

# **A380 TRENT 900 FULL TECHNICAL HANDLING TRAINING**

## **- Module 3 -**



**MAINTENANCE TRAINING CENTER**

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KOREAN AIR

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## **26-Fire Protection**

## FIRE PROTECTION

### RR Engine, APU & MLG Fire Protection Systems Presentation

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## **RR ENGINE, APU & MLG FIRE PROTECTION SYSTEMS PRESENTATION (1)**

### **General**

This chapter gives a description of the Fire Protection of:

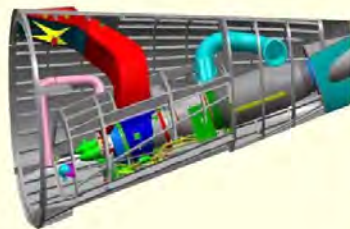
- The engines (Rolls Royce) and the pylons,
- The APU compartment,
- The body and wing landing gear bays,
- The avionics compartments,
- The cargo compartments,
- The cabin and the lavatories.

**ENGINES & PYLON**



RR T900

**APU COMPARTMENT**



**MLG BAY**



**FIRE PROTECTION**



**CABIN & LAVATORIES**



**CARGO  
COMPARTMENTS**



**AVIONICS  
COMPARTMENTS**

**GENERAL**

## **RR ENGINE, APU & MLG FIRE PROTECTION SYSTEMS PRESENTATION (1)**

### **RR Engine Fire Protection**

The engine fire protection function includes two systems:

- The fire detection system,
- The fire extinguishing system.

To operate, the fire detection system uses fire detection loops, a conversion module and the single Fire Detection Unit (FDU) which is also dedicated to the fire protection of the APU and the wing and body landing gear compartments.

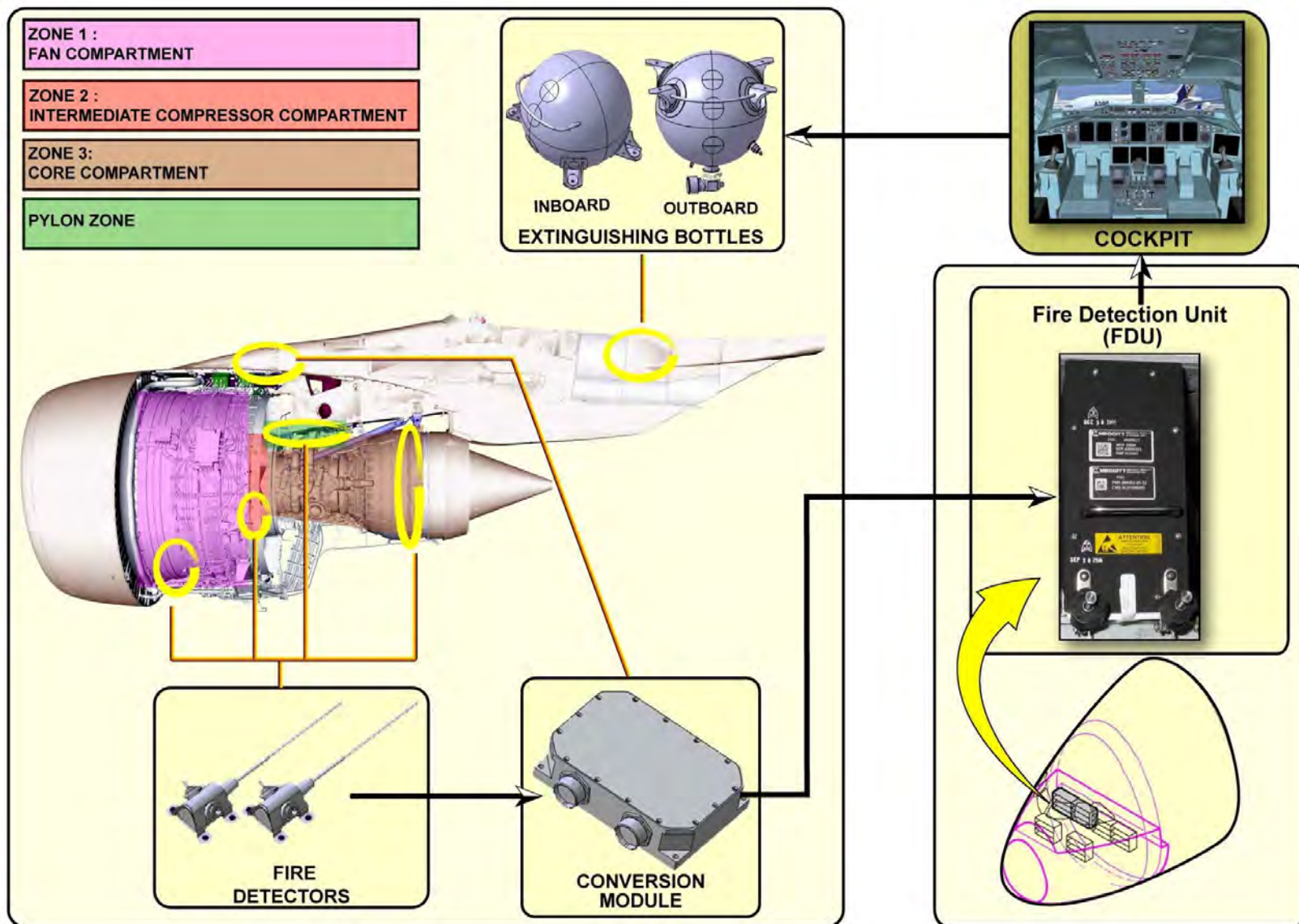
The fire extinguishing system has fire-extinguishing bottles installed in the pylon.

For each engine, there are three protection zones:

- Zone 1, the fan compartment,
- Zone 2, the intermediate compressor compartment,
- Zone 3, the core compartment,

and a protective area on the pylon: the pylon zone.

The discharge is controlled from the cockpit. The engine fire protection system gives aural and visual indications on different cockpit displays.



RR ENGINE FIRE PROTECTION

## **RR ENGINE, APU & MLG FIRE PROTECTION SYSTEMS PRESENTATION (1)**

### **RR Engine Fire Protection (continued)**

#### **Detection**

The protection of each engine is done by five pairs of fire detectors:

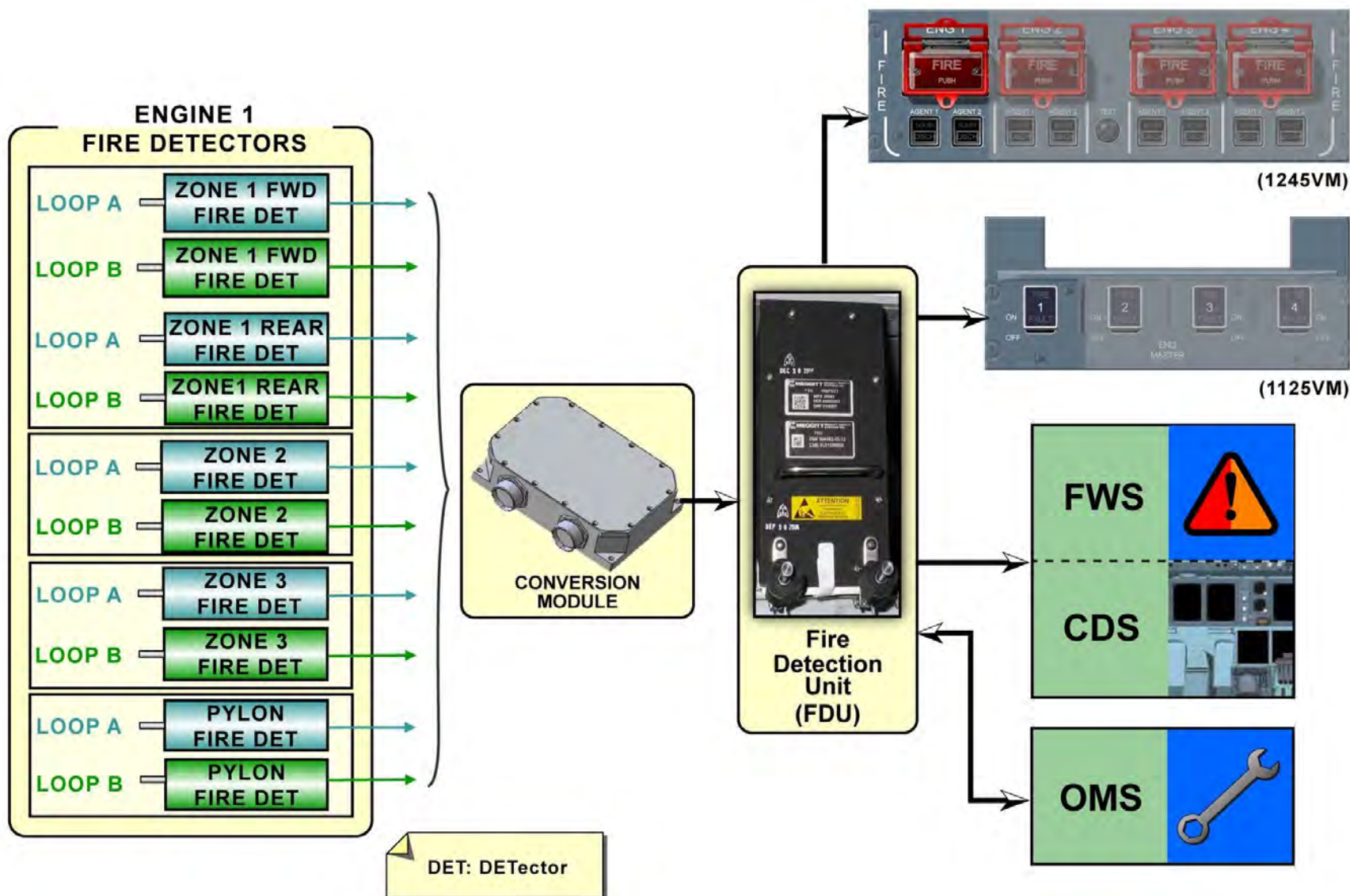
- 2 pairs of detectors for the fan compartment (zone 1),
- 1 pair of detectors for the intermediate compressor compartment (zone 2),
- 1 pair of detectors for the core compartment (zone 3),
- And 1 pair of detectors for the pylon zone above the combustion chamber.

Each fire detector has a sensing element and a responder assembly.

On each engine, the dual loop system includes the fire detectors connected to the conversion module. The conversion module digitizes the information of each responder and broadcasts these data to the FDU. The FDU collects all the digital values and processes them.

If fire or overheat is detected, the FDU sends signals to:

- The ENGINE/FIRE Integrated Control Panel (ICP),
- The ENG MASTER control panel,
- The Flight Warning System (FWS) for MASTER WARNING light activation and for display on Engine Warning Display (EWD) and the Control and System Display (CDS),
- The Onboard Maintenance System (OMS).



RR ENGINE FIRE PROTECTION - DETECTION

## **RR ENGINE, APU & MLG FIRE PROTECTION SYSTEMS PRESENTATION (1)**

### **RR Engine Fire Protection (continued)**

#### **Extinguishing**

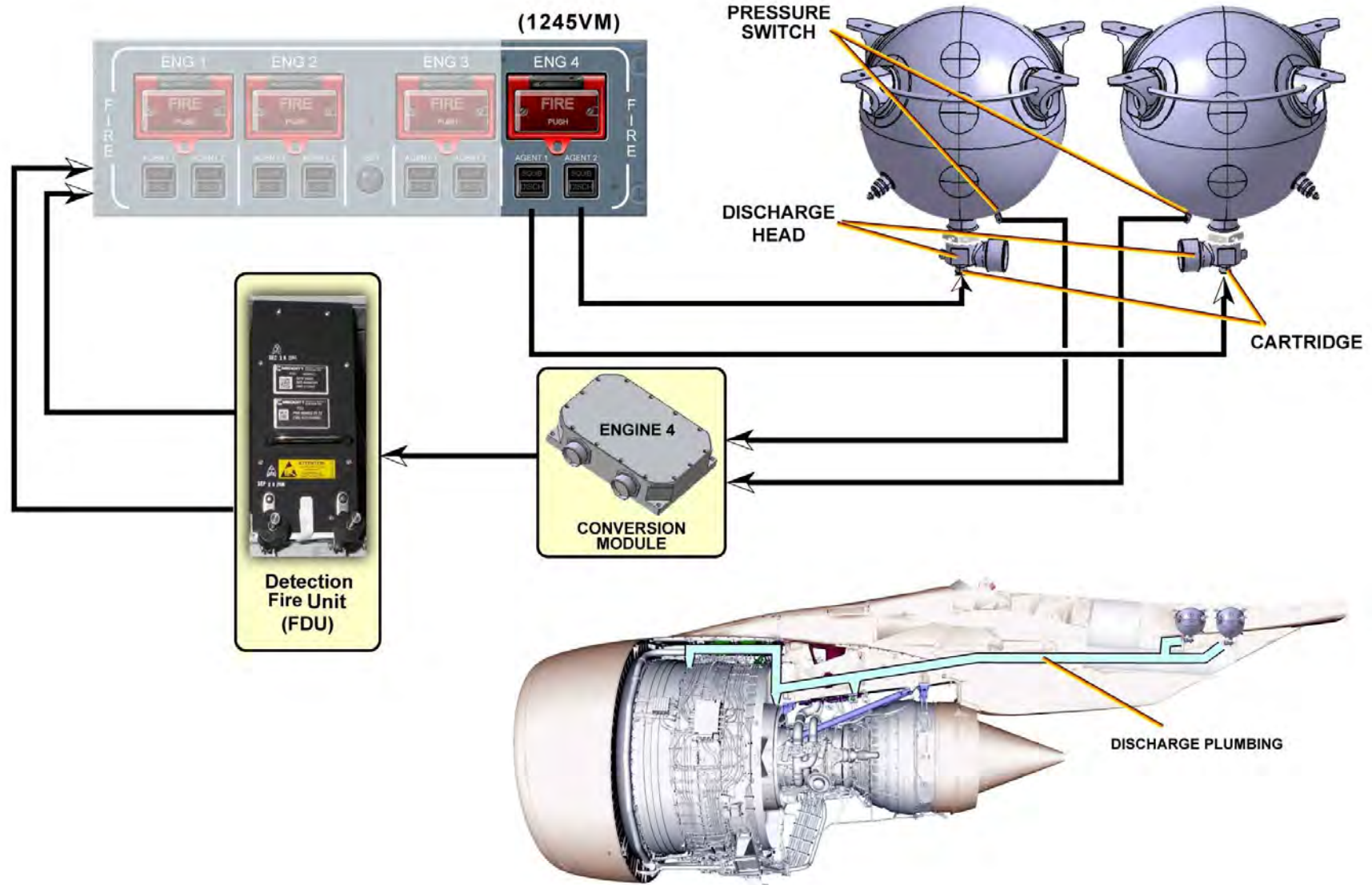
For each engine, the fire-extinguishing agent is contained in two fire EXTINGUISHING BOTTLES installed in each pylon. The extinguishing circuit goes along the pylon to the nacelle.

The fire EXTINGUISHING BOTTLE has:

- A discharge head,
- A cartridge,
- A pressure switch to monitor the bottle.

The fire extinguishing system is controlled from the cockpit.

When the AGENT P/B is pushed, this causes the bottle discharge if the related FIRE P/B is released.



## RR ENGINE FIRE PROTECTION - EXTINGUISHING

## **RR ENGINE, APU & MLG FIRE PROTECTION SYSTEMS PRESENTATION (1)**

### **APU Fire Protection**

The APU fire protection includes two systems:

- The fire detection system,
- And the fire extinguishing system.

To operate, the fire detection system uses fire detection loops, a conversion module and the Fire Detection Unit (FDU) which is also dedicated to the engine and the wing and body landing gear compartments. The fire extinguishing system has a fire EXTINGUISHING BOTTLE connected to the FDU.



## **RR ENGINE, APU & MLG FIRE PROTECTION SYSTEMS PRESENTATION (1)**

### **APU Fire Detection**

The protection of the APU compartment is done by two fire detectors. These fire detectors have the same design and operate independently. They are connected in parallel to the Fire Detection Unit (FDU) through the APU conversion module.

Each fire detector has a sensing element and a responder assembly. The conversion module digitizes the input signals sent from each fire detector and broadcasts them to the FDU.

The FDU collects all the digital values and processes them.

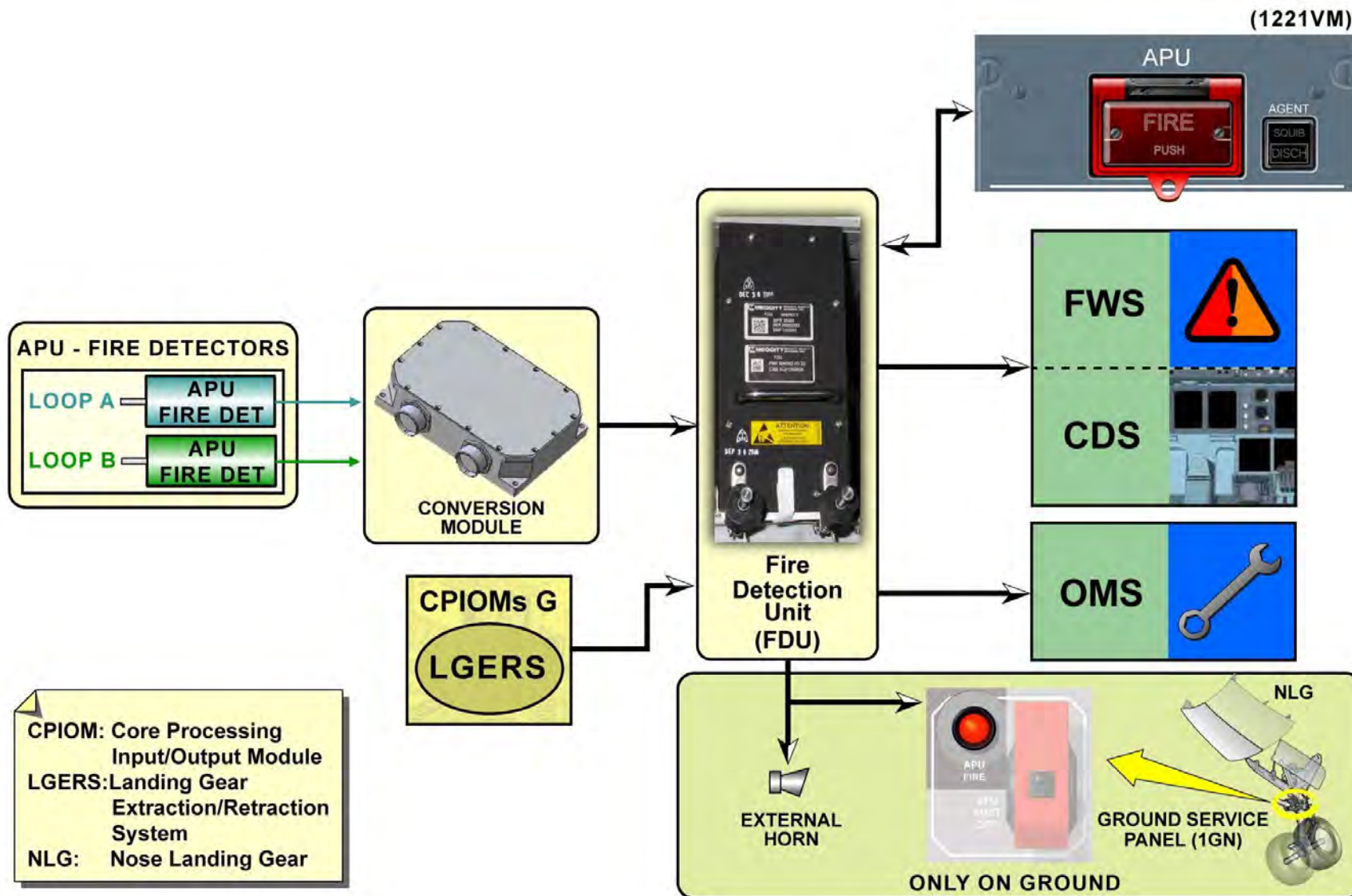
In flight, if a fire is detected, the FDU sends signals to:

- The APU FIRE panel in the cockpit,
- The Flight Warning System (FWS),
- The Onboard Maintenance System (OMS).

On ground, the FDU sends signals to:

- The APU FIRE panel in the cockpit,
- The FWS,
- The APU FIRE light on the Ground Service Panel at the Nose Landing Gear (NLG),
- The external horn,
- The Onboard Maintenance System (OMS),

and causes the automatic fire extinguishing function to operate.



APU FIRE DETECTION

## **RR ENGINE, APU & MLG FIRE PROTECTION SYSTEMS PRESENTATION (1)**

### **APU Fire Extinguishing**

For the APU the fire-extinguishing agent is contained in a single bottle, which is installed forward of the front firewall of the APU compartment. The fire-extinguishing bottle has:

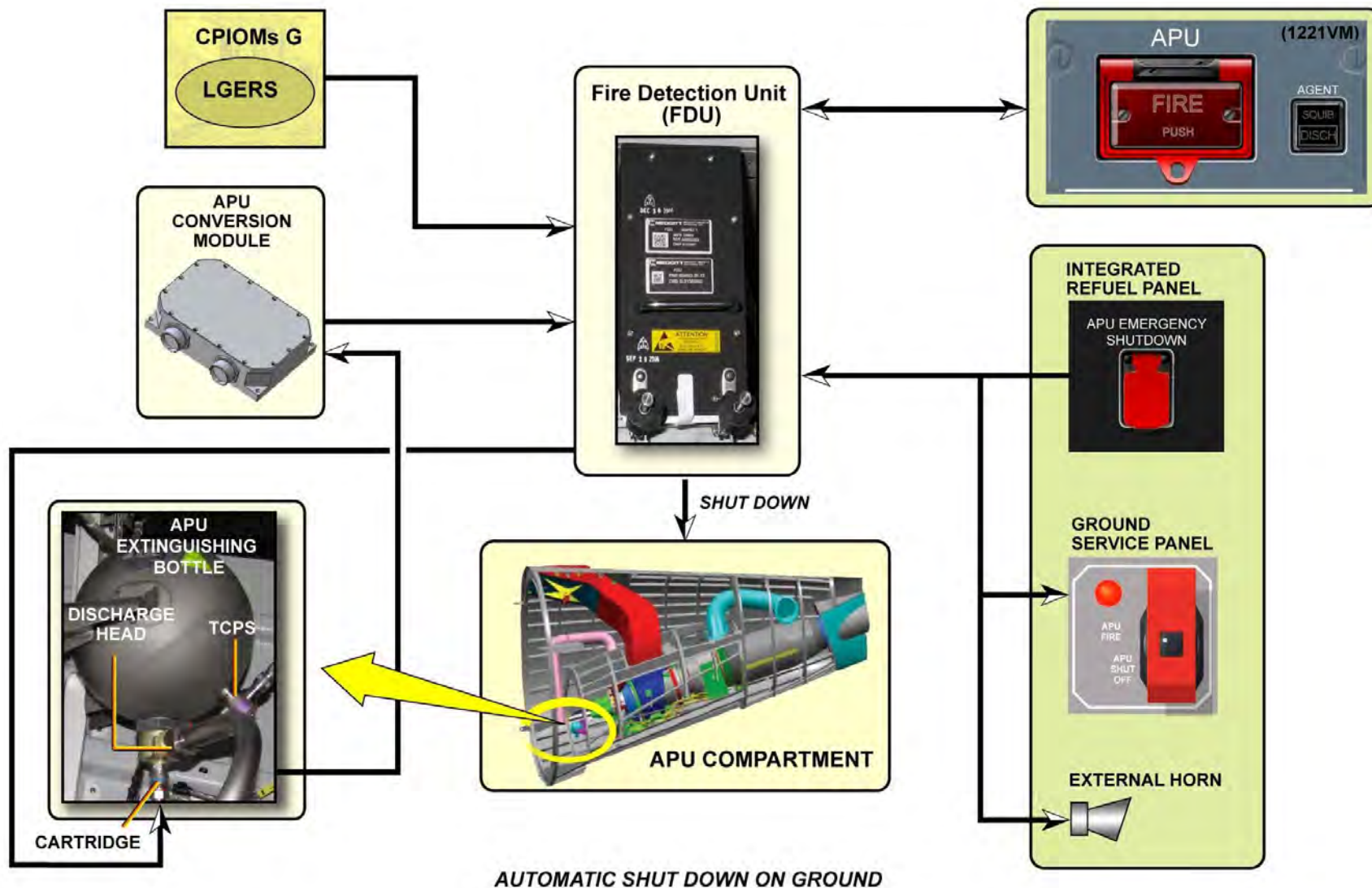
- A discharge head,
- A Temperature Compensated Pressure Switch (TCPS) to monitor the bottle,
- A cartridge.

#### **On ground**

On ground, the FDU stops the APU and operates the APU fire extinguishing system automatically.

The horn is ON:

- While the fire condition continues,
- Or until one of these pushbuttons is pushed:
  - The APU EMERGENCY SHUTDOWN P/B on the Integrated Refuel Panel (IRP),
  - Or the APU SHUT OFF pushbutton on the ground service panel,
  - Or the APU FIRE P/BSW on the cockpit panel.



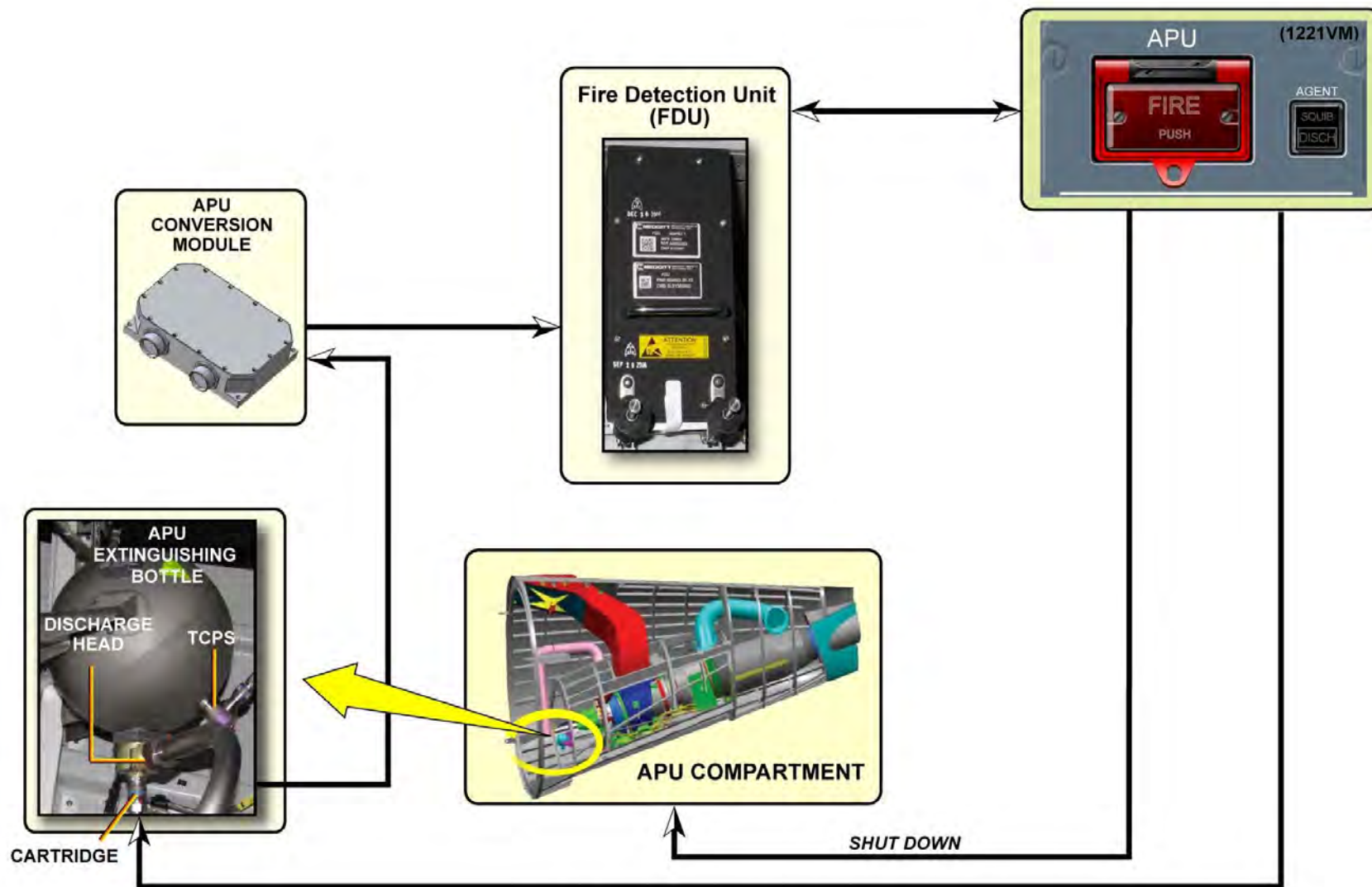
APU FIRE EXTINGUISHING - ON GROUND

## **RR ENGINE, APU & MLG FIRE PROTECTION SYSTEMS PRESENTATION (1)**

### **APU Fire Extinguishing (continued)**

#### **In Flight**

In flight, the extinguishing system is manually operated from the cockpit with the APU FIRE P/BSW which is on the overhead panel.



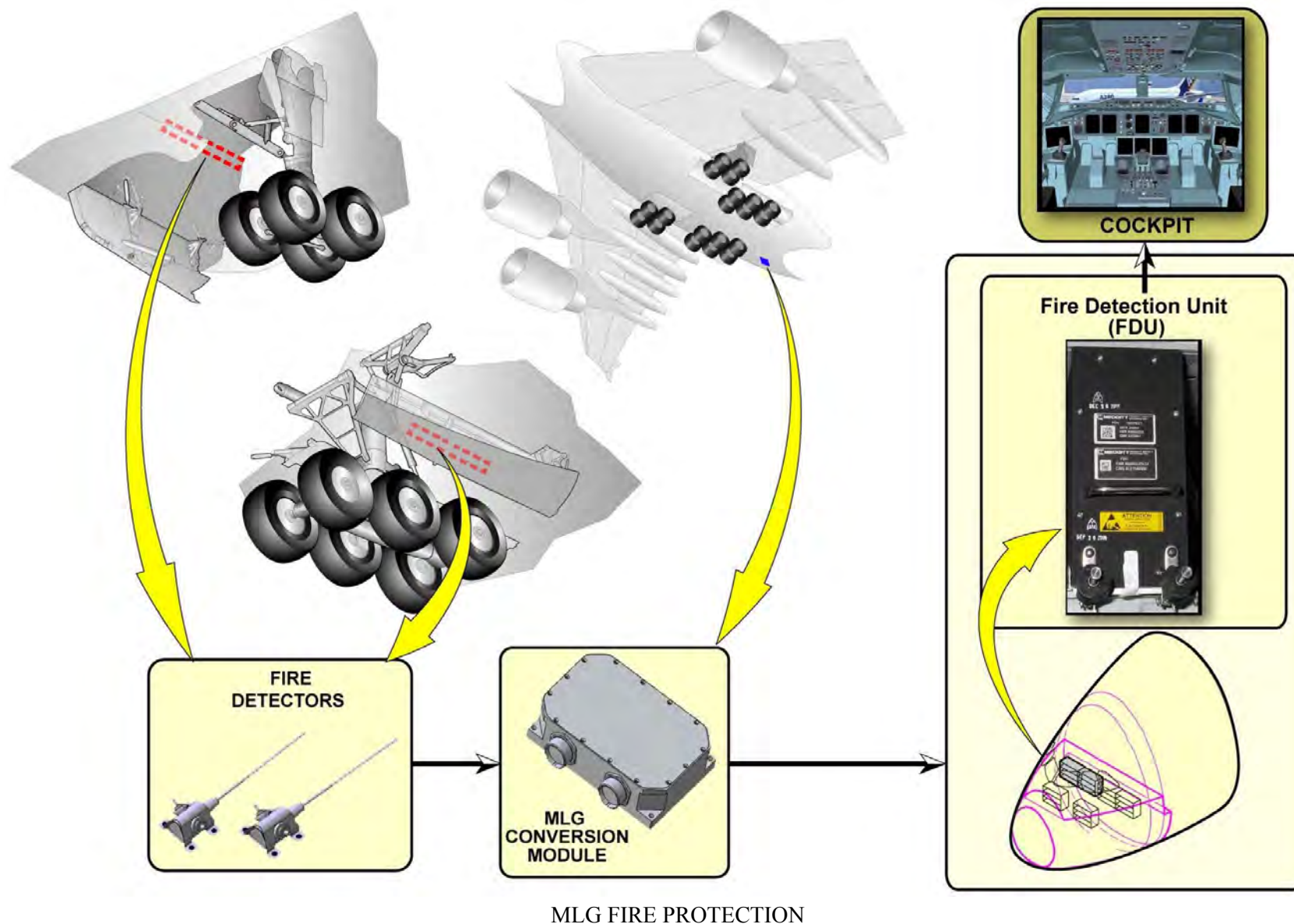
**IN FLIGHT APU SHUT DOWN**  
APU FIRE EXTINGUISHING - IN FLIGHT

## **RR ENGINE, APU & MLG FIRE PROTECTION SYSTEMS PRESENTATION (1)**

### **MLG Fire Protection**

The Main Landing Gear (MLG) fire protection includes only a fire detection system.

To operate, this system uses fire detection loops, a Conversion Module (CM), and the Fire Detection Unit (FDU).



## **RR ENGINE, APU & MLG FIRE PROTECTION SYSTEMS PRESENTATION (1)**

### **MLG Fire Protection (continued)**

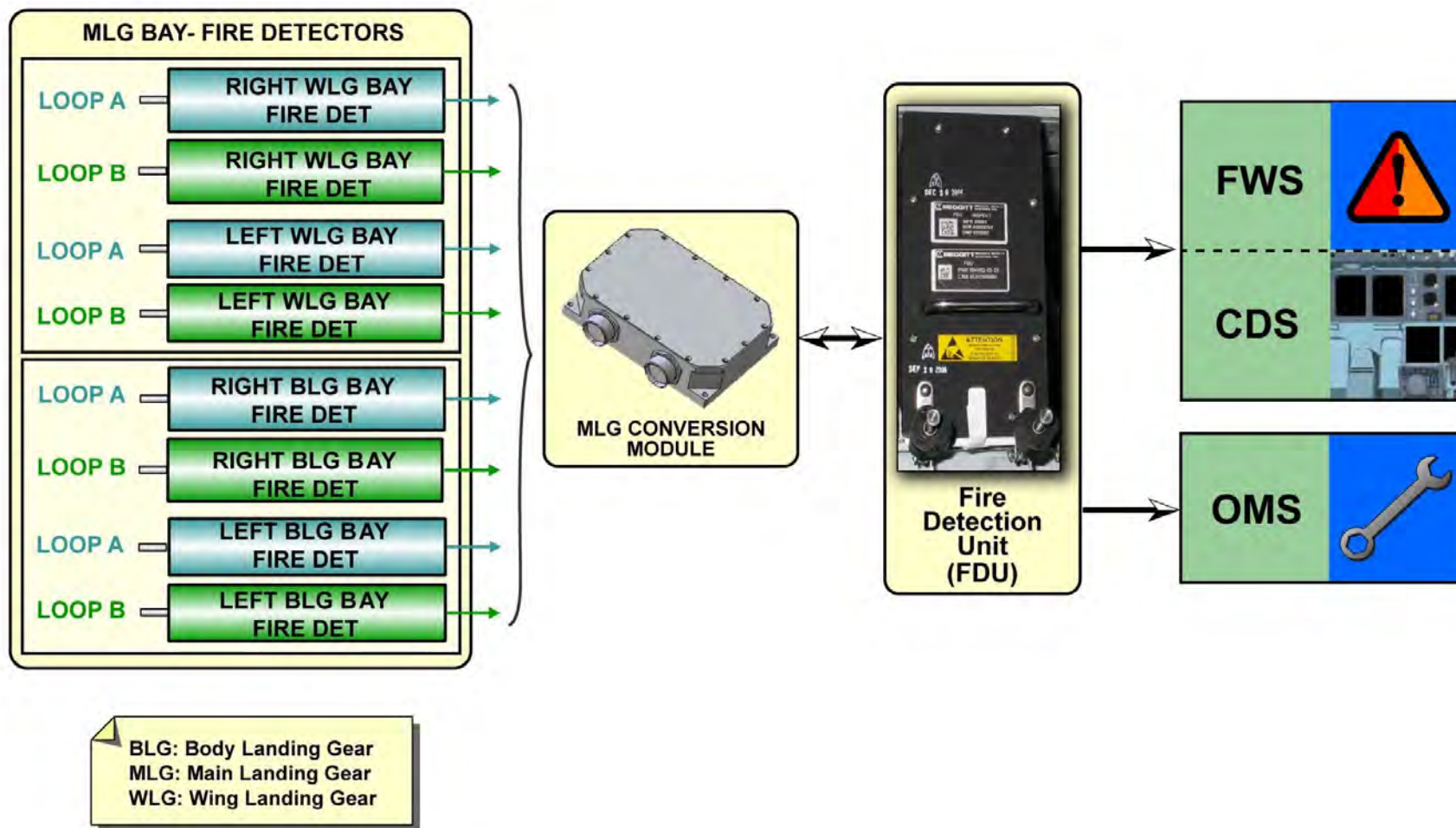
#### **Detection**

In each fire zone, there are two fire detectors (one for the loop A and one for the loop B) which are connected in parallel to the conversion module.

The conversion module digitizes the input signals sent from each fire detector and transmits them to the FDU. The FDU collects all the digital values and processes them.

If a fire is detected, the FDU sends signals:

- To the Flight Warning System (FWS),
- To the Control and Display System (CDS),
- And to the Onboard Maintenance System (OMS).



### MLG FIRE PROTECTION - DETECTION

## **RR ENGINE, APU & MLG FIRE PROTECTION SYSTEMS PRESENTATION (1)**

### **Safety Items**

When you do work on the fire protection system, make sure that you obey all the AMM safety precautions. This will prevent injury to persons and/or damage to the aircraft. Here is an overview of the main safety precautions related to the fire protection system.

When you do work near or on the fire protection components, you must make sure there is good airflow in the working area because of the risk of discharge of the fire EXTINGUISHING BOTTLE.

Before all maintenance operations, make sure that all the safety devices and all the warning notices are in position.

Be careful when you:

- Install or remove the fire detector elements. You can easily cause damage to them,
- Move a filled fire EXTINGUISHING BOTTLE. A heavy shock or damage to the frangible disc can cause unwanted discharge,
- Remove or install the discharge head with the cartridge installed. The cartridge is an explosive device.

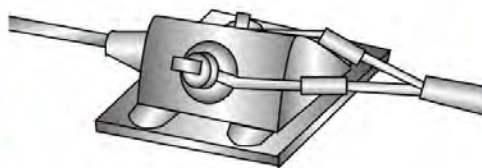
Explosion of the cartridge can cause injury to persons. To prevent explosion of the cartridge, install the applicable protective device on it to give protection to the electrical connector. Do not use a foil shunt. Make sure that the maximum permitted life of the cartridge is longer than the time to the next scheduled inspection.

Ground Support Equipments (GSE) is necessary for the maintenance tasks on the fire protection system.

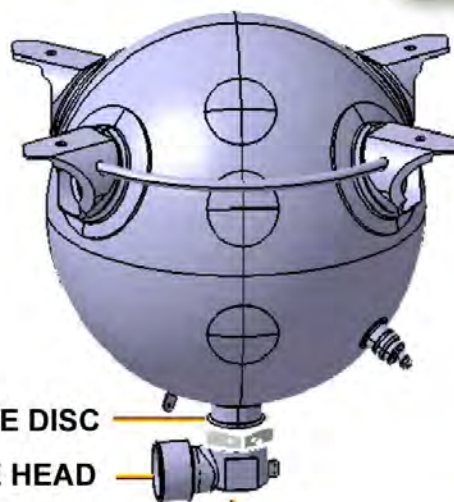
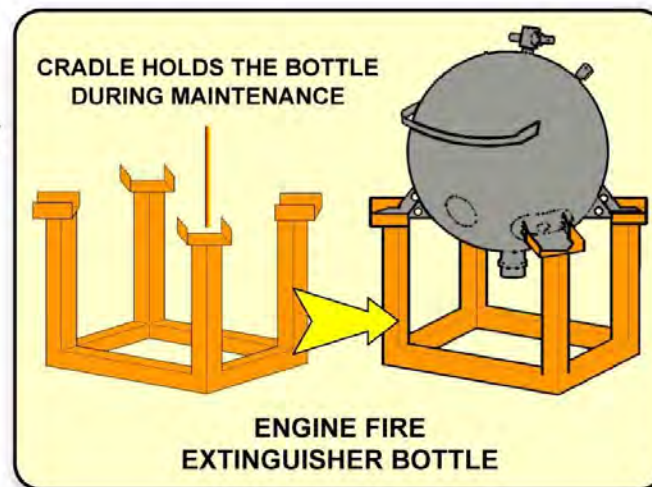
An example of GSE, is the cradle for the engine fire EXTINGUISHING BOTTLES, which is used to hold the bottles during maintenance.

Refer to the AMM for the tasks.

Also, refer to the illustrated TEM (Tool and Equipment Manual) for the full list of tools.



**FIRE DETECTOR**



**FRANGIBLE DISC  
DISCHARGE HEAD**

**CARTRIDGE**

**SAFETY ITEMS**

Depending on the engines  
(RR T900 or EA GP7200),  
engine fire extinguishing  
bottles are different.  
Inboard and outboard  
bottles are different.



## **30-Ice & Rain Protection**

## ICE & RAIN PROTECTION

|                                                                 |          |
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| <u>RR Ice and Rain Protection System Presentation (1) .....</u> | <u>2</u> |
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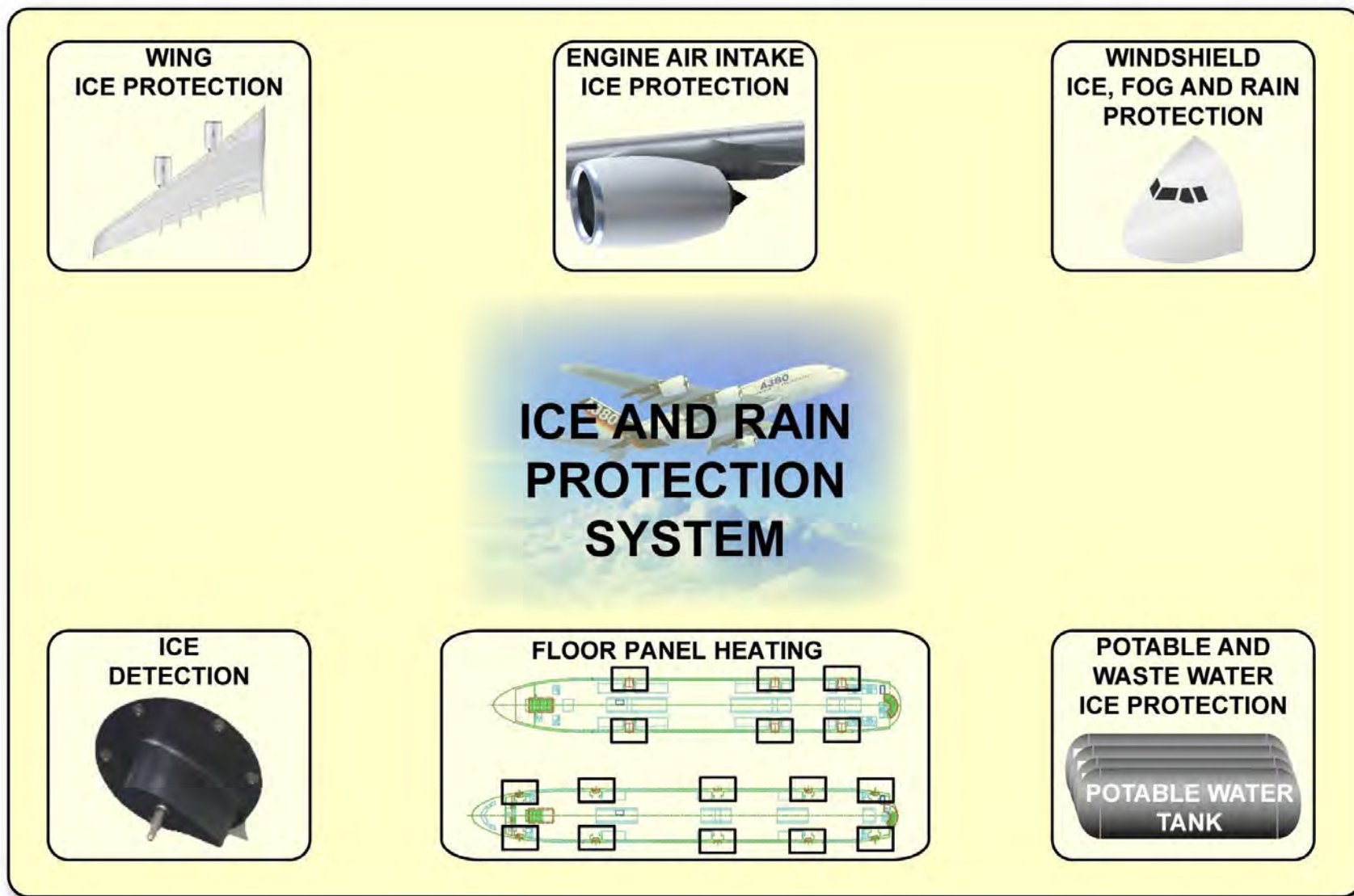
## **RR ICE AND RAIN PROTECTION SYSTEM PRESENTATION (1)**

### **General**

The aircraft can be operated without restriction in icing conditions or heavy rain thanks to the Ice and Rain Protection system. Hot air or electrical heating protect critical areas of the aircraft.

The different sub systems of the Ice and Rain Protection system are:

- The wing ice protection,
- The engine air intake ice protection,
- The windshield anti-icing, defogging and rain protection,
- The potable and waste water ice protection,
- The floor panel heating
- The ice detection.



GENERAL

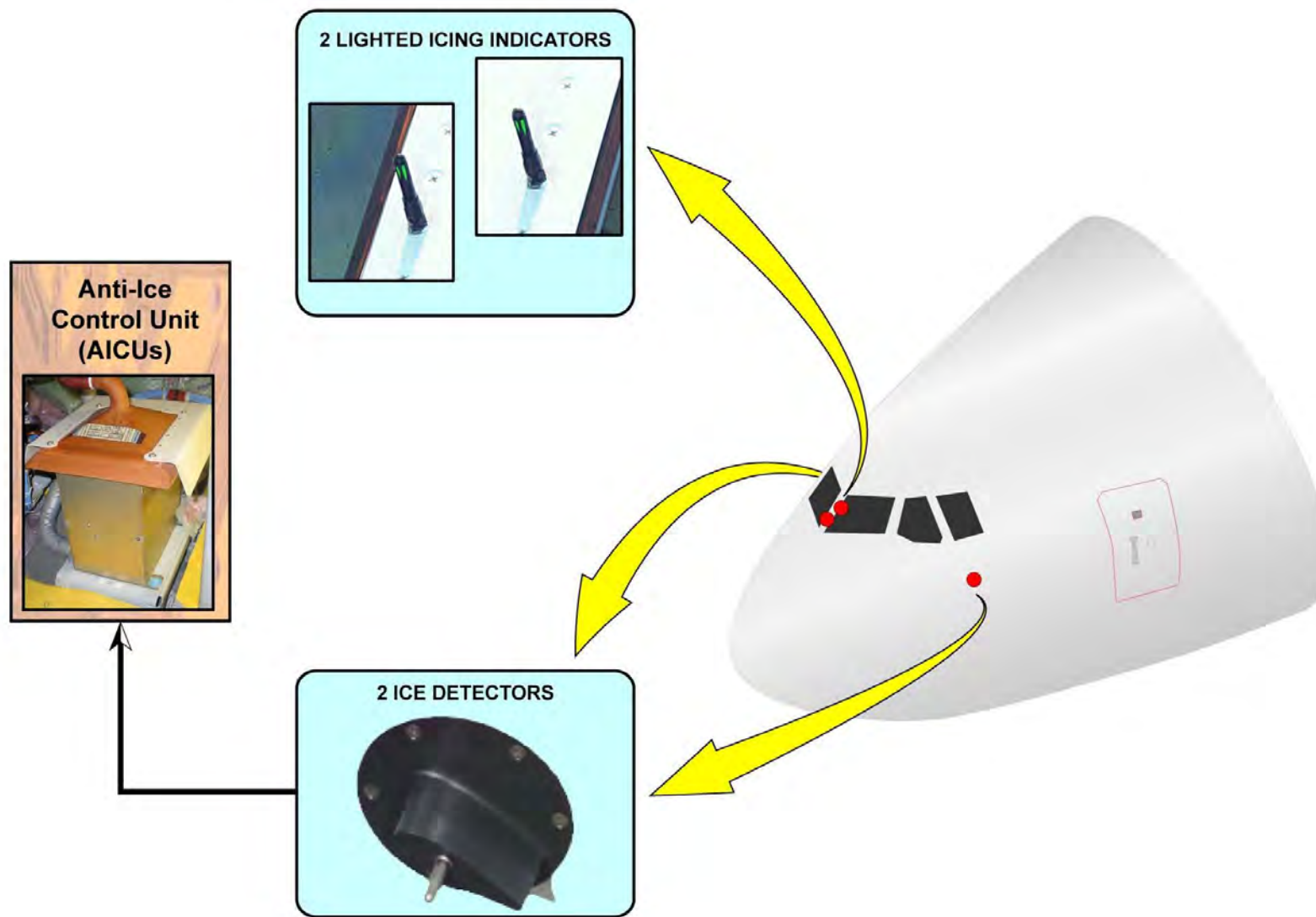
## **RR ICE AND RAIN PROTECTION SYSTEM PRESENTATION (1)**

### **Ice Detection System**

The function of the Anti Ice Control Units (AICUs) is to give automatically to the crew, indications of icing conditions.

The system is composed of two separate ice detectors installed symmetrically on the upper part of the nose part of the fuselage below the rear fixed windows.

Two external Lighted Icing Indicators installed between the two windshields tell the crew that icing conditions are encountered, by formation of ice on visual Indicators.



ICE DETECTION SYSTEM

## **RR ICE AND RAIN PROTECTION SYSTEM PRESENTATION (1)**

### **Ice Detection System (continued)**

#### **Indication and Monitoring**

The functions of the advisory ice-detection system are:

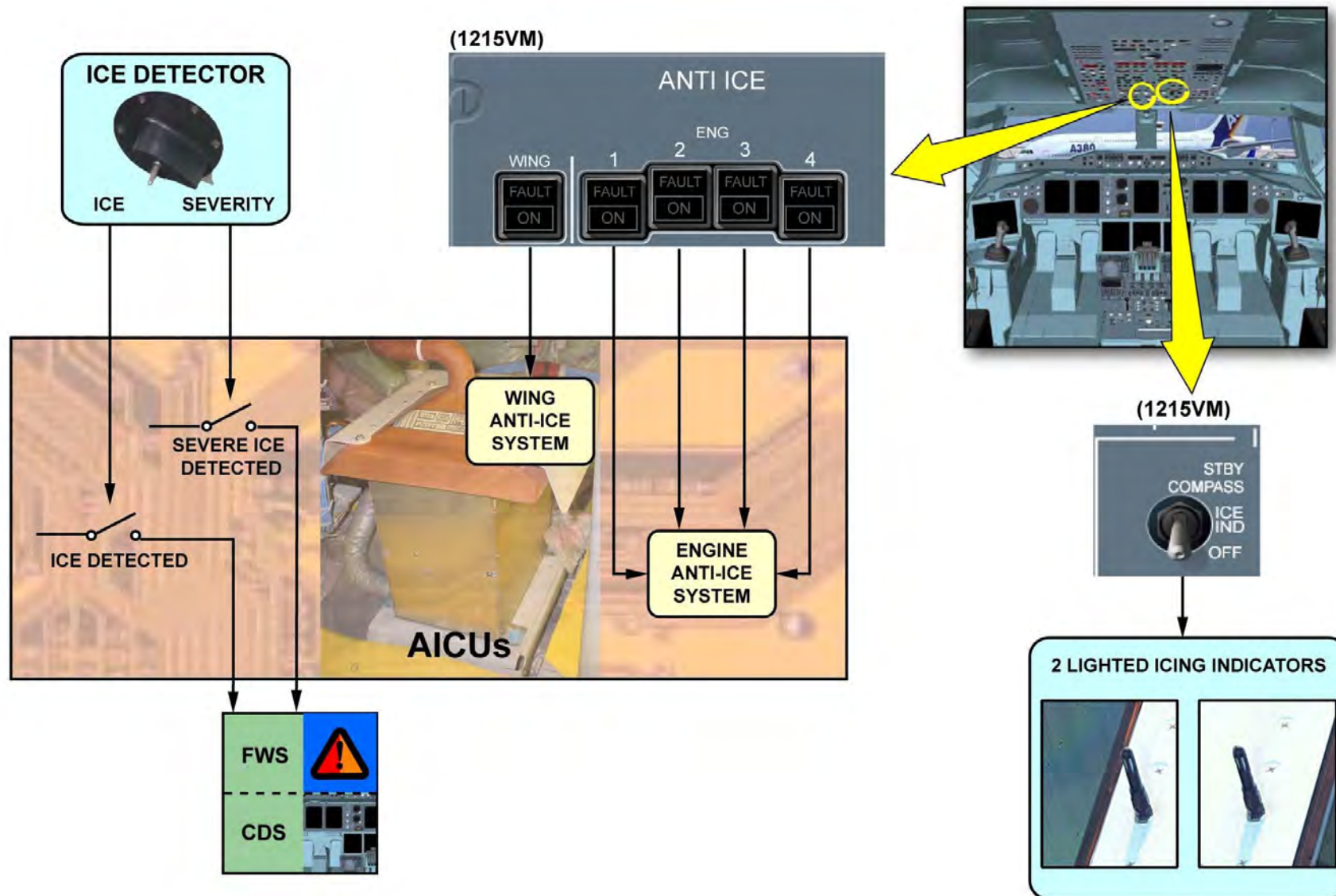
- To detect the level of icing,
- To send warning message(s) to the flight crew when ice is detected. There are two levels of detection:
  - ICE DETECTED,
  - SEVERE ICE DETECTED.

These 2 levels are shown on the EWD. A fault signal is shown when the two ice detectors are faulty.

#### **Visual Light Indicators**

The ICE IND AND STBY COMPASS switch controls the lighting of the lighted icing indicators. This switch has three positions:

- STBY COMPASS,
- ICE IND,
- OFF.

