

### 12.19.1 Introduction

The Auxiliary Power Unit (APU) replaces the standard composite tailcone with a titanium tailcone and firewall. The APU is accessed by two clamshell type doors on the bottom of the tail cone. It consists of a gas turbine engine driving a DC starter-generator. The APU supplies bleed air for the Environmental Control System (ECS), and 28 VDC to the electrical system. The APU cannot be operated in flight.

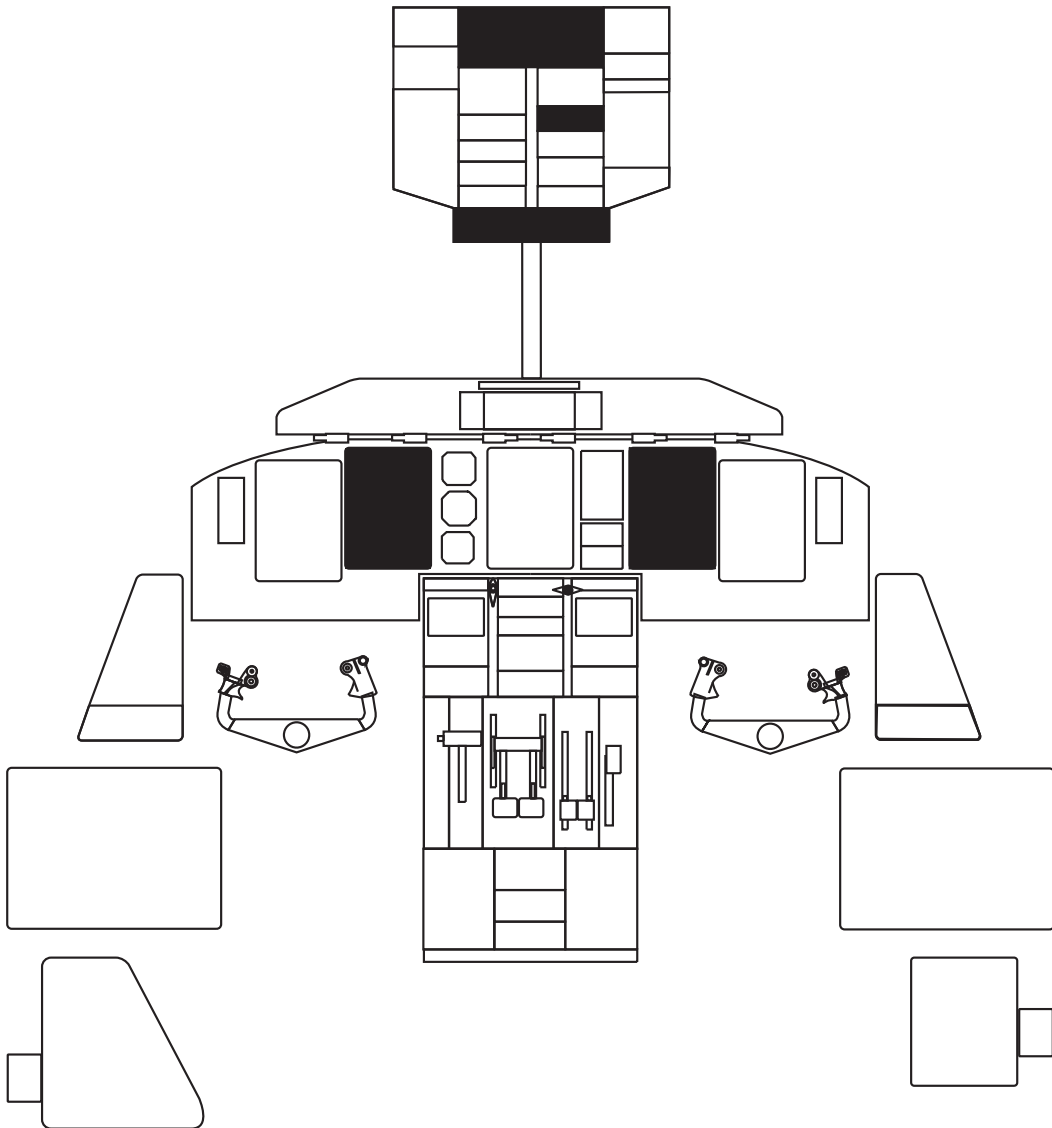
### 12.19.2 General

The start control, normal operation, and malfunction monitoring of the APU is automatically performed by the APU FADEC. The APU starter-generator can be powered from either the aeroplane main battery or external power. Intake air is drawn through a screened inlet duct on the right rear of the fuselage. Exhaust gases flow through an exhaust ejector and are discharged through an upwards pointing outlet at the aft end of the titanium tailcone. The APU is protected by its own automatic fire detection and extinguishing system that continuously monitors the APU and its compartment whenever electrical power is supplied to the system. The APU control panel is mounted on the overhead console in the flight deck.

#### **APU Louvered Inlet Cover**

A louvered cover is provided for the APU Air Inlet to help prevent snow and sleet from entering the APU Inlet when the aeroplane is on a long turnaround or remaining overnight.

12.19.3 Controls and Indications - Auxiliary Power Unit



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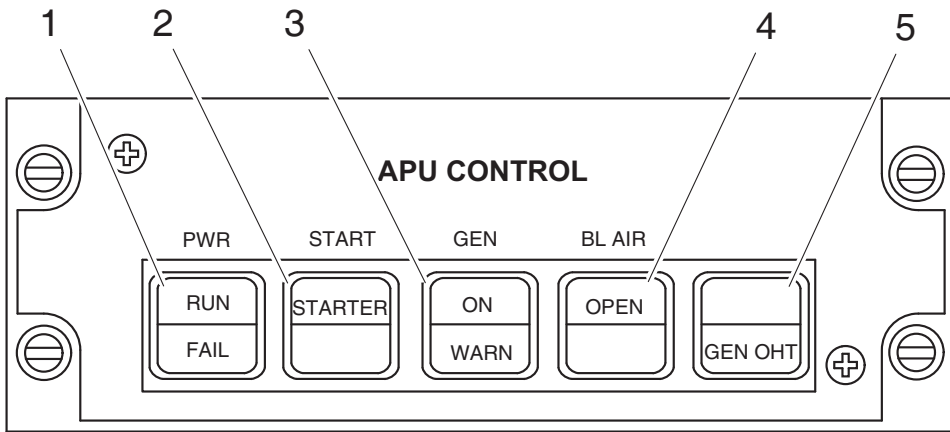
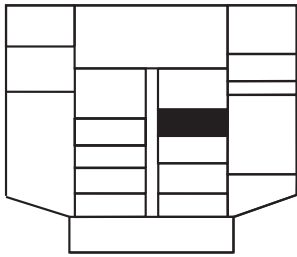


