A350
TECHNICAL TRAINING MANUAL
MAINTENANCE COURSE - T1+T2 - RR Trent XWB
Airborne Auxiliary Power

This document must be used for training purposes only

Under no circumstances should this document be used as a reference

It will not be updated.

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AIRBORNE AUXILIARY POWER

V2414251 - V00T0MM0

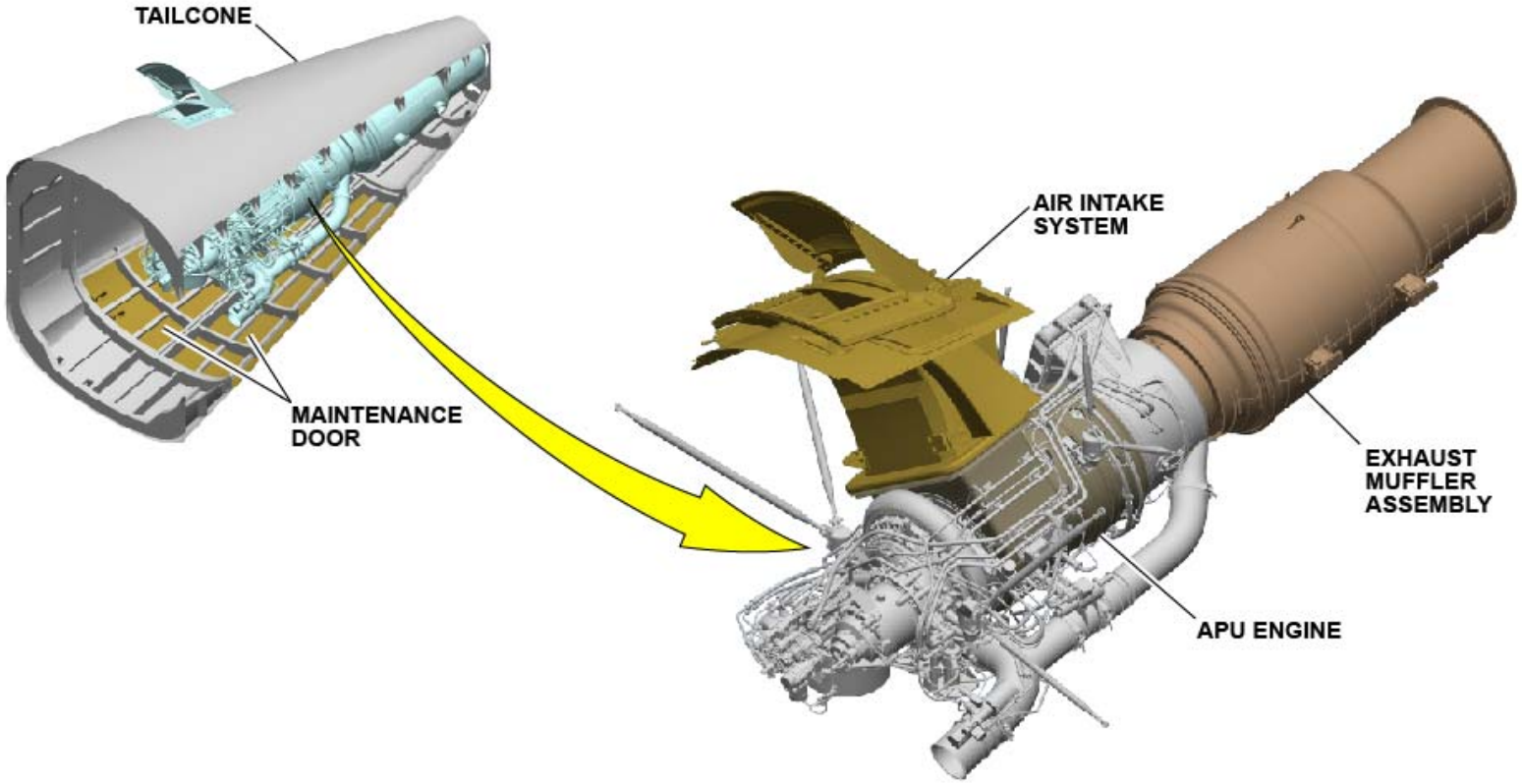
APU INSTALLATION DESCRIPTION (2/3)

General Presentation

The Auxiliary Power Unit (APU) is installed in the tailcone area in a fireproof compartment.
The APU includes:
- The engine system
- The air intake system
- The exhaust muffler.

The compartment of the APU has two maintenance doors to give access to the APU.

V2414251 - V00T0MM0 - VM49D1INSTL3001



GENERAL PRESENTATION

APU INSTALLATION DESCRIPTION (2/3)

Doors

The APU compartment is fitted with two maintenance fireproof doors (manually operated). The maintenance doors are hinged at the top and latched at the bottom with hook latches (four) and pin latches (four) and an internal locking device.
Each door is fitted with a hold open rod.
An overpressure door is fitted on the RH APU maintenance door.
In case of overpressure inside the APU compartment the overpressure door opens.
To open the APU maintenance doors, this door should be opened first in order to release the door locking device with an internal handle.
When the locking device handle is in the open position, it prevents the overpressure door to be closed.

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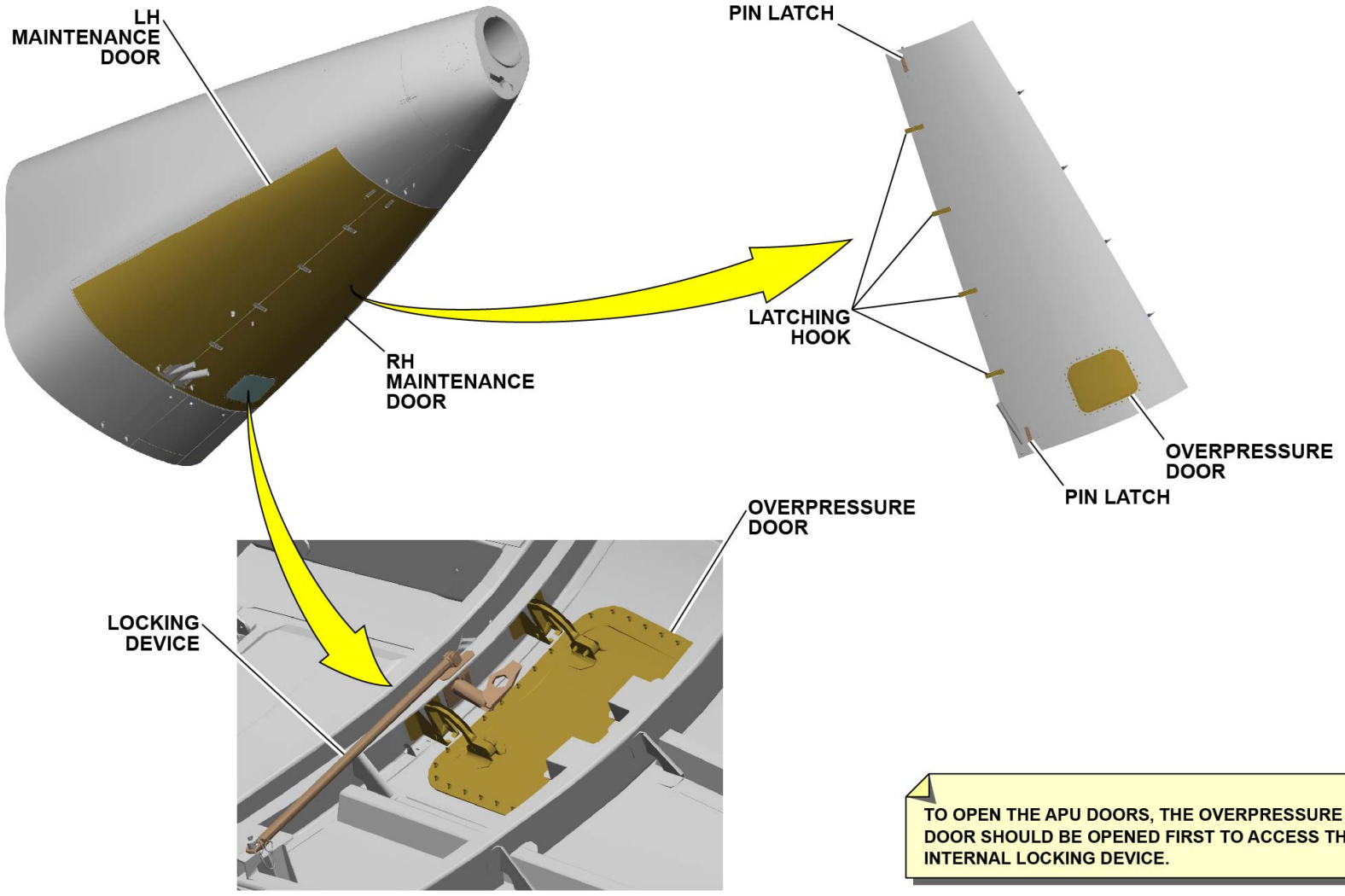
LH
MAINTENANCE
DOOR
RH
MAINTENANCE
DOOR
PIN LATCH
LATCHING
HOOK
OVERPRESSURE
DOOR
PIN LATCH
OVERPRESSURE
DOOR
LOCKING
DEVICE
TO OPEN THE APU DOORS, THE OVERPRESSURE DOOR SHOULD BE OPENED FIRST TO ACCESS THE INTERNAL LOCKING DEVICE.

DOORS

APU INSTALLATION DESCRIPTION (2/3)

Mounts

The APU mounts are composed of brackets, vibration isolators and struts.
There are struts (eight) that suspend the APU in its specified position.
The struts are attached at one end to the fuselage, and at the other end, to the vibration isolators (four).
The vibration isolators are attached to the APU brackets (four). They decrease vibrations and shocks, which are transmitted by the APU to the A/C structure.
The brackets are fitted on the APU at four dedicated location.

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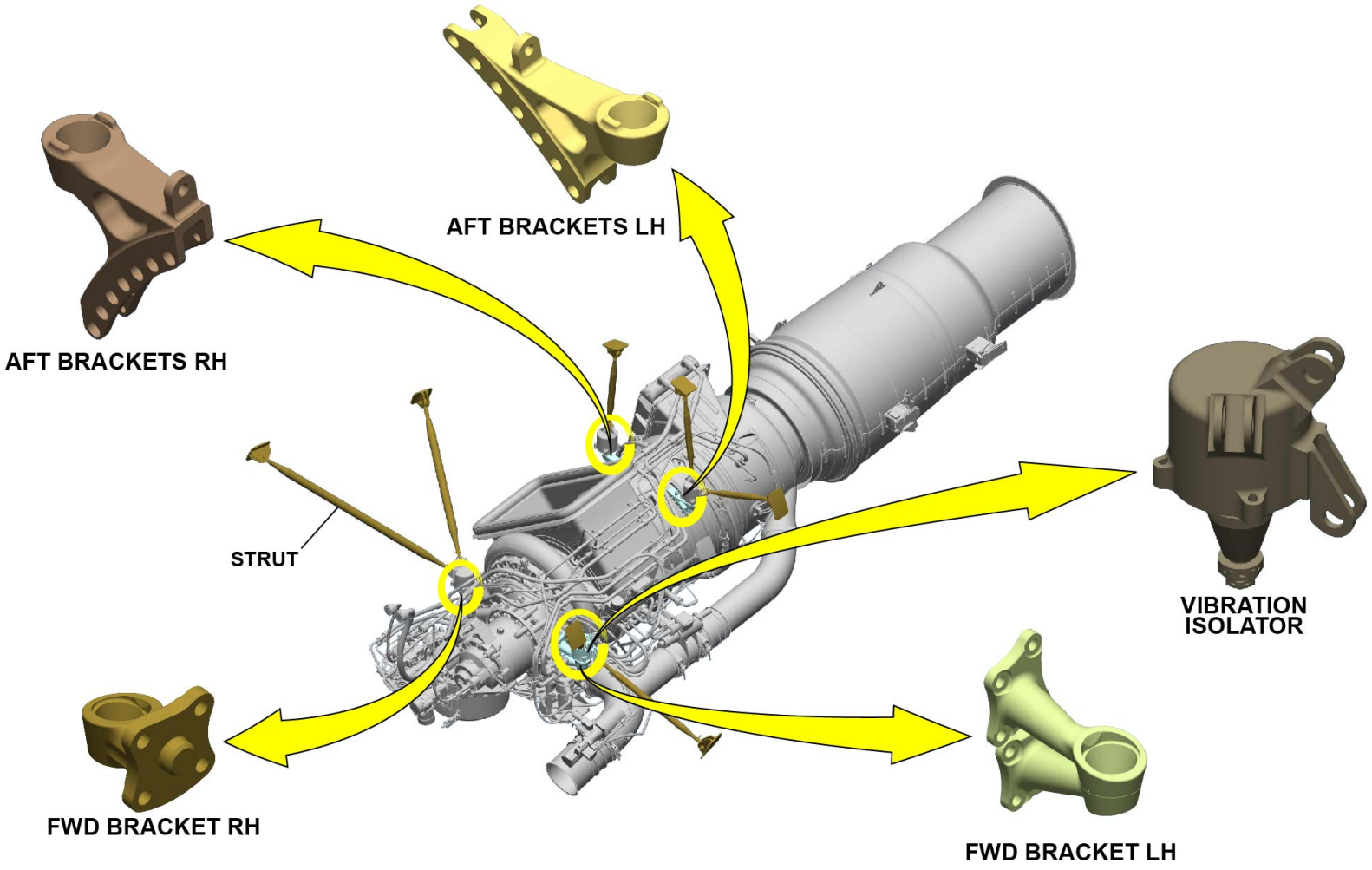
AFT BRACKETS LH
AFT BRACKETS RH
STRUT
VIBRATION ISOLATOR
FWD BRACKET RH
FWD BRACKET LH

MOUNTS

APU INSTALLATION DESCRIPTION (2/3)

Drains

The power plant drain system removes fluid leaks or accumulation from the APU and the APU exhaust muffler.
Drainage of fluids from APU and APU exhaust muffler flow overboard through drain lines.
The APU drain lines include:
- Two APU drain masts fitted on engine
- Two APU compartment drain masts fitted on doors
- One exhaust muffler drain port.

The APU drain system discharges fuel and/or oil and/or water from the engine drain masts, compartment drain masts and exhaust drain mast.

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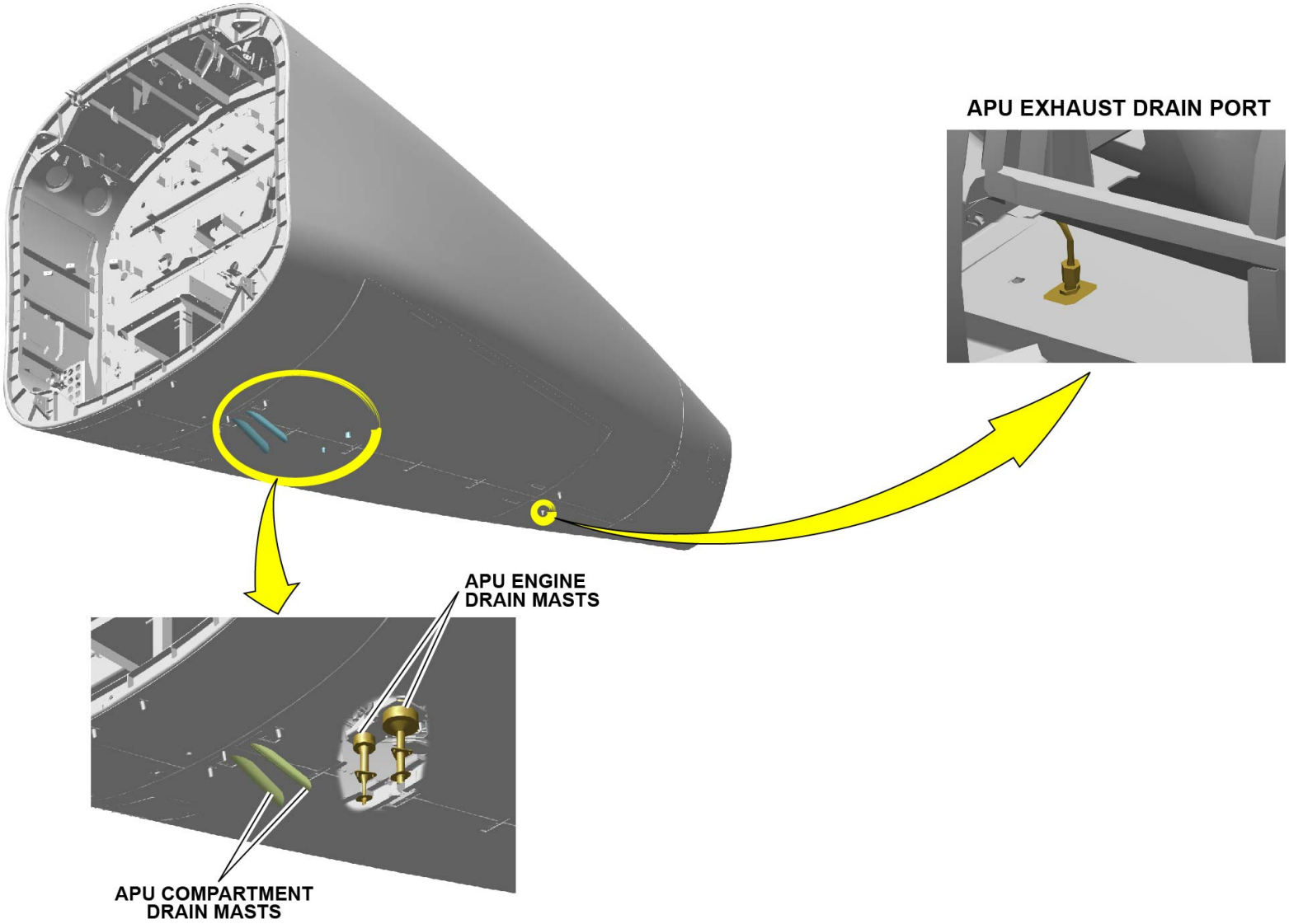
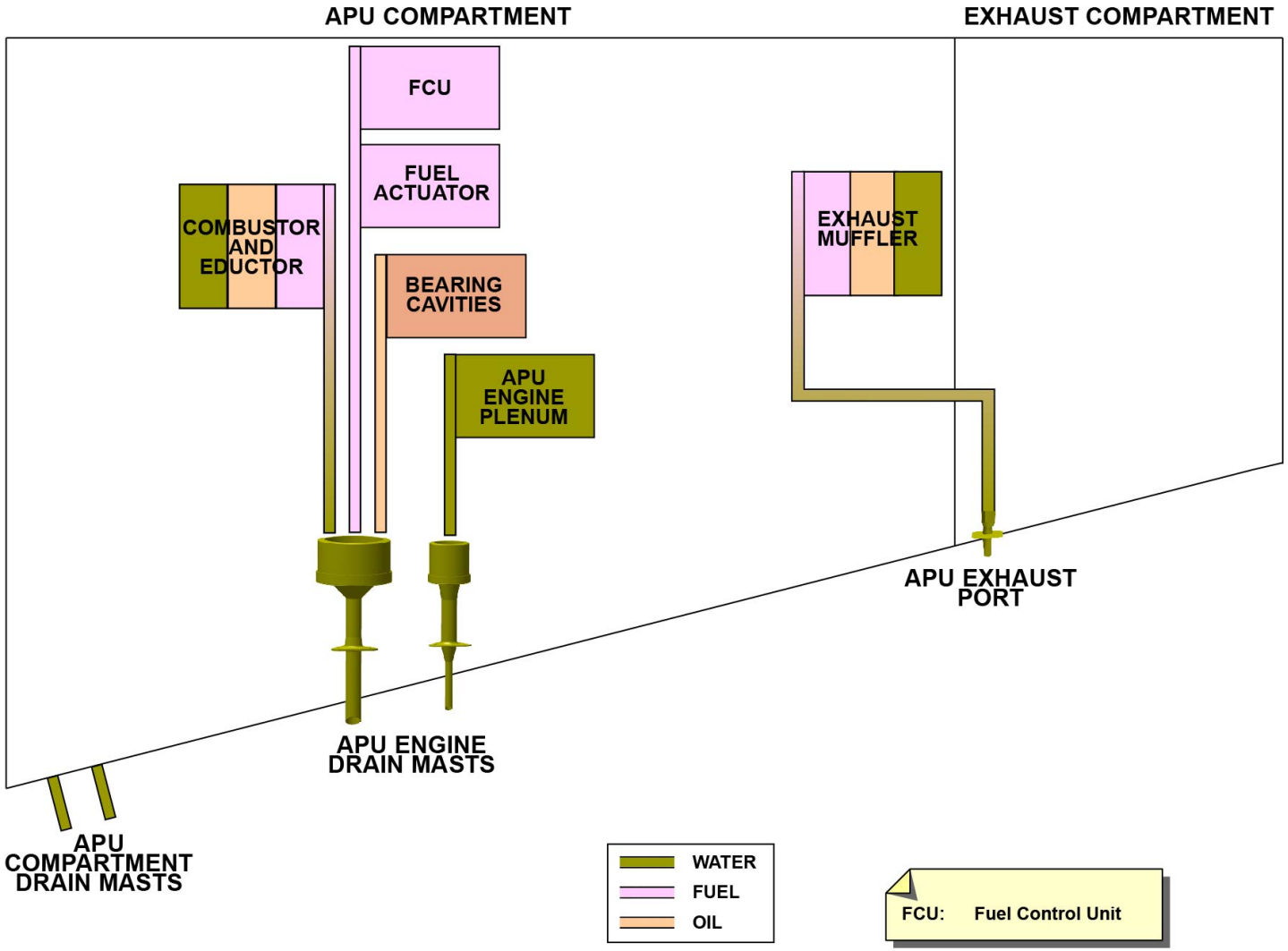

APU EXHAUST DRAIN PORT
APU ENGINE
DRAIN MASTS
APU COMPARTMENT
DRAIN MASTS

DRAINS


APU COMPARTMENT
EXHAUST COMPARTMENT
FCU
FUEL ACTUATOR
COMBUSTOR AND EDUCTOR
BEARING CAVITIES
APU ENGINE PLENUM
EXHAUST MUFFLER
APU EXHAUST PORT
APU ENGINE DRAIN MASTS
APU COMPARTMENT DRAIN MASTS
WATER
FUEL
OIL
FCU: Fuel Control Unit

