CL-350

CL-350 TRAINING MANUAL

AUXILIARY POWER UNIT 08

AIRCRAFT SYSTEMS

TRAINING MANUAL

LOFT.AERO

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AUXILIARY POWER UNIT

I. INTRODUCTION

The Challenger 350 utilizes a Honeywell 36-150BD constant-speed gas turbine auxiliary power unit (APU) installed in a fireproof compartment in the aircraft tailcone. The APU functions as a fully automated gas turbine powerplant with automatic fault detection, automatic and remote shutdown capabilities, and automatic fire extinguishing in ground fire scenarios.

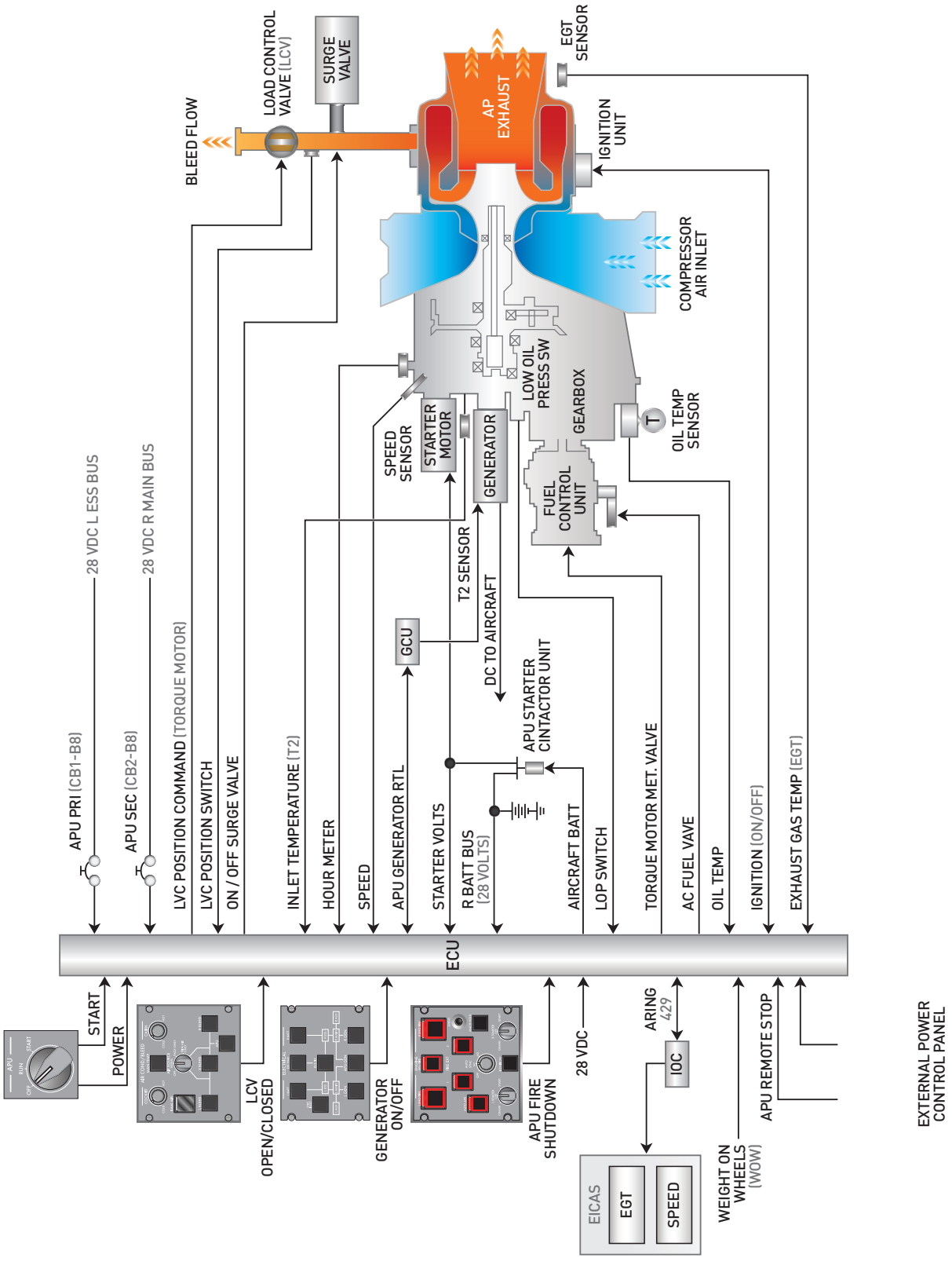
A. APU SPECIFICATIONS

Parameter	Value
APU Model	Honeywell 36-150BD
APU Type	Constant-speed gas turbine
Installation Location	Fireproof tailcone compartment
Control System	Electronic Control Unit (ECU)
Maximum RPM	108%
Maximum EGT Start	973°C
Maximum EGT Normal	718°C
Generator Output	12 kVA (400 amp)
Generator Voltage	29.5 volts nominal
Primary Function	Gearbox-mounted 400 amp DC generator power supply
Secondary Functions	Bleed air supply for ECS and main engine starting
Fuel Source	Right hand collector tank

B. SYSTEM ARCHITECTURE

- Primary Function: Gearbox-mounted 400-amp DC generator power supply
- Secondary Functions: Bleed air supply for ECS and main engine starting
- Load Priority: Electrical loads take priority over pneumatic loads under high demand
- Control Philosophy: Single-switch operation with full ECU automation
- Access: Single panel aft of aft equipment bay door (fuselage underside)