Figure 12.19-1 APU Control Panel

## APU CONTROL PANEL CALLOUTS

### 1. PWR SWITCHLIGHT (alternate action)

**PUSH** - arms APU start circuits and opens the APU fuel valve, APU FUEL VALVE OPEN light (green) shown on the APU fire protection panel

- only arms if aeroplane on ground, no fire detected, and EXTG switch not selected

**RUN** segment (green)

- APU is at operating speed after the START switchlight is pushed

**PUSH** - RUN segment (out)

- closes APU fuel valve, APU FUEL VALVE CLOSED light (white) shown on the APU fire protection panel, and the APU stops

**FAIL** - a failure is detected and the APU automatically stops

### 2. START SWITCHLIGHT (alternate action)

**PUSH** - STARTER segment (amber)

- starts automatic APU start sequence

**STARTER** segment (out)

- APU start sequence complete or stopped

### 3. GEN SWITCHLIGHT (alternate action)

**PUSH** - ON segment (green)

- APU starter-generator is supplying DC power

**PUSH** - ON segment (out)

- selects APU generator off line

**WARN** segment (amber)

- APU starter-generator off line with APU running

### 4. BL AIR SWITCHLIGHT (alternate action)

**PUSH** - OPEN segment (green)

- APU bleed air valve open

- APU bleed air supplies air to the ECS if engine bleed air is off

**PUSH** - OPEN segment (out)

- APU bleed air valve is closed

- selects APU bleed air off

### 5. GEN OHT ADVISORY LIGHT

**GEN OHT** segment (amber)

APU starter-generator overheat condition

APU automatically shuts down

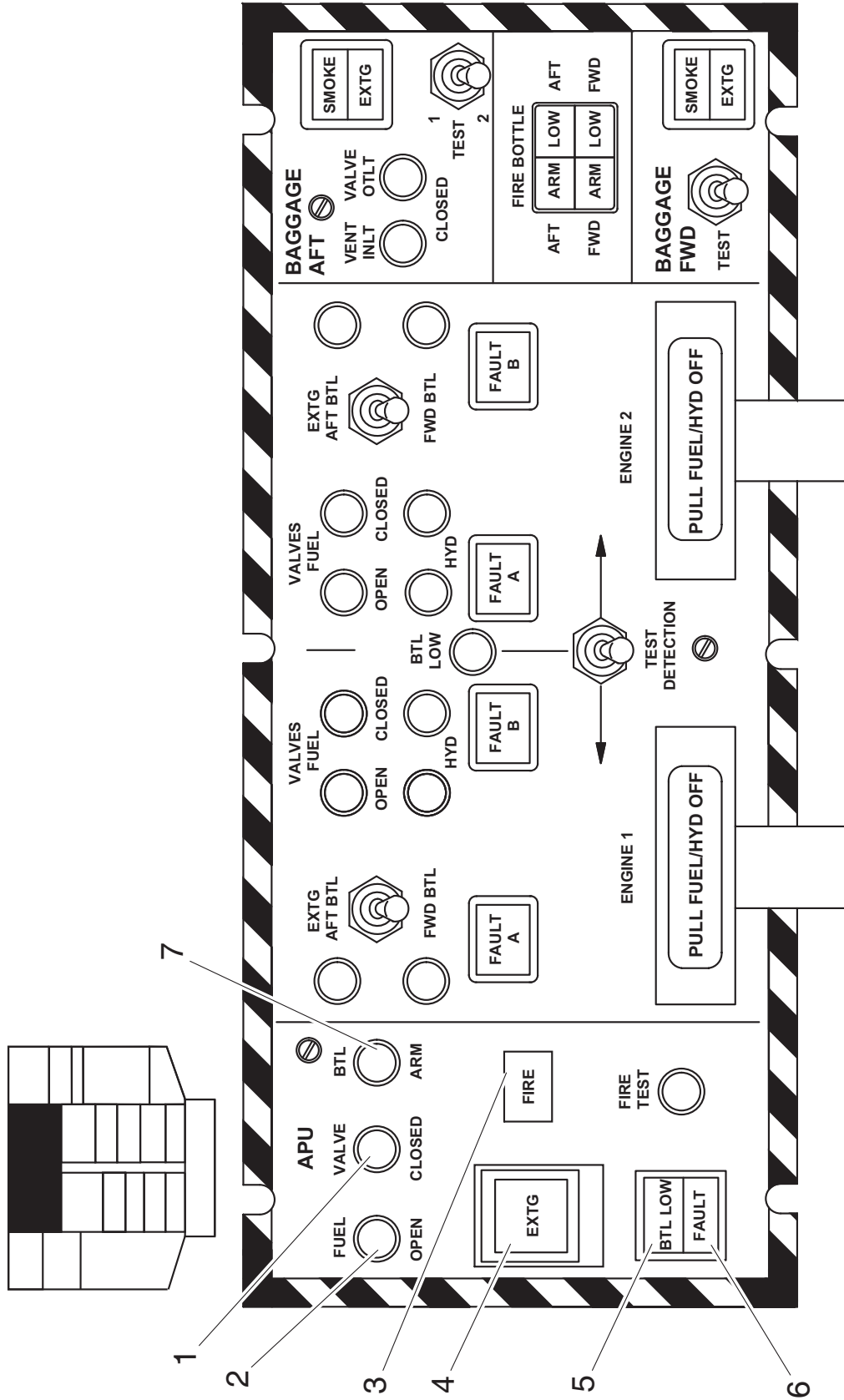


Figure 12.19-2 APU Fire Protection Panel (1 of 2)

## APU FIRE PROTECTION PANEL CALLOUTS

### 1. FUEL SHUT-OFF VALVE CLOSED ADVISORY LIGHT (white)

- APU fuel shut-off valve closed
- APU shutdown, manually or automatically

### 2. FUEL SHUT-OFF VALVE OPEN ADVISORY LIGHT (green)

- APU fuel shut-off valve open
- PWR switchlight pushed
- APU circuits armed for starting or fire test

### 3. FIRE ADVISORY LIGHT (red)

- APU fire detected
- after 7 seconds extinguishing agent automatically releases, and amber BTL ARM light goes out

### 4. EXTG SWITCHLIGHT (guarded, alternate action)

**EXTG** segment (white)

- APU fire extinguisher bottle can be activated manually if BTL ARM light is on

**PUSH** - EXTG segment (out)

- APU fire bottle cannot be activated, or has been set off

### 5. BOTTLE LOW LIGHT (amber)

- fire extinguisher bottle is low or empty

### 6. FAULT ADVISORY LIGHT (AMBER)

- fault in the APU fire extinguisher system
- fault in the APU FPP

### 7. BTL ARM ADVISORY LIGHT

(amber)

- APU fire extinguisher bottle ready to be activated

(OUT)