DRAINS

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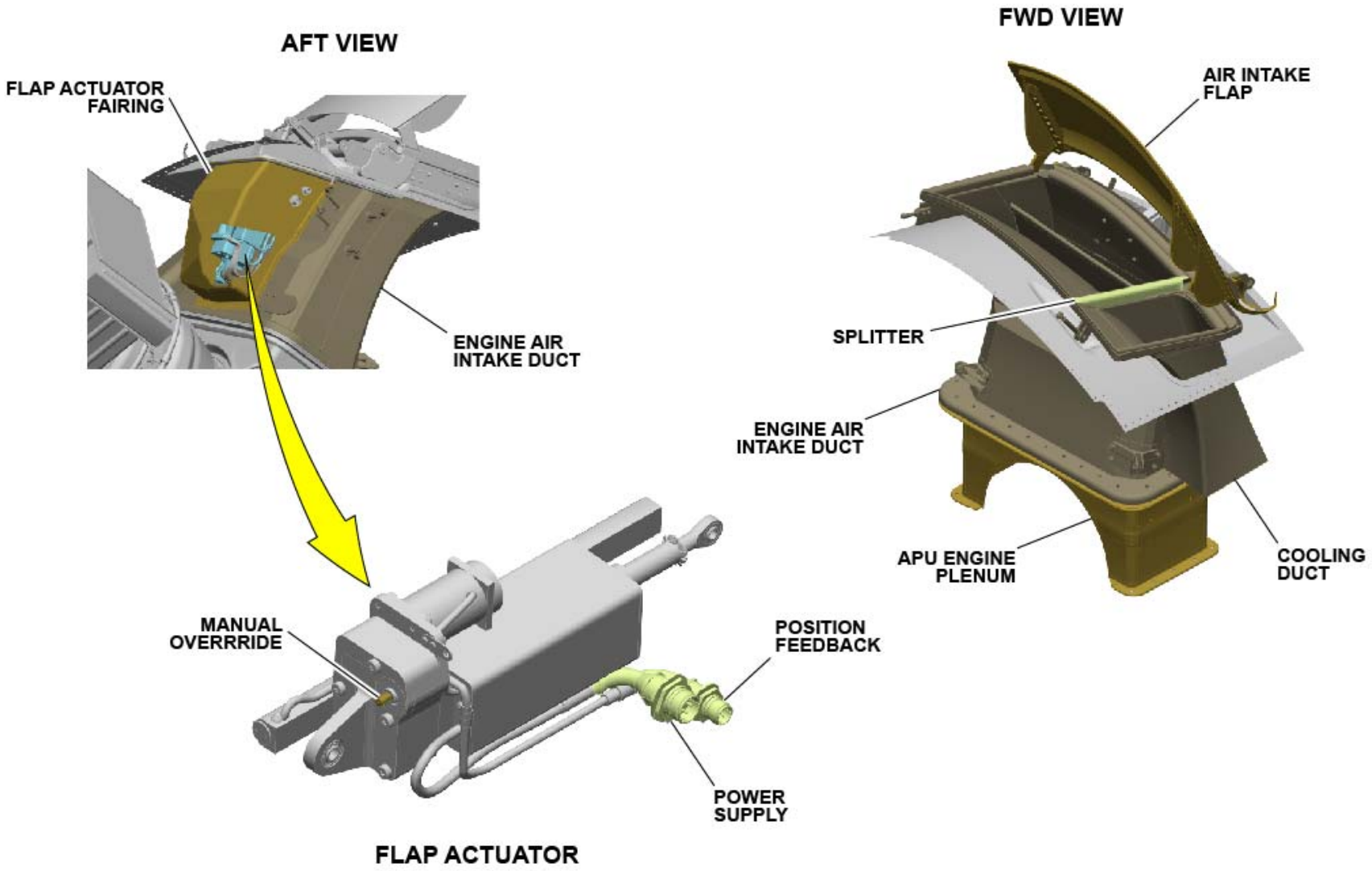
APU INSTALLATION DESCRIPTION (2/3)

Air Intake System

The air intake system is composed of two separated ducts, an engine air intake duct and a cooling duct.
The engine air intake duct has interfaces with the APU engine plenum.
The engine air intake duct provides external air to the APU engine compressor, the bleed load compressor.
The cooling duct provides fresh external air to the APU compartment directly.
The APU intake flap allows outside air to go into the APU air intake system.
The flap opens facing FWD into the air stream.
The air intake flap is flush with the fuselage skin when closed.
The air intake flap opens at two different positions. One for ground operation (45 DEGs) and one for flight operation (20 DEGs).
The flap opens and closes by an electro-mechanical actuator fitted at the back side of the air intake duct.
The electro-mechanical actuator is protected against overheat by a removable fairing.
The actuator has two electrical plugs, one for the power supply, one for the position feedback.
A manual override deactivation device is located on the actuator and is accessible from the APU compartment.

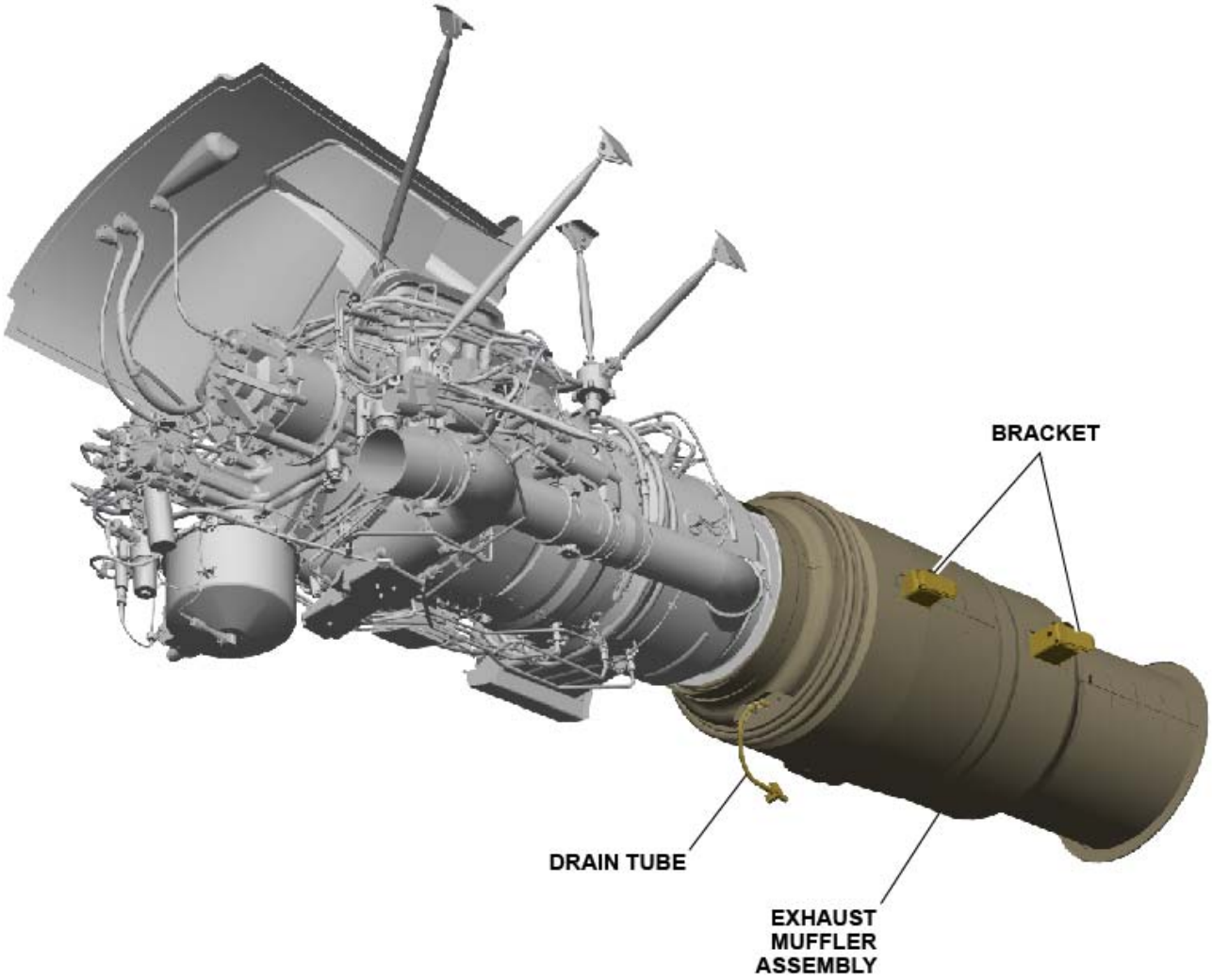


AIR INTAKE SYSTEM

APU INSTALLATION DESCRIPTION (2/3)

Exhaust Muffler

The exhaust muffler lets the exhaust gases to flow overboard.
It also decreases exhaust noise and is thermally insulated.
It is fitted with brackets at each side for installation and a drain tube.



EXHAUST MUFFLER

APU ENGINE DESCRIPTION (3)

General Presentation

The Auxiliary Power Unit (APU) engine is an Honeywell HGT1700, single shaft design, running at constant speed.
The APU is designed to:
- Provide electrical from ground to the maximum A/C ceiling
- Provide pneumatic power for Environmental Control System (ECS) (up to 22500 ft) and Main Engine Start (MES) (up to 25000 ft).

The APU engine is composed of:
- A power section
- An inlet plenum
- A load compressor assembly
- An accessory gearbox.

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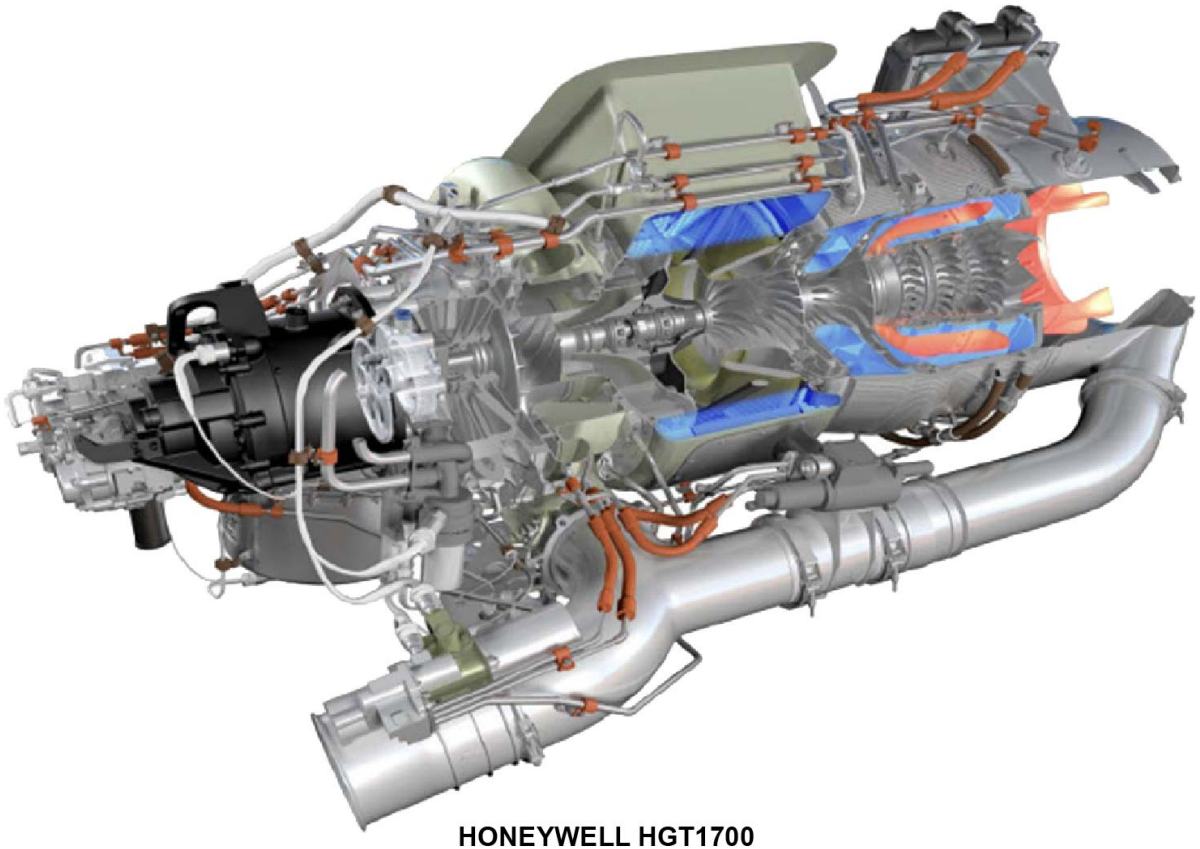
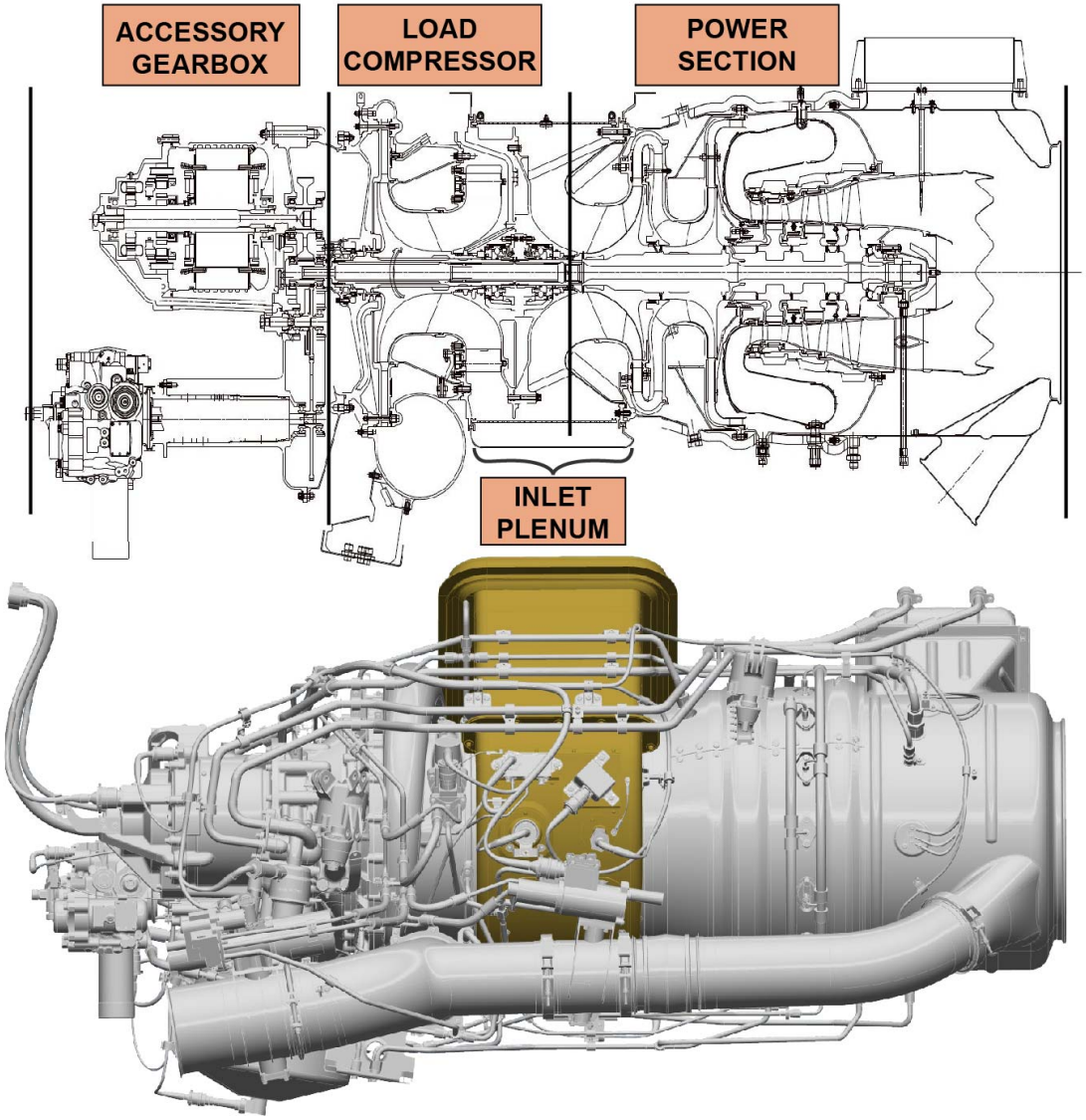


HONEYWELL HGT1700

GENERAL PRESENTATION



GENERAL PRESENTATION

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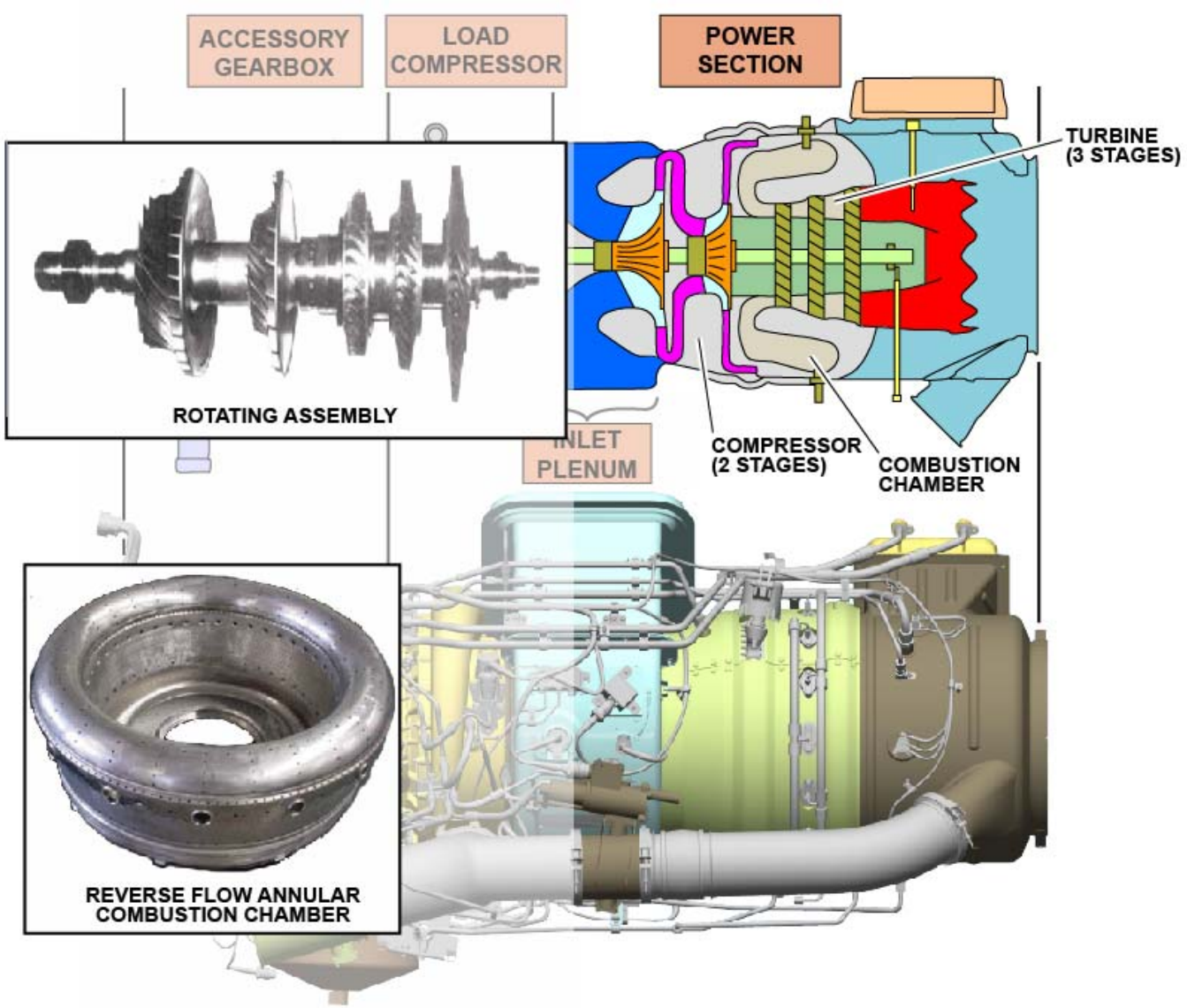
APU ENGINE DESCRIPTION (3)

Power Section

The power section is composed of:
- Single shaft
- Centrifugal compressor assembly (two stages)
- Reverse flow annular combustion chamber
- Turbine assembly (three stages).



POWER SECTION

APU ENGINE DESCRIPTION (3)

Inlet Plenum

The inlet plenum allows external air which comes from the engine-air intake duct to enter the engine compressor and the load compressor assemblies, through an inlet screen.
The inlet plenum is fitted with an access door and a drain at the bottom.

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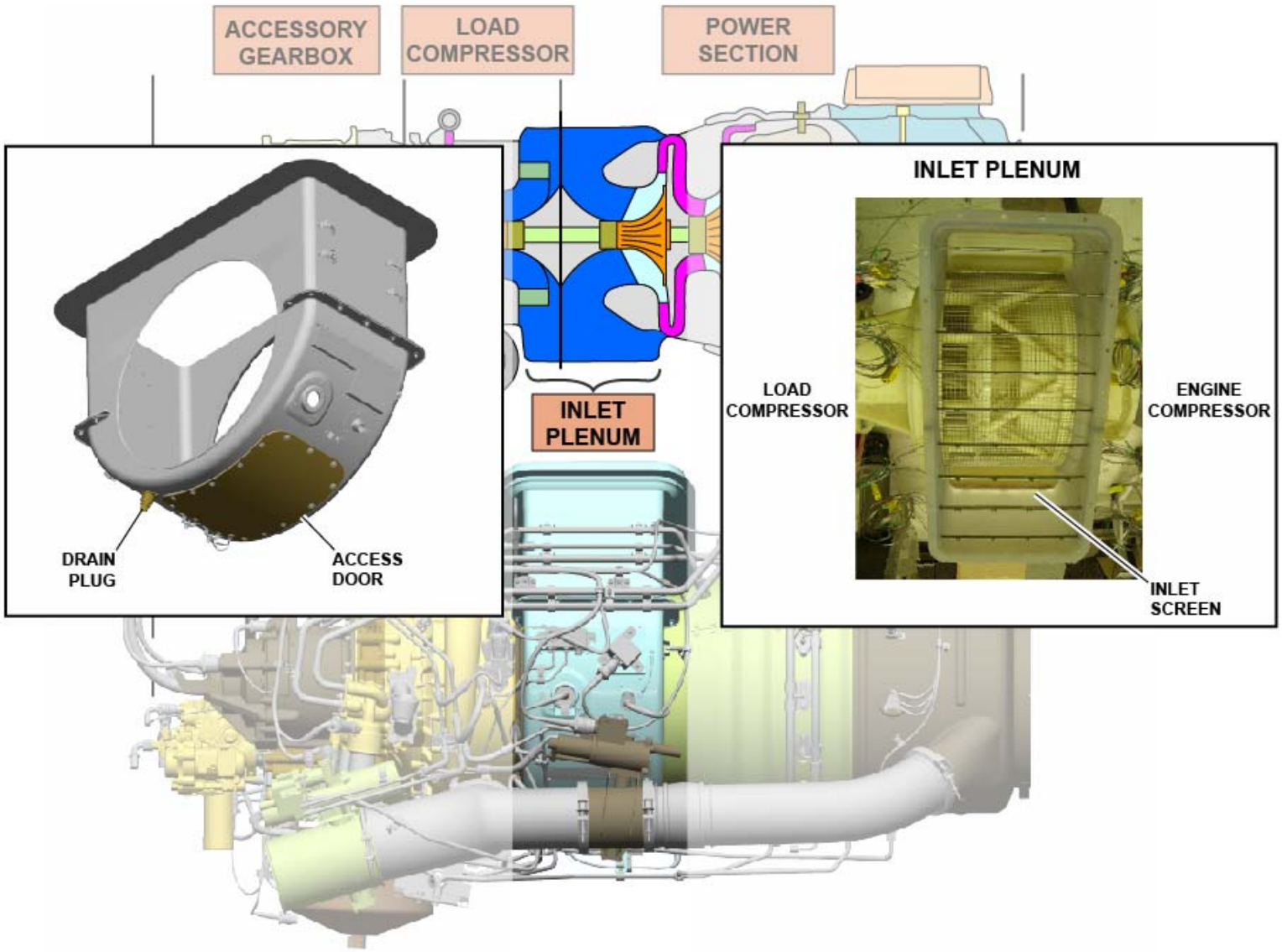

INLET PLENUM

APU ENGINE DESCRIPTION (3)

Load Compressor

The load compressor assembly is a centrifugal compressor (single stage) driven by the APU engine shaft.
The Inlet Guide Vanes (IGVs) are installed at the load compressor entry to modulate the airflow coming from inlet plenum.
The compressed air is then distributed through a scroll to the bleed valve.

