G600 POWERPLANT

N2

>52%   <52%   <52%   >52%

Permanent Magnet Alternator (PMA)

L ESS DC

R ESS DC

Permanent Magnet Alternator (PMA)

Electronic Engine Controller (EEC)

Channel A	Channel B

Electronic Engine Controller (EEC)

Channel A	Channel B

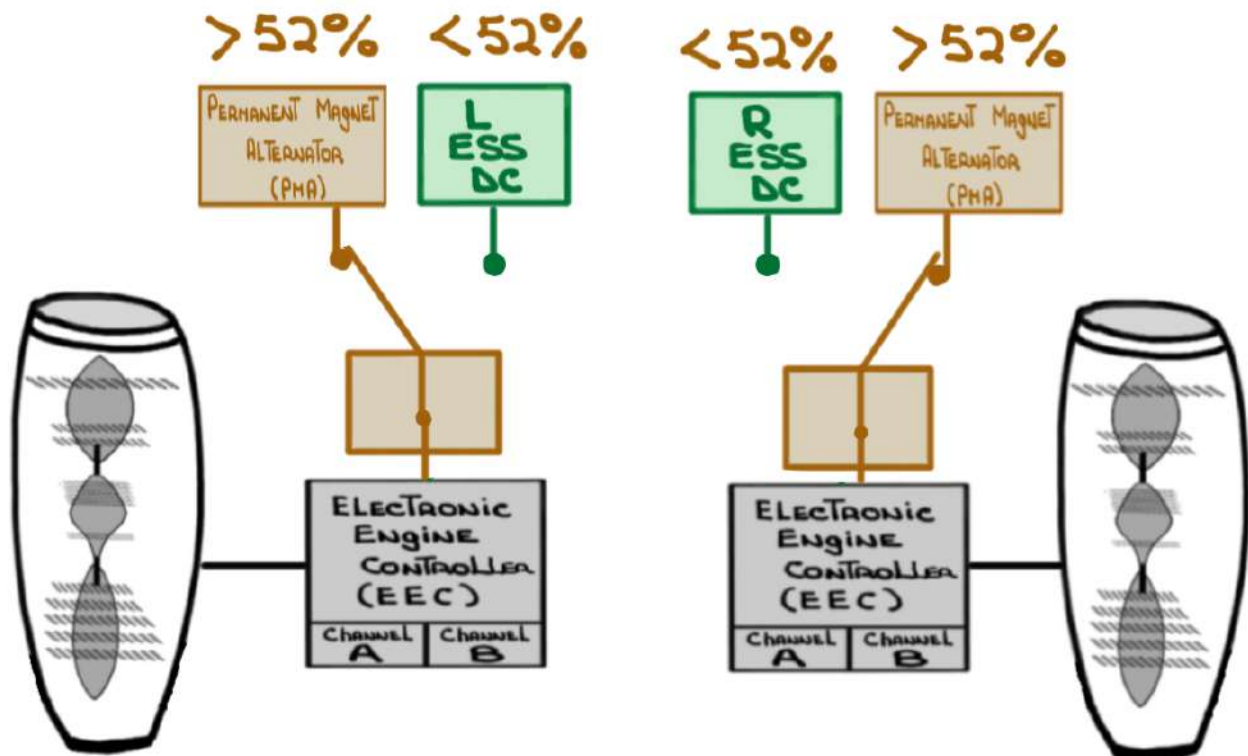**For study purposes only**

- Pratt & Whitney PurePower PW 800 engines

  PW 815 GA   – 15,681 pounds of thrust

- High-Bypass Turbo fan   – 6:1 Bypass Ratio

- FADEC - controlled

- Thrust reverser

- Single-stage Titanium LP fan (24 blades)
  (Integrally Bladed Rotor (IBR) or Blisk)
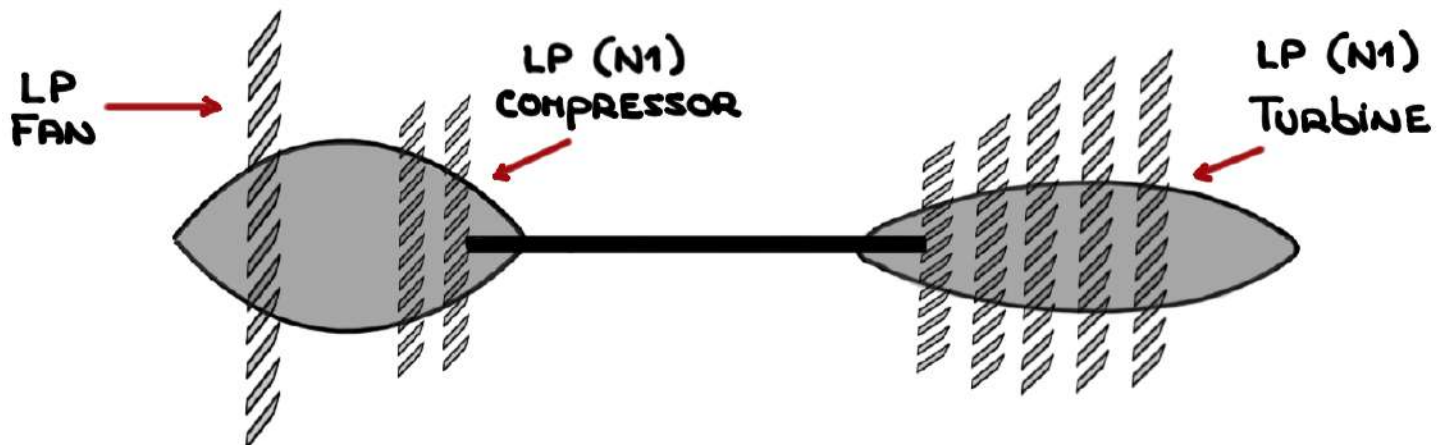
- Stage 5 (FAA) / Chapter 14 (ICAO)

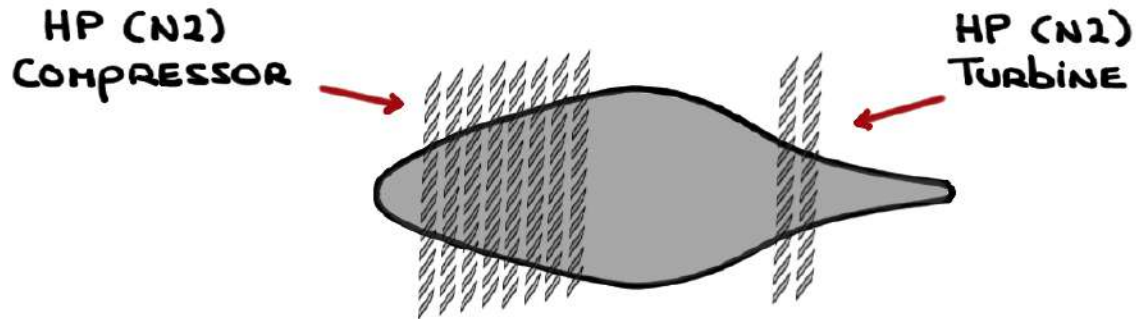- Twin - spool

  • Low pressure rotor (N1):