- APU fire extinguishing bottle cannot be activated
- no power to the system

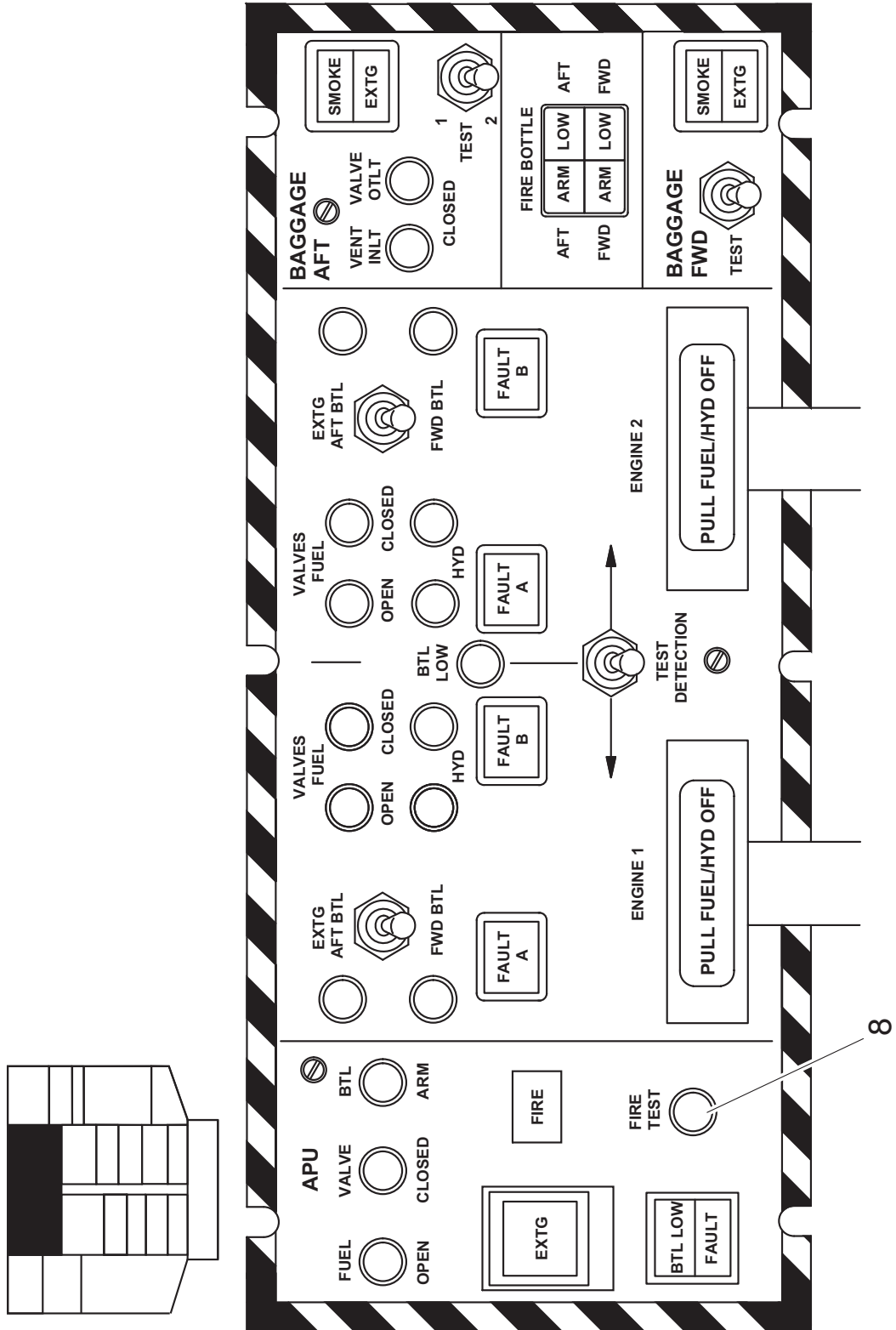


Figure 12.19-3 APU Fire Protection Panel (2 of 2)

**APU FIRE PROTECTION PANEL CALLOUTS (cont'd)**

**8. FIRE TEST PUSHBUTTON (momentary action)**

**PUSH AND HOLD** - check the following lights:

- MASTER WARNING light (red) flashes
- CHECK FIRE DET warning light (red) flashes
- FIRE segment (red)
- BTL ARM light (amber)
- FUEL VALVE OPEN (out)
- FUEL VALVE CLOSED (white)
- FAULT light (amber)
- EXTG segment (white)

**RELEASE** - check the FUEL VALVE OPEN (green) comes on



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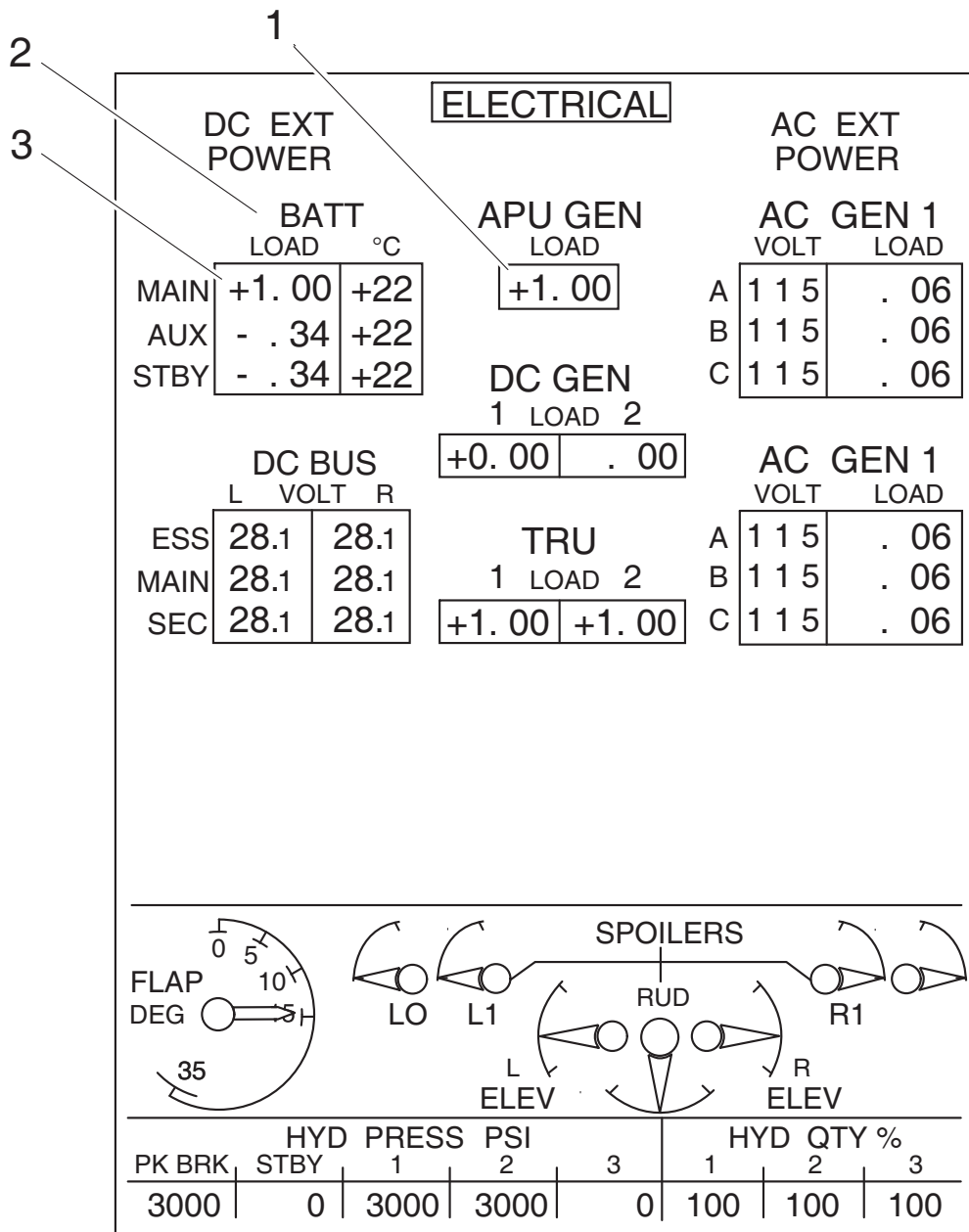
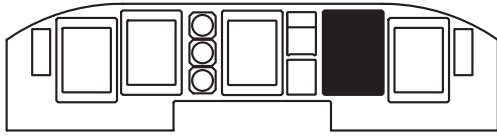