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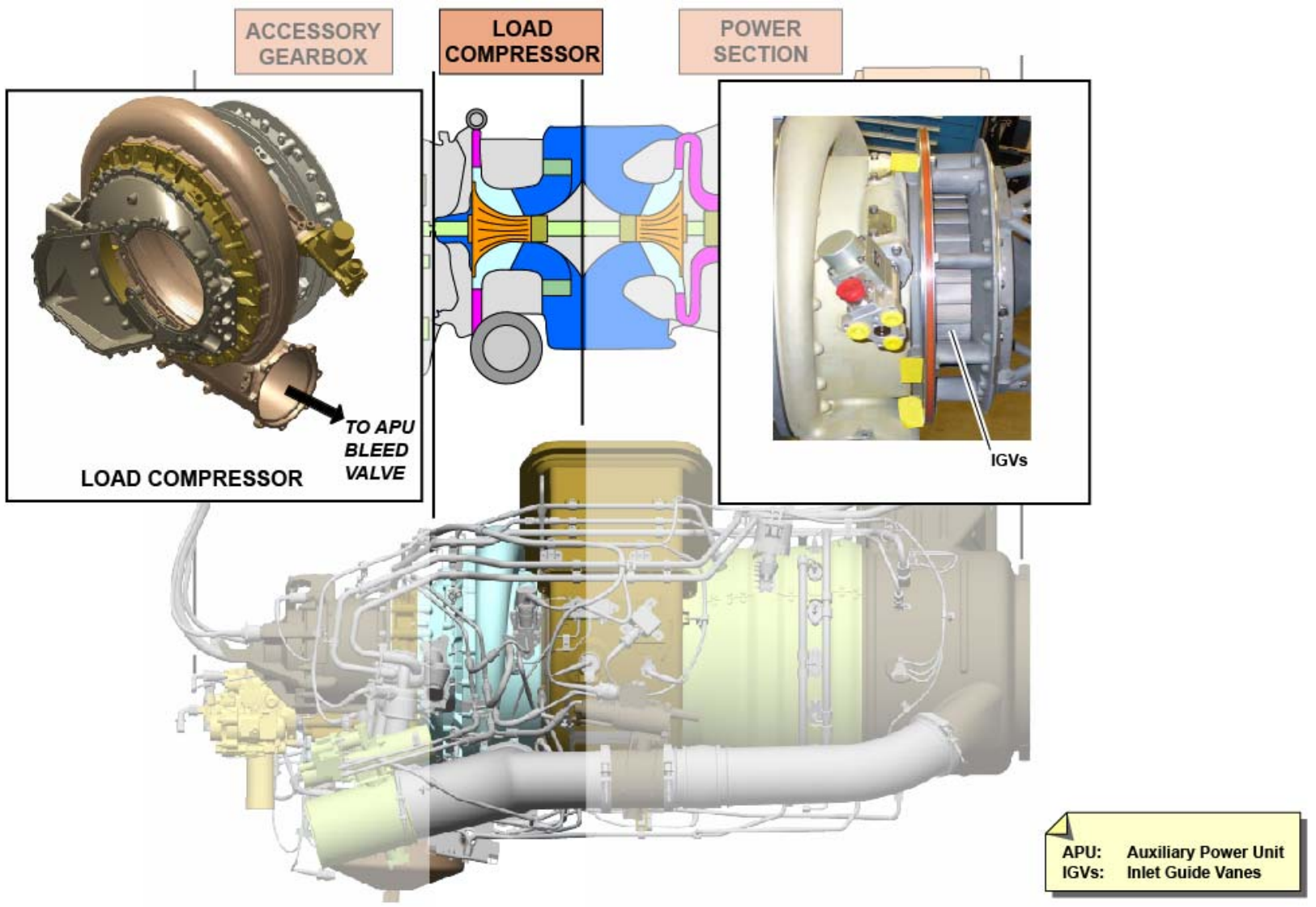


LOAD COMPRESSOR

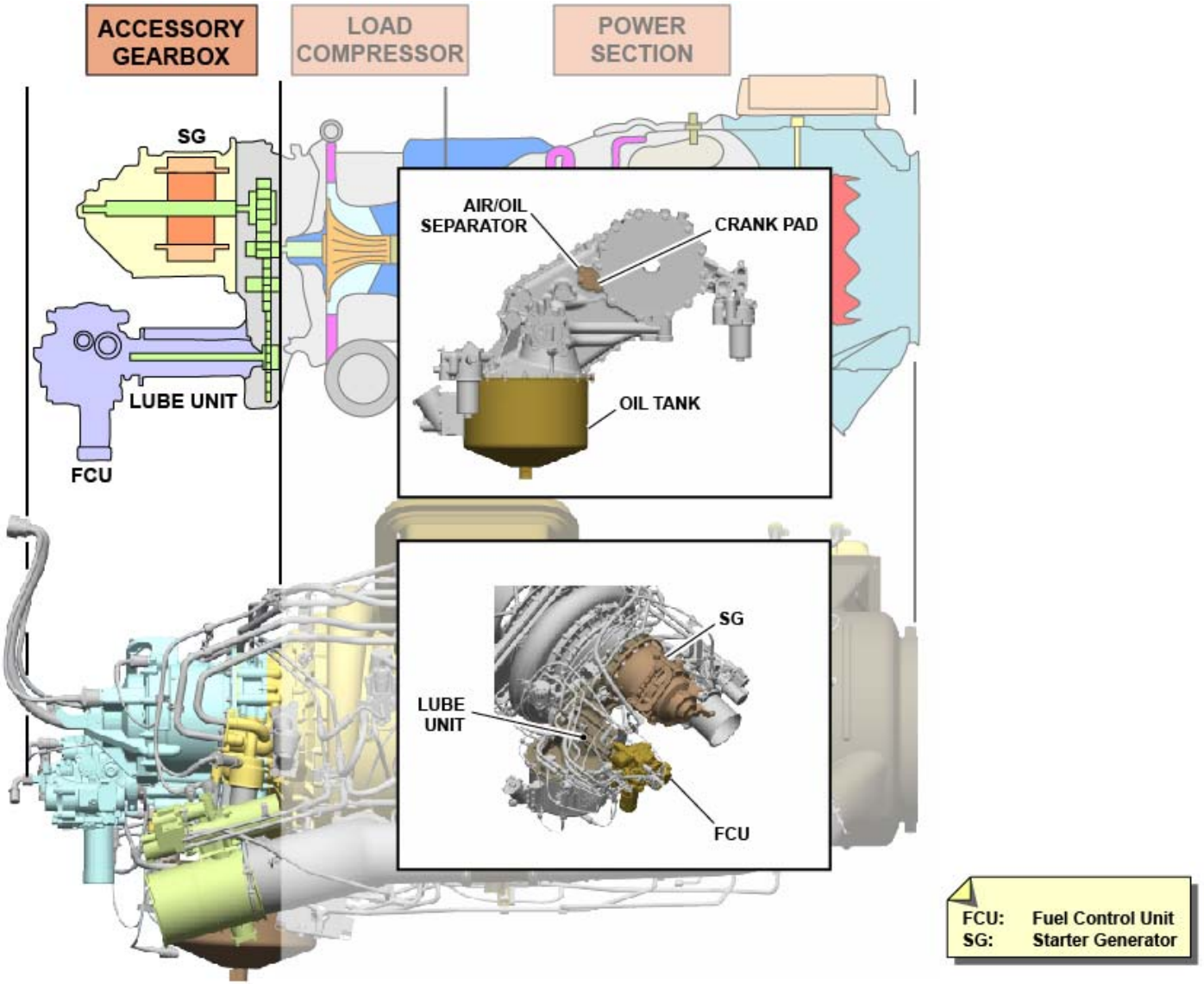
APU ENGINE DESCRIPTION (3)

Accessory Gearbox

The accessory gearbox is fitted with:
- Starter Generator (SG)
- Fuel Control Unit (FCU)
- Lubrication unit
- Oil tank
- Air/oil separator.

The accessory gearbox is used to transfer power from SG to APU power section during APU start, and to drive the accessories (SG, FCU pump, lubrication unit pumps) during APU operation.
The gearbox also has a manual crank pad to rotate manually the APU shaft for boroscope inspections.

V2414251 - V00T0MM0 - VM49D2ENGIN3001



ACCESSORY GEARBOX

APU FUEL SYSTEM DESCRIPTION (2/3)

General Presentation

The primary function of the Auxiliary Power Unit (APU) fuel system is to provide and control the fuel flow to the APU combustion chamber during starting, governed speed operation, and shutdown sequence.
The secondary function of the APU fuel system is to provide fuel muscle pressure to the APU bleed air system actuators (bleed valve, surge control valve, Inlet Guide Vane (IGV) actuator).
The APU fuel system is composed of the following main components:
- The Electronic Control Box (ECB) to control the Fuel Control Unit (FCU) for all APU fuel system operations
- The FCU to pressurize fuel from A/C fuel system (ATA 28), deliver metered fuel to the APU combustion chamber and fuel muscle pressure to the APU bleed air system actuators
- Primary and secondary manifolds associated with fuel nozzles (14) to equally distribute the fuel from FCU to the combustion chamber.

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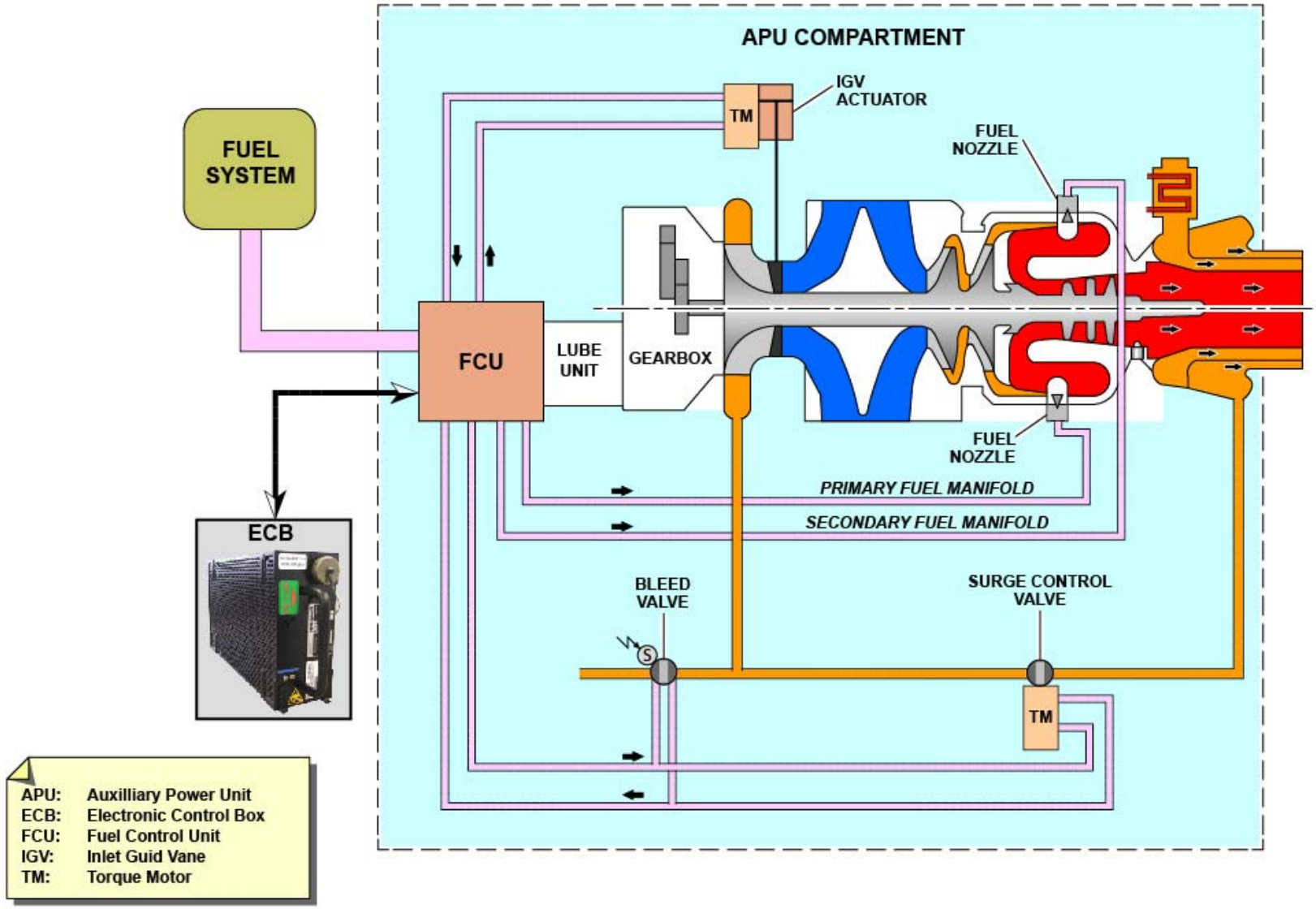


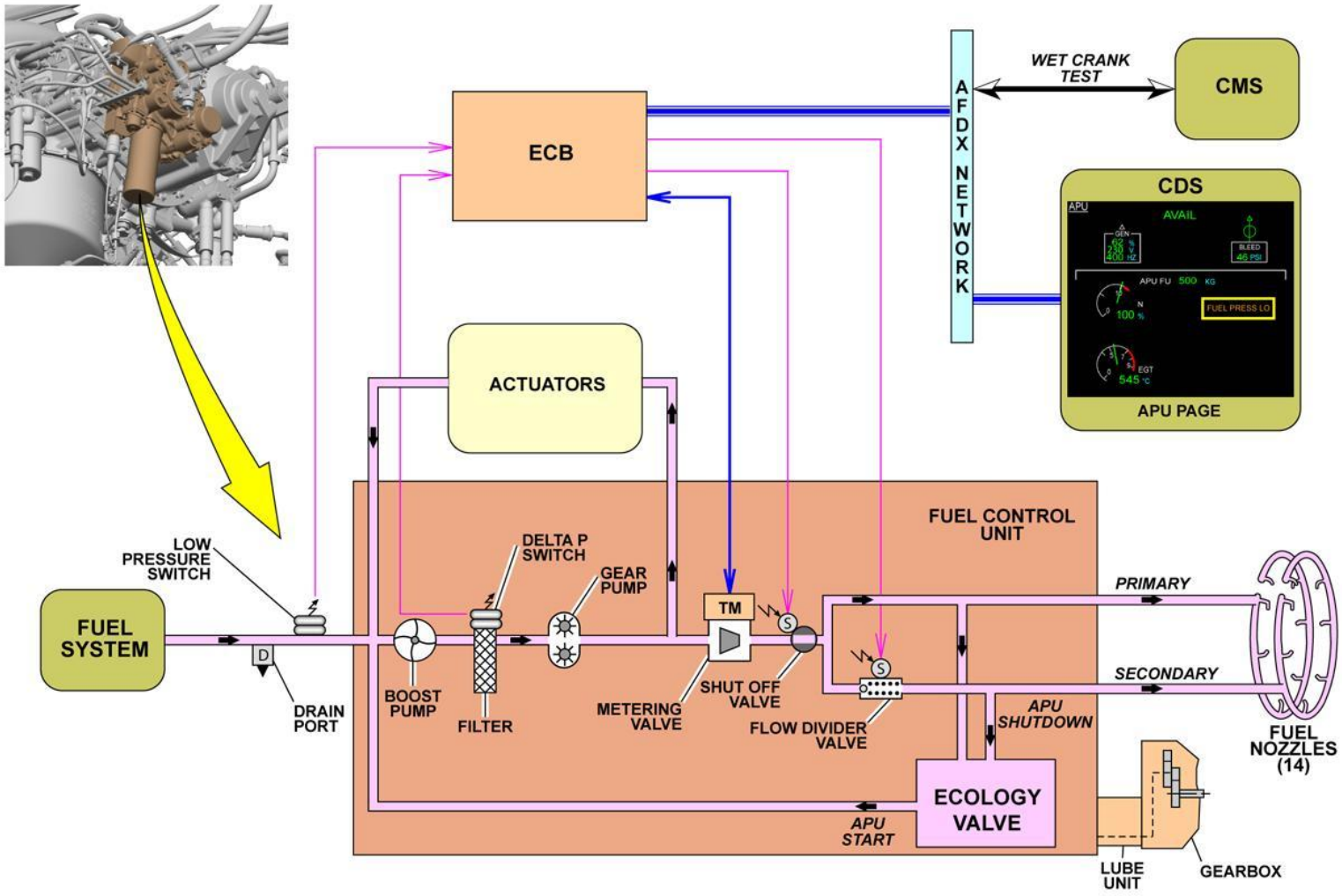
GENERAL PRESENTATION

APU FUEL SYSTEM DESCRIPTION (2/3)

Fuel Control Description

The FCU receives its control input commands from the ECB.
The FCU integrates a drain port, a LP switch, a pump assembly (LP boost, HP gear), a filter with DELTA P switch, a metering valve, a shut-off valve, a flow divider valve, an ecology valve.
A manual drain port, at the FCU inlet, is used to bleed the air from the APU fuel supply line (ATA 28), for maintenance purpose only.
If the fuel pressure is too low at the FCU inlet, the fuel LP switch provides a signal to the ECB for APU page indication "FUEL PRESS LO".
The FCU receives LP supply of fuel from the A/C and routes it through an inlet fuel filter.
A DELTA P switch, connected to the ECB, monitors any filter clogging condition.
The FCU is fitted with a two stage pump assembly (LP boost stage and HP gear stage).
Both fuel pump stages are driven by the gearbox through the oil pump assembly shaft.
The pump assembly pressurizes the filtered fuel that is delivered to the Fuel Metering Valve (FMV).
The FMV is controlled by the ECB via a Torque Motor (TM) using fuel muscle pressure.
The flow rate to the fuel nozzles is proportional to the FMV position.
The metered fuel flow is delivered to the APU combustion chamber via a fuel shut-off valve operated by a solenoid.
The solenoid is energized by the ECB to open the valve.
When de-energized (fail safe position), the shut-off valve is closed.
The flow divider valve split the metered fuel into two flows.
The primary flow goes to the primary manifold directly.
The secondary flow goes to the secondary manifold through a spring loaded valve fitted with a solenoid.
The solenoid lower the spring loaded valve crack point when energized.
That feature allow a more precise control on the secondary fuel flow depending on APU operating mode and altitude.
During APU shutdown, an ecology valve sequentially purges fuel from the primary and secondary manifolds into a piston chamber within the valve.
The fuel will remain inside the chamber until next APU start at which time it will be returned to the inlet of the FCU LP pump.
Ecology drain valve is integrated inside the FCU and the fuel is reused at next APU start.
For maintenance purpose, the FCU is automatically operated when a CMS wet crank test is launched.

V2414251 - V00T0MM0 - VM49D3FUEL03001



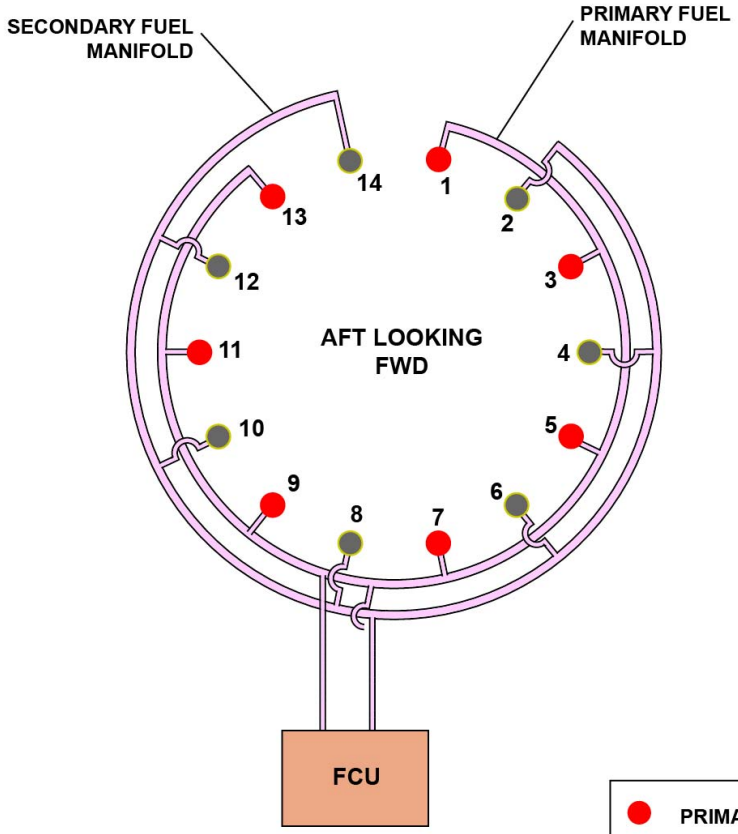
FUEL CONTROL DESCRIPTION

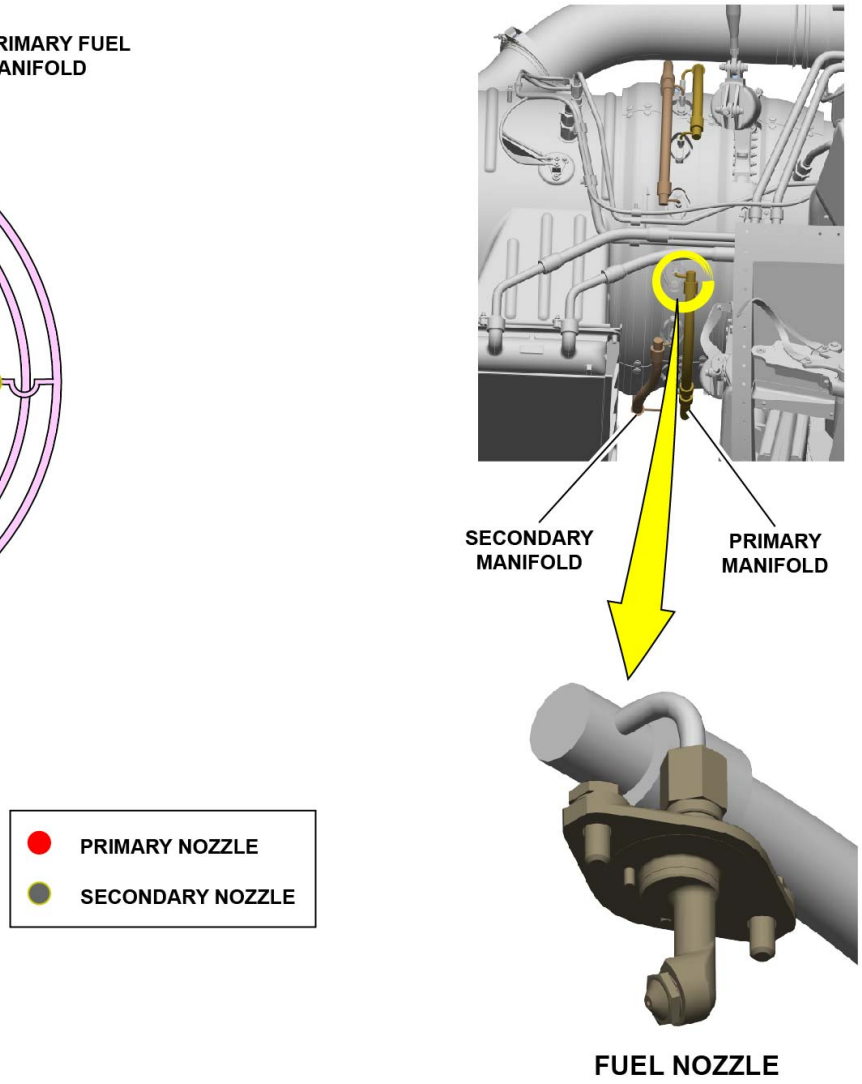
APU FUEL SYSTEM DESCRIPTION (2/3)

Fuel Distribution Description

The fuel is distributed to the APU engine combustion chamber via two manifolds: the primary and the secondary.
The primary and the secondary manifolds supply different fuel nozzles (7 nozzles per manifold).