APU SCHEMATIC



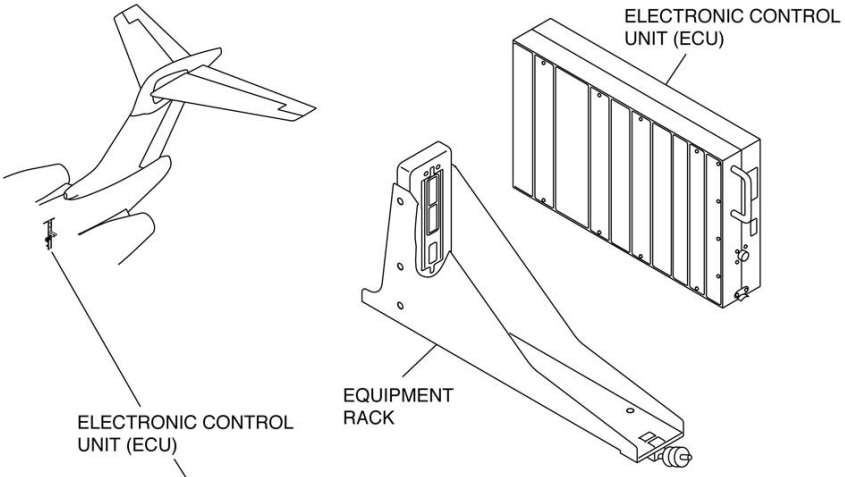
II. ELECTRONIC CONTROL UNIT (ECU)

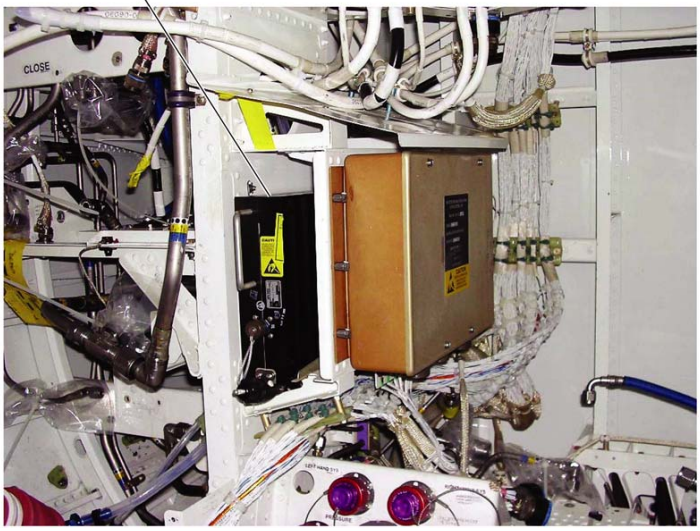
A. ECU DESCRIPTION

- Installed in equipment rack in aft equipment compartment
- Electrically operated, computer-controlled digital controller
- Powered by the aircraft 28 VDC battery bus
- "Mini-FADEC" controlling all facets of APU operation

B. ECU MONITORING CAPABILITIES

- Automatic recording and monitoring of operating hours
- Automatic counting and tracking of starts
- Fuel Acceleration Schedules: Automated DC-powered fuel scheduling
- EGT Schedules: Exhaust gas temperature monitoring and control
- Data Relay: Operating data transmission to EICAS displays





III. START AND IGNITION SYSTEM

A. STARTER SYSTEM

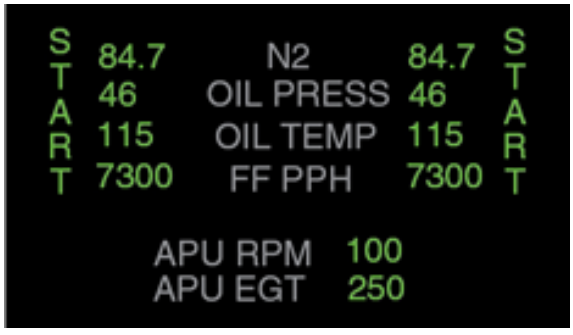
Components:

- DC starter motor controlled by ECU relay series
- Electronic control unit on battery bus
- APU starter on battery direct bus
- Right battery isolation during start sequence – Left battery powers both L & R essential busses during APU start

Operation:

- APU start contactor closure connects right battery to starter
- Right battery contactor opens during start to prevent voltage drop to essential busses
- **R BATT OFF** light illuminates momentarily during start
- R BATT flowline turns white on ELECTRICAL synoptic page
- Left battery maintains power to essential buses during APU start

B. IGNITION SYSTEM



Components:

- Single ignition unit with igniter plug lead
- Single igniter plug configuration
- ECU-controlled ignition timing

System Operation:

- Ignition energized at 5% APU rpm
- Ignition de-energized at 95% APU rpm
- Automatic relight function for flameout conditions
- 28 VDC power from right aircraft battery bus

C. START SEQUENCE

Initiation:

1. APU switch pulled up and set to RUN position for approx. 3 seconds until APU indications are displayed on the left MFD.
2. Move switch to START and hold until START icon appears on MFD
3. ECU automatically begins start sequence

Auto Relight Features:

- Automatic igniter firing during flameout
- Immediate restart capability below 10% rpm rolldown
- ECU auto relight function integration

D. START LIMITATIONS

APU Start Limitations

Ground	
Ground Start Attempts	Three attempts with 1-minute cooling between each attempt
Cooling After Third Attempt	20 minutes
Additional Attempts	Two more after cooling period
Final Wait Period	40 minutes minimum
Successive Starts	Six starts at 10-minute intervals with 1-hour wait
Maximum In-Flight Start Speed	285 KIAS
Hung Start RPM Threshold	30% RPM after 30 seconds
Left Engine Start Ground Limit	Do not use APU above 9,000 ft
Anti-icing Fluid Delay	5 minutes after application to allow fluid to drain

In-Flight	
Unsuccessful Start	No restart attempts until after landing following unsuccessful start
Hung Start	No restart attempts until after landing following hung start

NOTE: A Left Engine ground start above 9,000' MSL is prohibited utilizing the APU.

