G650 Hydraulic System
The Hydraulic System is about the storage and delivery of hydraulic fluid (Skydrol) under high pressure to actuate various systems.

Two (2) main systems

Supported by two (2) sub-systems
Hydraulic System Components

Reservoir: To store fluid
- Compressed by bootstrap to prevent cavitation
- Located in the tail compartment
- System must be pressurized for accurate quantity checks

Shutoff valve: To shutoff hydraulic fluid to the engine in the event of engine fire or failure

Fire Handles

Pump: To pressurize system
- Engine-driven pump
- Located in the engine's gearbox
- 3,000 ± 300 Psi
Filter Manifold: To filter hydraulic fluid and control direction of flow
- Located in the tail compartment
- Left Hydraulic System: Six (6) filters
- Right Hydraulic System: Three (3) filters

Hydraulic fluid-to-fuel heat exchanger:
To cool hydraulic fluid and to warm up cold fuel
- Located in the on-side fuel hopper
- Continuous flow

Accumulator: To absorb system shocks
- Pre-charged to 1,200 Psi @ 70°F
- Absorbs fluid shocks within the system
- Provides minimum pressure of 1,200 Psi
- Serviced with nitrogen
- Located in the tail compartment
L Hydraulic System

- Independent and isolated from Right Hydraulic System
- Supported by the AUX pump and PTU sub-systems

To Hydraulically-powered Systems
- Total capacity: 19.38 gallons
- Largest reservoir: 4.55 gallons
- Considered full at: 3 gallons

- Six (6) filters (electronically monitored via CMC)
  - Four (4) non-bypassable
  - Two (2) bypassable

- Powered by the left engine-driven pump (EDP)
  - Mounted on engine gearbox
  - Constant pressure, variable volume pump
  - Pressurizes fluid to 3,000 ± 300 Psi
  - Flow rate varies based on power setting

- Failure of EDP results in loss of:

  1. Left thrust reverser
  2. Mid spoiler panels

(285 KCAS/M0.90 maximum)
- **Offload Feature:**

  - Automatically controlled by Electronic Engine Controller (ECC)
  - Reduces pump outlet pressure in flight when engine drops below idle (<55% N₂)
  - Reduces drag on engine to maximize airstart capability

- **Largest Reservoir:**

  - Considered full at 3 gallons
  - Must be pressurized for accurate reading
  - Supplies hydraulic fluid to:

    - **Left EDP**
    - **AUX Pump**
    - **PTU**

  - **L Hydraulic Quantity Low**: < 1.98 gallons
- Majority of aircraft hydraulic functions:
  
  - **Landing gear**
  
  - **Brakes**
    
  - **Flaps**

  - Mid spoiler panels

  - **Main door**

  - **Nose wheel steering**

  - **Left thrust reverser**

  - **Flight controls**
R Hydraulic System

- Independent and isolated from Left Hydraulic System

To Hydraulically-powered Systems
- Total capacity: 14.59 gallons
- Smallest reservoir: 2.77 gallons
- Considered full at: 1.5 gallons

- Three (3) filters (electronically monitored via CMC)
  - Two (2) non-bypassable
  - One (1) bypassable

- Powered by the Right Engine-driven pump (EDP)
  - Mounted on engine gearbox
  - Constant pressure, variable volume pump
  - Pressurizes fluid to 3,000 ± 300 Psi
  - Flow rate varies based on power setting
  - Failure of EDP results in loss of:
    1. Right thrust reverser
    2. Inboard and outboard spoiler panels (285 KCAS/M0.90 maximum)
- **Offload Feature:**

  - Automatically controlled by **Electronic Engine Controller (ECC)**
  - Reduces pump outlet pressure in flight when engine drops below idle (< 55% N₂)
  - Reduces drag on engine to maximize airstart capability

- **Smallest Reservoir:**

  - Considered full at 1.5 gallons
  - Must be pressurized for accurate reading
  - Supplies hydraulic fluid to:

    - Right EDP
    - PTU
    - **R Hydraulic Quantity Low**: < 0.80 gallons
- Actuates the following aircraft hydraulic functions:

  - **Brakes**
    
  - **Flight Controls**
    
  - **Inboard/Outboard panels**
    
  - **Right Thrust Reverser**
Auxiliary (AUX) Hydraulic System

- Supplements the Left Hydraulic System

- Powered by the AUX pump
  - Located in the tail compartment below the left hydraulic reservoir
  - Electrically powered by L ESS DC bus

- Uses Left System fluid

- Operates either automatically or manually

- 3,000 Psi @ two (2) gallons per minute
- **Primary function:**
  
  Hydraulic pressure for utility systems during ground and maintenance activities

- **Landing gear**

- **FLAPS**

- **Nose Wheel Steering**

- **Brakes**

- **Main Door**

- **Secondary function:**
  
  Inflight back up to assist the if necessary
Functions on the **Ground**:

1. **Auto Latch Feature (ASC 902)**
   - Low hydraulic pressure
   - **Wow Ground** and brake pedal application

2. **Maintenance Operations (Gear swing while the aircraft is on jacks)**
3. **Exterior pre-flight inspection (opening/closing of gear doors)**

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**Diagram:**

- Inboard Accumulator
  - < 1,500 Psi
  - PSI x 1000
  - -4
  - -3
  - -2
  - -1

- Aux Pump
  - Off/Arm
  - On

- Aux Hyd Pump On
Auto Operation In Flight:

Normally inactive in flight but will power **ON** automatically for the operation of landing gear and flaps.