    single-stage fan and two (2) stage compressor
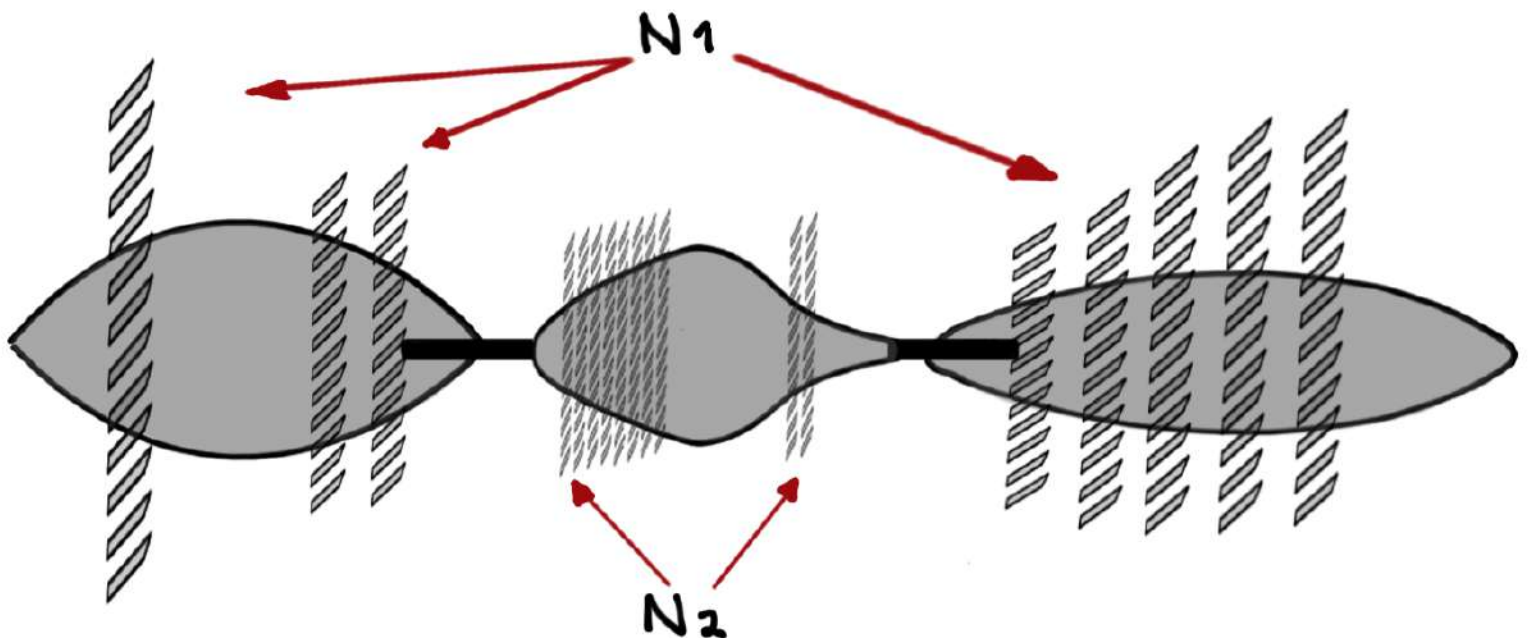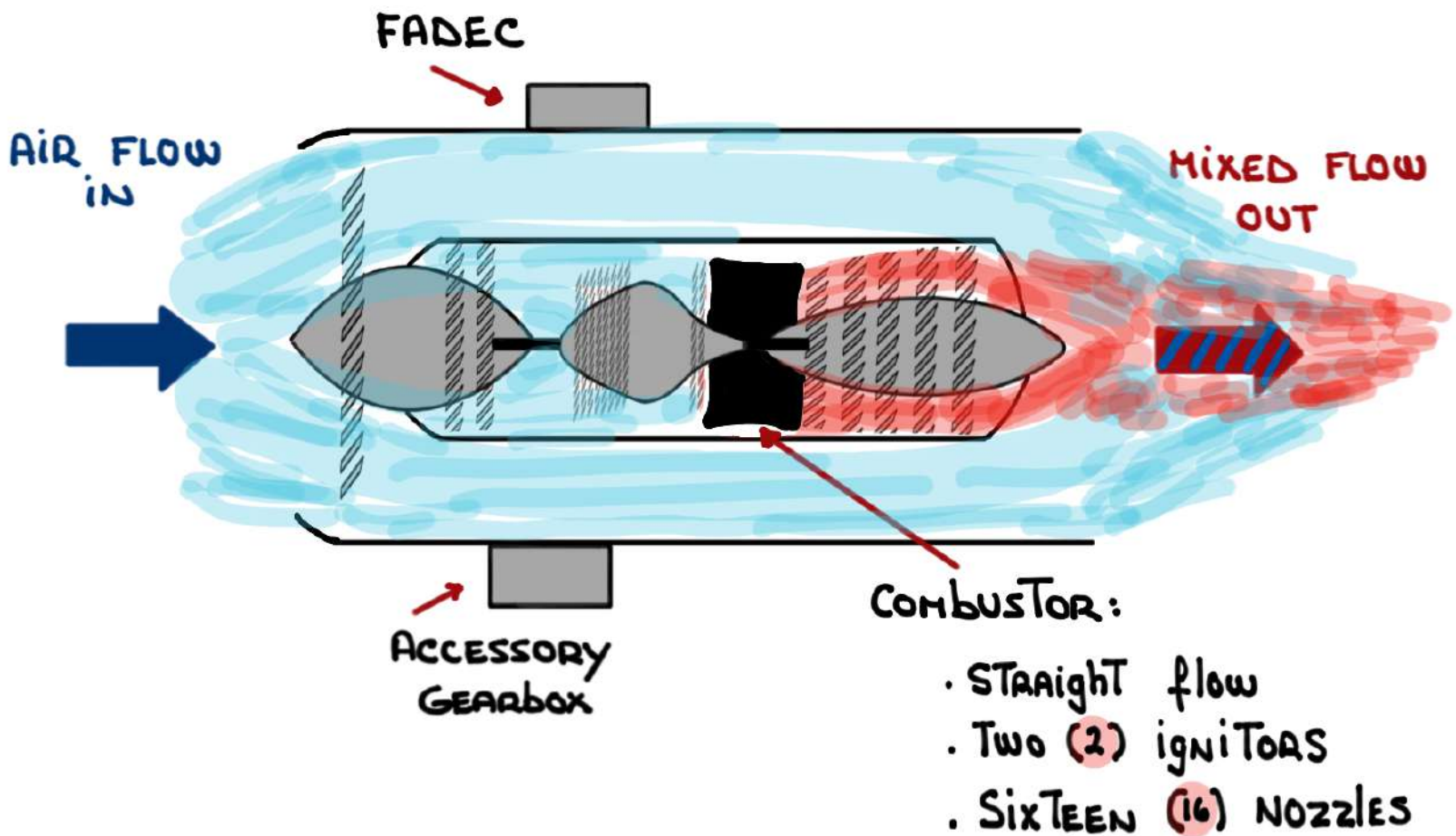
    driven by five (5) stage Turbine

LP
FAN

LP (N1)
COMPRESSOR

LP (N1)
Turbine

- **High pRESSURE ROTOR (N2):**

EighT (8) STAge compRESSOR dRiven by A Two (2) STAge TuRbine

HP (N2)
COMPRESSOR

HP (N2)
TuRbiNE

$(LP = N1 \ / \ HP = N2)$

N1

N2

FADEC

AIR FLOW IN

MIXED FLOW OUT

Accessory Gearbox

Combustor:
- Straight flow
- Two (2) ignitors
- Sixteen (16) nozzles

- Accessory Gearbox:

Uses power extracted from the N_2 compressor shaft to drive the following ACCESSORIES:

- Breather
- Fuel Metering Unit (FMU)
- Hydraulic pump
- Integrated Drive Generator (IDG)
- Oil Tank and pump
- Permanent Magnet Alternator (PMA)

– Full Authority Digital Electronic Control (FADEC):

The FADEC consists of Three (3) major components:

FADEC

Electronic Engine Controller (EEC)	Data Storage Unit (DSU)
Channel A Channel B	Permanent Magnet Alternator (PMA)
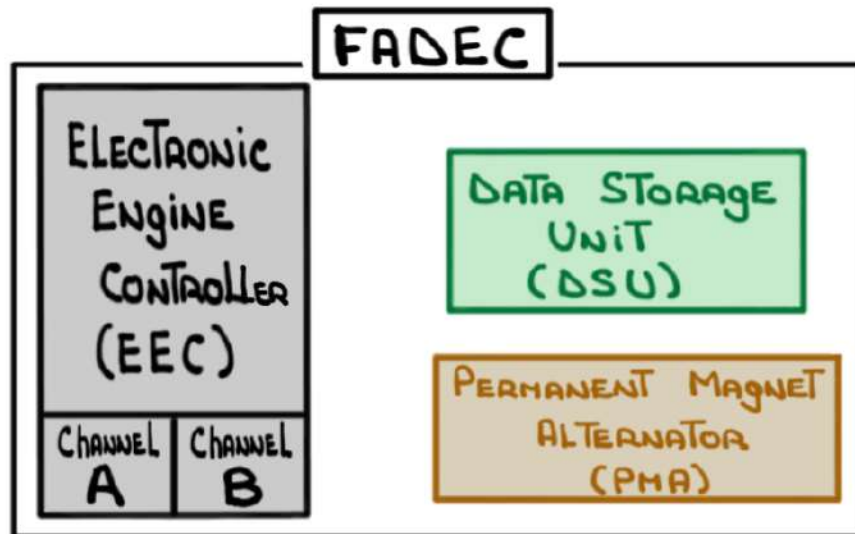
The FADEC controls N1 speed/Thrust based on:

- Thrust lever position
- Ambient conditions
- Level of bleed air extraction

The FADEC provides:

- Engine protection
- Improved handling
- Better fuel efficiency
- Prolonged engine life

Electronic Engine Controller (EEC)

- Dual channel — one active and one standby

- Communicates with various systems across the DCN

- Receives input from various sensors then controls:
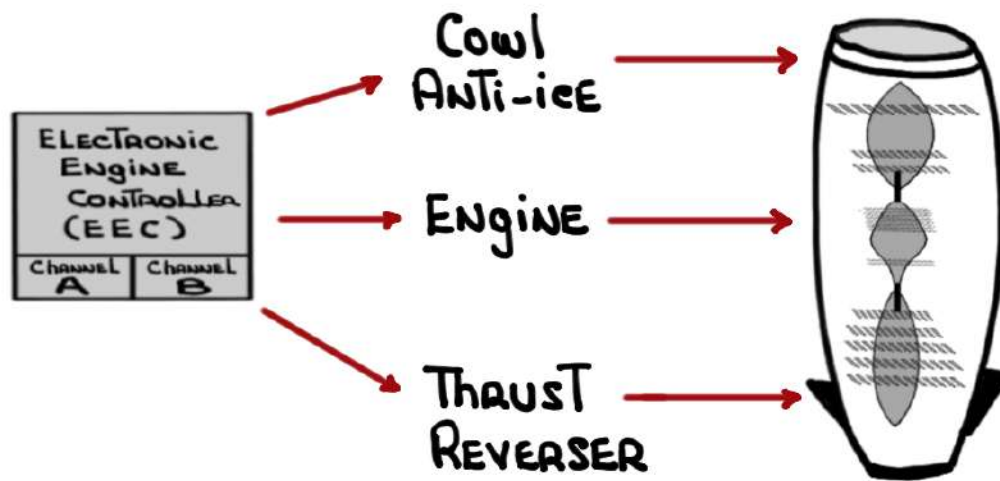
- EEC <u>controls</u> Engine Idle Speed

Idle Speed Control is based on N_1 speed with Thrust Levers at idle. There are four (4) modes:

① Flight Idle

② WAI Idle

③ Approach Idle

④ Ground Idle

① **Flight Idle:**
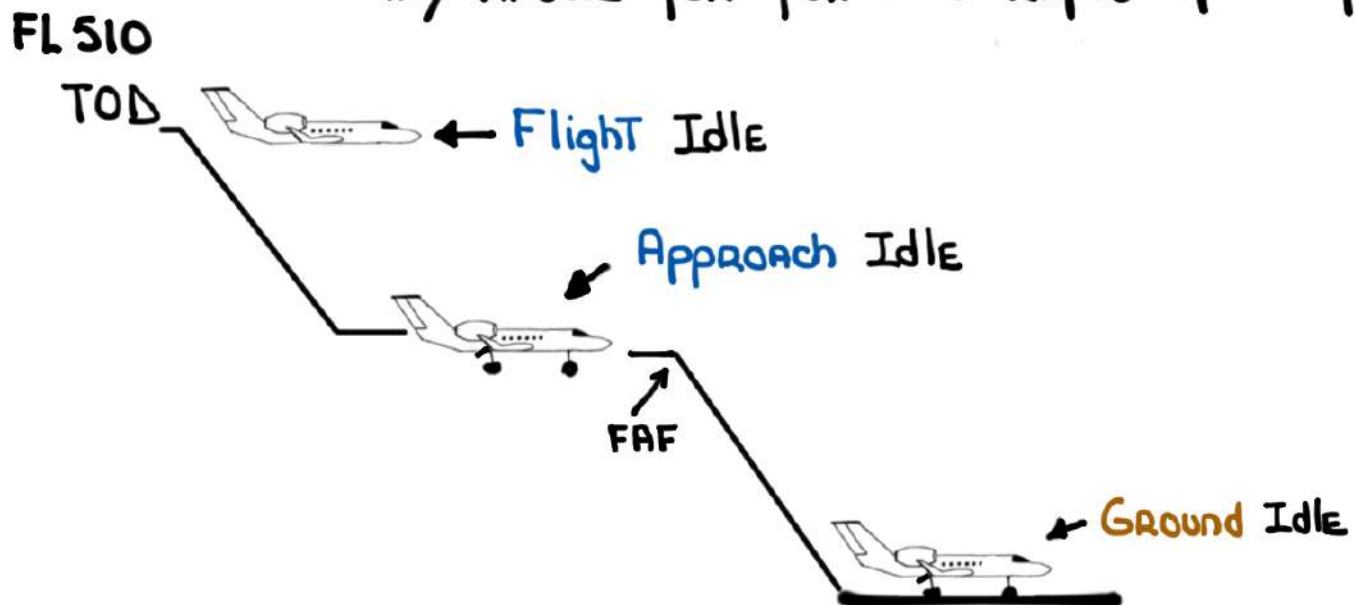- GEAR NOT down AND locked, AND
- Flaps < 39°