V2414251 - V00T0MM0 - VM49D3FUEL03001





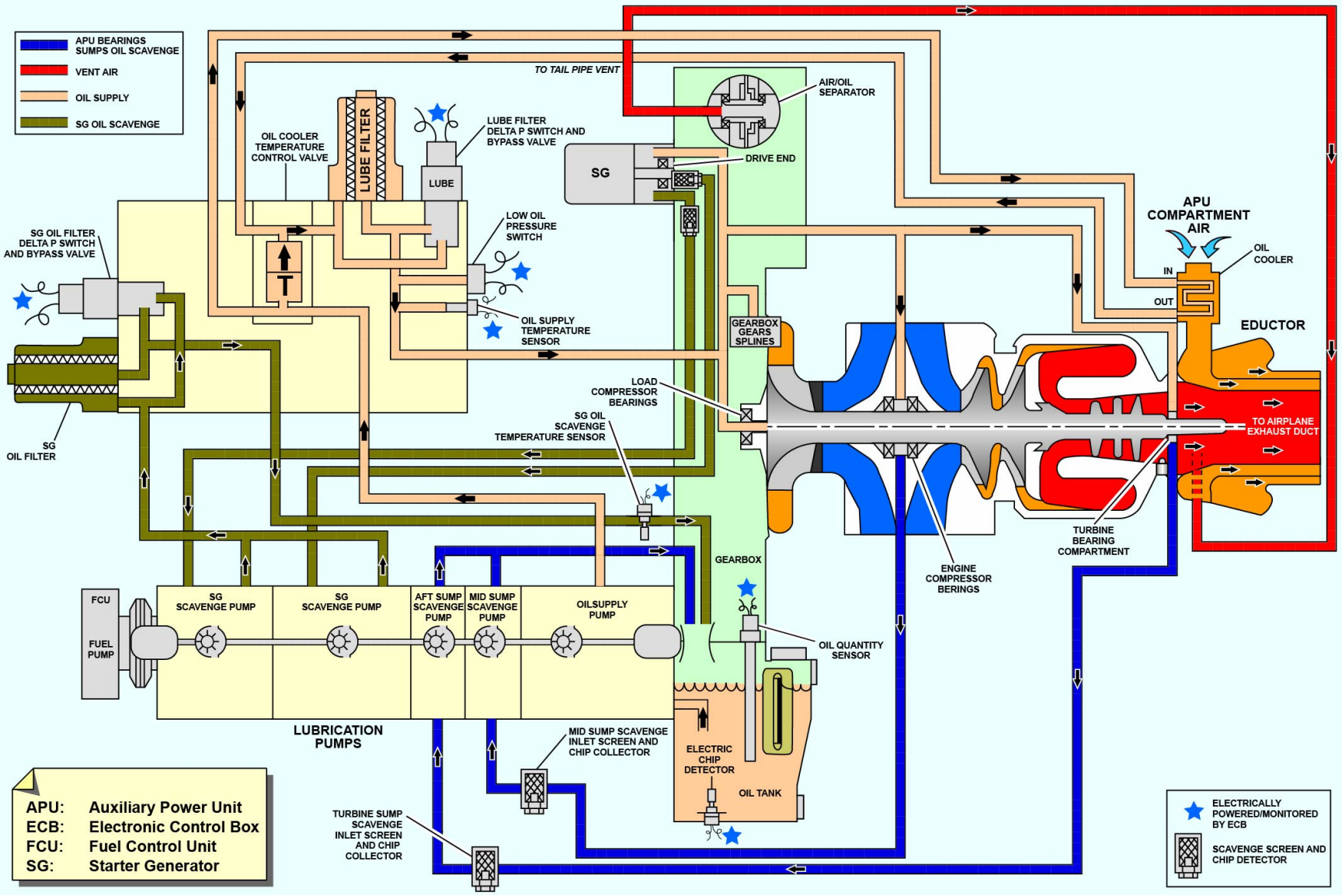
FUEL DISTRIBUTION DESCRIPTION

APU OIL SYSTEM DESCRIPTION (2/3)

APU Oil System Function and Description

The Auxiliary Power Unit (APU) oil system function is to provide pressurized and filtered oil to the APU critical components for lubrication and cooling.
A pump pressurizes oil from the tank and send it, through an oil cooler and a filter, to rotating parts such as gearbox, Starter Generator (SG) and shaft bearings sumps.
The oil cooler can be bypassed via an oil temperature control valve if oil temperature is too cold or in case of oil cooler clogging.
The oil is cooled by the Oil Cooler using the eductor (venturi) effect.
On the lubrication unit, scavenge pumps suck the oil from the sumps and the SG back to the oil tank.
The oil is screened before re-entering the lubrication unit scavenge pumps, and SG scavenge oil goes through an additional filter to minimize cross-contamination.
The lubrication system includes various detectors and sensors (chip detectors, filter clogging switches, pressure and temperature sensors, oil level sensor) connected to the Electronic Control Box (ECB) which monitor the condition of the system.
The APU oil system is only mechanically driven, with an oil pump unit connected to the gearbox. There is no ECB control.
A centrifugal air/oil separator, driven by the gearbox, is used to reduce the oil consumption.
The oil is returned to the gearbox by gravity and air is evacuated to the APU exhaust via a dedicated pipe.

V2414251 - V00T0MM0 - VM49D4OIL003001



APU OIL SYSTEM FUNCTION AND DESCRIPTION

APU OIL SYSTEM DESCRIPTION (2/3)

Components Description

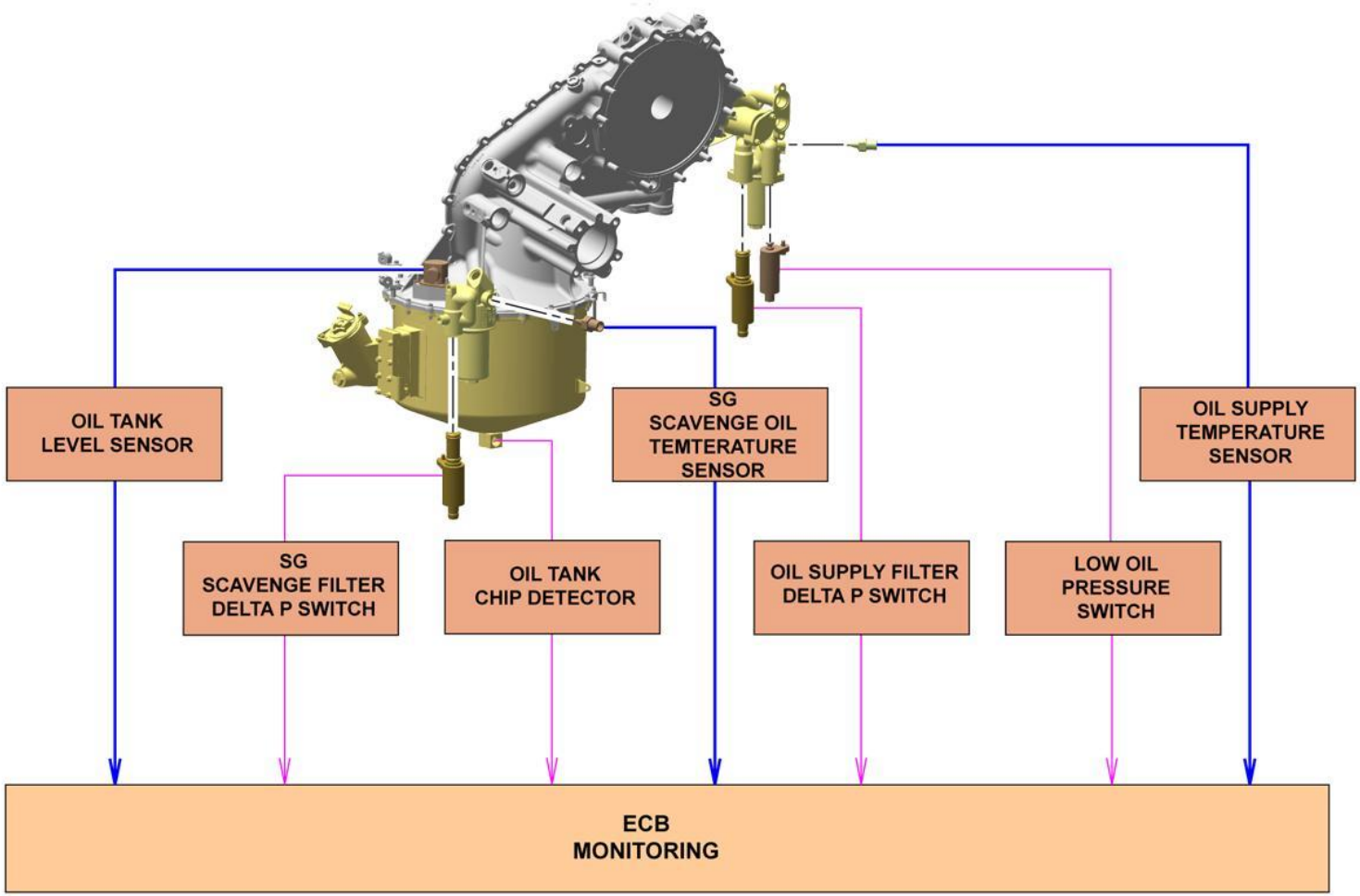
Detectors and Sensors

The ECB monitors the oil system with detectors and sensors, to provides messages with (on ground) or without (in flight), APU auto shutdown if one of them detect a problem that can lead to an unsafe APU operation.

The oil system detectors and sensors monitored by the ECB are:

- Oil tank level sensor
- Oil tank chip detector
- Oil supply filter Differential Pressure (Delta P) switch
- Oil supply temperature sensor
- Low oil pressure switch
- SG scavenge filter Delta P switch
- SG scavenge oil temperature sensor.

V2414251 - V00T0MM0 - VM49D4OIL003001



COMPONENTS DESCRIPTION - DETECTORS AND SENSORS

V2414251 - V00T0MM0 - VM49D4OIL003001

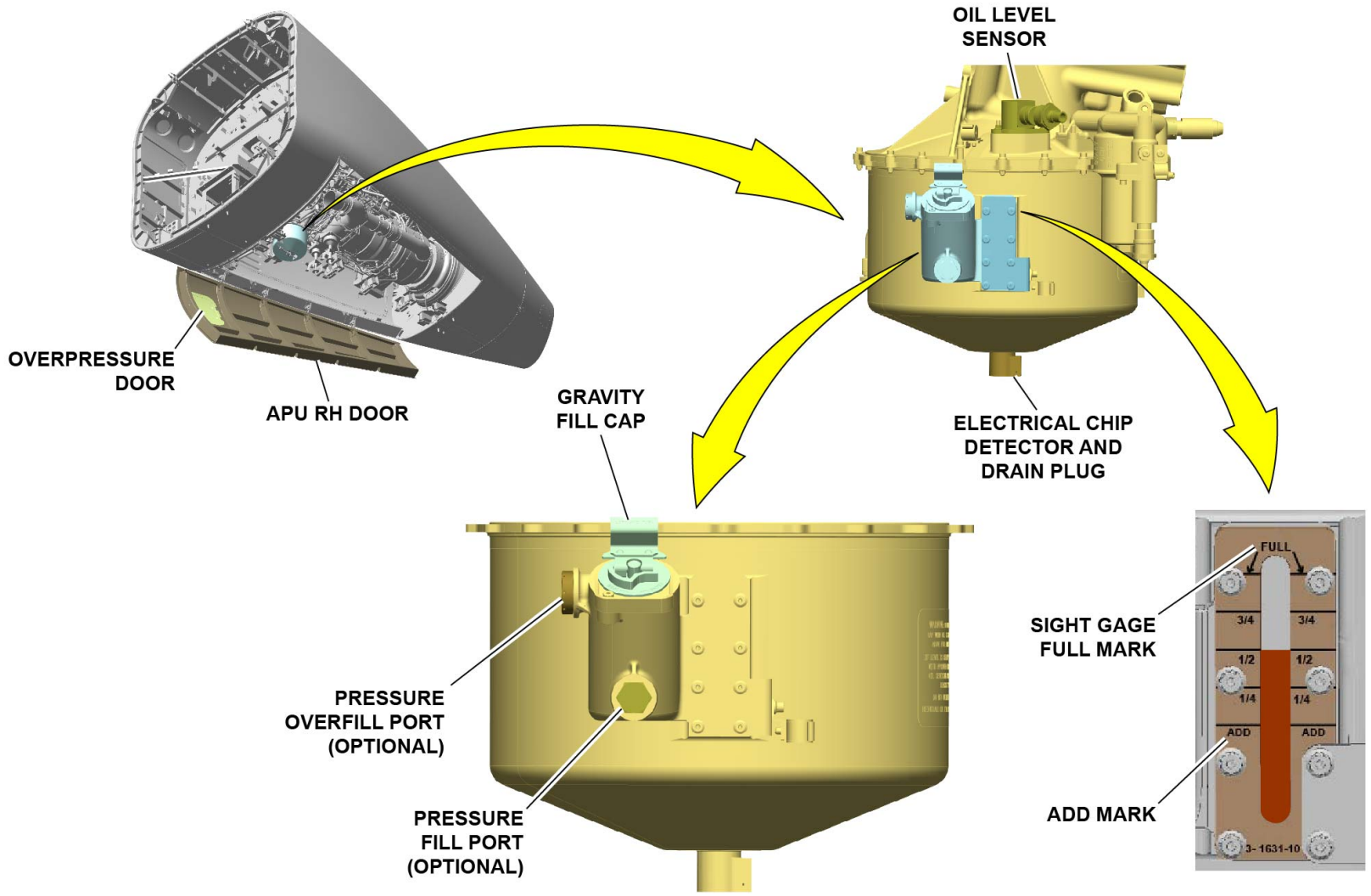
APU OIL SYSTEM DESCRIPTION (2/3)

Components Description (continued)

Oil Tank

The oil tank is a separate unit attached at the RH bottom of the gearbox.
It is used to store the oil for the system.
The oil tank can be seen directly by opening the overpressure door, but the APU oil servicing requires opening of the APU doors.
The oil tank has an oil level sensor, a sight glass with "FULL" and "ADD" indications, gravity and pressure fill ports (optional).
The base of the tank holds an electrical chip detector with a magnetic head, if chips are detected.
It is also used as a drain plug for oil tank.

V2414251 - V00T0MM0 - VM49D4OIL003001



COMPONENTS DESCRIPTION - OIL TANK

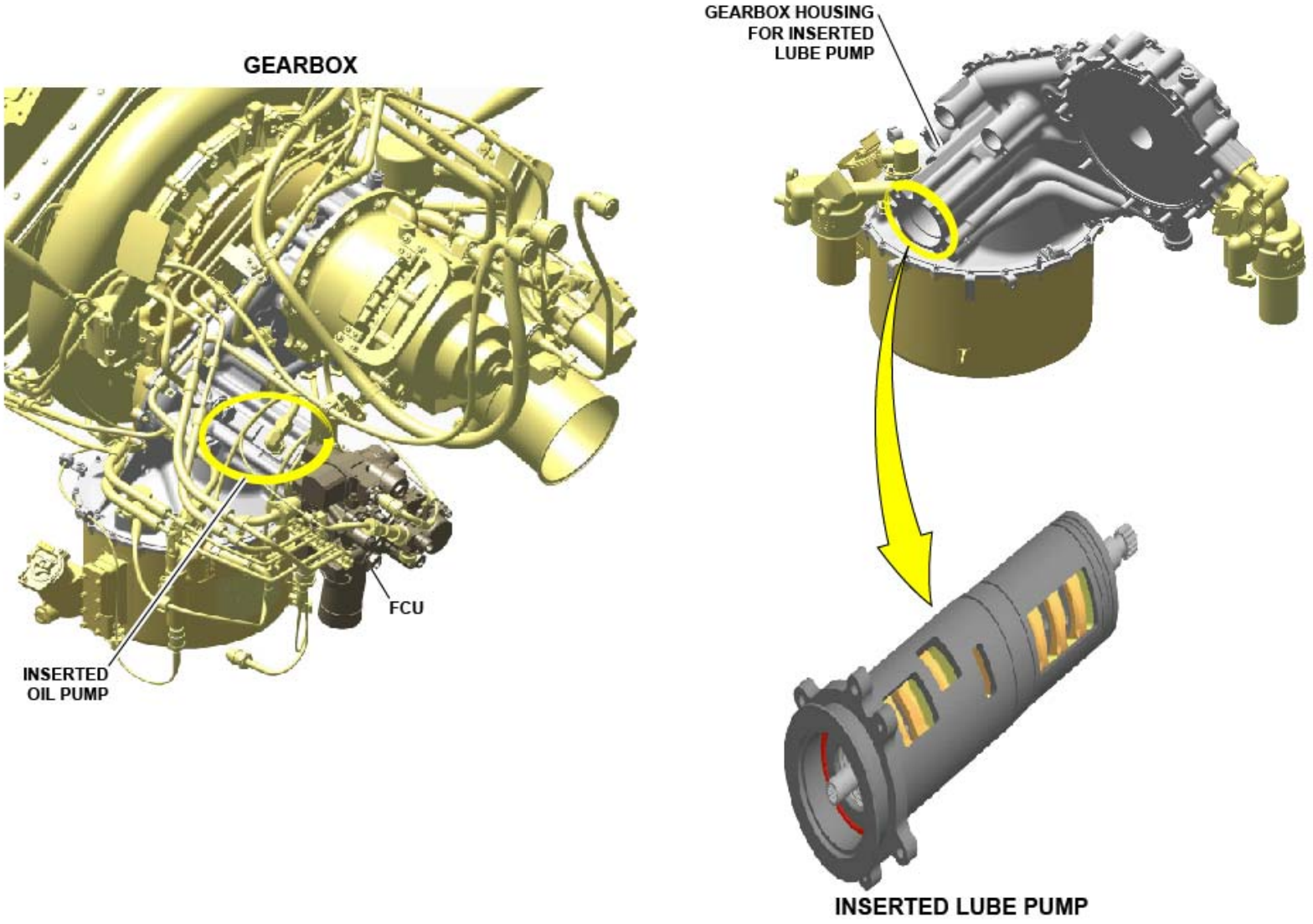
APU OIL SYSTEM DESCRIPTION (2/3)

Components Description (continued)

Lubrication Unit Pumps

The lubrication unit pump is an inserted pump driven by the gearbox. Its shaft is also used to transmit gearbox rotation movement to the Fuel Control Unit (FCU) installed at the front of the lubrication unit. The pump supply enough oil pressure to the oil system in any APU operating mode, including cold start operation.

V2414251 - V00T0MM0 - VM49D4OIL003001



COMPONENTS DESCRIPTION - LUBRICATION UNIT PUMPS

APU OIL SYSTEM DESCRIPTION (2/3)

Components Description (continued)

Oil Cooler

The oil cooler is an oil/air heat exchanger.
It cools the oil that has been heated up by the lubrication process.
The APU compartment air is sucked through the air cooler with an educator (venturi) effect generated by the exhaust gas.

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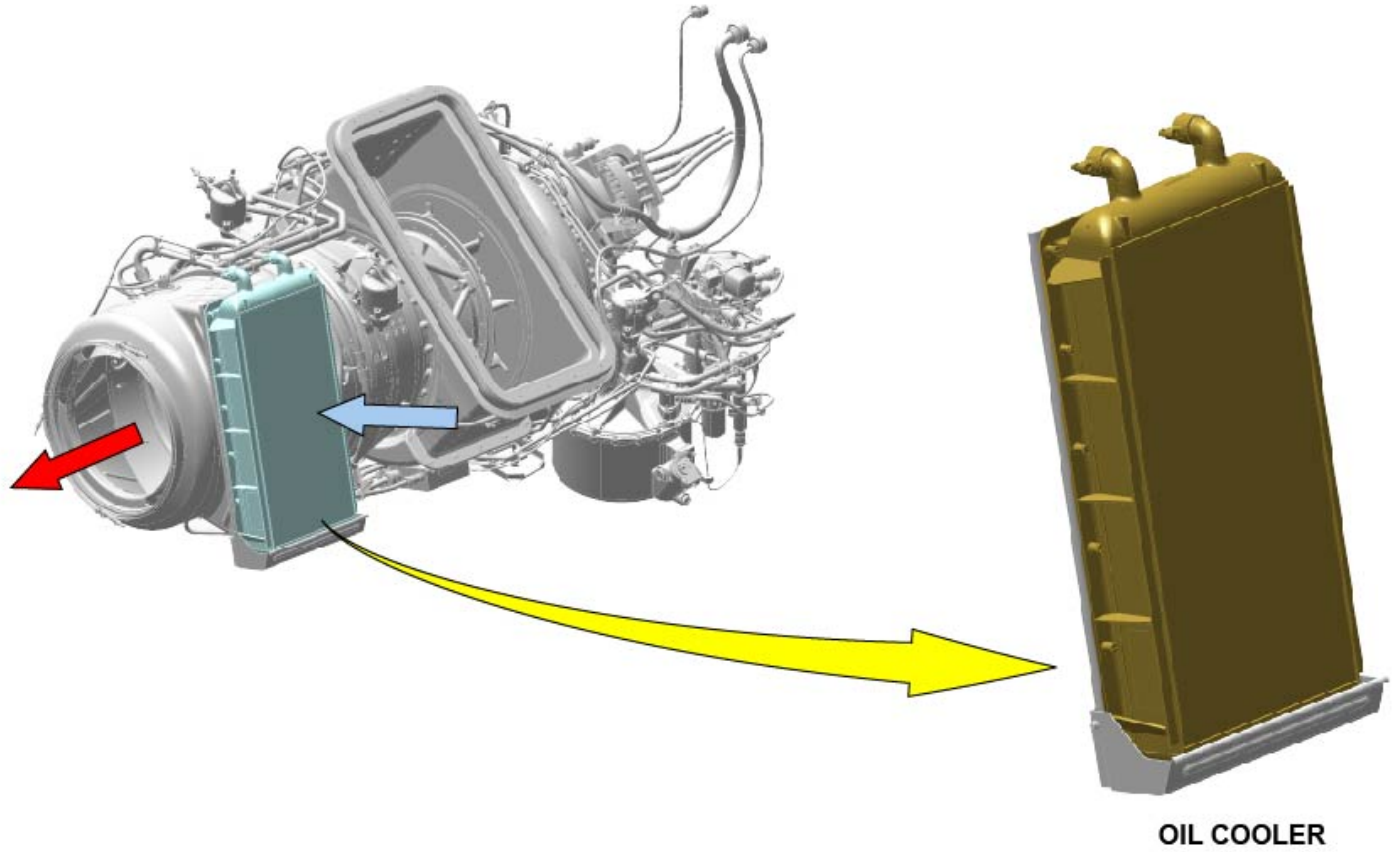

COMPONENTS DESCRIPTION - OIL COOLER

APU AIR SYSTEM DESCRIPTION (2/3)

APU Air System General Presentation

The Auxiliary Power Unit (APU) is an air source for the pneumatic system, on ground and in flight as a backup for engine bleed (up to 22 500 ft).
APU provides compressed air to the Bleed Air System (BAS).
The airflow is controlled through three components: bleed valve, surge control valve and Inlet Guide Vanes (IGV).
A compartment cooling system cools and ventilates the APU compartment. The system consists in an external air supply from a cooling duct and an air extraction with APU exhaust gas. It creates a venturi effect and extract air of APU compartment through the air/oil cooler.

