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INTRODUCTION

The Honeywell 36-150BD constant-speed gas turbine auxiliary power unit (APU) is installed in a fire-proof compartment in the tailcone of the airplane. The APU is a fully automated gas turbine powerplant with automatic fault detection, automatic and remote shutdown, and in the event of an APU fire on the ground, automatic fire extinguishing.

The APU compartment is accessed by a single panel aft of the aft equipment bay door. The panel must be unscrewed from the fuselage underside. The APU is a self-contained unit.

The primary purpose of the APU is to provide power for the gearbox-mounted 400-amp DC generator. Secondary functions of the APU are bleed-air supply for the environmental control system (ECS) and main engine starting. Under high demand, the APU electrical loads take priority over pneumatic loads.

For APU maximum operating altitudes for ground and flight, and also for continuous starter attempts, refer to the Approved Airplane Flight Manual.

The APU should not be started above speed limits stated in the Approved Airplane Flight Manual, as the APU may reverse windmill.

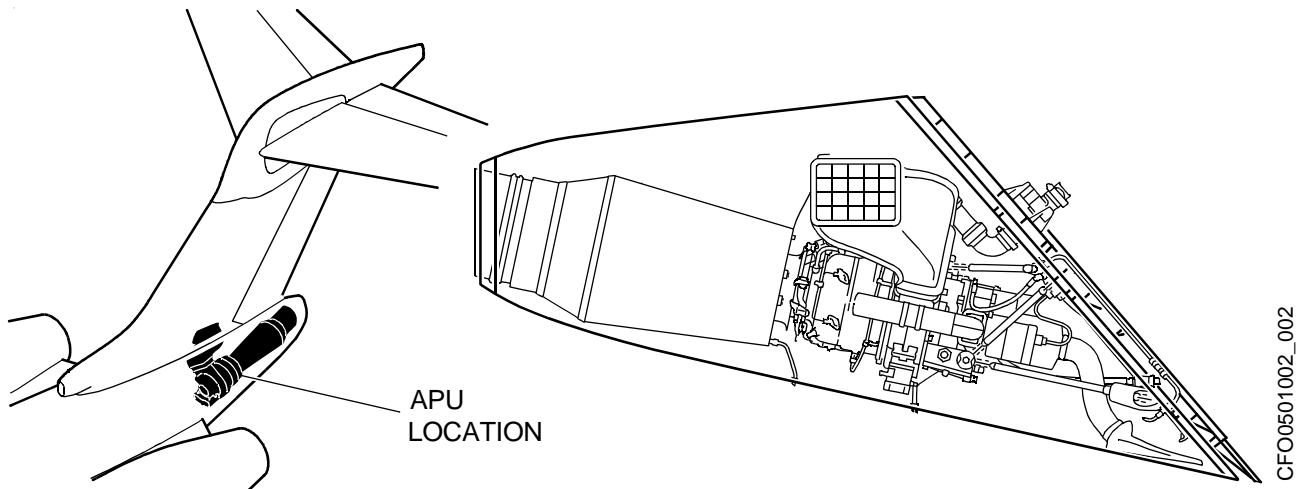
An engine control unit (ECU) controls and monitors all facets of APU operation, including the recording of operating hours and start cycles. The DC-powered ECU sets up the appropriate fuel acceleration and EGT temperature schedules. It relays appropriate operating data to the pilots through the EICAS displays.

APU start is initiated by one switch on the APU control panel in the flight compartment. Operational control of the APU electric and bleed-air systems is performed at the ELECTRICAL and AIR COND/BLEED control panels.

COMPARTMENT

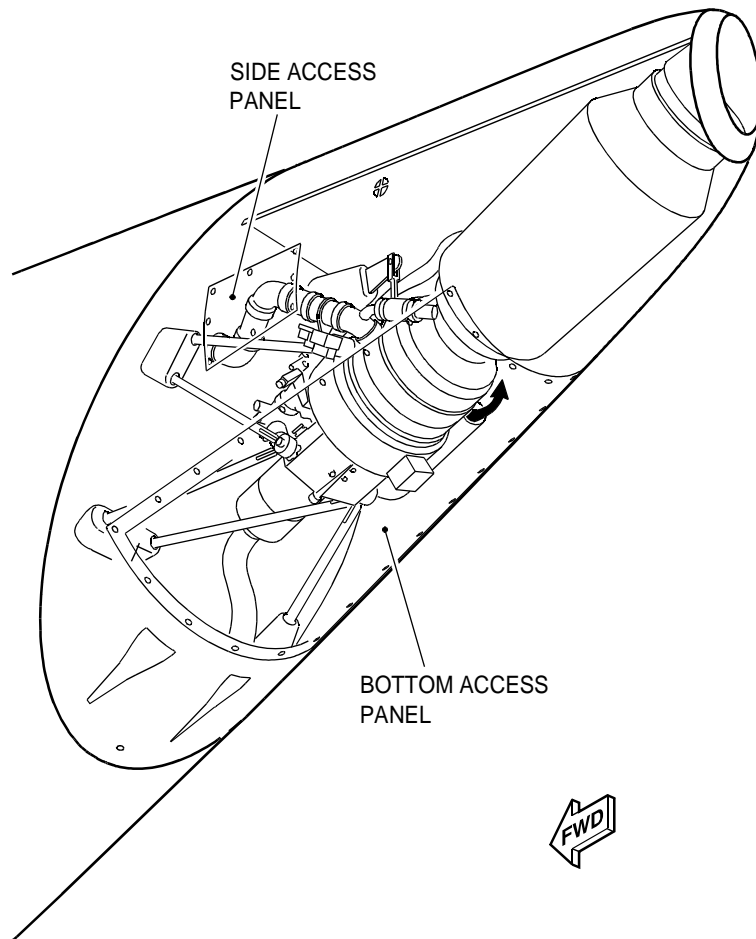
The APU is mounted in the airplane tailcone and is accessed via the access panel located on the fuselage underside. The APU compartment has a NACA inlet for ventilation. The air is pulled through the NACA inlet and routed through the compartment to cool the APU and its mounted components. This air is then exhausted overboard via the APU exhaust eductor.

