve (PRV) Closure Control
- Fan Air Valve Thermostat Control (ThC)
- Engine Bleed Fault
- Crossbleed Valve Control
- Auxiliary Power Unit (APU) Bleed Valve Control
- Engine Leak Detection
- Auxiliary Power Unit (APU) Leak Detection
- Zone Controller

HIGH PRESSURE VALVE (HPV) CLOSURE CONTROL

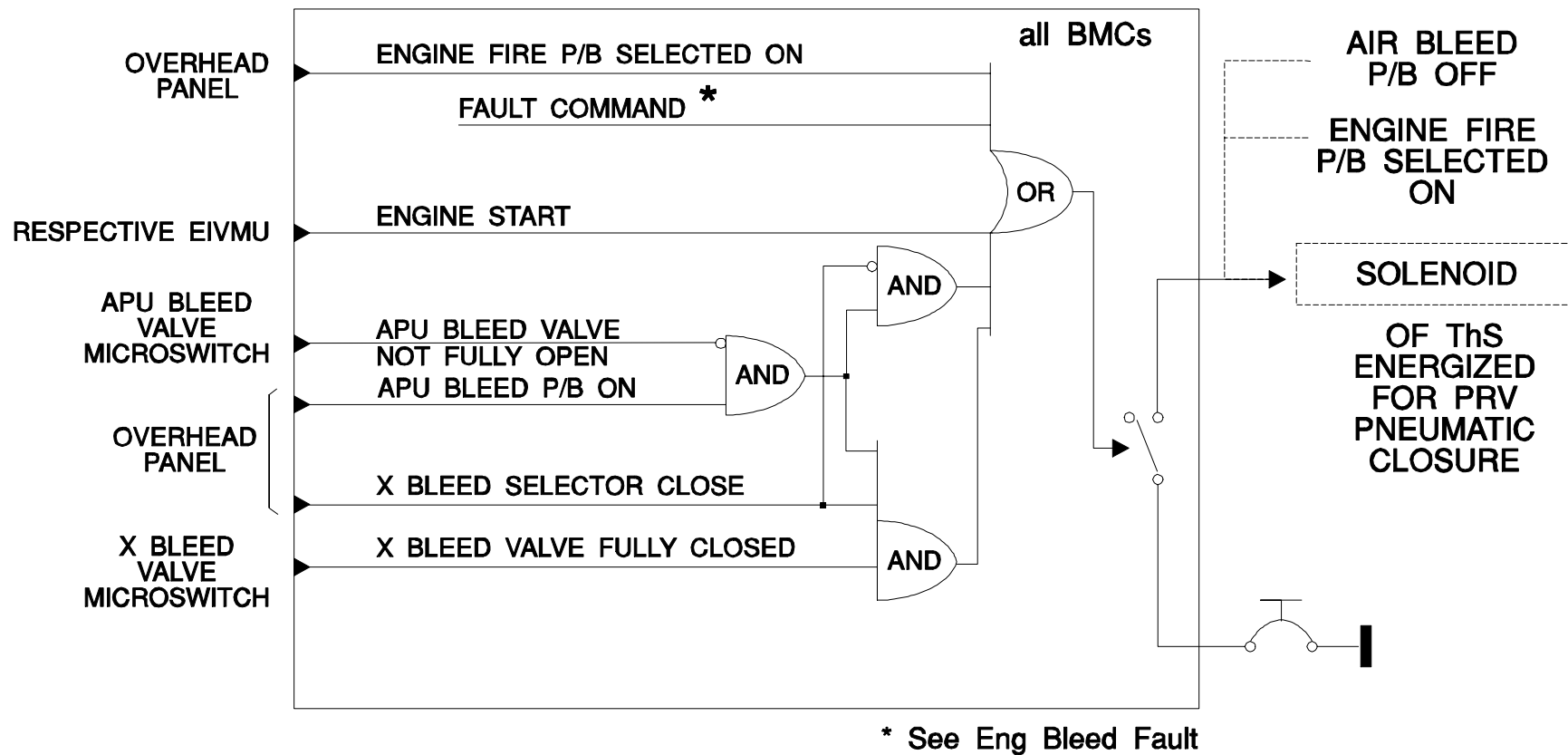
The HPV is either pneumatically closed during HP/IP transfer or electrically closed by the Bleed Monitoring Computer (BMC) according to the following logic.



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PRESSURE REGULATING VALVE (PRV) CLOSURE CONTROL

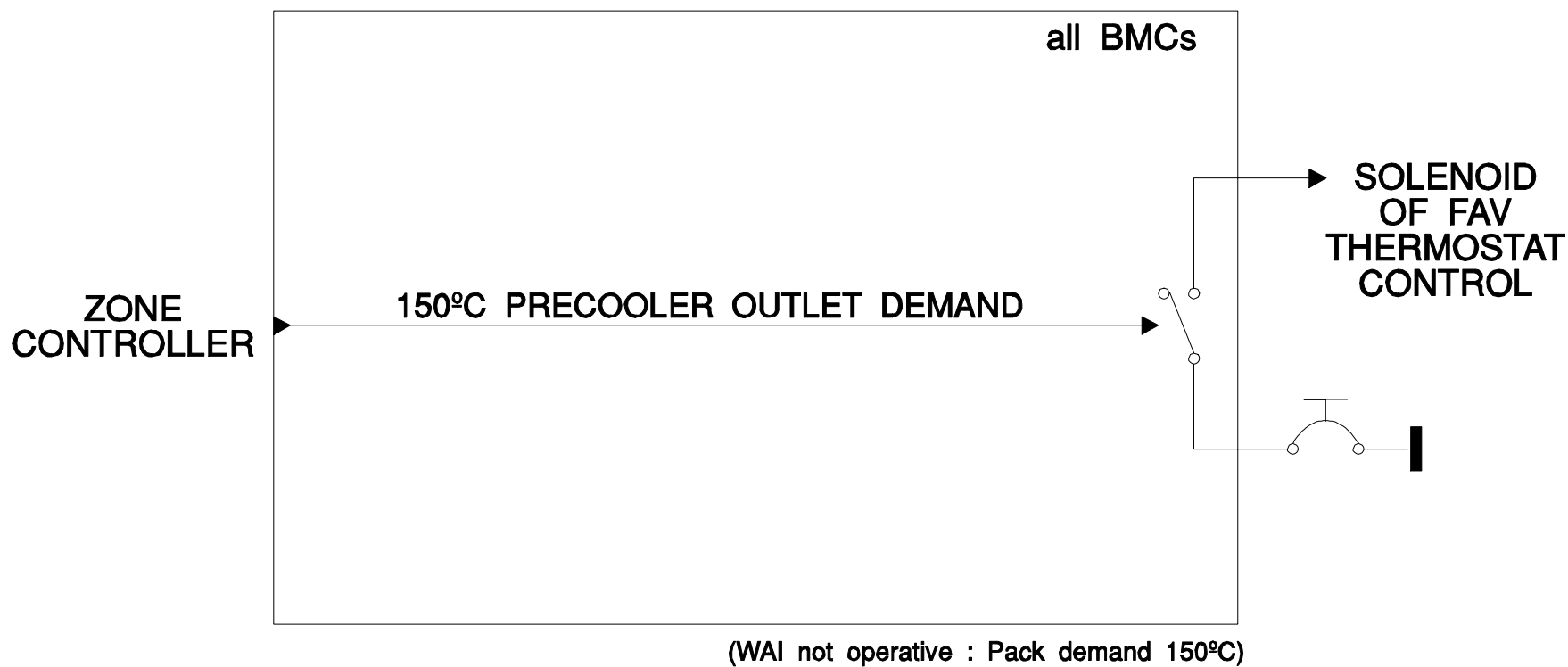
When the APU Bleed Valve is open and the CrossBleed Valve is closed by its selector in the "CLOSE" position, Pressure Regulating Valve 1 is closed and PRV 2 may regulate.