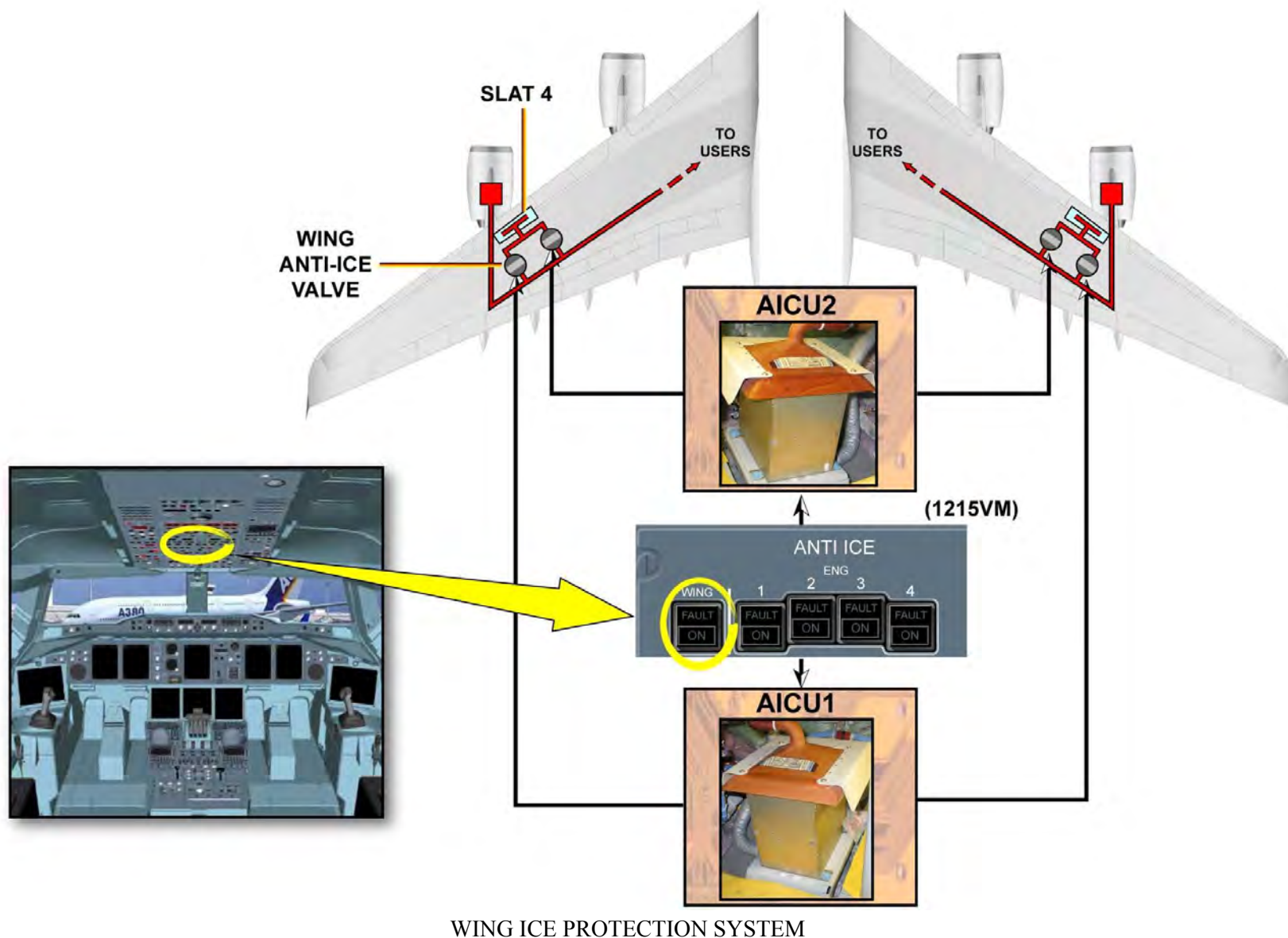


ICE DETECTION SYSTEM - INDICATION AND MONITORING & VISUAL LIGHT INDICATORS

## **RR ICE AND RAIN PROTECTION SYSTEM PRESENTATION (1)**

### **Wing Ice Protection System**

During icing conditions the slat N°4 of each wing is heated with hot air from the pneumatic system through two redundant Wing Anti-Ice Valves (WAIVs). Two Anti-Ice Control Units (AICUs) control the WAIVs.



## **RR ICE AND RAIN PROTECTION SYSTEM PRESENTATION (1)**

### **Wing Ice Protection System (continued)**

#### **Operation, Control and Monitoring**

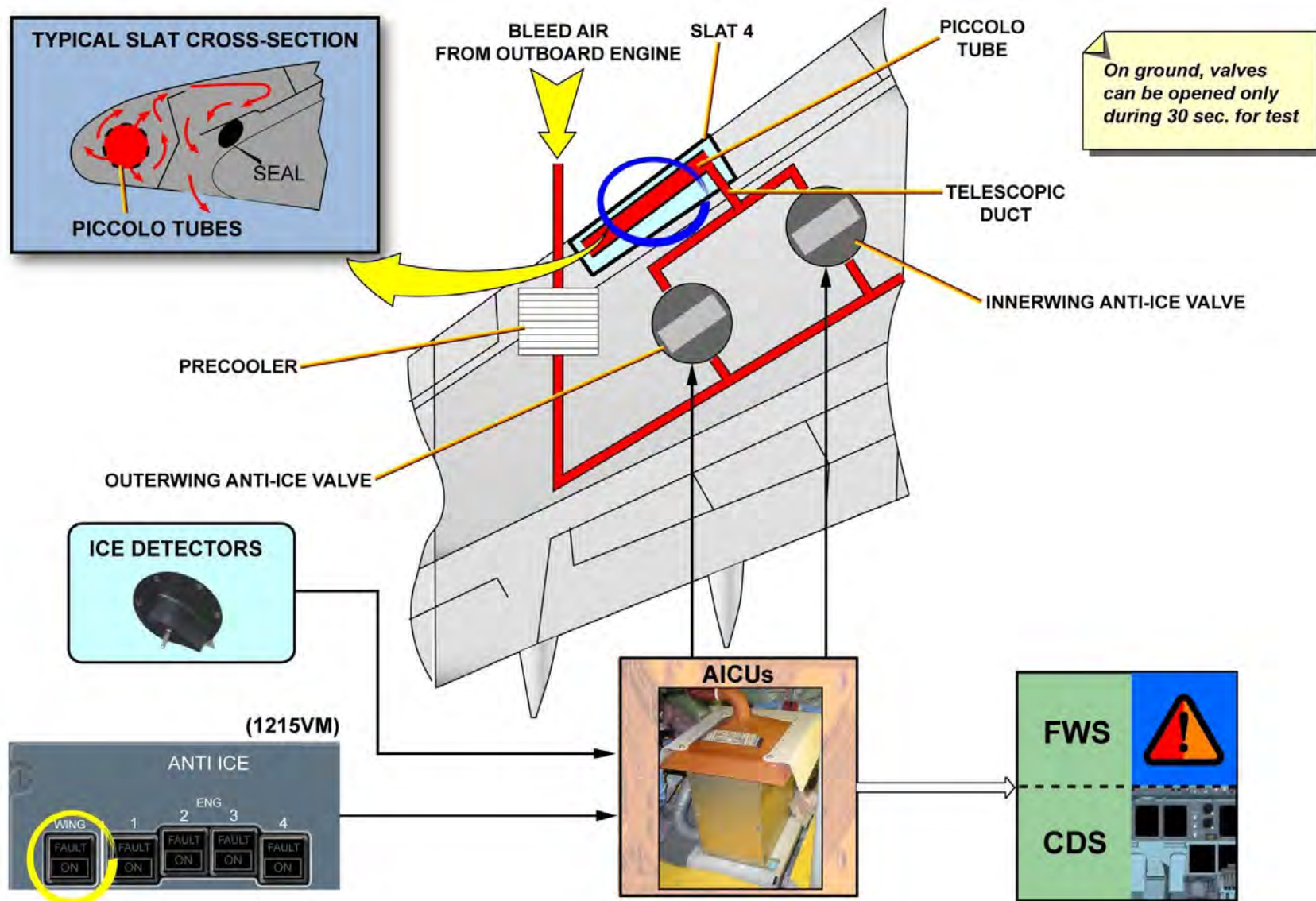
Hot air is supplied to each wing via two redundant wing anti-ice valves installed in each wing leading edge. Hot air is bled in the slat via piccolo tubes. The valves are pneumatically operated and electrically controlled.

In case of loss of electrical power supply or lack of pressure, the valve closes.

The valves are controlled by the AICUs and by one pushbutton on the "ANTI-ICE" control panel, installed on the overhead panel. The system operates manually and in flight only. The "FAULT" light comes on in case of abnormal operation.

On ground and only for test functions, the WING pushbutton electrically opens the valves for 30 seconds to prevent heat damage.

Two ice detectors generate, via AICUs, an ECAM indication of ice detection requesting the use of the wing anti-ice system.



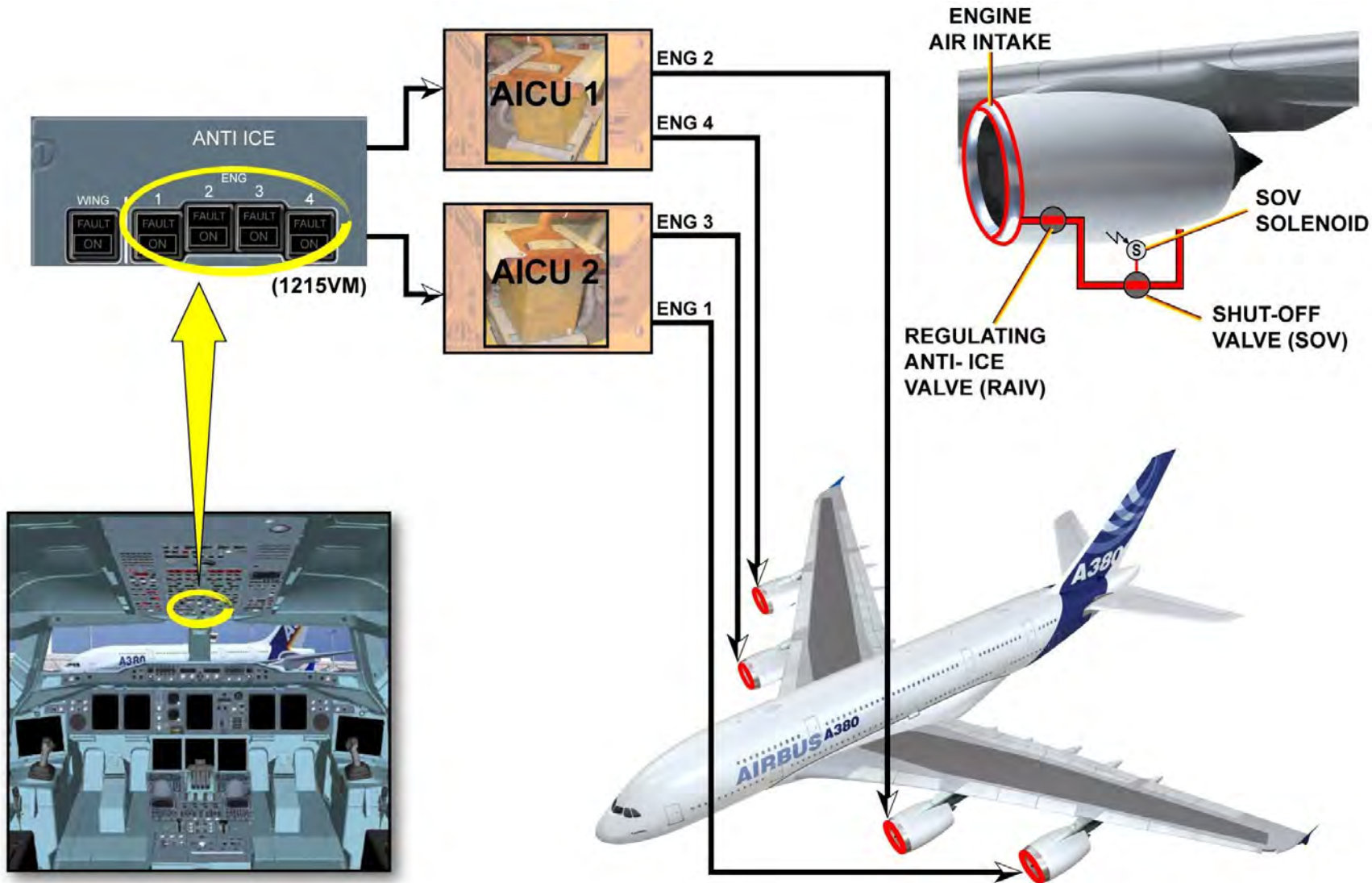
WING ICE PROTECTION SYSTEM - OPERATION, CONTROL AND MONITORING

## **RR ICE AND RAIN PROTECTION SYSTEM PRESENTATION (1)**

### **Engine (RR) Air Intake Ice Protection System**

The engine air intake anti-ice protection is manually selected when icing conditions are expected on ground or in flight.

The function of the engine air intake ice protection is to supply hot air to heat the inlet lip during icing conditions. The system is manually activated by means of the ANTI ICE/ENG pushbuttons through the AICUs.



ENGINE (RR) AIR INTAKE ICE PROTECTION SYSTEM

## **RR ICE AND RAIN PROTECTION SYSTEM PRESENTATION (1)**

### **Engine (RR) Air Intake Ice Protection System (continued)**

#### **Bleed Air Source**

Hot air used to heat the engine air intake lip is bled from the third stage of the engine High Pressure Compressor (HP3) through a Shut-Off valve (SOV) and a pressure Regulating Anti Ice Valve (RAIV).

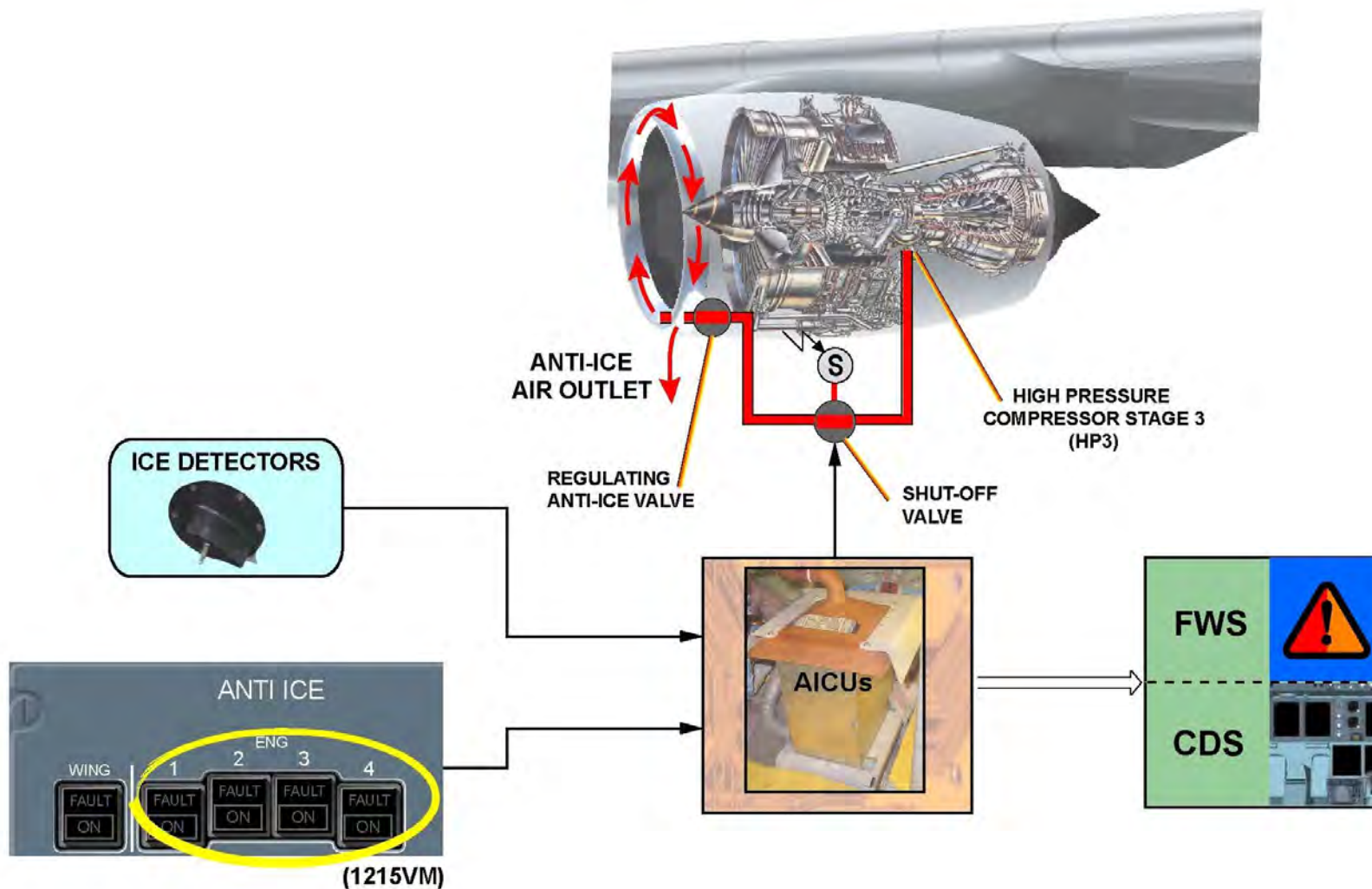
For each engine, hot bleed air is ducted via a pressure regulating valve and a shut-off valve. The SOV is pneumatically operated, electrically controlled via a solenoid and spring loaded open.

#### **Control And Indicating**

The controls and indicating are installed on the anti-ice overhead panel. For each engine, the Anti-Ice Control Unit (AICU) controls the valves.

In case of abnormal operation the pushbutton FAULT light comes on. If at least one of the 4 engine anti-ice systems is on, the indication is shown on the Central Display System (CDS).

Ice detectors launch to the ECAM an indication when ice formation is detected and ask for engine anti-ice system to be selected.



ENGINE (RR) AIR INTAKE ICE PROTECTION SYSTEM - BLEED AIR SOURCE & CONTROL AND INDICATING

## **36-Pneumatic**

## PNEUMATIC

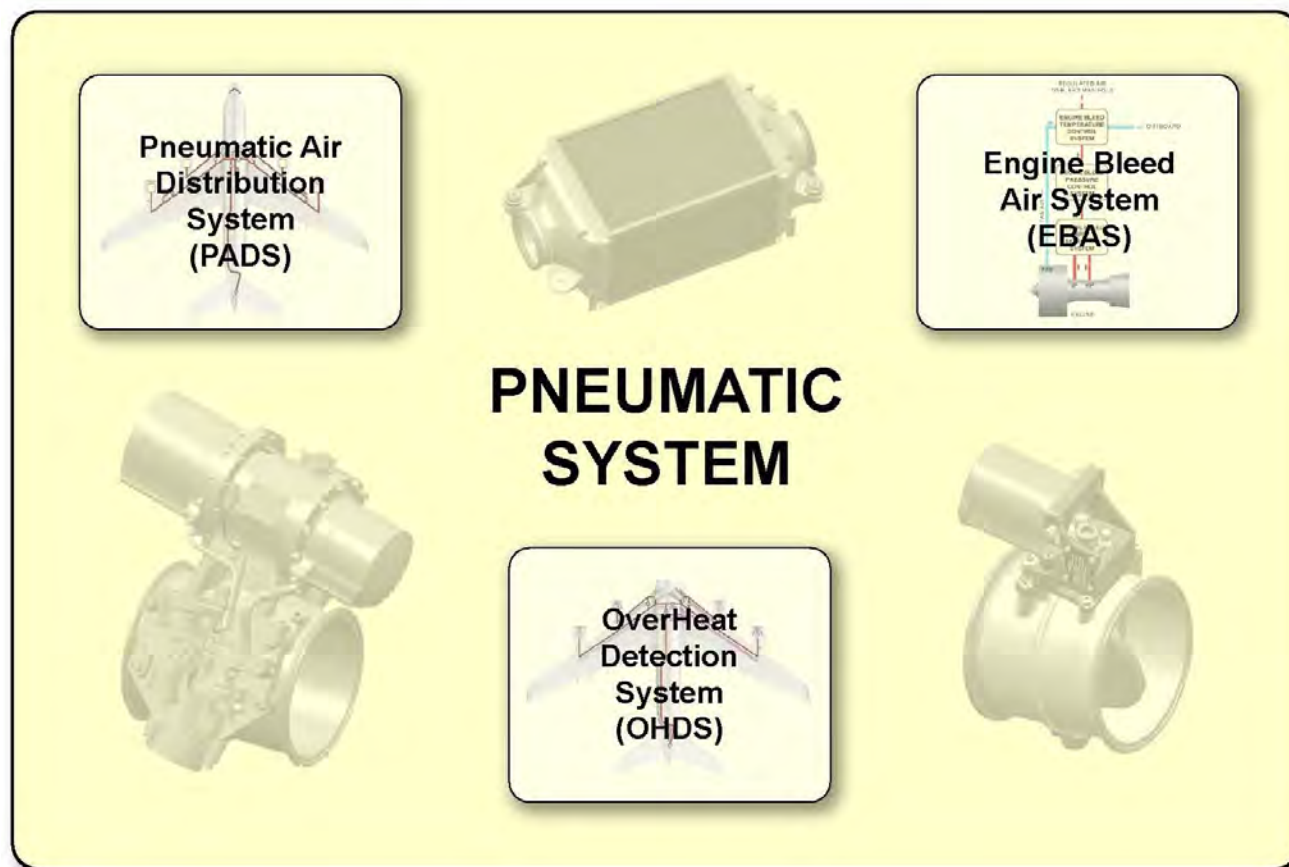
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| Pneumatic System Presentation (1) ..... | 2 |
|-----------------------------------------|---|

## PNEUMATIC SYSTEM PRESENTATION (1)

### General

The Pneumatic system is composed of three sub-systems:

- The Pneumatic Air Distribution System (PADS),
- The Engine Bleed Air System (EBAS),
- The OverHeat Detection System (OHDS),



GENERAL

## **PNEUMATIC SYSTEM PRESENTATION (1)**

### **Pneumatic Air Distribution System Overview**

The Pneumatic Air Distribution System (PADS) collects compressed air from the various bleed air sources and supplies it to the aircraft users.

#### **Air Sources**

The air sources are:

- The four engines,
- The APU and,
- A ground air source via the three High Pressure Ground Connectors.

#### **Users**

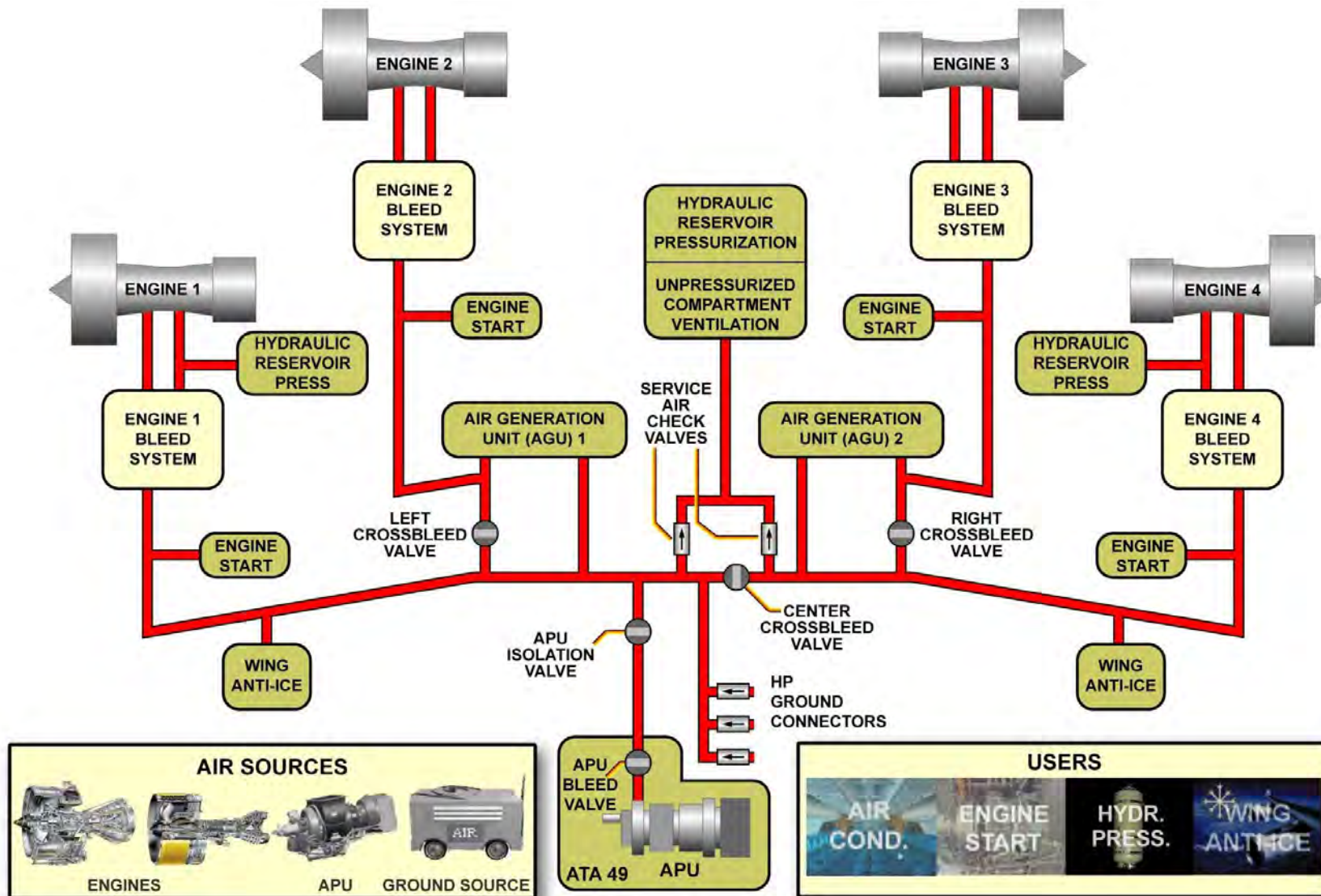
The Users of the pneumatic system are:

- The Air Conditioning System for hot air feed and unpressurized compartment ventilation,
- The Wing Anti-Ice (WAI) System,
- The Engine Starting System to give compressed air to the engine starters and,
- The Hydraulic System for reservoir pressurization.

#### **PADS components**

The main components of the PADS are:

- The crossbleed manifold,
- The three crossbleed valves (left, center and right,)
- The APU isolation valve and,
- The HP ground connectors.



PNEUMATIC AIR DISTRIBUTION SYSTEM  
OVERVIEW

## **PNEUMATIC SYSTEM PRESENTATION (1)**

### **Pneumatic Air Distribution System Overview (continued)**

#### **PADS Control and Indicating**

The PADS controls are located on the AIR panel (1225VM).

These controls are:

- The XBLEED (crossbleed) selector and,
- The APU BLEED P/BSW.

Indications concerning the PADS are displayed on the ECAM BLEED PAGE.

#### **Crossbleed System**

All the air sources are connected to the crossbleed manifold. Three crossbleed valves are used to isolate the left hand and right hand bleed systems and also each engine bleed system when required. The APU and the HP ground connectors are connected to the left hand side of the crossbleed manifold.

The crossbleed valves control is done by a PADS application hosted in the four Core Processing Input/Output Modules (CPIOMs)-A.

The crossbleed selector located on the overhead panel is used to choose the control mode of the valves.

Three modes are available:

- The manual OPEN mode, to open the three crossbleed valves manually,
- The manual CLOSE mode, to close the three valves manually and,
- The AUTO mode, to use an automatic control of the valves by the four CPIOM-A.

Note that in normal operation, the selector is on the AUTO position.

#### **APU Bleed System**

The APU bleed duct is connected to the left hand side of the crossbleed manifold.

The APU isolation valve allows compressed air from the APU to go to the crossbleed manifold.

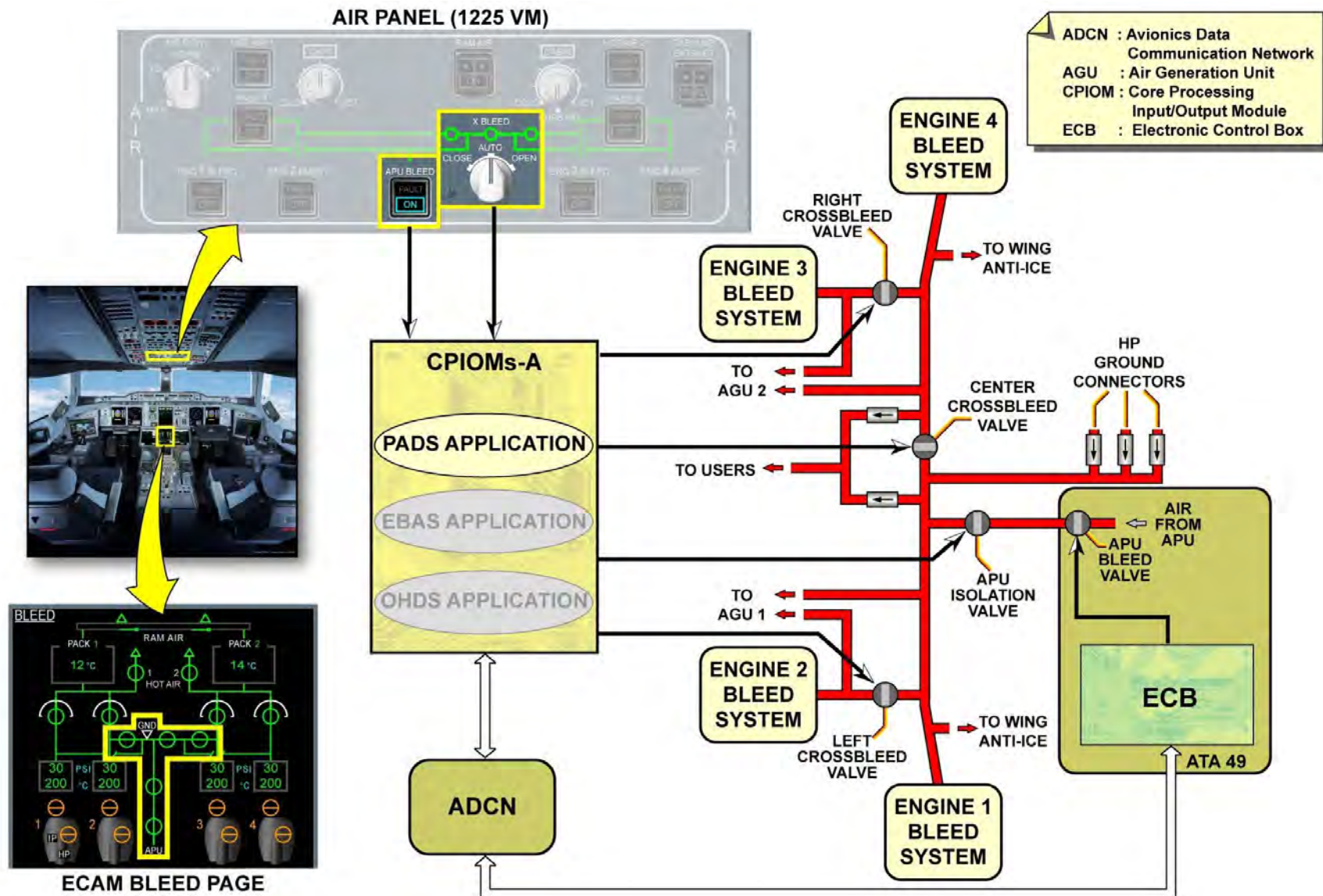
When you need APU bleed air supply, press the APU BLEED P/BSW located on the AIR panel (1225VM). The signal is received by the 4 CPIOMs-A, which command the APU isolation valve to open. At the same time, the Electronic Control Box (ECB) opens the APU bleed valve.

Airflow coming from the APU is regulated and can be used directly by the users.

#### **Ground Compressed Air Supply**

An alternative compressed air source is available when the aircraft is on ground. A ground air source can supply pressurized, temperature regulated and flow regulated air to the aircraft via three High Pressure Ground Connectors, located at the bottom of the belly fairing.

The HP Ground Connectors are connected to a common duct, connected onto the left hand side of the crossbleed manifold.



PNEUMATIC AIR DISTRIBUTION SYSTEM OVERVIEW - PADS CONTROL AND INDICATING ... GROUND COMPRESSED AIR SUPPLY

## **PNEUMATIC SYSTEM PRESENTATION (1)**

### **Engine Bleed Air System Overview**

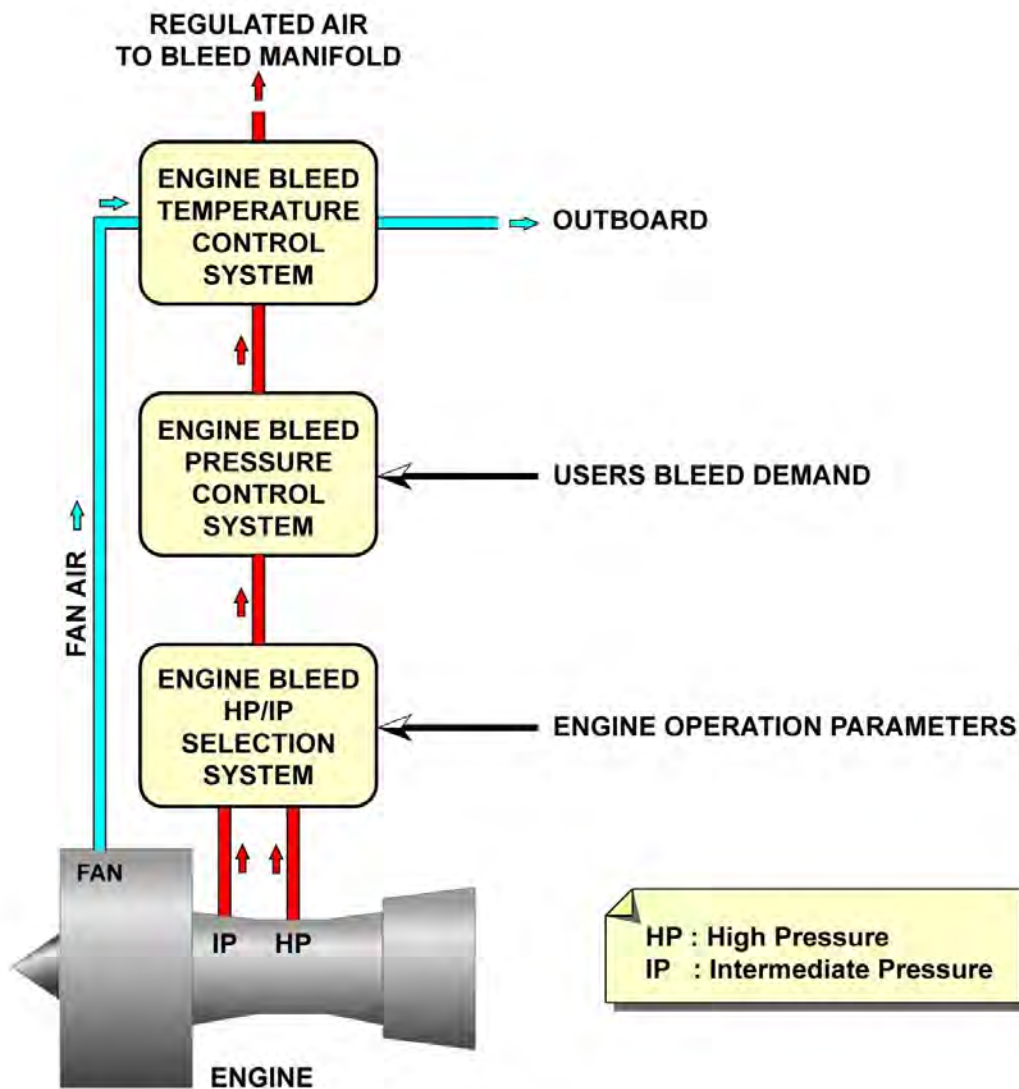
Engine Bleed Air is the main compressed air source during flight. It supplies pressure and temperature regulated air to the Pneumatic Air Distribution System (PADS).

On each engine, air is bled from either an Intermediate Pressure (IP) port or a High Pressure (HP) port on the engine compressor.

The engine bleed IP/HP selection system selects the appropriate bleed port according to engine operation parameters.

Then, the engine bleed pressure control system regulates the bleed pressure according to the bleed users demand.

Finally, the engine bleed temperature control system cools the bleed air using fan air.



ENGINE BLEED AIR SYSTEM  
OVERVIEW

## **PNEUMATIC SYSTEM PRESENTATION (1)**

### **Engine Bleed Air System Overview (continued)**

#### **Bleed Control and Indicating**

The Engine Bleed Air System (EBAS) controls are located on the AIR panel (1225VM). These controls are the four ENGINE BLEED P/BSWs.

Indications concerning the EBAS are displayed on the ECAM BLEED page.

#### **Bleed Functions**

EBAS is controlled automatically by the EBAS application hosted in the four CPIOMs-A.

It is possible to switch off one or several engine bleed system(s) by releasing out the corresponding ENGINE BLEED P/BSW.

Engine bleed port selection is achieved through the HP Bleed Valve and the IP Bleed Check Valve.

Using pressure sensors feedback, the EBAS application of the CPIOM-A opens or closes the HP Bleed valve depending on the Bleed demand and the pressure available at the IP port.

Most of the time, air is bled from the IP port. The HP port is used when the engine is running at low-rating and the IP is not sufficient to meet the user demand at such rate.

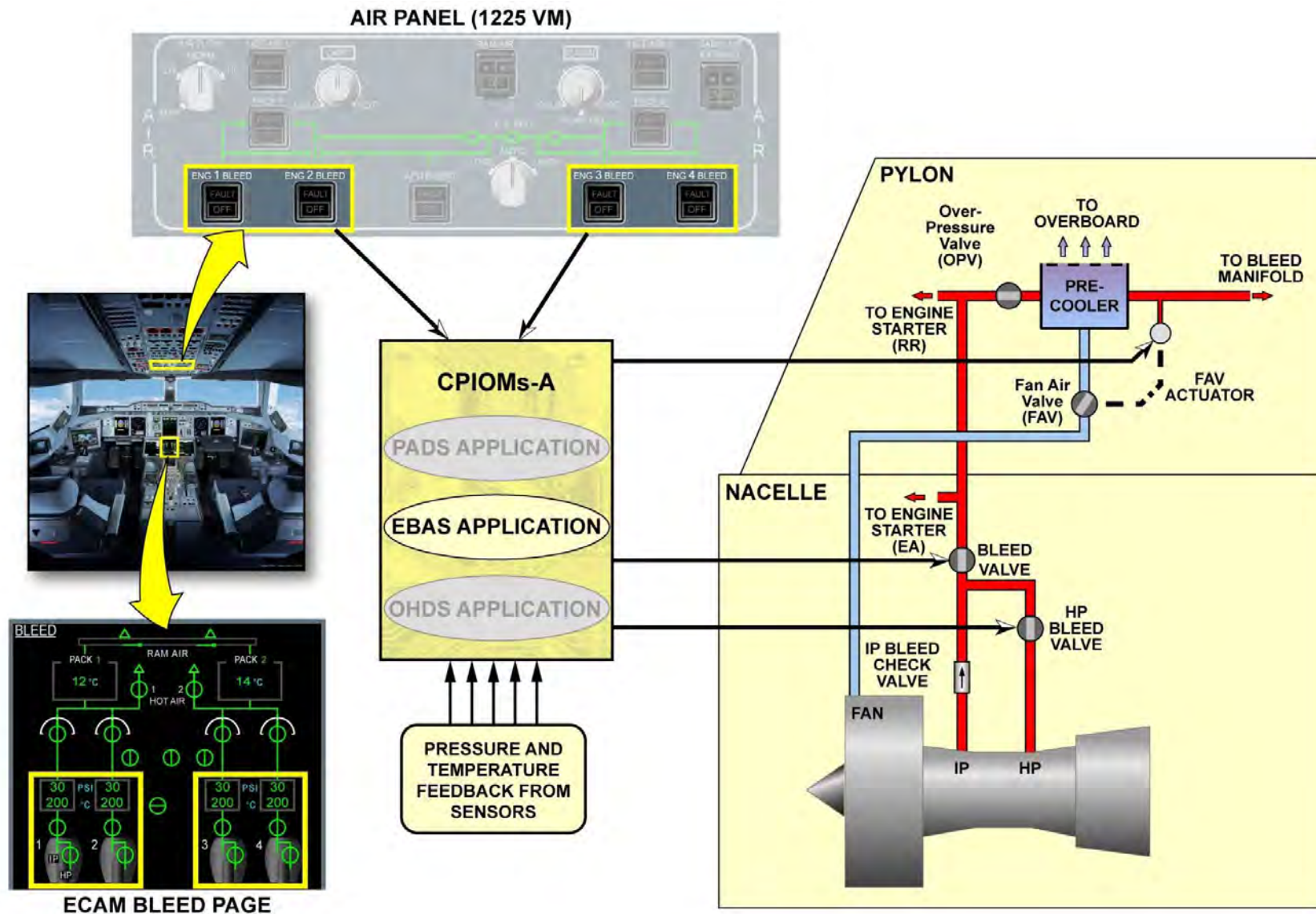
The Bleed Valve and the OverPressure Valve (OPV) ensure engine bleed pressure control.

Using pressure sensors feedback, the EBAS application of the CPIOM-A modulates the Bleed Valve position in order to reach the user pressure demand.

The OPV protects the system against overpressure in case of EBAS failure.

The Fan Air Valve (FAV) ensures engine bleed temperature control.

Using temperature sensor feedback, the EBAS application hosted in the CPIOMs-A modulates fan airflow through the pre-cooler heat exchanger to cool down the bleed air to the correct temperature.



## **PNEUMATIC SYSTEM PRESENTATION (1)**

### **OverHeat Detection System**

#### **Architecture**

The OverHeat Detection System (OHDS) detection loops are located along the pneumatic system duct network and around some air conditioning system components.

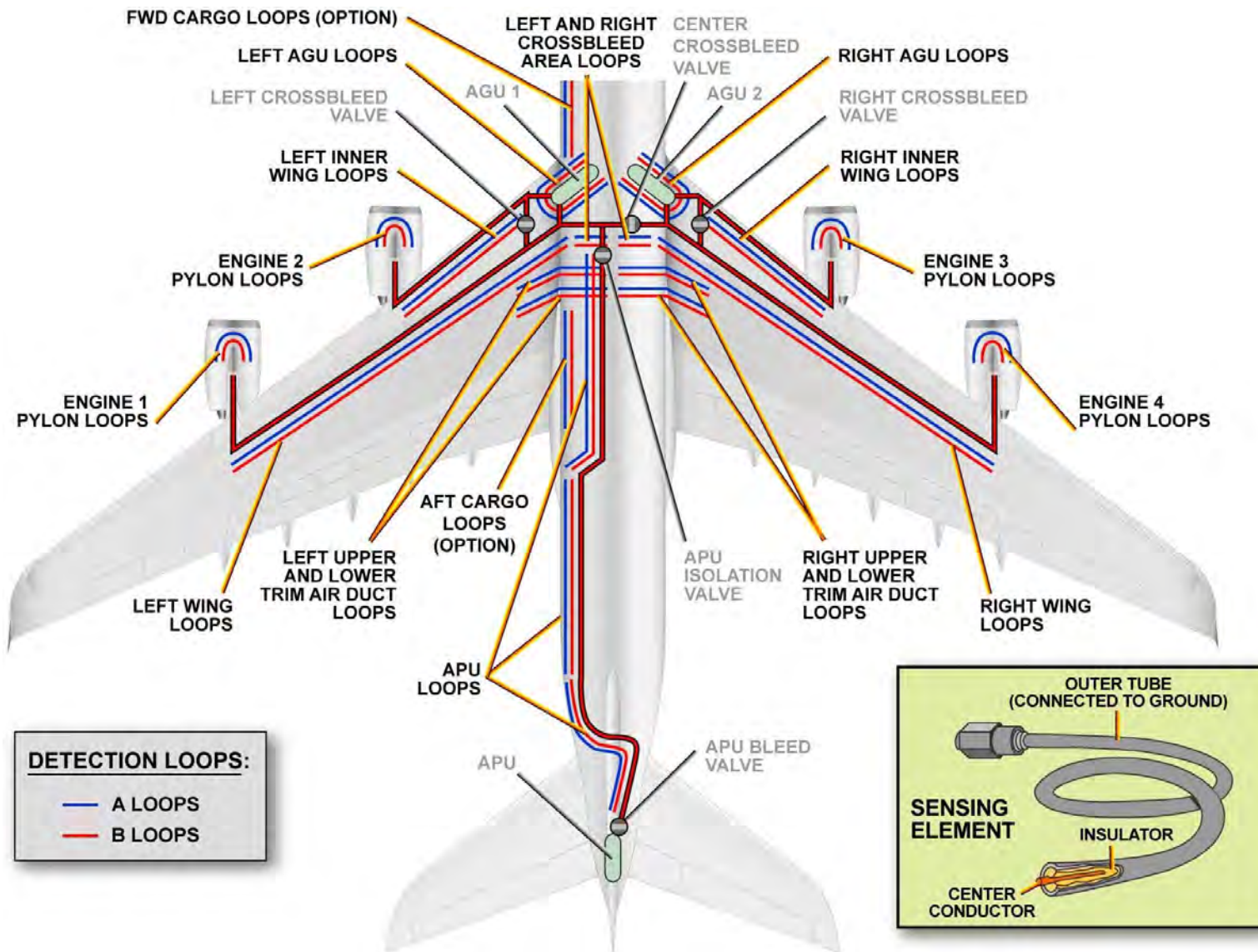
Each of the monitored area is equipped with dual detection loops (A loops and B loops).

Dual detection loops are installed:

- On each engine pylon,
- On the wings bleed ducts,
- On the inner wings bleed ducts,
- In the left and right Air Generation Unit (AGU) bays,
- On the upper and lower trim air ducts,
- In the crossbleed valve area,
- And on the APU bleed duct.

If the optional FWD/AFT cargo compartment temperature control system is installed, an additional loop is required.

Each detection loop is composed of sensing elements connected in series.



OVERHEAT DETECTION SYSTEM - ARCHITECTURE

## **PNEUMATIC SYSTEM PRESENTATION (1)**

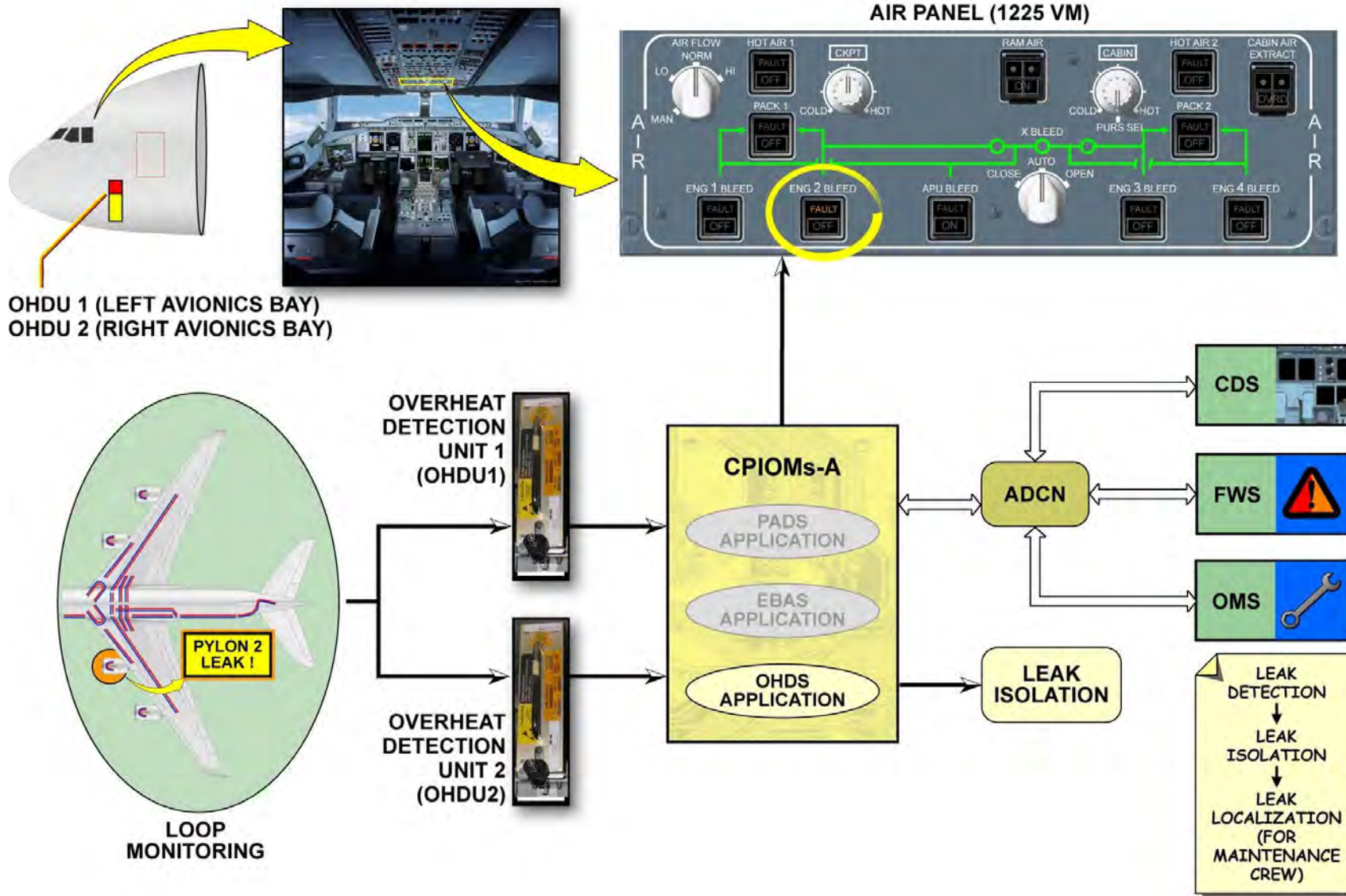
### **OverHeat Detection System (continued)**

#### **Loop Monitoring**

Two OverHeat Detection Units (OHDU) monitor the detection loops. They are located in the left and right avionics bay racks (2300VU and 2400 VU).

If a leak is detected, the OHDU sends a signal to the CPIOM-A. Then, the OHDS application hosted in the CPIOM-A triggers appropriate valve closure and sends a leak message to the Flight Warning System (FWS), to the Control and Display System (CDS) for indication and to the Onboard Maintenance System (OMS) for leak localization.

If a leak is detected, fault lights illuminate on the corresponding BLEED pushbutton on the AIR panel (1225VM).



OVERHEAT DETECTION SYSTEM - LOOP MONITORING

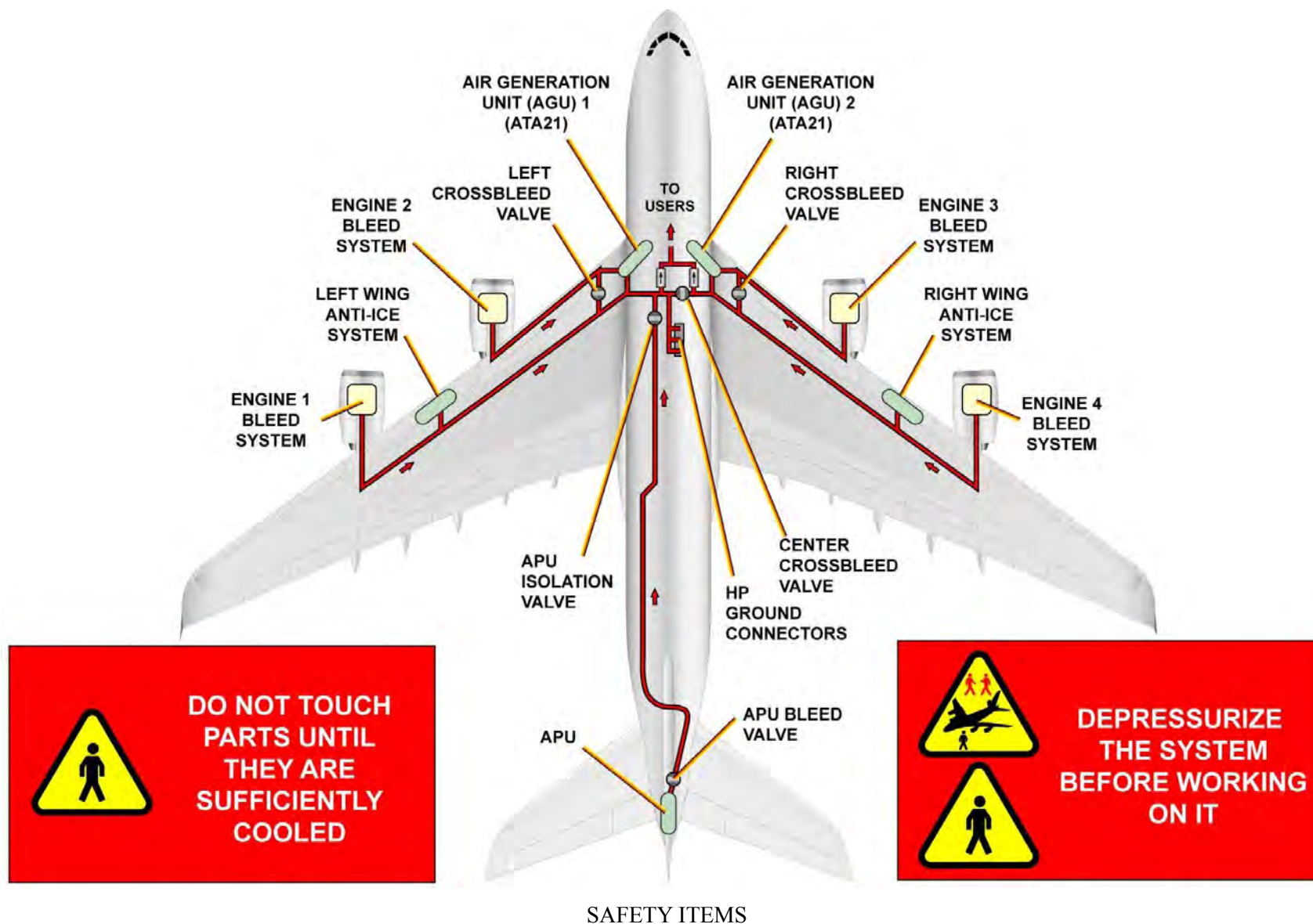
## PNEUMATIC SYSTEM PRESENTATION (1)

### **Safety Items**

Here is an overview of main safety precautions relative to the pneumatic system.

Make sure that the pneumatic system is depressurized before starting the work, pressurized air can cause unwanted pressurization of the aircraft, and injury to personnel.

Parts can be hot for 1 hour after engine shutdown. Do not touch them until they are sufficiently cool.



## **70-Power Plant (RR)**

## POWER PLANT (RR)

|                                                               |           |
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### Engine Systems

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## NACELLE, DRAINS & RR ENGINE PRESENTATION (1)

### **Nacelle**

The Pylon fulfils all interfaces between the aircraft wing and the power plant (engine plus nacelle assembly).

The Nacelle provides a smooth airflow around the engine and its accessories.

