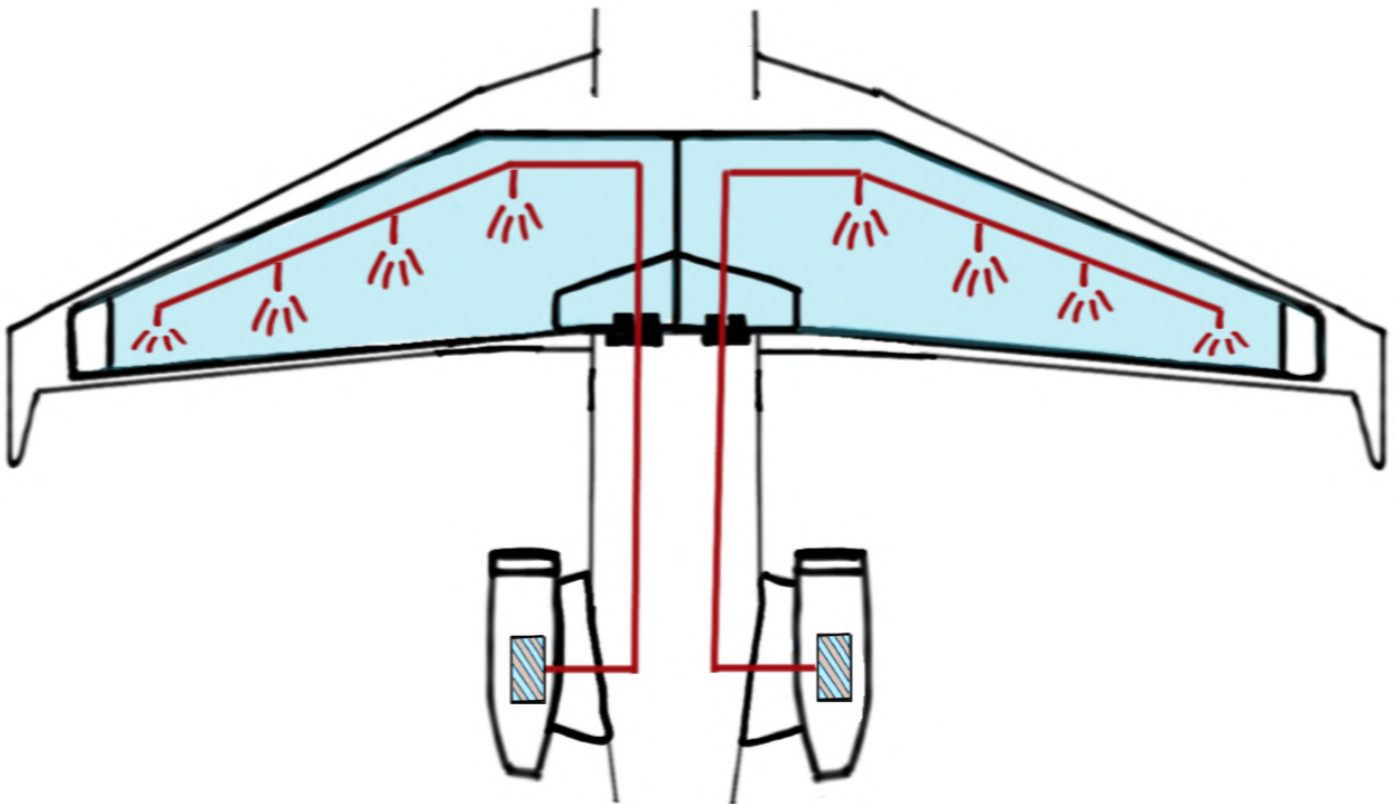
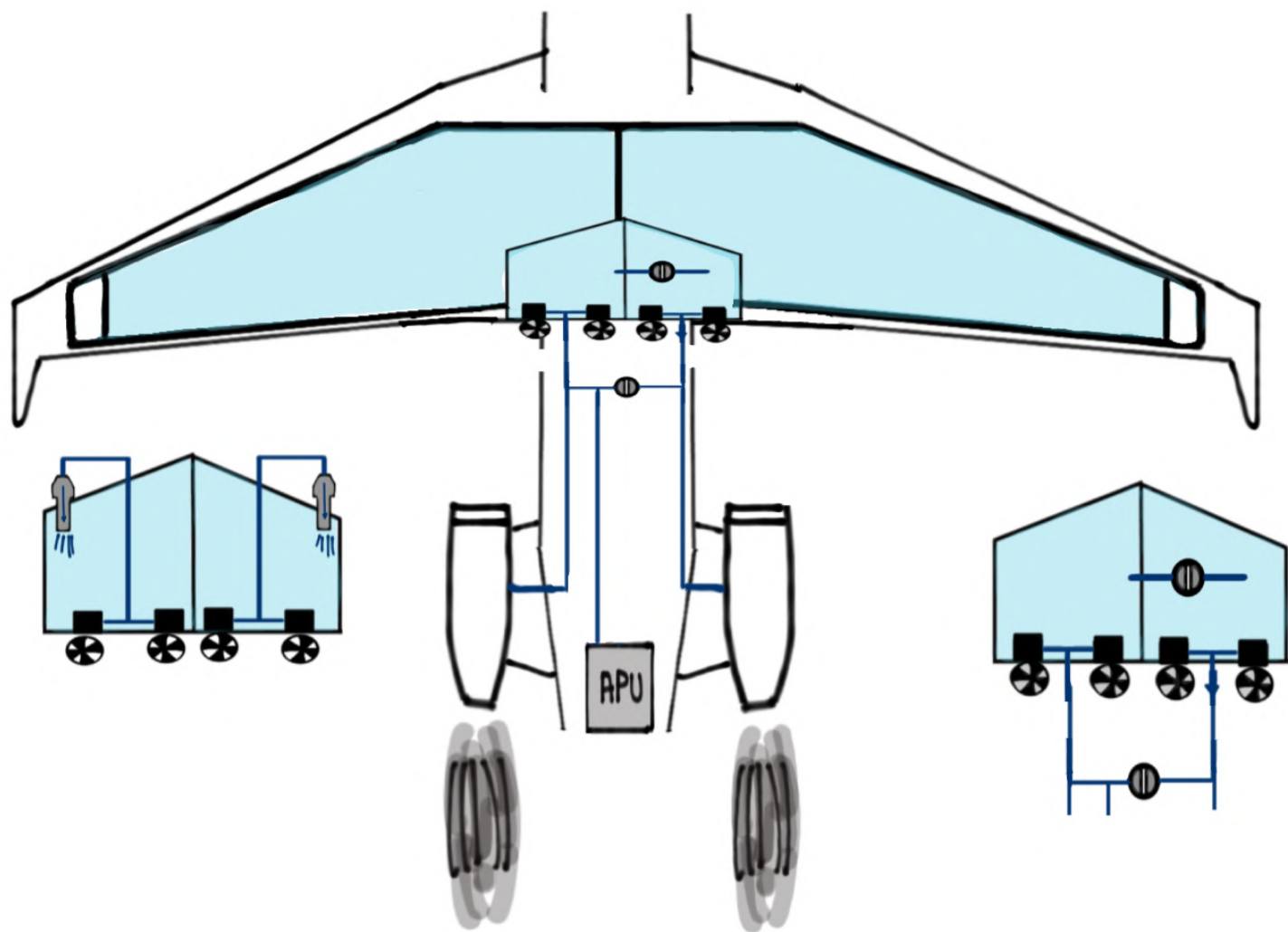


# G650 FUEL SYSTEM



For study purposes only

The FUEL SYSTEM consists of Two (2) wing TANKS which STORE all fuel and FEED the MAIN ENGINES AND APU via low pressure, electrically-driven boost pumps



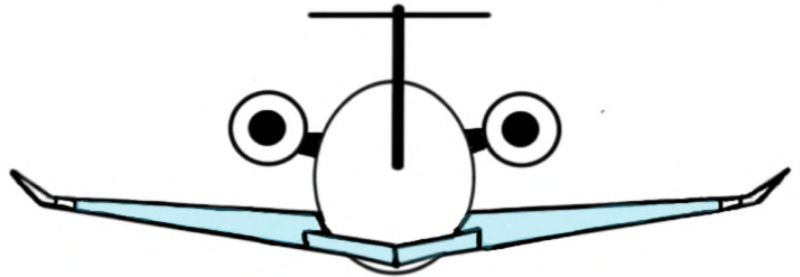
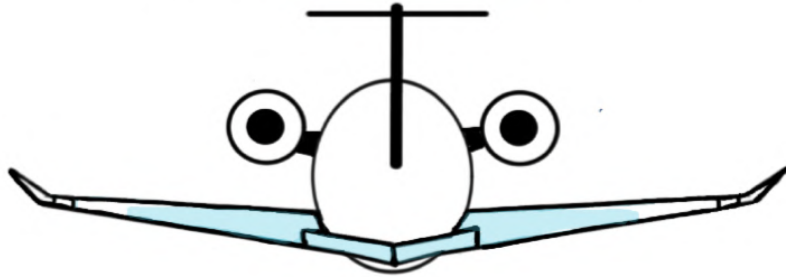
- The wing TANKS ARE PART OF THE INTERNAL wing STRUCTURE AND do NOT have bladders

# Wing TANKS

- TOTAL fuel capacity:

G650: 44,200 lbs

G650ER: 48,200 lbs



- IT MAY BE POSSIBLE TO upload fuel QUANTITIES IN EXCESS OF THE ABOVE. THIS IS PERMITTED AS LONG AS THE FOLLOWING LIMITATIONS ARE NOT EXCEEDED:

1) MAXIMUM RAMP WEIGHT:

G650: 100,000 lbs

G650ER: 104,000 lbs

2) MAXIMUM TAKEOFF WEIGHT (MTOW):

G650: 99,600 lbs

G650ER: 103,600 lbs

3) LOADED AIRCRAFT IS WITHIN C.G. LIMIT

\* TANK QUANTITY AND TOTAL QUANTITY INDICATIONS MAY SHOW DASHES. MCDU AND SMC WILL INDICATE ACTUAL FUEL LEVELS

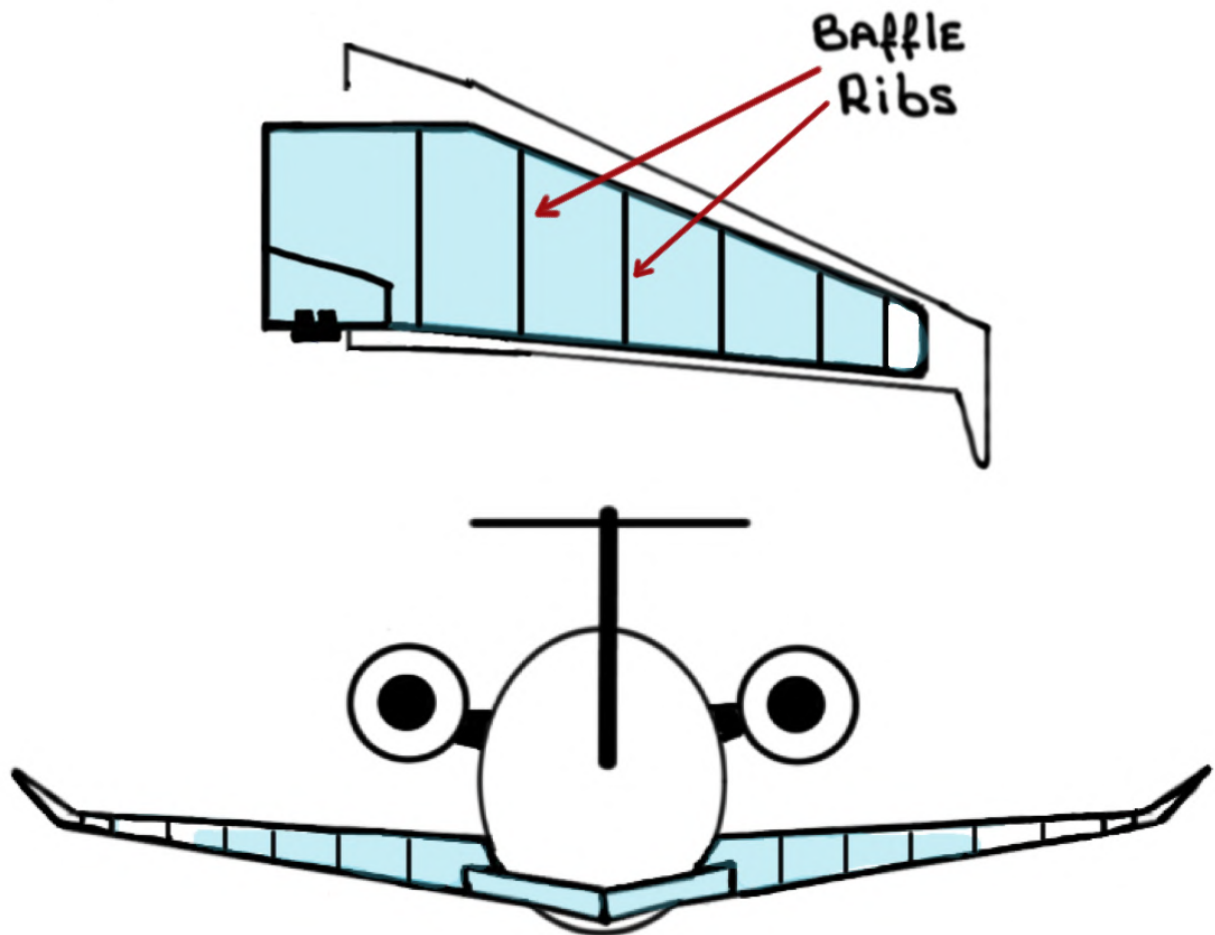
- Refueling:

① Single-point pressure refueling (35-55 PSI)

② Overwing gravity refueling - MAXIMUM capacity:

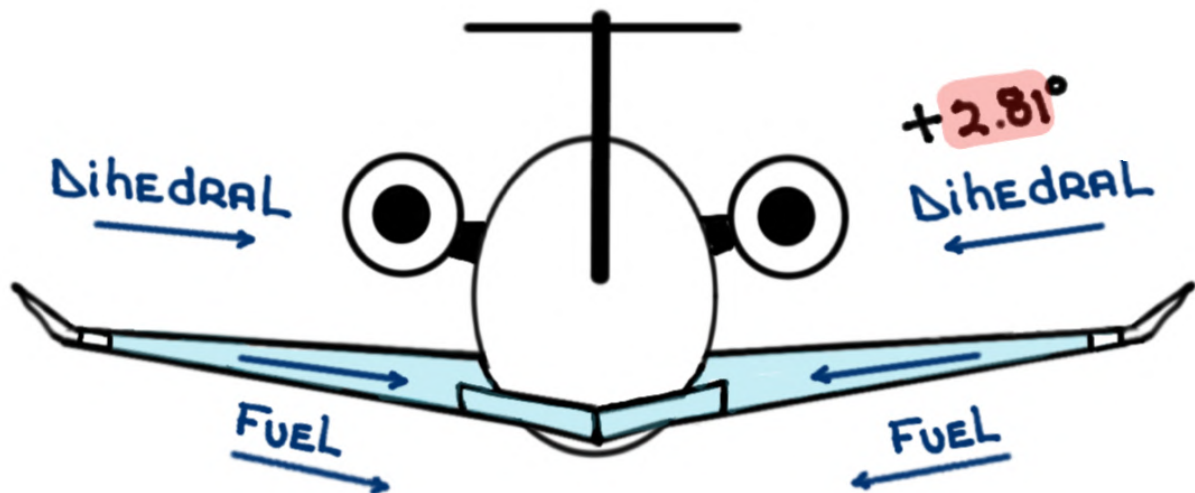
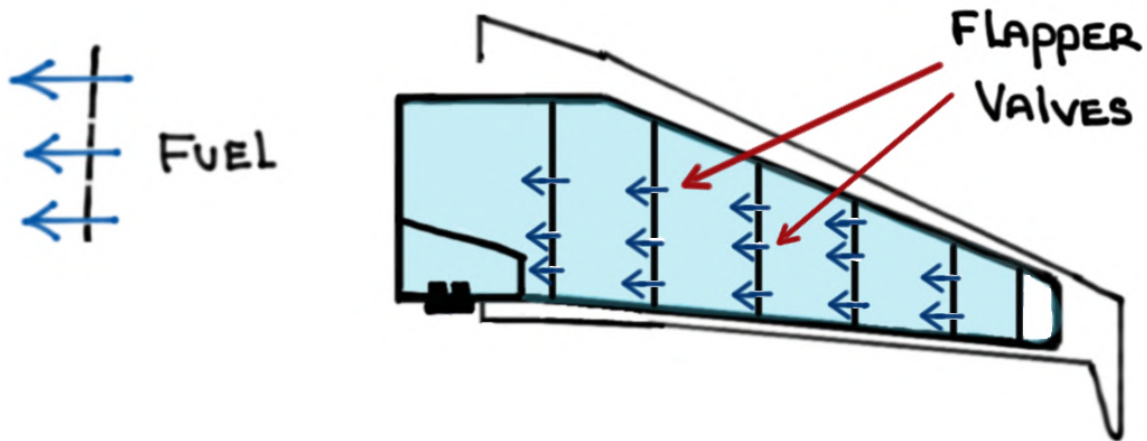
43,650 lbs

- Rapid changes in C.G. due to slushing ARE AVOIDED THROUGH THE USE OF baffle ribs WITHIN THE TANKS. This design CREATES MULTIPLE COMPARTMENTS OR bays WITHIN THE wing TANKS



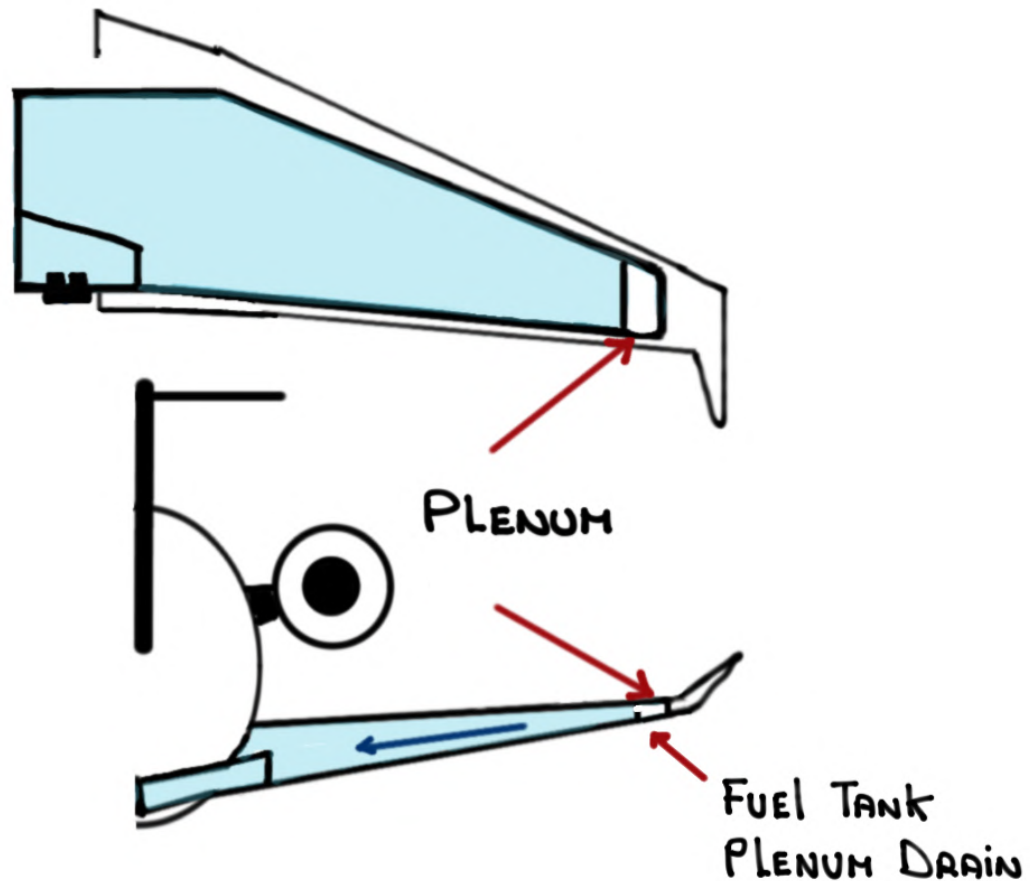


- FLAPPER VALVES AT THE BOTTOM OF EACH BAFFLE RIB ALLOW FUEL TO TRAVEL IN ONE DIRECTION FROM COMPARTMENT TO COMPARTMENT AND TOWARDS THE FUEL HOPPERS



- ANY FUEL BELOW THE FLAPPER VALVES MOVES TOWARDS THE FUEL HOPPERS THROUGH SMALL ORIFICES CALLED WEEP HOLES

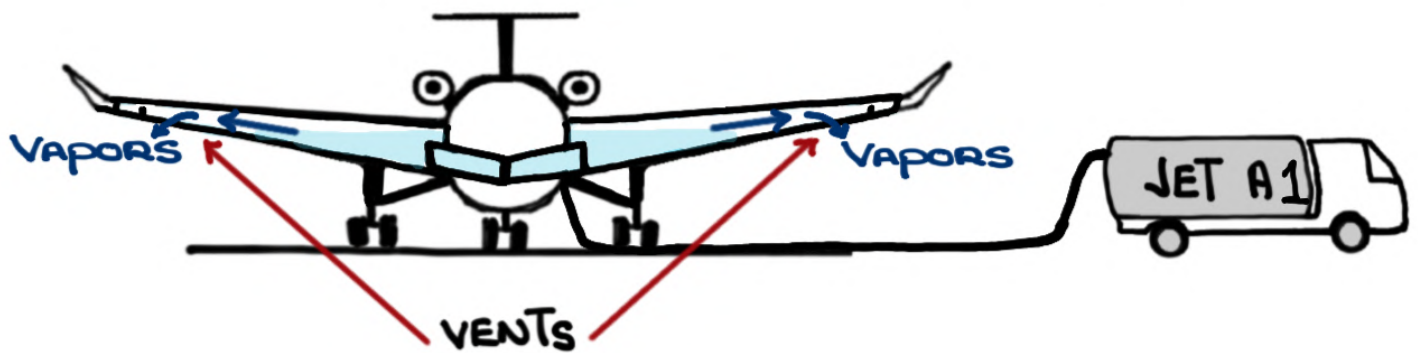
- The PLENUM, also known as the vent tank, catches fuel vent system during transient maneuvers. This fuel is then drawn back into the fuel tanks when stable flight is resumed
- The PLENUM also allows for a two (2) percent fuel expansion



- The PLENUM should be DRAINED of any fuel prior to Takeoff

- The fuel TANKS ARE VENTED (NACA VENTS) TO provide POSITIVE INTERNAL PRESSURE AND TO PROTECT AGAINST OVER AND UNDER PRESSURIZATION
- The fuel VENT SYSTEM IS FULLY AUTOMATIC AND DOES NOT REQUIRE ELECTRICAL POWER
- The fuel VENT SYSTEM ALLOWS VAPORS AND AIR TO ESCAPE AS FUEL GOES INSIDE THE TANKS DURING REFUELING

PREVENTS wing RUPTURE (POSITIVE PRESSURE)

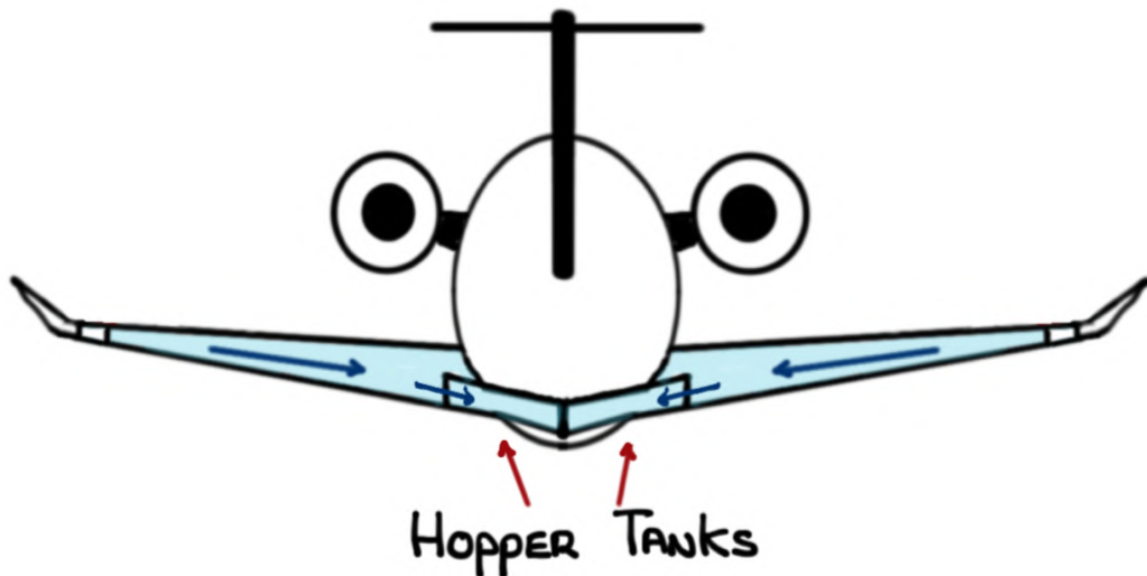
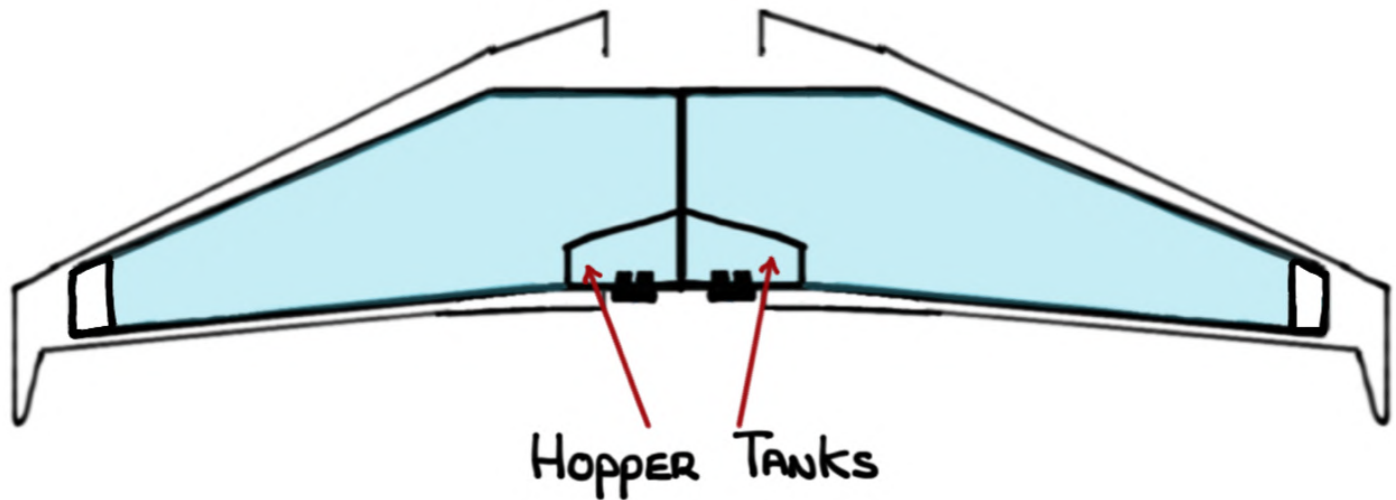


- The fuel VENT SYSTEM ALLOWS AIR TO ENTER THE FUEL TANKS AS FUEL IS CONSUMED DURING FLIGHT



PREVENTS wing COLLAPSE (NEGATIVE PRESSURE)

- The Hopper Tanks ARE SEGREGATED TANKS within The wing Tanks
- They ARE located ADJECENT TO THE CENTERLINE rib AT THE LOWEST point within The wing TANK



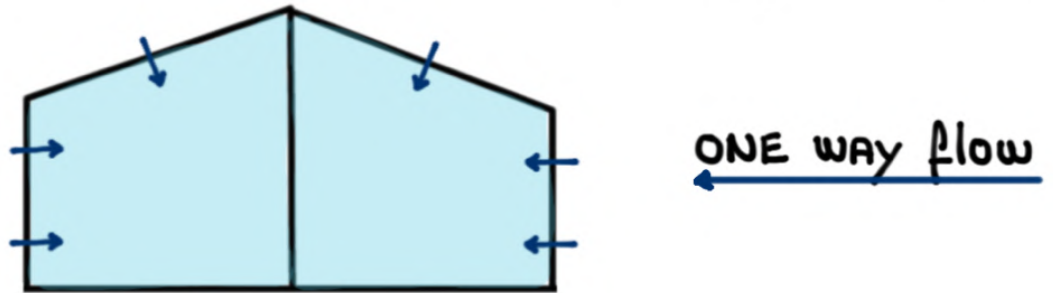
- IT IS FROM THE Hopper Tanks THAT fuel IS DRAWN TO FEED THE ENGINES AND APU



- The Hopper Tanks ARE KEPT full via:

① FLAPPER-Type VALVES (GRAVITY)

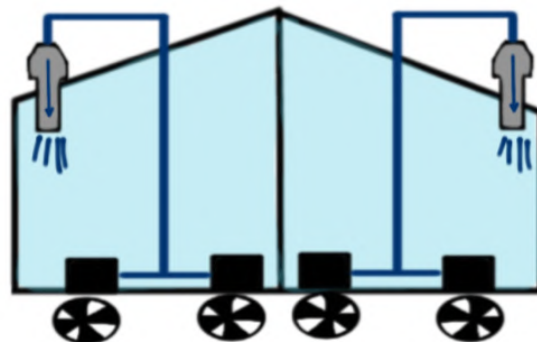
- THREE (3) flapper valves PER Hopper
- Allow GRAVITY flow of fuel FROM wing TO Hopper



② EJECTOR pumps, which DON'T HAVE MOVING PARTS.

