CHAPTER

49

Airborne Auxiliary Power

CHAPTER 49
AIRBORNE AUXILIARY POWER

A = Added, R = Revised, D = Deleted, O = Overflow, C = Customer Originated Change

49-EFFECTIVE PAGES

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AUXILIARY POWER SYSTEM - INTRODUCTION

Purpose

The AlliedSignal Engines 331-500 gas turbine APU supplies the auxiliary power system with electric and pneumatic power. This permits airplane systems to operate independently of ground external power sources or the main engines. Auxiliary power is also available in the air.

Operating Limits

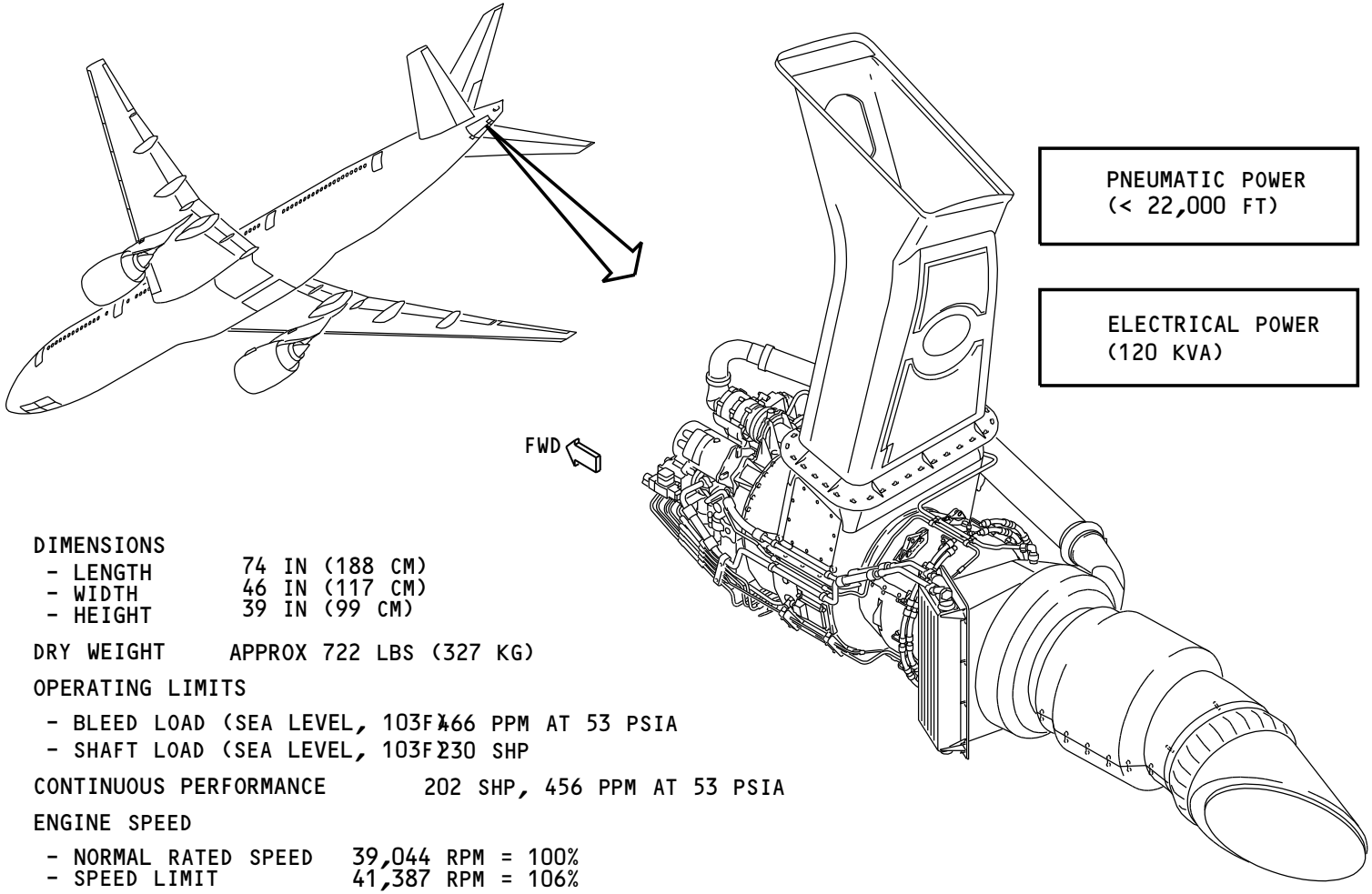
The APU generator supplies 120 KVA electrical power at any altitude. Pneumatic pressure is available up to an altitude of 22,000 feet (6700 m).

Specifications

The dimensions and weights shown do not include the air inlet duct, the exhaust duct, and the APU generator.

Abbreviations and Acronyms

- ADIRU - air data inertial reference unit
- ADP - air-driven pump
- AIMS - airplane information management system
- APU - auxiliary power unit
- APUC - auxiliary power unit controller
- ARINC - aeronautical radio, inc.
- ASCPC - air supply and cabin pressure controller
- ATS - air turbine starter
- ATSCV - air turbine starter control valve
- BPCU - bus power control unit
- CTC - cabin temperature controller
- DLODS - duct leak and overheat detection system
- DMM - data memory module
- dr - door
- ECS - environmental control system
- EDIU - engine data interface unit
- EGT - exhaust gas temperature
- EHSV - electrohydraulic servo valve
- ELMS - electrical load management system
- FODC - fire overheat detection card
- GCU - generator control unit
- HYDIM - hydraulic interface module
- IGV - inlet guide vanes
- LVDT - linear variable differential transformer
- LRU - line replaceable unit
- MFD - multi-function display
- OPAS - overhead panel ARINC system
- PPM - pounds per minute
- PSI - pounds per square inch
- PSIA - pounds per square inch absolute
- PSID - pounds per square inch differential
- PSIG - pounds per square inch gage
- RPM - revolutions per minute
- RVDT - rotary variable differential transformer
- SCV - surge control valve
- SHP - shaft horsepower
- S/O - shutoff
- temp - temperature
- WOW - weight on wheels



DIMENSIONS
- LENGTH 74 IN (188 CM)
- WIDTH 46 IN (117 CM)
- HEIGHT 39 IN (99 CM)

DRY WEIGHT APPROX 722 LBS (327 KG)

OPERATING LIMITS
- BLEED LOAD (SEA LEVEL, 103F) 466 PPM AT 53 PSIA
- SHAFT LOAD (SEA LEVEL, 103F) 230 SHP

CONTINUOUS PERFORMANCE 202 SHP, 456 PPM AT 53 PSIA

ENGINE SPEED
- NORMAL RATED SPEED 39,044 RPM = 100%
- SPEED LIMIT 41,387 RPM = 106%

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AUXILIARY POWER SYSTEM - INTRODUCTION

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AUXILIARY POWER SYSTEM - GENERAL DESCRIPTION

General

The APU system contains these subsystems:

- APU control system (49-60)
- APU power plant (49-10)
- APU engine (49-21)
- APU and generator lubrication system (49-27)
- APU oil indicating system (49-94).
- APU engine fuel system (49-30)
- APU ignition/starting system (49-40)
- APU air (49-50)
- APU indicating system (49-70)
- APU exhaust system (49-80).

APU Control System

An APU controller controls APU system functions and is an interface with other airplane systems.

APU Power Plant

The APU is a single shaft gas turbine engine which drives an electric generator and a load compressor. A gearbox on the front of the APU supplies power to APU accessories.

The power plant has these systems and components:

- Auxiliary power unit
- APU mounts
- APU wire harness
- APU air inlet
- APU drains.

APU Engine

The APU engine has a two stage centrifugal flow compressor, a reverse flow annular combustion chamber, and a three stage axial flow turbine.

APU and Generator Lubrication System

The APU and generator lubrication system lubricates and cools the APU bearings, the gearbox, and the electric generator.

APU Oil Indication System

The oil indication system supplies APU oil temperature, pressure, and quantity for flight deck display.

APU Engine Fuel System

The APU engine fuel system supplies pressurized and metered fuel to the APU combustion chamber. It also supplies pressurized fuel to operate the inlet guide vanes and the surge control valve.

APU Ignition/Starting System

During engine start, the ignition/starting system turns the APU and supplies ignition.

APU Air System

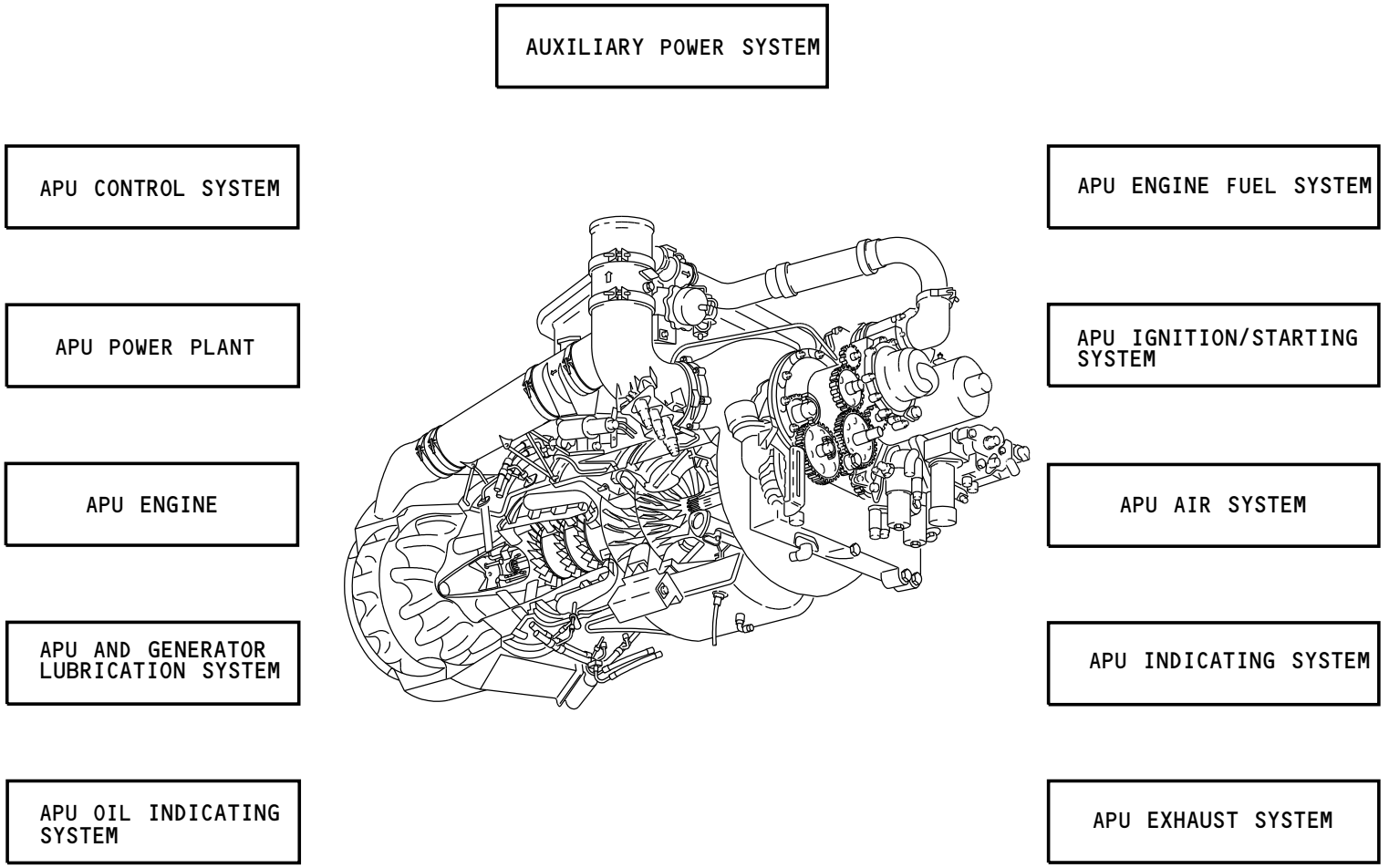
The APU air system supplies pressurized air to the airplane pneumatic system. Inlet guide vanes control the amount of air supplied to the load compressor. A surge control valve releases excess bleed air overboard. An eductor removes APU compartment air by suction through the oil cooler to cool engine oil.

APU Indicating System

The APU indicating system supplies APU EGT data for flight deck display. A data memory module keeps APU operation data.

APU Exhaust System

The APU exhaust system sends the APU exhaust gasses out of the left side of the tailcone.



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AUXILIARY POWER SYSTEM - GENERAL DESCRIPTION

AUXILIARY POWER SYSTEM - INTERFACES

General

The APUC gets airplane system data and sends APU data to airplane systems through the left and right system ARINC 629 data buses. The APUC also sends and receives some data through other connections.

ARINC 629 Interfaces

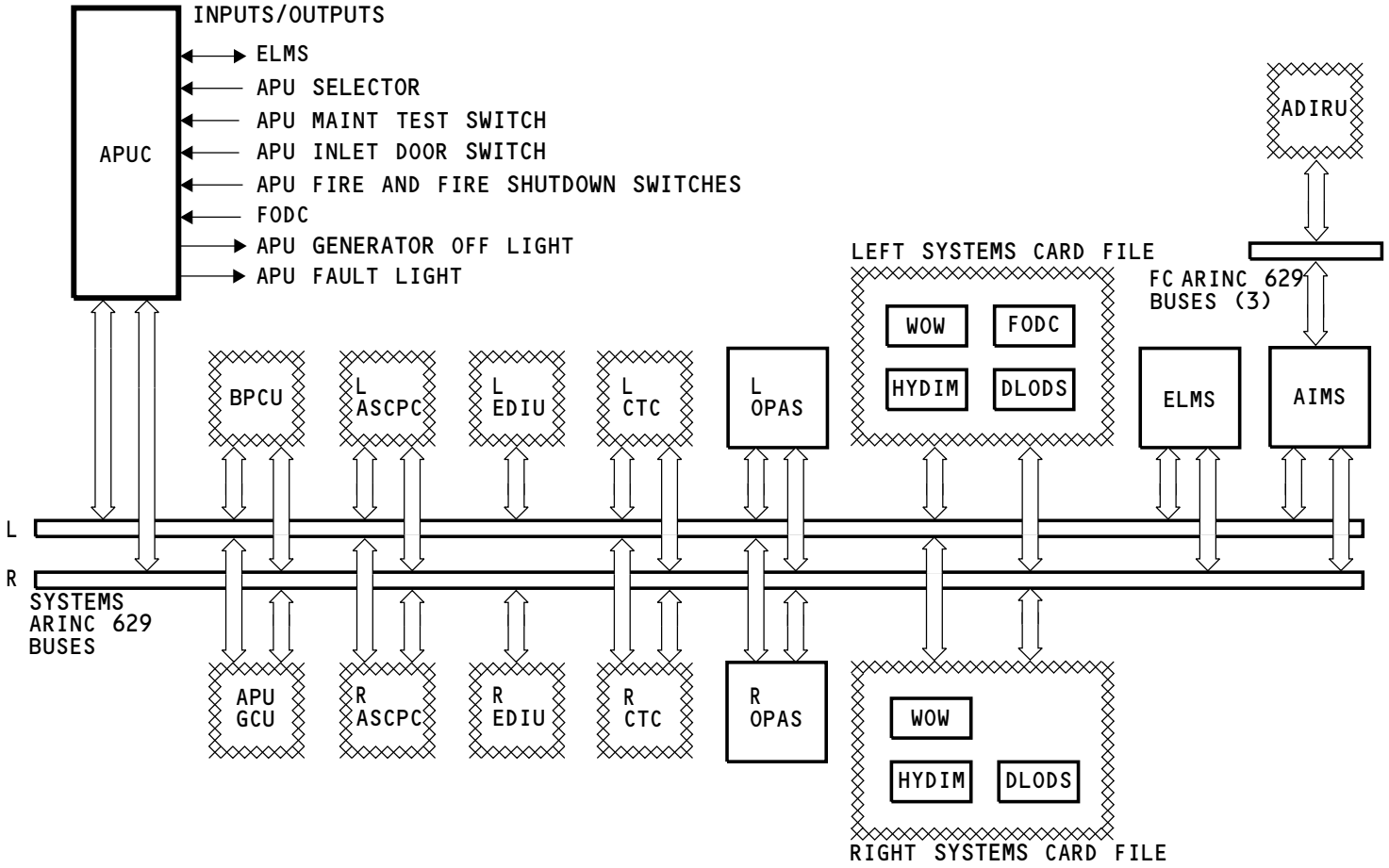
These systems have interfaces with the APUC through systems ARINC 629 buses:

- Bus power control unit (BPCU) - generator trim frequency
- APU generator control unit (GCU) - generator load
- Left and right air supply cabin pressure controller (ASCPC) - pneumatic valve positions, pack operation, and pneumatic duct pressure
- Left and right engine data interface unit (EDIU) - engine data
- Left and right cabin temperature controller (CTC) - pneumatic valve position and ECS data
- Left and right overhead panel ARINC 629 system (OPAS) - overhead panel switch/selector positions
- Left and right weight on wheels (WOW) cards - air/ground condition
- Hydraulic interface module (HYDIM) cards - ADP operation data
- Fire overheat detection card (FODC) - APU fire
- Left, right, and center duct leak and overheat detection system (DLODS) - wing/body duct overheat
- Electrical load management system (ELMS) - start control, shutdown control, autostart, attended/unattended mode
- Airplane information management system (AIMS) engine running status, air data (from ADIRU), airplane data, fault reporting, indications.

Other Interfaces

The APUC also has hardwire interfaces with these systems and components:

- Electrical load management system (ELMS)
- APU selector
- APU maintenance switch
- APU inlet door switch
- APU fire switch and fire shutdown switch
- Fire overheat detection card (FODC)
- APU generator OFF light
- APU fault light.



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AUXILIARY POWER SYSTEM - INTERFACES

AUXILIARY POWER SYSTEM - COMPONENT LOCATIONS

General

The APU is in the tailcone at a 10 degree nose down attitude in relation to the tail of the airplane. A titanium firewall isolates the APU compartment from the rest of the airplane.

Ducts

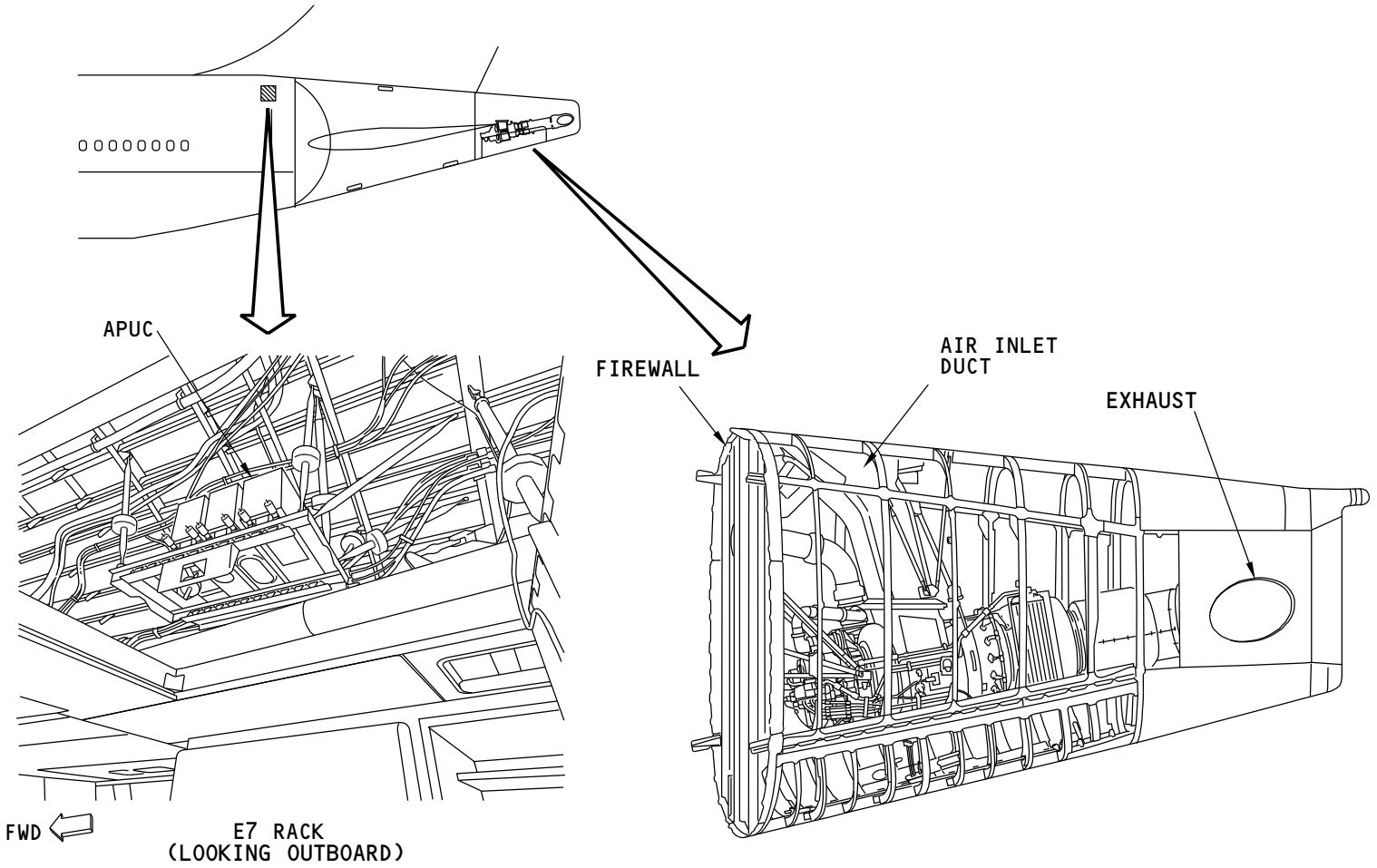
The air inlet is on the top, right side of the fuselage behind the rudder. The APU exhaust gases exit on the left side of the tail fairing.

Doors

Two APU access doors on the bottom of the APU compartment permit service and maintenance access.

APU Controller

The APU controller (APUC) is in the E7 rack in the ceiling of the aft cabin.



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AUXILIARY POWER SYSTEM - COMPONENT LOCATIONS

AUXILIARY POWER SYSTEM - APU GENERATOR

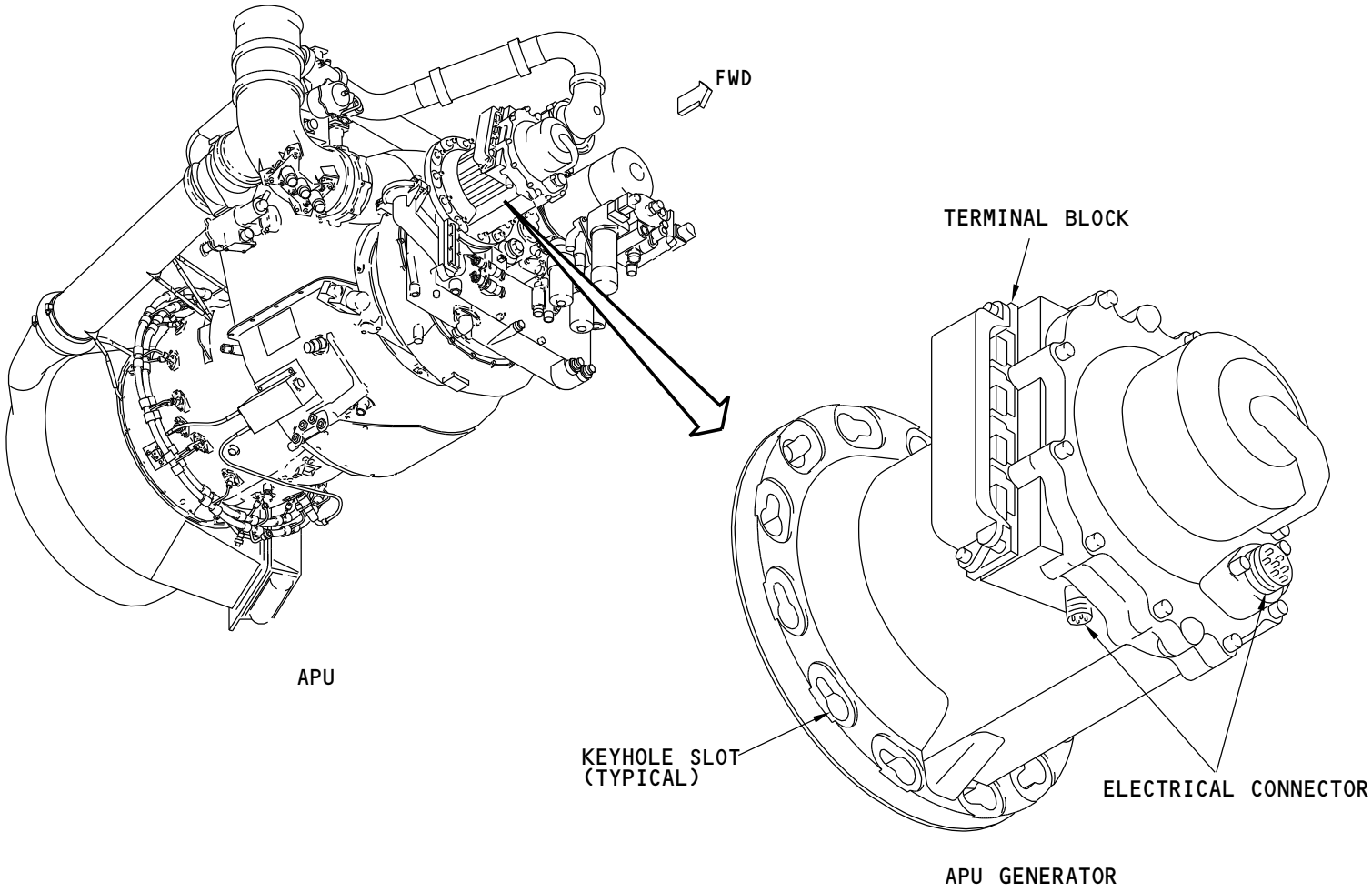
General

The APU generator is a secondary source of electrical power for airplane systems. It can supply 120 kva of ac electrical power when the airplane is on the ground or during flight. See chapter 24 for more information on the electrical system.

The APU generator attaches to the accessory pad of the APU gearbox.There is a seal plate between the APU generator and the APU gearbox.

The APU generator has a terminal block and two electrical connectors.

The APU gearbox turns the APU generator. The APU oil system lubricates the APU generator and keeps it cool.



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AUXILIARY POWER SYSTEM - APU GENERATOR

APU Flight Deck Controls

These control the APU from the flight deck:

- The APU selector
- The APU maintenance switch
- The APU fire switch.

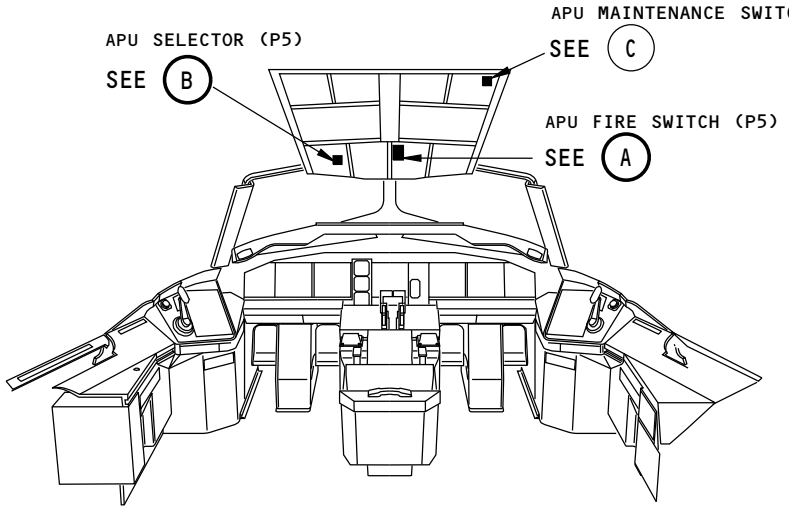
You use the APU selector on the electrical panel (P5) to start and shut down the APU.

You use the APU maintenance switch on the P61 overhead maintenance panel to supply power to the APUC when the APU selector is OFF. This permits the APUC to show APU indications on the status and maintenance page formats.

You can shutdown the APU with the APU fire switch on the cargo fire/engine control panel (P5).

Auxiliary Shutdown Control Switch

You can shutdown the APU from outside the airplane with the APU fire shutdown switch. This switch is on the P40 service and APU shutdown panel on the nose landing gear strut.



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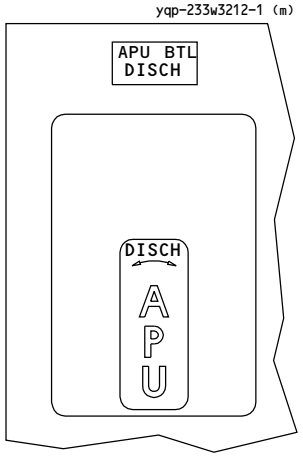
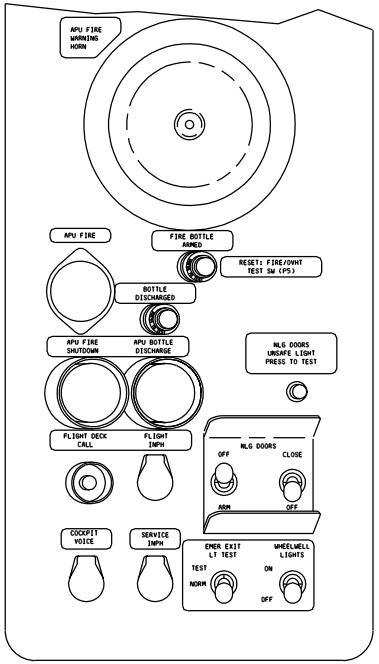
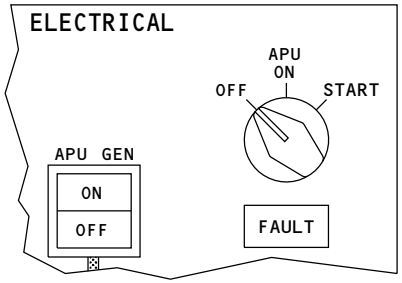


APU FIRE SWITCH (P5)

A



P40 SERVICE AND APU SHUTDOWN PANEL (NOSE LANDING GEAR)



APU SELECTOR (P5)

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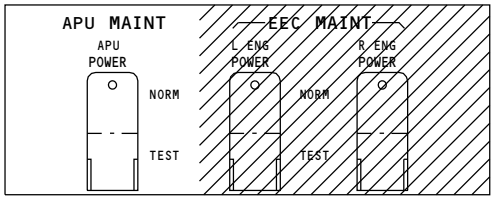

APU MAINTENANCE SWITCH (P61)

C

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AUXILIARY POWER SYSTEM - CONTROLS

AUXILIARY POWER SYSTEM - OPERATION

Pre-Start

The left main fuel tank must contain a minimum of 950 pounds (430 kg) of fuel to start and operate the APU for one hour.

The battery switch on the electrical panel (P5) must be in the ON position before you can start the APU.

The APU GEN switch on the electrical panel should be in the ON position before you start the APU.

If electrical power is available, you should do a test of the fire detection system before you start the APU. You do this test with the fire/OVHT test switch on the cargo fire panel (P5).

If electrical power is available, you should also do a check of the APU oil quantity. You can see the APU oil quantity on the status display or on the APU maintenance page.

Start

You can start the APU with the electric starter motor or the air turbine starter. If pneumatic power is available, the APUC will normally select the air turbine starter to start the APU.

The APU BLEED switch on the bleed air/pressurization Panel (P5) must be in the AUTO position to do a pneumatic start.

You move the APU selector from OFF to START to start the APU. After you move the APU selector to START, you hold the APU selector at the START position for one second and manually move the APU selector to ON. The start is automatic. It is recommended that you do not release the APU selector from the START position to the ON position. Damage to the internal contacts in the APU selector can cause an APU no start problem.

The APU FAULT light below the APU selector will flash one time during APU start. The APU RUNNING memo message shows on the EICAS engine primary format when the APU speed is greater than 95 percent RPM.

Normal Operation

The APU operates at 100 percent RPM. The status page shows EGT, RPM, and oil system data.

Normal Shutdown

You move the APU selector to OFF to shutdown the APU. The APU stays at 100 percent RPM for 15 seconds after you move the selector. The APU then decreases speed from 100 percent RPM to 84.8 percent RPM for 8 seconds (deceleration rate of 1.9 percent RPM for each second in a 8 second interval). The APU then decreases speed from 84.8 percent RPM to 70 percent RPM for 82 seconds (deceleration rate of approximately 0.2 percent RPM for each second in a 82 second interval). The memo message APU COOLDOWN shows during this period. After the 105 second cooldown period, the APU then decreases speed from 70 percent RPM to 0 percent RPM (APU shutdown). The APU FAULT light flashes one time during APU shutdown.

Non-Normal Shutdown

You can also shutdown the APU with the APU fire switch on the P5 overhead panel. From outside the airplane you can shut down the APU with the APU fire shutdown switch on the P40 panel.

The APU shuts down immediately when you use the APU fire switch or the APU fire shutdown switch.

The APU shuts down automatically for non-normal conditions.

APU Maintenance Switch

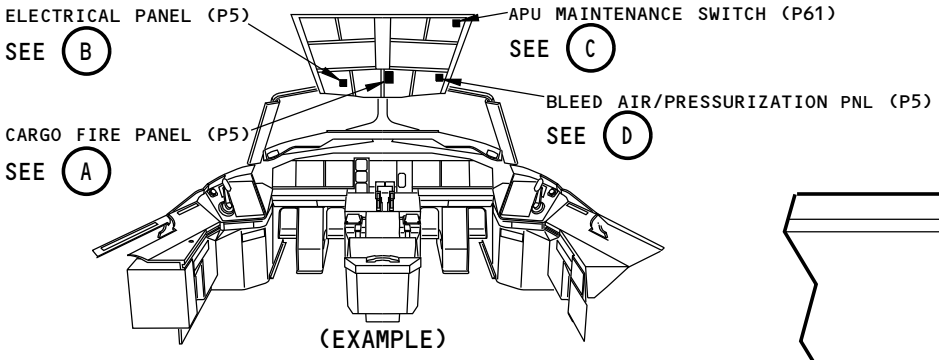
The APU maintenance switch (P61) in the TEST position supplies power to the APUC when the APU control selector is OFF. This permits the APU data to show on the status and maintenance page formats.

Training Information Point

After an emergency shutdown from the APU fire shutdown switch (P40), push the fire and overheat test switch to reset the start system.

After an APU fire switch (P5) shutdown, push the fire switch back in to reset the system.

The APU uses 675 lb (306 kg) of fuel for each hour of APU operation after the first hour.



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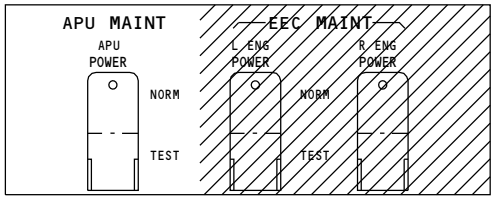
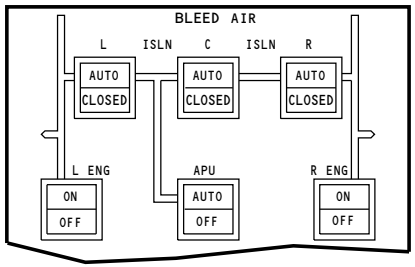


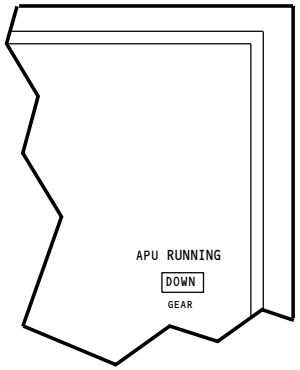
APU MAINTENANCE SWITCH (P61)

C

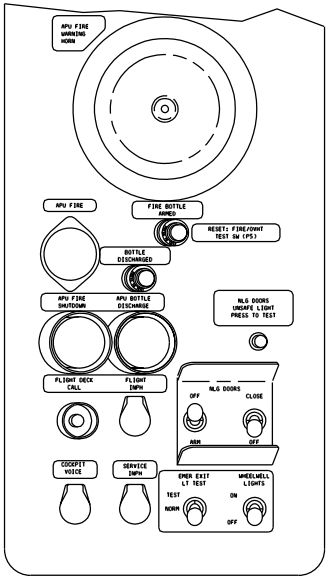


BLEED AIR/PRESSURIZATION PNL (P5)

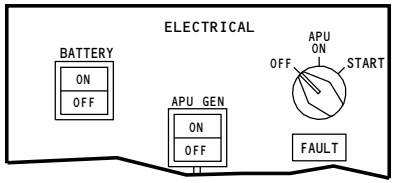
D



EICAS DISPLAY

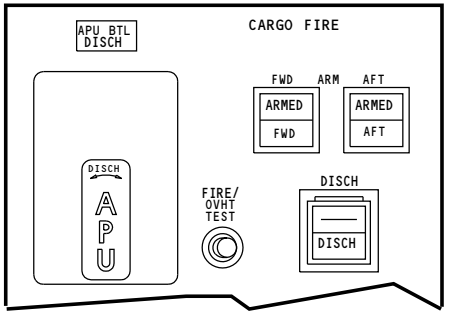


P40 SERVICE AND APU SHUTDOWN PANEL



ELECTRICAL PANEL (P5)

B



CARGO FIRE PANEL (P5)

A

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AUXILIARY POWER SYSTEM - OPERATION

AUXILIARY POWER SYSTEM - STARTING

General

The APU can be started at any altitude.

The APU selector makes inputs to the P310 standby power management panel in the ELMS. The ELMS sends signals to the APUC.

The APUC controls the APU fuel, ignition, and starter systems during APU start.

APU Selector - ON

When you move the APU selector to ON, the APU shutoff valve and the APU air inlet door open. The APU dc fuel pump also turns on if ac power is not available. If ac power is available, fuel system boost pumps supply fuel to the APU and the APU dc pump stays OFF.

When you move the APU selector to START, hold the APU selector at the START position for one second and manually move the APU selector to the ON position, the APUC then selects the air turbine starter system or the electric starter system.

The APUC selects the air turbine starter system if pneumatic pressure is available. The APUC selects the electric starter system if pneumatic pressure is not available or if the air turbine start fails.

APU engine RPM must be less than 12 percent RPM and the air inlet door must be fully open before the start sequence starts.

As the APU speeds up, the pressurizing shutoff valve in the fuel cluster opens at 7 percent RPM. The igniter plugs energize immediately after the pressurizing shutoff valve opens.

During a low altitude electric start (below than 22,000 feet, (6700 meters)), the starter motor turns off at approximately 49 percent RPM. For a high altitude electric start (above 22,000 feet, 6700 meters), the starter motor turns off at 55 percent RPM.

During a pneumatic start, the ATSCV closes at 55 percent RPM.