It also provides:

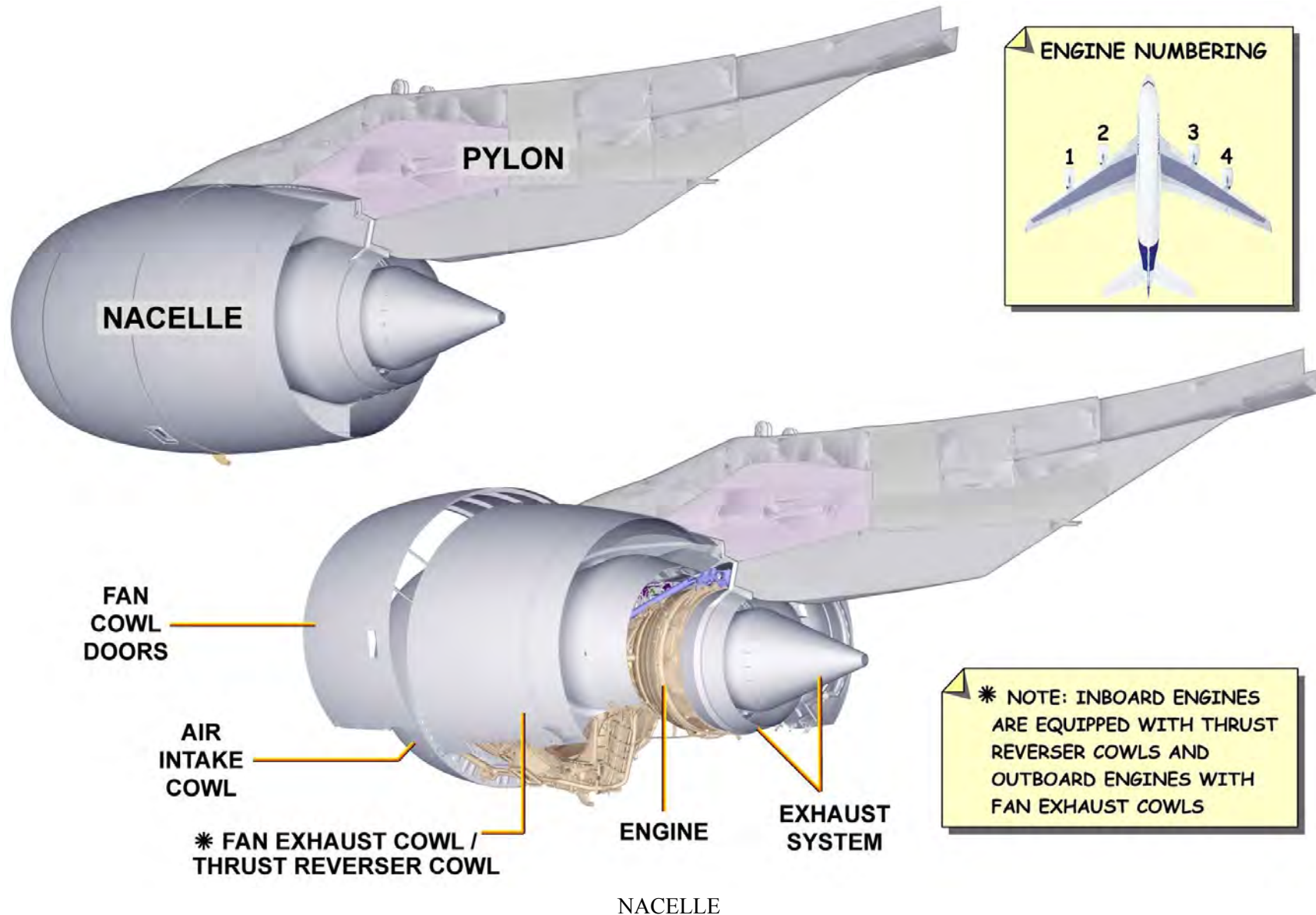
- Engine protection,
- Engine ventilation,
- Noise attenuation,
- Thrust reverse (inboard engines only).

The nacelle includes:

- An air intake cowl,
- 2 fan cowl doors,
- 2 Thrust Reverser Cowls (inboard engines) or 2 fan exhaust cowls (outboard engines),
- An exhaust system.

The nacelle gives access to the engine components.

Note: The engines are numbered from 1 to 4 from the left to the right.



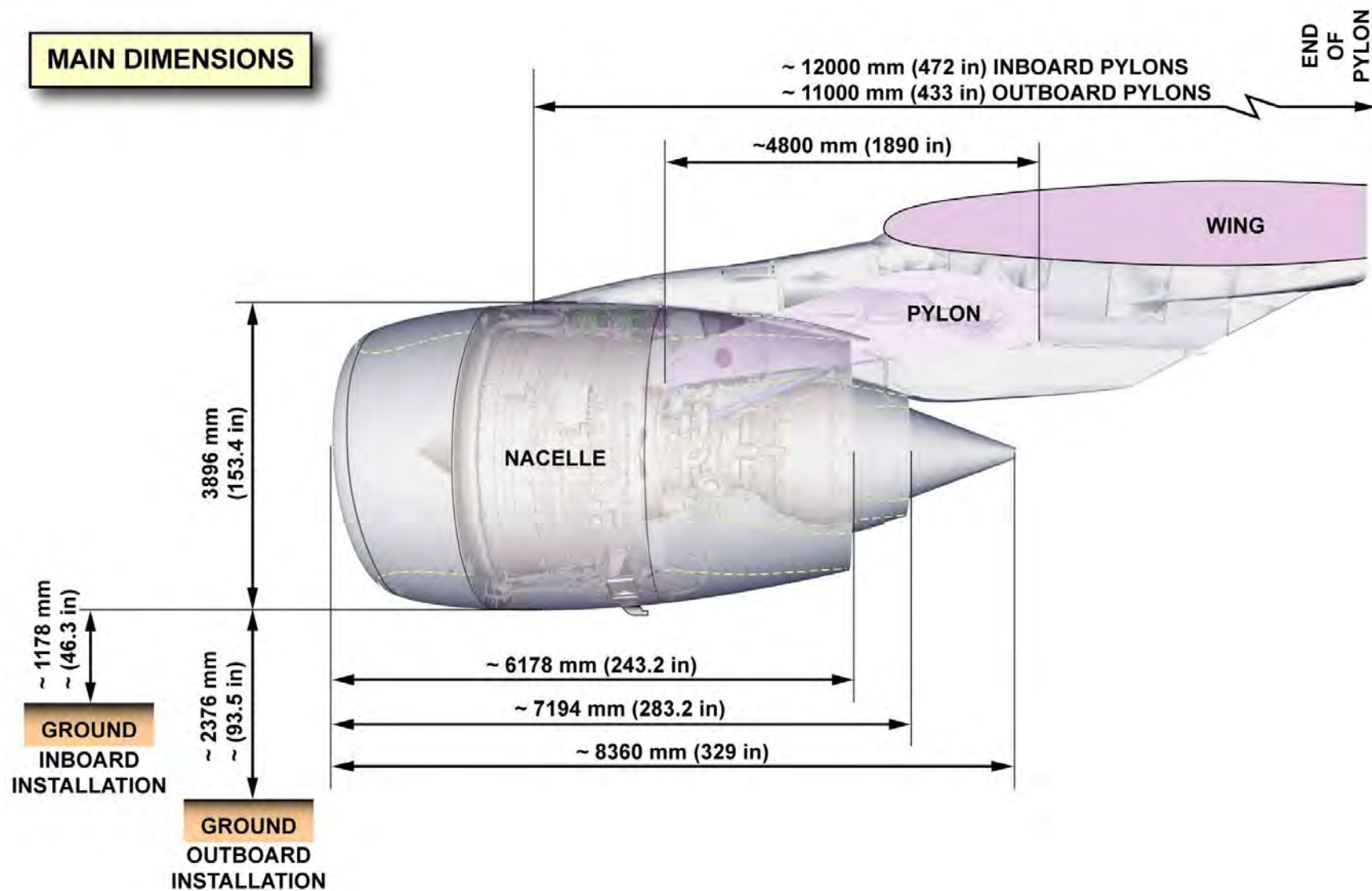
## NACELLE, DRAINS & RR ENGINE PRESENTATION (1)

### **Main Dimensions**

The total length of an inboard pylon is about 12 meters (472 inches)  
and about 11 meters (433 inches) for an outboard pylon.

The total length of the nacelle is about 8,360 meters (329 inches).

The maximum diameter of the nacelle is about 3.9 meters (153.4 inches).



MAIN DIMENSIONS

## NACELLE, DRAINS & RR ENGINE PRESENTATION (1)

### Pylon

The pylon is made of a primary structure and a secondary structure.  
The primary structure (also called pylon box) carries the mechanical loads between the power plant and the aircraft wing.  
The secondary structure has fairings and space for components.  
The pylon also includes an aft pylon fairing (also called lower fairing).

#### **Pylon / Power Plant: Interfaces**

The pylon interfaces with the power plant through engine mounts, connections and cowling fittings.  
The installation is designed to make the engine change easier.

#### **Engine Mounts**

The Engine Mounts transfer power plant loads to the pylon.  
There are 3 mount assemblies between the engine and the pylon: the forward mount, the aft mount and the struts mounts.

##### **FORWARD MOUNT ASSEMBLY**

The Forward Mount assembly carries most of vertical and side loads. It is attached at the intermediate case of the engine.

##### **AFT MOUNT ASSEMBLY**

The Aft Mount assembly carries vertical, side and torsion loads.  
It is attached to the tail support structure of the engine.

##### **STRUT MOUNTS ASSEMBLY**

There are 2 Strut Mount assemblies, which transmit the engine thrust. The right and left strut mounts are attached on each side of the intermediate case of the engine.

#### **Connections**

On the left hand side of the pylon front secondary structure, there are pneumatic (starter) and electrical connections.

On the right hand side of the front secondary structure, there are fluid connections (fuel, hydraulics).

Below the pylon primary structure there are pneumatic connections (bleed air).

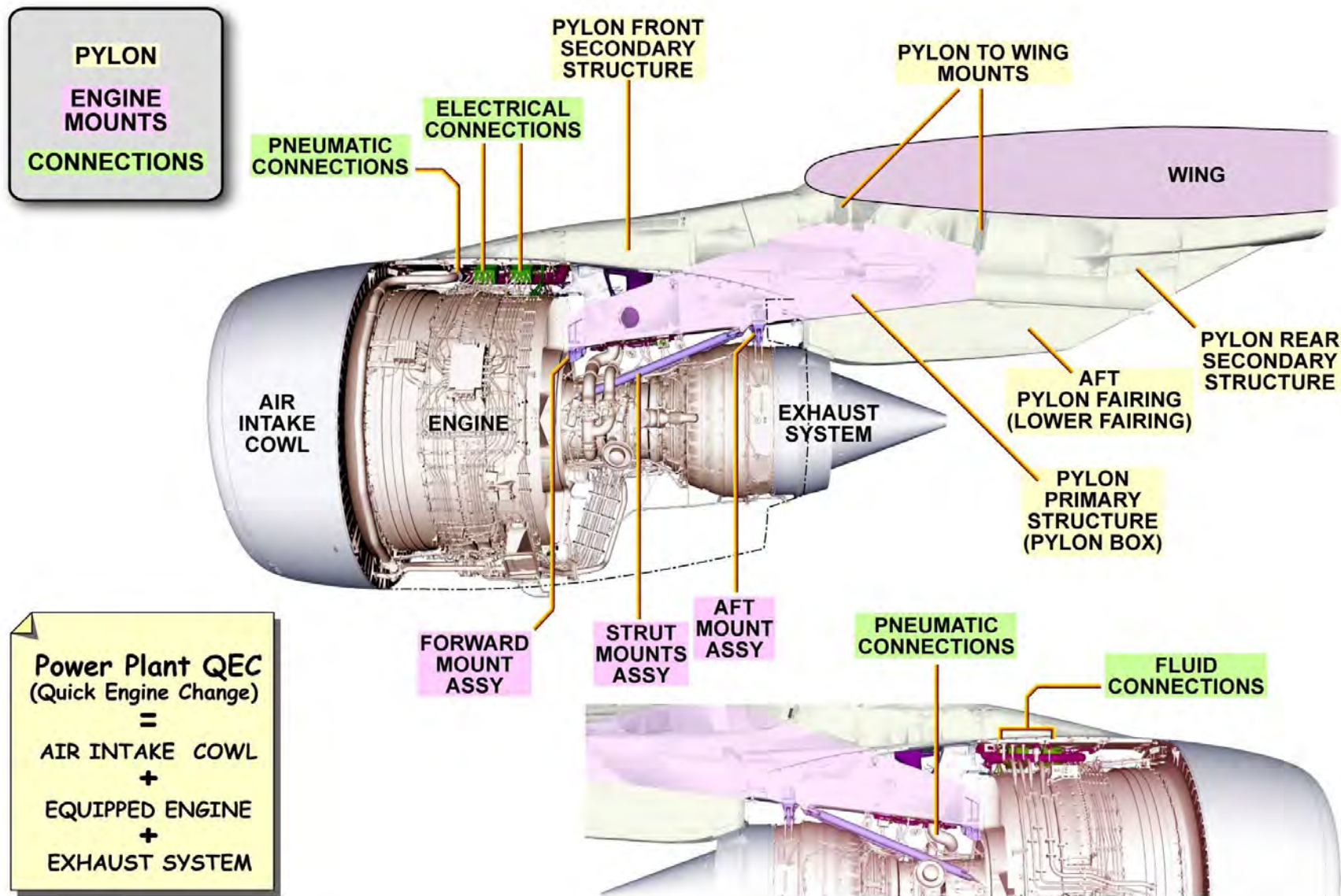
#### **Quick Engine Change (QEC)**

A Quick Engine Change (QEC) unit is an engine, which is prepared and ready for installation on the pylon.

A QEC includes:

- The air intake cowl,
- The engine,
- The exhaust system,
- The applicable accessories.

Note that a QEC does not include the fan cowl doors and the fan exhaust cowls because they are directly installed on the pylon and they remain on it in case of quick engine change operation.



PYLON - PYLON / POWER PLANT: INTERFACES ... QUICK ENGINE CHANGE (QEC)

## NACELLE, DRAINS & RR ENGINE PRESENTATION (1)

### **Maintenance Access**

For complete access to the engine mounted components, it is necessary to open the fan cowl doors and the fan exhaust cowls, for this function, there are latches installed at the bottom center line of the nacelle. Fan cowls and fan exhaust cowls are electrically operated. When opened, they are held in position by hold open rods. However for quick servicing the nacelle has inspection and access panels.

#### **Nacelle Left Side**

On the left hand side of the air intake cowl there are:

- The left fan cowl up/down switches and,
- A maintenance interphone jack.

On the left fan cowl door there is:

- The starter valve manual override access.

The left thrust reverser cowl has 3 accesses for the thrust reverser actuators (not applicable for the outboard engines).

#### **Nacelle Right Side**

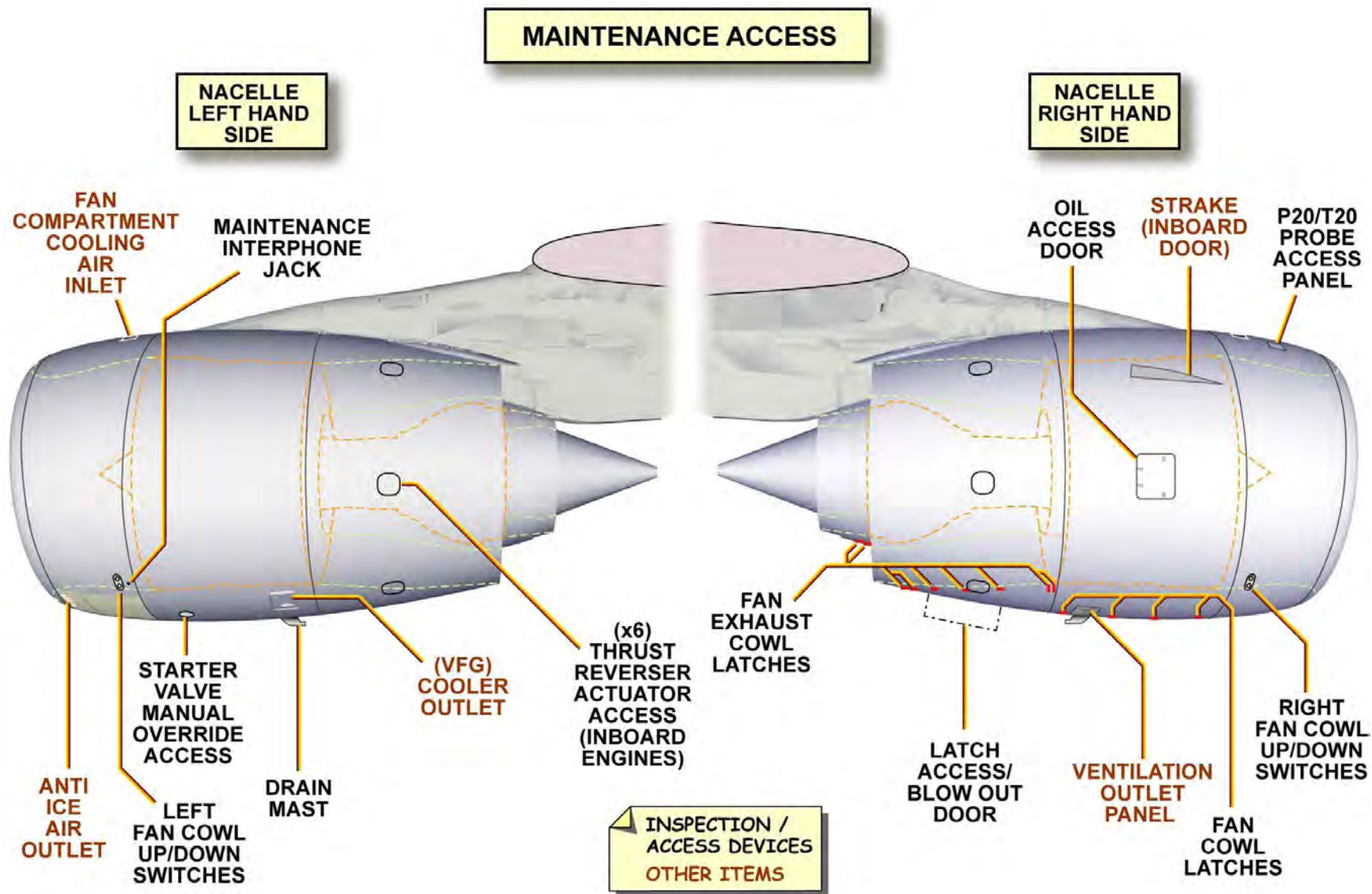
On the right hand side of the air intake cowl there are:

- The right fan cowl up/down switches and,
- The P20/T20 probe access panel.

On the right fan cowl doors there is the oil access door panel.

At the bottom of the fan exhaust cowl there is latch access/the blow out door.

The right thrust reverser cowl has 3 accesses panels for the thrust reverser actuators (not applicable for the outboard engines).



MAINTENANCE ACCESS - NACELLE LEFT SIDE & NACELLE RIGHT SIDE

## NACELLE, DRAINS & RR ENGINE PRESENTATION (1)

### Power Plant Drains

The power plant drains collect and discard from the pylon, nacelle and engine, all the unwanted liquids to avoid fire and fluid accumulation.

These fluids are fuel, hydraulic fluid, oil and water.

The power plant drains system is a help for trouble shooting, to identify the source of a leak.

### Pylon

The primary, the front secondary and the rear secondary structures of the pylon are separately drained.

The drains, of the primary and front secondary structures of the pylon, exit at the split line of fan exhaust cowl rear part.

The drains of the pylon rear secondary structure directly exit through pylon trailing edge.

### Nacelle

Drained nacelle areas are the zone 1 and the zone 3. The Zone 2 is an engine area.

The zone 1 of the nacelle is also called fan compartment and the zone 3 of the nacelle is also called core compartment.

The zone 1 is drained through both the split line and the ventilation outlet of the fan cowl doors.

The zone 3 is drained through a hole located at the lowest point of the fan exhaust cowl.

### Engine

Zone 2 is enclosed by the engine core fairings. The drain of the zone 2 exits at the split line of the fan exhaust cowl front part.

The drain of the tail support structure exits at the split line of the fan exhaust cowl rear part, just in front of the 2 pylon drains. This drain discards any residual fuel after an aborted start or a wet crank.

The other engine components are drained through the drain mast.

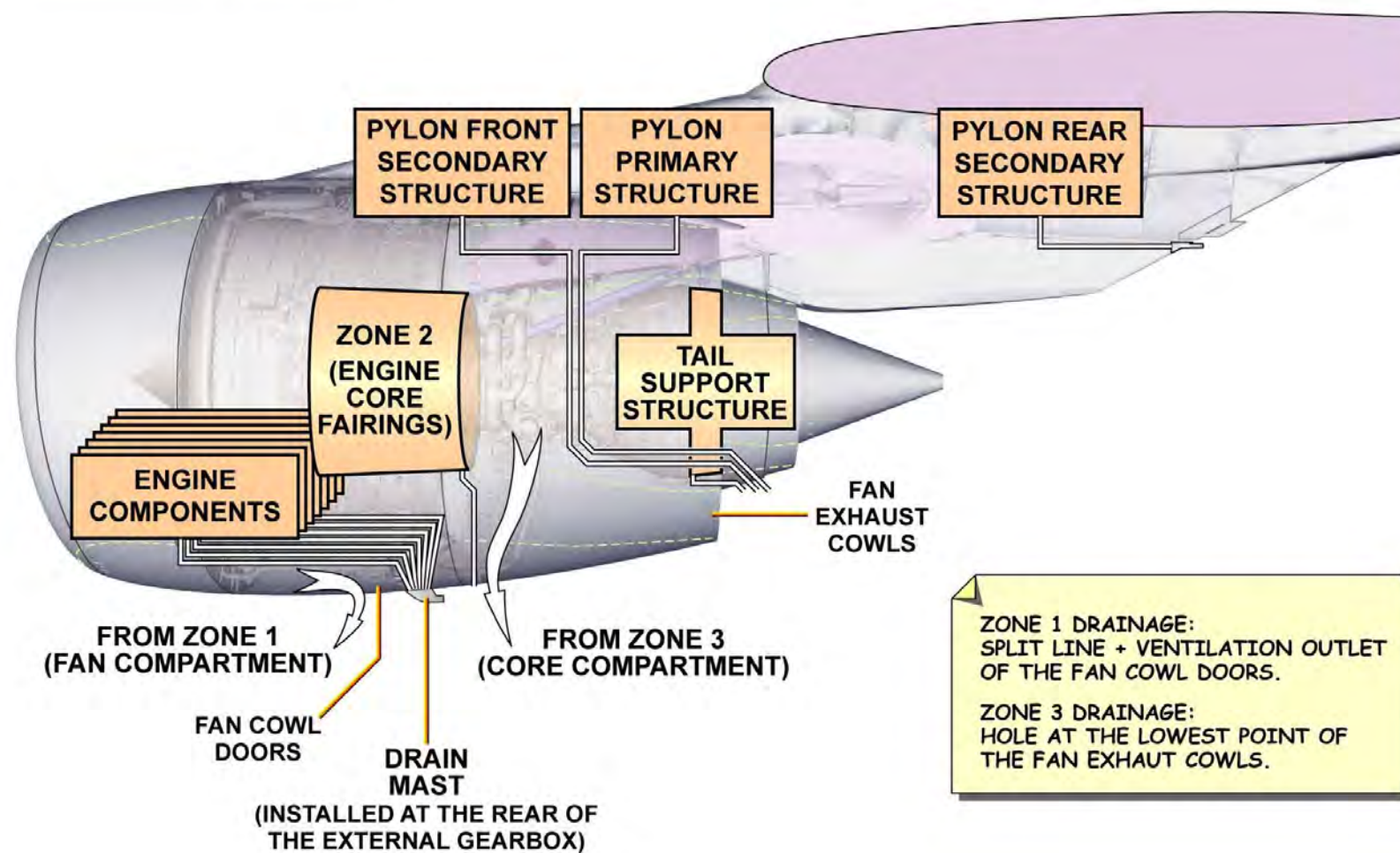
### Drain Mast

The drain mast has an aerodynamic shape and it is installed at the rear face of the external gearbox.

It protrudes the nacelle at the bottom split line between the 2 fan cowl doors.

The drain mast is connected from the drained components via separate lines.

**POWER PLANT DRAINS**



POWER PLANT DRAINS - PYLON ... DRAIN MAST

## NACELLE, DRAINS & RR ENGINE PRESENTATION (1)

### Engine Main Characteristics

The Rolls Royce RB 211-TRENT 900 engine is designed to power the whole A380 Family with the same engine hardware.

Each Aircraft model of the A380 Family has its dedicated ENGINE MARK.

A Data Entry Plug is attached to the engine and it is plugged to the FADEC. A Data Entry Plug (DEP) is attached to the engine and is connected to the Full Authority Digital Engine Control (FADEC) System. The DEP defines the ENGINE MARK and sets its related takeoff thrust. The takeoff thrust, from 311.38 kN (70000 lb) to 359.33 kN (80780 lb) is flat rated at ISA+15°C (59F°).

The Pressure ratio (P20 / P30) equals 1 / 41.7.

The Bypass ratio equals 1 / 8.12.

### DIMENSIONS AND WEIGHT

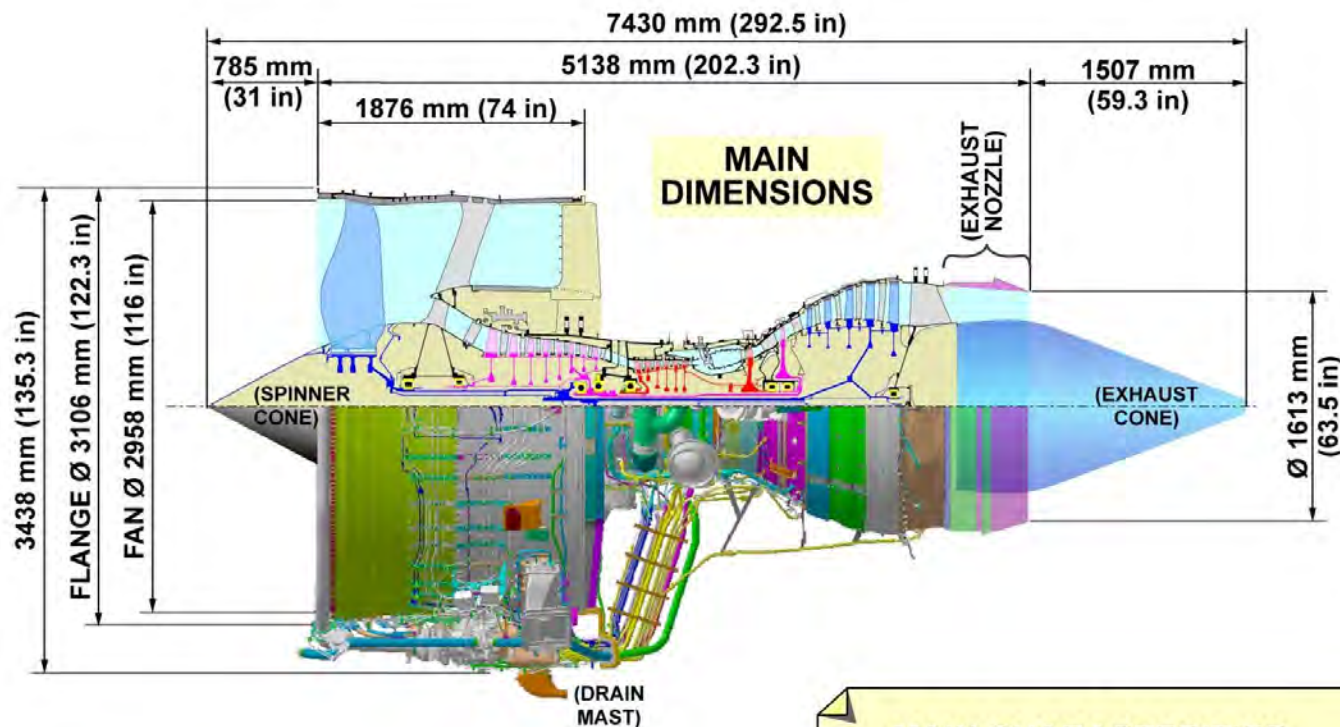
Overall length of the engine from the front of the spinner cone to the rear of the exhaust cone is 7430 mm (292.5 in).

The LP compressor (or Fan) diameter is 2958 mm (116 in).

The maximum engine diameter, drain mast not included, is 3438 mm (135.3 in).

The weight of the dressed basic engine (dry) is approximately 6440 kg (141200 lb).

The fuel flow per engine at Take Off/Go-Around (TOGA) is approximately 9500 kg/h (20940lb).



| ENGINE MARK                                         | TAKEOFF THRUST |       | AIRCRAFT MODEL |
|-----------------------------------------------------|----------------|-------|----------------|
|                                                     | kN             | lb    |                |
| RB211-TRENT 970                                     | 311.38         | 70000 | A380-841       |
| RB211-TRENT 972                                     | 320.27         | 72000 | A380-842       |
| RB211-TRENT 977                                     | 359.33         | 80780 | A380-843F      |
| THE TAKEOFF THRUST IS FLAT RATED AT ISA+15°C (59°F) |                |       |                |

#### MAIN CHARACTERISTICS:

- TAKEOFF THRUST SET BY DATA ENTRY PLUG (DEP)
- BYPASS RATIO : 1 / 8.12
- PRESSURE RATIO (P20/P30) : 1 / 41.7
- APPROXIMATE WEIGHT OF THE DRESSED BASIC ENGINE (DRY) : ~ 6440 kg (14200 lb)
- TAKEOFF FUEL FLOW : ~ 9500 Kg/h (20940 lb)

#### ENGINE MAIN CHARACTERISTICS

## NACELLE, DRAINS & RR ENGINE PRESENTATION (1)

### Engine Rotors

The engine has 3 rotors:

- Low Pressure (LP) rotor,
- Intermediate Pressure (IP) rotor,
- High Pressure (HP) rotor.

The rotors are supported by 8 bearings, 2 types of bearings are used:

- Ball bearings also called location bearings support both radial and axial loads.
- Roller bearings support radial loads and give axial thermal expansion.
- Bearing housings are sealed by labyrinth air seals.

#### LP Rotor

The LP rotor has a single stage LP compressor driven by a 5-stage LP turbine.

The LP compressor, also called fan, has 24 wide-chord blades that are engaged in axial dovetail slots in the LP compressor disk.

For the blade replacement access you have to remove the spinner cone.

The LP compressor supplies most of the engine thrust.

The LP rotor is supported by 3 bearings

- 1 roller bearing at the rear of the LP compressor disk.
- 1 ball bearing close to the mid length of the LP rotor.
- 1 roller bearing at the LP turbine rear end.

The LP rotor speed is called N1. It turns in counter clockwise direction when viewed from the rear.

#### IP Rotor

The IP rotor has an 8-stage compressor driven by a single stage turbine. It is supported by 3 bearings:

- 1 roller bearing at the front end of the IP compressor.
- 1 ball bearing at the IP compressor rear part, around the mid length of the IP rotor.

- 1 roller bearing at the level of the IP turbine.

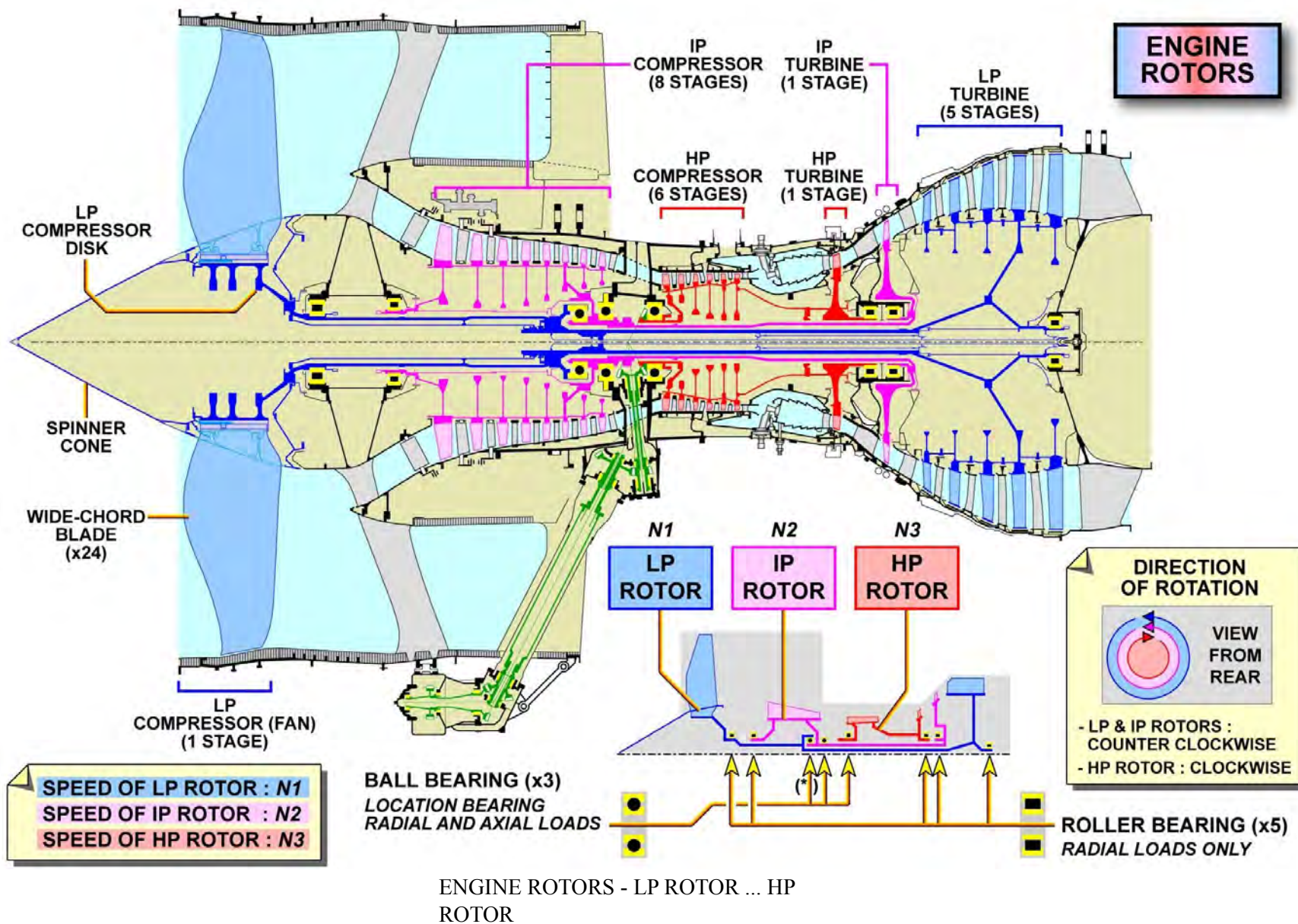
The IP rotor speed is called N2. It turns in counter clockwise direction when viewed from the rear.

#### HP Rotor

The HP rotor has a 6-stage compressor driven by a single stage turbine. It is supported by 2 bearings:

- 1 ball bearing at the HP compressor front end.
- 1 roller bearing at the HP turbine rear end.

The HP rotor speed is called N3. It turns in clockwise direction when viewed from the rear.



## NACELLE, DRAINS & RR ENGINE PRESENTATION (1)

### Accessory Drive Section

The accessory drive section transmits the mechanical power from the HP rotor to the accessory units installed on the accessory gearbox.

The power from the HP rotor goes successively through:

- The internal gearbox,
- A radial shaft,
- The intermediate gearbox,
- The external gearbox drive shaft,
- The transfer gearbox and,
- The accessory gearbox.

### EXTERNAL GEARBOX

The external gearbox is made of the transfer gearbox and the accessory gearbox.

The external gearbox assembly is attached and located beneath the LP compressor case, using 3 clevis mounts and a spigot.

The accessory gearbox has gear shafts that drive airframe and engine accessories. Each gear shaft is an individually replaceable plug-in type unit, which fits into the face of gearbox housing.

At the forward tip of the input gear shaft, the gearbox is supplied with a hand turning port, it is used to manually drive the HP rotor for maintenance task.

The sealing of the accessory drives is done by air blown seal.

### Location Of Accessories

Both front and rear faces of the accessory gearbox are supplied with mounting pads for accessory installation.

#### ACCESSORIES INSTALLED ON THE FRONT FACE:

- Dedicated alternator (FADEC),
- Starter,
- Hydraulic pumps 1 and 2 (ATA29).

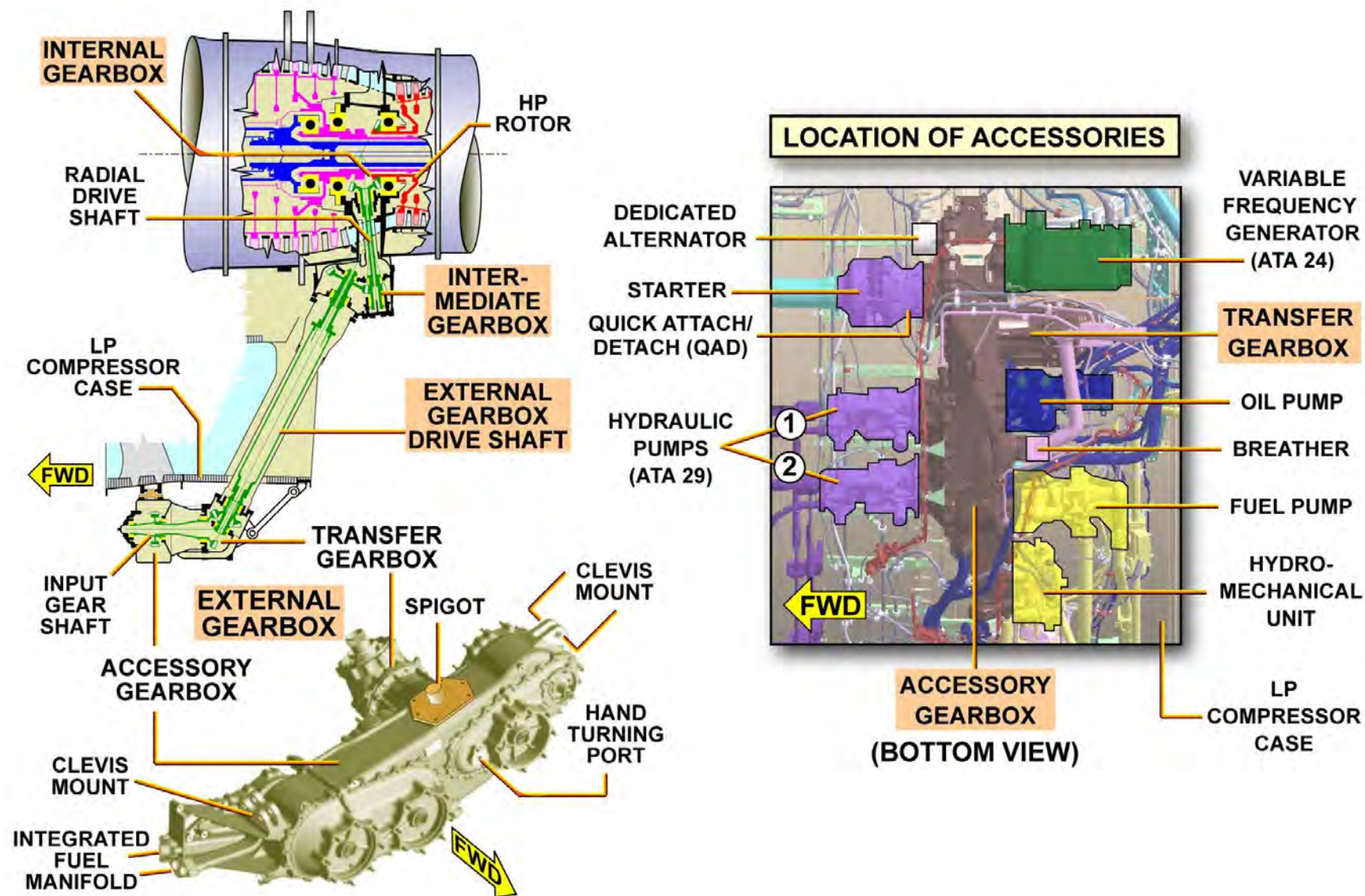
Note that the starter is installed with a Quick Attach/Detach (QAD) ring.

#### ACCESSORIES INSTALLED ON THE REAR FACE:

- Variable Frequency Generator (ATA 24),
- Oil pump,
- Breather,
- Fuel pump.
- Hydro mechanical unit.

The right hand side of the gearbox housing integrates a fuel manifold with internal fuel flow supply for both fuel pump and HMU.

Notice that the HMU is not mechanically driven by the accessory gearbox. The HMU is only hydraulically connected.



ACCESSORY DRIVE SECTION - LOCATION OF ACCESSORIES

## ENGINE SYSTEMS PRESENTATION (1)

### FADEC & EIPM

The Full Authority Digital Engine Control (FADEC) System includes two engine-mounted units:

- Engine Electronic Controller (EEC), including two independent channels,
- Engine Monitoring Unit (EMU) fulfills the vibration monitoring function for the cockpit display and the engine health monitoring for advanced engine maintenance functions.

The EEC receives inputs from the cockpit, aircraft sensor and engine sensors to control the engine and to give engine information to the aircraft systems. The EEC is connected to the Avionics Data Communication Network (ADCN).

The EEC manages the engine thrust according to Air data parameters and cockpit controls.

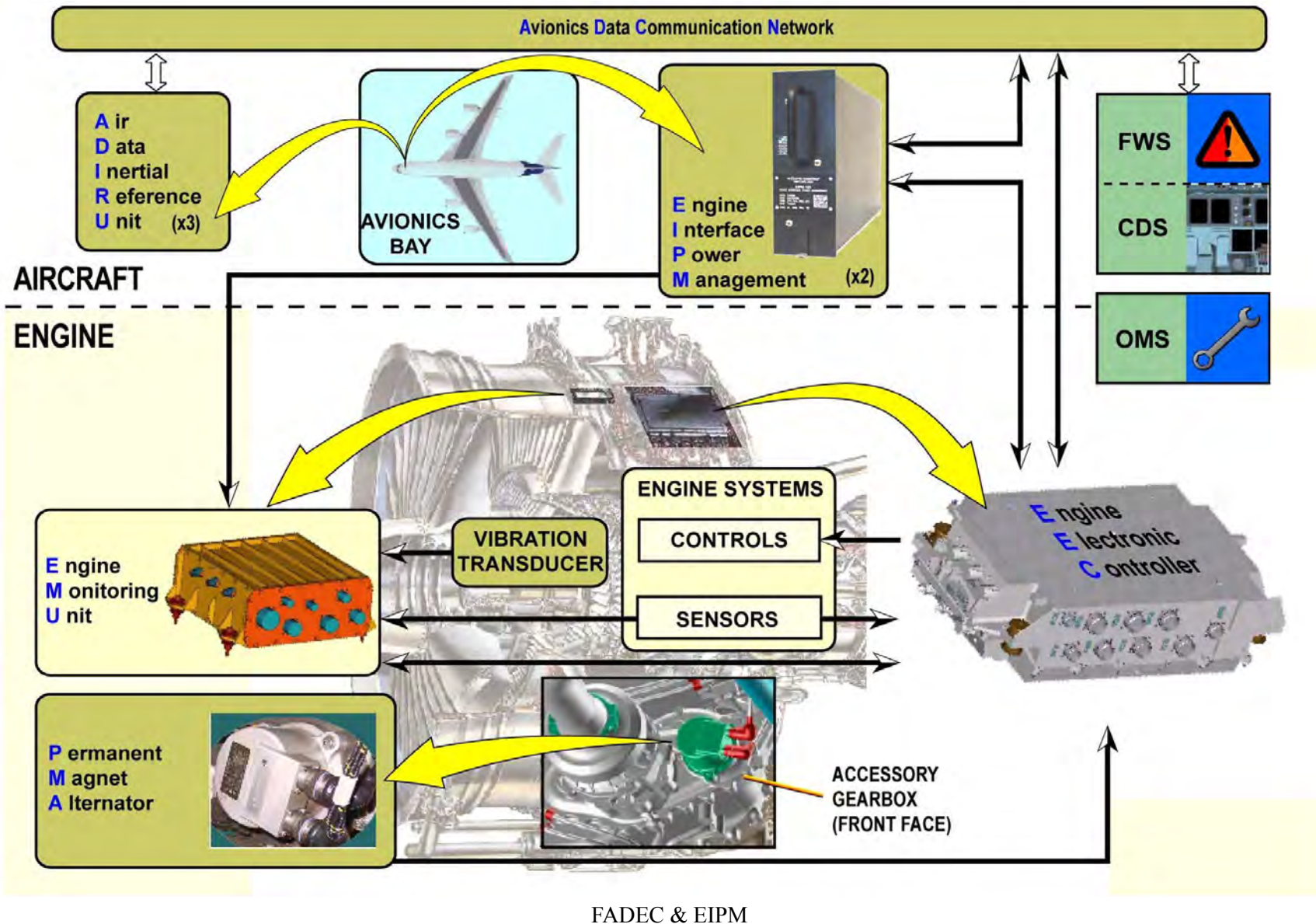
The EEC dialogs with the Air Data Inertial Reference Units (ADIRUs) through the ADCN network to make the air data selection logic.

The EEC sends signals to:

- The FWS for alert activation,
- The CDS for display,
- The OMS for maintenance.

The Engine Interface Power Management (EIPM) controls and delivers electrical power supplies from the aircraft to the engine EEC, the EMU and to the engine systems.

The EEC can be powered by an engine driven Permanent Magnetic Alternator (PMA) or from aircraft power via the EIPM.



## ENGINE SYSTEMS PRESENTATION (1)

### EEC Main Functions

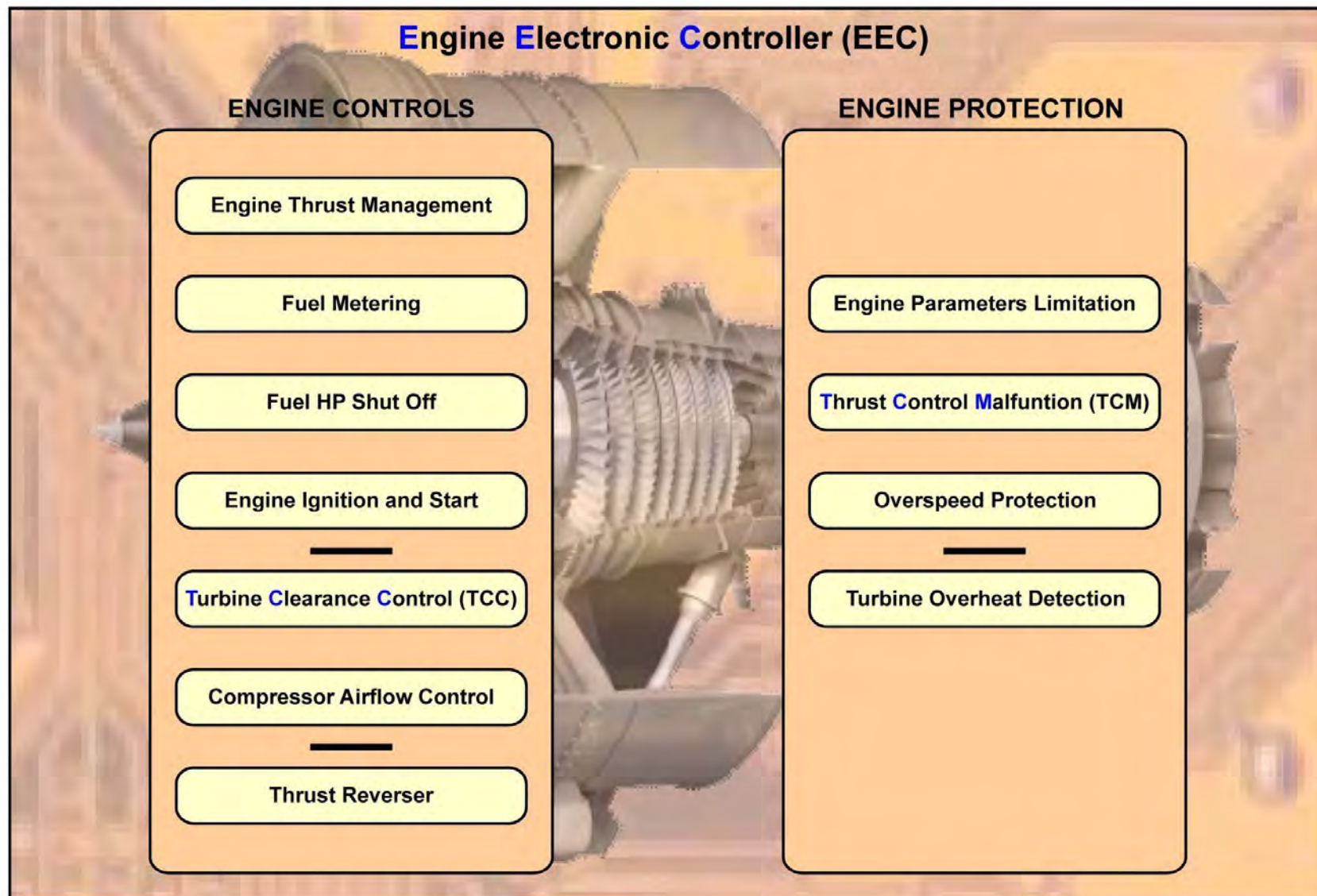
The EEC system supplies full authority of engine control to achieve starting, shut down, steady state and transient engine operations.

The EEC main control functions are:

- Engine thrust management (Manual and auto thrust modes),
- Fuel metering through Hydro Mechanical Unit (HMU),
- Fuel HP Shut Off,
- Engine start in automatic mode with auto start abort capability,
- Engine start in manual mode,
- Continuous relight,
- Turbine Tip Clearance Control by case cooling,
- Compressor airflow control, as anti-surge devices, by means of Handling Bleed Valves and Variable Stator Vanes,
- Thrust reverser control through Electrical Thrust Reverser Actuation Controller (ETRAC).

The EEC main protection functions are:

- Engine N1, N2, N3 speeds limitation,
- EGT limitation during autostart,
- Thrust control malfunction which protects the engine when the actual thrust differs from the commanded thrust,
- LP turbine and rotors overspeed,
- IP turbine overheat detection, cockpit warning activation.



EEC MAIN FUNCTIONS

## ENGINE SYSTEMS PRESENTATION (1)

### Fuel System

The engine fuel system is designed to supply metered fuel to the combustion chamber to achieve the requested engine thrust.

In addition the fuel is used to exchange heat with the engine oil.

The fuel is also used as servo pressure to operate actuators of the engine air system.

The Hydro Mechanical Unit (HMU) and the fuel pump assembly are the main components of the engine fuel system.

The fuel pump assembly houses 3 pumps. Each pumps feeds a specific circuit of the fuel system.

The Engine Electronic Controller (EEC) manages the fuel system through the HMU following the thrust request from the cockpit or by the auto thrust.

The EEC sends signals to:

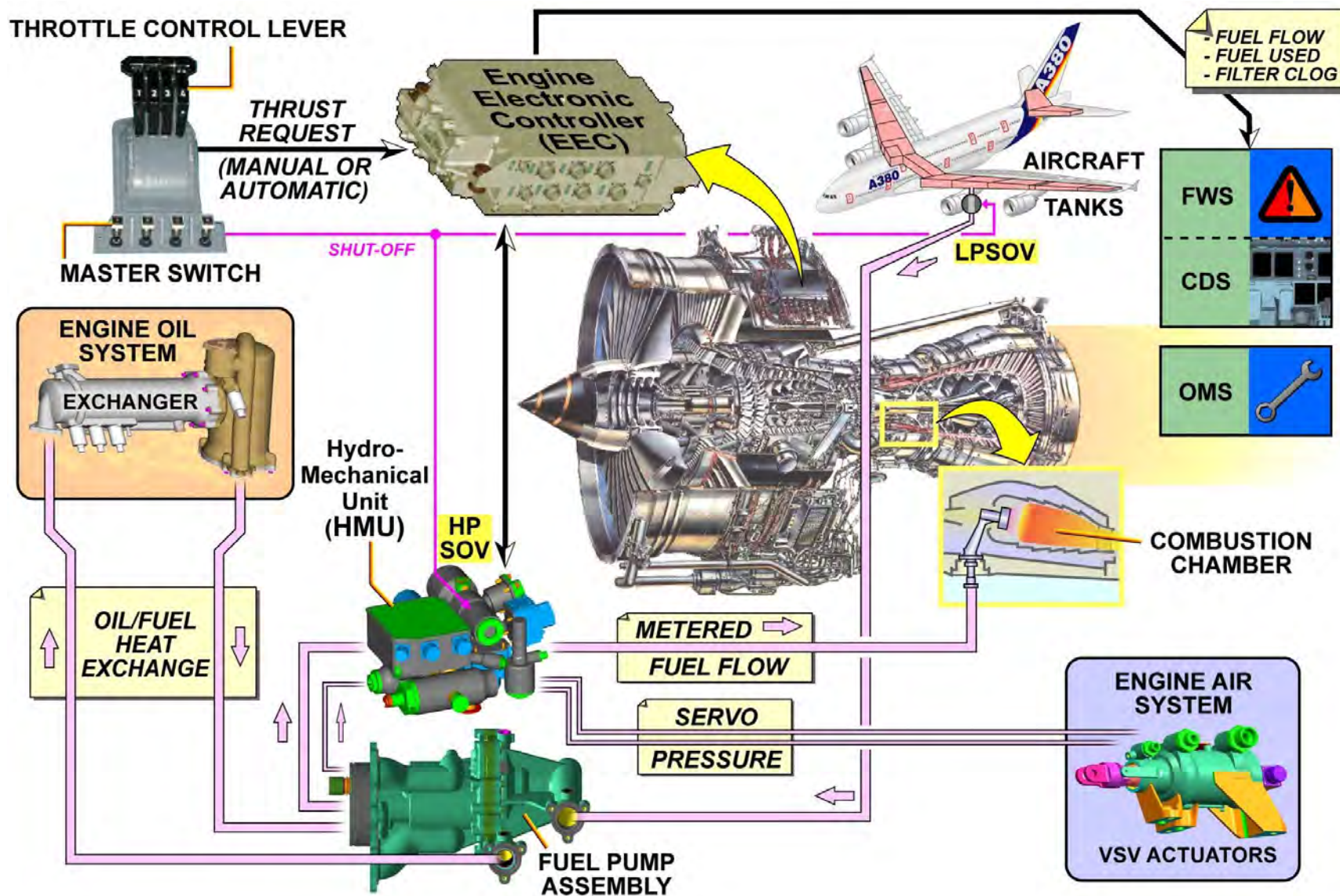
- The FWS for alert activation,
- The CDS for display,
- The OMS for maintenance.

### Low Pressure & High Pressure Fuel Shut-Off

The LP Shut-Off Valve is installed at the exit of the aircraft tank and the HP Shut-Off Valve is installed inside the HMU.

Engine shut down is done by setting the MASTER switch OFF, which closes the LP Shut Off valve and the HP Shut Off Valve directly.

The EEC can also close the HP Shut Off Valve automatically in case of aborted start sequence on ground.



FUEL SYSTEM - LOW PRESSURE & HIGH PRESSURE FUEL SHUT-OFF

## ENGINE SYSTEMS PRESENTATION (1)

### Oil System

The engine oil system supplies clean oil at a correct pressure and temperature to lubricate and to cool main bearings and gearboxes. It is a recirculatory and de-aerated system. The scavenged oil is returned to the tank.