Figure 12.19-4 MFD Electrical Page with APU Generator Operating (1 of 2)

## MFD ELECTRICAL PAGE CALLOUTS

### 1. DIGITAL DISPLAY OF APU GENERATOR LOAD (white)

**APU GEN** (white)

**LOAD** (cyan)

- is activated only if the APU is installed depending on the aeroplane configuration
- the load demand on the APU generator is displayed in the following format:
  - “+” sign is displayed on the left of the lead digit to indicate an overload of the DC power source
  - nothing is displayed when the load is in the expected range
  - leading zero is suppressed in the lead digit position
  - digital number gives the rate of the load, with 1.00 equal to 100% of load
- examples:
  - “.60” indicates that the DC generator or TRU is loaded at 60% of the maximum output.
  - “+1.30” indicates an overload of the DC generator or TRU

### 2. BATTERY LOAD AND TEMPERATURE ANNUNCIATION AREA

**BATT** (white)

**LOAD, °C** (cyan)

**MAIN, AUX, STBY** (white)

### 3. DIGITAL DISPLAY OF BATTERY LOAD (white)

- displays the load of the battery
- + or - sign on the left of the lead digit, whether the battery is in overcharge (“+” displayed) or in discharge (“-” displayed)
- nothing is displayed when the battery is in charge within the expected range
- leading zero is suppressed in the lead digit position
- digital number gives the rate of the load, with 1.00 equal to 100% of load
- examples:
  - “.60” indicates that the battery is in charge at 60% of its maximum rate of charge
  - “-1.30” indicates that the battery is discharging at 30% over the maximum rate of discharge

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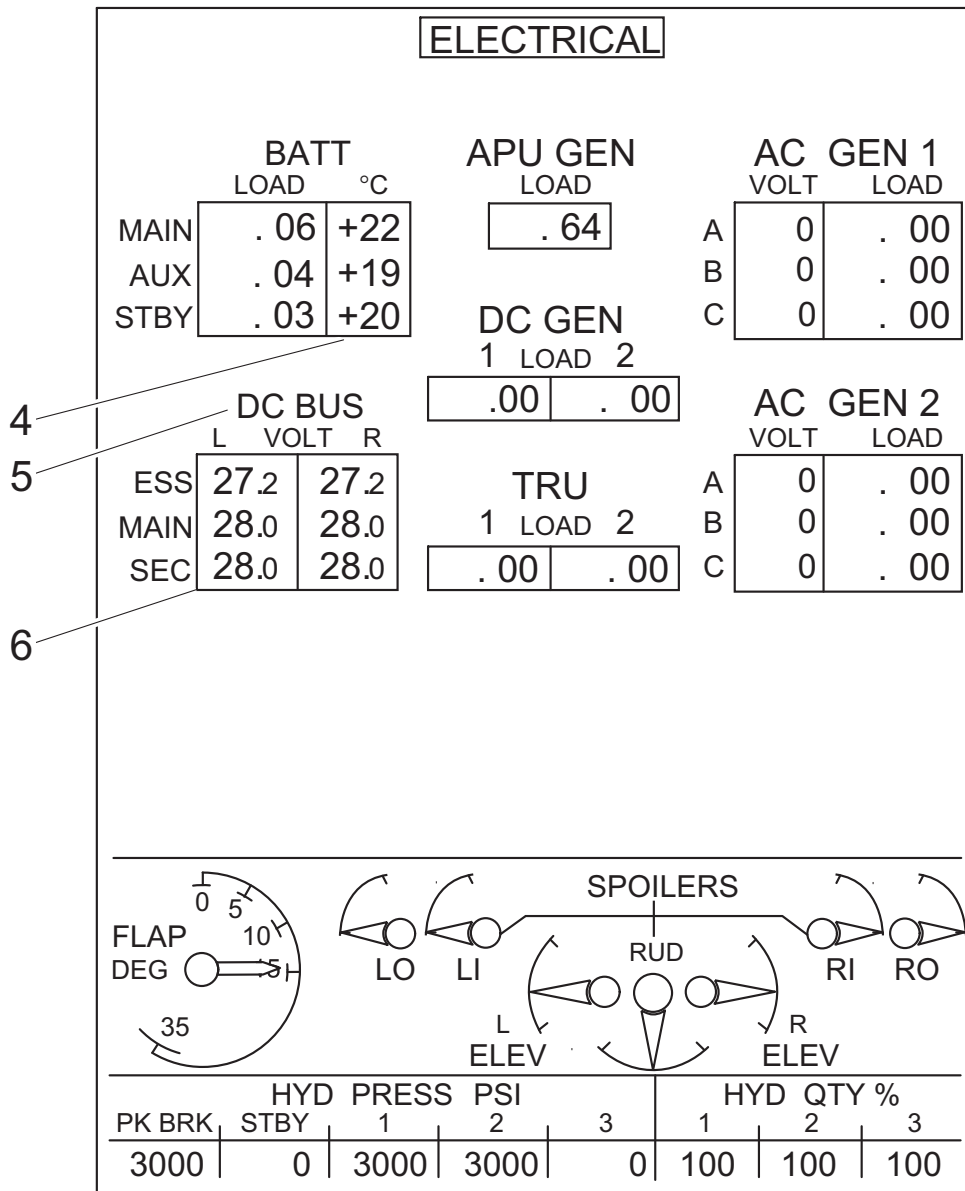
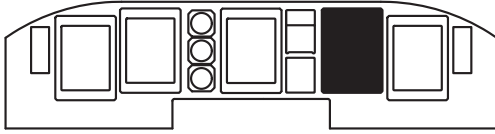


