



# TECHSAVIATION

*Training Center*

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## Auxiliary Power Unit

### Introduction

The Auxiliary Power Unit (APU) supplies electrical power to the airplane systems on the ground or in flight.

The APU can start at all altitudes up to 43,100 feet. Electrical power is available up to 43,100 feet.

The APU automatically starts if the airplane is in the air and only one VFSG is online.

The APU is in the tailcone of the airplane.

The APU has these features:

- Single-stage centrifugal compressor
- Reverse flow annular combustor
- Two-stage axial turbine
- Accessory gearbox.

### APU Controller

The APU Controller (APUC) controls and monitors all phases of APU operation. It also stores system and fault information.

System and fault information shows on the Head-Down Displays (HDD) and Maintenance Laptop (ML).

The APUC can also initiate an APU protective shutdown to prevent damage to the APU.

The APUC is in the E12 rack in the bulk cargo compartment.

### Inlet Sensor Module

An Inlet Sensor Module (ISM) records maintenance data in a Non Volatile Memory (NVM). The ISM stores this type of information:

- APU hours
- APU cycles
- Pressure data
- Temperature data
- Speed data
- Exhaust gas temperature data.

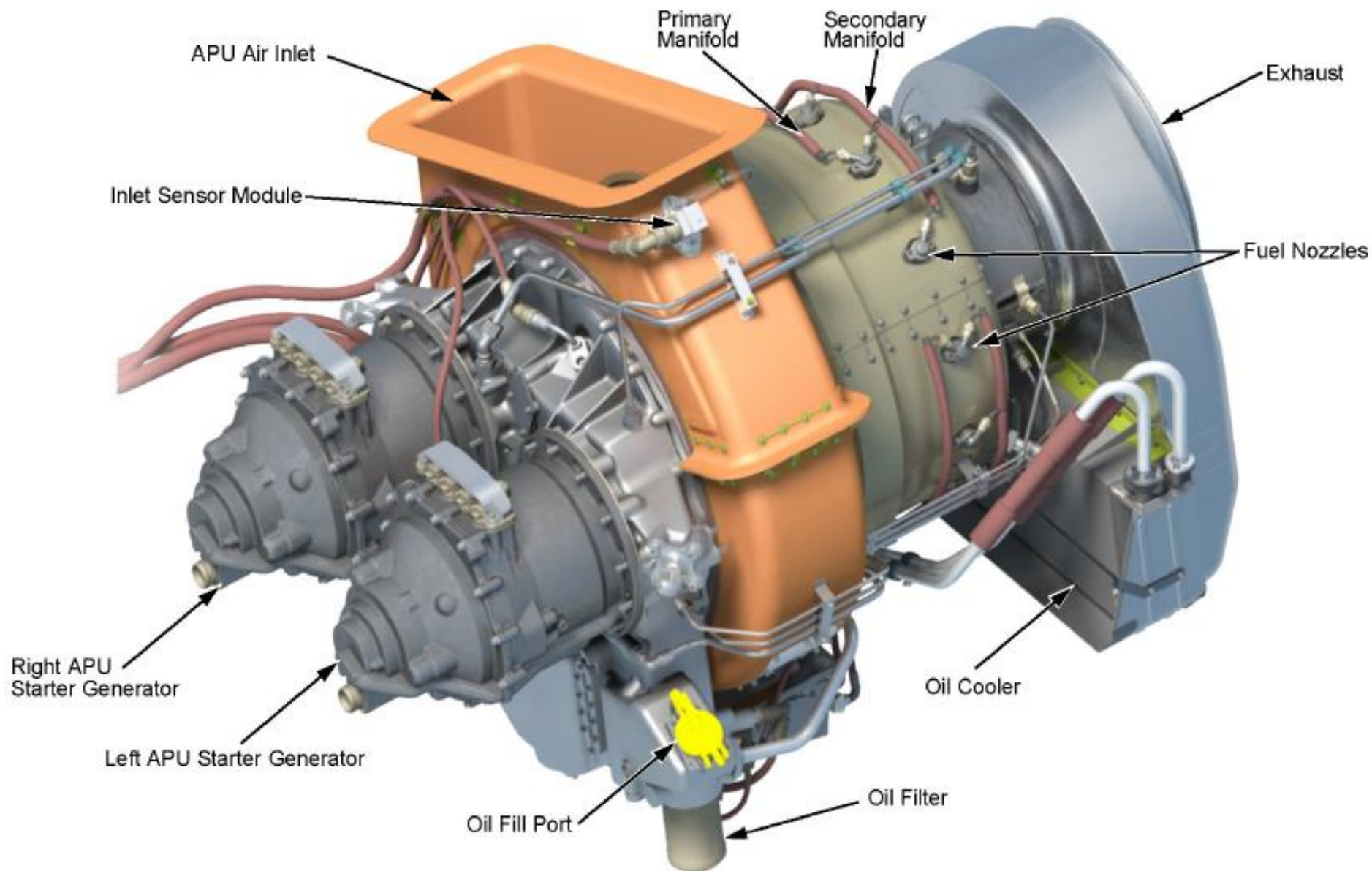


## APU Components-Left Side

The APU has these components on the left side:

- Left APU Starter Generator (ASG)
- Inlet sensor module
- Oil fill port
- Oil cooler
- Fuel nozzles
- Fuel manifolds.

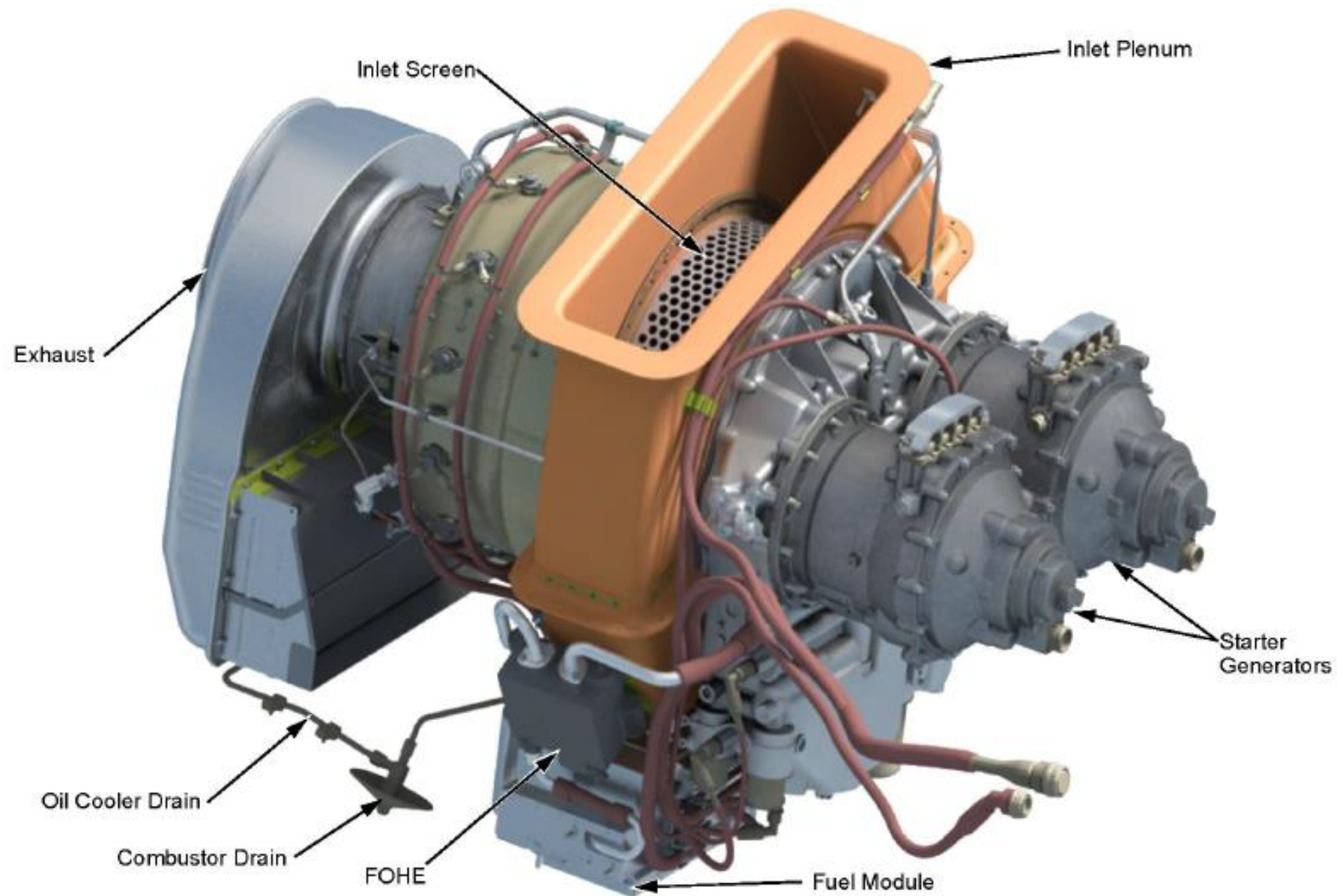




## **APU Components-Right Side**

The APU has these components on the right side:

- Oil cooler drain
- Combustor drain
- Fuel/Oil Heat Exchanger (FOHE)
- Fuel module
- Right starter generator.



