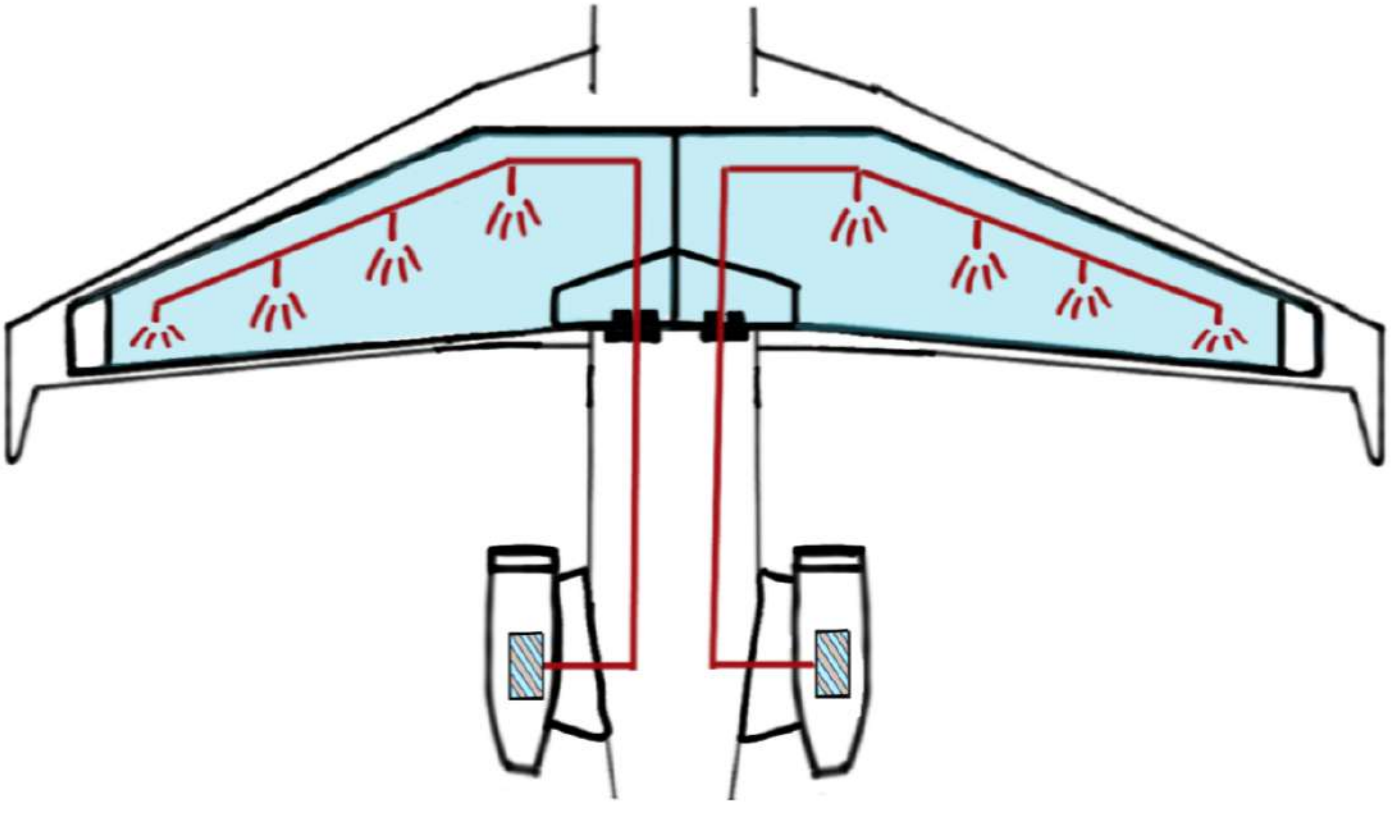
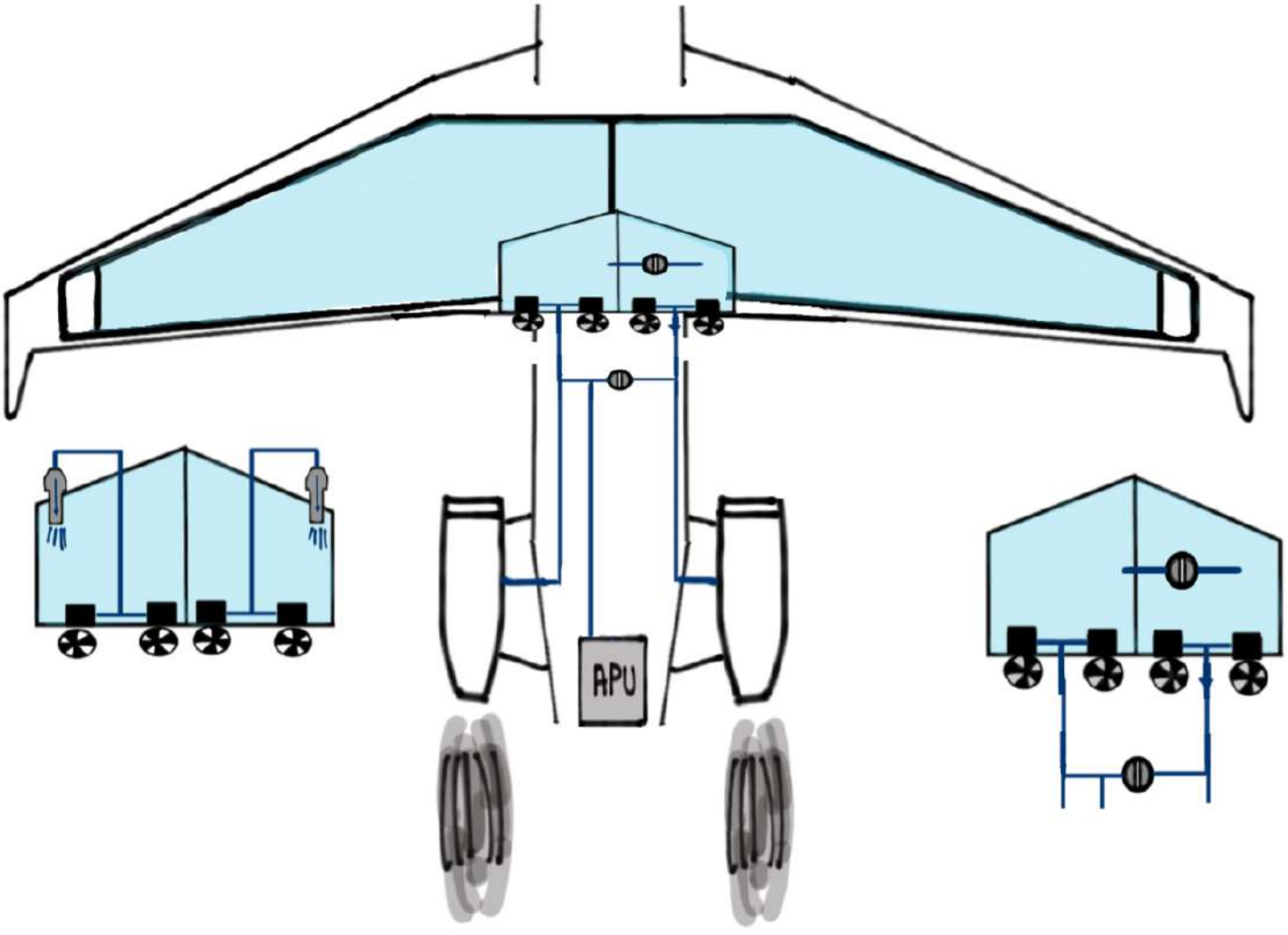
G650 FUEL SYSTEM



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

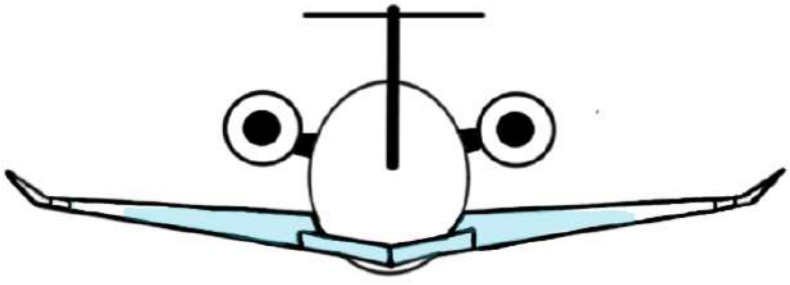


- The wing Tanks are part of the internal wing structure and do not have bladders

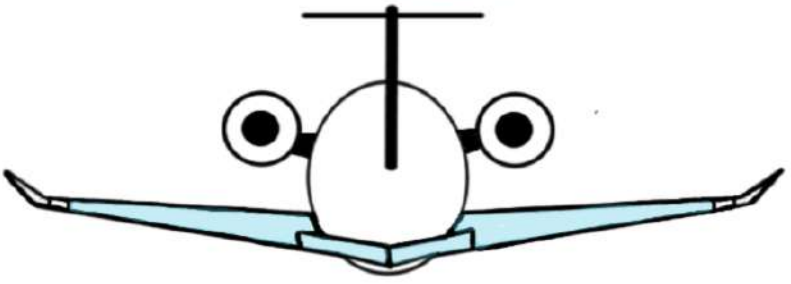
Wing Tanks

- 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

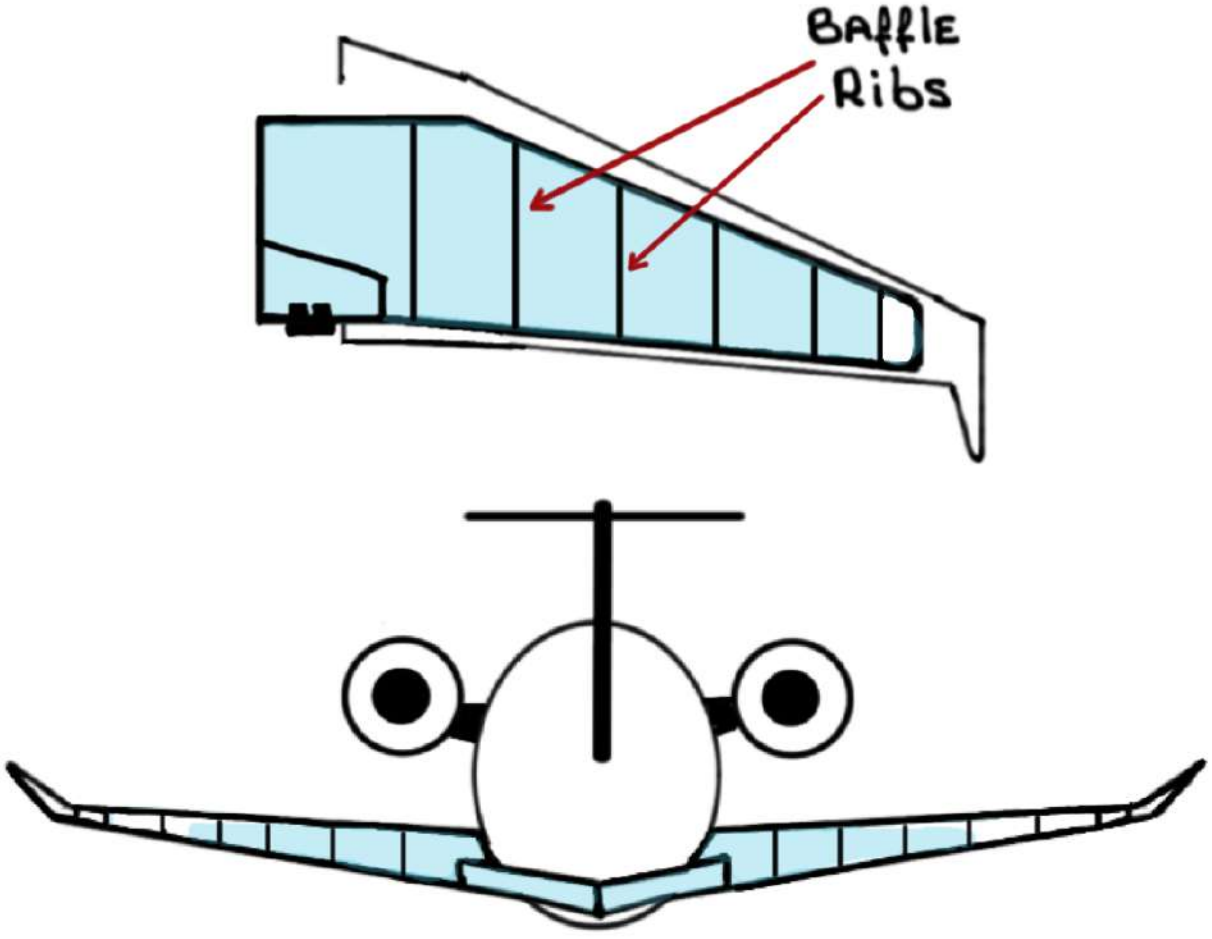
- Refueling:

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

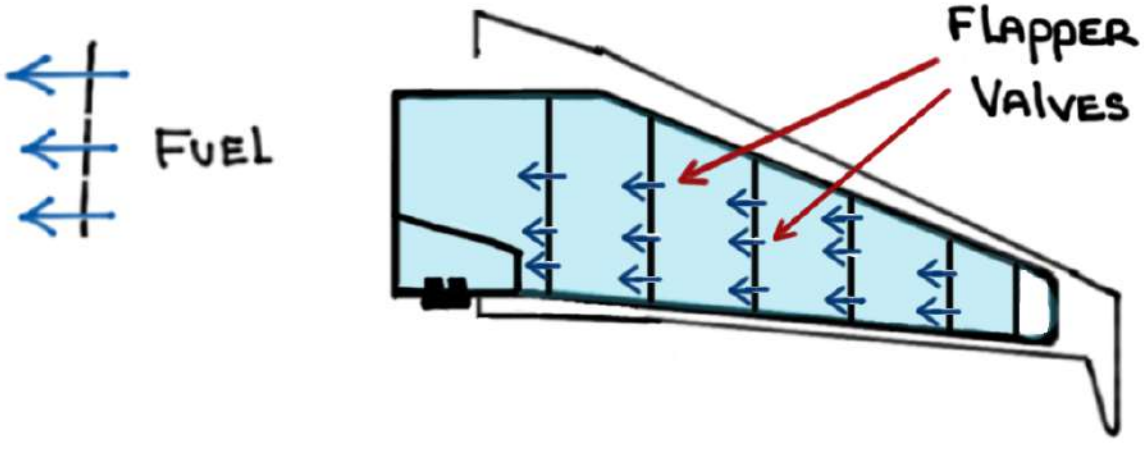
② Overwing gravity refueling – Maximum capacity:

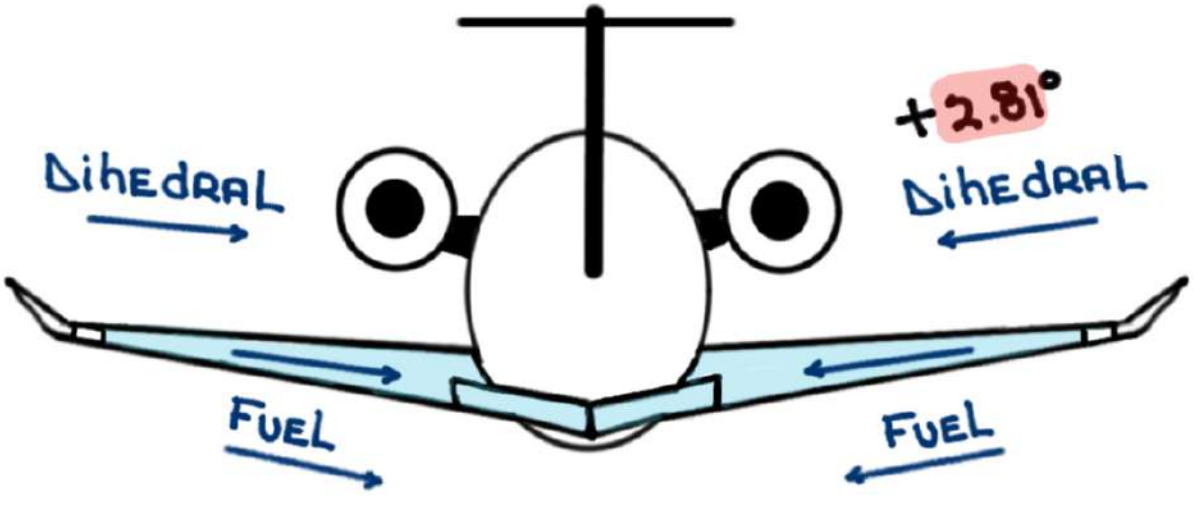
43,650 lbs

- Rapid C.G. changes due to slushing are avoided through the use of <u>baffle ribs</u> within the tanks. This design creates multiple compartments or bays within the 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

