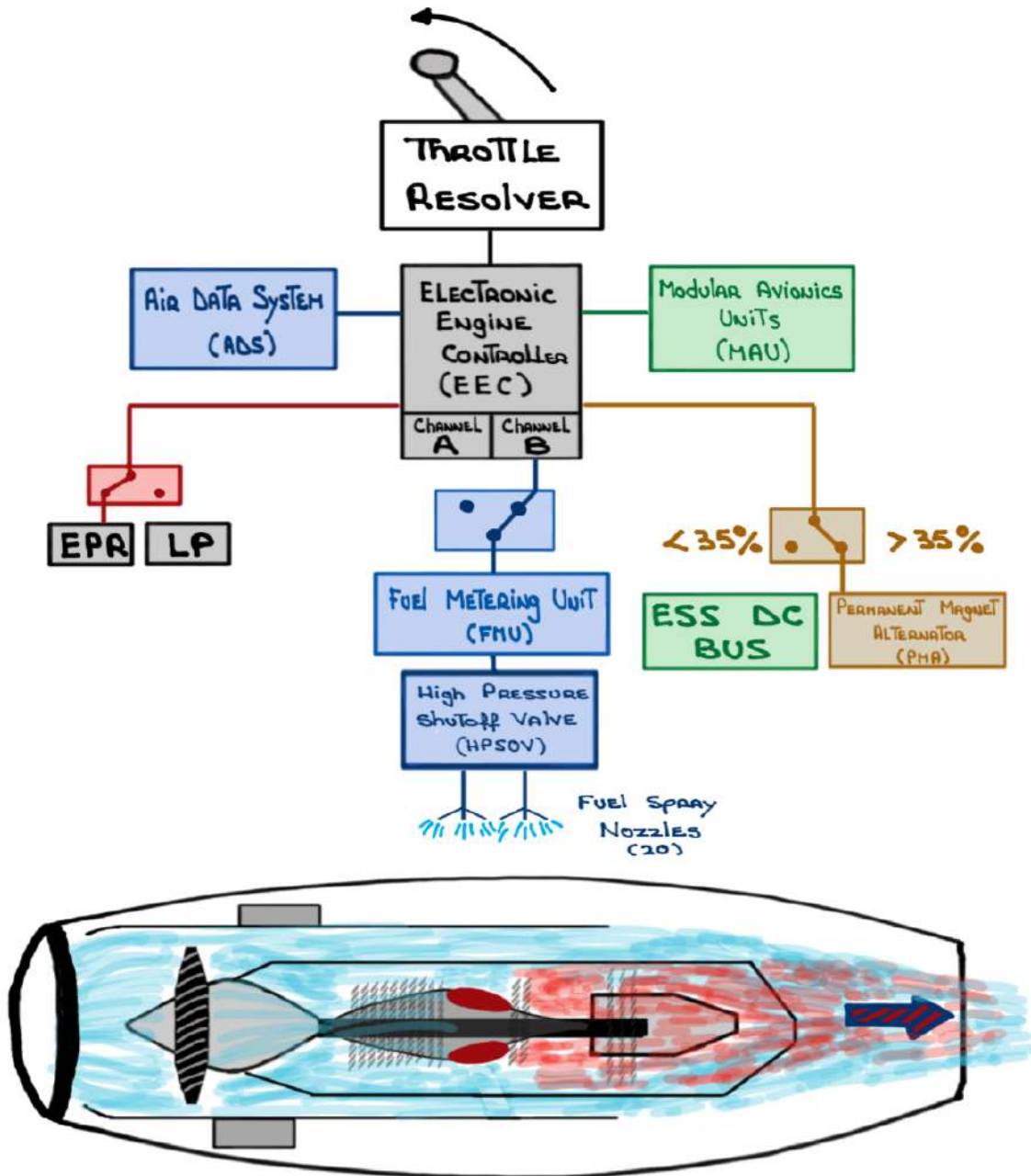
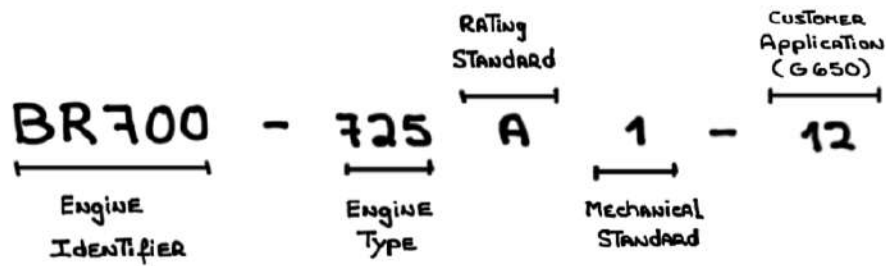


G650 POWERPLANT

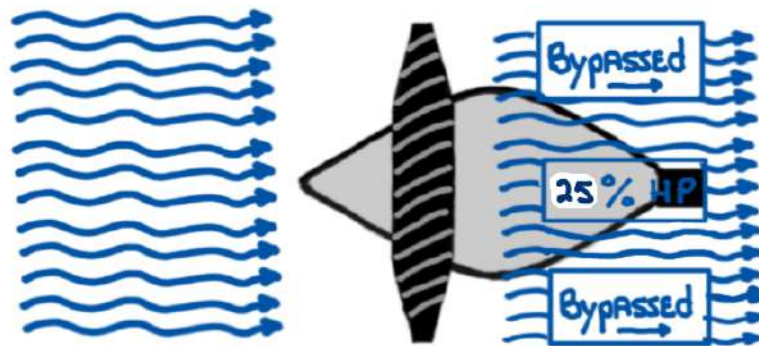


For study purposes only

Two (2) Rolls-Royce BR700-725A1-12



- 16,900 lbs of Thrust @ SEA LEVEL & ISA + 15°C
- High bypass Turbofan - 4.18:1

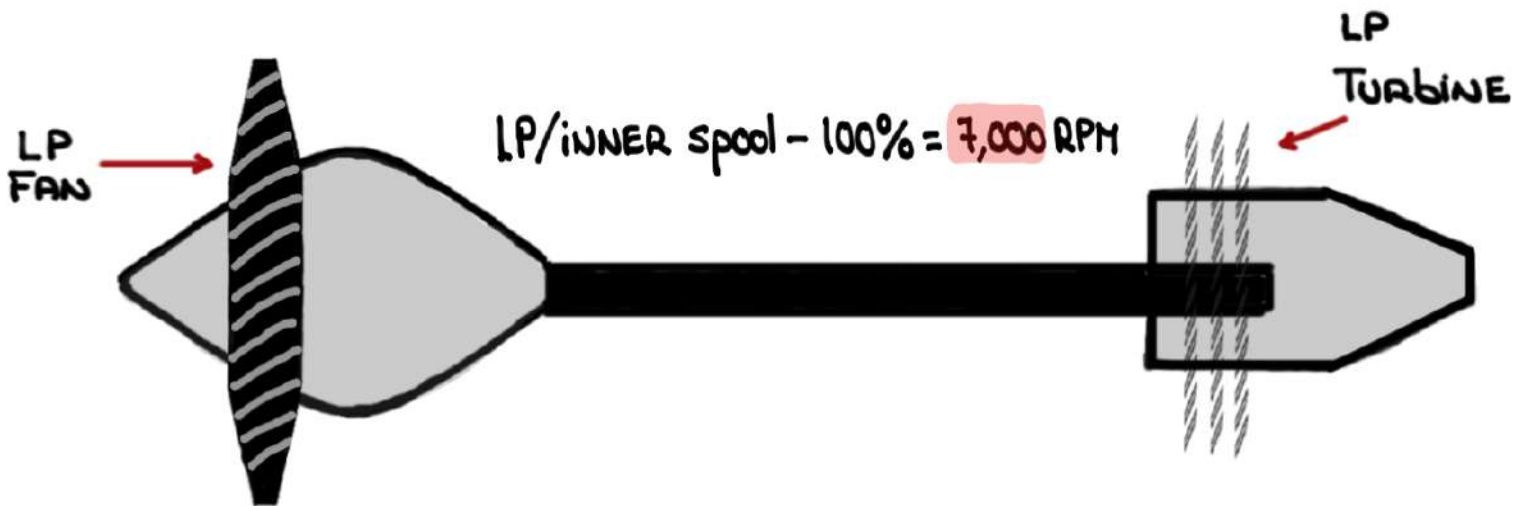


- FADEC - controlled
- ENGINE PRESSURE RATIO (EPR) $EPR = \frac{\text{OUTPUT}}{\text{INPUT}}$
- TITANIUM INLET COWLING
- High Thrust-to-weight ratio $\left\{ \begin{array}{l} \text{FUEL EFFICIENCY} \\ \text{NOISE REDUCTION} \end{array} \right.$
- Left Engine is designated as the CRITICAL ENGINE (AFM - PERFORMANCE, SECTION 5.01.10)