The APU-driven air-cooled DC generator also has a NACA inlet for cooling air flow. The air is pulled through the generator and dumped in the APU compartment. This air is then exhausted overboard via the APU exhaust eductor.



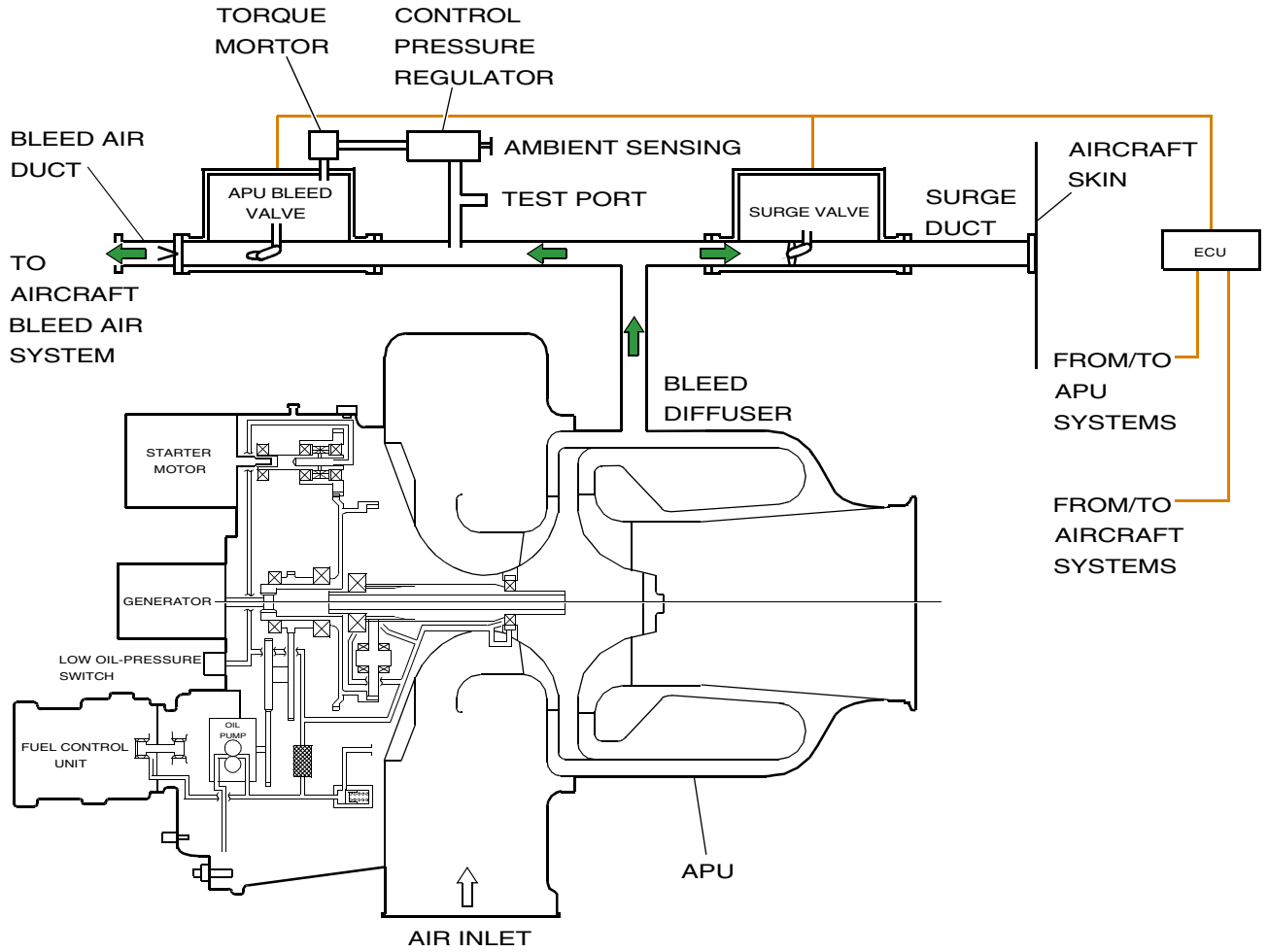
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


APU ACCESS PANEL LOCATIONS



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APU SCHEMATIC



-  INLET AIR
-  BLEED AIR
-  ELECTRICAL CIRCUITS

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POWER SECTION AND GEARBOX

DESCRIPTION

The power section of the Honeywell 36-150BD APU consists of a gas turbine engine with integrated oil, ignition and start systems. The power section drives a gearbox that reduces the rotational speed of the APU for operation of the gearbox-mounted accessories.

The APU contains the following components:

- Single-stage centrifugal compressor
- Single-stage radial turbine
- Accessory gearbox with an integral oil reservoir
- Annular reverse flow combustor

COMPONENTS AND OPERATION

POWER SECTION

Engine power is developed through compression of ambient air by a centrifugal compressor. The compressed air, when mixed with fuel and ignited in the annular reverse flow combustor, drives a single-stage radial turbine. The rotating shaft of the turbine rotor drives the compressor, output drive shaft, and accessories.

