A330-200
TECHNICAL TRAINING MANUAL

MECHANICS / ELECTRICS & AVIONICS COURSE

49 APU

GE Metric

For Training Purposes Only
Issued By SPL/GK March 2006

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Under no circumstances
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APU PRESENTATION

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Engine
Oil
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GENERAL

The APU is a Model GTCP 331-350 designed by Garrett.
The APU is an independant source of pneumatic and electrical power. It can be used in flight and on ground.

ENGINE

The APU is a single shaft type engine which produces the energy used to drive the load compressor and the accessory gearbox.
The engine is composed of :

- a dual stage centrifugal compressor
- a reverse flow combustion chamber
- a three stage axial turbine.

The combustion chamber is equipped for the installation of dual fuel nozzles and two ignitor plugs.

OIL

The self contained oil system lubricates, cleans and cools the APU bearings and gears. The oil is also used to cool and lubricate the gearbox mounted generator.
To help cold start, a de-oiling valve is mounted on the oil pump inlet.
Oil system condition is monitored by the Electronic Control Box which receives temperature, pressure and filter clogging signals.

FUEL

The Fuel Control Unit (FCU) is the main component of the fuel system. The Electronic Control Box computes the fuel/air ratio, corresponding to the APU load, and meters the fuel flow accordingly.
Fuel pressure is also used as muscle pressure to operate two actuators : one for the load compressor Inlet Guide Vane actuator, the other for the surge control valve.

AIR

The main role of the air system is bleed air supply to the pneumatic system. This is supplied by the load compressor.
The bleed air system includes a bleed valve, a flow regulation by means of Inlet Guide Vanes and a surge protection. Control and operation of these components are controlled by the Electronic Control Box.
Independently of the bleed air system, air from a gearbox driven fan is used to cool the APU oil and to ventilate the APU compartment.

IGNITION AND STARTING

The APU start sequence is initiated from the cockpit and is controlled by the Electronic Control Box.
During starting, the electrical starter motor drives the APU and initial combustion is seconded by the ignition system.

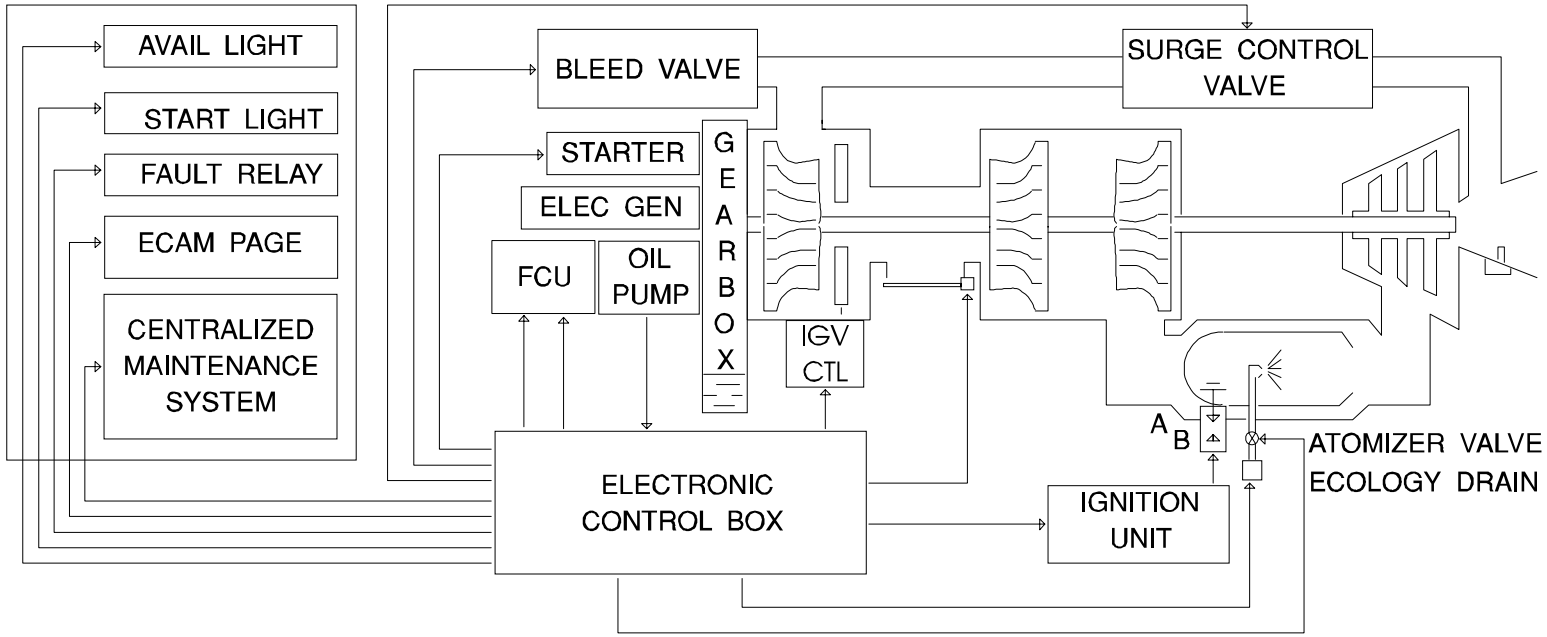
CONTROL AND MONITORING

APU control and monitoring are performed by the Electronic Control Box. The ECB also ensures interface between the aircraft and the APU.
The ECB has a Built In Test Equipment used for the Power Up Test and the monitoring test, which are automatically performed by the ECB itself, and for a self test initiated from the cockpit.
Should a fault occur during APU operation, the ECB records it and sends the fault message to the ECAM system and to the Centralized Maintenance System.

INDICATION

The ECB receives the APU main parameters and sends them to the ECAM system.
The parameters and the indications displayed on the ECAM APU page are :

- speed (N) and Exhaust Gas Temperature (EGT)
- bleed pressure and APU Generator
- inlet flap position
- low oil level and low fuel pressure.



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STUDENT NOTES:

APU INSTALLATION PRESENTATION

General
Access Doors
Mounts
Air Intake Flap
Air Intake Duct
Exhaust
Drain System

GENERAL

The Auxiliary Power Unit is mounted in a fireproof compartment located in the aircraft tail cone.

ACCESS DOORS

Two access doors allow access to the APU compartment.
The access doors can easily be removed to improve access to the APU. The APU can be removed and installed with its attached accessories through the access door opening.

MOUNTS

The APU is suspended in its compartment by three mounts. Vibration insulators are installed between the APU mount bracket and the tie rods.
The insulators mechanically isolate the APU from the aircraft structure. No vibration and shock can be transmitted in either direction.

AIR INTAKE FLAP

The air intake system ducts ambient air to the APU inlet plenum chamber. An air intake flap cuts off the air supply when the APU does not operate.
In case of failure, the flap actuator can be operated manually.

AIR INTAKE DUCT

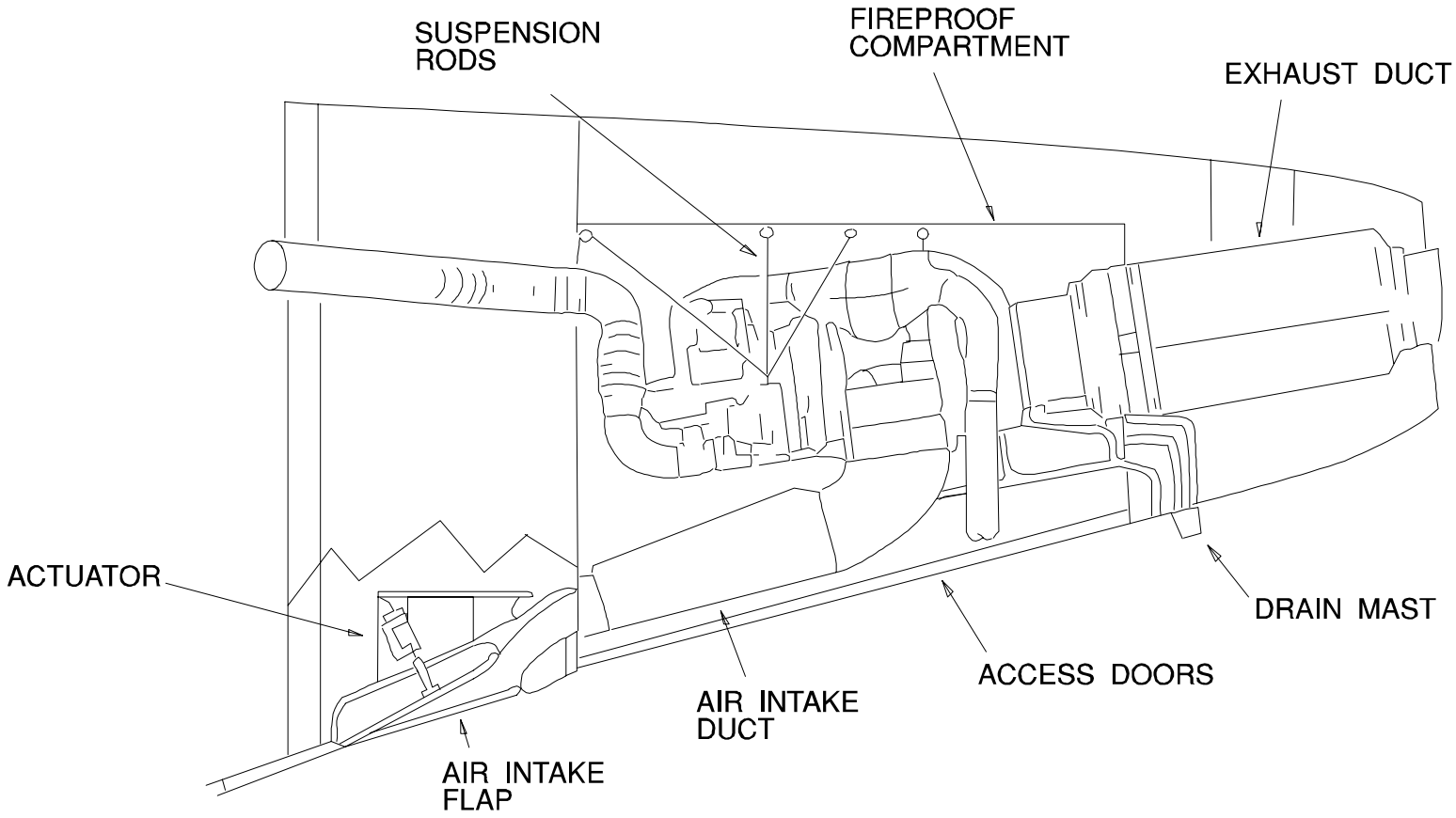
The air intake duct, which is composed of a diffuser and elbow, provides correct airflow to the APU inlet plenum.
This assembly can be removed to improve access to the APU.

EXHAUST

The exhaust system releases the APU exhaust gas into the atmosphere and decreases the exhaust noise level.
The exhaust muffler thermal insulation protects the aircraft structure.

DRAIN SYSTEM

A drain system prevents the collection of fluids in the APU compartment. Any fluid that may accumulate in the APU compartment is discharged through a drain mast.



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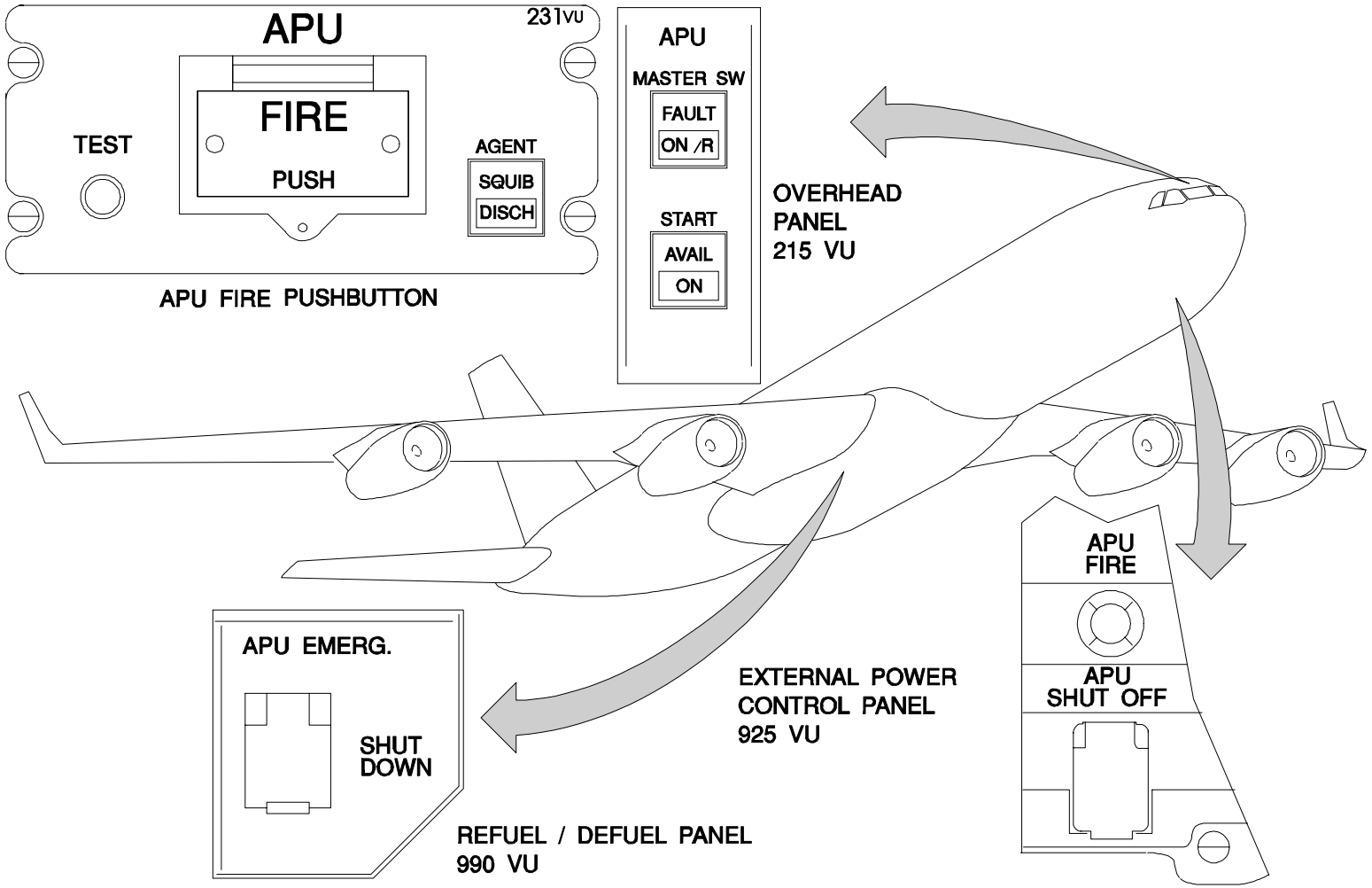
STUDENT NOTES:

APU CONTROLS AND INDICATING

General
Overhead Panel
External Power Control Panel
Refuel/Defuel Panel

GENERAL

Normal control of the APU is carried out from the APU control panel located in the cockpit. Emergency shutdown can be performed on ground from outside the aircraft.



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OVERHEAD PANEL

MASTER SWITCH

The MASTER SWITCH controls the power supply for APU operation and protection.
The ON / R light comes on blue. If ground power or main generator power is used, the APU page appears on the ECAM system display. The APU system is powered, the ECB carries out the Power Up Test, the air intake flap opens.
The APU fuel isolation and fuel low pressure valve open. If required, the APU fuel pump starts running.

A normal shutdown sequence is initiated when the master switch is released out.
The ON/R light in the MASTER SWITCH goes off. If bleed air was used, the APU keeps running for a cooling period of 120 seconds maximum. At 7 % speed (N) the air intake flap closes.

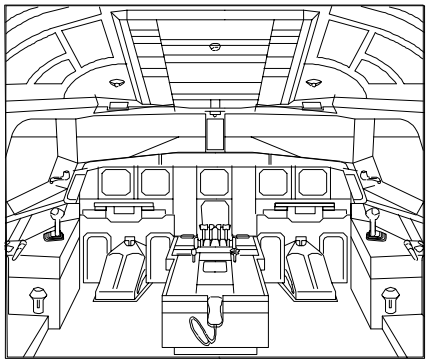
The FAULT light comes on amber and the corresponding warnings are activated when an automatic shutdown occurs.

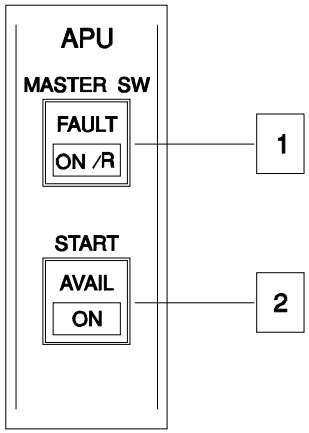
START PUSHBUTTON

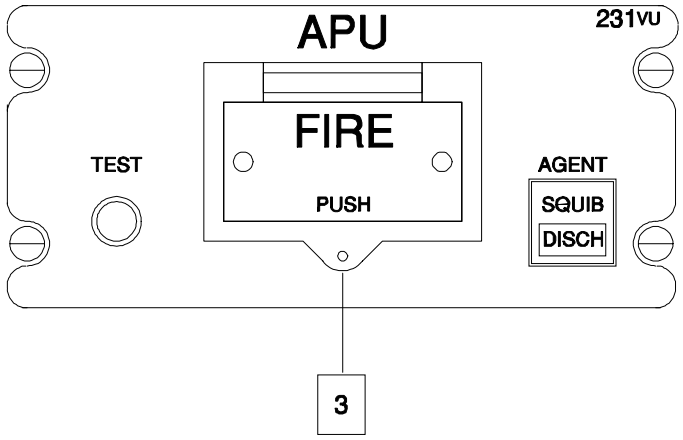
The START pushbutton initiates the APU start sequence.
The ON light comes on blue until 95%.
The AVAIL light comes on green above 95%. During shutdown the AVAIL light goes off below 88%.

APU FIRE PUSHBUTTON

When the APU fire pushbutton is released out, an APU emergency shutdown is initiated.







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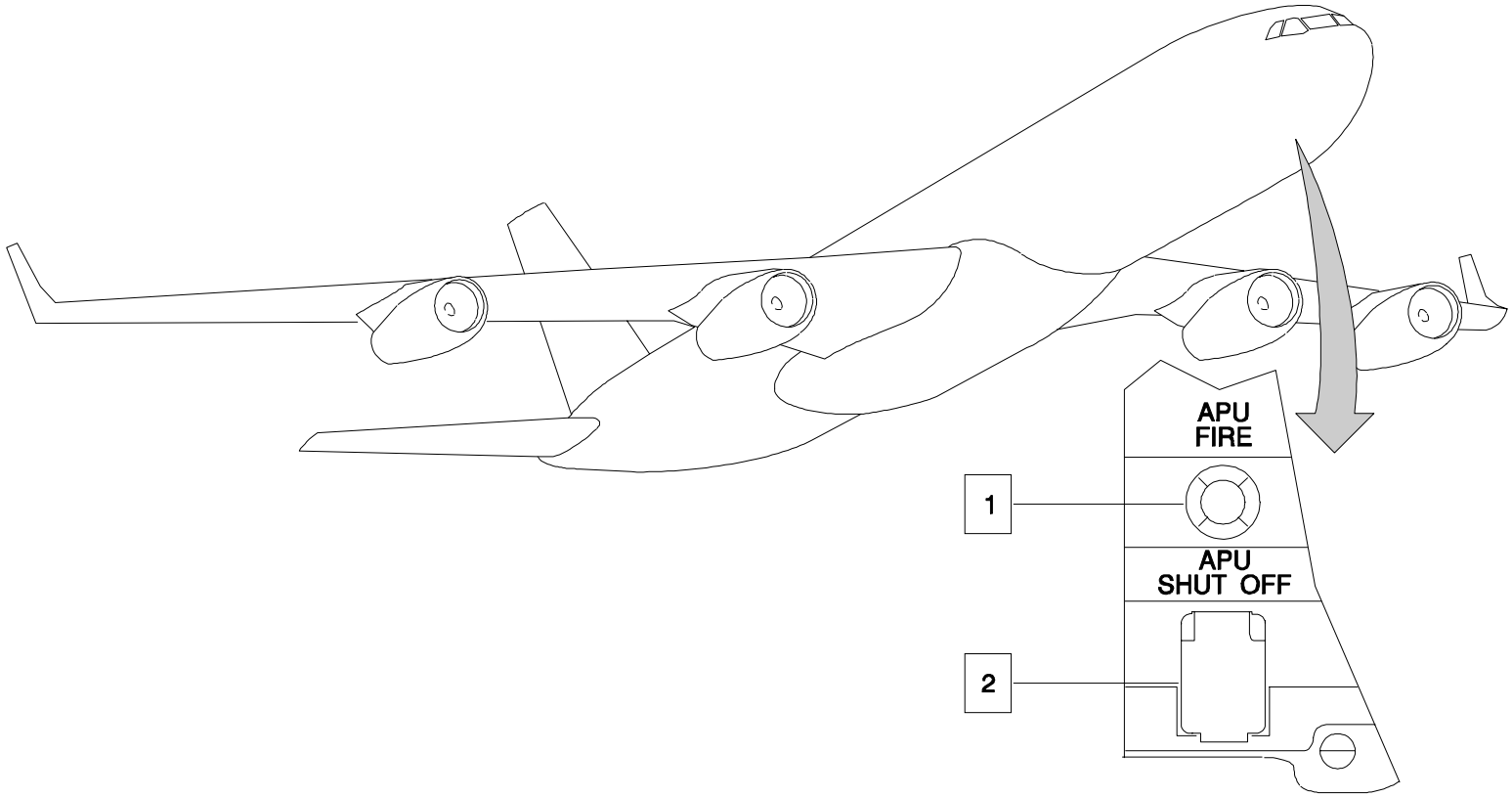
EXTERNAL POWER CONTROL PANEL

APU FIRE LIGHT

The APU FIRE red light comes on when a fire is detected on ground. Red light illumination is accompanied by the ground horn.

APU SHUT OFF PUSHBUTTON

An APU emergency shutdown can be performed using the APU SHUT OFF pushbutton located on the external power control panel, next to the nose landing gear.



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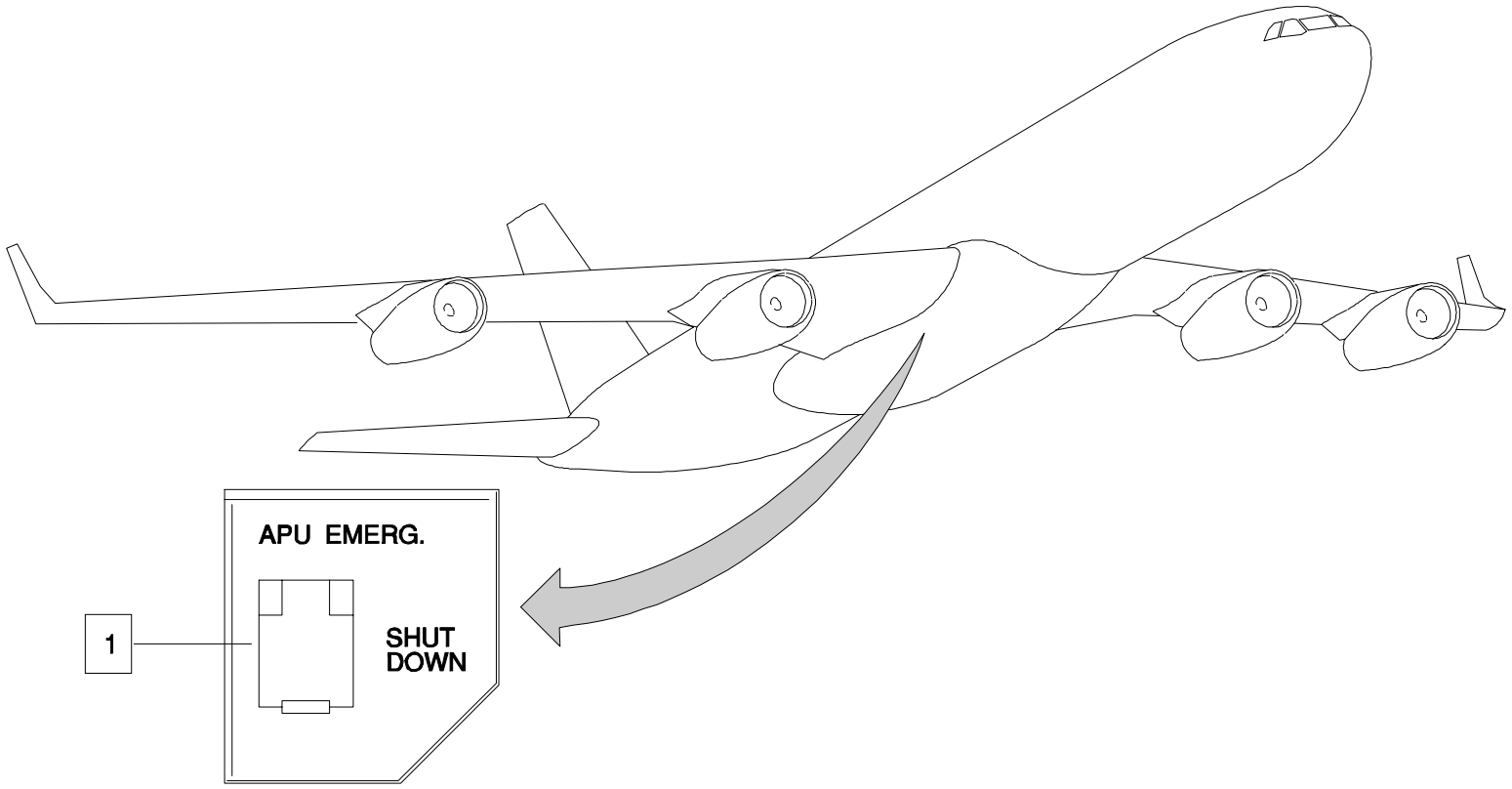
REFUEL/DEFUEL PANEL

APU EMERGENCY SHUT DOWN PUSHBUTTON

An APU emergency shutdown can be performed using the APU SHUT DOWN pushbutton on the refuel/defuel panel.



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STUDENT NOTES:

ECAM PAGE PRESENTATION

General
Exhaust Gas Temperature
Speed
Flap Open
Available
APU Generator
APU Bleed
Fuel Low Pressure
Low Oil Level

GENERAL

The APU indications are displayed on the ECAM page. This page is called either manually or automatically during APU start.

EXHAUST GAS TEMPERATURE

The Exhaust Gas Temperature is displayed green in normal configuration that includes needle and digital indication.
It pulses when an advisory is detected by the ECB.
The EGT indication becomes red when exeeding the limits. A movable red line is computed by the ECB. The red EGT limit value is different during APU starting and when the APU becomes available.
Amber XX when not available.

SPEED

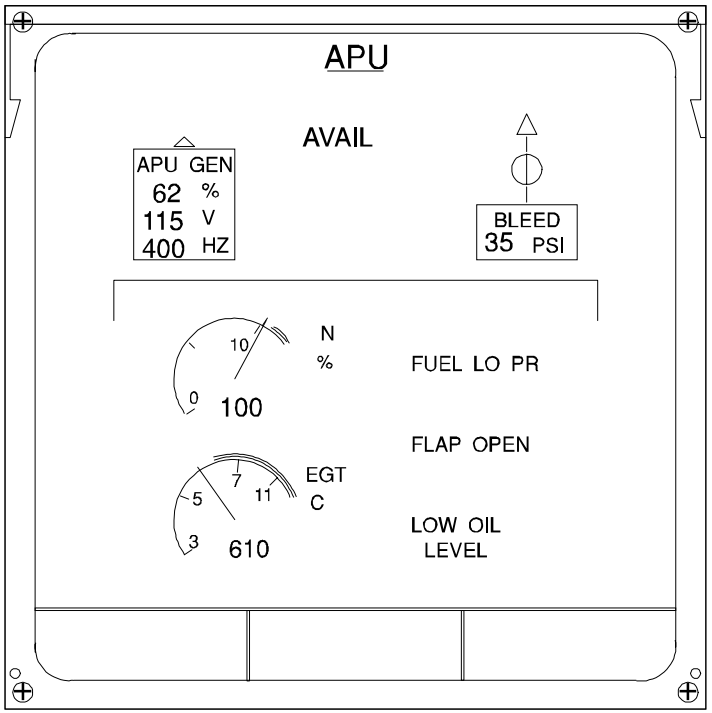
The APU speed is displayed green in normal range.
The speed indication is red in case of overspeed (Above 107 %)
Amber XX when not available.

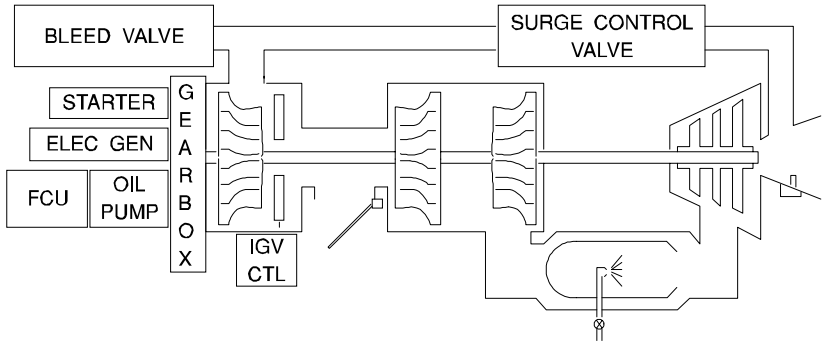
FLAP OPEN

The green FLAP OPEN indication is displayed when the air intake flap is fully open. No indication is displayed otherwise.

AVAILABLE

The green AVAILable indication is displayed when the APU speed is above 95 %. Nothing is displayed otherwise.





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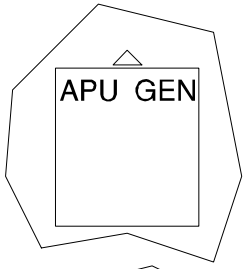
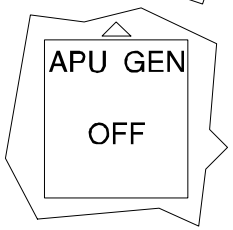
APU GENERATOR

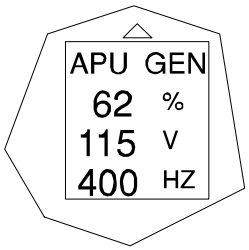
The APU electrical generator output is displayed as shown on the picture.
The load, voltage or frequency indication is displayed amber when the corresponding parameter is out of range.
The APU GEN indication is displayed amber in case of overload, voltage or frequency out of range. When an information is not available, it is replaced by amber XX.



The APU is off.



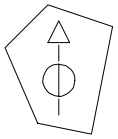
The APU is running and the electrical generator is off.



The electrical generator is on and all the parameters are in range.

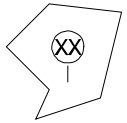
APU BLEED

The APU bleed valve indication is displayed as shown on the picture.
The bleed pressure indication is replaced by amber crosses when the indication is not available.

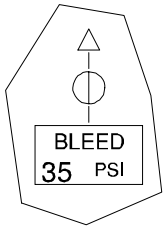


The valve is open.

The valve is closed.



The valve position information is not available.



The bleed pressure is the difference between the APU bleed pressure given by the ECB and the corrected average static pressure given by the Air Data and Inertial Reference Units.

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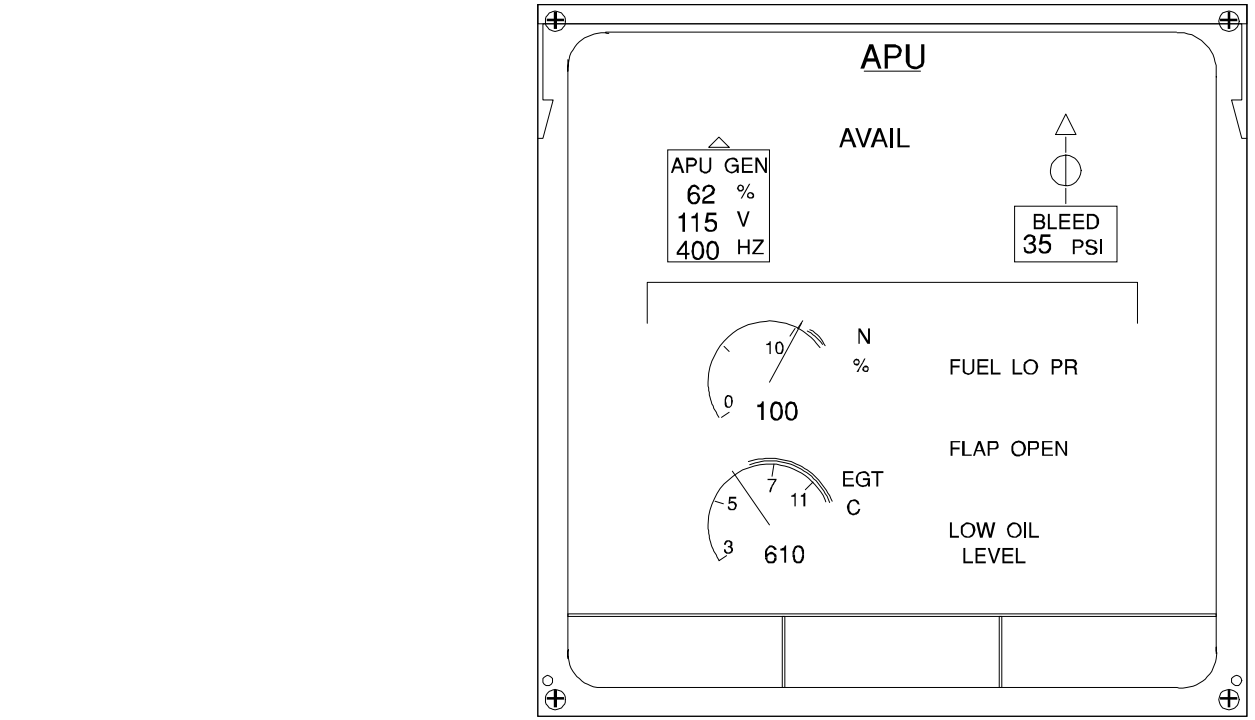
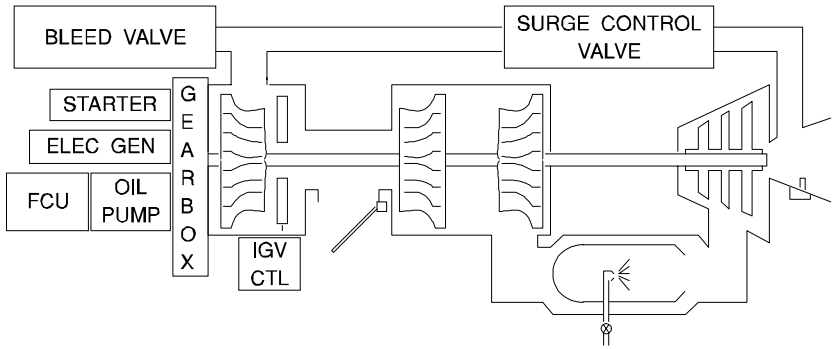
FUEL LOW PRESSURE

The amber FUEL LOW PRessure indication comes on when the pressure upstream the Fuel Control Unit is too low.