② **WAI Idle:**
- WAI ON
- GEAR UP
- TAT ≤ +2°C

③ **Approach Idle:**
- GEAR down AND locked, OR
- Flaps 39°

④ **Ground Idle:**
- Aircraft WOW (Ground)
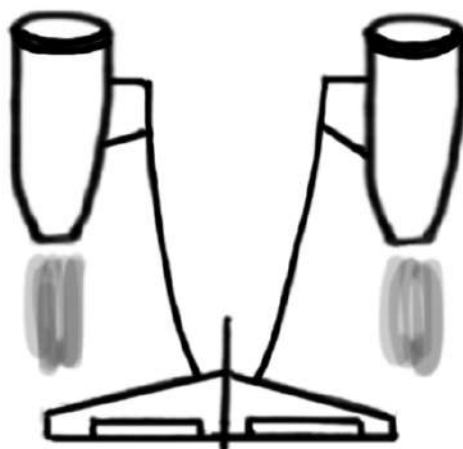- Touchdown + five (5) seconds
- Delay allows for full and rapid spool up

FL 510
TOD

← Flight Idle

↙ Approach Idle

↑ FAF

← Ground Idle

⑤ No Dwell Zone (NDZ):

- Prevents steady-state engine operation in the N1 resonance zone ($41\% < N1 < 46\%$)

- When the commanded N1 (throttle angle) is within the NDZ, in lieu of either engine being allowed to dwell at or near the resonance zone, the engines N1 are split as required to achieve the total net commanded thrust

Left Engine bias:		Right Engine bias:
$\leq 41\%$ N1 During NDZ Split		$\geq 46\%$ N1 During NDZ Split

- Cockpit indication limited to displayed N1 %
- Active when the following conditions exist:

- WAI - ON
- Gear Down OR Flaps > 22° OR Airspeed < 160 KCAS
- TAT < 0°C

⑥ NDZ with Elevated EVM logic:

- Active any time NDZ logic enabled and EVM > 1.0 ips to limit resonance zone transitions during ice shedding events with elevated EVMs

- FADEC limits N1 transitions from power settings > 46% N1 into NDZ

- N1 idle floor remains fixed 46% N1 until one of the following occurs:

  * EVM remains < 1.0 ips for Ten (10) seconds
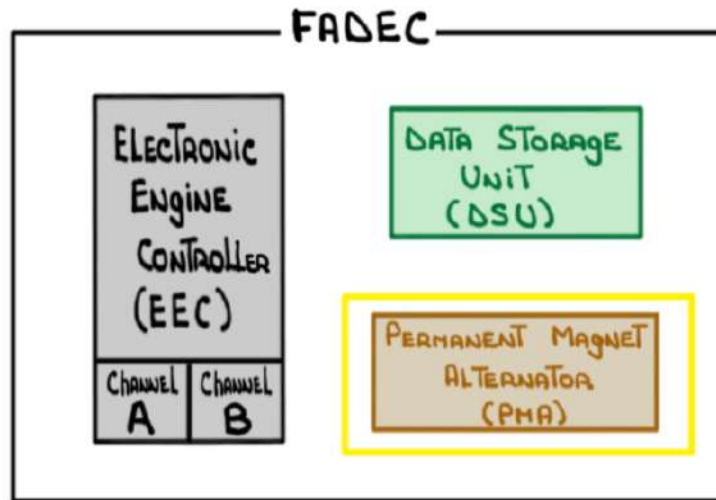
  * Throttle manually set to idle

  * SAT < 0°C

Data Storage Unit (DSU)

The DSU CONTAINS engine trim data. This trim data is utilized by the EEC to make all engines produce the same thrust. The DSU is mounted on the EEC which is mounted on the outside, upper portion of the engine
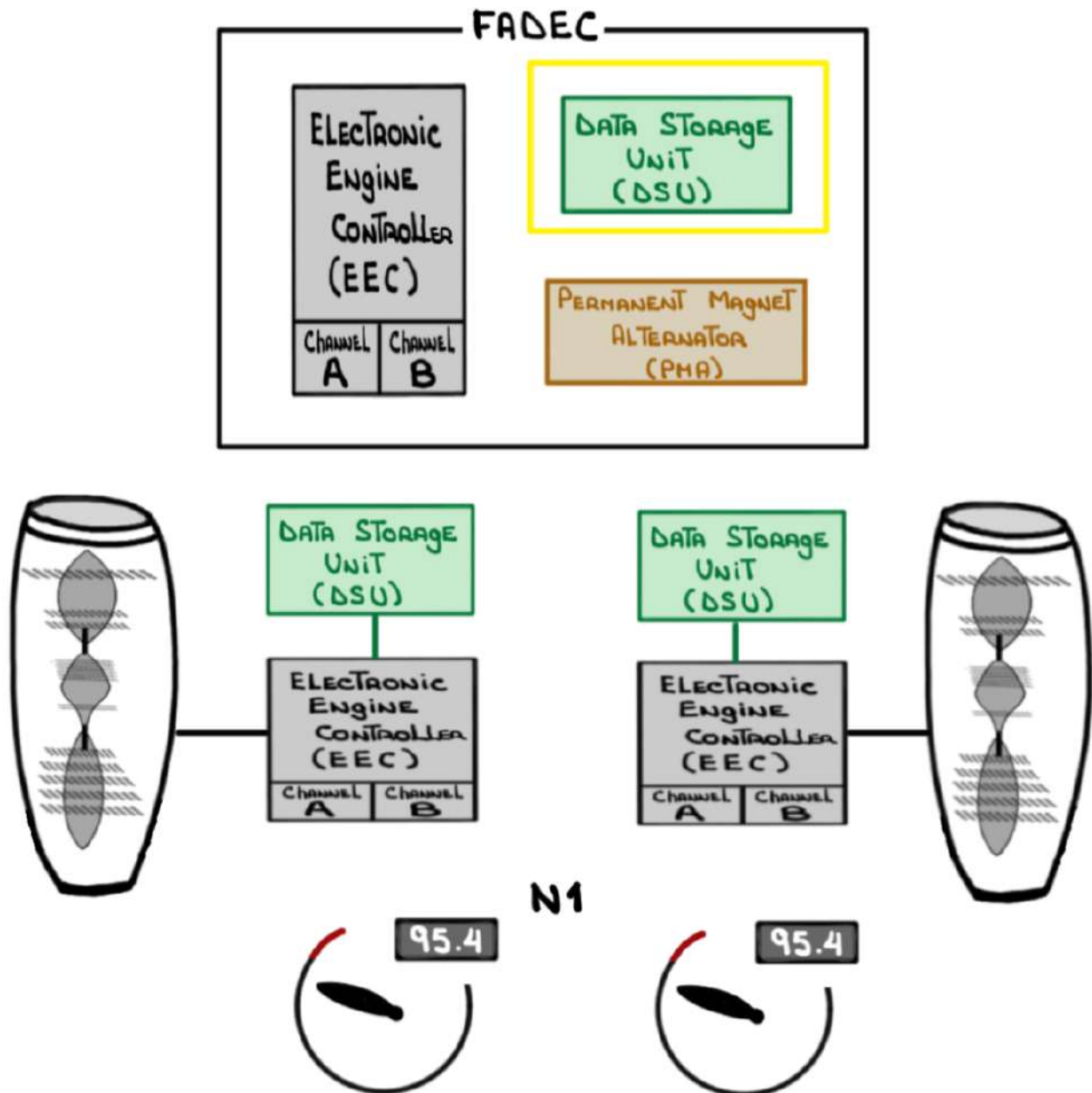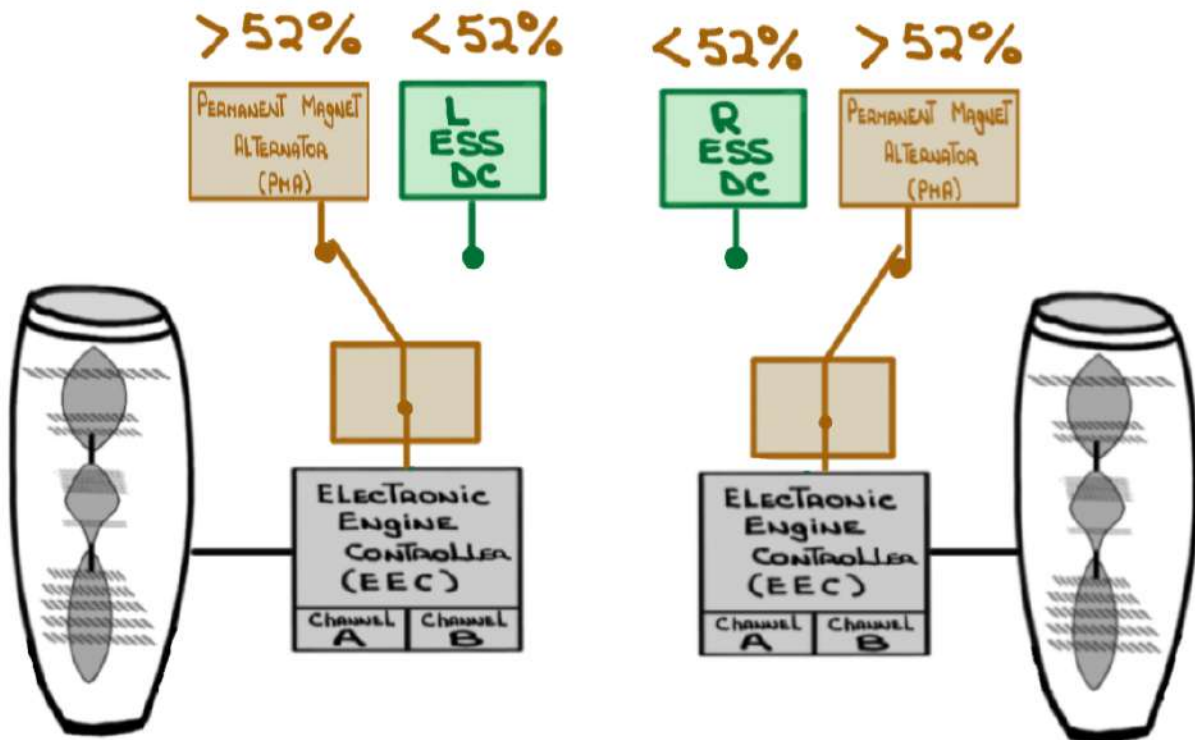
PERMANENT MAGNET ALTERNATOR (PMA)

