

CHAPTER

49

Auxiliary Power System



CHAPTER 49
AUXILIARY POWER SYSTEM

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**AIRBORNE AUXILIARY POWER - INTRODUCTION****Purpose**

The Honeywell 131-9(B) auxiliary power unit (APU) supplies electrical and pneumatic power to other airplane systems. This permits these airplane systems to operate without the use of ground power sources or the engines. The APU can also supply electrical and pneumatic power in the air. The APU can be used to supply pneumatic power for starting the main engines (MES).

Altitude Operational Limits

The APU generator can supply 90 KVA electrical power up to 32,000 feet (9,754 meters) and 66 KVA to 41,000 feet (12,500 meters). Electrical and pneumatic power is available at the same time up to 15,000 feet (4,572 meters). Pneumatic power alone is available up to 17,000 feet (5,183 meters). The APU can be started at 41,000 feet or below.

Abbreviations and Acronyms

- APB - auxiliary power breaker
- APU - auxiliary power unit
- ACS - air conditioning system
- BAT - battery
- BAV - bleed air valve
- BPCU - bus power control unit
- DP - differential pressure
- DMM - data memory module
- DPC - display processing computer
- DFDAU - digital flight data acquisition unit
- DU - display unit
- ECU - electronic control unit
- EGT - exhaust gas temperature
- FCU - fuel control unit
- FMV - fuel metering valve
- AGCU - APU generator control unit

- HOT - high oil temperature
- IGV - inlet guide vane
- KVA - kilovolt-ampere
- LOP - low oil pressure
- LVDT - linear variable differential transformer
- LRU - line replaceable unit
- MDS - Max display system
- MES - main engine start
- OLS - oil level sensor
- OMF - onboard maintenance function
- P2 - inlet pressure
- PPH - pounds per hour
- 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
- PT - total pressure
- PWR - power
- RPM - revolutions per minute
- RTL - ready to load
- RVDT - rotary variable differential transformer
- SCU - starter converter unit
- SCV - surge control valve
- SHP - shaft horsepower
- SPU - start power unit
- sta - station
- T2 - inlet temperature
- T/M - torque motor

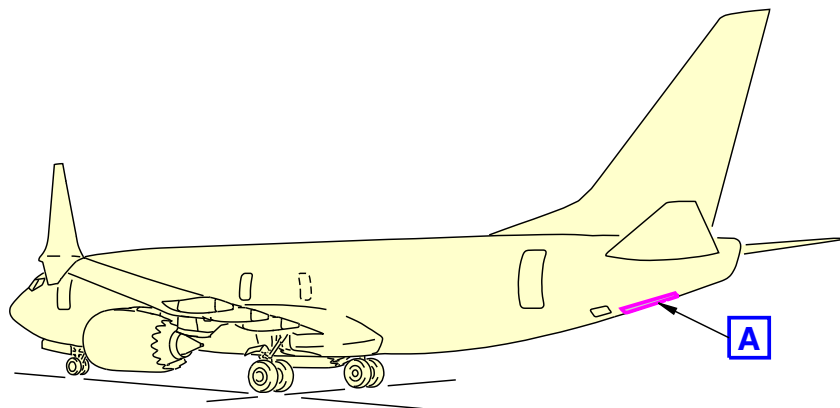
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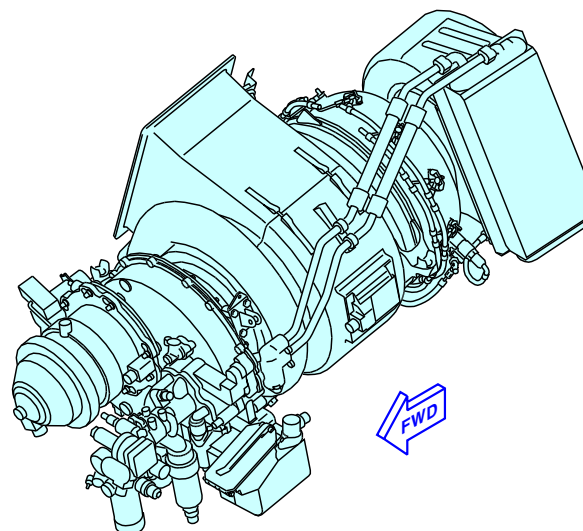
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AIRBORNE AUXILIARY POWER - INTRODUCTION



PNEUMATIC POWER
(<17,000 FT)

ELECTRICAL POWER
(90 KVA <32,000 FT)
(66 KVA <41,000 FT)



DIMENSIONS

- LENGTH 56.76 IN (144 CM)
- WIDTH 34.33 IN (87 CM)
- HEIGHT 29.55 IN (75 CM)

DRY WEIGHT APPROX 390 LBS (177 KG)
(DOES NOT INCLUDE APU FLUIDS)

OPERATING LIMITS

- BLEED LOAD (SEA LEVEL, 60F) 160 PPM AT 60 PSIA
- ELECTRICAL LOAD (SEA LEVEL, 60F) 90 KVA

ENGINE SPEED

- NORMAL RATED SPEED 48,800 RPM = 100%
- OVERSPEED 51,728 RPM = 106%

AIRBORNE AUXILIARY POWER - INTRODUCTION

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**AIRBORNE AUXILIARY POWER - GENERAL DESCRIPTION****General**

The APU system contains these subsystems:

- APU power plant (49-10)
- APU engine (49-20)
- APU fuel system (49-30)
- APU ignition and start system (49-40)
- APU bleed air system (49-50)
- APU controls (49-60)
- APU indicating system (49-70)
- APU exhaust system (49-80)
- APU lubrication system (49-90).

APU Power Plant

The APU is a gas turbine engine. It has a single shaft and operates at a constant speed. It drives an electric generator, pneumatic load compressor, and a reduction gearbox.

APU Engine

These are the primary APU engine components:

- The power section
- The load compressor
- The accessory gearbox.

The power section has a single stage centrifugal compressor. It has a reverse flow annular combustor with a two-stage axial turbine.

The load compressor turns on the same shaft with the power section compressor. The load compressor also uses the same air inlet as the power section compressor.

The gearbox provides gear reduction for the high speed torque of the power section to the accessories on the gearbox.

APU Fuel System

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

APU Ignition and Start System

The APU ignition and start system begins the rotation and acceleration of the APU. The starter-generator is used as a starter during APU starting. The start power unit (SPU) and start converter unit (SCU) change ac or dc power so it can be used for starting.

APU Bleed Air System

The APU bleed air system supplies pressurized air to the airplane pneumatic system. Inlet guide vanes control the quantity of air that goes to the load compressor. A surge control valve vents unnecessary bleed air overboard through the exhaust. A bleed air valve (BAV) isolates the APU air system from the airplane ducts.

APU Controls

An electronic control unit (ECU) controls the APU functions. The ECU interfaces with other airplane systems.

The ECU monitors APU functions using built in test equipment (BITE) which uses the OMS (Onboard Maintenance System). THE ECU shows unsatisfactory conditions found by BITE and the cause for protective shutdowns on the MDS (Max Display System). The unsatisfactory conditions are called maintenance messages. Some of the maintenance messages and all the protective shutdowns cause one of these lights in the flight compartment to come on:

- Low oil pressure light (amber)
- Fault light (amber)
- Overspeed light (amber)
- APU Door indication (amber)

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**AIRBORNE AUXILIARY POWER - GENERAL DESCRIPTION****APU Indicating System**

The APU indicating system consist of these components:

- Data Memory Module
- ECU (Electronic Control Unit).

The APU indications are found on the P5-4 panel in the flight deck.

APU Exhaust System

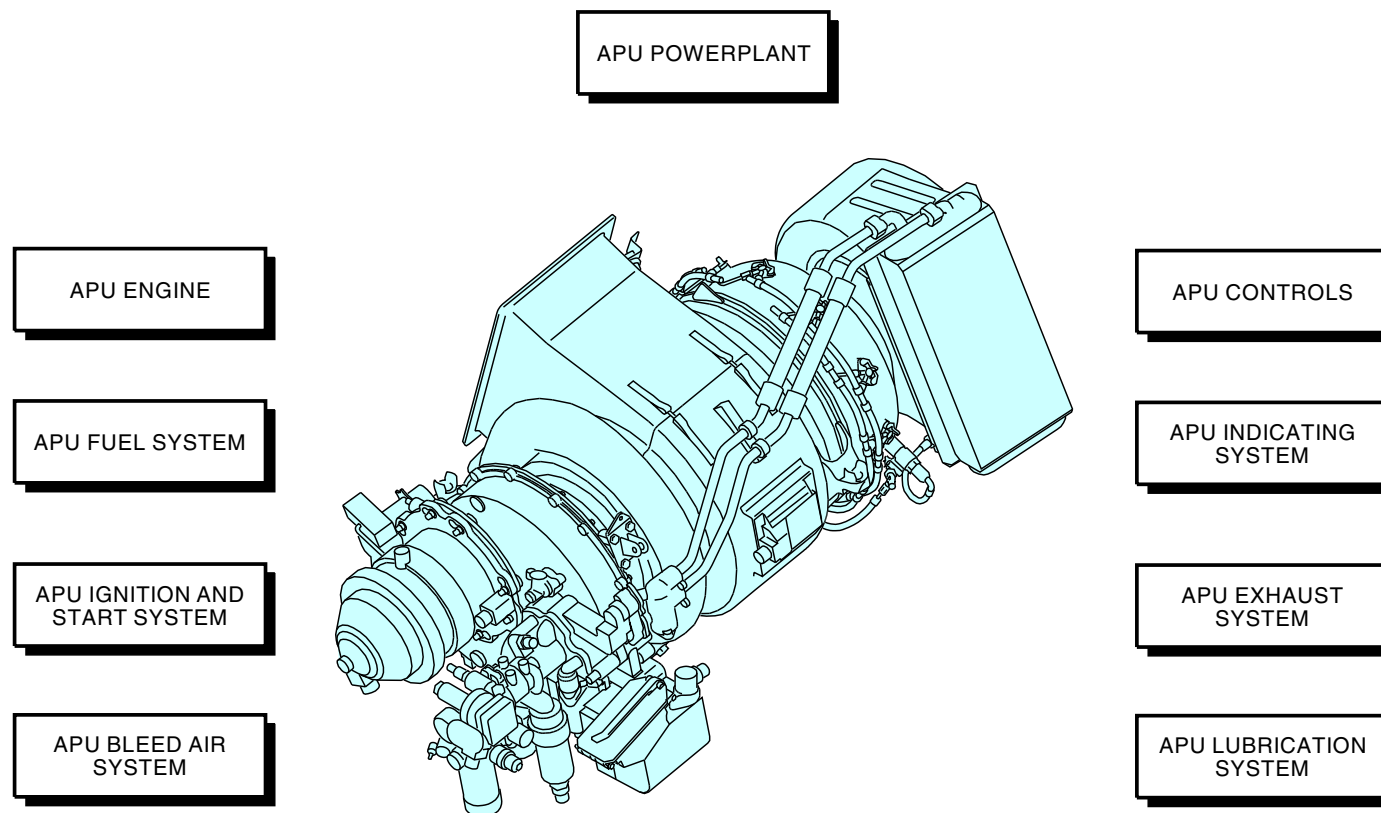
The APU exhaust system sends the APU exhaust gases through the APU exhaust muffler assembly.

APU Lubrication system

The APU lubrication system lubricates and cools the APU bearings, the gearbox, and the starter generator. An eductor moves air through the oil cooler to control oil temperature. It also takes in the ambient air to cool the APU compartment.

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AIRBORNE AUXILIARY POWER - GENERAL DESCRIPTION



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AIRBORNE AUXILIARY POWER - GENERAL DESCRIPTION

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**AIRBORNE AUXILIARY POWER - COMPONENT LOCATION****General**

The APU is in the aft fuselage of the airplane. A firewall isolates the APU compartment from the airplane fuselage and horizontal stabilizer assembly.

Air Inlet

The APU air inlet is on the right side of the aft fuselage. It is forward and below the horizontal stabilizer.

Doors

The APU access door at the bottom of the APU compartment is for servicing and maintenance.

Electronic Control Unit (ECU)

The APU electronic control unit (ECU) is in the aft cargo compartment. It is on the right side of the compartment, aft of the cargo door.

Electronic Equipment Compartment

These APU components are in the EE compartment:

- APU generator control unit (AGCU)
- Start power unit (SPU)
- Start converter unit (SCU).

Right Wheel Well

The APU ground control panel (P28) and fire alarm horn are in the right main wheel well, on the aft bulkhead.

Flight Compartment

These APU components are in the flight compartment:

- APU switch - (APU/engine start panel) (P5)
- APU bleed air switch - (air conditioning panel) (P5)
- APU generator switches - (AC system generator/APU control panel) (P5)

- APU indication lights - (AC system generator/APU control panel) (P5)
- APU light (system annunciator lights) (P7)
- APU fire warning switch (Engine and APU fire protection panel) (P8).

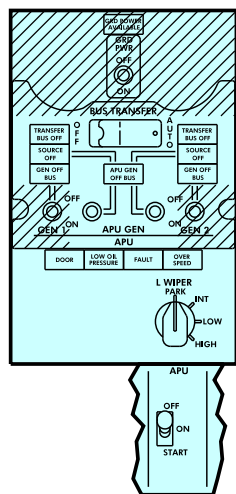
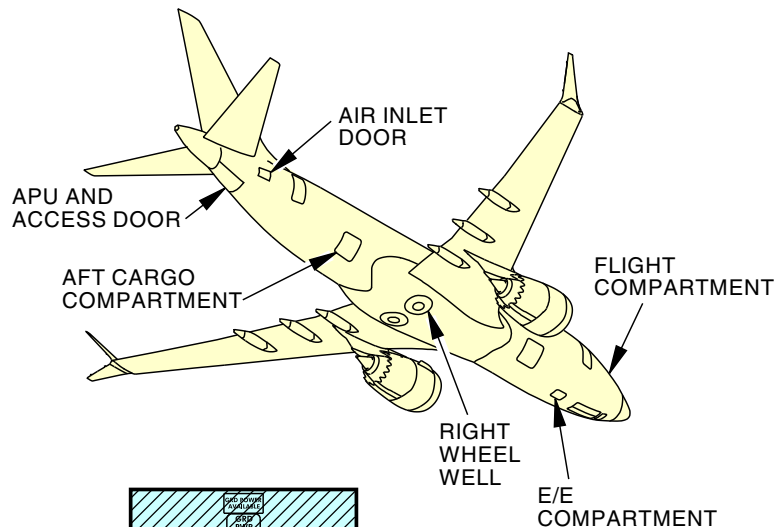
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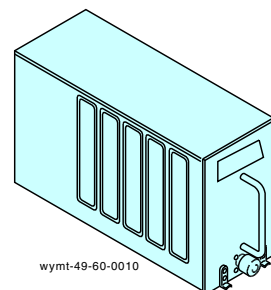
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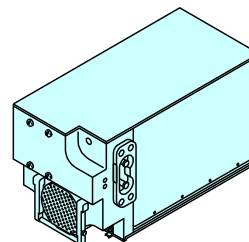
AIRBORNE AUXILIARY POWER - COMPONENT LOCATION



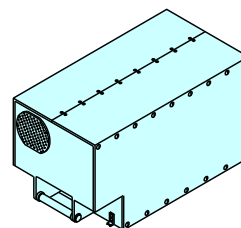
APU CONTROL PANEL (P5)



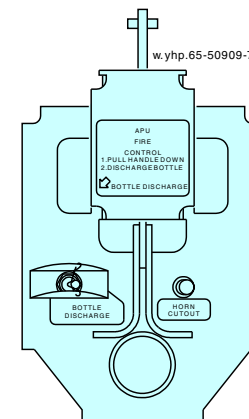
ELECTRONIC CONTROL UNIT (AFT CARGO)



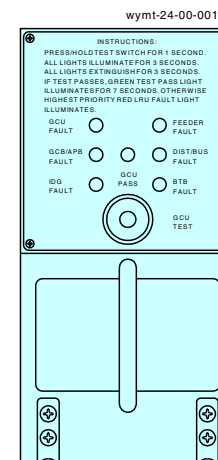
START POWER UNIT (E2-2)



START CONVERTER UNIT (E2-2)



APU GROUND CONTROL PANEL (P28 RIGHT WHEEL WELL)



APU GCU (E3-1)

AIRBORNE AUXILIARY POWER - COMPONENT LOCATION

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**AIRBORNE AUXILIARY POWER - CONTROLS****APU Flight Compartment Controls**

These switches are used to control the APU from the flight compartment:

- APU switch (P5)
- APU fire warning switch (P8)
- Battery switch (P5).

The APU switch starts and stops the APU.

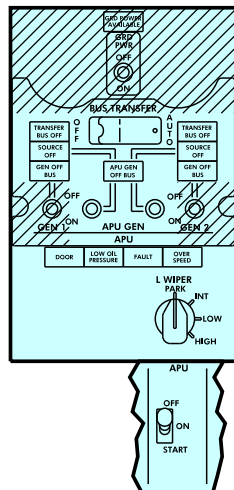
The APU can also be stopped with the APU fire warning switch on the engine and APU fire control module (P8) and the battery switch on the electric meters and galley power panel (P5).

APU Ground Control Panel (P28)

The APU can be stopped from outside the airplane by using the remote fire switch handle (P28) in the right wheel well aft bulkhead.

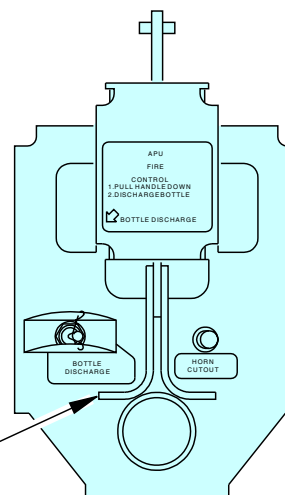
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AIRBORNE AUXILIARY POWER - CONTROLS



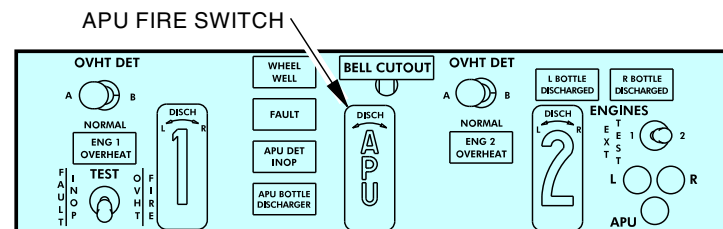
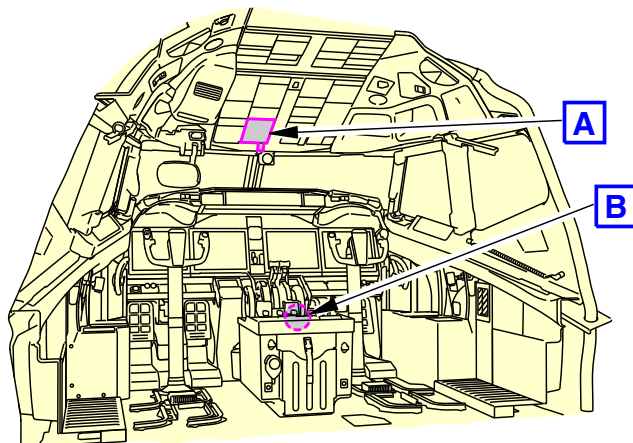
APU CONTROL PANEL (P5)

A



APU REMOTE FIRE SWITCH HANDLE

P28 GROUND CONTROL PANEL (RIGHT WHEEL WELL)



OVERHEAT/FIRE PROTECTION PANEL (P8)

B

AIRBORNE AUXILIARY POWER - CONTROLS

2370402 S00061521614_V1

**AIRBORNE AUXILIARY POWER - OPERATION - START****General**

The APU can be started up to an altitude of 41,000 feet (12,500 meters).

The APU electronic control unit (ECU) controls these components during start:

- APU inlet door
- APU fuel shutoff valve
- APU fuel
- Ignition system
- APU start system.

Prestart

The battery switch must be ON before the APU can be started.

If AC power is available, turn the aft number 1 fuel boost pump on. This gives pressurized fuel to the APU. Pressurized fuel makes the APU start better.

Starting the APU

When the APU switch is moved to the START position and released, the switch moves back to the ON position. This sends a signal to the electronic control unit (ECU). The ECU then opens the APU fuel shut-off valve and the APU air inlet door. The ECU also causes the low oil pressure light to come on. When the air inlet door is fully open, the door switch closes. The door switch sends a door fully open signal to the ECU.

APU Start Sequence

The ECU controls the APU start sequence. This is the start sequence:

- At 0 percent speed and before the start system is energized, the ECU energizes the ignition unit
- At 0 percent speed for start or 7 percent speed for restart, the ECU energizes the starter-generator
- At 7 percent speed, the fuel solenoid valve opens

- At approximately 30 percent speed, the Low oil pressure light (P5) goes out
- At 60 percent speed the ignition unit deenergizes
- At 70 percent speed, the starter-generator deenergizes
- At 95 percent speed, the APU can supply electrical power up to 41,000 feet (12,500 meters). The APU can also supply air up to 17,000 feet (5183 meters)
- The APU accelerates to 100 percent speed.

NOTE: The inlet guide vanes (IGV) close to 20-24 degrees when the APU bleed air valve is closed. This will keep the load compressor cool when it does not have a load.

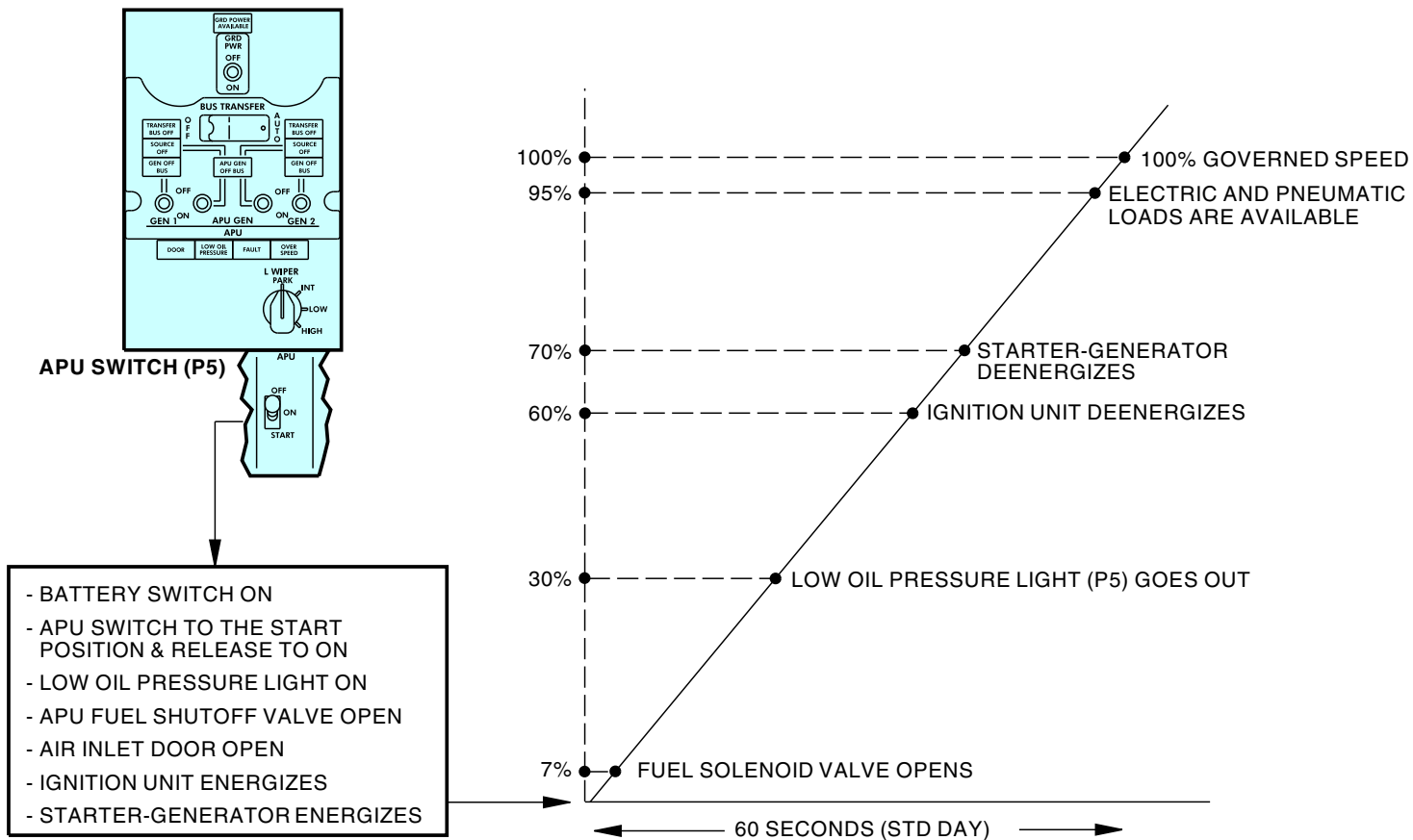
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AIRBORNE AUXILIARY POWER - OPERATION - START



AIRBORNE AUXILIARY POWER - OPERATION - START

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SIA ALL EFFECTIVITY

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ECCN 9E991 BOEING PROPRIETARY - See title page for details

**AIRBORNE AUXILIARY POWER - OPERATION - SHUTDOWN****General**

The ECU controls the APU shutdown. The APU has two types of shutdowns, normal shutdown and protective shutdown.

The APU fuel shutoff valve and air inlet door will close for a normal or protective shutdown. Wait 5 minutes after moving the APU switch to the OFF position for the inlet door and fuel shutoff valve to close before you move the battery switch to the OFF position. Turning the battery switch to the OFF position before the APU door reaches the full closed position will prevent the inlet door from fully closing.

Do not use the battery switch or fire switches to begin a normal APU shutdown. The 60 second cool down is required to prevent coke formation in the turbine bearing and fuel nozzles.

If the inlet door does not close in the required time, the APU DOOR light will come on and stay on until the APU is started again or the battery switch is put in the off position.

See the APU engine controls section for more information on APU faults. (SDS Section 49-60).

APU Switch to OFF

When the APU switch is moved to the OFF position, it removes the 28v dc ON signal to the ECU and gives a 28v dc OFF signal to the ECU.

APU Cool Down

An APU shutdown causes a cool down cycle. The cool down cycle time is 60 seconds. The time starts when the APU switch is put to the OFF position.

The ECU does these steps for a cool down:

- Removes the ready-to-load signal
- Closes the bleed air valve
- Closes the inlet guide vanes (22 degrees)
- Opens the surge control valve
- Deenergizes the starter-generator
- Starts the 60 second timer.

Upon completion of the 60 second timer, the ECU initiates the shutdown.

Completion of the Shutdown

During shutdown of the APU, these steps occur:

- APU completes the cool down cycle
- At 30% speed, the APU fuel valve is commanded to close by the ECU
- At 15% speed, the APU inlet door is commanded to close by the ECU
- At less than 7 percent speed, an APU restart can be initiated.

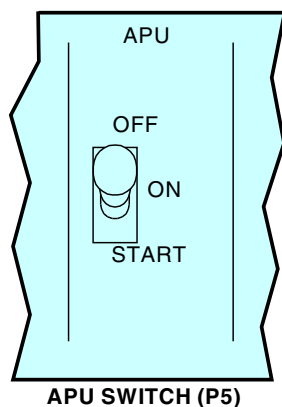
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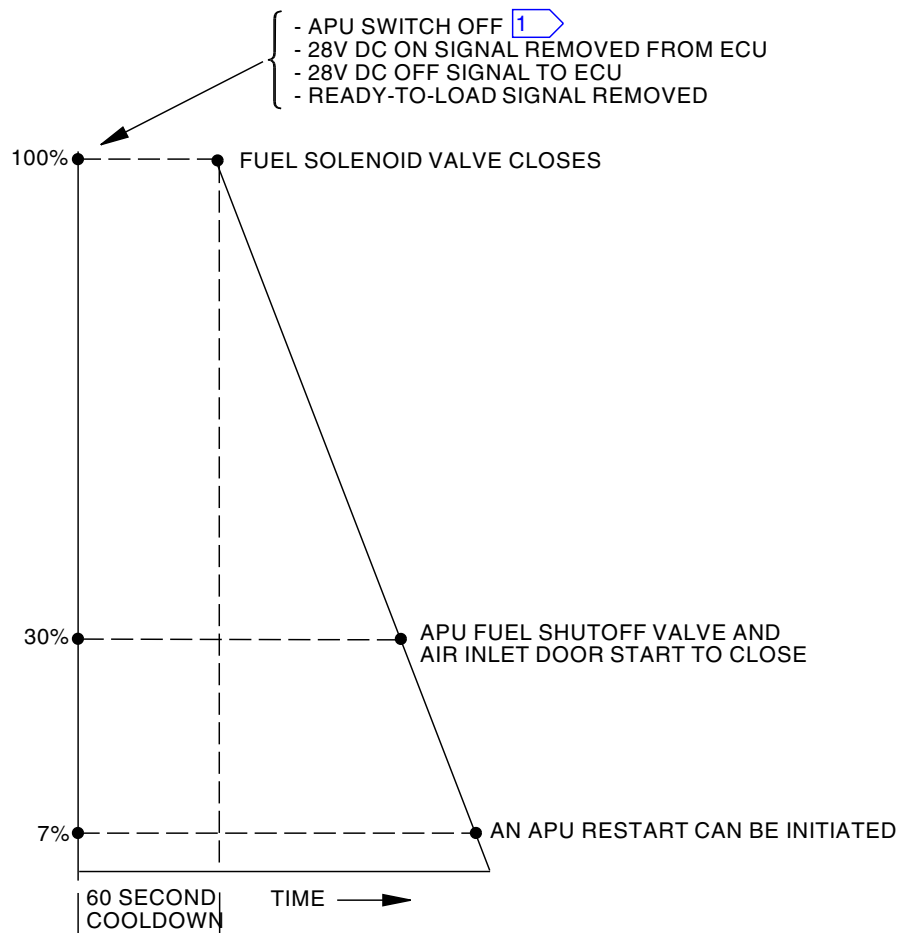
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AIRBORNE AUXILIARY POWER - OPERATION - SHUTDOWN



1 THE APU WILL START THE 60 SECOND COOL DOWN TIME.



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AIRBORNE AUXILIARY POWER - OPERATION - SHUTDOWN

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**AIRBORNE AUXILIARY POWER - PROTECTIVE SHUTDOWN****General**

A protective shutdown prevents damage to the APU or the airplane.

The ECU controls an automatic protective shutdown of the APU. If the ECU finds a fault, it does a protective shutdown.

There are three different protective shutdown indications in the flight deck. These are the flight compartment protective shutdown indications:

- Fault light
- Overspeed light
- Low oil pressure light.

The cause for the shutdown shows on the MDS (Max Display System).

Protective Shutdown

These are the conditions that cause a protective shutdown and a fault light:

- Fuel shutoff valve not in commanded position
- Loss of dc power
- ECU failure
- APU fire
- Inlet door not in command position
- APU inlet overheat
- Loss of both EGT signals
- No speed signal
- No acceleration
- No APU rotation
- No flame
- Generator filter clogged.
- High oil temperature
- Overtemperature
- Reverse flow (load compressor)
- Oil temperature or inlet air temperature sensor failure

- Underspeed.

These are the conditions that cause a protective shutdown and an overspeed light:

- Fuel control unit solenoid failure
- Loss of overspeed protection
- Overspeed.

Low oil pressure for 20 seconds causes a protective shutdown and a Low oil pressure light.

When a protective shutdown occurs, the ECU removes electrical power from these components:

- Fuel solenoid
- Ignitor
- SCU Start signal
- Bleed air valve (BAV)
- Fuel control unit (FCU) signal
- Surge control valve (SCV) signal.

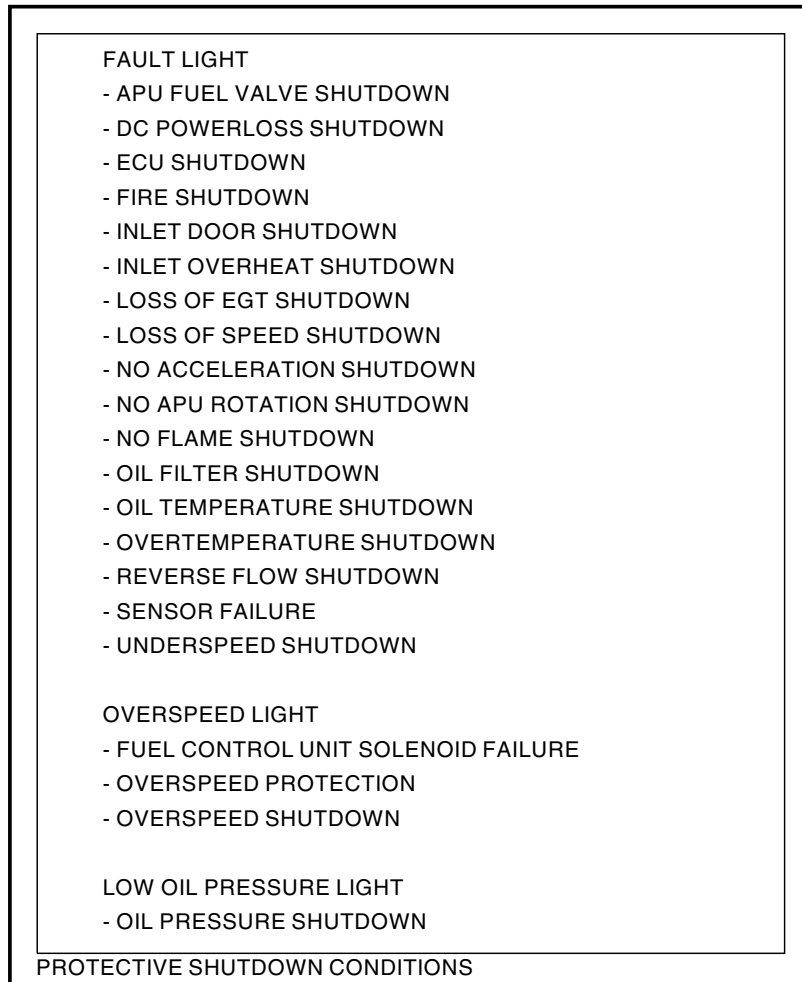
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EFFECTIVITY
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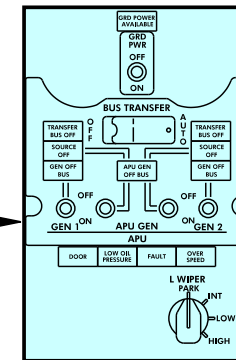
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AIRBORNE AUXILIARY POWER - PROTECTIVE SHUTDOWN



ECU



APU INDICATOR PANEL (P5)

SYS MENU	STATUS	MAINT DATA PGS	MAINT COTRL PGS	ONBD MAINT
APU				
MODE	XXXXXXXXXX	APU GEN LOAD		XXX.X
RPM	XXXXX			
EGT	XXXXX	----- INLET DOOR -----		
OIL TEMP	XXXX	APU GEN LOAD		XXXXXXXXXX
OIL QTY	XXXX	CLOSE COMMAND		XXXXXXXXXX
		POSITION SW		XXXXXXXXXX
COMP INLET TEMP	XXXX	COR EGT		XXXXX
INLET STATIC PRESS	XX.X.X	COR TOTAL PRESS		XXX
LOAD COMP TOTAL PRESS	XX.XX	COR FUEL FLOW		XXX
LOAD COMP DEFF PRESS	XX.XX	COR IGV POS		XXX
		APU HOURS		XXXXXXXX.X
SURGE CTRL VLV POS	XX.X	APU CYCLES		XXXXXX
IGV ACTUATOR POS	XX.X	HOURS SINCE INSTALLATION		
BLD CORRECTED FLOW	XXX	ON AIRPLANE		XXXXXXXX.X
FUEL FLOW	XXX			
----- STATUS CODE -----				
	BIT 1 5			
	STATUS 1 [XXXX] [XXXX]			
	STATUS 2 [XXXX] [XXXX]			
	STATUS 3 [XXXX] [XXXX]			
	STATUS 4 [XXXX] [XXXX]			
AUTO EVENT MESSAGE DATE XX XXX XX UTC XX:XX:XX				
PREV MENU	PRINT	SEND	RECORD	PREV PAGE
				NEXT PAGE

OMS, APU DISPLAY

2370405 S00061521620_V1

AIRBORNE AUXILIARY POWER - PROTECTIVE SHUTDOWN

**AIRBORNE AUXILIARY POWER - INDICATIONS****General**

The APU has four indication lights on the APU indicator panel:

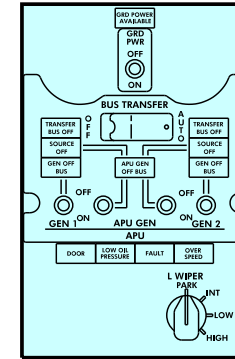
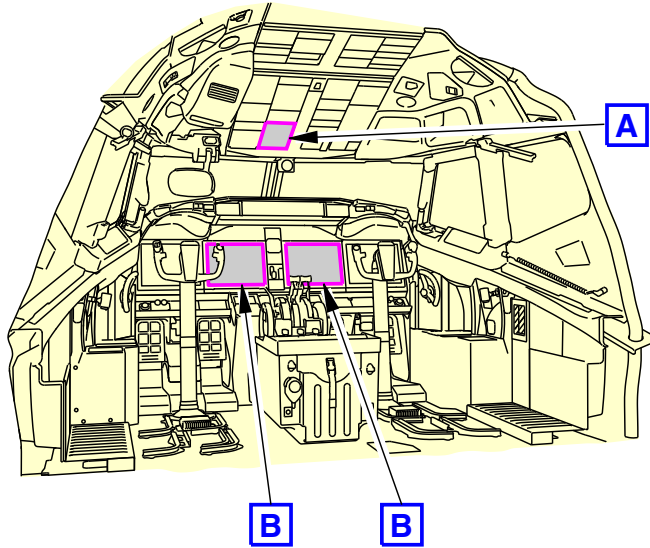
- DOOR - APU door open indication (amber)
- LOW OIL PRESSURE - automatic shutdown (amber)
- FAULT - automatic shutdown (amber)
- OVERSPEED - automatic shutdown (amber).

The MDS (Max Display System) shows this APU system data:

- Current status
- Fault history
- Maintenance history
- Ident/config
- Input monitoring (real time data)
- Oil quantity.