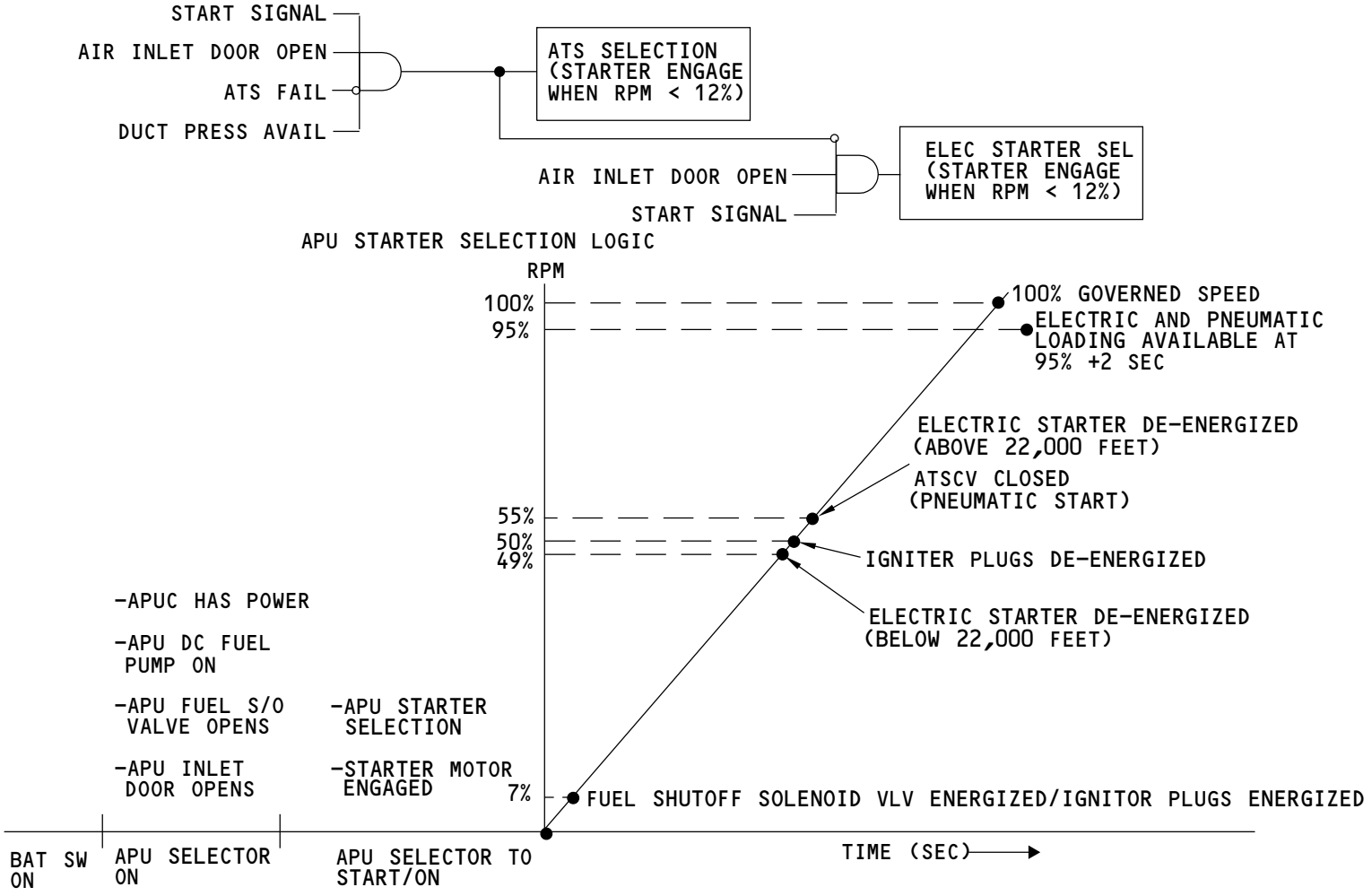
The APUC turns off the igniter plugs at 50 percent RPM.

The APU continues to speed-up. Two seconds after the APU reaches 95 percent RPM, pneumatic and electric loading become available.

The APU speeds up to its normal operating speed of 100 percent (39,044) RPM.

Training Information Point

During an APU start, if the APU stops its acceleration for more than seven seconds, the APUC shuts down the APU.



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AUXILIARY POWER SYSTEM - STARTING

AUXILIARY POWER SYSTEM - NORMAL SHUTDOWN

General

The APUC controls the APU shutdown sequence. APU shutdown is not immediate. The APU goes through a cool-down period before shutdown.

There are different cooldown schedules for when the airplane is above 14,000 feet (4265 m) and below 14,000 feet (4265 m).

APU Selector to OFF

When you turn the APU control selector to OFF, the APUC sends a signal to the ASCPCs to close the APU shutoff valve. The APUC also closes the IGVs and opens the SCV to pneumatically unload the APU.

Thirteen seconds after you move the selector to OFF, the APUC sends a signal to the APU generator control unit (GCU) to unload the APU generator.

Above 14,000 Feet Cooldown

When the airplane is above 14,000 feet (4265 m), the APU cools down at 100 percent RPM for 105 seconds after you move the selector to OFF.

Below 14,000 Feet Cooldown

When the airplane is below 14,000 feet (4265 m), the APU stays at 100 percent RPM for 15 seconds. The APU then starts a 90 second deceleration to 70 percent RPM.

Shutdown

After cooldown, the APUC does a test of the overspeed shutdown circuits to shut down the engine. The APUC sends a signal to the fuel shutoff solenoid valve and to the torque motor on the fuel metering valve to stop fuel flow. The APU speed then starts to decrease.

At 15 percent RPM, the air inlet door begins to close and the APU fuel shutoff valve in the left wing tank closes.

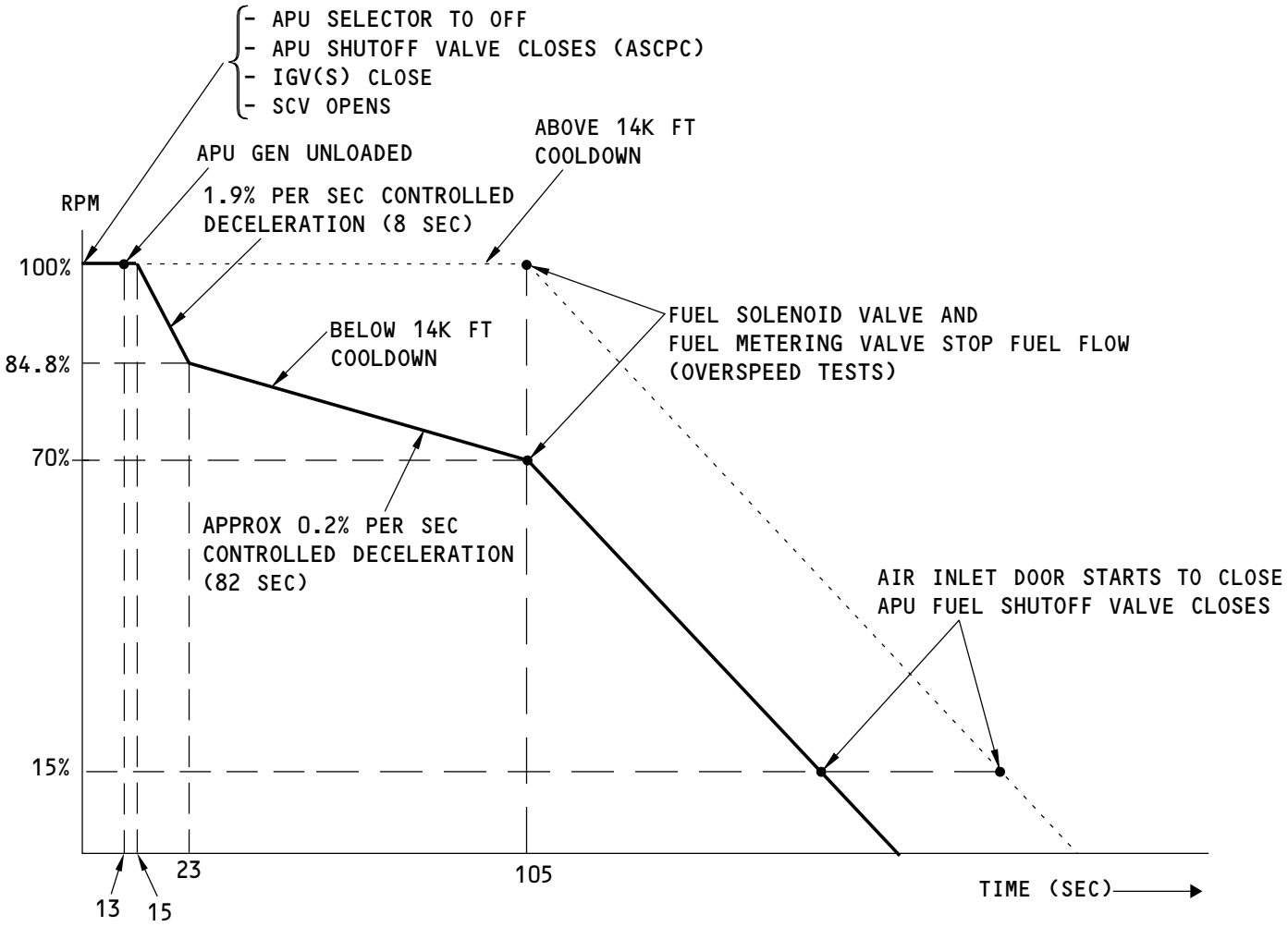
The APU speed decreases to zero.

Training Information Point

15 seconds after you move the APU selector to the OFF position, the APU COOLDOWN memo message shows. This message goes out of view after 90 seconds.

If you move the APU selector to the ON position during APU cooldown (less than 105 seconds after the selector is moved to OFF), the APU will accelerate to 100 percent and continue to operate.

If you move the APU selector to the ON position after the cooldown period has ended (more than 105 seconds after the selector is moved to OFF), the APU shutdown will continue.



M42164 S000620786_V3

AUXILIARY POWER SYSTEM - NORMAL SHUTDOWN

AUXILIARY POWER SYSTEM - PROTECTIVE SHUTDOWNS

General

The APUC controls the automatic protective shutdown of the APU. If the APUC finds some APU conditions or faults, it sends a protective shutdown signal.

There are two modes of APU automatic shutdown protection, the attended mode and the unattended mode.

Attended Protective Shutdown

The attended mode operates when at least one engine is running or if the aircraft is in the air. These conditions will cause a protective shutdown in the attended mode:

- APU overspeed (more than 106 percent RPM)
- Loss of overspeed protection (loss of the two overspeed protection circuits)
- APU compartment fire
- APU inlet fire/load compressor reverse flow (T2 > 177C)
- Load compressor Low flow (surge control valve does not follow command and pressure sensors show low flow condition)
- APU speed droop (RPM less than 88 percent and no acceleration for 10 seconds)
- APUC internal failure
- Loss of power to the APUC
- Air inlet door closes (air inlet door position switch indicates door closed, which occurs at 70 percent of full open position).

Unattended Protective Shutdown

The unattended mode operates when the main engines are not running and the airplane is on the ground. This mode supplies protective shutdown for all of the attended mode conditions plus these conditions:

- Low oil pressure (less than 35 psi)
- Loss of oil pressure signal (from both the pressure sensor and the low oil pressure switch)
- High EGT (calculated turbine inlet temperature is above 1288C)
- Loss of EGT signal (from both thermocouple rakes)
- Generator scavenge filter is clogged
- High oil temperature (more than 156C).

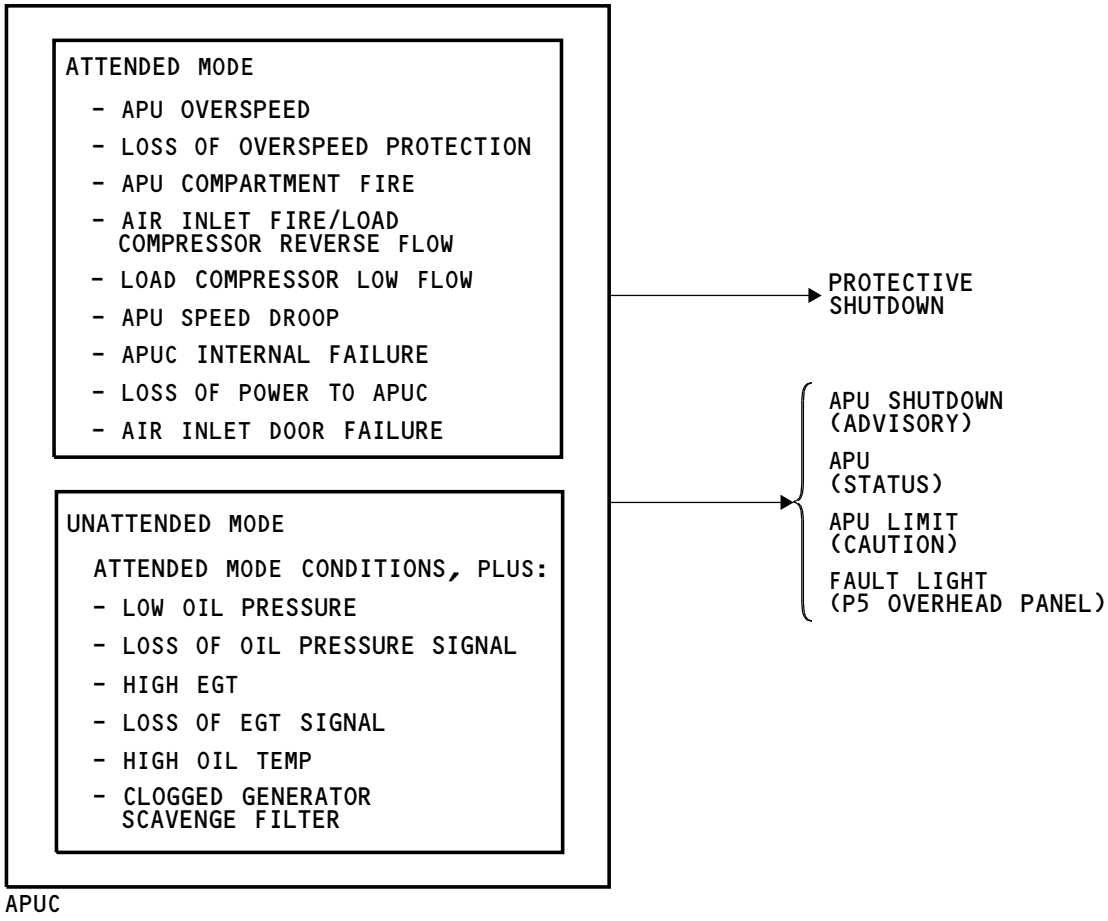
Indication

All protective shutdowns cause the APU SHUTDOWN advisory message to show and turn on the APU fault light on the P5 overhead panel. The APU status message also shows when there is a protective shutdown. In the attended mode, these conditions cause the APU LIMIT caution message to show:

- Low oil pressure
- High EGT
- High oil temperature.

Training Information Point

You can attempt to restart the APU after you move the APU selector to OFF to unlatch the protective shutdown.



M42165 S000620787_V1

AUXILIARY POWER SYSTEM - PROTECTIVE SHUTDOWNS

AUXILIARY POWER SYSTEM - INDICATIONS

General

The status display and maintenance page show APU system data.

Status Display

The status display shows these data:

- APU RPM
- APU EGT in degrees C
- APU oil pressure in psi
- APU oil temperature in degrees C
- APU oil quantity in liters.

Maintenance Page

The APU maintenance page shows the status of many APU systems and the outputs of the APU sensors. The data shown includes:

- APU pneumatic mode
- APUC mode
- Speed sensor input in percent RPM. A box shows for the highest value
- Exhaust gas temperatures corrected to standard sea level conditions in degrees C
- Exhaust gas temperatures from each of the two rakes in degrees C
- Oil pressure in psi
- Oil temperature in degrees C
- Oil quantity in liters (LO shows when the quantity is less than 3.50)
- Inlet static pressure (P2) in psia
- Load compressor total pressure (exit pressure from the load compressor) in psia
- Load compressor differential pressure (DP) in psi (difference between the load compressor total pressure and the static pressure downstream of the load compressor)
- Compressor inlet temperature (T2) in degrees C
- Oil sump temperature in degrees C
- Surge control valve position from 90 degrees (fully closed) to 10 degrees (fully open)
- Inlet guide vane actuator position from 76 degrees (fully closed) to -10 degrees (fully open)
- Fuel metering unit fuel temperature in degrees C
- Fuel cluster fuel metering valve position from 0 percent (fully closed) to 100 percent (fully open)
- Air inlet door command - OPEN or CLOSED (from ELMS)
- Air inlet door position - OPEN or CLOSED
- Bleed corrected flow in pounds of air per minute from the load compressor
- Bleed corrected flow setpoint in pounds of air per minute (calculated by the APUC). This is the surge margin set point
- APU battery DC voltage and amperage (charging or discharging)
- APU generator AC voltage, frequency, and load in percentage of maximum load.

APU fuel feed data also shows on the maintenance page. This data includes:

- APU fuel shutoff valve data
- DC fuel pump data
- AC fuel pump data.

The status codes show in digital format (1 or 0) the status of some of the APU inputs and outputs. Refer to section 49-70 in Part II of the airplane maintenance manual (AMM) for more information on the status codes.

APU operating hours and the number of APU starts also shows on the maintenance page.

Training Information Point

You can use the APU maintenance switch to power the APUC when the APU selector is OFF. This permits you to read APU oil system indications on the status display without turning the APU selector to ON.

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APU Access

You get access to the APU compartment through the APU doors.

You open the APU vent doors first to permit air to go into the APU compartment. This makes the pressure equal in the APU compartment and permits you to open the main APU doors when the APU is on.

Each main APU door has a latch on the forward edge of the door. You must release the latches to permit the main APU doors to open. Hold-open rods keep the doors in the open position.

APU Oil Servicing

You add oil to the APU at the oil fill port. The oil level sight gage shows full on the APU OFF side when the oil quantity is at the correct level.

The status display shows the APU oil quantity in liters. The APU maintenance page (not shown) also shows the APU oil quantity.

This is a summary of the procedure to add oil to the APU:

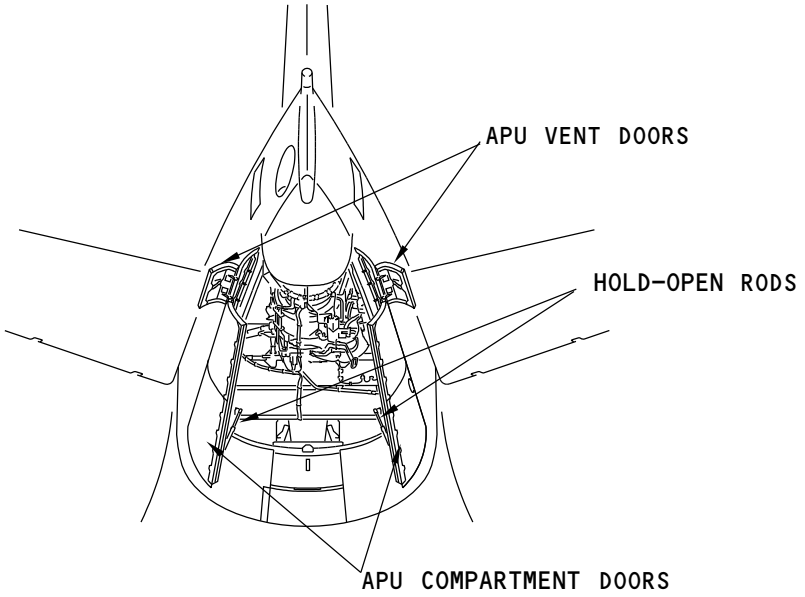
- Make sure the APU selector on the P5 overhead panel is OFF and attach a D0-NOT OPERATE tag
- Open the APU access doors
- Open the oil fill cap
- Slowly add oil until the oil level is at the FULL mark on the APU OFF side of the oil level sight gage
- Close the oil fill cap
- Put the airplane back in its usual condition.

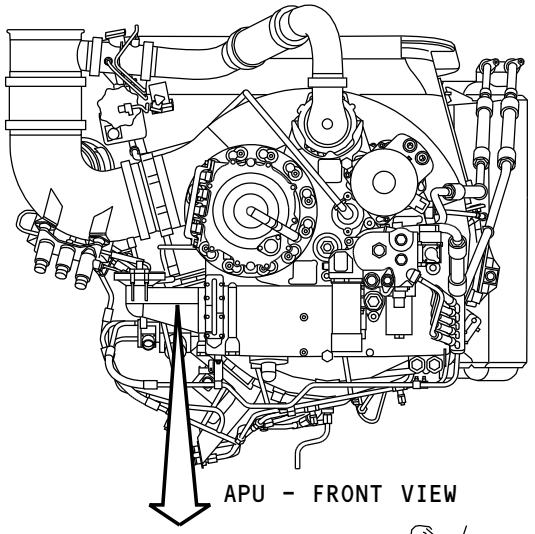
WARNING DO NOT LET HOT OIL GET ON YOU. PUT ON PROTECTIVE CLOTHES, GOGGLES, AND EQUIPMENT, OR LET THE APU BECOME COOL. HOT OIL CAN BURN YOU.

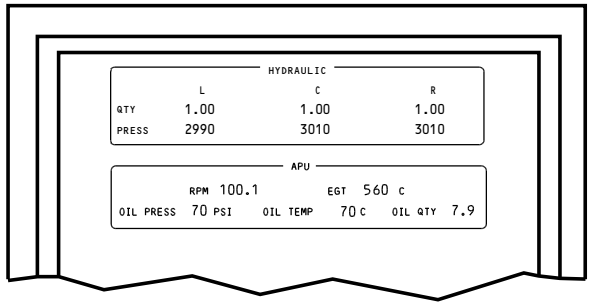
WARNING DO NOT LET THE OIL STAY ON YOUR SKIN. YOU CAN ABSORB POISONOUS MATERIALS FROM THE OIL THROUGH YOUR SKIN.

CAUTION DO NOT LET OIL GET ON THE APU OR OTHER COMPONENTS. IMMEDIATELY CLEAN THE OIL WHEN IT FALLS ON THEM. OIL CAN CAUSE DAMAGE TO PAINT AND RUBBER.

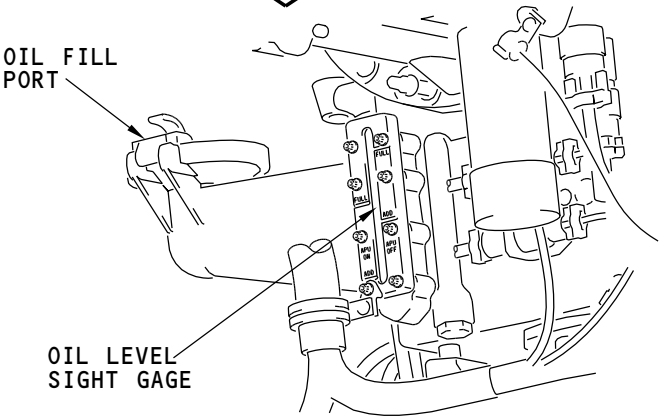
CAUTION DO NOT MIX TYPES OR BRANDS OF OIL WHEN YOU ADD OR REPLACE THE OIL IN THE APU. INCORRECT OILS CAN CAUSE DAMAGE TO THE APU.







STATUS DISPLAY



M42169 S000620791_V1

AUXILIARY POWER SYSTEM - APU ACCESS AND SERVICING

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APU POWER PLANT - INTRODUCTION

General

The power plant has these systems and components:

- Auxiliary power unit
- APU mounts
- APU wire harness
- APU air inlet
- APU drains.

Auxiliary Power Unit

The auxiliary power unit contains these major sections:

- Accessory gearbox
- Pneumatic load compressor
- Gas turbine engine.

APU Mounts

The APU mounts hold the APU in the APU compartment and isolate the structure from APU vibration.

APU Wire Harness

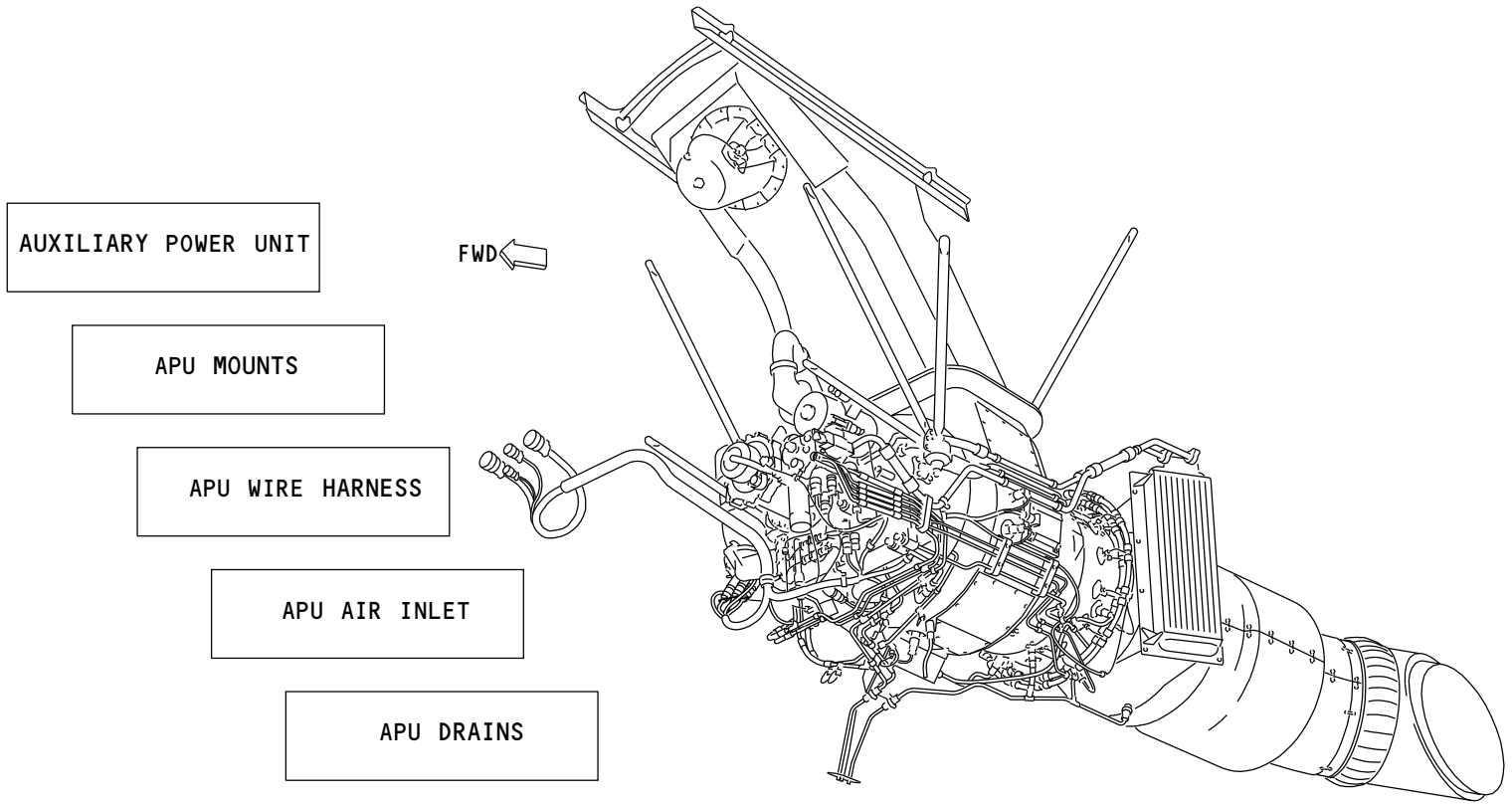
The APU wire harness contains all the electrical wiring for the APU.

APU Air Inlet

The APU air inlet supplies the air for the APU engine and APU load compressor operation.

APU Drains

The APU drains permit flammable fluid to drain from the APU.



M42172 S000620794_V1

APU POWER PLANT - INTRODUCTION

Clustered Components

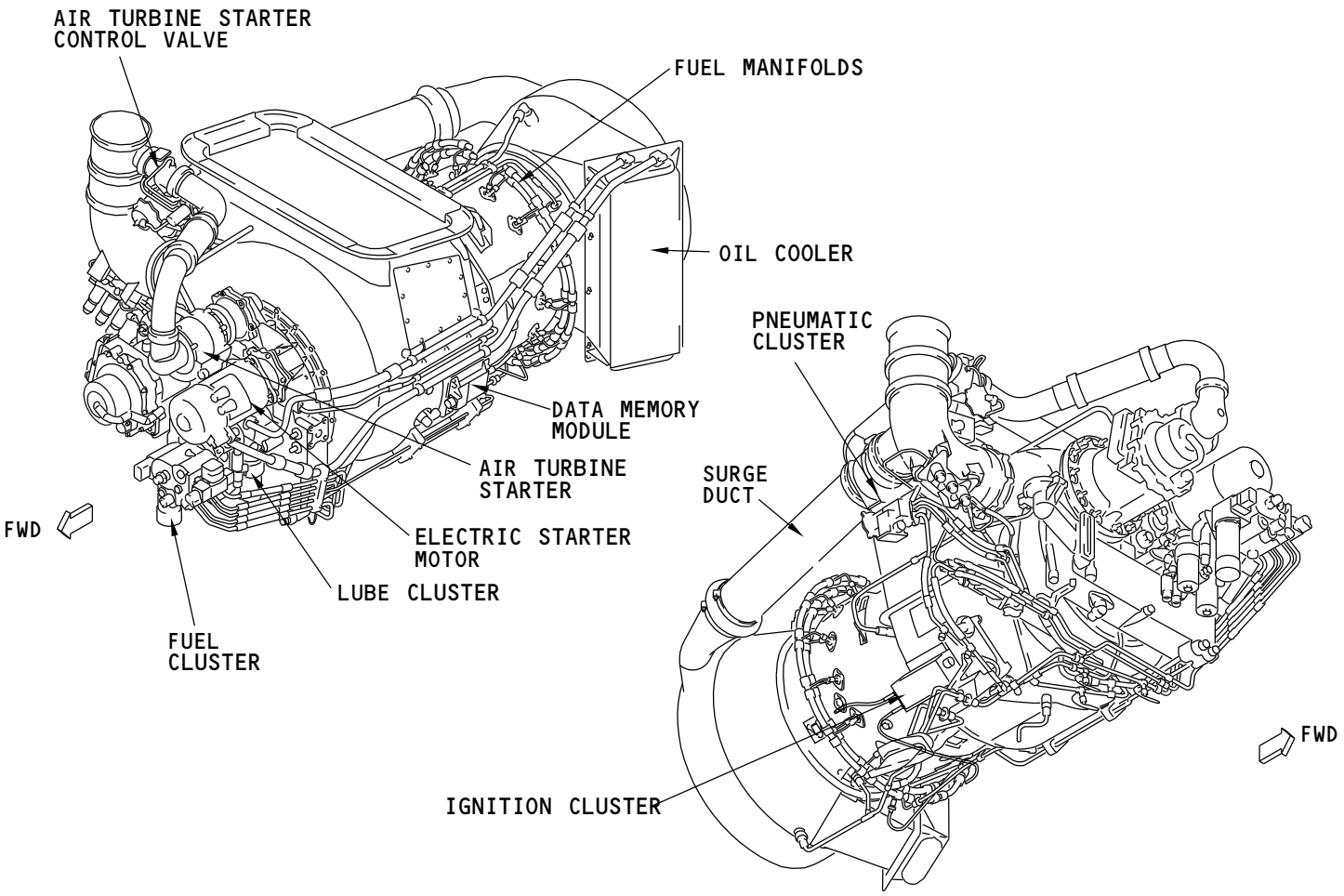
Some APU components are in functional clusters to make maintenance easier. These clusters include:

- Lube cluster
- Fuel cluster
- Pneumatic cluster
- Ignition cluster.

Other Components

These are the other main APU components:

- Air turbine starter control valve (ATSCV)
- Fuel manifolds
- Oil cooler
- Data memory module (DMM)
- Air turbine starter (ATS)
- Electric starter motor
- Surge duct.



M42173 S000620795_V1

APU POWER PLANT - AUXILIARY POWER UNIT

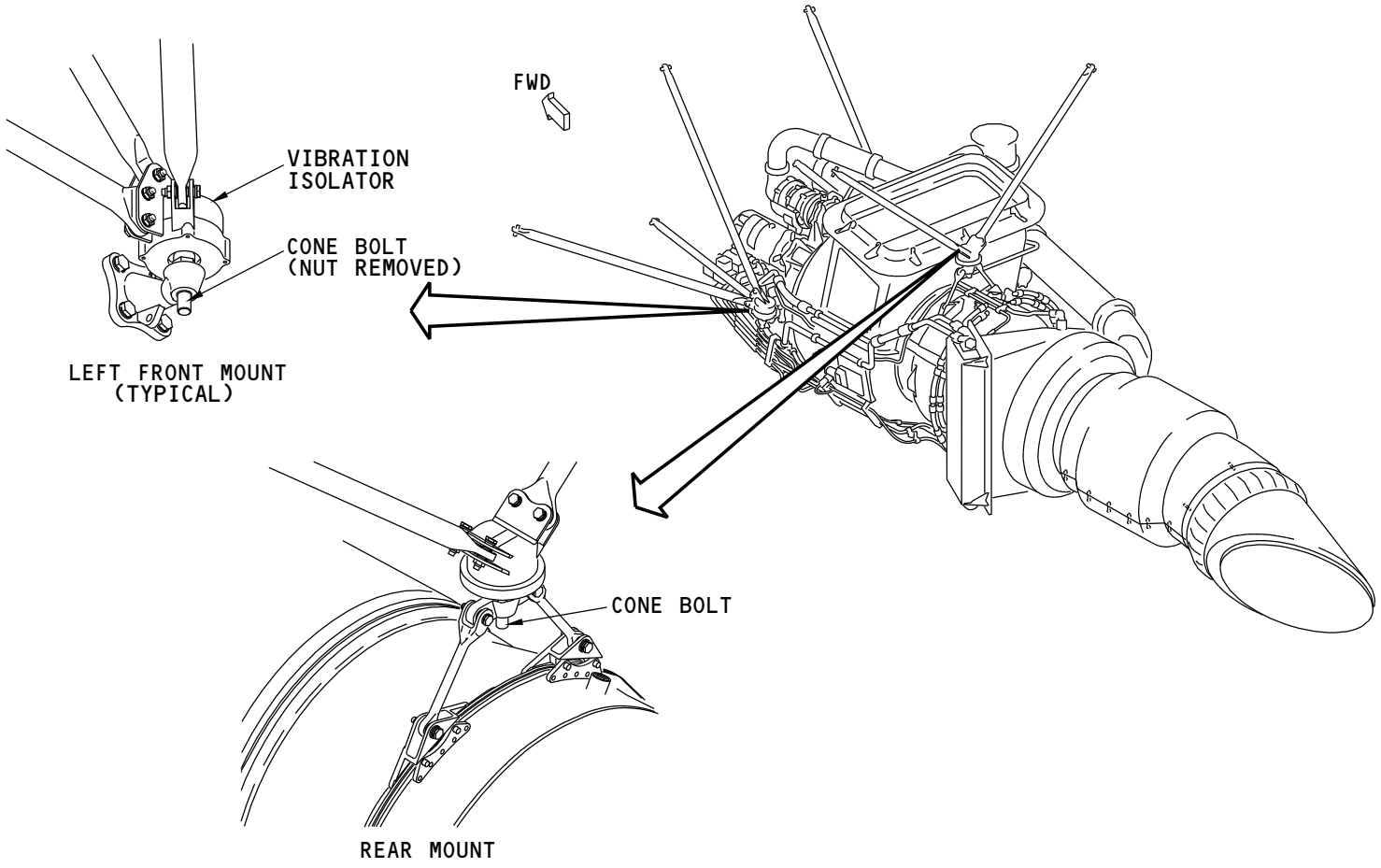
APU POWER PLANT - APU MOUNTS

Purpose

Three APU mounts hold the APU in its compartment. The mounts also isolate the structure from APU vibration.

Location

The two forward mounts attach to the APU firewall. The aft APU mount hangs from the upper tailcone structure.



M42175 S000620797_V1

APU POWER PLANT - APU MOUNTS

APU POWER PLANT - APU WIRE HARNESS

Purpose

The APU wire harness holds all the electrical wires in one assembly.

Location

The APU wire harness extends from the firewall connector to the front of the APU. From the front of the APU it goes in different directions around the APU to connect all electrical components.

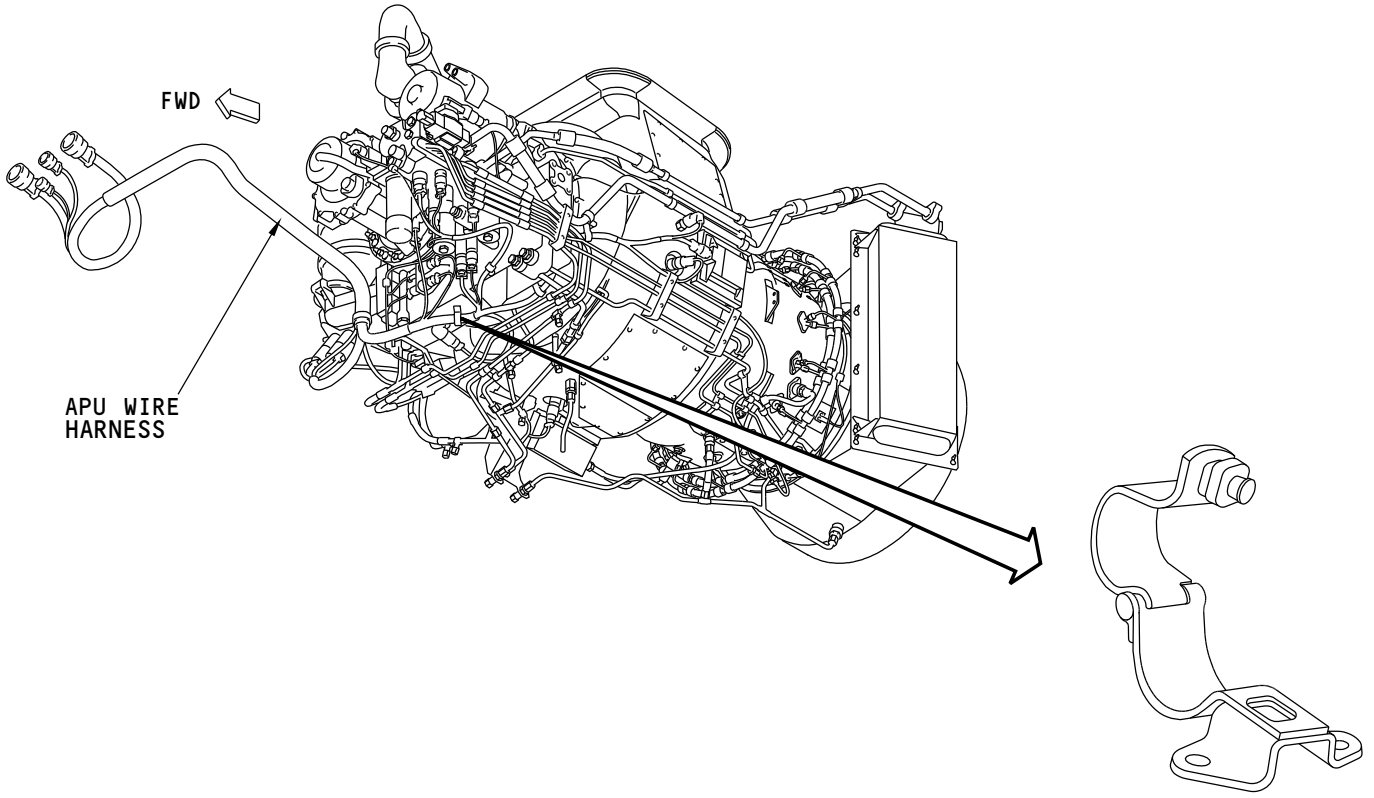
Physical Description

Shielded, twisted pair conductors keep electromagnetic interference on circuits to a minimum. APU harness connectors are threaded, stainless steel, and self-locking.