## **APU Engine-Introduction**

The APU engine supplies power to operate the APU Starter Generators (ASG).

The APU engine has these main sections:

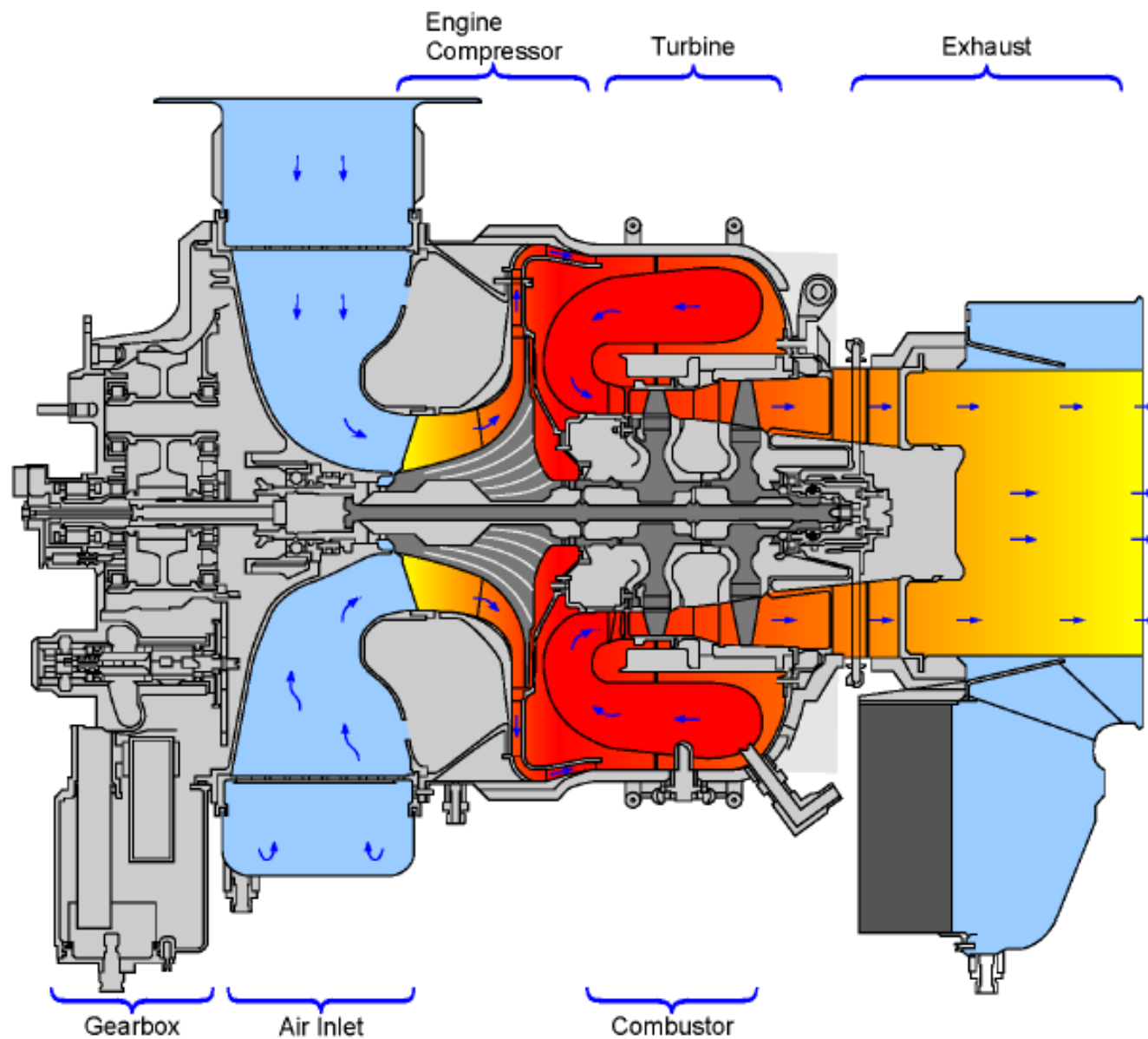
- Accessory gearbox
- Single-stage engine compressor
- Reverse flow annular combustor
- Two-stage axial flow turbine.