GAS GENERATOR

The gas generator contains the following components:

- Compressor
- Annular reverse flow combustion chamber
- Turbine

GEARBOX ASSEMBLY

The gearbox assembly provides power transfer from the starter motor to the accessories and power section during APU starting as well as to all gearbox-mounted accessories during on-speed operation.

The APU accessories include:

- Starter
- DC Generator
- Oil pump
- Speed sensor
- Fuel control unit and high-pressure pump

The APU gearbox also serves as a sump for the lubrication system and incorporates the oil gravity fill cap and quantity sightglass.

AIR INTAKE AND EXHAUST

DESCRIPTION

The APU air intake is located above the APU compartment on the right side of the fuselage, below the vertical stabilizer.

The APU exhaust gases are discharged by an exhaust duct and eductor through the tailcone of the aircraft.

COMPONENTS AND OPERATION

EXHAUST

The exhaust duct is covered by an insulated exhaust muffler.

EXHAUST GAS TEMPERATURE

The APU exhaust gas temperature (EGT) is displayed as a digital readout on the EICAS.

LUBRICATION SYSTEM

DESCRIPTION

The APU has a self-contained lubrication system. Major components include a gearbox mounted oil pump and an integral gearbox oil sump. Intake air cools oil and ventilates of the APU enclosure. A magnetic chip collector provides visual indication of metal particles in the lubrication system.

COMPONENTS AND OPERATION

The oil pump directs filtered oil under pressure to the APU bearings, gearbox, and generator bearings.

FUEL DISTRIBUTION

DESCRIPTION

The Honeywell 36-150BD APU fuel system is a full-authority digital electronic engine (FADEC) controlled system. During start, the fuel system provides the correct amount of fuel to support combustion and smooth acceleration of the engine to full power. When full power is reached, fuel flow is modulated to meet electrical and pneumatic load while maintaining a constant engine speed.

Protection from overtemperature during APU acceleration is provided by protective features incorporated in the ECU.

The APU receives fuel from the right collector tank. The APU fuel system incorporates the right DC-powered fuel pump, fuel feed shutoff valve (SOV), fuel shutoff solenoid, fuel system filters, a high-pressure fuel pump (mounted on the APU), fuel control unit (FCU), and the fuel manifold assembly.

COMPONENTS AND OPERATION

APU FUEL SUPPLY

The right DC-powered fuel pump delivers fuel under pressure to the APU fuel control unit. When the right engine is running, the fuel pump ceases operation and fuel is delivered by the main engine ejector pump.

FUEL CONTROL UNIT AND FUEL SHUTOFF SOLENOID

The APU fuel control unit (FCU) meters fuel under command of the electronic control unit (ECU). During the start sequence, the fuel shutoff solenoid, located between the FCU and the fuel nozzles is opened by the ECU at 5% rpm. Fuel is supplied in accordance with a schedule that accelerates the APU throughout the start sequence. When the APU is stabilized, fuel scheduling is influenced by the rpm and EGT as well as generator and bleed air demands.

During normal or automatic APU shutdown, an overspeed signal closes the fuel solenoid valve and torque motor at the APU and causes the APU to shutdown.

APU SHUTDOWN MODE

Engagement of the APU master switch to OFF, remote stop, emergency/fire, or in the event of an exceeded limit, the ECU initiates the APU shutdown sequence by commanding the fuel off. When the shutdown sequence is complete, the ECU transitions to idle mode and then powers down if the APU master switch is in the OFF position. The following is a list of all the APU protective shutdowns showing the ones that are inhibited in-flight (essential mode):

* - An asterik indicates these shutdowns are inhibited in the essential mode.

28 VDC Power Loss	Fire Indication*
Reverse Flow*	No Acceleration (during start)*
Loss of EGT Signal*	Overspeed
Low Oil Pressure*	Emergency Fire
High Oil Temperature*	Internal ECU Failure
Overtemperature*	Loss of Overspeed Protection Circuit
No Flame (during start)*	

START AND IGNITION

DESCRIPTION

The starting and ignition systems operate automatically during the APU start sequence.

COMPONENTS AND OPERATION

STARTER

The APU start system consists of a DC starter and a series of relays controlled by the electronic control unit (ECU). The electrical power source is:

- ECU — battery bus
- Starter — APU battery direct bus

To start the APU, the APU start contactor is closed and the right battery is connected to the APU starter.

The right battery contactor is opened to isolate the right battery from the right essential bus during APU start to prevent a voltage drop on the essential busses. The left battery maintains power to the left and right essential busses during APU start.

It is important to delay starting the APU for five minutes after application of anti-icing fluid near the APU area. This allows any anti-icing fluid inadvertently directed into the APU inlet to drain out.

Three consecutive APU start attempts may be made at 1 minute intervals, followed by a 20 minute wait. Two more start attempts may be made. No further attempts may be made for a period of at least 40 minutes.

Six consecutive and successful APU starts may be made at 10 minute intervals with a one-hour waiting period prior to additional start attempts.

IGNITION SYSTEM

The APU ignition system consists of an ignition unit, igniter plug lead and a single igniter plug. The ignition system is energized during the APU start cycle and is de-energized when the APU start sequence is complete. To engage the APU, pull up on the switch, position the switch to RUN for approximately 3 seconds until the APU indications are displayed on the left MFD. Then move the switch to START and hold until the START icon is displayed on the left MFD, the APU will then begin the start sequence.

The APU ignition system consists of a single output ignition unit. Should a flameout occur during operation, the ignition unit automatically fires the igniter through the auto relight function of the ECU. An immediate restart (APU starter re engagement) can be initiated upon APU rolldown below 10% rpm.