IV. FUEL DISTRIBUTION SYSTEM

A. SYSTEM DESCRIPTION

- Full Authority Digital Electronic Engine (FADEC) controlled
- Fuel is drawn from the right-hand collector tank
- Fuel flow automatically modulated to maintain RPM for electrical and pneumatic load requirements
- ECU over-temperature protection during acceleration

B. FUEL SYSTEM COMPONENTS

Primary Components:

- DC-powered fuel pump
- Fuel feed shutoff valve (SOV)
- Fuel shutoff solenoid
- Fuel system filters
- High-pressure fuel pump (APU-mounted)
- Fuel control unit (FCU)
- Fuel manifold assembly

C. FUEL CONTROL OPERATION

Fuel Control Unit (FCU):

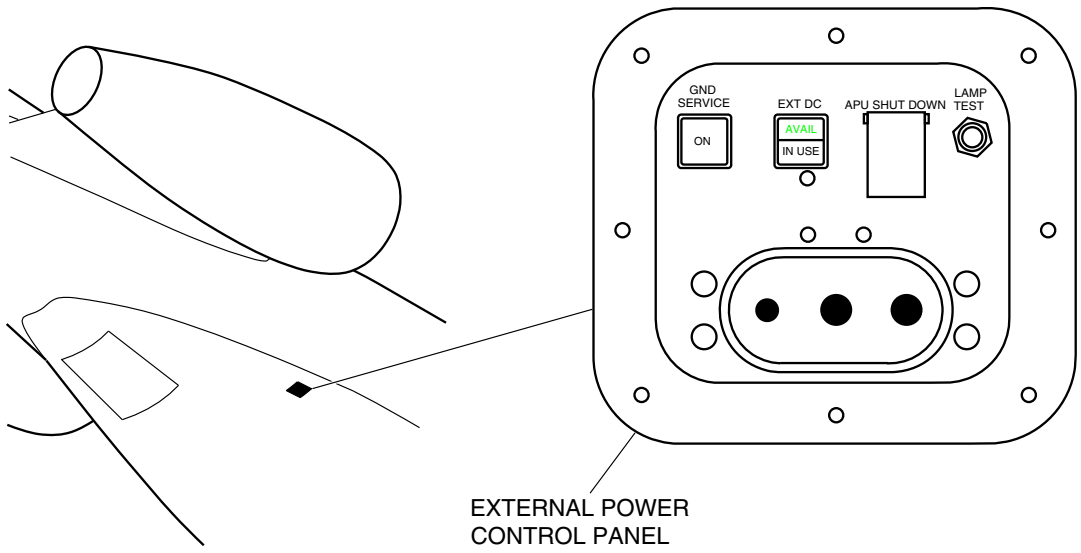
- Meters fuel under ECU command
- Fuel shutoff solenoid opens at 5% rpm during start
- Fuel scheduling based on rpm, EGT, generator and bleed demands

Fuel Pump Operation:

- DC-powered pump delivers fuel under pressure to FCU
- Pump ceases operation when right engine running
- Main engine ejector pump provides fuel when right engine running

Shutdown Modes:

- Normal shutdown: ECU commands fuel off
- Automatic shutdown: Overspeed signal closes fuel solenoid and torque motor
- Emergency shutdown: Fire or exceeded limit triggers fuel cutoff via ECU



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

V. PROTECTIVE SHUTDOWNS

For certain aircraft configurations (specifically aircraft 20501 to 20696 not incorporating Service Bulletin SB 350-49-001), the Auxiliary Power Unit (APU) can operate in an **"essential mode" during flight**, where some of its protective shutdown mechanisms are inhibited.

For aircraft 20697 and subsequent models, or those that have incorporated Service Bulletin SB 350-49-001, the APU operates in a "non-essential mode" for both on-ground and in-flight operations, meaning these specific shutdowns are not inhibited.

Essential Mode Protective Shutdowns

Shutdown Condition	Status
Fire Indication	Ground Only
Reverse Flow	Ground Only
Loss of EGT Signal	Ground Only
Low Oil Pressure	Ground Only
High Oil Temperature	Ground Only
Overtemperature	Ground Only
No Flame (during start)	Ground Only
No Acceleration (during start)	Ground Only
28 V DC Power Loss	Ground/In-Flight
Overspeed	Ground/In-Flight
Emergency Fire	Ground/In-Flight
Internal ECU Failure	Ground/In-Flight
Loss of Overspeed Protection Circuit	Ground/In-Flight

Non-Essential Mode Protective Shutdowns

Shutdown Condition	Status
Fire Indication	Ground/In-Flight
Reverse Flow	Ground/In-Flight
Loss of EGT Signal	Ground/In-Flight
Low Oil Pressure	Ground/In-Flight
High Oil Temperature	Ground/In-Flight
Overtemperature	Ground/In-Flight
No Flame (during start)	Ground/In-Flight
No Acceleration (during start)	Ground/In-Flight
28 V DC Power Loss	Ground/In-Flight
Overspeed	Ground/In-Flight
Underspeed	Ground/In-Flight
Emergency Fire	Ground/In-Flight
Internal ECU Failure	Ground/In-Flight
Loss of Overspeed Protection Circuit	Ground/In-Flight
No Crank	Ground/In-Flight
Loss of Speed Signal	Ground/In-Flight
Speed Fallback	Ground/In-Flight

VI. PNEUMATIC SUPPLY SYSTEM

Under high demand, the APU electrical loads take priority over pneumatic loads, such as bleed air supply. The APU's electronic control unit (ECU) manages the pneumatic load by controlling the bleed valve, which diverts compressor discharge air to the aircraft's bleed air manifold.

When bleed air is extracted, this pneumatic energy is no longer available to drive the turbine or cool the combustion system, leading to a significant increase in exhaust gas temperature (EGT). To prevent overtemperature, the ECU will reduce bleed air flow by modulating the bleed valve towards the closed position if the EGT limit is reached. This mechanism ensures that electrical power requirements are met first when both electrical and pneumatic demands are high.