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FAN AIR VALVE THERMOSTAT CONTROL (ThC)

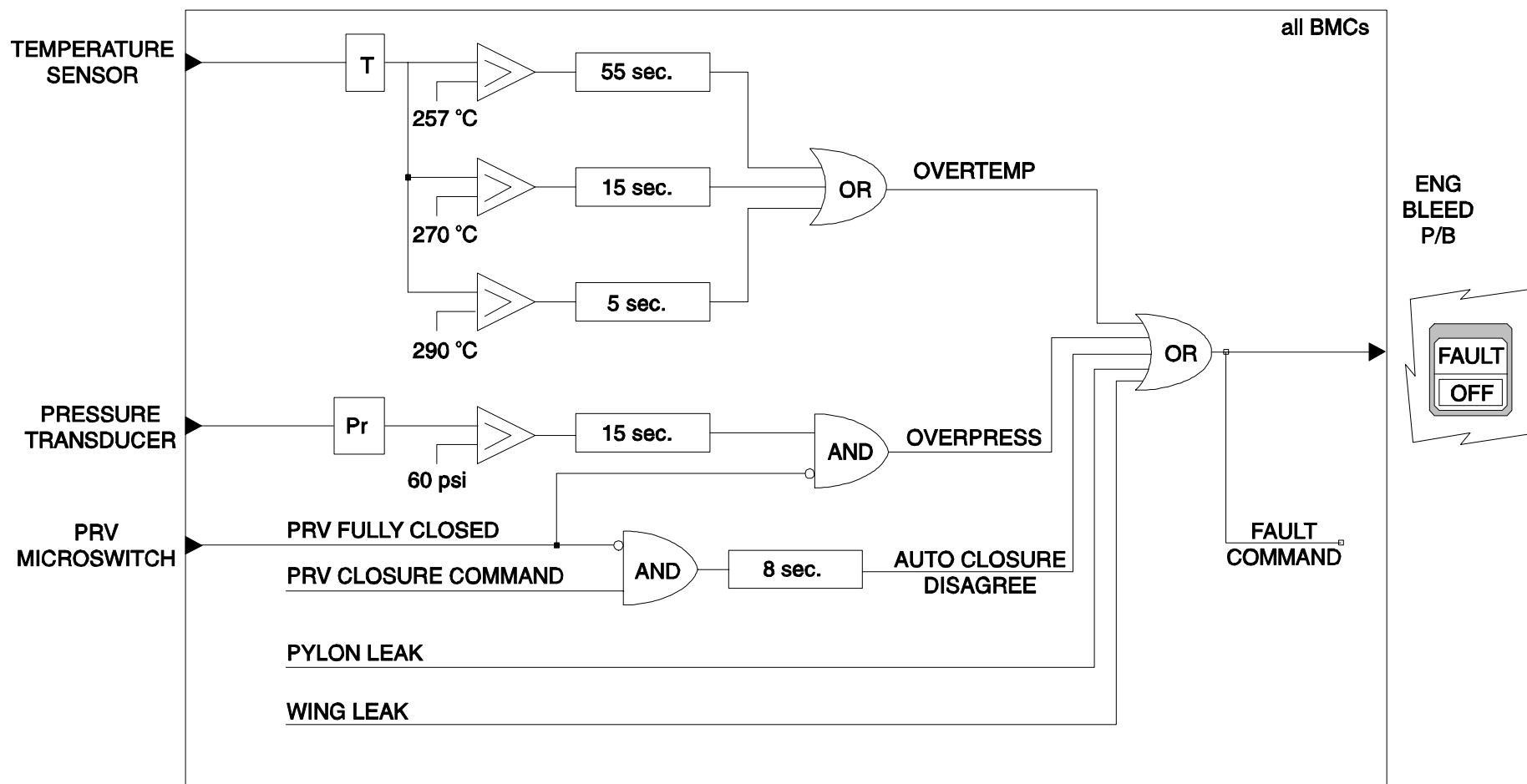
The Fan Air Valve Thermostat Control switches temperature regulation from 200°C to 150°C according to the following logic.



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ENGINE BLEED FAULT

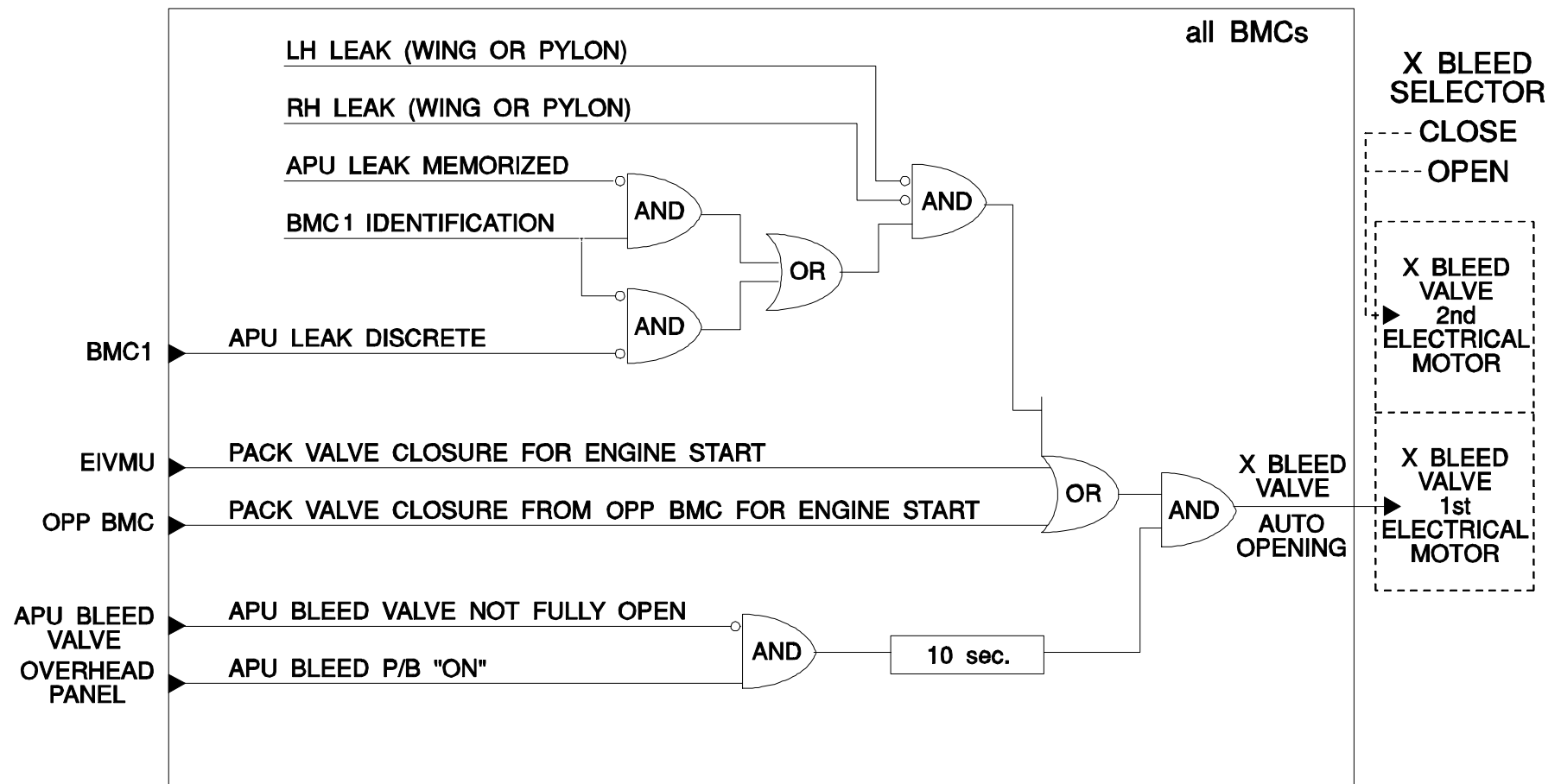
If the failure is no longer present, the ENGINE BLEED pushbutton must be pressed to reactivate the system.