SYSTEM OPERATION

The ECU uses 28 vdc power from the right aircraft battery bus to energize the ignition system during the ignition/start sequence. During the start sequence, the R BATT switch is illuminated OFF on the ELECTRICAL panel and the flow line from R BATT to the R ESS BUS on the Electrical synoptic page is depicted in white. The ignition system is energized at 5% APU rpm and stays energized until 95% rpm.

PNEUMATIC SUPPLY

DESCRIPTION

APU compressor bleed air is used to pressurize the right side of the bleed air manifold to provide pneumatics for engine starting and air conditioning. Reverse airflow protection is provided by a one way check valve.

COMPONENTS AND OPERATION

The APU pneumatic control system consists of a bleed valve and a surge control valve.

BLEED VALVE MODULATION/BLEED AIR LOADS

The pneumatic load on the APU is controlled by the ECU as a function of demands sent from the APU bleed valve. When the bleed valve is opened, a portion of the compressor discharge air is diverted from the plenum chamber to the right side of the bleed air manifold. The bleed valve opens when the flight deck APU bleed load switch is placed in the open position.

The APU engine reaction to bleed loads is different from shaft loading. Bleed air extraction from the APU diverts pneumatic energy from the turbine and some of the cooling air from the combustion system. As with the shaft load, the rpm drops, and with the corresponding ECU command fuel flow increase, recovers to full governed speed.

Air diverted into the aircraft bleed manifold is no longer available to drive the turbine or cool the combustion system. The loss of pneumatic energy is replaced with thermal energy (fuel) with significant temperature increase.

The following variables influence exhaust gas temperature (EGT) under bleed air load conditions:

- Aircraft demand for bleed air
- Ambient air temperature and density

Should EGT reach the limit, the ECU will reduce bleed air flow by modulating the bleed valve toward the closed position to prevent over temperature.

BLEED VALVE

The APU bleed valve controls airflow to the aircraft bleed system and protects the APU from an overtemperature condition. The valve is controlled electrically and the valve mechanism operates a butterfly valve pneumatically. When the bleed VALVE is open, the ECU adjusts the butterfly plate position to supply the correct quantity of bleed air. These adjustments are related to the required quantity of bleed air and APU EGT.

SURGE CONTROL VALVE

The surge control valve is automatically controlled by the ECU. The surge valve is commanded open when the APU is supplying electrical loads at flight altitudes above 15 000 ft. This function reduces APU surge potential when operating in an unloaded condition.

BLEED AIR AVAILABILITY

For the ECU to energize the bleed-air supply system, the APU must be more than 95% of its maximum speed.

BLEED AIR LIMITATIONS

Refer to the Approved Airplane Flight Manual for bleed air limitations.

CONTROL AND INDICATIONS

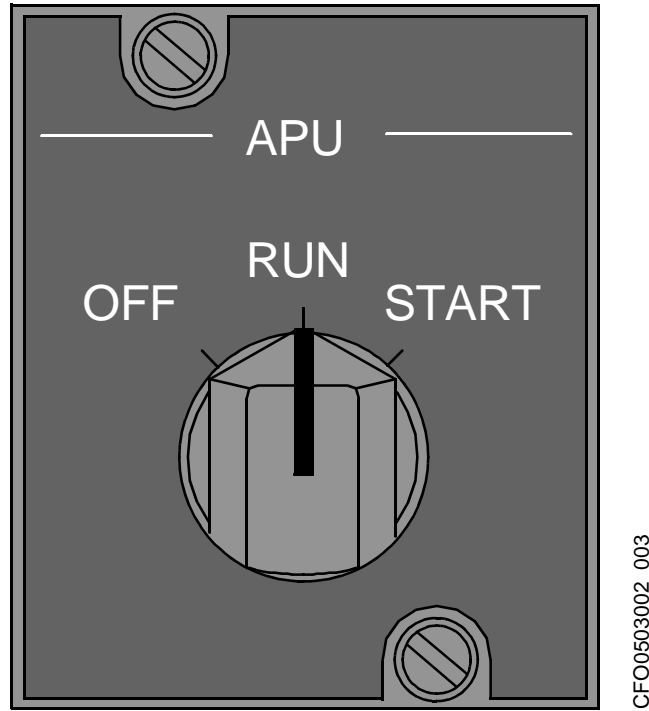
DESCRIPTION

The APU control panel contains a single three position switch with OFF, RUN and START positions.

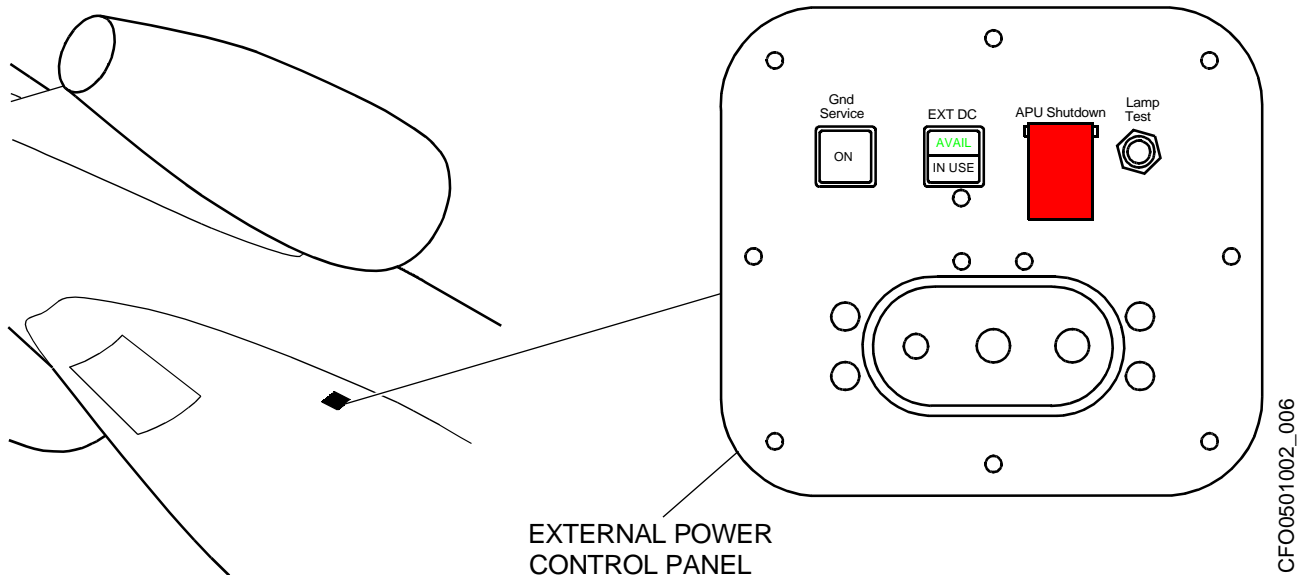
For ground operations, a remote cutoff switch is located on the right side of the aircraft, aft of the wing and behind the electrical connection access door.