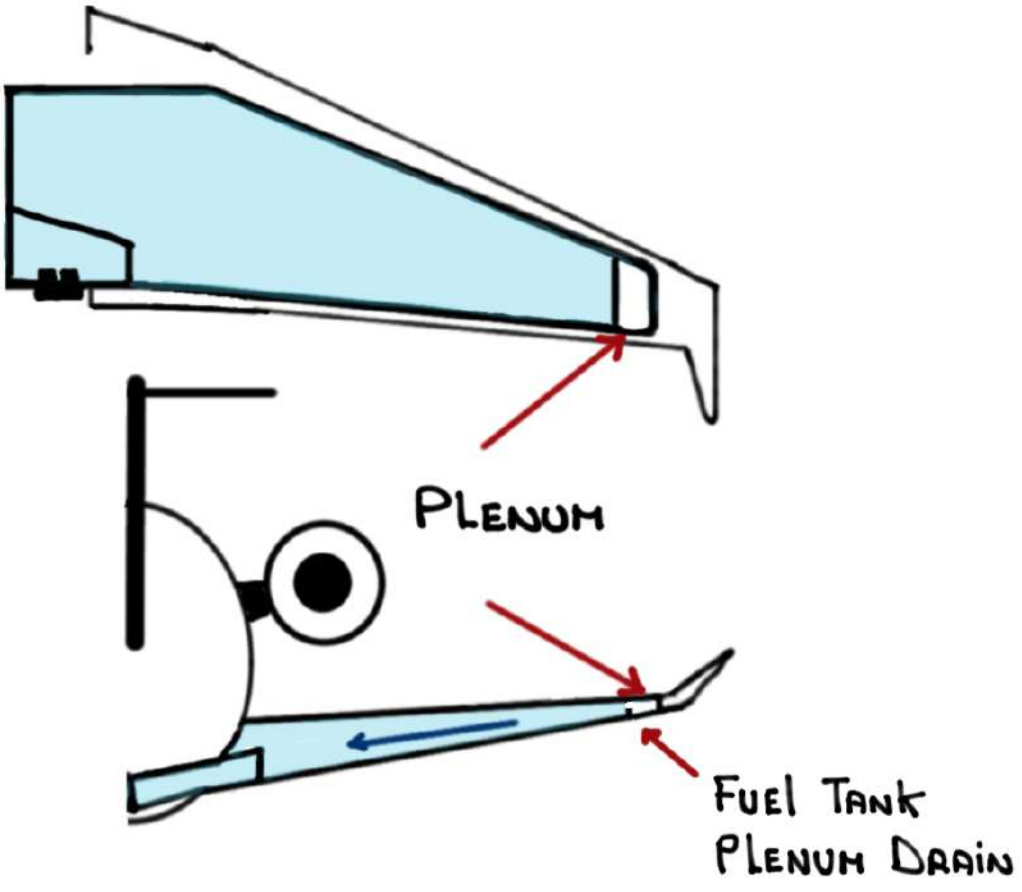




- Any fuel below the flapper valves moves towards the fuel Hoppeas through small orifices called Weep Holes

- 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

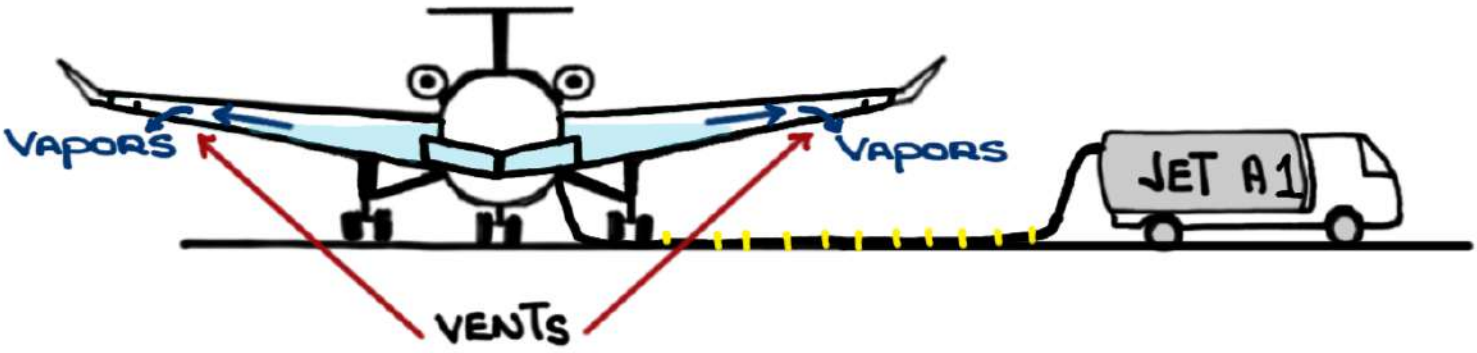
- The fuel vent system is fully automatic and does not require electrical power

- The fuel vent system allows air to enter the fuel tanks as fuel is consumed during flight

Prevents wing collapse (Negative pressure)

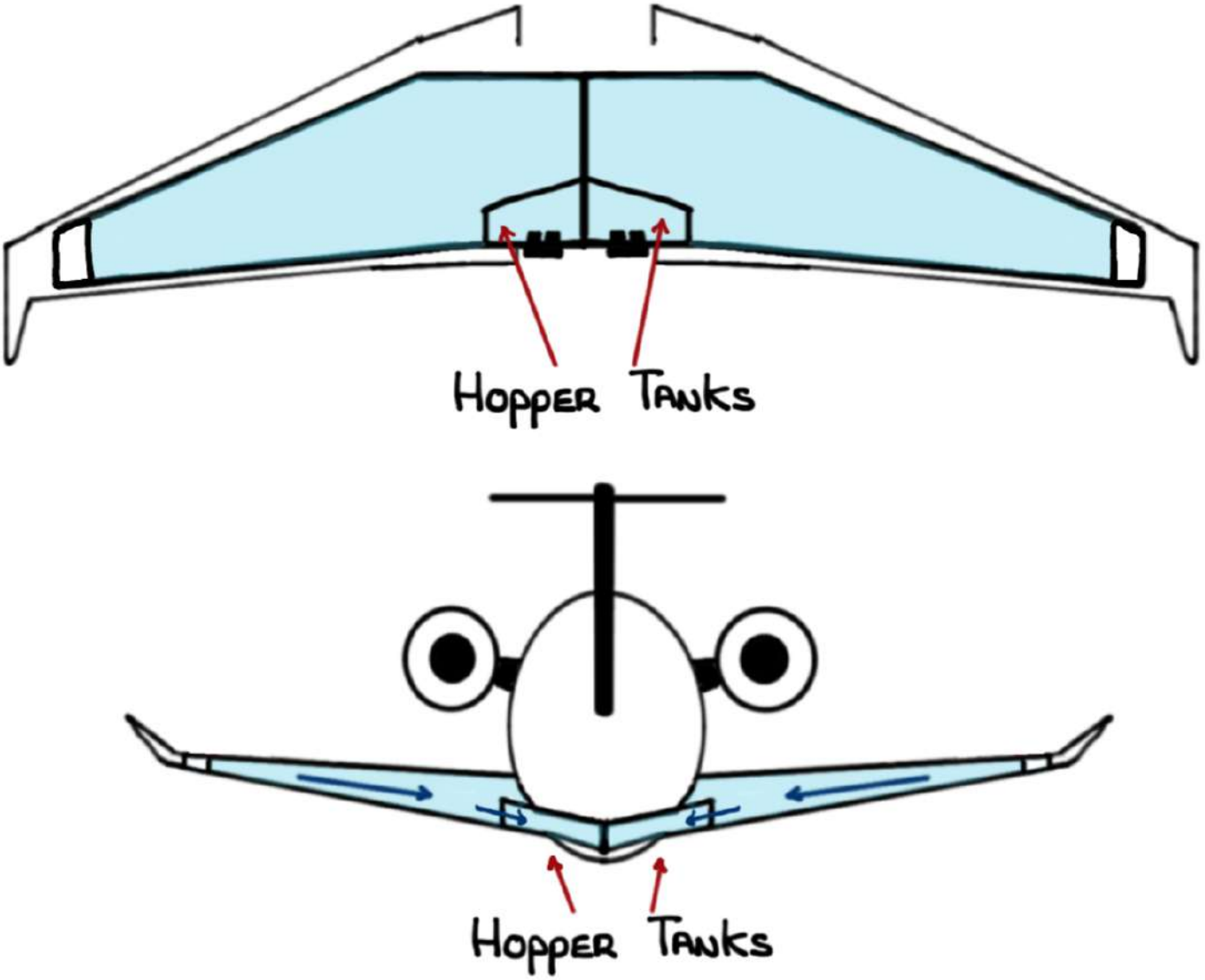
- The fuel vent system allows vapors and air to escape as fuel goes inside the tanks during refueling

Prevents wing rupture (positive pressure)



- The Hopper Tanks are <u>segregated</u> tanks within the wing tanks

- They are located adjecent to the centerline rib at the lowest point within the wing tank

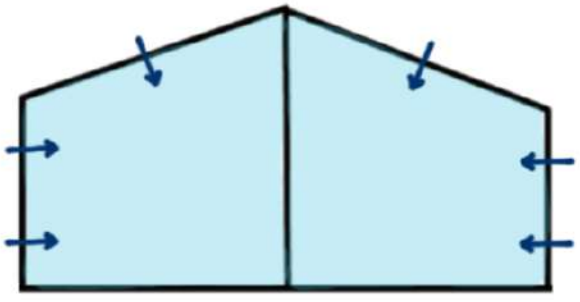


- It is from the Hopper Tanks that fuel is drawn to feed the engines and APU

- 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

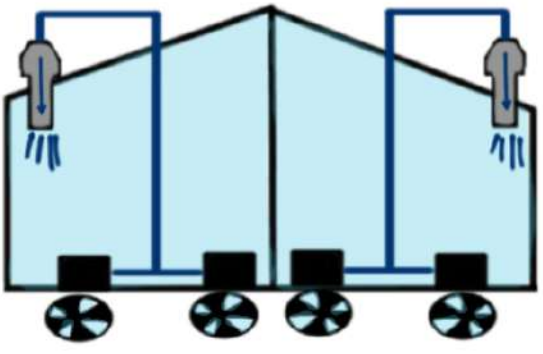


ONE WAY flow

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

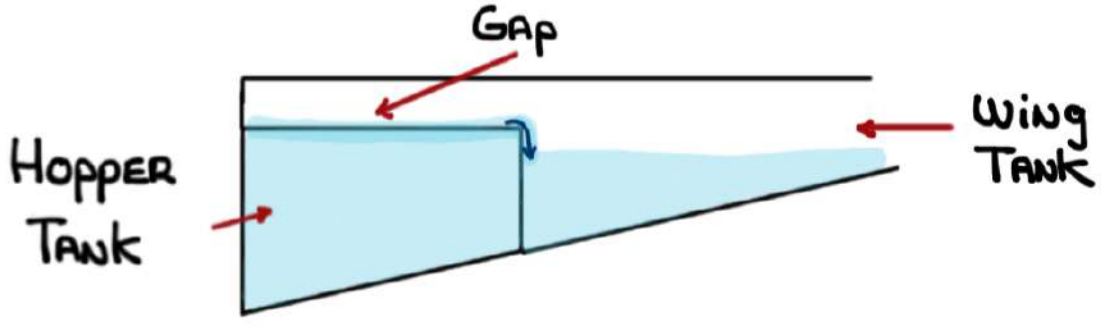
- Deliver steady flow of fuel from wing to Hopper
- Low pressure, high volume pumps
- 4,450 pounds per hour



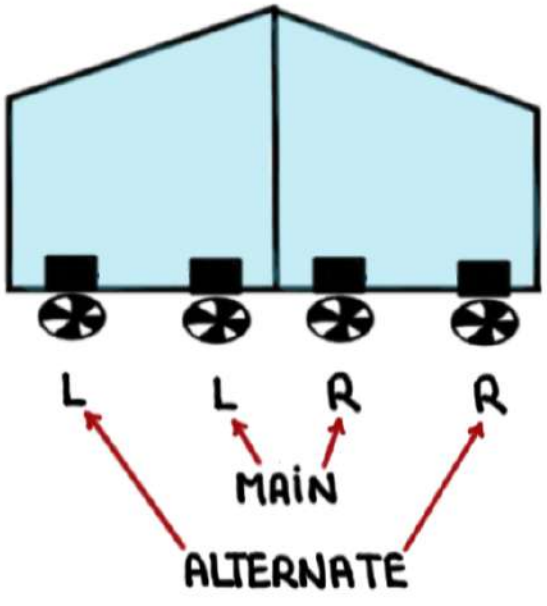
- The Hopper Tanks have a fuel capacity of:

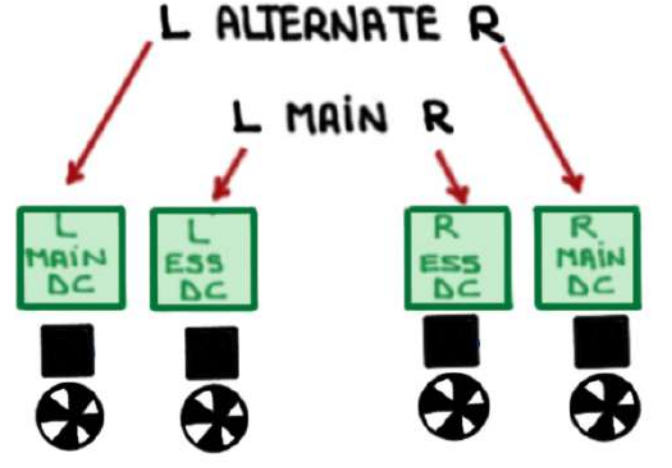
up to 190 gallons / 1,283 lbs

- 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





Brushless boost pumps

- 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

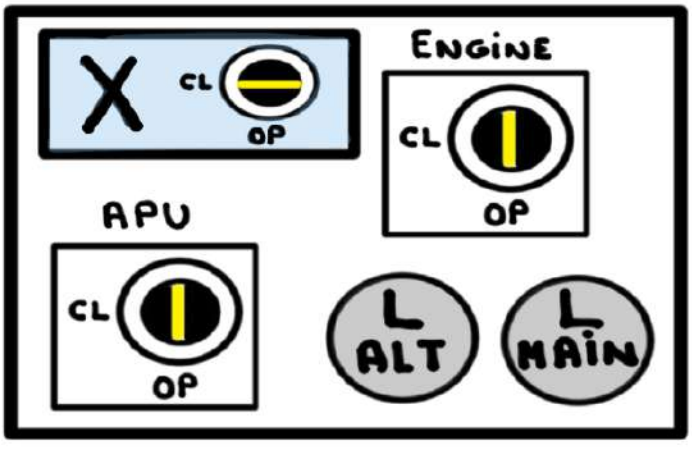
- Two (2) Alternate powered by respective