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AIRBORNE AUXILIARY POWER - INDICATIONS



APU INDICATOR PANEL (P5)

SYS MENU	STATUS	MAINT DATA PGS	MAINT COTRL PGS	ONBD MAINT
APU				
MODE	XXXXXXXXXXXX	APU GEN LOAD		XXX.X
RPM	XXXXX			
EGT	XXXXX	----- INLET DOOR -----		
OIL TEMP	XXXX	APU GEN LOAD		XXXXXXXX
OIL QTY	XXXX	CLOSE COMMAND		XXXXXXXX
COMP INLET TEMP	XXXX	POSITION SW		XXXXXXXX
INLET STATIC PRESS	XX.X.X	COR EGT		XXXXX
LOAD COMP TOTAL PRESS	XX.XX	COR TOTAL PRESS		XXX
LOAD COMP DEFF PRESS	XX.XX	COR FUEL FLOW		XXX
SURGE CTRL VLV POS	XX.X	COR IGV POS		XXX
IGV ACTUATOR POS	XX.X	APU HOURS		XXXXXXXX.X
BLD CORRECTED FLOW	XXX	APU CYCLES		XXXXXX
FUEL FLOW	XXX	HOURS SINCE INSTALLATION ON AIRPLANE		XXXXX.X
----- STATUS CODE -----				
	BIT	1	5	
	STATUS 1	[XXXX]	[XXXX]	
	STATUS 2	[XXXX]	[XXXX]	
	STATUS 3	[XXXX]	[XXXX]	
	STATUS 4	[XXXX]	[XXXX]	
AUTO EVENT MESSAGE				
DATE XX XXX XX UTC XX:XX:XX				
PREV MENU	PRINT	SEND	RECORD	PREV PAGE
				NEXT PAGE

MDS, APU DISPLAY

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AIRBORNE AUXILIARY POWER - INDICATIONS

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**AIRBORNE AUXILIARY POWER - APU ACCESS AND SERVICING****APU Access**

Access to the APU compartment is through the APU cowl door on the bottom of the aft fuselage.

Three latches on the left side open the APU cowl door. The APU access door opens to the right on two hinges. Hold open rods keep the door open safely.

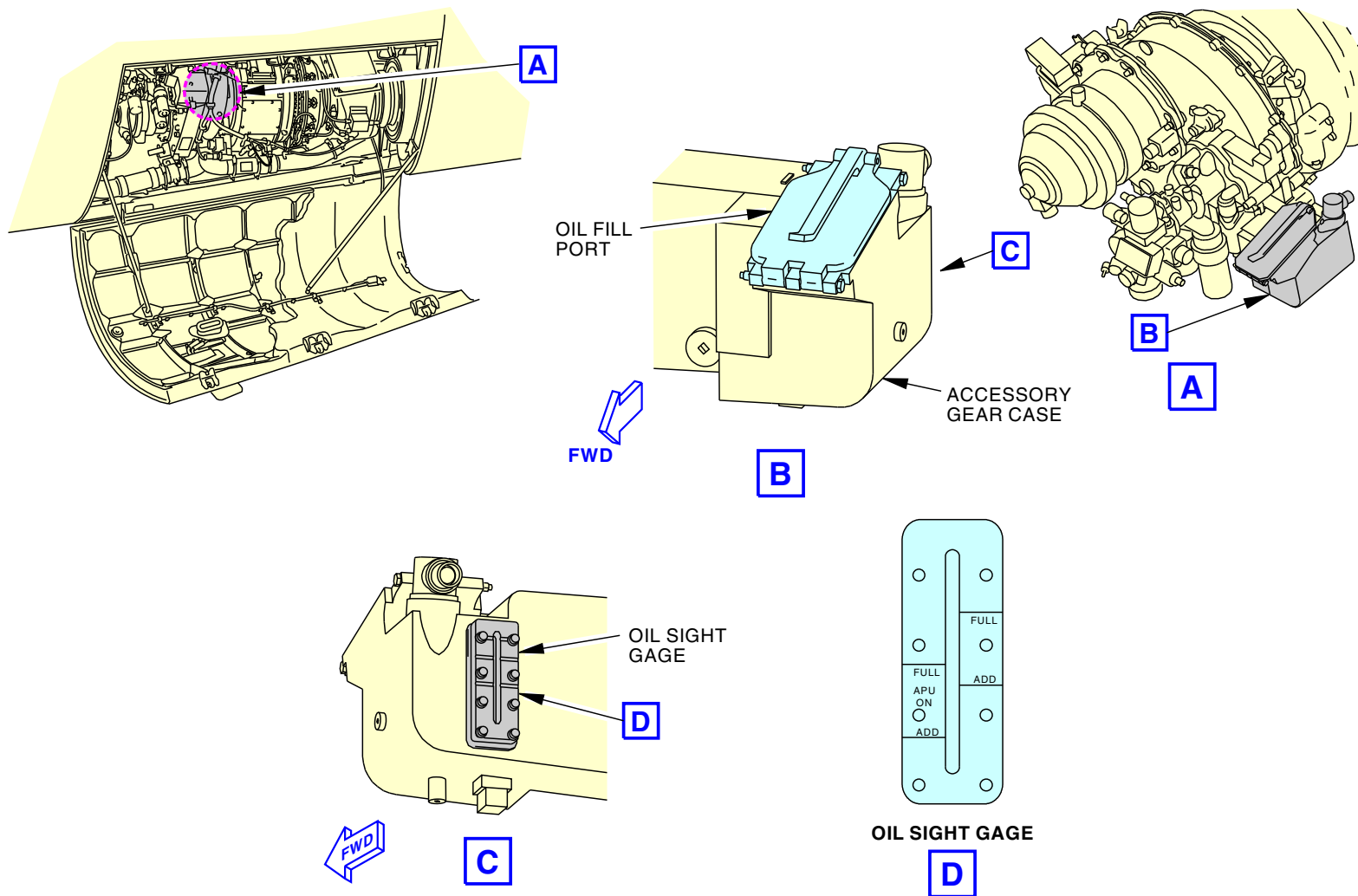
APU Oil Servicing

Oil is added using the APU fill port on the left side of the accessory gear case. There are two FULL and ADD marks on the oil sight gage. The left side of the oil sight gage shows the oil level during APU operation. The right side of the oil sight gage shows the oil level for no APU operation (APU shutdown).

The MDS (Max Display System) shows the APU oil quantity with a FULL, ADD, or LOW indication.

EFFECTIVITY	
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AIRBORNE AUXILIARY POWER - APU ACCESS AND SERVICING



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AIRBORNE AUXILIARY POWER - APU ACCESS AND SERVICING

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AIRBORNE AUXILIARY POWER - INTERFACE

General

The ECU sends and receives data with airplane systems. The data is digital and analog. The ARINC 429 data bus transmits the digital data to the OMF.

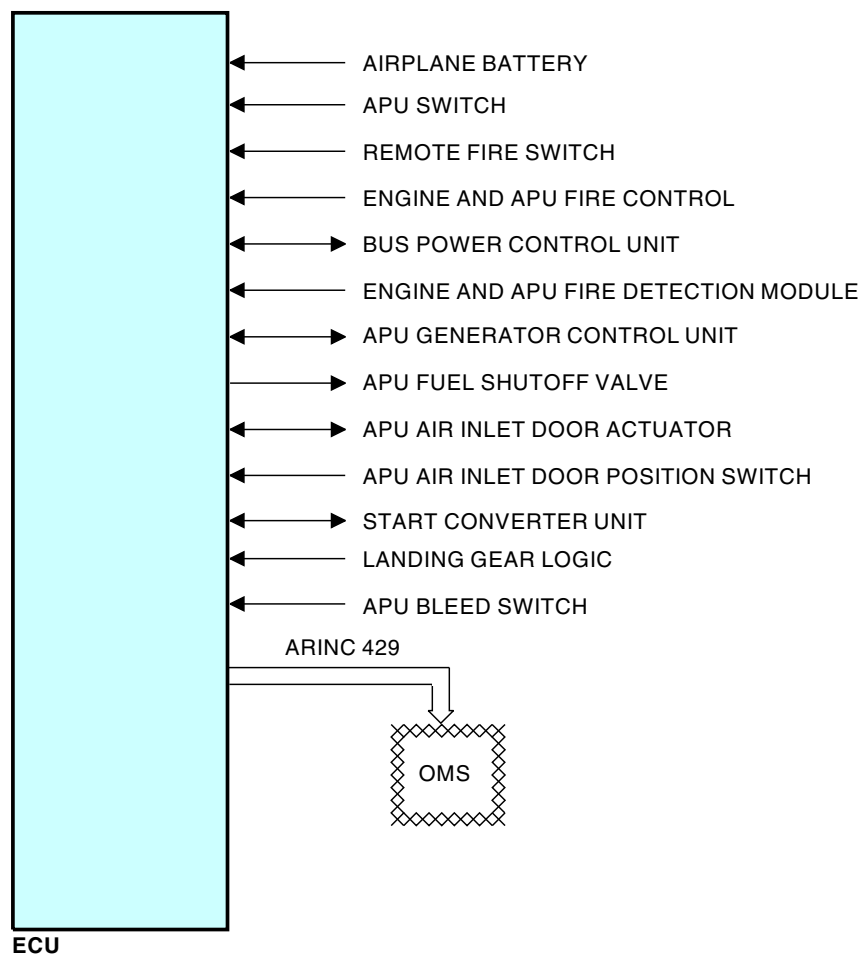
Other interfaces

The ECU also has analog interfaces with these systems and components:

- APU switch
- APU bleed switch
- Remote fire switch
- Engine and APU fire control
- Bus power control unit
- Engine and APU fire detection module
- APU generator control unit
- APU fuel shutoff valve
- APU air inlet door actuator
- Air inlet door position switch
- Start converter unit
- Landing gear logic
- Airplane battery
- Air conditioning system (ACS) flow control valves
- Main engine start switches 1 and 2.

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AIRBORNE AUXILIARY POWER - INTERFACE



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AIRBORNE AUXILIARY POWER - INTERFACE

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SIA ALL EFFECTIVITY

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**AIRBORNE AUXILIARY POWER - APU COOLING****General**

The APU cooling air system cools the APU compartment and the APU engine oil.

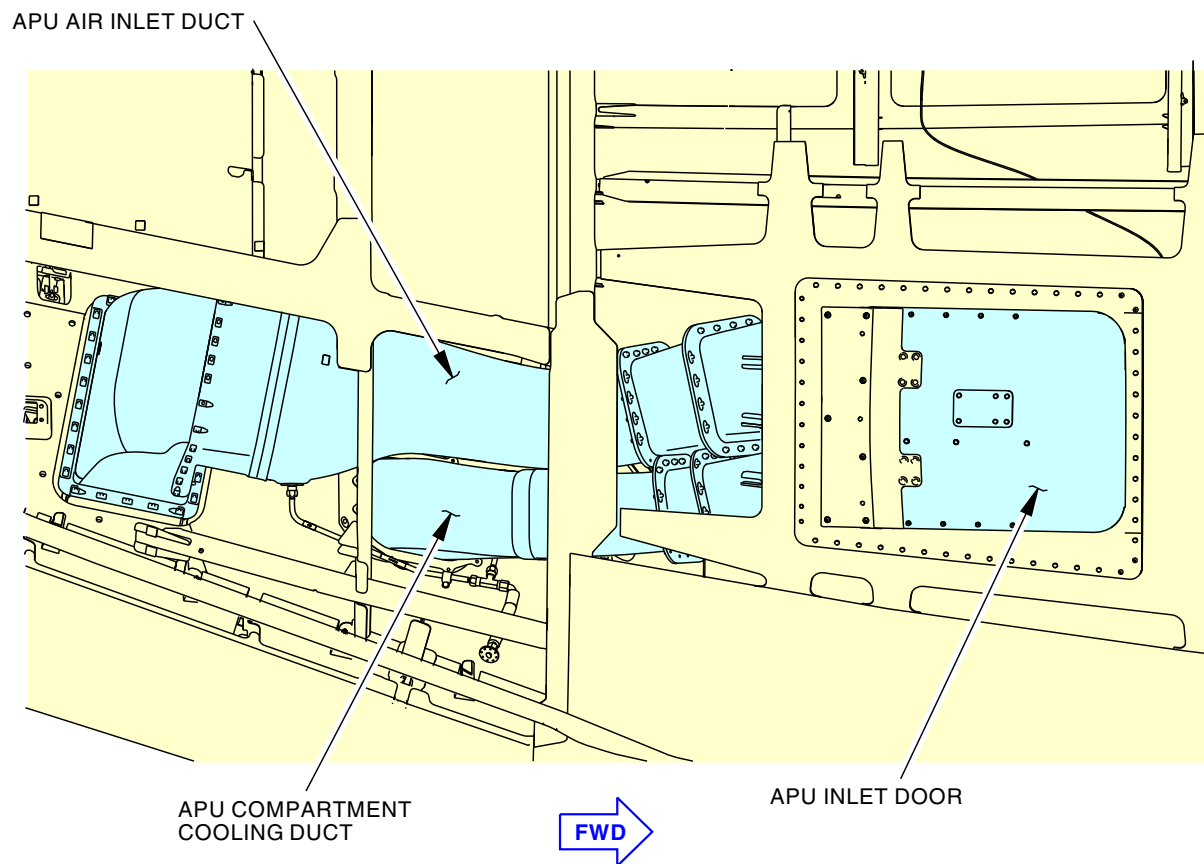
Compartment Cooling

The cooling air eductor inlet is integrated with the APU air inlet. The cooling air duct (eductor duct) is located below the air inlet duct. The eductor inlet can be closed completely. The cooling air goes through the oil cooler and out the APU exhaust duct.

See the APU oil section for more information on the oil cooler.
(SECTION 49-90)

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AIRBORNE AUXILIARY POWER - APU COOLING



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AIRBORNE AUXILIARY POWER - APU COOLING

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APU POWER PLANT - INTRODUCTION

Purpose

The APU power plant supplies electrical and pneumatic power to the airplane systems. This permits the airplane systems to operate without engine or ground power when necessary.

General

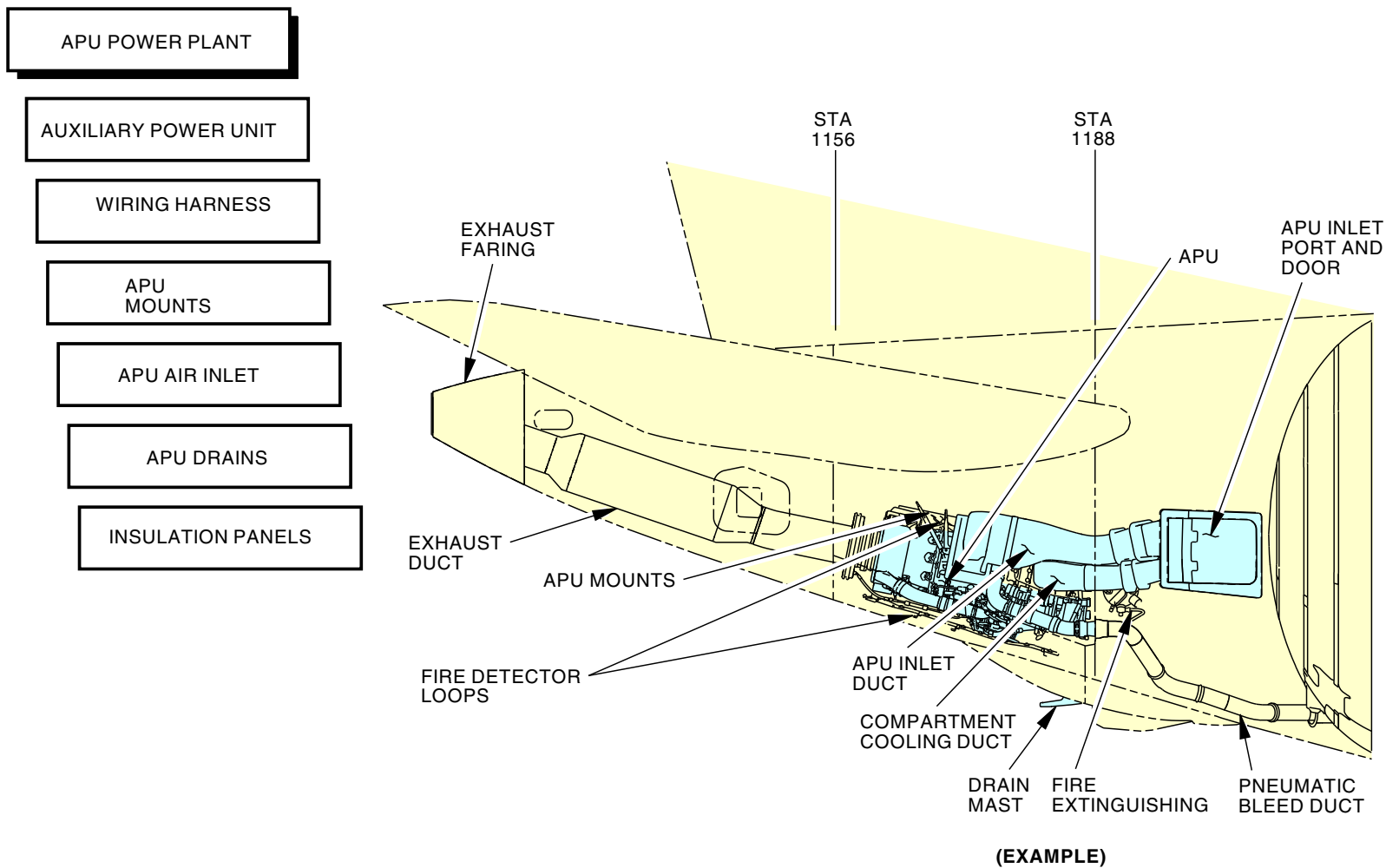
These are the APU power plant systems and components:

- Auxiliary Power Unit
- APU wire harness
- APU mounts
- APU air inlet
- APU drains
- Insulation panels.

See the APU engine section for more information. (SECTION 49-20)

EFFECTIVITY	
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APU POWER PLANT - INTRODUCTION



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APU POWER PLANT - INTRODUCTION

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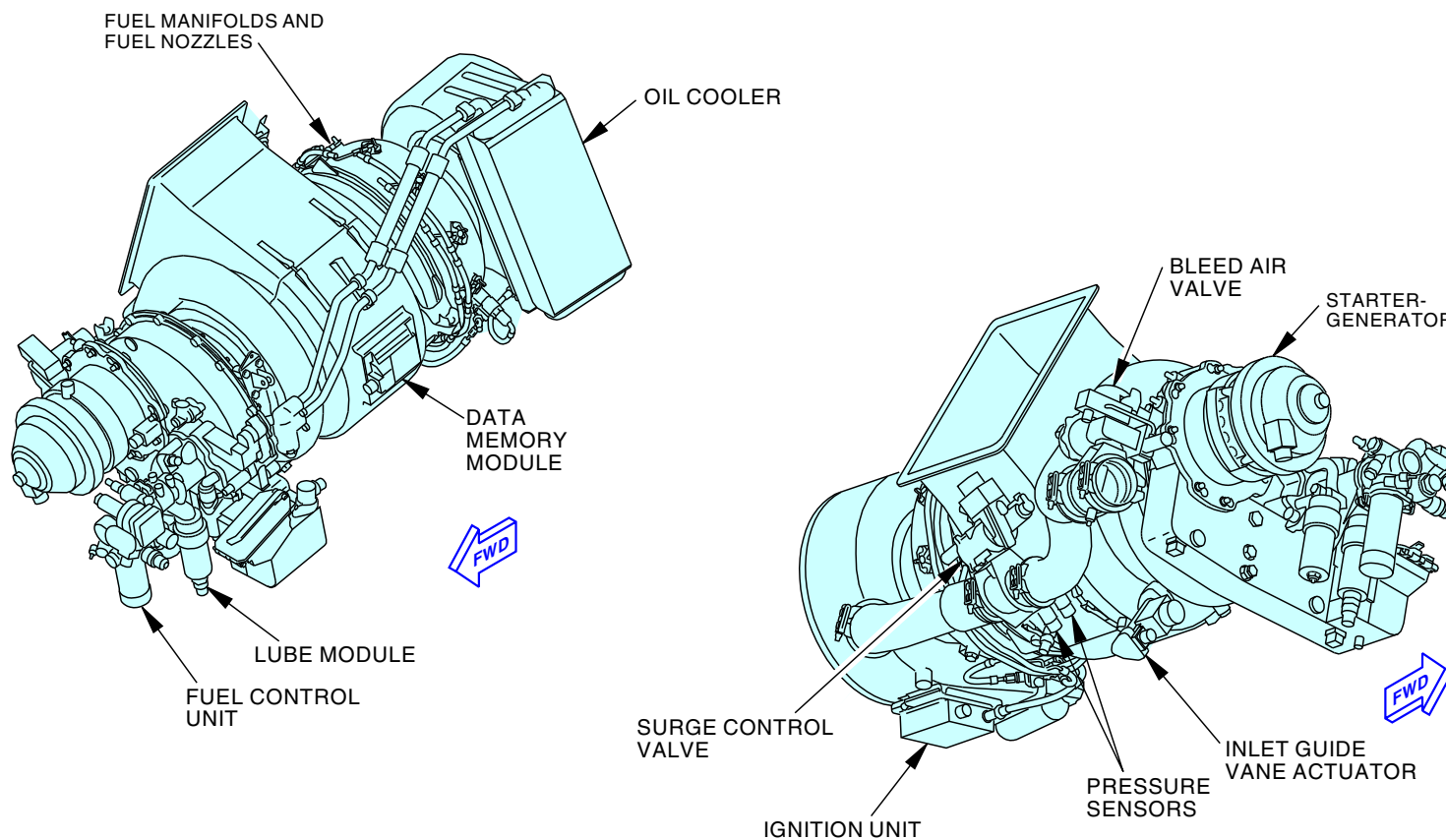
APU POWER PLANT - AUXILIARY POWER UNIT - INTRODUCTION

General

These are the major components for the auxiliary power unit:

- Fuel manifolds
- Fuel nozzles
- Oil cooler
- Starter-generator
- Bleed air valve (BAV)
- Inlet guide vane actuator (IGVA)
- Pressure sensors
- Ignition unit
- Surge control valve (SCV)
- Data memory module (DMM)
- Lube module
- Fuel control unit (FCU)
- APU engine.

APU POWER PLANT - AUXILIARY POWER UNIT - INTRODUCTION



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APU POWER PLANT - AUXILIARY POWER UNIT - INTRODUCTION

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EFFECTIVITY

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**APU POWER PLANT - WIRING HARNESS****Purpose**

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

Location

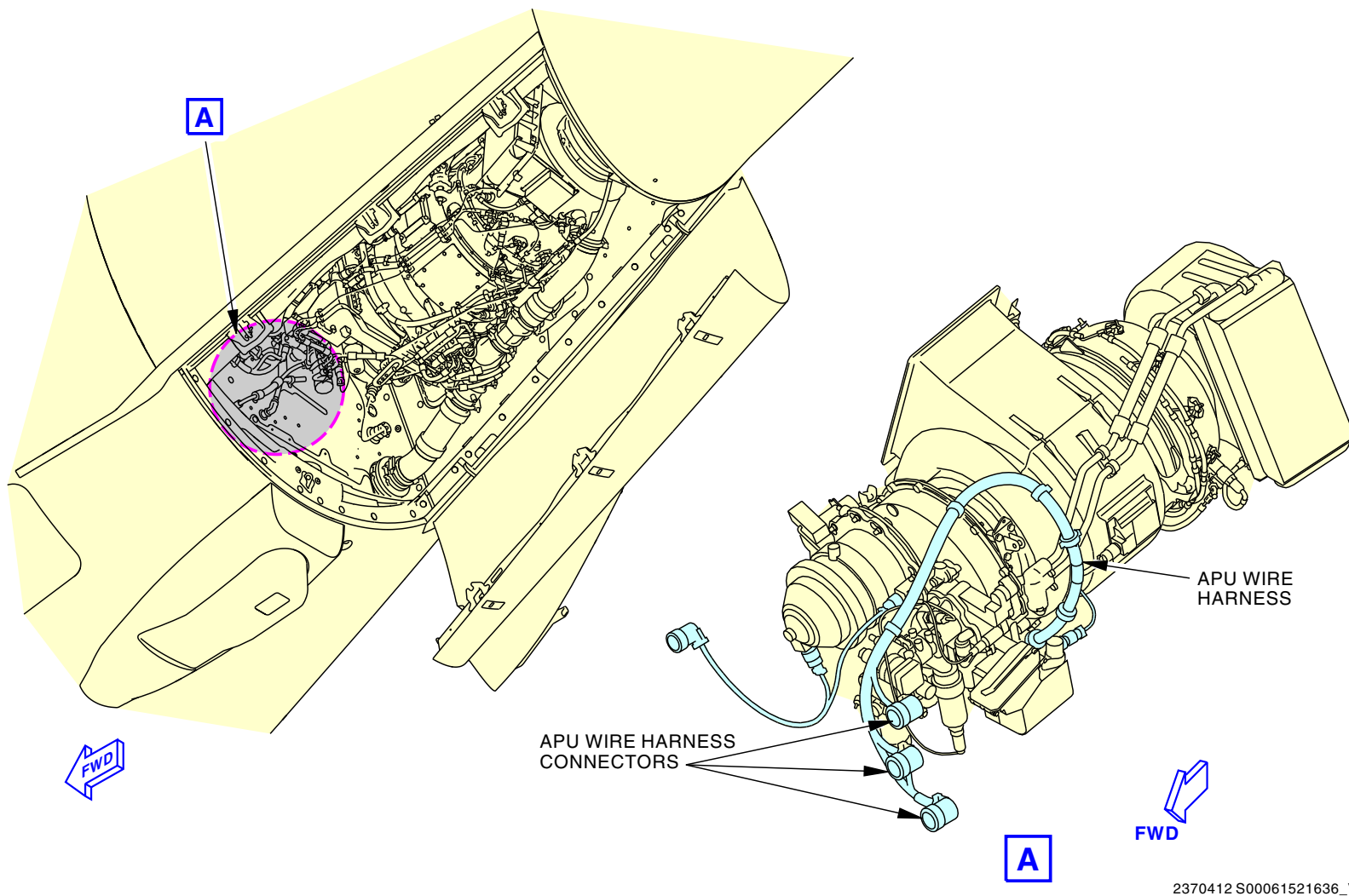
The APU wiring harness goes from the firewall connector to the front of the APU. From the front of the APU it goes in different directions to connect all electrical components.

Physical Description

The wires have shields with twisted pair conductors to keep electromagnetic interference to a minimum. The harness connectors are stainless steel and have a self-lock connection. The harness connectors have an index to prevent improper connections.

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APU POWER PLANT - WIRING HARNESS



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APU POWER PLANT - WIRING HARNESS

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**APU POWER PLANT - APU MOUNTS****Purpose**

Three primary APU engine mounts hold the APU in its compartment. The mounts isolate the airplane structure from APU vibration. The primary APU engine mounts use a cone bolt type interface.

The forward left mount is a redundant vertical strut. This mount is not vibration isolated. The forward right side strut is also redundant. If there is a mount failure, these redundant struts, with the remaining primary mounts, hold the APU.

Location

The two forward mounts attach to a single crossbeam. The crossbeam attaches to the upper structure of the APU compartment.

The two aft mounts attach to a double crossbeam. These crossbeams attach to the upper structure of the APU compartment.

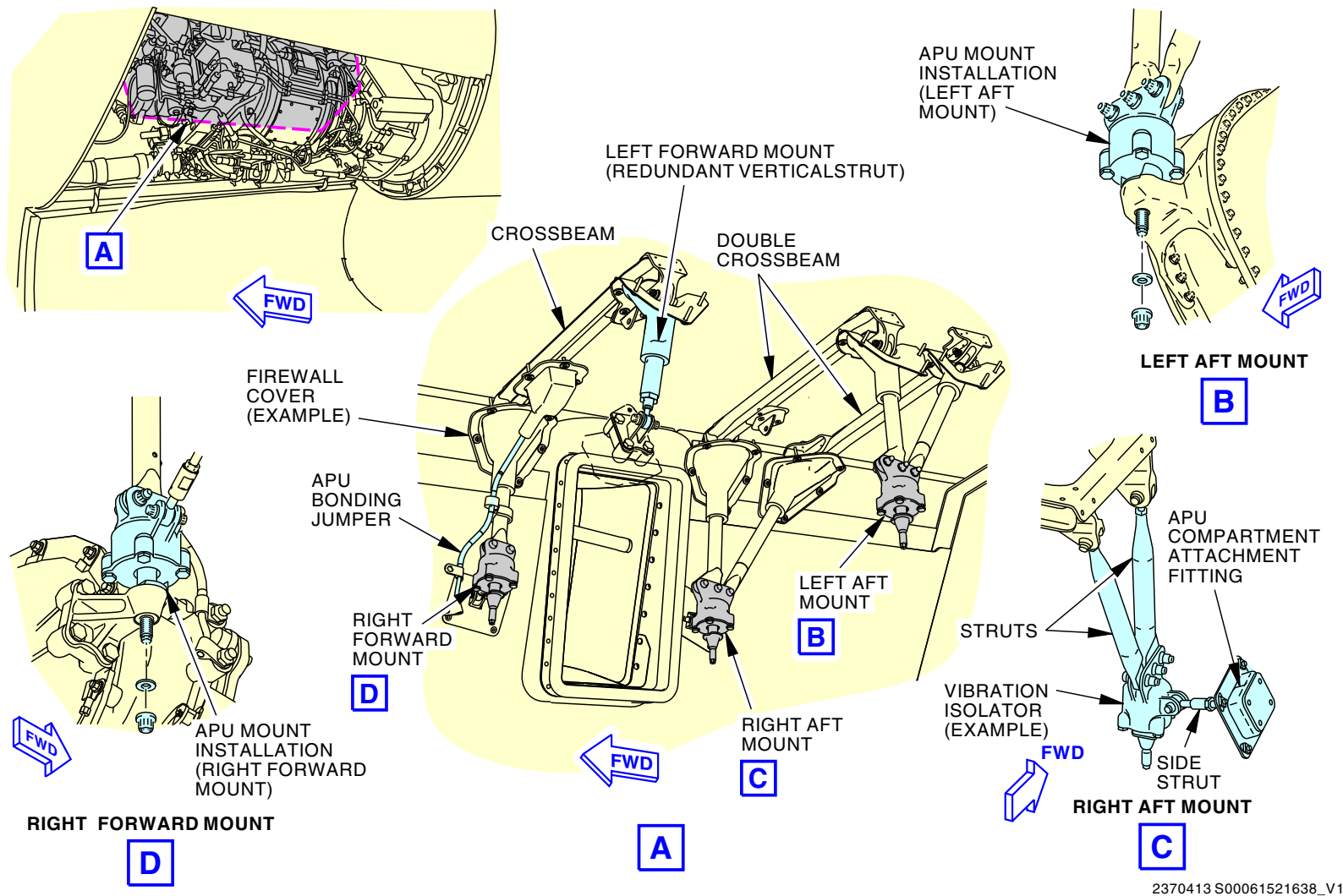
The right forward and right aft mounts attach to the side wall of the APU compartment.

Physical Information

All of the vertical primary mount struts are adjustable at the top. However, adjustments to the primary mount struts are not required unless a strut is repaired or replaced. The redundant vertical strut (forward left) and the redundant side strut (forward right) may require adjustment during APU replacement. To gain access to the upper jam nut on the mount strut it is necessary to remove the firewall cover. Care must be taken not to damage the firewall cover.

EFFECTIVITY	
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APU POWER PLANT - APU MOUNTS



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APU POWER PLANT - APU MOUNTS

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**APU POWER PLANT - APU AIR INLET - INTRODUCTION****Purpose**

The APU air inlet supplies air through two ducts, the APU air inlet duct and the APU eductor inlet duct (cooling air duct).

Location

These are the air inlet components on the lower right side of the tail section:

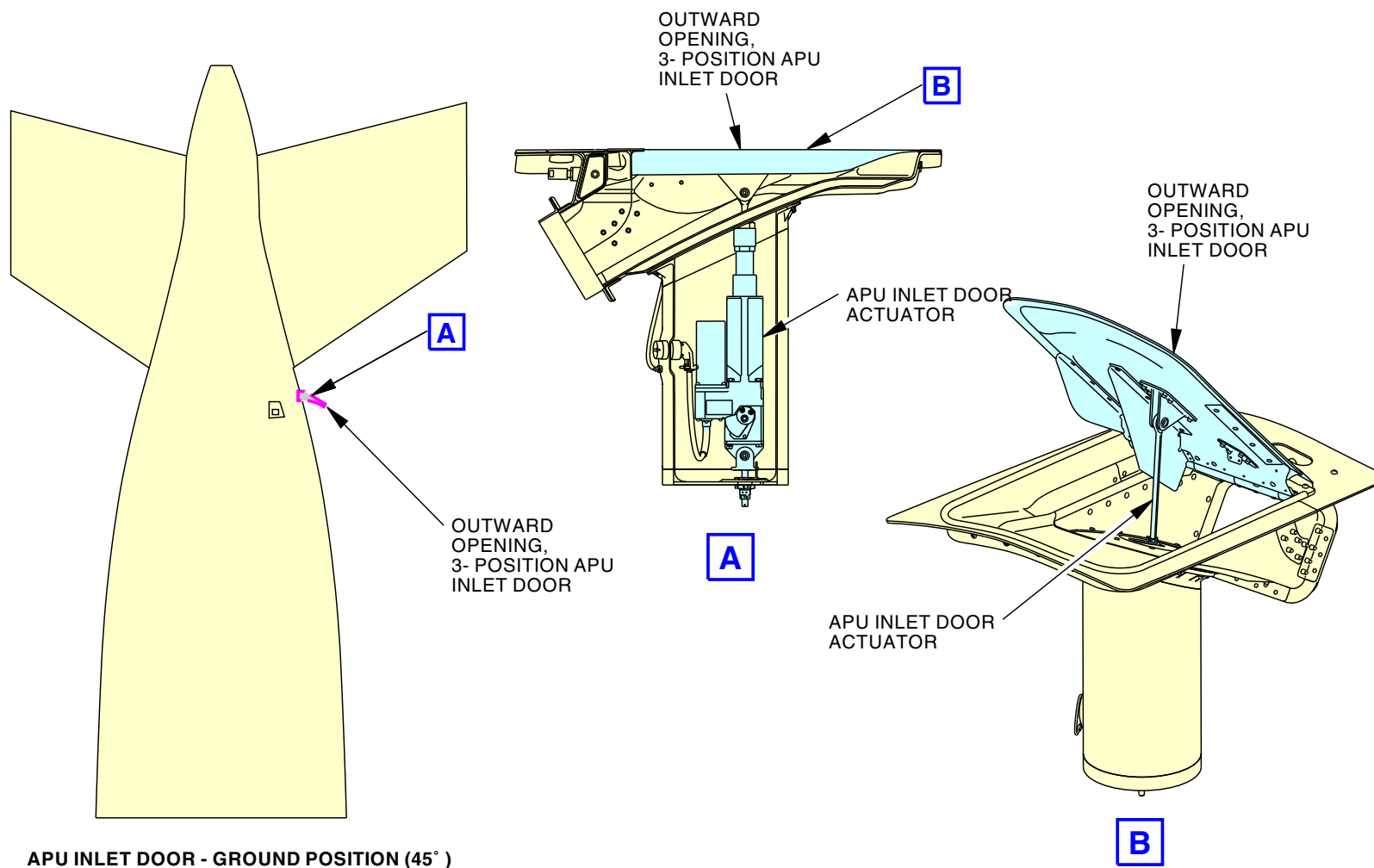
- Inlet door housing
- Air inlet door, three-position (closed/off, ground and flight), forward facing - outward opening inlet door
- Air inlet door actuator and actuator rod
- Air inlet door switch
- Split bifurcated diffuser ducts (air inlet duct and eductor inlet duct)

Interface

The APU switch and the APU electronic control unit (ECU) control the air inlet door operation. The inlet door will close completely when the APU is not operating.

SIA ALL	EFFECTIVITY
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APU POWER PLANT - APU AIR INLET - INTRODUCTION



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APU POWER PLANT - APU AIR INLET - INTRODUCTION

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**APU POWER PLANT - APU AIR INLET FUNCTIONAL DESCRIPTION****General**

The APU air inlet door opens for APU operations. It is in the closed position when the APU is not in operation. The ECU and APU switch control the APU air inlet door.

APU Start

When the APU switch is moved to the ON or START position, this sequence occurs:

- ECU sends an open signal to the fuel shutoff valve
- When the fuel shutoff valve opens, the fuel shutoff valve open limit switch changes position
- Open signal goes to the ECU
- ECU sends the open signal to the air inlet door actuator
- Air inlet door actuator opens the air inlet door
- When the air inlet door is fully open, the air inlet door switch sends a signal to the ECU.

Normal Operation

During normal operation, the air inlet door and fuel shutoff valve stay open until they get a signal to go to the closed position.

APU Shutdown

When the APU switch is moved to the OFF position, it causes these conditions:

- APU shuts down
- APU fuel shutoff valve closes
- APU air inlet door closes.

These signals shutdown the APU and close the air inlet door and the fuel shutoff valve:

- APU switch to the OFF position (P5)
- APU fire switch in close position (P8)

- APU remote fire switch in close position (P28)
- Engine/APU fire detection module detects a fire
- Automatic protective shutdown (ECU logic).

APU Air Inlet Door Positions

These are the three positions of the APU air inlet door:

- Closed/off is when APU is not in operation
- Flight open position is when APU inlet door is open for in-flight operation (approximately 17 degrees)
- Ground open position is when the APU inlet door is open for ground operation (approximately 45 degrees).

EFFECTIVITY	
SIA ALL	



The diagram illustrates the electrical system for the P6 Circuit Breaker Panel, which controls the APU and engine fire detection module, and interfaces with the ECU (AFT CARGO) and various actuators.

P6 Circuit Breaker Panel Components:

- 28V DC SW HOT BAT BUS:** Connected to the APU CONT switch.
- 28V DC BATTERY BUS:** Connected to the APU FIRE SW switch.
- 28V DC HOT BATTERY BUS:** Connected to the FUEL S/O VALVE BATTERY.
- FUEL S/O VALVE BATTERY:** Connected to the FUEL SHUTOFF VALVE BATTERY (P6).
- SENSING LINE:** Connected to the FUEL SHUTOFF VALVE BATTERY (P6).
- FUEL SHUTOFF VALVE BATTERY (P6):** Connected to the FUEL SHUTOFF VALVE (STA 727).

ECU (AFT CARGO) Components:

- ECU LOGIC OFF ON:** Controls the APU FUEL SHUTOFF VALVE (STA 727) and the AIR INLET DOOR ACTUATOR (STA 1055).
- ECU LOGIC:** Receives signals from the APU FIRE SWITCH (P8), REMOTE FIRE SWITCH (P28), and ENGINE/APU FIRE DETECTION MODULE (E2-2).