Figure 12.19-5 MFD Electrical Page with APU Generator Operating (2 of 2)

**MFD ELECTRICAL PAGE CALLOUTS (cont'd)**

**4. DIGITAL DISPLAY OF BATTERY TEMPERATURE**

- battery temperature digits are displayed in white with a + or - sign on the left of the lead digit, when the temperature is within normal limits
- when the temperature is in the range (+50°C to +65°C) the digits turn yellow
- when the temperature exceeds 65°C the digits are displayed in red

**5. DC bus voltage annunciation area**

**DC BUS** (white)

**L, R** (white)

**VOLT** (cyan)

**6. DIGITAL DISPLAY OF DC BUS VOLTAGE (white)**

- indicates the voltage on the associated bus

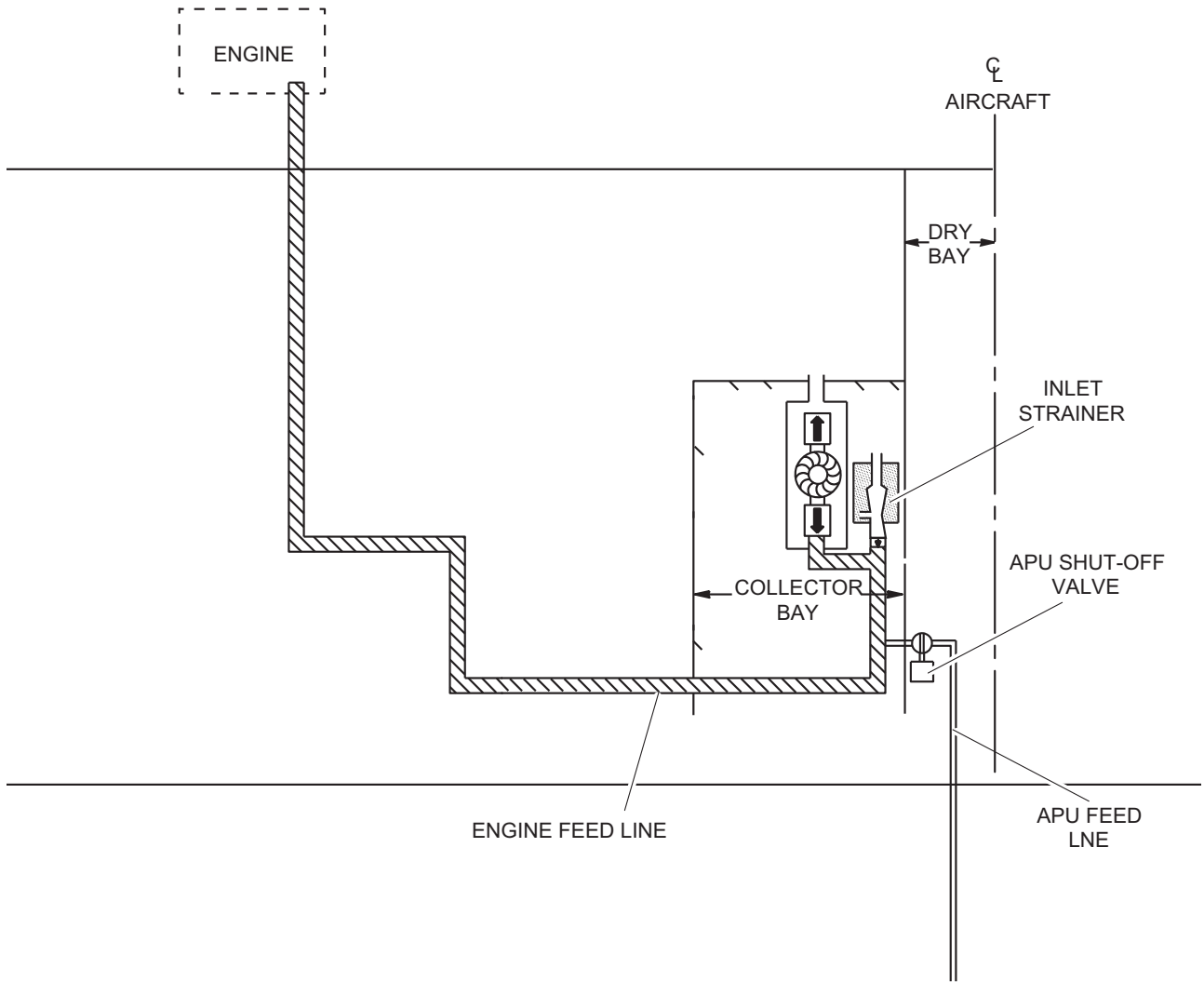


Figure 12.19-6 APU Fuel Schematic

## **12.19.4 Auxiliary Power Unit - Description**

### **12.19.4.1 APU Fuel System**

APU fuel is supplied from the left wing collector bay through an APU shutoff valve. A rigid fuel line is routed from the shutoff valve to the APU/tailcone firewall (Figure 12.19-6), outside the pressurized part of the fuselage. A gravity-fed, APU-driven fuel pump keeps positive fuel pressure to the APU engine.

The APU shutoff valve opens when the APU PWR switchlight is pushed and closes when the APU is shut down. The position of the shutoff valve is shown on the APU Fire Protection Panel (FPP). Fuel is automatically scheduled for starting, acceleration, and speed regulation.