LOW OIL LEVEL

The green LOW OIL LEVEL indication pulses when the oil in the gearbox reaches the low level and needs servicing.





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APU BASIC DESCRIPTION

GENERAL

POWER SECTION

- Compressor
- Combustion Chamber
- Turbine

LOAD COMPRESSOR

- Load Compressor
- Inlet Guide Vanes

ACCESSORY GEARBOX

- Gearbox Assembly
- Accessories

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GENERAL

The APU has a modular design.

The three APU modules are :

- the power section,
- the load compressor,
- the accessory drive gearbox.

POWER SECTION

COMPRESSOR

The compressor is of a two stage centrifugal compressor design.

The main components of the compressor are :

- the inlet bellmouth,
- the first stage impeller and first stage diffuser,
- the second stage impeller and second stage diffuser,
- the deswirl vane assembly,
- the compressor housing.

The Compressor is a submodule which can be removed at shop maintenance level.

COMBUSTION CHAMBER

The combustion chamber is of a reverse flow annular design and fits inside the turbine plenum.

The main parts of the combustion chamber are :

- the combustion chamber liner,
- the outer combustion chamber case.

The following components are installed on the combustion chamber :

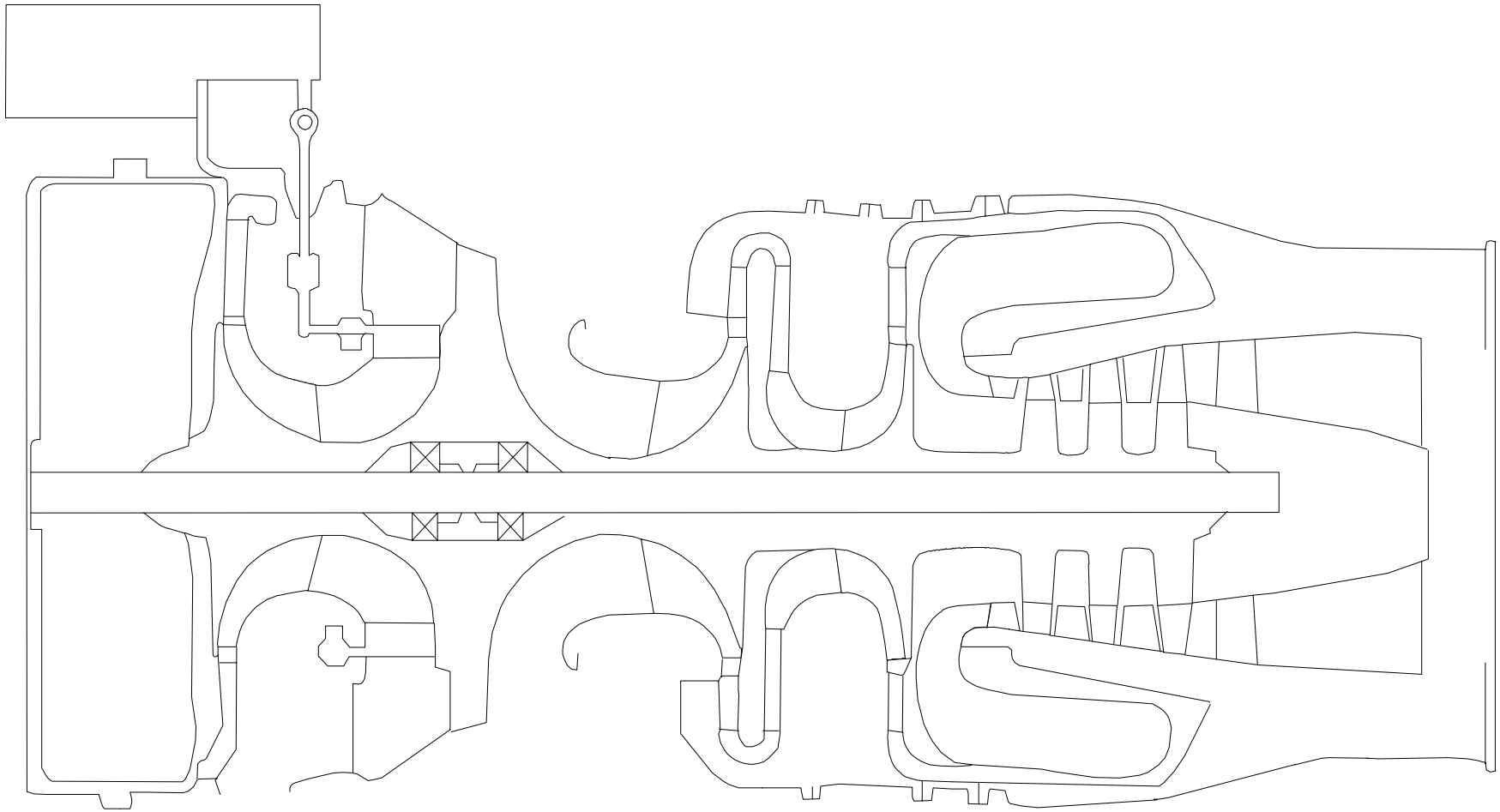
- the igniter plugs,
- the fuel nozzles,
- the combustion chamber drain valve.

TURBINE

The turbine assembly drives the compressor, the load compressor and the geartrain of the accessory gearbox.

The turbine is of a three stage axial design.
The turbine first stage vanes and blades are air cooled by compressor discharged air.

The turbine submodule can be removed at shop maintenance level.



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LOAD COMPRESSOR

LOAD COMPRESSOR

The load compressor is of a single centrifugal stage design.

The main components of the load compressor are :

- the inlet guide vane aseembly,
- the impeller,
- the diffuser,
- the collector scroll,
- the accoustic material.

INLET GUIDE VANES

The Inlet Guide Vane assembly controls the airflow through the load compressor.

The 24 Inlet Guide Vanes are moved simultaneously by a geartrain operated by an actuator.

The Inlet Guide Vane actuator is operated by high pressure fuel supplied from the Fuel Control Unit.

The Inlet Guide Vane opening angle depends on the bleed air demand for :

- the Main Engine Start (MES) system,
- the Environmental Control System (ECS).

ACCESSORY GEARBOX

GEARBOX ASSEMBLY

The accessory gearbox is directly connected to the Load Compressor module which transmits the shaft power from the power section.

The gearbox transmits the shaft power to the APU accessories and to the APU generator which are installed on the gearbox pads.

The gearbox is also the oil reservoir for the APU oil system and provides attachment for the two forward APU mount brackets.

ACCESSORIES

The components mounted on the accessory gearbox are :

- the electrical generator,
- the starter and the starter clutch assembly,
- the compartment cooling fan,
- the oil pump which drives the Fuel Control Unit.

STUDENT NOTES:

STUDENT NOTES

APU INSTALLATION DESCRIPTION

Air Intake Flap
Air Intake Flap Manual Operation
Access Door Operation
Access Door Removal/Installation
Air Intake Duct Removal/Installation
Drain System

AIR INTAKE FLAP

The Electronic Control Box controls the air intake flap to open when the master switch is selected on and to close when the APU is shut down.

AIR INTAKE FLAP MANUAL OPERATION

The manual override device permits manual operation of the air intake flap on ground.

47 turns are necessary to move the flap from the closed to open position and vice versa.

ACCESS DOOR OPERATION

The APU compartment access doors are closed by push to release latches.

When opened, the doors are maintained open by hold open rods.

When the access doors are open, do not operate the elevators.

ACCESS DOOR REMOVAL/INSTALLATION

For a better access to the APU compartment, for instance for APU removal, the access doors can be removed.

AIR INTAKE DUCT REMOVAL/INSTALLATION

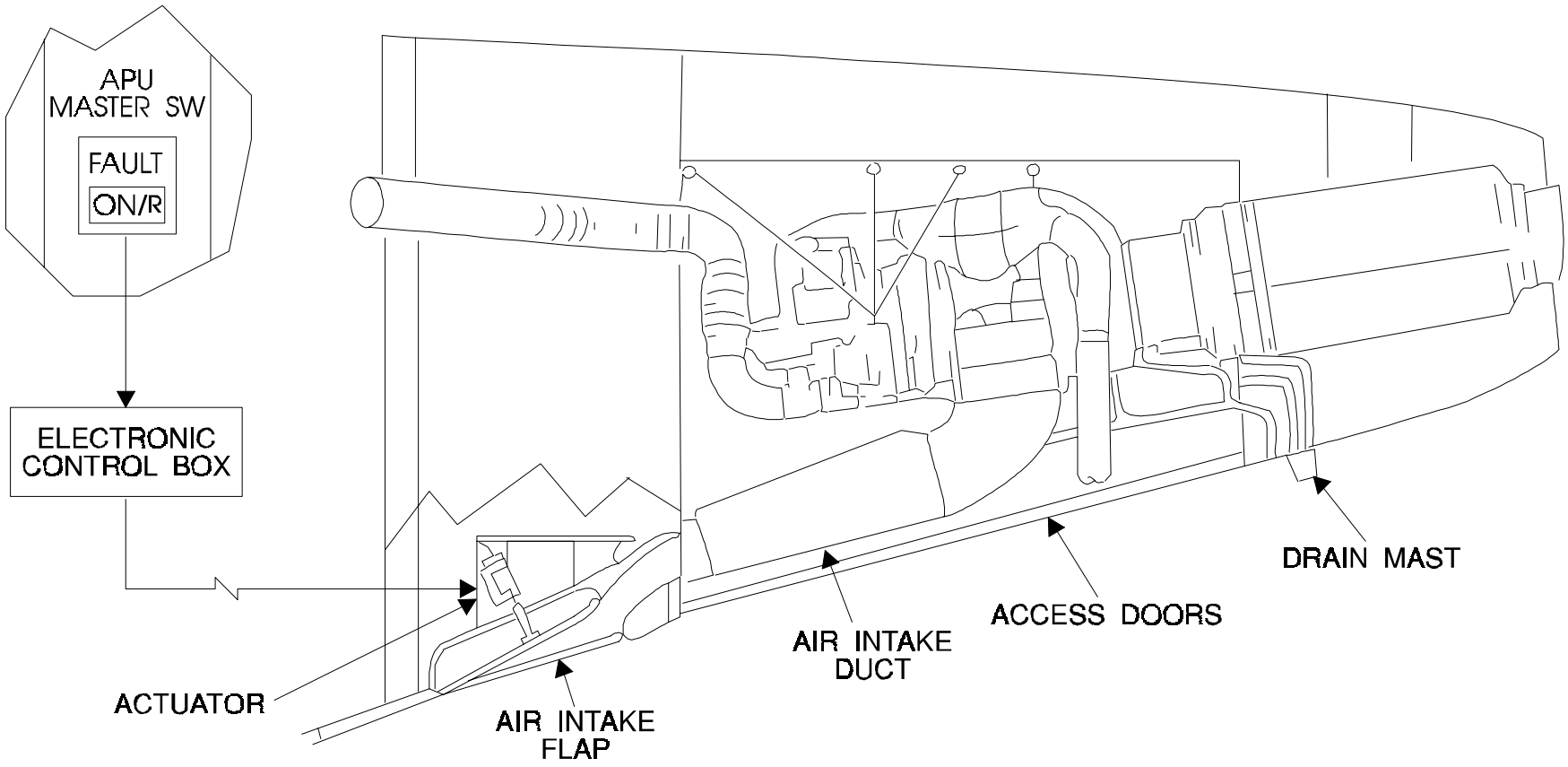
The air intake duct can be removed by disconneting the four tie-rods which hold it in position.

Be careful, the air intake duct weights 34 Kgs.

DRAIN SYSTEM

The following components are connected to the drain system :

- Inlet Guide Vane actuator
- Surge control valve actuator
- Fuel Control Unit
- Combustion chamber
- Exhaust cone
- Exhaust muffler.



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STUDENT NOTES:

APU FUEL SYSTEM DESCRIPTION AND OPERATION

General
Fuel Control Unit
Fuel Schedule
Muscle Pressure
Fuel Shut-Off
Flow Divider
Fuel Distribution
Fuel Drain
Control
Monitoring

GENERAL

The fuel system provides metered fuel to sustain combustion.

Part of the fuel is used as muscle pressure to operate the Inlet Guide Vane actuator and the surge valve actuator.

FUEL CONTROL UNIT

The Fuel Control Unit has five functions :

- fuel filtering
- pressure increase
- fuel metering
- positive fuel shut-off
- fuel muscle pressure regulation.

The Fuel Control Unit is composed of an inlet filter, a high pressure pump, a high pressure filter, a torque motor metering valve and a shut-off valve.

FUEL SCHEDULE

The fuel metering valve is controlled by the Electronic Control Box through a torque motor.

The Electronic Control Box schedules fuel flow for start sequence, on speed operation and shutdown sequence.

The Electronic Control Box modulates the on speed fuel schedule to match the aircraft demand: for bleed air and electrical power.

MUSCLE PRESSURE

Fuel muscle pressure is used to operate the surge valve actuator and the load compressor Inlet Guide Vane actuator.
Servo fuel is returned to the fuel filter inlet.

FUEL SHUT-OFF

The Electronic Control Box controls the fuel solenoid valve for positive fuel shut-off.
The valve is controlled open during start sequence and closed during stop sequence.

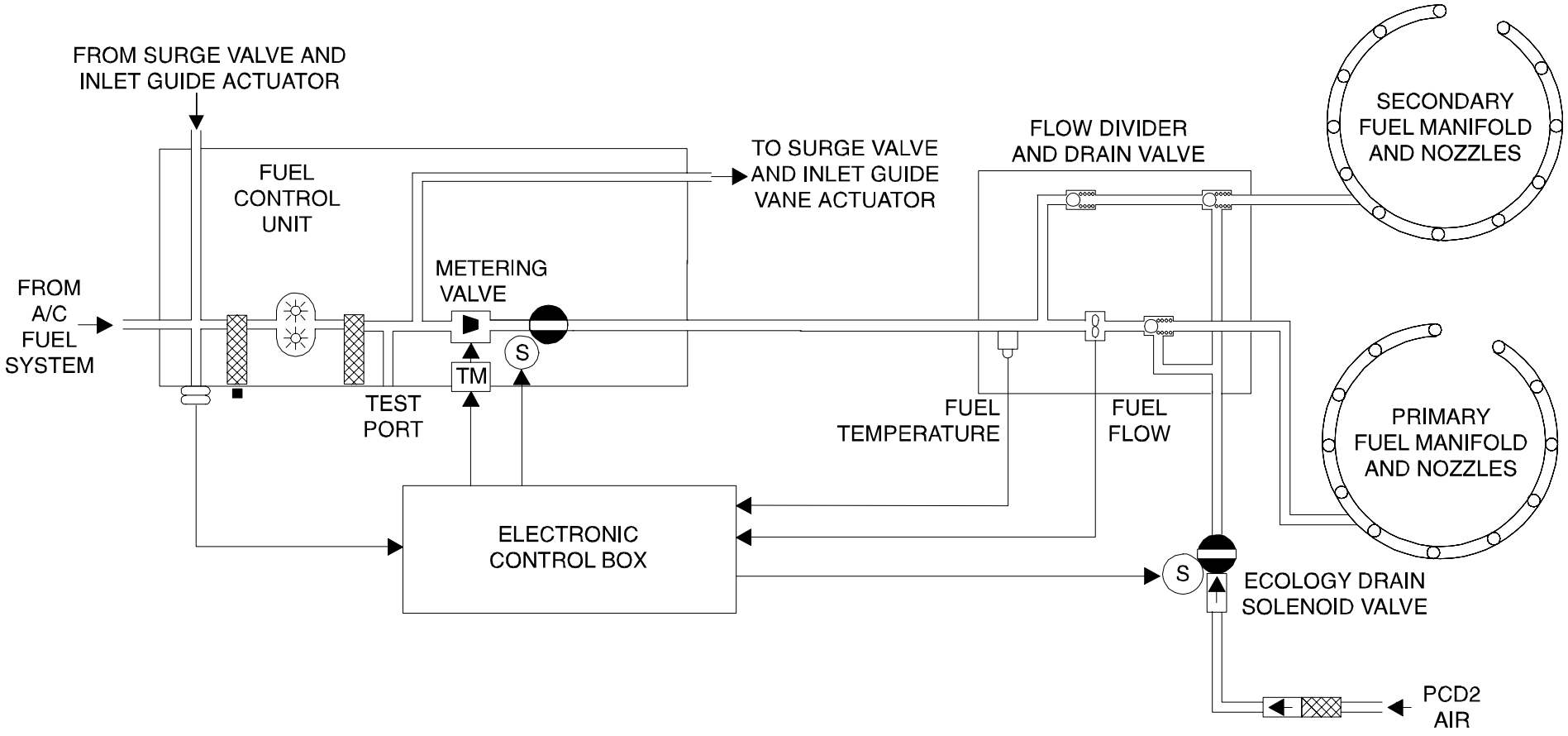
FLOW DIVIDER

The flow divider and drain valve divides fuel into primary and secondary flows.
During initial start sequence, only the primary flow is supplied.

FUEL DISTRIBUTION

Fuel distribution is assumed by twelve dual fuel nozzles.
Initially the flow divider directs fuel to the primary flow nozzle for good light-off.

At a preset fuel pressure, secondary flow nozzles are supplied for acceleration and governed speed operation.



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FUEL DRAIN

Compressor discharge stage two air is stored in a reservoir and an ECB controlled valve allows this air to blow out the residual fuel from the fuel manifold during APU shut-down.

CONTROL

The Electronic Control Box controls the fuel system using several parameters.

During on speed operation, the ECB uses APU speed, Exhaust Gas Temperature and aircraft demand signals.

During start, it uses speed, EGT, fuel temperature and fuel flow.

The Electronic Control box acts on the fuel metering valve and fuel shut-off solenoid valve.

MONITORING

The Electronic Control Box monitors proper operation of the aircraft APU boost pumps through a pressure switch installed at the Fuel Control Unit inlet.

Contamination of the fuel system is monitored by a visual filter clogging indicator.

STUDENT NOTES:

STUDENT NOTES

APU OIL SYSTEM DESCRIPTION AND OPERATION

Storage
Supply
Scavenge
Venting
Control
Protection
Monitoring

STORAGE

The lower part of the accessory gearbox is used as a 8.5 litre (2.25 US gallons) oil reservoir. It is fitted with an Oil Heater.
The Oil Heater increases the temperature of the oil when the oil temperature is too low and the APU MASTER SWitch is OFF.

On the left side of the gearbox are located :

- a gravity fill port,
- pressure and overflow fill ports,
- a sight glass gage.

SUPPLY

The oil is drawn from the tank and pressurized by a triple lube pump element. Regulated oil passes through a cooler and a filter.

The oil is then directed to the electrical generator, the gearbox pinions and the APU supporting bearings.

SCAVENGE

Oil from the electrical generator and APU bearings is returned to the tank by scavenge pumps.
Oil from the gearbox pinions is scavenged by gravity.

Note that the generator scavenge oil is filtered and sent to the starter sprag clutch.

VENTING

An air/oil Separator removes the oil particules from the gearbox air.
This oil free air is discharged in the APU exhaust.

CONTROL

The only component of the oil system controlled by the Electronic Control Box is the de-oiling solenoid valve.

The de-oiling solenoid valve is electrically controlled open during APU cold start to reduce the load on the starter, and during shutdown to keep the oil in the gearbox.

PROTECTION

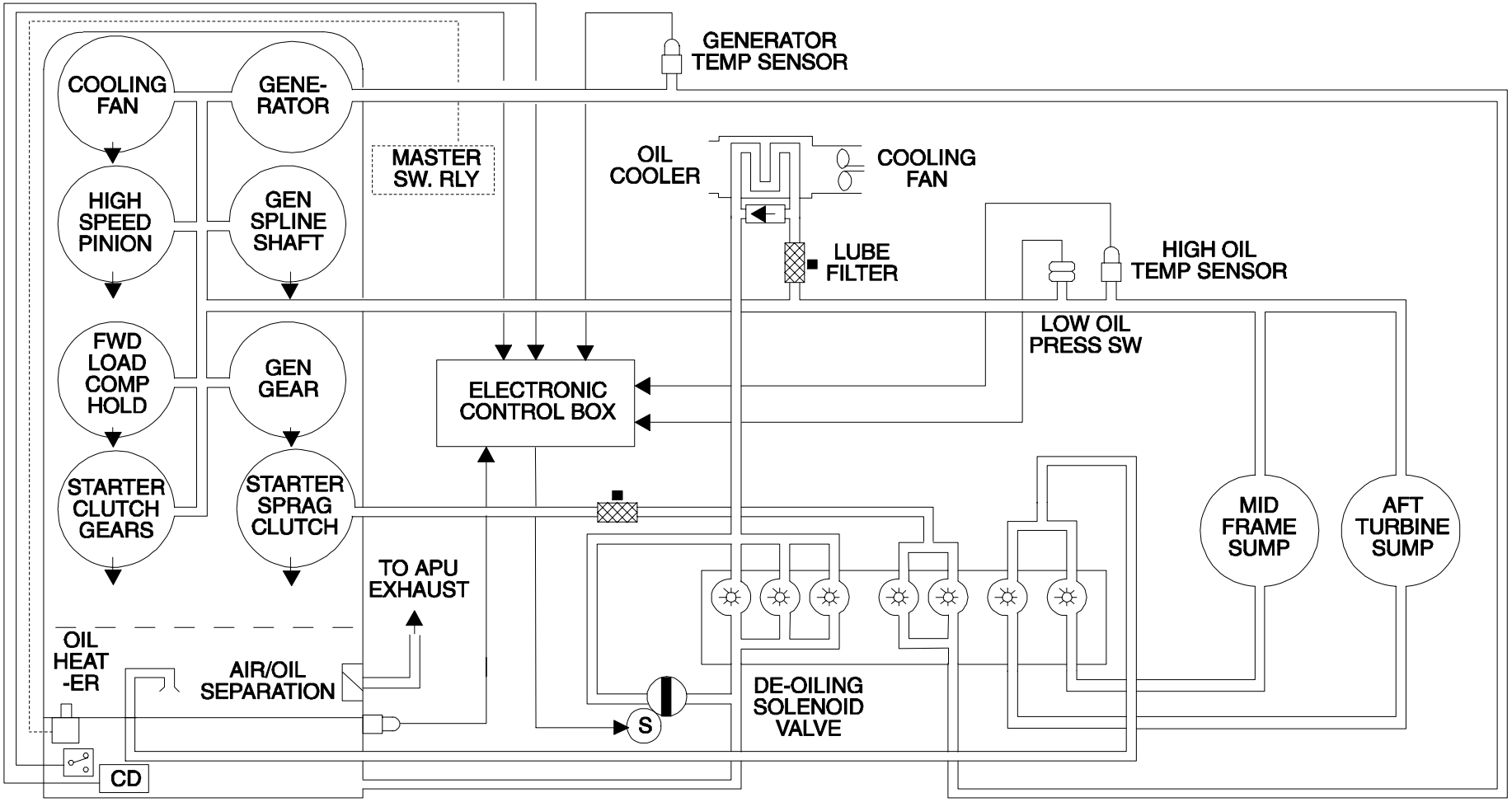
The Electronic Control Box protects the APU in case of oil system malfunction. The ECB monitors oil pressure and oil temperature.

If one of the oil parameters is out of range, the Electronic Control Box shuts down the APU according to APU speed and current flight phase.

MONITORING

The oil system is monitored to increase the APU life. Lube and scavenge filters are equipped with visual clogging indicators.

The oil tank is equipped with a low level switch and an electrical chip detector to display maintenance information in the cockpit.



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STUDENT NOTES:

APU AIR SYSTEM DESCRIPTION AND OPERATION

Bleed Supply
Bleed Control
Surge Protection
Oil Cooling
Compartment Cooling
Compressor Discharge Stage 1
Compressor Discharge Stage 2
Oil Vent
Control
Monitoring

BLEED SUPPLY

Bleed air supply to the aircraft pneumatic system is controlled by a bleed load valve.

The pneumatically operated bleed load valve is a shut-off valve.

BLEED CONTROL

The amount of air required by the pneumatic system is controlled by the load compressor Inlet Guide Vanes.

The Inlet Guide Vanes are moved by a fuel powered actuator.

SURGE PROTECTION

Load compressor surge protection is ensured by a modulating surge valve which discharges the excess of air in the exhaust.

The surge control valve is hydraulically operated for accurate and fast operation.
The hydraulic fluid is high pressure fuel from the FCU.

OIL COOLING

A gearbox driven fan draws filtered air from the inlet plenum and forces it to pass through the oil cooler.
After leaving the oil cooler, the air is discharged overboard.

COMPARTMENT COOLING

Air supplied by the fan is also used for APU compartment cooling.
The pneumatic cooling valve is fully closed in altitude.

An uncontrolled cooling orifice allows permanent cooling when the APU is running.

COMPRESSOR DISCHARGE STAGE 1

Compressor first stage discharge air is used to operate the compartment cooling valve and the bleed load valve.

COMPRESSOR DISCHARGE STAGE 2

Compressor second stage discharge air is used to blow out the residual fuel from the fuel manifolds during APU shut-down.

OIL VENT

The gearbox is vented to the APU exhaust.

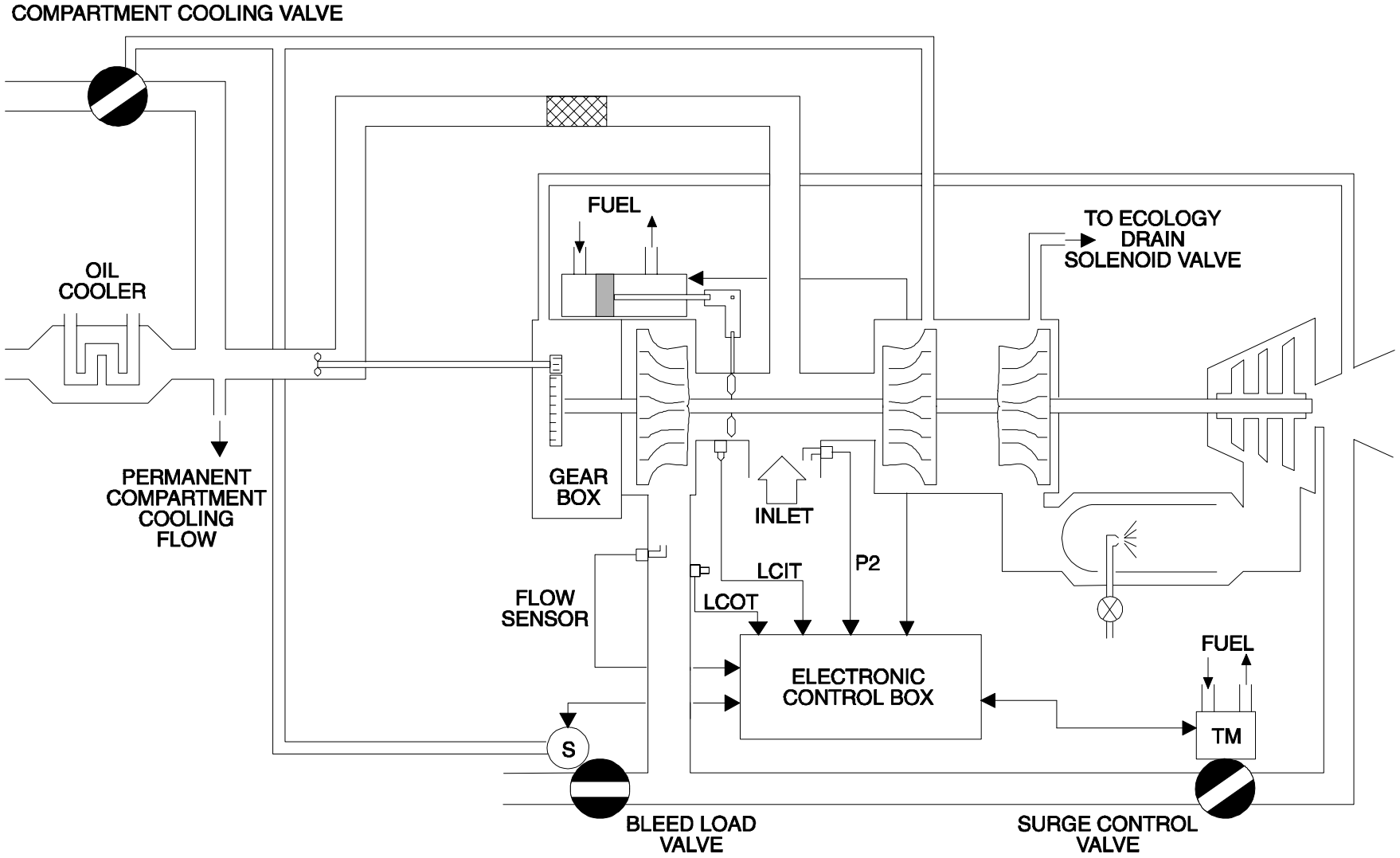
CONTROL

The Electronic Control Box controls the air system using several parameters:
- APU inlet pressure (P2) and Load Compressor Inlet Temperature (LCIT)
- load compressor discharge flow (total and differential pressures)
- command and feed back signals from the actuator and the valves.

MONITORING

To help maintenance and troubleshooting, the bleed load valve and the surge valve are equipped with visual position indicators.

The Load Compressor Outlet Temperature sensor (LCOT) is used to monitor the efficiency of the load compressor.



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STUDENT NOTES:

APU IGNITION AND STARTING DESCRIPTION AND OPERATION

Starter Control
Ignition Control

STARTER CONTROL

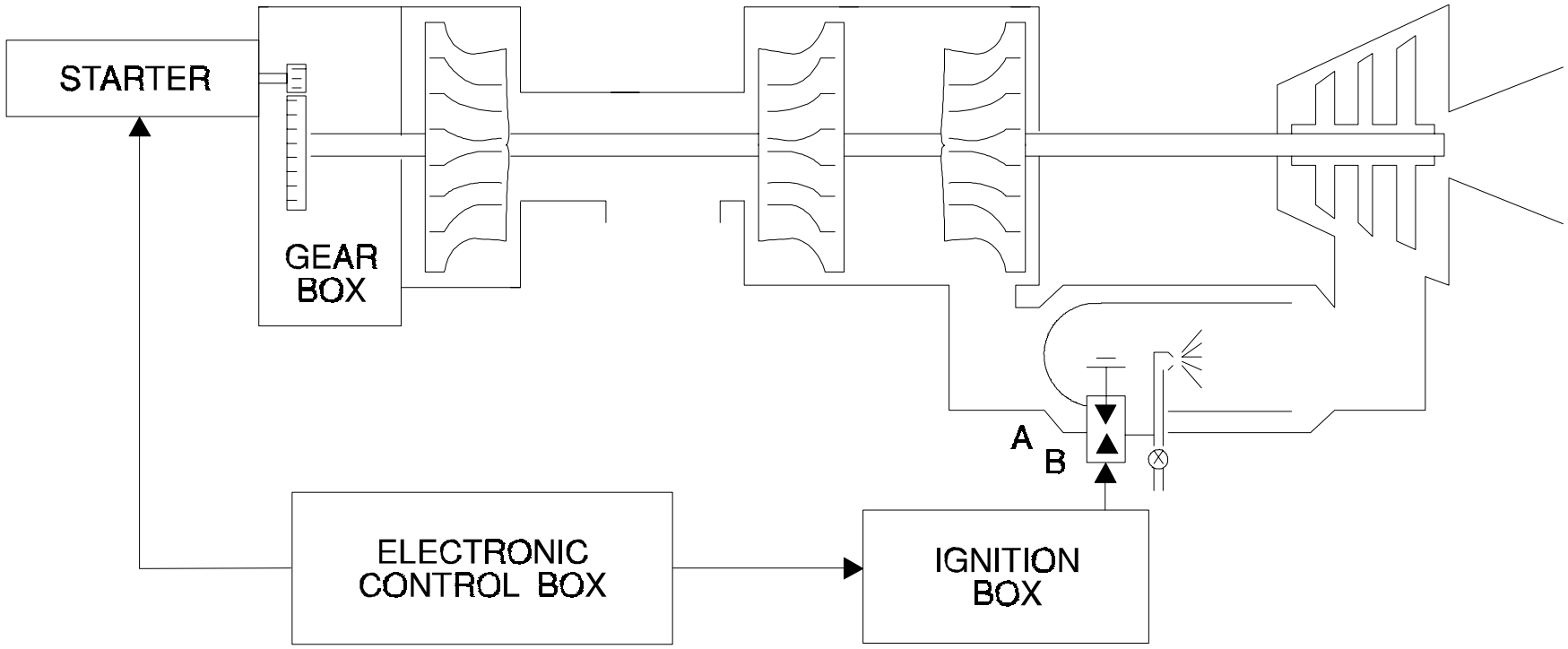
During starting, the electrical starter provides initial rotation of the APU shaft, by driving the accessory gearbox.