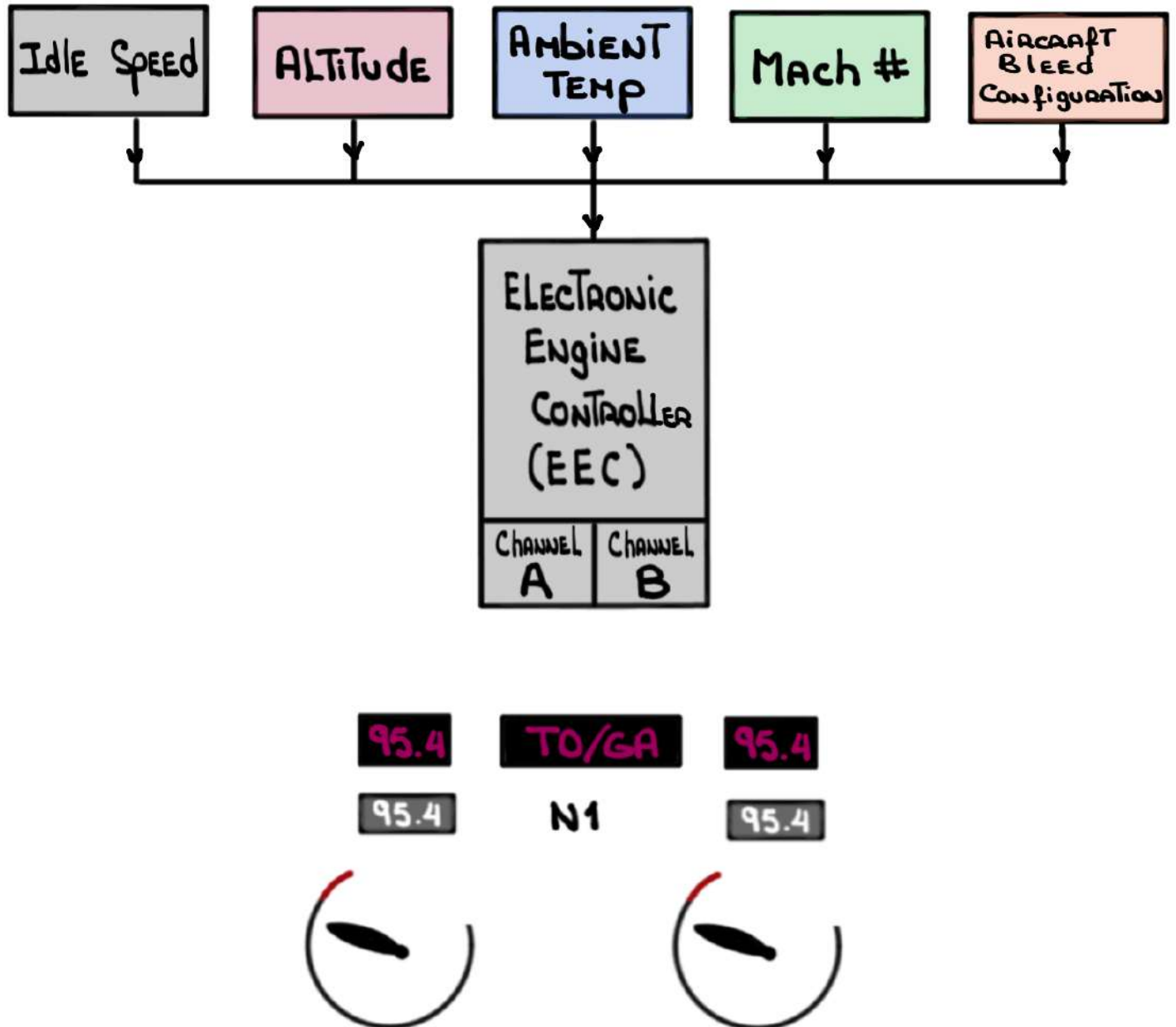Primary source of EEC power once the engine accelerates > 52% N2. The PMA, while part of FADEC, is mounted on the AGB

– Thrust Control Modes:

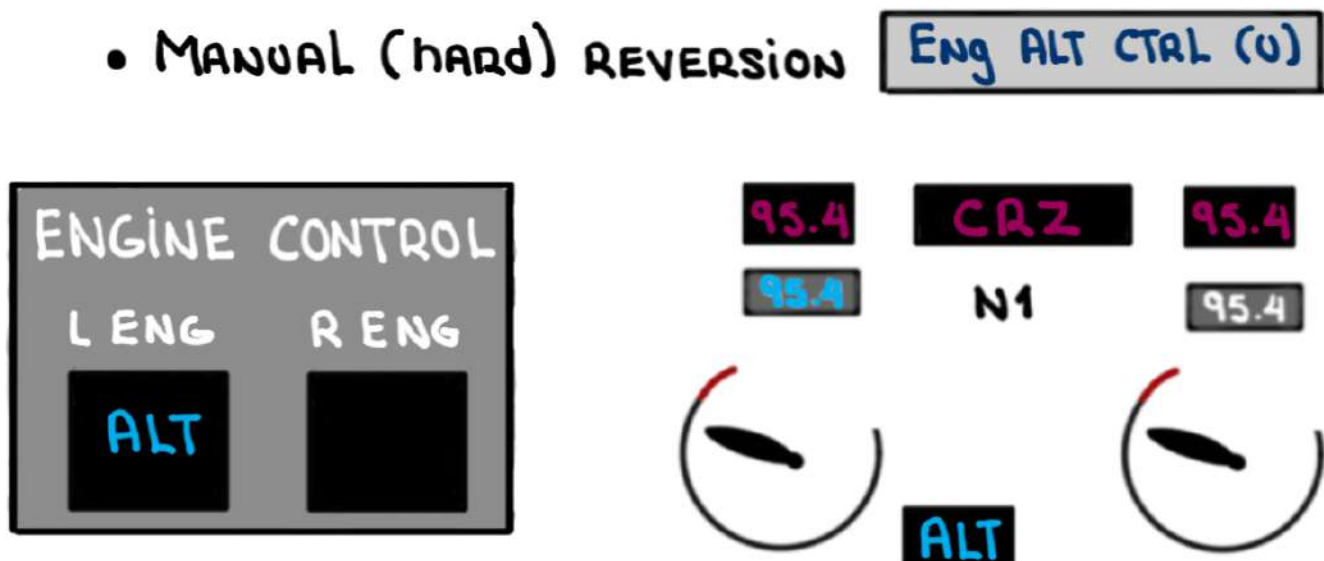① __Normal mode:__ EEC generates N1 speed based on:

Idle Speed	Altitude	Ambient Temp	Mach #	Aircraft Bleed Configuration

```
Electronic Engine Controller (EEC)
┌──────────┬──────────┐
│ Channel  │ Channel  │
│    A     │    B     │
└──────────┴──────────┘
```

95.4	TO/GA	95.4
95.4	N1	95.4

② ALTERNATE Mode (Backup): Thrust lever directly sets N1 speed. Downside:

- Overboost potential
- Auto Throttles inop
- No dispatch (Takeoff prohibited)
- Ops in icing conditions – prohibited

• AUTO (soft) REVERSION   Eng ALT CTRL (v)

| 95.4 | CRZ | 95.4 |

95.4   N1   95.4

ALT
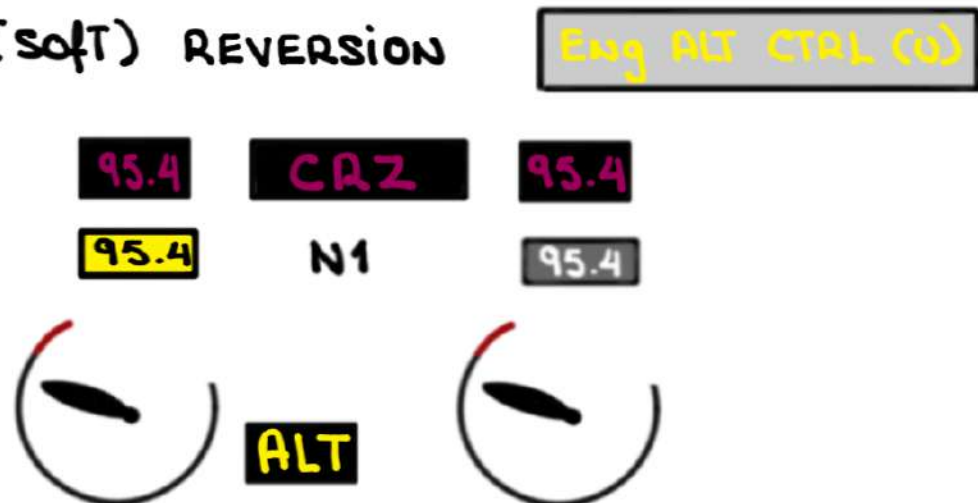
• MANUAL (hard) REVERSION   Eng ALT CTRL (v)