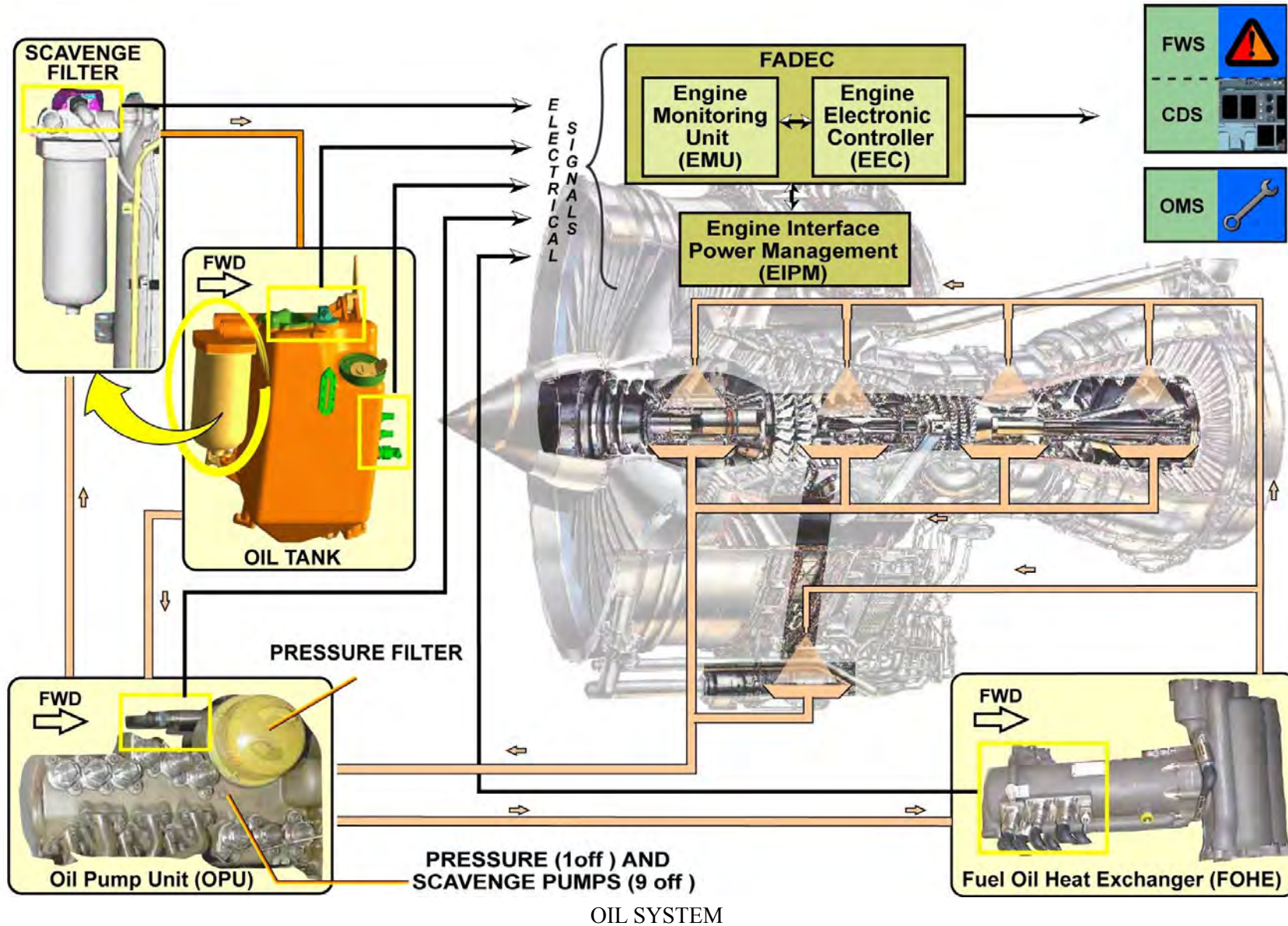
The main components of the oil circuit are:

- The oil tank,
- The Oil Pump Unit (OPU),
- The Fuel Oil Heat Exchanger (FOHE),
- The scavenge filter.

The FADEC and the Engine Interface Power Management (EIPM) monitor the main oil parameters.

The EEC sends signals to:

- The FWS for alert activation,
- The CDS for display,
- The OMS for maintenance.

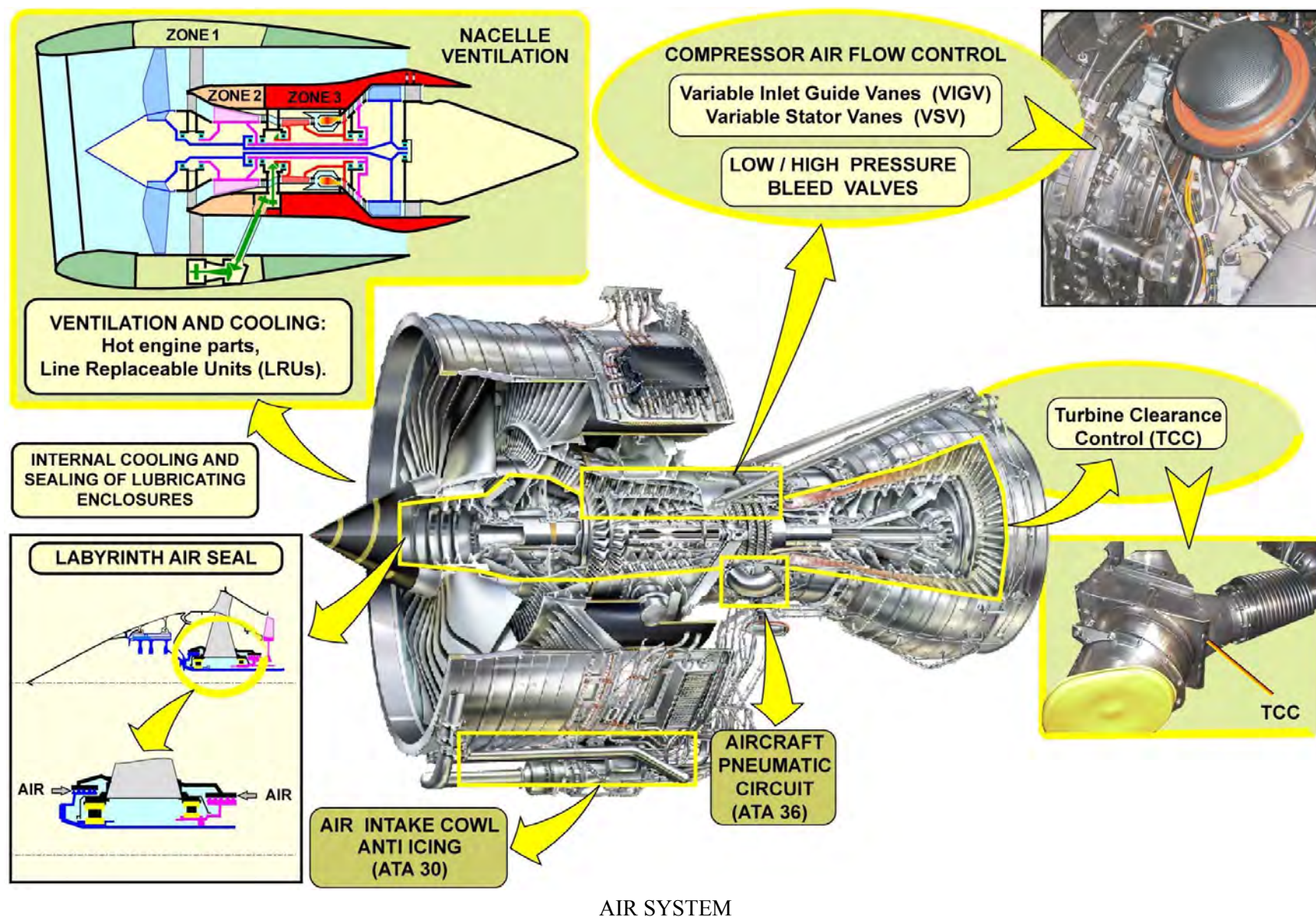


## ENGINE SYSTEMS PRESENTATION (1)

### **Air System**

Engine air is tapped from the engine compressor and the nacelle, it includes of the following subsystems:

- Nacelle ventilation and cooling of parts subjected to high thermal stresses,
- Cooling of the internal hot engine parts and Sealing of the lubricating enclosures,
- Compressor airflow control using bleed valves and variable inlet guide vanes and variable stator vanes (VIGV,VSVs),
- Supplying air for the aircraft pneumatic circuit (ATA36),
- Supplying air for the intake cowl anti icing device (ATA 30).



## ENGINE SYSTEMS PRESENTATION (1)

### **Air System - Nacelle Ventilation**

The power plant includes three ventilated zones.

The function of the zones ventilation system is:

- To supply cooling for the components and the parts installed on the engine,
- To keep nacelle temperature at satisfactory levels,
- To isolate areas of the engine for better fire protection.

Zone 1: Is the annular space between the Low Pressure (LP) compressor case and the fan cowl doors.

Zone 2: Is the annular space between the Intermediate Pressure (IP) compressor case and the gas generator fairings.

Zone 3: Is the annular space between the core engine and the inner fixed structure of the fixed fan exhaust cowls.

### **Zone 1 - Fan Case Ventilation**

The primary function of the zone 1 ventilation is to prevent fire and to maintain the Line Replaceable Units (LRUs) for the fuel, oil, hydraulic and FADEC systems at a satisfactory temperature level. An inlet at the top of the air intake cowl supplies the zone 1 with airflow.

An outlet at the bottom of the right fan cowl door exhausts the air overboard.

### **Zone 2 - Intermediate Compressor Case Compartment**

The primary function of the zone 2 ventilation is to prevent fire and to keep the engine components at a satisfactory temperature. Air from the LP compressor flows through two front inlets in the top gas generator fairings.

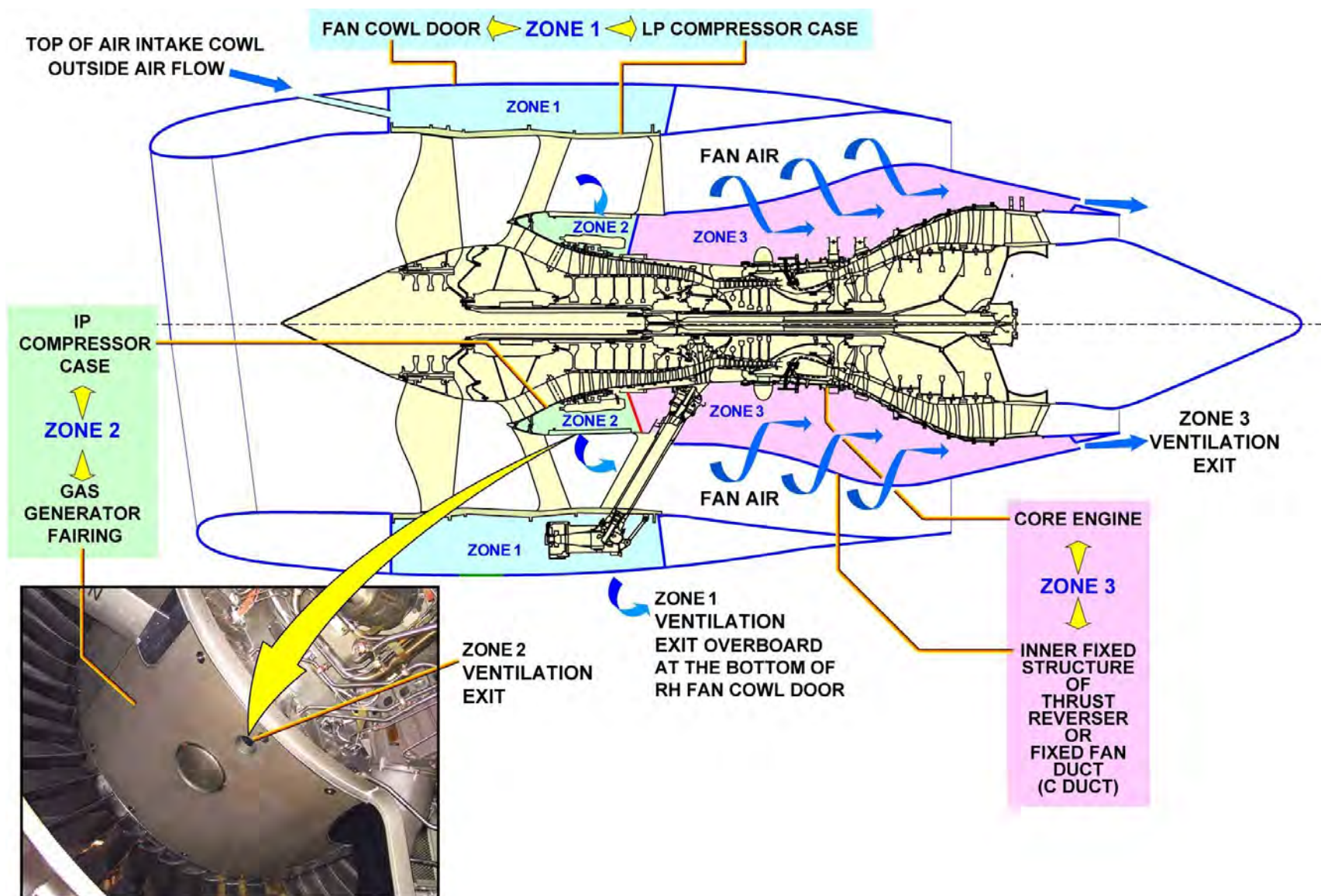
At the bottom, two rear outlets in the gas generator fairings bleed back the air into the LP airflow.

### **Zone 3 - Engine Core Compartment**

Zone 3 is a hot area; the primary function of the zone 3 ventilation is to keep engine components at a satisfactory temperature.

LP compressor air flows through openings in the inner fixed structure of the fan exhaust cowls. The air flowing around the zone cools down the components.

At the rear of the zone the air is bled overboard through an annular gap between the fan exhaust cowls after-body and the exhaust nozzle.



AIR SYSTEM - NACELLE VENTILATION - ZONE 1 - FAN CASE VENTILATION ... ZONE 3 - ENGINE CORE COMPARTMENT

## ENGINE SYSTEMS PRESENTATION (1)

### **Air System**

Turbine Case Cooling (TCC) system is used to cool the LP turbine case and controls HP, IP and LP turbine blades tip clearances, in order to increase the engine efficiency. The air for the TCC system is the LP compressor flow (fan air).

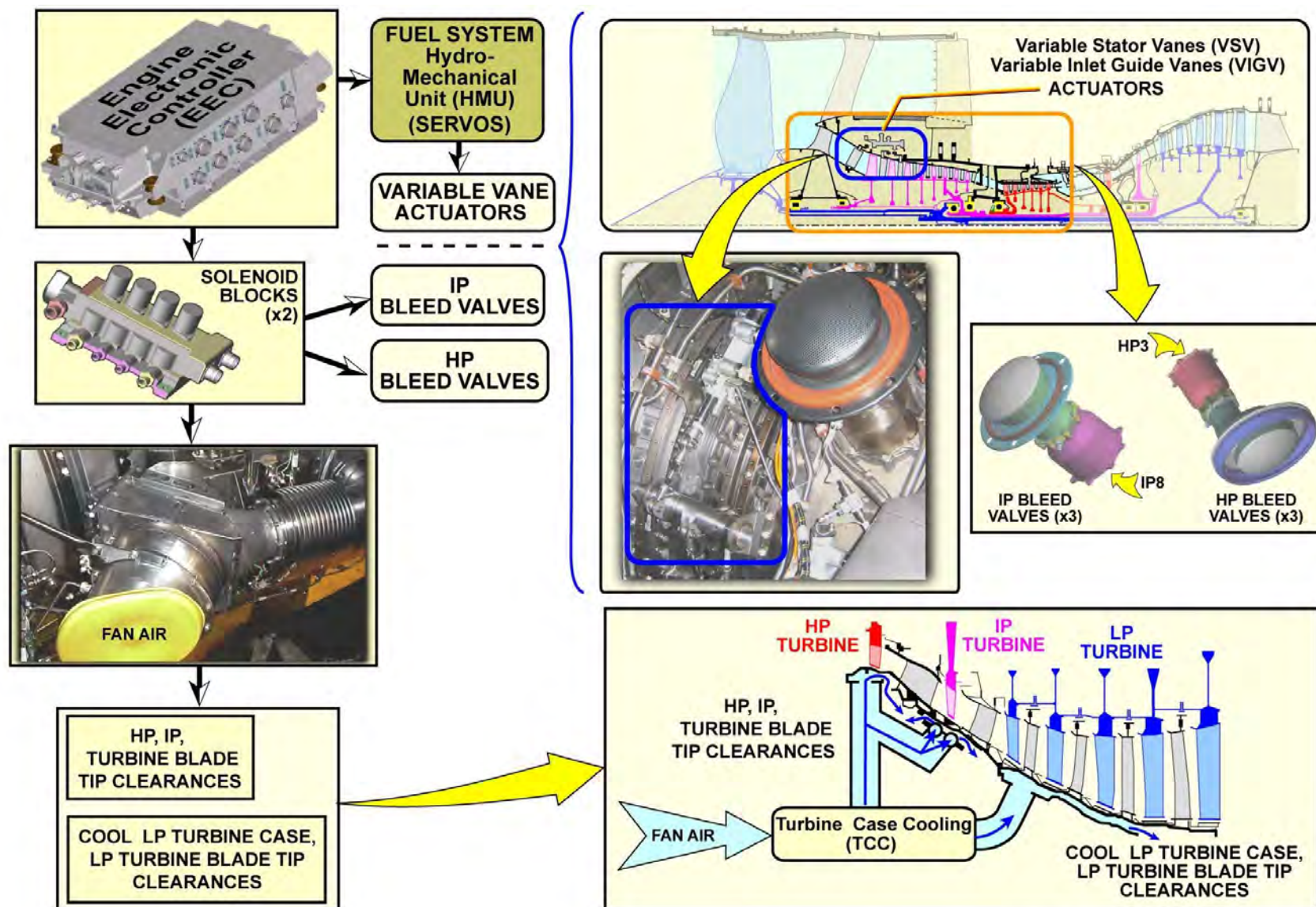
The EEC controls the operation of the TCC valve.

#### **IP/HP Compressor Airflow**

The EEC controls the airflow system, which is composed of:

- Three IP bleed valves in line with stage 8 of the IP compressor,
- Three HP bleed valves in line with stage 3 of the HP compressor,
- One stage of IP compressor Variable Inlet Guide Vanes (VIGVs),
- Two stages of IP compressor Variable Stator Vanes (VSVs),

Both bleed valves and variable vanes are used to protect the engine against surge and stall.



AIR SYSTEM - IP/HP COMPRESSOR AIRFLOW

## ENGINE SYSTEMS PRESENTATION (1)

### Ignition & Starting Systems

The ignition and starting systems are used for ground or in-flight starting and to crank the engine.

The EEC is able to make an automatic and manual engine starts, they are initiated from the cockpit controls.

The EEC controls the following sequences:

- Automatic engine ground starting,
- Manual engine ground starting,
- Engine crank,
- in flight starting,
- Continuous ignition,
- Auto relight function.

The ignition and starting systems use pneumatic power to drive the HP rotor and produce electrical sparks to ignite the fuel / air mixture in the combustion chamber.

The EEC gives the Ignition and Starting indications to the ECAM System Display (SD).

#### Starting System

The starting system includes:

- Pneumatic starter air duct,
- Starter Control Valve (SCV),
- Pneumatic starter.

The system uses pressurized air to drive an air turbine starter at high speed. The starter drives the engine High Pressure (HP) rotor through a reduction gear and the engine accessory drive system. The air, which is necessary to drive the starter, comes from one of the following three sources:

- Auxiliary Power Unit (APU) bleed air supply,
- Another engine cross bleed air supply,
- External Ground HP air supply.

The Starter Control Valve is a butterfly type valve. It is electrically controlled and pneumatically operated.

The SCV is controlled open and closed by the EEC, during start or crank sequences.

The SCV is located on the lower left side part of the Low Pressure (LP) compressor case.

In case of failure, the SCV can be manually operated through a manual override.

#### Ignition System

Each engine has two ignition systems.

Each ignition system includes:

- One ignition unit,
- One ignition lead,
- One igniter plug.

Each ignition system can operate together or independently.

Each system has an ignition power supply and an ignition distribution system.

The EEC alternates between the "A" and "B" ignition system for automatic engine ground start.

Each EEC channel controls and monitors the supply of electrical power to each ignition unit.

The EEC is supplied with 115VAC from Aircraft Emergency and Normal busses through the EIPM.

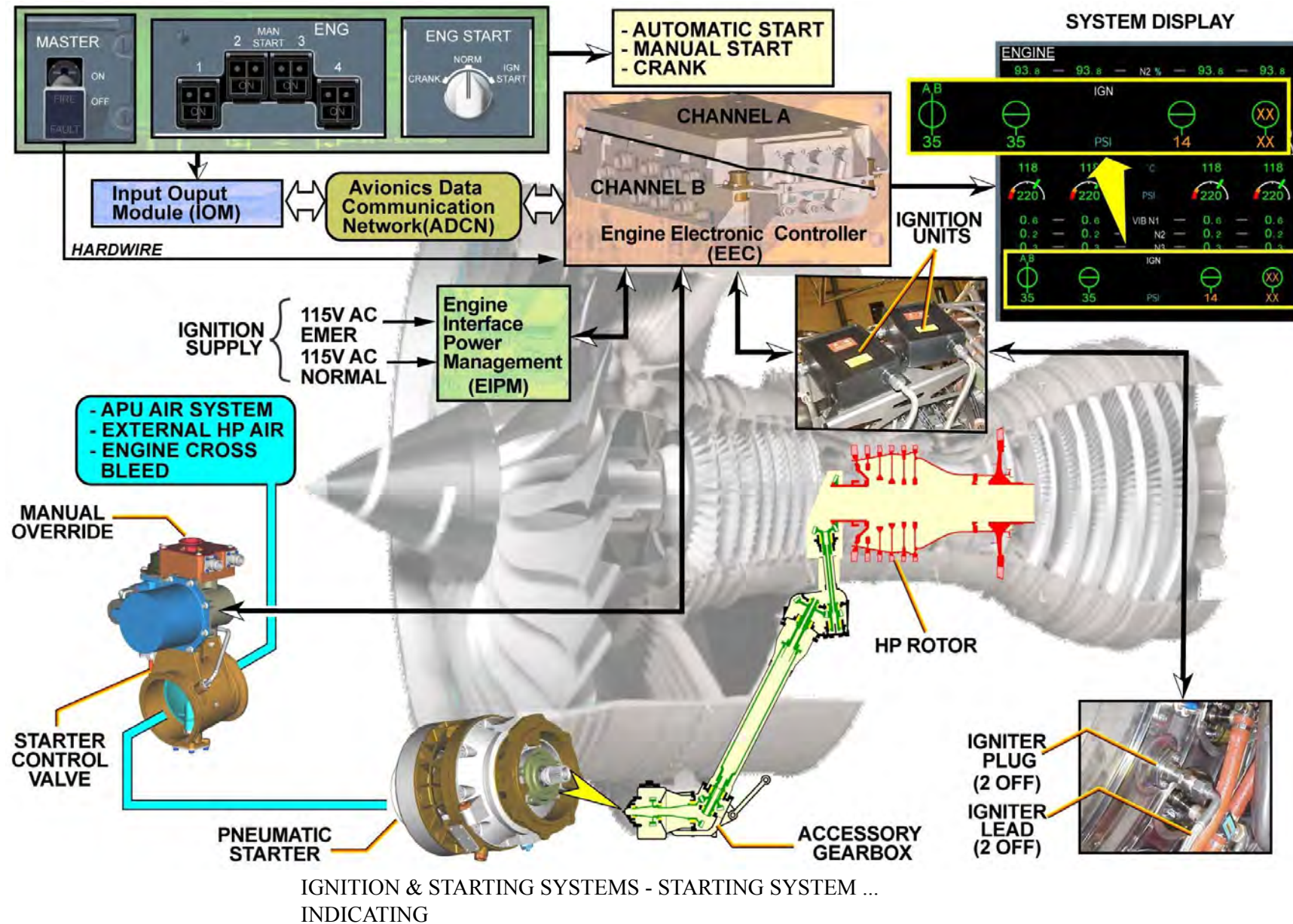
#### Indicating

During the Starting or Cranking sequence the NACelle temperature indication is replaced automatically by the IGNition and Start parameters on the System Display (SD) ENGINE page.

For each engine the following indications are displayed:

- The ignition system selected by EEC (IGN A and/or B),
- The bleed pressure value available (PSI) and,
- The Starter Control Valve position (in line when open or not in line when closed).

The EEC also supplies fault annunciation to the Flight Warning System (FWS).



## ENGINE SYSTEMS PRESENTATION (1)

### Thrust Reverser System

The thrust reverser of the A380 is an Electrical Thrust Reverser Actuation System (ETRAS). The thrust reverser is only installed on the inboard position nacelles.

The Thrust Reverser structure has two translating cowls.

In forward thrust configuration the translating cowl is in the forward, stowed position, covering the cascade vanes.

The blocker doors are faired into the inner acoustic panel of the translating cowl in stowed position.

In reverse thrust, deployed position, the translating cowl moves backward to uncover the cascade vanes, while the blocker doors rotate inward to blank the fan flow duct.

The reverse thrust is obtained by redirecting the engine fan flow forward, by means of the cascade vanes.

### ETRAS Command Lines

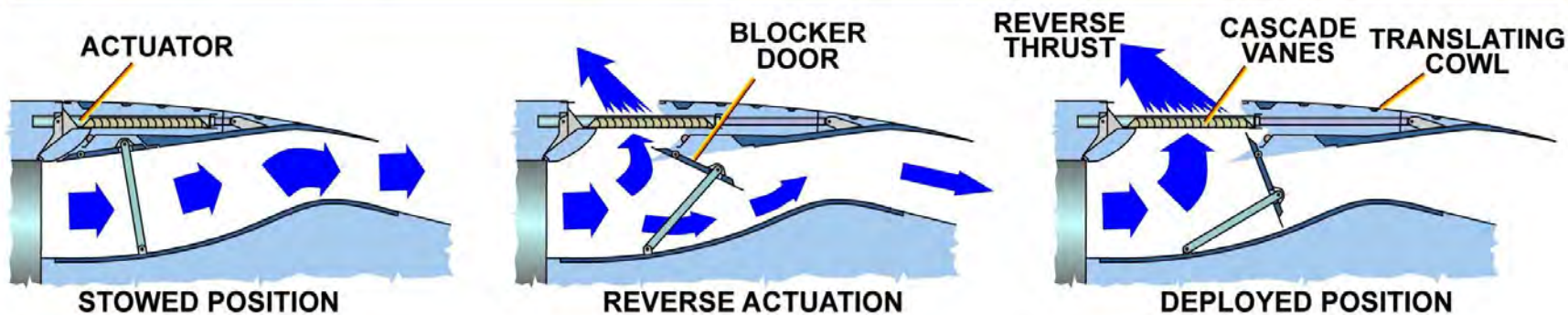
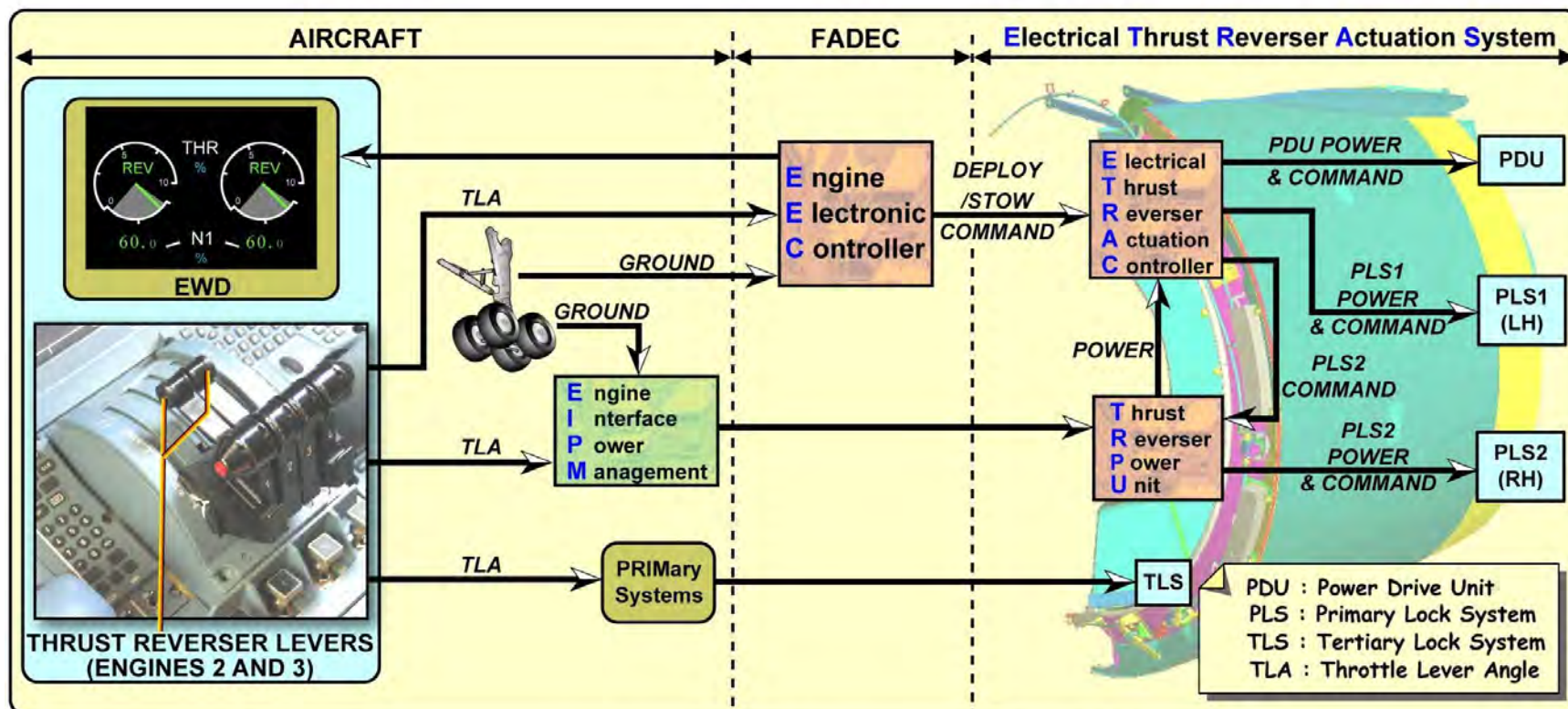
The Thrust Reverser actuation power chain is made of the following components:

- Electrical Thrust Reverser Actuation Controller (ETRAC),
- Thrust Reverser Power Unit (TRPU),
- The Power Drive Unit (PDU),
- The Primary Lock Systems (PLS), LH and RH,
- The Tertiary Lock System (TLS).

The ETRAC digitally interfaces with EEC and supplies control for the position of the sleeves.

The ETRAS requires three separate aircraft commands to start the deployment (3 lines of defense):

- The command to unlock the TLS through the PRIMary systems,
- The command to supply the TRPU through EIPM,
- The deploy or stow command to the ETRAC through EEC.



THRUST REVERSER SYSTEM - ETAS COMMAND LINES

## ENGINE SYSTEMS PRESENTATION (1)

### Thrust Reverser System (continued)

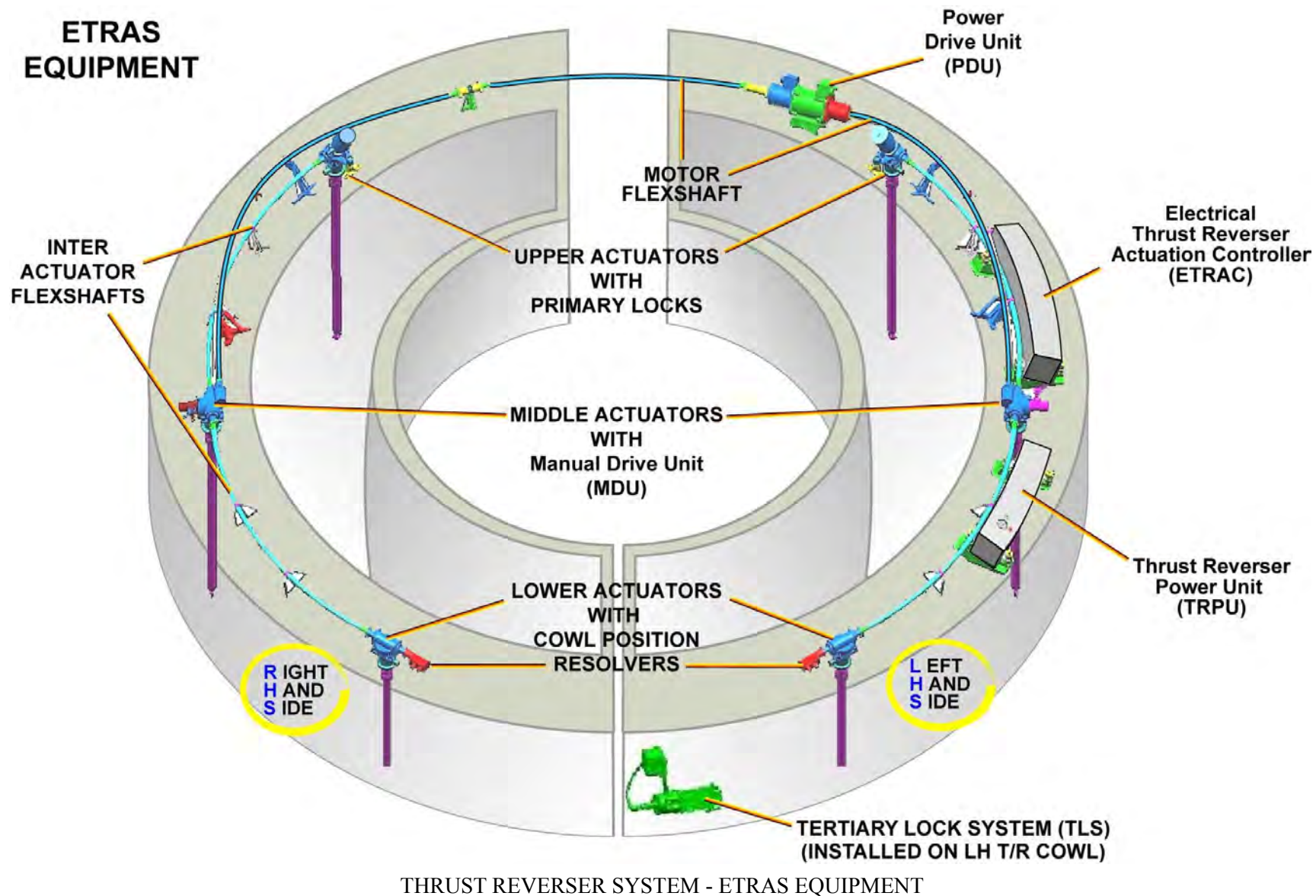
#### ETRAS Equipment

The Electrical Thrust Reverser Actuation System (ETRAS) deploys and stows the two mechanically linked transcowl sleeves.

The ETRAS includes:

- Electrical Thrust Reverser Actuation Controller (ETRAC),
- Thrust Reverser Power Unit (TRPU),
- Power Drive Unit (PDU) electrical motor,
- Flexshafts,
- Actuators (2 lowers, 2 centers, 2 uppers),
- Primary Locks (integrated to upper actuators),
- Manual Drive Units (integrated to middle actuators),
- Tertiary Lock System (TLS),
- Electrical Harnesses (Power and control/monitoring).

The thrust reverser is locked by mechanical means inside the upper actuators named Primary Lock System (PLS) and supplemented by an electrical Tertiary Locking System (TLS).



## ENGINE SYSTEMS PRESENTATION (1)

### Control & Indicating

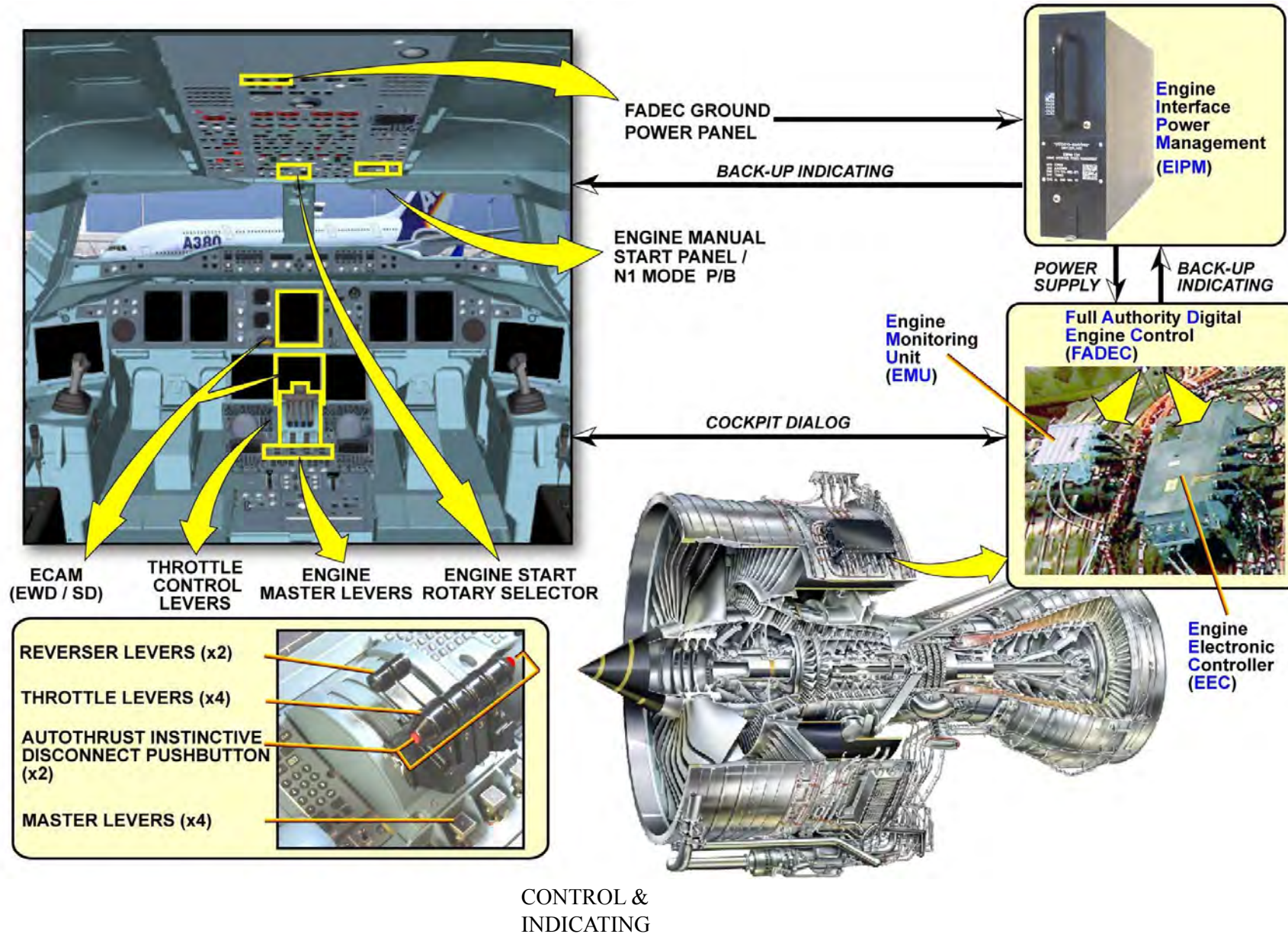
The engine controls are located on the overhead panel and on the center pedestal.

The engine controls are:

- The throttle control levers,
- The engine master levers,
- The engine start rotary selector,
- The man start pushbuttons,
- N1 mode selection pushbutton,
- The FADEC ground power pushbuttons

The engine parameters are displayed on the ECAM, which is divided over two screens, the Engine Warning Display (EW/D) and the System Display (SD).

In case of network failure the Engine Electronic Controller (EEC) and the Engine Interface Power Management (EIPM) are linked to keep the engine parameters indication.



## ENGINE SYSTEMS PRESENTATION (1)

### Control & Indicating (continued)

#### Throttle Control Assembly

The Throttle Control Assembly (TCA) is a single mechanical box assembly. The primary function of the TCA is to sense throttle control lever position.

It features four throttle levers and two reverser levers, one for each inboard engine.

It features also soft detents, which correspond to thrust settings (idle, Climb, FLX/MCT, TOGA).

In both automatic and manual thrust setting modes, the selection of the throttle levers to full forward position leads the FADEC system to set the engine at max available power.

#### Engine Master Levers

The ENGINE MASTER lever (one per engine) is the primary control to initiate engine start sequence and to shut down the engine

The ENGINE MASTER lever is hardwired to the fuel High Pressure Shut-Off Valve (HPSOV) and to each channel of the EEC.

A "FAULT" indication is situated at the top of the ENGINE MASTER lever; this indication is managed by the EIPM, based on digital data received from the related EEC.

#### Engine Start Rotary Selector

The ENGINE START rotary selector is a single cockpit command for the four engines. It is positioned on the overhead panel and has three positions, "CRANK", "NORM" and "IGN START".

##### CRANK

The CRANK position allows wet or dry motoring of the engine.

##### NORM

The NORM position is the usual position selected after engine start. The FADEC can operate the ignition systems in this position for auto relight/flameout.

##### IGN START

The IGN START position is used to initiate automatic or manual starts.

#### Engine Man Start PushButtons

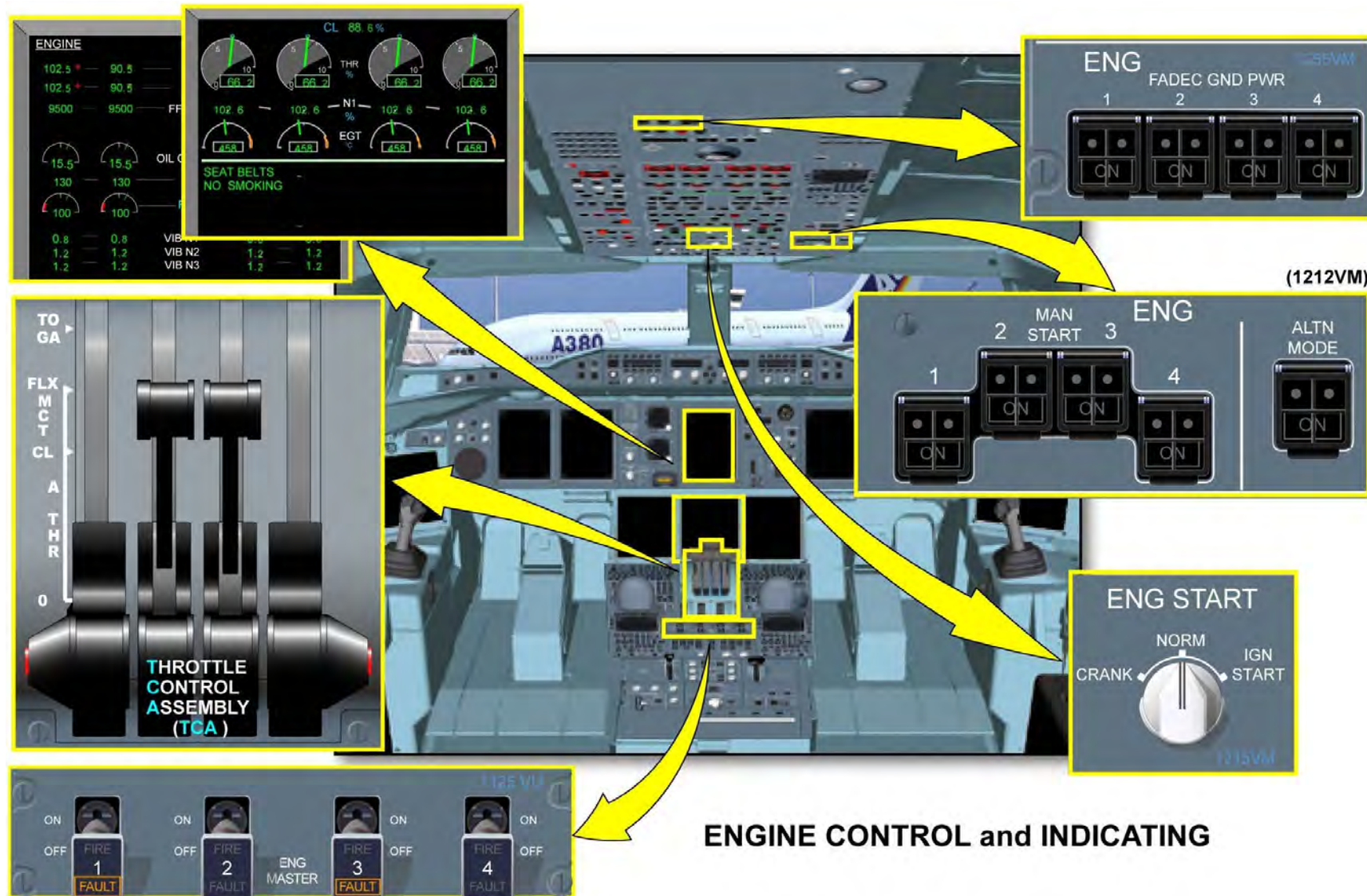
The MANual START pushbutton is used to inform the EEC to operate the related start valve for a manual starting sequence (when the engine start rotary selector is set to IGN START) or to crank the engine (when the engine start rotary selector is set to CRANK).

#### N1 Mode Selection: Alternate Mode

A single N1 pushbutton interfaces with the four EECs. This pushbutton is labeled as ALTerNate MODE on the overhead panel. This pushbutton is used to force or confirm the engines to operate in N1 back up mode, when the EEC detects a failure of the primary engine control mode.

#### FADEC Ground Power PushButtons

The FADEC GrouND PoWeR pushbutton is directly connected to the EIPM. The EIPM maintains the EEC and the Engine Monitoring Unit (EMU) airframe power supply for 10 minutes.



CONTROL & INDICATING - THROTTLE CONTROL ASSEMBLY ... FADEC GROUND POWER PUSHBUTTONS

## **ENGINE SYSTEMS PRESENTATION (1)**

### **Control & Indicating (continued)**

#### **Engine Primary Indication**

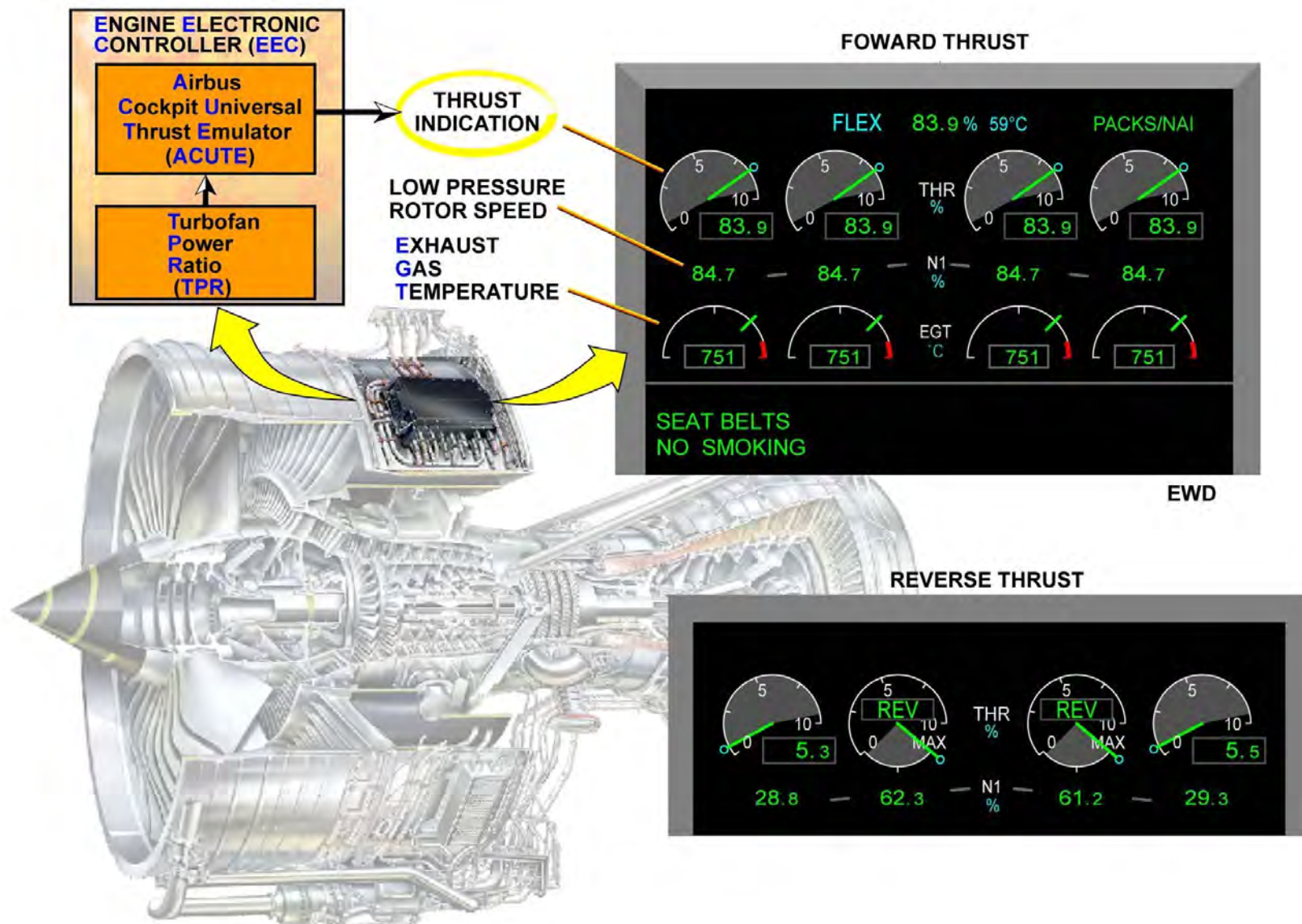
The main parameters, THRust (THR), low pressure rotor (Fan) speed N1, and the Exhaust Gas Temperature (EGT), are displayed on the Engine Warning Display (EWD).

The engine power indication is named thrust "THR", it is derived from the ratio combustion chamber pressure to engine intake pressure corrected by turbine gas temperature and engine intake temperature. THR is expressed as a percentage of thrust available (for the forward power operation and for the reverse power operation).

The thrust indication comes from an EEC processing function named ACUTE (Airbus Cockpit Universal Thrust Emulator).

The Turbofan Power Ratio (TPR) is the preliminary parameter to compute the thrust indication. (TPR is not displayed in the cockpit).

100% of thrust represents the maximum available thrust, with Bleed OFF and the throttle control levers set at TOGA detent point.



CONTROL & INDICATING - ENGINE PRIMARY INDICATION

## ENGINE SYSTEMS PRESENTATION (1)

### Control & Indicating (continued)

#### Engine Secondary Indication

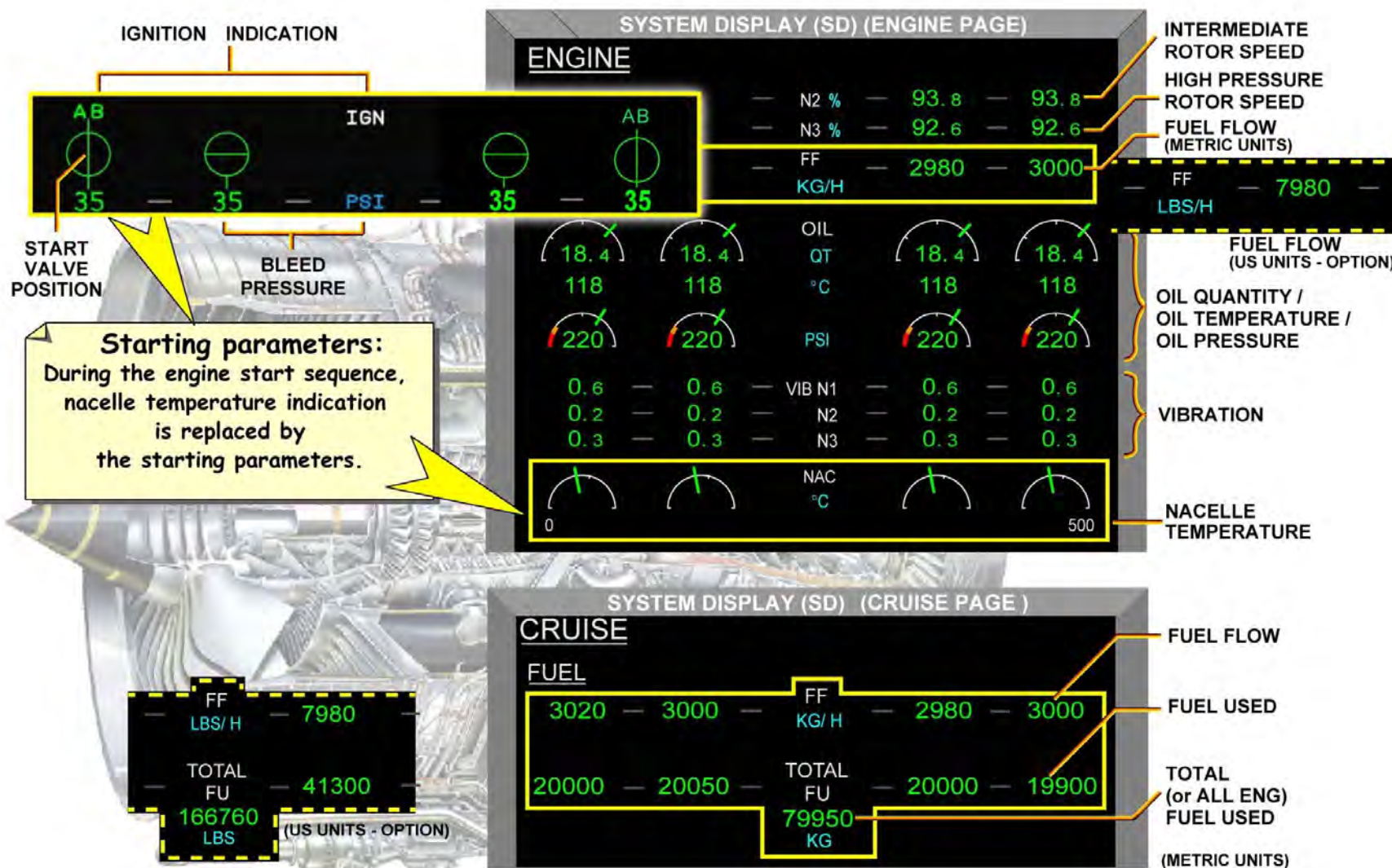
The secondary parameters are shown on the System Display (SD), through the ENGINE page or the CRUISE page.

They are:

- The intermediate rotor speed N2,
- The high pressure rotor speed N3,
- The fuel flow (F/F),
- Oil quantity (OIL QTY), oil pressure (OIL PRESS), oil temperature (OIL TEMP),
- Vibration indication (VIB N1), (VIB N2), (VIB N3),
- Nacelle temperature (NAC),

During the start sequence the engine nacelle temperature indication is replaced by the starting parameters.