Training Information Point

Wiring routing tags on the harness show pin to pin electrical continuity.

Quick release fastener cable clamps attach the APU harness to the APU.



M42176 S000620798_V1

APU POWER PLANT - APU WIRE HARNESS

APU POWER PLANT - AIR INLET - INTRODUCTION

Purpose

The APU air inlet supplies air to the APU for APU engine and load compressor operation, and for oil and APU compartment cooling. These are the APU air inlet components:

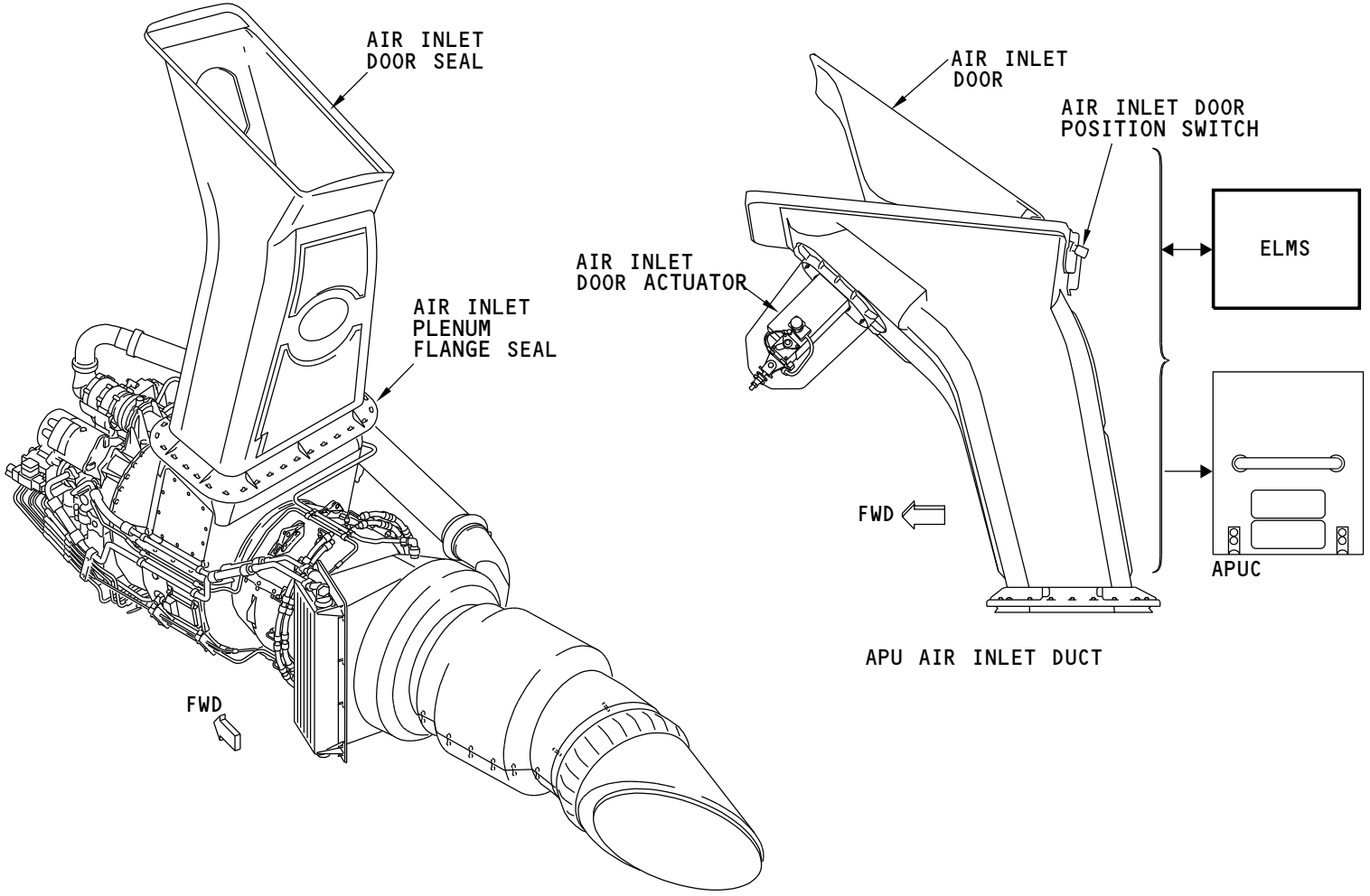
- Air inlet duct
- Air inlet plenum flange seal
- Air inlet door
- Air inlet door actuator
- Air inlet door position switch
- Air inlet door seal.

Location

The air inlet components are above the APU. The air inlet door is on the upper right side of the tailcone.

Interface

The electrical load management system (ELMS) controls the air inlet door. The APUC receives door position data for control and fault indications.



M42178 S000620800_V1

APU POWER PLANT - AIR INLET - INTRODUCTION

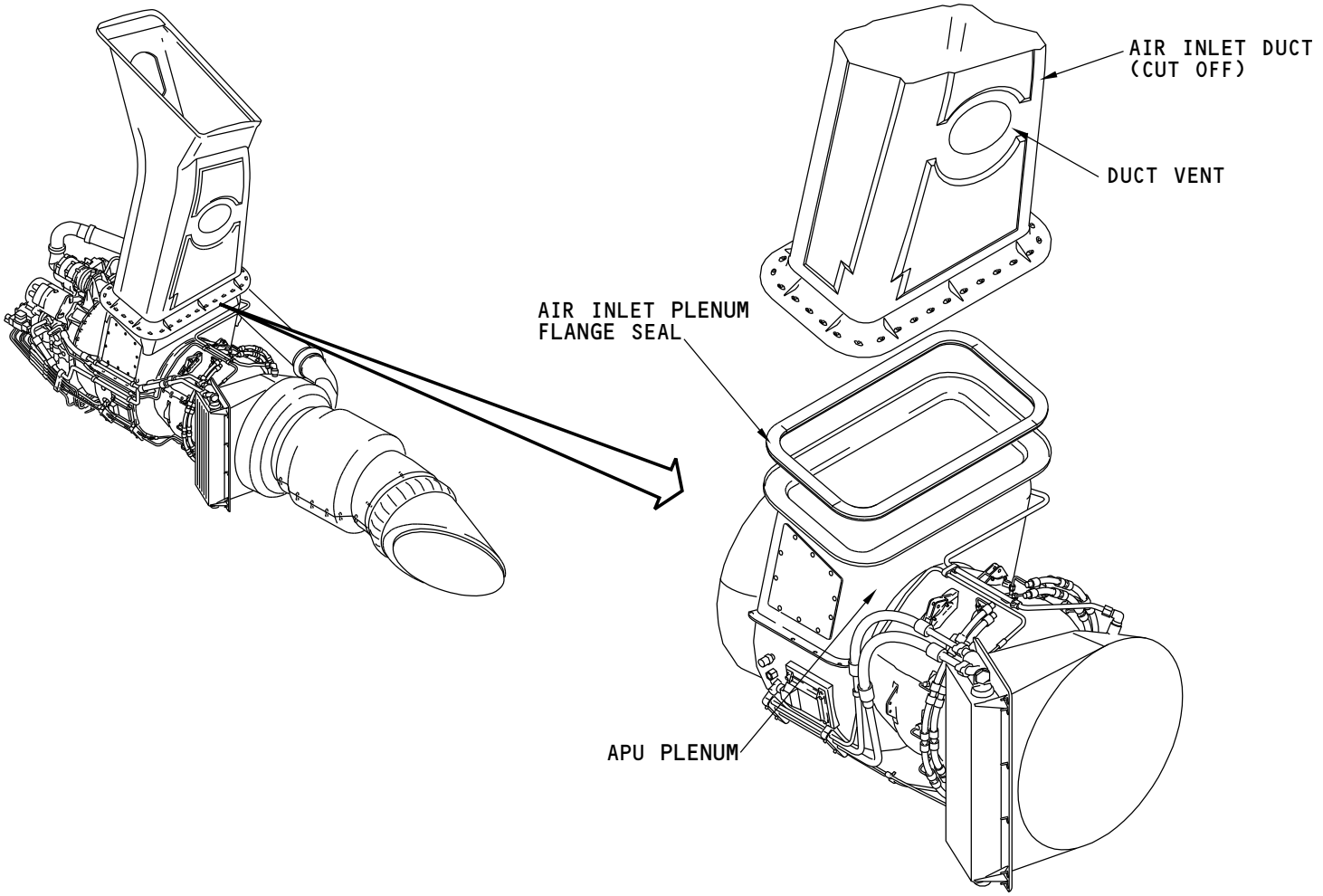
Air Inlet Duct

The air inlet duct connects the APU door to the APU plenum. The duct supplies air to the APU by the shortest, most direct path. The duct is made of composite material.

The duct vent supplies air to the APU compartment for compartment and oil cooling.

APU Air Inlet Plenum Flange Seal

The air inlet plenum flange seal closes and seals the air inlet duct where it connects with the APU plenum. The flange seal is made of a flexible fiberglass/NOMEX/silicone material. The seal also helps to isolate APU vibration from the duct.



M42180 S000620802_V1

APU POWER PLANT - AIR INLET - AIR INLET DUCT AND PLENUM FLANGE SEAL

Air Inlet Door

The air inlet door opens to let air into the engine and load compressor plenum.

The air inlet door is on the right, upper surface of the tail cone immediately aft of the rudder trailing edge. This position decreases the possibility of water or slush ingestion during ground and flight operations.

Air Inlet Door Seal

The air inlet door seal keeps fluids and contaminants out of the inlet duct when the door is closed. The seal is a bulb-type seal made of silicone rubber.

Air Inlet Door Actuator

The air inlet door actuator is an electric actuator that opens and closes the air inlet door.

The inlet door actuator is in a canister assembly on the upper forward section of the air inlet duct. The canister assembly supports the actuator and seals the operating rod slot in the duct.

Air Inlet Door Position Switch

The air inlet door position switch supplies a door open or door not open signal to the ELMS and to the APUC. The switch is on the aft side of the air inlet duct.

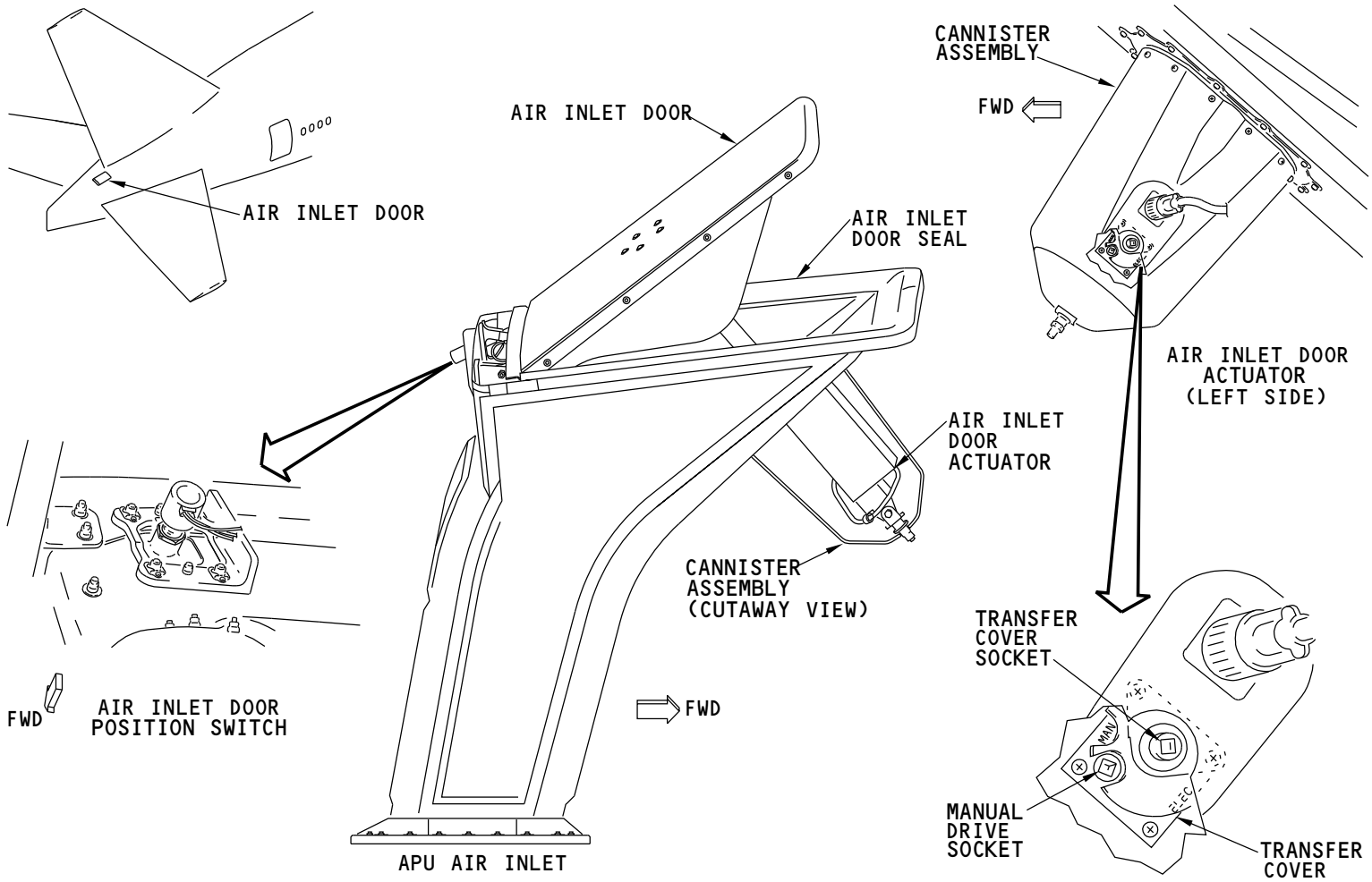
Training Information Point

You can manually operate the air inlet door with the manual drive socket on the inlet door actuator assembly.

You must remove a cover (not shown) on the canister assembly to get access to the transfer cover and the manual drive sockets.

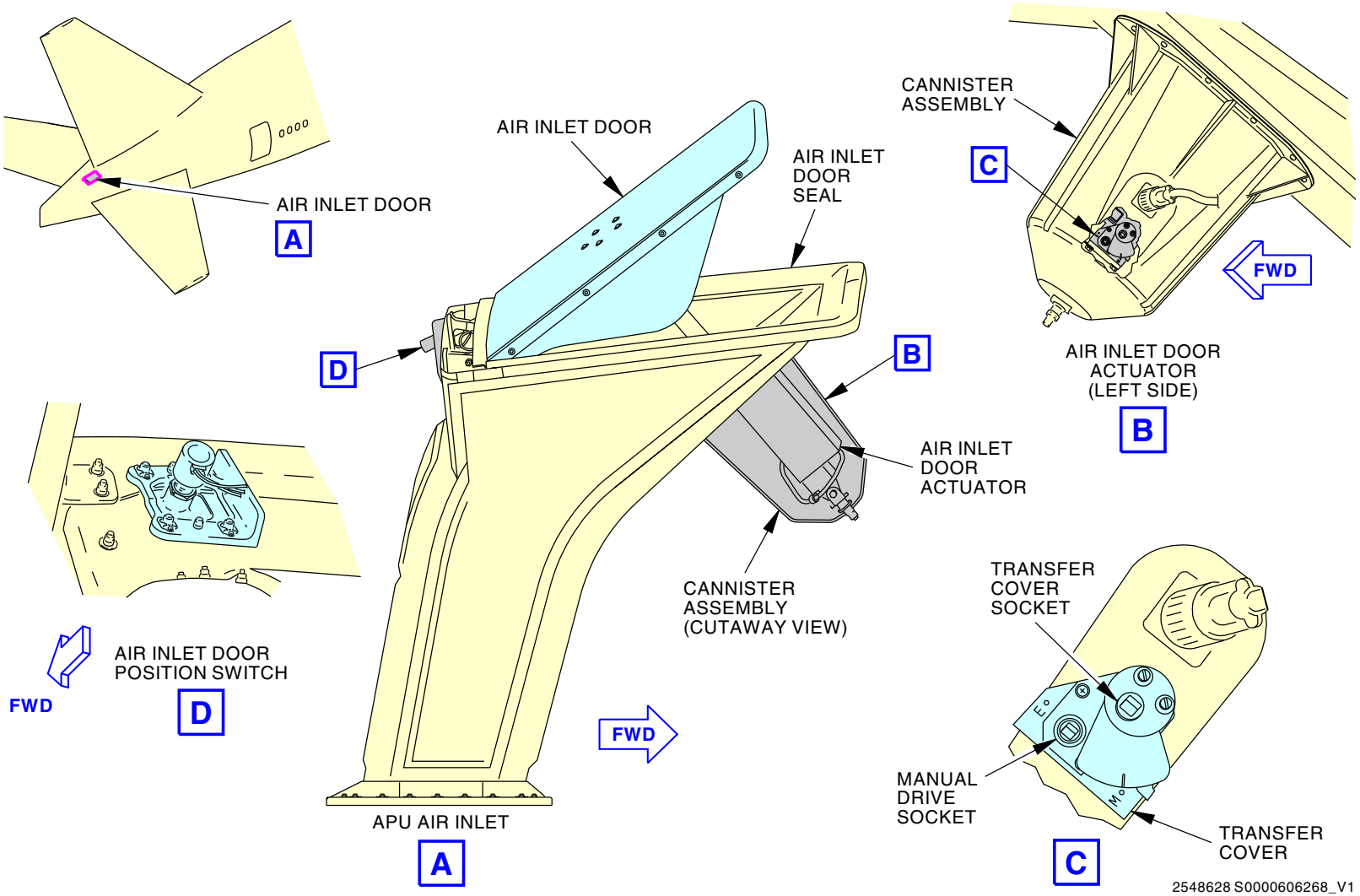
You turn the transfer cover socket to select the manual mode. This does these things:

- Uncovers the manual drive socket
- Disengages the electrical drive mechanism
- Engages the manual drive mechanism.



M42181 S000620803_V1

APU POWER PLANT - APU AIR INLET - AIR INLET DOOR COMPONENTS (ACTUATOR R5365-1, R5365–2, R5365–3)



APU POWER PLANT - APU AIR INLET- AIR INLET DOOR COMPONENTS (ACTUATOR 734-07390-01)

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APU POWER PLANT - APU AIR INLET - FUNCTIONAL DESCRIPTION

General

The APU air inlet door opens for APU start and run operation and closes when the APU is not running. The ELMS contains the control logic for the APU air inlet door.

APU Start

When the APU is OFF, the air inlet door is closed and sealed. When the APU selector is in the ON or START position, the ELMS energizes the control relay to open the air inlet door.

The air inlet door position switch sends a signal to the APUC and to the ELMS when the air inlet door gets to the open position. The door takes 30-40 seconds to open fully.

Normal Operation

During normal operation, an APU running signal from the APUC to the ELMS keeps the door open.

APU Shutdown

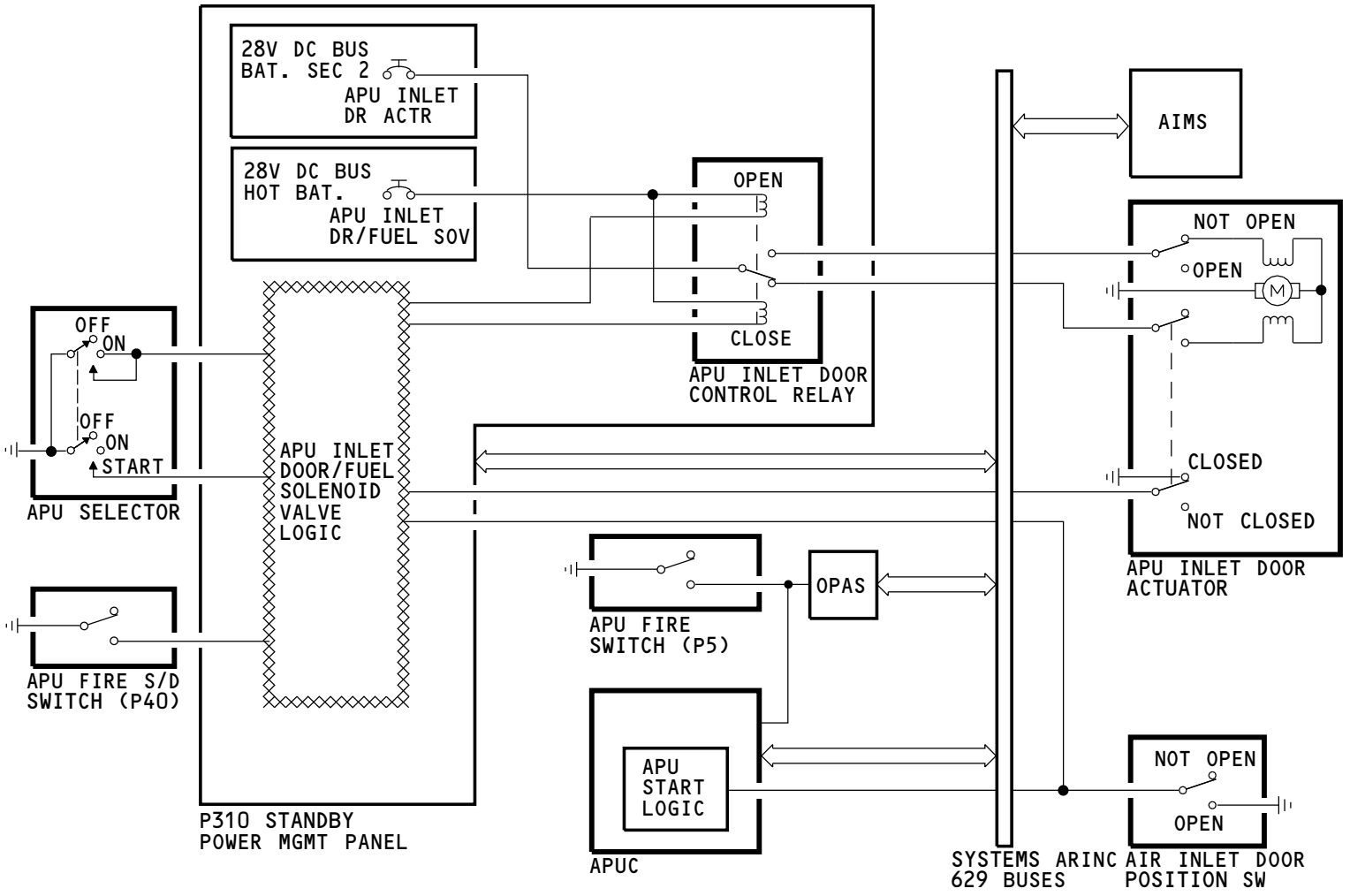
On shutdown, the ELMS energizes the control relay to close the air inlet door when the speed of the APU engine goes below 15 percent RPM. The door takes 30-40 seconds to close fully.

The APU fire switch (P5) or fire shutdown switch (P40) operation cause the air inlet door to close immediately.

Door Position Disagreement

If door position disagrees with the commanded position, the ELMS sends a signal to the AIMS to show the APU DOOR status message.

An air inlet door failure causes an automatic APU shutdown when the APU is in the unattended mode. See the auxiliary power system section for more information on the protective shutdowns (SECTION 49-00).



M42182 S000620804_V2

APU POWER PLANT - APU AIR INLET - FUNCTIONAL DESCRIPTION

APU POWER PLANT - APU DRAINS - INTRODUCTION

General

APU flammable fluids drain overboard through drains connected to a drain mast. These drains remove fuel or oil that leaks through seals. These drains also remove fuel that does not burn from the combustion chamber and tailpipe.

APU non-flammable fluids drain overboard through drain holes in the APU compartment doors. These drains remove fluids that go into the APU air inlet plenum from the APU air inlet. These fluids go from the APU air inlet plenum into the APU compartment through the APU plenum drain.

Flammable Fluid Drains

Flammable fluid drains through three separate tubes. The drains attach together at the bottom of the APU. They connect with a drain mast on the right APU access door when the door is closed.

Fuel that does not burn during APU start or operation goes through the APU combustor drain valve. The APU combustor drain valve is at the bottom of the combustion chamber. The drain line from the combustion chamber connects to the combustor drain valve. APU combustion chamber pressure closes the combustor drain valve when the APU operates. The valve is open when the APU is off.

Non-Flammable Fluid Drains

The APU plenum drain is at the bottom of the air inlet plenum.

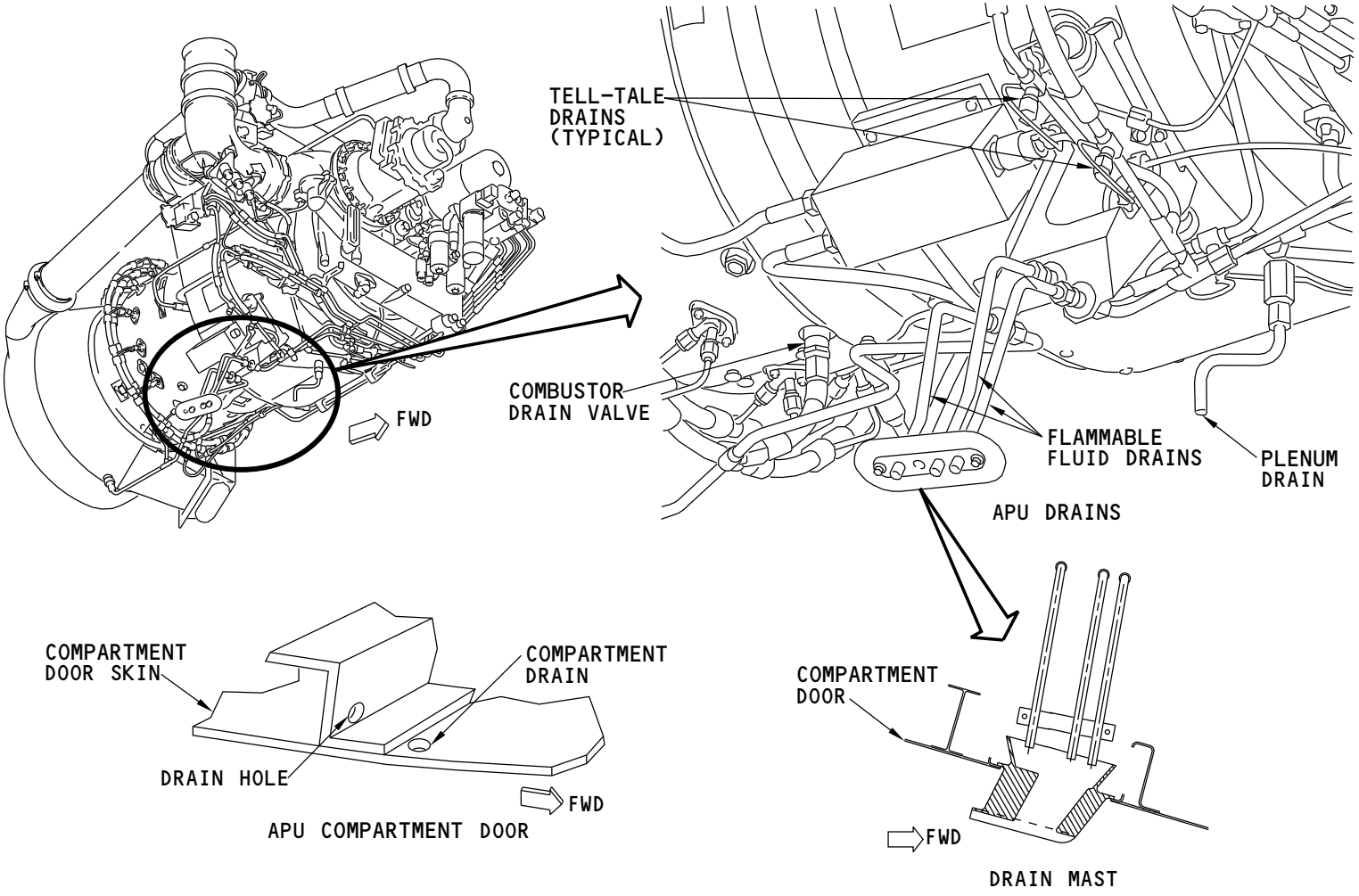
Compartment drains are along the bottom skin of the APU compartment access doors. The APU access doors and compartment structure have drain holes to permit the fluid to flow to the compartment drains.

Training Information Point

Tell-tale drains help find fuel seal failures. Three tell-tale drains are on the APU.

If fuel goes through a drain tube with a tell-tale drain, then the tell-tale drain fills with fuel. You remove the cap of the tell-tale drain to do a check for fluid. If fluid is in the tell-tale drain, the APU component that connects to the drain tube is leaking fuel.

The APU combustor drain valve is an LRU.



M42183 S000620805_V2

APU POWER PLANT - APU DRAINS - INTRODUCTION

APU POWER PLANT - APU DRAINS - FUNCTIONAL DESCRIPTION

General

These APU drains send fuel and oil to the drain mast on the right APU access door:

- Combustion chamber fuel drain
- Eductor/Tailpipe fuel drain
- Surge control valve (SCV) actuator seal drain
- Inlet guide vane (IGV) actuator seal drain
- Forward mid-bearing seal drain
- Aft mid-bearing seal drain
- Load compressor bearing seal drain
- Fuel cluster seal drain.

Drains

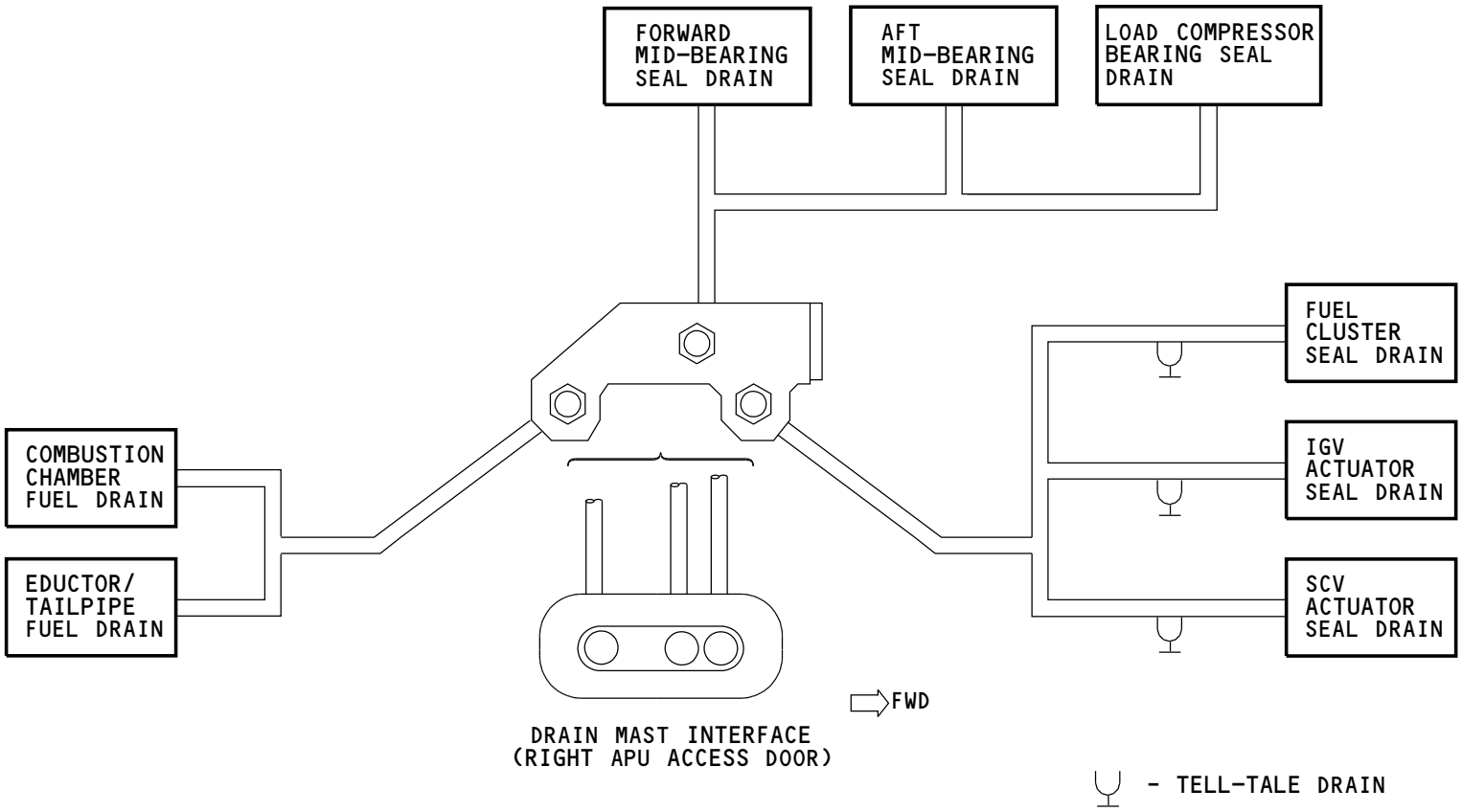
The APU drains connect directly to the drain mast.

The combustion chamber fuel drain and the eductor/tail pipe fuel drain connect together at the bottom of the APU.

The surge control valve seal drain, the IGV actuator seal drain, and the fuel cluster seal drain connect at the bottom of the APU.

The two mid-bearing seal drains and the load compressor bearing seal drain connect at the bottom of the APU.

The drain lines from the SCV actuator seal drain, the IGV actuator seal drain, and the fuel cluster seal drain have tell-tale drains. These tell-tale drains let you find the source of fluid in these drain lines and do a check of the leakage rate.



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APU POWER PLANT - APU DRAINS - FUNCTIONAL DESCRIPTION

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APU ENGINE - INTRODUCTION

Purpose

The APU engine supplies power to operate the load compressor and the APU generator.

General Description

The APU gas turbine engine has these main components:

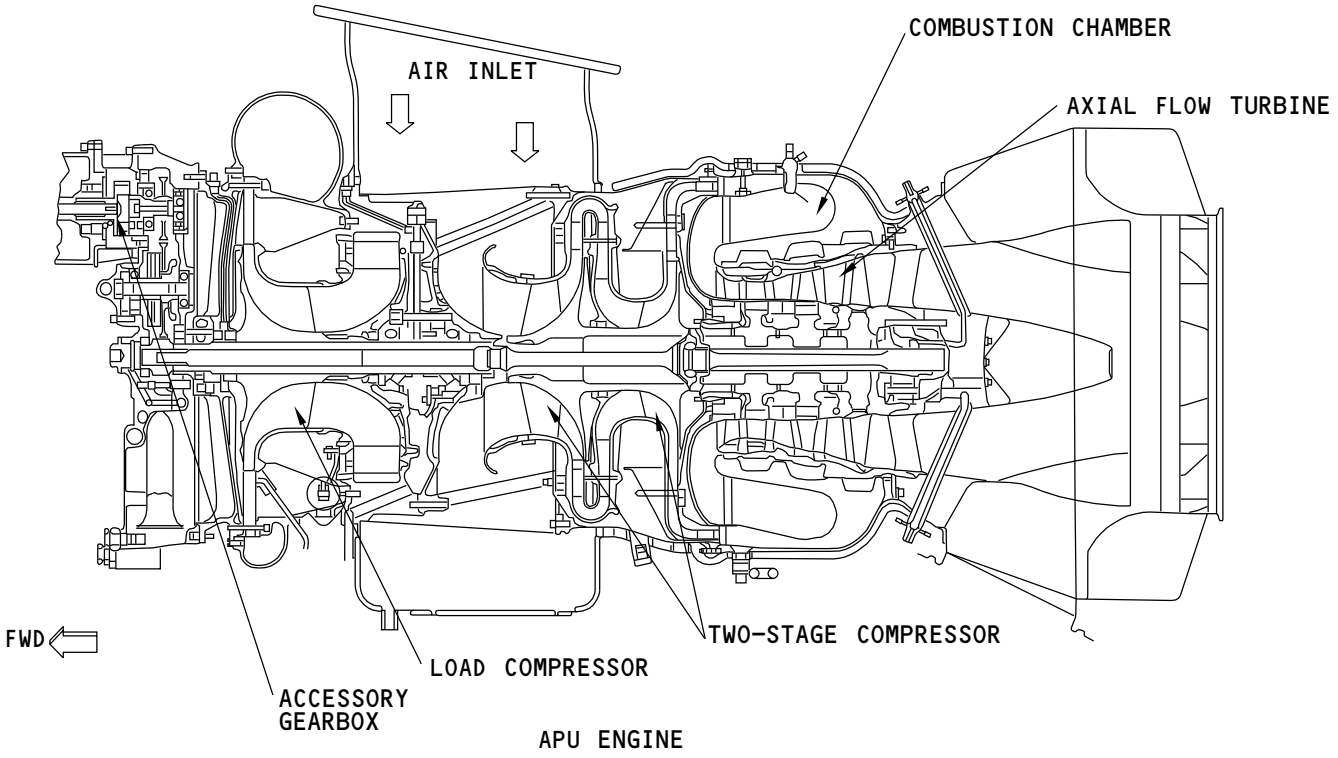
- Two-stage centrifugal compressor
- Reverse flow annular combustion chamber
- Three stage axial flow turbine.

All rotating components in the engine are on a common shaft.

The shaft turns the accessory gearbox and the load compressor. The accessory gearbox turns the APU generator and other APU components.

The engine uses air that flows through the air inlet duct.

The engine operates at a constant speed to permit a 400 hertz generator output frequency. The APU adjusts fuel flow to the engine to keep a constant speed when electrical and pneumatic loads change.