- HP AND LP COMPRESSOR SECTIONS ARE DRIVEN BY THEIR OWN COAXIAL SHAFTS (SHAFT WITHIN A SHAFT)
- Twin - spool

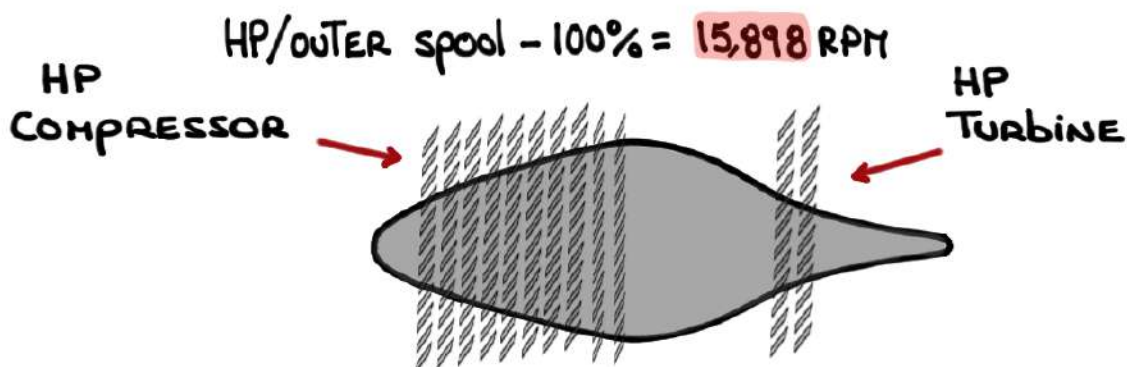
- LOW PRESSURE ROTOR

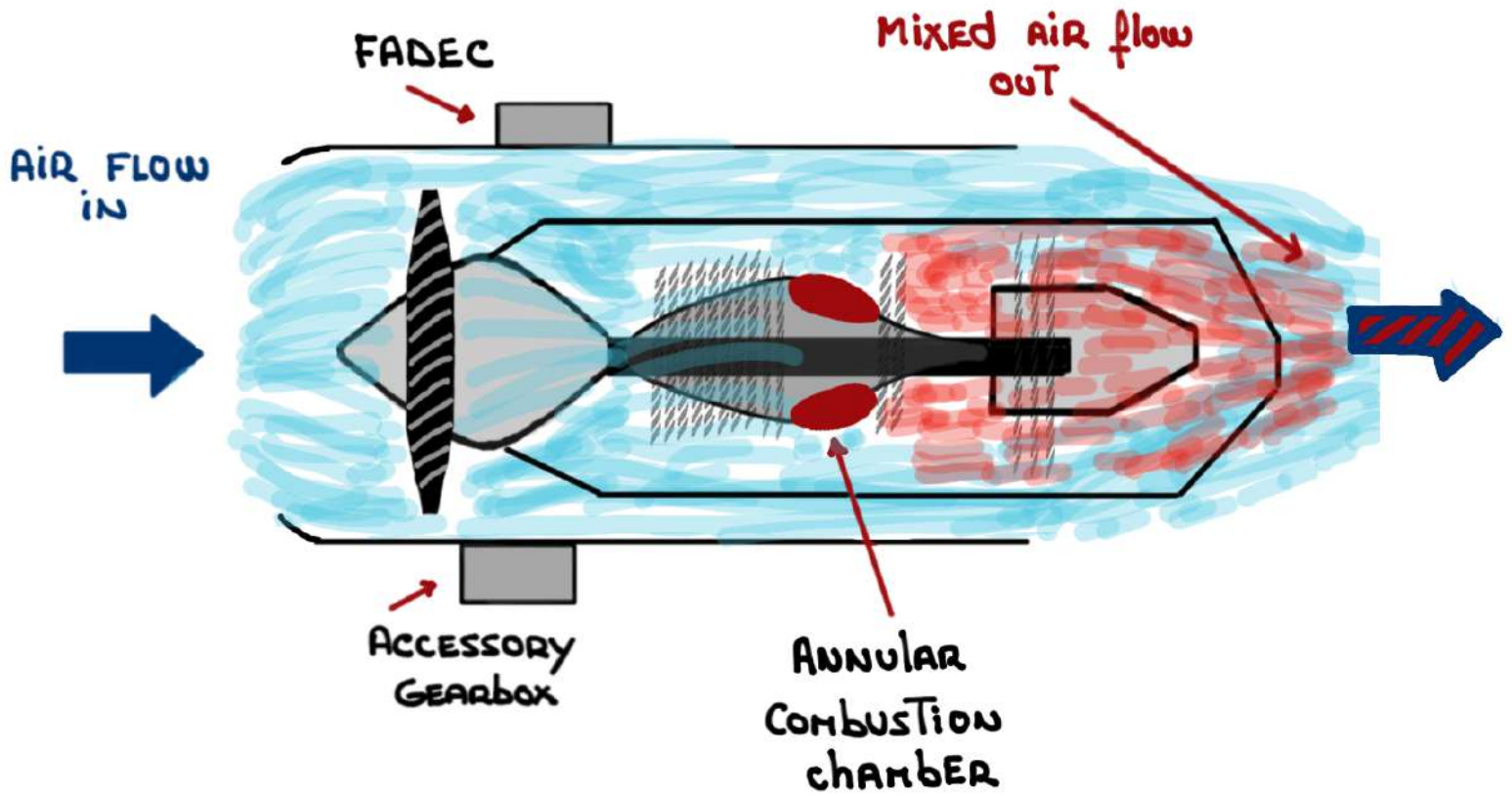
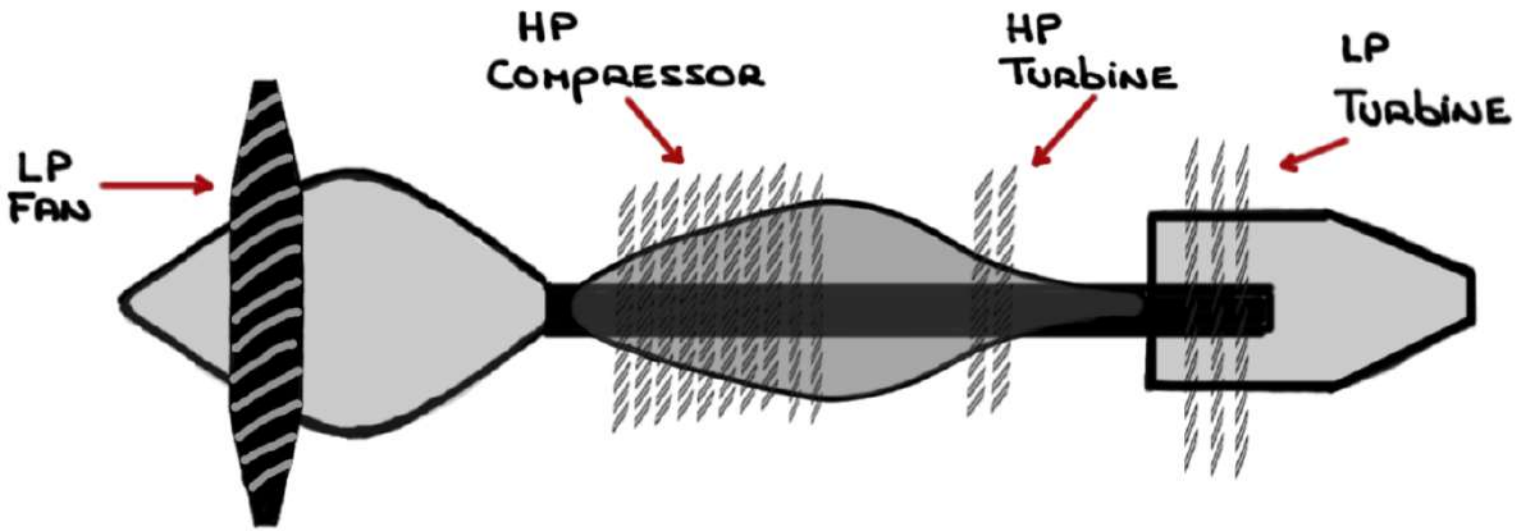
SINGLE-STAGE wide chord, 50 inch diameter, twenty-four (24) blade fan driven by a three (3) stage turbine



- High pressure rotor

TEN (10) stage compressor driven by a two (2) stage turbine



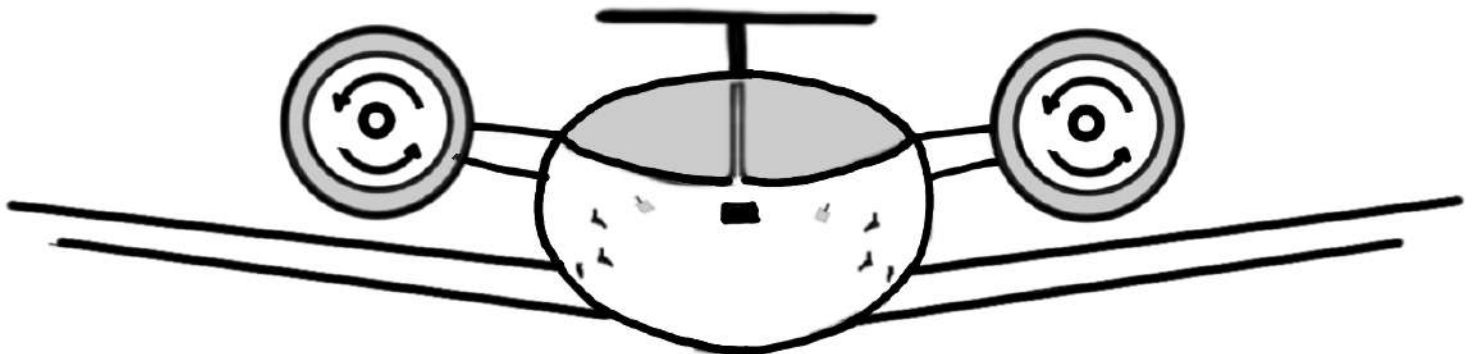


- ACCESSORY GEAR BOX (AGB)

USES POWER EXTRACTED FROM THE HP COMPRESSOR SHAFT
TO DRIVE THE FOLLOWING ACCESSORIES:

- INTEGRATED DRIVE GENERATOR (IDG)
- FUEL METERING UNIT (FMU)
- FUEL PUMP
- OIL PUMP AND BREATHER
- PERMANENT MAGNET ALTERNATOR (PMA)
- HYDRAULIC PUMP

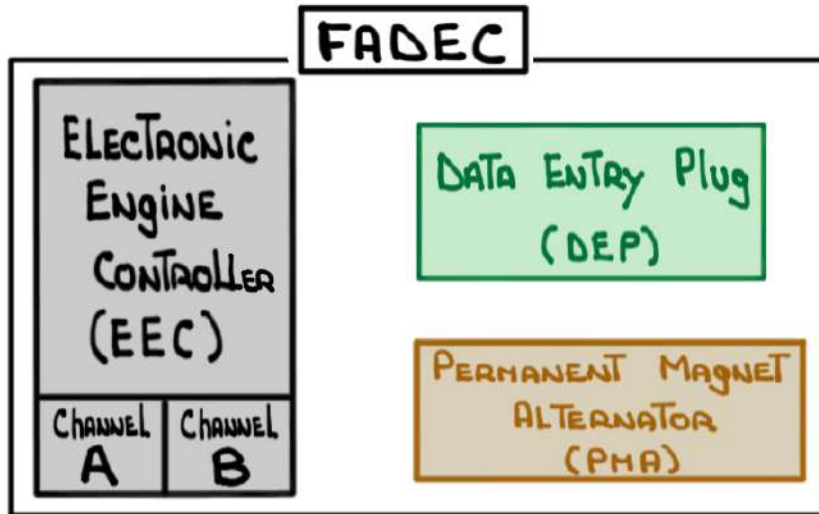
- THE FANS TURN COUNTER-CLOCKWISE WHEN SEEN FROM
THE FRONT



- Full Authority Digital Electronic Control (FADEC):

MOUNTED ON OUTSIDE, UPPER PORTION OF THE ENGINE.

CONSISTS OF THREE (3) MAJOR COMPONENTS:



- FADEC PROVIDES ENGINE START PROTECTION :

① ON THE **GROUND** only

② ^{START MASTER} **ON** switch only

- CONTROLS AND RESPONDS TO EPR REQUIREMENTS

- THE FADEC PROVIDES:

- ENGINE PROTECTION
- IMPROVED HANDLING
- BETTER FUEL EFFICIENCY
- PROLONGED ENGINE LIFE

- FADEC AUTOMATICALLY PERFORMS A ROTOR bow (UNEVEN HEATING OF THE ENGINE'S CORE) AVOIDANCE PROCEDURE DURING START if ENGINE HAS BEEN SHUTDOWN WITHIN:

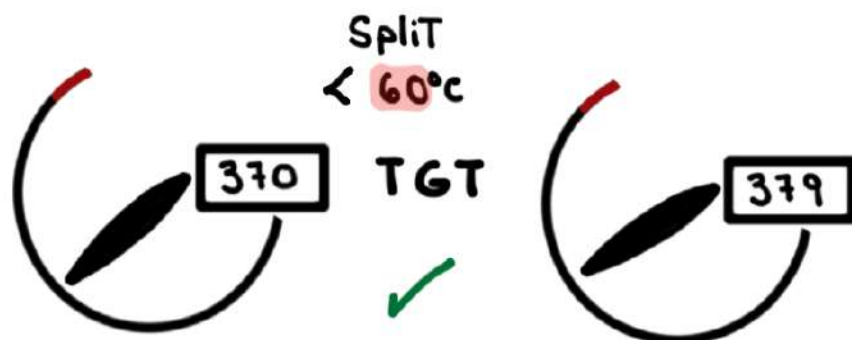
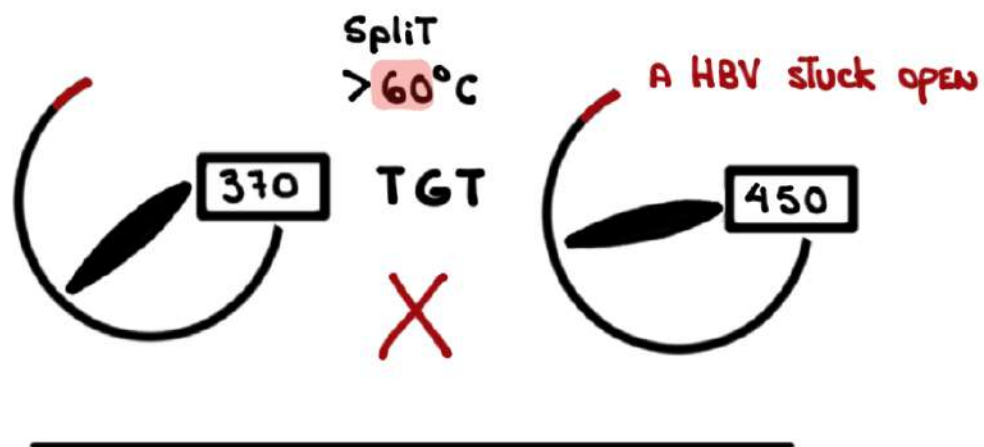
> 20 MINUTES < 5 HOURS

THE CREW IS NOTIFIED VIA THE FOLLOWING CAS MESSAGE:

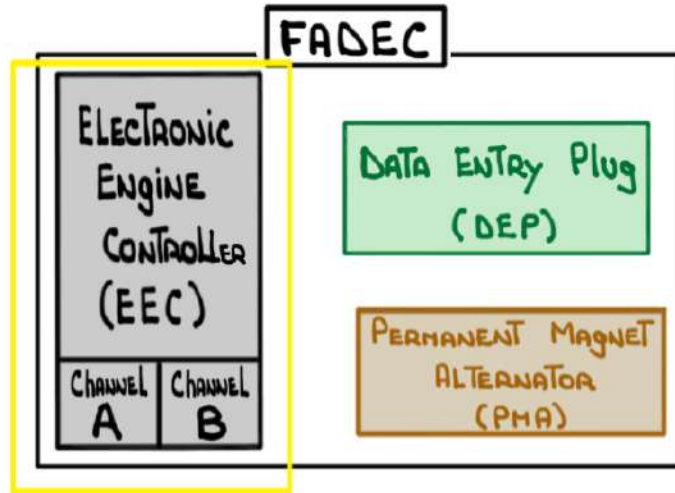
ENGINE START PROTECT

- If A FADEC WERE TO FAIL THE ENGINE WOULD FLAME OUT
- FADEC CONTROLS THE ENGINE HANDLING BLEED VALVES (HBV) ON THE 5TH AND 8TH STAGE SECTIONS OF THE HP COMPRESSOR
 - 5TH = THREE (3) HBVs
 - 8TH = ONE (1) HBV
- DURING ENGINE START AND AT LOW POWER SETTINGS THESE HBVs ARE FULLY OPEN TO OPTIMIZE THE AIRFLOW OVER THE COMPRESSOR STAGES

- As Thrust is increased these HBVs start to close and are fully closed at high power settings
- When water ingestion is detected the FADEC commands the HBVs to open to reduce the amount of water entering the core engine
- After starting both engines compare TGTs. A TGT split greater than 60°C may be caused by an 8th stage HBV stuck open



ELECTRONIC ENGINE CONTROLLER (EEC)



- BRAINS of THE FADEC
- DUAL CHANNELS - ONE ACTIVE AND ONE STANDBY
- FUEL CONTROL SWITCH: CHANGES CHANNELS
- ECC CONTROLS ENGINE IDLE SPEED

Idle Speed Control is based on EPR with THROTTLE LEVERS AT idle. THERE ARE THREE (3) MODES:

- ① Flight Idle
- ② Approach Idle
- ③ Ground Idle

① Flight Idle:

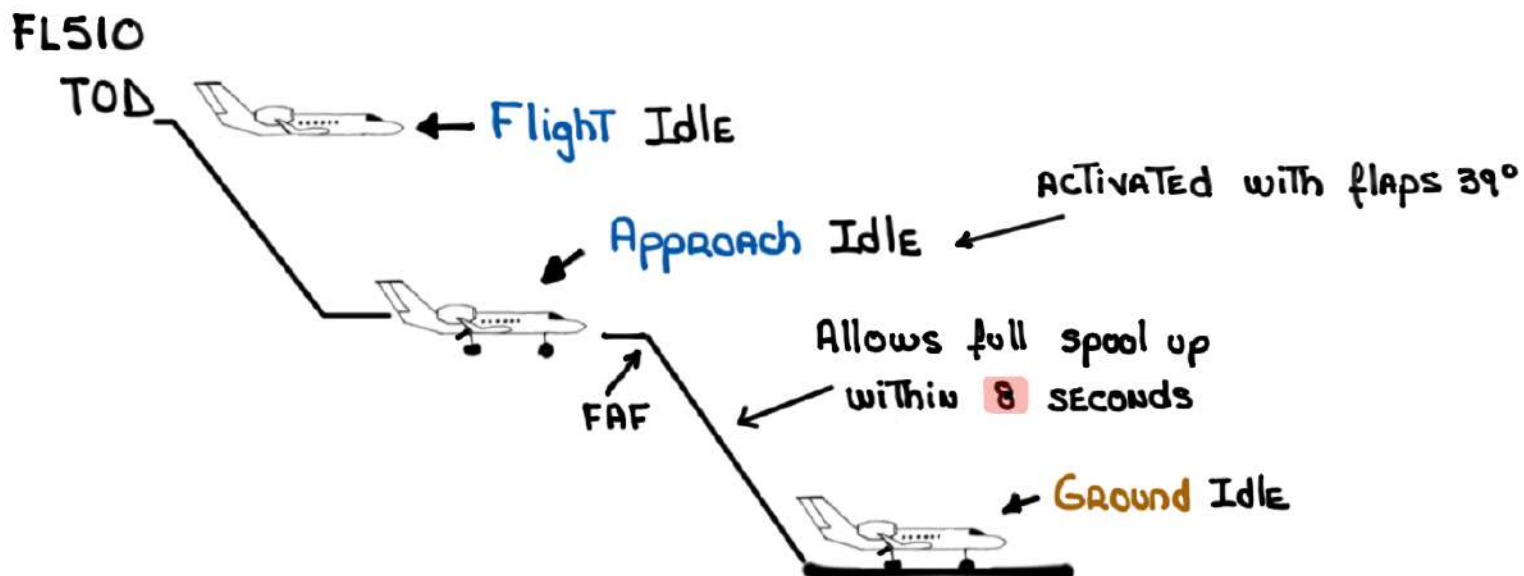
- Flaps < 22°

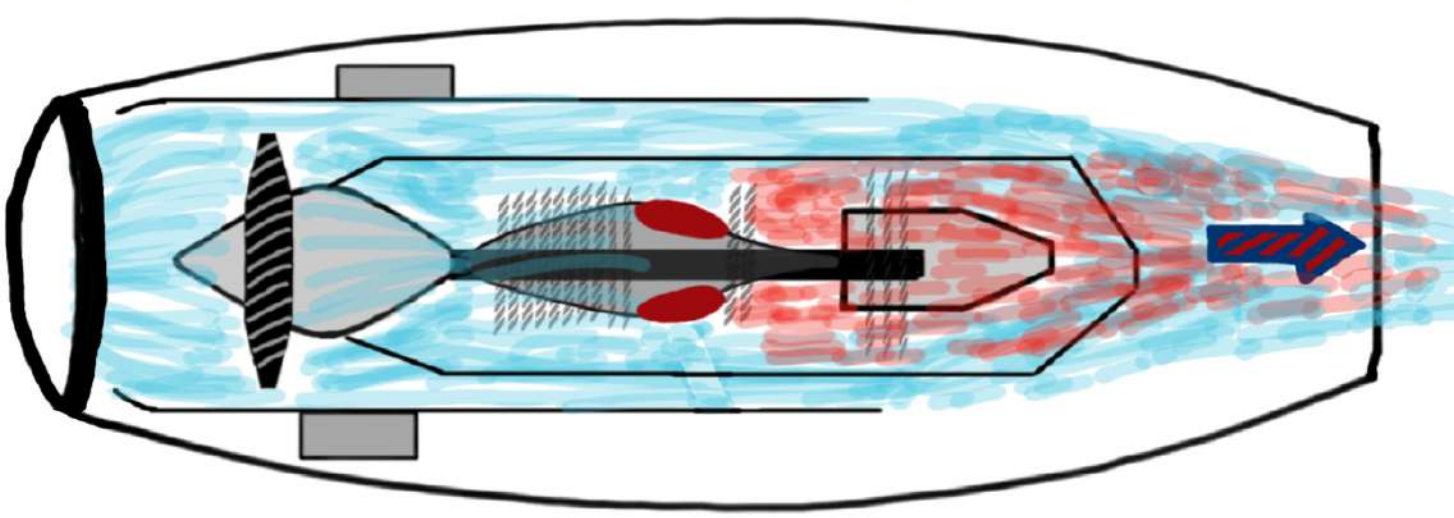
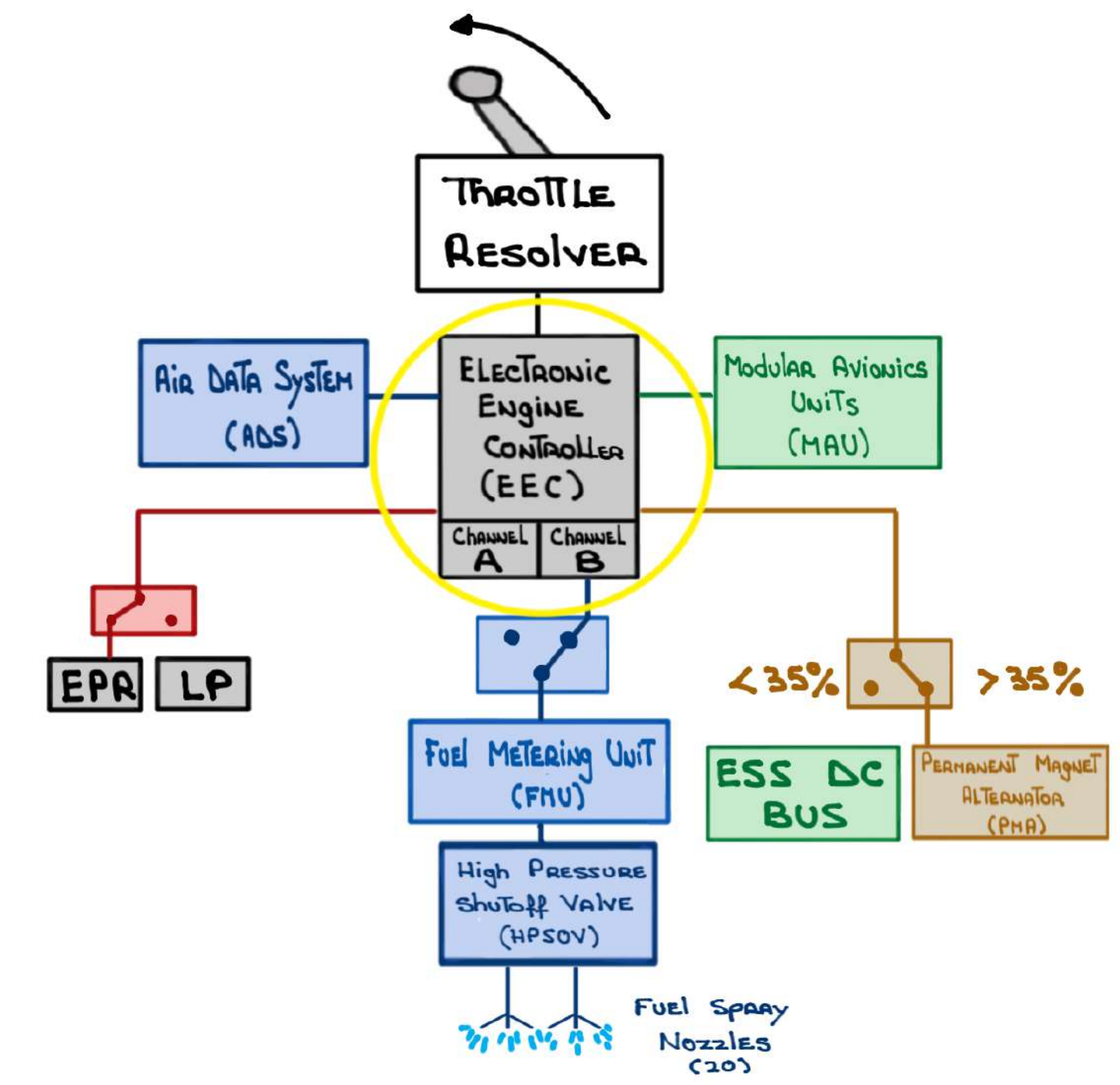
② Approach Idle:

- Flaps > 22°
- WOW - AIR
- wheel speed < 53 knots

③ Ground Idle:

- AIRCRAFT WOW (GROUND)
- Touchdown + five (5) SECONDS
- Delay allows for full AND RAPID spool up



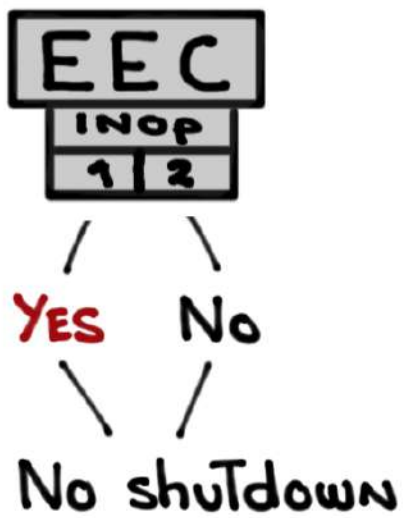




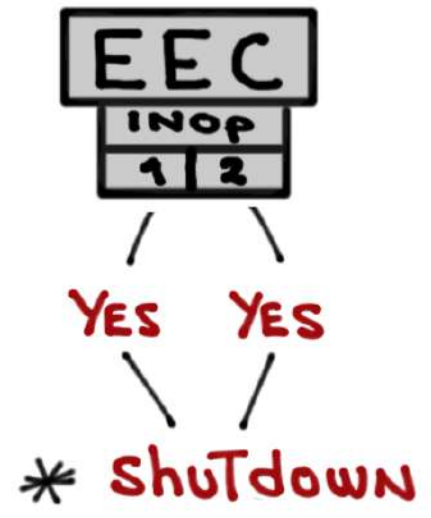
- PRIMARY CONTROL MODE
- ALTERNATE CONTROL MODE
- REVERSE THRUST CONTROL MODE

- PRIMARY CONTROL MODE — EPR, HP RPM @ idle
- ALTERNATE CONTROL MODE — LP RPM
- REVERSE THRUST CONTROL MODE — LP RPM

• INDEPENDENT OVERSPEED PROTECTION (IOP)



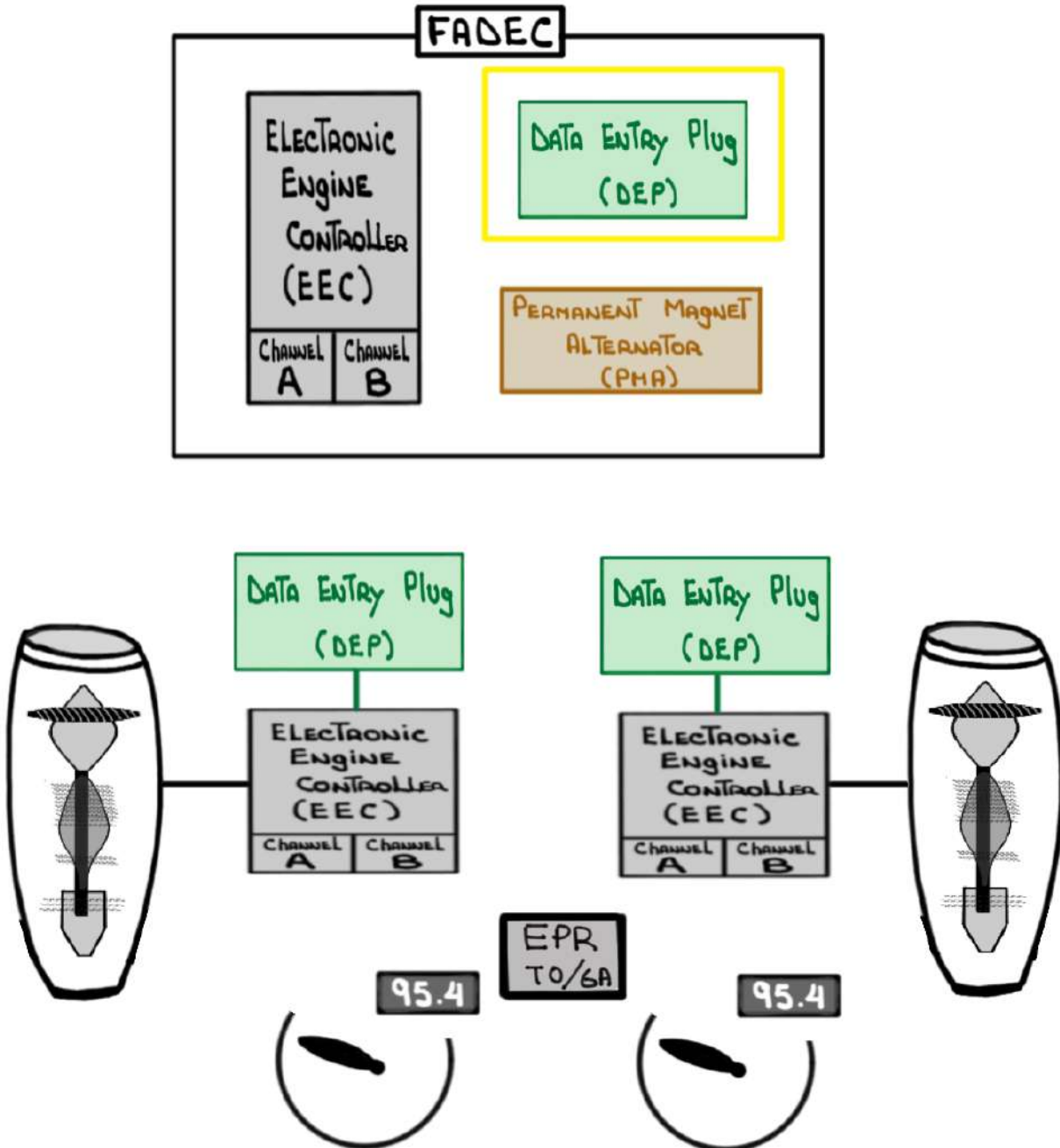
OVERSPEED?