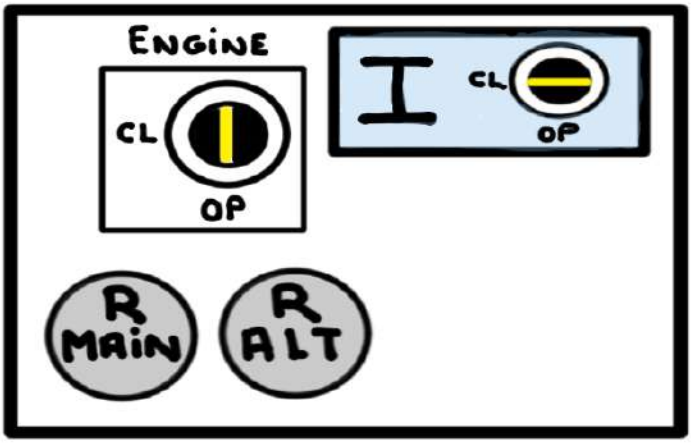
- Without Boost pump pressure the engines will:

① < 20,000' = suction feed

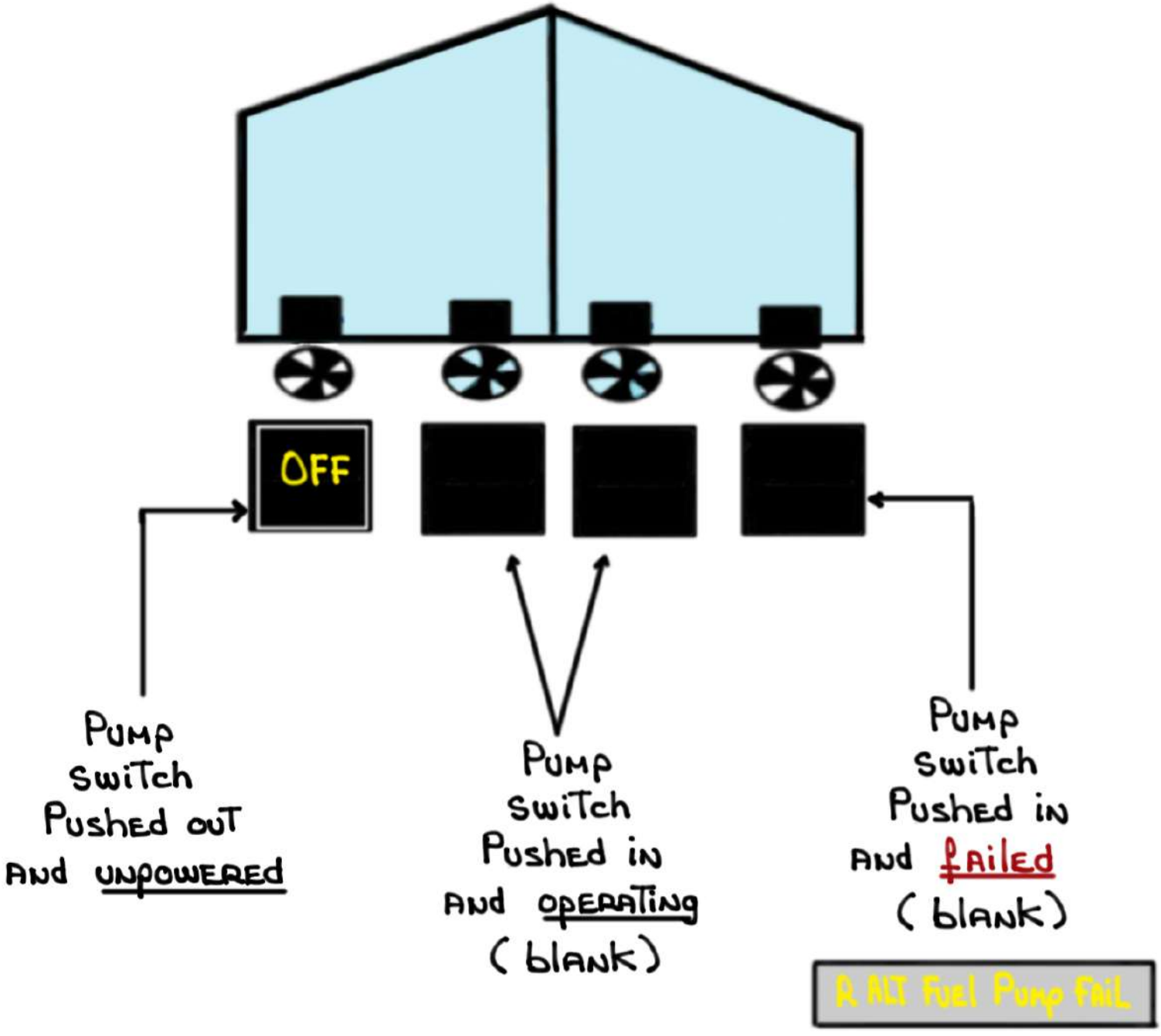
② ≥ 20,000' = run erratically and flameout

- 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

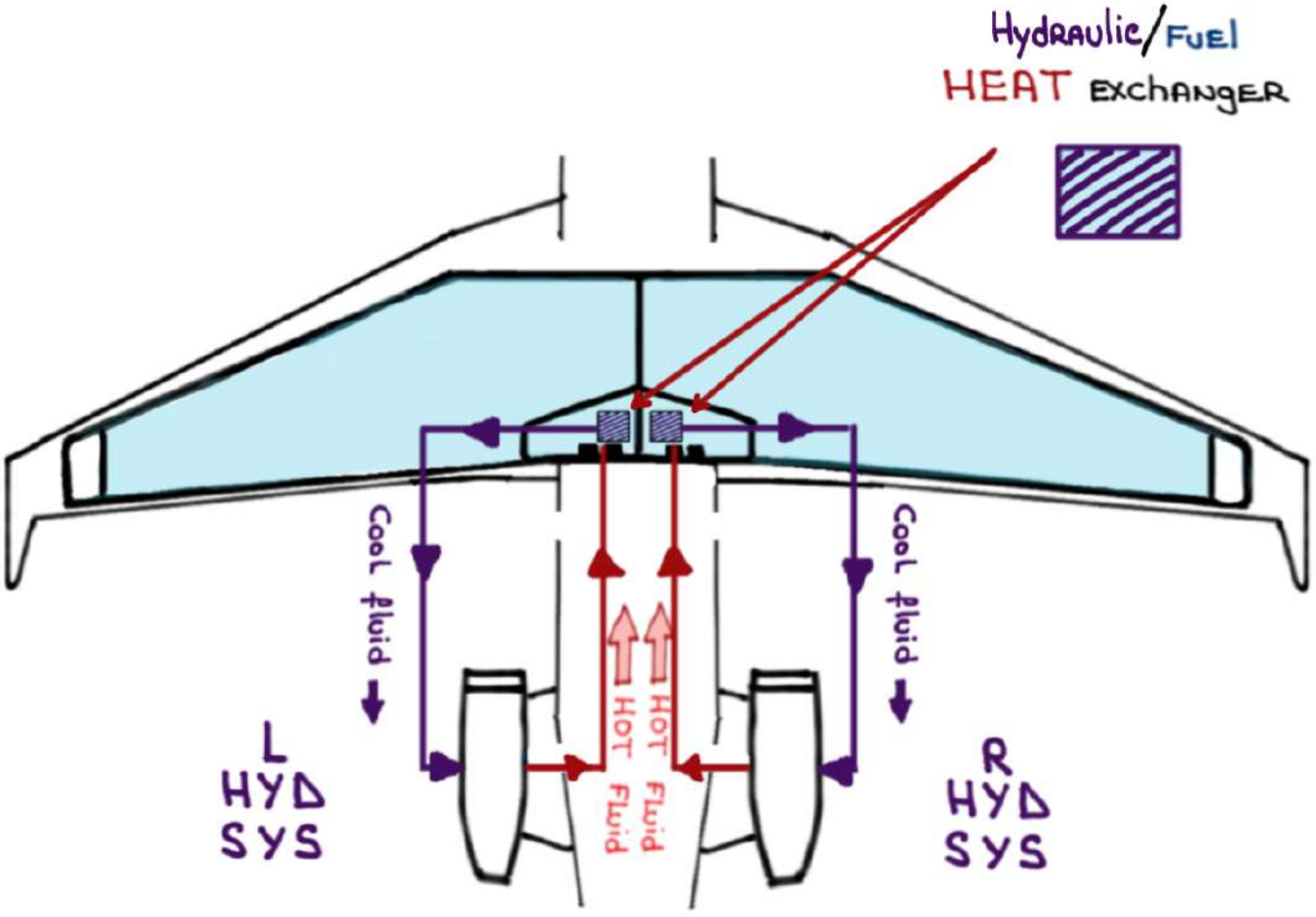




– Boost pump switch (indications)



- 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

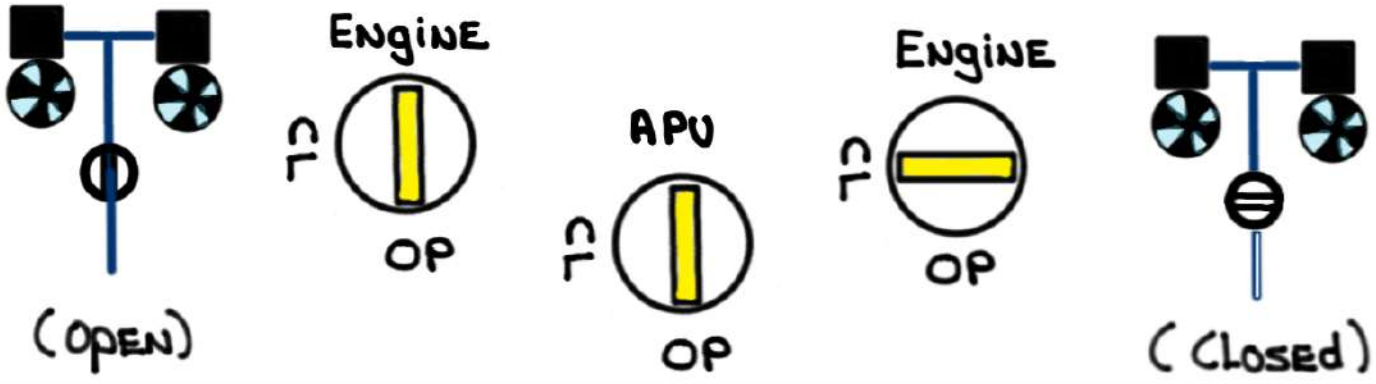
- There are Three (3) fuel shutoff valves (SOV)

  ① Left Engine
  ② Right Engine
  ③ APU

- Located in the wheel well and attached to the aft portion of the Hopper

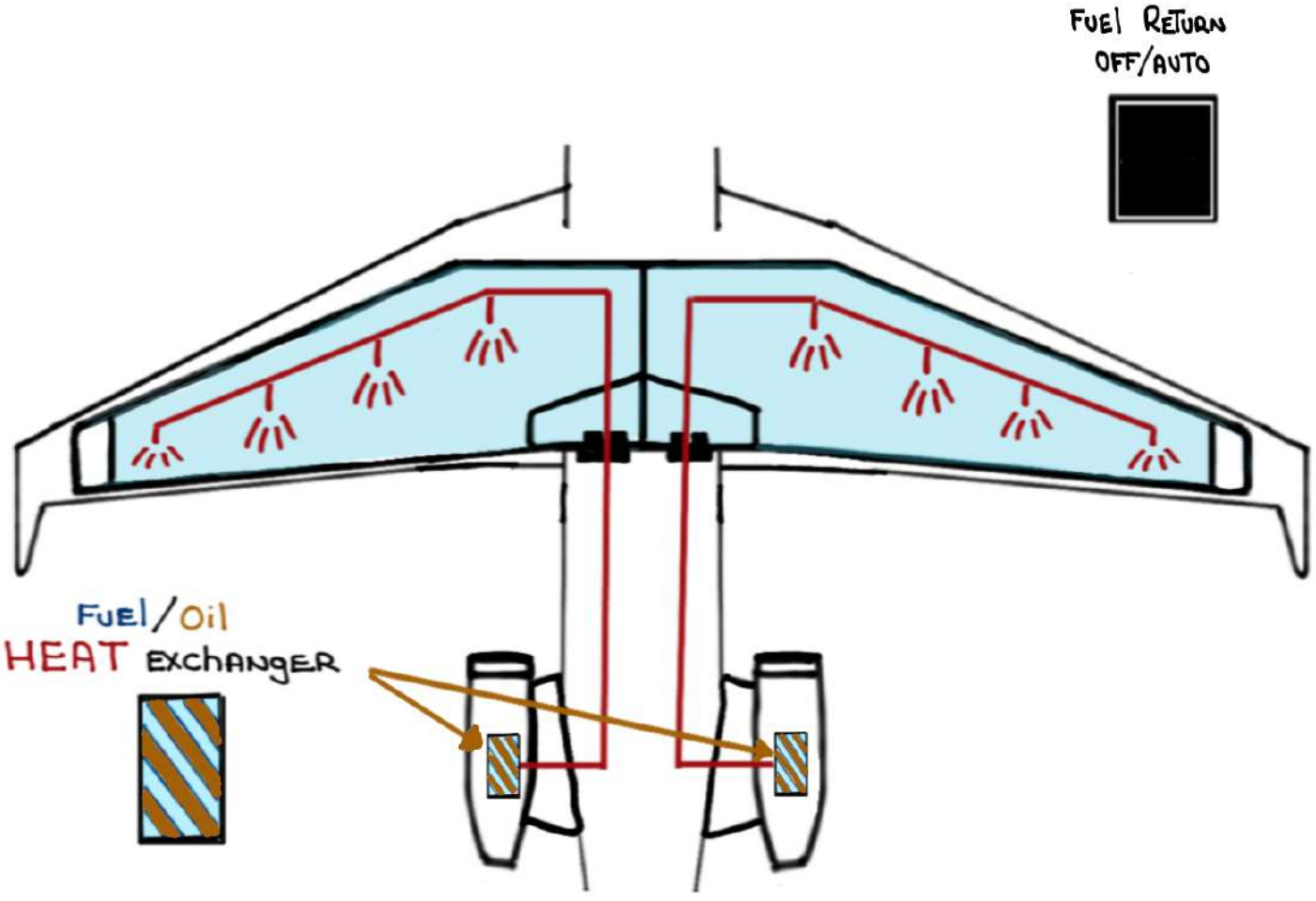
- Main engine SOV is operated by the respective **FIRE** handle in the cockpit and powered by its respective DC ESS bus

- SOV position indicator - wheel well



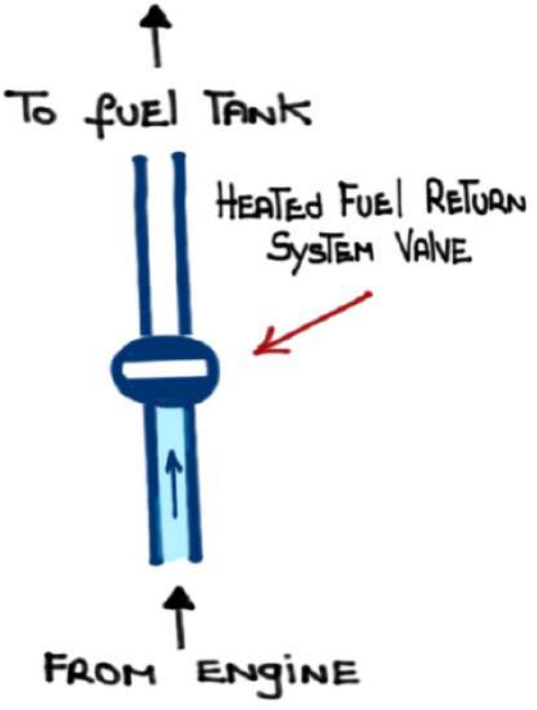
Heated Fuel Return System (HFRS)