M42185 S000620807_V1

APU ENGINE - INTRODUCTION

APU ENGINE - TRAINING INFORMATION POINTS

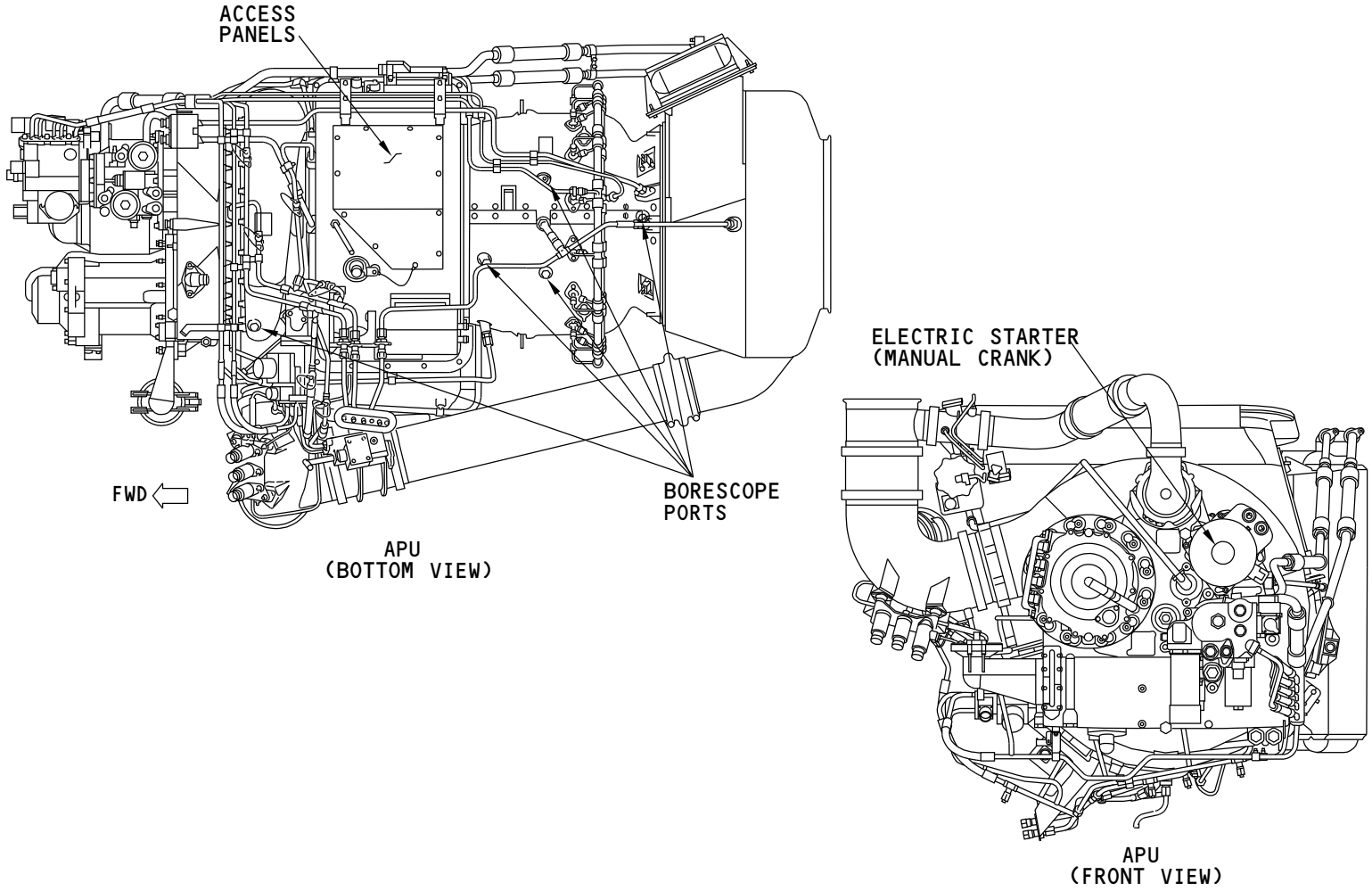
Borescope Inspection Ports

Borescope inspection ports and access panels permit inspection of these components:

- Load compressor
- Engine compressor
- Combustion chamber
- Turbine section.

Engine Manual Rotation

You can turn the APU engine main shaft with a wrench through a drive connection on the electric starter.



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APU ENGINE - TRAINING INFORMATION POINTS

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APU AND GENERATOR LUBRICATION SYSTEM - INTRODUCTION

Purpose

The APU lubrication system lubricates and cools these components:

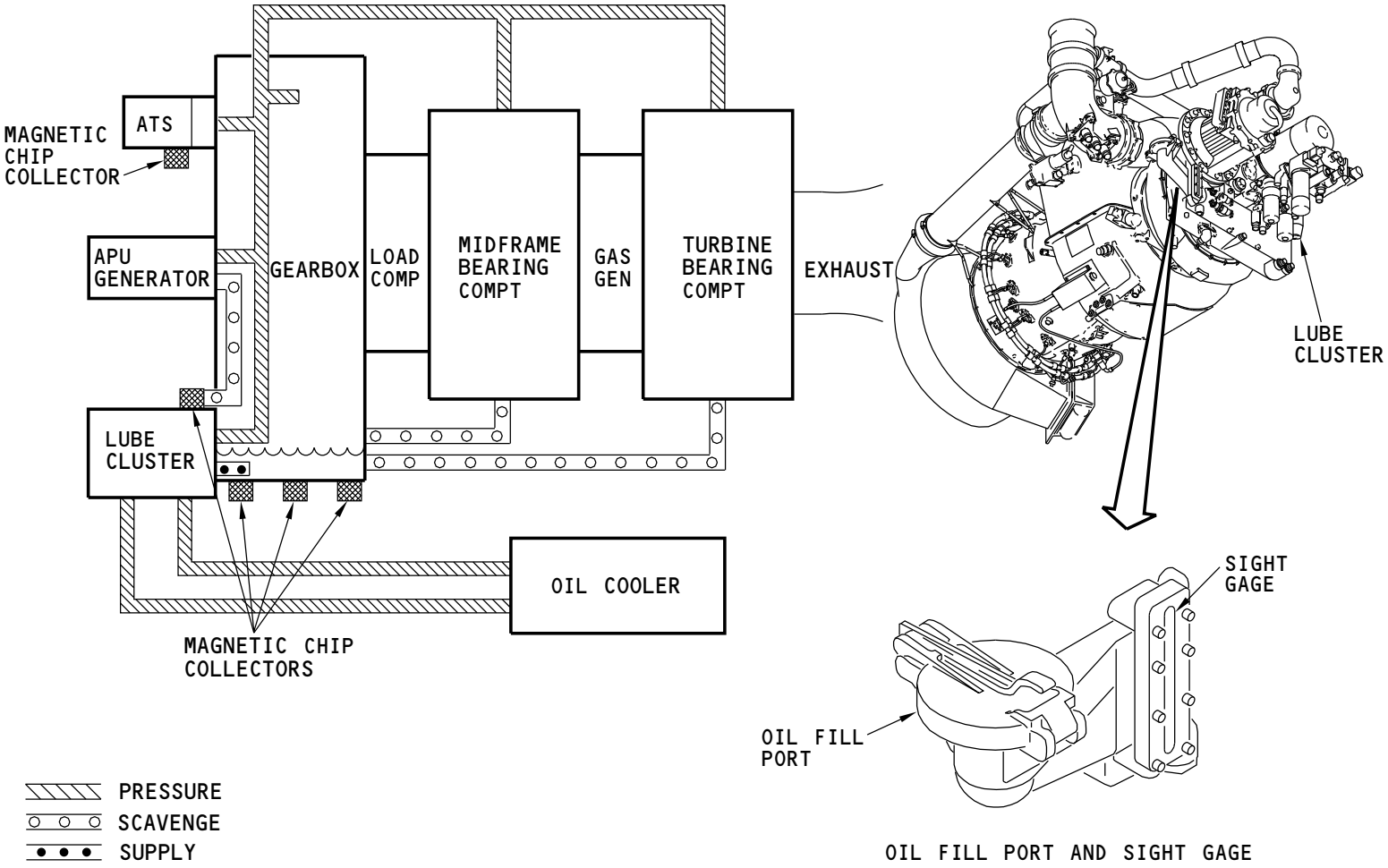
- APU generator
- Air turbine starter (ATS)
- APU bearings
- APU gearbox.

Components

Some lubrication system components are on a common cluster on the front of the APU. These lubrication system components are not on the cluster:

- Magnetic chip collectors
- Oil cooler.

An 8.2 quart (7.8 liter) oil tank is inside the load gearbox. A sight gage shows the oil level. An oil fill port is adjacent to the gage.



M42188 S000620810_V2

APU AND GENERATOR LUBRICATION SYSTEM - INTRODUCTION

APU AND GENERATOR LUBRICATION SYSTEM - LUBE CLUSTER - INTRODUCTION

General

The lube cluster contains many of the lubrication system components. It is on the gearbox on the front of the APU.

Components

The lube cluster contains lube and scavenge pump elements internally. A shaft from the gearbox turns the pumps. A pressure regulating/relief valve is also internal to the lube cluster.

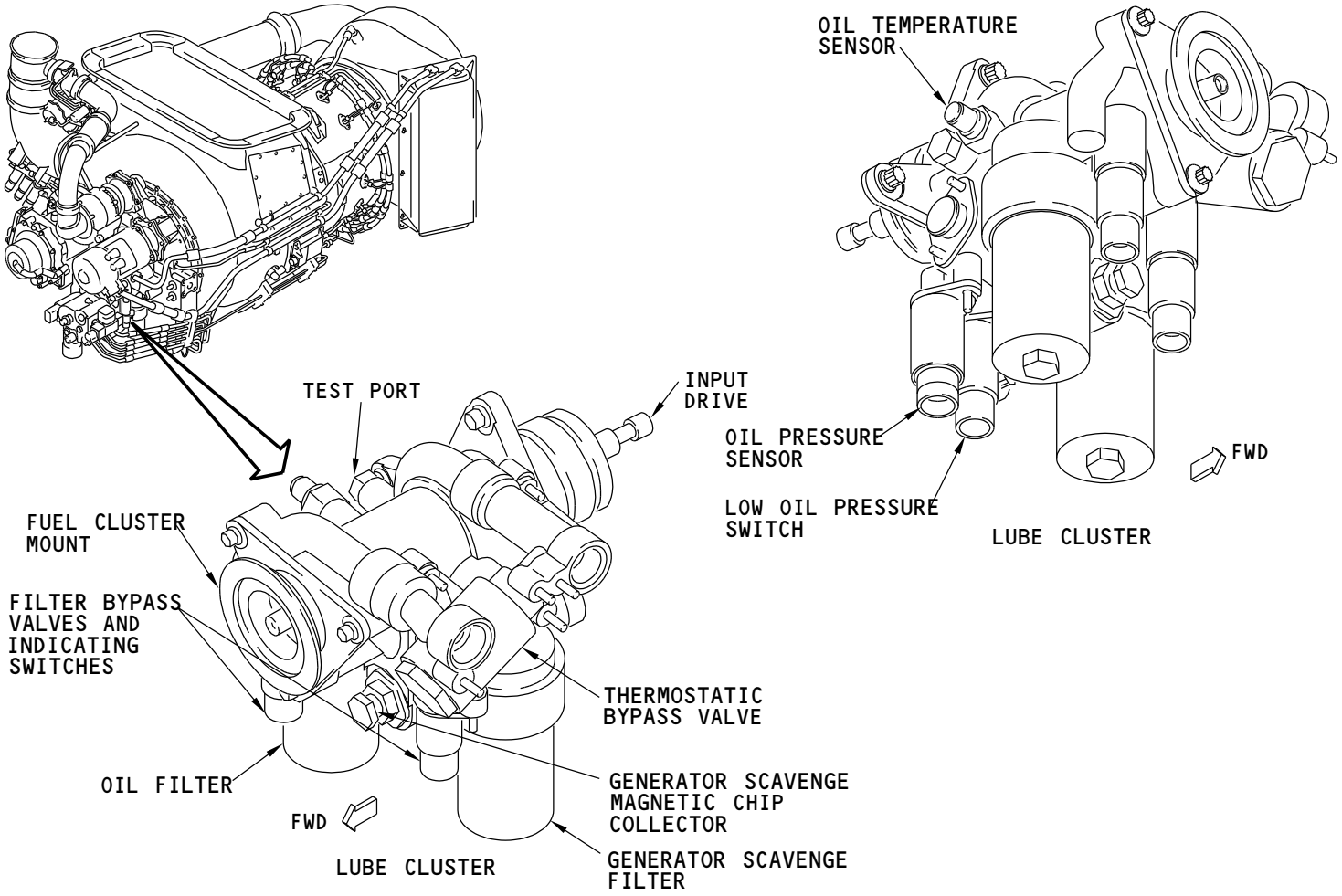
These components are on the outside of the lube cluster and are LRUs:

- Generator scavenge magnetic chip collector
- Filter bypass valve and indicating switches
- Oil and generator scavenge filters
- Low oil pressure switch
- Oil pressure sensor
- Oil temperature sensor
- Thermostatic bypass valve.

A test port permits you to attach a pressure gage to the lube cluster to do a check of the output pressure.

Training Information Point

The fuel cluster mounts to the lube cluster. To remove the lube cluster, you must first remove the fuel cluster.



M42189 S000620811_V1

APU AND GENERATOR LUBRICATION SYSTEM - LUBE CLUSTER - INTRODUCTION

APU AND GENERATOR LUBRICATION SYSTEM - LUBE CLUSTER - FUNCTIONAL DESCRIPTION

Lube and Scavenge Pumps

The lube and scavenge pump elements are on a common shaft driven by the gearbox. Three of the elements are lube pump elements. Three elements are generator scavenge pump elements and two are APU scavenge elements.

Pressure Regulating/Relief Valve

The pressure regulating/relief valve keeps the oil pressure at 65 to 75 psi. If pressure is more than this range, the valve returns the oil to the oil pump inlet.

Thermostatic Bypass Valve

The thermostatic bypass valve controls the oil flow to the oil cooler to control oil temperature and to bypass the oil cooler when the oil is cold.

When the oil temperature is 60C (140F) or less, the valve is fully open and the oil does not go to the oil cooler. When the oil temperature is 77C (170F) or more, the valve is fully closed and the oil goes to the oil cooler. Between 60C (140F) and 77C (170F), the valve will be partially open.

A pressure difference of 60 psi also opens the valve to permit the oil to continue to flow if the oil cooler clogs.

Oil Filter Elements

There are two interchangeable oil filters. The scavenge oil from the APU generator goes through one filter. Pressurized oil goes through the other filter after it goes through the oil cooler.

Filter Bypass Valves and Indicating Switches

Both filters have an indicating switch and a bypass valve to monitor for filter clogs and to allow the oil to flow if there is a clog. When there is a pressure difference of more than 30 to 40 psi across the filter, the switch closes and sends a signal to the APUC. The Filter begins to bypass oil at approximately 50 psid.

Oil Pressure Sensor

The oil pressure sensor sends lube oil pressure data to the APUC.

Oil Temperature Sensor

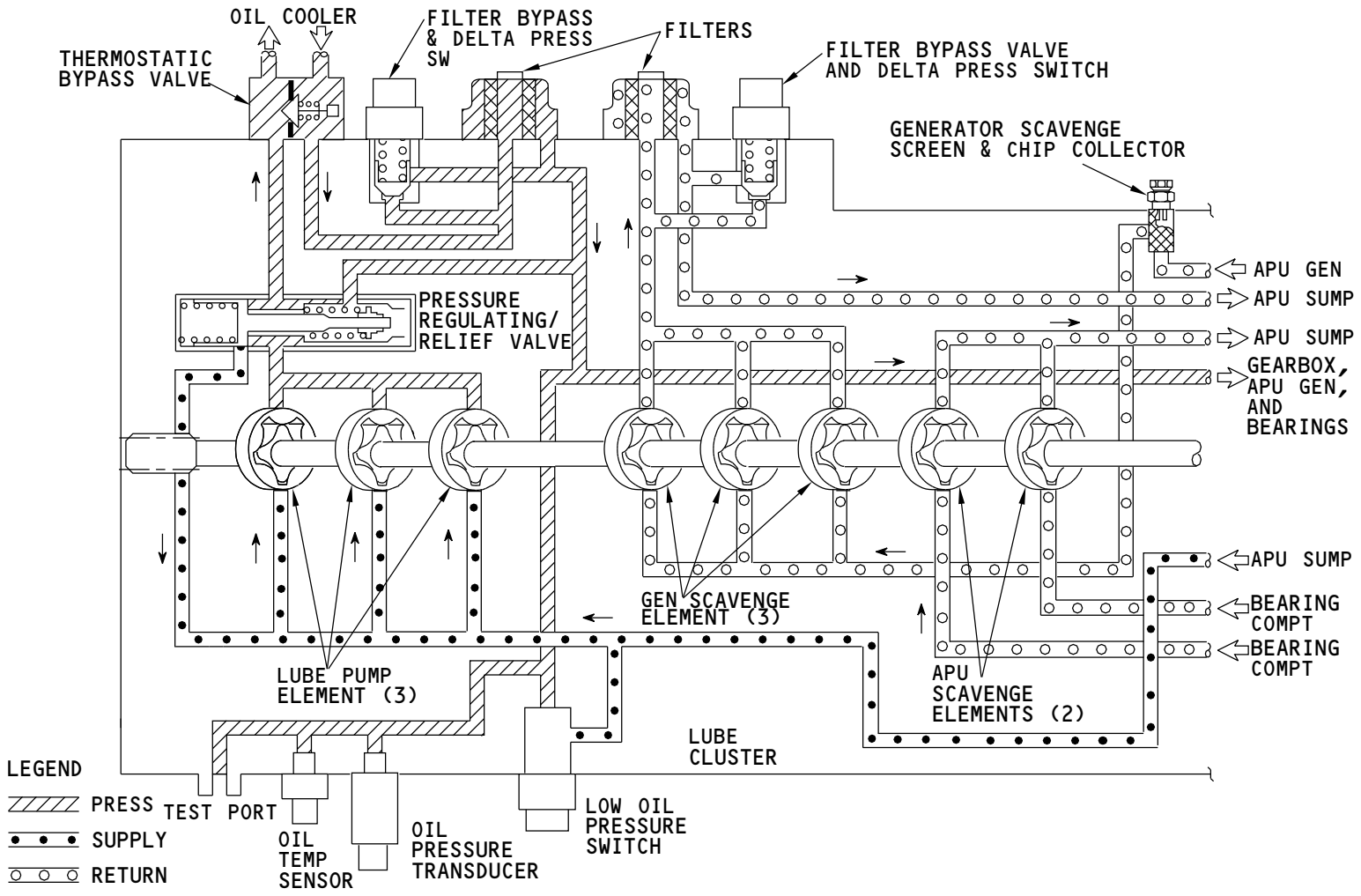
The oil temperature sensor sends lube oil temperature data to the APUC.

Low Oil Pressure Switch

The low oil pressure switch sends a signal to the APUC when the oil pressure is less than 30-40 psi.

Generator Scavenge Magnetic Chip Collector

This chip collector is in the scavenge oil flow from the APU generator. A screen filters the oil flow after it goes by the magnetic tip.



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APU AND GENERATOR LUBRICATION SYSTEM - LUBE CLUSTER - FUNCTIONAL DESCRIPTION

APU AND GENERATOR LUBRICATION SYSTEM - MAGNETIC CHIP COLLECTORS

Purpose

Magnetic chip collectors collect metallic particles in the engine oil. This permits you to do an inspection of the APU for damage.

Location

These are the five chip collectors on the APU:

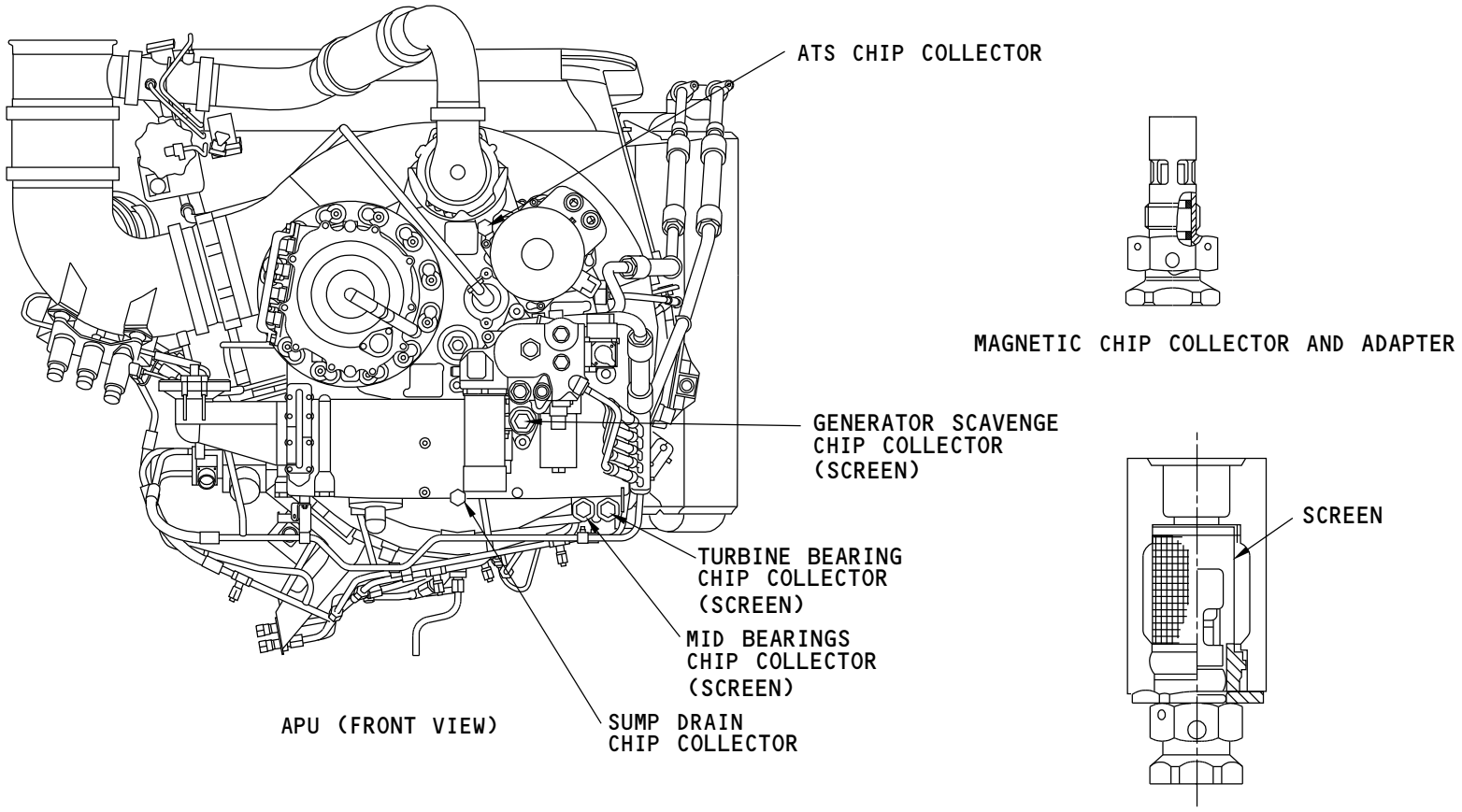
- ATS chip collector - on the lower side of the air turbine starter
- Generator scavenge chip collector - on the lube cluster
- Turbine bearing chip collector - on the left forward side of the load gearbox
- Mid-bearings chip collector - on the left forward side of the load gearbox inboard of the turbine bearing chip collector
- Sump drain chip collector - on the forward side of the load gearbox in the center.

Physical Description

The magnetic chip collectors have magnets inside them to collect the metal chips.

All the chip collectors are the same. They are in adapters which are also removal check valves. The check valves close to prevent oil loss when you remove the chip collector.

Some removal check valves are inside screens. The screens stop large metal particle movement through the lubrication system.



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APU AND GENERATOR LUBRICATION SYSTEM - MAGNETIC CHIP COLLECTORS

APU AND GENERATOR LUBRICATION SYSTEM - OIL COOLER

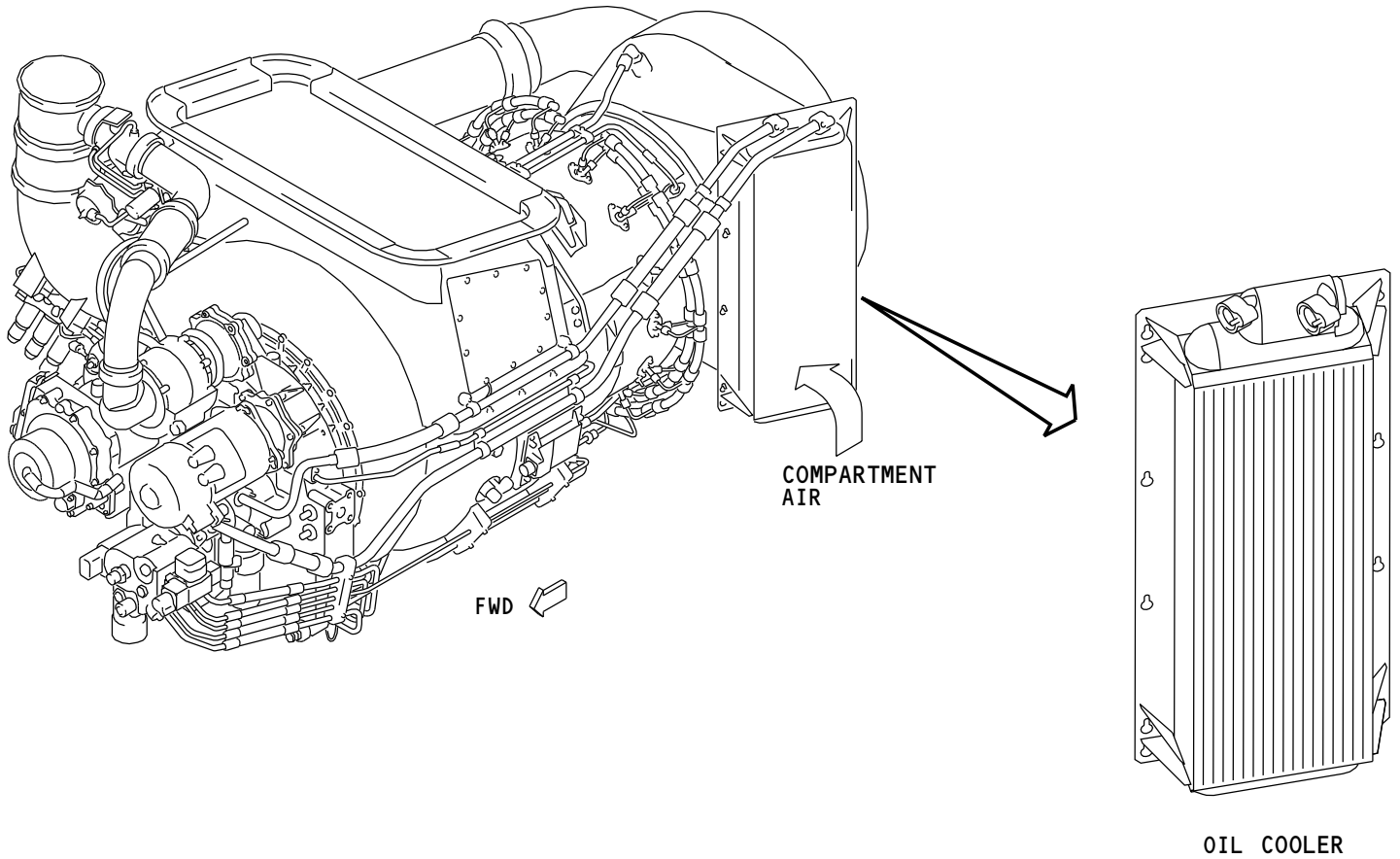
General

The oil cooler is a stainless steel air/oil heat exchanger. Compartment air cools the pressurized oil after the oil leaves the oil pump.

The oil cooler is on the left side of the APU turbine case. It is part of the exhaust eductor cooling system.

Functional Description

The APU exhaust causes a suction of air. This causes APU compartment air to move through the oil cooler to cool the APU oil. The cooling air then flows overboard through the exhaust duct.



M42192 S000620814_V1

APU AND GENERATOR LUBRICATION SYSTEM - OIL COOLER

APU AND GENERATOR LUBRICATION SYSTEM - FUNCTIONAL DESCRIPTION

General

The APU and generator lubrication system supplies pressurized oil to cool and lubricate APU components and the APU generator. A scavenge system returns the oil to the gearbox reservoir.

Supply

Oil pump elements in the lube cluster pump oil from the gearbox reservoir. Pressurized oil from the lube cluster goes to the oil cooler and then returns to the lube cluster.

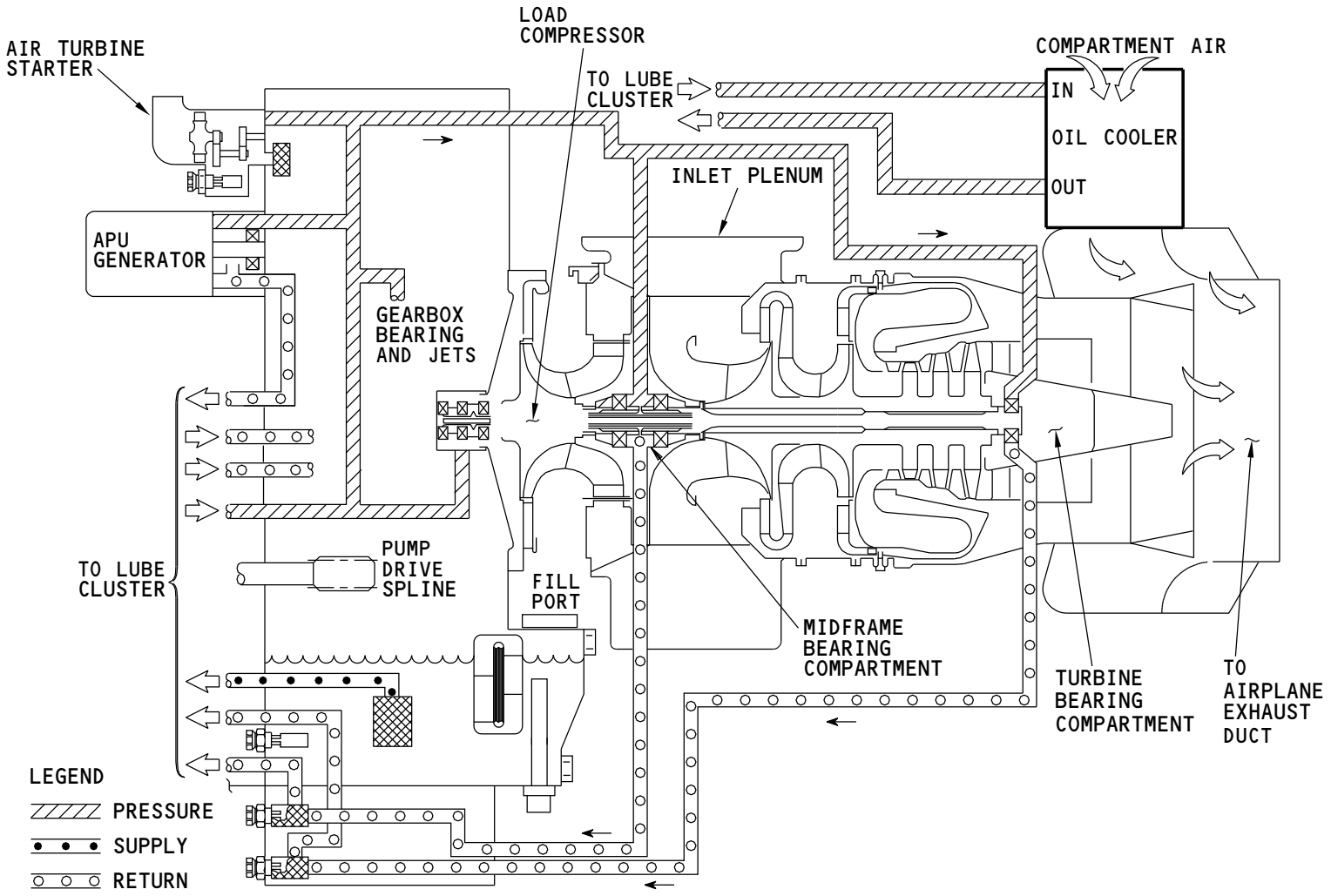
The lube cluster cleans the oil and regulates the oil pressure. Oil pressure and temperature sensors supply data to the APUC.

The oil then goes to the these components:

- APU generator
- Air turbine starter (ATS)
- Gearbox bearings and jets
- Load compressor bearings
- Midframe bearing compartment
- Turbine bearing compartment.

Scavenge

Scavenge pump elements in the lube cluster send the oil from the midframe and turbine bearing compartments back to the reservoir. Other scavenge pump elements send the scavenge oil from the APU generator through the scavenge filter and back to the gearbox reservoir.



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APU AND GENERATOR LUBRICATION SYSTEM - FUNCTIONAL DESCRIPTION

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APU FUEL SYSTEM - INTRODUCTION

Purpose

The APU fuel system supplies pressurized and metered fuel to the APU combustion chamber. It also supplies pressurized fuel to actuators for the inlet guide vanes and the surge control valve.

Interfaces

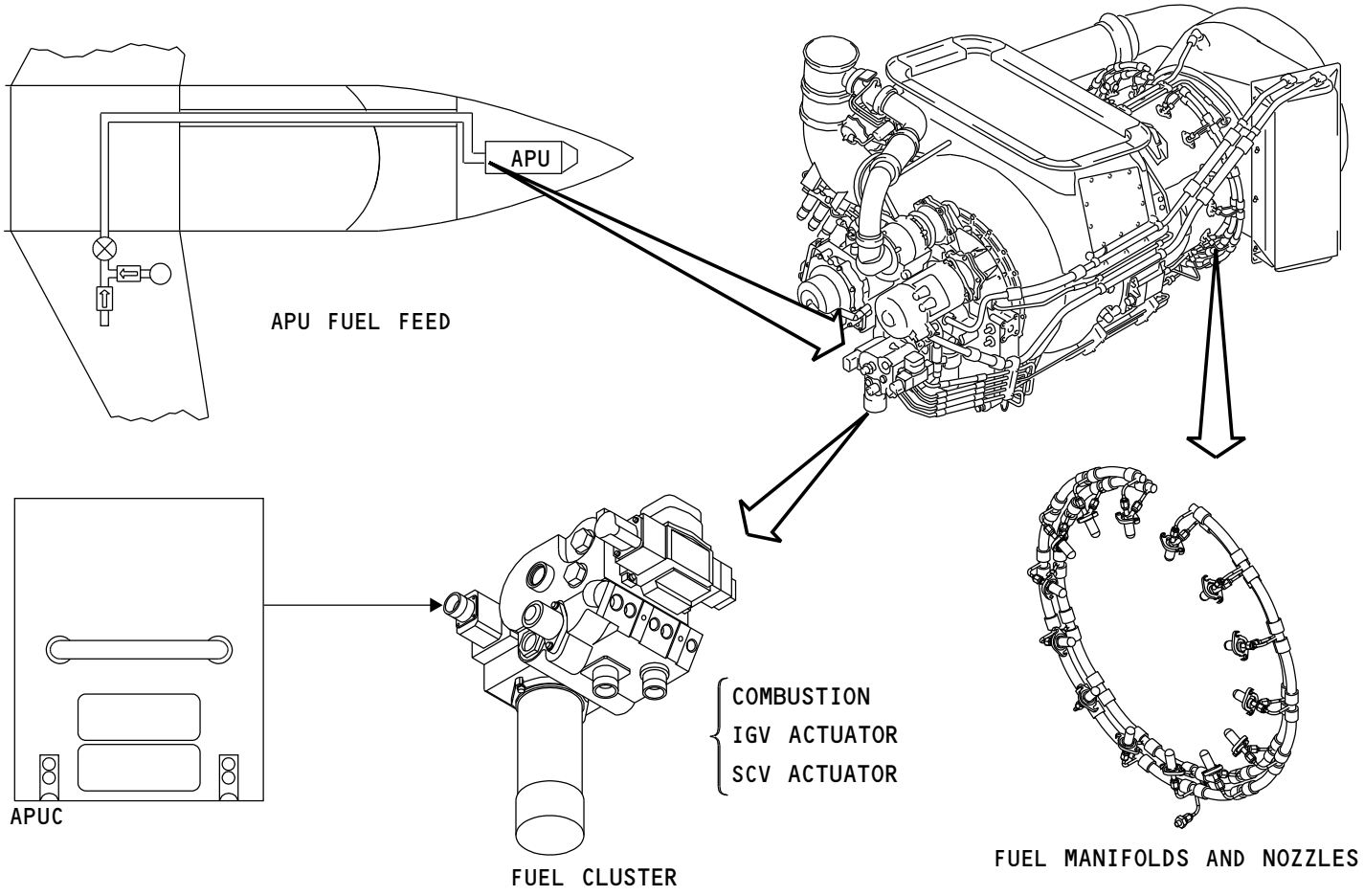
Fuel system ac boost pumps or the APU dc fuel pump in the wing supply fuel from the airplane fuel system for APU operation.

The APU controller (APUC) controls the APU fuel system.

Components

Most fuel system components are on a common fuel cluster on the forward side of the APU gearbox.

Other fuel system components are the fuel manifolds and the fuel nozzles.



M42195 S000620817_V1

APU FUEL SYSTEM - INTRODUCTION

APU FUEL SYSTEM - FUEL CLUSTER - INTRODUCTION

General

The fuel cluster contains the APU fuel control and other fuel system components. The fuel cluster is attached to the lube cluster which turns the fuel system pumps.

Training Information Point

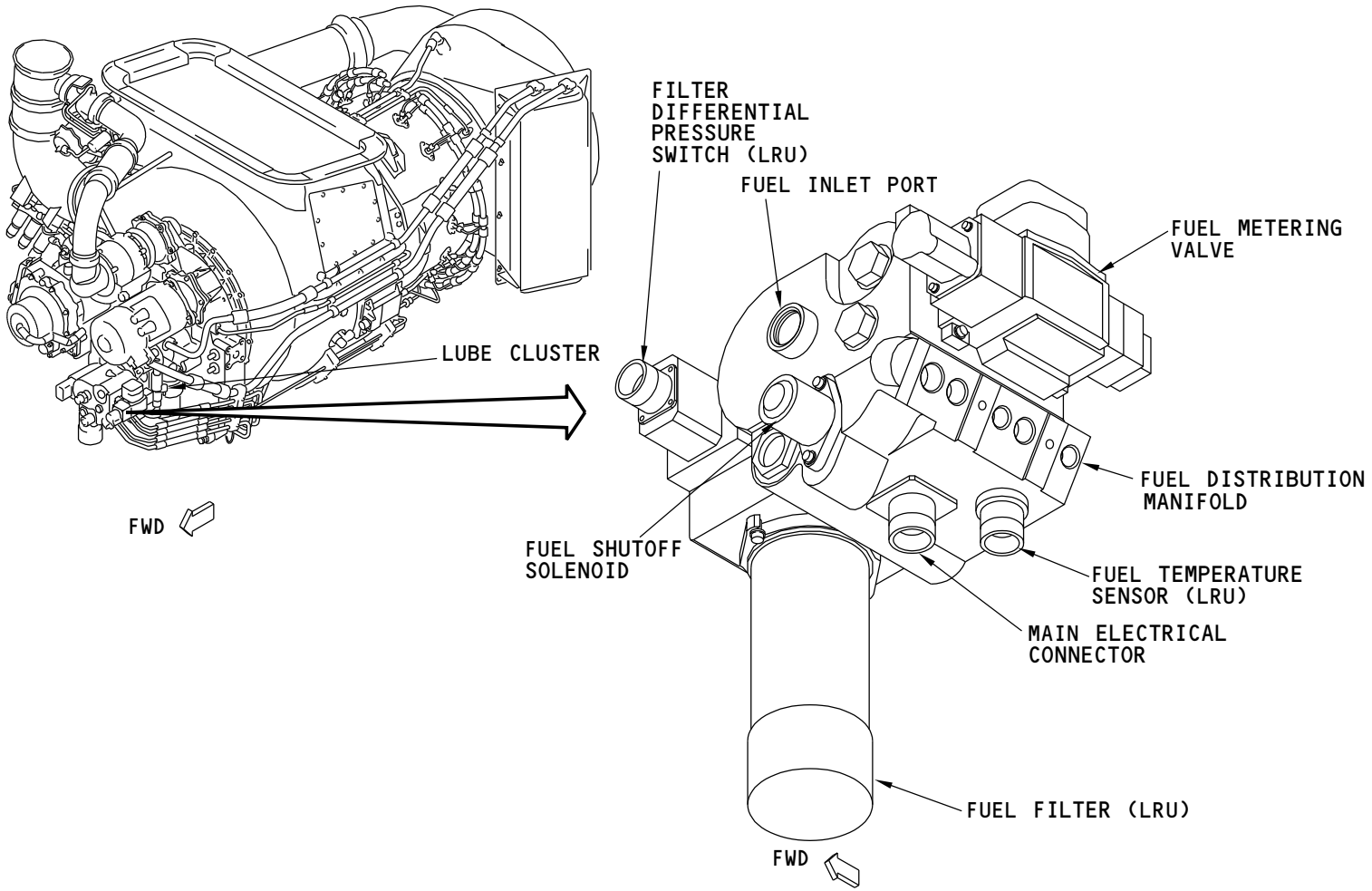
The entire fuel cluster is an LRU. These components are also LRUs:

- Fuel filter
- Fuel filter differential pressure switch
- Fuel temperature sensor.