The APU shutoff valve will close if:

- PWR switchlight is pushed off
- Fire is detected in the tailcone
- EXTG switchlight is pushed
- Aeroplane is in flight

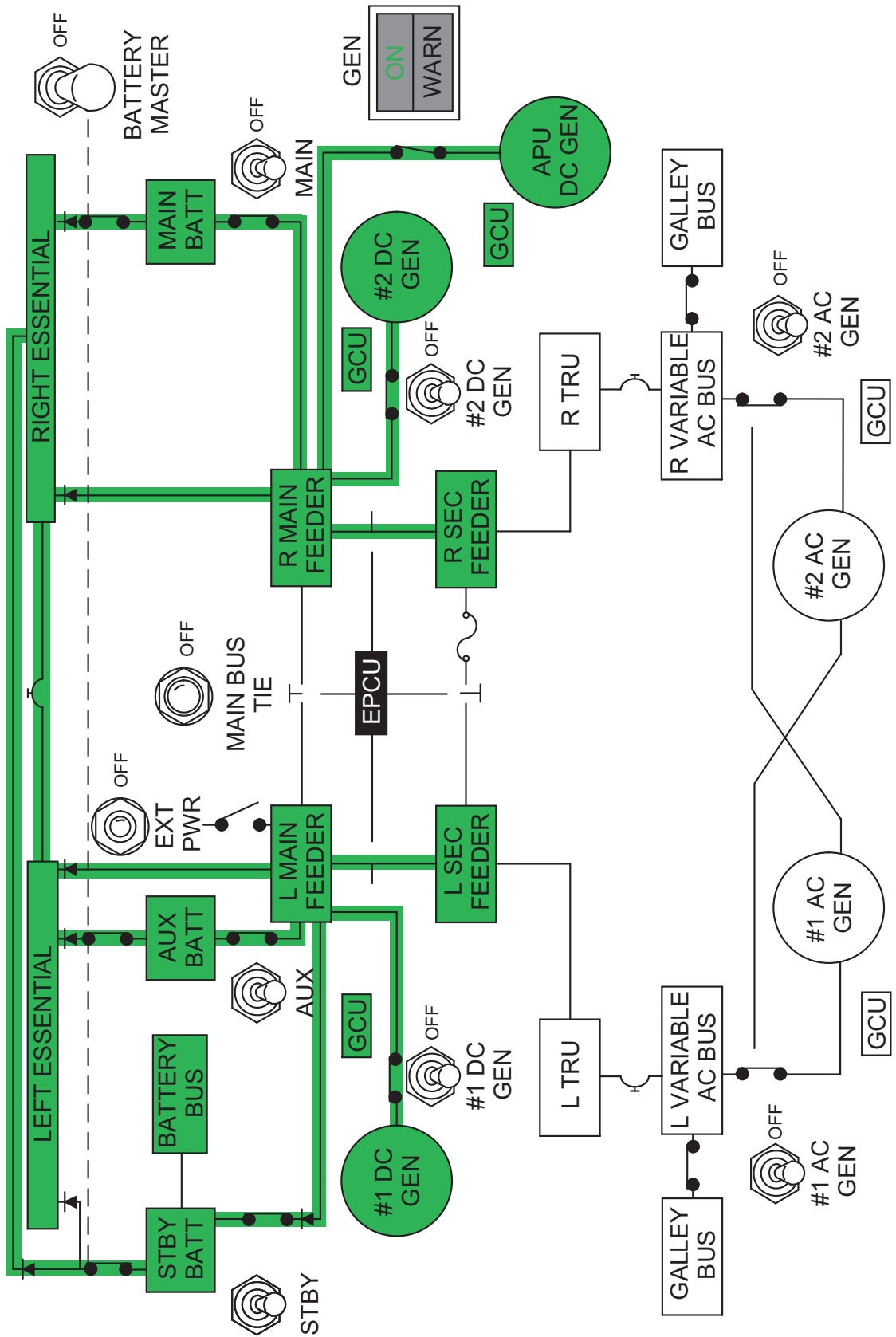


Figure 12.19-7 Starter-Generator Schematic

#### 12.19.4.2 Starter-Generator

The APU has a gearbox mounted 28 VDC starter-generator (Figure 12.19-7). An APU start requires either aeroplane batteries or external power. When the APU starts, the starter stays engaged until the APU reaches half its operating speed. When the APU is operating, the RUN segment comes on to show that, the generator mode is available to supply 28 VDC. The WARN segment of the GEN switchlight comes on when the generator is off-line.

The APU electrical load and voltage can be monitored on the ELECTRICAL page of the MFD.

After the aeroplane main engine DC starter-generators are on line, the APU generator will continue to supply power in parallel to the DC buses. The APU system will automatically prevent APU generator output if external AC or DC power is applied to the aeroplane.

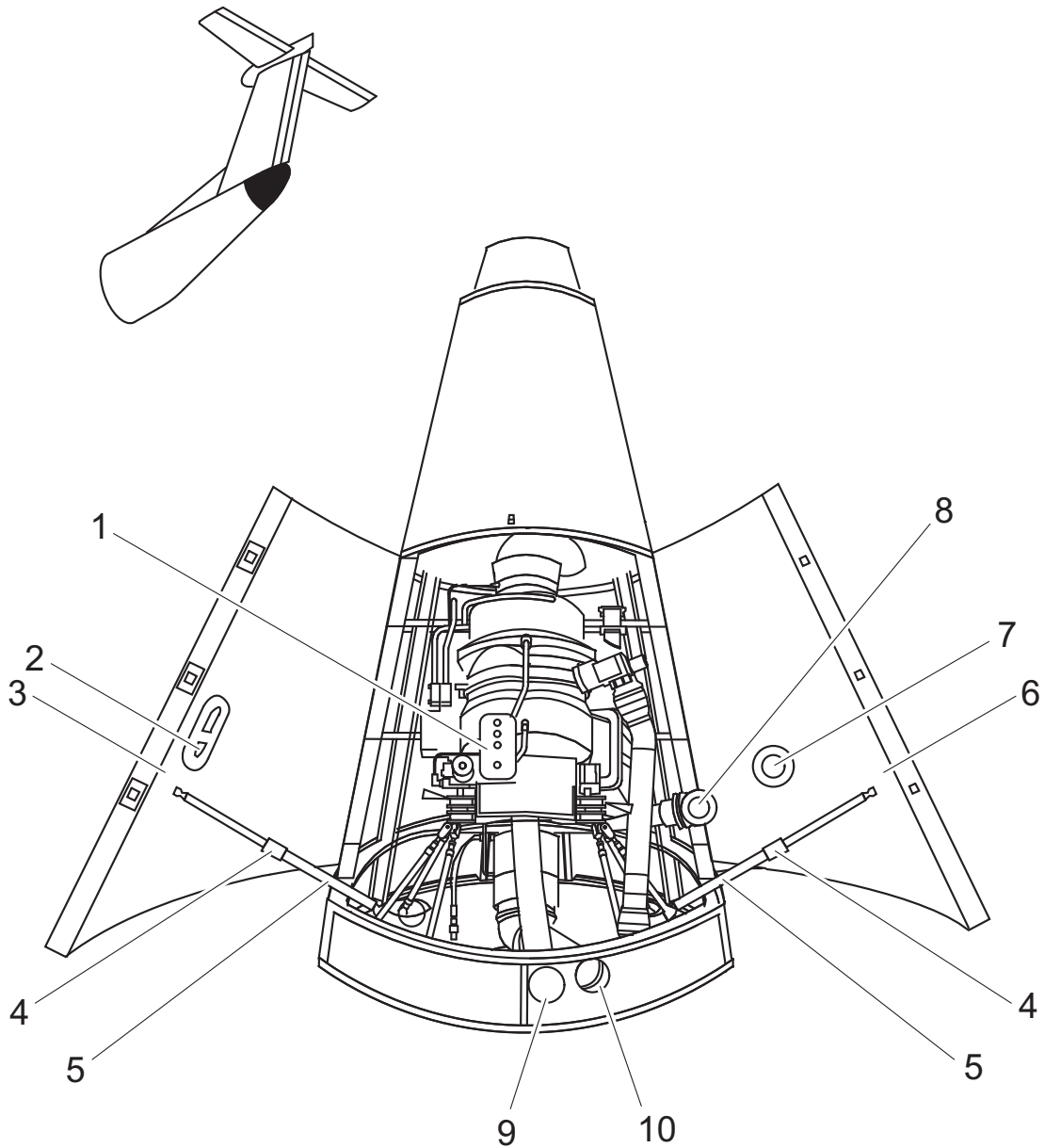
The starter-generator is cooled by air which enters through a metal mask screen at the bottom forward section of the tailcone and exits through the tailcone right side door (Figure 12.19-8). If the starter-generator overheats, the APU will automatically shut down, shown by the GEN HOT advisory light.