- The HFRS prevents fuel tank temperatures from getting too cold during long range, high altitude flights
  - The HFRS 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:

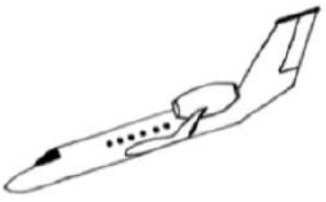
a) Fuel Tank Temperature > 10°C ✳
b) Crossflow Valve open ✳
c) Engine Thrust Lever setting at high power ✳
d) HFRS switch selected OFF ✳
e) Engine FIRE handle pulled/not stowed ✳
f) Low fuel pressure/quantity ✳
g) FADEC HFRS inhibit ON ✳
h) Engine fuel filter blocked ✳
i) Abnormal engine indication ✳



✳ Both Tanks

✳ Affected side

- Fuel Tank Temperature:



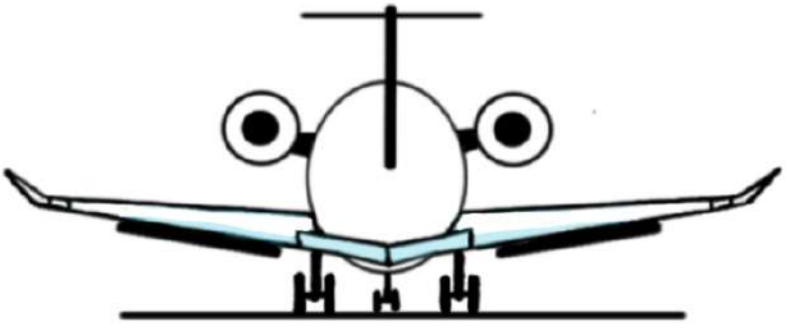
< -37° C

Fuel Tank Temperature

- 34.5 To -37°C

Fuel Tank Temperature

Descend To altitude SAT < -60°C

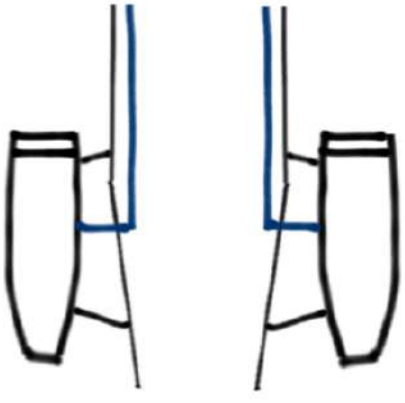


Delay Takeoff

≥ + 54° C

Fuel Tank Temperature

- Engine Fuel Temperature:



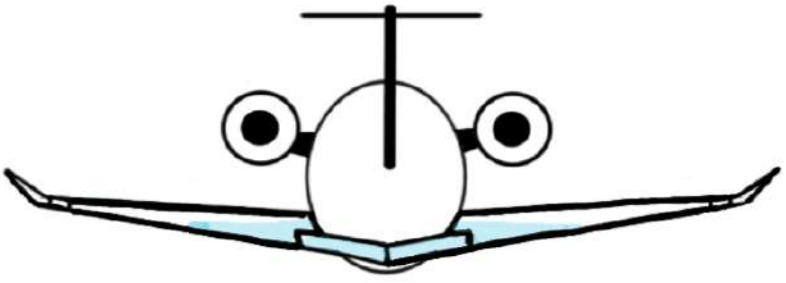
MAX: +165°C (15 minutes)

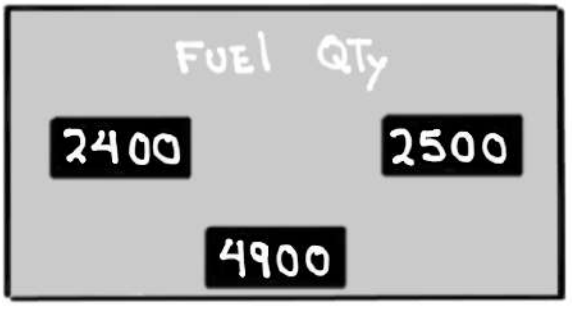
MAX: +140°C (unrestricted)

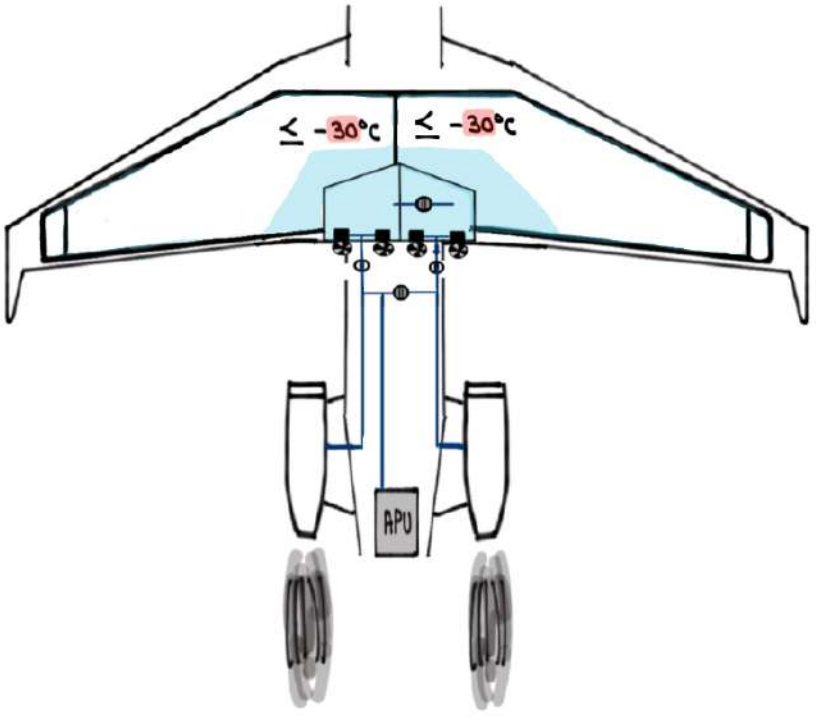
Min: -40°C

- If inflight with a fuel tank temperature ≤ -30°C and <5,000 lbs total remaining:

- Descend to an altitude where the SAT is -60°C or warmer and maintain a speed of M.080 or greater







SAT

-70°C

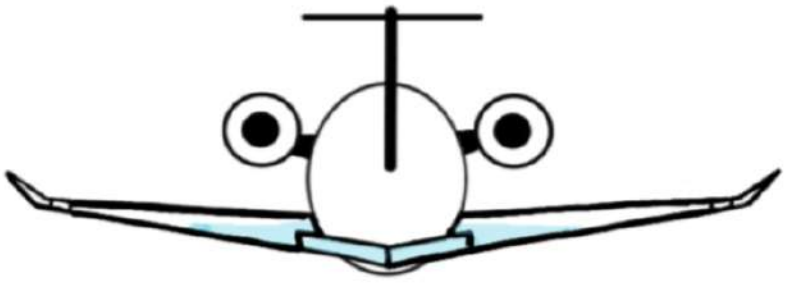
-65°C

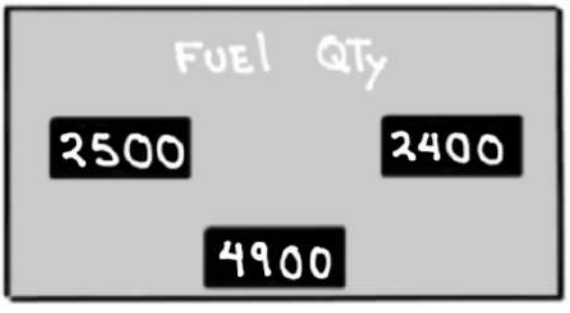
-60°C

Mach 0.80 or higher

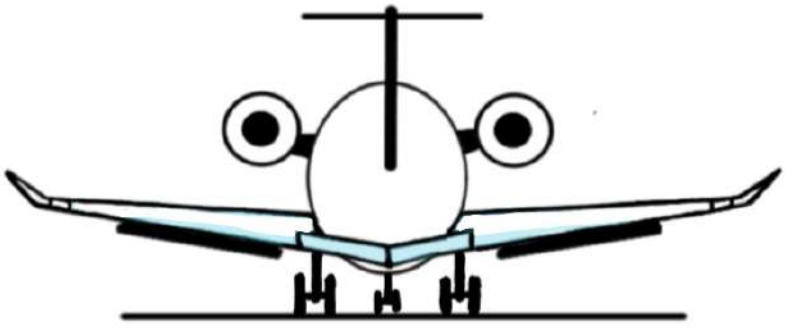
-55°C

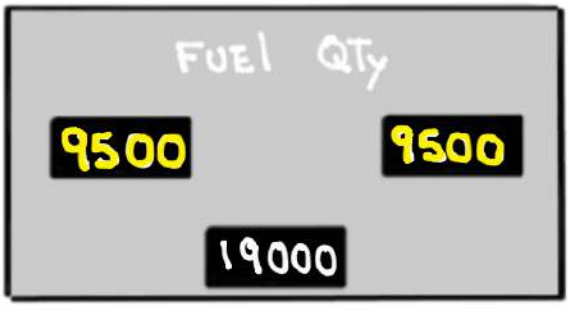
- Prolonged flight at altitudes with temperatures colder than -70°C with fuel tank temperatures colder than -30°C and less than 5,000 lbs fuel remaining:



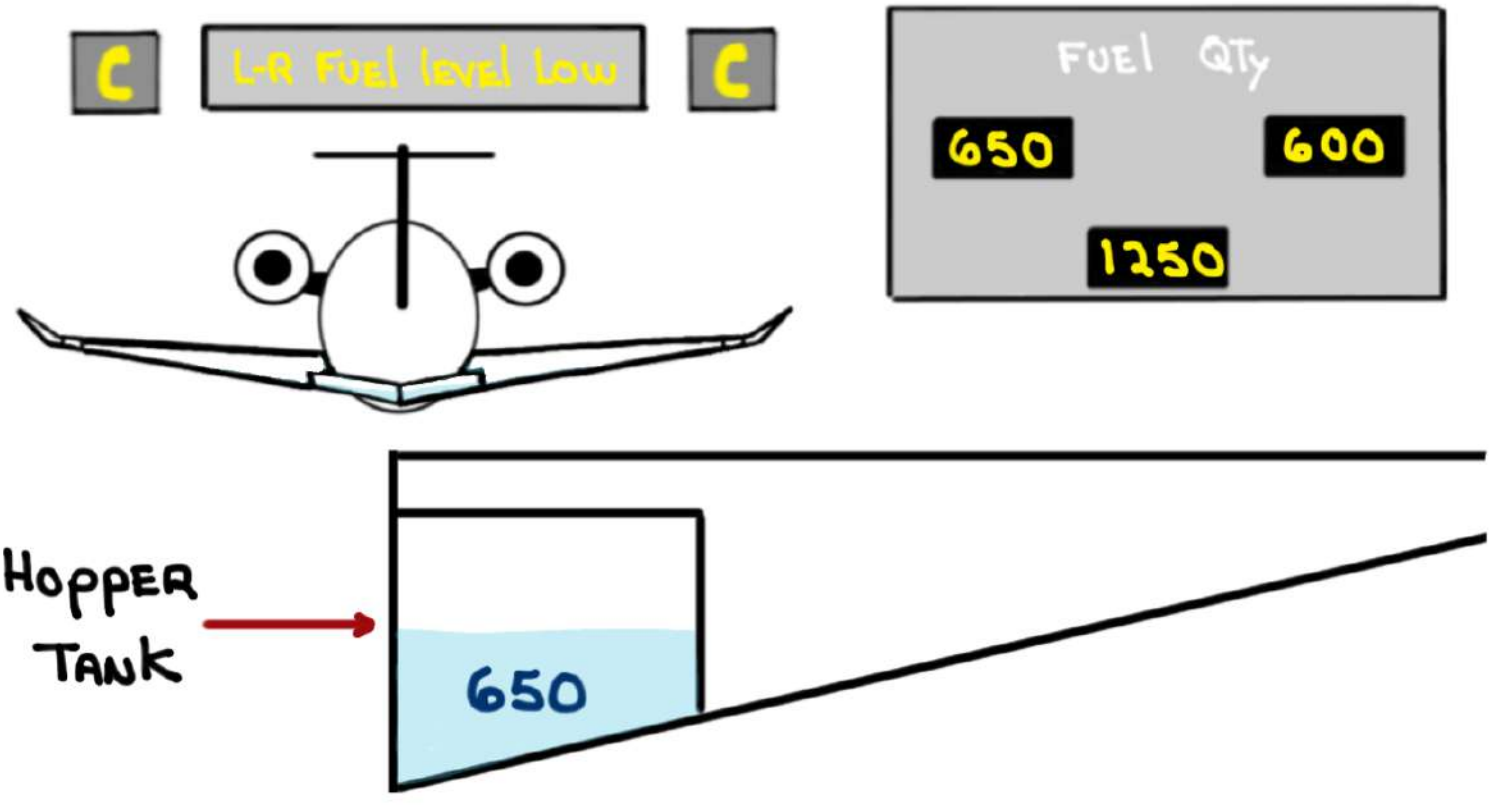


- Prolonged ground operation with ≤ 10,000 lbs of fuel in each tank:
  - Turn fuel boost pumps ON to refill the hoppers





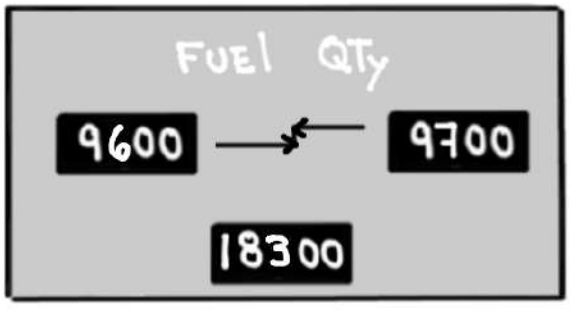
- ≤ 650 lbs remaining in either or both hoppers



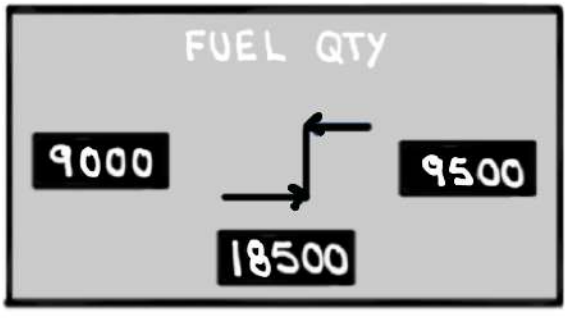
- NEVER fly with less than 650 pounds of fuel in either side of your 650!
- PROCEED to nearest available airport and land
- AVOID extreme nose high/low attitudes, excessive forward acceleration and uncoordinated flight maneuvers
- DO NOT go-around with < 600 pounds in either tank

Fuel Imbalance Arrows

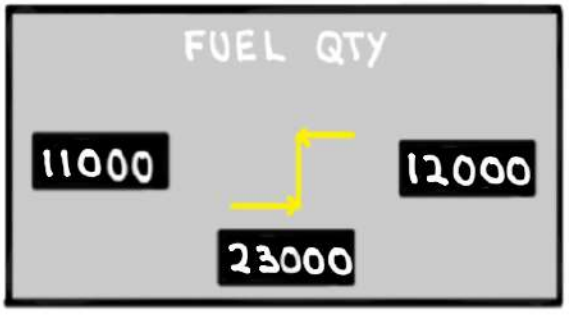
- Fuel arrows appear when a fuel imbalance condition exists
  - Arrow colors and deflection indicate severity level
  - Higher side higher arrow



Appears at 100 lbs imbalance

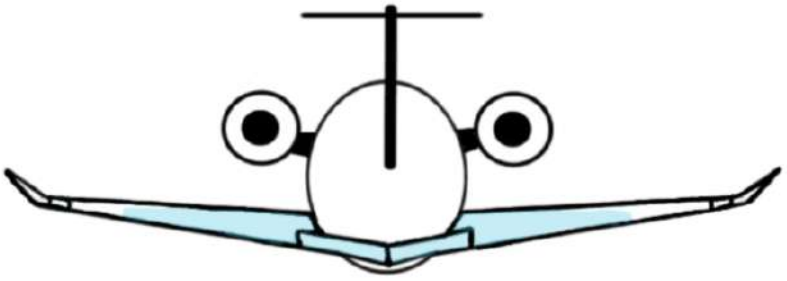


Full scale deflection at 500 Lbs imbalance



Full scale Turns AMBER at 1000 Lbs imbalance

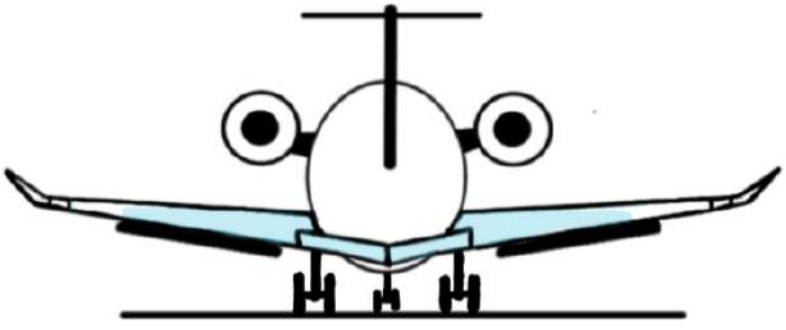
Maximum Fuel Inbalance



FUEL IMBALANCE

Inflight: 2,000 lbs.