ENGINE CONTROL

L ENG   R ENG

ALT

| 95.4 | CRZ | 95.4 |

95.4   N1   95.4

ALT

Engine Ignition System

- Dual channel Ignition Exciter (A and B) on each engine

- Controlled by dual channel EEC and powered by 28 VDC

- GENERATES high voltage pulse transmitted through ignition leads to ignition plugs in combustor
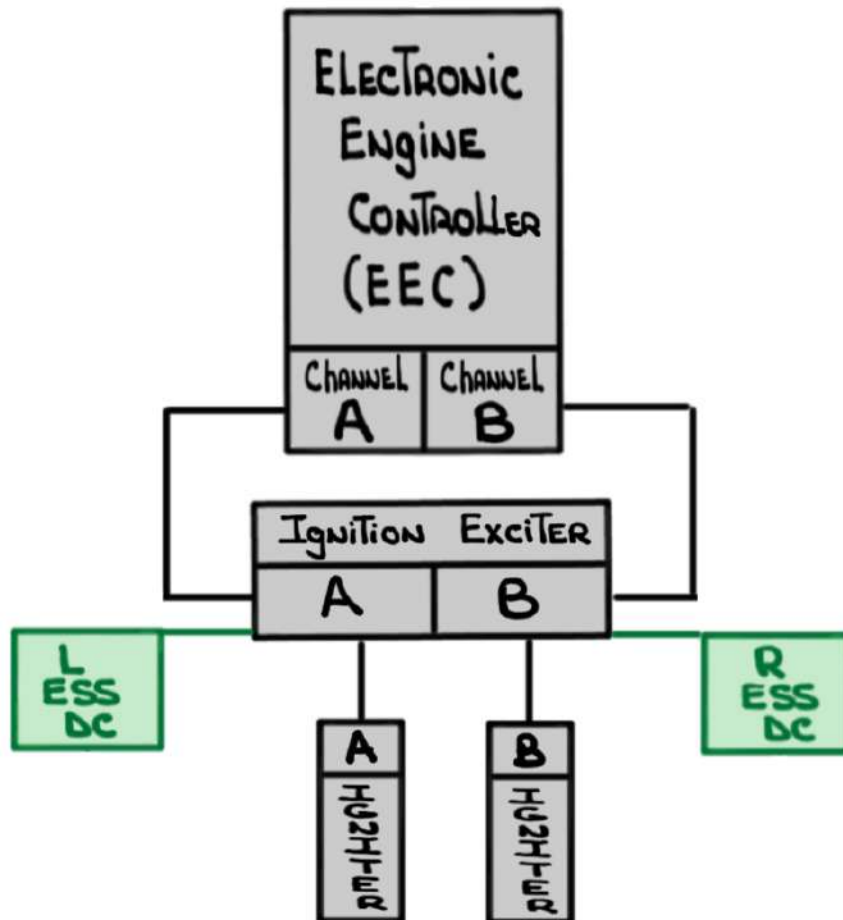

- Ground starts → One (1) igniter
- Airstarts → Two (2) igniters (high sparking rate)

Engine Fuel System

- **METERED** fuel from tanks' boost pumps to nozzles
- Introduction of fuel is **controlled** by the EEC
- Low pressure fuel coming from the wings
- High pressure fuel coming from the Fuel Metering Unit (FMU)

FUEL RETURN

AUTO

DISCH L

LP

HP

FMU

FCOC
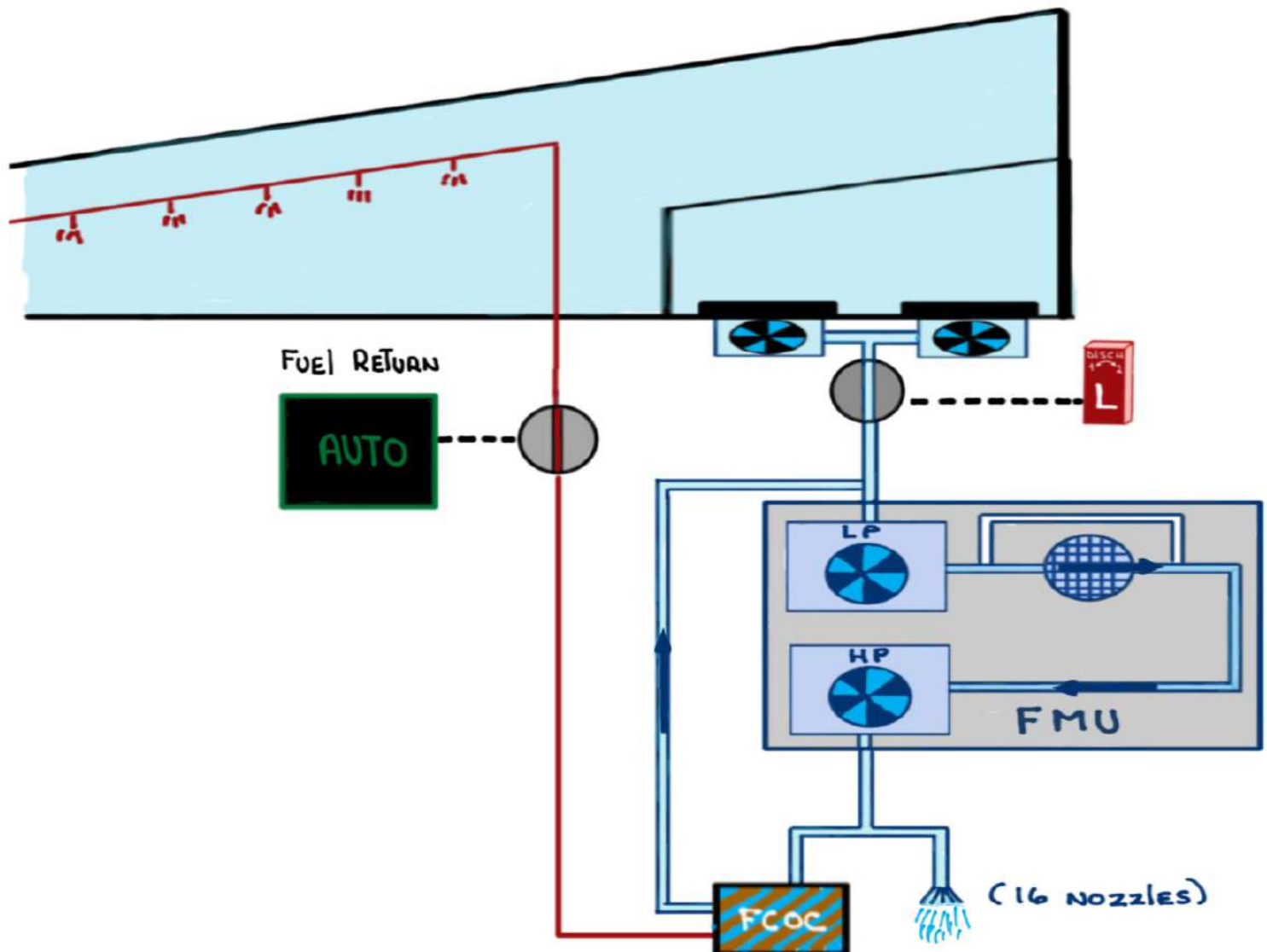
(16 NOZZLES)

– As Thrust Levers are advanced or retarded the EEC commands the FMU to modulate fuel to nozzles
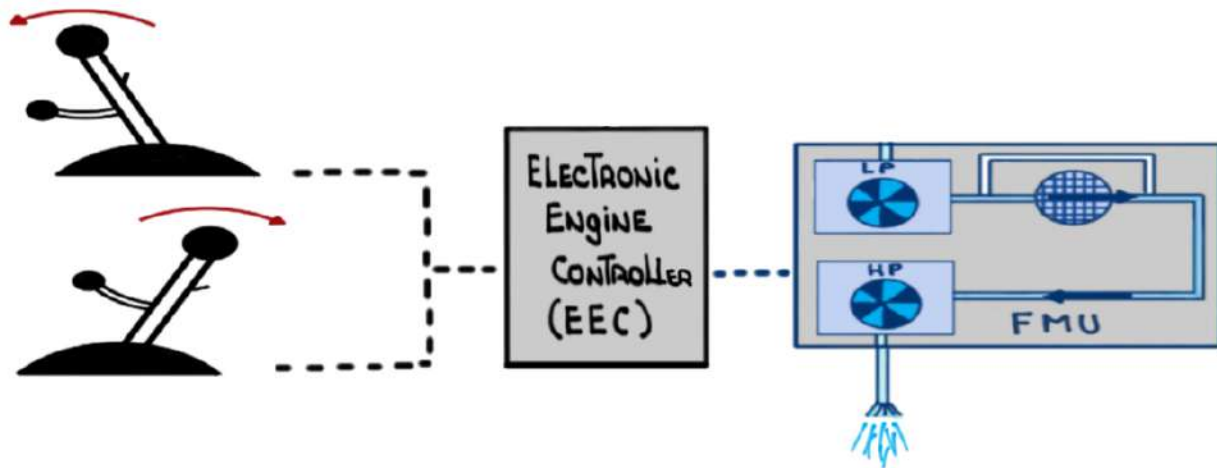
– Placing a fuel control switch to OFF closes FMU All fuel is cutoff to the fuel nozzles and the engine shuts down
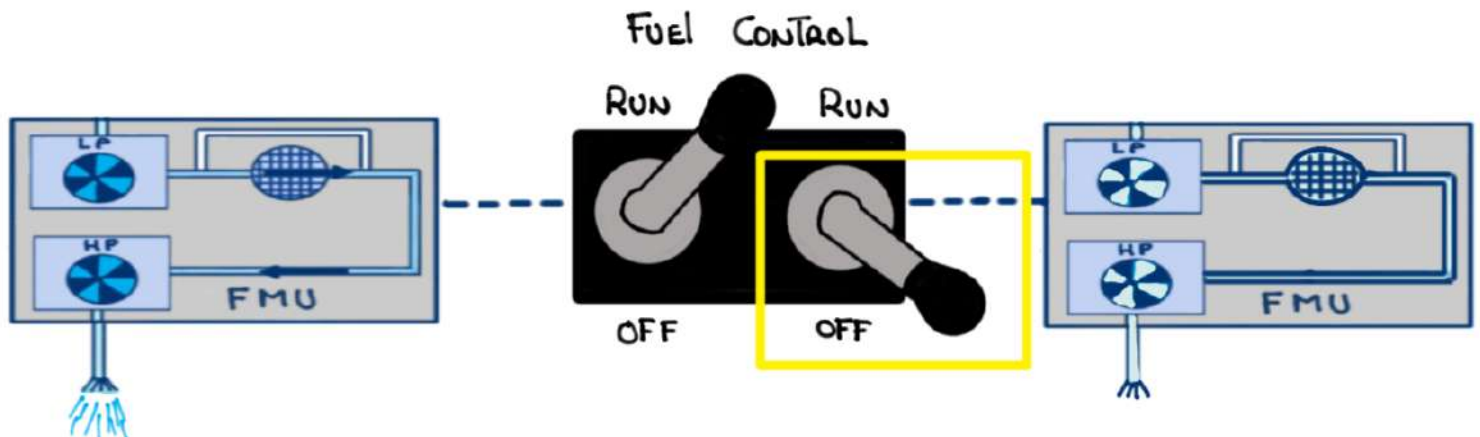
– The FMU contains two (2) internal pumps:
- Low pressure (LP) 1ST stage →
- High pressure (HP) 2nd stage →

