G650 FUEL SYSTEM
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.

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g650_fuel_system 4 / 31 11/3/18
- 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 adjacent 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

![Diagram of one way flow](image)

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:
  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.
• 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
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 of heated fuel @ 50°C per minute
• 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

[Diagram of heated fuel return system]
- **Fuel Tank Temperature:**

  - Descend to altitude SAT < -60°C
  - Fuel Tank Temperature
    - < -37°C
    - -34.5°C to -36°C
    - Fuel Tank Temperature
    - > +54°C
    - Fuel Tank Temperature

- **Delay Takeoff**

- **Engine Fuel Temperature:**

  - Max: +165°C (15 minutes)
  - Max: +140°C
  - Min: -40°C
- If inflight with a fuel tank temperature of \(-30^\circ\text{C}\) and <7,000 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.
- Prolonged flight at altitudes with temperatures colder than \(-70^\circ C\) with fuel tank temperatures colder than \(-30^\circ C\) 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
- ≤ 650 lbs remaining in either or both hoppers

- 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.

**Appear at 100 Lbs Imbalance**

**Full scale deflection at 500 Lbs Imbalance**

**Full scale turns amber at 1000 Lbs Imbalance**
**Maximum Fuel Imbalance**

- **Inflight**: 2,000 lbs.
  - *Proceed with balancing before imbalance > 1,000 lbs.*

- **Takeoff**: 1,000 lbs.

- **Gravity Refueling**: 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, it allows fuel from heavy tank to feed both engines.

- Rear wing beam.

![Diagram of Crossflow Valve and Intertank Valve with labels and icons]
**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 tank's boost pumps to fuel nozzles
- Introduction of fuel is controlled by FADEC
- Low (LP) and High (HP) pressure pumps are driven by engines' accessory gearbox
- FCOC extracts heat from hot engine oil
- LP pump can suction feed the engine ≤ 20,000'
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:

- L_ESS DC
- L_ESS TRU
- R_ESS TRU
- R_ESS DC
- RAT GEN

(*) > 180 Kts

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Inter Tank Valve

L Main Boost Pump

R Main Boost Pump

Crossflow Valve

L_ESS DC

R_ESS DC
- **ZERO FUEL WEIGHT**: 60,500 lbs

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

ZFW C.G. MUST BE WITHIN ENVELOPE

Fueled airplane C.G. will then remain within C.G. POR:
  - Taxi
  - Takeoff
  - In flight
  - Landing

- **WEATHER RADAR OFF - FUELING OPERATIONS**

- During fueling operations the truck and the aircraft must be bonded
Questions, comments or errors...please send me an email: ivan.luciani@gmail.com

Thank you!