These fuel cluster components are not LRUs:

- Fuel shutoff solenoid
- Fuel metering valve
- Fuel distribution manifold.

The fuel cluster also contains the fuel pumps and some internal pressure regulating valves.



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APU FUEL SYSTEM - FUEL CLUSTER - INTRODUCTION

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APU FUEL SYSTEM - FUEL CLUSTER - FUNCTIONAL DESCRIPTION

General

Fuel for the APU fuel cluster comes from the airplane fuel system. The APU fuel cluster supplies pressurized and metered fuel for combustion and to operate the IGV and SCV actuators.

The fuel cluster includes these components:

- Fuel boost and gear pumps
- Fuel filter
- Fuel differential pressure switch
- Gear pump check valve
- Pressure relief valve
- Fuel temperature sensor
- Mode select valve
- Pressure regulator
- Bypass valve
- Fuel metering valve
- Pressurizing shutoff valve
- Fuel shutoff solenoid valve
- Shutoff relief valve
- Shutoff restrictor
- Flow divider.

Fuel Boost and Gear Pumps

A shaft from the lube cluster turns the fuel boost and gear pumps. The first stage boost pump pressurizes fuel for the gear pump. The second stage gear pump sends high pressure fuel for use in the fuel cluster. The fuel line from the boost pump to the gear pump is a return line in the fuel cluster.

Fuel Filter and Differential Pressure Switch

There is a 35 micron filter between the boost pump and the gear pump. The fuel filter has a differential pressure switch that sends a signal to the APUC when the pressure difference across the filter is 11 psi or more.

Gear Pump Check Valve

The gear pump check valve permits flow from the filter to the gear pump. The check valve prevents pressurized fuel to flow back to the filter during reverse windmill operation of the APU.

Pressure Relief Valve

The spring-loaded pressure relief valve keeps the maximum pressure in the fuel system to 1050 psi more than the boost pump pressure.

Fuel Temperature Sensor

The fuel temperature sensor supplies the fuel temperature signal to the APUC. The APUC uses this signal to correct for fuel viscosity changes during APU start and operation.

Mode Select Valve

The mode select valve has a wash filter to supply clean fuel to dirt-sensitive components. The mode select valve sends high pressure fuel to the pressure regulator, the bypass valve, and the fuel shutoff solenoid valve.

The mode select valve also acts as a flow-sensitive device to control the pressure to the pressurizing shutoff valve. During engine start, the gear pump output pressure goes directly to the pressurizing shutoff valve. When the APU speed is 59 percent RPM, the gear pump output pressure is high enough to move the mode select valve. The mode select valve then sends boost pump pressure to the pressurizing shutoff valve.

Pressure Regulator

The pressure regulator keeps the fuel pressure at 325 psi more than the boost pump pressure for the IGV and SCV actuators and the fuel metering valve.

Bypass Valve

The bypass valve sends all fuel not needed by the fuel metering valve back to the return line. This keeps the pressure differential across the fuel metering valve.

APU FUEL SYSTEM - FUEL CLUSTER - FUNCTIONAL DESCRIPTION

Fuel Metering Valve

The fuel metering valve is an electro-hydraulic servo-valve. It controls the amount of fuel supplied to the combustion chamber.

An LVDT measures the position of the metering valve and sends a feedback signal to the APUC.

Pressurizing Shutoff Valve

The pressure-operated pressurizing shutoff valve permits flow from the fuel metering valve to the fuel divider when the valve is open. When the valve is closed, flow from the fuel metering valve goes to the return line through the shutoff relief valve.

During APU start, the valve opens when the gear pump output pressure is 129 psid or more. During APU shutdown, high pressure from the fuel shutoff solenoid valve closes the valve. When there is no pressure, a spring keeps the valve closed.

Fuel Shutoff Solenoid Valve

The fuel shutoff solenoid valve controls the pressurizing shutoff valve during APU start and shutdown.

During APU start, the APUC energizes the solenoid of the fuel shutoff solenoid valve at 7 percent RPM. The valve then closes and removes pressure to the pressurizing shutoff valve.

During APU shutdown, the APUC removes the power from the solenoid of the fuel shutoff solenoid valve. The valve then opens to permit high pressure fuel to close the pressurizing shutoff valve. This stops the flow of fuel to the combustion chamber.

Shutoff Relief Valve

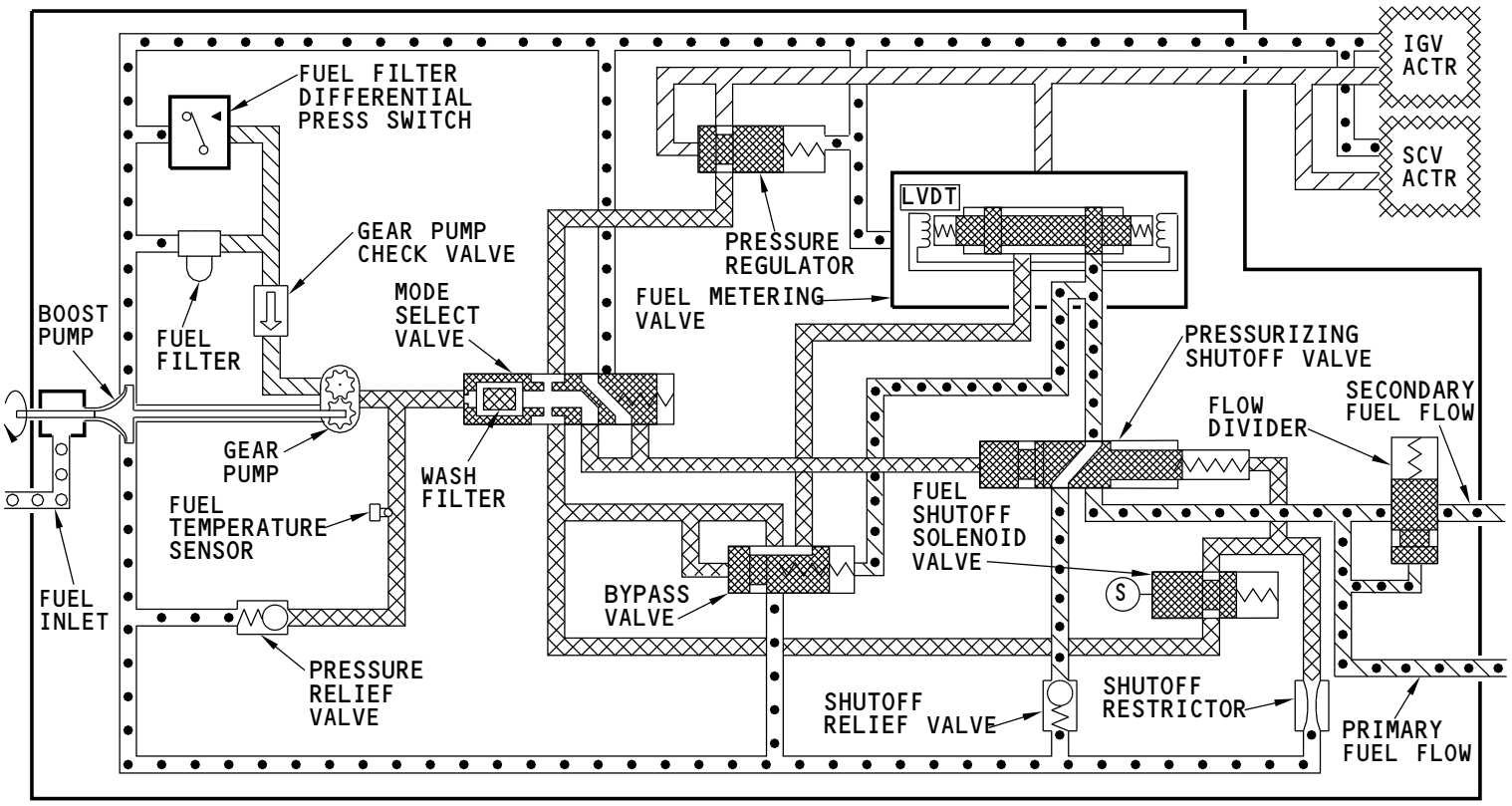
The shutoff relief valve permits the metered fuel to flow to the return line when the pressurizing shutoff valve is closed. The shutoff relief valve opens at 300 psid to keep pressure on the fuel metering valve.

Shutoff Restrictor

The shutoff restrictor permits the pressure on the pressurizing shutoff valve to bleed to return when the fuel shutoff solenoid valve is closed.

Flow Divider

The flow divider is a pressure-operated valve that controls fuel flow to the secondary manifold. During APU start, the flow divider opens at approximately 50 percent RPM. This permits fuel flow to the secondary manifold and greater flow to the combustion chamber when it is necessary. The flow divider stays open during APU operation.



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APU FUEL SYSTEM - FUEL CLUSTER - FUNCTIONAL DESCRIPTION

APU FUEL SYSTEM - MANIFOLDS AND NOZZLES

Fuel Manifolds

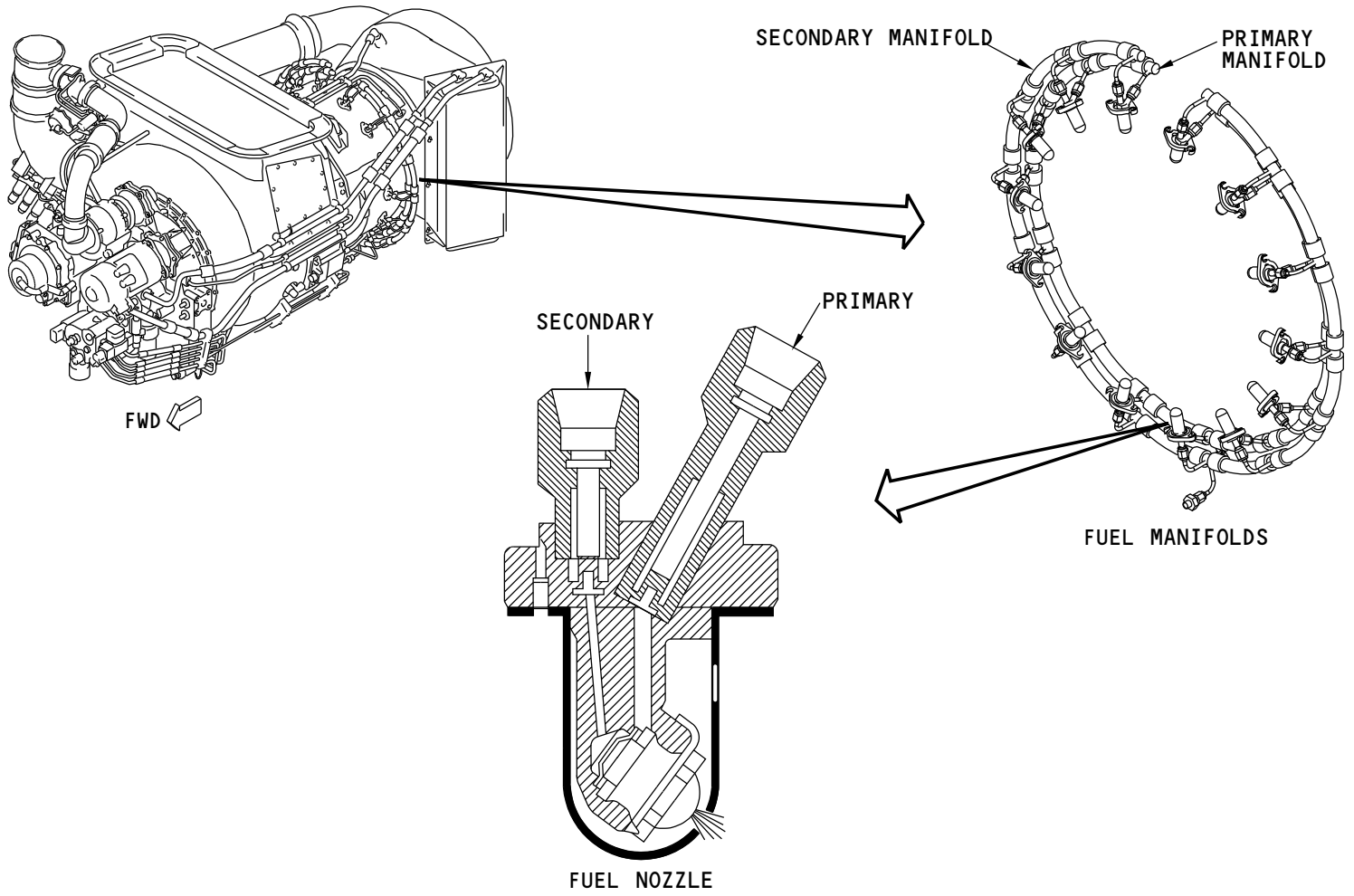
A primary fuel manifold and a secondary fuel manifold supply fuel from the fuel cluster to the fuel nozzles.

The manifolds are insulated flexible lines and are on the combustion section.

Both manifolds supply fuel when the APU is running. Only the primary manifold supplies fuel during the first part of APU start at low RPM.

Fuel Nozzles

Fourteen fuel nozzles atomize and inject fuel into the engine combustion section. The fuel nozzles are equally spaced around the combustion section.



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APU FUEL SYSTEM - MANIFOLDS AND NOZZLES

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APU FUEL SYSTEM - FUNCTIONAL DESCRIPTION

General

The APU controller controls the APU fuel system. The APU fuel system supplies fuel for combustion and is a pressure source for the IGV and SCV actuators.

Fuel Supply

Fuel system ac boost pumps or the APU dc fuel pump supplies fuel through the APU fuel shutoff valve. The shutoff valve opens when the APU selector is ON. The dc pump operates when ac power is not available. When ac power becomes available, the left forward boost pump turns on and the dc pump turns off.

Fuel Cluster

The fuel cluster gets the fuel from the airplane fuel system and does these functions:

- Pressurizes the fuel (fuel pump)
- Cleans the fuel (filter)
- Controls the fuel pressure (pressure regulator)
- Controls fuel flow (fuel metering valve and fuel shutoff solenoid valve)
- Divides the fuel flow (fuel flow divider)
- Monitors the fuel temperature (fuel temperature sensor).

APUC Control

The APUC has the logic to control the fuel solenoid valve and the fuel metering valve.

During APU start, the APUC energizes the fuel shutoff solenoid valve when the APU engine RPM is more than 7 percent. The APUC also controls the fuel metering valve when the RPM is more than 7 percent.

The APUC uses start-up control logic to control the fuel metering valve when the RPM is less than 95 percent. This logic schedules fuel flow to start the APU quickly and to keep the EGT low. Start-up fuel flow logic uses these inputs:

- APU RPM (N)
- Inlet pressure (P2)
- Inlet temperature (T2)
- Turbine inlet temperature (T4)
- Exhaust gas temperature (EGT)
- ATS command
- Fuel temperature.

The APUC uses on-speed control logic to control the fuel metering valve when the RPM is more than 95 percent. This logic schedules fuel flow to keep APU speed at 100 percent RPM or at the correct speed for no-break power transfers. During no-break power transfers between the APU generator and external power, the APUC adjusts the APU speed between 96.25 percent and 104.5 percent.

The on-speed control logic uses these inputs:

- APU RPM
- Fuel temperature
- Frequency trim.

Fuel Manifolds

The fuel cluster supplies metered fuel to the primary and secondary fuel manifolds for combustion.

Only the primary manifold gets fuel at low engine speeds during engine start. Both manifolds get fuel when the engine speed is more than 50 percent RPM.

Servo Fuel

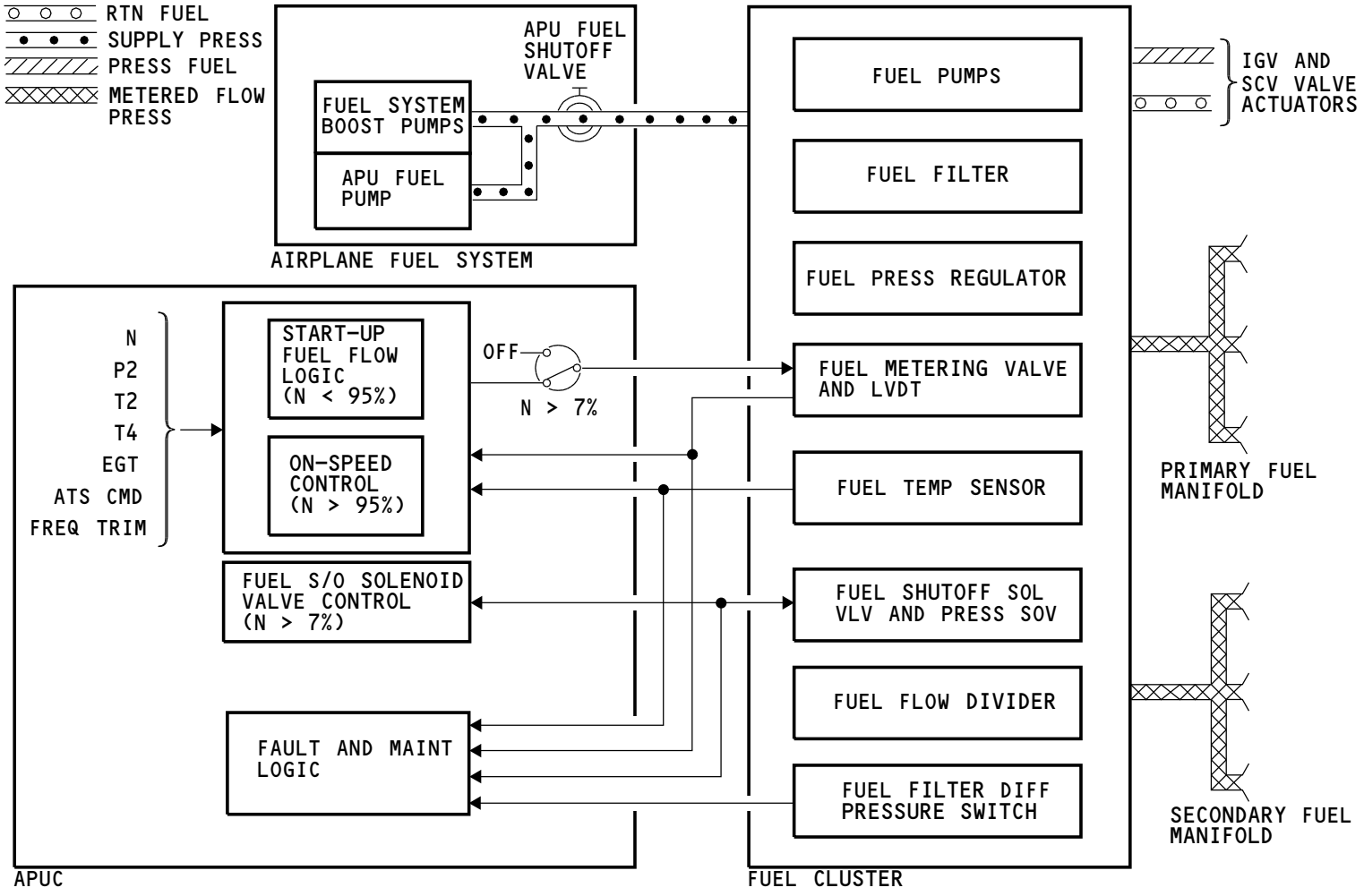
The fuel cluster also supplies pressurized fuel to operate the inlet guide vane and surge control valve actuators.

Return fuel from these actuators goes back to the pump in the fuel cluster.

APUC Monitoring

The APUC monitors these APU fuel system components:

- Fuel temperature sensor
- Fuel filter differential pressure switch
- Fuel metering valve
- Fuel shutoff valve.



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APU FUEL SYSTEM - FUNCTIONAL DESCRIPTION

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APU IGNITION/STARTING - INTRODUCTION

General

The APU ignition/starting system has these systems:

- Ignition system
- Air turbine starter system
- Electric starter system.

Ignition System

The ignition system starts the APU combustion during APU start. These components are part of the ignition cluster on the right side of the APU:

- Ignition unit
- Ignition lead (2)
- Igniter plug (2).

The APUC controls the ignition system.

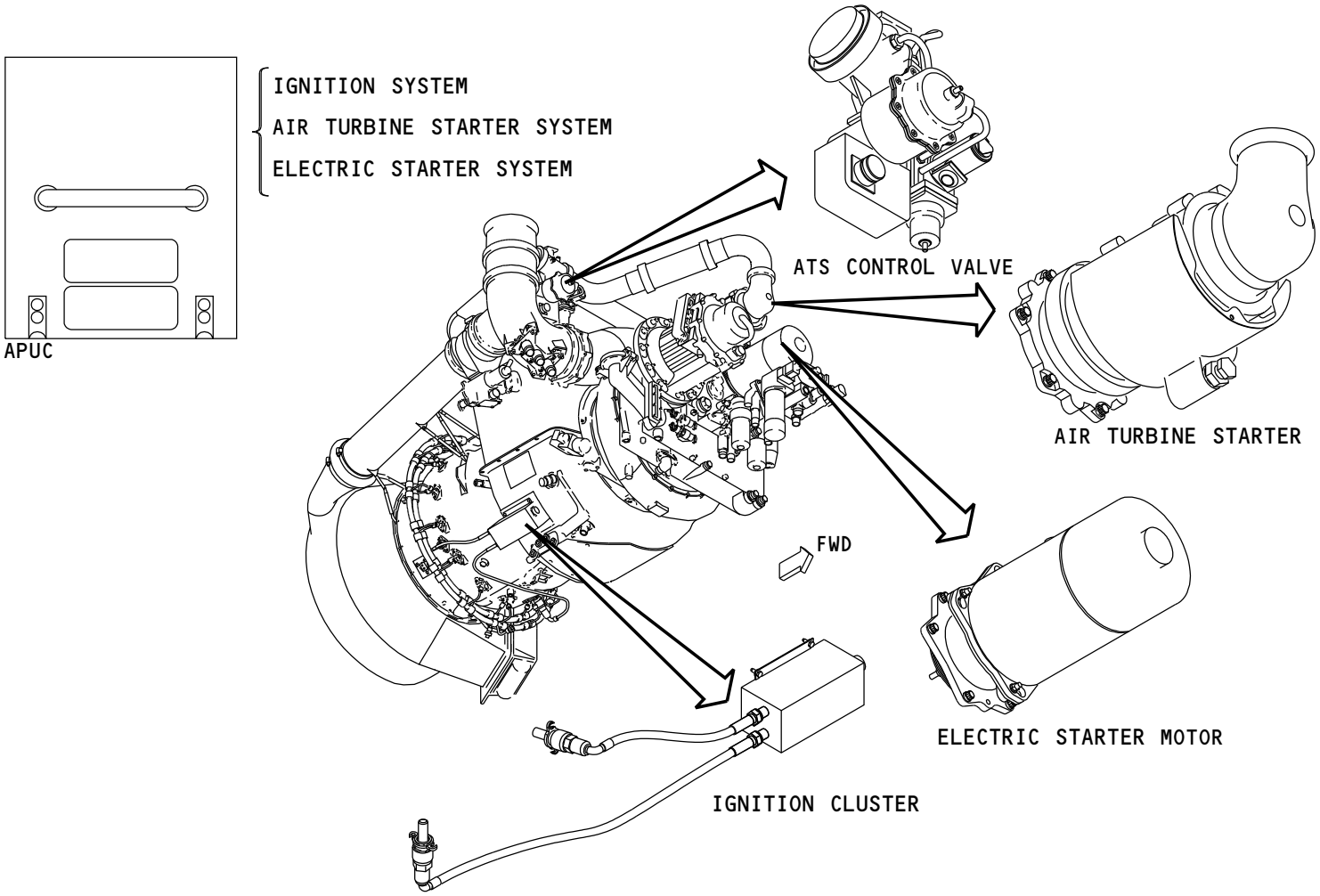
Start Systems

There are two starter motors: one pneumatic and one electric. They are on the front of the APU.

The air turbine starter system starts the APU when pneumatic pressure is available. The air turbine starter system uses an air turbine starter control valve (ATSCV) to control pneumatic flow to the air turbine starter.

The electric starter system starts the APU only when the pneumatic system is not pressurized or if there is a failure in the air turbine starter system.

The APUC controls both start systems and automatically selects between the starters.



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APU IGNITION/STARTING - INTRODUCTION

APU IGNITION/STARTING - APU IGNITION SYSTEM - GENERAL DESCRIPTION

General

The ignition system starts the combustion of the fuel-air mixture during engine start. The APU controller controls the ignition system.

The ignition system components are part of a common cluster and are on the right side of the engine.

Ignition Unit

The ignition unit changes 28v dc power to high voltage pulsed current that goes to the ignitor plugs. The ignition unit has two channels: one for each igniter plug. Four bolts hold the ignition unit to the APU.

Ignition Leads

Ignition leads connect the ignition unit to the igniter plugs. The leads are insulated to protect against radio interference. There are connectors at each end of the ignition leads.

Igniter Plugs

Two igniter plugs supply the high energy spark for fuel/air ignition. One is on the right side and the other is on the bottom of the APU combustion section. The ignition lead connectors hold the plugs in the boss.

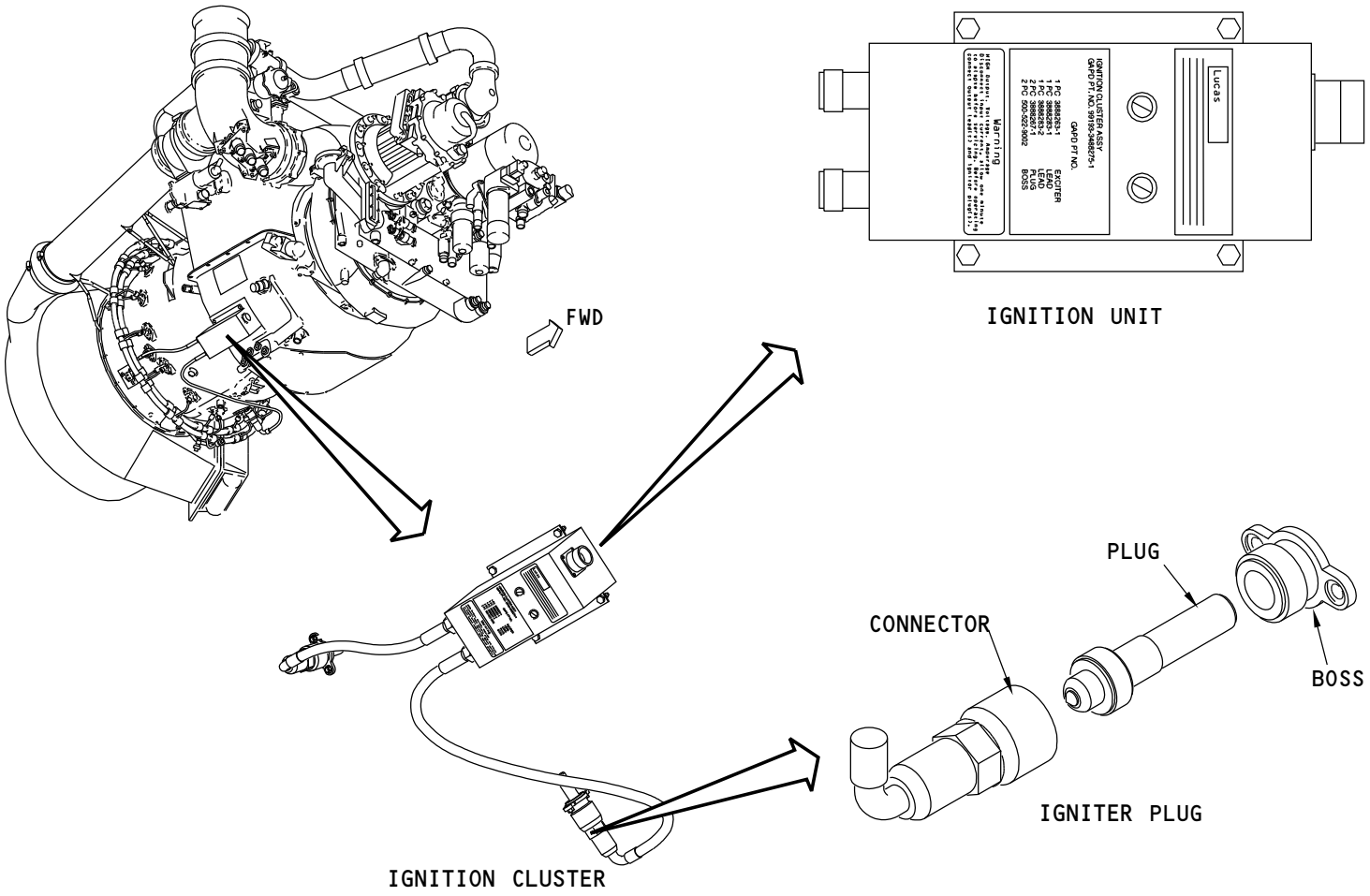
Functional Description

The APUC turns on the igniter plugs at 7 percent APU engine RPM during APU start. The APUC turns the plugs off at 50 percent RPM.

The APUC also turns the igniter plugs on if the APU engine RPM goes below 95 percent RPM during APU operation (speed droop).

Training Information Point

WARNING DO NOT TOUCH THE IGNITION COMPONENTS UNTIL YOU RELEASE THE HIGH VOLTAGE FROM THE IGNITION UNIT. IF YOU DO NOT OBEY THIS PROCEDURE, INJURY TO PERSONS CAN OCCUR.



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APU IGNITION/STARTING - APU IGNITION SYSTEM - GENERAL DESCRIPTION

APU IGNITION/STARTING - APU ELECTRIC STARTER SYSTEM - GENERAL DESCRIPTION

General

The electric starter system has these components:

- The electric starter motor
- The electric starter clutch.

The electric starter system starts the APU when pneumatic power is not available or if the air turbine starter system has a failure. The APUC controls the electric starter system.

Physical Description

The electric starter motor is a 28v dc series-wound motor. Four bolts hold the motor to the gearbox adapter on the front of the APU. A ratchet on the electric starter motor shaft connects the starter motor to the electric starter clutch. The starter motor weighs 38 pounds (17 kg).

The electric starter clutch is a pawl and ratchet type mechanism which transmits the starter motor torque to the APU gearbox. The pawls turn with the APU and the ratchet wheel turns with the starter motor. Pawl springs hold the pawls against the ratchet wheel at low speeds. The pawls disengage by centrifugal force after the starter turns off. A single bolt attaches the clutch to the starter drive gear shaft. The clutch is inside the gearbox adapter.

Functional Description

During an electric start, the starter motor turns the ratchet wheel and the electric starter clutch through the three pawls. The clutch turns the APU engine through the APU gearbox.

The electric starter motor turns off at 49 percent engine RPM for low altitude starts and 55 percent engine RPM for starts above 22,000 feet (5800m). The pawls then move outward against the pawl springs by centrifugal force. This disengages the clutch from the starter motor.

During an air turbine start, the electric starter clutch turns with the APU engine. The electric starter motor and the ratchet wheel do not turn. The pawls move up the sloped edge of the ratchet teeth to permit rotation between the ratchet wheel and the clutch. At approximately 17 percent APU engine RPM, the pawls lift off of the ratchet by centrifugal force to disengage the clutch from the starter motor.

Training Information Point

A lifting lug on the top of the electric starter permits attachment of a fishpole hoist for removal and installation.

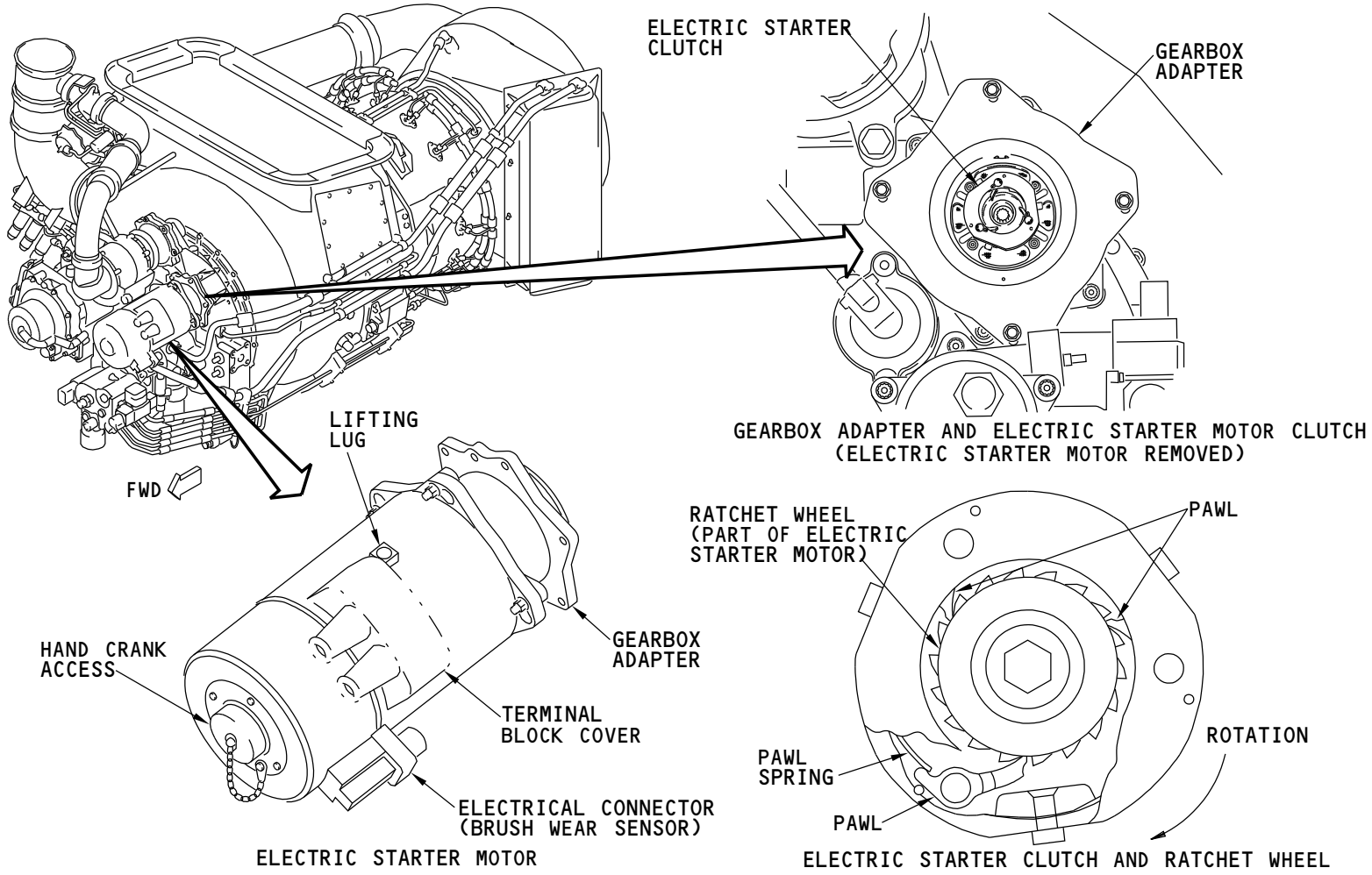
A hand crank access on the electric starter motor permits you to manually crank the engine through the starter motor.

You can try three APU starts in a 60 minute period with the electric starter motor.

A brush wear sensor inside the starter motor sends a signal to the APUC when the motor needs to be replaced. The APU CONTROL status message shows for this condition.

Both the electric starter motor and the electric starter clutch are LRUs.

The ATS clutch and electric starter clutch are not interchangeable.



M42201 S000620824_V1

APU IGNITION/STARTING - APU ELECTRIC STARTER SYSTEM - GENERAL DESCRIPTION

APU IGNITION/STARTING - AIR TURBINE STARTER SYSTEM - GENERAL DESCRIPTION

General

These are the air turbine starter system components:

- Air turbine starter
- Air turbine starter clutch
- Air turbine starter control valve (ATSCV).

The air turbine starter system starts the APU when pneumatic pressure is available.

A magnetic chip collector on the air turbine starter collects metallic particles in the oil.

Physical Description

The air turbine starter is an axial flow turbine. The starter attaches with a V-band clamp to the gearbox adapter which is on the APU gearbox. A ratchet wheel on the air turbine starter shaft connects the starter to the clutch. The APU lubrication system supplies the air turbine starter with oil for cooling and lubrication. The air turbine starter weighs 9.5 pounds (4.3 kg).

The air turbine starter clutch is a pawl and ratchet type mechanism which transmits the starter motor torque to the APU gearbox. Pawl springs hold the pawl in the ratchet wheel at low speeds. The pawls disengage by centrifugal force after the ATSCV closes and the starter speed decreases. A single bolt attaches the clutch to the starter drive gear shaft. The clutch is inside the gearbox adapter.

The ATSCV is a pneumatically actuated, solenoid-controlled butterfly valve. It is spring-loaded closed. The ATSCV is above the air turbine starter. The ATSCV weighs 6.5 lbs (2.9 kg).

Functional Description

The air turbine starter clutch is functionally equivalent to the electric starter clutch. During an air turbine start, the ATSCV opens to permit air from the pneumatic system to go to the air turbine starter. The air turbine starter turns the ratchet wheel. The ratchet wheel turns the air turbine starter clutch through the three pawls. The clutch turns the APU engine through the APU gearbox.

At 55 percent APU engine RPM, the ATSCV closes to stop the air supply to the air turbine starter. The pawls then move outward against the pawl springs by centrifugal force. This disengages the clutch from the air turbine starter motor.