When the APU speed is about 50%, the Electronic Control Box cuts off the supply to the Starter.

IGNITION CONTROL

The ignition system provides initial light-off of the fuel air mixture.
The ignition system includes an ignition box which powers two ignition plugs.

During starting, the ECB switches on the ignition between 7 % and 50 %. In operation, if the APU speed decreases between 95 % and 50 %, the ignition is switched on to avoid APU flame out.



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STUDENT NOTES:

APU OPERATION

General
APU Start
On Speed
APU shutdown

GENERAL

APU normal operation, starting and shutdown, is performed using the APU control panel.

APU START

MASTER SWitch ON :

When the MASTER SWITCH is set to ON, the Electronic Control Box is electrically supplied and the sequence listed occurs :

- the ON/R light comes on
- the air intake flap opens
- the APU fuel feed line is supplied
- the ECB performs the Power Up Test
- the Inlet Guide Vanes receive a signal for closure
- the APU page is displayed on the ECAM.

START push button ON :

When the START pushbutton is set to ON, the starter cranks the APU:

- the ON light in the pushbutton comes on
- the de-oiling solenoid valve used to unload the lube pump opens at low oil temperature.

7 % :

When the speed reaches 7 %, the ignitors are energized and the FCU enables fuel flow, then combustion occurs.

50 % :

When APU speed is around 50 %, the ECB cuts off electrical power to the starter and ignition is cut off.

60 % :

When the APU speed reaches 60 %, the de-oiling solenoid valve closes, if it was open.

95 % :

When APU speed reaches 95 %, the ON light in the START push button goes off and the AVAILable light comes on.
The ECB switches to the governed speed schedule by regulating fuel flow in the FCU.

100 % :

100 % is the APU governed speed. The APU generator can be used and APU bleed be switched on.
15 seconds after the APU is available, the DOOR page is displayed again on the ECAM.

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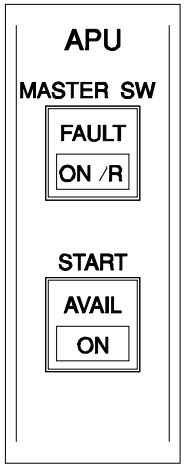

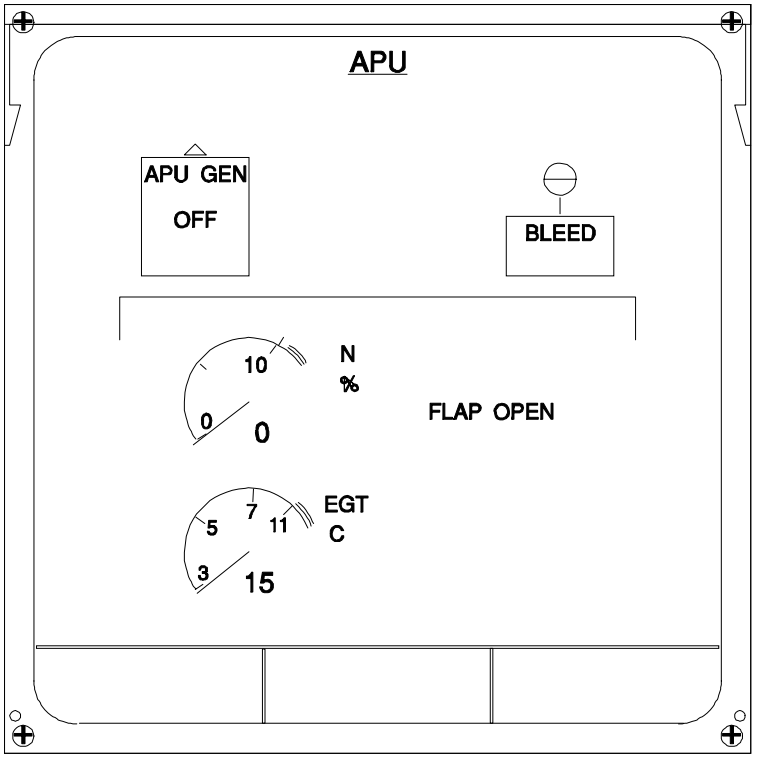

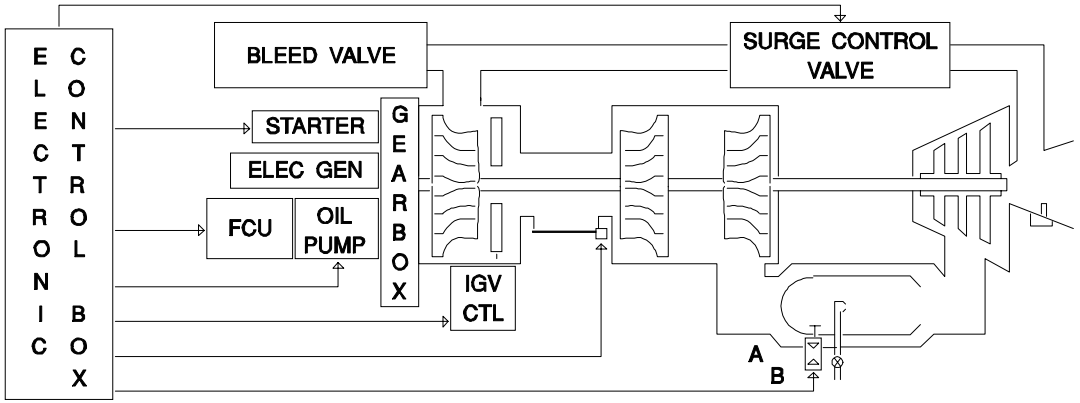

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ON SPEED

APU Bleed :

When the APU bleed is switched ON, bleed parameters are displayed on the ECAM system page.

APU Generator :

When the APU generator is used, the generator output parameters are displayed on the ECAM page.

APU SHUTDOWN

MASTER SWitch OFF :

If the bleed valve was open, it closes and the APU enters a cool down cycle.

When the cool down cycle is ended, the ECB generates a signal to test the overspeed logic, which causes APU shutdown by stopping fuel flow in the FCU.

95 % :

At 95% speed, the de-oiling solenoid valve opens to avoid the bearing sump cold soak during next start.

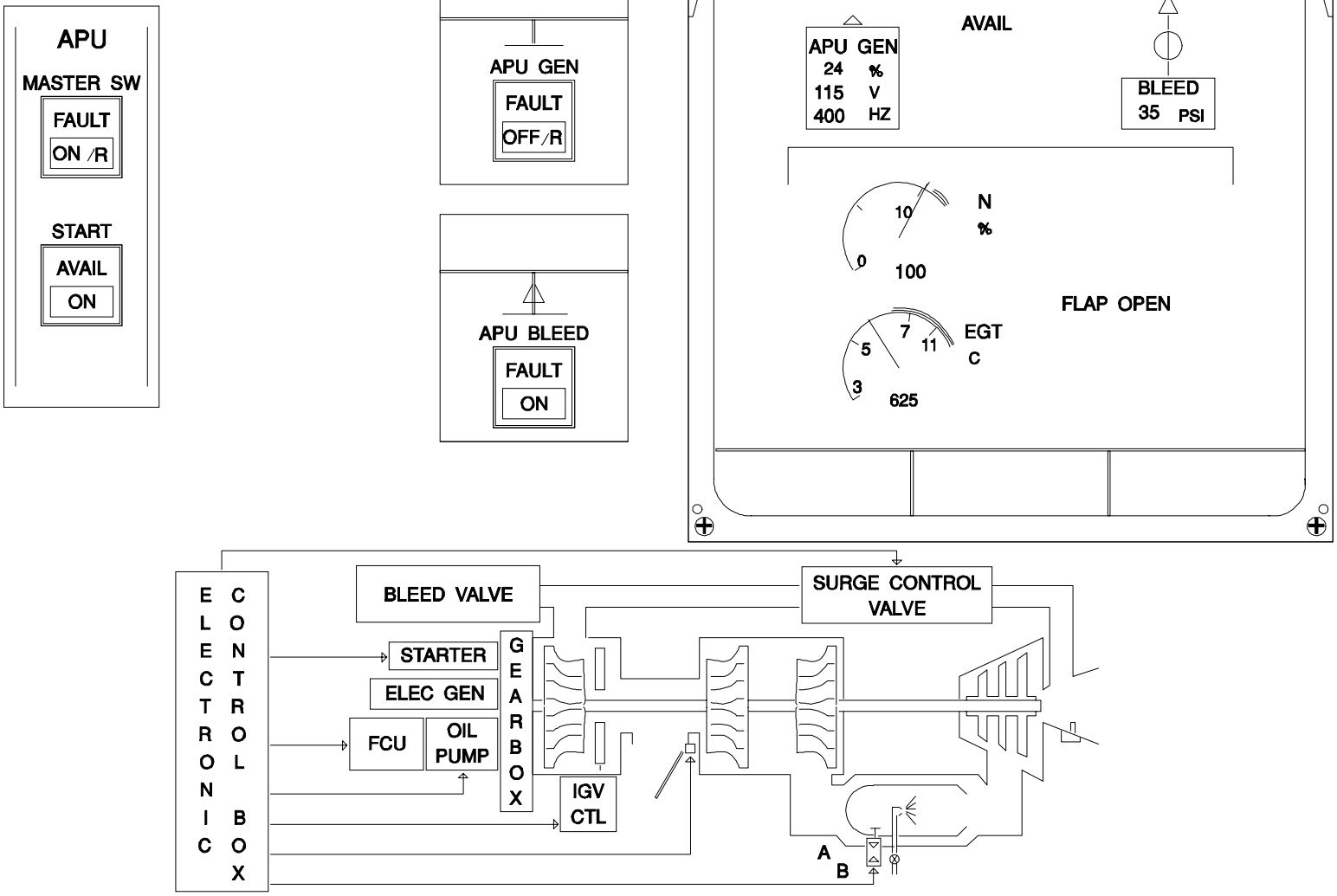
The AVAILable light goes off, the Inlet Guide Vanes close, the surge control valve and the ecology drain valve open.

7 % :

When APU speed decreases to 7 %, the de-oiling solenoid valve and the ecology drain valve receive a closing signal, the air intake flap starts to close and the APU fuel feed line is depressurized.

Electrical Power OFF :

The ECB is de-energized when the flap is fully closed.



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STUDENT NOTES:

APU CONTROL AND MONITORING

General
Air Intake Flap
Fuel System
Ignition and Starting
Air System
Indication
Oil System

GENERAL

The Electronic Control Box provides full authority digital control over the APU throughout the complete operating envelope.

To achieve APU control, the Electronic Control Box interfaces with the APU and the aircraft systems.
Multiple sensors and self-monitoring enable a fault tolerant operation of the APU.

AIR INTAKE FLAP

The air intake flap opens when the MASTER SWITCH is set to ON during starting.

The air intake flap closes during shutdown when the APU speed is below 7%.

FUEL SYSTEM

The Electronic Control Box controls :

- the fuel metering valve
- the fuel solenoid valve
- the ecology drain valve.

FUEL METERING VALVE

During starting, the Electronic Control Box controls the fuel metering valve torque motor using an acceleration schedule on which protection logics are applied.

In operation, the ECB also follows a governed speed schedule on which variations due to electrical load demand are applied.

Note that the torque motor is controlled when the APU speed is above 7% and no protective shutdown signal is present.

FUEL SOLENOID VALVE

The fuel solenoid valve opens when the APU speed is above 7% and no protective shut down is present.

ECOLOGY DRAIN VALVE

The ecology drain valve opens during APU shutdown when the APU speed is between 95% and 7%.

IGNITION AND STARTING

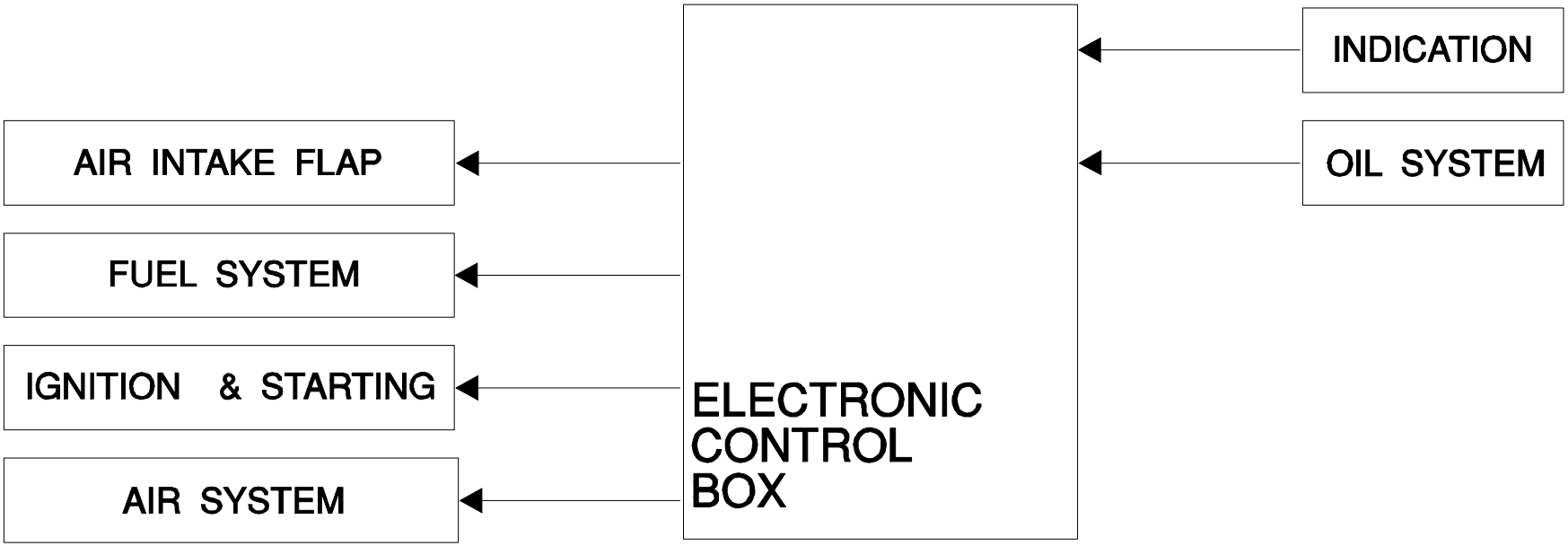
The Electronic Control Box controls the electrical starter motor and the ignition unit.

STARTER

The starter operates below 25,000 ft up to 50% and above 25,000 ft up to 54.5%.

IGNITION UNIT

The ignition unit operates during starting when the speed is between 7% and 50%.



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AIR SYSTEM

The ECB controls :

- the bleed load valve
- the Inlet Guide Vane actuator
- the surge control valve.

BLEED LOAD VALVE

The ECB controls the bleed load valve according to the demand signal from the Bleed Air Monitoring Computer.

The BMC sends an open signal when the APU bleed switch is on, APU speed is above 95%, altitude is less than 23,000 ft and no leak detected except during engine starting.

INLET GUIDE VANE ACTUATOR

The actuator position is a function of the air inlet temperature and the demand signal.

The various demands are Main Engine Start and air conditioning. The schedules are limited by an EGT trim function.

SURGE CONTROL VALVE

The ECB calculates the load compressor output flow using inlet pressure (P2), total pressure (Pt) and differential pressure.

The ECB controls the surge valve to prevent load compressor surge. The valve goes to the fully open position in case of protective shut down, stop command, failed sensor or altitude above 23,000 feet.

INDICATION

The Electronic Control Box receives the following indications from the APU :

- speed
- exhaust gas temperature
- bleed valve position
- bleed pressure
- air intake flap position
- low oil quantity
- low fuel pressure

OIL SYSTEM

The ECB monitors the correct operation of the oil system and shuts down the APU in case of low oil pressure, high oil temperature or generator scavenge high oil temperature (on ground).

To help maintenance, the Electronic Control Box receives a low oil quantity signal and oil sump chip detector signal.

INTERFACES ECB/AIRCRAFT

Power Supply
Master Switch Pushbutton
Start Pushbutton
Emergency Stop
LGCIU 1
EIVMUs
BMCs
Wing Anti-Ice Pushbutton
Memory Module
APU Fuel Pump
FCMCs
ECS
BCL 3
GCU
SDAC
CMC
DMU (option)

POWER SUPPLY

The Electronic Control Box is electrically supplied by the APU battery, the aircraft DC network and/or from the APU transformer rectifier.

MASTER SWITCH PUSHBUTTON

The MASTER SWITCH provides the ECB with a supply and reset signal and with a shutdown signal.

The Electronic Control Box sends a signal to the FAULT light when a shutdown occurs.

START PUSHBUTTON

When the ECB receives the start signal from the START pushbutton, the start sequence is initiated.

The ECB illuminates the ON light during APU start sequence.
The AVAIL light in the START pushbutton comes on when the APU speed is above 95 %.

EMERGENCY STOP

An emergency stop signal causes an immediate shutdown of the APU.

The four sources for emergency stop signals are :

External Power Control Panel shut off pushbutton, Refuel/ Defuel Panel shut-down pushbutton, Automatic Fire Extinguishing Control Unit and Fire pushbutton.

LGCIU 1

The ECB receives the flight/ground logic from the Landing Gear Control and Interface Unit.
This signal is used for automatic shutdown inhibition logic and for failed sensor logic.

EIVMUs

The ECB receives the Main Engine Start signal from the Engine Interface and Vibration Monitoring Units.
This signal is used to control the Inlet Guide Vanes and the surge control valve.

BMCs

The ECB receives the APU bleed valve command signal from the Bleed Air Monitoring Computers.

This signal is used to control the APU bleed valve.

WING ANTI-ICE PUSHBUTTON

The ECB receives a discrete input when the wing anti-ice system is selected on ground. This enables to boost automatically the APU to perform a wing anti-ice test.

MEMORY MODULE

A memory module mounted on the APU inlet plenum stores and exchanges the following information with the ECB :

- APU serial number
- APU successful starts (N > 95 %)
- APU unsuccessful starts (N < 95 %)
- APU turbine life consumed
- APU Operating hours.

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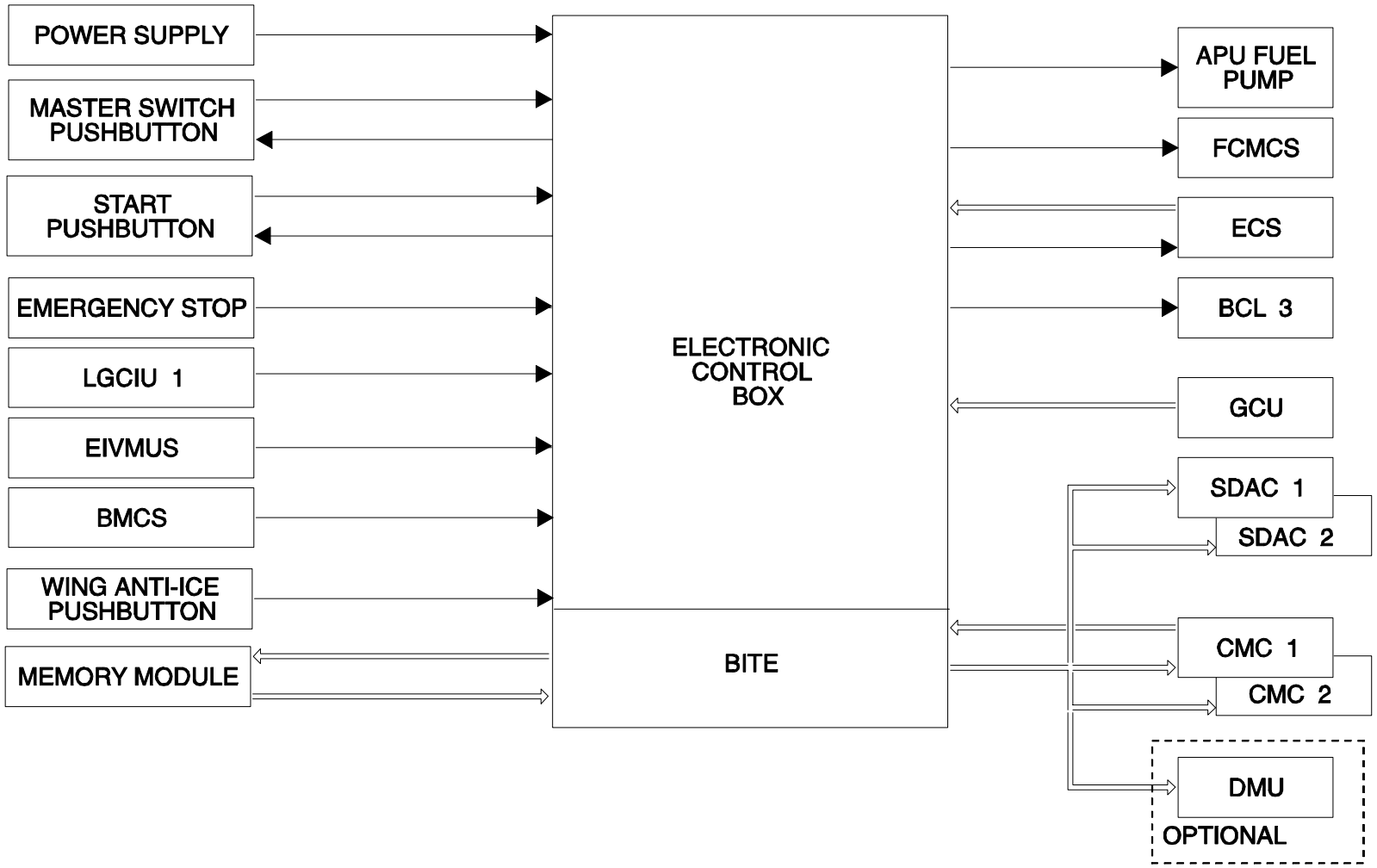

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APU FUEL PUMP

The Electronic Control Box sends a fuel demand signal to the APU fuel pump logic.

FCMCs

The Electronic Control Box sends a fuel demand signal to the Fuel Control and Monitoring Computer.

ECS

The ECB receives the bleed demand signal from the Environmental Control System (Zone Controller).
This signal is used to control the Inlet Guide Vanes and the surge control valve.

The ECB provides the Environmental Control System with the APU bleed valve open signal.

BCL 3

The ECB sends an APU available signal to the Battery Charge Limiter 3.

GCU

The ECB receives a speed variation demand signal from the Generator Control Unit.

This signal is used to vary APU speed so that the generator outputs (voltage and frequency) stay in range.

SDAC

The ECB sends to the SDACs the indications to be displayed on the ECAM APU page and shutdown information to trigger the corresponding warning.

CMC

The ECB is a type 1 computer.
The ECB receives flight information from the Centralized Maintenance Computer 1 and sends maintenance parameters to both CMCs.

DMU (option)

The ECB sends maintenance parameters to the Data Management Unit. This information is used for the Aircraft Condition Monitoring System.

APU SHUTDOWN : PROTECTIVE AND EMERGENCY

General
Air Intake Flap Not Open
Start Aborted
Underspeed
Low Oil Pressure
High Oil Temperature
Generator High Oil Temperature
Load Compressor High Temperature
Electronic Control Box (ECB) 1B Shutdown
Main Power Interruption
Overtemperature
Overspeed
Emergency
Electronic Control Box (ECB) 1A Shutdown

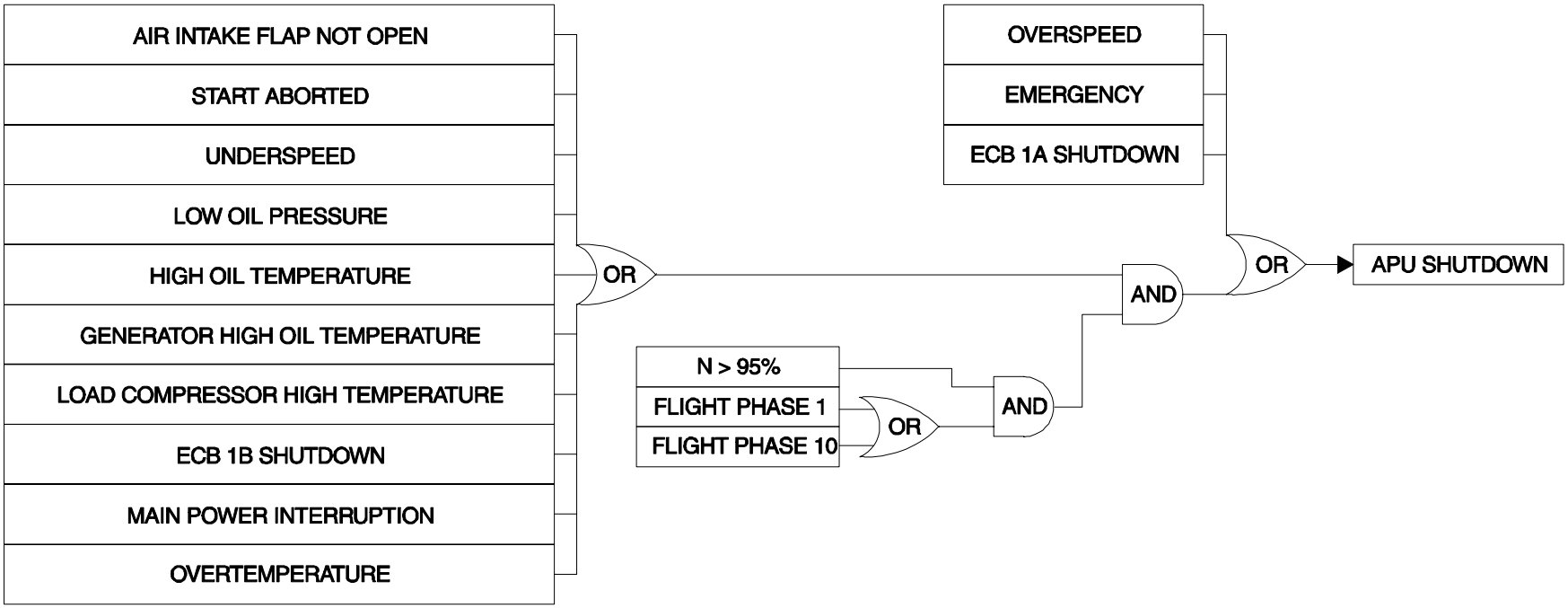
GENERAL

A warning is displayed in the cockpit when a shutdown occurs.

The first protective shutdown inhibits recognition of additional faults during APU rolldown.

Three of the shutdowns are active all the time.

The other shutdowns are inhibited (when the aircraft is in flight or on the ground) from the start of the first engine to the shut down of the last engine, if the APU speed is above 95%.



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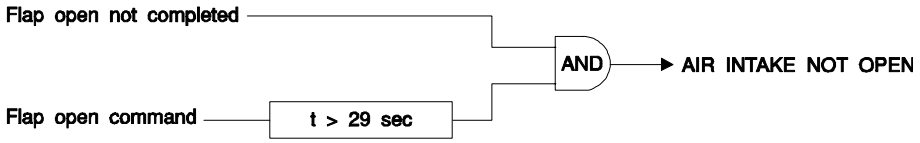
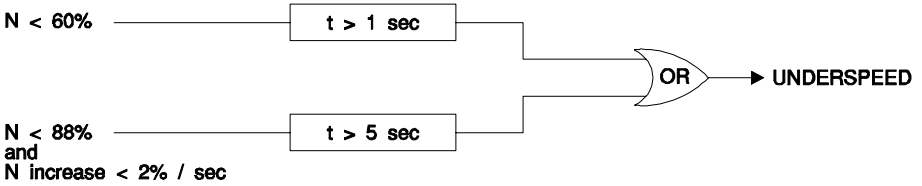
AIR INTAKE FLAP NOT OPEN

A shutdown occurs if the air intake flap takes more than 29 seconds to open.



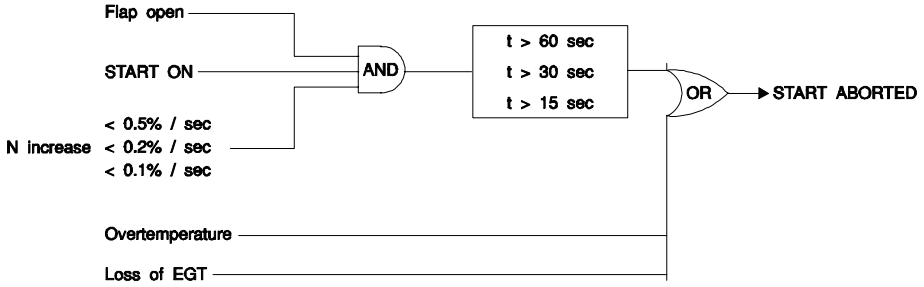
UNDERSPEED

An underspeed shutdown occurs if the APU speed was above 95% then decreases below 88% or 60%.



START ABORTED

The start abort logic shuts down the APU if it takes too much time to accelerate or in case of overtemperature or loss of EGT signal.



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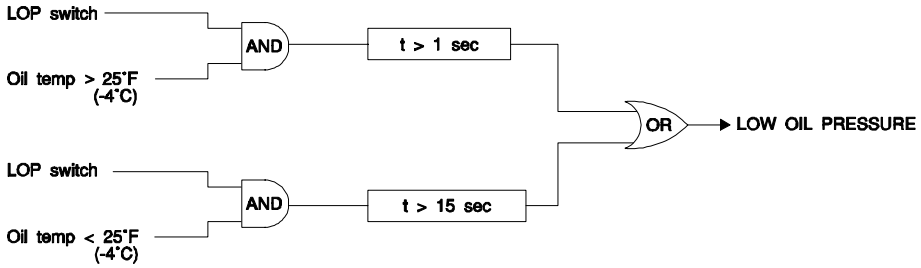
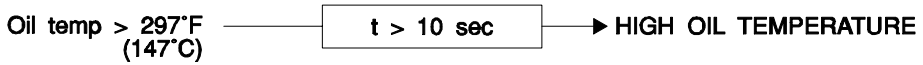
LOW OIL PRESSURE

The low oil pressure logic has two different settings depending on the oil temperature.



HIGH OIL TEMPERATURE

A high oil temperature logic causes the APU to shutdown.



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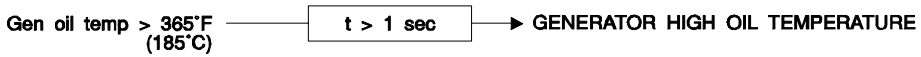
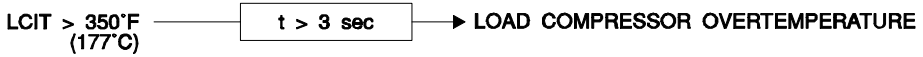
GENERATOR HIGH OIL TEMPERATURE

A generator scavenge high oil temperature logic causes an APU shut down.



LOAD COMPRESSOR HIGH TEMPERATURE

If the Load Compressor Inlet Temperature is above the limit, the APU shuts down.



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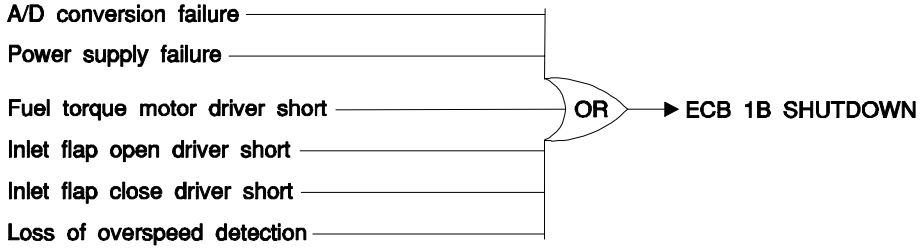
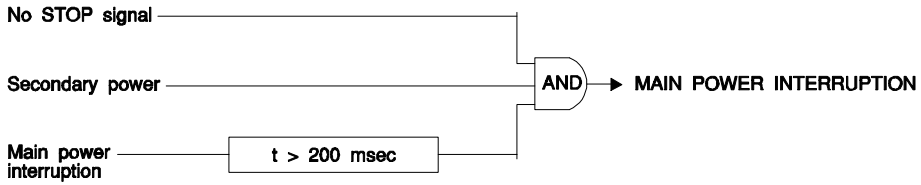
ELECTRONIC CONTROL BOX (ECB) 1B SHUTDOWN

A shutdown called ECB 1B occurs if internal failures of the Electronic Control Box are detected.



MAIN POWER INTERRUPTION

When the secondary power is available and there is a main power interruption longer than 200 milliseconds, the APU shuts down.