They USE MOTIVE flow FROM FUEL boost pump PRESSURE TO DRAW FUEL FROM THE wing TANKS INTO Hopper Tanks

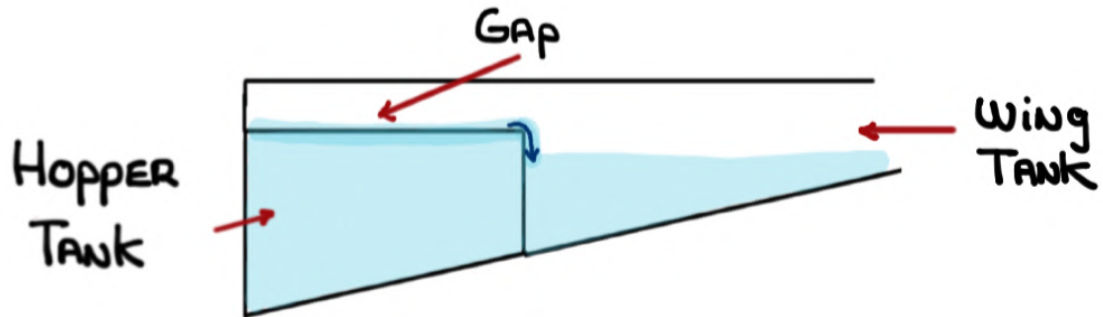
- DELIVER STEADY flow of fuel FROM wing TO Hopper
- Low PRESSURE, high volume pumps
- 4,450 pounds per hour



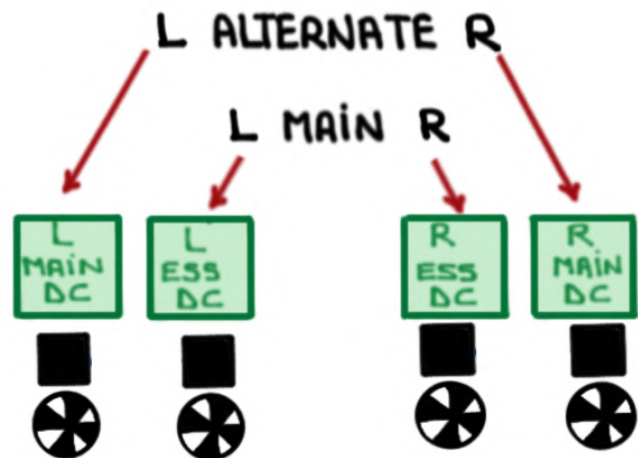
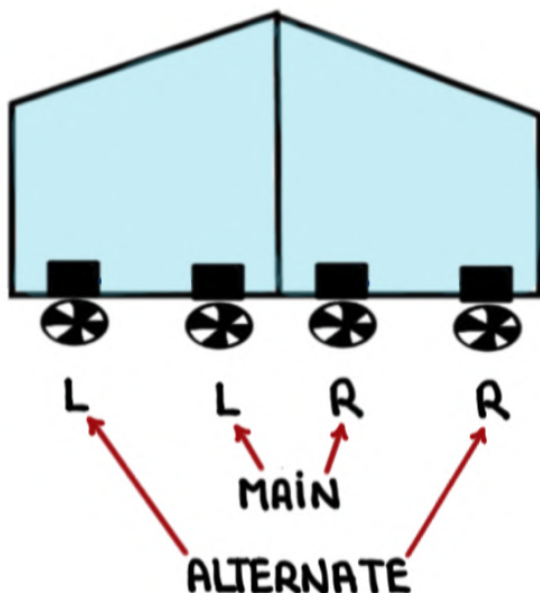
- The Hopper Tanks have a fuel capacity of:

199 gallons / 1,333 Lbs

- EXCESS fuel in The Hoppers can spill back into The wing Tanks via a gap above The Hopper walls



- The Hopper Tanks contain the electrically-driven boost pumps which deliver low pressure (25 psi) fuel to the engines and APU



- Two (2) boost pumps per Hopper
- Boost pumps ARE IDENTICAL AND INTERCHANGEABLE
- LOCATED IN THE WHEEL WELL AND ATTACHED TO THE AFT PORTION OF THE HOPPER

- Two (2) MAIN powered by RESPECTIVE



- Two (2) ALTERNATE powered by RESPECTIVE



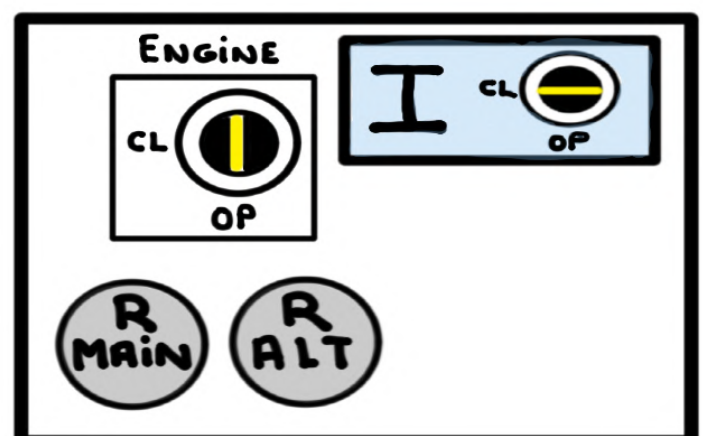
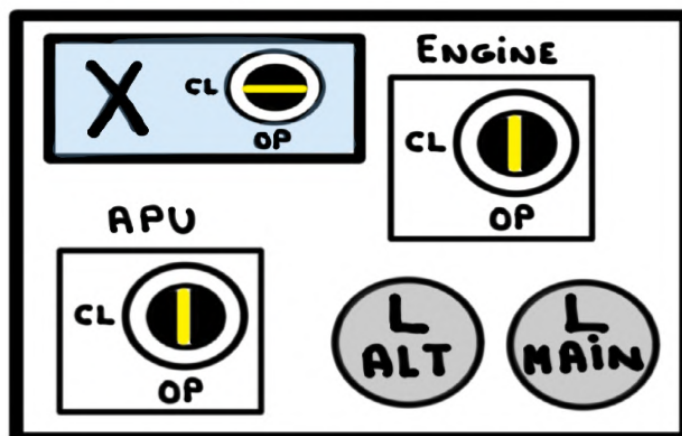
- WITHOUT Boost pump PRESSURE The ENGINES will:

① < 20,000' = SUCTION FEED

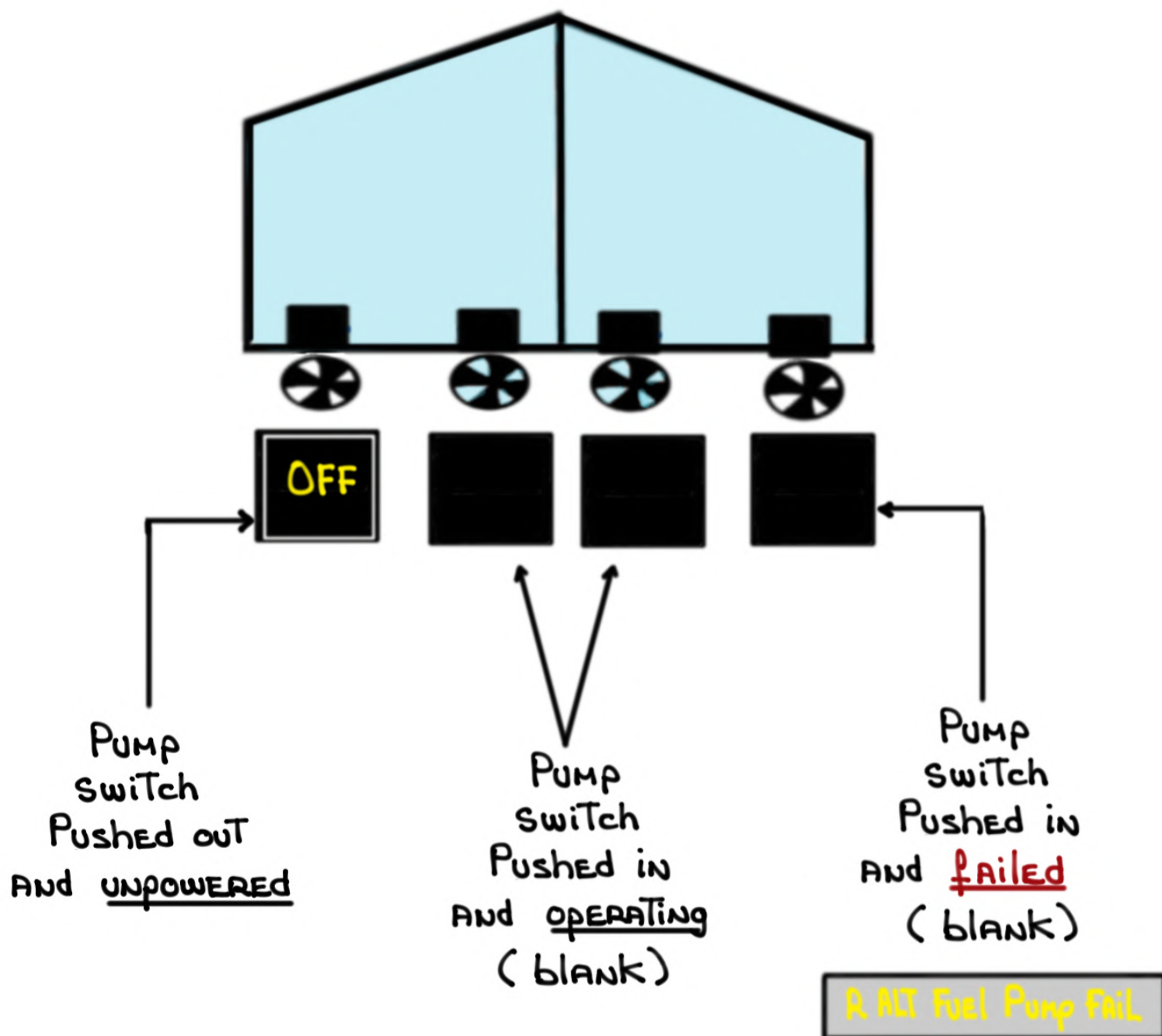
② ≥ 20,000' = RUN ERRATICALLY AND FLAMEOUT

- Each boost pump draws < 25 amps
- All operable boost pumps MUST BE SELECTED ON for all PHASES of flight UNLESS fuel balancing is in PROGRESS OR AS DIRECTED by THE CHECKLIST

- REAR wing BEAM

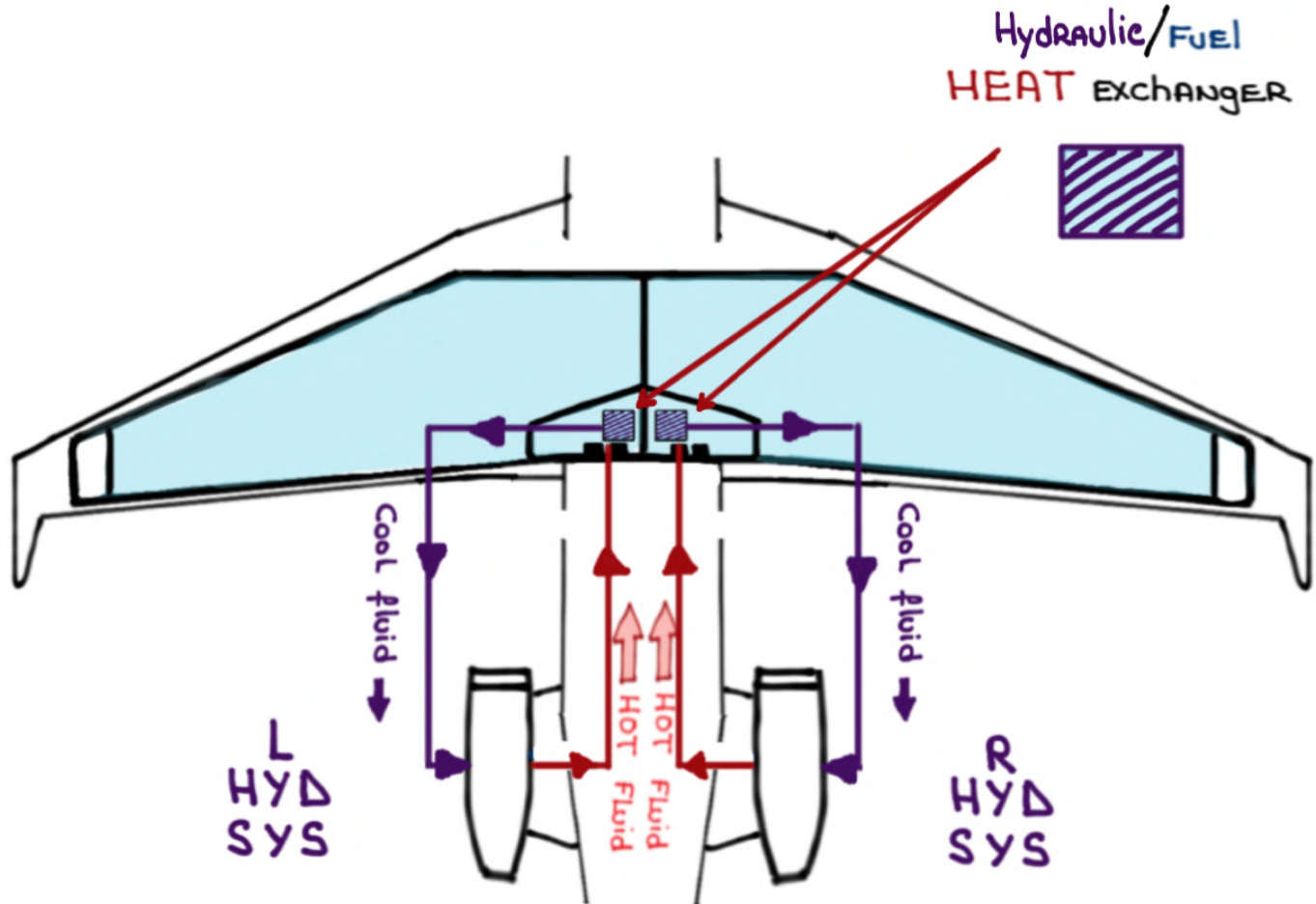


## - Boost pump switch (indications)





- The Hopper Tanks CONTAIN The **Hydraulic fluid-To-FUEL** HEAT EXCHANGERS



The HEAT EXCHANGER unit is inside the ONSIDE fuel Hopper. **HOT** hydraulic fluid flows CONTINUOUSLY Through The HEAT EXCHANGER without pilot input

**HOT** Hydraulic fluid is cooled while **COLD** fuel in The Hopper is warmed up

# FUEL ShutOff VALVES

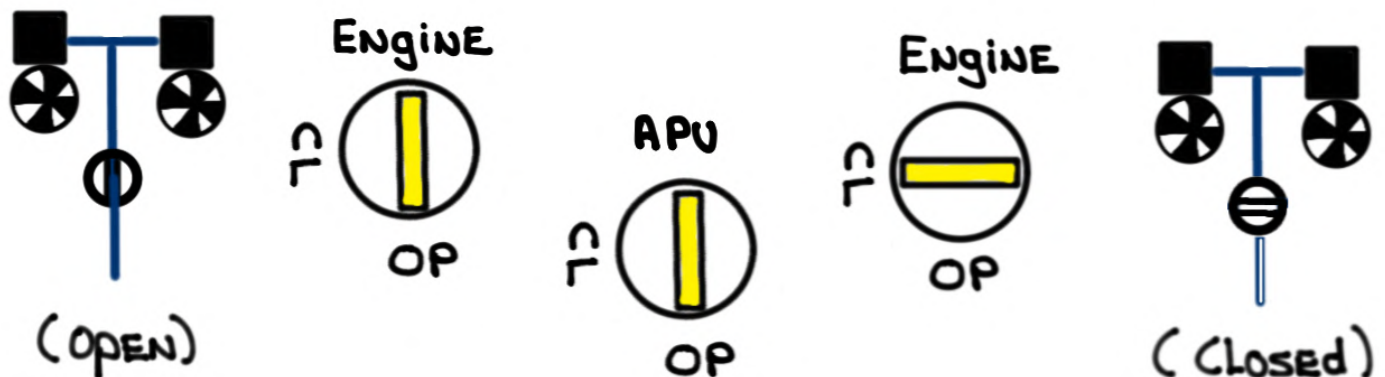
- THERE ARE THREE (3) fuel shutOff valves (SOV)