APU Air Components Description

The APU air system (APU bleed air) includes the following components:
- Bleed valve
- Surge control valve
- IGVs and IGV actuator
- Pressure module including:
- Total Pressure sensor (PT)
- Differential Pressure (Delta P) sensor.
- APU air inlet temperature sensor.

Bleed Valve

The bleed valve is an ON/OFF type valve. It controls the air flow from APU bleed to the pneumatic system. The bleed valve flap is actuated by an actuator which is supplied by high pressure fuel and is controlled by a solenoid.
The valve is equipped with a feedback position transducer and a visual position indicator.

Surge Control Valve

The surge control valve is a modulating valve hydraulically actuated by fuel muscle pressure.
The surge control valve releases excess of APU bleed air to the exhaust system to prevent load compressor surge.
The valve is set based upon outlet load compressor airflow. The valve is equipped with a Torque Motor (TM) and a feedback position transducer.

IGVs and IGV Actuator

Following the pneumatic system demand, variable IGVs control the air flow to the load compressor. They are actuated by an IGV actuator which is powered by fuel pressure and controlled by a TM.
The IGV actuator is equipped with a TM and a feedback transducer.

Pressure Module

The pressure module integrates a Total Pressure sensor (PT) and a Delta P sensor (DP).
Sensors data are used to compute the airflow downstream of the load compressor to control the surge control valve.

APU Air Inlet Temperature Sensor

An APU air intake inlet temperature sensor is used in the APU air system for the IGVs position adjustment.

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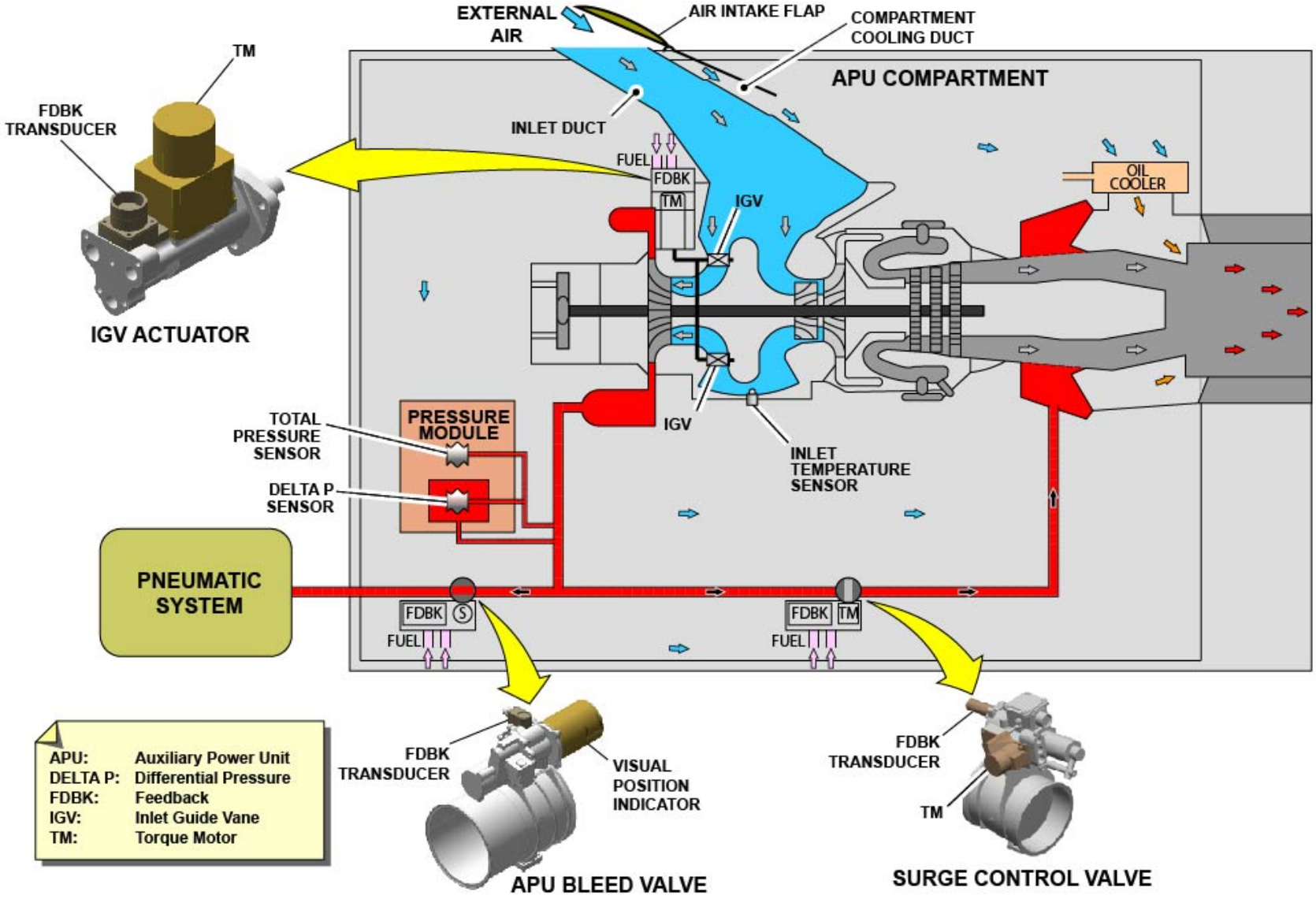


APU AIR SYSTEM GENERAL PRESENTATION & APU AIR COMPONENTS DESCRIPTION

APU AIR SYSTEM DESCRIPTION (2/3)

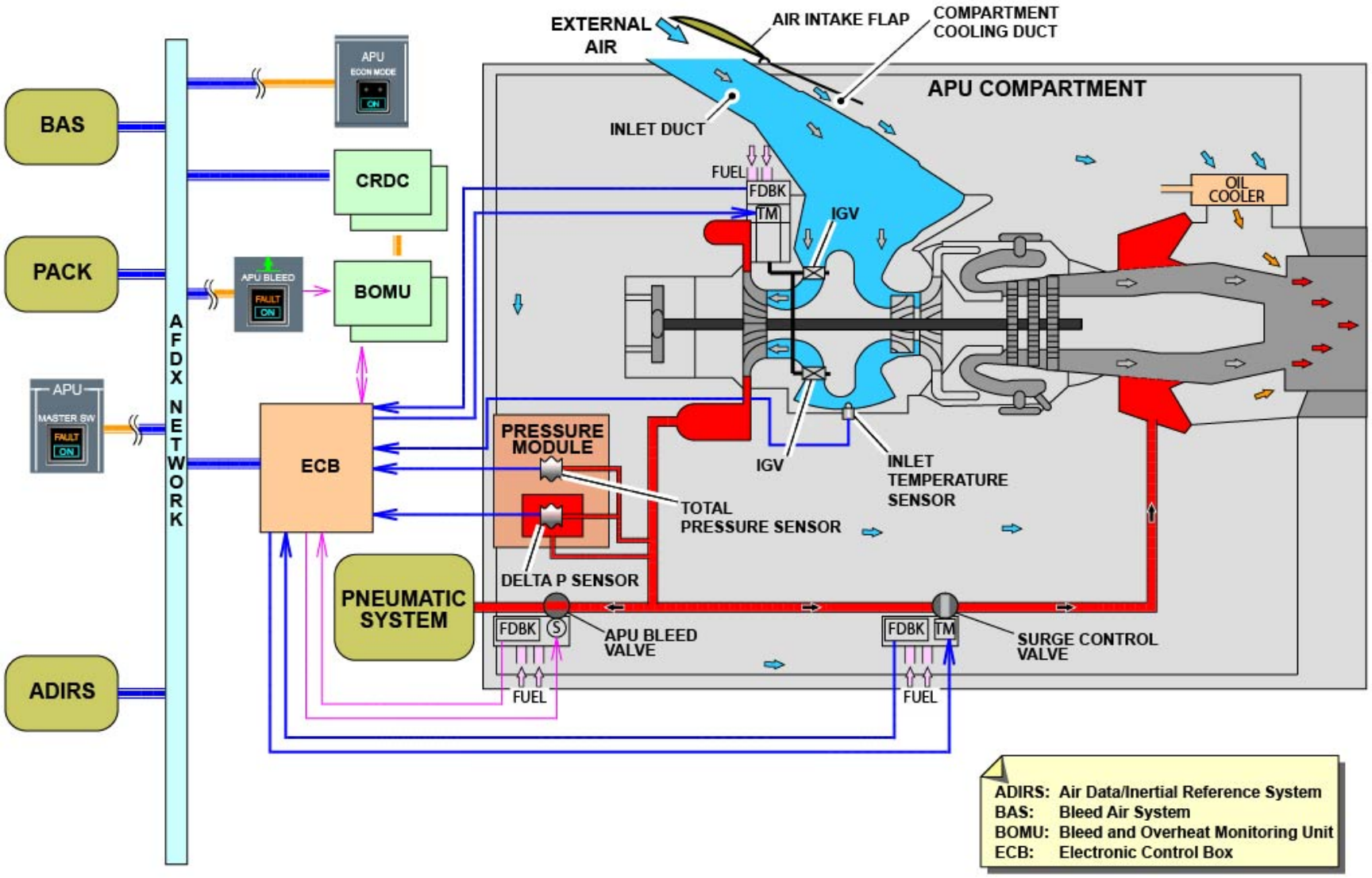
APU Bleed Air Description and Interface

The Electronic Control Box (ECB) controls the bleed valve, the IGV actuator and the surge control valve.
An APU bleed command from BAS application/CRDCs/Bleed and Overheat Monitoring Unit (BOMUs) is used by ECB to electrically energize the solenoid of the bleed valve, operated by fuel muscle pressure.
The IGVs are actuated by their actuator which is supplied by fuel muscle pressure via a TM. The control schedule of the IGVs is based on inlet air temperature and air inlet pressure provided by Air Data/Inertial Reference System (ADIRS).
The IGV controls the air flow quantity depending on air demand.
A surge control valve is controlled by ECB to avoid a load compressor surge.
In operation, the ECB uses inputs from the Total Pressure and Delta P sensors (PT/DP) to calculate the load compressor discharge airflow.
Based on this flow feedback and air demands (as PACK system) the surge control valve is adjusted in consequence.

ECON MODE

An APU ECON MODE corresponding to a dedicated cockpit P/B is used on ground only, to save fuel.
For some ground operations (with cabin door open for example) the PACK system requests lots of air from APU depending on cabin temperature selection.
Because the cabin temperature cannot be obtained, to save fuel, it is possible to select ECON MODE in the cockpit. With this selection the PACK system demand to ECB is set to the minimum.

V2414251 - V00T0MM0 - VM49D5AIR003001



APU BLEED AIR DESCRIPTION AND INTERFACE - ECON MODE

V2414251 - V00T0MM0 - VM49D5AIR003001

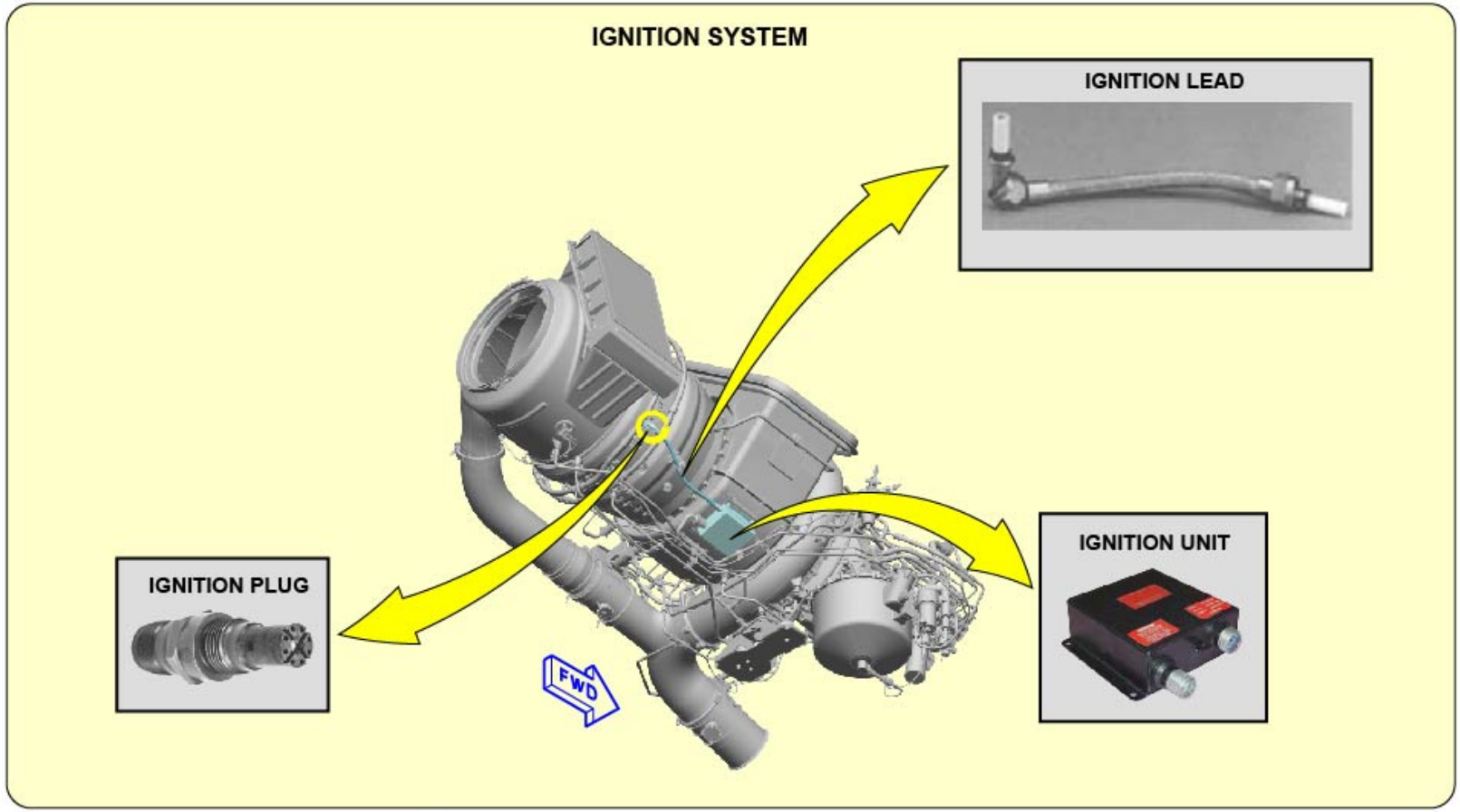
APU IGNITION AND STARTING SYSTEM DESCRIPTION (2/3)

General Presentation

Ignition

The ignition system is composed of:
- An ignition unit
- An ignition lead
- An igniter plug.

The unit delivers a high voltage pulse (more than 18,000 volts) to the igniter plug at a minimum spark rate (one spark per second).
WARNING: The ignition unit is a capacitor discharge and can keep high voltage. Make sure it is de-energized and grounded some minutes before you start working on the ignition system.



GENERAL PRESENTATION - IGNITION

APU IGNITION AND STARTING SYSTEM DESCRIPTION (2/3)

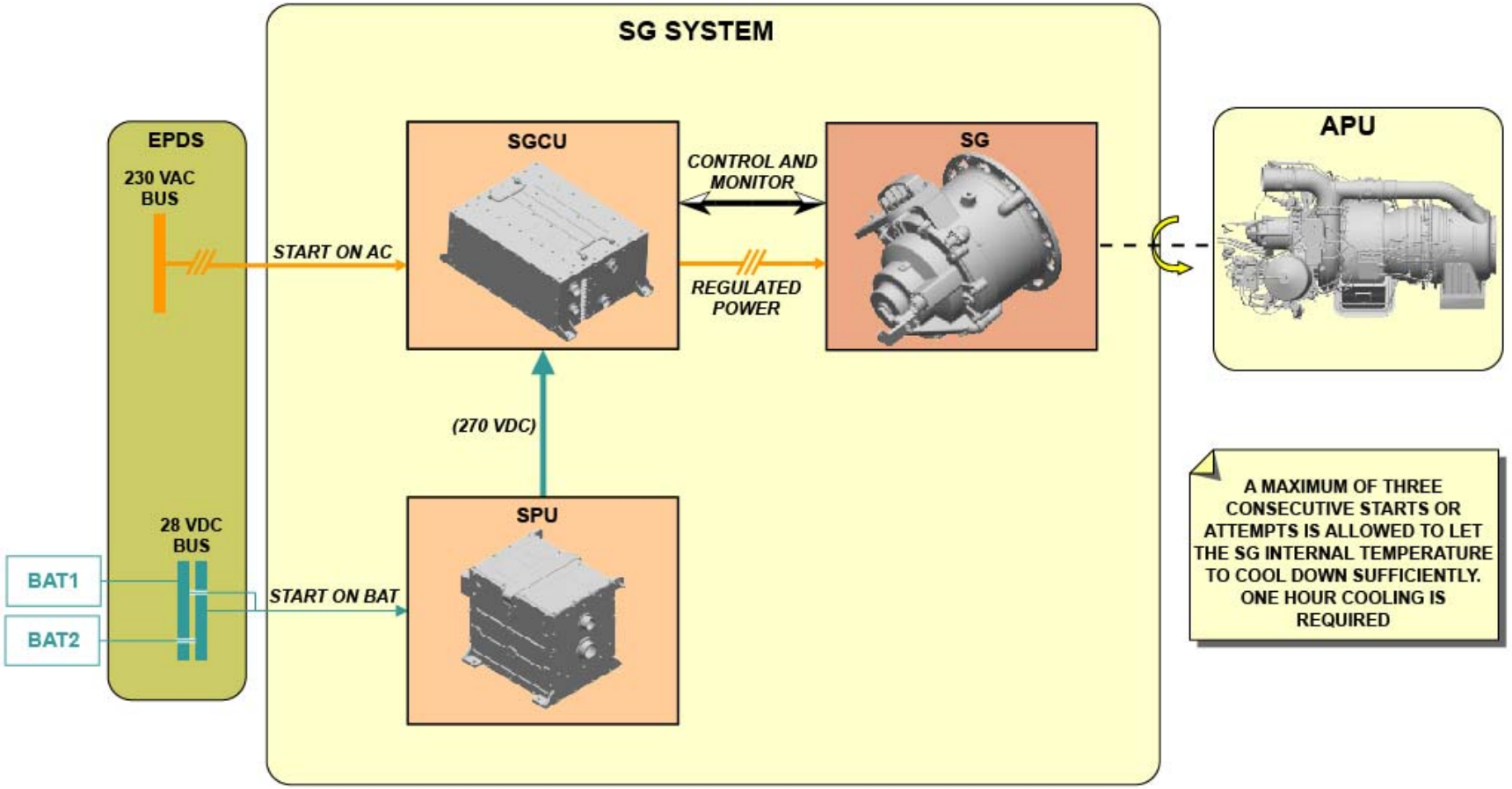
General Presentation (continued)

Starting

The starter generator system is a dual function system used to start the Auxiliary Power Unit (APU) and to provide electrical power to the A/C network when the APU is running.
The starter generator system consists of the following main elements:
- The Starter Generator (SG)
- The Start Generator Control Unit (SGCU)
- The Start Power Unit (SPU).

The SG rotates the APU shaft during start and provides electrical power supply on demand once APU is started.
The SGCU controls and monitors the SG.
Electrical power supply from the Electrical Power Distribution System (EPDS) is regulated by SGCU and sent to the SG to drive it during starting.
The SPU is used for APU start on batteries (A/C not electrically energized).
It converts batteries DC power (28VDC) into a higher DC voltage (270VDC) used by the SGCU for SG electrical supply.
NOTE: A maximum of three consecutive starts or attempts is allowed to let the SG internal temperature to cool down sufficiently. One hour of cooling is then required before another start attempt.