1. **Dual Engine Failure**

   ![Diagram of L-R Engine Fail]

   

2. **Dual Engine-driven Pump Failure**

   ![Diagram of L-R Hyd System Fail]

   

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*g650_hydraulic_system*
- Requirements for AUTO ON operation:
  
  - AUX pump ARMED
  - AUX pump not overloaded/overheated
  - Left system pressure < 1,500 Psi
  - Left system fluid available and not hot
    (> 0.36 gallons and < 107°C)
  - Flaps or gear position does not match handle position > 100 KCAS

- After the flaps or gear reaches its selected position, the AUX pump switches itself **OFF**
- **Operation Limitations:**

  - In flight when the AUX pump has been manually selected ON it will go OFF after two (2) minutes of operation. The timer can be reset by turning the AUX pump OFF then back ON.

  - There are no time limitations on the ground.

- **Two (2) Filters (electronically monitored via CMC)**
  - One (1) on the pump itself
  - One (1) on the left hyd system manifold

[Hydraulic Filter Maint Req’d]
Power Transfer Unit (PTU)

- Back up to the left hydraulic system engine-driven pump (operational redundancy)

- The [PTU] is a motor/pump assembly

The motor is driven by right system pressurized fluid. The pump is driven by the motor and its job is to pressurize left system fluid.

- It comes on automatically if left hydraulic system pressure is < 2,400 psi
- It cannot actuate:
  - Left Thrust Reverser
  - Flight Controls and Mid spoilers

- The PTU cannot operate without:
  - L Hydraulic System fluid
  - R Hydraulic System fluid and pressure

- The PTU is prevented from coming on automatically if:
  - L Hyd Sys < 0.36 g
  - R Hyd Sys > 107°C
  - < 2,850 psi
• Operates either automatically or manually

• **3,000** Psi @ 22 gallons per minute

• Helps retract the landing gear following a failure of the left engine after takeoff (regulatory requirement)

  PTU = “Pick Tires Up”

• IT uses:
  1. Right system pressurized fluid, and
  2. Left system fluid

• IT can actuate:

  **Landing gear**

  ![Landing gear diagram]

  **Flaps**

  ![Flaps diagram]

  **Nose Wheel Steering**

  ![Nose wheel steering diagram]

  **Brakes**

  ![Brakes diagram]

  **Main Door**

  ![Main door diagram]
• The PTU is located in the tail compartment.

• When armed it has a seven (7) second debounce. This means that it will run at least seven (7) seconds to prevent intermittent operation with fluctuating left system pressure.

Deactivation:

▷ Seven (7) seconds after left system pressure recovers ≥ 2,750 Psi

▷ Immediately if right system pressure drops < 2,849 Psi
- One Bearing Wear Indicator (BWI)
- Inspected for condition (flushed versus extended) during the Exterior Preflight Inspection

IT CAN BE RESET BY THE CREW
(AFM 02-01-20 Exterior Preflight Inspection)

If extended:

1. Reset BWI
2. Make an entry in the Techlog
3. Continued operation is permitted for fifty (50) hours
The hydraulic shutoff valves are located in the tail compartment and isolate the hydraulic fluid from the engine-driven pumps.

The hydraulic shutoff valves are motor-operated and energized only when the engine fire handles in the cockpit are pulled up.
• Pulling the **LEFT FIRE HANDLE** does **not** shut off the supply of **LEFT SYSTEM** fluid to the **PTU**.
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.
Hydraulic System Quantities/Pressures

- Total capacity: 19.38 gallons
- Largest reservoir: 4.55 gallons
- Considered full at: 3 gallons

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**L and R Hyd Syst Pump output**
- 25-37 gallons per minute (idle - takeoff)
- 3,000 Psi ± 300

**AUX Hyd Syst Pump output**
- 2 gallons per minute
- 3,000 Psi ± 300

**PTU Hyd Syst Pump output**
- 22 gallons per minute
- 3,000 Psi ± 300/-400

**L and R Hyd Syst Accumulator Precharge**
- 1,200 Psi @ 70°F
Questions, comments or errors...please send me an email: ivan.luciani@gmail.com

Thank you!