Other Components:

- APU SWITCH (P5):** Controls the APU.
- APU FIRE SWITCH (P8):** Controls the APU FIRE.
- REMOTE FIRE SWITCH (P28):** Controls the REMOTE FIRE.
- ENGINE/APU FIRE DETECTION MODULE (E2-2):** Controls the FIRE.
- APU FUEL SHUTOFF VALVE (STA 727):** Controls the APU FUEL SHUTOFF VALVE.
- AIR INLET DOOR ACTUATOR (STA 1055):** Controls the AIR INLET DOOR.
- DOOR OPEN SWITCH (STA 1055):** Controls the DOOR OPEN SWITCH.

APU POWER PLANT - APU AIR INLET FUNCTIONAL DESCRIPTION

**APU POWER PLANT - APU DRAINS****Purpose**

The APU engine drain system drains flammable fluid overboard through a drain mast.

The APU compartment drain system drains flammable and nonflammable fluids overboard through a drain hole on the APU cowl door.

APU Engine Drain System

These drains come together at the forward drain collector tube:

- Fuel control unit (FCU) seal
- Surge control valve (SCV) seal
- Inlet guide vane actuator (IGVA) seal.

The APU load compressor seal connects to the middle drain collector tube.

These drains come together at the aft drain collector tube:

- Combustor case
- Eductor
- Muffler.

The drain collector contacts the drain cup when the APU cowl door is closed.

Compartment Drain System

The compartment drain system collects external APU engine leakage and fluids that enter the APU compartment through the eductor inlet. This fluid drains through the APU cowl door. The drain extends past the cowl door to keep fluid off the airplane skin.

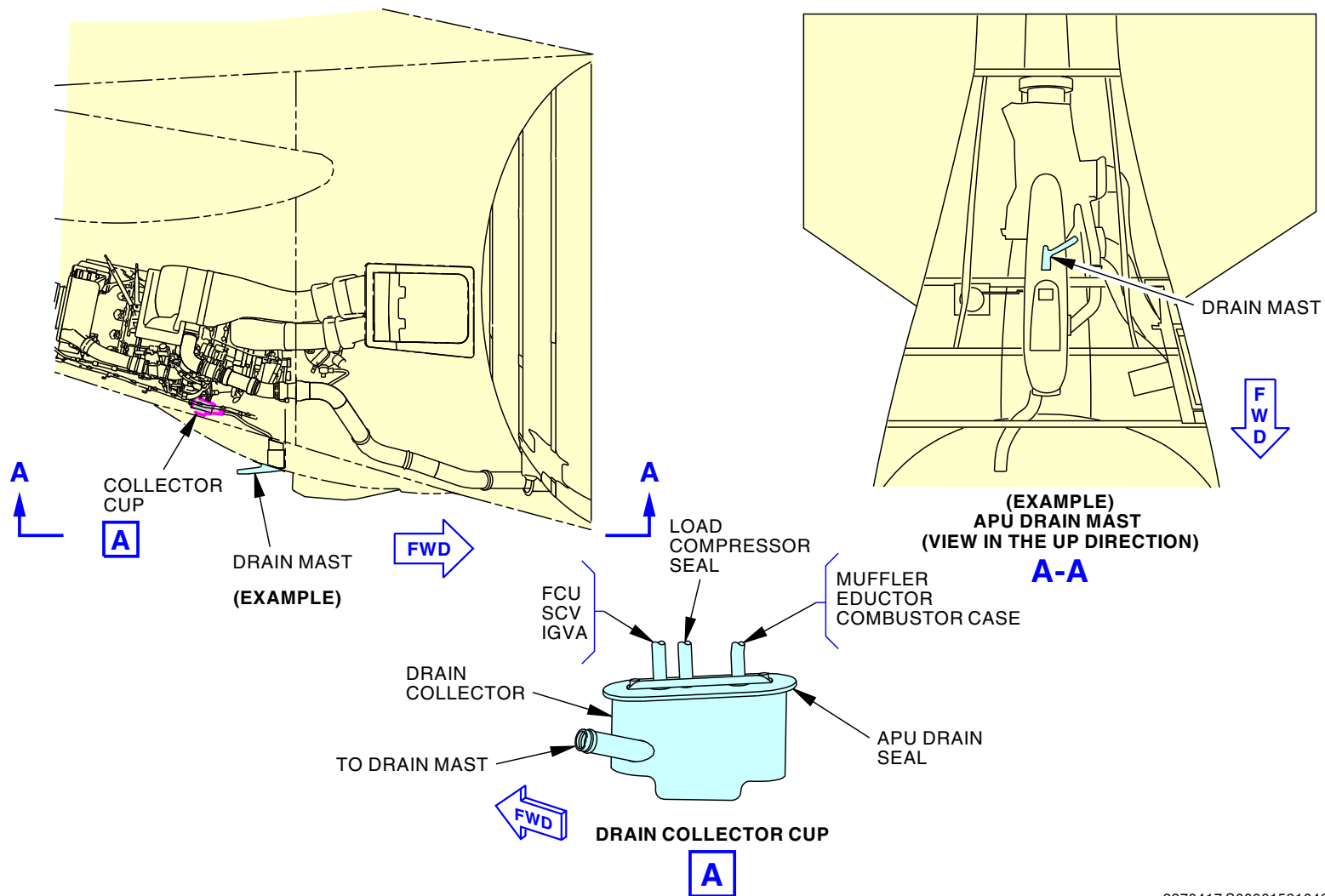
Physical Description

Fluid drainage from the drain mast must be investigated to determine the source of the leak. Fuel or oil leakage from the FCU, SCV, or IGVA is an indication of an APU failure.

Fluid leakage from the door drains through the door drain. The door drain connects to the drain mast. Oil or fuel leakage from the compartment drain indicates a loose connection on the APU which needs to be corrected. Water leakage from the drain mast is usual.

EFFECTIVITY	
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APU POWER PLANT - APU DRAINS



APU POWER PLANT - APU DRAINS - INTRODUCTION

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**APU POWER PLANT - APU INSULATION PANELS****Purpose**

The APU insulation panels provide thermal and fire insulation between the APU and APU compartment structure.

Physical Description

There are seven different insulation panels. Each panel fits in a particular area of the APU compartment.

The insulation panels in the APU compartment are installed in a specified order because of the insulation panel overlaps. The APU cowl door insulation panel is installed independently.

The panels are made of stainless steel face sheets with insulation between the face sheets. The APU insulation panels are not easily damaged, however, if the panels are punctured, the damage should be repaired as soon as possible.

Location

The insulation panels are around the inside of the APU compartment. The name of the panel is also the location of the panel in the compartment.

These are the seven insulation panels:

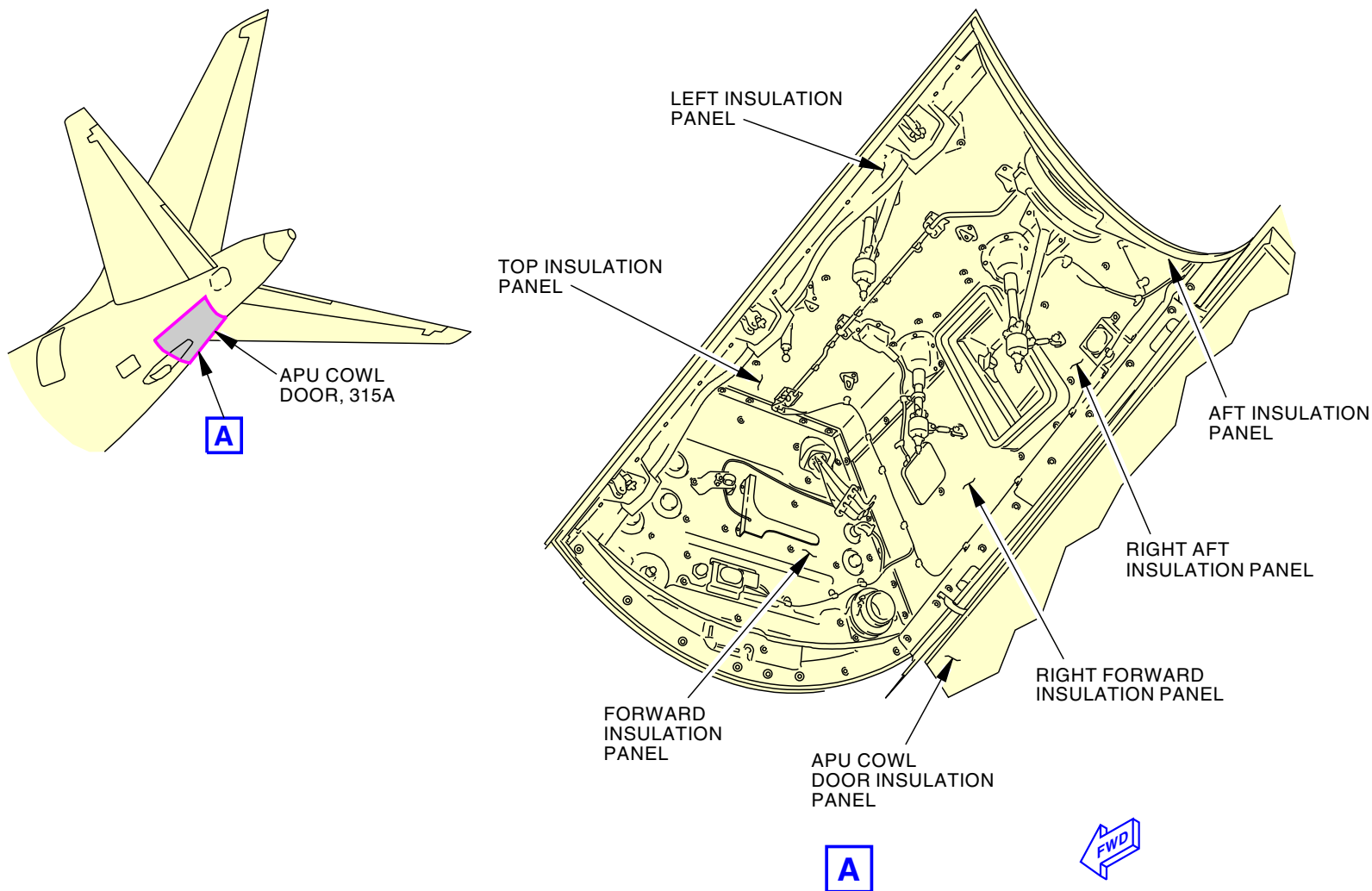
- Forward
- Forward right
- Aft right
- Aft
- Left
- Top
- Door.

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APU POWER PLANT - APU INSULATION PANELS



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APU POWER PLANT - APU INSULATION PANELS

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**APU POWER PLANT - INSTALLATION****General**

The auxiliary power unit is removed or installed from the airplane by one of these two methods:

- Fishpole hoist
- Hydraulic jack.

The fishpole hoist method uses two fishpole hoists and APU hoist equipment to lift and lower the APU. The APU hoist equipment has three parts:

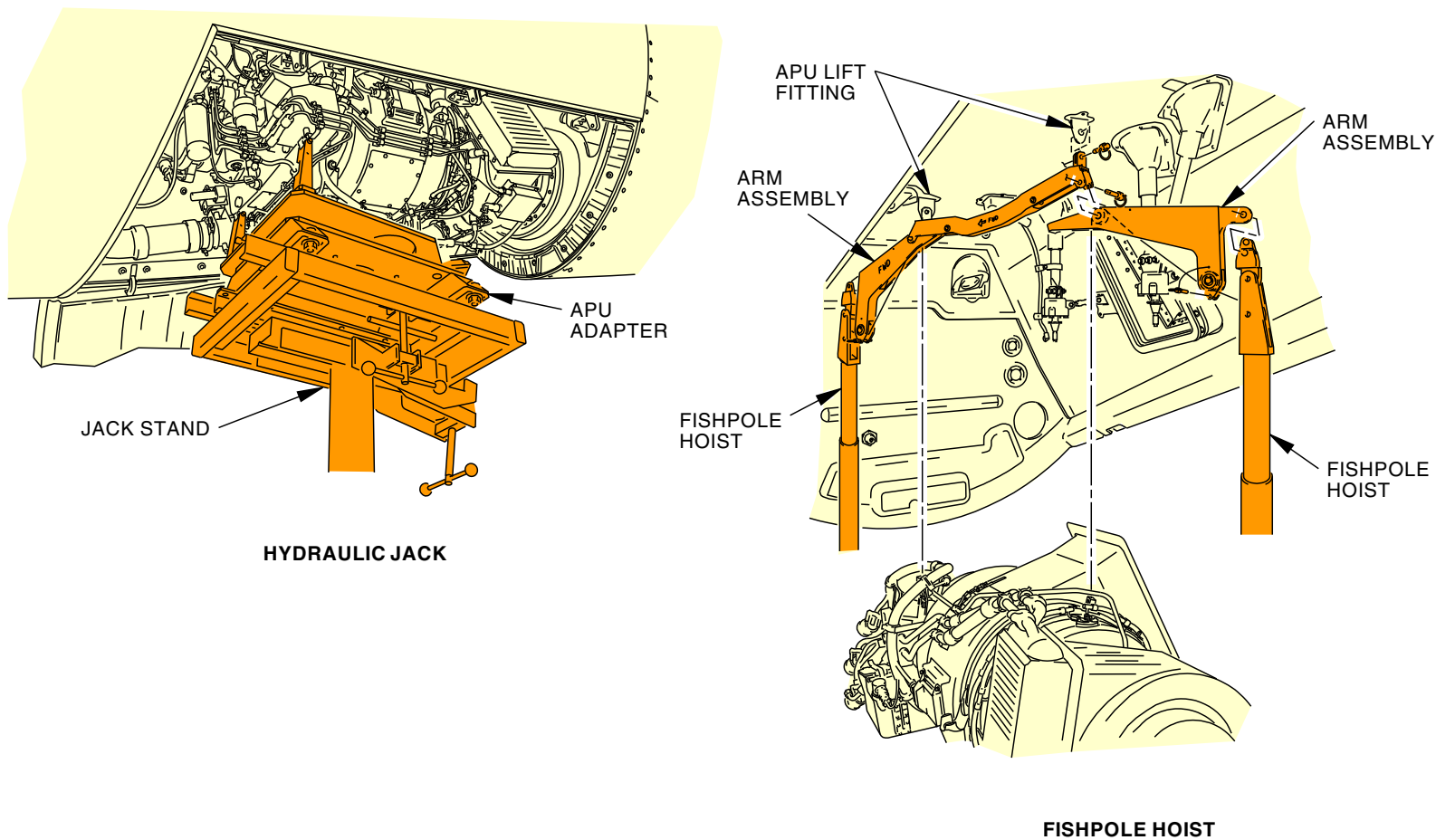
- Forward arm assembly
- Center beam assembly
- Aft arm assembly.

The APU hoist equipment attaches to the two APU lift fittings in the APU compartment. The two fishpole hoists attach to the APU hoist equipment and the APU. The two fishpole hoists are used to move the APU up and down in the APU compartment.

The hydraulic jack method uses a hydraulic jack assembly, an adapter, and a maintenance stand to lift and lower the APU. The adapter attaches to the hydraulic jack assembly. The maintenance stand is used to lift the APU, adapter and hydraulic jack assembly to the APU compartment. The hydraulic jack assembly then moves the APU up and down in the APU compartment.

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APU POWER PLANT - INSTALLATION



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APU POWER PLANT - INSTALLATION

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APU POWER PLANT - PRESERVATION

General

The factors that control the APU preservation and storage are:

- Where the aircraft or vehicle will be parked or stored.
- How long the aircraft or vehicle will be parked or stored.
- If the APU can be periodically motored.
- If the APU can be periodically operated.
- If the aircraft or vehicle fuel system have been preserved.

A mild environment is where the ambient temperature is between 30°F (-1°C) to 125°F (52°C), the humidity is below 40%, and there is no salt air present. A severe environment is where the ambient temperature is not between 30°F (-1°C) to 125°F (52°C), or the humidity is above 40%, or there is salt air present.

In a mild environment, the APU should be preserved within two months of the last APU operation when the APU will not be used. If the APU is sent to engine shop, continue the preservation until it goes to the shop.

In a severe environment, the APU should be preserved within three days of the last APU operation when the APU will not be used. If the APU is sent to the engine shop, continue the preservation until it goes to the shop.

Desiccant in the APU inlet and exhaust can help reduce corrosion, fungus and humidity in the sealed APU area. Desiccant can be put in the APU air inlet and/or exhaust. If space is limited, the desiccant can be distributed between the air inlet and the exhaust. DO NOT put the desiccant in the bleed air ducts.

The best general practices are:

- Operate the APU a minimum of five minutes before the preservation procedure to dry out the APU and APU compartment.
- It is recommended to use the APU supply bleed to operate both packs during the APU operation. Pack operation will raise the temperature of the load compressor and provide better dry out conditions.
- In high humidity environments, it is recommended to operate the APU for 20 to 30 minutes.

- Operate the APU periodically, the interval will depend on the storage environment.
- For severe environments, it is recommended to operate the APU every three days for a minimum of five minutes, and up to 30 minutes to make sure that the APU and APU compartment are dried out.
- If the APU is not operable during storage, motor the APU periodically. The interval will depend on the storage environment.
- If the APU cannot be motored or started, put desiccant in the gas path and seal the fuselage openings. Periodically check the desiccant and the seal on the fuselage openings.

The preservation of the APU fuel control unit with preservation oil is not necessary if the APU stays in the airplane and the APU fuel control unit is not removed or replaced. The low pressure fuel filter replacement is permitted. If the fuel control unit is replaced, the fuel system can be preserved by motoring or operating the APU at no load for one minute.

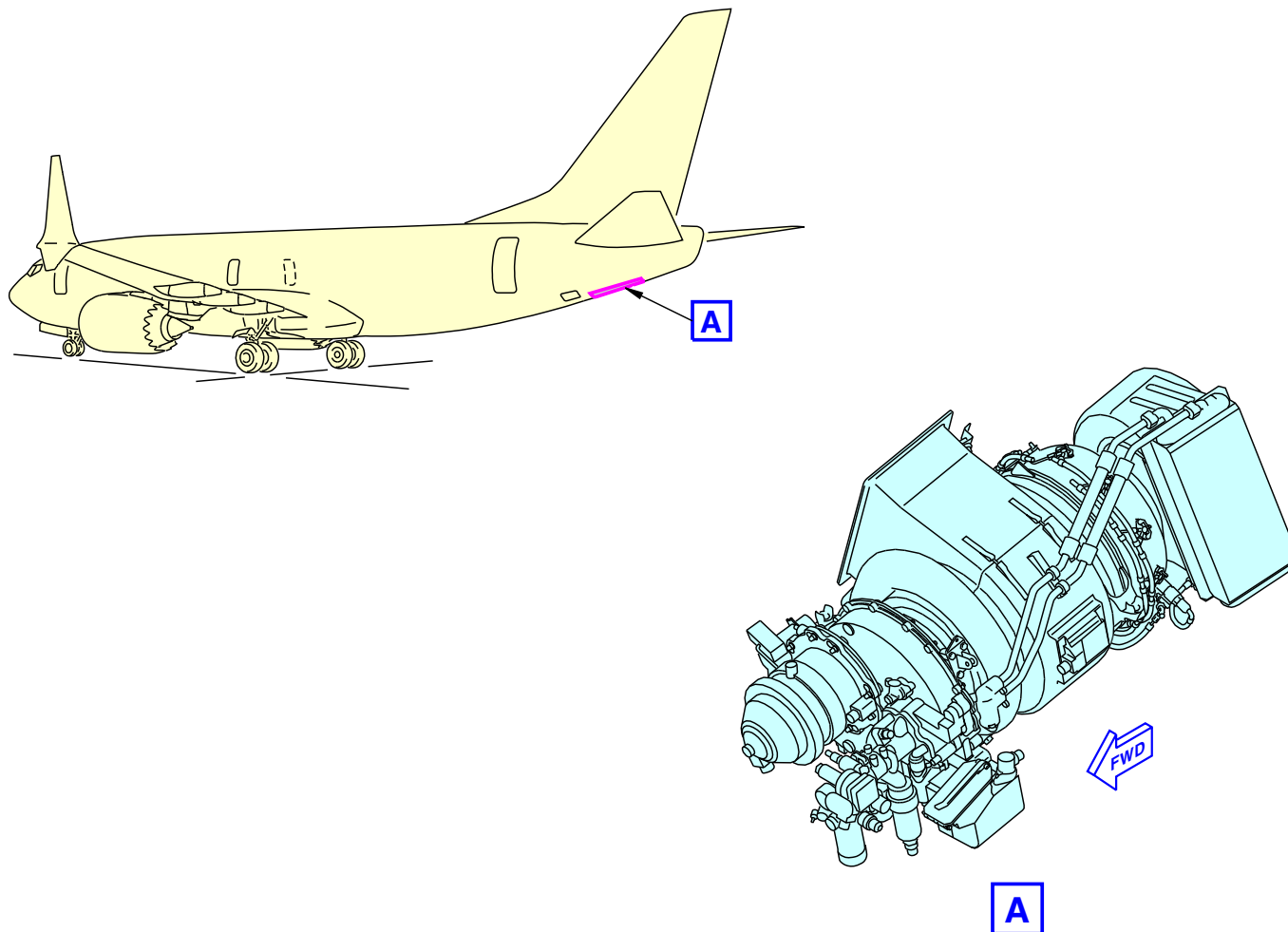
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APU POWER PLANT - PRESERVATION



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APU POWER PLANT - PRESERVATION

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APU ENGINE - INTRODUCTION

Purpose

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

General Description

The APU engine has these main sections:

- Accessory gear box
- Single stage load compressor
- Single stage engine compressor
- Combustor chamber
- Two stage axial flow turbine.

All the components in the APU engine that turn are on a common shaft.

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

The APU engine operates at a constant speed to provide 400 Hz generator output. The APU engine also supplies pneumatic pressure for airplane systems.

An inlet screen prevents foreign object damage (FOD) to the APU compressors.

General Description - APU Borescope

The borescope inspection is intended for troubleshooting the APU when recommended by the FIM. If the APU performs well (makes pneumatic pressure, electrical power and does not exceed the operational limits), it is not necessary to do a borescope inspection.

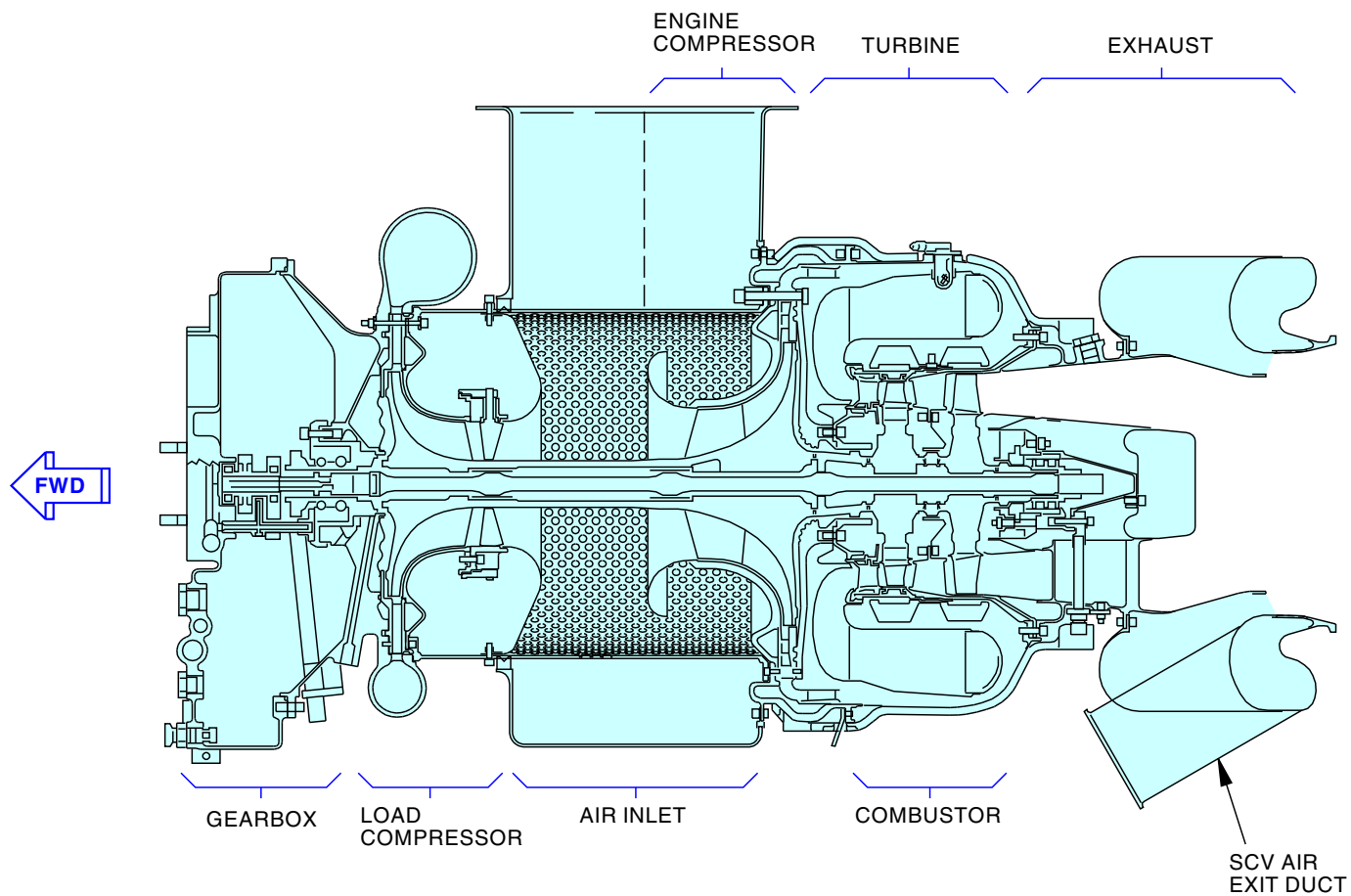
Borescope Inspection Ports:

- Load compressor
- Engine compressor
- Combustor chamber
- Turbine section

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APU ENGINE - INTRODUCTION



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APU ENGINE - INTRODUCTION

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APU FUEL SYSTEM - INTRODUCTION

Purpose

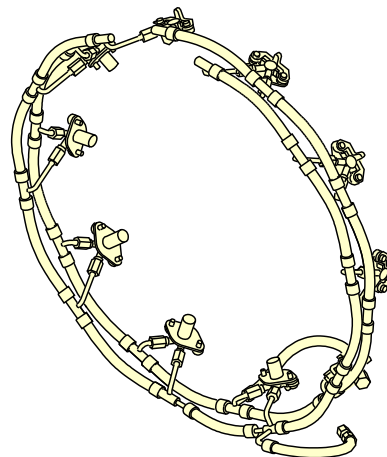
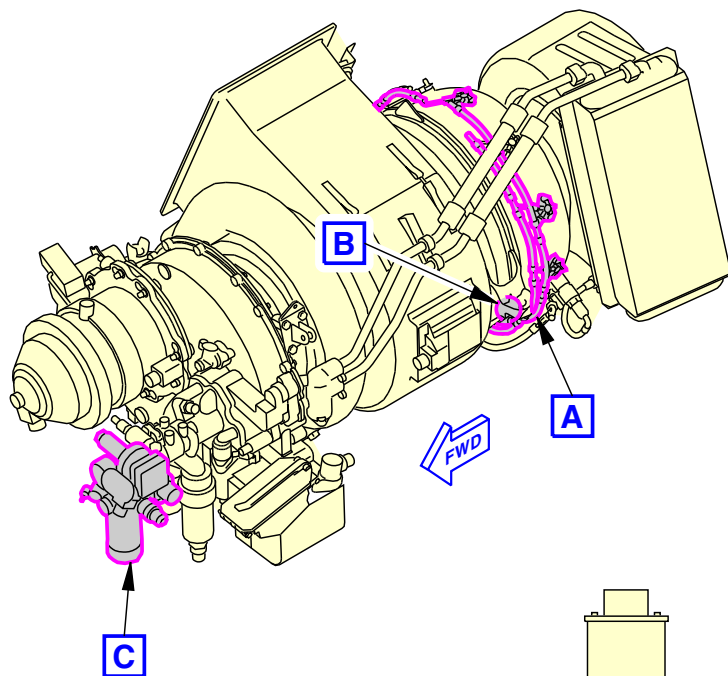
The APU fuel system pressurizes and supplies metered fuel to the APU combustion chamber. It also supplies pressurized fuel to the APU inlet guide vane and surge control valve actuators.

These are the APU fuel system components:

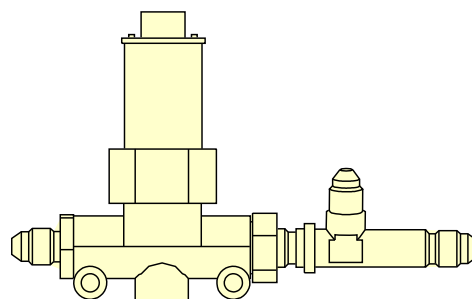
- Fuel control unit (FCU)
- Flow divider solenoid
- Flow divider
- Primary fuel manifold
- Secondary fuel manifold
- Fuel nozzles.

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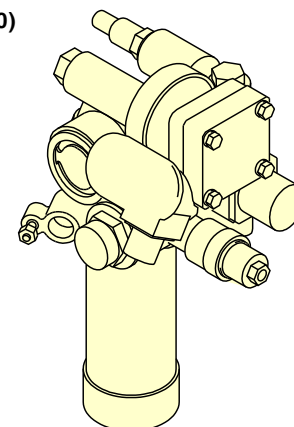
APU FUEL SYSTEM - INTRODUCTION



FUEL MANIFOLDS AND NOZZLES (10)



FLOW DIVIDER AND
FLOW DIVIDER SOLENOID



FUEL CONTROL UNIT

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APU FUEL SYSTEM - INTRODUCTION

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APU FUEL SYSTEM - GENERAL DESCRIPTION

General Description

The airplane fuel system AC boost pumps supply fuel for APU operation. The fuel goes through the APU fuel shutoff valve on the left wing aft spar. The AC boost pumps can supply fuel from any tank.

If the AC boost pumps do not supply fuel, the APU suction feeds from the left main tank.

See the APU fuel feed system for more information. (SECTION 28-25)

The ECU calculates the correct fuel flow for APU start and run. The ECU uses these values to calculate the correct fuel flow:

- APU speed
- APU exhaust gas temperature (EGT)
- Inlet temperature (T2)
- Inlet pressure (P2)
- Fuel temperature.

The ECU sends the fuel flow command signal to the fuel control unit (FCU) on the APU. The FCU sends the correct fuel flow to the flow divider and flow divider solenoid.

The flow divider solenoid gets a signal from the ECU to inhibit fuel flow to the secondary fuel manifold. The flow divider and flow divider solenoid send the metered fuel from the FCU to the primary and secondary fuel manifolds.

The fuel manifolds send primary and secondary fuel to ten dual tipped fuel nozzles. The nozzles inject the metered fuel to the APU combustor.

Component Location

Most fuel system components are part of the fuel control unit. The fuel control unit attaches to the lube module.

These are the APU fuel system components not in the fuel control unit

- Flow divider
- Flow divider solenoid
- Primary fuel manifold

- Secondary fuel manifold
- Fuel nozzles.

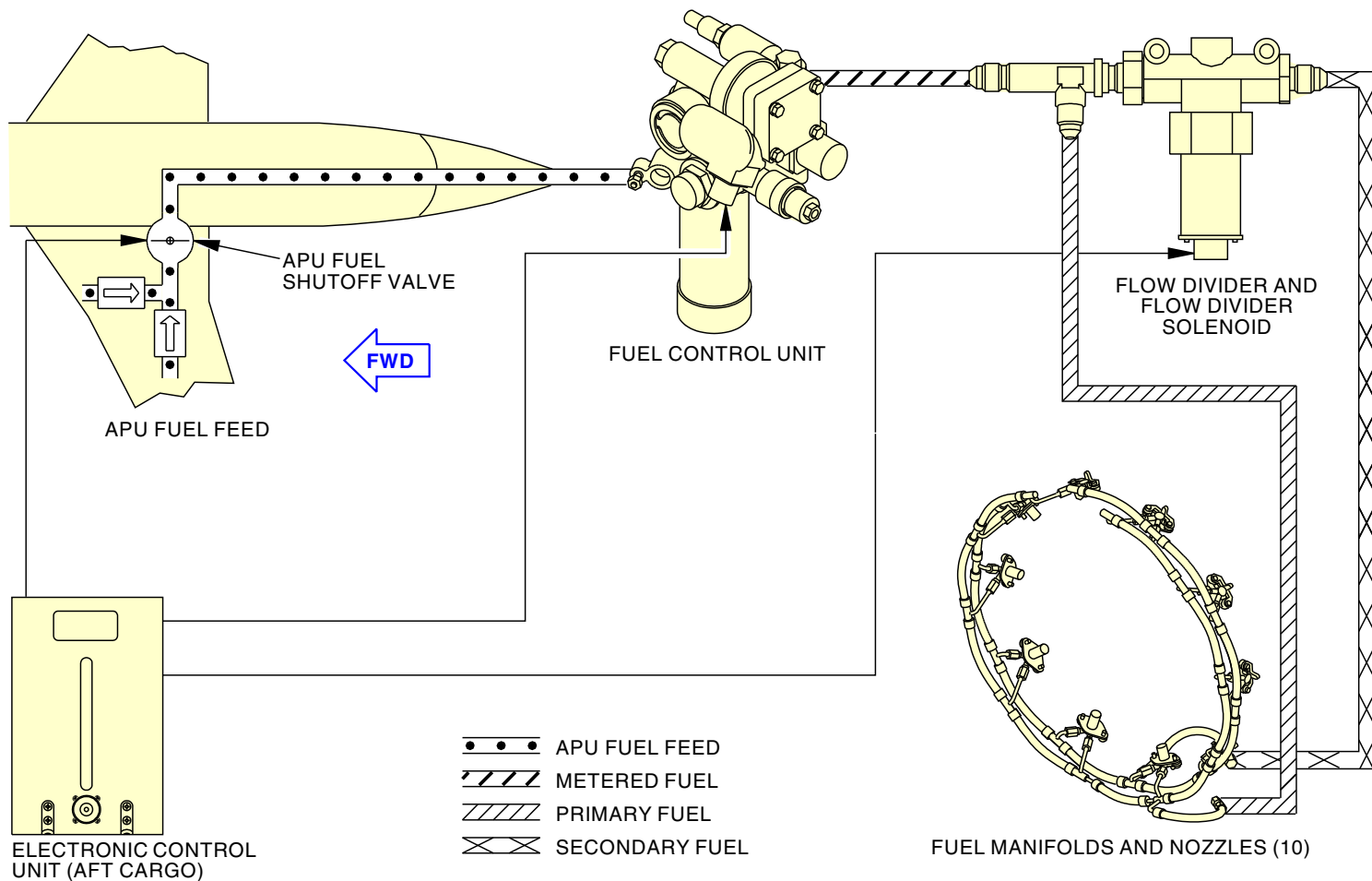
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APU FUEL SYSTEM - GENERAL DESCRIPTION



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APU FUEL SYSTEM - GENERAL DESCRIPTION

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APU FUEL SYSTEM - FUEL CONTROL UNIT

Purpose

The APU fuel control unit (FCU) supplies the correct metered fuel for these APU operations:

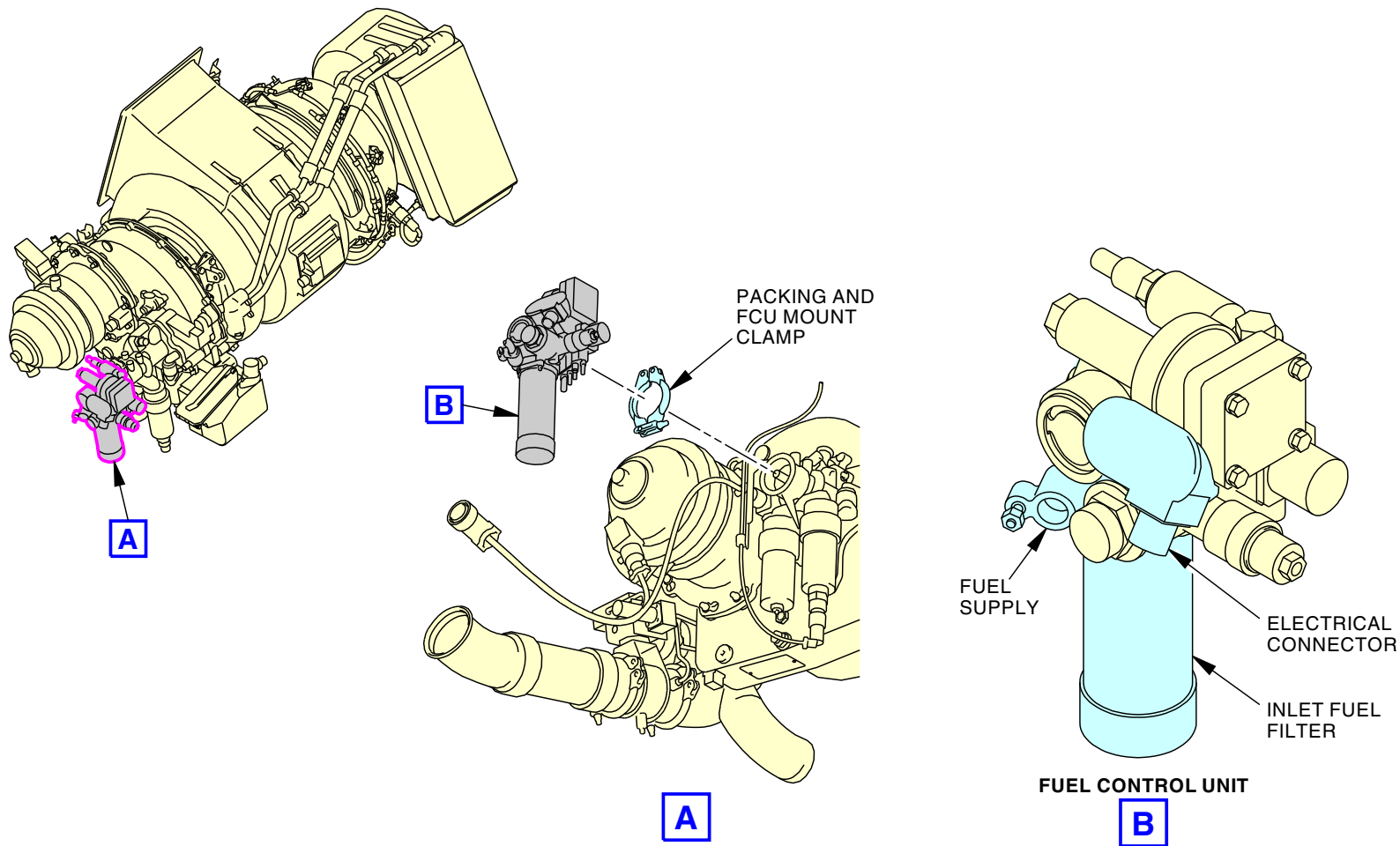
- Start
- Acceleration
- On speed.