V2414251 - V00T0MM0 - VM49D6START3001



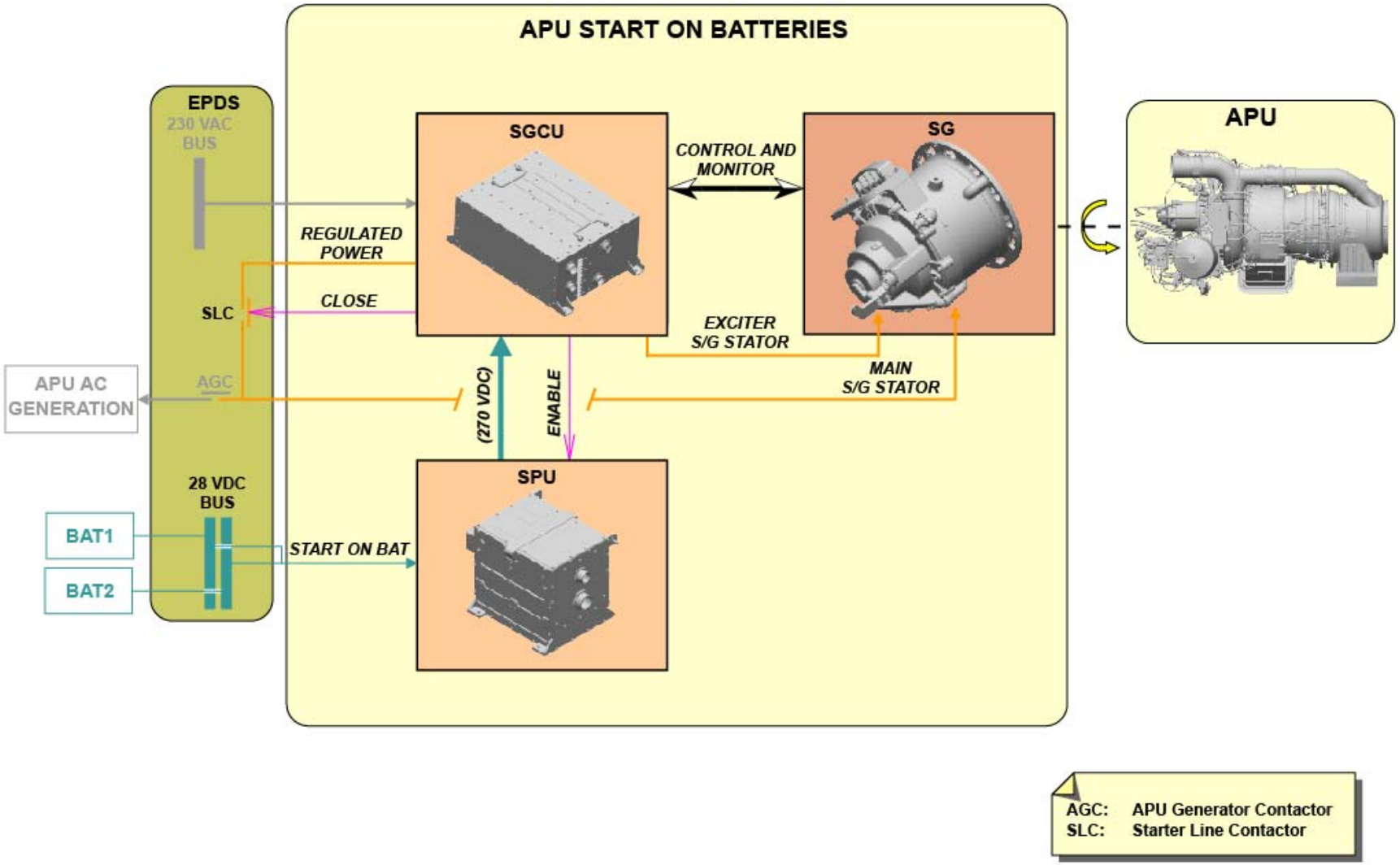
GENERAL PRESENTATION - STARTING

APU IGNITION AND STARTING SYSTEM DESCRIPTION (2/3)

Power Supply for APU Start

From Batteries

Both A/C batteries supply BAT bus, and then supply the SPU with DC power.
The SGCU sends an enable signal to activate the SPU for an APU start on batteries.
The SPU converts DC power (28VDC) into a high DC power (270VDC) and sends it to the SGCU.
The SGCU converts this high DC power into a regulated AC current (3-phase AC) used to supply the SG.
When ready, the SGCU send a signal to the EPDS to close the Starter Line Contactor (SLC).
The SGCU applies this regulated AC power (3-phase) to the SG main generator (stator winding) and an excitation power to the SG exciter generator (stator winding) in appropriate manners to generate a torque to drive the shaft.
Since the current used to start the SG is regulated, a dedicated battery for APU starting is not required.



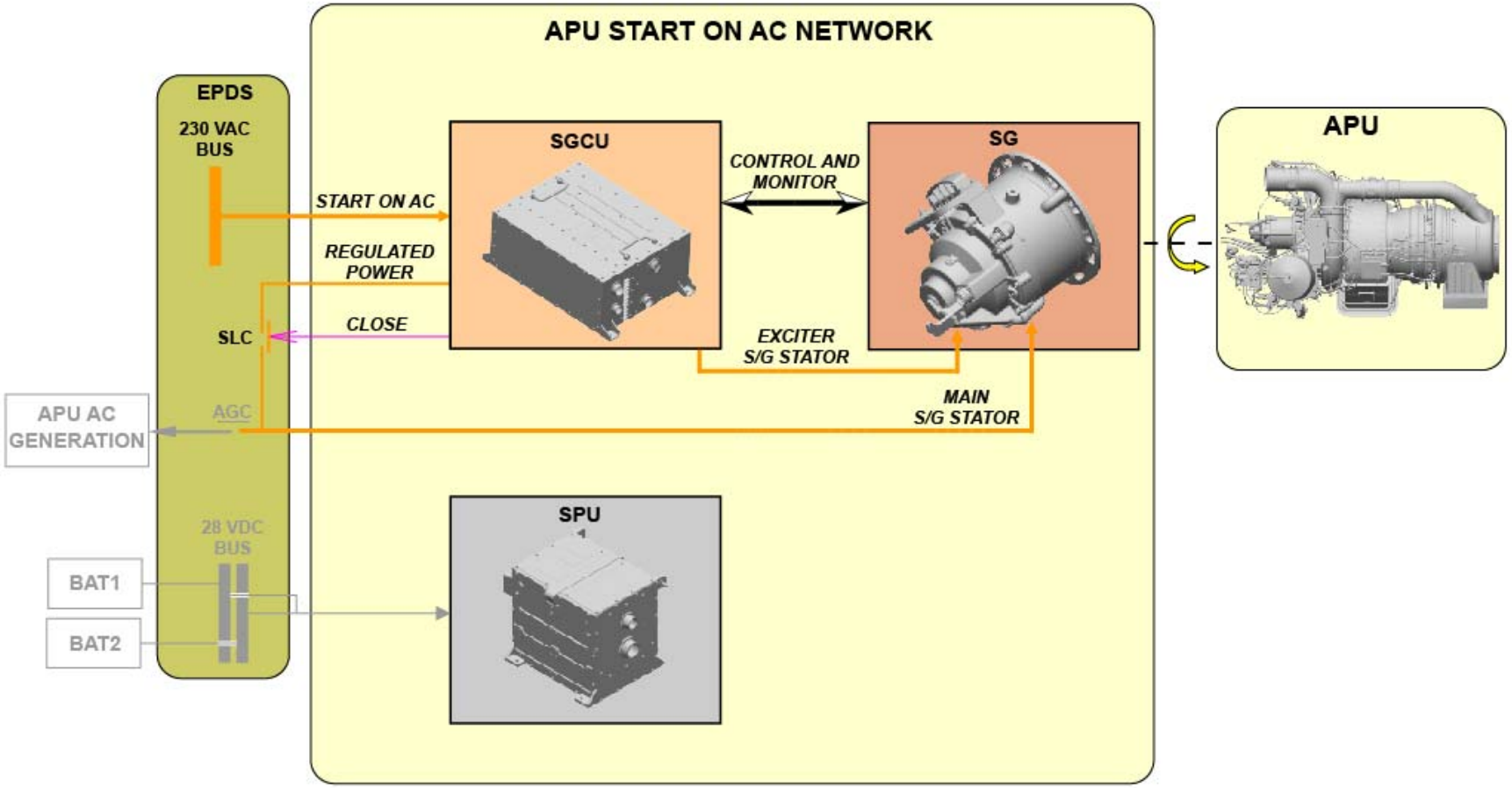
POWER SUPPLY FOR APU START - FROM BATTERIES

APU IGNITION AND STARTING SYSTEM DESCRIPTION (2/3)

Power Supply for APU Start (continued)

From AC Network

The A/C electrical network supply, through the EPDS, the AC power (230VAC) to the SGCU.
The SGCU converts this AC power into a regulated AC current (3-phase AC) used to supply the SG.
When ready, the SGCU send a signal to the EPDS to close the SLC contactor.
The SGCU applies this regulated AC power (3-phase) to the SG main stator winding and an excitation power to the SG exciter stator winding in appropriate manners to generate a torque to drive the shaft.
The SGCU selects the AC bus power source input, when available, over the DC power source from batteries.
This reduces the number of battery depletion/charge cycles, thus prolonging the battery on A/C life.



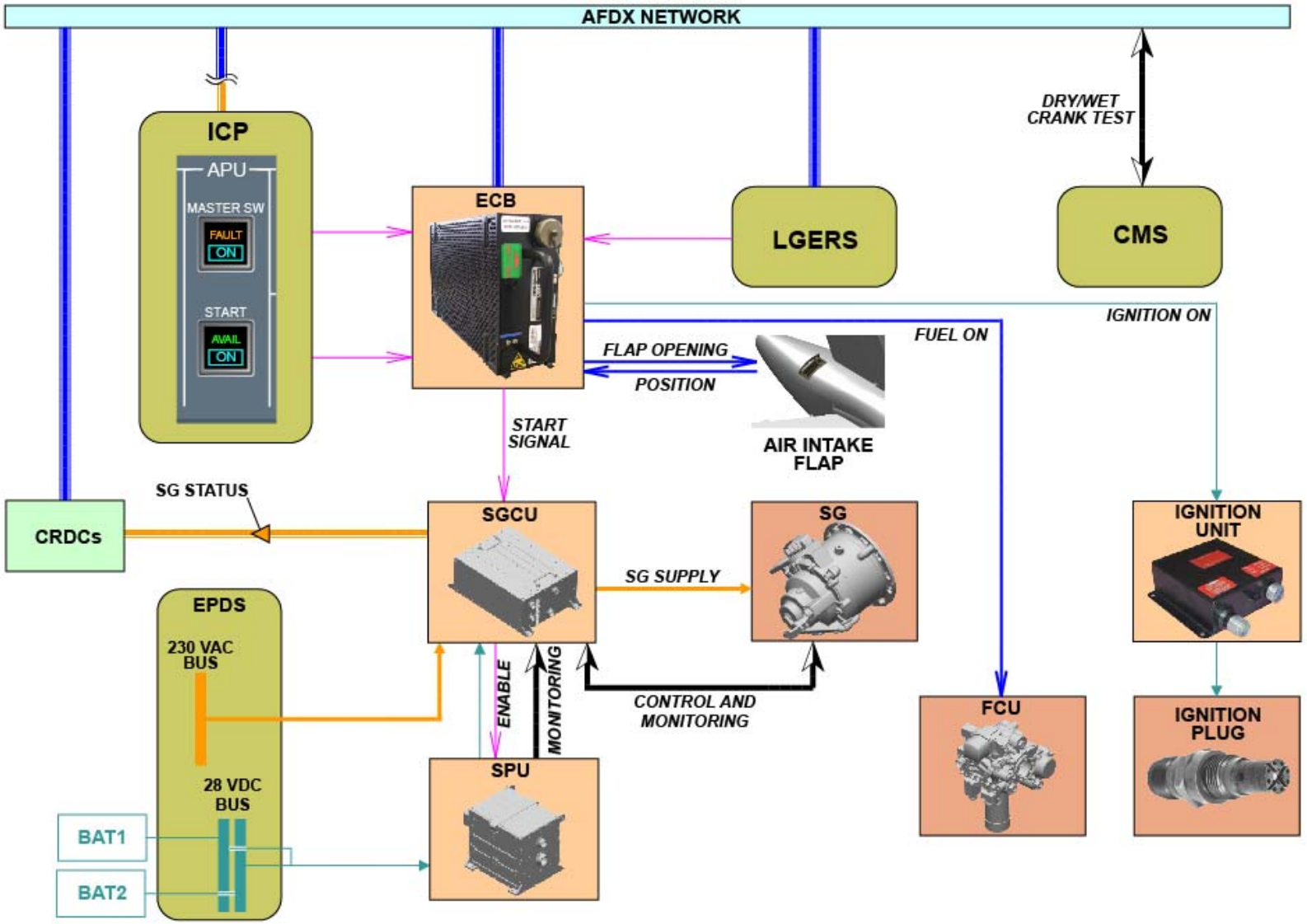
POWER SUPPLY FOR APU START - FROM AC NETWORK

APU IGNITION AND STARTING SYSTEM DESCRIPTION (2/3)

Ignition and Starting Function/Description

When the MASTER SW is set to ON, the signal is used by the ECB to open the air intake flap.
The flap is open at two different positions (45 deg GND/20 deg FLT) depending on the FLT/GND position given by the LGERS.
When, in addition to MASTER SW, the START SW is set to ON and the flap is opened, the ECB triggers the ignition ON and requests the SGCU to supply electrically the SG.
When the APU speed starts to increase (7%), the ECB sends a signal to the Fuel Control Unit (FCU) to supply fuel.
At sufficient APU speed (70%), the ECB stops ignition and send a signal to the SGCU to stop SG power supply.
The APU starting sequence finishes when the APU reach its nominal speed (100%).
The SGCU controls and monitors the SG and the SPU.
For APU start on batteries, the SGCU sends a signal to enable the SPU to convert batteries power into high DC power.
The SGCU status is monitored by ECB via CRDCs and AFDX network.
The CMS interactive test drives automatically the SG for dry or wet crank test.

V2414251 - V00T0MM0 - VM49D6START3001



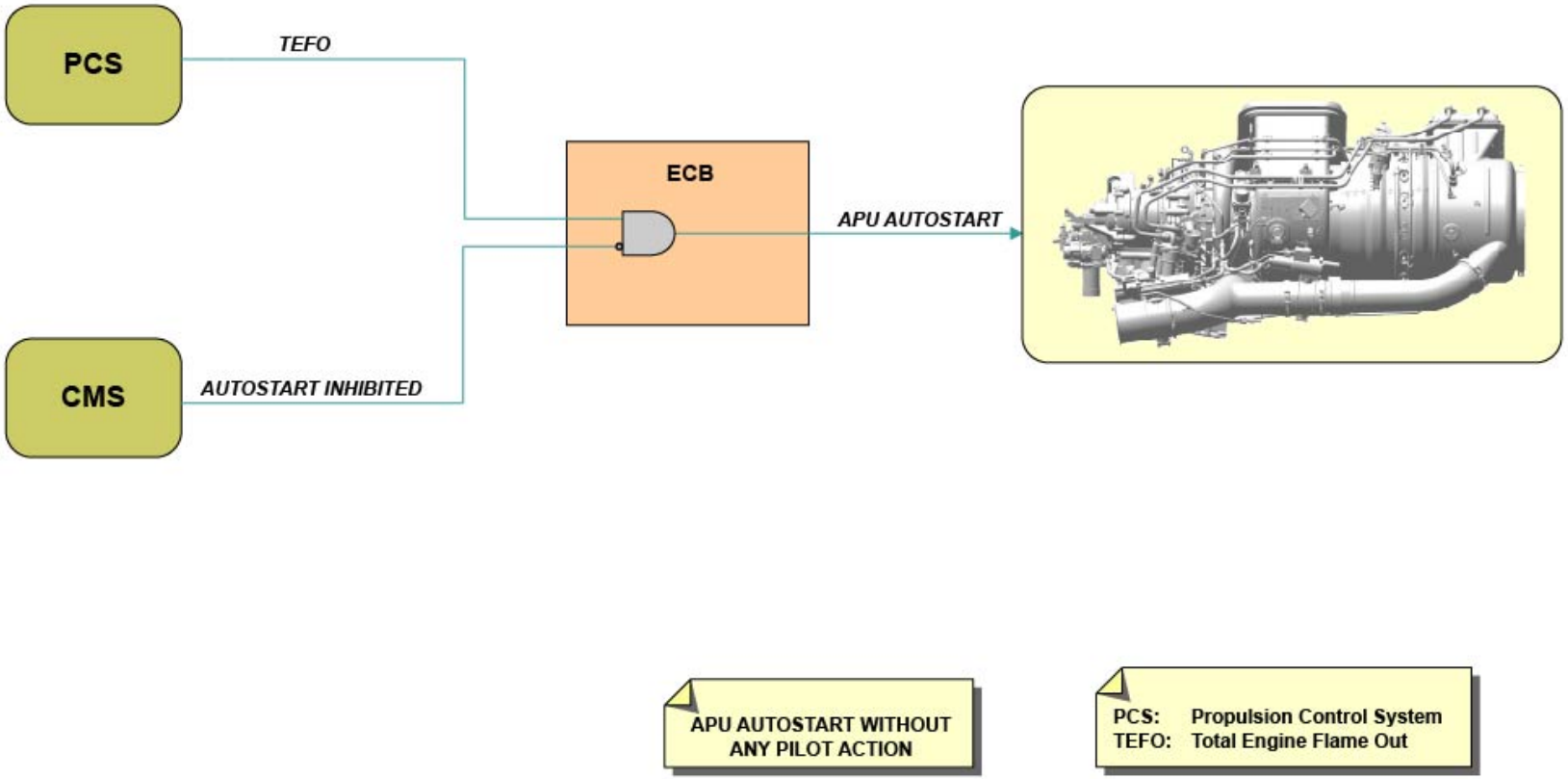
IGNITION AND STARTING FUNCTION/DESCRIPTION

APU IGNITION AND STARTING SYSTEM DESCRIPTION (2/3)

APU AutoStart In-Flight

In the event of a Total Engine Flame Out (TEFO) the APU will be started automatically without any crew action.
This APU autostart logic is active under the following conditions:
- TEFO signal is received by ECB from the Propulsion Control System (PCS)
- APU autostart function has not been inhibited via CMS interactive test.

The APU autostart sequence is the same sequence as a manual start, except no action is required from the pilot.
In case of unsuccessful APU autostart, the ECB will automatically and consecutively try a second and third start attempt.



APU AUTOSTART IN-FLIGHT

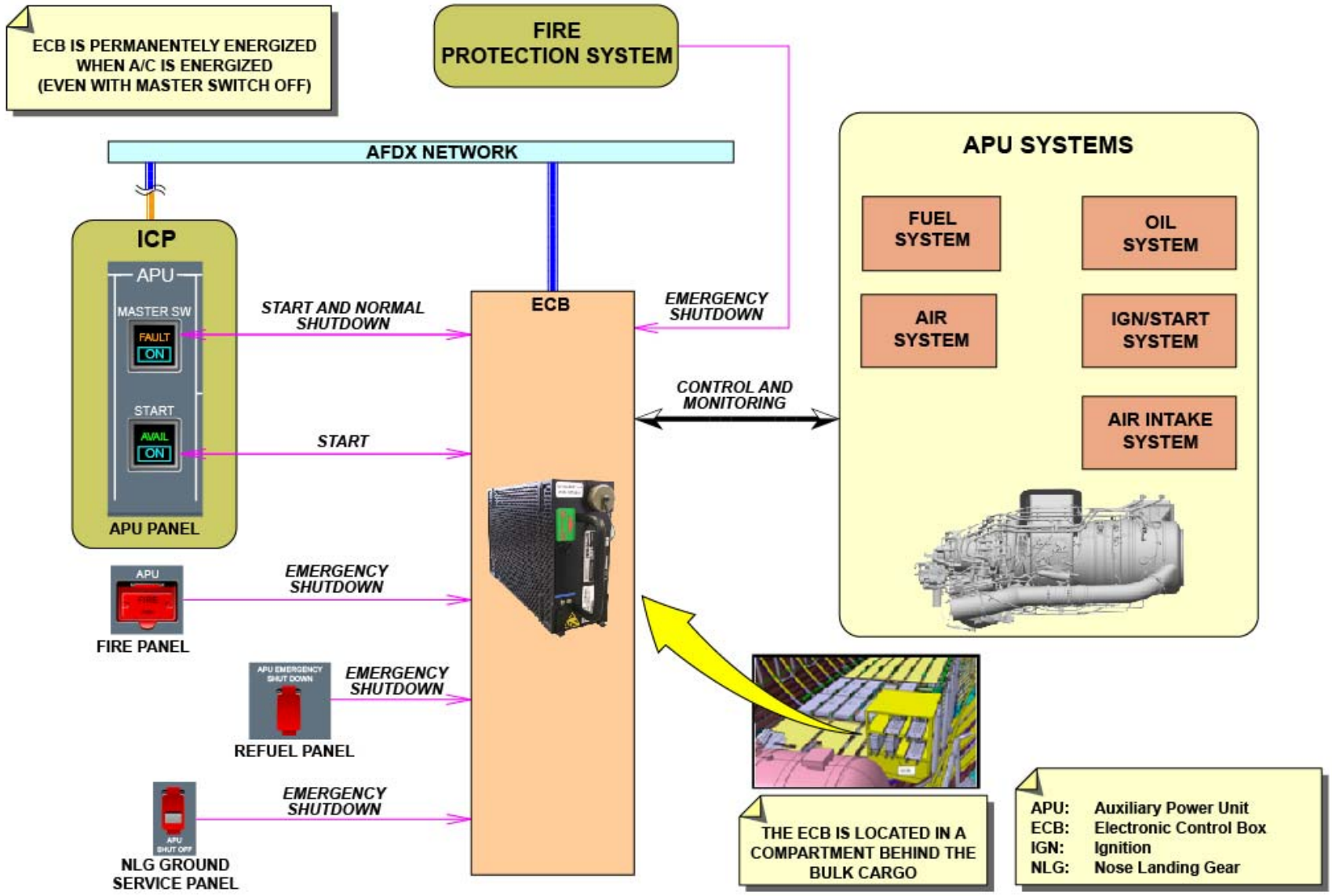
APU CONTROL AND MONITORING DESCRIPTION (2/3)

Electronic Control Box

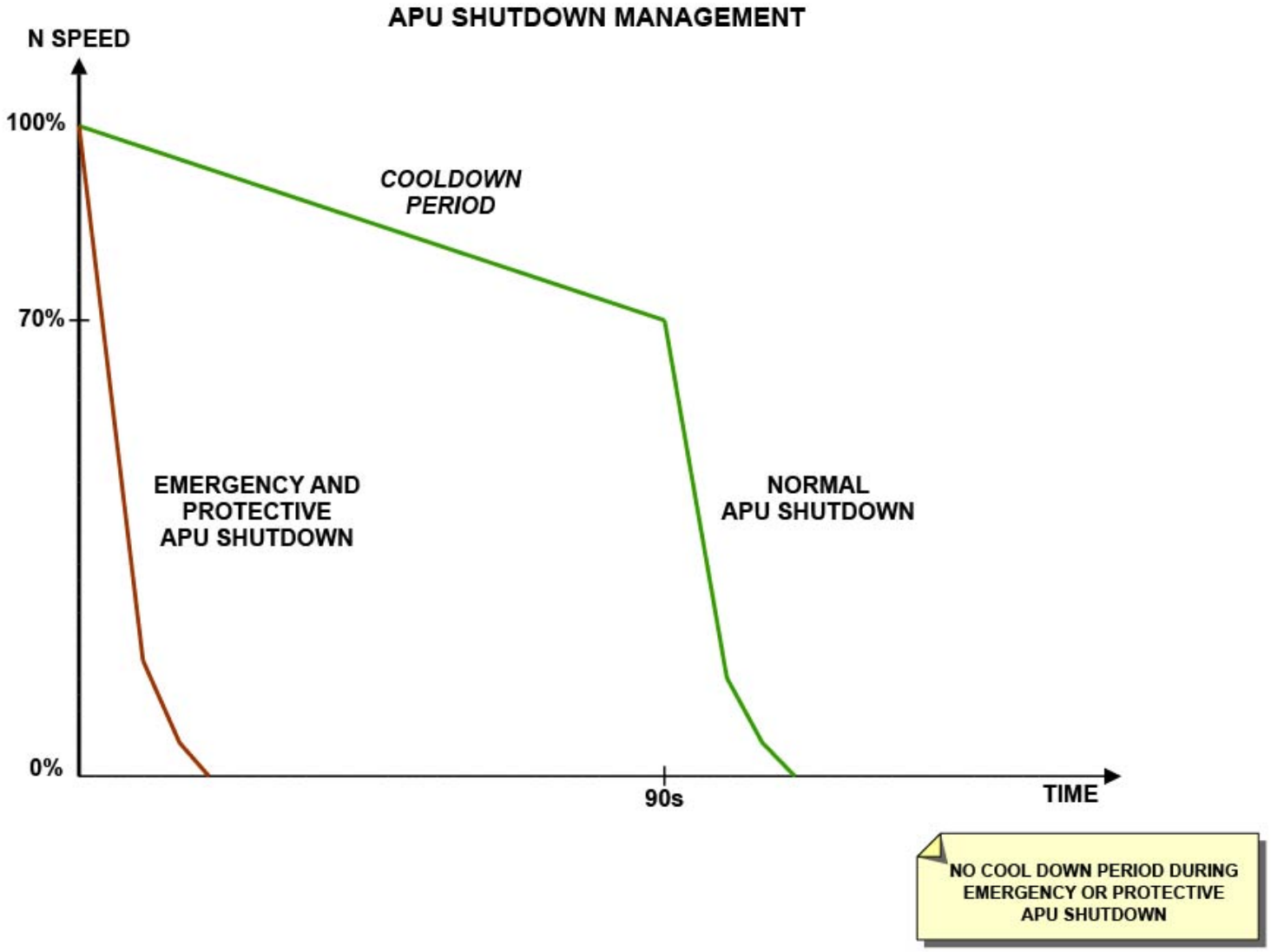
The Auxiliary Power Unit (APU) is controlled and monitored by an Electronic Control Box (ECB).
The ECB is a full-authority digital controller.
The ECB is installed in the compartment located rearward of the bulk cargo compartment.
The ECB is a part of the APU system and governs all APU operations, including starting and shutdown sequences.
The ECB controls the APU with following components and systems interfaces:
- Cockpit controls: MASTER SW, START SW, FIRE P/B
- Integrated Refuel Panel (IRP): EMERGENCY SHUTDOWN toggle SW
- Nose Landing Gear (NLG) control panel: EMERGENCY SHUTDOWN toggle SW
- Fire Protection System (FPS).