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CROSSBLEED VALVE CONTROL

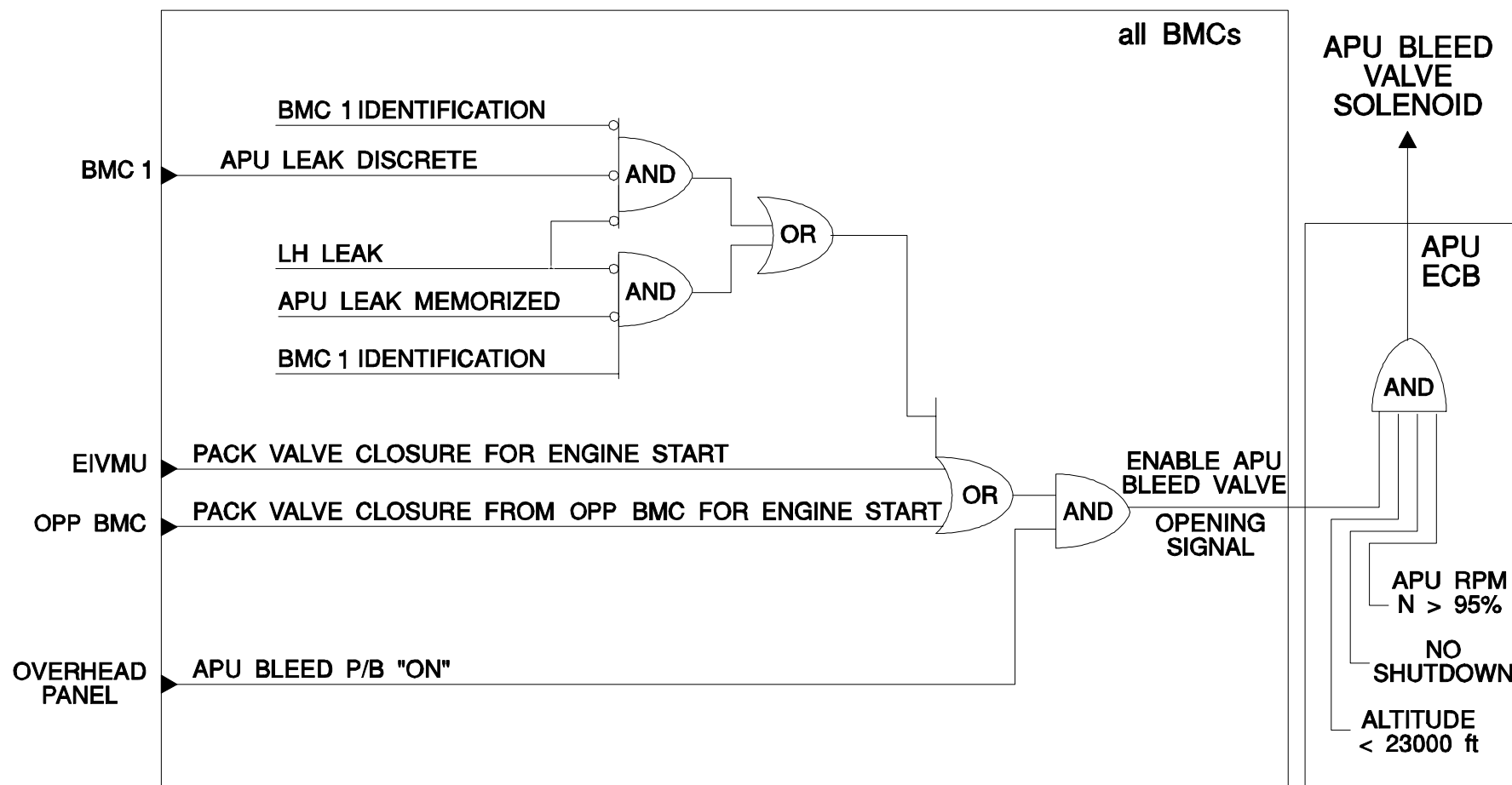
In AUTO mode, the Crossbleed Valve will not open when a pneumatic leak is detected, except during engine start.



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AUXILIARY POWER UNIT (APU) BLEED VALVE CONTROL

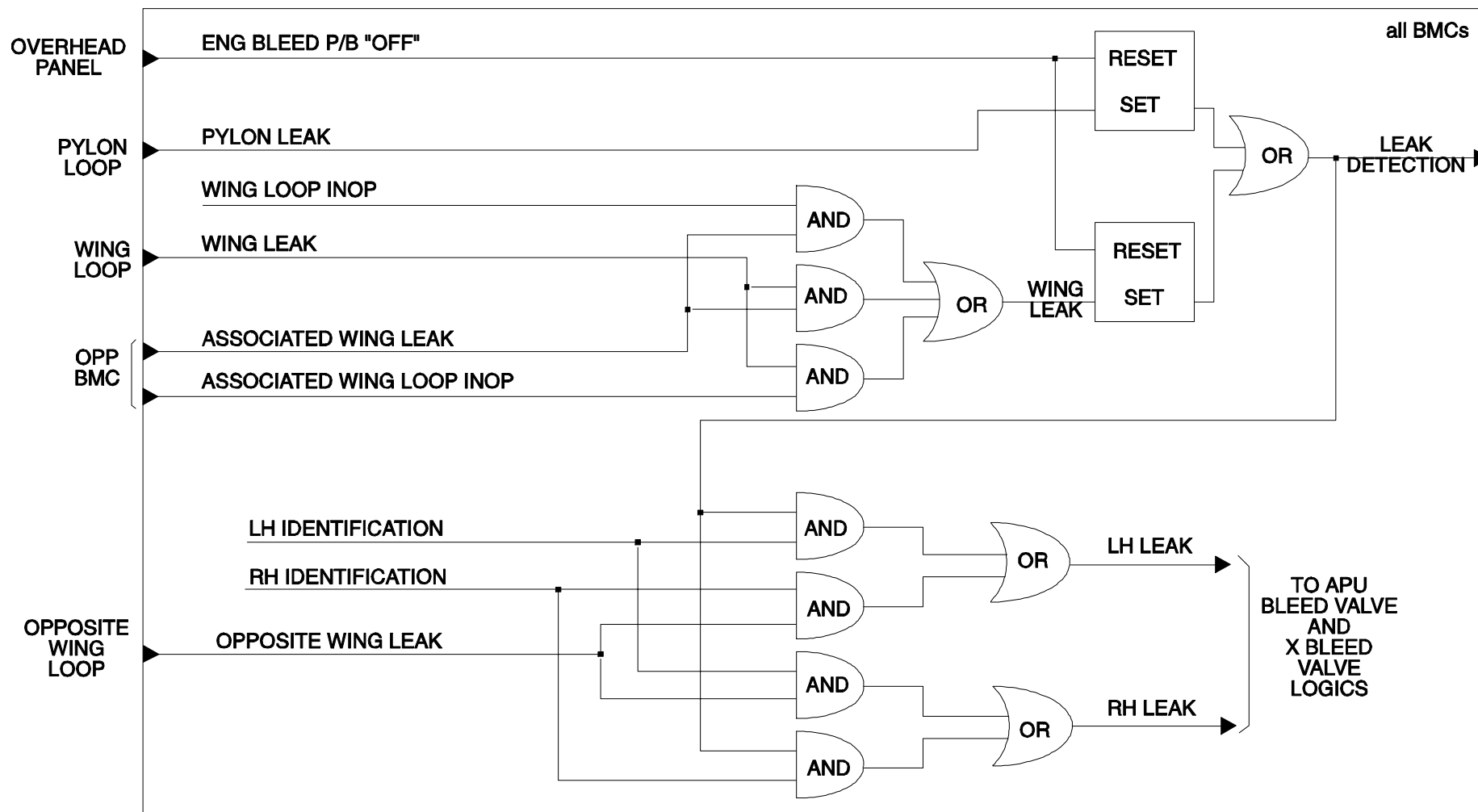
The opening signal is inhibited when a left pylon or APU leak is detected, except during engine start.