General

The FCU mounts to the front of the lube module by a V band clamp. The lube module drives the FCU. The FCU and the inlet fuel filter are line replaceable units (LRU).

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APU FUEL SYSTEM - FUEL CONTROL UNIT



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APU FUEL SYSTEM - FUEL CONTROL UNIT



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**APU FUEL SYSTEM - FUEL CONTROL UNIT - FUNCTIONAL DESCRIPTION****General**

Fuel for the APU fuel control unit (FCU) comes from the airplane fuel system. The APU FCU supplies fuel for combustion and servo fuel to operate the inlet guide vane actuator (IGVA) and the surge control valve (SCV).

The FCU includes these components:

- Inlet filter
- High pressure fuel pump
- Pump relief valve
- High pressure filter
- Differential pressure regulator
- Bypass bleed orifice
- Torque motor metering valve
- Pressurizing valve and flow meter
- Actuator pressure regulator
- Fuel solenoid valve
- Fuel temperature sensor.

Inlet Filter

The inlet filter removes contamination before the fuel goes into the high pressure gear pump.

High Pressure Fuel Pump and Pump Relief Valve

A shaft from the lube module turns the high pressure fuel pump. The pump supplies high pressure fuel for use in the FCU. The pump relief valve keeps fuel pressure below 950 psi (6550 kPa).

High Pressure Filter

The high pressure filter removes contamination caused by the gear pump.

Actuator Pressure Regulator

The actuator pressure regulator keeps actuator fuel pressure at 250 psid (1724 kPa). The FCU uses actuator fuel pressure to operate the inlet guide vane actuator and surge control valve.

Differential Pressure Regulator

The differential pressure regulator holds a constant differential pressure of 50 psid (345 kPa) across the metering valve.

Bypass Bleed Orifice

The bypass bleed orifice is installed between the torque motor metering valve and the input shaft of the high pressure fuel pump. Metered valve discharged fuel from the torque motor flows to the delta-P regulator and bypassed fuel goes through the bypass bleed orifice and into the input shaft of the high pressure fuel pump.

Fuel Metering Valve

The torque motor metering valve is an electrohydraulic servo valve. It controls the quantity of fuel to the combustion chamber.

Flow Meter Pressurizing Valve And Flow Meter

The flow meter pressurizing valve keeps a 50 psi (345 kPa) decrease in fuel pressure from the fuel metering valve to the fuel shutoff solenoid. A resolver is attached to the valve to measure valve position. The ECU uses this signal to calculate the fuel flow to the APU combustor.

Fuel Solenoid Valve

The fuel solenoid valve controls the fuel flow from the fuel control unit. The fuel solenoid valve is spring loaded closed.

During APU start, the ECU energizes the solenoid at 7 percent speed. This opens the fuel solenoid valve.

During shutdown, the ECU de-energizes the solenoid. The fuel solenoid valve closes. This shutdown sequence is the same for normal or protective shutdown.

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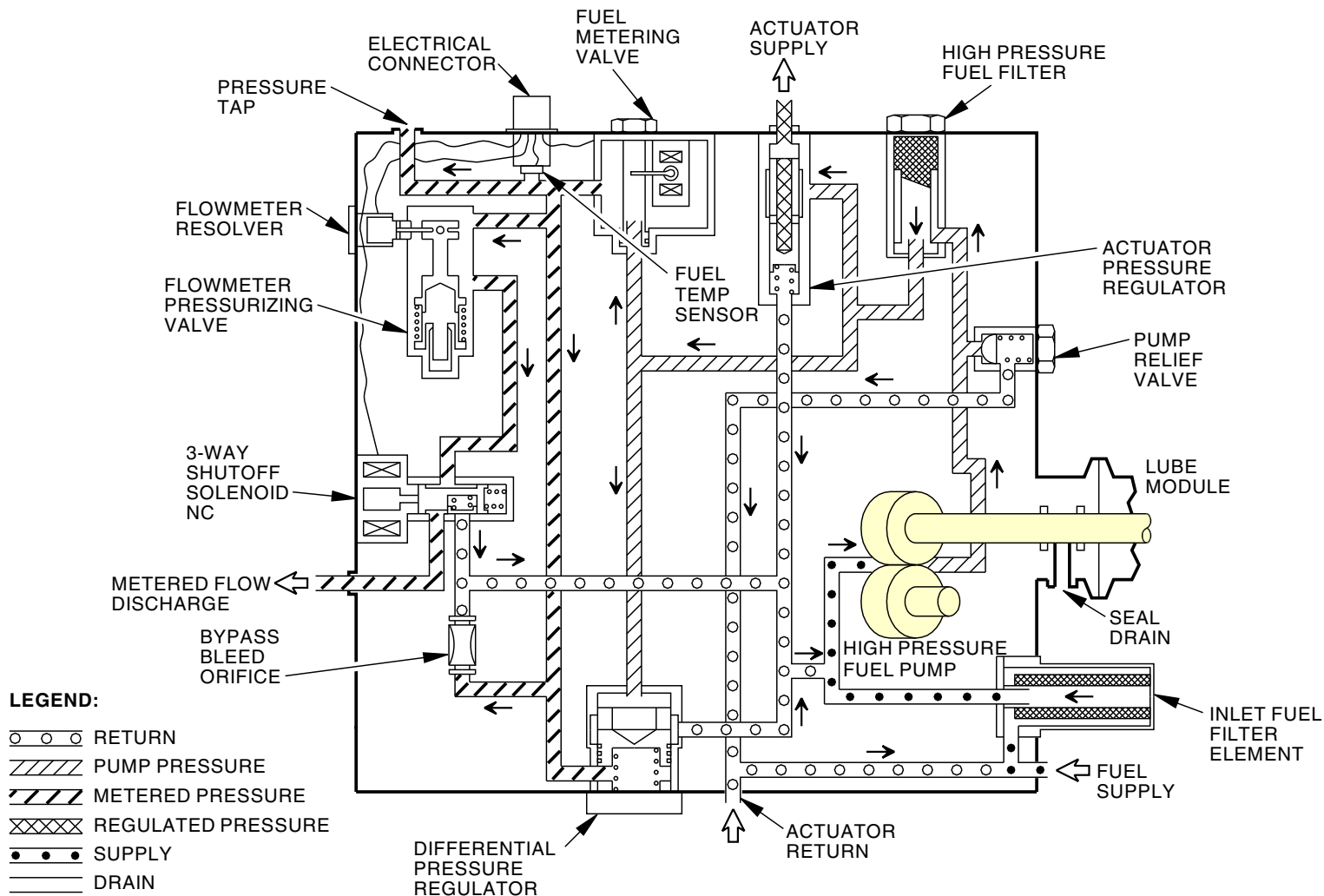
APU FUEL SYSTEM - FUEL CONTROL UNIT - FUNCTIONAL DESCRIPTION

Fuel Temperature Sensor

The fuel temperature sensor is a resistive temperature device (RTD). The fuel temperature sensor provides a fuel temperature signal to the ECU.

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APU FUEL SYSTEM - FUEL CONTROL UNIT - FUNCTIONAL DESCRIPTION



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APU FUEL SYSTEM - FUEL CONTROL UNIT - FUNCTIONAL DESCRIPTION

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**APU FUEL SYSTEM - FUEL FLOW DIVIDER AND FLOW DIVIDER SOLENOID****Purpose**

The fuel flow divider directs fuel to the primary and secondary manifolds.

Location

The fuel flow divider is on the lower left side of the APU engine near the combustion chamber.

Fuel Flow Divider and Flow Divider Solenoid Components

These are the main fuel flow divider components:

- Ball check valve
- Inlet filter
- Flow divider solenoid.

Functional Description

When the fuel solenoid valve opens, fuel flows to the fuel flow divider through the inlet filter in the flow divider.

The fuel flow divider directs fuel to the primary fuel manifold for initial start and acceleration.

The flow divider solenoid makes sure fuel does not go to the secondary manifold at the incorrect time. When the flow divider first sends fuel to the secondary manifold, the fuel pressure in the primary manifold momentarily decreases while the secondary manifold fills with fuel. If the primary fuel pressure decreases at the incorrect time, the APU flames out or goes under speed.

A spring holds the flow divider solenoid in the open position. The flow divider solenoid closes when the ECU energizes the solenoid.

The ECU energizes the flow divider solenoid closed from 7 percent to 30 percent speed. This prevents APU flame out and shutdown during a start.

At 25-40 percent speed (approximately 120 psi (827 kPa)), the check valve inside the flow divider T fitting opens and supplies fuel to the secondary manifold unless the fuel flow divider valve is in the closed position.

The ECU again energizes the flow divider solenoid at higher altitudes. This prevents an APU under speed and shutdown with the addition of electrical load above 25,000 ft (7620 m).

The ECU uses these values to determine when the flow divider solenoid should be energized:

- Inlet pressure (P2)
- Inlet temperature (T2)
- APU speed.

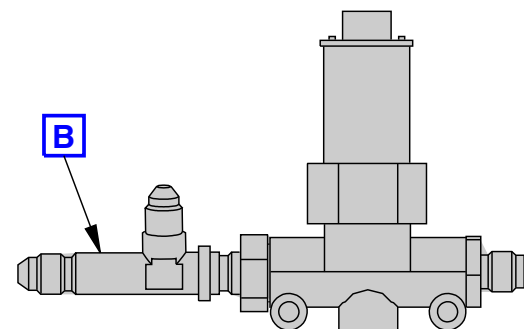
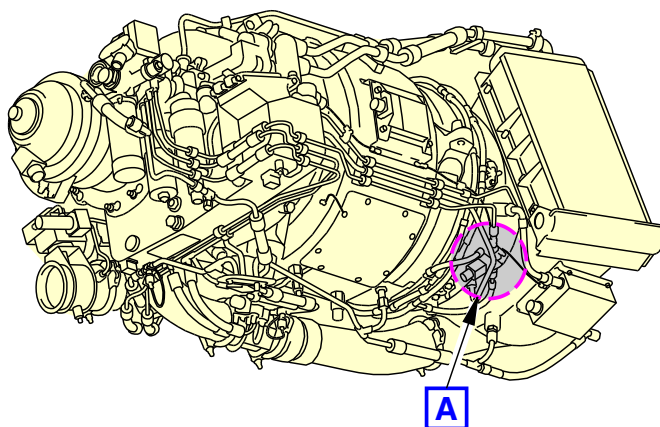
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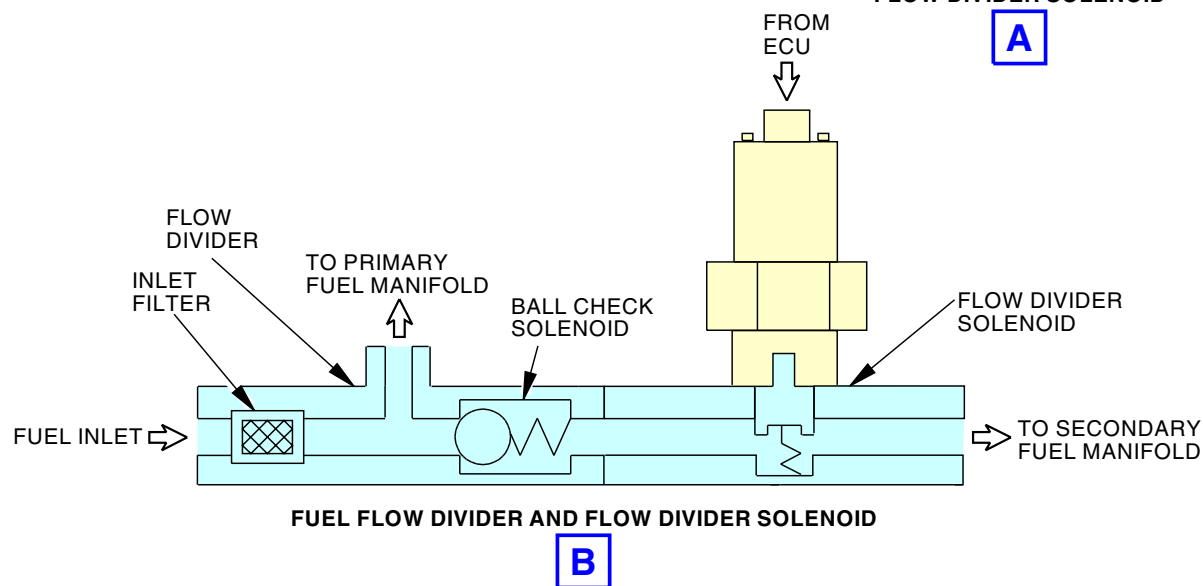
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APU FUEL SYSTEM - FUEL FLOW DIVIDER AND FLOW DIVIDER SOLENOID



**FUEL FLOW DIVIDER AND
FLOW DIVIDER SOLENOID**



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APU FUEL SYSTEM - FUEL FLOW DIVIDER AND FLOW DIVIDER SOLENOID

**APU FUEL SYSTEM - MANIFOLDS AND NOZZLES****Fuel Manifolds**

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

The manifolds are around the APU combustion chamber.

Both manifolds supply fuel when the APU is on speed below 25,000 ft (7620 m). Only the primary manifold supplies fuel up to 30 percent speed during APU start and above 25,000 ft (7620 m) for all APU operation.

Fuel Nozzles

Ten fuel nozzles atomize and inject fuel into the combustion chamber. The fuel nozzles are installed around the combustion section.

The 10 fuel nozzles have these components:

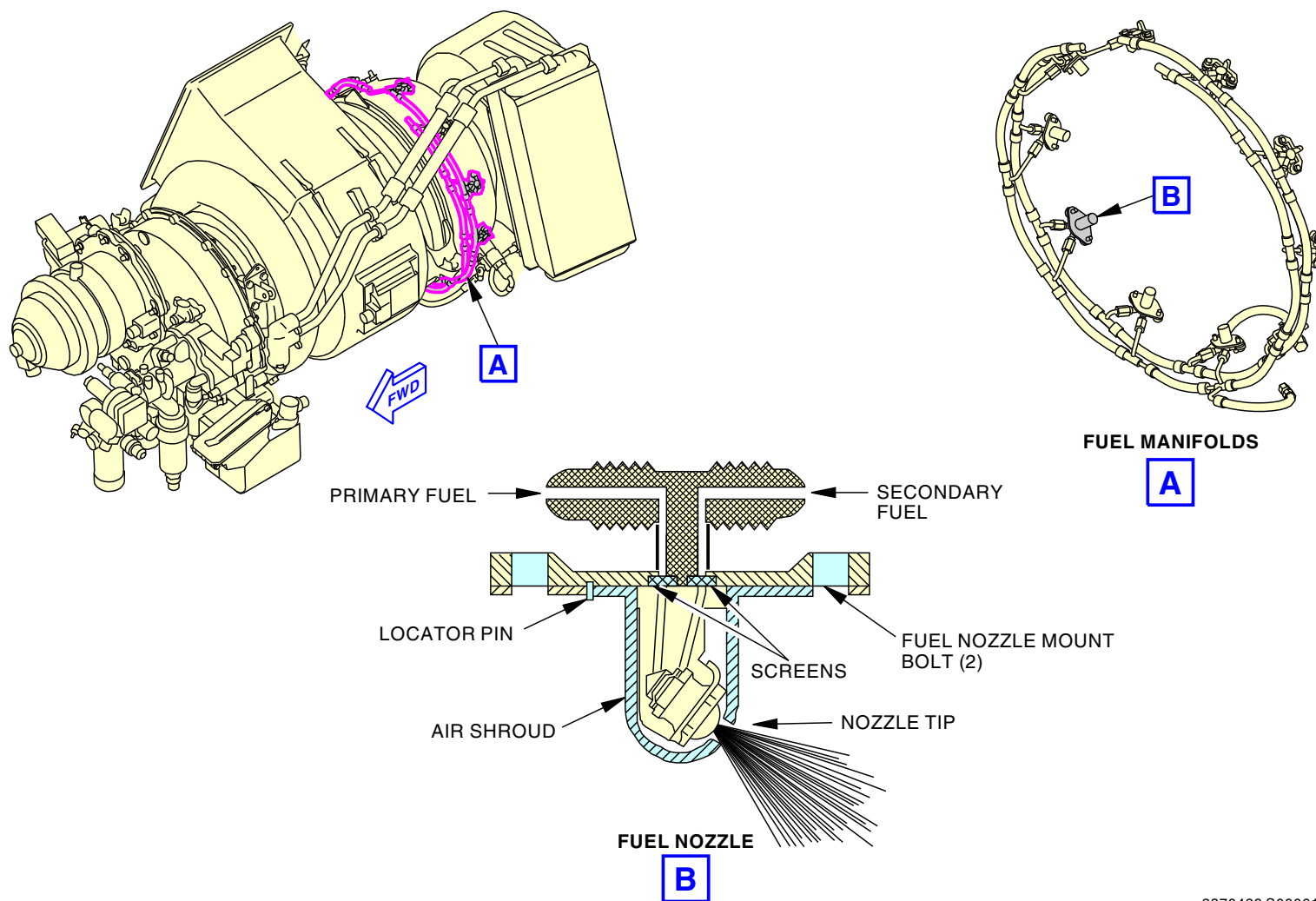
- Primary and secondary screen
- locating pin
- Air shroud
- Nozzle tip.

The fuel manifolds and fuel nozzles can be removed and installed without removal of the APU.

The fuel nozzles have a locator pin to make sure installation is correct.

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APU FUEL SYSTEM - MANIFOLDS AND NOZZLES



APU FUEL SYSTEM - MANIFOLDS AND NOZZLES

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**APU FUEL SYSTEM - APU COMBUSTOR DRAIN ORIFICE****Purpose**

The APU combustor drain supplies a drain for fuel that may accumulate in the combustor after an unsuccessful start. This prevents a possible hot start on the next start.

Location

The combustor drain is at the lowest point of the combustor case.

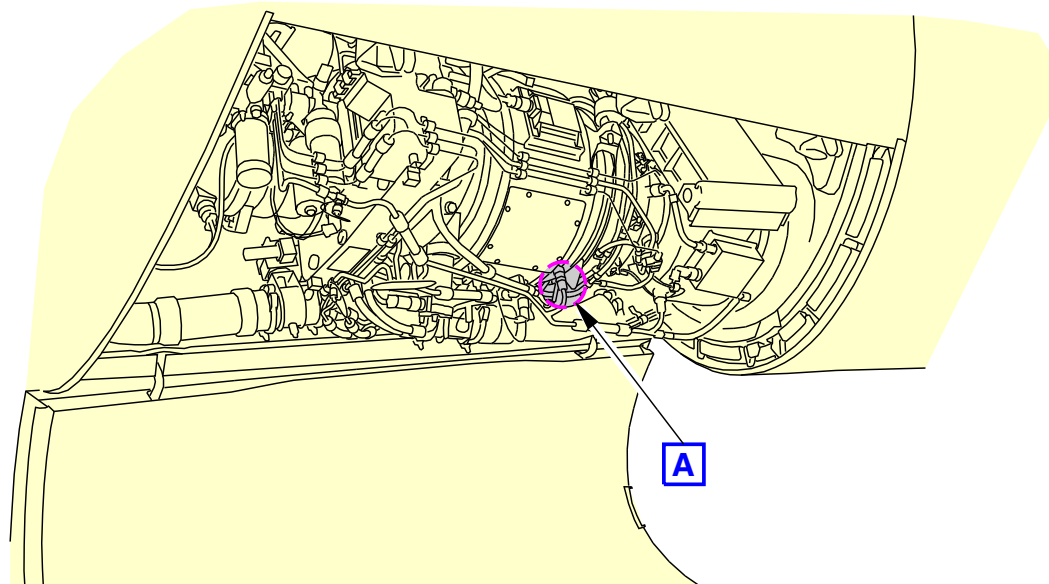
Functional Description

The combustor drain is a 0.060 in. (1.524 mm) diameter orifice that drains fluid. During APU operation, the orifice lets a small quantity of air go out from the combustor.

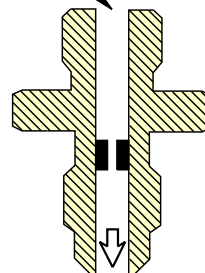
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APU FUEL SYSTEM - APU COMBUSTOR DRAIN ORIFICE

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INTERNAL AIR
PRESSURE



COMBUSTOR DRAIN



APU FUEL SYSTEM - APU COMBUSTOR DRAIN ORIFICE

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APU FUEL SYSTEM - FUNCTIONAL DESCRIPTION

General

The APU fuel system supplies fuel for combustion. The fuel control unit also supplies regulated fuel pressure for the inlet guide vane actuator (IGVA) and the surge control valve (SCV) operation. The APU electronic control unit (ECU) controls the APU fuel system.

Fuel Supply

The fuel system boost pumps supply pressurized fuel or the APU fuel control unit suction supplies fuel through the fuel shutoff valve to the APU. The shutoff valve opens when the APU switch is put in the ON or the START position.

Fuel Control Unit

The fuel control unit (FCU) has these functions:

- Pressurizes the fuel
- Cleans the fuel
- Controls the fuel pressure
- Controls fuel flow.

ECU Control

The ECU logic controls these fuel feed components:

- Fuel shutoff valve
- Fuel solenoid valve
- Fuel metering valve
- Flow divider solenoid.

The fuel shutoff valve opens when the APU switch is in the ON or START position. During the APU start, the ECU sends a signal to the fuel solenoid valve to open when the APU RPM is more than 7 percent. The ECU controls the fuel metering valve when the APU speed is more than 7 percent. The ECU also controls the flow divider solenoid valve on the fuel flow divider.

The ECU uses start-up control logic to control the fuel metering valve when the speed 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 speed (N)
- Inlet pressure (P2)
- Inlet temperature (T2)
- Exhaust gas temperature (EGT).

The ECU uses the same inputs for the on-speed logic above 95 percent speed.

The flow meter in the FCU sends a fuel-flow feedback signal to the ECU. The ECU uses this signal to make sure the APU gets the necessary fuel.

Fuel Flow Divider

The fuel flow divider supplies fuel to the primary manifold during start of the APU. At 25-40 percent speed or approximately 120 psi (827 kPa), the fuel flow divider supplies fuel to both the primary and secondary fuel manifolds for APU operation.

The fuel flow divider has a normally open flow divider solenoid. The ECU signals the flow divider solenoid closed above approximately 25,000 ft (7620 m) altitude to make sure the internal check valve for secondary fuel does not open and cause the APU speed to decrease.

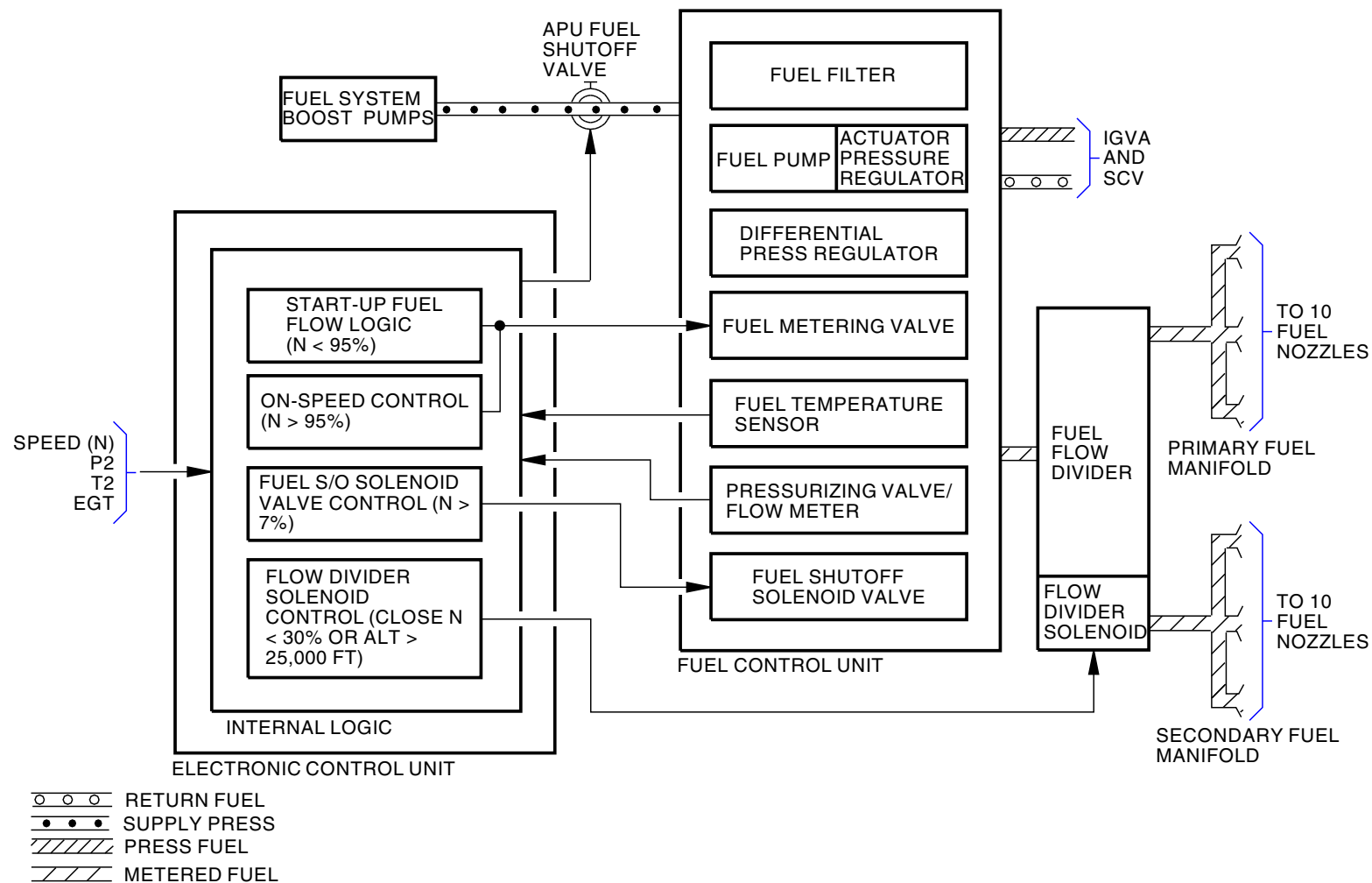
The flow divider solenoid also improves start capability in cold weather.

The ECU uses P2, T2, and speed signals to control the fuel flow divider solenoid valve.

Actuator Pressure Regulator

The FCU also supplies pressurized fuel to operate the IGVA and the SCV. The pressure is regulated at 250 $\pm$ 25 psi (1724 $\pm$ 173 kPa). Return fuel from these valves goes back to the pump inlet.

APU FUEL SYSTEM - FUNCTIONAL DESCRIPTION



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APU FUEL SYSTEM - FUNCTIONAL DESCRIPTION

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APU IGNITION AND START SYSTEM - INTRODUCTION

Purpose

The APU ignition and start system supplies the initial rotation of the engine and ignition.

General

The APU ignition and start system consists of these components:

- Ignition unit
- Igniter plug lead
- Igniter plug
- Start power unit (SPU)
- Start converter unit (SCU)
- Starter-generator.

The APU electronic control unit (ECU) controls the APU start sequence.

See the APU engine controls section for more information on the ECU.
(SECTION 49-60)

Ignition System

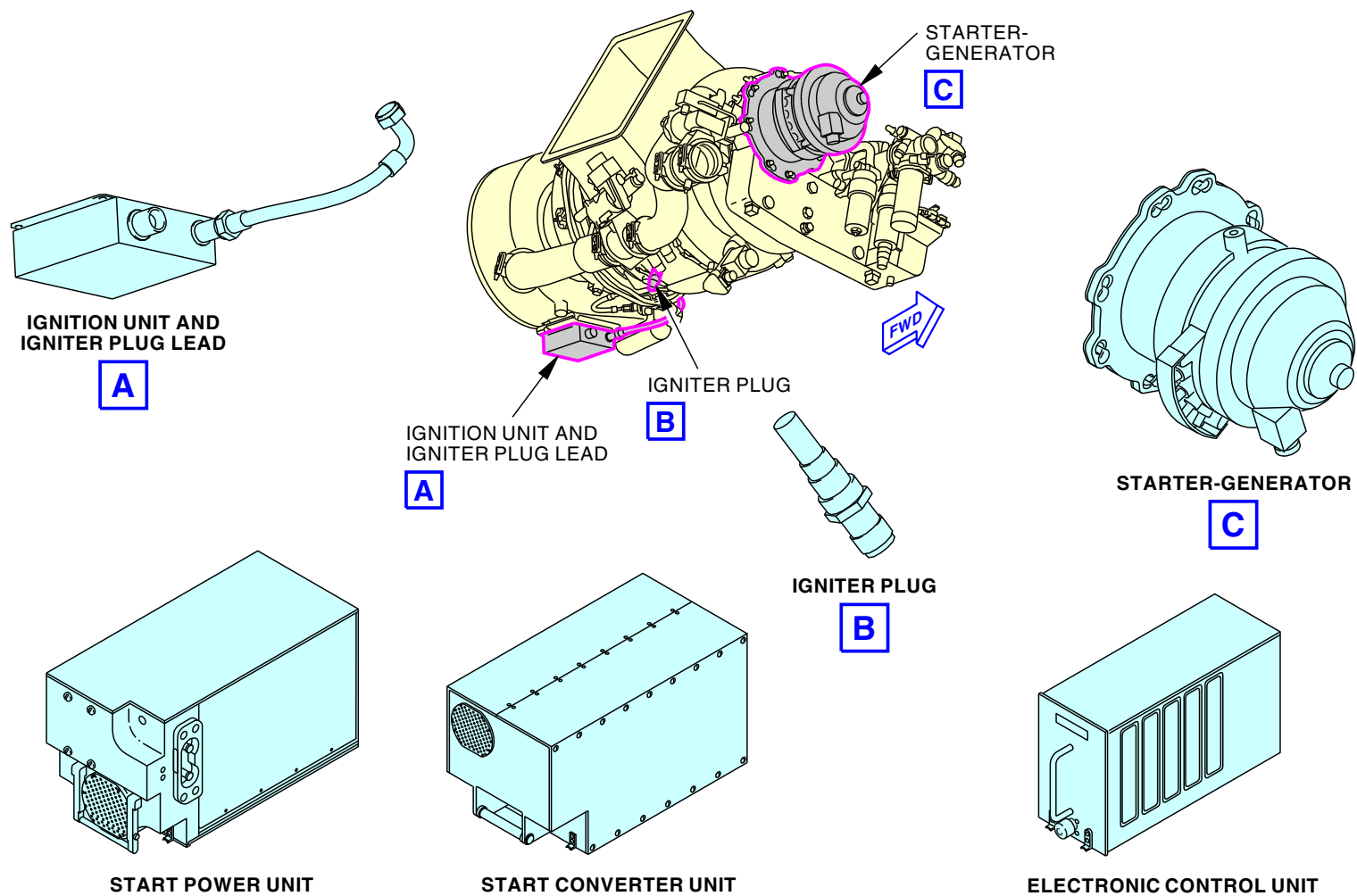
The ignition system supplies sparks to start APU combustion during the APU start. The ECU energizes the ignition unit at 0 percent speed and de-energizes the ignition unit at 60 percent speed.

Start System

The starter-generator, SPU, and SCU together supply initial rotation of the APU. The start power sources are 28 VDC from the battery or 115 VAC transfer bus number 1.

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APU IGNITION AND START SYSTEM - INTRODUCTION



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APU IGNITION AND START SYSTEM - INTRODUCTION

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**APU IGNITION AND START SYSTEM - SPU AND SCU GENERAL DESCRIPTION****Start Power Unit**

The start power unit changes 115 VAC or 28 VDC electrical power to 270 VDC power. Transfer bus 1 or the battery supplies power to the start power unit (SPU).

The SPU provides fault data to the ECU through the SCU for display on the MDS (Max Display System).

The (SPU) is in the EE compartment on the E2-2 shelf.

Start Converter Unit

The start converter unit (SCU) changes the 270 VDC power to AC and sends it to the starter-generator.

The SCU provides fault data to the ECU for display on the MDS (Max Display System).

The SCU is in the EE compartment on the E2-2 shelf.

See the electrical chapter for more information about the APU starter-generator generate function. (CHAPTER 24)

Start Control

The electronic control unit sends a signal to the start converter unit when the air inlet door is fully open. The start converter unit signals the start power unit to supply the 270 VDC. The start converter unit changes the 270 VDC to AC power for the operation of the starter-generator. At 70 percent speed, the electronic control unit removes the start signal from the start converter unit. With the start signal off, the SCU and the SPU removes power from the starter-generator.

The maximum duty cycle for the SPU and SCU is three starts, one after the other, followed by a 15-minute cool down period. If too many starts are attempted, the SCU and SPU will get too hot and stop the APU start. More starts are possible after the SCU and SPU cool.

Access to the SCU terminal block for the AC power feeder wires is on the back of the SCU. Remove the panel behind the E2 rack from the forward cargo compartment to get access to the back of the SCU.

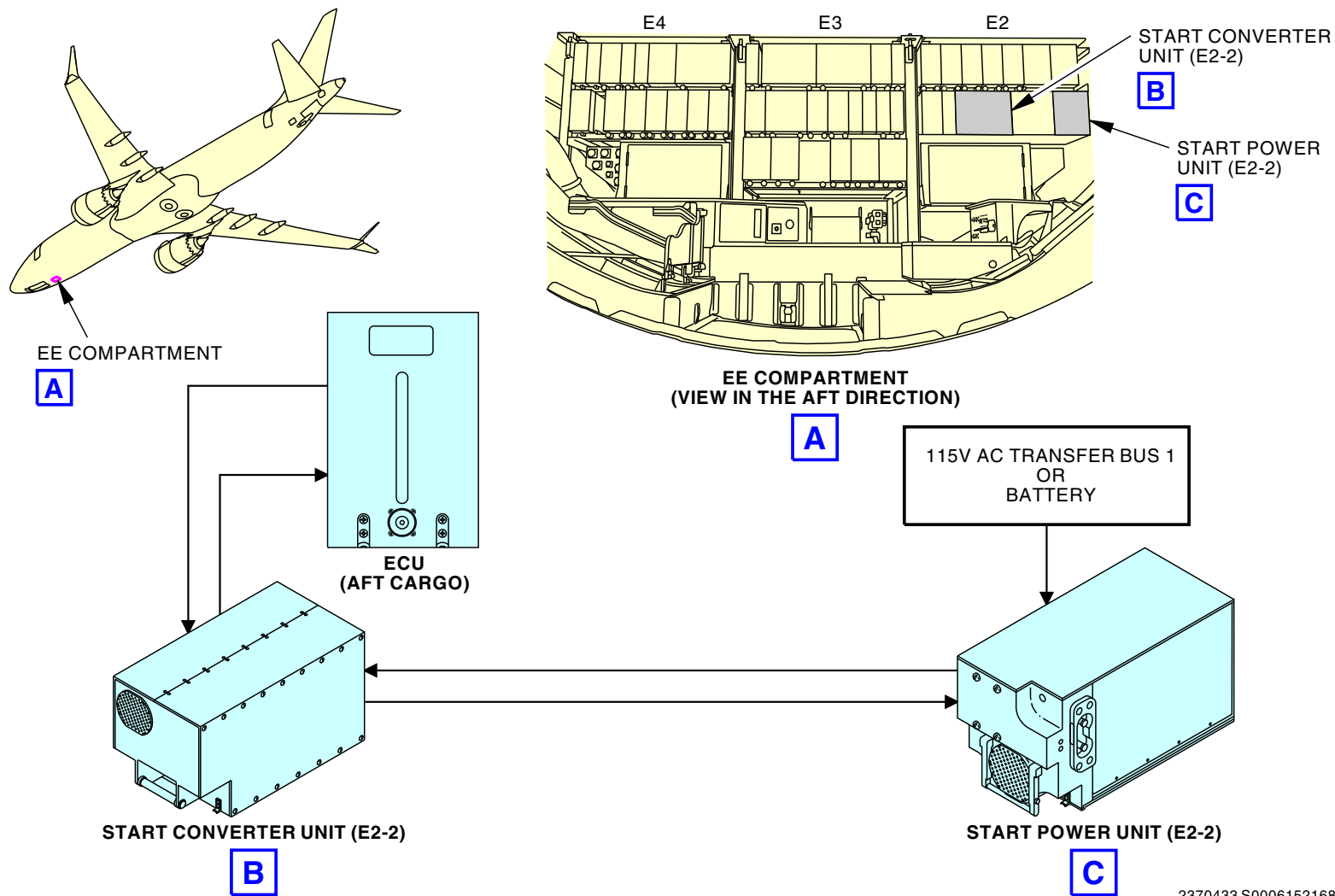
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APU IGNITION AND START SYSTEM - SPU AND SCU GENERAL DESCRIPTION



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APU IGNITION AND START SYSTEM - SPU AND SCU GENERAL DESCRIPTION

49-40-00

**APU IGNITION AND START SYSTEM - APU STARTER-GENERATOR****Purpose**

The starter-generator supplies the initial rotation of the APU for the start cycle.

The starter-generator is also a source of electrical power for the airplane systems. It supplies 90 kva of AC electrical power on ground and in flight.

See the electrical chapter for more information about the generate function of the starter-generator. (CHAPTER 24)

Location

The starter-generator is on the upper right side of the APU gearbox. Eight bolts hold the starter-generator to the gearbox.

General Description

The APU starter-generator has a terminal block and a electrical connector.

The starter-generator has three rotors mounted on the same shaft. For each rotor there is a stator winding installed in the starter-generator case. These are the rotor-stator pairs:

- Permanent magnet generator (PMG)
- Exciter
- Main generator.

The starter-generator also has 6 rotating diodes attached to the shaft.

A resolver mounted on the starter-generator shaft sends rotor position to the SCU. The SCU uses the rotor position signal to synchronize the AC power to the rotor position.

The APU oil system cools the starter-generator.

The weight of the starter-generator is 54.5 lb (24.7 kg).