* Proceed with balancing before imbalance ≥ 1,000 lbs.



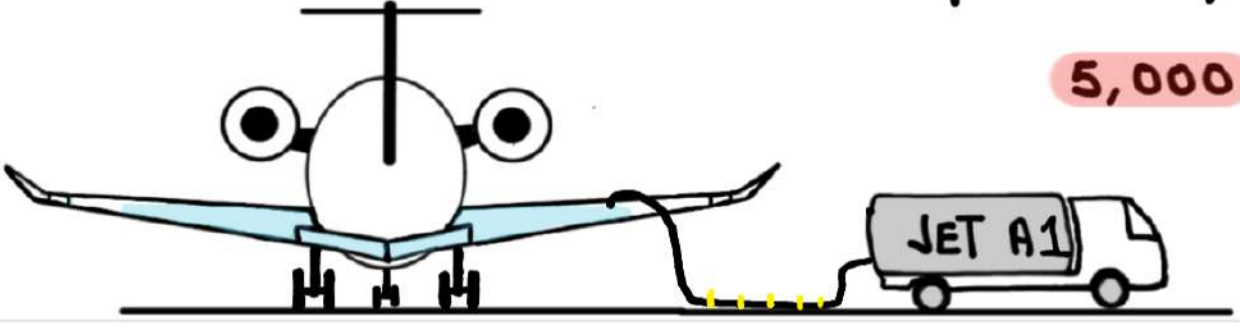
FUEL IMBALANCE

Takeoff: 1,000 lbs.

Refueling operations

(pressure / gravity)

5,000 lbs



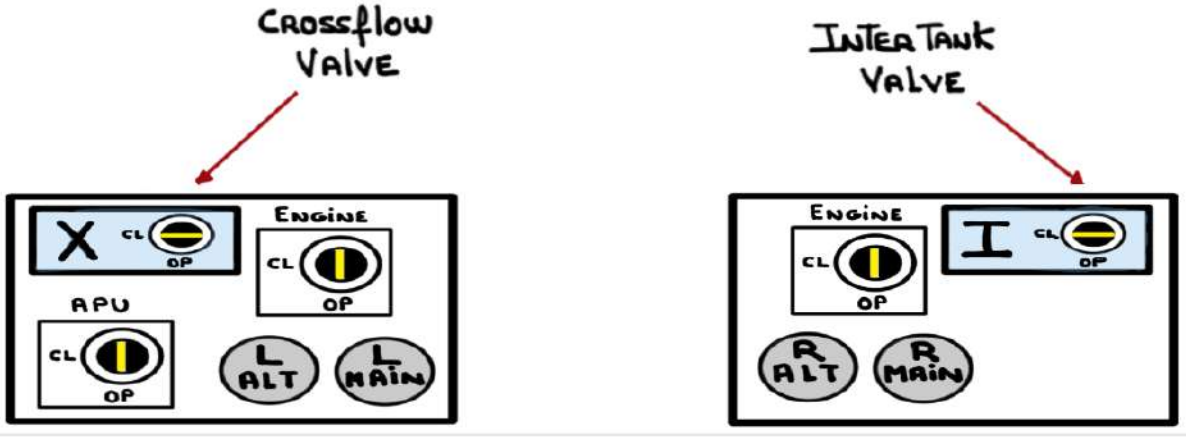
- In the event of a fuel imbalance condition (2) two methods are available to balance fuel:

① <u>InterTank Valve</u>:

- When **OPEN** it allows fuel to gravity flow between the right and left fuel tanks via the Hoppers
- Approximately 1/2 zoid displacement when applying rudder trim

② <u>Crossflow Valve</u>:

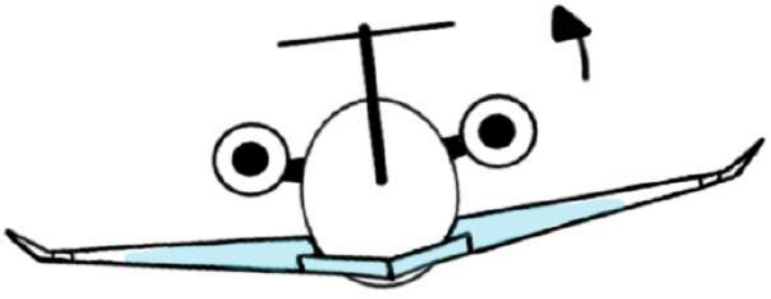
- When selected **OPEN** and boost pumps on light side are selected **OFF** allows fuel from heavy tank to feed both engines
- Rear wing beam



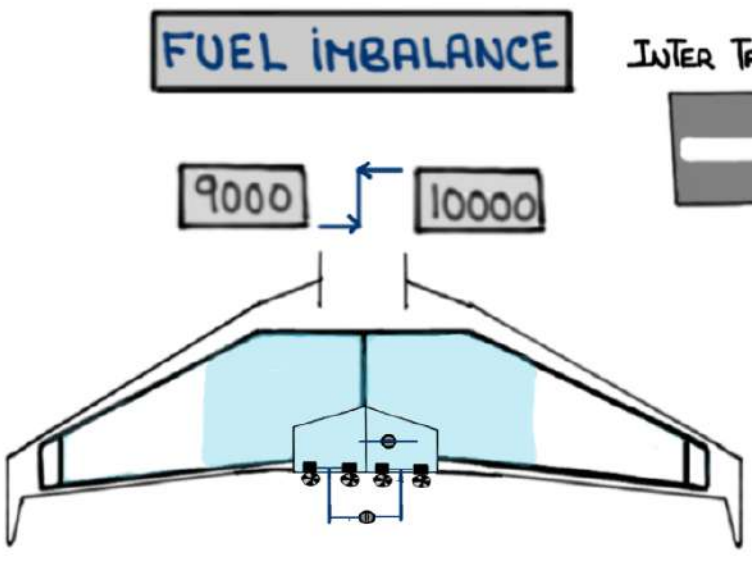
Method 1: Inter Tank

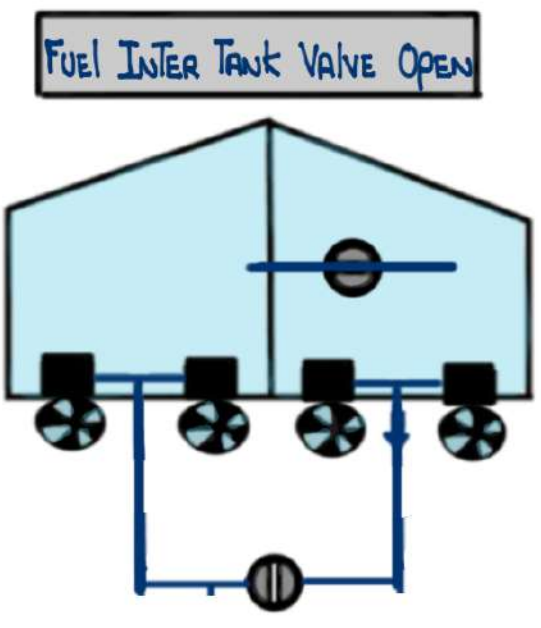
① Autopilot ON, Level flight

② Manually adjust Rudder Trim Towards The heavy wing



③ Open Inter Tank valve and monitor fuel progress



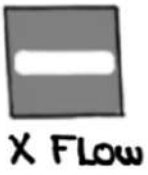


④ Close Inter Tank valve when within 200 lbs or so

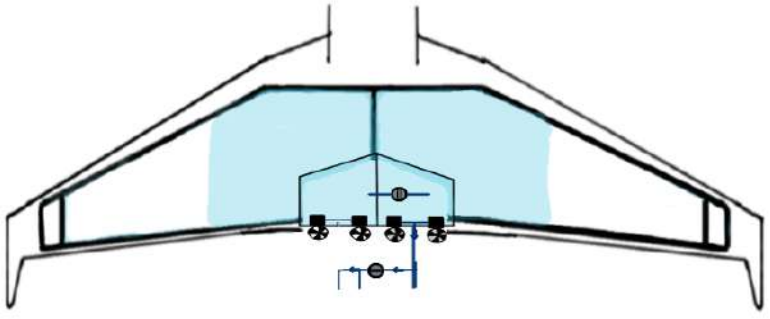
⑤ Retrim rudder

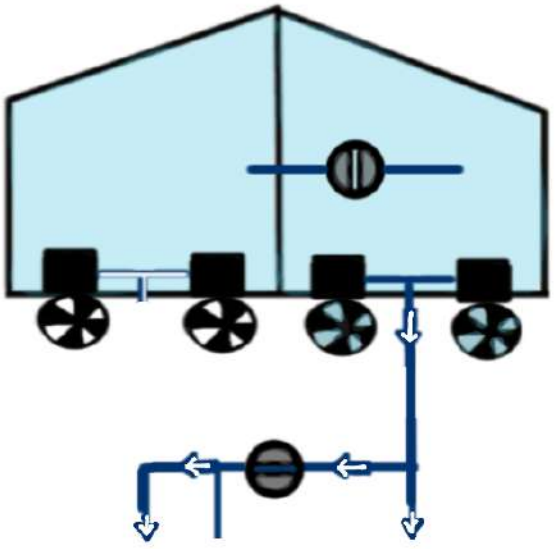
Method 2: Crossflow

① Open Crossflow valve



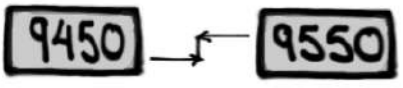
② Turn OFF boost pumps, one at a time, on lighter wing





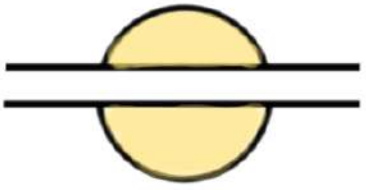
③ Turn ON boost pumps

④ Close Crossflow valve when desired balance is achieved

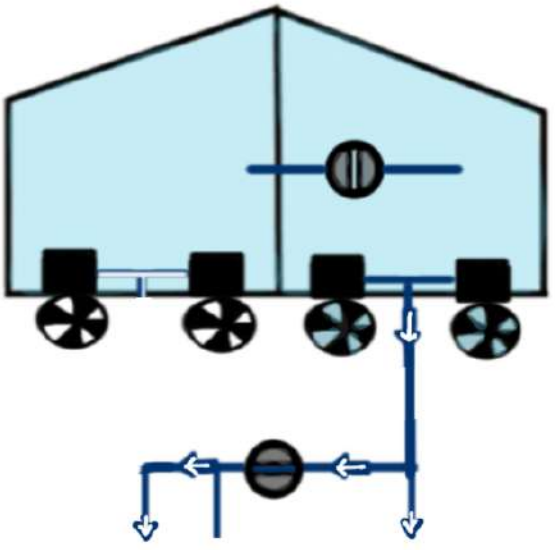


- The crossflow valve has a five (5) minute timer to alert the crew that it is still open. The CAS message turns amber (CAUTION) and a double-chime aural tone will sound

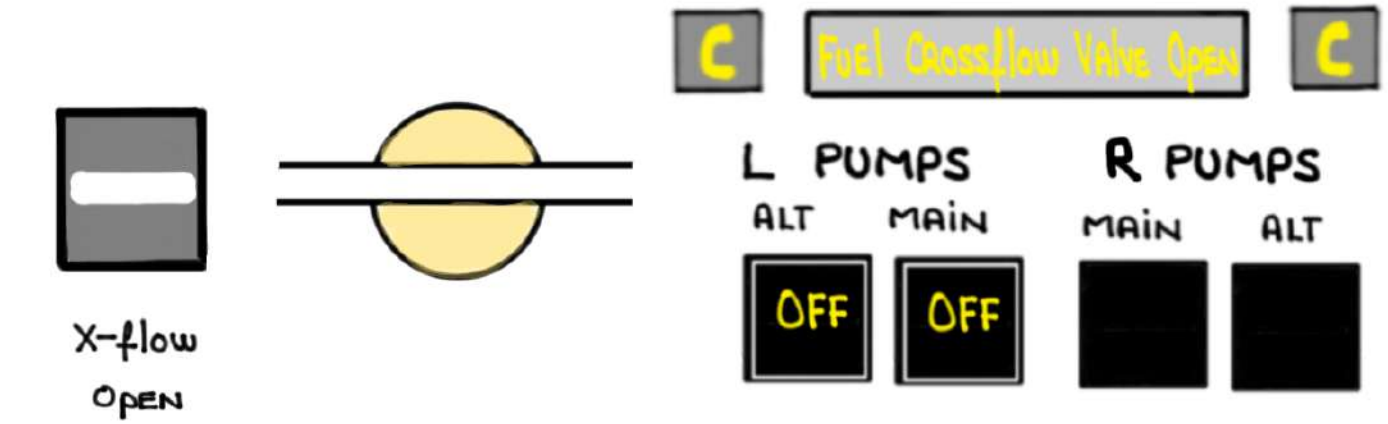
The crossflow valve on the fuel synoptic page will also turn amber