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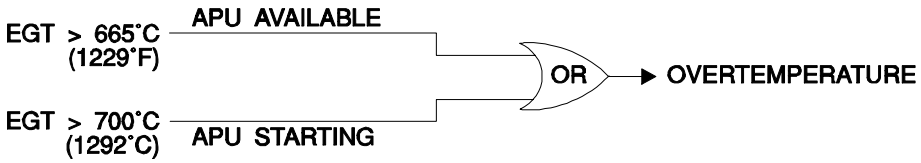
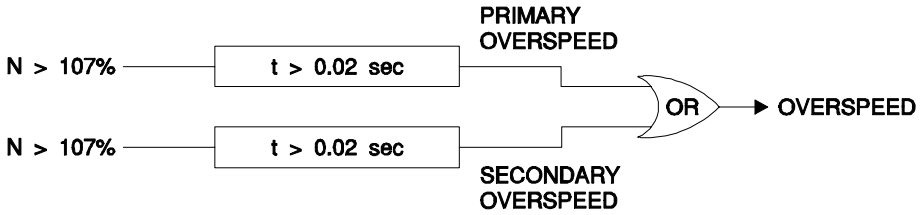
OVERTEMPERATURE

A shutdown occurs if an overtemperature is detected.
There are two EGT limits when the APU is available or during starting.



OVERSPEED

To protect the APU turbine and the generator, the overspeed logic shuts down the APU when the speed is above 107 %.



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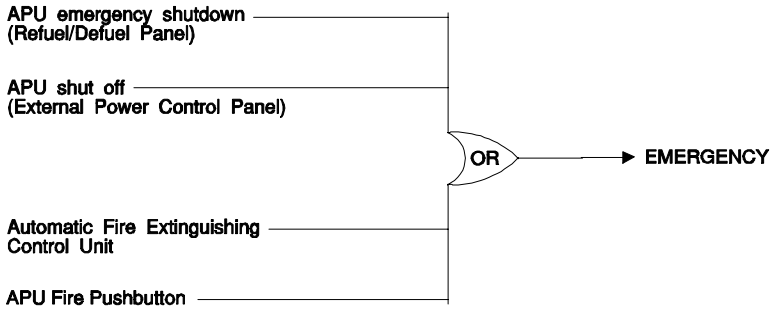
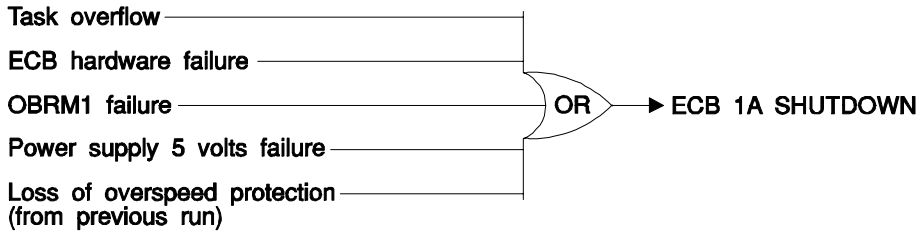
EMERGENCY

The emergency logic shuts down the APU if one of the manual emergency switches is pushed or if automatic fire extinguishing occurs.



ELECTRONIC CONTROL BOX (ECB) 1A SHUTDOWN

A shutdown called ECB 1A occurs if major failures of the Electronic Control Box are detected.



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STUDENT NOTES:

WARNINGS AND OPERATING LIMITATIONS

APU FAULT :
- Auto Shutdown
- Emergency Shutdown
- Inhibited Shutdown

Operating Limitations

APU FAULT :

- AUTO SHUTDOWN

Automatic shut down of the APU will occur for any abnormal situations other than a fire.
The Master Switch must be selected to off.

- EMERGENCY SHUTDOWN

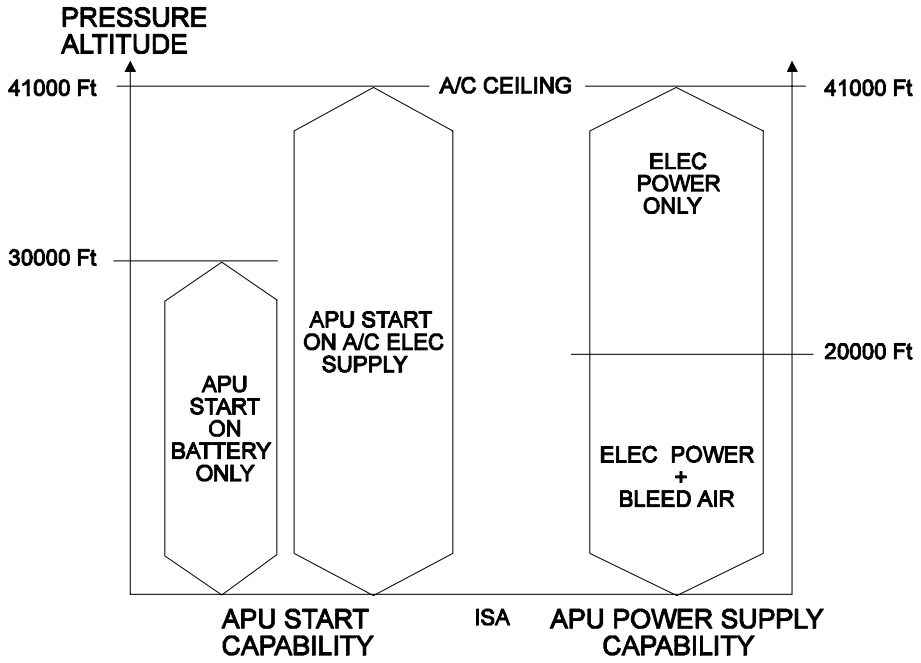
This warning occurs when:
- an APU fire is detected on the ground or,
- the APU shut-off pushbutton is pressed on the external control panel or,
- the APU EMERG SHUT DOWN P/B is pressed on the Refuel/Defuel panel or,
- the APU FIRE pushbutton is pressed on the overhead panel.

- INHIBITED SHUTDOWN

In flight, when the APU is used, some automatic shutdowns are inhibited. APU is still AVAIL.
If the APU is not required, the Master Switch must be selected off.

OPERATING LIMITATIONS

Two start attempts are allowed without a cool down.
A third attempt can be initiated after a one minute cool down period.
A 60 minutes cool down period must be observed after the third start attempt.



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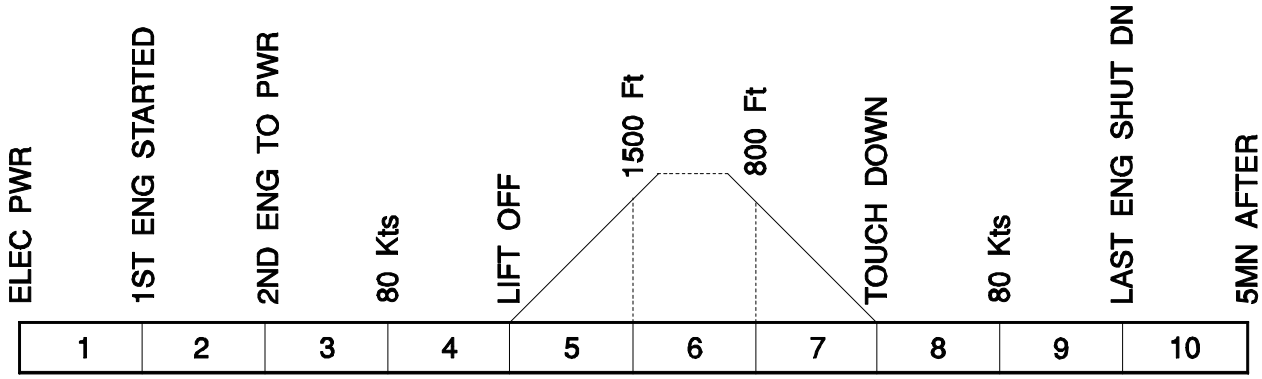

E/WD : FAILURE TITLE conditions	AURAL WARNING	MASTER LIGHT	STD PAGE CALLED	LOCAL WARNIGNS	FLT PHASE INHIB
AUTO SHUT DOWN Automatic shut down of APU for reason other than a fire	SINGLE CHIME	MASTER CAUT	APU	APU MASTER sw FAULT lt	3, 4, 5, 7, 8,
EMER SHUT DOWN Fire detection on ground or use of APU shut off pb on interphone panel or on defuel/refuel panel or APU FIRE P/B pushed.					
INHIBITED SHUT DOWN One of the inhibited shut downs detected in flight					

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STUDENT NOTES

APU INSTALLATION COMPONENTS

Mount Brackets
Mount Vibration Insulator
Air Intake Diverter
Air Intake Flap
Air Intake Flap Actuator
Air Intake Duct
Combustion Chamber Drain Valve
Exhaust Duct

SAFETY PRECAUTIONS

Pull and tag the appropriate circuit breakers.

Do not touch the APU until it is sufficiently cool to prevent burns when you do the maintenance tasks.

STUDENT NOTES

MOUNT BRACKETS

FIN : 5124KB, 5125KB, 5126KB.

ZONE : 315, 316.

COMPONENT DESCRIPTION

The mount brackets provide connection between the APU and its compartment.

There are seven tie-rods :

- three for the left mount and two for the right and the aft mounts.

MOUNT VIBRATION INSULATOR

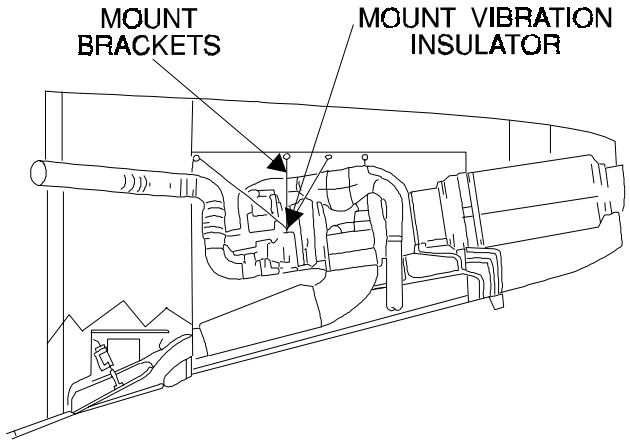
FIN : 5121KB, 5122KB, 5123KB.

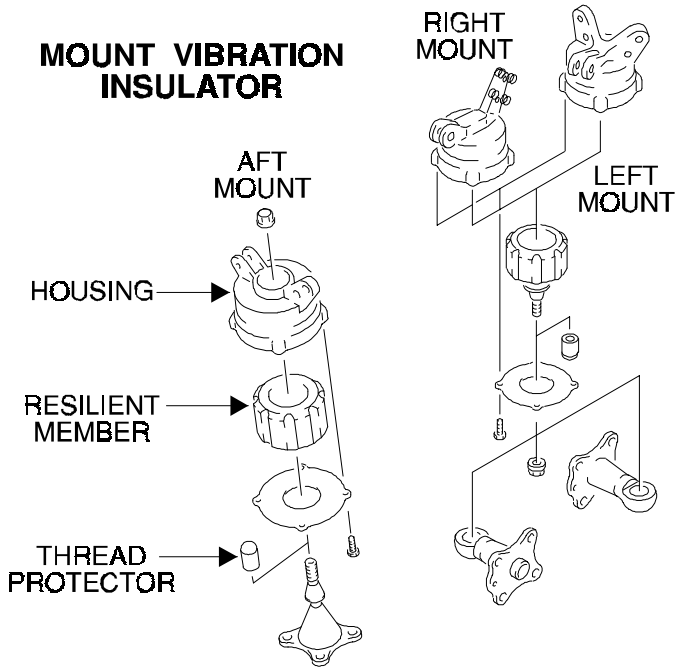
ZONE : 315, 316.

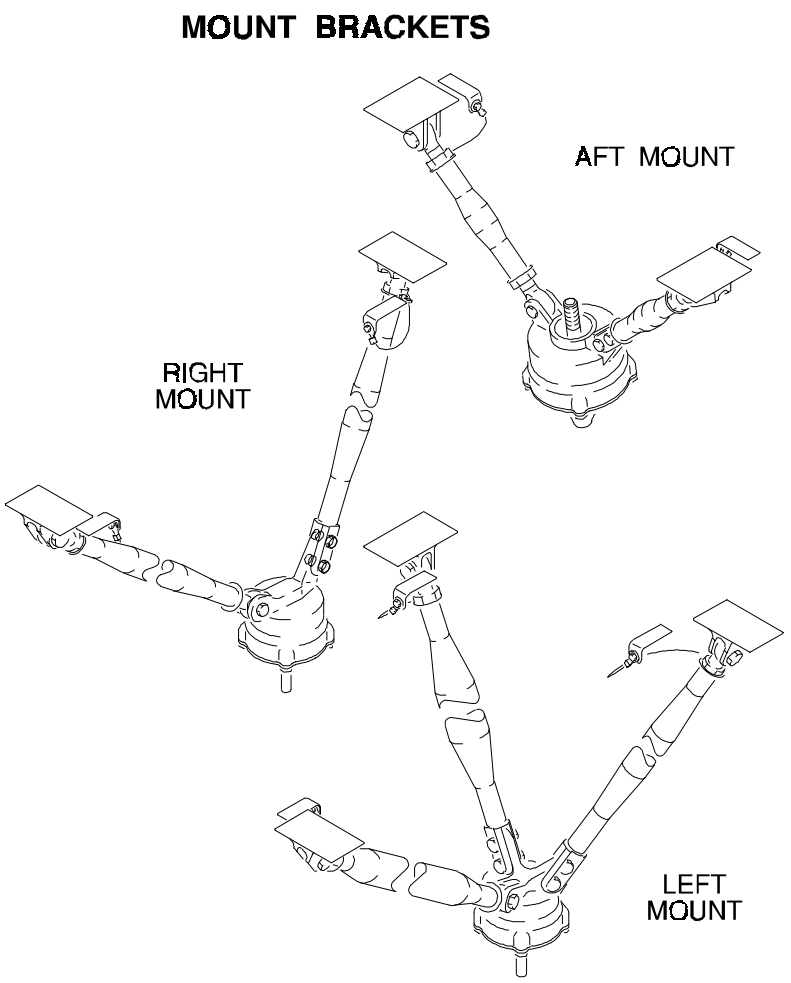
COMPONENT LOCATION

The mount vibration insulators comprise a housing made of stainless steel and a resilient member made of silicone elastomer compound which prevents vibration transmission.

Thread protectors are used to prevent damage when installing an APU.







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AIR INTAKE DIVERTER

ZONE : 311

COMPONENT DESCRIPTION

The diverter plate is screwed on the diverter case which is riveted to the fuselage.
The diverter increases the ram air recovery in flight and prevents any fluid from entering into the air intake on ground or in flight.

AIR INTAKE FLAP

ZONE : 313

COMPONENT DESCRIPTION

The air intake flap closes the air intake opening when the APU is not operated.
The air intake flap is hinged at its forward edge.
A flexible seal closes the clearance between the flap and the nose.

AIR INTAKE FLAP ACTUATOR

FIN : 516KB

ZONE : 313

COMPONENT DESCRIPTION

The air intake flap actuator is an electro-mechanical actuator.
The position of the air intake flap can be adjusted by adjusting the fork head of the actuator rod.

MANUAL OVERRIDE

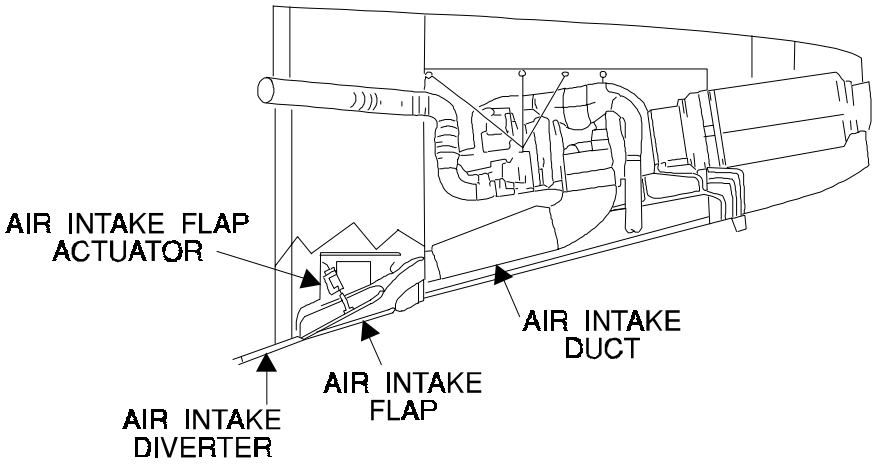
A manual override enables the air intake flap to be opened or closed using standard tools.

AIR INTAKE DUCT

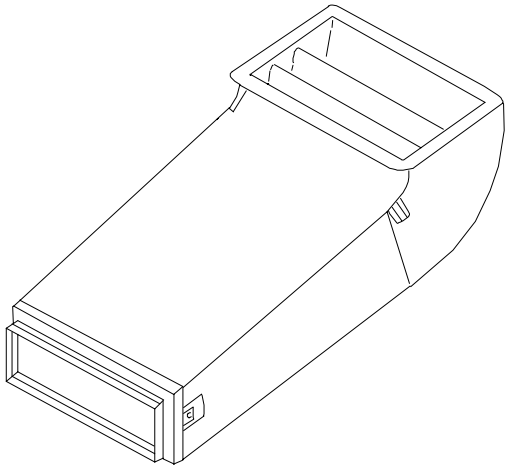
ZONE : 315

COMPONENT DESCRIPTION

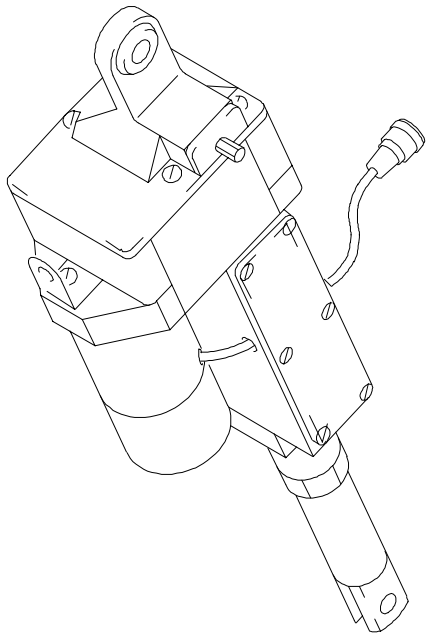
The air intake duct directs the air to the APU inlet plenum.
The air intake duct is held in position by adjustable tie-rods.



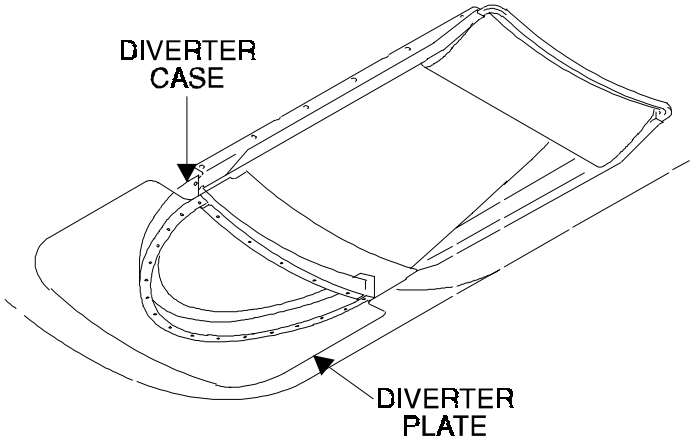
AIR INTAKE DUCT



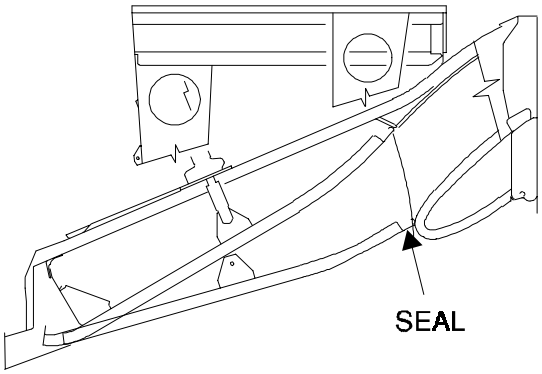
AIR INTAKE ACTUATOR



AIR INTAKE DIVERTER



AIR INTAKE FLAP



FQW4200 GE Metric

COMBUSTION CHAMBER DRAIN

ZONE : 315

COMPONENT DESCRIPTION

The drain valve is installed at the bottom of the combustion chamber. When the APU is shut down the valve opens to enable the combustion chamber to drain.

When the APU is running the valve is closed by air pressure.

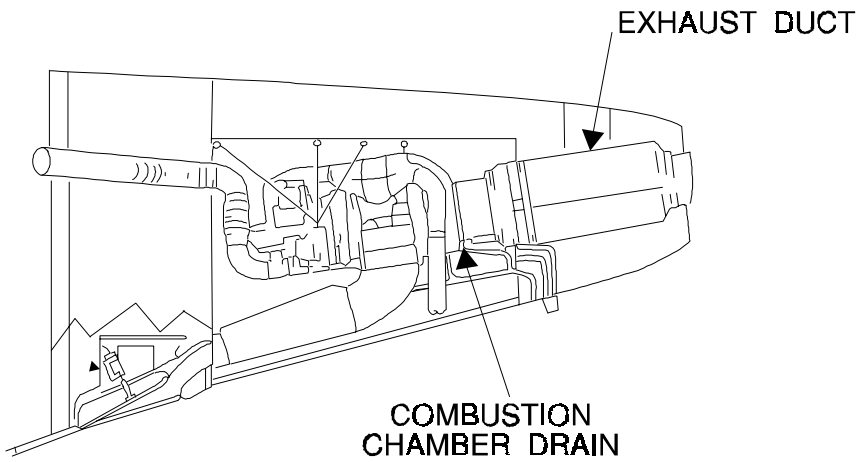
EXHAUST DUCT

ZONE : 317

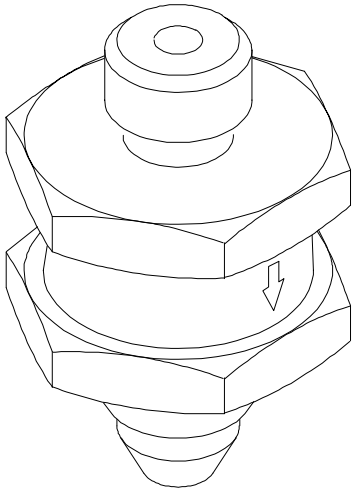
COMPONENT DESCRIPTION

The exhaust muffler provides noise reduction and thermal insulation. Guide rails on each side of the exhaust muffler enable thermal expansion.

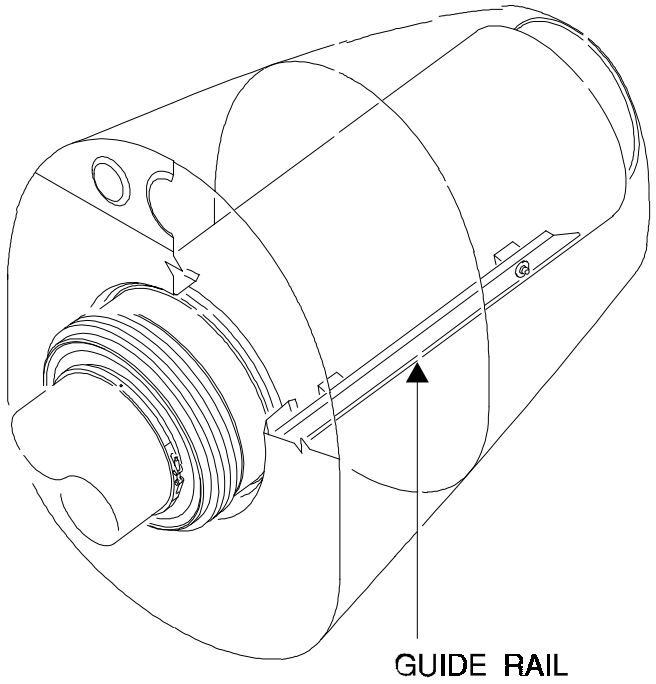
To get access to the exhaust muffler, the rear access fairing can be opened.



COMBUSTION CHAMBER DRAIN VALVE



EXHAUST DUCT



FQW4200 GE Metric

STUDENT NOTES

APU FUEL SYSTEM COMPONENTS

Fuel Control Unit
Fuel Filters
Low Pressure Switch
Flow Divider Assembly
Fuel Temperature Sensor
Fuel Nozzles
Ecology Drain Valve

SAFETY PRECAUTIONS

Pull and tag the appropriate circuit breakers.

Do not touch the APU until it is sufficiently cool to prevent burns when you do the maintenance tasks.

Do not forget to purge the fuel supply line after component change.

STUDENT NOTES

FUEL CONTROL UNIT

FIN : 59KF19

ZONE : 315

COMPONENT DESCRIPTION

The Fuel Control Unit comprises a high pressure gear pump, a torque motor metering valve, a fuel shut-off solenoid valve and an actuator pressure regulating valve.

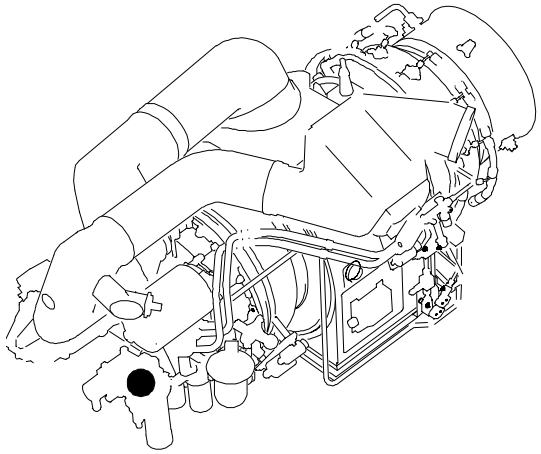
LOW PRESSURE SWITCH

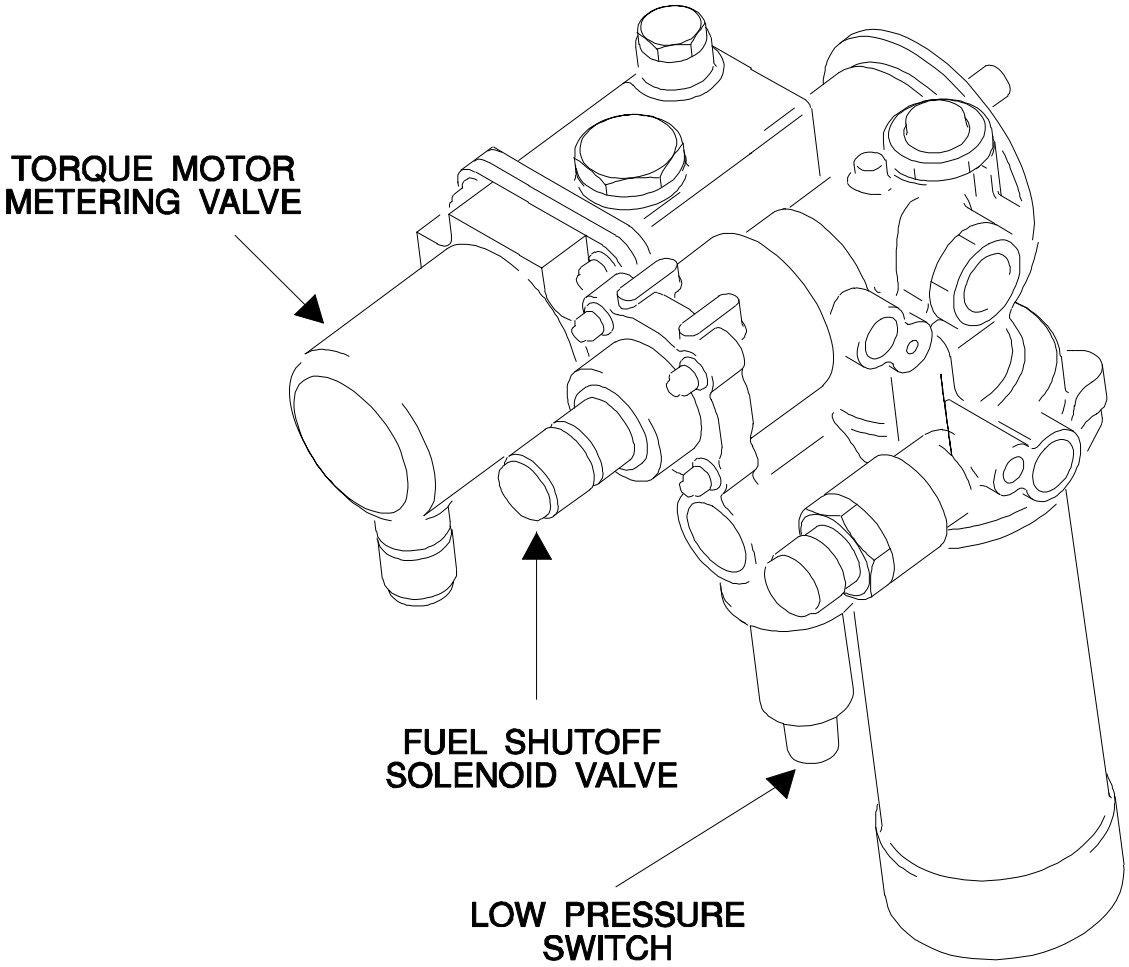
FIN : 59KF17

ZONE : 315

COMPONENT DESCRIPTION

The low pressure switch is mounted at the fuel filter inlet and monitors the aircraft APU fuel pumps.
The pressure switch closes at 15 psi and opens at 19.5 psi.





FQW4200 GE Metric

FUEL FILTERS

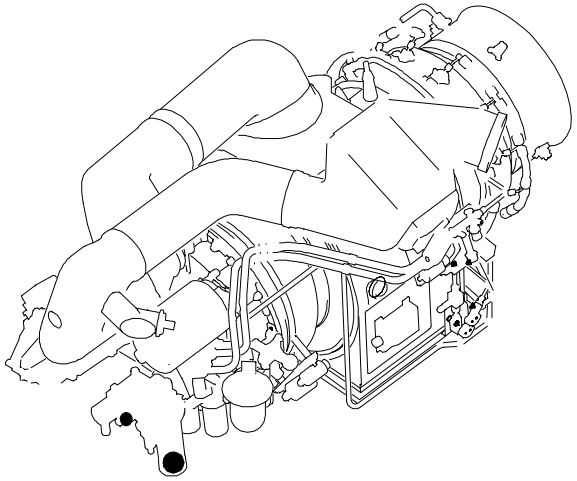
ZONE : 315

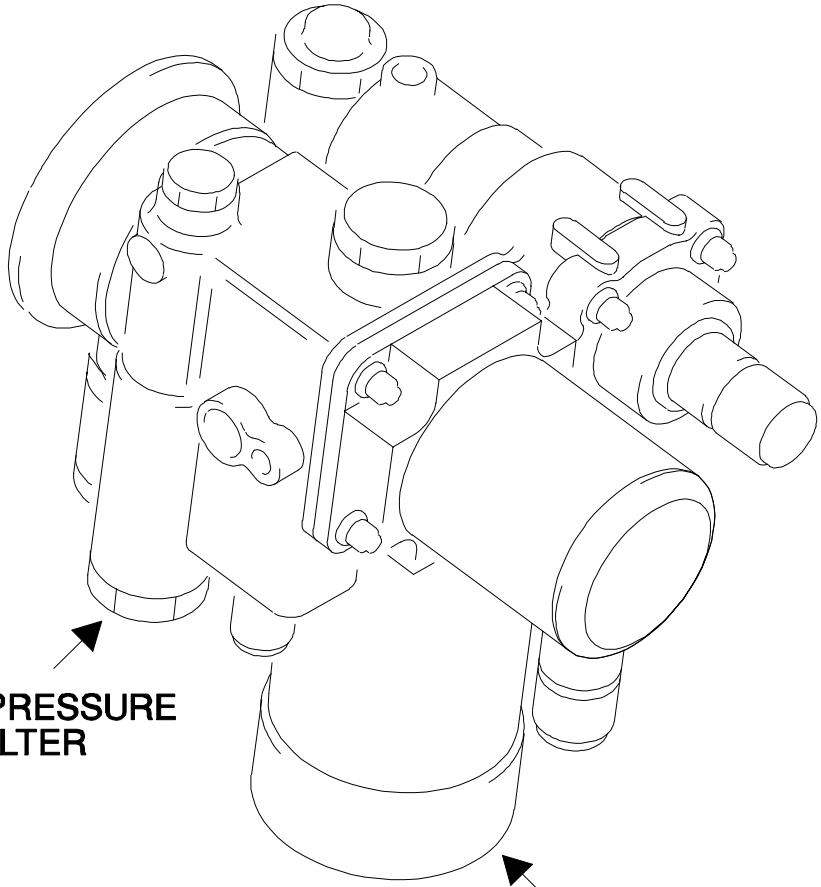
COMPONENT DESCRIPTION

The inlet fuel filter is a non cleanable cartrige type.
The filter element is specified to 10 microns nominal, 40 microns absolute.
The high pressure filter is a cleanable wire screen element with a filtration rate of 40 microns nominal.

CLOGGING INDICATOR

The inlet fuel filter clogging indicator pops out when the differential pressure across the filter reaches 5 psi.
The pop out indicator is reset by hand.
The inlet filter is equipped with a by-pass valve which opens when the differential pressure across the filter reaches 8 psid.





FQW4200 GE Metric

FLOW DIVIDER ASSEMBLY

FIN : 59KF25

ZONE : 315

COMPONENT DESCRIPTION

The flow divider assembly divides the fuel into primary and secondary flows.
Primary and secondary fuel outlet fittings have different sizes to avoid any error during installation.