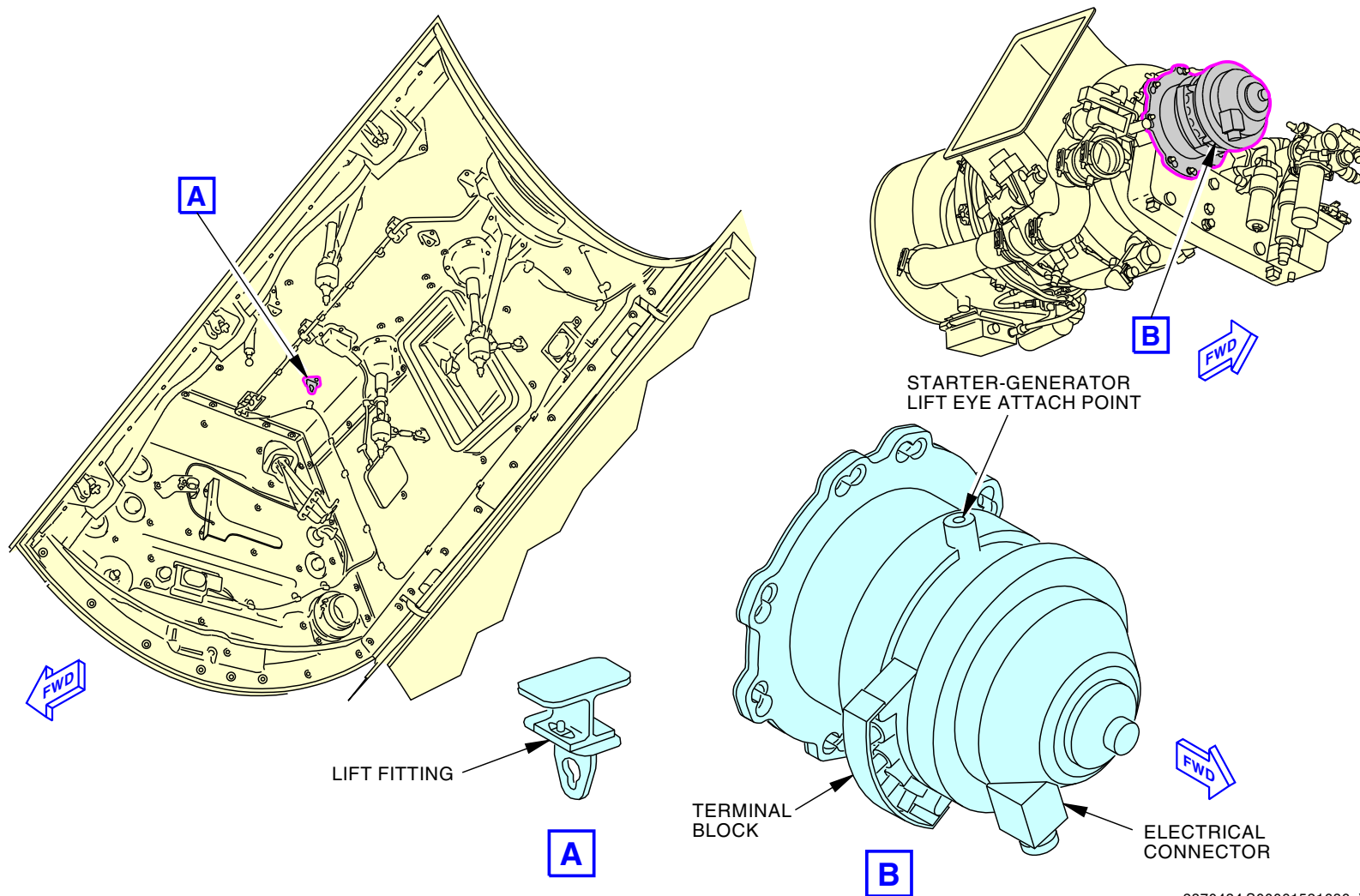
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APU IGNITION AND START SYSTEM - APU STARTER-GENERATOR



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APU IGNITION AND START SYSTEM - APU STARTER-GENERATOR

49-40-00

APU IGNITION AND START SYSTEM - IGNITION SYSTEM - GENERAL DESCRIPTION**General**

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

The ignition system components are on the bottom of the engine.

Ignition Unit

The ignition unit changes 28v dc power to a high voltage pulsed current that goes to the igniter plug. The ignition unit has one channel for one igniter plug lead and igniter plug. The ignition unit supplies one spark per second to the igniter plug.

 WARNING	MAKE SURE THAT THE IGNITION SYSTEM IS OFF FOR FIVE MINUTES BEFORE YOU TOUCH THE COMPONENT. IGNITION VOLTAGE IS HIGH WHICH MAKES IT DANGEROUS. IGNITION VOLTAGE CAN CAUSE INJURIES TO PERSONNEL.
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Igniter Plug Lead

The igniter plug lead connects the ignition unit to the igniter plug. The igniter plug lead insulation prevents radio interference.

Igniter Plug

There is one igniter plug. It supplies the high energy spark for fuel-air ignition.

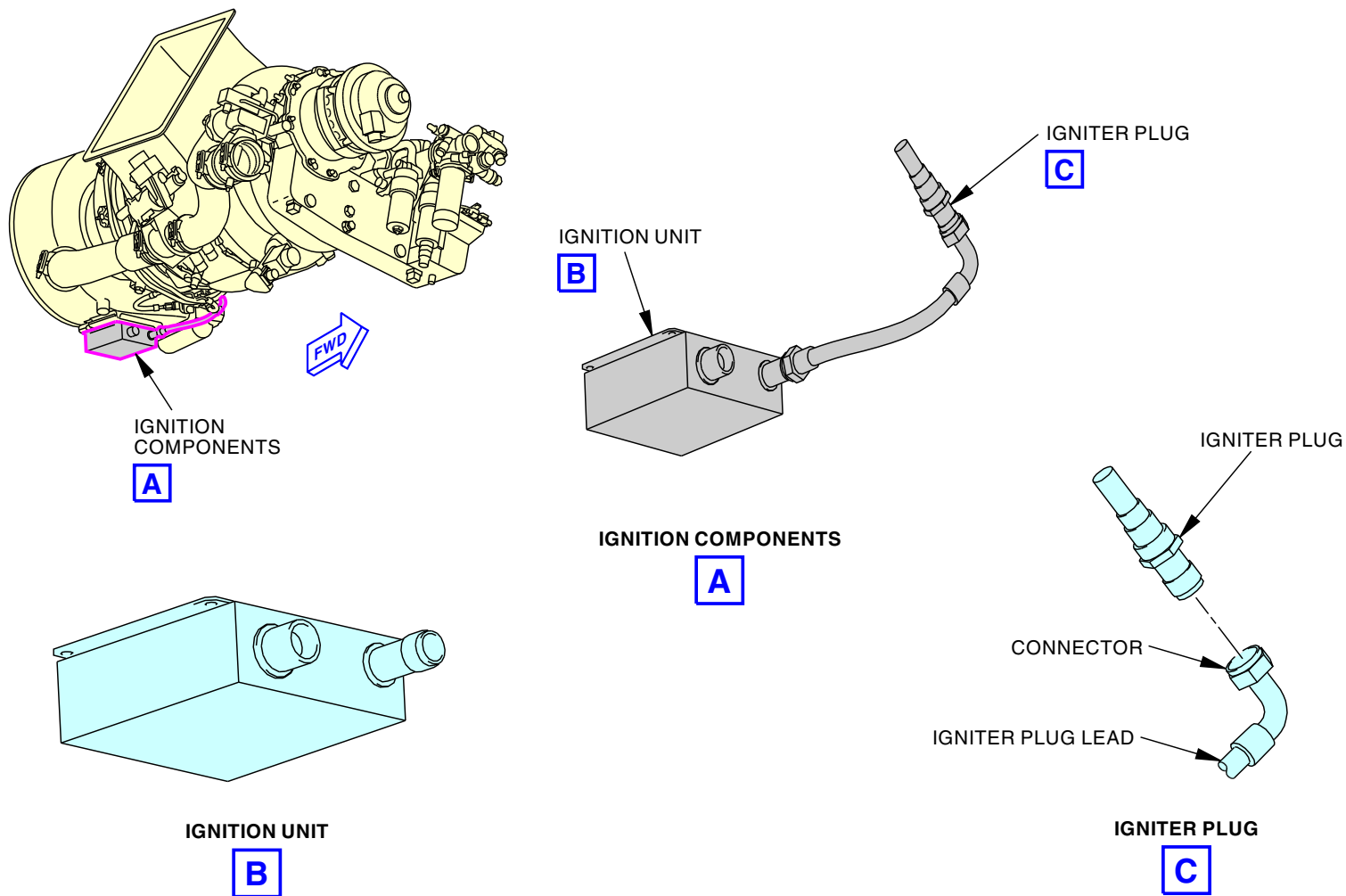
Functional Description

The ECU energizes the ignition system at 0 percent speed during APU start. The ECU deenergizes the ignition system at 60 percent speed.

The ECU energizes the ignition system if the APU engine speed goes below 95 percent speed during APU operation (speed droop).

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APU IGNITION AND START SYSTEM - IGNITION SYSTEM - GENERAL DESCRIPTION



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APU IGNITION AND START SYSTEM - IGNITION SYSTEM - GENERAL DESCRIPTION

49-40-00

**APU IGNITION AND START SYSTEM - FUNCTIONAL DESCRIPTION****General**

To start the APU, put the APU switch to the START position and release the switch to the ON position. This signals the ECU to begin the start cycle.

Electrical Power

These are the electrical power sources for the ignition and start system function:

- 24/28 VDC battery
- 24/28 VDC switched hot battery bus
- 115 VAC transfer bus 1.

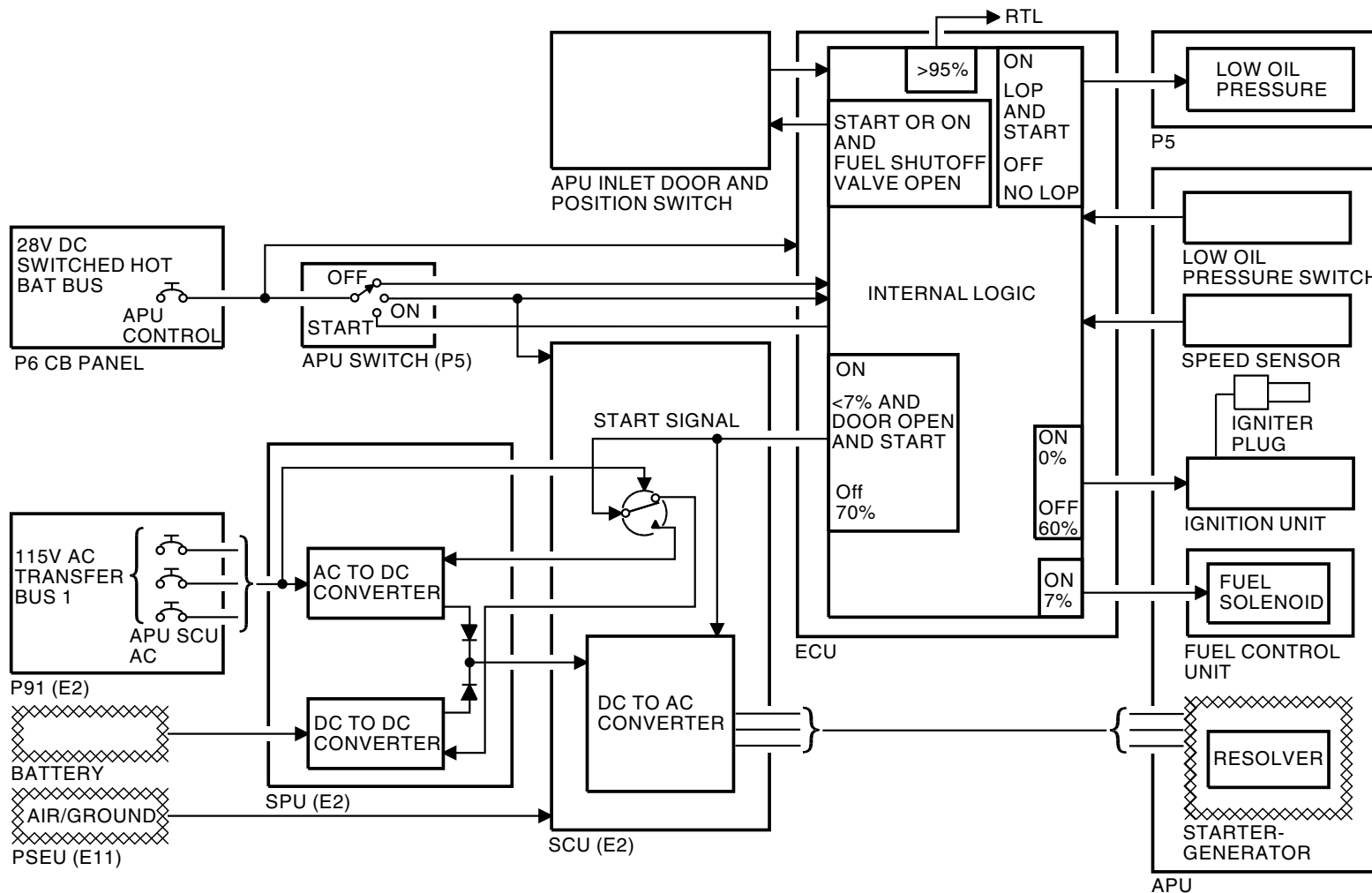
Ignition/Starting Function Sequence

This is the APU start sequence:

- The start sequence starts when the APU switch is put to the START position and released to the ON position.
- The ECU turns on the oil pressure light on the P5 panel when the ECU receives the start signal. The low oil pressure light goes out at 35 ± 5 psi (241 ± 35 kPa) oil pressure.
- The ECU opens the APU fuel shutoff valve and air inlet door. The inlet door switch sends a door open signal to the ECU when the air inlet door is open.
- At 0 percent speed and before the start system is energized, the ECU energizes the ignition unit.
- If the air inlet door is open and the APU speed is less than 7 percent, the ECU sends a start signal to the SCU. If the APU speed is more than 7 percent, the ECU waits until the speed is less than 7 percent.
- If 115 VAC is available on transfer bus 1, the SCU sends a start signal to the AC to DC converter in the SPU. The AC to DC converter gives 270 VDC power to the SCU.

- If 115 VAC is not available on transfer bus 1, the SCU sends a start signal to the DC to DC converter in the SPU. The DC to DC converter gives 270 VDC to the SCU. The SCU also has a control function to prevent the DC to DC converter from depleting the battery below limits (18 VDC on ground, 20 VDC in air) during a DC start attempt. The proximity switch electronics unit (PSEU) provides the air/ground input.
- The DC to AC converter in the SCU changes the 270 VDC power from the SPU into three-phase start power. This power goes to the starter-generator. The starter-generator turns the APU turbine shaft. The SCU receives starter-generator rotor position from the starter-generator resolver. The SCU uses this signal to synchronize the three-phase start power to the starter-generator rotor position.
- At 7 percent speed, the ECU energizes the fuel solenoid which supplies fuel for combustion.
- At approximately 30 percent speed, oil pressure goes above 35 ± 5 psi (241 ± 35 kPa). The oil pressure switch removes the low oil pressure signal. The ECU turns off the low oil pressure light.
- At 60 percent speed, the ECU de-energizes the ignition unit.
- At 70 percent speed, the ECU removes the start signal from the SCU. The SCU removes the start signal from the SPU AC to DC and DC to DC converters. This deenergizes the starter-generator.
- At 95 percent speed, plus two seconds, the ECU gives the ready to load (RTL) signal to other airplane systems. This signals the airplane systems that the APU is ready to accept pneumatic and electrical loads.

APU IGNITION AND START SYSTEM - FUNCTIONAL DESCRIPTION



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APU IGNITION AND START SYSTEM - FUNCTIONAL DESCRIPTION



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APU BLEED AIR SYSTEM - INTRODUCTION

Purpose

The APU bleed air system supplies pressurized air for these airplane pneumatic operations:

- Main engine start
- Air conditioning
- Pressurization.

- Pressure sensors.

Components

These are the APU bleed air system components:

- Load compressor
- Inlet guide vanes (IGV)
- Inlet guide vane actuator (IGVA)
- Bleed air valve (BAV)
- Pressure sensors (PT, DP, P2)
- Surge control valve (SCV).

All bleed air system components, except the load compressor and inlet guide vanes, are line replaceable.

Controls

The ECU sends signals to the IGV actuator to control the IGV position. With the APU bleed switch in the ON position and APU speed above 95 percent, the ECU sends a signal to open the BAV. The ECU sends signals to the SCV to make sure sufficient air flows through the load compressor to prevent a surge.

General Description

ECU BITE checks these bleed air system components:

- BAV
- IGVA
- SCV

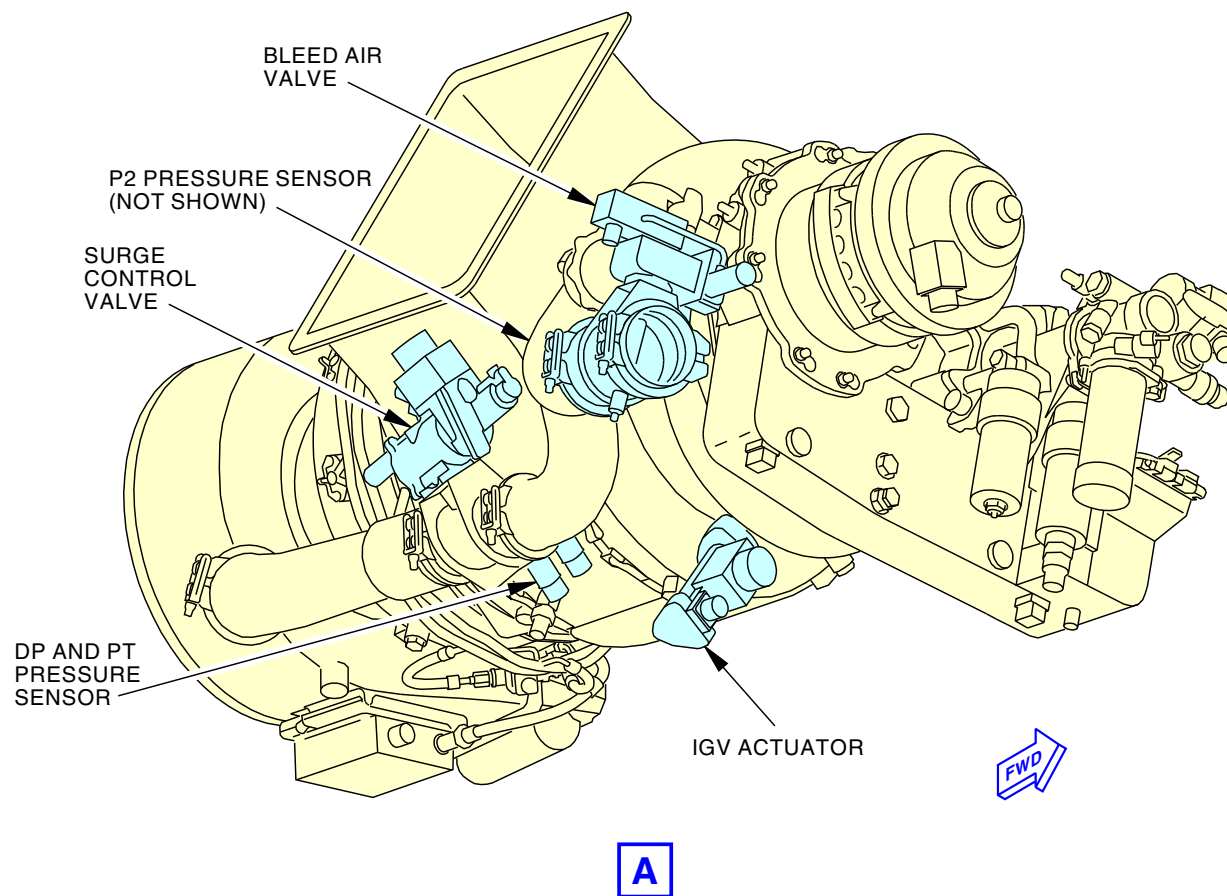
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APU BLEED AIR SYSTEM - INTRODUCTION



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APU BLEED AIR SYSTEM - INTRODUCTION

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APU BLEED AIR SYSTEM - APU BLEED AIR VALVE

Purpose

The APU bleed air valve (BAV) isolates the APU bleed air system from the airplane pneumatic manifold.

Physical Description

The APU bleed air valve has these components:

- Valve flow body with butterfly plate
- Spring-loaded pneumatic actuator
- Control solenoid and electrical connector
- Position indicator (visual)
- Limit switch assembly.

Location

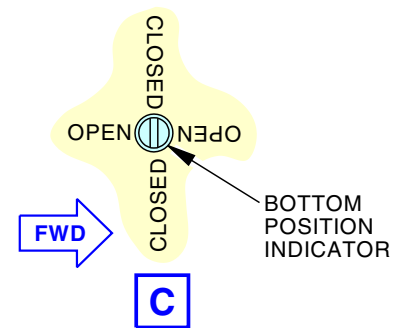
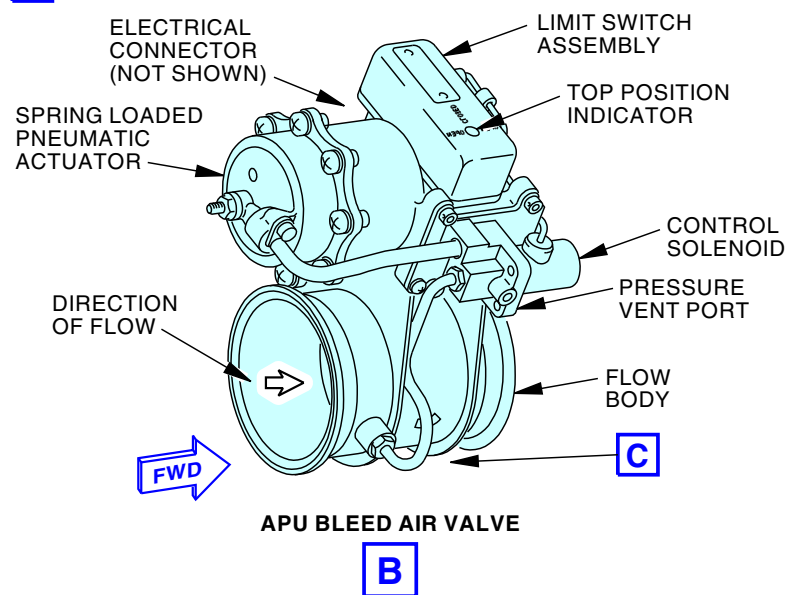
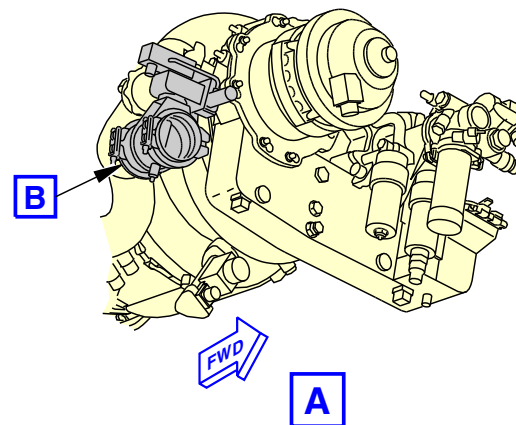
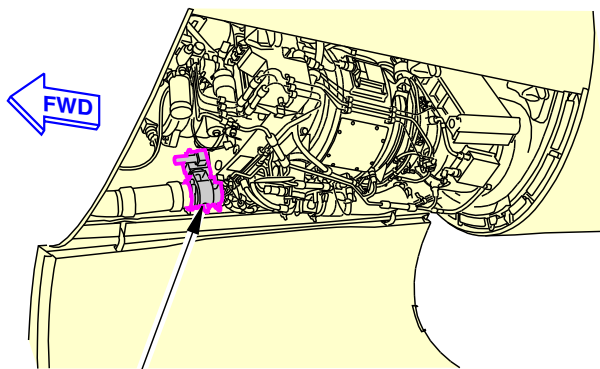
The APU bleed air valve is in the forward right side of the APU. Access is through the APU cowl door.

Mechanical Valve Position Indication

The APU bleed air valve has a visual position indicator on the bottom of the BAV flow body. The APU BAV also has a visual position indicator on the top of the limit switch assembly.

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APU BLEED AIR SYSTEM - APU BLEED AIR VALVE



APU BLEED AIR SYSTEM - APU BLEED AIR VALVE

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**APU BLEED AIR SYSTEM - APU BLEED AIR VALVE - FUNCTIONAL DESCRIPTION****General**

The bleed air valve (BAV) is a butterfly type valve that isolates the APU load compressor from the airplane bleed air system.

Operational Indications

These are the indications in the flight compartment:

- Duct pressure gage
- Dual bleed light.

The duct pressure gage gives the left and right bleed manifold pressures.

See the pneumatic system for more information on duct pressure indication. (SECTION 36-20)

The dual bleed light comes on when these conditions occur:

- APU bleed air valve is open
- Engine 1 or 2 bleed switch is ON and the isolation valve is open.

See the pneumatic system for more information on the dual bleed light. (SECTION 36-20)

Control

The APU bleed air switch sends a signal to the ECU. The APU bleed air switch is on the air conditioning/bleed air controls panel. The switch positions are OFF and ON.

The APU ECU controls the ON and OFF signal to the APU bleed valve solenoid. The BAV opens when the solenoid is energized from the ECU and pneumatic power is available from the load compressor.

The APU ECU energizes the solenoid when these conditions occur:

- APU bleed air switch is in the ON position
- APU is not in cool down cycle
- APU speed is more than 95 percent

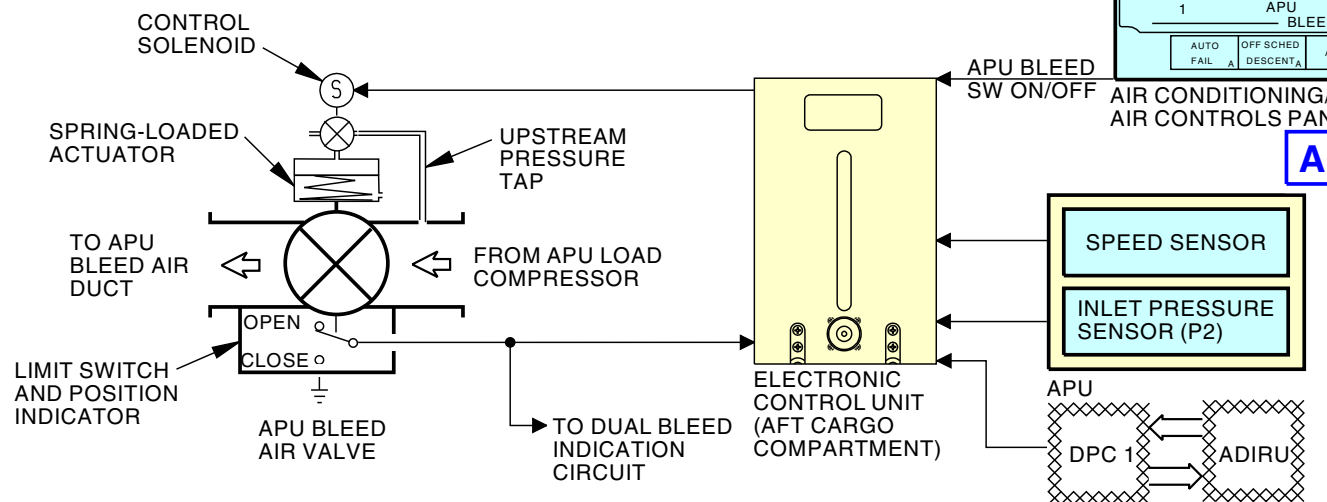
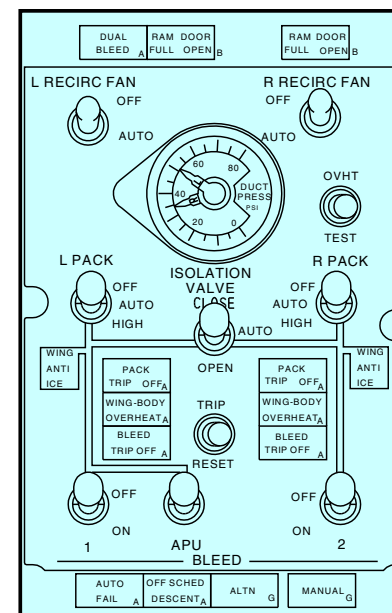
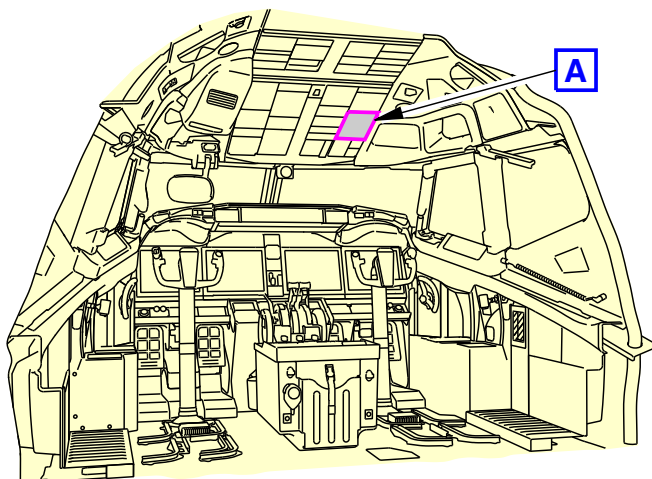
- The altitude is less than 18,000 ft (5486 m), if altitude comes from the ADIRU
- The altitude is less than 21,000 ft (6401 m), if increasing altitude and altitude comes from inlet pressure sensor (P2)
- The altitude is less than 19,000 ft (5791 m), if descending and altitude comes from inlet pressure sensor (P2).

The bleed air valve has a spring to hold it in the closed position. Air from the APU load compressor moves the valve open when the ECU energizes the solenoid.

NOTE: Bleed duct pressure will be 0-6 psig (41 kPa) when the APU bleed air switch is in the OFF position.

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APU BLEED AIR SYSTEM - APU BLEED AIR VALVE - FUNCTIONAL DESCRIPTION



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APU BLEED AIR SYSTEM - APU BLEED AIR VALVE - FUNCTIONAL DESCRIPTION

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**APU BLEED AIR SYSTEM - INLET GUIDE VANES AND ACTUATOR****Purpose**

The inlet guide vanes control the air flow to the load compressor. The IGV actuator controls the IGV position.

Physical Description

Sixteen inlet guide vanes (IGVs) are inside the APU around the load compressor inlet. These are the parts in the inlet guide vane assembly:

- Inlet guide vanes (16)
- Ring gear
- Support assembly
- Segment gears (16).

The inlet guide vane actuator (IGVA) is on the right side of the compressor. These are the actuator components:

- Electrical connector
- Linear variable differential transformer (LVDT)
- Actuator rod
- Fuel inlet line
- Fuel return line
- Drain line.

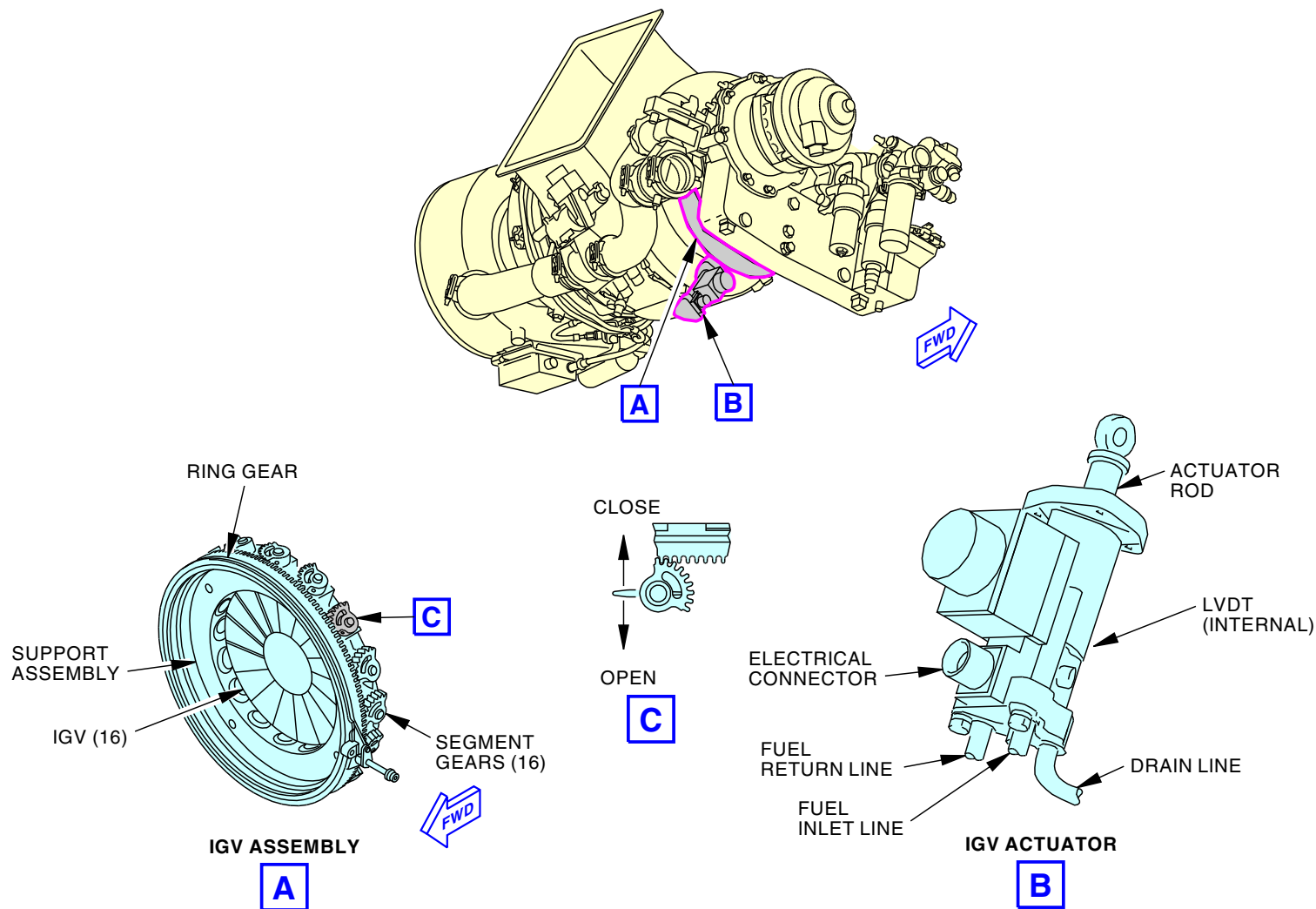
Functional Description

The inlet guide vanes turn between 15 degrees (fully closed) to 115 degrees (fully open). The vanes do not fully close. The vanes are set to stop at the 15 degrees position to cool the load compressor.

The actuator receives signals from the ECU and uses fuel pressure from the FCU to move the vanes. The ECU controls the inlet guide vanes to the correct angle by the air demand from the airplane.

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APU BLEED AIR SYSTEM - INLET GUIDE VANES AND ACTUATOR



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APU BLEED AIR SYSTEM - INLET GUIDE VANES AND ACTUATOR

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**APU BLEED AIR SYSTEM - INLET GUIDE VANES - FUNCTIONAL DESCRIPTION****General**

The ECU receives airplane systems inputs and selects from four bleed air modes. These are the bleed air modes:

- No bleed
- Duct pressurization
- Main engine start
- Air conditioning system (ACS).

The ECU sends a signal to the IGv actuator to change the angle of the IGvs. The angle of the IGvs changes to control the air supply.

The ECU puts the IGvs at 15 degrees when the APU bleed air valve closes.

No Bleed Mode

The no bleed mode occurs when the ECU closes the IGvs to 15 degrees, the APU bleed valve closes, and there is no pneumatic system demand.

Duct Pressurization Mode

The ECU selects the duct pressurization mode when the APU bleed air valve opens and there is no air system demand. The IGvs open to let the load compressor pressurize the air ducts.

Main Engine Start Mode

In main engine start mode, the ECU opens the IGvs to meet the increased airflow requirements. This mode has priority over all other modes.

ACS Mode

In each ACS mode, the ECU opens the IGvs as necessary to supply air to the air conditioning system. These are the four ACS modes:

- One pack in-flight
- One pack ground
- Two pack, normal
- Two pack, high.

The IGv positions in the ACS modes are different for each airplane model.

The ECU finds the airplane model from three signature pins on the airplane ECU connector.

It is recommended that the APU be operated with the two air conditioning packs when maximum cabin cooling is necessary. Use the two air conditioning packs as an alternative to the one air conditioning pack operation. The results of the operation of two air conditioning packs will be cooler cabin temperatures, lower APU fuel burn, better APU hot section life and lower APU noise. Refer to Service Letter 737-SL-49-060 for more data on these results.

Control

After the mode selection, the ECU uses inlet temperature, inlet pressure, and airplane specific data (flight or ground conditions) to find the commanded IGv angle.

The ECU sends control signals to the servo valve on the IGv actuator to open or close the guide vanes. The LVDT in the IGv actuator supplies vane position feedback to the ECU.

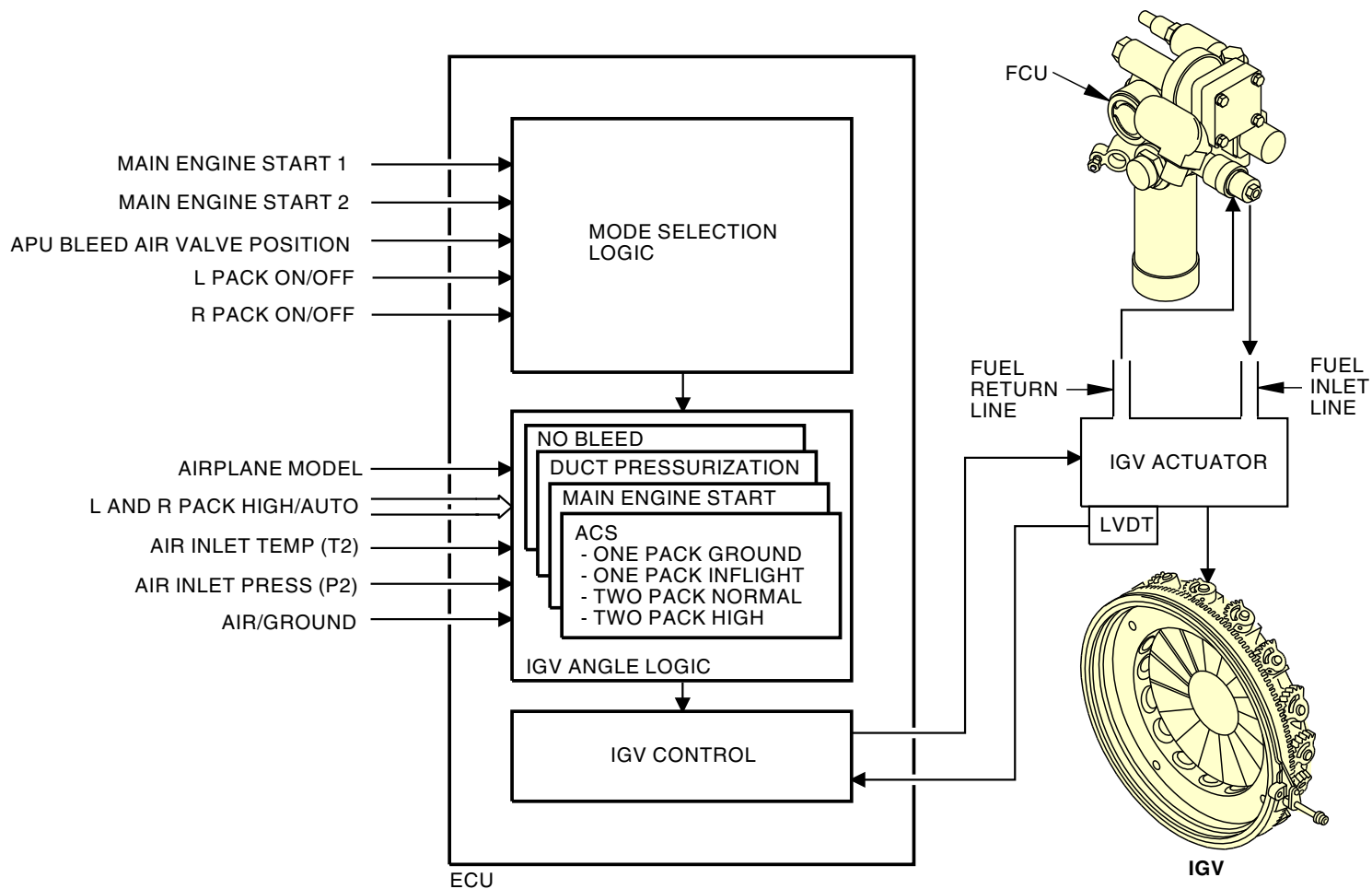
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APU BLEED AIR SYSTEM - INLET GUIDE VANES - FUNCTIONAL DESCRIPTION



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APU BLEED AIR SYSTEM - INLET GUIDE VANES - FUNCTIONAL DESCRIPTION

**APU BLEED AIR SYSTEM - P2, PT, AND DP PRESSURE SENSORS****Purpose**

The three pressure sensors measure load compressor pressures and convert these pressures into a electric signals. The electric signals are sent to the ECU.