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ENGINE LEAK DETECTION

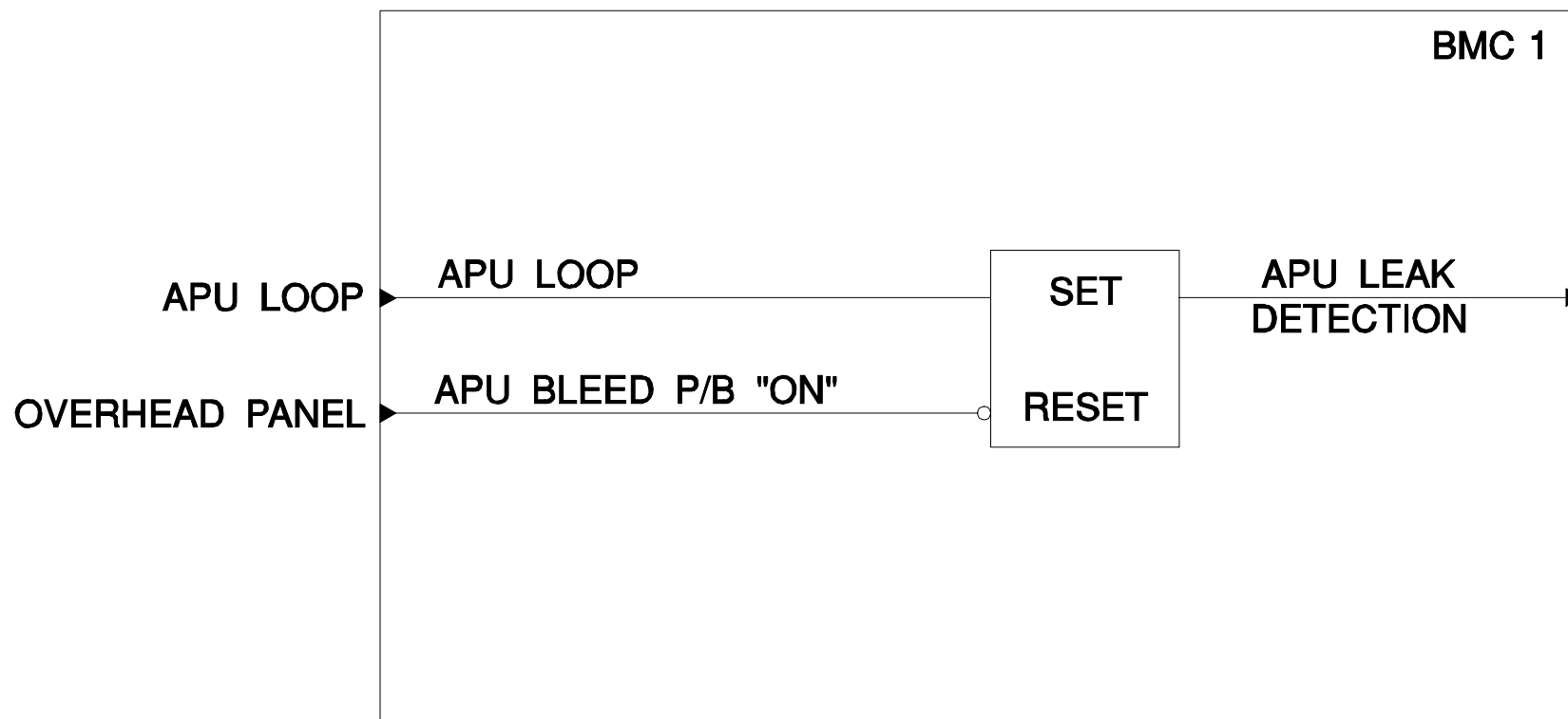
In case of failure of one BMC, the corresponding pylon leak detection is lost but the wing leak detection warning will be activated by the associated BMC.



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AUXILIARY POWER UNIT (APU) LEAK DETECTION

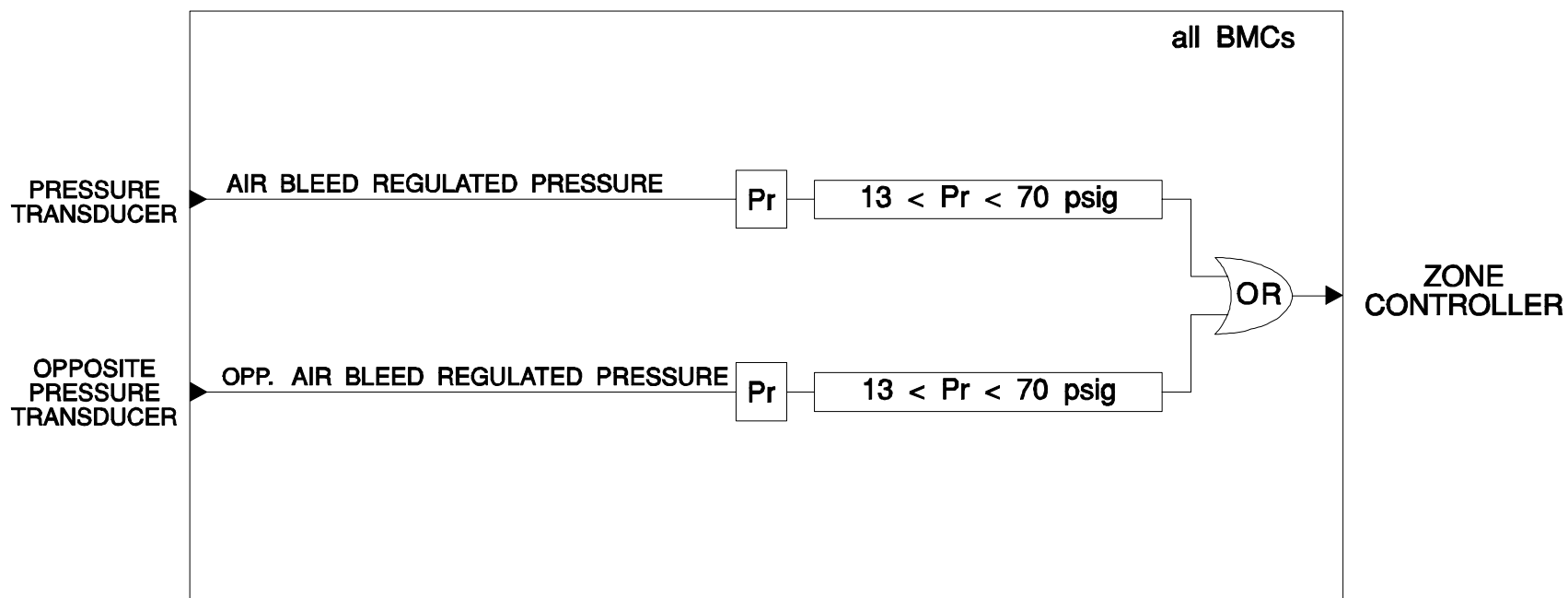
In case of failure of BMC 1, the APU leak detection is lost.