* both CHANNELS MUST AGREE FOR TO COMMAND TO SHUT OFF FUEL TO THE ENGINE

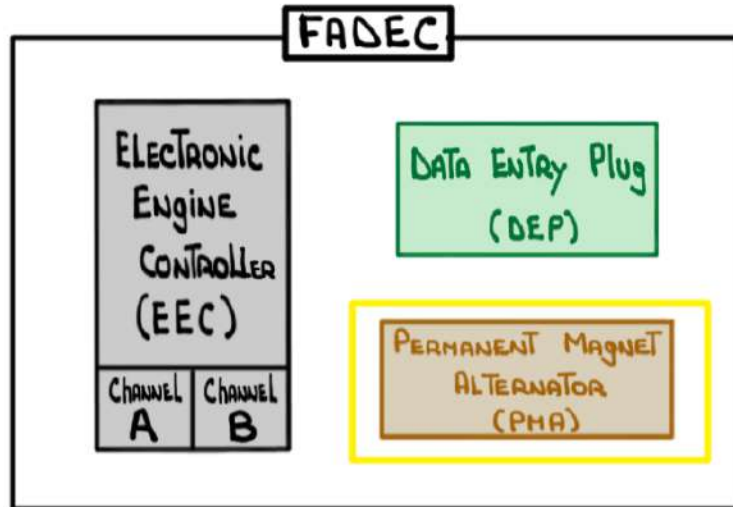
DATA ENTRY Plug

THE DEP CONTAINS ENGINE TRIM DATA. THIS TRIM DATA IS UTILIZED BY THE EEC TO MAKE ALL ENGINES PRODUCE THE SAME THRUST

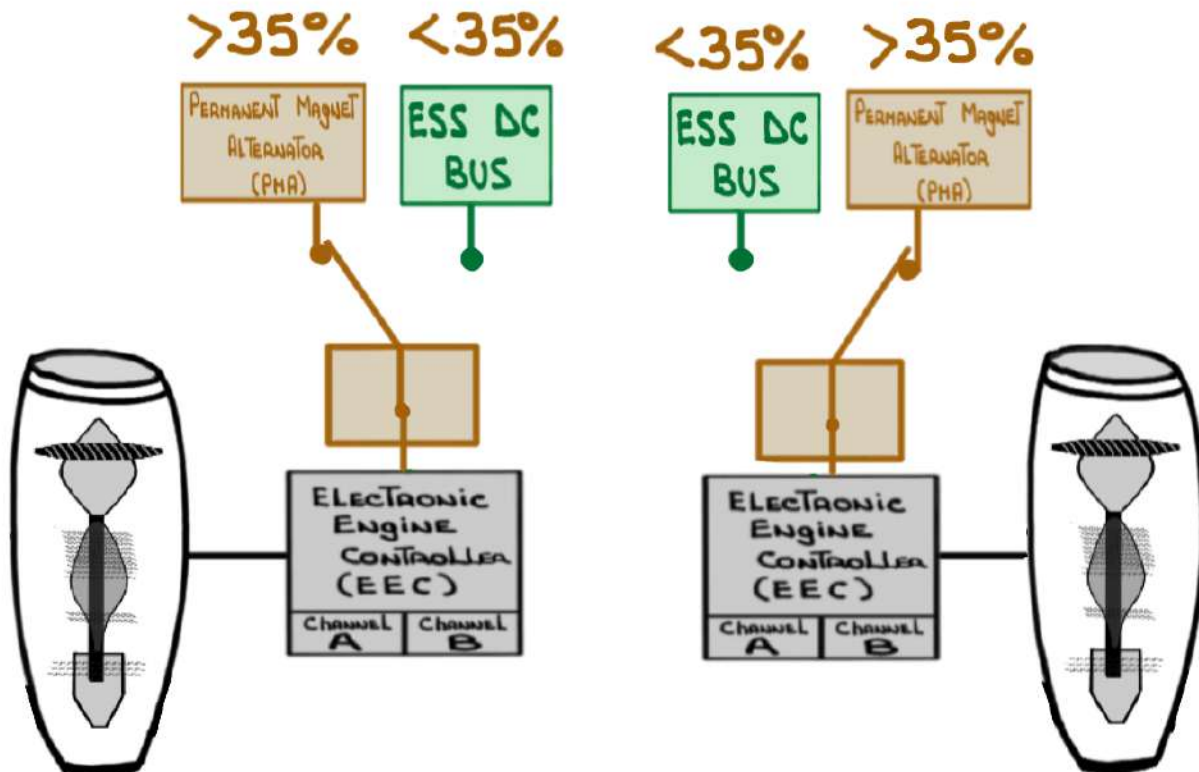


PERMANENT MAGNET ALTERNATOR (PMA)

PRIMARY SOURCE OF EEC POWER ONCE THE ENGINE ACCELERATES > 35% HP RPM

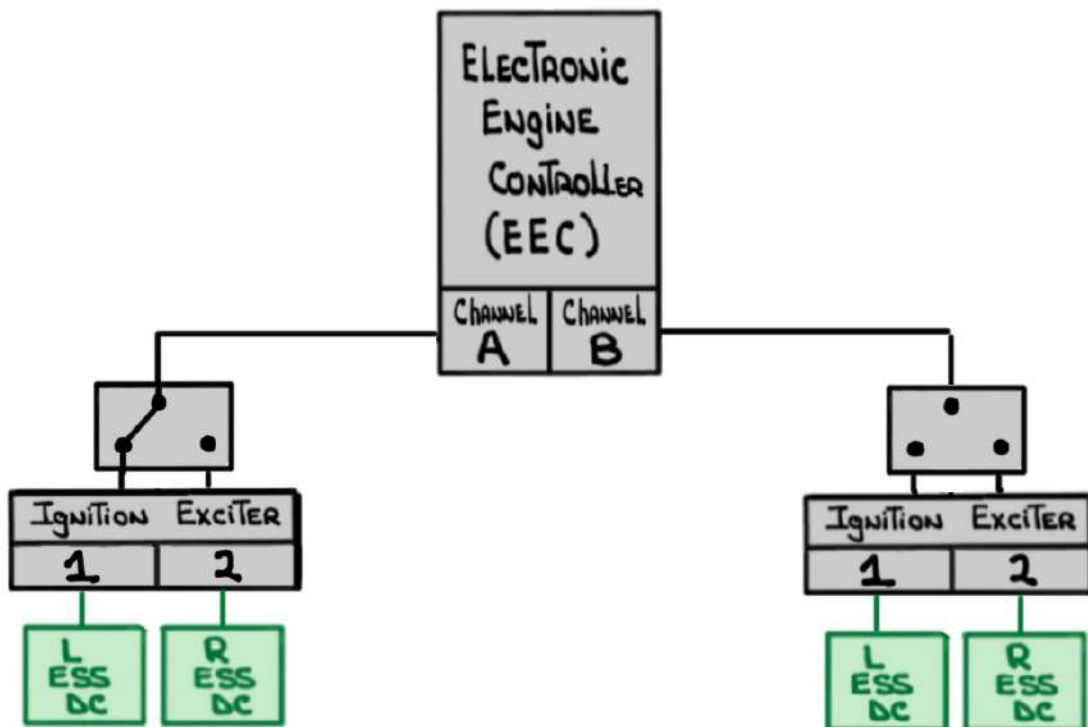


HP RPM



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)

- MANUAL ignition → Two (2) ignitERS
- IgnitERS ARE TURNED OFF AUTOMATICALLY AT 42% RPM HP DURING ENGINE START
- EECs ALTERNATE CHANNELS AND ignitERS AS follows:

1. EEC CHANNEL A / IgnitER 1
2. EEC CHANNEL B / IgnitER 1
3. EEC CHANNEL A / IgnitER 2
4. EEC CHANNEL B / IgnitER 2

- WHEN A NORMAL ground START is ABORTED DUE ANOMALIES FADEC AUTOMATICALLY SELECTS THE OTHER ignitER

L-R AUTOSTART ABORT

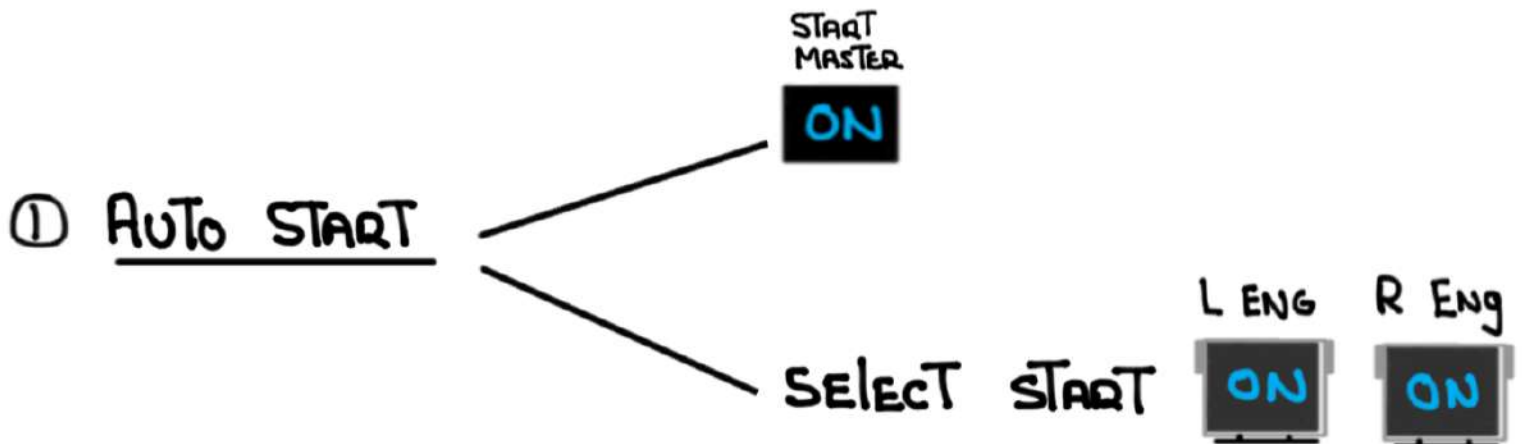
- THERE IS NO TIME LIMIT ON THE USE OF CONTINUOUS ignition

CONT IGN

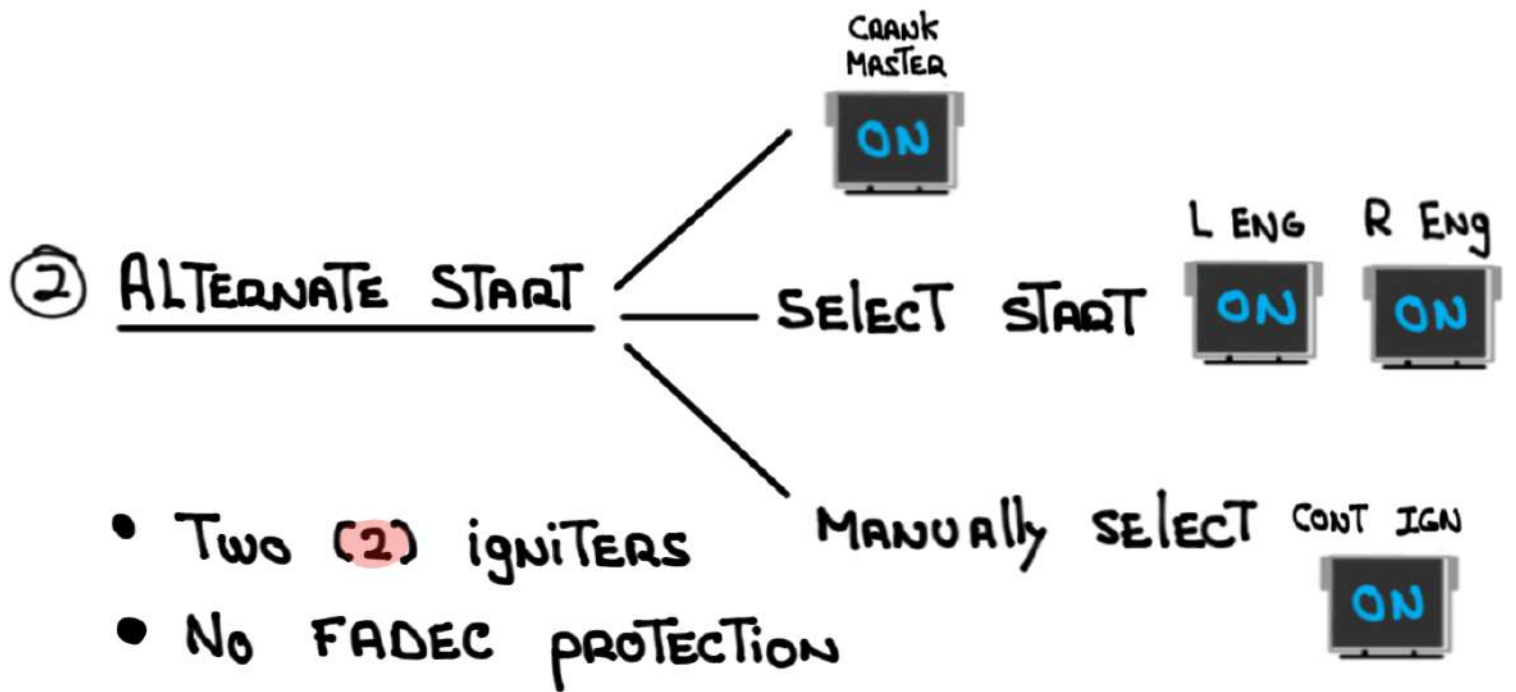


- Ignition modes:

1. AUTO START
2. ALTERNATE START
3. INCREMENT WEATHER MODE
4. AUTO - RELIGHT MODE
5. QUICK RESTART MODE



- ONE (1) ignITER only
- EEC ALTERNATES CHANNELS
- FUEL CONTROL SWITCHES CHANGE ignITER plugs



③ INCREMENT WEATHER MODE

T30 PROBE SENSES MOISTURE

④ AUTO - RELIGHT MODE

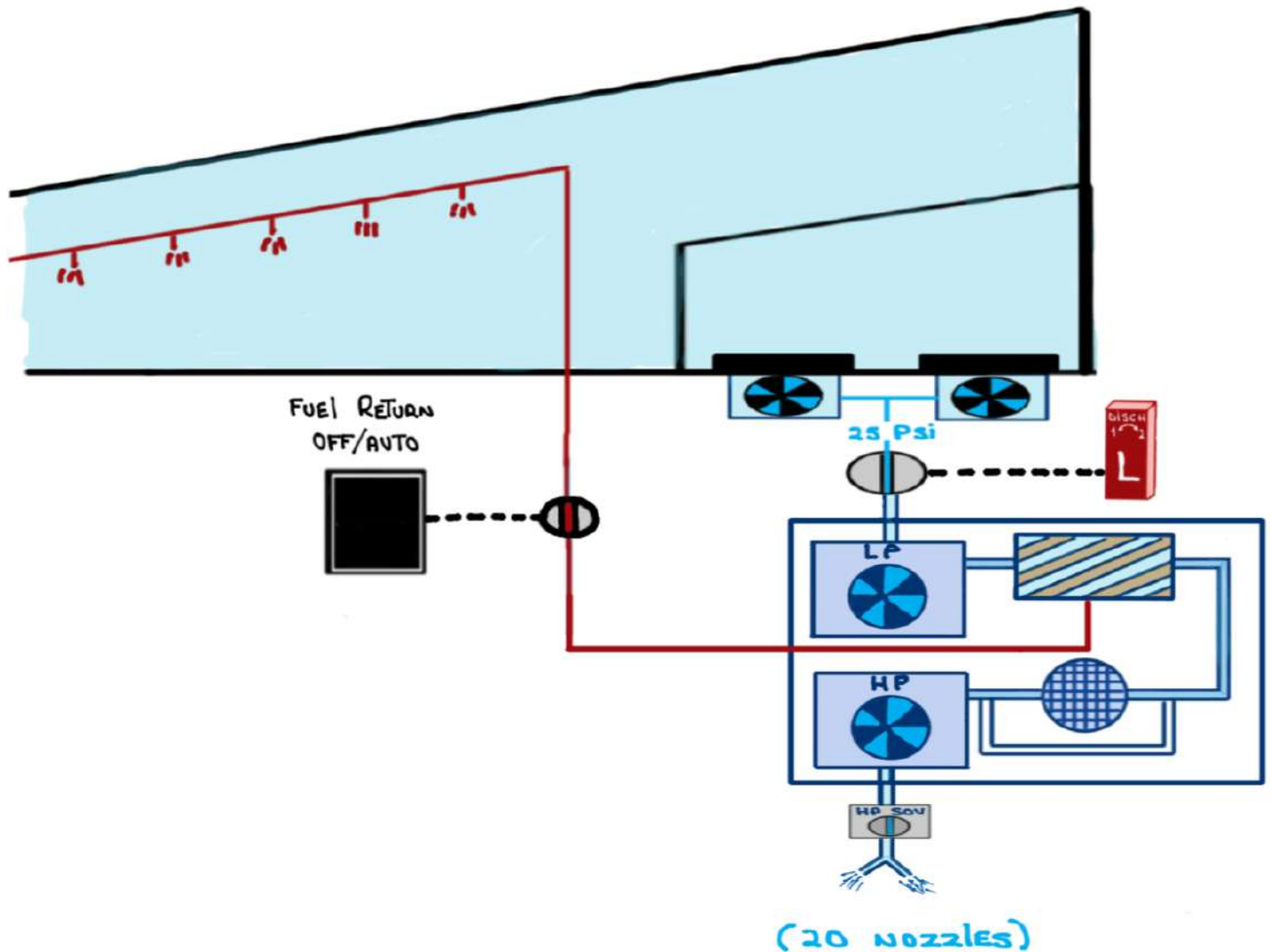
HP, LP OR TGT ABNORMALITY

⑤ QUICK - RESTART MODE

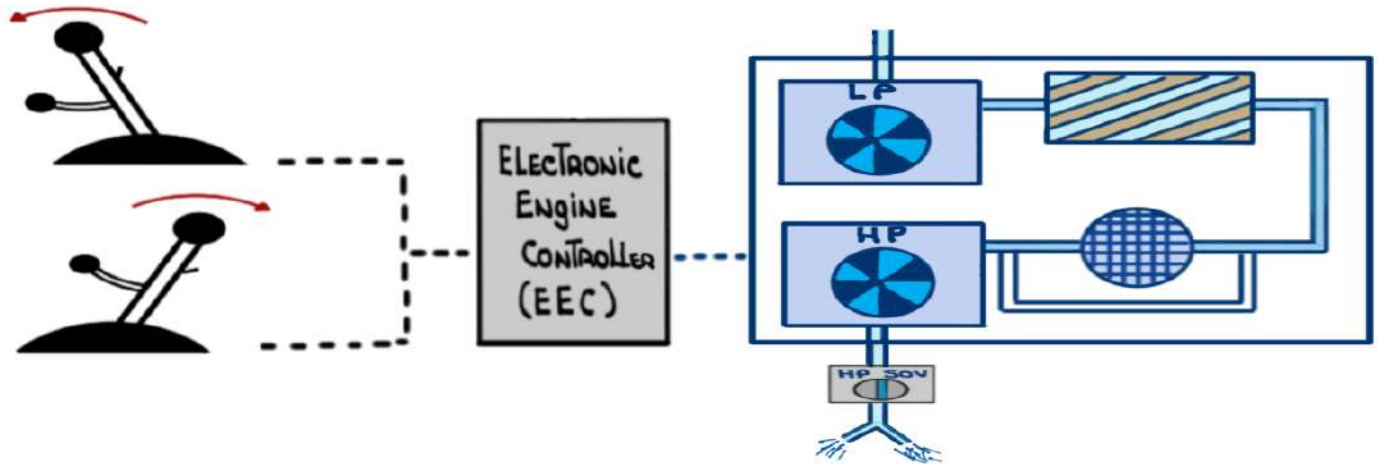
- INADVERTENT ENGINE SHUTDOWN *inflight*
- RETURN FUEL CONTROL TO RUN WITHIN **30** SECONDS

ENGINE FUEL SYSTEM

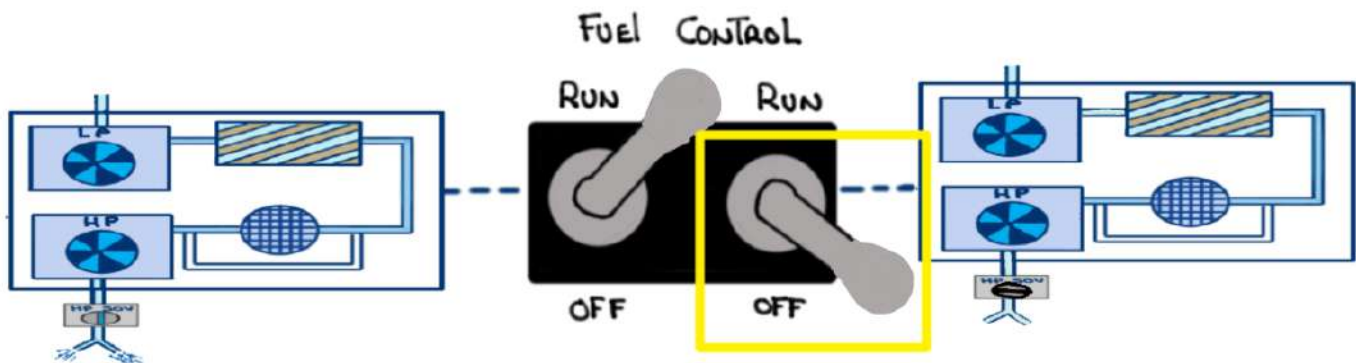
- METERED fuel from TANKS' boost pumps to NOZZLES
- INTRODUCTION of fuel is CONTROLLED by THE EEC
- LOW PRESSURE fuel coming from THE wings
- High PRESSURE fuel coming FROM THE FUEL METERING UNIT (FNU)



- AS THRUST LEVERS ARE ADVANCED OR RETRADED THE EEC COMMANDS THE FMU TO MODULATE FUEL TO NOZZLES

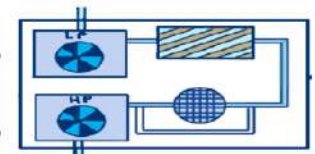


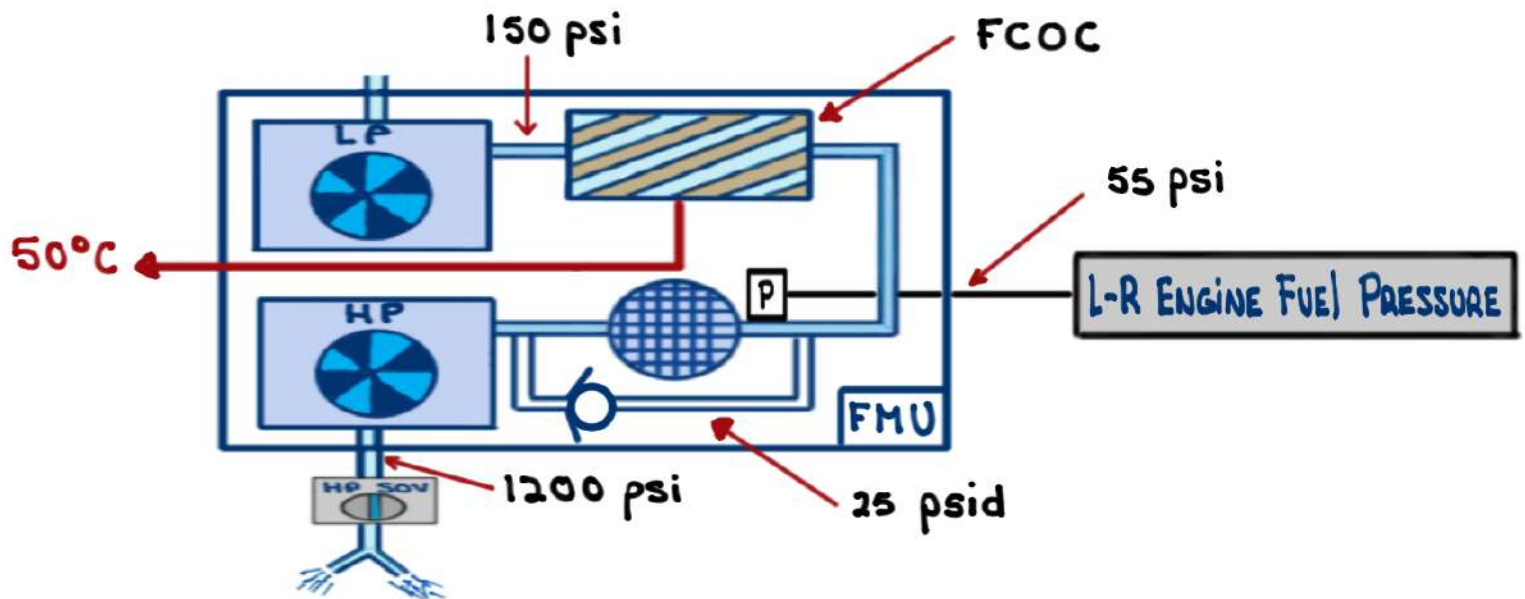
- PLACING A FUEL CONTROL SWITCH TO OFF CLOSSES FMU. ALL FUEL IS CUTOFF TO THE FUEL NOZZLES AND THE ENGINE SHUTS DOWN




- THE FMU CONTAINS TWO (2) INTERNAL PUMPS :