If a starter-generator fault is detected, the:

- Starter-generator is removed from the right main feeder bus
- ON segment of the GEN switchlight goes out
- WARN segment of the GEN switchlight goes amber

The APU utilizes 2x40 Ahr NiCad batteries for starting when external DC power is not available. The characteristics of the Starter are such that the initial current draw is not highly dependent on the load being driven, but more a function of the Starter itself, and the state of charge of the batteries. Due to the high inrush currents during starting, there is a drop in voltage at the battery, and hence the Main Buses. Technical data shows that for a "battery only start", with a battery at 100% charge, bus voltage drops to about 20 VDC (value varies with temperature). For a battery at 50% charge, the bus voltage drops to about 18 VDC (value varies with temperature). It is clear that starting the APU using batteries with insufficient charge can lead to system problems which jeopardize successful start.





**LEGEND**

- |                          |  |
|--------------------------|--|
| 1. Drain Mast.           | 7. Starter/Generator Exhaust Air Duct Opening. |
| 2. Drain Outlet Opening. | 8. Starter/Generator Exhaust Air Duct.         |
| 3. Left APU Door.        | 9. APU Ventilation Inlet.                      |
| 4. Strut Push-Release.   | 10. APU Starter/Generator Air Inlet.           |
| 5. Telescopic Struts.    |  |
| 6. Right APU Door.       |  |

Figure 12.19-8 APU Starter-Generator Air Inlet and Exhaust

**12.19.4.3 APU Compartment Ventilation**

APU compartment ventilation is established by the APU exhaust air ejector system.

Ventilation air enters the compartment through a screened inlet near the bottom forward end of the tailcone. Air is directed by a composite duct to the area in front of the oil sump to assist oil cooling. Air then flows around the APU before being mixed with the exhaust ejector flow.

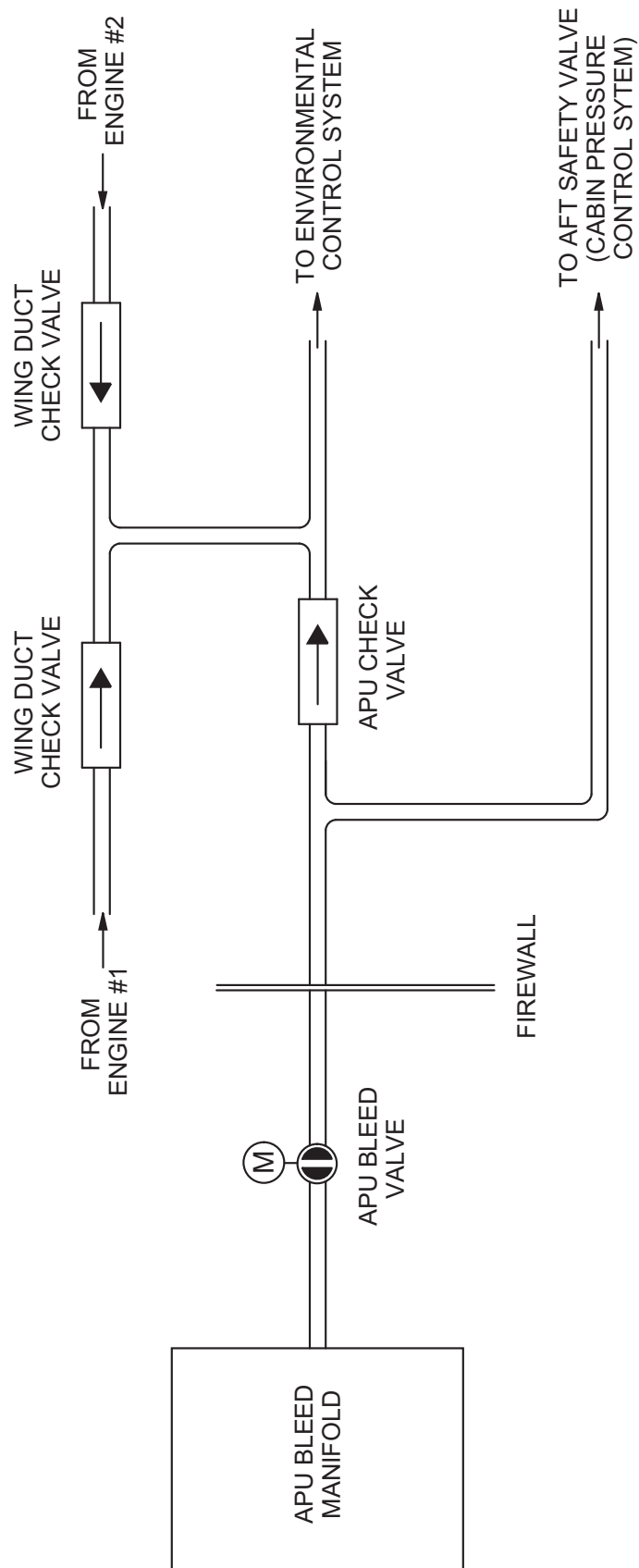


Figure 12.19-9 APU Bleed Air System Schematic

**12.19.5 APU Bleed-Air System**

When the APU is operating, the APU bleed air valve can be opened by pushing the BL AIR switchlight on the APU control panel. APU bleed air supplies bleed air for the ECS, and holds the Cabin Pressure Control System (CPCS) aft safety valve open (Figure 12.19-9). When the valve is not closed, the OPEN segment (green) of the BL AIR switchlight will come on. The bleed air supply is reduced if the APU exhaust temperature reaches an established temperature limit. This gives APU generator load priority over bleed air.