ZONE CONTROLLER

The Wing Anti Ice command signal is available when the bleed pressure is between 13 and 70 psig for at least one engine on each wing.

This signal is used for Wing Anti Ice fault detection.



STUDENT NOTES:

WARNINGS

Engine bleed fault
Engine bleed leak
Wing leak
APU bleed leak
Crossbleed fault

ENGINE BLEED FAULT

ENG 1(2) bleed air pressure overheat or high pressure.

In case of overheat or high pressure, the engine bleed valve closes automatically. The FAULT light remains on as long as the failure is present.

ENG 1(2) bleed air low pressure.

If automatic closure inoperative or low pressure, the pushbutton must be set to OFF. In this case of low pressure, the local warning is not triggered.

Note that if one bleed is inoperative, the crossbleed valve must be opened.

ENGINE BLEED LEAK

A bleed air leak has been detected in the engine 1,(2) pylon.

The engine bleed valve on the same side and the APU bleed valve close automatically, and the crossbleed receives a closure signal. If not, they must be closed manually. The wing anti-ice system must not be used as only one wing will be de-iced. Only the FAULT light associated with the engine bleed leak remains on as long as the failure is present.

WING LEAK

A bleed air leak is detected by two detection loops in one wing. (temperature above limit).

The bleed valve on the related side closes automatically, and the crossbleed receives a closure signal. The associated FAULT light is on. APU bleed valve closes automatically in case of left wing leak. The wing anti-ice cannot be used.

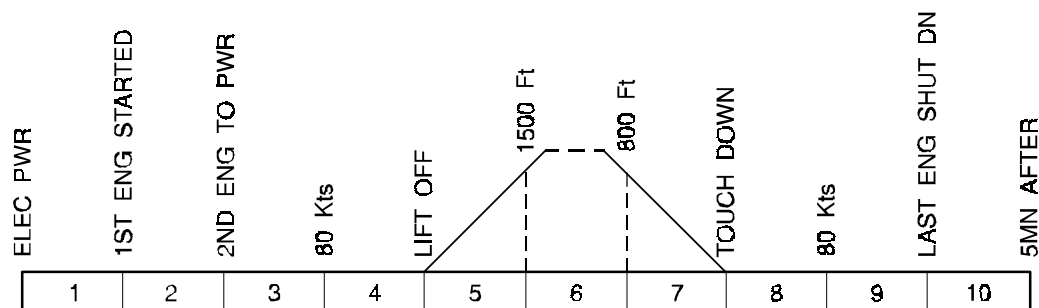
APU BLEED LEAK

The APU bleed is on. Temperature above limit is detected by the loop.

The APU bleed valve and the crossbleed valve close automatically. FAULT light is on as long as the failure is present.

CROSSBLEED FAULT

The crossbleed valve disagrees with its commanded position. Manual control of the crossbleed may be used.



E/WD : FAILURE TITLE conditions	AURAL WARNING	MASTER LIGHT	SD PAGE CALLED	LOCAL WARNINGS	FLT PHASE INHIB	
ENG 1 (2) BLEED FAULT Bleed air pressure overheat or lo pr or hi pr	SINGLE CHIME	MASTER CAUT	BLEED	ENG BLEED FAULT It	1, 3, 4, 5, 7, 8, 10	
ENG 1 (2) BLEED LEAK temperature > 204°C detected by the loop					3,4,5 7,8	
L (R) WING LEAK temperature > 124°C detected by the loops				APU BLEED FAULT It		
APU BLEED LEAK temperature > 124°C detected by the loop						
X BLEED FAULT Valve disagree				NIL		