A. PNEUMATIC SYSTEM DESCRIPTION

- APU compressor bleed air pressurizes right bleed air manifold
- Provides bleed air for engine starting and air conditioning
- One-way check valve prevents reverse airflow

B. PNEUMATIC CONTROL COMPONENTS

Bleed Valve:

- Controls airflow to aircraft bleed system
- Protects APU from overtemperature conditions
- Electrically controlled with pneumatic operation
- Butterfly valve mechanism with ECU position adjustment

Surge Control Valve:

- Automatically controlled by ECU
- Opens when APU supplies electrical loads above 15,000 ft
- Reduces APU surge potential during unloaded operation

C. BLEED AIR OPERATION

Load Control:

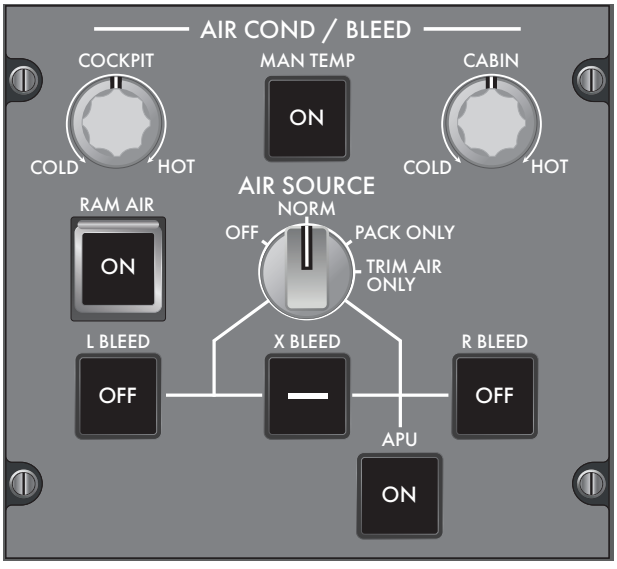
- ECU controls pneumatic load through bleed valve demands
- Bleed valve opens when flight deck switch placed to open position
- Bleed air extraction affects turbine pneumatic energy and combustion cooling
- Surge valve opens to reduce surge potential above 15,000' when APU is supplying electrical loads but no bleed loads

EGT Management:

- Bleed loads cause rpm drop and EGT increase
- ECU fuel flow increase recovers to governed speed
- ECU modulates bleed valve toward closed position to prevent overtemperature

Availability Requirements:

- APU must be above 95% maximum speed for bleed air energization
- ECU energizes bleed-air supply system at proper rpm threshold



VII. ELECTRICAL GENERATOR SYSTEM

A. GENERATOR SPECIFICATIONS

- Output Rating: 12 kVA (400 amp) - identical to engine generators
- Voltage Output: 29.5 volts nominal
- Altitude Capability: 30,000 ft maximum for backup generator use
- Load Sharing: Medium and low altitude capability with engine generators
- Start Power: Right battery with isolation from essential busses during start sequence

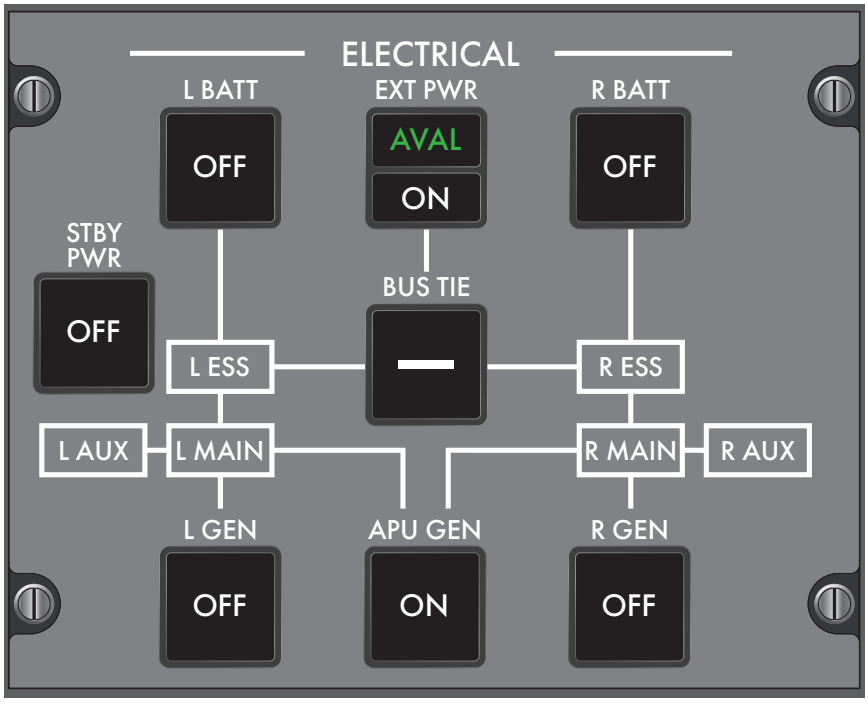
B. GENERATOR OPERATION

Power Distribution:

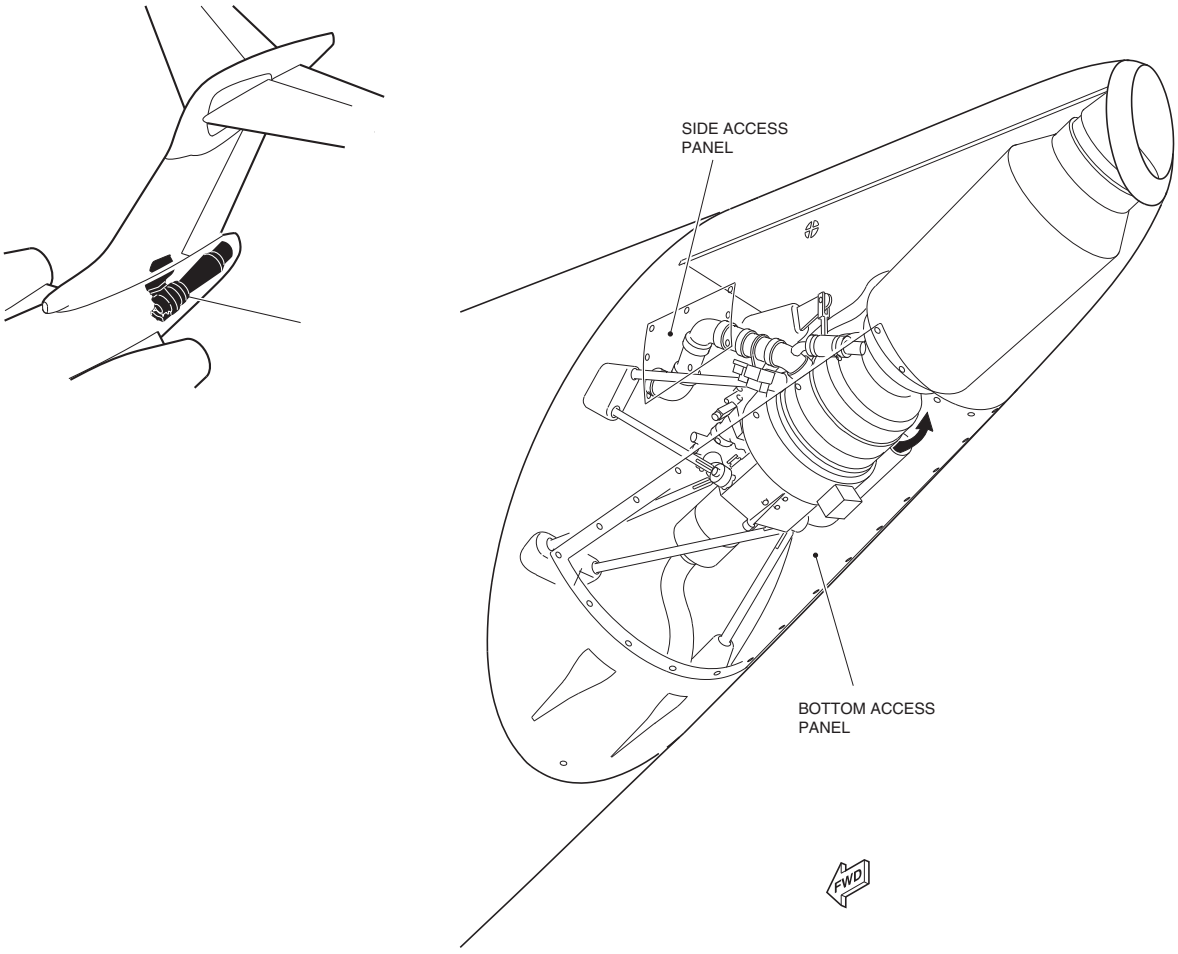
- Emergency replacement for failed engine generator(s)
- Automatic load distribution with engine generators
- Ground operation capability for all aircraft systems
- Connects through APU Power Center

Generator Control:

- DC electrical power controlled from ELECTRICAL panel
- Bus tie operations with generator priority
- Automatic connection systems for load management



VIII. APU COMPARTMENT AND ACCESS



A. COMPARTMENT DESIGN

Location and Access:

- Tailcone installation in fireproof compartment
- Access via single panel aft of aft equipment bay door
- Panel removal required from fuselage underside
- Self-contained unit design

Ventilation System:

- NACA inlet for compartment ventilation
- Air routing through compartment for APU cooling
- Exhaust via APU exhaust eductor
- Generator cooling with separate NACA inlet

B. AIR INTAKE AND EXHAUST

Air Intake:

- Located above APU compartment on right fuselage side
- Positioned below vertical stabilizer
- Provides combustion air for APU operation

Exhaust System:

- Exhaust gases discharged via exhaust duct and eductor
- Insulated exhaust muffler coverage
- Tailcone exhaust routing

IX. CONTROL AND INDICATIONS

A. APU CONTROL PANEL

Primary Control:

- Single three-position switch (OFF/RUN/START)
- Ground operations remote cutoff switch on right fuselage
- Located aft of wing behind electrical connection access door

Control Integration:

- DC electrical power control from ELECTRICAL panel
- Bleed air services control from AIR COND/BLEED panel
- System monitoring via EICAS pages

B. DISPLAY SYSTEMS

EICAS Monitoring:

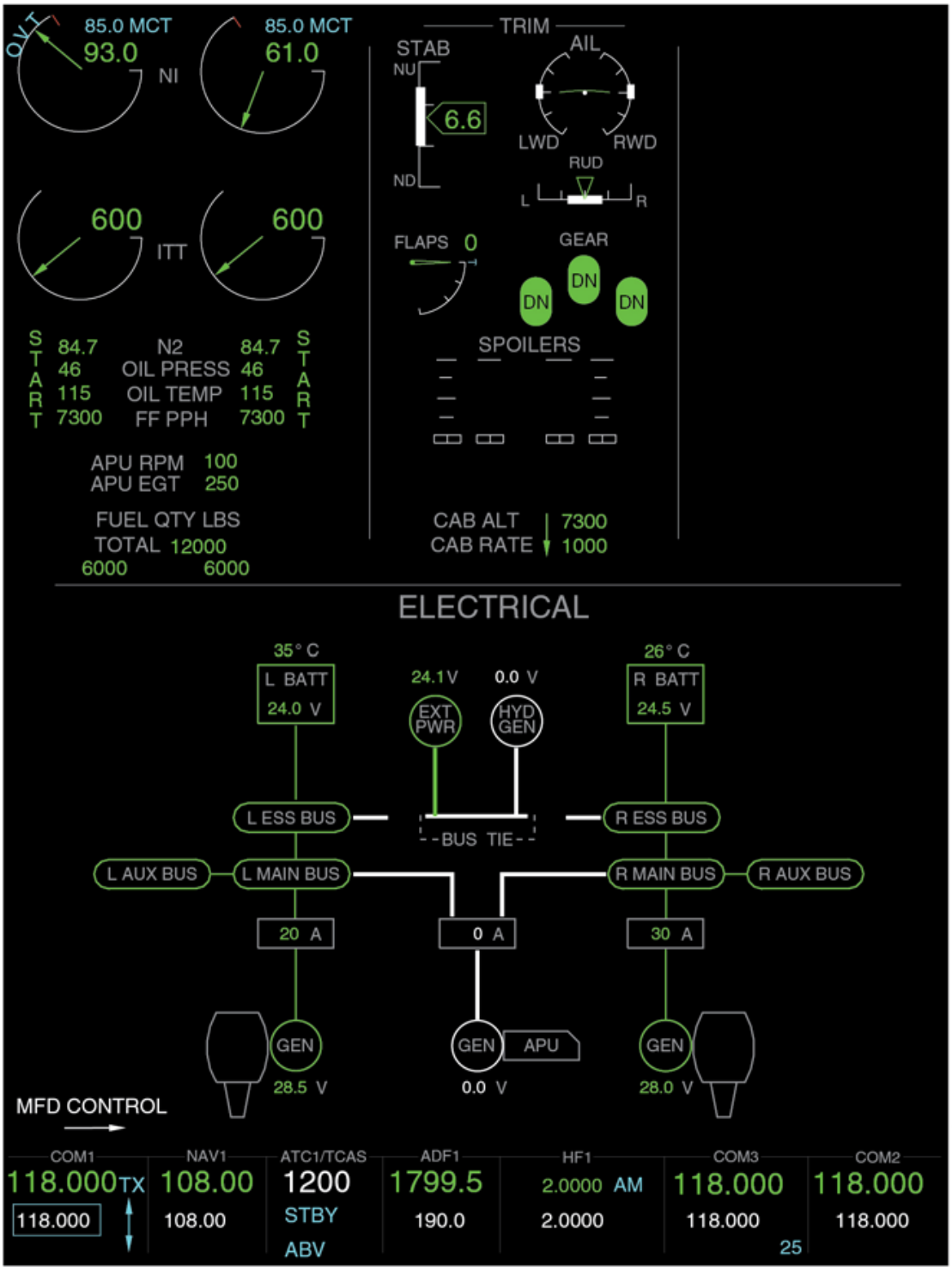
- FUEL synoptic page monitors APU pump and fuel SOV
- ECS synoptic page displays pneumatic operations
- ELECTRICAL synoptic page shows generator status

Parameter Displays:

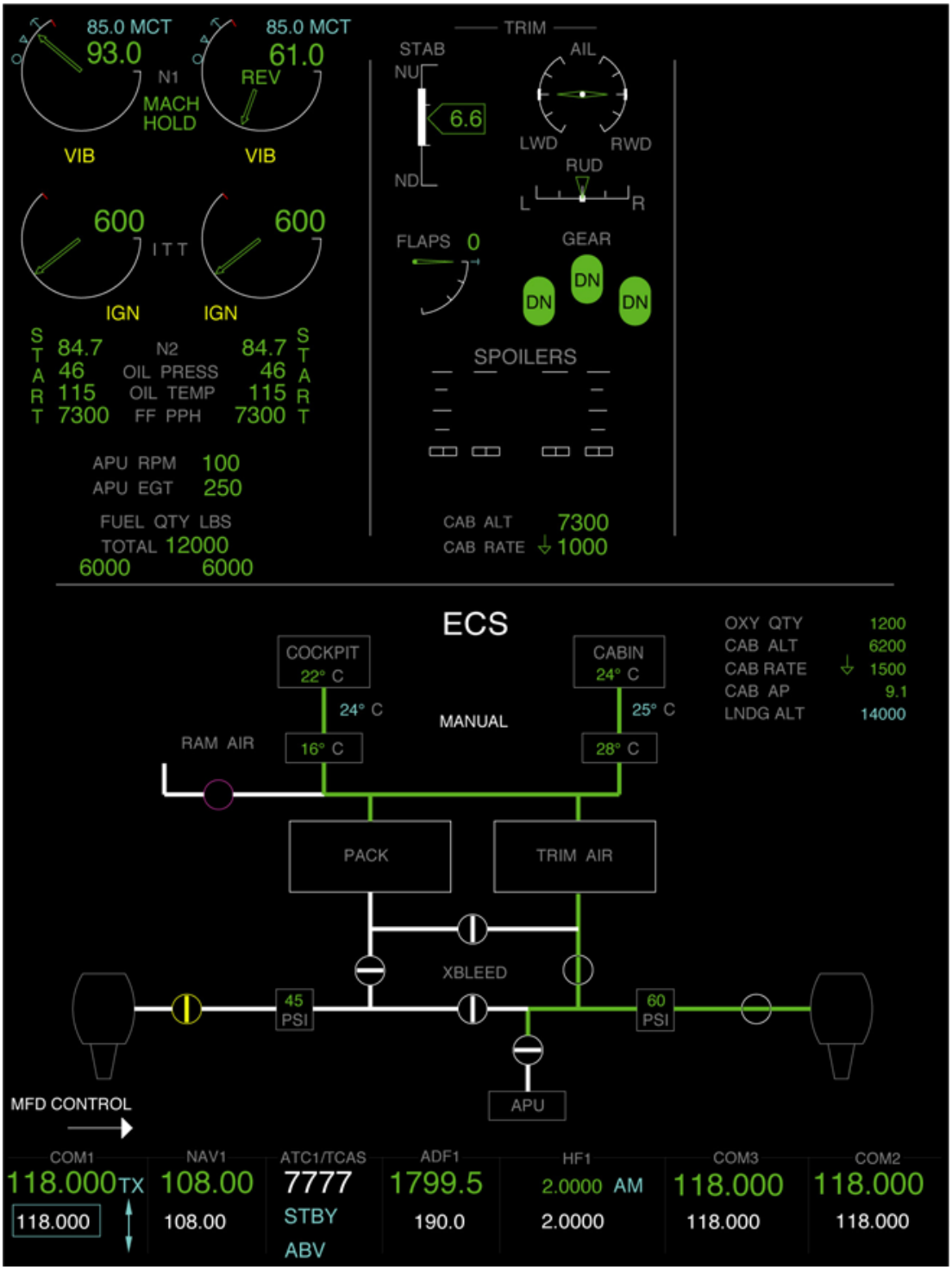
- Digital RPM display
- EGT digital readout
- Generator amperage and voltage indications
- Bleed air status indications