LP

HP

FMU

(16 NOZZLES)

FCOC
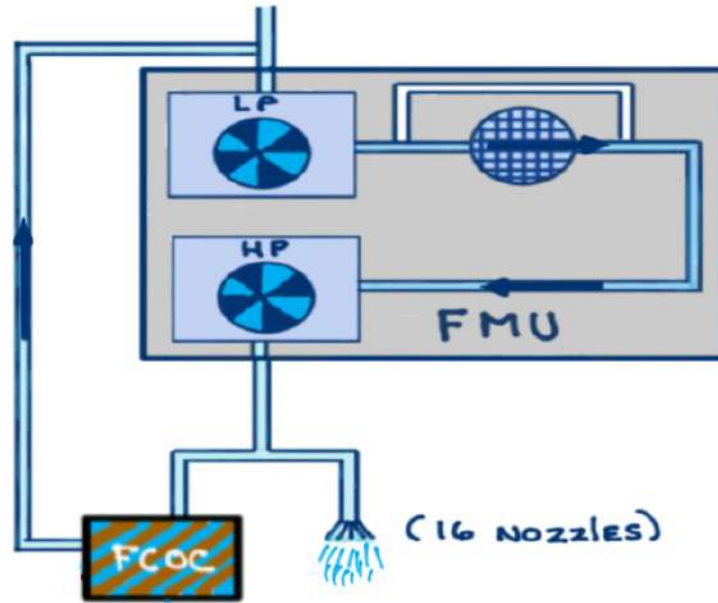
- The LP and HP pumps are driven by the engine accessory gearbox

- A fuel filter RECEIVES fuel from the 1ST stage LP pump and REMOVES debris and contaminants

- A filter bypass valve ensures CONTINUAL fuel flow to the engine if filter is blocked

- Excess fuel is recirculated through the Fuel/Oil heat exchanger

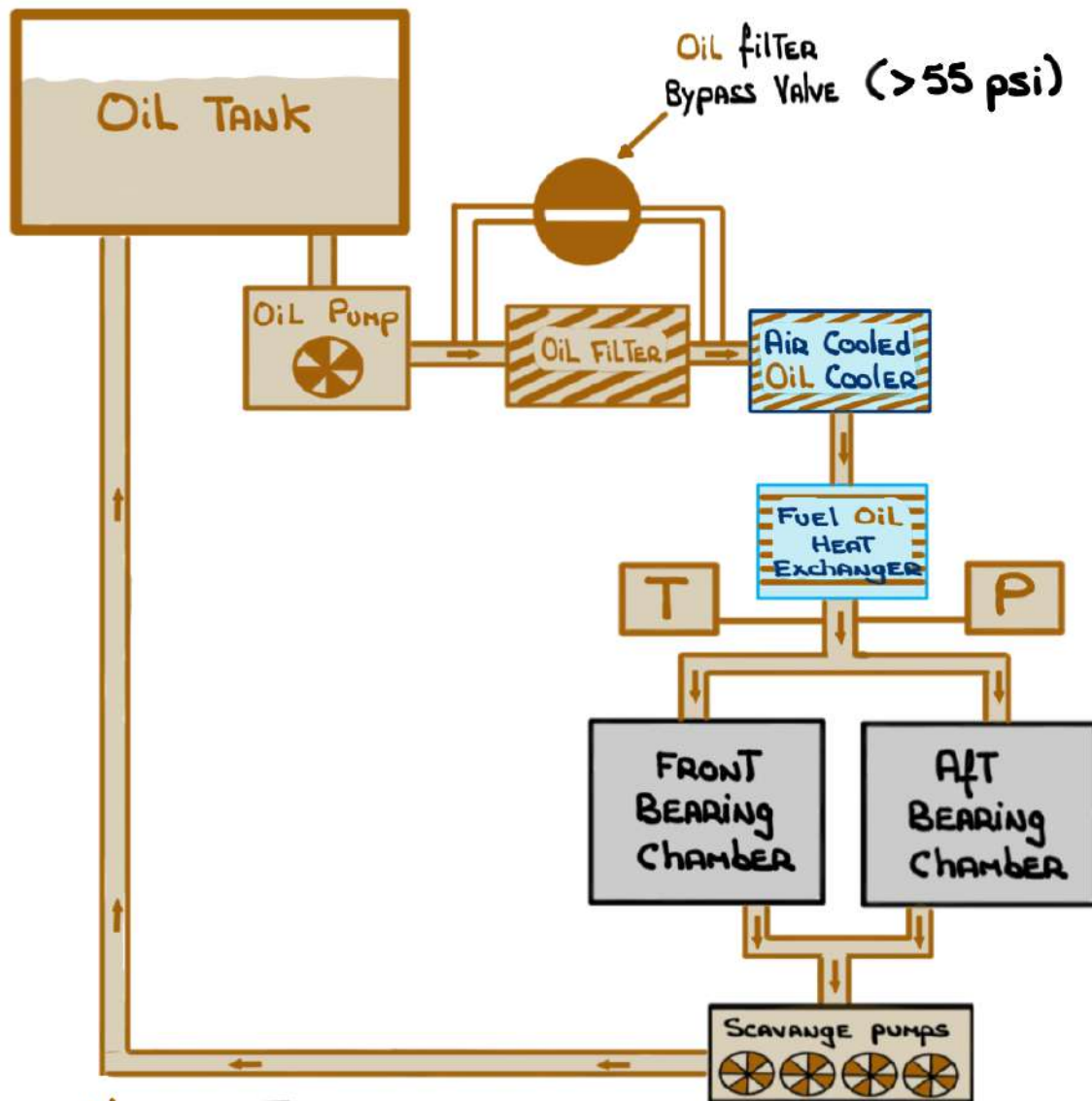- Each engine has its own **FIRE HANDLE**
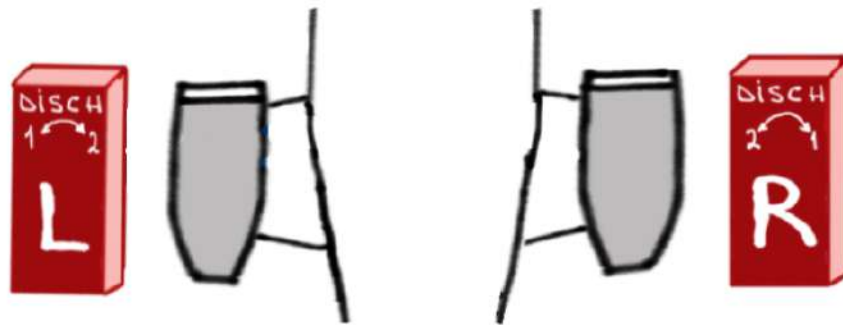
- Pulling a **FIRE HANDLE** shuts off fuel <u>AT THE TANK</u>

Shutoff Valve
Open

Shutoff Valve
Closed
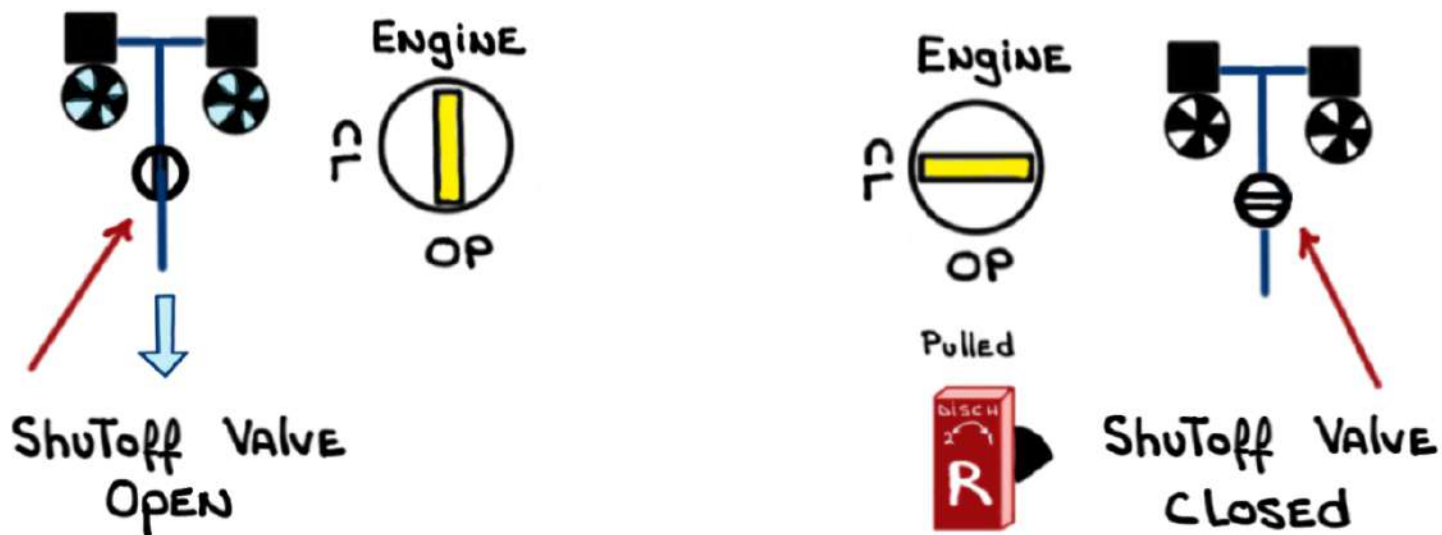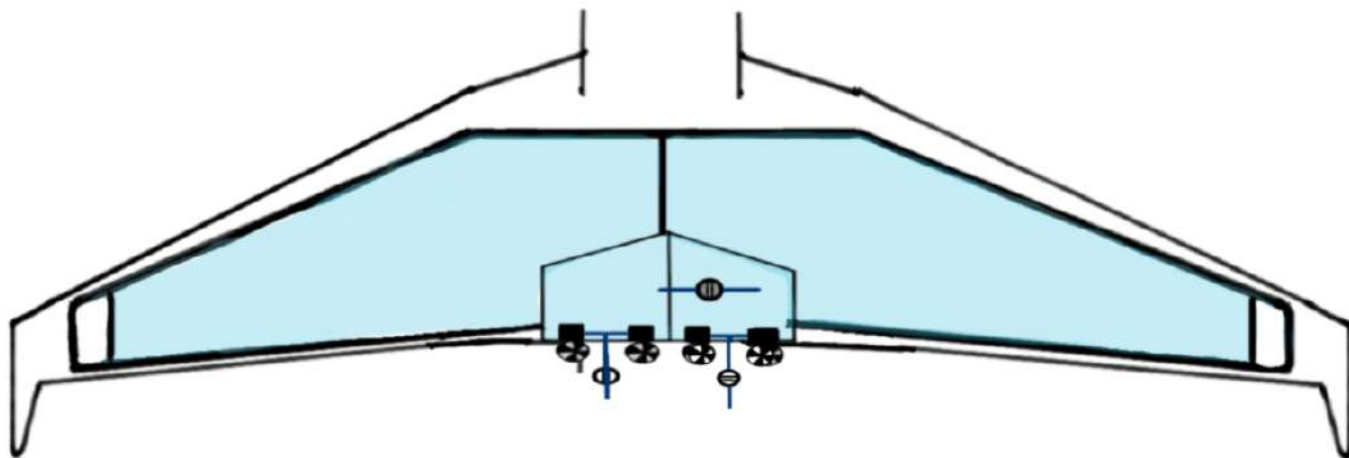
Engine Oil System