These are the three pressure sensors:

- Inlet pressure (P2) sensor
- Total pressure (PT) sensor
- Differential pressure (DP) sensor.

Location

The P2 sensor is attached to the APU inlet. The PT and DP sensors are above the surge control valve (SCV) on the APU inlet.

Functional Description

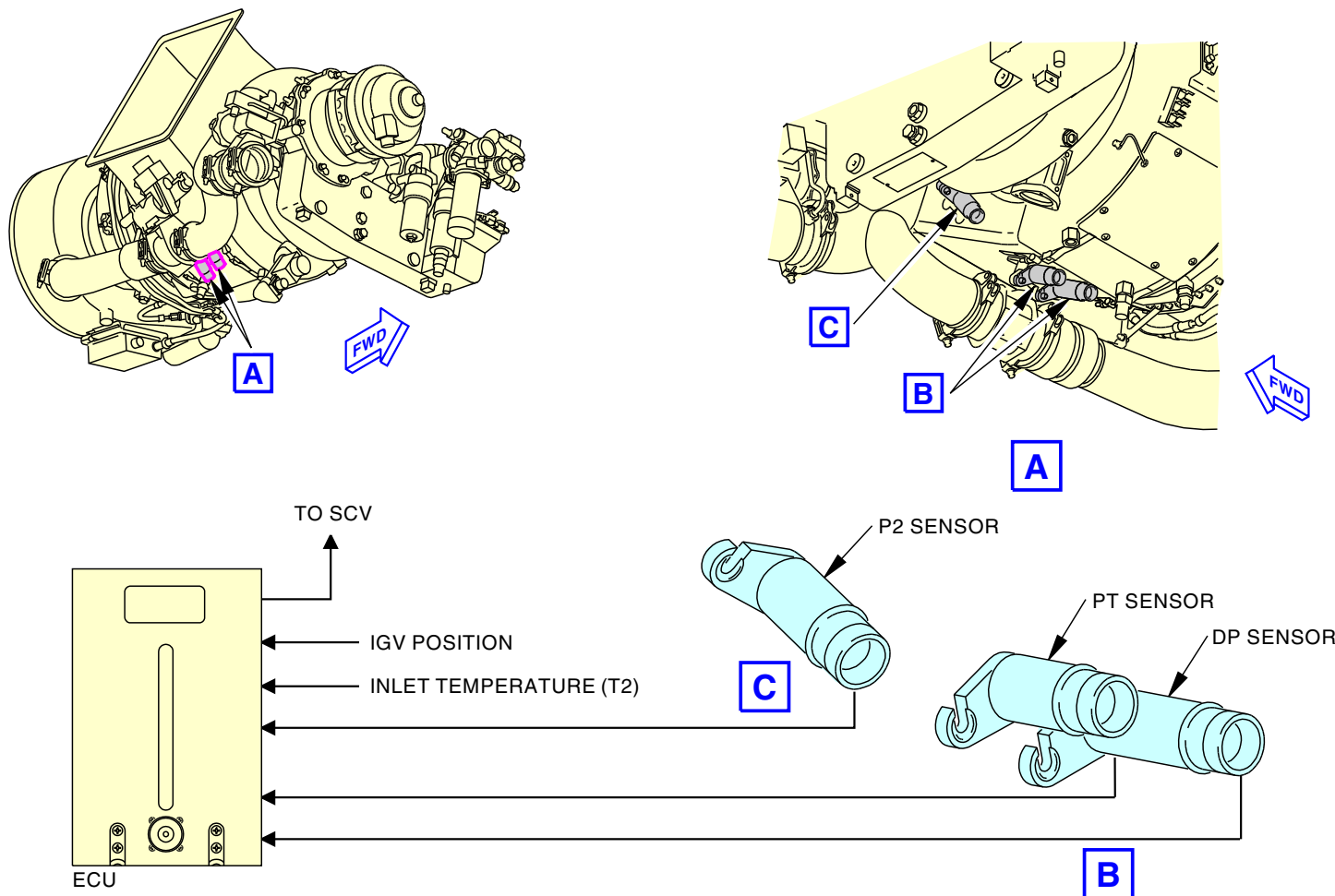
The P2 sensor measures the APU inlet pressure of the load compressor. The ECU uses this data to control APU functions.

The PT sensor measures load compressor total discharge pressure.

A DP sensor measures the difference between the total discharge pressure and the static pressure in the diffuser. Differential pressure equals total pressure minus static pressure.

The ECU uses PT and DP to calculate load compressor airflow. The ECU uses load compressor airflow, inlet temperature, and IGV position to operate the surge control valve.

APU BLEED AIR SYSTEM - P2, PT, AND DP PRESSURE SENSORS



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APU BLEED AIR SYSTEM - P2, PT, AND DP PRESSURE SENSORS

**APU BLEED AIR SYSTEM - SURGE CONTROL VALVE****Purpose**

The surge control valve (SCV) releases air from the load compressor. The SCV ensures there is a minimum flow of air through the load compressor. This prevents a surge. If a surge does occur, the SCV opens to help the load compressor recover.

Physical Description

The SCV is a butterfly type valve. The surge control valve actuator is on the top of the valve. A two-stage servo valve controls the actuator. A visual indicator on the valve indicates the position of the valve.

The SCV has a visual position indicator. This indicator is on the bottom of the SCV flow body.

Location

The valve is in the surge bleed duct on the right side of the APU.

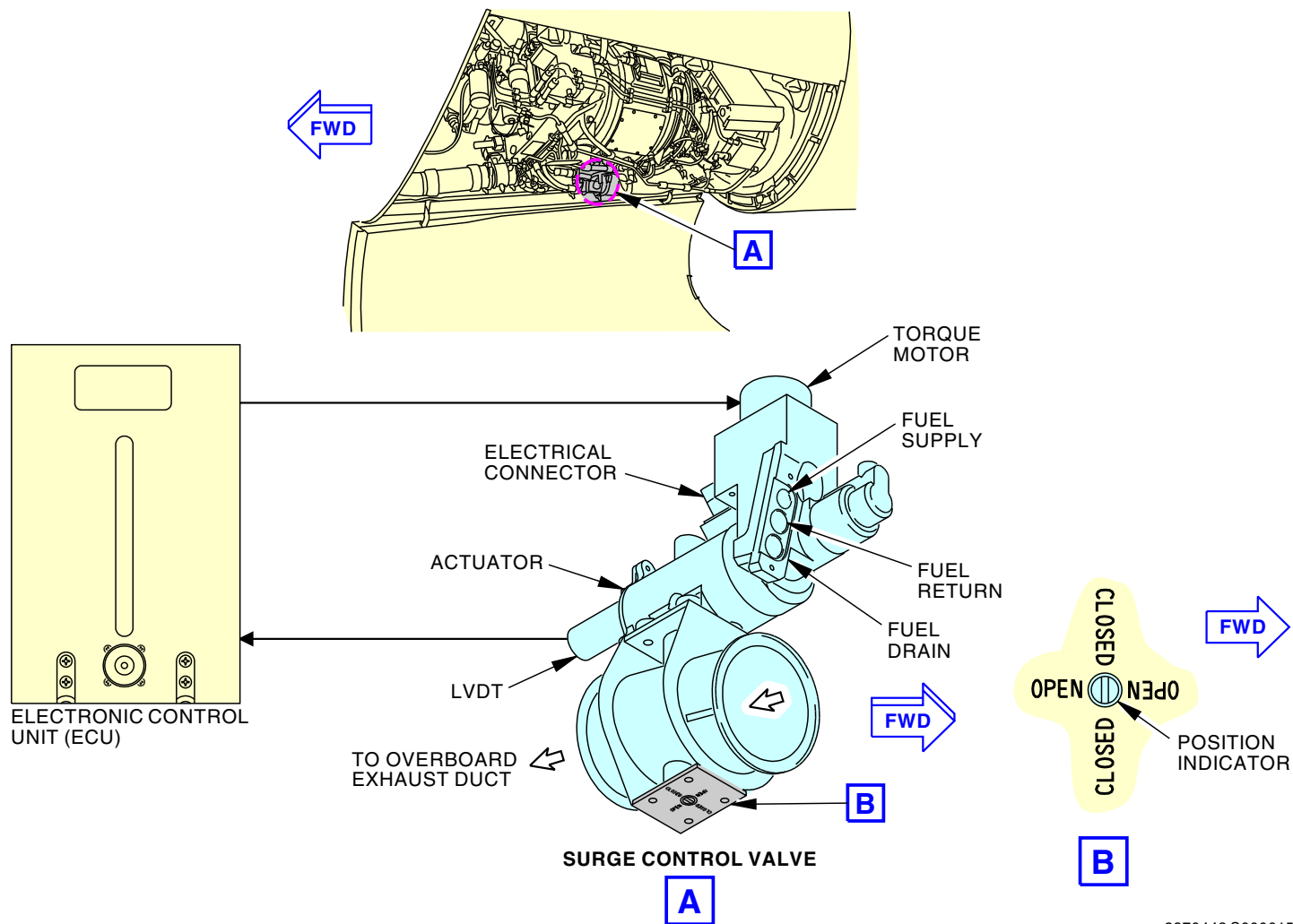
Functional Description

The ECU controls a torque motor on the servo valve. This motor sends 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). A linear variable differential transformer (LVDT) supplies valve position feedback to the ECU.

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

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APU BLEED AIR SYSTEM - SURGE CONTROL VALVE



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APU BLEED AIR SYSTEM - SURGE CONTROL VALVE

**APU BLEED AIR SYSTEM - SURGE BLEED - FUNCTIONAL DESCRIPTION****General**

The APU uses surge bleed to prevent load compressor surges. If there is not sufficient flow through the load compressor, the surge control valve (SCV) releases bleed air into the APU exhaust. The bleed air flow into the exhaust is the surge bleed.

Corrected Air Flow and Surge Margin Setpoint

The ECU calculates the corrected airflow and the surge margin setpoint.

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

The surge margin setpoint is the minimum quantity of corrected air that should flow through the load compressor to prevent load compressor surge.

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

- Inlet temperature (T2)
- IGV position
- Bleed mode
- Air/ground.

If the corrected air flow is less than the surge margin set point, the ECU opens the surge control valve. When the SCV is open, the SCV releases air into the APU exhaust. This surge bleed keeps the airflow through the load compressor at or more than the minimum level.

SCV Actuator Control

The ECU 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 ECU.

APU Start and Shutdown

During the APU start, the surge control valve stays in the full open position. The valve butterfly closes when the APU speed is more than 95 percent speed and the APU bleed switch is in the ON position. This helps prevent stall conditions during a start.

The surge control valve opens when the APU shuts down.

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APU BLEED AIR SYSTEM - SURGE BLEED - FUNCTIONAL DESCRIPTION

**APU BLEED AIR SYSTEM - FUNCTIONAL DESCRIPTION****Purpose**

The APU bleed air system supplies air to the airplane pneumatic system. The APU uses surge bleed to prevent load compressor surges.

APU Bleed Air System

The ECU controls the APU bleed air system.

These are the components of the bleed air system:

- Load compressor
- Inlet guide vanes
- Inlet guide vane actuator
- Bleed air valve
- Pressure sensors
- Surge control valve.

The load compressor supplies airflow to the airplane pneumatic system. The inlet guide vanes control the quantity of air to the load compressor. The inlet guide vane actuator operates the inlet guide vanes.

The inlet guide vane actuator receives commands from the ECU and uses fuel pressure for operation.

The ECU sends a open signal to the APU bleed air valve when the APU is at 95 percent speed and the APU bleed switch is in the ON position.

Electric power controls the bleed air valve and air pressure operates it.

APU Surge Bleed

Load compressor surge protection is on during all APU operations. The surge control valve gives this protection.

The ECU controls the surge control valve by a torque motor. The ECU calculates the correct position of the surge control valve with APU and airplane operating parameters.

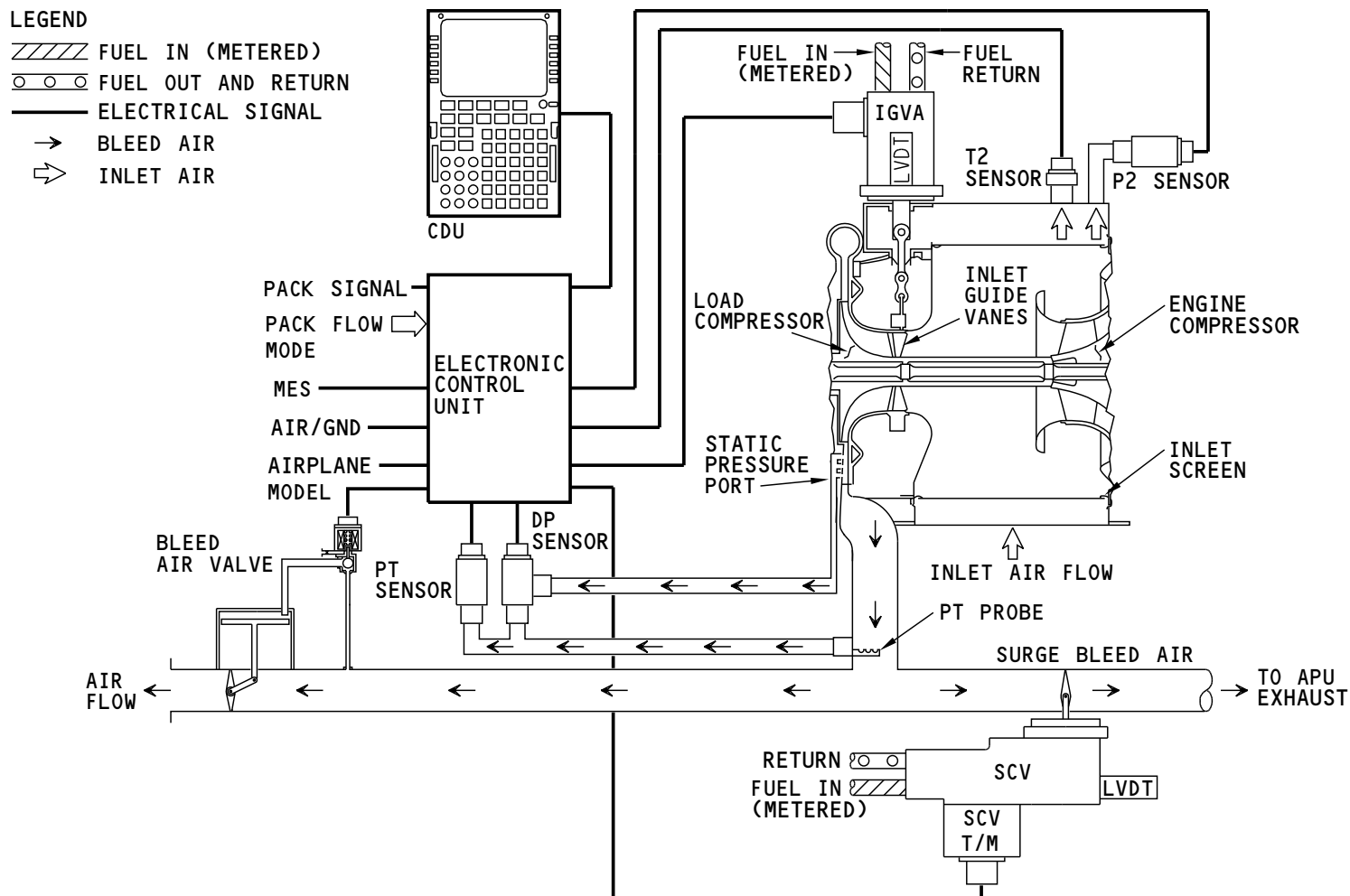
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APU BLEED AIR SYSTEM - FUNCTIONAL DESCRIPTION



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APU BLEED AIR SYSTEM - FUNCTIONAL DESCRIPTION

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APU CONTROLS - INTRODUCTION

Purpose

The APU controls provide control for the APU for all operating conditions.

Flight Compartment Controls and Panels

These are the APU controls and panels in the flight compartment:

- APU switch (P5)
- APU bleed air switch (P5)
- APU generator switch (P5)
- APU fire warning switch (P8).

Other Control Components

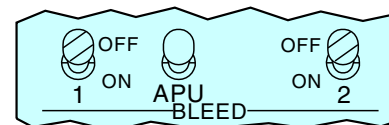
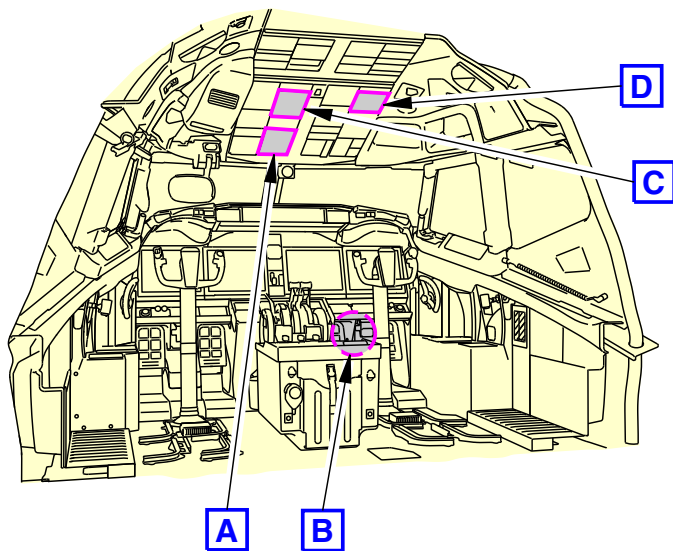
The P28 APU remote control panel is on the right wheel well aft bulkhead.

The electronic control unit (ECU) controls the APU operation when the ECU receives a signal from the controls in the flight compartment. The ECU is in the aft cargo compartment right side.

The ECU also uses signals from certain APU and airplane systems for correct operation of the APU.

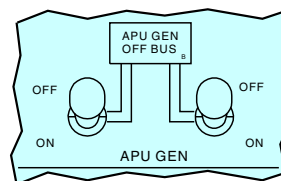
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APU CONTROLS - INTRODUCTION



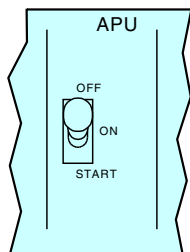
APU BLEED SWITCH (P5)

D



APU GENERATOR SWITCHES(P5)

C



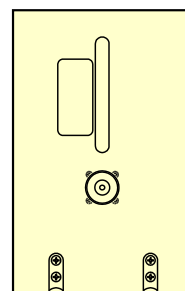
APU SWITCH (P5)

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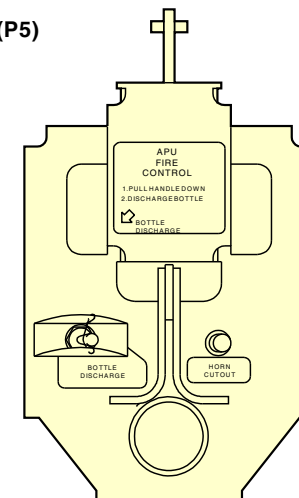


APU FIRE WARNING SWITCH (P8)

B



ELECTRONIC CONTROL UNIT (AFT CARGO COMPARTMENT)



P28 APU REMOTE CONTROL PANEL (RIGHT WHEELWELL)

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APU CONTROLS - INTRODUCTION

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APU CONTROLS - ELECTRONIC CONTROL UNIT - INTRODUCTION

Purpose

The ECU controls APU functions. The ECU also contains circuits for fault detection and isolation.

Location

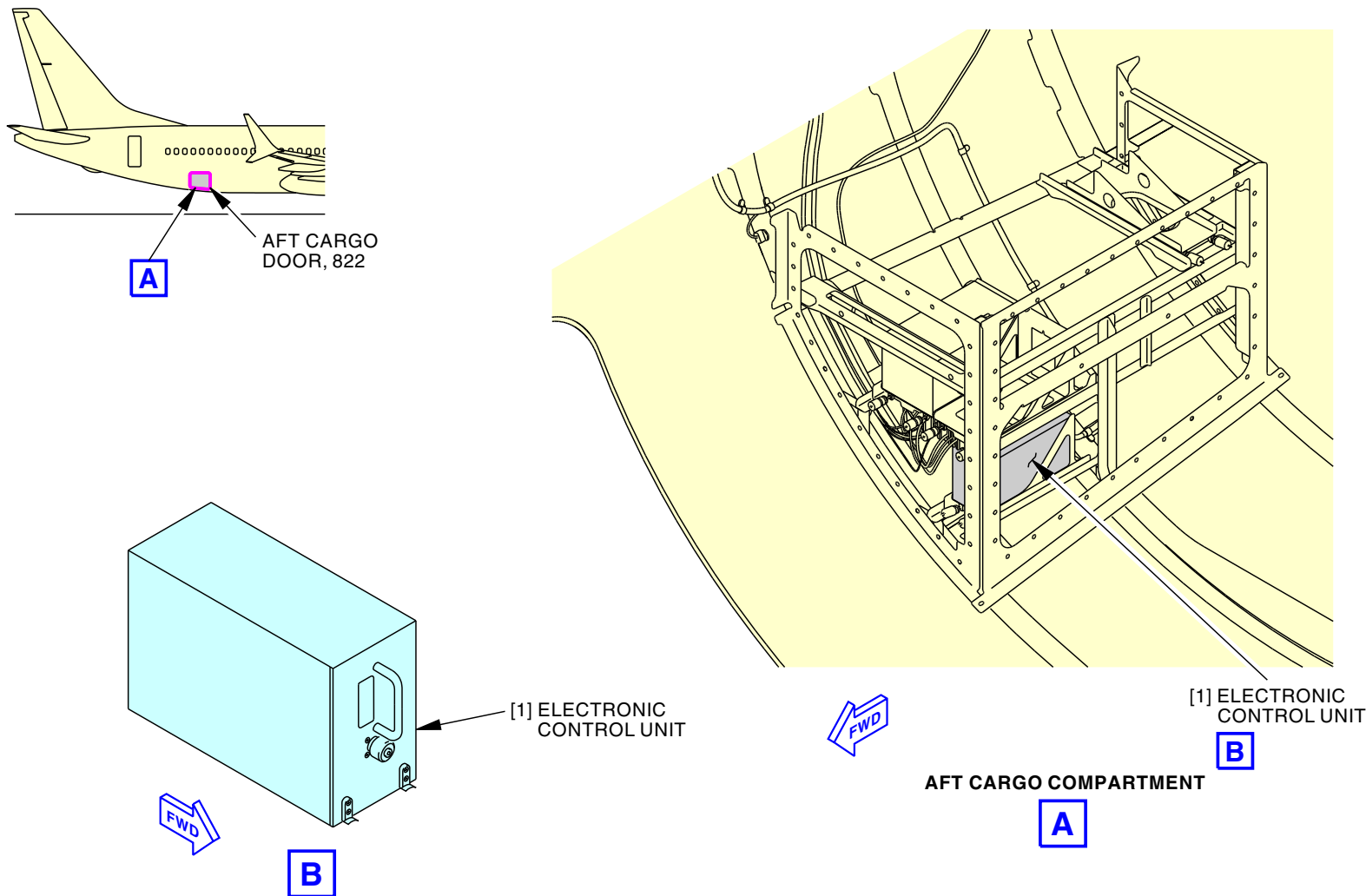
The ECU is on a shelf in the aft cargo compartment near the aft cargo door.

General Information

The ECU is a line replaceable unit (LRU). The circuit cards in the ECU are not LRUs. Access to the ECU is inside the aft cargo door and the hinge door that protects the ECU front face.

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APU CONTROLS - ELECTRONIC CONTROL UNIT - INTRODUCTION



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APU CONTROLS - ELECTRONIC CONTROL UNIT - INTRODUCTION

49-60-00

**APU CONTROLS - ELECTRONIC CONTROL UNIT - INPUTS****General**

The ECU receives inputs from airplane systems and from the APU.

The ECU receives 28v dc power from the 28v dc switched hot battery bus.

Airplane System ARINC 429 Data Bus

The ECU receives airplane data from the display processing computer (DPC). The ARINC 429 bus transmits this information. The MDS is used to get APU BITE data from the ECU.

Operational Software Loading

Maintenance personnel can install operation software in the ECU with the data loader. See the data loader section for more information on the data loader. (SECTION 34-61)

Airplane Systems Discrete Inputs

The ECU receives these airplane system inputs:

- ACS pack ON/OFF
- Air/ground indication
- Airplane model
- APU automatic fire shutdown
- APU BITE power up
- APU bleed command
- APU fire warning switch
- APU fuel shutoff valve position
- Air inlet door position
- APU OFF signal
- APU ON signal
- APU remote fire switch
- APU START signal
- Generator load
- Main engine start/run

- Start converter BITE data.

APU Inputs

These inputs are from the APU to the ECU:

- Air inlet temperature
- APU bleed air valve position
- APU fault data
- Data memory module (DMM)
- Delta pressure (DP)
- EGT (2)
- Filter pressure switch
- Fuel flow
- Fuel temperature
- IGV position
- Inlet air pressure (P2)
- Low oil pressure switch
- Oil level
- Oil pressure
- Oil temperature
- SCV position
- Speed sensor with 2 signals
- Total air pressure (PT).

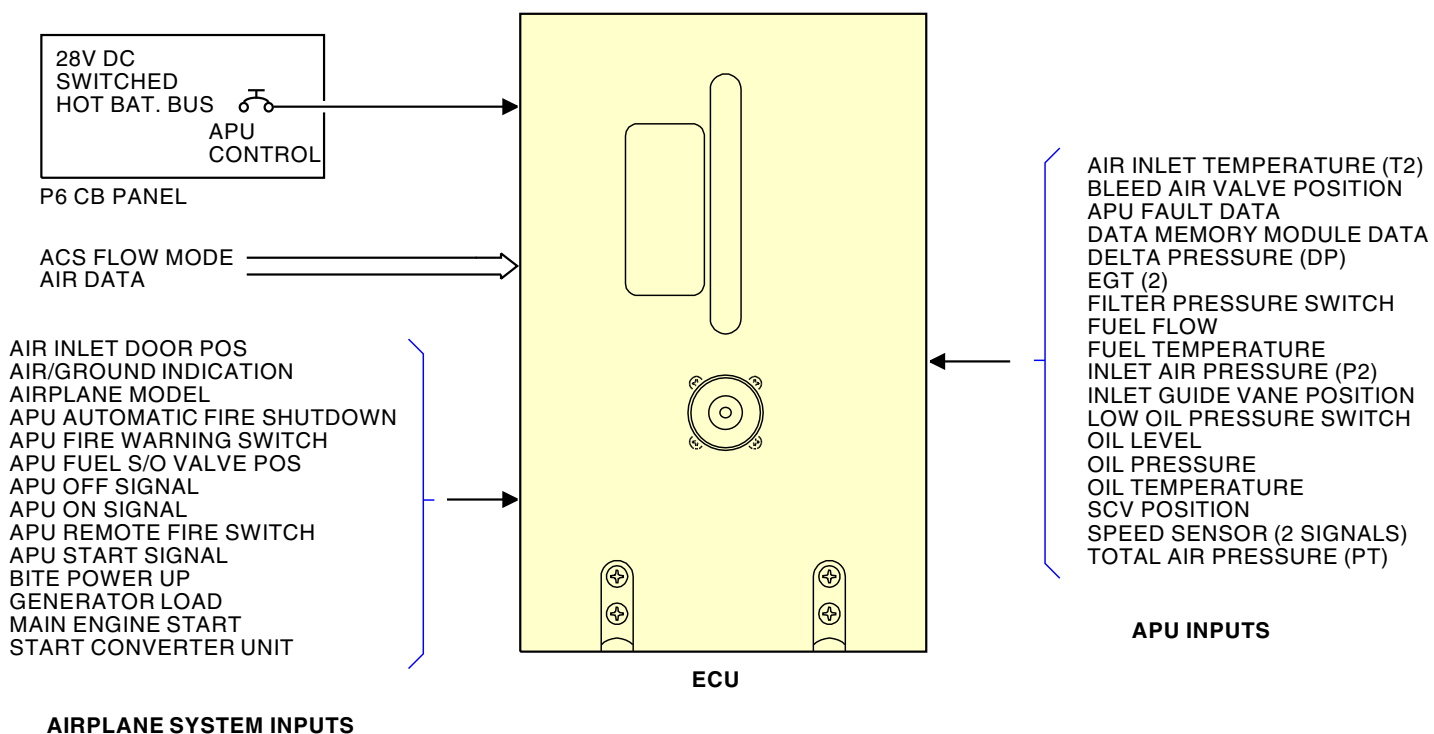
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APU CONTROLS - ELECTRONIC CONTROL UNIT - INPUTS



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APU CONTROLS - ELECTRONIC CONTROL UNIT - INPUTS

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**APU CONTROLS - ELECTRONIC CONTROL UNIT - OUTPUTS****General**

The ECU supplies APU data to airplane systems and it controls APU functions.

ECU ARINC 429 Outputs

The ECU supplies this APU data to the MDS (Max Display System) through the ARINC 429 bus. :

- APU and ECU part numbers and serial numbers
- APU fault data
- APU maintenance data
- APU running status (over 40 indications, shown on the MDS (Max Display System))
- Oil quantity.

ECU Outputs to the APU

The ECU sends signals to control these APU components:

- Bleed air valve (BAV)
- Fuel metering valve
- Fuel solenoid valve
- Flow divider solenoid
- Ignition unit
- Inlet guide vane actuator (IGVA)
- Surge control valve (SCV).

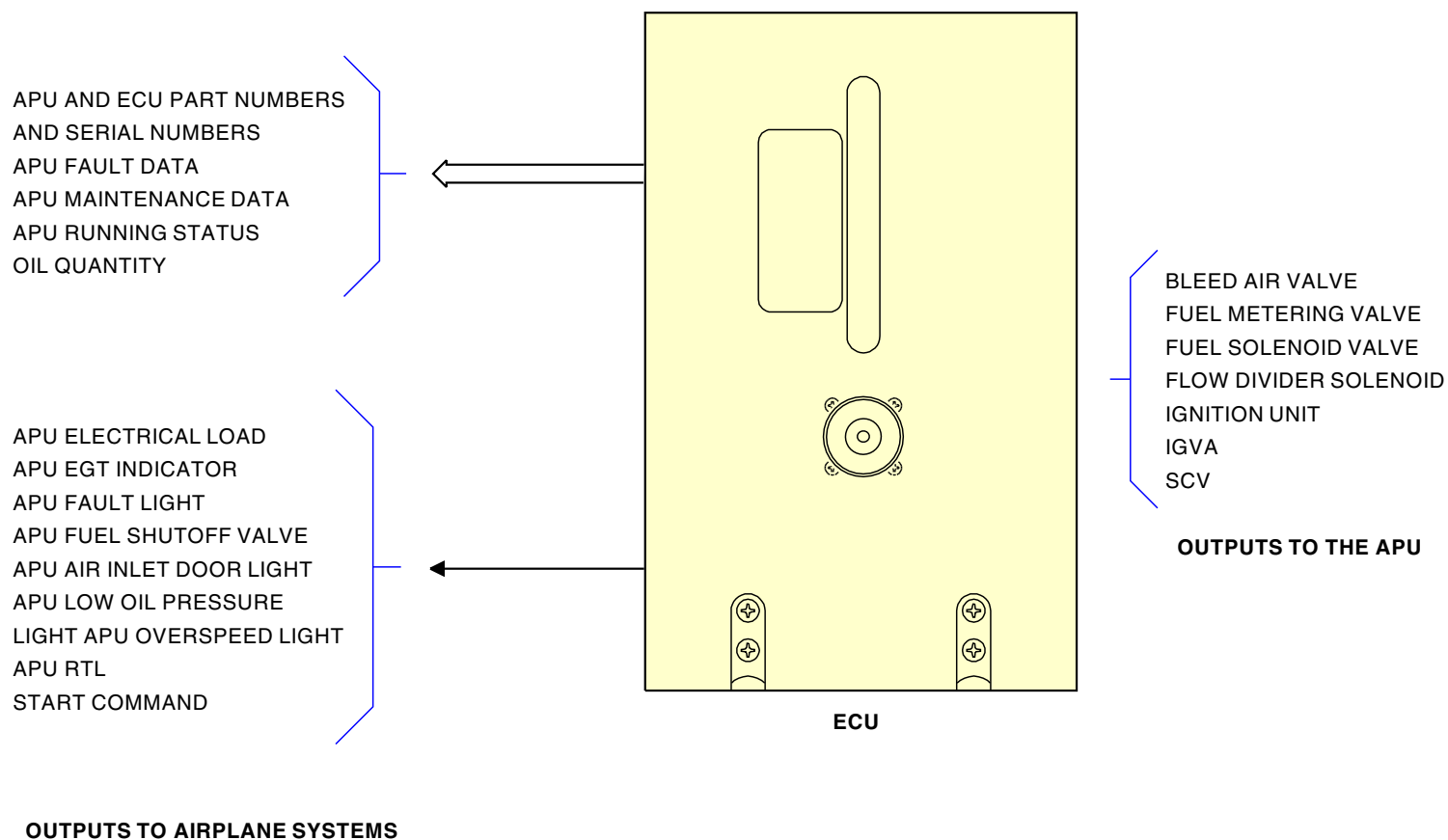
ECU Outputs to Other Airplane Systems

The ECU also sends these analog signals:

- APU EGT indicator
- APU electrical load shed command
- APU fault light (amber)
- APU fuel shutoff valve

- APU air inlet door
- APU low oil pressure light (amber)
- APU door light (amber)
- APU overspeed light (amber)
- Ready to load APU GEN OFF BUS light on at 95 percent speed (blue)
- Start command.

APU CONTROLS - ELECTRONIC CONTROL UNIT - OUTPUTS



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APU CONTROLS - ELECTRONIC CONTROL UNIT - OUTPUTS

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**APU CONTROLS - ELECTRONIC CONTROL UNIT - FAULT MONITORING****General**

The ECU does tests of the APU components and its internal functions. The ECU does some component tests continuously and others only when the APU is in a specific mode.

The ECU memory holds up to 99 faults. When the memory is full, new faults record over the oldest faults.

- Start converter unit (SCU)
- Start power unit (SPU)
- Starter-generator
- Surge control valve (SCV)
- Total air pressure (PT) sensor.

Monitored Components

The ECU monitors these components:

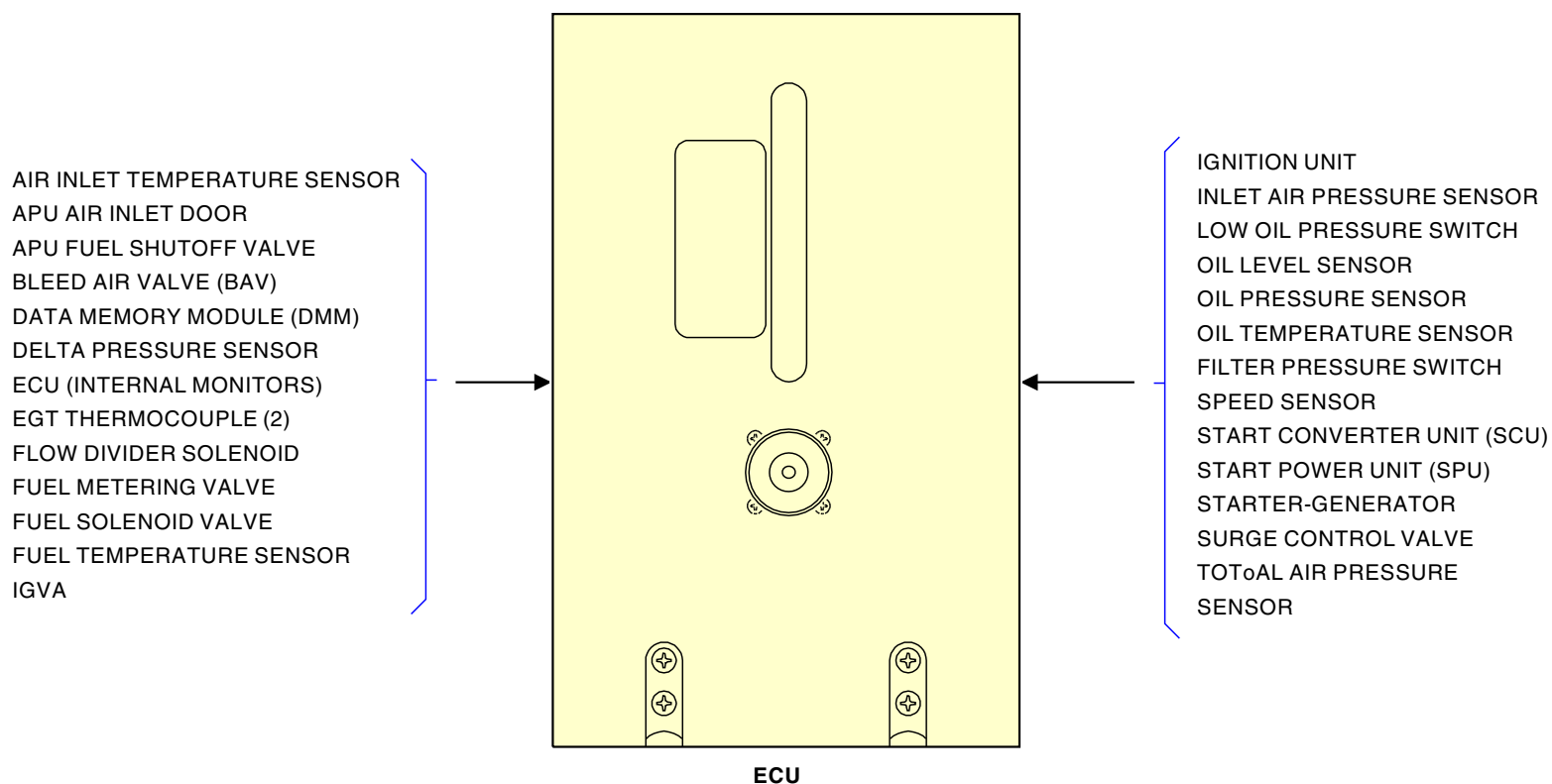
- Air inlet temperature (T2) sensor
- APU air inlet door
- APU fuel shutoff valve
- Bleed air valve (BAV)
- Data memory module (DMM)
- Delta pressure (DP) sensor
- ECU (internal monitors)
- EGT thermocouple (2)
- Flow divider solenoid
- Fuel metering valve
- Fuel solenoid valve
- Fuel temperature sensor
- IGVA
- Ignition unit
- Inlet air pressure (P2) sensor
- Low oil pressure switch
- Oil level sensor
- Oil pressure sensor
- Oil temperature sensor
- Filter pressure switch for starter-generator filter
- Speed sensor

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APU CONTROLS - ELECTRONIC CONTROL UNIT - FAULT MONITORING



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APU CONTROLS - ELECTRONIC CONTROL UNIT - FAULT MONITORING

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**APU CONTROLS - ELECTRONIC CONTROL UNIT - PROTECTION SYSTEM****General**

The ECU ensures the APU operates correctly. If the ECU senses APU operation that could cause damage, the ECU shuts down the APU. This is a protective shutdown. A protective shutdown can occur anytime during APU start and operation. The ECU keeps protective shutdown data in memory. The MDS is used to get this data.