FQW4200 GE Metric

STUDENT NOTES

BLEED MONITORING COMPUTER INTERFACES

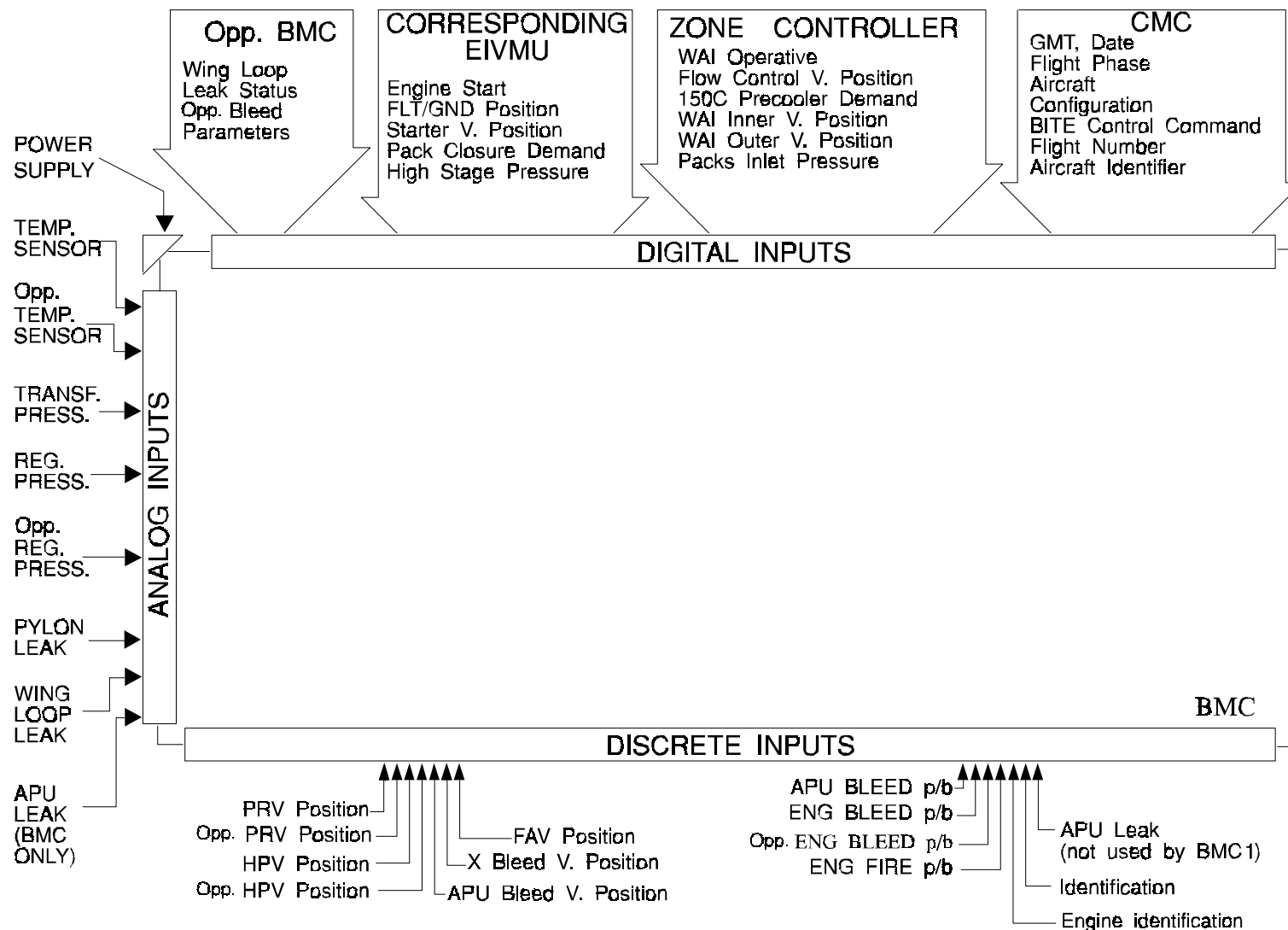
Inputs
Outputs

INPUTS

Each Bleed Monitoring Computer has three types of inputs.

- DIGITAL INPUTS via ARINC 429 buses, from opposite BMC, corresponding EIVMU, ZONE CONTROLLER and CMC.
- ANALOG INPUTS from the bleed sensors.
- DISCRETE INPUTS from valve position switches, BMC and overhead panel.

28 Volts Direct Current power is supplied for energization of ThS, ThC and HPV solenoids.



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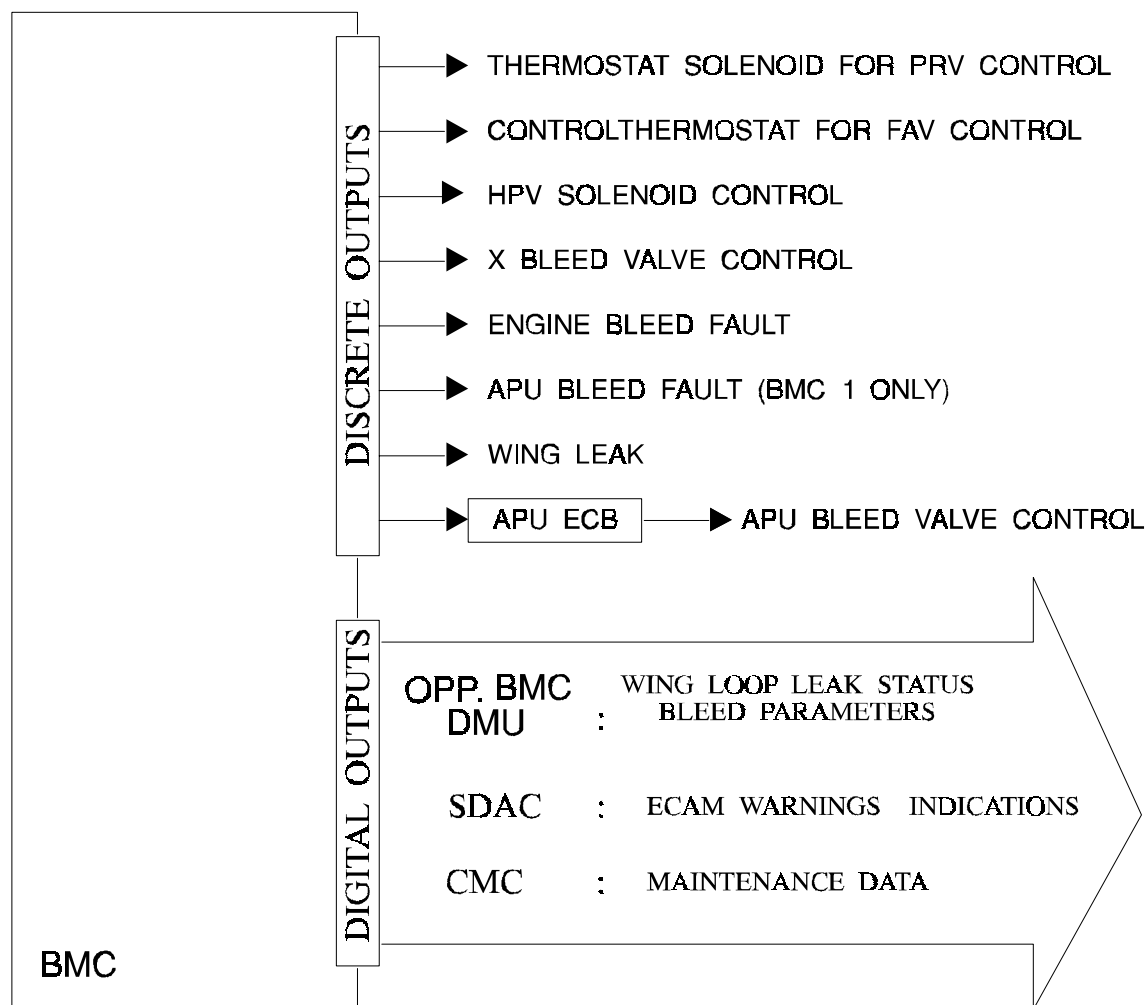
OUTPUTS

Each Bleed Monitoring Computer has two types of outputs.

DIGITAL OUTPUTS via ARINC 429 buses to the SDACs, the CMCs, the DMU and the opposite BMC.

- To System Data Acquisition Concentrators (SDACs), for ECAM warnings and indications.
- To Centralized Maintenance Computers (CMCs), for maintenance purposes.
- To Data Management Unit (DMU), and opposite BMC for bleed monitoring purposes.

DISCRETE OUTPUTS to APU Electronic Control Box for APU availability, to overhead panel for bleed faults, to Cross Bleed Valve, HPV solenoid, ThS, and ThC for control.