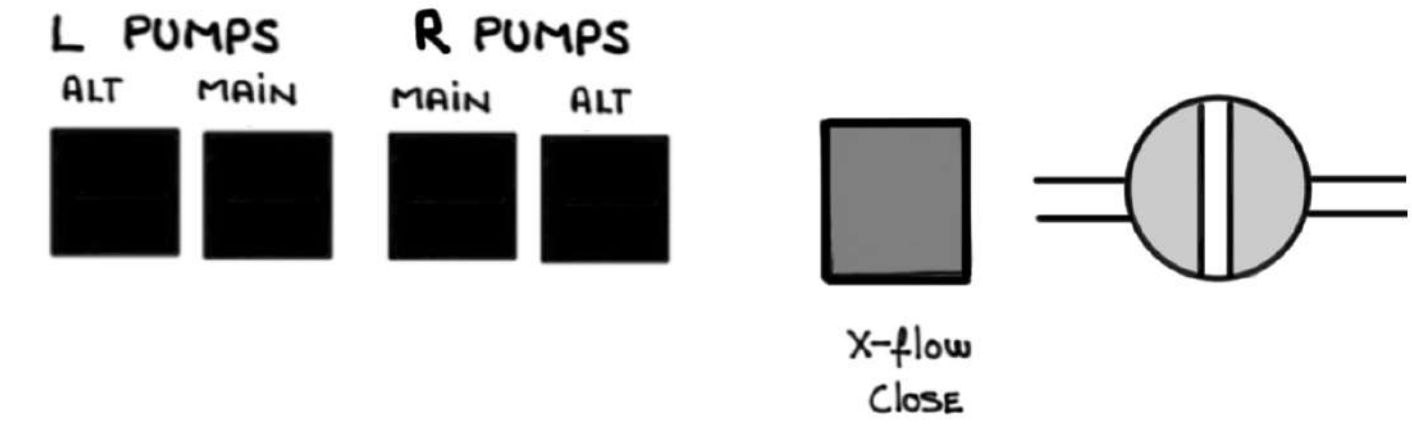


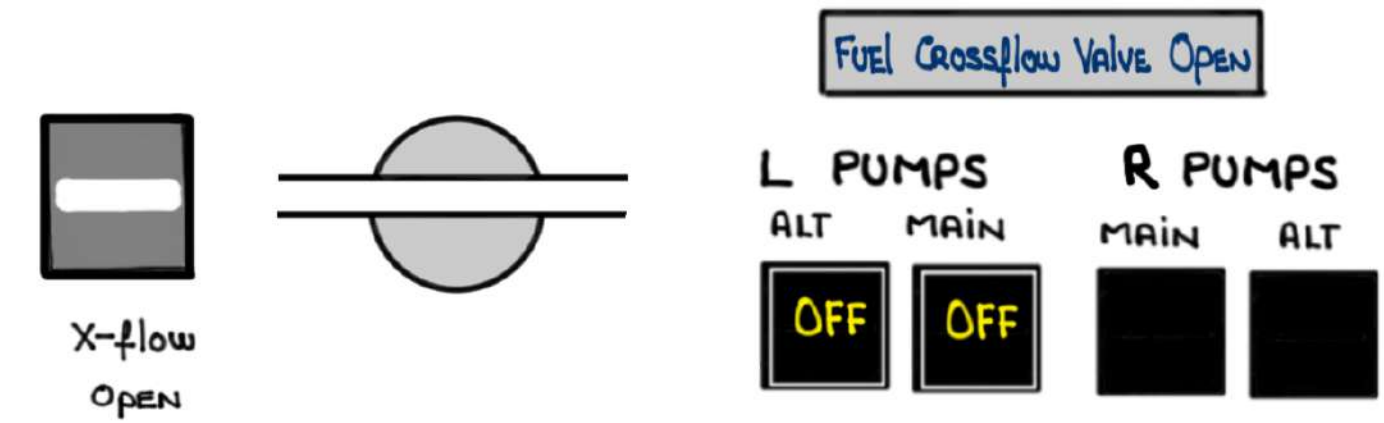
> 5 minutes



After reassessing the status of the fuel imbalance reset the timer by cycling the crossflow valve closed and then, if required, open it again

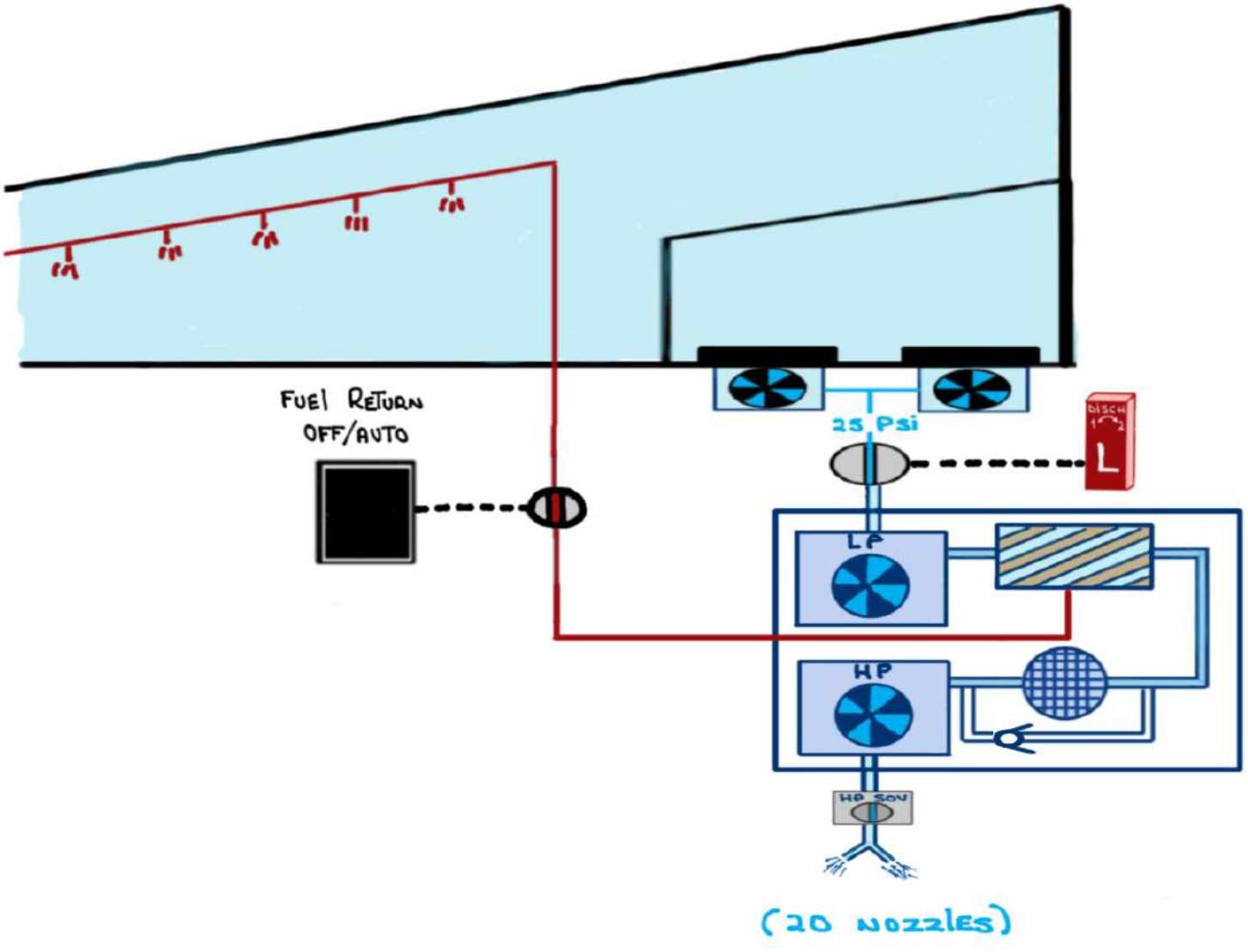




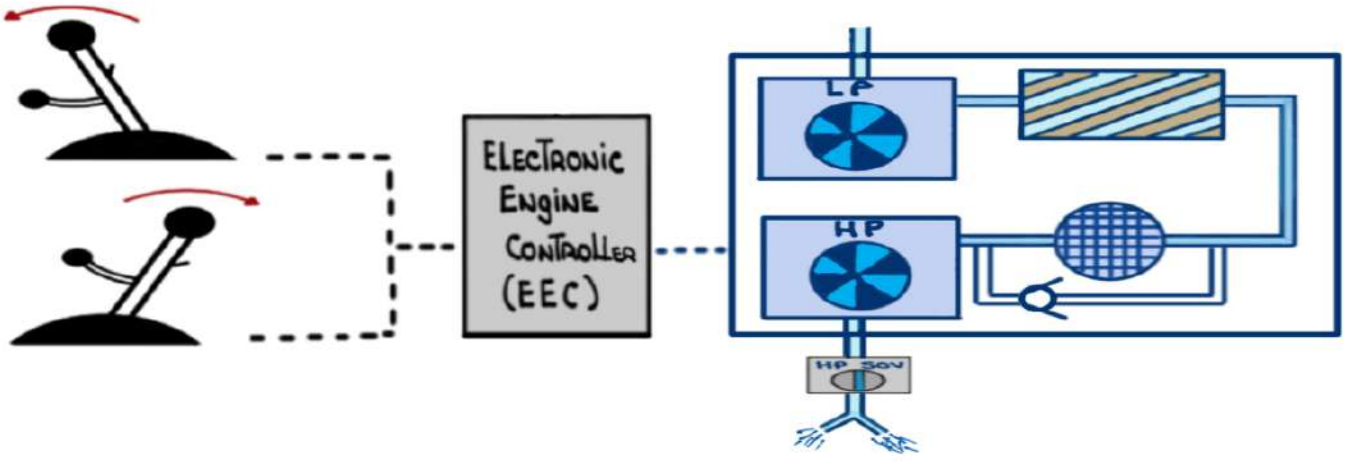


Engine Fuel System

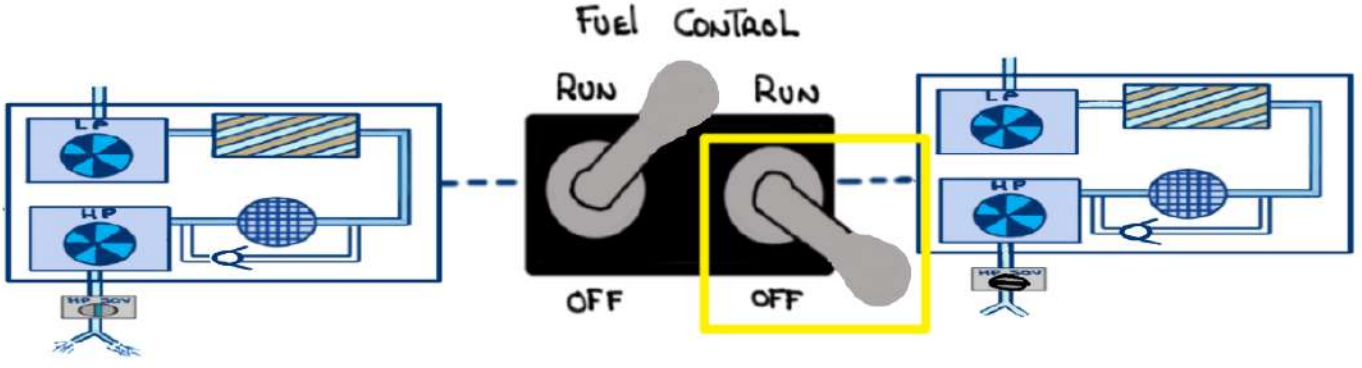
- Metered fuel from Tanks' boost pumps To nozzles
- Introduction of fuel is controlled by The EEC
- Low pressure fuel coming from The wings
- High pressure fuel coming from The Fuel Metering Unit (FMU)



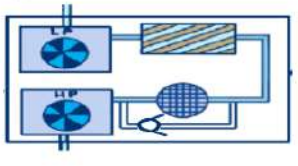
- As Thrust Levers are advanced or retarded the EEC commands the FMU to modulate fuel to nozzles

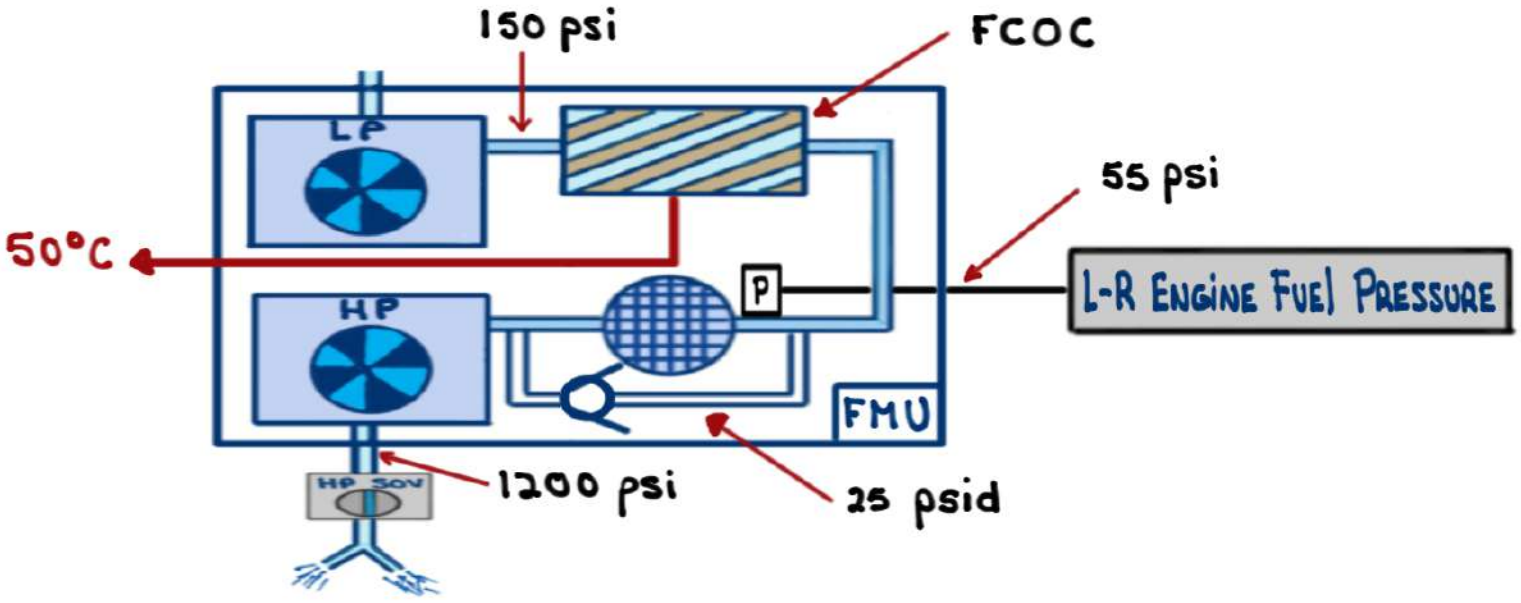


- Placing a fuel control switch to OFF closes FMU. All fuel is cutoff to the fuel nozzles and the engine shuts down



- The FMU contains Two (2) internal pumps:
  - Low pressure (LP) 1ST stage →
  - High pressure (HP) 2nd stage →





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

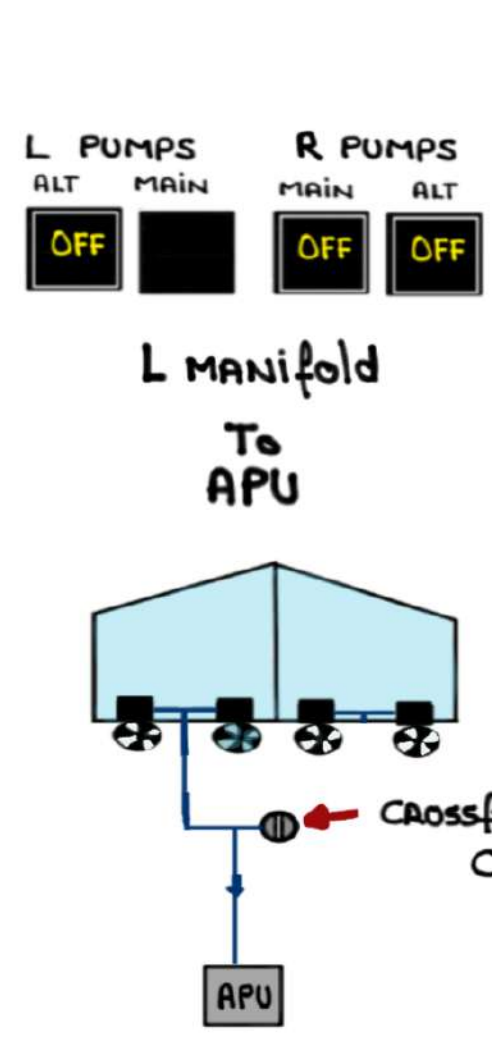
- A fuel filter <u>receives</u> fuel from the 1st stage LP pump and <u>removes</u> debris and contaminants