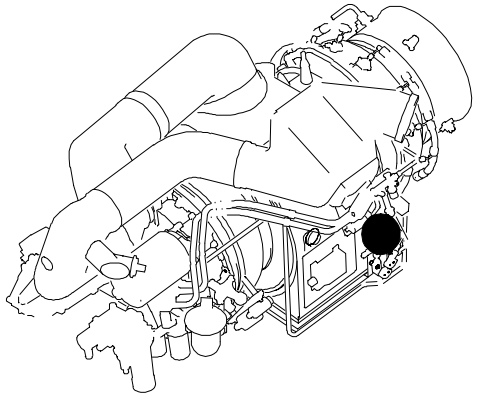
FUEL TEMPERATURE SENSOR

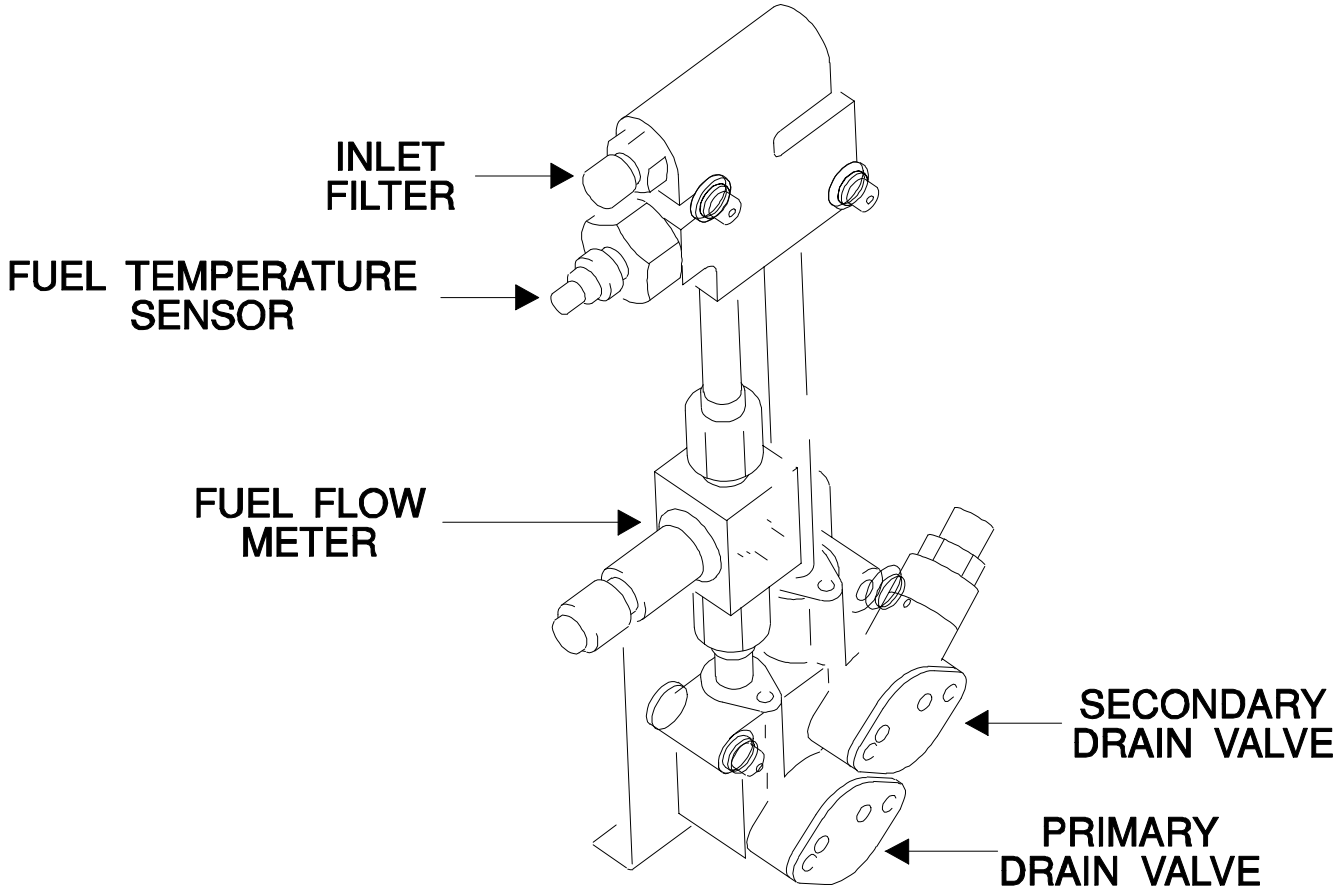
FIN : 59KF6

ZONE : 315

COMPONENT DESCRIPTION

The fuel temperature taken at the flow divider inlet is used for fuel flow schedule.
The temperature sensor is of the resistance temperature detector type.





FQW4200 GE Metric

FUEL NOZZLES

FIN : 5100KF1

ZONE : 315/316

COMPONENT DESCRIPTION

The fuel atomizers have two flow paths (primary and secondary) and different diameter connections.
The air shroud protects the atomizer against heat from the combustion chamber.

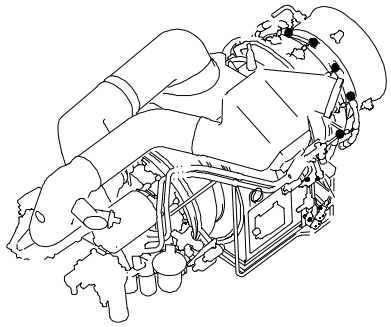
ECOLOGY DRAIN VALVE

FIN : 59KF28

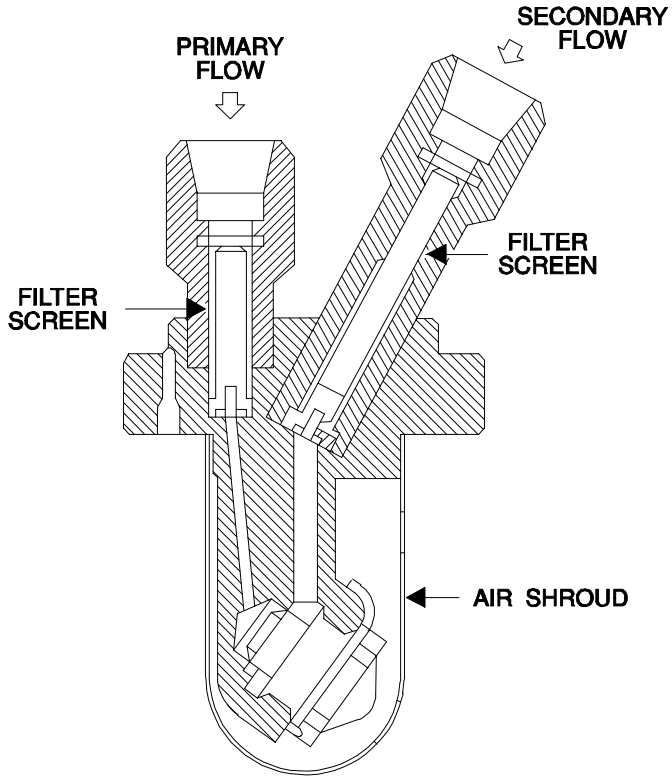
ZONE : 315

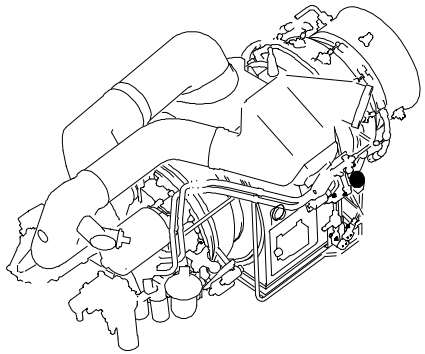
COMPONENT DESCRIPTION

The ecology drain valve is used to blow out the fuel manifolds during shutdown.
The ecology drain solenoid valve is normally closed, it opens when the solenoid is energized.

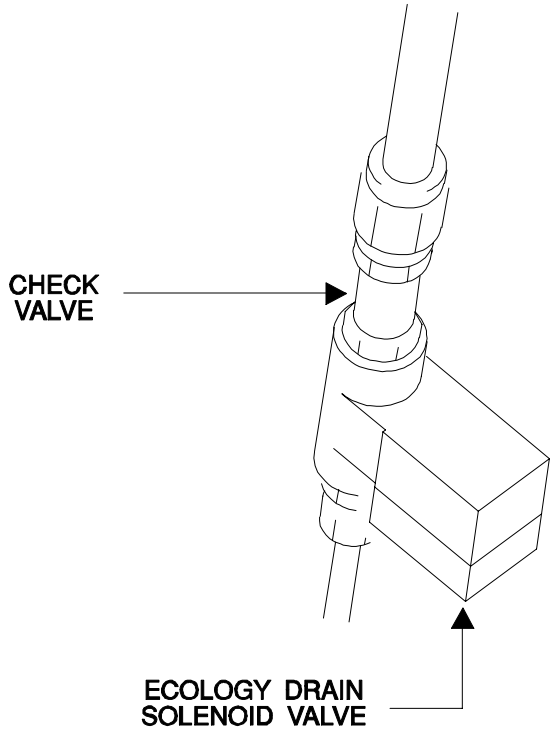


FUEL MANIFOLD AND NOZZLES





ECOLOGY DRAIN VALVE



FQW4200 GE Metric

STUDENT NOTES

APU OIL SYSTEM COMPONENTS

Oil Pump
Oil Filters
Oil Cooler
High Oil Temperature Sensor
Low Oil Pressure Switch
Low Oil Level Switch
Low Oil Temperature Switch
Electrical Chip Detector
Oil Heater

SAFETY PRECAUTIONS

Pull and tag the appropriate circuit breakers.

Do not touch the APU until it is sufficiently cool to prevent burns when you do the maintenance tasks.

STUDENT NOTES

OIL PUMP

FIN : 5100KT14

ZONE : 315

COMPONENT DESCRIPTION

The oil pump module comprises :

- 3 lubrication elements, 2 generator scavenge elements, 1 aft sump scavenge element, 1 mid sump scavenge element, a pressure relief valve, a pressure regulating valve and a de-oiling solenoid valve.

OIL FILTERS

ZONE : 315

COMPONENT DESCRIPTION

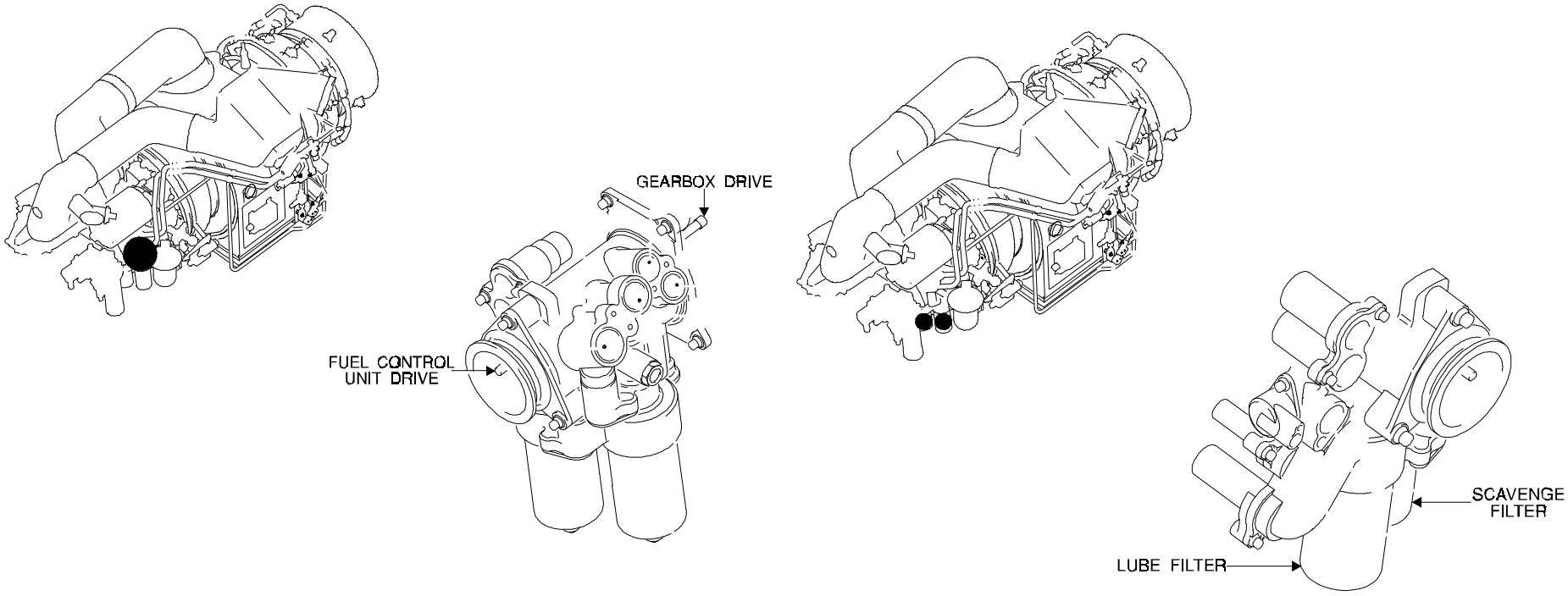
There are two disposable filters :

- lubrication filter
- generator scavenge filter

Each filter is equipped with a by-pass valve which opens when the differential pressure across the filter reaches 65 psid.

CLOGGING INDICATOR

Each filter is equipped with a clogging indicator which pops out when the differential pressure across the filter reaches 33 psid.
Each clogging indicator is reset by pushing it into its housing.



FQW4200 GE Metric

OIL COOLER

FIN : 5100KT8

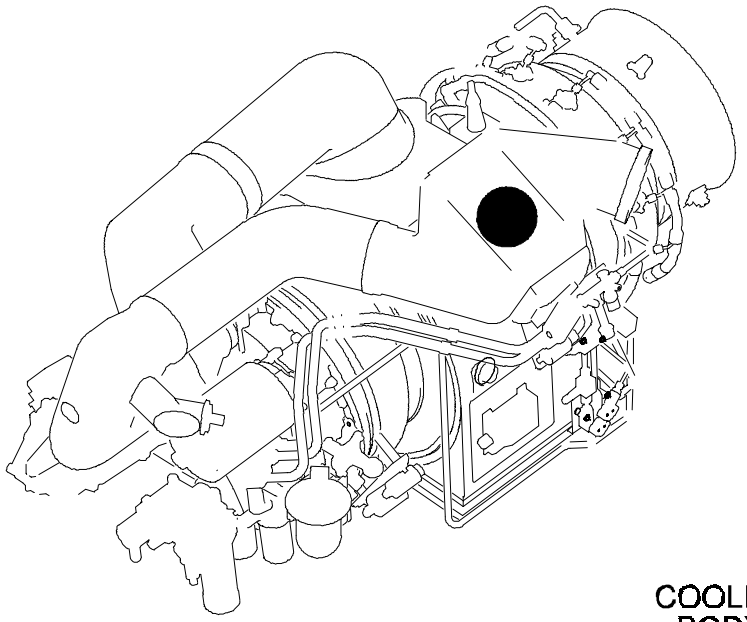
ZONE : 315

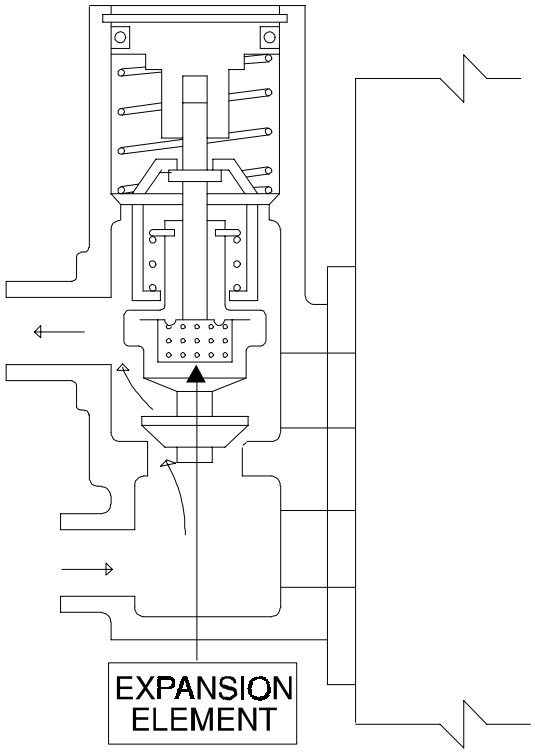
COMPONENT DESCRIPTION

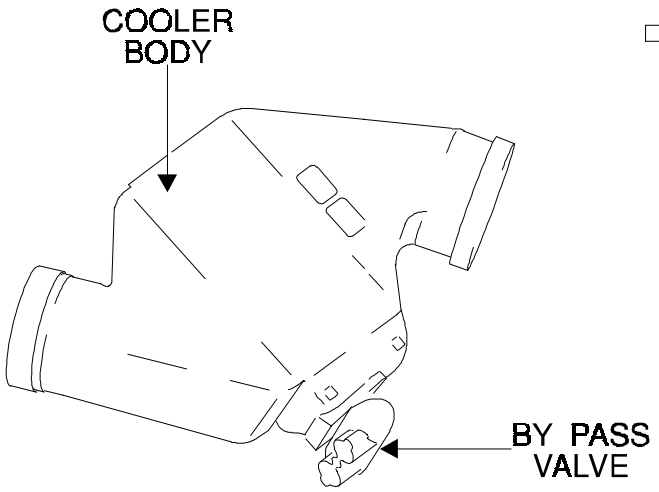
The oil cooler maintains the oil temperature within limits.
The cooler is protected against high oil pressure by a thermal by-pass valve.

BY-PASS VALVE

The expansion element allows the oil to by-pass the cooler when the oil temperature is less than 60°C (140°F).
The spring allows the cooler to be by-passed when it is clogged (Delta P>50 psid).







FQW4200 GE Metric

HIGH OIL TEMPERATURE SENSOR

FIN : 59KT11

ZONE : 315

COMPONENT DESCRIPTION

The temperature sensor is a resistive temperature type sensor which is installed downstream of the oil cooler.
The oil temperature is used to initiate an APU shutdown when the temperature is above 147°C (297 °F).

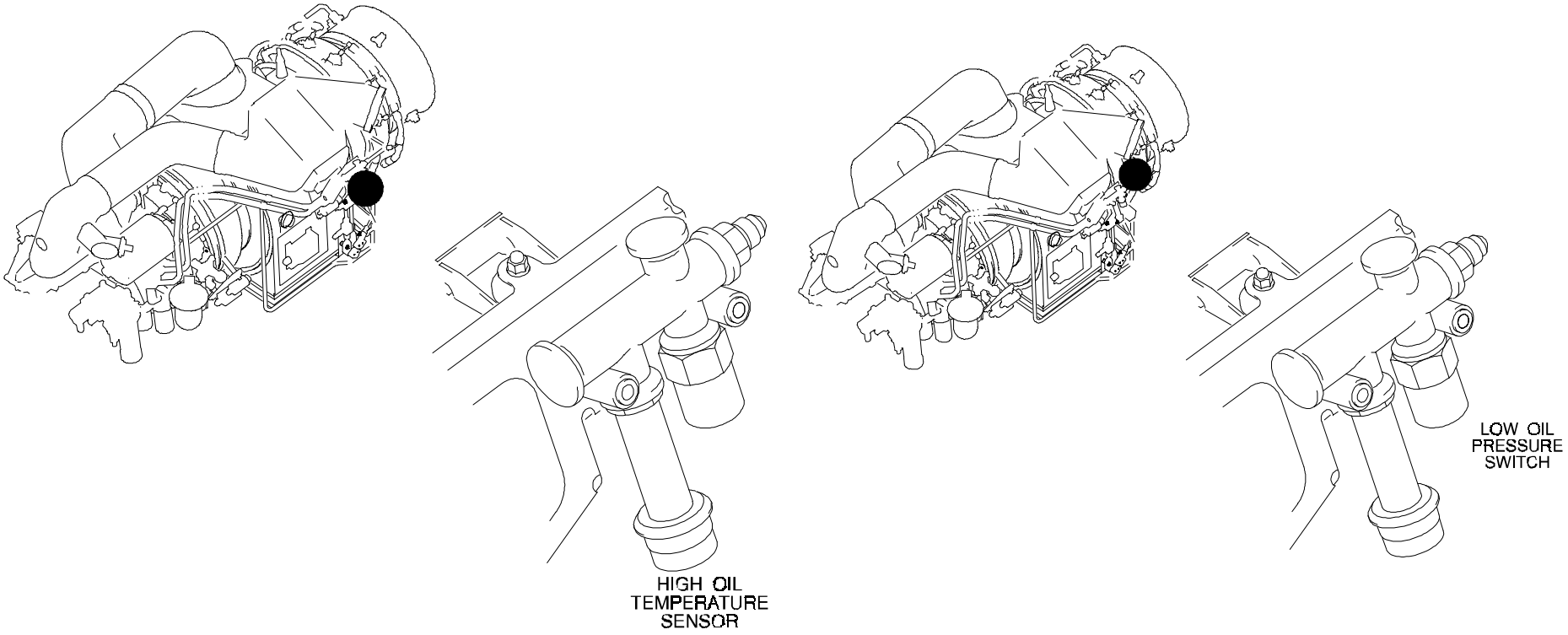
LOW OIL PRESSURE SWITCH

FIN : 59KT14

ZONE : 315

COMPONENT DESCRIPTION

The low oil pressure switch is installed downstream of the oil cooler. The pressure switch closes at 28 psi and opens at 38 psi.
The low oil pressure signal is used to initiate an APU automatic shutdown.



FQW4200 GE Metric

LOW OIL LEVEL SWITCH

FIN : 59KT8

ZONE : 315

COMPONENT DESCRIPTION

The oil low quantity switch is of a floating magnet type which operates two redundant switches connected to the ECB.
The switches are triggered when the oil quantity decreases below 4.4 l (1.16 US gal).

LOW OIL TEMPERATURE SWITCH

FIN : 59KT9

ZONE : 315

COMPONENT DESCRIPTION

The low oil temperature switch is mounted on the accessory gearbox. It switches at 20°F (-6.6°C).
The low oil temperature signal is used to control the de-oiling solenoid valve .

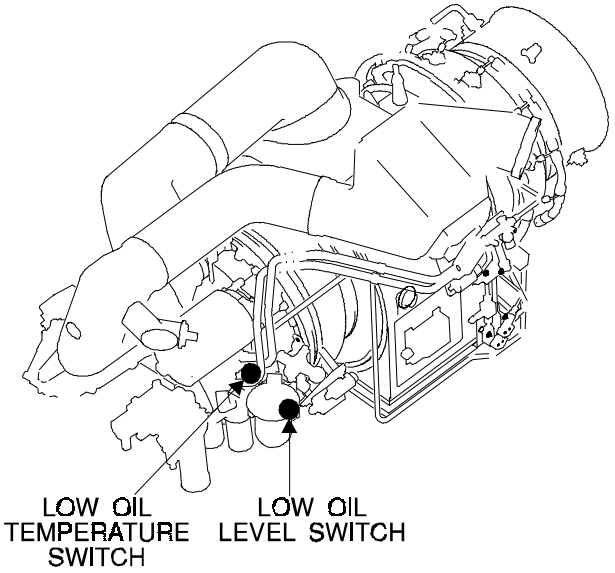
ELECTRICAL CHIP DETECTOR

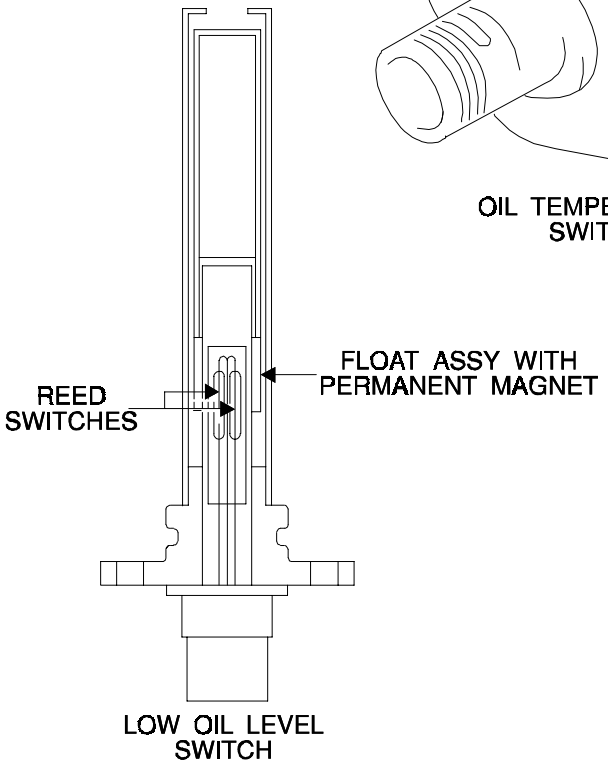
FIN : 59KT5

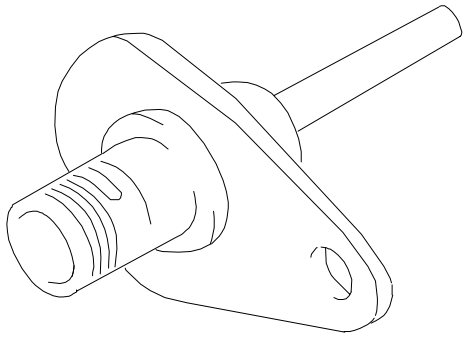
ZONE : 315

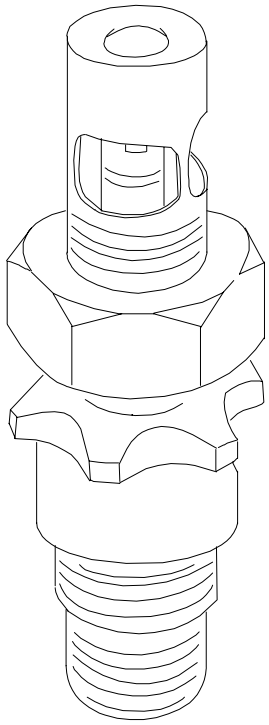
COMPONENT DESCRIPTION

The electrical chip detector is mounted at the bottom of the accessory gearbox in the oil drain plug.
The drain plug has a check valve which closes to prevent oil leakage when the chip detector is removed.









FQW4200 GE Metric

OIL HEATER

FIN : 59KT16

ZONE : 315/316

COMPONENT DESCRIPTION

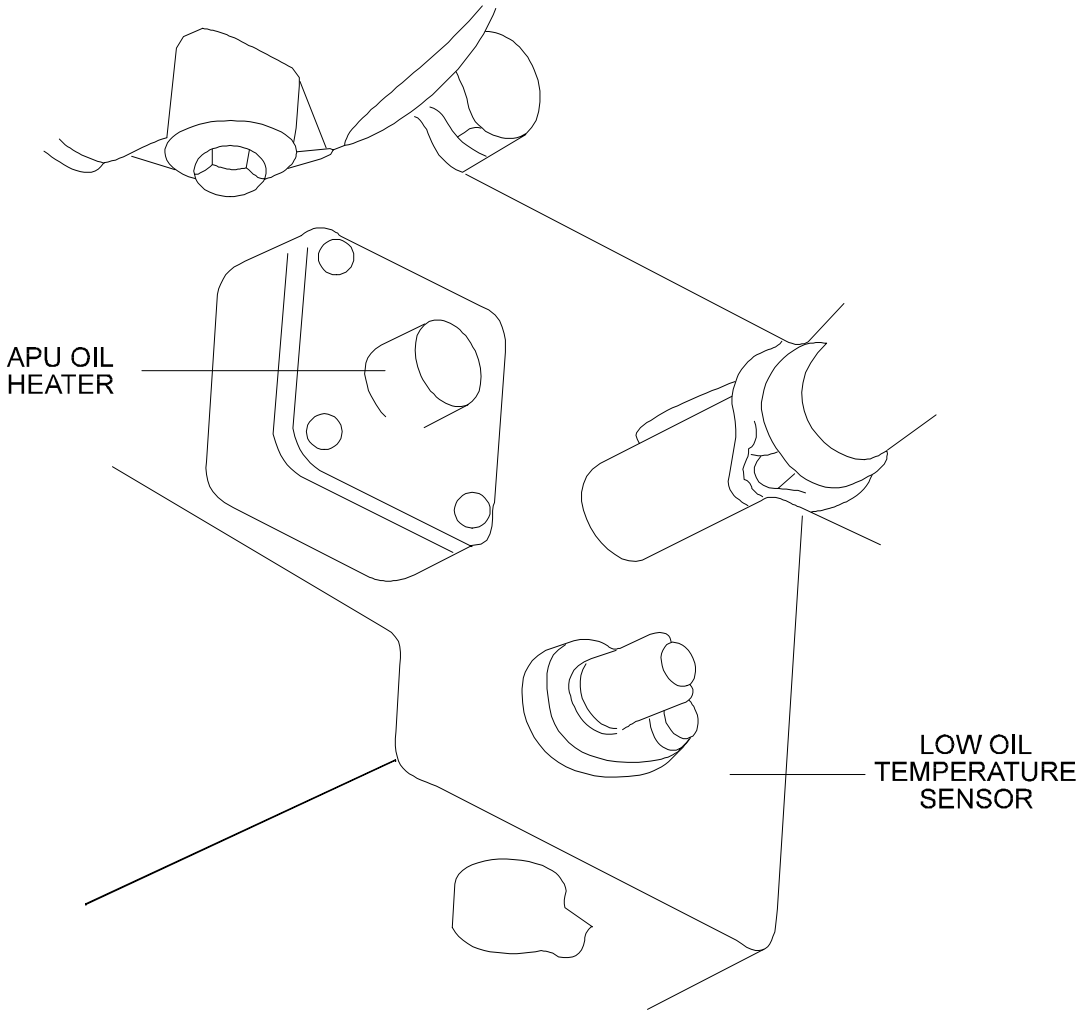
The APU OIL HEATER has an oil temperature switch and a heater coil.

The heater is energized with Master Switch OFF when the oil temperature in the tank is below 21 °C (70 °F).

It is de-energized when the Master Switch is set to ON.

COMPONENT LOCATION

The OIL HEATER is fitted on the front lower part of the APU gearbox.



FQW4200 GE Metric

STUDENT NOTES

APU AIR SYSTEM COMPONENTS

Safety Precautions
Bleed Load Valve
Surge Control Valve
Inlet Guide Vane (IGV) Actuator
Cooling Fan
Compartment Cooling Valve
Inlet Pressure Transducer
Bleed Flow Sensor
Load Compressor Inlet Temperature (LCIT) Sensor
Load Compressor Outlet Temperature (LCOT) Sensor

SAFETY PRECAUTIONS

Pull and tag the appropriate circuit breakers.

Do not touch the APU until it is sufficiently cool to prevent burns when you do the maintenance tasks.

STUDENT NOTES

BLEED LOAD VALVE

FIN : 59KH7

ZONE : 316

COMPONENT DESCRIPTION

The APU bleed valve controls the airflow to the aircraft pneumatic system.

The bleed valve is a shut-off valve spring loaded to close. The valve is electrically controlled and pneumatically operated.

POSITION INDICATOR

To help maintenance and trouble shooting, the bleed valve is equipped with a visual position indicator.

SURGE CONTROL VALVE

FIN : 59KH18

ZONE : 316

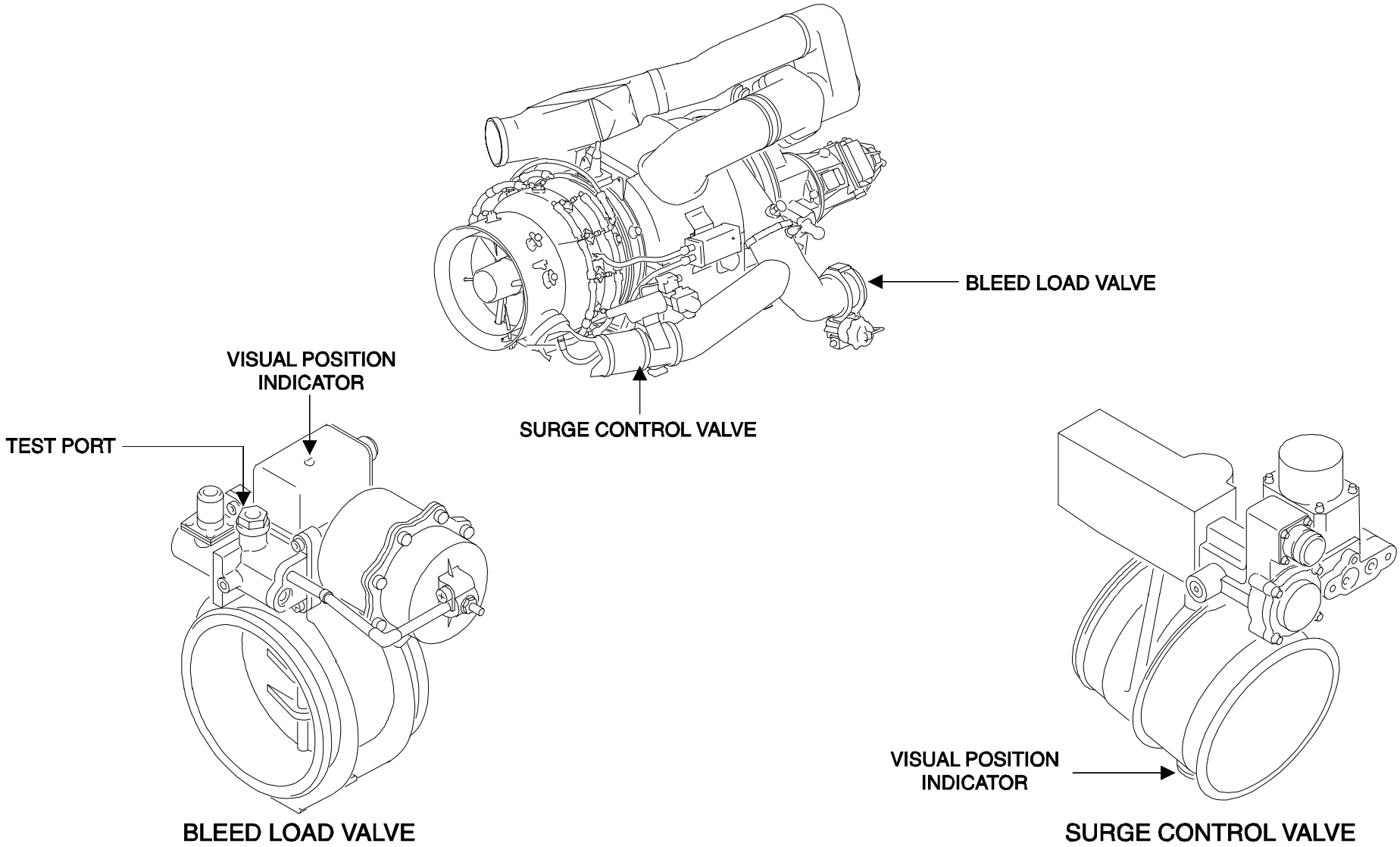
COMPONENT DESCRIPTION

The surge control valve prevents load compressor surge.