Start
APU MASTER SW and START SW are used by ECB to trigger an APU start.
Normal Shutdown
APU MASTER SW is also used by ECB for a normal APU shutdown.
Emergency Shutdown
APU FIRE P/B, IRP and NLG panels emergency SWs send a signal to the ECB to trigger an emergency APU shutdown.
On GND, in case of an APU fire detection, the FPS sends a signal to the ECB to trigger an emergency APU shutdown.
Protective Shutdown
The ECB controls and monitors all systems components used for air, oil, fuel, Ignition (IGN)/starting, air intake (flap actuator) systems.
The ECB can trigger a protective shutdown on GND if a major parameter goes out of range (ie, oil pressure too low).
In flight, the protective shutdowns are inhibited except major failures (ie, overspeed, major ECB failure).
On GND, when the A/C is energized, the ECB is permanently energized, even with MASTER SW OFF.
When a normal APU shutdown is requested, the ECB decreases slowly the APU speed (from 100% to 70%) for a cooldown period of approximately 90 seconds. The APU is then shutdown by cutting off the fuel supply.
When a manual or automatic emergency APU shutdown is requested, or a protective APU shutdown is initiated by ECB, the APU is shutdown immediately without cooling period.

V2414251 - V00T0MM0 - VM49D7CTLMO3001



ELECTRONIC CONTROL BOX



ELECTRONIC CONTROL BOX

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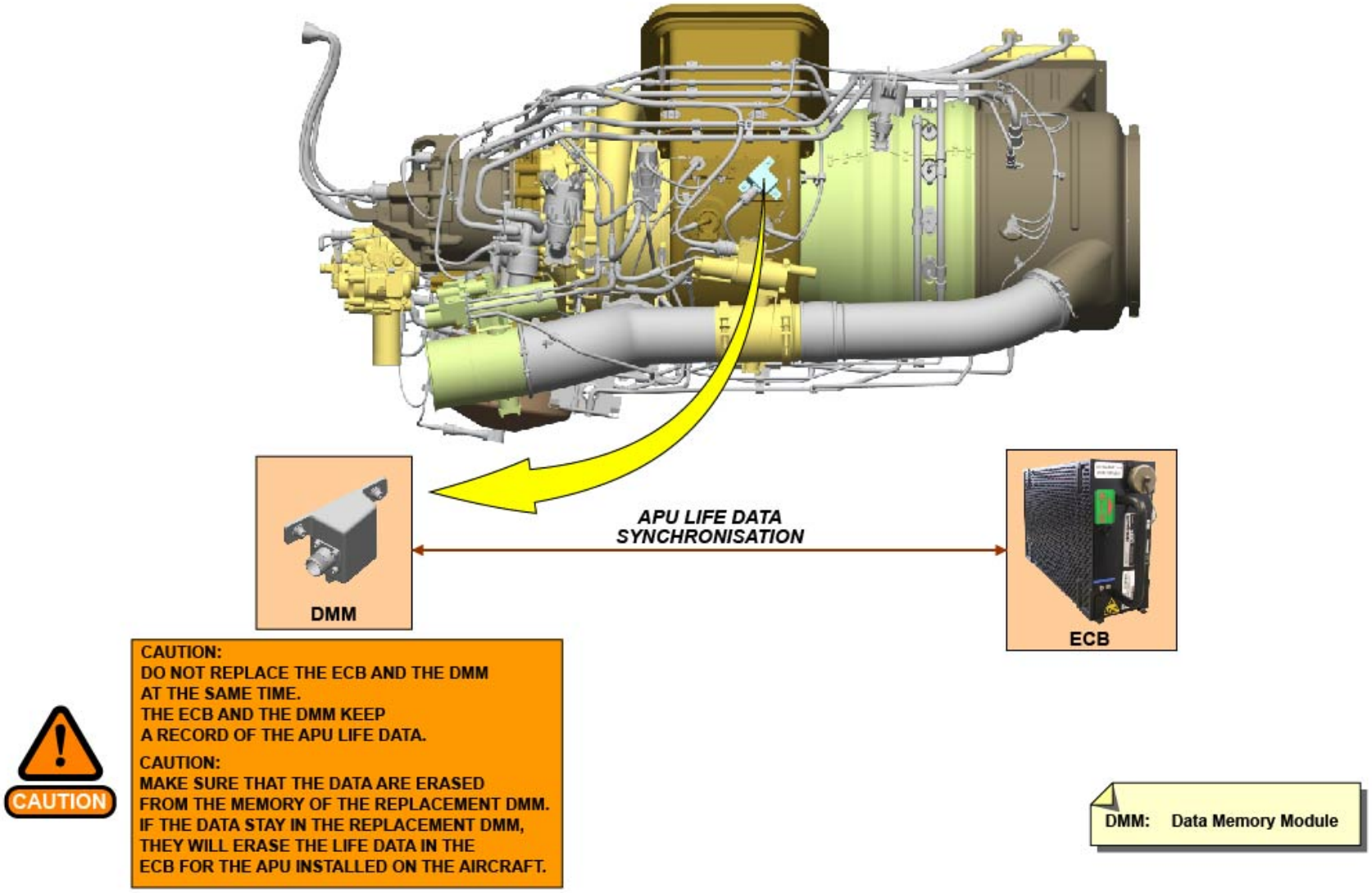
APU CONTROL AND MONITORING DESCRIPTION (2/3)

Data Memory Module

The Data Memory Module (DMM) is a non-volatile memory device used to store information regarding the health monitoring and life data of the APU, the serial number, operating hours, start cycles, fault history, and performance parameters.
The same information are also stored inside the ECB memory.
Once installed on the A/C, the DMM data is updated by the ECB each time the APU is operated.
When a new ECB is installed on A/C, the DMM transmits its memory to the new ECB.
When a new DMM is installed, the ECB transmits necessary data to the new DMM.
To keep APU data, never replace the DMM and the ECB at the same time and never install a DMM with a memory not cleared.

V2414251 - V00T0MM0 - VM49D7CTLMO3001

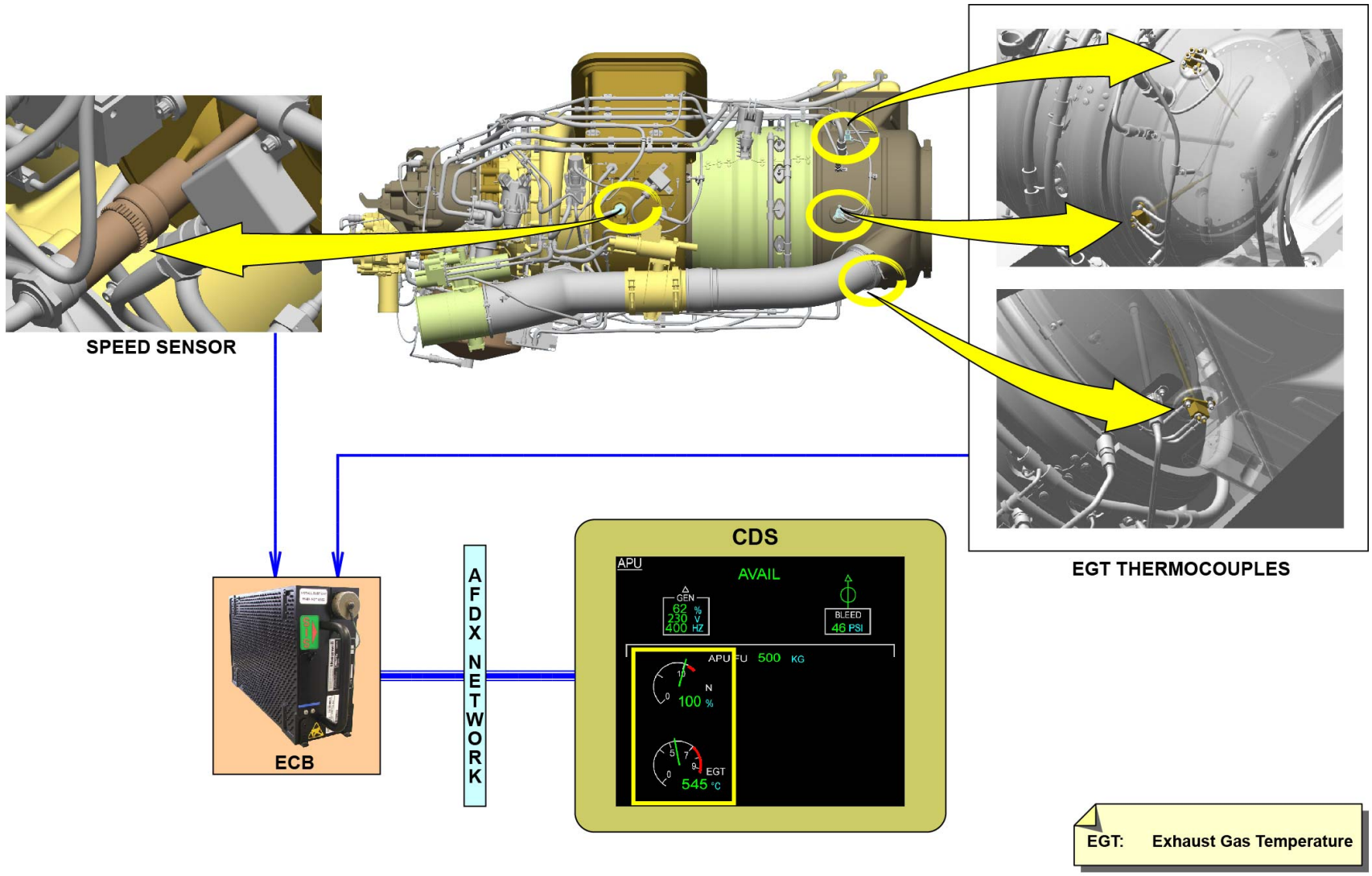


DATA MEMORY MODULE

APU CONTROL AND MONITORING DESCRIPTION (2/3)

Speed and EGT Sensors

Three Exhaust Gas Temperature (EGT) thermocouples measure the APU exhaust gas downstream the turbine, for APU monitoring and control by ECB.
The EGT thermocouples are connected to the ECB and EGT value is displayed on ECAM APU SD page.
A speed sensor measures the APU shaft speed.
The sensor is connected to the ECB for APU monitoring and speed indication on ECAM APU SD page.



SPEED AND EGT SENSORS

APU CONTROL AND INDICATING (2)

APU System - General (2)

APU Start and Shutdown with External Power (2)

The following cockpit APU controls are located on the overhead panel:
- Both, APU MASTER SW and START P/Bsw are located on the APU panel.
- The APU GEN P/Bsw is located on the ELEC panel.
- The APU BLEED P/Bsw is located on the AIR panel.
- The APU FIRE P/B located on the ENG/APU FIRE panel.

The following parameters are displayed on the APU System Page:
- The Shaft speed (N),
- Exhaust Gas Temperature (EGT),
- The Fuel Used (FU),
- The flap messages: "FLAP MOVING", "FLAP OPEN", "FLAP CLOSED"
- The APU AVAIL message: the APU is running,
- The APU GEN parameters,
- The APU BLEED valve position and current pressure.

Two APU memos can be displayed on the Warning Display (WD):
- The APU AVAIL message, when APU running.
- The APU BLEED message, When APU supplies Bleed air to pneumatic sytem.

APU system page messages:
- In case of an APU fuel low pressure detected, the amber warning message "FUEL PRESS LO" is displayed on SD APU page.
- In case of the APU oil quantity is detected low, "OIL LVL LO" pulses in green on SD APU page.

APU Start sequence:
When the MASTER SW pushbutton is set to ON:
- The ON light of MASTER SW comes on blue
- The APU page appears on the SD
- The APU Electronic Control Box (ECB) is energized from A/C circuits.
- "FLAP MOVING" then "FLAP OPEN" indications appear in green.

When the START pushbutton is set to ON:
- The APU start sequence begins
- At N speed above 95% , on the START P/B, ON blue light goes off and AVAIL green light comes on.
- The ON light of MASTER SW remains illuminated.
- The APU AVAIL memo appears in green on the WD.

APU Shutdown sequence:
When the MASTER SW pushbutton is set to off:
- The ON light of the MASTER SW goes off
- The AVAIL light of the START pushbutton goes off
- The APU Bleed valve closes (if open)
- A cooling period of around 90 seconds begins including a decreasing speed schedule down to 70%.
- Fuel supply to the APU stops and APU shuts down
-The air-intake flap closes

The following parameters are displayed on the APU System Page:
- The Shaft speed (N),
- Exhaust Gas Temperature (EGT),
- The Fuel Used (FU),
- The flap messages: "FLAP OPEN", "FLAP MOVING", "FLAP CLOSED" (for 10s)
- The APU AVAIL message: the APU is running (APU speed >95%),
- The APU GEN parameters,
- The APU BLEED valve position and current pressure.

Two APU memos can be displayed on the Warning Display (EWD):
- The APU AVAIL message, when APU running.
- The APU BLEED message, When APU supplies Bleed air.

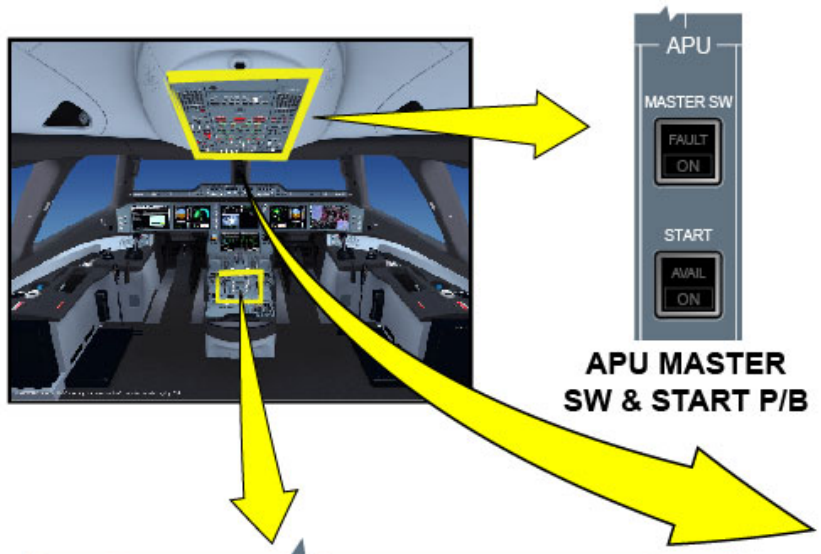
APU system page messages:
- In case of an APU fuel low pressure detected, the amber warning message "FUEL PRESS LO" is displayed on SD APU page.
- In case of the APU oil quantity is detected low, "OIL LVL LO" pulses in green on SD APU page.

APU Start and Shutdown on Batteries (2)

APU Emergency Shut Down (no cool down period):
There are two APU external shutdown controls:
- The APU SHUT OFF P/B located on the External Nose Gear panel.
- The APU EMERGENCY SHUTDOWN P/B located on the Integrated Refuel Panel (IRP).
When the APU EMERGENCY SHUTDOWN P/B is selected:
- The single chime sounds
- The MASTER CAUTION light illuminates
- EWD displays "APU FAULT" in amber with associated message "EMER SHUTDOWN"
- FAULT light illuminates on APU master switch.
- The APU Bleed valve closes (if open)
- Fuel supply to the APU stops and APU shuts down
-The air-intake flap closes
-The ECB is de-energized from A/C circuits.

APU Oil Level Low (2)

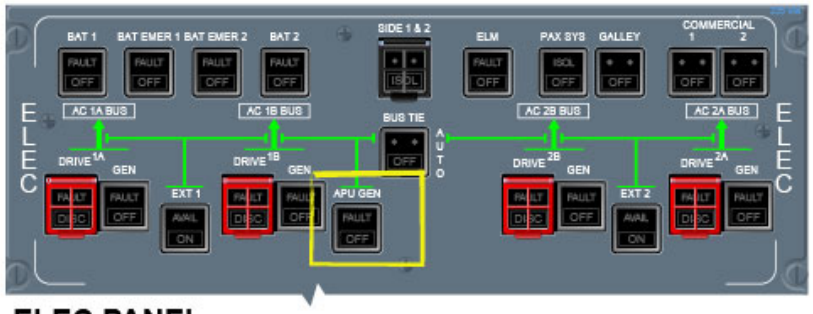
On ground, when the APU MASTER SW is pressed ON and APU not running, the ECB uses an oil level sensor to monitor the oil level.
The ECB generates dedicated message at two different levels:
- Measurement Point number 1 (ADD+60): The APU can operate for 60 hours at normal oil consumption before the "ADD" mark.
- Measurement Point number 2 (ADD): At the "ADD" mark, it shows the low oil-level condition.
If the oil level is below the ADD+60 indication, the CMS receives the message "CHECK APU OIL".
When the oil level falls below the ADD indication, the ECB transmits a low oil-level condition Failure message to the CMS.
The CDS then shows the advisory legend "OIL LVL LO" pulsing in green on the APU page.