All the components in the engine that turn are on a common shaft.

The shaft turns the accessory gearbox. The accessory gearbox turns the ASGs.

An inlet screen prevents Foreign Object Damage (FOD) to the APU compressor.





## APU Control and Indications

### Control

The APU selector is on the P5 electrical panel. This selector is used for normal APU start and shutdown.

The APU Controller (APUC) controls these APU functions:

- Starting and ignition
- Fuel control
- Normal shutdowns
- Protective shutdowns
- APU indications
- Data storage
- Fault reporting.

The APU fire switch on the P5 overhead panel or the APU fire shutdown switch on the P40 service and APU shutdown panel are used for emergency shutdown.

### Indication

The EICAS display can show these APU messages:

- APU LIMIT (caution level)
- APU SHUTDOWN (advisory)
- APU RUNNING (memo)
- APU COOLDOWN (memo).

The status page shows this APU data:

- Speed
- Exhaust Gas Temperature (EGT)
- Oil pressure
- Oil temperature
- Oil quantity.

The status messages can show:

- APU
- APU CONTROL
- APU DOOR
- APU OIL QUANTITY
- APU REMOTE SHUTDOWN
- APU START SYSTEM.

A fault annunciator below the APU selector comes on when the APU does a protective shutdown.



## P5 Electrical Panel



## P40 Service and APU Shutdown Panel



## P5 APU and Cargo Fire Control Panel APU Control and Indications



## APU Operation Start

The APU can be started up to an altitude of 43,100 feet (13,137 meters).

The APU Controller (APUC) controls these components:

- APU inlet door
- APU fuel shutoff valve
- APU fuel
- Ignition
- APU start system.

### Prestart

To start the APU with the battery, the battery switch must be ON.

If AC power is available, the left aft fuel boost pump turns on automatically. If the APU is started using battery only, the APU DC pump turns on. This ensures that the APU receives pressurized fuel.

### APU Start

The APU selector is moved to the START position and released. This sends a signal to the APUC. The APUC then opens the APU fuel shutoff valve and the APU air inlet door.

When the air inlet door is fully open, the door switch sends a door fully open signal to the APUC.

### APU Sequence

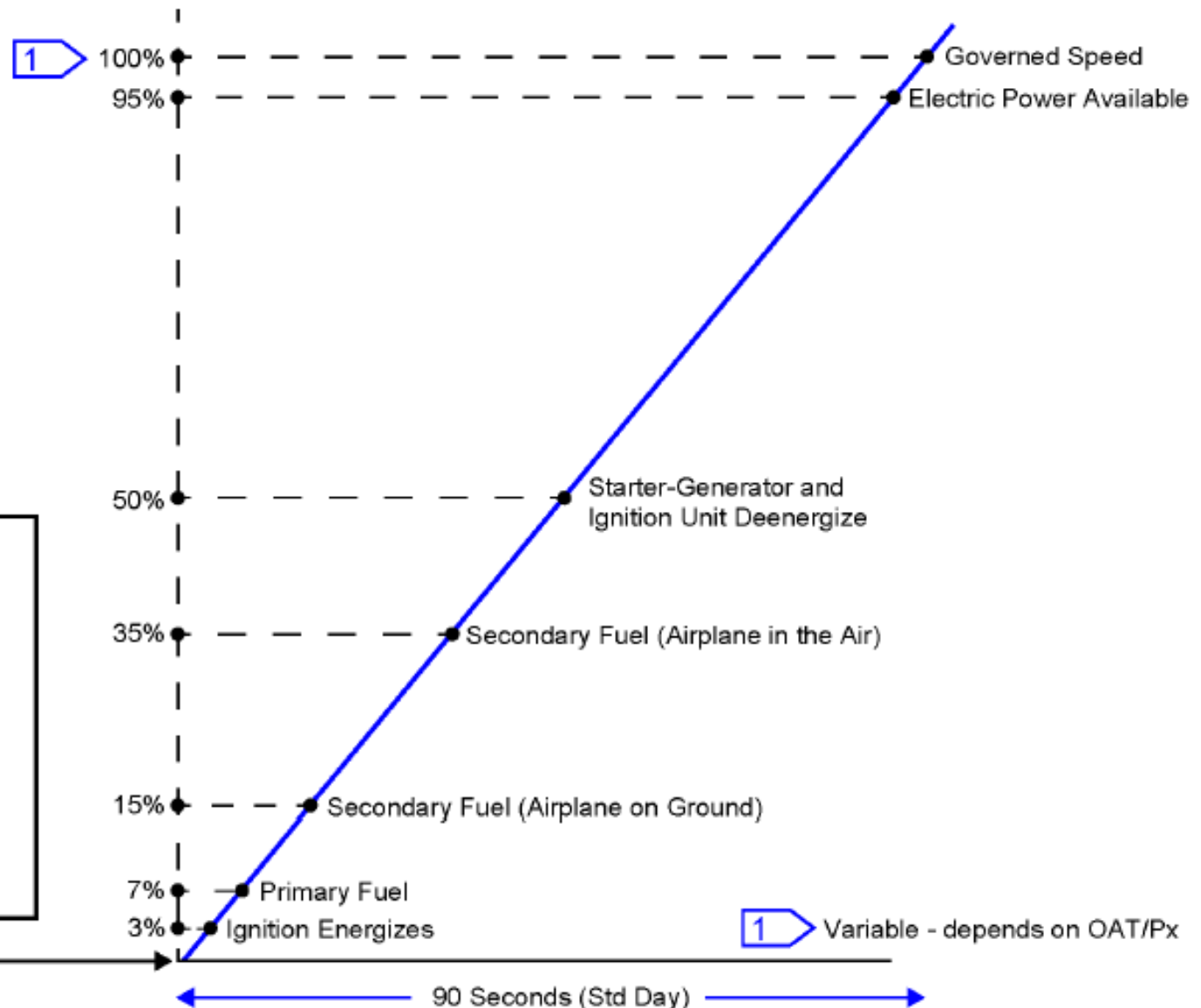
The APUC controls this APU start sequence:

- At 0 percent speed for start or 7 percent speed for restart, the BPUC energizes the APU Starter Generator (ASG)
- At 3 percent speed, one igniter is energized
- At 7 percent speed, the fuel module meters primary fuel to the APU
- At 15 percent speed, the fuel module meters secondary fuel to the APU if the airplane is on the ground
- At 35 percent speed, the fuel module meters secondary fuel to the APU if the airplane is in the air
- At 50 percent speed, the ASG and igniter de-energizes
- At 95 percent speed, the APU can supply electrical power and air
- The APU accelerates to and stays at target speed.

The target speed is variable and depends on Outside Air Temperature (OAT) and pressure (Px).



1. Battery Switch ON
2. APU Selector to the **START** position and release to **ON**
3. Air inlet door open
4. APU fuel shutoff valve opens
5. DC Fuel pump turns on (battery start)/left aft ac fuel pump turns on (ac power available)
6. Ignition Unit energizes
7. Starter-Generator Energizes





## APU Operation-Shutdown

The APU Controller (APUC) controls the APU shutdown. There are two types of shutdown, normal and protective.

When the APU selector is set to OFF, an OFF signal is sent to the APUC.

These steps occur when the APU is selected OFF:

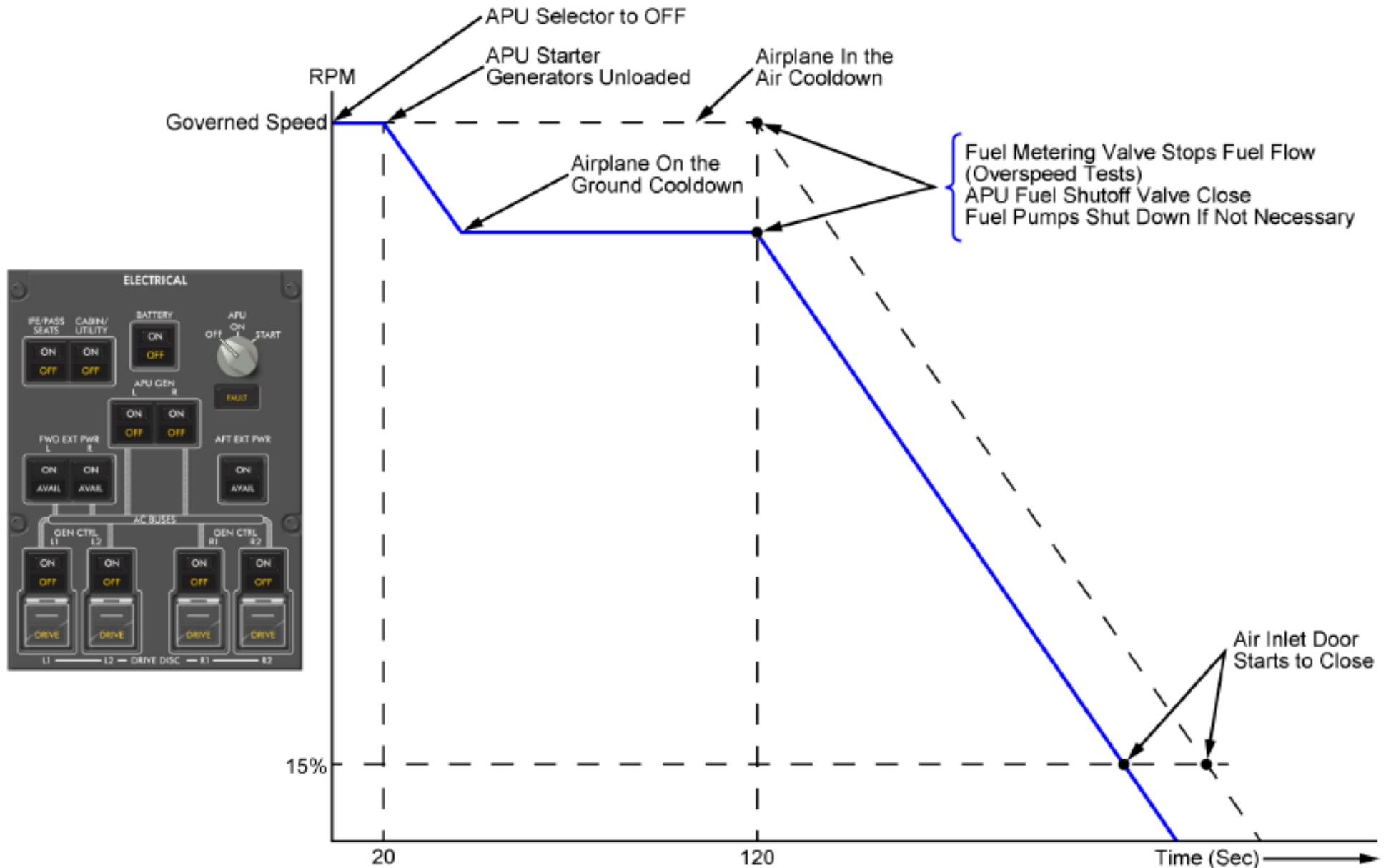
- On the ground, the APU maintains governed speed for 20 seconds
- On the ground after 20 seconds, the APU Starter Generators (ASG) are unloaded and the ready to load signal is removed
- On the ground, the APU decelerates to approximately 80 percent
- The 100-second cooldown timer is started.

When the cooldown period has ended, the APUC does a test of the overspeed functions to shut down the APU. The APU fuel shutoff valve closes and the fuel module stops fuel flow to the APU.

During the cooldown period, if the APU selector is set to the ON position, the APU will continue to operate.