The CRUISE page displays the fuel flow (FF), the fuel used (F. USED), the APU and engine consumption (TOTAL F. USED), engine consumption without APU (all ENG).



CONTROL & INDICATING - ENGINE SECONDARY  
INDICATION

## ENGINE SYSTEMS PRESENTATION (1)

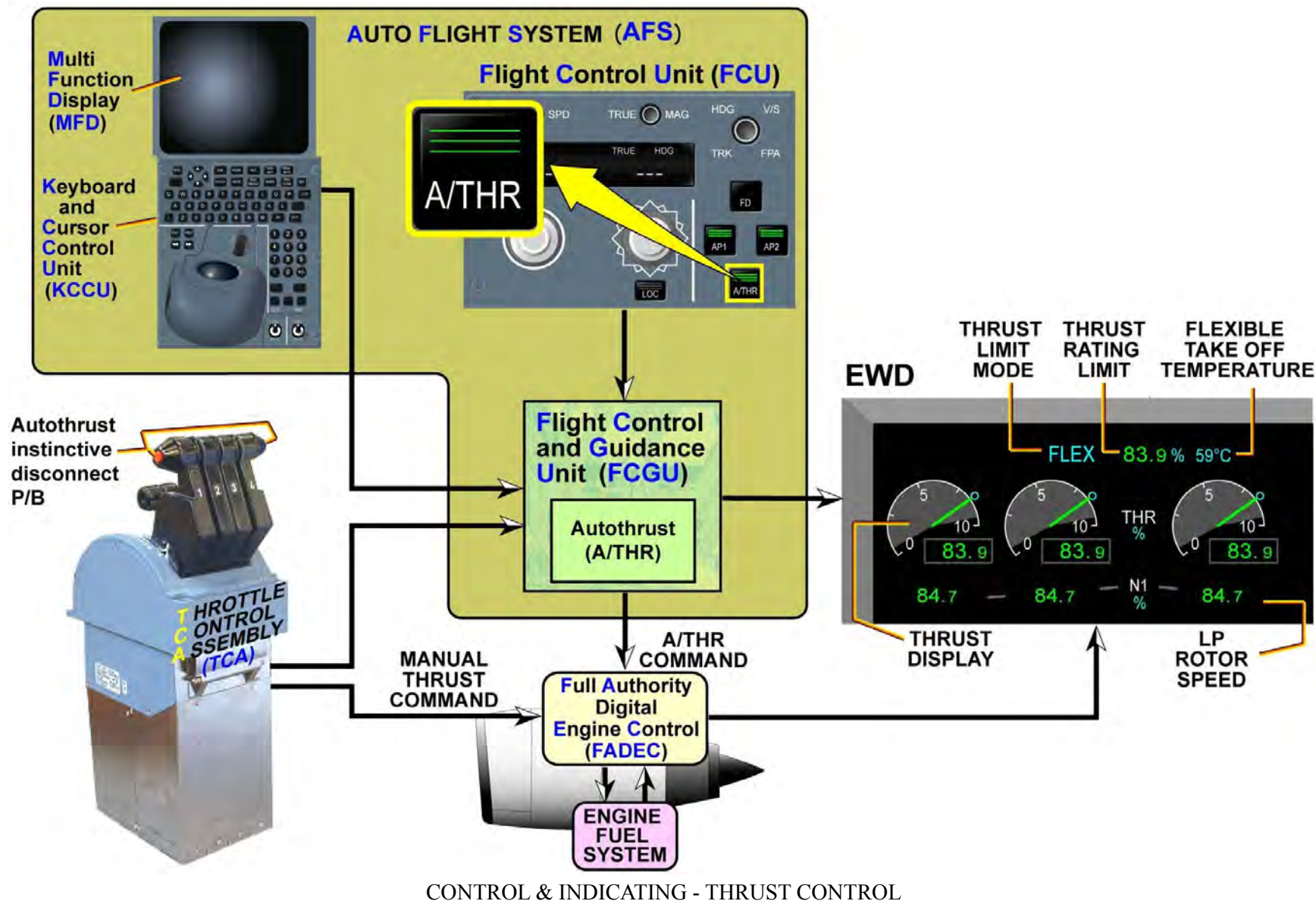
### Control & Indicating (continued)

#### Thrust Control

The thrust control fulfills the following functions:

- Modulation of engine thrust in manual mode, according to throttle control lever position,
- Thrust management in Auto THRust (A/THR) mode, according to thrust request coming from the Flight Control and Guidance Unit (FCGU),
- Instinctive disconnection of A/THR.

The Keyboard And Cursor Control Unit (KCCU) and the Multi Function Display (MFD) are used to set the necessary data to make a derated take-off or a flexible take off.



## ENGINE MAINTENANCE PRESENTATION (1)

### Engine Safety Items

Here is an overview of main safety precautions relative to the engines. For maintenance tasks, deactivate the thrust reverser before working around it, put the safety devices and the warning notices in position. Otherwise the thrust reverser can operate accidentally.

Make sure that all engine areas are as clear as possible and that the proper fire fighting equipment is in place.

Do not try to stop the fan by hand.

To open the engine cowls, respect the wind limitations and the given opening/closing sequence.

After the engine shutdown, parts can stay hot for almost one hour.

Let the pressure decrease in the oil tank before doing the oil servicing to prevent hot engine oil splashes.

Let the ignition system energy dissipate fully before working on it as it uses dangerous levels of electricity. Keep in mind that this system may be energized through tests.

The engine fuel and oil are poisonous. If you spray oil or fuel on your skin wash yourself.

DE-ACTIVATE THRUST REVERSER SYTEM  
WHEN OPERATING ON ENGINE:



DO NOT TOUCH PARTS UNTIL  
THEY ARE SUFFICIENTLY COOLED:



LET THE IGNITION SYSTEM ENERGY  
DISSIPATE FULLY BEFORE WORKING ON IT:



DO NOT TRY TO STOP THE FAN  
BY HAND:



LET DECREASE THE OIL PRESSURE  
BEFORE SERVICING:



RESPECT WIND LIMITATIONS  
FOR COWLS OPENING:



## ENGINE SAFETY ITEMS

## ENGINE MAINTENANCE PRESENTATION (1)

### **Engine Ground Support Equipment**

Some engine maintenance tasks require Ground Support Equipment (GSE).

Refer to the Aircraft Maintenance Manual (AMM) for the tasks.

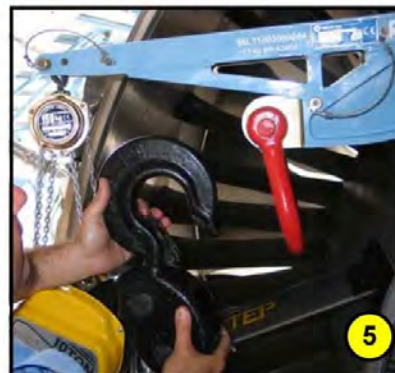
Also, refer to the illustrated Tool and Equipment Manual (TEM) for the complete list of the tools.

Engine Removal/Installation (R/I) procedure is done using bootstraps.

Due to the weight of the pull lift (100 kg, 6 meters chain long), a specific device (mini lift) has been developed and incorporated in the bootstrap kit. This system will ease the pull lift installation by reducing the load. Holding wrench tools for front/rear mounts have been developed to untorque the mounts in good condition.



**LIFT INSTALLATION**



**ENGINE GROUND SUPPORT EQUIPMENT**



**BOOTSTRAP INSTALLATION**



**TORQUE WRENCH**



**ENGINE GROUND SUPPORT EQUIPMENT**

## ENGINE MAINTENANCE PRESENTATION (1)

### Engine Storage and Preservation

Storage and preservation procedures must be applied for engines being not operated for a period of time according to the AMM. The preservation procedures protect the engine against corrosion, liquid and debris entering the engine, and atmospheric conditions during period of inactivity.

CAUTION: under no circumstances shall preservative oil or equivalent be sprayed into the engine inlet, core compressor or turbine, or engine exhaust. Dirt particles on wet blades and vanes may adversely affect engine performance during subsequent operation.



FOR A380, STORAGE AND PRESERVATION PROCEDURES MUST BE APPLIED FOR ENGINES BEING NOT OPERATED FOR A PERIOD OF TIME.

PROTECTION AGAINST  
ATMOSPHERIC CONDITIONS



THE PRESERVATION PROCEDURES PROTECT THE ENGINE AGAINST CORROSION, LIQUID AND DEBRIS ENTERING THE ENGINE, AND ATMOSPHERIC CONDITIONS DURING PERIOD OF INACTIVITY.



EXAMPLE OF TRENT 900



**UNDER NO CIRCUMSTANCES SHALL PRESERVATIVE OIL OR EQUIVALENT BE SPRAYED INTO THE ENGINE INLET, CORE COMPRESSOR OR TURBINE, OR ENGINE EXHAUST. DIRT PARTICLES ON WET BLADES AND VANES MAY ADVERSELY AFFECT ENGINE PERFORMANCE DURING SUBSEQUENT OPERATION.**

#### ENGINE STORAGE AND PRESERVATION

## ENGINE START / CRANK CONTROL DESCRIPTION (3)

### Ignition and Starting System Description

The ignition and starting system has three subsystems:

- Starting,
- Fuel command,
- Ignition.

#### Starting

To start, the engines can use the APU air bleed, a ground air supply or crossbleed air from an engine in operation.

The Engine Electronic Controller (EEC) controls the opening and closing of the Starter Control Valve (SCV) in all start modes. The SCV controls the air flow to the pneumatic starter. The pneumatic starter drives N3 through the accessory gearbox.

The starter has three different cycles:

The normal cycle is as follows:

- Up to 2 minutes continuous operation then runs down to zero N3,
- Up to 1 minute continuous operation then runs down to zero N3 and wait 30 minutes for the cooling.

Extended start cycle:

- Up to 5 minutes continuous operation followed by 30 minutes wait for the cooling.

#### Fuel command

The EEC controls the Fuel Metering Valve (FMV) through the Metering Valve (MV) servovalve. The FMV adjusts the fuel flow to the manifolds. The ENGINE MASTER lever controls the closing of the High Pressure Shut-OFF Valve (HP SOV) through the airframe shutdown solenoid. The HPSOV is also called the Minimum Pressure Shut-Off Valve (MP SOV). EEC controls the closing of the HPSOV through the protection motor. The Fuel Flow Transmitter (FF XMTR) sends its data to the EEC.

#### Ignition units power supply

The Engine Interface Power Management (EIPM) supplies power to the ignition units (A and B) through the EEC (channels A and B) control. The A/C ESSEntial BUS BAR 115 VAC supplies the EIPM CHAN A function.

The A/C BUS 2 BAR 115 VAC supplies the EIPM CHAN B function.

EEC ignition units switching function:

Each EEC channel can control the activation of the two ignition systems A and B.

During an engine auto start on ground, the EEC selects automatically the ignition systems A and/or B as necessary.

During an engine manual start, the EEC selects the two ignition systems A and B, for ignition efficiency.

Note: During Engine auto start in flight, the two ignition systems are energized, for redundancy.

#### Controls from the cockpit

The engine start/crank is controlled from the cockpit by:

- The ENGINE rotary selector,
- The ENGINE MASTER levers,
- The ENGINE MANUAL START P/B SW,
- The Throttle Control Assembly (TCA).

#### System functions

There are two procedures to start the engine:

- Automatic start (normal procedure),
- Manual start (back-up procedure).

There are two procedures to crank the engine:

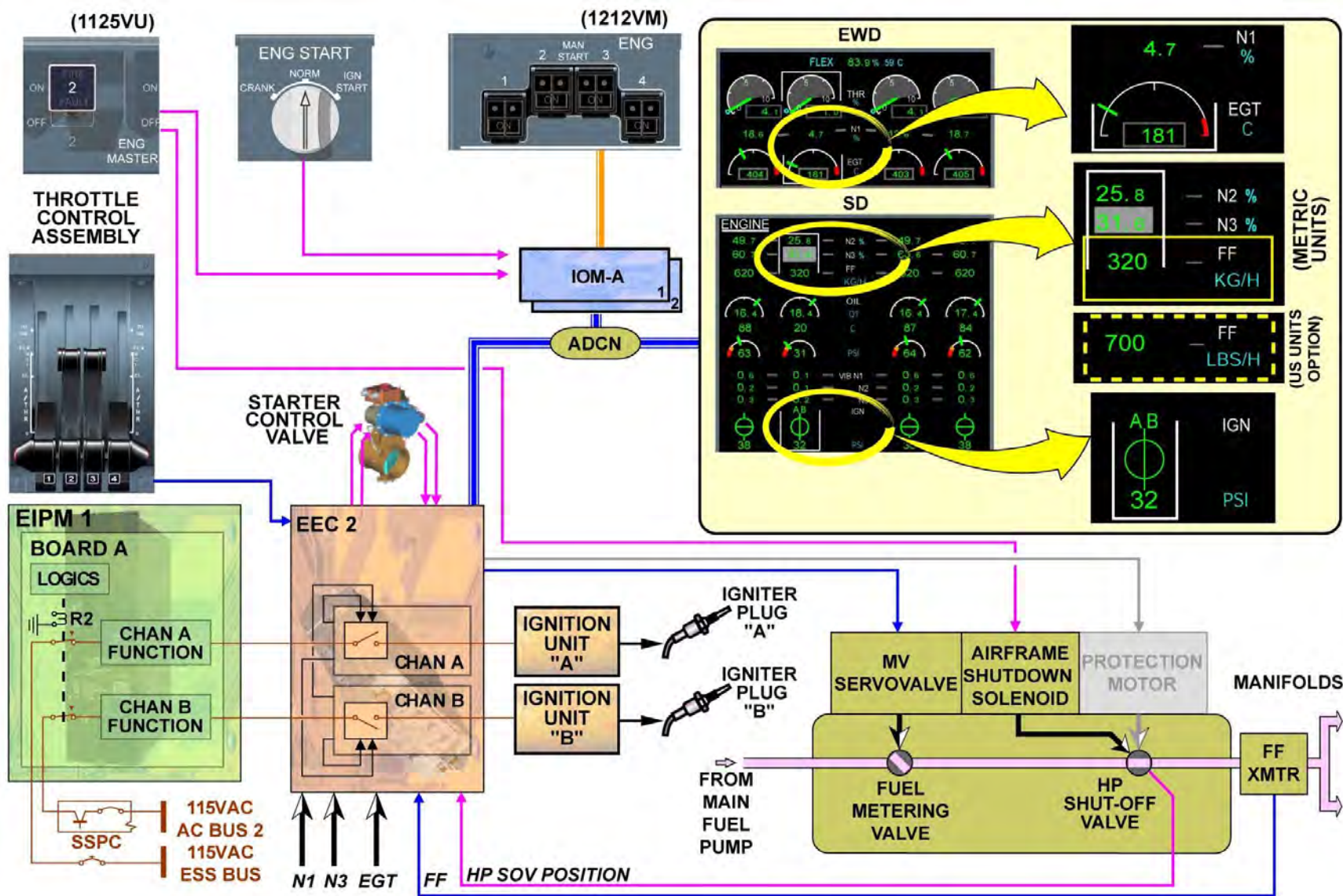
- Dry crank,
- Wet crank.

Auto-relight function:

- When a flame-out is detected, the system energizes the two igniters.

Quick relight function (in flight only):

- If the ENG MASTER lever is accidentally set to "OFF", the ENG MASTER lever can be set to "ON" again in a time period of 30 seconds to cancel the shutdown sequence.



IGNITION AND STARTING SYSTEM DESCRIPTION

## ENGINE START / CRANK CONTROL DESCRIPTION (3)

### Instructions and Precautions For Engine Ground Operation

WARNING: -YOU MUST MAKE SURE THAT ALL AREAS WHERE YOU OPERATE THE ENGINE ARE AS CLEAN AS POSSIBLE. ALL AREAS MUST BE VERY CLEAN TO PREVENT INJURY AND SERIOUS DAMAGE TO THE ENGINE AND AIRCRAFT.

-YOU MUST NOT GO NEAR AN ENGINE THAT IS IN OPERATION ABOVE MINIMUM IDLE. IF YOU DO, IT CAN CAUSE AN INJURY. WHEN AN ENGINE IS IN OPERATION AT MINIMUM IDLE, YOU CAN ONLY GO NEAR IT THROUGH THE ENTRY CORRIDORS.

-TO ABORT THE ENGINE START SEQUENCE, YOU MUST PUT THE ENGINE MASTER LEVER BACK TO THE OFF POSITION. IF YOU ONLY CHANGE THE POSITION OF THE ENGINE MODE ROTARY SELECTOR SWITCH (FROM IGN/START TO NORM), THE FADEC SYSTEM WILL NOT ABORT THE START SEQUENCE. THIS CAUSES A RISK THAT THE ENGINE WILL CONTINUE TO START. THIS, IN TURN, CAN CAUSE INJURIES TO PERSONNEL.

-BEFORE YOU OPERATE THE ENGINES AT POWER SETTINGS ABOVE IDLE, MAKE SURE THAT THERE IS NO RISK OF PRE-PRESSURIZATION OR RESIDUAL PRESSURE IN THE AIRCRAFT AFTER SUBSEQUENT ENGINE SHUTDOWN. TO DO THIS, MAKE SURE THAT THE AIR CONDITIONING OUTFLOW VALVES ARE OPEN DURING THE ENTIRE TEST.

-IF PERSONS TRY TO OPEN A DOOR WHEN THERE IS RESIDUAL PRESSURE IN THE AIRCRAFT:

-THE DOOR CAN OPEN WITH DANGEROUS

-THERE IS A RISK OF SEVERE INJURY OR DEATH,  
-THERE CAN BE DAMAGE TO THE AIRCRAFT.  
-ENSURE THAT THE TRAVEL RANGES OF THE FLIGHT CONTROL SURFACES ARE CLEAR BEFORE YOU MOTOR THE ENGINE. MOVEMENT OF THE FLIGHT CONTROL SURFACES CAN BE DANGEROUS AND/OR CAUSE DAMAGE.

CAUTION: -YOU MUST NOT OPERATE THE ENGINE IF THE FAN EXHAUST COWLS ARE OPEN. IF THE ENGINE IS OPERATED WHEN THE FAN EXHAUST COWLS ARE OPEN, DAMAGE TO THE POWER PLANT CAN OCCUR.

-YOU MUST NOT START, DRY MOTOR OR WET MOTOR THE ENGINE IF THE OIL TEMPERATURE IS TOO COLD (REFER TO AMM). LOW OIL TEMPERATURES CAN CAUSE DAMAGE TO THE ENGINE BEARINGS.

MAKE SURE THAT ALL  
AREAS WHERE YOU  
OPERATE THE ENGINE  
ARE AS CLEAN AS  
POSSIBLE.



DO NOT GO NEAR AN ENGINE  
THAT IS IN OPERATION  
ABOVE MINIMUM IDLE.



TO ABORT THE ENGINE  
START SEQUENCE, USE  
THE ENGINE MASTER  
LEVER AND NOT THE  
ROTARY SELECTOR.



BEFORE YOU OPERATE THE ENGINES AT  
POWER SETTINGS ABOVE IDLE,  
MAKE SURE THAT THE AIR CONDITIONING  
OUTFLOW VALVES ARE OPEN  
(TO NOT PRESSURIZE THE A/C)  
DURING THE COMPLETE TEST.



MAKE SURE THAT THE  
TRAVEL RANGES OF THE  
FLIGHT CONTROLS ARE CLEAR  
BEFORE YOU MOTOR  
THE ENGINE.



DO NOT OPERATE  
THE ENGINE IF THE  
FAN EXHAUST COWLS /  
THRUST REVERSER COWLS  
ARE OPEN.



**LIMIT AIR POLLUTION  
(EXHAUST SMOKE,  
GAS EMISSION...)**

DO NOT START, DRY OR  
WET MOTOR THE  
ENGINE IF THE OIL  
TEMPERATURE IS  
TOO COLD.



## INSTRUCTIONS AND PRECAUTIONS FOR ENGINE GROUND OPERATION

## ENGINE START / CRANK CONTROL DESCRIPTION (3)

### Automatic Start

The automatic start sequence can be aborted automatically or manually.

#### Automatic Start on Ground

The procedure to start the engine in automatic mode is as follows.

Initial configuration of controls (engine not in operation):

The ENG MASTER lever is set to the "OFF" position and the ENG START rotary selector is set to the "NORM" position.

Set the ENG START rotary selector to the "IGN/START" position.

The ECAM ENGINE page comes into view and the Air Generation Unit (AGU) flow control valves close.

Set the ENG MASTER LEVER to the "ON" position. The Low Pressure (LP) fuel valve opens and the SCV opens.

When N3 is at 25% and the Exhaust Gas Temperature (EGT) is less than 150°C:

- The ignition is in function on the igniter A or B,
- The HP SOV opens,
- The FF increases,
- The EGT increases.

Note: The maximum EGT during a start is 700°C.

When N3 is at 48%, the SCV closes, the igniters stop and the AGU flow control valves open if there are no other engines in starting sequence.

Set the ENG START rotary selector to the "NORM" position. The ECAM ENGINE page goes out of view.

#### Automatic Start Abort

Automatic start abort is initiated when the following troubles occur:

- Hot start / stall,
- Hung start,
- No light-up,
- Locked N1 rotor,

- SCV failure in closed position,

- High N3.

If there is a fault, the HP SOV automatically closes and the ignition stops.

If there is a hot start /stall, hung start or no light-up occurs, the EEC automatically does a shutdown followed by a dry cranking period (to decrease the EGT to less than 150°C, only in hot start configuration) and then the EEC tries a new start.

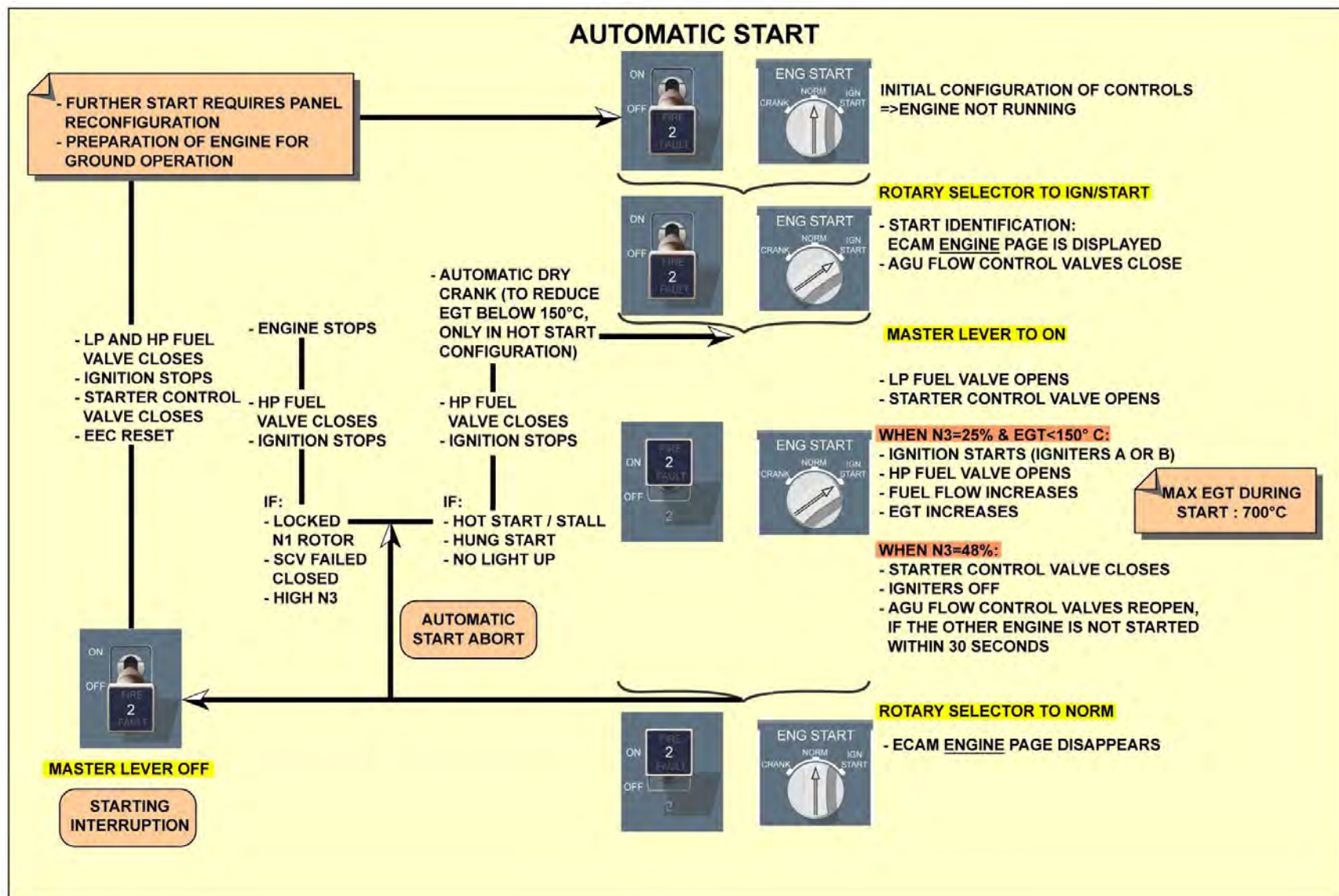
If there is a locked N1 rotor, an SCV failure in closed position or too high N3, the engine start is automatically aborted.

#### Automatic Start Manual Abort

If a fault occurs you can set the ENG MASTER lever to the "OFF" position at all times.

The ENG MASTER lever set to the "OFF" position has priority over the automatic mode. At this time, the HP and LP SOVs close, the ignition stops, the SCV closes and the EEC is reset.

To restart the engine, do a new automatic start.



AUTOMATIC START - AUTOMATIC START ON GROUND ... AUTOMATIC START MANUAL ABORT

## ENGINE START / CRANK CONTROL DESCRIPTION (3)

### Manual Start

The manual start sequence can only be aborted manually

#### Manual Start on Ground

The procedure to start the engine in manual mode is as follows.

Initial configuration of controls (engine not in operation):

The ENG MASTER lever is set to the "OFF" position, the ENG START rotary selector is set to the "NORM" position and the ENG MAN START P/B SW "ON" legend lights are off.

Set the ENG START rotary selector to the "IGN/START" position.

The ECAM ENGINE page comes into view and the AGU flow control valve closes.

Set the ENG MAN START to the "ON" position. The SCV opens.

When N3 is at 25% and the Exhaust Gas Temperature (EGT) is less than 150°C, set the ENG MASTER lever to the "ON" position.

- The ignition starts on the igniter A and B,
- The LP fuel valve and the HP SOV open,
- The FF increases,

Start the  
chronometer:

- In less than 30 seconds, the EGT increases.

Note: The maximum EGT limit during a start is 700°C.

When N3 is at 48%:

- The SCV closes. The ENG MAN START pushbutton must be set to the "OFF" position only for confirmation.
- The ignition stops.

When N3 is at 50%, set the ENG START rotary selector to the "NORM" position:

- The AGU flow control valves opens if there are no other engine in starting sequence,
- The ECAM ENGINE page goes out of view.

### Manual Start Interruption

Before you set the ENG MASTER lever to the "ON" position, you can stop the start sequence. To do this, set the ENG MAN START P/B SW to the OFF position. This causes the closing of the SCV.

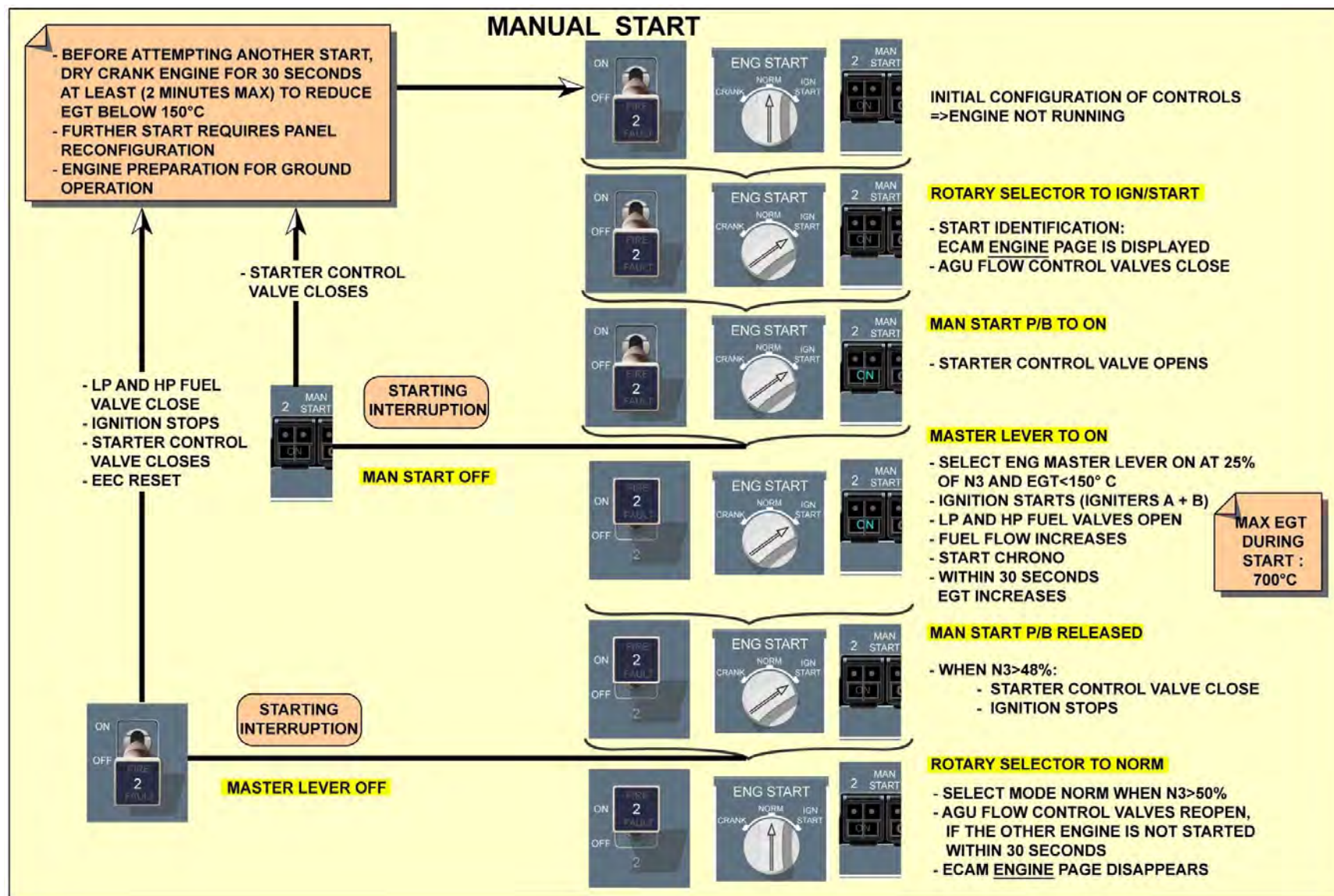
If there is an SCV failure in the closed position, a locked N1 or a too high N3, you must set the ENG MAN START P/B SW to the "OFF" position.

After you set the ENG MASTER lever to the "ON" position, you can stop the engine starting. To do this, set the ENG MASTER lever to the "OFF" position. The LP fuel valve and the HP SOV close, the ignition stops, the SCV closes and the EEC is reset.

The ENG MASTER lever must be set to the "OFF" position if these incidents occur:

- Hot start / stall,
- Hung start,
- No light-up,
- Locked N1 rotor,
- SCV failure in the closed position,
- High N3.

Before you try to start the engine again, dry crank the engine for a minimum of 30 seconds (2 minutes max) to decrease the EGT to less than 150°C.



MANUAL START - MANUAL START ON GROUND & MANUAL START INTERRUPTION

## ENGINE START / CRANK CONTROL DESCRIPTION (3)

### Cranking

You can do a dry crank or a wet crank.

#### Dry Crank

Dry crank is used to remove remaining fuel from the combustion chamber and to do a check for oil leakage.

Initial configuration of controls (engine not in operation):

The ENG MASTER lever is set to the "OFF" position, the ENG START rotary selector is set to the "NORM" position and the ENG MAN START P/B SW "ON" legend lights are off.

Set the ENG START rotary selector to the "CRANK" position. The ECAM ENGINE page comes into view.

Set the ENG MAN START to the "ON" position. The SCV opens. Start the chronometer.

Note: Dry crank the engine for a period between 30 seconds and 5 minutes.

Set the ENG MAN START to the "OFF" position. The SCV closes. Stop the chronometer.

Set the ENG START rotary selector to the "NORM" position. The ECAM ENGINE page goes out of view.

#### Wet Crank

Wet crank is used to do a check for fuel leakage.

Initial configuration of controls (engine is not in operation):

The ENG MASTER LEVER is set to the "OFF" position, the ENG START rotary selector is set to the "NORM" position and the ENG MAN START P/B SW "ON" legend lights are off.

NOTE: Obey the starter limit: the total motoring time permitted is 5 minutes for a 35 minutes time period

Set the ENG START rotary selector to the "CRANK" position. The ECAM ENGINE page comes into view.

Set the ENG MAN START to the "ON" position. The SCV opens.

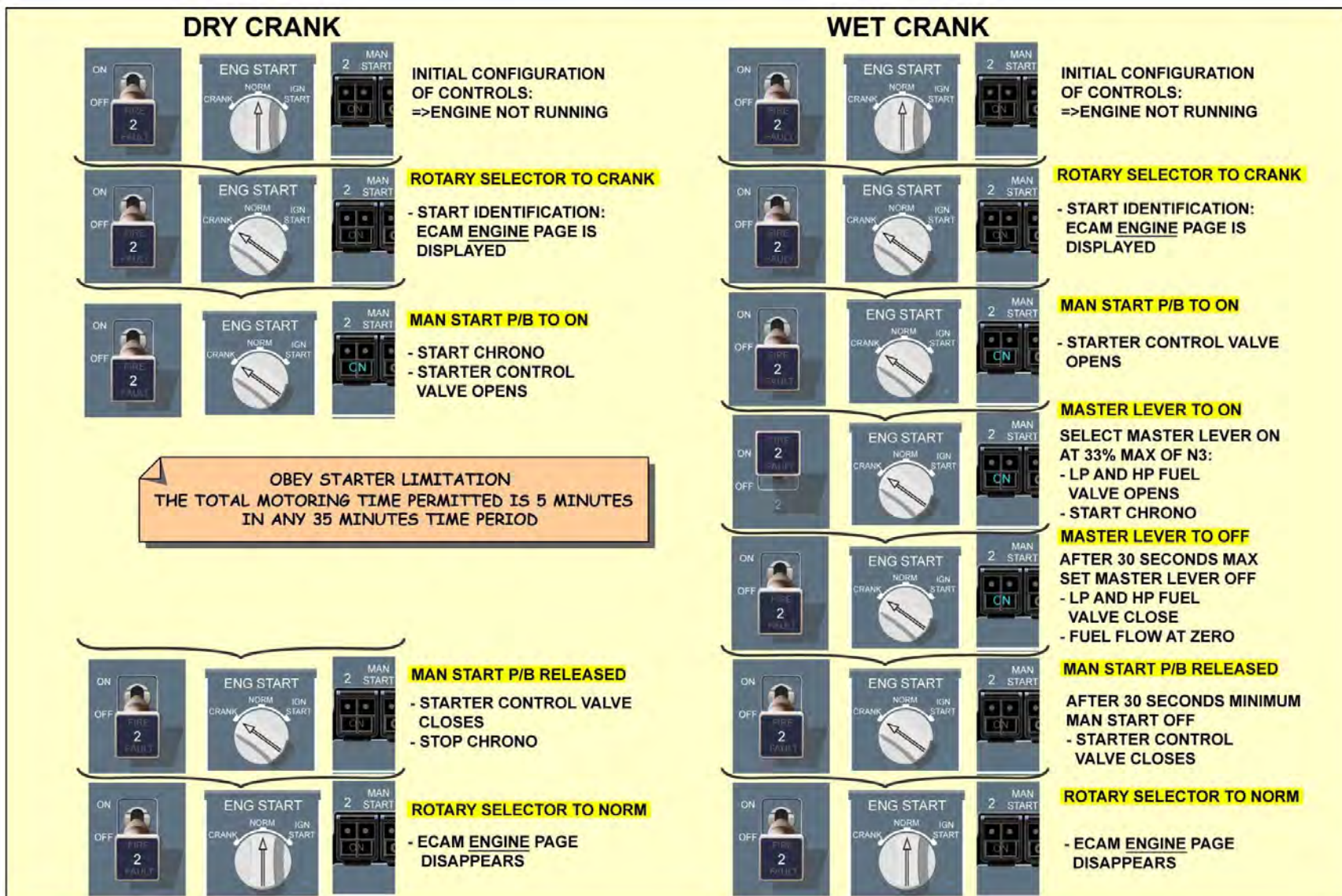
When N3 is at 33%, set the ENG MASTER lever to the "ON" position. The LP fuel valve and the HP SOV open. Start the chronometer.

After a maximum wet motoring time of 30 seconds set the ENG MASTER lever to the "OFF" position. The LP and the HP fuel valves close. (Make sure that the FF is at zero.)

After 30 seconds, set the ENG MAN START to the "OFF" position. The SCV close.

Stop the chronometer.

Set the ENG START rotary selector to the "NORM" position. The ECAM ENGINE page goes out of view.



CRANKING - DRY CRANK & WET CRANK

## ENGINE MASTER CONTROL DESCRIPTION (3)

### General

The ENGINE MASTER lever, on the center pedestal, is an interface with the fuel system and the FADEC system.

The engine FIRE pushbutton also has an effect on the LP fuel valve. In the fuel system, the ENGINE MASTER lever has an effect on the LP valve and the Minimum Pressure Shut-Off Valve (MPSOV).

In the FADEC system, the ENGINE MASTER lever is used for the starting mode selection and the Engine Electronic Controller (EEC) memory reset.

### Low Pressure Fuel Valve and Airframe Shutdown Solenoid

The ENGINE MASTER lever is directly hardwired to the airframe shutdown solenoid of the HMU. It also controls the Low Pressure fuel valve through the engine MASTER switch slave relay.

When the lever is set from the 'ON' to the 'OFF' position, the airframe shutdown solenoid is directly energized, then the MPSOV moves to the closed position.

This gives the independent authority to close the MPSOV, independently of the EEC command.

After one minute, the power-off relay de-energizes the solenoid to prevent heat dissipation in the HMU.

### ENGINE MASTER and Network Interface

The ENGINE MASTER lever is directly hardwired to each channel of the EEC. Then each channel sends its own discrete signal via the EEC internal data bus to the other channel.

This signal is used to let you read the MASTER lever position in the EEC if an AFDX failure occurs.

The MASTER lever is also hardwired to the IOM and makes an interface with the EEC through the ADCN.

The MASTER lever signals through the metering valve of the HMU have an effect on the opening and closure of the MPSOV.

### ENGINE MASTER and EEC Reset

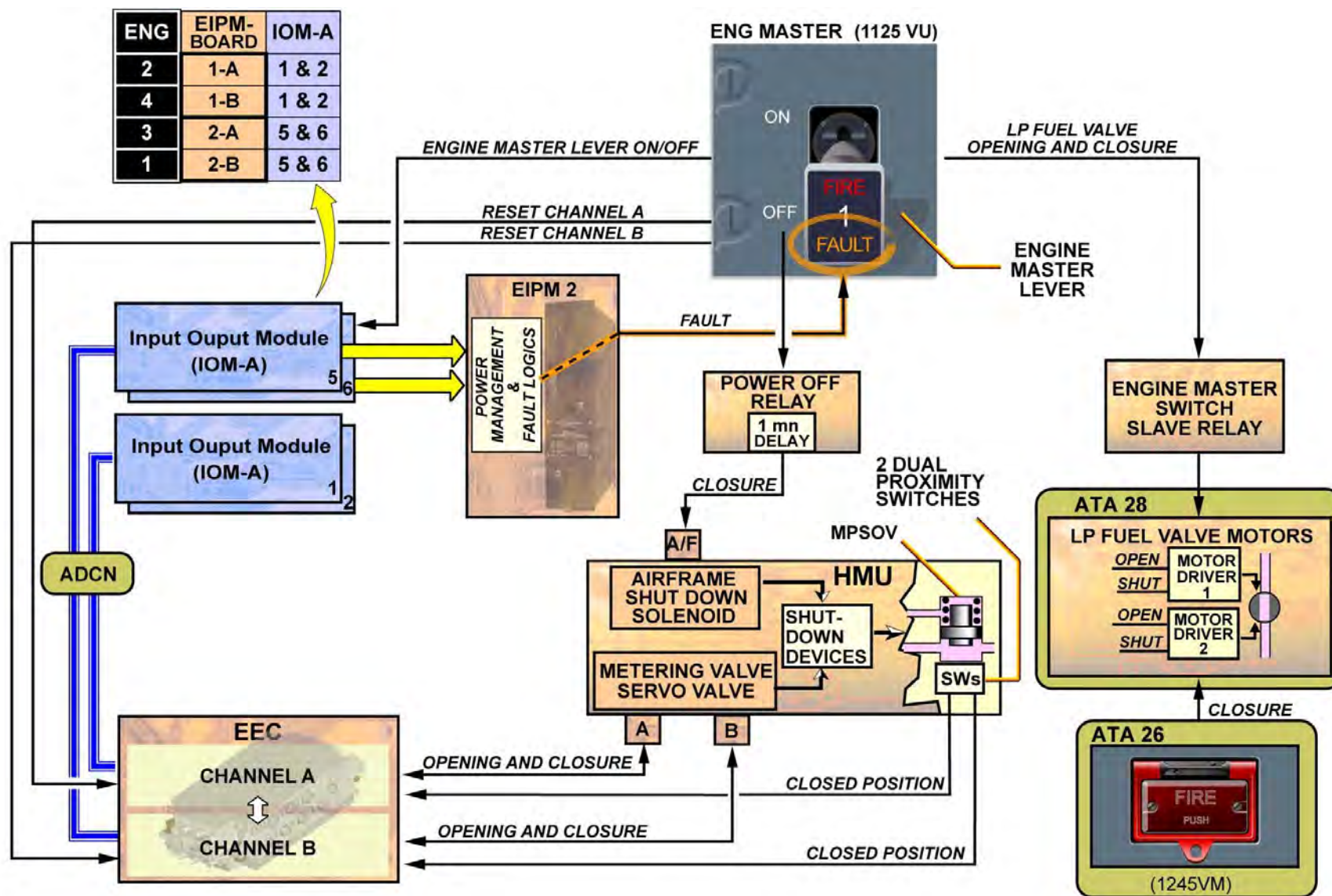
When the ENGINE MASTER lever is moved from the "ON" to the "OFF" position, the discrete input is reset on the two EEC channels.

### ENGINE MASTER FAULT Light

The amber "FAULT" light, on the ENGINE MASTER lever, comes on when there is a disagreement between the MPSOV position and its commanded position.

This light also comes on for all faults that occur during the engine start. The MASTER lever FAULT light is managed by the EIPM. To do this, the EIPM uses the digital data received from the related EEC via the IOM.

The EEC uses a dual proximity sensor to find the position of the MPSOV.



GENERAL ... ENGINE MASTER FAULT LIGHT

## THROTTLE CONTROL ASSEMBLY DESCRIPTION (3)

### General

The Throttle Control Assembly (TCA) design is based on a modular concept.

It is composed of 4 independent assemblies (two inboard assemblies and two outboard assemblies), each one dedicated to one engine.

Each assembly is composed of:

- A housing,
- A throttle control lever,
- A thrust reverser lever (inboard assemblies, engines 2 and 3),
- An Auto THRust (A/THR) instinctive disconnect push button (outboard assemblies, engines 1 and 4),
- Electrical connectors.

### Modulation of Engine Thrust

Except during A/THR mode, control of the forward thrust of each engine shall be achieved by modulation of the related throttle control lever position.

The throttle control levers can only be manually moved and the four throttle control levers can be moved independently.

The throttle control levers move over a sector divided into three areas separated by pre-determined detent points and stops.

The detent points and stops are used to select the thrust limit mode.

### Thrust Reverser Mode

Control of the reverse thrust of either engine 2 or 3 is achieved by modulation of thrust reverser levers fitted on the throttle lever inboard assemblies.

Control of the stow/deploy sequence is achieved when the thrust reverser levers are in the reverse area.

As in forward mode, the thrust reverser levers can be moved independently.

When the throttle levers are not at idle, the thrust reverser levers are

mechanically locked in the stowed position.

### Sensing Devices

The primary function of the TCA is to sense the commands and to generate electric signals. This positional information is received by several A/C systems.

The throttle control lever sensing devices are composed of 4 independent groups of 2 resolvers, and 4 independent groups of 3 potentiometers.

The thrust reverser lever deployed order (inboard levers only) is provided by means of a switch (one per lever).

These 2 switches signals are obtained through one track of potentiometers.

### Throttle Control Levers and Thrust Reverser Levers Detents Points and Stops

The device including the detent points and stops gives tactile information to select a thrust limit mode with the throttle control lever and to select the thrust reverser operation with the thrust reverser levers.

The detents points and stops of the throttle control lever are located as follows:

- 0 (idle) - stop
- CL (maximum CLimb) - detent point
- FLX / MCT (Flexible takeoff / Maximum Continuous Thrust) - detent point
- TO GA (TakeOff / Go Around) - stop

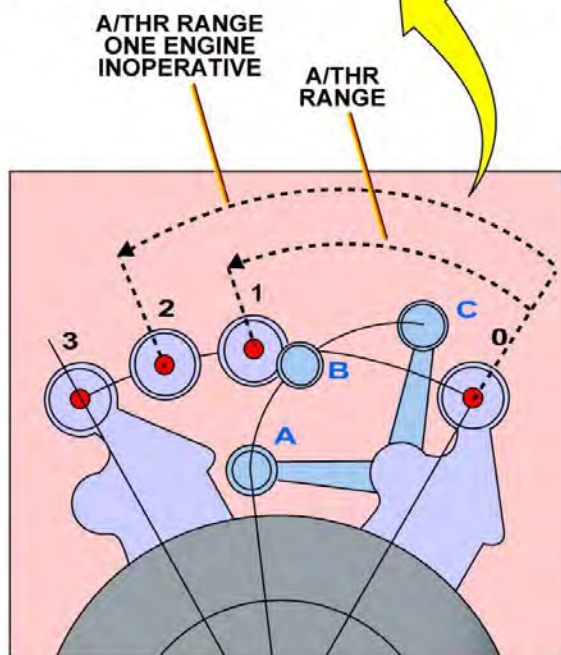
The detent point and stops of thrust reverser lever are located as follows:

- 0: stop
- IDLE REV (idle reverse) - detent point
- MAX REV (maximum reverse) - stop

Each assembly has its own detent point and stop device

The normal operating range for A/THR is comprised between idle stop to max CLimb (CL) detent points.

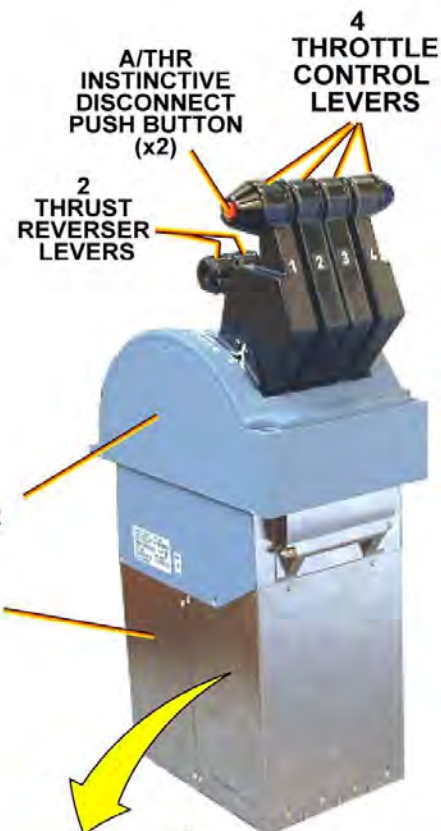
If one engine is inoperative the A/THR range is comprised between idle stop to Max Continuous Thrust (MCT) detent points for the three remaining engines.



## THROTTLE CONTROL ASSEMBLY (TCA)

FOUR FULLY INDEPENDENT  
ASSEMBLIES TIED TOGETHER

MECHANICAL MODULE  
AND SENSING DEVICES



**SENSING DEVICES :**

- 8 RESOLVERS  
(2/ THROTTLE CONTROL LEVER)
- 12 POTENTIOMETERS  
(3/ THROTTLE CONTROL LEVER)
- 2 SWITCHES THROUGH  
1 TRACK OF POTENTIOMETERS  
(1/ THRUST REVERSER LEVER)

GENERAL ... THROTTLE CONTROL LEVERS AND THRUST REVERSER LEVERS DETENTS POINTS AND STOPS

## THROTTLE CONTROL ASSEMBLY DESCRIPTION (3)

### Inboard and Outboard Assemblies

There are internal mechanical features that are installed into each inboard and outboard assembly, which are:

- The artificial force feel device (friction force),
- The soft detent device, related to several thrust settings,
- The interlock device (inboard assemblies only).

There are internal electrical features that are installed into each inboard and outboard assembly, which are:

- The 3 potentiometers and one switch (inboard assemblies) which are installed inside the Throttle Transducer Unit (TTU),
- The 2 resolvers,
- A/THR push button switch (outboard assemblies),
- The electrical connectors.

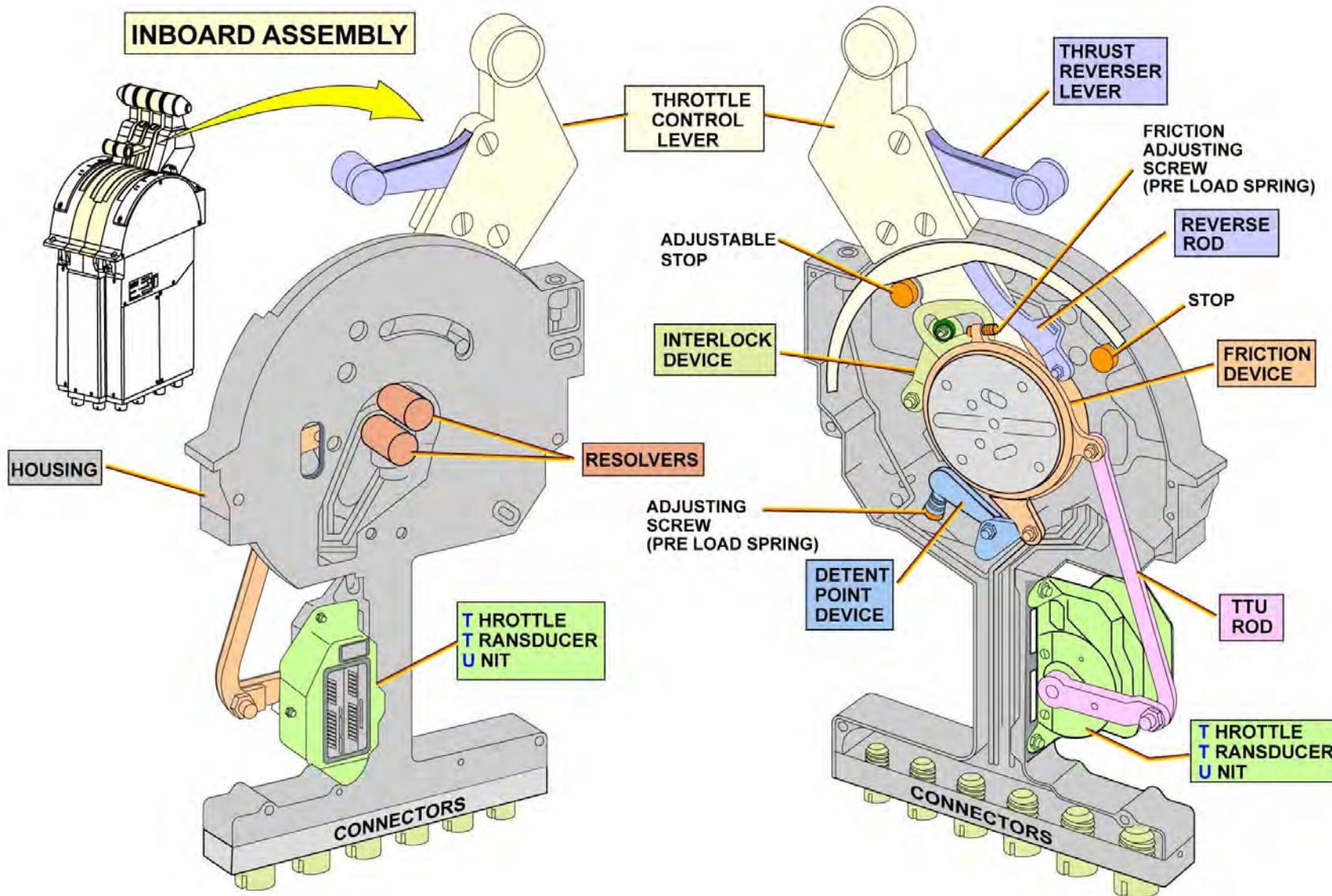
### Interlock Device

This mechanism is implemented only on inboard assemblies.

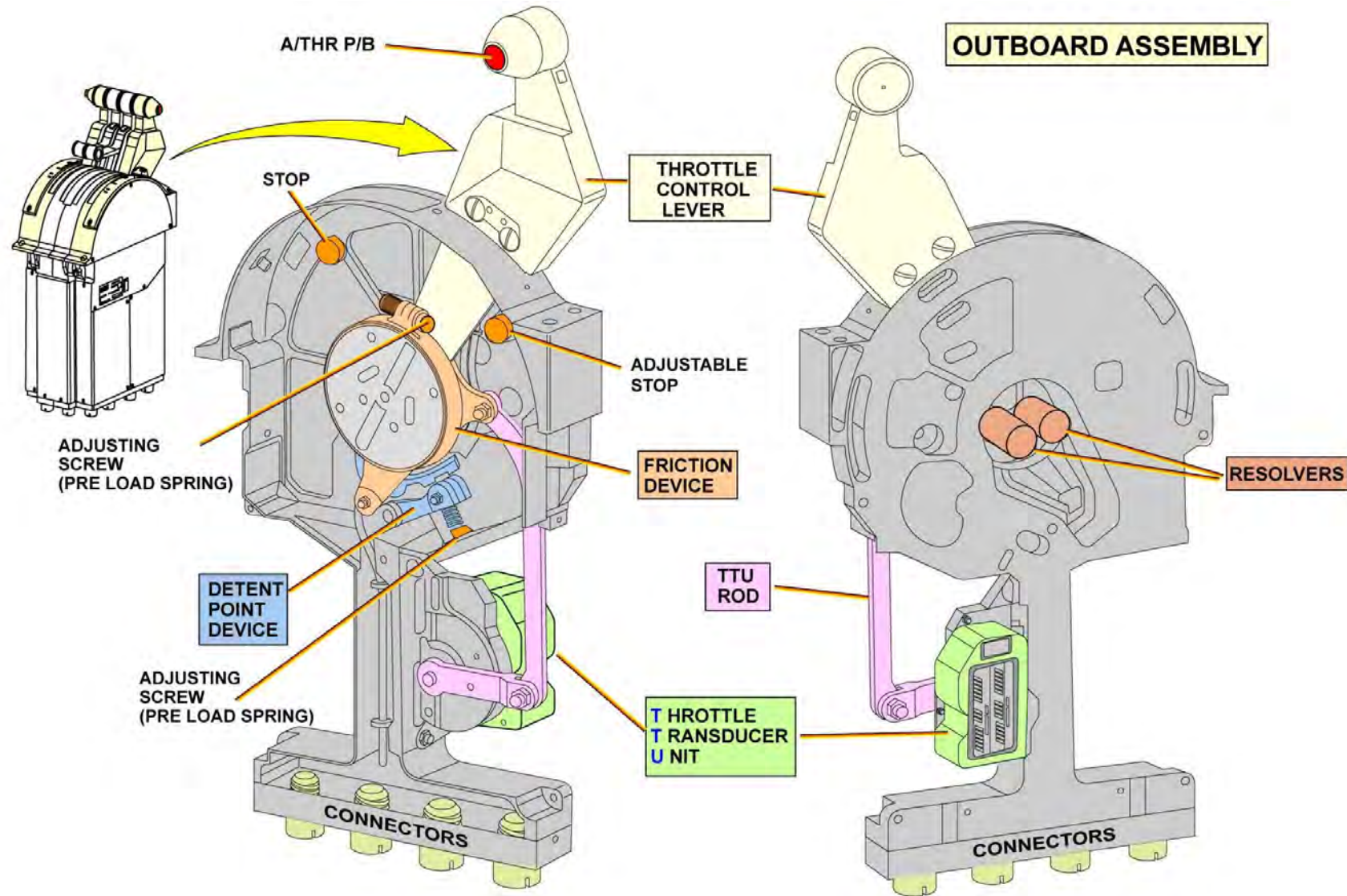
The purpose of the interlock device is to prevent thrust reverser levers movement from the stowed position if one of the throttle levers is out of the forward idle position.