- ① LEFT ENGINE
- ② Right ENGINE
- ③ APU

- LOCATED IN THE WHEEL WELL AND ATTACHED TO THE AFT PORTION OF THE HOPPER
- MAIN ENGINE SOV IS OPERATED BY THE RESPECTIVE **FIRE** HANDLE IN THE COCKPIT AND POWERED BY ITS RESPECTIVE DC ESS bus

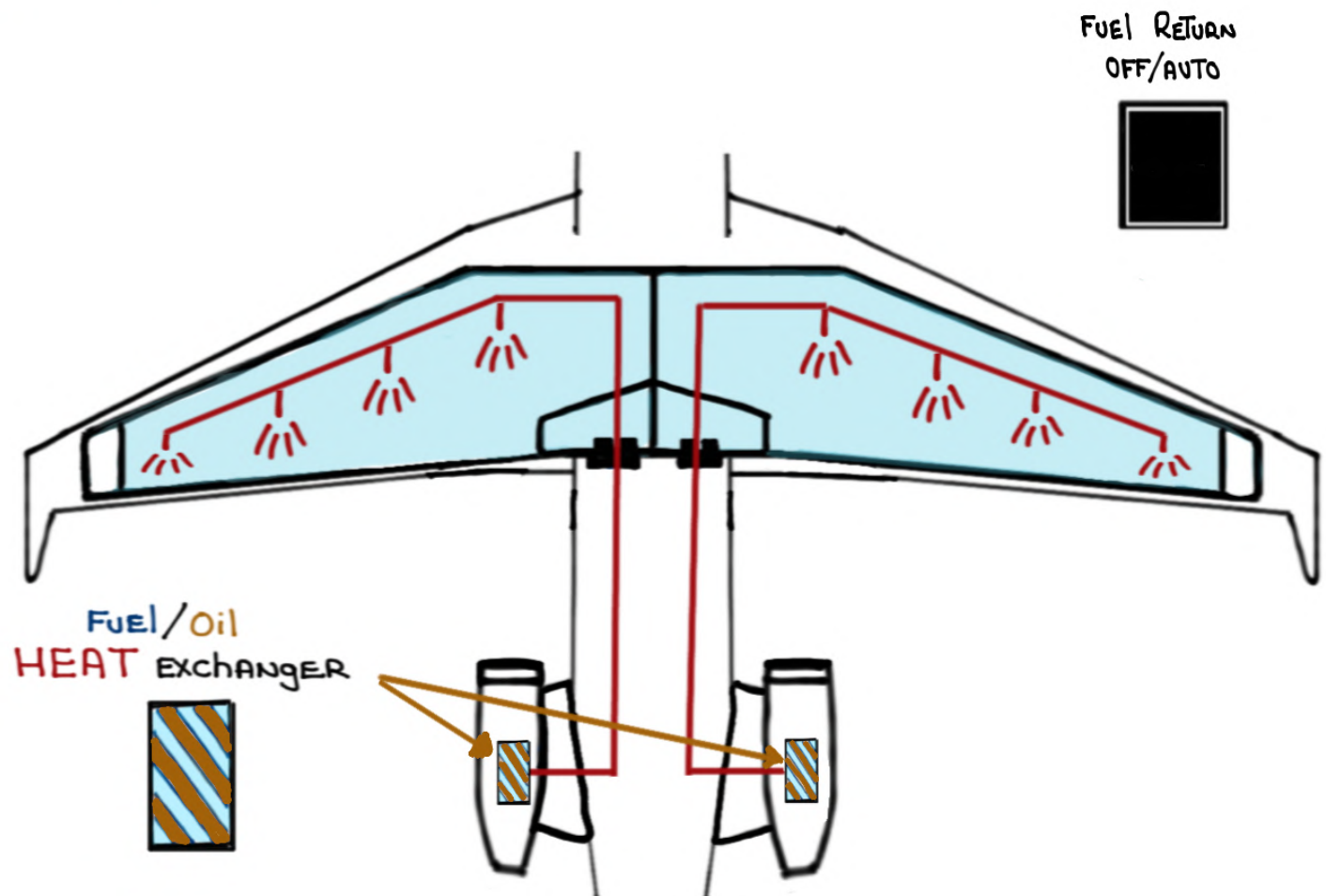


- SOV position indicator - wheel well



# HEATED FUEL RETURN SYSTEM (HFERS)

- The HFERS PREVENTS FUEL TANK TEMPERATURES FROM GETTING TOO COLD DURING LONG RANGE, HIGH ALTITUDE FLIGHTS
- The HFERS SENDS FUEL HEATED BY THE FUEL/OIL HEAT EXCHANGER (FOHE) INTO THE WING TANKS
- The FOHE COOLS DOWN HOT ENGINE OIL AND WARMS UP COLD FUEL



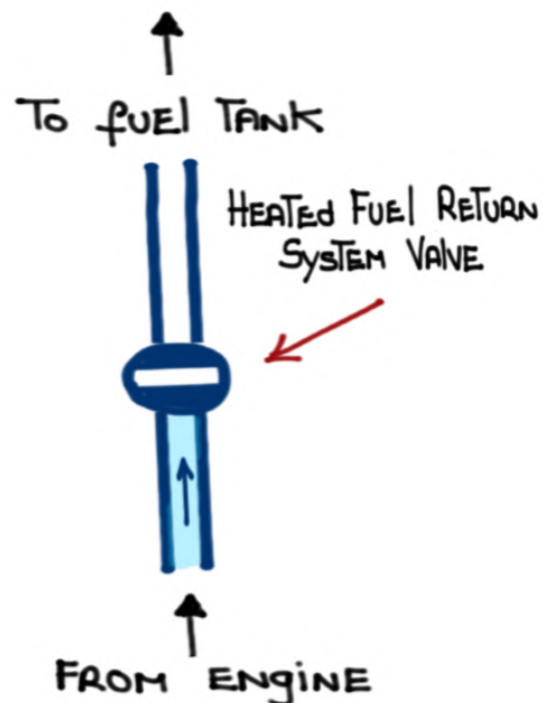


- Controlled by FADEC
- AUTO ON: 0°C    AUTO OFF: 10°C
- THREE (3) gallons PER MINUTE of HEATED FUEL @ 50°C
- HFRS is inhibited under the following conditions:

- FUEL TANK TEMPERATURE > 10°C \*
- CROSSFLOW VALVE OPEN \*
- ENGINE THRUST LEVER SETTING AT high POWER \*
- HFRS switch selected OFF \*
- ENGINE FIRE handle pulled/NOT STOWED \*
- Low FUEL PRESSURE/QUANTITY \*
- FADEC HFRS inhibit ON \*
- ENGINE FUEL FILTER blocked \*
- ABNORMAL ENGINE INDICATION \*

\* BOTH TANKS

\* AFFECTED SIDE





## - FUEL TANK TEMPERATURE:



DESCEND TO ALTITUDE SAT  $< -60^{\circ}\text{C}$

$< -37^{\circ}\text{C}$

FUEL TANK TEMPERATURE

$-34.5$  TO  $-37^{\circ}\text{C}$

FUEL TANK TEMPERATURE

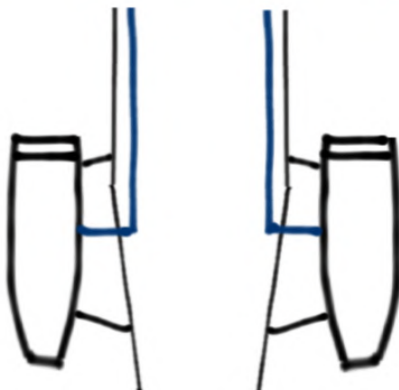


Delay TAKEOFF

$\geq +54^{\circ}\text{C}$

FUEL TANK TEMPERATURE

## - ENGINE FUEL TEMPERATURE:



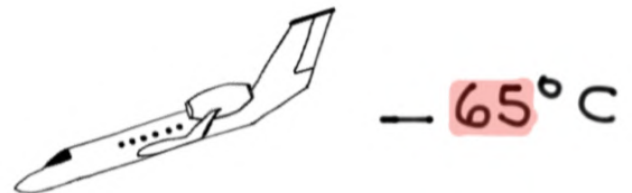
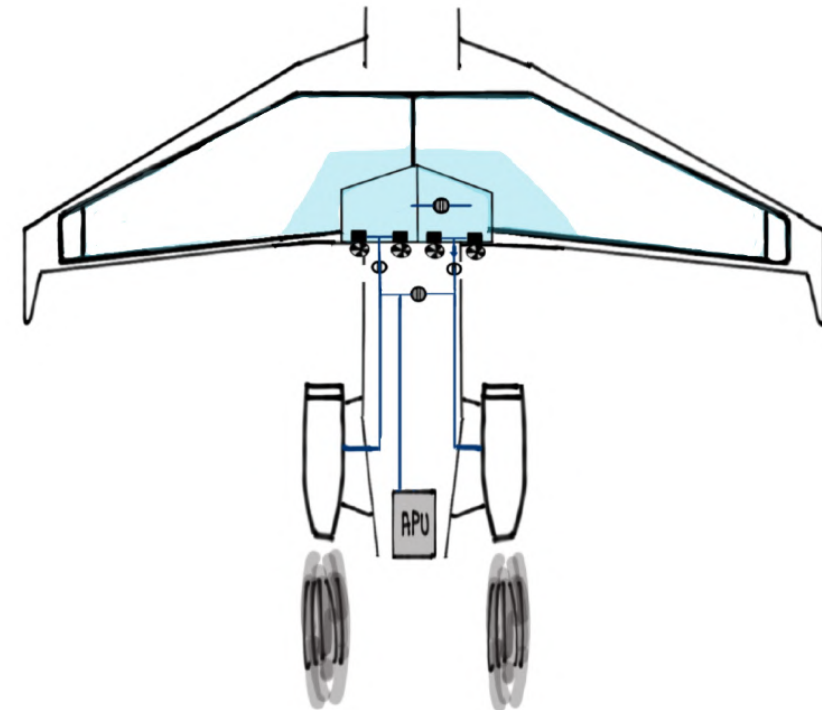
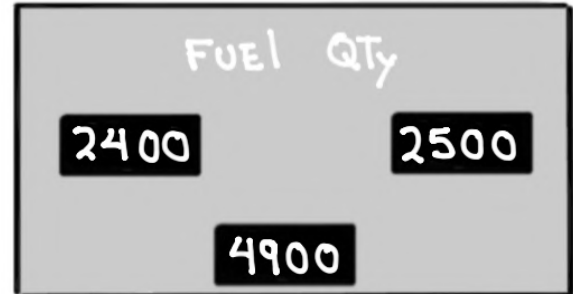
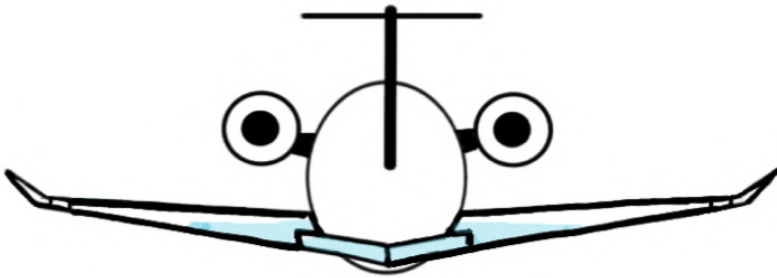
MAX:  $+165^{\circ}\text{C}$  (15 MINUTES)

MAX:  $+140^{\circ}\text{C}$  (UNRESTRICTED)

MIN:  $-40^{\circ}\text{C}$

- If inflight with a fuel Tank Temperature  $\leq -30^{\circ}\text{C}$  and  $< 5,000$  lbs TOTAL REMAINING:

- DESCEND TO AN ALTITUDE WHERE THE SAT IS  $-60^{\circ}\text{C}$  OR WARMER AND MAINTAIN A SPEED OF M.080 OR GREATER



$-60^{\circ}\text{C}$

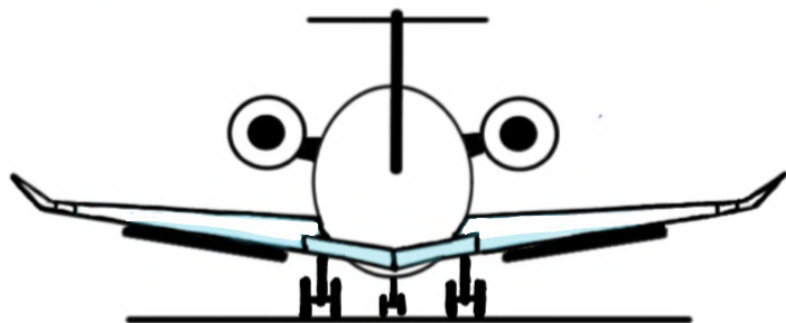
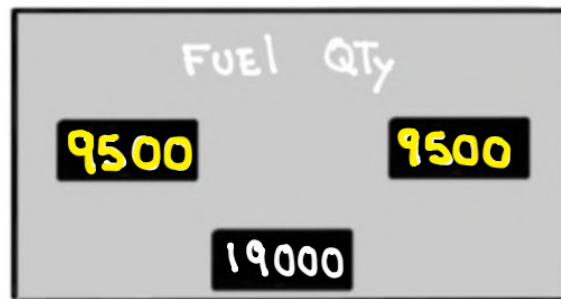


- Prolonged flight AT ALTITUDES with TEMPERATURES colder THAN  $-70^{\circ}\text{C}$  with FUEL TANK TEMPERATURES colder THAN  $-30^{\circ}\text{C}$  AND LESS THAN 5,000 lbs fuel REMAINING:



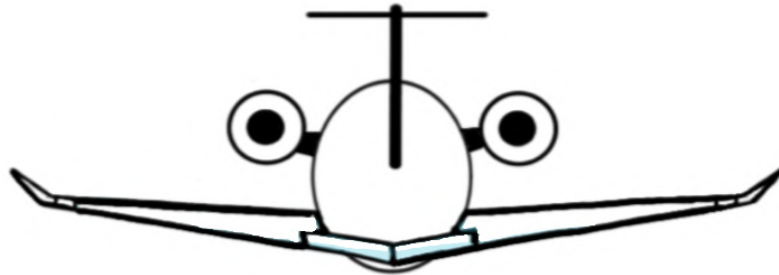
- Prolonged ground operation with  $\leq$  10,000 lbs of fuel in EACH TANK:

- TURN fuel boost pumps ON To refill The hoppers

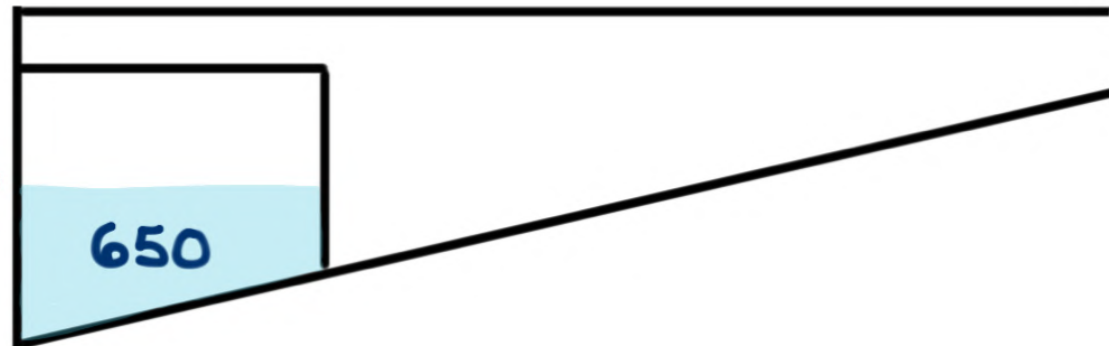


-  $\leq$  650 lbs REMAINING IN EITHER OR BOTH HOPPERS

C L-R FUEL level LOW C



Hopper  
TANK

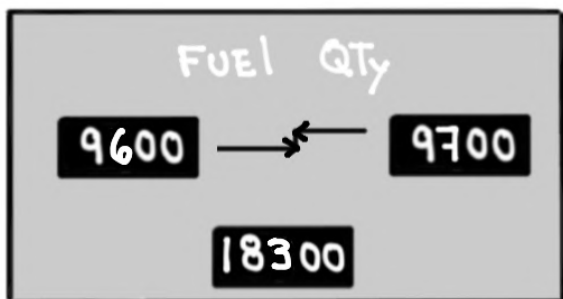


- PROCEED TO NEAREST AVAILABLE AIRPORT AND LAND
- AVOID EXTREME NOSE high/low ATTITUDES, EXCESSIVE FORWARD ACCELERATION AND UNCOORDINATED FLIGHT MANEUVERS
- DO NOT GO-AROUND WITH  $<$  600 lbs IN EITHER TANK
- DO NOT EXCEED 10° PITCH UP ATTITUDE

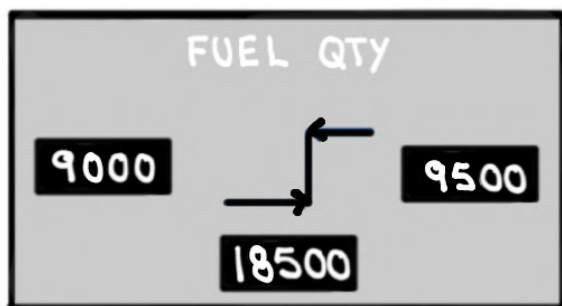


# FUEL IMBALANCE ARROWS

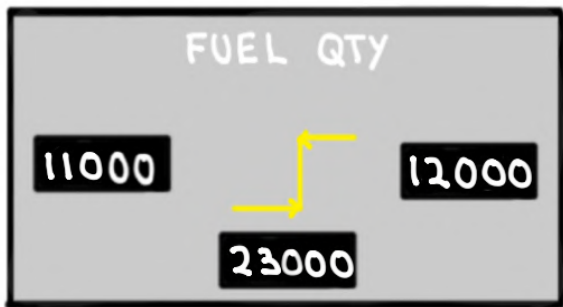
- FUEL ARROWS APPEAR WHEN A FUEL IMBALANCE CONDITION EXISTS
- Arrow colors and deflection indicate SEVERITY LEVEL
- HIGHER SIDE HIGHER ARROW



Appears AT 100 lbs imbalance

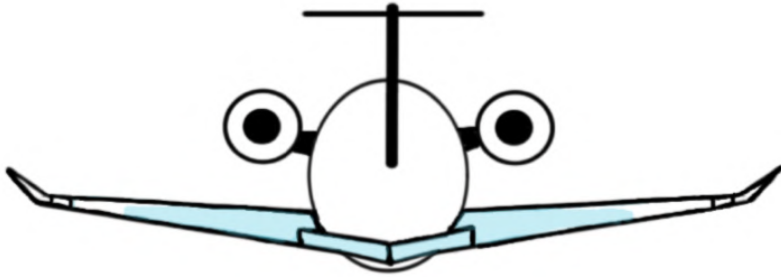


Full scale deflection AT 500 lbs imbalance



Full scale Turns AMBER AT 1000 lbs imbalance

# MAXIMUM FUEL ImBALANCE



FUEL ImBALANCE

Inflight: 2,000 lbs.

\* PROCEED with balancing before imbalance  $\geq$  1,000 lbs.

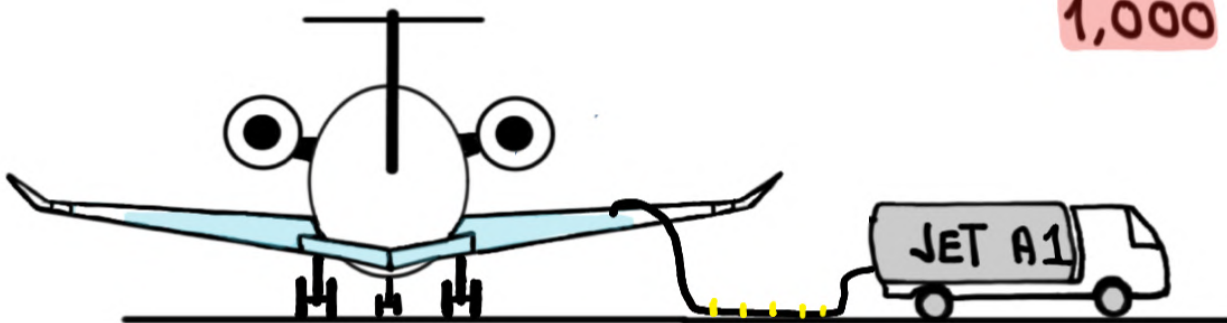


FUEL ImBALANCE

Takeoff: 1,000 lbs.

Refueling operations  
(gravity)

1,000 lbs.



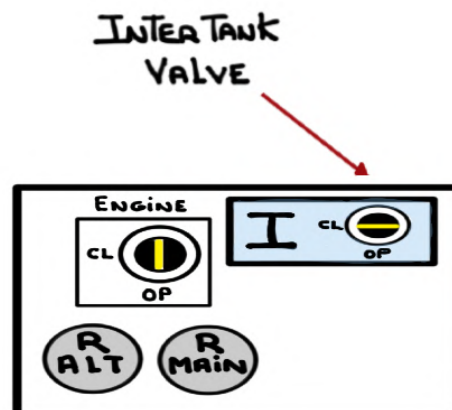
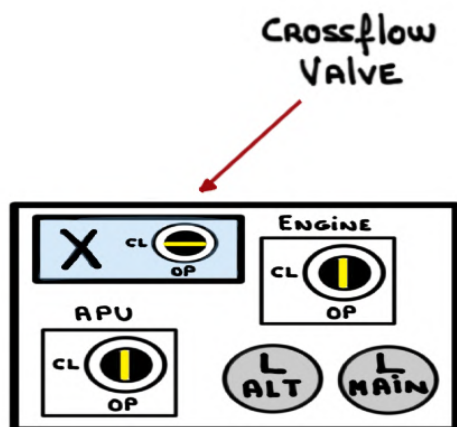
- IN THE EVENT OF A FUEL IMBALANCE CONDITION TWO METHODS ARE AVAILABLE TO BALANCE FUEL:

### ① INTERTANK VALVE:

- When **OPEN** it allows fuel to gravity flow BETWEEN THE RIGHT AND LEFT FUEL TANKS VIA THE HOPPERS
- Approximately  $\frac{1}{2}$  zoid displacement when applying RUDDER TRIM

### ② CROSSFLOW VALVE:

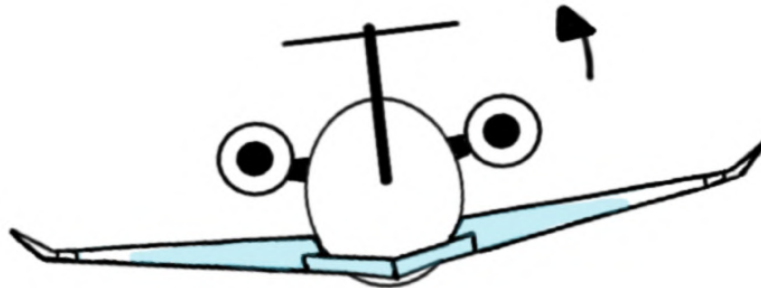
- When selected **OPEN** AND boost pumps on light side ARE SELECTED **OFF** TO ALLOW FUEL FROM HEAVY TANK TO FEED BOTH ENGINES
- REAR wing beam



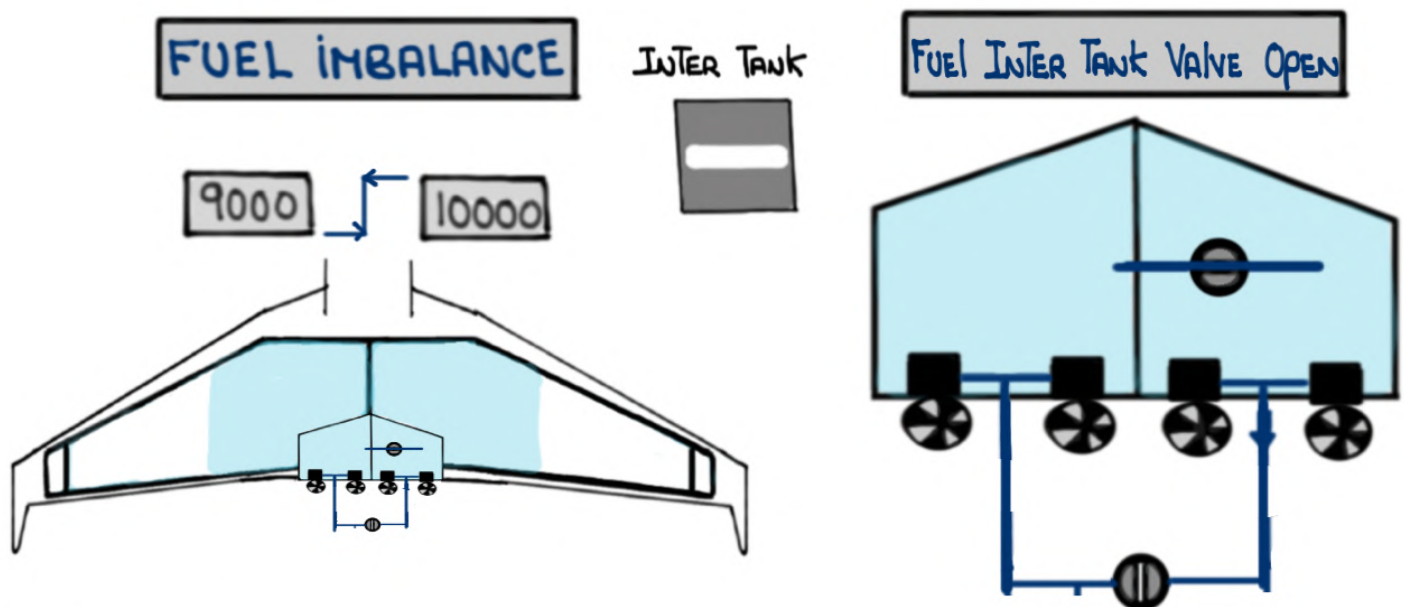
# METHOD 1: INTER TANK

① Autopilot ON, Level flight

② MANUALLY ADJUST RUDDER TRIM TOWARDS THE HEAVY WING



③ OPEN INTER TANK VALVE AND MONITOR FUEL PROGRESS



④ CLOSE INTER TANK VALVE when within **200** lbs or so



⑤ RETRIM RUDDER



## METHOD 2: Crossflow

① Open Crossflow valve



FUEL Crossflow VALVE Open



X Flow

② Turn OFF boost pumps, ONE AT A TIME, ON lighter wing

FUEL IMBALANCE

9000 10000

L PUMPS

ALT

MAIN

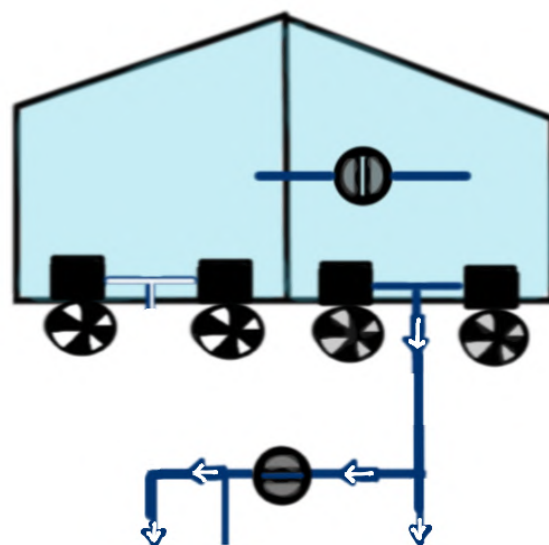
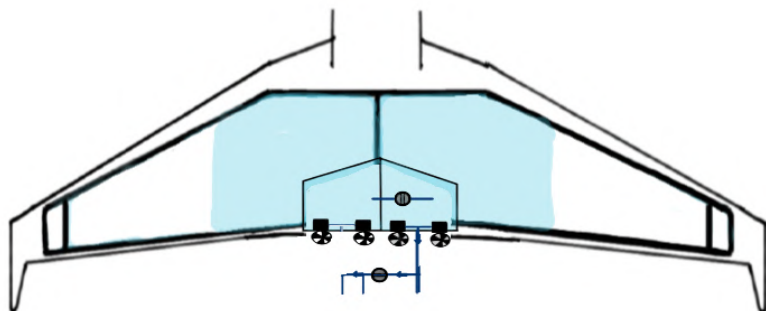
OFF

OFF

R PUMPS

MAIN

ALT



③ Turn ON boost pumps

④ Close Crossflow valve when desired balance is achieved



9450 9550

- The crossflow valve has a five (5) minute timer to alert the crew that it is still open. The CAS message turns amber (CAUTION) and a double-chime aural tone will sound

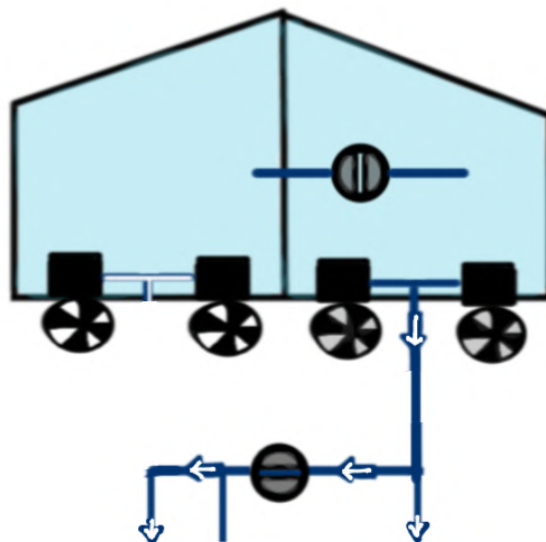
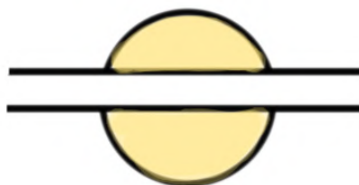