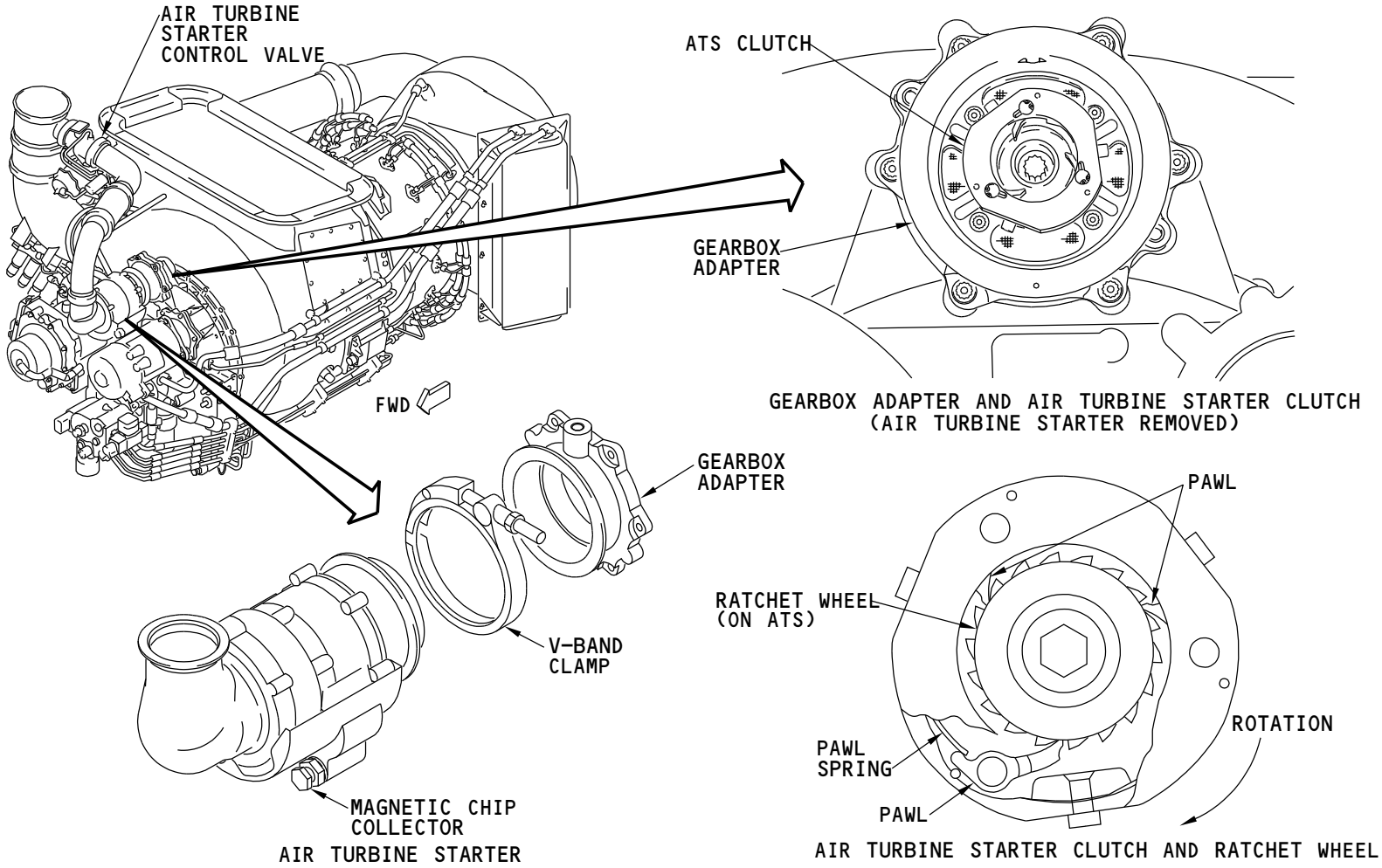
During an electric start, the air turbine starter clutch turns with the APU engine. The air turbine starter and the ratchet wheel do not turn. The pawls move up the sloped edge of the ratchet teeth to permit rotation between the ratchet wheel and the clutch. At approximately 17 percent APU engine RPM, the pawls lift off of the ratchet wheel by centrifugal force to disengage the clutch from the air turbine starter.

Training Information Point

The air turbine starter, the air turbine starter clutch, and the ATSCV are LRUs.

The air turbine starter clutch and the electric starter clutch are not interchangeable.

You can try three APU starts in a 60 minute period with the air turbine starter.



M42202 S000620825_V1

APU IGNITION/STARTING - AIR TURBINE STARTER SYSTEM - GENERAL DESCRIPTION

APU IGNITION/STARTING - AIR TURBINE STARTER SYSTEM - AIR TURBINE STARTER CONTROL VALVE

Purpose

The ATSCV controls pneumatic pressure to the air turbine starter during APU start.

Physical Description

The ATSCV is a pneumatically-actuated, solenoid- controlled, butterfly valve. It is spring-loaded closed. The ATSCV is above the air turbine starter.

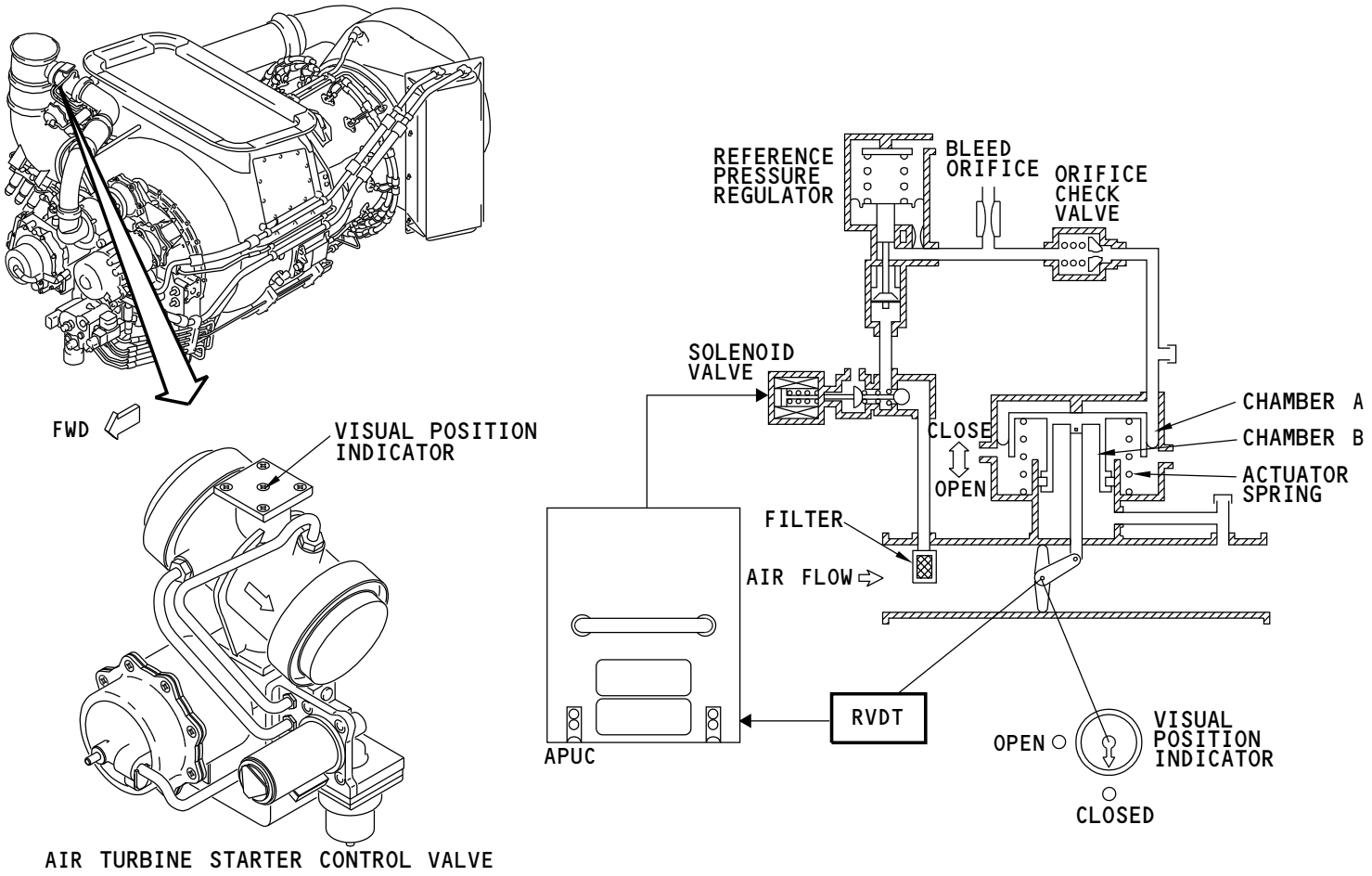
Functional Description

To start the APU air turbine starter operation, the APUC opens the solenoid valve. This permits bleed air to flow to the reference pressure regulator. The reference pressure regulator controls air pressure to chamber A of the spring and pressure balanced butterfly valve. This opens the butterfly valve. Duct pressure downstream of the butterfly valve pressurizes chamber B to balance the butterfly valve. Air output of the starter control valve is 18 to 22 psig.

An RVDT sends butterfly valve position to the APUC for feedback.

Training Information Point

A visual position indicator shows butterfly valve position.



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APU IGNITION/STARTING - AIR TURBINE STARTER SYSTEM - AIR TURBINE STARTER CONTROL VALVE

APU IGNITION/STARTING - FUNCTIONAL DESCRIPTION

General

To start the APU, turn the APU switch to START and then release it to ON. This signals the APUC through the ELMS to start the APU.

Pneumatic Start

The APUC gets pneumatic system pressure signals through ARINC 629. If pressure is available, the APUC energizes the solenoid valve on the ATSCV. This opens the starter control valve and pressure regulated air flows to the air starter and turns the APU engine.

At approximately seven percent engine RPM, the APUC energizes the ignition unit. The ignition unit supplies the ignition power to energize the igniter plugs. The ignition turns off at approximately 50 percent engine RPM.

At approximately 55 percent engine RPM, the APUC removes power from the ATSCV solenoid valve to shut off the air turbine starter. The APU continues to increase the speed of rotation to its operating RPM (100 percent).

Electric Start

If pneumatic pressure is not available, the APUC energizes the APU crank contact relay. This supplies 28v dc power from the APU battery to the electric starter which turns the APU. At about 49 percent engine RPM, the APUC removes power from the electric starter and the APU continues to increase the speed of rotation to its operating RPM.

The ignition system operates the same during both types of starts.

Autostart

The APU will automatically start for these conditions:

- Airplane is in the air
- Power removed from the left and right transfer buses.

The ELMS contains the APU autostart logic and sends the start signal to the APUC.

To shutdown the APU after an autostart, you must first move the APU selector to ON and then back to OFF.

The ram air turbine will automatically extend during an APU autostart.

Start Failure

These conditions cause an APU start failure:

- No acceleration (no RPM increase after ignition or start command failure)
- No ignition (no EGT increase above 7 percent RPM).

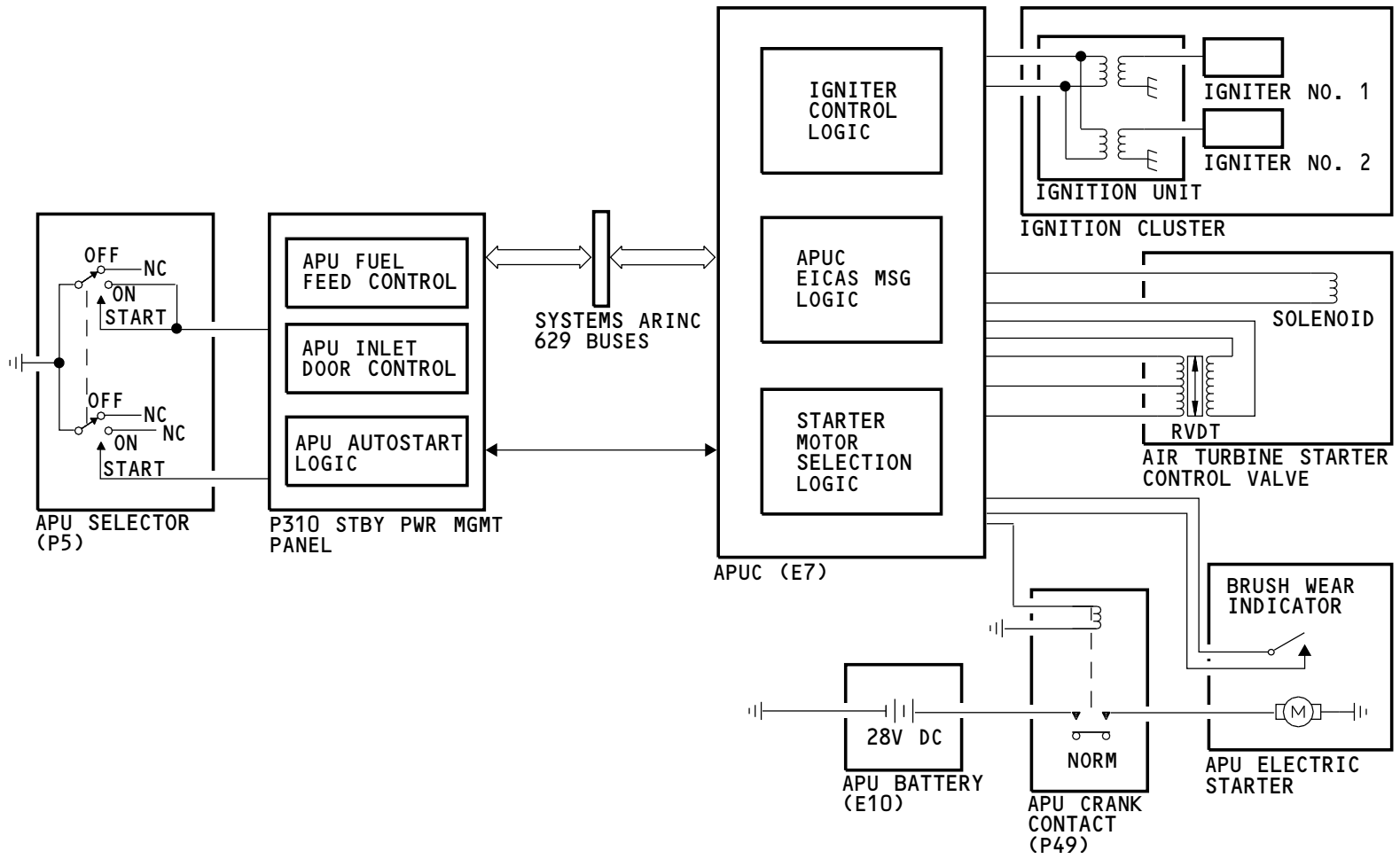
These are the indications of a start failure:

- APU SHUTDOWN advisory message
- APU status message
- APU fault light.

Training Information Point

If you lift the airplane on jacks, the APU may do an autostart. To prevent this, you need to pull some circuit breakers.

See the applicable section in part two of the airplane maintenance manual for the full procedure.



M42204 S000620827_V1

APU IGNITION/STARTING - FUNCTIONAL DESCRIPTION

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APU AIR - INTRODUCTION

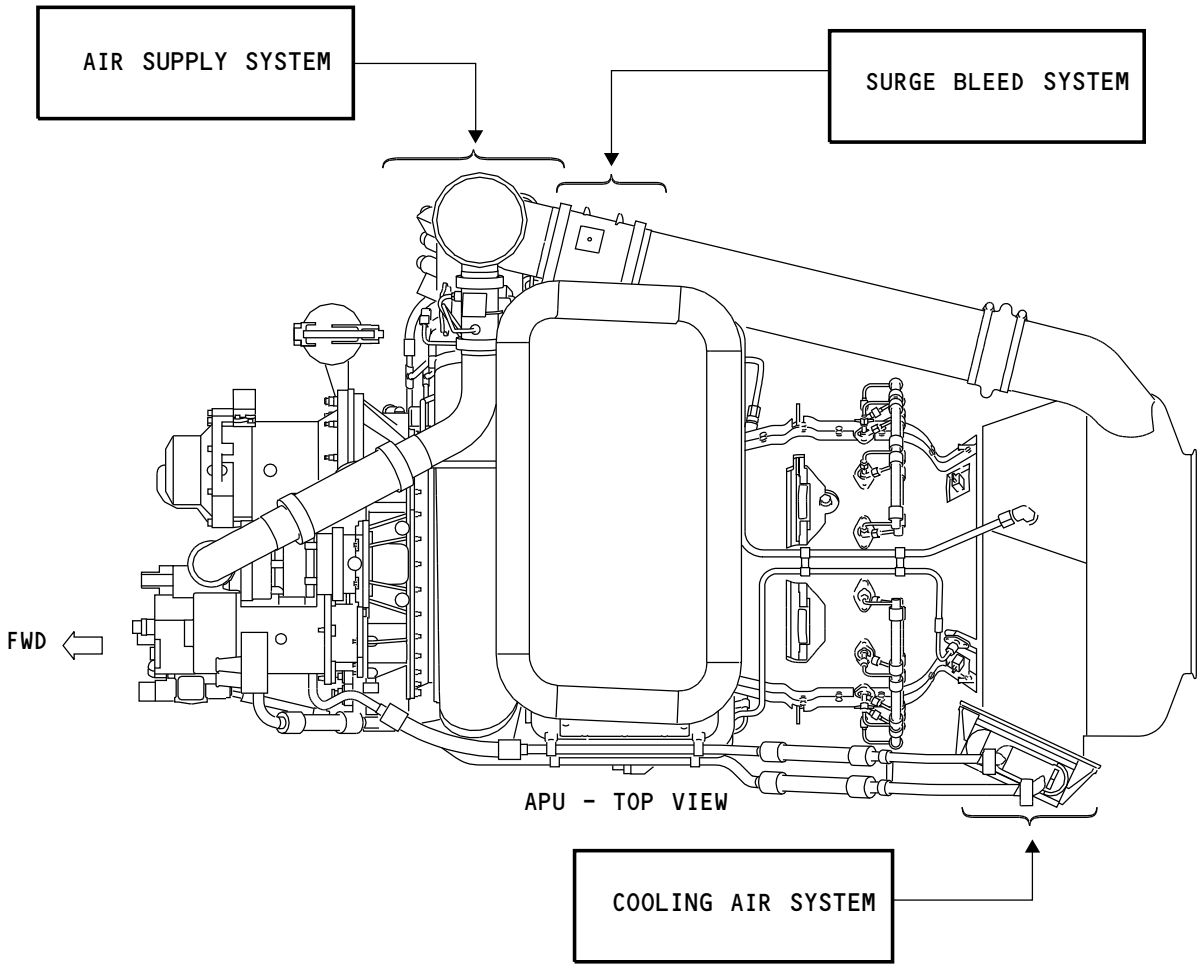
Purpose

These subsystems make up the APU Air System:

- APU cooling air system
- APU air supply system
- APU surge bleed system.

The APU air system does these functions:

- Cools the APU compartment and the APU engine oil
- Supplies compressed air to the airplane pneumatic system
- Releases excess load compressor output (surge control).



M42206 S000620829_V2

APU AIR - INTRODUCTION

APU AIR - APU COOLING AIR SYSTEM - GENERAL DESCRIPTION

General

The APU Cooling Air System cools the APU compartment and the APU engine oil. There are no moving parts in this system.

Compartment Cooling

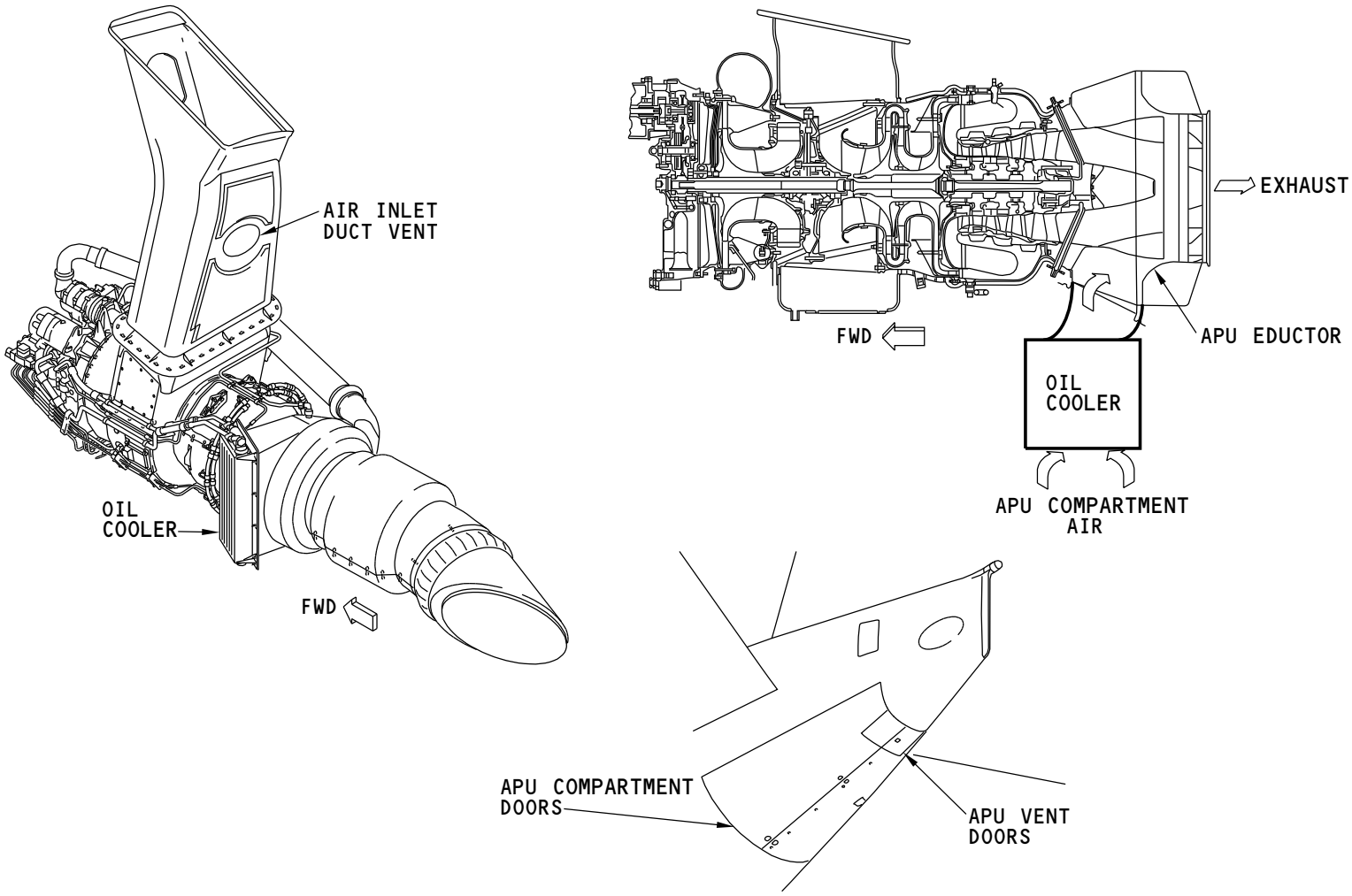
A cooling eductor behind the APU engine turbine uses high speed exhaust flow to form low pressure suction. This suction pulls a continuous cooling air flow from the compartment through the oil cooler and out through the exhaust duct.

See the APU and generator lubrication section for more information about the oil cooler (SECTION 49-27).

Outside air goes into the APU compartment through an opening in the back of the air inlet duct.

Training Information Point

There is a small negative pressure in the APU compartment when the APU is running. APU vent doors on the APU compartment doors permit you to equalize pressure before you open the doors.



M42208 S000620831_V1

APU AIR - APU COOLING AIR SYSTEM - GENERAL DESCRIPTION

APU AIR - APU AIR SUPPLY SYSTEM - INTRODUCTION

Purpose

The APU air supply system supplies compressed air to the airplane pneumatic system for:

- Main engine start
- Air conditioning and pressurization
- Air-driven hydraulic pump operation
- Other pneumatic system functions.

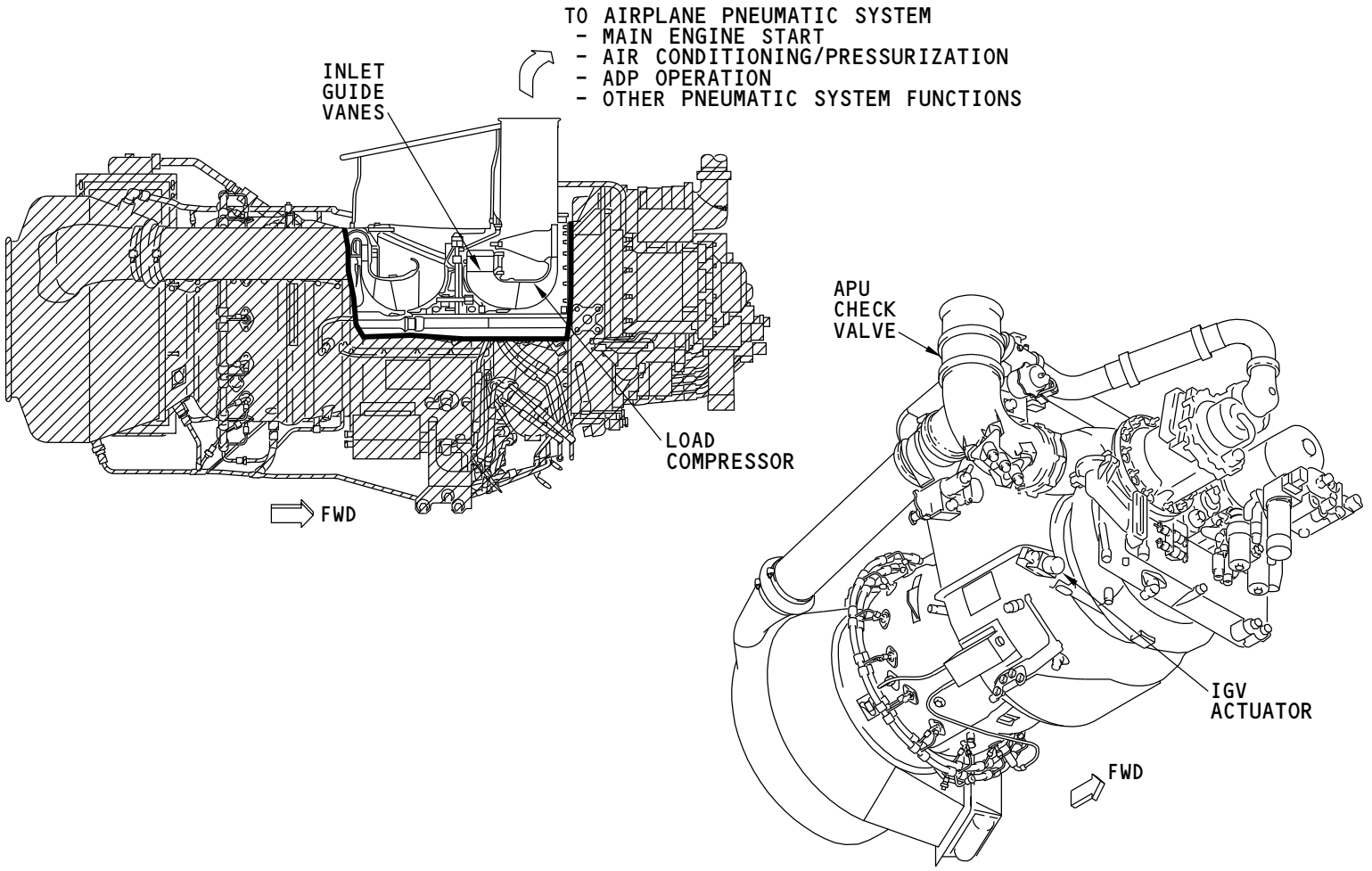
Components

Air supply components include:

- Inlet guide vanes (IGVs)
- Inlet guide vane actuator
- APU check valve.

Control

The APUC sends signals to the IGV actuator to control the IGV angle position. This controls the output of the air supply system.



M42209 S000620832_V1

APU AIR - APU AIR SUPPLY SYSTEM - INTRODUCTION

APU AIR - APU AIR SUPPLY SYSTEM - INLET GUIDE VANES

Purpose

The inlet guide vanes control the air flow to the load compressor and thus control APU air output.

Physical Description

Twenty eight inlet guide vanes (IGVs) are inside the APU around the load compressor inlet.

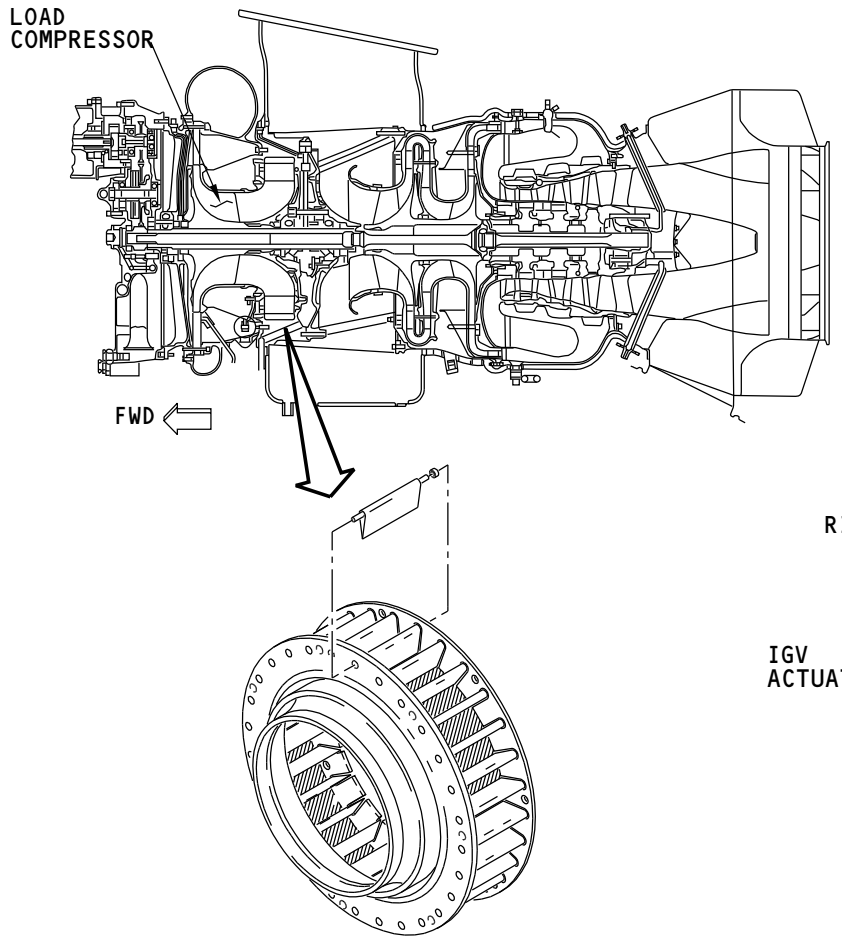
Functional Description

The guide vanes rotate between 76.2 degrees (fully closed) and -10 degrees (fully open). This angle is in relation to the airflow.

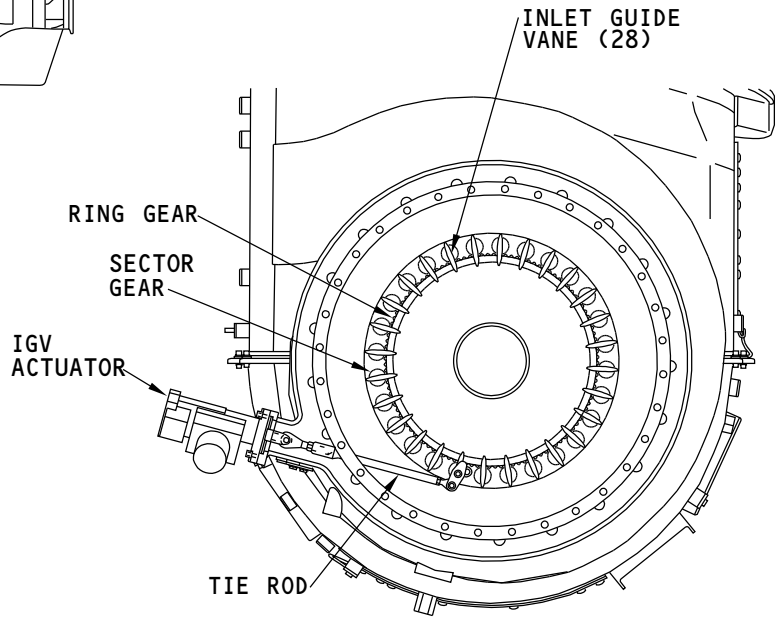
Sector gears connect each IGV to a ring gear. The IGV actuator connects to the ring gear by the tie rod.

Training Information Point

The IGV position shows on the APU maintenance page.



INLET GUIDE VANES



IGV MECHANISM - LOOKING AFT

M42210 S000620833_V1

APU AIR - APU AIR SUPPLY SYSTEM - INLET GUIDE VANES

Inlet Guide Vanes Actuator

The IGV actuator uses high pressure fuel to operate the inlet guide vanes.

The APUC controls a torque motor on a two-stage servo-valve to move the actuator. An internal LVDT sends actuator position to the APUC for position feedback.

The IGV actuator connects to the IGVs through a tie rod, ring gear, and sector gears (not shown).

The IGV actuator is on the right side of the APU below the pneumatic cluster.

APU Check Valve

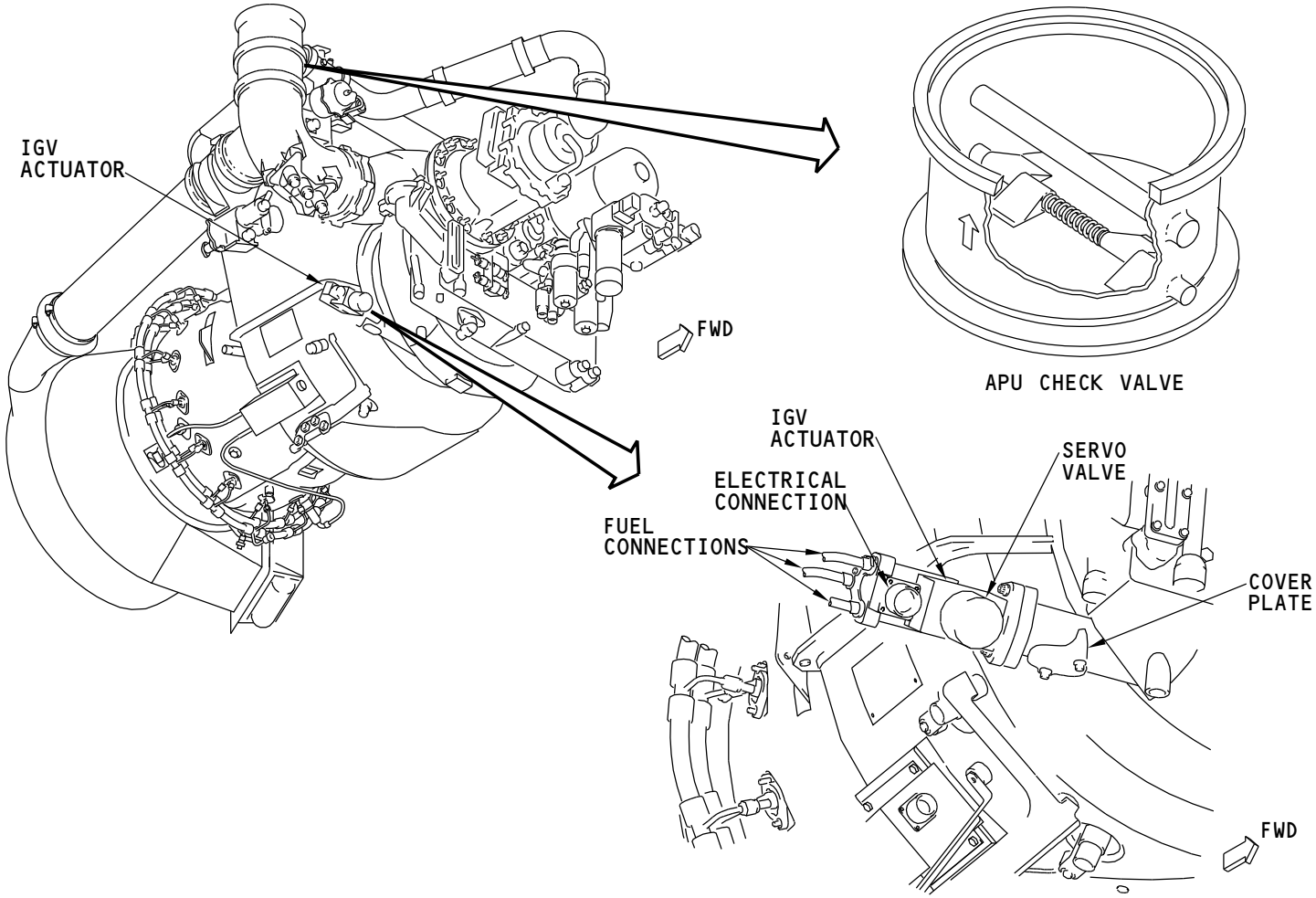
The APU check valve prevents pneumatic system flow from turning the APU load compressor in reverse.

The valve is in the pneumatic duct between the load compressor and the air turbine starter control valve (ATSCV).

The check valve is spring-loaded closed and opened by airflow from the load compressor.

Training Information Point

A cover plate supplies access to a captive bolt that connects the IGV actuator to the tie rod. You loosen this captive bolt when you remove the IGV actuator.



M42211 S000620834_V1

APU AIR - APU AIR SUPPLY SYSTEM - IGV ACTUATOR AND CHECK VALVE

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APU AIR - APU AIR SUPPLY SYSTEM - FUNCTIONAL DESCRIPTION

General

The APUC contains pneumatic mode selection logic and IGV control logic to control the inlet guide vanes. The APUC monitors pneumatic system demands and selects a pneumatic mode. The IGV control logic sends signals to the electro-hydraulic servo valve (EHSV) to change the IGV position. A linear variable differential transformer (LVDT) sends actuator position feedback signals to the APUC.

The APUC also calculates a turbine inlet temperature (T4). If T4 is too high, the APUC starts to close the IGVs to reduce the pneumatic loading. This permits electrical power output of the APU to have the highest priority.

Pneumatic Modes

The APUC uses these inputs to select a pneumatic mode:

- APU shutoff valve position
- Main engine start
- ADP operation
- A/C pack operation
- Air inlet pressure (P2).

These are the pneumatic modes:

- Idle
- Duct Pressurization
- Main Engine Start
- Air Driven Pump (ADP)
- ECS
- ADP/ECS.

The APUC selects the idle mode when the APU shutoff valve is closed and there is no pneumatic system demand. The IGVs are closed in this mode. The APUC also selects this mode any time the airplane is above 22,000 feet (6700 meters).

The APUC selects the duct pressurization mode when the APU shutoff valve is open and there is no pneumatic system demand. With the APU operating, APU bleed valve (APU shutoff valve) open and no bleed demand, the trapped bleed air may cause a rumbling noise which is most noticeable at the door No. 3 area. The IGVs open enough to pressurize the pneumatic ducts.

During a main engine start, the APUC selects the main engine start mode. The IGVs open to meet airflow requirements for a main engine start. This mode has priority over all other modes.

The APUC selects the ADP mode when one or two of the ADPs operate. The IGVs open to supply enough airflow to operate the air driven hydraulic pumps.

When one or two air conditioning packs operate, the APUC selects the ECS mode. The IGVs open the amount necessary to supply air to the airplane environmental control system.

When the ADPs and the air conditioning packs operate, the APUC selects the ADP/ECS mode and opens the IGVs the amount necessary to supply both of these systems.

Inlet Guide Vane Control Logic

After pneumatic mode selection, the APUC uses inlet temperature and inlet pressure data to adjust the IGV angle for the correct airflow. For the ECS and ADP/ECS modes, the APUC also uses ECS inputs and APU total operating hours to control the IGV position.