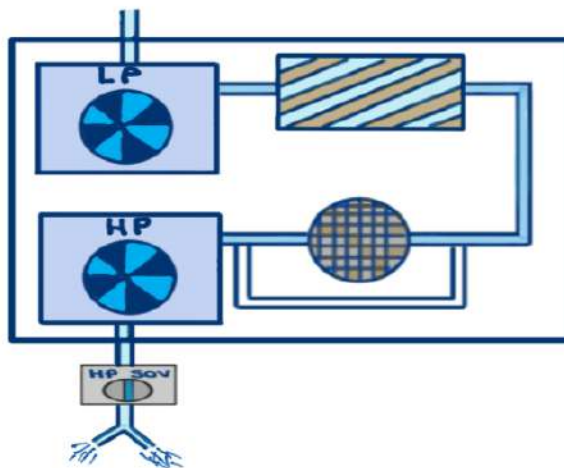
- LOW PRESSURE (LP) 1ST STAGE →
- HIGH PRESSURE (HP) 2ND STAGE →





- 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 

- IMPENDING blockage of indicated LP filter:



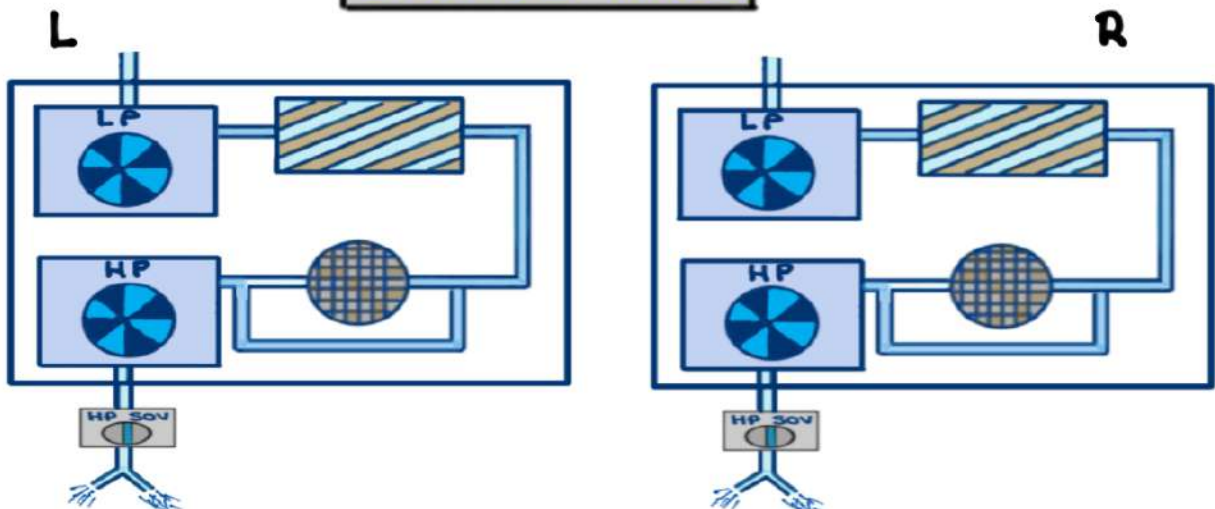
L FUEL FILTER

OR

R FUEL FILTER

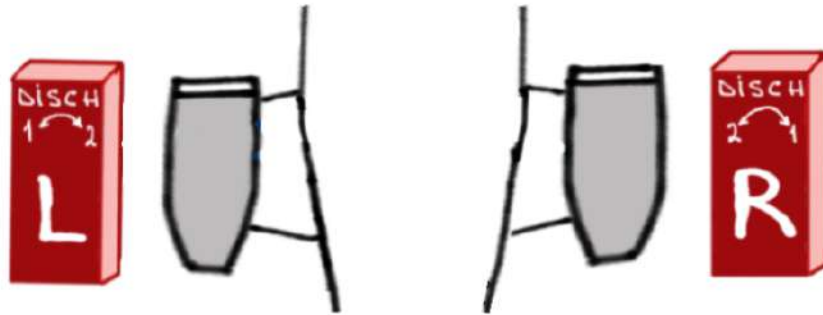
- FUEL BYPASSING indicated filter OR impending blockage / bypassing of both LP filters:

L-R FUEL FILTER

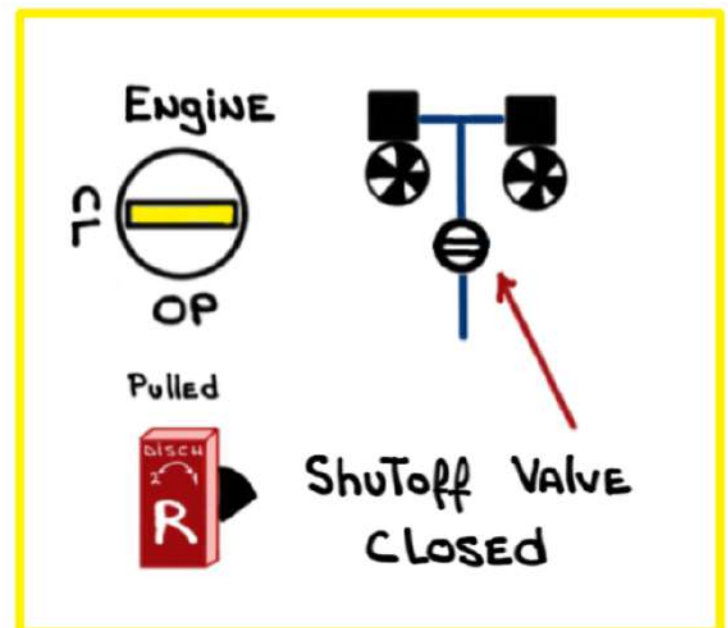
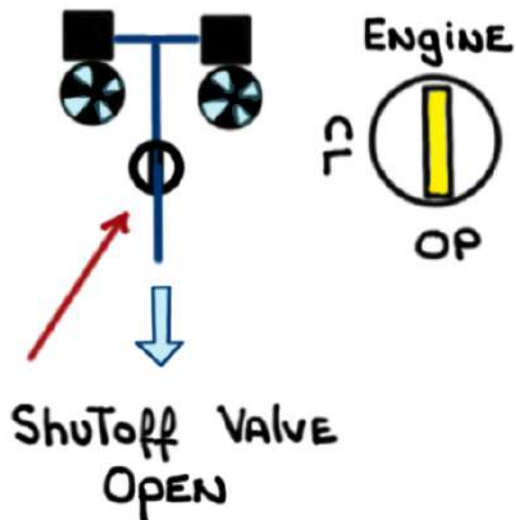
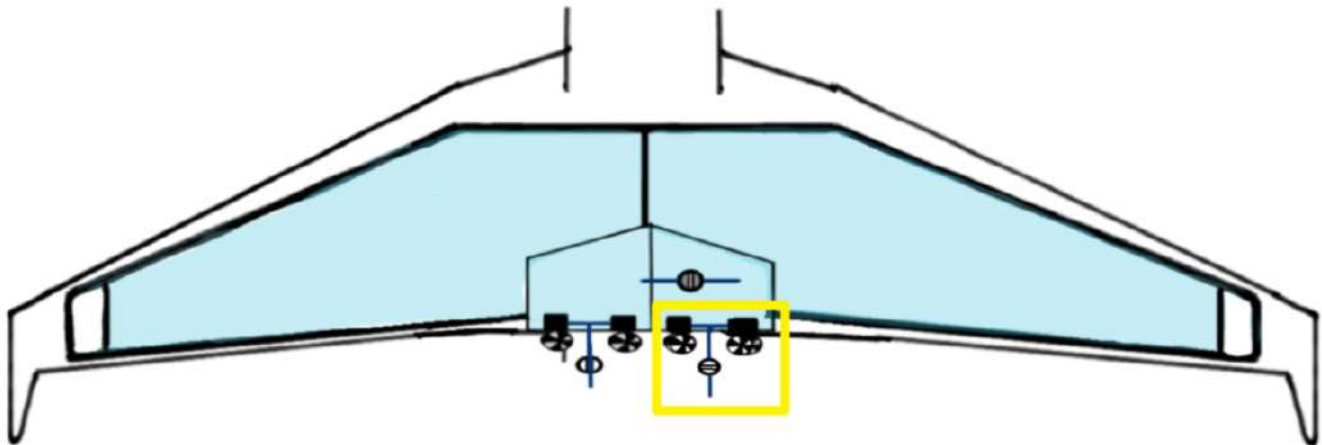