The interlock also has the following functionalities:

- Prevent the throttle lever movement forward from idle position if reverse lever is raised.
- Automatic recall of the throttle lever to IDLE when thrust reverser lever is moved.
- Automatic recall of the thrust reverser lever to 0°-STOP when the throttle levers are moved from IDLE and when thrust reverser levers are positioned between 0° and 10°.



INBOARD AND OUTBOARD ASSEMBLIES - INTERLOCK DEVICE



INBOARD AND OUTBOARD ASSEMBLIES - INTERLOCK DEVICE

## THROTTLE CONTROL ASSEMBLY DESCRIPTION (3)

### Throttle Control Assembly Interfaces

Modulation of engine thrust and selection of the thrust limit mode functions are achieved using throttle lever position sent by resolvers and potentiometers.

For each throttle control lever:

- Each of the two resolvers transmits the angle information of the throttle lever to the A and B channels of the EEC (cross-communicated to the other channel).

The EEC supplies 6 VAC power to the resolvers.

- Each potentiometer transmits the angle information of the thrust lever to each PRIM.

The PRIM supplies 10 VDC power to the potentiometers

For each thrust reverser lever:

The reverse switch sends a discrete signal via the Engine Interface Power Management (EIPM) to control the Engine Thrust Reverser Actuator Controller (ETRAC) power.

In addition of the two resolvers signal, the EEC receives, via the AFDX network, three digital throttle angle values coming from the three PRIMs. PRIM potentiometer information is used to consolidate resolver signal selection.

### Selection Logic of the Throttle Control Lever Position

To measure the throttle control lever position, the EEC has 5 sources of lever angle measurement:

- 2 Resolvers (one analog signal per channel, cross-communicated to the other channel).
- 3 Potentiometers signals (sensed by Flight Controls Primary Computers) received from AFDX Network.

Based on the 5 sources of throttle position, the EEC does the following selection logic:

Resolver and Potentiometers signals are all validated by the EEC (range & consistency checks).

The resolvers are selected if they are both validated and agreed by

each other (digital information from potentiometers are disregarded). When both resolvers are in disagreement, then the potentiometers are used as a referee to identify which resolver has failed.

Then, the EEC selects the valid resolver.

If there is a disagreement between a single resolver and the potentiometers, then the potentiometers are selected (via AFDX).

### Instinctive Disconnect Pushbutton Interface

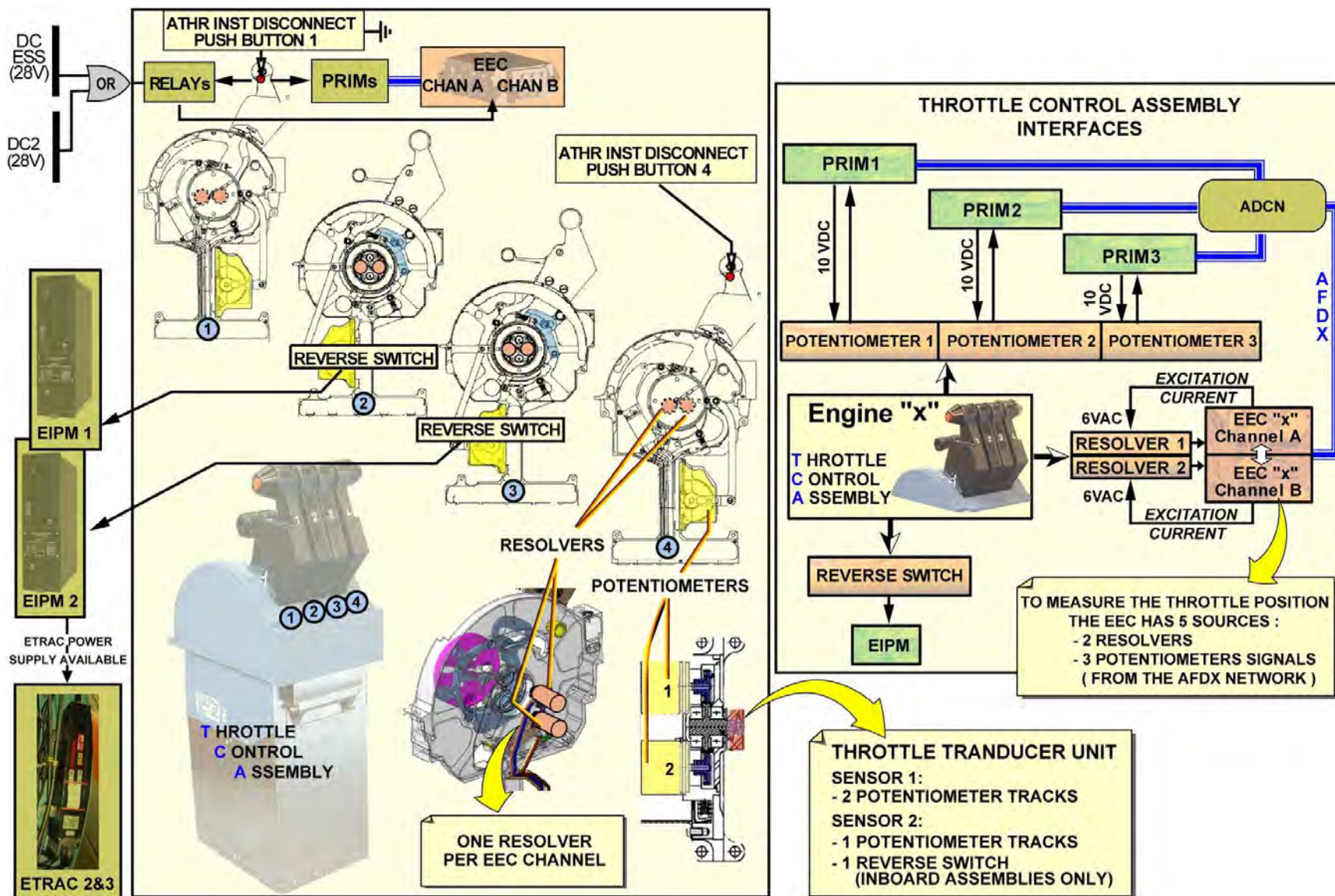
The disengagement of the A/THR function can be done manually through action on the instinctive disconnect pushbuttons on the throttle levers.

Both Instinctive Disconnects (A/THR disengagement) are directly hardwired to each EEC.

The EEC receives also this signal as an AFDX information from the PRIM.

The FADEC Autothrust Function is inhibited until the next EECs reset if the Autothrust Instinctive Disconnect signal is asserted continuously for more than 15 seconds.

The ESS BUS and DC 2 BUS supply 28 VDC power to the instinctive disconnect pushbutton.



THROTTLE CONTROL ASSEMBLY INTERFACES - SELECTION LOGIC OF THE THROTTLE CONTROL LEVER POSITION & INSTINCTIVE DISCONNECT PUSHBUTTON INTERFACE

## THRUST CONTROL DESCRIPTION (3)

### Engine Power Philosophy

The engine thrust is the result of different cockpit settings. To meter the fuel flow, in accordance with its own laws, the Engine Electronic Controller (EEC) uses:

- The throttle control levers positions,
- The Auto Flight System (AFS) N1 Target signal.

The command signals and other relevant input signals are processed in the EEC.

The EEC output control signals are transmitted to the engine Hydro Mechanical Unit (HMU) to be converted in fuel flow and through the ACUTE (Airbus Cockpit Universal Thrust Emulator) for the indication of the thrust parameters. The EEC sends to the CDS (Control and Display System) the thrust that must be indicated via the Aircraft AFDX network (ADCN).

### Manual Thrust and Autothrust

Two thrust setting modes can be used to get the necessary thrust: the manual mode and the automatic mode.

In the manual mode, the EEC receives the Throttle Resolver Angle (TRA) signal, to set the thrust. When the Auto THRust (A/THR) is activated, the EEC uses the data that follow to set the thrust:

- The N1 target from the AFS and,
- The TRA, for the thrust limitation and to display the thrust limit mode.

In autothrust mode, the EEC uses the throttle control lever position to set a limit to the maximum thrust, which can be commanded by the AFS, except when ALPHA FLOOR protection is commanded. The EEC uses the TRA related to the detent points of the throttle control levers to determine the thrust limit mode.

During Take-Off, the A/THR function is engaged but not active.

### Memo Thrust Mode

This is a transition mode of thrust control between the autothrust and the manual thrust mode.

The Memo Thrust Mode is selected by the EEC as a result of a deactivation of the autothrust mode, with the Throttle Control Levers in the Max Climb or Max Continuous Thrust detent points. When this occurs the EEC locks the N1 rotation speed to the last level when autothrust was in operation. To do this, the N1 actual speed is recorded during autothrust operation.

The Memo Thrust Mode prevents possible thrust step changes, which can occur when the autothrust reverts to the manual mode.

### Thrust Setting: TPR Mode and N1 Mode

Two EEC internal thrust laws can be used to meter the fuel flow. The "Turbopan Power Ratio" (TPR) law is the normal operating mode to compute the thrust. The selected parameters for TPR thrust control are:

- P20/T20: LP compressor inlet pressure/ temperature,
- P30: Combustor inlet pressure,
- Exhaust Gas Temperature (EGT): Low pressure turbine inlet temperature.

The N1 law is activated as a back-up mode if a failure of the TPR mode occurs.

In manual or in A/THR modes, the EEC related to each engine adjusts the metered fuel flow to set the thrust. The EEC makes sure that the thrust is not more than the limit related to the throttle lever position in manual mode and in automatic mode.

The EEC controls the engine to an N1 reversionary schedule as a result of cockpit command (ALTerNate mode push button) or loss of TPR parameters.

There are two types of N1 reversionary control:

- Rated N1 Reversionary Mode:

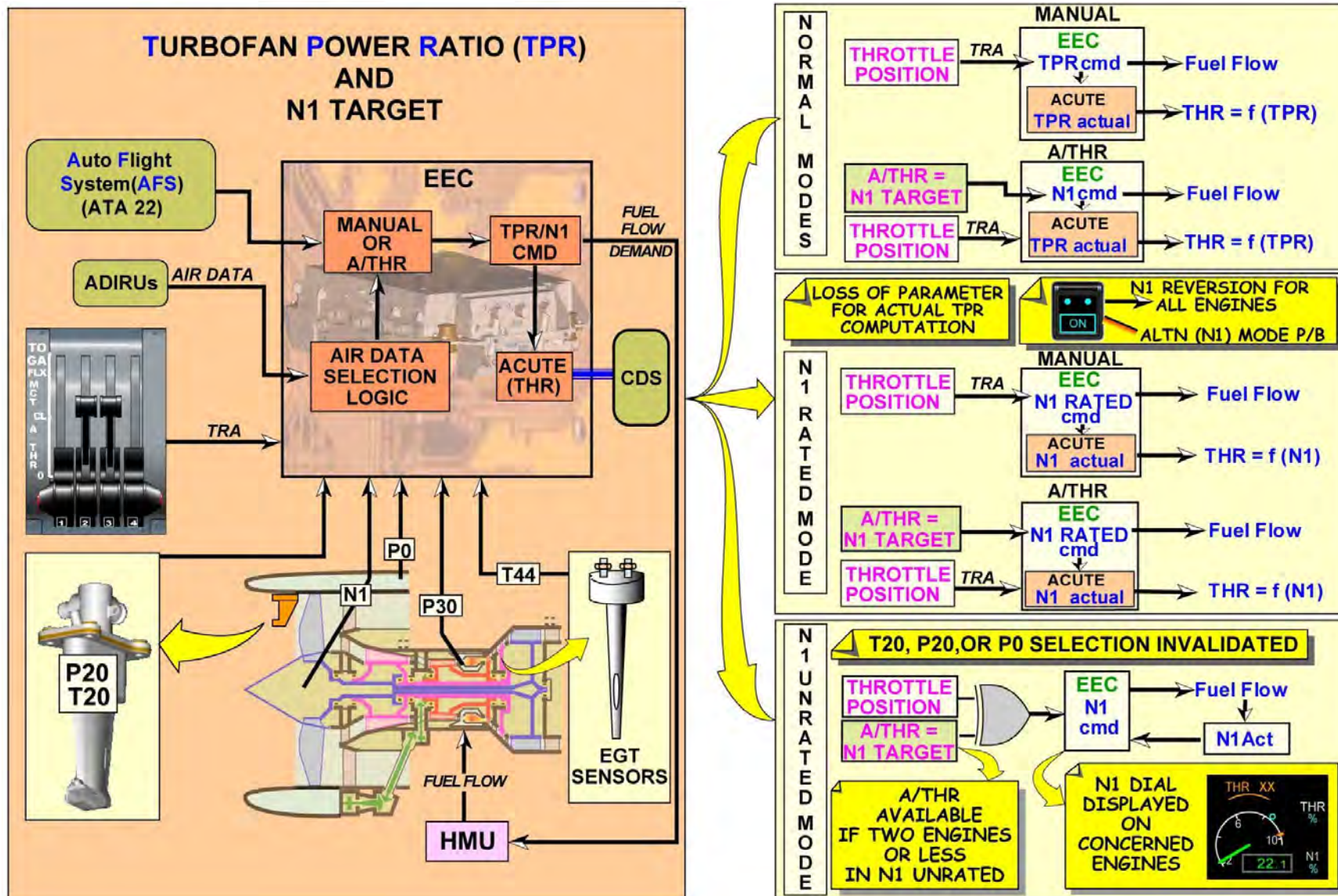
The TPR command is converted into a N1 command. The EEC uses a simple comparison table "N1 versus TPR" to calculate the N1 command which used to control the engine.

- Unrated N1 reversionary mode:

The EEC sets the idle detent position equal to idle N1 and the max take-off detent position equal to "red line" N1. The EEC then uses a graphical comparison table such that the N1 versus TRA profile is equivalent to the TPR versus TRA profile. This N1 command is then used to control the engine.

In TPR or in Rated or Unrated N1 mode, the manual mode or A/THR mode can be used.

Note: A/THR mode stays available if no more than two engines are reverted to N1 unrated.



ENGINE POWER PHILOSOPHY - MANUAL THRUST AND AUTOTHURST ... THRUST SETTING: TPR MODE AND N1 MODE

## THRUST CONTROL DESCRIPTION (3)

### Air Data Selection Logic

Engine signals (P0 and P20/T20) are compared by the EEC to the 3 independent Air Data Inertial Reference Units (ADIRUs) signals (Ps, Pt, TAT) via the Aircraft AFDX network to be used as inputs for the air data selection logic.

Engine P0 is measured by a single transducer, which is in the EEC. The transducer measures the air pressure P0 from Zone 1 as under-cowl pressure environment.

The Engine air data selection logic has the input of each of the three parameters (P0, P20 and T20) of the EEC compared with each of the three ADIRU parameters, which are:

- Ps (static pressure) equivalent to engine P0,
- Pt (total pressure) equivalent to engine P20,
- TAT (Total Air Temperature) equivalent to engine T20.

The 3 ADIRUs plus the 4 EECs give a total of 7 available sources that are compared and validated through the AFDX network, to compute the TPR or N1 command and to make sure that the engine thrust symmetry or N1 symmetry and the selection between the TPR and the N1 mode are related to the availability of air data inputs to the EEC.

### TPR Actual Calculation

TPR actual is derived from the P20, P30, T20 and EGT parameters. P20/T20 probe is installed in the Engine air intake forward of the fan. The probe is electrically heated to prevent ice formation.

P30 (measure of the HP Compressor exit pressure) is used in the EEC to calculate the TPR and to schedule fuel to the fuel spray nozzles.

14 EGT thermocouples (low pressure turbine inlet temperature) supply a gas temperature measurement. This temperature measurement is also used to compute the TPR.

The value of TPR is calculated by the relationship:

$TPR = P30 \cdot TGT / P20 \cdot T20$

### Reversionary Thrust Control

The Reversionary Thrust Control gives a backup control if the FADEC System can no longer support the TPR control.

The reversionary thrust control mode has the settings that follow:

- Rated reversionary thrust control, which is selected when there are not enough valid engine parameters. It is not possible to calculate the actual TPR.
- Unrated reversionary thrust control, which is selected when there are not enough valid air parameters. It is not possible to calculate the thrust demand.

#### Rated Reversion Thrust Control

Rated reversion is used when it is not possible to calculate an engine TPR actual, but the TPR command can be derived and thus rated N1 is derived from the TPR command.

The rated reversionary thrust control N1 command is calculated as the product of T20 and TPR command and calculated mach number. The EEC selects rated reversionary thrust control when one or more of the conditions that follow are true:

- 1) EGT measurement is confirmed as Invalid.
- 2) Selection of model P30 is confirmed as Invalid.
- 3) P30 measurement is confirmed as Invalid.
- 4) TPR measurement is confirmed as Invalid.
- 5) TPR control loop upward run-away is detected.
- 6) P30 pipe fault detection is confirmed.
- 7) P30 pipe freezing is detected.

#### Unrated Reversion Thrust Control

The unrated reversionary thrust control N1 command is selected as the reversionary thrust control N1 command when it is not possible to calculate a TPR demand.

The unrated reversionary thrust control N1 command is scheduled as a function of TRA position and altitude.

The EEC selects unrated reversionary thrust control when one or more of the conditions that follow are true:

- 1) P0 signal is confirmed as Invalid.
- 2) P20 signal is confirmed as Invalid.
- 3) T20 signal is confirmed as Invalid.

## **Autothrust Control**

The AFS operates with the FADEC to give the autothrust function, which includes the Alpha Floor protection.

The autothrust function can be engaged or disengaged in accordance with the logic implemented in the PRIM computers. When the autothrust is engaged, the function can be active or not active.

When it is engaged and active, the EEC uses the airframe N1 target to set the engine power level. In normal mode, even if the A/THR sends an N1 target to the engine, the THR is computed from the TPR.

Autothrust is operative in the TPR and ALTerNate (N1) modes.

The autothrust function can be engaged if the engines are not in the same mode (TPR or N1).

The PRIM accepts one engine in ALTerNate N1 Unrated mode.

### **Autothrust Function Engagement / Disengagement / Activation**

The engagement of the autothrust function can be done manually or automatically.

The autothrust function can be engaged manually with the A/THR push button of the Flight Control Unit (FCU).

The autothrust is automatically engaged but not active when the throttle control levers are set to TOGA or FLX detent with aircraft on the ground.

The autothrust will become active at the thrust reduction altitude when the pilot moves the throttle control levers to CLimb detent.

If the Alpha FLOOR protection is activated, the autothrust is automatically engaged and active and it orders TOGA thrust for all engines.

The disengagement of the autothrust function can be done:

- Manually with the instinctive disconnect pushbuttons which are on the throttle control levers (normal operation),
- Manually with the FCU autothrust push-button (if already engaged),
- Automatically when all (4) throttle control levers are selected to Idle,
- Automatically when all (2) thrust reverser levers are selected to Reverse,
- Automatically when more than 1 engine are not in A/THR mode,
- Automatically when there is a failure of more than 1 engine,
- Automatically when a failure is seen by the AFS.

When an autothrust disengagement occurs, each engine is controlled in manual mode, or in memo mode if the disconnection was accidental. When the autothrust is engaged, it can be:

- Active: throttle control levers between IDLE and CLB (or Maximum Continuous Thrust (MCT) with one engine failure) and one throttle or more at or below CLB (with no engine failure). The thrust is controlled by the A/THR function.
- Inactive: if all throttle control levers are above CLB (or above MCT with one Engine failure). The thrust is controlled by the position of the throttle control levers.

### **ALPHA FLOOR: Autothrust Activation**

If Alpha FLOOR detection occurs, the A/THR mode is automatically activated and commands the TOGA thrust mode, independently of the throttle control lever position.

## **Cockpit Thrust Display (ACUTE)**

The ACUTE (AIRBUS Cockpit Universal Thrust Emulator) is a percentage indication of thrust.

The ACUTE function calculates percentage parameters from engine command and thrust feedback parameters, for cockpit display on EWD.

The parameters are:

- THR Limit,
- THR Actual,
- THR Command,
- THR REF (position of the throttle control lever),
- THR Idle,
- THR Max.

THR WML: Thrust achieved when engine in Wind Milling (0%).

THR 100: Thrust 100 is the THR achieved when the throttle control lever is set to TOGA and Bleed Off (100%).

THR IDLE: The low-end of the grey sector is for the THR achieved when the engine operates at Idle.

THR MAX: The high-end of the grey sector is for the THR achieved when the throttle control lever is set to TOGA detent.

THR Actual: Raw engine thrust corrected by engine drag.

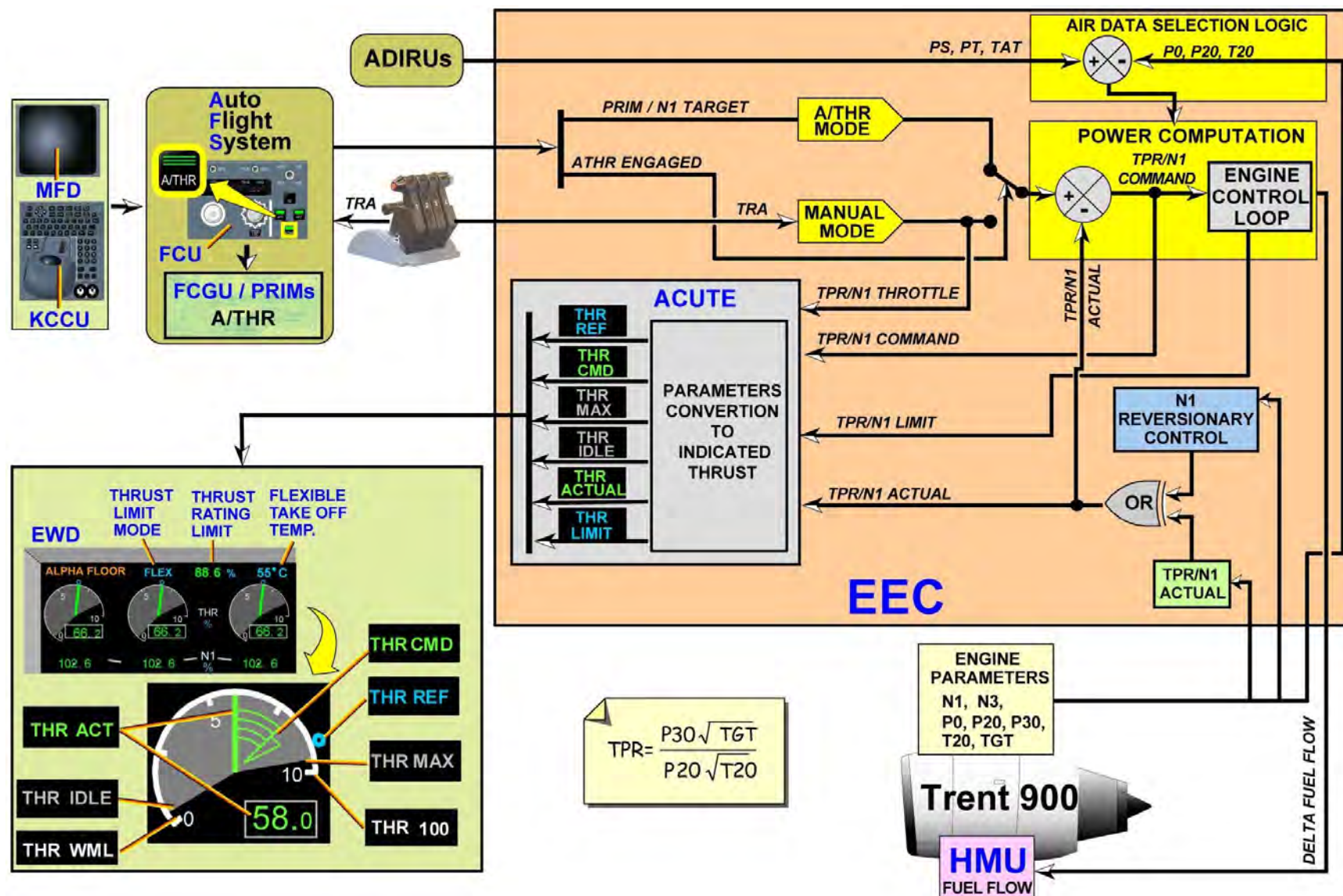
The THR100, THR Limit, THR Actual, THR Command, THR Throttle, THR Idle and THR MAX parameters are sent to the airframe CDS through the AFDX network.

In Unrated N1 mode, the EEC THR parameters output sent to the airframe CDS are not computed.

### **Thrust Limit Modes and Thrust Rating Limit**

The thrust limit modes (Max CLB, Derated Climb, Derated Take-Off, FLEXible take off, MTO, MCT, GA, FlexGA), are calculated to show the engine thrust setting mode from which the thrust Limit (THR LIMIT) value is calculated. The selected thrust limit mode is shown near the thrust limit value indication in the cockpit.

The THR Limit value in N1 mode is the value of THR Limit calculated as derived for N1 mode.



AIR DATA SELECTION LOGIC ... COCKPIT THRUST DISPLAY (ACUTE)

## FADEC ARCHITECTURE & INTERFACE DESCRIPTION (3)

### FADEC Overview

The Full Authority Digital Engine Control (FADEC) system, together with aircraft systems, controls engine starting, shutdown, power management and engine indicating. The FADEC system is controlled and monitored by an Engine Electronic Controller (EEC). The EEC is a dual channel digital unit. The EEC reads inputs from the aircraft systems and the engine systems and gives engine control and cockpit indications. Output data from channel A of the EEC is sent to the Engine Interface Power Management (EIPM) computer via an ARINC 429 bus, for the Back-up function. The EEC also sends an N1 ANALOG speed back-up signal directly wired to the EIPM. The N1 speed value is then forwarded to the IOM through the ARINC 429 bus. Each channel of the EEC receives its own Throttle Resolver Angle (TRA) analog signal from the Throttle Control Assembly, independently from the AFDX network through two dedicated resolvers.

The Autothrust (A/THR) instinctive disconnect discrete signal is directly hardwired to each channel of the EEC. The two A/THR instinctive disconnect P/Bs are used by the flight crew to disengage the A/THR mode on all engines.

The EEC exchanges signals and data with the Engine Monitoring Unit (EMU). The EMU does an analysis of data from engine sensors such as pressure sensors, accelerometers, tachometers and Electrical Magnetic Chip Detectors (EMCDs). The EMU gives a report on the engine condition and identifies irregular data. Some processed data are sent from the EMU to the EEC for cockpit display.

The EEC acquires the signals that follow from cockpit panels, through 4 IOMs and the Avionics Data Communication Network (ADCN):

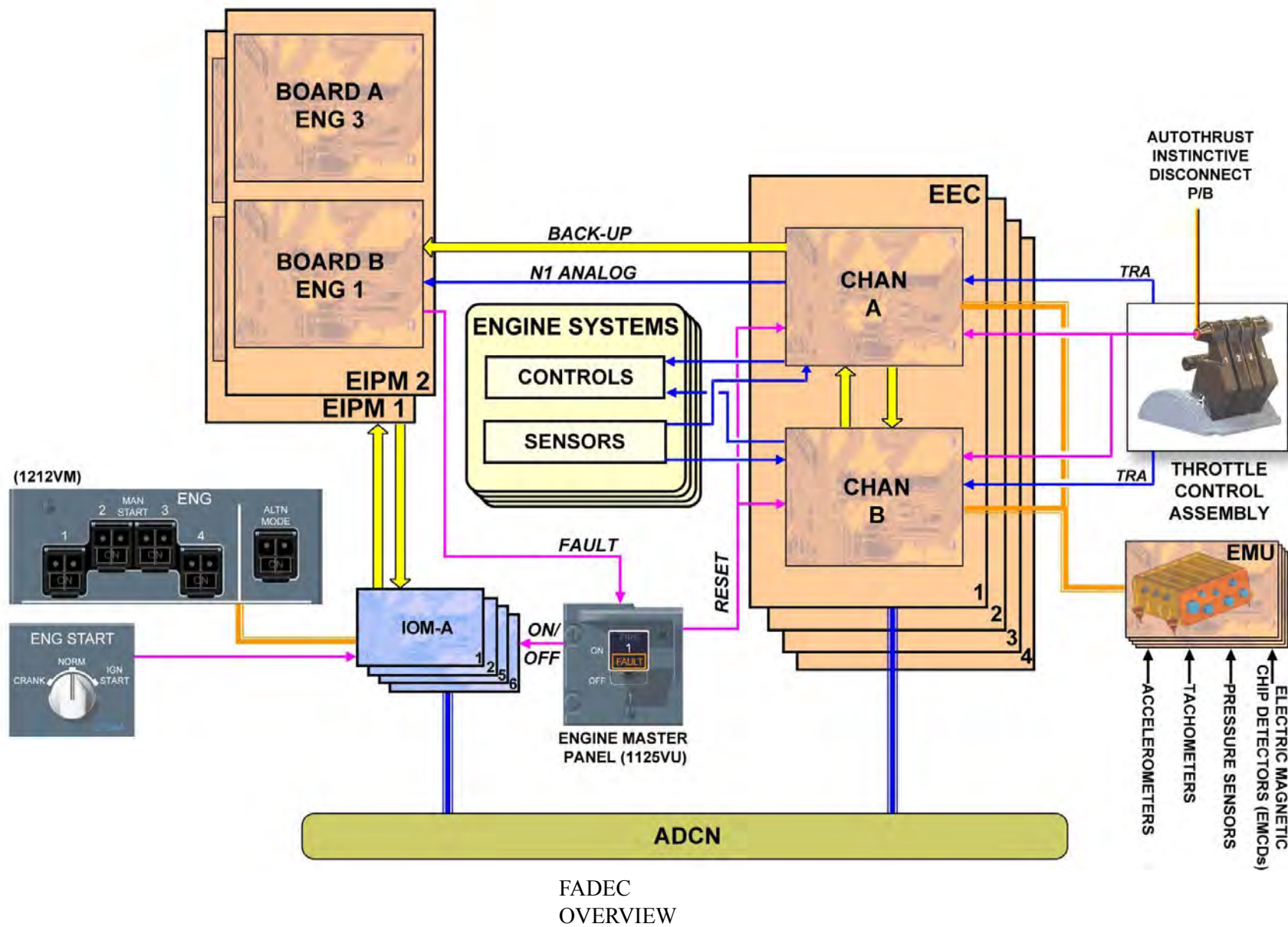
- Rotary selector CRANK/NORM/IGN START position,
- ENG MAN START P/B switches status,
- ENG ALTN MODE P/B switch status (for N1 Back-up mode),

- MASTER lever position ON/OFF (one for each engine), to start the

Engine Starting sequence (in Automatic Start) or to supply the fuel (in Manual Start or Wet crank).

A discrete signal is directly hardwired from the MASTER lever to each channel of the EEC for EEC reset, and to keep the MASTER Lever position when there is an AFDX failure.

The EIPM uses digital data received from the related EECs, via the 4 IOMs, to manage the MASTER Lever FAULT light. The EIPM sends a discrete signal to the ENG MASTER lever for the FAULT light.



## FADEC ARCHITECTURE & INTERFACE DESCRIPTION (3)

### EEC Aircraft Interfaces

EEC has digital interfaces, analog and discrete inputs/outputs.

#### EEC Digital Interfaces

The four EECs have digital interfaces with the aircraft systems through the ADCN.

The IOMs transmit cockpit commands (MASTER Lever, START rotary Selector, N1 P/B or ALTerNate MODE P/B, MANual START P/B) and EIPM and Anti-Ice Control Unit (AICU) data to the EEC. The EIPMs receive, via the IOM, engine status data (speed, starting, shutdown, reverse inhibition, reverse locked...) from the EEC own and opposite data buses.

The Anti-Ice Control Unit (AICU) receives, via the IOM, data about engine running, maximum take-off/go-around, flex take-off and derated take-off limit mode selected. It sends Wing Anti-Ice/Nacelle Anti-Ice (WAI/NAI) status to the EEC for engine thrust modulation. The Engine Bleed Air System (EBAS), the Pneumatic Air Distribution System (PADS) and the Overheat Detection System (OHDS) are hosted in CPIOM-A. These systems receive data from the EEC about:

- Engine status (engine starting and running, reverse operation) and starting data for pack closure,
- Engine pressure & temperatures (P0, P30, T30),
- Starter control valve position,
- Burst duct detection (to OHDS).

The EBAS, PADS and OHDS send data to the EEC about:

- Bleed configuration status,
- HP/IP command,
- Bleed manifold pressure,
- Cross-bleed valves position,
- APU isolation valve.

The Avionics Ventilation System (AVS), the Air Generation System (AGS) and the Cabin Pressure Control System (CPCS) are hosted in

CPIOM-B (AVS hosted in B3 and B4). The AVS receives data from

the EEC about the Engine Status (engine running / not running).

The CPCS receives data from the EEC about the Engine running, the engine take-off power and the N1 speed. The AGS receives engine-starting data for the closure demand of the pack valves from the EEC. The AGS sends data about the AGU flow demand and the position of the 'PACK' pushbutton switches to the EEC.

The Flight Warning System (FWS) is hosted in CPIOM-C. It receives engine failure warnings annunciation and engine status (speed, starting, shutdown, reverse operation) from the EEC via the ADCN and from the EIPM for back-up with the ARINC 429 bus. The Weight and Balance Back-up Computer (WBBC), hosted in CPIOM-C, receives data about fuel used from the EEC.

The Air Traffic Control (ATC) is hosted in CPIOM-D1 and receives data from the EEC about engine status (engine running, not running...). The ATC Data Link application uses two engine started statuses to begin the transmission of data to the Tower. The CPIOMs from the EECs use this data, together with the landing gear data, to determine if the aircraft is on the ground or in flight. The Landing Gear Extension and Retraction System (LGERS) is hosted in CPIOM-G. It sends wing and body landing gear statuses (for flight/ground status computation) to the EEC.

The Fuel Quantity Management System (FQMS) is hosted in CPIOM-F. It receives fuel used data from the EEC and sends fuel temperature data to the EEC.

The Doors and Slides Management System (DSMS) receives engine running/engine not running data from the EEC. This signal is used as part of the logic controlling operation of the Residual Cabin Pressure Warning lights.

The Electrical Power Generating System (EPGS) receives data from the EEC about the engine status (MASTER lever OFF, engine Start/crank sequence active) and about engine speed N3. The engine

status from the EEC lets the EPGS activate the Ram Air Turbine (RAT) generation mode if there is a total engine flame out.

The PRIM (Flight Controls and Guidance Computer) receives engine status (speed, starting, shutdown, reverse operation) and autothrust feedbacks (actual thrust, commanded thrust, thrust limits...) from the EEC. It sends to the EEC:

- Autothrust N1 target,
- Autothrust engaged and active signals,
- Alpha floor protection,
- Throttle position (for consolidation of EEC signals from potentiometers),
- T/O mode selection input (Flex temperature, derated T/O levels, Derated Climb levels),
- Thrust Control Malfunction (TCM) permission discrete command,
- Wheel speed (provision).

The Aircraft Environment Surveillance System (AESS) receives engine running, selected take-off power and thrust data from the EEC. The "engine running" parameter is used by the AESS for the automatic activation of the weather radar emission and the "Engine at take-off power" parameter is used for the automatic activation of the Predictive Windshear (PWS) function.

The Air Data and Inertial Reference System (ADIRS) receives engine data from the EEC for consolidation of ADIRU internal parameters. The ADIRS sends air data parameters (Ps, Pt, TAT, Mn), probe heat status (pitot, static, TAT, AOA) and calibrated airspeed (CAS) to the EEC.

The Electronic Control Box (ECB) (APU controller) receives the start sequence signal for the APU boost from the EEC and sends the APU availability signal (to determine bleed configuration) to the EEC. The Slat/Flap Control Computer (SFCC) sends the slat/flap configuration (for approach selection) to the EEC.

The Control and Display System (CDS) receives from the EEC:

- Engine primary parameters (THR, N1, EGT),
- Engine secondary parameters (N2, N3, FF, fuel used, oil quantity,

oil temperature, oil pressure, vibration levels),

-Engine status (speed, starting, shutdown, reverse operation).

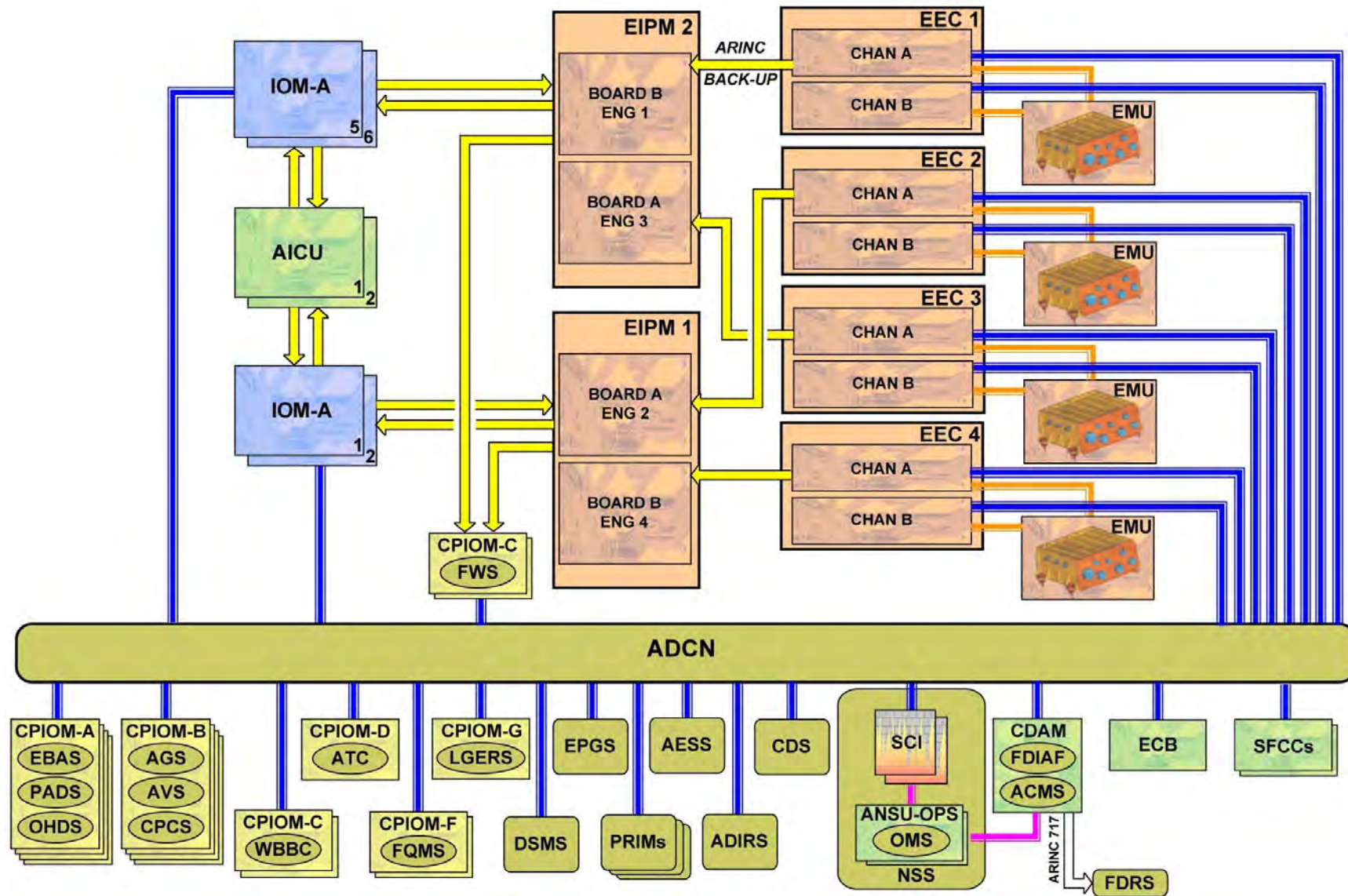
The Aircraft Condition Monitoring System (ACMS) and the Flight Data and Interface/Acquisition Function (FDIAF) are hosted in the Centralized Data Acquisition Module (CDAM). These systems receive engine data for performance trend monitoring, engine manufacturer's reserved parameters and EMU advanced maintenance reports.

The Flight Data Recording System (FDRS) receives data from the EEC, through the CDAM, about:

- PS3, regulated pressure, engine bleed demand / K factors,
- N1/TPR limit, N2, N3,
- Each thrust reverser position and throttle / power lever position,
- EGT, oil quantity, engine vibration, oil temperature and oil pressure,
- HP/LP fuel valve,
- Fuel flow and derated take-off,
- Position engine relight indication,
- Thrust command,
- Engine warning (each engine vibration),
- Thrust/Power on each engine.

The CDAM transmits its data to the OMS (Onboard Maintenance System).

The OMS application interfaces with the ADCN through the Secure Communication Interface (SCI) data.



## FADEC ARCHITECTURE & INTERFACE DESCRIPTION (3)

### EEC Aircraft Interfaces (continued)

#### EEC Analog and Discrete Inputs/Outputs

The EEC has direct interfaces with aircraft systems and cockpit controls. It receives and sends analog and discrete data.

The engines are controlled by modulation of a throttle lever angle. The Throttle Control Assembly (TCA) receives the excitation current for the resolvers from each channel of the EEC.

The Throttle Resolver Angle (TRA) of the throttle lever position is transmitted in analog signals to each channel of the EEC.

A discrete signal from the MASTER lever is directly hardwired to each channel of the EEC, for the EEC reset function.

The activation of the A/THR instinctive disconnect P/B is used to disengage the A/THR mode on all engines. An A/THR instinctive disconnect discrete signal is directly hardwired to one EEC channel (internally cross-wired) and to the Flight Controls Computers (PRIMs) and Flight Warning System (FWS).

To protect the engine from Thrust Control Malfunction (TCM), an independent discrete signal from the aircraft is directly hardwired to each EEC. The function of this independent input is to authorize the EEC to do engine shutdown if it detects an uncommanded and uncontrollable thrust excursion, which can have an effect on the aircraft controllability. The Flight Controls PRIMary (PRIM) sets the TCM protection signal.

Each EEC receives hardwired discretes from the airframe that give the engine position on the aircraft. These discretes are directly hardwired from the pylon junction box to the EEC.

An N1 speed back-up signal will be made available at the aircraft level. The analog signal is wired from the EEC channel A to the EIPM computer. The N1 back-up indication is used to keep as a minimum the N1 display available in the conditions that follow:

- AFDX network failure,
- Total loss of EEC,

- Total loss of AFDX buses on the engine.

When the engine speed detected is higher than 50% N3, the two EEC channels set the engine running discrete output.

But only the output from EEC channel A is used and the EEC channel B output is wired to ground.

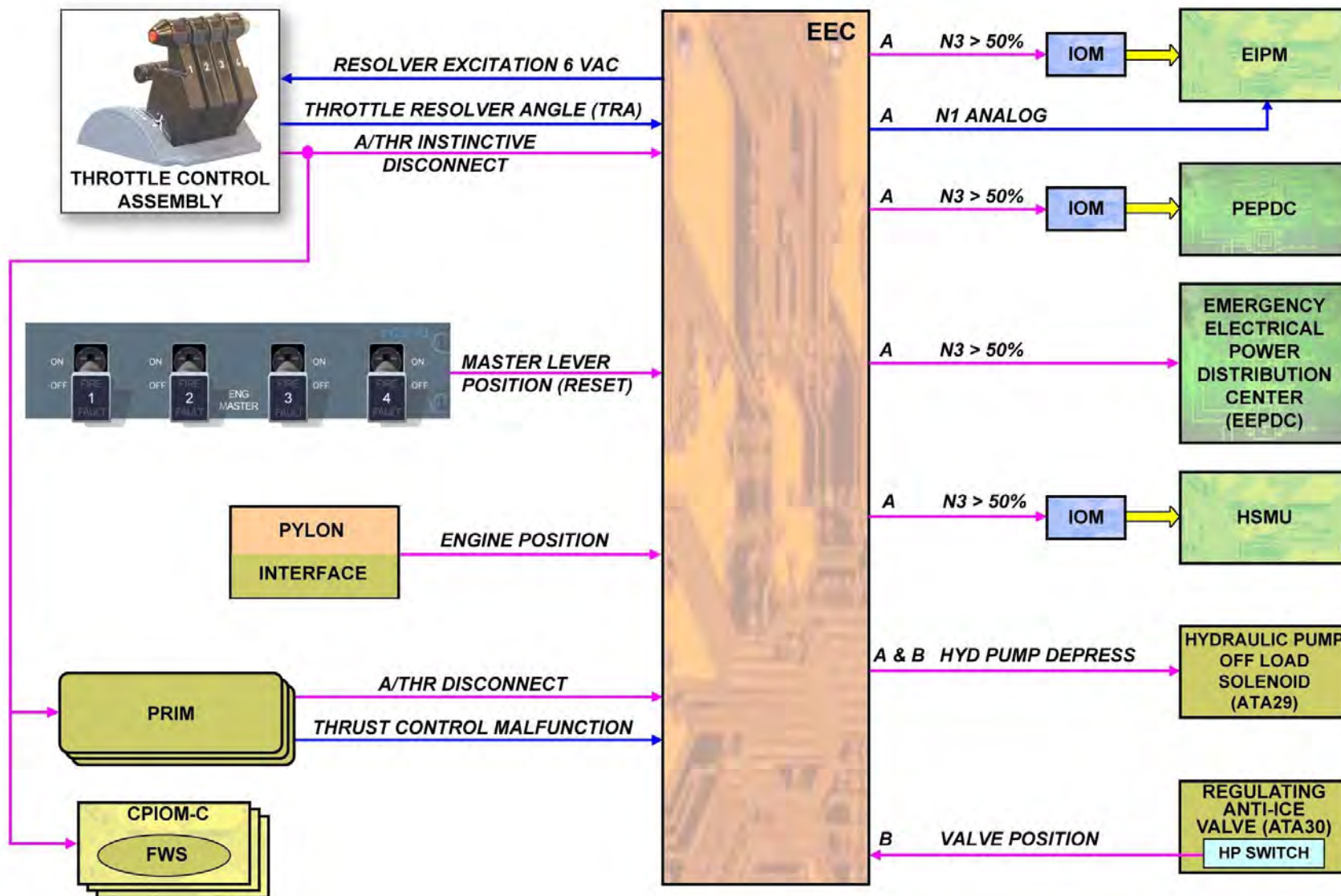
These discrete signals are used by:

- The Emergency Electrical Power Distribution Center (EEPDC) to detect total engine flameout during flight for the deployment of the Ram Air Turbine (RAT),
- The Hydraulic System Monitoring Unit (HSMU) to monitor the hydraulic pump exit pressures when on the ground,
- The Primary Electrical Power Distribution Controller (PEPDC) to deactivate the safety test when an engine is running on the ground,
- The Engine Interface Power Management (EIPM) to supply input into the thrust reverser second line of defense.

The discrete signals are sent directly to the EEPDC and via Input/Output Modules (IOMs) to the HSMU, PEPDC and EIPM.

For engine in-flight windmilling restart functions, the EEC can depressurize the two hydraulic pumps on the engine. To do this function, the two EEC channels can switch one output ground/open discrete signal that controls the depressurization of the two Engine-Driven hydraulic Pumps (channel A for EDP1 and channel B for EDP2) by the control of the hydraulic pump off-load solenoids. EEC channel B only monitors the Regulating Anti-Ice Valve (RAIV) position with a High Pressure Switch.

The EEC receives feedback from the engine anti-ice protection system for bleed status demand.



EEC AIRCRAFT INTERFACES - EEC ANALOG AND DISCRETE INPUTS/OUTPUTS

## **FADEC ARCHITECTURE & INTERFACE DESCRIPTION (3)**

### **EEC Command and Sensor Interfaces**

#### **Data Entry Plug (DEP)**

The FADEC does engine control and monitoring.

The Data Entry Plug (DEP) is a dual channel serial memory device used as storage for engine specific performance and configuration data. The DEP is a plug and housing that is attached to the engine by a lanyard. The data entry plug is only programmed with the applicable data for the engine on which it is installed. It cannot be removed and then installed on a different engine unless it is programmed for that engine.

The data entry plug is programmed with the data that follows:

- Turbofan power ratio trim,
- Engine rating selection,
- EGT trim,
- Engine serial number,
- Idle trim.

**NOTE:** If the DEP data and the engine data do not agree, the engine will not operate correctly.

#### **Engine Fuel System Sensors**

The fuel flow XMTR continuously monitors the fuel flow to the combustion system. The XMTR supplies analog signals to EEC channel B that are in proportion to the mass fuel flow rate. The EEC uses these signals to calculate the flow rate and the quantity of fuel used. The EEC then transmits this data for display in the cockpit.

The fuel filter differential pressure switch tells the EEC if the fuel filter is clogged.

#### **Engine Oil System Sensors**

The oil quantity XMTR is installed through an opening in the center of the top face of the oil tank. The EEC uses this signal for display in the cockpit.

The oil pressure XMTR senses the difference between the supply and scavenge oil pressures. One XMTR for each EEC channel supplies an oil pressure indication.

The oil temperature thermocouples are installed at the top of the scavenge oil filter housing. The system uses the thermocouples that are sensitive to temperature changes. An oil temperature signal is sent through the EEC to the aircraft indicating system. The filters differential pressure switches (supply and scavenge) compare the difference between upstream and downstream pressure for their related filters.

#### **Engine Temperature Sensors**

The two channels of the EEC have a T20 thermocouple analog input. The T25 thermocouple sends the signal of the Total Air Temperature (TAT) at the IP compressor exit to the EEC. This signal is used for health monitoring functions. The signal is input to EEC channel B only.

The T30 signal is made by two single element thermocouples installed at different radial positions around the engine. Each thermocouple sends a signal to the related channel of the EEC. T30 is the TAT at the HP compressor.

The Exhaust Gas Temperature (EGT) or Turbine Gas Temperature (TGT) is derived from 14 double element thermocouples installed in the nozzle guide vanes. The thermocouples are wired in parallel by two leads, one in alumel and one in chromel. Each pair of leads is connected to each channel of the EEC.

The Turbine Cooling Air Front (TCAF) probe converts the IP turbine disc-cooling air temperature at the front of the disc into an electrical signal.

The Turbine Cooling Air Rear (TCAR) probe converts the IP turbine disc-cooling air temperature at the rear of the disc into an electrical signal.

TCAF and TCAR thermocouples are used for IP Turbine disk overheat detection.

A dual element Resistive Thermal Device (RTD) measures the temperature of air at the exit of Zone 1. The sensor is connected to the EEC and senses duct leakage to prevent nacelle structure damage. A single thermocouple, installed on the IP/LP TCC flange, sends a temperature signal from the Zone 3 nacelle to EEC channel A. This signal is used for condition monitoring functions.

### **Engine Speed Sensors**

The N1C and N1T shaft speeds are derived from engine pulse probes. The probes supply a sinusoidal frequency voltage proportional to the LP compressor and LP turbine shaft speed rotation. The N1 Compressor speed signal is sent to each channel of the EEC, as a primary parameter for thrust limitation and N1 mode back-up computation. The comparison between N1C and N1T speeds is used to give an LP Turbine overspeed protection.

The N2 shaft speed signal is derived from engine pulse probes. The probes supply a sinusoidal frequency voltage proportional to the IP shaft speed rotation. The N2 speed signals are used for engine control functions and are used by the Rotor OverSpeed (ROS) protection.

The N2 speed signal is sent to each channel of the EEC.

The N3 shaft speed signal, used in the EEC, is derived from the Permanent Magnetic Alternator (PMA). The outputs from the PMA are at a frequency proportional to the N3 shaft speed and send an N3 speed signal to each channel of the EEC.

### **Engine Pressure Sensors**

The P0 signal is input to channel B.

The P20 probe sends the signal of the Total Air Temperature (TAT) at the engine air intake to the EEC. The EEC automatically selects

the P20 probe heater to prevent the formation of ice on the probe air inlets. The P20 signal is input to channel B.

The HP compressor pressure signal called P30 is split in the EEC to give a pressure that taps to a transducer in each channel. The ratio P30/P20 is used for the TPR thrust computation.

The IP Compressor pressure signal called P25 is input to the EMU for condition monitoring functions.

The P50 signal is an exhaust gas pressure signal which is split in the EMU to give a pressure that taps to a transducer in each channel of the EEC. A fan exit signal called P160 is used for condition monitoring functions and is input to the EMU.

### **Vibration Transducer (XDCR) and Magnetic Chip Detector**

A dual vibration XDCR signal and a magnetic chip detector signal are computed by the Engine Monitoring Unit (EMU), which monitors engine performance trend and engine vibrations.

### **Engine Starting and Ignition Systems**

The EEC controls the starting system during the engine start sequence. The EEC opens the starter control valve to operate the pneumatic starter from the APU air, the cross-bleed air or an external air source. The EEC receives feedback from the starter control valve position switch.

The EEC supplies the two ignition units (A and B) of the Ignition system with 115 VAC aircraft power.