DC electrical power provided by the APU generator is controlled from the ELECTRICAL control panel. Bleed-air services are controlled from the AIR COND/BLEED control panel.

APU system operation and fault presentation is provided on the EICAS pages. The FUEL, ECS, ELECTRICAL synoptic pages monitor the APU system and services.



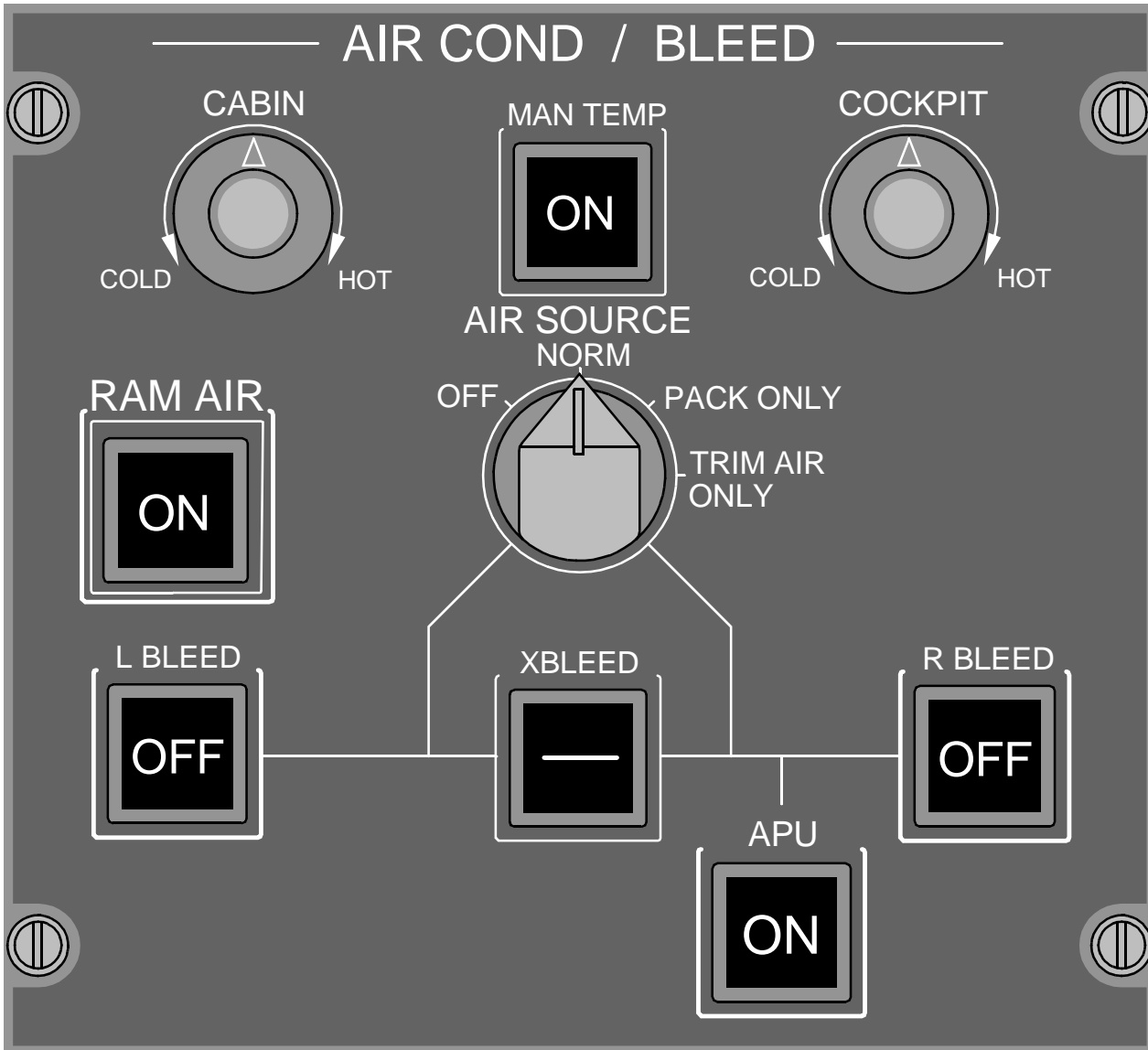
EXTERNAL POWER CONTROL PANEL



CONTROLS AND INDICATIONS (Cont)

AIR COND/BLEED CONTROL PANEL

The APU bleed selection can be controlled from the AIR COND/BLEED panel, and the bleed valve position is displayed on the ECS synoptic page.