Protective Shutdown

The ECU uses protective shutdown logic to automatically shutdown the APU. The ECU did a protective shutdown if the fault or overspeed lights come on. The ECU also does a protective shutdown and the low oil pressure (LOP) light comes on if oil pressure is too low when the APU speed is more than 95%. These lights are on the ac systems, generator, and APU module. When the ECU does a protective shutdown, the master caution and APU annunciator light on the P7 panel also come on.

The APU protective shutdown lights go off when the APU switch is moved to OFF and back to ON with APU speed less than 7 percent or when the ECU deenergizes. The ECU de-energizes five minutes after these condition occur:

- APU switch in OFF position
- APU BITE is off
- APU fuel shutoff valve is closed.

If the fuel shutoff valve fails in the open position, the ECU will not deenergize. This causes the FAULT light to be on until the battery switch is moved to the off position.

These are the protective shutdowns that cause a fault light:

- APU fuel valve shutdown
- DC powerloss shutdown
- ECU shutdown
- Fire shutdown
- Inlet door shutdown
- Inlet overheat shutdown

- Loss of EGT shutdown
- Loss of speed shutdown
- No acceleration shutdown
- No APU rotation shutdown
- No flame shutdown
- Oil filter shutdown
- Oil temperature shutdown
- Overtemperature shutdown
- Reverse flow shutdown
- Sensor failure
- Underspeed shutdown
- Shorted rotating diode

These are the protective shutdowns that cause an overspeed light:

- Overspeed shutdown
- Overspeed protection.

A low oil pressure protective shutdown causes the low oil pressure light to come on.

During a protective shutdown, these APU and airplane system changes occur:

- Fuel solenoid valve closes
- Fuel control unit metering valve closes
- APU light comes on
- Remove ready to load signal (RTL)
- Igniter deenergizes, if energized
- IGVs close
- SCV opens
- APU fuel shutoff valve closes
- APU inlet door closes.

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**APU CONTROLS - ELECTRONIC CONTROL UNIT - PROTECTION SYSTEM**

The fuel shutoff valve and inlet door start to close when the APU speed decreases to 30 percent on all shutdowns except FIRE and OVERSPEED. The fuel shutoff valve and inlet door begin to close as soon as a FIRE or OVERSPEED shutdown begins.

Protective Shutdown Logic

An APU fuel valve shutdown occurs if the ECU commands the fuel shutoff valve closed and the ECU does not get a closed signal 29 seconds after the command. This fault makes the FAULT light come on and stay on until the fuel valve closes or the battery switch is moved to the OFF position.

A DC power loss shutdown occurs if ECU power is lost for more than 50 msec and APU speed is more than 7 percent.

An ECU shutdown occurs when a failure of any ECU component that does not let the ECU detect or control APU operations. An example of this is a failure of the fuel torque motor driver.

A fire shutdown occurs if one of the APU fire handles is pulled or if the fire detection system detects a fire.

An inlet door shutdown occurs if the ECU commands inlet door open and the ECU does not get an open signal from the inlet door position switch in 30 seconds. An inlet door shutdown also occurs if the door open signal is lost for 1 second after APU speed is more than 7 percent.

An inlet overheat shutdown occurs if the compressor inlet temperature is more than 350F (180C) for 3 seconds.

A loss of EGT shutdown occurs if both EGT thermocouples fail. Loss of one EGT thermocouple does not shutdown the APU.

A loss of speed shutdown occurs if both speed sensing circuits fail. Loss of one speed circuit does not shutdown the APU. A speed circuit includes the speed sensor, aircraft wiring and the ECU.

A no acceleration shutdown occurs if, after ignition and before 95 percent, acceleration is less than 0.2 percent per second for 12.5 seconds.

A no APU rotation shutdown occurs if speed is less than 7 percent 20 seconds after the ECU gives the start command to the SCU.

A no flame shutdown occurs if EGT change is less than 100F (38C) 23 seconds after the ECU commands the fuel solenoid valve open.

An oil filter shutdown occurs if these conditions occur:

- Oil temperature is more than 100F (38C)
- Both main engines are off for more than 90 seconds
- Airplane is on ground
- Starter-Generator Oil filter is clogged for more than 5 seconds.

A oil temperature shutdown occurs if the oil temperature is more than 300°F (149°C) for 10 seconds and the sensor is good.

An overtemperature shutdown occurs if the turbine inlet temperature or exhaust gas temperature goes too high. When APU speed is above 95 percent, the maximum turbine inlet temperature is 2200°F (1204°C). The ECU uses exhaust gas temperature to calculate turbine inlet temperature. When APU speed is less than 95 percent, the ECU uses these values to find the maximum exhaust gas temperature:

- APU speed
- Inlet temperature (T2)
- Inlet pressure (P2).

A reverse flow shutdown occurs if load compressor air flow decreases to approximately zero for 6 seconds. The ECU commands the BAV closed when the air flow decreases to approximately zero for one second. With the BAV closed, bleed air can not reverse flow from the airplane to the APU load compressor. This prevents most reverse flow shutdowns.

A sensor failure shutdown occurs if the inlet temperature (T2) or the oil temperature sensor fails and the airplane is on the ground.

An underspeed shutdown occurs if these conditions occur for 10 seconds:

- APU acceleration is less than 0.5 percent per second
- APU speed is less than 85 percent
- APU is not starting.
- The starter has a shorted rotating diode.

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**APU CONTROLS - ELECTRONIC CONTROL UNIT - PROTECTION SYSTEM**

An overspeed protection shutdown occurs if the APU fails the overspeed circuit test. The ECU does the overspeed circuit test during APU shutdown.

An overspeed protection shutdown also occurs if the fuel solenoid valve fails in the open position. The fuel solenoid valve fails in the open position if these conditions occur:

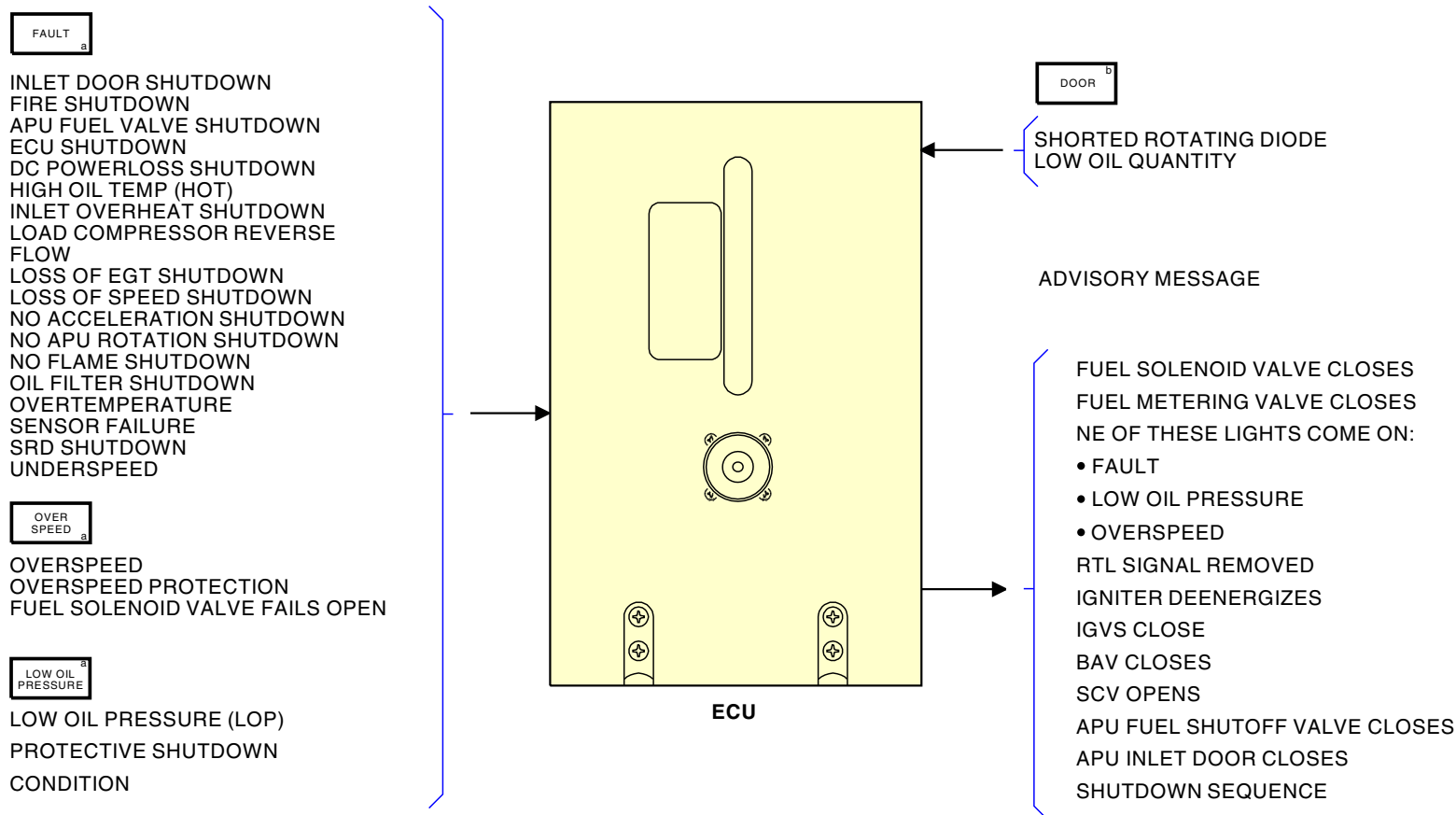
- Power is removed from fuel solenoid valve for 10 seconds
- APU speed is more than 90 percent.

An overspeed shutdown occurs if the APU speed is more than 106 percent.

An oil pressure shutdown occurs if the APU is on speed and oil pressure is low for 20 seconds.

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APU CONTROLS - ELECTRONIC CONTROL UNIT - PROTECTION SYSTEM



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APU CONTROLS - ELECTRONIC CONTROL UNIT - PROTECTION SYSTEM

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APU CONTROLS - ELECTRONIC CONTROL UNIT - ICE BREAK LOGIC

General

The IDENT CONFIG page 2 shows the status of the ICE LOGIC for the ECU. The status messages are:

- ICE LOGIC ON
- ICE LOGIC OFF

When the ice logic is selected on, the inlet guide vanes are swept at a regular interval when the temperature is near freezing to prevent ice from forming and freezing the vanes in place. During the sweep of the inlet guide vanes, it is normal to hear a change in the APU sound.

ICE CONFIG

NOTE: The ICE CONFIG is also known as the APU ECU Ice Breaker Logic (IBL).

Transition (when the APU is moving from one mode to another, for example RTL to ECS):

- When $T2 < 52^{\circ}\text{F}$ (11°C) and when position error is detected which keeps the IGVs from moving, there will be no noticeable effects, but the IGVs will be commanded partially open and closed indefinitely unless APU is shutdown, or until the IGVs move to their commanded position.

Ready to Load (APU on, APU Bleed Switch off):

- When $T2 < 52^{\circ}\text{F}$ (11°C) there will be a small noise increase for 2 seconds every 60 seconds due to small IGV commanded movements. This noise is due to a small sweep (+7 degrees and back to RTL position) that serves to detect if vanes are stuck.

Duct Pressurization and ECS modes (APU on, APU Bleed Switch on, R&L Packs on or off):

- When $T2 < 52^{\circ}\text{F}$ (11°C) and when ice is accumulating on the IGVs, there will be an audible “whoosh” for 3 seconds every 60 seconds noticeable in and around the aircraft. This noise is due to the IGVs being commanded full open and back to original position under this weather and ice condition. Correspondingly, the additional air flowing through the load compressor goes downstream to the Air Cycle Machine (ACM), and the resulting spooling up and down of the ACM creates the audible difference. This feature will automatically turn off when the APU is shutdown or when MES is attempted.

MES mode will not be affected. In-flight operations will not be affected.

The IBL option may be turned on and off from the CDU Ident./Config. page 2. The on/off toggle will be shown at all times on Line 11 of the CDU. Line 11 will read one of the following messages:

- ICE LOGIC ON
- ICE LOGIC OFF

The IBL Scratch Pad Entries for turning this feature on and off will be typed into Line 14 with wording as follows:

- ICELOGICON
- ICELOGICOFF

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APU CONTROLS - ELECTRONIC CONTROL UNIT - ICE BREAK LOGIC

	SYS MENU	STATUS	MAINT DATA PGS	MAINT CTRL PGS	ONBD MAINT
LINE MAINT		EXTENDED MAINT		OTHER FUNCTIONS	
SPECIAL FUNCTIONS					

	SYS MENU	STATUS	MAINT DATA PGS	MAINT CTRL PGS	ONBD MAINT
LINE MAINT		EXTENDED MAINT		OTHER FUNCTIONS	
SPECIAL FUNCTIONS					
SELECTION ▶ PRECONDITIONS ▶ FUNCTION ▶ POST CONDITIONS					
APU - Ice Break Logic					
Function Description: This function turns ON or OFF the inlet guide vane ice break logic					
Approximate Time to Run Test: Less than 1 minute					
Airplane Effects: No visible effect					
Limitations/Special Requirements: None					
TO RUN THE FUNCTION: 1 - Set APU MAINT POWER switch to TEST or set APU Master Control switch to ON 2 - Push CONTINUE at the bottom of this screen					
GO BACK				CONTINUE	

APU CONTROLS - ECU - SPECIAL FUNCTIONS - ICE BREAK LOGIC

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APU CONTROLS - ELECTRONIC CONTROL UNIT - ICE BREAK LOGIC

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**APU CONTROLS - ELECTRONIC CONTROL UNIT - LIMITED RESTART****General**

Some protective shutdown conditions prevent the restart of the APU.

The APU limited restart function allows the electronic control unit (ECU) to be reset after one of these protective shutdowns occur.

On the max display system (MDS), the following selections on the onboard maintenance (ONBD MAINT) are used to access this function:

- OTHER FUNCTIONS
- SPECIAL FUNCTIONS
- 49 — Airborne Auxiliary Power System
- APU - Limited Restart

Follow the screen prompts to reset the protective shutdown. This will allow a restart of the APU.

SIA ALL	EFFECTIVITY



APU CONTROLS - ELECTRONIC CONTROL UNIT - LIMITED RESTART

	SYS MENU	STATUS	MAINT DATA PGS	MAINT CTRL PGS	ONBD MAINT
LINE MAINT	EXTENDED MAINT	OTHER FUNCTIONS			
		SPECIAL FUNCTIONS			

	SYS MENU	STATUS	MAINT DATA PGS	MAINT CTRL PGS	ONBD MAINT
LINE MAINT	EXTENDED MAINT	OTHER FUNCTIONS			
SPECIAL FUNCTIONS					
SELECTION ▶ PRECONDITIONS ▶ FUNCTION ▶ POST CONDITIONS					
Select ATA System (5)					
32 - Proximity Switch Electronic Unit					
49 - Airborne Auxiliary Power System					
71 - 80 Left Engine					
71 - 80 Right Engine					
97 - OMF Debug					
Select System Function (5)					
APU - Reset Hours Since Installation					
APU - Limited Restart					
APU - Ice Break Logic					
CONTINUE					

APU CONTROLS - ECU - SPECIAL FUNCTIONS - LIMITED RESTART

APU CONTROLS - ELECTRONIC CONTROL UNIT - LIMITED RESTART

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**APU CONTROLS - SPEED SENSOR****Purpose**

A dual-coil speed sensor measures APU shaft speed and supplies two independent speed signals to the ECU.

Location

The speed sensor is on the right side of the compressor case.

Functional Description

The speed sensor is a variable reluctance motion sensor. The sensor sends a signal with a frequency proportional to engine speed. The ECU selects the higher of the two signals for control and display functions.

Control

The ECU uses engine speed to control these functions:

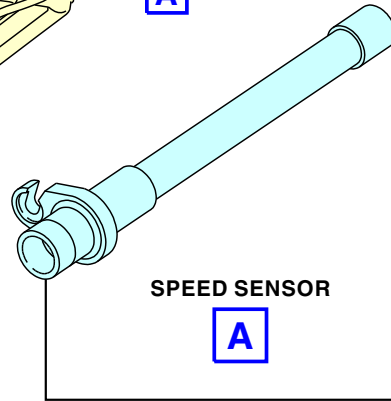
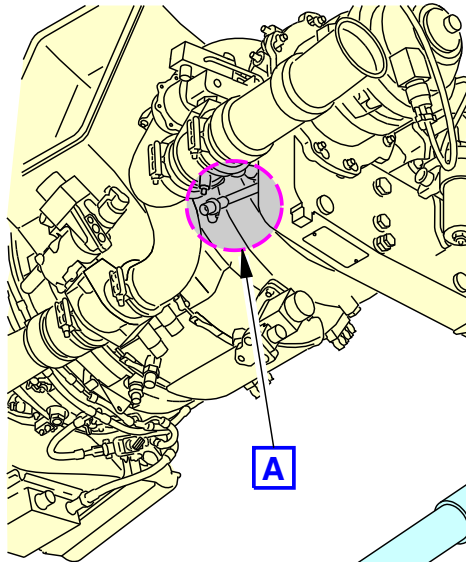
- Ignition system control
- Starter system control
- Fuel system control
- APU speed control
- Overspeed automatic shutdown protection
- No-acceleration automatic shutdown protection.
- APU ready-to-load (RTL).

Indications

APU engine speed shows on the MDS (Max Display System).

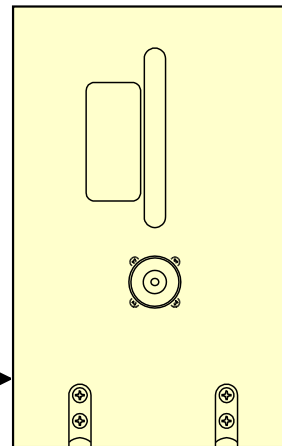
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APU CONTROLS - SPEED SENSOR



SPEED SENSOR

A



ECU

SYS MENU	STATUS	MAINT DATA PGS	MAINT CTRL PGS	ONBD MAINT
APU				
MODE	XXXXXXXXXXXX	APU GEN LOAD	XXX.X	
RPM	XXX.X			
EGT	XXXX	INLET DOOR	----	
OIL TEMP	XXXX	OPEN COMMAND	XXXXXXXX	
OIL QTY	XXXX	CLOSE COMMAND	XXXXXXXX	
COMP INLET TEMP	XXXX	POSITION SW	XXXXXXXX	
INLET STATIC PRESS	XX.XX	COR EGT	XXXX	
LOAD COMP TOTAL PRESS	XX.XX	COR TOTALPRESS	XXX	
LOAD COMP DIFF PRESS	XX.XX	COR FUEL FLOW	XXX	
SURGE CTRL VLV POS	XX.X	COR IGV POS	XXX	
IGV ACTUATOR POS	XX.X	APU HOURS	XXXXXXXX.X	
BLD CORRECTED FLOW	XXX	APU CYCLES	XXXXXX	
FUEL FLOW MEAS	XXX	HOURS SINCE INSTALLATION ON AIRPLANE	XXXXX.X	
z- - - -STATUS CODE- - - -z BIT# 1 5 STATUS 1 [XXXX] [XXXX] STATUS 2 [XXXX] [XXXX] STATUS 3 [XXXX] [XXXX] STATUS 4 [XXXX] [XXXX]				
AUTO EVENT MESSAGE DATE XX XXX XX UTC XX:XX:XX PREV MENU PRINT SEND RECORD PREV PAGE NEXT PAGE				

MAX DISPLAY SYSTEM (MDS)
APU MAINTENANCE PAGE

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APU CONTROLS - SPEED SENSOR

**APU CONTROLS - INLET TEMPERATURE SENSOR T2****Inlet Temperature Sensor**

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

- Fuel control
- IGV control
- SCV control
- EGT trim schedule (ECS and MES modes)
- Inlet overheat.

Location

The inlet temperature sensor is on the bottom of the APU compressor plenum.

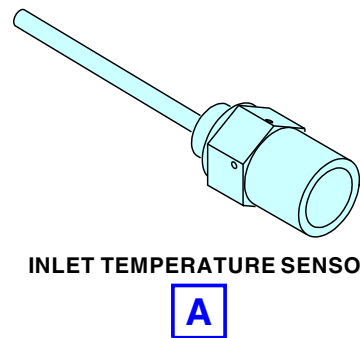
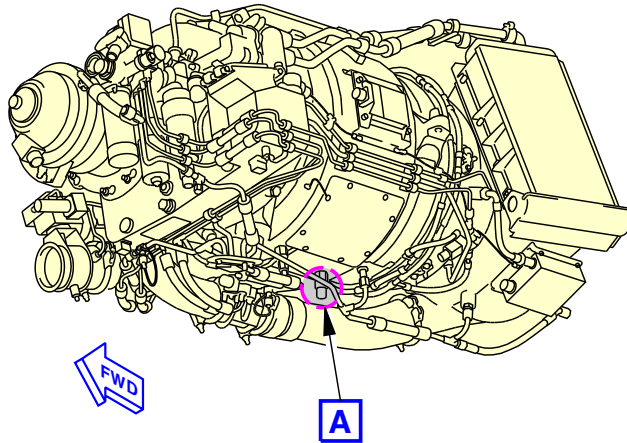
Functional Description

The inlet temperature sensor is a resistive temperature device (RTD). When the air temperature into the inlet of the compressor changes, the resistance changes in the sensor. The ECU senses this change in resistance. The ECU adjusts the APU operation due to that temperature change.

The ECU also sends the temperature to the MDS (Max Display System) in the flight compartment.

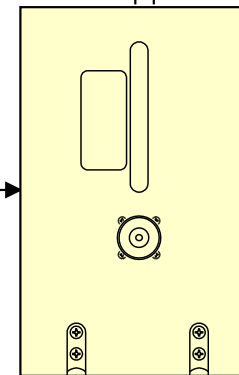
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APU CONTROLS - INLET TEMPERATURE SENSOR T2



SYS MENU	STATUS	MAINT DATA PGS	MAINT CTRL PGS	ONBD MAINT
APU				
MODE	XXXXXXXXXXXX	APU GEN LOAD	XXX,X	
RPM	XXX,X			
EGT	XXXX	- - - - INLET DOOR - - - -		
OIL TEMP	XXXX	OPEN COMMAND	XXXXXXXX	
OIL QTY	XXXX	CLOSE COMMAND	XXXXXXXX	
		POSITION SW	XXXXXXXX	
COMP INLET TEMP	XXXX	COR EGT	XXXX	
INLET STATIC PRESS	XX,XX	COR TOTAL PRESS	XXX	
LOAD COMP TOTAL PRESS	XX,XX	COR FUEL FLOW	XXX	
LOAD COMP DIFF PRESS	XX,XX	COR IGV POS	XXX	
SURGE CTRL VLV POS	XX,X	APU HOURS	XXXXXXXX,X	
IGV ACTUATOR POS	XX,X	APU CYCLES	XXXXXX	
BLD CORRECTED FLOW	XXX	HOURS SINCE INSTALLATION	XXXXXX,X	
FUEL FLOW MEAS	XXX	ON AIRPLANE		
1 - - - - STATUS CODE - - - - 1				
BIT# 1 5				
STATUS 1 [XXXX] [XXXX]				
STATUS 2 [XXXX] [XXXX]				
STATUS 3 [XXXX] [XXXX]				
STATUS 4 [XXXX] [XXXX]				
AUTO EVENT MESSAGE DATE XX XX XX UTC XX:XX:XX				
PREV MENU	PRINT	SEND	RECORD	NEXT PAGE

MAX DISPLAY SYSTEM (MDS) APU MAINTENANCE PAGE



ECU

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APU CONTROLS - INLET TEMPERATURE SENSOR T2



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**APU INDICATING SYSTEM - EGT INDICATION****Purpose**

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

Location

Two chromel/alumel thermocouples are on the bottom of the exhaust section. Each thermocouple has two temperature sensing junctions. The thermocouples are close together, but the tips in the exhaust stream are 60 degrees apart.

Functional Description

The ECU receives temperature inputs from the two thermocouples. The ECU uses the highest temperature for indication and control.

Indication

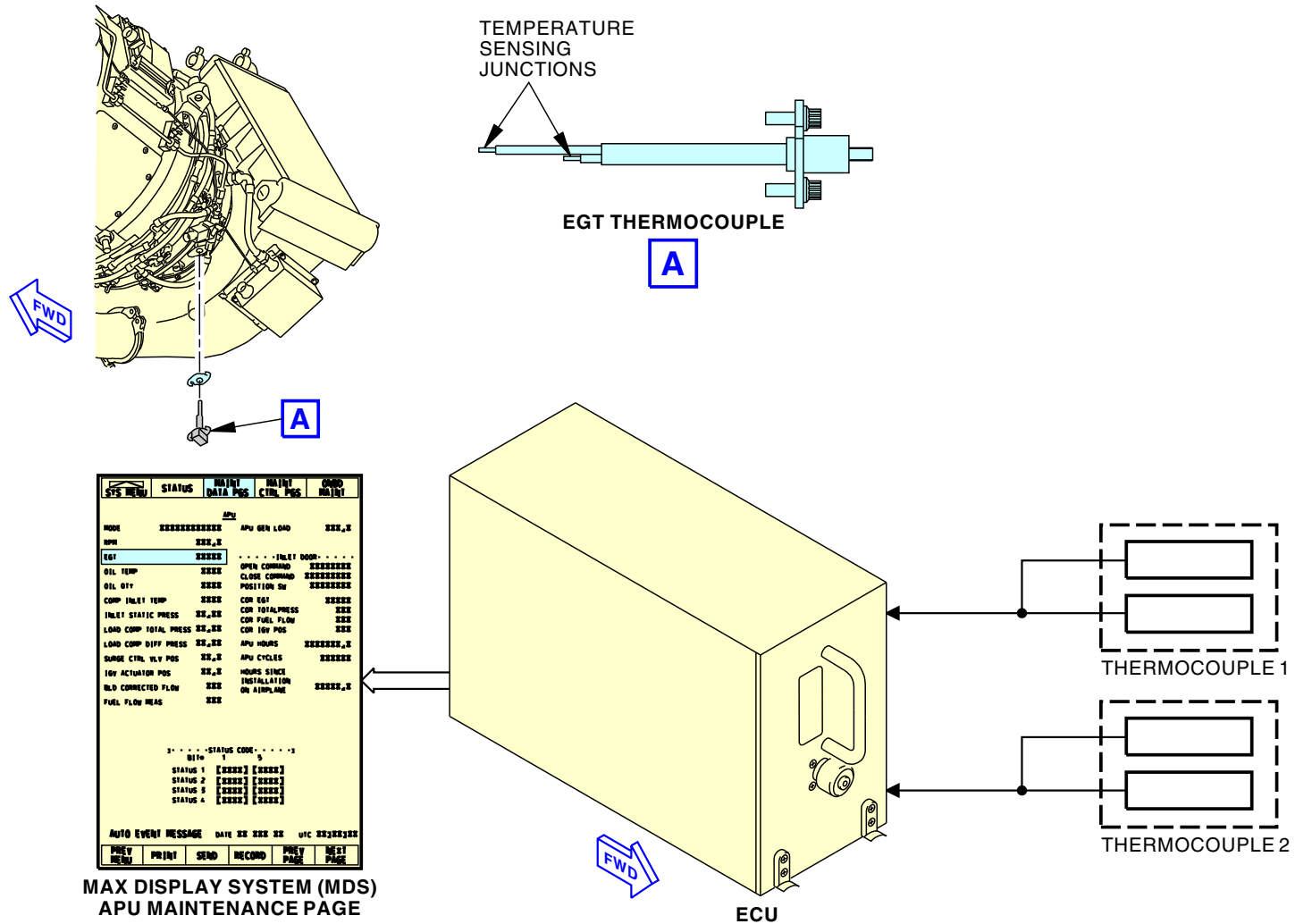
The APU EGT is on the MDS (Max Display System).

General Information

Loss of input from one thermocouple does not cause the loss of EGT indication. Loss of EGT input from both thermocouples causes loss of indication. EGT overtemperature or loss of EGT from both thermocouples cause an APU protective shutdown.

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APU INDICATING SYSTEM - EGT INDICATION



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APU INDICATING SYSTEM - EGT INDICATION

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**APU INDICATING SYSTEM - DATA MEMORY MODULE (DMM)****Purpose**

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

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

The DMM keeps this APU data so that APU engine data stays with the APU engine.

General Description

The ECU controls the data that goes in the DMM. The ECU reads the DMM memory during the APU start sequence and gives updated information to the DMM during APU shutdown. The MDS (Max Display System) shows APU parameters that are in the DMM.

Location

The DMM is on the left side of the APU.

General Information

DMM data is read with special test equipment or with the MDS.

Replacement of the ECU does not cause loss of the data that is in the DMM.

Data will be lost if the data memory module is removed at the same time the ECU is removed.

If the data memory module is replaced, it must be replaced with a blank module (a module with no data in memory).

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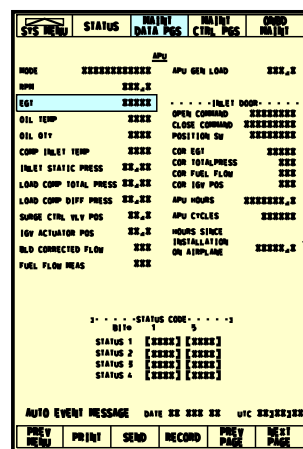
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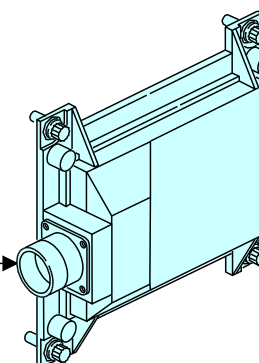
A detailed line drawing of the engine compartment of a vehicle, viewed from the front-left. The engine block is on the left, and the alternator and other components are visible. A blue arrow points to a fuse box located on the right side of the engine compartment, near the battery. The fuse box is labeled with a blue square containing the letter 'A'.

A



A diagram of a yellow rectangular unit, likely a battery or power source, with a handle on the right side. A blue arrow points to the unit with the label "FWD".

ECU



DATA MEMORY MODULE

A

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APU INDICATING SYSTEM - DATA MEMORY MODULE (DMM)



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**APU EXHAUST SYSTEM - EXHAUST DUCT****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

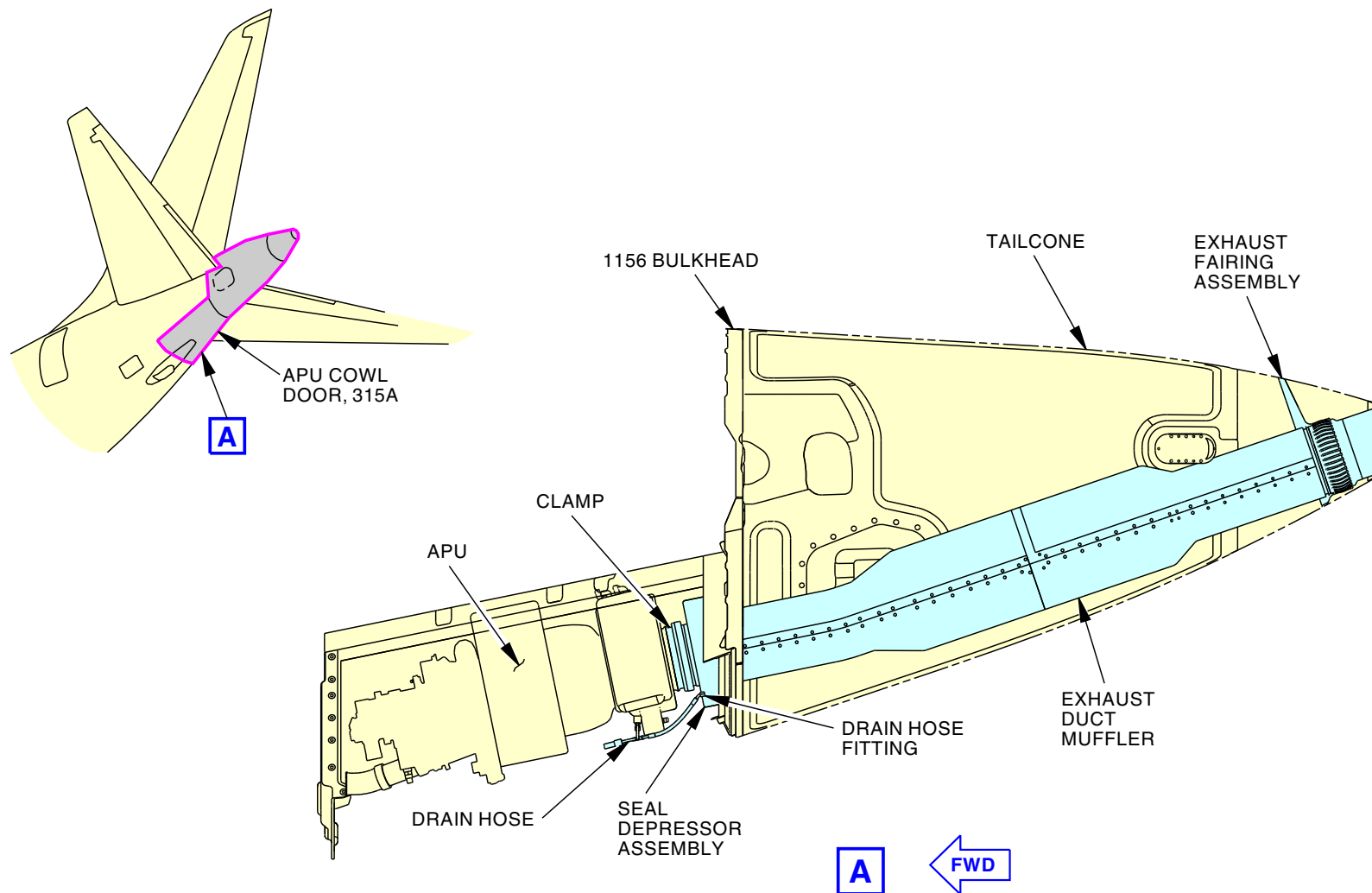
The APU exhaust duct is attached to the APU turbine section with a V-band clamp.

These are the major components of the exhaust duct:

- Drain fitting
- V-band clamp flange
- Bellows assembly
- Fluid drip ring
- Baffle
- Acoustic liner
- Outer skin
- Insulation blanket
- Aft support leaf spring.

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APU EXHAUST SYSTEM - EXHAUST DUCT



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APU EXHAUST SYSTEM - EXHAUST DUCT

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APU EXHAUST SYSTEM - EXHAUST DUCT

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APU LUBRICATION SYSTEM - INTRODUCTION

Purpose

The APU lubrication system lubricates, cleans, and cools these components:

- APU starter-generator
- APU bearings
- APU gearbox.

