DOCUMENT

GSM-AUS-ATP.018

DOCUMENT TITLE

GAS TURBINE ENGINES (CASA ATPL)

CHAPTER 11 – APU AND RAT

Version 2.0

June 2014

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INTRODUCTION

Auxiliary Power Units (APUs) are usually small gas turbine engines fitted to aircraft to provide pneumatic and/or electrical power to the aircraft systems. Depending on the application, they may provide both pneumatic and electrical services whilst the aircraft is on the ground, and may have limited in flight use (within specified airspeed and altitude limits) as an emergency source of electrical power. Their main purpose is to make the aircraft self-sufficient by providing pneumatic power for engine starting and airconditioning, whilst also providing electrical power for systems use during preflight and for ground maintenance.

LOCATION

The APU is usually located in an unpressurised, fire-proof compartment at the rear of the aircraft. Most manufacturers locate the APU to the rear of the main cabin aft bulk-head which keeps the hot exhaust gases and the noise as far away from passengers, and terminal buildings, as possible. Refer to Figure 11-1.

Figure 11-1 APU Location, B737

CONSTRUCTION

Gas turbine engines produce a very high power to weight ratio, making it an ideal power plant for an APU. The type of engine layout normally used is that of a Free Turbine, Turbo Shaft Engine. A turbo shaft engine is both small and light weight yet produce around 600 HP. A free turbine arrangement makes the engine very flexible, as the compressor is not affected by changes of load on a free turbine which drives the accessories via a gearbox. The free turbine is usually designed to run at a constant speed. This ensures that a generator run by the APU maintains a constant frequency without the need for an additional constant speed unit.

Some aircraft use air bled from the compressor of the APU to power the aircraft's pneumatic system, but it is more common for the free turbine to drive a separate Load Compressor to supply these services. A typical layout for an APU is shown in Figure11-2.

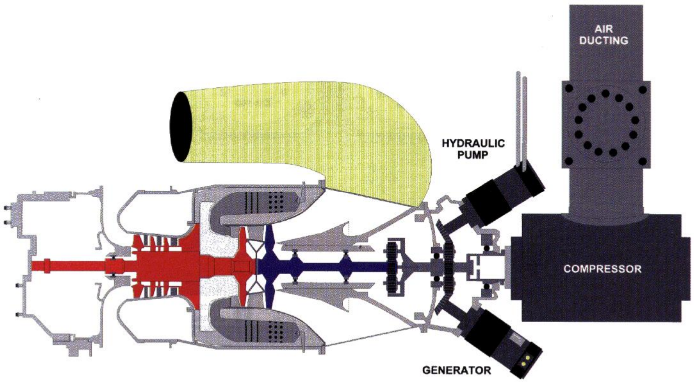

Figure 11-2 Typical APU Layout

APU OPERATIONS IN FLIGHT

The APU was further developed so that it could also be operated in the air, providing a back-up source of power to the systems in the event of an engine failure. This requirement has become more important with the introduction of twin engine aircraft now flying long haul routes under Extended Twin Operation's (ETOPS) regulations.

The design philosophy behind the APU is to keep is simple, rugged and reliable. It must however be able to be started in flight at high altitudes, and continue to operate under load at even higher altitudes.

APU OPERATION AND CONTROL

The pilot has very little in the way of indication when using an APU, Indications of Turbine Temperature, Compressor Speed (NG) and fault indicating lights may be displayed. Refer to Figure 11-3. APU starting is usually an automated sequence beginning with the opening of the air inlet door.

Most aircraft have a remote APU control panel on the outside of the aircraft. The Boeing 777 remote control is located on the nose strut.

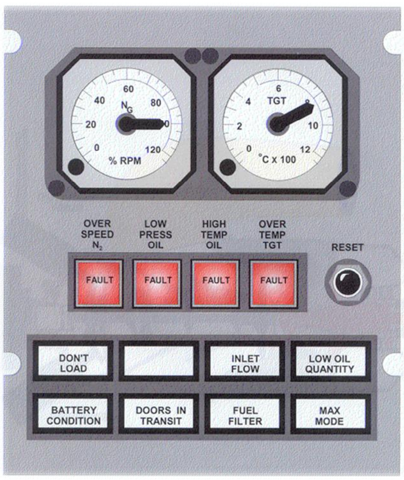

Figure 11-3 Cockpit APU Indicators (Airbus)

As the APU operates for long periods of time with no crew monitoring it is fitted with automatic protection devices that will shut the APU down should a malfunction occur. These auto shut down protections include;

- Low oil pressure,
- High oil temperature,
- High EGT,
- RPM overspeed,
- Fuel control unit failure and
- APU fire warning.

The APU has its own fire detection, protection system and HRD (high rate discharge) fire bottle. If the fire warning occurs on the ground, the discharge system will activate. In flight it is a crew responsibility to activate the system. Refer to Figure 11-4. Fire Systems are covered in detail in Air Frame Systems.

As with all gas turbine engines, the APU should be left at idle (under no load) for at least two minutes prior to being shut down. This allows temperatures to stabilise and increases the life of the engine.

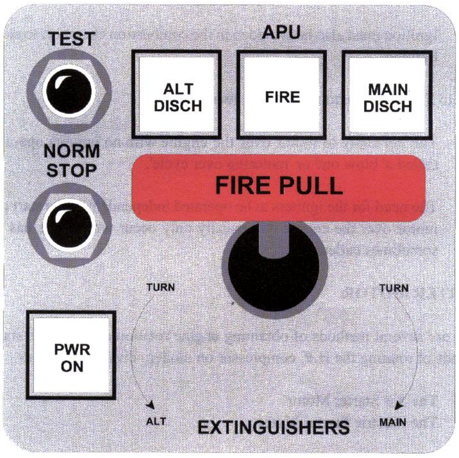

Figure 11-4 APU Control Panel (Airbus)

RAM AIR TURBINE (RAT)

The RAT is used as an emergency source of Hydraulic and Electrical Power in flight throughout the flight envelope. The RAT generates power from the airstream due to the speed of the aircraft.

The main purpose of the RAT is to provide hydraulic pressure to the primary flight controls.

In normal conditions the RAT is retracted into the fuselage (or wing), and is deployed manually, or automatically following complete loss of power. In the time between power loss and RAT deployment, batteries are used.

This system can be described as a fail safe system.

On a Boeing 777, the RAT will deploy automatically if;

- both engines are failed and center hydraulic system pressure is low, or
- both AC transfer busses are unpowered, or
- all three hydraulic system pressures are low.

The RAT can be deployed manually by pushing the RAM AIR TURBINE switch. The RAT is deployed by a compressed spring or an electric motor. Once deployed, the RAT cannot be stowed in flight. Refer to Figures 11-5 and 11-6.

The RAT usually has an amber UNLOCKED caution light, and has a green PRESSURE light.

Figure 11-5 Ram Air Turbine

Figure 11-6 Boeing 777 RAT Deployed