X. SYNOPTIC PAGES

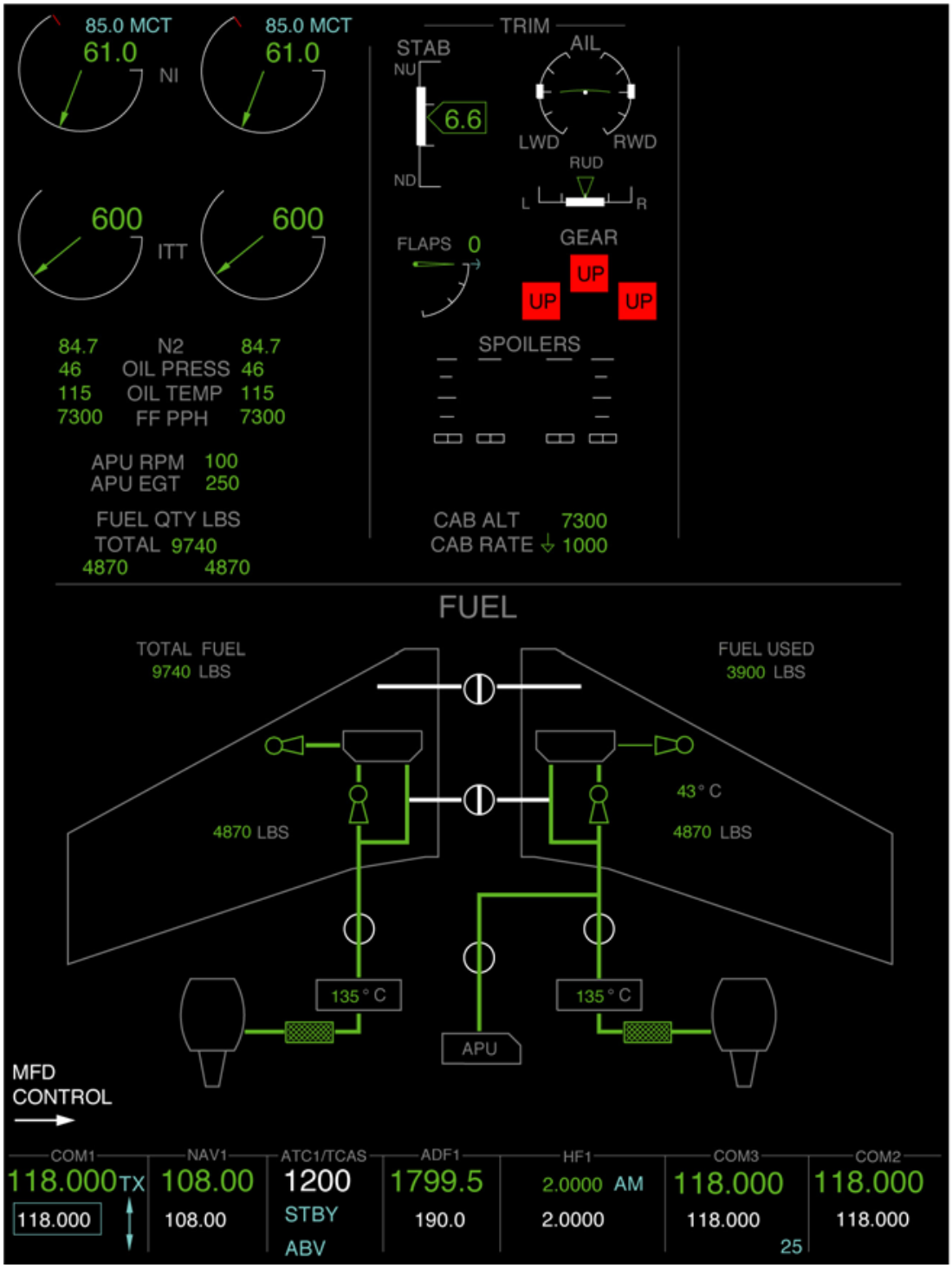
A. ELECTRICAL SYNOPTIC PAGE



B. ECS SYNOPTIC PAGE



C. FUEL SYNOPTIC PAGE



XI. EICAS MESSAGES

A. WARNING MESSAGES

WARNING MESSAGES

Immediate crew action required

Message	Meaning	Inhibits
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 OVERTEMP	An APU EGT overtemperature has been detected. On the ground, the APU will automatically shut down	TO/LAND

B. CAUTION MESSAGES

CAUTION MESSAGES

Timely crew awareness/action needed

Message	Meaning	Inhibits
APU BLEED ALT LIMIT	APU bleed air has been commanded above 20,000 ft, or the APU bleed modulated due to excessive EGT	TO/LAND
APU FIRE DET FAIL	The APU fire detection system has failed	TO/LAND
APU FUEL SOV FAIL	The APU fuel feed shutoff valve has failed	TO/LAND
APU GEN FAIL	The APU generator has failed	TO/LAND
APU GEN OVERLOAD	APU generator overloaded	TO/LAND
APU OVERSPEED	The APU has shutdown due to an overspeed	TO/LAND
APU OIL PRESS LOW	The APU oil pressure is low while in flight	TO/LAND
APU OIL TEMP HIGH	The APU oil temperature is high while in flight	TO/LAND
APU STARTER FAIL ON	Power is still being supplied to the APU starter when electronic control unit is not commanding a start	TO/LAND
FIREX APU SQUIB FAULT	APU fire extinguisher squib is inoperative	TO/LAND