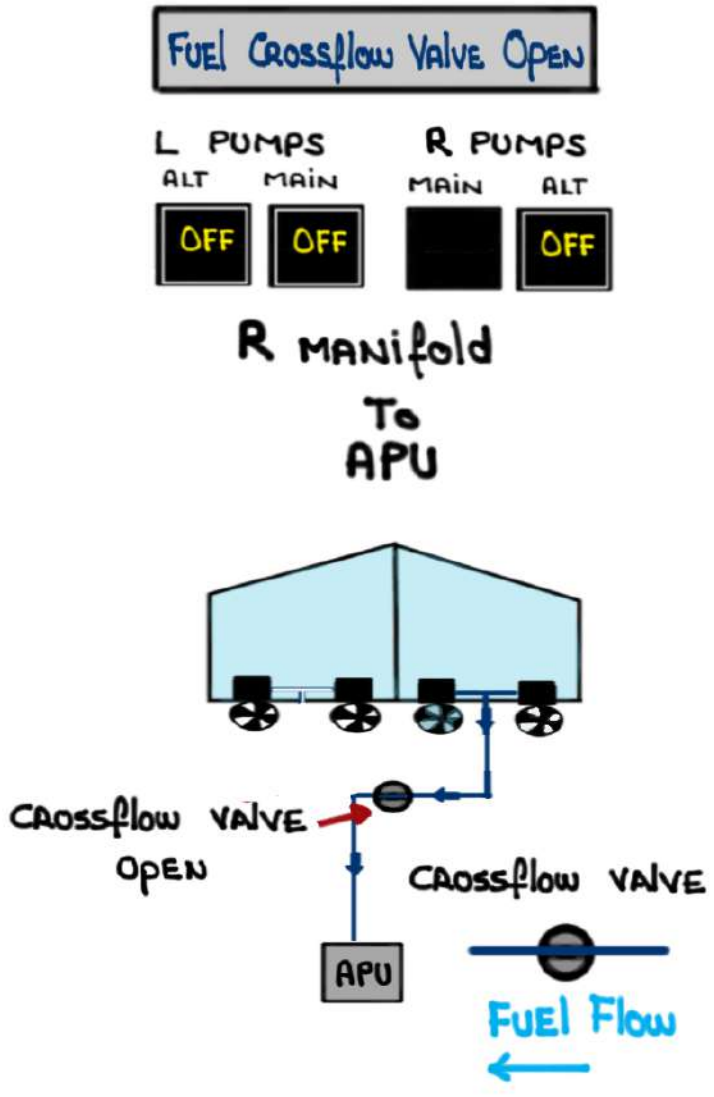
- A filter bypass valve ensures <u>continual</u> → fuel flow to the engine if filter is blocked

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

APU Fuel Supply

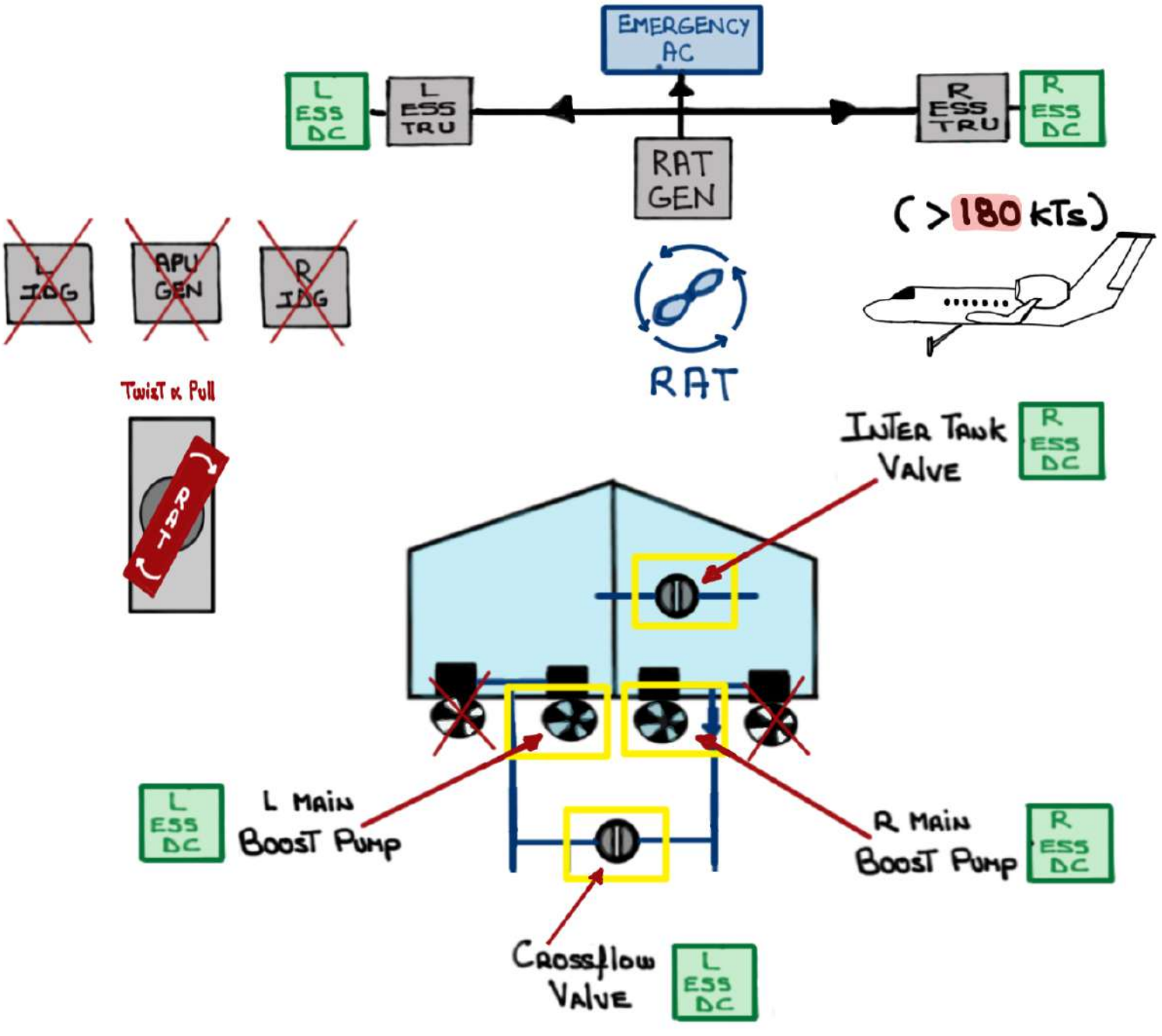
Fuel is normally supplied from the left fuel manifold but it can also be supplied from the right manifold by temporarily opening the crossflow valve





RAT Operations

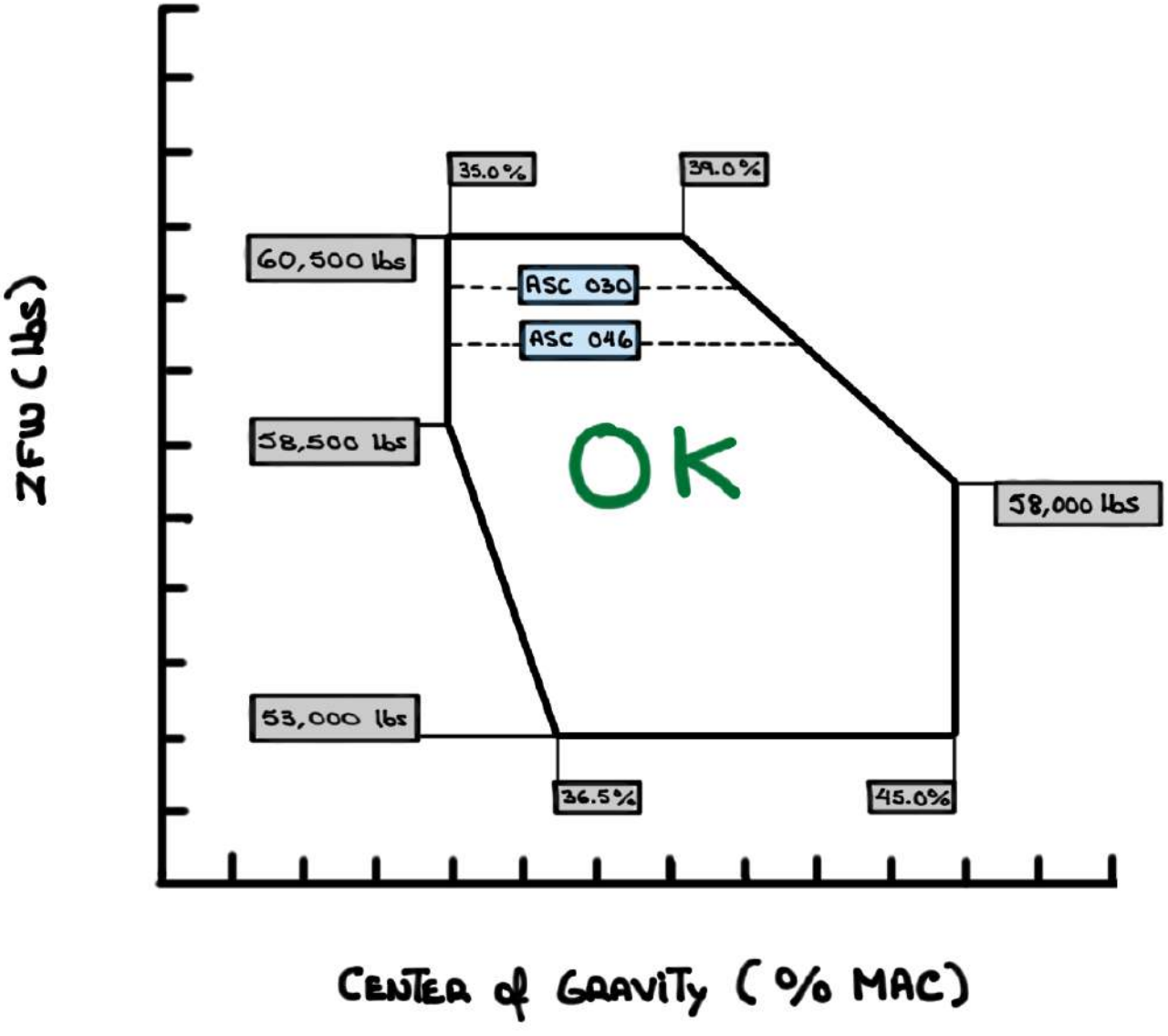
When operating with the **RAT** the following fuel system components remain operative