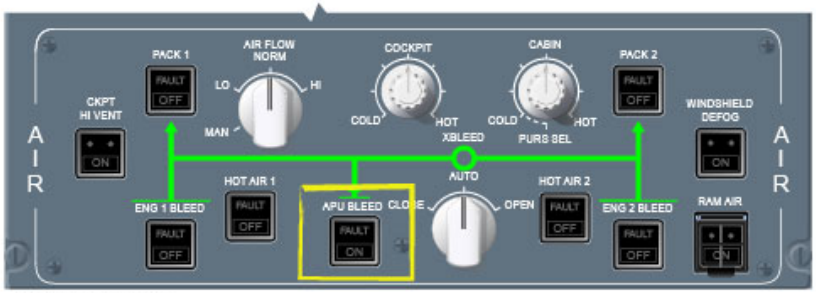
APU MASTER SW & START P/B

ECAM CONTROL PANEL

ENG / APU FIRE PANEL

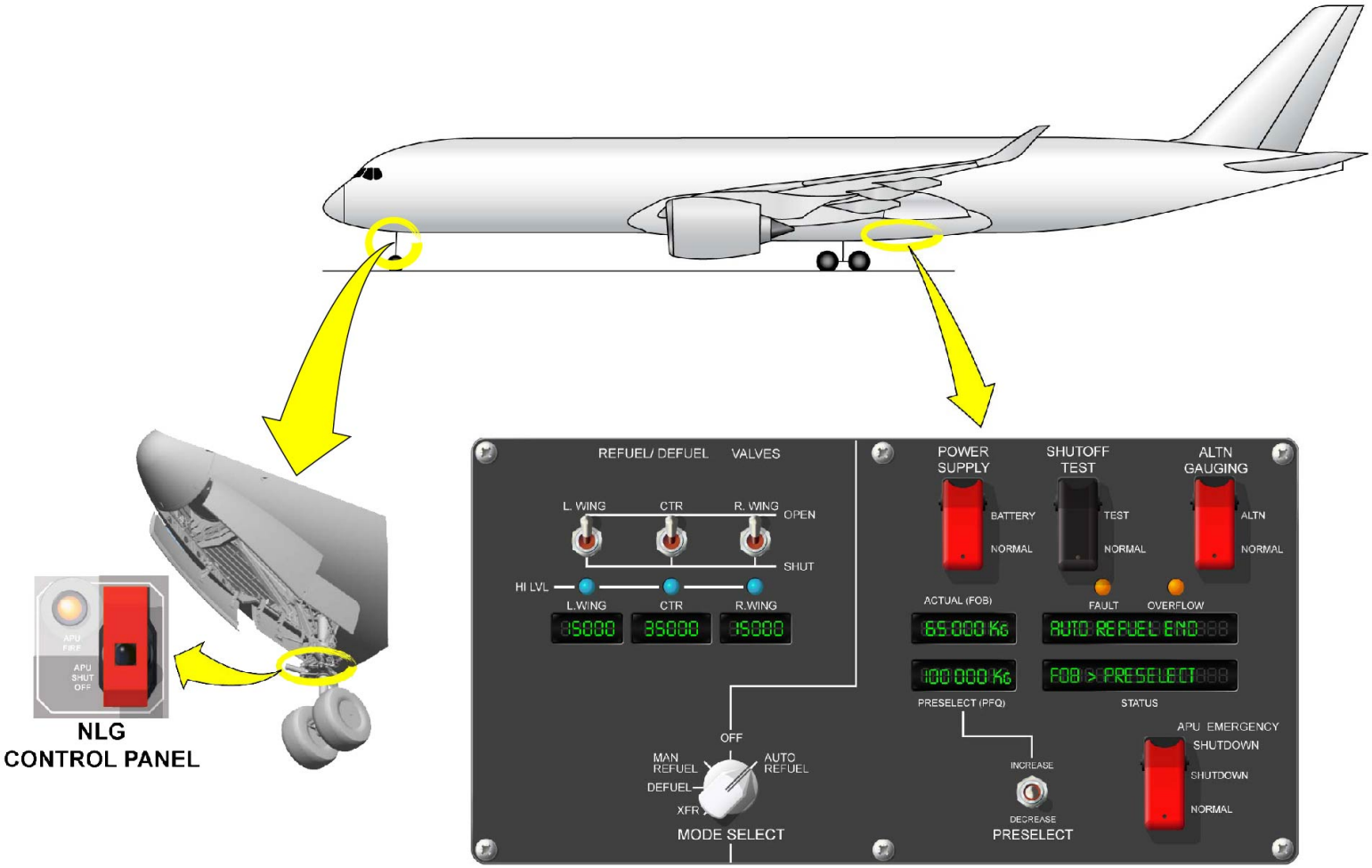


ELEC PANEL

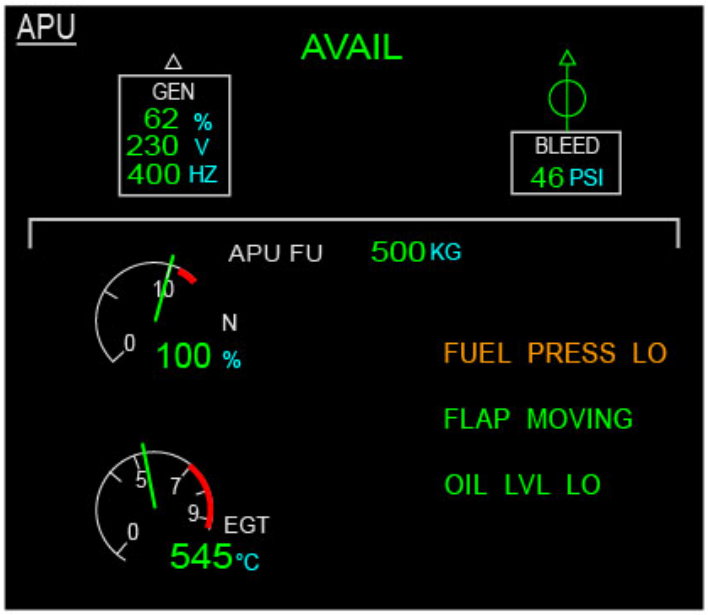


AIR PANEL

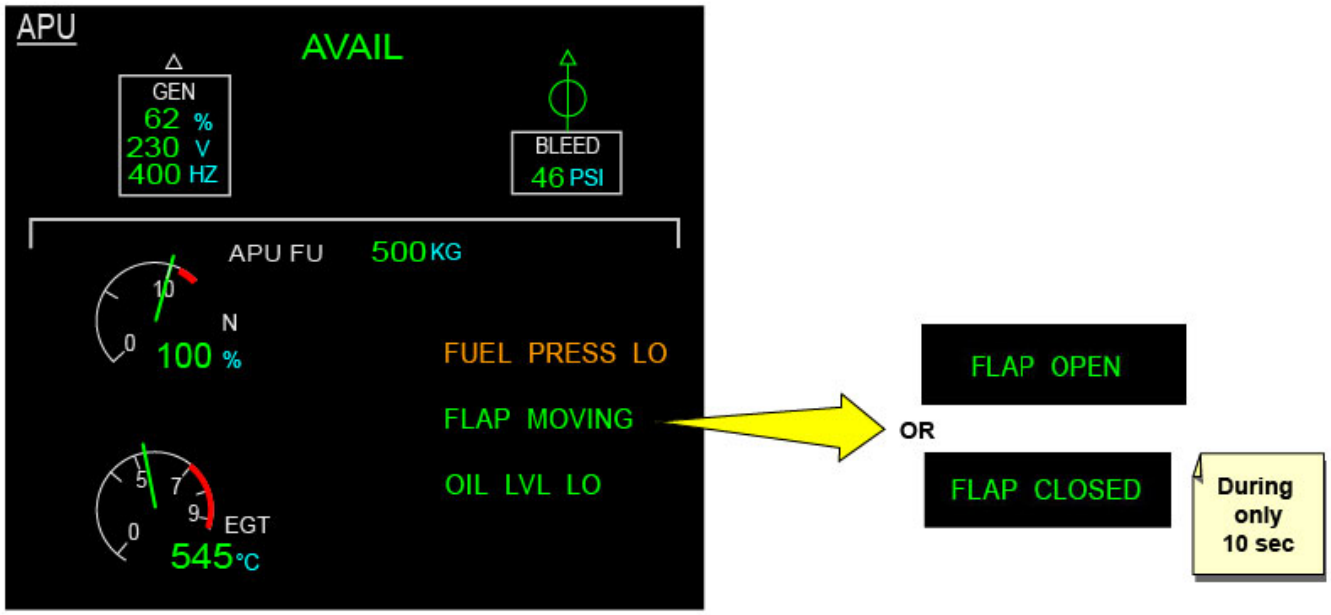
APU SYSTEM - GENERAL (2) ... APU OIL LEVEL LOW (2)



INTEGRATED REFUEL PANEL



ABNORMAL APU SD PAGE



ABNORMAL APU SD PAGE

APU SYSTEM - GENERAL (2) ... APU OIL LEVEL LOW (2)

APU CONTROL AND INDICATING (3)

APU Start Fault (3)

In case of APU Fault occurring during a normal starting procedure, the ECB automatically aborts the start sequence and the following cockpit effects are triggered:
- Single Chime sounds,
- MASTER CAUT lights,
- FAULT light on APU MASTER SW,
- APU FAULT amber warning on WD,
- APU SD page automatic call selection.

APU Flap Not Fully Closed After Shutdown (3)

During an APU normal shut down, after approximately 90 seconds of cool down, when the APU speed decreases to 7%, the inlet flap is commanded to close.
In case the APU inlet flap is not confirmed fully closed, the FAP MOVING indication remains on APU page and corresponding cockpit effect are triggered.

APU Auto Shutdown (3)

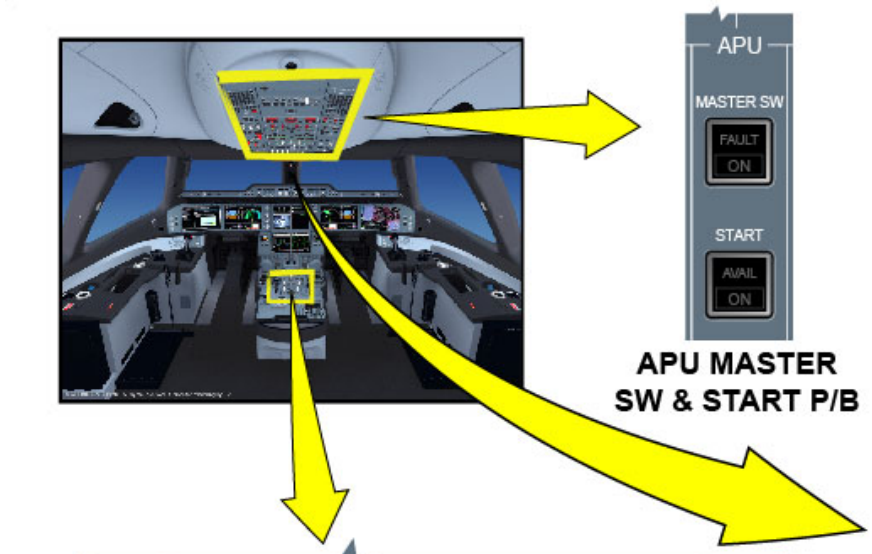
APU Protective Shutdown:
Each protective shutdown signal results in immediate APU shutdown by energizing the FCU shutdown solenoid.
The cause of any protective shutdown is stored in the DMM and ECB.
When a protective shutdown is initiated, there is no cool down period.
In case of APU overspeed detected (on ground or in flight), an APU auto shutdown occurs with the following cockpit effects
- Single Chime
- MASTER CAUT lights illuminated
- APU FAULT triggered on WD with AUTO SHUTDOWN amber message
- FAULT light illuminated on APU MASTER SW
- APU SD page automatic call out

APU Emergency Shutdown

In case of an abnormal operation of APU, an APU emergency shut-down must be done immediately.
You can initiate the emergency shutdown from:
- the cockpit APU FIRE P/B on ENG/APU FIRE panel,
- the external APU SHUT OFF switch on the NLG ground service panel,
- the external APU EMERG SHUT DOWN switch on the IRP.

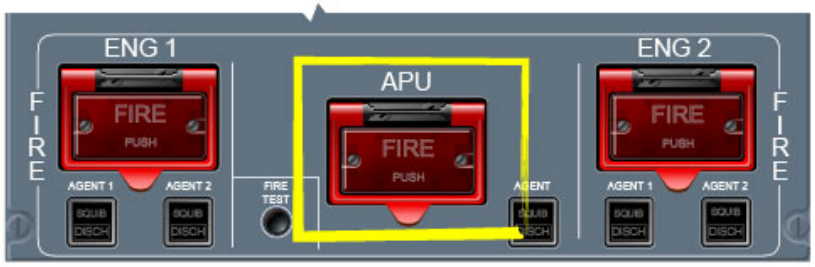
When an Emergency shut-down is initiated from the cockpit or the external controls, the following occurs:
- The single chime sounds
- The MASTER CAUTION light illuminates
- EWD displays "APU FAULT" in amber with associated message "EMER SHUTDOWN"
- FAULT light illuminates on APU master switch.
- The APU Bleed valve closes (if open)
- Fuel supply to the APU stops and APU shuts down
-The air-intake flap closes.

V2414251 - V00T0MM0 - VM49I2000003001

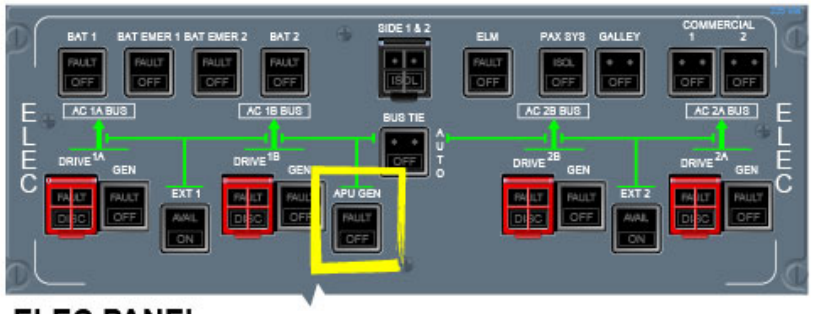


APU MASTER SW & START P/B

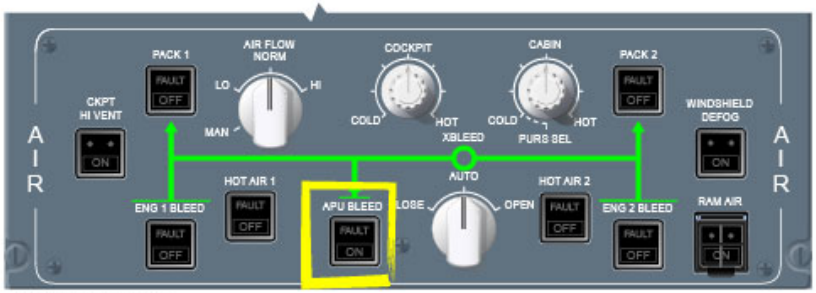
ECAM CONTROL PANEL



ENG / APU FIRE PANEL

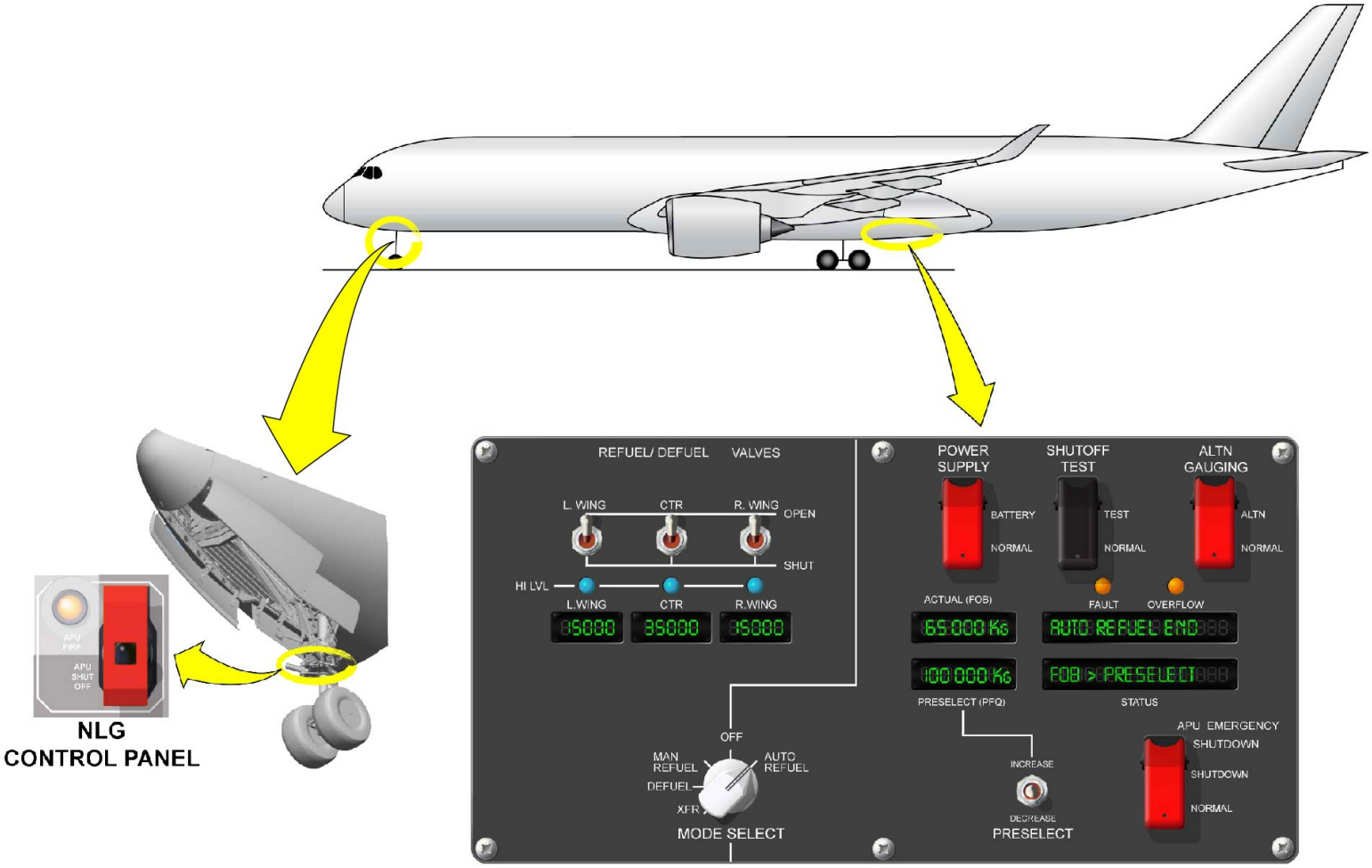


ELEC PANEL

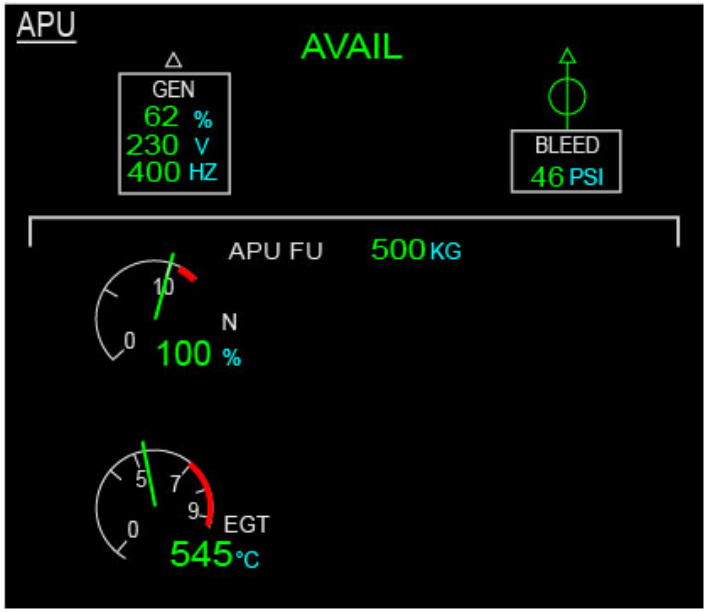


AIR PANEL

APU START FAULT (3) ... APU EMERGENCY SHUTDOWN

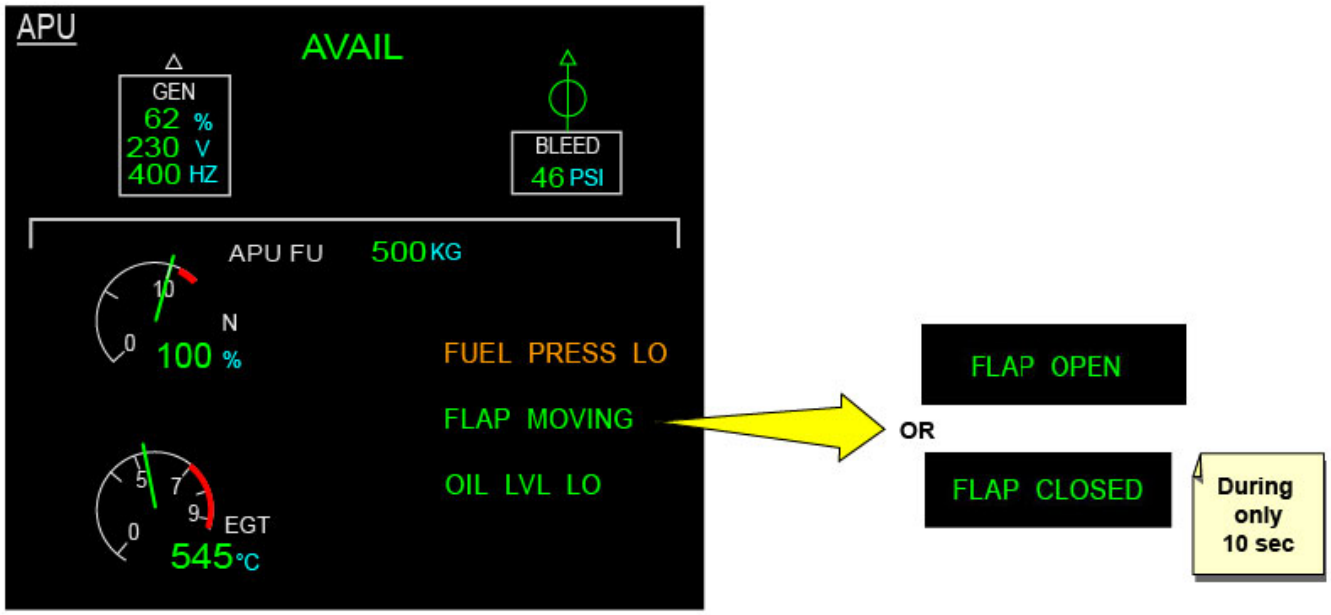


APU START FAULT (3) ... APU EMERGENCY SHUTDOWN



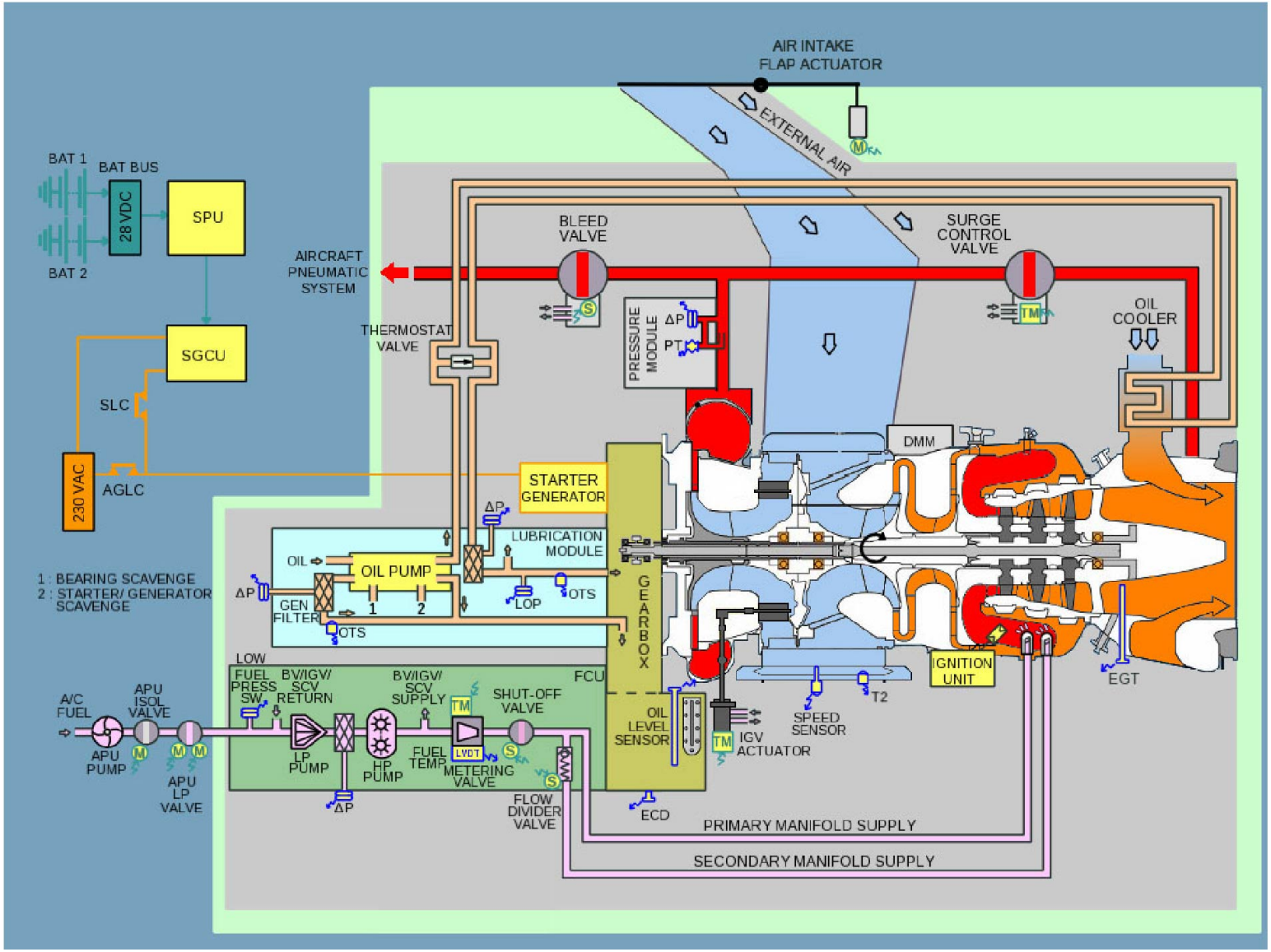
SD APU PAGE

APU START FAULT (3) ... APU EMERGENCY SHUTDOWN



ABNORMAL APU SD PAGE

APU START FAULT (3) ... APU EMERGENCY SHUTDOWN



APU START FAULT (3) ... APU EMERGENCY SHUTDOWN

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