Components

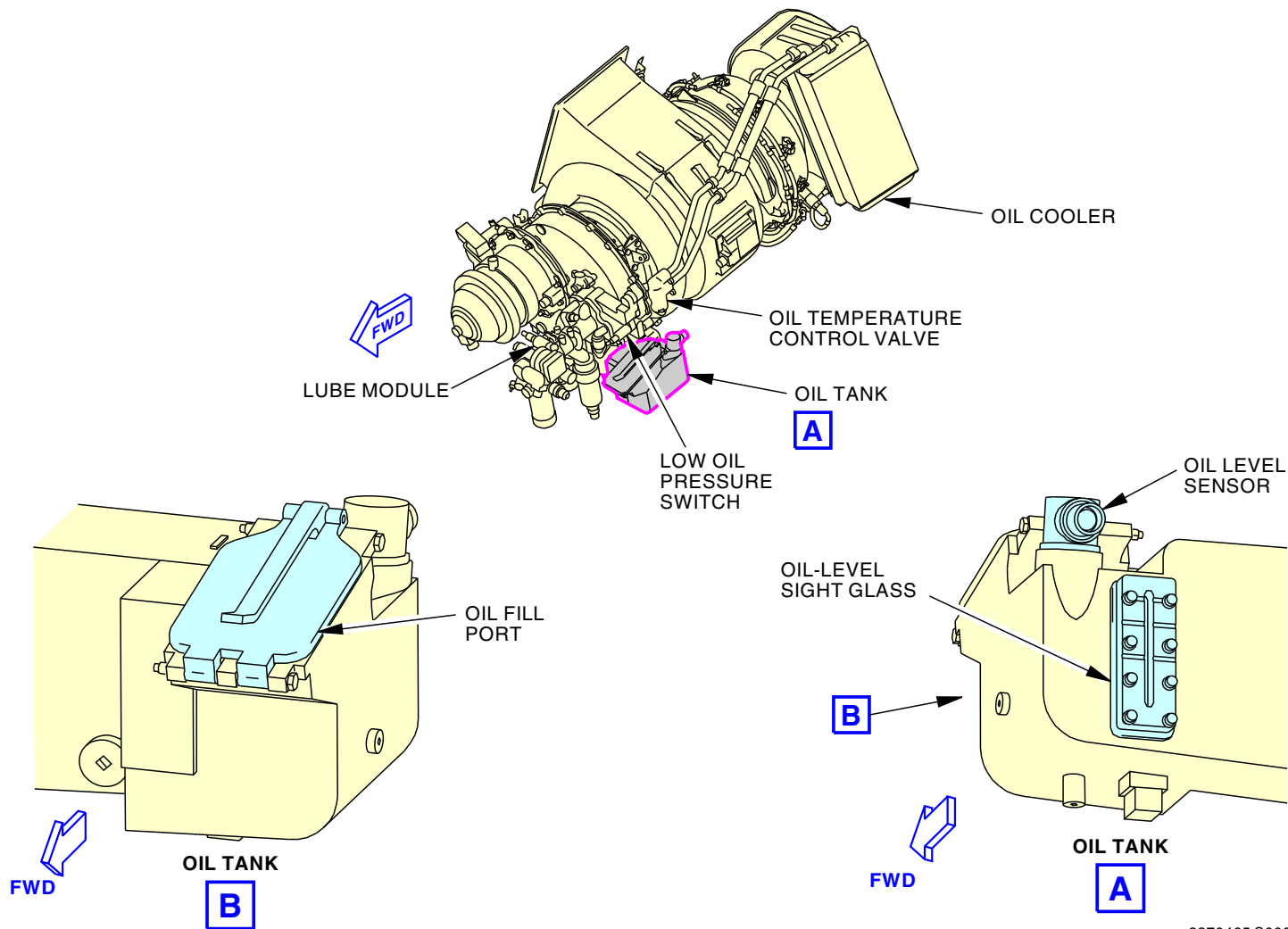
Some lubrication system components are on a common lube module on the front of the APU. These lubrication system components are not on the lube module:

- Magnetic drain plug
- Low oil pressure switch
- Oil level sensor
- Oil cooler
- Temperature control valve
- Oil-level sight glass and an oil fill port.

A 5.7 qt (5.4 l) oil sump is inside the gearbox. The APU oil cooler and oil lines hold approximately 3.0 qt (2.8 l) of oil. The total oil quantity of oil in an APU at full is 8.7 qt (8.2 l). An oil-level sight glass shows the oil level. An oil fill port is adjacent to the oil-level sight glass.

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APU LUBRICATION SYSTEM - INTRODUCTION



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APU LUBRICATION SYSTEM - INTRODUCTION

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**APU LUBRICATION SYSTEM - LUBE MODULE****General**

The lube module contains many of the lubrication system components. The lube module is mounted on the front of the Auxiliary Power Unit (APU) gearbox.

Components

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

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

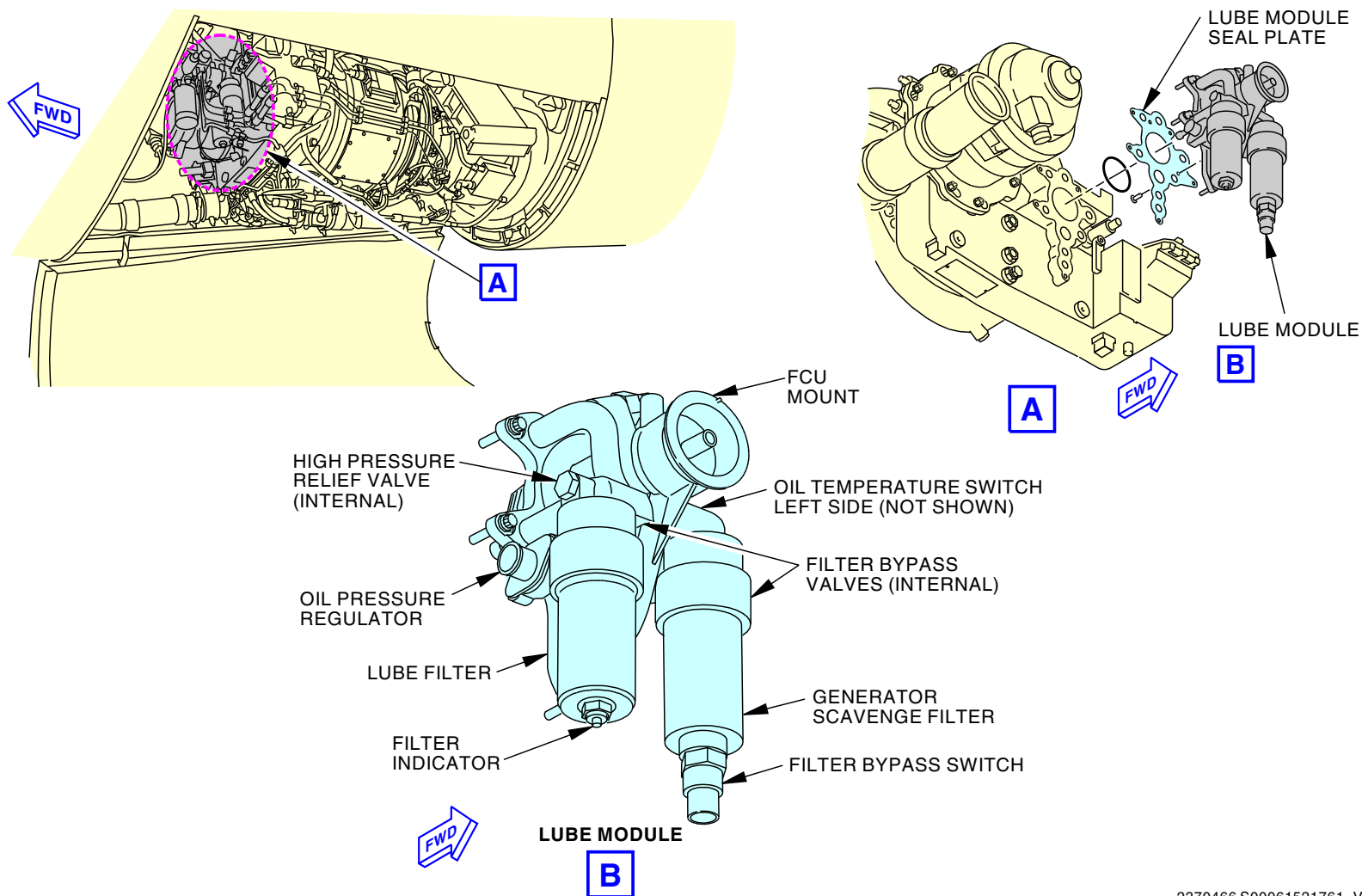
- Filter indicator
- Filter bypass switch
- Oil filter
- Generator filter
- Oil temperature sensor.

Location

The Fuel Control Unit (FCU) is attached to the lube module. The FCU must be removed in order to remove the lube module.

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APU LUBRICATION SYSTEM - LUBE MODULE



APU LUBRICATION SYSTEM - LUBE MODULE

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**APU LUBRICATION SYSTEM - LUBE MODULE - FUNCTIONAL DESCRIPTION****Lube and Scavenge Pumps**

The lube and scavenge pumps are on a common shaft. Three of the pumps are lube pumps. Three elements are starter-generator scavenge pumps and one is a turbine bearing scavenge pump.

Pressure Regulating/Relief Valve

The pressure regulating/relief valve keeps the oil pressure at 67 ± 7 psi (462 ± 48 kPa). If the pressure is more than this, the valve returns the oil to the oil pump inlet. The relief valve is set at 240 ± 40 psi (1655 ± 276 kPa).

Temperature Control Valve

The temperature control 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 140°F (60°C) or less, the valve is fully open and the oil does not go to the oil cooler. When the oil temperature is 170°F (77°C) or more, the valve is fully closed and the oil goes to the oil cooler. Between temperatures of 140°F (60°C) and 170°F (77°C), the valve is not fully open.

A pressure difference of 50 psid (345 kPa) also opens the valve to permit the oil to continue to flow if the oil cooler clogs.

Oil Filters

There are two interchangeable oil filters. The oil from the Auxiliary Power Unit (APU) generator goes through the generator filter. Pressurized oil goes through the oil filter after it goes through the oil cooler. The filters are throw-away type elements. They both have a 10 micron rating.

Oil Filter Bypass Valve and Indicator Button

The oil filter has an indicator button to monitor for filter clogs. When there is a pressure difference of more than 33 ± 7 psid (228 ± 49 kPa) across the filter and the oil temperature is more than 90°F (32°C), the indicator button extends.

The oil filter also has a bypass valve that allows the oil to flow if there is a clog or the oil is cold. The filter bypasses oil at 60 ± 10 psid (414 ± 69 kPa).

Generator Filter Bypass Valve and Filter Switch

The generator filter has a filter pressure switch to monitor for filter clogs. When there is a pressure difference of more than 35 ± 5 psid (241 ± 35 kPa) across the filter, for 5 seconds, the switch sends a signal to the Electronic Control Unit (ECU). The ECU shuts down the APU if these occur:

- High filter delta pressure
- Oil temperature is more than 100°F (38°C)
- Main engines not running for 90 seconds
- Airplane on ground.

The generator filter also has a bypass valve to let the oil flow if there is a clog or the oil is cold. The bypass valve bypasses oil at 60 ± 10 psid (414 ± 69 kPa).

Oil Temperature Sensor

The oil temperature sensor sends lube oil temperature data to the ECU. The ECU shuts down the APU if the APU speed is more than 95 percent and the oil temperature is 300°F (149°C) or more for 10 seconds.

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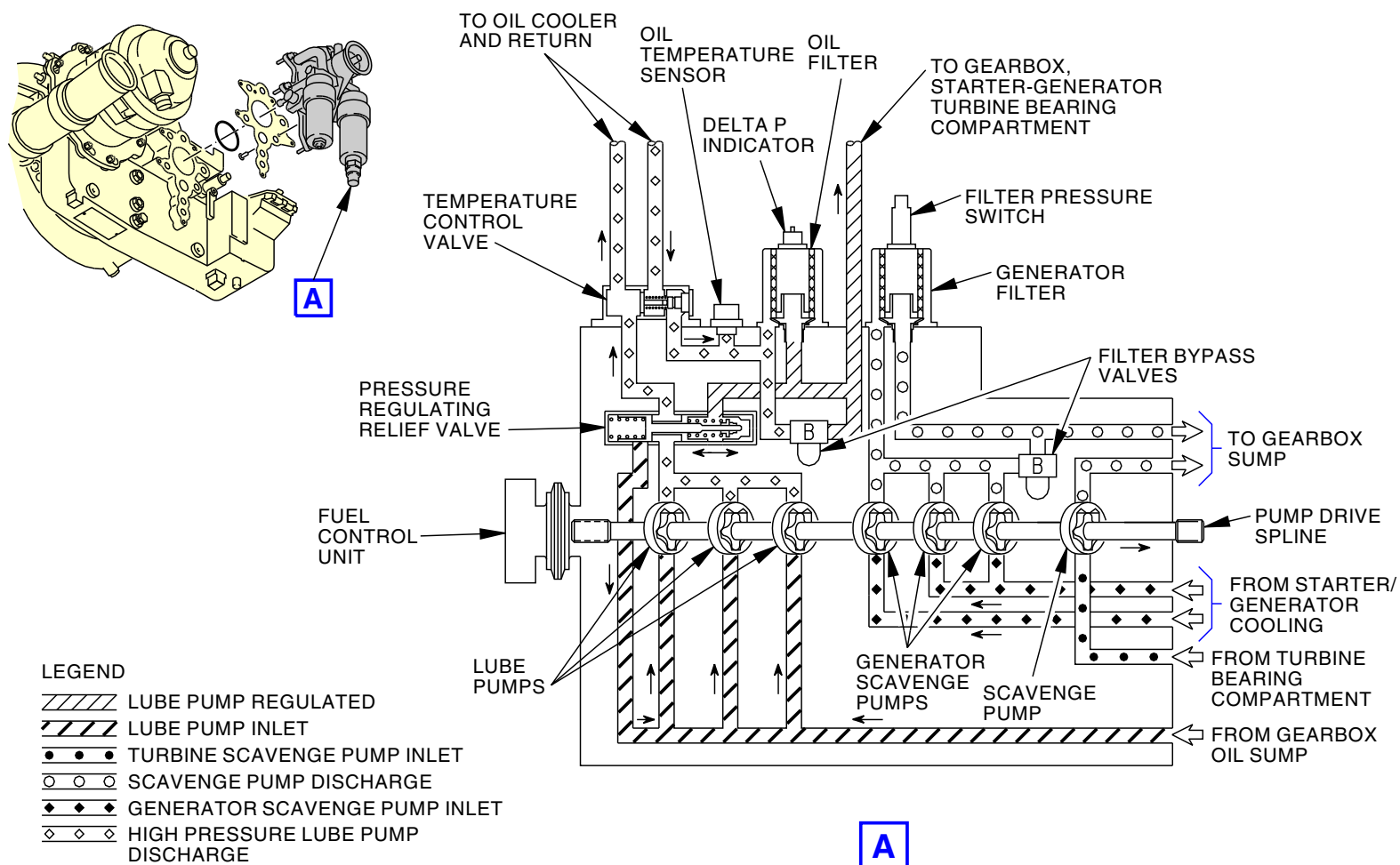
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APU LUBRICATION SYSTEM - LUBE MODULE - FUNCTIONAL DESCRIPTION



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APU LUBRICATION SYSTEM - LUBE MODULE - FUNCTIONAL DESCRIPTION

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**APU LUBRICATION SYSTEM - OIL COOLER AND TEMPERATURE CONTROL VALVE****General**

The oil cooler is an air/oil heat exchanger. Compartment and outside air cool the pressurized oil after it leaves the oil pump.

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

The temperature control valve is on the APU gearbox behind the lube module. The valve controls the oil flow to and from the oil cooler.

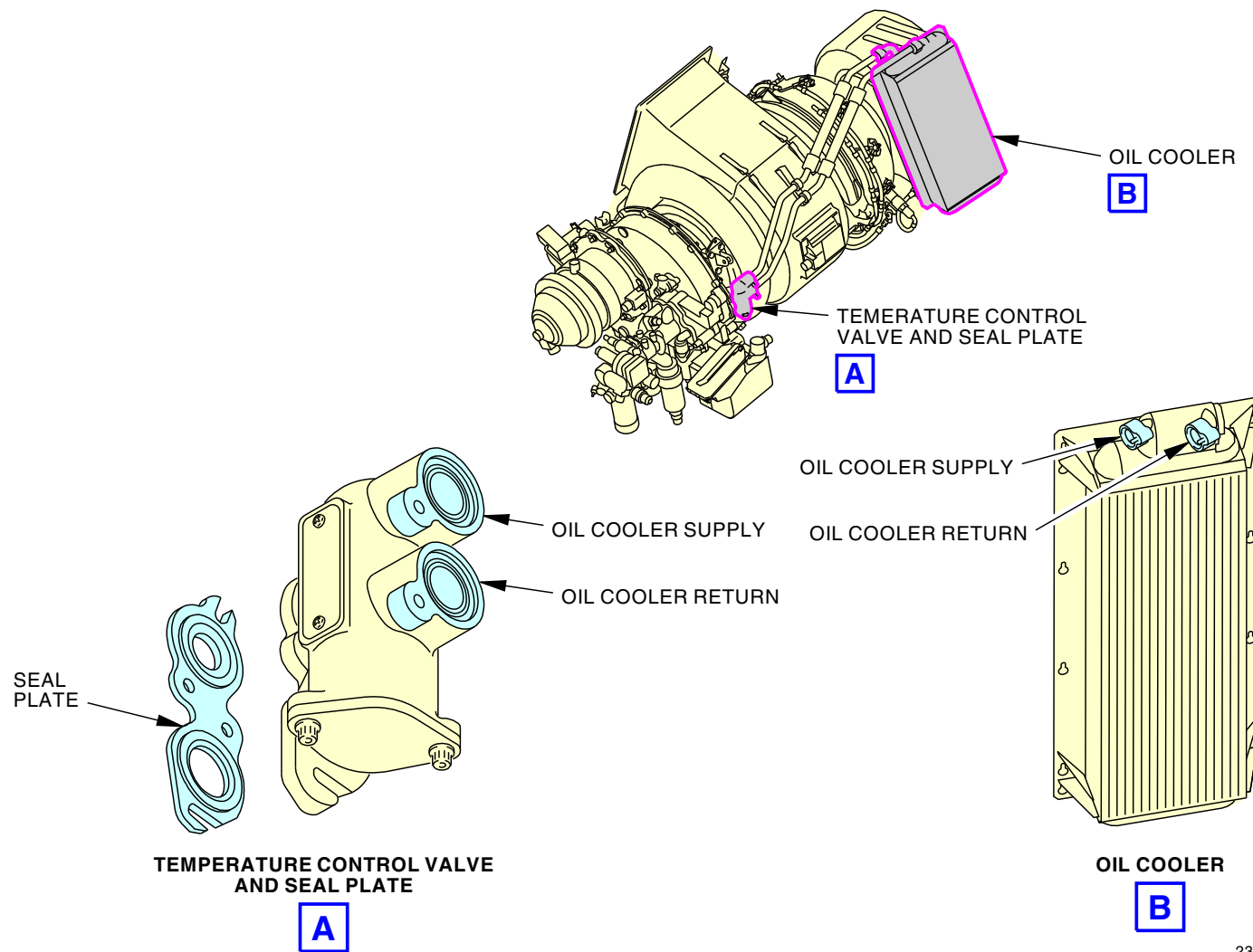
Functional Description

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

The temperature control valve lets oil bypass the oil cooler if the oil temperature is less than 140°F (60°C). The valve lets oil flow through the cooler if the oil temperature is more than 170°F (77°C). If the oil pressure is more than 50 psid (345 kPa) across the bypass valve, the oil bypasses the cooler.

The temperature control valve uses a seal plate for attachment to the gearbox.

APU LUBRICATION SYSTEM - OIL COOLER AND TEMPERATURE CONTROL VALVE



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APU LUBRICATION SYSTEM - OIL COOLER AND TEMPERATURE CONTROL VALVE

**APU LUBRICATION SYSTEM - MAGNETIC DRAIN PLUG****Purpose**

The magnetic drain plug collects metallic particles that are in the engine oil. It has two parts, the magnetic chip collector and the drain plug. The drain plug is also used to drain the oil out of the gearbox.

Location

There is one magnetic drain plug. It is on the bottom front of the gearbox.

Components

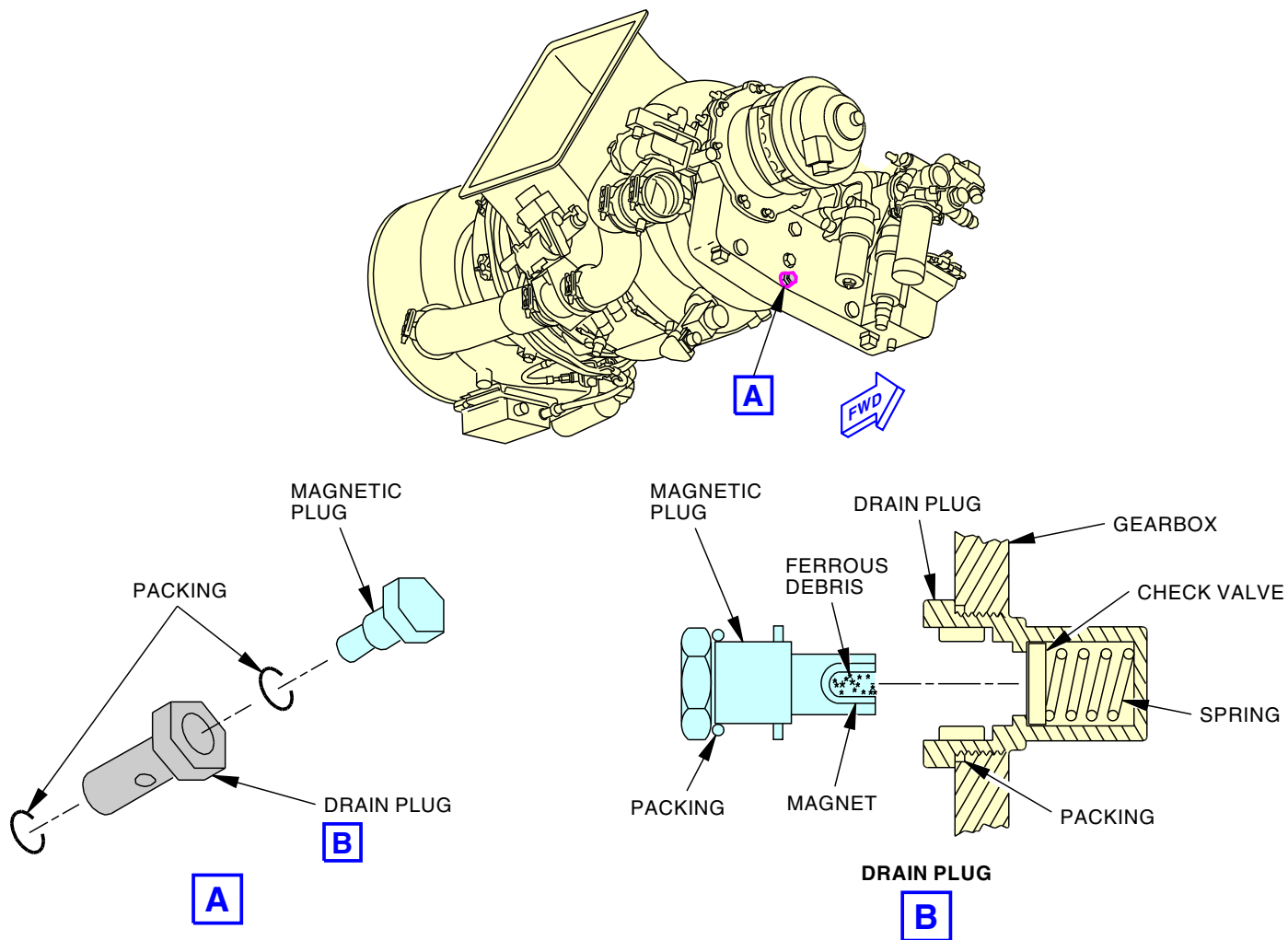
These are the components of the magnetic drain plug:

- Magnet plug
- Drain plug
- Magnet
- Packing
- Check valve
- Spring.

The check valve closes to prevent oil loss when you remove the magnetic chip detector from the magnetic drain plug.

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APU LUBRICATION SYSTEM - MAGNETIC DRAIN PLUG



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APU LUBRICATION SYSTEM - MAGNETIC DRAIN PLUG

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**APU LUBRICATION SYSTEM - FUNCTIONAL DESCRIPTION****General**

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

Supply

Oil pumps in the lube module, pump oil from the reservoir in the gearbox. Pressurized oil from the lube module goes to the oil cooler and then returns to the lube module.

The lube module cleans the oil and controls the oil pressure. These components supply data to the ECU:

- Oil pressure switch
- Oil level sensor
- Oil temperature sensor
- Generator filter pressure switch.

The oil goes to these areas:

- APU starter-generator
- Gearbox bearings and gears
- Turbine bearing compartment.

Scavenge

Scavenge pumps in the lube module send the oil from the turbine bearing compartment back to the gear box reservoir. Other scavenge pump elements send the scavenge oil from the APU starter-generator through the scavenge filter and back to the gearbox reservoir.

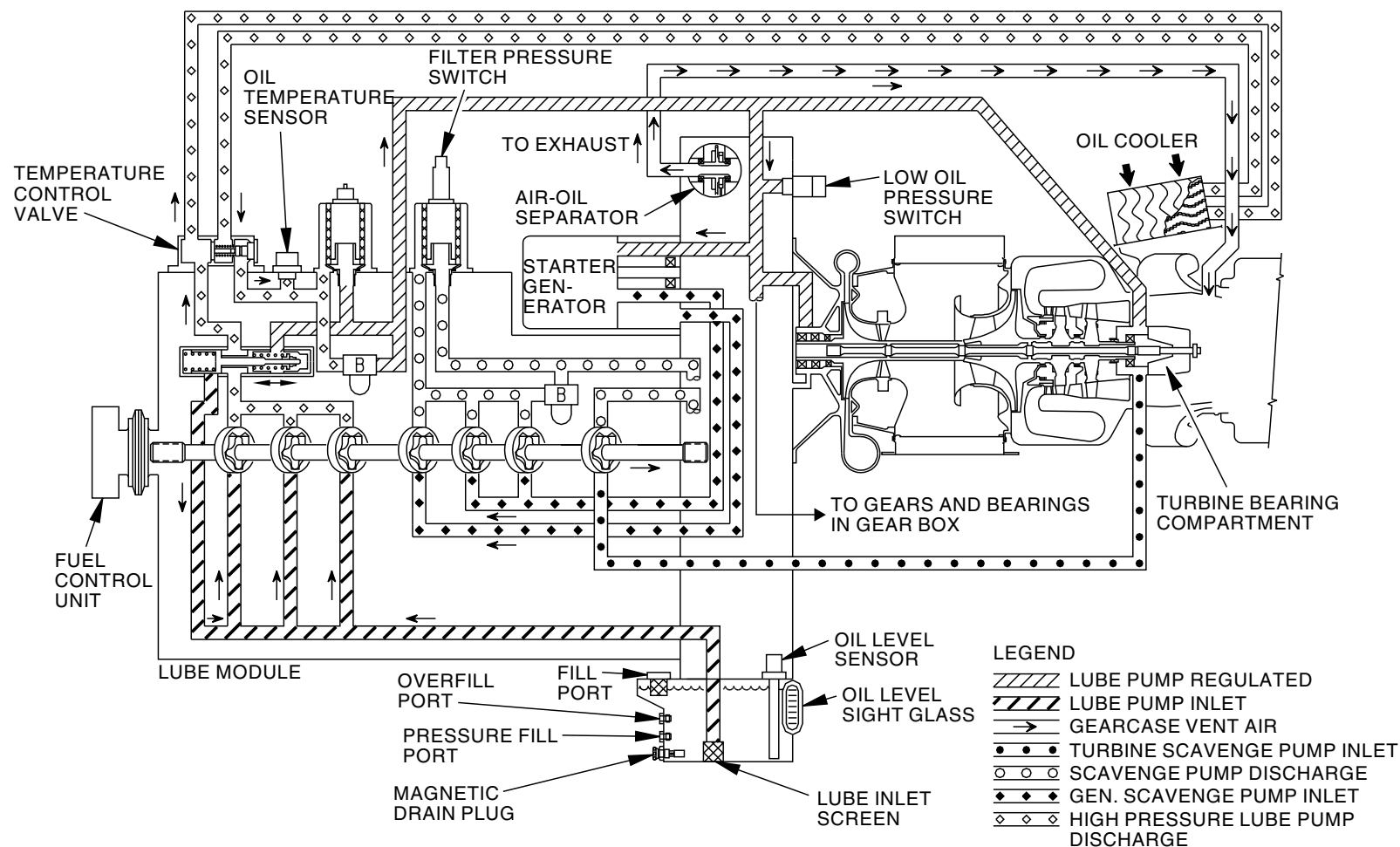
Vent

An air-oil separator separates the air that mixes with the oil in the scavenge system. The air-oil separator is on the right side of the lube module on the gearbox.

Air that goes by the bearing cavities and mixes with the scavenge oil goes through the air-oil separator. Through centrifugal action, the air-oil separator returns the oil to the sump in the gearbox and the air vents overboard. The air vents overboard through the APU exhaust duct. The air-oil separator is not a line replaceable component.

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APU LUBRICATION SYSTEM - FUNCTIONAL DESCRIPTION



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APU LUBRICATION SYSTEM - FUNCTIONAL DESCRIPTION

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**APU LUBRICATION SYSTEM - OIL INDICATING - GENERAL DESCRIPTION****Purpose**

The APU oil indicating system supplies this data for the flight compartment:

- Oil temperature (P5 panel amber FAULT light only)
- Oil pressure (P5 panel amber LOW OIL PRESSURE light only)
- Oil level (MDS (Max Display System))
- Starter-generator scavenge filter clogged (P5 panel amber APU FAULT light only).

General Description

The ECU receives APU oil indicating system inputs and supplies this data to the airplane flight compartment.

The oil level indication only shows on the MDS (Max Display System).

Components

These are the APU oil indicating system components:

- Low oil pressure switch
- Oil temperature sensor
- Oil level sensor
- Filter pressure switch.

Low Oil Pressure Switch

The low oil pressure switch sends a signal to the ECU when the oil pressure is less than 35 $\pm$ 5 psi (241 $\pm$ 35 kPa). If the APU speed is more than 95 percent, the ECU shuts down the APU after 20 seconds. These amber lights come on for a low oil pressure indication:

- LOW OIL PRESSURE (P5)
- MASTER CAUTION (P7)
- APU annunciator (P7).

Oil Temperature Sensor

The oil temperature sensor sends lube oil temperature data to the ECU. The ECU shuts down the APU if the APU speed is more than 95 percent and oil temperature is 300°F (149°C) or more for 10 seconds. The MDS shows the oil temperature.

These amber lights come on for a high oil temperature indication:

- FAULT (P5)
- MASTER CAUTION (P7)
- APU annunciator (P7).

Oil Level Sensor

The oil level sensor sends the oil level data in the gearbox sump to the ECU. The ECU sends this data to the MDS (Max Display System) for display.

The ADD message shows on the APU oil quantity page of the MDS when approximately 4.3 qt (4.1 l) of oil remains in the APU sump.

The LOW message shows on the APU oil quantity page of the MDS when approximately 3.8 qt (3.6 l) of oil remains in the APU sump.

The APU sump holds 5.7 qt (5.4 l) of oil when full.

Filter Pressure Switch

The filter pressure switch monitors the differential pressure between the inlet and outlet of the starter-generator scavenge filter. If the pressure is greater than 35 $\pm$ 5 psid (241 $\pm$ 35 kPa), the filter switch sends a signal to the ECU.

Protective Shutdowns

Low oil pressure, high oil temperature or starter-generator filter clogged causes the ECU to do a protective shutdown when the APU is above 95 percent speed.

The low oil pressure switch causes the amber LOW OIL PRESSURE light on the P5 panel to come on.

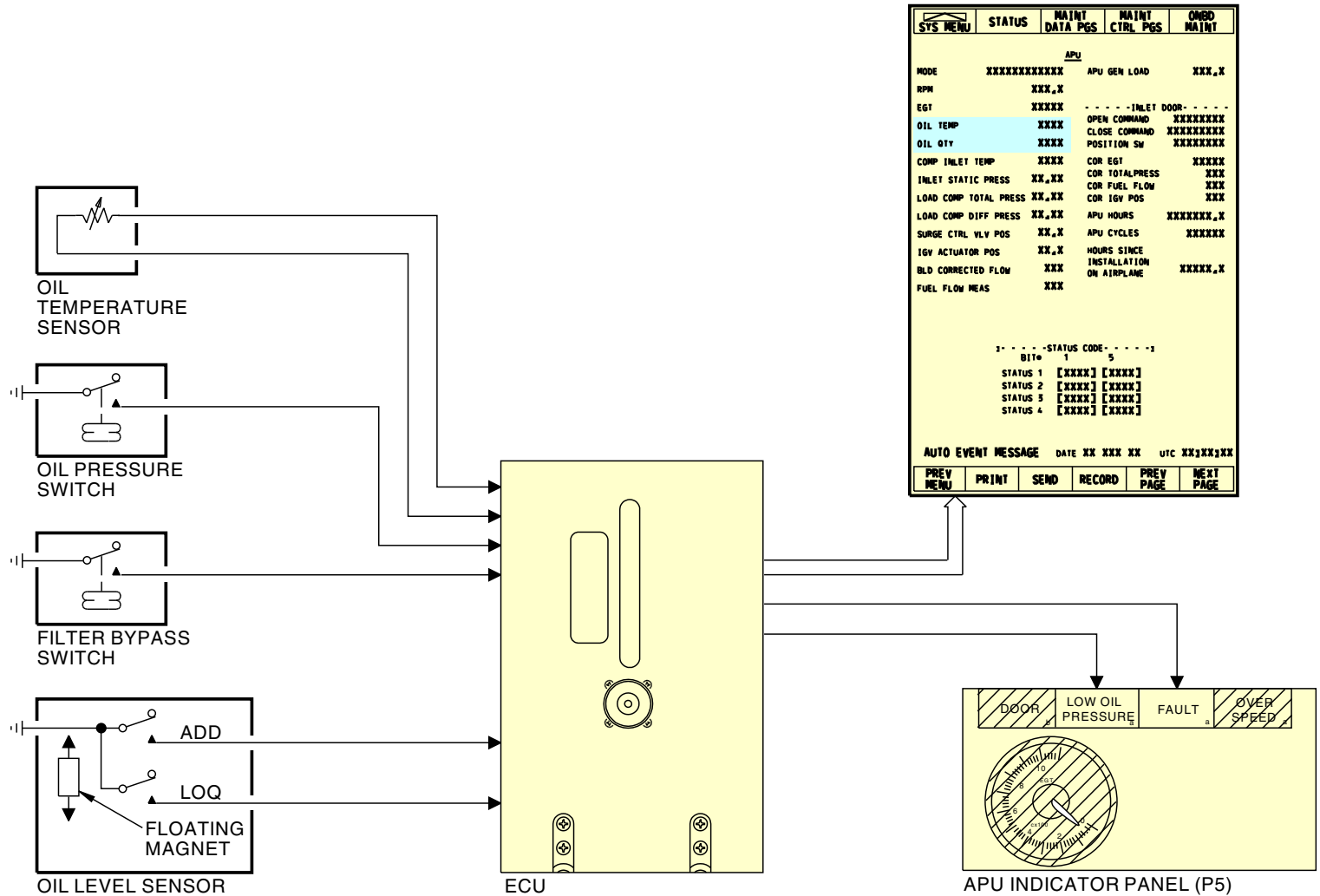


APU LUBRICATION SYSTEM - OIL INDICATING - GENERAL DESCRIPTION

High oil temperature and filter clogged causes the amber FAULT light on the P5 panel to come on.

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APU LUBRICATION SYSTEM - OIL INDICATING - GENERAL DESCRIPTION



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APU LUBRICATION SYSTEM - OIL INDICATING - GENERAL DESCRIPTION



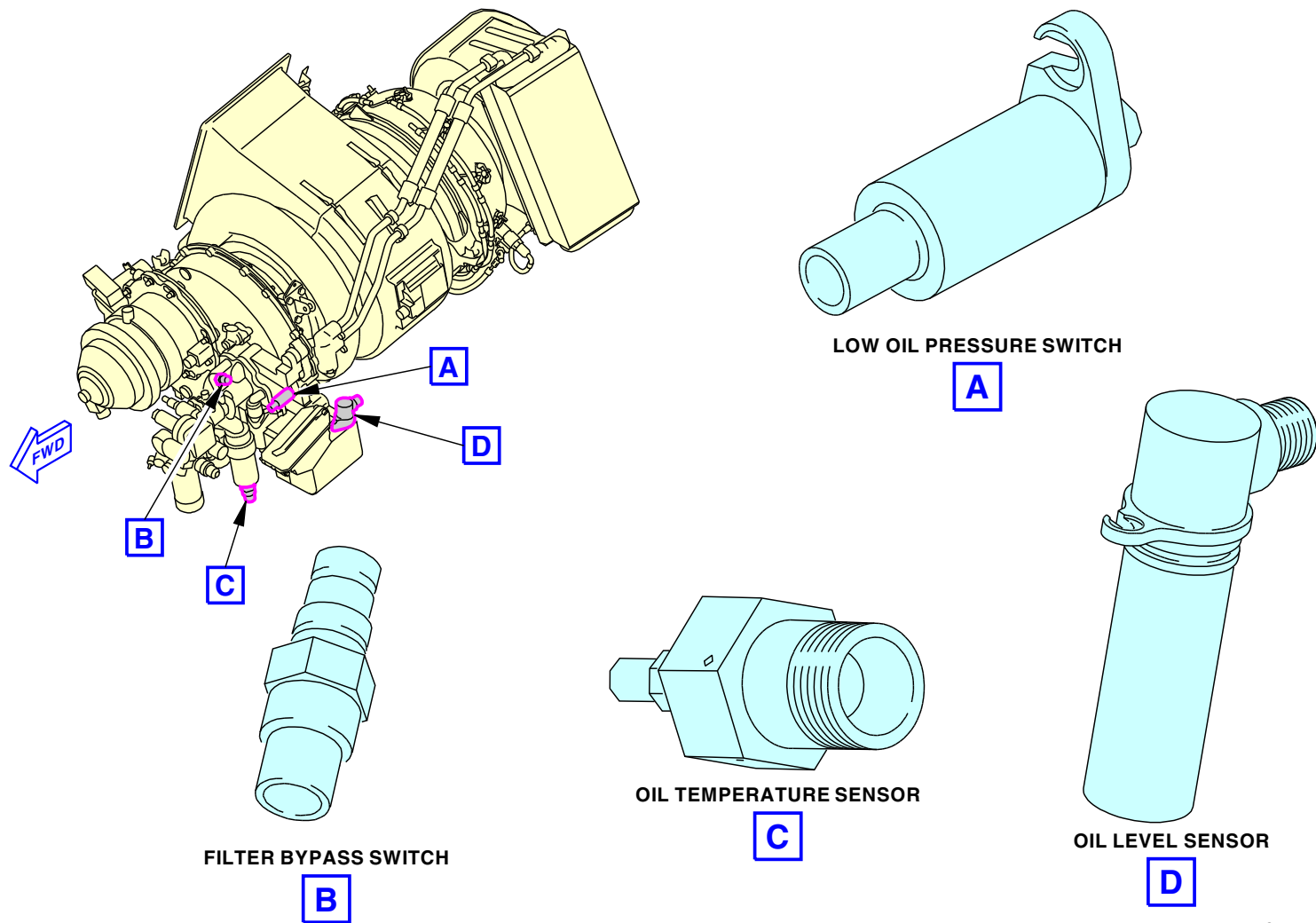
APU LUBRICATION SYSTEM - OIL INDICATING - COMPONENTS

Location

The low oil pressure switch is on the upper left side of the gearbox. The oil temperature sensor and filter bypass switch are on the lube module. The oil level sensor is on the gearbox.

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APU LUBRICATION SYSTEM - OIL INDICATING - COMPONENTS



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APU LUBRICATION SYSTEM - OIL INDICATING - COMPONENTS

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