An APU check valve and wing duct check valves prevent APU bleed air from entering the engine bleed air supply, including airframe de-icing. If either main engine BLEED air toggle switch is set to 1 or 2, the APU BL AIR switchlight is automatically de-energized. This ensures that bleed air is not supplied from the engines and APU at the same time.

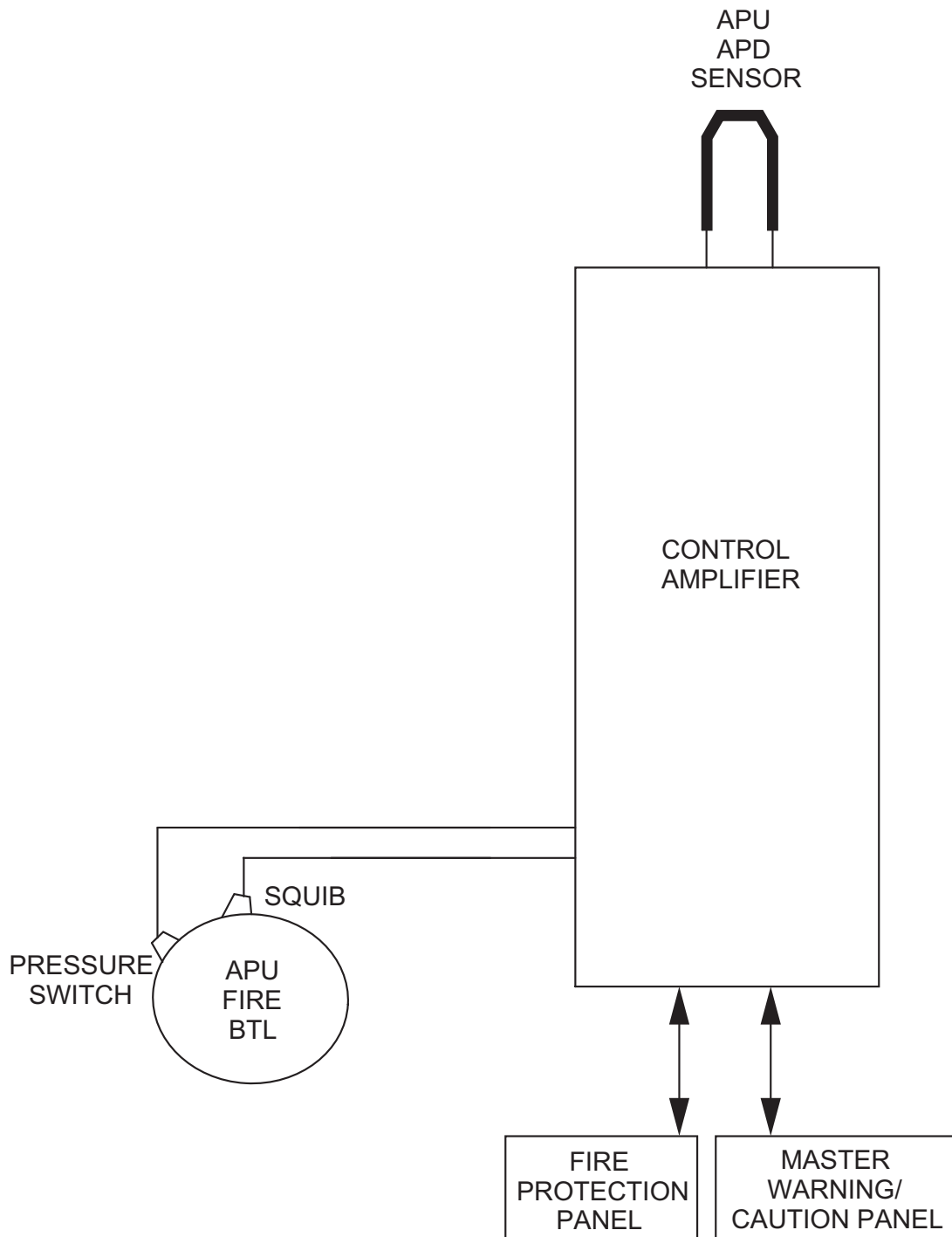


Figure 12.19-10 APU Fire Detection Schematic

### 12.19.6 APU Fire Protection

The APU has a fully automatic fire detection and extinguishing system (Figure 12.19-10). The system monitors the APU hot section and exhaust whenever the right essential 28 VDC bus is energized. The system is operated from the Fire Protection Panel (FPP) on the overhead console.

The system includes a:

- stainless steel fire extinguisher bottle and distribution tubing
- loop sensor routed along the tailcone above the APU
- control circuit

When a fire or overheat condition is sensed by the detection loop, the:

- FIRE light (red), on the FPP illuminates
- MASTER WARNING light flashes (red)
- CHECK FIRE DET warning light flashes (red)
- BTL ARM advisory light (amber); then (out) if the bottle has discharged
- APU FUEL VALVE CLOSED advisory light (white) illuminates
- APU FUEL VALVE OPEN advisory light (out) extinguishes
- EXTG segment of EXTG switchlight (white) illuminates
- MASTER CAUTION light flashes (amber)
- APU caution light (amber) illuminates

### 12.19.7 APU Fire Extinguishing

If a fire is detected, the APU automatically shuts down and the fire extinguishing agent is released after 7 seconds. If automatic fire extinguisher discharge fails, the BTL ARM light stays on. The guarded EXTG switchlight can be pushed to discharge the fire extinguishing agent, if the BTL ARM is on.

**NOTE:** Once the bottle has been discharged, restarting the APU is prevented until the bottle has been replaced.

### 12.19.8 APU Faults

The APU system can detect a fault, isolate the APU and supply protection. The system will protect and shut down the APU.

The APU system monitors:

- Overspeed
- Underspeed
- Start Failure
- Accelerate Failure
- EGT overtemperature
- Low Oil pressure
- High Oil temperature
- Failed Sensors
- Failed Valves, relays, circuits
- Internal failure

If an APU fault is detected, the:

- APU automatically shuts down
- FAIL segment of the APU PWR switchlight (amber)
- APU FUEL VALVE CLOSED advisory light (white)
- APU FUEL VALVE OPEN advisory light (out)
- APU caution light (amber)

The APU PWR switchlight must be reselected after an automatic shutdown or failure to start.

### 12.19.9 APU Shutdown

Before shutting down the APU, close the bleed air valve and select the GEN off. Normal APU shut down is then accomplished by pushing the PWR switchlight.

### 12.19.10 Limitations

#### Item 1 (Ref. Para 12.19.4.3)

With composite cooling duct removed, ambient temperature limitation applies: 30°C or ISA +25°C, whichever is lower.

#### Item 2

For APU operation with the Air Inlet Louvre installed, ambient temperature Limitation of 21°C applies.