- Provides lubrication during engine operation

- Oil Tank and pump are located in the engine's accessory gearbox

Oil filter Bypass Valve (>55 psi)

Oil Tank

Oil Pump

Oil Filter

Air Cooled Oil Cooler

Fuel Oil Heat Exchanger

T

P

Front Bearing Chamber

Aft Bearing Chamber

Scavange pumps

- Check oil quantity:

  - Last flight of the day, or
  - Interval not > 24 cumulative flight time
  - 10-30 minutes after shutdown

Engine Limitations - Start

- Minimum OAT: $-40°C$
- Minimum bleed air: 22 Psi
- Maximum TGT prior to start: $120°C$
- Maximum TGT: $975°C$ (ground $875°C$)
- Rotorbow protection: if engine shutdown < 8 hours
- Starter duty cycle
  - Maximum of Three (3) minutes per start cycle
  - Delay fifteen (15) seconds between cycles
  - Ten (10) minute cooling period required if start attempt exceeds Three (3) minutes
  - After Three (3) start cycles delay use of the starter ten (10) minutes or more
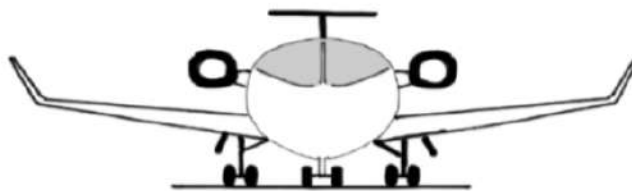
- Maximum Tailwind and crosswind:

← 40 kts

↑ 25 kts
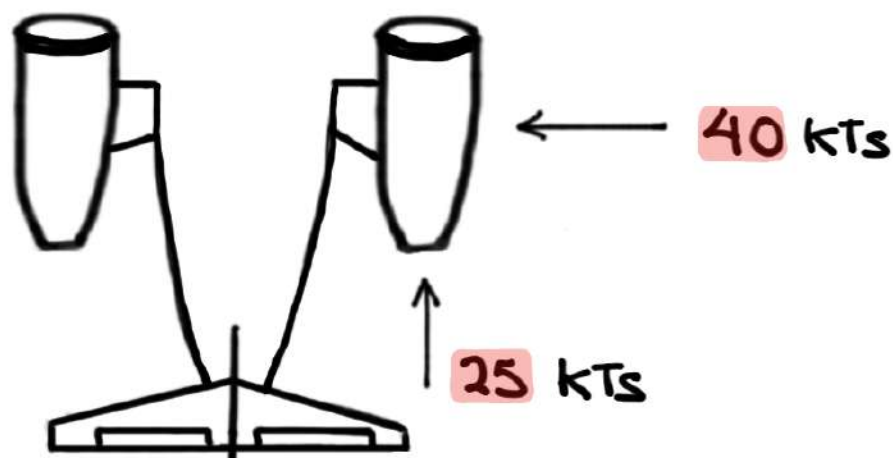
Engine Limitations – High Power Ground Ops

← **25** kTs

↑ **20** kTs
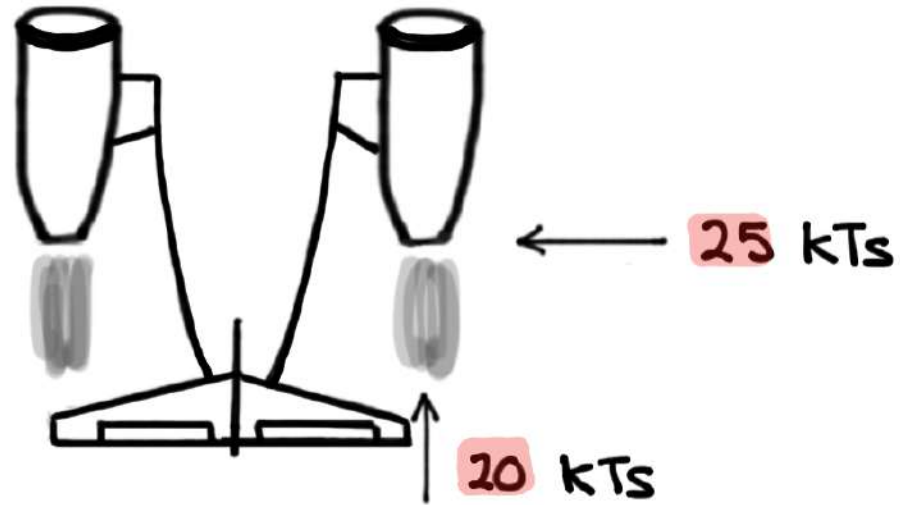
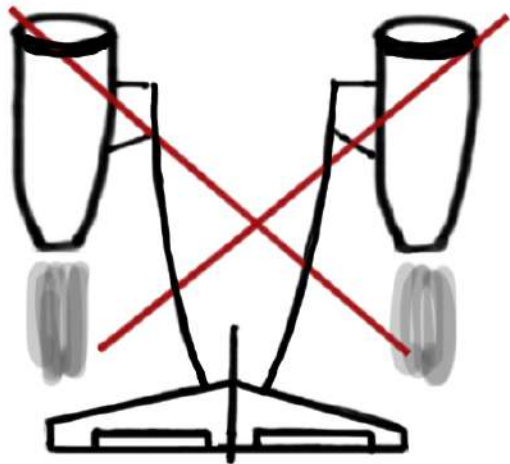# Engine Limitations – Taxi

Taxi operation with engine oil temperature between – **30°** C to + **10°**C: only thrust required for taxi shall be used

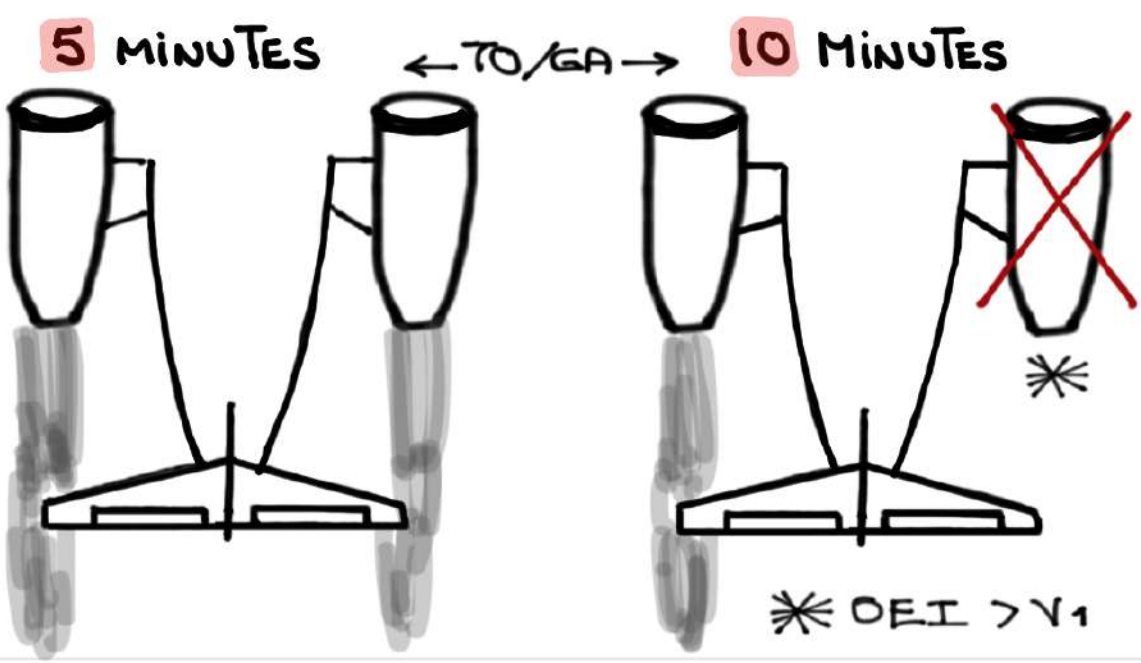# Engine Limitations - Takeoff

- Takeoff in **ALT** mode is prohibited

- Minimum oil temperature: + 10 °C
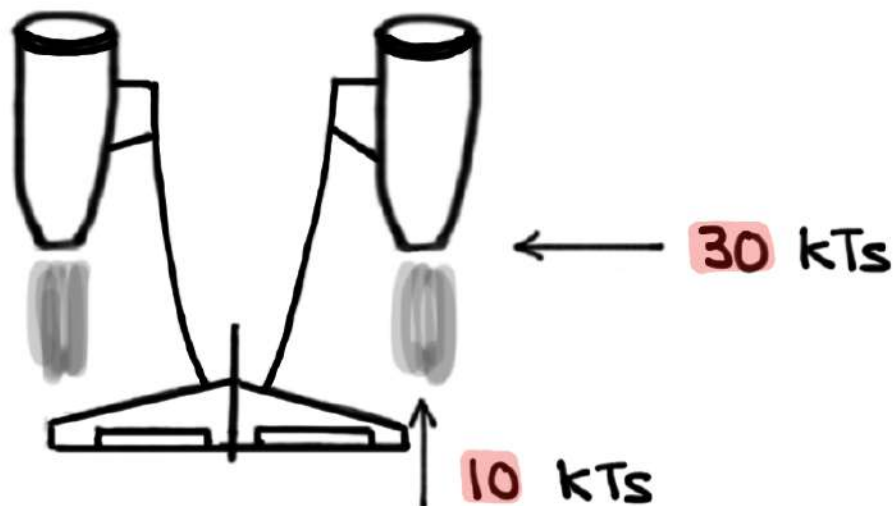- Minimum fuel temperature: + 9 °C
- Maximum TGT: 965 °C