### **Engine Fuel and Air Systems**

The EEC controls the fuel flow to the combustion system. The control elements are:

- The Fuel Metering Valve, which controls the fuel flow rate (the EEC receives feedback from an LVDT),
- The PROT MOTOR, which has three positions (STBY, TCM, OVSP),

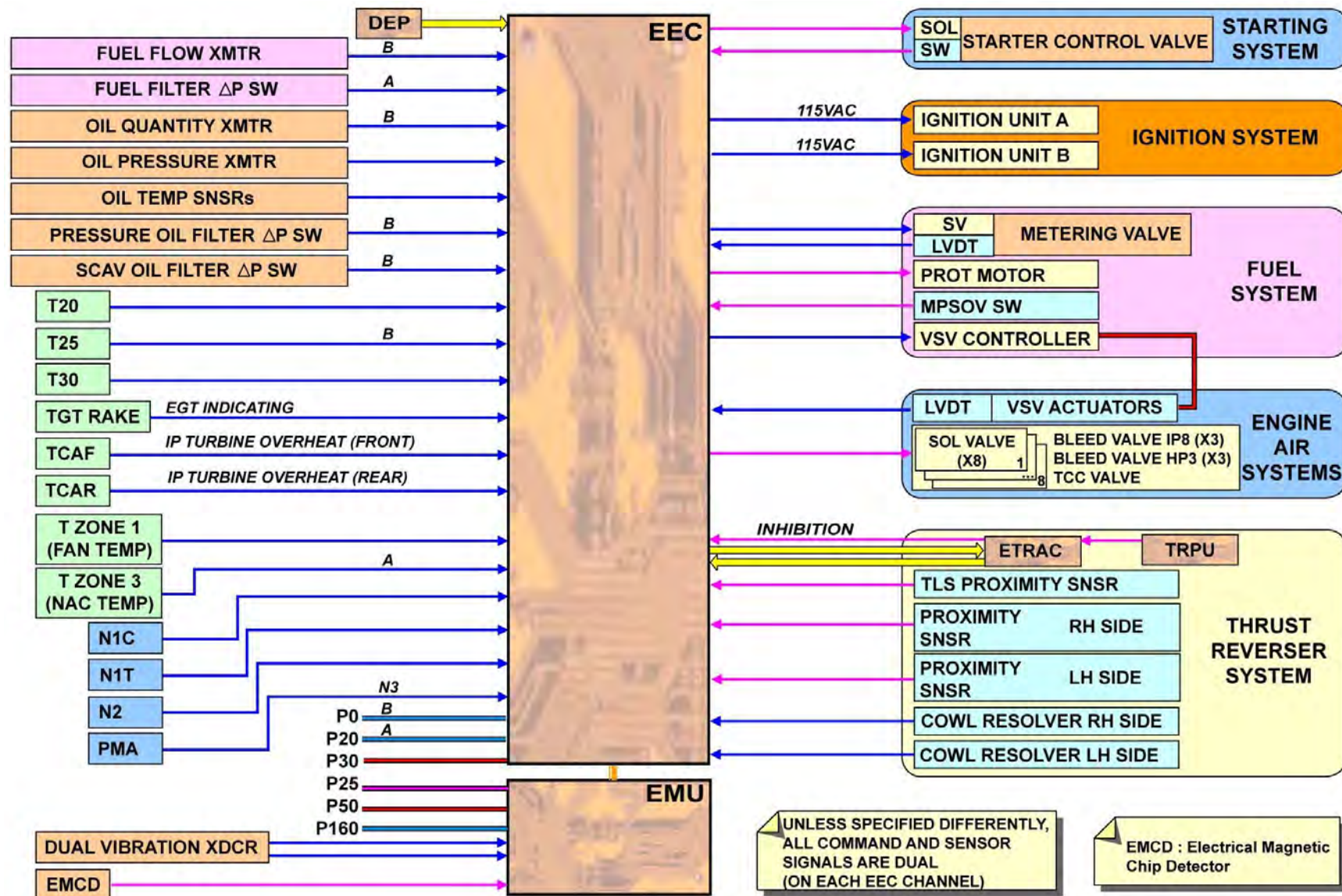
- The MPSOV, which can stop the flow and cause an engine shutdown if there is an overspeed (the feedback is given by the MPSOV proximity sensor),
- The VSV controller, which supplies fuel to the VSV actuators (the EEC receives feedback from an LVDT installed on the VSV actuators). In the engine air system, the EEC controls the operation of:
  - Three IP 8 bleed valves,
  - Three HP 3 bleed valves,
  - The Turbine Case Cooling (TCC) valve.

To prevent an engine surge condition, bleed valves controlled by solenoids are independently supplied with electrical power from the EEC. In cruise conditions, the EEC fully opens the TCC valve to supply LP compressor air to the external surface of the turbine cases. This causes a smaller clearance between the cases and the tips of the HP and IP/LP turbine blades to increase the turbine performance.

There is no feedback of the bleed valves and TCC valves.

### **Engine Thrust Reverser System**

The EEC controls the Electronic Thrust Reverser Actuation Controller (ETRAC) through an ARINC 429 BUS. The Thrust Reverser Power Unit sends an inhibition signal to the EEC through the ETRAC. The EEC receives feedback from the Tertiary Locking System (TLS) proximity SNSRs, from the RH and LH side proximity SNSRs and from the RH and LH side cowl resolvers.



EEC COMMAND AND SENSOR INTERFACES - DATA ENTRY PLUG (DEP) ... ENGINE THRUST REVERSER SYSTEM

## EIPM ARCHITECTURE & INTERFACE DESCRIPTION (3)

### Architecture

There are two Engine Interface Power Management Units (EIPMs) per aircraft, one unit per two engines with separated dedicated boards and processor per engine.

EIPM1:

- Board A: ENG 2

- Board B: ENG 4

EIPM2:

- Board A: ENG 3

- Board B: ENG 1

The EIPM, installed in the avionics bay, controls and delivers electrical power supply from the aircraft to the engine systems.

The basic function of the EIPM is to control and monitor the electrical power supply to:

- Engine Electronic Controller (EEC),
- Cowl Opening System (COS) via the Primary COS Power Unit (PCPU),
- P20T20 via the EEC,
- Electronic Thrust Reverser Actuation Controller (ETRAC),
- Engine Monitoring Unit (EMU),
- Ignition Units.

The EIPM converts N1 analog signal in ARINC 429 bus, for back-up.

From a Discrete Signals Input (DSI) group the EIPM generates, for aircraft interface purpose, Discrete Signals Output (DSO) group.

The EIPM also exchanges data via ARINC 429 with:

- The Onboard Maintenance System (OMS) through the Secure Communication Interface (SCI). The OMS and the SCI are in the Network Server System (NSS),
- The Control and Display System (CDS) via the Core Processing Input Output Modules (CPIOMs) of the Flight Warning System (FWS) as a back-up output,
- The Input Output Module (IOM),
- The EEC Channel A (back-up).

There is one reset push button per EIPM board.

In the cockpit, the overhead panel is provided with 4 EIPM reset buttons.



## EIPM ARCHITECTURE & INTERFACE DESCRIPTION (3)

### Interfaces

#### Electrical Power Supply Control Logics

Each electrical power supply AC2 BUS (EEC, Ignition Unit, ETRAC, P20T20, EIPM) is controlled by SSPCs.

In case of EIPM failure or loss, the EEC channels are fail-safe power supplied.

In the EIPM each power supply is controlled by relays, which are controlled by the electrical power supply control logics.

#### Interface Control Logics

The EIPM does the control and monitoring of the DSI and DSO groups.

The EIPM computes the "oil low press and ground" signal based on the acquisition and the combination of discrete signals from the Landing Gear Remote Data Concentrators (LGRDCs) and Oil Low Press switch, and ARINC signal from IOM (SCI, EEC).

The EIPM sends (via discrete signal) the "oil low press and ground" signal to other users (IOM, Cabin Intercommunication Data System (CIDS), Flight Control Data Concentrator (FCDC)).

The EIPM controls the second line of defense of the Thrust Reverser system, only according to states of inputs of the LGRDC status, reverse switch position, and ARINC bus. This second line of defense is authorized via discrete output Remote Control Circuit Breaker (RCCB) command.

The EIPM monitors the T/R second defense line authorization via the RCCB monitoring input.

The RCCB Command function is only available for engine 2 and engine 3 (inboard engine).

The EIPM controls the power supply of the Cowl Opening System. The fan and Thrust Reverser (or Fan Exhaust) cowl opening is done via the PCPU supplying electrical actuators.

The power supply of the COS is only available when the aircraft is on ground and with engine not running.

EIPM also uses ARINC data to manage COS.

The power supply to the COS is cut in case of action on the FIRE pushbutton of the associated engine.

When the Full Authority Digital Engine Control (FADEC) ground power P/B is activated, the EIPMU electrically powers the EEC channels for 10 minutes (maintenance only) if no OMS interactive mode.

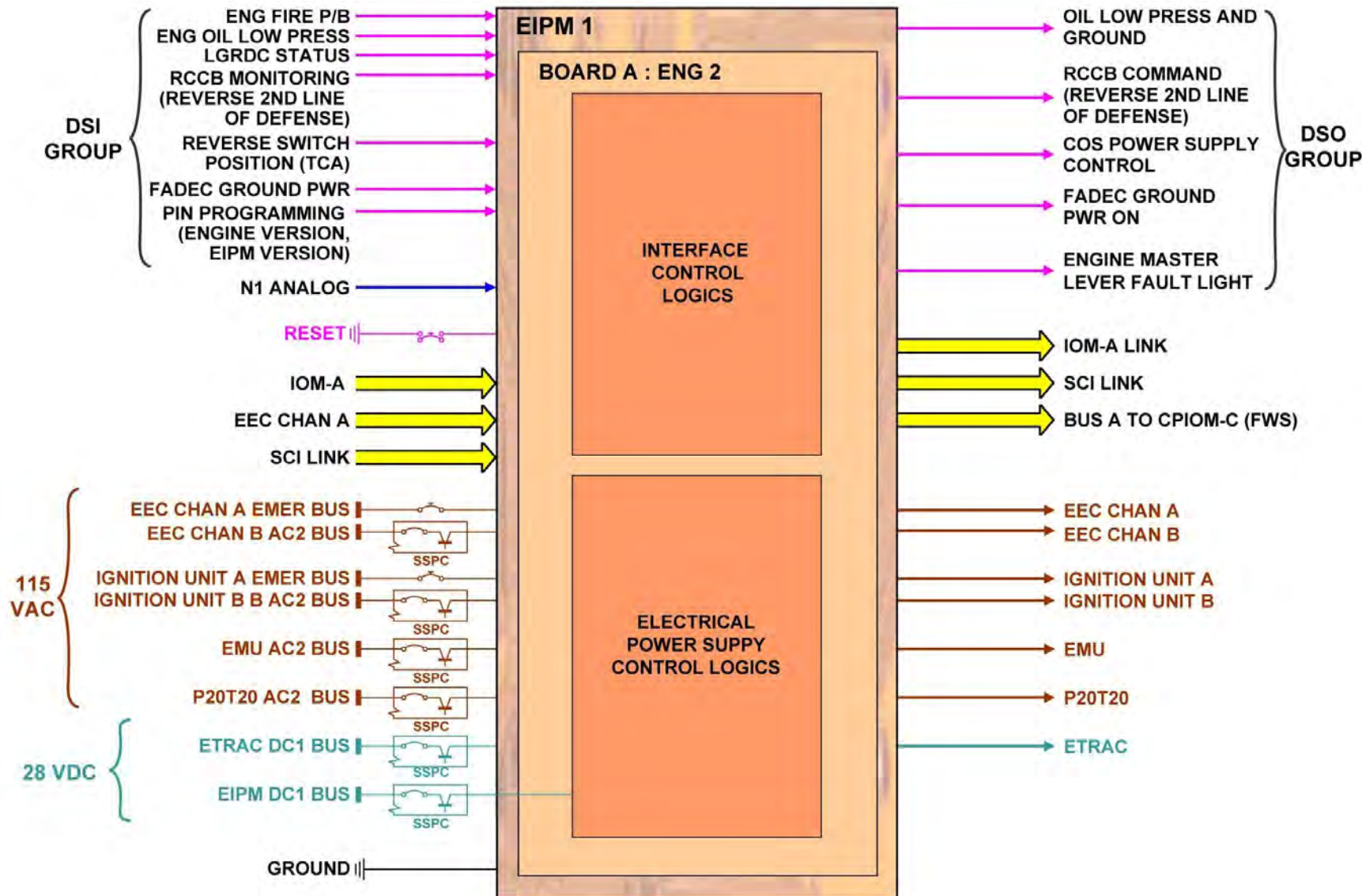
If the ENG FIRE P/B SW is activated, the EIPM cuts-off the electrical power supply to EEC channels for isolation purpose, The EEC sends the MASTER lever FAULT light to the EIPM.

The EIPM generates a power supply discrete signal to turn the Engine FAULT light on, on the MASTER Lever.

The EIPM acquires N1 speed in an analog form and transmits it via ARINC 429 to the IOM and the FWC. This information is used as a back up information of the N1 speed from the EEC via the ADCN.

By pulling the reset button, a discrete signal triggers the software reset of the corresponding EIPM board.

As long as the button is pulled, the corresponding EIPM board is in fail-safe configuration, so the EEC channels, the ignition units, the EMU, the probe P20/T20 and the ETRAC are electrically supplied.



INTERFACES - ELECTRICAL POWER SUPPLY CONTROL LOGICS & INTERFACE CONTROL LOGICS

- LM7RD7000000001

## **EIPM & FADEC POWER SUPPLY DESCRIPTION (3)**

### **General**

The Full Authority Digital Engine Control (FADEC) has two computers:

- Engine Electronic Controller (EEC),
- Engine Monitoring Unit (EMU).

The power supply of the EEC can be processed in two different manners:

- By the airframe power supply (115 VAC) that comes from the Engine Interface Power Management (EIPM),
- By the EEC dedicated alternator, also called Permanent Magnet Alternator (PMA).

EEC is normally powered by its own power supply (PMA), when engine is running.

EMU is supplied by airframe power supply (115 VAC).

**WARNING: DO NOT SET THE MASTER LEVER TO THE "ON" POSITION WITH THE ENG START SELECTOR ALREADY IN THE "IGN/START" POSITION. THIS WILL LAUNCH THE ENGINE START SEQUENCE.**

### **Airframe Power Supply**

EIPM is powered by 28 VDC DC1 BUS.

The EEC receives power from two airframe 115VAC buses through the EIPM control logic function.

The supply line from the emergency bus is connected into channel A of the EEC and the line from the Airframe AC2 bus is connected to channel B of the EEC. In an emergency situation (following loss of all variable frequency generators), only the emergency bus from airframe will operate.

The airframe power supply is available on ground and in flight and shall be used by the EEC for its ground tests, ground engine starting, and in flight starting when engine speed is below 8% N3, or in case of PMA failure.

### **EEC Dedicated Alternator Power Supply (PMA)**

The PMA has a stator and rotor that supply two independent three-phase power windings to the EEC (1 per channel). A mechanical drive from the engine gearbox is used to rotate the PMA Rotor. The interface is required to power the EEC in all Engine running conditions.

When the engine speed is above 8% N3, the PMA will deliver the electrical power necessary for the EEC to achieve its functions including in-flight starter assist or wind-milling engine starting.

Note: Between 5% and 8% of N3 the power supply to the EEC is shared between airframe power and PMA power.

Note: one single phase is also dedicated to N3 sensing.

### **FADEC Power Supply**

#### **Aircraft Power-Up**

At aircraft Power-up or EIPM initialization, the EEC and the EMU will be powered as detailed below:

Channel A is powered by 115 VAC Emergency Bus.

Channel B is powered by 115 VAC Bus2.

Channel A & B and the EMU will be powered for 15 minutes if the full airframe electrical network is available.

#### **Engine START Selector**

With engine not running:

- When you set the ENG START rotary selector to "CRANK" or "STAR/IGN" position, power is supplied to the EEC and the EMU
- When you set the ENG START rotary selector to the "NORM" position the power supply to the EECs and the EMU is cut off.

#### **Engine MASTER Lever**

With engine not running:

-Each ENG MASTER lever in the "ON" position supplies power to the related EEC and EMU.

On the ground, airframe 115 VAC will be removed from the EEC and EMU 15 minutes after selection of the ENG MASTER lever from the "ON" to "OFF" position. This will not occur in flight.

### **Engine FADEC Ground Power**

For maintenance operation, with the ENG FADEC GrouND PoWeR P/B selected to the "ON" position and the EEC interactive mode not instigated, airframe 115 VAC will be cut off after 10 minutes.

The airframe 115 VAC power will be cut off immediately by selecting the ENG FADEC GrouND PoWeR P/B to the "OFF" position or by returning the ENG START selector to the "NORM" position (with the ENG MASTER lever to the "OFF" position).

### **Engine FIRE Push-Button**

In the case of fire, in flight or on ground, airframe 115 VAC power will be cut off immediately following operation of the ENGINE FIRE P/B .

### **EIPM Failure**

In the event of EIPM failure, airframe 115 VAC power will be permanently available to the EEC whenever the airframe electrical network is powered.

### **EEC Dedicated Alternator Failure**

If the EEC dedicated alternator winding for the EEC channel in control becomes defective, there will be an EEC channel change over if the second winding is healthy.

If both alternator windings fail, the EEC will be supplied by the airframe 115 VAC through the EIPM.



## EIPM & FADEC POWER SUPPLY DESCRIPTION (3)

### Synthesis Table

On the table here after there is a synthesis of the FADEC power supply duration depending on various events.

**FADEC POWER SUPPLY DURATION  
DEPENDING ON  
THIS VARIOUS EVENTS**

| ITEM<br>N° | ON GROUND EVENT                                      | POWER SUPPLY<br>DURATION |
|------------|------------------------------------------------------|--------------------------|
| 1          | After A/C Power-up                                   | 15 mn                    |
| 2          | FADEC GND PWR P/B set to ON                          | 10 mn                    |
| 3          | FADEC GND PWR P/B set to OFF                         | cut-off                  |
| 4          | With OMS Interactive Mode (FADEC menu)               | permanent                |
| 5          | After OMS Interactive Mode exit                      | 5 mn                     |
| 6          | ENG MODE selector set to CRANK or IGN                | permanent                |
| 7          | ENG MODE selector set to NORM (Engine not running)   | cut-off                  |
| 8          | MASTER lever set to ON                               | permanent                |
| 9          | MASTER lever set from ON to OFF                      | 15 mn                    |
| 10         | After engine shutdown or cranking (MASTER Lever OFF) | 15 mn                    |
| 11         | ENG FIRE P/B activated                               | cut-off                  |
| 12         | EIPM Failure                                         | permanent                |
| 13         | EIPM reset (C/B pulled)                              | permanent                |

Note : When the aircraft power is ON,  
the EIPM is energized.

SYNTHESIS  
TABLE

## FADEC MAINTENANCE (3)

### Tests

The Onboard Maintenance System (OMS) is used for the test of two main computers of the power plant system:

- EEC (Engine Electronic Controller),
- EIPM (Engine Interface Power Management).

These tests are launched from the OMS Human-Machine Interface (HMI) with the Onboard Maintenance Terminal (OMT), Onboard Information Terminal (OIT) or Portable Multipurpose Access Terminal (PMAT).

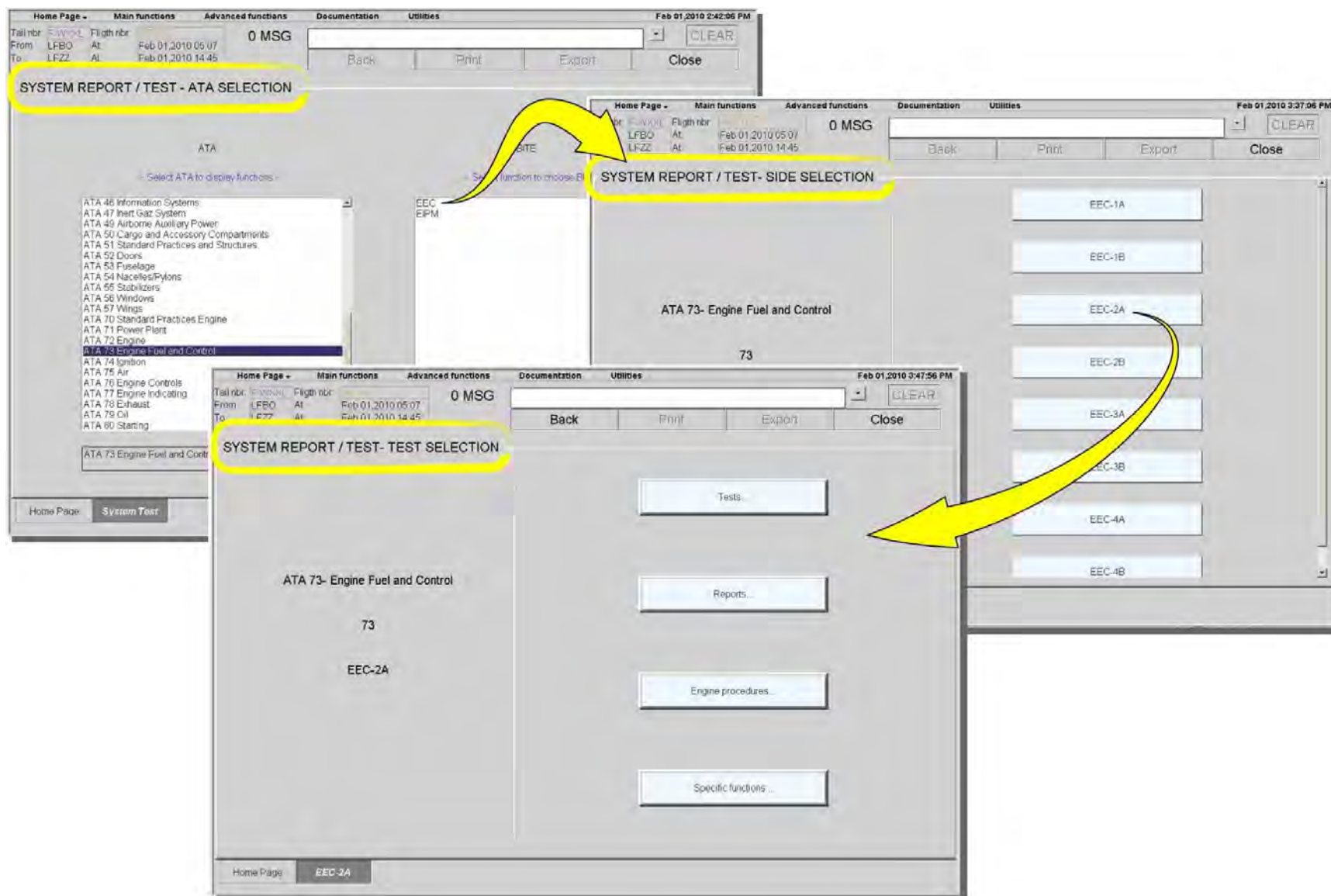
### EEC

The EEC is used for engine control system self-testing to detect problems at LRU levels.

The EEC system is designed such that no engine ground run for trim operations is necessary after component replacement.

To get access to the "TEST SELECTION" page of an EEC, select the ATA 73 "Engine Fuel and Control" in the "ATA SELECTION" page and then EEC. Then, select the applicable EEC and channel on the next page called "SIDE SELECTION".

The EEC gives the interactive tests, reports, engine procedures and specific functions that follow:



## TESTS - EEC

## FADEC MAINTENANCE (3)

### Tests (continued)

#### EEC Tests

##### SYSTEM TEST

The FADEC system test gives the most comprehensive static test possible for the control system. During this test, the Engine Electronic Controller (EEC) energizes the solenoids and torque motor drives. It also monitors the system for failure messages in normal mode.

During the test, the EEC does tests on the functions that follow:

- Fuel Metering Valve (FMV) drives,
- Variable Stator Vane (VSV) drives,
- Intermediate Pressure (IP) and High Pressure (HP) Bleed Valve drives,
- Turbine Case Cooling drives,
- Overspeed Torque-motor drives.

##### AUDIBLE TEST OF THE IGNITERS

**WARNING: THE IGNITERS WILL SPARK DURING THE TEST.**

This test does a check for faults in the ignition system (the igniter boxes, igniter leads and igniters). The EEC cannot detect the operation of the igniter during the test, thus it is necessary to listen for operation of the igniters at the engine.

##### VARIABLE-STATOR-VANES SYSTEM TEST

This test makes sure that the EEC can operate the Variable Stator Vane (VSV) actuators correctly. The EEC moves the VSVs to a number of positions to make sure that they operate satisfactorily. The engine will be dry-motored during the test.

**WARNING: SET THE CONTROLS AS SPECIFIED IN THE PROCEDURE SHOWN ON THE OMS. DRY-MOTORING WILL START IMMEDIATELY.**

##### P20T20 PROBE HEATER TEST

This test does a check to make sure that the P20T20 probe heater system operates satisfactorily. During the test, the EEC supplies power to the P20T20 probe heater for 5 seconds. This makes the P20T20 probe become hot. Make sure that no covers, caps or plugs are installed on the P20T20 probe. The two channels of the EEC automatically monitor the P20T20 probe heater current and look for faults.

**CAUTION: THE P20T20 PROBE WILL BE ENERGIZED FOR 5 SECONDS AND WILL BECOME HOT DURING THIS TEST.**

##### HYDRAULIC PUMP OFFLOAD TEST

During this test, the hydraulic pump offload function will be physically tested.

The engine will be dry-motored during the test. Make sure that the engine area is clear of personnel before you start this test. This test can cause injuries to personnel and damage to equipment.

**WARNING: SET THE CONTROLS AS SPECIFIED. DRY-MOTORING WILL START IMMEDIATELY. IN THIS TEST, YOU MUST MONITOR THE HYDRAULIC PRESSURE TO SEE IF IT INCREASES AND DECREASES AT THE APPLICABLE TIMES.**

##### HARNESS TEST

##### THRUST REVERSER CYCLING TEST

Note: This test is only done on the EEC of the inboard engines.

**WARNING: THE THRUST REVERSER WILL BE ENERGIZED AND MOVED DURING TEST. MAKE SURE THAT THE THRUST REVERSER AREA IS CLEAN AND CLEAR OF PERSONS AND TOOLS OR OTHER ITEMS.**

Make sure that the thrust reverser is not in an inhibited condition. Obey the instructions given on the OMT. It will be necessary to configure the controls and move the throttle lever to the reverse idle position to deploy the thrust reverser, then back to the forward idle position to stow it. The deploy and stow operations have time limits monitored by the OMS.

#### **ENGINE RUNNING SIMULATION**

Some airframe systems can only be energized when the channel A engine-running discrete is energized. Usually, this engine-running discrete is only energized during an engine operation. During this procedure, the Engine Electronic Controller (EEC) energizes the channel A engine-running discrete for a maximum of 10 minutes. The engine does not operate during the test period, but this makes it possible to energize the applicable aircraft systems.

#### **AIRCRAFT HARDWIRED INPUTS TEST**

The aircraft hardwired inputs test does a check of the status of the hardwired inputs from the aircraft for the master lever, autothrust instinctive disconnect, aircraft permission and engine position discretes. It also does a check of the Throttle Resolver Angle (TRA) and throttle potentiometer angle hardwired input positions.

#### **Reports**

The reports are the same for the two channels of the four EEC.

##### **EEC CONFIGURATION REPORT**

##### **EGT EXCEEDANCE REPORT**

##### **SHAFT-SPEED EXCEEDANCE REPORT**

The applicable shaft speed exceedance data includes the maximum shaft speeds that occurred and the total time the shaft speeds were above their limits.

The shaft-speed exceedance data values are erased automatically during each engine start. Thus, if a shaft-speed exceedance occurs, you must do this procedure and record the exceedance data before you start the engine.

#### **Engine Procedures**

The engine procedures are the same for the two channels of the four EEC.

##### **FAN TRIM BALANCE**

Selection of the Fan Trim Balance function opens another page where you can select:

- One-Shot Trim Balance or,
- Trial Weight Trim Balance.

Obey the procedures in the AMM and on the OMT to do the fan trim balance procedures.

##### **ENGINE CORE WASHING**

These procedures are used to for the recovery of the engine performance by cleaning the Intermediate Pressure and High Pressure compressors. Selection of the Engine Core Washing function opens a page where you can select the different procedures for compressors cleaning. They are:

- The water method,
- The water and glycol method
- The water and detergent method.

Always obey the relevant AMM procedure to do engine core washing.

##### **BLEED-VALVE TEST SCHEDULING**

There are two tests related to bleed valve scheduling on the OMT:

- The High Pressure (HP) bleed valves scheduling test,
- The Intermediate Pressure (IP) and HP bleed valves scheduling test. For these two tests, the test engine must be started and operated at more than idle speed for a period of five minutes. This makes sure that sufficient air pressure is generated for bleed valve operation.

Always obey the related AMM procedures when you do this task and obey the instructions on the OMT.

The test must be activated before engine start and then the OMS session closed before engine start. When the necessary engine conditions are met, the EEC will start the selected test automatically. The EEC will not tell you when the test starts, is aborted or finished.

When the engine is stopped, you must look for failure messages in the OMS because no related messages tells you if the test was satisfactory.

Note: It is possible that you will see changes in the engine speeds and other parameters when the EEC operates the handling bleed-valves. It is also possible that you will hear the sound of the test-engine change when the handling bleed-valves operate. This will tell you that the test is in operation.

**WARNING: THE ENGINE MUST BE STARTED TO SUPPLY  
THE AIR PRESSURE TO OPERATE THE BLEED  
VALVES WHEN COMMANDED BY THE EEC.**

#### **INHIBITION OF THRUST REVERSER**

This procedure will inhibit the Thrust Reverser command. Only use this procedure if the mechanical Thrust Reverser inhibition lever is inoperative and the procedure must be done on the two EEC channels.

**CAUTION:** Use this procedure only if indicated by an Airbus  
Technical Approval.

#### **Specific Functions**

The specific functions are the same for the two channels of the four EEC.

##### **RESET FUEL USED**

The fuel-used value is usually reset automatically when an engine starts. Thus, if an engine is unserviceable at the start of a flight, its fuel-used value will not be reset automatically. Because of this, the total fuel-used indication will not be correct during the flight. If the total fuel-used value is incorrect, the aircraft system that senses fuel leaks does not operate correctly. This procedure lets the operator reset the fuel-used value without the engine start that is necessary for an automatic reset.

TESTS, REPORTS, ENGINE PROCEDURES AND SPECIFIC FUNCTIONS ARE SIMILAR FOR ALL ENGINES, BUT THERE IS ONE MORE TEST FOR THE INBOARD ENGINES.

|                    |                    |                                   |                                                                                                                                                                                                                                                                                                                                                            |
|--------------------|--------------------|-----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| EEC 2<br>CHAN<br>A | TESTS              | SYSTEM TEST                       | STATIC TEST OF EEC INPUTS / OUTPUTS                                                                                                                                                                                                                                                                                                                        |
|                    |                    | AUDIBLE TEST OF THE IGNITERS      | THE EEC CANNOT DETECT THE OPERATION OF THE IGNITER DURING THE TEST. EVEN IS "TEST OK" IS SHOWN, YOU MUST MAKE SURE THAT YOU HEAR THE IGNITION SYSTEM OPERATION AT THE ENGINE.<br><b>WARNING:</b> THE IGNITERS WILL SPARK DURING THE TEST.                                                                                                                  |
|                    |                    | VARIABLE-STATOR-VANES SYSTEM TEST | TEST FOR THE CORRECT OPERATION OF THE VSV BY ACTUATION OF THE SYSTEM WITH THE FUEL PRESSURE.<br>THE ENGINE WILL BE DRY-MOTORED DURING THE TEST.<br><b>WARNING:</b> SET THE CONTROLS AS SPECIFIED. DRY-MOTORING WILL START IMMEDIATELY.                                                                                                                     |
|                    |                    | TEST OF THE P20T20 PROBE HEATER   | <b>CAUTION:</b> THE P20T20 PROBE WILL BE ENERGIZED FOR 5 SECONDS AND WILL BECOME HOT DURING THIS TEST.<br>MAKE SURE THAT NO COVERS, CAPS OR PLUGS ARE INSTALLED ON THE P20T20 PROBE.                                                                                                                                                                       |
|                    |                    | HYDRAULIC PUMP OFFLOAD TEST       | PHYSICAL TEST OF THE HYDRAULIC PUMP OFFLOAD.<br>THE ENGINE WILL BE DRY-MOTORED DURING THIS TEST.<br><b>WARNING:</b> SET THE CONTROLS AS SPECIFIED. DRY-MOTORING WILL START IMMEDIATELY. DURING THIS TEST, YOU MUST MONITOR THE HYDRAULIC PRESSURE AND SEE IF IT INCREASES AND DECREASES AT THE APPLICABLE TIME                                             |
|                    |                    | HARNESS TEST                      | THIS TEST MONITORS THE FADEC SYSTEM FOR 15 MINUTES AND LOOKS FOR FAULTS WHILE YOU MOVE THE HARNESS.                                                                                                                                                                                                                                                        |
|                    |                    | THRUST REVERSER CYCLING TEST      | <b>WARNING:</b> THRUST REVERSER WILL BE ENERGIZED AND MOVE DURING TEST. MAKE SURE THAT THE THRUST REVERSER AREA IS CLEAN AND CLEAR OF PERSONS AND TOOLS OR OTHER ITEMS..<br>MAKE SURE THAT THE THRUST REVERSER IS NOT IN INHIBITED POSITION. MOVE THROTTLE LEVER TO REVERSE IDLE WITHIN 50 SECONDS. MOVE THROTTLE LEVER TO FORWARD IDLE WITHIN 50 SECONDS. |
|                    |                    | ENGINE RUNNING SIMULATION         | DURING THIS TEST THE ENGINE OPERATION IS SIMULATED                                                                                                                                                                                                                                                                                                         |
|                    |                    | AIRCRAFT HARDWIRED INPUTS TEST    | CHECK OF THE CURRENT STATUS OF HARDWIRED INPUTS FROM THE AIRCRAFT                                                                                                                                                                                                                                                                                          |
|                    | REPORTS            | EEC CONFIGURATION                 | CHECK OF DATA VALUES STORED IN EEC NVM TO SEE IF THEY ARE CORRECT FOR ENG & A/C OPERATION                                                                                                                                                                                                                                                                  |
|                    |                    | EGT EXCEEDANCE REPORT             | DISPLAY OF THE EGT PEAK VALUE AND RESET OF THE EXCEEDANCE VALUES                                                                                                                                                                                                                                                                                           |
|                    |                    | SHAFT SPEED EXCEEDANCE REPORT     | DISPLAY OF THE N1, N2 AND N3 PEAK VALUE AND RESET OF THE EXCEEDANCE VALUES                                                                                                                                                                                                                                                                                 |
|                    | ENGINE PROCEDURES  | FAN TRIM BALANCE                  | NECESSARY PARAMETERS FOR THE ENGINE FAN BALANCE                                                                                                                                                                                                                                                                                                            |
|                    |                    | ENGINE CORE WASHING               | ENGINE PERFORMANCE RECOVERY                                                                                                                                                                                                                                                                                                                                |
|                    |                    | BLEED-VALVE TEST SCHEDULING       | <b>WARNING:</b> THE ENGINE MUST BE STARTED TO SUPPLY THE AIR PRESSURE TO OPERATE THE BLEED VALVES WHEN COMMANDED BY EEC                                                                                                                                                                                                                                    |
|                    | SPECIFIC FUNCTIONS | RESET FUEL USED                   | FUNCTION USED TO CLEAR THE FUEL USED VALUES FOR TEST PURPOSES                                                                                                                                                                                                                                                                                              |

#### TESTS - EEC TESTS ... SPECIFIC FUNCTIONS

## FADEC MAINTENANCE (3)

### Tests (continued)

#### EIPM

To get access to the "TEST SELECTION" page of an EIPM, you must select the ATA 73 "Engine Fuel and Control" in the "ATA SELECTION" page and then EIPM.

Then, select the applicable EIPM and engine combination in the "SIDE SELECTION" page.

The EIPM gives the interactive tests, reports and specific functions that follow:

#### Tests

The tests are the same for each EIPM.

##### SYSTEM TEST

The System Test is used to verify the integrity of the EIPM by initiating a series of internal checks including the EIPM processor, different memories, ARINC and discrete input and output functions.

##### FADEC GROUND POWER "ON" LIGHT

The FADEC ground power pushbutton switch 'ON' light operation can be verified using this test.

##### ENGINE MASTER "FAULT" LIGHT

The ENG MASTER lever 'FAULT' light operation can be verified using this test.

#### Reports

The reports are the same for each EIPM.

##### DISCRETE INPUTS REPORTS

The Discrete Inputs Report displays the discrete signal input signals to the EIPM, so the operator can check that the displayed discrete inputs report corresponds to the discrete inputs state.

##### DISCRETE OUTPUTS REPORTS

The Discrete Outputs Report displays the discrete signal output signals from the EIPM, so the operator can check that the displayed discrete outputs report corresponds to the discrete outputs state. PIN PROGRAMMING REPORTS

The Pin Programming Report displays the engine and EIPM positions as detected by the wiring configuration to the EIPM.

#### Specific Functions

##### OIL LOW PRESS AND GROUND

The selection of this specific function will artificially turn on the EIPM output that indicates Oil Low Pressure and Ground. This is to allow checks of various systems that use the EIPM output. On the EIPM 1 ENG 2 and the EIPM 2 ENG 3 there are two other specific functions:

##### THRUST REVERSER 3\*115 V / 25 KW POWER SUPPLY

The use of this specific test deactivates the second line of defense of the Electrical Thrust Reverser Actuation System (ETRAC) by activating the power supply to the Thrust Reverser Power Unit (TRPU) which is controlled by the EIPM.

**WARNING: REVERSE SECOND LINE OF DEFENSE WILL BE DEACTIVATED; POSSIBLE REVERSE DOORS ACTIVATION CAN OCCUR.**

##### ETRAC MANUAL POWER SUPPLY

The use of this specific test allows power to be supplied to the Electrical Thrust Reverser Actuation Controller (ETRAC).

**WARNING: ELECTRONIC THRUST REVERSER ACTUATION CONTROLLER (ETRAC) WILL BE POWER SUPPLIED; POSSIBLE REVERSE DOORS ACTIVATION CAN OCCUR.**

**SYSTEM REPORT / TEST - ATA SELECTION**

**SYSTEM REPORT / TEST- SIDE SELECTION**

**SYSTEM REPORT / TEST- TEST SELECTION**

**TEST (AND FUNCTION) SELECTION PAGE**

**SIDE SELECTION PAGE**

ATA 46 Information Systems  
ATA 47 Inert Gas System  
ATA 49 Airborne Auxiliary Power  
ATA 50 Cargo and Accessory Compartments  
ATA 51 Standard Practices and Structure  
ATA 52 Doors  
ATA 53 Fuselage  
ATA 54 Nacelles/Pylons  
ATA 55 Stabilizers  
ATA 56 Windows  
ATA 57 Wings  
ATA 70 Standard Practices Engine  
ATA 71 Power Plant  
ATA 72 Engine  
**ATA 73 Engine Fuel and Control**  
ATA 74 Ignition  
ATA 75 Air  
ATA 76 Engine Controls  
ATA 77 Engine Indicating  
ATA 78 Exhaust  
ATA 79 Oil  
ATA 80 Starting

ATA 73 Engine Fuel and Control

73

EIPM2 ENG1

EIPM2 ENG1  
EIPM1 ENG2  
EIPM2 ENG3  
EIPM1 ENG4

Tests  
Reports  
Specific functions

| EIPM 1 ENG 2 | TESTS              | SYSTEM TEST                                                  | EIPM PROCESSOR, MEMORIES, ARINC & DISCRETE INPUTS/OUTPUTS                                                 |
|--------------|--------------------|--------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
|              |                    | FADEC GROUND POWER "ON" LIGHT<br>ENGINE MASTER "FAULT" LIGHT | OVERHEAD PANEL<br>ENG MASTER LEVER                                                                        |
|              | REPORTS            | DISCRETE INPUTS REPORTS                                      |                                                                                                           |
|              |                    | DISCRETE OUPUTS REPORTS                                      |                                                                                                           |
|              |                    | PIN PROGRAMMING REPORTS                                      |                                                                                                           |
|              | SPECIFIC FUNCTIONS | OIL LOW PRESS AND GROUND                                     |                                                                                                           |
|              |                    | THRUST REVERSER 3 PHASE 115 V / 25 KW POWER SUPPLY           | <b>WARNING</b> REVERSE SECOND LINE OF DEFENSE WILL BE DEACTIVATED<br>=> POSSIBLE REVERSE DOORS ACTIVATION |
|              |                    | ETRAC MANUAL POWER SUPPLY                                    | <b>WARNING</b> ETRAC WILL BE POWER SUPPLIED<br>=> POSSIBLE REVERSE DOORS ACTIVATION                       |

TESTS, REPORTS AND SPECIFIC FUNCTIONS ARE SIMILAR FOR ALL ENGINES. BUT FOR THE INBOARD ENGINES THERE ARE TWO ADDITIONAL SPECIFIC FUNCTIONS :  
"THRUST REVERSER 3 PHASE 115 V / 25 KW POWER SUPPLY" AND "ETRAC MANUAL POWER SUPPLY"

TESTS - EIPM ... SPECIFIC FUNCTIONS

## FADEC MAINTENANCE (3)

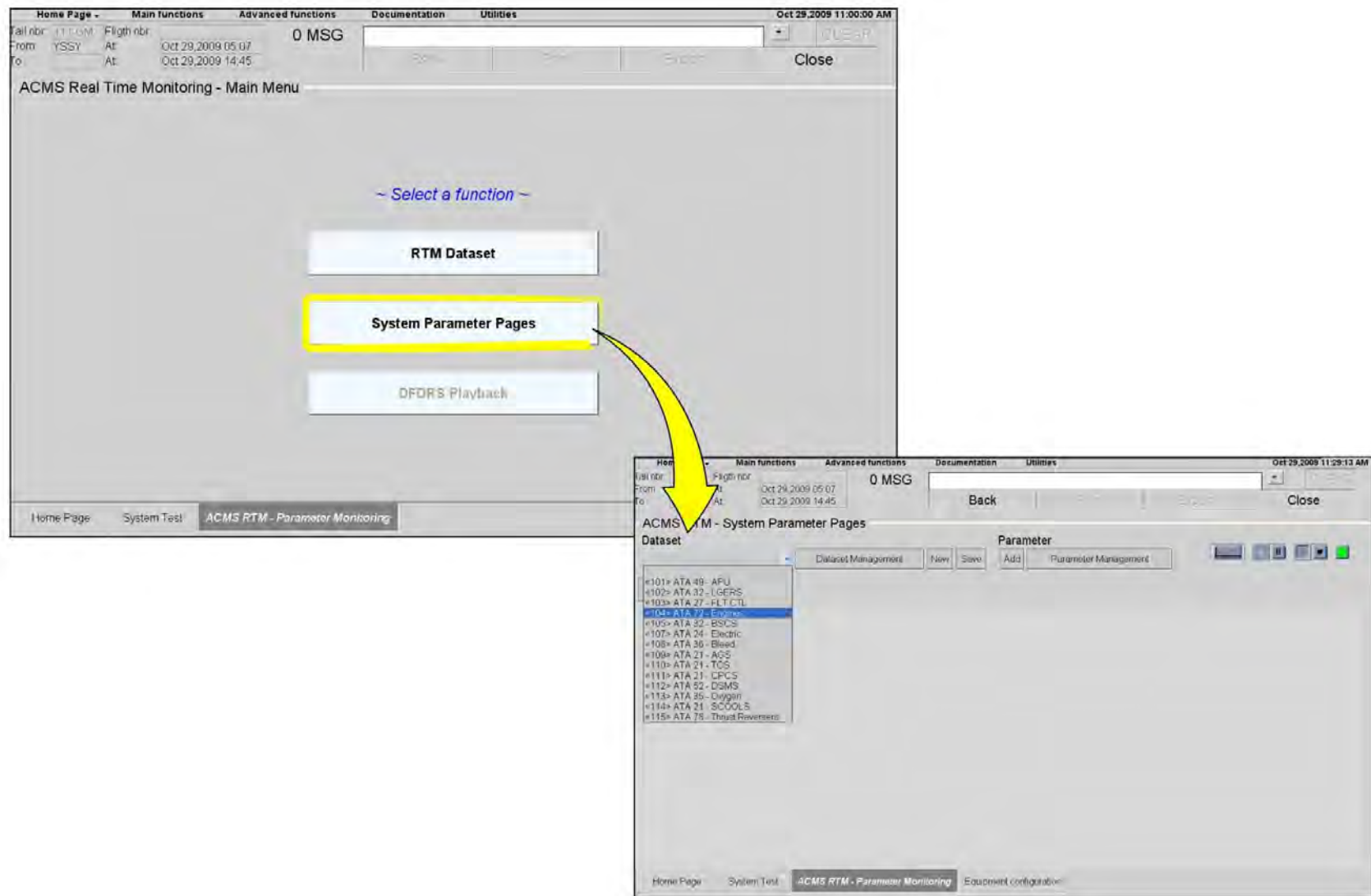
### ACMS Parameters

#### **System Parameter Pages Access (ATA72 - Engines)**

When you click on the "Advanced Functions" Menu, you can get access to the ACMS Real-Time Monitoring function.

When you click on the "System Parameter Pages" Menu, you can get access to the ACMS RTM - System Parameter Pages.

Select "ATA 72 - Engines" in the Dataset scrolling menu to get access to the parameter monitoring pages.



### ACMS PARAMETERS - SYSTEM PARAMETER PAGES ACCESS (ATA72 - ENGINES)

## FADEC MAINTENANCE (3)

### ACMS Parameters (continued)

#### System Parameter Pages (ATA72 - Engines)

The purpose of this page is to display the engine parameters. These parameters are split into four sheets:

- General & Start,
- Thrust Control,
- Air Data,
- Pressure & Temperatures.

##### General & Start

The "General & Start" sheet shows the engine components status during an engine start or cranking sequence.

For each engine, the status of the EEC channels (In control/Not in control) is shown and the position / status of the rotary selector, pushbutton switches (On/Off) and relevant valves are clearly identified (Commanded Open/ Not commanded or Open/Closed).

This page also provides a direct reading of the engine parameters such as N3 selected (%), Fuel flow (kg/hr), Bleed pressure (psi), etc.

##### Thrust Control

The "Thrust Control" sheet shows the engine rating (Trent 9XX (ISA+15)), the autothrust status (selected / not selected), TRA position (in degrees), N1 (%) and thrust parameters.

The sheet also provides the valve positions (Open/Closed) of engine air system (ATA75).

##### Air Data

The "Air Data" sheet shows the air data parameters from Air Data and Inertial Reference System (ADIRS) sensors and indicates if these parameters are in accordance with those from the EECs or not (Agree/Disagree).

For each engine, the sheet gives the source of the air parameters and the values selected by the engine.

For each EEC channel, the sheet gives the pressure (psi) and the temperature (°C) taken as a reference for computation.

##### Pressures & Temperatures

The "Pressures & Temperatures" sheet shows the pressures (psi) and the temperatures (°C) measured into the fan, IP and HP compressor, and LP turbine. The sheet also provides Flex, nacelle and EEC internal temperatures (°C).

In addition, the sheet indicates the delta pressures (psid) through the oil filter and the fuel filter plus fuel manifold pressure.

The status of the hydraulic pump offload (Commanded / Not commanded) is clearly identified.

Context: Home Page Tools Data Documents Utilities Jul 03, 2006 10:41:37

Tail nbr: Flight nbr: D message: [X]

From: At To: At

Back Print Close

### ACMS RTM - Parameter Monitoring

Dataset: <104> ATA 72 - Engines Dataset Management New Save Add Parameter Management

General & Start Thrust Control Air Data Pressures & Temperatures

| ENG 1          |            | ENG 2          |            | Channel In Control                                                             | ENG 3          |            | ENG 4          |            |
|----------------|------------|----------------|------------|--------------------------------------------------------------------------------|----------------|------------|----------------|------------|
| Ch. A          | Ch. B      | Ch. A          | Ch. B      |                                                                                | Ch. A          | Ch. B      | Ch. A          | Ch. B      |
| Not in Control | In Control | Not in Control | In Control |                                                                                | Not in Control | In Control | Not in Control | In Control |
| CRANK          |            | CRANK          |            | Rotary Selector Position<br>Manual Start P/B Position<br>Master Lever Position | CRANK          |            | CRANK          |            |
| Off            |            | Off            |            |                                                                                | Off            |            | Off            |            |
| Off            |            | Off            |            |                                                                                | Off            |            | Off            |            |
| Not Active     |            | Not Active     |            | Start Crank Sequence<br>SAV Open Command<br>SAV Position<br>N3 Selected (%)    | Not Active     |            | Not Active     |            |
| Not Commanded  |            | Not Commanded  |            |                                                                                | Not Commanded  |            | Not Commanded  |            |
| Closed         |            | Closed         |            |                                                                                | Closed         |            | Closed         |            |
| 0.0000         |            | 0.0000         |            | HPSOV Position<br>FMV Command (in)<br>FMV Position (in)<br>Fuel Flow (lbs/hr)  | 0.0000         |            | 0.0000         |            |
| Closed         |            | Closed         |            |                                                                                | Closed         |            | Closed         |            |
| 0.0000         |            | 0.0000         |            |                                                                                | 0.0000         |            | 0.0000         |            |
| NC (0)         |            | NC (0)         |            | Ignition Commanded                                                             | NC (0)         |            | NC (0)         |            |
| Not Running    |            | Not Running    |            | Engine Running                                                                 | Not Running    |            | Not Running    |            |
| 0.0075         |            | 0.1891         |            | Bleed Pressure (psi)                                                           | 0.3144         |            | 0.2685         |            |

ALMS RTM - Parameter Monitoring

ACMS PARAMETERS - SYSTEM PARAMETER PAGES (ATA72 - ENGINES)

## FADEC MAINTENANCE (3)

### ACMS Parameters (continued)

#### System Parameter Pages Access (ATA78 - Thrust Reversers)

When you click on the "Advanced Functions" Menu, you can get access to the ACMS Real-Time Monitoring function.

When you click on the "System Parameter Pages" Menu, you can get access to the ACMS RTM - System Parameter Pages.

Select "ATA 78 - Thrust Reversers" in the Dataset scrolling menu to access to the parameter monitoring pages.

#### System Parameter Pages (ATA78 - Thrust Reversers)

The purpose of this page, applicable to the engine 2 and 3 only, is to display the thrust reverser system parameters.

These parameters are split into two sheets:

- T/R General,
- T/R Actuation.

##### T/R General

The "T/R General" sheet shows the following Electrical Thrust Reverser Actuation Controller (ETRAC) identification data: ETRAC part number, serial number and software part number.

The sheet also gives the following system status:

- EEC operating mode (Interactive/Normal),
- Engine running or not,
- Thrust reverser inhibited or not,
- Inhibition status (Local sensor Failed or Valid),
- Tertiary, left primary and right primary locks (Failed/Valid),
- Reverser transcowl local status (Resolver Failed or Valid),
- ETRAC, Thrust Reverser Power Unit (TRPU), Calibration Memory Module (CMM) board temperatures (°C).

This information is given for inboard engines only, per each EEC channel. The EEC channel in control is clearly identified.

- T/R Actuation

The "T/R Actuation" sheet is dedicated to the status of the actuation command chain for each EEC channels of each engine:

- the PRIMary command status for the Tertiary Lock Systems (TLS),
- the Throttle position,
- the Electrical power availability,
- Tertiary, left primary and right primary locks status (Locked/Unlocked),
- the thrust reverser commanded and actual position (%).

ACMS PARAMETERS - SYSTEM PARAMETER PAGES ACCESS (ATA78 - THRUST REVERSERS) & SYSTEM PARAMETER PAGES (ATA78 - THRUST REVERSERS)

## ENGINE & FADEC SYSTEMS OPS/CTL & IND (3)

### General

Let's see the general view of the A380 cockpit.



GENERAL

## ENGINE & FADEC SYSTEMS OPS/CTL & IND (3)

### General (continued)

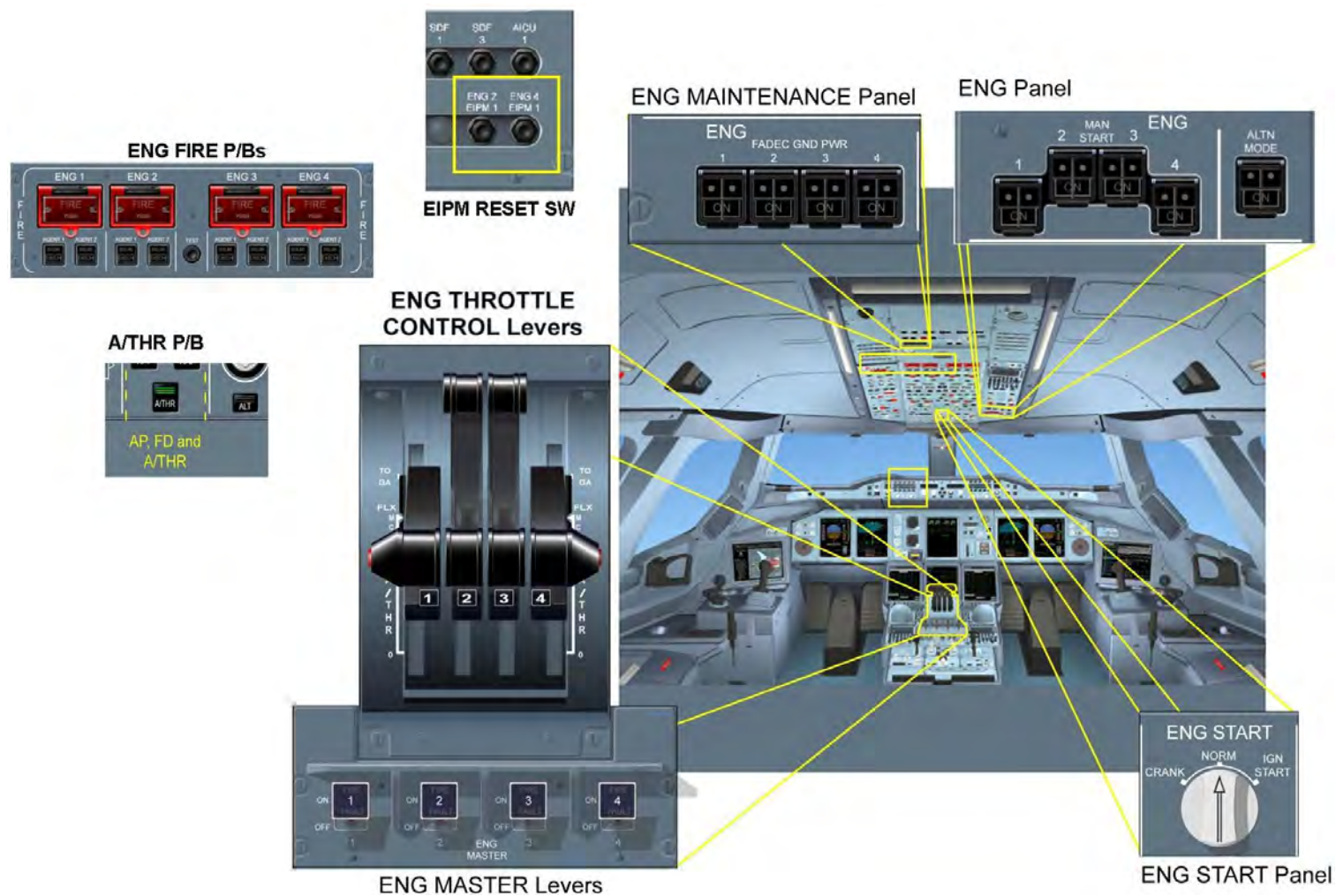
#### Engine Control Panels Location

The engine control panels are located on the overhead panel:

- The EIPM 1 & 2 reset circuit breakers,
- The ENGINE FADEC GND PWR panel,
- The ENGINE FIRE panel,
- The ENG MANUal START panel with the ALTN MODE P/BSW,
- The ENG START panel.