C. ADVISORY MESSAGES

ADVISORY MESSAGES		
Crew awareness - no immediate action required		
Message	**Meaning**	**Inhibits**
APU FAULT	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	**TO/LAND**
APU SHUTDOWN	The auxiliary power unit electronic control unit has shut down the APU for protective reasons	**TO/LAND**

NOTES

- All warning messages are accompanied by a triple chime
- All caution messages are accompanied by a single chime
- APU FIRE message includes continuous "APU FIRE" aural warning
- "TO/LAND" indicates the message is inhibited during takeoff and landing phases

XII. LIMITATIONS

A. ALTITUDE LIMITATIONS

Operation Type	Maximum Altitude
APU Operation	37,000 ft
APU Generator	30,000 ft
Bleed Air for Engine Start	20,000 ft
Bleed Air for ECS	20,000 ft
APU Start Altitude	30,000 ft
APU Start (Ground)	14,000 ft
Left Engine APU Start (Ground)	9,000 ft msl

B. OPERATIONAL LIMITATIONS

Ground	
Ground Start Attempts	Three attempts with 1-minute cooling between each attempt
Cooling After Third Attempt	20 minutes
Additional Attempts	Two more after cooling period
Final Wait Period	40 minutes minimum
Successive Starts	Six starts at 10-minute intervals with 1-hour wait
Maximum In-Flight Start Speed	285 KIAS
Hung Start RPM Threshold	30% RPM after 30 seconds
Left Engine Start Ground Limit	Do not use APU above 9,000 ft
Anti-icing Fluid Delay	5 minutes after application to allow fluid to drain

In-Flight	
Unsuccessful Start	No restart attempts until after landing following unsuccessful start
Hung Start	No restart attempts until after landing following hung start

RPM and Temperature	
Maximum APU RPM	108%
Max EGT Start	973°C
Max EGT Normal Operations	718°C

NOTE: A Left Engine ground start above 9,000' MSL is prohibited utilizing the APU.

XIII. APU SYSTEM CIRCUIT BREAKERS

APU System Circuit Breakers

CB Name	Bus	Location
APU	LEFT ESS	CB1-B8
APU SECONDARY CONTROL	RIGHT MAIN	CB2-B8

NOTE: MM Designators differ from QRH

CB1 = LCBP (Left Cockpit Breaker Panel)

CB2 = RCBP (Right Cockpit Breaker Panel)

CB3 = LSPC (Left Side Panel Circuit)

CB4 = RSPC (Right Side Panel Circuit)

CB5 = LDCPC (Left DC Power Center)

CB6 = RDCPC (Right DC Power Center)

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XIV. APU QUIZ

1. What is the maximum altitude for APU generator operation?

A) 37,000 ft
B) 30,000 ft
C) 20,000 ft
D) 14,000 ft

2. At what RPM percentage does the APU ignition system energize?

A) 3%
B) 5%
C) 10%
D) 15%

3. What is the maximum EGT limit for normal APU operations?

A) 650°C
B) 718°C
C) 800°C
D) 973°C

4. How many consecutive APU start attempts are permitted on the ground before a cooling period?

A) Two
B) Three
C) Four
D) Five

5. Which battery is isolated during APU start?

A) Left battery
B) Right battery
C) Both batteries
D) Standby battery

6. What is the APU generator output rating?

A) 8 kVA (300 amp)
B) 10 kVA (350 amp)
C) 12 kVA (400 amp)
D) 15 kVA (450 amp)

7. At what percentage RPM does the fuel shutoff solenoid open during start?

A) 3%
B) 5%
C) 10%
D) 15%

8. What is the maximum altitude for APU bleed air use for engine starting?

A) 15,000 ft
B) 20,000 ft
C) 30,000 ft
D) 37,000 ft

9. Which system takes priority when APU is under high demand?

A) Pneumatic loads
B) Electrical loads
C) Both equally
D) Depends on altitude

10. What is the cooling period required after three consecutive start attempts?

A) 10 minutes
B) 15 minutes
C) 20 minutes
D) 40 minutes

11. At what RPM percentage does the APU ignition system de-energize?

A) 85%
B) 90%
C) 95%
D) 100%

12. What type of control system does the APU use?

A) Mechanical control
B) Hydraulic control
C) Electronic Control Unit (ECU)
D) Pneumatic control

13. What is the maximum RPM limit for the APU?

A) 105%
B) 106%
C) 107%
D) 108%

14. Which fuel tank supplies the APU?

A) Left collector tank
B) Right collector tank
C) Center tank
D) Both collector tanks

15. What happens to the right battery during APU start?

A) It remains connected
B) It is isolated from the essential bus
C) It is completely disconnected
D) It switches to standby mode

16. How long must anti-icing fluid be allowed to drain before APU start?

A) 2 minutes
B) 3 minutes
C) 5 minutes
D) 10 minutes

17. What is the maximum airspeed for APU start in flight?

A) 250 KIAS
B) 275 KIAS
C) 285 KIAS
D) 300 KIAS

18. Where is the APU ECU located?

A) APU compartment
B) Cockpit
C) Aft equipment compartment
D) Tailcone

19. At what RPM percentage must the APU operate for bleed air availability?

A) Above 90%
B) Above 95%
C) Above 98%
D) At 100%

20. What provides protection from reverse airflow in the pneumatic system?

A) Bleed valve
B) Surge control valve
C) One-way check valve
D) ECU control

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