During APU start, the APUC closes the IGVs to keep APU loading to a minimum. At 95 percent RPM, the IGVs can open to supply pneumatic airflow.

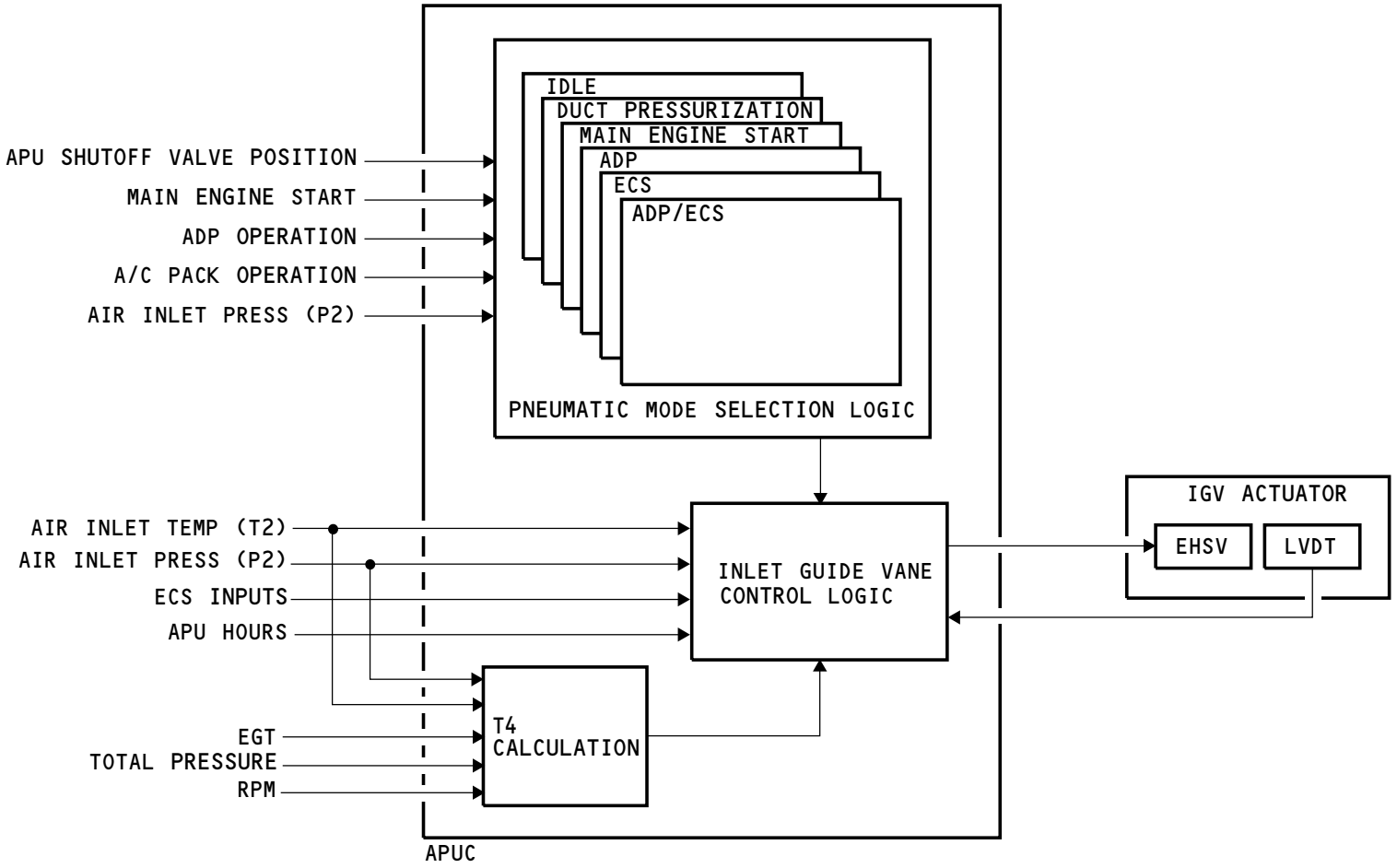
Turbine Inlet Temperature Calculation

The APUC calculates turbine inlet temperature (T4) from these inputs:

- Air inlet temperature (T2).
- Air inlet pressure (P2)
- Exhaust gas temperature (EGT)

- Total pressure
- RPM.

If a heavy APU load causes a T4 increase, the APUC starts to close the IGVs. If T4 continues to increase, the APUC can close the IGVs completely. This gives APU output priority to electrical power generation.



M42212 S000620835_V1

APU AIR - APU AIR SUPPLY SYSTEM - FUNCTIONAL DESCRIPTION

APU AIR - APU SURGE BLEED SYSTEM - INTRODUCTION

Purpose

The APU surge bleed system releases load compressor air that the aircraft pneumatic system does not use. This air flows outboard through the APU exhaust.

The APUC controls the surge bleed system.

Components

Surge bleed system components are on a common pneumatic cluster. These are the components:

- Surge control valve and actuator
- Inlet pressure sensor
- Total pressure sensor
- Differential pressure sensor.

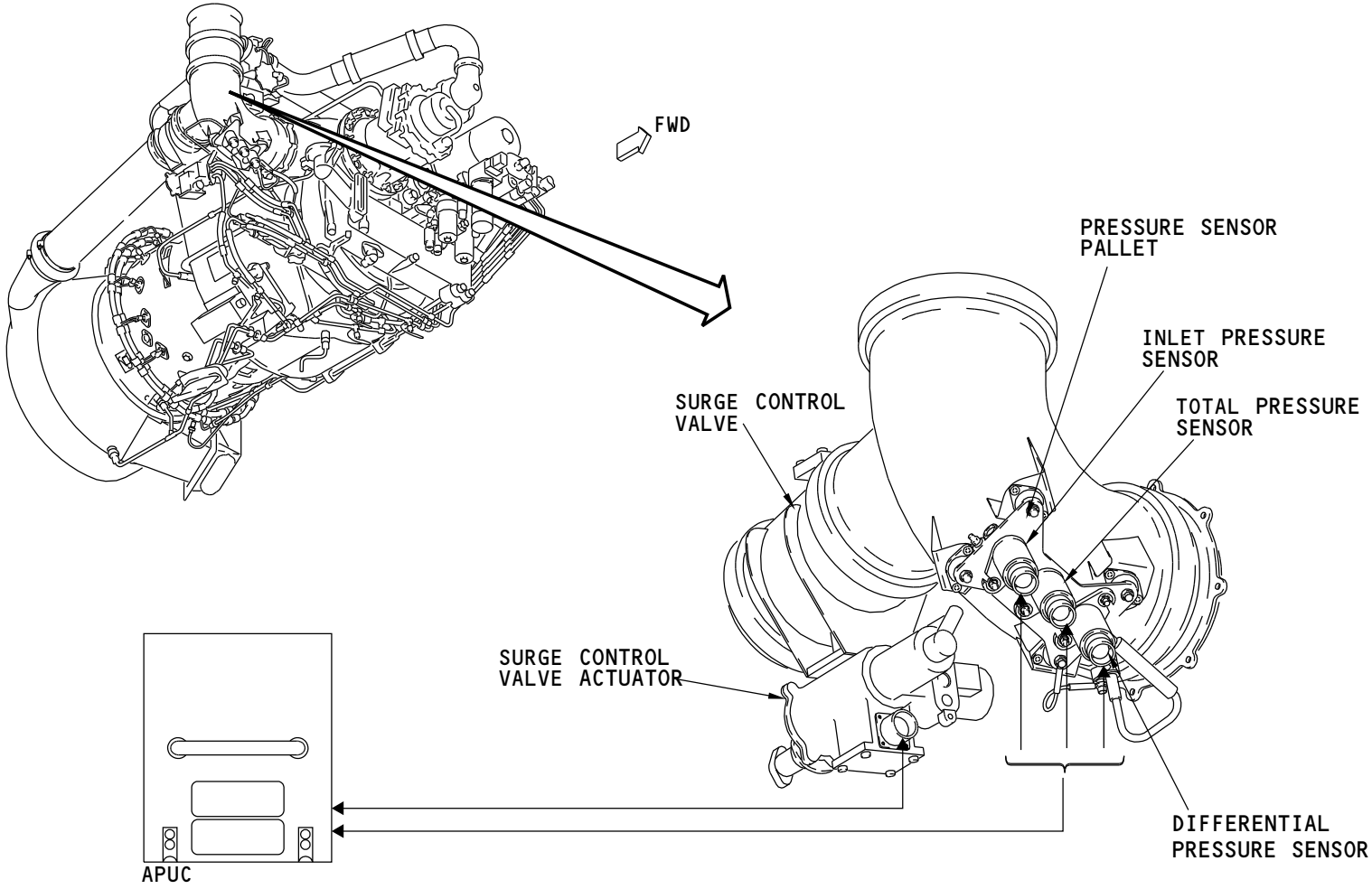
Control

The APUC controls the surge bleed system.

Training Information Point

These are the surge bleed system LRUs:

- Pneumatic cluster
- Surge control valve
- Pressure sensor pallet
- Each pressure sensor.



M42213 S000620836_V1

APU AIR - APU SURGE BLEED SYSTEM - INTRODUCTION

APU AIR - APU SURGE BLEED SYSTEM - SURGE CONTROL VALVE

Purpose

The surge control valve releases pneumatic pressure from the load compressor. This keeps a minimum flow of air through the load compressor to prevent compressor surge.

Physical Description

The valve is a butterfly type valve that is spring-loaded open. The surge control valve actuator is on the bottom of the valve. A two-stage servo valve controls the actuator.

Location

The valve is on the aft part of the pneumatic cluster.

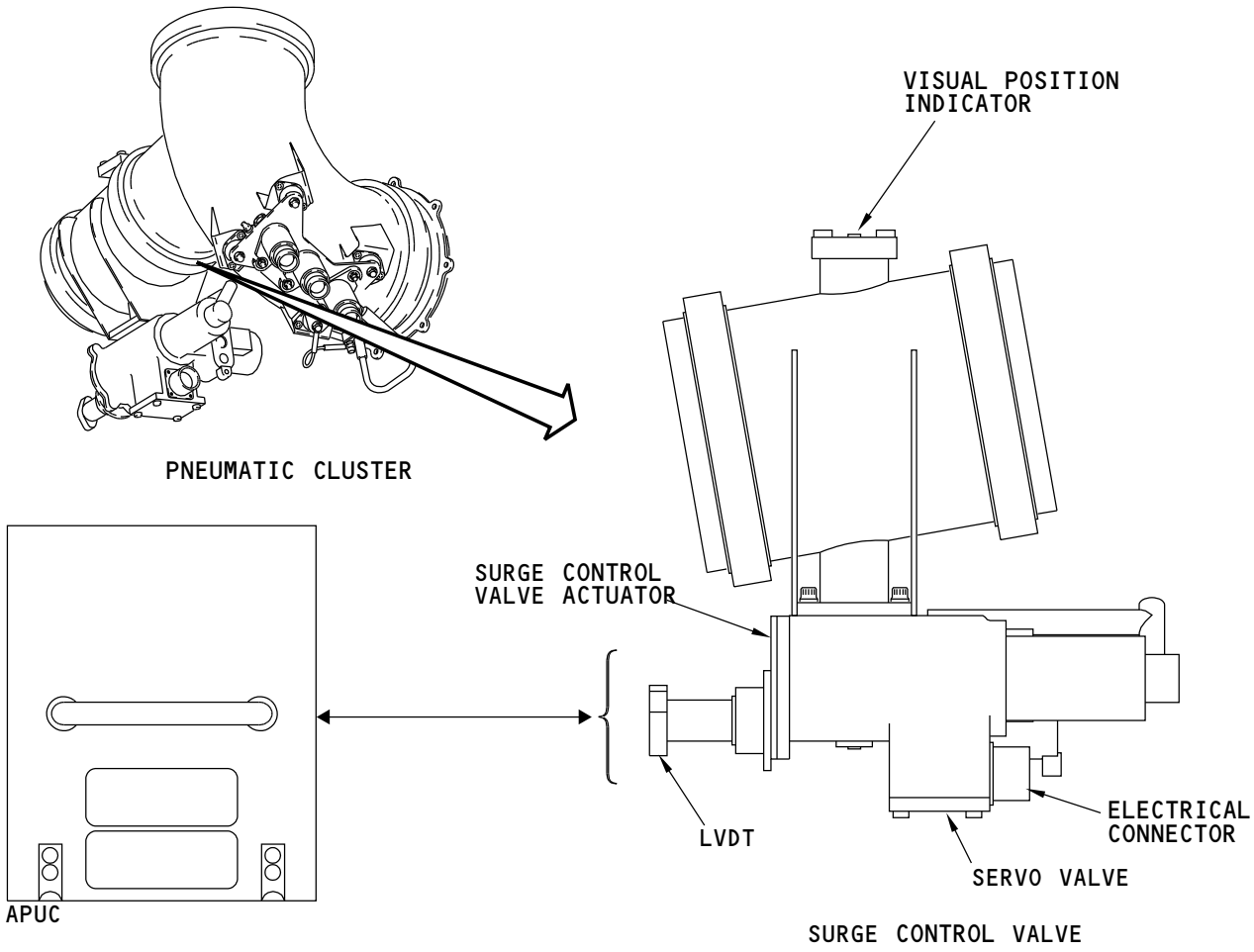
Functional Description

The APUC controls a torque motor on the servo valve. This motor controls high pressure fuel from the APU fuel system to open or close the surge control valve. The valve moves between 10 degrees (open) and 90 degrees (closed). An LVDT supplies valve position feedback to the APUC.

Air that flows through the surge control valve goes overboard through the exhaust duct.

Training Information Point

A valve position indicator shows valve position.



M42214 S000620837_V1

APU AIR - APU SURGE BLEED SYSTEM - SURGE CONTROL VALVE

APU AIR - APU SURGE BLEED SYSTEM - PRESSURE SENSORS

Purpose

Three pressure transducers measure load compressor pressure conditions.

Location

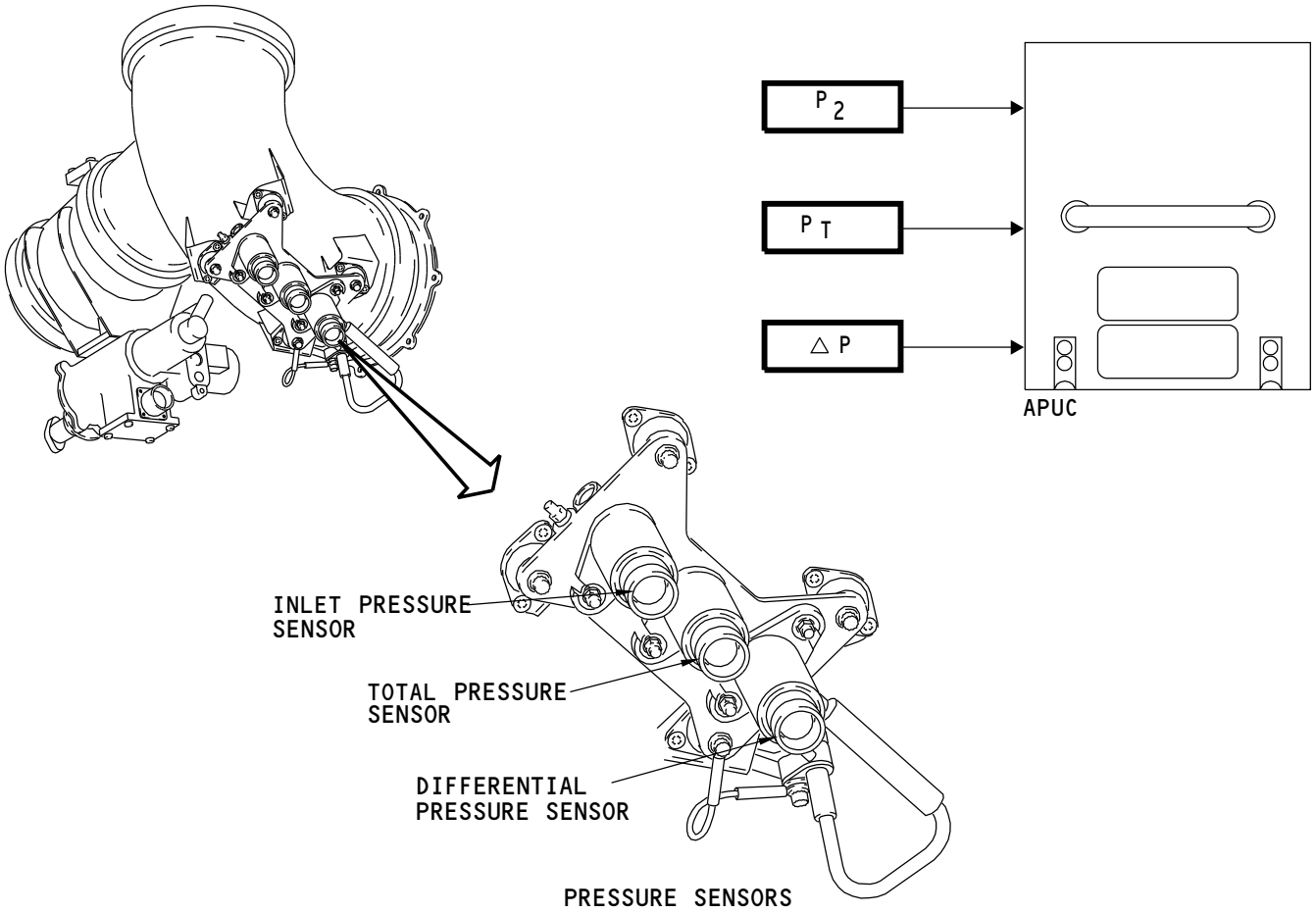
The pressure transducers are on the forward lower face of the pneumatic cluster.

Functional Description

The inlet pressure sensor (P2) measures ambient pressure upstream of the load compressor. The APUC uses this data to control some APU functions.

The total pressure sensor (PT) measures load compressor discharge pressure. A differential pressure sensor (DP) measures the difference between the total pressure and the static pressure in the diffuser (differential pressure equals total pressure minus static pressure).

The APUC uses PT and DP to calculate load compressor airflow to operate the surge control valve.



M42215 S000620838_V1

APU AIR - APU SURGE BLEED SYSTEM - PRESSURE SENSORS

APU AIR - APU SURGE BLEED SYSTEM - FUNCTIONAL DESCRIPTION

General

The APU surge bleed system releases the air from the load compressor that the airplane pneumatic system does not use. This keeps air moving through the load compressor and prevents compressor surge.

Corrected Air Flow and Surge Margin Set Point

The APUC calculates a corrected airflow and a surge margin set point.

The corrected airflow is the amount of air that flows through the load compressor. The APUC uses total pressure (PT) and differential pressure DP) to calculate the corrected airflow.

The surge margin set point is the minimum amount of air that should flow from the load compressor for the APU operating conditions.

The APUC uses these inputs to calculate the surge margin set point:

- Total pressure (PT)
- Inlet pressure (P2)
- Inlet temperature (T2)
- IGV position
- Pneumatic mode
- APU shutoff valve position
- ADP condition.

The corrected airflow must be more than the surge margin set point to prevent a compressor surge. If the corrected airflow is less than the surge margin set point, the APUC opens the surge control valve. This increases the airflow from the load compressor to the minimum level.

For the ECS pneumatic mode, the usual position for the surge control valve is fully closed. For the duct pressurization, main engine start, ADP, and ADP/ECS pneumatic modes, the usual position for the surge control valve is between fully closed and fully open. For these pneumatic modes, the surge control valve opens more if the corrected airflow goes below the surge margin set point.

For the idle pneumatic mode, the usual position for the surge control valve is fully open.

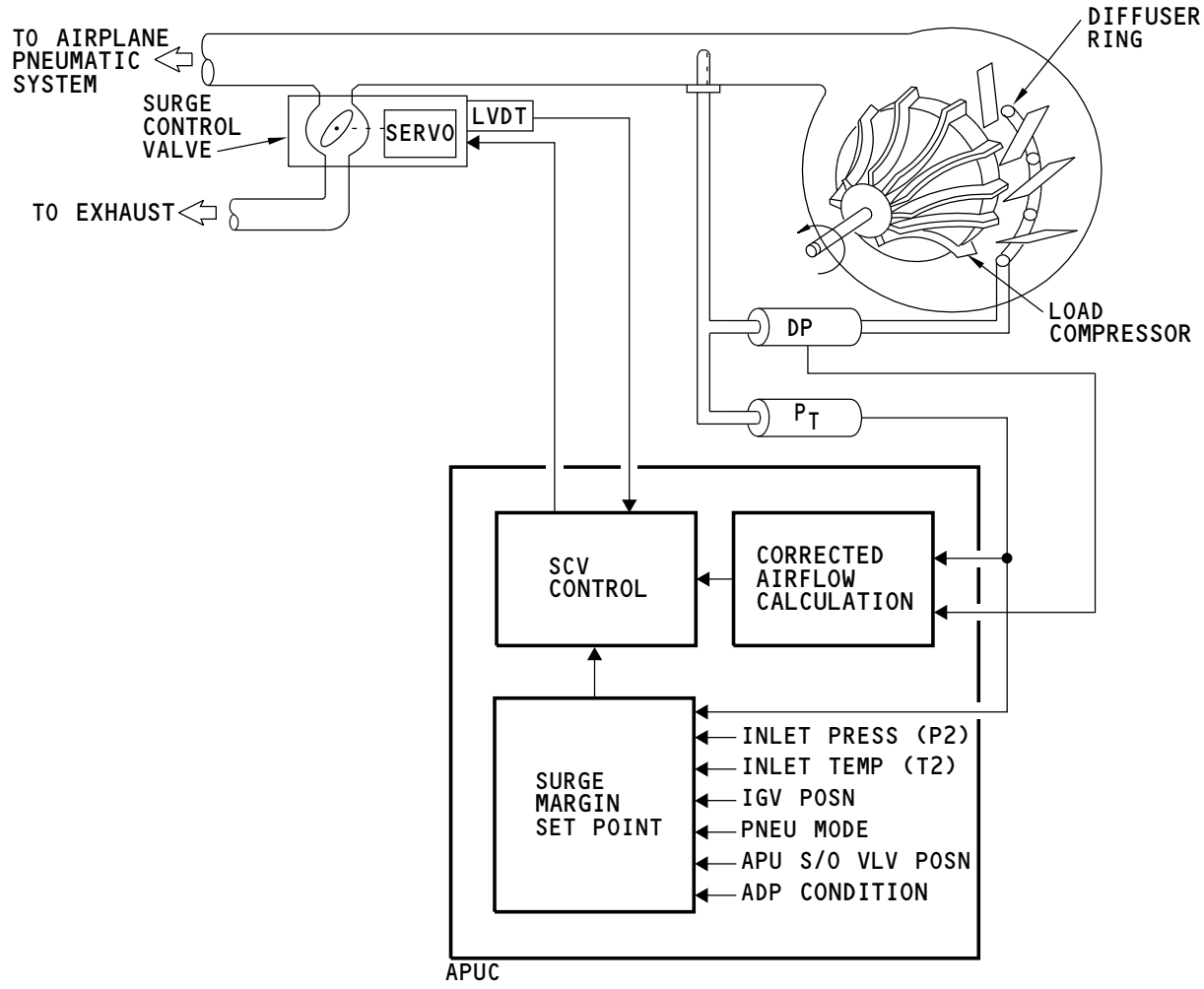
Surge Control Valve Actuator Control

The APUC sends control signals to the servo valve on the SCV actuator to open or close the valve. The LVDT in the surge control valve supplies valve position feedback to the APUC.

APU Start and Shutdown

During APU start, the surge control valve is in the fully open position. The valve closes when APU speed is 95 percent RPM.

During APU shutdown, the surge control valve fully opens when you move the APU selector to the OFF position.



M42216 S000620839_V1

APU AIR - APU SURGE BLEED SYSTEM - FUNCTIONAL DESCRIPTION

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APU CONTROL SYSTEM - INTRODUCTION

Purpose

The APU control system uses an APU controller to control these APU functions:

- Starting and ignition
- Fuel metering
- Surge control
- Inlet guide vane (IGV) control
- Data Storage
- Protective shutdown
- BITE/fault reporting
- APU indication.

System Components

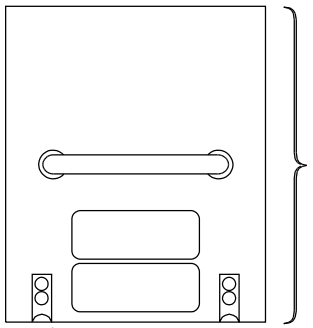
The other control system components are:

- The speed sensor (2)
- The inlet temperature sensor.

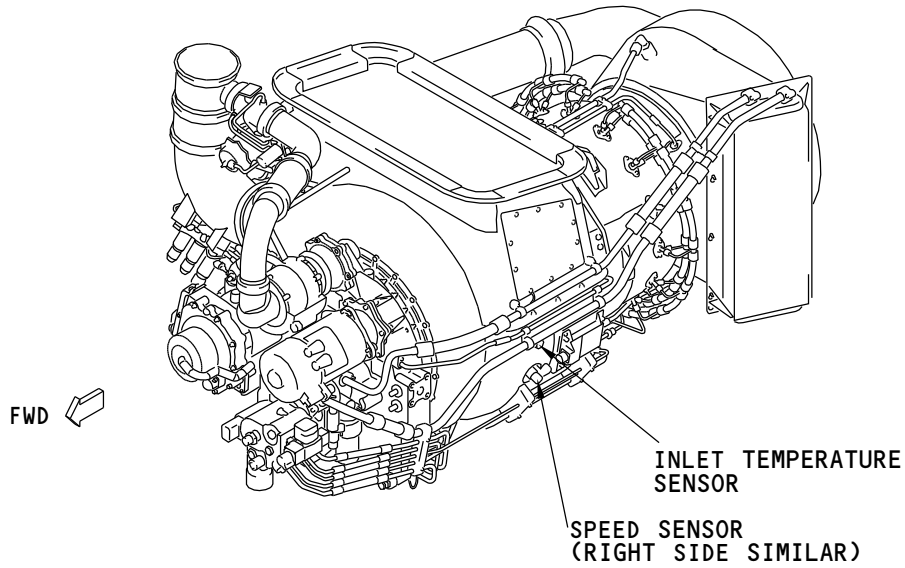
These sensors supply data to the APUC for control functions.

Location

The APUC is on the E7 rack above the aft galley. The two APU speed sensors and the inlet temperature sensor are on the sides of the APU.



STARTING AND IGNITION
FUEL METERING
SURGE CONTROL
IGV CONTROL
DATA STORAGE
PROTECTIVE SHUTDOWN
NORMAL SHUTDOWN
BITE/FAULT REPORTING
APU INDICATION



M42217 S000620840_V1

APU CONTROL SYSTEM - INTRODUCTION

APU CONTROL SYSTEM - APU CONTROLLER - INTRODUCTION

Purpose

The APU controller (APUC) controls APU functions. The APUC also contains circuits for fault detection and isolation.

APUC Modes

The APUC operates in one of these eight modes:

- Test mode - APUC does power-up test
- Idle mode - APUC powered and APU is not on
- Start - air mode - APU does an air start
- Start - electric mode - APU does an electric start
- Onspeed mode - APU RPM is more than 95 percent
- Cooldown mode - APU is in the cooldown mode
- Shutdown mode - APU RPM is less than 70 percent during APU shutdown
- Auto-shutdown mode - the APUC does an APU protective shutdown.

Location

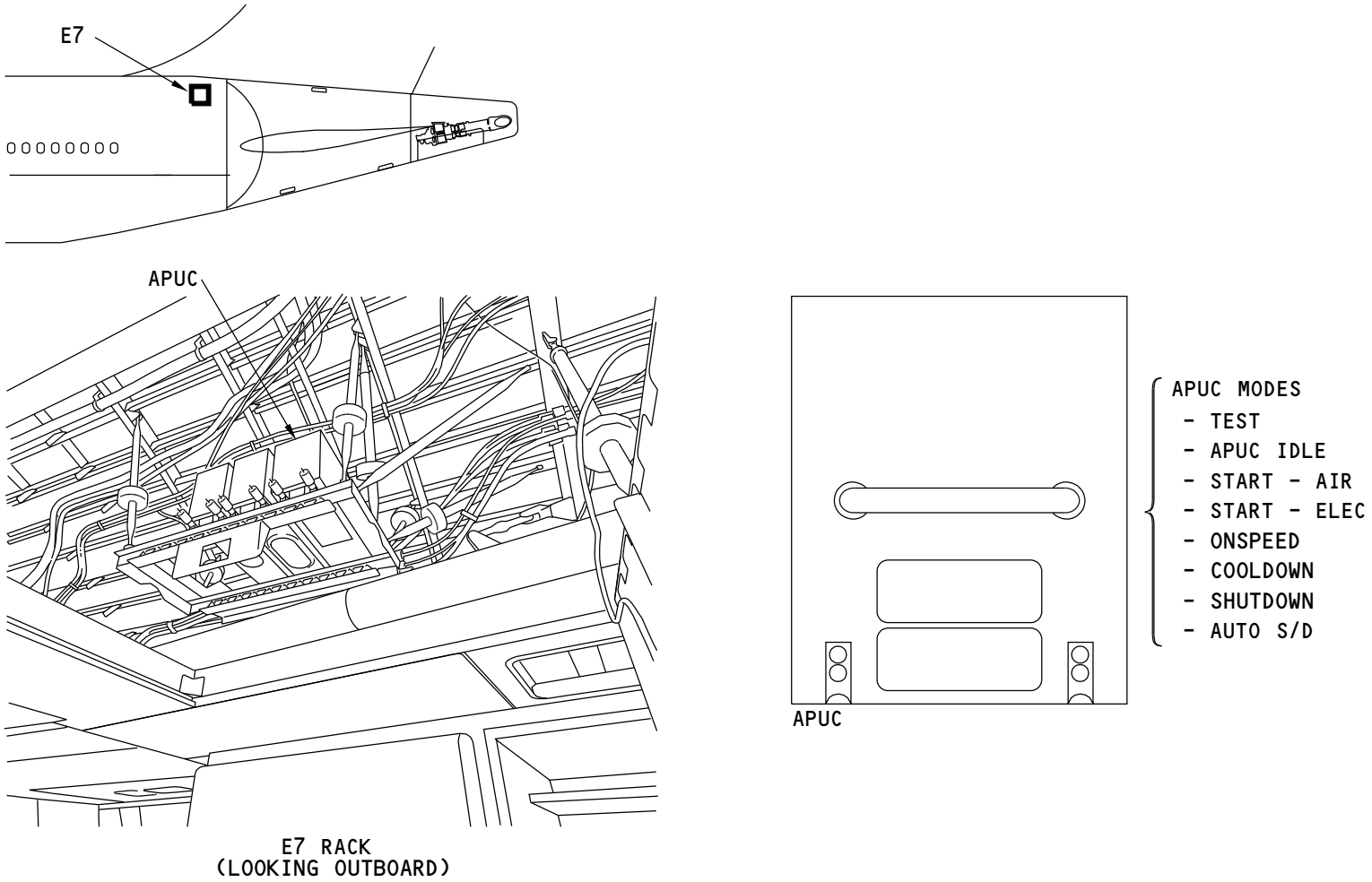
The APUC is on the E7 rack above the aft galley.

Training Information Point

The APUC is an LRU. The circuit cards in the APUC are not LRUs.

You must open a hinged access panel above the aft galley to get access to the APUC.

CAUTION DO NOT REMOVE THE APUC AND THE DATA MEMORY MODULE AT THE SAME TIME. IF YOU REMOVE THE APUC AND THE DATA MEMORY MODULE AT THE SAME TIME, YOU WILL LOSE THE DATA FOR THE APU.



M42218 S000620842_V1

APU CONTROL SYSTEM - APU CONTROLLER - INTRODUCTION

APU CONTROL SYSTEM - APU CONTROLLER - INPUTS

General

The APUC gets inputs from both airplane systems and the APU.

The APUC receives 28v dc power from both the 28v dc battery bus and the 28v dc APU battery bus.

Airplane Systems ARINC 629 Inputs

The APUC receives these airplane system inputs through the left and right ARINC 629 system buses:

- Pneumatic duct pressure
- APU fuel shutoff valve position
- ECS data
- Main engine start/run
- Air driven pumps (ADPs) ON
- Electrical system demand
- Air/ground indication
- Date/time
- Air data
- APU bleed valve position.

Airplane Systems Discrete Inputs

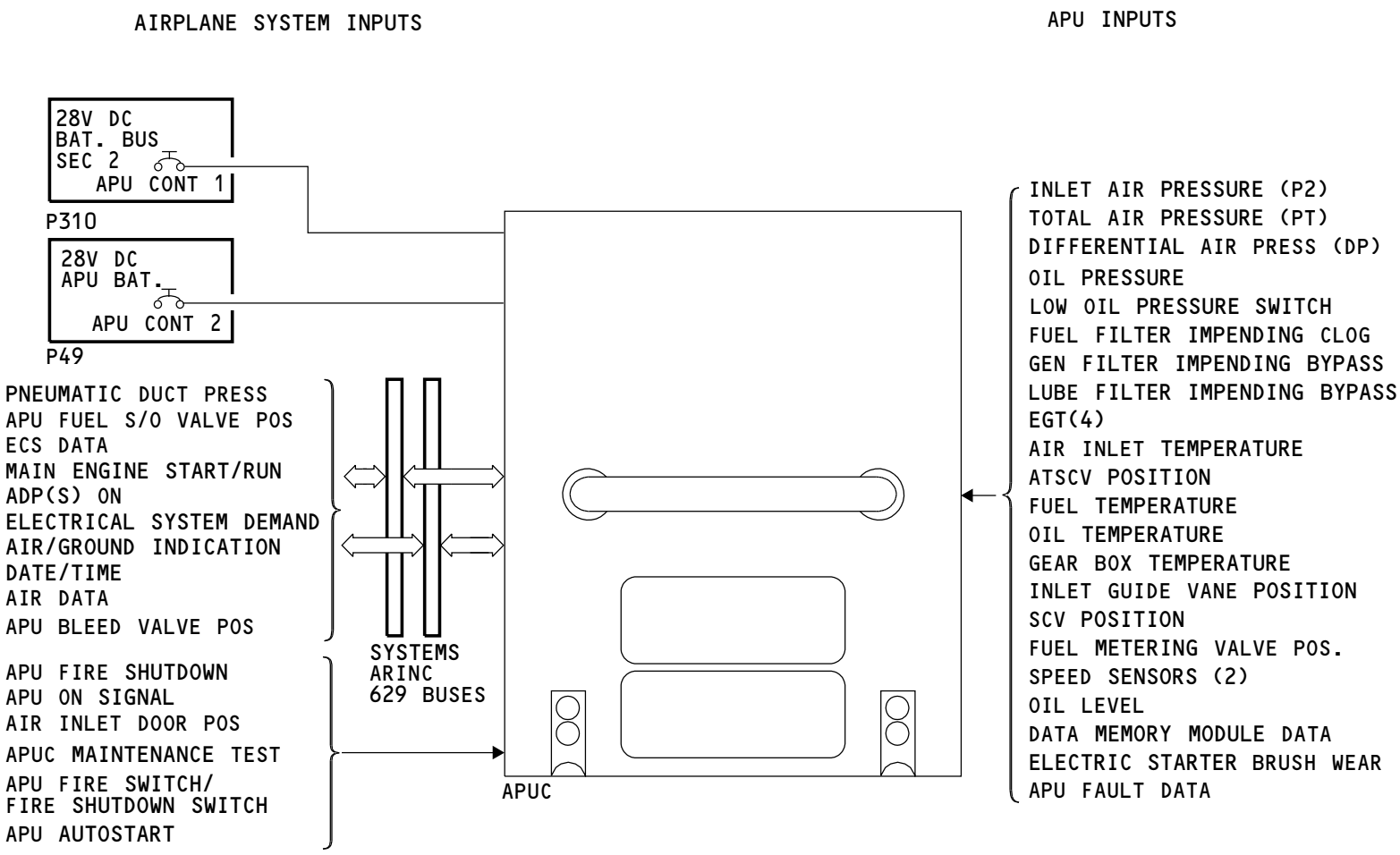
The APUC also receives other airplane systems inputs. These inputs include:

- APU fire shutdown
- APU ON signal
- Air inlet door position
- APUC maintenance test
- APU fire switch/fire shutdown switches
- APU autostart.

APU Inputs

Inputs from the APU to the APUC are:

- Inlet air pressure (P2)
- Total air pressure (PT)
- Differential air pressure (DP)
- Oil pressure
- Low oil pressure switch
- Fuel filter impending clog
- Generator filter impending bypass
- Lube filter impending bypass
- EGT (4)
- Air inlet temperature
- Fuel temperature
- Oil temperature
- Gear box temperature
- IGV position
- SCV position
- Fuel metering servo valve position
- ATSCV position
- Speed sensors (2)
- Oil level
- Data memory module data
- Electric starter motor brush wear
- APU fault data.



M42219 S000620843_V1

APU CONTROL SYSTEM - APU CONTROLLER - INPUTS

APU CONTROL SYSTEM - APU CONTROLLER - OUTPUTS

General

The APUC supplies APU data to airplane systems and controls some APU functions.

APUC ARINC 629 Outputs

The APUC supplies this APU data to the airplane through the left and right systems ARINC 629 buses:

- EGT
- Air inlet temperature
- APU speed
- Oil quantity
- Oil pressure
- Gearbox temperature
- Fuel temperature
- Generator load available
- APU fault data
- APU shutdown data
- IGV angle
- SCV angle
- Pressure sensor data
- Ignitor ON/OFF
- Fuel shutoff solenoid ON/OFF
- Filter clog sensor status (3)
- Low oil pressure status
- Electric starter brush wear
- Maintenance test status.