An autothrust (A/THR) P/B is located on the glareshield and on the pedestal there are:

- The THROTTLE CONTROL LEVERS with the instinctive disconnect P/Bs and the reverser levers on the engine 2 and 3 only,
- The ENG MASTER levers panel.



GENERAL - ENGINE CONTROL PANELS LOCATION

## ENGINE & FADEC SYSTEMS OPS/CTL & IND (3)

### Engine Controls and Indication Presentation

#### EEC Powering / Depowering

By setting the ENG START selector switch to the CRANK or IGN START position with engines not running the FADEC is powered. The corresponding indication is clearly displayed on the EWD and the amber "XX" which were displayed due to the absence of information are replaced by the main thrust parameters.

Also when you press the FADEC GND PWR P/BSW to ON, the FADEC parameters are clearly displayed on the EWD and the amber "XX" are replaced by the main thrust parameters. If the FADEC GND PWR P/BSW remains ON, this means that the FADEC is powered for 10 min, except if OMS in interactive mode. In this case the FADEC stays automatically energized as long as you are in the related EEC tests menu. After these 10 min, on FADEC GND PWR panel, the ON legend goes off automatically.

NOTE: The MASTER LEVER could be used for powering the FADEC.

In this case, the dedicated FADEC will be powered for 15 minutes, but it is not recommended on A/C, because there is a risk of the engine to be started if the rotary selector has been forgotten in IGN START position.

If you do so, observe quick ON and OFF action, because you do not have to forget that when the MASTER LEVER is set to ON the LP fuel SOV is controlled to open.

If the EIPM reset switches are pulled for maintenance purposes, the dedicated EECs are fail-safe powered. The ENGINE FIRE P/BSW also has effects on the EEC powering/depowering. When this P/BSW is released out, it has effects on the various aircraft systems such as:

- FADEC power supply is cut,
- The hydraulic system: closure of the fire shut-off valves in order to isolate the hydraulic pumps from the reservoir,

- The electrical system,
- The bleed system,
- The fuel system: closure of the engine LP valve.

CAUTION: WITH ENG FIRE PUSH BUTTON RELEASED OUT, THE FIRE EXTINGUISHERS ARE ARMED. DO NOT PRESS ON THE AGENT P/BSWs.



## ENGINE CONTROLS AND INDICATION PRESENTATION - EEC POWERING / DEPOWERING

## **ENGINE & FADEC SYSTEMS OPS/CTL & IND (3)**

### **Engine Controls and Indication Presentation (continued)**

#### **Engine Parameters Display**

Among the main parameters displayed on the EWD, you have the thrust mode indication (CLB, MCT, TO).

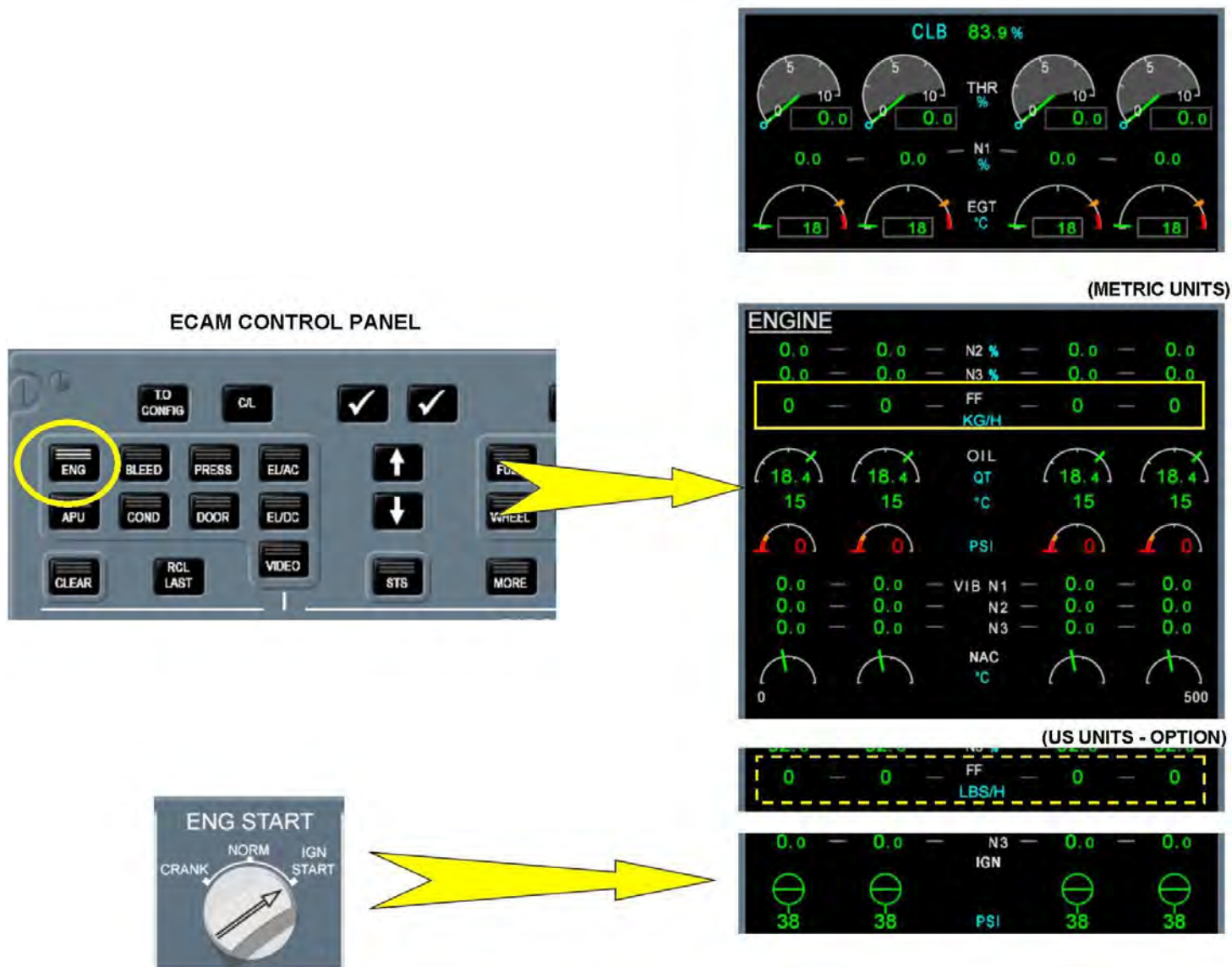
The N1 and EGT indications are given as numerical values.

The ECAM ENGINE page can be called by the selection of the ENG key on the ECAM Control Panel (ACP) located on the pedestal.

The secondary engine parameters, which are shown on the ECAM ENGINE page, are:

- IP rotor speed (N2),
- HP rotor speed (N3),
- Fuel Flow (FF),
- Engine oil quantity (OIL QTY),
- Engine oil temperature (OIL TEMP),
- Engine oil pressure (OIL PRESS),
- Engine rotor vibration levels (N1, N2, N3),
- Nacelle temperature (NAC) from 0 to 500°C.

The nacelle temperature indication will be replaced by the data about the starter valve position and ignition system, if the Mode selector is in IGN/START or CRANK position, with one engine or more not running.



ENGINE CONTROLS AND INDICATION PRESENTATION - ENGINE PARAMETERS  
DISPLAY

## **ENGINE & FADEC SYSTEMS OPS/CTL & IND (3)**

### **Engine Controls and Indication Presentation (continued)**

#### **Throttle Control Levers**

The Throttle Control Levers can be individually moved and manually only, they are used to adjust the aircraft forward thrust. The range of the levers movement is divided into 4 detent points: 0 (IDLE), CL for climb, FLX/MCT and TO/GA. When you supply an engine FADEC for example, by pushing the FADEC GND PWR P/BSW to ON and when you move the corresponding Throttle Control Lever, you will see the displacement of the cyan circle on the EWD THR indicator. The thrust mode corresponding to the lever position is also displayed on the upper part of the EWD. On the Throttle Control Lever, are the reverser levers to control the deployment or the stowing of the reversers and adjust the reverse thrust. These thrust reversers are installed on the engine 2 and 3 only. The reverser levers move between two detents: IDLE and full reverse thrust.

Two A/THR instinctive disconnect P/BSWs (red) are located on the Throttle Control Levers (engines 1 and 4 only). They direct input to all EECs in order to disconnect the A/THR function as soon as one of them is pushed.

#### **A/THR P/B**

An A/THR P/B is located on the Flight Control Unit (FCU) section of the glareshield. When it is pressed, three green lines on this P/BSW illuminate. The green lines go off when any instinctive disconnect P/B is pressed or when you press the A/THR P/B again.

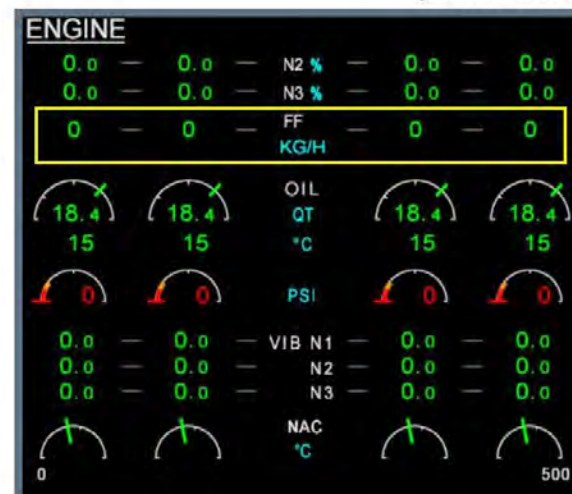


A/THR P/B

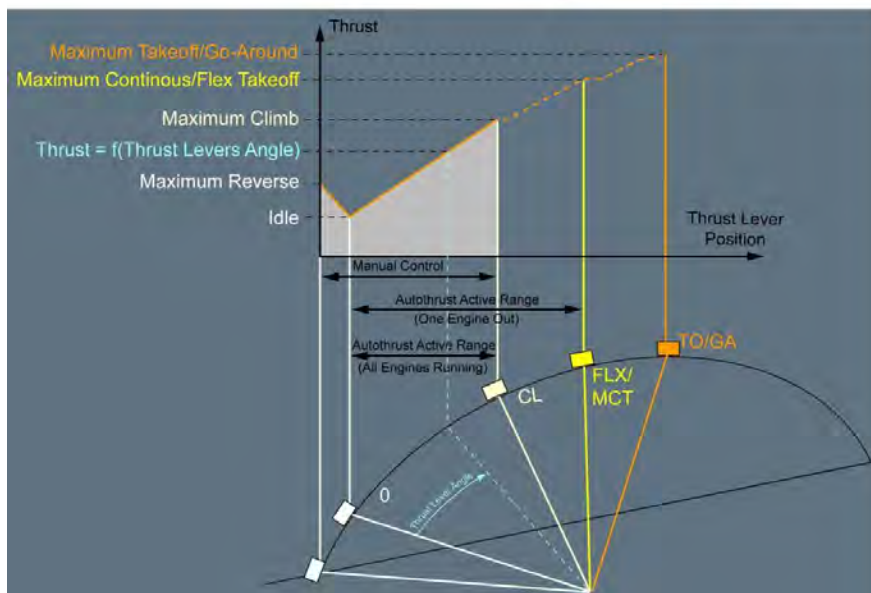
INSTINCTIVE  
DISCONNECT  
SWITCH



(METRIC UNITS)



(US UNITS - OPTION)



ENGINE CONTROLS AND INDICATION PRESENTATION - THROTTLE CONTROL LEVERS & A/THR P/B

## **ENGINE & FADEC SYSTEMS OPS/CTL & IND (3)**

### **Engine Operation**

#### **Engine Auto Start**

To perform an automatic start of the engine:

- Set the ENG START rotary selector to IGN START position,
- Set the ENG MASTER lever ON,

The start valve opens and the N3 rate will increase. At 25% N3 ignition (IGN) and fuel flow (FF) indications come automatically into view on the ENGINE page. Then the light up is automatically initiated by the FADEC, the EGT increases normally. At 48% N3, the ignition stops and the start air valve closes automatically.

NOTE: Before starting, make sure that the EGT is less than 150 °C (302 °F).

During the engine start sequence; you have to monitor the status of the packs valve. The packs valves have to close automatically when the ENG START rotary selector leaves the NORMAl position. The packs valves will reopen once the start sequence has been completed.

**AUTO START**



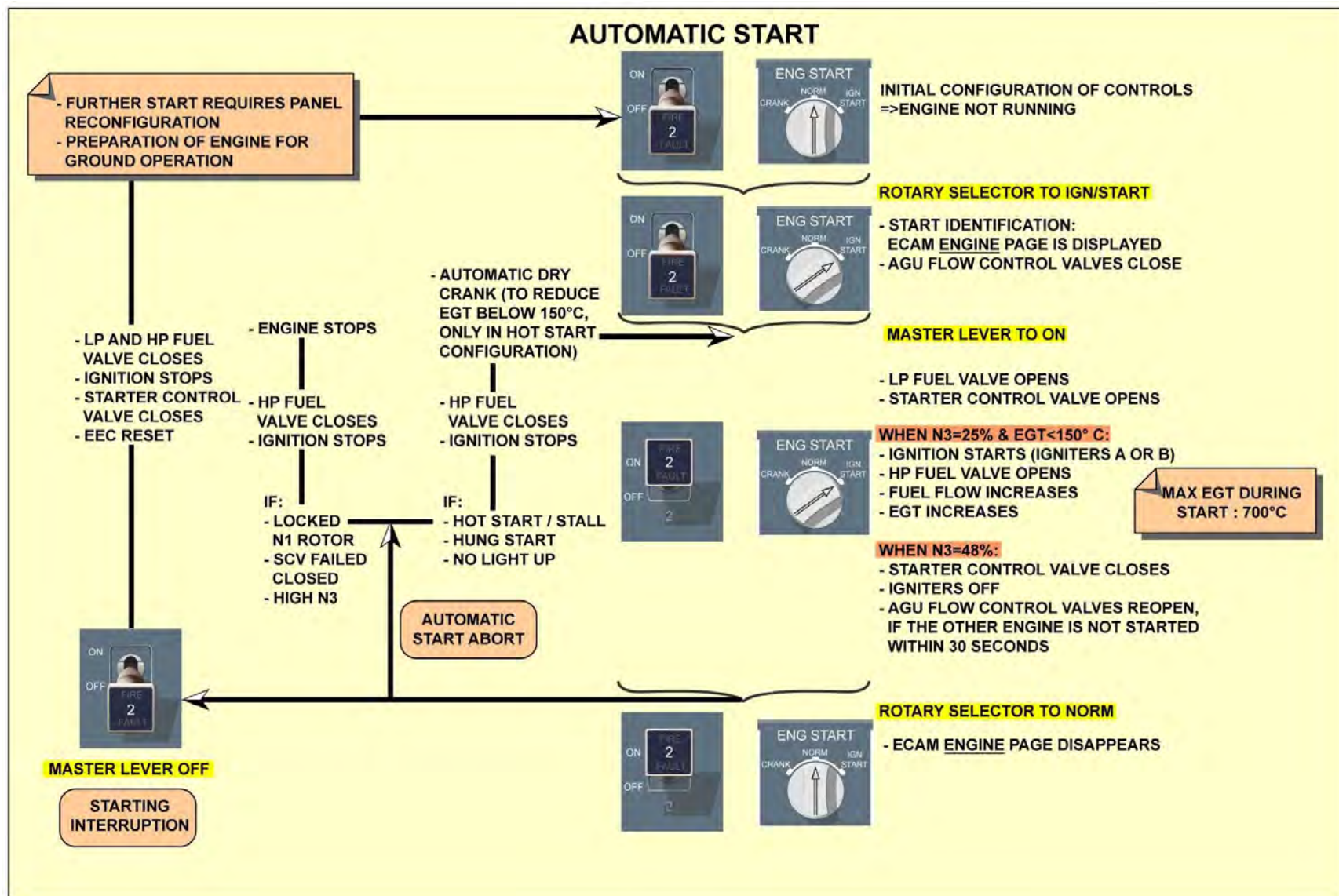
(METRIC UNITS)



(US UNITS - OPTION)



**ENGINE OPERATION - ENGINE AUTO  
START**



### ENGINE OPERATION - ENGINE AUTO START

## ENGINE & FADEC SYSTEMS OPS/CTL & IND (3)

### Engine Operation (continued)

#### Engine Manual Start

To perform a manual start of the engine:

- Set the ENG START rotary selector to IGN START position,
- Directly push the MAN START P/BSW to ON,  
The start valve opens and the N3 rate will increase.
- At 25% N3 set the ENG MASTER lever ON, ignition (IGN) and fuel flow (FF) indications come automatically into view on the ENGINE page.

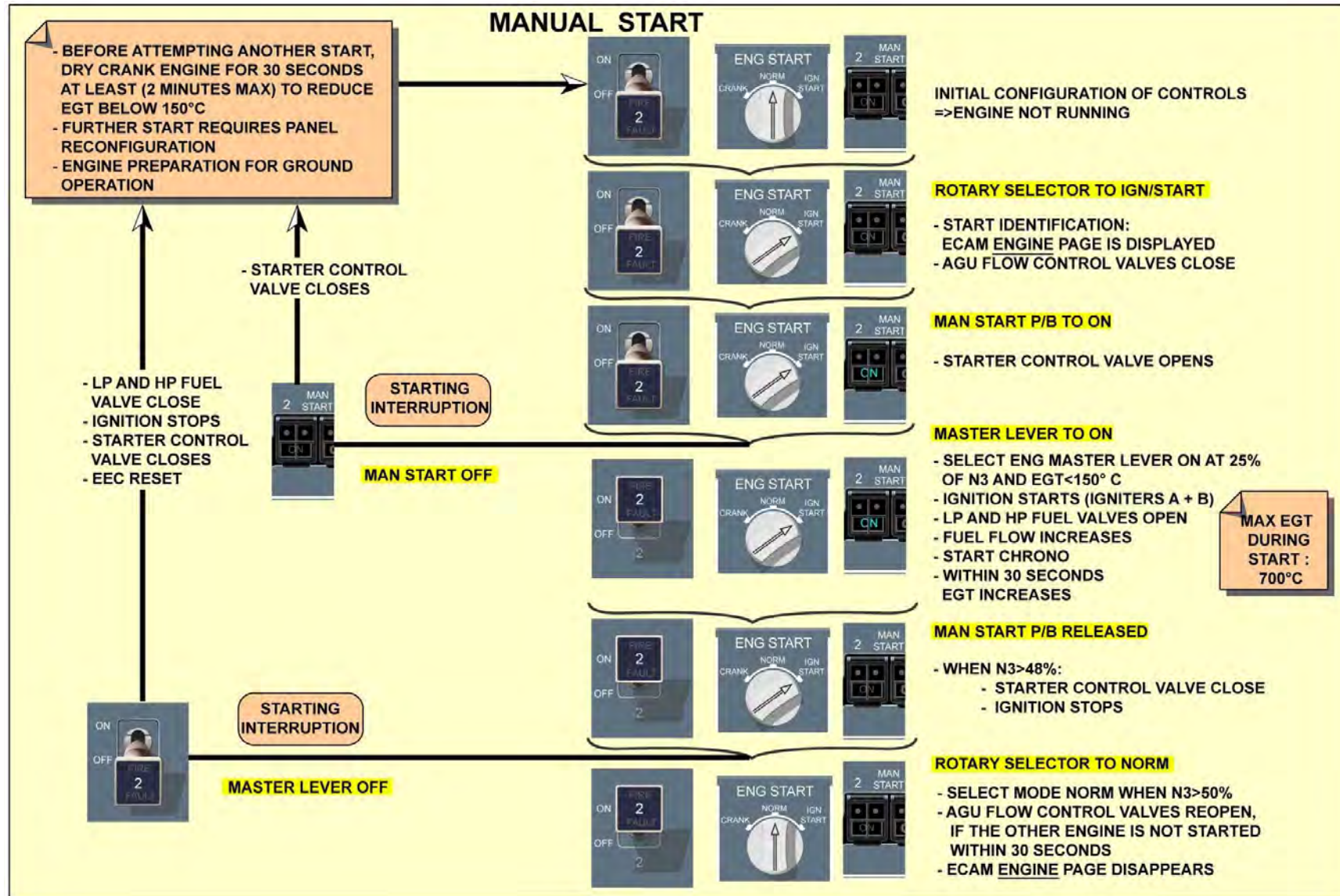
Then the light up is automatically initiated by the FADEC, the EGT increases normally.

- At 48% N3, deselect the MAN START P/BSW, the start air valve closes automatically and the ignition stops.

NOTE: You must not start the engine if the EGT is more than 150 °C (302 °F). If you do so, the EGT will exceed its limit during the engine start. You can dry motor the engine to decrease the EGT.

CAUTION: MAKE SURE THAT THE EGT IS LESS THAN 150 °C (302 °F).

Be careful and observe all the engine parameters, there is no automatic protection during the engine manual start.



## ENGINE OPERATION - ENGINE MANUAL START

## MANUAL START

### CAUTION:

- THERE IS NO AUTOMATIC PROTECTION WHILE PERFORMING AN ENGINE START IN MANUAL MODE. WATCH CAREFULLY EGT PARAMETERS.
- ABORT IMMEDIATELY THE START BY THE MASTER LEVER TO OFF, IF EGT TENDS TO OVERSHOOT THE MAX EGT START.



(METRIC UNITS)



(US UNITS - OPTION)



## ENGINE OPERATION - ENGINE MANUAL START

## ENGINE & FADEC SYSTEMS OPS/CTL & IND (3)

### Engine Operation (continued)

#### Engine Start Faults

In some conditions, the engine start sequence can be aborted because of a detected fault.

These faults include:

##### ENG START FAULT, EGT OVERLIMIT:

The EGT is at the maximum permitted limit during the engine start sequence.

When this fault occurs during an automatic engine start, the EEC aborts the automatic start sequence and does an auto dry crank to decrease the EGT to less than 150°C (EGT). The re-engagement of the starter will occur at approximately 10% N3. The new start sequence will be done with the two igniters A and B active. If the fault continues, the start sequence is aborted again.

When the fault occurs during a manual engine start, there is no automatic abort sequence and the EGT increases. The operator must set the ENG MASTER lever to OFF to start an immediate shutdown before the EGT is at the maximum permitted start temperature (700°C).

##### ENG IGN A+B FAULT:

This message will be displayed if there is a fault on the ignition exciters or on the igniter plugs.

During the start sequence, the EGT does not increase and no light up is detected by the EEC. The engine automatic start sequence is aborted and a second start sequence starts after 15 seconds with a dry cranking cycle. If the fault continues, the start sequence is automatically aborted.

##### HP FUEL NOT OPEN/NOT CLOSED:

This message will be displayed if the HP fuel valve stays in the closed or open position.

When this fault occurs during an automatic engine start, these indications are shown on the ECAM:

-The Start Air Valve (SAV) opens,

-Igniters A and/or B are displayed,

-N3 is cranked but even with N3 >25% the fuel flow is 0.

The operator must identify the related warnings. The integrated "FAULT" light on the ENG MASTER lever comes on if the related ENG MASTER lever is kept in the ON position. The ENG MASTER lever must be set to the OFF position.

**FAULT SYMPTOM:**

- HOT START

**WARNING MESSAGE:**

- **EGT OVERLIMIT or ENG STALL**

**CONSEQUENCE:**

- EGT HAS REACHED THE MAX EGT DURING START (700°C).



**FAULT SYMPTOM:**

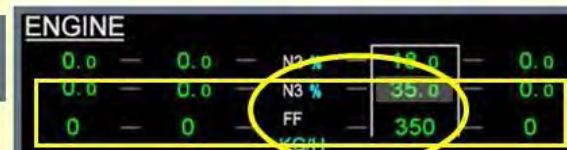
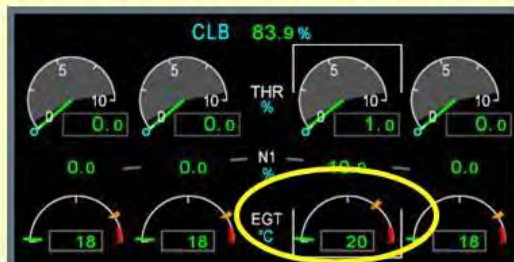
- NO LIGHT UP

**WARNING MESSAGE:**

- **ENG IGN A/B FAULT**

**CONSEQUENCE:**

- Even with IGN A or B and Fuel Flow Indicated, no EGT increase is recognized.



**FAULT SYMPTOM:** NO FUEL FLOW

**WARNING MESSAGE:**

- **ENG HP FUEL V NOT OPEN**

**CONSEQUENCE:**

- F F indication remains at zero with MASTER LEVER set to ON.
- MASTER LEVER DISAGREE
- MASTER LEVER integrated FAULT light is on.



ENGINE OPERATION - ENGINE START  
FAULTS

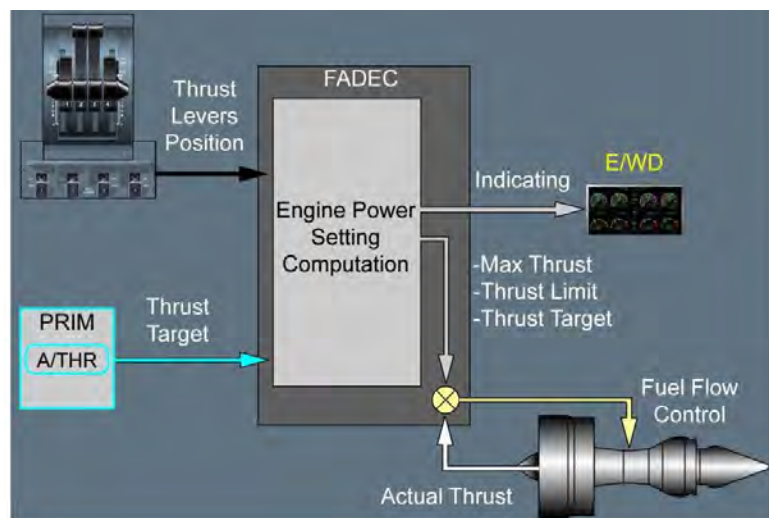
## **ENGINE & FADEC SYSTEMS OPS/CTL & IND (3)**

### **Engine Operation (continued)**

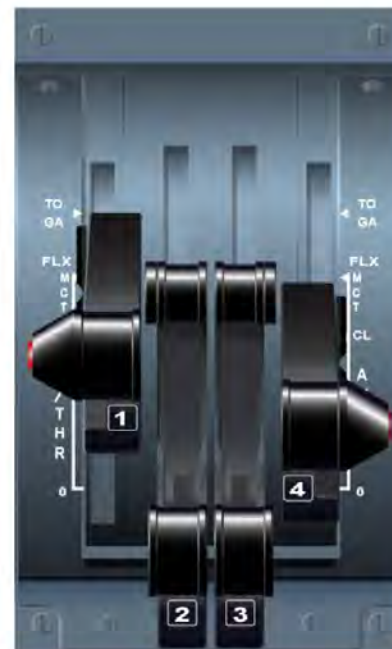
#### **FWD Thrust and Mode Settings**

The forward thrust is adjusted by moving the thrust lever into the different detent points. In function of the selected detent the corresponding thrust mode and indications are displayed on the EWD. Each engine thrust can be adjusted individually.

NOTE: The Engine Electronic Controller (EEC) software does not let the engine operate in the 64% to 72% N1 speed range. Thus, speed increase will stop at 64% N1, until the throttle lever is in a position for engine operation at 72% N1. The EEC software will then let the engine accelerate through the 64% to 72% N1 speed range.  
This function is called "Keep Out of Zone" (KOZ)  
The full engine thrust will be available only when the aircraft speed is above 45 knots  
This function is called "Modified Engine Take Off Thrust Settings"(METOTS)



- SLOWLY INCREASE POWER OF THE ENGINE TO BE TESTED TO 78% N1.
- AT THE SAME TIME, SLOWLY INCREASE POWER OF THE OPPOSITE ENGINE TO 50% OF POWER, FOR LATERAL BALANCE.



### ENGINE OPERATION - FWD THRUST AND MODE SETTINGS

## **ENGINE & FADEC SYSTEMS OPS/CTL & IND (3)**

### **Engine Operation (continued)**

#### **Thrust Control Faults**

When the two resolvers and the three potentiometers of the same Throttle Control Assembly (TCA) are defective, the ENG THR LEVER FAULT message is displayed on the EWD.

The EEC does not get the throttle control lever position signal and the throttle reference (cyan circle) related to this position does not follow the actual throttle control lever demand. When the aircraft is on the ground with the throttle control levers position between IDLE and TOGA, the FADEC automatically selects idle thrust for the engine on which the fault occurs.

The Turbofan Power Ratio (TPR) is the primary thrust control parameter used on the engine to calculate the engine thrust. It is used in the EEC for engine control. If there is a total TPR calculation loss, the related thrust indication is no longer available.

A "THR XX" indication, underlined by an amber arc, is displayed on the EWD. The TPR mode automatically goes back to N1 DEGRADED MODE. The ENG NORM + ALTN MODE warning is displayed on the EWD. When the ALTN MODE P/BSW is pushed to the ON position, this causes the EECs of the other engines to be in N1 RATED MODE while a THR indication stays available.

**FAULT SYMPTOM:**

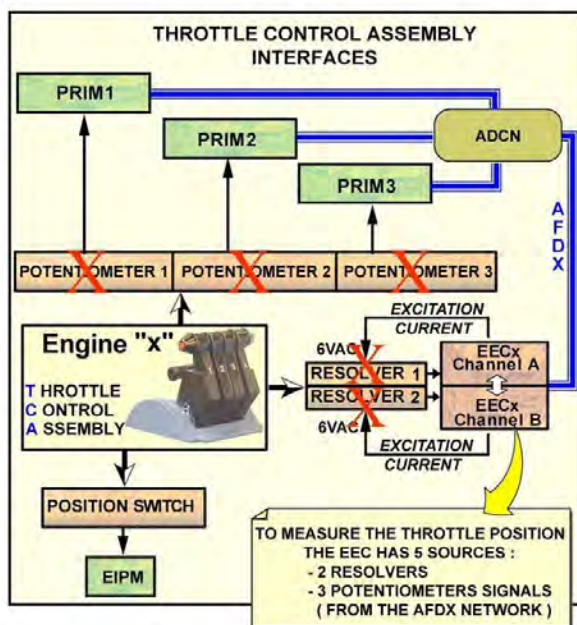
THRUST LEVER ANGLE SIGNAL LOSS

**WARNING MESSAGE:**

- **ENG THRUST LEVER FAULT**

**CONSEQUENCE:**

- THRottle REFERENCE, cyan circle, corresponding to the THRottle Control Lever position does not follow the actual throttle Control Lever position.



ENGINE OPERATION - THRUST CONTROL  
FAULTS



**FAULT SYMPTOM:**

- TPR MODE LOSS

**WARNING MESSAGE:**

- **ENG NORM + ALTN MODE FAULT**

ALTN MODE.....ON

**CONSEQUENCE:**

- The EEC has reverted automatically into N1 DEGRADED MODE.
- THR indication is replaced by amber symbols and N1 is the main control parameter

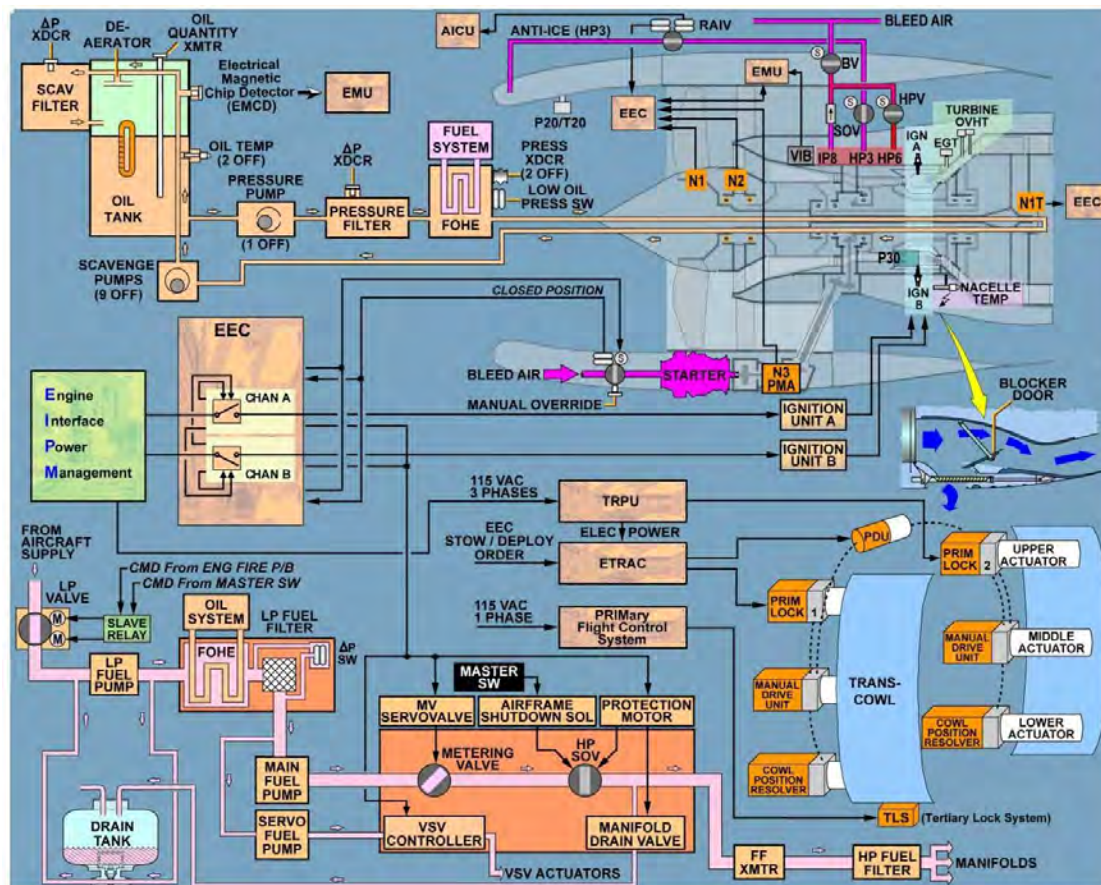
ENGINE OPERATION - THRUST CONTROL  
FAULTS

## ENGINE & FADEC SYSTEMS OPS/CTL & IND (3)

### Engine Operation (continued)

#### Reverse Thrust

The aircraft is on ground and the engine 2 and 3 are running. The engines 2 and 3 Throttle Control Levers are equipped with reverser levers to control the deployment or the stowing of the reversers and adjust the reverse thrust. When they are moved (with the Throttle Control Levers into IDLE detent stop only) the corresponding indications are displayed on the EWD. The thrust reverser activation logic activates the deployment of the reversers.



ENG 2 AND 3 REVERSE THRUST SET TO IDLE

## ENGINE OPERATION - REVERSE THRUST

## ENGINE & FADEC SYSTEMS OPS/CTL & IND (3)

### Engine Operation (continued)

#### Reverser Fault

When the thrust reversers are fully deployed, the REV green indication is displayed on the N1 dial on EWD. This indication is displayed in amber when the reverse is selected and the thrust reverser is stowing or deploying on ground or the reverse is unlocked. In this case the ENG REV UNLOCKED message is displayed and the operator has to push the Throttle Control Lever to FWD IDLE in order to stow the reversers.



## ENGINE & FADEC SYSTEMS OPS/CTL & IND (3)

### Engine Operation (continued)

#### Engine Parameters Faults

Engine secondary parameters also indicate some faults when they occur. An amber CLOGGED flag under the fuel flow indicates that the fuel filter is clogged. The amber ENG FUEL FILTER CLOGGED message is displayed on the EWD. The rotor vibration levels are also to be monitored VIB N1, N2, N3, when these VIB indications are above a specific threshold they pulse green. In case of fan unbalance, there can be a sound effect.

**CAUTION: YOU MUST NOT OPERATE THE ENGINE IF THE FUEL FILTER IS CLOGGED. CONTAMINATED FUEL CAN BYPASS THE FILTER AND CAUSE DAMAGE TO THE ENGINE. REPLACE THE LP FUEL FILTER BEFORE YOU OPERATE THE ENGINE AGAIN.**

The engine turbine overheat is detected by two thermocouples, one located in front of the IP turbine disk and the other located at the rear of the IP turbine disk.

When detected, the red ENG TURBINE OVHT message is displayed on the EWD, the EGT increases abnormally but remains under the maximum EGT MCT limit (850°C). The MASTER WARNING lights flash and the Continuous Repetitive Chime sounds.

The engine oil low pressure can drop when the engine is running. In this case the green oil pressure value reverts to amber and becomes red if it drops below 25°PSI.

The red ENG OIL PRESS LO message is displayed on the EWD, the MASTER WARNING lights flash, the Continuous Repetitive Chime (CRC) sounds and the ENGINE SD page is automatically displayed.

**FAULT SYMPTOM:**

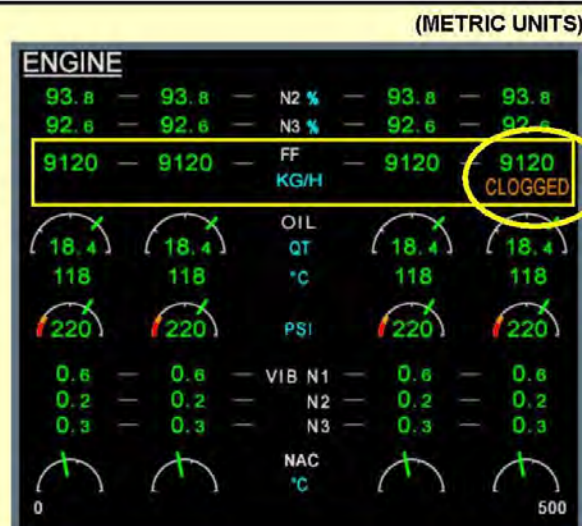
- LP FUEL FILTER CONTAMINATION

**WARNING MESSAGE:**

- **ENG FUEL FILTER CLOGGED**

**CONSEQUENCE:**

- **CLOGGED** indication appears in amber under the Fuel Flow indication.
- Fuel filter inspection and change required before next flight.



**FAULT SYMPTOM:**

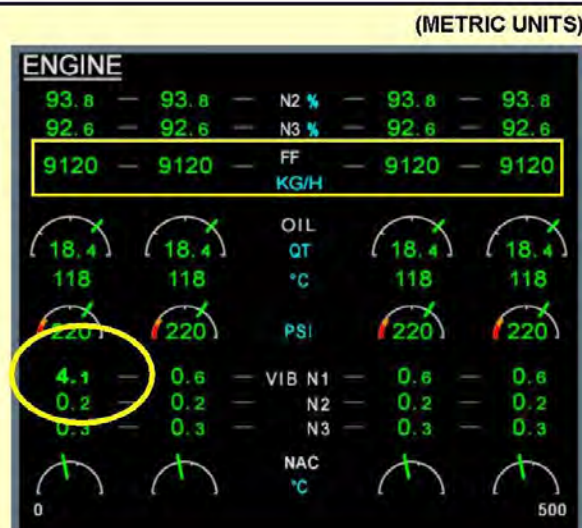
- HIGH N1 VIBRATION

**ADVISORY:**

- N1 vibration indication pulses green

**CONSEQUENCE:**

- ECAM Advisory, If N1 vibrations level is reached (2.8 Cockpit Unit),
- Engine fan unbalance,
- Compressor rumble noises could be heard.



ENGINE OPERATION - ENGINE PARAMETERS  
FAULTS

**FAULT SYMPTOM:**

IP TURBINE DISK OVERHEAT

**WARNING MESSAGE:**

- **ENG TURBINE OVHT**

**CONSEQUENCE:**

- Air temperature around the IP turbine disk increases,
- The EGT could increase, but below over limit of 850°C,
- Reduce THRUST LEVER to Idle stop,
- If the fault occurs on the ground, Initiate an Engine shutdown to avoid damage of IP Turbine.



**FAULT SYMPTOM:**

- ABNORMAL OIL PRESSURE DROP

**WARNING MESSAGE:**

- **ENG OIL PRESS LO**

**CONSEQUENCE:**

- The oil pressure quadrant shows a low pressure value.
- If the oil pressure reduces below red line limit (25 psi):
- Reduce THRUST LEVER to Idle stop,
- Initiate an engine shutdown, to avoid engine damage.

(US UNITS – OPTION)



(METRIC UNITS)



ENGINE OPERATION - ENGINE PARAMETERS  
FAULTS

## ENGINE & FADEC SYSTEMS OPS/CTL & IND (3)

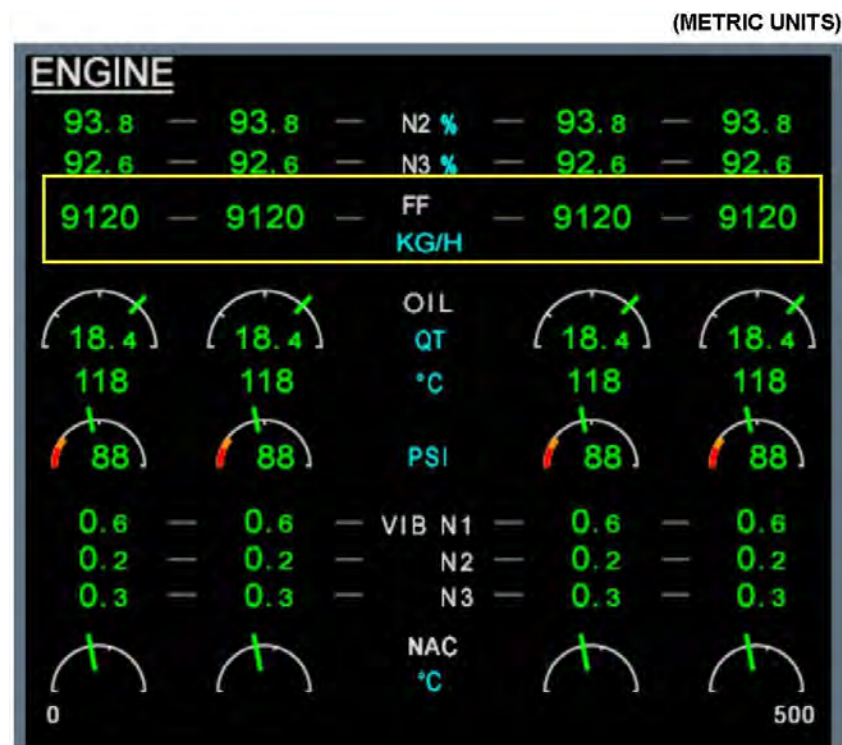
### Engine Operation (continued)

#### Engine Operation Limits Summary

Here are listed the red lines limits of the engine parameters. The maximum rotor operation speeds are: 96.1% N1, 97.8% N2 and 97.8% N3.

The MAX EGT is limited to 700°C for ground start, to 850°C for in flight relight and 850°C for maximum continuous operation. The EGT is limited to 900°C for take-off for a maximum of 5 minutes. The residual EGT before start must be less than 150°C, in contrary case the EEC will initiate an automatic crank during automatic start. The minimum oil low pressure with N3 at or above IDLE is limited to 25 psi differential pressure. The maximum oil consumption rate is approximately 0.45 l per hour (0.48 US QT per hour). At engine start, the oil temperature must be more than -30°C. Before acceleration to take-off, the oil temperature must be 40°C or more. The maximum allowed oil temperature is 196°C when the operation condition is stable.

The engine is started by cycles; the maximum continuous motoring is limited to 5 minutes. After a continuous motoring of 5 minutes, the starter must be cooled for 30 minutes before the starter is motored again. The total motoring time permitted is 5 minutes in any 35 minutes period. The starter is activated at 10% N3 on ground, and will require 30% N3 as re-engagement speeds in flight. The rotor vibration levels are also monitored on the ECAM ENGINE page, they are given in cockpit units. An advisory is displayed when the rotor vibration level becomes more than 5 cockpit units for N1, N2 and N3. An advisory is also displayed when the nacelle temperature becomes more than 300°C.



## ENGINE OPERATION - ENGINE OPERATION LIMITS SUMMARY

## THRUST REVERSER INHIBITION (2)

### Thrust Reverser

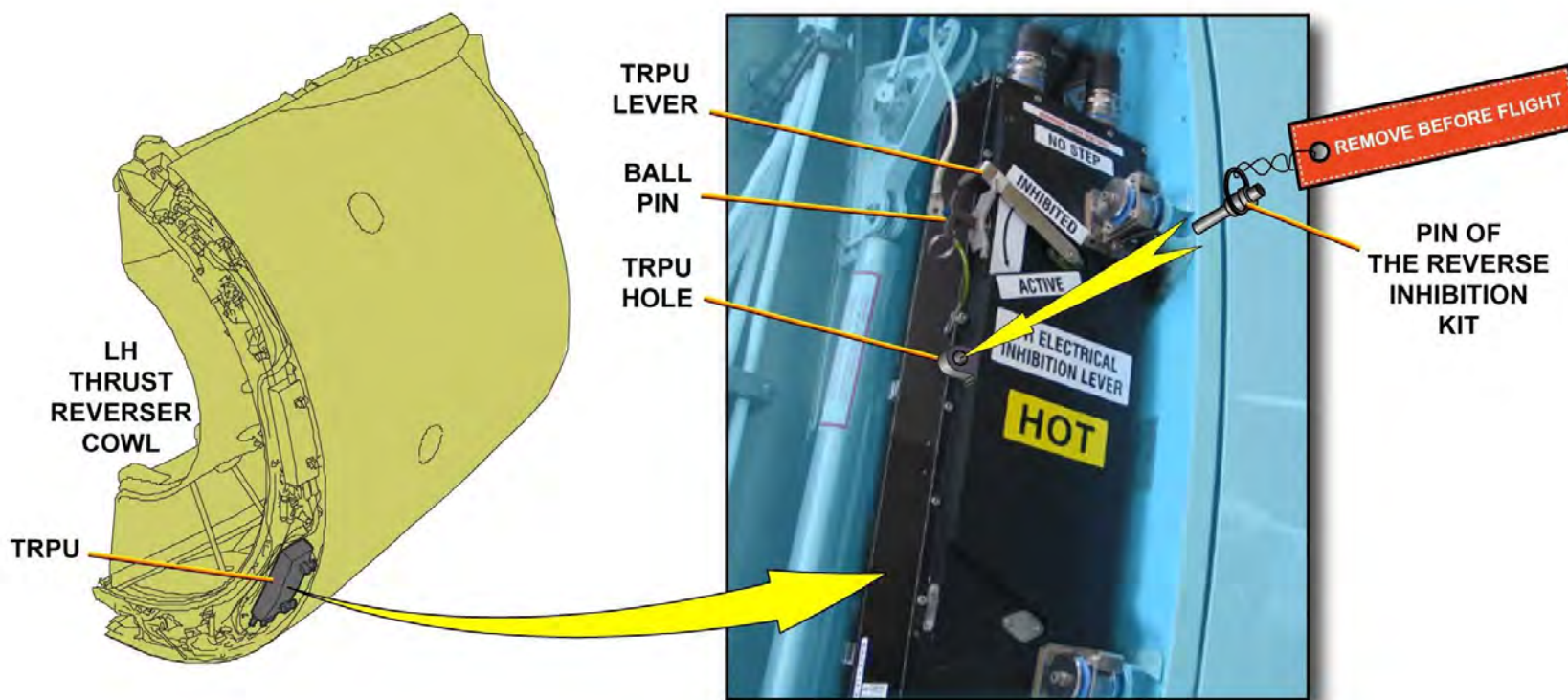
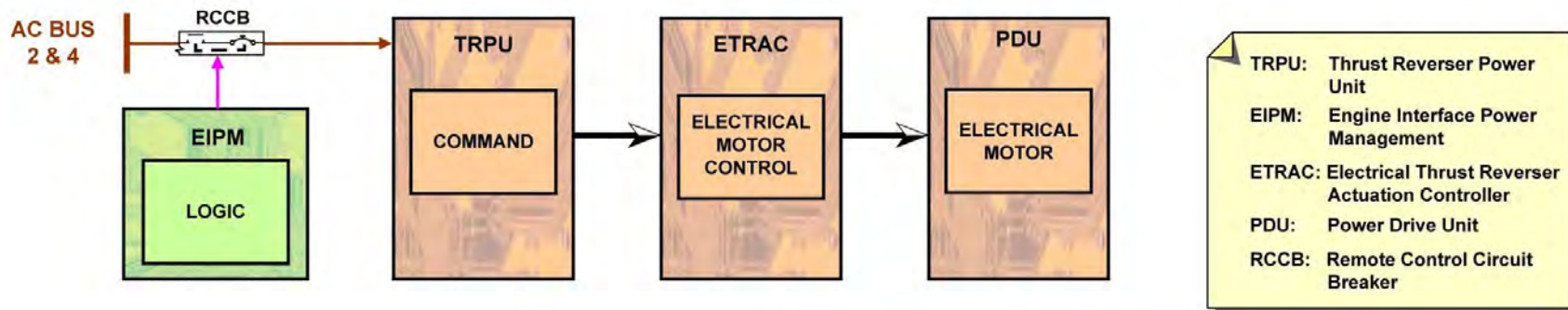
#### Power Inhibition for Maintenance

To make sure that the thrust reverser system is unserviceable for maintenance, the Thrust Reverser Power Unit (TRPU) has to be deactivated by inhibiting the power supply of the thrust reverser system. The TRPUs are installed on the inboard engines only, under the LH fan cowl door.

In normal operation, the TRPU is powered with 115 VAC 3 phase by the EIPM logic. The TRPU then energizes the Electronic Thrust Reverser Actuation Controller (ETRAC), which will supply the Power Drive Unit (PDU) to control the actuators.

So the power supply inhibition requires the removal of the ball pin from the TRPU and to turn the TRPU lever to the "INHIBITED" position. The ball pin must be re-installed. When the TRPU lever is in the "INHIBITED" position, the ETRAC is no longer supplied.

The pin of the reverse inhibition kit, with the "REMOVE BEFORE FLIGHT" flag, must be installed in the TRPU hole.



THRUST REVERSER - POWER INHIBITION FOR MAINTENANCE

## THRUST REVERSER INHIBITION (2)

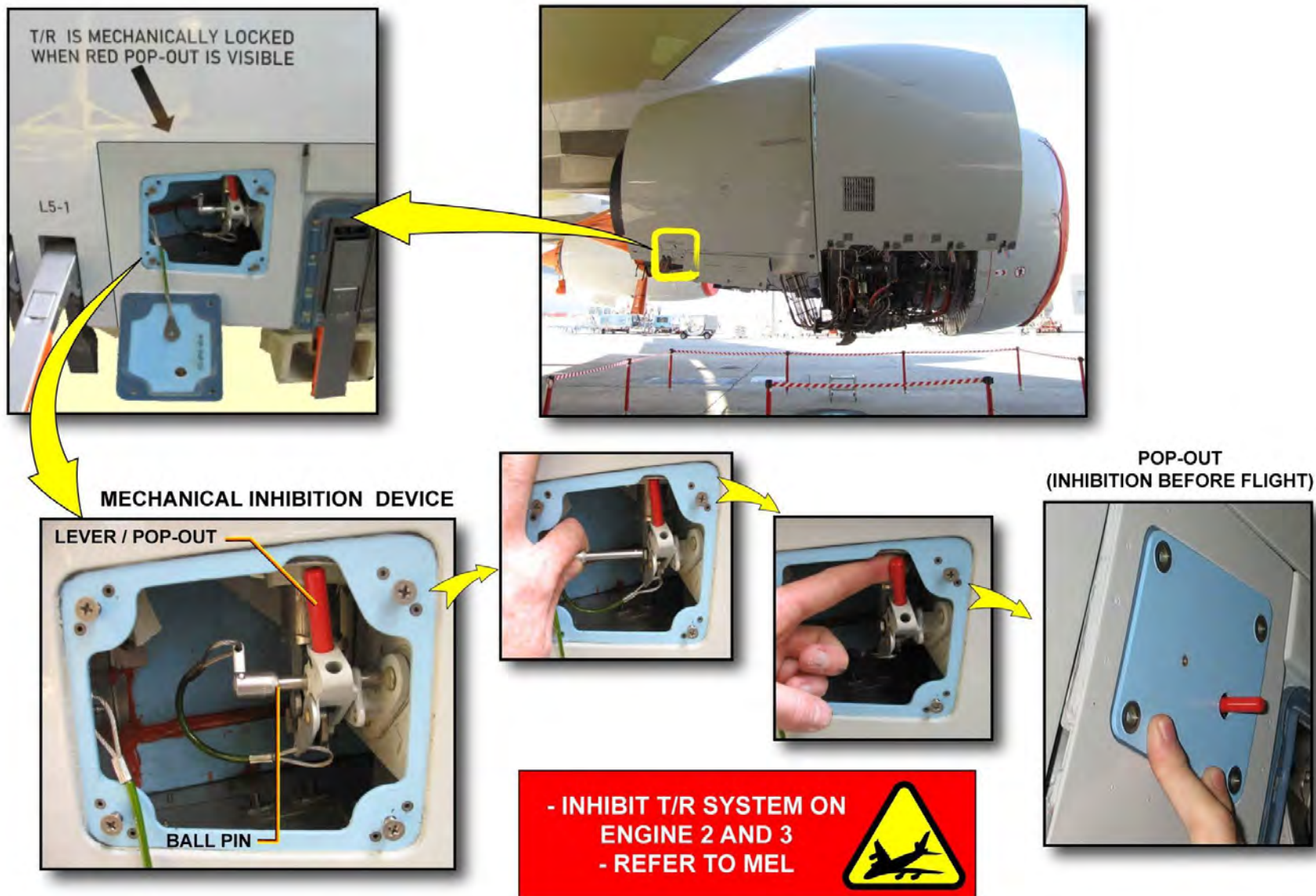
### Thrust Reverser (continued)

#### **Power Inhibition and Mechanical Inhibition Before Flight**

To make sure that the thrust reverser system is unserviceable for flight, the TRPU has to be electrically deactivated and the two translating cowls mechanically deactivated. The mechanical inhibition device of the thrust reverser is accessed by loosening the four captive screws on the mechanical inhibition access panel installed on the rear lower part of the thrust reverser cowls.

The mechanical inhibition requires the removal of the ball pin from the mechanical device. By using a lever, the mechanical inhibition device is then set to the "INHIBITED" position. The ball pin has to be re-installed to lock the mechanical inhibition device. When the thrust reverser system is mechanically inhibited a red pop-out is visible on the inhibition access panel.

WARNING: - TO INHIBIT THE THRUST REVERSER  
SYSTEM YOU MUST INHIBIT IT ON ENGINE 2  
AND 3,  
- REFER TO MMEL + CDL.



THRUST REVERSER - POWER INHIBITION AND MECHANICAL INHIBITION BEFORE FLIGHT

# **A380 Full Technical Handling Training (Module 3)**

A380 TRENT 900 System General & Differences

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