G650 Hydraulic System
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) Aux Hyd Pump Sub-systems

Power Transfer Unit (PTU)
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 case of engine fire or failure

Fire handles

Pump: To pressurize the system
- Engine-driven pump
- Located in the engines’ accessory gearbox section
- 3,000 psi (+ 300)
**Filter Manifold**: To filter hydraulic fluid and control direction of flow

- Located in the tail compartment

  - L Hyd Sys (6) filters
  - R Hyd Sys (3) filters

**Hyd fluid to fuel heat exchanger**: To cool hydraulic fluid (and warm up fuel)

- Located in the on-side fuel hopper

**Accumulator**: To absorb fluid 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

- Total capacity of **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

- Majority of functions

- Everything the R Hydraulic System does, except:
  1. R thrust reverser
  2. Inboard/outboard spoilers
  3. Outboard brakes

- Left engine-driven hydraulic pump *
  - Constant pressure (3,000 psi) variable volume
    * Off loads in flight as the engine spools down (<55 % RPM) during an engine shutdown

- L Hydraulic System failure: **285 KCAS/M 0.90** due surface failure
R Hydraulic System

- Total capacity of 14.59 gallons
- Smallest reservoir - 2.37 gallons
  considered full at 1.5 gallons

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

- Right engine-driven hydraulic pump

  constant pressure (3,000 psi) variable volume

  * Off loads in flight as the engine spools down (<55 \% RPM) during an engine shutdown

- R Hydraulic System failure: 285 KCAS / M0.90
  due surface failure

- R Hydraulic System solely powers:
  - Right engine thrust reverser
  - PTU motor
Auxiliary (AUX) Hydraulic Pump

- Supplements the L Hydraulic System
- Operates either automatically or manually

- The pump is powered by the R Batt bus

When AC power is available the TR mode of the battery chargers can sustain AUX pump operation without draining the L MAIN BATT and R MAIN BATT

- The pump is located in the tail compartment

- Two (2) gallons/minute @ 3,000 psi (Slow)
- Two (2) filters (Electronically monitored via CMC), one (1) on the pump itself and one (1) on the L Hyd manifold

Hydraulic Filter Maint Req'd

Functions on the GROUND:

1. Auto latch feature (ASC 902):
   - brake pedal application and low hydraulic pressure

WOW GROUND and brake pedal application

- Inboard Accumulator
  - < 1,500 PSI

AUX PUMP
  - OFF/ARM ON

2. Maintenance Operations (gear ops while on jacks)
3. Exterior Preflight Inspection: gear doors opening/closing
Functions in the **Air**:  

1. Normally **inactive in flight but will automatically power on** if:  
   - [Diagram of hydraulic system]
   - $< 1500$ **Psi**  
   - **WOW Air** Mode or speed above **100 KCAS**  
   - Flap handle or gear has been positioned

* **Provided:**  
  - $> 0.36$ **g**  
  - $< 107^\circ$C

* After flaps or gear reaches its selected position, **aux pump automatically switches itself OFF**

2. **Inflight when the aux pump has been manually selected ON** it will go OFF after two (2) minutes of operation to preserve the batteries.
Power Transfer Unit (PTU)

- **Backup** to the **L** Hydraulic System's Engine-driven Hydraulic Pump (Operational Redundancy)
- **PTU** = Motor/pump assembly
- Operates either automatically or manually
- Comes ON automatically if **L** Hydraulic System pressure is < 2,400 psi

PWR XFR UNIT
OFF/ARM ON

- Driven by **R** Hydraulic System pressure and uses **L** Hydraulic System fluid

- **L** Hydraulic System fluid
- **R** Hydraulic System fluid and pressure

PTU

Pump

Hydraulically-actuated Systems
- The **PTU** powers everything the **L** Hydraulic System powers, except:
  - **L** Thrust Reverser
  - Flight controls
  - Mid spoilers

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

- The **PTU** is located in the tail compartment

- Can be selected on manually

- 22 gallons/minute at 3,000 psi ± 300/-400
- The **[Diagram]** is prevented from coming **ON** automatically if:

- **L Hyd Sys** $< 0.36$ g

- **R Hyd Sys** $> 107\, ^\circ C$

- **PWR XFR UNIT** $< 2,850$ Psi

- Helps retract the landing gear following left engine failure after $V_1$ (regulatory purpose)

  - **P** Pick
  - **T** Tires
  - **U** Up

- When armed it has a **7-second debounce**. This means that it will run at least 4 seconds to prevent intermittent PTU operation with fluctuating L hydraulic pressure.
- Pulling the **Left Fire Handle** does not shut off the supply of **L** Hydraulic System fluid to the **PTU**.