The crossflow valve on the fuel synoptic page will also turn amber

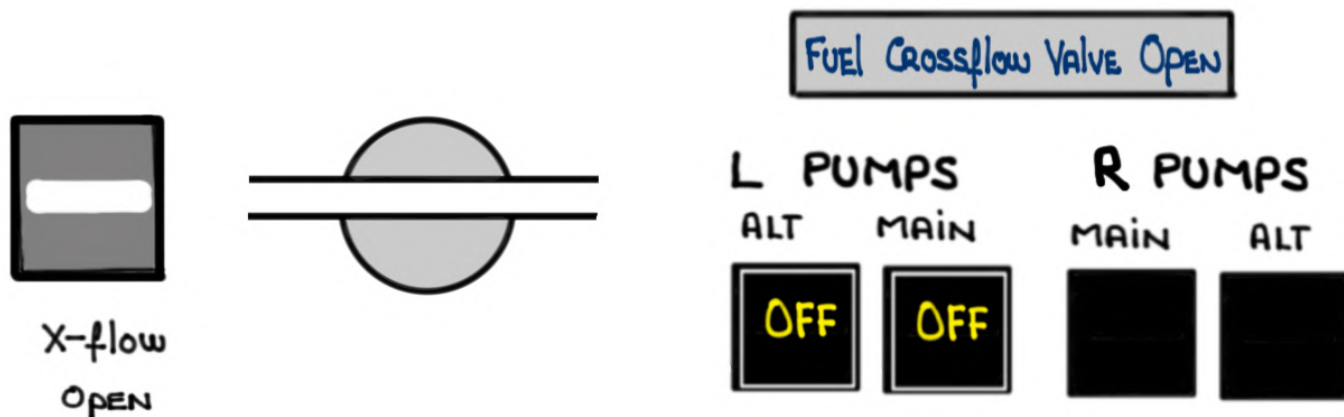
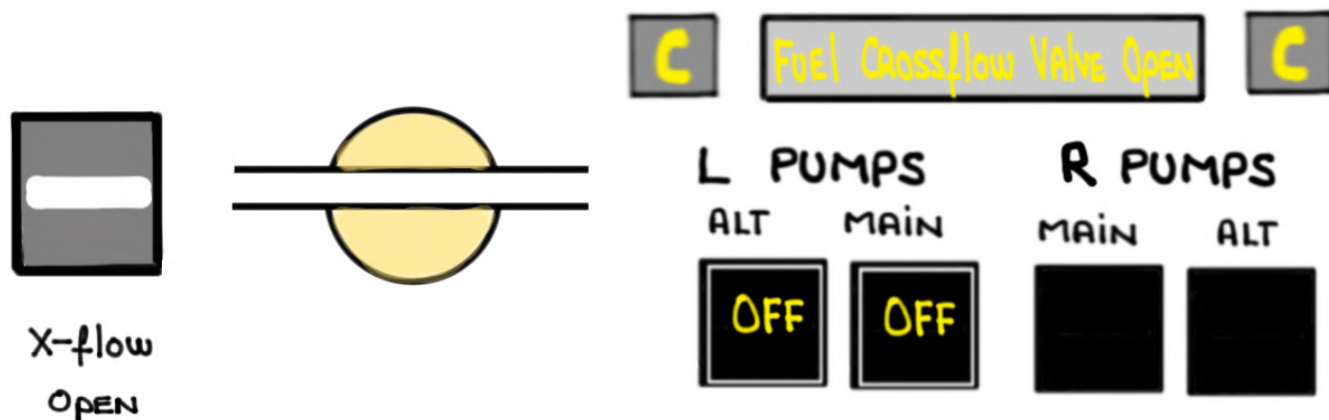


X-flow

> 5 MINUTES

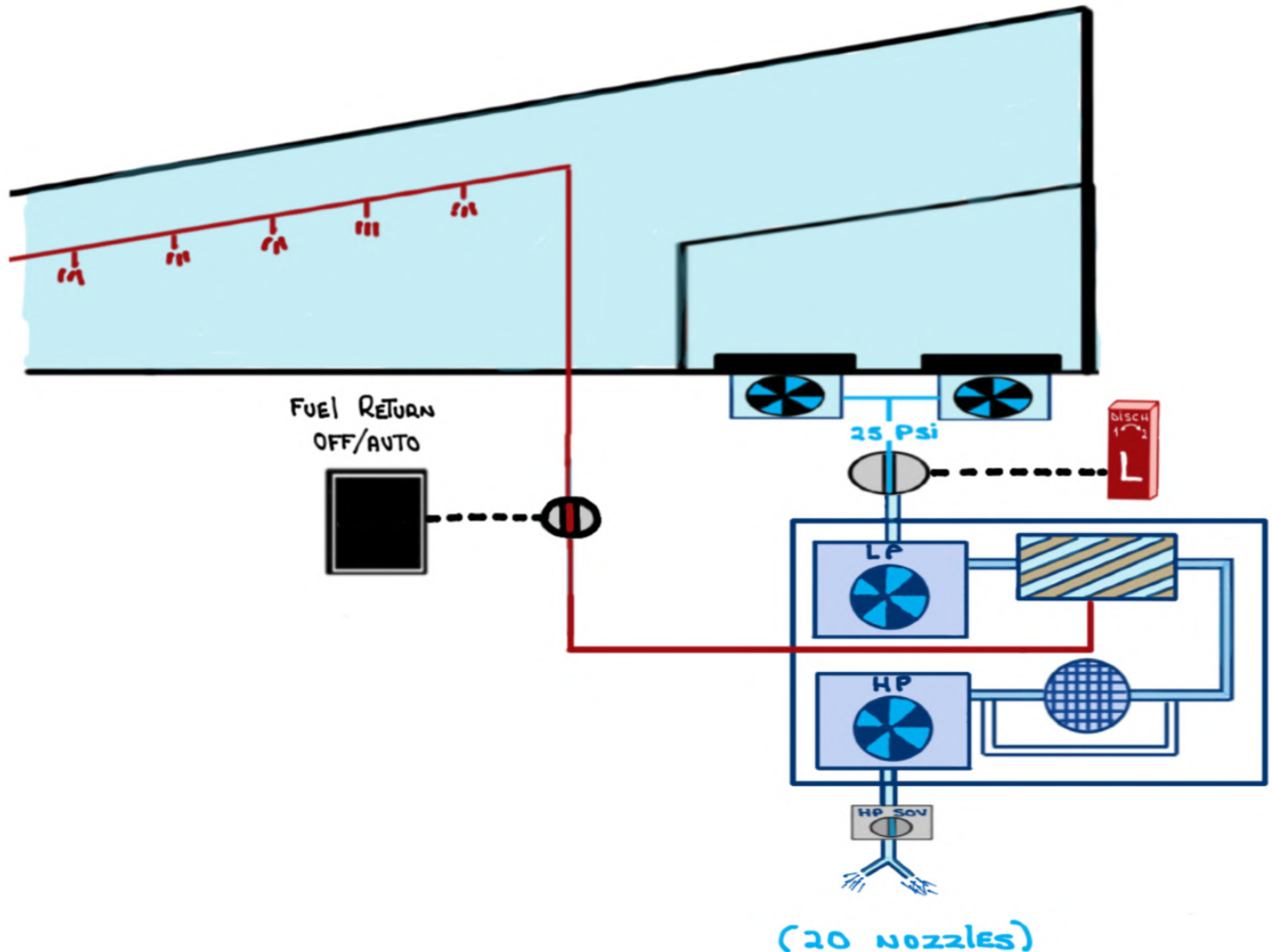


AFTER REASSESSING THE STATUS OF THE FUEL IMBALANCE  
RESET THE TIMER by cycling the crossflow valve  
closed AND THEN, if REQUIRED, open it again



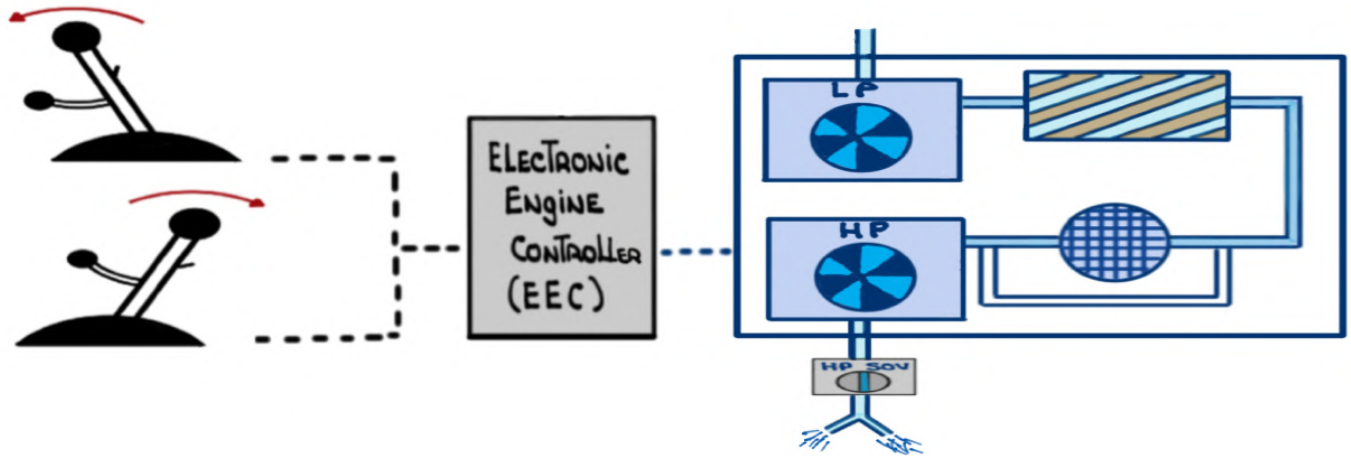
# ENGINE FUEL SYSTEM

- 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)

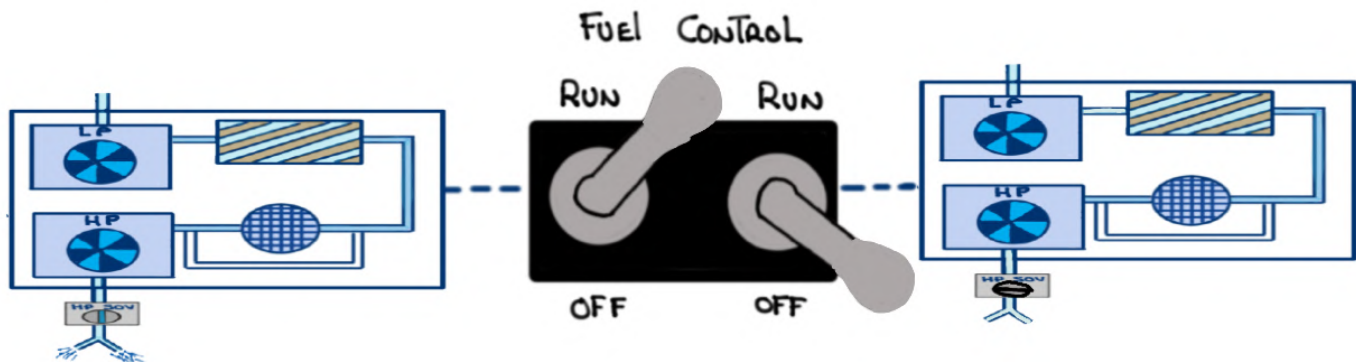




- AS THRUST LEVERS ARE ADVANCED OR RETARDED THE EEC COMMANDS THE FMU TO MODULATE FUEL TO NOZZLES

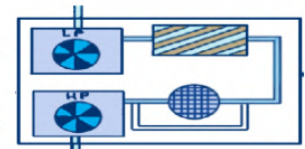


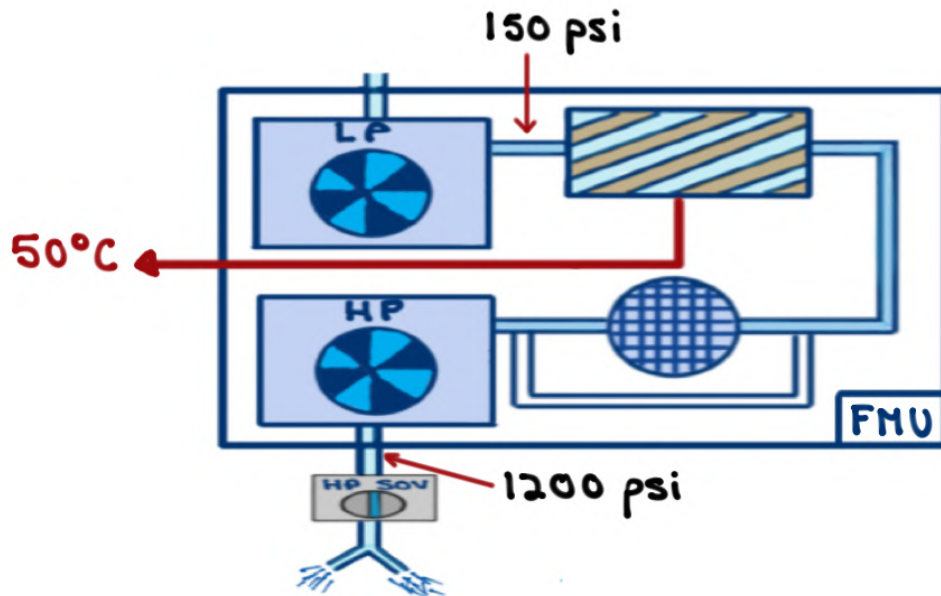
- PLACING A FUEL CONTROL SWITCH TO OFF CLOSSES FMU  
All fuel is cutoff To The fuel NOZZLES AND THE ENGINE SHUTS DOWN




- THE FMU CONTAINS TWO (2) INTERNAL PUMPS :

- LOW PRESSURE (LP) 1<sup>ST</sup> STAGE →
- HIGH PRESSURE (HP) 2<sup>ND</sup> STAGE →