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STUDENT NOTES

SPECIFIC CMS PAGES PRESENTATION

System Report/test

SYSTEM REPORT/TEST

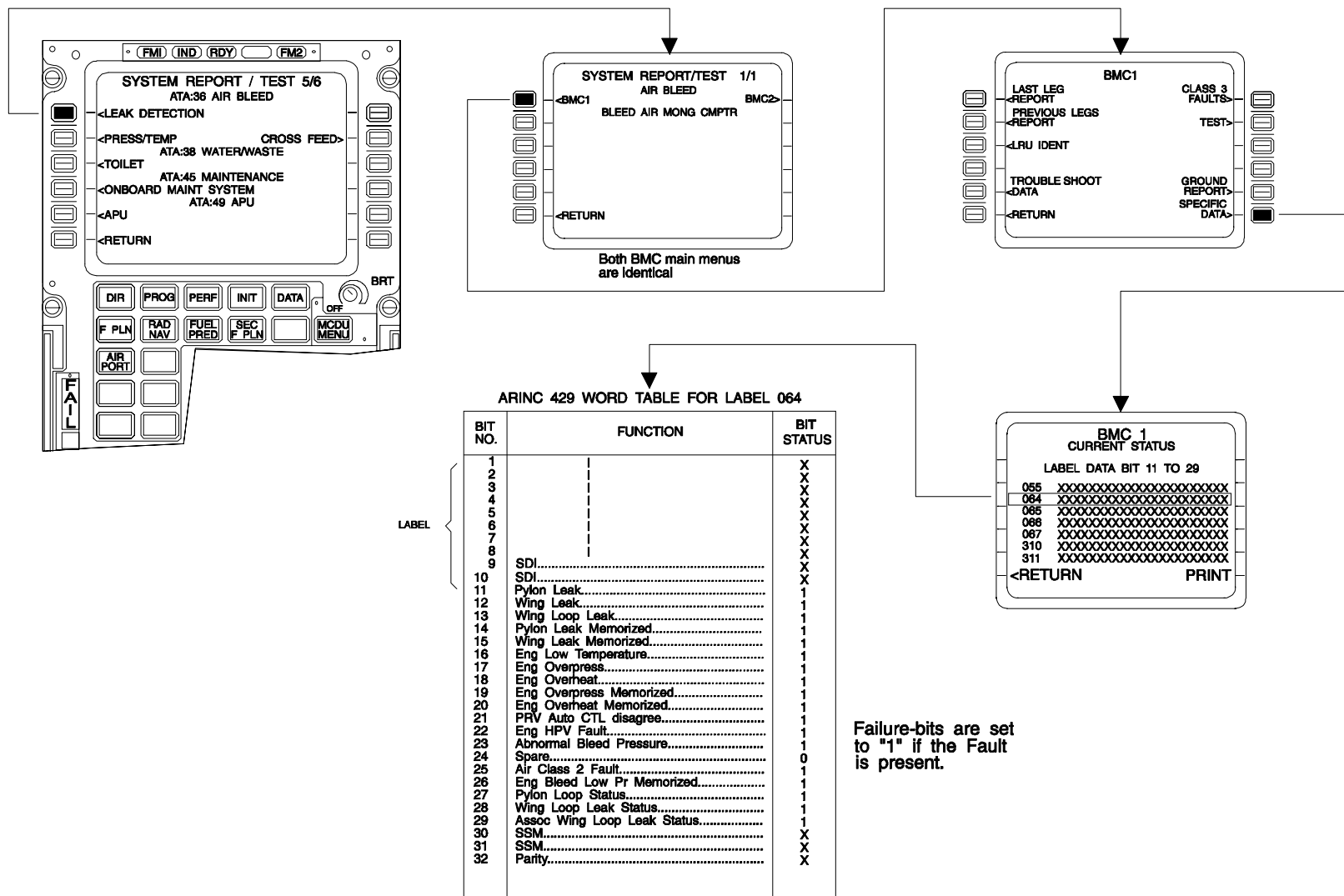
Selecting Leak Detection enables access to the 2 BMCs main menus.
Both BMC main menus are identical.

BMC 1 menu includes a SPECIFIC DATA key.

SPECIFIC DATA items are displayed on this MCDU page.

The CURRENT STATUS of the engine bleed air system is continuously transmitted by ARINC 429 words.

The tables for the different labels are available in the operational test to read the current status of the engine bleed air system described in the AMM.



STUDENT NOTES

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AIR CONDITIONING SERVICING

Low Pressure Ground Connection
High Pressure Ground Connection

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LOW PRESSURE GROUND CONNECTION

WARNING: MAKE SURE THAT THE FWD AVIONICS ACCESS
DOOR 811 IS OPEN WITH A WARNING
PLACARD ATTACHED TO IT.
THE WARNING NOTICE MUST TELL PERSONS NOT
TO CLOSE THE DOOR. THIS PREVENTS
ACCIDENTAL PRESSURIZATION OF THE AIRCRAFT.

JOB SET-UP

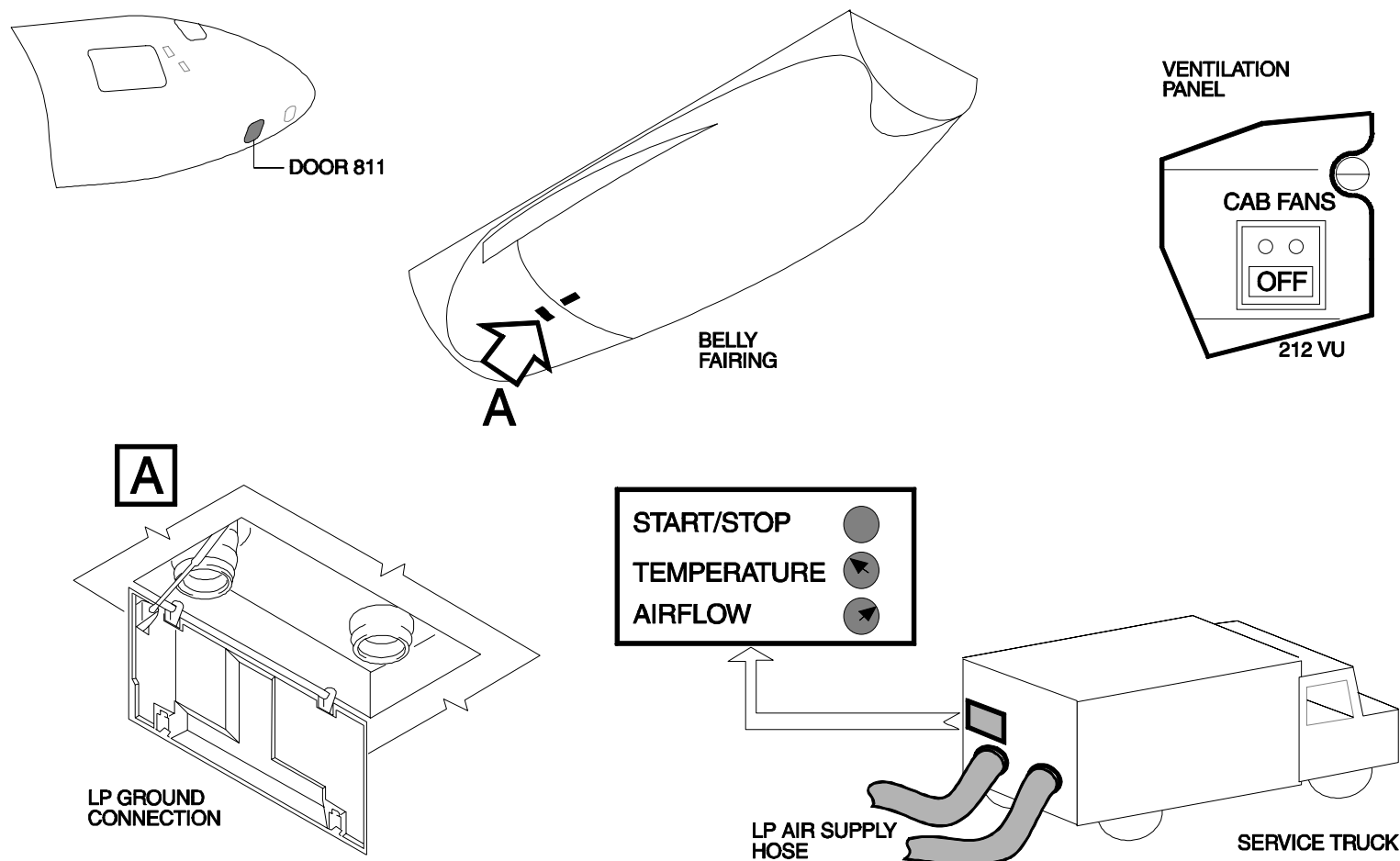
- ~ Consider that the aircraft is electrically powered and that the
Low Pressure connector access door is open.
- ~ Connect the ground air-supply unit to the aircraft LP connectors.

