E230 Aircraft Systems

Blackout

6th Presentation
Function of Aircraft Electrical System

• To generate, regulate and distribute electrical power throughout the aircraft
• Systems that requires electrical power:
  – Electronic Flight Indicating System (EFIS)
  – Communication and navigation systems
  – Passenger Services
    • Cabin lighting
    • Operation of entertainment system
    • Preparation of food in galley
  – Many more…
Types of electrical power required

- Following are the common electrical power used by aircraft systems:
  - 115 VAC @ 400 Hz
  - 28 VDC
- VAC stands for Volts (Alternating Current)
  Frequency = 400 Hz
  Period = 1/400 = 0.0025 s = 2.5 ms
- VDC stands for Volts (Direct Current)
Power sources for aircraft

- Engine-driven AC generator
- Auxiliary Power Unit (APU)
- Ram Air Turbine (RAT)
- Ground Power Unit (GPU)
- Batteries
- Hydraulic Motor Generator (HMG)
Engine Driven AC Generators

• Each of the engines on an aircraft drives an AC generator
• The electrical power produced by the generator is used in normal flight to supply the entire aircraft
How Generators Work

- When a coil of wire is rotated inside a magnetic field, electric current is “generated”.

![Diagram of a generator showing the flow of electromagnetic induction and a meter recording the generated voltage.](image-url)
APU Power

- APU used on the ground for
  - Starting the engines
  - Maintenance

- Can also be used during flight as backup power
Ground Power Unit (GPU)

- Provide AC power through an external plug on the aircraft
- GPUs may be either portable or stationary units
Ram Air Turbine

- Emergency power source in case of
  - Generator failure
  - APU failure
  - Engine failure
Aircraft Batteries

- Nickel Cadmium (NiCad) battery
- DC voltage
- Backup power source
- Inverters can convert DC from batteries to AC
Electrical Generation System

- AC Generator
- Constant Speed Drive (CSD)
- Integrated Drive Generator (IDG)
- Generator Control Unit (GCU)
- Transformer Rectifier Unit (TRU)
Constant Speed Drive (CSD)

- Rotates the generator coil at a constant speed, regardless of changes in engine speed
- This is necessary because the generator output must be 400Hz
Integrated Drive Generator (IDG)

- An IDG is simply a CSD and generator combined into one unit
Generator Control Unit (GCU)

- Used to regulate generator voltage output
- Protects against the following faults:
  - Over-voltage
  - Under-voltage
  - Over-current
  - Under-current
  - Short circuit
Transformer Rectifier Unit (TRU)

- Used to convert 115 VAC, 400Hz power into 28 VDC so that aircraft systems can use the electrical power generated.

![Diagram showing the process of converting 115 VAC to 28 VDC through a Transformer and Rectifier.]
Electrical Load Parallel

• In a multiple engine aircraft, the electrical power is shared among the generators.
• This is done by connecting the generators on a split bus system with load parallel to generators.
• Electric current needs to be at the same voltage, frequency and phase.
• In event that one generator fails, the electrical power system of the aircraft is still functioning as a whole.
Electrical System schematic

SSB - split system breaker
BTB - bus tie breaker
GCB - generator circuit breaker
TR/TRU - Transformer Rectifier unit
ESS - Essential (i.e. Captain/FO instrument)
# Electrical Load Sharing

<table>
<thead>
<tr>
<th></th>
<th>4 Engines operating</th>
<th>Engine 1, 2, 3 operating. Engine 4 fail</th>
<th>Only Engine 4 operating</th>
<th>All Engines off On Ext Pwr 1 &amp; Ext Pwr 2</th>
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<td>SSB</td>
<td>Close</td>
<td>Close</td>
<td>Close</td>
<td>OPEN*</td>
</tr>
<tr>
<td>GCB1</td>
<td>Close</td>
<td>Close</td>
<td>OPEN</td>
<td>Open</td>
</tr>
<tr>
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<td>OPEN</td>
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<tr>
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<tr>
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</tbody>
</table>

* SSB opens because Ext 1 and Ext 2 cannot synchronise

School of Engineering
Learning objectives

• Describe the principle of electrical power generation.
• List the various electrical power sources available to an aircraft and explain when they are used
• Describe the functions of CSD, IDG, TRU and GCU
• Interpret a schematic of aircraft electrical system.