The valve is a modulating valve hydraulically operated by fuel and electrically controlled by a torque motor.

POSITION INDICATOR

To help maintenance and trouble shooting, the surge control valve is equipped with a visual position indicator.



FQW4200 GE Metric

INLET GUIDE VANE (IGV) ACTUATOR

FIN : 59KE21

ZONE : 315

COMPONENT DESCRIPTION

The Inlet Guide Vane actuator controls the airflow to the load compressor. The actuator is a hydromechanical actuator operated by fuel and electrically controlled by a torque motor.
The actuator rod is equipped with an adjustable linkage.

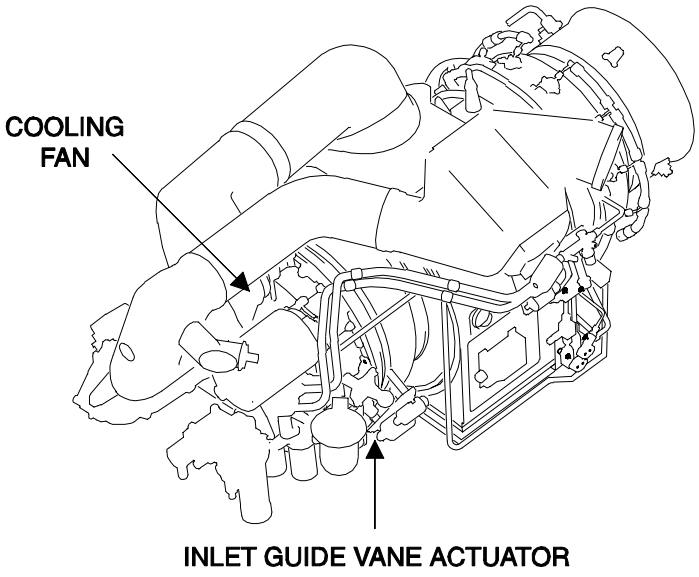
COOLING FAN

FIN : 5100KH6

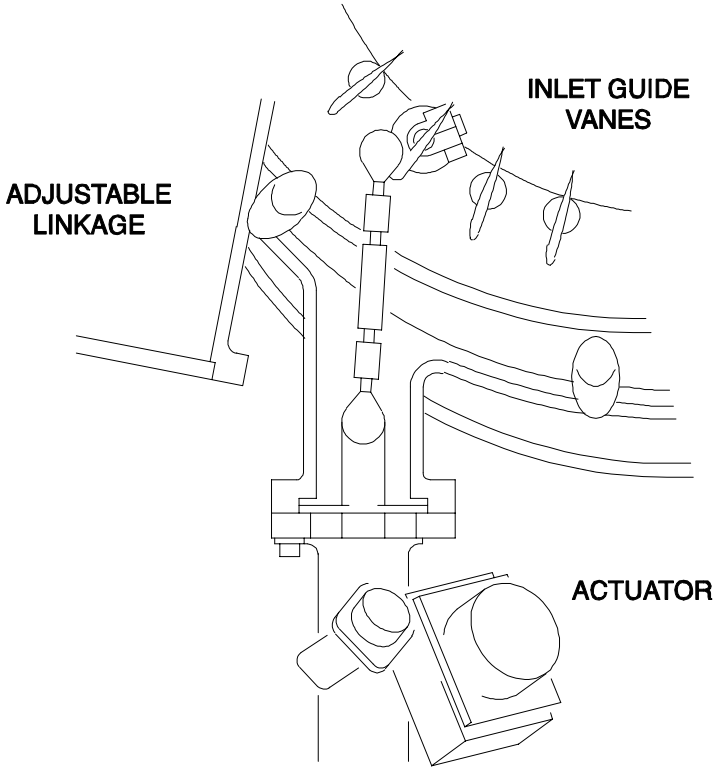
ZONE : 316

COMPONENT DESCRIPTION

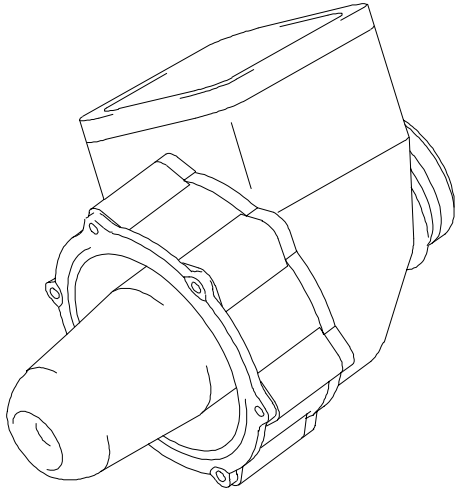
Air used for compartment cooling and oil cooler is drawn for the inlet plenum by the cooling fan. The cooling fan assembly includes a rotor, a stator, supporting bearings and the driving gear. The assembly is mounted with a V-clamp on gearbox.



INLET GUIDE VANE ACTUATOR



COOLING FAN



FQW4200 GE Metric

COMPARTMENT COOLING VALVE

FIN : 5100KH7

ZONE : 315

COMPONENT DESCRIPTION

The compartment cooling valve controls the cooling air. The valve closes progressively as the altitude increases. The valve is pneumatic and spring loaded closed.
The position of the valve is not monitored.

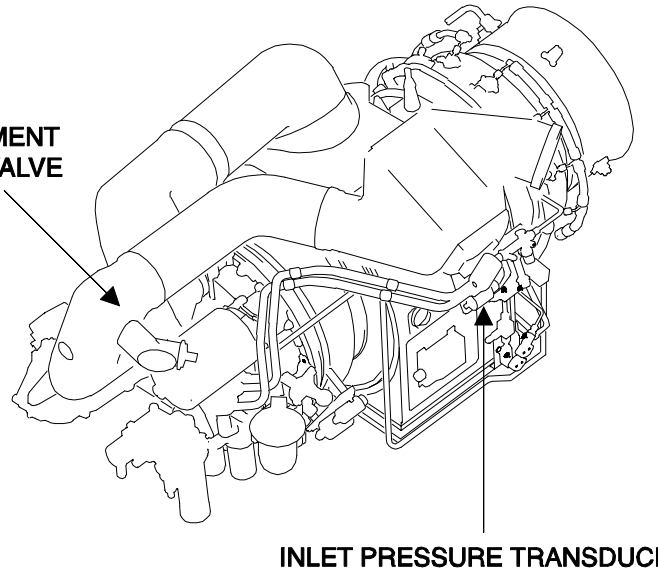
INLET PRESSURE TRANSDUCER

FIN : 59KE22

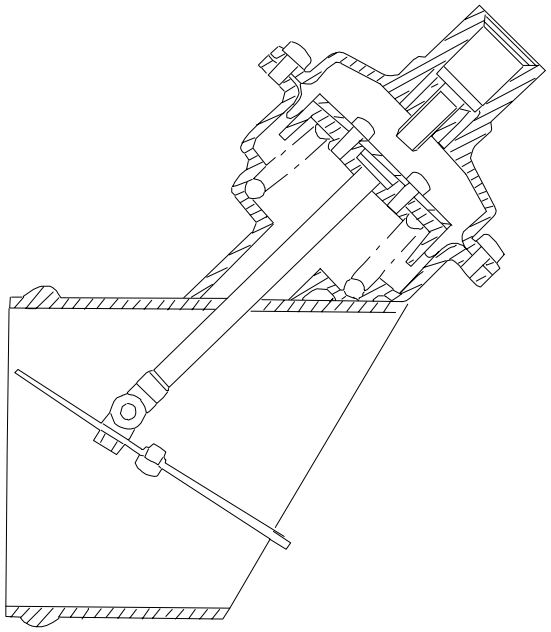
ZONE : 315

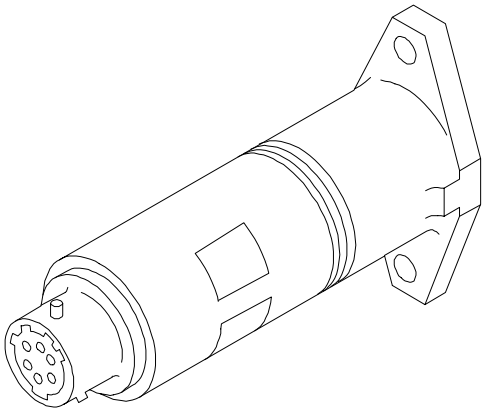
COMPONENT DESCRIPTION

The inlet pressure is used for fuel flow schedule and to inhibit bleed air use above 23,000ft.
The inlet pressure transducer is equipped with a steel diaphragm and strain gauges.



COMPARTMENT COOLING VALVE





INLET PRESSURE TRANSDUCER

FQW4200 GE Metric

BLEED FLOW SENSOR

FIN : 59KH23

ZONE : 315

COMPONENT DESCRIPTION

The flow sensor is used to control the surge valve.
The flow sensor includes a total pressure transducer and a differential pressure transducer.

LOAD COMPRESSOR INLET TEMPERATURE (LCIT) SENSOR

FIN : 59KE1

ZONE : 315

COMPONENT DESCRIPTION

The Load Compressor Inlet Temperature is used for fuel flow schedule, bleed airflow control and load compressor protection.
The LCIT sensor is a single element thermocouple probe made of a Chromel/Alumel wire.

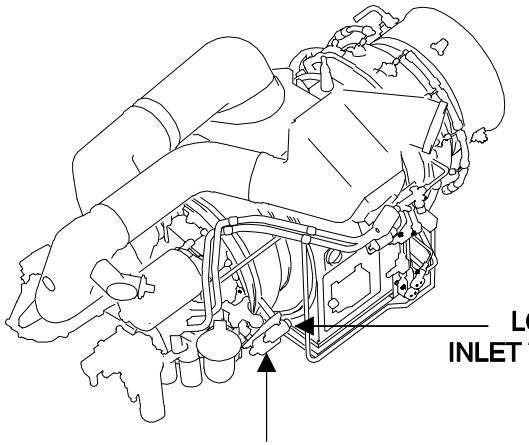
LOAD COMPRESSOR OUTLET TEMPERATURE (LCOT) SENSOR

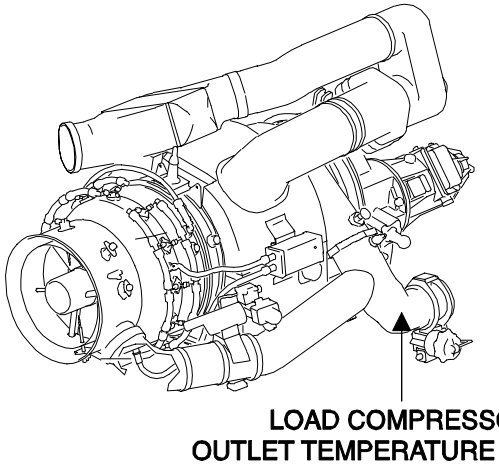
FIN : 59KE2

ZONE : 316

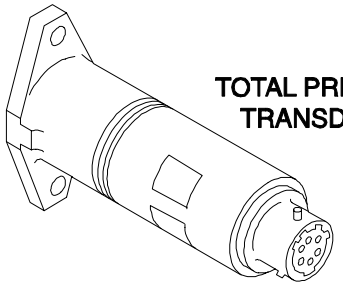
COMPONENT DESCRIPTION

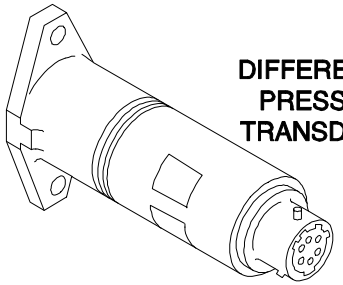
The Load Compressor Outlet Temperature is used to monitor efficiency of the load compressor.
The LCOT sensor is a single element thermocouple probe made of a Chromel/Alumel wire.



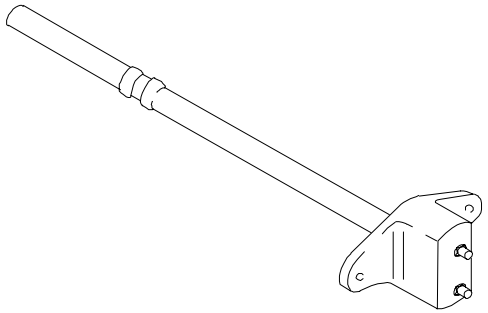


BLEED FLOW SENSOR

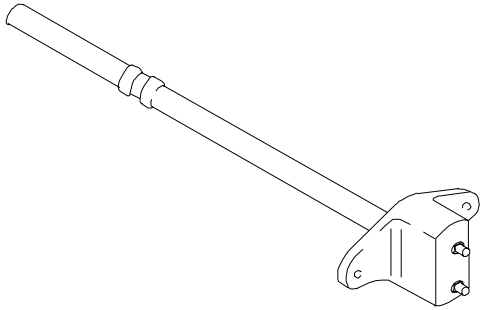




LOAD COMPRESSOR
INLET TEMPERATURE SENSOR



LOAD COMPRESSOR
OUTLET TEMPERATURE SENSOR



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STUDENT NOTES

APU IGNITION AND STARTING COMPONENTS

Starter Motor
Starter Clutch Module
Start Contactors
Ignition Box
Ignition Leads
Ignition Plugs

SAFETY PRECAUTIONS

Pull and tag the appropriate circuit breakers.

Do not touch the APU until it is sufficiently cool to prevent burns when you do the maintenance tasks.

The ignition system is a high current and voltage system.
Precautions have to be taken when working on the ignition box, leads and plugs.

STUDENT NOTES

STARTER MOTOR

FIN : 8KA

ZONE : 315

COMPONENT DESCRIPTION

The starter is a DC motor which provides initial rotation of the APU.
The starter is attached by a V-clamp to the accessory gearbox.
Three consecutive start attempts are allowed without cooldown.
After third start attempt, the starter must cool down for at least 1 hour.

MANUAL DRIVE START

The starter motor is equipped with a manual drive shaft used to rotate the APU spool for borescope inspection.

BRUSH WEAR INDICATOR

The starter is equipped with a brush wear indicator showing a green pin. When the green pin is no longer visible, the starter must replaced.

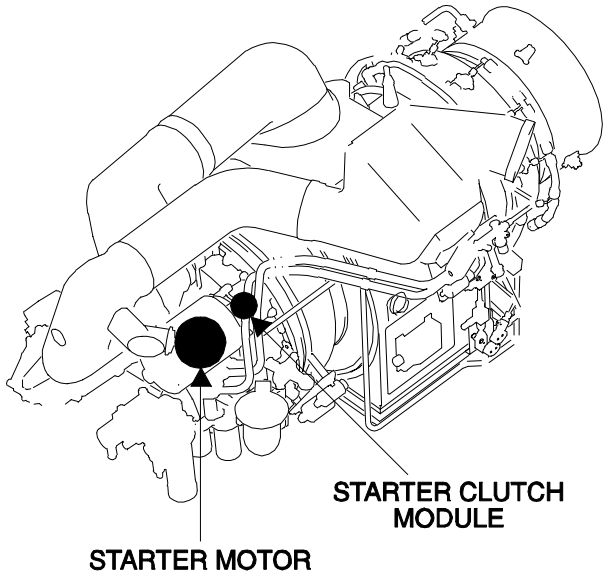
STARTER CLUTCH MODULE

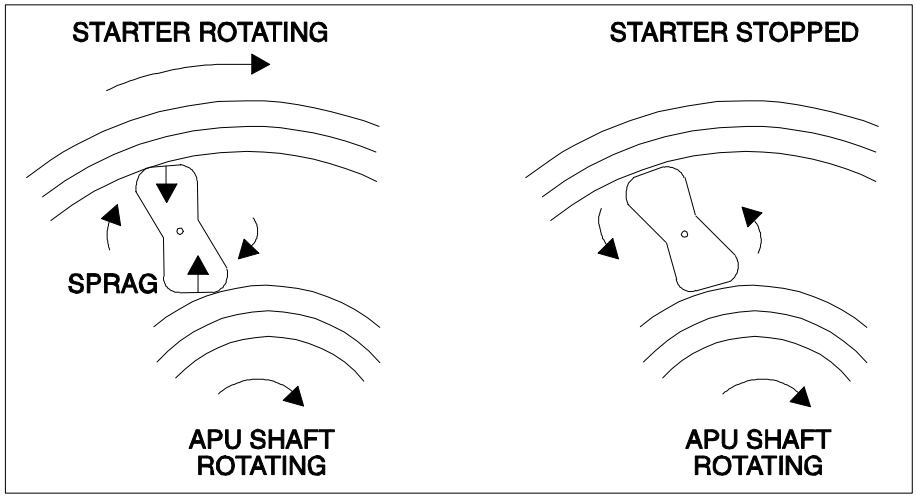
FIN : 5100KA5

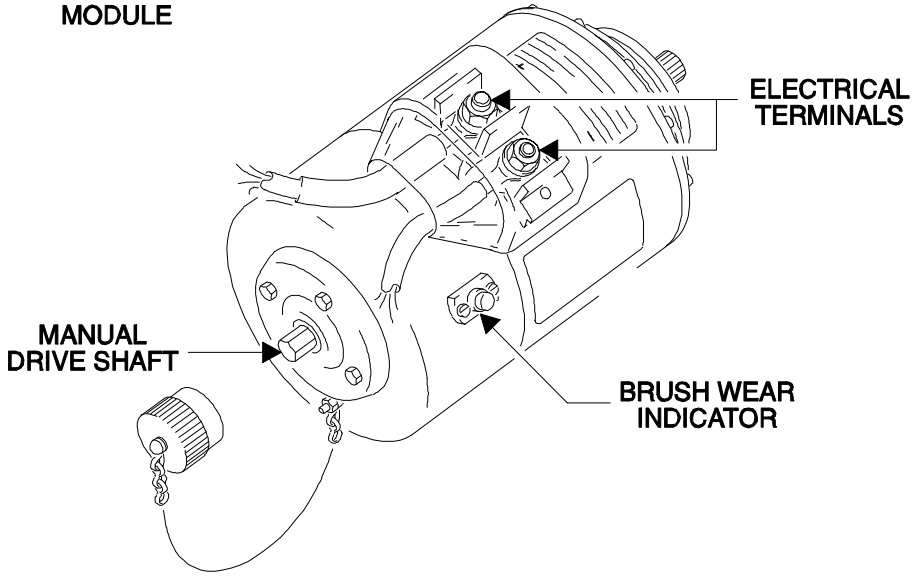
ZONE : 315

COMPONENT DESCRIPTION

The starter clutch module is a kind of free- wheel.
When the starter turns, the friction locks the sprags between the races of the gearbox splined shaft and the starter gear shaft.







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START CONTACTORS

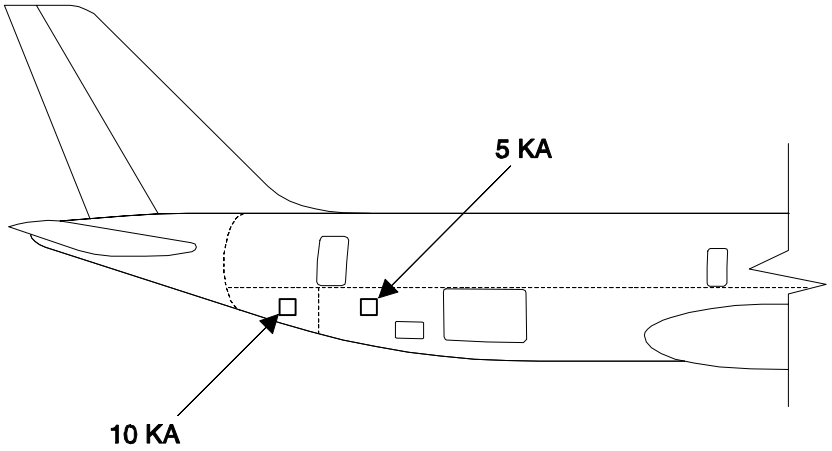
FIN : 5KA
10KA

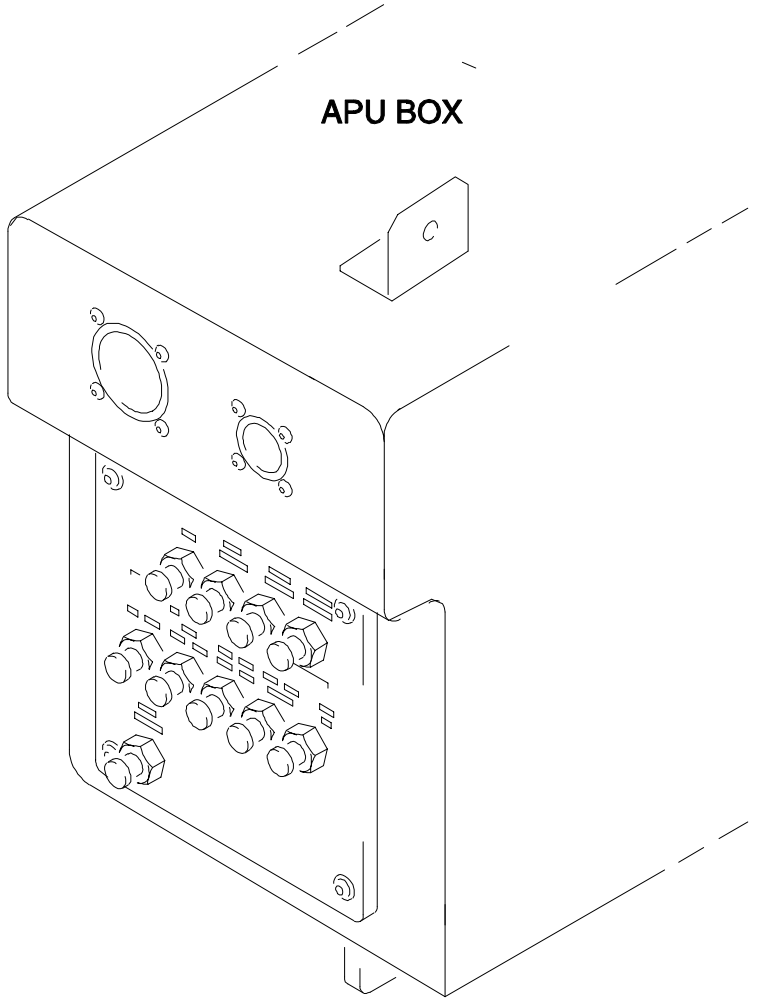
ZONE : 162
172

COMPONENT DESCRIPTION

The start contactors are controlled by the ECB during APU starting. Each contactor is a heavy duty contactor which supplies electrical power to the starter motor.

Start contactor 5KA is installed in the APU box, whereas contactor 10KA is installed in a specific box behind the rear cargo compartment.





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IGNITION BOX

FIN : 59KA10

ZONE : 316

COMPONENT DESCRIPTION

The ignition exciter is a high energy and voltage device.
A transformer supplies four joule nominal energy and 18 KV voltage to the igniter plugs.
The ignition exciter provides two sparks per second.

IGNITION LEADS

FIN : 59KA32
59KA33
ZONE : 315
316

COMPONENT DESCRIPTION

The ignition leads are made of a teflon insulated center conductor shielded with copper inner braid.

IGNITION PLUGS

FIN : 59KA31

ZONE : 315
316

COMPONENT DESCRIPTION

The igniter plugs consist of :

- the electrode,
- the insulator,
- two piece outer shell.

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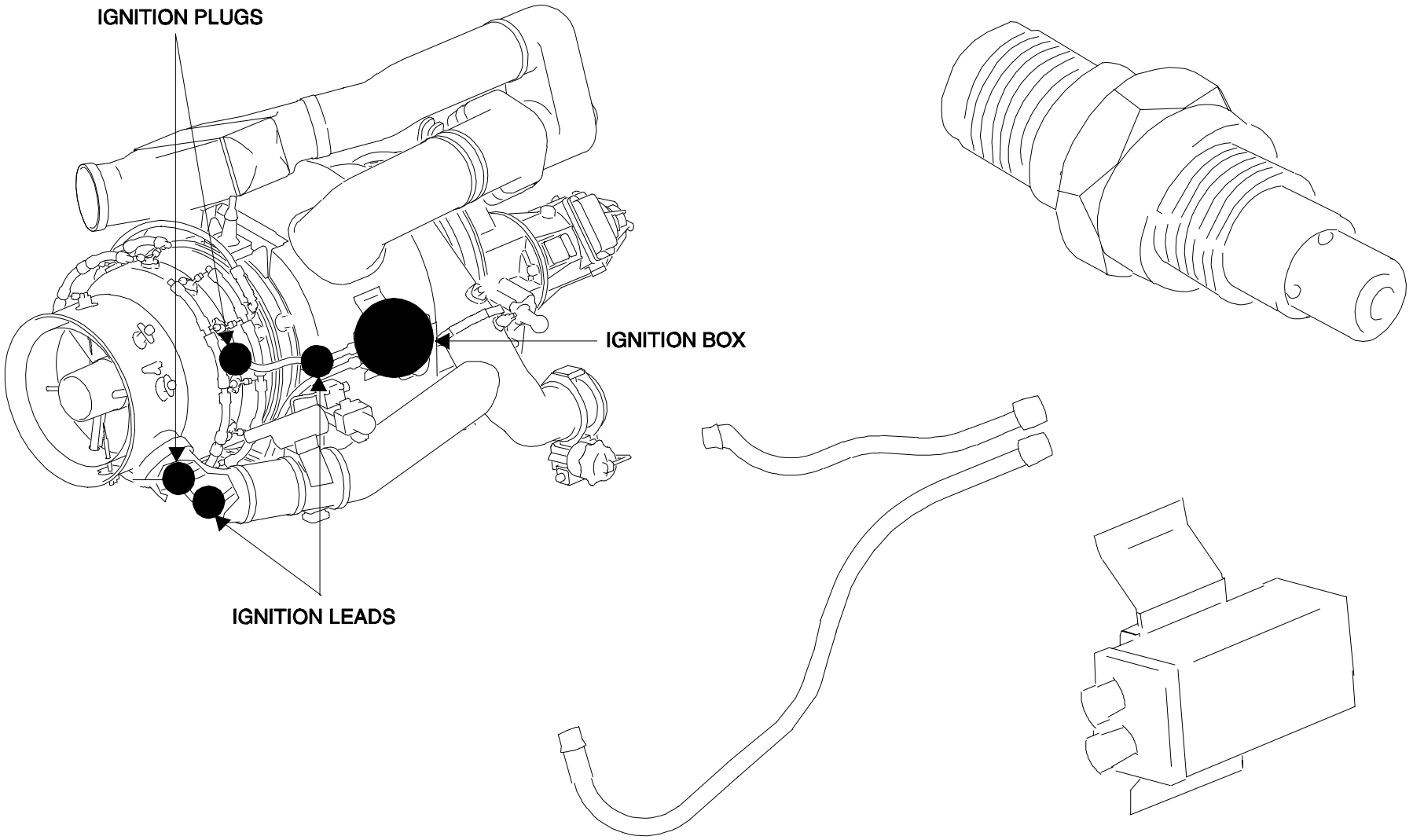

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STUDENT NOTES

APU CONTROL AND MONITORING COMPONENTS

Safety Precautions
Electronic Control Box
APU Box
Speed Sensors
EGT Thermocouples
Memory Module

SAFETY PRECAUTIONS

Pull and tag the appropriate circuit breakers.

Do not touch the APU until it is sufficiently cool to prevent burns when you do the maintenance tasks.

STUDENT NOTES

ELECTRONIC CONTROL BOX

FIN : 59KB

ZONE : 162

COMPONENT DESCRIPTION

The ECB is located in the aircraft pressurized zone in the bulk cargo compartment.

The ECB has one RS 232 test connector and one connect module.

APU BOX

FIN : 5000VE

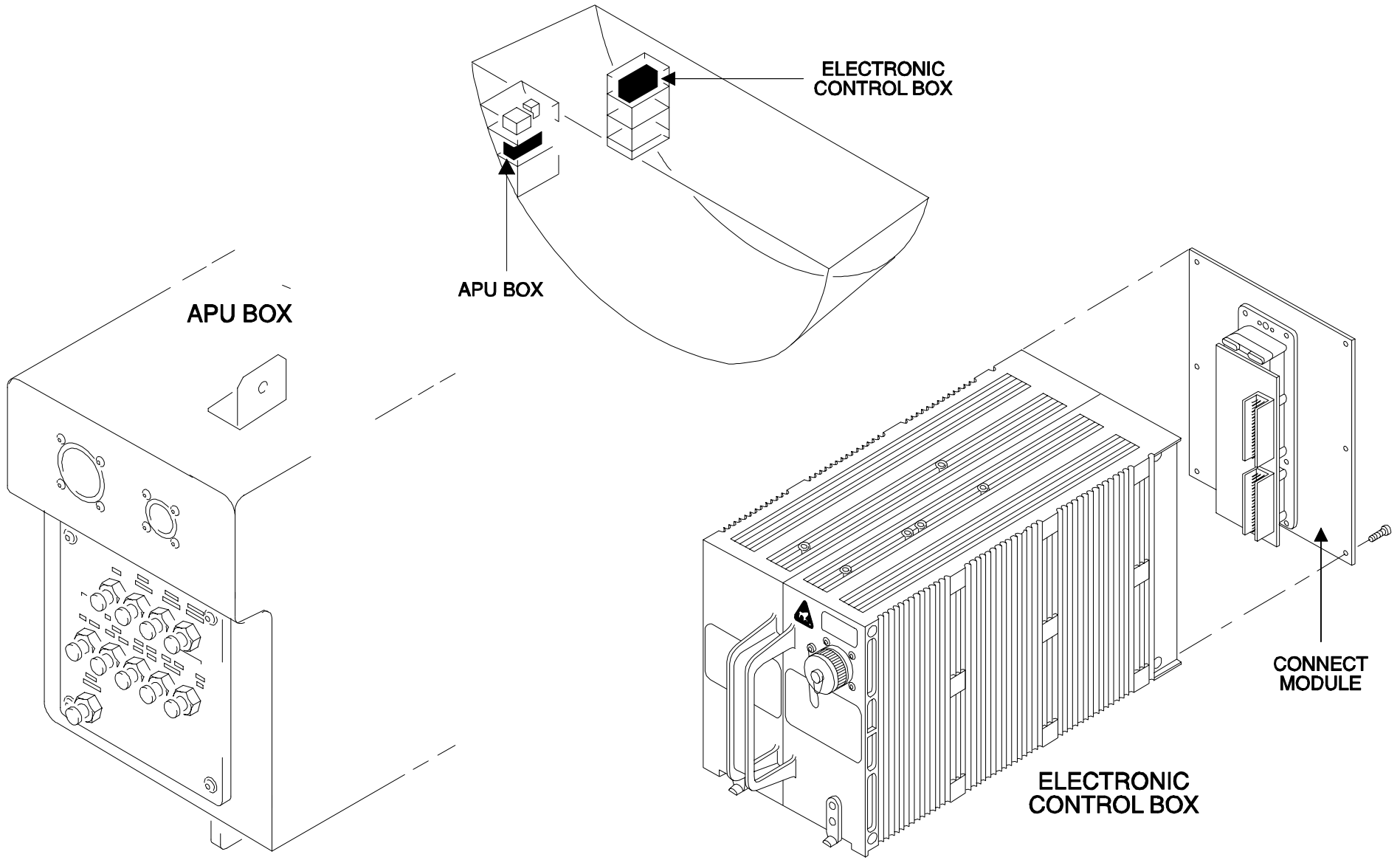
ZONE : 160

COMPONENT DESCRIPTION

The APU box is located in the aircraft pressurized zone in the bulk cargo compartment.

The APU box includes the fuses and one start contactor.

The APU circuit breakers are located on the front face of the box.



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SPEED SENSORS

FIN : 59KV26
59KV27

ZONE : 315
316

COMPONENT DESCRIPTION

Speed indication is used for indication in the cockpit and for APU control.
The speed sensor is of the permanent magnet type.
The speed sensor produces a frequency proportional to the APU speed.

EGT THERMOCOUPLES

FIN : 59KV34
59KV35

ZONE : 315
316

COMPONENT DESCRIPTION

Exhaust Gas Temperature (EGT) is used for indication in the cockpit and for APU limitation schedules.
The EGT thermocouple is a chromel allumel type which has two probes of different length.
The output voltage is fed to the ECB through a shielded cable.