NOTE: Six (6) percent fuel penalty with RAT deployed

MAXIMUM ZERO FUEL WEIGHT: 60,500 lbs

ZFW C.G. ENVELOPE AFM 01-03-70

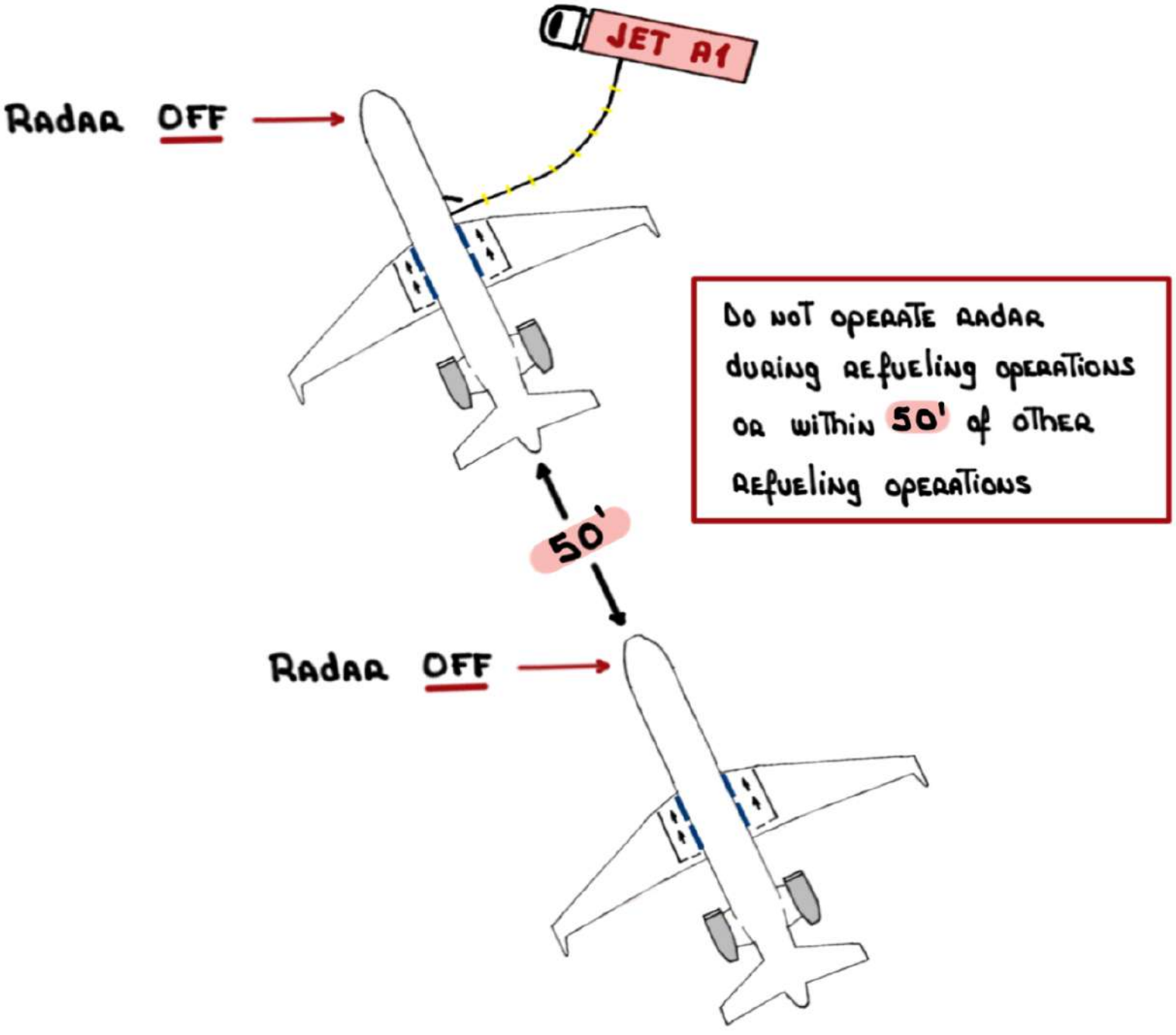


ZFW MUST BE WITHIN ZFW C.G. ENVELOPE

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

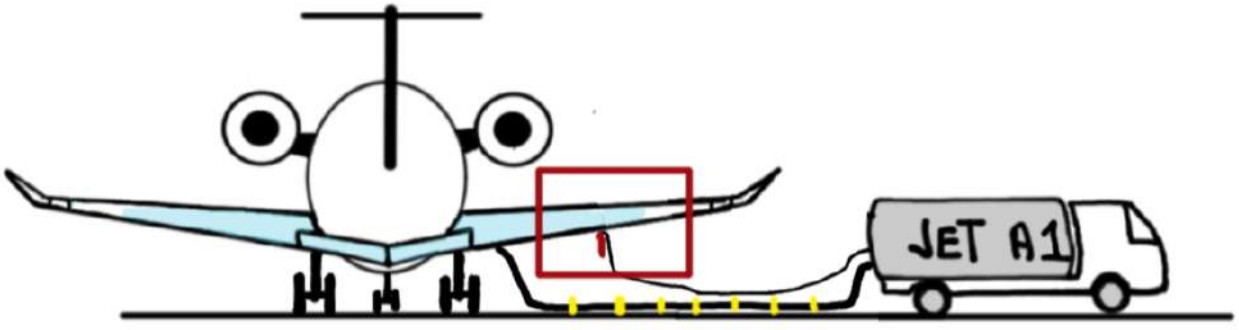
- TAXI
- INFLIGHT
- TAKEOFF
- LANDING

Fueling operations

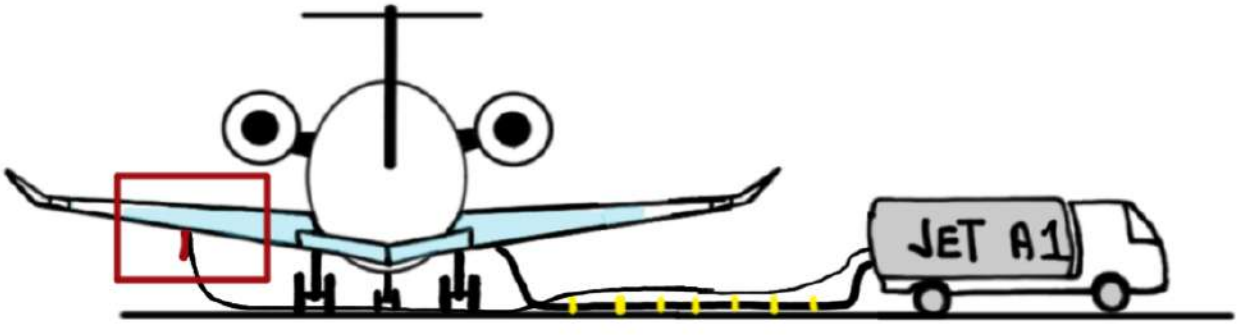


Do not operate radar within eleven (11) feet of ground personnel

Before refueling, ensure airplane is bonded To the fuel source

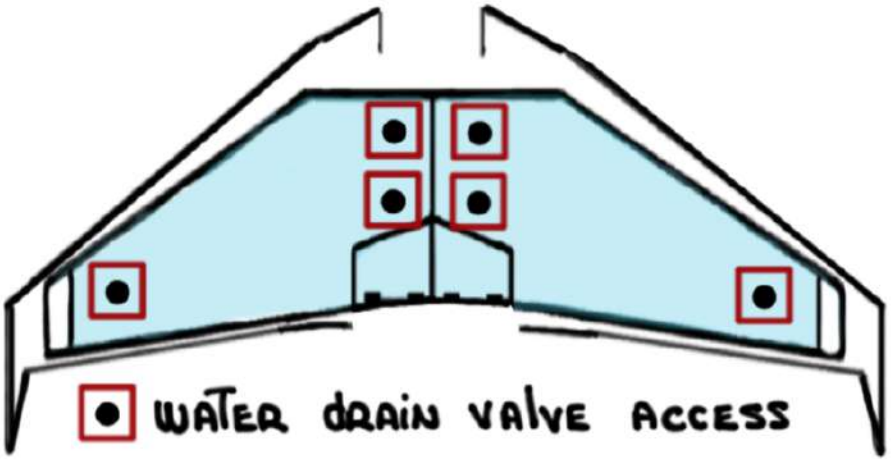


Grounding jacks are located in The lower Trailing Edges



Water contamination/fuel tank damage prevention measures

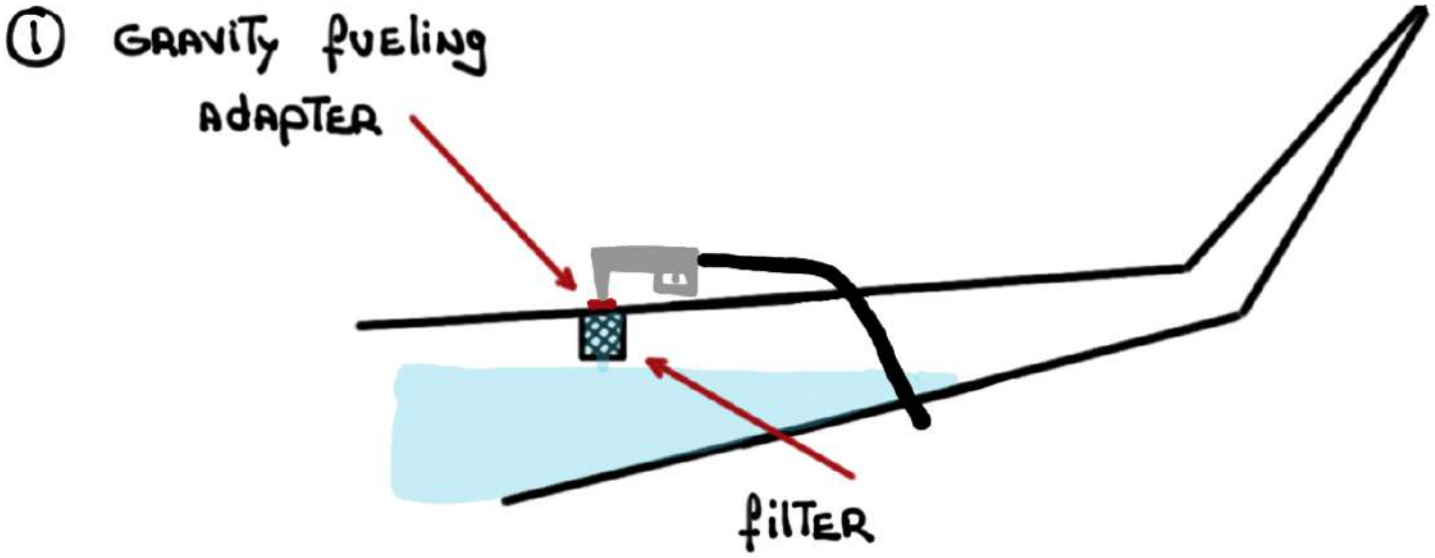
- Biobor JF aviation fuel biocide treatment:
  - * kills and prevents microbial growth
  - * Prevents microbial corrosion issues and filter plugging
- Fuel tank sumping at consistent water draining frequencies

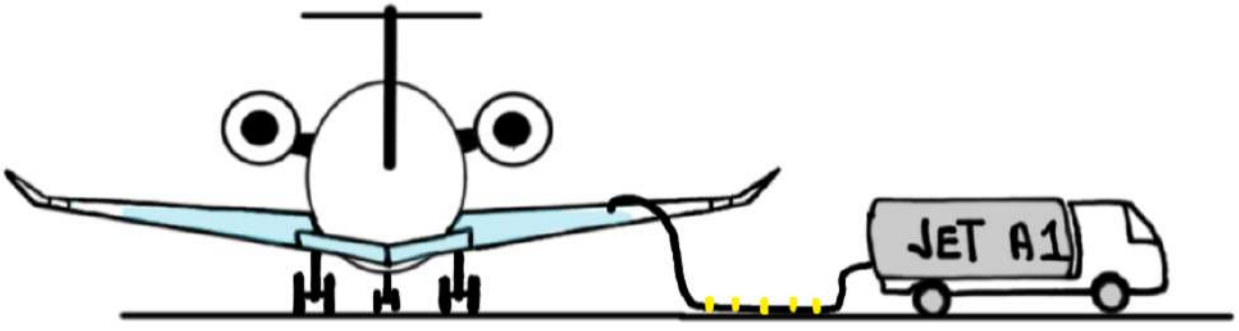


- Fuel quality check of fuel source prior to each refueling operation

Fuel Filtration

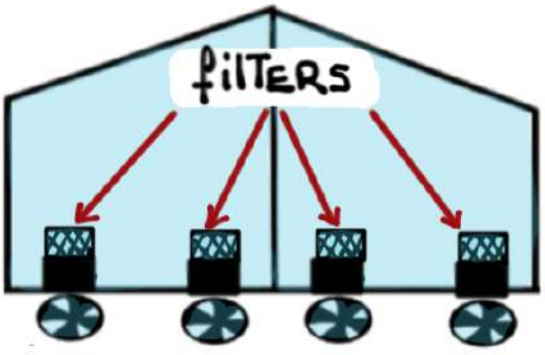
The fuel filtration system prevents contaminants from entering the wing tanks during overwing gravity refueling



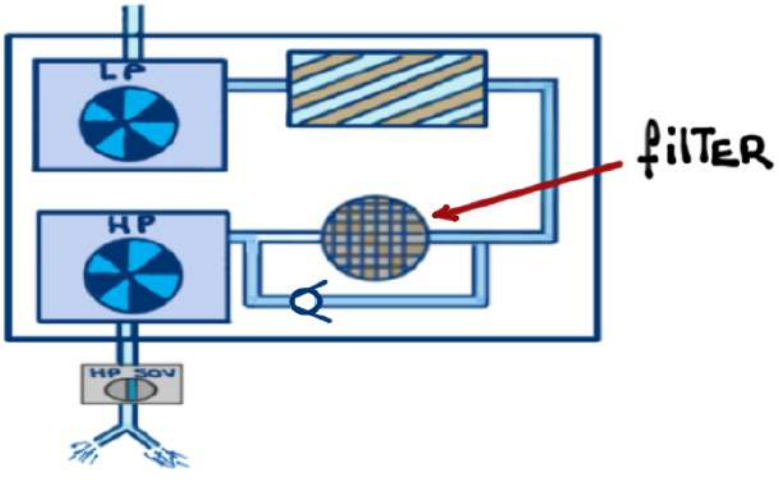


Filtration is also accomplished as follows:

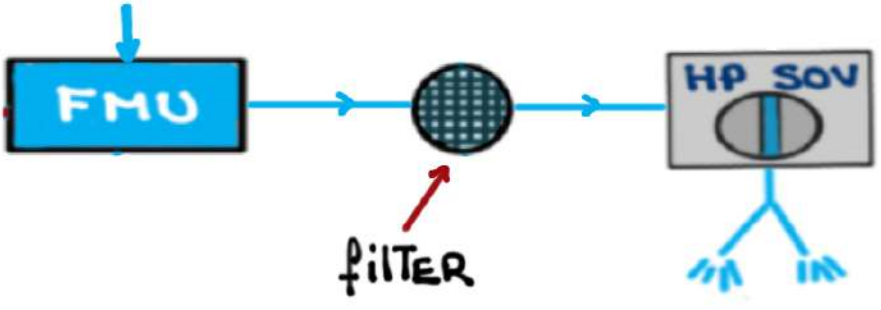
(2) At the inlets of all four (4) boost pumps



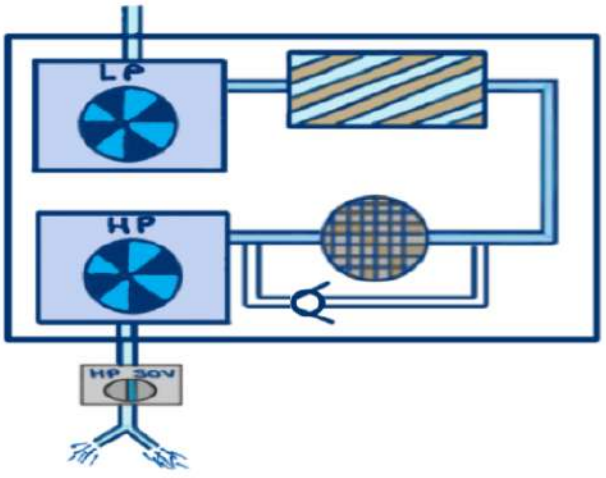
(3) Prior to the HP pump (LP filter)



(4) After the Fuel Metering Unit (FMU)



Impending blockage of indicated LP filter:



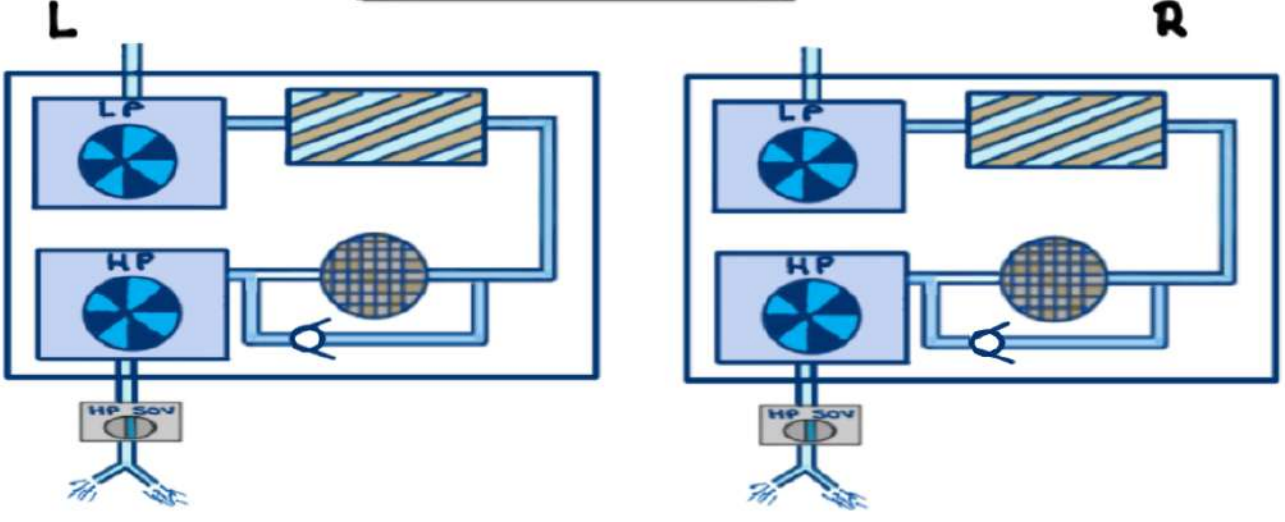
L Fuel Filter

OR

R Fuel Filter

Fuel bypassing indicated filter OR impending blockage/bypassing of <u>both</u> LP filters:

L-R Fuel Filter

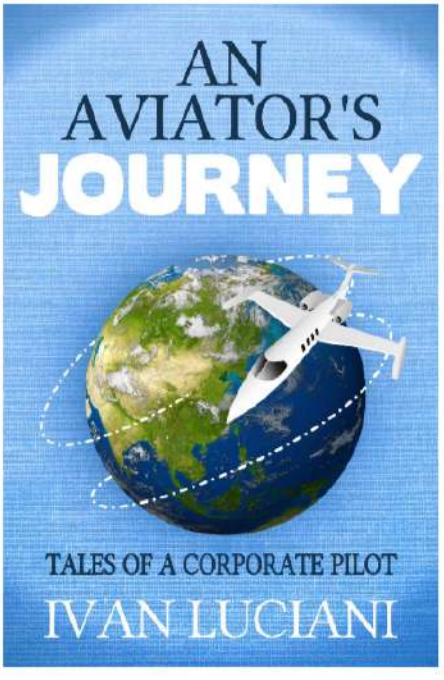


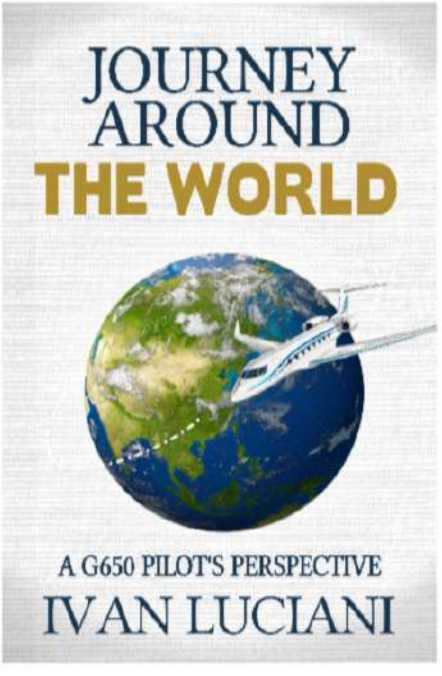
25 psi differential = filter bypasses

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!