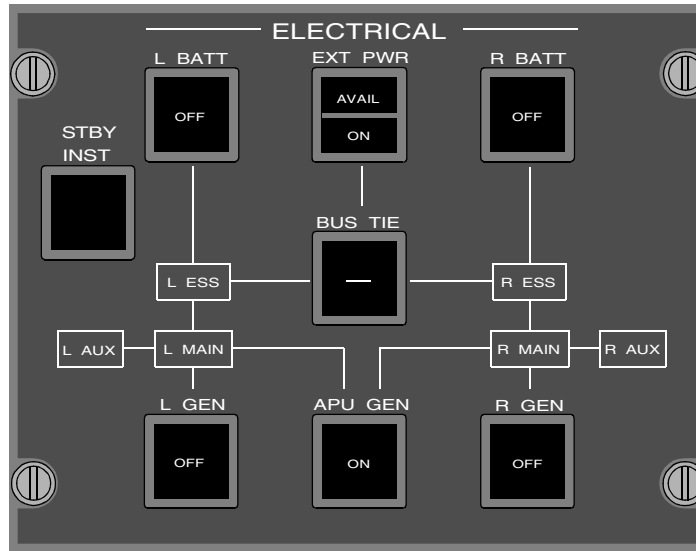


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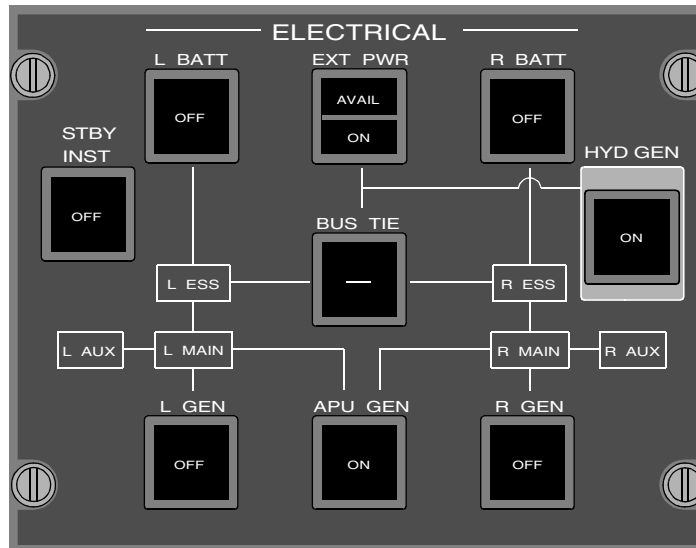
CONTROL AND INDICATIONS (Cont)

ELECTRICAL CONTROL PANEL

The APU generator can be controlled by switches located on the ELECTRICAL control panel.

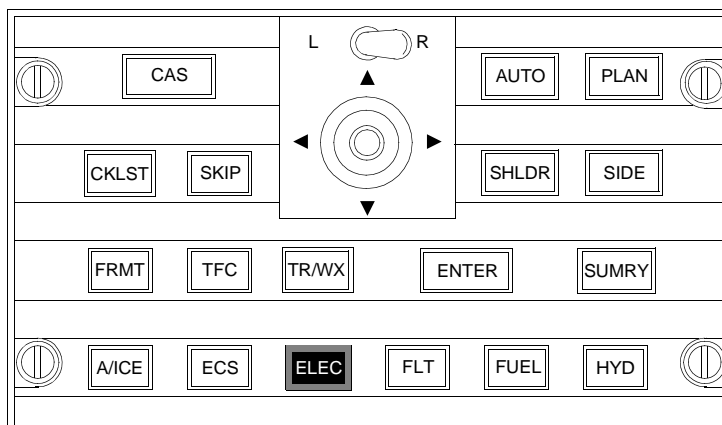
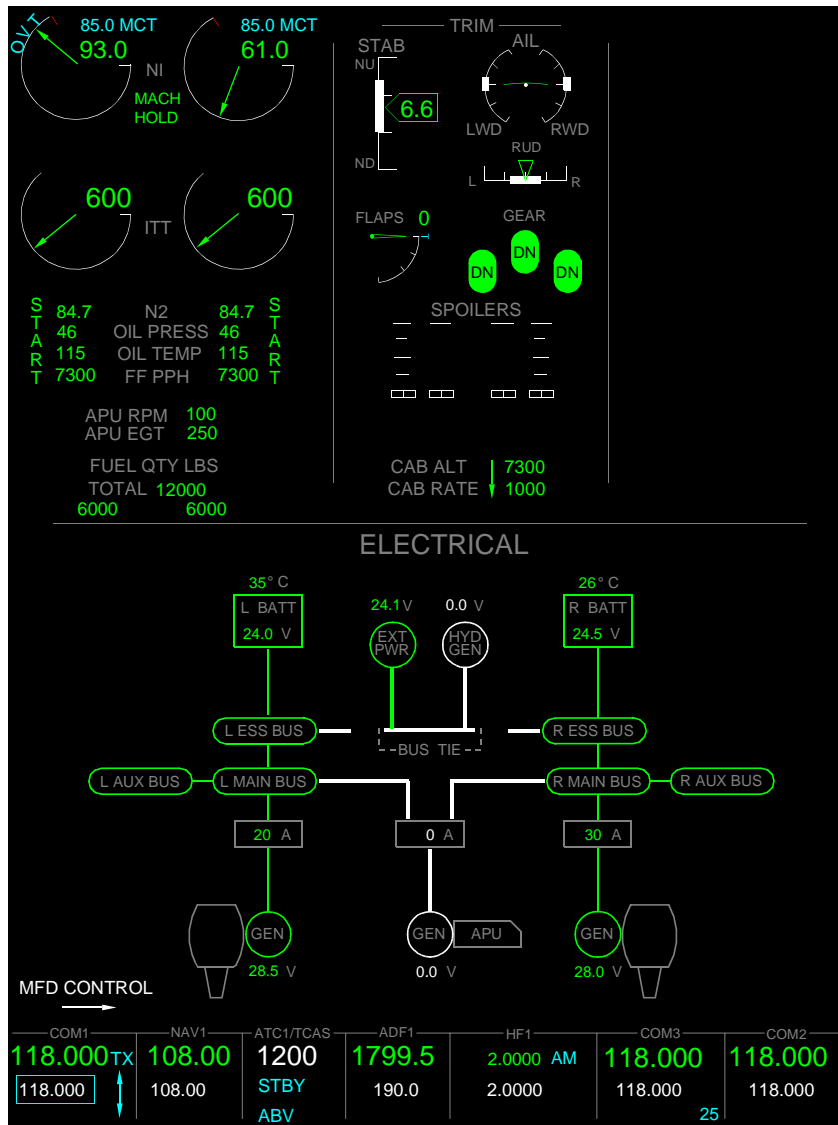