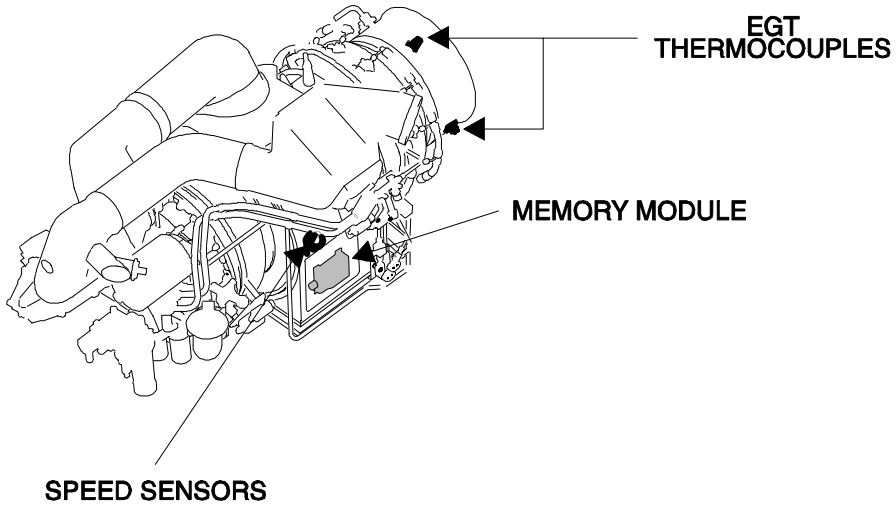
MEMORY MODULE

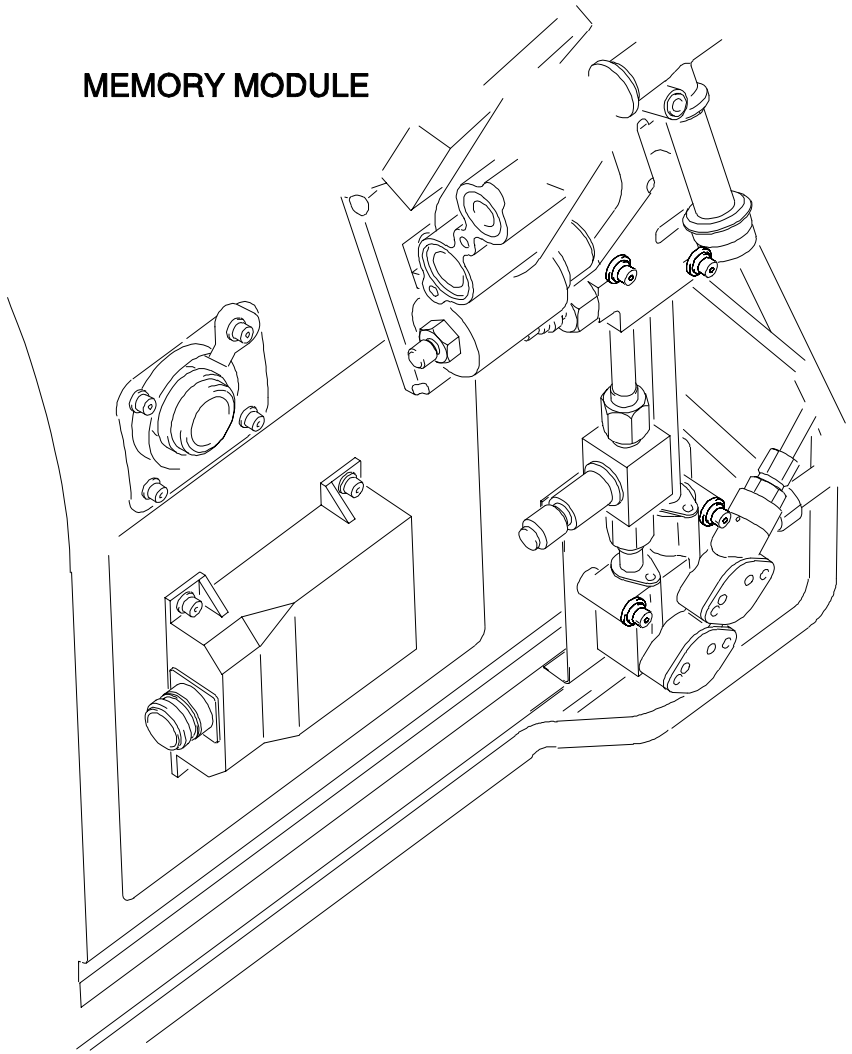
FIN : 59KV20

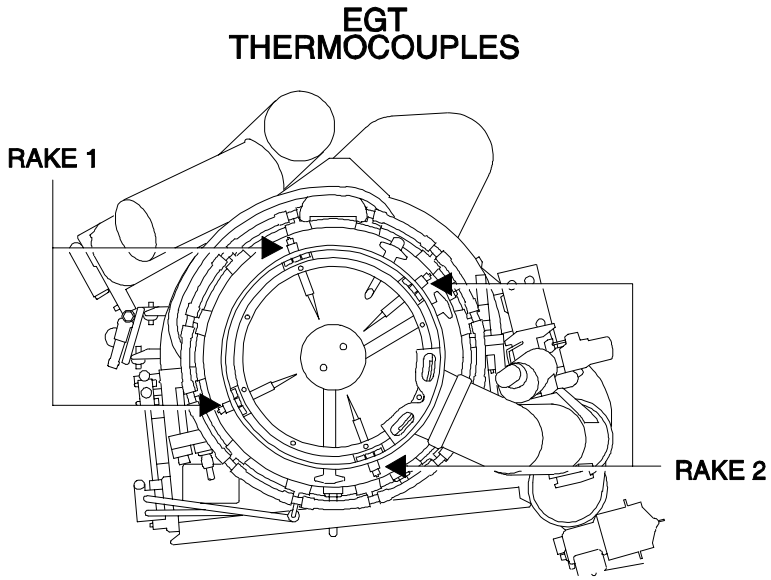
ZONE : 315

COMPONENT DESCRIPTION

The ECB and the Memory Module keep in parallel the APU data life. When a new Memory Module or ECB is installed, the remaining component transmits the data to the new installed component.







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STUDENT NOTES

APU PRESENTATION (Mock-up) (FILM)

FILM NARRATION

The Garrett GTCP-331-350 APU provides an independent source of pneumatic and electrical power that can be used during flight and ground operations.

The APU is mounted in a fireproof compartment located in the aircraft tail cone. Access for servicing and maintenance is provided by two doors. The doors are held open by two telescoping rods. The APU is controlled by the Electronic Control Box. The Electronic Control Box is located in the bulk section of the aft cargo compartment.

Hello, this is the Garrett GTCP-331-350 APU. It supplies the aircraft pneumatic system with air for engine starting and air-conditioning and provides shaft power to drive a 115 KVA generator that supplies the aircraft's electrical busses.

All component location references are from the rear, looking forward. The APU comprises three major sections: the Accessory Gearbox, the Load Compressor and the Power Section.

The power section includes a 2-stage centrifugal flow compressor, an annular reverse flow combustion chamber with 12 dual flow fuel nozzles and a 3-stage axial flow turbine.

The power section drives the load compressor and the accessory gearbox through a single common shaft.

The load compressor has single stage centrifugal flow impeller and a fuser and a row of inlet guide vanes.

The load compressor and power compressor share a common air inlet plenum duct.

The accessory gearbox provides support and gear reduction for the accessories and mounting bosses at the three and nine o'clock positions for installation into the aircraft.

The accessories include the oil pump unit, the fuel control unit, the starter, the cooling fan, and the APU generator. The APU generator is mounted on the right side of the accessory gearbox. It provides a 115KVA-power supply to the aircraft's electrical busses.

The electrical power is available throughout the aircraft-operating envelope.

The starter is mounted on the left side of the accessory gearbox. It is controlled by the electronic control box. The starter is equipped with a brush wear indicator and a manual drive receptacle for maintenance operation.

Oil servicing is accomplished from the left side of the accessory gearbox; the lower part of the gearbox is the oil reservoir for the lubrication system. The reservoir may be filled through the gravity fill cap or through the pressure fill and overflow connections. A sight gauge verifies the oil quantity. The oil pump unit is mounted on the left side of the accessory gearbox. It provides a mounting flange for the fuel control unit. It includes the oil supply and oil scavenge pump elements.

There are three oil pump components located on the right side of oil pump: the oil pressure relief valve, the oil pressure regulating valve, and the de-oiling valve.

The oil pump unit houses two oil filters. One filters the generator scavenge oil and one filters the oil to the bearings. Both filters are fitted with clog indicators.

The pressurized oil is routed to the thermal bypass valve mounted on the air-cooled oil cooler.

If the thermal bypass valve is open, the oil is routed back to the oil supply filter. When the thermal bypass valve is closed the oil flows through the oil cooler and returns to the oil supply filter.

Filtered oil is supplied to an oil manifold located on the left side of the APU. The manifold houses an oil pressure switch and an oil temperature sensor. Both line replaceable units are monitored by the Electronic Control Box..

Two oil supply lines are connected to the oil manifold. One line supplies the turbine rear bearing compartment and one line supplies the load compressor and mid bearing compartment.

The load compressor front bearing and the gearbox accessories are supplied internally by the gearbox oil manifold.

The oil pump unit contains four scavenge pump elements: One for the Aft bearing sump, one for the mid-bearing sump, and two for the oil cooled generator.

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The aft bearing sump oil is scavenged through an external line from the six o'clock position on the turbine case and returned to the oil reservoir The mid bearing sump oil is scavenged through a line from the six o'clock position on the load compressor housing and returned to the oil reservoir. The load compressor front bearing and the upper gearbox oil is returned internally by gravity. The generator scavenge oil temperature is monitored by an internal temperature sensor. This sensor is monitored by the Electronic Control Box. If the generator's scavenge oil temperature exceeds a certain threshold, the APU will shut down automatically if the aircraft is on the ground. This sensor is not a line replaceable unit.

The scavenge oil is returned through an internal passage to the scavenge filter inlet tube, through the scavenge filter and into the gearbox reservoir.

There are four additional line replaceable units located on the accessory gearbox. They are: The low oil temperature sensor, The electronic chip detector, The oil heater, And the low oil quantity switch.

They are monitored by the electronic control box.

The low oil temperature sensor is located on the front lower center of the accessory gearbox. The oil temperature is used to control the de-oil valve. The electronic chip detector is installed at the bottom center of the accessory gearbox. If metal particles are detected, the Electronic Control Box sends a signal to the central maintenance computer. The gearbox reservoir can be drained through the integral drain plug. The oil heater is mounted on the front lower right side of the accessory gearbox. It is controlled by the main APU relay in the APU box. The APU box is located in the aft cargo compartment near the Electronic Control Box. The oil heater is not powered if the APU master switch is in the on position. The low oil quantity switch is located on the bottom right side of the accessory gearbox, if the oil quantity decreases to a low level, the Electronic Control Box sends a low oil level signal to the electronic centralized aircraft monitoring system.

The oil system is vented through an air-oil separator located on the front of the accessory gearbox.

The oil is returned to the reservoir and the air is vented through a vent line to the APU exhaust.

FUEL SYSTEMS

The APU fuel is supplied from the aircraft fuel tanks. Fuel from the aircraft is delivered to the fuel control unit. The fuel control unit is mounted on the front flange of the oil pump unit. It is driven by a quill shaft from the oil pump

A case drain vents the chamber between the flanges through a one-way check valve. The fuel control unit has five main functions: Fuel filtering Fuel metering Pressure increasing Servo pressure regulation and Positive fuel shutoff.

The fuel control unit supplies the APU with high pressure metered fuel for combustion and servo fuel for actuator operation. Fuel from the aircraft enters the low-pressure fuel filter. A fuel pressure switch installed at the filter in the housing is monitored by the electronic control box.

If the fuel pressure is low, the Electronic Control Box sends a fuel low-pressure signal to the electronic centralized aircraft monitoring system.

The low-pressure fuel filter is monitored by a clog indicator. To reset it, after a maintenance action has been performed, push the red button.

The fuel gear pump supplies high-pressure fuel to the fuel control unit.

The system is protected by a high-pressure relief valve. Fuel flows internally through the high-pressure fuel filter to the fuel torque motor. The fuel torque motor controls the internal fuel-metering valve that supplies fuel to the fuel shut-off solenoid valve. The fuel torque motor and fuel shut-off solenoid valve are controlled by the Electronic Control Box.

When the APU is started, the electronic control box opens the fuel solenoid valve and fuel is supplied to two outlet ports. One port supplies high-pressure servo fuel to the inlet guide vane and surge control valve actuators. This fuel is returned to the filter inlet. The other port supplies the fuel flow divider and drain valve assembly located on the left side of the APU.

This unit includes a filter, a fuel temperature sensor, a start sequence valve, two fuel manifolds, a fuel flow meter, and primary and secondary drain valves. The Electronic Control Box uses fuel temperature and fuel flow data for fuel scheduling.

During the initial start cycle, fuel from the primary manifold is supplied to the twelve dual flow fuel nozzles. When the backpressure increases, the start sequence valve opens and supplies fuel to the secondary manifold for acceleration and on-speed operation. When the Electronic Control Box receives the shutdown signal it closes the fuel shut-off solenoid valve, and fuel flow stops. Then it energizes the ecology drain valve solenoid.
High-pressure air from the second stage of the power compressor is stored in the ecology drain accumulator.
When the ecology drain valve opens, the air is released through the drain valves.
The air flows through the fuel manifolds and evacuates unused fuel to the combustion chamber where it is burned during shutdown.

PNEUMATIC SYSTEM

Air from the inlet plenum supplies the power section compressor, the load compressor, the APU compartment cooling valve, and the oil-cooler. The Electronic Control Box monitors the air inlet pressure through a pressure transducer. The inlet pressure transducer is mounted on the left side of the inlet plenum. It measures the plenum duct pressure. Electronic Control Box uses this data as an altitude signal. This signal is used for fuel scheduling and to inhibit bleed load valve opening at cruising altitude.
The airflow through the load compressor is controlled by internal inlet guide vanes and inlet guide vane actuator. The inlet guide vane actuator is located at the 8 o'clock position on the load compressor housing. It's operated by high-pressure servo fuel and is controlled by the Electronic Control Box. The load compressor inlet and outlet temperature and pressure is monitored by the Electronic Control Box. The load compressor inlet temperature sensor is installed at the 7 o'clock position on the load compressor housing. The data is used for fuel close scheduling, over temperature shutdowns and reverse airflow detection.
The pneumatic manifold, located at the 6 o'clock position on the load compressor, receives inputs from the load compressor inlet and outlet air off-takes. It supplies the bleed flow sensor assembly. The bleed flow sensor assembly includes the total pressure transducer and a differential pressure transducer.
The electrical output signal is used by the Electronic Control Box to control the surge control valve. The load compressor outlet manifold is located on the right side of the APU. The load compressor outlet air off-take supplies a pressure signal to the pneumatic manifold. The pressure signal is used to calculate differential pressure. The load compressor outlet temperature sensor, located at the 3 o'clock position on the load compressor manifold, is monitored by the Electronic Control Box. This data is used to monitor the efficiency of the load compressor.
The bleed load valve is installed on the front of the bleed air manifold. It controls the airflow to the aircraft pneumatic system. It is spring-loaded to the closed position. When the Electronic Control Box receives a bleed demand signal, it energizes the bleed valve solenoid. High-pressure air from the first stage of the power section compressor, enters the bleed valve actuator and the bleed valve opens. The bleed valve position is monitored by a bleed valve position switch and a visual position indicator.
The surge control valve is installed on the rear of the bleed air manifold. It controls the airflow through the bleed load valve and prevents bleed compressor surge and stalls. It opens during APU shutdown cycle and vents the excess air to the APU exhaust
The surge control valve actuator is operated by servo fuel from the fuel control unit. The fuel torque motor is controlled by the electronic control box. Air from the inlet plenum is ducted to the gearbox driven fan. The fan supplies air to the APU compartment-cooling valve and to the oil cooler. The compartment-cooling valve controls the cooling airflow into the APU compartment.
It is pneumatically controlled by a barometric control actuator and air from the first stage of the power section compressor. The valve is closed at cruising altitudes. The remaining cooling air is ducted rearward through the oil cooler and exhausted overboard through the air exhaust duct.

RECORDING AND INDICATING

The data memory module is mounted on the left side of the inlet plenum. It stores data specific to the APU. The data is stored in parallel with the Electronic Control Box. This data includes: the APU serial number, total operating hours, the number of starts and high oil temperature shutdowns. This data is retained in the event of an electronic control box replacement and will be transmitted to the new electronic control box at the first APU start.
The APU rpm is measured by two speed sensors. They are installed in the air inlet plenum at the 3 and 9 o'clock positions. They are monitored by the Electronic Control Box. The data is used for fuel scheduling and cockpit display.
The exhaust gas temperature is measured by two thermocouple rakes installed in the turbine exhaust case. The number one rake is on the right side, the number two rake is on the left side. Each rake has two thermocouples. They are monitored by the Electronic Control Box.
The data is used for fuel scheduling, cockpit display, and for over-temperature protection.

IGNITION SYSTEM

The ignition system is located on the right side of the APU. It includes two igniter plugs installed in the turbine exhaust case at the 2 and 5 o'clock positions. The power is supplied by a high energy ignition exciter mounted on the air-inlet plenum at the 3 o'clock position.
The ignition system is controlled by the Electronic Control Box. The ignition is active during the start cycle between 7 and 50% of rpm. It is activated during the run cycle if the rpm decreases to 95% to prevent a flameout.

DRAIN SYSTEM

The APU drain system collects fluids from the fuel control unit, oil pump flange cavity, the inlet guide vane actuator, the surge control valve actuator, and the combustion chamber drain valve. These fluids are drained overboard through a drain mast located at the 6 o'clock position at the rear of the APU.

SUMMARY

The APU operation is controlled and monitored by the electronic control box. The Electronic Control Box serves as a maintenance interface with the central maintenance system for fault reporting and troubleshooting operations.
The APU is an integral part of the aircraft systems. It enhances the operation of the aircraft by providing an independent source of electrical and pneumatic power that can be used during flight for extended range operations and on the ground allowing the aircraft to be independent of ground facilities.

STUDENT NOTES

ACMS REPORTS

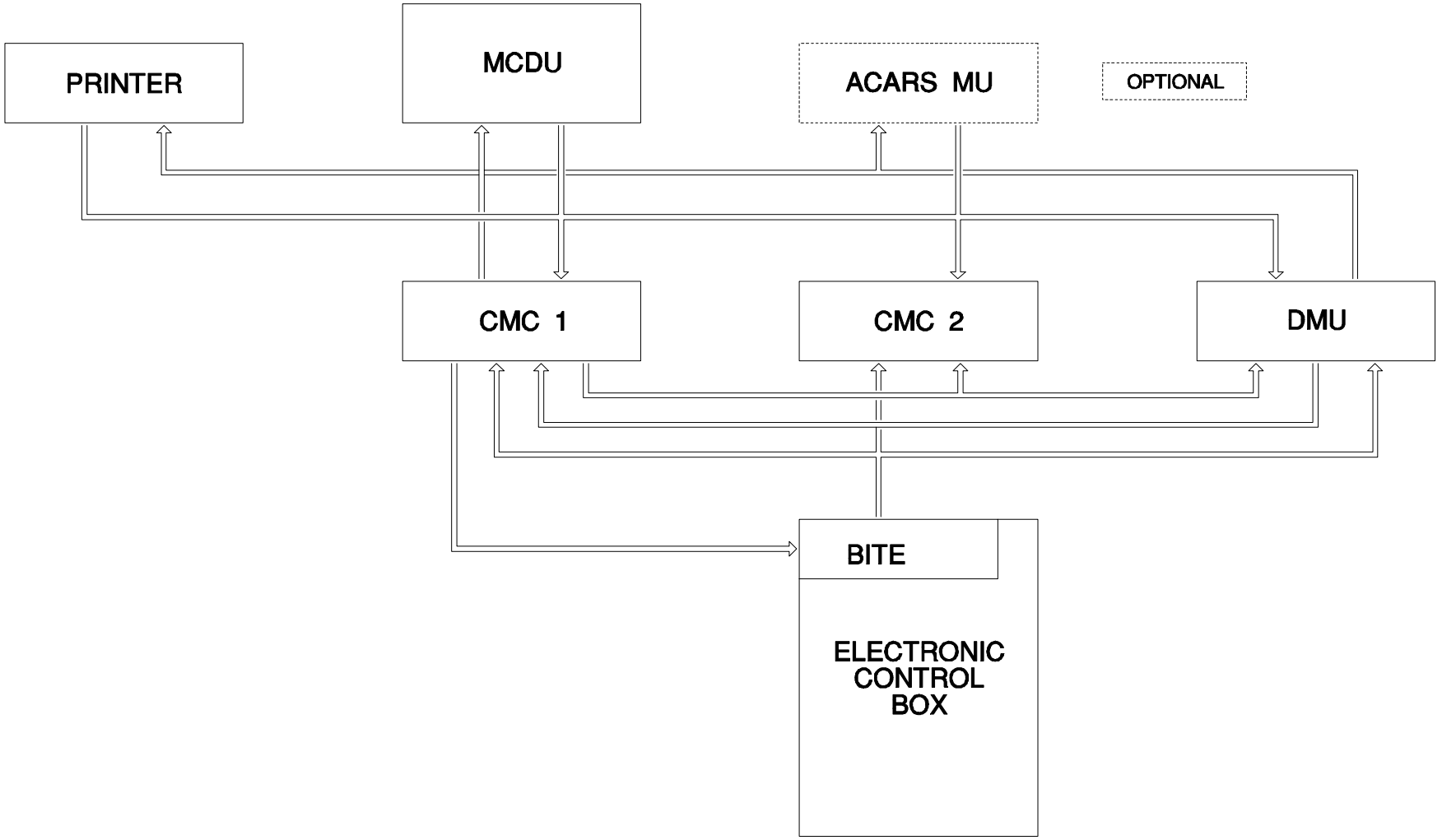
General
MES/Idle Report
APU Shutdown Report

GENERAL

The ACMS can produce two APU condition reports through the Data Managment Unit :

- the Main Engine Start/Idle report,
- the APU Shutdown report.

The reports can be launched from the MCDU.
The reports are available on a hard copy from the printer or on ground through the ACARS, if installed.



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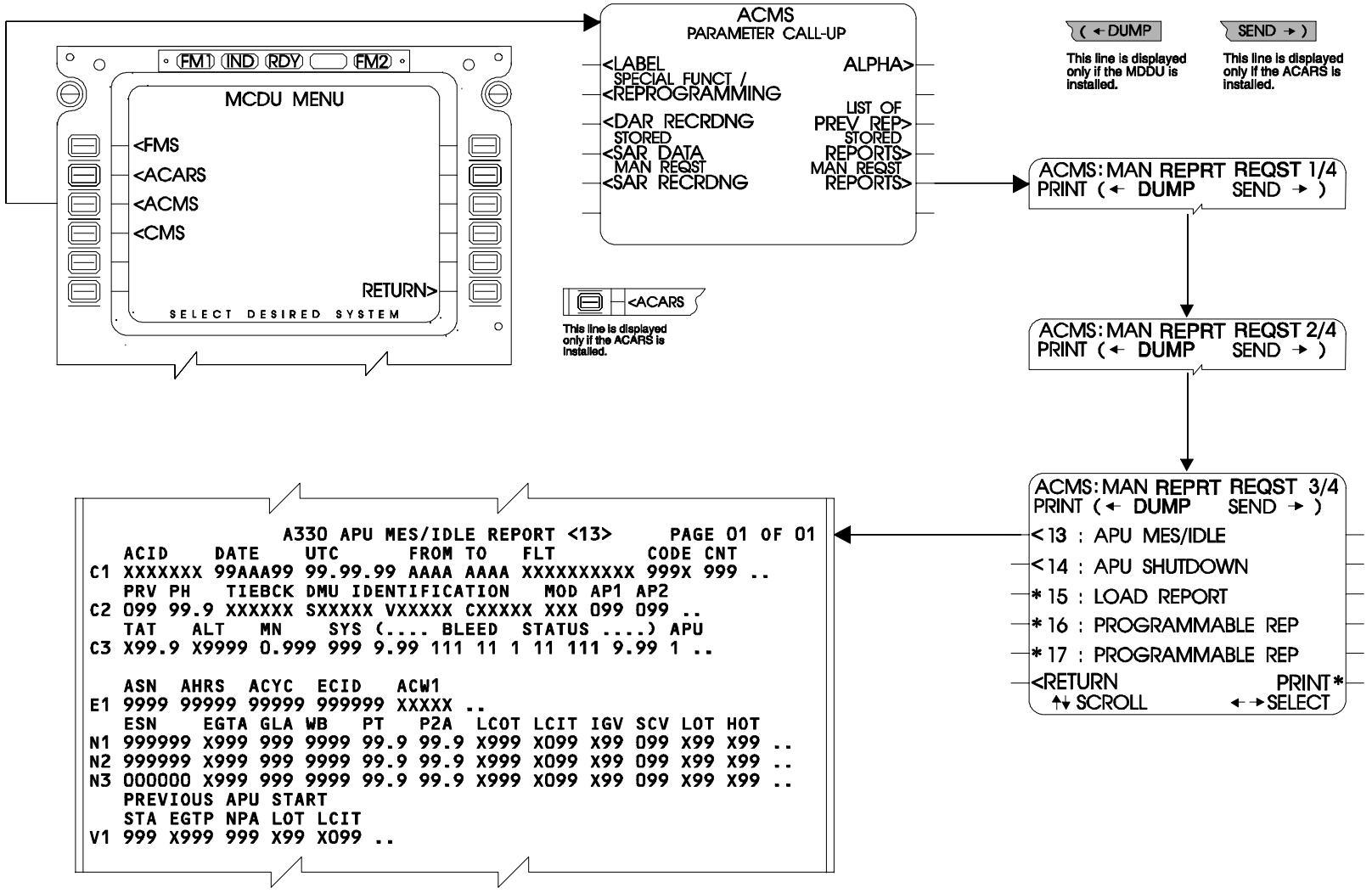
MES/IDLE REPORT

The Main Engine Start/Idle report monitors the APU related data when the APU bleed air is used for a Main Engine Start.

Here is an example of a report.
The information displayed is Serial number, operating hours, cycles, load compressor temperatures and pressures, APU speed, EGT, component positions, failed...



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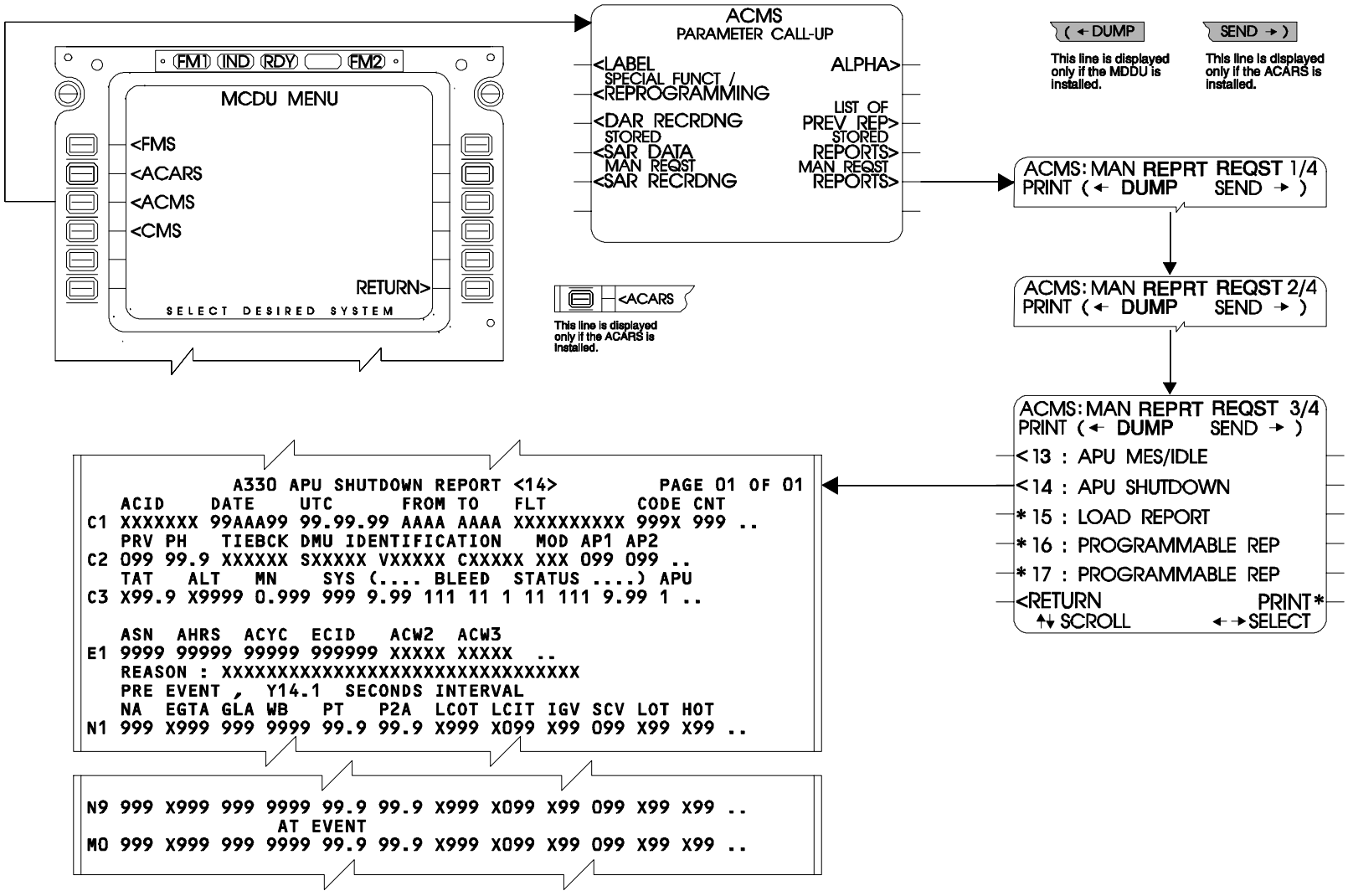
APU SHUTDOWN REPORT

The APU Shutdown report monitors the APU related data and is started when an abnormal shutdown is detected.
The last ten seconds before the shutdown are recorded.

Here is a shutdown report.
The information displayed is Serial number, operating hours, cycles, APU speed, EGT, pressures, temperatures, valve positions, reason for shutdown..., the last 10 seconds before shutdown.



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STUDENT NOTES

APU REMOVAL/INSTALLATION

Warnings
Job set-up
- Cockpit and avionics bay
- Doors removal

Disconnection
- Pneumatic
- Fuel line
- Electrical harness
- Electrical cables
- Drain hoses
- Exhaust muffler

Hoisting
Mounts
Support frame attachment
Installation

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WARNINGS

Do not touch the APU until it is sufficiently cool to prevent burns when you do the maintenance tasks.
Make sure that the hydraulic systems are depressurized.
Make sure that you have the correct fire fighting equipment available.

STUDENT NOTES

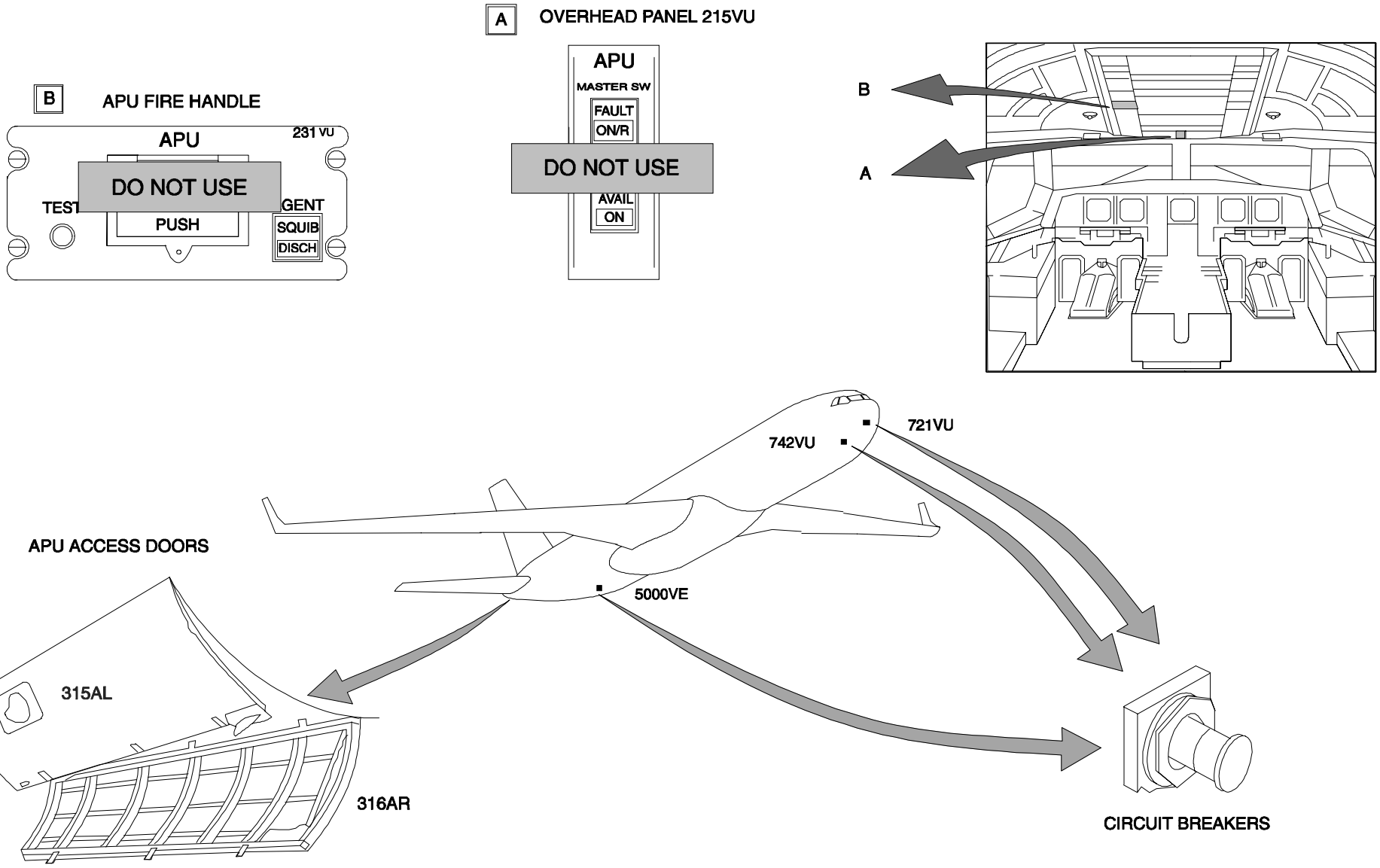
JOB SET-UP

COCKPIT AND AVIONICS BAY

Put a warning notice in position on the panel 215VU to tell persons not to start the APU.
Open, safety and tag the appropriate circuit breakers (721VU, 742VU, 5000VE).