5 minutes ← TO/GA → 10 minutes

※ OEI > V₁

– Maximum Tailwind and Crosswind for Takeoff:

← 30 KTs

10 KTs

Exhaust Danger Area

29'

59'

Idle Thrust

26 KNOTS / 112°F

21'

100'

Takeoff Thrust

117 KNOTS / 133°F

21'
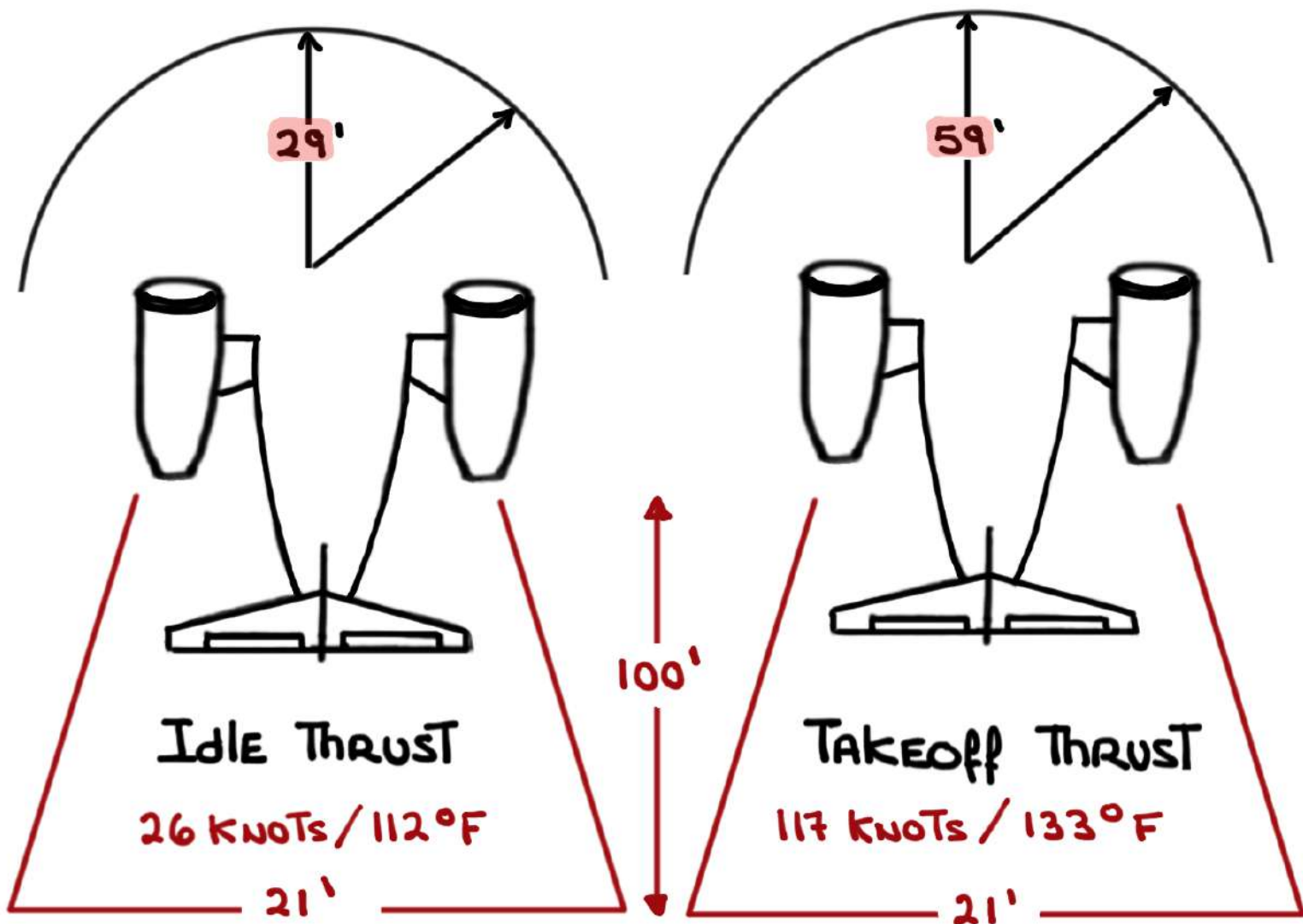
Engine Limitations - Inflight

- Maximum Continuous Thrust (MCT): **956°C**
- Engine operations < 0 Gs limited to less than seven **(7)** seconds

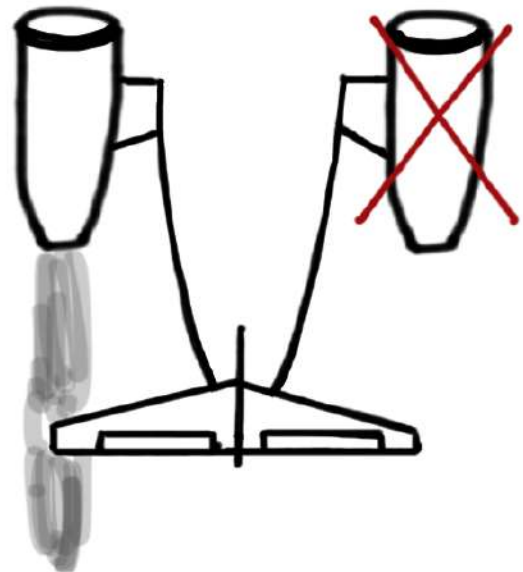## Airstart

Priority: ① Crossbleed
② APU Assisted
③ Windmill

Airstart Type	Altitude	Speed	Minimum N_2
• Starter Assist	≤ 30,000	Vref – Vmo	N/A
• Windmill	≤ 16,500'	250 KCAS – Vmo	9%

Note: No FADEC protection

Maximum TGT: **975%**

Do not attempt airstart if:

- FIRE
- FOD
- FROZEN

Engine Limitations - Landing

Thrust reversers:

- Reverse idle by sixty (60) knots

- Use for power back not approved

- If used in an emergency to bring the aircraft to a complete stop must report to maintenance

- Thrust reverser must be deployed and stowed at least once every one hundred (100) hours

- Use of both thrust reversers below ten (10) knots is prohibited
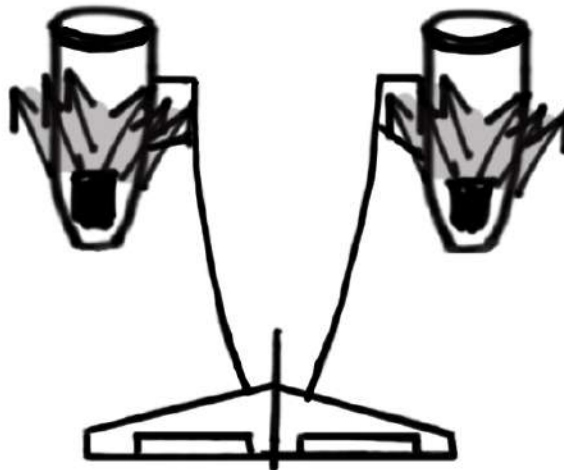
Engine Limitations - Taxi in/shutdown
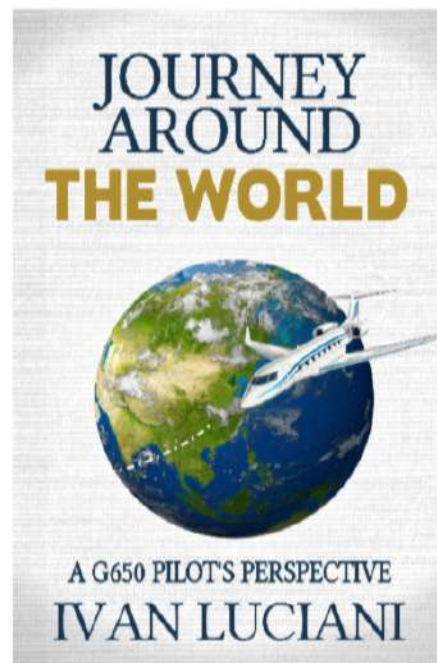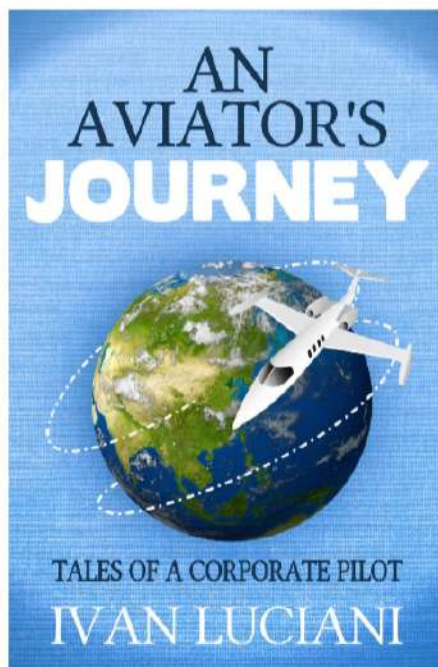
00:00 IDLE POWER 00:03
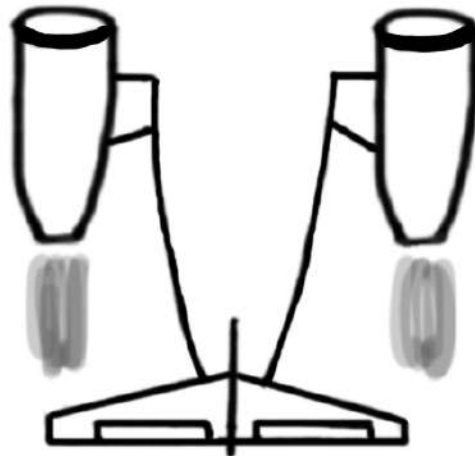
A Three (3) minute post-landing at IDLE power needs to be observed prior to engine shutdown

Conducting manual ice shedding during Taxi in does NOT RESET the post-landing Three (3) minute engine idle time requirement prior to engine shutdown (P&W engine Maintenance Manual 71.00.03)

REMINDER: these system notes are intended for study purposes only. Always refer to official Gulfstream manuals and other approved references when operating your aircraft.

NOTE: these system notes are updated from time to time and what is posted on Code450.com will always be the most recent version.

Questions, comments or errors...please do send me an email: ivan.luciani@gmail.com

Thank you!