Other APUC Airplane System Outputs

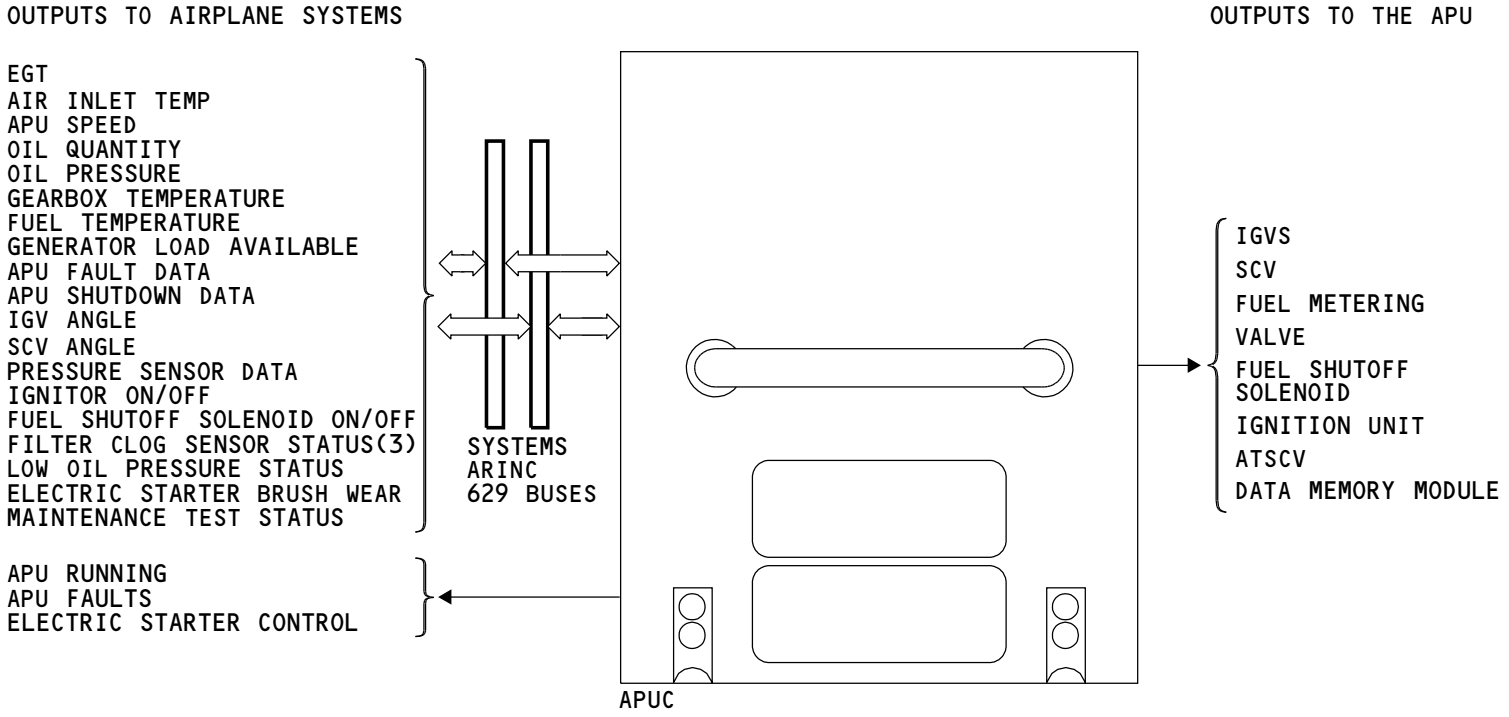
The APUC also sends these signals on non-ARINC 629 connections:

- APU running status
- APU fault indication
- APU starter control.

APUC Outputs to the APU

The APUC sends signals to control these APU components:

- IGVs
- SCV
- Fuel metering valve
- Fuel shutoff solenoid
- Ignition unit
- Air turbine starter control valve
- Data memory module.



M42220 S000620844_V1

APU CONTROL SYSTEM - APU CONTROLLER - OUTPUTS

APU CONTROL SYSTEM - APU CONTROLLER - FAULT MONITORING

General

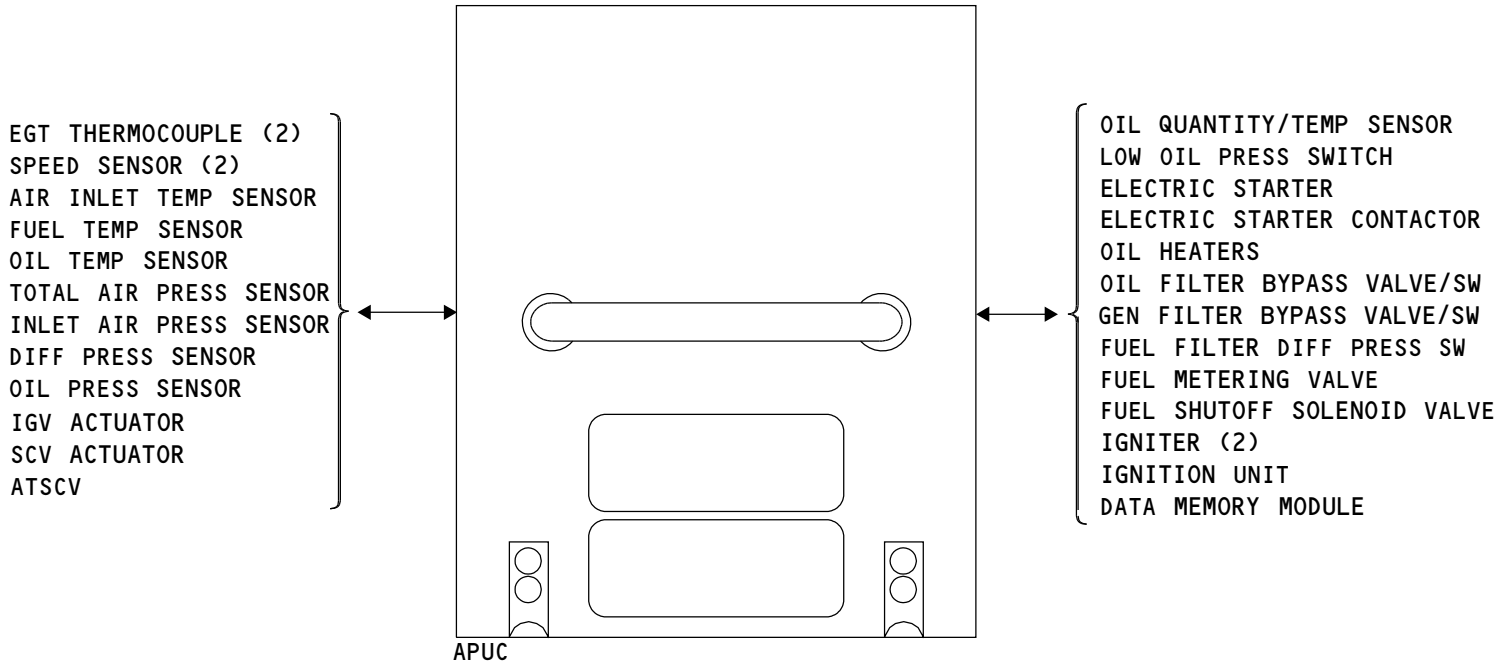
The APUC does tests of APU components and the internal functions of itself. The APUC tests some components continuously and others only when the APU is in a specific mode (power-up, power-down, shutdown).

The APUC memory holds 256 faults. When the memory is full, new faults record over the oldest faults.

APU Faults

The APUC monitors these APU components:

- EGT thermocouple (2)
- Speed sensor (2)
- Air inlet temperature sensor
- Fuel temperature sensor
- Oil temperature sensor
- Total air pressure sensor
- Inlet air pressure sensor
- Differential pressure sensor
- Oil pressure sensor
- IGV actuator
- Surge control valve actuator
- ATSCV
- Oil quantity/temperature probe
- Low oil pressure switch
- Electric starter (brush wear)
- Electric starter contactor
- APU oil heater assembly
- Oil filter bypass valve/switch
- Generator filter bypass valve/switch
- Fuel filter differential pressure switch
- Fuel metering valve
- Fuel shutoff solenoid valve
- Igniter (2)
- Ignition unit
- Data memory module.



M42221 S000620845_V2

APU CONTROL SYSTEM - APU CONTROLLER - FAULT MONITORING

APU CONTROL SYSTEM - SPEED SENSORS

Purpose

Two speed sensors measure APU shaft speed and send this data to the APUC for control and display functions.

Location

The speed sensors are on each side of the compressor section.

Functional Description

The speed sensors are variable reluctance motion sensors. Each speed sensor sends a signal with a frequency in proportion to engine RPM. The APUC selects the higher of the two signals for control and display functions.

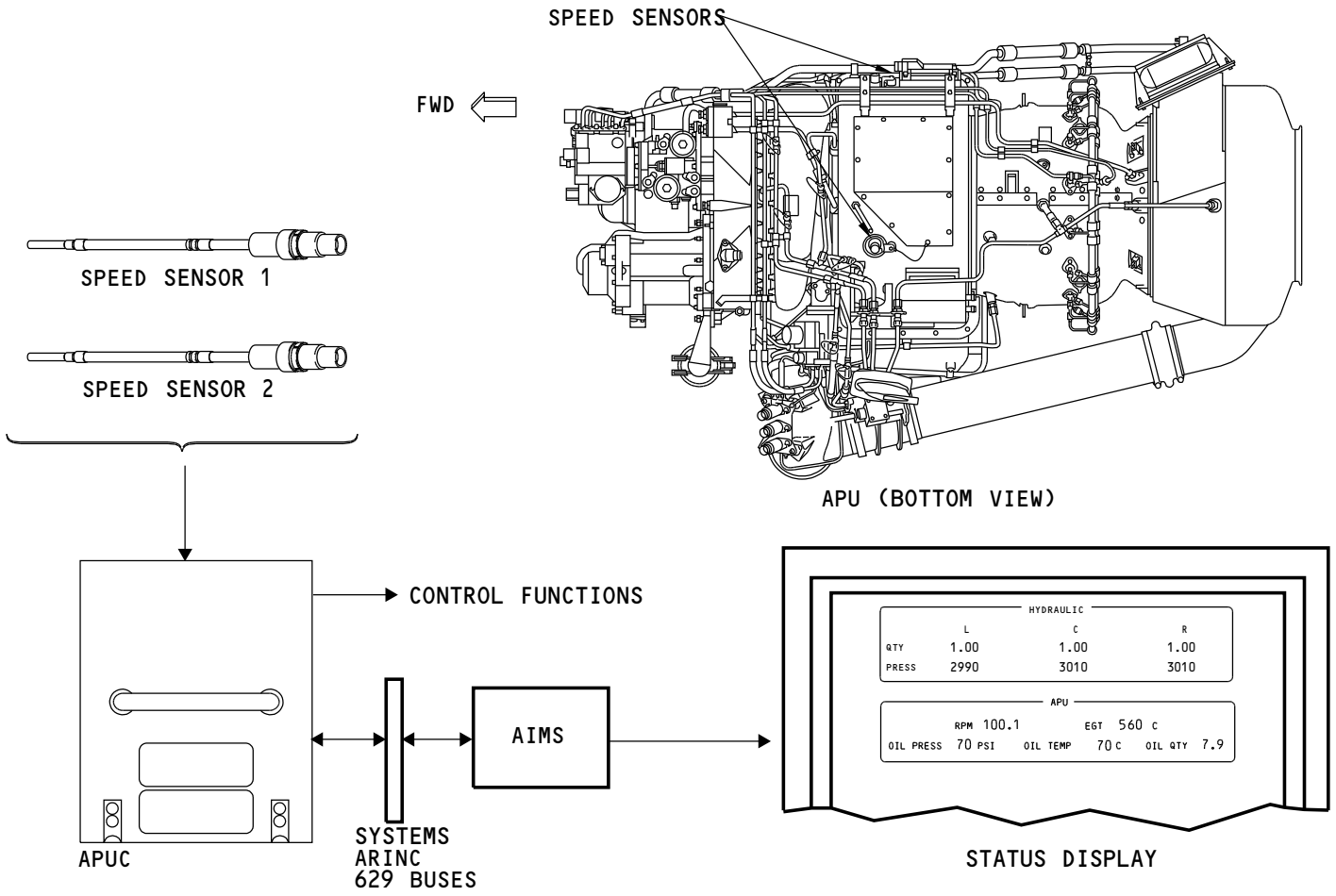
Control

The APUC uses engine speed to control these functions:

- Ignition system control
- Starter system control
- Fuel system control
- Engine speed control
- Overspeed automatic shutdown protection
- No-acceleration automatic shutdown protection.

Indications

APU engine RPM shows on the status display and the maintenance page.



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APU CONTROL SYSTEM - SPEED SENSORS

APU CONTROL SYSTEM - INLET TEMPERATURE SENSOR

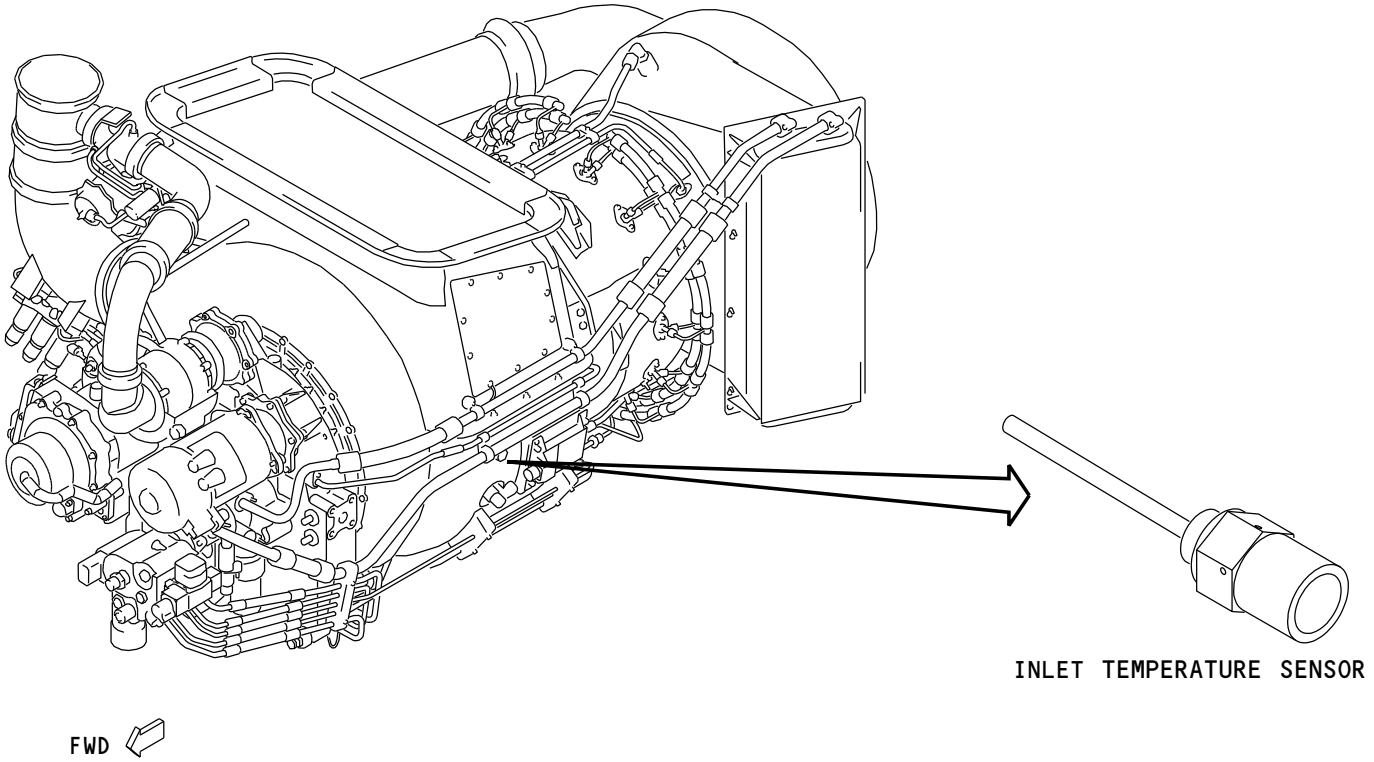
Inlet Temperature Sensor

The inlet temperature sensor supplies inlet air temperature data (T2). The APUC uses this data for these functions:

- Fuel control
- IGV control
- SCV control
- Turbine inlet temperature calculation.

The inlet temperature sensor is an RTD (resistance temperature detector) type sensor.

This sensor is on the left side of the APU.



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APU CONTROL SYSTEM - INLET TEMPERATURE SENSOR

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APU INDICATING SYSTEM - EGT INDICATING SYSTEM

Purpose

The APU EGT indicating system supplies APU exhaust gas temperature data for flight deck indication and APU control.

Component Locations

Four chromel/alumel thermocouple probes, grouped in two rakes, are on the exhaust section 90 degrees apart. The thermocouple housing is stainless steel. Each probe has two temperature sensing junctions.

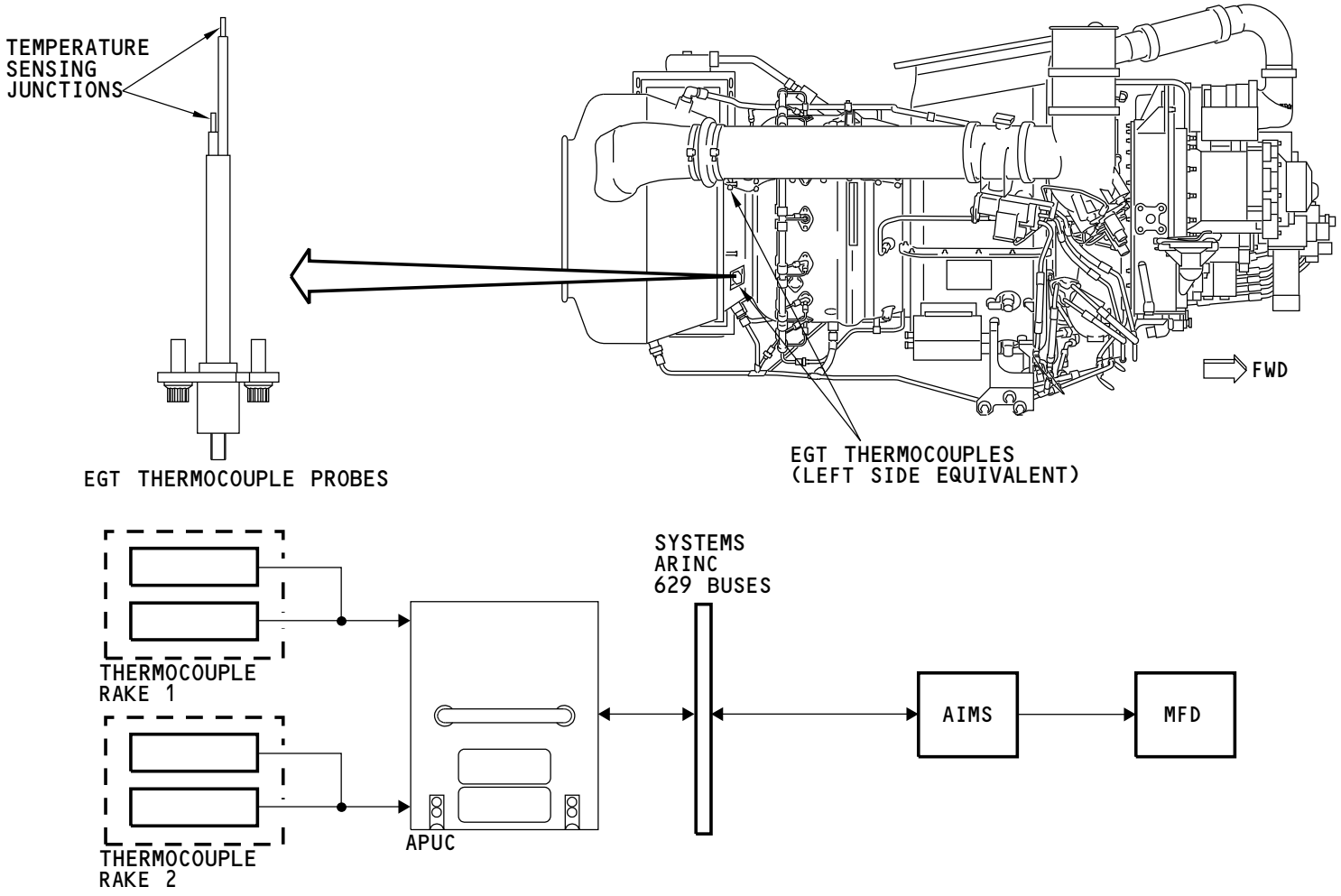
Functional Description

The APUC receives temperature inputs from the two thermocouple rakes. The APUC uses the strongest signal output (highest temperature) for indication and control.

Training Information Point

Loss of input from one rake does not cause the loss of EGT indication. Loss of EGT input from both rakes causes loss of indication. EGT overtemperature or loss of EGT from both rakes causes an APU protective shutdown in the unattended mode.

APU EGT shows on the MFD status display and the APU maintenance page.



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APU INDICATING SYSTEM - EGT INDICATING SYSTEM

APU INDICATING SYSTEM - DATA MEMORY MODULE

Purpose

The data memory module(DMM) keeps this APU data in non-volatile memory:

- APU serial number
- APU operating hours
- Number of APU starts
- Start data
- Shutdown data
- Pneumatic system operating mode
- APU turbine life used.
- APU health data.

The DMM keeps this APU data so that APUC replacement will not cause loss of APU operation data.

General Description

The APUC controls the data flow into the DMM. The APUC reads the DMM memory during the APU start sequence and transmits updated information to the DMM during APU shutdown.

Location

The DMM is on the left side of the APU.

Training Information Point

You can read DMM data with special test equipment.

Replacement of the APUC does not cause the loss of the data stored in the DMM.

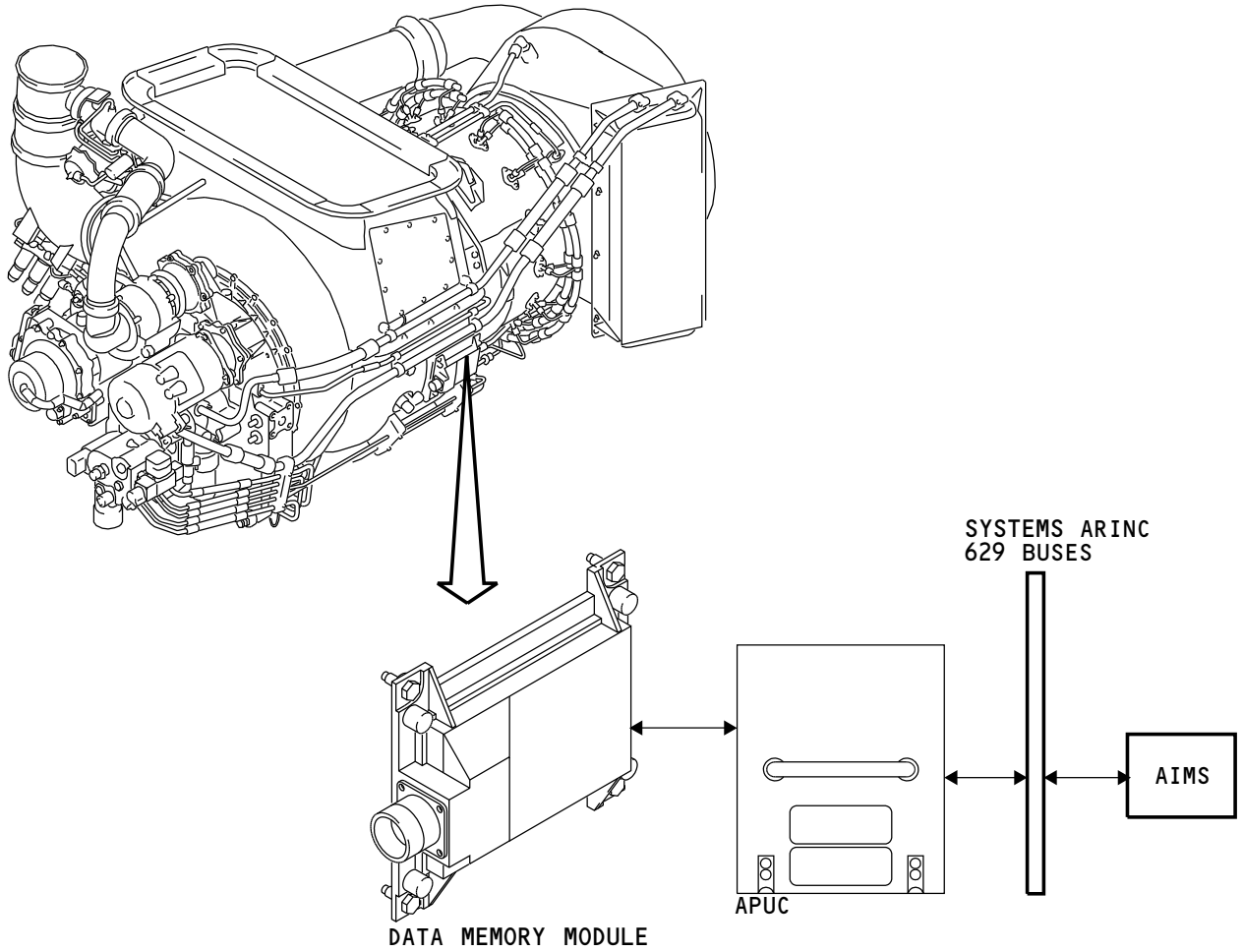
CAUTION DO NOT REMOVE THE APUC AND THE DATA MEMORY MODULE AT THE SAME TIME. IF YOU REMOVE THE APUC AND THE DATA MEMORY MODULE AT THE SAME TIME, YOU WILL LOSE THE DATA FOR THE APU.

If you replace the DMM, make sure you obey the precaution given below.

CAUTION YOU MUST USE A BLANK DATA MEMORY MODULE. IF YOU DO NOT USE A BLANK DATA MEMORY MODULE, LOSS OF DATA OR INCORRECT DATA CAN OCCUR.

If you replace both the APUC and the DMM, make sure you obey the precaution given below.

CAUTION YOU MUST DO THE APU CONTROLLER INSTALLATION TEST BEFORE YOU REMOVE THE DATA MEMORY MODULE. IF YOU DO NOT DO THE INSTALLATION TEST FOR THE APU CONTROLLER BEFORE YOU REMOVE THE DATA MEMORY MODULE, YOU WILL LOSE THE DATA FOR THE APU.



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APU INDICATING SYSTEM - DATA MEMORY MODULE

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APU EXHAUST SYSTEM

Purpose

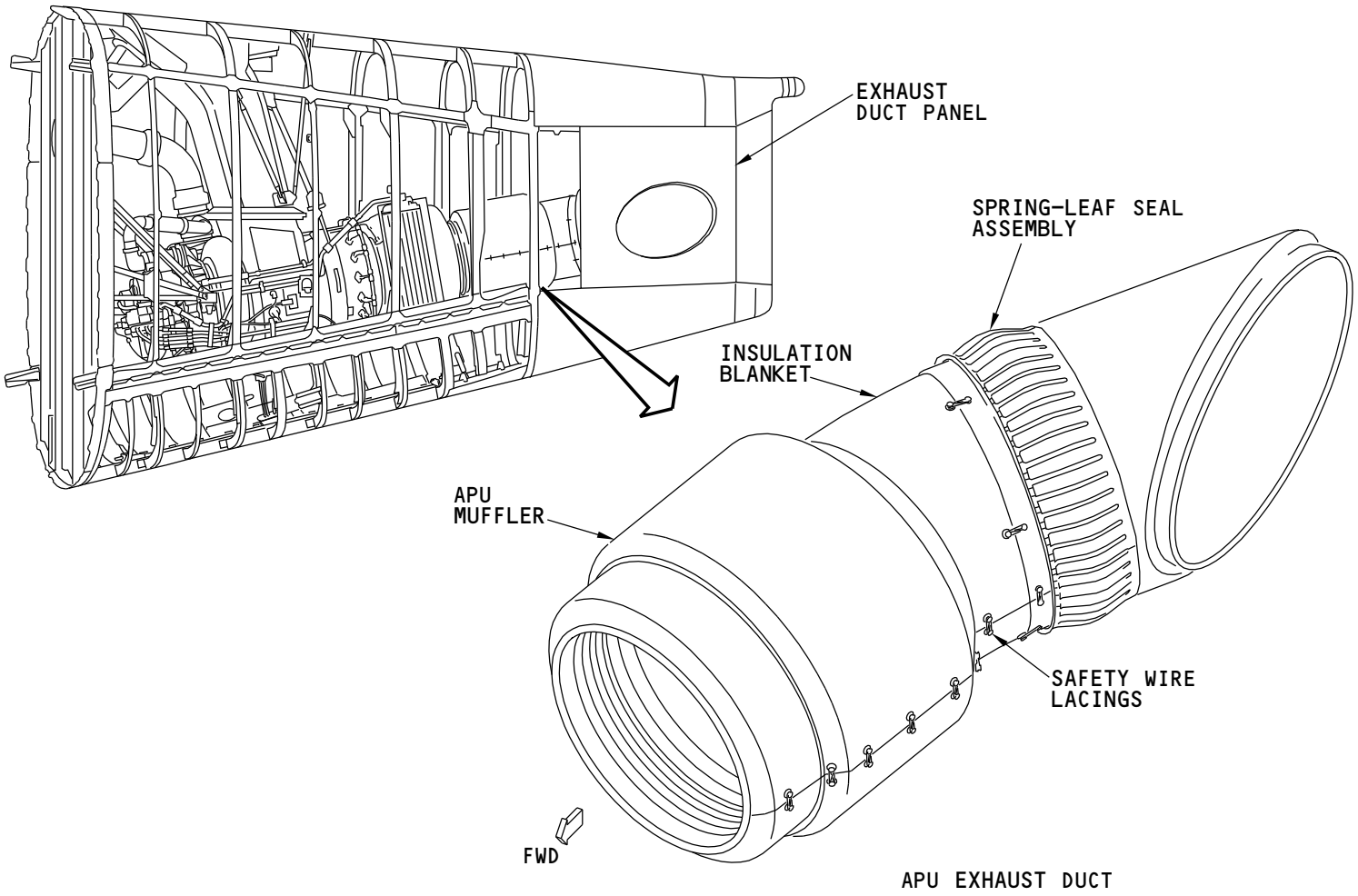
The APU exhaust system sends the APU exhaust overboard through the exhaust duct. The exhaust system prevents APU compartment damage from high exhaust gas temperatures and decreases exhaust noise levels.

Components

The stainless steel APU exhaust duct attaches to the APU turbine section with a V-Band clamp. A spring-leaf seal assembly holds the exit end of the exhaust duct in the exhaust duct panel. The 13 degree exhaust duct angle sends the exhaust out the left side of the aircraft.

An insulation blanket goes around the exhaust duct. Safety wire lacings hold the blanket together.

A muffler and acoustic assemblies in the exhaust duct decrease exhaust noise.



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APU EXHAUST SYSTEM

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APU OIL INDICATING SYSTEM - INTRODUCTION

Purpose

The APU oil indicating system supplies APU oil temperature, pressure, and quantity data for APU flight deck display and APU control functions.

Components

These are the oil indicating system components:

- Oil pressure sensor
- Low oil pressure switch
- Oil temperature sensor
- Oil quantity/sump temperature sensor.

An oil level sight gage on the gearbox shows oil level.

Location

The oil pressure sensor, the low oil pressure switch, and the oil temperature sensor are on the lube cluster. The oil quantity/sump temperature sensor and the oil level sight gage are on the APU gearbox.

General Description

The APUC receives oil indicating system inputs and supplies this data to the AIMS to show on the MFD.

Oil indicating system data shows on the status display and on the APU maintenance page.

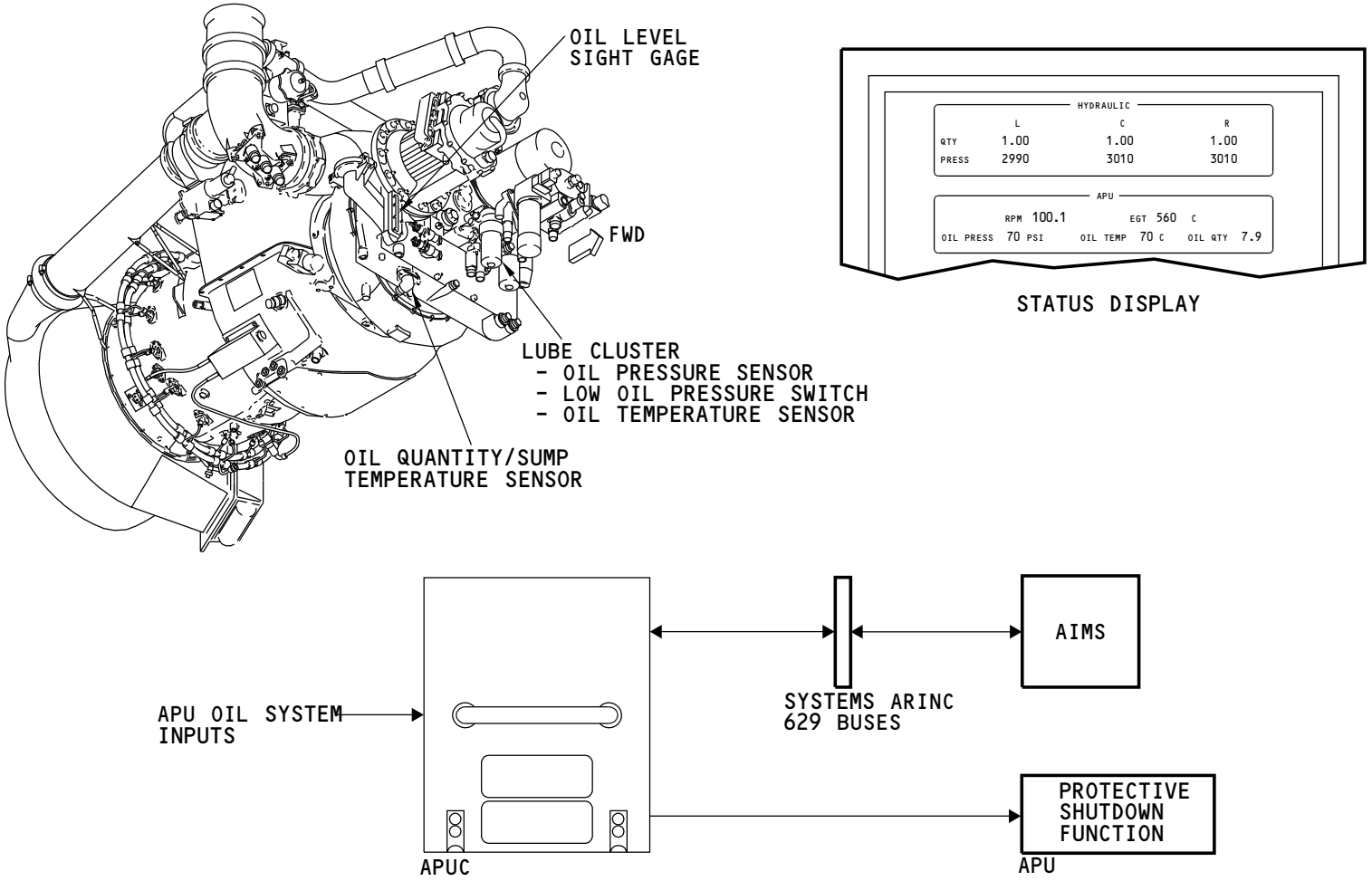
Protective Shutdowns

Low oil pressure, loss of oil pressure input, or high oil temperature will cause the APUC to do a protective shutdown when the APU is in the unattended mode.

Non-Normal Indications

The APU OIL QTY status message shows when the APU oil quantity is 3.8 quarts (3.5 liters) or less. This message also shows for an oil quantity/sump temperature sensor failure.

The APU status message shows for an oil temperature sensor failure.



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APU OIL INDICATING SYSTEM - INTRODUCTION

APU OIL INDICATING SYSTEM - COMPONENTS

Oil Quantity/Sump Temperature Sensor

The oil quantity/temperature sensor is a capacitance-type sensor and is in the sump of the oil reservoir on the bottom of the APU gearbox. The sensor sends both oil quantity and oil temperature data to the APUC.

Oil Pressure Sensor

The oil pressure sensor sends oil system pressure data to the APUC. This sensor is on the lube cluster.

Low Oil Pressure Switch

The low oil pressure switch sends a low oil pressure signal to the APUC when APU oil pressure is below 30 to 40 psi. This switch is on the lube cluster.

Oil Temperature Sensor

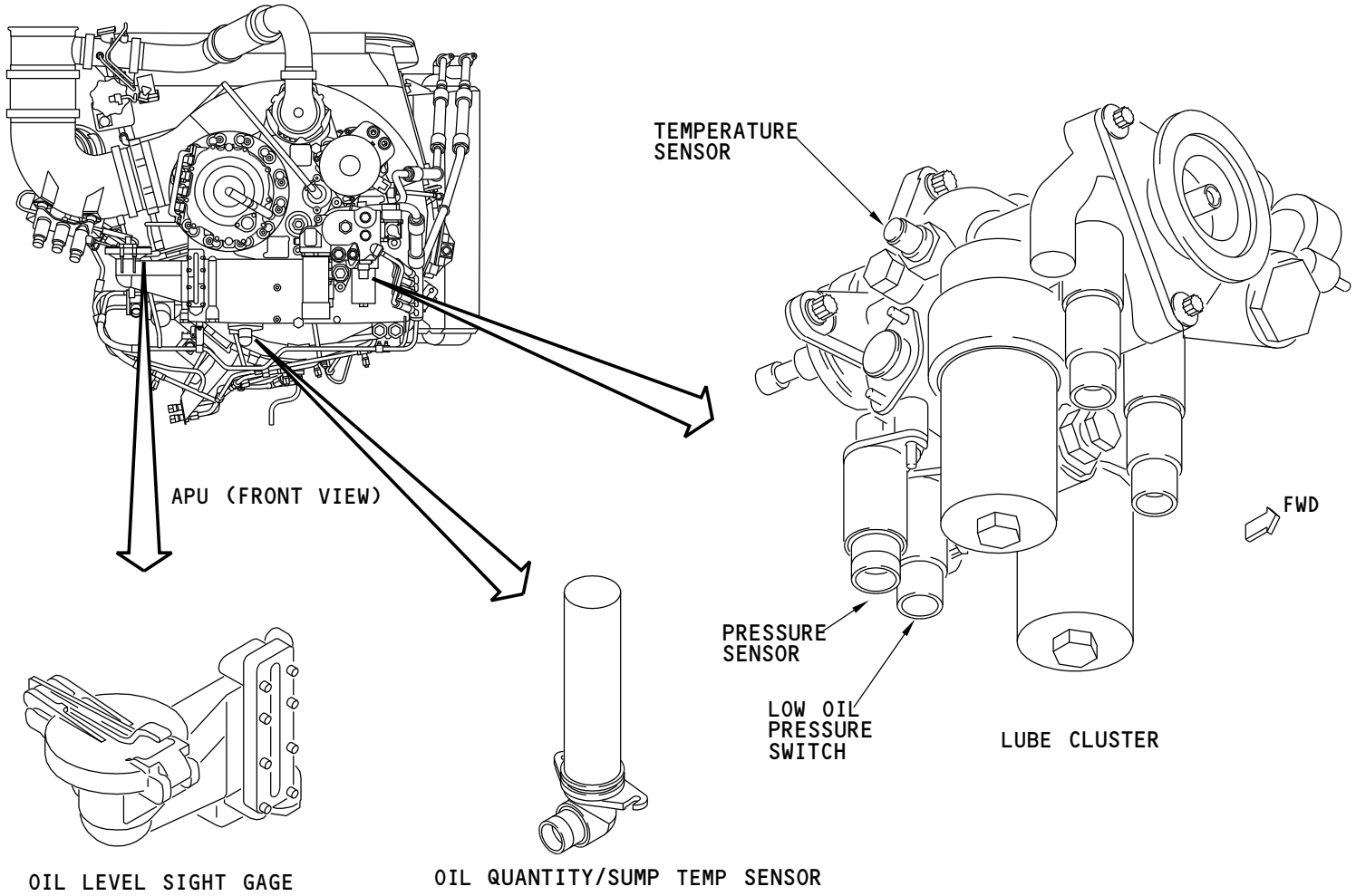
The oil temperature sensor is a resistive type sensor. It sends oil temperature data to the APUC and is on the Lube cluster.

Oil Level Sight Gage

The oil level sight gage is on the right, front of the gearbox. The sight gage is part of the oil fill port.

Training Information Point

All APU oil sensors are LRUs. The sight gage and fill port are a single LRU.



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APU OIL INDICATING SYSTEM - COMPONENTS