![Diagram of hydraulic system]

- **L Engine Fire**

- **Pulled up**

- **L Hyd Sys**

- **R Hyd Sys**

- **Hydraulic Shutoff Valve closes**

- **PTU**
- One (1) Bearing Wear Indicator (BWI)

- Inspected for condition (flushed versus extended) during the Exterior Preflight Inspection

  \[
  \text{flushed} \checkmark \hspace{1cm} \text{extended} \times
  \]

  CAN BE RESET BY THE CREW

  (AFM 02-01-20 Exterior Preflight Inspection)

  \[
  \text{PTU Manifold}
  \]

  If extended:

  1. Reset BWI
  2. Make an entry in the Techlog
  3. Continued operation is permitted for 50 hours
Hydraulic Shutoff Valves

1. **Fire Handles**

2. Diagram showing L Hyd Sys and R Hyd Sys connected by Hydraulic Shutoff Valves.

3. The Hydraulic shutoff valves are located in the tail compartment and isolate the hydraulic fluid from the engine-driven pumps. The valves are motor operated and energized only when the fire handles in the cockpit are pulled up.
Hydraulic fluid to fuel \textbf{HEAT exchanger}

\textbf{HEAT EXCHANGER UNITS} \textbf{ARE LOCATED INSIDE THE ON-SIDE fuel hopper}

\textbf{HOT} hydraulic fluid flows \underline{continuously} through the \underline{HEAT EXCHANGER} and is cooled while \underline{COLD} fuel in the hopper is warmed up

No pilot input
<table>
<thead>
<tr>
<th>System</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>L Hyd System</td>
<td>19.38 gallons</td>
</tr>
<tr>
<td>L Hyd Reservoir</td>
<td>4.55 gallons</td>
</tr>
<tr>
<td>- Considered</td>
<td>3.0 gallons</td>
</tr>
<tr>
<td>R Hyd System</td>
<td>14.59 gallons</td>
</tr>
<tr>
<td>R Hyd Reservoir</td>
<td>2.77 gallons</td>
</tr>
<tr>
<td>- Considered</td>
<td>1.5 gallons</td>
</tr>
<tr>
<td>L and R Hyd Sys</td>
<td>25 - 37 gallons/minute</td>
</tr>
<tr>
<td>- Pump output</td>
<td>Idle to takeoff</td>
</tr>
<tr>
<td>- Pressure</td>
<td>3,000 psi ± 300</td>
</tr>
<tr>
<td>AUX Hyd System</td>
<td>2 gallons/minute</td>
</tr>
<tr>
<td>- Pump output</td>
<td>3,000 psi ± 300</td>
</tr>
<tr>
<td>PTU Hyd System</td>
<td>27 gallons/minute</td>
</tr>
<tr>
<td>- Pump output</td>
<td>3,000 psi ± 300/± 100</td>
</tr>
<tr>
<td>L and R Hyd Sys Accumulator Precharge</td>
<td>1,200 psi @ 70°F</td>
</tr>
</tbody>
</table>
The failure of either engine will result in:

1. Loss of an engine-driven Hydraulic pump (EDP)

2. If the left engine fails, the Power Transfer Unit (PTU) will take over the duties of the inoperative EDP as soon as hydraulic system pressure drops below 2400 psi.
The following components will be lost:

- Redundant hydraulic power to flight controls
- Left thrust reverser
- Mid spoiler panel

3. If the right engine fails the R Hyd System will be unavailable and the following components will be lost:

- Redundant hydraulic power to flight controls
- Right thrust reverser
- Inboard spoiler panel (outboard spoiler panel OK)
- Parking brake - outboard

Limitations:

285 KCAS / M 0.90 due surface failure
Questions, comments or errors?

ivan.luciani@gmail.com

Thank you!