25 psi differential = filter bypasses

- Each ENGINE has its own **FiRE HANDLE**

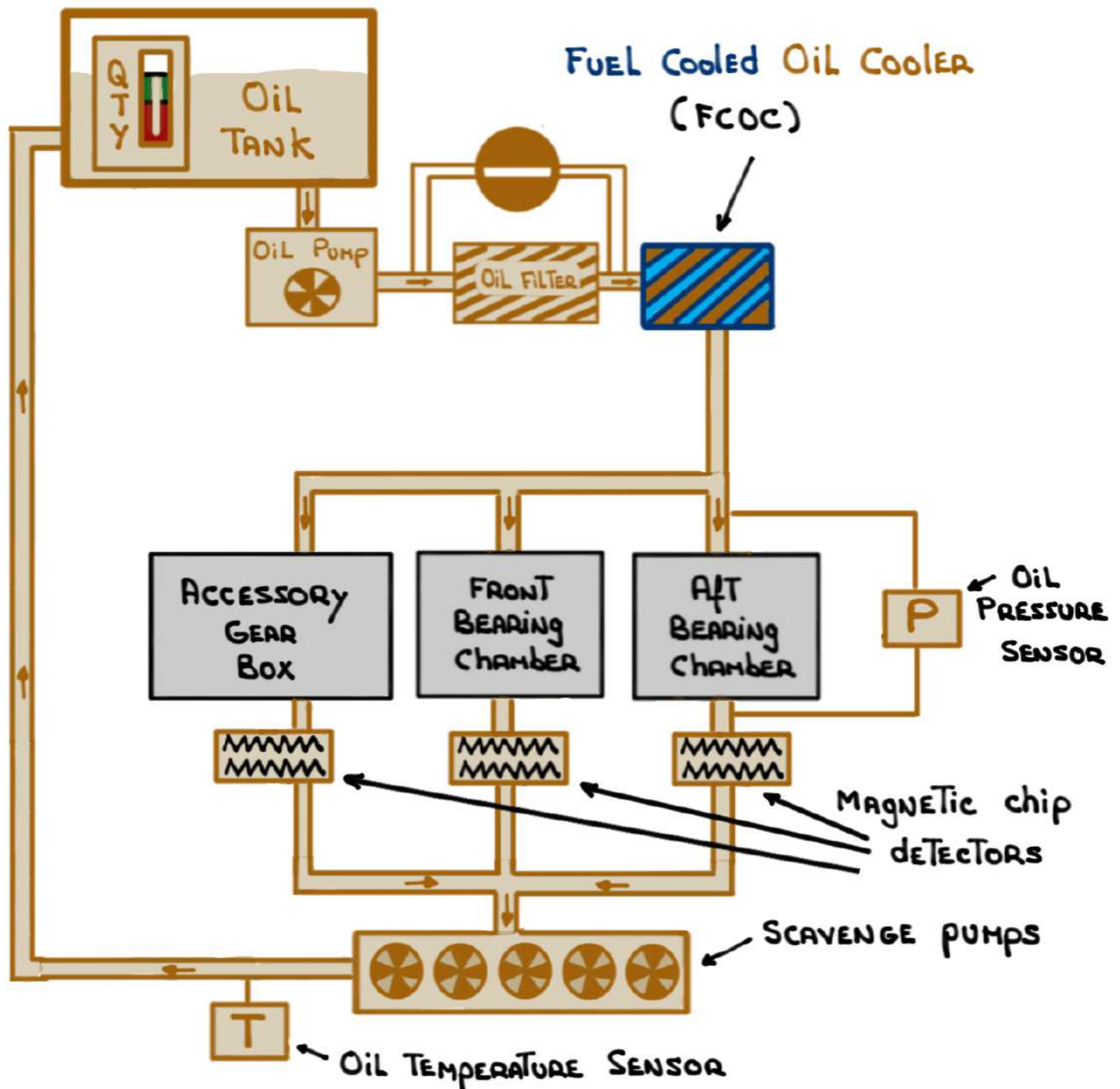


- Pulling a **FiRE HANDLE** shuts off fuel AT THE TANK

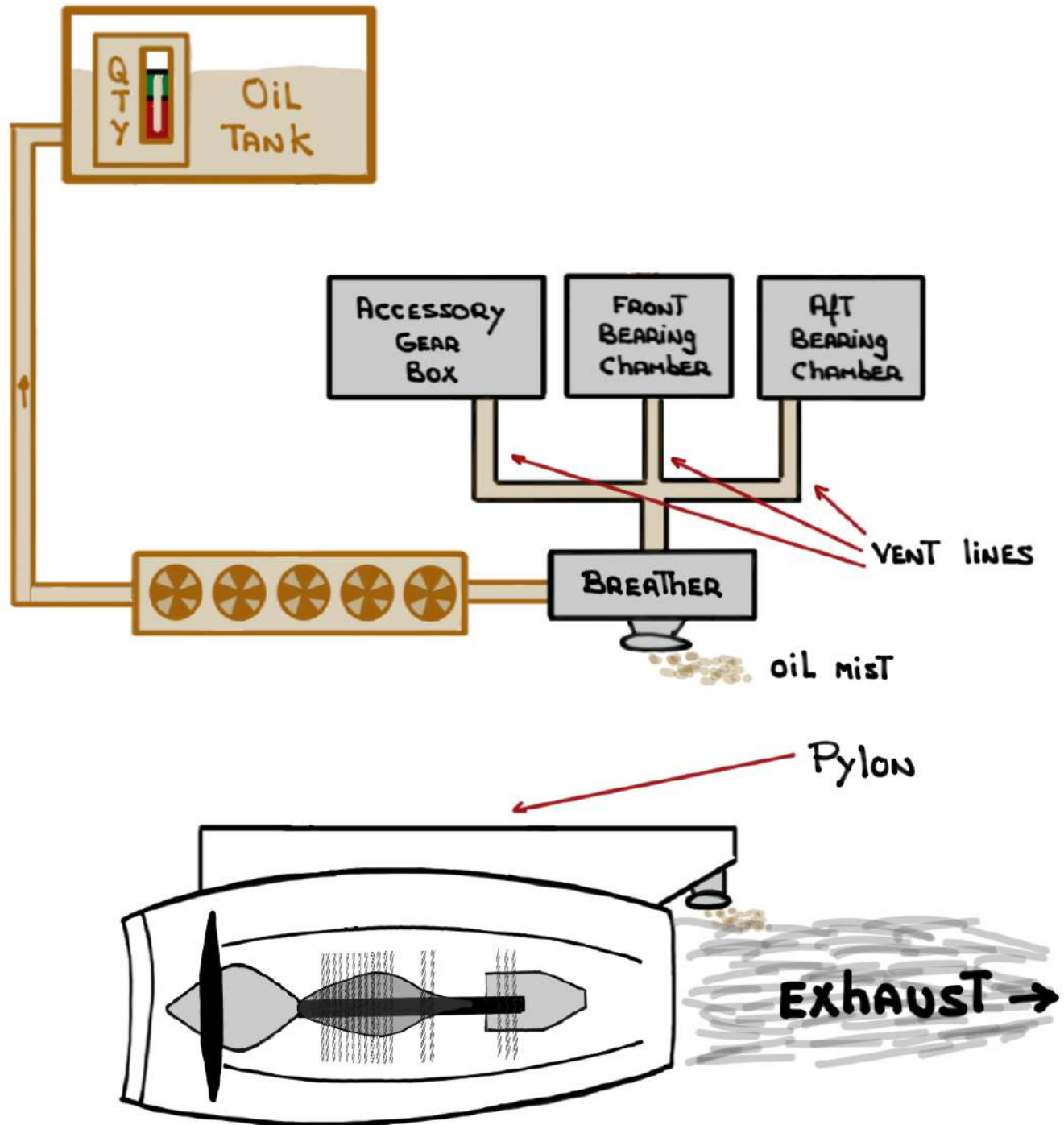


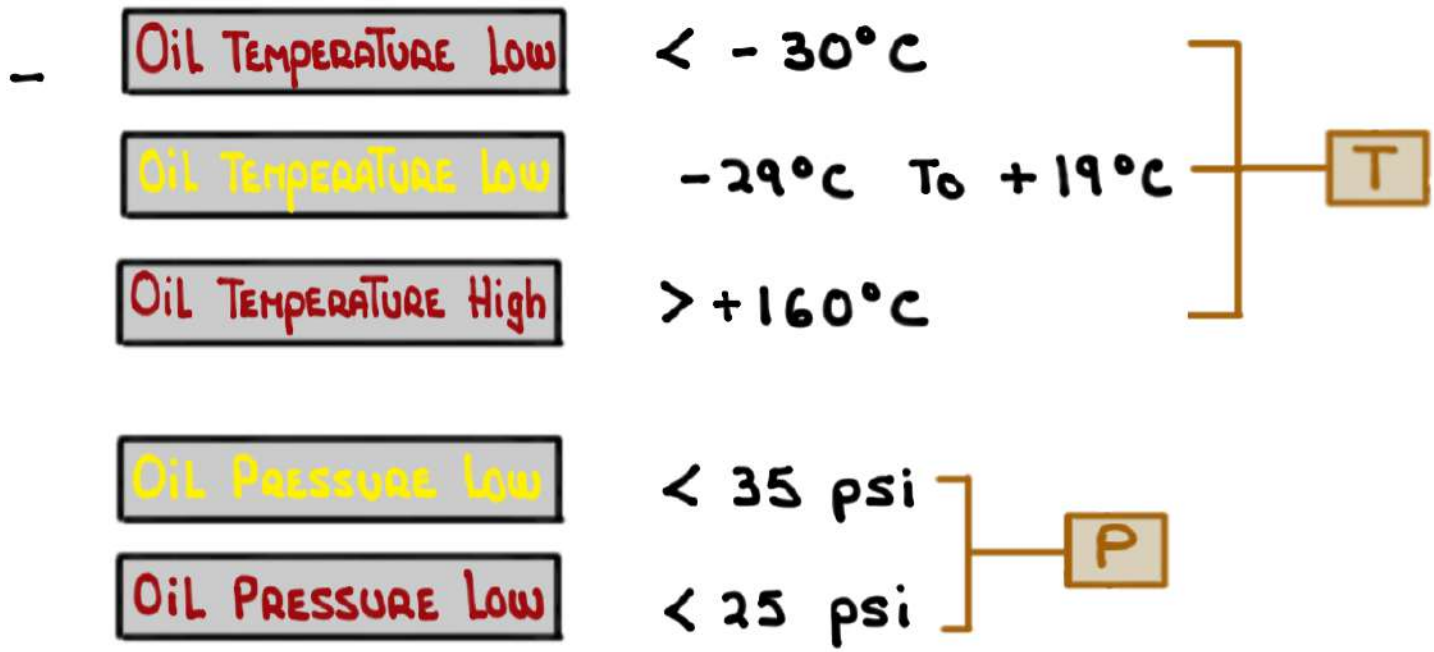
ENGINE OIL SYSTEM

- ENGINE oil Tank: 16.8 U.S QUARTS / 15.9 LITERS

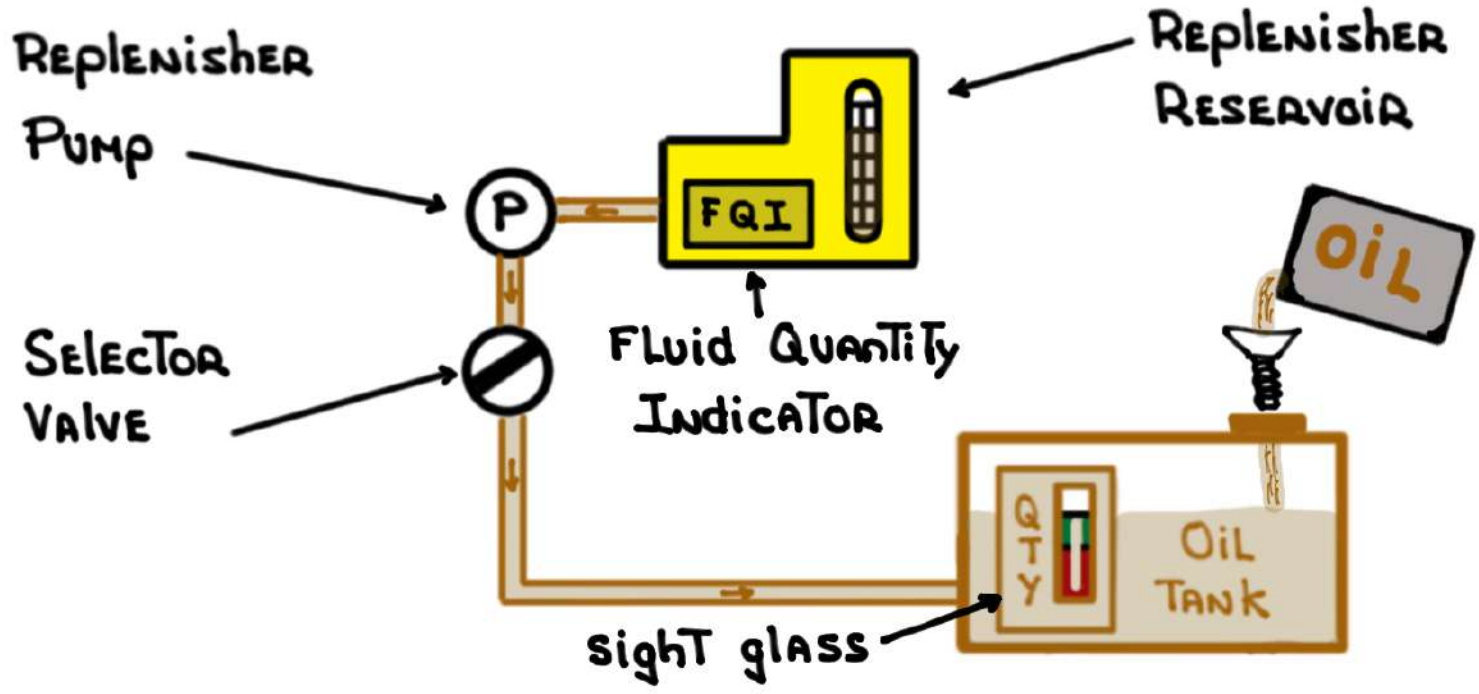


- The oil breather uses centrifugal circulation to remove oil mist from the vent lines and dump it overboard. Oil in the vent lines is collected by the scavenger pumps and returned to the oil tank.





- ENGINE OIL SERVICING
 - CONVENTIONAL GRAVITY
 - REMOTE REPLENISHMENT SYSTEM



ENGINE LIMITATIONS

ENGINE OIL TEMPERATURE

- 40°C START
- +20°C TAXI/TAKEOFF
- +160°C MAXIMUM

ENGINE FUEL TEMPERATURE

- 40°C
- +140°C (UNRESTRICTED)
- +165°C (15 MINUTES)

ENGINE START CYCLES

cycle / COOLING PERIOD

- 3 MINUTES / 15 SECONDS
- 3 MINUTES / 15 SECONDS
- 3 MINUTES / 15 MINUTES

ENGINE TGT TEMPERATURE LIMITS

- 150°C INTRODUCE FUEL
- 700°C START - GROUND
- 850°C START - Inflight
- 900°C TAKEOFF (5 MINUTES)
- 900°C OEI (10 MINUTES)
- 885°C MAX CONTINUOUS

ENGINE OIL LEVEL CHECK

5 MINUTES TO 24 HOURS FROM ENGINE SHUTDOWN

ENGINE LIMITATIONS - START

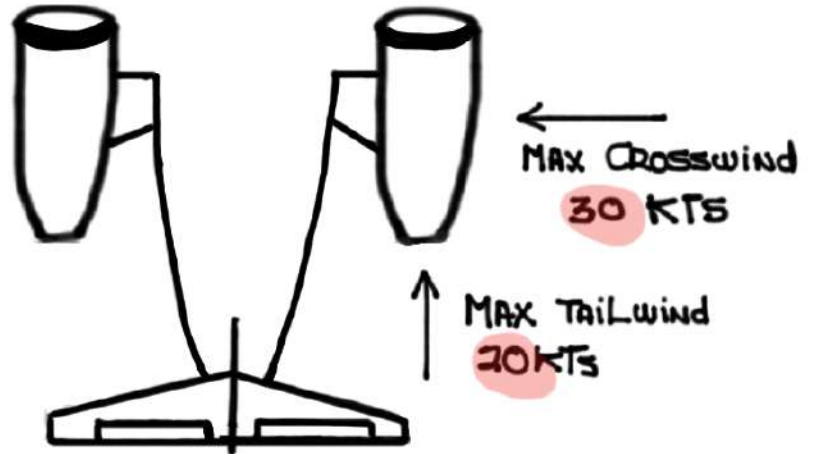
MINIMUM OIL TEMPERATURE -40°C

MINIMUM BLEED AIR 40 psi

MAXIMUM TGT < FUEL 150°C

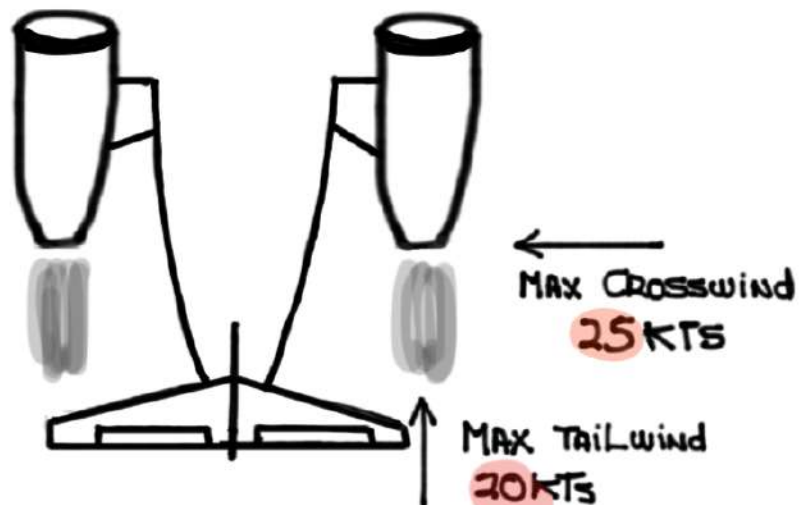
MAXIMUM TGT 700°C

ENGINE START cycles
 $3\text{ MINUTES} / 15\text{ SECONDS}$
 $3\text{ MINUTES} / 15\text{ SECONDS}$
 $3\text{ MINUTES} / 15\text{ MINUTES}$