Shown with optional Hydraulic Motor Generator (HMDG) system.



CONTROLS AND INDICATIONS (Cont)

ELECTRICAL SYNOPTIC PAGE

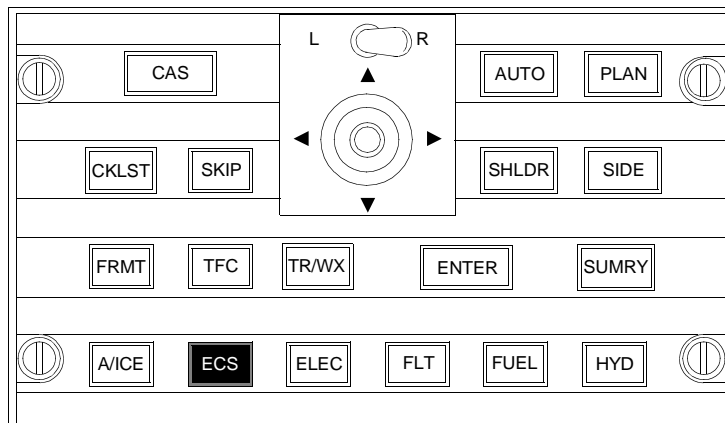
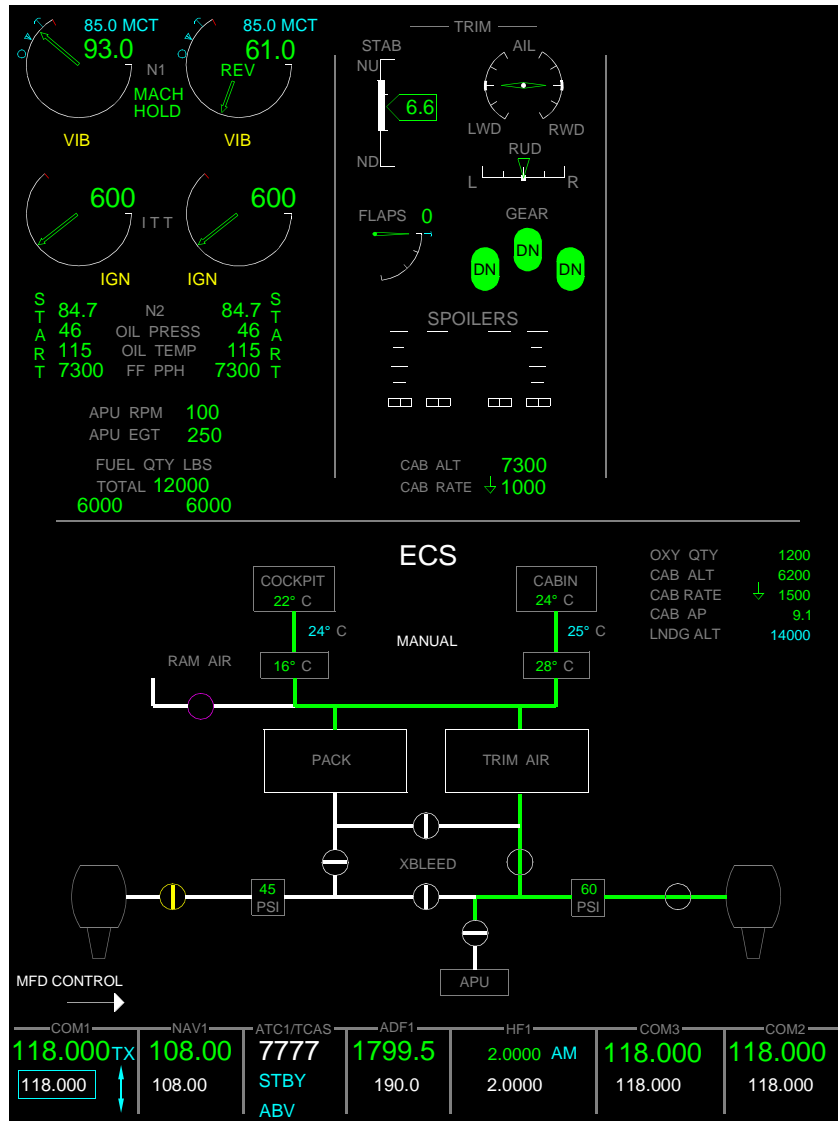


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CONTROL AND INDICATIONS (Cont)

ECS SYNOPTIC PAGE

The ECS synoptic page is used to monitor the APU load control valve.