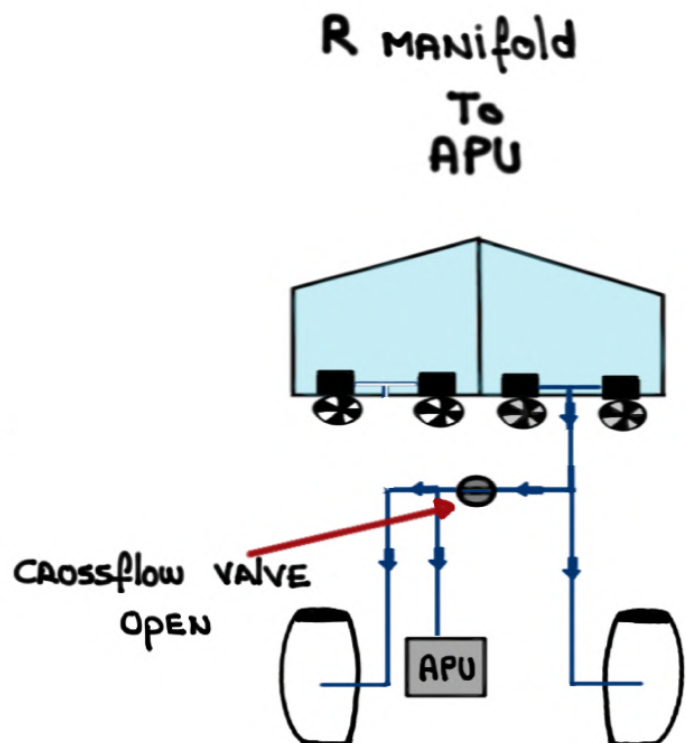
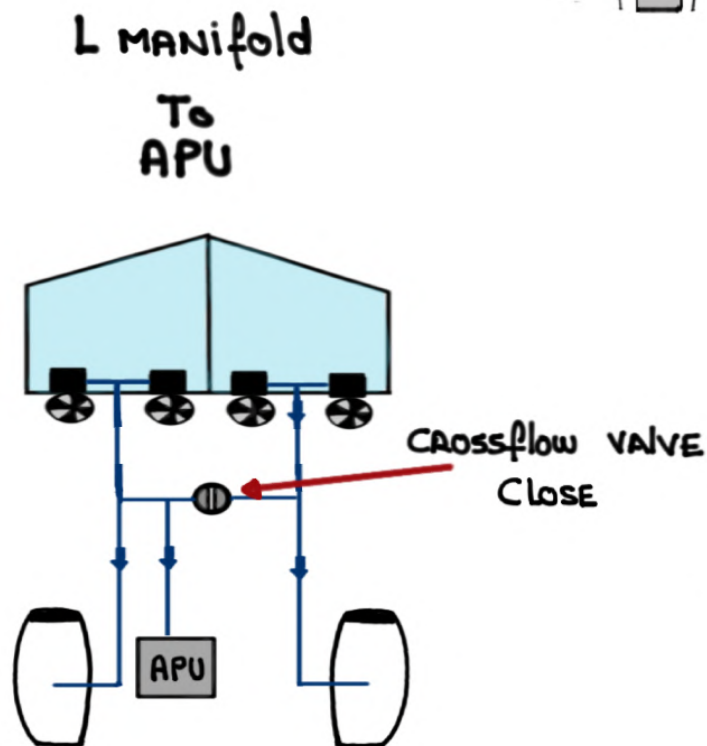
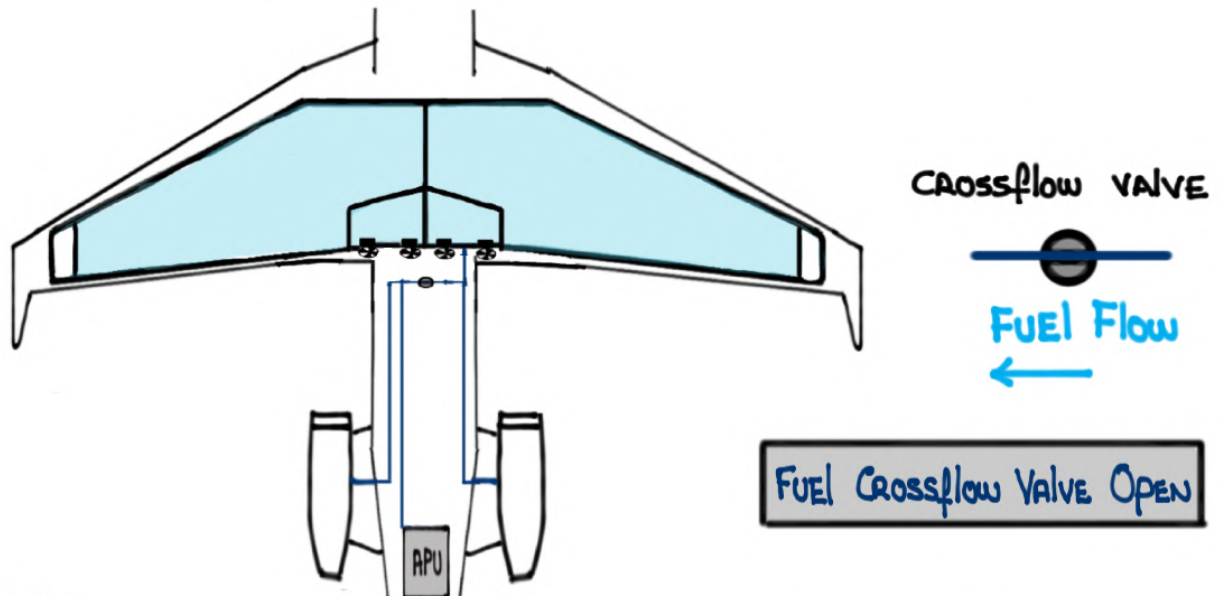




- The LP and HP pumps ARE DRIVEN by THE ENGINE ACCESSORY gearbox
- A fuel filter RECEIVES fuel FROM THE 1<sup>ST</sup> STAGE LP pump AND REMOVES debris AND CONTAMINANTS
- A filter bypass valve ENSURES CONTINUAL fuel flow TO THE ENGINE if filter is blocked
- EXCESS fuel is RECIRCULATED THROUGH THE FUEL/OIL HEAT EXCHANGER 

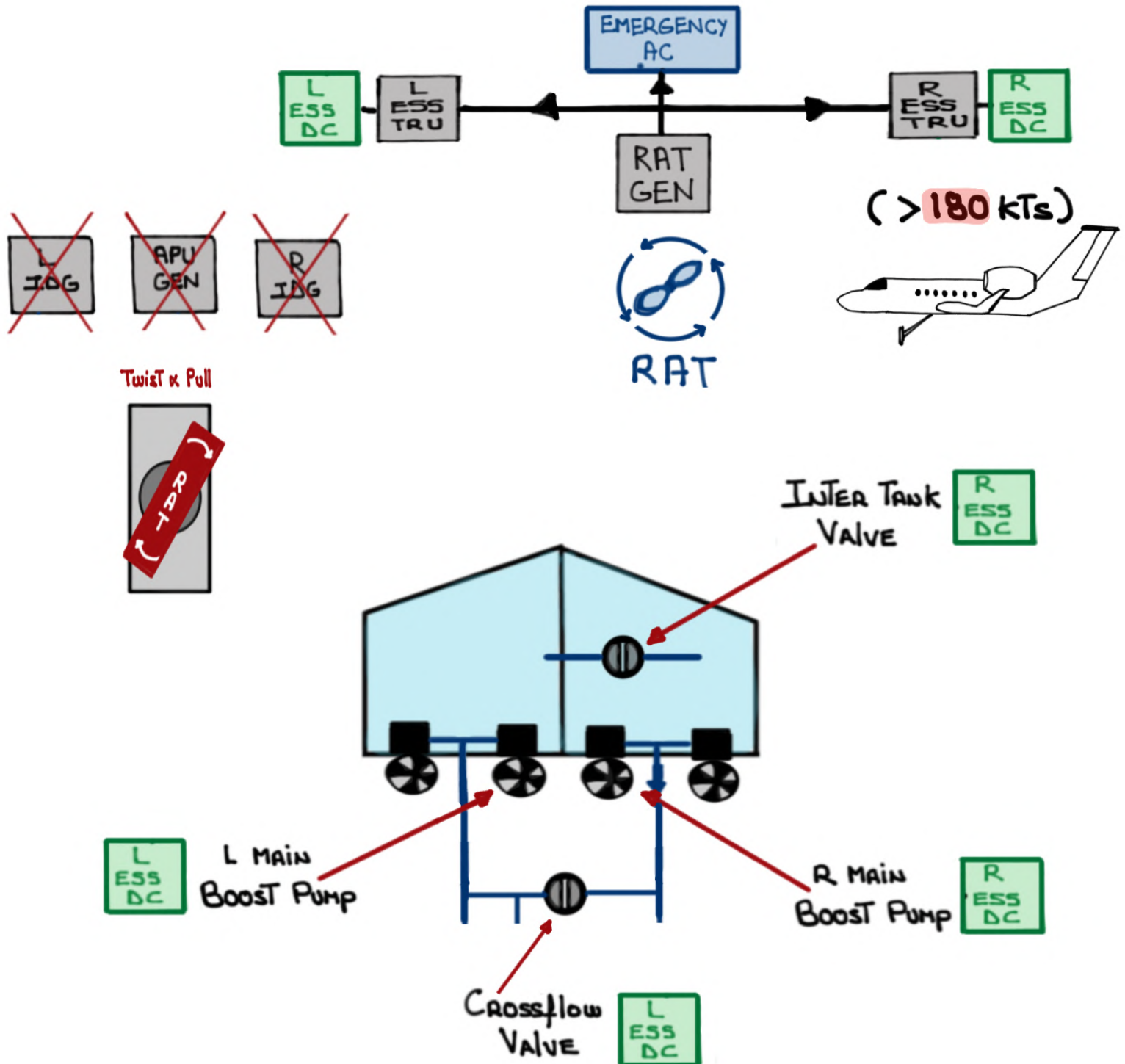
# APU FUEL Supply

FUEL IS NORMALLY SUPPLIED FROM THE LEFT FUEL MANIFOLD BUT CAN ALSO BE SUPPLIED FROM THE RIGHT MANIFOLD BY TEMPORARILY OPENING THE CROSSFLOW VALVE



# RAT OPERATIONS

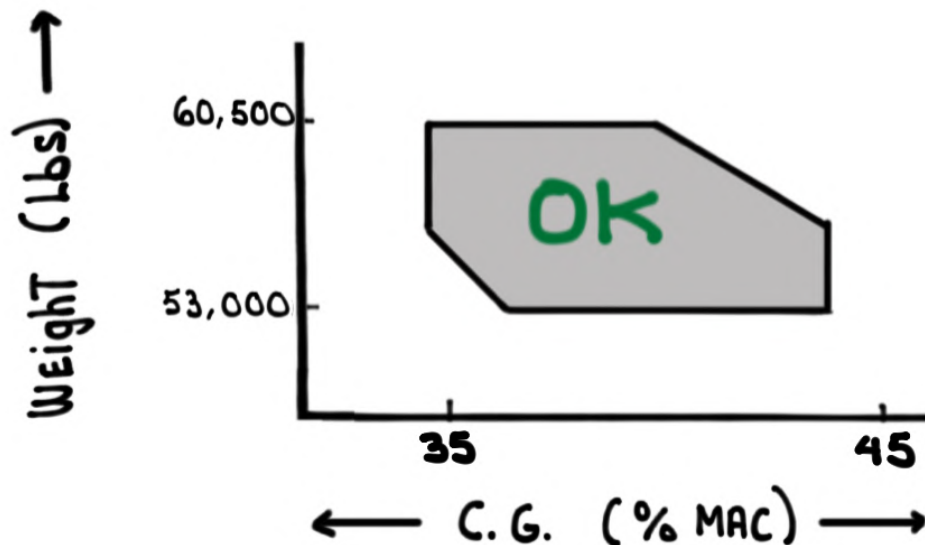
When operating with The **RAT** The following fuel system components remain OPERATIVE





MAXIMUM ZERO FUEL WEIGHT: 60,500lbs

ZFW C.G. ENVELOPE      AFM 01-03-70

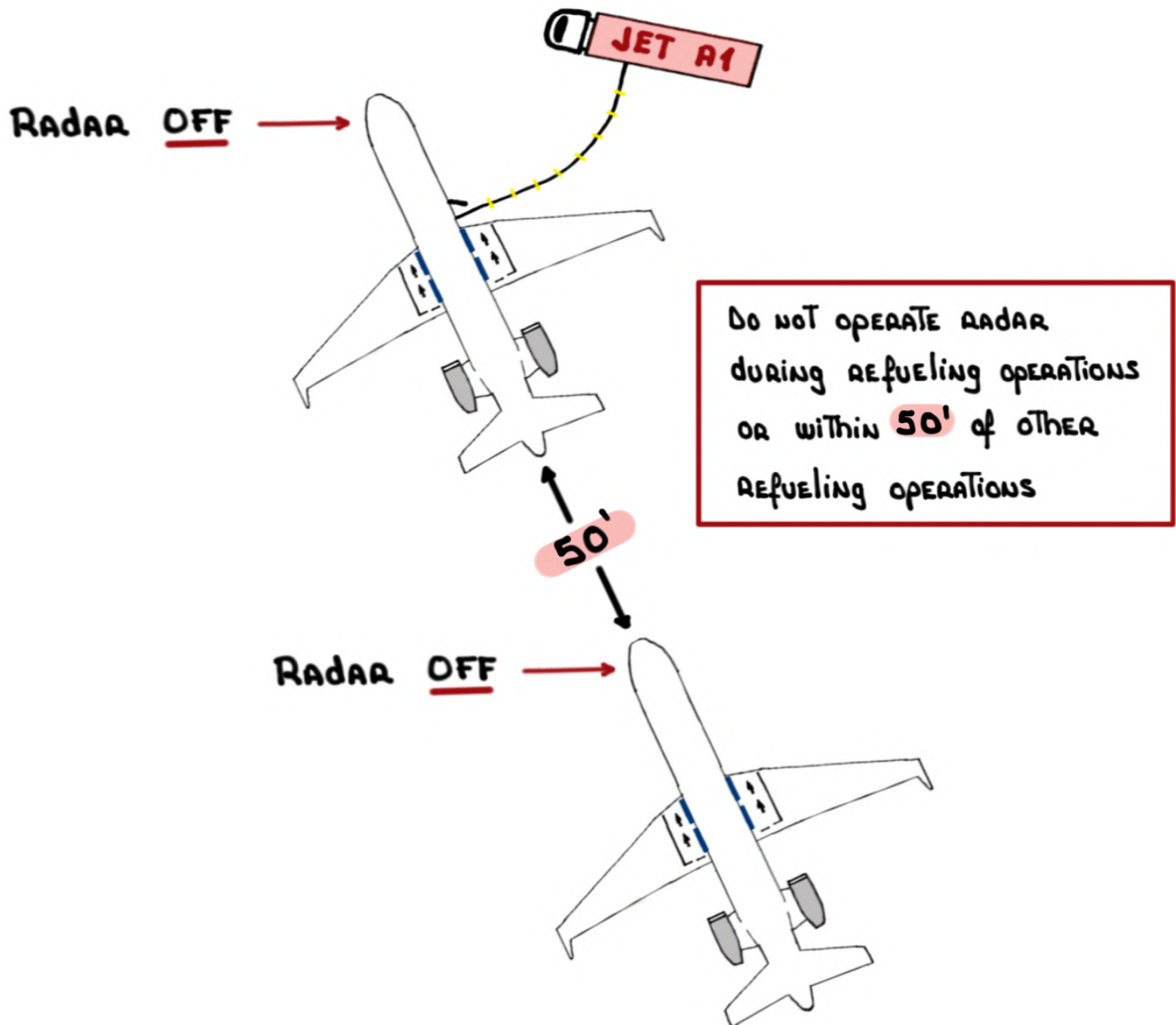


ZFW MUST BE WITHIN ZFW C.G. ENVELOPE

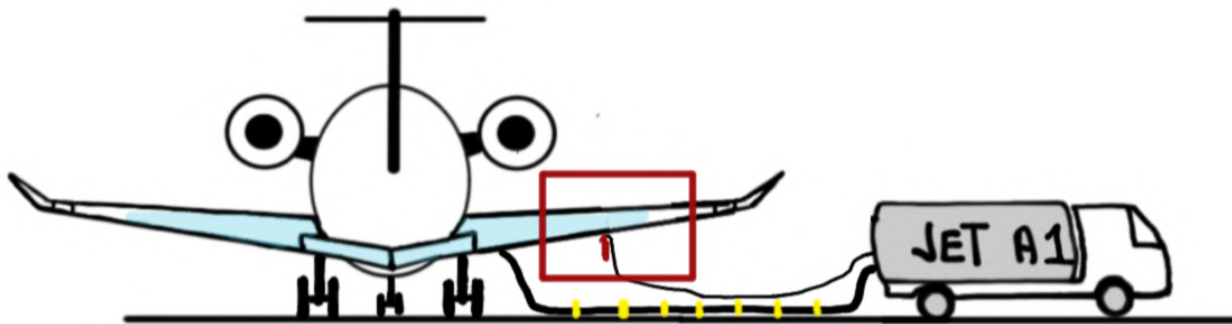
FUELED AIRPLANE C.G. WILL THEN REMAIN WITHIN  
C.G. FOR:

- TAXI
- TAKEOFF
- INFLIGHT
- LANDING

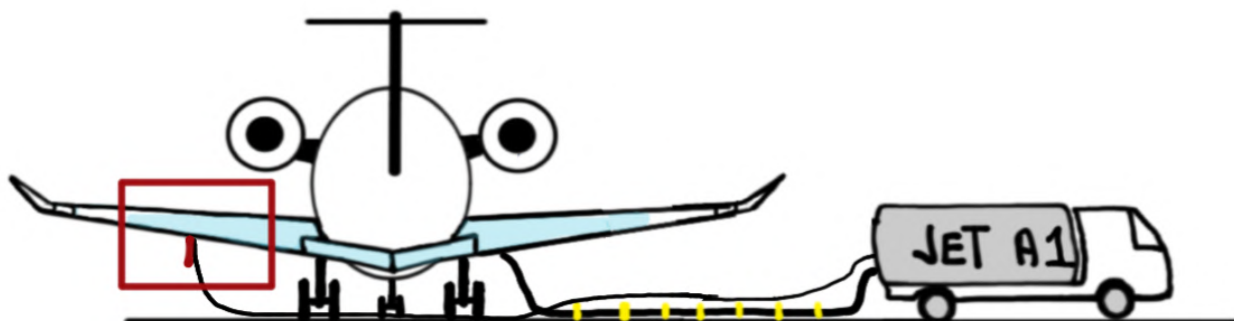
# FUEling OPERATIONS



BEFORE REFUELING, ENSURE AIRPLANE IS BONDED  
TO THE FUEL SOURCE

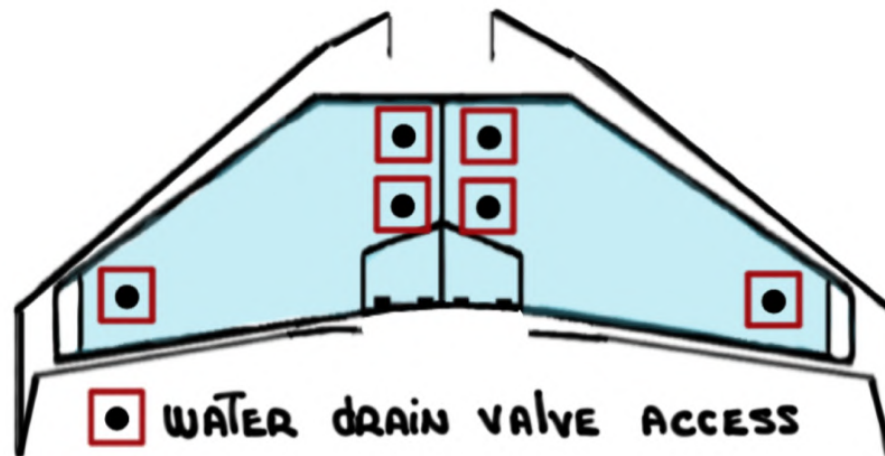


GROUNDING JACKS ARE **LOCATED** IN THE LOWER  
TRAILING EDGES



# WATER CONTAMINATION / FUEL TANK DAMAGE PREVENTION MEASURES

- Biobor JF AVIATION fuel biocide TREATMENT:
  - \* Kills AND PREVENTS MICROBIAL GROWTH
  - \* PREVENTS MICROBIAL CORROSION ISSUES AND FILTER plugging
- FUEL TANK SUMPING AT CONSISTENT WATER DRAINING FREQUENCIES



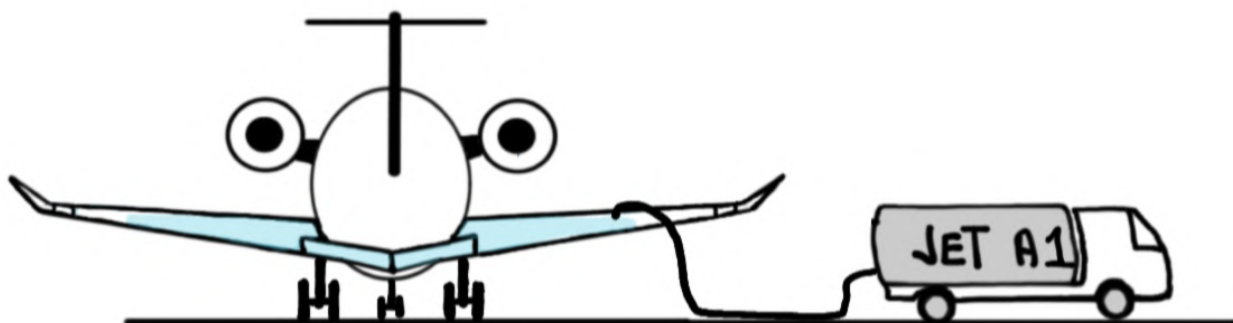
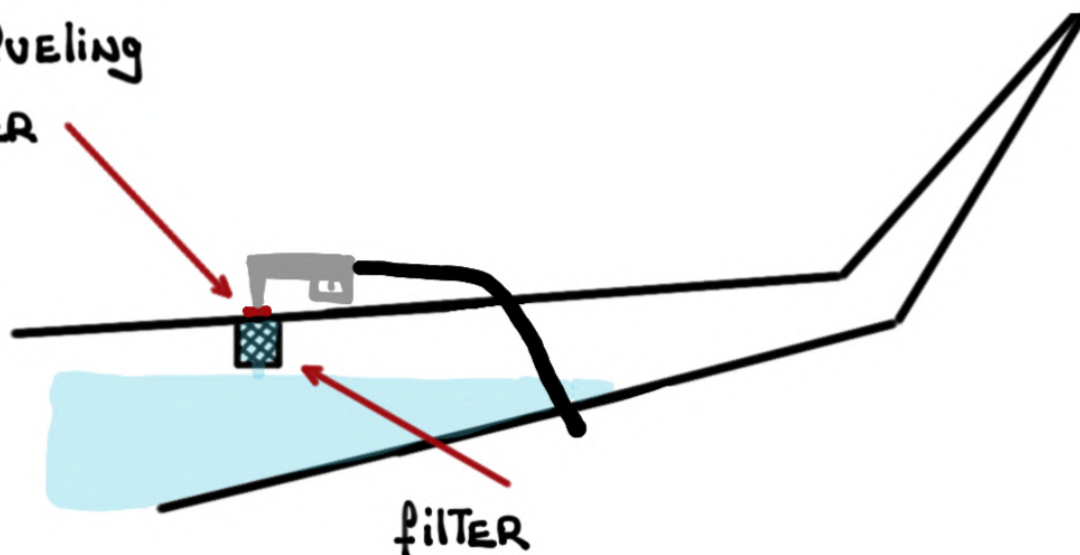
- FUEL quality check of FUEL SOURCE PRIOR TO EACH REFUELING OPERATION



# FUEL FilTRATion

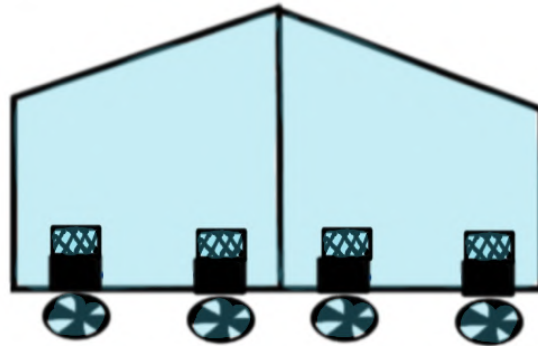
The fuel filtration system prevents contaminants from entering the wing tanks during overwing gravity refueling

① GRAVITY FUELING  
ADAPTER

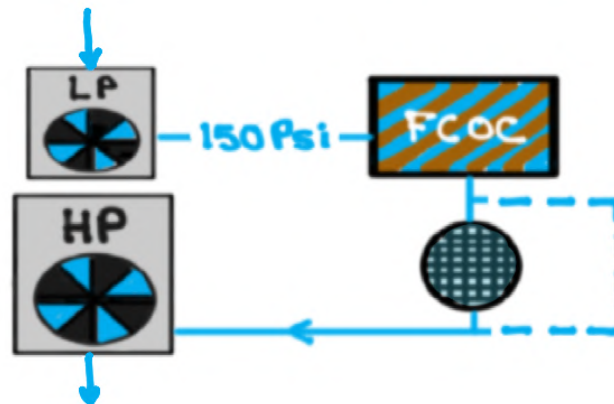


FILTRATION IS ALSO ACCOMPLISHED AS FOLLOWS:

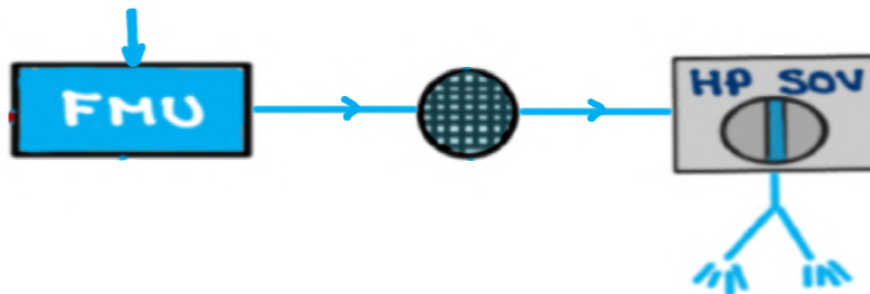
② AT THE INLETS OF ALL FOUR (4) BOOST PUMPS



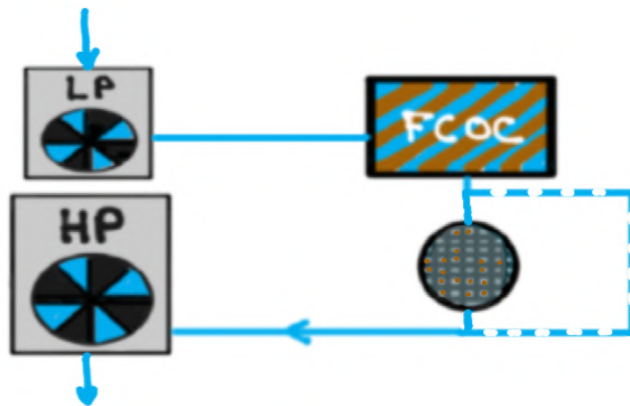
③ PRIOR TO THE HP PUMP (LP FILTER)



④ AFTER THE FUEL METERING UNIT (FMU)



— Impending blockage of indicated LP filter:



L FUEL FILTER

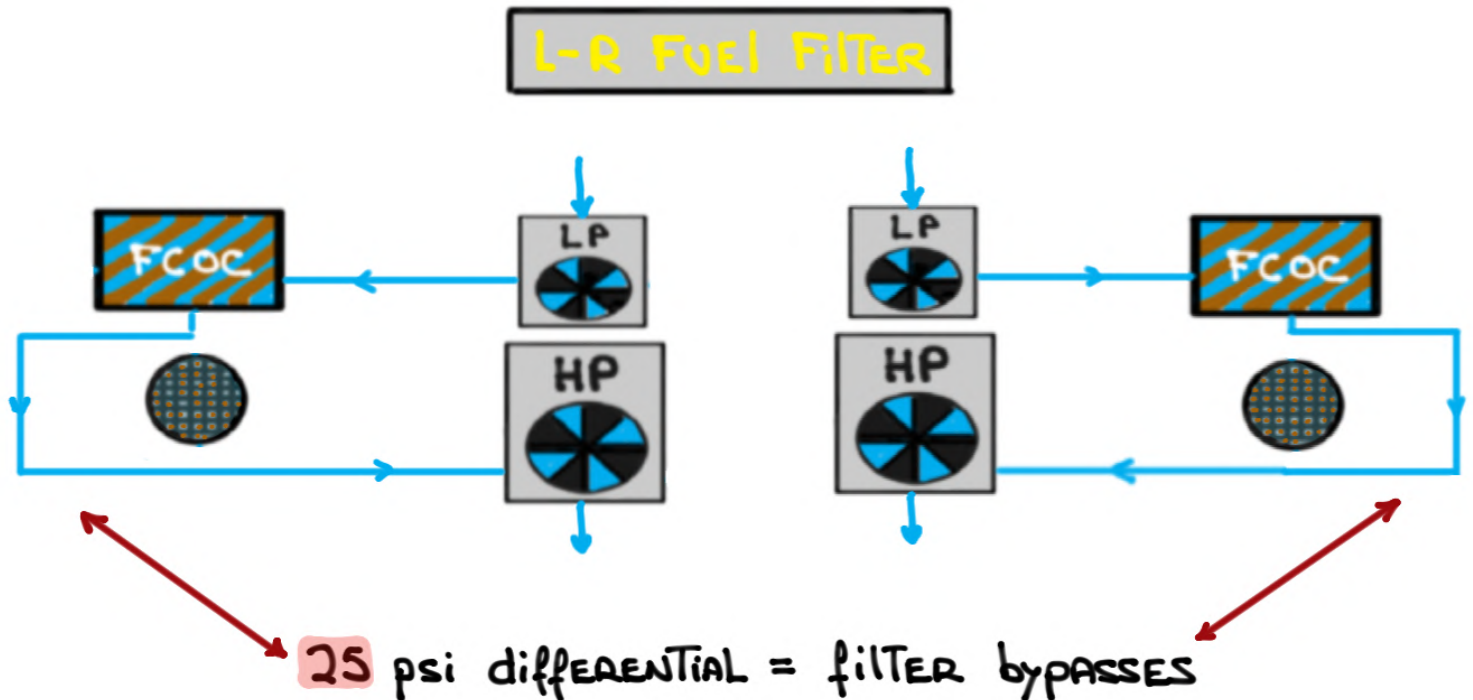
OR

R FUEL FILTER

OR

L-R FUEL FILTER

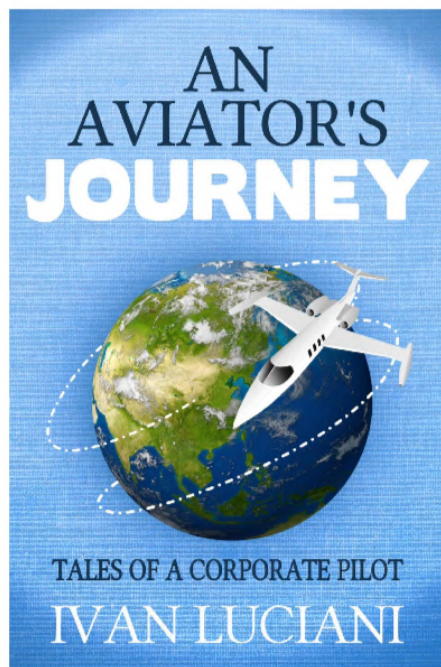
— FUEL BYPASSING INDICATED FILTER OR IMPENDING  
blockage/ bypassing of both LP filters:



**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](mailto:ivan@code7700.com)



Thank you!