DOORS REMOVAL

Open and remove the APU access doors 315AL and 316AR.
Set the light switch 3LJ to ON.



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DISCONNECTION

PNEUMATIC

Remove the air intake duct, the APU bleed-air duct elbow and the oil-cooler outlet duct.

FUEL LINE

Drain the fuel from the APU fuel line, then disconnect the drain valve and the adapter from the fuel control unit.

ELECTRICAL HARNESS

Disconnect the electrical connectors from the APU front bulkhead.

ELECTRICAL CABLES

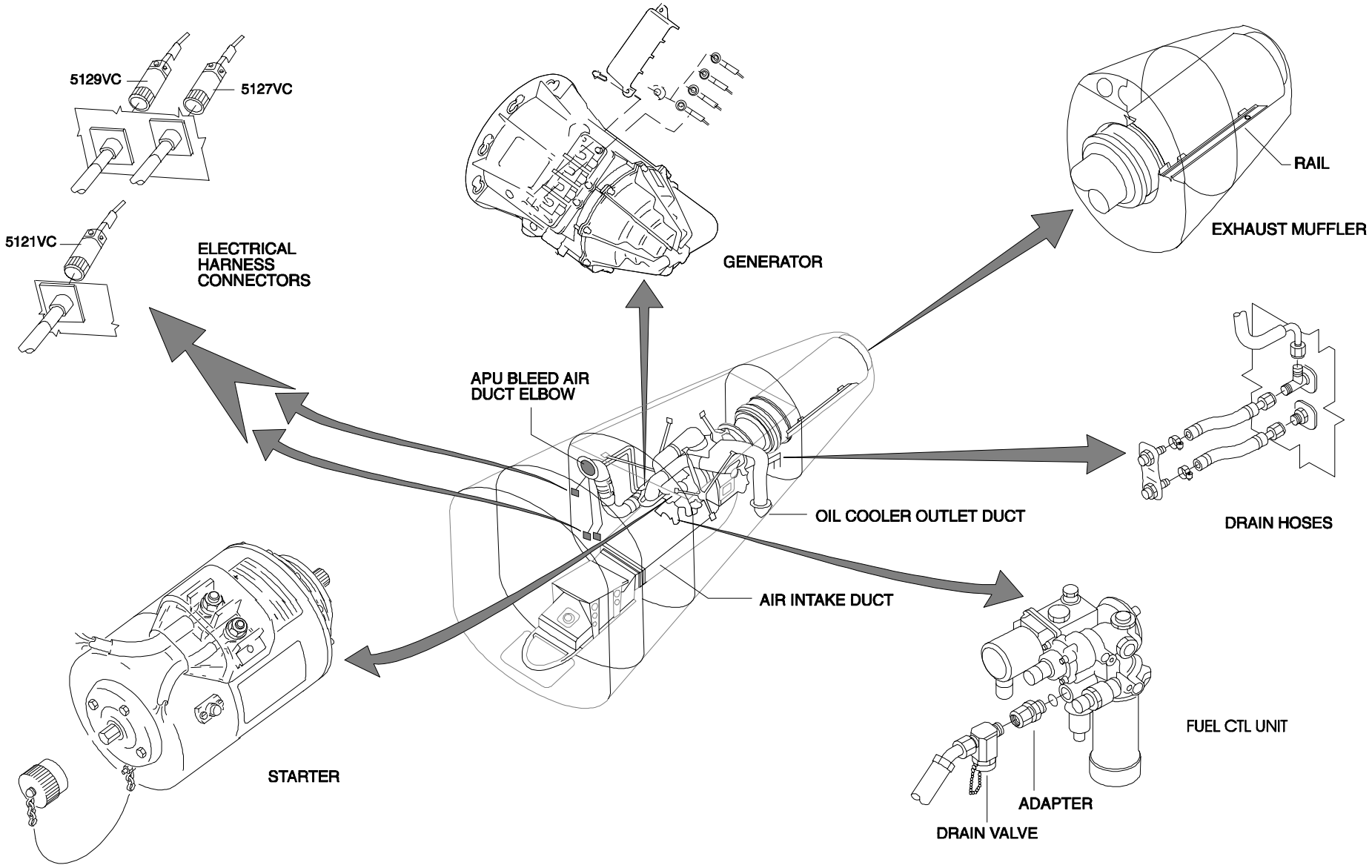
Remove the electrical cables from the generator and from the starter.

DRAIN HOSES

Disconnect the drain hoses from the unions on the rear fire wall of the APU compartment.

EXHAUST MUFFLER

Remove the insulation, the coupling and the bolts which hold the exhaust muffler in position. Then, move it rearwards on the rails in order to free the APU.



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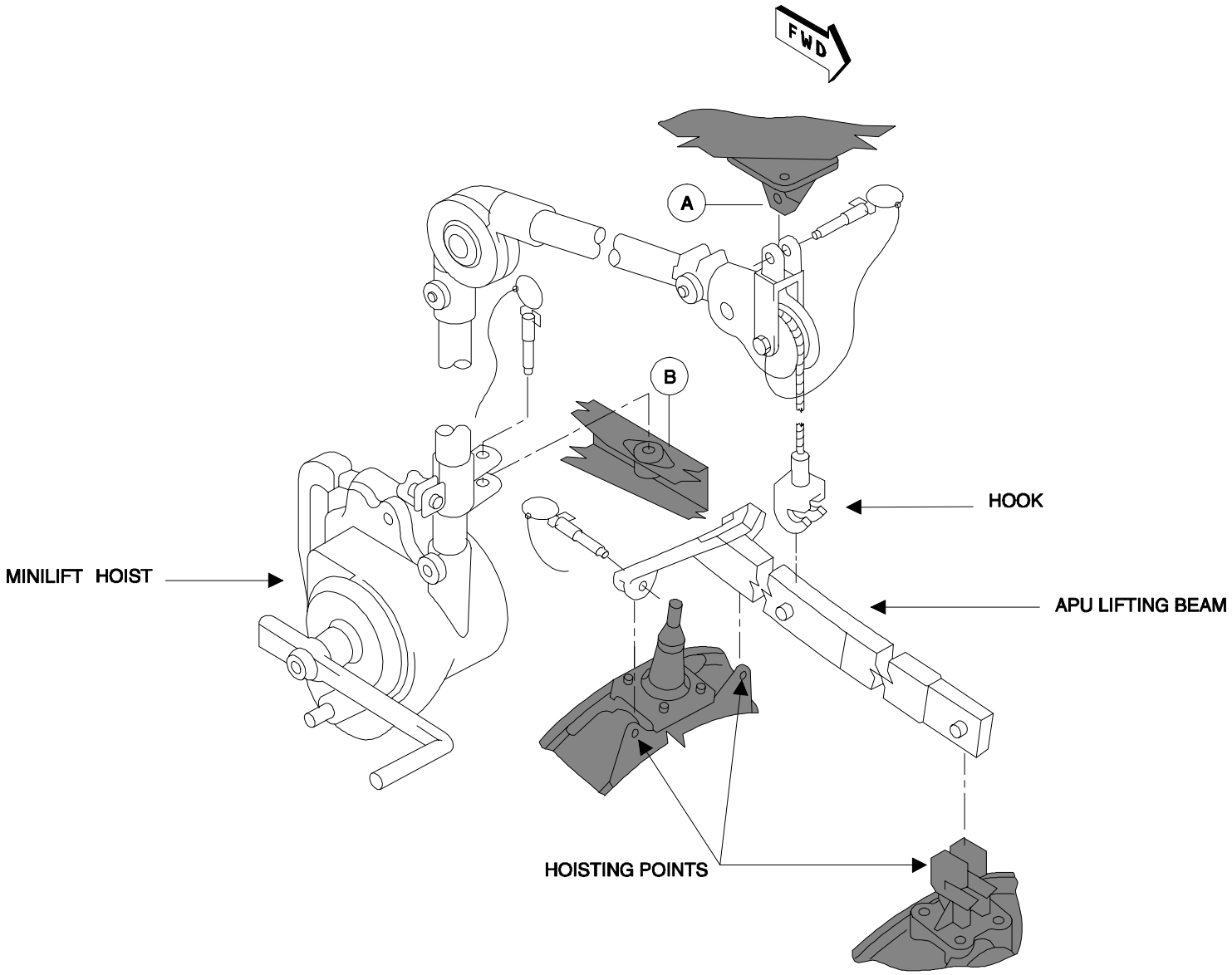
HOISTING

Install the minilift hoist on the top fire wall on the APU compartment (A) and on the bearing assembly in the lower support bracket of the oil-cooler outlet duct (B).
Install the APU lifting beam on the APU.
Connect the hook to the APU lifting beam.



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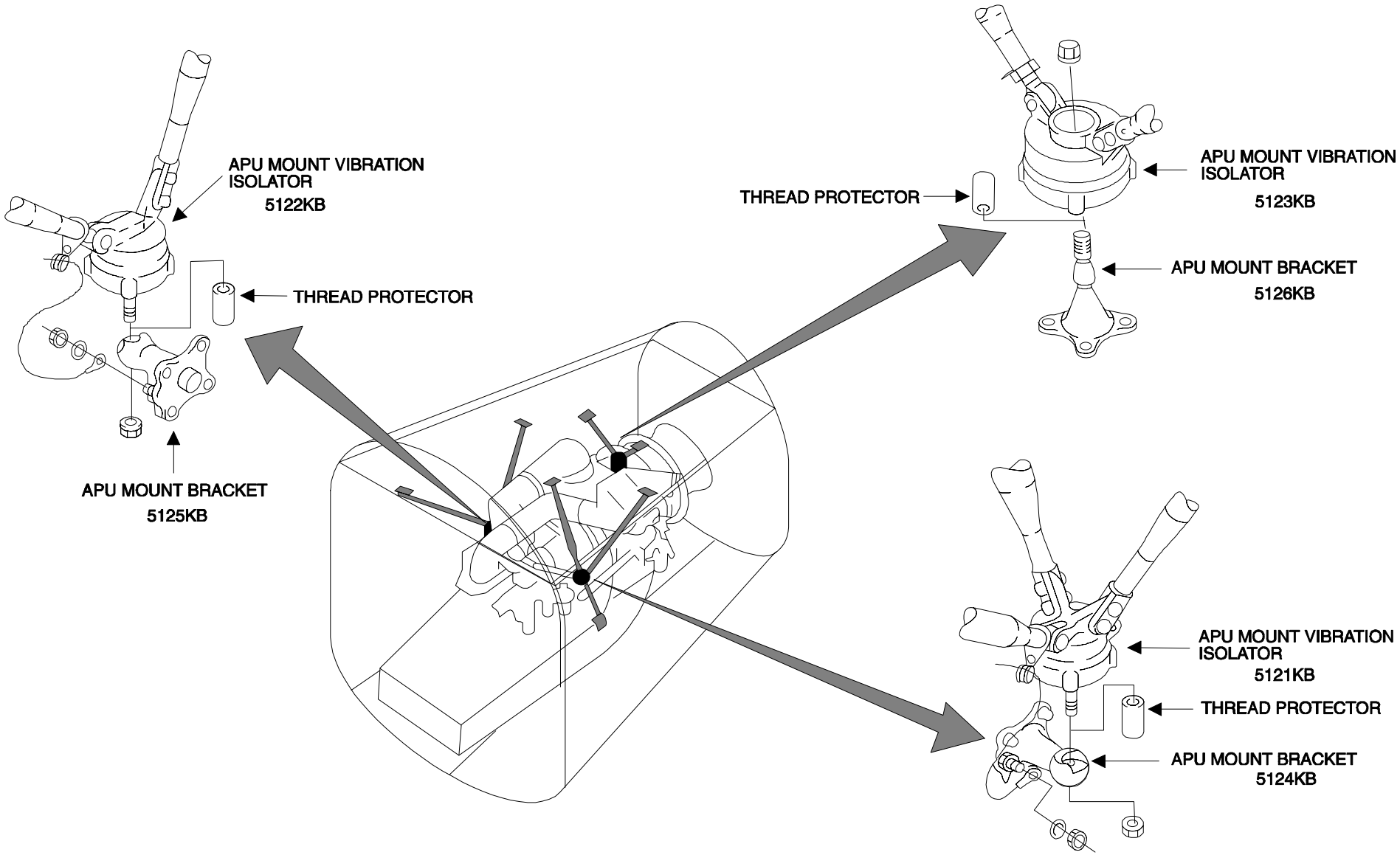
MOUNTS

Operate the minilift hoist until the weight of the APU is removed from the APU mounts.
Remove the APU mount units and protect the APU mount threads.



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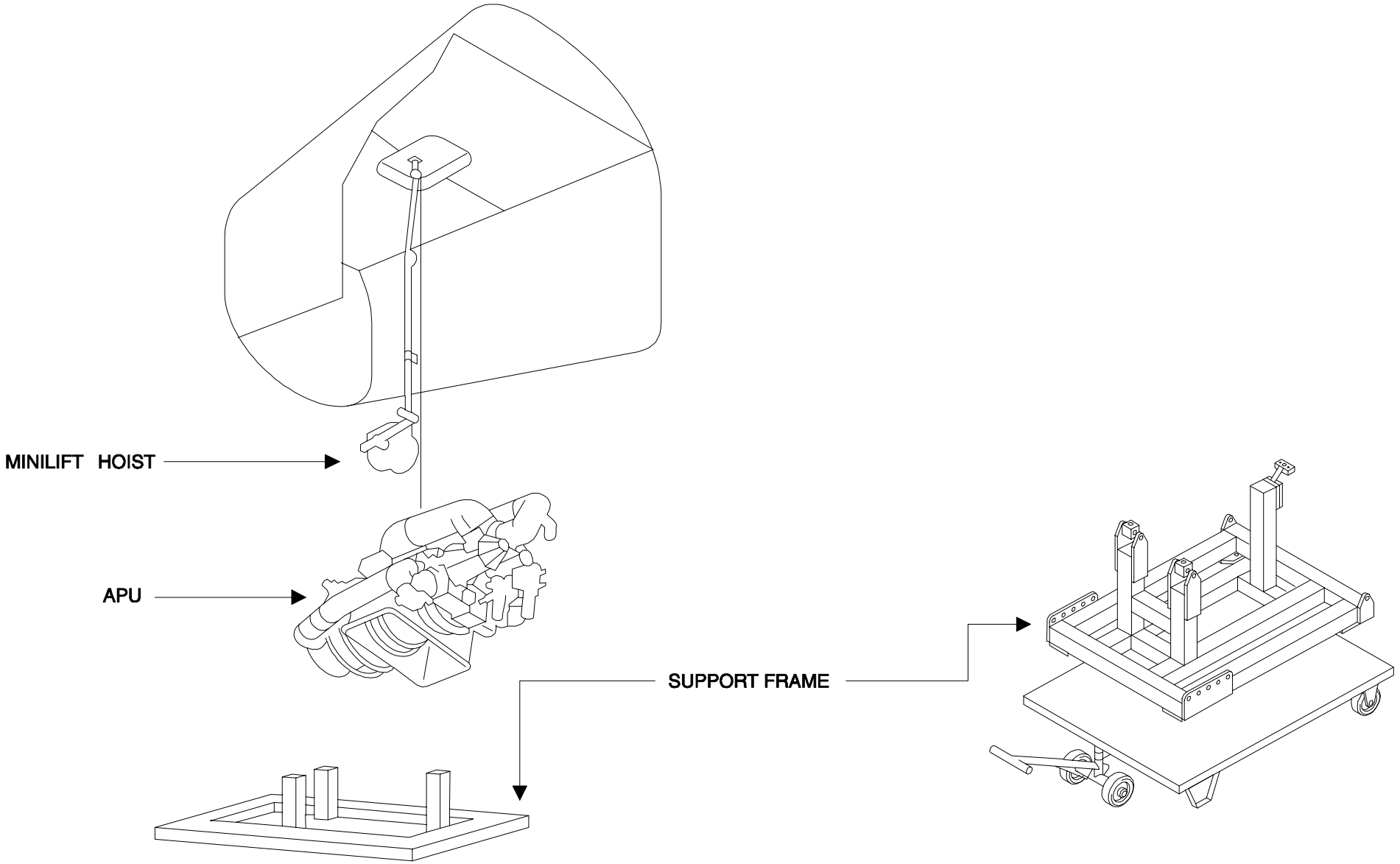
SUPPORT FRAME ATTACHMENT

Using the mounts, attach the APU to its support frame.
Disconnect the minilift hoist and the APU lifting beam.



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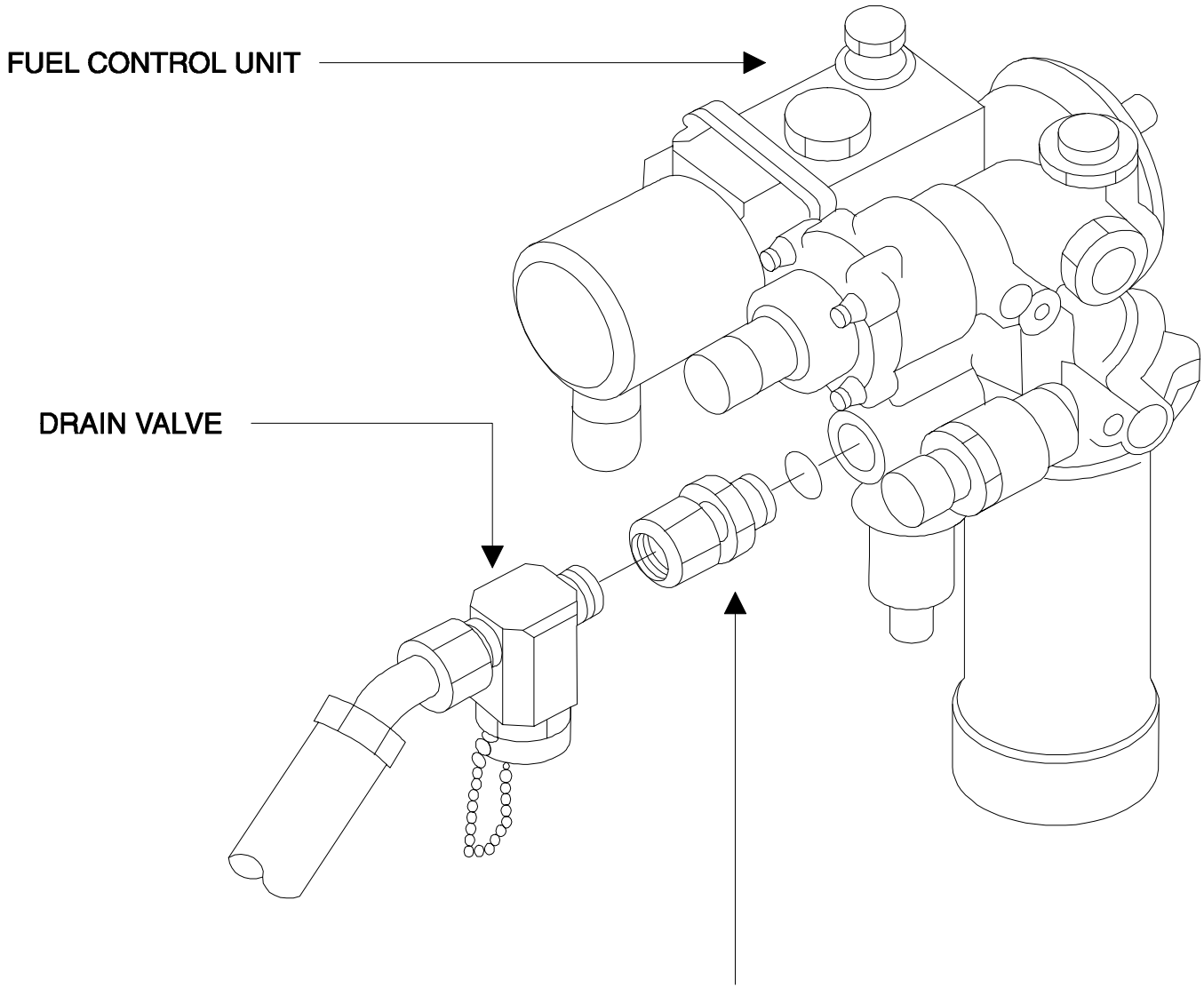
INSTALLATION

Perform the actions in the opposite way to install the APU.
NOTE : After APU installation, purge the APU fuel feed line before you try to start the APU.



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STUDENT NOTES

CMS SPECIFIC PAGES

General
Shutdowns
Service Data

GENERAL

This is the APU maintenance main menu. Only two functions are specific to the APU, the other functions are standard and are described in the ATA 45 course.

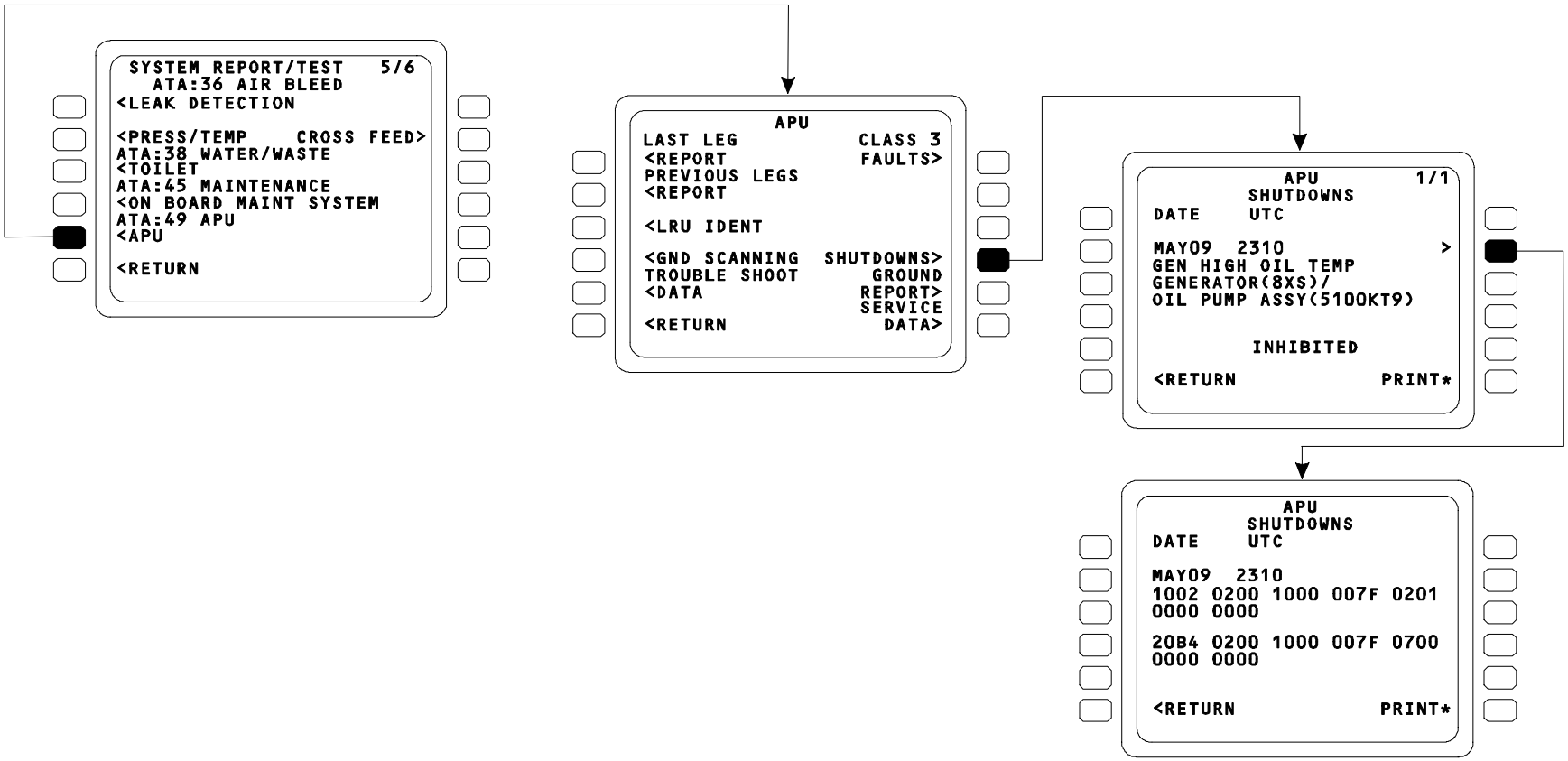
SHUTDOWNS

When you push the line key adjacent to the SHUTDOWNS indication, on the APU system page, the screen shows the cause of the shutdown and the related class 1 LRUs.
If the system has no failures, the screen shows the NO FAULT DETECTED message.

NOTES :

- only one shutdown per page,
- the message INHIBITED shall be displayed if the shutdown occurs in the inhibited mode.

The SHUTDOWNS Trouble Shooting data is available for the line mechanic, but more can be obtained for use by the engineering staff.



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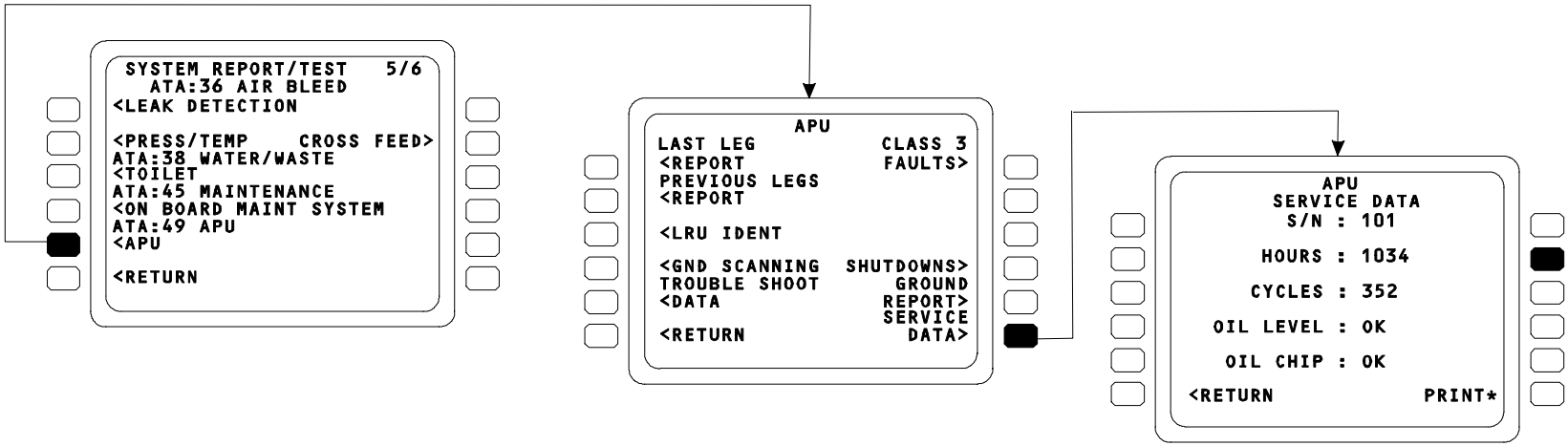
SERVICE DATA

When you push the line key adjacent to the SERVICE DATA indication, on the APU system page, the screen shows the following data :

- APU Serial Number, S/N :
- operation hours, HOURS :
- APU starts, CYCLES :
- oil level, OIL LEVEL : OK or LOW
- oil chip detector, OIL CHIP : OK or CHECK



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STUDENT NOTES

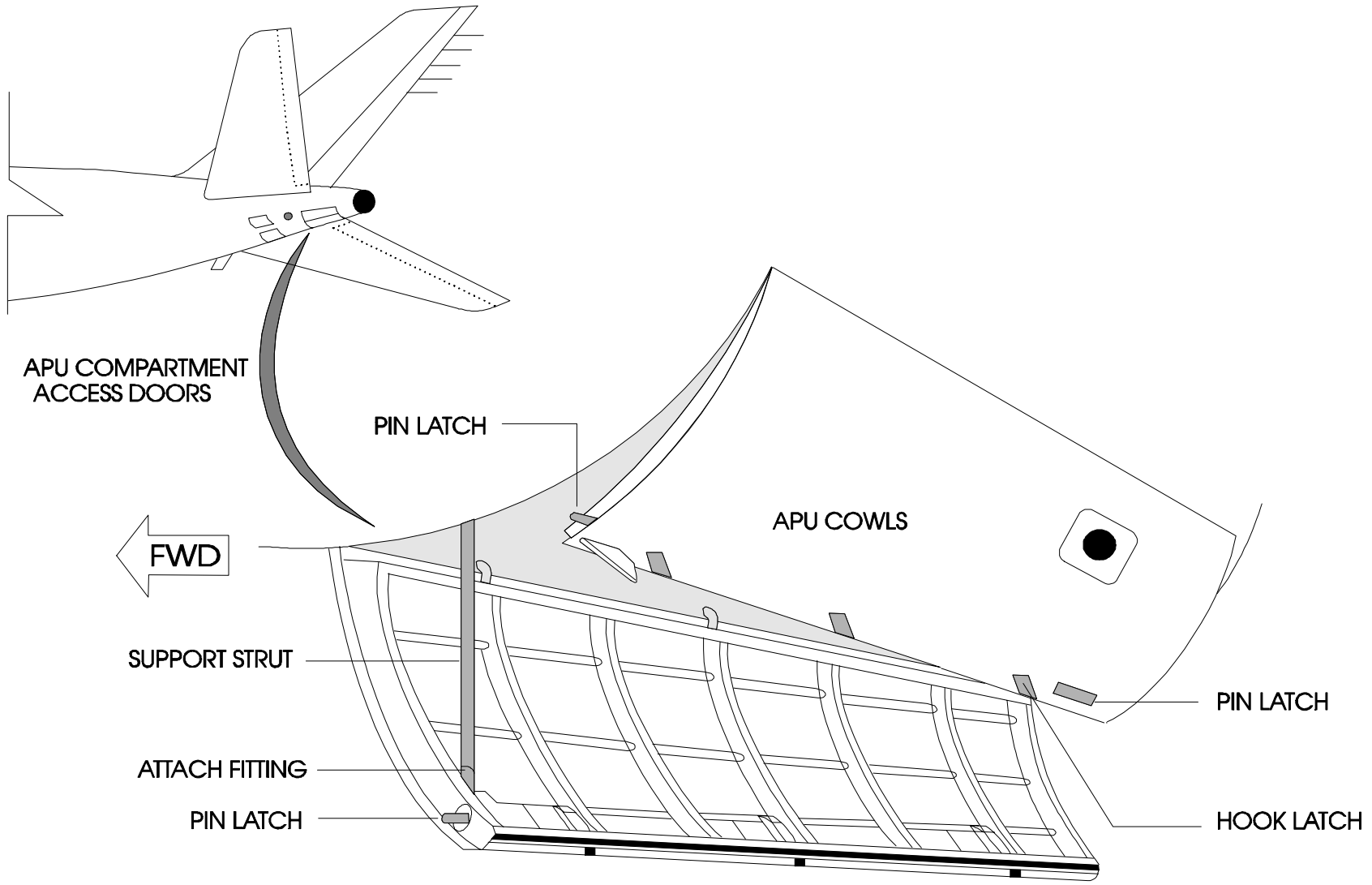
APU COMPARTMENT ACCESS DOOR OPERATION

APU door opening /closing

APU DOOR OPENING / CLOSING

This part presents the APU compartment access door operation.
The APU access doors are installed in the fuselage tail cone in zone 310.

- Put an access platform in position below the APU access doors.
- If any maintenance operation has to be performed with the APU shut-down, you have to open, safety and tag the circuit breakers listed in your maintenance manual.
- To operate the doors, first open the three hooks by pressing the catches.
- Then open the two pin latches by pressing the catches.
- Control the downwards movement of the door as it opens.
- To keep a door in the fully open position, remove the quick release pin, install the support strut by disconnecting its upper fitting and connecting it to the related fitting in the APU compartment.
Then install the quick release pin.
- Before you close the doors you must disconnect the support struts.
- To lock the hook latches, close the catches.
- Then close the catches of the pin latches which engage with the arrester fittings to lock the doors.



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