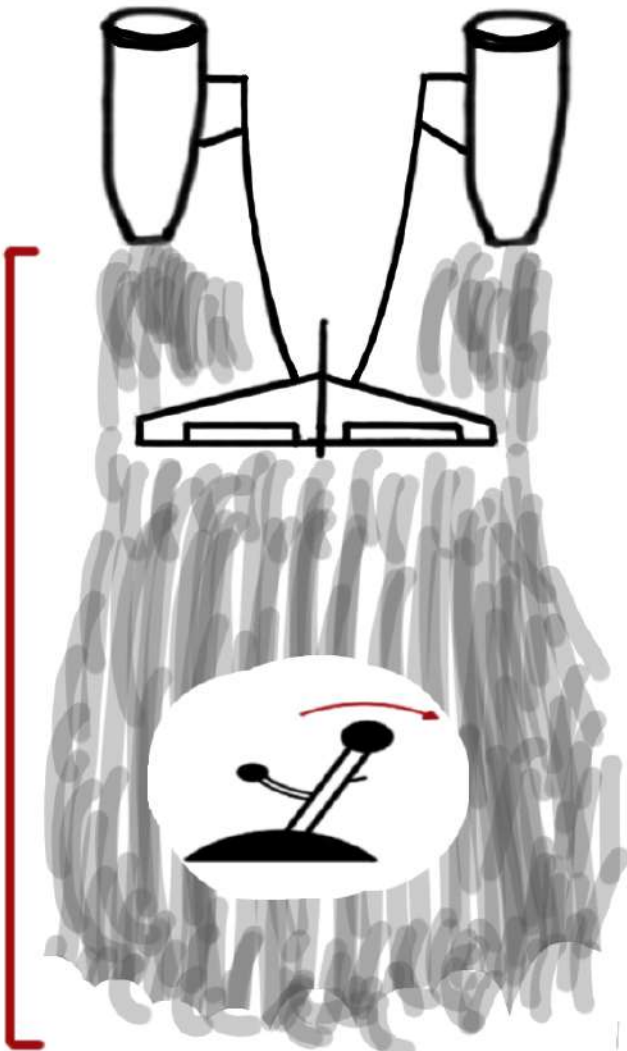
ENGINE LIMITATIONS - STATIC GROUND RUN

> idle RPM



EXHAUST DANGER AREA

Idle Thrust



275'

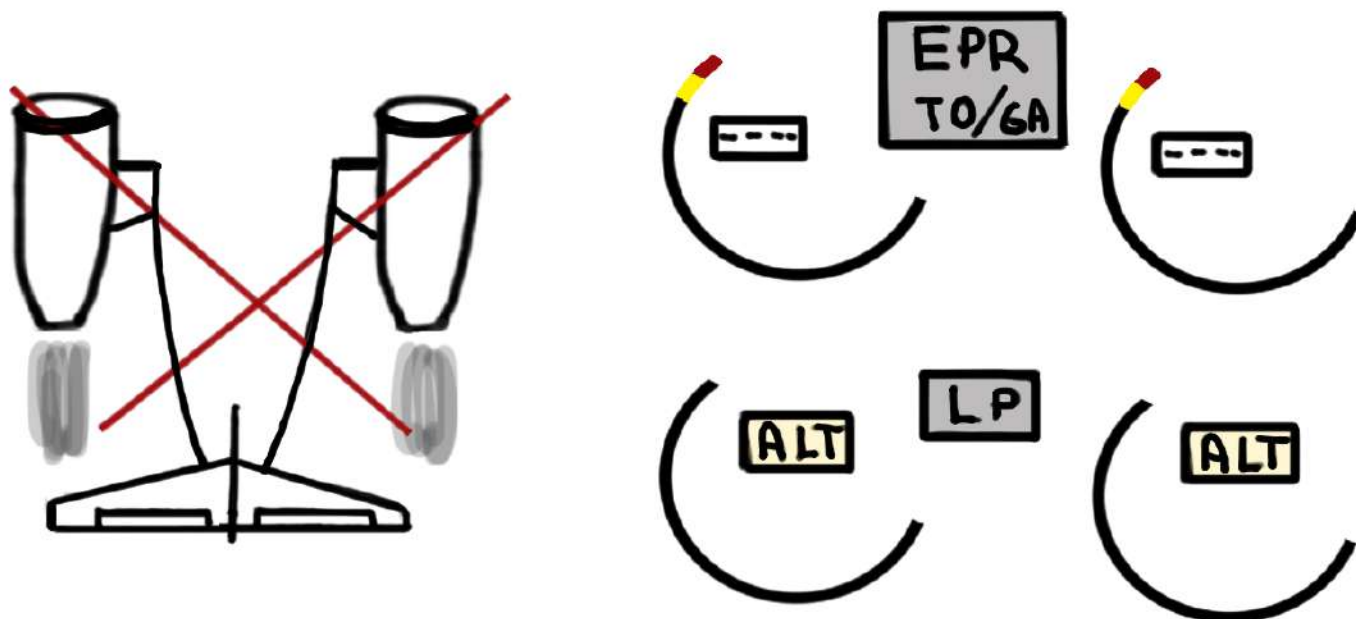
Takeoff Thrust



750'

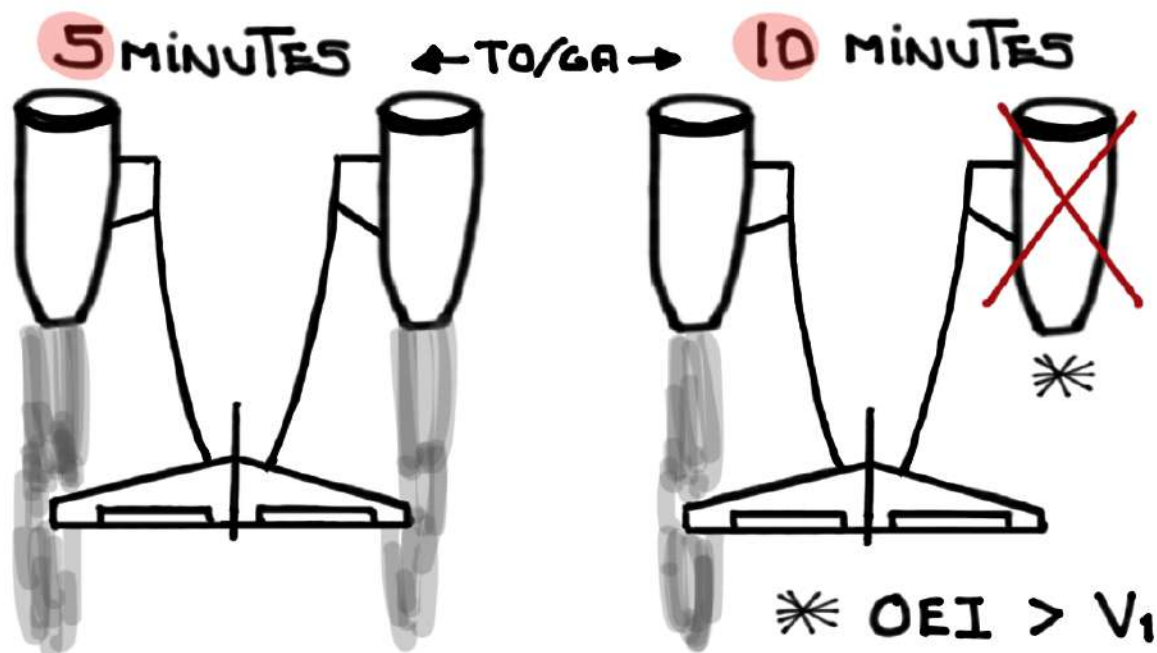
ENGINE LIMITATIONS - TAKEOFF

TAKEOFF IN **ALT** MODE (LP) IS PROHIBITED



MINIMUM OIL TEMPERATURE FOR TAKEOFF: +20°C

MAXIMUM TGT: 900°C



ENGINE LIMITATIONS - Inflight

MAXIMUM CONTINUOUS THRUST (MCT) **885**°C TGT

START ENVELOPE:

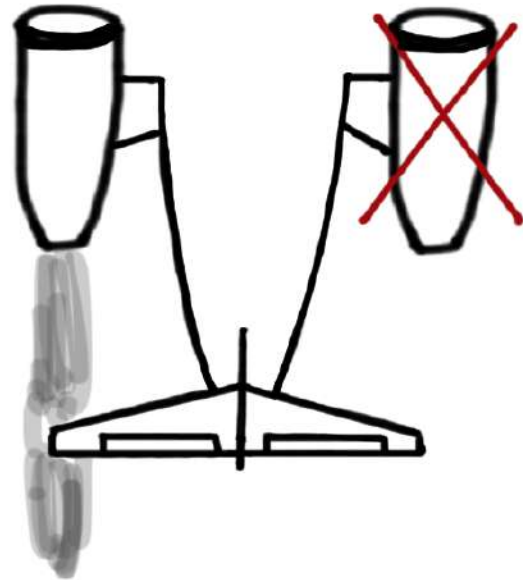
≤ **30,000'**

STARTER ASSIST windmilling

≤ **250** KCAS ≥ **251** KCAS

MAXIMUM TGT **850**°C

NOTE: NO FADEC PROTECTION

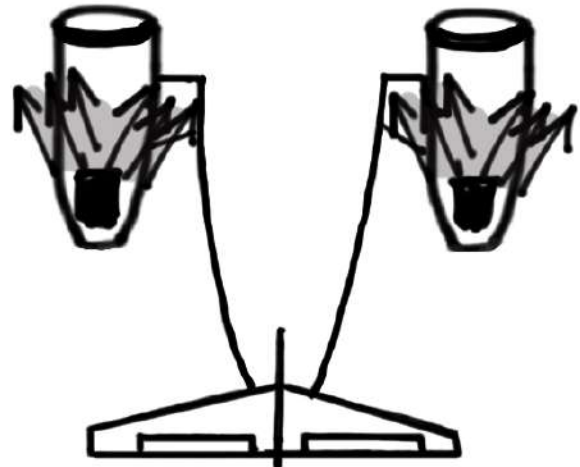


ENGINE LIMITATIONS - LANDING

THRUST REVERSERS

78.1% LP - **30** SECONDS

idle REVERSE by **60** KCAS

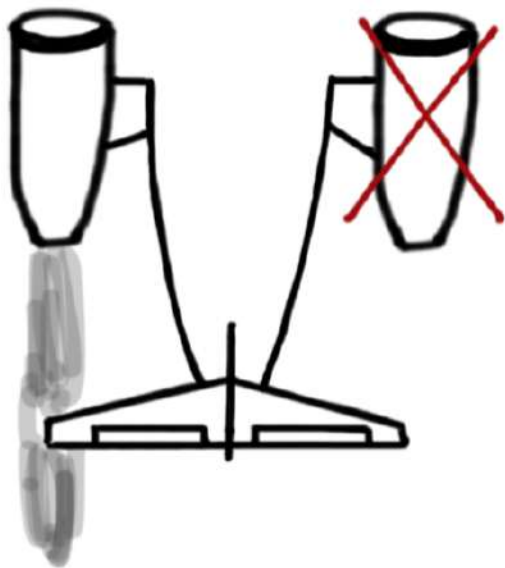


STATIC = **30**% LP MAXIMUM

ENGINE LIMITATIONS - TAXI IN / SHUTDOWN

NOTE: IT IS RECOMMENDED TO OPERATE ENGINES AT IDLE FOR THREE (3) MINUTES BEFORE SHUTDOWN

ENGINE FAILURE



DO NOT ATTEMPT RESTART:

- FIRE
- FOD
- FROZEN

RESTART - YES OR NO?

YES ? NORMAL AIRSTART ✓-list *

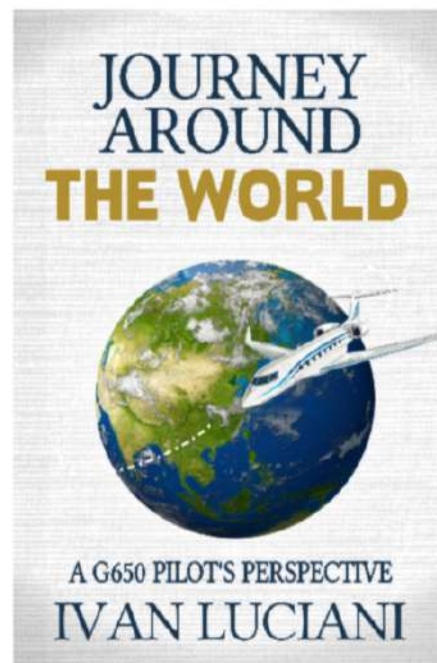
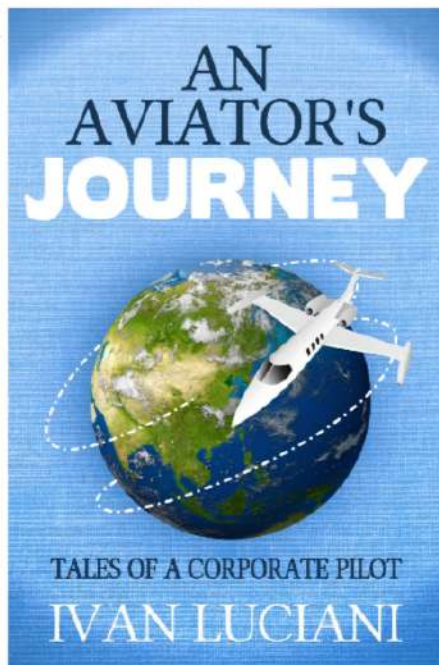
* NO FADEC PROTECTION DURING START

NO ? ENGINE SHUTDOWN IN FLIGHT ✓-list

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@code7700.com



Thank you!