At 15 percent speed, the APU air inlet door starts to close.

Three minutes after the APU selector is set to the OFF position, the APUC shuts down.



## APU Operation-Protective Shutdown

A protective shutdown prevents damage to the APU or the airplane.

The APU Controller (APUC) controls the automatic protective shutdown of the APU. If the APUC finds a fault, it does a protective shutdown.

These are two modes of APU automatic shutdown protection, the attended mode and the unattended mode.

The unattended mode is when the airplane is on the ground and the engines are not running. The attended mode is enabled when a main engine is started.

These are the flight deck effects when a protective shutdown occurs:

- Fault light on the P5 electrical panel
- EICAS message APU SHUTDOWN displayed
- Status message APU displayed.

When a protective shutdown occurs, there is no cooldown period and the APUC performs these functions:

- Fuel module solenoid valves close
- APU fuel shutoff valve closes
- APU inlet door closes.

These conditions will cause a protective shutdown in the attended mode:

- Overspeed
- Loss of overspeed protection
- Fire
- Air inlet overheat/fire
- Speed drop

- APUC power loss
- Air inlet door failure
- No acceleration during start
- No rotation during start
- No flame during start.

These conditions will cause a protective shutdown in unattended mode:

- All attended mode conditions
- Loss of EGT signal
- High EGT
- Loss of fire protection
- Generator oil filter bypass
- Oil low pressure
- Oil high temperature
- Fuel high temperature.

In attended mode, these conditions will cause an EICAS caution message to show.

The flight crew can manually shut down the APU in an emergency by using the APU fire switch on the P5 overhead panel. The APU can also be shut down from the P40 service and APU shutdown panel on the nose landing gear.