PROCEDURE

- ~ On the ventilation panel, make sure that the CAB FANS
pushbutton switch is on. Thus, the OFF legend must be off.
- ~ Start the ground air-supply unit and make sure that the airflow is
max. 3.2 kg./sec. (7.0547 lb./sec.).
- ~ Set the necessary output air temperature on the ground
air-supply unit.
- ~ Stop the ground air-supply unit when the pre-conditioning is no
longer necessary.

CLOSE-UP

- ~ Disconnect and remove the ground air-supply unit from the aircraft
LP connector.
- ~ Put the aircraft back in a configuration related to the next operation:
 - Make sure that the work area is clean and clear of
tools and other items.
 - Close the LP connections access door.
 - Close access door 811.
 - Remove the warning notices.
 - Remove the access platforms.
 - Remove all equipment, tools and other items.



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HIGH PRESSURE GROUND CONNECTION

WARNING: MAKE SURE THAT THE FWD AVIONICS ACCESS DOOR 811 IS OPEN WITH A WARNING PLACARD ATTACHED TO IT. THE WARNING NOTICE MUST TELL PERSONS NOT TO CLOSE THE DOOR. THIS PREVENTS ACCIDENTAL PRESSURIZATION OF THE AIRCRAFT.

JOB SET-UP

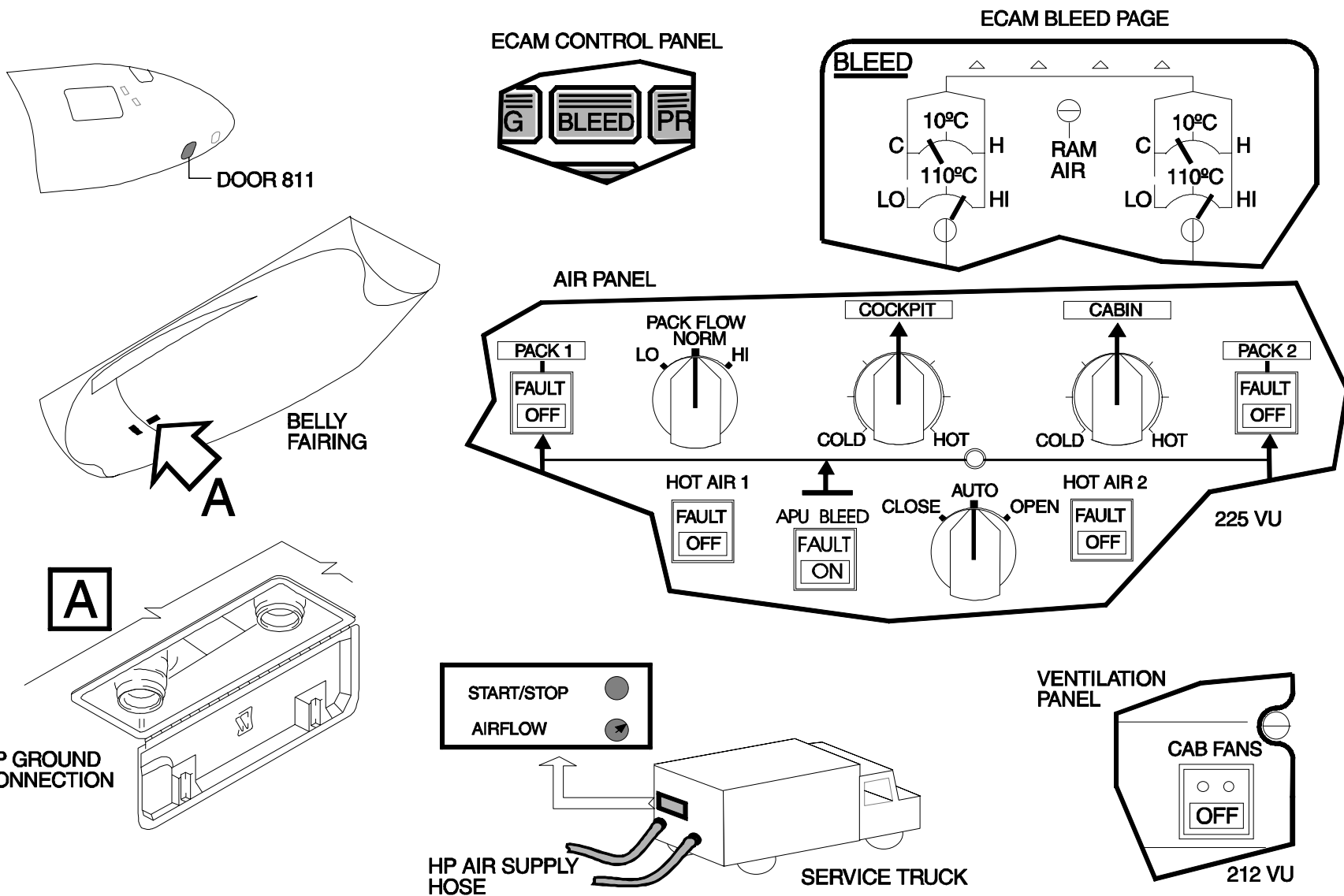
- ~ Consider that the aircraft is electrically powered, that the circuit breakers related to ATA chapters 21 and 36 are closed and that the High Pressure connectors access door is open.
- ~ Push the BLEED key on the ECAM control panel to get the System Display BLEED page.
- ~ On the AIR panel, check the following:
 - The PACK 1 and PACK 2 pushbutton switches are on. Thus, the FAULT legends are on and the OFF legends are off.
 - The COCKPIT and CABIN temperature selectors are at the 12 o'clock position.
 - The HOT AIR 1 and HOT AIR 2 pushbutton switches are AUTO. Thus the OFF legends are off.
- ~ On the AIR panel, set the crossbleed valve selector-switch to OPEN.
- ~ On the ventilation panel, check that the CAB FANS pushbutton switch is on. Thus the OFF legend must be off.
- ~ Connect the ground air-supply unit to the aircraft High Pressure connectors.

PROCEDURE

- ~ Start the ground air-supply unit and make sure that the airflow is max 2.0 kg./sec. (4.4092 lb./sec.). As soon as the flow control valves open, the PACK 1 and PACK 2 FAULT legends on the AIR panel go off.
- ~ Check on the System Display BLEED page, that the pack discharge-temperature is normal (green).
- ~ Stop the ground air-supply unit when the pre-conditioning is no longer needed.

CLOSE-UP

- ~ On the AIR panel, set the crossbleed valve selector-switch to AUTO.
- ~ Disconnect and remove the ground air-supply unit from the HP connectors.
- ~ Put the aircraft back in a configuration related to the next operation:
 - Make sure that the work area is clean and clear of tools and other items.
 - Close the HP connectors access door.
 - Close access door 811.
 - Remove the warning notices.
 - Remove the access platforms.
 - Remove all equipment, tools and other items.



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STUDENT NOTES

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