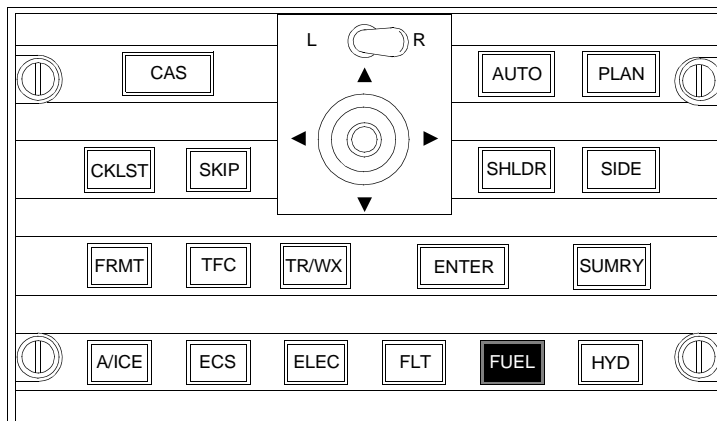
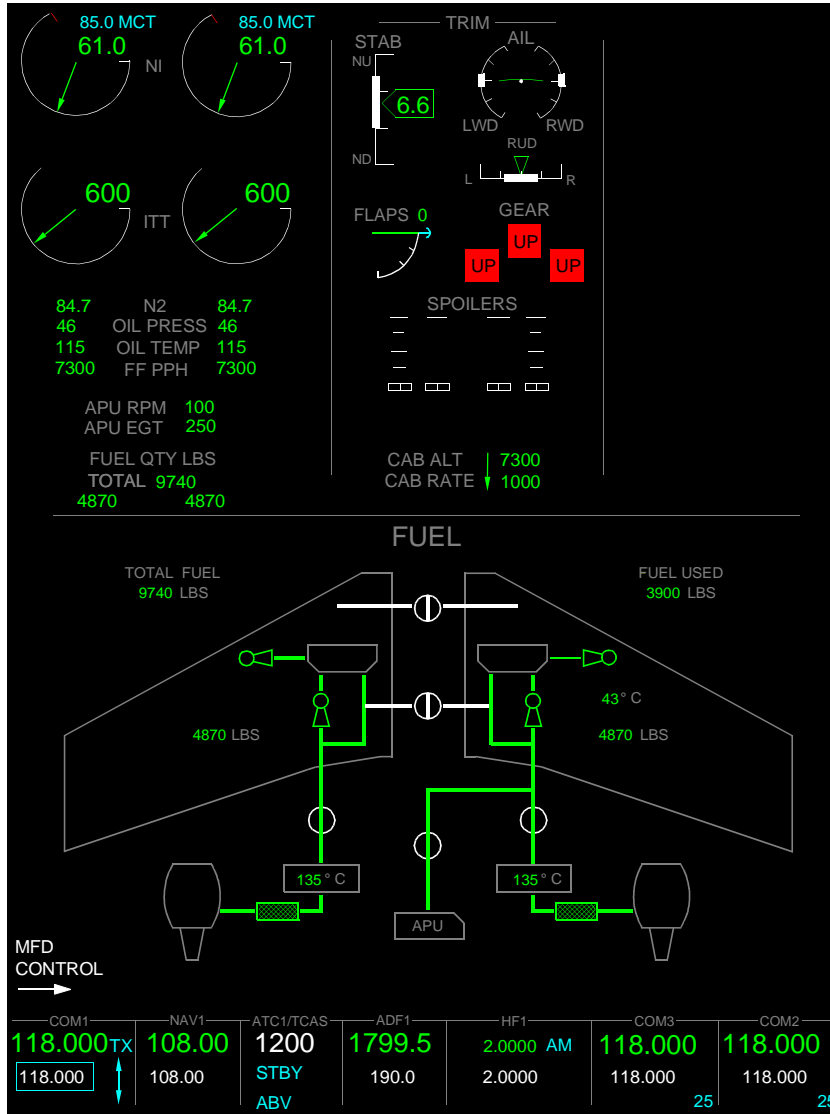


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CONTROL AND INDICATIONS (Cont)

FUEL SYNOPTIC PAGE

Operation of the APU pump and fuel SOV is monitored on the FUEL synoptic page.



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EICAS MESSAGES

The APU system messages are displayed on the EICAS.

Inhibits, a brief description, and aural warnings (if applicable) are listed in the table below.

MESSAGE	INHIBITS	MEANING	AURAL WARNING
APU FIRE		The APU fire detection loop has activated. On the ground the system should automatically shut the APU down and activate the fire extinguisher. In flight the APU will not automatically shut down or activate the fire extinguisher	"APU FIRE"
APU OVERTEMP	TO	An APU EGT over temperature has been detected. On the ground, the APU will automatically shutdown	
APU BLEED ALT LIMIT	TO/LAND	APU bleed air has been commanded above 20 000 ft or the APU bleed modulated due to excessive EGT	
APU FUEL SOV FAIL	TO/LAND	The APU shutoff valve has failed	
APU OVERSPEED	TO/LAND	The APU has shutdown due to an overspeed	
APU OIL PRESS LOW	TO/LAND	The APU oil pressure is low while in flight	
APU OIL TEMP HIGH	TO/LAND	The APU oil temperature is high while in flight	
APU STARTER FAIL ON	TO/LAND	Power is still being supplied to the APU starter when electronic control unit is not commanding a start	
APU FAULT	TO/LAND	A fault is indicated in the APU system. One or more of the following has occurred: - The APU bleed valve has failed - The APU fuel solenoid has failed - A start is prevented - The avionics are not communicating with the APU electronic control unit - Reverse flow has been detected	
APU SHUTDOWN	TO/LAND	The auxiliary power unit electronic control unit has shut down the APU for protective reasons	